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The Economic Impact of Water Restrictions on Water-Dependent Business in South East Queensland, Australia

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The Economic Impact of Water Restrictions on Water-Dependent Business in South East Queensland, Australia

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LIST OF ABBREVIATIONS

A	Annus (Latin; meaning: year)
AC	Average costs
AU$	Australian Dollar
BWEP	Business Water Efficiency Program
C	Factors like climate circumstances or technology
COAG	Council of Australian Governments
Ɛ	Elasticity
E.g.	Exempli gratia (Latin; meaning: for example)
Et al.	Et alli (Latin; meaning: and others)
GNP	Gross national product
GRP	Gross regional product
GVA	Gross value added
LGA	Local government authorities
MC	Marginal costs
MJA	Marsden Jacob Associates
ML	Megalitre
MNB	Marginal net benefit
OECD	Organisation for Economic Co-operation and Development
P_w	Price of water
P_i	Prices of other factors of production like capital and labour
P_a	Output prices
Q_w	Quantity of water
QWC	Queensland Water Commission
S	Supply function
SEQ	South East Queensland
W	Water
WEMP	Water-Efficiency Management Plan
WTP	Willingness to pay
X	Quantity of products

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INTRODUCTION

Water is a vital necessity for each creature on this planet. Its subsistence allows life and represents our environment. On earth, water reserves are limited and factors such as economic growth, innovations in transportation of water, growth in population, and climate change influence the original condition of our water resources.

Demand for water is increasing and natural water supply from existing sources is limited. Therefore, water as gets scarcer and societies have to deal with drought periods and imminent water shortfalls.

To understand why decision makers decide on policies like water restrictions, it is necessary to illuminate the market of water. This final thesis begins with a theoretical part, which shows the mismatch between demand and supply on the water market, and illustrates why the water market is out of balance in Chapter 1.

As a result of the failure of the water market, demand management is an important sequence to deal with increasing demand for water as long as supply enhancement is constricted. Therefore, water restriction is one possible demand management tool to reduce consumption of water.

Chapter 2 describes the situation of the water market in South East Queensland and illustrates the development of water restrictions and their effects. Later, the advantages and disadvantages of restrictions are illustrated and discussed in Chapter 3.

This final thesis examines water restrictions on business to discover the reactions and economical effects on businesses. The purpose of this thesis is to answer the following questions: What are the formal institutional arrangements governing demand for water in South East Queensland? How have these arrangements impacted on water-dependent businesses and society's welfare and why have the effects been as they are?

In this final thesis the terminology of business stands for industry and commercial enterprises, apart from agriculture. While industrial water users utilise water for production of services or goods, commercial users consume water for human needs and sanitary accessories on the office premises. These include restaurants, retail or hotels.[1]

In South East Queensland, Australia, water restrictions have been in effect since 2005. This area is highly urbanised and is getting more populated all the time. In South East Queensland, residential and business water usage accounts for approximately 70 %, with agriculture accounting for only 24 %[2] of the total water consumption. The effects on agriculture, caused by water restrictions, are not included in this thesis. Therefore this study focuses primarily on urban water consumption and supply.

In South East Queensland, incisive reforms accomplished and changed the structure of water supply and the area of responsibility of councils only recently, therefore, limited literature is available and sources older than 2007 do not apply anymore. Therefore, a comparison of data and information received from the Queensland Water Commission with other sources was not possible.

In this regard, research has to fill a large gap of knowledge about water restrictions and the resulting economical impacts for this particular area.

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[1] See Young 2005, p. 222.

[2] See Queensland Water Commission 2008 a, p. 77.

1 WATER MARKET

From space, the earth is a blue planet with great wealth in water. However, only 2.5 % of water resources on this blue planet are fresh water reserves. Even if fresh water is renewable by hydrologic cycle, it is also finite as long as the renewable supply decreases as population on earth increases.[3] That is why it must be seen as scarce good.

Water could be categorised as a private or public good with consumptive or non-consumptive uses. Tisdell et al. (2002) define consumptive usage in the following way: “Consumptive uses consist of off-stream extractions and processing that alters the chemical or physical constitution of water. The reduced volume of accessible water of a designated quality level effectively excludes utilisation by other water users.”[4] Opportunity costs emerge from deterioration of water quality by users, hence it increases relative scarcity.

If water usage is not diminishing or impacting the utilisation of other users it is called a non-consumptive use. It includes transportation such as shipping, hydro-electricity, fishing, etc. It is used in situ and provides the environment for culture and aesthetic value.[5]

Water as a private good clarifies that only one can consume the good and no one else can (rivalry)[6] and that with one’s consumption others are excluded from obtaining a benefit out of it (exclusion). For example only consumers can obtain the benefit out of a bottle of water, if they are able and willing to pay the market price for this bottle.[7]

Otherwise, water as a public good is a non-rival good. The consumption of a good by one person allows another person to consume the same unit as well. Moreover public goods can involve externalities (see also Subsection 1.3.1). As soon as property rights are involved, water alters from a public to a private good (see also Subsection 1.3.4). In contrast to property rights such as homes or estates, water rights could be seen as the legal right for usage of water. Hence, property rights of

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[3] See Postel 1999, p. 109.
[4] Tisdell et al. 2002, p. 75.
[5] See Tisdell et al. 2002, p. 74 f.
[6] See Shaw 2005, p. 16.
[7] See McConnell et al. 2008, p. 544.

water do not define the ownership of the volume of water[8] itself but defines how to access water. These water markets with explicit and universally assigned water rights are formal markets. Informal markets have no legal sanction or clear assigned rights.[9]

Since nowadays, water for consumption is mostly allocated by water rights, in developed countries, it cannot be seen exclusively as a public good anymore. Therefore, this thesis discusses that aspect of water which is a private good which is scarce with a consumptive character, depending on the purpose it is used for.

Scarcities in natural resources appeared in advanced economies after men had started to pollute and use environmental assets unsustainably. This leads to an allocation-system of property rights. Obviously, a linkage between environmental problems and economic growth exists. At the existing stage of development, the pressure on economies is increasing. Waste of water, its pollution, climate change and an increase of population sharpen the situation of supply shrinkage and demand enhancement of fresh water. As an advantage, richer developed countries have more money to invest in environmental and -conservation arrangements. Furthermore, the stable politics of developed countries can implement stricter regulations and adopt policies for sustainability.[10]

The rarity of a good is always reflected in the price in liberal markets. Therefore, markets and prices stimulate an economy to minimise the wastage of a scarce good by efficient allocation. It facilitates the development for new technology to advance the efficiency of allocation, for instance through recycling or re-use of water. If the price does not reflect the scarcity of a good and drops below its real costs, consumers tend to use more of this good than would be sustainable.[11] For that reason, it would be important to raise the price so that the real costs are covered. Then economic agents would behave rationally and reduce consumption as much as they are able to.

Since water is indispensable to life and there are no close substitutes, water demand functions are price-inelastic when water is used efficiently.[12] That means

[8] See Shaw 2005, p. 16.
[9] See Qureshi et al. 2009, p. 3 f.
[10] See Beltratti 1996, p. 10 and Booth 1998, p. 2 ff.
[11] See Gimble 1999, p. 78.
[12] See Young 2005, p. 228 and Berrittella et al. 2007, p. 1806.

that a change in price is not affecting the quantity of demand for water in the same dimension. If the price rises for one unit, restriction of demand quantity is less than one unit.[13] Consequently, it is morally unacceptable to raise the price to the extent that some consumers could not afford the market price and would be excluded from consumption. Nevertheless, price elasticity must not always be inelastic. If water is extravagantly consumed and it is easy and inexpensive to decrease water consumption by using water more efficiently, then price-increases would have a larger effect on the quantity of water demand. Hence, water demand functions could tend to be price-elastic as far as expenditures and costs are low enough to easily decrease demanded quantity.[14]

In the following, demand and supply are examined more intensively to understand the imbalance on the market. The status quo of efficiency of allocation of water is elucidated and failures of markets are shown. As a consequence of market failure, demand management strategies and supply enforcement are introduced.

1.1 Demand and supply

To understand the mismatch between supply and demand both sides should first be examined separately.

The main obligations of water suppliers are securing water from surface water or ground water resources, storing raw water in tanks or reservoirs, the treatment of water to maintain a legal quality, water transportation, and distribution to consumers. All these operational steps entail variable costs such as for energy or labour as well as fixed and capital costs for storage capacity, distribution systems, or treatment facilities which includes pipelines, equipments, pumping stations or water tanks.[15] As the amount of delivered water increases, total costs also increase. Derivatives of total costs with respect to water (W) are marginal costs (MC). The marginal cost function is dependent on W and falls with a rising number of deliveries (Figure 1).

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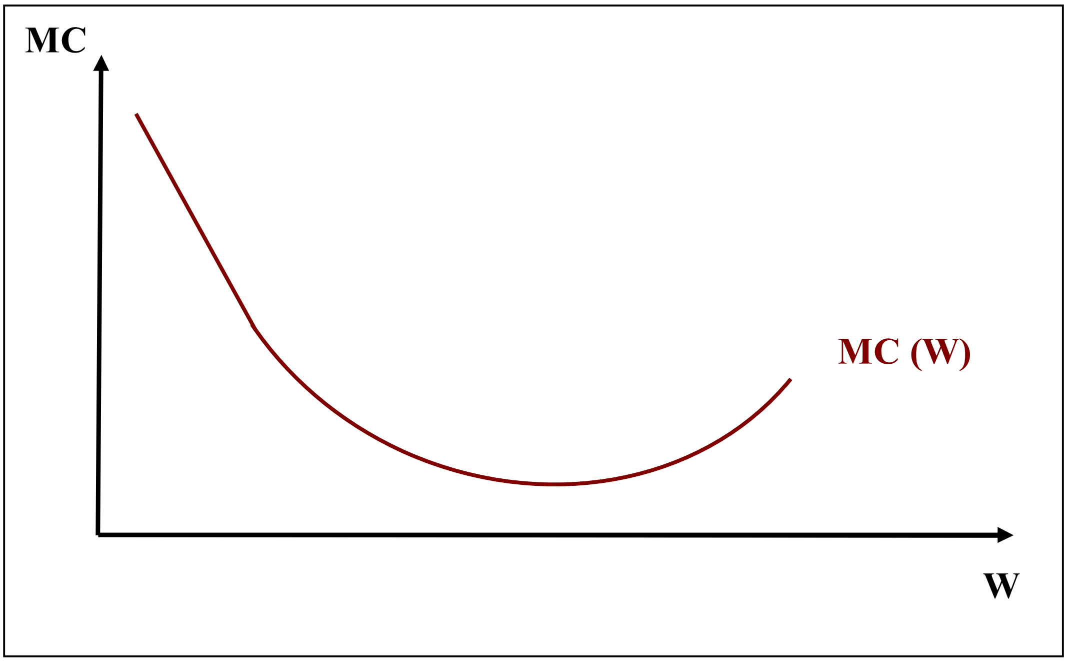
[13] See Griffin 2006, p. 32.
[14] See Pigram 2006, p. 85, Brennan et al. 2007, p. 12 f., and Griffin 2006, p. 312.
[15] See Shaw 2004, p. 103.

In this stage it allows the supplier to utilise more intensively its treatment facilities and experience more the effects of economies of scale. After a certain point, capacity limitations require a more cost-intensive approach and limitations of water resources raise the costs for acquisition.[16] If the acquired amount of water continues to rise, marginal costs will rise simultaneously.

As long as the competition of suppliers on the market is limited, it can be assumed that most of existing suppliers exceed the minimum of marginal costs. Thus, a rising demand entails an increase of marginal costs. If the number of suppliers is not increasing, competition will not get better and marginal costs increase with rising demand.

Figure 1: Marginal costs of water supply



Source: Diagram derived from: Griffin, R.C. (2006): Water Resource Economics: The Analysis of Scarcity, Policies, and Projects, Cambridge, p. 15.

As long as traditional water resources such as surface water or groundwater diminish as a result of climate change in the future, it is not attractive for investors to enter water markets when prices on the market do not increase in the same level as costs for the provision of water increase.

[16] See Griffin 2006, p. 16.

If supply from traditional water resources do not cover the demand for water, more cost-intensive non-traditional alternatives could be a remedy for the supply-demand-mismatch. Non-traditional alternatives are e.g. desalination, recycling, stormwater harvesting, or rainwater tanks. These non-traditional water supplies are more cost-intensive and must result in higher prices for water on the market. Only when costs are covered, investors and competition could increase.[17] Therefore, marginal costs must not increase with rising demand, if more competition is achieved by development of non-traditional water supply and market prices cover the cost of provision of water.

The opposite side of the market is demand for water. The competition for water usage is big. Next to industrial or commercial users, households and agriculture use surface water or groundwater to satisfy needs.[18] Since this final thesis focuses primarily on urban water consumption, municipal business and urban residents play a major role.[19]

From a short-term perspective, demand is highest in summer and lowest in winter, therefore consumed water varies seasonally and is dependent on climatic circumstances such as temperature and rainfall. Long-term variables include e.g. income levels of consumers: the higher the incomes of the consumers are, the higher is the demand for the company's products. As a result, the production is increasing and water consumption of the company rises. Other long-term variables are water usage efficiency, population, climate change, and partly, water prices, if the business is supplied by a public water provider.[20]

Business demand for water is variable. It is utilised for producing steam or electricity, for cooling and transportation, for sanitation, and it is used as an inclusion in the companies' output as in beverage industry.[21]

The availability of data about demand of industry and commercial users is much less than about agricultural or household demand. But scientists found out that the function of business water demand is affected by water prices as well as input

[17] See Hughes et al. 2008, p. 7 f.
[18] See Horbulyk 2005, p. 56.
[19] See Hughes et al. 2008, p. 6.
[20] See Hughes et al. 2008, p. 6.
[21] See Renzetti 1993, p. 181.

(such as for energy) and output prices (for example if market prices are influenced by subsidies).[22] Moreover, the mixture of products, technological features, the production process, and the level of output are variables which influences industrial water demand. The quantity of water (Q_w) withdrawn for business is a function of the price of water (P_w), prices of other factors of production such as capital and labour (embodied in the vector P_i), the quantity of products X, output prices (P_a), and other factors such as climate circumstances or technology (embodied in the vector C).

$Q_w = Q_w(P_w, P_i, P_a, X, C)$[23]

In locations where there is adequate groundwater with good quality, some water users supply and process water by themselves by having their own water source and rights to use the water. Mainly larger companies with a water-intensive production tend to be more self-supplied if regulations do not limit their choice and if it is not possible to negotiate a special price with public suppliers. The choice about quantity of water and source of supply made by a corporation depends on the most cost-saving option. The costs for production of a given level of output should be minimized. Self-suppliers are generally less dependent on market water prices, if they are not metered and charged for the volume of water used.[24] In many cases the usage of water is mostly unmetered and unreported since they pay no market-price for their water. As long as business is not experiencing costs for water usage,[25] the costs are not separable from general expenses of the company by researchers without transparency support of business. For that reason, not many statistically based studies have been done for business demand for water in the past.[26]

Nevertheless, studies found out that price elasticity is dependent on the form of water supply of businesses. Water demand functions are price inelastic when efficiency in water usage is exploited.[27] Generally, publicly supplied companies are more price-elastic than self supplying business because they have larger water

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[22] See Griffin 2006, p. 310.
[23] See Young 2005, p. 225 f.
[24] See Renzetti 1993, p. 182 ff. and Griffin 2006, p. 311.
[25] See Griffin 2006, p. 311.
[26] See Young 2005, p. 226.
[27] See Young 2005, p. 228 and Berrittella et al. 2007, p. 1806.

cost shares. Prices per unit are assumed to be higher; thus publicly supplied companies are more sensitive to price changes on the water market.

When the price for water is set very low on the market or has been unmetered such as for a lot of self-suppliers, an introduction of meters or a relatively small increase in prices for water entails a more price-elastic approach.[28] Waste of water or inefficient used water would be minimised. But water has no close substitute; therefore the elasticity is limited and depends on which function water has in the production process and how efficient the water consumption is.[29]

Residential water use does not necessarily embody their need for water. The minimal amount of water which is needed for basic living is usually exceeded considerably. This disparity differs with the purpose water use, the market prices for water and other factors e.g. supply conditions. For some usage, for instance cleaning the pathway with water, demand for water tends to be more price-elastic, the need for and use of water are not very close. Consumers would clean the pathways with a broom instead of using water when the market price increases (water is substituted by the broom). Demand for water is more price-inelastic when it is used for cooking and substitution is not possible. Here the correlation between use and need for water is closer.[30]

1.2 Efficiency of water-allocation

The ratio of achievement of an economic agent's objective in relation to all consumed resources is defined as efficiency. Hence, efficiency is the ratio between output and inputs.[31] In circumstances of scarcity of natural resources or growing competition of resource-users, economic efficiency is an important factor for societies to avoid conflicts and involve social injustice. In terms of Pareto optimality, economic efficiency would be a situation in which resources are allocated so that no further reallocation is feasible to provide benefits to companies or individuals without penalising others at the same time. Pareto optimality is "achieved

[28] See Renzetti 1993, p. 186.
[29] See Liaw et al. 2006, p. 593 ff., Pigram 2006, p. 85, Brennan et al. 2007, p. 12 f., and Griffin 2006, p. 312.
[30] See Pigram 2006, p. 85.
[31] See Green 2003, p. 39 and 137.

by a society when it is impossible to alter the allocation of resources and make one person better off without making someone else worse off".[32] Or in other words, "the ideal equilibrium that allowed for the optimal allocation of resources occurred when one could no improve the situation of one individual without diminishing the well-being of another individual."[33] This could be only achieved in an economy with perfect competition. When the marginal benefits of usage in goods or services are equal to marginal supplying-costs, Pareto efficiency is achieved.[34]

That means that efficiency is only accomplished, when all users´ marginal net benefits[35] (MNB) are equalized. If the marginal net benefit is not equalised it is always possible to reallocate water from users with low MNB to those with higher MNB. By this transfer the additional received water is valued higher than before and net benefits of the water use increases. When all MNB are equal, this transfer is not possible without lowering net benefits.[36]

This way of allocation between and within industrial users of water is called the allocative efficiency. The term of technical efficiency describes in which way water is used for output-production. Both kinds of efficiency are influencing water productivity[37]. The measurement of water productivity can be taken for a whole nation, a group of users or individually. In the case of individual businesses, water productivity is mostly influenced by technical efficiency factors such as wastage, pollution, evaporation, or technology of production.[38] The value[39] added to water by production of goods or services is higher for industries than for agriculture.[40] For example the Australian mining industry's gross value added (GVA) per

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[32] See Waud et al. 1996, p. 429.
[33] See Baíllargeon et al. 2002, p. 71.
[34] See Young 2005, p. 25 ff.
[35] Marginal net benefits are marginal benefits (demand side) minus marginal costs (supply side) (See Griffin 2006, p. 36), whereas marginal benefit is an increase in total benefit followed from an increase of one unit of a good (See McTaggart et al. 2006, p. 311 f.) and marginal costs are progressive costs for production of one additional unit of a good (See Young 2005, p. 66)
[36] See Tietenberg 1998, p. 144 f.
[37] Water productivity describes which amount of water is used for production of a given output. (See Roberts et al. 2006, p. 59)
[38] See Roberts et al. 2006, p. 59 f.
[39] The value of a good depends on many factors such as willingness to pay or scarcely of a good. As long as agricultural goods are not scarce or subsidized by governments, the gross value added to water by production is less than for industrial goods.
[40] See Young 2005, p. 93 f.

megalitre (ML) of consumed water is more than AU$ 80,000 GVA/ML whereas agriculture's is below AU$ 5,000 GVA/ML. Therefore, reallocation of water between industries and agriculture could advance efficiency of water-allocation with a growth of economic benefits as a result.[41]

To achieve an optimal allocation some basic criteria for allocation on the water market have to be complied with: first, the allocation of already existing water supplies must be flexible and mobile to achieve a certain ability to respond to demographic variations, economical or climatic situations. Second, full resource accounting and the real opportunity costs of providing the resource must be paid by the user. In this way externalities or other water demands are internalised. (See 1.3.1) Third criterion is security of tenure for established users and the assurance of long term use which is essential for efficient allocation. Additionally, the outcome of the allocation procedure must be predictable to minimise uncertainty and costs. Fifth condition of efficient water allocation is equity of the allocation process. That means that no economic agent should be unduly favoured nor unfairly discriminated. Furthermore, political and public acceptability of the allocation process is necessary. Implementation must be unmistakably understood and be transparent by all claimants. It is important that water allocation is reflecting the values of water as a public good since it could not be included in individual market performances.[42]

If these criteria are not maintained, water allocation cannot be optimised. In the following are exposed the most momentous sources of inefficiency and it is clarified why market forces fail.

1.3 Market failures and sources of inefficiency

Only in economies of perfect competition is efficient water allocation under Pareto conditions possible. Given that Pareto-Optimum cannot be accomplished in reality, conditions are existing which lead to market failure and inefficiency. Market mechanisms for allocation of resources fail when demand and supply are not balanced by the market. They are not meeting in equilibrium with the result

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[41] See Roberts et al. 2006, p. 61.

[42] See Ford et al. 2001, p. 10. and Tisdell 2002, p. 91 f.

that market price is set wrong. Reasons for market failure could be found in the nature of water. Water is not a good as others: it is not driven of market forces as they exist for e.g. chocolate or eggs. For this thesis water is seen as a scarce, private good confronted by externalities which appear by the usage of water and a wrong set price on the market.

Next to externalities, false water pricing, transaction costs, an incorrect arrangement of property rights, and the existence of natural monopoly are reasons for market failure and inefficiency; shown in the following.

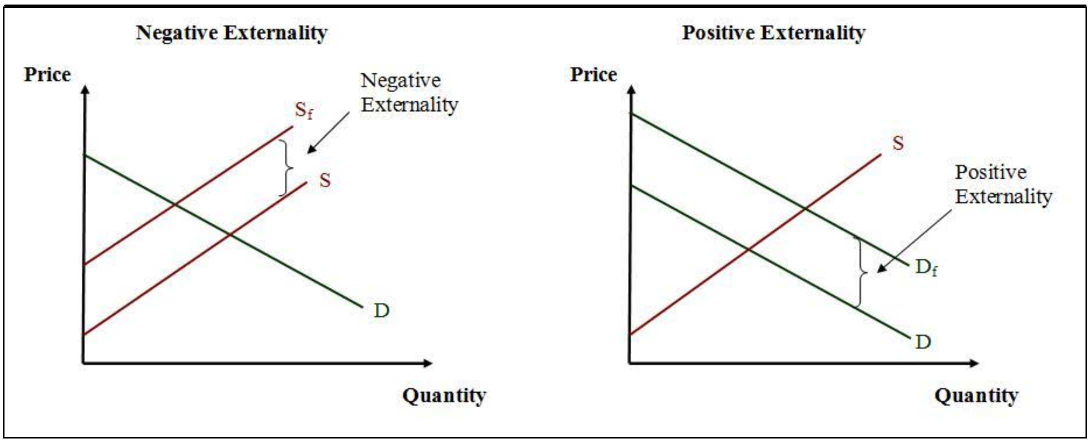
1.3.1 Externalities

Externalities occur when one agent's consumption or supply affects the production output or utility of another agent. External effects can be positive or negative. A beneficial external effect emerges, when the action of an agent raises the utility of an uninvolved agent at the same time. For instance, a positive externality is, if one agent plants trees in his garden and neighbours get the benefit from the natural view and green environment, also when they do not pay for this advantage. In the case of negative externalities, the action of an agent decreases the utility of uninvolved agents.[43] If water is polluted by the usage of one agent, another agent has a disadvantage of this action in which he is not involved.

External diseconomies could be produced by consumption of water or production of other goods. In the case of production, costs for usage of water are not included in the price when water is seen as a free good without apparently limits in availability[44] –as it was seen until the 70s of the last century[45]. Accordingly, external diseconomies are not internalised in costs as those for private costs. Both private and external or incidental costs are social costs. As you can see in Figure 2, externalities affect the allocation of resources negatively. By shifting parts of their costs onto society, producers supply function S - which includes only private costs - does not represent the full social costs as it would be in function S_f. The difference between S and S_f is the externality.[46]

[43] See Lipsey et al. 2004, p. 327.
[44] See Petersen 1993, p. 146.
[45] See Petersen 1988, p. 223.
[46] See McConnell et al. 2008, p. 548.

Figure 2: Positive and negative externalities



Source: Diagram derived from: McConnell et al. (2008): Economics: Principles, Problems, and Policies, McGraw-Hill p. 548.

As you can see, market prices are only reflecting private prices; therefore the market-price is set too low to cover all costs inclusive of external costs (see Sub-section 1.3.2). Market mechanisms fail in this situation.

Analogical, the problem of externalities is the same with consumption of water. In this case costs which accrue to society stay unconsidered and end in environmental damage by polluting the used resource. These parts of social costs which are not given any account by internalisation (see Section 1.4)[47] reflect an overvalued gross national product (GNP) in the society.[48] If an adjustment payment is compensated for the external effect, costs are internalised and have not be borne by society.[49] This should be the goal to reach an efficient allocation of water resources. As a result of externalities, market prices are set wrong and do not show the real scarcity of a good as you can see in the following.

1.3.2 Water pricing

The two components of costs of water are costs of its retrieval including variable and fixed costs as well as its opportunity costs. Opportunity costs occur when a reserve is not renewable and reserve-depletion burdens a cost on usage in future.

[47] See Petersen 1993, p. 146.
[48] See Petersen 1988, p. 222 f.
[49] See Shaw 2005, p. 57.

These real costs are unavoidable and shall be borne by users, taxpayers or next generations.[50]

The charged prices by public companies are too low especially for surface water. A reason for this is that water was a free good in the past on the one hand. This situation changed because of the awareness of scarcity of this resource. But the price did not rise fast enough. Historic costs are lower than potential costs – that is why current costs for water as a private good are too low.

On the other hand pricing includes only average cost to cover costs of running processes. To receive an effective pricing the use of marginal costs would be necessary. That means that consumers would have to pay for supply of the last unit of water. Usage of average costs and ignoring marginal user costs result in wastage of water.[51]

To expand on the previous Subsection 1.3.1 about externalities, water was originally a free good and became scarce because of pollution, climate change or other factors. Therefore, costs resulting from the pollution of water have to be included in the price. If the market price ignores costs arising from pollution, external costs accrue. If these externalities are not internalised, the market only covers private costs. Consequently, the market price for the resource is too low and supply of this resource beyond optimum.[52]

The market price does not present an optimum of water-allocation and demand and supply do not meet in equilibrium at the water market: "As tersely…stated by Myles, 'An externality represents a connection between economic agents which lies outside the price system of the economy. As the level of externality generated is not controlled directly by price, the standard efficiency theorems on market equilibrium cannot be applied' ".[53] Accordingly, market prices do not reflect the real price for water and lead to overconsumption, pollution, and wastage of a scarce resource.

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[50] See Grimble 1999, p. 79.
[51] See Tietenberg 1998, p. 149.
[52] See Petersen 1999, p. 150 f.
[53] Griffin 2006, p. 109.

1.3.3 Transaction costs

In perfectly competitive markets transactions are cost-less or at least fractionally less. That means that rights could be transferred and enforced without practical occurring costs.[54] Transaction costs could be defined as added indirect or direct costs which occur with making transactions. They are considerable in allocation of water because of the inefficiency of water institutions. Different prices and composition depend on regional divergence and could produce difficulties in arranging transactions or lead to market inefficiencies. [55] Transaction costs include costs of search for gratification of unmet demand or for internalisation of external effects[56], by substitute technical work or machinery by labour and time investment[57], as well as costs for public administration, research, and brokerage.[58] Costs for transactions could be so high that a transaction is not taking place because expenses for the collection of information, bargaining, or contracting are higher than the value of the transaction itself. In this case market is failing. Another example is that a policy for internalisation of external effects could exceed the value of the correction itself. The policy would not be conducted because of the high transaction costs.[59]

1.3.4 Property rights

Societies constructed rights on property to legitimate agents to use and consume a scarce good or resource. A property is a benefit stream that is protected by the state and accepted by society. It excludes these agents which are not the proprietor of this right for the property.[60] Historically, water was seen as a free good. But as soon as pollution of water and increasing demand is causing scarcity, this resource is not indefinitely reclaimable.[61] Water rights were bound to real estate in former times. Property rights called "riparian rights" provide legal owners of land to use adjacent water for their needs. In the course of time, people settled in areas where

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[54] See Tisdell 2002, p. 81.
[55] See Shaw 2005, p. 63.
[56] See Tisdell 2002, p. 81.
[57] See Huges et al. 2008, p. 11.
[58] See Shaw 2005, p. 63.
[59] See Griffin 2006, p. 110 f.
[60] See Tisdell 2002, p. 79.
[61] See Horbulyk 2005, p. 59 f.

they had no direct access to surface- or groundwater. Thereby, transportation of water became more important and water rights had to be differently defined. A system of water rights with the need for transferability was invented.[62]

Hence, water rights are rights protected by law which legalise agents to use water. These rights define the volume of water that is allowed to be used. Groundwater is running water with relocation such as surface and sea water.[63] Therefore, it is not possible to clarify a right for a certain unit of water, but for the volume an agent is legalised to use. The allocation of water has been regulated by a system of water rights based on temporal transfers.[64] A distinctiveness of water rights is that it may vanish if the proprietor of the right for a certain volume of water is not able to use it. On the contrary to the good water, if you do not use a good as your own car for some days, it still stays your property right also when you are not using it unless you sell it.

Many states claim the ultimate ownership of water to themselves. In such states agents are able to receive water-rights for a certain volume of water, but cannot do anything with respect to withdrawals. Thus, the states utilise property rights to minimise impacts of externalities by enacting laws about e.g. pollution of water.[65]

In general, property rights can be characterised as completely specified, transferable and enforceable rights with an exclusive disposition. Additionally, water rights needs to be determined and flexible concerning place and time of delivery, the time period of the entitlement, conditions of the transfer of entitlements, and the method of retrieval of water.[66]

One of the reasons why the water market fails is because water rights are not flexible and assigned incorrectly. As long as water is a scarcely good, it must be used in an efficient way and allocated rational to maximise value of uses. In this way economic and environmental outcomes could be improved.[67] Mostly, water is used and allocated inefficiently as you can see looking at the example of Australia. This country is one of the world's biggest net exporters of water used in pro-

[62] See Tietenberg 1998, p. 146.
[63] See Petersen 1999, p. 152.
[64] See Horbulyk 2005, p. 59 f.
[65] See Shaw 2005, p. 16.
[66] See Tisdell 2002, p. 79.
[67] See Roberts et al. 2006, p. 54.

duction (virtual water). Water which is contained in a product is only a proportion of water used in total for the production of a good. Food production is very water intense. Therefore, it is incomprehensible that Australia - as a water-scarce country - is exporting a significant share of their water resources in the form of food and cotton.[68]

Facing the problem that demand for water is rising and supply decreases, water transfer must be efficient. Therefore, it makes sense to reallocate from low to higher valued uses. The price for water is very different depending on the area and use. Often agricultural users are paying much less than urban ones because the government substitutes water for farming.[69] If water would be reallocated from agriculture, the prices would increase for water-intense products without having subsidies and the relative competitive positions of all industries would modify.

Water productivity would gain as well.[70] But to receive these market effects, water rights must be flexible and transferable to the most efficient solution.

1.3.5 Natural monopoly

Typically for water markets is that there is one or only a few utilities existing in one region. When a single supplier can procure water more inexpensively than multiple suppliers, a natural monopoly exists. As mentioned before, a reason for this is the occurring economy of scale. Average costs (AC)[71] decline with increasing production. Although, average costs are always higher than the marginal costs (MC) of supplying an additional unit of water for big water-suppliers (as long as capacity limitations do not require a more cost-intensive approach) as illustrated in Figure 3.[72]

In a situation of natural monopoly the price of water can never cover the average costs and is not able to cover total costs if the price is equal with marginal costs.[73]

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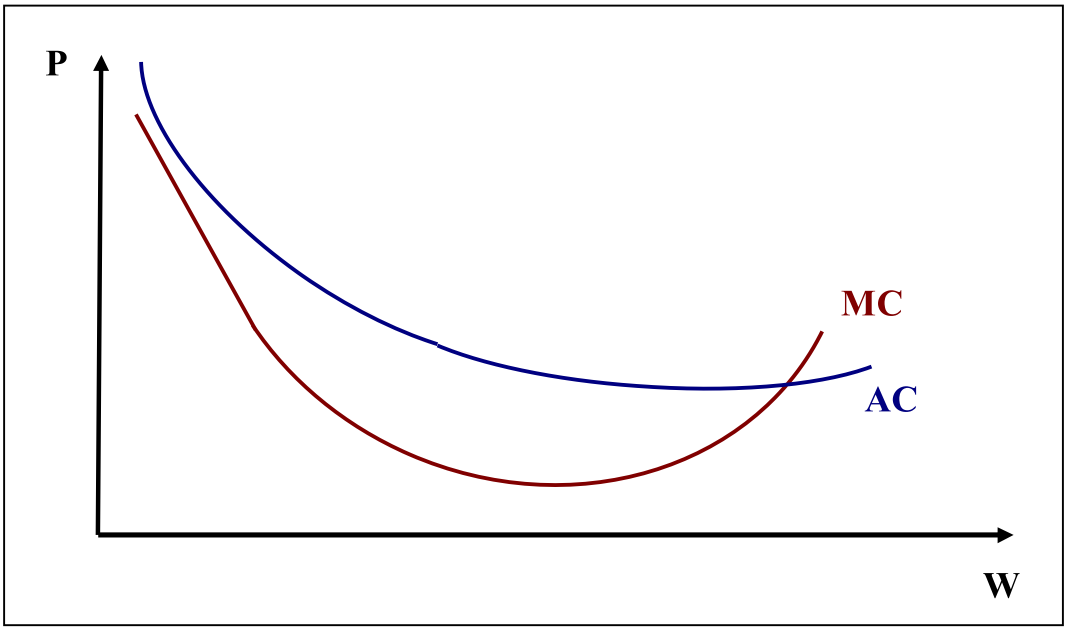
[68] See Berrittella et al. 2007, p. 1800 f.
[69] See Libecap et al. 2005, p. 2.
[70] See Berrittella et al. 2007, p. 1801.
[71] Average costs are total costs devided by the amount of supplied water.
[72] See Griffin 2006, p. 111.
[73] See Shaw 2005, p. 106.

Figure 3: Natural monopoly



Source: Diagram derived from: Griffin, R.C. (2006): Water Resource Economics: The Analysis of Scarcity, Policies, and Projects, Cambridge, p. 112.

Water utilities are mostly regulated when there is a monopoly in a certain area unless it is publicly owned. Excess profits are not typically endorsed by the government.[74] Regulations, inflexibility, and market-prices which cannot cover costs in the existing system shy away private investors to provide water to customers as residents. For that reason water is commonly supplied by only one or a few entities which are fairly often public corporations.[75]

[74] See Tietenberg 1998, p. 153.
[75] See Shaw 2005, p. 107.

1.4 Reaction to market failures

As mentioned in the previous section, the water market is susceptible for failures and inefficiencies. Generally, the problem can only be solved by enhancement of supply, demand management, or reallocation of the resource water. But experts do not find a common solution how to accomplish equilibrium of supply and demand. Whereas one group of experts thinks that markets and prices help to ensure efficient water allocation, others assume that governments should have an impact on the relationship between demand and supply quantifiably or qualifiedly to minimize pollution of water and conserve this scarce resource.[76]

1.4.1 Liberal perspective

To start with the liberal view, markets and prices are seen as the solution for efficient allocation, reduction of wastage, and sustainable usage of water. Liberal markets with competition provide incentives for innovations and research for water-efficient technologies. Furthermore, liberal markets are an impulse for recycling and re-use of water.[77] Because of the usage of different water resources for raw water with quality-divergences or diverse production scales, marginal costs vary a lot between water utilities. With competition and flexible water-rights less efficient water-suppliers are inspired to reduce their production, whereas more efficient ones could increase it. Therefore, a trade-off in water rights increase efficiency and welfare gains could be enlarged overall. To refer to the example of Subsection 1.3.4, Australian farmers would be less productive without subsidies than other kinds of industries. A reallocation of water rights from agriculture to industry would be the consequence in a liberal economy. Efficiency would rise and it would be more attractive to invest in the water market.

A step which could be taken by water-scarce countries with liberal markets is to increase imports of products that require a lot of water in their production. In this case costs could be saved for the retrieval of water. Production costs would be less in countries were water is abundant. Therefore, virtual water (see Subsection 1.3.4) could be seen as an additional source of water in water-short countries.[78]

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[76] See Ford 2001, p. 21 and Grimble 1999, p. 78.
[77] See Grimble 1999, p. 78.
[78] See Berrittella et al. 2007, p. 1801.

In liberal markets the price is a signal to show the scarcity of a good and is an incentive to improve infrastructure. That means that agents would try to reduce wastage, evaporation, and leakage. Water would be stored more cost-effectively and end-users would reach a larger amount of water.[79]

For an enhancement of supply, liberal thinking experts suggest investments in new dams, recycling, drilling of wells, desalination and trade with rural water holders to provide more for municipal areas. Although, investments in capital and operational costs are higher for non-traditional systems such as desalinations and recycling; they have the advantage that they are stable sources of water. Again, higher investments would be required if there are no pipelines or pumping infrastructure existing to connect rural and urban systems if a reallocation is desired.[80] However, there exist more disadvantages of the suggested ideas: desalination is not only very expensive, it can also just be a solution for areas close to saltwater-sources. The energy expenditure which is necessary for fresh-water catchments is huge and disposal of highly concentrated brine generates a pollution problem. The option of re-using municipal effluent is a costly variation which requires a dual system of pipelines. One negative point is that water still contains substances such as endocrine disrupters like antibiotics after treatment.[81] To enhance supply by building dams is very limited because most rivers are already dammed and run dry because of climate change and less rainfall.

In addition, drilling wells cannot be the answer for enhancing a sustainable supply. The more wells that are drilled and the less rainfall which is expected, the lower the groundwater is and the more expensive it is to drill deeper into the ground for water catchment.[82] Another consequence of over-drilling is, that the pressure is getting less and more costs in form of energy or better pumps must be invested. Hence, liberal solutions have also disadvantages and can result in higher costs.

[79] See Roberts et al. 2006, p. 63.
[80] See Hughes et al. 2008, p. 8 f.
[81] See Glennon 2006.
[82] See Glennon 2006

1.4.2 Governmental arrangements

As long as there are market failures and inefficiencies, some experts believe that the water market cannot solve the problem of imbalance of supply and demand by itself and government has to be involved. Optimal situation cannot be achieved by market in these situations; deadweight loss is the result. Depending on different intensities of market failure, governmental interventions could be necessary.
Governmental arrangements could internalise external effects, retrieve public goods, or implement regulations as explained in the following:

Externalities could be internalised by governments in several ways. One is the determination such as fines on companies or other users which pollute the environment heavily. It would compensate for the gap which exists between social costs and private costs. Companies would then cover more costs which result from their activities.[83] An alternative to direct control is the indirect internalisation by taxation. Firms require profit-maximising and try to produce the most efficient amount of pollution with the goal of costs-minimisation. Decentralised decisions can be made by producers individually. However, on the one hand it is difficult to measure pollution with low investments, on the other hand required information is not easy to achieve. Therefore, it is a big challenge to find the right taxation rate.[84] One pollution tax method was developed by Arthur Pigou in 1920. Tax per unit is set on a level where it is thought to be optimal. Optimality exists at the point where marginal external costs meet the marginal costs of pollution abatements. Companies would choose the most cost-saving option. Either they invest in pollution abatement technique to reduce pollution and avoid the tax or they pay the tax and continue their pollution. This "polluter-pays-principle" reduces the production of environmental damaging goods in the long-term because additional costs are passed on in the form of higher prices to consumers. In return, consumers would switch their demand for cheaper - and environmental friendlier – products. That means that production of taxed goods which pollute the environment is getting less.[85]

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[83] See Baumol et al. 2006, p. 313.
[84] See Lipsey et al. 2004, p. 330.
[85] See Waud et al. 1996, p. 492 f.

The second contemplated governmental arrangement is the case of retrieval of a public good. Because of the nonrival and nonexcludable characteristics of public goods, everyone gains a benefit from the production of these goods also when no one is paying for it. Therefore there is no official demand for a public good existing on the market. The government has to provide a public good if society wants to have it. Otherwise it would not be produced.[86]

To clarify the third kind of governmental arrangements, regulations could be necessary when a free market entry is not warranted and free competition is not possible. One consequence could be market control by a monopoly or occurrence of a natural monopoly as illustrated in Subsection 1.3.5.[87] Additionally, regulations could be needed when the social benefit is higher than private benefit. In this case regulations require the terms how given water rights can be used and external effects could be internalised by obviating their accruement.[88] The last reason for the necessity of regulations is the existence of diversity in public and private risk.[89] That means that there is a difference between the social rate of time preference and the consumption rate of interest. This clarifies whether the preference for the consumption of a good is sooner rather than later and indicates the effect of changes in consumption on the marginal utility of consumption.[90] Accordingly, regulations could help to adjust the social rate of time preference and the consumption of a good.

Next to general economic law a specified business law exists in regulated markets. The intention is to achieve a direct control of economic activities on the operations side by governmental intervention or other mechanisms.[91] One big advantage of regulations is that they are transparent, simple and define clearly the desired behaviour. But this economic instrument has a lot of disadvantages. To enumerate only a few, it determines costs and expenditure of time for those agents

[86] See McConnel et al. 2008, p. 544.
[87] See Petersen 1999, p. 128 f.
[88] See Ford et al. 2001, p. 30.
[89] See Petersen 1999, p. 129.
[90] See Boscolo et al. 1998, p. 1.
[91] See Petersen 1999, p. 129.

whose behaviour would be affected. They have to decide how to behave in regulated situations.[92]

Historically, regulations were made under special technological and sociological conditions. Often regulations ensured the provision for population. In some cases regulations were used to support special economical sectors and industries.[93] In many countries water is still subsidised heavily by governments. That means that the price for water is set too low and agents have no or only little incentive to use water efficiently.[94] Next to this negative effect subsidies gain benefit when they support water-saving technologies and their distributions for a wide range of users. In this case they have the positive effect to promote the protection of environment.[95]

In general, water utilities are influenced by water quality directives, tax rules, pricing requirements, accounting, as well as health and safety policies. Not only regulations itself influence water utilities, but diversities in regulations relating to jurisdiction as well. Different regulations and rules have tactile impacts on markets when they benefit companies from one area but not from another area.[96]

Looking on the water market, demand must be reduced if supply enhancement is already exploited under best available technology. But the practice of user's consumption is difficult to change. If the water market could not balance itself, then regulatory solutions must help to bring supply and demand for water closer to the equilibrium.

Water scarcity makes it essential to amend behaviour of water consumption. Next to the governmental arrangements enumerated above, rationing policies are determined by governments to manipulate the mismatch between supply and demand on the market. Price-rationing policies increase water rates to overcome the temporary shortfall of water supply.[97] Most economists agree that increasing prices is a good way of minimizing demand for water during drought periods and

[92] See Green 2003, p. 146 f.
[93] See Petersen 1999, p. 131.
[94] See Grimble 1999, p. 78.
[95] See Waud et al. 1996, p. 495.
[96] See Renzetti et al. 2004, p. 1866.
[97] See Griffin 2006, p. 154.

thus enlarge water-use efficiency. But when consumers (including industries) reduce their demand until a certain point, where technology is not supporting additional water-saving anymore and efficiency of usage is achieved already, then the ability to diminish demand is not possible to any further extent. As long as water has no close substitute, price elasticity of demand is limited. Other reasons for the failure of price-rationing policies are self-suppling companies which are not dependent on market-prices and non existing meters in some areas. Additionally, water is billed quarterly, commonly. That means that immediate or temporary price-increases are not noticed right away and reduction of demand is less than desired.[98]

One drastic regulatory effect on the economy is the quantity-rationing policy of water restrictions as you can see in the subsequent section.

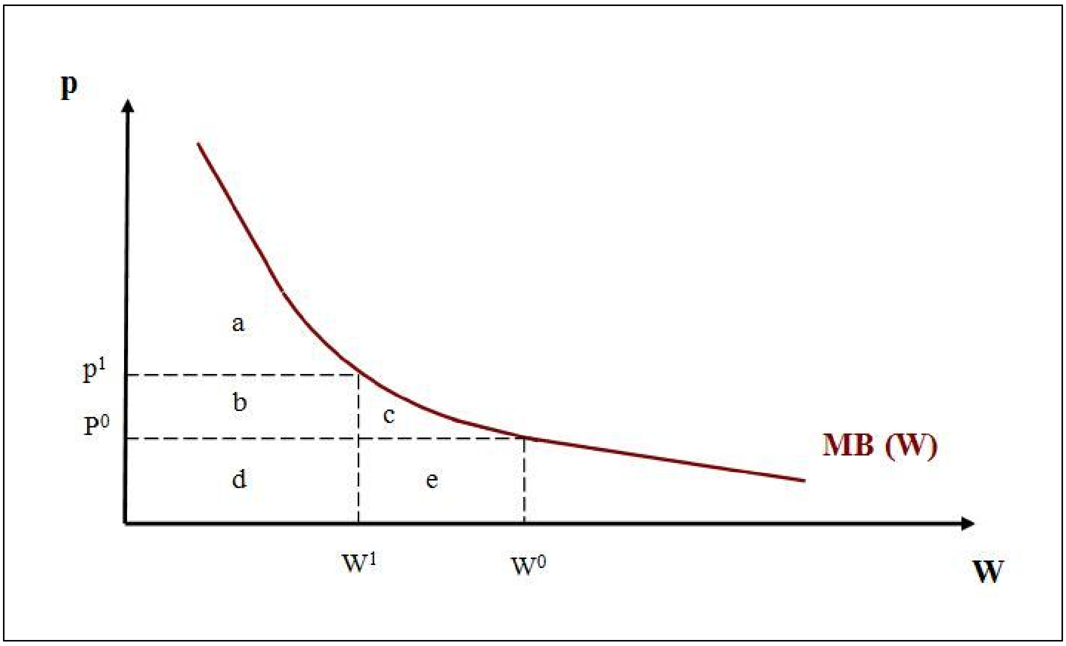
1.5 Water restrictions and welfare effects

Next to price-rationing policies mentioned in the section above, another opportunity to reduce water consumption could be achieved by establishing quantity-rationing policies as restrictions on water consumption. In situations of supply deficits, users are either told not to pursue an intense water-consuming activity on their property or the government arranges a certain percentage of consumption-cutback in general.[99] Mostly restrictions and their seriousness are dependent on the levels of water storages. Restrictions are often deliberated to decrease domestic water used on gardens, swimming pools, car washing, and cleaning surfaces around homes in the case of activity-restrictions.[100] But also business consumption could be regulated by restrictions directly. Additionally, business (which are for instant reliant on outdoor compositions) are influenced explicit when governmental arrangements cutting the dimension of external water use of residential. This affects indirectly the lifestyle horticulture sector including nurseries, turf farms, swimming pool builders, landscape gardeners and suppliers. One major result of restrictions for outdoor activities is the decrease of demand

98 See Grafton et al. 2008, p. S58.
99 See Griffin 2006, p. 154.
100 See Randolph et al. 2007, p. 535.

for goods and services of the lifestyle horticulture sector.[101] Restrictions also cause public costs and unemployment. As diagrammed in Figure 4, quantity-rationing policy has always impacted on consumer welfare and revenue of utility. The result of a quantity-rationing policy is that it reduces water consumption from level w^0 to w^1, the price for water remains at p^0. The loss of total benefit is given in areas c and e, whereas area e shows utility revenue losses. Area c illustrates net benefit losses of consumers if users between the point of origin and w^1 are preserved and only users between w^1 and w^0 are eliminated along the demand curve.[102]

Figure 4: Effects of water restrictions



Source: Diagram derived from: Griffin, R.C. (2006): Water Resource Economics: The Analysis of Scarcity, Policies, and Projects, Cambridge, p. 154.

There are several issues influencing the welfare of consumers of water. One of them is the preference for greenness of gardens. If the preference for greenness is high, demand is more inelastic and water restrictions cause a substitution for labour at all levels of income. That means that they would invest more time and labour (by watering their gardens with hoses)[103] to keep the garden green instead

[101] See Marsden Jacob Associates 2006, p. 47.
[102] See Griffin 2006, p. 154 f.
[103] See Brennan 2007, p. 3 and 13.

of giving it up and leaving it brown how consumers with lower preferences would do it. [104] Welfare losses are higher, the more labour must be invested to substitute the restricted water. In the case of companies it is similarly, the more production is dependent on water the less elastic a company is to reduce consumption of water in the process. An exception is, when there are many opportunities in saving water by rising efficiency in water consumption. Then elasticity is bigger until the point where all opportunities of efficient-enhancement are utilised. Welfare losses for companies are illustrated in area c where all users are captured as well.
One example for restrictions is the ban of sprinklers for lawn-watering. This restriction limits the permitted amount of water which consumers can use by sprinklers to water their lawns. To show an example from Australia, Brennan et al. (2007) found out that under a sprinkler ban the welfare loss for a household with middle income is AU$ 7,964 under inelastic preferences and AU$ 1,761 under more elastic preferences for greenness. This indicates a very high willingness to pay (WTP –see Appendix 7) to avoid the restriction of sprinkler bans.
Another issue influencing the welfare of consumers of water is the difference in the implementation of restrictions. If there are restrictions with a certain percentage of consumption-cutback, each user has to find the most efficient way to deal with this situation. To minimise losses, each individual or company should decrease only the least valued uses. Regarding the example from above this means that users with low preference for greenness of gardens would reduce water consumption for irrigation of gardens first. For them this would be the least valued use.
The function MB (W) represents demand for a faction of consumers. It is simply possible that some consumers reduce their demand for water not efficiently. If they would not diminish their water-consumption to the point w^1 then the water-allocation would not be efficient. The likelihood of efficient allocation in situations of equal percentage cutback of consumption is small. It would be more efficient when low-value water uses curtail their consumption more than consumers with higher value water uses.[105]

[104] See Brennan et al. 2007, p. 13.
[105] See Griffin 2006, p. 154 f.

However, restrictions cannot only have negative welfare effects. The risk of a society to be short in water supply is reduced and security of supply is ensured. However the literature does not illustrate the dimension of welfare benefits of restrictions and how these effects could be measured. Thus positive effects cannot be demonstrated at this point.

Thus, restrictions obviously cause welfare effects. The dimension of welfare effects depend on different circumstances and can be positive or negative.

2 THE SITUATION IN SOUTH EAST QUEENSLAND

The area known as South East Queensland stretches from Noosa, south to the state New South Wales, and west to Toowoomba.[106] South East Queensland (SEQ) has a sub-tropical climate and is rich in natural resources and biodiversity. It supports a diversified economy that includes agriculture, manufacturing, aquaculture, mining industry, tourism and commercial businesses.[107] Before 2008, SEQ had its worst drought in history resulting in the water storages being at minimal levels. With a population of nearly 3 million people[108] the SEQ region faces a serious water supply problem because it is one of the fastest growing residential areas in Australia. By the year 2026, 1.2 million new residents are expected to settle in SEQ. Therefore, demand for water will increase dramatically. In contrast, the water supply will become a scarcer commodity in future.[109] Additionally, irregular rainfall and climate change in the long-term may worsen this situation.

An overview of SEQ's water allocation, demand and supply is illustrated in Section 2.1. Subsequently, the development and status quo of institutional arrangements are shown in Section 2.2, followed by effects of restrictions in Section 2.3. This chapter concludes with a short description of planned restrictions in SEQ (Section 2.4).

2.1 Water allocation in SEQ

In the past, the Australian water law was based on the common law of English colonies. Water rights were linked to the ownership of land and it was not possible to sell or buy them. In the 1870s and 1880s, these principles were not working anymore to provide secure supplies of water. Therefore, the English colonies gave the Crown the right to allocate water rights for the usage of surface water.

In the 20th century water right allocation was diverse, there were "riparian water rights" existing for users adjacent to rivers and creeks, in some states, water rights were allocated by permits, licences or irrigation schemes. Water agencies had the

[106] See Queensland Water Infrastructure 2007, p. 5.
[107] See Queensland Water Commission 2008 a, p. 27.
[108] See Natural Resources, Mines and Water 2006, p. 4 f.
[109] See ACIL Tasman 2006, p. 1.

authority to cancel or change licences, but licences were commonly seen as rights in perpetuity but, in many places in Australia, were over-allocated by the end of the 1970s. The volume of extracted water, by the existing entitlement holders, were unsustainable and endangered the environmental balance. In 1994, the Council of Australian Governments (COAG)[110] instigated reforms with the focus on institutions and a formation of secure and unmistakably defined entitlements for water.[111] One key element of this reform was the separation of water entitlements from land. This was necessary to guarantee water trade. Additionally, a cost reflecting pricing of water was implemented to make any subsidies transparent.[112]
To manage, plan, price, trade and measure water, Australian governments signed the Intergovernmental Agreement on a National Water Initiative in June 2004.[113]
The state of Queensland established the *Water Act 2000* to manage water resources in September 2000 to replace the requirements of the *Water Resources Act 1989*. The *Water Act 2000* provides that non-landholders can own water separate from land. Water allocations are similar to land arrangements registered on a title system.[114] For example, the *Water Act 2000* (s 19) says "All rights to the use, flow and control of all water in Queensland […] vested in the state".[115] In 2007 there were 22 water storages in SEQ. These were owned by 12 different entities, including local government, councils, the state, or council-owned companies. The involvement of the state was and is multi-dimensional.[116]
The urban area is the largest water consumer in SEQ with 69 % of the total water usage in 2005. Rural production only consumed 24 %. Therefore this study focuses primarily on urban water consumption and supply.[117]
Urban water treatment and arrangements are characterised by a hierarchy distinguished by bulk supply, treatment of water, transport of bulk, distribution and retail.[118] At the end of this chain are the customers who are in demand for water.

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[110] Governments (Commonwealth, State and Territory) (See Australian Copyright Council 2007, p. 1.)
[111] See Roberts et al. 2006, p. 57 f.
[112] See Cox a, p. 3.
[113] See Australien Government, National Water Commission 2008
[114] See Cox b, p. 4
[115] See *Water Act 2000* (s 19)
[116] See PriceWaterHouseCoopers 2007, p. 12 f.
[117] See Queensland Water Commission 2008 a, p. 77.
[118] Graphics: Appendix 2, 3 and 4

Before July 2008 each level was represented by several entities which made the whole urban water arrangement very complex (see Appendix 4).[119] By July 2008 the bulk entity, manufactured water entity, bulk transport entity for drinking water and the water grid management were established and operational. These entities are owned by the local government. The next step is the establishment of the SEQ Distribution entity and three retailers which should be operational by July 2010.[120] The major differences are described in the following.

2.1.1 Suppliers

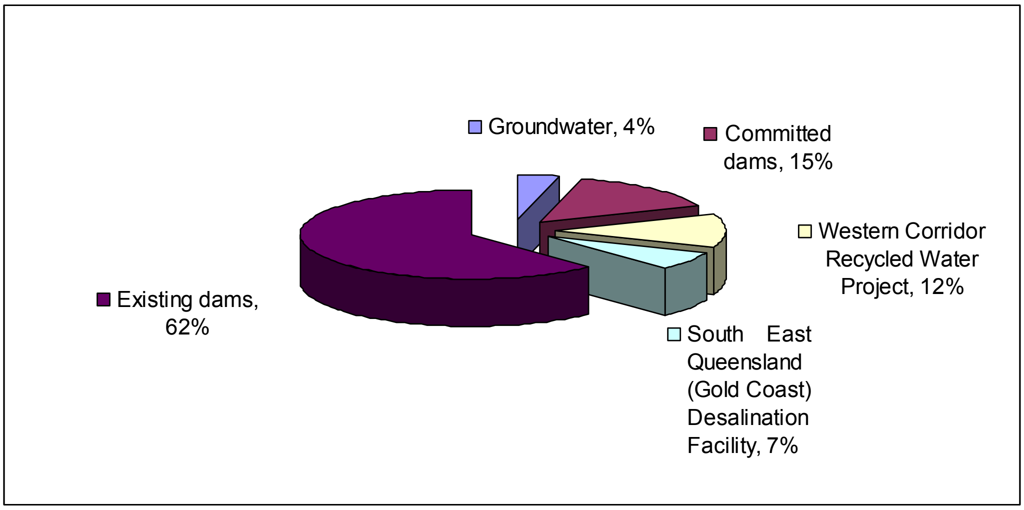
In SEQ, water is primarily extracted from dams and weirs; only 5 % of the drinking water is supplied from groundwater. The reliance on dams and weirs should decrease from 95 % of total regional supply in 2006 to around 77 % in 2012 by increasing the diversity of water sources. See Figure 5.[121]

The total storage volume, including the minimum operating volume, was 2,475,400 ML in 2006. About 555,600 ML (excluding annual volumetric limits) of this volume was allocated to urban areas in 2007, whereas 541,500 ML was allocated by communities connected to the Water Grid and by communities with unconnected sources of water supply. 14,100 ML of urban allocation were distributed for industries who obtain their water supplies straight from delivery schemes.[122]

The manner of water allocation of water supplies in SEQ is determined by the *Water Act 2000* through Water Resource Plans and Resource Operations Plans.[123] The *Water Act 2000* clarifies that water supply should be sustainable and secure. This goal should be achieved by regional water security programs for SEQ and an established commission (Queensland Water Commission - QWC). Additionally, the *Water Act 2000* (s 340) says that “the market for the supply of declared water services and the sale of water supplied by the services” should be established and “rules governing the operation of the market”[124] should be made.

[119] See Queensland Water Commission 2009 b
[120] See Gold Coast City Council 2009 a
[121] See Queensland Water Commission 2008 a, p. 103.
[122] See Queensland Water Commission 2008 a, p. 111 f.
[123] See Queensland Water Commission 2008 a, p. 103.
[124] See *Water Act 2000* (s 340)

Figure 5: Diversity of supply at 2012



Source: Diagram derived from: Queensland Water Commission (2008 a): Water for today, water for tomorrow: South East Queensland Water Strategy – Draft, March 2008, p. 108.

As noted above, there were different entities existing in the water market before July 2008. The bulk sources were owned by 22 different entities and was subsequently reduced to two entities by the SEQ Water Reform. This should optimise efficiency of asset portfolio and advances knowledge according to QWC. The transport of bulk water is now owned by a single company which contains all the main pipelines and the connected reservoirs. The distribution system will be owned by only one company with retail entities reduced from 17 to three by July 2010. The QWC stated that by the aggregation of retailers, more efficiency and better customer service should be achieved.[125] The separation of bulk transportation and distribution assets are necessary to create a framework for competition according to QWC. Thereby, the Water Grid Manager[126] has the task of purchasing water from the bulk supply and selling it to retailers and power stations.[127] The retailers will be owned by local governments and will purchase water from

[125] See Appendix 2 and 3.

[126] The Water Grid Manager is a new state owned entity (commenced on 1st July 2008) ensuring that water supplies are maintained in SEQ. By the usage of monitoring and contractual arrangements, the Water Grid Manager connects new water sources with already existing water supplies. In this way it can be ensured that water could be moved to areas where it is required; water availability will increase for 14 %. (See Queensland Water Commission 2008 b)

[127] See Queensland Water Commission 2007, p. 16 f.

the Water Grid Manager. The three retailers will be comparable in sizes with their operation area determined geographically.[128]
Due to the fact that the whole water industry is monopolistically structured (after the reform even more than before), the incentives to amend the allocation of water and therefore to achieve increased efficiency are remote. As mentioned in Subsection 1.3.5 monopolies result in inflexibility. Market-prices, with today's structure (2009), cannot cover costs and private investors cannot enter the market in SEQ. Consequently, competition has no chance to get established. But the QWC believes there will be an opportunity for competition after the reform because of several reasons: there will be competition between the two bulk suppliers and additional (maybe also private-sector) supply is anticipated to enter the market because of growing population.[129] Supply could increase by development of non-traditional supplies such as desalination, recycling, stormwater harvesting, or rainwater tanks.[130] But as long as market-prices do not cover costs, the belief of the Commission that competition will occur is erroneous. Hence, only the right water pricing could increase supply and create fair competition. Finally, the development of access for third parties, in the bulk treatment area and transportation of water, could initiate alternative supply and reuse remedies.[131]

Under the Water Act the councils set prices for water services. However, based on demanded volume, reliability, and water quality, prices differed greatly. In addition, the pricing, for end users, was not transparent.[132] The Queensland Government disclosed an outlook for prices of bulk water for SEQ and announced the Market Rules under which the state-owned entities and the Water Grid Manager are operating. Since "prices for bulk water are yet to be determined by the State Government […] rates will be determined individually by Councils."[133] The Queensland Government announced with recommendations by the QWC a 10 year price path for bulk water prices for SEQ. This path reflects the prices of al-

[128] See Gold Coast Water 2009 b
[129] See Queensland Water Commission 2007, p. 36.
[130] See Natural Resources, Mines and Water 2006, p. 10.
[131] See Queensland Water Commission 2007, p. 36.
[132] See Queensland Water Commission 2007, p. 69 f.
[133] Queensland Water Commission 2008 b

ready existing bulk water assets and water security projects such as the water grid, recycled water, new storages, the pipeline network of the region and desalination plants. The end-users will have an explicit increase in their water bills in future. The price increases will differ, from region to region, because the councils do not have equal costs for bulk water at present. The latest point in time when the final price is reached is 2018 for e.g. Brisbane and the Sunshine Coast.[134] To illustrate how significant these changes are, see Table 1.

Table 1: Price Path for Bulk Water Prices (2008 – 2018)

Council	Bulk Prices 2008	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013
	(AU$/ML)	(AU$/ML)	(AU$/ML)	(AU$/ML)	(AU$/ML)	(AU$/ML)
Brisbane	628	902	1,162	1,409	1,643	1,864
Sunshine Coast Regional Council	683	683	807	994	1,238	1,469
Gold Coast	796	1,066	1,322	1,565	1,795	2,013

Council	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	total change
	(AU$/ML)	(AU$/ML)	(AU$/ML)	(AU$/ML)	(AU$/ML)	(AU$/ML)
Brisbane	2,074	2,273	2,461	2,638	2,755	2,127
Sunshine Coast Regional Council	1,689	1,897	2,094	2,280	2,755	2,072
Gold Coast	2,219	2,415	2,599	2,755	2,755	1,959

Source: Table derived from: Queensland Water Commission (2008 c): Bulk water prices, http://www.qwc.qld.gov.au/Bulk+water+prices, 27. May 2009.

The total change of bulk water prices between 2008 and 2018 are AU$ 2,127/ML for Brisbane, AU$ 2,072/ML for the Sunshine Coast Regional Council and AU$ 1,959/ML for the Gold Coast. At the end of this price path one ML of bulk water will cost AU$ 2,755 in all areas of SEQ. Therefore, an equal price-system

[134] See Queensland Water Commission 2008 c

will exist, after the reform. In addition, prices will cover costs if councils pass the bulk water prices directly to end-users without manipulating the prices. If so, this uniform system would not reflect diverse availabilities of water in different areas and also not dissimilar levels of scarcity. It ignores the fact, that market prices would vary in free markets depending on demand and supply in different areas (see Subsection 1.3.2). Some areas of SEQ have a greater abundance of water than others and would therefore, normally have lower prices than areas with less water resources. However, the major sources of water, transport networks for bulk water, and water treatment plants will be connected by the SEQ Water Grid. Therefore, water will be supplied more flexible.[135] This flexibility is important to come closer to the optimal allocation.

As mentioned in Section 1.2, one out of five basic criteria of optimal allocation is the flexibility and mobility of water supplies to be able to respond to changes. Therefore, a more flexible water grid, such as in SEQ, could help to meet increasing demand in future. However, to achieve optimal allocation, the other criteria must be fulfilled as well. As long as the users do not pay completely the cost for water supply, the ability to come closer to optimal allocation will not be achieved.

2.1.2 Demand

Typical Australian demand is dominated by rural production which constitutes 83 % of total water consumption. In contrast, SEQ's rural production only consumes 24 % of water use, including agriculture. 1 % of total water use is consumed by rural communities and 6 % by power stations.

Urban consumers used the extant 69 % in 2005. How the urban water use is structured is illustrated in Figure 6. In 2005 there were 59,808 ML/a losses, that is 14 % of total urban water usage system lost, including metering errors, fire service, leakages and thefts. Most of the consumption was used by detached residential water users[136] (52 %) and attached residential water users[137] (12 %). The total urban water consumption was 428,693 ML/a in SEQ in 2005.

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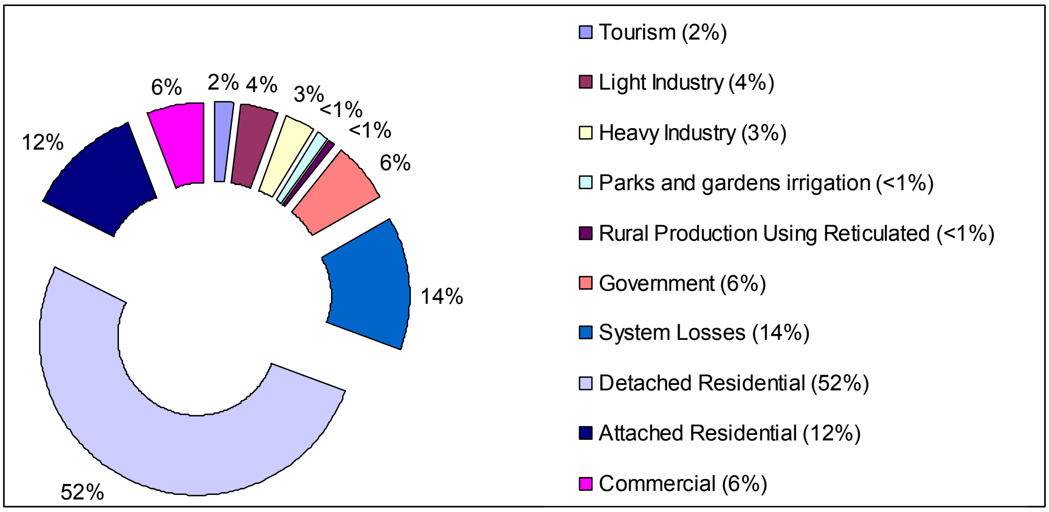
[135] See Queensland Water Commission 2008 b
[136] Detached residents live in a house
[137] Attached residents live in an apartment or townhouse

Residents connected to the grid of drinking water consumed an average water consumption of nearly 300 litres per day, per person, before the drought period in SEQ.[138] This is an approximately 26 % higher consumption than the average of OECD countries.[139]

An average consumption of residents of 230 litres per day, per person, as a target would not require additional supply sources until 2028[140] if consumption could be

Figure 6: Customer classes of urban water use in SEQ in 2005



Source: Diagram derived from: Queensland Water Commission (2008 a): Water for today, water for tomorrow: South East Queensland Water Strategy – Draft, March 2008, p. 77.

reduced by, for example, increasing water prices, adoption of water-saving appliances, consumer education,[141] or other institutional arrangements.

The largest non-urban users of raw water are agriculture and the largest industrial users are power stations. Power stations in SEQ consume 95 % more water for wet cooling processes than facilities with air cooling systems. But since the installation of dry cooling systems are more expensive and also operation is more cost-intensive, the SEQ's power companies do not want to move to dry cooling systems. In addition, the consumption of water by power stations is assumed to in-

[138] See Queensland Water Commission 2008 a, p. 76 ff.
[139] See Pigram 2006, p. 83.
[140] See Queensland Government - Department of Infrastructure and Planning 2008, p. 59.
[141] See Pigram 2006, p. 84.

crease in the next 10 years.[142] This situation would change if prices for water rise and the price difference between costs for wet cooling and dry cooling reduces.

Within the SEQ region, self-supply of water is limited to groundwater sources for agriculture or for domestic use. Much of this is not regulated or monitored. As a result, there is little data available and no further statement possible. Rainwater tanks fed from both residential and industrial roofs.[143] Again there is little data available.

The Queensland government has implemented a series of programmes to manage demand and reduce the consumption by enhancing water efficiency. The SEQ Water Strategy contains a number of initiatives to reduce water demand by industry, business, residents and government. These initiatives have long-term implications (according to QWC) and have showed some initial successes.[144] For instance, residential water consumption was reduced to an average of 134 litres/person/day across SEQ councils subject to restrictions by May 29th 2009.[145] For details of the initiatives and institutional arrangements see Section 2.2.

Hoffmann et al. (2006) found in a study[146] about urban water demand in Brisbane that residential demand is price inelastic at -0.588 in the short-run and price elastic at -1.442 in the long-run. Additionally they found that the price elasticity of demand is lower for rental households compared to owner-occupied households.[147] That means that households would be able to save water if prices would increase. But water prices do not currently represent the scarce situation of water in SEQ because water is subsidised, as illustrated in the following.

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[142] See The State of Queensland (Department of Natural Resources and Mines) and Brisbane City Council 2004, p. 31.

[143] See Warwick 2009, p. 4.

[144] See Queensland Water Commission 2009 c

[145] See Queensland Water Commission 2009 d

[146] "The […] study uses linear and non-linear regression techniques to model household residential water demand." (Hoffmann et al. 2006, p. 357)

[147] "Over the period 1997-1998 to 2003-2004, residential water has been billed quarterly with an annual access charge of AU$ 100 and a volumetric rate rising from AU$ 0.60 in 1997-1998, AU$ 0.70 from 1998-1999, to 1999-2000, AU$ 0.80 from 2000-2001 to 2001-2002, AU$ 0.82 in 2002-2003, and AU$ 0.84 in 2003-2004." (Hoffmann et al. 2006, p. 356.)

2.1.3 Subsidies and contributions

The water market in SEQ is heavily subsidised. Regional councils receive either monetary or physically contributed assets for the water infrastructure. There are three existing kinds of contributed assets.

Firstly, councils -who are the owner of water utilities- receive monetary contributions from operators of new developments when water infrastructure is needed to serve a developing area with water supply and sewerage systems.

Secondly, the State Government subsidised councils to assist in the funding of sewerage and water services for several decades. Since 1995, the State Government gave councils a subsidy of up to 40 % of the capital cost for new or augmented water sources such as dams, bores or weirs.[148] The Queensland Government supports for example local councils with subsidies to accelerate the implementation of leakage management. Councils got a subsidy "of up to AU$ 32 million and were paid out AU$ 9.5 million to May 2007, which is a subsidy of 40 per cent of capital costs."[149] Furthermore, a subsidy of 50 % is paid through the Water and Sewerage Program for costs resulting from re-use of wastewater.[150]

Thirdly, another contribution is through agreements with a "developer to pay for and construct water and sewerage infrastructure within their developments […] and/or pay for and construct trunk infrastructure to support the development."[151]

The prices which users have to pay are therefore much less with this governmental support. Prices charged to consumers reflect the subsidies and contributions that have been made.

Consequently, councils are dependent on non-recurrent revenues if they want to keep prices for end-users reduced. However, the consequence of these contributions is that water is used unsustainably, resulting in waste and pollution. As a result of water reform, the risk, which councils faced before and which was offset by subsidies, are shifted to the Water Grid Manager, retailers and owners of infra-

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[148] See Queensland Water Commission 2007, p. 61.

[149] Queensland Government – Office of Urban Management (Department of Infrastructure) 2007, p. 51.

[150] See Queensland Water Commission 2007, p. 61.

[151] See Queensland Water Commission 2007, p. 61 f.

structure, who have to make contractual arrangements about the recovery of costs.[152]

2.2 Institutional arrangements

As discussed in Subsection 1.4.2, there are several existing reasons why governments impose regulations that influence demand and supply in an imbalanced water market. The water market in SEQ is obviously out of balance since this area faces a drastic population growth, the most persistent drought in the last 60 years, the lowest levels of water storages and future climate change.[153] The supply side of the water market in SEQ is monopolistic and subsidies peg market prices for water. Therefore, water is not allocated efficiently (see Section 1.2) and demand and supply cannot be co-ordinated by market mechanisms. Additionally, a wastage of water results in negative externalities because market prices do not represent private and social costs (see Sections 1.3.1 and 1.4). As long as these market-barriers exist, government must interfere by imposing regulations that enhance supply and manage demand.

On one hand, water reform was intended to provide water supply security through the *Water Act 2000*. Since 2005, the government of Queensland and councils improved institutional and regulatory arrangements.[154] Significant structural changes are proposed for water utilities up to July 2010 (see Subsection 2.1.1). An enhancement of water supply is also being pursued by the new SEQ Water Grid. This includes the implementing of a desalination plant, new dams, and the Western Corridor Recycled Water Scheme. Additionally, regional interconnecting pipelines will help to ally new and already existing water sources to make water allocation more flexible.[155] To minimize the leakage and accordingly water losses of up to 14 % of total water consumption in SEQ, the Queensland Government increased subsidies to councils to accomplish the Pressure and Leaking Management Program expeditiously.[156]

[152] See Queensland Water Commission 2007, p. 64.
[153] See ACIL Tasman 2006, p. 1 f.
[154] See Queensland Water Commission 2008 a, p. 42.
[155] See Queensland Water Commission 2008 d
[156] See Queensland Government – Department of Infrastructure and Planning2008, p. 61.

On the other hand, the Queensland Government established a range of programmes to increase efficiency of water usage and consumption. Water management strategies for business, industry, government, and residents were initiated.
For businesses, a long-term arrangement was implemented by the QWC. Businesses which use water intensively are required to compile a Water-Efficiency Management Plan (WEMP). Within this plan they have to prove that they use water efficiently. If they cannot demonstrate their efficiency, they have to develop a plan to show how they will save 25 % of their water consumption in the near future (see Subsection 2.2.3). Moreover, the Queensland Government established an incentive program called Business Water Efficiency Program (BWEP) which helps businesses realise water savings at a cost of AU$ 43 million. The target is to achieve a reduction of business water consumption of 12 ML per day in SEQ (see Subsection 2.2.3).
For residents who consume 64 % of total water consumption in SEQ, the Queensland Government created a series of rebate schemes in 2006. The Home WaterWise rebate scheme offered residents rebates for water-saving products. For example they received up to AU$ 1,500 for water tanks of minimum 3,000 litres which is internally plumbed.[157]
One part of the South East Queensland Water Strategy is the setting and control of water restrictions. With restrictions, the water consumption of households and business water usage should be minimised.[158] As mentioned in Section 1.5, restrictions are either regulations, for a specific sector (residential or business) to reduce water consumption to accomplish a percentage target or to ban or constrain a special activity of water-users.[159] There is no consistent restriction system across SEQ. For an overview of restriction levels and different area solutions, see the following sub section of this thesis.

[157] See Queensland Government – Department of Infrastructure and Planning 2008, p. 60.
[158] See Queensland Water Commission 2009 c
[159] See Marsden Jacob Associates 2006, p. 9.

2.2.1 Restrictions in SEQ

Under the *Water Act 2000*, the QWC is legally entitled to restrict water supply. S360ZD (1) says:

"If the commission considers it necessary, it may impose a written restrictions (a commission water restriction) restricting all or any of the following in all or part of the SEQ region or a designated region –

(a) the volume of water taken by or supplied to a customer or type of customer of a service provider;

(b) the hours when water may be used on premises for stated purposes;

(c) the way water may be used on premises."[160]

These restrictions are only allowed to be introduced when a sustainable and secure water supply could not be retained without the restrictions or if the water level of sources has fallen to a certain level and it is in the public interest to ban consumption with restrictions. Additionally, restrictions could be introduced when they help to achieve a long-term solution for demand management.[161] If the Commission decides to impose a restriction, it must inform everyone who is affected by these restrictions.[162]

As mentioned before, the water grid has recently been formed and expanded meaning that water sources can be transferred to areas with low water access more easily. There are 11 different regional and city councils existing in SEQ including the local government district of Brisbane, Sunshine Coast, Gold Coast, Ipswich, Logan, Redland, Lockyer Valley, Scenic Rim, Moreton Bay, Somerset and Toowoomba (see Appendix 5 for map of councils in SEQ).[163] Because each area had different opportunities for water access, different levels of restrictions were set by the QWC in different time schedules.

2.2.1.1 Level of restriction since 2005

The drought in SEQ and low dam levels made it necessary to constrain the unsustainable use of water and prevent serious water deficiencies. Therefore, a regulation to establish water restrictions on consumers was implemented.

[160] *Water Act 2000*, s 360ZD (1), p. 287.
[161] See *Water Act 2000*, s 360ZD (2), p. 287.
[162] See *Water Act 2000*, s 360ZE (1), p. 288.
[163] See Council of Mayors, South East Queensland 2008.

Level-1 restrictions were implemented in SEQ on the 13th of May 2005. This level of restriction was triggered by a combined storage level of the major dams Wivenhoe, Somerset, and North Pine Dam[164] of less than 40 %. Residential areas and business production areas were not allowed to be watered by unattended watering devices or sprinklers within 4 and 8 am and 4 and 8pm on special weekdays. Odd and even numbered properties were not allowed to water on same days, but on alternate days. Sports fields and active recreation recreational areas were only allowed to be watered between 4 and 8 am and between 4 and 8pm.[165] Level-1 restrictions affected residential, lifestyle horticulture and the public sector.

On the 3rd of October 2005 level-2 restrictions commenced, which affected vehicle washing and car dealerships in addition to the sectors mentioned above. The entry trigger to this level was 35 % of storage levels.[166] At this level, the uses of unattended watering device or sprinklers were prohibited and watering with a hand held hose was only permitted on certain days before 7am and after 7 pm. For nurseries, turf farms and market gardens it was only permitted to water business stock or production areas at anytime before 1 December 2005. After this day it was only permitted to water on any day before 7am and after 7pm (using the alternate system of odd and even numbers of properties). After 1 December 2005 it was also prohibited for vehicle washing to use high-pressure water cleaning with a trigger nozzle (if not directly filled from a tap) between 7 am and 7pm. Exceptions could be obtained by councils on basis of Water Efficiency Management Plans (WEMPs) established by affected businesses.[167] WEMPs had to be developed by significant nurseries, turf farms, market gardens, commercial vehicle washers, parks, gardens, and sports grounds.[168]

Level-3 restrictions were implemented on the 13th of June 2006 when the storage level dropped to 30 % affecting on residential, public sector, lifestyle horticulture, car dealerships, vehicle washing, and the irrigation sector. At this level it was prohibited to do outdoor watering with hoses or sprinklers generally.[169] It was only

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[164] See Queensland Government 2009, p. 1.
[165] See Queensland Water Commission 2005 a
[166] See Marsden Jacob Associates 2006, p. 12 f.
[167] See Queensland Water Commission 2005 b.
[168] See Marsden Jacob Assiciates 2006, p. 79.
[169] Marsden Jacob Associates 2006, p. 12 f.

acceptable to water with hand-held buckets or watering cans. Topping up residential swimming pools and spas was only permitted before 7am and after 7pm using the alternate system of odd and even numbers of properties. Roof sprinkling or washing, hosing of hard surfaces such as driveways, paths, or patios was prohibited at all times. Water of production areas or business stock was not allowed between 7am and 7pm. Exceptions could only be made by local councils based on developed WEMPs. In general it was recommended to all businesses in this production area to establish a WEMP with a target to save 25 % of water consumption or to achieve water efficiency of the best practice. Local councils advised a date after which construction sites and land development were only allowed to use recycled water or other sources except[170] portable water[171].
Level-4 water restriction took effect on the 1st of November 2006 for several councils including Brisbane City and Gold Coast City. Residential restrictions were the same as for Level 3. Additionally, outdoor swimming pools or spas had to be covered when not in use after 1 July 2007. Non-residential premises were distinguished into users with water consumption of 20 ML or greater (N1) and more than 10 ML and less than 20 ML (N2). For these two consumption groups or facilities with cooling towers, water use from the urban supply system was only permitted if an annual or quarterly reduction of 25 % of water consumption was achieved or "the water was used on the premises in accordance with a WEMP that has […] been submitted to the service provider"[172]. The third group were users with less than 10 ML and greater than 1 ML of water consumption annually (N3). Here it was only permitted to use water from a reticulated supply system if taps, showerheads, and trigger sprays were water efficient or a WEMP has been submitted to the service provider.
To mention only the most significant restrictions, nurseries, turf farms, market gardens and commercial vehicle washing (in a permanent location) were not allowed to water business stock and production areas beyond the conducted watering according to the already submitted WEMP since the 1st of January 2007.[173]

[170] See Queensland Water Commission 2006 a, p. 1 ff.
[171] „Portable water means water of portable (drinking water) quality, which is soured from the council reticulated water supply system." (See Queensland Water Commission 2006 a, p. 5.)
[172] Queensland Water Commission 2006 b, p. 11 and p. 14.
[173] See Queensland Water Commission 2006 b, p. 11 ff.

Level-4 restrictions affected sectors such as residential, lifestyle horticulture, public, industry, irrigation, and commerce.[174] For an overview about Level 1 to Level 4 restrictions, please see Appendix 6.

On the 10th of April 2007, a Level 5 restriction took effect for the same local government areas mentioned in Level 4. Water usage from the urban water grid was not permitted for outdoor use if residential consumers using 800 litres or more per day did not prepare and submit a Water Use Assessment Form to the service provider. New or renovated swimming pools and spas were no longer allowed to be filled or partially filled. Non-residential water consumption on the premises, watering business stock and production areas, urinal systems, as well as cooling towers were only permitted to use reticulated water in accordance with a WEMP. Public water play facilities, without recirculated water, were not permitted to top up these facilities. The same applied for public swimming pools if water was not used in accordance with a WEMP. Professional vehicle washing in permanent locations was not permitted to use water from the reticulated supply system after 31 July 2007, except the vehicle washing was following requirements of the Vehicle Washing Best Practice Guidelines. Washing external surfaces of buildings, using water on construction sites and land development was restricted.[175]

The highest level of restrictions were introduced in March 2008 in 8 out of 11 local governments, including Brisbane City and Gold Coast City Council. Additional to the restrictions already in place, this level required that non-residential premises had to install a sub-meter by a licensed plumber and write a report to the service provider quarterly. Professional car washing locations had to provide an approved sign of service provider on the premises and install sub-meters for weekly readings.[176]

This illustrates SEQ's stepped process into the restriction levels. The high level of regulation and control made the water market very inflexible. The frequent changes in the levels of restrictions and the many sub-categories and exceptions made it difficult for residential and non-residential consumers to comprehend the regulations.

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[174] See Marsden Jacob Associates 2006, p. 13.
[175] See Queensland Water Commission 2007 b, p. 1 ff.
[176] See Queensland Water Commission 2008 e, p. 3 ff.

2.2.1.2 Level of restriction today

At the end of 2008 water scarcity improved. However, the removal of high-level restrictions in SEQ is different than the way in which the Level 1 to Level 6 restrictions were implemented.[177] The restriction levels are now separated into extreme, high, medium and permanent water conservation-level as illustrated in Table 2.

High restriction levels are determined by the QWC if the combined dam level is 40 % or less. QWC chair Elizabeth Nosworthy said in February 2008: "At 40 per cent with continued responsible usage we will have enough water to ensure that even if we continue to remain in drought and receive worst case inflows our dam levels would stay above 10 per cent for three years – that's three wet seasons. That means that if dam levels drop below 40 per cent again we will have a level of security that means we would not have to return to extreme (Level 6) restrictions."[178] The high restriction levels were suspended differently for residents and non-residential water users. For instance, on the Gold Coast the high level restriction was suspended for residents in January 2009.

Non-residential water restrictions which required WEMPs, the assembling of water efficiency devices, and other conservation measures were not relaxed or suspended by the QWC.[179]

In June 2009, councils such as Brisbane City, Ipswich City, Logan City, Somerset, Moreton Bay, and Lockyer Valley were already under the medium level restriction with the target of 200 litres/person/day. The councils of Redland City, Sunshine Coast, and Scenic Rim will commence medium restrictions on the 1st of December 2009. For non-residential consumers compliance measures were commenced on the 30th of March 2009.[180]

[177] See Queensland Water Commission 2008 f, p. 3.
[178] Queensland Water Commission 2008 f, p. 3.
[179] See Queensland Water Commission 2009 e.
[180] See Queensland Water Commission 2009 f.

Table 2: Restriction levels, triggers, targets, and key elements

Restriction level	Trigger	Residential Target (litres/person/day)	Key elements
Extreme (Level 6)	Contingency Only	140	Outdoor: Bucketing, no car washing. Indoor: As at present.
High	40 %	170	Outdoor: Limited hosing using town water, Car washing reintroduced. Indoor: As at present.
Medium	50 %	200	Outdoor: Limited efficient irrigation using town water reintroduced. Indoor: Additional efficient use.
Permanent Water Conservation	60 %	230	Permanent restrictions to prevent water wastage.

Source: Table derived from: Queensland Water Commission (2008 f): Drought Exit Strategy: Information Kit, 11 February 2008.

Under medium restriction levels, water restrictions regulate non-residential water users such as industry, business, government and other large consumers in several ways. Consumers with consumption larger than 10 million litres per year have to comply with a WEMP to save 25 % of water usage or ensure best practice water use. Consumers with a usage of more than 1 million litres per year have to have water appliances such as trigger sprays, showerheads, cooling towers, or low-flow taps which are efficient and save water. Vehicle washers have to follow guidelines which describe how they can use water efficiently. Professional spa and pool operators have to install for example a sub-meter, a rainwater tank, and must keep a weekly log. Tourist operators have to inform guests about a water wise usage in bathrooms. Additionally, every business or industrial company has to provide a compliance report. If actors do not comply with these restrictions, penalties are imposed.[181] If a person is intervening in a water restriction given by the QWC, the maximum penalty is 1665 penalty units for non-residents and 200 penalty units for others.[182]

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[181] See Queensland Water Commission 2009 e.
[182] See *Water Act 2000* (s 360ZE), p. 288.

2.2.2 Water Efficiency Management Plans

Water Efficiency Management Plans (WEMPs) are a component of water restrictions in SEQ and affect most high water-using businesses. A WEMP must be prepared by all non-residential customers who use more than 10 ML water per year, public pools which use 1 ML or more per year, nurseries, market gardens, and turf farms, premises with cooling towers, and non-residential premises with an area to irrigate, with town water, larger than 350 m^2. [183]

According to the *Water Act 2000* (s 360ZCB) the Commission could "require a water service provider to give a customer, or type of customer, a written notice –

(a) to prepare a plan (a water efficiency management plan); and
(b) to give it to the water service provider within the reasonable time stated by the commission."[184]

WEMPs are a demand management policy with long-term character to encourage and influence businesses to become more water use efficient. The main aim is to make water efficiency a normal part of a business' way of operating. It also should enable businesses, while they develop and implement WEMPs, to estimate their water consuming activities and implement water saving strategies. The QWC made WEMPs a permanent component of the water conservation measure irrespective of restriction levels.[185] According to the QWC's WEMP Guideline, WEMPs must "be prepared in accordance with the Guideline; be submitted for approval to the relevant water service provider; be capable of third party certification; and contain details (including dates) of how the business is achieving, or plans to achieve, a 25 % reduction of water use or best practice."[186]

There are three main categories of WEMPs. The standard WEMP is for non-residential water consumers who use 10 ML or more per year, including turf farms, public pools, nurseries, and premises with cooling towers. The simplified WEMP is for the same category of non-residential water users, as above, with a

[183] See Queensland Water Commission 2009 g, p. 10 ff.
[184] *Water Act 2000* (s 360ZCB), p. 263.
[185] See Gold Coast City Council 2009 c.
[186] Queensland Water Commission 2009 g, p. 5.

usage of less than 10 ML per year. The third category is the simplified WEMP for garden irrigation, for non-residential gardens, which are larger than 350 m^2.[187]
Best practice can be demonstrated by water customers by documentation and justification why measures are considered to achieve best practice. Business could benchmark and assess their procedures and activities against relevant industry or business standards.[188]

The QWC sees WEMPs as one part of water restrictions. But since WEMPs have a long-term character and initiate businesses to invest in more water efficient technology and change production processes, it can be seen as an incentive for improvement of water efficiency as well.

A survey concerning water efficiency, for non-residential use, tends to be more challenging than for the residential sector because water usage is so diverse. Therefore, non-residential usage of water is not standardised and difficult to survey. Moreover, water use in the non-residential sector tends "to be dominated by a small number of businesses that use vast quantities of water compared to the average. This 'high' water use does not necessarily imply 'inefficient' water use, as some higher users are already very water efficient."[189] As a result, it is not necessarily proven that restrictions and the development and implementation of WEMPs make water usage more efficient. In contrast, these regulations could have heavy negative effects, such as financial burden and administrative complexities. If businesses do not develop and implement a WEMP, penalties are imposed to sanction the absence of cooperation. The maximum penalty is 500 penalty units.[190]

[187] See Queensland Water Commission 2009 g, p. 10 ff.
[188] See Gold Coast City Council 2009 c.
[189] Integrated Urban Water Management and Accounting Task Group 2007, p. 79.
[190] See *Water Act 2000* (s 360ZCB), p. 263.

2.3 Effects of restrictions in SEQ

When the water market is influenced by governmental regulations by imposition of restrictions, the effects are enormous. All agents in the water market are affected directly or indirectly.

As mentioned in Section 1.5, restrictions could have negative or positive welfare effects. Because of the reforms on the water market and the frequent changing of restrictions, there is little literature available on the impacts of water restrictions in SEQ. Therefore deductions to assess the effects of restrictions in SEQ are derived from case studies of other regions under the assumption that water restrictions have similar impacts on agents on comparable structured water markets.

In reference to the theoretical part of this thesis (Section 1.5), it can be asserted that restrictions in SEQ are not only policies to rationalise the quantity of water demand by banning certain water uses but also telling consumers to cut back their usage by a certain percentage. Restrictions also affect net benefits by shifting demand for water in SEQ. As described in the previous Section 2.2, more efficient water use technology is subsidised by government and WEMPs direct business about how they can save water by using, for instance, water-conserving fixtures. Through these policies, the water demand curve is shifted or rotated. Conversely, for quantity-rationing policies, demand changes result in a movement along the water demand curve.[191] Griffin declares the demand shifting policy as a "policy mechanism for affecting net benefits"[192], not as a policy of restriction as the QWC sees their action. As described previously, WEMPs are restrictions and incentives for improvement of water efficiency at the same time. Because there is no data available which classifies policies and their impacts in quantity-rationing and demand-shifting policy, the impacts of both policies are described by impacts of restrictions at the same time in the following.

Restrictions on the water usage have significant effects on the regional economic growth and security of water supply, on residents, business and result in an increase of public costs, as illustrated below.

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[191] See Griffin 2006, p. 154 ff. and Shaw 2005, p. 122 f.
[192] Griffin 2006, p. 156.

2.3.1 Welfare effects

The gross regional product (GRP) of SEQ was approximately AU$ 100,000 million in 2006[193] which is about 60 % of Queensland's gross state product or 11 % of the Australian gross domestic product. If there is no enhancement in water supply or demand for water decreases, the economic growth and consequently the quality of life will be seriously impacted for future generations.[194] SEQ's economic growth in comparison to the Australian average (with an annual rate of 3.7 % in 2005-06-period) is more rapid and higher. The average growth rate of SEQ was 4.7 % in 2005-06 year.[195]

To clarify welfare costs, it is necessary to differentiate between costs of restrictions and costs which would be generated if restrictions had not been introduced to reduce water demand.
The positive welfare effects of restrictions rest on the reduction of the risks concerning security of supply in drought situations. Private and social costs would be higher in situations of supply shortfall than under restricted circumstances to prevent serious supply shortfall. Hence, prevention is better than cure.
Since there is no existing published research about the positive welfare effects in SEQ, they cannot be embodied numerically at this point. The only statement which can be made, is that the water saving level, which was reached by restrictions, is significant. Before restrictions came into effect, the daily residential water consumption was 300 litres per person. After high-level restrictions, the average daily consumption reduced to 125 litres per person in September 2008 (which is an average of total residential usage of 352.6 ML per day over the quarter in September 2008). Since 64 % of customers are residential in SEQ, there could be a substantial saving of water. The total non-residential usage average was 134.4 ML per day over the September-2008-quarter.[196] As the QWC declared in April 2008,

[193] See ACIL Tasman 2006, p. 10.
[194] See Natural Resources, Mines and Water 2006, p. 5 f.
[195] See Marsden Jacob Associates 2006, p. 46.
[196] See Queensland Water Commission 2008 g, p. 4.

the non-residential consumption dropped "by around 31.6 % by the December 2007 quarter when compared to the 2004/05 pre-restriction period."[197]
Hence, by implementing these water saving measures, after 2005, the risk of society enduring a water shortfall, in a drought period, was minimised by the use of restrictions. Social and private costs could be saved by this preventive governmental arrangement. Consequently, this effect must be seen as a welfare benefit.
The study of ACIL Tasman concerning the impact of restricted water supply in SEQ shows evidence that without water restrictions in SEQ, there would have been a clear loss in GRP. ACIL Tasman assumed that water levels would decrease in future to two different levels. In Case 1, the level of supplied water remains at 530,000 ML per year from 2006 onwards. This would results in a loss of AU$ 57 billion (present value) between 2010 and 2020[198]. Case 2 assumed that the yield of water supply had been reduced to 450,000 ML per annum. The lost GRP would be AU$ 111 billion (at present value) between 2006 and 2020 in SEQ. But in addition, as this study announced, it is difficult to quantify the impacts on industry or population since it was not observing multiplier effects on total economical activities nor the impacts of feedback loops.[199] Consequently, the fast growing population and the increasing demand for water, would have serious economical impacts on SEQ's economy without additional water supply or demand managing regulations. Since restrictions would decrease the loss of GRP by decreasing the reduction of annual water supply, restrictions have positive effects on the welfare of a society.

In contrast, the emergence of welfare costs is a result of an accumulation of different ascendancies. The emergence of private and public costs result in negative effects on the welfare of a society caused by restrictions.
To estimate the welfare costs of restrictions, Hensher et al. (2006) used a choice model in the time-frame from 2002 to 2003 to calculate the marginal WTP (see Appendix 7) to avoid restrictions in drought situations. Hereby, they analysed 240

[197] Queensland Water Commission 2008 h, p. 4.
[198] "The calculations were based on real 2006 Australian dollars. The reductions in gross regional product were estimated for each year […] and brought to a present value in 2006 using a discount rate of 5 % per annum." (ACIL Tasman 2006, p. 9.)
[199] See ACIL Tasman 2006, p. 11.

business and 240 residential respondents in the Australian capital of Canberra. They found that business customers shared the same concerns regarding water restrictions, as residents. The respondent's pattern of the WTP to avoid low-level water restrictions was nonexistent. They were only prompted to pay 23 % of their 2002/2003-water bill to avoid restrictions of Level 3 or higher which last all year. That means that their WTP had an average of AU$ 1,104. This was a smaller average than for residents, but the median WTP is nearly the same at AU$ 239. Customers can accept high- level restrictions, for a special time each year, if their water bill does not increase.[200] Hence, long-time restrictions, which last all year, seem to cause more welfare costs than short-period restrictions. Additionally, high-level restrictions result in higher welfare costs than low-level restrictions because the WTP to avoid these restrictions is larger and it is more difficult for customers to adapt high-level restrictions than low-level restrictions[201].

This means for SEQ, welfare costs rose when higher level restrictions were in place. Therefore, the highest welfare costs for this region would have occurred presumably under restriction Level 6 from March 2008 onwards. Derived from the research results of Hensher et al. (2006), an additional reason for high welfare costs is the long-term character of restrictions, lasting all year in SEQ. Under this condition the WTP to avoid the restrictions was high.

With the same method of WTP Marsden Jacob Associates (MJA) prepared a report for the Queensland Department of Natural Resources and Water to evaluate the economic costs of water restrictions in SEQ. To calculate the commercial, industrial and residential WTP, methods such as contingent valuation or the choice modelling were used on a survey base. MJA built an average WTP for a group of each demand-class and applied this result to the total number of water-users of these classes.[202] The results are shown in Table 3. As you can see the WTP increases significantly from Level 2 to 3, even when the water savings are nearly the same. This result is identical with the findings of Hensher et al. Higher levels of restriction cause more welfare costs for the society. This study also de-

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[200] See Hensher, D. et al. 2006, p. 60 ff., Tapsuwan et al. 2007, p. 4. and Grafton et al. 2008, p. S59.
[201] See Hensher, D. et al. 2006, p. 65 f.
[202] See Marsden Jacob Associates 2006, p. 61.

termined that the highest costs accrue at restriction Level 4 with AU$ 291 million per year. Costs of higher restriction levels were not specified because Level 5 and 6 were introduced to SEQ after this study had been completed.
The method of using the WTP to avoid restrictions is one possible way to estimate the welfare loss for a society. Another way would be to evaluate the costs which occurred by preparation and implementation of WEMPs for commercial and industrial customers. Thereby, the costs which resulted from the necessity to change the production process to comply the requirements of WEMPs would be included. For the resultant effects on industrial and commercial economy see Subsection 2.3.3.

Table 3: Willingness to pay to avoid water restrictions in SEQ

	Reduction in water use	Cost per annum in million AU$
Level 1	11%	12
Level 2	21%	24
Level 3	25%	233
Level 4	30%	291
Level 5	not specified	not specified
Level 6	not specified	not specified

Source: Table derived from: Marsden Jacob Associates (2006): Economic Cost of Water Restrictions in South East Queensland: A report by Marsden Jacob Associates for the Queensland Department of Natural Resources & Water, Final Report: 31. October 2006, p. 62.

Additionally, restrictions cause transaction costs (see Subsection 1.3.3) which are imposed to customers because the substitutional spent time for watering by hand held hoses or buckets and therefore inconvenient costs are not recoverable.[203]
To diagnose total welfare effects, positive welfare effects must be countervailed against negative effects. Since there are no specific numerical values existing for SEQ, this gap must be closed by research in future.

2.3.2 Effects on residents

The effects of restrictions on households are enormous during situations of high-level and long-term restrictions. The case study done by Brennan et al. (2007)

[203] See Huges et al. 2008, p. 11.

used a consumer choice model to find out a production function for the quality of lawns. This was done to represent the costs of substituting labour intense lawn watering methods such as hand-held hoses and use of buckets for sprinklers. Their experimental study was done over three consecutive summers in Perth. They priced the time consumers spent watering their lawns, against their reduced time for leisure activities, and found that a complete sprinkler ban would cost between AU$ 347 to AU$ 870 per household per summer. These costs were welfare costs generated only for households. The study did not include non-residential customers. To transfer this to SEQ, there were 854,282 households registered in 2001.[204] Since 78.8 % or 673,174 of residential users are detached households (see Figure 6 above), it could be assumed that most of households have a lawn. Therefore, welfare costs, for this region, would have been approximately AU$ 233 million to AU$ 585 million in 2001 by applying the Brennan et al. (2007) findings.

Since SEQ's water restrictions are multi-dimensional and are not confined to sprinkler bans nor only affect residents, it must be assumed that total welfare costs would be higher than the aforementioned analysis.

Next to the costs generated from substituting sprinklers for more labour-intense watering methods, the following costs must be considered as effects on households.

Due to restrictions, residents' amenity and the value derived from water use decreased. Additional costs occurred by substituting water supply methods such as water tanks. The costs for rainwater tanks range between AU$ 550 and AU$ 1,700, depending on size, plus installation costs of between AU$ 1,300 to AU$ 4,300. Moreover, costs accrued because of the loss of plants and lawn which died during drought periods and had to be replaced. Additionally, car washing caused additional costs of between AU$ 15 million to AU$ 30 million per year because this activity was restricted first by Level 2 after December 2005. In SEQ 165,000 pools existed in 2006. Under restrictions of Level 4, each pool had to be covered after July 2007. A pool cover or blanket costs about AU$ 300. Therefore,

[204] See Queensland Government 2008

this restriction-requirement caused costs additional of approximately AU$ 49.5 million.[205]

All these additional costs could be indicators for a higher WTP to avoid restrictions. Hence, the value of WTP could be good evidence for real occurred costs but there is no enumerated value existing for total costs affecting residents in SEQ.

Water restrictions addressing residents also affect business directly or indirectly by a change of demand for business products or services, as pointed out below.

2.3.3 Effects on business

Since these restrictions do not regulate agriculture in SEQ, effects on business could be only experienced by power stations and urban businesses. Since businesses, including government agencies, account for circa 22 % of the total urban water use (see Figure 6), water restrictions could save 29,803 ML/a [206] of total consumption in December 2007 compared to the pre-restriction period 2004/05. With these water-savings, business could reduce costs for water supply and sewage. This would be a positive effect on business on the one hand. For instance, the Brisbane City Council announced, in a fact sheet for efficient water usage in hotels, that the hotel 'Sofitel' in Brisbane made immense water savings by increasing water efficiency. The hotel saved approximately 18 million litres of water per year which resulted in a savings of approximately AU$ 30,000 annually. Additional savings are made by economising on electricity, which is used to heat water, and on chemicals used for cooling towers.[207] On the other hand, in this particular example, costs for installation of water efficient technology and other investments and initiatives were not disclosed by the council. A long payback period might be expected.

Another positive effect occurs for businesses which produce products or services which support the restriction regime in SEQ. For instance, licensed plumbers or producers of sub-meters or pool covers were in increasing demand and made substantial gains. Hence, new markets were established by water restrictions.

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[205] See Marsden Jacob Associates 2006, p. 19 f.

[206] Total urban water consumption was 428,693 ML/a in 2005 (see Queensland Water Commission 2008 a, p. 77.) and non-residential consumption of water dropped by circa 31.6 % (see Queensland Water Commission 2008 h, p. 4.)

[207] See Brisbane City Council 2008, p. 4.

Contrary to the positive effects of restrictions concerning businesses, huge losses resulted from the implementation of water restrictions in SEQ.

As mentioned before, MJA prepared a study regarding costs which resulted from the preparation and implementation of WEMPs. The study estimated costs of AU$ 1,104 per WEMP, regarding the commercial WTP which Hensher et al. (2006) valued in their study discussed earlier.

WEMPs had to be prepared from restriction Level 2 on (see Subsection 2.2.1.1). 80 % (242 accounts) of large manufacturing companies had to prepare WEMPs. Additionally, 10 % out of the 18,548 existing commercial accounts had to develop a WEMP. Including the WEMPs from industry, the total costs for providing and implementing WEMPs were estimated at AU$ 3.4 million for Level 2. At restrictions of Level 3, 25 % of business accounts had to reduce their water consumption by 25 % or target the best practice of water efficiency. This caused costs of approximately AU$ 7.8 million according to MJA. They found that costs for preparation of WEMPs were relatively low in comparison to the implementation process.[208] Implementation includes investments in water efficient technology, self-supplying systems (rainwater tanks), or process changing procedures which are required by restriction exigencies. These processes are cost intensive and necessitate high capital investment. Depending on the sector and business, water and wastewater costs account for only a minority of the total utility costs of a company. However, restrictions do increase the relative part of water costs to total utility costs.[209]

In general, business incur the costs of preparing a WEMP, costs of changing processes and finding substitute supplies, the loss in amenity from water use, and costs caused by the movement of labour and capital to alternative uses (adjustment costs). All these incurred costs were not specified by any study and cannot be enumerated at this point. Further research is required to find out how these costs impact on business.

MJA concentrated their research on a specific sector: the lifestyle horticulture sector which was previously referred to in Section 1.5 and includes nurseries, turf

[208] See Marsden Jacobs Associates 2006, p. 79 f.
[209] See Holt et al. 2000, p. 326.

farms, swimming pool builders and suppliers, as well as landscape gardeners. The total number of operators in this sector was 3,141 in June 2003 with 5,813 employees in SEQ. The most significant employers in this class of business were landscapers (1,285), wholesale nurseries (1,026), and retail nurseries (937).
MJA contacted businesses, by systematic telephone interviews, to find out about demand for business' products or services. As a part of this study, they contacted 20 lawn-mowing businesses in SEQ. They found that under restrictions of Level 2 20-30 % (Level 3: 40 %) demand decreased for products or services of the lifestyle horticultural business. This shows the indirect effect of residential restrictions on businesses. But MJA also found that business started to diversify their supply of products or services to adapt to restrictions. Mostly affected were growers supplying their products to retail nurseries. They experienced a 30 % decline in sales, part of which may be attributed to drought not just restrictions. Since the total sales revenue was AU$ 321.8 million for green life (trees, shrubs, bedding plants etc.) in 2002/03, a 30 % decline would mean a loss of AU$ 96.54 million.[210] Another result is that these companies reduced their staff or did not hire new staff when existing staff resigned. Therefore, the unemployment rate increased, but there are no data existing about dimensions of unemployment caused by restrictions in SEQ.
Data about effects of restrictions or dimensions of restrictions on power stations in SEQ are not available. Therefore, a statement about effects on power stations is not possible.
As shown, water restrictions have enormous effects on business. Caused by the lack of data, exact assumptions about total loss or gain cannot be made. Therefore it is necessary to do further research, especially when SEQ plans to continue having water restrictions in future. While much adjustment has already been made, long-term restrictions could have additional significant impacts on business and economy in this area.

[210] See Marsden Jacob Associates 2006, p. 50.

2.3.4 Occurrence of public costs

Water restrictions have significant impacts on the welfare of a society including effects on residents and businesses. In addition to that, public costs occur. Public costs are expenses spent for public welfare by governments.[211] Since there is no enumerated value about costs which would be generated in situations of serious water shortfalls, it must be suggested that costs resulting from restrictions are less than costs which would have appeared without restrictions.

Public costs, such as planning costs, promotion costs, costs for health as well as environmental costs could be attributed to restrictions.

In SEQ, there are many public open spaces such as parks, botanical gardens, sports fields, and reserves. From restriction Level 1 on, public open spaces were affected by restrictions. To give an example of the scope of damages caused by not watering plants and lawns, the Gold Coast City Council accumulated losses, caused by drought and the implementation of restrictions, of approximately AU$ 0.5 million until 2006. From restriction Level 2 on, it was not allowed to top up or fill lakes or ponds, and all fountains could not be operated if they used potable water. This caused a loss of amenity.[212] Additionally, AU$ 2.5 – 3 million was spent for planning restrictions, AU$ 10 – 12 million per year for the advertising and promotion of water savings. The rebate system for rainwater tanks and water efficient devices cost AU$ 20 million.[213] Monitoring and enforcement cost an additional AU$ 1.6 million per year. In total, it cost AU$ 50.2 million (without the costs of damaged plants or lawns) until 2006. Costs after this year are not itemised publicly.

Urban green spaces and vegetation provide several ecosystem services from which humans benefit. Air pollution is minimised, temperature in summer decreased, there is a reduction in the speed of wind, stormwater and its quality is regulated and green spaces absorb and sequestrate carbon. Yamamoto (1999) found in a study that trees in Brisbane sequestrate between 1.3 % until 1.8 % of carbon emissions produced in Brisbane and that energy for cooling processes

[211] Own definition
[212] See Marsden Jacobs Associates 2006, p. 40 f.
[213] See Marsden Jacobs Associates 2006, p. v.

could be saved by between AU$ 11 to AU$ 24 per dwelling.[214] These ecosystem services however cannot be exploited when the conditions of plants and green spaces are not in balance. Hence, when pollution is not internalised in private prices, social costs and therefore externalities occur.

Additionally, the existence of more dust and pollen means that people who have asthma or allergies are affected more. The result of restrictions on watering public areas is an increase in health costs. This increase in costs would be further intensified by the risk of injuries caused by carrying buckets to water outdoor facilities or by sport activities played on sports fields that were too hard.[215]

As mentioned in Subsection 2.3.3, water restrictions made the situation of employment in the lifestyle horticulture sector difficult. If unemployment increases as a result of restrictions, it would cause higher costs to society.

All in all, there are high public costs generated by water restrictions. These impacts must be considered when a government decides on a restriction scheme as did the QWC.

2.4 Planned restrictions

In spite of the high economic costs and unpleasantness, the QWC plans to implement restrictions to councils which were not previously affected by water restrictions. In future, the water restriction level 'medium' applies to all councils except the Toowoomba Regional Council, whereas the Redland City Council, Scenic Rim Regional Council and the Sunshine Coast Regional Council were not previously involved in Level 6 restriction.[216] This step is made also when the combined dam levels were at 74.51 % on 19th June 2009.[217]

From the 1st of July 2009 on there should be restrictions about watering established and for newly established gardens and lawns, the filling or topping up of pools and spas, washing vehicles and outdoor cleaning etc. for residents and non-residential premises. By the 31st of October 2010 commercial vehicle washing, existing spas and swimming pools, and urinals have to install water efficient fit-

[214] See Yamamoto 1999 and Marsden Jacobs Associates 2006, p. 46.
[215] See Marsden Jacobs Associates 2006, p. 44 ff.
[216] See Queensland Water Commission 2009 h, p. 1.
[217] See Queensland Water Commission 2009 i.

tings and submit a plumbers certificate or a statutorily declaration to their councils. By the 30th of November 2009 public swimming pools, premises with a larger consumption than 10 ML per year, nurseries, turf farms and market gardens, and cooling towers have to submit a WEMP. For more details regarding the schedule of the water restriction with a medium level, see Appendix 8.

Surprisingly, the QWC clarified, in their classification of levels of water restrictions, that the trigger for medium level restrictions is a combined dam level of 50 % (see Table 2). The trigger value for the entrance to the lowest level of permanent water conservation is 60 %. Therefore, it is not clear why water restrictions of medium level were introduced when combined dam level, at the moment, is 74.51 %.

This shows that SEQ will remain under a level of long-term restriction when the critical situation of drought and water shortage is over. This will have explicit effects on the economy and society of SEQ.

3 EVALUATION OF RESTRICTIONS

Water restrictions are -next to water pricing- one possible way to manage demand on water. When the pricing-policy could decrease demand for water in the long-term more efficient than restrictions[218], the government of SEQ decided for a restriction regime in 2005. As mentioned above, the SEQ's water restrictions were accompanied by advertising campaigns and incentives for improvement of water efficiency. Evidence of the success of this program was shown by the decrease in demand for water. But it has to be queried if it was the most efficient way of demand management.

3.1 Advantages of restrictions

The average residential water usage was 300 litres per person daily before restrictions came into effect in SEQ. This average was much higher than in other OECD-countries. Water usage was inefficient and awareness of the impact and seriousness of drought and the subsequent shortfall of water went for the most part unnoticed. After restrictions came into effect the average daily consumption decreased clearly to 125 litres per person in September 2008. But water restrictions were not only placed on residents, they were also placed on businesses and other public facilities in SEQ. Non-residential consumption dropped by circa 31.6 % by the December 2007 quarter compared to a pre-restriction period.[219] Restrictions were combined with an educational program and subsidies were offered for water efficient technology. For instance, QWC distributed a shower timer to residents with the slogan "if we all cut our showers to 4 minutes, we'd save up to 90 million litres a day" (see Appendix 9).

Since quantity-rationing policies, such as water restrictions, only resulted in a movement of customers along the demand curve[220], educational programs and therefore a change of 'taste' or subsidies of efficient water use technology shifts

[218] As long as demand is still price-elastic because of existing reserves to improve efficiency in water consumption. See Hoffmann et al. 2006, p. 357, Huges et al. 2008, p. 11, Grafton et al. 2008, p. S58.
[219] See Queensland Water Commission 2008 h, p. 4.
[220] See Shaw 2005, p. 122 f. and Griffin 2006, p. 154 f.

or rotates the demand curve.[221] This shifting means a long-term change in water demand.

Additional positive effects of restrictions could be achieved by the requisition of WEMPs and their implementation.[222] Once a business installed water efficient technology, they would not reverse the installation back to water inefficient technology. This means that there is also a shift of demand curve. Consequently, if water restrictions were removed, it is highly unlikely that demand would go back to the same water inefficient consumption levels it did prior to the implementation of restrictions. The same result would apply to alternative landscaping[223]. Once a customer decided to replace dead plants with plants that did not need as much water, they would still save water even when there are no water restrictions anymore.

Water restrictions are an applicable institutional arrangement to reduce demand in drought periods and prevent high welfare costs which would occur in situations of serious water shortfalls. However, restrictions must be combined with other policies to receive a long-term and demand shifting result. Without other policies it would be only a short-term solution with a lot of disadvantages as discussed below.

3.2 Disadvantages of restrictions

To evaluate restrictions, they must be contemplated individually without additional initiatives such as advertising or other incentives to reduce water demand. Without this, restrictions would not shift or rotate the demand curve. Therefore, demand would go back to the same behaviour pattern it did before the implementation of restrictions. Restrictions cannot be a long-term solution to solve water problems as in SEQ with its forecasted population growth. Hence, this demand management strategy caused huge costs and welfare loss (shown in Section 2.3) without having a long-term effect for the future.

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[221] See Shaw 2005, p. 123 and Griffin 2006, p. 156.

[222] WEMP's are seen as part of restrictions by QWC, but have also a character of an incentive for improvement of water efficiency.

[223] See Shaw 2005, p. 123.

When water usage is already efficient and there are no other ways to improve efficiency of consumers (e.g. with water saving technology) then water restrictions always entail welfare losses and economical damages. The longer and higher restrictions are, the higher the welfare loss and damage. In addition, water efficient companies have to reduce their water consumption by 25 % if they cannot prove that they are already water efficient in comparison to other business of the same sector. This is an unrealistic expectation, of the initiator of water restrictions, to believe that businesses have access to competitors data regarding their water consumption. Therefore, companies, who are already water efficient, have to reduce their consumption by 25 % as well. This general percentage cut back of water consumption is not economically reasonable, because already efficient businesses must still reduce their production as a consequence (such as happened in the lifestyle horticultural sector in SEQ). This results in negative economic growth and effective allocation is not possible.

Additional disadvantages occur when businesses, under water restrictions, have economical activities outside the region and competitors in other regions are not restricted in their water consumption. The non-restricted business could underprice the restricted business which could result in a loss for the affected company. Consequently, there would be trade from unconstrained to constrained regions.[224] Therefore, water restrictions also intervene into competitive market processes.

[224] See Berrittella et al. 2007, p. 1809.

CONCLUSION

In this final thesis, water restrictions have been discussed as one institutional arrangement. Moreover, the development of water restrictions for the region SEQ and the main changes from the reform have been described. Strong effects on residents and businesses as well as heavy welfare effects were disclosed in this thesis. However, not all sectors were affected in the same way. Especially the lifestyle horticulture sector had immense losses due to direct water restrictions, on these businesses, and indirect effects caused by decreased demand for their products or services.

Hence, water restrictions modify the water market and interfere the market mechanisms which control demand and supply. The market mechanisms were not operating as they would have done in an ideal market situation, such as Pareto-Optimum and this lead to market failure and inefficiency.

In SEQ, water allocation is not efficient and the water market prices do not even cover costs or reflect scarcity of the good water. Therefore, this monopolistic structured water market is doomed to fail, resulting in inefficiency and welfare losses.

Water restrictions did however, result in some successes and decrease demand. This has been illustrated and discussed in this final thesis. The critical drought period was endured without significant changes in the water supply system and a serious water shortfall (which would cause high costs and welfare losses) was avoided.

Since a decrease of demand is limited, supply must be expanded and be more flexible. Hence, the supply system must change to achieve a stable water supply and ensure flexibility. Therefore, water reforms were necessary to improve the water supply in SEQ.

This is going to be realised in SEQ in the future. In 2012, 62 % of the total water supply will come from existing dams, 15 % from committed dams, 4 % from groundwater, 7 % from desalination facilities and 12 % from recycled water.[225] In addition, the water grid will be more flexible due to expansion and the connecting

[225] See Queensland Water Commission 2008 a, p. 108.

of major bulk water sources in SEQ. Consequently, water transportation will ensure that water is moved from areas with a water surplus to areas experiencing a water shortfall.

Opportunities for supply enhancement are centred around the use of alternative water supplies such as stormwater harvesting, desalination plants or the reuse of wastewater and municipal effluent.[226] These types of water catchment are sustainable and would guarantee a safe water supply to meet the needs of a rapidly increasing population, now and in the future.

For example, the Western Corridor Recycled Water Project is one of the largest water recycling projects in the world. With a capacity of 84,700 ML per year, by treatment of six wastewater treatment plants, it has supplied power stations and industry since the end of 2008. Another example is the SEQ Desalination Facility on the Gold Coast. By the end of 2008, the water supply was enhanced by 45,600 ML per year through the desalination of sea water.[227]

Additional important supply enhancements include rainwater tanks and stormwater harvesting. Rainfall can be very heavy in SEQ. Therefore, the installation of rainwater tanks on existing or new houses and on commercial buildings increase water supply significantly. This ensures greater independence for consumers and decreases demand for public water supply from existing water supplies. In SEQ rainwater tanks are becoming more common as a source of water. For instance, the Brisbane City Council reported that rebates on 18,981 rainwater tanks installed by residents were given between 2002 and 2007.[228] To meet the needs of a household with a daily water demand of 550 litres, a tank size of 90,000 litres, with a water catchment area of 290 m^2, is required.[229] Hence, it is impossible to cover full demand by rainwater tanks, but it does contribute to the total overall water supply and decrease demand for public water supply.

Stormwater harvesting involves the capture of rainwater from impervious or hard surfaces, and is collected in pipes or stormwater drains to be stored in small dams

[226] See Glennon 2006, p. 1 f.
[227] See Queensland Water Commission 2008 a, p. 109 ff.
[228] See Queensland Water Commission 2008 a, p. 77.
[229] See Warrick 2009, p. 4.

or reservoirs.[230] This solution of water catchment is very costly and is only a good solution when prices on the water market are high and reflect water scarcity.

To achieve optimal water allocation in the long-term, a combination of the right water pricing system[231], competition of water supply, flexible water rights, educational programs, subsidies for efficient technologies, investment in research, as well as usage of non-traditional water supply sources could improve the situation in SEQ without restrictions.
If all of the aforementioned solutions were implemented, restrictions would only be necessary, on short-term basis, in times of extreme drought. The short-term implementation of water restrictions would minimize welfare losses and would not impact on businesses to the same degree they have, to date, in SEQ.

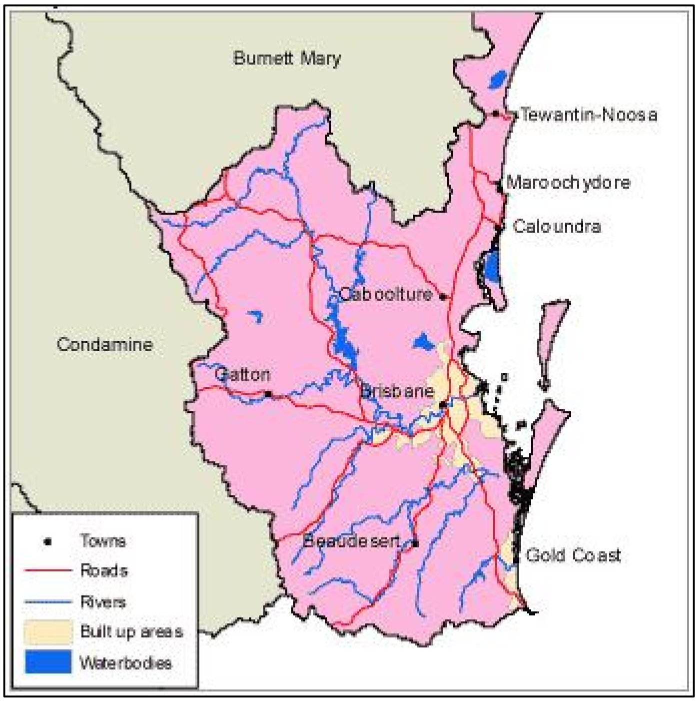
Market mechanisms have a strong role to play in managing a scarce commodity such as water. Flexible mechanisms and prices are essential to deal with increasing demand for water and limited natural water supply from existing sources. When SEQ is finally capable of increasing supply by the implementation of the aforementioned non-traditional water supplies and were able to keep demand on a efficient level, it would ensure the water supply, in SEQ, for future generations.

[230] See Queensland Water Commission 2008 a, p. 91 f.
[231] The most efficient water pricing system would be scarcity pricing which includes the full opportunity costs. Prices for water are high when water gets scarce; when water storages fill again and water gets less scarce, the market price for water decreases. (See Hughes et al. 2008, p. 13 and Sydney Water 2007, p. 88.) In serious drought period prices would increase significantly. Therefore, a society must be careful that customers still could satisfy their basic needs for water also when their price-elasticity is getting inelastic.

LIST OF APPENDICES

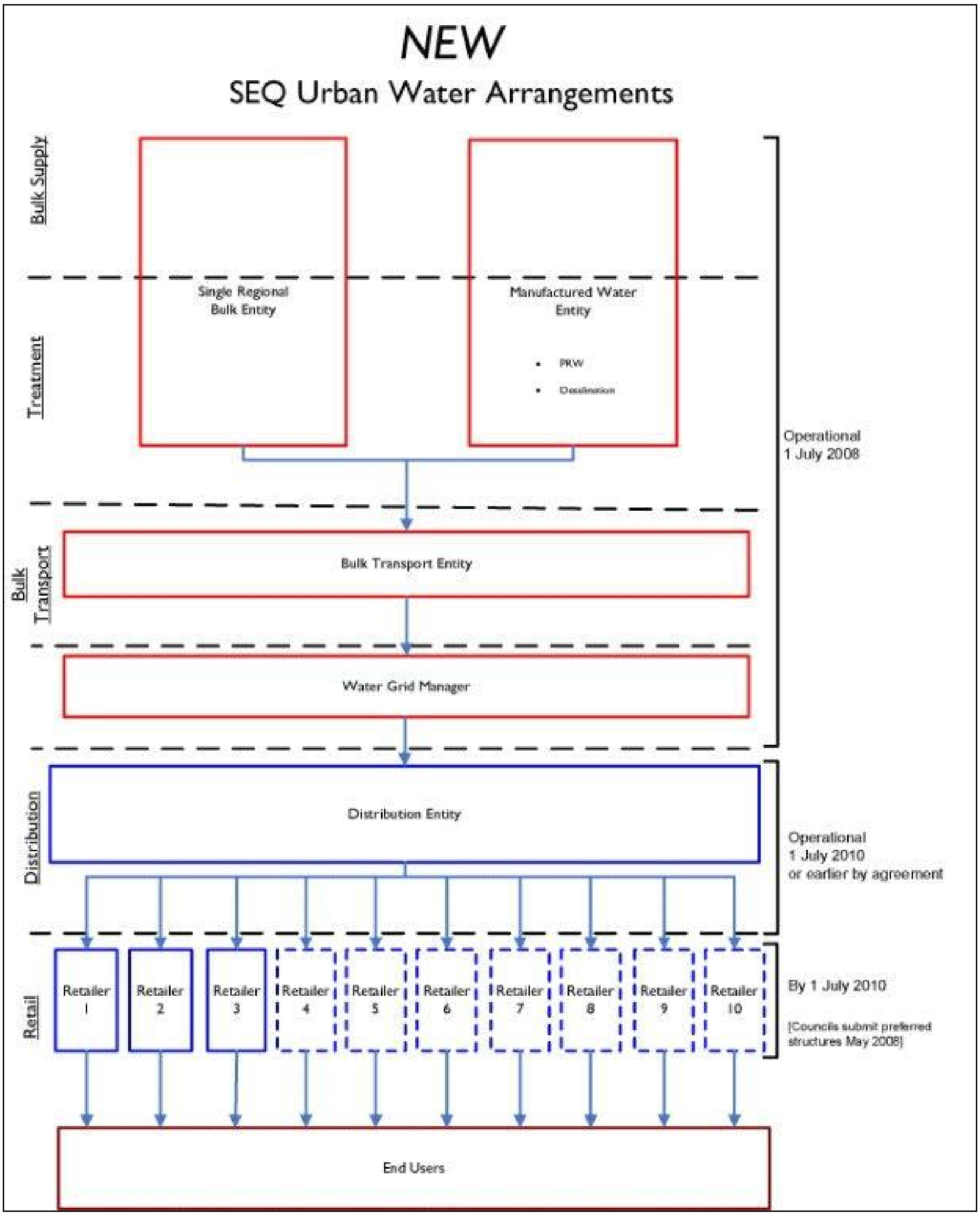
APPENDICES

Appendix 1: Map of South East Queensland, Australia



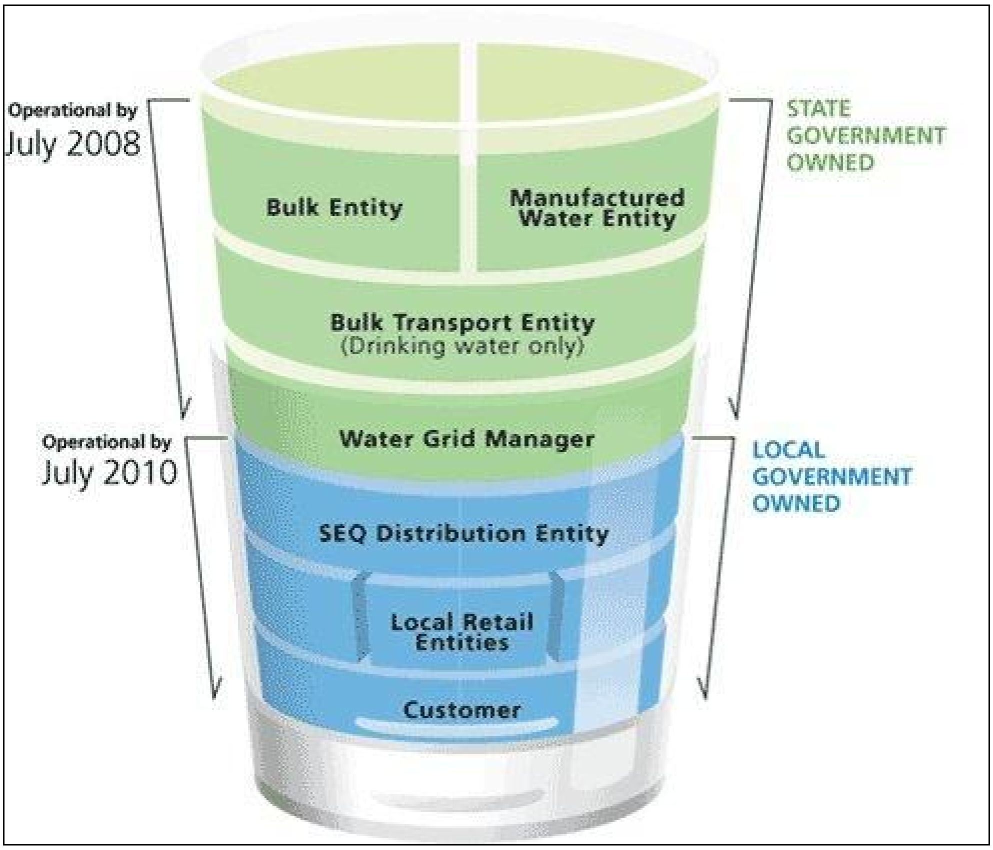
Source: Australian Government (2008): South East Queensland – Natural Resource Management region, http://www.nrm.gov.au/nrm/qld-seq.html, 12. May 2009

Appendix 2: Future SEQ urban water arrangements



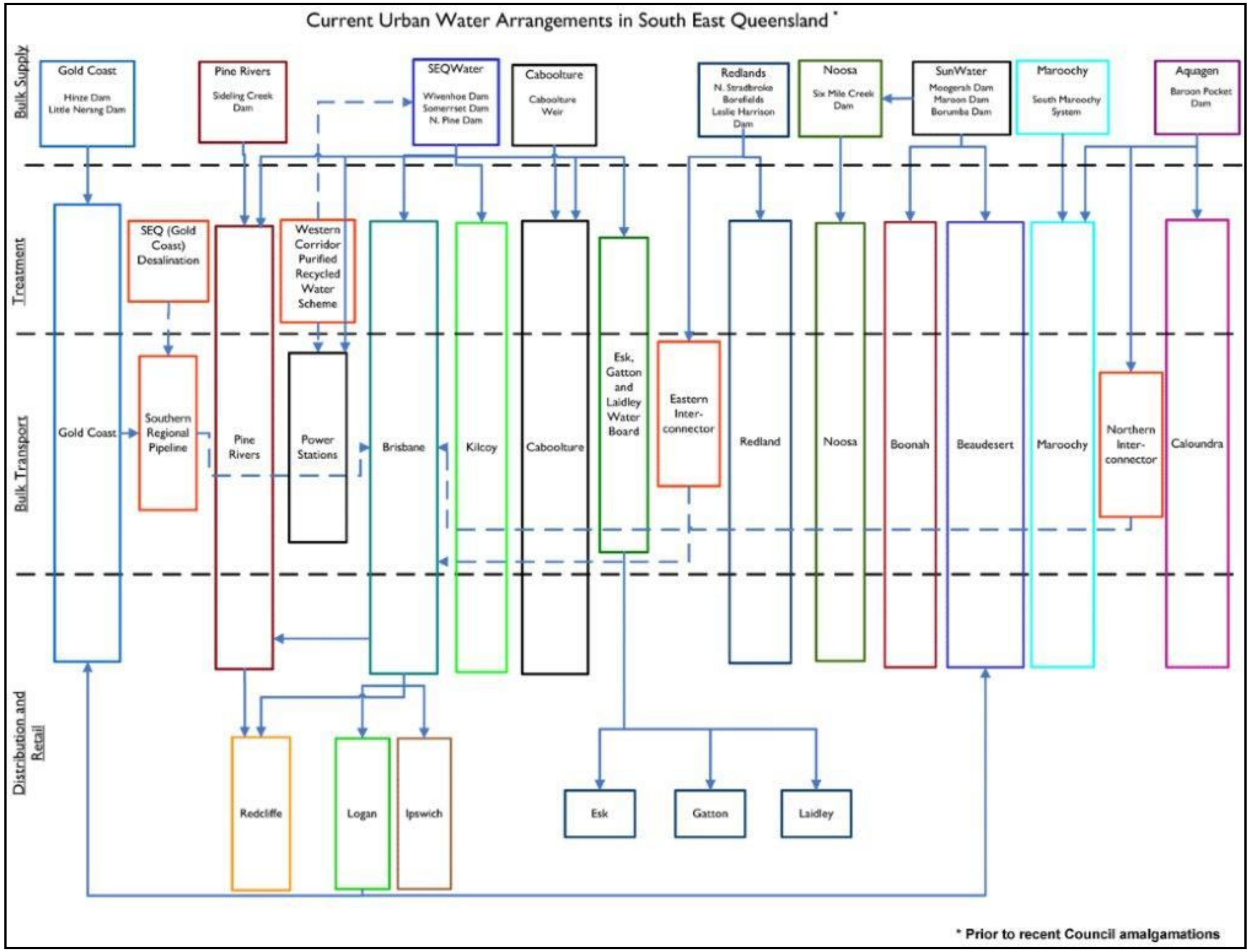
Source: Queensland Water Commission (2009a): New SEQ Urban Water Arrangements, http://www.qwc.qld.gov.au/myimages/qwc/seq-water-reform-fig2.gif, 21. May 2009.

Appendix 3: Water Reform Model



Source: Gold Coast City Council (2009): South East Queensland Water Reform: Water Reform Model, http://www.goldcoastwater.com.au/t_gcw.asp?PID=7457, 21. May 2009.

Appendix 4: Current Urban Water Arrangements in South East Queensland



Source: Queensland Water Commission (2009b): Current Urban Arrangements in South East Queensland, http://www.qwc.qld.gov.au/myimages/qwc/seq-water-reform-fig1.gif, 21. May 2009

Appendix 5: Councils in SEQ

Source: Council of Mayors, South East Queensland (2008): About the Council of Mayors, http://www.infrastructurenow.com.au/About+Us, 02. June 2009.

Appendix 6: Water restrictions Level 1 to 4

	Level-1	Level-2	Level-3	Level-4
Date implemented	13 May 2005	3 October 2005	13 June 2006	1 November 2006
Entry trigger (combined storage volume)	40%	35%	30%	25%
Exit trigger (combined storage volume)	To be confirmed	40%	35%	30%
Target water savings (relative to BAU)	11%	21%	25%	30%
Observed water savings	22%	28%.	39%	n / a
Watering of *established* gardens, lawns & landscaping (residential)	Calls for the voluntary implementation of water saving practices.	Watering using attended hand held hose permitted every second day before 7.00am and after 7.00pm. Watering with hand held buckets or watering cans is permitted at any time. No sprinklers allowed.	Watering gardens and lawns with hand held buckets or watering cans only.	TBA As for level-3 but could include time restrictions on watering using buckets.
Watering *new* gardens lawns & landscaping (residential)	n / a	Watering permitted for 1 hour daily for the first 14 days following establishment.	As for level-2	TBA
Watering of hard surfaces	n / a	Prohibited.	Prohibited.	Prohibited.
Other restrictions (residential)	n / a	n / a	n / a	Could include requirement that pools only allowed to be filled / topped up if covers fitted, or if filled using substitute supplies.
Non-residential sector – rules	No requirements.	As for residential restrictions, plus: ▪ Watering of road reserves and parks with potable water is prohibited. ▪ Active playing surfaces can be watered before 7.00am and after 7.00pm on any day to allow competitive sport and / or to maintain ability to be used for the intended active purpose. ▪ Watering of commercial nursery, turf farm and market garden stock and production areas is only permitted before 7.00 am and after 7.00 pm on any day. ▪ Topping up or filling of ponds, lakes and other water features with potable water is prohibited. Fountains using potable water must not be operated.	As for level-2	TBA
WEMPs required	n / a	If an exemption is required (see below).	If an exemption is required (see below). Water efficiency management plans that target a 20% water saving or best practice water efficiency are recommended for sports grounds, active playing surfaces, nurseries, turf farms and market gardens.	As for levels-2 and -3, but also businesses and sporting clubs to develop and implement WEMPs. Industrial customers also required to develop WEMPs.
Exemptions	n / a	Exemptions to water-restrictions for designated significant parks and gardens, sports grounds, active playing surfaces, nurseries, turf farms and market gardens and commercial vehicle washers are available, subject to council approval and the development of a WEMP.	As for level-2.	
Sectors affected	Residents, lifestyle horticulture, public sector.	Residents, lifestyle horticulture, public sector, vehicle washing, car dealerships.	Residents, lifestyle horticulture, public sector, irrigation sector, vehicle washing, car dealerships.	Residents & lifestyle horticulture, public sector, commerce & industry, irrigation sector.

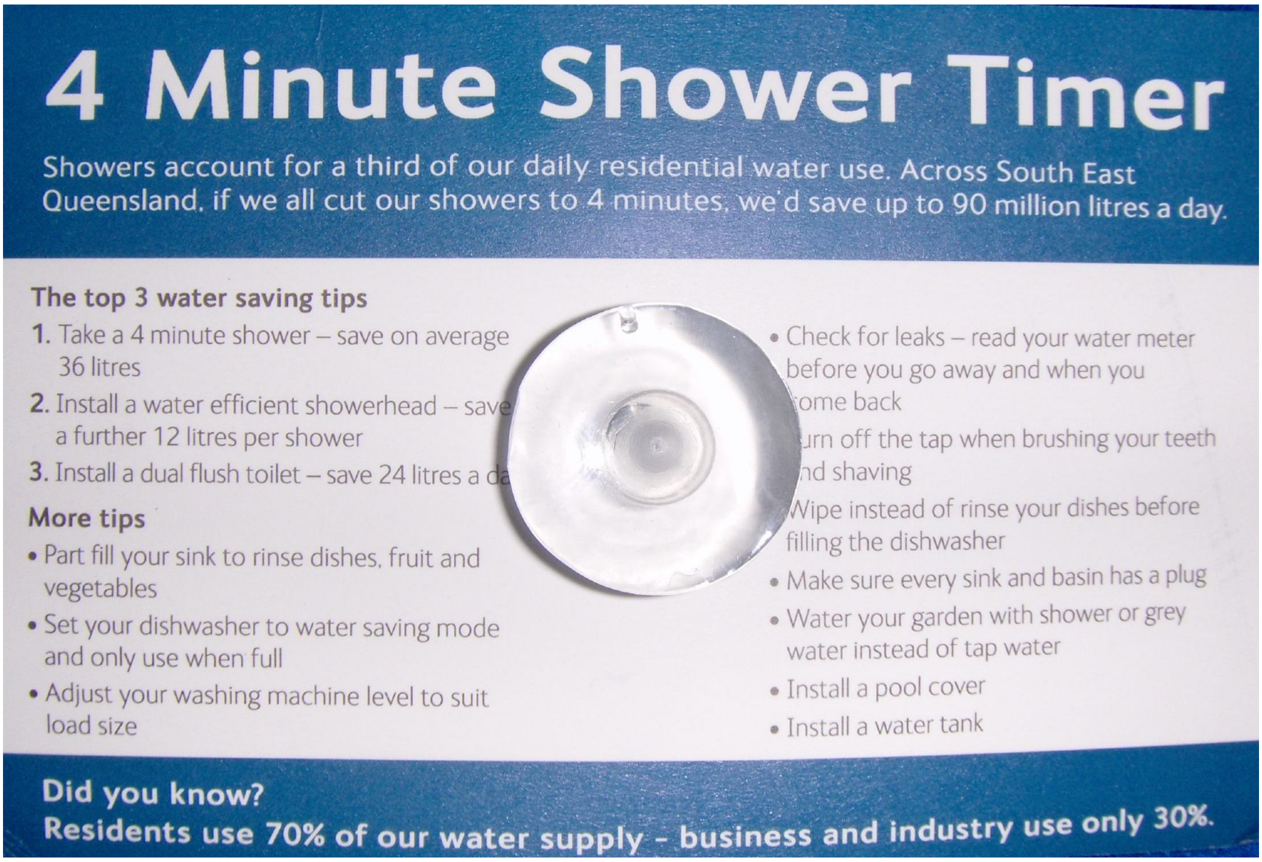
Source: Marsden Jacob Associates (2006): Economic Cost of Water Restrictions in South East Queensland: A report by Marsden Jacob Associates for the Queensland Department of Natural Resources & Water, Final Report: 31 October 2006.

Appendix 7: The 'willingness to pay' approach

"The economic cost of water restrictions is often evaluated by estimating the WTP of residential, commercial and industrial customers to avoid restrictions. WTP to avoid water-restrictions will be driven by a number of factors including some of the costs of mitigating action, the value that people attach to maintaining gardens in a healthy state, the value attached to other activities constrained by water-restrictions (e.g hosing down pathways), and the 'inconvenience factor' associated with restrictions. Ultimately, however, WTP represents the value people attach to an uninterrupted water supply given the many factors that contribute to the enjoyment/ satisfaction people derive from water use." (Marsden Jacob Associates (2006): Economic Cost of Water Restrictions in South East Queensland: A report by Marsden Jacob Associates for the Queensland Department of Natural Resources & Water, Final Report: 31. October 2006, p. 19.)

The method of WTP is "most commonly estimated using one of two techniques: choice modelling (CM) or contingent valuation (CVM). Both are 'stated preference' techniques in that they involve directly asking respondents how much they would be willing to pay to avoid water-restrictions." (Marsden Jacob Associates (2006): Economic Cost of Water Restrictions in South East Queensland: A report by Marsden Jacob Associates for the Queensland Department of Natural Resources & Water, Final Report: 31. October 2006, p. 21.)

Appendix 8: QWC's advertisement for 4 minute showers



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