



Port Pirie Regional Council

# Potential for Sewer Mining in Port Pirie

## Extraction Point Investigation and Feasibility

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June 2010

Ref No 2009230RA7

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## Document History and Status

Rev	Description	Author	Reviewed	Approved	Date
A	Draft for comment	MB	DGS		15 June 2010

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# Table of Contents

1	<b>Executive Summary</b>	3
2	<b>Background</b>	5
3	<b>Available Quantities of Wastewater</b>	6
	3.1 Review of Sewage Monitoring Data	6
	3.2 Catchment Based Review	7
	3.3 Concluded Wastewater Quantities	8
4	<b>Salinity of Available Wastewater</b>	9
	4.1 Irrigation with Reclaimed Water	9
	4.2 Review of March 2010 WDS Data	9
	4.3 Irrigation Management	10
5	<b>Potential Extraction Locations</b>	11
	5.1 Intersection of Anzac Road and Symonds Street	11
	5.2 Intersection of Anzac Road and Esmond Road (Upstream Leg)	11
	5.3 Allowable Extraction Rates	12
6	<b>Review of Cost Estimate</b>	13
	6.1 Review of Cost Estimates and Estimated Nett Present Value	13
7	<b>Project Considerations</b>	14
	7.1 Benefits, Risks and Issues	14
	<b>Tables</b>	
	Table: 3.1 Wastewater Flowrates Monitored in March 2010	6
	Table: 3.2 Summary of Average Wastewater Flowrates at Monitoring Locations	8
	Table: 3.3 Concluded Wastewater Quantities	8
	Table: 4.1 Salinity Information for Potential Extraction Locations	9
	<b>Figures</b>	
	Figure: 3.1 Variation in wastewater flow rates over the monitoring period	7

# 1 Executive Summary

Following the investigation of a number of potential sewer mining locations within an area of Port Pirie deemed to have the key determinants of flow and salinity levels suitable for viable re-use, it is now evident that whilst such a project is feasible, the decision to proceed with such a concept requires careful consideration by the Port Pirie Council.

The investigation has highlighted that whilst SA Water allowable flow rates are acceptable, salinity levels from the locations deemed most suitable for sewer mining purposes will present both a re-use and associated cost challenge to Council. The proposed locations for sewer mining are the intersection of Anzac Road and Esmond Road (upstream), and the intersection of Anzac Road and Symonds Street. Both locations have differentials in SA Water allowable flow rates and salinity levels, to the extent that if used, an irrigation management process utilising potable water as a supplement for shandyng purposes will be required at least until the use of stormwater is available under a proposed Phase 2 activity to the project.

Based on an estimated minimum construction capital cost of \$2.0 million, with an annual operating cost of \$160,000, and an estimated extraction amount ranging from 120ML to 90ML/year, the notional cost of treated wastewater will range from \$1.50/kl to \$1.70/kl. This assumes a 25 year project life and 7% discount rate. The capital and operating costs will vary based on the amount of wastewater extracted and exclude any initial project management or design fees. In addition, this estimated NPV excludes any use of supplement water supply for irrigation purposes.

Whilst salinity levels present the major challenge to a viable system, a number of project related issues and potential resulting costs also require appropriate consideration in the Council's decision making process. In particular:

- Potential increasing salinity levels with seasonal variations.
- With high salinity levels, there will be the need for commensurate irrigation management for the protection of soil and vegetation, and the potential requirement for appropriately trained resources for management purposes. The extent of irrigation management will not be known without specific on-site investigations at each of the proposed sites for irrigation.
- The extraction of water flow from either of the potential extraction locations will result in specific conditions from SA Water for the purposes of flushing solids through the network. In addition SA Water will not guarantee ongoing quality or accept liability for water supplied.
- The potential extraction points identified do not readily lend themselves to simple infrastructure, resulting in the potential need for either the construction of a roundabout with ongoing traffic management issues, or possibly the purchase of adjacent land to site a re-lift pump station for the purpose of pumping to the treatment site.
- The sewer network within Port Pirie is currently operated and maintained by SA Water, with no Council involvement. Construction of a sewer mining, treatment and re-use system will bring a degree of Council responsibility for the sewer system and ongoing management of solids. In addition, there will be a requirement for EPA (Environment Protection Authority) Licensing for the scheme with associated EPA operation and maintenance conditions.
- Availability of the land identified for the potential treatment site at an appropriate cost.
- Availability of adequate electrical supply at both the sewer mining and treatment areas at appropriate cost.

- The appropriateness of the identified land for the treatment site based on identified high water table levels and the resulting impacts on the construction of treatment and storage lagoons. In addition, the placement of treatment and storage lagoons will present challenges based on current EPA guidelines relating to the proximity of treatment lagoons to residential housing.
- Salinity levels of future stormwater capture and re-use in supplementing irrigation is unknown.
- The construction schedule for the proposed sewer mining scheme (Phase 1) in order to secure allocated Local Government Association (LGA) funding is aggressive and difficult to achieve.
- The estimated construction capital cost of approximately \$2.0 million exceeds the allocated budget of \$1.6 million for Phase 1 of the project.

It is understood that alternative water sources are being considered for Port Pirie and whilst the issues outlined above suggest the viability of the sewer mining concept is open to question, it should be considered in the context of alternative cost effective water supply sources and available LGA funding. It is therefore recommended that, based on the finding of this investigation and associated issues, the Port Pirie Council decide the future direction of this project as soon as possible.

## 2 Background

Port Pirie Regional Council is investigating opportunities for sewer mining within Port Pirie, where Council would extract sewage from the SA Water sewer network for treatment, and re-use for irrigation of open space areas within Port Pirie. This project potentially forms Stage 1 of a wider project to facilitate the use of both treated sewage and stormwater within Port Pirie for irrigation reuse.

Investigations on the feasibility of treated sewage re-use to date have resulted in the identification of a potential area within Port Pirie for sewage extraction. This study now identifies two preferred locations for sewer mining within the area. SA Water has recently been advised of these locations, and asked to give advice on allowable extraction quantities and conditions for extraction.

This report summarises these recent investigations and current activities with the intent of assisting to determine the continued feasibility of the proposed sewer mining concept.

The report states some of the key issues, benefits, risks and obligations associated with implementation and ongoing operation of such a scheme.

## 3 Available Quantities of Wastewater

### 3.1 Review of Sewage Monitoring Data

Previous investigations by the Regional Council of Port Pirie has shown that there is a potential to extract medium level salinity water from the SA Water sewer network in the south-western area of Port Pirie, for re-use through irrigation.

In August 2009, the hydrographic firm AWT were subcontracted to monitor flow and salinity levels at seven sites, generally to the south and west of Esmond Road and The Terrace respectively. This review suggested that the preferred locality in terms of the potential flow available for extraction, coupled with manageable levels of salinity, occurred within the vicinity of Anzac Road, between Balmoral and Kingston Roads. Within this area, locations to the north (i.e. towards Esmond Road) have higher flow rates (being further downstream), but have also shown to have higher salinities.

As a result, subsequent to the initial monitoring in August 2009, an additional one week period of monitoring at three locations by the South Australian based hydro graphic firm Water Dater Services (WDS), was conducted in March 2010. The three locations were:

- The upstream (southern) leg of the SA Water maintenance hole (MH) at the intersection of Anzac Road and Symonds Street.
- The upstream (southern) leg of the SA Water MH at the intersection of Anzac Road and Esmond Road.
- The downstream (eastern) leg of the SA Water MH at the intersection of Anzac Road and Esmond Road.

In total, sewer monitoring has been conducted over a five (5) week period.

Review of results of the March 2010 monitoring by WDS, resulted in the following summary, outlined in Table 3.1.

**Table 3.1 Wastewater Flowrates Monitored in March 2010**

Potential Extraction Point	Minimum Flowrate (L/s)	Maximum Flowrate (L/s)	Average Flowrate (L/s)	Measured Flowrate/Hydstra Estimate Based on Measured Depth
Intersection of Anzac Road and Symonds Street (upstream leg)	1.96	7.99	4.59	Hydstra Estimate
Intersection of Anzac Road and Esmond Road (upstream leg)	0.126	16.12	4.61	Measured Flowrate
Intersection of Anzac Road and Esmond Road (downstream leg)	8.57	35.4	15.84	Hydstra Estimate

Note: Hydstra is a software package for time-series analysis and management of water resources data.

To damp variations in instantaneous flow rates, in order to enable a better picture of fluctuation in flow over the monitoring period, the 5 minute instantaneous flow rates were averaged over two hour periods. These results are given in Figure 3.1. The values for Anzac/Esmond downstream were deemed to be anomalous, as the estimated flow rate was notably higher than flows measured elsewhere and were not consistent with on-site observations.

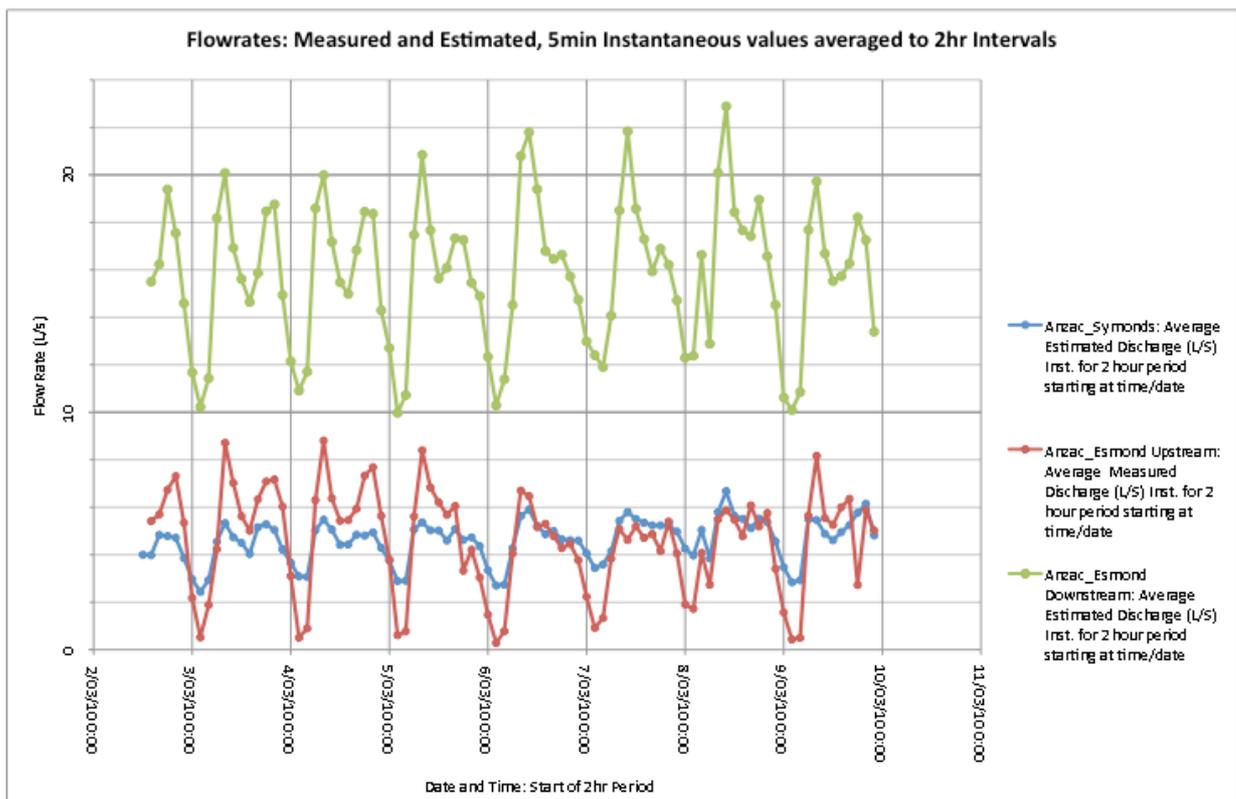


Figure 3.1 Variation in wastewater flow rates over the monitoring period

### 3.2 Catchment Based Review

As a further review, analyses of SA Water's wastewater network clarified catchments leading to each of the monitoring locations. Aerial photography was used to determine the number of developed properties within each catchment. Australian Bureau of Statistics data indicate that there is an average of 2.3 individuals per household in Port Pirie. Table 3.2 summarises these analyses.

**Table 3.2 Summary of Average Wastewater Flowrates at Monitoring Locations**

Potential Extraction Point	Monitoring Agency	Average Flowrate (kL/day)	Approx. Number of Dwellings	Estimated Contributing Population	Estimate of Average Contribution per Person (L/person/day)
AWT Site 1 (intersection of Kingston Road and Dunn Street)	AWT - August 2009	256	481	1,106	231
AWT Site 2 (intersection of Anzac Road and Fisher Street)	AWT - August 2009	367	773	1,778	207
Intersection of Anzac Road and Symonds Street	WDS - March 2010	397	773	1,778	223
Intersection of Anzac Road and Esmond Road (upstream)	WDS - March 2010	389	823	1,893	205
Intersection of Anzac Road and Esmond Road (downstream)	WDS - March 2010	1,365	1,127	2,592	527

Based on these values, it appears that 200–230 L/person of wastewater is produced on average within the catchment areas. This flowrate is consistent with SA Water design figures. Given the level of this flow rate, it is assumed that there is a groundwater flow component entering the wastewater network.

### 3.3 Concluded Wastewater Quantities

Annual quantities of wastewater at these locations have been concluded based on the above analyses. These are given in Table 3.3. Given that minimum flowrates for the flushing of solids through the network will be required to be retained, the intersection of Kingston Road and Dunn Street (being the most upstream location of the sites under consideration) appears less promising as a feasible location for wastewater extraction than the other three locations. As a result, it has been excluded from further analyses.

**Table 3.3 Concluded Wastewater Quantities**

Potential Extraction Point	Adopted Average Flowrate (kL/day)	Average Flowrate (ML/annum)
Intersection of Kingston Road and Dunn Street	256	93
Intersection of Anzac Road and Symonds Street	370	135
Intersection of Anzac Road and Esmond Road (upstream)	389	142
Intersection of Anzac Road and Esmond Road (downstream)	518 (based on 200 L/person/day)	189

## 4 Salinity of Available Wastewater

### 4.1 Irrigation with Reclaimed Water

Irrigation using treated wastewater is a beneficial means of re-using and disposing wastewater, however it must be managed accordingly as both the salinity and nutrient levels within treated wastewater have the potential to increase soil salinity and nutrient content and as such, reduce plant growth. If irrigation water is too saline, and/or the salt is not appropriately leached from the rooting zone, soil salinity will increase over time. The overall effect on the plant is influenced by the plant's tolerance to salinity.

It is important to remember that most impacts from salinity are evident in the middle to longer term. For irrigation projects, impacts may typically not be evident for 5–10 years.

As a rough indicator, wastewater salinity of less than 1000  $\mu\text{S}/\text{cm}$  generally has few limitations or management requirements associated with its use. As the salinity increases, the management requirements also increase and when salinity is extremely high this can make the water unsuitable without pre-treatment. High salinity water can also result in leaf burn if spray irrigated where the salts are predominantly sodium chloride.

### 4.2 Review of March 2010 WDS Data

A summary of wastewater salinity monitoring results from March 2010 is given in Table: 4.1. Flows monitored at the downstream intersection of Anzac Road and Esmond Road showed excessive salinity for irrigation, and have therefore been excluded from any further review.

With careful management, either Anzac Road/Symonds Street or Anzac Road/Esmond Road (upstream leg) could potentially be used as extraction locations for wastewater for the purpose of irrigation re-use. However, it should be noted that storage of wastewater in the treatment lagoon system will result in a further elevation of salinity levels due to evaporation.

**Table: 4.1 Salinity Information for Potential Extraction Locations**

Potential Extraction Location	Flow Weighted Average Salinity ( $\mu\text{S}/\text{cm}$ )	Salinity - 50 <sup>th</sup> Percentile ( $\mu\text{S}/\text{cm}$ )	Salinity - 90 <sup>th</sup> Percentile ( $\mu\text{S}/\text{cm}$ )	Salinity - 95 <sup>th</sup> Percentile ( $\mu\text{S}/\text{cm}$ )
Anzac Road/Symonds Street	1,116	1,112	1,273	1,348
Anzac Road/Esmond Road (upstream)	1,317	1,327	1,566	1,699
Anzac Road/Esmond Road (downstream)	3,319	2,990	4,999	5,978

### 4.3 Irrigation Management

Whilst salinity from irrigation water can be managed over the longer term with appropriate management, important considerations include site selection, leaching, irrigation methods and monitoring.

#### Irrigation Site Selection

An irrigation site with sandier soil will assist in salinity management. It is also important that sensitive receptors, such as high quality groundwater, are not in close proximity to the irrigation site.

Plant species vary greatly in their tolerance to salt. Age also has an affect. Older, small leafed plants are able to tolerate higher salinities than younger, larger leaved plants. In general, turf and grasses are more tolerant to salinity than other, larger leaved plants.

#### Shandyng Treated Wastewater with Alternative Water Source

Shandyng treated wastewater with lower salinity mains water (or potentially stormwater) can be an effective salinity management technique. This is where an allowance is made in the water balance to apply an additional quantity of water at each irrigation site to help move the salt through the soil profile. This method is very successful for sandier soil, but is less successful for increasing clay content regardless of the additional water applied. Unless the irrigation site has a significant sandy fill layer, the likely natural clay soils will require additional consideration when managing the irrigation process.

Consideration also needs to be given to the volume of the additional irrigation using lower salinity water. Applying this extra amount also increases the potential for nutrients to be leached from the soil profile. There is generally a maximum practical amount that can be applied to the soil in addition to the plant's requirement for water. Such amounts would require quantification based on the soil profile.

#### Irrigation Technique

Typically, plant leaves are less salt tolerant than their roots. Therefore, irrigation methods that target plant roots rather than the leaves will assist effective irrigation using high salinity water.

An irrigation management program can be developed when a detailed water balance model has been developed. With due consideration and management, salinity can be managed, however as previously outlined, there are limitations.

## 5 Potential Extraction Locations

From this and previous reviews of wastewater in Port Pirie, there are two preferred extraction locations identified. These potential extraction locations are at the intersection of Anzac Road and Symonds Street, and the upstream (southern) leg of Anzac Road and Esmond Road.

### 5.1 Intersection of Anzac Road and Symonds Street

#### Relift Pump Station Location

A major consideration for adopting any extraction site will be the siting of the relift pump station. The relift pump station will need to be monitored, serviced and maintained. The pump station should ideally be clear of trafficked areas as not to present an OH&S issue to the scheme operators.

On this basis, if flows were extracted from the intersection of Anzac Road and Symonds Street, an option which would avoid locating the relift pump station within the road reserve would involve construction of a low level pipe, approximately 250 m long, to gravitate flows from Anzac Road to the Council Reserve on Symonds Street. A pump station could be located in this reserve which would provide a significantly safer work environment when compared to a road reserve. However, the depth of the new transfer pipe will quite likely be below the watertable, and as a result, careful consideration will need to be given to ensure effective ongoing operation of the transfer pipe.

#### Wastewater Extraction Rate

135 ML/annum is the assumed total flowrate through the intersection of Anzac Road and Symonds Street. If all wastewater were to be extracted from this location, there would be no residual flow within the SA Water sewer downstream of this location to assist in flushing solids through the pipe. However SA Water has advised that provided a flushing process is designed and implemented to provide for the flushing of solids within the network the whole flow at this location can be extracted. On this basis, whilst the whole flow may be available, until an appropriate flushing mechanism acceptable to SA Water is designed the whole flow may not necessarily be available.

#### Wastewater Salinity

With salinity levels as outlined in Table 3.1, and with potential salinity increases due to evaporation during storage, careful management will be required to enable irrigation without adverse effects on the soil and plant life of the areas to be irrigated. Detailed data and models will be required to develop an appropriate irrigation management plan.

The appropriate use of stormwater which is being considered as Stage 2 of this project can be an effective management tool in dealing with the salinity of treated wastewater.

### 5.2 Intersection of Anzac Road and Esmond Road (Upstream Leg)

#### Pump Station Location

No parcels of land are readily available near the intersection of a potential extraction point at the intersection of Anzac Road and Esmond Road. As such, consideration for locating a relift pump station within the road reserve must be given. Possible options would include construction within the footpath, although this will notably impact on

pedestrian amenity and may aggrieve local residents. A further alternative would be to construct a roundabout, and site the relief pump station within the roundabout area. However, the feasibility of a roundabout in terms of traffic management would need to be investigated beforehand, as well as consideration of cost. A roundabout would provide a degree of protection for operators working at the site however, it is likely that additional traffic management measures would still be required during operation or maintenance works.

#### **Wastewater Extraction Rate**

A total flow rate of 142 ML/annum is assumed through the upstream (southern) leg of the maintenance hole at the intersection of Anzac Road and Esmond Road. Two further flows enter the maintenance hole at this location, which will assist in flushing pipes downstream of this extraction location. SA Water has advised that provided a flushing process is designed and implemented to provide for the flushing of solids within the network the whole flow at this location can be extracted. On this basis, whilst the whole flow may be available, until an appropriate flushing mechanism acceptable to SA Water is designed, the whole flow may not necessarily be available.

#### **Wastewater Salinity**

With salinity levels as outlined in Table 3.1, and with potential salinity increases due to evaporation during storage, careful management will be required to enable irrigation without adverse effects on the soil and plant life of the areas to be irrigated. Detailed data and models will be required to develop an appropriate irrigation management plan. It is noted that the salinity at this location is higher than upstream locations, such as the intersection of Anzac Road and Symonds Street.

The appropriate use of stormwater, which is being considered as Stage 2 of this project, can be an effective management tool in dealing with the salinity of treated wastewater.

### **5.3 Allowable Extraction Rates**

SA Water has been provided with a summary of flowrates at the intersections of Anzac Road at Symonds Street and Esmond Road, and has provided the following advice;

"The Port Pirie Regional Council may extract the whole flow of wastewater available subject to Council implementing a cleaning (flushing) process that is acceptable to SA Water. Should Council wish to proceed with this scheme, Council will need to submit a concept design to SA Water. Upon assessment of the concept design, SA Water will be in a position to stipulate the terms and Conditions by which Council may extract wastewater and manage its waste activated sludge. The following must be noted;

- SA Water is unable to guarantee the quality of the wastewater supplied to Council
- Council will be solely responsible for the wastewater it extracts
- SA Water will have no liability for the use of recycled water produced from the extracted wastewater."

## 6 Review of Cost Estimate

### 6.1 Review of Cost Estimates and Estimated Nett Present Value

Based on an overall construction capital cost of \$2.0 million, with an annual operating cost of \$160,000, and an estimated extraction amount ranging from 120ML to 90ML/year, the notional cost of treated wastewater will range from \$1.50/kl to \$1.70/kL. This assumes a 25 year project life and 7% discount rate. The capital and operating costs will vary based on the amount of wastewater extracted and exclude any initial project management or design fees.

The extraction rates of 120ML/year decreasing to 90ML/year have been used to provide a notional range of costs and have been selected on the basis that SA Water will require a solids flushing process which when designed may require the retention of flow at each of the location, hence potentially reducing the flow available.

When the preferred extraction site is selected, a further, more detailed review of cost estimates, NPV and an estimated cost of treated wastewater on a dollar per kilolitre basis is warranted, should the project proceed to a detailed design stage.

# 7 Project Considerations

## 7.1 Benefits, Risks and Issues

The investigation into determining the most appropriate locations for potential sewer mining in Port Pirie has highlighted that whilst the concept has some benefit, there are a number of issues which the Port Pirie Council needs to be aware of and take into consideration in resolving if to proceed. The key highlights are as follows:

### Benefits

The proposed project will allow for Council to obtain an independent although finite water supply which can be used for the public open space within the community. It will enable Council to make decisions regarding the level of amenity that is provided within such spaces, irrespective of any mains water restrictions.

The undertaking of a water reuse project of this kind will involve Council taking responsibility for a component of its own water supply, and considering the long-term availability of water in regional South Australia, the Port Pirie Council can provide a water source which is potentially independent of the River Murray.

### Key Risks

The outcomes of this investigation indicate that the feasibility of sewer mining at Port Pirie requires careful consideration. The primary risks to the sewer mining concept are the identified levels of salinity and resulting costs associated with developing the system, including ongoing extraction, treatment and irrigation management.

The identified salinity levels of extracted water may also vary seasonally with changes in groundwater levels and groundwater infiltration to the sewer network. Sewer monitoring to date (five weeks in total) does not cover an extended period (e.g. a one year period) as a result both seasonal flow and salinity variations have not been identified.

Due to budget constraints, it is proposed that the sewage be treated through a lagoon based process. As a result, the treatment and storage in holding lagoons prior to irrigation would have an increasing effect on the salinity levels. Any irrigation programme is likely to require supplementary water on irrigation sites. Until a reliable alternative source (such as stormwater) is secured, it is likely that mains water will still be required at irrigation sites, particularly given the clay soils present.

It should also be noted that the salinity levels of stormwater in the local catchment areas is unknown and could present irrigation management issues when used as an addition to the mined wastewater.

### Key Issues

- Following the various sewer monitoring activities carried out as part of the investigation, two (2) preferred locations have been identified for potential sewer mining. However, both locations have salinity levels which will require significant irrigation management. These salinity levels are likely to increase due to increased seepage into the existing sewer system and evaporation whilst retained in holding lagoons. As a result irrigation with high salinity levels will require management which will include a process of shandyng with lower salinity mains water until stormwater can be utilised, following a subsequent phase to the project. The use of mains water supplementation will incur additional cost to the overall sewer mining scheme. In addition, the salinity levels of stormwater are unknown and hence the impact unclear until assessed.

- With high salinity levels detected at the preferred locations e.g. Anzac Road and Symonds Street having 1,116  $\mu\text{S}/\text{cm}$  and Anzac road and Esmond Road (upstream) having 1,317  $\mu\text{S}/\text{cm}$ , the need for commensurate irrigation management processes for the protection of soil and vegetation will require the utilising of appropriately trained resources and associated management costs.
- The extraction of water flow from either of the potential extraction locations will require specific requirements from SA Water for the purposes of flushing solids through the network. These requirements will potentially add operational and maintenance costs to ensure ongoing compliance. In addition SA Water will not guarantee ongoing water quality or accept any liability for water supplied.
- The sewer mining scheme will require EPA licensing along with specific management and reporting requirements.
- The potential extraction points identified do not readily lend themselves to simple infrastructure for pumping to the treatment site. In both instances, no adjacent Council land has been identified which can be used for siting a relift pump station. Road reserves are relatively well developed and siting a pump station within the road reserve may aggrieve residents and compromise existing pedestrian and vehicle movements. Options include construction of a deep offtake main at Symonds Street, or construction of a roundabout, or other road modification. Ongoing traffic management for any infrastructure located within a road reserve will be required.
- The sewer network within Port Pirie is currently operated and maintained by SA Water, with no Council involvement. Construction of a sewer mining, treatment and re-use system will require additional Council skills and resources, and potentially bring a degree of Council responsibility for the sewer system. As the SA Water sewer network handles solids, the management of these solids, along with operation of the offtake from the SA Water system, will require careful consideration and management with associated costs, based on appropriate operation and maintenance regimes. Availability and associated costs for land to site the sewer mining pump station, if not placed within a roundabout.
- Availability of the land identified for the potential treatment site at an appropriate cost.
- Availability of adequate electrical supply at both the sewer mining and treatment areas at appropriate cost.
- The appropriateness of the identified land for the treatment area based on high water table levels and the associated costs for the construction of treatment and storage lagoons. In addition, the placement of treatment and storage lagoons will present challenges based on current EPA guidelines relating to the proximity of treatment lagoons to residential housing.
- Based on estimated construction capital costs only, the estimated cost of treated wastewater is considerable (\$1.50/kL to \$1.70/kL over a 25 year project life) and should be assessed against Council's current charges for irrigation. This figure should be further reviewed, given the issues outlined in this report which have the potential to add additional cost, only identifiable following the selection of the preferred extraction location and during a Detailed Design process.
- With current resource limitations, the ability of the Port Pirie Council to adequately facilitate and resource to assist the Detailed Design and Construction phases of an already tight schedule to complete is questionable.
- With a minimum construction Capital cost estimate of approximately \$2 million, the allocated budget of \$1.6 million for Phase 1 of the project is insufficient. Further assessment of estimates, budgets and project funding is therefore warranted should the project proceed.

### Alternative Water Sources

It is understood that alternative water sources are being considered for Port Pirie. Considering the issues and risks identified with sewer mining, Council should consider feasible alternatives and determine if both sources can complement each other or from a practicality and cost perspective, an alternative source of supply is deemed more appropriate.