EASTERN MONTANA COUNTY LEVEL POPULATION PROJECTIONS

A METHODOLOGY FOR INCORPORATING THE MONTANA DEPARTMENT OF TRANSPORTATION'S ANALYSIS OF THE ESTIMATED EFFECTS POTENTIAL FUTURE INCREASES IN OIL PRODUCTION MAY HAVE ON THE EASTERN MONTANA REGION'S TOTAL POPULATION WITH eREMI'S COUNTY-LEVEL ESTIMATED POPULATION PROJECTIONS

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The Census and Economic Information Center (CEIC) at the Montana Department of Commerce (MDOC) purchased a population projections product, known as eREMI, from Regional Economic Models, Inc. (REMI). The eREMI product contains annual population projections (historical population from 1990 – 2010; projected population from 2011 – 2060) *at the county level* for the state of Montana.

The Montana Department of Transportation – Planning Division (MDT) has done extensive research and analytical modeling focused on the potential impacts of oil development on transportation infrastructure in eastern Montana contingent on various levels of projected oil production in the State. As part of that research, MDT estimated growth trends of the total resident population *for the defined 16 county region in eastern Montana* (referred to as the "Region") based on 4 potential oil production level scenarios for the time period 2012 - 2035 (See Appendix A for a map defining the Region in question).

Figure 1 (below) displays the five different projected total population trends for the Region estimated by MDT's four levels of future oil production scenarios and one from eREMI. The projected population for the Region produced by eREMI is equal to the sum of the 16 individual eREMI county population projections that make up the Region in eastern Montana.

Figure 1.

Total Projected Population for Eastern Montana 16 County Region (MDT Region #4)
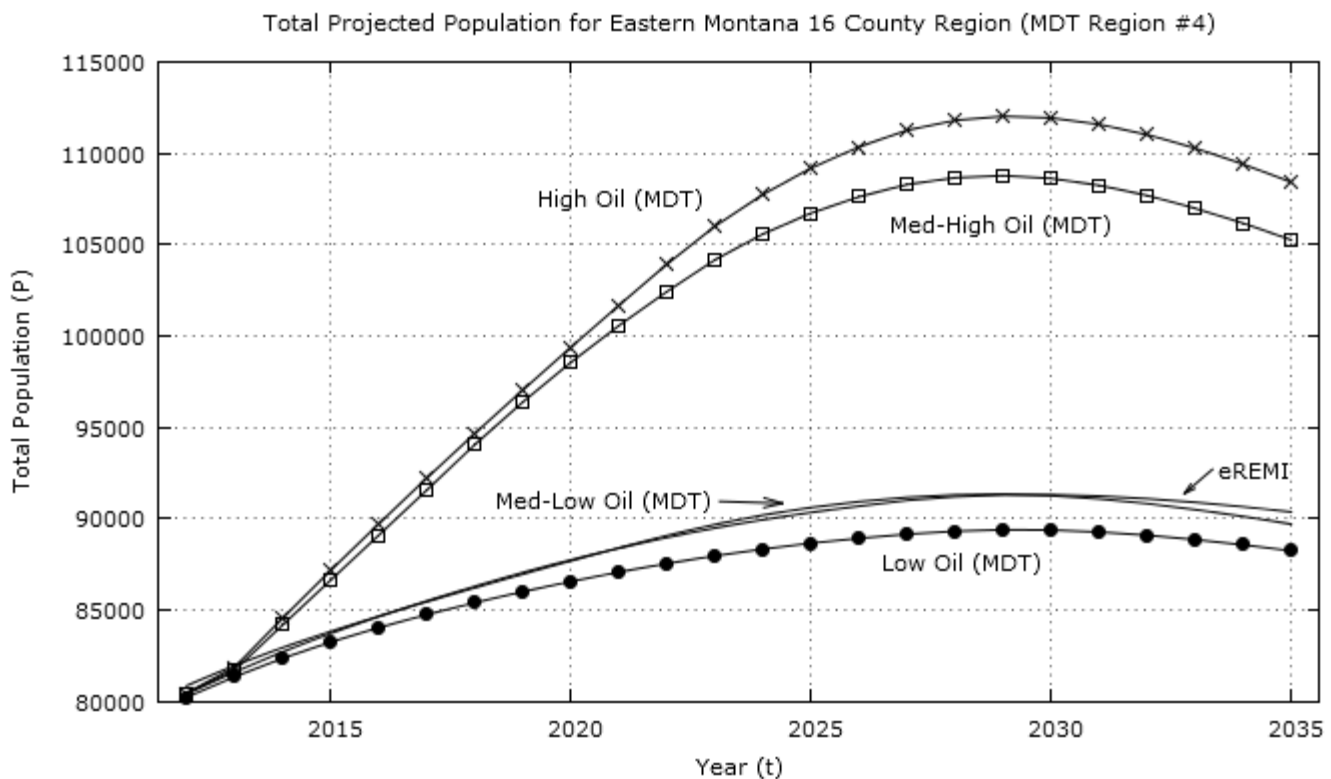
High Oil (MDT)	Represents the total projected population for the Region based on MDT's highest level of oil production scenario
Med-High Oil (MDT)	Represents the total projected population for the Region based on MDT's medium-high level of oil production scenario
Med-Low Oil (MDT)	Represents the total projected population for the Region based on MDT's medium-low level of oil production scenario
eREMI	Represents the total projected population for the Region as estimated by eREMI
Low Oil (MDT)	Represents the total projected population for the Region based on MDT's lowest level of oil production scenario

The four total resident population curves for the Region produced by MDT's research (displayed in Figure 1) are products of analytical modeling based on assumptions of, among other things, different levels of future oil production in Montana. The two curves that project fairly moderate growth in the Region (*Low Oil (MDT)* and *Med-Low Oil (MDT)*) explicitly assume low to moderate levels of oil development and production in the State, where the two curves projecting more drastic growth of the total population (*High Oil (MDT)* and *Med-High Oil (MDT)*) assume more aggressive oil development and accelerated production in the State.

Population projections for the Region based on MDT's medium-low oil production scenario (*Med-Low Oil (MDT)*) and those produced by eREMI (*eREMI*) are almost congruent to one another over time (from 2012 – 2035) (see Figure 1). Because these two estimated growth curves are nearly equal *for the Region*, it's assumed that eREMI's individual population projections for each of the 16 counties provide adequate estimates of the total population *at the county level* assuming low to moderate levels of future oil production in the State.

The goal here is to allocate the projected growth of the Region (in terms of total population) based on the two higher MDT oil production scenarios (*High Oil (MDT)* and *Med-High Oil (MDT)*) to the 16 counties in the Region using eREMI county level projections as a base to maintain the idiosyncratic growth trend of each county.

METHODOLOGY

The Montana Department of Transportation, Planning Division's (MDT) research on the potential impacts of accelerated oil production on Montana's transportation infrastructure geographically focuses on MDT's District 4 – the respective district is made up of 16 counties in eastern Montana (referred to as the "Region"). This paper provides a methodology to allocate the potential effects on total resident population growth presented by MDT's analysis at the regional level to each of the individual 16 counties.

The following terms are defined as:

TP_eREMI_t is equal to the total population of the Region in year *t* based on eREMI projection estimates (*eREMI* in Figure 1.)

$TP\_HighOil_t$ is equal to the total population of the Region in year *t* based on MDT's highest level of oil production scenario (*High Oil (MDT)* in Figure 1.)

$TP\_MedHighOil_t$ is equal to the total population of the Region in year *t* based on MDT's medium-high level of oil production scenario (*Med-High Oil (MDT)* in Figure 1.)

t represents the year (2012 – 2035)

The total population for the Region projected by both of MDT's higher oil production scenarios ($TP\_HighOil_t$ and $TP\_MedHighOil_t$) is larger in magnitude (total population) for all years *t* (2012 – 2035) than that of eREMI (TP_eREMI_t) (see Figure 1 above).

For explanation purposes and an attempt at clarity, MDT's highest oil production scenario ($TP\_HighOil_t$) will only be used in the following examples; the methodology used to share-out MDT's medium-high oil production scenario ($TP\_MedHighOil_t$) to the county level follows exactly the same process.

The difference between the total population of the Region in year t based on MDT's highest oil production scenario and that of eREMI projection estimates can be represented as:

Equation 1
$$diffTP_{HighOil-eREMI_t} = TP\_HighOil_t - TP\_eREMI_t$$

Such That: $diffTP_{HighOil-eREMI_t}$ is equal to the difference in total population projected for the Region between MDT's highest level of potential oil production scenario and eREMI

The difference in total population between MDT and eREMI for every year t (Equation 1) is essentially being distributed to the respective counties within the Region. The trick is to distribute this difference in projected population across all 16 counties in an equitable way while taking into account differences in total population and growth trends between each county from year to year.

The total population of the Region, as estimated by eREMI, can be represented as the sum the 16 county populations (Equation 2).

Equation 2
$$TP\_eREMI_t = \sum_{Ci=1}^{16} P\_eREMI_{Ci_t}$$

Such That: TP_eREMI_t is equal to the total population of the Region in year t based on eREMI projection estimates

$P\_eREMI_{Ci_t}$ is equal to the total population of county Ci in year t as estimated by eREMI

Each of the 16 counties that make up the Region differs in their overall size – some counties have larger populations than others. Therefore, the total population of the Region as estimated by eREMI (TP_eREMI_t) is disproportionally made up of the sum of the 16 county populations (Equation 2). In other words, some counties account for more of the total population (as a proportion) for the Region than others. The share of each county $Ci's$ population of the total population for the Region in year t as estimated by eREMI is represented by Equation 3.

Equation 3
$$shareP\_eREMI_{Ci_t} = \frac{P\_eREMI_{Ci_t}}{TP\_eREMI_t}$$

Such That: $shareP\_eREMI_{Ci_t}$ is equal to the county Ci's share of the total population for the Region in year t as estimated by eREMI

It should be noted that for each year t, the sum of all 16 county $Ci's$ shares of the Region's total population (Equation 3) equals 1 (Equation 4).

Equation 4
$$\sum_{Ci=1}^{16} shareP\_eREMI_{Ci_t} = 1$$

To calculate the final estimated population projection of each individual county Ci in year t based on MDT's highest level of future oil production scenario, the base population projection for the county Ci estimated by eREMI ($P\_eREMI_{Ci_t}$) is added to the respective county's share of the Region's total population ($shareP\_eREMI_{Ci_t}$) multiplied by the total difference in projected population between MDT's estimate and eREMI ($diffP_{HighOil-eREMI_t}$) for the Region (Equation 5).

Equation 5

$$P\_HighOil_{Ci_t} = \left(shareP\_eREMI_{Ci_t} * diffP_{HighOil-eREMI_t}\right) + P\_eREMI_{Ci_t}$$

Such That: $P\_HighOil_{Ci_t}$ is equal to the total population of county i in year t based on MDT's high level of oil production scenario

By using a weighting factor based on each county $Ci's$ proportional share of the Region's total population in each year t, as estimated by eREMI ($shareP\_eREMI_{Ci_t}$), differences in growth trends between counties relative to the overall growth of the Region are implicitly accounted for over time. In other words, if County A is projected to grow at a faster rate than County B by eREMI, County A's proportional share of the Region's total population will increase at a relatively proportional rate, over time, compared to that of County B.

Equation 5 (above) provides a function for estimating the projected population for each of the 16 counties within the Region in eastern Montana based on idiosyncratic growth trends between each county produced by eREMI as well as the Montana Department of Transportation, Planning Division's scenario analysis focused on the effects of potential increased levels of oil production in the State.

The Montana Department of Transportation's analysis of the potential effects various levels of future oil production may have on Montana's transportation infrastructure was focused on MDT's District 4 (see the map below). Estimates of potential population projections based on MDT's research were produced for the entire district (referred to as the "Region") *as a whole*; providing county level population projections were beyond the scope of MDT's study.