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MetroScope Model Version 4.1.1,

Scenarios #1771-1780

MetroScope 4.1.1 Validation,

Phase One—Sensitivity Tests

Evaluating the performance of Metro's land use forecasting model Appendix to MetroScope 4.1.1 Validation, Phase One

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INTRODUCTION

MetroScope is Oregon Metro's land use allocation forecast model. Staff in the Metro Research Center develop, maintain, and apply MetroScope to support Metro's growth and transportation planning responsibilities. A companion document (*MetroScope Generation 4.1.1 Methodology*) explains the model's history, purpose, structure, and mathematics. This document is the second half of the *MetroScope 4.1.1 Validation, Phase One* report. The purpose of this half is to examine the sensitivity of the current MetroScope using selected indicators from the model validation reported in the first half. Understanding model sensitivity is crucial to informing staff and stakeholders about the model's ability to answer questions during application.

This version of the report is targeted to expert forecasters, specifically the MetroScope peer review panel to be convened in October of 2017. Future versions of the report will change based on peer review recommendations and other lessons learned by Metro staff.

SENSITIVITY PROTOCOL

Staff designed sensitivity tests to represent general changes to key input conditions that are likely to change in the future, that are subject to policy questions, or to which economic theory would expect the model to respond. The tests seek to answer questions such as:

- Is the land use model responding in a reasonable manner to economic and real estate stimuli (appropriate direction and magnitude of development patterns)?
- Is the land use model accurately forecasting residential and employment growth in the correct locations? (see Map 1 below for District boundaries)
- What does the model's response tell us about its behavior and, if any, idiosyncrasies?

Staff tested five themes and ten scenarios as listed in Table 1.

General sensitivity themes and scenarios

Scenario No.	Description
	Travel time sensitivity test
#1771	District 3 (Southwest UGB) – increase travel times +30%
#1772	District 3 (Southwest UGB) – decrease travel times - 30%
	Neighborhood amenity value sensitivity test

Table 1: Sensitivity Scenario Assumptions

#1773	District 3 (Southwest UGB) – increase neighborhood values +30%
#1774	District 3 (Southwest UGB) – decrease neighborhood values - 30%
	Owner single family (OSF) land supply sensitivity test
#1775	District 3 (Southwest UGB) – increase OSF land development capacity +50%
#1776	District 3 (Southwest UGB) – decrease OSF land development capacity -50%
	Renter multi-family urban renewal economic subsidy test
#1777	Urban renewal areas – Double residential subsidies
#1778	Urban renewal areas – Eliminate all subsidies (zero)
	Renter multi-family (RMF) land supply sensitivity test
#1779	District 5 (East Portland) – increase RMF land development capacity +50%
#1780	District 5 (East Portland) – decrease OSF land development capacity -50%

The base scenario for all tests was #1770 (same as first half of validation report).

The primary purpose of these tests is to display the model's reaction to the stimuli, not to test specific policy scenarios. That said, for the most part staff chose the scale of the stimuli (the amount change in the inputs) to be within a range of values the region could conceivably experience over the course of three decades given other studies of, for example, concerted large-scale transportation investments or major changes to zoning. Staff designed symmetrical tests for each input theme that increased and decreased by the same amount.

Each test started with the reference scenario and changed only a single input.

Sensitivity theme design and rationale

Travel times in district 3 (Southwest UGB) were bumped up 30% in scenario #1771 and dropped 30% in scenario #1772. This was carried out by altering the travel time matrix to reflect an increase (or decrease) to the Rzone-by-Rzone travel time assumptions relative to the reference scenario.

- Travel time sensitivity assumptions by Rzone
 - Travel times to/from District 3 were increased by +30% from the reference scenario

• Travel times to/from District 3 were decreased by -30%

Neighborhood amenity assumptions (i.e., neighborhood scores) on a Rzone basis were estimated for the reference scenario. The scores represent neighborhood value that has not been fully capitalized into the sales price of homes or the housing values in each neighborhood (i.e., Rzone). The neighborhood score for each Rzone was calculated from the residual value of a hedonic price equation which estimates a neighborhood's underlying value. The residual is normalized to a scale between 0 and 1. A higher score indicates a neighborhood with greater amenity value. The neighborhood score is a fixed exogenous forecast input.

For testing model sensitivities, RC staff raised (or decreased) the neighborhood scores for all Rzones in district 3 (Southwest UGB) by +50% (or -50%) relative to the reference scenario. Neighborhood scores in the other districts were unchanged from the reference scenario.

- Neighborhood amenity assumptions:
 - Neighborhood scores for all Rzones (i.e., census tracts) in District 3 (Southwest UGB) were increased by +50% from the reference scenario
 - Neighborhood scores for all Rzones in District 3 (Southwest UGB) were decreased by -50%

Buildable land supply includes both vacant, infill and redevelopment capacity. This estimate is net of environmentally constrained areas such as wetlands, waterways and flood plains. Deductions for streets, other right of ways, parks and other public uses reduce the estimate to a buildable acreage estimate. Permissible residential development types are based on zoning districts and overlaid on to the buildable land supply to determine SF and MF capacity estimates. Tenure for the land supply is based on historical land use trends which are imposed beforehand as a modeling and forecast input assumption. Capacity for the other seven districts remains unchanged.

- Owner single family (OSF) land supply assumption:
 - OSF capacity in District 3 was increased by +50% from the reference scenario
 - OSF capacity in District 3 was decreased by -50%

Municipalities in the Metro UGB have identified specific zones for special tax treatment or **development incentives** which promise to promote neighborhood revitalization, increases in development or influences the style and density of development. Enterprise zones, local improvement districts and housing tax credits are a few examples of programs that intervene in the market to advance certain desirable forms of construction. These target areas are called out in our

modeling as *urban renewal areas*. Development capacity is unchanged in these zones aside from whatever exists as current zoning. Staff monetized on a per housing unit basis the value of these government programs in modeling and forecasting. The economic subsidy reduced the cost construction. The subsidy is applied only to multi-family development in designated urban renewal areas.

- Multi-family (MF) construction subsidy assumption:
 - Designated urban renewal areas double the construction subsidy assumptions from the reference scenario
 - Designated urban renewal areas zero out the construction subsidies

Residential multi-family land supply is similarly estimated. Multi-family development capacity is determined by zoning, and tenure is given to be the same as historical trends.

- Renter multi-family (RMF) land supply assumption
 - \circ RMF capacity in District 5 was increased by +50% from the reference scenario
 - RMF capacity in District 5 was decreased by -50%

Map 1 depicts the regional subareas. Of particular note, District 3, denoted as the Southwest UGB, and district 5, denoted as East Portland, are the subject areas of the sensitivity testing.

Map 1: District Map



- District 1– Portland CBD
- District 2 Washington Co.
- District 3 Southwest UGB
- District 4 Clackamas Co.
- District 5 East Portland
- District 6 East Multnomah Co.
- District 7 West Portland
- District 8 Clark Co. (in Washington State)

SENSITIVITY TEST RESULTS: SUMMARY

	Refer-		Themes and Scenarios								
	ence										
Indicator	Scenari	Trave	l Time	Neighb	orhood	OSF Ca	pacity	RMF S	ubsidy	RMF Ca	apacity
	0										
		#1771	#1772	#1773	#1774	#1775	#1776	#1777	#1778	#1779	#1780
	#1770	+30%	-30%	+50%	-50%	+50%	-50%	2x	0	+50%	-50%
Capture											
Rate	61.6%	61.3	61.9	64.9	59.4	62.5	60.6	61.6	61.6	62.9	60.1
(Res.)		%	%	%	%	%	%	%	%	%	%
Tenure:											
Ox.m. 0/	((0))	66.8	66.8	65.9	67.4	67.2	66.2	66.8	66.8	64.8	69.1
Own %	Own % 66.8%	%	%	%	%	%	%	%	%	%	%
Dent 0/	22.20/	33.2	33.2	34.1	32.6	32.8	33.8	33.2	33.2	35.2	30.9
Kent %	33.2%	%	%	%	%	%	%	%	%	%	%
Structur											
e Unit											
Type:											
Single	60 70/	69.7	69.7	69.2	69.9	70.3	69.1	69.7	69.7	67.8	72.1
%	09.7%	%	%	%	%	%	%	%	%	%	%
M	20.20/	30.3	30.3	30.8	30.1	29.7	30.9	30.3	30.3	32.2	27.9
Multi %	ulti % 30.3%	%	%	%	%	%	%	%	%	%	%
Capture		734	74.4	74.0	73.9	73.9	73.9	73.9	739	73 9	73.9
Rate	73.9%	0/	7.T 0/2	0/	0/	0/2	0/2	06	0/	0/2	06
(Empl.)		70	70	70	70	70	70	70	70	70	70

Table 2: Regional Validation Indicators

A significant change to an input assumption is needed to cause even a small percentage point change in the regional indicators. Perhaps not surprising, the alterations in the OSF and RMF capacity test cases seem to generate larger responses in the indicators.

Input assumptions were changed in district 3 for all scenario alternatives except the RMF capacity tests in which district 5 was the focus of the input changes. Staff did not run sensitivities over the other

districts; although the directional effects are likely to be the same, but the magnitude of the impact on the indicators may vary.

SENSITIVITY TEST: REGIONAL EMPLOYMENT CAPTURE RATE (UGB SUMMARY LEVEL)

Background

The employment capture rate from the *reference scenario* (#1770) is **73.9 percent**, meaning the increment of employment growth (2010 to 2020) in the Metro UGB was about 74 percent of the total number of nonfarm jobs increase for all of the Portland MSA. Historically this rate has been generally in the range of 70 percent and 80 percent. The capture rate varies with regional business and real estate development cycles.

Sensitivity results

Sensitivities for each theme and scenario are for the forecast period 2010 to 2020.

Table 3: Capture rate sensitivities

<u>Scenario Input</u>	Travel Time	<u>Neighborhood</u>	OSF Capacity	<u>RMF Subsidy</u>	<u>RMF Capacity</u>
Direction					
Increase:	#1771	#1773	#1775	#1777	#1779
	73.4%	74.0%	73.9%	73.9%	73.9%
Decrease:	#1772	#1774	#1776	#1778	#1780
	74.4%	73.9%	73.9%	73.9%	73.9%

Reference scenario (#1770) capture rate = 73.9%

Discussion

- Rzones in district 3 (Southwest UGB) showed measurable sensitivity to travel time changes. Overall, the Metro UGB captured fewer jobs when district 3 travel times were lengthened (#1771). District 3 as expected loses employment. At the margin, some of the jobs get redistributed to other districts in the UGB and a small fraction leaves to Clark County, WA and areas outside the UGB in Oregon. When travel times shortened (#1772) for travelers in district 3, the analysis showed a shift in which employers / employees found it more desirable to work inside the Metro UGB.
- When the neighborhood scores for Rzones in district 3 (Southwest UGB) were increased (#1773), it became slightly more desirable for households to reside in the Metro UGB. This

in turn attracted jobs that tend to follow rooftops, i.e., residential development. This resulted in a small increase in the employment capture rate. A decrease in the neighborhood amenity scores (#1774) in district 3 showed no detectable impact on the employment capture rate.

• Changes in tenure and type capacity (OSF and RMF) had no measurable impact on the employment capture rate. (Scenarios #1775, #1776, #1779, #1780)

SENSITIVITY TEST: RESIDENTIAL CAPTURE RATE (UGB SUMMARY LEVEL)

Background

The residential capture rate for the *reference scenario* (#1770) is **61.6 percent**, meaning the increment of household growth (2010 to 2020) in the Metro UGB was about 62 percent of the total amount of household increase for all of the Portland MSA. Historically, this rate has ranged between roughly 60 percent up to 70+ percent. The capture rate varies with swings in the regional business and real estate development cycles.

Sensitivity results

Sensitivities for each theme and scenario are for the forecast period 2010 to 2020.

Table 4: Capture rate sensitivities

<u>Scenario Input</u>	<u>Travel Time</u>	<u>Neighborhood</u>	OSF Capacity	<u>RMF Subsidy</u>	<u>RMF Capacity</u>
<u>Direction</u>					
Increase:	#1771	#1773	#1775	#1777	#1779
	61.3%	64.9%	62.5%	61.6%	62.9%
Decrease:	#1772	#1774	#1776	#1778	#1780
	61.9%	59.4%	60.6%	61.6%	60.1%

Reference scenario (#1770) capture rate = 61.6%

Discussion

- An increase in travel times to / from district 3 (Southwest UFGB) resulted in a small decrease in the residential capture rate (#1771). An opposite effect appeared with reduced travel times: the capture rate edged up in district 3 (#1772).
- Changes in the neighborhood score are as expected. An increase to neighborhood amenity scores (#1773) raised the UGB capture rate by making district 3 (Southwest UGB) a more desirable location to live. The opposite effect resulted when neighborhood scores were lowered (#1774).
- Development subsidies had no effect on the residential capture rate (#1777 and #1778).
- The capture rate had the expected increases after raising OSF (#1775) and RMF (#1779) capacity in their respective scenarios. Capture rates decreased from the reference scenario

when capacity was reduced in the OSF capacity test (#1776) and RMF capacity test (#1780).

INDICATOR: TENURE CHOICE (MSA SUMMARY LEVEL)

Background

The reference scenario (#1770) shows a homeownership rate of **66.8 percent** for the forecast increment from 2010 to 2020. Figures are for the MSA region.

Tenure choice is one of three consumer choice levels that residents choose in the residential location model. The 2010 Decennial Census reports a final homeownership rate in the Portland MSA of 61.7 percent. Nationwide, the current homeownership rate is 63.7 percent as of the July 2017 Census reading¹.

Sensitivity results

Sensitivities for each theme and scenario are for the forecast period 2010 to 2020.

				·	
<u>Scenario Input</u>	<u>Travel Time</u>	<u>Neighborhood</u>	OSF Capacity	<u>RMF Subsidy</u>	<u>RMF Capacity</u>
Direction					
Increase:	<u>#1771</u>	<u>#1773</u>	<u>#1775</u>	<u>#1777</u>	<u>#1779</u>
	<u>66.8%</u>	<u>65.9%</u>	<u>67.2%</u>	<u>66.8%</u>	<u>64.8%</u>
Decrease:	<u>#1772</u>	<u>#1774</u>	<u>#1776</u>	<u>#1778</u>	<u>#1780</u>
	<u>66.8%</u>	<u>67.4%</u>	<u>66.2%</u>	<u>66.8%</u>	<u>69.1%</u>

Table 5: MSA Tenure choice sensitivities – homeownership rates (2010 to 2020 increment)

Reference scenario (#1770) capture rate = 66.8%

Discussion

- Travel times appeared to have little direct impact on tenure choices across the MSA (#1771 and #1772).
- Increasing the neighborhood amenity scores (#1773) in district 3 (Southwest UGB) triggered a noticeable increase in households choosing to locate in district 3 (please see: Figure 2). This is offset by reductions in the other districts. Tenure choice decreases a bit as the shift in households to other districts from the reference scenario results in more households choosing to live in renter multi-family units. The opposite (#1774) occurs when neighborhood amenity scores are lowered in district 3. These results may not carry through if the neighborhood test were applied to other districts. Differences in type and tenure

¹ Quarterly Residential Vacancies and Homeownership, Second Quarter 2017, U.S. Census Bureau, Release No. CB17-110, July 27, 2017

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capacity in other districts and subsequent reallocations will lead to different final demand results. This test demonstrates that neighborhood choices matter, but takes a fairly sizable shock to even move small percentages.

- Increasing OSF capacity (or RMF capacity) in district 3 had the expected result: more households locating in district 3 (Southwest UGB) from other districts and a shift in households that had formerly chosen to live outside the UGB to locate in district 3.
- Development subsidy scenarios (#1777 and #1778) indicate no measurable impact on regional tenure choice.

INDICATOR: HOUSING STRUCTURE TYPE CHOICE (MSA SUMMARY LEVEL)

Background

The reference scenario (#1770) shows **69.7 percent** of households choose single-family (SF) structure type for the forecast increment from 2010 to 2020. Figures are for the MSA region.

Structure type choice is the second of three consumer choices that residents make in the residential location model. According to the last two Decennial Censuses, the proportion of single family occupied structure type was 69.8 percent in 2000 and 71.4 percent in 2010.

Sensitivity results

Sensitivities for each theme and scenario are for the forecast period 2010 to 2020.

<u>Scenario Input</u>	<u>Travel Time</u>	<u>Neighborhoo</u>	<u>OSF Capacity</u>	<u>RMF Subsidy</u>	<u>RMF Capacity</u>
Direction		<u>d</u>			
Increase:	#1771	#1773	#1775	#1777	#1779
	69.7%	69.2%	70.3%	69.7%	67.8%
Decrease:	#1772	#1774	#1776	#1778	#1780
	69.7%	69.9%	69.1%	69.7%	72.1%

Table 6:MSA Structure type sensitivity – single family (SF) proportion (2010 to 2020 increment)

Reference scenario (#1770) capture rate = 69.7%

Discussion

- Travel times (#1771 and #1772) did not change overall SF (single family) structure choices across the MSA.
- An increase in neighborhood scores (#1773) in district 3 (Southwest UGB), attracts about 12 percent more SF residents to live in the Southwest UGB subarea, but it reduced overall SF structure choices in the Metro UGB. The increase in scores drove more households into living inside the Metro UGB and resulted in proportionally more households making a MF (multi-family) choice. Decreasing the neighborhood scores had an opposite impact (#1774) in district 3, as expected. The number of SF residents in district 3 showed a 26% decrease, by far more households not choosing to live in district 3. The SF choice over all for the MSA actually increased slightly over the reference case. More households chose to live outside

the Metro UGB and Clark County, WA in #1774 and in so doing raises the SF choice share because capacity in outside zones is predominantly SF.

- An increase (decrease) in OSF capacity in district 5 (East Portland) raises (lowers) the overall SF choice in the MSA, as compare to the reference scenario result, scenarios #1775 and #1776 respectively.
- Doubling the subsidy amount (#1777) or eliminating it (#1778) (with no change to the capacity or number of units that were subsidized) had no impact on structure type choice.
- An increase (decrease) in RMF capacity in district 5 (East Portland) lowered (raised) the overall SF choice in the MSA (#1779 and #1780).

INDICATOR: HOUSEHOLD LOCATION CHOICE (DISTRICT SUMMARY LEVEL)

Background

The following series of charts illustrates MetroScope's locational response by District to the ten sensitivity tests. Staff chose to apply the test stimuli at the district-wide rather than the zonal level particularly to enable efficient visualization of the spatial results. The District summaries do not, of course, reveal fine-grained responses but are useful for quickly understanding the model's general geographic response.

Validation results

Increase TT: +30%



Figure 1: Travel time to / from District 3 (Southwest UGB)

Increase NS: +50%



Figure 2: Neighborhood amenity in District 3 (Southwest UGB)

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Decrease TT: -30%



Decrease NS: -50%





Figure 3: Owner Single Family Land Supply in District 3 (Southwest UGB)

Renter Multi-family Development Subsidies (regionwide)

Double subsidy amount	No subsidies
<chart as="" did="" is="" meaningful="" not="" not<="" subsidies="" td=""><td><chart as="" did="" is="" meaningful="" not="" not<="" subsidies="" td=""></chart></td></chart>	<chart as="" did="" is="" meaningful="" not="" not<="" subsidies="" td=""></chart>
materially shift household location choices>	materially shift household location choices>
Figure 4: Renter Multi-family Development Subsidies (regionw	ide)

RMF capacity: +50%

RMF capacity: -50%



Figure 5: Renter Multi-family Land Supply in District 5 (East Portland)

Discussion

District 3 (Southwest UGB) was the subject of most of the sensitivity testing. An exception was made for the RMF sensitivity test because RC staff deemed district 3 did not have the depth and breadth of renter multi-family capacity as district 5 (East Portland). The fairer test was to use a district like 5 (East Portland) that had a broader selection of MF choices.

- An increase (decrease) in travel times to/from district 3 produced increases (decreases) to impedances in district 3 and the expected result of relatively fewer (more) households choosing to locate in district 3.
- An increase (decrease) in the neighborhood amenity score in district 3 produced the expected increase (decrease) in the number of household choosing to relocate to live in district 3 as compared to the reference scenario.
- Increases (decrease) in the district level residential capacity of either OSF or RMF land supply yielded the expected increase (decrease) in households of the same district.
- The sensitivity tests revealed no significant effect from residential subsidies. This suggests that unit construction costs were all well below the market clearing bid rent-price and thus had no impact on the supply-side decision to build or not build. Market clearing prices in all the subsidy zones were all above the array of construction costs by type and tenure and therefore subsidies were not needed to trigger development because development would have occurred with or without subsidies. Staff are conducting additional detailed assessments of this response to better understand the implications of these findings.

INDICATOR: OWNER HOUSING COST - SINGLE FAMILY (OSF) HOME VALUE

Background

Housing price projections provide a useful indication of how well the residential land supply is able to meet housing demand in future years. The residential land supply is a mix of observed vacant land and an estimate of potential redevelopment and infill permissible under current zoning. MetroScope derives demand from a regional household forecast that segments future new households by size, household income, and age of the householder interacting with market factors. The forecast drivers include neighborhood amenities (the "neighborhood score", travel time indices, and price indices which change in response to demand conditions. The prices shown in the charts are at model equilibrium, in other words the price at which all the simulation clears all real estate submarkets by Rzone, tenure, and type. They represent weighted prices by district and by tenure. The weights are the number of homeowners by Rzone. The charts index all prices so that year 2010 = 1.

Price sensitivity results



Figure 6: Forecast of OSF Price Response to Travel time sensitivity tests



Figure 7: Forecast of OSF Price Response to Neighborhood amenity tests



Figure 8: Forecast of OSF Price Response to Owner single family (OSF) land supply sensitivity tests



Figure 9: Forecast of OSF Price Response to Renter multi-family urban renewal construction subsidy tests



Figure 10: Forecast of OSF Price Response to Renter multi-family (RMF) land supply sensitivity tests

Discussion

- There is significant similarity in final demand prices in all districts except the Portland CBD (district 1). In the case of district 1, there is little SF capacity and what little exists is very expensive. The index does not readily show actual housing prices. thus the lack of price appreciation over time is not indicative of the latent OSF demand in district 1. Because the market price for OSF in district 1 is so much higher than other districts, only the very wealthy household segments are competitive in this district. Thus demand pressures are not very high until year 2040 when supply conditions region-wide bring more households demand into the district and prices rise accordingly.
- RC staff observe that MetroScope seems to need its first five-year forecast cycle for its market simulation to begin to realistically capture market activity in all zones. The charts illustrate this in the rapid price rise from 2015 to 2020 whereas from 2020 to

2035 prices rise moderately in all districts. RC staff believe the price increase up through year 2035 to be a reasonable response to the land supply for OSF development inside the four-county geography (Multnomah, Washington, Clackamas, and Clark counties) in the validation scenario. By the final forecast year of 2040, increasing demand interacting with available OSF supply causes the model to raise prices more sharply and to shift some of what in early years was OSF demand into the substitute of MF units.

INDICATOR: RENTER HOUSING COST – GROSS RENT

Background

Forecast residential rents complement forecast ownership prices in showing how well the overall residential land supply is able to meet housing demand in future years. The residential land supply includes a mix of observed vacant land and an estimate of potential redevelopment and infill combined with current zoning densities. As with owned units, the rents shown in the charts are reported from the model's market-clearing equilibrium solution and represent weighted prices by district and by tenure. The weights are the number of renters by Rzone. The index is set to 2010 = 1.

Sensitivity results



Figure 11: Forecast of RMF Rent Response to Travel time sensitivity tests



Figure 12: Forecast of RMF Rent Response to Neighborhood amenity value tests



Figure 13: Forecast of RMF Rent Response to Owner single family (OSF) land supply sensitivity tests



Figure 14: Forecast of RMF Rent Response to Renter multi-family urban renewal construction subsidy tests



Figure 15: Forecast of RMF Rent Response to Renter multi-family land supply sensitivity tests

Discussion

- The model's first-cycle "ramp up" appears as the higher slope of the rent increases 2015 to 2020 although the effect is less marked than with OSF pricing.
- Renters see less of an increase in out years than prices for owner single family residents, indicating that in the validation scenario there is sufficient supply in all districts to meet existing and latent MF demand. There is some sign of tightening in the land supply in the final cycle, obviously more so in the test case (#1780) that decreased MF supply. The underlying small out-year rental price effect in the reference scenario is likely partly due to would-be SF owners shifting into the rental market.