Economic analysis of landholder water management under Cap & Pipe the Bores program: case studies in the NSW Great Artesian Basin

Christine Hill, Noel Flavel and Neil Eigeland

54th Annual Conference | February 2010

Australian Agricultural and Resource Economics Society

Abstract

The NSW Cap & Pipe the Bores Program is a jointly funded Commonwealth and State initiative that operates within the Australian Government's Great Artesian Basin Sustainability Initiative (GABSI) framework. The third five-year period of GABSI was due to commence on 1st July 2009.

This economic study of changes in landholder water management under the Cap & Pipe the Bores program was undertaken to inform the development of GABSI phase 3 policy in NSW.

The study consisted of a small number of case studies of farming enterprises across the Great Artesian Basin Groundwater Management Zones of Surat South, Surat East, Surat West, Warrego and Central in NSW. The apparent landholder economic feasibility of the program was dependent on individual farm characteristics as much as location to the bore and geographic location within the GAB.

The NSW Office of Water is a separate office within the Department of Environment, Climate Change and Water

NOW 10_026

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1 Introduction

The NSW Cap & Pipe the Bores Program is a jointly funded initiative that operates within the Australian Government's Great Artesian Basin Sustainability Initiative (GABSI) framework. This economic study was undertaken to inform the development of GABSI phase three in NSW which commenced in mid 2009.

Implementation of the Cap & Pipe the Bores program is affected by landholder participation. Capping free flowing bores and piping water has benefits for landholders as well as the community. State and Commonwealth governments contribute to the implementation costs of the schemes in recognition of the substantial community benefits resulting from reduced water losses and improved regional groundwater pressure.

Implementation of a scheme generally involves capping at least one bore and installing a communal network of pipes through a number of properties to service stock and domestic outlets. While all these works are implemented on private land, benefits accrue to the landholder and the community at large. As the capping of bores is generally under a Trust arrangement which involves the agreement of a number of landholders, the program required the participation of all landholders within a Trust. Non participation by any one of the individual landholders would have prevented the implementation of that particular scheme for that bore. Where landholders could clearly identify their personal benefits and reconcile these with their share of the costs, participation was likely to increase. As the program involves a subsidy to participating landholders, the State and Commonwealth governments also have an interest in the benefits of the Program.

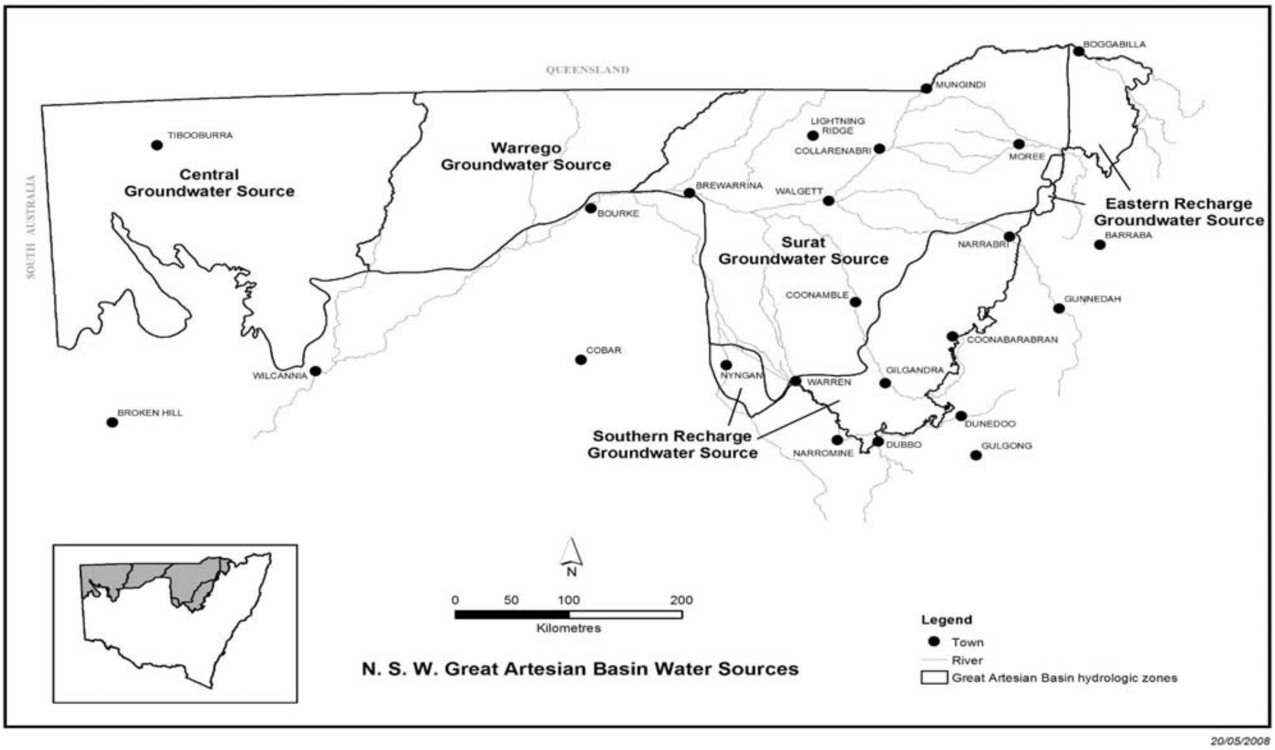
Table 1 Cost of GABSI Phase 2 2004-2009

cost	**expenditure over 5 years of GABSI phase 2** **$**
NSW State Government	15,600,000
Commonwealth Government	15,600,000
total	31,200,000

*Source NSW Office of Water

Following a literature review of economic studies relating to the Great Artesian Basin (Hill 2008) a small number of case studies were undertaken of farming enterprises throughout the NSW Great Artesian Basin (GAB). The aim of the study was to identify the economic benefits and costs of the Cap & Pipe the Bores program for landholders and for the State and Commonwealth Governments in the context of reviewing the GAB Sustainability Initiative (GABSI) operations and policies.

Figure 1 Great Artesian Basin NSW



Source NSW Office of Water

The Great Artesian Basin is a large underground water resource providing for the establishment of a pastoral industry and sustainability of rural communities in NSW, Queensland, Northern Territory and South Australia. It underlies 22% of Australia (DNR, 2006) and 207,000 million square kilometres in NSW. Flows from bores and artesian pressure have been declining over the last 100 years. Where flowing bores deliver water to bore drains much water is wasted through evaporation and seepage.

Ongoing issues within the GAB are (Hill 2008);

- declining groundwater pressures and bores ceasing to flow and springs drying up,
- wastage of water through uncapped bores and open drain systems,
- negative impacts on land sustainability and conservation of biodiversity, and
- potential of groundwater contamination impacts.

The GAB Sustainability Initiative (GABSI) is focussed on bore rehabilitation and replacing open bore drains with piped water systems. Funding is by the Commonwealth and States, with landholder contribution.

2 Literature review

A number of studies have been commissioned over time to assess the impacts of bore management programs. NSW studies assessing the economic benefits of capping and piping bores were undertaken from 1989 (Benson and Chewings 1989) with periodic updates (Christiansen 1991 and Flavel 1994). Queensland also undertook a range of studies and more recently the Commonwealth commissioned a comprehensive review of the program (CIE 2003) in the context of farm costs, presenting a significant listing of case studies.

The later studies were broader in scope (CIE 2003; SKM 2008), addressing current policy, and suggesting ways forward to increase adoption rates as well as including results from significant social studies. The SKM (2008) and Rolfe (2008) studies did not include specific landholder economic assessments, but provided more comment on overall project costs calculated as $ per ML and possible values of ML saved than earlier studies (Hill 2008).

The literature indicates that most studies undertook benefit cost analysis, utilising net present values, discount rates and internal rates of return. These studies addressed private benefits and private costs. Some also assessed benefit cost ratios based on private benefits to project costs. Several earlier studies (Benson and Chewings 1989; Christiansen 1991) included landholder capital borrowing costs in the analysis and calculated property level cash flows.

The range of potential benefits could be extensive. The economic analyses have been reasonably consistent in identifying and quantifying private benefits and costs. Public benefits, such as externalities of changing water pressure to adjacent flowing bores, changes in native and feral animal populations, conservation and biodiversity issues have been acknowledged but not quantified.

The literature reviewed addressed investment analysis for landholders, social perspective and views, economic analysis, and landholder cash flows.

The main issues identified both from landholder and state perspectives under the Cap & Pipe the Bores program were;

- accessibility of water,
- quality of water,
- evaporation/seepage losses,
- water pressure declines,
- weeds and their management,
- water supply maintenance, and
- soil erosion.

The benefits of the program were seen as more frequent water points on participating properties resulting in more even grazing over the properties. Water points enabled efficient stock management and mustering. Some reports indicated that water maintenance requirement were much less under the piped water supply than open bore drains.

Costs incurred were the capital costs of the capping the bores and the water reticulation system and maintenance.

3 Economic analysis

3.1 BACKGROUND

The economic analysis is based on interviews and data obtained from 7 case study farming operations across the NSW Great Artesian Basin (GAB) Management Zones of Surat (Surat South, Surat East and Surat West), Warrego and Central. To ensure respondent confidentiality, particularly given the small sample size, only summarised data are provided.

The case studies and analysis were undertaken on individual farms post implementation of the Cap & Pipe the Bores program. These case studies were identified as fulfilling the requirements of having undertaken capping and piping, willingness to provide quality data and having the time to discuss the implications of the project to their enterprises as well as availability to be interviewed, and their varied geographic locations.

The data obtained from the case studies were used to calculate net present values, and benefit cost ratios for the private costs and for total project costs. The study results highlight the variability in pre and post Cap & Pipe the Bores program farming operations.

The purpose of the economic analysis was to obtain indicative data across the NSW GAB that provided information on the:

- Economic feasibility of farmer participation in the Cap & Pipe the Bores program;
- Extent of the impact of the Cap & Pipe the Bores program subsidy in the economic feasibility to the farmer;
- Contribution of the Cap & Pipe the Bores program subsidy as an incentive to farmer participation; and
- Consistency with similar studies under GABSI.

This economic analysis section outlines the methodology in data gathering, the assumptions applied to the economic analysis and results of the case studies. The final section discusses the implications of the economic analysis for the program participants.

These 7 case studies are of properties within 6 cap and pipe schemes. There are a variable number of other properties in each scheme that are not included in this study. Each scheme would have differing BCR measures as do the different properties within any scheme.

3.2 BENEFITS

The quantified benefits of the program were calculated as;

- avoided labour required to provide water to stock,
- avoided labour to maintain water supplies,
- avoided mustering costs in terms of labour and vehicles,
- avoided chemical costs and time incurred in spraying for weeds.
- avoided stock losses through water supply interruption or bogging in drains
- increases in carrying capacity, if any.

The unquantified benefits were;

- reliable water supplies for stock,
- clean water supplies for households,
- enterprise management options for landholders,
- increased bore pressures positively affecting mound springs,
- environmental impacts,
- changes in property values.

3.3 COSTS

The quantified costs of participating in the program were calculated as:

- For landholders;
  - capital contribution for capping the bores and piping water,
  - additional troughs and tanks,
  - water supply maintenance costs,
  - trust costs.
- For the state and commonwealth governments;
  - the cost of subsidies to landholders for capital contribution for capping the bores and piping water.

3.4 ASSUMPTIONS

A number of assumptions were applied in the economic analysis to maintain consistency across the geographic areas and with earlier studies:

- The discount rate applied was 7% (NSW Treasury 2007). In the sensitivity analysis the Commonwealth discount rate of 6% was used as well as 4% and 10%;
- The timeframe of the study was 30 years;
- A sensitivity analysis was undertaken for discount rates and key variables, such as labour, machinery costs and timeframe;
- The data were calculated based on capital costs incurred in year 1 and benefits ongoing to year 30; and
- Some dollar values, i.e. for labour were provided by the respondents. Other data used were based on the then NSW Department of Primary Industry Gross Margin Handbooks, industry standards and local knowledge.

3.5 DATA GATHERING

3.5.1 Interview procedure

The intention of the case study approach was to personally interview a selection of farmers who had already participated in the NSW Cap & Pipe the Bores program, either as individuals or as part of a bore trust. Supporting information was provided by then Department of Water and Energy (DWE) Cap & Pipe the Bores officers. The case study approach was used because resources were insufficient to gather data from a larger number of farmers, and already substantial studies and reviews had been undertaken (CIE 2003).

Initially several person to person interviews took place in February 2008 but ongoing flooding in the north of the State presented a challenge that was overcome by three-way telephone interviews with each of the remaining farmers, the Cap & Pipe the Bores field officer and the interviewer. Both methods have their advantages but in this case all interviews were extensive and valuable in gaining an understanding of the social impact of the program. In all cases a Cap & Pipe the Bores field officer was present, which enabled in- depth and knowledgeable discussions. As well, the farmers had previously been provided with a copy of the questionnaire, so they had a good idea of the direction of the discussions.

The 7 farms were located across the NSW GAB area, including the Surat (South, East, and West), Warrego and Central GAB Management zones. The enterprises varied from all cropping to part cropping/part grazing to all grazing.

All interviewed farmers had undertaken capping and piping within the last 7 years.

In general, the farmers interviewed;

- were pleased to have spent money on the project,
- considered it worthwhile in terms of the farm business,
- consistently mentioned the benefits of less stress on themselves in managing with reliable water for stock, and
- along with their families, enjoyed the amenity of clean water for the house.

3.5.2 Questionnaire

The questionnaire was based on earlier questionnaires (Hill 2008 and CIE 2003) to establish some continuity of data and responses. Basically the questionnaire identified and quantified the difference in the farm operation and for the farmers' management between the previous flowing bore and open drain water supply management system and the current capped bore and piped water supply management (utilising tanks and troughs) in terms of;

- owner labour,
- hired labour,
- vehicle costs,
- machinery costs,
- weed maintenance,
- mustering costs, and
- stock changes.

4 Results

4.1 CASE STUDY BENEFITS AND COSTS

The benefits to the farmers of the capped bore and piped water supply system were high in terms of decreased labour, machinery and vehicle costs as no longer did drains need to be cleared, delved, and checked. Piping the water to tanks and troughs now requires trough cleaning and checking which is mostly undertaken while routinely checking stock.

The cleaner water under the Cap & Pipe the Bores system meant reduced costs in time and chemicals for spraying. Mustering stock changed from using extensive air and vehicle resources to now using trap yards near troughs, reducing labour and aircraft costs.

The unquantified benefits of the Cap & Pipe the Bores system were clean water for the house and reduced stress for farmers and their families. For others, the removal of the drains and reliable water supply gave the farming business more enterprise management options and in one case the property had expanded its cropping operations and completely replaced grazing. The farmers recognised the change in land value for a property with piped water. One farmer indicated that now he would not consider purchasing a property without a piped water supply system.

Other unquantified benefits of the Cap & Pipe the Bores program on a broad scale include increased bore pressure, reduced pumping costs, and more reliable water to mound springs and wetlands.

The results highlight the variability of enterprises. Farm 3 was notable in that the bore water had been supplied via a natural drainage system which did not require delving, instead of a man made channel. This has a great impact on the analysis as there were minimal costs associated with the natural drainage delivery system and consequently minimal savings as the creek bed remains after piping.

In Farm 7, the farming operation changed significantly post capping and piping the bore although no doubt the landholder has every expectation that these changes would have created a net positive result. The data provided for Farm 7 does not reflect the capital costs incurred in the change, nor the broader benefits of the change in enterprise.

The findings support earlier work which identified the extent of variability between schemes and even within schemes.

Benefits and costs were calculated over 30 yrs at a discount rate of 7%, providing present values for comparison over time. The net present value (NPV) for each farm was calculated i.e. present values (discounted value) of benefits less the discounted value of costs. The benefit cost ratio (BCR), reported in this study, is the PV of benefits divided by the PV of costs. The following tables indicate the range of BCR based on the data, interpreted in several ways to reflect private economic returns to the farmer, and overall economic returns to the project.

In the following tables a range of benefit cost ratios are shown for the 7 farms interviewed. The calculations are;

- *Present value of private benefits*; The PV of private benefits is the sum of the benefits to the landholder from shifting from bore drains to capping the bore and piping water. (discounted over 30 years at 7%).
- *Present value of private operational costs*; The PV of private operation costs is the sum of costs incurred by the landholder in operating the current capped bore and piping system (discounted over 30 years at 7%). This does not include the capital contribution by the landholder of the Cap & Pipe the Bores scheme.
- *The net present value* (NPV) is the difference between discounted benefits and discounted costs. For economic feasibility of quantified benefits and costs the NPV needs to be positive.
- *The benefit cost ratio* is the discounted present value of benefits divided by the discounted present value of costs. For economic feasibility the BCR should be greater than 1.

Benefit cost ratios, shown in the following tables, were calculated based on landholder private benefits and;

- Landholder operating costs (Operating BCR - Table 2).
- Landholder operating costs and landholder capital contribution to the Cap & Pipe the Bores program (Landholder BCR - Table 3).
- Landholder operating costs, landholder capital cost and Government subsidy under the Cap & Pipe the Bores program (Program BCR - Table 4).

Quantifying the value of the public benefit of the Cap & Pipe the Bores program was not in the scope of this study.

The following three sections review the various BCRs for the farming enterprise case studies.

4.1.1 Private operating environment

Table 2 Landholder Operating Benefit Cost Ratio (BCR) for Present Value private benefits and Present Value private operating costs

	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6	Farm 7
Operating BCR	8.1	4.7	0.9	10.5	51.8	19.7	3.5

The Operating BCR in Table 2 provides a clear indication of the direct discounted value of benefits to the landholder of the changed water supply system within the farm enterprise before and after capping and piping. It also highlights the impact on net benefits of particular farming operations and the need for individual farming enterprises to assess the benefits applicable to their own situation.

The BCR ranges from 0.9 to 51.8 - a clear indicator of the spread of impacts on the farming business. Farm 3 had originally few bore drain costs with no delving due to use of natural drainage lines for water delivery; therefore the avoided costs, or benefits of changing to piping, were less than for other farms. Farm 5 had high stock losses and water management costs in operating with the bore drains as well as high mustering costs, which are now less with troughs. They also increased their cropping enterprise.

Table 2 indicates that the farms in the case study (except Farm 3) benefited in their day to day management costs from the shift in water supply to the piped water system. Some farms, such as the Farm 5 enterprise, showed substantial operating benefits from participating in the project.

The net present values in the private operating environment ranged from minus $11,000 to $850,000 over 30 years.

4.1.2 Private economic environment

However, the capital cost of Cap & Pipe the Bores implementation is not included in the above farm operating BCRs. When the capital cost to the landholder is calculated, as shown in Table 3, the BCRs decline. The extent of the decrease is dependent on the capital cost component and subsidy level encountered by each farm.

Table 3 Landholder Benefit Cost Ratio (BCR) for Present Value private benefits and Present Value private costs (including subsidised capital cost of Capping and Piping)

	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6	Farm 7
Landholder BCR	3.5	1.3	0.7	2.1	7.2	3.4	0.4

The Landholder BCR reflects the benefits and costs to the landholder in participating in the Cap & Pipe the Bores scheme. The lower BCRs in Table 3, (compared to Table 2) ranging from 0.4-7.2, show the impact of the capital cost incurred by the landholder in the overall economic feasibility of the program to the landholder. However, while the subsidised Cap & Pipe the Bores program is still advantageous to all the landholders in the case study, Farms 3 and 7 have costs exceeding benefits. The large drop in BCR from Operating BCR to Landholder BCR for Farm 7 reflects the relative high cost of capping and piping for the landholder. The situation is further compounded with a move to cropping meaning that the livestock benefits (saved costs) are unrealised while cropping investment costs remain unaccounted.

To keep the benefit cost ratios in perspective, Farm 3 would only need its unquantified benefits of more reliable and clean water supply due to capping and piping the bores to equal $4,300 annually for the BCR to break even and equal one. Likewise, Farm 7 would need its currently unquantified benefits to equal an annual amount of $4,800 for the BCR to break even. The net present values in the private economic environment ranged from minus $60,000 to $750,000 over 30 years.

4.1.3 Community environment

Table 4 Program Benefit Cost Ratio (BCR) for Present Value private benefits and Present Value total costs of Capping and Piping

	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6	Farm 7
Program BCR	2.0	0.8	0.3	0.8	2.9	2.1	0.2

The Program BCRs in Table 4 reflect the overall perspective and not necessarily from the participant landholder perspective as it includes the state and commonwealth government investment in the program. Including the total capital cost of the Cap & Pipe the Bores program without quantifying the public benefits results in even lower BCRs for the case studies.

In Table 4, the inclusion of the total capital cost of capping and piping (i.e. the capital cost of the landholder and the subsidy by the government) indicates that for four enterprises the BCR would fall below 1. Without some subsidy the capital investment would appear unattractive to the landholder based on quantifying the benefits in terms of reduced farm costs. Here the private unquantified benefits, such as reduced stress and reliable water supplies, could be sufficient, if quantified, to bring the BCR to 1 and confirm the economic feasibility of the project. The public benefits of protection of the groundwater resource and related environmental issues with the free flowing bores and open drains, together with private welfare benefits, if quantified, could be sufficient for the BCRs to equal at least one in all these case studies.

For the BCRs of Farms 2, 3, 4 and 7 to break even and equal 1, the annual unquantified private and public benefits would need to equal $2,900, $19,000, $7,000 and $10,300 respectively. The net present values in the public environment ranged from minus $240,000 to $570,000 over 30 years.

The following table reviews the subsidy levels provided to the case study enterprises.

Table 5 Level of subsidy to landholder as a percentage of total capital cost

	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6	Farm 7
Subsidy/total capital cost (%)	56%	46%	82%	68%	63%	44%	44%

The level of subsidy to each landholder, calculated as a percentage of total capital cost of the program to each landholder, is shown in Table 5 – varying from 44% to 82%. This includes the subsidy for capping of the bore and the subsidy for piping the water. Clearly the subsidy has been a generous incentive for some landholders, although each landholder has still been required to provide capital as well. The dollar value of the subsidies for these case studies varied from $25,000 to $250,000 per property. The landholder capital investment incurred ranged from $19,000 to $115,000 per property.

The results indicated that in some circumstances the subsidy could be reduced, and quite substantially, but in other circumstances would need to be increased to achieve economic feasibility for the landholder.

4.2 SENSITIVITY ANALYSIS

Key variables in the economic analysis were varied to determine their significance in the overall benefit cost ratios. The discount rate was varied, as were labour, machinery and stock values.

4.2.1 Discount rate

The above tables and calculations were based on a discount rate of 7% per annum. Changing this to the Commonwealth rate of 6% had little impact on the program benefit cost ratios, which are shown in table 6. Further discount rate changes in the sensitivity analysis using discount rates of 4 % and 10% are also shown in the following table but had little overall impact.

Table 6 Program Benefit Cost Ratio (BCR) for Present Value private benefits and Present Value total costs of Capping and piping with various discount rates

Discount rate	Farm 1 Program BCR	Farm 2 Program BCR	Farm 3 Program BCR	Farm 4 Program BCR	Farm 5 Program BCR	Farm 6 Program BCR	Farm 7 Program BCR
4%	2.5	1.0	0.4	1.0	3.9	2.7	0.3
6%	2.2	0.8	0.3	0.8	3.2	2.3	0.3
7%	**2.0**	**0.8**	**0.3**	**0.8**	**2.9**	**2.1**	**0.2**
10%	1.7	0.6	0.3	0.6	2.3	1.7	0.2

Note that rounding data to one decimal place does not reflect smaller changes in the ratios.

4.2.2 Other variables

A number of other key variables pertinent to the landholder and farming enterprises were changed in value to identify the level of impact on the landholder BCR results. In the following table are shown the Landholder BCRs where labour rates, machinery costs and stock values are changed.

The value for labour was both increased and decreased for the sensitivity analysis. There are a number of views on the appropriate valuation of farm labour for the functions performed. The value of the tasks as implied by the minimum skill required, would establish a low valuation. On the other hand, it is recognised that this work is actually carried out, in most cases, by the owner/manager. However, there is also an argument that valuing the labour time in terms of alternative returns (for example, watching cricket) could result in a very low dollar value. Reducing the value of labour certainly reduced the benefits as measured by the avoided costs incurred in managing the open bore drain system. Increasing the value of labour affected both the benefits and costs of the piped system. With only a marginal change for Farm 3, increasing labour value had a significant impact on the economic feasibility of the other case studies, and even increased the BCR of Farm 7 to over 1.

Livestock valuation requires analysis as the value of stock losses that are attributed to the bore drains existence has been questioned by several of the respondents. One position is that the livestock were not worth anything as they were in very poor condition thus unable to escape from the bore drain mud. Reducing stock values only had a marginal impact on Farm 3 but greater impacts on Farms 5 and 6.

The apparent little effect of the sensitivity analysis on the BCR for Farm 3 is a function of the balance in enterprise and labour costs between the previous bore drain water supply system and the current water supply system for that farm.

The valuation of tractor and vehicle costs requires sensitivity analysis as the appropriateness of the value used depends upon the primary reason for the tractor/vehicle being part of the farm resources. If the tractor/vehicle exists for other reasons then it is appropriate to use a marginal cost for their applications to the bore drain/piped system. If the tractor/vehicle is available primarily to deal with the bore drain/piped system then a value including capital is appropriate. Here the study assumes marginal costs for tractors, vehicles (including quad runners) and fuel. The analysis of tractor/vehicle cost sensitivity indicates that response is small, with Farm 1 being the most responsive.

Table 7 Impact of changes in key variables on Landholder (LH) BCR

	Farm 1 BCR	Farm 2 BCR	Farm 3 BCR	Farm 4 BCR	Farm 5 BCR	Farm 6 BCR	Farm 7 BCR
Landholder BCR	3.5	1.3	0.7	2.1	7.2	3.4	0.4
labour rate doubled to average $50/hr	4.5	2.1	0.7	2.9	10.1	4.3	0.7
labour rate increased to $100/hr	6.1	2.8	0.7	4.2	16.2	6.4	1.4
labour cost reduced $5/hr***	2.5	0.3	0.7	1.0	4.5	2.7	0.2
DSE and cattle value halved	n.a	n.a	0.6	n.a.	5.8	2.8	n.a.
DSE and cattle value=0	n.a.	n.a.	0.5	n.a.	4.5	2.1	n.a.
Tractor, vehicle, fuel costs doubled	4.3	1.3	0.6	2.0	7.4	4.4	0.4

n.a: not applicable as these farms did not indicate mortalities or did not have stock

Note that rounding data to one decimal place does not reflect smaller changes in the ratios.

The sensitivity analysis indicated that different farms were responsive to different changes in key input data. Certainly quadrupling the labour rate increased the BCR for all farms except Farm 3. Valuing labour at $0 reduced the BCR to below 1 for farm 2 and halved the BCR for Farm 4. The reason for the increase in BCR for an increase in labour cost is that the labour cost was used to value the avoided time spent by landholders in managing their water supply after the capping and piping. As mentioned earlier, Farm 3 had originally few bore drain costs with no delving due to use of natural drainage lines for water delivery. Therefore the avoided costs, or benefits of changing to piping, were less than for other farms. Similarly for the increase in tractor and vehicle costs, the avoided costs of participating in the program are reflected here in the BCRs.

4.2.3 Investment timeline

The length of the investment period of 30 years is reasonable considering the longevity of the capital infrastructure involved in the Cap & Pipe the Bores program. In fact, investment in such infrastructure could well be requiring a benefit cost study of 50 years. However, some landholders may view this investment as an optional technology upgrade, that is, an operating cost, implying an investment horizon that is much shorter, where even 10 years could appear too long.

The nature of the investment timetable, with costs incurred up front and benefits enjoyed over time, means that the longer timeframe results in a higher benefit cost ratio and the shorter timeframe results in a lower benefit cost ratio.

The following tables outline the changes in benefit cost ratios using different timeframes.

Table 8 Impact of investment timeframe changes Landholder (LH) BCR

timeframe	Farm 1 LH BCR	Farm 2 LH BCR	Farm 3 LH BCR	Farm 4 LH BCR	Farm 5 LH BCR	Farm 6 LH BCR	Farm 7 LH BCR
10 years	2.4	0.8	0.6	1.3	4.3	2.1	0.2
30 years	3.5	1.3	0.7	2.1	7.2	3.4	0.4
50 years	3.7	1.4	0.7	2.3	7.9	3.7	0.4

Table 9 Impact of investment timeframe changes Program BCR

timeframe	Farm 1 Program BCR	Farm 2 Program BCR	Farm 3 Program BCR	Farm 4 Program BCR	Farm 5 Program BCR	Farm 6 Program BCR	Farm 7 Program BCR
10 years	1.3	0.5	0.2	0.4	1.7	1.2	0.1
30 years	2.0	0.8	0.3	0.8	2.9	2.1	0.2
50 years	2.2	0.8	0.4	0.8	3.2	2.3	0.3

The results indicate the variable and often marginal impact of timeframe change on the benefit cost ratios for both landholders and the program. This analysis presented has not included a residual value of assets that would clearly exist at the end of the period, (particularly in 10 years) which would increase the benefit cost ratios. It has also not included the cost of some asset replacement or major maintenance (i.e. pumps) over the longer 50 year timeframe, which would lower the benefit cost ratios.

5 Summary and Discussion

This study reviewed the economic costs and benefits in terms of water management of the Cap & Pipe the Bores program in NSW for landholders and for the program. Case studies included seven farming enterprises across the Great Artesian Basin Management Zones of Surat South, Surat East, Surat West, Warrego and Central in NSW. The case studies had already invested in capping the bores and piping water for a range of agricultural enterprises including grazing sheep, cattle and cropping.

Discounted economic benefits and costs over 30 years were generated. Two Landholder BCRs and the Program BCRs were calculated. Benefit cost ratios varied between case studies and the apparent landholder economic feasibility of the program was dependent on individual farm characteristics as much as location to the bore and geographic location within the GAB. The rate of subsidy received by landholders was applied consistently between farms in any particular scheme but the subsidies differed between Management Zones.

The results are consistent with earlier comprehensive studies in identifying the main costs and benefits of the Cap and Pipe the Bores program. Based on these case studies and relevant literature there are significant advantages to landholders in considering their own unique circumstances and participating in the program. Even where immediate economic returns are not realised, the benefits of enterprise flexibility and change in land value, among other unpriced benefits, were well recognised by respondents in this study and influenced their participation in the scheme.

The study highlights the variability in landholder circumstances and enterprise operations which significantly influence the apparent landholder economic feasibility as expressed through the two Landholder BCRs, compared with the Cap & Pipe the Bores program expressed in the Program BCR. The Operating benefit cost ratios varied considerably, indicating the underlying uniqueness of each farming enterprise and the impact of water management on its economics. The Landholder benefit cost ratios indicated the impact that capital investment in water management could have on a farming enterprise. These two measures influence landholder participation. The Program benefit cost ratios indicated the magnitude of annual unquantified benefits required for the public and private benefits to at least equal the public and private costs. This ratio drives State and Australian Government participation.

The results indicated that in some circumstances the subsidy could be reduced, and quite substantially, but in other circumstances would need to be increased to achieve economic feasibility for the landholder. It should be noted that only some of the private benefits have been enumerated, while some private benefits and all public benefits remain unquantified in the analysis. If these private benefits and public benefits had been quantified and included in this study, the benefit cost ratios would be higher. Changing the investment planning horizon to approximate the landholders' financial planning horizon was evaluated by reducing the study timeframe, from 30 years to 10 years. The results indicated a variable and often marginal impact of timeframe change on the benefit cost ratios for both landholders and the program.

These results indicate the economic benefits of the change in water management and supply to 7 case studies, which form a small sample of farming enterprises in the NSW Great Artesian Basin. They highlight the variability of farming enterprises and circumstances as well as the impacts of water management in an historical context on current water supply options and viability. The policy implications from this study include the difficulty in setting suitable subsidies given the variations in geography, circumstances, prior management and future management options for each landholder. The study concentrated on water management changes and did not reflect in detail the impacts (and benefits and costs) of changed enterprise inputs and outputs (for example, the complete shift on one farm from grazing to cropping).

Many of the benefits of a piped water supply lie in the opportunity for landholders to manage their properties and resources in a different manner. Extension of water supplies further through the properties enables more opportunities for variation in stocking rates and rotations. These are some of the benefits of property planning where landholders can take advantage of a new water supply regime and capitalise on the investment in water supply by increasing returns through improving and changing their management. Certainly this small sample of landholders highlighted the availability of a variety of enterprise and management options of post Cap and Pipe the Bores program participation.

Further exploration and research into maximising landholder uptake would benefit the progress of the Cap and Pipe the Bores program, which has experienced delays in implementation in several significant trust areas. Variables on which to focus could include; the change in property values post capping and piping; increased marketability of piped properties; the social benefits of reduced household stress due to reliable water supplies; and the private benefits to landholders of enterprise and management flexibility. Of considerable interest is the extent of change in the management of land and consequent impacts on biodiversity and environmental conditions post Cap and Pipe the Bores program.

6 References

Benson R, Chewings R (1989) Benefits and Costs of Piping Tunda Bore NSW Agriculture and Fisheries, Dubbo.

Christiansen G. (1991) Piping the Milroy Bore A Benefit-Cost Analysis, Soil Conservation Service of NSW, Tamworth.

CIE (2003) Farm costs, benefits and risks from bore capping and piping in the GAB Consultants report for Commonwealth Department of Agriculture, Fisheries and Forestry, by The Centre of International Economics, Australia.

Crisp, R., Kellaway, J., Madden, J. and Batterham, R. (1994) An investment analysis of replacing bore drains by a polypipe water reticulation system in the Border Rivers Region, Department of Agricultural Economics University of Sydney, Sydney.

DNR (2006) Great Artesian Basin Sustainability Initiative Cap & Pipe the Bores, Department of Natural Resources.

DPI (2008) Gross Margins http://www.dpi.nsw.gov.au accessed 26/5/08

Flavel, N. (1994) Milroy Bore Piping Benefit-Cost Analysis revisited Economic Notes, Department of Conservation and Land Management, Tamworth.

GABCC (1998) Great Artesian Basin Resource Study Summary Great Artesian Basin Consultative Committee.

Hill C. M (2008) Economic Analysis of the GAB Cap and Pipe the Bores Program – A Literature Review, Draft NSW Department of Water and Energy, Water Management Division

Hill C M and Flavel N (2008) Cap and Pipe the Bores in NSW- Economic analysis- Case Studies in the Great Artesian Basin, Environmental Evaluation and Performance, Water Management Division, NSW Dept of Water and Energy.

NSW Treasury (2007) NSW Government Guidelines for Economic Appraisal NSW, NSW Treasury.

Rolfe, J. (2008) Associated Off-Farm Economic Values of Saving Water and Restoring Pressure in the Great Artesian Basin Report provided to the Australian Department of the Environment, Water, Heritage and the Arts R&Z Consulting.

Schirmer, J. and Baker, R. (2007) Great Artesian Basin Sustainability Initiative Extension Activities Review report for the Australian Dept of Environment and Water Resources.

SKM (2008) Great Artesian Basin Sustainability Initiative - Mid term review of Phase 2 report for the Australian Govt Dept of the environment and Water Resources.

Weber, J., Weber, D., and Brake, L. (2000) The Social Value of Artificial Wetlands to Pastoralists in the South Australian Portion of the Great Artesian Basin

7 Appendix 1

Photograph 1 Trenching for Piping in Northern NSW

Source NSW Office of Water

Photograph 2 Uncapped bore in Northern NSW with water flowing into drains

Source NSW Office of Water

Photograph 3 Capping bore in Northern NSW

Source NSW Office of Water

Photograph 4 Open Bore Drain Northern NSW

Source NSW Office of Water