Report for the Essential Services Commission of South Australia

LRMC of SA Water's Trade Waste services

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sapere research group

About Sapere Research Group Limited

Sapere Research Group is one of the largest expert consulting firms in Australasia and a leader in provision of independent economic, forensic accounting and public policy services. Sapere provides independent expert testimony, strategic advisory services, data analytics and other advice to Australasia's private sector corporate clients, major law firms, government agencies, and regulatory bodies.

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Contents

Glossary

AAF	Average annual flow
AIC	Average incremental cost
BOD	Biochemical oxygen demand
Commission	Essential Services Commission of South Australia
EPA	Environment Protection Authority of South Australia
LRIC	Long run incremental cost
LRMC	Long run marginal cost
NWI	National Water Initiative
Sapere	Sapere Research Group
Turvey method	The perturbation method to calculating LRMC.
SS	Suspended solids; a measure of suspended particles in an effluent
TDS	Total dissolved solids
TKN	Total kjeldahl nitrogen
TP	Total phosphorus
NFR	Non-filterable residue another term for "suspended solids"
PWWF	Peak Wet Weather Flow
WWAS	Waste water asset system
WWTP	Waste water treatment plants

Summary

Introduction

The Essential Services Commission of South Australia (Commission) is inquiring into options for pricing reform for drinking water and sewerage retail services provided by SA Water.

To assist them with this inquiry, the Commission engaged Sapere Research Group (Sapere) to undertake an assessment of the appropriateness of using long run marginal cost (LRMC) pricing for trade waste services, and the use of location-based pricing. Sapere has also prepared separate papers on LRMC pricing of water and sewerage services.

SA Water defines trade waste as any wastewater and substances contained within it, arising from any commercial, industrial, business, trade or manufacturing activity, which is discharged from a property to an SA Water sewerage system. SA Water's standard sewerage service includes the collection, treatment, and disposal of wastewater (i.e. sewage) from normal activities in households and from staff and office amenities such as toilets, showers and tearooms, to SA Water's sewerage system. Customers wishing to discharge any other sewage into the system must first apply to SA Water for specific authorisation.

Trade waste differs most notably from sewerage services in that it is practical, for large customers, to meter usage volumes. Currently trade waste usage charges are only applied to the largest trade waste customers.

LRMC of managing trade waste

The volumetric costs of managing trade waste relate to the cost of processing at waste water treatment plants (WWTPs). SA Water reports that currently 97 per cent of trade waste is treated at the SA Water's Bolivar WWTP.

SA Water recently provided estimates of the LRMC of trade waste services for the Bolivar WWTP. The results suggest that a significant increase in trade waste fees would be required.

We have recommended an adjustment to SA Water's LRMC estimate for sewage flow volume. This is because SA Water's estimate is based on average flows received (i.e. inflows) and not the contribution of sewage produced by customers to the peak flows. Due to infiltration, inflows differ from flows produced by customers. It is also necessary to consider peak flows, as it is the capacity required to meet peak flows that drives additional investment. We have modified SA Water's original estimate to estimate the LRMC of sewage volume to be $0.40 per kL of sewage produced.

The broad approach adopted by SA Water to estimate LRMC for the other trade waste services (pollutants measured by load) appears reasonable. We have a concern that the methodology to apportion costs between pollutants does not accurately estimate the marginal impact of each pollutant; however, this may not be a material issue, given the uncertainty in forecasting future demand.

Should short run or long marginal cost pricing be used?

As trade waste can be efficiently monitored, some form of marginal cost pricing should be used. The alternative to LRMC pricing is to price at short run marginal cost (SRMC), whereby the prices are based on a temporary (as opposed to permanent) change in demand. Generally SRMC would reflect the variable costs and not include future capital costs of expansion.

A SRMC price could provide a more efficient price signal if trade waste customers were responsive to short-run price signals; that is producing more trade waste when prices were low and responding rapidly to increasing prices. However SRMC pricing causes higher price variability, which may be costly for business and send a less transparent price signal if businesses are not made aware of how prices may change.

We expect the additional efficiency benefits of using SRMC are likely to be minimal and would likely be outweighed by the costs; in particular, the risk of sending an inefficient price signal in the long-run. On this basis, adopting SRMC pricing for trade waste would not appear to be a worthwhile alternative and, therefore, we recommend using LRMC pricing for trade waste customers.

Nevertheless, in situations where the demand for trade waste services is stable, the SRMC and LRMC should be similar.

Need for location based pricing

Where there are no capacity constraints, the LRMC will be closer to SRMC and, therefore, may differ substantially to the LRMC from the Bolivar plant. Given that only 3 per cent of trade waste volumes are treated at WWTPs other than Bolivar, the benefits of locational based pricing of trade waste are likely to be very small. However, the costs of locational based pricing, which are administrative, may also be very small.

In situations where the entry of a new customer, or the expansion of existing customer, drives the need for (or advances the need for) new capital investment, it would be efficient for the customer to be levied directly for the incremental cost caused by the customer's action. Such a levy would provide an efficient signal to customers as to the costs of new development and expansion and, in effect, provide an appropriate location-based price signal for capital costs.

1. Introduction

SA Water defines trade waste as any wastewater and substances contained within it, arising from any commercial, industrial, business, trade or manufacturing activity, which is discharged from a property to an SA Water sewerage system. SA Water's standard sewerage service includes the collection, treatment, and disposal of wastewater (i.e. sewage)[1] from normal activities in households and from staff and office amenities such as toilets, showers and tearooms, to SA Water's sewerage system. Customers wishing to discharge any other sewage into the system must first apply to SA Water for specific authorisation.[2]

A key action in the National Water Initiative (NWI) requires jurisdictions to review and develop pricing policies for trade waste to encourage the most cost-effective methods of treating industrial wastes, whether at the source or at downstream plants.

In recent years, SA Water has sought to develop trade waste prices in line with the NWI pricing principles. SA Water is responsible for determining the prices it charges for trade waste customers (within a regulated revenue cap).

To assist the Commission in reviewing the most appropriate methodology for setting trade waste prices, the Commission engaged Sapere Research Group (Sapere) to develop this report, to assess the appropriateness of setting trade waste prices based on long-run marginal cost (LRMC), including at a regional level.[3]

To assess the appropriateness of LRMC pricing of trade waste services, this report:

- provides a background to SA Water's trade waste services and the Commission's price setting role (Section 2)
- examines information on current and expected trade waste costs and LRMC estimates developed by SA Water (Section 3)
- reviews alternative pricing structures (Section 4), and
- provides recommendations as to the appropriateness of using LRMC to price trade waste services (Section 5).

1 The terms 'wastewater' and 'sewage' may be used interchangeably. For consistency we have used the term 'sewage' where possible.

2 SA Water, Trade Waste 2013-14 Key Information, available from http://www.sawater.com.au/sawater/yourbusiness/tradewaste, accessed 18/Nov/2013.

3 This paper is one of four papers on the LRMC prepared by Sapere for the Commission. The others are on a background to LRMC pricing, a report on LRMC of SA Water's drinking water services, and LRMC of sewerage services.

2. Background

2.1 SA Water and the Commission

SA Water is a corporation wholly owned by the Government of South Australia (SA Government) that provides water and sewerage services to the majority of people in South Australia.

The Commission is the economic regulator for essential services in South Australia, including the water and sewerage services provided by SA Water.

Until recently, the Commission's role in water pricing was primarily focused on reviewing the Government's application of certain Council of Australian Governments (CoAG) pricing principles, namely under the 1994 Water Reform Framework and the 2004 National Water Initiative.

Due to recent reforms the Commission's role is expanding. On 1 July 2012, the *Water Industry Act 2012* (Water Industry Act) commenced, empowering the Commission under the *Essential Services Commission Act 2002* (the ESC Act) to make a determination regulating prices, conditions relating to prices, and price-fixing factors for water retail services. Under the Water Industry Act, the Treasurer is permitted to direct the Commission on various matters when making a price determination through a 'Pricing Order'. The Commission received two Pricing Orders relating to the first SA Water price determination, which have limited its powers to regulating SA Water's revenues only, for the duration of the first determination. Prices for this period will be set by SA Water and the SA Government.

The Commission is undertaking an Inquiry into options for reforming SA Water's drinking water and sewerage (including trade waste) prices. The Inquiry terms of reference require the Commission to examine options that promote economic efficiency and/or water security. The Commission has flagged that greater use of marginal cost pricing may increase economic efficiency.

In undertaking the inquiry, the Commission will be guided by its ESC Act. Section 6 of the ESC Act requires that, with regard to all of its functions, the Commission must have as its primary objective the '***protection of the long-term interests of South Australian consumers with respect to the price, quality and reliability of essential services.***'

2.2 Trade waste services

There are a number of different types of trade waste. The key trade waste measures used by SA Water are summarised in Box 1 below. In addition, SA Water measures (and charges based on) the volume of sewage produced by trade waste customers.

SA Water reports that there are about 8,000 metropolitan and 965 regional premises subject to an alternative tariff structure for the disposal of commercial / trade waste.[4] This accounts

4 SA Water, 2013, Regulatory Business Proposal, page 12.

for about 1.6% of metropolitan wastewater customers and 1.4% of regional wastewater customers. Trade waste customers are distributed around the state. However, SA Water reports that 97 per cent of trade waste is treated at the Bolivar Waste Water Treatment Plant (WWTP), which services the Adelaide and Greater Adelaide regions.[5]

Box 1: SA Water's measures of trade waste

- **Biochemical Oxygen Demand (BOD)** — A measure of the strength of sewage: the higher the value, the more putrescibles in the wastewater. It represents the oxygen needed by micro-organisms to oxidise and stabilise waste. Pollutants measured are biodegradable carbonaceous compounds, primarily from human faecal wastes. These include carbohydrates (e.g. starches and sugars), proteins and fats. Units are milligrams of oxygen consumed per litre of wastewater (mg/L).
- **Suspended Solids (SS)** — A measure of the small particles of inorganic (minerals) and organic matter carried in wastewater (e.g. grit, sand, clay, meat, vegetables). The organic component contributes to BOD. Units are milligrams of solids per litre of wastewater (mg/L).
- **Total Dissolved Solids (TDS) —** A measure of the salinity of a wastewater. TDS measures the combined content of all inorganic and organic substances contained in wastewater: molecular, ionized or micro-granular (colloidal sol) suspended forms. The most common chemical constituents are sodium, calcium, potassium and chloride. Salinity is a key measure of the suitability of recycled water for irrigation of crops and plants. Freshwater is typically defined as where TDS is less than 1,500 mg/L.
- **Total Kjeldahl Nitrogen (TKN)** — A measure of the total amount of inorganic and organic nitrogen (from ammonia, urea, proteins, amino acids and other compounds) present in wastewater. The term refers to the chemical test procedure used to obtain the measurement. Both nitrogen and phosphorous are considered pollutants when their concentrations in water are sufficient to allow excessive growth of aquatic plants, particularly algae. Units are milligrams of nitrogen compounds (expressed as the nitrogen equivalent) per litre of wastewater (mg/L).
- **Total Phosphorus (TP)** — Phosphorous is a nutrient and, in domestic sewage, principally originates from the degradation of phosphate-containing commercial detergents and the human metabolism. Some commercial practices also produce high levels of phosphorous compounds.

Source: SA Water Regulatory Business Proposal 2013, Attachment E.2 SA Water Wastewater Treatment Plants and Catchments (Section 1).

2.3 SA Water's management of trade waste

SA Water's framework for managing trade waste is comprised of a number of elements.[6] Volume based charges for trade waste form just one part of this framework. The other elements of this framework include:

- authorisation

5 SA Water unpublished data [Dinesh (2013), page 4].

6 These are outlined in SA Water's Restricted Wastewater Acceptance Framework, (SA Water, 2013).

- pre-treatment
- risk assessment
- compliance audits
- routine sampling and monitoring, and
- fees and charges.

Each of these elements is briefly discussed below. This discussion includes extracts from SA Water's Restricted Wastewater Acceptance Framework (SA Water, 2013)

Authorisation

SA Water provides water and sewerage services to our customers based on a Standard Customer Contract to supply. The sewerage service involves the collection, treatment and ultimate disposal of wastewater arising from normal activities in households and specific wastewaters relating to sanitation from other properties. All waste generators wishing to discharge trade waste into SA Water's sewerage system require a Trade Waste Discharge Permit. It is illegal to discharge unauthorised trade waste into SA Water's sewerage system.

Pre-treatment

Authorised waste generators are responsible for meeting an acceptable discharge quality determined by SA Water. Where SA Water believe that an authorisation applicant's untreated trade waste would not consistently comply, SA Water will require the authorisation holder to install appropriate equipment to pre-treat the waste. SA Water provides guidance and advice on pre-treatment and where appropriate specifies the basic equipment type and size needed to pre-treat trade wastes to an acceptable standard.

Risk assessment

SA Water calculates risk at each site by systematically assessing the aspects affecting trade waste discharge. This risk assessment is based on a number of factors relating to:

- Substance: the nature and quantity of substances discharged, or could be discharged
- Activity: the principal activity and its potential risks to the sewerage system
- History: the performance history of trade waste management on site
- Volume: the daily average, or maximum permitted volume of trade waste discharge from the site
- Network: how the location of the site's discharge affects the operation of the downstream portion of the sewerage network, and
- Controls: the level of control over trade waste discharge quality/quantity.

Of note, through the network factor, this risk assessment includes a location based assessment. This is of relevance from a pricing perspective as it means that the various risks posed by each customer site, and potentially new customer sites, could be factored into the system design and expansion (i.e. capital costs of expansion).

Compliance audits

As a condition of authorisation, each discharger of trade waste is responsible, at the discharger's expense, for demonstrating ongoing compliance with the authorisation conditions. Compliance audits of a discharger's premise are conducted on a random basis to verify compliance. The frequency and the cost of the compliance audits depends on the site risk assessment.

Routine sampling and monitoring

As a condition of authorisation, SA Water may require routine sampling and monitoring of trade waste discharges to test that authorisation holders comply with quality standards and quantity limits.

SA Water may require certain dischargers to demonstrate discharge compliance, or provide data for calculating trade waste charges, by providing results obtained from laboratory testing of collected samples. SA Water also collects samples from time to time for other purposes.

Fees and charges

All trade waste customers pay fees to cover administration costs, including the costs of authorisation, compliance audits, sampling and monitoring etc. To an extent, these fees provide customers with a partial incentive to reduce the costs imposed by them on the network.

Trade waste usage charges are only applied to the largest (around 40) trade waste customers. The bulk of trade waste customers do not pay SA Water usage charges for trade waste services. Rather, the trade waste charges are reflected in the wastewater charges which, as with residential and other non-residential customers, are based on property value.

Trade waste usage charges apply to those customers whose trade waste discharges exceed:

- 10 tonnes of Biochemical Oxygen Demand (BOD) or Suspended Solids (SS), or
- 20 tonnes of Total Dissolved Solids (TDS), or
- 10,000 kL volume per year.

For these customers, SA Water applies usage charges for five types of trade waste plus a waste water volumetric charge (as summarised in Table 1 below). We understand that these charges are based on the avoidable costs they impose on the sewerage system.[7] Customers who pay usage charges receive a reduction in the property-value based fees they charge.

In addition, separate charges apply for liquid waste accepted at SA Water's receiving stations from tanker trucks.

The revenue collected from trade waste charges in 2012/13 was estimated to be $5.5 million, which is roughly 1.6% of the revenue collected from sewerage rates and 1.3% of all sewerage services revenue.[8]

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7 Transparency Statement – Part A: 2010-11 Potable water and sewerage prices South Australia, page 56.

8 SA Water's sewerage revenue includes revenue from sources other than sewerage rates; these include revenue from community service obligations and recycled water sales. Source: The Commission's Revenue Determination (see http://www.escosa.sa.gov.au/projects/186/determination-of-sa-water-s-drinking-water-and-sewerage-revenue-2013-14-2015-16.aspx).

Table 1: Current trade waste charges

Parameter	Charge rate (ex GST)	Application
Volume	$0.151/kL	All volume
Biochemical Oxygen Demand	$0.251/kg	Up to 1000 mg/L
	$0.378/kg	For component of load above 1000 mg/L
Suspended Solids	$0.218/kg	Up to 500 mg/L
	$0.315/kg	For component of load above 500 mg/L
Total Dissolved Solids	$0.126/kg	For component of load above 650 mg/L
Total Kjeldahl Nitrogen	$0.392/kg	All concentrations
Total Phosphorus	$1.908/kg	All concentrations

Source: SA Water website.

3. Costs of trade waste services

3.1 Approach to determining LRMC for trade waste

As trade waste is a form of sewage that enters the sewerage system, the costs of processing trade waste relate to the cost of providing sewerage services. SA Water's sewerage services are delivered through primarily disconnected asset zones, referred to as "drainage areas" or "catchments".

The costs of the network infrastructure are fixed costs that do not vary with changes in the volume of trade waste released by customers. Therefore, the marginal costs of managing a trade waste service relate to costs of treatment and disposal of the trade waste at wastewater treatment plants (WWTPs). These costs will include the marginal operating costs of processing additional waste and, potentially, capital costs to expand capacity.

The LRMC of a trade waste service can be estimated using the standard methods to estimate LRMC (described in the companion paper LRMC Pricing). There are, however, particular issues about trade waste that need to be considered relating to:

- shared costs for multiple services, and
- significant incremental demands.

Shared costs

An issue with determining the marginal cost of a particular trade waste service (e.g. for BOD) is that the costs (both infrastructure and operational) of providing the service may be shared with other services. For example the same infrastructure can be used to remove suspended solids, dissolved solids, nitrogen and phosphorus.

An implication of shared costs is that the marginal impact of an increase in the demand for one service may depend on the capacity of infrastructure that is driven by demand for other services. For example, consider two trade waste services A and B that use the same infrastructure. Projected increases in the demand for service A may drive the need for the infrastructure long before it is required for service B. In this situation, a marginal increase in the demand for service B may have negligible impact on cost, as it would not change the need for, or timing of, the new infrastructure. The issue is analogous to the provision of a bridge, the capacity of which is being stretched at peak times and is expected to be stretched in the future at off-peak times. The current bridge capacity may be insufficient to meet the future demand at off-peak times, however the LRMC of off-peak travel may be very small, if expansion of the bridge capacity is required to meet peak travel times first.

The issue of shared costs may be complicated if there is uncertainty as to which service will drive the need for future investment[9] and/or where the demand for services is price sensitive

9 Using the bridge analogy, there may be uncertainty over when the peak occurs in the future.

(thereby potentially modifying the extent to which each service contributes to future capacity expansion).[10]

LRMC may be appropriately calculated when there are shared costs, by either the Turvey (perturbation) method or the average incremental (AIC) method. However, care is required to attribute future costs to the appropriate service. Conceptually, the Turvey method is simpler as it can be used to focus on the marginal change in demand for a particular service.

Incremental changes

Another issue in estimating the LRMC for trade waste services is that, often, changes in demand for trade waste services are not marginal changes (i.e. an increase in one unit of demand) but rather are significant incremental changes that occur due to decisions of a single customer (for example, a new factory begins operation). In such a situation, the LRMC of a change in demand of existing customers may be significantly different to the additional cost per unit caused by the incremental increase in demand from a future customer. For example, due to excess capacity, the LRMC of changes in demand of existing customers may be very low but, due to the additional capacity that will be required, the average costs of meeting the demands of a new factory that is considering entry may be very high.

Such situations have important implications for pricing based on LRMC. For example, consider a situation where an entrant's incremental demand for services would result in a capacity upgrade at a cost that, if borne by the entrant, would deter entry. A price set at the LRMC that reflects the existing level of demand may be inefficient, as it does not deter the entrant. Similarly, a price at the LRMC reflecting the incremental demand could deter the entrant but then be inefficiently high for the remaining customers.

The issue can be resolved by requiring, through the authorisation process, levying the entrant for the additional costs required to service them (see discussion in section 4.1.2 below).

3.2 SA Water's estimates of costs

SA Water has indicated it has used a cost-reflective pricing framework for trade waste services for some time. In 2004-05, SA Water stated that for the trade waste charges (which at the time related to flow, BOD and SS): [11]

> *The basic rates of these [Trade Waste] charges were determined to reflect avoidable costs imposed by trade waste discharges but include a 50% surcharge for high concentration flows.*

Similar statements have been made in later transparency statements. In recent years SA Water has stated it has undertaken further analysis. SA Water notes:[12]

> *SA Water undertook a review of flow and load based trade waste charging policy in 2009. This review identified that the SA Water trade waste charges were extremely low compared*

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10 Again using the bridge analogy, a higher price on peak-time usage may change the timing of the peak.

11 Transparency Statement – Wastewater 2004-05, Part A (page 32).

12 SA Water unpublished document [Dinesh (2013a, page 4)].

to that of interstate Water utilities for key parameters including flow, biochemical oxygen demand (BOD) and suspended solids (SS).

As a result of the above, the trade waste charging policy was revised by SA Water in 2010/11 based on the long run marginal costs (LRMC) 2010 treatment & cost model which estimated the cost associated with augmentation works required at Bolivar wastewater treatment plant (WWTP) to handle additional flows, BOD, SS, Total nitrogen (TN), Total Phosphorus (TP) and Total dissolved solids (TDS) as a result of new and or increased trade waste discharges.

3.2.1 SA Water's LRMC estimates of trade waste

SA Water has recently undertaken a revised preliminary analysis of the LRMC of trade waste services for the Bolivar WWTP (which services 97 per cent of trade waste volume in South Australia). The results are summarised in Table 2 below. The results suggest that a significant increase in trade waste fees would be required to cover LRMC costs.

Table 2: SA Water's estimate of LRMC of trade waste at Bolivar plant (all costs excluding GST)

Parameter	Current charge rate (refer Table 1 above)	LRMC 12/13 estimate	% of cost due to capital augmentation
Flow	$0.151/kL	$1.33/kL	97%
BOD	$0.251/kg to $0.378/kg	$0.74/kg	98%
SS	$0.218/kg to $0.315/kg	$0.82/kg	95%
TDS	$0.126/kg	$1.37/kg	43%
TKN	$0.392/kg	$2.91/kg	58%
TP	$1.908/kg	$12.05/kg	87%

Source: SA Water unpublished information [Revised SAWI008].

As shown in the table above, the LRMC estimates are largely driven by the capital expenditure assumptions.

Our understanding is that SA Water's approach for calculating the LRMC has involved:[13]

1. Forecasting the growth of trade waste processed by the Bolivar WWTP
2. Identifying the growth-related expenditure required to meet the forecast demand

13 The detail is provided in SA Water unpublished papers [Dinesh (2013a)].

3. Apportioning the costs of the additional growth-related expenditure among the different measures of trade waste. This is done by:
   (a) estimating the hypothetical effect of a doubling of the measure on the required capacity
   (b) allocating the costs based on the relative size of the effect measured in (a).
4. For each future year, estimating AIC (calculated over a 30 year period) by dividing the present value (PV) of forecast incremental costs by the PV of forecast incremental demand (being the load of the pollutant of interest).
5. Calculating LRMC as the 20 year average of the AIC estimates.

3.2.2 Review of SA Water's LRMC estimates

We have reviewed SA Water's approach to estimating the LRMC for trade waste services.[14] The broad approach adopted, of estimating incremental costs and demand and estimating LRMC as a 20 year average of yearly estimates of LRMC, appears reasonable. However, we have recommended a modification to the flow LRMC and have noted some concerns as to the calculation of LRMC for individual load-based measures. These are discussed below.

LRMC of the flow measure

We recommend a revision of SA Water's LRMC estimate for flow (i.e. sewage volumes) for two reasons.

First, if LRMC is to be used as a basis of pricing sewage volumes for trade waste customers, it should estimate the impact of a marginal (but permanent) change in sewage volume *produced* by customers. However, SA Water's estimate of LRMC is based on the marginal permanent change in sewage volume *received* (i.e. inflows) at the Bolivar WWTP.

Due to infiltration into wastewater pipes, the sewage volumes produced by customers will be less than the volume received at the Bolivar WWTP. The implication of infiltration is that, in percentage terms, a change in the sewage volume produced by customers will be smaller than the change in sewage received.

Second, the driver of future investment is the peak, not average, flows. At the Bolivar WWTP, new infrastructure will be required to meet growth in both peak wet weather flow (PWWF) and annual average flow (AAF). However, at Bolivar (and other WWTPs) a change in AAF without a change in PWWF will not materially change the timing of (or need for) new infrastructure. This is because the new infrastructure required to meet growth in AAF will be required first to meet growth in PWWF. Therefore, the marginal cost of additional sewage flow arises from the extent to which this flow contributes to PWWF; not its contribution to AAF.

14 We did not review the cost and volume estimates made by SA Water or conduct an audit of the spreadsheets SA Water used.

An appropriate modification to the LRMC estimate can be obtained by adjusting the incremental volume used (the denominator in a LRMC calculation). This adjustment can be calculated using estimates of infiltration and estimates of the ratio of PWWF to AAF. In this regard, SA Water has advised:

- that the level of infiltration into the Bolivar plant is in the order of 15 per cent; that is, the AAF into Bolivar is around 1.18 (=1÷ (1 – 15%)) times the flow produced by customers.[15]
- the PWWF to AAF ratio at Bolivar is around 2.7; however, the standard planning assumption is for a ratio of 3 to 1.[16]

Thus in summary, the ratio of the PWWF (for planning purposes) to sewage flow produced by customers is estimated as 3.53 (= 3 ÷ (1 – 15%)). Therefore, for example, a 10 per cent increase in flows by customers will result in a 2.8% (=10%/3.53) increase in the PWWF (for planning purposes) that drive costs.

This adjustment factor can be used to modify SA Water's LRMC estimate to produce a LRMC estimate for sewage volume. However, before applying the modification it is necessary to separate out capital costs (that are driven by increases in PWWF) and variable costs (that are driven by increases in average inflow). As earlier noted, the capital costs represent 97 per cent of the LRMC calculation. Therefore the LRMC for sewage volume can then be estimated as follows:

LRMC for sewage volume produced by customers is the sum of:

Capital cost component = $0.37 per kL (= $1.33 / kL x 97% / 3.53)

Variable cost component = $0.03 per kL (= $1.33 / kL x 3% / 1.18).

This gives a revised flow LRMC of $0.40 per kL. This also represents the LRMC of sewage produced by other customers.

LRMC of load-based measures

With regard to the load-based measures, we have confirmed with SA Water that:[17]

- there is no material infiltration of the pollutants that are measured by load
- the pollutant load drives the need for the WWTP investment that was identified, and
- although tighter Environmental Protection Authority (EPA) discharge licence criteria can also drive the need for investment, the need for investment will continue to be

15 There is some variation in the levels of infiltration. SA Water advised that the proportion of infiltration can vary with the intensity of wet years and changing catchment characteristics. SA Water advisee that, for the period 2006 to 2010 the infiltration to Bolivar was around 14 ML/day, which is slightly less than 10 % of the AAF of 148 ML/day but that the 'planning allowance for Bolivar may be typically up to 22% for infiltration.' [Reponses to SAWI151 and SAWI152].

16 We understand the PWWF to AAF ratio may vary significantly by WWTP due to a range of factors, such as soil moisture, that will affect the extent of infiltration; but that the planning assumption of 3 to 1 is commonly applied.

17 Source: unpublished correspondence with SA Water [Reponses to SAWI151 and SAWI152].

related to the load processed. The effect of tighter EPA discharge criteria would be to increase the marginal cost of the trade waste pollutants.

We conclude that the broad approach adopted by SA Water, of attributing the cost of investment to the set of load-based measures, is reasonable.

We do have some concerns with the apportionment methodology used to determine the LRMC of particular load-based measures. The apportionment methodology applied is based on the relative effect of a doubling of the volumes of each trade waste measure. Preferably, LRMC should reflect the cost of a *marginal* permanent change in a measure. Due to the need to expand capacity to service one type of trade waste, there may be substantial excess capacity in the future to service a second type of waste; therefore the LRMC of this second type of waste may be quite low, as it is not the driver of future costs. However, the apportionment methodology used may allocate a substantial cost to the second type of trade waste.[18]

This may not be a material issue. Given that there is uncertainty as to the projected growth of each measure and, therefore, uncertainty as to which type of trade waste will drive future expenditure, the results provided using the proposed apportionment may be reasonable. Nevertheless, we recommend that in the future this be reviewed and that consideration be given to examining the marginal change of particular load-based measures.

3.2.3 Location based costs

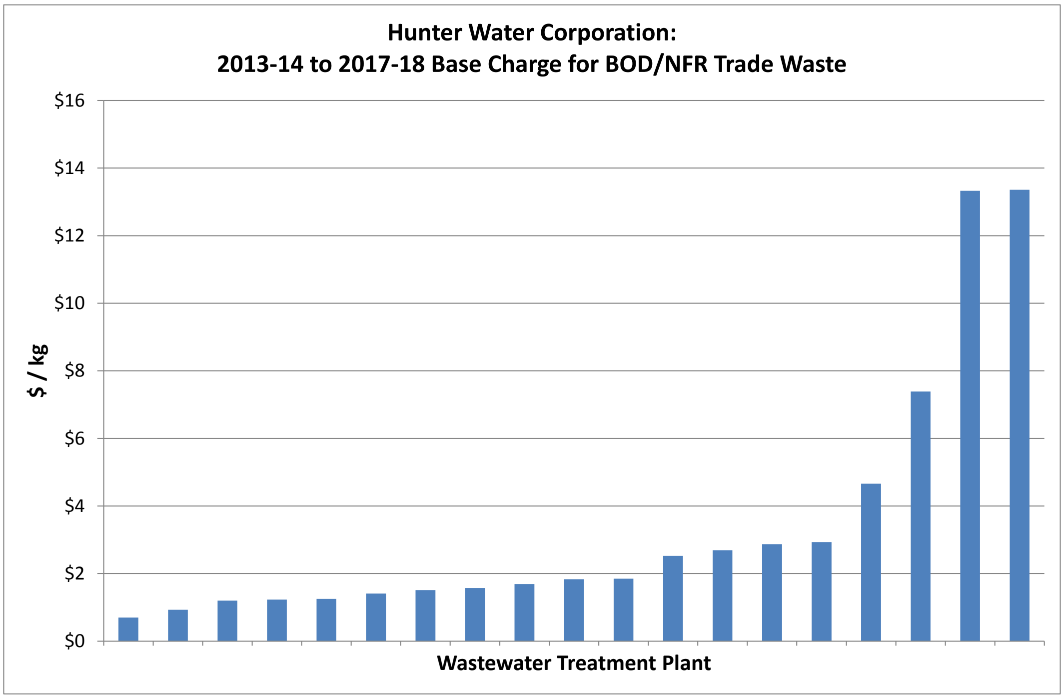
SA Water has not estimated the marginal costs by plant for other locations. However, we expect these to vary by each WWTP, due to differences in capacity, degree of infiltration and WWTP processing.

A guide to the potential cost variation can be found by examining the cost estimates undertaken in other jurisdictions. Hunter Water Corporation (Hunter Water) applies differential trade waste charges to reflect the differences in processing costs by WWTP. The most significant variation is in the BOD/NFR[19] charges which vary from $0.70 per kg to $13.36 per kg (see Figure 1 below). The trade waste charges for other trade wastes are the same across WWTP with one exception, for heavy metals, due to differences in the treatment process used at a particular WWTP.

18 For example, in a review of the Bolivar plant, Kampe (2010) notes that there is significant capacity available for BOD and SS growth and that growth in these services are not drivers of capital expansion (see Kampe 2010, pages 9-10).

19 NFR refers to non-filterable residue, another term for "suspended solids".

Figure 1: Hunter Water Corporation Trade Waste Charges



Source: Hunter Water Corporation (2012).
Note: The BOD/NFR charge is applied to whichever of the BOD or NFR makes up the higher load in the waste from an individual customer.

4. Pricing of trade waste services

Given that volumes of trade waste can be measured, and usage based pricing is practical, it is appropriate that some form of marginal cost pricing be used so as to send efficient price signals.

The key remaining pricing decisions relate to:

- whether LRMC pricing, or some other measure of marginal cost, should be used, and
- whether there should be location based pricing.

These two issues are related because the key variation in cost by location may be the capital costs.

4.1 Whether to use LRMC?

4.1.1 SRMC pricing

An alternative to LRMC pricing is to price at SRMC, whereby the prices are based on a temporary (as opposed to permanent) change in demand. Generally, SRMC would reflect only the variable costs and not include future capital costs of expansion and, therefore, be less than LRMC. However, when capacity is limited SRMC may be greater than an LRMC that has been estimated based on average of costs over a period of time.

A SRMC price could provide a more efficient price signal if trade waste customers were responsive to short-run price signals; that is producing more trade waste when prices were low and reducing trade waste in response to increasing prices.

We are unaware of any empirical evidence on the price responsiveness of trade waste customers in the short-run. However, we expect that the short-run responsiveness would be low, because the levels of trade waste produced are likely to be based on established infrastructure and processes that are difficult to change in the short-term.[20]

Furthermore, we expect there are some benefits to stable trade waste prices that reflect LRMC. Stable prices based on LRMC are likely to send a clearer signal to trade waste customers for making long-term business decisions (such as installation of infrastructure and changes to business processes) that may affect volumes of trade waste produced. SRMC pricing would introduce a level of volatility and make it difficult for business to analyse such decisions. For customers whose trade waste charges are significant, the price volatility of SRMC could also impose additional administrative costs.

Given these considerations, we expect the efficiency benefits of using SRMC are likely to be minimal and be outweighed by the additional costs and inefficiencies borne by business. On

[20] Furthermore, as noted immediately before Table 1 above, the trade waste charges are small. In 2012/13 it was estimated to be $5.5 million, which is roughly 1.6% of the revenue collected from sewerage services charges and 1.3% of all wastewater revenue.

this basis, adopting SRMC pricing for trade waste would not appear to be a worthwhile alternative.

Nevertheless, the difference between SRMC and LRMC may generally be small. If new customers are not entering, and existing customers produce volumes within their authorised amount, then the marginal cost of usage will reflect variable costs (and be similar to SRMC). To the extent that WWTPs processes are established to meet the authorised amount, the marginal cost of additional usage may be higher than the marginal benefit of reduced usage.[21]

4.1.2 Dealing with large incremental changes

As discussed in section 3.1 above, situations may arise where incremental decisions may results in significant — rather than marginal — changes in demand for trade waste services. These may involve, for example, decisions about building a new factory in a non-metropolitan area.

In such situations, a suitable pricing approach is to levy the potential customer for the additional costs that they impose. The charge would vary according to variation of the incremental costs (e.g. would depend on factors such as location, timing and size of additional demand). In effect, this would be a one-off charge similar to an augmentation charge that captures the additional costs of new customers.[22]

Such a levy on the entering business provides the appropriate price signal as to the costs it will impose. Conversely, if such a levy was not applied and rates are set at LRMC to reflect the new investment, then the additional costs imposed by the new businesses will be shared with existing trade waste customers.

4.1.3 Location based pricing

The appropriateness of using locational based pricing will depend on the costs (primarily administrative) and efficiency benefits of having cost-reflective pricing by location.

The key benefits of cost-reflective pricing are the efficiency benefits that can be obtained from more efficient management of trade waste. Should trade waste charges be too low, then there is the risk that business will not undertake efficient options to reduce trade waste. Conversely, if trade waste charges are too high, business may undertake inefficient (i.e. overly expensive) options to reduce trade waste.

The efficiency benefit of more accurate cost-reflective pricing will depend on three factors: [23]

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21 Perhaps, reflecting this asymmetry, Hunter Water applies penalty charges to customers who use more than their permit allows. Hunter Water applies incentive usage charges at 3 times the base usage charge to businesses that use more than the allowance (Hunter Water, 2012).

22 This approach has also been applied by Hunter Water (Hunter Water, 2012).

23 Under the National Water Initiative (NWI), states and territories agreed to develop cost reflective trade waste pricing policies. Specifically to to 'Review and development of pricing policies for trade wastes that encourage the most cost effective methods of treating industrial wastes, whether at the source or at downstream plants by 2006' (Clause 66(iij)).

1. The level of price distortion; that is the degree to which prices would change under cost-reflective pricing — the greater the variation in pricing the greater the potential benefits of cost-reflective pricing; and
2. The demand for trade waste services, in particular the responsiveness of businesses to variations trade waste prices — the greater the responsiveness, the greater the benefit of ensuring the prices are cost reflective;[24] conversely, if firms do not respond at all to changes in price, then there is no benefit (in terms of efficiency) of cost-reflective pricing.
3. The marginal costs of treating trade waste (of supply), in particular the extent to which marginal costs vary with the volume supplied.

The benefit can be calculated as efficiency loss associated with the pricing distortion, which can be estimated using a deadweight loss formula (see Box 2 below) as:

Efficiency loss $\approx 0.5 \times$ Price less marginal cost $\times$ Change in demand (in response to price)

Where there are no capacity constraints we might expect the marginal costs of treating waste to be constant, in which case 'price less marginal cost' = 'price change'.

It is useful to express this formula in terms of the current revenue collected, the price elasticity of demand[25] and percentage change in price. Assuming constant marginal cost then:

Efficiency loss $\approx 0.5 \times$ Current revenue $\times$ (% Change in price)$^2 \times$ Price elasticity

Thus, for example, for a particular trade waste service, if current revenue is $100 000, the price elasticity of demand[26] is -0.4 and the price change required to achieve efficient pricing is 60 per cent, then the benefit of efficient pricing would be in the order of $7 200.[27]

Based on Bolivar accepting 97 per cent of trade waste volumes,[28] the trade waste revenue in non-Bolivar locations is estimated as $165 000 in total. Given this low annual revenue, there appears to limited scope for efficiency benefits from location-based pricing. This may change in the future; for example, if the thresholds for determining trade waste customers are reduced. Furthermore, as noted above, the use of charges to reflect the capital costs of new connections also provides a method of providing location-specific price signals to new or potential customers.

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24 Businesses may respond to price changes in a number of ways. They may change their initial investment decisions; for example, in response to trade waste costs a firm may change the location of the factory or change the initial design. Once established, a firm may also change their production processes to reduce their level of trade waste either by capturing or treating trade waste on-site.

25 The price elasticity of demand is a measure of the percentage change in demand for a percentage change in price.

26 Unfortunately there are few empirical estimates of the extent to which firms respond to changes in the price of sewerage services and many of the studies that have been undertaken come from developing countries (e.g. Dasgupta et al. 2001).

27 Note: $\$7{,}200 = 0.5 \times \$100{,}000 \times .6^2 \times -0.4$

28 SA Water unpublished data [Dinesh (2013a, page 4)].

The key costs of applying cost-reflective pricing are primarily the administrative costs of calculating and applying the trade waste charges for each location. We expect these administrative costs to be small. Regardless of pricing, it is good business practice to understand cost drivers.

In summary, while the benefits of location-based pricing of trade waste services may generally be small, given the costs of applying location-based pricing are also small it is appropriate that it is used where there are potential benefits.

Box 2: Estimating deadweight loss

The efficiency loss from inaccurate pricing (and therefore the benefit of efficient pricing) can be estimated using information on demand, the marginal cost of supply and the size of the price distortion.

The cost of a too high a price is the amount of additional demand in excess of the marginal cost of supply. This is represented by the shaded area in the figure below.

The size (i.e. area) of the shaded area can be estimated as one-half multiplied by

- the current price less marginal cost (the height of the triangle shaped area), multiplied by
- the change in demand.

That is:

Efficiency loss ≈ 0.5 × Change in price × Change in demand (in response to price)

If the price distortion is removed then:

- % Change in price = Change in price / Current price
- % Change in demand = Change in demand / Current demand
  = % Change in price × Price elasticity

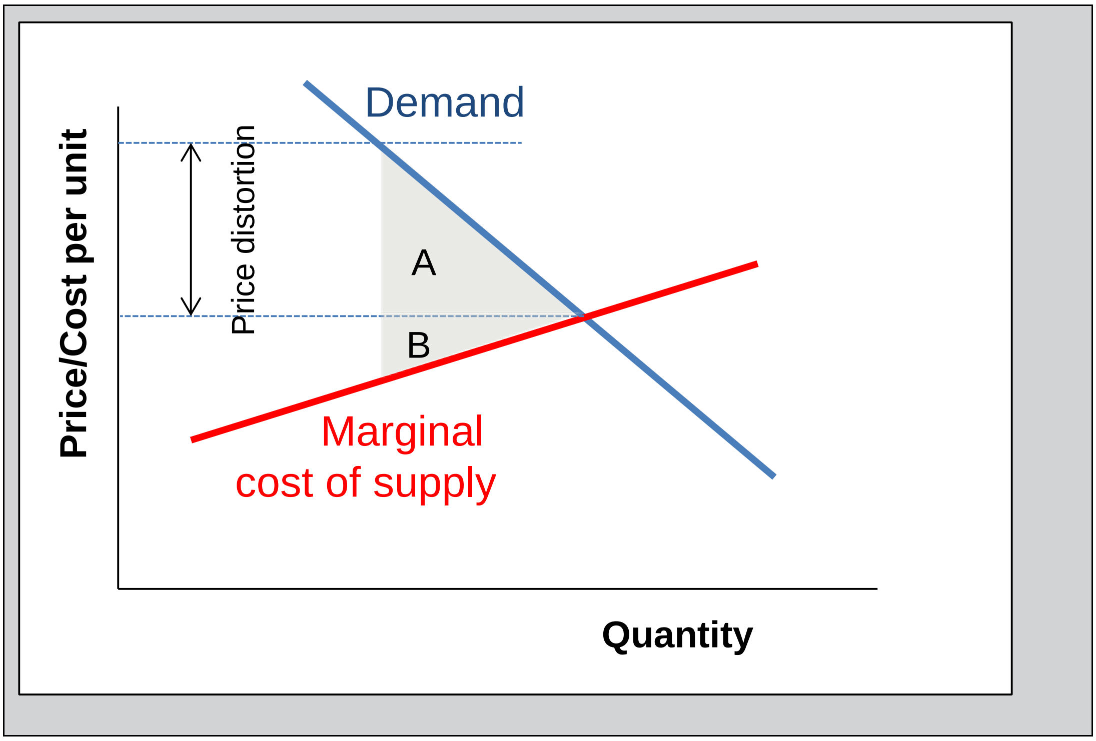
Rearranging the above, if the marginal cost of supply is constant (i.e. a horizontal line in the figure) then:

Efficiency loss ≈

0.5 × Change in price × Change in demand

= Current price × Current demand × (% Change in price)^2 × Price elasticity

= 0.5 × Current revenue × (% Change in price)^2 × Price elasticity


Demand
Price/Cost per unit
Price distortion
A
B
Marginal
cost of supply
Quantity

5. Conclusion and recommendations

Trade waste services differ to normal sewerage services, most importantly, in that it is practical (for large customers due to the volume of the waste disposed) to measure volumes of waste and thus apply usage-based charges. LRMC pricing of trade waste services is, therefore, plausible and appropriate.

We have recommended an adjustment to SA Water's LRMC estimate for sewage flow volume. This is because SA Water's estimate is based on average flows received (i.e. inflows) and not the contribution of sewage produced by customers to the peak flows. Due to infiltration, inflows differ from flows produced by customers. It is also necessary to consider peak flows, as it is the capacity required to meet peak flows that drives additional investment. We have modified SA Water's original estimate to estimate the LRMC of sewage volume to be $0.40 per kL of sewage produced.

The broad approach adopted by SA Water to estimate LRMC for the other trade waste services (pollutants measured by load) appears reasonable. We have a concern that the methodology to apportion costs between pollutants does not accurately estimate the marginal impact of each pollutant; however, this may not be a material issue, given the uncertainty in forecasting future demand.

Where there are no capacity constraints, the LRMC will be closer to SRMC and, therefore, may differ substantially to the LRMC from the Bolivar plant. Given that only three per cent of trade waste volumes are treated at WWTPs other than Bolivar, the efficiency benefits of locational based pricing of trade waste are likely to be very small. However, the costs of locational based pricing, which are administrative, may also be very small.

In situations where the entry of a new customer (or the expansion of an existing customer) drives (or advances) the need for new investment, it would be efficient for the customer to be levied directly for the incremental cost caused by the customer's action. Such a levy would provide an efficient signal to customers as to the costs of new development and expansion and, in effect, provide an appropriate location-based price signal.

References

Dasgupta, S., Huq, M., Wheeler, D., & Zhang, C. (2001). Water pollution abatement by Chinese industry: cost estimates and policy implications. *Applied Economics*, 33(4), 547-557.

Hunter Water Corporation (2012). Submission to IPART on prices to apply from 1 July 2013, September 2012.

SA Water (2013). 'Restricted Wastewater Acceptance Framework', available at http://www.sawater.com.au/sawater/yourbusiness/tradewaste/.

SA Water unpublished documents.

Dinesh, Nirmala (2013a). Bolivar WWTP Augmentation Summary Report: Trade Waste Charging Review, Rev. 2., 16 May 2013.

Dinesh, Nirmala (2013b). Trade Waste Charging Review: Peaking factor flows to Bolivar WWTP, Rev. 2., 13 December 2013.

Krampe, Jörg (2009) Bolivar WWTP review – current situation, March 2009.

Krampe, Jörg (2010) Bolivar WWTP Future Strategy Rev. 1, 26/02/2010.