Attachment 8.3A

Response on Mains Replacement

SA Final Plan July 2021 – June 2026

January 2021

Australian Gas Networks

apa

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Contents

Figures

Tables

1. Executive Summary

The Distribution Mains and Services Integrity Plan (DMSIP) for our South Australia distribution network (our Network) outlines the program of work we undertake to manage network performance and integrity on a rolling five-year basis. Within the DMSIP's work program, there are four programs of work. The largest of these is commonly referred to as our mains replacement program (MRP). The others are our inline camera inspection program, multi user service replacement program, and condition and performance monitoring.[1]

This response on mains replacement provides an update to our work program for the next Access Arrangement (AA) period (1 July 2021 to 30 June 2026) and should be read in conjunction with the DMSIP submitted as Attachment 8.3 to our Final Plan in July 2020.

In our revised Final Plan we propose to invest $226 million (direct, unescalated $2019/20), which is a reduction of $38 million from the $264 million[2] proposed in our Final Plan.

Our investment will allow us to undertake:

- 780 kilometres of block and piecemeal mains replacement (a reduction of 90 kilometres from our Final Plan);
- 457 service replacements at multi user service (MUS) sites (no change from our Final Plan);
- 316 kilometres of inline camera inspections and reinforcement of mains (no change from our Final Plan);
- 2,450 reactive service replacements that are forecast to be required separate to the annual mains replacement program (non-AMRP service replacement – no change from our Final Plan); and
- Continued monitoring of the condition and performance of all other mains to determine the need for replacement into the future.

This work program follows on from a larger work program which will be delivered in the current AA period (1 July 2016 to 30 June 2021) at a total forecast investment of $274 million[3] (direct, real $2019/20) and includes:

- 1,059 kilometres of block and piecemeal mains replacement;
- 233 service replacements at MUS sites;
- 310 kilometres of inline camera inspections and reinforcement of mains;
- 2,749 reactive service replacements that have been required separate to the annual mains replacement program; and
- Continued monitoring of the condition and performance of all other mains.

We have modified our proposed replacement of high density polyethylene (HDPE) 575 Medium Pressure (MP) mains, accepting the deferral of 90 kilometres of replacement to future periods. While we have accepted this position, we note these mains are subject to the same squeeze off damage as the equivalent High Pressure (HP) mains and they remain an "intermediate risk"

[1] Condition and performance monitoring is an operating expenditure activity, so all costs relating to this program are excluded from total (capital) expenditure noted within this document
[2] Note this total includes an allowance for piecemeal replacement activity of $6 million, which is treated as an operating expense
[3] Note this includes around $5 million of piecemeal replacement activities which are treated as an operating expense

despite the lower failure numbers. Their replacement is the only risk mitigation measure available to us. As is usual practice, we will continue to monitor the condition and performance of these and other at risk mains. During this process, some of these mains may be reprioritised for replacement during the next AA period in accordance with our mains risk reduction prioritisation approach.

The following sections summarise the additional information we have provided to support our Cast Iron / Unprotected Steel (CI/UPS) – Block replacement totalling 558 kilometres (including 38 kilometres in North Adelaide), HDPE 575 HP replacement of 198 kilometres, amended depreciation of inserted HDPE mains and services and the non-AMRP unit rate proposed in our Final Plan. This additional information includes:

- Independent review of our proposed program by GHD, which agrees with the scope and timing of replacement for CI/UPS – Block (520 kilometres) and HDPE 575 HP (198 kilometres) mains;
- Deteriorating leak performance of cast iron mains in 2019 and 2020 which demonstrates that the lower run rate of around 81 kilometres each year for CI/UPS replacement in the current AA period (to allow for prioritisation of replacement of HDPE mains following significant failures on these mains – which was the correct risk based asset management decision) is not sufficient to address the further deterioration of these mains each year they remain in service;
- Evidence of CI mains cracking during routine leak repairs, further demonstrating the poor condition of the CI remaining in the network;
- Further information on the block replacement of CI/UPS mains and other materials that are captured in this program, demonstrating the approach is efficient;
- An internal memo dated 26 August 1991 which outlines potential changes to be made to the squeeze off procedure for polyethylene mains, including procuring new mechanical stops for squeeze-off jacks, which supports that mains laid up to 1993 would likely be subject to the squeeze off damage;
- Technical review by GHD of the ongoing role of inserted HDPE mains and services which demonstrates the replaced mains and services have no ongoing technical or asset management benefit to the delivery of haulage services; and
- Further reasoning for the increased material/other costs in the non-AMRP service replacements from 2019/20.

The additional information responds to issues raised in submissions received on our Final Plan, the AER's Draft Decision including Zincara's technical findings in its review of the program and ongoing engagement with the Office of the Technical Regulator (OTR) for South Australia.

Table 1.6: Comparison of our mains replacement program forecast with the AER's Draft Decision, ($ million, 2019/20 direct unescalated)

	Final Plan		AER Draft Decision		Revised Final Plan	
Category	Volume	Total capex	Volume	Total capex	Volume	Total capex
CI/UPS - block	520km[4]	[redacted]	405km	[redacted]	520km[4]	[redacted]
CI/UPS North Adelaide	38km	[redacted]	38km	[redacted]	38km	[redacted]
HDPE 250 remaining	14km	[redacted]	14km	[redacted]	14km	[redacted]
HDPE 575 DN40 – HP (insertion)	198km	[redacted]	150km	[redacted]	198km	[redacted]
HDPE 575 DN40 MP – (direct)	90km	[redacted]	0km	[redacted]	0km	[redacted]
Piecemeal replacement	10km	[redacted]	10km	[redacted]	10km	[redacted]
Total mains replacement	**860km**	[redacted]	**607km**	[redacted]	**780km**	[redacted]
HDPE 575 DN50 - inspection	316km	[redacted]	316km	[redacted]	316km	[redacted]
Total inspection	**316km**	[redacted]	**316km**	[redacted]	**316km**	[redacted]
MUS - Priority group 1	457 sites	[redacted]	457 sites	[redacted]	457 sites	[redacted]
Non-AMRP service replacement^	2,450 sites	[redacted]	2,450 sites	[redacted]	2,450 sites	[redacted]
Total service replacement	**2,907 sites**	[redacted]	**2,907 sites**	[redacted]	**2,907 sites**	[redacted]
Total cost of program		**$264.0**		**$184.3**		**$226.0**

Note: In this 'traffic light' table, green shading represents the acceptance, orange represents a modification and red shading represents a rejection

[4] Other LP materials such as HDPE 250, HDPE 575 and New PE are included in addition to CI & UPS as part of this block renewal program.

2. Our Final Plan

2.1. Our plan for the next AA period

In our Final Plan we proposed a total of 870[5] kilometres of mains to be replaced in the next AA period. In addition to the replacement of mains we proposed to continue the inline camera inspection and reinforcement of 316 kilometres of HDPE mains and replace 457 of the highest priority MUS. The forecast cost of this program was $264 million dollars.[6]

Under this program, we would complete the replacement of all remaining high risk CI/ UPS and other low pressure mains in our South Australian distribution network, effectively removing LP from our Network by June 2026.[7] This would be a significant safety milestone for our business, modernising our Network to consist of steel and plastic mains has the added benefit of contributing to the readiness of our Network for hydrogen.[8]

The Final Plan DMSIP work program for the next AA period by asset category is summarised in Table 2.1.

Table 2.1: DMSIP work program proposed – next AA period (July 2021 to June 2026)

Asset Category	Untreated Risk[9]	Proposed Treatment	Opening inventory	Closing inventory	Treated Risk
Mains replacement					
CI/UPS - block (km)[10]	High	Replace	558	0	Low
HDPE 250 - remaining (km)	High	Replace	14	0	Low
HDPE 575 DN50 - HP (km) [11]	High	Inspect	57	0	Intermediate (ALARP)
HDPE 575 DN50 - MP (km)	Intermediate	Inspect	259	0	Intermediate (ALARP)
HDPE 575 DN40 (km)	Intermediate	Replace	447	159	Intermediate (ALARP)
Inline camera inspection					
HDPE 575 – inspected (km)	Intermediate	Monitor	310	626	Intermediate (ALARP)

[5] Inclusive of 860km of programmed replacement (summarised in Table 2.1) and 10km of reactive (piecemeal) mains replacement
[6] All cost estimates in this plan are direct costs (excluding overhead) presented in real dollars of December 2019 and do not include real cost escalation, unless otherwise stated. The methodology is described in Section 5 of Attachment 8.3 – DMSIP with additional information provided in Attachment 8.9 - Unit Rates Report
[7] The only remaining LP in our Network post 2026 will be the newly installed 7kPa network in the CBD
[8] For further information about our decarbonisation focus, please see our SA Final Plan July 2020
[9] Throughout this paper, the term 'untreated risk' refers to the current risk with all normal BAU controls (most notably inspections) but without the addition of other targeted risk mitigation programs
[10] Throughout this paper, the term 'CI/UPS – block' refers to all remaining mains in the LP network (to the specific exclusion of the new CBD LP mains) which includes mains of material other than CI/UPS
[11] Note that while high pressure HDPE 575 DN50s untreated risk is rated as high, the inspection and reinforcement treatment of these mains reduces this risk to intermediate. It is subsequently assessed as ALARP as the cost to further reduce the residual risk of these mains to low is not considered proportionate to the reduction in risk. This is discussed in more detail in Sections 3 and 4 of Attachment 8.3 – DMSIP.

Asset Category	Untreated Risk[9]	Proposed Treatment	Opening inventory	Closing inventory	Treated Risk
Service replacement					
MUS replacement (units) [12]	High	Replace	457	0	Low

Note: 10 kilometres of reactive (piecemeal) mains replacement and 2,450 reactive service replacements are also forecast in the period.

2.2. Current AA period

A total of 1,059 kilometres of mains will have been replaced in the current AA period. This compares to 1,072 kilometres allowed in the AER's final decision in April 2016. The key reason for this minor variance is that the approved program included 20 kilometres of reactive replacement, but we forecast to complete just 7 kilometres in the period. In addition to the replacement of mains – which was the focus for the current AA period – a further 310 kilometres of mains will have been inspected with the use of an inline camera. 233 MUS sites will also be replaced.

The expected cost for the current AA period is $274 million, which is $56 million (17%) less than the AER's final decision of $330 million (direct and inclusive of real cost escalation).

The completion of the CBD replacement by the end of the current AA period will remove all extreme risk mains from our Network, with the last 8 kilometres of CBD mains due to be removed in 2020/21. This is a significant safety milestone for our business and delivers against our commitments made to the OTR and in our AA submission in 2016 to remove the highest risk rated assets in the Network, as a priority.

Table 2.2 provides a summary of the actual and allowed volume of mains replacement for the current AA period by asset category.

[12] Note there are also Intermediate and Low risk MUS in our Network, but replacement of these is not proposed for the next AA period. They will remain at Intermediate and Low risk through to 2026, with Intermediate considered ALARP thanks to the introduction of additional controls.

Table 2.2: Actual versus allowed volume – current AA period (kilometres)

Asset Category	Risk	Opening inventory	Actual volume	Allowed volume	Variance	Closing inventory
Mains replacement[13]						
CI/UPS CBD Mains (km)	Extreme	53	53	44	9	0
CI/UPS Trunk Mains (km)	Extreme	59	59	62	(3)	0
CI/UPS – LP (km)*	High	839	288	307	(19)	550
CI/UPS – MP (km)*	High	12	4	-	4	8
HDPE 250 (km)	High	305	291	180	111	14
HDPE 575 (km)	High	1,430	357	479	(119)	743[14]
Inline camera inspection						
HDPE 575 – inspected (km)	High	0	310	440	(130)	310
Service replacement						
MUS replacement (units)	High	633	176[15]	1,328	1,152	457

*Together these form "CI/UPS – block" and refer to all remaining mains in the LP network (to the specific exclusion of the new CBD LP mains replaced in the current AA period) which includes mains of material other than CI/UPS.

2.3. We continually seek efficient and effective options to manage mains risk

We closely monitor the condition and performance of our mains to understand the risk they pose to public safety and reliability and take measures to reduce this risk to as low as reasonably practical (ALARP). Our MRP is one of the key risk mitigation activities we undertake.

In our Final Plan, we forecast that there will be 1,645 kilometres of high and intermediate risk mains remaining in our Network by 30 June 2021. As is current practice, we continue to prioritise the replacement and inline camera inspection and reinforcement (where it is technically feasible as an effective alternative to replacement) for our at risk mains each year. This process is summarised in our annual operational DMSIP.

The program originally proposed for the next AA period included the replacement of 870 kilometres of mains at a cost of $244.2 million and the inspection and reinforcement of 316 kilometres of mains, at a cost of $[redacted] million. This program was expected to eliminate all

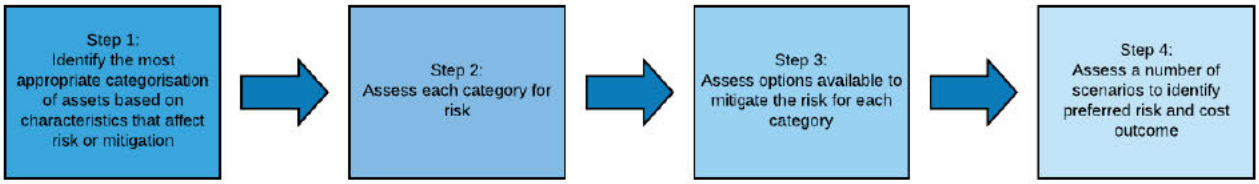
[13] Note that 7 kilometres of reactive (piecemeal) mains replacement is also forecast in the period
[14] Note that 310 kilometres of these mains are now reflected in 'HDPE 575 – inspected' category.
[15] Note that 233 MUS replacements were done in total, but 176 of those were priority group 1, High risk.

remaining high risk mains from our Network by the end of June 2026, leaving just 159 kilometres of intermediate risk mains to be replaced along with 626 kilometres of HDPE 575 DN50 mains that will have been inspected and reinforced to achieve a rating of ALARP. These HDPE DN50s are forecast for replacement from 2027 onwards.

2.4. Our program aims to achieve an appropriate risk reduction for the least cost to consumers

We followed a similar four step approach to develop our DMSIP work program for the next AA period to that used in previous periods and for our other distribution networks as illustrated in Figure 2.1. The approach identifies and assesses different categories of assets based on risk drivers and mitigation options and then considers options to achieve the target level of risk at an efficient cost.

Figure 2.1: Our approach to developing our mains replacement program



2.4.1. Assessing and reducing risk for each category of asset

We modified the categories of assets in developing the program for the next AA period to reflect better information on key characteristics which drive risk and management over the period.

For example, HDPE 575 mains have been split into different categories based on diameter, pressure and whether they have been subject to our inline inspection program. The CI/UPS and HDPE mains are referred to as 'remaining' as those at highest risk were replaced in the current AA period.

Table 2.3 presents the categories of mains adopted for the next AA, the risk rating under AS/NZS 4645 and recommended risk treatment in the next AA period.

Table 2.3: Mains categories and associated risk and risk mitigation (treatment) in the next AA period

Mains category	Inventory July 2021 (km)	Untreated Risk	Treatment in next AA	Treated Risk
CI/UPS - block[16]	558	High	Replace – remove from Network	Low
HDPE 250 - remaining	14	High	Replace – remove from Network	Low
HDPE 575 DN50 - HP	57	High	Inspect and reinforce	Intermediate (ALARP)
HDPE 575 DN50 - MP	259	Intermediate	Inspect and reinforce	Intermediate (ALARP)

[16] Other LP materials such as HDPE 250, HDPE 575 and New PE are included in addition to CI & UPS as part of this block renewal program.

Mains category	Inventory July 2021 (km)	Untreated Risk	Treatment in next AA	Treated Risk
HDPE 575 DN40	447	Intermediate	Prioritised replacement – remove 288km from Network and monitor remaining 159km	Intermediate (ALARP)
HDPE 575 DN50 inspected	310	Intermediate (ALARP)	Monitor only	Intermediate (ALARP)

As outlined earlier, we have three categories of MUS based on the risk assessed priority for replacement.

Table 2.4 presents the categories, risk rating and proposed risk treatment in the next AA period.

Table 2.4: Multi User Site categories and associated risk and risk mitigation (treatment) in the next AA period

Service category	Inventory July 2021 (sites)	Untreated Risk	Treatment in next AA	Treated Risk
MUS - Priority group 1	457	High	Replacement	Low
MUS - Priority group 2	1,653	Intermediate (ALARP)	Continued additional monitoring and leak survey activities and awareness campaign	Intermediate (ALARP)
MUS - Priority group 3	361	Low	Monitor only	Low

The approach to rating the risk of each asset category is presented in Section 3 of our original AA DMSIP submitted as Attachment 8.3 to our Final Plan.

2.4.2. Achieving the target risk at an efficient cost

To determine the program that achieves the targeted risk outcome at an efficient cost, we considered a number of scenarios of varying risk outcomes. Under all scenarios, regular inspection (e.g. leak survey) and reactive (piecemeal) replacement when required is assumed to continue. The scenarios assessed were as follows:

- Scenario A: Complete established programs only – this program replaces only the remaining CI/UPS block and HDPE 250 mains;
- Scenario B: Achieve low risk – this program removes all high and intermediate risk assets from our Network;
- Scenario C: Remove all high risk – this program removes all high risk mains and priority 1 MUS;
- Scenario D: Maintain ALARP for all mains and MUS – this program removes all high and intermediate risk mains unless they can, or have been, inspected through the inline inspection program and removes all priority group 1 MUS;
- Scenario E: Efficient ALARP for all mains and MUS – this program is the same as Scenario D except it takes a prioritised approach to replacing HDPE 575 DN40 mains, deferring the replacement of some of these mains until the subsequent AA period as the incremental cost of

replacing all these mains is not proportionate to the incremental reduction in risk. This was the recommended scenario.

The volume of assets to be replaced or inspected under the inline camera inspection program is shown in Table 2.5 with the cost and residual risk for each scenario.

Table 2.5: Scenarios considered for next AA period

Asset Category	km in network	Scenario A	Scenario B	Scenario C	Scenario D	Scenario E (preferred)
Mains replacement						
CI/UPS - block[17]	558	558	558	558	558	558
HDPE 250 - remaining	14	14	14	14	14	14
HDPE 575 DN50 - HP	57	-	57	57	-	-
HDPE 575 DN50 - MP	259	-	259	-	-	-
HDPE 575 DN40	447	-	447	-	447	288
HDPE 575 DN50 inspected	310	-	310	-	-	-
Piecemeal	-	60	10	40	10	10
Total km replaced		**632**	**1,655**	**669**	**1,029**	**870**
Inline camera inspection						
HDPE 575 – inspected (km)	310	-	-	-	316[18]	316
Total km inspected/reinforced		-	-	-	**316**	**316**
Service replacement						
MUS – Priority group 1	457	125	457	457	457	457
MUS – Priority group 2	1,653	-	1,653	-	-	-
MUS – Priority group 3	361	-	-	-	-	-
Total MUS replaced (sites)	-	**125**	**2,110**	**457**	**457**	**457**
Non AMRP MUS	470,000+	2,450	2,450	2,450	2,450	2,450
Risk at June 2026		High	Low	Intermediate	Intermediate (ALARP)	Intermediate (ALARP)
Total capex ($ million)[19]		**$197.1**	**$467.4**	**$203.7**	**$300.6**	**$259.1**
Cost to customers ($ million)[20]		**$14.3**	**$33.1**	**$14.8**	**$21.0**	**$18.3**
Cost per customer per annum ($)[21]		**$5.94**	**$13.72**	**$6.13**	**$8.72**	**$7.57**

The Final Plan program for the next AA period reflected Scenario E. We determined this program would achieve an intermediate risk rating at the end of the period that is considered ALARP

[17] As noted in Table 2.1, other LP materials such as HDPE 250, HDPE 575 and New PE are also included in this program

because the cost of reducing the risk rating to low is disproportionate to the reduction in risk. Further, the cost of replacing the lower priority HDPE 575 DN40 mains (those laid from 1993) within the period was not proportionate to the risk reduction achieved of replacing those remaining mains. Therefore, this program achieved ALARP at an efficient cost to customers.

Scenarios A and C would not achieve a low or ALARP risk rating and therefore do not comply with our obligations under AS/NZS 4645 to manage identified risk on our Network. Scenario B achieved a low risk rating, but at a significant cost to the customer. Scenario D achieved ALARP but also at a higher cost than Scenario E.

As a result of the plan for the next AA period, we expected to reduce the risk associated with our at risk mains and services to low or intermediate (ALARP).

The proposed DMSIP work program in our Final Plan was considered consistent with the actions of a prudent and efficient service provider, acting in accordance with accepted good industry practice to maintain and improve the safety of gas distribution services at the lowest sustainable cost. The proposed program best meets the National Gas Objective (NGO) as it addresses the inherent Network risk, using a combination of risk treatments that minimises asset replacement in the short term, and allows for prudent asset management over the long term. Customers will benefit from maintained safety of the network with minimal cost impact.

[18] 316km = 57km of HDPE 575 DN50 HP + 259km of HDPE 575 DN50 MP
[19] Note there is no inclusion of non AMRP in these capex totals as their cost and impact is unchanged across all scenarios.
[20] This reflects the cost to customer over the 5 years of the next AA period only and does not consider the impact over future periods.
[21] This reflects the average cost to a customer each year over the 5 years of the next AA period.

3. Customer and Stakeholder Engagement

3.1. Submissions to our Final Plan

We received ten submissions to our Final Plan. Four of the submissions from the SAFFRA, SAFCA, Origin and the CCP were supportive of our expenditure levels, capex proposal or mains replacement program specifically. One submission from the Minister for Energy and Mining queried our proposed mains replacement levels. Three of the submissions from Business SA, ECA and Energy Australia asked the AER to consider the necessity of our proposed mains replacement (and other capex) given the current uncertainty.

Table 3.1: Summary of stakeholder submissions on mains replacement in our Final Plan

Organisation	Feedback	Our response
Business SA	• Recognised there is a level of necessary mains replacement, but asks the AER to remain mindful of both the impact of aggregate capital spending, along with the relative merits of each individual capital proposal, given it will occur during an environment of falling gas consumption, and considering the impact the capital base has on the ultimate cost borne by consumers.[22]	• Our revised mains replacement of 780km considers the feedback from customers, stakeholders, the AER and the OTR to balance safety and costs over the next AA period.
CCP24	• Note the single largest element of proposed capital expenditure is the conclusion of the mains replacement program, which is an established program over multiple Access Arrangement periods and will result in the completion of this substantial work program.[23] • CCP24 understand that consumer groups and the SARG have a good understanding of the merits of the mains replacement program and have been supportive of it for some time and continue to be positive about the merits of the program and the safety benefits, including reductions in unaccounted for gas through leaks from fragile mains.[24]	• Our revised mains replacement of 780km will see completion of the cast iron and low pressure replacement program in the next AA period, but has deferred replacement of additional HDPE mains until subsequent AA periods. • We believe completion of the cast iron and low pressure replacement program is a key milestone that should be achieved in the next AA period and we have provided additional information in support of this timing to the AER.
ECA	• Cost benefit analysis and risk assessment to inform whether it would be more prudent to continue with the mains replacement program or deferring some/all of the program until more is known in 2022 about hydrogen.[25]	• Our revised mains replacement of 780km considers the feedback from customers, stakeholders, the AER and the OTR to balance safety and costs over the next AA period, given the current uncertainty around the future of gas networks.

[22] Business SA, Submission on Australian Gas Infrastructure Group's 2021-26 Final Plan for South Australia's gas distribution network, August 2020, p. 3.
[23] CCP24 Advice to Australian Energy Regulator on Australian Gas Networks Final Plan (CCP Advice), August 2020, p. 19.
[24] CCP24 Advice, p. 19.
[25] ECA, Response to AGNSA AA Proposal for 2021-26, August 2020, p. 14.

Organisation	Feedback	Our response
Energy Australia	• Raises prudency of spending on risk mitigation measures, primarily upstream hydrogen investment and mains replacement to accommodate hydrogen in the context of absence of clarity on when or how (or whether) the recovery of long-term investment value takes place over the next 5 or 6 access arrangement periods.[26]	• Our revised mains replacement of 780km considers the feedback from customers, stakeholders, the AER and the OTR to balance safety and costs over the next AA period, given the current uncertainty around the future of gas networks.
Origin	• Note our capex forecasting process appears reasonable, but there is also a need for the AER to be cognisant of uncertainty including potential asset stranding risk.[27]	• Our revised mains replacement of 780km considers the feedback from customers, stakeholders, the AER and the OTR to balance safety and costs over the next AA period, given the current uncertainty around the future of gas networks.
Minister for Energy and Mining (SA)	• Accepts mains replacement will continue to be an activity to ensure the ongoing safety of the gas network, but highlights the expenditure in any given period should reflect reductions in risk already achieved.[28] • Notes the success of the accelerated mains replacement program undertaken to date and questions whether the volume of the accelerated program is still necessary where all extreme and a portion of high risks will have been removed from the network.[29] • OTR yet to review in detail and asked for further clarity on the amount of cast iron and unprotected steel and other material mains that still require replacement.[30]	• Our revised mains replacement of 780km will see completion of the cast iron and low pressure replacement program in the next AA period, but has deferred replacement of additional HDPE mains until subsequent AA periods. • We believe completion of the cast iron and low pressure replacement program is a key milestone that should be achieved in the next AA period and we have provided additional information in support of this timing to the AER. • While we note the leak performance of the network has improved significantly since we started our cast iron and low pressure replacement program, completion of this program as soon as practicable is important to meet our legislative public safety and risk obligations under the Australian Standards. • We have provided further information on the block replacement of cast iron and other materials operating at low pressure in Section 5.5 of this response.

[26] Energy Australia, Submission to Australian Gas Networks South Australia (AGN) – Proposed Access arrangement 2021-26 – 1 July 2020, August 2020, pp. 4-5.
[27] Origin, Submission to AGN (SA) access arrangement proposal, August 2020, pp. 2-3.
[28] Minister for Energy and Mining (SA), submission to Australian Gas Networks' Access Arrangement proposal for 2021-26 (Submission), August 2020, p. 2.
[29] Minister for Energy and Mining (SA), Submission, p. 2.
[30] Minister for Energy and Mining (SA), Submission, p. 2.

Organisation	Feedback	Our response
SAFCA	• Support replacement of 860kms of old cast iron and other unreliable mains.[31] • Noted our Final Plan capex is a responsible plan that will improve safety and reliability for the SA Community.[32]	• Our revised mains replacement of 780km considers the feedback from customers, stakeholders, the AER and the OTR to balance safety and costs over the next AA period.
SAFFRA	• Support mains and inlets replacement program for LP cast iron and HP HDPE while delivering a price cut to customers.[33]	• Our revised mains replacement of 780km considers the feedback from customers, stakeholders, the AER and the OTR to balance safety and costs over the next AA period.

3.2. Ongoing engagement

We engaged with SARG and RRG on 9 December 2020 on our proposed approach in this revised Final Plan, and all members supported that we:

- Seek independent technical advice on the prudency of our mains replacement and other distribution capex programs; and
- Continue to engage with the OTR to reach an agreed position for mains replacement over the next five years.

We engaged GHD to undertake a technical review of our proposed mains replacement and other distribution capex programs. GHD's findings on the prudency of our proposed mains replacement program are summarised in this attachment and also provided in Attachment 8.12 to our revised Final Plan.

We have continued to engage with the OTR on our proposed mains replacement. This includes presentation of our proposed approach in this revised Final Plan on 5 January 2021. Our response below includes additional information that responds to feedback from the OTR at that meeting. We believe this, along with continued engagement after the submission of our revised Final Plan, will enable us to reach an agreed position on mains replacement for the next AA period.

[31] SAFCA, submission re Australian Gas Networks South Australia (AGN(SA)) gas access arrangement proposal for the period 1 July 2021 to 30 June 2026 (Submission), August 2020, p. 2.
[32] SAFCA, Submission, p. 2.
[33] SAFFRA, Submission to AGN South Australia 2021 -26 Gas Access Arrangement (AA) Review, August 2020, p. 3.

4. AER's Draft Decision

4.1. Actual and forecast capex in the current AA period

The AER has accepted in full our capex program over the current AA period as conforming capex but note that our 2019-20 and 2020-21 expenditures are considered to be place holders until the AER makes its assessment in the final decision (for 2019-20) and at the next AA (2026-31) review for 2020-21.

4.2. Forecast capex for the next AA period

The AER has approved $184 million (real direct unescalated $2019/20), or 71%, of our forecast DMSIP capex proposed for the next AA period as conforming capex. This is a reduction of $74 million or 29% compared to our Final Plan, noting the $6 million for forecast piecemeal mains replacement is expensed and therefore forms part of our opex base year.

In particular, the AER's Draft Decision is to:

- Reduce the speed of CI/UPS – Block replacement compared to our Final Plan, to align with the current run rate of 81 kilometres per annum, which will see 115 kilometres of CI/UPS mains replacement deferred to the subsequent AA period – meaning we will not complete the program until around December 2027;
- Approve the CI/UPS – North Adelaide replacement capex, providing for 38 kilometres of replacement, with a small reduction to the forecast unit rate to complete this replacement;
- Approve the HDPE 250 replacement capex, providing for 14 kilometres of replacement;
- Reduce the scope of HDPE 575 mains replacement capex compared to our Final Plan, reducing the scope of the high pressure aspect of that program to include mains laid up to 1990, and considering the replacement of the medium pressure aspect of that program was not commensurate with the risk reduction it would achieve, providing for 150 kilometres of replacement and deferring 138 kilometres of replacement into future AA periods;
- Approve the HDPE 575 Inline Camera Inspection, providing for 316 kilometres of inspection and reinforcement;
- Approve MUS replacements at high risk sites, providing for 457 MUS replacements; and
- Approve the non-AMRP service replacement, providing for 2,450 service replacements, with a small reduction to the forecast unit rate to complete this replacement.

The AER's Draft Decision and reasons on our DMSIP capex program our outlined in Table 4.1 below.

Table 4.1: Summary of the AER's Draft Decision on our forecast DMSIP capex proposal for next AA period

	AER Draft Decision	AER Comment
CI/UPS - Block	**Modify**	• Accepted that block replacement is the most efficient approach to replace CI/UPS mains • Accepted block replacement is justified on safety and integrity grounds

	AER Draft Decision	AER Comment
		• Reduced the program to the current replacement rate of 81km pa, which sees 115km of our proposed 520km of block replacement of low pressure CI/UPS mains deferred to the subsequent AA period citing stable failure rates in recent years
CI/UPS – North Adelaide	**Modify**	• Accepted that block replacement is the most efficient approach to replace CI/UPS mains • Accepted 38km of block replacement is justified on safety and integrity grounds • Slightly reduced the unit rate for North Adelaide by taking a weighted average rate over three years plus adding a premium for new requirements, rather than the most recent actual costs
HDPE 250 - Remaining	**Accept**	Accepted 14km as proposed
HDPE 575 DN40 - HP	**Modify**	• Accepted replacement is justified on safety and integrity grounds • Adjusted the cut off to include mains laid prior to 1991 (rather than 1993) which defers 48km of our proposed 198km high pressure HDPE 575 DN40 mains by insertion
HDPE 575 DN40 - MP	**Reject**	Did not accept that the replacement of HDPE 575 DN40 MP mains by direct burial is commensurate with the risk reduction achieved based on historic failure data with respect to squeeze off failure in this category.
HDPE 575 DN50 – camera inspection and reinforcement	**Accept**	Accepted 316km as proposed
MUS replacement	**Accept**	Accepted 457 replacements as proposed
Non-AMRP service replacement	**Modify**	• Accepted 2,450 replacements as proposed • Slightly reduced proposed unit rate for the non-AMRP service replacement by taking a weighted average of material costs over four years, rather than the most recent actual costs

Note: In this 'traffic light' table, green shading represents the acceptance, orange represents a modification and red shading represents a rejection

4.2.1. CI/UPS Block

In reducing the volume of CI/UPS block replacement in its Draft Decision, the AER stated:

> *A review of the asset condition shows that the remaining cast iron assets are gradually deteriorating with age, and will need to be replaced over time. However, the information provided in the proposal does not appear to support a significant increase in level of mains replacement currently occurring. In particular, historic crack and break data indicates a downward*

trend in the number of reported incidents, which can be attributed to the removal of the high risk sections of CI and UPS mains.[34]

4.2.2. CI/UPS North Adelaide

The AER approved 38 kilometres of block replacement for North Adelaide as conforming capex but applied a slightly lower unit rate than we proposed. Based on the advice of its technical expert, Zincara, the AER considered "a revised unit rate consisting of the 3-year weighted average unit rate and an additional allowance for premium costs associated with the CBD works, is more likely to reflect the costs in the North Adelaide mains replacement program."[35]

4.2.3. HDPE 575 DN40 – HP (mains insertion)

In its Draft Decision the AER considered the replacement of HDPE 575 DN40 HP mains by insertion in the next AA period should focus on replacement of mains laid prior to 1991, totalling 150 kilometres of replacement. This was based on its analysis of squeeze off failure data "showing 40 failures since 2005, of which five have been reported on mains laid after 1990."[36]

In addition to its reduction of the proposed volumes of replacement for these mains, the AER noted:

[T]he insertion method of addressing poor asset performance can be viewed as an asset reinforcement or modification rather than a like for like replacement. This distinction would influence our regulatory depreciation decision in terms of whether or not the existing assets are subject to accelerated depreciation post insertion (Attachment 4 – Regulatory Depreciation). In its revised proposal, we expect AGN to clarify whether the existing assets will not be providing any ongoing services to consumers post insertion as well as further information on key assumptions used in Incenta's mains replacement analysis.[37]

4.2.4. HDPE 575 DN40 – MP (direct burial)

The AER did not accept the replacement of HDPE 575 DN40 MP mains by direct burial in the next AA period. This was based on its analysis of squeeze off failure data which "shows that there were three failures reported for the medium pressure DN40 mains between 2005 and 2011, and that no further failures have since been reported."[38] The AER considered:

This data does not suggest an ongoing or recurrent problem with respect to squeeze off failure in this category. As the direct burial option proposed by AGN is the most expensive method of mains replacement, we consider that the proposal to mitigate risk in this category is disproportionate to the risk being managed.[39]

[34] AER, Draft Decision – Australian Gas Networks (SA) Access Arrangement 2021-26, Attachment 5: Capital expenditure, pp. 14-15.
[35] AER, Draft Decision, Attachment 5, p. 15.
[36] AER, Draft Decision, Attachment 5, p. 15.
[37] AER, Draft Decision, Attachment 5, p. 15.
[38] AER, Draft Decision, Attachment 5, p. 16.
[39] AER, Draft Decision, Attachment 5, p. 16.

4.2.5. Non-AMRP Service Replacement

The AER approved 2,450 non-AMRP service replacements as conforming capex in the next AA period but applied a slightly lower unit rate than was proposed. The AER applied a "unit rate which combines the current actual labour rate with the 3-year materials/other rate"[40] stating "the materials/other component for the current actual year is not reflected in previous years, and it therefore not likely to reflect the forecast for the next AA period."[41]

[40] AER, Draft Decision, Attachment 5, p. 17.
[41] AER, Draft Decision, Attachment 5, p. 17.

5. Our Response

5.1. Overview

Our revised Final Plan proposes a modified mains replacement program of 680 kilometres, which is 90 kilometres less than our Final Plan. We have accepted the deferral of 90 kilometres of HDPE 575 MP mains to future periods. We have provided additional information to support our CI/UPS – Block replacement of 558 kilometres and HDPE 575 HP replacement of 198 kilometres proposed in our Final Plan.

While we have accepted the AER's position to defer 90 kilometres of HDPE 575 MP mains to future periods, we note these mains are subject to the same squeeze off damage as the HDPE 575 HP mains and remain an intermediate risk with their replacement the only risk mitigation measure available to us. As is usual practice, we will continue to monitor the condition and performance of these and other at risk mains. During this process, some of these mains may be reprioritised for replacement during the next AA period in accordance with our mains risk reduction prioritisation approach.

Table 5.1 below summarises the AER's Draft Decision and our response in our revised Final Plan for forecast DMSIP capex in the next AA period.

Table 5.1: Summary of the AER's Draft Decision on our forecast DMSIP capex proposal for next AA period

	AER Draft Decision	Our Revised Final Plan	Our Response
CI/UPS - Block	**Modify**	**Reject**	• Leaks on CI/UPS mains have substantially increased over the last two years demonstrating the continued deterioration of these mains and that it is inappropriate to defer their replacement beyond the next AA period. • GHD has independently reviewed our proposed program and agrees a prudent service provider would replace these mains within the next five years. • We have demonstrated our capacity to deliver the level of replacement we are asking for.
CI/UPS – North Adelaide	**Modify**	**Accept**	While we consider the most recent actuals for forecasting the unit rate for North Adelaide, including materials, provides the best estimate of costs for the next AA period, we have accepted the AER and Zincara's proposed rates in its Draft Decision.
HDPE 250 - Remaining	**Accept**	**Accept**	No change to the Final Plan or Draft Decision.
HDPE 575 DN40 - HP	**Modify**	**Reject**	• We have provided an internal memo which supports that squeeze off damage continued to occur until late 1991. We consider it is appropriate to assume all mains laid up to the end of 1992 would still be susceptible to squeeze off damage as the change in procedure would have taken some time to fully implement, including the procurement of mechanical stoppers for squeeze off jacks.

	AER Draft Decision	Our Revised Final Plan	Our Response
			• GHD has independently reviewed our proposed program and agrees a prudent service provider would replace mains laid up to 1993 within the next five years
HDPE 575 DN40 - MP	**Reject**	**Accept**	We have accepted AER's Draft Decision to defer 90 kilometres of medium pressure HDPE 575 DN40 mains to the subsequent AA period, noting we will continue to monitor the condition and performance of these mains during the next AA period and reprioritise their replacement if it is warranted.
HDPE 575 DN50 – camera inspection and reinforcement	**Accept**	**Accept**	No change to the Final Plan or Draft Decision.
MUS replacement	**Accept**	**Accept**	No change to the Final Plan or Draft Decision.
Non-AMRP service replacement	**Modify**	**Reject**	We consider the most recent actuals for forecasting the unit rate for non-AMRP services provides the best estimate of costs for the next AA period. The primary driver for the increase in the material/other costs in the most recent year is a change in the treatment of motor vehicle leasing costs which more accurately allocates these costs to capital projects and programs.

Note: In this 'traffic light' table, green shading represents the acceptance, orange represents a modification and red shading represents a rejection

The following sections summarise the additional information we have provided to support our:

- CI/UPS – Block replacement of 558 kilometres (including 38 kilometres in North Adelaide);
- HDPE 575 HP replacement of 198 kilometres;
- Accelerated depreciation of inserted HDPE mains; and
- Services and non-AMRP unit rate proposed in our Final Plan.

This additional information includes:

- Independent review of our proposed program by GHD, which agrees with the scope and timing of replacement for CI/UPS – Block and HDPE 575 HP;
- Deteriorating leak performance of CI mains in 2019 and 2020 which demonstrates that the lower run rate of around 81 kilometres each year for CI/UPS replacement in the current AA period (to allow for prioritisation of replacement of HDPE mains following significant failures on these mains – which was the correct risk based asset management decision) is not sufficient to address the further deterioration of these mains each year they remain in service;
- Evidence of CI mains cracking during routine leak repairs, further demonstrating the poor condition of the cast iron remaining in the network;
- An internal memo dated 26 August 1991 which outlines potential changes to be made to the squeeze off procedure for polyethylene mains, including procuring new mechanical stops for squeeze off jacks, which supports that mains laid up to 1993 would likely have been subjected to squeeze off damage;

- Technical review by GHD of the ongoing role of inserted HDPE mains and services; and
- Further reasoning for the increased material/other costs in the non-AMRP service replacements from 2019/20.

The additional information responds to issues raised in submissions received on our Final Plan, the AER's Draft Decision, including Zincara's technical findings in its review of the program, and ongoing engagement with the OTR.

5.2. GHD's independent review of mains replacement capex

We engaged GHD to undertake an independent review of some of our capex programs against the new capital expenditure criteria in the National Gas Rules (NGR)[42]. GHD's review included an independent assessment of the scope and timing of our proposed mains replacement for the next AA period. GHD's report is provided as Attachment 8.12 to our revised Final Plan.

In summary GHD agreed that, as a prudent operator in the next AA period, we would seek to replace:

- All remaining low pressure including CI/UPS mains in our network (and that we had clearly demonstrated a capability to undertake the proposed 520 kilometres of block replacement volumes proposed in our Final Plan); and
- 198 kilometres of HDPE 575 DN40 high pressure mains laid up to 1993.[43]

GHD agreed with the conclusion of the AER and Zincara that it was unclear the cost of replacement of HDPE 575 DN40 medium pressure mains was commensurate with the risk reduction achieved given the significantly lower number of failures compared to high pressure and the significantly higher cost.

5.2.1. Low Pressure CI/UPS

For low pressure CI/UPS – Block, GHD concluded "[d]elay of the replacement to the subsequent AA period is not prudent."[44] In coming to this conclusion GHD stated:

> *Based on our analysis of the data up to CY19, GHD supports the replacement of the remaining CI/UPS during the next AA period (2021-26). The leak profile based on the smaller data set indicates the leak rate was approaching one leak per km, which is high for a distribution network and an order of magnitude higher than older-style HDPE systems. The additional data for FY20 and CY20 reinforces the prudency of promptly replacing the CI/UPS with the leak rate increasing to over one leak per km and close to three leaks per km in the final year of data.*[45]

[42] NGR, r. 79.
[43] GHD, Review of selected distribution capex programs for Australian Gas Networks (SA) (Review of capex), January 2021, p. ii.
[44] GHD, Review of capex, p. ii.
[45] GHD, Review of capex, p. 10.

5.2.2. HDPE 575 DN40 HP

GHD disagreed with the AER's decision to reject the replacement of HDPE 575 DN40 HP mains laid in 1991 and 1992.[46]

GHD reviewed the same squeeze off failure data for HDPE 575 mains as the AER and Zincara. In addition, we provided GHD with an internal memo from August 1991 which proposed the investigation of using mechanical stops to reduce squeeze off damage caused by squeeze off practices that existed at the time.

GHD concluded it would be appropriate to replace HDPE 575 DN40 HP mains laid up to 1993 as proposed given that:

- The small sample size of failure rate data applicable to the DN40 mains makes it difficult to determine with statistical confidence a particular year where the procedure causing the issue was changed;
- It would likely have taken some time to undertake the investigation suggested in the August 1991 memo and then implement a change in procedure in the field; and
- The memo applies to both the DN50 and DN40 mains, and considering the failure data for both mains, there is a clear flattening of the trend after 1993.[47]

5.2.3. HDPE 575 DN0 MP

In reference to HDPE 575 DN40 MP mains laid up to 1993, GHD concluded that:

> *The current (untreated) risk rating is intermediate for the DN40 MP, rather than high as is the case for the DN40 HP. Both programs replace mains made of the same material (HPDE 575) and were subject to the same squeeze off procedures prior to 1993. The same slow-crack growth and subsequent failures may be occurring across the mains where that material was used, and the squeeze off procedure applied. We suggest the differing failure rates in the DN50 data compared with the DN40 is likely explained by the lower operating stresses in the DN40 resulting in a longer time to failure.*
>
> *In terms of the risk of failure of the HDPE 575, a prudent operator would consider the uncertainty inherent in relying on the small amount of data available and adopt a conservative position based on an ALARP approach. This would be to replace the mains, because the (known) consequence is at least a major or catastrophic impact, rather than to rely on increased surveillance through leak surveys and the analysis of leak reports.*[48]

However, GHD also noted "[i]t is unclear from the evidence if the risk posed by mains is not commensurate with the cost required to further reduce the risk by replacing them."[49] In the absence of this analysis, GHD concluded we "should continue to monitor these mains for signs of an increase in failure rate as has been seen in other HDPE 575 mains and re-evaluate the current risk level and mains replacement program if this is to occur."[50]

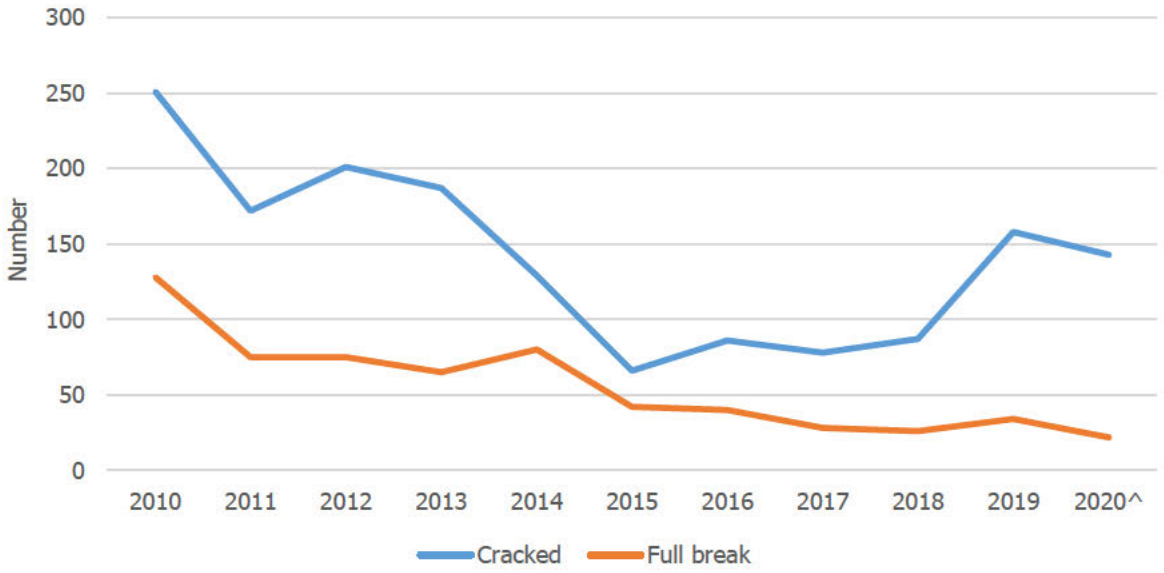
[46] GHD, Review of capex, p. ii.
[47] GHD, Review of capex, p. 12.
[48] GHD, Review of capex, p. iii.
[49] GHD, Review of capex, p. 5.
[50] GHD, Review of capex, p. 5.

5.3. Deteriorating leak performance of cast iron mains

The AER and Zincara refer to a downward trend in the number of reported incidents in the historic crack and break data to support a reduced program of CI/UPS block replacement, consistent with levels in the current AA period.[51] The Minister for Energy and Mining also submitted that ongoing replacement of at risk mains needs to consider the level of risk reduction already achieved.[52]

Figure 5.1 below provides an update of the cast iron failure history (cracks and breaks only) over time to include data up to November 2020 (i.e. 11 months of 2020). Failure data for 2020 has been pro-rated to get an estimate of the full year and shows an upward spike in incidents in 2019, which is sustained in 2020.

Figure 5.1: Cast iron failure history over time

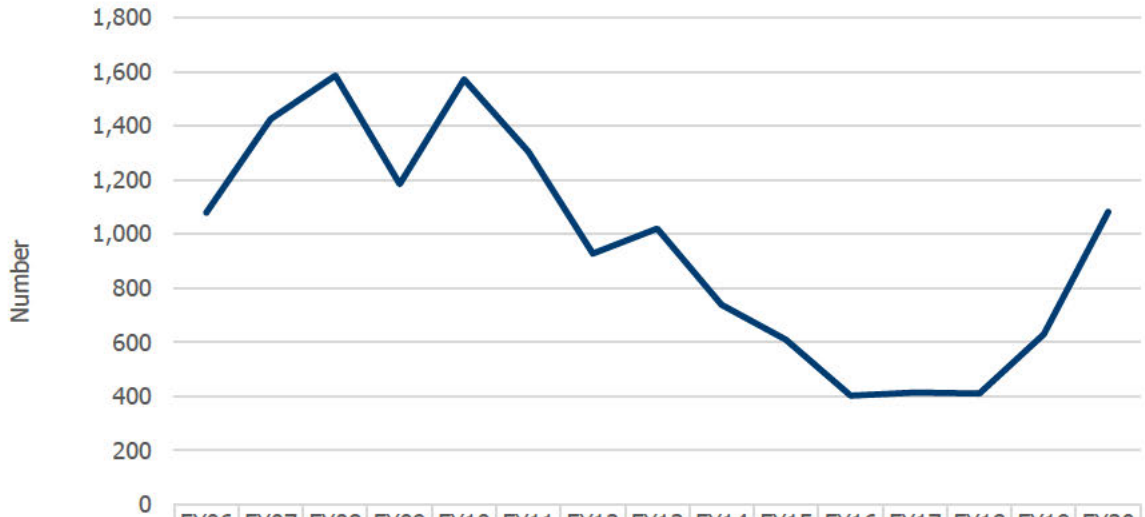


^Pro-rated based on actual failure data to November 2020

Further, Figure 5.2 below shows total leaks on CI (including cracks and breaks in addition of other failures for example joint leaks) has increased substantially in each of the last two financial years to June 2020.

[51] AER, Draft Decision, Attachment 5, pp. 14-15.
[52] Minister for Energy and Mining (SA), Submission, p. 2.

Figure 5.2: Historic failures on cast iron mains (by financial year)

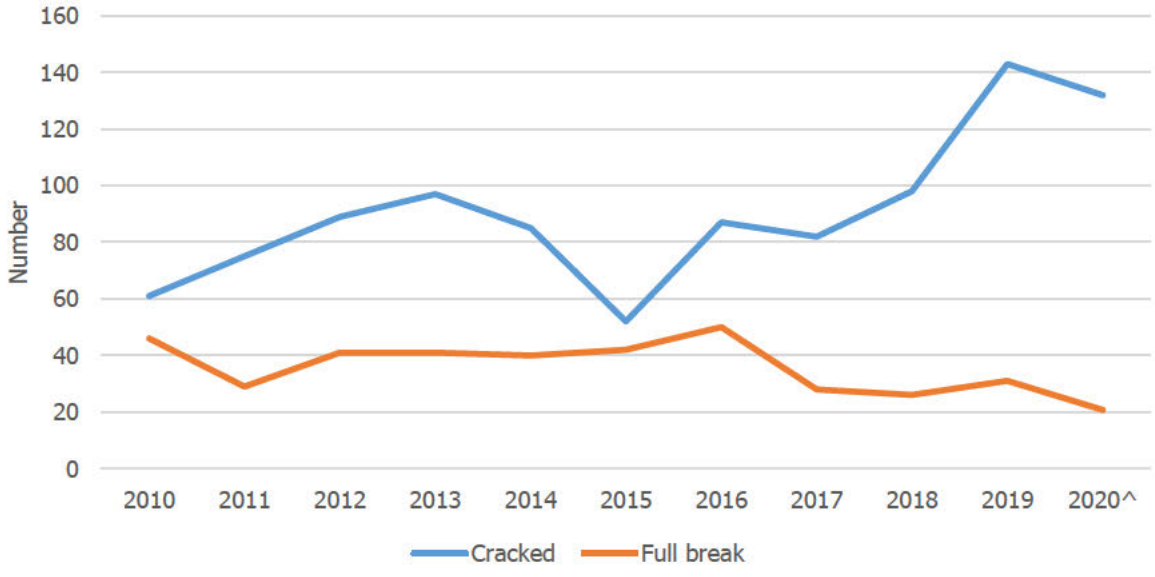


	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20
Cast Iron	1,079	1,424	1,585	1,184	1,571	1,304	928	1,020	739	610	403	414	411	630	1,081

More recent data shows CI cracks and breaks (in addition to other failure modes) are again trending upward. This increase is attributed to deterioration of the remaining cast iron mains population and highlights the effect of slowing down the program after two to three years of reduced replacements (which was done to allow for replacement of higher priority HDPE mains). The results would indicate that lower replacement levels consistent with the levels in the current AA period (i.e. 81 kilometres per annum) are not sufficient to address the continuing deterioration in the condition of the remaining CI mains.

Figure 5.3 below provides an update of historic breaks and cracks on CI mains remaining in our network up to November 2020. As above, failure data for 2020 has been pro-rated to get an estimate of the full year.

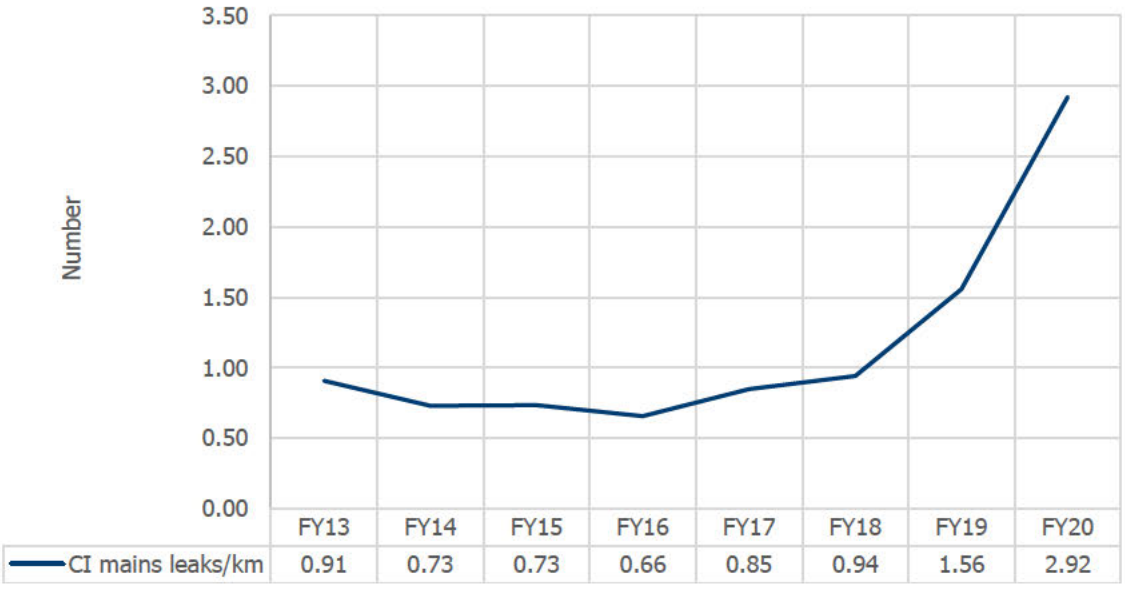
Figure 5.3: Historic breaks and cracks on cast iron mains remaining in our network



^Pro-rated based on actual failure data to November 2020

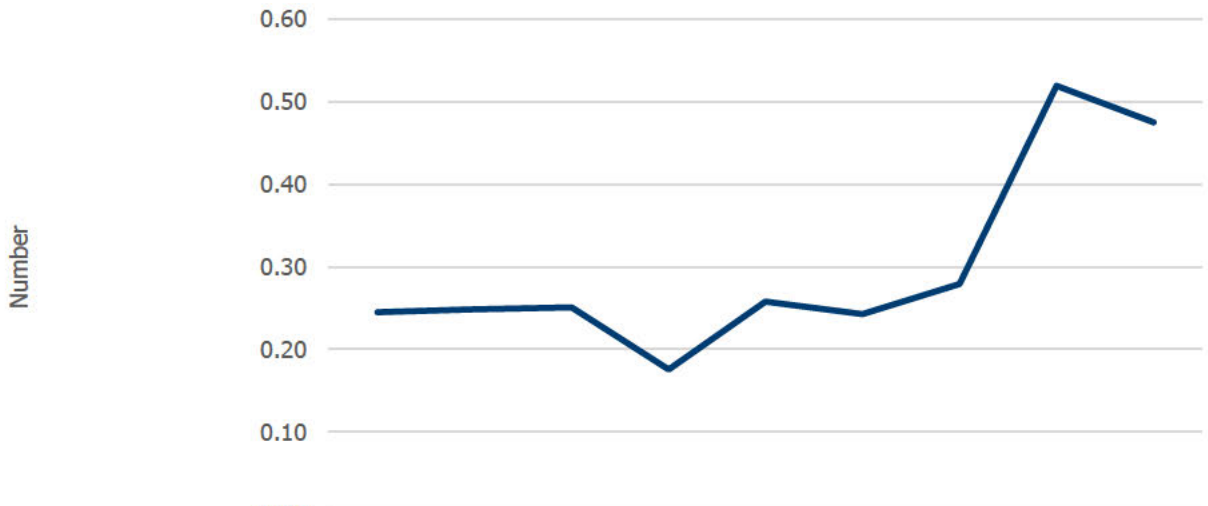
A large proportion of leaks on CI mains are attributable to joint leaks (around 60%). Figure 5.4 below shows total leaks on CI mains per kilometre of cast iron mains in the network each year. Figure 5.5 shows cracks and breaks per kilometre of mains for CI mains in the network each year.

Figure 5.4: Cast iron mains leaks per km (financial year)



	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20
CI mains leaks/km	0.91	0.73	0.73	0.66	0.85	0.94	1.56	2.92

Figure 5.5: Cast iron cracks and breaks per km (calendar year)



	CY 12	CY 13	CY 14	CY 15	CY 16	CY 17	CY 18	CY 19	CY 20^
CI cracks+breaks/km	0.25	0.25	0.25	0.18	0.26	0.24	0.28	0.52	0.47

^Pro-rated based on actual failure data to November 2020

All recent leak performance data for CI mains would not support the reduced program of replacements in the AER's Draft Decision and therefore our revised Final Plan is to undertake 520 kilometres of CI/UPS block replacement, plus the approved 38 kilometres of North Adelaide block replacement. This will see us complete the replacement of all LP mains in the next AA period, and, in particular, remove all remaining high risk CI/UPS mains from our network.

5.4. Condition of remaining cast iron in our network

Figure 5.3, Figure 5.4 and Figure 5.5 above show the leak performance of remaining cast iron mains in our network. In addition to this, we receive condition information from field crews and contractors undertaking leak repairs on our network, including CI mains.

A recent example of this is a brittle cast iron main incident in [redacted] on 23 September 2020. Crews were undertaking a small piecemeal replacement due to a recent leak. The main was found to be in extremely poor condition. The crew were unable to use cast iron cutters on the asset as the main was too brittle. The crew tried multiple cutting techniques before reverting to a hand saw to prevent the main "falling apart".

During backfilling of the replaced section, the crew detected gas so re-excavated and found another leak on a section of main under the road adjacent to their worksite. A leak response crew was called to attend and found the main had cracked quite significantly. While fitting a repair clamp to the leak, the main cracked again within half a metre of the repair clamp location. The crew reported the second crack occurred prior to placing any tension on the repair clamp.

The crew reported they were unable to use compaction during backfilling due to concerns ground vibration would cause further cracking of main. The crew leader stated in his incident report he has not previously "seen or worked on a cast iron main in such poor condition. You could almost say it's rotting."

Figure 5.6 below shows photographs that were taken during the works.

Figure 5.6: CI/UPS - Case Study (23 September 2020, [redacted])

1 Section of the brittle cast iron main after being cut out

2 Another hairline crack visible on a 45 degree angle to the cut

3 The crack which occurred during backfilling

4 The size of the crack after the main had been cleaned in preparation for fitting the repair clamp

5 The secondary leak which occurred when placing a repair clamp over the first leak

6 The porous nature of the main which is leaking in multiple places

This recent example of the condition of CI mains remaining in our network would not support the reduced program of replacement in the AER's Draft Decision and therefore our revised Final Plan is to undertake 520 kilometres of CI/UPS block replacement, plus the approved 38 kilometres of North Adelaide block replacement. This will see us complete the replacement of all low pressure mains in the next AA period, and, in particular, remove all remaining high risk CI/UPS mains from our network.

5.5. Block replacement approach for CI/UPS mains

As noted in Section 1.2 of Attachment 8.3 to our Final Plan, other low pressure materials such as HDPE 250 and HDPE 575 are also included in the CI/UPS block replacement program. This section includes further information on our block replacement approach in response to feedback and ongoing engagement with the OTR.

Mains replacement can be undertaken using two methods - "like-for-like" or "block" renewal.

Like-for-like replacement, as the name suggests, involves the replacement of mains with another of equal capacity. For example, a 100mm CI main operating at low pressure will need to be replaced with a 125mm PE100 main also operating at low pressure in order to maintain network capacity. In this scenario, the new main is direct buried which contributes significantly to unit rates.

Block renewal, as adopted for the CI/UPS block program, involves replacing large sections of the network accompanied by an increase in network operating pressures (e.g. increased from low pressure to high pressure). This increase in pressure allows us to insert a smaller main into the existing main while also increasing network capacity because of the compressibility of methane. The now redundant main acts as a conduit which significantly decreases replacement unit rates. Increasing the pressure also adds additional network benefits including increased capacity and network reliability.

It is widely accepted that block replacement is the most efficient approach to removing high risk low pressure mains from the network, with other gas distributors in Australia and around the world undertaking replacement of low pressure mains in their networks. Zincara commented on the replacement of other low pressure materials (which make up over 30% of the total kilometres) in its report to the AER.[53] Zincara did not raise any concerns with the prudence or efficiency of this approach to replacement of the CI/UPS mains remaining in our network.

Table 5.2 below summarises the materials included in our CI/UPS block and North Adelaide replacement programs.

Table 5.2: Summary of materials to be replaced in the CI/UPS - Block and North Adelaide replacement programs

Pressure/material	CI	UPS	PS	HDPE 250	HDPE 575	PE 80	PE 100	Total
LP	300	32	17	118	36	44	3	550
MP	7	1	-	-	-	-	-	8
Total	**307**	**33**	**17**	**118**	**36**	**44**	**3**	**558**
Proportion	55%	6%	3%	21%	6%	8%	1%	55%

[53] Zincara, AER Access Arrangement 2019 AGN Capital Expenditure (AGN Capital Expenditure), November 2020, p 23.

CI/UPS mains account for over 60% of the program, with the other materials including end-of-life HDPE 250 interspersed among the CI/UPS mains. These mains exist from previous repairs to the network or small network extensions that have happened some time after the original mains were laid.

Figure 5.7 below shows our gas network in North Adelaide, with small lengths of modern PE materials (in red and yellow) interspersed amongst CI/UPS and older HDPE materials (grey).

Figure 5.7: North Adelaide network

There are a number of reasons why it is appropriate to undertake the low pressure replacement program as block replacement. In particular:

- It is more cost effective to undertake mains replacement in blocks, when compared to like-for-like replacement;
- The replacement of other materials at low pressure is also warranted on safety grounds because the low pressure replacement program also includes a pressure upgrade, most commonly to high pressure; and
- The upgrade of pressure provides additional ancillary benefits including increased network capacity and customer pressure protection via the installation of a pressure regulator at the customer's meter.

We would also highlight that we undertake the block replacement program as efficiently as possible by:

- Pressure testing and uprating modern materials, rather than replacing them; and
- Continuing to reassess risk to ensure the highest risk mains are prioritised and replaced first.

5.5.1. Block replacement is more cost effective than piecemeal replacement

The OTR raised the cost impact to customers of the replacement of other materials. General block replacement of CI/UPS mains (i.e. excluding North Adelaide) is forecast to cost [redacted]/metre

compared to piecemeal replacement which is forecast to cost over twice that amount at [redacted]/metre. Therefore, we can replace over twice the volume of mains in a block replacement approach compared to a piecemeal approach that would target only the CI/UPS materials.

5.5.2. The replacement of other low pressure materials is also warranted on safety grounds

The OTR has questioned whether the replacement of other materials operating at low pressure and within the CI/UPS block replacement program is warranted on safety grounds. While it is true these other materials are currently behaving well at low pressures, we also undertake pressure upgrade of the new mains and services when replacing low pressure mains in our network. In the majority of cases, the new mains will operate at high pressure.[54] This will be the case for the 520 kilometres of CI/UPS – Block replacement proposed in the next AA period. Therefore, we need to be sure that the mains are appropriate for operating at high pressure.

HDPE 250

HDPE 250 mains are not rated to operate at high pressure, therefore these mains would also need to be replaced on safety grounds. We would also highlight that we have almost completed the replacement program for all medium pressure HDPE 250 mains in our network as these mains are now brittle, susceptible to sudden cracks and breaks and deemed uneconomic to repair. This also applies for HDPE mains operating at low pressure. HDPE 250 makes up 21% of the material in the CI/UPS low pressure block replacement program inclusive of North Adelaide.

HDPE 575

HDPE 575 mains are subject to squeeze off damage where we have seen slow crack growth and fractures leading to excessive gas escapes, and explosions. In particular, we have seen these types of failures more commonly on HDPE 575 mains operating at high pressure. We would also highlight that we have an ongoing program to inspect and reinforce these mains, where the diameter of the main is large enough to allow this risk mitigation approach, or replace these mains where inspection and reinforcement is not feasible.

For these reasons, HDPE 575 mains would also need to be replaced or inspected and reinforced on safety grounds. Given we are already undertaking replacement of the surrounding mains, and inspection and reinforcement is not a long-term risk mitigation measure, it is appropriate that the HDPE 575 mains currently operating at low pressure are replaced. In addition, these mains have been operating at low pressure for the whole of their operational life. Introducing an increased pressure at the end of their useful life is considered a high risk activity. HDPE 575 makes up 6% of the material in the CI/UPS low pressure block replacement program inclusive of North Adelaide.

5.5.3. There are further benefits of upgrading low pressure areas of the network

There are a number of further benefits associated with upgrading low pressure areas of the network including operationally, for safety and future capacity.

- Reduction in District Regulators - It is operationally simpler to minimise the number of pressure zones in the network. Our distribution network is made up of three predominate pressure tiers – High, Medium and Low pressure. Each pressure tier is supplied by district regulators connected to higher pressure network. For example, low pressure networks are

[54] In high consequence areas, such as the CBD, however, we will maintain lower pressures to reduce the consequence of a potential risk event.

supplied by district regulators connected to the high or medium pressure network. Eliminating the low pressure network removes the need for these district regulating stations.

- Over pressure protection - Unique to South Australia in the Australian context, our low pressure networks are free flow into customer homes and premises (there are no service regulators at customer meters to regulate the pressure that our customers receive in their homes). The absence of this regulator increases the potential consequences in the very unlikely event the low pressure network is over pressurised. This has never occurred on our network, but parallels can be drawn from the Merrimack Valley, Massachusetts[55] incident that occurred in 2018 where an over pressurisation event in the upstream gas network saw high pressure gas enter directly into customer homes and premises. This incident resulted in catastrophic safety outcomes.
- When our low pressure networks are replaced and upgraded, so are the customer services (or inlets) and service regulators are installed consistent with current practice for new connections. This adds an additional layer of protection to mitigate any risks of over pressurisation of a customer's fitting line.
- Increased network capacity - Another added benefit of the pressure upgrade of our low pressure networks is the uplift in capacity. This circa 50% uplift in capacity from high pressure will allow continued infill growth in these areas of our network deferring the need for augmentation, increasing the utilisation of assets and reducing costs for all customers. The increase in pressure also allows us to offer end customer increased supply pressure, from 1.1kPa (or line pressure) to 2.75kPa or above.

  In some of our low pressure networks we do not have sufficient capacity or flow pressure to connect new residential customers with a larger heating load. For example in Semaphore, in the area around Semaphore road, supply is limited due to distance of district regulators and the smaller sized trunks feeding the area. In Medindie, the increase in high capacity domestic connections (e.g. for pool heaters) has caused capacity issues and in Lockleys and Underdale, close to the Karrawirra Parri river, LP areas can only be supplied from one side limiting capacity.
- Increased network reliability – Increased reliability is achieved through the elimination of "water in mains" outages as the pressure within a high or medium pressure main is greater than the water table, not allowing water to enter the network. Water related outages is a key reliability challenge for low pressure networks and especially the LP networks close to the Adelaide hills have a long history of water in main outages.

5.5.4. Modern materials are typically not replaced

PE80 and PE100 mains are modern materials which are still in common use today. They range from zero to circa 30 years in age and have a very low history of leaks. Where we come across these materials in the CI/UPS block replacement program, we will pressure test the pipe, and if it is in good condition and in a compliant location, we will leave it in service (i.e. we will connect it to the new pipe, rather than replace it).

This is consistent with our practice in the current and prior AA periods when undertaking block replacement of CI/UPS. PE80 and PE100 make up 9% of the material in the CI/UPS low pressure block replacement program inclusive of North Adelaide. This is comparable with the current AA

[55] National Transportation Safety Board, Pipeline Accident Report, 13 September 13, 2018. Accessible at: https://www.ntsb.gov/investigations/AccidentReports/Reports/PAR1902.pdf

period, where these materials have also made up around 9% of the CI/UPS block replacement including the Adelaide CBD, and therefore is represented in the forecast unit rates.

5.5.5. Replacement within the block program is prioritised on risk

Our mains replacement program is underpinned by a risk prioritisation framework which identifies the highest risk materials (namely CI and UPS) for replacement. This is applied to the CI/UPS – block and HDPE replacement programs.

Details of our risk based approach is contained in:

- Final Plan Attachment 8.10 - Risk Management Framework
- SA Formal Safety Assessment (FSA) Report, issued 01/04/2019
- Final Plan Attachment 8.3 Distribution Mains Services Integrity Plan
- Operational DMSIP, September 2020
- AGN SA 2016-21 Access Arrangement Attachment 8.14 - AGN Risk Prioritisation Model

As part of their review, GHD undertook an assessment of our prioritisation approach, GHD concluded "collectively the documents demonstrate that AGN is managing its asset risks appropriately and in line with good industry practice and standards."[56]

The OTR highlighted they support the continued prioritised replacement of CI/UPS for the low pressure block replacement program.

5.6. Change in squeeze off practice for HDPE mains

An internal memo from August 1991 indicates squeeze-off procedures at this time did not include stops on the squeeze-off jacks, hence there was the potential for over squeezing causing damage to the structural integrity of the main. The memo explains consideration is to be given to fitting stops to reduce the potential squeeze-off damage occurring to HDPE mains. The memo also outlines a number of areas of damage found on mains laid in 1991. The memo is provided at Appendix 1 of this response.

This additional information would not support the replacement of HDPE 575 DN40 HP mains up to 1990 in the AER's Draft Decision as, at this time, there had been no significant change to squeeze-off procedures in our network. Our revised Final Plan reiterates the proposal in our Final Plan to replace HDPE 575 DN40 HP mains up to 1993 as it would take some time for new equipment and practices to be considered, introduced and adopted in the field. This will ensure mains with a high risk of failure related to squeeze-off damage are removed from our network over the next AA period.

5.7. Ongoing role of inserted HDPE mains and services

We engaged GHD to undertake a technical review in response to the AER's request for us to clarify whether existing HDPE mains and services which have been replaced through insertion of new PE mains will not be providing any ongoing services to consumers post insertion.

Our response and GHD's findings are summarised in Attachment 9.3 and Attachment 9.4 to this revised Final Plan.

[56] GHD, Review of capex, p. 13.

5.8. Unit rate for non-AMRP service replacement

In its Draft Decision the AER applied a "unit rate which combines the current actual labour rate with the 3-year materials/other rate"[57] stating "the materials/other component for the current actual year is not reflected in previous years, and it therefore not likely to reflect the forecast for the next AA period."[58]

The primary driver of the increase in the material/other component of the unit rate for non-AMRP service replacements in 2019/20 is payroll & vehicle costs. The increase is payroll & vehicles costs makes up [redacted] of the difference in unit rate when compared to the average material/other component of the unit rate for the three years 2016/17 to 2018/19. This increase is due to a recent change in the accounting treatment of motor vehicle leasing costs that more accurately allocates these costs to the capital projects and programs in which they are incurred.

This is an ongoing change that is already reflected as a reduction in our capitalised overhead and therefore the current actual material/other rate is a better reflection of the forecast for the next AA period than the 3-year materials/other rate. For these reasons we have rejected the AER's Draft Decision unit rate for non-AMRP service replacement and propose a unit rate of [redacted]/service consistent with our original Final Plan.

5.9. Summary

5.9.1. Modified Scenario E – Efficient ALARP

Our revised Final Plan results in a modified 'Scenario E' from our original Final Plan submission. Under this scenario all remaining high risk mains would be replaced or inspected and reinforced when required. This includes replacement of all remaining low pressure mains under the CI/UPS – Block programs (558 kilometres), all remaining medium pressure HDPE 250 mains (14 kilometres) and inspection and reinforcement of HDPE 575 DN50 HP mains (57 kilometres). All high risk MUS will also be renewed.

Intermediate risk HDPE 575 DN50 mains would be inspected and reinforced when required (259 kilometres). We will undertake prioritised replacement of intermediate risk HDPE 575 DN40 mains. This results in 198 kilometres of HDPE 575 DN40 mains to be replaced in the next AA period, reflecting a prioritised replacement of older, higher risk mains (consistent with the prioritised program being undertaken in the current AA period). The replacement of the relatively lower risk DN40s (128 kilometres covering the post 1993 high pressure DN40 and all medium pressure DN40) has been deferred to the subsequent AA period.

In summary, this scenario includes replacement of 770 kilometres of mains, inspection and reinforcement of 316 kilometres of mains and renewal of 457 MUS. The total cost of this scenario is $226 million and results in a treated risk of Intermediate (ALARP) by the end of the period.

The cost to customers of this scenario is $16.6 million over the next AA period, which equates to $6.88 per customer per year for the 5 years. This is a reduction of $0.7 million over the next AA period compared to our original Final Plan submission of $18.3 million and equates to a saving of $0.69 per customer per year for the 5 years compared to our Final Plan submission of $7.57.

[57] AER, Draft decision – Australian Gas Networks (SA) Access Arrangement 2021-26, Attachment 5: Capital expenditure, p 17.
[58] AER, Draft decision – Australian Gas Networks (SA) Access Arrangement 2021-26, Attachment 5: Capital expenditure, p 17.

As we have in the current and prior AA periods, we will continue to prioritise our annual mains replacement activities using the most up to date information on the performance and condition of all at risk mains to ensure that higher risk mains are addressed first.

The revised Final Plan mains replacement program (modified Scenario E) is summarised in Table 5.3 below.

Table 5.3: Modified Scenario E – Efficient ALARP

Asset Category		Inventory at July 2021	Risk at July 2021	Inventory at July 2026	Risk at July 2026
1	CI/UPS - block[59]	558	High	0	Low
2	HDPE 250	14	High	0	Low
3	HDPE 575 DN50 - HP	57	High	0	Intermediate (ALARP)
4	HDPE 575 DN50 - MP	259	Intermediate	0	Intermediate (ALARP)
5	HDPE 575 DN40	447	Intermediate	249	Intermediate (ALARP)
6	HDPE 575 DN50 inspected	310	Intermediate (ALARP)	626	Intermediate (ALARP)
7	MUS – Priority group 1	457	High	0	Low
8	MUS – Priority group 2	1,653	Intermediate (ALARP)	1,653	Intermediate (ALARP)
Residual risk in 2026					Intermediate (ALARP)
Total capex					**$226.0 million**
Total cost to customer					**$16.6 million**
Cost per customer					**$6.88 per annum**

5.9.2. Forecast cost for the next AA

There are six categories of assets that will be replaced or inspected in the next AA period. However, included in the cost of the program is a small allowance for piecemeal replacement across asset types to allow for unplanned events. The forecast piecemeal replacement reflects the lower level of piecemeal replacement achieved in the current AA period.

Table 5.4 presents the categories of assets that will be replaced and inspected in the next AA period, the volume to be replaced, unit rates and the cost by asset category. Due to the higher cost of replacing CI and UPS mains in North Adelaide, these mains are presented separately.

[59] As noted in Section 1.2, other LP materials such as HDPE 250, HDPE 575 and New PE are also included in this program

Table 5.4: Estimated cost by category ($ million 2019/2020)

#	Asset category	Unit rate	Volume	Total Capex	Basis of unit rate
1	CI/UPS - block	[redacted]	520km[60]	[redacted]	Current actual cost
1a	CI/UPS North Adelaide	[redacted]	38km	[redacted]	3-year weighted average plus CBD premium
2	HDPE 250 remaining	[redacted]	14km	[redacted]	Current actual cost
3 & 4	HDPE 575 DN50 - inspection	[redacted]	316km	[redacted]	Current actual cost
5	HDPE 575 DN40 – insertion	[redacted]	198km	[redacted]	Current actual cost
6	HDPE 575 DN40 – direct bury	[redacted]	0km	[redacted]	Current actual cost plus direct bury premium
7	MUS - Priority group 1	[redacted]	457 sites	[redacted]	Weighted historical average rate
-	Piecemeal replacement	[redacted]	10km	[redacted]	Weighted historical average rate
-	Non-AMRP service replacement^	[redacted]	2,450 sites	[redacted]	Weighted historical average rate

^Non-AMRP service replacement is an ongoing reactive program of work to address service replacements for non-compliant (insufficient depth) or corroded/deteriorated services which are identified outside of mains replacement.

For more detail on the unit rate identification and derivation process, please refer to the Unit Rates Report provided as Attachment 8.9 to our Final Plan in July 2020.

5.9.3. Delivery capability

We have assessed our capability to deliver the program outlined for the next AA period.

In the next AA period, we are forecasting the replacement of 780 kilometres of mains – including 38 kilometres of challenging North Adelaide mains, inspection of 316 kilometres of HDPE 575 DN50s, replacement of 457 MUS and 10 kilometres of piecemeal replacement.

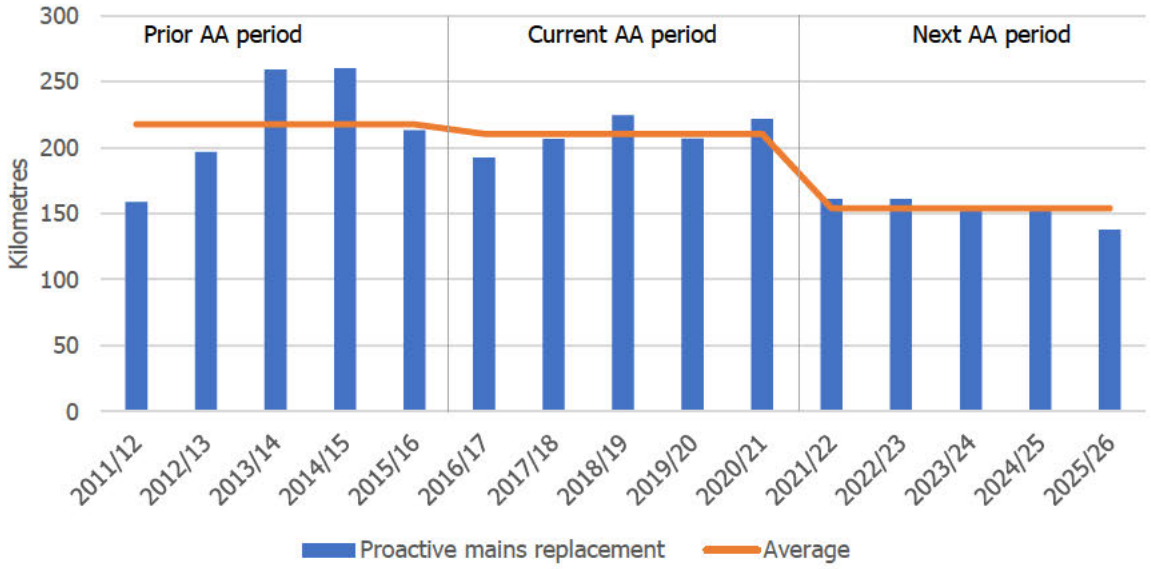
This compares to a significantly larger program in the current AA period, where we will have replaced 1,059 kilometres of mains, with 53 kilometres of particularly challenging mains within the Adelaide CBD and a further 59 kilometres of complex MP Trunk mains replacements. We will have also inspected 310 kilometres of HDPE 575 DN50s and replaced 233 MUS.

[60] As noted in Section 1.2, other LP materials such as HDPE 250, HDPE 575 and New PE are also included in this program

In particular, the AER and Zincara refer to a significant increase in the block replacement of low pressure CI/UPS mains from 288 kilometres in the current period to 520 kilometres in the next AA period.[61]

Figure 5.8 presents the volume of activity proposed in the next AA period compared to that undertaken in the current and prior AA period.

Figure 5.8: Delivery capability – proactive mains replacement



As indicated, the volume of mains forecast for replacement in the next AA period is less than that achieved in the current and prior AA period, with an annual average of 210 kilometres proactively replaced in the current AA period, 218 kilometres proactively replaced in the prior AA period and a forecast average of 154 kilometres of proactive replacement forecast for the next AA period.

GHD has also agreed in its independent review that we have clearly demonstrated our capability to deliver above the levels proposed in the current AA period.

[61] AER, Draft Decision, Attachment 5, p. 14. Zincara, AGN Capital Expenditure, p. 23-24.

Appendix 1 – Internal memo on PE squeeze-off, 26 August 1991

F.E.P 029

Simon PLEASE REFER TO INFO IN @ THIS IF SQUEEZE OFF COMES OFF TITE BLACK LIST

Note on project

MEMO TO : MANAGER, FIELD OPERATIONS

SUBJECT : P.E. SQUEEZE-OFF. F.E.R. 029.

DATE : 26 AUGUST 1991.

FROM : D. BARR.

COPIES : MANAGER, OPERATIONS SUPPORT.
: AREA MANAGER, NORTH.
: AREA MANAGER, METRO WEST.
: AREA MANAGER, METRO EAST.
: AREA MANAGER, SOUTH.

SUBJECT.

There is confusion and possible bad practice in the field that needs to be investigated and a reasoned procedure for squeezing off of P.E. pipe determined. Questions to be answered.

(1) When and how should rerounding occur.
(2) What damage do we cause by not having stops on the squeeze-offs.
(3) Does the class of P.E. pipe or the density affect the way in which a squeeze-off is applied.

RECOMMENDATION.

1. Continue with current Sagasco procedure while ensuring that Field Operations personnel adhere to existing guide lines.
2. Consideration be given to fitting stops and using 2 squeeze-offs with a vent in between.
3. Consideration be given to the use of Finlayson steel mechanical joiners in lieu of stub flanges.

Following discussions with the Area Managers it was decided,

1. To continue with the current practice of using hot water prior to applying the squeeze-off.
2. To assist the pipe to reround the same procedure is to apply after the squeeze-off is removed.
3. No mechanical methods are to be employed to assist in rerounding the pipe.
4. Insert in 6.7 (e) of the Field Operations Safety Manual, Apply hot water to pipe both before applying squeeze-off and after removal.

DONE

SUMMARY

Question 1.

	CODE	SAGASCO	GAS@FUEL
Prior to squeeze-off.	No Requirements	Apply hot water	Not Known
Rerounding after squeeze-off.	No	Not Since 1988	No
Install approved fitting	Yes	No Wrap with black tape	No

Discussions with M. Stahmer, Technical manager of Vinidex Tubemakers and M. Ebden, Senior Technical Officer of the Gas and Fuel Corp. indicate that neither of them can see any problems arising from the use of hot water being applied before squeezing-off and after removing squeeze-off jig.

Question 2.

Stops on squeeze -off machine.	Yes	No Refer Report 2A.-2B.	Stops Fitted ? Not Used

Question 3.

M.D.P.E. / H.D.P.E. Refer investigation report A.B.C.D.

NOTE: Of 41,086 leak cards surveyed only 27 recorded a X against " Plastic Mains Squeeze-off Damage ".

INVESTIGATION.

(1) When and how should rerounding occur
A.S.3723-1989. Clause 4.3.2. The squeeze-off device, hot air, hot water, or any other means, shall not be used to accelerate the rerounding of the pipe.
A.S.3723-1989. Clause 4.3.3. RETURN TO SERVICE.
(a) The squeezed section of pipe is adequately supported using a suitable approved fitting to ensure-
(1) the area is not squeezed off again; and
(11) the possible future risk of wall cracking at the corners of the squeeze line is minimize.

SAGASCO CURRENT METHODOLOGY.

Rags soaked in hot water are to be placed over the pipe prior to that area being squeezed-off. After removal of squeeze-off the affected area is wrapped with black tape to indicate the pipe has been previously squeezed-off.
NOTE: Prior to 1988 rags soaked in hot water plus mechanical means were used to reround the pipe.

PIPE SUPPORTS.

At present no fittings are used to support the pipe. Mechanically tightened thinsulators from size 50mm. up are available to support the P.E. pipe, application of this fitting contravenes the rerounding code.
Electrofusion fittings in Couplers and Tapping Saddle Tees may soon be available in the P.S.I. range. This method would be restricted by the lack of electrofusion machines and will require partial rerounding of the pipe to fit the fitting. Evidence seems to suggest that squeezed-off pipe does not completely reround.

(2) What damage do we cause by not having stops on the squeeze-off machine.
A.S.3723-1989 Clause 4.3.2. (d) The provision of stops integral to the devices operation, which limit the gap between the rollers to not less than 1.8 times wall thickness.

2A. The Gas @ Fuel Corp. have stops fitted to their squeeze-offs (up to 50mm.) but do not reround or fit supporting fittings to squeezed-off pipe. Field practice indicates that unofficially these stops are not always used.

2B. Experiments with stops by the S.A. Gas Coy Training Centre indicate that the rate of gas by-passing the squeeze-off is higher than acceptable particularly when using a shaver.

2C. One solution to this problem in the 40mm and 50mm. size range is to replace the stub flanges with Finlayson mechanical couplers (as used by the Gas @ Fuel Corp.) this would negate the use of the shaver. A 2nd. possible solution is to apply 2 squeeze-offs fitted with stops with a Saddle Fusion Tee installed between them to vent off gas bypassing the first squeeze-off. Complications arise when a cutout is being performed which would require 2 squeeze-offs to be applied each side of the cutout.

2D. When using a squeeze-off without a stop the operator flattens the pipe walls to stop the flow of gas, this excessive pressure on the "edges" is evidenced by the appearance of a white line appearing on each edge.

2E. Records of leak repairs do not appear to indicate that this practice of not using stops is having any adverse affect upon the Gas Coy,s reticulation system, but what of the long term effects.

2F. Although squeeze-off jigs appear to be used universally, consideration must be given to the fact that many other organization are using M.D.P.E. NOT H.D.P.E. pipe.

Precis of Test for squeeze-off properties of pipe.
A.S. 1667.1-1984 Appendix F.
Hold test section in cold bath at 0 Deg. C. for 1 hour.
Squeeze down to twice the wall thickness.
Hold test section in press for 4 hours at 0 Deg. C.
Remove from press, reround by mechanical means at ambient temperature.
Increase temp. to 80 Deg. C. then apply internal Hydrostatic pressure to a hoop stress of 4.2. M.P.a. for 44 hours.

(3) Does the class of P.E. pipe or the density affect the way in which a squeeze-off is applied.
H.D.P.E. pipe is manufactured from type 50 resin.
M.D.P.E. pipe is manufactured from type 63 resin.
Type 63 resin is 26% stronger than type 50.
Advantages of M.D.P.E. are,
(A) Better squeeze-off recovery.
(B) Less chance of crack propagation when scratched.
(C) Less residual stress in pipe.
(D) Better coiling and handling properties.
This leads to the assumption that M.D.P.E. is better suited to being squeezed-off. There does not appear to be any information available that will indicate that

there are any different methods of installing a squeeze-off jig to either H.D.P.E. OR M.D.P.E. pipe. Although the code does not appear to differentiate between Class 250 @ 575 with regard to the effect of a squeeze-off on the pipe walls, it would be logical to assume that class 250 with a wall thickness of 3.5mm. would require less effort to squeeze-off and that it should reround better than Class 575 whose wall thickness is 5.2mm. similarly the potential for "edge" cracking may be less in Class 250.

Summary of recorded squeeze-off damage to P.E. pipe.

LEAK NO.	ADDRESS.	SIZE	FITTER	DATE	COMMENT
3417/88S	[redacted]	100	[redacted]	23/9/88	22
9/89D		80		6/1/89	22
10/89D		80		6/1/89	22
2749/89D		80		14/12/89	9
362/89S		50		10/3/89	22
600/89S		50		3/4/89	9
1055/89S		50		17/4/89	9
2491/89S		?		13/8/89	7
171/90D		80		17/1/90	22
218/90D		50		17/1/90	22
463/90D		80		28/1/90	22
1047/90D		40		5/3/90	9
1792/90D		?		6/4/90	9
3692/90D		50		27/6/90	9
3842/90D		50		28/6/90	19
5688/90D		50		23/10/90	9
49/90I		100		2/2/90	9
278/91D		50		8/1/91	22
2019/91D		80		4/6/91	8
2037/91D		50		5/4/91	13/14
2496/91D		100		19/4/91	10
2935/91D		80		1/5/91	2
3392/91D		50		16/5/91	14

3665/91D	[redacted]	80	[redacted]	3/6/91	22
3966/91D		50		4/6/91	22
4163/91D		50		11/6/91	14
666/91I		?		24/4/91	20

TOTAL 100mm. main assumed class 250 3 off
80mm. main assumed class 250 8 off
50mm. main assumed class 575 12 off
40mm. main assumed class 575 1 off

3 off main size not shown, checked on maps @ appears to be,
1 X 50mm. class 575
1 X 80mm. class 250
1 X 100mm. class 250

[redacted]

D. BARR.
TECHNOLOGY OFFICER.