AUTOMATED WASTE SYSTEM FOR KINGSFORD AND KENSINGTON

Prepared for:

Randwick City Council
30 Frances St
Randwick NSW 2031

SLR

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PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Tenancy 202 Submarine School, Sub Base Platypus, 120 High Street
North Sydney NSW 2060 Australia

T: +61 2 9427 8100
E: sydney@slrconsulting.com www.slrconsulting.com

BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Randwick City Council (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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DOCUMENT CONTROL

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610.18852-R01-v4.0	21 April 2020	Tim Good, Tony Yates, Dan Thompson, Andrew Quinn, Taylor Parsons	Andrew Quinn	Andrew Quinn
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EXECUTIVE SUMMARY

Introduction

Randwick City Council is investigating the feasibility of an automated underground waste collection system (AWCS) in Kensington and Kingsford to reduce the number of garbage bins on the streets and the number of collection vehicles as well as increasing recycling and reducing litter in the town centres. Council appointed SLR to undertake a scoping and feasibility analysis for an underground AWCS.

Automated Waste Collection Systems

AWCS collect waste and transports it at high speeds through underground pneumatic pipes or tubes to a collection station where it is compacted into bulk containers. The bulk containers are then collected from the collection station and transported to downstream waste management treatment or disposal systems. Mobile vacuum vehicles can also be used. These collect from purpose-built outlets, compact waste and transport it to facilities for treatment or disposal.

Their benefits include:

- Removing the need for waste storage areas
- Removing the need for users to remember to put bins out on specific days
- Supporting higher density developments
- Reducing or eliminating odours and risk of vermin
- Removing, or significantly reducing waste collection vehicle movements
- Reducing noise, vehicle emissions, carbon emissions, improving safety and reducing road congestion
- Reducing operational costs associated with bins and collection vehicles
- Reducing health and safety risks for residents, staff and waste operators.

AWCS Concepts

There are two basic AWCS designs, an area-wide system or a local system. **Area-wide collection systems** involves taking waste from connected buildings to a fixed remote collection point. **Local collection systems involve waste being held** in underground tanks while awaiting collection by vehicles fitted with automatic suction equipment.

Costs

The table below show the cumulative costs of each option and their potential viability.

Option	Total Cumulative Cost	Commentary on Option Viability
Option 1a	A$50,548,087	Two collection stations to future-proof the AWCS scheme for new developments. Collection stations are stand alone and therefore potentially limited opportunities for operational cost efficiencies. Both collection stations would require construction in Year 0 as pipework is unconnected between Kensington and Kingsford.

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Option	Total Cumulative Cost	Commentary on Option Viability
Option 1b	A$49,277,398	Two collection stations to future-proof for new developments. Installation of Kingsford AWCS in the back streets results in a lower capital cost (125 metres less pipework and 6 less inlets based on outline design), however there are some properties which will not be as well serviced in terms of walking distances, and there may be a perception that the scheme is not as easy to use as a scheme where the inlets are located on Anzac Parade for use as people exit their apartment buildings to access shops, businesses, transport options.
Option 1c	A$39,904,899	The hybrid option delivers an area-wide AWCS for Kingsford. The area-wide scheme ensures the removal of the greatest number of vehicle movements from the study area. There are a large number of pipe turns in Option 1c, from the western pipe run due to the avoidance of crossing the light rail system. If this option is to be considered further SLR recommends that AWCS suppliers are consulted to ensure the scheme would be viable and obtain advice on any increases in equipment specification or power consumption which may arise from the required pipe route south to Sturt Street for crossing Anzac Parade. In Kensington, a local AWCS is implemented and it is assumed that one collection vehicle would be sufficient to service the requirements of the potential number of apartments.
Option 2	A$41,799,468	Single collection station which may require night time operations and potentially limits AWCS resilience to any maintenance requirements or temporary shut downs.
Option 3	A$41,438,745	Single collection station which may require night time operations and potentially limits AWCS resilience to any maintenance requirements or temporary shut downs.
Option 4	A$33,621,682	Increased inlet spacing to 50 metres results in reduced scheme costs but introduces a risk of reduced ease of use and reduced user satisfaction and therefore increased risk of accidental or deliberate misuse and dumping of waste. This option also has a single collection station which may require night time operations and potentially limits AWCS resilience to any maintenance requirements or temporary shut downs.
Option 5	A$45,501,926	The addition of a third waste stream (food waste) to the AWCS results in about A$2 million increase in costs associated with additional inlets and collection station equipment. This option also has a single collection station which may require night time operations and potentially limits AWCS resilience to any maintenance requirements or temporary shut downs.
Option 6	A$49,730,188	Two collection stations to future-proof for new developments. Although co-location of two collection stations at the Racecourse site results in the requirement for connecting pipework between Kingsford and Kensington (not required in Option 1a), it does offer the potential for operational savings which offset the additional capital expenditure. Traffic movements related to waste vehicles are also restricted to one location in the study area. Potential for one collection station to be constructed in Year 0 to service existing tonnages, with second collection station to be constructed later when waste quantities grow from new developments.
Option 7	A$32,057,698	The local AWCS is installed for both Kensington and Kingsford and two vacuum collection vehicles will be required to service the requirements of the potential number of apartments. As mentioned previously, the local AWCS scheme could operate block-by-block or could cross blocks in order to minimise the number of docking points, and therefore vehicle stopping points. The latter would result in additional pipe network costs and construction disruption to traffic during construction.

Conclusions

The key conclusions from this feasibility assessment are summarised below:

- A single integrated AWCS scheme could be delivered, or two separate AWCS schemes
- Two sites identified by Council in Rainbow Street and at Randwick Racecourse, appear to be of sufficient size to accommodate a collection station

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- At the maximum quantities estimated two collection stations would be required and would ensure best practice and system resilience. A single collection station could be used in an integrated scheme, however, the viability of this would need to be tested further
- The light rail system has presented engineering challenges for the installation of a pipe from west to east under Anzac Parade. Tunnelling may be possible, however, installation methods and costs would need to be understood from suppliers
- Construction and installation of an AWCS along Anzac Parade is not viable. As a result, a system would need to be installed in the rear shared laneways. Proposed rear shared laneways in Kensington would assist with implementation of a local AWCS, however, an area-wide AWCS for Kensington is unviable. An area-wide AWCS is a viable option for Kingsford subject to certain assumptions.
- Certain waste streams, such as bulky waste, cannot be managed using AWCS. Alternative systems will need to be made for these waste streams.

Next Steps

SLR recommends the following next steps:

- Develop and refine the waste generation estimates (residential and commercial) to confirm the quantity of waste generated in the proposed areas
- Develop and refine the potential residential unit estimates to confirm the number of apartments which may join an AWCS scheme
- Develop an understanding of the types of commercial waste being generated and its appropriateness for an AWCS
- Consider whether the scheme would be operated for residential waste only or residential and commercial waste
- Develop a time line for future development of apartments and commercial space to understand timing for additional users and quantities to access the AWCS
- Consult with various parties including suppliers, NSW EPA, resident groups and others
- Confirm the viability of the Rainbow Street site as a collection station location
- Review the services installed in the rear shared laneways, pavements and roads to determine whether and where an underground pneumatic pipe network could be best installed
- Review the location and size of service conduits constructed in the light rail scheme to confirm whether crossing under Anzac Parade and the light rail system is viable without requiring the use of boring or directional drilling
- Collate current waste management costs of servicing the study area (residential and commercial) to support development of a business case.

DOCUMENT REFERENCES

TABLES

FIGURES

APPENDICES

1 Introduction

Randwick City Council (Council) local government area covers 36 km^2 and is located about 6 km southeast of the Sydney CBD. The town centres of Kensington and Kingsford are located in the northwest of the Council area and are undergoing a period of significant transition driven in large part by the development of the Sydney CBD to South East Light Rail network which runs along Anzac Parade, the main transport corridor through the two town centres.

Council's strategic planning documents guide the future of Anzac Parade in Kensington and Kingsford, and the supporting Urban Design Report, developed following a detailed review of existing planning controls, built form, opportunities and constraints, shows a clear vision for each town centre and guiding principles for the built form strategy. An action in the strategy seeks to investigate the feasibility of implementing an automated underground waste collection system (AWCS) to reduce the visual clutter caused by garbage bins on streets and associated collection vehicles, increase recycling and reduce litter in the town centres.

1.1 Council Brief

Council has appointed SLR to undertake a scoping and feasibility analysis for an underground AWCS incorporating a separate food collection system for the Kingsford and Kensington town centres.

Council requires the scoping and feasibility analysis to allow it to:

- Enable the town centres to be a best practice environmentally sustainable precinct through delivering:
    - Improved aesthetics by removing the need for bins to line streets awaiting collection and a reduction in litter
    - Reduced truck movements, resulting in reduced greenhouse gas emissions and improved air quality and traffic congestion
    - Reduced collection operational costs
    - Better hygiene – no odour and no pests
    - The reduction, re-using, recycling or proper safe disposal of waste and
    - The efficient use of space - no waste storage rooms needed in residential developments.
- Amend the DCP 2013 to require developments in the town centres to be capable of connecting to an automated underground waste collection system.

1.2 Report Structure

This feasibility study summarises the work undertaken by SLR including the modelling and high-level financial analysis. The feasibility study is structured as follows:

- Section 2 – Waste Management in Randwick: providing an overview of the current system
- Section 3 – AWCS: providing an overview of the technology, potential suppliers, design and operation considerations and highlighting the use of AWCS in Australia at present

- Section 4 – Randwick City AWCS: introduces the study area, an estimate of the waste generated in the study area now and in the future, development of outline designs and a high-level financial assessment of capital and operational costs
- Section 5 – Other Considerations: approvals and licencing consideration, amendment to existing council controls, pilot project and potential funding sources
- Section 6 – Innovative Alternatives to AWCS: reviewing alternative innovative methods of managing waste which may address the key Council objectives
- Section 7 – Conclusions and Next Steps.

The feasibility study is supported by a series of outline drawings which are provided as appendices.

2 Waste Management in Randwick City

This section summarises the current waste management methodologies delivered in Randwick City and summarises key waste management data and findings.

2.1 Introduction

Council provides all households with a conventional kerbside service, which includes:

- weekly garbage (red-lid) bin
- fortnightly fully comingled recycling (yellow-lid) bin
- green waste (green-lid) bins and
- four free bulky waste (two scheduled and two on-call) collection services.

Council also provides electronic waste, household chemicals, polystyrene, paper and cardboard, soft plastics and whitegoods drop-off services at the Randwick Recycling Centre located in Matraville (about 5 km by road to the south of the southernmost part of the Kingsford study area).

Council provides regular street cleaning service and a network of 613 public place garbage and recycling bins for residents, visitors and workers. Council provides regular streetscape, town centre and shopping village cleaning services as well as regular cleaning of parks, reserves, sporting fields and beaches. In addition, during summer, Council provides additional staff, bins and increases its service levels to manage the extra demand created by the large influx of visitors.

2.2 Waste Generation and Composition

In 2016-2017, 52,175 tonnes of household waste were collected. As shown in the Randwick City Waste Management Strategy[1] the quantity of household waste has fluctuated over the last seven years but no notable upward or downward trend is apparent.

Since the 2014-2015 financial year, Council started processing incremental amounts of general waste at the EarthPower alternative waste treatment (AWT) facility. EarthPower is a small-scale anaerobic codigestion plant at Camellia in Western Sydney. The facility produces gas which is used to generate electricity and the remaining sludge is dried and pelletised and used as fertiliser in industrial processes.

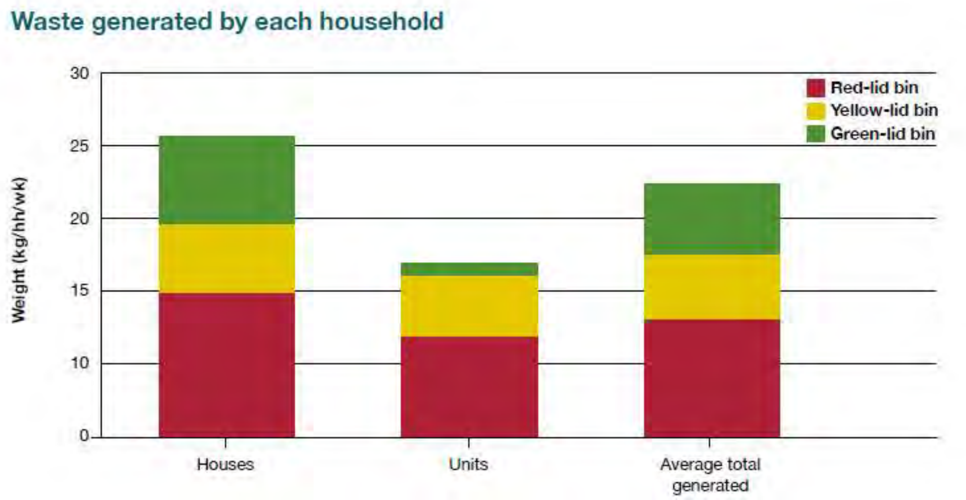
The remaining kerbside garbage is disposed of to landfill. Recyclables and green waste collected are processed at a materials recovery facility and composting facility respectively.

Audits of household garbage, recycling and garden organics bins were conducted in July 2015. The audits provided the following key information:

- average amount of waste generated by each household (Figure 2-1)
- composition of the bins and
- characteristics such as bin capacity, contamination and potential for diversion rate (Figure 2-2).

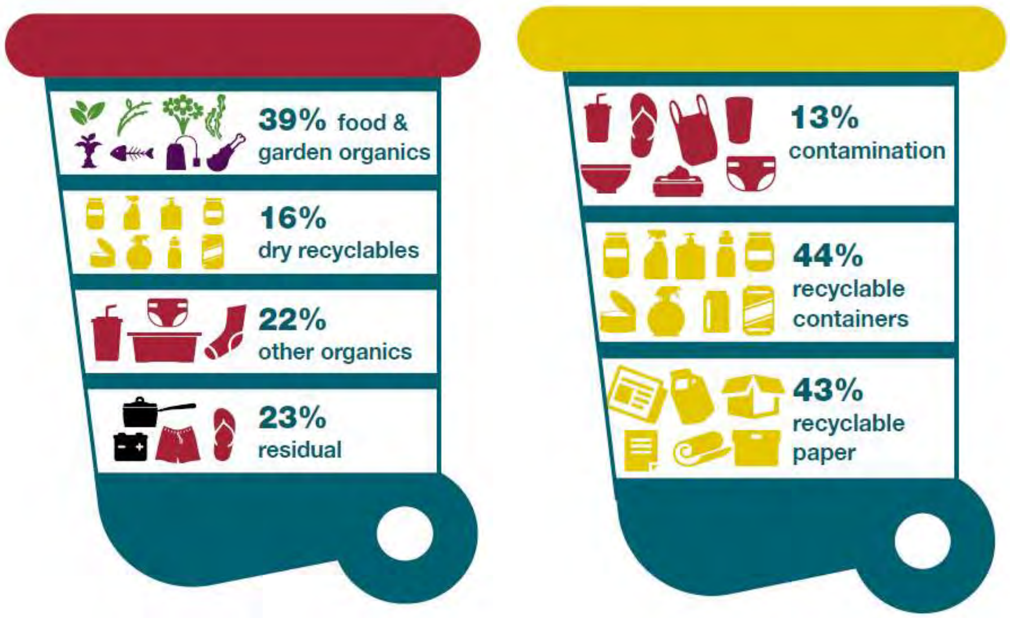
[1] http://www.randwick.nsw.gov.au/__data/assets/pdf_file/0005/223196/Waste-Management-Strategy.pdf

Figure 2-1 - Summary of Waste Generated by Households in Randwick City



Source: Randwick City Council

Figure 2-2 – Simple Compositional Analysis of Garbage Bin (left) and Recycling Bin (right)



Source: Randwick City Council

2.2.1 Food Waste Collection Trial

As shown in Figure 2-2 above, about 40% of the garbage stream is food waste and garden organics. To explore the potential for food waste recovery, in 2013 Council implemented a food waste collection trial in multi-unit dwellings (MUDs).

The trial involved approximately 4,000 selected units as well as some that requested to participate. Residents were given kitchen benchtop bins (caddies) and compostable bin liner bags to put food waste in. When the liner bags were full, residents dropped the bags into Council-provided bins with maroon lids. The collected food waste was sent to the EarthPower Technologies facility, In 2016-2017 the average amount of food waste collected and recycled per month through the trial was approximately five tonnes. Participating householders are supported with ongoing engagement and information.

As part of Council's Waste Management Strategy, Council is prioritising the introduction of an opt-in organics recycling service for all MUDs and freestanding houses in the coming years.

2.3 Commercial Waste

Randwick City Council provides businesses in the area with a commercial waste disposal service on a contract basis including paper and cardboard recycling services.

Where a decision is made to incorporate commercial waste into the AWCS then consideration will need to be given to the extent of the service offered and the means of charging users of the system.

3 Automated Waste Collection Systems

AWCS collects waste and transports it at high speeds through underground pneumatic pipes or tubes to a collection station where it is compacted into bulk containers. The bulk containers are then collected from the collection station and transported to downstream waste management treatment or disposal systems. Mobile vacuum vehicles can also be used. These collect from purpose-built outlets, compact waste and transport it to facilities for treatment or disposal. AWCS are also sometimes referred to as pneumatic waste collection systems (PWCS) or automated vacuum collection systems.

3.1 Overview

The first AWCS were designed and installed in Sweden in the 1960s and since them a large number of systems have been developed across many countries servicing residential, commercial, hospital, airport and leisure complexes. AWCS can be designed to manage a single 'general' waste stream, or multiple waste streams such as garbage, recyclables and food waste. In hospitals, the system can also be used to manage dirty laundry.

Considering the number of schemes implemented and operational and the number of years which some systems have been in place, AWCS is clearly a proven technology. By its very nature, the installation of below ground pipework, installation of multiple inlets, development of a collection station plus equipment, the development of an AWCS is capital cost intensive and therefore systems often require the support and backing of a significant investor or local authority with a long-term interest or view to get projects established. The high initial capital costs are offset over a number of years by savings in operational costs.

There are a number of benefits which the installation of an AWCS can bring to a project or area. A summary is listed below:

- Removes the requirement for in-building or external storage areas for multiple bins resulting in:
  - Freeing up floor space for other uses, commercial area, green spaces, car parking, bike stores
  - Reducing the visual impact of bin stores and overflowing bins
  - Reducing or eliminating odours and risk of vermin in bin stores
- Increased frequency of waste collection resulting in:
  - removing the requirement for users to remember to put out their bins on specific days
  - supporting higher density developments, traditionally the larger the development the more space required to be assigned for a bin storage room
  - reducing or eliminating odours and risk of vermin
- Removal, or significant reduction, in waste collection vehicle movements in the area resulting in:
  - Reduced noise from vehicle movements and emptying of bins
  - Reduced air pollution from vehicle emissions
  - Reduced carbon emissions associated with waste collection
  - Improvement in safety by reducing vehicle – human interfaces

    - Reduced road congestion
- Reduction in operational costs associated with:
    - Bin purchase, maintenance and replacement
    - Collection vehicles, purchase, operations, fuel and staffing and maintenance and repair
- Reduction in health and safety risks for residents, business staff and waste operators, associated with manual handling of waste containers
- Improvement in the amenity value of the area due to all the above factors

AWCS can deliver significant improvements in the day-to-day operations of waste management, however, there are certain waste streams that cannot be managed with AWCS. Consequently, alternative systems or arrangements need to be made for those waste streams. Table 3-1 outlines various building uses and corresponding waste types and identifies their appropriateness for AWCS.

Table 3-1 - Typical AWCS Material Acceptance

	Paper	Cardboard	Cans	Glass	Rigid Plastics	Plastic Film / Polystyrene	Textiles / Linen	Food	Garden	Bulky Items / C&D Waste	Clinical Waste	Hazardous Waste	WEEE	Liquid Waste
Residential	Y	C	Y	C	Y	C	Y	Y	Y	N	N	N	N	N
Offices	Y	C	Y	C	Y	C	Y	Y	N	N	N	N	N	N
Restaurants	Y	C	Y	C	Y	C	N	Y	N	N	N	N	N	C
Catering Facilities	Y	C	Y	C	Y	C	N	Y	N	N	N	N	N	C
Public Realm	Y	N	Y	C	Y	C	Y	Y	Y	N	N	N	N	N
Retail	Y	C	C	C	Y	C	Y	Y	N	N	N	N	N	N
Healthcare / Hospitals	Y	C	Y	C	Y	C	LINEN OK	Y	N	N	C	N	N	N
Airports	Y	C	Y	C	Y	C	N	Y	N	N	N	N	N	N

Key: Y = Yes, N = No, C = Conditional to quantities, system design and processing requirements

Source: Draft PAS 908:2018

As such, even with an AWCS in place, there are likely to be requirements for access to the study area for some waste collection services, although the number and frequency of vehicles will be vastly reduced.
Table 3-2 details the types of waste cannot be collected through an AWCS.

Table 3-2 - AWCS Prohibited Materials

Waste type	Description
Bulky waste	Furniture, refrigerators and others, should be collected separately
Combustible articles likely to cause fire or explosions	Charcoals, burning cigarette butts, oil, such as gasoline, kerosene, cooking oil, portable and disposable spray cans.
Hard materials	Stones, lumps of metal scraps such as scrap iron, large quantities of glass and others
Viscous materials	Binders and adhesives such as paste and rapid binding adhesives.
Spongy materials	Sponges, cushions, and others, which tend to expand and block the chute and/or the transport pipe.
Materials emitting an offensive odour	Animal faeces and urine, bodies of house pets and rats
Dangerous chemicals	Acidic and alkaline solutions among others
Highly moist waste	Food waste from residents can be handled by the system in a separate chute. Large quantities of very liquid food waste will require a separate pipe.
Christmas trees and garden waste	Will become wedged in the pipework

3.2 AWCS Concepts

There are two basic AWCS concept designs, an area-wide system or a local system. A brief description of each is provided below:

- **Area-wide collection systems -** involves conveyance of waste from connected buildings to a remote collection point, a fixed collection station, for bulking into containers prior to collection. Collection stations are positioned at a convenient location which can be above or below ground and can be located up to 2.5 km from the furthest point of the network.
- **Local collection systems -** focussed on one building or a small number of proximate buildings the waste is held in underground tanks below each inlet while awaiting collection. Multiple fractions can be collected, each with its own underground tank, and a separate collection vehicle. Containers are emptied using a waste collection vehicle fitted with automatic suction equipment[2]. The collection docking points are typically located in, or at the edge of, the development at a convenient access point for the vehicles. Each docking point can be connected to a number of tanks. Examples are shown in Figure 3-1 and Figure 3-2 below.

[2] Pricing for a mobile vacuum truck is estimated at a maximum of A$1.25 million.

Figure 3-1 - Schematic of Local Collection System Underground Tanks and Mobile Vacuum Truck

Source: ENVAC

Figure 3-2 - Local Collection System Using a Mobile Vacuum Collection Vehicle and Docking Point

Source: ENVAC

Discrete local AWCS schemes could be installed at certain key locations in the study area if identified by Council. These could include high-rise residential buildings, areas where there are problems with street bins or where vehicles can't stop or park and community spaces where amenity could be improved. Alternatively, multiple local AWCS schemes could be implemented to cover the entire study area.

The cost of installing one local AWCS is likely to be high due to the high purchase or lease costs of one vacuum collection vehicle. This approach may only be commercially viable if there are more than one key location to improve the efficient use of the vacuum vehicle. Typical costs for such a system are:

- Capital Costs: A$1,300–1,850 per unit;
- Operational Costs A$75-95 per unit per year.

It is often possible to integrate a local collection system into an area-wide collection system although equipment redundancy needs to be borne in mind, particularly where the adapted vacuum collection vehicles have been purchased rather than hired.

Given the size and nature of the Kensington and Kingsford study area, and the desire to remove as many waste vehicles as possible from the town centre streets, the area-wide AWCS would be the most appropriate design and installation.

A local system could be used as a pilot scheme if Council wished to investigate and test the AWCS prior to committing to the full area-wide scheme. Further details regarding a pilot scheme are provided in Section 5.4. The remainder of this document focuses on the area-wide collection system, although many of the aspects will also be relevant to some extent to the local collection system.

3.3 AWCS Suppliers

A small number of companies operate in the global AWCS sector. The table below summarises the key companies and their credentials and suitability for this project.

Table 3-3 - AWCS Suppliers Summary

Supplier Name	Company Overview	Systems Offered
ENVAC	ENVAC Centralsug AB is wholly-owned by Stena Adactum AB. With more than 40 years' experience in the development and adaptation of its technology to local standards in more than 30 countries ENVAC consider themselves as the global market leader of underground automated waste collection systems. The company takes full responsibility from the planning phase to the installation, including the operation of the systems. ENVAC has 300 employees, in 30 offices and in 16 countries. Systems across the municipal, hospital (including laundry) and airport sectors.	Mobile and Static Pneumatic collection systems
Ros Roca	The company began with Ferrán Ros Pijoan and Ramón Roca Sala in 1953 in Agramunt (Lleida province, Spain) more than 60 years ago. In 1956 the company began to fabricate waste collection equipment. Since then it has evolved, grown, expanded the range of equipment and markets and continue to invest in R&D.	Known to have installed systems previously. Appear not to be currently active in this sector.
MariMatic	MariMatic Oy® specialises in AWCS and vacuum conveying systems. The company manufactures two types of waste collection systems: the Taifun®, launched in the 1980s for use in industrial applications, and the MetroTaifun®, launched in 2010, and is specifically designed for subterranean conveyance of municipal waste. MariMatic Oy® has delivered around 1,000 systems in more than 40 countries. Appears to specialise in food waste facilities, factories and health care systems. Other municipal large projects are underway.	Static Pneumatic collection systems
Stream	The Nexa corporation was formed in 1991 and was established as the first Malaysian makers of central vacuum systems. The brand name 'STREAM' was established in 1993, to cover the range of products sold by the company. The company focussed on vacuum conveying technology for all streams of homogeneous waste material. In 1999, a key client – the Ministry of Home Affairs in Singapore required a three-waste fragment system – dust, shredded paper and solid waste. This marked the first milestone for STREAM moving away from primarily dust and homogenous conveying systems to conveying solid municipal waste. STREAM has operations in five countries and has more than 25 city grade references for pneumatic waste technology.	Static Pneumatic collection systems. Two systems available, the Gravity vacuum system is suitable for residential developments.

Supplier Name	Company Overview	Systems Offered
Logiwaste	Logiwaste is a Swedish environmental technology company founded in 2006. The company provides automated waste and laundry collection. Logiwaste is a leading operator in Scandinavia for automated waste collection solutions in residential and central city districts, and commercial properties, as well as for the automated collection of waste and laundry for hospitals and other care facilities.	Full vacuum systems and gravity vacuum systems available.
Ecosir	Ecosir pneumatic waste collection systems include a number of automated vacuum transfer solutions for waste and laundry. The company has a reference history of 30 years with more than 100 large scale waste transfer systems and close to 1000 smaller scale vacuum systems installed since 1987. The international market is covered by 15 local certified Official Partners through Ecosir Group support. Mainly specialise in campus installations, hospitals and commercial and more recently residential.	Static pneumatic collection systems. Two systems offered, the CityMaster is suitable for residential city areas.

3.4 Inlet Connection – On Street, New Build Only or Retrofit

Waste is deposited into the AWCS via the use of ‘inlets’. One inlet point can host one or several inlets dedicated to serve that building and/or adjacent buildings.

Inlets can be located external to buildings, for example, on street, in courtyards, or in buildings. For inlets in buildings, a single inlet point can be installed at ground floor (lobby) level or multiple inlet points installed at various levels in the building using a vertical chute type system, commonly found in high rise residential buildings. Table 3-4 below summarises the advantages and disadvantages of the different inlet locations with Figure 3-3 and Figure 3-4 showing examples of external and internal inlet points.

Table 3-4 - Inlet Location Options

	Inlet Location	Advantages	Disadvantages
External	On street	• Visible location which should limit vandalism, incorrect use and dumping of waste around inlets.	• Distances which residents are required to walk to deposit waste, although depending on inlet location design this may not be any greater than existing waste deposit distances. Furthermore, the new system may result in behavioural change and residents taking their waste out more frequently when leaving the building.
	Courtyard	• Removed from street scene, but still in visible location to support proper use. • Potentially more convenient location than on street, if residents depositing waste and returning to apartment. • Self-regulating from a safety and dumped rubbish perspective as inlets are located in busy and overlooked areas.	• Likely to be applicable only in new build developments.
Internal	Lobby	• Can be located adjacent normal thoroughfares to and from building. • No requirement to leave the building in order to deposit waste.	• One inlet point required per building, as opposed to multiple buildings per inlet location point, such as in an on street or courtyard system.
	Inlet room on each floor	• Shorter distance for residents to deposit waste. • Suitable for buildings with existing refuse chute, or new build high rise buildings, for example, greater than 10 floors.	• Additional expense resulting from multiple inlets in each building. • When installed as retrofit to existing waste chute system will be limited to one waste stream or fraction. If additional inlets are provided at lobby level or external to the building, then it is likely that the material stream inside the building, that is, the most conveniently located, will be preferentially used. If the chute is used for general waste then recycling rates could be impacted, if the chutes are used for recycling then there is a risk that contamination levels will be high.

It is SLR's opinion and experience that chute-based collection systems would be unnecessary for the majority of buildings in the study area. Developers of new developments could consider whether to install floor by floor chute systems or those with lobby or external inlets.

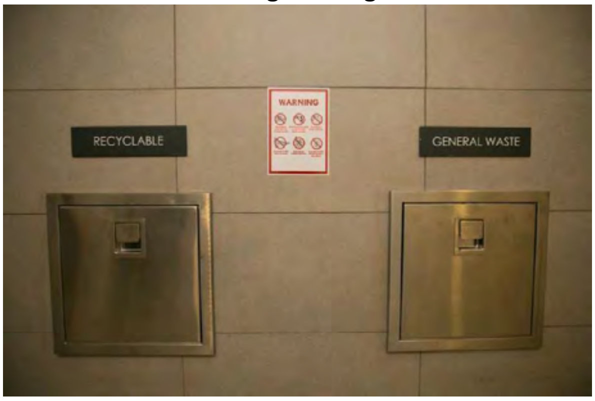
Figure 3-3 - Examples of Inlets Located On Street

Source: ENVAC

Figure 3-4 - Examples of Inlets Located in Buildings

Purpose Installed Inlets

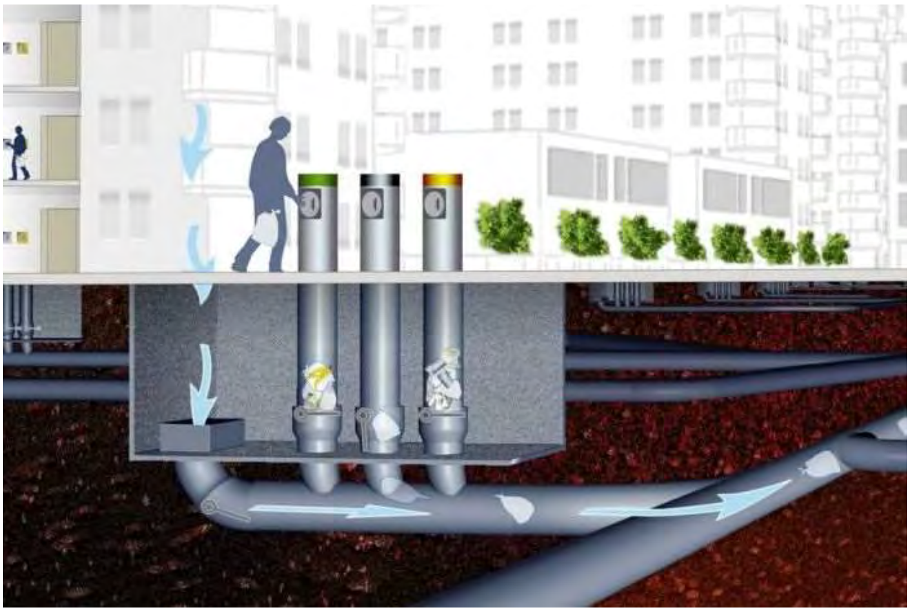
Retrofitted Utilising Existing Waste Chutes



The entire AWCS system, including inlets located in buildings, can be installed as part of new build development or installed into existing developments and areas. Inlets in buildings, at lobby level only or multi-floor level, can be retrofitted into buildings where there are appropriate basement space and heights. If installing a local AWCS system, building basements would have to be sufficiently sized to accommodate interim storage tanks in addition to the pipe network.

One inlet is required for each waste stream being collected. To deposit the waste, the user opens the door of the inlet and deposits the waste into the inlet. Doors can be freely opened or locked and operated by RFID fob to track use. The waste drops down the pipe into a storage section, and at timed intervals, or if the fill level sensor is triggered, the discharge valve opens and the waste is pneumatically transported along the pipe network to the collection station. See Figure 3-5 for a schematic of the waste inlets, storage sections and air inlet valve.

Figure 3-5 - On Street Inlets Schematic



Source: ENVAC

The number of households connected to one inlet point depends on the expected waste quantity, walking distance, storage capacity in the inlet and size of the system. Typically, 40-80 households are allocated to each inlet point. If there is a need for more households this can be solved by expanded storage.

3.5 Preliminary Design Information

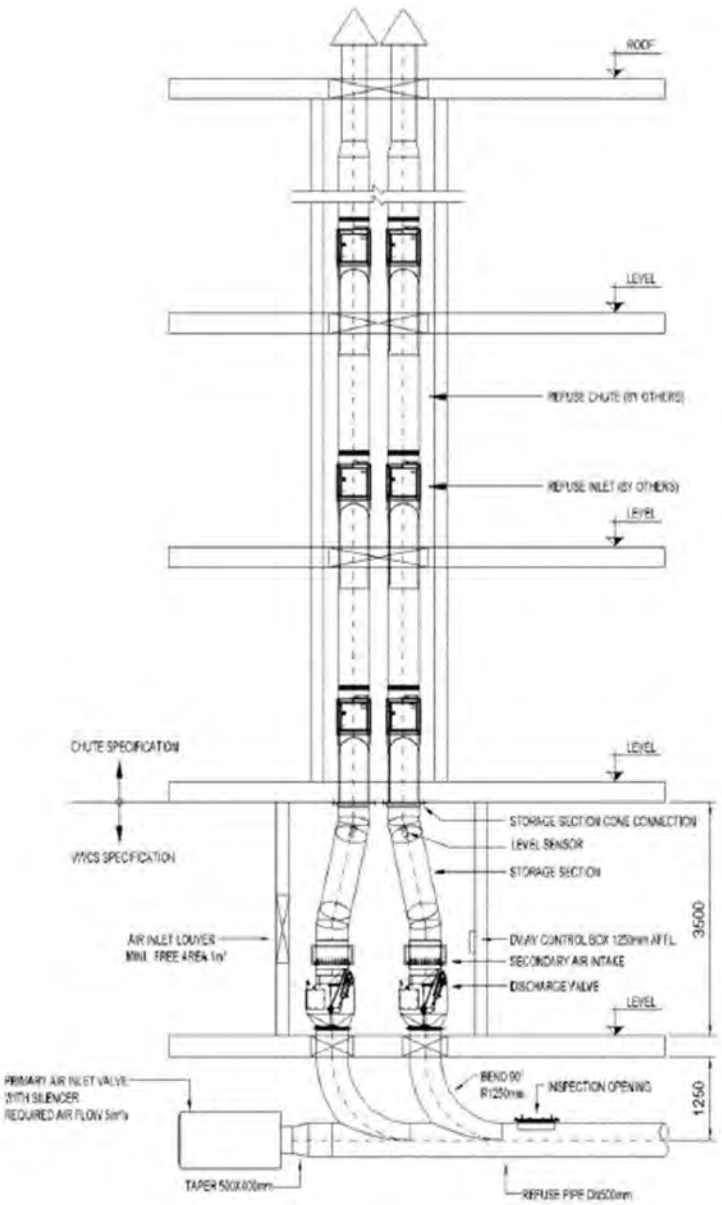
As identified above, inlets can be installed within buildings or externally. The maximum size of the waste bag to be deposited in the inlets depends on the pipe diameter used in the system. In 500 mm systems, usually bags from residential areas of 10-30 litres, and from commercial areas of up to 120 litres, can be deposited in to the system.

The information below provides typical arrangements for internal and external discharge valves (DV) used in area-wide AWCS. This section also provides typical information regarding the collection station design requirements.

3.5.1 Internal Discharge Valve Room

Figure 3-6 illustrates the typical arrangements for an internal discharge valve system. The diagram shows inlets on each floor, but equally the diagram is applicable to a single set of inlets at ground level. Waste is held in the DV room until it is ready for transportation through the pipe network.

Figure 3-6 - Typical Arrangements for Internal Discharge Valve

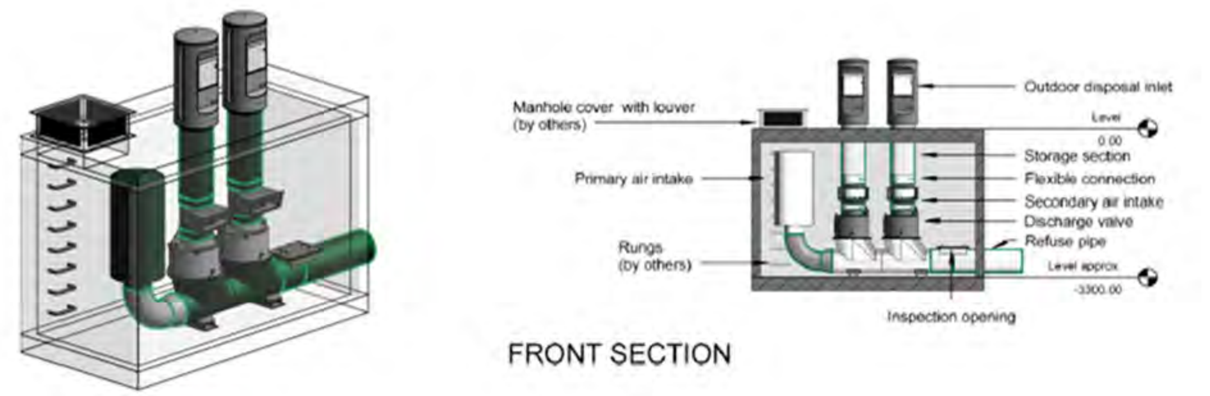


Source: Draft PAS 908:2018

3.5.2 External Discharge Valve Room

Figure 3-7 illustrates the typical arrangements for an external discharge valve system.

Figure 3-7 - Typical Arrangements for External Discharge Valve



Source: Draft PAS 908:2018

3.5.3 Discharge Valve Room Sizing

The minimum areas required for DV rooms, for internal inlets, and DV chambers, for external inlets, are provided in Table 3-5 below. It is not always necessary to provide an air valve with every discharge valve, and therefore the DV room or chamber requires less space if only a DV is required.

Table 3-5
Minimum Areas for DV Rooms and Chambers (m^3)

DV Room Position	Air Inlet Valve	1 fraction	2 fractions	3 fractions
Internal	With	6	9	12
	Without	5	7	10
External	With	8	11	13
	Without	8	11	13

Source: Draft PAS 908:2018

It should be noted that the areas above are for the operation of the AWCS only, and that additional area may be required for the storage of materials unsuitable for disposal through the AWCS.

3.5.4 Underground Pipework

The sub-sections below consider the key elements of the underground pipework design, manufacture and installation.

3.5.4.1 Pipe Size

The standard diameter of steel pipes for AWCS is 500 mm, although smaller diameters of 400 mm are occasionally used.

3.5.4.2 Pipe Manufacture Material

Generally, straight pipes are made of carbon steel at different thicknesses depending upon the expected waste loads and their erosion properties. Bends are especially sensitive and therefore often made of boron steel. The expected erosion factor is the most critical factor for the design of an installation.

3.5.4.3 Air speed in the Pipes

Depending on the density of the waste and the transportation distance, the air speed in the pipes varies between 20 and 25 metres per second, or about 60-70 km per hour.

3.5.4.4 Glass and Other Erosive Waste

Glass and other erosive waste materials can be collected when mixed with other waste. Glass or other erosive material should not exceed 10% of the total weight of the waste collected.

3.5.4.5 Corrosion Protection

The pipes are protected with a polyethylene coating which is normally enough for installation in trenches. In the case of bends, other types of external coatings can be also used, but always according to international standards.

Corrosion of pipes may occur if they are installed in corrosive environments. In these cases, anode or cathode protection can be installed. This gives sufficient protection and is normally less expensive than using stainless steel pipes.

3.5.4.6 Cleaning the Pipe System

It is not normally necessary to clean the pipes. Waste passing through pipes is enough to cleans them in most applications. If wet and very sticky waste is transported, a cleaning buoy should be used periodically.

3.5.4.7 Pipe Repair

It is usually not necessary to excavate streets to repair damage to pipes. In a 500 mm pipe system, most of the repair can be done from inside the pipe by fitting (welding) small plates to the holes. Internal pipe repair can be done in less than one day.

3.5.4.8 Location of Pipes

Pipes can be installed in the road or the pavement. Linking pipework will be required from the main pipe to the inlets, which as previously identified, could be located external to the building or internal.

The location of the pipe network is a project-specific decision and must be based on the review of a number of key factors including:

- whether the project is part of a new development and therefore less constrained by other services, or being installed in existing urban environment, which is the case for Randwick
- the below ground services, electricity, water, sewerage, gas, telecoms and others, and the potential interaction or conflict of the AWCS pipe with the existing services
- the potential disruption to pedestrian and vehicle traffic and how this varies with the different installation positions

- for Randwick, consideration must also be given to the recently constructed Sydney CBD and South East Light Rail system and how any requirement to install AWCS pipework east-west across Anzac Parade, and under the light rail lines, would be managed.

One of the benefits of a local AWCS scheme using mobile vacuum collection system is that it allows, to a certain extent, more flexibility to design a system around critical services and transport schemes.

3.5.4.9 Depth at which Pipes are Buried

Pipes are generally buried 1 m-1.5 m below street level. If there are valves in the street, the depth is normally 1.5 m-2.5 m.

In addition to the carbon steel pipe network, an electric line and a small pipe for compressed air are installed. These link all the valves of the system with the collection station, providing electrical power and managing all the discharge air compression valves.

3.5.4.10 Lengths of Pipes Delivered for Installation

Straight pipes are available in 6 m or 12 m lengths.

3.5.4.11 Curves in Pipes

Waste is transported at high speed in an AWCS, for this reason the curve radius must be carefully considered and calculated. Table 3-6 provides example standard radii for bends for both the 400 mm and 500 mm pipe networks.

Table 3-6 - Example Standard Radius for Bend

System	Outer diameter (mm)	Bend radius (mm)	Straight par (mm)
400 mm	406 – 426	1500	250
500 mm	508 – 534	1800	250

Source: Draft PAS 908:2018

The above is the standard bend, however the design may also require the use of:

- hardened steel bends in areas with high calculated erosion and
- short radius bends for use in branches or main pipe with calculated low erosion and for DV connections.

Figure 3-8 - Photographs Showing Installed Pipe Bends and Branch Connections

Source: ENVAC

3.5.4.12 Maximum inclination of a pipe

It is normally recommended not to exceed a 20° gradient either downhill or uphill. There is always a risk that not all waste will be taken away by the air stream if the inclination is greater than 20°. Residual waste in the pipes may then cause blockages, which must be cleared.

Figure 3-9 - Installed Pipework Showing Cabling for Electric and Compressed Gas

Source: ENVAC

3.5.5 Collection Station

The key requirements for collection stations are listed below in Table 3-7. Figure 3-10 shows a typical layout of a collection station and Figure 3-11 shows the range of architectural external finishes which existing collection stations have implemented. The architectural requirements of the collection station will be driven by the setting and location of the collection station in the broader development area, the local planning requirements and the desire of the developer funding the scheme.

Table 3-7 - Requirements for Collection Station

Component	Requirements

Filter Room	• Where the filter room is installed in situ by general contractor the following shall be provided.
	  ○ Reinforced concrete dividing wall with roof slab to withstand a 3 kPa pressure with penetration for fitting filter frame.
	  ○ Steel door to each filter section 700 x 2100 mm opening internally with EPDM gasket.
	  ○ Epoxy floor finish
	  ○ Lighting
	NOTE: Cooling is not required.
	• Where installations include prefabricated filter module, the following shall be provided.
	  ○ Support slab/steel structure with safe access to doors.
	  ○ Electrical connection to lights

Exhauster room	• Design set temperature shall be <30°C; • Heat emission from exhauster shall be <8% of exhauster motor power during operation; • Exhauster sound level shall be < 100 DbA during operation; • NOTE: A typical acoustic treatment to the exhauster room wall's internal face might be 100 mm Rockwool with galvanised punched steel plate covering. • The exhauster room shall have an airtight double steel acoustic door of 900 x 2100 mm; • The exhauster room shall have an epoxy floor finish; • The exhauster room shall have a three-phase electrical supply to variable frequency drives terminated in isolator on pole support adjacent to each VFD.

Control room	• The control room shall have:
	  ○ AC – design 24°C;
	  ○ lighting in accordance with building code for computer rooms;
	  ○ raised access floor; and
	  ○ viewing window

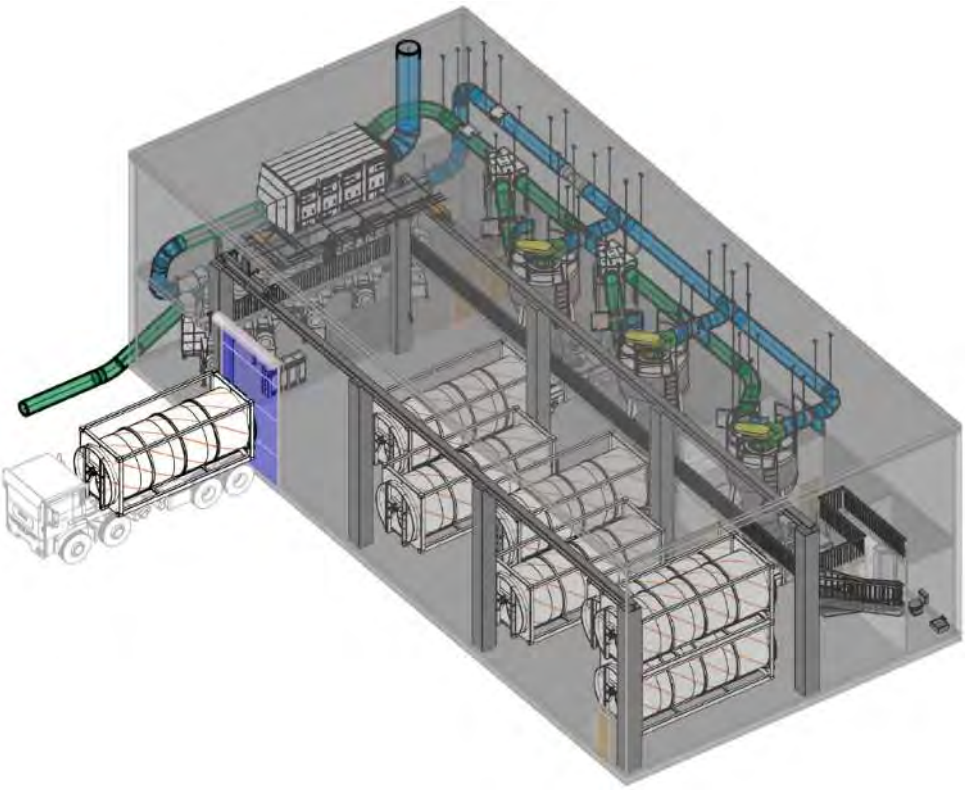
Container hall	• The container hall shall have:
	  ○ lighting level in accordance with plant room standards;
	  ○ design set temperature of 28°C;
	  ○ container drainage, including trench drain or tray to underside of container/compactor connection or at filter type container docking support to facilitate cleaning of any leachate;
	  ○ compactor power: three-phase 60 amp 400 v switched supply to compactor control box location;
	  ○ acoustic sectional overhead roller shutter doors to container pickup locations;
	  ○ epoxy floor finish; and
	  ○ container rolling guide to protect floor – steel plate hot dip galvanized 10 x 300 x 1800 mm.

Welfare Facilities	• Welfare facilities shall include:
	  ○ Toilets; and
	  ○ Washroom
	• Welfare facilities shall be provided in accordance with OSH requirements

Component	Requirements
Structural Loads	• The following structural loads shall be considered for the collection station: ○ container – 200 kN; ○ compactor – 60 kN; ○ cyclone – 100 kN; ○ rotating screen – 7.5 kN; ○ exhauster – 20 kN; ○ compressor – 3 kN; ○ conveyor trolley – 120 kN; ○ gantry crane – 200 kN; ○ pipe diverter valve – 50 kN; ○ MCC – 12 kN; ○ ECC/EPC – 12 kN; and ○ filter (dust and deodorising) – 32 kN

Source: Draft PAS 908:2018

Figure 3-10 - Example Collection Station Arrangement



Source: Draft PAS 908:2018

Figure 3-11 - Example External Appearance of Collection Stations

Source: Draft PAS 908:2018 and ENVAC

3.5.6 Power Requirements and Upgrade

The primary energy consumers are as follows:

- **Exhauster:** vacuum pump or fan, used as single or multiple setup, in series or parallel, to create negative pressure and air flow in the transport pipe
- **Compactor:** machine, consisting of a compacting unit and container that compacts loose materials into a container. The compactor is usually connected directly between the cyclone and the container maintaining the full vacuum seal
- **Rotating screen:** included as part of the gas clean-up system to remove dust from the ventilation air and
- **Compressor:** providing compressed air to the control system.

Typically, the collection station will include the following equipment, although actual equipment provision will be site specific:

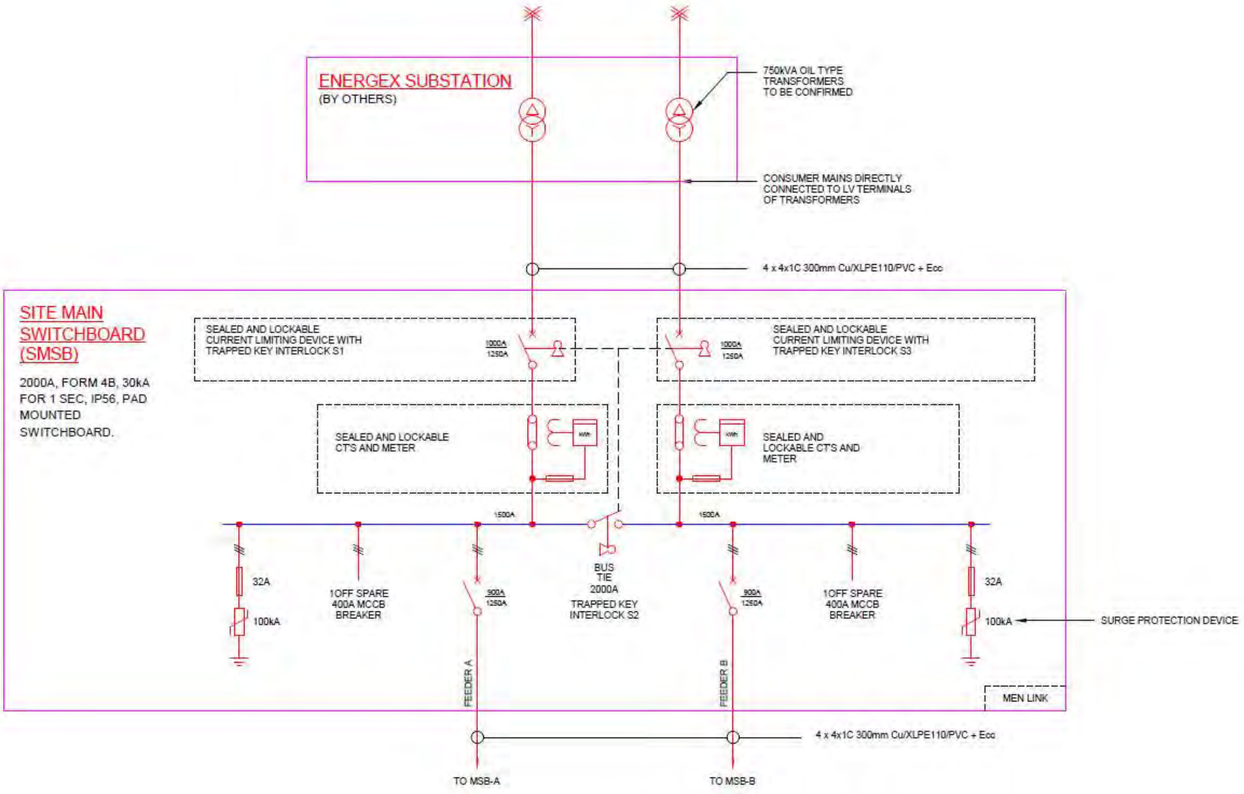
Table 3-8 - Collection Station Equipment and Power Requirements

Item	Number of units	Power Rating (kW)	Installed Power (kW)
Exhauster	5	110	550
Compactors	3	15	45
Rotating screens	3	7.5	22.5
Compressor	1	15	15
Total			**632.5**

Assuming a 3-phase supply at 0.4kV, the incoming power supply would need to be fitted with a 1,000 amp circuit breaker.

A typical electrical systems diagram for a collection station is provided in Figure 3-12 below.

Figure 3-12 - Example AWCS Collection Station Electrical Systems Diagram



A review of the power system around the chosen collection station location(s) would be required to determine whether the power demands can be addressed or whether power network upgrade work is required.

3.6 Key Operational Considerations

Consideration regarding the operation of the AWCS is required to decide what waste types will be collected and who will have access. There are a number of possibilities:

- Waste sources:
  - Residential waste only
  - Residential and commercial waste
- Access to AWCS:
  - Voluntary participation in the scheme by property or business
  - Compulsory participation in the scheme
  - New development buildings connected only.

To best achieve Council's objectives, as outlined in Section 1.1, the system should be designed and operated for compulsory use by both residents and businesses. As previously identified (see Section 3.1), there are potential issues associated with the collection of some material streams and certain commercial waste, for example large quantities of cardboard, which must be considered.

3.7 Long Term Maintenance Requirements

Once installed, AWCS underground pipe networks should have a lifetime of at least 50 years, although certain elements such as sharp bends might require replacement more frequently. Pipework includes inspection openings to allow inspection of equipment condition.

Assuming that adequate preventative maintenance is undertaken, equipment in the collection station should have a lifetime of 20 years or more. Maintenance should include the inspection fans, fan motors, separators, containers and other technical equipment. The system should be periodically cleaned, check the automatic emptying function, and inspect all visible moving parts.

The high-level financial model prepared for this feasibility assessment includes an assumption regarding operating and maintenance costs.

3.8 AWCS in Australia

To the best of SLR's knowledge, there are no AWCS currently operational in Australia. One AWCS is under construction by Sunshine Coast Regional Council, Australia's fifth largest municipality, 100km north of Brisbane.

The Sunshine Coast Council AWCS is being installed in the new Maroochydore City Centre, a new development on a greenfield site. The system is being installed in phases over 10 years and will ultimately include 6.5 km of pipe network and 300 inlet locations, each collecting three waste streams. The 53-hectare site will be densely populated with more than 2,000 apartments, retail outlets and significant commercial space.

The Maroochydore City Centre project is designed to be one of the cleanest and greenest cities in the country and includes installation of high-speed fibre optic network across the area to enable a 'smart' city. ENVAC has been commissioned for the AWCS design, equipment supply and installation supervision.

The photograph in Figure 3-13 below shows installation of the AWCS underground pipework in the greenfield setting.

Figure 3-13 - AWCS Pipe Installation in Maroochydore City

Source: ENVAC

Sunshine Coast Regional Council has in place a system of approved contractors and approval steps to ensure buildings connecting to the AWCS do so according to design requirements. The Prescribed Waste Infrastructure Standard stipulates that only an approved contractor may design, construct, install, commission, and maintain the private pneumatic waste infrastructure. Approved contractors are required for a development to proceed through the requisite approval steps at each phase of the development[3].

[3] https://www.sunshinecoast.qld.gov.au/Living-and-Community/Waste-and-Recycling/Automated-waste-collection-system/Developers-designers-and-builders

4 Randwick City AWCS

This section provides context around the study area being considered in this AWCS feasibility study and details the outline design options and high-level financial analysis.

4.1 Study Area

The study area covered by this feasibility study is the town centres of Kensington and Kingsford. The specific areas and plots included in the assessment are as shown in the below figures. Figure 4-2 shows both the Kensington and Kingsford town centres and their relationship to each other; Figure 4-3 and Figure 4-4 show the Kensington and Kingsford study areas respectively in more detail. Full sized versions of the below drawings are included in Appendix A.

The study areas are sited around Anzac Parade, the main transport corridor through the two town centres. Building types vary in the study areas from small detached houses to multi-storey apartment blocks to low rise commercial units or multi-level commercial and leisure buildings. The development documents note that regeneration of the Kensington and Kingsford town centre areas has the potential to generate up to 5,200 new apartments and 54,000 m^2 of commercial floor space.

SLR understands that there is at least one developer in the Kensington and Kingsford areas who is interested in the potential of in-building inlets and connection to AWCS for student accommodation.

An AWCS system designed and installed must be able to accommodate the needs of the study area now and in the future without substantial change.

Randwick City Council has prepared a draft planning strategy to guide the future of Anzac Parade in Kensington and Kingsford. The strategy proposes new building heights and extensive public improvements. Modest height increases are proposed along the 2.5 km Anzac Parade corridor with taller buildings proposed at three nodes (see Figure 4-1 below).

Figure 4-1 - General and Node Height Controls for the Kensington and Kingsford Study Areas

General height controls:

	Current permissible height	Proposed maximum height
Kingsford	7 storey (24m)	9 storey (31m)
Kensington	6-7 storey (25m)*	9 storey (31m)

Node height controls:

	Proposed maximum height
Todman Ave intersection, Kensington	18 storey (60m)
Strachan St intersection, Kingsford	18 storey (60m)
Nine-ways roundabout node, Kingsford	17 storey (57m)

Source: Randwick City Council

These design guidelines suggest that for the entire development area, except for the three nodes, building heights will be no more than nine storeys.

Figure 4-2 - Relative Relationship of the Kensington and Kingsford Study Areas

Figure 4-3 - Kensington Study Area

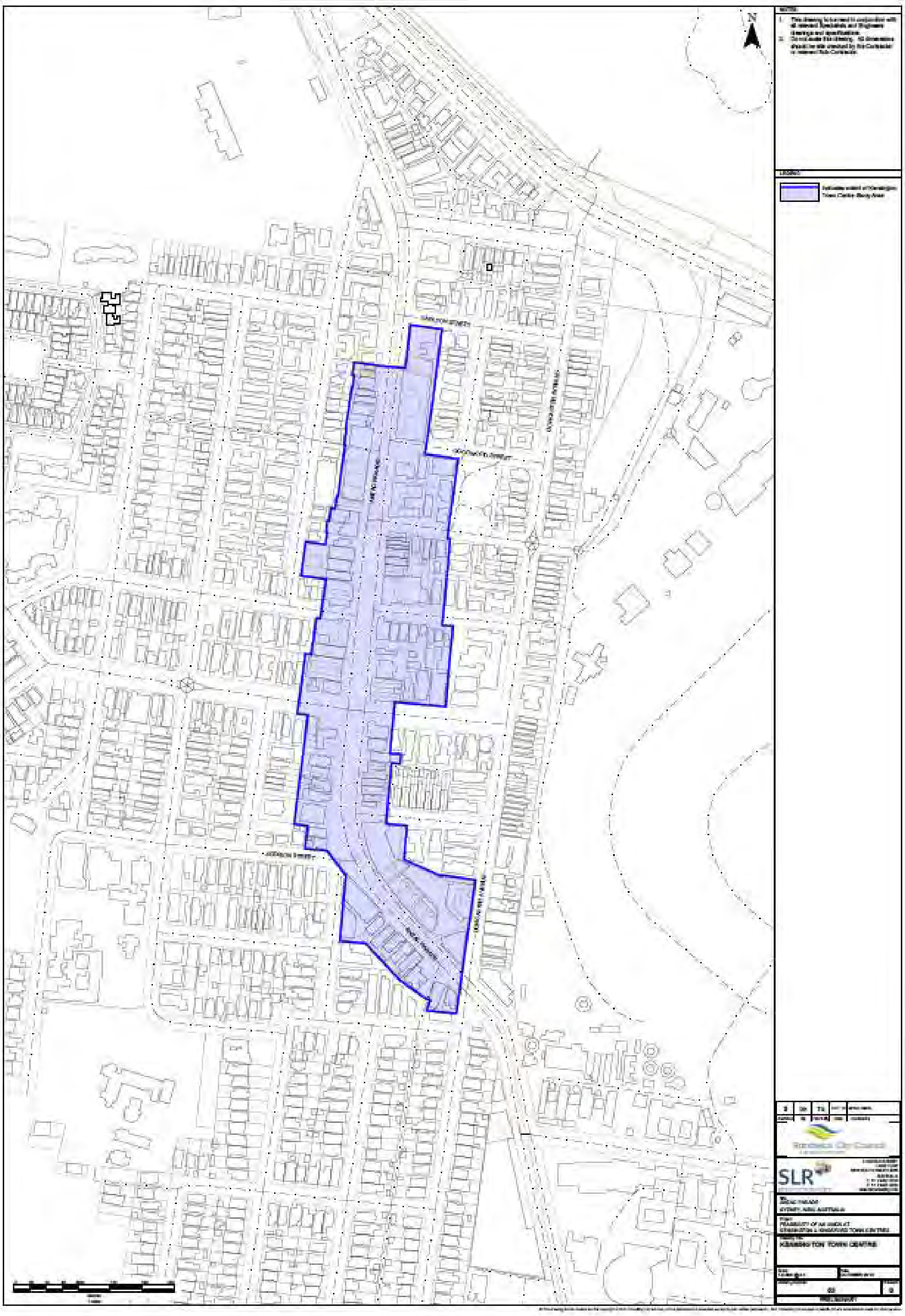
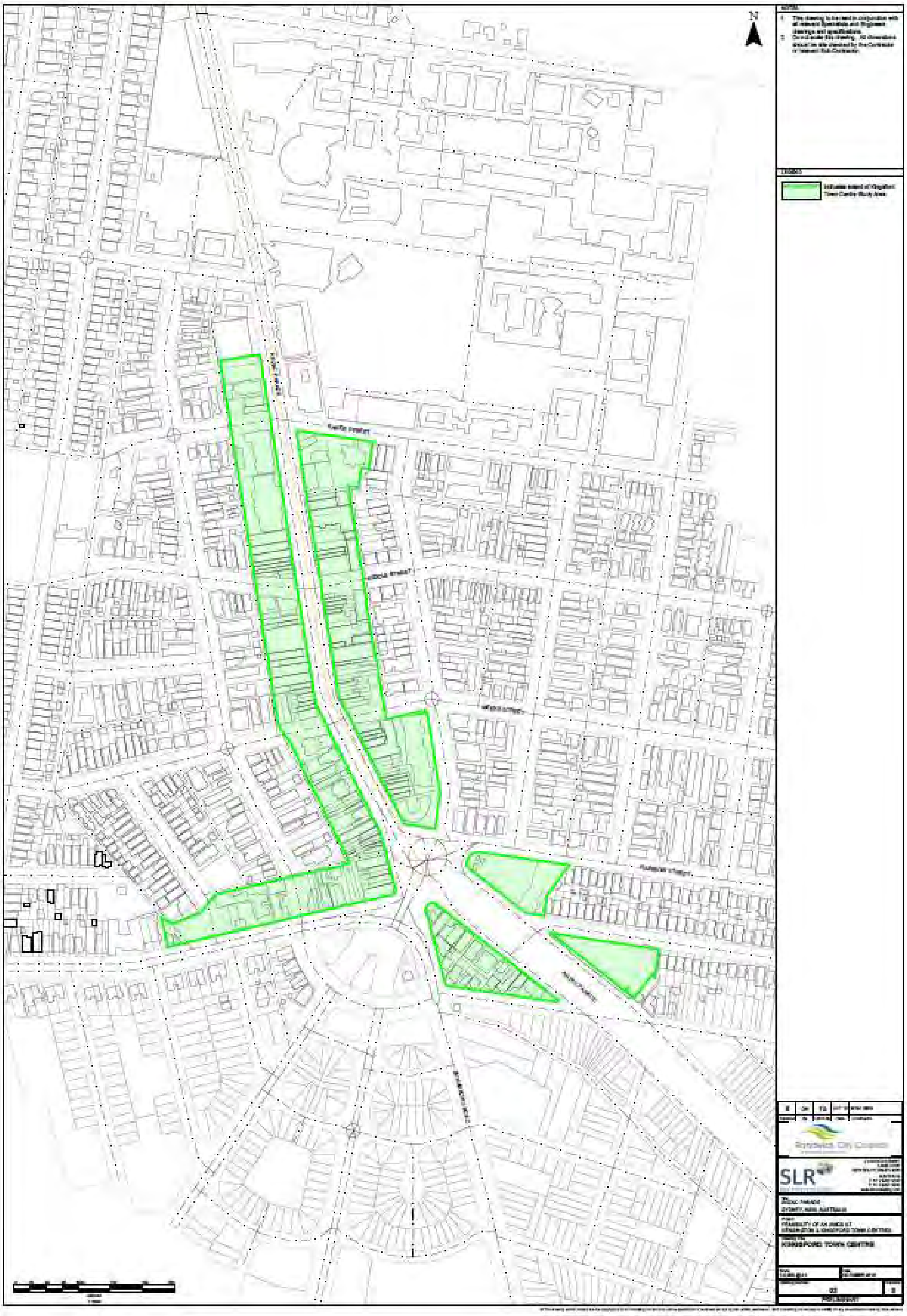


Figure 4-4 - Kingsford Study Area



4.2 Waste Generation Estimate

No information regarding waste generation in the study area was provided to SLR or available from a search of publicly available information. As such SLR has developed a high-level waste generation estimate. In summary, the calculations work as described below.

4.2.1 Waste from Existing Buildings

- Building footprint areas extracted from the study area maps
- Building footprints, gross external area, GEA, multiplied by an assumed factor of 85% to obtain Net Internal Area (NIA). Details can be found in Appendix B.
- Ground floor area usage divided by residential and commercial based on sourced report[4]
- First floor area usage divided by residential and commercial based on above mentioned report
- For residential floor area:
  - Type of residents (houses or apartments) proportions from above mentioned report
  - Floor area associated with apartments calculated.
    - Divide apartment floor area by the average size of an apartment in NSW to obtain an estimate of the number of apartments in the study area.
    - Multiply number of apartments by average amount of waste generated by an apartment, as shown in Randwick's Waste Management Strategy report
  - Floor area associated with houses calculated
    - Divide house floor area by the average size of a house in NSW to obtain an estimate of the number of houses in the study area
    - Multiple number of houses by average quantity of waste generated by a house, as shown in Randwick's Waste Management Strategy report
- For commercial floor area:
  - Calculate floor area for commercial use
  - Multiple commercial floorspace by waste generation metric[5].

4.2.2 Waste from New Developments

- The number of new apartments and amount of new commercial floorspace obtained from Council project brief.
- Apartment numbers and commercial floorspace multiplied by factors used in the calculations mentioned above to derive waste tonnages.

4.2.3 Existing and New Developments

The quantities for existing buildings and new developments are combined and then divided by 365 to obtain a daily amount that the AWCS will have to manage. The results of the waste generation calculations are summarised in Table 4-1 below.

[4] http://www.randwick.nsw.gov.au/__data/assets/pdf_file/0014/52115/Kingsford-and-Kensington-Town-Centre-Issues-Paper.pdf
[5] Assumes 50kg per square metre per year waste generation factor

Table 4-1 - Existing and Potential Future Study Area Waste Generation

Development Type	Household (t)	Commercial (t)	Total (t)	Equivalent Per Day (t)
Existing	2,434.6	4,786.7	7,221.4	19.8
New Development	4,596.8	2,700.0	7,296.8	n/a
Existing and New Development	7,031.4	7,486.7	14,518.2	39.8

Waste quantities are one area of significant uncertainty in this feasibility assessment and further work will be required to define tonnages more accurately. The potential downside of inaccurate forecasting is potential oversizing or undersizing of collection systems and stations.

4.3 Working Assumptions for Outline AWCS Design

A number of working assumptions are inherent in the outline designs presented in this feasibility study and the high-level financial analysis. These working assumptions are summarised below:

- Area-wide collection system
- Installation of underground pneumatic piping, either in road or footpath, to be determined at detailed design phase and therefore assumed that laying of pipework is feasible along routes, that is, no consideration of existing services or any re-routing is required
- Installation of inlets on street
- New build apartments and commercial space could have the option to build in AWCS into the building and connect to network if desired. Any costs for works and connection to the main pipe network would be assumed to be covered by the building owner
- Existing building owners could retrofit AWCS inlets in the buildings and/or modify gravity chute systems if desired. Any costs for works and connection to the main pipe network would be assumed to be covered by the building owner[6]
- Distances between inlets set at a nominal 30 m to match NSW EPA guidance on maximum distances that people should walk to access waste facilities. At some locations 30 m is exceeded by a small margin due to road locations, or branches of pipe which marginally exceed 60 metres in length in total but would not necessarily warrant a second inlet location and the costs associated with it
- Pipe at the end of the network ends 30 m from the end of the study area, as assumed first inlet could be 30 m inside of the study area, to minimise pipe network costs
- Base case assumption of collecting two materials, general waste and recyclable materials, with a sensitivity analysis included in the high-level financial modelling of a third waste stream for food waste
- Potential collection station locations, Randwick Racecourse and Rainbow Street, have been identified by Council and this feasibility study assumes one or both are viable considering suitable location, siting of a collection station, land ownership or lease, costs for land ownership or lease
- Pipe length from boundary of collection station plot to collection station excluded from the assessment as collection station location is not known at present.

[6] The potential number of opportunities for retrofitting inlets or chute system to AWCS cannot be assessed at this feasibility stage.

4.3.1 Consultation with AWCS Supplier

SLR has consulted with one AWCS supplier (ENVAC) for information on inlet spacing, high level capital costs and collection station capacities.

With regards to collection station capacity, this is ultimately determined by the scheme design including length of pipe network, number of inlets, location of inlets (density close to collection station and density at extremity of network), numbers of residential units and businesses using the scheme and resulting daily quantities. The high level waste estimates presented in Section 4.2 indicate a daily amount of about 20 t per day (residential and commercial) at present, increasing to a potential of about 40 t per day (residential and commercial) with the new development of apartments and commercial space.

Existing operational AWCS schemes are managing the estimated daily tonnages using a single station, however these systems, generally located in the Middle East, have shorter network lengths and operate at night, with maintenance also occurring at night. Although viable from an operational perspective, SLR has been advised that this is not best practice, and removes any contingency in handling any issues.

As such, should Council require the AWCS to handle the maximum tonnage as currently estimated (residential and commercial waste; existing and future development) then SLR is of the opinion that two collection stations are developed and operated.

4.4 Outline AWCS Design Options

A number of design options have been drafted and considered in this feasibility study. The options are summarised as follows:

- Two separate AWCS schemes, with two collection station locations:
    - Option 1 - Kensington AWCS network to racecourse collection station (see Figure 4-5)
    - Option 1a - Kingsford to Rainbow St collection station via main road pipes (see Figure 4-6)
    - Option 1b - Kingsford sub option pipes via back street, where possible, pipes.
- One integrated AWCS scheme, with one collection station:
    - Option 2 - Kensington and Kingsford to racecourse collection station, using pipe route from Option 1a for Kingsford, that is, Anzac Parade.
    - Option 3 - As above but pipes routed to Rainbow St collection station.
- Sensitivity testing:
    - Option 4 – as per Option 2 but with inlet spacing of 50 metres.
    - Option 5 – as per Option 2 but with collection of food waste in addition to general waste and recyclable waste. Note that this Option does not require a separate drawing.
    - Option 6 – as per Option 2 but with two collections stations located at the Racecourse site. This approach would retain all operation and maintenance activities, staffing and vehicle movements, at a single site which is likely to lead to operational and cost efficiencies. This approach would also allow the flexibility to move from an integrated system with one collection station to two collection stations at the appropriate time when new developments reach a critical mass. Note that this Option does not require a separate drawing.

Figure 4-5 – Possible Racecourse Site

Figure 4-6 – Rainbow Street Site

From these design option drawings, which are presented below but also included in Appendix A, the following key information has been extracted for use in the high-level financial modelling:

- Pipe network lengths
- Number of inlet locations
- Number of collection stations.

In general, as highlighted above in Section 3.2, the maximum length of pipework from the collection station to the furthest inlet should not exceed 2.5 km. The design option drawings have confirmed that the maximum pipe run lengths, even with an integrated AWCS, are below this limit. As such, all design options presented below are deemed to be technically viable from a pipework length perspective.

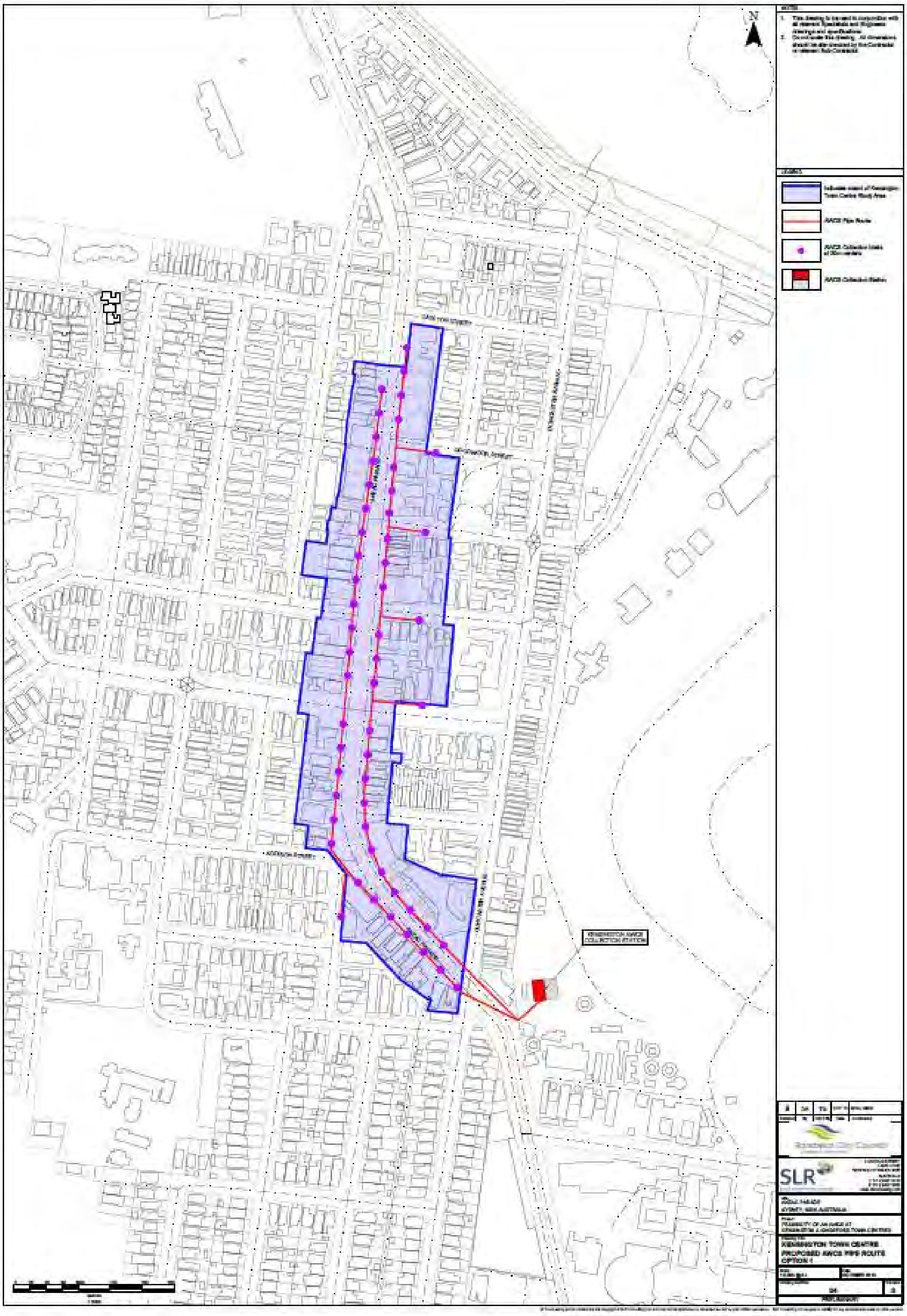
4.4.1 Two Separate AWCS

The development of two separate AWCS systems, with two independent collection stations, would result in a reduction of about 650 metres in underground pipe network length. This is the distance between the southern extent of the Kensington area and the northern extent of the Kingsford area. The approach would allow both systems to be capable of running with existing and future residential and commercial developments.

4.4.1.1 Kensington AWCS

Figure 4-7 below shows an AWCS design for a standalone scheme in Kensington with a collection station located at the racecourse.

Figure 4-7 - Option 1 - Kensington AWCS with Collection Station at Racecourse



4.4.1.2 Kingsford AWCS

Figure 4-8 below shows an AWCS design for a standalone scheme in Kingsford with a collection station located at the Rainbow Street site (see Figure 4-6). Figure 4-8 shows the pipe network located along Anzac Parade, an alternative design would locate the pipe network along the secondary streets located parallel to Anzac Parade, as shown in Figure 4-9.

Although both schemes are potentially viable, it is anticipated that most residential activity will be on foot along the Anzac Parade. As such Option 1b is considered to be a less convenient option. There are some small differences in pipe network length and inlet numbers between Option 1a and 1b.

Figure 4-8 - Option 1a - Kingsford AWCS with Collection Station at Rainbow Street

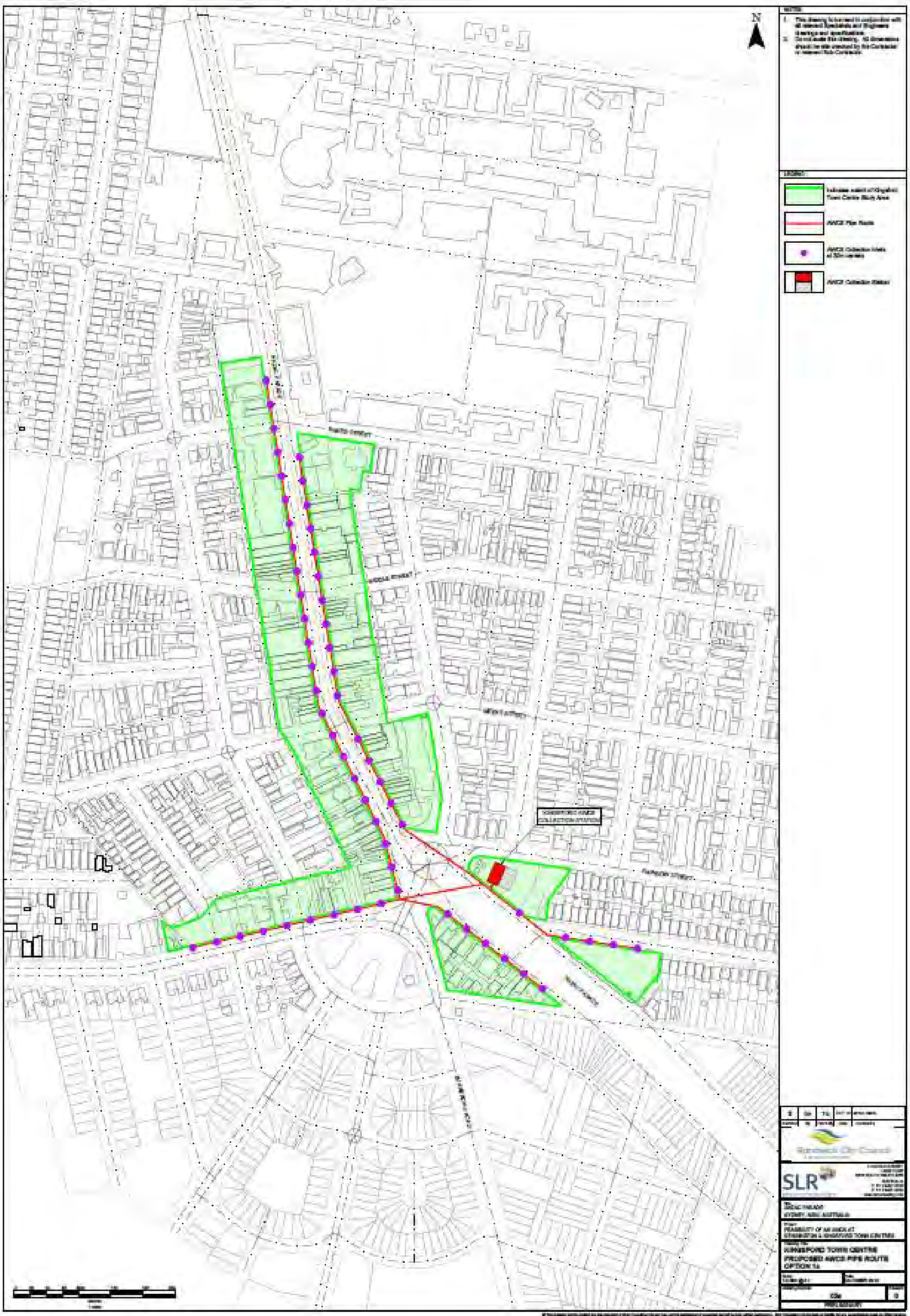
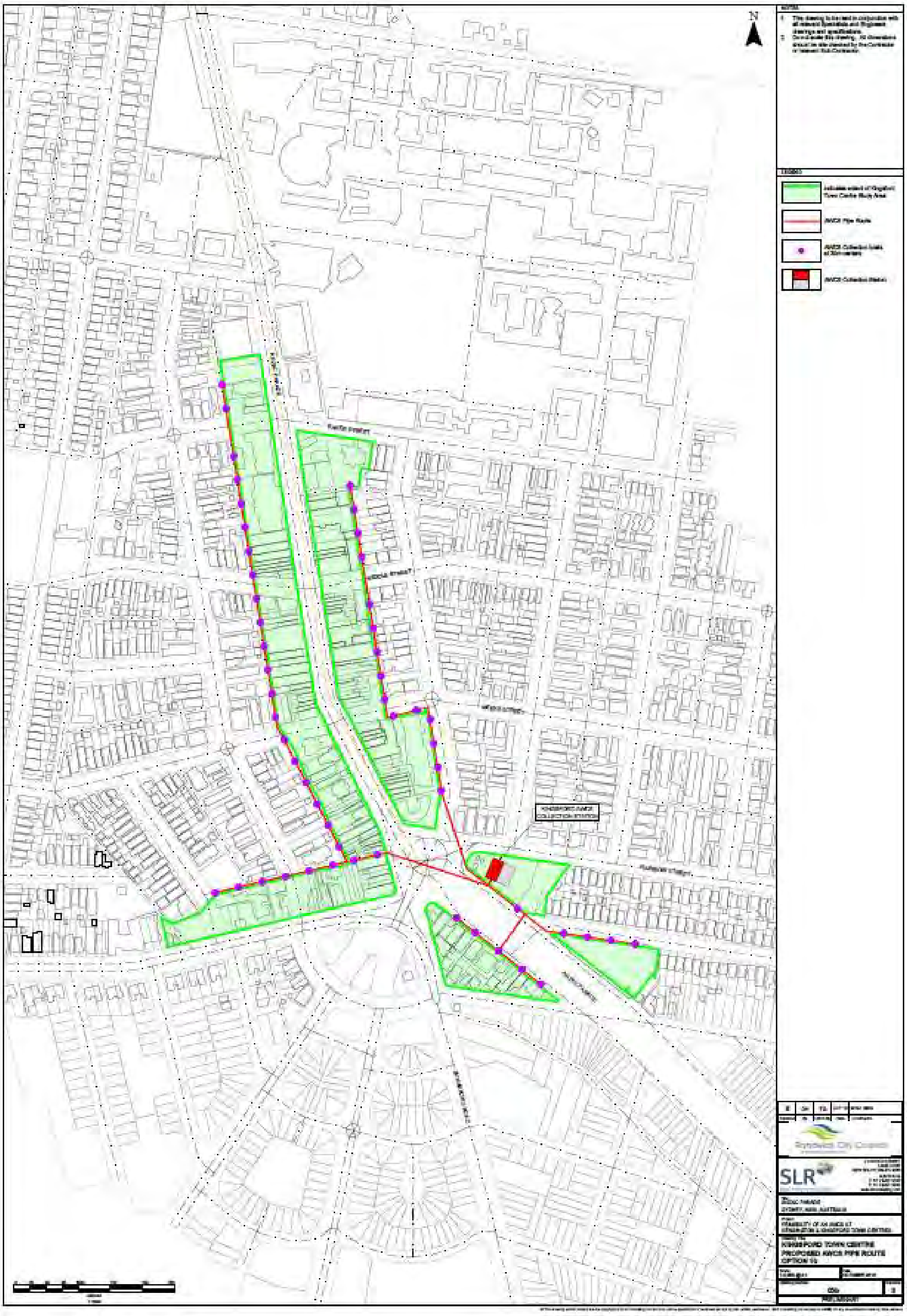


Figure 4-9 - Option 1b - Alternative Kingsford AWCS with Pipework and Inlets in Secondary Streets

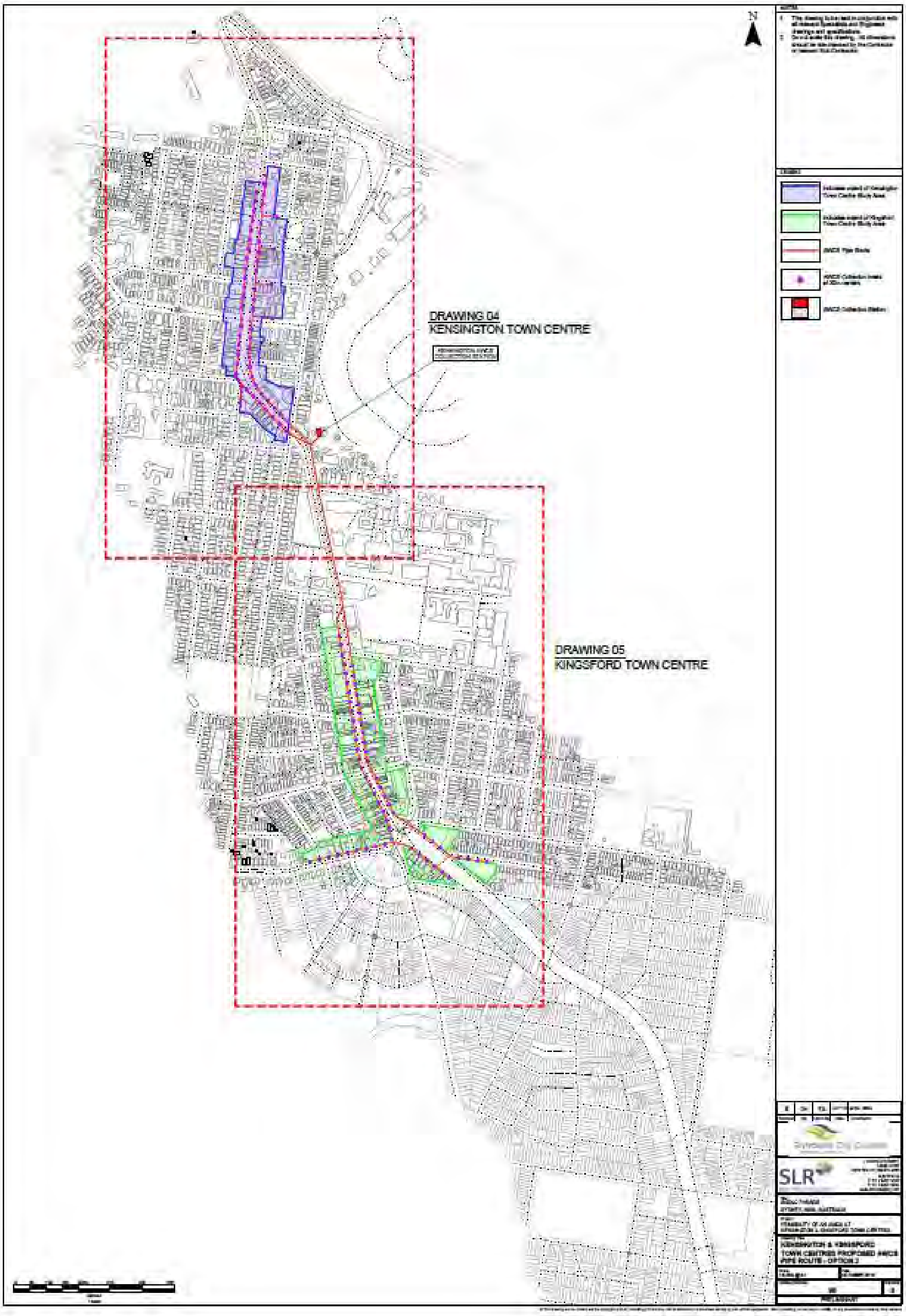


4.4.2 Integrated AWCS

The integrated AWCS system designs have the potential benefit of only requiring one collection station. This approach must be caveated with the advice provided by an AWCS supplier (see sub-section 4.3.1).

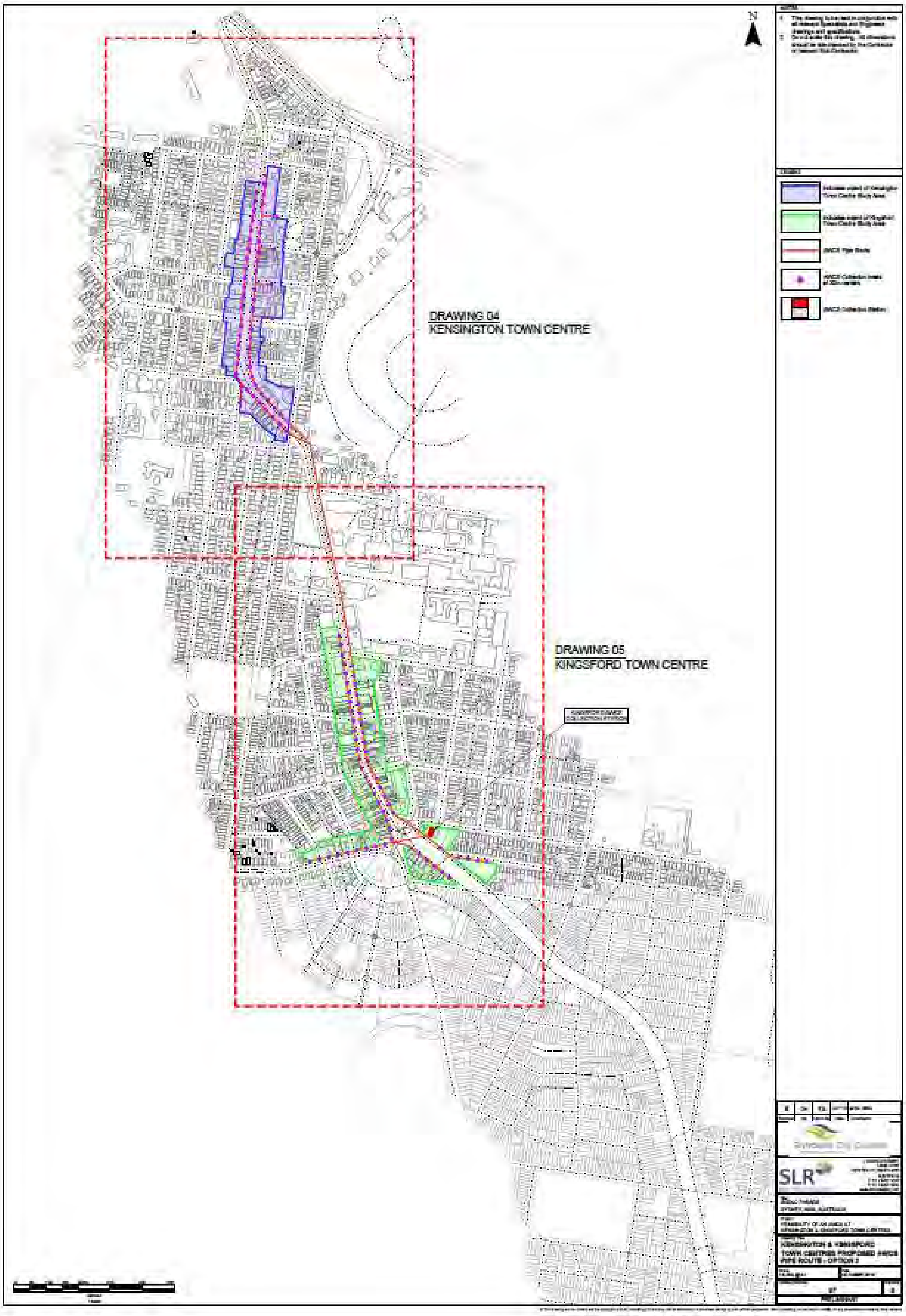
4.4.2.1 Collection Station in Kensington (Racecourse)

Figure 4-10 - Option 2 - Integrated AWCS with Collection Station at Kensington Racecourse



4.4.2.2 Collection Station in Kingsford (Rainbow Street)

Figure 4-11 - Option 3 - Integrated AWCS with Collection Station at Kingsford Rainbow Street

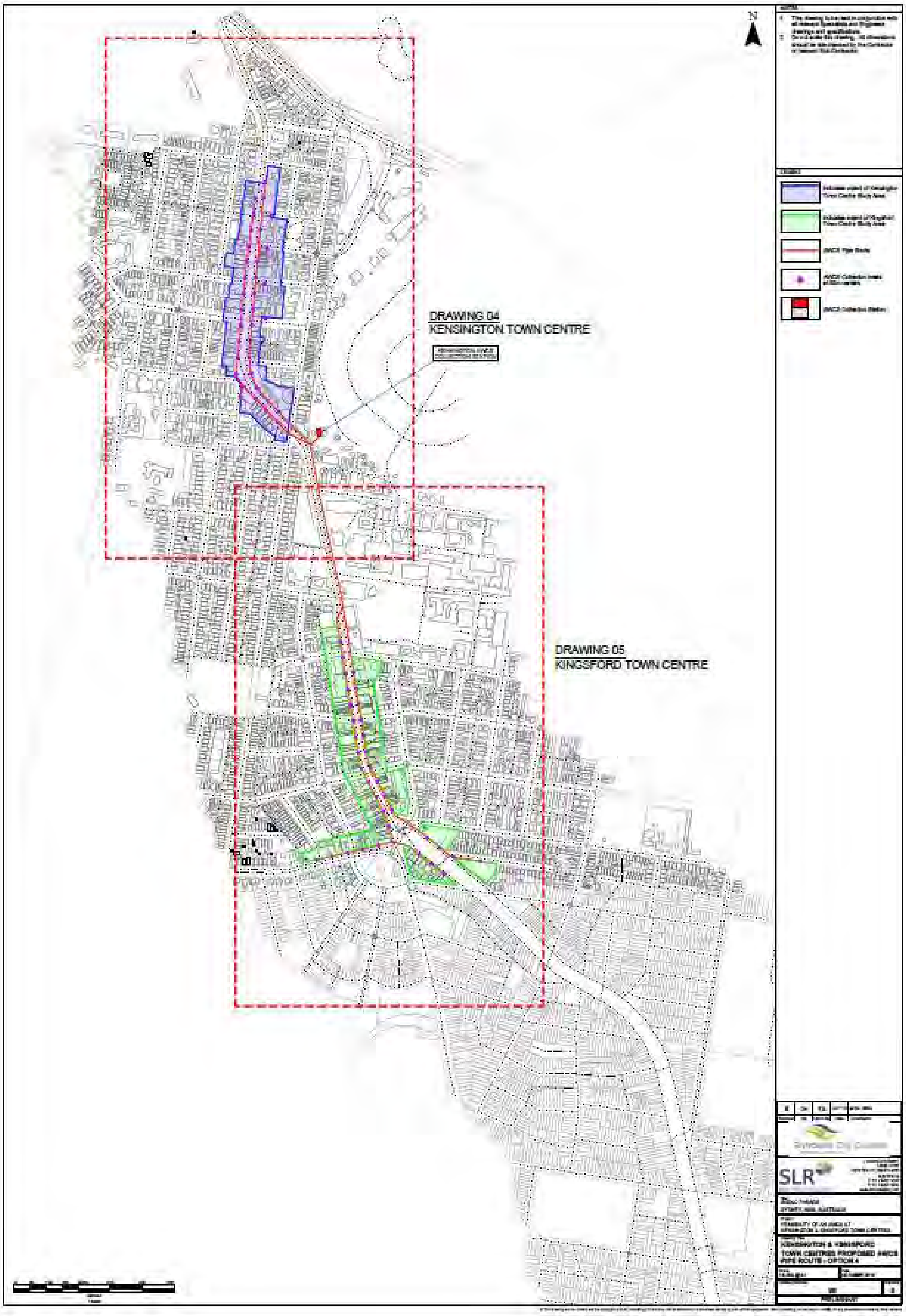


4.4.3 Sensitivity Testing

4.4.3.1 Increased Inlet Spacing

The design drawings above are based on an inlet spacing distance of 30 metres, this matches the requirement of the NSW EPA guidance for people carrying waste to a deposit point. Consultation with one of the AWCS suppliers (ENVAC) has confirmed that inlet spacing varies scheme to scheme and in a project that the company is working on in Korea the inlet spacing is up to 80 metres.

Figure 4-12 - Option 4 - Alternative Integrated AWCS (50 metre Inlet Spacing)



There is obviously a balance to be considered for the distance between inlets. Higher density of inlets results in increased scheme costs and lower density of inlets results in a less convenient scheme for residents and businesses. To test the financial impact of increasing the inlet spacing above 30 m, the drawing in Figure 4-12 above shows inlets with a spacing of 50 m.

Implementing 50 m inlet spacing instead of 30 m, results in a reduction of 45 inlet locations across the integrated AWCS scheme.

4.4.3.2 Food Waste Collection and Two Collection Stations at Racecourse

As previously noted, Option 5 (addition of food waste as a collection stream) and Option 6 (two collection stations located at the racecourse (see Figure 4-5) to allow servicing of existing waste quantities, but future protection for additional waste from new developments) do not require additional outline design drawings as they are largely based on Option 2 and the variations will be assessed in the financial assessment.

4.4.4 Additional Options Considered

During a meeting to discuss the draft feasibility report, Council stated that it would not be able to excavate Anzac Parade for the installation of pipework. Council also stated that it was unlikely that the service corridors built in to the light rail system, to enable services to cross the light rail system, would be of sufficient size for AWCS pipes. The locations and sizes of the light rail service corridors were to be investigated by Council to confirm whether this was the case.

Due to these constraints, the area-wide AWCS options for Kensington are considered unviable. In addition, all options for Kingsford, other than a modified Option 1b (AWCS pipes in the back streets), are also considered unviable.

Following the meeting, Council shared some plans for ‘proposed through site links’ for Kensington and Kingsford Town Centres. In Kingsford, the potential site shared way/laneways could assist with an improved design for a modified Option 1b. As a result a new Option, Option 1c, has been developed to make the best use of the potential new shared laneways. This modifies the pipe routing to avoid the light rail system when crossing Anzac Parade to reach the east side where the collection station is proposed to be located.

In Kensington, the potential through site shared way/laneway offers opportunities to lay AWCS pipework in back streets, but the shared way coverage does not provide sufficient opportunities for an area-wide AWCS. There is also the issue of not being able to cross the light rail system to reach the east side of Anzac Parade and the Racecourse where the collection station is proposed to be located. As a result, it appears that a local AWCS using mobile vacuum vehicles is a more feasible solution for Kensington Town Centre.

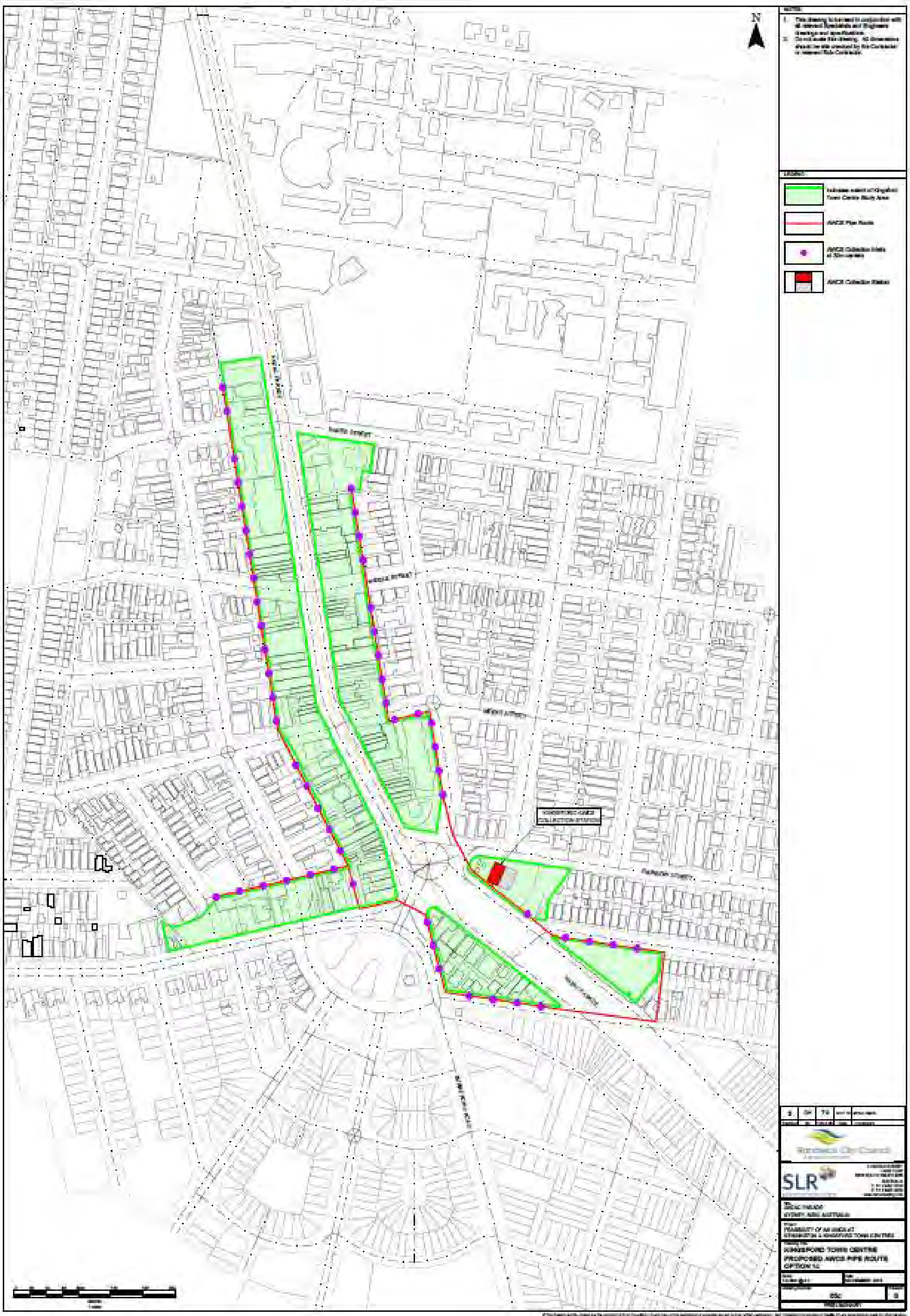
To summarise, two further options have been developed for consideration:

- Hybrid Scheme – Option 1c for Kingsford and a local AWCS for Kensington (named as Option 1c on the financial charts in section 4.5);
- Local AWCS – Both Kensington and Kingsford operate a local AWCS (named as Option 7 on the financial charts in section 4.5).

4.4.4.1 Hybrid Scheme – Option 1c

Figure 4-13 below shows an AWCS design for a standalone area-wide scheme in Kingsford with a collection station located at the Rainbow Street site. The figure shows the pipe network along the secondary streets parallel to Anzac Parade and the pipe route crossing Anzac Parade at the junction with Sturt Street, which is south of the light rail terminus.

Figure 4-13 Option 1c - Kingsford AWCS avoiding Anzac Parade and Light Rail



As previously commented, it is anticipated that most resident activity, arriving and leaving properties, will be on foot along Anzac Parade. As such Option 1c is a less convenient option for ease of use, but necessary due to the limitations of any installation along Anzac Parade.

4.4.4.2 Local AWCS – Option 7

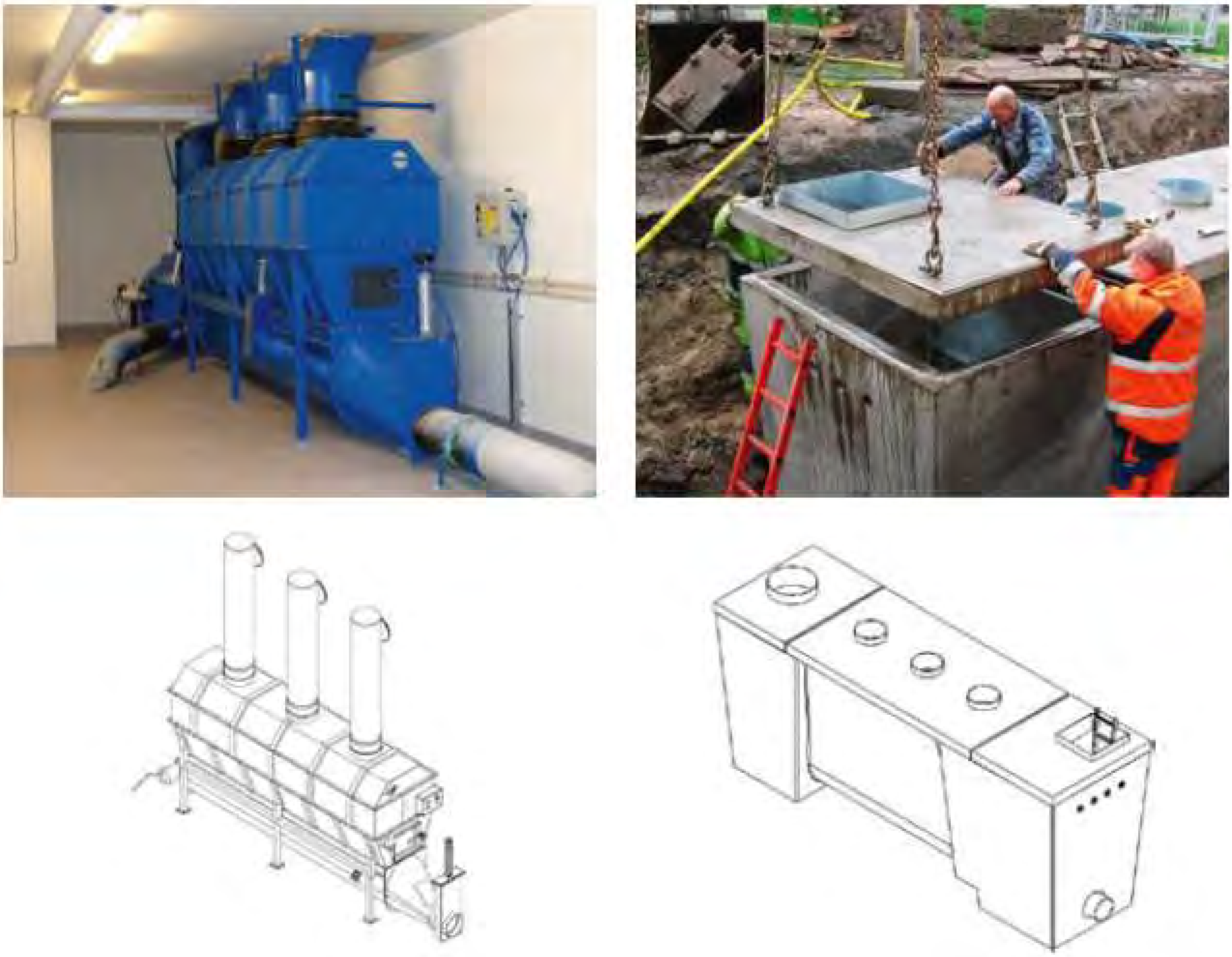
The design of a local AWCS, which would include the number of inlets, locations of inlets and tanks, number of properties and area included in each system and location of docking station, would be determined by the developments to be included in the scheme now and in the future. To avoid disruption to traffic, SLR suggests that the local AWCS could be installed using a staged approach, block-by-block, with one or more docking stations per block. The number of docking stations required will be determined by length of pipework in blocks and the number of tanks to be installed in each block to service residents and/or businesses. A block-by-block solution would require the mobile vacuum collection vehicle to visit each block. Alternatively, where the scale of the development allowed, that is, where the number of apartments and/or commercial floorspace was viable, one docking point could service two or more blocks. This would require connecting pipework to cross the east-west street network, which would cause disruption to traffic during construction.

A local AWCS operated with mobile vacuum vehicles shares many of the benefits and opportunities that an area-wide AWCS with collection station can deliver. The key differences between local AWCS with mobile vacuum vehicles compared to area wide with fixed collection stations are listed below:

- Advantages:
  - Smaller areas, pockets of development and single large buildings can be targeted for AWCS
  - The network of local AWCS can be built up over time, which would allow the speed and extent of AWCS roll out to match available budgets
  - Any construction disruption will be minimised to localised areas as each scheme is developed, which maybe be advantageous given the recent disruption to Anzac Parade with the light rail construction.
- Disadvantages:
  - Potential for high initial costs and redundancy in the mobile vacuum vehicle whilst the first phase local AWCS schemes are constructed. This could particularly be the case if local AWCS is going to be implemented in new build apartments only as opposed to retrofitting all existing areas;
  - Although a reduction in the amount of time waste vehicles spend in the area will be achieved, access to and through the areas will still be required for mobile vacuum vehicles (whereas a collection station can be located remote from district centres and closer to the strategic highway network to remove the majority of waste collection vehicles). It should be recognised, as detailed elsewhere in this report, that both schemes will still require waste vehicles to access the area for certain waste streams which cannot be deposited in an AWCS inlet.

The design requirements for a local AWCS in terms of inlets, pipework and other infrastructure, will be the same as an area wide scheme, with Section 3.5 providing preliminary design information, albeit the inlets feed a tank below ground, pipe lengths and potential number of curves within the local network would be reduced and the pipe would terminate at a suction outlet or docking point. Figure 3-1 illustrates the underground storage tank and pipework feeding to a docking point and mobile vacuum vehicle. Tanks can either be located in building basements or external to buildings, as shown in the photos in Figure 4-14 , which also includes tank design drawings and typical tank sizes and volumes.

Figure 4-14 – Screw Tanks for Local AWCS



Storage tanks – facts

Screw tanks	SCT - B2	SCT - A2	SCT - B4	SCT - A4
Minimum floor area, Length x Width	4000x1850 mm	4000x1850 mm	6000x1850 mm	6000x1850 mm
Theoretical storage volumes	2.8 m³	3.9 m³	5.4 m³	7.7 m³

As per the inlets on an area wide AWCS, the tanks will be fitted with fill level sensors to provide an alert when reaching full status. It is probable that the mobile vacuum vehicle would operate a regular collection round incorporating each docking point such that wastes are removed prior to reaching the alert fill level.

As the photographs in Figure 3-2 demonstrate, there are various options for docking point installation, location and integration within surrounding environment, and as such inclusion of docking points within the shared way or laneways are anticipated to be viable. The caveat to this is that the widths of the shared way or laneways and ability to turn into and out of them must be suitable for the mobile vacuum vehicle dimensions. As previously detailed, one docking point can service multiple tanks, with potentially 30 tanks capable of being connected to a single docking point. Detailed design of a local AWCS would need to consider the cost benefit of additional pipe lengths in order to utilise a reduced number of docking points versus a larger number of docking points and shorter pipe lengths. All of the suction equipment is located on the vacuum vehicle itself.

The latest generation of mobile vacuum vehicles have a payload of 8 t. The number of properties which can be served by one vehicle will be dependent upon several project specific factors including:

- property type
- wastes collected, residential only or also commercial wastes
- the number of waste fractions separated
- the number of households per tank
- the number of tanks per docking point
- potential congestion and time spent by the vehicle in traffic
- and importantly the distances and time which the vehicle has to travel to a tipping or disposal point.

An estimate of the potential dwelling numbers that can be serviced by one mobile vacuum vehicle has been calculated at between circa 2,200 and 5,600 depending on whether conservative or optimistic assumptions are applied; assumptions and summary calculations are shown in Table 4-2. The trip numbers achieved per day is the most significant variable.

Table 4-2 Estimated Number of Apartments Serviced by One Mobile Vacuum Vehicle

	Conservative	Optimistic
Payload of Mobile Vacuum Truck (t)	7.5	8
Trips Per Day to Tipping Point (number)	1	2
Daily Payload (t)	7.5	16
Days per Week Vehicle Operated (days)	5	6
Weekly Payload (t)	37.5	96
Weekly Waste Arisings per Apartment (kg)	17	17
Number of Apartments Serviced by One Vehicle	2,206	5,647

The key benefits of a local AWCS compared to the existing service offering are similar to the benefits of the area wide AWCS, with the primary benefits outlined in 3.1 and relating to an increase in footprint available for internal building use and external amenity areas as bin stores are removed, reduction in health and safety risks, reduction in waste collection vehicle movements. With a local AWCS however, if only one or two areas or buildings are connected, then wastes from all other buildings would remain on the existing waste collection scheme, and thus the benefits of AWCS would be significantly reduced.

Local AWCS and the use of mobile vacuum vehicles is well established with the company Envac developing the systems in the late 1980s. A list of reference projects is included in Table 4-3below.

Table 4-3 Example Local AWCS Projects

Location	Number of Apartments	Number of Fractions	Number of Tanks	Length of Pipe (m)
Essinge Udde, Stockholm, Sweden	900	1	34	1100
Ryesgade 4, Copenhagen, Denmark	161	1	5	110
Tomasjordnes, Tromso, Norway	600	5	17	600
Hammarby Sjostad, Stockholm, Sweden	2400	2	270	3800
Norumshojd, Gothenburg, Sweden	800	2	86	1849
AKB Stjernen, Fredriksberg, Denmark	626	1	36	1000
Lyngmyra BL, Trondheim, Norway	234	2	12	490
Bo01, Malmo, Sweden	1000	2	70	1632
Sandviken Brygge, Bergen, Norway	260	2	12	100
Fort d'Issy, Paris, France	1600	2	50	1780

The example installations of local AWCS are all located in Scandinavia. ENVAC's APAC office has highlighted a potential concern when using mobile systems in hot climates. Collection vehicles are not fitted with odour abatement due to space constraints on the vehicle. This is a potential concern, however, SLR notes that mobile systems are used in warm climates, such as France without apparent concerns and that conventional waste collection vehicles are also not fitted with odour suppression systems. As a result, there may be little if any difference in odour emissions.

Should a local AWCS be of interest to Council, then it is suggested that dialogue with the Envac team in Scandinavia is opened up to explore in greater detail the use of mobile vacuum vehicles. Should Council choose to progress with the AWCS then odour potential and mitigation could be one of the issues explored in a trial.

4.5 Financial Assessment

A high-level financial analysis has been completed in Microsoft Excel to estimate the capital and operational costs associated with the development of each of the design options presented above. The financial analysis considers the costs over 20 years, although as noted above the anticipated life of the system is expected to be much greater. More details of the yearly amounts can be found in Appendix C.

4.5.1 Area-Wide AWCS Key Assumptions

A number of assumptions have been applied in the high-level financial assessment. The key assumptions are summarised below:

- Costs associated with land purchase or lease for collection station(s) are not included
- Costs associated with the design, planning and environmental permitting of the collection station(s) are not included
- Financial benefits for new build developments associated with space saving from avoided bins stores is not included. A calculator available on the ENVAC website indicates that 3,650 m^2 of floor space will be gained with the new 5,200 apartment developments by implementing an AWCS
- Cost of pipework and inlets are derived from a previous AWCS quotation in Australia with inflationary uplift applied or from consultation with an AWCS supplier

- 50% uplift applied to cost of inlet per additional waste fraction to be collected
- Trenching costs for pipework assumed at A$300 per metre based on SLR experience of civils costs
- Cost of collection station equipment derived from consultation with an AWCS supplier
- 25% uplift applied to cost of collection station equipment for each additional waste fraction to be collected in excess of the base case of two material fractions
- Costs for collection station construction, such as civils and architectural, based on an assumed building size of 26 x 14 m and a cost per square metre of A$1,095 derived from the RLB Rider Digest
- 5% allowance made for project administration and quality assurance
- Capital costs are profiled over five years as shown in the table below.

Table 4-4 Capital Cost Profile Assumptions for Area Wide AWCS

Year	1	2	3	4	5
Pipe network	50%	50%			
Waste inlets and air inlet valves	20%	20%	20%	20%	20%
Pipework installation and trenching costs	50%	50%			
Collection station equipment	100%				
Uplift for additional fractions	100%				
Collection station building and architecture	100%				
Project administration and quality assurance	100%				

- Operational costs include electricity costs, supervisor(s) and operation and maintenance (O&M) costs.
  - Electricity costs are based on electricity costs from a previous AWCS quotation in Australia with inflationary uplift applied and with costs pro-rated based on the number of inlets
  - Addition of a third waste stream (food waste) is assumed to result in a 10% increase in electricity costs
  - Supervisor and O&M costs are based on estimates from a previous AWCS quotation in Australia with inflationary uplift applied with costs pro-rated based on the number of collection stations;
  - For options with two collection stations on different sites (Options 1a and 1b) it is assumed that a 10% saving could be realised in supervisor and O&M costs
  - For options with two collection stations at the same site (Option 6) it is assumed that a 25% saving could be realised in supervisor and O&M costs
- Operational costs are inflated at 3.5% per annum over the 20-year financial model period
- All costs associated with the removal of waste from the collection station(s) by vehicle and downstream management (processing, treatment, disposal) are excluded from the assessment.

4.5.2 Local AWCS Key Assumptions

A number of assumptions have been applied in the high-level financial assessment. The key assumptions are summarised below:

- Capital costs associated with purchase and installation of local AWCS, that is, inlets, tanks, pipework, docking stations, assumed on a per-apartment basis using typical cost provided by AWCS supplier ENVAC
- Capital costs of local AWCS are profiled over five years assuming 20% of scheme is installed each year
- Capital costs associated with purchase of mobile vacuum collection vehicle are assumed at A$1.25 million. This is a conservative cost estimate provided by AWCS supplier ENVAC and applied in Year 1. The capital costs for a replacement vehicle are included in Year 11. The vehicle cost in Year 11 is inflated from Year 1 at 3.5% per annum
- The hybrid option requires one vehicle, and the Local AWCS option requires two vehicles based on high level calculations regarding potential number of apartments, typical waste generation mass per apartment and the payload of the vacuum collection vehicle
- Operational costs, based on information provided by AWCS supplier ENVAC, associated with the local AWCS assumed on a per-apartment basis per annum
- Operational cost per apartment is inflated at 3.5% per annum over the 20-year financial model period
- All costs associated with the removal of waste from the mobile vacuum collection vehicle(s) and downstream management, such as processing, treatment, disposal, are excluded from the assessment.

As the projected capital and operational costs for the local AWCS system are based on apartment numbers, SLR developed a series of calculations to convert the cumulative plot areas by block to a potential number of apartments per block using proposed building height information supplied by Council.

The financial model has been designed to be flexible and allow changes to the key input assumptions as these items are refined.

4.5.3 Financial Assessment Outputs

As shown by the capital cost profile above in Table 4-4, capital costs are only included for the first five years of the project, after which all pipework and equipment is assumed to be installed and thereafter only operational costs are incurred. The hybrid AWCS and local AWCS option includes a spike for capital cost in Year 11 associated with the purchase of replacement of one or more vacuum collection vehicles.

The total costs (capital and operational) are shown by year and cumulatively in Figure 4-15 and Figure 4-16 respectively. The yearly total annual costs show a large variation in Year 1, ranging from about A$4.8 million for Option 4 to about A$14.3 million for Option 6. This reflects the nature of the reduced capital works involved with Option 4, associated with reduced pipe lengths and no requirement for construction of a collection station and purchase of collection station equipment, and the more significant capital works of Option 6, involving the construction of two collection stations, which are closely followed by Options 1a and 1b, and also involve construction of two collection stations.

After Year 1, the cost variation narrows and follows a similar trajectory, reflecting the capital costs in Years 1-5 and then operational costs only from Year 6 onwards. The exceptions are Options 1c and 7, which include a spike for replacement vacuum collection vehicle(s) in Year 11.

In Year 20, the maximum operational cost is about A$2 million (Option 1a) and the minimum operational cost about A$1.1 million (Option 7) with a range of about A$1 million.

Figure 4-15 - Annual Capital and Operational Costs

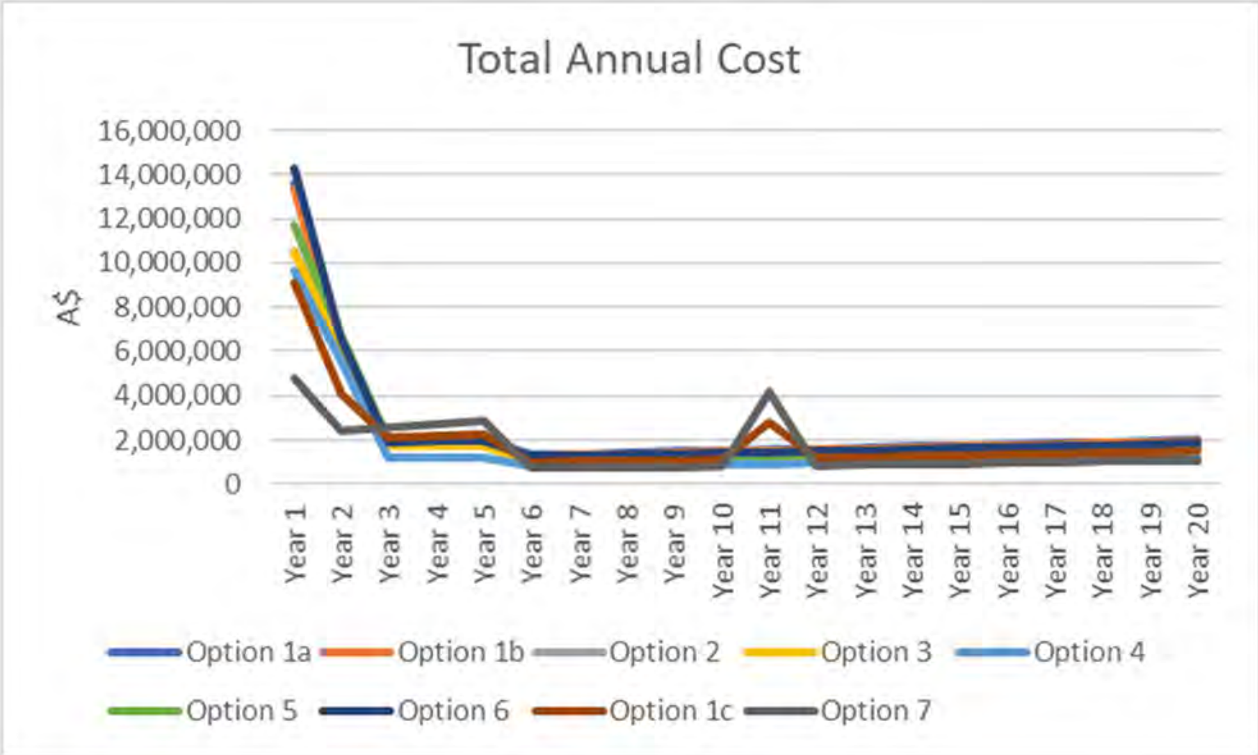
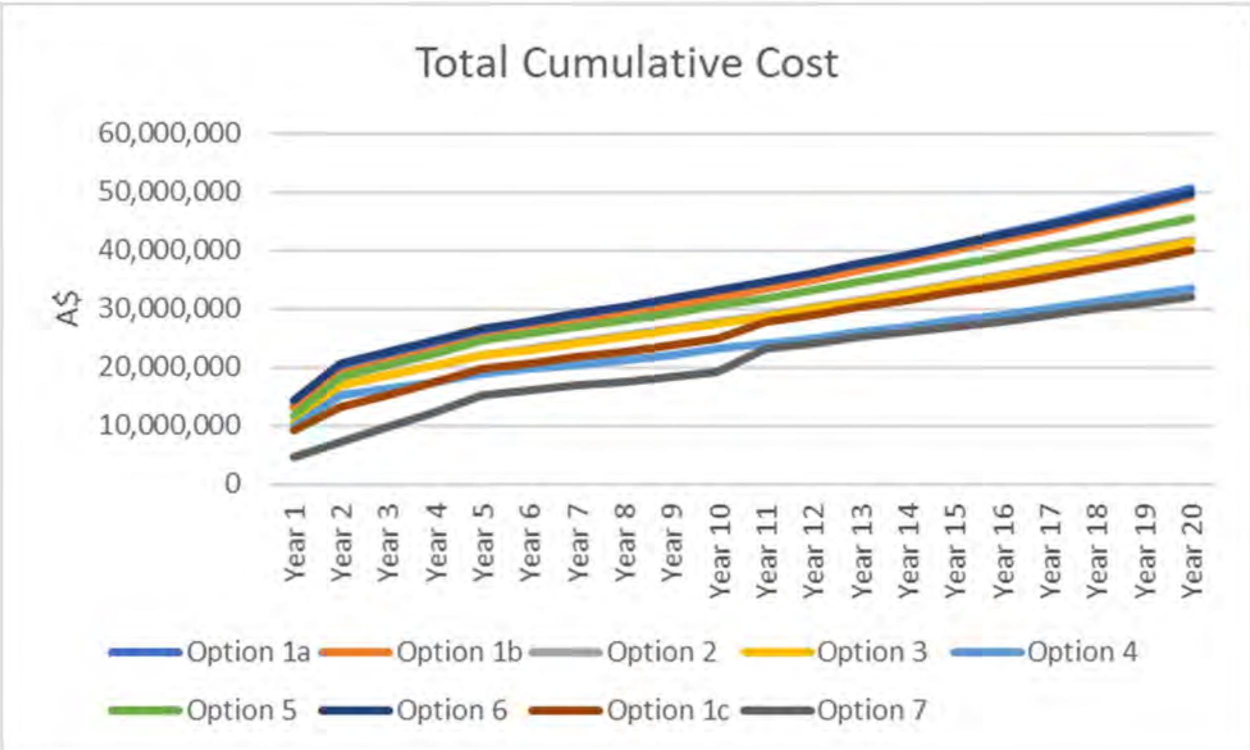


Figure 4-16 - Cumulative Capital and Operational Costs



The cumulative capital and operational costs over the 20-year model period ranges from about A$32.1 million (Option 7) to about A$50.5 million (Option 1a). This results in a variation of cost of about A$18.5 million depending on the design parameters and system assumed. Option 1a, 1b and 6 are closely aligned; likewise, Option 2 and 3 are closely aligned. Figure 4-17 presents the Year 20 cumulative cost to allow visibility of all options.

The lowest cost option for an area-wide AWCS, as might be expected, is Option 4, which has an increased inlet spacing of 50 metres, compared to 30 metres for the other options, which results in 71 inlet points in total compared to 108 to 116 for the other options assessed. It should be noted that Option 4 is based on Option 2 and therefore only includes one collection station, at the Racecourse (see Figure 4-5). Consultation with an AWCS supplier indicates that, based on the estimated waste tonnages, one collection station would result in 24-hour operations and maintenance activities at night, which are not considered to be best practice.

Figure 4-17 - Year 20 Cumulative Capital and Operational Costs

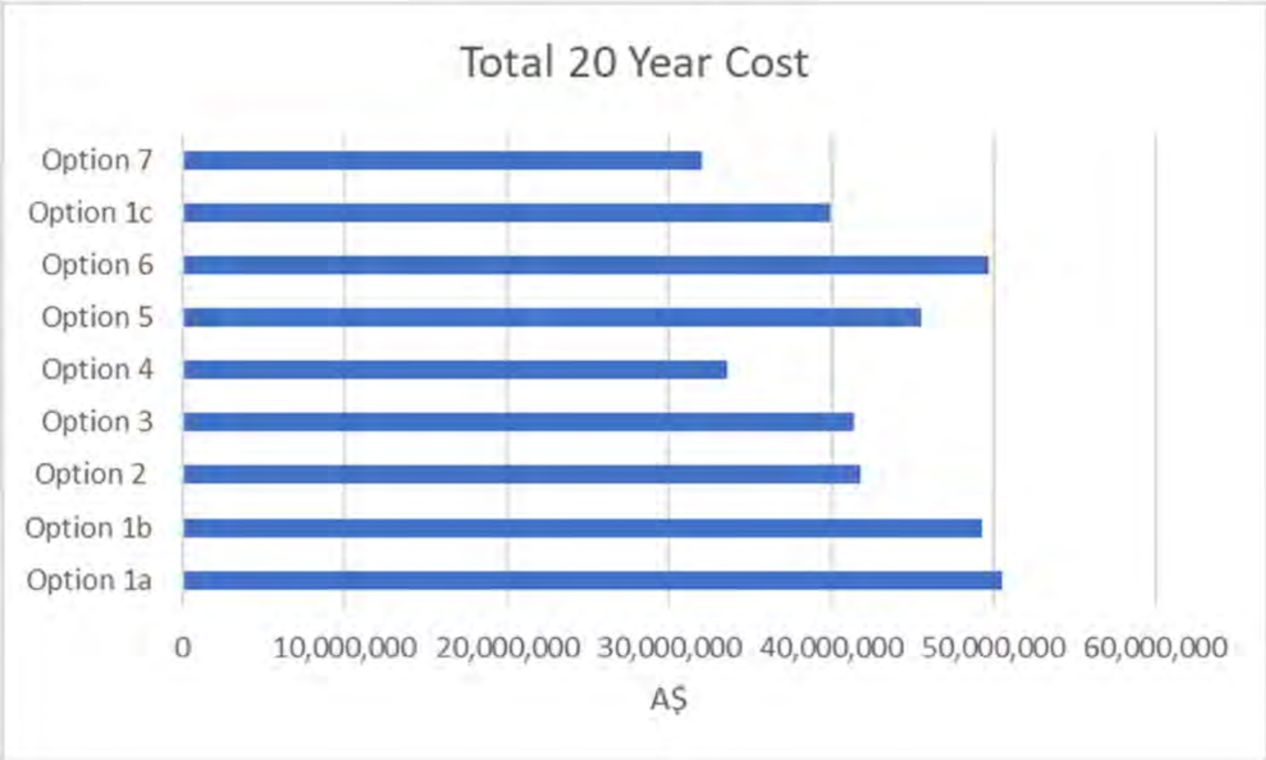


Figure 4-18 - Example Split of Capital and Operational Costs Year 1 – 5 (Option 1a)

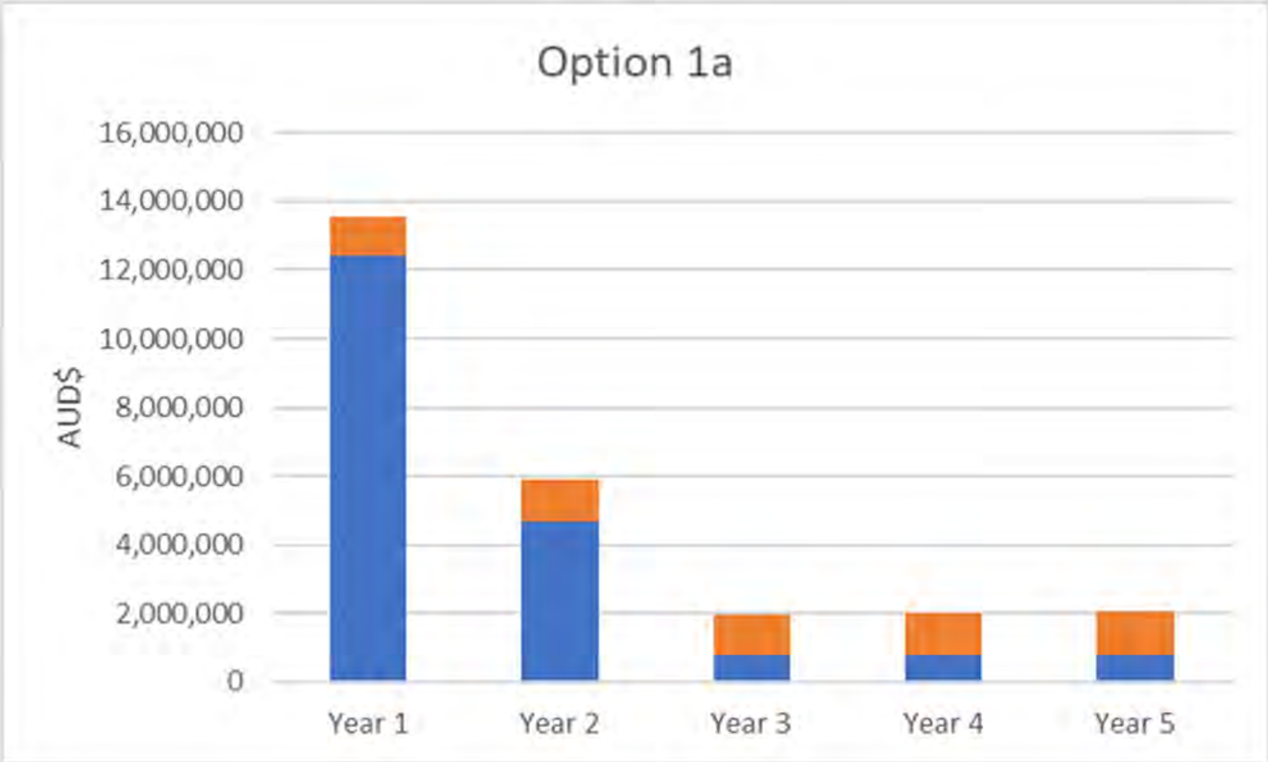


Figure 4-18 above is an example showing the split of annual costs by capital and operational. By the end of Year 2, the pipe network and collection stations are assumed to be installed, therefore the capital cost activities in Years 3 to 5 relating to the installation of additional inlets.

Table 4-5 below provides summary commentary on the cumulative costs of each option and the potential viability of the option.

Table 4-5 - Total Cumulative Costs and Commentary of Option Viability

Option	Total Cumulative Cost	Commentary on Option Viability
Option 1a	A$50,548,087	Two collection stations to future-proof the AWCS scheme for new developments. Collection stations are stand alone and therefore potentially limited opportunities for operational cost efficiencies. Both collection stations would require construction in Year 0 as pipework is unconnected between Kensington and Kingsford.

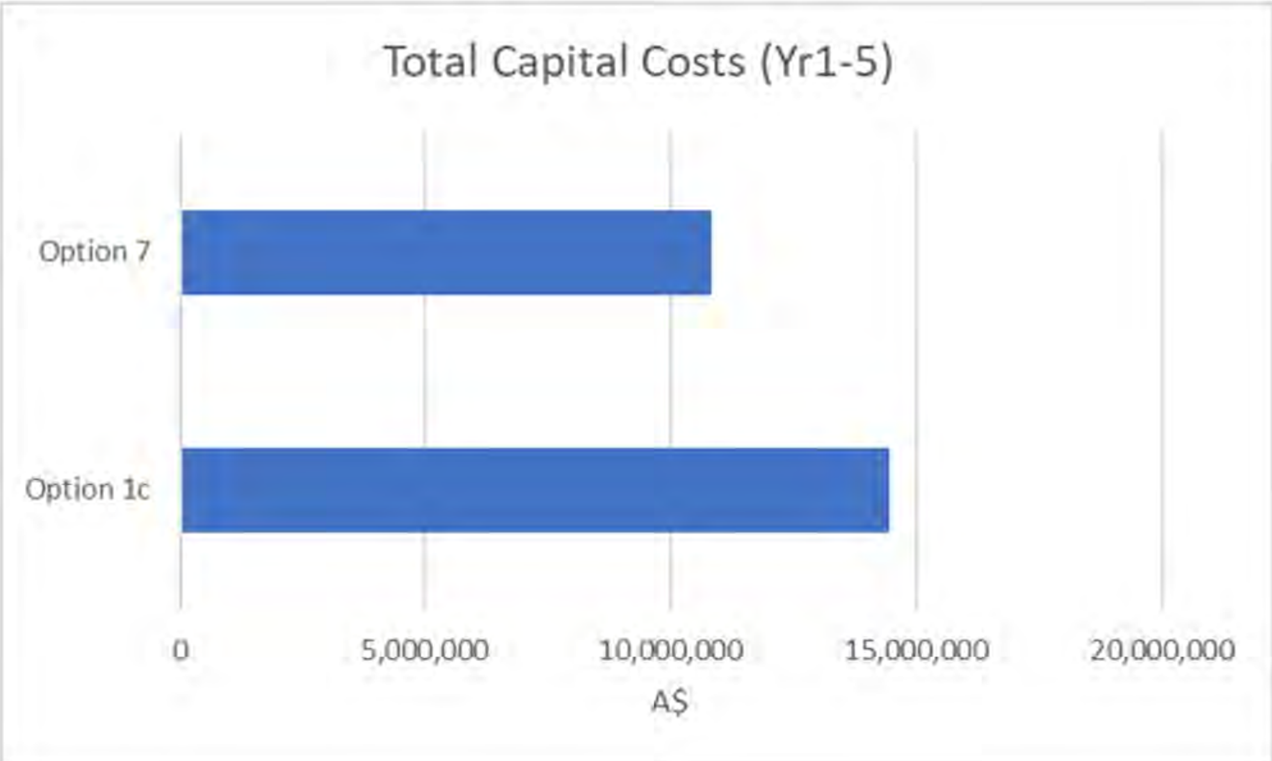
Option	Total Cumulative Cost	Commentary on Option Viability
Option 1b	A$49,277,398	Two collection stations to future-proof for new developments. Installation of Kingsford AWCS in the back streets results in a lower capital cost (125 metres less pipework and 6 less inlets based on outline design), however there are some properties which will not be as well serviced in terms of walking distances, and there may be a perception that the scheme is not as easy to use as a scheme where the inlets are located on Anzac Parade for use as people exit their apartment buildings to access shops, businesses, transport options.
Option 2	A$41,799,468	Single collection station which may require night time operations and potentially limits AWCS resilience to any maintenance requirements or temporary shut downs.
Option 3	A$41,438,745	Single collection station which may require night time operations and potentially limits AWCS resilience to any maintenance requirements or temporary shut downs.
Option 4	A$33,621,682	Increased inlet spacing to 50 metres results in reduced scheme costs but introduces a risk of reduced ease of use and reduced user satisfaction and therefore increased risk of accidental or deliberate misuse and dumping of waste. This option also has a single collection station which may require night time operations and potentially limits AWCS resilience to any maintenance requirements or temporary shut downs.
Option 5	A$45,501,926	The addition of a third waste stream (food waste) to the AWCS results in about A$2 million increase in costs associated with additional inlets and collection station equipment. This option also has a single collection station which may require night time operations and potentially limits AWCS resilience to any maintenance requirements or temporary shut downs.
Option 6	A$49,730,188	Two collection stations to future-proof for new developments. Although co-location of two collection stations at the Racecourse site results in the requirement for connecting pipework between Kingsford and Kensington (not required in Option 1a), it does offer the potential for operational savings which offset the additional capital expenditure. Traffic movements related to waste vehicles are also restricted to one location in the study area. Potential for one collection station to be constructed in Year 0 to service existing tonnages, with second collection station to be constructed later when waste quantities grow from new developments.
Option 1c	A$39,904,899	The hybrid option delivers an area-wide AWCS for Kingsford. The area-wide scheme ensures the removal of the greatest number of vehicle movements from the study area. There are a large number of pipe turns in Option 1c, from the western pipe run due to the avoidance of crossing the light rail system. If this option is to be considered further SLR recommends that AWCS suppliers are consulted to ensure the scheme would be viable and obtain advice on any increases in equipment specification or power consumption which may arise from the required pipe route south to Sturt Street for crossing Anzac Parade. In Kensington, a local AWCS is implemented and it is assumed that one collection vehicle would be sufficient to service the requirements of the potential number of apartments.
Option 7	A$32,057,698	The local AWCS is installed for both Kensington and Kingsford and two vacuum collection vehicles will be required to service the requirements of the potential number of apartments. As mentioned previously, the local AWCS scheme could operate block-by-block or could cross blocks in order to minimise the number of docking points, and therefore vehicle stopping points. The latter would result in additional pipe network costs and construction disruption to traffic during construction.

Based on the waste estimates to date and discussions with an AWCS supplier, an area-wide option which includes two collection stations would seem prudent (Options 1a, 1b, 6). However, increased inlet spacing (Option 4), addition of food waste collection (Option 5) could both be modelled with two collection stations. Furthermore, given the significant uncertainty surrounding the waste estimates and to who the scheme will be targeted, existing buildings and/or new buildings, residential and/or commercial waste, SLR would recommend that all options are retained for further investigation.

However, following discussions with Council, SLR was advised that there was no opportunity to excavate Anzac Parade for the installation of pipework and that it was unlikely that the service corridors built in to the light rail system to enable services to cross the light rail system would be of sufficient size for AWCS pipes. Council was investigating the locations and sizes of service corridors to confirm whether this was the case.

Considering the above, the area-wide AWCS options for Kensington are considered unviable. Options 1c and 7 therefore, remain the two options which remain feasible, as they avoid construction on Anzac Parade and the crossing of the light rail system. Council further advised SLR that a capital budget has been identified for the AWCS project of A$6.4 million and A$7.6 million for Kingsford and Kensington respectively. This is a total of A$14.0 million. Figure 4-19 below summarises the capital costs for the two feasible options.

Figure 4-19 Capital Costs Year 1 – 5



Option 7 is the only option which is within the total Council budget allocation of A$14 million. Option 1c is marginally outside of the budget (3% higher than assigned budget), however, given the high-level nature of the cost estimation in this feasibility assessment SLR suggests that it should not be removed from the shortlist of potentially viable options on the basis of cost alone.

4.6 Indicative Program

The program in Table 4-6 presents a project program which identifies the key events to delivery of an AWCS from concept agreement through to final construction and commissioning. As only one option meets the affordability envelope set by Council, the below program is based on a local AWCS scheme. In total, with the support, capital funding and commitment of Council, two and a half to three years is the minimum time required for an AWCS to commence operations.

Options for phasing of the AWCS scheme are addressed in Section 4.6.1 below.

Table 4-6 Outline Program of Development of AWCS Scheme

Task	Year 1				Year 2				Year 3			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Soft Market Testing of AWCS Suppliers.	■											
Refinement of scheme requirements - apartment numbers, waste quantities, target areas for pilot scheme and first phase of construction.		■										
Procurement of AWCS Supplier.			■									
AWCS supplier scheme design - inlet locations, pipe routes, docking point locations				■	■							
Council Approval.						■						
Procurement of Vacuum Collection Vehicle including manufacture and supply							■	■	■			
Installation of pipe network and docking station and connections to plots known to connect to the scheme from commencement.							■	■	■	■	■	⇨
Connection of buildings to local AWCS.									■	■	■	⇨
Commissioning.										■	■	⇨

Any new developments going through the planning system should be required to identify space, either internally in a lobby or basement, or externally within the property boundaries, for the inlet locations and storage tanks. Developers should also be aware of, and ensure they make provision for, pipe routing from the tank locations to the anticipated pipe connection point.

4.6.1 Phasing of the AWCS

The local AWCS lends itself to a phased implementation much more so than an area-wide system, where a collection station and most pipework would be required from project commencement. AWCS schemes, including pilot projects, could be develop concurrently in Kensington and Kingsford, with the sharing of a single collection vehicle until a critical mass is connected. They could also be installed under separate timescales if desired. As the redevelopment of the Kensington and Kingsford town centres is likely to occur over several years, it is also likely that the connection to the local AWCS will take several years, and therefore reaching the total potential apartment numbers and waste quantities may not occur for many years.

4.7 Additional Collection Services Required

As outlined in previous sections, there are restrictions on what material types or quantities can be used in an AWCS. In general garden waste, bulky waste and large quantities of glass, not as a bag of co-mingled materials, should not be deposited in an AWCS and therefore alternative collection systems must be put in place to manage these streams. Cardboard can also be an issue depending on the size and quantity and the design of the system, some supplementary information regarding cardboard management methods is also included.

4.7.1 Garden Waste

Council currently collects garden organics using the green lid bin and this system would need to be retained. Given the nature of the study area, SLR assumes that few households, if any, would require a garden organics collection.

SLR also assumes that any green spaces, as part of an apartment block or commercial space, requiring maintenance would be contracted to a landscaping company, and that the contract in place would require removal of all organic waste by the contractor.

4.7.2 Bulky Waste

Council currently collects bulky waste using a kerbside system and this system would need to be retained. As the AWCS would not handle bulky waste, and that the service and costs would be the same for all options, the costs associated with bulky waste collections not included in this feasibility assessment.

Planning approvals for new developments should include the requirement to assign space for a temporary storage area, ideally secured by building management, for the interim storage of bulky waste while waiting for collection.

4.7.3 Glass

Glass which is disposed of as part of mixed recyclables is acceptable in an AWCS. Larger quantities of glass, more than 10% of the total weight of waste, or segregated glass, such as might be generated from certain commercial premises such as bars or restaurants, are not acceptable due to the impact and erosion risks. See sub-section 3.5.4. Should the recycling system for households require the separation of glass, or commercial premises generating high quantities of glass wish to use the AWCS, then the glass must be collected using a separate conventional collection system.

4.7.4 Cardboard

Cardboard can pose a problem in AWCS due to its size and bulk. Small items of cardboard can be collected in a standard AWCS, larger items of cardboard, such as corrugated carboard packing, may not be acceptable, depending on the design of the system.

One AWCS supplier has designed a cardboard shredding system which is integrated into its AWCS. In March 2017, Bergen in Norway became the first location in the world to install an ENVAC inlet dedicated to shredding cardboard in a public area (Figure 4-20). Now, all residents can dispose their cardboard boxes using ENVAC's system. The cardboard is shredded as it enters the inlet before it is transported to the collection station using airflow. In the next 12 months, a cardboard shredding system will be installed in the Barking and Dagenham development in London, UK.

Figure 4-20 - Cardboard Inlet in Bergen, Norway

Source: ENVAC

Due to the bulkier size and greater expense of the cardboard shredding inlets, it is possible that they could be installed at selected locations only, and/or at key commercial locations where they could also be accessible to residents.

5 Other Considerations

This section reviews other licencing and funding considerations for an AWCS project and also outlines the potential for Council to develop a pilot project if it wishes to install and operate a small scale AWCS system prior to implementing a full scale AWCS to cover the whole study area.

5.1 Development Approvals and Licensing

The following approvals and licences are potentially applicable to the AWCS.

5.1.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) provides the overarching legislative framework for the assessment and determination of the development within NSW. The EP&A Act Division 3.4 identifies the framework for local plan-making authorities, being local councils within the relevant local government area to develop local environmental plans.

5.1.2 Randwick Local Environmental Plan 2013

The *Randwick Local Environmental Plan 2013* (RLEP) provides the primary land use controls applicable to the site, including the site zoning, with associated implications for approvals requirements under the EP&A Act.

The RLEP identifies the site extents aligning with the B2 and SP2 zoned land in the Kensington and Kingsford town centres. The B2 land contains the primary retail, commercial and high-density residential components of the centres, with the SP2 zoned land containing the major thorough fares bisecting the centres. The land use controls applicable to the centres and the implications for approvals are discussed below.

5.1.2.1 B2 Local Centre Zone

The B2 zoning permits all land uses other than those identified as prohibited, which includes: *Resource recovery facility* and *Waste disposal facility*.

Resource recovery facilities are defined as:

> *'a building or place used for the recovery of resources from waste, including works or activities such as separating and sorting, processing or treating the waste, composting, temporary storage…'*

Waste disposal facilities are defined as:

> *'a building or place used for the disposal of waste by landfill, incineration or other means,'*

The AWCS provides an interim collection point for waste, transferred via underground pipes to a consolidated collection station for transport by truck to a resource recovery facility. The AWCS performs the same function as a waste bin, only with a consolidated collection point and the associated environmental benefits. Consequently, the system is not defined as a resource recovery facility.

The proposal would not provide the ultimate disposal of waste and is not therefore defined as a waste disposal facility. Consequently, the proposal would be permissible with consent in the B2 zone.

5.1.2.2 SP2 Infrastructure Zone

The SP2 zoning permits the following land uses with consent:

'The purpose shown on the Land Zoning Map, including any development that is ordinarily incidental or ancillary to development for that purpose.'

The specific categorisation of the SP2 zone is '*Infrastructure*', with roads and associated infrastructure being the applicable use. The RLEP defines roads as per the *Roads Act 1993*. Under the *Roads Act 1993* a road is defined as including:

'…(c) any bridge, tunnel, causeway, road-ferry, ford or other work or structure forming part of the road.'

Where the waste system is included on the paved area within in the road reserve it can be identified as '*other work or structure forming part of the road'* and would be permissible in the SP2 zone.

In summary, the waste system is permissible with consent in both the B2 and SP2 zones under Part 4 of the EP&A Act.

5.1.3 State Environmental Planning Policy (Exempt and Complying Development Codes) 2008

State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 (Codes SEPP) identifies development that is either Exempt or Complying Development. Part 2, Division 1, Subdivision 39C Waste storage containers states:

'The installation of a waste storage container in a public place (within the meaning of the Local Government Act 1993) is development specified for this code.'

The waste storage container must be located in accordance with an approval granted under the *Local Government Act 1993* (LG Act). Consequently, subject to an approval under the LG Act the construction of the bins can be undertaken as Exempt Development without the need for planning approval. However, the Codes SEPP does not specifically identify the system of transfer pipes and collection station as Exempt Development. Consequently, approval under Part 4 of the EP&A Act would still be required for transfer pipes and collection station.

5.1.4 Local Government Act 1993

Section 68 of the LG Act, Part C Management of waste, includes the need for LG Act approval for:

'1 For fee or reward, transport waste over or under a public place…

3 Place a waste storage container in a public place'

The AWCS would meet both the above criteria. Consequently, once Part 4 approval under the EP&A Act is obtained for the AWCS, other than the bins, approval under the LG Act will be required.

5.1.5 *Protection of the Environment Operations Act 1997*

Section 48 of the *Protection of the Environment Operations Act 1997* (POEO Act) identifies licensing requirements for premises based scheduled activities, with these included in Schedule 1 of the POEO Act. Schedule 1 identifies the following activities of potential relevance:

34 Resource recovery comprising:

> *'recovery of general waste, meaning the receiving of waste (other than hazardous waste, restricted solid waste, liquid waste or special waste) from off site and its processing, otherwise than for the recovery of energy.'*

The AWCS is not recovering material, only transferring it to the collection point. Consequently, it is not considered that the AWCS meets the definition of a resource recovery facility under Section 34 and an environmental protection licence (EPL) is not required.

41 Waste processing (non-thermal treatment) comprising:

> *'non-thermal treatment of general waste, meaning the receiving of waste (other than hazardous waste, restricted solid waste, liquid waste or special waste) from off site and its processing otherwise than by thermal treatment.'*

The AWCS does not process waste, only transferring it to the collection point. Consequently, the AWCS is not defined as a waste processing facility under Section 41 and an EPL is not required.

42 Waste storage comprising:

> *'waste storage, meaning the receiving from off site and storing (including storage for transfer) of waste.*
>
> *(1A) Waste is taken to be stored at premises for the purposes of this clause even if the waste is only being transferred at those premises between units of rolling stock, motor vehicles or trailers.'*

The AWCS site comprises the full area serviced by the system. While the waste would be transferred across lot boundaries via the underground pipe network to a central collection point it would not leave the overall site serviced by the AWCS. Consequently, it is not considered that the AWCS meets the definition of a waste storage system under Section 42 and an EPL is not required.

5.2 Recommended Amendments to Council's Existing Controls in Section B6

Section B6 of the *Randwick Comprehensive Development Control Plan 2013* (DCP) addresses recycling and waste management requirements in the development application process for demolition, construction and ongoing use of developments.

Where introducing the AWCS, amendments to the DCP will be required to incorporate appropriate measures for the inclusion of waste and recycling inlet infrastructure within new, and potentially existing, buildings or development sites and to guide the connection of private AWCS infrastructure to the public AWCS infrastructure.

Given the significant differences between traditional waste management systems and the AWCS, it is recommended that the DCP be updated with a subsection to address development in the AWCS implementation areas, rather than a revision of the existing wording of the DCP to accommodate both systems. A land application map should be prepared, defining areas to be included in the AWCS scheme and subchapter prepared addressing the following development controls:

- Identify estimated quantities of general waste and recycling be generated on the premises
- The provision of suitable and accessible waste and recyclable inlet location(s) within new and existing buildings
- Minimum qualifications or certification for those designing, installing and maintaining private AWCS infrastructure
- Minimum detailed design and documentation standards required for Development Application submission.
- Details to be included on DA plans and drawings including:
    - Location of inlet infrastructure
    - Path of pipe system within building(s)
    - Means of connection of private AWCS infrastructure to the public system.

5.3 Other considerations

During the course of this assessment, a number of other matters to assist with the implementation of the AWCS have been identified. These include:

- Updates and significant additions will be required to the Randwick City Council Waste Management Guidelines for Proposed Developments and associated appendices. These documents are likely to contain the bulk of the technical details and specifications for the installation and ongoing use of AWCSs in private residential and commercial developments. This information should be developed in close consultation with the ultimate provider of the AWCS system.
- Implementation of the scheme will require the update of Randwick Council Development Application forms.
- Consideration should be given to the appointment of Approved Contractors for the design, construction and maintenance of private and public AWCS infrastructure. See 0 for more about funding and operational models.

5.4 Pilot Project

Whether Council decides that an area-wide AWCS, a local AWCS or hybrid scheme, is the preferred solution to meet its objectives, it may wish to develop a pilot project in the first instance. The pilot project could be developed to test the system, its installation approach, any potential issues regarding conflicts with existing services, operability, and user feedback and satisfaction. A pilot project could be designed to test certain options and parameters such as inlet spacing and whether to include food waste collection.

SLR recommends that a pilot project be designed to operate with a mobile vacuum unit in one or two discrete areas. Any design of the pilot project pipe network and inlet configuration should have consideration for the potential future connection to a fully implemented area-wide or local AWCS to avoid incurring additional costs for the system installed at pilot stage.

One potential barrier to the development of a pilot project is the capital cost associated with the purchase of a mobile vacuum collection unit, which is estimated at this time to be about A$1.25 million. It may be that a vehicle could be leased for the pilot project period, but the potential redundancy of that investment should the area-wide system be implemented must be considered. The potential cost and finance options for a mobile vacuum collection unit would need to be discussed with AWCS suppliers.

5.4.1 Pilot Project Program

The program for a pilot project is anticipated to be very similar to the program outlined in Chapter 4.6 and Table 4-6 above for the full local AWCS scheme. This is because the same key design considerations must be made, even for a pilot project, and a supplier and a mobile vacuum vehicle procured, manufactured and delivered. As such, the timescales are unlikely to be reduced by much for a pilot project. The only exception is if a mobile vacuum vehicle could be leased, in which case, depending on the size of the pilot and amount of construction required for inlets, tanks, pipes and docking stations, the connection and commissioning date could potentially be brought forward by three to six months.

6 Funding Options

6.1 Grant Opportunities

There is a range of grant opportunities available to fund elements of the construction, installation and operation of the proposed AWCS. These are shown in Table 6-1 below.

Table 6-1 - Grant opportunities

Grant Name	Grant Provider	Amount of Grant Funding	Grant Qualification Requirements	Grant Availability	Link to further information
National Collaborative Research Infrastructure Strategy (NCRIS) 2018	The Federal Government under the NCRIS	A different amount is available each year. Rates for individual projects are not given but the total available to spend per year is: 2019-20: $159.962 million 2020-21: $163.641 million 2021-22: $167.732 million 2022-23: $171.925 million	This grant must be used for funding nationally significant assets, facilities and services to support leading edge research and innovation. It is available to publicly and privately funded users across Australia and internationally.	Close 30 June 2023.	**Error! Hyperlink reference not valid.**
Road Safety Awareness and Enablers Fund Phase Two	The Federal Government	$700,000 available	To be eligible for a grant you must: • have an Australian Business Number • be registered for the purposes of GST • have an account with an Australian financial institution. • You and the project must be located in Australia. And, be one of the following legal entity types: • a company incorporated in Australia • a company incorporated by guarantee • an incorporated trustee on behalf of a trust • an incorporated association • a partnership • a joint (consortia) proposal with a lead organisation • a not-for-profit organisation • a publicly funded research organisation as defined in the Glossary • an Australian local government body • an Australian state or territory government body	Close 15 November 2019 6pm.	https://www.grants.gov.au/?event=public.GO.show&GOUUID=33971064-060B-AF2B-F6BA666C5004FA0D

			• an Aboriginal and/or Torres Strait Islander Corporation registered under the *Corporations (Aboriginal and /or Torres Strait Islander) Act 2006* Those ineligible include: • individuals • unincorporated associations • overseas residents and organisations • any organisation not included in the section above.		
Major Resource Recovery Infrastructure Program	*Waste Less, Recycle More* Initiative managed by both the NSW EPA (under the waste and recycling infrastructure fund) and the NSW Environmental Trust	Offers grants to cover up to 50% of the capital costs of the proposed new resource-recovery infrastructure, up to $1–5 million for projects proposed by the private sector and not-for-profit organisations	Private industry or partnerships can apply if they are fit the definition in the *Corporations Act 2001*. This program is aimed at accelerating and stimulating investment in waste and recycling infrastructure to help meet the NSW 2021 recycling targets. The program is designed to fund major resource recovery facilities that can increase recycling of waste materials from households and businesses in a cost-effective manner. Priority will be given to proposals that focus on • recovery of recyclables from sorted and unsorted waste from business and households • reuse, recycling and reprocessing of recyclable materials from business and households such as plastics, timber, paper, cardboard, consumer packaging and tyres • processing, stabilisation and energy recovery from residual business and household waste This infrastructure focuses on the processing and recovery of sorted household waste.	Round 4 applications closed on 27 August 2019 and are currently being assessed. These grants are awarded every few years. The next round of grants will not be until 2020 at the earliest.	https://www.epa.nsw.gov.au/working-together/grants/infrastructure-fund/major-resource-recovery-infrastructure
Community Road Safety Grants	NSW Government's Transport for NSW Centre for Road Safety	Grants of up to $5,000 for projects that improve road safety awareness in local communities and $30,000 for larger projects	The Community Road Safety Grants Program allows community groups and charity or not-for-profit organisations across NSW the opportunity to deliver local safety projects. Locally run projects will help increase road safety awareness and support safer road use. Community grants will create opportunities that:	Grants closed 22 September 2019. A new round opens 2020/2021	https://roadsafety.transport.nsw.gov.au/aboutthecentre/communitygrants/index.html

			• Allow community organisations to develop road safety projects in their local areas in partnership with other groups • Encourage safer road user behaviour and reduce road trauma • Contribute to achieving targets in the NSW Road Safety Plan 2021 for reducing deaths and serious injuries on our roads. Community projects should align with the internationally recognised Safe System approach. This approach takes a holistic view of the road transport system and the interactions among the main components within the system. These include the road users, roads, roadsides, vehicles and travel speeds, which all have a role within the system to help keep people safe. It may be possible to argue that the AWCS, particularly in small spaces where there would be significant congestion with truck access, would reduce road deaths and serious injuries in line with those targets.		
My Community Project	The NSW Government's Improving NSW - Projects and Initiatives	Between $20,000 and $200,000 has been allocated to each successful project	Successful projects align with one or more of the six program categories: • **Accessible communities** – Makes everyday life more inclusive to all community members by increasing accessibility and mobility. • **Cultural communities** – Adds to the cultural and artistic life of the community by increasing opportunities for residents to participate in arts and cultural activities. • **Healthy communities** – Supports the community's physical and mental wellbeing, by enabling healthy and active lifestyles. • **Liveable communities** – Improves local amenity and environment. • **Revitalising communities** – Fosters stronger community bonds, encourages social engagement and participation in public programs.	Voting has closed as of 15 August 2019. These may reopen in future.	https://www.nsw.gov.au/improving-nsw/projects-and-initiatives/my-community-project/

			• **Safe communities** – Promotes a safe and secure community where people can participate and enjoy the benefits of community life. This program is about improving community and wellbeing. Other eligibility criteria include: • Be open, accessible and available to the wider community • Have any other required funding sources confirmed, if additional funding is required to complete the project • Be within a NSW state electorate • Be a legal activity • Be deemed viable. The AWCS could contribute to a liveable and safe community, due to reduced road traffic, and contribute to the environment through reduced emissions.		
Increasing Resilience to Climate Change	Local Government NSW	Grants between $30,000 to $120,000 are available to individual councils.	This funding is provided to address climate change risks and vulnerabilities facing NSW councils. Key criteria for this grant include: • Addressing climate risks and building adaptive capacity • Partnering and collaboration • Scalability and replicability • Has effective project planning • Value for money Local Government NSW uses a climate change risk assessment to determine eligibility. To show this, they need: • A climate change risk assessment, meeting Australian standards (AS/NZ 4360 or ISO 31000) completed in the last five years. This can be obtained through Statwide Mutual Corporation, Sustainability Advantage or Guide to Climate Change Risk Assessment for NSW local Government. • A climate change vulnerability assessment completed within the last five years which includes participation in	The Climate Change Fund is providing $2.8m of funding over three rounds. Applications for Round 2 have closed since 2 September 2019. One round remains which will open in 2020-2021. Round 3 funding terms will be for 12 months.	https://www.lgnsw.org.au/policy/increasing-resilience-climate-change. A recording of a webinar about the selection process is available on this site.

			cross government Integrated Regional Vulnerability Assessments or Enabling Regional Adaption projects from OEH. • To provide alternative documentation showing how a climate change risk has been previously identified, that it's still current, and what work has been done to determine the suitability of the project as an adaptation project Grants then evaluated by a technical committee who makes recommendations to a management committee, with members from local government NSW and the DPIE.		

6.2 Delivery and Ownership of Vacuum Waste Systems

Grant funding can assist with elements of this kind of waste infrastructure, but it can only go so far. The bulk of costs will be borne by the parties involved, Council and/or its partners. One of the main considerations in this regard is the ownership and operational structure for the various components that make up the system.

Typically, waste management is a role undertaken by municipal authorities however, with an AWCS, few municipal authorities have the capacity to provide the capital costs to set up the collection system.

The *Local Government Act 1993* sets out the general responsibilities, powers, and functions of Councils. These include providing best value for residents and ratepayers, responsible and sustainable spending and effective financial and asset management. Under Section 55 of the Act, Councils are required to tender for certain contracts, generally for amounts over $250,000. As any AWCS system, or associated plant, vehicles or services, is likely to be over this amount, Council should plan to go through an appropriate tender process, open or by invitation. Council might also prepare a probity plan and/or engage a probity auditor to ensure the process is lawful and accords with probity requirements and community expectations.

The Act also governs how councils are funded. Because the AWCS would be collecting domestic waste it could be funded under the annual domestic waste management charge.

6.3 Potential Ownership and Funding Models

6.3.1 Traditional Procurement

Most waste infrastructure is procured in Australia using traditional procurement models that require the government authority to retain ownership. There are a number of variations to this model, which are described below.

Construct Only

Under this model an authority prepares a design, either in-house or through an independent consultant, then calls for tenders from construction firms to build the facility to the design for a fixed price. The authority is responsible for operating and maintaining the facility, either using its own staff and management or one or more third-party contractors.

Design and Construct

Under this model, an authority develops a performance specification that describes the outcomes that a proposed facility must achieve and the requirements it must meet. The authority then issues a tender to which private design and construct contractors respond. The preferred contractor will design and construct a facility that meets the performance specification for a fixed price. The authority is responsible for operating and maintaining the facility, either using its own staff and management or one or more third-party contractors.

Design, Construct and Maintain

Sometimes referred to as a design, build and maintain, or a DCM model, this is the same as a design and construct arrangement but with the additional specification that the contractor must also maintain the facility for a certain period, usually between 10 and 30 years. The contractor does not own the facility, but is paid a fixed monthly fee for planned activities as well as additional fees for any unplanned activities. Payments may be linked to performance. Payments may be withdrawn or reduced if the facility is not available or fails to perform at specified levels.

Under this model, contractors are able to design and build the facility in a way that minimises the design, construction and maintenance costs, which reduce whole-of-life costs for the authority. Tenderers for large DCM projects often involve several specialist contractors working together, who each undertake different roles in the joint venture.

Design, Construct, Maintain and Operate

Design, construct (or build), maintain and operate (DCMO/DBMO) models are similar to the DCM model but as well as maintaining the facility, the contractor also operates it for a specified period. The contractor does not own the facility. This is a common delivery model for waste management facilities under which activities are contracted to an entity for a specific period, perhaps 15 to 20 years. Large projects often involve several specialist contractors who take different roles in the joint venture and are more or less involved over the life of the facility.

Managing Contractor

An authority appoints a managing contractor who then engages subcontractors through a competitive tender process to prepare a design for the facility and construct it. The managing contractor is typically engaged early in the process to assist the authority define the scope, develop the design and prepare work packages. The managing contractor is paid a fixed fee and is reimbursed for the amounts paid to subcontractors. The managing contractor may also receive incentive payments for achieving cost, time and quality targets. Once construction is complete the authority is responsible for the maintenance of the facility.

Alliance

Under this model, all the major parties, the authority, the contractor and the designer, agree to collectively share all risks associated with the design and construction of the facility. Maintenance of the facility is not normally covered by an alliance contract. Contracting under this arrangement is complex. The contract includes a sophisticated ‘cost plus’ system where the authority pays the contractor’s and designer’s direct costs as well as a fee on account of profit margin and contribution to overheads that is adjusted upwards or downwards depending upon the collective performance of the alliance members against agreed key performance indicators.

The main benefit of this arrangement is that participants agree to a ‘no blame’ regime, under which they give up any entitlement to make claims against each other for poor performance or negligence. This encourages alliance participants to accept stretch targets, and abandon adversarial behaviour designed to protect legal positions.

This model is particularly suited to risky projects, or projects with uncertain or changing scope, for which it is difficult to calculate a fixed price.

Operator Franchise

Under this model, the authority engages a contractor to operate and maintain infrastructure owned by the authority. The infrastructure is often uneconomic to duplicate, so ownership stays with the authority to avoid a contractor establishing a monopoly of indefinite duration. The result is effectively a franchise, which is open to tender from time to time to encourage competition, innovation and value for money. These kinds of franchises are common in the transport sector.

6.3.2 Public Private Partnership Models

Increasingly new waste infrastructure is being delivered under public private partnership (PPP or 'P3') models. In a PPP, unlike traditional procurement, it is usually the private sector that finances and builds the infrastructure and is ultimately responsible for its condition and performance over the life of the project.

Governments generally retained the responsibility providing core services. This is often the case where they have responsibilities to the general public using the service, as would be the case with local councils and waste collections. Non-core services are included in the private sector scope and typically include maintenance, cleaning and security. In some cases, governments have expanded the scope of private sector provision to include core services although this depends on the complexity and nature of the project and the project's ability to be decoupled from government operations. It also depends on the economic and political climate and government appetite for risk transfer at a particular point in time.

A range of PPP models are discussed below.

Lease, Develop and Operate

Under a lease, develop and operate (LDO) model a private company is granted a long-term lease to operate and expand an existing facility. The company is responsible for maintenance and operation and agrees to invest in facility improvements and can recover the investment plus a reasonable return over the term of the lease. This model provides a platform for the private sector to perform well but does not require any capital investment from the private sector.

Build, Own, Operate and Transfer

The purpose of a build, own, operate and transfer (BOOT) structure is to limit the cost liabilities to the public sector. Typically BOOT projects involve the design, construction, maintenance and operations for a period, perhaps 20 to 50 years. BOOT projects are usually fully financed by the private sector which also takes on revenue risk. At the end of the contract period, the facility is returned to government ownership. This kind of model is usually used for infrastructure such as toll roads, long distance rail, utilities such as electricity and water, and telecommunications.

BOOT is a good solution for most projects, especially if the government has a large infrastructure financing gap. It minimises the public cost by taking advantage of private sector efficiencies for minimal investment. Often there are incentives to the private organisation developing the infrastructure, such as tax breaks. BOOTs also reduce public debt because the private sector absorb the debt of the initial phases. Governments can balance their budget but their influence in the infrastructure's development is reduced. Governments can put the saved money towards other programs, thus allowing them govern and meet infrastructure requirements at the same time.

Private sector contractors can apply their expertise and develop innovative solutions, usually not possible when the private sector is not involved. As a result, both parties play to their strengths. Public sector provides structure and cost containment while the private sector provides efficiencies and resource access, allowing projects to be completed faster. A project's development by two parties also fosters more trust in the feasibility of the task as two parties are monitoring it.

Although often used for linear transport projects, BOOT structures are not best for all infrastructure projects. They are not likely to be beneficial for urban road and rail projects. For utility services, it is possible that privatisation of networks might provide even greater gains. In addition, they may be suitable for large-scale infrastructure projects such as large buildings but not for a small number of street front shops such as a strip mall.

The private sector will not be attracted until funds are in place to begin project planning. As a result, the public sector often looks for private entities which already have a funding mechanism in place to complete the proposed project. In addition, large revenues must be generated during the operational phase to attract the private sector. BOOT contracts have long transfer waiting times because by stretching out the relationship private organizations increase the chances of making returns on their investments, plus profits, before losing control of the project.

BOOT projects require strong corporate governance and can often fail due to lack of communication between the private and public sectors. When the project is managed poorly on the private side, the public side must be able to step in. If the public sector has limited expertise in infrastructure, then the private sector can take advantage of this. Both sides must have knowledge of the complexity, competitiveness, and risks involved to ensure a balanced relationship.

BOOT projects can also have higher transaction costs than other contract opportunities and can be time-consuming.

Build, Own and Operate

Build, own and operate (BOO) projects operate in a similar way to BOOT projects, except that there is no transfer of ownership, the private sector owns the facility in perpetuity. The long term right to operate the facility provides the developer with significant financial incentive for capital investment although they may be subject to regulatory constraints on operations and, in some cases, pricing.

BOO is best suited to projects that involve significant investment and operating content. It is often the step before privatization and can be a good solution for toll roads. However, it has similar drawbacks as BOOT projects and there is unlikely to be help from the public sector in financial crises.

Build, Operate, Lease and Transfer

Under the build, operate, lease and transfer (BOLT) model, the government gives concession to a private entity to build a facility and, at the end of the project, transfers ownership to the government. It is an effective way to deliver public services and has the benefit of full authority to government. On the down side, the private sector has limited motivation to engage in this model due to the transfer of ownership.

Build, Own and Maintain

A build, own and maintain (BOM) arrangement involves the private sector developer building, owning and maintaining a facility. The government leases the facility and operates it using public sector staff. This differs from BOOT because full authority remains with the public sector.

Rehabilitate, Own, Operate and Transfer

Rehabilitate, own, operate and transfer (ROOT) is largely the same as a BOOT but applies to the rehabilitation of an existing facility rather than the construction of a new one. It is suitable for capacity expansion and road upgrading and for projects that involve a significant investment or operating content. It's disadvantages are similar to BOOT.

6.3.3 AWCS PPP Examples

Two vacuum waste collection system have been installed under PPPs, Maroochydore in Queensland and Hammarby Sjöstad in Sweden. The precise model used in each case is not known, however, in the Australian example, Sunshine Coast Regional Council's agency, SunCentral Maroochydore Pty Ltd, partnered with a private environmental technology company in Sweden to install the system.

Half the $21 million development cost was funded by developers, while the other half is expected to be fully recovered from occupants of the development over the life of the system. This system is a 6.5 km network of pipes covering over 52 hectares of land in Maroochydore, which the Government is redeveloping into a central business district.

In the Hammarby Sjostad example, a consortium model was used where the developers formed a company with individual shares according to their unit holdings. The company owns the system including the pipes, terminal and equipment installed inside the buildings. When the developer sells the units, their shares are transferred to the housing association, the building owners. The company provides the upfront capital investment and has a contract with a private vacuum waste company for operations and maintenance. The City of Stockholm charges a lower waste collection tariff for all neighbourhoods serviced by the underground waste system.

Based on these two examples, local context considerations are important for choosing the PPP model, such as legislation and regulation. Some common areas of consideration for PPP to develop, build, and operate an AWCS are determining who will design and build the system as well as operate and maintain it. In addition, deciding how it will it be funded, under what financing model, who will provide the funding for construction, operation and maintenance and once built who will own the assets and how will capital and recurrent expenditure be recovered. During the process, who will make and approve decisions at different stages of the work flow.

In addition, consideration must be given to the need for pipe infrastructure to be installed in Council rights-of-way. Council approval of the design and location of the piped infrastructure as well as the central collection terminal will be required. Legal agreements would be in place to require building connections and to address owner and operator access for operations and maintenance.

In summary, potential simplified ownership and operational structures for AWCS are shown in Table 6-2 below.

Table 6-2 – AWCS ownership and operational structures

Option	Description
Option 1 - Municipal Authority	Council provides the investment for the entire system including the terminal, pipe network and inlet networks. Individual developers are subsequently charged for each building connected to the system. A usage charge is payable by all building owners, owners' corporations or households connected to the system.
Option 2 - Special Purpose Vehicle	Similar to Option 1 but a separate commercial entity is established to fund and operate the collection scheme.
Option 3 – Private Developer	A private developer replaces Council and provides the investment for the entire system. The developer charges building owners, owners corporations or households connected to the system or may negotiate a rebate from Council to cover the waste collection costs.
Option 4 - BOT	A commercial organisation is appointed to deliver and operate the system over a set period, for example, 20 years, after which the system is transferred to Council to manage thereafter
Option 5 - Intermediary	A variation to Option 1 where Council pays for the collection terminal and the pipe network and each individual developer pays for the inlet network.

Decisions on a proposed option can also be influenced by political and commercial decisions for example:

- In Sweden, collection charges for AWCS users are discounted to reflect the lower collection costs incurred by authorities compared to conventional collections
- Singapore has implemented a planning system which requires all developments over a certain size to connect to an AWCS. Similar approaches are used in many other cities.

6.3.3.1 Examples of adopted solutions

Details of other examples can be found in Appendix D.

Roosevelt Island, New York

This system is owned and operated by the Roosevelt Island Operating Corporation (RIOC), a state agency mandated to manage, develop and operate the system. RIOC owns the vacuum waste system and has an agreement with the City of New York Sanitation Department for operation and maintenance. RIOC is self-sufficient through development revenues and can receive state financial appropriations for special large-scale projects.

City of Barcelona

Barcelona uses an approach where developers pay for the capital installation of underground pipes, builders pay for the in-building connections and receptacles and the City pays for the central collection terminal. The residential property tax includes a waste collection fee and the City has a contract with a private vacuum waste company for operations and maintenance. Each building on the system pays annual maintenance fees to the City.

Wembley, London

This system follows a single-owner-operator model where a single developer provides the capital investment, owns the system, and finances operational costs through a property management fee.

Torrent dels Maduixers, Barcelona

Completed in 2013, a new building for the management of street waste collected in the Sarrià-Sant Gervasi district of Barcelona is delivering a range of benefits to the area's 86 000 local residents and to the city as a whole. As well as improving waste collection services, the facility offers energy efficiency savings, reduces water consumption and provides a new urban space for the community to enjoy.

The new municipal infrastructure has been built underground and comprises two floors with a total area of 2,400 m^2. The lower floor is used to transfer and compact the waste collected every day from the district's streets, pavements, parks and squares.

It also houses geothermal equipment, parking spaces for the street cleaning trucks and charging facilities for a fleet of electric vehicles. The upper floor contains the control room, various storerooms and a classroom for training. The building also has a 3,000 m^2 'green roof' planted with native trees, flowers and shrubs, which has been designed as an urban park for local families.

The project contributes to Barcelona's strategic goal of becoming a 'compact city' to make it economically and environmentally more sustainable. The location of the building means waste collection takes less time which improves efficiency while delivering a better service to local residents. Service quality has also been improved through restructuring street cleaning operations across the district.

Total investment for the project is €4,199,529, of which the EU's European Regional Development Fund contributed €3,359,623.

Maroochydore City Centre

Sunshine Coast Regional Council is installing Australia's first underground automated waste collection system in the new Maroochydore City Centre. The new development is a greenfield site in an existing urban area and will feature 150,000 m^2 commercial floor area, 65,000 m^2 retail floor area and 2000 residential apartments.

Instead of using bins, waste will be transported from commercial buildings and apartments through a 6.5 km system of underground pipes. The system will be installed in stages over the coming decade. The system will eliminate the need for bins and trucks in the Maroochydore City Centre. Other issues such as odour and vermin will also be avoided, and the costs of daily street cleaning reduced.

The ENVAC system will cost $21 million, which will be recovered from occupants of the CBD over the life of the system. Each building in the CBD will have at least three waste inlets, one each for organics, recyclables and general waste. Collected waste will be stored in compactors at a central facility, from where it will collected by Council's contractor. Public areas would be serviced with waste inlets connected to the system.

The development has other smart city technologies including a high-speed fibre optic network which supports 'smart' signage, free Wi-Fi hotspots, real-time transport information, movement sensors and smart lighting.

7 Innovative Alternatives to AWCS

The implementation of an area-wide AWCS is likely to deliver the best achievement of Council objectives for amenity improvement and removal of waste bins and vehicles from the study area. This would be followed by multiple local AWCS schemes. This Section aims to identify other innovative alternatives to remove bins or reduce bin numbers and reduce vehicle movements, which may be of interest to Council if an area-wide AWCS is proven to be technically or financially unviable.

7.1 Underground Waste Collection Chambers

Several manufacturers offer a system of underground waste collection chambers. The general principle involves an above ground waste collection infrastructure (Figure 7-1 and Figure 7-2), in which users deposit their waste, and an underground chamber for waste storage (Figure 7-2). Chamber types and collection methods vary between suppliers. Chambers can include 1100 litre wheeled containers (Figure 7-4 and Figure 7-5) of larger chambers emptied using hydraulic cranes or bags (Figure 7-3). Methods for collecting the waste from the chambers include conventional collection vehicle and bin lift, compaction collection vehicle with modified tail and hydraulic crane fitted, fully modified side arm loading vehicle.

The Citys of Sydney installed an underground system in Royston Street, Darlinghurst in Sydney (Figure 7-5).

Figure 7-1 – Surface infrastructure

Figure 7-2 – Molok underground bins

Figure 7-3 – Other underground bins being serviced

Figure 7-4 – Underground system using conventional bins

Figure 7-5 – City of Sydney's underground system

This type of system will require suitable locations for the chambers allowing full vehicle access, subterranean excavation and construction works. The system would allow the removal of collections of individual bins by building and on the street and may contribute, depending on underground chamber sizes, to a reduced collection frequency, however, waste collection vehicles will still require regular access to the areas.

7.2 Satellite collection vehicles

Widely use in Europe where large collection vehicles cannot enter narrow city centres (Figure 7-6), a fleet of smaller collection vehicles navigates the streets collecting waste (Figure 7-7) before returning to the larger compactor vehicle parked somewhere convenient nearby. The smaller vehicles unload into the larger vehicle (Figure 7-8), which then transport waste for disposal or recycling, or into bins for later collection (Figure 7-9).

Because the range of these vehicles is small, they can be electric powered to reduce noise and emissions (Figure 7-10).

Figure 7-6 - Small sattelite collection vehicle

Figure 7-7 - Smaller vehicles collect a range of bin sizes using conventional lifting systems

Figure 7-8 - Smaller vehicles unload into larger vehicles

Figure 7-9 - Smaller vehicles can also unload into bins for later collection

Figure 7-10 - Smaller vehicles can be electric powered to reduce noise and emissions

7.3 Public Place Collection Bins

Also widely used in Europe where narrow streets, high density living, historic buildings and limited onside storage space prevent a kerbside collection being provided to individual households, are bulk public place bins like those shown in Figure 7-11 below.

Figure 7-11 - Bulk public place bins

These systems are similar to underground collection systems but are entirely above ground. Often they are collected in a similar way by vehicles with hydraulic arms. Some of these are emptied using more conventional front lift systems.

8 Conclusions and Next Steps

This report considers the feasibility of developing an AWCS in the town centre areas of Kensington and Kingsford in the City of Randwick. Following the completion of outline design drawings and a high-level financial analysis, the below conclusions and next steps are presented for Council consideration.

8.1 Conclusions

The key conclusions from this feasibility assessment are summarised below:

- From a pipe network distance perspective, a single integrated AWCS scheme could be delivered, or two separate AWCS schemes
- In large part due being located either side of the north-south oriented Anzac Parade, the study areas lend themselves to a pipe network operating on the east and the west of both Kensington and Kingsford with branches off the main network to accommodate buildings on side streets
- Both sites identified by Council appear to be of sufficient size to accommodate a collection station
- The Rainbow Street site appears to be fairly well defined (see Figure 4-6), the potential location of the Racecourse site is unclear (see Figure 4-5). It would be beneficial to determine whether the Racecourse site could accommodate two collection stations
- Potentially a single collection station could be used in an integrated scheme, however, the viability of this would need to be tested further based on a greater understanding of waste quantities, whether the AWCS will collect residential waste only or residential and commercial waste and the degree of resilience to build into an AWCS
- At the maximum quantities estimated in this assessment, an AWCS supplier has indicated that two collection stations would be required and would ensure best practice and system resilience.
- The recent construction of the light rail system has presented engineering challenges for the installation of a pipe from west to east under Anzac Parade for an area-wide AWCS scheme. Thrust boring or directional drilling for pipe installation may be possible, however, the implications of pipe gradients, installation methods and installation cost and operational cost increases would need to be understood from suppliers
- Council has stated that construction and installation of an AWCS along Anzac Parade is not viable due to the disruption to traffic during construction along this main arterial route. As a result, any system, whether an area-wide AWCS or local AWCS, would need to be installed in the rear shared laneways. Council has indicated that new rear shared laneways are proposed in some areas of Kingsford and Kensington Town Centres.
- The proposed additional rear shared laneways in Kensington would assist with implementation of a local AWCS, however, an area-wide AWCS for Kensington remains unviable.
- In Kingsford there is a comprehensive system of rear shared laneways which will be improved further with new shared laneways. As a result, an area-wide AWCS remains a viable option for Kingsford if the pipe network from the west crosses Anzac Parade at Sturt Street, to avoid the light rail system, the light rail services conduits prove to be of sufficient size, or the use of boring or tunnelling under the light rail system proves to be technically and financially viable.

- Option 1c (hybrid scheme) and option 7 (local AWCS) avoid the crossing of the light rail scheme on Anzac Parade and can incorporate pipe installation largely on the rear shared laneways.
- Despite the additional proposed rear shared laneways, there remain some apartment blocks, for example two at the south of the Kensington Town Centre area, where rear shared laneways will not be available. In such situations, pipework may have to be installed across plots, if all plots are being developed at the same time, or along Anzac Parade if the plots and blocks are to be included in an AWCS scheme.
- Option 7, fully local AWCS, is less than the assigned budget maximum. Option 1c is marginally outside of the assigned Council budget (3% higher), however, given the high-level nature of the cost estimation in this feasibility assessment, SLR suggests that it should not be removed from the shortlist of potentially viable options on the basis of cost alone.
- Whether an area-wide AWCS or local AWCS scheme is adopted, certain waste streams cannot be managed using this system. Consequently, alternative systems and arrangements will need to be made for those waste streams. A key example is bulky waste, which will still require a separate collection service to buildings, and the temporary storage of bulky waste in buildings between collections. The costs associated with such collections will be the same for all AWCS options and have not been calculated in this feasibility study.

8.2 Next Steps

SLR recommends the following next steps in order to further develop the evidence base and support the decision-making process for the AWCS project:

- Develop and refine the waste generation estimates (residential and commercial) to confirm the quantity of waste generated in the study area, currently and in the future;
- Develop and refine the potential residential unit estimates to confirm the potential number of apartments which may be within each block and join an AWCS scheme;
- Develop an understanding of the types of commercial premises in the study area and therefore the types of commercial waste being generated and their appropriateness for an AWCS
- Consider whether the scheme would be operated for residential waste only or residential and (suitable) commercial waste
- Develop a time-based profile of future development of apartments and commercial space to understand at what point in time additional users and quantities will require access to the AWCS
- Develop an understanding of the spatial profile of future development of apartments and commercial space to understand where in the AWCS network growth in waste will be deposited, to inform consideration of whether increased density, or strategically placed inlet points, are required to future proof the AWCS scheme
- Once there is more clarity on the various bullet points above, suppliers could be contacted to gauge interest in the project as part of a soft market testing exercise or expression of interest
- Consult with various parties including suppliers, who hold significant banks of data about their schemes, NSW EPA, resident groups and others, and discuss the AWCS potential project in order to seek opinions about optimum inlet spacing

- Confirm the viability of the Rainbow Street potential collection station location identified by Council, as this is a critical component of the scheme and without which an area-wide AWCS for Kingsford will be undeliverable, or alternative suitable sites will have to be identified
- Review the services installed in the rear shared laneways, pavements and roads to determine whether and where an underground pneumatic pipe network could be best installed
- Review the location and size of service conduits constructed in the light rail scheme to confirm whether crossing under Anzac Parade and the light rail system is viable without requiring the use of boring or directional drilling
- Collate current waste management costs of servicing the study area (residential and commercial) to support development of an Outline Business Case, should the AWCS project remain of interest to Council.

APPENDIX A

Site Drawings

NOTES

1. This drawing to be read in conjunction with all relevant Specialists and Engineers drawings and specifications.
2. Do not scale this drawing. All dimensions should be site checked by the Contractor or relevant Sub-Contractor.

LEGEND

- Indicates extent of Kensington Town Centre Study Area
- Indicates extent of Kingsford Town Centre Study Area

Revision	By	Chk'd By	Date	Comments
0	DH	TG	OCT 19	INITIAL ISSUE

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2 LINCOLN STREET
LANE COVE
NEW SOUTH WALES 2066
AUSTRALIA
T: 61 2 9427 8100
F: 61 2 9427 8200
www.slrconsulting.com

Site
ANZAC PARADE
SYDNEY, NSW, AUSTRALIA

Project
FEASIBILITY OF AN AWCS AT
KENSINGTON & KINGSFORD TOWN CENTRES

Drawing Title
KENSINGTON & KINGSFORD TOWN CENTRES

Scale: 1:5,000 @ A1
Date: OCTOBER 2019
Drawing Number: **01**
Revision: **0**

PRELIMINARY

NOTES

1. This drawing to be read in conjunction with all relevant Specialists and Engineers drawings and specifications.
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LEGEND

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AUSTRALIA
T: 61 2 9427 8100
F: 61 2 9427 8200
www.slrconsulting.com

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Drawing Title
KENSINGTON TOWN CENTRE

Scale
1:2,000 @ A1

Date
OCTOBER 2019

Drawing Number
02

Revision
0

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NOTES

1. This drawing to be read in conjunction with all relevant Specialists and Engineers drawings and specifications.
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LEGEND

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LANE COVE
NEW SOUTH WALES 2066
AUSTRALIA
T: 61 2 9427 8100
F: 61 2 9427 8200
www.slrconsulting.com

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Drawing Title
KINGSFORD TOWN CENTRE

Scale
1:2,000 @ A1

Date
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Drawing Number
03

Revision
0

PRELIMINARY

NOTES

1. This drawing to be read in conjunction with all relevant Specialists and Engineers drawings and specifications.
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LEGEND

- Indicates extent of Kensington Town Centre Study Area
- AWCS Pipe Route
- AWCS Collection Inlets at 30m centers
- AWCS Collection Station

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AUSTRALIA
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F: 61 2 9427 8200
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Drawing Title
KENSINGTON TOWN CENTRE
PROPOSED AWCS PIPE ROUTE
OPTION 1

Scale	Date
1:2,000 @ A1	OCTOBER 2019

Drawing Number	Revision
04	0

PRELIMINARY

NOTES

1. This drawing to be read in conjunction with all relevant Specialists and Engineers drawings and specifications.
2. Do not scale this drawing. All dimensions should be site checked by the Contractor or relevant Sub-Contractor.

LEGEND

	Indicates extent of Kingsford Town Centre Study Area
	AWCS Pipe Route
	AWCS Collection Inlets at 30m centers
	AWCS Collection Station

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F: 61 2 9427 8200
www.slrconsulting.com

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Drawing Title
KINGSFORD TOWN CENTRE
PROPOSED AWCS PIPE ROUTE
OPTION 1a

Scale	Date
1:2,000 @ A1	OCTOBER 2019

Drawing Number	Revision
05a	**0**

PRELIMINARY

NOTES

1. This drawing to be read in conjunction with all relevant Specialists and Engineers drawings and specifications.
2. Do not scale this drawing. All dimensions should be site checked by the Contractor or relevant Sub-Contractor.

LEGEND

- Indicates extent of Kingsford Town Centre Study Area
- AWCS Pipe Route
- AWCS Collection Inlets at 30m centers
- AWCS Collection Station

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NEW SOUTH WALES 2066
AUSTRALIA
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F: 61 2 9427 8200
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Drawing Title
KINGSFORD TOWN CENTRE PROPOSED AWCS PIPE ROUTE OPTION 1b

Scale: 1:2,000 @ A1
Date: OCTOBER 2019

Drawing Number: 05b
Revision: 0

PRELIMINARY

NOTES

1. This drawing to be read in conjunction with all relevant Specialists and Engineers drawings and specifications.
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LEGEND

- Indicates extent of Kensington Town Centre Study Area
- Indicates extent of Kingsford Town Centre Study Area
- AWCS Pipe Route
- AWCS Collection Inlets at 30m centers
- AWCS Collection Station

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LANE COVE
NEW SOUTH WALES 2066
AUSTRALIA
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F: 61 2 9427 8200
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Drawing Title
KENSINGTON & KINGSFORD TOWN CENTRES PROPOSED AWCS PIPE ROUTE - OPTION 2

Scale	Date
1:5,000 @ A1	OCTOBER 2019

Drawing Number	Revision
06	0

PRELIMINARY

NOTES

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2. Do not scale this drawing. All dimensions should be site checked by the Contractor or relevant Sub-Contractor.

LEGEND

- Indicates extent of Kensington Town Centre Study Area
- Indicates extent of Kingsford Town Centre Study Area
- AWCS Pipe Route
- AWCS Collection Inlets at 30m centers
- AWCS Collection Station

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Drawing Title
KENSINGTON & KINGSFORD TOWN CENTRES PROPOSED AWCS PIPE ROUTE - OPTION 3

Scale
1:5,000 @ A1

Date
OCTOBER 2019

Drawing Number
07

Revision
0

PRELIMINARY

NOTES

1. This drawing to be read in conjunction with all relevant Specialists and Engineers drawings and specifications.
2. Do not scale this drawing. All dimensions should be site checked by the Contractor or relevant Sub-Contractor.

LEGEND

- Indicates extent of Kensington Town Centre Study Area
- Indicates extent of Kingsford Town Centre Study Area
- AWCS Pipe Route
- AWCS Collection Inlets at 50m centers
- AWCS Collection Station

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F: 61 2 9427 8200
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Drawing Title
KENSINGTON & KINGSFORD TOWN CENTRES PROPOSED AWCS PIPE ROUTE - OPTION 4

Scale: 1:5,000 @ A1
Date: OCTOBER 2019

Drawing Number: 08
Revision: 0

PRELIMINARY

NOTES

1. This drawing to be read in conjunction with all relevant Specialists and Engineers drawings and specifications.
2. Do not scale this drawing. All dimensions should be site checked by the Contractor or relevant Sub-Contractor.

LEGEND

- Indicates extent of Kingsford Town Centre Study Area
- AWCS Pipe Route
- AWCS Collection Inlets at 30m centers
- AWCS Collection Station

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LANE COVE
NEW SOUTH WALES 2066
AUSTRALIA
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F: 61 2 9427 8200
www.slrconsulting.com

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Drawing Title
**KINGSFORD TOWN CENTRE
PROPOSED AWCS PIPE ROUTE
OPTION 1c**

Scale: 1:2,000 @ A1
Date: NOVEMBER 2019

Drawing Number: **05c**
Revision: **0**

PRELIMINARY

APPENDIX B

Projections of Potential Numbers of Apartments in Study Area

Block Naming Convention

Each block in the Kensington and Kingsford study areas was assigned a unique reference numbers for the purposes of obtaining block areas from CAD plans and estimating the potential number of apartments which could be constructed on each block following redevelopment.

For Kensington, the block reference commenced KE and for Kingsford the block reference commenced KI. Then E or W was added to signify whether it was the east or west side of the study area. Finally, a numerical reference was added, starting at the southernmost block of each study area on each side with the number 1. Hence the final reference is in the format KE_E_1 for the southernmost block on the east side of the Kensington study area.

Assumptions

- Storeys for Commerce – 1.
  - The estimate assumes that all buildings will have commercial at ground floor level, and therefore a nine-storey building will have eight storeys of residential space.
- Plot Area to gross external area (GEA) - 80%
  - According to SLR's analysis of CAD drawings Randwick buildings occupy 59.1% of the available plot space at present. We have assumed that where buildings, or a collection of buildings, are demolished and redeveloped the plot utilisation will be greater. However, it may also be the case that the ground floor level occupies the majority of the plot, but that level 1 upwards is stepped back, thus it may not be possible to multiply the plot size by the number of storeys to obtain a true GEA. We have therefore assumed that 80% of plot area is used to obtain a GEA which is then multiplied by the number of storeys
- GEA to net internal area (NIA) - 85%
  - This assumption was used in the waste tonnage estimation
- Average Unit Size - 116.5 m^2
  - Average unit size as used in the waste tonnage estimation.

Table 8-1 – Potential Number of Apartments in Study Area After Redevelopment – Kensington

Block Reference	Area m^2	HOB Storeys	Residential Storeys	Percent of Block to be redeveloped	GEA ground m^2	Total GEA m^2	Total NIA m^2	Number of Units
KE_E_1	9,575	9	8	100%	7,660	61,280	52,088	447
KE_E_2	1,658	9	8	100%	1,326	10,611	9,020	77
KE_E_3	1,393	16	15	100%	1,114	16,716	14,209	122
KE_E_4	1,588	16	15	100%	1,270	19,056	16,198	139
KE_E_5	7,568	9	8	100%	6,054	48,435	41,170	353
KE_E_6	6,944	9	8	100%	5,555	44,442	37,775	324
KE_E_7	6,109	9	8	100%	4,887	39,098	33,233	285
KE_E_8	5,298	9	8	100%	4,238	33,907	28,821	247
KE_W_1	8,003	9	8	100%	6,402	51,219	43,536	374
KE_W_2	4,680	9	8	100%	3,744	29,952	25,459	219
KE_W_3	1,891	16	15	100%	1,513	22,692	19,288	166
KE_W_4	1,377	16	15	100%	1,102	16,524	14,045	121
KE_W_5	2,820	9	8	100%	2,256	18,048	15,341	132

Block Reference	Area m²	HOB Storeys	Residential Storeys	Percent of Block to be redeveloped	GEA ground m²	Total GEA m²	Total NIA m²	Number of Units
KE_W_6	11,573	9	8	100%	9,258	74,067	62,957	540
TOTAL	**70,477**				**56,382**	**486,047**	**413,140**	**3,546**

Table 8-2 – Potential Number of Apartments in Study Area After Redevelopment – Kingsford

Block Reference	Area m²	HOB Storeys	Residential Storeys	Percent of Block to be redeveloped	GEA ground m²	Total GEA m²	Total NIA m²	Number of Units
KI_E_1	5,663	9	8	100%	4,530	36,243	30,807	264
KI_E_2	2,081	9	8	100%	1,665	13,318	11,321	97
KI_E_3	3,437	15	14	100%	2,750	38,494	32,720	281
KI_E_4	11,722	9	8	100%	9,378	75,021	63,768	547
KI_E_5	7,528	9	8	100%	6,022	48,179	40,952	352
KI_E_6	2,660	16	15	100%	2,128	31,920	27,132	233
KI_E_7	2,650	9	8	100%	2,120	16,960	14,416	124
KI_E_8	6,342	9	8	100%	5,074	40,589	34,500	296
KI_W_1	5,063	9	8	100%	4,050	32,403	27,543	236
KI_W_2	2,865	15	14	100%	2,292	32,088	27,275	234
KI_W_3	1,245	9	8	100%	996	7,968	6,773	58
KI_W_4	4,370	9	8	100%	3,496	27,968	23,773	204
KI_W_5	5,423	9	8	100%	4,338	34,707	29,501	253
KI_W_6	8,107	9	8	100%	6,486	51,885	44,102	379
KI_W_7	6,002	9	8	100%	4,802	38,413	32,651	280
KI_W_8	1,908	15	14	100%	1,526	21,370	18,164	156
KI_W_9	2,852	15	14	100%	2,282	31,942	27,151	233
KI_W_10	6,314	9	8	100%	5,051	40,410	34,348	295
KI_W_11	3,534	9	8	100%	2,827	22,618	19,225	165
TOTAL	**89,766**				**71,813**	**642,496**	**546,122**	**4,688**

The grand total for Kensington and Kingsford is 8,234 m²

APPENDIX C

Tables from High Level Financial Model

Total Annual Cost by Option – A$

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Option 1a	13,573,629	5,889,184	1,983,609	2,020,546	2,058,590	1,345,376	1,385,737	1,427,309	1,470,128	1,514,232
Option 1b	13,363,876	5,700,233	1,911,842	1,947,813	1,984,864	1,310,225	1,349,532	1,390,018	1,431,719	1,474,670
Option 2	10,535,980	6,339,800	1,731,965	1,760,956	1,790,816	1,055,973	1,087,652	1,120,282	1,153,890	1,188,507
Option 3	10,498,979	6,306,740	1,708,042	1,736,712	1,766,241	1,044,256	1,075,584	1,107,851	1,141,087	1,175,320
Option 4	9,671,222	5,566,660	1,193,708	1,215,461	1,237,867	792,345	816,116	840,599	865,817	891,792
Option 5	11,701,101	6,655,379	2,049,355	2,080,212	2,111,994	1,123,930	1,157,648	1,192,378	1,228,149	1,264,993
Option 6	14,266,832	6,507,013	1,904,194	1,938,352	1,973,535	1,244,173	1,281,498	1,319,943	1,359,541	1,400,327
Option 1c	9,121,801	4,082,262	2,081,535	2,163,767	2,250,215	996,049	1,025,930	1,056,708	1,088,409	1,121,062
Option 7	4,791,030	2,422,300	2,561,334	2,708,481	2,864,102	717,819	739,354	761,535	784,381	807,912

	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Total cost over 20 years
Option 1a	1,559,659	1,606,449	1,654,643	1,704,282	1,755,410	1,808,073	1,862,315	1,918,184	1,975,730	2,035,002	50,548,087
Option 1b	1,518,910	1,564,478	1,611,412	1,659,754	1,709,547	1,760,833	1,813,658	1,868,068	1,924,110	1,981,834	49,277,398
Option 2	1,224,162	1,260,887	1,298,714	1,337,675	1,377,805	1,419,139	1,461,714	1,505,565	1,550,732	1,597,254	41,799,468
Option 3	1,210,579	1,246,897	1,284,303	1,322,833	1,362,517	1,403,393	1,445,495	1,488,860	1,533,525	1,579,531	41,438,745
Option 4	918,545	946,102	974,485	1,003,719	1,033,831	1,064,846	1,096,791	1,129,695	1,163,586	1,198,493	33,621,682
Option 5	1,302,943	1,342,032	1,382,293	1,423,761	1,466,474	1,510,468	1,555,782	1,602,456	1,650,530	1,700,045	45,501,926
Option 6	1,442,337	1,485,607	1,530,176	1,576,081	1,623,363	1,672,064	1,722,226	1,773,893	1,827,110	1,881,923	49,730,188
Option 1c	2,834,589	1,189,334	1,225,014	1,261,765	1,299,618	1,338,606	1,378,764	1,420,127	1,462,731	1,506,613	39,904,899
Option 7	4,191,940	857,114	882,827	909,312	936,591	964,689	993,630	1,023,439	1,054,142	1,085,766	32,057,698

Total Cumulative Cost by Option - A$

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Option 1a	13,573,629	19,462,813	21,446,423	23,466,968	25,525,559	26,870,934	28,256,671	29,683,981	31,154,109	32,668,341
Option 1b	13,363,876	19,064,109	20,975,951	22,923,764	24,908,628	26,218,853	27,568,385	28,958,404	30,390,122	31,864,793
Option 2	10,535,980	16,875,780	18,607,745	20,368,701	22,159,518	23,215,491	24,303,143	25,423,425	26,577,315	27,765,822
Option 3	10,498,979	16,805,719	18,513,761	20,250,473	22,016,714	23,060,970	24,136,554	25,244,405	26,385,492	27,560,812
Option 4	9,671,222	15,237,882	16,431,590	17,647,052	18,884,919	19,677,264	20,493,380	21,333,979	22,199,796	23,091,588
Option 5	11,701,101	18,356,480	20,405,836	22,486,048	24,598,042	25,721,973	26,879,621	28,071,999	29,300,148	30,565,141
Option 6	14,266,832	20,773,845	22,678,040	24,616,392	26,589,926	27,834,099	29,115,597	30,435,540	31,795,081	33,195,408
Option 1c	9,121,801	13,204,062	15,285,597	17,449,365	19,699,580	20,695,628	21,721,558	22,778,267	23,866,676	24,987,737
Option 7	4,791,030	7,213,330	9,774,664	12,483,145	15,347,248	16,065,067	16,804,421	17,565,955	18,350,336	19,158,248

	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Total cost over 20 years
Option 1a	34,228,001	35,834,450	37,489,092	39,193,374	40,948,784	42,756,857	44,619,172	46,537,356	48,513,086	50,548,087	50,548,087
Option 1b	33,383,703	34,948,181	36,559,593	38,219,347	39,928,894	41,689,728	43,503,386	45,371,454	47,295,565	49,277,398	49,277,398
Option 2	28,989,984	30,250,871	31,549,584	32,887,259	34,265,064	35,684,204	37,145,917	38,651,482	40,202,214	41,799,468	41,799,468
Option 3	28,771,391	30,018,288	31,302,591	32,625,424	33,987,941	35,391,334	36,836,829	38,325,688	39,859,214	41,438,745	41,438,745
Option 4	24,010,133	24,956,235	25,930,720	26,934,439	27,968,270	29,033,116	30,129,907	31,259,602	32,423,188	33,621,682	33,621,682
Option 5	31,868,084	33,210,116	34,592,409	36,016,170	37,482,644	38,993,112	40,548,895	42,151,351	43,801,880	45,501,926	45,501,926
Option 6	34,637,746	36,123,353	37,653,528	39,229,609	40,852,972	42,525,037	44,247,263	46,021,155	47,848,265	49,730,188	49,730,188
Option 1c	27,822,326	29,011,660	30,236,675	31,498,439	32,798,057	34,136,663	35,515,427	36,935,554	38,398,286	39,904,899	39,904,899
Option 7	23,350,188	24,207,302	25,090,129	25,999,441	26,936,033	27,900,722	28,894,352	29,917,790	30,971,932	32,057,698	32,057,698

Total Capital Costs by Option – A$

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Option 1a	12,413,096	4,693,835	752,400	752,400	752,400	19,364,131
Option 1b	12,233,664	4,536,115	712,800	712,800	712,800	18,908,179
Option 2	9,625,089	5,401,582	765,600	765,600	765,600	17,323,471
Option 3	9,598,194	5,378,932	752,400	752,400	752,400	17,234,326
Option 4	8,987,738	4,862,672	468,600	468,600	468,600	15,256,209
Option 5	10,731,589	5,656,782	1,020,800	1,020,800	1,020,800	19,450,771
Option 6	13,193,598	5,401,582	765,600	765,600	765,600	20,891,980
Option 1c	7,225,944	3,362,093	1,283,178	1,283,178	1,283,178	14,437,569
Option 7	2,167,190	2,167,190	2,167,190	2,167,190	2,167,190	10,835,952

Total Operational Costs by Option – A$

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Option 1a	1,160,533	1,195,349	1,231,209	1,268,146	1,306,190	1,345,376	1,385,737	1,427,309	1,470,128	1,514,232
Option 1b	1,130,212	1,164,118	1,199,042	1,235,013	1,272,064	1,310,225	1,349,532	1,390,018	1,431,719	1,474,670
Option 2	910,892	938,218	966,365	995,356	1,025,216	1,055,973	1,087,652	1,120,282	1,153,890	1,188,507
Option 3	900,785	927,808	955,642	984,312	1,013,841	1,044,256	1,075,584	1,107,851	1,141,087	1,175,320
Option 4	683,484	703,989	725,108	746,861	769,267	792,345	816,116	840,599	865,817	891,792
Option 5	969,512	998,598	1,028,555	1,059,412	1,091,194	1,123,930	1,157,648	1,192,378	1,228,149	1,264,993
Option 6	1,073,234	1,105,431	1,138,594	1,172,752	1,207,935	1,244,173	1,281,498	1,319,943	1,359,541	1,400,327
Option 1c	645,857	720,169	798,358	880,590	967,038	996,049	1,025,930	1,056,708	1,088,409	1,121,062
Option 7	123,839	255,109	394,144	541,291	696,912	717,819	739,354	761,535	784,381	807,912

	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Total cost over 20 years
Option 1a	1,559,659	1,606,449	1,654,643	1,704,282	1,755,410	1,808,073	1,862,315	1,918,184	1,975,730	2,035,002	31,183,956
Option 1b	1,518,910	1,564,478	1,611,412	1,659,754	1,709,547	1,760,833	1,813,658	1,868,068	1,924,110	1,981,834	30,369,219
Option 2	1,224,162	1,260,887	1,298,714	1,337,675	1,377,805	1,419,139	1,461,714	1,505,565	1,550,732	1,597,254	24,475,998
Option 3	1,210,579	1,246,897	1,284,303	1,322,833	1,362,517	1,403,393	1,445,495	1,488,860	1,533,525	1,579,531	24,204,419
Option 4	918,545	946,102	974,485	1,003,719	1,033,831	1,064,846	1,096,791	1,129,695	1,163,586	1,198,493	18,365,472
Option 5	1,302,943	1,342,032	1,382,293	1,423,761	1,466,474	1,510,468	1,555,782	1,602,456	1,650,530	1,700,045	26,051,155
Option 6	1,442,337	1,485,607	1,530,176	1,576,081	1,623,363	1,672,064	1,722,226	1,773,893	1,827,110	1,881,923	28,838,208
Option 1c	1,154,693	1,189,334	1,225,014	1,261,765	1,299,618	1,338,606	1,378,764	1,420,127	1,462,731	1,506,613	22,537,434
Option 7	832,149	857,114	882,827	909,312	936,591	964,689	993,630	1,023,439	1,054,142	1,085,766	15,361,955

APPENDIX D

AWCS Supplier Example Case Studies

ENVAC

Title	GrowSmarter, Stockholm	The City of Bergen	Sunshine Coast Regional Council	Tianjin Eco-City	Tomasjordnes, Tromsø
Country	Sweden	Norway	Australia	China	Norway
Capacity	0.4 tons per day	February 2019, collecting 4 tons/day	13 tons per day	87 tons per day	Unknown
Launched	2017	2015	On-going installation	2012	Unknown
Type of Project	Retrofitting. Static.	Retrofitting. Static.	New build. Static.	New build. Static.	Mobile vacuum system incorporating the OptiBag concept
Pipe network length	Approx 500 metres	N/A Ongoing project	2,000 metres for present stage. When completed: approx 6,500 metres	10,500	600 metres
Waste fractions	General / Organic / Plastic and Paper	General waste / Packaging / Cardboard	General waste / Recyclables / Organic	General waste and organic	Organic, incinerable, plastic, cardboard and paper. Each fraction has a different coloured bag.
No. of Apartments/ commercial users	350	March 2019: 7,000 households, 200 commercial users	2,000	32 residential communities and 20 public buildings	600 apartments, via 17 storage tanks

MariMatic

Title	VTB Arena Park in Moscow	Etne care centre, Rogaland county	Myyrmäki Care Home, Vantaa	New techno park, Park Zaryadye in Moscow	Vällingby Parkstad AEVS
Country	Russia	Norway	Finland	Russia	Sweden
Capacity	unknown	unknown	unknown	unknown	unknown
Launched	unknown	unknown	unknown	unknown	Autumn 2013
Completed	unknown	unknown	Summer 2019	2017	2017
Type of Project	unknown	New build	New build	New build but within historic city centre setting	unknown
Pipe network length	unknown	unknown	unknown	unknown	unknown
Waste fractions	solid and food waste	mixed waste and laundry	unknown	solid waste	three waste fractions
Number of Apartments/ commercial users	N/a. Sports and leisure complex	40 living units for senior citizens of Etne	199 apartments with care for senior citizens	N/a. Public park and recreation space	1400 apartments, commercial and shopping areas

Stream

Title	Al Muneera Al Raha Beach	Al Zeina Al Raha Beach	Adnic Residential Plot	Al Bandar Al Raha Beach	Imperia Puteri Harbour	Royal Malaysian Customs Office and Residential Complex Kelana Jaya
Country	Abu Dhabi, UAE	Abu Dhabi, UAE	Abu Dhabi, UAE	Abu Dhabi, UAE	Johor, Malaysia	Selangor, Malaysia
Capacity	8 tonnes per day	19 tonnes per day	0.84 tonnes per day	3.1 tonnes per day	0.7 tonnes per day	1.5 tonnes per day
Launched	2009	2009	2013	2009	2012	2002
Completed	2011	2011	2013	2011	2014	2004
Type of Project	Stream AWCS Gravity Vacuum System	Stream AWCS Gravity Vacuum System	Stream AWCS Gravity Vacuum System	Stream AWCS Gravity Vacuum System	Stream AWCS Hybrid system	Stream AWCS Gravity Vacuum System
Pipe network length	2,000 m	2,800 m	174 m	1,100 m	200 m	800m
Waste fractions	Mixed Waste and Recyclable Waste.	Mixed Waste and Recyclable Waste.	Mixed Waste and Recyclable Waste.	Mixed Waste and Recyclable Waste.	General waste	General waste
Development	Residential	Residential	Residential	Residential	Mixed Development	Mixed Development

Logiwaste

Title	Tiller Øst	The Solbjers district, Lund	Grilstad Marina, Trondheim
Country	Norway	Sweden	Norway
Capacity	The system is built in stages to handle the waste from 2,650 homes.	700 units	1000 homes
Launched	2019-2018	2016-2021	2012-2013 (1st Phase)
Type of Project	The expansive city of Trondheim is building a new residential area in the scenic Tiller Øst, where Logiwaste has been awarded the contract to build the main pipe network and a terminal for an automatic waste collection system. The system is built in stages to handle the waste from 2,650 homes.	The Solbjers district, Lund. This is the first large phase of a new city district, incorporating vacuum waste disposal.	Grilstad Marina is an extensive coastal development in Trondheim, Norway. Initially with 480 homes.
Type of System	Type of system: Stationary AVAC system	Stationary vacuum system	Automatic, AVAC system, touchless inlets.
Pipe network length	950 m	unknown	1000 m
Capacity	Current capacity 990 homes and a day centre. Waste Quantity: 476 tonnes of residual waste per year, 151 tonnes per year	131 tons residual waste, 73 tons paper per year.	40 m^2 of residual waste per week.
Waste fractions	Two fractions. Mixed waste and recyclable paper and plastic.	Four fractions. Residual waste, cardboard, packaging, food.	Two fractions, residual waste and paper.
Development	Residential	Residential	Residential

Ecosir

Title	ASTAKA Skyscrapers 1 and 2	Langfang PR.	Yinchuan P.R
Country	Malaysia	China	China
System type and capacity	Skymaster 500 PWCS -system • Highest residential towers in East Asia • 132 Indoor inlets and D500mm vacuum piping	Citymaster 500 and XMIT BIO - systems • Second biggest single construction site in China • Eight 5-star towers with IDI's and D500 PWCS system. • Food waste system for 18 restaurants	Citymaster PWCS -system • 42 towers, 12 000 people area with ODI's • Vacuum piping 4 km
Development	Residential	Residential and commercial	Residential

ASIA PACIFIC OFFICES

BRISBANE
Level 2, 15 Astor Terrace
Spring Hill QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
Unit 5, 21 Parap Road
Parap NT 0820
Australia
T: +61 8 8998 0100
F: +61 8 9370 0101

GOLD COAST
Level 2, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

MACKAY
21 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Suite 2, 2 Domville Avenue
Hawthorn VIC 3122
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Ground Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

SYDNEY
2 Lincoln Street
Lane Cove NSW 2066
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TOWNSVILLE
Level 1, 514 Sturt Street
Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

TOWNSVILLE SOUTH
12 Cannan Street
Townsville South QLD 4810
Australia
T: +61 7 4772 6500

WOLLONGONG
Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 404 939 922

AUCKLAND
68 Beach Road
Auckland 1010
New Zealand
T: +64 27 441 7849

NELSON
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628