Attachment 8.2

Mains Replacement Plan

2016/17 to 2020/21 Access Arrangement Information

Australian Gas Networks

Page intentionally left blank

APA Group

Asset Strategy and Planning

Australian Gas Networks

SOUTH AUSTRALIA NETWORK

MAINS REPLACEMENT PLAN

June 2015

ACCESS ARRANGEMENT INFORMATION
ATTACHMENT 8.2
[redacted]

Prepared By:

Manager, Networks Asset Strategy and Planning [redacted]

Approved By:

General Manager South Australian Networks [redacted]

Manager Operations & Engineering, AGN [redacted]

Distribution List

Name	Title
[redacted]	Networks Executive Manager
[redacted]	General Manager, SA Networks
[redacted]	Manager Planning & Engineering
[redacted]	Manager, SA Networks System Operations
[redacted]	Manager, Field Operations
[redacted]	Manager, Capital Projects (Acting)
[redacted]	National Manager, Network Asset Strategy & Planning
[redacted]	National Manager, Mains Replacement Program
[redacted]	Manager Operations & Engineering - AGN

Reference Documents

Date	Title	File Reference
July 2010	2010 SA Networks Mains Replacement Plan	
December 2014	SA UAFG Forecast 2016-21	
April 2015	2015 SA Networks Asset Management Plan	
June 2015	South Australian Access Arrangement Information - Attachment 8.2 2016/17 – 2020/21 Unit Rates Forecast	

Abbreviations

Abbreviation	Definition
AA	Access Arrangement
AER	Australian Energy Regulator
AGN	Australian Gas Networks
AMP	Asset Management Plan
CAPEX	Capital Expenditure
CBD	Central Business District
CI	Cast Iron
DSPR	Distribution System Performance Review
FY	Financial Year
GIS	Geospatial Information System
HDPE	High Density Polyethylene
HP	High Pressure
LP	Low Pressure
MAT	Moving Annual Total
MDPE	Medium Density Polyethylene
MP	Medium Pressure
MRP	Mains Replacement Plan
OPEX	Operating Expenditure
PE	Polyethylene
SA	South Australia
SP	Polyethylene Coated Steel Pipe
TP	Transmission Pressure
UAFG	Unaccounted for Gas
UPS	Unprotected Steel

CONTENTS

Tables

Graphs

Figures

1 EXECUTIVE SUMMARY

This Mains Replacement Plan provides details of:

1. Progress against the current regulatory period AER mains replacement benchmarks;
2. An assessment of that plan's impact on network performance and integrity; and
3. The mains replacement program for the next regulatory period (FY 2016/17 to 2020/21).

A 5-year mains replacement program totalling 1072 km was approved by the AER for this current regulatory period. The objectives of this program were (and remain) to reduce risk and improve supply reliability to gas consumers by replacing ageing CI and UPS mains and services within the Adelaide and Mount Gambier distribution networks.

Progress over the first three years of the current regulatory period has exceeded the regulatory benchmark length by 30 km. Planned replacement for FY 2014/15 and FY 2015/16 will result in a replacement of 1,172[1] km over this current period, which is 100 km higher than the regulatory benchmark. The 100 km difference can be attributed to the replacement of vintage polyethylene (PE) pipe, which was not contemplated when the last regulatory submission was prepared but recent risk analysis has seen a need to commence replacement. The table below summarises progress to date and the forecast for the remaining two years.

Current Regulatory Period Mains Replacement - km						
	FY 11/112	FY 12/13	FY 13/14	FY 14/15	FY 15/16	Total
Regulatory Period Benchmark	140	233	233	233	233	1072
Actual/Forecast	166	206	264	247	289	1172
Annual Variance	26	-27	31	14	56	100

Table 1 – Regulatory Benchmark Replacement Performance

This replacement program has been effective in improving the integrity and reliability of the network as summarised by the following key performance indicators:

1. 50% reduction (1055) in CI and UPS mains and service leaks since 2010;
2. 36% reduction (136) in CI mains breaks since 2010;
3. 34% reduction (730 TJ) in the Adelaide network UAFG since 2010; and
4. 60% reduction in customer reported supply complaints related to water in mains.

The South Australian networks moving annual total (MAT) UAFG, as at 30 June 2014, was 1433 TJ, about 200 TJ below the regulatory bench mark of 1626 TJ (by end of FY 2015/16). Ongoing mains replacement is forecast to reduce UAFG further to about 1035 TJ by the end of FY 2020/21.

[1] Includes 5 km of HDPE replacement I FY 2012/13 and 95 km HDPE replacement planned over FY 2014/15 and FY 2015/16

[redacted] 26km of HDPE is planned for replacement during FY 2014/15 in order to reduce identified risk to an acceptable level.

Analysis has shown that HDPE mains are prone to brittle crack failures under certain conditions where defects exist, resulting in a sudden release of gas. [redacted] To minimise the risk associated with HDPE the following actions are being pursued

1. Replacement of all MP Class 250 HDPE mains within the Adelaide distribution network by the end of FY 2020/21;
2. Replacement of HP Class 575 HDPE mains in locations where deemed warranted by a risk assessment has deemed a strong likelihood of a brittle failure in a location that could result in gas entering a building;
3. Research and development of inline camera technology to identify defects in pipe, to enable repair;
4. Installation of ground vents over HDPE mains in locations were ground conditions could "seal" in gas leaks making them difficult to detect.
5. Development of a reliability forecast model to predict the remaining life of Class 575 HDPE, so that risk mitigation strategies, including replacement, can be optimised.

Replacement program FY 2015/16

The FY 2015/16 replacement program will focus on CI and UPS mains replacement within the Adelaide and Mount Gambier distribution networks. In addition, work will commence on the replacement of 69 km of HDPE mains at locations assessed as being at high risk. The following table summarises the proposed FY 2015/16 replacement program.

FY 2015/16 Replacement Program		
Item	Suburb	Length km
1	**CI & UPS Program**	
2	Alberton	12
3	Brahma Lodge	54
4	Largs North	36
5	Tranmere	32
6	Pooraka	30
7	Christies Beach	8
8	Adelaide CBD	20
9	Mount Gambier	10
10	Piecemeal	3
11	Carry Over Block	15
12	**Total**	**220**
13	**HDPE Program**	
14	Class 250 HDPE	52
15	Class 575 HDPE	17
16	**Total HDPE**	**69**
17	**Grand Total**	**289**

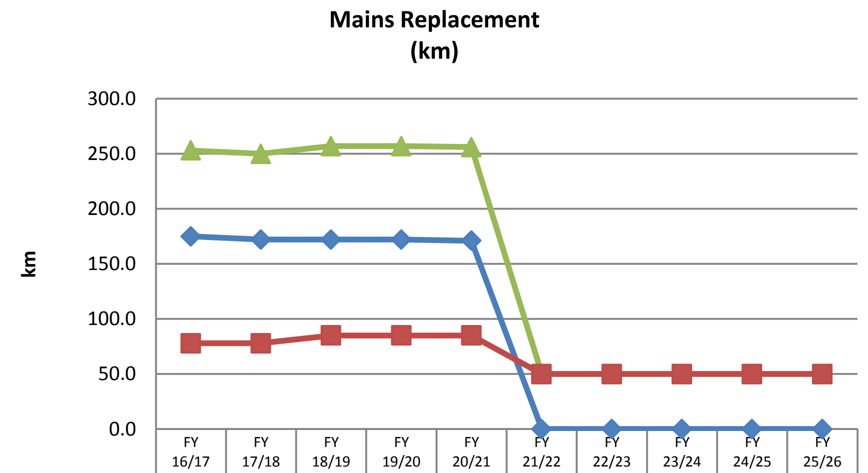
Table 2 – FY 2015/16 Replacement Program

Replacement program next regulatory period

The key elements of the replacement program over the next regulatory period are:

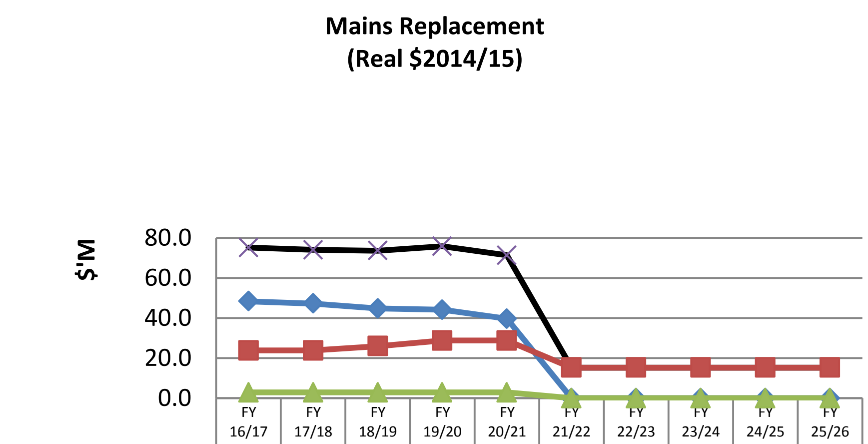
1. Replacement of all remaining CI and UPS mains (approximately 862 km of predominately LP CI and UPS mains);
2. Replacement of about 1300, predominately UPS, multi-user inlet services;
3. Replacement of remaining 260 km of MP Class 250 HDPE; and
4. Replacement of 151 km MP and HP Class 575 HDPE identified as being at highest risk.

The following graphs summarise planned replacement volumes and costs.



	FY 16/17	FY 17/18	FY 18/19	FY 19/20	FY 20/21	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26
Total	252.9	249.9	257.0	257.0	256.0	50.0	50.0	50.0	50.0	50.0
CI & UPS	175.0	172.0	172.0	172.0	171.0	0.0	0.0	0.0	0.0	0.0
HDPE	77.9	77.9	85.0	85.0	85.0	50.0	50.0	50.0	50.0	50.0

Graph 1 – Mains Replacement Schedule - Length



	FY 16/17	FY 17/18	FY 18/19	FY 19/20	FY 20/21	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26
Total	75.1	74.0	73.6	75.8	71.3	15.3	15.3	15.3	15.3	15.3
CI & UPS	48.4	47.3	44.7	44.1	39.6	0.0	0.0	0.0	0.0	0.0
HDPE	23.8	23.8	26.0	28.8	28.8	15.3	15.3	15.3	15.3	15.3
Mult User Services	2.9	2.9	2.9	2.9	2.9	0.0	0.0	0.0	0.0	0.0

Graph 2 –Replacement Schedule - Cost

This program of work is aimed at delivering:

1. Reduction of public and maintenance personnel risk associated with gas leaks from the LP and MP CI and UPS steel network;
2. Reduction of public and maintenance personnel risk associated with brittle failure of MP and HP HDPE mains; and
3. Improved network reliability and capacity.

It is therefore consistent with rule 79(2) c (i) and (ii) (ie, the expenditure is necessary to maintain and improve the safety of services and maintain the integrity of services).

Further analysis of HDPE material behaviour, planned during the next regulatory period, will confirm the timing and volume of future HDPE replacement. Based on current understanding of material behaviour, replacement of about 50 km per year from 2021 may be required.

2 INTRODUCTION

This plan is reviewed annually to ensure that the latest information is taken into account in setting business objectives. It also provides an update on the progress of the 5-year mains replacement plan presented in the SA Networks 2010 MRP for the current regulatory period. At that time approximately 1610 km of predominately LP CI and UPS mains remained in the network and were planned for replacement, with 1072 km endorsed by the AER for replacement during the current regulatory period.

This plan reviews the impact of mains replacement on key asset integrity and performance indicators, provides details of the proposed 2015/16 mains replacement program, and sets out replacement requirements for the next regulatory period (2016/17 – 2020/21).

Update and review cycle

The development of this plan is part of the annual asset management planning process with two parallel streams of work.

The first stream involves the ongoing monitoring of asset performance and monitoring of implementation of the previous year's program of work.

The second stream involves the review of asset performance, risk assessment, development of technical solutions, development of budgets and securing approvals for future replacement work.

The South Australian Networks Asset Planning Manager is responsible for reviewing and updating this plan.

3 MAINS REPLACEMENT OVERVIEW

It has been recognised that ageing CI and UPS mains pose a safety risk to maintenance personnel and the public.

Over the last few years a further safety issue associated with brittle crack failures of HDPE mains has been identified, particularly those that have been damaged during construction and/or maintenance.

While the past focus has been on replacement of ageing CI and UPS mains, developing integrity management strategies (including replacement) to address risks posed by brittle crack failure of HDPE mains has now also become a priority with replacement of HDPE mains now being undertaken on a risk assessment basis.

Mains that require replacement fall into one or more of the following categories:

1. Safety - In this category the primary concern is that of the safety of the public. A key risk associated with CI is that of fracture. [redacted]

   Studies in the UK and Australia have indicated that the major risk of an explosion is from gas escaping from a CI break/crack at locations where the surface between the leak and a property is sealed by a road or pavement. Under these conditions gas is unable to vent to atmosphere and can travel into ducts, basements and other confined spaces, creating a risk of explosion.

   A similar risk exists with HDPE mains under certain conditions, [redacted]

   This plan prioritises replacement of mains that are assessed as posing the highest risk.

2. Asset integrity and performance - This category covers a variety of issues including:

   - Areas of the network suffering low pressure or loss of supply at a customer's meter due to water ingress or other asset integrity issues;
   - Areas expected to have capacity issues due to increasing peak loads (due to increasing penetration of appliances with high instantaneous demand and increasing housing density); and
   - Mains where it is not cost effective to repair (e.g. because it involves short length piecemeal replacement).

3.1 Policy

AGN's mains replacement program objectives are to:

1. Maintain and improve safety to persons (both the public and workers) and property, thereby meeting regulatory obligations and requirements;
2. Maintain asset integrity and performance;
3. Reduce environmental impact of greenhouse gases.

The objective is also to implement the program in a cost effective manner that balances cost and risk, for the long term benefit of consumers. Where possible, mains replacement is undertaken by insertion on a "block" based basis, as this is the most cost efficient technique.

The drivers and strategy for mains replacement are reviewed annually.

3.2 Strategy

Mains replacement is undertaken in an efficient manner. This includes the use of "block" based replacement, and effective tendering/procurement processes. This ensures that expenditure complies with the National Gas Rules. Rule 79 sets the criteria governing the recovery of capex, which criteria provides:

> *"(1) Conforming capital expenditure is capital expenditure that conforms with the following criteria:*
>
> *(a) The capital expenditure must be such as would be incurred by a prudent service provider acting efficiently, in accordance with accepted good industry practice, to achieve the lowest sustainable cost of providing services;*
>
> *(b) The capital expenditure must be justifiable on a ground stated in sub rule (2)."*

The grounds stated in sub rule (2) require that the capex is necessary in order to:

- Maintain and improve the safety of services; or
- Maintain the integrity of services; or
- Comply with a regulatory obligation or requirement; or
- Maintain the capacity to meet levels of demand for services existing at the time.

These criteria are consistent with the National Gas Objective (NGO) that is set out in Section 23 of the National Gas Law (NGL), which is to promote efficient investment in natural gas services that is in the long term interests of consumers with respect to price, quality, safety, reliability and security of supply of natural gas services.

Practical considerations including the availability of resources, planning periods, ramp-up time, etc., are considered by management in preparing and reviewing the mains replacement plan.

Opportunities are also pursued to combine mains replacement with council and road authority road construction and resurfacing programmes, in order to minimise costs, public disruption and complaints.

The mains replacement strategy is to:

1. Replace mains in "at risk" areas - mains identified as posing an unacceptable safety risk are replaced as a priority. In some cases this may mean undertaking such work on a "piece-meal" basis;

2. Replace mains in poor condition with a history of water ingress and/or capacity issues; and

3. Undertake replacement in broad "block" areas where feasible, while simultaneously upgrading to high pressure. Upgrading of pressure allows smaller diameter mains to be inserted, minimising replacement unit cost while increasing capacity.

All of the above is subject to practical, financial and regulatory considerations, and where replacement cannot be undertaken in an appropriate timeframe, leak and risk management measures are undertaken (these measures, however, do not negate the need to replace aged mains in the longer term).

In undertaking block mains replacement, it is recognised that pockets of mains that may not necessarily pose a risk, may also need to be replaced. Prudence and efficiency may dictate that some PE mains require replacement at the same time that CI is replaced.

As with any long term program, the areas subject to mains replacement may change over time, as would be expected of any prudent operator, to reflect latest information and evolving risk.

3.3 Process

Mains are prioritised for replacement having regard to:

1. Leakage risk, which is based on a risk assessment that takes into account historic leak frequency (identified by both leakage survey and public reported leaks);

2. History of mains breaks (this being a sub-set of leak history) and assessment of consequences (recognising that breaks create a much higher risk of substantial volumes of gas being released compared to leaks from corrosion or pipe joints);

3. LP networks water ingress incidents which can lead to multiple customer outages; and

4. Capacity performance issues, to ensure that the network can continue to meet demand.

After linking performance, condition and breakage zone data to asset records, priority replacement areas are identified for further evaluation. These areas are then reviewed and a program of work is determined taking into account; current outstanding replacement work, relativity of risk, poor pressure reports, water in mains issues, resource and budget objectives.

For the defined priority areas:

1. Network design is optimised in line with meeting short and long term capacity requirements;

2. A detailed design and specification is developed and issued for tender; and

3. Contracts are approved and awarded in accordance with AGN's delegations of authority.

4 NETWORK PERFORMANCE AND INTEGRITY

This section provides an overview of key performance and integrity issues associated with AGN's South Australian distribution network. Sections 4.1 to 4.4 deal with CI and UPS mains and the impact of mains replacement on leak repairs and UAFG. Section 4.5 deals with emerging integrity issues with HDPE mains.

4.1 Mains Inventory

The following table summarises the inventory of distribution mains within AGN's South Australian (Adelaide & Regional) distribution networks as of 30 June 2014.

Adelaide Metropolitan Distribution Mains - km						
Network	MDPE	HDPE	CI	UPS	SP	Total
LP	103	326	763	75	37	1,303
MP	1,148	769	68	11	388	2,385
HP	1,571	851	0	0	1,091	3,513
TP					190	190
TOTAL	2,821	1,946	830	86	1,706	7,390

Table 3 – Adelaide Metro Network Distribution Mains Inventory

Regional Networks Distribution Mains - km						
Network	MDPE	HDPE	CI	UPS	SP	Total
LP	4	12	3	14	2	35
MP	112	50	0	5	101	269
HP	81	111	0	0	38	229
TP					18	18
TOTAL	197	172	3	19	159	551

Table 4 – Regional Networks Distribution Mains Inventory

4.2 Age Profile

Details of when individual mains segment were laid were not kept historically and consequently an accurate age profile is not available for the old CI and UPS mains. An indicative age of CI and UPS within the network was derived from an initial age profile provided by GHD in 1997 as part of the original Envestra prospectus in 1997. Based on this, CI is estimated to be between 50 and 71 years old and UPS between 48 and 62 years old.

However, it should be noted that mains are not replaced based on age but on condition, risk and capacity factors (i.e. useful life).

4.3 *Mains Condition and Integrity*

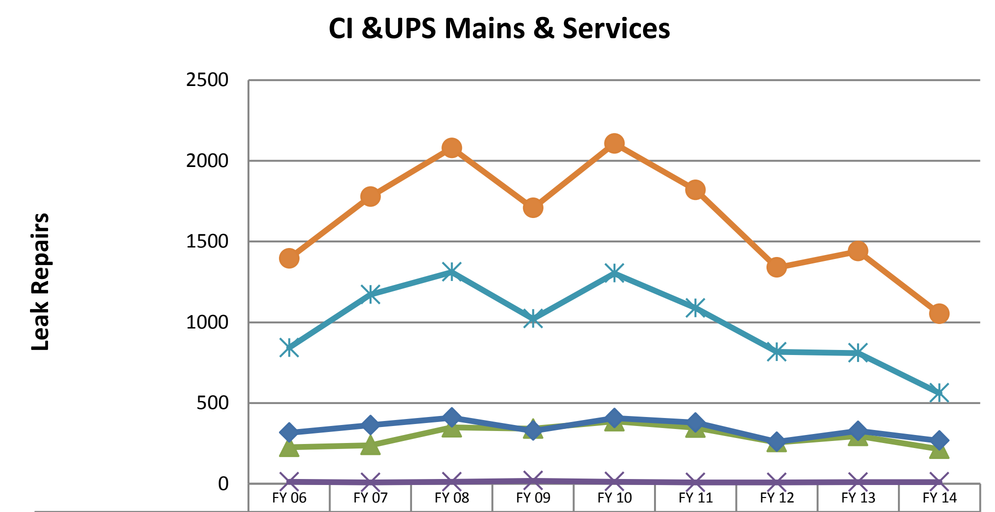
Mains performance and network integrity is reviewed annually and reported in the SA Networks Distribution System Performance Review (DSPR).

Key indicators used to assess the integrity issues associated with the CI and UPS networks are:

1. Mains and service leaks
2. CI mains breaks
3. Water in main incidents
4. UAFG

These are discussed in the following sections.

4.3.1 CI & UPS Leaks



	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11	FY 12	FY 13	FY 14
Total	1395	1778	2079	1707	2107	1819	1338	1440	1052
Joint Leak	842	1171	1311	1021	1303	1088	816	809	561
Corrosion	226	238	348	340	386	346	256	295	215
Pipe Cracked	316	362	409	328	406	378	259	327	266
Failure of Prior Repair	11	7	11	18	12	7	7	9	10

Graph 3 – CI & UPS Mains & Service Leaks

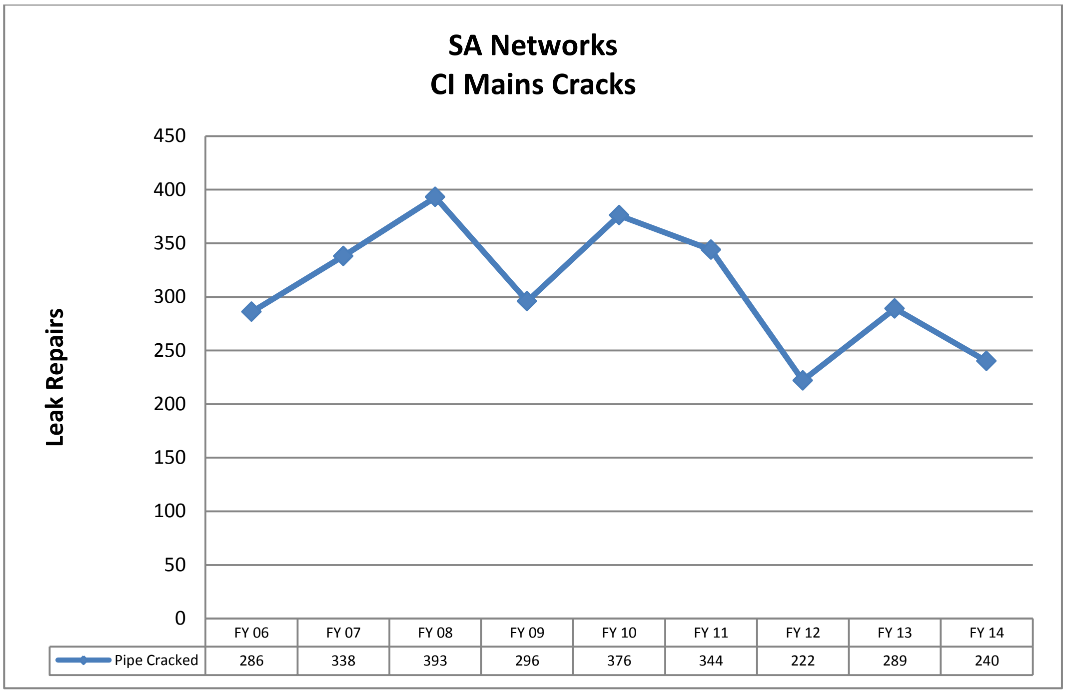
CI and UPS mains and service leak have been trending down over the last 4 years with a 50% reduction since 2010. This reduction is consistent with replacement of over 730 km of predominately CI and UPS mains over this period.

Mains and services leaks per kilometre of CI and UPS mains has reduced from 1.5 in 2010 to 1.12 in 2014, indicative of improving network integrity and public safety.

While the integrity of the CI and UPS network has improved, the leak rate per kilometre remains relatively high at 1.12 versus 0.33 for the remaining, predominately PE, network.

4.3.2 *CI Mains Cracks*

Cracking of mains is associated with a combination of soil movement, traffic loads and reduced pipe wall strength as result of graphitisation (a form of corrosion). In some instances graphitisation has resulted in sections of the main suddenly blowing out when repairs are attempted, presenting a significant safety risk to maintenance personnel.



Graph 4 – CI Mains Cracks

There has been a 36% reduction in mains breaks since 2010, consistent with targeting replacement in areas with a relatively high incidence of cracks.

4.3.3 *Adelaide CBD - CI & UPS Leaks*

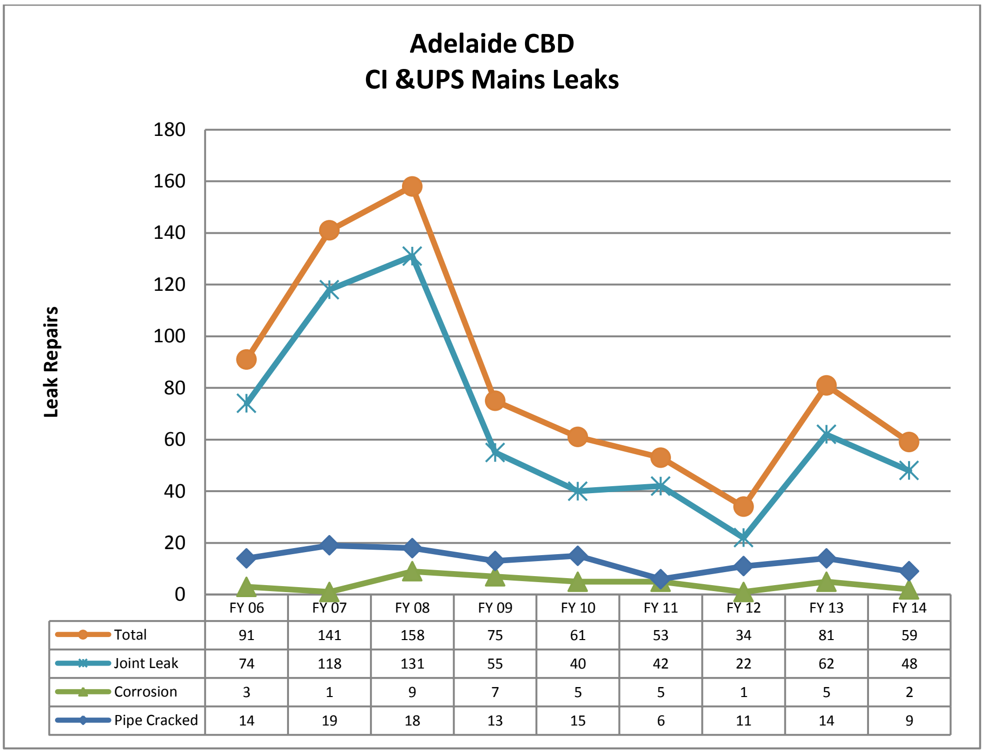
Leaks within the Adelaide CBD present a higher risk to the public due to the combination of population density and the number of ducts, passages and other confined spaces where dangerous concentrations of natural gas can accumulate. This risk is somewhat mitigated by relatively low operating pressures, while the higher volume of foot traffic can also increase the probability of leaks being detected and reported by pedestrians.

The following table and graph summarises the LP network inventory and the nature of CI and UPS mains failures within the CBD as at 30 June 2014.

Adelaide CBD - Mains Inventory (km)							
	CI	UPS	Poly	Poly MD	Poly HD	SP	Total
Trunk Mains	18	0	0	0	0	7	25
Reticulation Mains	40	5	5	3	4	8	66
Total	58	5	5	3	4	15	91

Table 5 – Adelaide CBD Mains Inventory

Approximately 75% of the CBD network consists of old CI mains that have the potential for joint leaks and cracks/breaks.



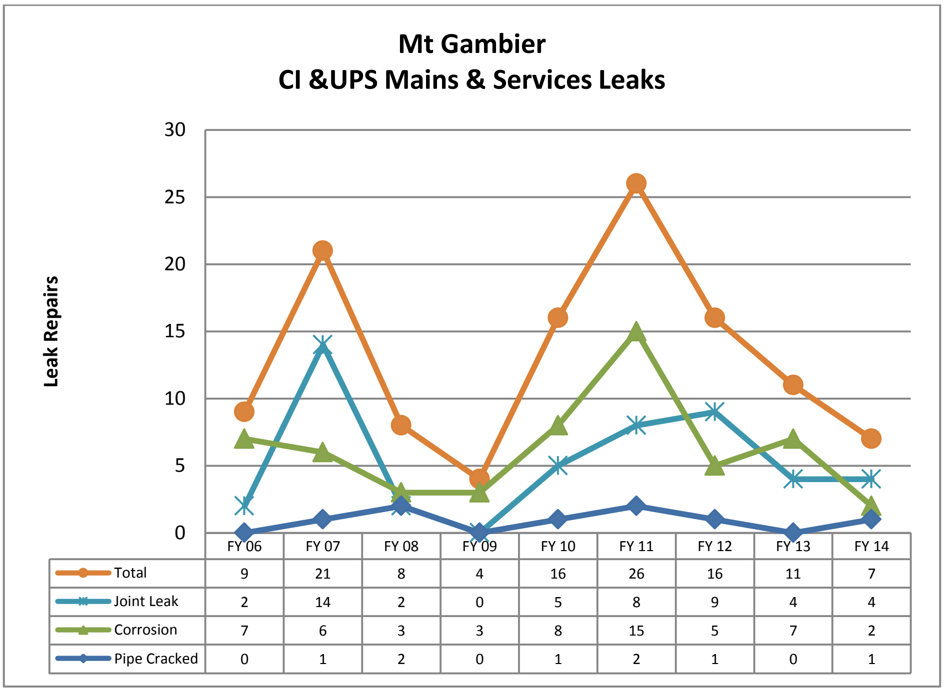
	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11	FY 12	FY 13	FY 14
Total	91	141	158	75	61	53	34	81	59
Joint Leak	74	118	131	55	40	42	22	62	48
Corrosion	3	1	9	7	5	5	1	5	2
Pipe Cracked	14	19	18	13	15	6	11	14	9

Graph 5 – Adelaide CBD Mains Leaks

There is no clear explanation for the relatively low incidence of leaks since 2008 given no substantial replacement of mains during this period. A possible explanation is that leaks reported in FY 06/07 and FY 07/08 may have been unusually high as result of a public awareness advertising campaign in 2007 that encouraged the public to report any smell of gas.

The greatest risk is posed by pipe cracks and breaks, and these remain relatively low (9 in FY 13/14).

4.3.4 Mt Gambier - CI & UPS Leaks



	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11	FY 12	FY 13	FY 14
Total	9	21	8	4	16	26	16	11	7
Joint Leak	2	14	2	0	5	8	9	4	4
Corrosion	7	6	3	3	8	15	5	7	2
Pipe Cracked	0	1	2	0	1	2	1	0	1

Graph 6 – Mt Gambier Mains & Service Leaks

The relatively small number of leaks in Mt Gambier makes it difficult to identify trends, however leak numbers peaked in FY11 and have reduced by 72% since that time.

Maintenance personnel have flagged that corrosion of UPS is a major issue in general and particularly in Mt Gambier, with first response teams commonly finding the main riddled with corrosion, with piecemeal replacement the only repair option.

Experience has shown that UPS has a useful life of about 45 years. The UPS mains within the Mt Gambier network are over 45 years old and considered to be at the end of their useful life.

4.3.5 *Integrity of CI & UPS Services*

From about 2004 until 2012, LP inlet services (CI and UPS) to multi-user sites (unit developments) were only replaced (in conjunction with the mains replacement program) if they failed a safety (pressure) test. Those services passing a pressure test were fitted with a boundary regulator and were left operating at LP. This process was undertaken in order to maximise the efficiency of mains replacement by deferring the more complex and lower risk asset (multi user sites) replacement to a later date, whereby those sites could be replaced as a contract package on a stand-alone basis. This process also minimised disruption to surrounding consumers and the public, as multi-user sites are more complex and time consuming to upgrade.

The majority of multi-user services consist of UPS that are estimated to be over 45 years old. Experience has shown UPS of this vintage is at the end of its useful life [redacted]

These assets will be replaced in a planned manner to minimise supply disruption and align system integrity with that of the inserted and pressure upgraded mains that these assets are connected to.

4.3.6 *MP CI & UPS Trunk Mains Integrity*

The Adelaide distribution network includes approximately 58 km of MP CI trunk (DN150 – DN380) mains and 6 km of MP UPS trunk (DN150-DN450) mains. These mains provide the primary supply to downstream MP and LP networks.

The MP CI and UPS trunk network is considered to be in poor condition with CI having a propensity for crack failures, while UPS mains are subject to extensive external corrosion.

The cracking of CI mains is associated with soil movement and reduced wall strength as result of graphitisation.

Experience has shown that UPS mains are generally significantly corroded after about 45 years, with replacement the only option in response to a leak. These MP trunk mains are estimated to be between 45 and 50 years old and are at the end of their useful lives.

The extent of graphitisation can be difficult to determine solely by visual inspection, since pipe dimensions and overall appearance are generally unaffected by all but the most progressive graphitisation. As a result, any leak repair work can, and has, resulted in unexpected disintegration of discrete sections of the main. This creates a higher level of risk to repair crews and can result in the sudden loss of supply to large numbers of consumers.

As significant sections of the LP CI and UPS network are replaced and upgraded to high pressure, the upstream MP CI trunk mains feeding these networks are being replaced with either inserted HP supply mains within the existing alignment or new HP supply mains on a different alignment. Where a replacement main is not deemed necessary due to existing or new HP infrastructure, the old trunk main may simply be abandoned.

In some cases MP CI and UPS trunk mains provide the primary supply to MP networks that will continue to be maintained at MP in the long term. In these instances abandoning the main is not an option.

Prioritisation for replacement/abandonment of trunk mains is undertaken having regard to:

1. Leak frequency/history;
2. Safety and operational risks associated with the condition of the main;
3. The timing of downstream network replacement program; and
4. Availability and capacity of HP network infrastructure to support the replacement.

The following table summarises the MP trunk mains replacement schedule.

Zone	Zone Description	CI (m)	UPS (m)	Total (m)	Priority	Action	Replace %	Replace (m)	FY 16/17	FY 17/18	FY 18/19	FY 19/20	FY 20/21
A	Royal Park - Hendon - Seaton - Fulham Gardens	6,610		6,610	3	Abandon / Replace	50%	3,305					
B	Underdale - Torrensville - Thebarton - Mile End - Cowandilla - Hilton - Richmond - Marleston - North Plympton - Plympton - Glandore - Netley - Plympton Park - Camden Park - Morphettville - Kurralta Park - Ascot Park	12,221	1,660	13,881	2	Abandon / Replace	75%	10,411					
C	Wingfield - Cavan - Mawson Lakes - Dry Creek - Gepps Cross - Blair Athol - Kilburn - Mile End	6,895	10	6,905	1	Replace	100%	6,905					
D	Para Hills - Para Hills West - Salisbury East - Parafield - Brahma Lodge - Salisbury - Salisbury Downs - Paralowie - Salisbury North - Salisbury South - Gulfview Heights - Greenfields - Parafield Gardens	8,911		8,911	1	Replace	100%	8,911					
E	Elizabeth Vale - Elizabeth South - Elizabeth Grove - Edinburgh - Elizabeth	2,473		2,473	1	Abandon / Replace	50%	1,237					
F	Tea Tree Gully - Vista - Highbury - St Agnes - Hope Valley	2,339		2,339	3	Replace	100%	2,339					
H	Felixstow - Marden - Klemzig	1,950		1,950	-	Abandon	0%	0					
I	Modbury - Modbury North - Valley View	1,776		1,776	2	Replace	100%	1,776					
K	Bowden - Brompton - Ovingham - Ridleyton - Renown Park - Devon Park - Fitzroy - Prospect - Dudley Park - Hindmarsh	819	2,925	3,744	1	Abandon / Replace	50%	1,872					
L	Semaphore Park - Ethelton - Semaphore South	920		920	3	Replace	100%	920					
N	Cheltenham - Woodville - Albert Park	731	32	763	2	Abandon / Replace	50%	382					
O	North Plympton - Camden Park - Novar Gardens	1164	161	1,325	5	Replace	100%	1,325					
P	Kilkenny - Woodville Park - West Croydon - Croydon Park - Beverley	1,104		1,104	4	Replace	100%	1,104					
Q	Glenelg - Glenelg East - Glenelg North	23	936	959	6	Replace	100%	959					
R	Marion - Oaklands Park - Mitchell Park - Sturt - Park Holme	4,023		4,023	-	Abandon	0%	0					
S	North Brighton - Somerton Park	336	95	431	-	Abandon	0%	0					
T	Warradale - Oaklands Park - Dover Gardens - Seacombe Gardens - Glengowrie	3,041		3,041	-	Abandon	0%	0					
U	Bedford Park	27	583	610	7	Replace / Abandon	50%	305					
X	Ottoway - Port Adelaide - Rosewater	2,230		2,230	-	Abandon	0%	0					
	Grand Total	57,593	6,402	63,995				41,750					

Table 6 – MP Trunk Mains Replacement Schedule

4.3.7 UAFG

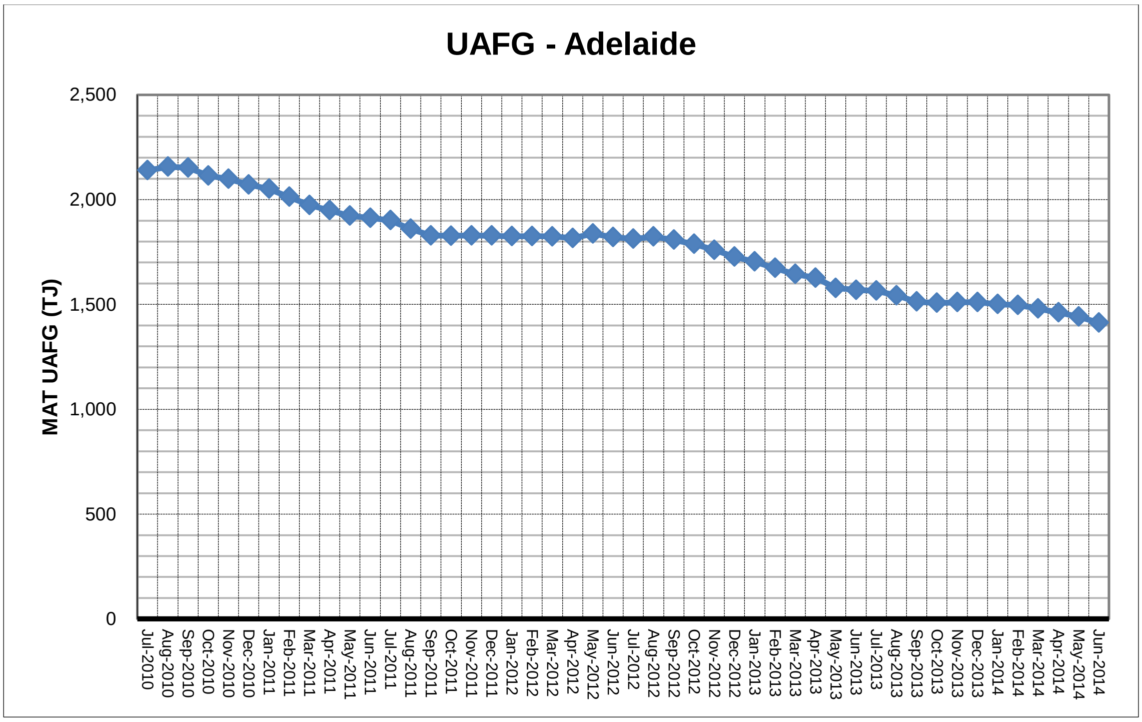
The following graphs show the trend in level of UAFG, a crude proxy for network integrity in networks containing CI and UPS. It is recognised that there a number of contributors to UAFG (e.g. metering error, heating value differences, gas temperature and pressure, etc., as well as leakage from all mains), however leakage from old parts of the network that contain CI and UPS can be a material contributor in old networks.

The remaining CI and UPS in the South Australian network is located in the Adelaide and Mount Gambier distribution networks.

UAFG is an indicator of the general condition of the distribution network. A high value of UAFG would indicate higher risk associated with:

- Pipeline failure of the age-deteriorated cast iron through joint leaks and fracturing; and unprotected steel mains through corrosion;
- The integrity and performance of the gas distribution network which will suffer as a result of increased gas outages due to more frequent unplanned repairs, water ingress and pressure loss due to pipe failure.
- The environment, with leakage of methane. It should be noted that methane is approximately 22 times worse than carbon dioxide in terms of environmental impacts

Adelaide MAT UAFG



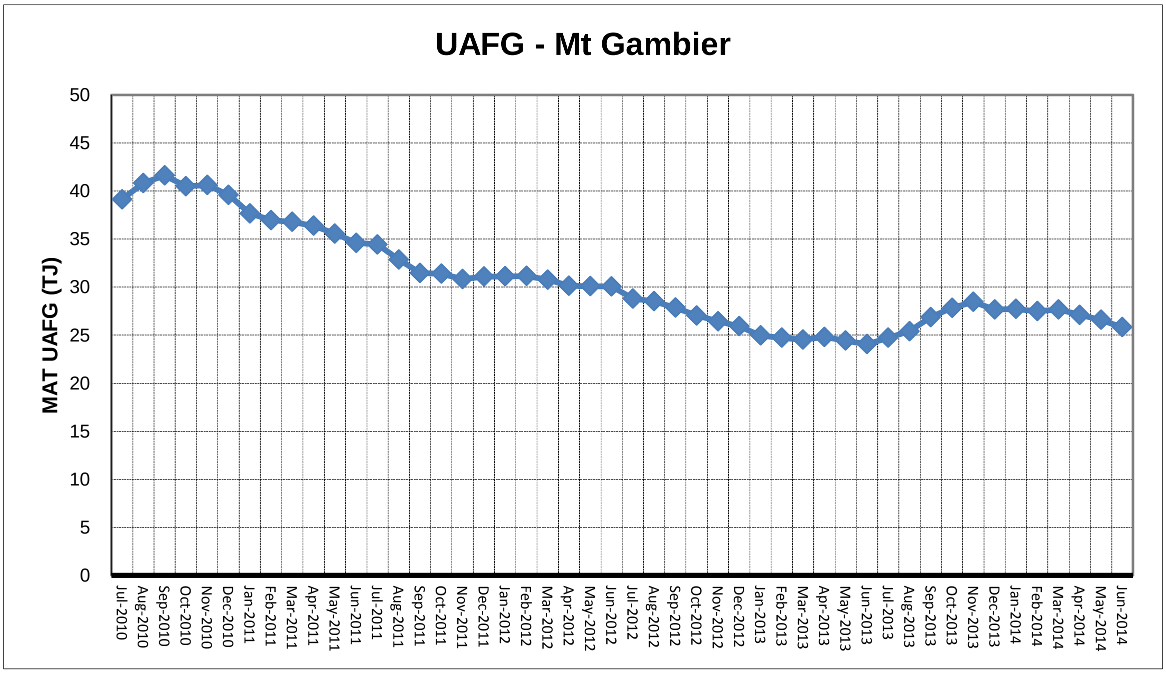
Graph 7 – Adelaide Metro UAFG

Adelaide UAFG summary:

1. The 12-month moving annual total (MAT) UAFG for the Adelaide network was approximately 1,410 TJ as at the end of June 2014 (based on December 2014 SA UAFG AEMO Report), a 730 TJ reduction (34%) since July 2010.

2. The sustained downward trend is considered to be largely associated with the CI and UPS main replacement program, however the magnitude of the reduction is higher than originally anticipated. As CI and UPS leakage is reduced with ongoing mains replacement, other contributing factors will dominate the makeup of UAFG (refer to Section 7.2 for discussion of UAFG forecast).

Mount Gambier MAT UAFG



Graph 8 – Mount Gambier UAFG

Mount Gambier UAFG summary:

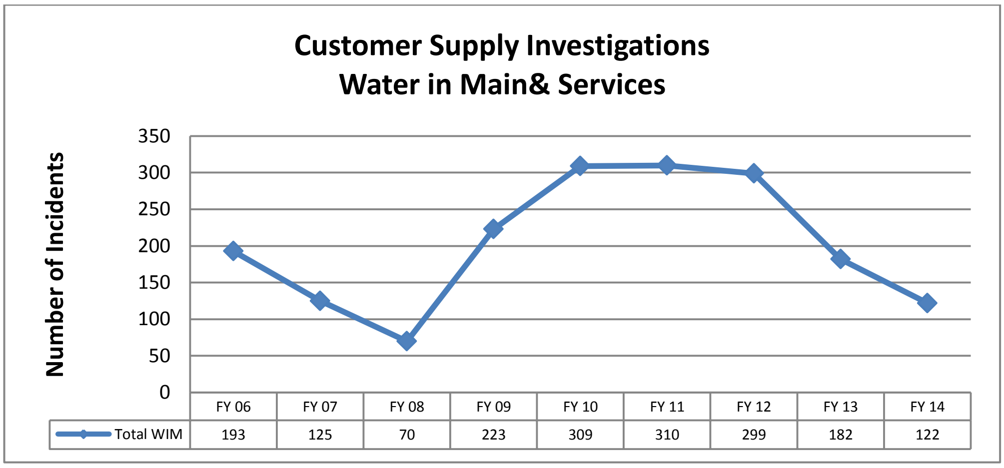
1. The 12-month MAT UAFG for the Mount Gambier network was 26 TJ as at the end of June 2014 (based on December 2014 SA UAFG AEMO Report), a 13 TJ reduction (34%) since July 2010.

2. The downward trend is considered the result of the mains replacement program focusing on replacement of MP UPS mains.

4.4 Supply Reliability

4.4.1 Water in Mains & Services

Groundwater ingress into pipe due to porosity, corrosion and breakage is an indicator of pipe having reached the end of its useful life. The following graph summarises the number of customer supply investigations where water in the main was identified as the primary cause of supply problems.



Graph 9 – Water in Main Incidents

There has been a significant (60%) reduction in reported water in main incidents since 2010. While there can be a number of contributing factors (amount of rainfall) the reduction is considered to be attributed to the mains replacement program.

4.4.2 *LP Network Capacity*

Over the last 3 years there has been an 85% reduction in reactive LP network augmentation projects, indicative that mains replacement is reducing capacity related problems. This is in line with expectation as LP mains are replaced with new mains with higher capacity.

4.5 ***HDPE Pipe Integrity***

There is an emerging issue with the integrity of HDPE mains, with increasing evidence that such mains are susceptible to sudden brittle crack failures under certain conditions. [redacted] The following sections provide an overview of the issue and strategies being developed to mitigate risks associated with these mains. A detailed analysis of the issue and risk mitigation strategies is provided in Appendix A.

4.5.1 *Background*

High density polyethylene (HDPE) pipe has been used for gas reticulation within South Australia (and elsewhere in Australia and around the world) between the early 1970s until the late 1990s. The type of HDPE was known as Class 250 (SDR 17.6) and Class 575 (SDR 9.9). A newer generation of medium density polyethylene (MDPE) was used from the late 1990s and is still in use. [redacted]

[redacted]							
[redacted]	[redacted]		[redacted]		[redacted]		[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

[redacted]

[redacted]

Analysis of the characteristics and performance of HDPE has been undertaken by AGN in order to determine optimum measures for minimising the risk associated with old PE (see Appendix A for details). This issue is not unique to AGN, but to networks overseas also. In the USA, this issue is referred to as "vintage PE", and many utilities there have commenced wholesale replacement of such pipe.

AGN has essentially two types of vintage PE – Class 250 and Class 575:

1. Class 250 - Installed from the early 1970s, and over time has become brittle to the extent that fractures occur in service or when undertaking repairs.

2. Class 575 was installed from the early 1980s, and is also becoming brittle over time, but due to its younger age, the associated risk is more related to the combination of brittleness and any defects that may have affected the pipe during its installation or service.

Following several years of research and testing, AGN has developed a preliminary HDPE risk model that is being used as part of its asset management strategy. This model takes into account a number of factors in order to determine those parts of the HDPE network that should be replaced. For other parts of the HDPE network, appropriate risk mitigation and monitoring strategies are in place, and continual review of performance and risk, in conjunction with further significant development of the risk model, will inform annual asset management strategies.

The conclusion of the analysis undertaken is that all MP Class 250 pipe (312 km) should be replaced, commencing in 2015/16 and completed by 2020/21, [redacted] In addition to 5km of Class 575 HDPE replaced in 2012/13, and replacement of 26 km of Class 575 HDPE pipe in 2014/15, a further 158 km of Class 575 [redacted] has been identified for replacement (see Appendix A for details).

In conjunction with the above strategy, research and development of pipe internal camera inspection (insertion of a small camera into live pipes to detect defects) will be undertaken with a view to enhancing the current risk assessment techniques and developing a more focussed risk reduction strategy.

The current strategies minimise replacement of mains, while ensuring that risks are maintained to as low as reasonably practicable (referred to in the industry as "ALARP"). This provides an appropriate balance between cost and risk in accordance with prudent asset management.

The longer term (post the next regulatory period) replacement strategy for Class 575 PE is somewhat dependant on further analysis and material testing to determine residual life and risk. The current understanding of material behaviour is that it is expected to have a 50 year life before it becomes increasingly "brittle" and difficult to maintain. Based on this, the residual (about 1300 km) of MP and HP Class 575 PE will require replacement over 25-30 years at a rate of about 50 km per year (see Appendix A for details).

4.6 *Distribution Network Performance and Integrity Summary*

1. The CI and UPS mains replacement program has been effective to-date in improving the safety, integrity and reliability of the gas distribution network. The replacement program is on track to deliver a reduction in both public risk (leaks) and UAFG and an improvement in system capacity that were the key drivers for this program.

2. While the current CI and UPS program has been effective in reducing risk, the leak rate per kilometre of main is about three times that of the remaining PE network. A continuation of the replacement program to reduce the leak rate to that of the remaining network is considered prudent.

3. While there has been a significant reduction in UAFG to about 4.3% (total South Australia Networks) it is higher than what is considered a "good" bench mark of about 3%. Analysis by an independent consultant indicates that the remaining CI and UPS network is contributing about 400 TJ to the MAT UAFG (refer to Section 6 for details). Completion of the CI and UPS replacement program is expected to reduce UAFG to about 1035 TJ or about 3%.

4. The CI and UPS mains are considered at the end of their useful lives with escalating leaks and UAFG if the program is curtailed. This was demonstrated when replacement rates were reduced to an average about 65 km per year over the 2004-2009 period from about 150 km in the preceding 5 year period. As a result UAFG increased by 5% year on year with the overall deterioration of the network calculated at about 12% per year. The relatively high deterioration rate was indicative of the condition of the CI and UPS assets reaching the second point of inflection associated on the asset condition "bath tub" curve. This is the point where accelerated deterioration is experienced as the asset approaches the end of its life.

5. Brittle crack failure of HDPE is an emerging issue that poses a significant integrity management challenge. [redacted]. A four-pronged integrity management strategy to address this risk has been put in place:

   a. HDPE mains replacement (reduction of immediate risk).
      (i) Class 250 - Because of age and relatively thin wall, brittle failures of Class 250 HDPE mains are expected to increase over the next 5-10 years to the extent that a risk reduction program is necessary. This program will result in all MP Class 250 HDPE being replaced by 2020/21.
      (j) Class 575 - Where a combination of past failures, location, operating pressure and soil type and housing construction are likely to present an unacceptable public risk, these mains will be replaced. Approximately 158 km of HP HDPE [redacted] has been identified for replacement over the next 6 years
   b. Research and development of internal camera inspection (reducing risk and extending asset life). This strategy is aimed at identifying those sections of pipe (by internal remote inspection) at highest risk, to enable improvement in localised repairs, thus avoiding replacement. [redacted]

   c. Installation of ground vents over HDPE mains in locations where soil and surface conditions can "seal" in the gas. This measure is aimed at providing a more direct vent to atmosphere where it is more likely to be detected (by the public or regular leak survey) reducing the risk of gas leaks travelling horizontally to an adjacent building. [redacted]

d. The development of a reliability forecast model (future HDPE integrity management optimisation). While an initial behaviour model has been developed, further work is required to refine the model to include crack failure predictive behavior, so that asset management strategies can become more targeted. [redacted]

5 REPLACEMENT SCHEDULE

5.1 2015/16 Replacement Program

The following sections summarise replacement volumes and costs for the 2015/16 financial year.

5.1.1 CI and UPS Replacement

Over the 3 years to 2013/14 about 630 km predominately LP mains will have been replaced with a further 221 km planned for replacement in 2014/15. The replacement of these mains has been based on targeting the worst performing areas taking into consideration:

- Service history (leaks, water in main incidents)
- Public risk (e.g. mains breaks)
- Supply reliability (poor pressure)
- Practical considerations (e.g. significant and careful planning has been required for the CBD), in order to ensure an optimum balance of gas distribution pressure, risk and implementation cost, taking into account the unique access issues in the CBD.

The program to date has been very effective with a significant reduction in UAFG and leaks as reported in Section 4.3. The program for FY 15/16 will see a total of 220 km planned for replacement, as set out in the following table.

FY 2015/16 Replacement Program		
Item	Suburb	Length km
1	**CI & UPS Program**	
2	Alberton	12
3	Brahma Lodge	54
4	Largs North	36
5	Tranmere	32
6	Pooraka	30
7	Christies Beach	8
8	Adelaide CBD	22
9	Mount Gambier	10
10	Piecemeal	3
11	Carry Over Block	13
12	**Total**	**220**

Table 8 – FY 15/16 Mains Replacement Schedule

Key elements and assumptions underpinning of the FY 15/16 program are:

- 185 km of block replacement;
- Contractor capacity to complete 22 km within the CBD; and
- 13 km of awarded block replacement that was due to be completed in FY14/15 will be outstanding as from 30 June 2015 (in accordance with information available at the time of preparation of this plan) and be carried over into FY15/16.

5.1.2 *CI and UPS Piecemeal Mains Replacement*

Some mains renewals are performed on a "reactive" piecemeal basis as a means of overcoming urgent leakage problems or localised cases of water ingress.

Subject to the condition of the existing mains, it is sometimes found that conventional repairs are either not possible or economically not feasible due to multiple leaks in a localised area. In these cases piecemeal mains renewal is undertaken with replacement in the order of 100 metres or less in length using direct burial, rather than insertion.

An average of 3.9 km of piecemeal replacement has been completed over the last 3 three years with 4km budgeted in FY 2014/15 and a nominal 3km for FY 15/16.

5.1.3 *CI and UPS Inlet Service Replacement*

There are cases where inlet services need to be renewed on a stand-alone basis (unrelated to mains renewal works). The need for such inlet service renewals arise when leaks or damages occur on the inlet service and inspection reveals that the service is heavily corroded or in such poor condition that repairs are not viable. In such cases, the service is replaced.

Based on actual replacements over the last few years a nominal 100 reactive inlet service renewals have been included for FY 15/16.

5.1.4 *HDPE Mains Replacement*

The following table summarises planned HDPE replacement in FY 15/16.

HDPE Class	FY 15/16
MP Class 250 HDPE	52
HP Class 575 HDPE	17.2
Total (km)	69.2

Table 9 – FY 15/16 HDPE Replacement

Replacement will be focussed on those mains where a combination of past failures, location, operating pressure, building and soil type present an unacceptable public risk.

5.2 Next Regulatory Period Replacement Program

The following sections provide an overview of replacement requirements for the next regulatory period FY 2016/17 to FY 2020/21. An overview of the derivation of costs has been provided in this section with further details included in the "South Australian Access Arrangement Information - Attachment 8.6 2016/17 – 2020/21 Unit Rates Forecast".

This Plan is the culmination of investigation, analysis, planning and modelling over the first half of FY 2014/15 and reflects the latest data available at the time.

The replacement program will focus on:

1. Completing the replacement of residual CI and UPS mains and services;
2. Replacement of residual MP Class 250 HDPE; and
3. Replacement of HP Class 575 HDPE in a number of locations

5.2.1 CI and UPS Replacement

The replacement of CI and UPS continues to be an important element of the program in the next regulatory period. The drivers for this program are to reduce risk, reduce UAFG and improve network capacity.

Based on key performance indicators detailed in Section 4.3 the program to date has met or exceeded expectations and completion of the program will arrest the impact of continual degradation of these very old assets and continue to deliver improved outcomes.

The forecast volume of replacement necessary to complete the replacement of all CI and UPS mains over the next regulatory period is based on:

1. Mains inventory as at 30 June 2014.
2. A total of 120 km of LP HDPE remaining post replacement of CI and UPS mains with all other (365 km) LP PE & SP mains replaced along with CI and UPS mains;
3. Planned replacement of 441 km is completed over FY 14/15 and FY 15/16; and
4. Completing replacement of all CI and by the end 2020/21.

The following table summarises the forecast replacement schedule.

CI & UPS REPLACEMENT FORECAST – km									
	FY 13/14	FY 14/15	FY 15/16	FY 16/17	FY 17/18	FY 18/19	FY 19/20	FY 20/21	Total
Actual CI & UPS Inventory (GIS 30/6/14)	938								
Total LP HDPE and SP	485								
LP HDPE to Remain	120								
LP HDPE and SP to be replaced	365								
Total Replacement	1303								
% LP HDPE & SP of Total Replacement	28%								
Planned Overall Replacement Program		221	220	175	172	172	172	171	1303
Estimated Residual CI & UPS		779	621	495	371	247	123	0	
Estimated Residual LP HDPE		423	361	312	264	216	168	120	
Total Outstanding Replacement	1303	1082	862	687	515	343	171	0	

Table 10 – CI & UPS Replacement Forecast

5.2.2 CI and UPS Block Replacement

The CI and UPS block replacement program has been derived from the planned overall replacement program lengths detailed in Table 10, from which the Adelaide CBD replacement and abandonment (refer to Section 5.2.3) and MP Trunk main replacement and abandonment (refer to Section 5.2.4) has been subtracted.

A forecast block replacement average unit rate has been derived based on:

1. Contractor average unit rates (as per proposed contract award recommendation) for the FY 16/17 replacement program (mains and services, excluding materials). The FY 16/17 replacement areas being typical of remaining replacement areas;

2. Average material unit rates of over the 3 years of the current regulatory period ending 2014/15; and

The following table summarises the forecast CI and UPS block replacement schedule.

	FY 16/17	FY 17/18	FY 18/19	FY 19/20	FY 20/21	Total
CI and UPS Block Replacement - km	145	148	149.5	151	159	752
Block Replacement Unit Rate - $/m	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Direct Cost - $'M (Real 2014/15)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 11 – CI & UPS Block Replacement Schedule

5.2.3 Adelaide CBD CI and UPS Replacement

The replacement of CI mains within the CBD was originally (as per the 2010 MRP) planned to be completed within the current regulatory period. However the development of a strategic plan and subsequent tendering of work has taken longer than expected due to the complexities involved.

Replacement has commenced in the southern section of the CBD with an estimated 49 km to be replaced, upgraded or abandoned over the next regulatory period.

The actual replacement, upgrade and abandon lengths are pending a final detailed design for the network north of Franklin and Flinders streets (design for the area south of this has been completed). Based on an initial concept design for this area it is expected that:

1. 5 km of the existing steel trunk mains may be upgraded, rather than replaced;

2. 2 km of main with no services could be abandoned; and

3. 4 km of inserted DN160 trunk main will be required.

These volumes are subjected to change (potentially higher if the existing steel trunk mains cannot be upgraded) pending completion of detailed design.

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

The higher block unit rates FY 16/17 is related to replacement in the congested areas north of Franklin and Flinders streets requiring increased traffic management, night works, and a relatively high number of meter sets inside buildings to be relocated.

5.2.4 MP CI and UPS Trunk Mains

As discussed in Section 4.3.6 a number of MP CI and UPS trunk mains will be either fully replaced, partially replaced or abandoned. Of the existing 64 km, it is forecast that 22 km will be abandoned and 42 km replaced. The timing of these works is, to a great extent, dependent on completion of the CI and UPS block replacement program, and finalising detailed designs which will be completed over the next 18 months.

The unit rate for trunk main replacement and abandonment has been based on:

- A 3 year (FY 2011/12 to March 2015) weighted average of actual trunk main costs [redacted]
- Excavating and sealing pipe ends every 50 metres (to prevent road subsidence) when the trunk main is abandoned.

The following table sets out the forecast replacement schedule and cost (real $2014/15).

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 13 – Forecast MP CI & UPS Trunk Main Replacement Schedule

5.2.5 *CI and UPS Piecemeal Replacement*

An average of 3.9 km of piecemeal replacement has been completed during the first three years of the current regulatory period ending 30 June 2014 with 3km budgeted for FY 2015/16.

As the remaining CI and UPS mains are progressively replaced, through the block replacement program, the need for piecemeal replacement will diminish. A notional 1 km per year reduction has been planned for from FY 2015/16.

The following table sets out the forecast replacement schedule and cost (real $2014/15). Costs are based on actual direct cost for FY 2013/14.

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 14 – CI & UPS Piecemeal Replacement Schedule

5.2.6 CI and UPS Inlet Service Renewal

Inlet Services – Single Supply Point

There are cases where inlet services need to be renewed on a stand-alone basis (unrelated to mains renewal works). The need for such inlet service renewals arise when leaks or damages occur on the inlet service and inspection reveals that the service is heavily corroded or in such poor condition that repairs are not viable.

A nominal 100 service replacements have been budgeted for in FY 2015/16. As the CI and UPS mains replacement program progresses, the number of stand-alone service replacements will diminish. A nominal reduction of 20 service replacements per year from the 2015/16 budget has been assumed.

The following table summarises the forecast replacement schedule (real $2014/15. Unit costs are based on a 3 year weighted average of actual service replacement costs.

	FY 16/17	FY 17/18	FY 18/19	FY 19/20	FY 20/21	Total
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 15 – Forecast Single Supply Point Inlet Service Replacement Schedule

Inlet Services – Multi User Sites

As discussed in Section 4.3.5, a number of CI and UPS inlet services at existing multi user sites (unit developments) remain to be replaced.

It is planned to replace all outstanding multi-user site inlets over a five year period in order to achieve the most efficient use of resources.

The following table summarises the planned volumes and costs (real $2014/15) of replacement.

	FY 16/17	FY 17/18	FY 18/19	FY 19/20	FY 20/21	Total
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 16 – Multi User Inlet Service Replacement Schedule

Volumes and costs rates were derived based on:

1. An average of 1.9 multi user services per kilometre of mains replacement. This is the weighted average of actual volumes included in the scope of work for the FY 2012/13/15/16 block replacement tenders as detailed in the table below. Volumes from the FY 13/14 tender were excluded as they were considered to be an outlier.

	FY 12/13	FY 13/14	FY 14/15	FY 15/16
Mains Replacement –km	201	204	201	213
Multi User Service Sites	386	955	382	427
Weighted Average (sites/km)	2.6			

Weighted Average (excluding FY13/14)	1.9			

Table 17 – Multi User Service Site Density

2. The total number of multiuser sites based on 1.9 sites per kilometre of mains replacement (refer to point 1 above) and mains replacement volumes prior to 2012 as detailed in the table below. Since FY 11/12 multi-user inlet replacements has been included in the scope of work for mains replacement and have been excluded from the number of legacy sites.

	FY 04/05	FY 05/06	FY 06/07	FY 07/08	FY 08/09	FY 09/10	FY 10/11	FY 11/12	Total
Replacement – Km	56.5	63.1	71.5	96.8	57.1	86.3	104.2	147.9	683.4
Multi User Sites - No	110	123	139	188	111	168	203	287	1328

Table 18 –Numbers of Multi User Sites

3. Weighted average unit rate based on FY 15/16 contractor tendered volumes and rates, and material estimates as summarised in the following table.

	Multi-User Site Unit Costs			
	Units (2-4)	Units (5-10)	Units (11-20)	Units (20+)
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]			

Table 19 – Multi User Sites Average Unit Cost

5.3 HDPE Mains Replacement

5.3.1 Class 250 MP HDPE

As discussed in Section 4.5 Class 250 HDPE mains are approaching the end their useful life.

The majority of LP Class 250 HDPE will be replaced as part of the CI and UPS mains replacement program. The risk associated with any residual LP HDPE will be assessed post completion of the CI and UPS program. The risk associated with this material is considered lower at the low operating pressure compared with HDPE operating at higher pressure.

There is 312 km of MP Class 250 HDPE material that is planned for replacement. This is facilitated by the tapering off of the CI and UPS mains replacement program over the coming years, which will see an increasing pool of resources available.

Replacement of the 312 km of MP Class 250 HDPE will be spread out evenly over the next 6 years, starting in FY 15/16.

The following table summarises the planned volumes and costs (real $2014/15) of replacement.

	FY 15/16	FY 16/17	FY 17/18	FY 18/19	FY 19/20	FY 20/21	Total AA
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 20 – Forecast MP Class 250 Mains Replacement Schedule

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

5.3.2 *Class 575 HDPE*

The following table summarises the planned block replacement of Class 575 HDPE. [redacted] Replacement of these mains is planned to commence in FY15/16.

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

[redacted]

As discussed in Section 4 of Appendix A, a project (SA 52 – HDPE Camera Investigation and Repair) is planned for [redacted] where HDPE brittle crack failures may occur. These defects can then be excavated and reinforced with stainless steel clips (which are clamped around the pipe) [redacted] This program covers about 1300 km of HDPE that will not be part of the planned replacement program.

It is expected in some instances, because of the frequency and location of defects found by internal inspection, that piecemeal replacement will be more cost effective than excavating and repairing. [redacted]

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

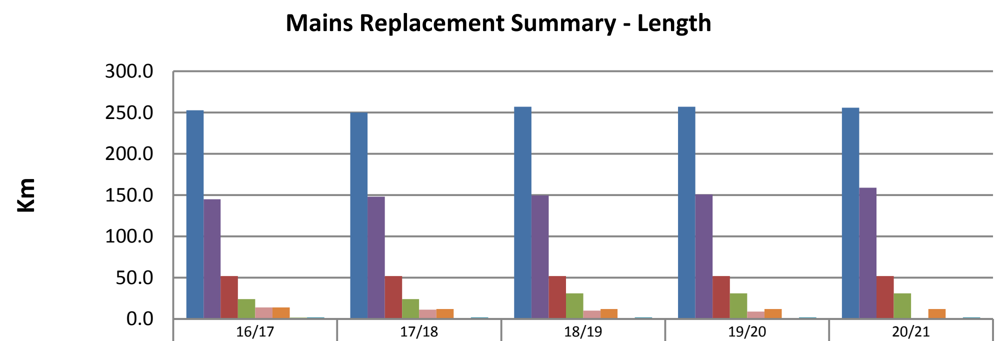
Table 22 – Class 575 HDPE Piecemeal Replacement Schedule

5.4 Next Regulatory Period Replacement Program Summary

The following table and graphs summarise proposed mains and services replacement volumes and expenditures for the next regulatory period.

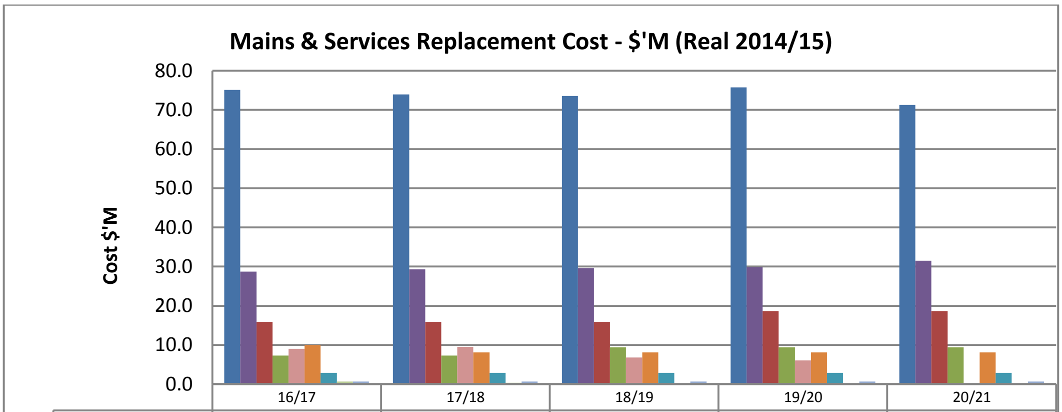
Mains & Services Replacement Schedule								
Asset Class	Category	Item	FY 16/17	FY 17/18	FY 18/19	FY 19/20	FY 20/21	Total
CI & UPS	Block - General	Mains - km	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		Total Cost - $'M	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Piecemeal	Mains - km	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		Total Cost - $'M	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	CBD - Block & Trunk	Mains - km	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		Total Cost - $'M	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	MP Trunk	Mains - km	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		Total Cost - $'M	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Multi User - Inlet Services	Sites	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		Total Cost - $'M	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
HDPE	MP Class 250 Mains	Mains - km	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		Total Cost - $'M	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	HP Class 575 Mains	Mains - km	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		Total Cost - $'M	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	HDPE Piecemeal	Mains - km	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		Total Cost - $'M	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Summary		**Total Mains - km**	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		Total Mains Cost - $'M	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		Total Services - No	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		Total Services Cost - $'M	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		Grand Total Replacement - $'M	**75.1**	**74.0**	**73.6**	**75.8**	**71.3**	**369.7**

Table 23 Next Regulatory Period Mains & Services Replacement Schedule



	16/17	17/18	18/19	19/20	20/21
Total	252.9	249.9	257.0	257.0	256.0
CI & UPS - Block	145	148	149.5	151	159
Class 250	52	52	52	52	52
Class 575	23.9	23.9	31.0	31.0	31.0
CI & UPS - CBD	14.0	11.0	10.0	9.0	0.0
CI & UPS MP Trunk	14.0	12.0	12.0	12.0	12.0
CI & UPS Piecemeal	2	1	0.5	0	0
HDPE Piecemeal	2	2	2	2	2

Graph 10 – Mains Replacement Summary - Length



	16/17	17/18	18/19	19/20	20/21
Total	75.1	74.0	73.6	75.8	71.3
CI & UPS - Block	28.7	29.3	29.6	29.9	31.5
Class 250	15.9	15.9	15.9	18.7	18.7
Class 575	7.3	7.3	9.5	9.5	9.5
CI & UPS - CBD	9.0	9.5	6.8	6.1	0.0
CI & UPS MP Trunk	10.0	8.1	8.1	8.1	8.1
Multi - User Services	2.9	2.9	2.9	2.9	2.9
CI & UPS Piecemeal	0.7	0.3	0.2	0.0	0.0
HDPE Piecemeal	0.7	0.7	0.7	0.7	0.7

Graph 11 – Mains Replacement Summary – Cost

The following comments and assumptions apply to the planned replacement program for the next regulatory period:

1. A total of 1,273 km of mains replacement (including abandonment and upgrade) is planned which is about 9 % higher than the replacement forecast for the current regulatory period.
2. The CI and UPS replacement forecast is based on completing 441 km over FY 14/15 and 15/16 as detailed in Section 5.2.1;
3. The CI and UPS replacement program includes approximately 240 km of LP HDPE; and
4. HDPE replacement volumes are based on completing the 26km planned replacement of HDPE in FY14/15 and 69 km during FY15/16 as detailed in Section 5.1.

The delivery of the program is considered achievable given the demonstrated existing replacement contractor pool capacity of 255 km per year (actual average FY 2012/13 and 2014/14) with planned increase in capacity to 289 km per year for the planned FY 2015/16 program of work.

6 UAFG FORECAST

6.1 UAFG Analysis

AGN engaged Asset Integrity Australasia Pty Ltd (AIA) to undertake an independent analysis of the Network's UAFG at a point in time (30 June 2014) and to prepare a UAFG forecast for the next regulatory period.

AIA analysis uses a bottom-up approach, whereby elements of a distribution network are allocated emissions factors and factors of uncertainty, which is then combined with a top-down approach to enable an estimate of the contribution to UAFG of all of the contributing elements.

AIA quantified the following elements of UAFG, which are described below:

1. Timing 'mismatch' – if data inputs do not relate to the same periods, network injections and deliveries will be miss matched, resulting in either a positive or negative contribution to UAFG. The impact of this component is minimised by using longer (annual) periods and ensuring appropriate data is used.

2. Tolerance on gate station meters (injection meters) – all meters, including those at gate stations, have inherent margins of accuracy.

3. Pressure compensation – the pressure of gas at most delivery points is not measured but regulated by a device at the meter, to be within certain limits. The difference between actual pressure and billing pressure results in a positive contribution to UAFG, as billing factors are designed to ensure that consumers are not disadvantaged.

4. Temperature compensation – the temperature of gas at most delivery points is not measured but assumed to be at a certain temperature. The difference between actual and assumed temperature results in a positive contribution to UAFG, as billing factors are designed to ensure that consumers are not disadvantaged.

5. Heating value differences – the heating value of gas consumed is not measured, with an average figure used in accordance with established methodologies. This leads to a difference between actual energy consumed and that billed to the customer.

6. Metering accuracy at delivery points – all meters have an inherent tolerance, and can measure slightly above or below the actual volume of gas delivered. The tolerance on meters generally favours the consumer.

7. Change in line pack – as networks grow, gas is required to fill the new pipes, giving rise to relatively small increases in UAFG over time.

8. Company own use – gas can be used to purge new mains and services, and to drive compressors, water bath heaters or other equipment. Such gas is not measured, for practical reasons.

9. Theft

10. Line losses/leakage (mains, services, meters, regulators) – leakage from pipe joints and fittings represents a material amount of loss in all distribution networks, due to the technical

practicalities associated with materials and construction.

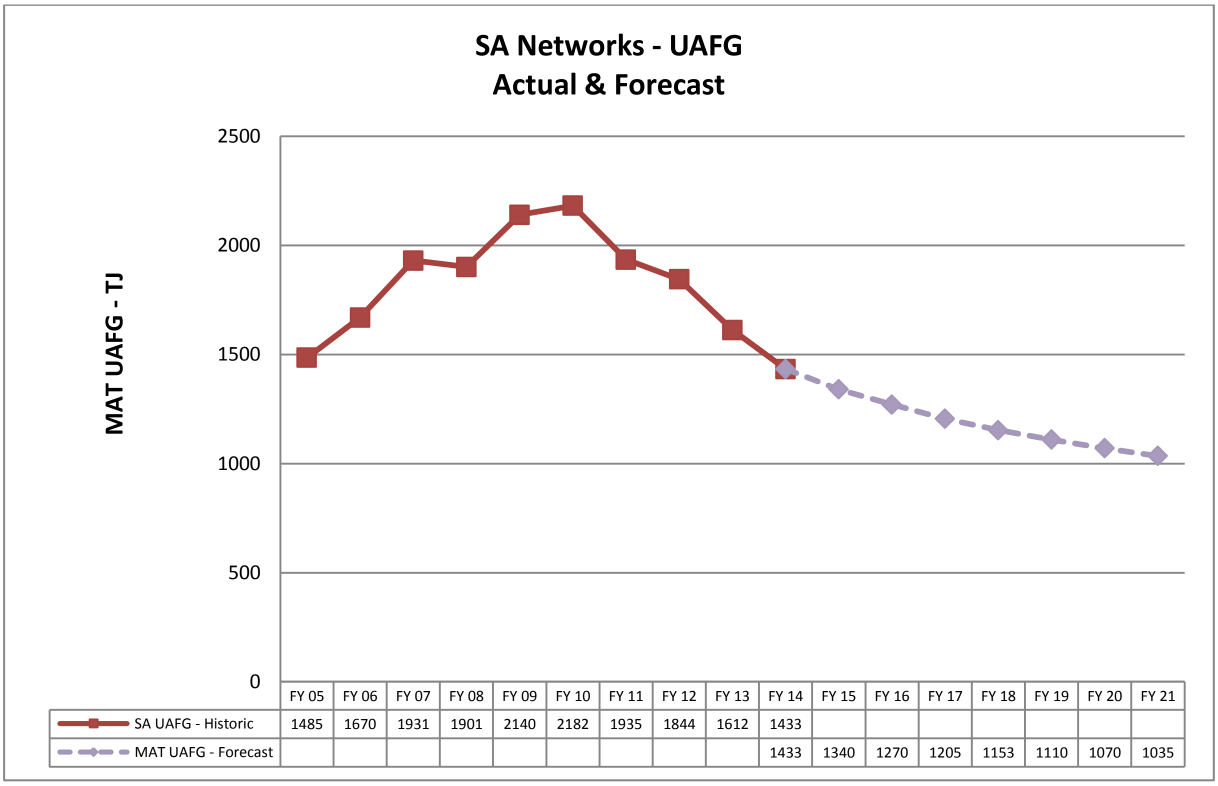
11. Third party damage – gas pipes are often damaged by other parties, resulting in gas lost to atmosphere.

AIA analysed each of the above components in order to estimate their quantitative contribution to UAFG in the Network. The AIA report is incorporated into AGN's UAFG forecast document[2].

6.2 UAFG Forecast

AIA used AGN's planned annual replacement to estimate the annual level of UAFG. This was done by leaving all other UAFG factors constant, and replacing the length of low pressure main in the model with an equivalent length of high pressure mains, in accordance with the mains replacement program. The resultant forecast UAFG is shown below. Consequently it is expected that UAFG will reduce to around 1035 TJ by the end of FY 20/21 if the program of replacement detailed in the preceding section is carried out.

While the forecast end point (1035 TJ or about 3%) is consistent with a network in good condition, the actual year on year reduction will vary as not all mains leak at the same rate.



Graph 12 – UAFG Forecast

[2] SA UAFG Forecast 2016-21 080115.docx

7 REGULATORY BENCHMARK

7.1 *Mains Replacement Benchmark*

Based on year end FY 13/14 the replacement program is forecasted to exceed the regulatory benchmark of 606 km for the first 3 years of the current regulatory period by about 30 km (includes 5km of HDPE replacement in 2012/13).

Based on planned replacement in FY 14/15 and FY 15/16 it is forecasted that total replacement will exceed the regulatory benchmark of 1,072 by 100 km (9%).

The following table summarises benchmark replacement volumes and forecast completion over the current regulatory period. The forecast higher level of replacement reflects a need to commence replacement of vintage PE that was not anticipated at the time the last Access Arrangement was prepared.

	FY 11/12	FY 12/13	FY 13/14	FY 14/15	FY 15/16	Total
AA Benchmark - km	140	233	233	233	233	1072
Actual/Forecast - CI & UPS	166	201	264	221	220	1072
Actual/Forecast - HDPE	0	5	0	26	69	100
Total Actual/Forecast	166	206	264	247	289	1172
Annual Variance	26	-27	31	14	56	100

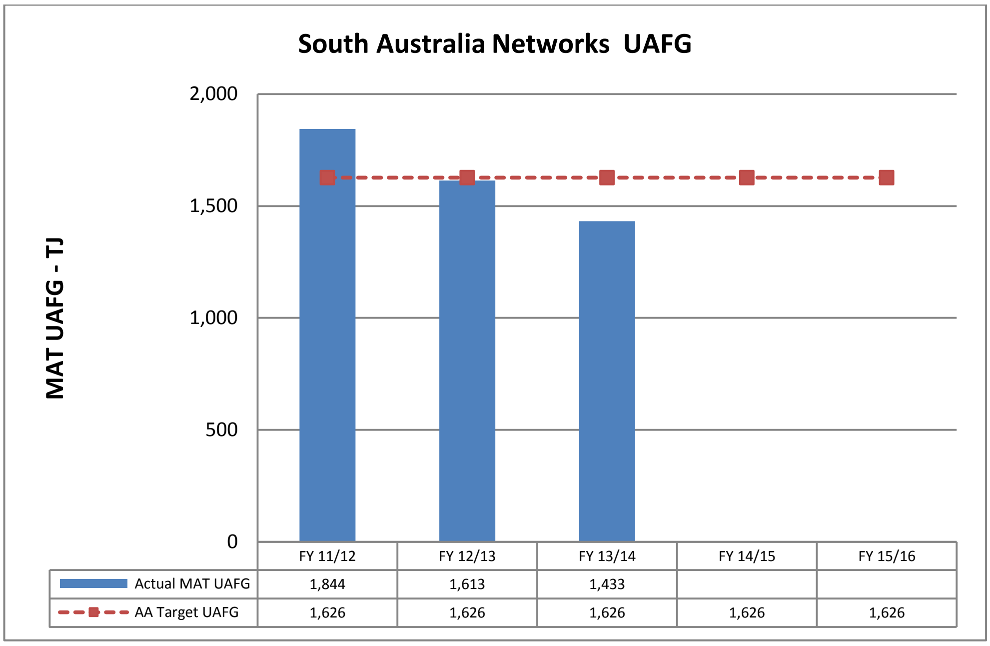
Table 24 – Mains Replacement Regulatory Benchmark Performance

7.2 *UAFG Benchmark*

Since 1 July 2011, the Gas Distribution Code has required AGN to use its best endeavours to achieve:

- A level of UAFG for its distribution system of less than 1,626 TJ by the end of 2016;and
- Annual reductions in each year up to and including 2016

There has been a sustained reduction in UAFG over the last 3 years as detailed in the following graph. The current level is below the regulatory target and based on current trends, is expected to stay below the regulatory target by the end of the current regulatory period. UAFG is expected to reduce to about 1270 TJ (about 350 TJ less than the regulatory target) by the end of this regulatory period.



Graph 13 – UAFG Regulatory Benchmark Performance

[redacted]

[redacted]

[redacted]

[redacted]

[redacted] the USA National Transportation Safety Board (NTSB) concluded that much of the PE pipe produced for gas service from the 1960s through the early 1980s may be susceptible to brittle cracking and premature failure. It further noted that vulnerability of this material to premature failure could represent a serious potential hazard to public safety.

The NTSB reported that early PE piping was susceptible to premature brittle-like cracking under conditions of stress intensification. The phenomenon of brittle-like cracking was characterised by the initiation of cracks on the inner wall of the pipe typically at a stress point, followed by slow crack growth (SCG) that progressed under normal pipeline operating pressures (much lower than the pressure required to rupture the pipe). The process culminated with the crack reaching the outside wall of the pipe, showing up as slit-like opening on the surface resulting in a sudden release of gas.

Stress intensification on PE pipe systems can be caused by:

1. Squeeze-off procedures;
2. Rock impingement;
3. Improperly installed fittings;
4. Dents or gouges to the pipe surface; and
5. Poor jointing procedures.

[redacted]

[redacted]

[redacted] a HDPE behaviour model was developed using material testing and information gained from scientific research papers. This model examined the expected life of HDPE and the impact of “squeezing-off”.

A series of tests were conducted by an external test laboratory using:

1. HDPE pipes with no squeeze-offs;
2. HDPE pipes freshly squeezed-off in the laboratory under differing conditions; and
3. HDPE pipes with historical squeeze-offs exhumed from the network.

The results from these tests correlated reasonably well with the field failure data.

The following diagrams summarise the expected behaviour over time of HDPE pipe.

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

The behaviour model highlights that:

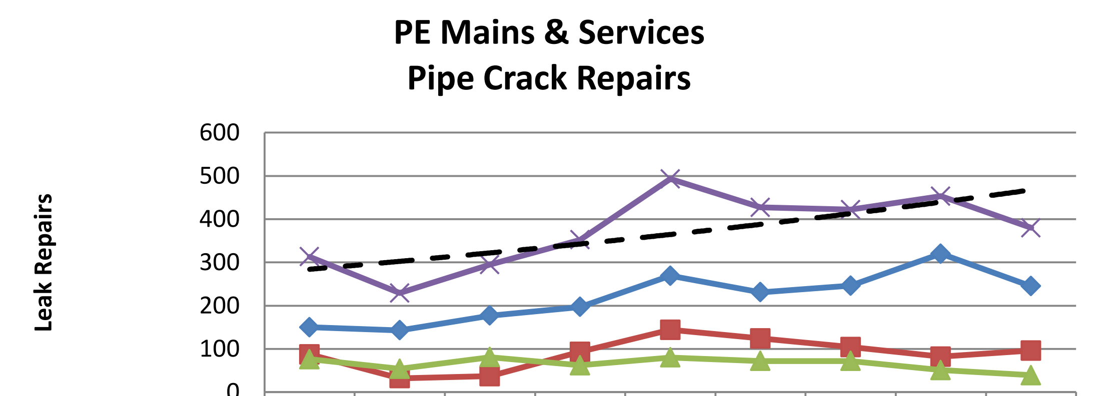
1. The process of squeezing-off HDPE for construction and maintenance purposes can significantly reduce the material's life expectancy. This is supported by crack related failures recorded on Class 575 HDPE mains that are less than 30 years old.

2. When Class 250 mains approach 40 years of service there is a high risk of causing squeeze-off damage when effecting repairs. Ignoring any reduction in asset life from previous squeeze-off damage, this material is of an age (37-41 years) where brittle failures are likely to become increasingly prevalent over the next 5-10 years, making it difficult to maintain and posing a safety risk to operating personnel and the public.

3. When Class 575 HDPE mains approach 50 years of age there is a high risk of causing squeeze-off damage when effecting repairs. Ignoring any reduction in asset life from previous squeeze off damage, this material is of an age (20-34 years) where brittle failures are likely to become increasingly prevalent in about 15 years making it difficult to maintain and posing a safety risk to the public.

1. HDPE Failure History

The following graph summarises the historic trends associated with brittle failures of PE (HDPE and MDPE) mains.



	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11	FY 12	FY 13	FY 14
Broken Pipe - Cracked	150	143	177	197	269	231	246	320	245
Broken Pipe - Full Break	87	32	37	93	144	124	104	82	96
Squeeze Off Damage	76	54	81	62	80	72	72	51	39
Total	313	229	295	352	493	427	422	453	380

Graph 14 – PE Mains & Services Pipe Crack Repairs

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted] suburbs with a history of squeeze-off failures (130 suburbs) were risk ranked based on the following factors.

1. Numbers of squeeze off leaks (likelihood) – Suburbs with a high history of squeeze off failures are considered more susceptible to future failure.
2. Pressure factor (consequence) – Higher pressure generates higher volume gas escapes that can travel further underground.
3. Soil type (consequence) – Clay soils were determined as having the highest factor due to odorant stripping characteristics and sandy soils the lowest.
4. Housing construction (consequence) – Suburbs with cottages close to the front property boundary were assessed as having the highest factor and properties with predominately slab construction buildings, more distant from the front boundary, the lowest factor.

[redacted]

[redacted]

[redacted]		[redacted]		[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

[redacted]

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

To address the ongoing risks associated with HDPE the following strategies/actions are being undertaken:

1. Priority replacement of all MP Class 250 kPa HDPE mains – Based on the age of these asset brittle failures are expected to become a significant issue over the next 5-10 years. These mains have been prioritised on the basis that they have a higher susceptibility to brittle failure than Class 575 HDPE and as such pose a high risk of "random" sudden release of significant volumes of gas, either in service or when repairs are being affected. A replacement program has been detailed in Section 5.3.1.

   Replacement of the majority of LP Class 250 HDPE will coincide with the CI and UPS mains replacement program.

2. Replacement of Class 575 HDPE – The focus of replacement is 158 km of HP Class 575 mains within the top 50 risk ranked suburbs addressing 87 % of the risk. Consideration was given to extending this to the top 75 suburbs covering 96% of the risk however the marginal (9%) increase in risk reduction would require a further 161 km of replacement. The significant additional cost for marginal reduction in risk was not considered cost effective.

3. Use of internal camera technology to identify squeeze-off locations within HDPE mains and then repair or piecemeal replacement of identified sites. [redacted] Tests have shown the application of stainless steel clips over previous squeeze-off locations not only delays the occurrence of a failure of the pipe, but in the event that a failure does occur, it restricts the amount of gas released allowing more time for the leak to be detected before there is sufficient build up to cause an explosion. A business case (SA 52 – HDPE Camera Investigation and Repair) has been prepared for additional expenditure to identify and repair previous squeeze-off locations. This

initiative is aimed at reducing long term risk issues with cracking pipe and extending the life of the remaining 1300 km of Class 575 HDPE mains.

4. Installation of ground vents over HDPE mains in locations where soil and surface conditions can "seal" in the gas. This measure is aimed at providing a more direct vent to atmosphere where it is more likely to be detected (by the public or regular leak survey) reducing the risk of gas leaks travelling horizontally to an adjacent building. For details refer to business case "SA 56 Gas Vents for HDPE mains". About 8,000 vents are to be installed in high risk locations.

5. Development of a reliability forecast model (integrating pipe age, repair data, material test analysis and statistical modelling) to assist in predicting the remaining life of Class 575 HDPE pipe. The output of this model will form a key input into the integrity management of the residual 1300 km of HP Class 575 mains. A business case (SA 54 Risk Management of HDPE) has been prepared for additional resources to analyse PE failures, undertake material testing and develop the forecast model.

2. GTI Audit

The Gas Technology Institute (GTI), a leading North American gas research, development and training organisation was engaged (January 2015) to review APA Group's technical and operational risk reduction strategies.

GTI has a long history in assisting the gas operators in North America and in other parts of the world to identify and address issues related to aging polyethylene (PE) pipelines.

APA requested GTI review their HDPE pipeline risk mitigation strategies specifically addressing the following questions:

- Are procedures implemented to mitigate squeeze-off failures appropriate?
- Are replacement efforts, procedures, leak survey, etc. implemented for vintage HDPE pipe appropriate?
- What are the best practices of others?

GTI conducted a review of APA's work instructions, practices, procedures, and risk mitigation strategies in the South Australian network through; review of various APA documents; onsite operational personnel interviews and main replacement construction site observations.

In general, GTI concluded that the risk mitigation measures initiated by APA were sound and fall in line with other natural gas operators that are also dealing with aging natural gas PE infrastructure. They further commented that APA is being prudent by identifying and acknowledging the HDPE system and squeeze-off points as risks that are compromising the integrity of the SA network.

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

3. Future HDPE Replacement

Replacement of the remaining 1309 km MP and HP Class 575 HDPE post the next regulatory period will be determined by outcomes of the various strategies/actions detailed above. In particular the development of reliability forecast model.

[redacted]

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]