What’s New? - Version 9.0.0

WFRC / MAG

2023-06-09

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# 1. Wasatch Front Travel Demand Model Documentation

The Wasatch Front Travel Demand Model (WF TDM) is a macro transportation model. It forecasts daily travel patterns based on household characteristics and where people live in relation to the location of their daily activites and transportation opportunities. Travel decisions are based on a series of models that are calibrated to travel behavior of Wasatch Front residents measured from household travel diary surveys. Trips are assigned to a set of highway or transit-system routes by time of day based on where and by what mode people are likely to travel and the best route available to them.

The travel demand models are able to evaluate transportation and traffic impacts resulting from:

* transportation improvements
* provision of new modes of travel and/or enhancement of existing alternative modes
* changes in land use activity
* changes in travel behavior or policies/economic circumstances affecting behavior

As such, travel demand output is used to forecast where future travel demand is likely to exceed capacity and to assess the merits of future transportation investments. Travel demand output is also used to analyze air quality and other ancillary impacts of the transportation system.

The current WF TDM covers Weber, Davis, Salt Lake, and Utah Counties and a portion of Box Eder County. The WF TDM is jointly owned by the Wasatch Front Regional Council (WFRC) and the Mountainland Association of Governments (MAG). To request a copy of the WF TDM, please contact the following persons:

* Suzie Swim (WFRC): sswim@wfrc.org
* Matt DeLora (MAG): mdelora@magutah.org

# 2. General Parameters

Changes made to the 0\_GeneralParameters.block file are discussed in this section.

## 2.1 Zone Parameters

The TAZ and highway node schema was changed in version 9. The following parameters were updated to reflect these changes.

### 2.1.1 TAZ

Note, the following TAZ parameters ranges were removed from the general parameters file in v9 as they were not being used in the WF TDM:

* RegionRange
* WFRCRange
* MAGRange

Table 2.1: Renumbered TAZ Ranges

| Parameter | v9 Value | v8 Value | Notes |
| --- | --- | --- | --- |
| UsedZones | 3629 | 2881 | Highest TAZ number used by model |
| BoxElderRange | 1-153 | 1-140 | Box Elder County Range |
| WeberRange | 154-581 | 141-423 | Weber County Range |
| DavisRange | 582-905 | 424-654 | Davis County Range |
| SLRange | 906-2216 | 655-1788 | Salt Lake County Range |
| UtahRange | 2217-3546 | 1789-2881 | Utah County Range |
| Dummyzones | 3547-3600 | 2882-3400 | Placeholder for future TAZ splits |
| Externalzones | 3601-3629 | 136-140, 421-423, 1782-1788, 2874-2881 | External zones |
| NorthBC | 3604-3606 | 138, 139, 140 | North Brigham City external zones |

### 2.1.2 Highway Nodes

Table 2.2: Renumbered Highway Nodes

| Parameter | v9Value | v8Value | Notes |
| --- | --- | --- | --- |
| HwyNodes | 10000-99999 | 3401-999999 | Highway and transit node range |

### 2.1.3 College Zones

Where noted, several colleges were effectively discontinued, meaning references to these schools are still in the code base, but enrollment was set to zero.

Table 2.3: Renumbered College Zones

| Area | Parameter | v9 Value | v8 Value | Notes |
| --- | --- | --- | --- | --- |
| WFRC Colleges | Ensign (was LDSBC) | 1029 | 950 | Ensign College |
|  | Westmin | 1263 | 1150 | Westminster College |
|  | UOFU\_Main | 1051 | 1075 | University of Utah - Main |
|  | UOFU\_Med | 1007 | 1076 | University of Utah - Medical (removed) |
|  | WSU\_Main (was WSU\_OGDEN) | 437 | 383 | Weber State University - Main |
|  | WSU\_Davis | 693 | 525 | Weber State University - Davis |
|  | WSU\_West | 521 | 290 | Weber State University - West (removed) |
|  | SLCC\_Main (was SLCC\_TL) | 1580 | 897 | Salt Lake Community College - Main |
|  | SLCC\_SC | 1231 | 1126 | Salt Lake Community College - South City |
|  | SLCC\_JD | 1776 | 1493 | Salt Lake Community College - Jordan |
|  | SLCC\_Mead |  | 1206 | Salt Lake Community College - Meadbrook (removed) |
|  | SLCC\_ML | 1886 | 1516 | Salt Lake Community College - Miller |
|  | SLCC\_LB | 1085 | 989 | Salt Lake Community College - Library (removed) |
|  | SLCC\_HL | 1525 | 1294 | Salt Lake Community College - Highland (removed) |
|  | SLCC\_Airp | 979 | 746 | Salt Lake Community College - Airport (removed) |
|  | SLCC\_West | 959 | 745 | Salt Lake Community College - Westpointe (removed) |
|  | SLCC\_HM | 2031 | 1607 | Salt Lake Community College - Herriman (removed) |
| MAG Colleges | BYU | 2939 | 2384 | Brigham Young University - Main |
|  | UVU\_Main | 2848 | 2326 | Utah Valley University - Main |
|  | UVU\_Geneva | 2882 | 2280 | Utah Valley University - Geneva (removed) |
|  | UVU\_Lehi (was UVU\_THANKP) | 2606 | 2099 | Utah Valley University - Lehi |
|  | UVU\_Vine | 2809 | 2259 | Utah Valley University - Vineyard |
|  | UVU\_Payson | 3336 | 2690 | Utah Valley University - Payson |

Table 2.4: Renumbered College Zones (continued)

| Parameter | v9Value | v8Value |
| --- | --- | --- |
| colleges | 437, 521, 693, 959, 979, 1007, 1029, 1051, 1085, 1231, 1263, 1491, 1525, 1580, 1776, 1886, 2031, 2606, 2809, 2848, 2882, 2939, 3336 | 290, 383, 525, 897, 950, 989, 1075, 1076, 1126, 1150, 1294, 1493, 1516, 1607, 2099, 2259, 2280, 2326, 2384, 2690 |

### 2.1.4 Zones with Off-line Trip Tables

Table 2.5: Renumbered Off-line Trip Table Zones

| Parameter | v9Value | v8Value |
| --- | --- | --- |
| Lagoon | 781 | 562 |
| Airport | 965 | 742 |

### 2.1.5 Special Generator Zones

Table 2.6: Renumbered Special Generator Zones

| Parameter | v9Value | v8Value |
| --- | --- | --- |
| TempleSquare | 1035 | 966 |
| SLC\_Library | 1147 | 1015 |

## 2.2 Exogenous Trip Table Parameters

Income break points for the airport exogenous trip table generation were updated to reflect 2019 base year income.

Table 2.7: Income Break Points for Airport Exogenous Trip Table Generation

| Parameter | v9Value | v8Value | Notes |
| --- | --- | --- | --- |
| Income\_Lo | $45,000 | $35,000 | breakpoint between Inc1 & Inc2 |
| Income\_Md | $75,000 | $70,000 | breakpoint between Inc2 & Inc3 |
| Income\_Hi | $125,000 | $100,000 | breakpoint between Inc3 & Inc4 |

## 2.3 Household Disaggregation Parameters

The regional median income was updated using 2019 5-year ACS data and kept in 2019 dollars to reflect 2019 base year. v8 was estimated from 2015 ACS data and deflated to 2010 dollars.

Table 2.8: Household Disaggregation Parameter Income Update

| Parameter | v9Value | v8Value |
| --- | --- | --- |
| Reg\_Median\_Inc | $74,946 | $58,793 |

## 2.4 Distribution, Mode Choice, and Assignment Parameters

### 2.4.1 K-Factors

K-factors were expanded by trip purpose to allow for more flexibility in calibrating distribution. All K-factors were reset to 1.

Table 2.9: Reset K-Factors

| Area | v9Parameter | v9Value | v8Parameter | v8Value |
| --- | --- | --- | --- | --- |
| between Salt Lake and Utah counties | SL\_UT\_KFAC\_Wrk | 1 | SL\_UT\_KFAC | 0.85 |
|  | SL\_UT\_KFAC\_Oth | 1 |  |  |
|  | SL\_UT\_KFAC\_Trk | 1 |  |  |
|  | SL\_UT\_KFAC\_Ext | 1 |  |  |
| between Salt Lake and Davis counties | SL\_DA\_KFAC\_Wrk | 1 | SL\_DA\_KFAC | 0.95 |
|  | SL\_DA\_KFAC\_Oth | 1 |  |  |
|  | SL\_DA\_KFAC\_Trk | 1 |  |  |
|  | SL\_DA\_KFAC\_Ext | 1 |  |  |
| between Box Elder and Weber counties | WE\_BE\_KFAC\_Wrk | 1 | WE\_BE\_KFAC | 1.00 |
|  | WE\_BE\_KFAC\_Oth | 1 |  |  |
|  | WE\_BE\_KFAC\_Trk | 1 |  |  |
|  | WE\_BE\_KFAC\_Ext | 1 |  |  |

### 2.4.2 Auto Occupancy

Auto or vehicle occupancy rates were expanded to include additional trips purposes and calculated based on the reprocessed 2012 Household Travel Survey. Values represent average persons per vehicle for just the Wasatch Front model space. External trips are average for IX + XI; all other parameters are averages for II trips.

Table 2.10: Vehicle Occupancy Rates

| v9Parameter | v9Value | v8Parameter | v8Value | Notes |
| --- | --- | --- | --- | --- |
| VehOcc\_HBW | 1.1 | VEH\_OCCUPANCY\_HBW | 1.1 | Home-Based Work |
| VehOcc\_HBShp | 1.63 | VEH\_OCCUPANCY\_HBSHP | 1.58 | Home-Based Shopping |
| VehOcc\_HBOth | 1.68 | VEH\_OCCUPANCY\_HBOTH | 1.66 | Home-Based Other |
| VehOcc\_HBSch | 1.76 | VEH\_OCCUPANCY\_HBSCH | 2.14 | Home-Based School |
| VehOcc\_HBC | 1.12 | VEH\_OCCUPANCY\_HBC | 1.26 | Home-Based College |
| VehOcc\_NHBW | 1.21 | VEH\_OCCUPANCY\_NHBW | 1.2 | Non-Home-Based Work |
| VehOcc\_NHBNW | 1.76 | VEH\_OCCUPANCY\_NHBNW | 1.7 | Non-Home-Based Non-Work |
| VehOcc\_Rec | 1.68 | (Uses HBO) | 1.64 | Recreation |
| VehOcc\_HBO | 1.67 | VEH\_OCCUPANCY\_HBO | 1.64 | Home-Based Other (HBShp+HBOth) |
| VehOcc\_NHB | 1.54 | VEH\_OCCUPANCY\_NHB | 1.48 | Non-Home-Based (NHBW+NHBNW) |
| VehOcc\_ExtWrk | 1.16 | (Uses HBW) | 1.1 | External Work |
| VehOcc\_ExtHBO | 1.82 | (Uses HBO) | 1.64 | External Home-Based Other |
| VehOcc\_ExtNHB | 1.73 | (Uses NHB) | 1.48 | Non-Home-Based |
| VehOcc\_ExtRec | 1.73 | (Uses HBO) | 1.64 | External Recreation |

Table 2.11: Vehicle Occupancy 3+ Rates

| v9Parameter | v9Value | v8Parameter | v8Value | Notes |
| --- | --- | --- | --- | --- |
| VehOcc\_3p\_HBW | 3.53 | VEH\_OCC\_3P\_HBW | 3.4 | 3+ Person Home-Based Work |
| VehOcc\_3p\_HBShp | 3.49 | (Uses HBO) | 3.55 | 3+ Person Home-Based Shopping |
| VehOcc\_3p\_HBOth | 3.73 | (Uses HBO) | 3.55 | 3+ Person Home-Based Other |
| VehOcc\_3p\_HBSch | 3.88 | (Uses HBO) | 3.55 | 3+ Person Home-Based School |
| VehOcc\_3p\_HBC | 3.24 | VEH\_OCC\_3P\_HBC | 3.53 | 3+ Person Home-Based College |
| VehOcc\_3p\_NHBW | 3.71 | (Uses NHB) | 3.51 | 3+ Person Non-Home-Based Work |
| VehOcc\_3p\_NHBNW | 3.71 | (Uses NHB) | 3.51 | 3+ Person Non-Home-Based Non-Work |
| VehOcc\_3p\_Rec | 3.73 | (Uses HBO) | 3.55 | 3+ Person Recreation |
| VehOcc\_3p\_HBO | 3.68 | VEH\_OCC\_3P\_HBO | 3.55 | 3+ Person Home-Based Other (HBShp+HBOth) |
| VehOcc\_3p\_NHB | 3.71 | VEH\_OCC\_3P\_NHB | 3.51 | 3+ Person Non-Home-Based (NHBW+NHBNW) |

### 2.4.3 Value of Time

Value of time parameters were updated using 2019 5-year ACS data and previous model assumptions and are in 2019 dollars. v8 parameters were calibrated to 2015 ACS data and deflated to 2010 dollars. Values of time are in cents/minute.

Table 2.12: Value of Time Rates

| v9Parameter | v9Value | v8Parameter | v8Value | Notes |
| --- | --- | --- | --- | --- |
| VOT\_Auto\_Wrk | 22 | VOT\_Auto\_Wrk | 18 | work trips (HBW) |
| VOT\_Auto\_Per | 17 | VOT\_Auto\_Per | 14 | non-work trips |
| VOT\_Auto\_Ext | 20 | VOT\_Auto\_Ext | 16 | external |
| VOT\_LT | 37 | VOT\_LT | 30 | light truck |
| VOT\_MD | 50 | VOT\_MD | 40 | medium truck |
| VOT\_HV | 63 | VOT\_HV | 50 | heavy truck |
| VOT\_Toll | 63 | VOT\_Toll | 50 | all vehicles on tollway |
| VOT\_HOT\_DA | 63 | VOT\_HOT\_DA | 50 | drive alone on HOT |
| VOT\_Auto\_Wrk\_Lo | 9 |  |  | work trips - low income (added) |
| VOT\_Auto\_Wrk\_Hi | 24 |  |  | work trips - high income (added) |
| VOT\_Auto\_Per\_Lo | 7 |  |  | non-work trips - loc income (added) |
| VOT\_Auto\_Per\_Hi | 19 |  |  | non-work trips - high income (added) |

### 2.4.4 Auto Operating Costs

Auto operating costs were updated to reflect 2019 fuel cost, average fuel economy, and cost of vehicle maintenance and are in 2019 dollars. v8 parameters were calibrated to 2015 data and deflated to 2010 dollars. Costs are in cents/mile.

Table 2.13: Auto Operating Cost Rates

| Parameter | v9Value | v8Value | Notes |
| --- | --- | --- | --- |
| AOC\_Auto | 21.7 | 18.3 | auto |
| AOC\_LT | 27.3 | 24.6 | light truck |
| AOC\_MD | 55.5 | 47.8 | medium truck |
| AOC\_HV | 74.3 | 63.7 | heavy truck |

### 2.4.5 Managed Lane Costs

Tolls on managed lanes were updated to reflect approximately a $5.00 toll for work trips and a $3.00 toll for non-work trips for tollways (FT=40) and approximately a $3.50 toll for work trips and $2.20 for non-work trips for HOT (FT=38) and reliability lanes. Distances of 10.25 miles (length of average work trip) and 6.5 miles (average length of all trips) were used to determine the work/non-work toll costs in cents per mile in 2019 dollars. Toll costs for v8 are in 2010 dollars.

Table 2.14: Managed Lane Cost Rates

| Parameter | v9Value | v8Value | Notes |
| --- | --- | --- | --- |
| Cost\_Toll\_Pk | 48 | 24 | Tollways (FT 40) cost - Peak |
| Cost\_Toll\_Ok | 48 | 24 | Tollways (FT 40) cost - Off-peak |
| Cost\_HOT\_Pk | 34 | 10 | HOT (FT 38) cost - Peak |
| Cost\_HOT\_Ok | 17 | 5 | HOT (FT 38) cost - Off-peak |
| Cost\_REL\_Pk | 34 | 10 | Reliability lane cost - Peak |
| Cost\_REL\_Ok | 17 | 5 | Reliability lane cost - Off-peak |

### 2.4.6 Core Bus Constant Multiplier

The parameter used to set the Core Bus constant was renamed and updated in v9.

Table 2.15: Core Bus Constant Multiplier

| v9Parameter | v9Value | v8Parameter | v8Value | Notes |
| --- | --- | --- | --- | --- |
| RAIL2COR\_MULTIPLIER | 0.33 | RAIL2BRT\_MULTIPLIER | 0.4 | factor to set Core Route constant relative to LRT constant |

### 2.4.7 CRT Adjustment Factors

The following parameters were added to adjust CRT ridership for Davis and Utah Counties. The parameters are applied in the mode choice utility calculation and represent a penalty/incentive in equivalent minutes.

* ADJ\_CONST\_UT = 0 ;place holder
* ADJ\_CONST\_CRT\_UT = -5 ;encourge CRT in UT County
* ADJ\_CONST\_CRT\_DA = 5 ;discourage CRT in Davis County
* ADJ\_CONST\_BRT = 0 ;place holder

### 2.4.8 Transit Fare Discount Factor

Added a transit fare discount factor to adjust transit fares in PT fare input file to calculate effective transit fares (effective fares include discounts for transit passes and other discounts). Transit fares are in v9 are encoded as the standard 2019 fares (in 2019 dollars). Fares in v8 are encoded as discounted 2015 fares deflated to 2010 dollars. The discounted fare in v8 was approximately 54% of the standard fare. This ratio was carried forward into v9.

* FARE\_DISCOUNT = 0.54

## 2.5 Removed Parameters

The following parameters were removed from the 0\_GeneralParameters.block file.

### 2.5.1 County Identification Parameters

The following county identification parameters are no longer used in v9 and were removed:

* CountyRange = ‘1-5’
* CountyName1 = ‘Weber’
* CountyName2 = ‘Davis’
* CountyName3 = ‘SaltLake’
* CountyName4 = ‘Utah’
* CountyName5 = ‘BoxElder’
* CO\_Name1 = ‘WE’
* CO\_Name2 = ‘DA’
* CO\_Name3 = ‘SL’
* CO\_Name4 = ‘UT’
* CO\_Name5 = ‘BE’

### 2.5.2 Air Quality Conformity Report Parameters

The following air quality conformity reporting parameters are no longer used in v9 and were removed:

* RE\_ID = 0 ;Entire region
* WE\_ID = 1 ;Weber
* DA\_ID = 2 ;Davis
* SL\_ID = 3 ;Salt Lake
* UT\_ID = 4 ;Utah
* BE\_ID = 5 ;BoxElder
* OC\_ID = 55980 ;Ogden
* SC\_ID = 67000 ;Salt Lake City
* PC\_ID = 62470 ;Provo

### 2.5.3 Bus Speed Ratios

Bus speed ratios were updated in v9 and bus speed ratio parameters are now input via a file. The following bus speed ratio parameters were removed from the 0\_GeneralParameters.block file:

* ratio\_fway = 0.95 ;bus speed to auto speed - freeways
* ratio\_ramp = 0.75 ;bus speed to auto speed - freeway ramps
* ratio\_part = 0.60 ;bus speed to auto speed - principal arterials
* ratio\_mart\_urbcbd = 0.55 ;bus speed to auto speed - minor arterials, urban/cbd
* ratio\_mart\_subrur = 0.65 ;bus speed to auto speed - minor arterials, suburban/rural
* ratio\_collector = 0.60 ;bus speed to auto speed - collectors
* minimum\_bus\_speed = 10.0 ;mph

### 2.5.4 Prefixes for Transit Skims

Prefixes to identify transit skim output files are coded directly into the scripts in v9. The following transit skim prefix parameters were removed from the 0\_GeneralParameters.block file:

* W\_LCL\_skims = ‘skm\_w4’ ;walk-to-local skims
* D\_LCL\_skims = ‘skm\_d4’ ;drive-to-local skims
* W\_BRT\_skims = ‘skm\_w5’ ;walk-to-BRT skims
* D\_BRT\_skims = ‘skm\_d5’ ;drive-to-BRT skims
* W\_EXP\_skims = ‘skm\_w6’ ;walk-to-express bus skims
* D\_EXP\_skims = ‘skm\_d6’ ;drive-to-express bus skims
* W\_LRT\_skims = ‘skm\_w7’ ;walk-to-light rail skims
* D\_LRT\_skims = ‘skm\_d7’ ;drive-to-light rail skims
* W\_CRT\_skims = ‘skm\_w8’ ;walk-to-commuter rail skims
* D\_CRT\_skims = ‘skm\_d8’ ;drive-to-commuter rail skims
* W\_mode9\_skims = ‘skm\_w9’
* D\_mode9\_skims = ‘skm\_d9’

### 2.5.5 Diurnal Factors

Diurnal factors were updated in v9 and diurnal factor parameters are now input via a file. The following diurnal factor parameters were removed from the 0\_GeneralParameters.block file:

% of trips in period

* HBW\_AM\_Pct = 0.3254
* HBW\_MD\_Pct = 0.1831
* HBW\_PM\_Pct = 0.3074
* HBW\_EV\_Pct = 0.1841
* HBC\_AM\_Pct = 0.2592
* HBC\_MD\_Pct = 0.3374
* HBC\_PM\_Pct = 0.1853
* HBC\_EV\_Pct = 0.2181
* HBSch\_AM\_Pct = 0.3784
* HBSch\_MD\_Pct = 0.2931
* HBSch\_PM\_Pct = 0.2941
* HBSch\_EV\_Pct = 0.0344
* HBShp\_AM\_Pct = 0.0192
* HBShp\_MD\_Pct = 0.4391
* HBShp\_PM\_Pct = 0.2496
* HBShp\_EV\_Pct = 0.2921
* HBOth\_AM\_Pct = 0.0997
* HBOth\_MD\_Pct = 0.3129
* HBOth\_PM\_Pct = 0.2367
* HBOth\_EV\_Pct = 0.3507
* NHBW\_AM\_Pct = 0.0697
* NHBW\_MD\_Pct = 0.5582
* NHBW\_PM\_Pct = 0.2597
* NHBW\_EV\_Pct = 0.1124
* NHBNW\_AM\_Pct = 0.0498
* NHBNW\_MD\_Pct = 0.4752
* NHBNW\_PM\_Pct = 0.2426
* NHBNW\_EV\_Pct = 0.2324
* IX\_AM\_Pct = 0.1786
* IX\_MD\_Pct = 0.3291
* IX\_PM\_Pct = 0.2604
* IX\_EV\_Pct = 0.2319
* XI\_AM\_Pct = 0.1786
* XI\_MD\_Pct = 0.3291
* XI\_PM\_Pct = 0.2604
* XI\_EV\_Pct = 0.2319
* XX\_AM\_Pct = 0.1786
* XX\_MD\_Pct = 0.3291
* XX\_PM\_Pct = 0.2604
* XX\_EV\_Pct = 0.2319
* TR\_AM\_Pct = 0.1590
* TR\_MD\_Pct = 0.3522
* TR\_PM\_Pct = 0.2274
* TR\_EV\_Pct = 0.2614
* HBO\_AM\_Pct = 0.0840
* HBO\_MD\_Pct = 0.3383
* HBO\_PM\_Pct = 0.2401
* HBO\_EV\_Pct = 0.3376
* NHB\_AM\_Pct = 0.0563
* NHB\_MD\_Pct = 0.5024
* NHB\_PM\_Pct = 0.2482
* NHB\_EV\_Pct = 0.1931

% of trips in PA direction

* HBW\_AM\_PA = 0.9706
* HBW\_MD\_PA = 0.5690
* HBW\_PM\_PA = 0.0871
* HBW\_EV\_PA = 0.2891
* HBC\_AM\_PA = 0.9828
* HBC\_MD\_PA = 0.5259
* HBC\_PM\_PA = 0.2420
* HBC\_EV\_PA = 0.1057
* HBSch\_AM\_PA = 0.7899
* HBSch\_MD\_PA = 0.4306
* HBSch\_PM\_PA = 0.2268
* HBSch\_EV\_PA = 0.2391
* HBShp\_AM\_PA = 0.7826
* HBShp\_MD\_PA = 0.5615
* HBShp\_PM\_PA = 0.4604
* HBShp\_EV\_PA = 0.4228
* HBOth\_AM\_PA = 0.7147
* HBOth\_MD\_PA = 0.5517
* HBOth\_PM\_PA = 0.5181
* HBOth\_EV\_PA = 0.3806
* NHBW\_AM\_PA = 0.5000
* NHBW\_MD\_PA = 0.5000
* NHBW\_PM\_PA = 0.5000
* NHBW\_EV\_PA = 0.5000
* NHBNW\_AM\_PA = 0.5000
* NHBNW\_MD\_PA = 0.5000
* NHBNW\_PM\_PA = 0.5000
* NHBNW\_EV\_PA = 0.5000
* IX\_AM\_PA = 0.8563
* IX\_MD\_PA = 0.5627
* IX\_PM\_PA = 0.3288
* IX\_EV\_PA = 0.3290
* XI\_AM\_PA = 0.8563
* XI\_MD\_PA = 0.5627
* XI\_PM\_PA = 0.3288
* XI\_EV\_PA = 0.3290
* XX\_AM\_PA = 0.8563
* XX\_MD\_PA = 0.5627
* XX\_PM\_PA = 0.3288
* XX\_EV\_PA = 0.3290
* TR\_AM\_PA = 0.5000
* TR\_MD\_PA = 0.5000
* TR\_PM\_PA = 0.5000
* TR\_EV\_PA = 0.5000
* HBO\_AM\_PA = 0.7283
* HBO\_MD\_PA = 0.5495
* HBO\_PM\_PA = 0.5050
* HBo\_EV\_PA = 0.3901
* NHB\_AM\_PA = 0.5000
* NHB\_MD\_PA = 0.5000
* NHB\_PM\_PA = 0.5000
* NHB\_EV\_PA = 0.5000

### 2.5.6 Assignment Type Flag

The assignment type parameter is no longer used in v9 and was removed:

* AssignType = ‘managed’

# 3. Input Data

Changes made to the 1\_Inputs folder are discussed in this section.

## 3.1 Global Data

This section includes the changes made within the 0\_GlobalData subfolder.

### 3.1.1 Trip Tables

The college base distribution file BaseDistribution.csv that contains the household locations of students in the base year was updated using new enrollment data sources. Enrollment totals by zip code for public schools were obtained from the Utah System of Higher Education (USHE). After assigning dormitory populations to TAZs based on group quarter data from the census, the remaining enrollment distributions were done using StreetLight origin-destination data with public schools being control at the zip-code level based on USHE enrollment data.

### 3.1.2 Household Disaggregation and Auto Ownership

The age percent lookup file Lookup - BYTAZAgePct - AllCo.csv used in household disaggregation was updated using parameters developed statewide based on 2020 census block data, 2020 ACS block group data, and 2019 population by age group data.

### 3.1.3 Mode Choice

The bus speed ratios in the model were further categorized and refined using actual bus speed data. The resulting bus speeds ratios were removed from the model scripts, as detailed in the *General Parameters* section, and included in a new bus speed ratios file bus\_speed\_ratios.csv. The ratios were estimated based on 2019 General Transit Feed Specification (GTFS) data, which includes scheduled time and stop locations for all bus routes. [Figure 3.1](#fig-pdf-old-bus-speeds-plot) shows the old bus speed ratios and [Figure 3.2](#fig-pdf-bus-speeds-plot) shows the updated bus speed ratios.

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| --- |
| Figure 3.1: Bus Speeds Plot - Version 8.3.2 |

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| Figure 3.2: Bus Speeds Plot - Version 9.0.0. |

### 3.1.4 Assignment

As described in the *General Parameters* section, diurnal and production/attraction factors were moved out of the 0\_GeneralParameters.block file to an input file. The factors are now found in the Diurnal & PA factors.csv file.

## 3.2 Traffic Analysis Zones (TAZ)

The TAZ zone set includes new geographies, TAZ numbering ranges, zone attributes, and districts, as well as a new \\_Source subfolder.

### 3.2.1 Geographies

Changes in TAZ geographies include both expansion of the model area and splitting and/or changing zone boundaries. The expanded model area now includes TAZs in additional portions of Box Elder County, all of western Weber County, and the entirety of Davis, Salt Lake and Utah Counties. External dummy zones (represented as quadrilaterals) were removed from the TAZ shapefile.

Additional area in the expanded WFRC and MAG areas include the following:

* Canyon areas of the Wasatch mountains up to the eastern boundary of Salt Lake, Utah, and Davis counties, and additionally the canyon areas up to eastern boundary of Box Elder County for the portion of Box Elder County that was in the v8.3.2 model.
* Canyon areas of the Wasatch mountains up to the ridge line of Weber County, excluding the Ogden Valley (Huntsville, Eden, Liberty) and other portions of eastern Weber County which remain in UDOT’s transportation planning jurisdiction.
* Canyon areas of the Oquirrh mountain range up to the western boundary of Salt Lake County
* Great Salt Lake areas to the western boundary of Salt Lake, Davis, and Weber counties

The additional areas and reconfigured TAZs result in 694 additional zones, 688 internal zones and 6 new external zones. A comparison of zone counts is found in [Table 3.1](#tbl-taz-count).

Table 3.1: TAZ Count Comparions

| Category | v9 | v8 | Difference |
| --- | --- | --- | --- |
| Internal Used Zones | 3,546 | 2,858 | 688 |
| External Count | 29 | 23 | 6 |
| All New Used Zones | 3,575 | 2,881 | 694 |
| Internal Unused Zones | 54 | 0 | 54 |
| Max Used Zone | 3,629 | 2,881 | 748 |

The map in [Figure 3.3](#fig-taz-compare-map-pdf) shows the difference in v9 and v8 TAZs.

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| --- |
| Figure 3.3: TAZ Geography Comparison Map |

### 3.2.2 TAZ Ranges

The new and previous internal and external ranges of TAZIDs by for each county are shown in [Table 3.2](#tbl-new-taz-ranges).

Table 3.2: TAZ Ranges

| County | v9.0.0 Internal | v9.0.0 External | v8.3.2 Internal | v8.3.2. External |
| --- | --- | --- | --- | --- |
| Box Elder County | 1-153 | 3601-3606 | 1-135 | 136-140 |
| Weber County | 154-581 | 3607-3609 | 141-420 | 421-423 |
| Davis County | 582-905 | N/A | 424-654 | N/A |
| Salt Lake County | 906-2216 | 3610-3615 | 655-1781 | 1782-1788 |
| Utah County | 2217-3546 | 3616-3629 | 1789-2873 | 2874-2881 |

### 3.2.3 Attributes

This section describes the changes made to the attributes of the TAZ shapefile.

#### 3.2.3.1 REMM Space

To indicate which TAZs are included in the Real Estate Market Model (REMM) space, the REMM field was added with a value of 1 indicating that it is part of REMM and 0 indicating it is not part of REMM, as shown in [Figure 3.4](#fig-taz-remm-space-pdf).

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| Figure 3.4: TAZ REMM Space |

#### 3.2.3.2 Parking Costs

Parking costs were updated based on 2022 parking rates obtained from Salt Lake City, web searches, and field visits. A new methodology for calculating parking cost was envisioned but not implemented for v9. Accordingly, updates to parking data were done in a way to facilitate the change to the new methodology in the future. These updates include a new polygon source file for downtown and university areas. However, since the envisioned methodology removes the use of parking cost fields for Lagoon and Salt Lake City International Airport, they were not included in this new shapefile.

##### 3.2.3.2.1 Downtown and University Areas

Parking costs were developed for downtown areas for Ogden, Salt Lake City, and Provo, as well as major university areas along the Wasatch Front. A new source polygon shapefile was developed to hold rates for Home-Based Work (HBW), Home-Based College (HBC), Home-Based Other (HBO), and Non-Home-Based (NHB) trip purposes. While rates are included for these four purposes, the v9.0.0 model only utilizes HBW for permanent parking and HBO for temporary parking. The future methodology will incorporate all four purposes.

##### 3.2.3.2.2 Lagoon and Salt Lake City International Airport

The Airport & Lagoon parking costs were updated based on current parking rate information and the assumptions described in this section.

The cost of permanent parking for the Lagoon TAZ was set to $0 based on the assumption that workers at Lagoon do not pay for parking. The temporary parking was set to $6 as calculated by dividing the 2022 advertised parking rate of $18 per day by an assumed average occupancy of 3 people per vehicle. The cost of temporary parking in previous models was $5 in 2010 dollars. The resulting $1 increase in 2019 dollars (20%) over 9 years seems reasonable.

The cost of permanent parking at the Salt Lake City International Airport was set to *$0* based on the assumption that workers at the airport do not pay for parking. The cost of temporary parking was set to $1.25 based on a weighted average of short-term premium and economy rates and drop offs and a assumed average vehicle occupancy rate.

The 2022 the cost for the short-term premium parking in the garage is $5.00 per hour. Short-term economy rate is $2.00 per hour. And for drop-offs there is no charge for parking. The assumed occupancy rate of 2 people per vehicle would result in per-person rates of $2.50, $1.00, and $0.00, respectively. The average of the three per-person rates is $1.75. Given the unknown distribution of travelers, but assuming more drop-offs than parking, a lower value than $1.75 should be expected. The 2019 cost was chosen to be $1.25.

Compared to the previous temporary parking values of $1 in 2010 dollars, the chosen cost represents a 25 cent increase in 2019 dollars (25%) over 9 years. This growth seems reasonable, especially given the recent improvements to the airport. Additional justification for the chosen increase is the [CPI adjustment](https://www.bls.gov/data/inflation_calculator.html), which for the 2010 value of $1.00 in results in a 2019 value of $1.18.

### 3.2.4 Small Districts

There are now 129 total small districts sequentially numbered from northwest to southeast in each medium district. The small district name field DSML\_NAME includes a prefix of Medium District index followed by a colon and then the sequential small district count (e.g. 15:1). Districts are shown in [Figure 3.5](#fig-districts-pdf). Two additional polygon shapefiles were added to the Districts subfolder to represent the Wasatch Front sub area and the REMM area.

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| Figure 3.5: Districts |

### 3.2.5 Source

The \_Source subfolder was added and includes the following shapefile data sets: Cities, Counties, Districts, and Environmental Constraints. Additionally, a ArcGIS Pro project & mapping files can be found in the \_\_ViewTAZDistricts subfolder.

## 3.3 Socioeconomic Data

Forecasts and control totals were updated based on new census data, updated base year parcel data, and the results of the REMM Model.

### 3.3.1 Forecasts

The SE forecasts were updated for the WFRC areas. Box Elder updates were taken from the UDOT SE Forecasts from June 8, 2022. The updated SE forecasts can be found using the [Household and Job Forecasts Web App](https://wfrc.org/household-job-forecast-map). This map only contains the latest forecast and not any iterative step, such as the SE datasets in the model folder. Click on the *View Advanced Version* link in the header to enable the “Changes” option where you can see the change in forecasts between v8.3.2 and v9.0.0.

### 3.3.2 Control Totals

Updates to the county control totals were made based on projections from the Gardner Policy Institute.

### 3.3.3 School Enrollment

The Kindergarten through 12th grade (K-12) enrollment data was updated using the 2019 statewide school enrollment database. This was done at the state-wide level and then applied to the Wasatch Front.

### 3.3.4 Median Income

Median income & value-of-time (VOT) inputs for the model were updated with 2019 data and used to update the TAZ Median Income in the TAZ file.

## 3.4 Highway Network

The highway network was expanded to incorporate the new model areas. See TAZ Geographies. The 2023 RTP fields have been updated to reflect the adopted 2023 RTP.

### 3.4.1 Highway Node Numbering Schema

Updates to the highway node numbering schema are shown in [Table 3.3](#tbl-master-network-node-numbering-schema). An additional reference file called \_Node Definition - v832 & v9.xlsx is found in the 3\_Highway folder.

Table 3.3: Master Network Node Numbering Schema

| MPO | Transit Nodes | Highway Nodes | v9 Expansion Areas |
| --- | --- | --- | --- |
| WFRC | 10,000 - 19,999 | 20,000 - 49,999 | 90,000 - 94,999 |
| MAG | 50,000 - 59,999 | 60,000 - 89,999 | 95,000 - 99,999 |

The highway network updates include the following:

* Updated Commuter-Rail Transit (CRT) Fare Zone
  + Vineyard & Orem stations were modified to have the same fare zone (similar to North Temple & Central)
  + Updated and fixed fare zone definitions in WFRC area
* Fixed small network error in Box Elder where a local road was drawn to the centroid of v8.3.2 TAZ 53
* A few edits to WFRC draft RTP project list
* Updated segment ids
  + Made consistent with the latest segment shapefile
  + Updated segments to account for recent network changes & add segment definitions to account for rail transit
* Added SEGEX\_RTP & SEGEX\_NEED as text fields (to be populated later when script/processing updated). These are segment ID exception fields where the future SEGIDs are different than existing SEGIDs.
* Phase change for Managed Motorways in WFRC area
* A couple of phasing updates from the WFRC RTP project list
* Cleaned up GIS23\_32 and GIS23\_42 fields
* Differentiated what projects will be built by 2028 from what will be built by 2023
* Rail SEGID additions were made to allow for easier transit result visualization.

Additionally, a MergedMasterNet - 2022-09-19a folder was added to serve as a workspace for editing and updating Merged Master Network and for exporting to v8.3.2 & v9 master networks.

## 3.5 Transit

The transit line files and CUBE Public Transport (PT) files were updated to correspond with the 2023 RTP:

* 2019 was thoroughly vetted to represent Aug 2019 change day
* 2023: updated route alignment, headways & stops based on August 2022 change day (WFRC & MAG)
* 2028: updated route alignment, headways & stops based on UTA 5-Year Service Plan (WFRC & MAG)
* RTP 2032, 2042 & 2050: rolled 2028 changes forward into plan phased years & updated based on 2023 draft plan
* Needs 2032, 2042 & 2050: rolled 2028 changes forward into plan phased years & updated based on 2023 draft plan

Route S902 was updated so route no longer go to the I-80 Parleys Canyon external node.

### 3.5.1 Public Transport (PT) Parameters

The fare files were updated with 2019 fare data. The fares were updated to match the actual advertised fares, whereas the v8.3.2 model contained a 46% adjustment fares. This reduction accounts for monthly pass, education, fare-pay, senior, employer paid, and other discounts. This adjustment is now explicitly defined, as was discussed in the *General Parameters* section.

### 3.5.2 General Hand-Coded Support Links

General\_hand\_coded\_walk\_links.NTL files were reviewed and updated.

### 3.5.3 Transit Route Tester

A route tester script was added in the \_chk Transit Compile on Net folder. The script checks to see if transit line files for the respective scenario compile on the scenario highway network. This can be used for reviewing transit line edits outside of the model stream.

## 3.6 Externals

External locations and forecasts were updated. The locations of the former and updated location of externals is shown in [Figure 3.6](#fig-externals-pdf). Forecasts through 2060 were generated for the updated external locations using historical data through 2019.

|  |
| --- |
| Figure 3.6: v9 External Description. |

The updated numbering scheme can be found in [Figure 3.7](#fig-descrip1), [Figure 3.8](#fig-descrip2), and [Figure 3.9](#fig-descrip3).

|  |
| --- |
| Figure 3.7: v9 External Description. |

|  |
| --- |
| Figure 3.8: v8.3.2 External Description. |

|  |
| --- |
| Figure 3.9: v9 & v8.3.2 External Description. |

## 3.7 Segment

The Master\_Segs\_withFactors\_20220915.shp file contains the updated segments to align with 2023 RTP network changes. Additional segments for rail transit corridors were added in the Wasatch Front area.

# 4. Input Processing

Changes made to the 2\_ModelScripts\0\_InputProcessing folder are discussed in this section.

Global changes made to all the scripts in this folder included modifications to the script to account for removal of the CITY, COUNTY, and EXTERNAL fields from the TAZ shapefile and updates to use true shape link and node shapefiles.

## 4.1 Setup

The folder setup routine was integrated into the HailMary.s script to run automatically. It is no longer necessary to copy empty folders or run the \_CreateOutputFolders.s prior to running the model .

## 4.2 SE Processing

The 1\_DemographicsAnalysis.s script was updated to read   
ControlTotal\_SE\_AllCounties.csv. Weber County contains two sets of indexes bus on whether it is the UDOT Subarea 9057 or the Wasatch Front Subarea 9157.

## 4.3 Network Processing

A bug in the Connected-and-Autonomous Vehicle (CAV) calculation was fixed where the column index was needed to be incremented by 1 to link up with lookup tables.

The hard-coded turn penalty node numbers in the 3\_TurnPenalty.s script were updated to the new master network node numbering.

## 4.4 Time of Day Factors

A new file 1\_CalculateTimeOfDayFac.s is created during the model that includes time of day factors for use in following scripts.

# 5. Household Disaggregation and Auto Ownership

The 1\_LifeCycle.s script was modified to account for removal of the COUNTY field from the TAZ shapefile and for the removal of county-specific id variables from 0\_GeneralParameters.block.

# 6. Distribution

Changes made to the 2\_ModelScripts\3\_Distribute folder are discussed in this section. The changes described in this section were made exclusively in the 1\_Distribution.s script.

## 6.1 Convergence

The convergence criteria was updated for trip table and link convergences, as well as the check criteria.

### 6.1.1 Trip Table Convergence

For trip table convergence, the percent change threshold was reduced from 10% to 7.5%. For each iteration, only cells where the trips in the current iterations are greater than zero are considered. Cells with trips greater than zero are counted as significant trips and form the denominator in the percent converged calculation.

The trip matrix cell is considered converged if:

1. Percent change from previous iteration is within 7.5%, or
2. Trips from the current iteration are less than 1

With the exception that the cell is not converged if the trips from the current iteration are greater than zero and the trips from the previous iteration equals zero.

### 6.1.2 Link Convergence

For link volume convergence, the percent change threshold was increased from 5% to 7.5%. Centroid connectors are not considered when determining convergence. For each iteration, only cells where the trips in the current iterations are greater than zero are considered. Cells with trips greater than zero are counted as significant trips and form the denominator in the percent converged calculation.

The link is considered converged if:

1. Percent change from previous iteration is within 7.5%, or
2. Volume from current iteration equals zero and volume from previous iteration equals zero.

With the exception that the link is not converged if:

1. Volume from the current iteration is greater than zero and the volume from the previous iteration equals zero, or
2. Volume from the current iteration is zero and the volume from the previous iteration is greater than zero.

### 6.1.3 Check Criteria

The convergence check criteria was updated. The minimum of 5 iterations requirement was removed. The RGAP parameter passthrough variable was from moved from the block file to main script just before each assignment call. The EV RGAP parameter is set to the 0GeneralParameters.block value divided by 10.

## 6.2 Reports

The initializing and logging of trip, vehicle-miles traveled (VMT), and vehicle-hours traveled (VHT) variables were removed from the log file. The trip table and link convergence reports in the log file were updated.

The following new reports were added to better track convergence:

* \_Stats - Distrib Assign - @RID@.csv
* \_Stats - Distrib Loaded Net - @RID@.csv
* \_Stats - Distrib Trip Table - @RID@.csv

## 6.3 Other

A @unloadednetprefix@\_@n@\_convg.net file was added to Temp\3\_Distribute folder. It includes following fields (li.1=current iteration, li.2=previous iteration):

* AM\_Cur = li.1.AM\_VOL
* MD\_Cur = li.1.MD\_VOL
* PM\_Cur = li.1.PM\_VOL
* EV\_Cur = li.1.EV\_VOL
* DY\_Cur = li.1.DY\_VOL
* AM\_Pre = li.2.AM\_VOL
* MD\_Pre = li.2.MD\_VOL
* PM\_Pre = li.2.PM\_VOL
* EV\_Pre = li.2.EV\_VOL
* DY\_Pre = li.2.DY\_VOL
* AM\_Diff = AM\_Cur - AM\_Pre
* MD\_Diff = MD\_Cur - MD\_Pre
* PM\_Diff = PM\_Cur - PM\_Pre
* EV\_Diff = EV\_Cur - EV\_Pre
* DY\_Diff = DY\_Cur - DY\_Pre
* AM\_PctDiff = ABS(AM\_Diff) / AM\_Pre
* MD\_PctDiff = ABS(MD\_Diff) / MD\_Pre
* PM\_PctDiff = ABS(PM\_Diff) / PM\_Pre
* EV\_PctDiff = ABS(EV\_Diff) / EV\_Pre
* DY\_PctDiff = ABS(DY\_Diff) / DY\_Pre
* CONVLINK (if (DY\_PctDiff<=\_ConvThreshold) CONVLINK = 1)

# 7. Mode Choice

Changes made to the 2\_ModelScripts\4\_ModeChoice folder are discussed in this section. Updates to the mode choice portion of the model include transit skims and district summaries.

## 7.1 Transit Skims

Modifications to the transit skim script were made to incorporate the new bus speeds input file.

## 7.2 District Summaries

The district summary script was modified to change COUNTY field references to CO\_FIPS for county summaries due to removal of field from TAZ shapefile.

# 8. Highway Assignment

The summarize loaded networks script was modified to point the geometry input reference to the input processing output folder instead of the highway inputs folder.