Attachment A
2015 SWMP Update Research and Analysis Report

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County of Fairfax, Virginia
Department of Public Works and Environmental Services
Solid Waste Management Program
12000 Government Center Parkway • Suite 458 • Fairfax, VA 22035

2015 SWMP Update
Research and Analysis

September 2014

2015 SWMP Update
Research & Analyses

Ashley V. Evans, PE
Senior Project Engineer

Douglas E. Sawyers, PE, BCEE
Senior Vice President

Prepared for:
Fairfax County, VA

Prepared by:
ARCADIS U.S., Inc.
3101 Wilson Blvd.
Suite 550
Arlington
Virginia 22201
Tel 703 351 9100
Fax 703 351 1305

Our Ref.:
02779043.0000

Date:
September 2014

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1. Introduction and Purpose of Report

1.1 Introduction

Virginia Department of Environmental Quality (VDEQ) regulations require Fairfax County to review and update its solid waste management plan every five years. The requirements for this process are governed by 9VAC Code 20-130-175.F (requirements to maintain current plans) and 9VAC Code 20-130-120 (plan requirements and contents).

Fairfax County's *Solid Waste Management Plan 2004-2024* (2004 SWMP) was prepared in accordance with 9VA20-130-10 *et. seq.*, which required the development of complete, revised solid waste management plans by July 1, 2004. A subsequent minor modification, part of the 5-year update process, was completed in 2010. In accordance with applicable regulations, the County is required to submit a solid waste management plan update by June 24, 2015, addressing the 20-year planning period through 2035.

1.2 Purpose of Report

The purpose of this report is to present the findings of research and analysis performed by ARCADIS to support the County's 2015 SWMP update. Research and analysis authorized by ARCADIS was performed under Task Order Number 2 under Contract #4400003734.

1.2.1 Research and Analysis

In accordance with the referenced task order, research and analysis consisted of the following:

- Task 2.1 - Current and projected demographic information for the County, including identification of solid waste management facilities in Fairfax County and the surrounding region;
- Task 2.2 - Updated waste projections; and
- Task 2.3 - Identification and assessment of solid waste management technologies.

Updated projections were also compared to those presented in the 2004 SWMP to identify variations and analyze potential causes for such variations. For the purposes

of the SWMP update, Municipal Solid Waste (MSW) and Construction and Demolition Debris (CDD) are treated separately.

2. Task 2.1 – County Demographics

County demographics research included population, employment, and other demographic and economic data appropriate for the development of waste generation projections presented in Section 3 of this report.

2.1 Population

Population projections were developed using demographic information available from the Fairfax County Department of Neighborhood and Community Services and the U.S. Census Bureau.[1,2] U.S. Census population data for Fairfax County were reviewed for consistency with County population projections. Fairfax County's population data includes the Towns of Herndon, Vienna and Clifton.[3] As the 2004 SWMP covered the geographic footprint of the County, including Cities and Towns, U.S. Census data were used to incorporate the populations of Cities of Fairfax and Falls Church. The resulting population projections were within an acceptable range of variability (less than 3 percent). Therefore, the population projection used to develop waste generation are based on Fairfax County's demographics data, supplemented with U.S. Census data for the Cities of Fairfax and Falls Church.

Table 2-1 presents projected County population for the planning period. As County population projections are available at 5-year intervals, interim year population estimates were calculated using adjusted growth rates (AGRs) based on straight-line interpolations for each 5-year period. The calculated AGRs were applied to project County population and the populations of the Cities of Fairfax and Falls Church.

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[1] *Demographic Reports 2013*, County of Fairfax, Virginia, Department of Neighborhood and Community Services.

[2] http://factfinder2.census.gov U.S. Bureau of Labor Statistics (BLS), Databases, Tables and Calculators

[3] Table 4-1. *Demographic Reports 2013*, County of Fairfax, Virginia, Department of Neighborhood and Community Services.

Appendix A provides the County's projected overall population for each year of the planning period.

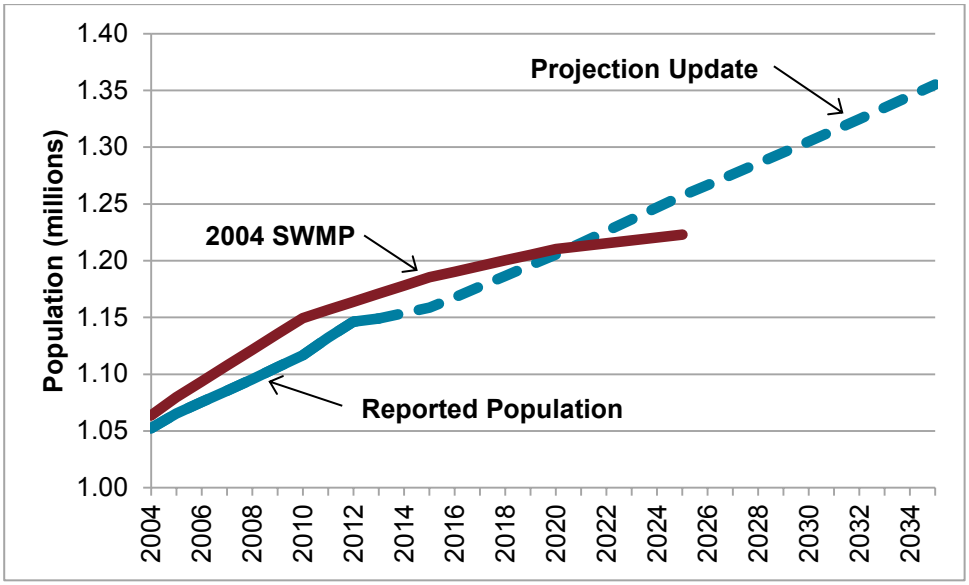
Table 2.1 – Population Projections

Year	Fairfax County	City of Fairfax	City of Falls Church	Total
2013	1,111,620	23,973	13,508	1,149,101
2015	1,120,561	24,314	13,700	1,158,575
2020	1,166,033	25,300	14,256	1,205,589
2025	1,216,111	26,387	14,868	1,257,366
2030	1,262,166	27,386	15,431	1,304,983
2035	1,310,744	28,440	16,025	1,355,209

2.1.1 Comparison to 2004 SWMP

The population projection presented above, including reported actual populations from 2004 to 2013, was compared to the population projection used in the 2004 SWMP. The updated population projection is within ±3% of the 2004 SWMP. Figure 2.1 graphically illustrates this comparison.

Figure 2.1 – Projected Population



The impact of reported historical population and the updated population projection on total MSW generation (using the waste generation rates in the 2004 SWMP) is similar, within a margin of ±4%.

2.2 Employment

Employment data was reviewed as a secondary means to support the evaluation of actual waste generation to that projected in the 2004 SWMP. Employment projections were developed based on data available from the U.S. Census and the Metropolitan Washington Council of Governments (MWCOG).[4,5] Figure 2.2 presents the comparison of current projected employment to that of the 2004 SWMP.

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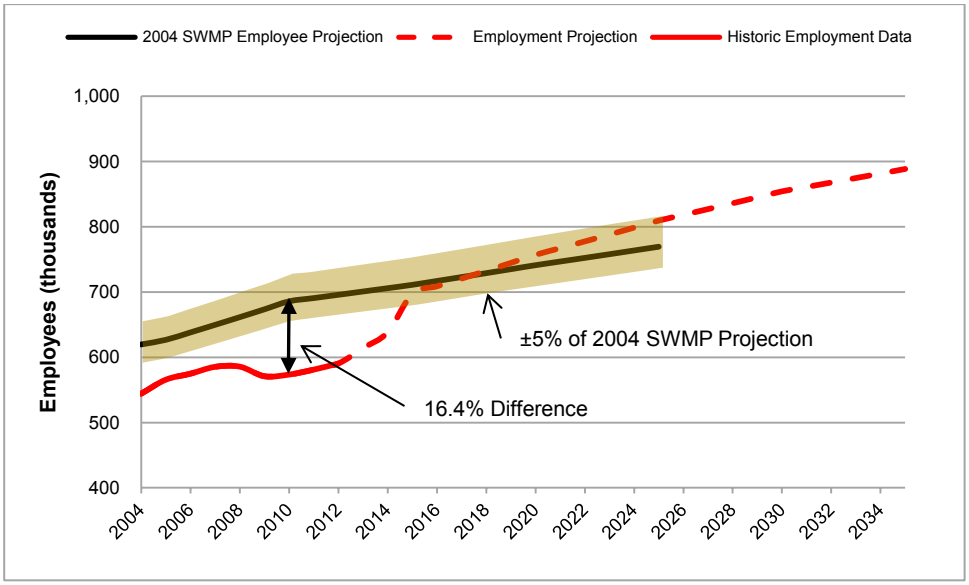
[4] U.S. Bureau of Labor Statistics (BLS), Databases, Tables and Calculators

[5] MWCOG. 2013 Round 8.2 Cooperative Forecasting.

Figure 2.2 – Projected Employment



As shown in Figure 2.2, historic employment lagged the 2004 SWMP projection beginning in 2004 (-12.2%), and reached a maximum difference in 2010 (-16.4%), consistent with the recent economic downturn. Reported employment in the County has shown recovery since 2010, although remaining significantly below the 2004 SWMP projection. Current employment projections anticipate a steady increase in employment in the County, reaching and exceeding the 2004 SWMP projection by 2018.

2.3 Other Analyses

In addition to population and employment, additional available data was reviewed, including housing projections, economic growth and development, recycling markets, and transportation conditions to support the comparison of the waste generation projections, discussed in Section 3, to that presented in the 2004 Plan. While these factors are not discussed explicitly in this Section 2, these factors, where appropriate, are referred to in the balance of our research and analysis as supporting information.

2.4 Solid Waste Management Facilities

Solid waste management facilities, generally within a 75-mile radius of the County's I-66 Transfer Station, were reviewed to identify facilities *potentially accessible* by the County for waste management services.[6] Appendix B includes a series of figures and tables that provide facility specific information, including reported remaining capacity and remaining life. The figures and tables presented in Appendix B, unless otherwise noted, are not intended to be inclusive of all solid waste management facilities within the designated radii. Specific notes relative to the figures are:

- Figure 1 – MSW Landfills within a 75-mile radius: Includes the King George Landfill, Prince William County Landfill and the Loudoun County Landfill.[7] Several privately owned landfills that the County has historically used for backup disposal capacity are beyond the 75-mile radius.
- Figure 2 – Waste-to-Energy Facilities within a 75-mile radius: includes the Montgomery County Resource Recovery Facility, although waste source restrictions limit the potential for accessing this facility.
- Figure 3 – Other MSW Processing Facilities within a 75-mile radius: inclusive of processing facilities, material recovery facilities (MRFs), transfer stations composting facilities and land clearing debris landfills, facilities included generally include privately-owned facilities, with the exception of Loudoun Composting and Prince William County's Balls Ford Road facility. For clarity, Figure 3 does not include Fairfax County's facilities.[8]
- Figure 4 – MSW Landfills and Waste-to-Energy Facilities within a 150-mile radius: replicating a MSW disposal market survey completed for the County in 2012, Figure 4 includes MSW disposal facilities within an expanded 150-mile radius, inclusive of those landfills with capacity accessible to the County.

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[6] MSW facilities were limited to facilities potentially accessible by the County. No restrictions were placed on CDD facilities.

[7] Regarding nearby facilities in neighboring jurisdictions, Prince William County and Loudoun County in general do not accept out-of-county MSW. Prince William County does collaborate with Fairfax County under the terms of its ongoing trade agreement.

[8] The Fauquier County CDD MRF ceased accepting CDD in June 2013.

Waste-to-energy facilities within the search area, including those with known restrictions (for example, the Montgomery County Resource Recovery Facility and the Harford County Waste-to-Energy Facility), are included.

- Figure 5 – includes active waste management facilities in Fairfax County.[9]
- Figure 6 – includes inactive/closed waste management facilities in Fairfax County.
- Figure 7 – Construction and Demolition Debris Facilities in Fairfax County. Includes the Lorton CDD Landfill; scheduled to close December 31, 2018.[10]

2.4.1 MSW Facilities

Fairfax County's solid waste management system utilizes a number of facilities for the management, processing and disposal of recyclables and MSW. Primary facilities include the I-66 Transfer Station and the Covanta Energy/Resource Recovery Facility (E/RRF) located at the I-95 Solid Waste Management Complex.[11] Approximately 75% of MSW generated and collected in the County is delivered to the I-66 Transfer Station, where post-recycling MSW is directed to various facilities for processing and disposal. Approximately 25% of the MSW generated and collected in the County is delivered directly to the Covanta E/RRF. Secondary facilities include the Prince William County Landfill and the King George Landfill, where the County transfers MSW at various times including peak MSW generation periods and periods during which processing capacity at the Covanta E/RRF is constrained due to maintenance. Ash residue

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[9] The BFI Telegraph Road Landfill Gas System is not shown.

[10] In the neighboring jurisdictions of Prince William County and Loudoun County, CDD is managed largely by the private sector.

[11] The County's Service Agreement with Covanta expires February 1, 2016. The County has executed a Waste Disposal Agreement with Covanta, commencing February 2, 2016 with an initial 5-year term and two 5-year options (at the mutual agreement of the County and Covanta). Under the WDA, the County has the contractual ability to deliver between 617,500 tons and 682,500 tons of MSW per year. The County has a put-or-pay obligation to deliver a minimum of 617,500 tons of processible MSW to Covanta each year of the WDA.

generated from MSW processing at the Covanta E/RRF is disposed in the County's I-95 Landfill (Area III).[12]

Table 2.2 lists facilities currently utilized by Fairfax County for the management of MSW (denoted by and asterisk (*)) as well as other facilities that may be options for the County should additional disposal capacity be required.[13]

Table 2.2 –MSW Facilities used by or potentially available to Fairfax County

Facility	Location	Use	Remaining Capacity(1)	Remaining Useful Life(1)
I-66 Transfer Station*	Fairfax, VA	MSW Transfer	3,000 TPD	>20 years
Covanta E/RRF*	Lorton, VA	MSW Disposal	3,000 TPD (~1.2 million TPY)	>20 years
I-95 Landfill (Area III)*	Lorton, VA	Ash Residue Disposal	4,209,861	32
Prince William County Landfill*	Manassas, VA	MSW Disposal	2,814,870	12
King George Landfill*,(2)	King George, VA	MSW Disposal	9,519,264	14.6
King and Queen Landfill	Little Plymouth, VA	MSW Disposal	9,441,589	29.8
Atlantic Waste Disposal	Waverly, VA	MSW Disposal	40,808,523	71.6
Old Dominion Landfill	Richmond, VA	MSW Disposal	2,546,103	6.2
Shoosmith Sanitary Landfill	Chester, VA	MSW Disposal	7,500,000	12

Notes:
1. Source: VDEQ *Solid Waste Managed in Virginia During Calendar Year 2013.* Reported current permitted capacity listed. Tons per day - TPD. Tons per year – TPY.
2. It has been reported the King George Landfill is currently planning a vertical expansion that would extend the facility's useful life by 15 years.

* Facility currently utilized by Fairfax County.

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[12] Assuming an annual delivery of 650,000 tons of MSW to the Covanta E/RRF and an ash residue generation rate of 24%, approximately 156,000 tons of ash residue will be disposed in the I-95 Landfill (currently Area III) annually. Sufficient disposal capacity for ash residue, currently estimated at 32 years, is available at the I-95 Landfill over the planning period.

[13] Facilities listed in Table 2.2 not currently utilized by Fairfax County include facilities evaluated in the 2012 *Disposal Market Analysis Report,* prepared by ARCADIS.

2.4.2 Recycling Facilities

The County recycling program is comprehensive, providing several avenues for residents and businesses to recycle. Curbside, single-stream recycling has been implemented Countywide. In addition, the County's offers drop-off services for principal (*i.e.*, paper, plastic, metal, glass, yard waste) and supplemental recyclable materials (*i.e.,* Special Waste and Household Hazardous Waste (HHW)) at both the I-66 Solid Waste management Complex and the I-95 Solid Waste Management Complex.

Fairfax County's recycling program is serviced by the private sector, with numerous outlets used for the range of recyclables recovered both curbside and at the I-66 and I-95 Solid Waste Management Complexes. Capacity of the private sector recycling infrastructure servicing the County is expected to be sufficient for the County's needs through the planning period.

2.4.3 CDD Facilities

CDD generation and disposal practices are difficult to predict as the private sector largely manages this waste stream. Limited CDD is accepted by the County at the I-66 Transfer Station and the I-95 Solid Waste Management Complex (30,000-40,000 tons per year). The 2004 SWMP indicates CDD generated in the County was managed largely by the private sector with disposal provided at six facilities: Hilltop Debris Landfill, Lorton CDD Landfill, Rainwater Conc. Company Landfill, Potomac Landfill, Corral Farm Landfill and the Waste Management Manassas Transfer Station. These facilities, as well as other identified CDD management facilities (*e.g., Ritchie Land Rubble Landfill*), were contacted to obtain operating data. In most cases, annual disposal or processing rates were not provided, nor was data specific to Fairfax County. Private sector management of CDD continues.

Table 2.3 lists CDD facilities either located in Fairfax County or those expected to be utilized by the County (or CDD generators within the County) for management of CDD. The Ritchie Land Rubble Landfill is included as this facility is owned by Environmental Alternatives, Inc., the parent company of C&D Recovery II (a CDD processing/transfer station) located in Manassas, and it is expected that CDD generated in Fairfax County likely is captured by this nearby facility.

Table 2.3 – CDD Facilities Accessible by Fairfax County CDD Generators[1]

Facility	Year					Estimated Remaining Capacity (tons, as of 12/2013)	Expected Remaining Life (years)
	2009	*2010*	*2011*	*2012*	*2013*		
	Tons Accepted						
Hilltop Sand & Gravel Company	59,296	173,820	76,524	68,031	35,277	Accepting clean fill only	0
Lorton CDD Landfill[2]*	675,708	672,697	1,183,348	844,986	1,065,426	4,351,506	5.0
Rainwater Landfill	40,049	21,095	29,365	23,855	28,802	402,408	15.8
Potomac CDD Landfill[3]	54,156	50,322	62,608	69,833	102,790	611,400	15.0
Corral Farm CDD Recycling	41,341	20,458	14,943	14,026	15,974	Facility reports cessation of waste acceptance in June 2103.	0
CDD Disposal/Facilities not reflected in 2004 SWMP							
Broad Run Recycling*	156,500	156,500	156,500	156,500	156,500	156,500	Not Applicable
Ritchie Land Rubble Landfill[4]	183,444	199,796	276,921	261,342	Not Available	6,085,287	27.5

Notes:
1. Source of Data: Unless otherwise noted, VDEQ and Maryland Department of the Environment annual solid waste reports. Fauquier County's Corral Farm data provided by facility.
2. The Lorton Landfill is scheduled to close by December 31, 2018.
3. The Potomac CDD Landfill's Part A Application for expansion is on hold pending review of expansion alternatives.
4. Ritchie Land Rubble Landfill – 2013 data not available. Estimated remaining capacity assumes 2013 tonnages equivalent to 2012. In addition, daily truck trip restrictions limits CDD acceptance.

* Facilities currently utilized by Fairfax County.

In addition to the facilities listed above, there are several CDD processing, recycling or transfer facilities in the region providing capacity for CDD generated in the County. These facilities include:

- CFP, LLC (C&D Recycling, LLC), Manassas VA: reported daily operating capacity: 189 tons per day (TPD);
- Potomac Landfill Inc. CDD MRF, Arlington VA: reported daily operating capacity: 221 TPD;
- Waste Management, Inc., Merrifield VA (transfer station): reported daily operating capacity: 721 TPD;

- Waste Management, Inc., Sterling VA (transfer station): reported daily operating capacity: 522 TPD;
- Waste Management, Inc., Leesburg VA (transfer station): reported daily operating capacity: 750 TPD; and
- W&N Material Recovery Facility, Lorton, VA (CDD materials recovery and processing facility): permitted operating capacity: 33 cubic yards (CY) per day.

2.4.4 Facility Status Changes

Review of regulatory permitting data and facility information indicates the following changes in status of solid waste management facilities:

MSW Management Facilities:

- INOVA Fairfax Hospital is listed as a closed facility in the VDEQ database.
- Metalpro is listed as a closed facility in the VDEQ database.
- Vanguard Research, Inc., Plasma Energy Pyrolysis System is listed as a closed facility in the VDEQ database.

CDD Management Facilities:

- County Waste, a transfer station in Fredericksburg, VA with a reported capacity of 600 TPD, is listed as a closed facility in the VDEQ database.
- Alex Transfer, a transfer station in Alexandria, VA with a reported capacity of 1,000 TPD, is listed as a closed facility in the VDEQ database.
- The Hill Top Sand and Gravel Company reports accepting clean soil only.
- W&N Material Recovery Facility, located across the street from the Lorton CDD Landfill in Lorton, VA, received a permit in 2010 to process CDD materials. The facility has a permitted capacity of 200 CY per week, which is equivalent to 33 CY per day.

VDEQ reported planned or pending MSW or CDD permit applications:[14]

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[14] http://www.deq.virginia.gov/Programs/LandProtectionRevitalization/PermittingCompliance/ActivePermits.aspx. In addition, public reports indicate the King George Landfill

- BFI Old Dominion Landfill, Richmond, VA. Permit 553 – VDEQ Part A Application for a new facility;
- Potomac CDD Landfill, Dumfries, VA, Permit 441 – VDEQ Part A Application for an expansion;[15]
- East End Landfill, Richmond, VA, Permit 524 – VDEQ Part A Application for an expansion; and
- Dominion Virginia Power, located in Chester, VA. Permit 609 – VDEQ Part B Application for a new facility. (Discussions with VDEQ indicate this application relates to coal ash impoundments proposed to be managed under VDEQ solid waste management regulations.)

For the purposes of the 2015 SWMP Update, none of the above facilities contributes significantly to the management of the County's solid waste.

3. Task 2.2 – Updated Waste Projections

3.1 Total MSW Generation

Updated waste projections were developed based on population (see Section 2.1) and per capita waste generation rates (WGR). WGRs were determined using historical MSW disposal and recovered recyclables data for the years 2004 through 2013, inclusive of the County and Cities and Towns:

- Calendar year MSW disposal tonnages were extracted from the County's FY904 Reports.
- Recovered recyclables data were obtained from annual calendar year recycling reports issued by VDEQ.[16] (Note: CDD recycling reported by Fairfax

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is planning to submit a permit application for a vertical expansion, adding approximately 15 years of additional capacity.

[15] Potomac Recycling indicates the Part an Application for expansion is on hold pending review of facility expansion alternatives.

[16] 2004-2012 Annual Recycling Rate Summary Reports, VDEQ. As the VDEQ 2013 report is not published as of the preparation of this report, 2013 recycling data was obtained from the submittals to VDEQ by the County, City of Falls Church, City of

County in 2011, 2012 and 2013 were excluded as generation estimates of MSW and CDD were developed independently.)

3.1.1 Analysis of Historical Data (2004-2013)

Table 3.1 summarizes the reported data from 2004 through 2013, including population, MSW disposed, recovered recyclables, total MSW generated, WGRs and calculated recycling percentages.

Table 3.1 - MSW Generation (2004-2013)

Year	Population	MSW Disposed	Recovered Recyclables	Total MSW Generated	WGR	Percentage Recycled
2004	1,052,287	954,334	495,870	1,450,204	7.55	34.2%
2005	1,065,346	1,001,353	465,340	1,466,693	7.54	31.7%
2006	1,075,347	998,586	532,803	1,531,389	7.80	34.8%
2007	1,085,245	942,997	531,680	1,474,677	7.45	36.1%
2008	1,095,562	861,708	536,630	1,398,338	6.99	38.4%
2009	1,106,139	811,588	491,936	1,303,524	6.46	37.7%
2010	1,116,623	772,845	522,862	1,295,707	6.36	40.4%
2011	1,132,278	752,020	610,068	1,362,088	6.59	44.8%
2012	1,146,302	716,675	689,572	1,406,247	6.72	49.0%
2013	1,149,101	656,271	555,664	1,211,935	5.78	45.8%

As shown in Table 3.1, WGRs have declined over the period 2004-2013, from a peak WGR of 7.80 lbs/cap/day in 2006 to a low of 5.78 lbs/cap/day in 2013. The per capita WGR fell by 14% from 2012 to 2013. Over the same period, although with some variability (in particular 2013), percentage recycled have steadily increased. In terms of total MSW generated (MSW disposed and recyclables recovered), annual tonnages have been somewhat variable. Figures 3.1 and 3.2 illustrate these trends for (a) WGRs and percentage recycled and (b) total MSW generated, respectively.

The 2013 MSW disposed tonnage was the lowest level since 2004, and eight percent (8%) percent lower than 2012. Similarly, recovered recyclable tonnage reported for

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Fairfax and Herndon. In accordance with 9VAC20-130-165, the Town of Vienna was not required to report in 2013; therefore, Vienna's 2012 reported tonnages were used as surrogates for 2013.

2013 was more than 19% lower than that reported for 2012, or nearly 200,000 tons. Considering calculated WGRs, the year-over-year change from 2012 to 2013 is approximately double of that observed since 2004.

This magnified trend from 2012 to 2013 may reflect actual conditions. However, and in our opinion more likely, data reliability and variability are likely factor as the data used in these analyses are from a number of sources, obtained using several data collection methods, and in all cases data quality objectives are not known. From a planning standpoint, 2013 may be considered an outlier; however, the appropriateness of excluding 2013 from the analysis will not be known until 2013 can be viewed within a proper historical perspective. Therefore, 2013 data is included with recognition that if proven a historic low, the analyses presented herein may under predict future conditions.

Figure 3.1 – Waste Generation & Percentage Recycled (2004-2013)

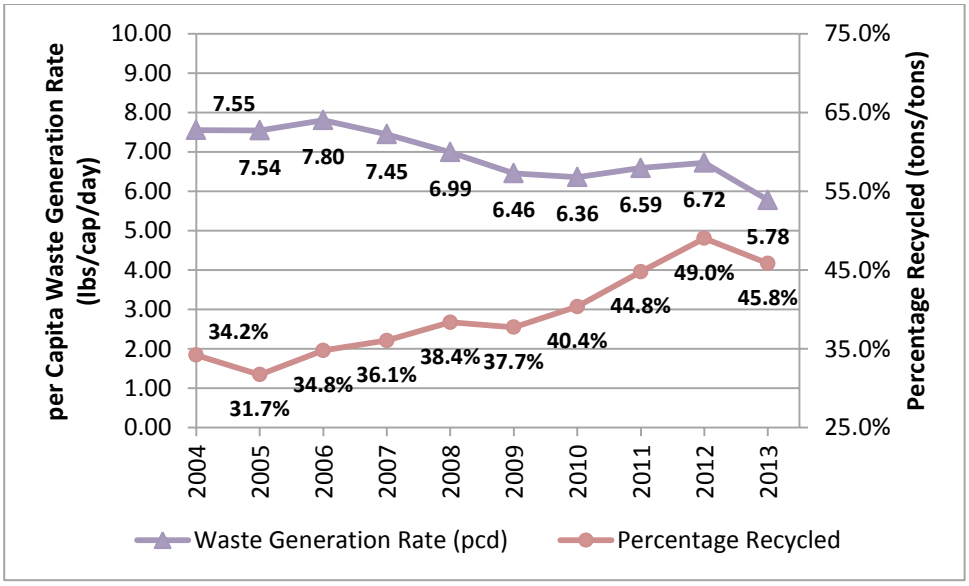
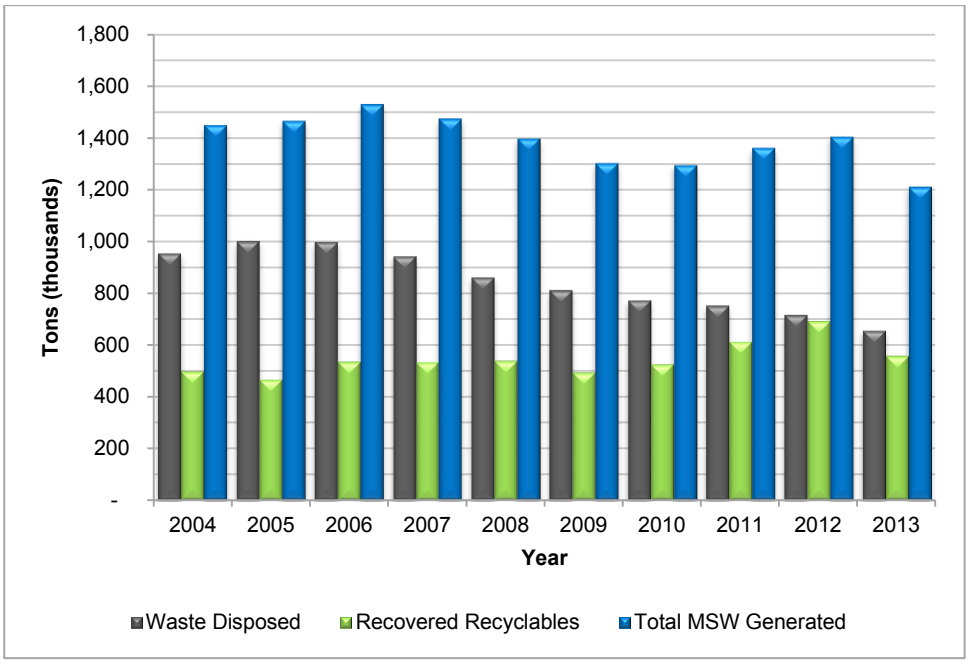


Figure 3.2 – Fairfax County MSW and Recycling (2004-2013)



3.1.2 Total MSW Projections

There are several means to evaluate historic data to develop potential future trends. In terms of total MSW generation, two variables that can be evaluated are total waste generation and the annual per capita WGR. The historical data, presented above, when evaluated considering various observed trends results in a range of estimates of future total MSW generation, examples of which include:

- WGR 5-year and 10-year average rates of change
- WGR or total MSW generated linear trends (5-year and 10-year)

WGR in each of the above scenarios steadily decline, some to very low levels over the planning period. For example, WGR projections based on the average annual rates of change for the immediately preceding 5-year (-3.52%) and 10-year (-1.78%) periods indicate 2035 WGRs of 2.72 lbs/cap/day and 3.96 lbs/cap/day, respectively. Similarly, using 5-year and 10-year linear trends based on total MSW generated, 2035 WGRs are projected to fall to 4.00 lbs/cap/day and 1.86 lbs/cap/day, respectively. These

projected WGRs are considered low for a higher income, urban area such as Fairfax County.

Therefore, two alternatives have been developed to conservatively estimate total MSW generation: (1) constant WGR using 2013 data (intended to present a lower expected bound); and (2) annual growth in WGR of one percent (intended to present an expected upper bound). The second alternative was developed in part to account for potential over-conservatism regarding 2013 data, as discussed in Section 3.1.

The resulting projections using these two factors are summarized in Table 3.2.

Table 3.2 - Projected Fairfax County MSW Generation (total)

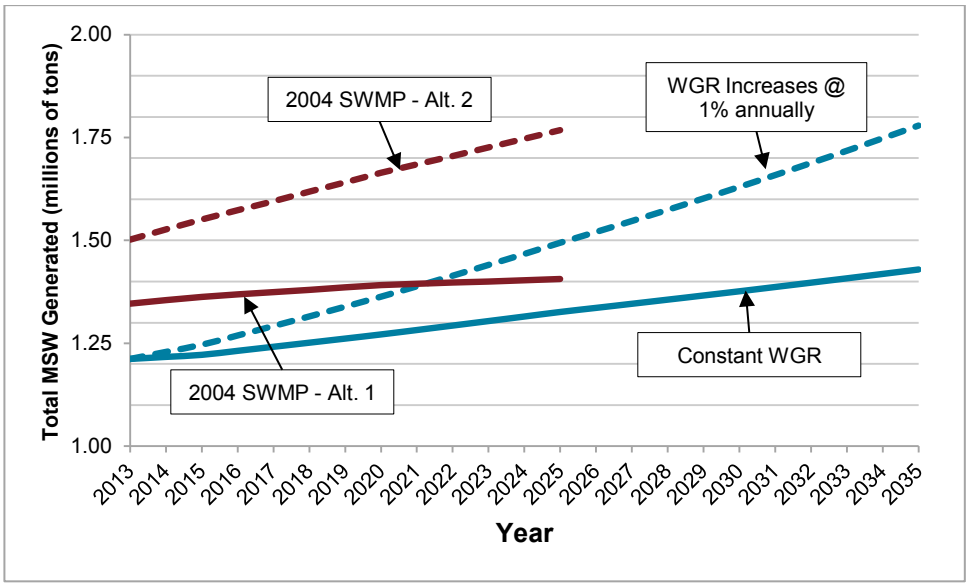
Year	Alternative 1 – Constant WGR		Alternative 2 – WGR Increase @ 1%/yr	
	WGR	Tons	WGR	Tons
2013	5.78	1,211,935	5.78	1,211,935
2014	5.78	1,216,930	5.84	1,229,099
2015	5.78	1,221,926	5.90	1,246,487
2020	5.78	1,271,512	6.20	1,363,233
2025	5.78	1,326,120	6.51	1,494,305
2030	5.78	1,376,341	6.84	1,630,007
2035	5.78	1,429,313	7.19	1,779,089

Appendix C provides the total MSW generation projections for Fairfax County for each year of the planning period.

3.1.3 Comparison to 2004 SWMP

Updated total MSW generation is projected below the 2004 SWMP Alternative 1 projection (baseline projection) by varying amounts (as much as 10 percent between 2014 and 2016. Both of the updated projections remain below the 2004 SWMP Alt. 1 until 2022, at which time the upper bound scenario (WGR increasing at an annual rate of one percent) surpasses the 2004 SWMP lower bound (Alt. 1). The updated MSW generation projection based on a constant WGR remains more than 5% below the 2004 Plan lower bound (Alt. 1) through 2025. Overall, the updated projections are similar, although somewhat lower, than the total MSW projections presented by Alt.1 and Alt. 2 of the 2004 SWMP. These projections are illustrated in Figure 3.3.

Figure 3.3 – Fairfax County Total Waste Generation



As discussed above, population projections contribute to this differential. Additionally, the observed WGR, while significantly higher than projected in the 2004 SWMP from 2004 through 2008, WGRs began to decline and were lower than the 2004 SWMP upper bound. In 2013, the observed WGR of 5.78 lbs/cap/day was lower than the baseline WGR in the 2004 SWMP (6.30 lbs/cap/day). One widely accepted cause for the decline in WGRs in the past five years was the economic recession. Additionally, lower employment through this period is expected to have contributed to this decline (see Figure 2.2), as are product stewardship efforts (changes in product packaging), marketing and purchasing trends. Although difficult to distinguish, the potential for MSW leaving the County's system is evident.

Recent MSW and recycling data from neighboring jurisdictions were reviewed to identify trends that could influence expected future performance. However, the comparison indicated no obvious trend. For example, MSW disposed and recyclables recovered by the District of Columbia has experienced a recent decline, while Prince William County has experienced an overall increase. These communities are representative of a number of communities that have experienced different and varying trends in recent years related to waste generation and recycling performance.

3.2 Recycling

County records provide recycling data for the period 2004 through 2013. VDEQ provided similar data for the City of Fairfax, Falls Church, Herndon and Vienna. These data were combined, as discussed above, to calculate overall Fairfax County percentage recycled (see Figure 3.1). As shown in Figure 3.1, from 2004 through 2009 the overall County percent recycled ranged between approximately 34% and 38%. Following recycling program enhancements, including the expansion of curbside source-separated collection and distribution of larger recycling bins, the overall County percent recycled increased to a high of 49% in 2012 before receding to 45.8% in 2013.[17]

As a matter of perspective, the County's overall percent recycled is higher than both the VDEQ's recycling goal of 25% for solid waste management planning units with populations greater than 100,000, as well as the USEPA's suggested nation-wide recycling goal of 35%, and is in-line with higher performing recycling programs in Virginia as well as the general metropolitan region. Additionally, the County's robust recycling program provides a high level of service, availability of options, and ease of access. It is the opinion of ARCADIS that the County's overall percent recycled will remain relatively consistent with rates experienced in the last several years unless new programs are implemented to target specific recyclables in the waste stream. Examples of such programs may include:

- Implementation of an expanded commercial recycling program.
- Implementation of targeted recyclable materials, such as organics.
- Introduction of material bans such as bottle bills, plastic bag bans or bans other materials.

Should the County consider any such improvement to its recycling program, each such initiative should be reviewed in terms of programmatic requirements, level of service, cost and other factors necessary to conduct a cost:benefit analysis given the expected amount of materials to be recovered. Projections of recycling program performance,

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[17] The County began implementation of single-stream curbside collection within the Sanitary Districts in 2009. Some areas of the County with private collection may have had single-stream collection earlier. The County's distribution of larger recycling bins was completed in 2012.

described in the following section, do not anticipate the implementation of new programs; rather, the recycling projections are based on recent historical performance and conservative assumptions regarding potential growth in recycling absent such new programs.

3.2.1 Recycling Projections

Projections for recycling over the planning period consider three scenarios. It is noted the following recycling projections are inclusive of principal recyclable materials as well as supplemental recyclable materials.[18] The scenarios analyzed are:

1. Scenario 1 – In this scenario, the percent recycled was set to equal the maximum percent recycled experienced since the full implementation of single-stream recycling and distribution of larger recycling bins (49.0%)
2. Scenario 2 – In this scenario, the percent recycled was set to increase at the annual rate of change in the County's recycling rate for the 5-year period from 2009-2013 (1.5%). To address the potential for over-estimation, as this timeframe includes program improvements known to yield short-term increases in recovered recyclables a maximum percent recycled of 60% was incorporated, a maximum attained (by projection) in 2032.
3. Scenario 3 – In this scenario, recycling tonnage was adjusted based on population, mirroring the total MSW generation projections. The average of recovered recyclables for the three-year period from 2011 to 2013 was used as the basis for this projection (50.2%). This scenario includes principal recyclable materials as well as supplemental recyclable materials.

   Scenario 3 recycling projections are based on the County's annual recycling reports to VDEQ (exclusive of independent solid waste management planning units within the County (City of Fairfax, City of Falls Church, Herndon, Vienna), some of which have higher recycling rates than the County.[19] For the

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[18] County CDD recycling, initiated in 2011, was excluded from the projections of recyclables recovered from MSW.

[19] In 2013, reported recycling rates for independent solid waste management planning units within the County: City of Fairfax – 58.4%; City of Falls Church – 60.9%;

purposes of this evaluation, 2013 reported recyclable materials recovered by the City of Fairfax, City of Falls Church, and Herndon were added to the 2011-2013 averages for Fairfax County (detailed recycling data for Vienna was not available).

Table 3.3 summarized the results of these scenarios.

Table 3.3 – Recycling Scenario Projections

Year	*Scenario 1*			*Scenario 2*			*Scenario 3*			
	Percentage Recycled	Recycled Tonnage		Percentage Recycled	Recycled Tonnage		Recycled Tonnage	Percentage Recycled	Recycled Tonnage	
		Alternative 1 - Constant WGR	Alternative 2 - WGR Increase @ 1%/yr		Alternative 1 - Constant WGR	Alternative 2 - WGR Increase @ 1%/yr			Alternative 1 - Constant WGR	Alternative 2 - WGR Increase @ 1%/yr
2013	45.8%	555,664	555,664	45.8%	555,664	555,664	555,664	45.8%	555,664	555,664
2014	49.0%	596,296	602,258	46.5%	566,293	571,956	610,398	50.2%	610,398	616,502
2015	49.0%	598,744	610,779	47.2%	577,117	588,717	612,904	50.2%	612,904	625,224
2020	49.0%	623,041	667,984	50.9%	646,777	693,432	637,776	50.2%	637,776	683,782
2025	49.0%	649,799	732,209	54.8%	726,493	818,631	665,166	50.2%	665,166	749,526
2030	49.0%	674,407	798,703	59.0%	812,063	961,730	690,357	50.2%	690,357	817,593
2035	49.0%	700,363	871,754	60.0%	857,588	1,067,453	716,927	50.2%	716,927	892,370

Appendix D provides the recycling scenario projections for each year of the planning period, including material specific projections used in Scenario 3.

3.3 MSW Requiring Processing or Disposal

The County's post-recycling MSW, representing the amount of disposal capacity the County must is available to be accessed, is the difference of projected total MSW generation and projected recovered recyclables. Table 3.4 summarizes projected

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Herndon – 43.0%. Vienna was not required to report in 2013. Vienna's reported recycling rate for 2012 was 59.5%.

MSW disposal capacity requirements, relative to the two total MSW generation alternatives described in Section 3.1.2 above.

Table 3.4 - Fairfax County Projected MSW Disposal Capacity Requirement

Year	Scenario 1			Scenario 2			Scenario 3		
	Percentage Recycled	Alternative 1 - Constant WGR (MSW disposal)	Alternative 2 - WGR increase @1%/yr (MSW disposal)	Percentage Recycled	Alternative 1 - Constant WGR (MSW disposal)	Alternative 2 - WGR increase @1%/yr (MSW disposal)	Percentage Recycled	Alternative 1 - Constant WGR (MSW disposal)	Alternative 2 - WGR increase @1%/yr (MSW disposal)
2013	45.8%	656,271	656,271	45.8%	656,271	656,271	45.8%	656,271	656,271
2014	49.0%	620,634	626,840	46.5%	650,636	657,143	50.2%	606,532	612,597
2015	49.0%	623,182	635,708	47.2%	644,809	657,770	50.2%	609,022	621,264
2020	49.0%	648,471	695,249	50.9%	624,735	669,801	50.2%	633,736	679,451
2025	49.0%	676,321	762,096	54.8%	599,626	675,674	50.2%	660,953	744,779
2030	49.0%	701,934	831,303	59.0%	564,278	668,276	50.2%	685,984	812,414
2035	49.0%	728,950	907,335	60.0%	571,725	711,636	50.2%	712,386	886,718

Appendix E provides the projected MSW disposal capacity requirement for Fairfax County for each year of the planning period.

The projected County MSW disposal requirement for the 2015-2035 ranges from approximately 610,000 tons to nearly 660,000 tons in 2015 and from 712,000 tons to 907,000 tons in 2035. The County's Waste Disposal Agreement (WDA) with Covanta secures 682,500 tons per year of MSW disposal capacity through February 1, 2021, and potentially through 2031 with the two 5-year extension options. The Covanta E/RRF, which has an annual processing capacity of approximately 1.2 million tons, remains the County's primary disposal facility and under the WDA the County has the contractual ability to access the remaining processing capacity of the Covanta E/RRF. Sufficient landfill capacity accessible by the County exists over the planning period for post-recycling MSW generated in excess of annual capacity of 682,500 tons contractually available to the County under the WDA with Covanta.[20,21]

[20] Under the County's Service Agreement with Covanta, which expires February 1, 2016, the County has contractual access to the full processing capacity of the Covanta

3.4 Construction and Demolition Debris

Construction and Demolition Debris (CDD) is generated from new construction, renovations and demolitions. Typically comprised of concrete, brick, wood, metal, shingles and other building materials, CDD generated in Fairfax County, with the exception of a small amount of CDD delivered to the County's I-66 and I-95 Solid Waste Management Complexes (30,000 to 40,000 tons per year), is managed entirely by the private sector. The County's CDD approach is similar to adjacent jurisdictions (*e.g.*, Prince William County, Loudoun County).[22] CDD facilities are required to report CDD tonnages on an annual basis to VDEQ; however, reporting is not specific to the generating solid waste management planning unit. This limitation in availability of data specific to Fairfax County makes projecting CDD generation difficult.

There are several methods for developing CDD generation estimates: methods that are based on (a) empirical calculations considering construction specifics (square footage, type of construction, value of construction) and (b) more generic calculations based on historic generation rates. In the case of the empirical approach, necessary data are not available.

As the County does not track and record CDD generation and management data (CDD facilities are not required to report in-County generation to the County or to state regulating agencies), a population-based estimating method was used. State agency annual waste management reports were reviewed to determine the total CDD generated in Virginia.[23] This method is conservative, as VDEQ reports CDD generation specifically by state and does not include Virginia generated CDD exported

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E/RRF (approximately 1.2 million tons per year). The WDA commences February 2, 2016.

[21] Covanta owns and operates the Covanta E/RRF under a land lease agreement with the County. The lease expires in 2031.

[22] Prince William County and Loudoun County both accept CDD for disposal at the landfills; however, the majority of CDD generated in both counties is managed by private sector collection, processing and disposal companies.

[23] VDEQ Annual Solid Waste Reports.

out-of-state. According to the VDEQ reports, CDD generated and managed in Virginia was 3,351,168 tons and 3,216,230 tons in 2012 and 2013, respectively. On a per capita basis, the corresponding CDD generation rate was 0.41 tons/person/year in 2012 and 0.39 tons/person/year in 2013.

For comparison purposes, CDD generation rates were also obtained from several studies, including:

- Mecklenburg County, NC (Charlotte area): 0.42 tons/person/year (2008)
- Seattle, WA: 0.46 tons/person/year (2010)
- Northeast States (CT, ME, MA, NH, NJ, NY, RI, VT): overall average 0.31 tons/person/year (2006)
- USEPA reported nation-wide CDD generation rate: 0.53 tons/person/year (1998).

Based on data reported in the MDE's *Annual Maryland Solid Waste Management and Diversion Reports*, estimated state-wide CDD generation for Maryland for 2011 was 0.37 tons/person/year and in 2012 was 0.46 tons/person/year. It is noted that Maryland Department of the Environment (MDE) reports total CDD managed by in-state facilities, CDD generated in state but exported, and CDD imported from other states.

Comparison of the above estimated generation rates to available Virginia information indicates the estimated Virginia per capita CDD generation rate, although conservative as data regarding Virginia generated CDD exported to other states is not known, is reasonable. Therefore, a range of CDD generation was developed using Fairfax County projected population and: (a) the average CDD generation for Virginia, based on available 2012 and 2013 data (0.40 tons/person/year or approximately 2.2 lbs/capita/day); and (b) the USEPA's estimated generation rate of 0.53 tons/person/year (2.93 lbs/capita/day). Table 3.5 summarizes the range of projections. It is noted the projected CDD generation rates are lower than those estimated in the 2004 SWMP.

Table 3.5 - Fairfax County Estimated CDD Generation (tons)

Year	CDD Generation Rate (tons/person/year)	
	0.40	0.53
2013	459,640	609,024
2014	461,535	611,534
2015	463,430	614,045
2020	482,236	638,962
2025	502,946	666,404
2030	521,993	691,641
2035	542,084	718,261

Appendix F provides the CDD generation estimate for Fairfax County for each year of the planning period.

As discussed above, the Lorton CDD Landfill is scheduled to close by 2018. The closure of this primary CDD disposal facility may create a limitation in disposal capacity over the planning period, as there appears to be insufficient CDD disposal capacity in the general region.[24,25] While other CDD disposal facilities have either recently entered the market (Ritchie Land Rubble Fill in Prince George's County Maryland) or are reported to be planning expansions (Potomac CDD Landfill in Prince William County), future CDD disposal capacity is not certain. In addition, significant redevelopment activities, such as the Tyson's Corner transformation driven by expansion of public transportation systems, will affect CDD generation. While it is noted that CDD can be accepted for disposal at MSW landfills and additional regulatory requirements for MSW landfills are expected to result in increased disposal costs, it is anticipated the private sector will address gaps in supply and demand and continue to provide for the management and disposal of CDD.

For planning purposes, the County should consider diversion programs that will reduce the dependency on CDD disposal capacity. This includes the development and

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[24] VDEQ reports 15.9 years of remaining CDD disposal capacity in Virginia as of December 31, 2013. *Solid Waste Managed in Virginia During Calendar Year 2013*.

[25] The Ritchie Land Rubble Landfill, while having a significant volume of capacity available, is subject to traffic restrictions limiting daily acceptance rates.

implementation of a CDD recycling program at the point of generation. The County would need to obtain legislative authority to implement a mandatory program. The development of CDD recycling program should include:

- Legislative and regulatory requirements;
- Scope of program (mandatory/voluntary);
- Institutional requirements;
- Generator permitting/licensing options;
- Guidance information and resource tool-kits;
- Public education/outreach and communication;
- Compliance efforts;
- Cost-of-service; and
- Other factors.

Should the County consider such a new program for inclusion in the 2015 SWMP Update, the 2015 SWMP Update should include a description of the planned program, a schedule of major milestones, and a plan for public outreach.

4. Task 2.3 - Review of New and Emerging Technology

The solid waste management industry continues to support the development of new and potentially increasingly efficient ways to manage wastes. In recent years, the industry has experienced resurgence in focus on new (or emerging) technologies. Part of any solid waste management planning process should consider the viability of potential new technologies, as well as the effectiveness of incorporating such technologies into the solid waste management system.

The following discussion of new or emerging technologies is relative to the County's current solid waste management system, including current and projected waste generation rates and disposal capacity requirements, as well as specific materials in the waste stream that may be targeted. The discussion also incorporates the information obtained by the County from the 2012 Request for Expressions of Interest (RFEI) that sought alternatives means, method or practices to manage all or a portion of the County's post-recycling waste stream.[26,27]

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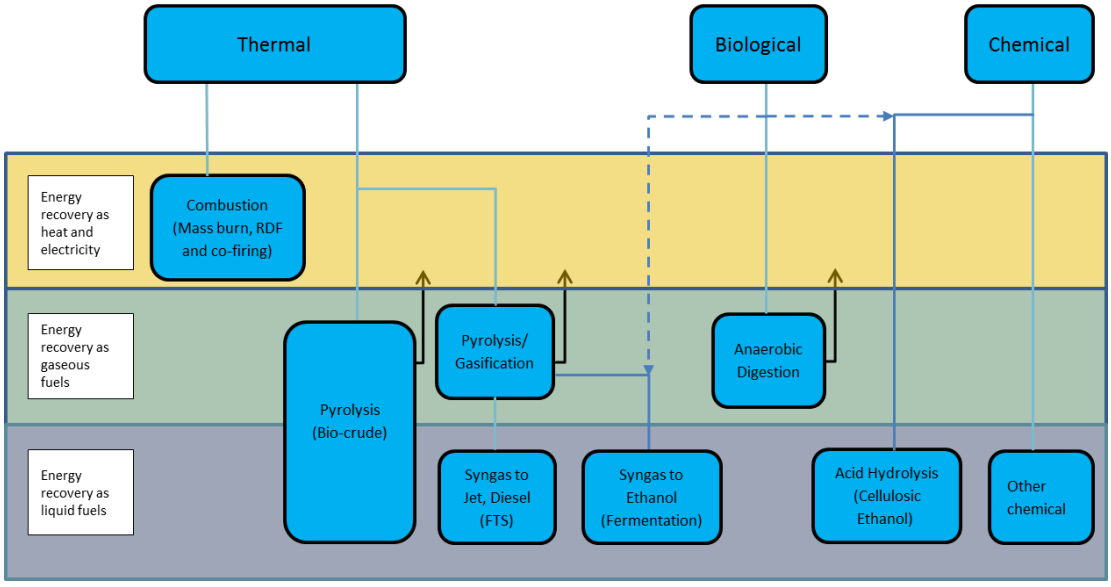
[26] *Request for Expressions of Interest. SWMP-2012-001 Solid Waste Management*. Fairfax County, 2012.

The technologies identified focus on those technologies that provide beneficial use, such as the recovery of energy or other resources. Conventional technologies such as recycling, landfilling and landfill gas utilization are well established in the County and are not addressed in this assessment. Conventional Waste-to-Energy (WTE), the technology utilized in the Covanta E/RRF is included for comparison with emerging thermal and chemical processes.

For the purpose of energy recovery, MSW technologies are broadly divided into three categories: thermal, biological and chemical. Figure 4.1 provides an overview of the processes available for converting MSW into various forms of energy. A general description of each technology is provided in the following paragraphs. Many of the technologies have been commercially applied to a range of biomass and fossil feedstock; however, the following assessments mainly focus on the handling and energy recovery from the types of solid wastes generated in the County.

Figure 4.1 – MSW Technologies for Energy and Resource Recovery



[27] Information obtained from the County's RFEI process included in this report is limited to protect confidential information submitted by prospective respondents.

4.1 Combustion

Heat generated from the combustion of MSW is used to drive a steam turbine that generates electricity. Combustion systems may also provide combined heat and power that improves plant efficiency by exporting steam if a nearby heating demand is available.

Two main types of combustion systems are used in the US: mass burn which features minimal pre-processing of the waste and requires combustion on a reciprocating or moving grate; and refuse-derived fuel (RDF) which features extensive preparation of the waste (e.g., shredding), permitting a combination of suspension firing and grate burning. Modern combustion plants may include enhancements to improve energy efficiency and operational flexibility; including advanced combustion control, fluidized bed combustion, cogeneration, high-pressure steam and external superheater designs.

In addition to generating power directly from the incoming waste, another option is to create fuel pellets that are then co-fired with coal at a coal-burning power plant or used in industrial furnaces such as cement kilns. The fuel pellets have a lower heating value than coal, but have similar handling properties and can be fed to the boiler without significant modification. Careful consideration of air pollution control measures is required when co-firing.

4.2 Thermal Conversion

This group covers a wide range of technologies that are characterized by treatment of the waste at high temperature in a reducing (limited oxygen) atmosphere to produce gaseous or liquid products. The most common technologies are fluid bed gasification, plasma arc gasification, pyrolysis or a combination of these. The combustible gas produced (syngas) can be cleaned up and purified prior to combustion, which may improve control of air pollutant emissions.

4.2.1 Gasification

Gasification of MSW involves heating the feedstock either using plasma arc or fluid bed in combination with steam/air/ oxygen in a reducing atmosphere causing a complex series of chemical reactions. The solid feedstock is converted into synthesis gas (syngas), solid residue and a small amount of tar, usually entrained in the gas stream. Syngas is primarily hydrogen and carbon monoxide with varying amounts of carbon

dioxide, nitrogen, methane and higher hydrocarbons. Following cleanup, the syngas may be used in several different ways:

- Raising steam for electricity and/or heating in a gas fired boiler
- Generating electricity in a combined cycle using a combustion system followed by steam turbine
- Generating electricity using internal combustion engines
- As feedstock for synthetic liquid fuels via Fischer Tropsch Synthesis (FTS).
- As feedstock for methanol synthesis via fermentation. This may be followed by a methanol-to-gasoline (MTG) conversion process.

Plasma arc gasification uses an electrical current between two electrodes (the arc) to heat a gas (usually air, oxygen, nitrogen, argon, or a combination thereof) to temperatures of many thousands of degrees Celsius within the plasma arc reactor. The heated and ionized plasma gas is then used to treat the waste. Plasma arc/gasification includes plasma as the initial step with the char or solid residue discharged to a gasification reactor. The molten residue from the gasification process is typically discharged to a water bath and quenched to form a glassy, slag-like material.

4.2.2 Pyrolysis

Pyrolysis of MSW is similar to gasification but the waste is heated in the absence of oxygen or other oxidants. This causes thermal breakdown of the material into char, pyrolysis oil and a small amount of syngas. Pyrolysis is an endothermic process that requires a source of heat to initiate the thermal reactions. Pyrolysis systems typically use drums, kiln structures, or tubes that are externally heated in a closed system (in the absence of oxygen). Pyrolysis systems operate at a range of temperatures (400°C to 800°C), depending on the feedstock and the desired products.

Pyrolysis treatment of MSW can be further categorized into the following commercial or near-commercial processes:

- Production of synthetic crude oil from waste plastics. Waste plastics are chipped and heated in reducing atmosphere to produce char, and a gaseous product containing petroleum-range hydrocarbons. The gas is condensed at ambient temperatures and can be further refined to make transport fuels.
- Production of bio-crude oil from cellulosic feedstock that may include non-recycled paper, food waste, demolition waste and yard waste. This category covers processes known as direct liquefaction and hydrothermal treatment.

Typically, the waste is heated to moderate temperatures and high pressure in the presence of a catalyst and reducing agent such as hydrogen. Several companies have commercialized this technology for woodchips and other biomass sources, but it is not clear whether conversion of MSW-derived materials has been developed.

- Pyrolysis/gasification systems may combine pyrolysis with gasification in a single unit or may be separately processed. Because the final product is syngas, these technologies can be considered a sub-category of gasification.

4.3 Biological

4.3.1 Aerobic Digestion (Composting)

Composting facilities accept yard waste, food waste, paper, cardboard and clean wood from demolition debris. These components are shredded and blended to achieve optimal moisture and nitrogen/carbon ratio. The material is allowed to decompose in a series of controlled phases designed to achieve drying, volume reduction and pathogen destruction. There are several techniques for composting, but typically, the material is placed in windrows up to 200 feet long. Windrows may be actively aerated, while oxygen content and temperature of the bulk material are closely monitored to ensure destruction of pathogens. Other technologies treat the material in a closed, rotating digester vessel before being placed in windrows.

The compost product is typically marketed as a soil amendment or gardening product. Composting facilities can also produce an RDF fuel for combustion by drying and stabilizing the organic waste.

4.3.2 Anaerobic Digestion (AD)

The typical process begins with separation and diversion of the MSW into organic and inorganic fractions (on a source-separated or post-collection basis). The organic fraction is then pulped and fed to a low-pressure vessel where it decomposes under anaerobic conditions to produce biogas.[28] The generated biogas consists mainly of methane (55 – 60%) and carbon dioxide as well as moisture and trace contaminants

[28] Several communities in the U.S. have been investigating the potential for diverting source-separated organics to wastewater treatment plants.

such as hydrogen sulfide and siloxane. Typically, the biogas is utilized as a fuel for internal combustion engines to generate electricity and for heat. There is also the potential for upgrading biogas for direct sale to pipeline as a fuel for compressed natural gas vehicles. Mixed MSW requires significant pre-processing including classifying, shredding, and separating of large objects and non-digestibles. Biological treatment produces a residue stream high in non-digestible organics, which may be landfilled but may also be suitable for land application or combustion.

4.3.3 Combined Anaerobic Digestion and Combustion

A recent trend in solid waste management is to combine biological and thermal technologies in an integrated facility to take advantage of the characteristics of the specific waste being handled. One such combination is a pre-processing plant followed by anaerobic digestion, with the reject stream (non-organic fraction) becoming feedstock to a combustion plant. This design makes use of the fact that biological systems require moisture to operate, often requiring addition of water, while combustion plants operate more effectively on a low-moisture waste stream to improve the heating value.

4.4 Chemical

4.4.1 Acid Hydrolysis for Cellulosic Ethanol

This process has been widely promoted in recent years to produce ethanol for use in light-duty vehicles. The process begins by separating the organic and cellulosic portions of the MSW including food waste, non-recycled paper and cardboard, demolition waste, yard waste and miscellaneous wastes. After shredding, the material is treated with dilute acid to convert the cellulose to sugars under high temperature and pressure. The sugars are then fermented to produce ethanol after which the liquid product is distilled to produce fuel-quality ethanol.

4.4.2 Other Chemical Processes

There are a number of less established technologies for converting organic portions of the MSW to liquid fuels. These may include aspects of pyrolysis and aspects of hydrotreating to convert the pyrolysis oil into petroleum-range hydrocarbons. This would include technologies for conversion of biomass-derived oils into biodiesel and renewable diesel. There is limited evidence that these technologies are being used commercially for MSW feedstock.

4.5 Pre-Processing

Many of the above-discussed technologies require processing of the waste stream prior to treatment. Pre-processing requirements associated with a number of technologies are integrated into the facility. Others are implemented at the point of generation, as with source-separated organics. Pre-processing requires additional capital and increases O&M, factors that are necessary to include in any detailed assessment of any proposed project. One technology, which may be considered an independent intermediate step on the waste management process, is mixed-waste processing, discussed further in the following section.

4.5.1 Mixed-Waste Processing

Mixed-waste processing, sometimes referred to as a “dirty MRF” is a physical sorting and separation processes using MSW on an as-delivered (or as-collected) basis. Benefits of mixed-waste processing can range from increased recovery of recyclables to producing an RDF pellet (fuel pellets) that is lightweight and contains higher fuel value inorganics. Fuel pellets can be marketed as a fuel stock for MSW combustion facilities as well as a fuel for co-firing at industrial boilers. Mixed-waste processing is currently available, with an increasing number of facilities being implemented across the United States. Risks associated with mixed-waste processing, or a dirty MRF, are primarily limited to the marketability of the fuel pellets.

4.6 Comparison of Technologies and Assessment of Viability

Table 4.1 presents a matrix comparing the technologies discussed above. Criteria used in the comparison are primary factors important to the County relative to its solid waste management program. Information in the comparative matrix is based on ARCADIS’s knowledge of and experience with technology development and general information obtained from the County’s RFEI process. Should the County consider a new technology for its solid waste management program, a review of the criteria listed in Table 4.1 is warranted.

Table 4.1 – Comparison of New and Emerging Technologies

Criteria	Thermal Conversion		Biological Conversion		Chemical	Physical
	Pyrolysis to Bio-Crude	**Pyrolysis/ Gasification to Syngas**	**Aerobic Digestion (Composting)**	**Anaerobic Digestion**	**Acid Hydrolysis**	**Mixed-Waste Processing**
Ability to Manage County MSW	Limited	Limited	Limited	Limited	Limited	☑
Applicable Waste Stream(s)	MSW CDD	MSW	MSW organics, yard waste, paper	MSW organics, yard waste (non-wood), paper	MSW organics, yard waste (non-wood), paper	MSW CDD
Proven Commercial Operations	Limited (not at commercial scale)	Limited (not at commercial scale)	☑	☑	■	☑
Technically Feasible at Scale	■	■	☑	☑	■	☑
Economically Feasible Scale	■	■	☑	☑	■	☑
Land Requirements	5-10 acres	Not known	25-30 acres	2-5 acres	Not known	2-5 acres
Est. Capital Cost ($/design ton)(1)	$250k - $587k	$350k-$450k	$30k-$40k	$120k-$200k	Reliable data not available	$50k-$75k
Est. Operating Cost ($/ton processed)(1)	Reliable data not available	Reliable data not available	$30-$70	$20-$40	Reliable data not available	$20-$45

Key:
☑ Yes – considered capable of meeting criteria
■ No – not considered capable of meeting criteria

Note:

1. Estimated capital and O&M costs are based on ARCADIS's experience and available literature and are provided for planning purposes only. For vendor provided services, O&M fees are more likely to be market based.

Aerobic digestion (composting), anaerobic digestion and mixed-waste processing are technologies considered commercially available for processing a portion of the County's post-recycling MSW. However, a strategy for deployment of such technologies or engagement of vendors would need to be developed and be integrated in a manner allowing the County to maintain its ability to provide cost-effective and efficient waste management services as well as the technology's complement to the County's existing solid waste management infrastructure and contractual obligations. It is understood there is a limitation of land available for such a facility in the County. In addition to potential siting limitations, capital investment requirements by the County will depend on project development arrangements (independent vendors, public-private partnerships, etc.). Prior County investigations regarding solid waste management technologies and processes indicated a desire for public capital investment by vendors.

Other technologies remain in development and any consideration of these technologies by the County should be based on the technologies' continued development and successful demonstration of viable operations at an appropriate commercial scale.