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Solid Waste Forecast FY20-21

Property and Environmental Services

Solid Waste Information and Analysis

November 2019

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CONTENTS

FIGURES

APPENDICES

EXECUTIVE SUMMARY

Metro's annual Solid Waste Forecast provides policymakers, the solid waste industry and the general public with insights into the types and quantities of waste that the greater Portland area is likely to generate in the next few years and the conditions that affect the generation of waste. The forecast is grounded in local and national economic data and trends. The forecast is also based on Metro's four decades of experience in managing the greater Portland area's garbage and recycling system and observing the economic and policy conditions that affect the amounts and types of waste that homes and businesses create.

The information in the forecast affects the revenues Metro is likely to generate for its solid waste operations, waste reduction and other related programs, and it illustrates the impacts that different policy decisions and economic conditions can have on waste streams. This forecast is intended to assist policymakers and industry leaders in making decisions affecting the management of garbage and recycling in the greater Portland area.

Assumptions Overview

The U.S. economy continues to grow albeit more slowly than it did a year ago, but there has emerged a heightened sense of uncertainty and greater global economic risk. To address this uncertainty, Metro incorporates a recession scenario into its normal baseline economic forecast. The forecast also incorporates solid waste policy assumptions with respect to upcoming new food waste diversion programs as well as regulatory assumptions around wet waste allocations that affect the flow of waste throughout the region.

The high-level implications of these assumptions on the tonnage outlook, from both a financial and regulatory perspective, are provided below. More detail on each assumption underpinning this year's forecast and detailed forecast results are provided in the Major Assumptions and Results sections, respectively, starting on page 5.

Financial

Tonnage that incurs the Regional System Fee ("system fee") is expected to grow from about 1.45 million tons last fiscal year (July 2018 through June 2019) to a little more than 1.47 million tons this fiscal year, and 1.48 million tons by fiscal year 2020-21.

Since the same tonnage that incurs the system fee also incurs the Solid Waste Excise Tax ("excise tax"), plus some additional waste from outside the region, tonnage subject to the excise tax should also continue to grow at slower rates, reaching about 1.50 million tons by fiscal year 2020-21.

Regulatory

Shifting to calendar years ("CY", January 1 through December 31), which is the unit of time relevant to Metro's regulatory purview, regional tonnage used in wet waste allocations slowed significantly in 2017 to about 735,000 tons, remained flat in 2018, and is expected to stay at this level for the next couple of years, as moderate food waste diversion from increased commercial food waste

capture offsets small growth in the underlying wet waste stream. The facility allocations that result from these expectations are presented on page 27.

METHODS

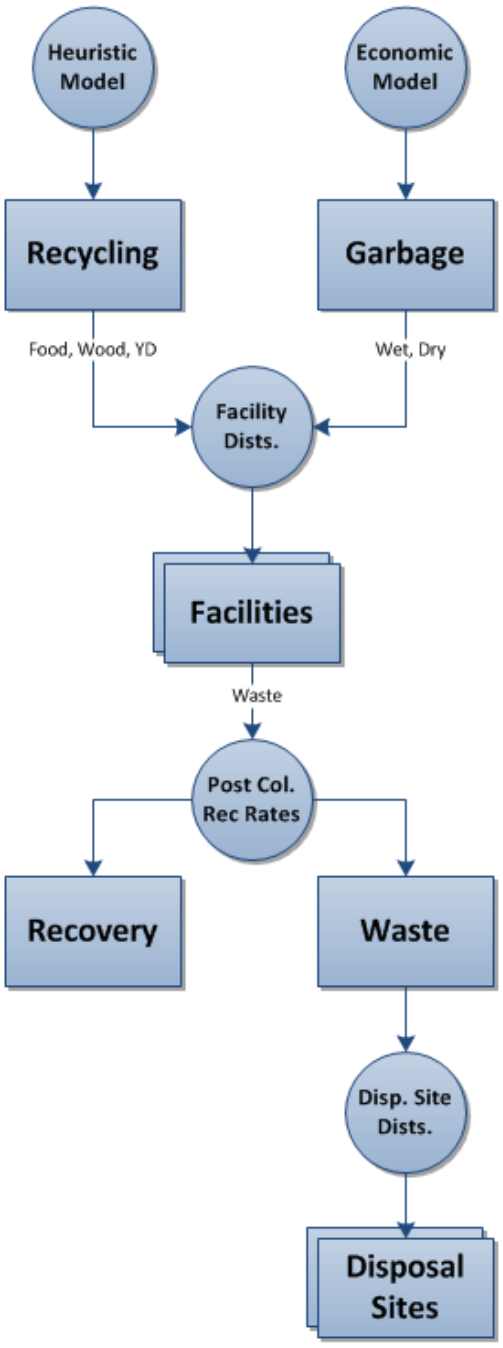
Model Summary

Metro's solid waste forecasting model (Figure 1) is an integrated temporal model of waste generation, distribution and disposal in the Metro region. The model is used annually to build the solid waste forecast for cost estimation, budgeting, rate-setting and regulatory purposes for the next calendar and fiscal years.

Because of its financial and regulatory focus, the forecast is focused primarily on garbage (wet and dry waste), but it also yields some high-level information on recycling streams. Since it produces five additional years of forecasts beyond the next calendar and fiscal years of focus, the forecast can be used in medium-range planning. Figure 1 depicts the key steps in the model which are summarized below.

Waste Generation: Metro uses a pair of econometric equations to estimate quantities of wet and dry wastes in Clackamas, Multnomah and Washington counties ("tri-county region"), and a simple heuristic model to estimate some source-separated recycling streams of interest. For the former, an initial equation uses economic indicators related to household and business consumption to forecast total regional garbage, while a second equation uses construction-related indicators to split the garbage into wet and dry sub-streams. The resulting wet and dry forecasts are then adjusted based on stakeholder feedback received during the forecast review process described below. Appendix C provides specification and model diagnostic details on these equations as well as historical and forecast data sources for all model variables.

Figure 1: Model Overview



For the latter, specifically source-separated food waste, wood waste and yard debris, the forecast assumes that current, or "base," tonnage will persist, and then new program tonnage (from anticipated new or expanded residential and commercial food waste programs) will add to this base in future years, depending on timing. These new program assumptions are developed largely from the feedback received through the review process. Assumed new programs in the model will

also act to divert additional wastes from wet or dry discarded materials forecasted by the econometric models and subsequent adjustments mentioned above.

The model also uses the latest MetroScope spatial forecast to split tri-county wet waste into wet waste generated within the Metro jurisdictional boundary ("Metro region") and that generated outside the Metro region but within the bounds of the tri-county region. MetroScope is an integrated land-use and transportation model that produces forecasts of where people work and where they live based on aggregate economic trends and population forecasts. It predicts the final demand of where people live and where businesses locate based on economic choices made by consumers, producers of goods and services, and real estate developers.

Facility-specific streams: After the model estimates the waste stream forecasts indicated above, it distributes each stream to various facilities. This distribution of waste is a vital part of the forecast's ability to predict which tons of waste set rates, incur costs and generate revenue for Metro. Issues that might affect these distributions, such as anticipated operational changes at facilities, market changes or new policies, are identified through the forecast review process and used by the model to inform distributions.

Post-collection recovery: Because Metro assesses fees and taxes on wastes that are ultimately disposed at a landfill or sent to a waste-to-energy facility, the model uses important assumptions identified through the review process about post-collection recovery operations at various facilities, including transfer stations and material recovery facilities in the Metro region. These issues may include anticipated new technologies, upcoming or assumed market disruptions or operational changes.

Disposition of waste: In order to estimate Metro's disposal costs and to monitor Metro's compliance with its flow guarantee through the end of 2019, the forecast includes assumptions of the distribution of waste to Waste Management and other landfills. Metro's new landfill contract will start on January 1, 2020, but will only apply to waste transferred from Metro Central and Metro South transfer stations.

Review Process

A review process is used to set the key assumptions within each of the modeling steps discussed above and to finalize the forecast. The process starts with a detailed assumptions review in mid-August. The assumptions are solicited through a questionnaire (Appendix B) submitted to solid waste planners, analysts, economists, regulators and local government solid waste program directors. Results from the questionnaire are combined with the economic outlook to form a preliminary forecast in late September. A Forecast Review Panel then reviews the preliminary forecast and suggests changes before finalization and distribution, typically in October.

MAJOR ASSUMPTIONS

Economic Outlook

This section outlines the national and regional economic outlook that underpins the forecast. The document also provides details on the history of and outlook for each of the indicators in Metro's solid waste economic models. More technical detail on the models is available in the attached Modeling Overview document in Appendix C.

Overview

The U.S. economy continues to grow albeit more slowly than it did a year ago, and the current expansion is now the longest period of continuous economic growth in the U.S. in the modern era. The baseline forecast of U.S. Gross Domestic Product (GDP) is expected to increase 1.9% in the fourth quarter of 2019 and 2% annually in 2020 and 2021. Both the U.S. and Portland region job markets are healthy. Since January, annual job growth in the region hovered around 2%, and the unemployment rate in August for the region was 3.9%, seasonally-adjusted, which is slightly above the 3.8% reading for the U.S. as a whole. With unemployment rates here and across the U.S. near 50-year lows, wages are also starting to rise. The Federal Reserve twice cut its key benchmark interest rates this year to bolster slowing GDP in the U.S., which has helped housing markets. Home price gains this past year have continued but moderated, boosting consumer demand and housing affordability. Overall, consumer confidence still remains relatively high.

Despite these favorable conditions, there has emerged a heightened sense of uncertainty and greater global economic risk. Trade uncertainty, with China and other countries, still clouds both global and U.S. economic growth prospects. Imports and exports out of the Port of Portland have been mixed due to trade tariffs which have squeezed grain exports. Recent national survey data has been indicating a decline in manufacturing with businesses beginning to cut back on employment and production levels in anticipation of a more widespread downturn. And the recent inversion of the yield curve[1] has instilled worry that the economy could tip into recession.

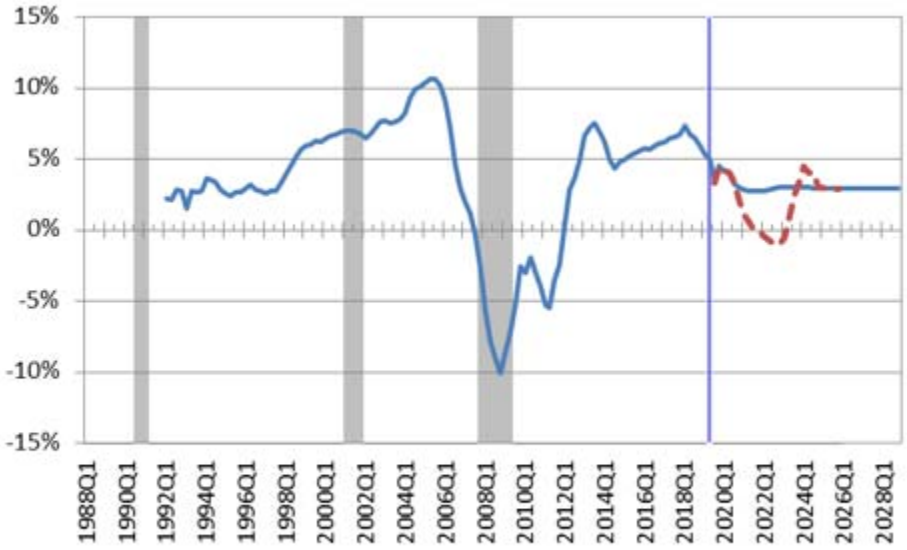
To address this uncertainty, the forecast (for the very first time) considers both a baseline economic scenario (assuming the current trajectory of continued but modest growth) together with a "recession" scenario that models a mild recession among the key variables that affect the solid waste forecast. The recession scenario is factored into the final solid waste forecast using a subjective probability weight scheme that blends the likelihood of the recession and baseline scenarios, together with stakeholder input derived during the review process. More information on the outlook of each of the economic variables in Metro's waste model is provided in the sections that follow.

[1] As of this writing, the curve is no longer officially inverted but remains close to zero and could invert again

Employment

Figure 2 presents the outlook for employment growth, as year-over-year (yoy) % change, in the Portland Metropolitan Statistical Area (MSA) for both baseline (blue line) and recession (dotted red line) scenarios. The dates of previous recessions are shaded grey.

Figure 2: Employment Outlook (YOY % Change) – Portland MSA



Source: Bureau of Labor Statistics (BLS), Northwest Economic Research Center (NeRC), Metro

The baseline forecast expected slightly faster job growth than actually materialized through the first half of 2019. The difference ran about 10,000 jobs too high. The current baseline corrects this difference in recent history and adjusts the near term to reflect lower than expected employment levels. In later forecast years, the current forecast converges with the previous forecast revealing virtually the same growth outlook in distant years.

The recession scenario suggests an alternative growth path that assumes a mild recession hits the U.S. in the third quarter of 2021. The impact then ripples to the regional economy through different lags and leads of the variables used in the solid waste economic models. Unlike the Great Recession, this hypothetical recession is significantly less deep, the duration much shorter, and the rebound to baseline trend occurs with less delay. The harm to the regional economy is consequently much less. The duration, depth, lags and leads of various variables are modeled in a manner consistent with a mild recession whose impact on these variables are similar to the 2001 U.S. recession and of other small recessions.

In the recession scenario, job growth starts to deviate from the baseline scenario in the fourth quarter of 2020. The growth rate starts to steadily decline, and by the fourth quarter of 2021 negative job growth is expected. After sliding into negative territory, nonfarm payroll employment growth rebounds and temporarily "overshoots" the baseline before settling into the projected long-run growth trend.

Home Prices

Figure 3 presents the current outlook for home price growth in the U.S., specifically the Federal Housing Finance Agency's (FHFA) home price index, for both the baseline (blue line) and recession (dotted red line) scenarios. The baseline forecast shows IHS Markit's latest forecast for average home sales prices nationwide, which is little changed from that made a year ago and used in the 2019-20 solid waste forecast.

Figure 3: Home Price Outlook (YOY % Change) – U.S.

Source: FHFA, IHS/Markit, Metro

In the recession scenario, a hypothetical downturn in home prices is constructed as illustrated in figure 4. The shape of the downturn is typical of a boom-bust cycle for real estate markets. The present real estate market is assumed to eventually produce an over-supply of residential homes which will in turn trigger a fall in real estate values that will be reflected in the HPI. The hypothetical recession scenario assumes housing demand will decrease as real GDP falls, employers react by cutting employment and unemployment rates rise leading to a drop in housing demand. The rise and fall in home prices is constructed to appear similar to the 2001 recession in its depth and duration. Of course no two recessions are identical, but there are similarities in how sectors of the economy might behave.

Construction Employment

The outlook for construction employment growth is presented in Figure 4 for both baseline (blue line) and recession (dotted red line) scenarios. Baseline expectations of future construction employment growth are quite similar to those of a year ago. If the expansion continues, the current forecast merely extends expectations for roughly another year before expectations of future construction employment start to taper down.

Figure 4: Construction Employment Outlook (YOY % Change) – Portland MSA

Source: BLS, NeRC, Metro

On the other hand, the recession scenario assumes a hypothetical recession is just around the corner, imposing a mild downturn on the regional economy in late 2021 and carrying the job recession forward for a couple of years before returning to baseline growth. The recession scenario asserts only a mild recession. We assume swings in regional construction employment will be more muted than what had occurred during the Great Recession. The downturn in construction growth in our hypothetical scenario is engineered to not exceed other downturns the region has experienced in its past. And since the recession is small the rebound is assumed to be characteristically small as well so that growth rates during the recovery phase don't "overshoot" the baseline for very long before it also settles back to the trend growth rate exhibited in the baseline forecast.

House Permits

Figure 5 presents the current and previous outlooks for residential (both single and multi-family units) construction permits in the Portland MSA, for both the baseline (blue line) and recession (red dotted line) scenarios. As is similar for the indicators above, this year's baseline outlook by the Northwest Economic Research Center at Portland State University (NERC) is relatively unchanged from that made a year ago.

In the recession scenario, it is asserted that the number of houses built during the recession is reduced. Instead of building at the baseline number of units, the recession forces a reduction in units built as some builders scale back and a few may quit the business. As the recession abates, construction returns to the trend set by the baseline forecast.

Figure 5: Construction Permit Outlook (issued permits) – Portland MSA

Source: US Census Bureau Building Permits Survey, NeRC, Metro

Mortgage Rates

Figure 6 presents the current and previous outlooks for 30-year fixed mortgage rates in the U.S. for both the baseline (blue line) and recession (red dotted line) scenarios. Significant economic risk and global uncertainty stemming from the China-U.S. trade dispute forced the Federal Reserve Board of Governors to cut its benchmark interest rate twice this year. This downshift in short-term interest rates put pressure on rates for longer-term debt instruments like mortgages to also dip during the year. The latest IHS Markit interest rate forecast that is the forecast baseline reflects the Federal Reserve cuts of the near term, but for rates in the longer run to edge higher. IHS Markit clearly believes interest rates have to increase to provide leeway for future monetary policy actions. However, the days of rapid inflation expectations and high interest rates do not seem to be a factor in the psyche of long-term forecasters or consumers so long rates will tend to be muted compared to earlier periods.

Metro's recession scenario has a bit more wiggle in the short-run as one might expect. In this scenario, it is anticipated that the Federal Reserve will react to a mild downturn by unleashing its monetary authority to expand the money supply through its open market operations in New York and to provide market guidance by slashing the federal funds rate to stimulate spending and capital investments.

Figure 6: Mortgage Rate Outlook – U.S.

Source: Freddie Mac Primary Mortgage Market Survey, IHS/Markit, Metro

Waste Generation

Metro's econometric models (detailed in Appendix C) predict the generation of garbage in the tri-county region as a function of the economic variables described in the previous section. These model forecasts are then weighted with independent stakeholder forecasts elicited during the review process previously outlined. The garbage forecast focuses on two sub-streams:

1. ***Wet wastes***, often referred to as "putrescible" wastes, are municipal solid wastes that have an organic component in the stream and are created from households and businesses in the region.

2. ***Dry wastes*** tend to be bulky wastes and construction and demolition (C&D) wastes that do not have a significant (or any) organic waste component. As such, they are often referred to as "non-putrescible" wastes, and come from households, businesses and construction activities in the region.

For the generation of recycling streams, Metro uses a heuristic approach consisting of two parts. First, "base" tonnage, or that from existing recycling programs, is assumed to continue at current levels for each stream. Second, tonnage from new recycling programs that are expected to start in the forecast horizon are added to the base in order to derive the final forecast of each stream. Since new recycling programs divert materials from wet or dry waste streams, the model subtracts this "additional" diversion from the wet and dry forecasts accordingly. Although the region's households and businesses generate many different recyclable waste streams, this forecast focuses on those that generate revenue or incur costs for Metro. Those streams are:

1. ***Residential food waste mixed with yard debris*** is a recycling stream generated by single-family households in select jurisdictions throughout the region that have "curbside" programs for this waste. Since the vast majority of the weight of this stream is yard debris (more than 90 percent), the food-specific diversion from overall wet waste tonnage tends to be minimal.

2. ***Commercial food waste*** is a recycling stream generated by businesses throughout the region. Since most if not all of the weight of this stream is food, new programs have a larger diversion effect on quantities of wet waste.

3. ***Wood and yard debris (to Metro facilities)*** are two separate streams generated by households, businesses and construction activities, the first of which diverts waste from discarded dry materials. Since regional quantities of these streams have no financial impact to Metro, the forecast focuses only on the wood and yard debris delivered to Metro's two public transfer stations.

Wet Waste

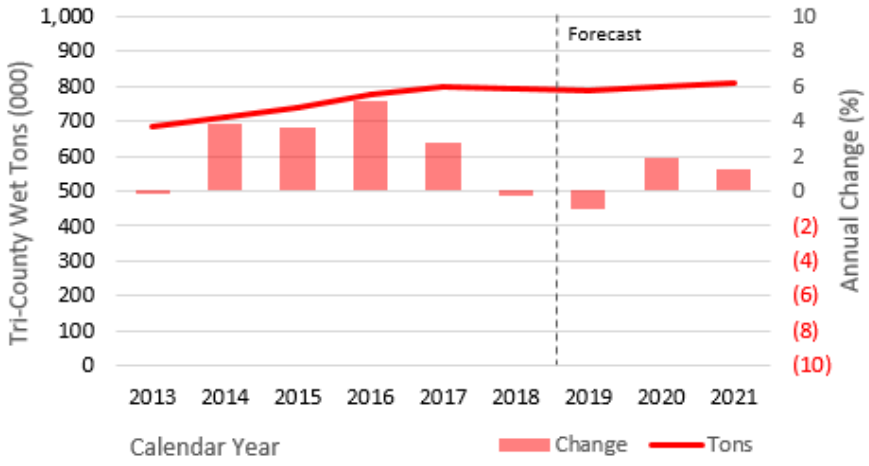
During the last recession, tri-county wet waste tonnage declined steadily from 2007 through 2013, bottomed out at about 685,000 tons in calendar year 2013, and then grew quickly up to a little under 800,000 tons by 2017. Rather than continue growth, wet waste tonnage was essentially flat

in 2018, and the data for 2019 suggests a moderate decline of about 1%, despite the lack of an evident economic recession.[2] Figure 7 presents historical and forecasted tonnage (line, left axis), along with annual growth rates (bar, right axis) from 2013 to 2021.

While the dating of economic cycles is complex, the process typically relies on movements of national production and income variables. These variables are not currently indicative of a recession, despite the fact that slower employment growth and slower home price appreciation in the Metro region have conspired to dampen wet tonnage growth. Moving forward, while the forecast incorporates a recession scenario (40% probability), this scenario does not play out and hit the wet waste stream until 2022. As a result, tonnage should grow moderately in 2020 (1.9%) and in 2021 (1.3%) with underlying economic expectations outlined above, reaching 812,000 tri-county wet tons by 2021.

Figure 7: Tri-County Region Wet Waste – 2013 - 2021

	Tons	Change
CY	thousands	YOY %
2013	685	-0.2
2014	711	3.8
2015	738	3.7
2016	776	5.2
2017	797	2.7
2018	795	-0.3
2019	786	-1.1
2020	801	1.9
2021	812	1.3



Notes:
o history: Metro Solid Waste Information System (SWIS)
o forecast: Weighted-average of econometric baseline and recession forecasts, and independent stakeholder forecasts

In order to forecast the split in wet waste between that generated in the Metro region and that generated outside the region, the model uses the latest MetroScope spatial forecast of household and employment growth in the region. MetroScope provides base year (2015) household and employment data by travel analysis zone (TAZ) as well as forecasts of those data for a horizon year (2040). For each year of the solid waste forecast, a linear interpolation of these data by transportation analysis zones is used in conjunction with wet waste generation parameters to estimate the percentage share of wet waste generated outside the region, and conversely, inside the region. The resulting out-of-region portions in 2020 and 2021 are 7.2% and 7.3%, respectively.

[2] The National Bureau of Economic Research (NBER) officially dates US recessions based on a number of criteria, and NBER's determination period takes between 6 and 21 months, on average. For example, NBER's determination of the peak date of December 2007 for the last recession occurred 11 months after that date.

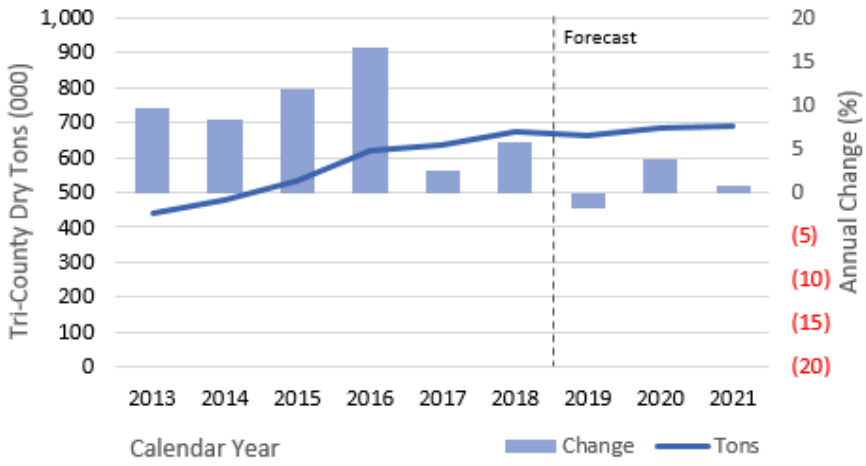
Dry Waste

Like the wet waste stream, tri-county dry waste expanded and contracted over the last couple of business cycles. During the last recession, dry tonnage hit an all-time low of about 385,000 tons in 2011 but then grew quickly in the proceeding years as regional employment growth and asset appreciation combined with declining mortgage rates and expanded construction activity in the region. Despite growth slowing considerably in 2017, tonnage hit an all-time high of 674,000 tons in 2018. Figure 8 presents historical and forecasted regional dry tonnage (line, left axis), along with annual growth rates (bar, right axis) from 2013 to 2021.

Recent data suggests that the slowing growth in tonnage should turn into an outright, but modest, decline in 2019 as economic growth and construction activity in the region slow. In 2020, the forecast calls for modest growth in dry tonnage to about 686,000 tons (3.7%) but then run essentially flat in 2021 as a recession scenario begins to pull waste tonnages down.

Figure 8: Tri-County Region Dry Waste – 2013 - 2021

	Tons	Change
CY	thousands	%
2013	440	9.6
2014	476	8.3
2015	532	11.8
2016	621	16.7
2017	637	2.5
2018	674	5.8
2019	661	-1.9
2020	686	3.7
2021	692	0.8



Notes:
o history: Metro Solid Waste Information System (SWIS)
o forecast: Weighted-average of econometric baseline and recession forecasts, and independent stakeholder forecasts

Residential Food Waste Mixed with Yard Debris

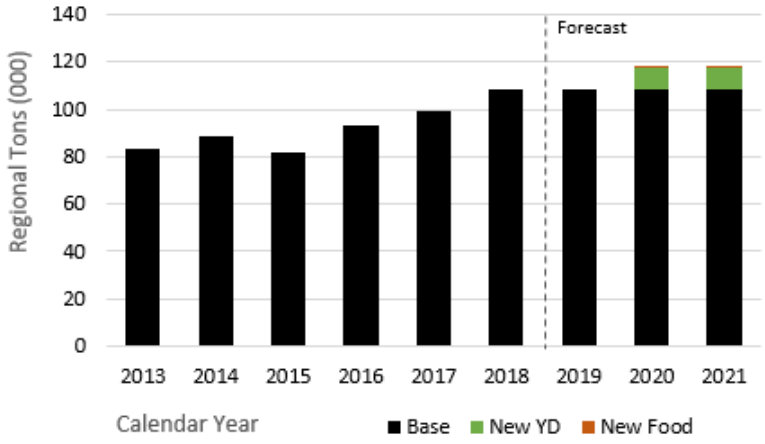
There are currently five local jurisdictions in the Metro region with curbside programs for residential food waste mixed with yard debris. Those programs (and their start dates) are: City of Portland (November 2011), City of Lake Oswego (June 2016), City of Forest Grove (July 2016), City of Milwaukie (August 2017) and City of Beaverton (October 2017). These programs currently capture a collective total of about 108,000 tons of material per year. Looking forward, this base tonnage is expected to remain stable through the forecast horizon, while one new program is expected to add to this base, as follows:

- City of Hillsboro – expected to begin January 2020 and yield about 10,000 annual tons. At 6.5 percent assumed food composition,[3] this program should divert an additional 650 tons of food scraps from the wet waste stream annually.

Figure 9 presents the implications of these existing and new program on regional tonnage of source-separated residential food waste mixed with yard debris. Before 2016, the City of Portland was the only jurisdiction with a curbside food waste collection program. Portland households (single-family) separated about 85,000 tons per year of material (food waste mixed with yard debris). Since 2016, additional programs in Lake Oswego, Forest Grove, Milwaukie and Beaverton added about 23,000 tons to that total. In 2020, the City of Hillsboro is expected to add another 10,000 tons of material, bringing the regional total up to almost 120,000 tons. Since most of the material in this stream is yard debris, less than 1,000 tons of Hillsboro's new material will be diverted from households' wet waste.

Figure 9: Residential Food Mixed with Yard Debris - 2013 - 2021

	Tons (000)		
	Existing	New Programs	
CY	Base	Yd Debris	Food
2013	83	---	---
2014	88	---	---
2015	82	---	---
2016	93	---	---
2017	99	---	---
2018	108	---	---
2019	108	---	---
2020	108	9	1
2021	108	9	1



Sources:

o history: Metro Solid Waste Information System (SWIS)

o forecast: Based on estimated new program tonnage, timing, and 6.5% food composition.

Commercial Food Waste

A variety of businesses in jurisdictions throughout the Metro region also participate in food waste recycling. Collectively, these firms capture about 27,000 tons per year and the expectation is that they should continue to do so. With the implementation of the regional Business Food Waste

[3] Figure from *Organics Stream Composition Study* (2012). Figure supported by current composition statistics of jurisdictions without every-other-week garbage, supplied by Oregon Dept. of Environmental Quality.

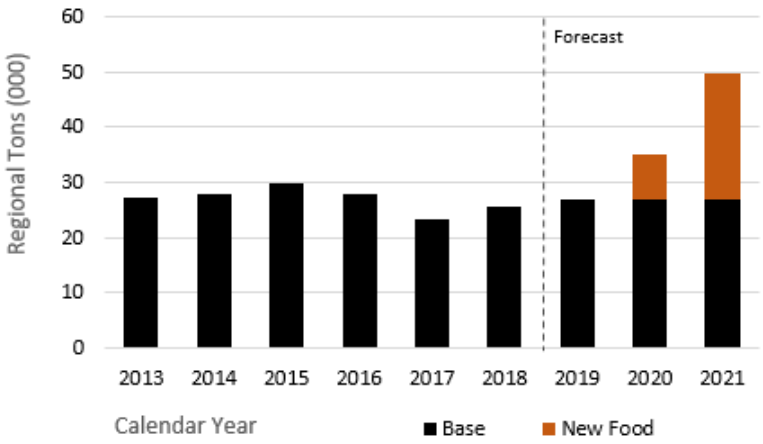
Program,[4] tonnage from new participating firms is expected to add to this base, and divert all tons from wet waste, as follows[5]:

- Group 1 (Businesses that generate 1,000 pounds or more of food scraps per week): Expected to add 10,000 additional tons per year starting in March 2020 and ramp up to about 13,000 additional tons per year by March 2021.
- Group 2 (Businesses that generate between 500 and 1,000 pounds of food scraps per week): Expected to add 10,000 additional tons per year starting in March 2021.
- Group 3 (K through 12 schools and businesses that generate between 250 and 500 pounds of food scraps per week): Expected to add another 6,500 tons per year starting in March 2022.

Figure 10 presents the implications of the new programs on regional tonnage of source-separated commercial food waste.

Figure 10: Commercial Food Waste – 2013 - 2021

	Tons (000)	
	Existing	New
CY	Base	Food
2013	27	---
2014	28	---
2015	30	---
2016	28	---
2017	23	---
2018	26	---
2019	27	---
2020	27	8
2021	27	23



Sources:

o history: Metro Solid Waste Information System (SWIS)

o forecast: Based on estimated new program tonnage and timing

Since 2013, existing businesses in the region have captured between 20,000 and 30,000 tons of food waste per year, with most recent estimates putting that at about 27,000 tons. In 2020, regional tonnage should increase by about 8,000 tons, and again in 2021 by another 23,000 tons, with the addition of food waste collected from Group 1 and 2 businesses. By 2021, regional

[4] Ordinance No. 18-1418, adopted by Metro Council in July 2018, establishes a phased program that requires businesses of various sizes to recycle food waste over the coming years starting in 2020.

[5] Starting tonnage estimates and timing taken from the Staff Report to Ordinance No. 18-1418 (p. 4), assuming 50 percent capture. Adjustments were made (to both tons and timing) to represent a gradual implementation of the program region-wide.

commercial food waste tonnage should hit about 50,000 tons, which represents an increase of more than 85 percent over current regional tonnage. All of this new material will be diverted from businesses' wet waste.

Wood and Yard debris (to Metro stations)

For source-separated wood and yard debris delivered to Metro transfer stations, the forecast assumes that current tonnage should continue with no new major sources. Specifically, Metro Central transfer station in Northwest Portland should continue to receive about 2,000 tons of yard debris, and 900 tons of source-separated wood waste, per year. Metro South transfer station in Oregon City should continue to receive about 14,500 tons of yard debris, plus another 2,300 tons of source-separated wood waste, per year.

Facility Distributions

After the model estimates the regional waste streams above, it incorporates assumptions for distributing each stream to facilities. The distribution of waste to various public and private facilities is important for setting rates and for estimating fixed and variable operating costs and revenues for Metro's disposal utility.

Wet Waste

Distributions of Metro region wet waste to transfer stations are regulated by Metro. Specifically, there are six private transfer stations operating in the region that are franchised and authorized by Metro to accept wet waste. In addition, Metro authorizes some wet waste to be hauled directly to out-of-region transfer stations or disposal sites by way of non-system licenses, including the Covanta Marion waste-to-energy facility near Brooks. Metro allocates specific wet waste tonnage amounts to these franchisees and non-system licensees as a public resource and in a manner that Metro believes will best achieve the public interest. Metro allocates up to 60% of the regional wet waste to private facilities, ensuring that at least 40% of the waste will flow to Metro's two public transfer stations. If private facilities do not use all of their allocations, the wet waste is assumed to flow to Metro's transfer stations. The distribution of wet tons to facilities is therefore based on the combination of assumed allocations to private facilities, and the assumed utilization of those allocations by those facilities (allocations multiplied by utilizations equals distributions).

This forecast incorporates a new allocation methodology that allocates 60% of the region's wet waste to private facilities in two 30% portions. The first 30% portion is allocated equally to each of the six private transfer stations in the region, after subtracting a small portion for authorized out-of-region facilities. This is called the equal share. The second 30% portion is allocated to the six private transfer stations in the region based on meeting goals in the 2030 Regional Waste Plan, however, Metro has not yet developed evaluation criteria for this goal-based share. For 2020, a transitional proportional approach is used in place of the goal-based share. During the transitional phase, the second 30% portion is allocated to private facilities based on their prior year's allocation.[6] This forecast applies the proportional approach beyond 2020 because the goal-based approach is not yet developed. Figure 11 provides the resulting allocations for each private facility, as a percentage of total regional tonnage.

[6] CY 2019 allocations shifted for Gresham Sanitary and City of Roses within the year, from about 24,000 tons to 49,000, and from 0 tons to 15,000 tons, respectively. For these two entities, the goal-based share will be based on a time-weighted average of their 2019 allocations.

Figure 11: Wet Waste Allocations – 2018 - 2021

	Allocation Percentages* by Calendar Year			
	2018	2019**	2020	2021***
In-region Facilities				
City of Roses Recycling	---	2%	5%	7%
Forest Grove Transfer Station	17%	17%	13%	12%
Gresham Sanitary Service	3%	7%	7%	8%
Pride Recycling	11%	12%	10%	10%
Troutdale Transfer Station	11%	11%	10%	10%
Willamette Resources Inc	11%	10%	10%	10%
Out-of-region Facilities				
Canby (direct-haul from Kahut)	2%	2%	2%	2%
Vancouver (direct-haul from WC)	3%	3%	2%	0%
Covanta Marion (direct-haul from various)	1%	1%	1%	1%
Total Private Allocation	**59%**	**65%**	**60%**	**60%**

* Allocation divided by regional tons (2018 actuals, 2019-2021 expected)
** 2019 allocations listed are final allocations, and include City of Rose's 1/2 year authorization of 15,000 tons, as well as a negotiated shift in allocations between Pride Recycling and Willamette Resources, Inc. that resulted in 88,880 and 70,880 ton allocations, respectively, to those facilities.
*** Estimated based on proposed transition-phase proportional allocation methodologies that are expected to be replaced by a goal-based approach for 2021 allocations.

In terms of the utilization of allocations (or the percentage of private facility allocations that are used by those facilities), history has shown that these vary significantly by facility and year, but average about 92% across facilities over the last several years. For the current year 2019, wet waste utilizations for each facility are expected to follow trend and come in just under 90%. Currently, Pride Recycling and Forest Grove transfer stations are the only facilities expected to use most or all of their 2019 allocations. Since City of Roses is a new facility and no prior data is available, the assumption is that this facility will use all of its 15,000 ton allocation this year.

In 2020 and beyond, utilizations for each facility are calculated as a function of the allocation it receives. Specifically, if a facility's allocation (in 2020 or beyond) is lower than the amount of waste that it typically used in a year, the expectation is that the facility will use 100% of its allocation. If the allocation is higher, the facility's average allocation utilization over the last several years will be assumed (something less than 100%).[7] The net result of this assumption is to see average utilizations increase to 95% in 2020, and come in around 91% in 2021.

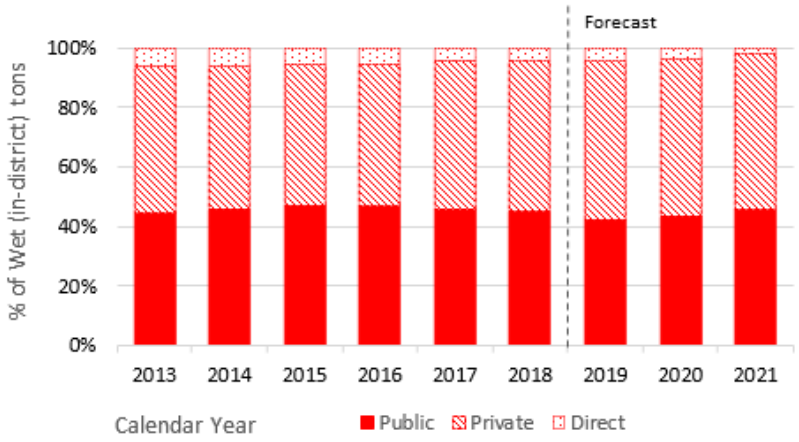
The implications of these allocation and utilization assumptions on the distribution of wet waste to public and private facilities is presented in Figure 12. Wet waste distributions to Metro are

[7] Where no historical facility use data are available, certain simplifying assumptions are made to ensure that final distributions to Metro are not negatively impacted by the uncertainty.

expected to decline this year since private allocations are set to rise faster than the offsetting effect of lower private utilization of those allocations. However, if the new allocation method and utilization assumptions bear out, the unused allocations would flow to Metro's transfer stations.

Figure 12: Distributions of Metro Region Wet Waste – 2013 - 2021

	% of Total		
	To Regional		Direct
CY	Public	Private	Haul*
2013	44.8%	48.9%	6.3%
2014	45.8%	47.9%	6.3%
2015	46.8%	47.6%	5.5%
2016	47.2%	47.5%	5.3%
2017	45.8%	49.9%	4.3%
2018	45.2%	50.5%	4.3%
2019	42.3%	53.3%	4.4%
2020	43.2%	53.2%	3.6%
2021	45.6%	52.4%	2.0%



Notes:
o source: Metro Solid Waste Information System (SWIS)
* Direct-haul are licensees authorized to deliver waste directly to Canby and Vancouver facilties, and to Covanta Marion

Distributions of the out-of-district portion of wet waste are assumed to follow historic patterns and are used primarily to determine the additional tonnage base for excise tax and community enhancement fee revenues. Specifically, about 35% of the out-of-district portion of wet waste should flow back into private facilities in the region with the remaining 65% flowing directly to facilities and disposal sites outside the region.

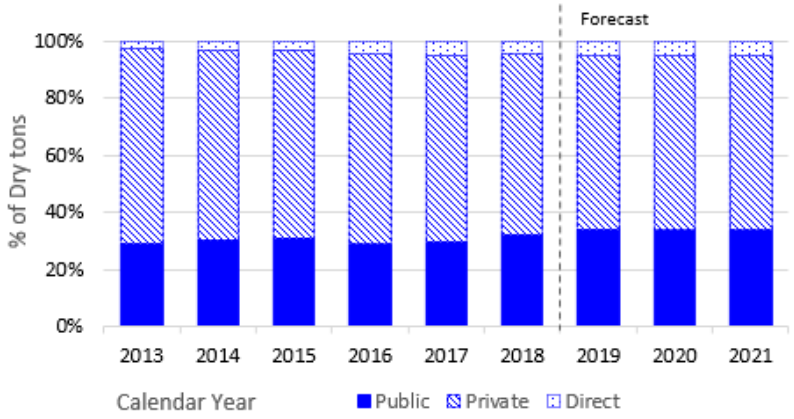
Dry Waste

The region has several facilities that accept and process mixed dry waste generated in the Metro region. These include transfer stations (both public and private) and material recovery facilities. In addition, a small but growing amount of dry waste is delivered directly to landfills. Metro does not regulate the distribution of dry waste to various facilities. Unless there are major market disruptions or operational issues at facilities, the distribution of mixed dry waste among these various players remains relatively stable over time.

Metro's current share of regional mixed dry waste is about 34% with the remaining 66% flowing to private facilities. These shares are expected to remain stable through the forecast horizon. Figure 13 presents the implications of these assumptions on the distribution of dry waste to private and public facilities.

Figure 13: Distributions of Dry Waste – 2013 - 2021

	% of Total		
	To Regional		Direct
CY	Public	Private	Haul*
2013	29.2%	68.2%	2.6%
2014	30.2%	66.7%	3.1%
2015	30.8%	66.2%	3.0%
2016	29.1%	66.7%	4.2%
2017	29.6%	65.3%	5.1%
2018	31.9%	63.4%	4.7%
2019	33.8%	61.2%	4.9%
2020	33.8%	61.2%	4.9%
2021	33.8%	61.2%	4.9%



Notes:
o source: Metro Solid Waste Information System (SWIS)
* Direct-haul are licensees authorized to deliver waste directly to a disposal site, including Covanta Marion

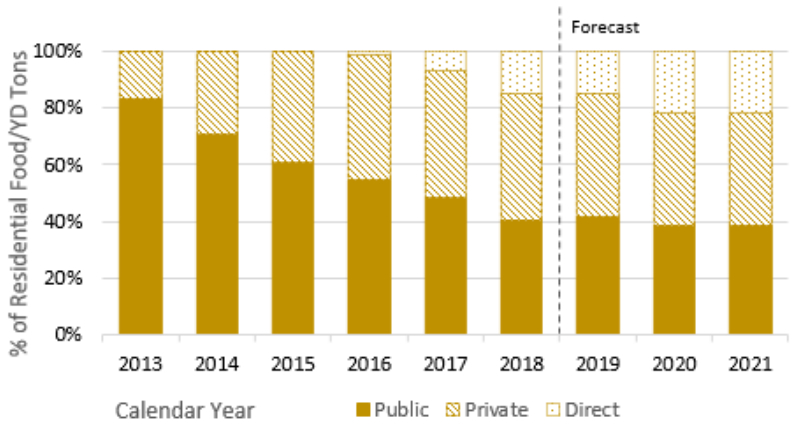
Residential Food Waste Mixed with Yard debris

There are currently five facilities in the region that accept the residential food waste mixed with yard debris that is generated and collected in the Metro region. These include four transfer stations and one food waste reload facility. In addition, growing amounts of food waste is delivered directly to out-of-region processing sites.

Haulers for the City of Hillsboro's expected new curbside food waste program are also anticipated to deliver waste directly to processors, in particular a compost faciltiy proximate to Hillsboro. As a result, Metro's share of the region's residential food waste mixed with yard debris should decline from about 42% for 2019 to about 39% each year through the forecast horizon. Figure 14 shows the implications of these assumptions on the distribution of residential food waste mixed with yard debris to private and public facilities.

Figure 14: Distributions of Residential Food/YD – 2013 - 2021

	% of Total		
	To Regional		Direct
CY	Public	Private	Haul*
2013	83.4%	16.6%	0.0%
2014	71.0%	29.0%	0.0%
2015	60.8%	39.2%	0.0%
2016	54.7%	43.8%	1.5%
2017	48.4%	45.0%	6.5%
2018	40.3%	44.8%	14.9%
2019	41.5%	43.8%	14.7%
2020	38.6%	39.5%	21.9%
2021	38.6%	39.5%	21.9%



Notes:
o source: Metro Solid Waste Information System (SWIS)
* Direct-haul are licensees authorized to deliver waste directly to processors outside the region

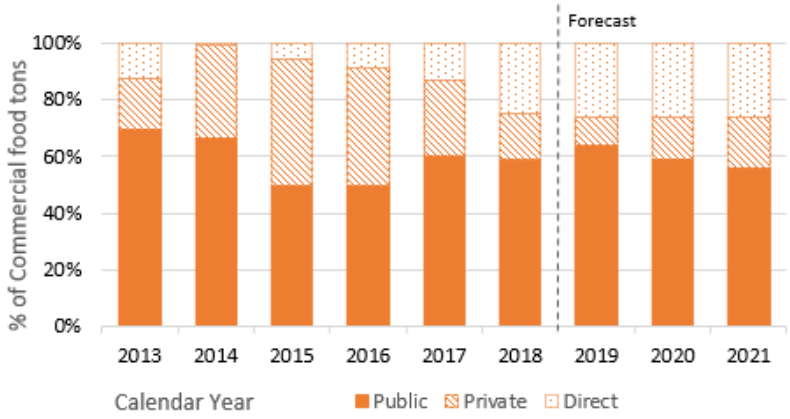
Commercial Food Waste

For commercial food waste transfer, reload and processing, there are only two in-region facilities (WRI and Metro Central) and a couple of out-of-region processing facilities handling Metro waste. As is the case with the residential stream, a growing amount of commercial food waste is delivered directly to these out-of-region processing sites.

Metro's current share of 64% of regional commercial food waste is expected to decline to about 59% in 2020 and to 56% in 2021 on account of Pride Recycling entering the system as an available point of transfer of this material. Figure 15 shows the tonnage implications of these assumptions on the distribution of waste between public and private facilities.

Figure 15: Distributions of Commercial Food Waste – 2013 - 2021

	% of Total		
	To Regional		Direct
CY	Public	Private	haul*
2013	69.9%	17.8%	12.3%
2014	66.8%	32.6%	0.6%
2015	49.9%	44.8%	5.3%
2016	49.6%	42.0%	8.4%
2017	60.6%	26.4%	13.0%
2018	59.0%	16.5%	24.5%
2019	63.9%	9.8%	26.3%
2020	59.2%	14.5%	26.3%
2021	55.7%	18.0%	26.3%



Notes:
o source: Metro Solid Waste Information System (SWIS)
* Direct-haul are licensees authorized to deliver waste directly to processors outside the region

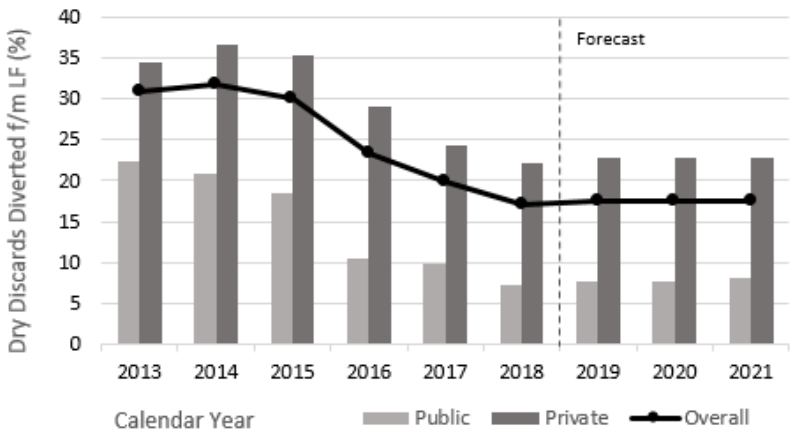
Post-Collection Diversion

After distribution, the model uses assumptions about post-collection recovery operations at public and private transfer stations and material recovery facilities that accept dry waste to forecast how much waste will be recovered and how much will be disposed, primarily for revenue and cost estimation purposes. While most recovery of recyclable materials happens by generators before collection (i.e. source-separation), between 100,000 and 200,000 tons of material gets recovered annually after collection. The region currently has two public facilities and nine private facilities that are engaged in post-collection recovery operations of dry waste.

Figure 16 presents recovery rates for public and private facilities engaged in post-collection recovery operations. Recovery rates declined significantly starting in 2016 for reasons that have been documented in other forecasts. This forecasts assumes that most of those market-induced declines have been played out, and that rates should stabilize roughly where they are now, at an overall rate of 17%. Recovery rates at Metro South are expected to increase from about 4% where they are now to a little over 5% by 2021 on account of new contract recovery targets. Rates at Metro Central should remain steady at about 13% through the forecast horizon.

Figure 16: Post-Collection Recovery Rates – Public, Private and Overall

	% Dry Recovered		
CY	Public	Private	Overall
2013	22.5	34.5	30.9
2014	20.9	36.6	31.7
2015	18.5	35.3	30.0
2016	10.4	29.1	23.4
2017	9.7	24.4	19.8
2018	7.1	22.2	17.1
2019	7.6	22.8	17.4
2020	7.8	22.8	17.5
2021	8.1	22.8	17.6



Notes:
o source: Metro Solid Waste Information System (SWIS)
o Rate (%) = estimated recovery from dry divided by total incoming dry tons

Waste Disposition

After distributing wet and dry waste to various types of facilities and estimating the amount of post-collection recovery processing residual waste ("dry residual waste"), the model incorporates assumptions for distributing the resulting waste from facilities to landfills. Since most of these assumptions come from the structure of Metro's current disposal contract which will be expiring at the end of the year, their relevance extends only through the next quarter, to December 2019.

In calendar year 2020 and beyond, Metro's new disposal contract stipulates that only wet tons from Metro facilities are applicable to Metro's disposal costs, and Metro will have no other flow guarantee obligations to its contractor, other than its own transfer station tons.

RESULTS

The needs that drive the solid waste forecast are currently focused on producing tonnage quantities that estimate key solid waste costs and revenues, budgets, rates, and regulatory tonnage allocations. As a result, the model structure and accompanying output all yield result quantities of a financial and regulatory nature. Those quantities are defined in more detail below and presented in the subsequent sections.

Focus Areas

The primary results of the solid waste forecast are presented within the following three focus areas:

1. *Regulatory Allocation Tonnage*: This section presents the regional tonnage and available tonnage that forms the basis for Metro's regulatory allocations of wet waste to private franchisees and licensees. Allocations are made on a calendar year basis and the results are presented from that perspective. While the allocation and utilization assumptions for the forecast are described above, any available tonnage that is unallocated, or allocated tonnage that is unused by private facilities, is assumed to flow to Metro transfer stations.
2. *Fee and Tax Related Tonnage:* This section presents actual and forecasted tonnage, by fiscal year, that generates system fee, excise tax, and Community Enhancement Fee ("enhancement fee") revenue for the Solid Waste, General and Community Enhancement Fee funds, respectively. Since the revenue involved with these funds is significant, the tonnage forecasts here are vitally important for the budgeting process. Also, the system fee and excise tax rates are rates that change annually, and the forecasts also assist with setting those annual rates. More detail on each fee and tax is provided below.
3. *Metro Disposal Utility-Related Tonnage*: This section presents tonnage that generates revenue to Metro's disposal utility, in order to cover the costs for operating (both fixed and variable expenses), transport and disposal of wastes. To cover these costs, Metro charges specific tonnage charges (per ton) and transaction fees (per load) for each of five streams of waste. Because these charges change annually like the system fee and excise tax rates, the forecasts here are also vital in setting those rates, anticipating costs and revenues to the Solid Waste Fund, and building agency budgets.

The forecast produces a number of other data series other than those described above. Appendix A provides some of these other series by calendar and fiscal years. Still other series are available upon request. The appendix also provides statistics on how well last year's forecast is performing against accumulated actuals, and how this forecast differs from the forecast made last year, in 2018.

Regulatory Allocation Tonnage

The Metro region tonnage available for allocation to private franchised or designated transfer stations is the portion of wet garbage that is generated in the Metro region after Metro has reserved 40 percent for its public transfer stations.

Figure 17 presents the total regional wet tonnage for the last three, current and next calendar years. After slowing significantly in 2017, tonnage was flat in 2018 at about 735,000 tons. This trend should continue in 2019 and 2020, with regional tonnage hovering around that mark. The drop in tonnage toward the end of 2018 and in 2019 was unexpected, as the current outlook for 2019 is more than 3% below last year's forecast for 2019. For 2020, Metro expects new commercial food waste diversion to reduce wet waste by approximately 10,000 tons, and in 2021, the recession scenario that is built into the economic forecast is expected to reduce tonnage further. However, from 2022 through the forecast horizon, modest growth should resume.

Figure 17: Metro Region Wet Tonnage

	Calendar Year					
	2016	2017	2018	2019		2020
	actuals	*actuals*	*actuals*	*budget**	*forecast*	*forecast*
Regional Wet Tonnage						
Tons	**718,993**	**734,742**	**734,599**	**759,567**	**734,180**	**734,520**
Change (%)	*4.5*	*2.2*	*(0.0)*	*3.4*	*(0.1)*	*0.0*

*"budget" is last year's Solid Waste Forecast (published Nov. 2018) for calendar year 2019

Applying calendar year 2020 allocation percentages from Figure 11 to 2020 forecasted tons, results in the following allocations for each facility in 2020:

- City of Roses Recycling (34,764 tons)
- Forest Grove Transfer Station (99,020 tons)
- Gresham Sanitary Service (51,048 tons)
- Pride Recycling (74,606 tons)
- Troutdale Transfer Station (74,606 tons)
- Willamette Resources Inc. (74,606 tons)
- Canby direct from Kahut Waste Services (16,053 tons)
- Vancouver transfer stations direct from Waste Connections (12,088 tons)
- Covanta Marion direct from various generators (3,921 tons)

Fee and Tax-Related Tonnage

Regional System Fee

The system fee is a specific (per-ton) fee on wet, dry and small amounts of industrial process wastes that are generated in the Metro region and ultimately disposed. The revenue from the system fee covers the costs for all associated regional solid waste activities related to managing, planning and administering the entire recycling, processing and disposal system. Revenue from the system fee does not cover any of Metro's direct costs for disposal and processing at its transfer stations.

Figure 18 presents the tonnage subject to the full system fee (currently $18.58 per ton) for the last three, current and next fiscal years. Tonnage grew last fiscal year to about 1.44 million tons, but it marked a significant slowdown of growth from prior years. This fiscal year, tonnage is expected to slow again and reach about 1.47 million tons and grow slightly to 1.48 million tons by fiscal year 2020-21.

Figure 18: Tonnage Subject to the Regional System Fee

	Fiscal Year-Ending (Jul 1 - Jun 30)					
	2017	2018	2019	2020		2021
	actuals	*actuals*	*actuals*	*budget* *	*forecast*	*forecast*
Subject to Full System Fee						
Tons	1,325,995	1,400,493	1,444,536	1,477,270	1,473,734	1,477,385
Change (%)	*3.4*	*5.6*	*3.1*	*2.3*	*2.0*	*0.2*

*"budget" is last year's Solid Waste Forecast (published Nov. 2018) for fiscal year 2019-20

Solid Waste Excise Tax

The Solid Waste Excise Tax is a specific tax assessed on wastes that are generated in the Metro region and ultimately disposed. The same tonnage that incurs the full system fee also incurs the full excise tax, plus some additional wet waste generated outside of the Metro region that get delivered to in-region private transfer stations. The revenue from the excise tax contributes toward Metro general government activities, including agency administration and the Metro Council. Like the system fee, the excise tax is collected at the same disposal sites and does not cover any of Metro's direct costs for disposal and processing.

Figure 19 presents the tonnage subject to the full excise tax (currently $11.57 per ton), for the last three, current and next fiscal years. Tonnage is expected to grow to almost 1.49 million tons this current fiscal year, which is slightly below last year's expectations, and then grow slightly to 1.50 million tons in fiscal year 2020-21.

Figure 19: Tonnage Subject to the Solid Waste Excise Tax

	Fiscal Year-Ending (Jul 1 - Jun 30)					
	2017	2018	2019	2020		2021
	actuals	*actuals*	*actuals*	*budget* *	*forecast*	*forecast*
Subject to Full Excise Tax						
Tons	1,342,432	1,420,952	1,466,082	1,502,310	1,492,911	1,498,043
Change (%)	*3.6*	*5.8*	*3.2*	*2.5*	*1.8*	*0.3*

*"budget" is last year's Solid Waste Forecast (published Nov. 2018) for fiscal year 2019-20

Community Enhancement Fee

The enhancement fee is a specific pass-through fee on certain types of solid waste delivered to regional solid waste facilities, collected for the benefit of the communities in which those facilities are located. The revenue collected from Metro's enhancement fee is allocated to community enhancement projects in the cities that host these solid waste facilities based on the recommendations of local committees that annually review applications for funding.

Figure 20 presents the tonnage subject to the enhancement fee (fixed in Metro code at $1.00 per ton) by host facility, for the last three, current and next fiscal years. Tonnage is expected to grow to about 1.09 million tons in fiscal year 2019-20 (slightly below what was previously forecast), and then reach about 1.11 million tons in fiscal year 2020-21.

Figure 20: Tonnage Subject to the Community Enhancement Fee

	Fiscal Year-Ending (Jul 1 - Jun 30)					
	2017	2018	2019	2020		2021
	actuals	*actuals*	*actuals*	*budget* *	*forecast*	*forecast*
Subject to CEF						
City of Roses Recycling	0	0	0	0	29,799	30,000
Forest Grove Transfer Station	125,655	122,561	125,449	102,062	115,099	95,218
Gresham Sanitary Service	11,656	24,771	39,377	47,592	52,964	58,781
Metro Central	288,593	287,640	300,763	301,579	293,373	310,676
Metro South	314,138	319,218	326,011	323,488	326,911	336,546
Pride Recycling	78,504	80,892	92,028	78,997	83,599	79,230
Suttle Road (Recology, Inc)	28,064	29,582	29,352	38,406	28,808	29,603
Troutdale Transfer Station	87,501	97,562	95,936	122,121	92,491	91,841
Willamette Resources Inc	93,035	87,093	61,625	87,999	66,684	76,269
Total						
Tons	1,027,147	1,049,319	1,070,541	1,102,244	1,089,728	1,108,163
Change (%)	*4.5*	*2.2*	*2.0*	*3.0*	*1.8*	*1.7*

*"budget" is last year's Solid Waste Forecast (published Nov. 2018) for fiscal year 2019-20

Metro Disposal Utility-Related Tonnage

Variable Operating Costs

Metro assesses tonnage charges for each of five incoming streams of waste to its transfer stations, in order to cover the variable operating costs associated with consolidating, processing, transport and disposal of each stream. For the 2019-20 fiscal year, those streams and their associated charges are:

- Mixed solid waste (garbage and mixed dry waste): $64.41 per ton
- Clean Wood: $64.23 per ton
- Yard Debris: $55.00 per ton
- Residential Organics (residential food mixed with yard debris): $76.99 per ton
- Commercial Organics (commercial food waste): $65.23 per ton

In addition, variable costs associated with processing mixed dry waste are dependent on the amounts of tons expected to be recovered at Metro transfer stations. Figure 21 presents the tonnage for each stream (tonnage for Metro Central and Metro South are combined but are available separately), as well as mixed waste recovery, for the last three, current and next fiscal years.

With moderately declining tri-county wet and dry tonnage in 2019, coupled with increased allocations of wet waste to private facilities, mixed solid waste at Metro's two transfer stations should decline this fiscal year to about 536,000 tons. In fiscal year 2020-21, mixed solid waste should increase to about 558,000 tons given the expectations for regional wet and dry waste growth and reduced wet waste tonnage allocations to private facilities.

Source-separated wood and yard debris should remain about 20,000 tons between both streams. Source-separated residential food waste mixed with yard debris should increase from about 43,000 tons in 2018-19 to almost 46,000 tons in fiscal year 2019-20 and remain steady into 2020-21. Source-separated commercial food waste should increase slightly in 2019-20 to about 18,000 tons, but then increase substantially in the 2020-21 fiscal year to more than 24,000 tons on account of the increased regional capture of this waste stream by the regional food waste program.

More regional dry waste over the next two fiscal years, in combination with new operating recovery targets at Metro South, should start to improve the number of tons of waste recovered to almost 18,000 tons in 2019-20 and 2020-21.

Figure 21: Metro Transfer Station Tonnage by Stream

	Fiscal Year-Ending (Jul 1 - Jun 30)					
	2017	2018	2019	2020		2021
	actuals	*actuals*	*actuals*	*budget* *	*forecast*	*forecast*
MSW						
Tons	**523,199**	**532,333**	**549,143**	**556,780**	**535,869**	**557,806**
Change (%)	*2.7*	*1.7*	*5.0*	*1.4*	*(2.4)*	*4.1*
Clean Wood						
Tons	**1,404**	**2,291**	**2,386**	**1,844**	**3,294**	**3,127**
Change (%)	*55.5*	*63.2*	*69.9*	*(22.7)*	*38.1*	*(5.1)*
Yard Debris						
Tons	**12,402**	**13,955**	**14,599**	**13,389**	**17,271**	**16,518**
Change (%)	*(8.4)*	*12.5*	*17.7*	*(8.3)*	*18.3*	*(4.4)*
Residential Organics						
Tons	**51,439**	**44,658**	**42,982**	**36,471**	**45,827**	**45,701**
Change (%)	*6.2*	*(13.2)*	*(16.4)*	*(15.1)*	*6.6*	*(0.3)*
Commercial Organics						
Tons	**14,287**	**13,621**	**17,663**	**16,585**	**18,023**	**24,070**
Change (%)	*1.5*	*(4.7)*	*23.6*	*(6.1)*	*2.0*	*33.6*
Recovery						
Tons	**18,598**	**18,135**	**14,482**	**11,921**	**17,891**	**18,534**
Change (%)	*(20.0)*	*(2.5)*	*(22.1)*	*(17.7)*	*23.5*	*3.6*

*"budget" is last year's Solid Waste Forecast (published Nov. 2018) for fiscal year 2019-20

Fixed Operating Costs

To cover the fixed operating costs associated with each stream, namely transaction costs and costs associated with operating its scale houses, Metro assesses two separate transaction fees (one for customers using its automated scale houses, and one for customers using its staffed scale houses), and a minimum load charge (for customers with loads of 360 pounds or less, using its staffed scale houses and including the staff scale house charge), on each load of waste to its transfer stations. Currently, the transaction fees are the same across waste streams, while the minimum load charges vary by stream, as follows:

- Automated scale house: $2.00 per load
- Staffed scale house: $10.00 per load
- Minimum load charges: Mixed solid waste ($28.00 per load), Clean Wood ($22.00 per load), Yard Debris ($20.00 per load), Residential Organics ($24.00 per load) and Commercial Organics ($22.00 per load)

Figure 22 presents the automated scale, staffed scale and total minimum weight loads for the last three, current and next fiscal years. Automated scale loads should remain stable for fiscal year 2019-20 at about 112,000 loads and then increase to about 117,000 loads in fiscal year 2020-21. Staffed scale loads are expected to increase substantially in 2019-20, reaching 328,000 loads, and then remain fairly flat in fiscal year 2020-21. Minimum weight loads on staffed scales should follow suit, increasing in 2019-20 and then remain flat in 2020-21 at about 116,000 loads.

Figure 22: Metro Transfer Station Loads by Type and Minimum Loads

	Fiscal Year-Ending (Jul 1 - Jun 30)					
	2017	2018	2019	2020		2021
	actuals	*actuals*	*actuals*	*budget* *	*forecast*	*forecast*
Auto Scale						
Loads	**98,267**	**104,597**	**112,239**	**109,880**	**112,124**	**117,018**
Change (%)	*1.6*	*6.4*	*7.3*	*(2.1)*	*(0.1)*	*4.4*
Staffed Scale						
Loads	**266,097**	**288,101**	**294,750**	**304,927**	**328,015**	**326,806**
Change (%)	*1.9*	*8.3*	*2.3*	*3.5*	*11.3*	*(0.4)*
Min Weight						
Loads	**100,513**	**109,615**	**109,027**	**110,856**	**113,202**	**115,662**
Change (%)	*14.2*	*9.1*	*(0.5)*	*1.7*	*3.8*	*2.2*

*"budget" is last year's Solid Waste Forecast (published Nov. 2018) for fiscal year 2019-20

Transport and Disposal

Metro's costs for transport and disposal of ***outgoing*** waste to Columbia Ridge Landfill are recovered by the tonnage charges assessed on ***incoming*** wastes described above. But for cost-estimation purposes, of its major trucking, fuel and disposal contracts, the forecast yields estimates of tonnage subject to these transport and disposal costs. The prices and rates (which, when multiplied by the tonnage and load units below) that determine these costs are contained in Metro's cost model and are beyond the scope here.

Figure 23 presents the outgoing tons and loads of waste from Metro transfer stations (loads determine Metro's trucking and fuel costs) to its disposal contractor, Waste Management, along with the additional waste tons from private facilities that contribute to Metro's declining block disposal costs. These data are provided for the last three, current and next fiscal years.

Consistent with lower inbound mixed solid waste expectations for this fiscal year, loads of waste out of Metro stations to landfill should decrease to about 15,300 this fiscal year, before growing to 16,000 loads by fiscal year 2020-21. Total tonnage subject to Metro's declining block rate should decrease to about 672,000 tons in the 2019-20 fiscal year due to the expiration of Metro's current disposal contract with Waste Management at the end of calendar year 2019. Since tonnage from private facilities will no longer apply to Metro's disposal commitments with Waste Management

starting in calendar year 2020, only tonnage from Metro's own facilities will determine Metro's disposal costs. Those tons are expected to reach about 539,000 tons in fiscal year 2020-21.

Figure 23: Tons, Loads Subject to Transport and Disposal Costs

	Fiscal Year-Ending (Jul 1 - Jun 30)					
	2017	2018	2019	2020		2021
	actuals	*actuals*	*actuals*	*budget* *	*forecast*	*forecast*
WM-Bound Waste						
From Metro						
Tons	503,326	498,493	523,715	544,917	528,583	539,288
Loads	**14,882**	**14,948**	**15,617**	**15,794**	**15,331**	**15,989**
From Private						
Tons	384,939	396,862	385,270	185,495	143,628	0
Total						
Tons	**888,264**	**895,355**	**908,985**	**730,412**	**672,211**	**539,288**
Change (%)	***6.9***	***0.8***	***1.5***	***(19.6)***	***(26.0)***	***(19.8)***

*"budget" is last year's Solid Waste Forecast (published Nov. 2018) for fiscal year 2019-20

Appendix A: Detailed Forecast Data

Table A1: Delivery Tonnage – Last Forecast Performance

(not seasonally-adjusted)	Month/Year												Cumulative Oct-18* - Sep-19**		
	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Totals	Difference Tons	Difference %
Delivery Tonnage* **															
Private Core															
Wet															
Actual	41,403	38,491	36,678	38,442	31,517	35,787	40,285	42,644	37,830	43,932	41,871	41,972	**470,851**	-20,246	(4.1)
Last FC	39,750	38,344	38,253	41,273	37,372	41,834	41,757	43,418	41,784	42,520	43,436	41,358	**491,097**		
Dry															
Actual	40,257	33,806	27,774	32,805	26,692	35,934	36,849	39,943	37,646	40,936	42,044	35,820	**430,505**	-42,613	(9.0)
Last FC	40,761	35,459	32,844	35,032	33,859	39,255	39,655	42,638	41,954	44,698	46,302	40,662	**473,118**		
Total															
Actual	81,660	72,297	64,452	71,246	58,209	71,721	77,134	82,587	75,476	84,868	83,915	77,791	**901,357**	-62,859	(6.5)
Last FC	80,511	73,803	71,097	76,305	71,232	81,088	81,411	86,055	83,738	87,218	89,737	82,020	**964,216**		
Metro Core															
Wet															
Actual	27,981	28,780	28,701	30,114	25,877	26,743	27,404	27,269	25,014	26,366	25,627	24,110	**323,985**	-7,181	(2.2)
Last FC	29,722	29,201	30,550	27,082	24,843	27,352	26,732	27,773	27,008	27,498	27,333	26,071	**331,166**		
Dry															
Actual	19,966	16,593	15,051	17,416	13,312	18,033	18,665	20,118	19,916	20,577	20,673	19,527	**219,847**	2,739	1.3
Last FC	18,575	15,820	14,640	15,466	15,413	18,614	18,877	20,479	19,409	20,337	20,481	18,996	**217,107**		
Total															
Actual	47,947	45,372	43,752	47,530	39,189	44,776	46,069	47,388	44,930	46,943	46,299	43,637	**543,832**	-4,442	(0.8)
Last FC	48,297	45,021	45,191	42,548	40,256	45,966	45,609	48,252	46,417	47,835	47,814	45,067	**548,274**		
Total Core															
Wet															
Actual	69,384	67,271	65,379	68,555	57,394	62,530	67,690	69,913	62,844	70,298	67,497	66,082	**794,837**	-27,427	(3.3)
Last FC	69,472	67,545	68,803	68,355	62,215	69,186	68,489	71,191	68,792	70,018	70,769	67,430	**822,264**		
Dry															
Actual	60,222	50,399	42,825	50,221	40,004	53,966	55,513	60,061	57,562	61,513	62,717	55,347	**650,352**	-39,874	(5.8)
Last FC	59,336	51,279	47,484	50,498	49,272	57,868	58,532	63,117	61,363	65,035	66,782	59,658	**690,226**		
Total															
Actual	129,607	117,670	108,204	118,776	97,398	116,497	123,203	129,974	120,406	131,811	130,214	121,429	**1,445,189**	-67,301	(4.4)
Last FC	128,808	118,824	116,287	118,853	111,487	127,054	127,021	134,308	130,155	135,053	137,551	127,088	**1,512,489**		

* First period of last year's forecast; ** Last period of actual tonnage data; *** tri-county region garbage, after diversion of new materials

Table A2: Delivery Tonnage – Calendar Year

(tons, unless otherwise specified)

	Calendar Year											
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Delivery Tonnage*												
Private Core												
Wet	415,439	436,528	460,334	462,765	475,754	475,165	455,565	452,519	451,482	457,245	466,751	477,330
Change	2.1	5.1	5.5	0.5	2.8	(0.1)	(4.1)	(0.7)	(0.2)	1.3	2.1	2.3
Dry	368,297	440,702	448,507	459,060	437,630	454,004	457,836	448,732	449,015	457,881	467,069	475,091
Change	10.8	19.7	1.8	2.4	(4.7)	3.7	0.8	(2.0)	0.1	2.0	2.0	1.7
Total	783,736	877,230	908,841	921,825	913,385	929,169	913,401	901,252	900,497	915,126	933,820	952,421
Change	6.0	11.9	3.6	1.4	(0.9)	1.7	(1.7)	(1.3)	(0.1)	1.6	2.0	2.0
Metro Core												
Wet	322,088	339,189	336,535	332,088	310,664	317,118	332,471	345,184	352,522	361,975	377,453	388,203
Change	5.7	5.3	(0.8)	(1.3)	(6.5)	2.1	4.8	3.8	2.1	2.7	4.3	2.8
Dry	163,916	180,458	188,276	214,860	223,770	232,142	234,102	229,447	229,591	234,125	238,823	242,925
Change	14.0	10.1	4.3	14.1	4.1	3.7	0.8	(2.0)	0.1	2.0	2.0	1.7
Total	486,004	519,646	524,811	546,948	534,434	549,260	566,573	574,631	582,113	596,099	616,276	631,127
Change	8.4	6.9	1.0	4.2	(2.3)	2.8	3.2	1.4	1.3	2.4	3.4	2.4
Total Core												
Wet	737,527	775,716	796,870	794,854	786,419	792,283	788,036	797,704	804,003	819,220	844,204	865,532
Change	3.7	5.2	2.7	(0.3)	(1.1)	0.7	(0.5)	1.2	0.8	1.9	3.0	2.5
Dry	532,213	621,160	636,783	673,919	661,400	686,146	691,938	678,179	678,606	692,005	705,891	718,016
Change	11.8	16.7	2.5	5.8	(1.9)	3.7	0.8	(2.0)	0.1	2.0	2.0	1.7
Total	1,269,740	1,396,876	1,433,652	1,468,773	1,447,819	1,478,429	1,479,974	1,475,883	1,482,610	1,511,225	1,550,096	1,583,548
Change	6.9	10.0	2.6	2.4	(1.4)	2.1	0.1	(0.3)	0.5	1.9	2.6	2.2

* tri-county region garbage, after diversion of new materials

Table A3: Delivery Tonnage – Fiscal Year

(tons, unless otherwise specified)

	Fiscal Year											
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Delivery Tonnage*												
Private Core												
Wet	405,290	425,490	447,375	467,852	457,502	484,443	465,464	454,057	452,006	454,334	461,950	471,987
Change	(0.2)	5.0	5.1	4.6	(2.2)	5.9	(3.9)	(2.5)	(0.5)	0.5	1.7	2.2
Dry	343,457	413,024	443,993	460,223	438,806	450,808	455,887	453,364	448,871	453,370	462,395	471,010
Change	5.6	20.3	7.5	3.7	(4.7)	2.7	1.1	(0.6)	(1.0)	1.0	2.0	1.9
Total	748,747	838,514	891,368	928,075	896,308	935,251	921,350	907,421	900,877	907,705	924,345	942,997
Change	2.4	12.0	6.3	4.1	(3.4)	4.3	(1.5)	(1.5)	(0.7)	0.8	1.8	2.0
Metro Core												
Wet	316,289	336,499	341,067	329,163	331,329	304,729	324,694	338,745	348,805	357,186	369,613	382,758
Change	7.7	6.4	1.4	(3.5)	0.7	(8.0)	6.6	4.3	3.0	2.4	3.5	3.6
Dry	155,438	172,787	182,132	203,171	217,814	231,140	233,112	231,799	229,518	231,834	236,449	240,852
Change	15.1	11.2	5.4	11.6	7.2	6.1	0.9	(0.6)	(1.0)	1.0	2.0	1.9
Total	471,727	509,286	523,199	532,333	549,143	535,869	557,806	570,544	578,323	589,020	606,061	623,609
Change	10.0	8.0	2.7	1.7	3.2	(2.4)	4.1	2.3	1.4	1.8	2.9	2.9
Total Core												
Wet	721,579	761,989	788,442	797,015	788,831	789,172	790,158	792,802	800,811	811,521	831,563	854,745
Change	3.1	5.6	3.5	1.1	(1.0)	0.0	0.1	0.3	1.0	1.3	2.5	2.8
Dry	498,895	585,811	626,125	663,394	656,619	681,947	688,998	685,163	678,389	685,204	698,843	711,862
Change	8.4	17.4	6.9	6.0	(1.0)	3.9	1.0	(0.6)	(1.0)	1.0	2.0	1.9
Total	1,220,474	1,347,800	1,414,567	1,460,408	1,445,451	1,471,119	1,479,156	1,477,965	1,479,200	1,496,725	1,530,406	1,566,607
Change	5.2	10.4	5.0	3.2	(1.0)	1.8	0.5	(0.1)	0.1	1.2	2.3	2.4

* tri-county region garbage, after diversion of new materials

Table A4: Revenue Tonnage and Other Aggregates – Last Forecast Performance

(not seasonally-adjusted)	Month/Year												Cumulative Oct-18* - Sep-19**		
	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Totals	Difference Tons	Difference %
Revenue Tonnage															
Private Core															
Actual	69,243	61,137	55,977	60,650	48,341	59,021	66,134	69,329	64,216	72,247	69,717	61,920	**757,931**	-40,035	(5.0)
Last FC	65,662	62,266	60,890	64,514	60,045	67,328	66,697	71,980	67,997	70,447	73,468	66,671	**797,966**		
Metro Core															
Actual	47,947	45,372	43,752	47,530	39,189	44,776	46,069	47,388	44,930	46,943	46,299	43,637	**543,832**	-4,442	(0.8)
Last FC	48,297	45,021	45,191	42,548	40,256	45,966	45,609	48,252	46,417	47,835	47,814	45,067	**548,274**		
Total Core															
Actual	117,190	106,509	99,730	108,180	87,530	103,797	112,203	116,716	109,146	119,190	116,017	105,557	**1,301,763**	-44,477	(3.3)
Last FC	113,959	107,287	106,081	107,062	100,301	113,294	112,307	120,233	114,414	118,283	121,282	111,738	**1,346,240**		
Incurs full Reg. System Fee															
Actual	127,144	117,066	110,360	120,832	101,447	123,004	126,770	127,085	119,581	131,920	126,852	118,033	**1,450,093**	-12,272	(0.8)
Last FC	123,771	116,728	114,631	117,102	110,418	124,350	123,909	129,906	123,312	127,430	129,903	120,905	**1,462,365**		
Incurs full Excise Tax															
Actual	129,184	118,927	111,990	122,539	102,776	124,528	128,430	128,581	120,963	133,786	128,605	119,558	**1,469,864**	-16,926	(1.1)
Last FC	125,736	118,646	116,544	118,990	112,141	126,544	125,918	132,021	125,378	129,667	132,297	122,910	**1,486,790**		
Other Tonnage															
Regional Wet															
Actual	64,040	62,694	61,099	63,879	53,750	58,059	63,157	65,339	58,685	65,377	62,870	61,384	**740,333**	-17,848	(2.4)
Last FC	64,132	62,587	64,004	63,267	57,586	63,874	62,952	65,680	63,249	64,197	64,654	61,998	**758,180**		
Incurs Metro Disposal Costs															
Actual	84,096	76,634	73,112	78,905	52,606	70,330	78,260	82,918	74,179	83,661	80,010	75,209	**909,920**	25,677	2.9
Last FC	78,355	71,916	71,793	70,391	64,513	73,848	71,646	76,372	73,106	77,789	80,190	74,324	**884,243**		
Incurs Com. Enhancement Fees															
Actual	94,337	91,439	84,449	88,914	71,672	84,628	95,191	99,721	89,508	96,745	92,845	90,820	**1,080,269**	-2,508	(0.2)
Last FC	92,003	91,294	86,311	83,812	78,616	90,955	91,438	98,269	93,880	93,492	93,961	88,747	**1,082,778**		

* First period of last year's forecast; ** Last period of actual tonnage data

Table A5: Revenue Tonnage and Other Aggregates – Calendar Year

(tons, unless otherwise specified)

	Calendar Year											
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Revenue Tonnage												
Private Core	598,524	699,909	725,956	767,221	767,939	774,711	756,880	745,004	743,246	754,387	768,788	783,606
Change	5.7	16.9	3.7	5.7	0.1	0.9	(2.3)	(1.6)	(0.2)	1.5	1.9	1.9
Metro Core	486,004	519,646	524,811	546,948	534,434	549,260	566,573	574,631	582,113	596,099	616,276	631,127
Change	8.4	6.9	1.0	4.2	(2.3)	2.8	3.2	1.4	1.3	2.4	3.4	2.4
Total Core	1,084,528	1,219,555	1,250,767	1,314,169	1,302,373	1,323,971	1,323,454	1,319,635	1,325,359	1,350,486	1,385,064	1,414,734
Change	6.9	12.5	2.6	5.1	(0.9)	1.7	(0.0)	(0.3)	0.4	1.9	2.6	2.1
Incurs full Reg. System Fee	1,185,303	1,329,548	1,351,722	1,431,613	1,458,256	1,478,395	1,476,419	1,471,141	1,475,406	1,499,075	1,532,193	1,560,404
Change	8.0	12.2	1.7	5.9	1.9	1.4	(0.1)	(0.4)	0.3	1.6	2.2	1.8
Incurs full Excise Tax	1,197,441	1,344,234	1,369,406	1,455,077	1,476,747	1,498,841	1,497,306	1,492,618	1,497,217	1,521,452	1,555,397	1,584,342
Change	8.0	12.3	1.9	6.3	1.5	1.5	(0.1)	(0.3)	0.3	1.6	2.2	1.9
Other Tonnage												
Regional Wet	687,824	718,993	734,742	734,599	734,180	734,520	729,026	737,027	742,385	756,001	778,650	797,903
Change	3.4	4.5	2.2	(0.0)	(0.1)	0.0	(0.7)	1.1	0.7	1.8	3.0	2.5
Incurs Metro Disposal Costs	787,569	858,392	881,049	925,906	847,436	531,245	547,546	555,982	563,452	577,070	596,864	611,383
Change	7.0	9.0	2.6	5.1	(8.5)	(37.3)	3.1	1.5	1.3	2.4	3.4	2.4
Incurs Com. Enhancement Fees	821,992	1,006,475	1,037,858	1,068,086	1,075,615	1,098,433	1,118,232	1,126,956	1,132,791	1,151,507	1,179,681	1,203,771
Change	26.6	22.4	3.1	2.9	0.7	2.1	1.8	0.8	0.5	1.7	2.4	2.0

Table A6: Revenue Tonnage and Other Aggregates – Fiscal Year

(tons, unless otherwise specified)

	Fiscal Year											
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Revenue Tonnage												
Private Core	567,814	654,057	709,796	755,645	756,265	782,207	765,920	751,025	744,137	748,739	761,487	776,094
Change	0.3	15.2	8.5	6.5	0.1	3.4	(2.1)	(1.9)	(0.9)	0.6	1.7	1.9
Metro Core	471,727	509,286	523,199	532,333	549,143	535,869	557,806	570,544	578,323	589,020	606,061	623,609
Change	10.0	8.0	2.7	1.7	3.2	(2.4)	4.1	2.3	1.4	1.8	2.9	2.9
Total Core	1,039,540	1,163,344	1,232,995	1,287,979	1,305,408	1,318,075	1,323,726	1,321,569	1,322,460	1,337,759	1,367,548	1,399,703
Change	4.5	11.9	6.0	4.5	1.4	1.0	0.4	(0.2)	0.1	1.2	2.2	2.4
Incurs full Reg. System Fee	1,129,187	1,282,491	1,325,995	1,400,493	1,444,536	1,473,734	1,477,385	1,473,769	1,473,202	1,487,042	1,515,372	1,546,068
Change	5.2	13.6	3.4	5.6	3.1	2.0	0.2	(0.2)	(0.0)	0.9	1.9	2.0
Incurs full Excise Tax	1,140,639	1,295,465	1,342,432	1,420,952	1,466,082	1,492,911	1,498,043	1,494,939	1,494,839	1,509,123	1,538,145	1,569,624
Change	5.2	13.6	3.6	5.8	3.2	1.8	0.3	(0.2)	(0.0)	1.0	1.9	2.0
Other Tonnage												
Regional Wet	673,812	708,685	729,382	733,555	733,249	734,897	731,753	732,962	739,666	749,115	767,197	788,174
Change	3.0	5.2	2.9	0.6	(0.0)	0.2	(0.4)	0.2	0.9	1.3	2.4	2.7
Incurs Metro Disposal Costs	760,626	831,250	888,264	895,355	908,985	672,211	539,288	551,711	559,668	570,168	586,834	604,025
Change	7.6	9.3	6.9	0.8	1.5	(26.0)	(19.8)	2.3	1.4	1.9	2.9	2.9
Incurs Com. Enhancement Fees	674,116	982,922	1,027,147	1,049,319	1,070,541	1,089,728	1,108,163	1,122,511	1,129,865	1,142,061	1,165,442	1,191,599
Change	7.1	45.8	4.5	2.2	2.0	1.8	1.7	1.3	0.7	1.1	2.0	2.2

Appendix B: FY 2019-20 Solid Waste Forecast Assumptions Questionnaire

FY 2020 - 21 Solid Waste Forecast

Forecast Assumptions Questionnaire

CY 2020 through CY 2026

Reviewer: _____

Date: _____

Note to Reviewer: **Please print, complete (parts in blue font) and return (scan/email or mail) by COB August 16, 2019. Feel free to use backside or additional pages as needed.**

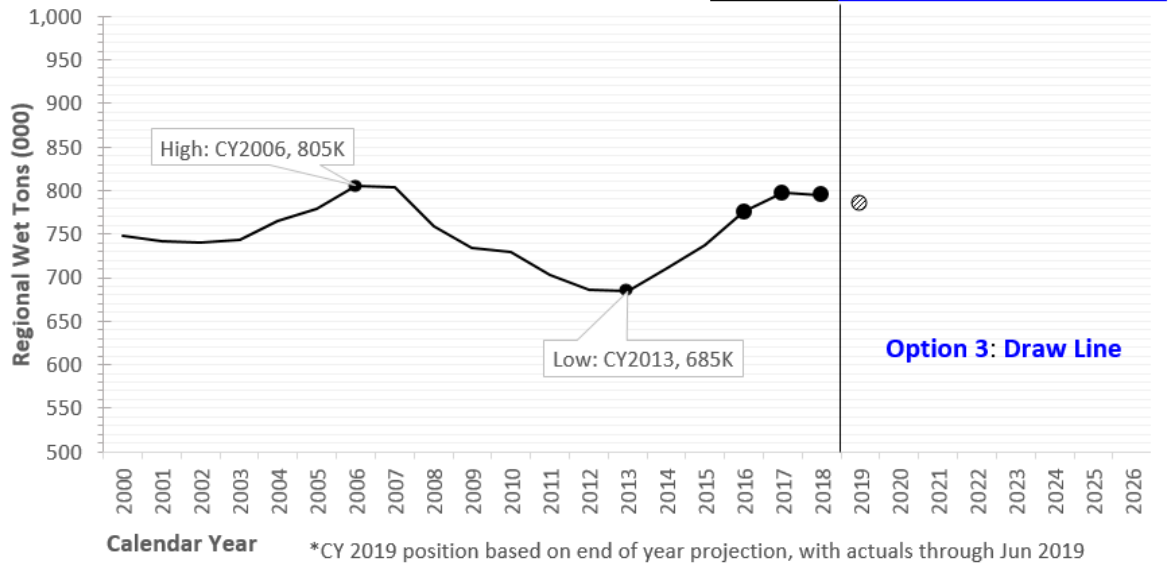
Return to:
Joel Sherman
Metro
600 NE Grand Avenue
Portland, Oregon 97232
joel.sherman@oregonmetro.gov

Garbage

Please provide your judgement on the direction of solid waste tonnage (both wet and dry) from now through 2026 by filling in expected calendar year tons (Option 1), growth rates (Option 2), or by drawing the tonnage path directly on each graph (Option 3) below.

Regional Wet Discards

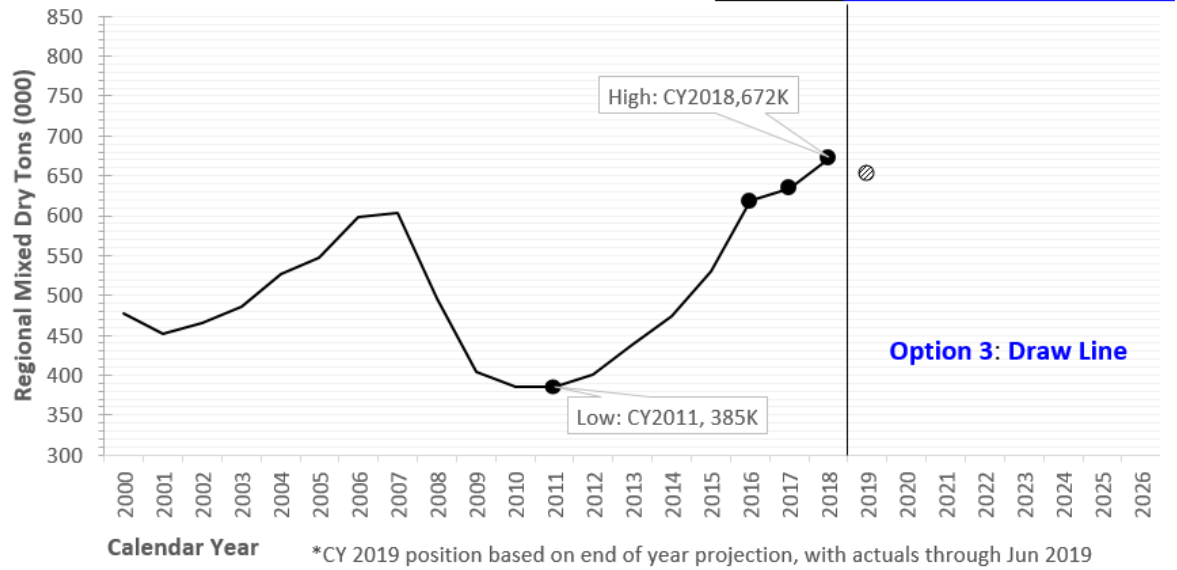
	Actuals			Short			Long
	2016	2017	2018	2019	2020	2021	2022 - 2026 Avg.
Option 1: Tons (thousands)	776	797	795				
Option 2: Annual Change (%)	5.2	2.7	(0.3)				



*CY 2019 position based on end of year projection, with actuals through Jun 2019

Regional Dry Discards

	Actuals			Short			Long
	2016	2017	2018	2019	2020	2021	2022 - 2026 Avg.
Option 1: Tons (thousands)	618	634	672				
Option 2: Annual Change (%)	16.7	2.6	6.0				



*CY 2019 position based on end of year projection, with actuals through Jun 2019

Food Waste Diversion

Please provide any knowledge about new or expanding programs for each of the source-separated food waste streams below, by completing the following tables.

Residential Food Waste Mixed with Yard Debris		
Program	**Start (M, Y)**	**Approx. Annual Tons**
Existing: Cities of Portland, Lake Oswego, Forest Grove, Milwaukie Beaverton	11/2011 (pdx) 6/2016 (lo) 7/2016 (fg) 8/2017(mw) 10/2017(bv)	Total of all existing programs ~107,000 tons/year
New/Expanded:_____	_____	_____
New/Expanded:_____	_____	_____
New/Expanded:_____	_____	_____
New/Expanded:_____	_____	_____
Comments:		

Commercial food scraps		
Program	**Start (M, Y)**	**Approx. Annual Tons**
Existing: Regional (various businesses)	Jan. 2007	25,000/year
New/Expanded:_____	_____	_____
New/Expanded:_____	_____	_____
New/Expanded:_____	_____	_____
New/Expanded:_____	_____	_____
Comments:		

Facility Distributions

Please describe any known regulatory, market or operational changes from now until 2026 that might affect the distributions (who gets what) of wet and dry garbage, residential and commercial food waste to solid waste facilities. *This may include new facility or non-system licensees, new mergers/acquisitions of existing haulers or facilities, or any events that may significantly modify facility operations.*

Issues affecting distributions of waste to facilities…

Post-Collection Recovery

Please describe your thoughts about the direction and magnitude of mixed dry waste recovery rates at material recovery facilities and transfer stations (public or privately-owned) in the region. *Thoughts can be on average recovery for the region, or for particular facilities with which you may have experience.*

Issues affecting post-collection recovery, how much and where…

Feedback

This questionnaire is a work-in-progress, and the Solid Waste Forecast strives for continuous improvement each year. Please provide any feedback below for improving this questionnaire, or the process as a whole, for next year. Thanks for your time!

Appendix C: Econometric Models of Waste Generation

Econometric Model of Waste Generation

Background

In FY 2018-19, the solid waste forecast management panel directed the forecast team to improve the accuracy of solid waste tonnage forecasts for the region. New statistical forecast models for wet and dry waste discards were developed. The new models were specified as regression equations and the periodicity changed to a quarterly frequency (as opposed to annual). The regional solid waste forecast deployed a two-step approach to forecast the split between wet and dry waste discards. The initial step utilized a regression model to forecast *total* solid waste discards in the region. The second-step utilized a second independent regression model to forecast dry-waste discards; thus the remainder was then wet-waste. These methodological changes were made to ensure the validity, reliability and precision of solid waste forecasts remains high, while adhering to the objectives of the forecast.

This is the third forecast made with Metro's new regression models. Each of the regression equations were updated and re-estimated with actual historical data through 2019Q2. The first forecast period was 2019Q3. This means that annual calendar year figures for 2019 were partly forecast.

Overview

This document summarizes the model information, input assumptions and results of the latest economic models of regional solid waste tonnage. Conceptually, two models are engaged to produce forecasts of regional (Tri-county) wet and dry wastes. The first model forecasts *total* regional core discards (DISPOSALCORE), while the second forecasts the share of core discards that are dry (DRY_SHARE). Dry and wet waste forecasts are then calculated as follows:

Equation 1: Dry waste model (identity)

$$Dry_t = DISPOSALCORE_t \times DRY\_SHARE_t$$

Equation 2: Wet waste model (identity)

$$Wet_t = DISPOSALCORE_t - Dry_t$$

The appendix is organized by model, and includes three sub-sections for each of the two regression models:

- **Model:** This section will describe the model's underlying macroeconomic theory in relation to solid waste, and will provide the equation and estimation diagnostics (from EViews) for the regression model.

- **Predictors:** This section will describe each of the model's predictor or right-hand-side (RHS) variables, including its historical and forecasted source and period, as well as any transformations made to it prior to model entry. This section will include a narrative and

graphical analysis of the history and current outlook for each RHS. The source for the RHS forecasts are from IHS Markit (US economic drivers) and PSU Northwest Economic Research Center (NERC) (regional macro drivers).

- **Outcome:** This section will describe the model's outcome or left-hand-side (LHS) variable, including its historical source and period, and transformations made prior to regression. This section will include a narrative and graphical analysis of the history and outlook for the LHS.

Core Discards

"Core" solid waste discards are the combination of municipal solid wastes (MSW), bulky wastes, and construction and demolition wastes (C&D) generated and discarded by households and businesses in the Metro region. The latter two types (bulky and C&D) tend to be non-putrescible (dry) wastes, while the former type (MSW) tends to be putrescible (wet) wastes because of some quantity of food material that makes its way into the waste stream. As such, core discards are those that arise from the consumption behaviors of homes, businesses and construction activities in the region, and are comprised of wet and dry waste discards.

Model

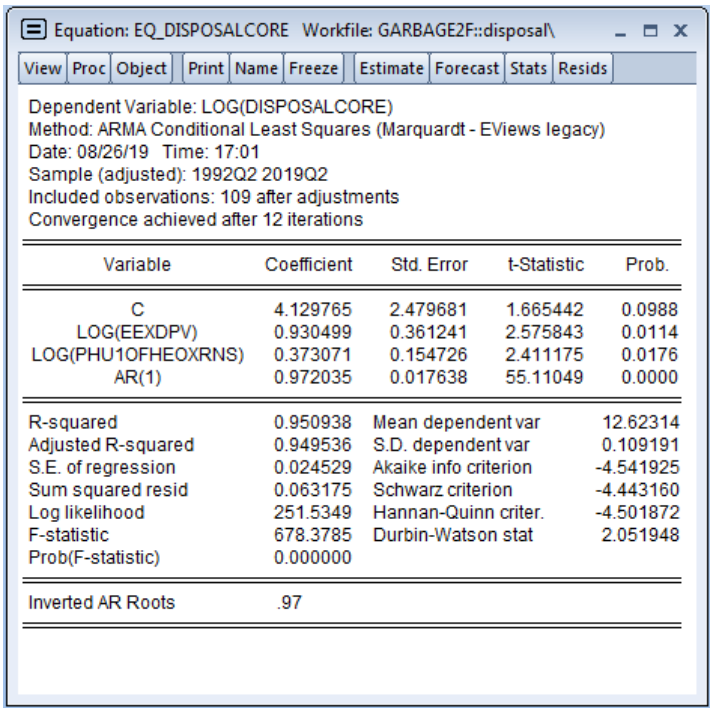
The consumption behaviors of households and businesses in the region, and the implications of those behaviors on the amounts and types of wastes generated can be difficult to measure, and even more difficult to forecast over time. The literature on the determinants of waste generation in a municipality yields a wide array of potential predictors, with some significant in one study, only to be shown insignificant in another. Population is a common indicator in studies, as more people in a municipality is typically linked to more waste generation. However, given the observed cyclical nature of waste in the Metro region over time, population is not a strong predictor; it simply varies too little over time to accurately gauge swings in discard levels.

Instead, Metro's economic model of core discards uses aggregate measures of the economic conditions that buttress consumption, namely jobs and major asset prices. The regional core discards (DISPOSALCORE) equation projects growth in core tonnage discards as a function of the growth in total regional employment (EEXDPV) and national housing prices (PHU1OFHEOXRNS), plus an autoregressive term (AR) of order 1 to correct for serial correlation, which uncorrected would biases results. The equation is specified as a log-log regression, and estimated with a least squares regression method (see equation 3).

Equation 3

$$\log DISPOSALCORE_t = \alpha + \beta_1 \log(EEXDPV) + \beta_2 \log(PHU1OFHEOXRNS) + \rho(AR_1)$$

Model coefficients, standard errors and p-values are provided in the figure below, as are standard model diagnostic statistics. The model was re-estimated with core disposal data (LHS) and predictors (RHS) through 2019 Q2. This estimation is shown in figure 1.



Equation: EQ_DISPOSALCORE Workfile: GARBAGE2F::disposal\

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: LOG(DISPOSALCORE)
Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)
Date: 08/26/19 Time: 17:01
Sample (adjusted): 1992Q2 2019Q2
Included observations: 109 after adjustments
Convergence achieved after 12 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.129765	2.479681	1.665442	0.0988
LOG(EEXDPV)	0.930499	0.361241	2.575843	0.0114
LOG(PHU1OFHEOXRNS)	0.373071	0.154726	2.411175	0.0176
AR(1)	0.972035	0.017638	55.11049	0.0000

R-squared	0.950938	Mean dependent var	12.62314
Adjusted R-squared	0.949536	S.D. dependent var	0.109191
S.E. of regression	0.024529	Akaike info criterion	-4.541925
Sum squared resid	0.063175	Schwarz criterion	-4.443160
Log likelihood	251.5349	Hannan-Quinn criter.	-4.501872
F-statistic	678.3785	Durbin-Watson stat	2.051948
Prob(F-statistic)	0.000000		

Inverted AR Roots	.97

Figure 1: Core Disposal equation

The re-estimated core disposal equation is shown to be highly stable as compared to previous estimations (2017 and 2018). The estimated coefficients changed very little with the update in data, and variable fits remained significant out past 2 standard deviations (or 95% confidence). Overall fit of the core disposal equation remains statistically significant as evidenced by an R-square value close in value to 1. The information criterion statistics (Akaike and Schwarz) show improvement in the latest model re-estimation. The improvement is due to the addition of more history that reinforces the trend and goodness of fit of the data to the model. Autocorrelation – normally evident in time series regression equations – has been corrected and signified by the AR1 adjustment term. The Durbin-Watson statistic which is close in value to 2 is evidence of the correction made. The overall goodness of fit for all variables taken together is significant as evidenced by the F-statistic exceeding the 1% critical value. This is a very tight fitting model; we can expect the equation to perform reasonably well in forecasting short-term changes in core solid waste levels.

Predictors

The model has two RHS predictors, as described below.

- **Total Non-Farm Employment (EEXDPV):** Total non-farm payroll employment for the Portland MSA.

    - *Historical Source:* Bureau of Labor Statistics (BLS) Current Employment Survey (CES) program. The BLS reports monthly employment estimates for the 7-county Portland MSA. Series is total (non-farm) employment for the Portland MSA (Series #SMU41389000000000001), data through June 2019 (2019 Q2).

- *Forecast Source:* Portland State University (PSU) Northwest Economic Research Center (NERC). NERC is an independent research unit at PSU. According to NERC, the center aims to provide high-quality, unbiased research and analysis by drawing on the wealth of knowledge and expertise available at PSU. The center produces economic and demographic growth projections for the Portland MSA on a semi-annual basis. NERC's latest total (non-farm) employment forecast for the MSA is their October 2019 forecast release.

- *Data Transformations*: The BLS reports employment estimates for the MSA by month. These monthly data are seasonally-adjusted using the X-13 method developed by the US Census Bureau. Seasonally-adjusted monthly data are averaged over 3 months to yield quarterly data frequency. Quarterly data undergo transformation to natural logarithms.

- **Federal Housing Finance Administration (FHFA) House Price Index (HPI) (PHU1OFHEOXRNS)**
  The FHFA HPI is a broad measure of the movement of single-family house prices. The HPI is a weighted, repeat-sales index, meaning that it measures average price changes in repeat sales or refinancings on the same properties. This information is obtained by reviewing repeat mortgage transactions on single-family properties whose mortgages have been purchased or securitized by Fannie Mae or Freddie Mac since January 1975.

  - *Historical Source*: FHFA housing price index – purchase only for the US, through 2019 Q2.

  - *Forecast Source*: IHS Markit. IHS Markit is a national vendor of forecast products. According to IHS Markit, they are a team of economists, data scientists, financial experts and industry specialists whose expertise spans numerous industries, including leading positions in finance, energy and transportation. They provide forecast insights to businesses, financial institutions and government agencies to help each make informed decisions. IHS releases forecasts of U.S. growth conditions and trends on a monthly basis. The latest HPI U.S. forecast is October 2019.

  - *Data Transformations*: Quarterly data (both historical and forecast) is received already seasonally adjusted from IHS Markit. The series is then transformed to natural logarithms for the regression equation.

Outcome: Core Discards Forecast

The model's LHS variable is tons of core discards for the Metro tri-county region (DISPOSALCORE).

- Historical Source: Metro's Solid Waste Information System (SWIS) tracks monthly deliveries of core discards to solid waste facilities in the region. Core discards are a composite of wet and dry discards in the SWIS database. Actual data is through June 2019 (2019 Q2).

- Data Transformations: Monthly core discards are seasonally-adjusted using the Census X-13 method, and summed over 3 months to yield quarterly data frequency. Quarterly data are transformed by natural logarithms for modeling purposes.

Dry Share

The share (or percentage) of core solid waste discards that are dry informs the split of core waste into wet and dry components for the purpose of the solid waste forecast. Dry waste, again, is mainly composed of bulky waste from garage or office cleanouts and C&D (construction and debris) wastes from demolitions, new construction or remodels of homes and buildings. Dry waste is much more cyclical than wet waste.

Model

Due to its highly cyclical nature and relationship to construction wastes, Metro's model of the share of dry waste discards uses economic indicators that follow the relative contribution of construction to economic growth. The equation projects growth in the dry share (DRY_SHARE) of core tonnage discards as a function of the growth in the proportion of construction industry employment to total employment (ECONPV/EEXDPV) in the region, national conventional mortgage interest rates (RMMTG30CON) and permits issued for the construction of residential units in the region (TOTALPERMITSPV). An autoregressive term of order 1 is also used to correct for autocorrelation. The equation is specified as a log-log regression, and estimated with a least squares regression approach.

Equation 4

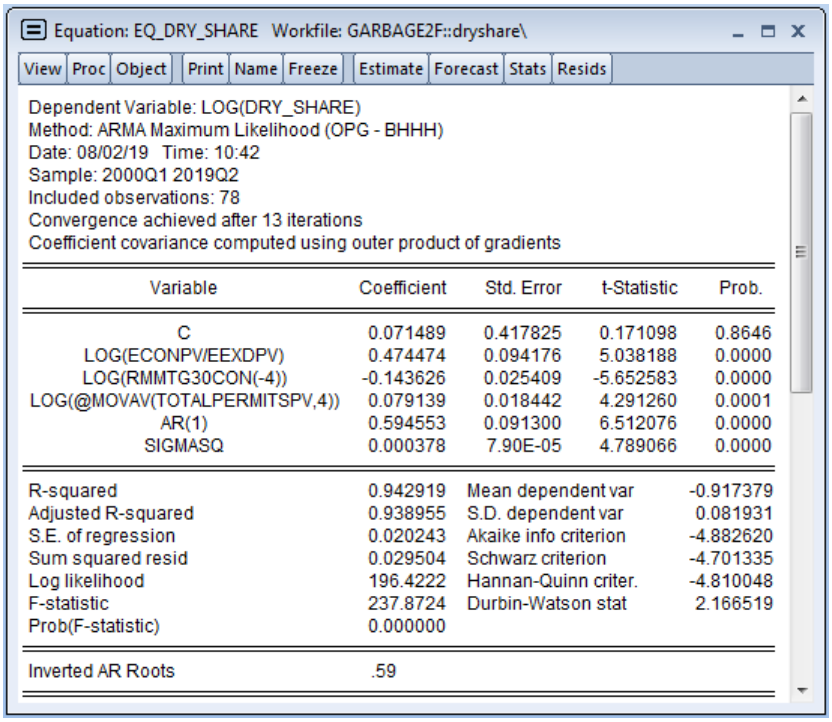
$$\log(DRYSHARE_t) = \alpha + \beta_1 \log\left(\frac{ECONPV_t}{EEXDPV_t}\right) + \beta_2 \log(RMMTG30CON_{t-4}) + \beta_3 \log(MAVG\_TOTALPERMITS_t) + \rho(AR_1)$$

A four-quarter lag, and a four-quarter moving average are indicated in RMMTG30CON and TOTALPERMITSPV, respectively, because the impact to the regional economy is delayed by the indicated number of quarters. For example, mortgage rates and building permits have a leading impact on real economic events because they take time for its effects to transmit through various economic channels. A moving average expression – also in this equation – behaves as an-equal weighted averaging term that transmits leading information that informs the movements of the cyclic-trend in dry wastes. The moving average for TOTALPERMITSPV is expressed in the form by equation 5.

Equation 5

$$\text{MAVG\_TOTALPERMITSPV}_t = 0.25 \sum_{i=0}^{3} TOTALPERMITSPV_{t-i}$$

Model coefficients, standard errors and p-values are provided in the figure below, as are standard model diagnostic statistics. The updated model was estimated with dry shares through 2019 Q2. The equation 4 estimation output is shown in figure 5.



Equation: EQ_DRY_SHARE Workfile: GARBAGE2F::dryshare\

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: LOG(DRY_SHARE)
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 08/02/19 Time: 10:42
Sample: 2000Q1 2019Q2
Included observations: 78
Convergence achieved after 13 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.071489	0.417825	0.171098	0.8646
LOG(ECONPV/EEXDPV)	0.474474	0.094176	5.038188	0.0000
LOG(RMMTG30CON(-4))	-0.143626	0.025409	-5.652583	0.0000
LOG(@MOVAV(TOTALPERMITSPV,4))	0.079139	0.018442	4.291260	0.0001
AR(1)	0.594553	0.091300	6.512076	0.0000
SIGMASQ	0.000378	7.90E-05	4.789066	0.0000

R-squared	0.942919	Mean dependent var	-0.917379
Adjusted R-squared	0.938955	S.D. dependent var	0.081931
S.E. of regression	0.020243	Akaike info criterion	-4.882620
Sum squared resid	0.029504	Schwarz criterion	-4.701335
Log likelihood	196.4222	Hannan-Quinn criter.	-4.810048
F-statistic	237.8724	Durbin-Watson stat	2.166519
Prob(F-statistic)	0.000000		

Inverted AR Roots	.59

Figure 2: Dry Share Disposal Equation

The re-estimated dry share equation is very stable as compared to the prior equation estimates in 2017 and 2018. The estimated coefficients changed little between estimations; variable fits remained significant out past 3 standard deviations (or 99% confidence). Overall fit of the dry share equation remains statistically significant as evidenced by an R-square value above 0.9 – this is typical of time series regressions. The Akaike and Schwarz criterion statistics shows improvement in the latest model re-estimation. The addition of 5 quarters to lengthen the historical data series appears to have strengthened the statistical fit and reinforced our hypothesis of the relationship between dry discards and the economic predictors. Autocorrelation – normally evident in time series regression equation – has been corrected as signified in the equation output as a lagged AR1 term. (Sigmasq can be ignored. It is not part of the variable list in the equation, but is routinely generated by EViews as a diagnostic element.) The Durbin-Watson statistic is close in value to 2 which is evidence that the autocorrelation problem has been statistically addressed. The overall goodness of fit for all variables taken together is significant as evidenced by the F-statistic exceeding the 1% critical value. The statistical fit is tight; we can expect the equation to forecast dry disposal tonnages to perform reasonably well.

Predictors

The model has three RHS predictors as described below.

- **Ratio of Construction to Total Employment (ECONPV/EEXDPV)** Construction employment divided by total nonfarm payroll employment for the Portland MSA.

- *Historical Source:* BLS CES. Ratio is of monthly construction employment in the MSA (Series #SMU41389002000000001) to monthly total (non-farm) employment in the MSA (Series #SMU41389000000000001). Model is estimated on data through June 2019 (2019 Q2).

- *Forecast Source*: NERC. October 2019 forecast release.

- *Data Transformations*: Each monthly series is seasonally-adjusted using the Census X-13 method developed by the US Census Bureau. Each seasonally-adjusted series is averaged over 3 months to yield quarterly series. The ratio of the two series (construction to total employment) is calculated by Metro to yield one series, and multiplied by 100. The series is transformed to natural logarithms for modeling purposes.

- **30-year Fixed Mortage Interest Rates (RMMTG30CON)** Average, conventional, 30-year fixed mortgage rates in the U.S.

  - *Historical Source:* Freddie Mac Primary Mortgage Market Survey (PMMS). The PMMS is a weekly survey of lenders based on first-lien prime conventional conforming home purchase mortgages with a loan-to-value of 80 percent. The PMMS reports average national rates for a number of products, the 30-year fixed product being the one of interest here.

  - *Forecast Source*: IHS Markit. October 2019 US Macro Forecast.

  - *Data Transformations*: Quarterly data (both historical and forecast) is received already seasonally adjusted from IHS Markit (which publishes the adjusted historical PMMS data with the forecast). The lagged fourth period rate (t-4) is assigned to the contemporaneous period (t). The series is transformed to natural logarithms for modeling purposes.

- **Home Permits (TOTALPERMITSPV)** Permits issued for the construction of residential units (including single and multi-family units) in the Portland MSA.

  - *Historical Source:* US Census Bureau, Building Permit Survey (BPS). The BPS provides national, state and local area statistics on new privately-owned residential construction each month. The BPS uses a monthly survey of selected permit-issuing places and an annual census of permit-issuing places that are not in the monthly sample. Permit data are available for structures with 1-unit, 2-4 units, and 5-units or more.

  - *Forecast Source*: NERC. October 2019 forecast.

- *Data Transformations*: Monthly data is seasonally-adjusted using X-13. The seasonally-adjusted series is summed over 3 months to yield a quarterly series. The average of the last four quarters is assigned to the contemporaneous quarter to generate the moving average. This series is then transformed to natural logarithms for modeling purposes.

Outcome: Dry waste share (a percentage)

The model's LHS variable is the share (interpreted as a percentage) of regional dry waste (DRY_SHARE) to total regional core discards.

- *Historical Source*: Metro's Solid Waste Information System (SWIS) tracks monthly deliveries of wet and dry discards to solid waste facilities in the region. All facilities keep wet and dry waste streams separate (and therefore are measured data) except for Metro transfer stations, where dry loads are distinguished from wet loads based on vehicle type (and are therefore calculated data). Data is through June 2019 (2019 Q2).

- *Data Transformations*: Monthly core discards, and monthly dry discards series are each seasonally-adjusted using the X-13 method. Each series is summed over 3 months to yield quarterly series. The ratio of the two series (dry to total waste) is calculated to yield one series, and multiplied by 100. The resulting series is converted to natural logarithms.