Detroit Water and Sewerage Department

# Wastewater Master Plan

DWSD Project No. CS-1314

# Year 2050 Population and Employment Projections

**Technical Memorandum**
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CDM

Task A.3.b – Establish Population Projections

This document contains the following sections:

- 2030 RFT Extension to 2050
- 2030 RDF Extension to 2050, by TAZ
- 2030 RDF Employment by Industrial Class Extended to 2050, by County
- SEMCOG 2030 Regional Development Forecast (RDF) Extended to 2050, by County

# 2030 RFT Extension to 2050

**February 2002**

**Abstract**
This document describes the technical procedures used to extend 2030 Regional Forecast Totals (RFT, including population, households, and employment) by five year intervals to 2050.

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*SEMCOG* Data Center Technical Documentation

O:/Obiero/2050RFTs/2030RFTto2050.wpd

**2030 RFT Extension to 2050**

**Purpose**
To produce regional 2050 totals by five year intervals that can be used to control 2030 RDF extended to 2050 RDF TAZ figures.

**Data Input**
- 2030 REMI Output
  - -Births
  - -Deaths
  - -Net International and Domestic Migration
  - -Population by Age
- 2050 Middle Series US Population Projection
  - -Births
  - -Deaths
  - -Net International and Domestic Migration
- 2025 US Labor Force Participation Rates
  - -Aged 16-64 Labor Force Participation Rates
  - -Aged 65+ Labor Force Participation Rates
- Five-year-survival rates from Michigan State Life Table (this is the proportion of population of a given age group that survives for the next five years).

**Overview**
2030 population total at the regional level is extended to 2050 using the component procedures: births, deaths and net migration. All these data come from the original REMI output. Then group quarters population is extended to 2050 based largely on the changes due population aged 65 and above. Persons per household from 2030 is also extended to 2050. Once we have extended group quarters population and persons per household 2050 total number of households is derived from 2050 total population. It is believed that extending group quarters population and persons per households reduces the magnitude of errors when total number of households is directly extended to 2050.
Extension of total employment to 2050 was done by (1) cohort-component method (2) extending labor participation rates from 2025 to 2050, and (3) extending jobs-to-worker ratio from 2030 to 2050.

**Process for Extending Total Population**

Step 1: Extending Natural Increase
REMI output has a time series data on natural increase that can be used to fit a linear trend over time. The nation's 2050 middle series population projection also has future time series data on

natural increase for the whole country. The region's 2030 natural increase from REMI was expressed as a proportion of the country's natural increase. It is the trend of the region's proportion of natural increase to the whole country that was extended to 2050 assuming linearity. Once these proportions are extended to 2050, they are multiplied by the nation's 2050 natural increase data to generate the region's natural increase for each forecast year: 2035, 2040, 2045, and 2050. Appendix A shows the details of the extension. Separate births and deaths extension were done to check on the extended natural increase.

Step 2: Extending Net International Migration
Both US net international migration and region's net international migration (REMI output) were used to extend the region's net international migration to 2050. The 2030 net international migration data were expressed as a proportion of the nation's net international migration. The proportions were then extended to 2050 assuming linearity. Once these proportions were extended to 2050, they were multiplied by the nation's 2050 net international migration data to generate the region's net international migration for each year: 2035, 2040, 2045, and 2050. Appendix A shows the details of the extension.

Step 3: Extending Net Domestic Migration
This step uses only the 2030 REMI output on net domestic migration which are then extended to 2050.

Step 4: Computing Total Population
Since we have all the components (natural increase, net international and domestic migration) extended to 2050, population total for each year was computed as follows:

$P_{2035}=P_{2030} + NI_{2030\text{-}2035} + \text{Net } I_{2030\text{-}2035} + \text{Net } DI_{2030\text{-}2035}$

$P_{2040}= P_{2035} + NI_{2035\text{-}2040} + \text{Net } I_{2035\text{-}2040} + \text{Net } DI_{2035\text{-}2040}$

$P_{2045}=P_{2040} + NI_{2040\text{-}2045} + \text{Net } I_{2040\text{-}2045} + \text{Net } DI_{2040\text{-}2045}$

$P_{2050}=P_{2045} + NI_{2045\text{-}2050} + \text{Net } I_{2045\text{-}2050} + \text{Net } DI_{2045\text{-}2050}$

P=Total Population

NI=Natural Increase (Births-Deaths)

Net I=Net International Migration

Net DI=Net Domestic Migration

**Process for Extending Group Quarters Population**

Step 5: Year 2000 to 2030 group quarters population numbers were extended to 2050 based on increasing trend.

**Process for extending Persons Per Household**

Step 6: Based on 2000-2030 RDF trend of persons per household declining by either 0.02 or 0.04, persons per household was declined by 0.02 every five years to 2045 and then declined by 0.01 to 2050 assuming that after 2045 the rate of decline in persons per household will eventually stabilize around 2.28.

Step 7: Calculating number of households for 2035, 2040, 2045, and 2050. The group quarters population was deducted from the total population to get household population for the four years listed above. Household population was then converted to number of households by dividing household population with persons per household.

The results of steps 1 to 7 are presented in the following table.

| | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|
| **Total Population** | 5,491,042 | 5,573,220 | 5,648,338 | 5,716,010 |
| **Total Households** | 2,304,804 | 2,355,861 | 2,404,250 | 2,438,354 |
| **Group Quarters** | 120,848 | 131,180 | 142,605 | 156,564 |
| **Persons Per Household** | 2.33 | 2.31 | 2.29 | 2.28 |

**Process for extending Total Employment**

Step 1: Establish Household Base population by five-year age groups. For this purpose RFT for the year 2030 is the base population. To get 2030 household population by age, 2030 total group quarters population was distributed to various age groups according to percent distribution of 2000 census group quarters population by age groups.

Step 2: Obtain age-specific five-year survival rates from Michigan Life Table. The survival rates for age groups 65+ were adjusted upwards by 2.5 percent under the assumption that significant improvements on mortality will occur only at these age groups.

Step 3: Multiply age-specific survival rate with its age-specific base population to project household population after five year period. For example, to get 2035 population aged 5 to 9, we multiplied 2030 population aged 0-4 by its five-year survival rates. Appendix B shows the details of this procedure.

Step 4: From step 3, obtain population aged 16-64 and 65+ for the forecast years 2035, 2040, 2045 and 2050. Survival rates procedure shown in Appendix B produces population aged 15-64 years. To get the required 16-64, we multiplied age 15-64 by the proportion of age 16-64 to age 15-64 based on REMI output.

Step 5: Use migration data from steps 2 and 3 under total population section to account for migration impact on age groups 16-64 and 65+. INS 1999 data by age was used to split the net total international migrants into age groups <16, 16-64, and 65+. Appendix B shows the result of this procedure.

Step 6: Obtain labor force participation rates for age groups 16-64 and 65+ from a book entitled *"Demographics of the US: Trends and Projections"* by Cheryl Russel (2000). Labor force participation rates are from 2000 to 2025. Extend these labor force participation rates linearly to 2050.

Step 7: Labor force participation rates are multiplied by population 16-64 and 65+ separately to produce number of people in labor force for each age group. The result from this step should be number in labor force 16-64 and 65+ for each year since 2000 to 2050.

Step 8: Calculate the ratio of jobs-to-worker by dividing total employment with number in labor force. This is only possible for years 2000 to 2030.

Step 9: The ratios obtained in step 8 above were extended to 2050 by allowing a 1.0 percentage growth, assuming more secondary jobs in the future.

Step 10: Convert the number in labor force to total employment by multiplying number in labor force with the ratios developed in steps 8 and 9. Appendix B shows the result of this procedure.

Component Method for Extending Total Population from 2030 to 2050

| Time Period | Natural Increase | | | | International Migration | | | Domestic Migration |
|---|---|---|---|---|---|---|---|---|
| | 2050 US Natural Increase | 2030 SEMCOG Natural Increase | Extended Proportions of SEMCOG to US Natural Increase | Extended 2050 SEMCOG Natural Increase | 2050 US Net International Migration | Extended Proportions of SEMCOG to US Net Int. Migration | Extended 2050 SEMCOG Net Int. Migration | Extended 2050 SEMCOG Net Dom. Migration |
| 00-05 | 7,651,296 | 103,770 | 0.0135624083 | 103,770 | 4,788,515 | 0.009775473 | 46,810 | -64,290 |
| 05-10 | 8,090,495 | 98,820 | 0.0122143330 | 98,820 | 4,070,364 | 0.013331732 | 54,265 | -66,980 |
| 10-15 | 8,717,556 | 91,370 | 0.0104811486 | 91,370 | 3,640,897 | 0.018513295 | 67,405 | -71,950 |
| 15-20 | 8,920,391 | 76,560 | 0.0085825834 | 76,560 | 3,735,178 | 0.016569491 | 61,890 | -45,330 |
| 20-25 | 8,729,242 | 64,165 | 0.0073505810 | 64,165 | 4,112,496 | 0.016875396 | 69,400 | -36,090 |
| 25-30 | 8,332,012 | 56,375 | 0.0067660728 | 56,375 | 4,891,297 | 0.015379356 | 75,225 | -35,195 |
| 30-35 | 8,015,403 | | 0.0051777904 | 41,502 | 5,272,661 | 0.015068293 | 79,450 | -31,195 |
| 35-40 | 7,899,483 | | 0.0035895111 | 28,355 | 5,146,454 | 0.015950627 | 82,089 | -28,267 |
| 40-45 | 7,983,674 | | 0.0020012319 | 15,977 | 5,056,140 | 0.016840603 | 85,148 | -26,007 |
| 45-50 | 8,269,360 | | 0.0004129526 | 3,415 | 4,987,367 | 0.017735393 | 88,453 | -24,196 |

**Extended Total Population**

| Year | Total Population | Numerical change |
|---|---|---|
| 2030 | 5,401,285 | |
| 2035 | 5,491,042 | 89,757 |
| 2040 | 5,573,220 | 82,177 |
| 2045 | 5,648,338 | 75,119 |
| 2050 | 5,716,010 | 67,672 |

Appendix B-Basic Table for Extending Employment to 2050

| | 2030 Hholdpop (Base Population) | Survival Rates (Michigan Life Table) | Projected 2035 Population | Projected 2040 Population | Projected 2045 Population | Projected 2050 Population |
|---|---|---|---|---|---|---|
| **Five Year Births** | **328,233** | **0.99803** | | | | |
| Age 0 - 4 years | 324,236 | 0.998088496 | 327,586 | | | |
| Age 5-9 Years | 319,469 | 0.998859007 | 323,616 | 326,960 | | |
| Age 10-14 Years | 318,623 | 0.997200056 | 319,104 | 323,247 | 326,587 | |
| Age 15-19 Years | 326,933 | 0.994860495 | 317,731 | 318,211 | 322,342 | 325,673 |
| Age 20-24 Years | 316,644 | 0.994547622 | 325,253 | 316,098 | 316,575 | 320,685 |
| Age 25 - 29 Years | 321,788 | 0.993806229 | 314,918 | 323,480 | 314,374 | 314,849 |
| Age 30 - 34 Years | 320,804 | 0.991971578 | 319,795 | 312,967 | 321,476 | 312,427 |
| Age 35 - 39 Years | 330,444 | 0.989292933 | 318,229 | 317,228 | 310,455 | 318,895 |
| Age 40 - 44 Years | 325,760 | 0.984610032 | 326,906 | 314,822 | 313,831 | 307,130 |
| Age 45 - 49 Years | 320,304 | 0.976266192 | 320,747 | 321,875 | 309,977 | 309,001 |
| Age 50 - 54 Years | 292,134 | 0.962210016 | 312,702 | 313,134 | 314,235 | 302,620 |
| Age 55 - 59 Years | 316,462 | 0.941585738 | 281,095 | 300,885 | 301,301 | 302,360 |
| Age 60 - 64 Years | 310,313 | 0.911199024 | 297,976 | 264,675 | 283,309 | 283,701 |
| Age 65 - 69 Years | **338,652** | 0.889763337 | 282,757 | 271,515 | 241,171 | 258,151 |
| Age 70 - 74 Years | **305,470** | 0.869609402 | **301,320** | 251,587 | 241,584 | 214,585 |
| Age 75 - 79 Years | **235,016** | 0.858836699 | **265,640** | **262,031** | 218,782 | 210,084 |
| Age 80 - 84 Years | **148,664** | 0.775729669 | **201,840** | **228,141** | **225,042** | 187,898 |
| Age 85 and older | 118,563 | | **115,323** | **156,573** | **176,976** | **174,572** |
| Pop15-64 | 3,181,587 | | 3,135,350 | 3,103,373 | 3,107,875 | 3,097,342 |
| Pop65ov | 1,146,365 | | 1,166,880 | 1,169,848 | 1,103,556 | 1,045,290 |
| Adjusted 16-64 | 3,113,883 | | 3,068,630 | 3,037,333 | 3,041,739 | 3,031,430 |
| Migration | | | 2030-2035 | 2035-2040 | 2040-2045 | 2045-2050 |
| **Net International** | | | **79,450** | **82,089** | **85,148** | **88,453** |
| 16-64 | | | 58,952 | 60,910 | 63,180 | 65,632 |
| ag65ov | | | 3,973 | 4,104 | 4,257 | 4,423 |
| **Net Domestic** | | | **-31,195** | **-28,267** | **-26,007** | **-24,196** |
| 16-64 | | | -9,183 | -6,158 | -3,637 | -1,445 |
| ag65ov | | | -18,821 | -19,968 | -21,106 | -22,249 |
| Final 16-64 | | | 3,118,399 | 3,092,085 | 3,101,282 | 3,095,617 |
| Final ag65ov | | | 1,152,032 | 1,153,984 | 1,086,707 | 1,027,464 |

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| Age 30 - 34 Years | 320,804 | 0.991971578 | 319,795 | 312,967 | 321,476 | 312,427 |
| Age 35 - 39 Years | 330,444 | 0.989292933 | 318,229 | 317,228 | 310,455 | 318,895 |
| Age 40 - 44 Years | 325,760 | 0.984610032 | 326,906 | 314,822 | 313,831 | 307,130 |
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| Age 50 - 54 Years | 292,134 | 0.962210016 | 312,702 | 313,134 | 314,235 | 302,620 |
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| Age 60 - 64 Years | 310,313 | 0.911199024 | 297,976 | 264,675 | 283,309 | 283,701 |
| Age 65 - 69 Years | **338,652** | 0.889763337 | 282,757 | 271,515 | 241,171 | 258,151 |
| Age 70 - 74 Years | **305,470** | 0.869609402 | **301,320** | 251,587 | 241,584 | 214,585 |
| Age 75 - 79 Years | **235,016** | 0.858836699 | **265,640** | **262,031** | 218,782 | 210,084 |
| Age 80 - 84 Years | **148,664** | 0.775729669 | **201,840** | **228,141** | **225,042** | 187,898 |
| Age 85 and older | 118,563 | | **115,323** | **156,573** | **176,976** | **174,572** |
| Pop15-64 | 3,181,587 | | 3,135,350 | 3,103,373 | 3,107,875 | 3,097,342 |
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| Adjusted 16-64 | 3,113,883 | | 3,068,630 | 3,037,333 | 3,041,739 | 3,031,430 |
| Migration | | | 2030-2035 | 2035-2040 | 2040-2045 | 2045-2050 |
| **Net International** | | | **79,450** | **82,089** | **85,148** | **88,453** |
| 16-64 | | | 58,952 | 60,910 | 63,180 | 65,632 |
| ag65ov | | | 3,973 | 4,104 | 4,257 | 4,423 |
| **Net Domestic** | | | **-31,195** | **-28,267** | **-26,007** | **-24,196** |
| 16-64 | | | -9,183 | -6,158 | -3,637 | -1,445 |
| ag65ov | | | -18,821 | -19,968 | -21,106 | -22,249 |
| Final 16-64 | | | 3,118,399 | 3,092,085 | 3,101,282 | 3,095,617 |
| Final ag65ov | | | 1,152,032 | 1,153,984 | 1,086,707 | 1,027,464 |

Appendix B (Cont)--Extending Total Employment from 2030 to 2050

| | | 16-64 | | 65+ | | Number In Labor Force | | | | Ratio of | Employment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Household** Population | 16-64 Household Population | Participation Rates | Household Population | Participation rates | 16-64 In Labor Force | 65+ In Labor Force | Total Labor Force | Employment | Jobs to Worker | Numerical Change |
| 2000 | 4,752,063 | 3,077,676 | 0.760 | 541,827 | 0.1250 | 2,339,034 | 67,728 | 2,406,762 | 2,673,710 | 1.11092 | |
| 2005 | 4,853,894 | 3,267,648 | 0.770 | 579,911 | 0.1345 | 2,516,089 | 77,998 | 2,594,087 | 2,785,155 | 1.07366 | 111,445 |
| 2010 | 4,948,262 | 3,321,279 | 0.780 | 639,738 | 0.1450 | 2,590,598 | 92,762 | 2,683,360 | 2,894,486 | 1.07868 | 109,331 |
| 2015 | 5,042,473 | 3,301,271 | 0.782 | 747,112 | 0.1500 | 2,581,594 | 112,067 | 2,693,660 | 2,986,444 | 1.10869 | 91,958 |
| 2020 | 5,123,709 | 3,230,523 | 0.781 | 889,121 | 0.1500 | 2,523,038 | 133,368 | 2,656,406 | 3,038,407 | 1.14380 | 51,963 |
| 2025 | 5,208,301 | 3,158,958 | 0.780 | 1,034,570 | 0.1500 | 2,463,987 | 155,186 | 2,619,173 | 3,069,981 | 1.17212 | 31,574 |
| 2030 | 5,290,280 | 3,113,883 | 0.788 | 1,146,365 | 0.1500 | 2,454,145 | 171,955 | 2,626,099 | 3,113,129 | 1.18546 | 43,148 |
| 2035 | 5,370,194 | 3,118,399 | 0.790 | 1,152,032 | 0.1500 | 2,462,316 | 172,805 | 2,635,121 | 3,142,964 | 1.19272 | 29,835 |
| 2040 | 5,442,040 | 3,092,085 | 0.793 | 1,153,984 | 0.1508 | 2,453,423 | 173,963 | 2,627,386 | 3,176,082 | 1.20884 | 33,118 |
| 2045 | 5,505,733 | 3,101,282 | 0.797 | 1,086,707 | 0.1515 | 2,472,639 | 164,640 | 2,637,280 | 3,204,857 | 1.21521 | 28,775 |
| **2050** | **5,559,446** | 3,095,617 | 0.801 | 1,027,464 | 0.1523 | 2,480,021 | 156,443 | 2,636,464 | 3,230,701 | 1.22539 | 25,844 |

# 2030 RDF Extension to 2050, by TAZ

February 2002


## Abstract

This document describes the technical process used to extend household, group quarters, population, and employment numbers by Traffic Analysis Zones (TAZs) from the 2030 Regional Development Forecast (RDF) by five year intervals to 2050.


*SEMCOG* Data Center Technical Documentation

Revised February 27, 2002

## Purpose

The RDF to 2030 is completed and the consultant to the Detroit Water and Sewerage Department (DWSD), Camp Dresser & McKee Inc., has asked us to project the small area population and employment numbers further to 2050. They require this for planning infrastructure maintenance and expansion needs in the DWSD 50-year master plan.

## Abbreviations

| | |
|---|---|
| HH | households |
| Pop | population |
| GQ | group quarters |
| Emp | employment |
| RDF | regional development forecast |
| TAZ | traffic analysis zone (a.k.a. small area) |
| MH | maximum households |

## Definitions

Maximum Households (MH) = Current Households + Vacant Holding Capacity (VHC)
Maximum Households is a soft limit and is the maximum amount of households a TAZ can accomodate once the vacant holding capacity is consumed.

| | |
|---|---|
| $r_{max}$ | maximum rate of growth over five years after MH reached |
| $HH_n$ | households in period n |
| $HH^i$ | households in TAZ i |
| $C_n$ | regional control total for period n |
| $r_{s_{2,3}}$ | calculated rate of growth using standard formula between periods two and three |

## Overview

SEMCOG has households, group quarters, population, and employment at the small area level projected to 2030 at five year intervals as part of the RDF. We continue extending these TAZ numbers to 2050 using a simplified version of the formula used to project from 2000 to 2030. For households, we limit the rate of growth to a maximum of five percent growth per period after the vacant holding capacity has been consumed. For group quarters, we use a simpler formula where regional growth is allocated only to areas that are growing, in proportion to their existing size. Then, we adjust the growth rates of these numbers such that the numbers sum to regional totals up to 2050. An Excel workbook is used because it is the simplest method.

Due to annexations, some TAZs were split into pieces. The new uniquely identifying key for each polygonal small area became a combination of TAZ identifier and MCD identifier. However, throughout this document, we continue to refer to the post-annexation polygons as TAZs.

## Process

### Step 1: Formula for the Rate of Growth of Households

The standard formula used to calculate a future period's households follows:

$$HH_{t+1} = HH_t\left[1 + r_{s_{t,t+1}}\right]$$

$$r_{s_{t,t+1}} = \left[\frac{2}{3}\left(\frac{HH_t - HH_{t-1}}{HH_{t-1}}\right) + \frac{1}{3}\left(\frac{HH_{t-1} - HH_{t-2}}{HH_{t-2}}\right)\right]$$

In words, the rate of growth during period t equals the weighted average of growth in the two previous periods with double weight given to the most recent period.

We assume the following rule: if the standard calculated rate of growth between period t and t+1 would cause $HH_{t+1}$ to exceed the MH for the zone, then we use an adjusted formula for the rate.

$$r_{a_{t,t+1}} = \left(r_{\max}\right)^{\left(\frac{HH_{t+1}-MH}{HH_{t+1}-HH_t}\right)}$$

This formula is the condensed version of a longer formula which says, in principle, that households grow at the standard formula rate up to MH and grows at the smaller of the maximum rate or the standard formula rate thereafter.

We assume the following rule: if the households in the prior period have already exceeded MP, then we simply use the following formula, but only when the standard rate of growth would have been greater or equal to $r_{max}$.

$HH_{t+1} = HH_t * (1 + r_{max})$

Combining all of these rules, we get the final programmatic formula:

if ( $HH_t * r_s$ > MP and $r_s > r_{max}$ )
then
if ( $HH_t$ > MP )
then
$HH_{t+1} = HH_t * r_{maz}$
else
$HH_{t+1} = HH_t * \left(r_{\max}\right)^{\left(\frac{HH_{t+1}-MP}{HH_{t+1}-HH_t}\right)}$
else
$HH_{t+1} = HH_t * r_s$

where,
$r_s$ = rate of growth from period t to t+1 using the standard formula

Step 2: Controlling by regional totals
The final step is to control the HH numbers by the regional control totals. Here, we adjust the rates of growth of each TAZ by a factor such that the raw HH total will equal the control total. The formula follows:

hh controlled = controlled total growth/raw total growth * (raw change in hh) + previous hh number

$$HH_{t+1(c)} = \frac{C_{t+1} - C_t}{\sum_{i=0}^{\#tazs} HH_{t+1}^{i} + \sum_{i=0}^{\#tazs} HH_{t(c)}^{i}} \times \left(HH_{t+1} - HH_{t(c)}\right) + HH_{t(c)}$$

Since controlled total growth (from the RFTs) was generally less than the raw calculated total growth, we reduced

the growth rates of all the TAZs. One side effect of this controlling is that fast growing TAZs over their maximum hh will grow less than the actual maximum of five percent per five years. We chose this formula rather than ordinary normalization because that method caused a discontinuity between 2030 and 2035. In addition to the discontinuity, TAZs that were growing very slowly appeared to lose households post-2035.

### Step 3: Converting HH to Population

To convert HH to Population for a particular TAZ, we simply multiplied the 2030 persons per household number by the number of households in each period. Persons per household in 2030 by TAZ was obtained from other RDF work. The final step was to control these numbers by the regional forecast totals for household population. We controlled household population to RFTs using the same method as for HH.

Later, we calculate household size for each TAZ by dividing household population by number of households. If not for the separate controlling of households and household population, household size would remain constant over the forecast period.

### Step 4: Adjusting for Detroit Control Totals

For both households and household population, we adjusted the normalization formula to account for Detroit control totals and regional control totals. Detroit TAZs are controlled using the ordinary forumula. The remaining TAZs are controlled to the difference between regional control totals and Detroit control totals. This ensures that Detroit TAZs sum up to the Detroit control total and the whole set of TAZs sum up to the regional control total.

### Step 6: Projecting Group Quarters Population

We divided the TAZs into two groups, those with increasing group quarters population from 2020 to 2030, and those with no change in group quarters population in the same period. We assumed that those with level population would continue to experience no growth and those that had increased would continue to increase. This is because the TAZs with increasing group quarters population had both the presence of assisted living facilities (or nursing homes) and increases in population over 65. We did not set any maximum group quarters population. These numbers are finally controlled to regional totals as before.

### Step 7: Total Population Forecast

The final population for each TAZ at each five year interval is simply the sum of the household population and group quarters population. The sum of these equals the regional forecast totals for population because the two components were controlled before adding.

### Step 8: Entering Formulas Into Excel

The formulas were entered into an Excel workbook in a series of four worksheets as follows:

| | |
|---|---|
| *HHto2050* | Projections of HH to 2050 |
| *HHtoPop* | Conversion of Households to Population |
| *GQPop* | Projections of GQ Population to 2050 |
| *FinalPopForecast* | Sum of group quarters and houshold population to give final population. |

The formulas in one sheet generally use data calculated in the previous sheet. Thus, all the sheets are linked together and changes in one affect the remaining. The maximum rate of growth is a named cell (*vhcmaxchange*) and is entered on the *HHto2050* sheet. The formulas are safe for TAZs with negative growth because they are using percentages, not absolute values.

In addition to these four worksheets, we added several ancilliary sheets for input and output data. For convenience, all the columnar data by TAZ was entered onto a *SourceData* worksheet. The data can be updated simply by copying the data from the RDF Access query and pasting it over the existing data. This data includes the MCD identifier, TAZ identifier, households from 2020 to 2030, persons per household in 2030, maximum

households, and group quarters population from 2020 to 2030.

To export the final data back to Access, we added three more sheets, *Export Step 1*, *Export Step 2*, and *Export Final*. Each of these sheets contains the following data from 2035 to 2050: total population, group quarters population, household population, households, and household size. On the *Export Step 1* sheet, we simply refer to the data from the extension sheets. We also calculate household size as the household population divided by the number of households (unless households is zero, in which case household size is also zero). On the *Export Step 2* sheet, we adjust household size up to one for those TAZs with household size less than one and greater than zero. Then, we recalculate the household population and the total population. Each formula or value only links to the *Export Step 1* or *Export Step 2* sheet. Finally, the *Export Final* sheet simply takes the values calculated on the *Export Step 2* sheet, and rounds them to whole numbers or to two decimal places for household size. This sheet can be directly imported into Access.
The entire sequence of calculations from *SourceData* to *Export Final* is automated and does not require any manual intervention except the entering of the control totals. These cells are highlighted with purple colored text.

### Step 9: Employment Trend Extension

We projected employment to 2050 separately from the rest of the extension, but in the same Excel workbook and using the same process. The employment sheets in order are *EmpSourceData*, *Employment*, and *ExportEmp*. The *EmpSourceData* contains for each TAZ, employment in 2020, 2025, and 2030, and maximum employment. The *Employment* sheet projects employment to 2050 using the same process as the households sheet, except there are no adjustments for Detroit control totals. Finally, *ExportEmp* organizes for export MCD identifier, TAZ identifier, and employment from 2035 to 2050.

## Conclusion

The standard formula basically extends growth from 2030 to 2050 at the growth rate established between 2020 to 2030. In addition, the weighted average formula tends to flatten out curve in the growth rate. The one exception is for TAZs with high rates of growth (more than five percent per five years) reaching their maximum household capacity. In this case, the growth rate abruptly changes to five percent every five years for the remainder of the forecast. (Note that controlling reduces the actual maximum growth rate.) In general, the farther out a forecast, the less we can predict and the simpler should be the rules for the forecast. Thus, for fifty years out, extending the historical trend and controlling to regional forecast totals provides a baseline estimate using the least objectionable methodology.

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File Location: A:\2050_T~1.WPD

# 2030 RDF Employment by Industrial Class Extended to 2050, by County

**February 2002**

**Overview:** This document describes the technical procedures used to extend 2030 Regional Development Forecast (RDF) employment numbers by eight industrial classes to 2050 by five year intervals for seven counties in Southeast Michigan.

**Extending regional employment numbers by industrial class from 2030 to 2050**
SEMCOG's 2030 Regional Development Forecast (RDF) includes employment numbers by eight industrial classes by five year intervals up to 2030. These eight classes are as follows:

| Abbreviation | Description |
|---|---|
| ag | Agriculture (including Agricultural Services), Mining, and Natural Resources |
| mfg | Manufacturing |
| tcu | Transportation, Communication, and Utilities |
| whl | Wholesale Trade |
| rtl | Retail Trade |
| fire | Finance, Insurance, and Real Estate |
| srv | Services |
| pub | Public Administration |

After total employment numbers were extended from 2030 to 2050 (see SEMCOG Data Center technical documentation *"2030 RFT Extension to 2050"*), employment numbers by each industrial class were extended individually. For extending manufacturing jobs, a regression analysis was performed based on 2000 to 2030 trend. For all other industrial classes, a "weighted rate of growth" method was used. This method computes the rate of growth for the current forecast period based on the weighted average of growth in the two previous periods with double weight given to the most recent period (see SEMCOG Data Center technical documentation *"2030 RDF Extension to 2050 by TAZ"* for the detailed formula). The extended employment numbers by eight industrial classes were then controlled by total employment.

**Extending county numbers**
For each county, employment numbers by eight industrial classes were also extended from 2030 to 2050 by five year intervals using the same "weighted rate of growth" method described above. Then a fratarization procedure was used to ensure that the sum of employment of all classes equals county total employment and the sum of the employment of one class of all counties equal regional employment of that class. Fratarization is a process to normalize the cell values to column totals and row totals, iteratively until equilibrium, the point at which all cells tally in both directions.

By Xuan Liu
*SEMCOG* Data Center Technical Documentation

# SEMCOG 2030 Regional Development Forecast (RDF)
## Extended to 2050, by County

| | 1990 | 2000 | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SEMCOG Region** | | | | | | | | | | | | |
| Total Jobs | 2,350,310 | 2,673,052 | 2,780,356 | 2,891,055 | 2,982,833 | 3,034,557 | 3,066,141 | 3,109,481 | 3,142,966 | 3,176,068 | 3,204,861 | 3,230,686 |
| ag | 30,424 | 31,441 | 30,073 | 32,230 | 34,267 | 36,168 | 38,369 | 41,185 | 43,650 | 46,429 | 49,296 | 52,327 |
| mfg | 486,644 | 491,029 | 488,183 | 479,008 | 485,583 | 485,758 | 475,954 | 458,831 | 460,223 | 452,426 | 443,937 | 432,739 |
| tcu | 124,287 | 140,602 | 143,043 | 144,654 | 147,198 | 148,360 | 151,165 | 153,843 | 155,257 | 157,019 | 158,595 | 160,116 |
| whl | 121,200 | 145,353 | 156,070 | 163,675 | 171,002 | 174,120 | 176,266 | 179,258 | 180,427 | 182,111 | 183,529 | 184,890 |
| rtl | 441,167 | 469,237 | 474,585 | 498,917 | 521,429 | 533,969 | 539,544 | 548,902 | 552,277 | 557,350 | 561,576 | 565,638 |
| fire | 173,122 | 206,324 | 211,353 | 214,584 | 220,039 | 224,824 | 230,372 | 239,511 | 245,645 | 252,912 | 259,907 | 267,027 |
| srv | 904,892 | 1,096,525 | 1,182,189 | 1,260,224 | 1,303,572 | 1,330,868 | 1,353,037 | 1,384,487 | 1,401,240 | 1,422,426 | 1,441,650 | 1,460,625 |
| pub | 68,502 | 92,541 | 94,860 | 97,763 | 99,743 | 100,490 | 101,434 | 103,464 | 104,247 | 105,395 | 106,371 | 107,324 |
| **Livingston** | | | | | | | | | | | | |
| Total Jobs | 39,339 | 59,159 | 70,537 | 78,716 | 86,784 | 92,660 | 97,652 | 103,869 | 109,148 | 114,528 | 118,906 | 122,605 |
| ag | 1,756 | 1,970 | 1,873 | 1,900 | 1,930 | 1,931 | 1,957 | 2,120 | 2,210 | 2,319 | 2,403 | 2,470 |
| mfg | 8,186 | 11,113 | 12,273 | 12,942 | 14,103 | 14,578 | 14,658 | 14,315 | 14,514 | 14,364 | 14,065 | 13,592 |
| tcu | 1,071 | 1,338 | 1,795 | 1,983 | 2,223 | 2,409 | 2,629 | 2,890 | 3,119 | 3,367 | 3,594 | 3,808 |
| whl | 2,036 | 3,096 | 3,574 | 3,911 | 4,226 | 4,433 | 4,629 | 4,901 | 5,082 | 5,278 | 5,419 | 5,526 |
| rtl | 8,772 | 13,111 | 15,670 | 18,109 | 20,731 | 22,587 | 24,111 | 25,950 | 27,417 | 28,992 | 30,327 | 31,515 |
| fire | 3,455 | 6,214 | 6,953 | 7,485 | 8,063 | 8,575 | 9,140 | 9,861 | 10,426 | 11,036 | 11,551 | 12,013 |
| srv | 12,935 | 20,565 | 26,251 | 30,052 | 33,000 | 35,510 | 37,765 | 40,869 | 43,275 | 45,914 | 48,166 | 50,196 |
| pub | 1,085 | 1,752 | 2,148 | 2,334 | 2,508 | 2,637 | 2,763 | 2,963 | 3,105 | 3,258 | 3,381 | 3,485 |
| **Macomb** | | | | | | | | | | | | |
| Total Jobs | 333,722 | 381,864 | 394,317 | 405,730 | 418,017 | 423,600 | 427,706 | 433,303 | 437,712 | 442,133 | 446,125 | 449,757 |
| ag | 3,374 | 4,168 | 3,923 | 4,210 | 4,470 | 4,663 | 4,896 | 5,207 | 5,444 | 5,719 | 5,994 | 6,274 |
| mfg | 102,751 | 110,465 | 105,787 | 105,297 | 105,518 | 104,234 | 101,501 | 97,640 | 97,303 | 95,211 | 92,993 | 90,251 |
| tcu | 10,160 | 10,930 | 12,230 | 12,334 | 12,841 | 13,152 | 13,615 | 14,107 | 14,430 | 14,815 | 15,186 | 15,560 |
| whl | 14,013 | 16,823 | 18,725 | 19,261 | 20,223 | 20,760 | 21,133 | 21,700 | 21,938 | 22,286 | 22,602 | 22,918 |
| rtl | 71,606 | 70,727 | 69,592 | 71,065 | 72,654 | 72,453 | 71,816 | 71,953 | 70,963 | 70,341 | 69,627 | 68,926 |
| fire | 16,605 | 21,217 | 22,755 | 23,082 | 24,037 | 24,830 | 25,741 | 27,125 | 28,069 | 29,215 | 30,350 | 31,530 |
| srv | 104,301 | 135,948 | 149,338 | 158,343 | 165,974 | 171,047 | 176,302 | 182,522 | 186,356 | 191,116 | 195,740 | 200,462 |
| pub | 10,913 | 11,586 | 11,967 | 12,138 | 12,300 | 12,461 | 12,702 | 13,049 | 13,209 | 13,430 | 13,633 | 13,836 |
| **Monroe** | | | | | | | | | | | | |
| Total Jobs | 50,364 | 54,444 | 58,510 | 62,590 | 66,809 | 70,654 | 74,032 | 77,748 | 80,718 | 83,531 | 85,972 | 88,151 |
| ag | 2,350 | 2,479 | 2,321 | 2,398 | 2,460 | 2,524 | 2,622 | 2,751 | 2,820 | 2,892 | 2,945 | 2,987 |
| mfg | 9,430 | 12,435 | 12,236 | 12,563 | 13,267 | 13,888 | 14,341 | 14,614 | 15,319 | 15,704 | 15,998 | 16,146 |
| tcu | 4,208 | 3,805 | 3,896 | 3,714 | 3,546 | 3,328 | 3,140 | 2,974 | 2,757 | 2,557 | 2,357 | 2,165 |
| whl | 1,489 | 1,957 | 2,258 | 2,499 | 2,765 | 2,998 | 3,222 | 3,473 | 3,666 | 3,871 | 4,063 | 4,251 |
| rtl | 10,690 | 11,373 | 12,533 | 13,880 | 15,142 | 16,291 | 17,222 | 18,269 | 18,982 | 19,728 | 20,391 | 21,013 |
| fire | 2,123 | 2,863 | 3,223 | 3,481 | 3,792 | 4,099 | 4,395 | 4,775 | 5,063 | 5,374 | 5,672 | 5,966 |
| srv | 18,964 | 17,798 | 20,255 | 22,128 | 23,803 | 25,426 | 26,939 | 28,667 | 29,862 | 31,129 | 32,257 | 33,328 |
| pub | 1,110 | 1,734 | 1,788 | 1,927 | 2,034 | 2,100 | 2,151 | 2,225 | 2,249 | 2,276 | 2,289 | 2,295 |
| **Oakland** | | | | | | | | | | | | |
| Total Jobs | 681,031 | 910,363 | 955,006 | 1,009,955 | 1,049,724 | 1,066,624 | 1,074,004 | 1,087,399 | 1,097,187 | 1,106,743 | 1,114,985 | 1,122,352 |
| ag | 8,397 | 9,565 | 8,791 | 9,375 | 9,874 | 10,294 | 10,887 | 11,625 | 12,288 | 13,009 | 13,740 | 14,495 |
| mfg | 116,987 | 131,353 | 130,186 | 127,769 | 130,796 | 129,211 | 125,202 | 119,175 | 118,407 | 115,135 | 111,774 | 107,777 |
| tcu | 30,089 | 32,793 | 34,939 | 35,396 | 36,137 | 36,429 | 37,064 | 37,723 | 38,126 | 38,571 | 38,961 | 39,321 |
| whl | 46,746 | 62,864 | 65,768 | 68,919 | 71,403 | 71,804 | 71,705 | 71,940 | 71,561 | 71,307 | 70,947 | 70,550 |
| rtl | 130,230 | 150,971 | 155,246 | 165,159 | 174,244 | 178,940 | 180,940 | 184,394 | 186,207 | 188,428 | 190,435 | 192,408 |
| fire | 70,704 | 98,237 | 97,571 | 99,236 | 100,973 | 101,290 | 101,883 | 104,053 | 104,991 | 106,249 | 107,335 | 108,388 |
| srv | 268,006 | 407,625 | 443,684 | 484,032 | 505,244 | 517,149 | 524,480 | 535,892 | 542,524 | 550,394 | 557,611 | 564,698 |
| pub | 9,878 | 16,955 | 18,821 | 20,069 | 21,053 | 21,507 | 21,843 | 22,597 | 23,083 | 23,650 | 24,182 | 24,715 |
| **St. Clair** | | | | | | | | | | | | |
| Total Jobs | 55,735 | 64,516 | 66,295 | 70,515 | 73,753 | 76,398 | 78,649 | 81,278 | 83,468 | 85,548 | 87,356 | 88,995 |
| ag | 2,533 | 2,207 | 1,852 | 1,808 | 1,764 | 1,687 | 1,644 | 1,620 | 1,571 | 1,524 | 1,473 | 1,418 |
| mfg | 10,565 | 13,093 | 12,123 | 11,983 | 11,982 | 11,860 | 11,604 | 11,255 | 11,302 | 11,106 | 10,862 | 10,537 |
| tcu | 3,984 | 4,860 | 5,099 | 5,364 | 5,595 | 5,774 | 5,958 | 6,148 | 6,269 | 6,389 | 6,486 | 6,569 |
| whl | 1,657 | 2,379 | 2,788 | 3,103 | 3,423 | 3,677 | 3,892 | 4,126 | 4,319 | 4,523 | 4,717 | 4,907 |
| rtl | 13,121 | 13,261 | 13,494 | 14,065 | 14,747 | 15,291 | 15,711 | 16,213 | 16,514 | 16,830 | 17,086 | 17,313 |
| fire | 3,038 | 3,645 | 3,744 | 3,862 | 4,055 | 4,290 | 4,547 | 4,905 | 5,196 | 5,518 | 5,831 | 6,150 |
| srv | 19,440 | 22,691 | 24,891 | 27,847 | 29,623 | 31,208 | 32,633 | 34,288 | 35,546 | 36,878 | 38,104 | 39,292 |
| pub | 1,392 | 2,380 | 2,304 | 2,483 | 2,564 | 2,611 | 2,660 | 2,723 | 2,751 | 2,780 | 2,797 | 2,809 |

## SEMCOG 2030 Regional Development Forecast (RDF)
## Extended to 2050, by County

| | 1990 | 2000 | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Washtenaw** | | | | | | | | | | | | |
| Total Jobs | 213,928 | 232,175 | 244,213 | 262,120 | 273,221 | 279,741 | 284,437 | 289,969 | 294,467 | 298,757 | 302,403 | 305,673 |
| ag | 4,550 | 4,549 | 4,039 | 4,377 | 4,602 | 4,751 | 4,903 | 5,074 | 5,193 | 5,324 | 5,440 | 5,554 |
| mfg | 37,363 | 34,517 | 38,330 | 41,032 | 43,048 | 44,292 | 44,728 | 44,308 | 45,694 | 46,142 | 46,477 | 46,495 |
| tcu | 6,912 | 8,916 | 9,216 | 9,745 | 10,187 | 10,411 | 10,732 | 11,068 | 11,299 | 11,555 | 11,786 | 12,012 |
| whl | 6,177 | 6,618 | 7,614 | 8,181 | 8,762 | 9,172 | 9,501 | 9,903 | 10,197 | 10,527 | 10,841 | 11,156 |
| rtl | 33,166 | 38,888 | 39,590 | 42,628 | 45,560 | 47,211 | 48,200 | 49,573 | 50,372 | 51,324 | 52,177 | 53,024 |
| fire | 10,970 | 10,729 | 11,779 | 12,366 | 12,736 | 13,163 | 13,563 | 14,319 | 14,843 | 15,460 | 16,053 | 16,662 |
| srv | 110,208 | 119,998 | 125,327 | 134,283 | 138,225 | 140,323 | 142,131 | 144,626 | 145,498 | 146,738 | 147,651 | 148,503 |
| pub | 4,549 | 7,960 | 8,318 | 9,508 | 10,101 | 10,418 | 10,679 | 11,098 | 11,371 | 11,687 | 11,978 | 12,267 |
| **Wayne** | | | | | | | | | | | | |
| Total Jobs | 976,191 | 970,531 | 991,478 | 1,001,429 | 1,014,525 | 1,024,880 | 1,029,661 | 1,035,915 | 1,040,266 | 1,044,828 | 1,049,114 | 1,053,153 |
| ag | 7,464 | 6,503 | 7,274 | 8,162 | 9,167 | 10,318 | 11,460 | 12,788 | 14,124 | 15,642 | 17,301 | 19,129 |
| mfg | 201,362 | 178,053 | 177,248 | 167,422 | 166,869 | 167,695 | 163,920 | 157,524 | 157,684 | 154,764 | 151,768 | 147,941 |
| tcu | 67,863 | 77,960 | 75,868 | 76,118 | 76,669 | 76,857 | 78,027 | 78,933 | 79,257 | 79,765 | 80,225 | 80,681 |
| whl | 49,082 | 51,616 | 55,343 | 57,801 | 60,200 | 61,276 | 62,184 | 63,215 | 63,664 | 64,319 | 64,940 | 65,582 |
| rtl | 173,582 | 170,906 | 168,460 | 174,011 | 178,351 | 181,196 | 181,544 | 182,550 | 181,822 | 181,707 | 181,533 | 181,439 |
| fire | 66,227 | 63,419 | 65,328 | 65,072 | 66,383 | 68,577 | 71,103 | 74,473 | 77,057 | 80,060 | 83,115 | 86,318 |
| srv | 371,038 | 371,900 | 392,443 | 403,539 | 407,703 | 410,205 | 412,787 | 417,623 | 418,179 | 420,257 | 422,121 | 424,146 |
| pub | 39,575 | 50,174 | 49,514 | 49,304 | 49,183 | 48,756 | 48,636 | 48,809 | 48,479 | 48,314 | 48,111 | 47,917 |