Technical Memorandum

Title	**Review of SA Water Asset Management System** **Further advice – Expenditure of wastewater mains**		
Client	Essential Services Commission of South Australia	**Project No**	360807
Date	22 May 2020	**Status**	v03-04 final for client
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1 Purpose

The purpose of this document is to respond to the brief provided by the Essential Services Commission of South Australia relating to wastewater mains expenditure “20200428 – SAW – RD20 – Brief for Cardno advice – Expenditure on wastewater mains program”. The questions from the brief are set out in the boxed sections below, and answered throughout this memorandum.

The overarching question is “How much expenditure is needed for SA Water to maintain the serviceability of its wastewater network reticulation mains?”.

2 Deteriorating overflows performance and implication for RD20

> Were Cardno’s comments on SA Water’s approach to managing the observable deteriorating trend confined to commenting on the approach taken by SA Water in the RD16 period or does this read forward into the proposed approach for the RD20 period too?

The observable trend relates to Type 1 and Type 2 overflows to the environment that are reportable to the Environment Protection Authority. This has deteriorated for a variety of reasons as outlined by SA Water, including a change in reporting. In our report, we state that this deteriorating performance justifies increased renewal work (capex) in the RD16 period. A key point of difference (and which probably explains much of the confusion) is that SA Water’s philosophy is to address this deteriorating performance through opex (maintenance - jetting and root cutting) only. On reflection, both our point of view and SA Water’s should better recognise that there will be an optimal mix of interventions (capex and opex) to address these overflows to the environment. Relevant to the renewal program is that there will be a benefit to dry weather overflows from renewals.

SA Water proposed increased opex for RD20 to address this deteriorating trend, which we accepted. We consider this is an appropriate response to deal with the deteriorating trend.

And, how does this comment fit in with other statements about SA Water's ability to manage the RD20 program within the same budget as in the RD16 period?

There is an inconsistency in the statement made by us because we compared a trend that SA Water addresses primarily through opex with a statement on the capex program. The following sections and responses to the questions posed should make clear the evidence available and the basis for our conclusion.

3 Forming the program

Has the Commission's discussion of the various programs mischaracterised Cardno's advice? And, if so, has this likely contributed towards the confusion SA Water has raised in its submission?

As detailed above, we consider that we have caused confusion by discussing sewage overflows to the environment which SA Water targets through opex alongside renewals expenditure (capex).

We consider that the following discussion and analysis should remove any remaining confusion.

Has SA Water's proposed wastewater mains relining program been developed consistent with a lowest lifecycle costing approach to maintaining historical service levels? Or has it been developed to improve service levels?

SA Water has not linked expenditure directly to service levels in its decision making. It has instead applied decision rules relating to risk and finance criteria to arrive at the proposed expenditure program. Service is then the result of these decisions, not the driver for them.

However, SA Water has had regard to levels of service in a limited way, in that it would not have adopted a level of expenditure that it considers would lead it to under-perform.

We consider that SA Water has proposed a business as usual program (i.e. not a clear desire to improve performance) for sewer serviceability within the bounds of long term trends and observed variation.
SA Water's performance measures proposed in its regulatory submission include one measure that was better than current performance (internal overflows – more than one in five years – target 29 v 32 current) and one that was worse than current performance (internal overflows incidence – target <190 v 180 current) supporting that there is no clear desire to improve performance.

Based on longer-term performance trends, does SA Water need to increase the level of wastewater mains being replaced/relined over the RD20 period?

The relevant trends reported by SA Water in addition to the reportable environmental overflows discussed previously are:

- Breaks and chokes
- Internal overflows

Performance data from July 2015 to September 2019 is available in the CE-AM report.

Figure 3-1 shows the metro, regional and combined performance for sewer main breaks and chokes. Performance improved from late 2016 to late 2017 before deteriorating. This deteriorating trend appears to have stabilised in the latest data.

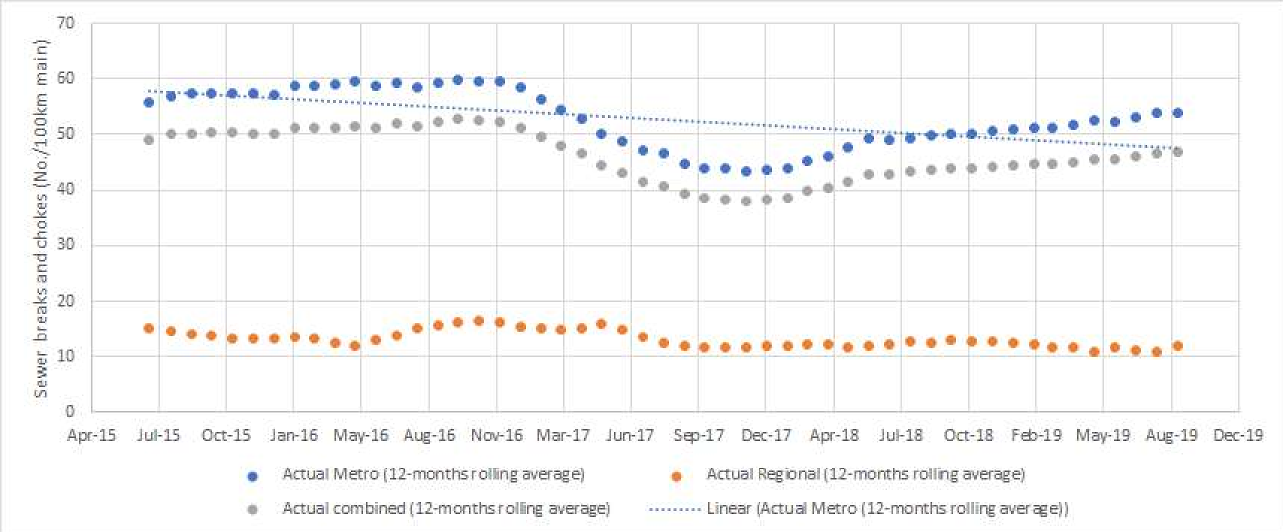

Figure 3-1 Sewer breaks and chokes performance

In practice it can be difficult to distinguish the cause of a break/choke. Field staff are trained to identify likely causes (e.g. are roots present, is the pipe cracked) but there can be uncertainty. For example, roots may have entered through a failure in the pipe rather than a joint, and pipes may be broken when being repaired.

SA Water notes and provides supporting evidence that sewer chokes are driven by seasonal factors in its supporting material – Figure 3-2 shows the seasonal variation, with most chokes occurring in winter and spring, following a dry summer that makes roots seek moisture. This is also supported by Figure 3-3 which shows a lagged correlation between rainfall and chokes.

These two figures support the need for maintenance activities (cleaning and root cutting) to address sewer choke performance, noting that it can be difficult to separate out the fundamental cause of a break or choke.

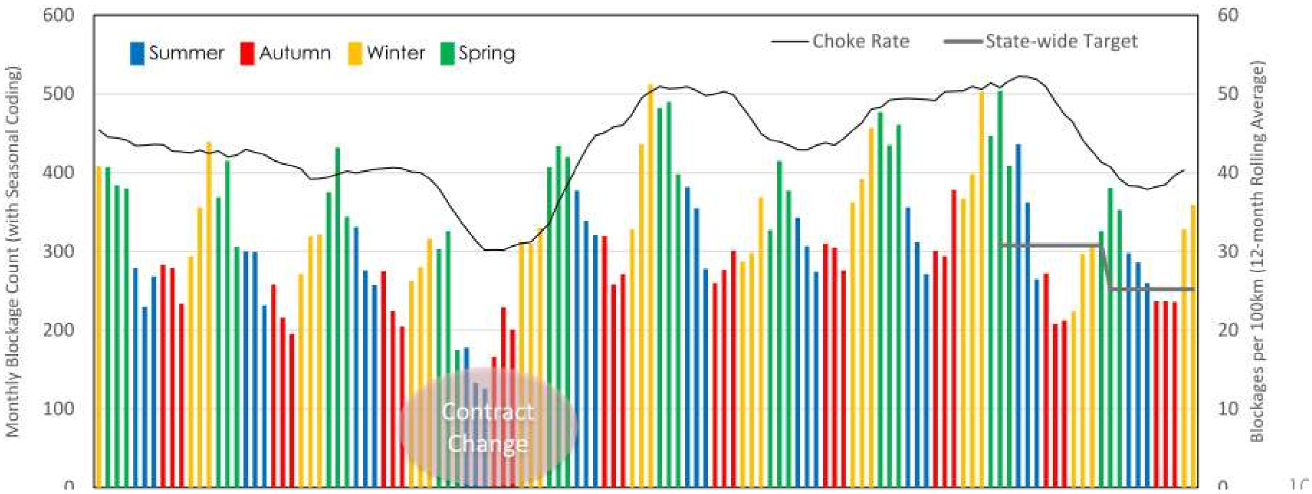

Figure 3-2 Seasonal variation of sewer chokes

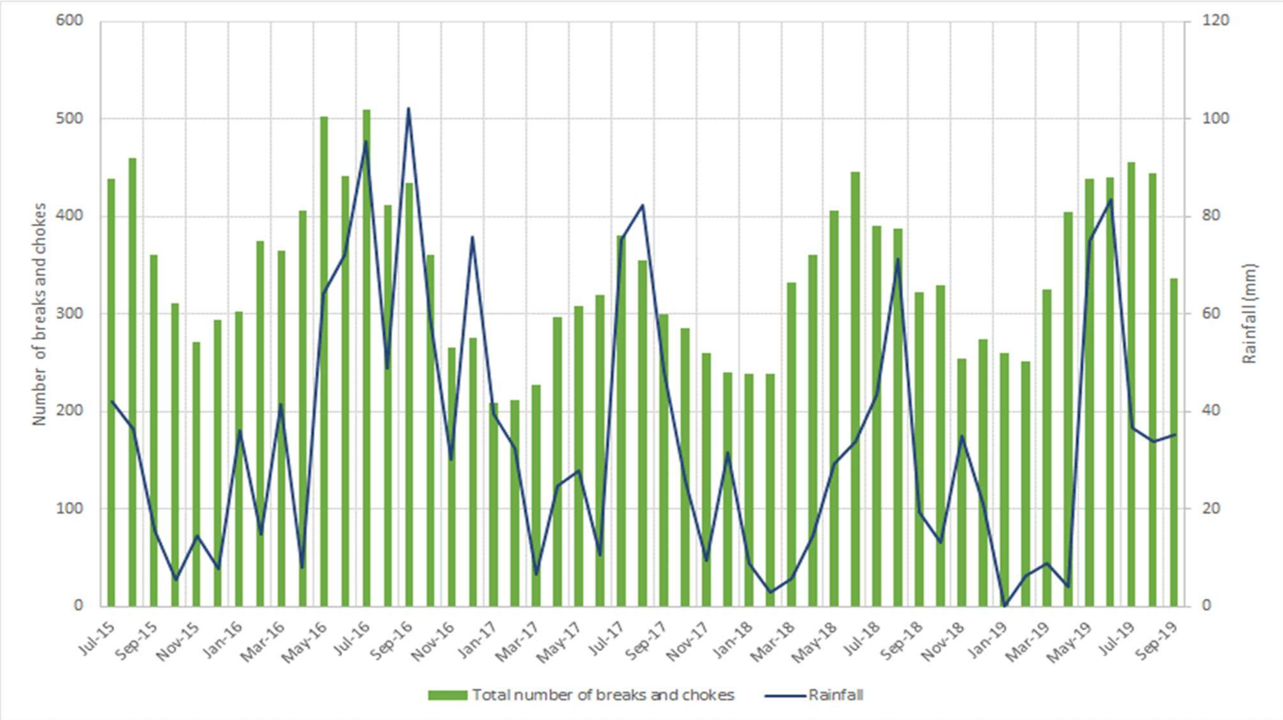

Figure 3-3 Monthly sewer breaks and chokes and rainfall

Figure 3-44 shows the trend for internal overflows – monthly totals and the rolling 12-month average. Over the period, the trend is declining. There was an increasing trend in the 12-month average from early 2018 to September 2018 but this trend has reversed since this time and continues to decline. Observed performance for internal overflows does not suggest any increased expenditure is justified.

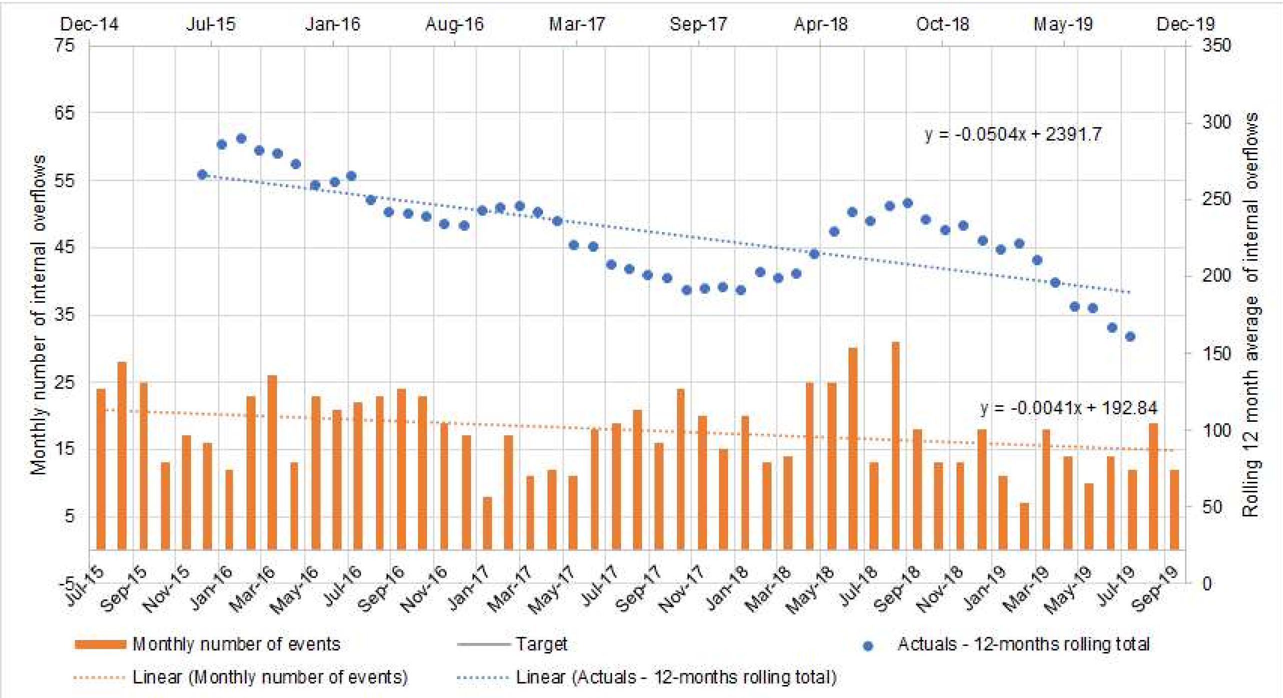

Figure 3-4 Internal overflow performance

If an increase in activity over the RD16 period levels is required, does Cardno think SA Water should be able to undertake this work within the same budget as within the RD16 period? If so, on what basis is this expectation made? (For example, are SA Water's cost estimates out of line with wider industry costs for the same/similar activities? Or is this based on an expectation that not all pipes included in the program are likely to need to be replaced? Does this suggest that additional operating expenditure may be required for additional condition inspections? Or are there other relevant factors that the Commission needs to consider?)

We do not consider that the performance trends warrant a step change in renewal activity. However, we have accepted following further investigation that the risk SA Water faces relating to concrete mains in poor condition does justify some increased expenditure. We discuss this further in Section 6.

Our methodology of applying the RD16 budget was driven by our assessment of the inadequacy of SA Water's decision rule, rather than making the link back to the performance trend for overflows to the environment. The statement was aimed at prudence – there is a need to act rather than the level of activity.

Our position that the performance trends do not warrant a step change in expenditure also applies to operating expenditure proposed by SA Water to "maintain" under the expenditure category of "asset investment operating costs". Relevant to wastewater mains, these activities included inspections of wastewater mains ancillaries and condition investigations of pumping mains. We commented in our Final Report that we consider that these activities should be part of 'business as usual' operating expenditure. SA Water did not provide evidence of a new obligation or significant change in circumstance to justify this expenditure. We noted that identifying new activities is not in itself a justification for an increase in total opex because new activities will also be offset by discontinued or reprioritised activities.

SA Water was requested to provide evidence as to whether it faced any changed circumstances or new obligations that led to these increases in expenditure. SA Water did not provide new information in response to this request, but referred to its *Asset Performance and Health Monitoring Key Practice Document* and advised that increased expenditure on inspections was part of its maturing approach to asset management. This Key Practice Document identifies that SA Water's assessed level of maturity was "2.5" in the area of Asset Performance and Health Monitoring against a desired level of maturity of "3" (competent). We infer that SA Water suggests that the additional expenditure is justified to move its level of maturity in this area to the desired level of "3". We do not accept this argument – maturing processes should be cost neutral or a source of operating efficiency across the business beyond the short term investment. SA Water's desire for increased maturity in this area also does not represent a change in its circumstances or a new obligation.

Are there any changes required to the recommendation on the increased operating expenditure proposed by SA Water to manage this program, on the basis of any new information on its approach to "lifecycle costing?

After further consideration of how SA Water has described its avoid fail program for concrete sewers and undertaken financial analysis, we consider no further opex is appropriate. A better use of consequence of failure to guide its strategy would allow SA Water to target its opex at higher risk sewers and also make totex savings by allowing lower risk sewers to fail and avoiding replacing them prematurely.

As noted, we consider the increased opex for proactive maintenance to address overflows to the environment is appropriate.

4 Decision rule for condition grade 4 and 5

4.1 Causes and remedies

Table 4-1 outlines typical sewer failure mechanisms, causes and possible mitigation options.

Table 4-1 Summary of sewer blockage failure mechanisms, causes and mitigation options

Failure mechanism	Causes	Mitigation options
Tree roots	Entry through joints and/or pipe defects	Inspection and cleaning Audit of new installations and repairs
	Shallow depth pipes	Inspection and cleaning Relining or renewal
	Sandy soils which have high root growth	Inspection and cleaning Relining or renewal
	Drought conditions leading roots to seek moisture sources	Inspection and cleaning Network monitoring (smart networks) Inspection program to consider soil moisture metrics
	Local tree population (type and quantity)	Proactive identification of possible hot spots Planning for new sewers – avoid specific tree types Customer education
Structural defects	Asset deterioration	Inspection Relining or renewal Proactive identification of possible choke hot spots from asset data / failure history
	Shallow depth pipes	Inspection Relining or renewal
	Quality of installation	Audit of new installations and repairs
	Soil corrosivity	Proactive identification of hot spots Inspection Relining or renewal
	Sewage septicity	Network management e.g. turnover, pumping strategies (smart networks) Wastewater treatment options (chemical dosing) Relining or renewal
Physical blockages	Low flow in oversized mains	Network modelling and reconfiguration (smart networks) Downsize via lining
	Bends, misaligned joints and protrusion of fittings	Inspection and cleaning
	Collapse of sewers e.g. bricks, lining	Inspection and cleaning
FOG (fats, oils and greases) and silt	Low flow in oversized mains	Network modelling and reconfiguration (smart networks) Downsize via lining Inspection and cleaning

Failure mechanism	Causes	Mitigation options
	Industrial and commercial discharges	Inspection and cleaning Education programs Discharge monitoring Proactive identification of potential hot spots
	Intrusion from surrounding soils	Inspection and cleaning
	Bends, misaligned joints and protrusion of fittings	Inspection and cleaning

4.2 Industry standards

Is the proposal to proactively renew all known condition grade 4 and condition grade 5 sewer mains supported by industry standards? If not, what is the industry standard regarding management of grade 4 and grade 5 condition sewer mains?

Industry standards are in place for the inspection and condition grading of sewers by investigative techniques such as CCTV. Guidance on remedial activities is often included. This information should be part of a decision framework driving the renewal strategy for the assets in question. A variety of information sources are assessed below which explore some of the information including industry codes and other utility approaches.

4.2.1 WSAA - Conduit Inspection Reporting Code of Australia

This code specifically establishes a uniform standard coding system for recording and comparing defects and features observed as a result of inspection of conduits and maintenance structures (usually CCTV survey). WSA 05 2013 3.1 Table C6 states the following:

WSA 05—2013-3.1 APPENDIX C

TABLE C6

SERVICE GRADING OF SEWERS

Grading	Description	Appropriate response in normal circumstances[1]	Peak score[2]	Mean score
1	No or insignificant loss of hydraulic performance has occurred. Appears to be in good condition and there is little likelihood of sewage pollution[3]	No immediate action required—Standard programmed condition assessment	<5	0 – 1.0
2	Minor defects are present causing minor loss of hydraulic performance and/or minor likelihood of sewage pollution	No immediate action required—Standard programmed condition assessment	5 – 9	>1.0 – 3.0
3	Developed defects are present causing moderate loss of hydraulic performance and/or moderate likelihood of sewage pollution	Take immediate action as appropriate to the defect e.g. cleaning, root cutting, point repair Monitor with programmed condition assessment for rehabilitation and/or renewal in medium term	10 – 39	>3 – 5.0
4	Significant defects are present causing serious loss of hydraulic performance and/or significant likelihood of sewage pollution	Take immediate action as appropriate to the defect e.g. root cutting, point repair, vermin treatment Immediately undertake risk assessment and further investigate as required As appropriate to outcomes of above, schedule appropriate action which may include rehabilitation and/or renewal in the short term	40 – 59	>5 – 10.0
5	Failure of the sewer or pollution of the environment has occurred or is imminent	Take immediate action as appropriate e.g. temporary support Immediately undertake risk assessment and further investigation, and, as necessary, take appropriate action which may include immediate rehabilitation and/or renewal	≥60	>10

NOTES:

1. The actual action to be taken for any sewer system will depend on the asset management policies and procedures of the asset owner/operator.
2. Rounded to the nearest whole number.
3. Pollution may occur through a sewage spill (overflow), exfiltration through a defect or cross-connection between the sewerage and stormwater systems.

Figure 4-1 Copy of Table 6, from Conduit Inspection Reporting Code of Australia, WSAA 05 2015

In terms of identifying condition 4 assets, while immediate action is appropriate, and a risk assessment/further investigation is clearly suggested, the WSAA code by no means states that rehabilitation is a certainty (for example, noting that an appropriate response "may include rehabilitation and/or renewal in the short term"). A key decision is when to schedule this work. In our experience, the SA Water approach is more conservative than that employed by other utilities.

We have not seen a wider decision framework around the CCTV inspection program. We would expect a more mature program to consider:

> Prioritisation of the condition 4 and 5 sewers on their overall risk score

> A site specific cost estimate and confirmation of the need and the proposed solution

> Further inspections – particularly if initial CCTV wasn't conclusive

> How the engineering contractor may provide efficiencies through delivery mechanisms and/or innovation in carrying out the works.

4.2.2 Industry approaches - WSAA Managing Sewer Overflows: Blockage Manual

SA Water's Wastewater Gravity Mains Approach document sets out a number of best practice guidance documents for managing wastewater mains including WSAA's Sewer Blockage Manual (developed November 2011 by SKM). SA Water has followed this document in classifying its sewers into three broad categories for management throughout their lifecycle. This classification is based on the consequence of failure of the asset. For assets that have a high consequence of failure, a predictive approach that attempts to avoid failure of the asset is adopted. For assets that have a lower consequence of failure, a "reactive approach" strategy is recommended. Where the frequency of failure of assets in this "reactive approach" category is found to be unacceptable, a "preventative approach" strategy is then recommended. This classification is shown as Figure 8 in SA Water's Wastewater Gravity Mains Approach document, and is re-produced below as **Error! Reference source not found.**.

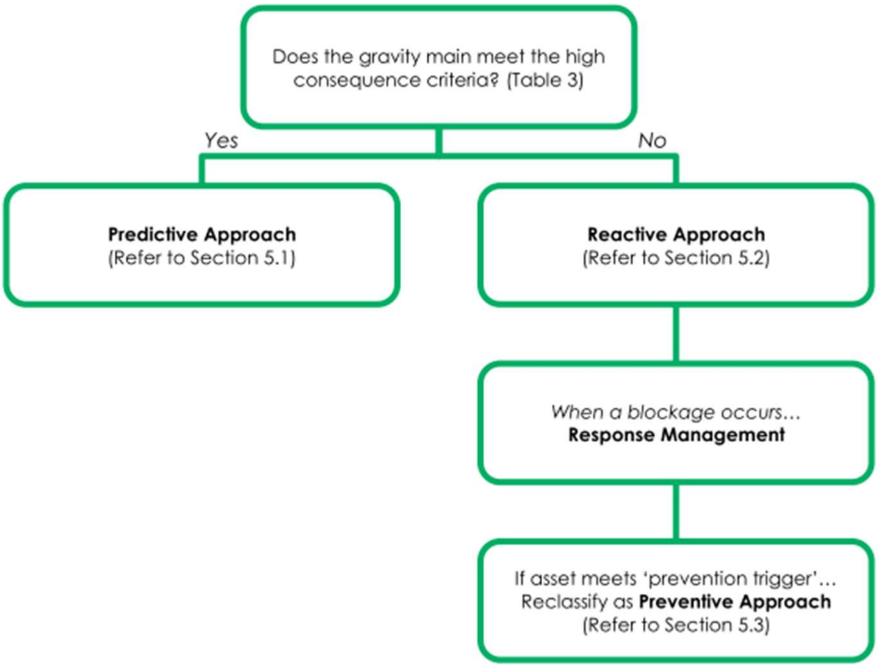

Figure 4-2 SA Water's flowchart for classifying sewer assets

This figure includes a cross reference to Table 3 within the Approach document to define the "high consequence criteria". However, Table 3 does not identify what constitutes a "high" consequence, there are only descriptions of what consequences may occur.

For sewer networks, there is usually a much greater length of smaller diameter reticulation sewers (versus larger diameter mains), so the split of asset categories across these strategies is usually very heavily weighted to the reactive approach / run to fail approach. In our experience, these proportions are typically 5-10% in the preventative / avoid fail approach and 90-95% in the reactive / run to fail approach.

SA Water does not employ this approach of classifying concrete sewer mains by assessing their consequence of failure. Instead, it is proactively avoiding failure on all identified mains, based on its financial decision rule.

In its Wastewater Gravity Mains Approach document, SA Water also states in reference to the WSAA Sewer Blockage Model that:

> *SA Water aims to build upon its current practices and seek improvements in risk based analysis, condition assessment and maintenance practices of gravity main assets which is further discussed in section 6.*

Based on the materials provided and reviewed, SA Water stops short of using the tool in its entirety as it notes in the Approach document:

> *While this tool can be used to assist in managing blockages, it is potentially very time-consuming to establish and maintain. SA Water has a mature GIS which can be enhanced to automate the functions performed in this tool which should be explored further.*

.Our assessment is that SA Water has chosen to align its approach rather than completely implement it. We recommend that SA Water moves towards implementing such criteria for classifying sewer mains assets as soon as practicable.

4.3 An example of best practice in action: Sydney Water

Sydney Water classifies its sewers into critical (avoid fail) and non-critical (plan to repair), in line with the WSAA guideline on managing sewer overflows[1].

For the non-critical sewers (predominantly the reticulation sewers), the asset management strategy uses trigger criteria to identify the efficient point to re-line or renew smaller sewers. The normal trigger for a CCTV inspection is three chokes in five years. At this frequency, it is considered that the asset has deteriorated but more importantly the cost of cleaning up, undertaking CCTV inspections, then clearing the choke is higher than the cost of re-lining. Once the trigger is reached, specific analysis confirms if it is more efficient to re-line the sewer.

Sydney Water's renewal decisions are not based on specific condition grades, rather, they are based on the need to meet EPA licence limits and/or performance outcomes. Financial analysis is used to assess whether an asset should be repaired or more fully rehabilitated (often relined). In other words, it is the service outcomes that drive the need for investment and those financial assessments consider the most efficient renewal approach.

4.4 Remaining Useful Asset Life Guideline – SA Water

For gravity mains, SA Water has a condition strategy which is based around replacement of known condition grade 4 and 5 assets. In NPV assessments (C3051, C3052), SA Water refer to condition grade 4 and 5 sewer assets being expected to have up to ten years and five years remaining useful asset life, respectively. This is broadly comparable with industry standards as explored below.

For example, Figure 4-3 shows an illustrative curve used for civil assets as presented in IPWEA's Practice Note 7, which covers condition assessment and asset performance guidelines for water and sewerage assets.

[1] This approach is described in Sydney Water's submission to its recent price review: https://www.ipart.nsw.gov.au/files/sharedassets/website/shared-files/pricing-reviews-water-services-metro-water-prices-for-sydney-water-corporation-from-1-july-2020/legislative-requirements-prices-for-sydney-water-corporation-from-1-july-2020/attachments-to-sydney-water's-proposal.pdf

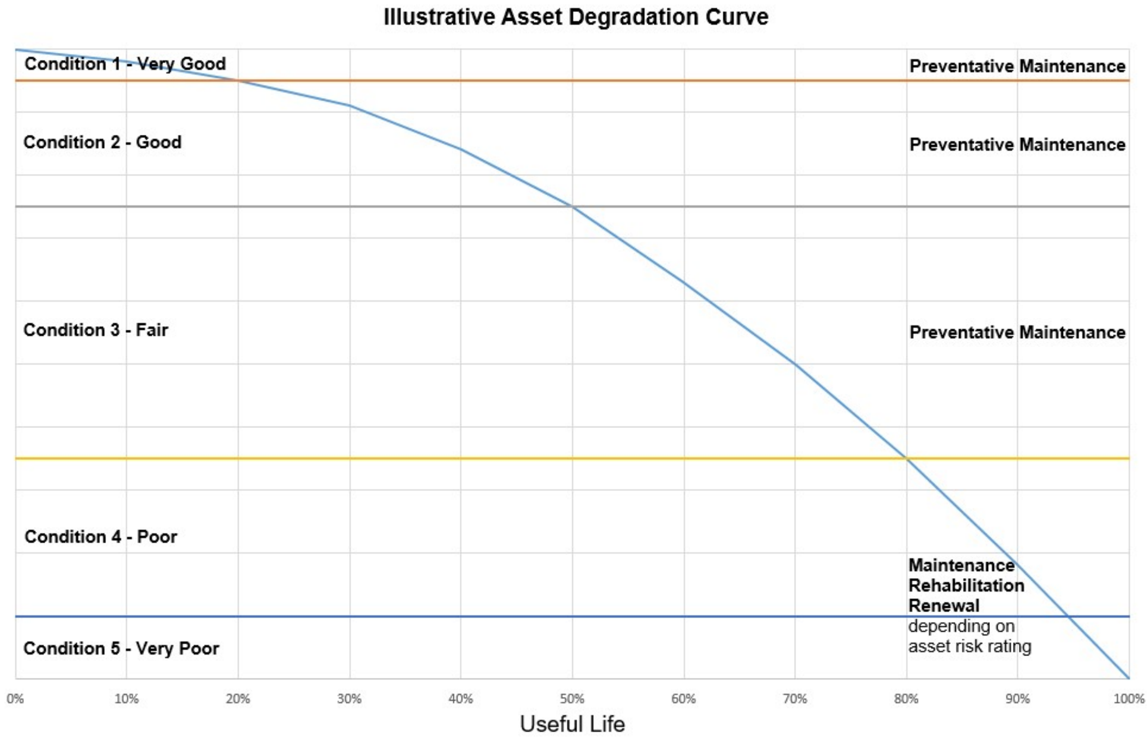

Figure 4-3 Asset deterioration v Remaining Useful Life, taken from IPWEA's Practice Note 7

Analysis Cardno has carried out for other authorities / utilities has used the following in useful life / condition grade relationships. In the example below, assets with an asset life of 60 years in condition 4 would have 3-12 years' asset life remaining.

Inferred Condition	Pump/elec/mech: Asset age (20 year assets)	Civil: Asset Age (60 years)
1	0 – 3	0 - 11
2	4 – 10	12 – 30
3	10 – 16	31 – 48
4	16 – 19	49 – 57
5	19+	58+

As can be seen above, condition grade 4 can equate to anywhere from 5-20% asset life remaining. For a reinforced concrete sewer (typically 60 year asset life), this would indicate a remaining useful asset life of between 3 and 12 years. This would indicate not all condition 4 assets are likely to require replacement within the next four years. A proportion would, but not all.

Is the proposal to proactively renew all known condition grade 4 and condition grade 5 sewer mains supported on a financial basis?

SA Water confirmed that the decision rule for replacement of condition grade 4 and 5 is based on the NPV analysis included in the *Wastewater Network Management - Mains (Trunk and Reticulation) Business Case*. We were informed that this analysis was developed for RD16 and also used to justify the RD20 approach to sewer renewal. It is somewhat surprising that the analysis had not been updated with more recent cost data, or a more complete range of repair-based costs, as already mentioned. SA Water provided the same information on request for further information in relation to NPV analysis completed on the RD20 program.

We have the following concerns with the financial analysis undertaken:

> The cost rates for the repair on failure events appear very high. For example, the repair on failure rate for the small diameter mains is $3,985/m. A repair on failure strategy will involve responding to the initial failure and usually undertaking a spot repair and clean up. The main will then be assessed and, if warranted (i.e. there is evidence of unacceptable deterioration of the main and that the initial failure wasn't caused by another factor), the main will be replaced or relined. Therefore, the marginal cost is only for the repair and clean up for the initial fault, which is typically only a small section. A worst-case scenario would be where the collapse caused damage to third party property not covered by insurance, or where the failure occurred in an area that needed extensive traffic control or protection. In our experience these are infrequent. SA Water has not provided evidence to understand what is driving these very high costs. As a check, the NSW reference rate manual ($2014) includes rates for construction of new sewers of $175/m to $440/m (1.5 – 4m depth). SA Water's rate is ten times higher than the top of this reference rate (we would expect it to be somewhat higher but this difference is difficult to explain).

> The repair on failure costs are also provided for long lengths of main. As detailed above, a repair on failure strategy usually deals with short sections only, with the remaining sections of main subsequently considered for relining or renewal. This calls into question whether the repair/renewal strategy for the selected jobs was appropriate and would be applicable to the rest of the assets.

> There is no evidence that the costs used in the analysis are appropriate for the forward program. Major drivers of cost for sewer repair and renewal works include the need for traffic management, the need for out of hours working, depth of the sewer, and accessibility of the access chambers.

> The NPV analysis uses a linear profile of all CG4 mains failing over the 10-year analysis period. The distribution is likely to have a flatter profile in the early years before increasing. In fact, it appears inconsistent that the CG4 mains are modelled to fail from year 1, at the same time as CG5 mains. If there is condition information that suggests they are in better condition then it is reasonable to expect that they would not fail in such proportions (one-tenth) from year one. Based on the previous discussion, we would also expect that not all CG4 mains would fail within the ten year period. These two impacts would lessen the net present cost of the base case to repair on fail (i.e. make it more favourable).

> The analysis includes CG5 mains, which will bias the overall result (and by implication, the result for CG4 mains), as the benefit of replacing the CG5 mains is greater than for the CG4 mains, as they are all assumed to occur sooner.

> The CG4 mains are not uniform in their cost to repair and replace/reline. We have noted that the analysis does not include information to demonstrate that the costs used in the analysis are reflective of the RD20 program (and we question whether the costs are at all reflective of actual costs). But beyond this, any modelling results will have varying applicability to each main in the forward program. There is likely to be benefit (i.e. savings through avoided work) in SA Water undertaking greater analysis on a main by main basis for the RD20 CG4 program.

> The relining cost assumed for small diameter mains is $227/m, which is relatively low compared to that used for the RD20 program. However, we have limited information on inclusions and exclusions for each.

In summary, we have two major concerns with the financial analysis that supports the decision rule to replace all CG4 mains:

> The assumption on costs to repair on fail are very high. They appear inconsistent with a strategy to repair an initial failure, and then identify whether it is appropriate to undertake more work, and the extent of that work.

> The modelling is coarse (includes CG5, includes simplistic replacement profile, includes broad assumptions) and there is likely to be considerable variability on a main by main/site by site location considering factors such as the need for traffic control. The level of expenditure for this work program warrants more detailed analysis.

5 Performance and expenditure

5.1 Impact on performance

Do you think we have allowed enough capex/opex for SA Water to 'maintain' the number internal overflows/worst served customers at the four-year average?

General

Internal overflows are not always representative of the wider network, as there are sometimes hydraulic issues or other factors at play that make particular properties more likely than others to suffer from an internal overflow. However, the trend of internal overflows over time, and across a large network, does provide a useful guide as to condition and performance.

Given the improving internal overflows trend and that of customers experiencing more than one internal overflow per five years, it is reasonable to allow wastewater mains renewal in line with previous periods.

Do you think we have allowed enough opex for SA Water to 'improve' the number of environmental sewer overflows? Is SA Water's ability to improve this adversely affected by our capex decision?

Yes, we have accepted the opex increase proposed by SA Water based on its own assessment (and we do not have any better evidence to come to a different conclusion).

The additional opex that has been allowed ($9m over 4 years) is consistent with what SA Water proposed. The program is based on providing this level of funding to inspect and clean mains to prevent overflows.

The Wastewater Pipe Networks AMP states that SA Water cleans around 440km year. It is assumed that the additional $9 million is on top of this. At $5-10/m for a sewer inspection and clean, this would give an extra 900-1800km of cleaning (or 225-450km/year). Using $10/m would equate to a 50% increase in mains cleaning activity (an extra 225km per annum). While the science is not precise, we have no reason or information provided by SA Water to say this is high or low.

Is Cardno able to identify the improvement in sewer overflows to the environment that SA Water expects to deliver through its sewer mains cleaning program? Can Cardno advise on the level of improvement we can reasonably expect from SA Water in this area?

We know that Type 1 and 2 incidents from gravity mains (addressed by mains cleaning) make-up 80-90 % of the total type 1 and 2 incidents, and is probably where most of the improvement is needed to go from 109 to 91 overflows. It appears that mains cleaning is going to be increased by around 50% in the overflows program, and this should be sufficient to drive a material improvement in sewer overflows, though it is not possible to quantify this. This should especially be sufficient if the inspection and cleaning is effectively targeted.

5.2 Possible alternative scenarios

There has not been time to analyse the assumptions in SA Water's financial model in detail. Our initial position was based on our understanding of industry practice (based on the decision rules and analysis undertaken by other utilities), and our own work applying risk based decision rules. We have not seen further information to suggest that our initial position – that SA Water is conservative in its decision rule to replace all CG4 mains – should change. It is difficult to see the applicability of the financial analysis when it appears to have materially flawed assumptions.

Notwithstanding the above, we accept that there are circumstances where replacing CG4 mains will make financial sense. This would ideally be identified through a more mature approach that considers individual site factors such as traffic, customer impacts, private property impacts, bypassing arrangements, access etc. A planning cost estimate would then be prepared to inform a more realistic and targeted financial analysis. Provided there was the right checks/balances and incentives, this would involve the contractor, to reduce the risk of cost variance from this assessment stage to outturn.

Without more detailed information, main diameter can be used as a proxy for complexity (noting that this is a guide only). The hypothesis is that a large sewer will cause more disruption and additional costs if allowed to fail. The following scenarios explore providing SA Water with various proportions of the program proposed.

The scenarios are based on:

> Renewing all sewer mains in Condition Grade 5 (which comprise $8.2 million or 17% of the total proposed program)

> Renewing all mains that have a nominal diameter greater than 375mm and are in Condition Grade 4, to reflect the potential consequence of failure of these larger diameter mains

> Renewing a proportion of the mains that are in Condition Grade 4 that are equal to or less than 375 mm nominal diameter.

Table 5-1 Gravity sewer program scenarios

Option A	Option B	Option C	Option D	Option E
All mains >375mm with 0 0 ≤375mm	All mains >375mm with 10% ≤375mm	All mains >375mm with 25% ≤375mm	All mains >375mm with 50% ≤375mm	All mains >375mm with 100% ≤375mm
30,300,000	32,200,000	35,100,000	39,800,000	49,300,000

We consider that Option C, which allows for, based on SA Water's own costs, replacement of:

> all mains in Condition Grade 5

> all mains in Condition Grade 4 greater than 375mm in diameter

> 25% (by value) of the mains in Condition Grade 4 that are equal to or less than 375 mm in nominal diameter

provides an appropriate balance between risk and cost.

This is not to prescribe the mains that SA Water should renew. This should be done by SA Water through a more comprehensive consideration of the consequence of failure of each individual main. This detailed analysis has only been undertaken to better illuminate the cost and risk trade-offs faced by SA Water. We expect that SA Water will collect further information on these assets and its approach will evolve such that that the actual mains renewed in the RD20 period will be further optimised.

Note that this analysis excludes four siphon condition assessment projects (which total $1.176 million) and the capitalised component of the CCTV program ($0.8 million).

6 Conclusion

Under the A0038 - Reticulation Mains Wastewater Network program included in its Regulatory Business Plan, SA Water proposed the following activities to maintain the serviceability of the wastewater network reticulation mains:

> Wastewater Mains Renewal including ($3.9 million general allowance, $51.2 million for specifically identified projects):
> Major and Minor Third Party Works Metro (Regulated) ($8.1 million)
> A general allowance for rising mains renewal ($2.5 million)
> Recycled water mains renewal ($1.9 million)

Based on the information provided by SA Water and our analysis, we recommended in our Final Report that the prudent and efficient expenditure for this program was $45.1 million, in line with RD16 expenditure levels. This was due to the absence of any compelling deterioration in performance, and due to our assessment that SA Water's decision rule to replace concrete mains on the basis of condition to be unduly conservative.

Further analysis of the information provided by SA Water suggests that, although it does not use consequence of failure as a decision rule to select the concrete mains that it proposes to renew in the forward period, this can be approximated by the diameter of the pipeline, to better include risk in forming the forward program. We consider that a level of expenditure which allows for replacement of

> all mains in Condition Grade 5
> all mains in Condition Grade 4 greater than 375mm in diameter
> 25% (by value) of the mains in Condition Grade 4 that are equal to or less than 375 mm in nominal diameter

provides an appropriate balance between risk and cost.

This is not to prescribe the mains that SA Water should renew, this should be done by SA Water through a more comprehensive consideration of the consequence of failure of each individual main. This detailed analysis included above has only been undertaken to better illuminate the cost and risk trade-offs faced by SA Water. We expect that SA Water will collect further information on these assets and its approach will evolve such that that the actual mains renewed in the RD20 period will be further optimised.

As recommended in the Final Report, we recommend that the efficiency applied to this program be increased from 3% to 5%. This adjustment totals $1.1 million and when applied, leads to a recommended level of prudent and efficient expenditure of $52.361 million.

Table 6-1 compares our revised recommendation on the level of prudent and efficient expenditure with that recommended by us in the Final Report and SA Water's RBP.

Table 6-1 Comparison of SA Water RBP, Final Report and revised position

<table>
<tr><th></th><th>SA Water RBP</th><th>Final Report</th><th>Revised recommendation</th></tr>
<tr><td>Wastewater mains renewal - specific project excluding condition assessment</td><td>49,221</td><td rowspan="6">45,000</td><td>35,077</td></tr>
<tr><td>Siphon condition assessment and capitalised CCTV</td><td>1,976</td><td>1,976</td></tr>
<tr><td>Wastewater mains renewal - general</td><td>3,886</td><td>3,886</td></tr>
<tr><td>Major and minor third party works</td><td>8,097</td><td>8,097</td></tr>
<tr><td>Rising mains renewal - general</td><td>2,483</td><td>2,483</td></tr>
<tr><td>Recycled water mains renewal</td><td>1,944</td><td>1,944</td></tr>
</table>

	SA Water RBP	Final Report	Revised recommendation
Total	67,607	45,956	53,463
Less efficiency adjustment		-948	-1,102
Recommended prudent and efficient expenditure		**45,008**	**52,361**

We recommend that SA Water's proposed increase in proactive maintenance for wastewater mains ($9m over four years) be considered efficient, but that the additional expenditure proposed for mains inspections ($2.4m on ancillaries, manholes, WW connections etc) and investigations on wastewater pumping main inspections ($1m) should not be considered efficient, as there is no case for why the RD20 period has increased needs compared with the RD16 period.

7 References

> IPWEA's Practice Note 7 which covers condition assessment and asset performance guidelines for water and sewerage assets.

> SA Water Approach – Wastewater Gravity Mains

> SA Water Approach – Wastewater Pumping Mains

> SA Water Wastewater Pipe Networks AMP

> SA Water DF0023C_Wastewater Network Environmental Overflows Approach

> SA Water Retic WWMR – Financial Evaluation NPV Model Wastewater Overflows Improvement

> SA Water Retic WWMR – Risk and Opportunity Assessment – RBP20 – Wastewater Pipe Networks

> SA Water Wastewater Gravity Main Decision Support Tool

> SA Water - Wastewater Network Management - Mains (Trunk and Reticulation) Business Case (July 2016)

> WSA 05 2013 WSAA - Conduit Inspection Reporting Code of Australia

> WSAA GSS1, Sewer Blockage Manual, SKM 2011