CSIRO LAND and WATER

Improving the Catchment through Market Based Instruments.

Freshwater Beach Catchment, NSW

Darla Hatton MacDonald

Policy and Economic Research Unit

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Cover Photographs:
Freshwater Beach on a Fine Day
Photograph by Darla Hatton MacDonald

Stormwater Draining out, Freshwater Beach
Photograph by Aarvon Roberts

Executive Summary

In a perfect world, there would be perfect compliance with the environmental guidelines. The reality is that people are often unaware of the full damage of small individual actions or fail to take the necessary steps to mitigate the effects of these actions. Alternatively, if there was a system of perfect monitoring and enforcement of optimally designed council by-laws and development controls, the catchment and coastal ecosystem would not suffer. However, perfect monitoring and enforcement is costly. Information programs are often not as effective as hoped. Market Based Instruments or MBIs represent a pragmatic approach to achieving desired environmental outcomes. The performance of MBIs will depend quite heavily on effective regulation and monitoring procedures. There are certain standards that many in society would suggest need to be embodied in regulation.

There are a number of instruments that can be potentially employed and these instruments fit roughly in two categories of **creating new markets/investment opportunities** or **changing the effective price of the good** associated with the environmental outcome. In this paper, six potential MBIs are discussed that have potential for improving environmental outcomes including:

- Taxing pollutants,
- Environmental levies with rebates,
- Penalties,
- Subsidies,
- Information and
- Offsets

Managing the urban water cycle may require a review of water pricing. Pricing each litre of water, according to its full cost, including the environmental cost, would send conservation signals to business and households. For example, if the price of water reflects the environmental costs, strict financial cost-benefit ratios on water conservation may support the installation of rainwater tanks. The uptake of water saving devices still may be slower than the socially desirable timetable in which case subsidies and rebates may be required in order to reach target levels. In the case of broken sewage pipes on private property, penalties may need to be put in place that encourage owners to fix the breaks.

Increasing standards need not stifle development. There is considerable potential to use offsets to allow new developments to proceed while ensuring that a net improvement for the environment occurs. Fixing broken sewerage pipes is going to require a fair bit of monitoring and enforcement to achieve any high degree of compliance. This may need to be weighed up against using some sort of penalty structure designed to increase compliance.

The coastal environment is an important recreational asset for Sydney as well as a functioning ecosystem. Increasing the amenity values associated with Freshwater Beach will require a commitment to getting the incentives right but it need not pose result in massive public expenditures or onerous conditions that shuts down new development.

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1 Introduction

Managing an urban catchment requires careful consideration not only of the issue of water use, sewerage systems but also of stormwater systems. Often the problems of stormwater and sewerage systems are considered in isolation. This paper reviews a series of market based strategies for reducing sewage, for managing stormwater and preventing the mixing of sewage and stormwater as part of an integrated approach using stormwater as the starting point. This paper is part of a broader initiative undertaken by CSIRO Urban Water Program to look at improving the water cycle in an urban setting. Freshwater Beach Catchment in the Sydney Metropolitan area has been selected as a case study for this initiative.

A market based strategy goes beyond the traditional approach of governments to use regulation, education and suasion to achieve environmental outcomes. A market based instrument (MBI) uses markets to change behaviour of consumers and businesses to the benefit of the environment. An MBI can include a wide array of tools such as fees, rebates and subsidies, through to green offsets and the creation of new markets. Many of the ideas relating to MBIs come from the recent policy innovations in natural resource management but not all the instruments will be appropriate for an urban catchment. Thus, it is useful to focus on a specific example in order to summarise the potential application of MBIs to urban water problems.

Since the Freshwater Beach Catchment is a built-up urban area, the opportunities are different than with a greenfield development where water recycling and a wetland might be planned from the outset.[1] In a built-up area, options are a bit more limited as the infrastructure is already in place and the houses have been built. Solutions will often involve replacing or adding-on to existing structures. If solutions are to be voluntary in nature, it is necessary to understand community preferences and to align potential products and/or technological solutions accordingly.

1.1 The Catchment

Freshwater Beach provides recreational opportunities for Sydney residents. Following a storm, however, there are health risks associated with swimming in the area for a few days after. As well, the algae growth occurring on the rocks immediately past the stormwater drains is marring the aesthetic quality of the beach. Aesthetic qualities aside, the stormwater may be nutrient rich which has potential implications for the marine environment.

The catchment was chosen because it is well defined, built-up urban area with all the associated issues of existing infrastructure. While there are characteristics and issues that are specific and unique to the catchment,

[1] For instance, with the Mawson Lakes project in South Australia, all lots were sold with the requirement that the house be connected to both the potable and recycled water system (Marks and Eddleston 2000).

many of the strategies examined will be transferable to other urban catchments.

Freshwater Beach Catchment is on the northern coast of Sydney in the suburb of Harbord under the Warringah Council (see Figure 1 and 2). The catchment is 1.125 km² in size and largely developed, consisting of built-up residential areas (three storey walk-ups and single family dwellings), some small businesses located in a couple of strips and a couple of community centres (Diggers RSL, Diggers Youth Club (Waves), the Freshwater Surf Life Saving Club, etc). As there is limited undeveloped land available, any future population growth is likely to be accommodated by an increase in the housing density.

The community has only a few main thoroughfares running through it and as a result the community has a cohesive feel to it. The existence of a sewage treatment plant directly across from the beach and the controversy surrounding that plant's operation has made the community very sensitive to issues surrounding sewage and stormwater management.

Figure 1: Location of Freshwater beach in Sydney from (2002)

Figure 1: Aerial photo of Freshwater beach catchment from (2002)

1.2 Stormwater

Stormwater run-off presents a challenge for management of urban catchments because of the nature of diffuse-source pollution problems. Stormwater pollutants can include larger objects such as litter and rubbish. Stormwater run-off can also include the less visible sources such as soil sediments, oil and grease from cars, garden waste, residual chemicals and animal faeces. Collectively, these sources of pollution can increase the number of unsafe swimming days, result in fish kills and have overall negative effects on the coastal ecosystems.

Stormwater quality is not monitored closely at this point for the Freshwater Beach catchment. It is known that there are a number of sewerage pipe leaks from Sydney Water mains and leaks occurring with pipes on private property. Sewage overflows are a problem.

There are three broad strategies for managing stormwater and stormwater pollution that include:

- reducing pollutants that might be picked up by stormwater,
- capturing stormwater and purifying according to potential use, or
- putting in place an end of pipe solution.

Reducing pollutants, in particular, will require more detailed knowledge of the sources of these pollutants. At present, little monitoring is occurring. Tailoring technological solutions will require more detailed knowledge of the source of problems beyond what is known about sewage and stormwater mixing.

There are numerous ways to capture stormwater including rainwater tanks, neighbourhood collection tanks, grass swales, infiltration systems, detention basins/retention basins, Atlantis systems, etc. These collection systems can incorporate various degrees of filtration and purification. Potentially stormwater could be stored for future use such as irrigation with aquifer storage and recharge (Dillon, *et al* 1997).[2]

There are a few "end of pipe" solutions which might also be considered. For instance, treatment facilities might be used to treat the early flows of stormwater which contain highest concentration of pollutants. Alternatively, there appear to be a few suitable locations for constructing wetlands to filter the stormwater.

In general, the technical solutions that involve capturing rainwater lend themselves quite well to the use MBIs. As information is gathered concerning the sources of pollution, it may be possible to target the pollutants specifically. End of pipe solutions are fairly major projects and are most likely to be undertaken by on behalf of an entity such as large developer or utility.

[2] A hydrogeological investigation would be required if this approach was deemed worthwhile.

1.3 Sewage Systems

Sewage for the catchment is treated at the North Head Sewage Treatment Plant which is across the bay from Freshwater Beach. This plant treats sewage for the lower NSOOS servicing plan. As in most urban catchments, the total amount of sewage from the catchment and the region could be reduced and thereby reduce the potential for sewage leaks.

During heavy rainfall, sewer overflows can and do occur. Due to the low permeability of the Hawkesbury sandstone underlying the catchment area and cracks in the sewer pipes, the sewer system can be become overloaded with stormwater that has seeped in. The sewer system is connected to the stormwater system at three points in the catchment. In the event of an overflow, stormwater, mixed with untreated sewage, flows into the ocean.

Reducing sewage related pollution would need to include repairs and/or relining sewerage system pipes. As the responsibility for house service lines lies with the property owners, the problem of getting owners to detect and fix leaks is a difficult one.

1.4 Why Use Market Based Instruments?

In a perfect world, there would be perfect compliance with the Environment Protection Authority's guidelines for industry, business, new development and the community concerning stormwater. The reality is that people are often unaware of the full damage of small individual actions or fail to take the necessary steps to mitigate the effects of actions. Alternatively, if there was a system of perfect monitoring and enforcement of optimally designed council by-laws and development controls, the catchment and coastal ecosystem would not suffer. However, perfect monitoring and enforcement is costly. Information programs are often not as effective as hoped.

MBIs represent a pragmatic approach to achieving the desired environmental outcomes. The performance of MBIs will depend quite heavily on effective regulation and monitoring procedures. MBIs will be complementary in nature and cannot replace regulation. There are certain standards that many in society would suggest need to be embodied in regulation.

This paper is intended to provide a summary of series of market-based approaches to improve the management of an urban catchment. The idea is to provide a means of moving catchment management forward from its present position of command and control to a model which mixes regulation with MBIs. A system of regulation, information and market-based instruments can be used simultaneously to protect and improve the ecosystem. When introducing market-based instruments, safe minimum standards need to be in place and monitoring needs to continue to ensure no back-sliding is allowed to occur.

2 Potential Set of Market Based Instruments

MBIs are an evolving area of research and there are examples of practical implementation in Australia. There are a number of instruments that can be potentially employed and these instruments fit roughly in two categories of **creating new markets/investment opportunities** or **changing the effective price of the good** associated with the environmental outcome. In creating new markets or investment opportunities, the rules have been changed in some way that businesses and households begin to look for opportunities to invest in ways associated with the environmental outcome. Changing effective prices can involve raising the price of a good by:

- imposing a tax or levy,
- lowering the price through subsidies and rebates or
- lowering the cost of making choices through the provision of information.

2.1 Creating Markets and Quasi-Markets

An interesting question for natural resource managers to consider is "Why is stormwater not valuable? Why is it allowed to run out to the ocean?" Part of the answer continues to lie in the artificially low price of reticulated water. However, there may also be uncertainty in the property rights structure surrounding stormwater that results in firms being unable to capitalise on the opportunities that stormwater presents. To put in place capital works to use stormwater requires a large degree of certainty over who owns the water - the Crown, Sydney Water, households or the firm who puts in place capital works at the end of the pipe? An example may help to clarify the issues. A firm may wish to put in place a filtration process to return stormwater to a state suitable for non-domestic purposes. Before putting in place a sizable investment, the firm may want guaranteed access to stormwater as this is an area of risk for the firm. For instance, if rainwater tanks become quite popular, the end of pipe volumes could be significantly reduced.

The issue for society is whether firms or households are most likely to collect and put to use the large volumes of stormwater. The next question is what the total cost of achieving the various solutions. Should there be a couple of large investments to collect a thousand ML of water or should there be numerous smaller investments made by households collecting a few hundred kL each? The property rights structure can be altered to encourage either approach.

Extending this line of thinking brings us to the area of what might be called quasi-markets. An example that will be explored later in this report is the idea of offsets where the regulatory agency requires that there be no net increase in environmental damage. In this scenario, all new developments must have an environmentally neutral impact or be offset. This results in developers looking for low cost opportunities or the creation of a quasi-market to offset any net impact of their proposed development.[3]

2.2 Water Pricing and Changing Effective Prices

At present, the price of water in Australia and in most other developed countries is kept relatively low (OECD, 1999). This creates problems for the feasibility of using water sources implementing technically feasible technologies for household and/or industrial water use. Hatton MacDonald, Young and Connor (2001) support the continued use of the two tier pricing structure for reticulated water where there is a small fixed charge and a volumetric charge. However, under their scheme the volumetric charge would reflect the full social cost of each additional kL of water. From an environmental perspective, a higher charge per kL would be desirable, as it would encourage conservation or increase the appeal of using water from supplementary sources of water such as rainwater tanks.

Pricing water to reflect the full cost including the environmental costs to society would be a positive step in solving a number of issues within rural or urban catchments in Australia. The full cost of water would reflect the marginal costs of operating the system and the marginal cost to the environment of the water being extracted from rivers and aquifers and later returned to catchments and coastal areas. Theoretically the best approach to incorporating external costs in the price of water is to charge each user the cost of the damage they generate. The point of this is to give water users, especially those who generate the largest external costs, price signals that align their personal interest with social objectives of reducing water use and/or switching to alternative water sources. Thus even if individual charges based on damages is not practical or feasible, environmental taxes or levies which move prices in the right direction will provide the right signals. Alternatively subsidies and rebates can encourage the uptake of technologies/devices that have better net effects on the environment.

Information and education can also be framed as a MBI in the sense that gathering information about products and devices is costly in terms of time and effort. Thus if information is provided at critical points in the decision making process then information campaigns can be effective.

3 Practical Applications for Reducing Stormwater and Sewage Leak Related Pollution

The potential suite of market based tools fall into two broad categories:

- tools which change the framework or context in which businesses and households make decisions (such as water pricing) or
- tools which are designed to target particular choices or actions.

[3] Alternatively in a regional setting, there is the potential for creating markets for pollution through load based licensing, see Young (1999). Firms could trade these licences.

The optimal solution likely involves a mix of tools. This section will outline applications of how MBIs might be applied to specific problems in the catchment.

3.1 Taxing Pollutants

One of the most economically efficient ways to reduce stormwater pollution would be to tax pollutants according to the marginal damage that occurs with each. In using a product or engaging in a practice, the consumer receives a clear economic signal. This necessarily assumes a fair level of knowledge concerning the source of pollutants, the damage that occurs with each and the ability to cost-out the damage. For some pollutants such as sediments and garden debris, the ability to tack on this environmental cost would be difficult. For other pollutants such as those relating to cars, the environmental tax would need to implemented on a larger geographic basis and require the Commonwealth or State government to implement the tax.[4]

3.2 Environmental Levies with Rebates

If taxing pollutants or altering the pricing structure of reticulated water is too slow and difficult a process to contemplate, an alternative is for the Warringah Council to introduce an environmental levy based on the third party impacts or externalities associated with sewage leaks and stormwater run-off. The externalities associated with the stormwater pollution include the damage to the coastal ecosystem, the loss of swimming days and amenity values.

In the environmental economics literature, there are fairly well developed techniques for estimating the cost of environmental damage to society. For instance, the loss of swimming days and amenity values associated with stormwater run-off could be estimated by considering the willingness to pay for fixing sewage leaks. Alternatively the use value of the beach areas could be estimated by considering the trade-offs and choices of recreationists as part of a travel cost model of beach use. These estimates of amenity values would form the basis of an environmental levy.

The environmental levy could represent a payment that has to be made to those who opt to go no further than current required practices, guidelines, etc. The levy, by itself, does not provide households and businesses with an incentive to change behaviour unless the levy model is altered to allow for a rebate. If a household or firm opts to go beyond current requirements then the levy could be refunded in full or in part based on specific actions taken. Examples of this in Australia include the Onkaparinga catchment in South Australia that refunds the environmental levy on land with native vegetation for property owners who enter into heritage agreements.

[4] In catchments with large industries or new housing estates, Young (1999) suggests a system of load based licences where polluters are allowed to produce a total quantity of pollutants. This system can then be capped and trade in licences can occur.

Environmental Levy with a Rebate

If it is determined that run-off from impervious surfaces is an important issue, an environmental levy could be put in place that represents a measure of the average damage that is occurring (i.e. measures of the loss of swimming days and amenity values due to stormwater runoff). The rebate can be targeted to reward developers who use less concrete and bitumen. To encourage households to redesign their immediate landscape, households that maintain an outdoor environment of less XX% impervious surface would also receive the rebate. The area might be based on self-reported estimates initially and updated over time based on inspections by Warringah Council employees. Thus properties with long driveways or parking areas may opt to reduce this area. The precise structure of the levy would need to be thought through carefully to avoid introducing other unintended effects. For instance, ripping out concrete to be replaced by plants with a high demand for water, fertilisers and pesticides may not leave the catchment ecosystem better off.

3.3 Penalties

Many households in the catchment are likely to have a sewer pipe leak on their property due to the age of the pipes and the havoc that tree roots create. The pipes that are located on private property are the responsibility of the property owner. Sydney Water as part of the SewerFix Program will be making customers aware of any faults discovered and the household will be given a time period to fix the fault. However, unless there is a blockage in a sewerage pipe on their property, households are going to be reluctant to volunteer to fix the problem. This is a classic problem of externalities. Fixing broken sewerage pipes is a cost to the household while the benefits to the marine environment are spread widely across the public. The problem is further exacerbated by the fact that unless everyone is fixing their pipes as well, the problem of leaking sewage is reduced only marginally.

While the responsibility for sewerage pipes lies with the property owner, it may be necessary and worthwhile to design a system which encourages households to detect and fix leaks on a timely basis. The penalty has to be enough to encourage households to fix pipes before SydneyWater detects the break but not so severe as to cause hardship. Otherwise, fixing broken sewerage pipes is going to require a fair bit of monitoring and enforcement to achieve any high degree of compliance.

3.4 Water Conservation and Sewerage Charge Rebates

Reducing the sewage load can be achieved in part by reducing household water use and and/or reclamation of grey water. There are a number of relatively inexpensive items that households can purchase and install that will reduce household water use. The problem lies in getting the attention of households that are time and money constrained. One means is to let households voluntarily sort themselves out and encourage households that most inclined to act to go over and beyond current requirements.

The Five Frogs Concept is an idea that is being floated by CSIRO to State governments, catchment boards and the media.

Five Frog Rating System for Households to Reduce Sewerage Charges

One component of the charges for water usage relates to sewage. This charge does not vary with water usage and acts as a disincentive for conservation and/or reuse. Metering sewage appears to be an expensive option because of the location of pipes, etc. Therefore, an intermediate solution is to base a rebate scheme on the water use and reuse efficiency of the house and gardens. The Five Frog scheme would operate by offering households a rebate on their sewage bill based on their assessed water/sewage efficiency. Households wishing to receive a rebate on their sewage bill would have to pay to have a water efficiency audit conducted on their house.

Under the Five Frog scheme, the water user would have a checklist of items and the corresponding number of points to reach a particular frog rating. The water user is free to choose water conservation items that make the most sense for that household. No frogs might be the current Building Code Requirements and Five Frogs might be the closed loop water efficiency system. For a Five Frog rating, the sewerage charge might be divided by 5 and the household required to pay only 20% of the current charge. All households would be required to pay some base amount because households and businesses receive some benefit from the existence of the sewerage system.

The closest example of such a system is the five-star energy rating system now in use for housing in the ACT under the *Energy Efficiency Ratings (Sale of Premises) Act 1997*. Introduced in 1998, this system classifies each house according to the degree to which it is designed to conserve energy. Essentially, the less glass, the more double glazing, the more insulation, etc., the higher the rating is. No house in the ACT may be sold without first obtaining an energy rating and this rating being drawn to the attention of the purchaser before a contract is signed.

3.5 Subsidies

After identifying products which have the potential to address stormwater pollution problems, the uptake of these products can be encouraged by offering a subsidy to households/firms wishing to participate. For example, if it is determined that rainwater tanks rank high on the priority list and the historical uptake level is low, then it might make sense to use public funds to subside the purchase of rainwater tanks to speed up the adoption. Alternatively, it might be determined that garden clippings and debris is an important source of pollutants, encouraging the use of green gardening companies or subsidising compost bins might be a means of encouraging households to reduce this source of pollution.

Subsidising Rainwater Tanks

Rainwater tank usage in the Sydney area is 1.8% which is considerably lower than the Australian average of 17% ABS (1998).[5] The Institute for Sustainable Future (2000) estimates that the stock of rainwater tanks in Sydney is likely to increase by only 2000 to 3800 tanks per year if the market is left alone. Approximately 4% of households are expected to have tanks by 2005 given present trends.

Rainwater tanks can be used for onsite detention as well as storage for household purposes such as gardening. Rainwater tanks that are not properly cleaned and maintained can present health issues for households. These concerns can be largely alleviated by third party maintenance contracts and/or the use of first flush devices which divert the first flow of water off the roof. These devices prevent the dust, debris and bird droppings from accumulating in the rainwater tank.
http://www.sustainable.com.au/rainwater.html accessed 26/07/02

Households in Sydney report that cost and time constraints are the main barriers to installing rainwater tanks. A significant proportion of households, 11.5%, believed that the tanks were not allowed in their district (Institute for Sustainable Futures 2000) which is interesting given that there are largely no such restrictions.

To achieve a significant increase in tank ownership will probably require an information campaign, to address misconceptions about restrictions, combined with a subsidy. How large the increase in demand for rainwater tanks will depend on the subsidy level and how easy it is for households to access information, make the decision and undertake the purchase and installation.

3.6 Information & Education

Public information campaigns have been an ongoing effort to reduce urban water use in major Australian cities. Research for the Urban Water Program reveals that education programs are not always as successful as one might hope. Translating attitudes into actions is the stumbling block of public information campaigns. For instance, asking households to be water wise by taking shorter showers may not change behaviour significantly over the long term. However, installing a low flow shower head will reduce water use from this source. People are able to change their habits in reaction to a crisis, such as water shortages, but long term changes in behaviour requires feedback, changes in devices and clear market signals.

The problem is to pick priority messages, tailor the incentive and not squander the good will of the public. Research by Bjornlund et al (2001) suggests that a combination of good products, user friendly information

[5] In a study of water supply interruptions, Hatton MacDonald and Young (2002) report that 39% of the sample in Adelaide report having a rainwater tank. This indicates that a much higher ownership rate is possible.

along with a market incentive such as a subsidy is probably one of the better ways to change behaviour.

3.7 Offsets

The NSW government is floating the concept of green offsets as part of a public consultation process http://www.epa.nsw.gov.au/greenoffsets/index.htm. A green offset is an action taken outside a development site that reduces the overall pollution or environmental impacts in a designated area, let's say a catchment. The developer either takes the action, pays others to do it or pays into a fund set aside for offsetting damages.

The offset concept has been used in various forms to combat air and water pollution throughout the world. A well designed offset process should result in a net environmental improvement within the specified geographical area with each new development.

Offsets have the potential to work as an extension of the existing environmental regulations. Increasing the level of monitoring and enforcement of regulations is expensive. Offsets , if targeted correctly, can result in greater improvements for a lower total cost when compared to regulation alone.

Stormwater Offset Example

Let's consider the development of a new apartment block to replace existing housing. The new development would increase the density of the area, paved parking area and the amount of roof surface area compared to the existing residential development. The council identifies that the project has a number of considerations such as soil erosion when earth is being disturbed and an increase in impervious surface area. The council requires the developer to control erosion during construction by using sediment fences and offset the increased run-off from impervious surfaces.

The developer might propose to offset the roof area of the apartment through a combination of onsite and offsite collection. The offset in this case is the offsite collection of stormwater in another part of the catchment. For instance, the developer might opt to do a carpark redevelopment because of site considerations with the apartment block. The viability of this redevelopment has been demonstrated with examples such as the St. Elizabeth Anglican Church carpark. In this project, the carpark, tennis courts and surrounding roof areas were redesigned to allow stormwater to infiltrate, be cleansed via oil/grease arrestor process, and then injected into an aquifer. Stormwater is then retrieved for use in watering church gardens.
http://www.unisa.edu.au/uwrc/church.html accessed 26/07/02

Offsets provide flexibility for developers to find the low-cost, easy opportunities.

4 Discussion of Options and Direction for Further Research

There are a number of opportunities for improving catchment management through market based instruments. The use of environmental levies with rebates and the use of offsets hold considerable potential for built-up urban catchments.

Careful analysis will be required in the next stage to determine:

- the cost to society and the ecosystem of stormwater pollution, i.e., the loss of swimming days, amenity values, marine life, etc.
- whether a series of small-scale or larger end of pipe solutions are required to fix the problem.

If economic criteria are used to decide whether to clean-up stormwater pollution and if so, to what extent, then it will be important to have extensive information on the third party costs of the present situation and the private and public cost of different solutions. Monitoring of stormwater quality may provide answers to the second issue of small-scale versus large-scale solutions.

It may be that an end of pipe solution is an economically efficient and pragmatic approach. As discussed, one potential solution is to divert the early flow of stormwater during an event to the sewer system or a detention basin. The engineering solution for a catchment would require careful study to understand the delay between the beginning of a rainfall event and when the first flow from various locations in the catchment are likely to hit the end of the pipe. If the purpose of this end of pipe solution is to mitigate the effects of a large number of small sources at least cost, it is important not to over-engineer the solution.

With every public choice problem of this sort, there are interesting cost implications that need to be sorted through. There may be some economies of scale with an end of pipe solution but there is the issue of who should pay. The cost of an end of pipe solution will have to be borne by some entity (Sydney Water who charges higher water rates, the State government who raise taxes or cuts expenditure or households and businesses in the catchment through an environmental levy). It is possible that trying to address the problem by encouraging households to act will require less public money but may result in a larger overall expenditure when full private and public costs are fully accounted for.

There are ways to adhere to a polluter pay principle with an end of pipe solution. As suggested above, the end of pipe solution could be paid for through an environmental levy or a green offset fund raised in the catchment. Society will be made better off if the benefits to the marine environment (biodiversity in the coastal ecosystem, the increase in swimming days, etc.) exceed the cost of the works.

It is likely that a mix of instruments and approaches will be required to achieve a significant environmental improvement.

- Getting households to install rainwater tanks voluntarily or voluntarily reduce the amount of impervious material on their property will likely require rebates and subsidies.
- Information campaigns alone are unlikely to convert attitudes into actions given the time and budget constraints of households.
- There is a real need for the right market signals to provide everyone with the incentive to use water carefully. The price of water at present does not reflect the full cost to society and the environment of water use. If the price reflected this full cost, stormwater reclamation would be more attractive.

Increasing standards need not stifle development. There is considerable potential to use offsets to allow new developments to proceed while ensuring that a net improvement for the environment occurs. Fixing broken sewerage pipes is going to require a fair bit of monitoring and enforcement to achieve any high degree of compliance. This may need to be weighed up against using some sort of penalty structure designed to increase compliance.

The coastal environment is an important recreational asset for Sydney as well as a functioning ecosystem. Increasing the amenity values associated with Freshwater Beach will require a commitment to getting the incentives right but it need not pose result in massive public expenditures or onerous conditions that shuts down new development.

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