Metrolina Regional Travel Demand Model
LUSAM
Land Use Allocation Model
Technical Documentation

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1 LUSAM model

LUSAM – Land Use Allocation Model is a spreadsheet model to allocate land use data (population, households, jobs and students) from districts to Traffic Analysis Zones (TAZ). Land Use categories are those used in the Metrolina Regional Model. The include household and population categories, employment in eight categories, and three categories of students.

The user must input district totals – or targets – for each land use category and a base dataset – or starting point of TAZ data. Other datasets are also accepted to provide more information for the allocation.

LUSAM aggregates the base TAZ data into the same districts as the targets. The difference between the target and base is allocated by percentages to the TAZ with the district and a new TAZ land use dataset is created.

Allocation is based on up to five variables:

- The change (growth) over time from an earlier projection (e.g. – projections for a new 2015 dataset would use the same growth allocation as an earlier projection between 2010 and 2020)
- Straight factor – the same proportion of TAZ to District as in the base TAZ file (e.g. if taz "1" has 100 retail employees of the 1000 retail employees in the district – it would receive 10% of all new retail employees)
- Vacant property in the TAZ. This is based on an estimate of households or jobs per acre (and total acres). Relative development density is a primary input to this category. It differs across categories and across geographies: employment density by acre is considerably higher in the the center city than in suburbs.
- Travel time to core-employment
- Planners Judgement

LUSAM accepts "Pipeline" data – by TAZ. The number of households or jobs under construction or planned can be added to specific TAZ. Similarly, known decreases, such as that for a factory being closed, can be subtracted from a particular TAZ. Pipeline data are added or subtracted to the base prior to allocation from districts.

The basic allocation equation is essentially the same for all categories. Households are used in the example below

$$
\begin{aligned}
& HH_future_{taz} \\
& = HH_base_{taz} + HH_pipeline_{taz} \\
& + (HH_target_{dist} - (HHbase_{dist} _ HH_pipeline_{dist})* \\
& (Wgt1*(\Delta HH_y2 - y1_{taz} / \sum \Delta HH_y2 - y1) \\
& + Wgt2*(HH_base_{taz} / \sum HH_base) \\
& + Wgt3*(Vacant_res_{taz} / \sum Vacant_res) \\
& + Wgt4*(TravTime_{taz} / \sum TravTime) \\
& + Wgt5*(PlannersJudgment / \sum PlannersJudgment))
\end{aligned}
$$

Where:

HH_future_{taz}	Future (projection) year TAZ households
HH_base_{taz}	base year TAZ households
$HH_pipeline_{taz}$	Pipeline households added to TAZ between base year & future year
$\Delta HH_y2\text{-}y1_{taz}$	Change in no. of HH in TAZ between y1 and y2 in ”old” projection set
$\sum \Delta HH_y2\text{-}y1$	Change in no. of HH in district (sum of all TAZ) between y1 and y2 in old projection set
HH_base_{taz}	No. of base households in district
$\sum HH_base$	Sum of base households for district
$Vacant_res_{taz}$	Vacant residential acres for TAZ
$\sum Vacant_res$	Sum of vacant residential acres for district
$TravTime_{taz}$	Reciprocal of travel time to core employment for TAZ
$\sum TravTime$	Sum of reciprocal of travel time to core employment for district
$PlannersJudgment_{taz}$	Planners Judgment value (1-5) for taz
$\sum PlannersJudgment$	Sum of Planners Judgment values for district
Wgt1 … Wgt5	Weights (0 – 1 for each variable (weights must sum to 1.0)

LUSAM is a one-year model. If you need to create datasets for a series of horizon years, you will need to save the spreadsheet as a different name and prepare each year as needed. For example, if you need datasets for 2005, 2015, 2025 and 2035 and wish to start from a base dataset of 2000, you will need to run LUSAM four times – once each for 2005, 2015, 2025 and 2035.

If you are basing the new projections on an earlier set of runs with land use datasets for 2010, 2020 and 2030, you may wish to use the old datasets as guides for the new run of LUSAM. For the above example, the four runs may use these datasets

	Forecast	Base	InOldY1	InOldY2
1	2005	2000	2000	2010
2	2015	2005 (from run 1 of LUSAM)	2010	2020
3	2025	2015 (from run 2 of LUSAM)	2020	2030
4	2035	2035 (from run 3 of LUSAM	2020	2030

2 LUSAM Operation

2.1 Data Preparation

You will need to have the following to start:

Required
- Base TAZ data set – Metrolina Model format.
- TAZ to District cross reference – maximum of 20 districts, numbered 1-20
- District targets – Metrolina model categories

Optional
- Two TAZ data sets of different years (e.g. 2000 and 2010) if you wish to use an earlier growth allocation as a guide
- Pipeline data by TAZ – Metrolina model categories
- Average development densities – by TAZ
- Planners judgment by TAZ
- Travel time to core employment (reciprocal)

2.2 Spreadsheet layout

The model is contained in a single MS Excel workbook with a number of pages. Tabs on the pages are color-coded to indicate purpose

	Green	User Input Pages – including targets, model definition, districts, input TAZ files,
	Yellow	Output datasets – TAZ data and statistics
	Blue	User input pages – Non-SE variables by TAZ
	Buff	Calculations pages – no user entry
	Red	Model Setup and run, Instructions

Throughout the worksheet, cells that require user entry have blue text. Black text indicates formulas and should not be disturbed.

2.3 District definintion

Districts can be any accumulation of TAZ. Districts can be as small as one TAZ or as large as the whole area. TAZ do not need to be physically adjacent to be defined as districts – either on a map or in data files.

For every district, you must have a target development total for each Metrolina Model category.

LUSAM currently allows a maximum of 20 districts – they must be numbered 1-20. You must have at least 1 district.

LUSAM was built using the Metrolina TAZ file with 2,934 TAZ. This is an arbitrary maximum. You may run the model with fewer TAZ, but to increase the maximum please see section X.X.

2.3.1 Page "DistName"

On this page, enter the names of the district – these are used throughout the worksheet on all district level tables.

At the bottom of the table, enter the number of districts for the model

Figure 2.3-1 DistName

RangeDistName

District	DistName
1	Cleve-Shelby
2	Cleve - SE
3	Cleve - N
	Iredell - S
5	Iredell - N
6	Linc-E Central
7	Linc-East
	Linc-W
8	Central
9	Linc-West
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

NumDist	**9**

2.3.2 Page "DistTazX"

Enter the TAZ to district cross-reference on this page. Column A contains TAZ number, column B contains district number. The easiest way to enter this table is to save a .dbf in TransCad of two columns – TAZ and district. Paste it into the worksheet.

All TAZ files must have the same sort order. They do not have to be sorted by TAZ number, but all must be sorted in the same manner.

District numbers are You are not required to sequential. Districts must be numbered 1-20 sequentially and not be greater than the NumDist entered on the "DistName" page.

Columns C – J contain a true/false test to identify if other TAZ pages on the worksheet are sorted in the same manner. Check this page – top to bottom – after adjusting any of the other TAZ files. "FALSE" in any column indicates that you have a mismatch.

If you have less than 2,934 TAZ, it is probably a good idea to delete all lines below your last TAZ on this table. At the top of the table (row 2), the true/false test is applied to the whole column, saving you the trouble of paging through the whole column. If you later need more rows, you can copy the last row as many times as you need (up to 2,934)

Figure 2.3-2 DistTazX

DISTRICT TAZ cross reference		All TAZ match?							
Cross-reference		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
TAZ	District	BASE	InOldY1	InOldY2	Pipeline	Density	Land	PlanJudge	TravTime
4001	1	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
4002	1	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
4003	1	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
4004	1	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
4005	1	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
4006	1	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
4007	2	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
4008	2	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
4009	1	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
4010	3	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
4011	1	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
4012	1	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE

2.4 Set Model Years

LUSAM is a one-year model. To keep track of what you are running, it is a good idea to enter the years for your run at the top of the "Model" page. These years will appear at the top of other pages as you continue your setup.

You have four "years" to enter. Further explanation is provided in later sections of the report.

Base	Base year – year the forecast is to built from (section 2.5)
Forecast	Forecast year – year that you are forecasting (section
InOldY1	Old TAZ datasets for 2 years – the delta (Y2 – Y1) between these datasets is a primary input to the LUSAM algorithm (section X.x)
InOldY2	

2.5 Base TAZ data

This is the starting point for the LUSAM model. The output table is built using this as the base. For the first horizon year, use the initial base table (2000 or 2005). For subsequent horizons, use the output from of a previous run of LUSAM. For example, if you wish to build a 2005, 2015, 2025 and 2035 dataset. Run LUSAM for 2005 first with 2000 as base. For 2015, use the output dataset from the 2005 run as base. For 2025, use the output from the 2015 run as base and so on.

Copy the base TAZ dataset onto this page starting with Column B. Column A will be filled with district number from page "DistTazX". TAZ order should be the same as entered on page "DistTazX" Check the Base column (col C) on page "DistTazX to make sure TAZ numbers match up.

Order of TAZ variables is very important. Figure 2.5-1 shows correct order. The easiest way to fill this table is to use Excel to open a dbase file. Copy and paste the TAZ data into the LUSAM spreadsheet (making sure the TAZ are sorted correctly and columns are correct).

Figure 2.5-1 Base TAZ columns

Column	Field name	Description
B	TAZ	Transportation Analysis Zone
C	HH	Households
D	POP	Population
E	POP_HHS	Population in households
F	POP_GRP	Population in group quarters
G	MEAN_INC	Mean household income
H	MIWTCU	Employment - Manufacturing, Industrial, Warehouse, Transportation, Communications, Utilities
I	RTL	Employment - Retail
J	HWY	Employment - Highway Retail
K	LOSVC	Low-traffic service employment
L	HISVC	High-traffic service employment
M	OFFGOV	Employment - office & government
N	BANK	Employment – bank
O	EDUC	Employment – Education
P	STU_K8	Students - Grades K-8
Q	STU_HS	Students - High School
R	STU_CU	Students – College
S	TOTEMP	Total employment

T	DORM	Flag - Group Qtrs is a dorm
U	STCNTY	FIPS State County ID
V	AREA	Area (Sq. Miles)
W	SEQ	Sequence number (1 - 2934)
X	AREA_LU	Area developed or able to be developed

This page has 2,934 rows (data rows 4 – 2,937). If you are running less than a full TAZ dataset, you do not need to remove rows below those you need. It doesn't hurt anything if you do though.

2.6 Pipeline TAZ data

The pipeline allows the user to add specific development to specific TAZs. If a subdivision is under construction, but not completed, you can add the households here. Similarly, if a facility, such as a factory, is scheduled to close, you can enter negative values here and they will be subtracted from the base.

Pipeline data will be added to/subtracted from the base data before running through LUSAM.

Add only those fields that you need for the TAZ you need. For a new grocery store, only the PIPE_RTL needs a value.

Pipeline data must be in land use file units (population, households, jobs (by category) and students (by TAZ of school).

The TAZ number and district are entered automatically on this page (from TazDistX). Fields

Figure 2.6-1 Pipeline TAZ columns

Column	Field name	Description
C	Pipe_HH	Pipeline households
D	Pipe_PHH	Pipeline population in households
E	Pipe_PGP	Pipeline population in group quarters
F	Pipe_MIW	Pipeline employment - Manufacturing, Industrial, Warehouse, Transportation, Communications, Utilities
G	Pipe_RTL	Pipeline employment - Retail
H	Pipe_HWY	Pipeline employment - Highway Retail
I	Pipe_LoS	Pipeline employment - low-traffic service
J	Pipe_HiS	Pipeline employment - high-traffic service
K	Pipe_OG	Pipeline employment - office & government
L	Pipe_BNK	Pipeline employment – bank
M	Pipe_EDU	Pipeline employment – Education
N	Pipe_K8	Pipeline students - Grades K-8
O	Pipe_HS	Pipeline students - High School
P	Pipe_CU	Pipeline students – College

2.6.1 Residential pipeline

For household data – you should enter both households (Pipe_HH) AND the persons in those households (Pipe_PHH).

Please consider that the Metrolina model is based on occupied Households – not housing units. Very few subdivisions are fully occupied, so a factor should be applied to account for vacant units. In the 2000 Census for the region, approximately 6% of units were vacant in the year 2000.

For group quarters pipeline, add the number of persons in Pipe_PGP. If the group quarters is a dormitory, you will need to change the "DORM" flag in the output dataset to "1" by hand

LUSAM sums total population from population in households and group quarters.

2.6.2 Non-residential pipeline

The Metrolina model uses jobs (employees) to estimate trips. They must be entered by category (see figure 2.3-3). In general, non-residential pipeline development is stated in square feet – not jobs. For Charlotte, the base conversion from square feet to jobs is:

Retail, Highway retail, Service	1 employee per 400 square feet
Office, bank, Service	1 employee per 250 square feet
MIWTCU	1 employee per 1000 square feet
Schools	100 per public elementary, 150 / middle school, 200 / high school

These values should be used only as guidelines.

Use only heated square feet. Parking decks are often very large with very few employees.

Warehouse facilities may have as few as one employee per 10,000 or 20,000 square feet.

Big-box retail has fewer employees per square foot than 400.

School employment is dependent on size of school and number of students. If you add a school, make sure to add both students (in proper category) and EDUC employees.

Many employers rent enough space to expand at a later date; so much of any new building may be rented, but empty.

Like households, new development is not automatically filled. Vacant space is often up to 20% or higher.

Use common sense. Compare it to other areas where you already have employment numbers.

2.7 Targets - District

The “Targets” page is for forecast year district level targets. Targets must be developed outside of LUSAM and entered on this page. LUSAM will build a new TAZ dataset that attempts to meet these targets.

Each variable in the Metrolina model land use dataset is included.

The forecast year entered on the “Model” page is at the top of the “Targets” page

District number and names from “DistName” page are in the first two columns

Target values – district totals for each category should be entered into the appropriate rows / columns.

Figure 2.7-1 Targets

Targets: Target Development by District 2015

Offset DistTarget		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
District	DistName	HH	POP	POP_HHS	POP_GRP	MIWTCU	RTL	HWY	LOSVC	HISRV	OFFGOV	BANK	EDUC	STU_K8	STU_HS	STU_CU	Tot Emp
1	Cleve-Shelby	15,582	39,609	38,577	1,033	5,521	3,125	1,394	1,328	4,254	2,379	360	2,276	5,290	2,252	3,707	20,636
2	Cleve - SE	14,896	37,755	37,397	358	7,133	1,054	639	714	1,295	503	59	1,483	6,392	1,446	0	12,879
3	Cleve - N	3,121	7,932	7,739	193	430	127	30	82	161	79	9	490	2,004	772	0	1,406
4	Iredell - S	23,425	60,066	59,587	479	9,717	5,639	3,158	3,601	7,388	5,974	449	2,484	9,723	3,818	0	38,409
5	Iredell - N	5,610	14,361	14,361	0	551	408	685	306	465	51	36	237	722	0	0	2,738
6	Linc-E Central	17,397	45,788	44,814	974	8,583	1,943	1,132	1,694	2,728	1,746	234	1,482	6,233	970	0	19,540
7	Linc-East	11,009	28,869	28,745	125	3,990	1,235	683	1,238	929	416	124	475	1,350	1,385	0	9,089
8	Linc-W Central	3,772	9,892	9,859	33	433	228	130	258	179	191	14	296	1,795	976	0	1,727
9	Linc-West	2,489	6,522	6,522	0	519	186	73	108	124	6	6	458	1,930	1,148	0	1,478
10																	0
11																	0
12																	0
13																	0
14																	0
15																	0
16																	0
17																	0
18																	0
19																	0
20																	0
	REGION	97,298	250,791	247,597	3,194	36,875	13,943	7,921	9,327	17,522	11,344	1,289	9,681	35,437	12,764	3,707	107,900

2.8 Previous (OLD) TAZ Land Use datasets (InOldY1 and InOldY2)

Much work has gone into producing land use datasets for the Metrolina region in the past. These datasets include earlier expectation of where future development would occur. These older projections are probably still the best source of expected allocation of growth for new projections. LUSAM uses the delta – or change – between any two datasets of the same format as a variable for allocating change to the new forecast dataset.

For example, if you wish to create a new 2015 dataset based on a new 2005 (or 2009) dataset, the predicted change between 2010 and 2020 from a few years ago may still be the best indication of growth between the 2005 and 2015. Any two Metrolina land use databases can be entered into these tables.

Be careful to enter the earlier year into Y1 and the later year into Y2 so the deltas are positive. The model will work (badly) with negative deltas.

Pages “InOldY1” and “InOldY2” should be filled with TAZ datasets. Copy the TAZ datasets onto these pages starting in Column B. Column A will be filled with district number from page “DistTazX”. TAZ order should be the same as entered on page “DistTazX” Check the InOldY1 and InOldY2 columns (cols D,E) on page “DistTazX to make sure TAZ numbers match up.

Order of TAZ variables is very important. Figure 2.8-1 shows correct order (same as Base data). The easiest way to fill this table is to use Excel to open a dbase file. Copy and paste the TAZ data into the LUSAM spreadsheet (making sure the TAZ are sorted correctly and columns are correct).

Figure 2.8-1 InOldY1 and InOldY2 TAZ columns

Column	Field name	Description
B	TAZ	Transportation Analysis Zone
C	HH	Households
D	POP	Population
E	POP_HHS	Population in households
F	POP_GRP	Population in group quarters
G	MEAN_INC	Mean household income
H	MIWTCU	Employment - Manufacturing, Industrial, Warehouse, Transportation, Communications, Utilities
I	RTL	Employment - Retail
J	HWY	Employment - Highway Retail
K	LOSVC	Low-traffic service employment
L	HISVC	High-traffic service employment
M	OFFGOV	Employment - office & government
N	BANK	Employment – bank
O	EDUC	Employment – Education
P	STU_K8	Students - Grades K-8
Q	STU_HS	Students - High School
R	STU_CU	Students – College
S	TOTEMP	Total employment
T	DORM	Flag - Group Qtrs is a dorm
U	STCNTY	FIPS State County ID
V	AREA	Area (Sq. Miles)
W	SEQ	Sequence number (1 - 2934)
X	AREA_LU	Area developed or able to be developed

2.9 Available Land

LUSAM makes an attempt to estimate available land and use it as an input to the model. Availability of land is a crucial factor in the development business. However, as less land is available, property may be developed (or redeveloped) more densely as is shown in every city in the world.

Two input files are required – an estimate of available acres and an estimate of development density.

In LUSAM, the number of acres of residential and non-residential developed land is estimated by dividing households or jobs by the density factors. Developed acres are subtracted from total acres to estimate vacant; or available acres.

LUSAM allows negative acres – lower density than actual. This acts against allocating additional development. Nevertheless – negative land is an impossibility – you should check negatives to make sure the inputs are correct and that densities used are reasonable.

2.9.1 "Land" page

The "Land" page includes a number of calculations and provides the user to override assumptions.

Figure 2.9-1 shows land estimates at the start of the allocation. District, TAZ and Acres (cols A-C) are automatically filled from the "DistTazX" and "Base" pages. Acres (col C) is filled from the ACRES_LU field in the Base land use database. ACRES_LU is supposed to contain the number of acres in a TAZ that is available for development (total acres less roads, water, cemeteries, or other un-developable land).

Development from the base file plus pipeline development are multiplied by assumed densities (section 2.9.2) to estimate residential (col D: AcRes) and non-residential acres (col E: AcNRes).

The next two columns (cols F,G: PctRes and PctNRes) are filled by the proportion of land shown in residential an non-residential. THESE FIELDS CONTROL ALLOCATION OF REMAINING LAND BETWEEN RESIDENTIAL AND NON-RESIDENTIAL. THEY SHOULD BE ADJUSTED BY HAND OR BY BRINGING IN OTHER DATABASES IF THIS INFORMATION IS AVAILABLE.

The last two columns (cols H, I: VacRes and VacNRes) contain the available acres for development. These fields should be checked for negative values indicating that more land is developed than available. The Density assumption (section 2.9.2 should be checked)

.

Figure 2.9-1 "Land" page

LAND at start (base + pipeline)

District	TAZ	Acres	AcRes	AcNRes	PctRes	Pct Nres	VacRes	VacNRes
1	4001	161.0	43.2	15.5	74%	26%	75.4	27.0
1	4002	212.5	111.7	73.1	60%	40%	16.8	11.0
1	4003	123.1	36.3	14.3	72%	28%	52.0	20.5
1	4004	295.5	31.7	12.5	72%	28%	180.4	70.9
1	4005	166.1	80.0	48.0	63%	38%	23.8	14.3
1	4006	147.8	41.5	4.4	90%	10%	92.1	9.8
1	4007	190.9	64.5	61.2	51%	49%	33.5	31.8
1	4008	104.9	24.2	62.0	28%	72%	5.3	13.5
1	4009	124.0	10.0	67.1	13%	87%	6.1	40.8
1	4010	235.7	62.5	17.0	79%	21%	122.8	33.4
1	4011	255.0	131.0	45.1	74%	26%	58.7	20.2
1	4012	232.9	81.3	1.2	99%	1%	148.2	2.2
1	4013	248.9	21.3	58.3	27%	73%	45.3	123.9

2.9.2 "Density TAZ" page

This page contains the average density used in calculating the acres on the "Land" page. Density varies greatly over an urban area. Density also varies over time. As land becomes more valuable, density generally increases. Density also changes with zoning or other planning initiatives. The starting values in the density table are based on the model's assigned area type. These are shown below. This table is at the top of the "Density TAZ" page.

Figure 2.9-2 Density Template

Templates		Jobs per acre							
Area Type	hh/acre	MIWTCU	Rtl	Hwy	LoSvc	HiSvc	OffGov	Bank	Educ
Center City (AT 1)	80	80	100	140	100	160	160	160	80
Fringe (AT 2)	12	15	15	20	15	20	20	20	25
Urban (AT 3)	6	10	12	15	12	15	15	15	25
Suburban (AT 4)	3	5	10	10	10	10	10	10	25
Rural (AT 5)	1	5	5	5	5	5	5	5	25
Station Areas	30	10	50	20	50	50	50	50	25
Mixed Use Centers	12	15	15	20	15	20	20	20	25
Industrial Centers	6	25	10	10	10	10	10	10	25

The TAZ density table is below the the template. TAZ and district are automatically updated from the "DistTazX" and "Base" tables. The remainder of the table contains a table initially created from an area type file for the year 2000. The important columns are the density columns (cols E – M). Data cann be edited by hand, or by copy / paste from the templates.

Figure 2.9-3 Density TAZ table

TAZ	DISTRICT	ATYPE00	STATIONTAZ	HHACRE	MIWTCU	RTL	HWY	LOSVC	HISVC	OFFGOV	BANK	EDUC
4001	5	3	0	6	10	12	15	12	15	15	15	25
4002	5	3	0	3	5	10	10	10	10	10	10	25
4003	5	4	0	3	5	10	10	10	10	10	10	25
4004	5	4	0	6	10	12	15	12	15	15	15	25
4005	5	3	0	3	5	10	10	10	10	10	10	25
4006	5	4	0	6	10	12	15	12	15	15	15	25
4007	5	3	0	6	10	12	15	12	15	15	15	25
4008	5	3	0	6	20	20	20	20	20	20	20	25
4009	5	3	0	6	10	12	15	12	15	15	15	25
4010	5	3	0	6	10	12	15	12	15	15	15	25
4011	5	3	0	3	5	10	10	10	10	10	10	25
4012	5	4	0	3	5	10	10	10	10	10	10	25
4013	5	4	0	6	10	12	15	12	15	15	15	25
4014	5	3	0	6	20	20	20	20	20	20	20	25
4015	5	4	0	3	5	10	10	10	10	10	10	25
4016	5	4	0	3	5	10	10	10	10	10	10	25
4017	5	4	0	3	5	10	10	10	10	10	10	25

2.10 Planners Judgment

The page "PlanJudge" is provided to allow planners a higher level of control over the allocation. It allows an arbitrary entry for any TAZ. This table can be used for TAZ that are particularly popular or those particularly unpopular. It can also be used for areas where development is emphasized or discouraged in the plan.

Initially they are filled with values 1-5 based on initial growth projections for 2000 to 2010. These can be changed as desired.

Four fields are provided:

PJRES	Applied to residential fields (households / population)
PJMIWTCU	Applied to MIWTCU
PJRTLSVC	Applied to Retail, Highway Retail, Hi-Traffic and Low-Traffic Service
PJOFFICE	Applied to Office and Bank fields

Figure 2.10-1 Planners Judgment

Plan or Planners judgement - numerical rating (currently 0 - 5)
Higher number rates higher

District	TAZ	PJRES	PJMIWTCU	PJRTLSVC	PJOFFICE
1	4001	5	5	4	4
1	4002	5	5	4	4
1	4003	5	1	4	4
1	4004	4	5	3	3
1	4005	5	5	4	4
1	4006	5	5	4	4
1	4007	5	5	4	4
1	4008	5	5	5	5
1	4009	5	5	4	4
1	4010	5	5	4	4
1	4011	5	5	4	4
1	4012	5	1	4	4
1	4013	5	4	4	4
1	4014	5	5	5	5
1	4015	5	1	4	4
1	4016	5	1	4	4
1	4017	5	3	4	4
1	4018	5	1	4	4
1	4019	5	1	4	4

2.11 Travel Time to Core

The page "TravTime" is designed to provide a field favoring those TAZ that have a travel time advantage to core employment opportunities. As shorter travel time is preferred to long, the model uses the reciprocal (1/TT) of the travel time in calculation.

Currently the TravelTime field is filled with peak highway travel time to TAZ 10010 – a TAZ on the square in Center City Charlotte.

This field can be filled with any value. In an earlier version of LUSAM, the field contained a weighted sum of travel time to a set of designated core employment zones.

The column TravTime (col D) is the column used in the model.

Figure 2.11-1 Travel Time to Core Employment

Travel time to core employment
Currently - TAZ 10010 (Charlotte CBD)

District	TAZ	TT10010	TravTime
1	4001	73.56	0.0136
1	4002	74.89	0.0134
1	4003	75.21	0.0133
1	4004	74.30	0.0135
1	4005	71.75	0.0139
1	4006	71.72	0.0139
1	4007	72.84	0.0137
1	4008	72.20	0.0139
1	4009	70.01	0.0143
1	4010	74.78	0.0134
1	4011	72.85	0.0137
1	4012	69.74	0.0143
1	4013	70.01	0.0143
1	4014	76.63	0.0130
1	4015	77.26	0.0129
1	4016	78.44	0.0127
1	4017	76.67	0.0130

2.12 Define Model

The variables defined in earlier parts of this section are combined in the Model definition. Below the year table set early in the process are a number of district based tables to set up the model. Progressing down the page, you have

- Households and population
- Students
- MIWTCU and Education employment
- Retail and Highway Retail employment
- Hi-traffic and Low-traffic Service employment
- Office/government and Banking employment

A different model can be defined for each category. Each group has a similar format. Two to five variables are available for each group. The user assigns a percentage weight to each of the variables. Total percentages must add to 100%. The first field in each group (in black) is filled with the equation: 100% - ∑other percentages. Different districts may use different formulas to fill the output dataset. These weights are used to allocate the difference between the district target and the district base + pipeline.

2.12.1 <u>Households and Population</u>

Households and population are the top model table. District ID and names are filled automatically.

Figure 2.12-1 Household and Population Model

COEFFICIENTS		HOUSEHOLDS					Pop in Households				Pop in Group Qtrs.	
ResCoef	Offset	3	4	5	6	7	8	9	10	11	12	13
District	DistName	Old HH delta	Base HH*	Vacant Res	Plan Judge Res	TravTime to Core	Old PHH Delta	Base PHH*	PPH Taz**	PPH District Delta**	Old GRP delta	Base GRP*
1	Cleve-Shelby	100%	0%	0%	0%	0%	20%	20%	30%	30%	10%	90%
2	Cleve – SE	33%	5%	10%	12%	40%	100%	0%	0%	0%	0%	100%
3	Cleve – N	100%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%

Household allocation can use up to five variables

1. **Old HH delta** is the TAZ proportion of the district of the difference (growth) in households between InOldY1 and InOldY2 – previous TAZ allocations. This defaults to 100% of the model.
2. **Base HH** is a proportional allocation based on the TAZ proportion of existing HH within the district. This is a simple factor of the base + pipeline HH to equal the target.

3. **Vacant Res** uses the TAZ proportion of the district's vacant residential acres of the district
4. **Plan Judge Res** uses the TAZ proportion of the sum of Plan Judge Res for the district.
5. **Trav Time to Core** uses the TAZ proportion of the district's travel time to core employment variable.

Population in Households is dependent on Households and has a different set of coefficients

1. **Old PHH delta** is the TAZ proportion of the district of the difference (growth) in persons in households between InOldY1 and InOldY2 – previous TAZ allocations. This defaults to 100% of the model
2. **Base PHH** is a proportional allocation based on the TAZ proportion of existing Persons in Households within the district. This is a simple factor of the base + pipeline Pop_HH to equal the target.
3. **PPH TAZ** assigns the new households the same persons per household as exists in the TAZ base + pipeline. **Because this formula has nothing to do with targets, output TAZ persons in households will not necessarily add up to the target.**
4. **PPH District Delta** assigns the same persons per household to new households based on the delta between the district targets and the district base + pipeline.

Persons in Group Quarters are allocated using two variables

1. **Old GRP delta** is the TAZ proportion of the district of the difference (grownt) in persons in group quarters between InOldY1 and InOldY2 – previous TAZ allocatins. This defaults to 100% in the model
2. **Base GRP** is a proportional alloatin baed on the TAZ proportion of existing persons in group quarters within the district. This is a simple factor of the base + popeline Pop_GRP to equal the target

2.12.2 <u>Students</u>

Student allocation is the next table down. Each group (Stu_K8, Stu_HS, StuCU) employs the same three variables. The land use model expects student to be allocated to TAZ of school. In general, new schools should be located in specific TAZ using the pipeline tables. Additional growth can be allocated to existing schools – generally using the Base category.

Figure 2.12-2 Student Model

COEFFICIENTS		**Students: K- 8**			**Students: High School**			**Students: College/Univ.**		
ResCoef	Offset	3	4	5	6	7	8	9	10	11
District	DistName	Old K8 delta	Base K8*	Old HH delta	Old HS delta	Base HS*	Old HH delta	Old CU delta	Base CU*	Old HH delta

1. **Old Stu delta** is the TAZ proportion of the district of the difference (growth) in students between InOldY1 and InOldY2 – previous TAZ allocations. This defaults to 100% of the model.
2. **Base Stu** is a proportional allocation based on the TAZ proportion of existing students within the district. This is a simple factor of the base + pipeline to equal the target.
3. **Old HH delta** uses the TAZ proportion of households rather than student to allocate the new students.

2.12.3 MIWTCU and Education Employment

Manufacuturing, Industrial, Warehouse, Transportation, Communications and Utilities employment and Education employment is the next table below students
.

Figure 2.12-3 MIWTCU and Education Employment Model

MIWTCU : Mfg, Indust., Transp, Comm. Util. employment						**EDUC: Education employees**		
3	4	5	6	7	8	9	10	11
Old MIWTCU delta	Old TotEmp delta	Base MIWTCU*	Vacant NonRes	TravTime to Core	Plan Judge MIWTCU	Old EDUC delta	Tot Students delta	Base EDUC*

MIWTCU allocation can use up to six variables

1. **Old MIWTCU delta** is the TAZ proportion of the district of the difference (growth) in MIWTCU employment between InOldY1 and InOldY2 – previous TAZ allocations. This defaults to 100% of the model.
2. **Old TotEmp delta** is the TAZ proportion of the district of the difference (growth) in total employment between InOldY1 and InOldY2 – previous TAZ allocations
3. **Base MIWTCU** is a proportional allocation based on the TAZ proportion of existing MIWTCU employment within the district. This is a simple factor of the base + pipeline to equal the target.
4. **Vacant NonRes** uses the TAZ proportion of the district's vacant non-residential acres of the district
5. **TravTime to Core** uses the TAZ proportion of the district's travel time to core employment variable.
6. **Plan Judge MIWTCU** uses the TAZ proportion of the sum of Plan Judge MIWTCU for the district.

EDUC – Education employment allocation is based three variables The land use model expects students and EDUC employees to be allocated to TAZ of school. In general,

new schools should be located in specific TAZ using the pipeline tables. Additional growth can be allocated to existing schools – generally using the Base category.

1. **Old EDUC delta** is the TAZ proportion of the district of the difference (growth) in EDUC employment between InOldY1 and InOldY2 – previous TAZ allocations. This defaults to 100% of the model.
2. **Old Students delta** is the TAZ proportion of the district of the difference (growth) in students between InOldY1 and InOldY2 – previous TAZ allocations
3. **Base EDUC** is a proportional allocation based on the TAZ proportion of existing EDUC employment within the district. This is a simple factor of the base + pipeline to equal the target.

2.12.4 Retail and Highway Retail Employment

The model for Retail Employment and Highway Retail Employment allocation is the next table below the MIWTCU / EDUC table.

Figure 2.12-4 Retail and Highway Retail Employment Model

RTL : Retail employment						**HWY** : Highway Retail employment					
3	4	5	6	7	8	9	10	11	12	13	14
Old RTL delta	Old RTL/SVC delta^	Base RTL*	Vacant NonRes	TravTime to Core	Plan Judge SRVRTL	Old HWY delta	Old RTL/SVC delta^	Base HWY*	Vacant NonRes	TravTime to Core	Plan Judge SRVRTL

Retail (RTL) employment allocation can use up to six variables

1. **Old RTL delta** is the TAZ proportion of the district of the difference (growth) in RTL employment between InOldY1 and InOldY2 – previous TAZ allocations. This defaults to 100% of the model.
2. **Old RTL/SVC delta** is the TAZ proportion of the district of the difference (growth) in retail + service employment (RTL + HWY + LOSVC + HISVC) between InOldY1 and InOldY2 – previous TAZ allocations
3. **Base RTL** is a proportional allocation based on the TAZ proportion of existing retail employment within the district. This is a simple factor of the base + pipeline to equal the target.
4. **Vacant NonRes** uses the TAZ proportion of the district's vacant non-residential acres of the district
5. **TravTime to Core** uses the TAZ proportion of the district's travel time to core employment variable.
6. **Plan Judge SRVRTL** uses the TAZ proportion of the sum of Plan Judge Retail + Service category for the district.

Highway Retail (HWY) employment allocation can use up to six variables

1. **Old HWY delta** is the TAZ proportion of the district of the difference (growth) in HWY employment between InOldY1 and InOldY2 – previous TAZ allocations. This defaults to 100% of the model.
2. **Old RTL/SVC delta** is the TAZ proportion of the district of the difference (growth) in retail + service employment (RTL + HWY + LOSVC + HISVC) between InOldY1 and InOldY2 – previous TAZ allocations
3. **Base HWY** is a proportional allocation based on the TAZ proportion of existing HWY employment within the district. This is a simple factor of the base + pipeline to equal the target.
4. **Vacant NonRes** uses the TAZ proportion of the district's vacant non-residential acres of the district
5. **TravTime to Core** uses the TAZ proportion of the district's travel time to core employment variable.
6. **Plan Judge SRVRTL** uses the TAZ proportion of the sum of Plan Judge Retail + Service category for the district.

2.12.5 Lo-traffic Service and Hi-traffic Service Employment

The model for Lo-traffic Service (LOSVC) Employment and Hi-traffic Service (HISVC) Employment allocation is the next table below the RTL/HWY table.

Figure 2.12-5 Lo-traffic Service Employment and Hi-Traffic Service Employment Model

LOSVC : Low-traffic Service employment						**HISVC** : Hi-traffic Service employment					
3	4	5	6	7	8	9	10	11	12	13	14
Old LOSVC delta	Old RTL/SVC delta^	Base LOSVC*	Vacant NonRes	TravTime to Core	Plan Judge SRVRTL	Old HISVC delta	Old RTL/SVC delta^	Base HISVC*	Vacant NonRes	TravTime to Core	Plan Judge SRVRTL

Low-traffic Service (LOSVC) employment allocation can use up to six variables

1. **Old LOSVC delta** is the TAZ proportion of the district of the difference (growth) in LOSVC employment between InOldY1 and InOldY2 – previous TAZ allocations. This defaults to 100% of the model.
2. **Old RTL/SVC delta** is the TAZ proportion of the district of the difference (growth) in retail + service employment (RTL + HWY + LOSVC + HISVC) between InOldY1 and InOldY2 – previous TAZ allocations
3. **Base LOSVC** is a proportional allocation based on the TAZ proportion of existing LOSVCl employment within the district. This is a simple factor of the base + pipeline to equal the target.
4. **Vacant NonRes** uses the TAZ proportion of the district's vacant non-residential acres of the district
5. **TravTime to Core** uses the TAZ proportion of the district's travel time to core employment variable.

6. **Plan Judge SRVRTL** uses the TAZ proportion of the sum of Plan Judge Retail + Service category for the district.

Hi-traffic Service (HISVC) employment allocation can use up to six variables

1. **Old HISVC delta** is the TAZ proportion of the district of the difference (growth) in HISVC employment between InOldY1 and InOldY2 – previous TAZ allocations. This defaults to 100% of the model.
2. **Old RTL/SVC delta** is the TAZ proportion of the district of the difference (growth) in retail + service employment (RTL + HWY + LOSVC + HISVC) between InOldY1 and InOldY2 – previous TAZ allocations
3. **Base HISVC** is a proportional allocation based on the TAZ proportion of existing HISVC employment within the district. This is a simple factor of the base + pipeline to equal the target.
4. **Vacant NonRes** uses the TAZ proportion of the district's vacant non-residential acres of the district
5. **TravTime to Core** uses the TAZ proportion of the district's travel time to core employment variable.
6. **Plan Judge SRVRTL** uses the TAZ proportion of the sum of Plan Judge Retail + Service category for the district.

2.12.6 Office/Governmment and Banking Employment

The model for Office/Government (OFFGOV) employment and Banking (BANK) employment allocation is the next table below the LOSVC/HISVC table.

Figure 2.12-6 Office Government and Banking Employment Model

OFFGOV : Office / government employment						**BANK** : Banking employment					
3	4	5	6	7	8	9	10	11	12	13	14
Old OffGov delta	Old OFFGOV delta^	Base OffGov*	Vacant NonRes	TravTime to Core	Plan Judge Office	Old BANK delta	Old Office delta^	Base BANK*	Vacant NonRes	TravTime to Core	Plan Judge Office

Office / Government (OFFGOV) employment allocation can use up to six variables

1. **Old OFFGOV delta** is the TAZ proportion of the district of the difference (growth) in OFFGOV employment between InOldY1 and InOldY2 – previous TAZ allocations. This defaults to 100% of the model.
2. **Old Office delta** is the TAZ proportion of the district of the difference (growth) in Office employment (OFFGOV + BANK) between InOldY1 and InOldY2 – previous TAZ allocations
3. **Base OFFGOV** is a proportional allocation based on the TAZ proportion of existing OFFGOV employment within the district. This is a simple factor of the base + pipeline to equal the target.

4. **Vacant NonRes** uses the TAZ proportion of the district's vacant non-residential acres of the district
5. **TravTime to Core** uses the TAZ proportion of the district's travel time to core employment variable.
6. **Plan Judge Office** uses the TAZ proportion of the sum of Plan Judge Office category for the district.

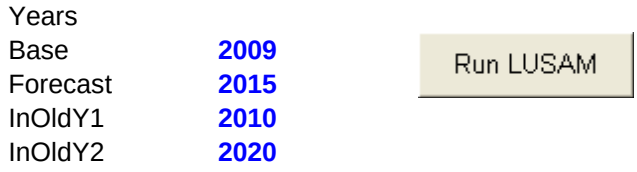
Banking (BANK) employment allocation can use up to six variables

1. **Old BANK delta** is the TAZ proportion of the district of the difference (growth) in BANK employment between InOldY1 and InOldY2 – previous TAZ allocations. This defaults to 100% of the model.
2. **Old Office delta** is the TAZ proportion of the district of the difference (growth) in Office employment (OFFGOV + BANK) between InOldY1 and InOldY2 – previous TAZ allocations
3. **Base BANK** is a proportional allocation based on the TAZ proportion of existing BANK employment within the district. This is a simple factor of the base + pipeline to equal the target.
4. **Vacant NonRes** uses the TAZ proportion of the district's vacant non-residential acres of the district
5. **TravTime to Core** uses the TAZ proportion of the district's travel time to core employment variable.
6. **Plan Judge Office** uses the TAZ proportion of the sum of Plan Judge Office category for the district.

2.13 Run LUSAM

At the top of the "Model" page, next to the year entry is a button. Push it. It may take a couple minutes to run through the calculations – mostly filling pivot tables on the page "Pivot". These tables are district totals which, in turn, are used to calculate TAZ percentages It will return to the "Model" page when complete.

Figure 2.13-1 Household and Population Model



3 Results

LUSAM creates a new TAZ dataset on the page “OutSE” and a set of district statistics comparing the output to targets and base. The output statistics on “OutStats” should be checked carefully to make sure the model operated as intended.

3.1 OutStats

The “Outstats” Page has six tables – each containing district summations

1. Target
2. OutSE
3. Target minus OutSE
4. Base
5. Pipeline
6. OutSE minus Base + Pipeline

Table 3 is particularly important to check for errors in model operations

3.1.1 Rounding error

Table 3 will likely have several small positive and negative values due to rounding error. Calculations are use floating point math, but the output TAZ data are rounded to integers. Some error is expected. Very small districts or large districts with very small changes may increase the magnitude of rounding errors.

3.1.2 Minimum (floor) error

A more important error may be created because LUSAM will not allow any category to be filled with negative households or jobs. In cases where a target is lower than the base + pipeline, the model may have insufficient available households or jobs to meet the target. These are usually found by large negative numbers in the Target minus OutSE dataset.

These errors usually point to a flaw in either the target or the base data. If both datasets are correct, and a decrease in a category is expected, you may want to use the pipeline page to remove a specific facility from a specific zone. If the decrease is an across the board drop, use the “Base XXX” category to factor the whole district downward.

Figure 3.1-1 provides an example of the Target minus OutSE table

Figure 3.1-1 OutStats – OutSE minus Target

E minus TARGET

ct	DistName	HH	POP	POP_HHS	POP_GRP	MIWTCU	RTL	HWY	LOSVC	HISRV	OFFGOV	BANK	EDUC	STU_K8	STU_HS	STU_C
	Cleve-Shelby	16	-1,287	-1,288	1	23	-9	8	-7	-13	9	3	0	1	1	
	Cleve – SE	-2	2	5	-3	-5	8	1	5	5	-4	1	0	-1	-1	
	Cleve – N	-1	2	2	0	-1	3	2	3	2	2	1	-5	1	-1	
	Iredell – S	-2	2	3	-1	-6	1	1	-3	-1	-1	1	-3	-1	0	
	Iredell – N	-1	-2	-2	0	2	41	1	-1	0	-1	1	0	1	0	
	Linc-E Central	11	-1	1	-1	278	1	-1	0	-1	-2	-1	1	1	-1	
	Linc-East	-2	-2	-3	1	-2	2	0	-1	0	-1	0	0	0	1	
	Linc-W Central	-4	-2	-3	1	0	-1	-1	-1	3	2	0	0	0	0	
	Linc-West	0	1	1	0	2	1	1	2	-1	1	1	-235	0	1	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	REGION	17	-1,288	-1,285	-3	292	47	11	-3	-7	5	5	-242	2	0	

3.2 OutSE

The output TAZ file is found on the page "OutSE". This page can be opened by TransCad and saved as a .dbf. If you have used less than 2,934 TAZ, delete all rows below the TAZ you used before saving as a .dbf. You can add more rows by copying the last row as many times as you need it (up to 2,934)

Household, population, employment and student files are filled from the model. Remaining fields (Dorm, Seq, Area, AreaLU, STCNTY) are copied from the Base file

3.2.1 MED_INC

Median household income is used in the generation model. If a base file TAZ had no households, but the TAZ gets households in the forecast dataset, then the TAZ is assigned the district median income.

$$MED_INC_{dist} = \sum(HH_{taz} * MED_INC_{taz}) / \sum HH_{taz}$$