2008 EIGHT-HOUR OZONE STANDARD PLANNING ASSUMPTIONS & MODELING INPUTS

(modified slightly to include demonstration of relaxed RVP for Atlanta 13 county area)

General Methods and Assumptions

1) Modeling Methodology: Use the MOVES model in inventory mode to determine the total NO_x and VOC emissions in the 15-county maintenance area.
2) Analysis Years: 2020, 2030, 2040
3) Conformity Test
    a. Motor Vehicle Emission Budget (MVEB) Test[1]
        i. For years prior to 2030, 2014 MVEBs are used:
            1. NOx: 170.15 tpd
            2. VOC: 81.76 tpd
        ii. For years 2030 and later, 2030 MVEBs are used:
            1. NOx: 58 tpd
            2. VOC: 52 tpd
4) Modeling Start Date: January 2018. This start date is defined by the ARC as the initiation of the first model run for plan amendment/update.

Travel Demand Modeling Assumptions

1) Calibration Year: 2010 (with some 2015 interim validations and benchmarking thereafter)
    a. Model validated to the year 2010 using a comparison between estimated volumes and observed counts. See Appendix A for validation/calibration information.
2) Social/Economic Data: Same as used for the Atlanta Region's Plan update. See Appendix B.
3) ARC's Activity-Based Travel Model (ABM) is the basis for these runs. See Appendix C for an overview of ABM specifications.

Emissions Modeling Assumptions

1) Emissions Model: MOVES2014a – Database: movesdb20151028
    a. Emissions Process – use MOVES in inventory mode for a July weekday
        i. For the years 2020, 2030 and 2040 modeled travel data is used to calculate emissions
    b. Run separately for the 13-county and 2-county portions of the nonattainment area[2]
        i. 13-county area activity, vehicle population and other inputs area assigned to Fulton County while running MOVES
        ii. 2-county area activity, vehicle population and other inputs are assigned to Bartow County while running MOVES

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[1] 2014 and 2030 MVEBs established as part of Georgia's 2008 Ozone Maintenance State Implementation Plan for the Atlanta 8-Hour Ozone Nonattainment Area, effective June 2, 2017

[2] For the eight-hour ozone standard there are two sets of MOVES input files, one for the 13 counties that make up the former one-hour ozone nonattainment area in which a specific set of emission control measures is in place, and one for the 2 remaining ring counties (out of the 7 historically used for 20-county conformity)

2) MOVES Inputs
   a. Road Type Distribution – Processed from the travel demand model, GDOT HPMS counts and MOVES defaults. Summarizes VMT fraction by road type and source type for the 13 and 2 counties separately.
   b. Source Type Population
      i. Started with 2014 R.L. Polk & Co. registration data for the Atlanta nonattainment counties, updated in fall 2017
      ii. Future analysis year data is grown from 2014 based on the ratio of MPO population estimates
      iii. Since the population of vehicle type 62 (combination long-haul trucks) can easily be underrepresented in areas with lots of through traffic, the vehicle population for MOVES source type 62 was revised using MOVES default VMT/VPOP ratios and VMT for HPMS type 60 data
   c. Vehicle Type VMT
      i. HPMS VTypeYear - Processed from the travel demand model, GDOT HPMS Counts, and an EPA daily to annual VMT converter. Assigns total annual VMT by HPMS vehicle type.
      ii. Month VMT Fraction: MOVES defaults
      iii. Day VMT Fraction: MOVES defaults
      iv. Hour VMT Fraction: Derived from the travel demand model by source and road type. The fractions are determined separately for the 13 and 2 county areas.
   d. I/M Programs– Applied to the 13-county area only (See Appendix D)
   e. Age Distribution – Age data was derived from 2014 R.L. Polk & Co. registration data for the 13 and 2 counties separately for all vehicle types, except HDV8b (Source type 62) where MOVES defaults were used, this data was updated in fall 2017
   f. Average Speed Distribution – Processed from the travel demand model with HPMS VMT Adjustment factors applied. Calculates VHT by hour by speed bin by source. The distribution is determined separately for the 13 and 2 county areas.
   g. Ramp Fraction – Processed from the travel demand model. Calculates VHT by freeway and ramps by area type. The fraction is determined separately for the 13 and 2 county areas.
   h. Fuel – MOVES2014 defaults after 2015 do not match local fuel due to the removal/modification of Georgia summer fuel in the 45 county Atlanta region effective Oct 1, 2015
      i. Tier 3 Low Sulfur fuel (10ppm, 80ppm refinery gate and 95ppm downstream cap) for all counties
      ii. Summer Fuel reclassification
         1. 13 counties –
            a. Base Case:
               i. Low Federal RVP summer requirements (June 1-Sept 15) for "designated volatility nonattainment areas" (40 CFR 80.27(a)(2)(ii))
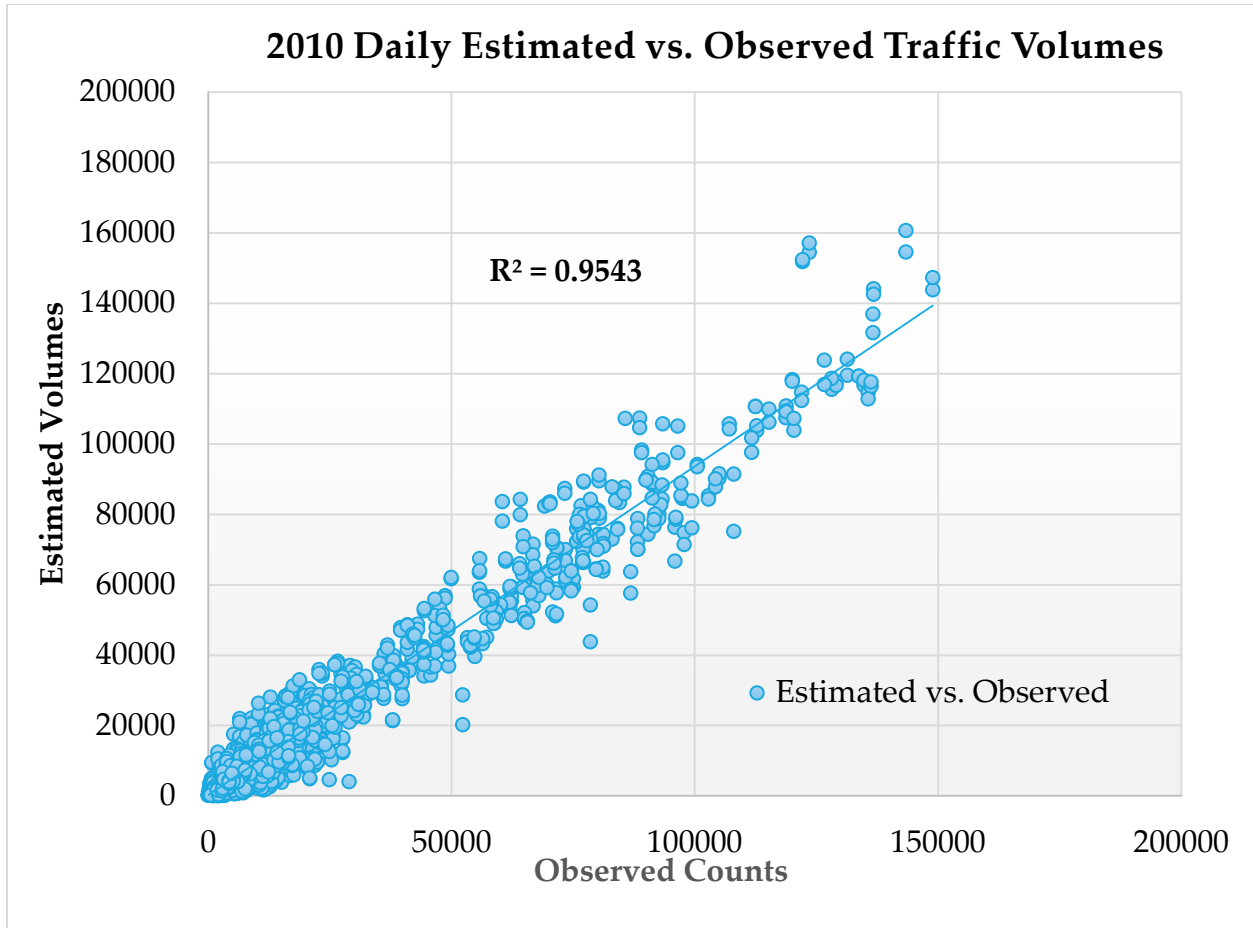
        ii. Fuel region ID 170000000 kept but fuel formulations reflect region 178000000 for any model years after 2015

     b. Test Case (RVP relaxed):

        i. Standard Federal RVP summer requirements (June 1-Sept 15) for "designated volatility attainment areas" (40 CFR 80.27(a)(2)(i))

        ii. Fuel region ID 170000000 kept but fuel formulations reflect region 100000000 for any model years after 2015

2. 2 counties –
   a. Standard Federal RVP summer requirements (June 1-Sept 15) for "designated volatility attainment areas" (40 CFR 80.27(a)(2)(i))
   b. Fuel region ID 170000000 kept but fuel formulations reflect region 100000000 for any model years after 2015

    iii. Ethanol – The current assumption is an increasing percentage of ethanol fuel
1. 2% in 2014, 28% in 2030 and 21% in 2040
2. The rest of the gasoline blends with a larger percent of E15 with time:
   a. 0.8% in 2014, 19% in 2030 and 23% in 2050
3. Remainder is E10

    iv. Volatility waiver for E10 allows 1.0 psi RVP increase, but not in E15

i. Meteorology – July 2014 weather for Hartsfield-Jackson Atlanta International Airport was used for this analysis consistent with the 2008 Eight Hour Ozone Maintenance SIP

j. Starts – Processed from the travel model. Determines the number of trip starts in each of the 13 and 2 county areas. Applies only to the trips per day input. Defaults used for the rest of the start inputs.

k. Hotelling – MOVES defaults

3) VMT HPMS Adjustment Factors
   a. Calculated for the year 2010 (See Appendix E)
   b. HPMS adjustment in base year of calibration in accordance with Section 93.122(b)(3) of the Transportation Conformity Rule which recommends that HPMS adjustment factors be developed to reconcile travel model estimates of VMT in base year of validation to HPMS estimates for the same period
   c. Summer (seasonal) adjustment to convert from average annual VMT to summer-season VMT[3]
   d. Factors applied to VMT estimates generated by ARC travel demand model for 13-county portion and 2-county portion of 20-county modeling domain, separately
   a. Factors aggregated up to MOVES road types from base HPMS functional classifications

4) Off-Model Calculations
   a. Senior I/M Exemption (emissions debit)
      i. The Senior I/M Exemption calculated for year 2002 is conservatively high and will be added to the regional emission inventories for each analysis year

5) TCMs

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[3] *Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources*, Section 3.4.2.6, EPA420-R-92-009, USEPA Office of Air and Radiation, Office of Mobile Sources, 1992.

a. No additional credit is taken in the emissions modeling process for SIP TCMs

APPENDIX A – Model Validation

2010 Daily Estimated vs. Observed Traffic Volumes

R² = 0.9543

Estimated Volumes

Observed Counts

● Estimated vs. Observed

APPENDIX B – Socioeconomic Data for the Travel Model

ARC periodically revises its population and employment forecasts based on best available current information. Each revision is a multi-step process. First, new region-level forecasts are produced, followed by county-level forecasts. These then become region-level controls for census tract and traffic analysis zone (TAZ) forecasts.

The most current region-level control forecasts will serve as a foundation for The Region's Plan, adopted in spring of 2016. The regional series, known as Series 15.0, was completed in late spring of 2015. The charts at the end of this section summarize the new updated population and employment controls for the 20-county study area.

Development of the most current draft regional forecast began in January of 2015. This forecast was developed from a calibration of a standard forecast for the 20-County Area by the Regional Econometric Models Inc. (REMI) econometric model, build 3.6.5R. This model was released by REMI in October 2014, and included 21 specific regions consisting of the 20 counties in ARC's MPO, plus the rest of the state of Georgia. Forecasts are produced for over 6,000 economic and demographic variables.

ARC staff was assisted in the development of these regional forecasts by a Technical Advisory Committee (TAC) of nationally known, local experts on the Atlanta Regional Economy. The committee met three times in late winter and early spring of 2015. TAC members advised staff on REMI model calibration, policy variable development, and related iterative revisions to model runs. The TAC then recommended the final regional forecasts for use in the Region's Plan forecasts.

In February of 2015 (in parallel to the TAC process), Research and Analytics division staff began a series of 23 meetings to meet with MPO member jurisdictions to collect "local expert" information that would be used in assessment of the draft regional forecasts and refinement of the county and subcounty forecasts of population and employment making up the entirety of series 15.0. These 'local outreach' meetings directly reviewed a previous series of forecasts (the 'Needs Assessment' or series 14.0) of households and total employment. These meetings also refined the region's Unified Growth Policy Map (UGPM), which is a key input to the generalized zoning that influences land development in the small area allocation model.

A subsequent step in The Region's Plan forecast process was development of county-level control totals. Regression analysis, third-party datasets, and input from the outreach meetings were core resources in arriving at these county control totals. The REMI model's regional forecast was then recalibrated to mirror/reflect the county control totals. The county level controls for series 15.0 were finalized in mid-summer, 2015.

The final step in the forecasting process uses mathematical models to disaggregate the region-level/county-level control population and employment forecasts to "small areas": the superdistrict, census tract and traffic analysis zone (TAZ) level. TAZs are nested within census tracts. Census tracts nest within superdistricts. The mathematical models underlying the region-level controls have evolved and become more complex, but ARC's basic approach is the same today as in 1975.

The Production, Exchange, Consumption, and Allocation System (PECAS) model is being used as part of The Region's Plan disaggregation of regional and county controls to small areas. This PECAS model runs annually and iteratively to produce not only a small-area allocation of population and households, but labor dollars by industry, that serve as direct inputs to the travel model sets. Further, REMI model output at the county level provided detailed age distribution data that served as direct input to the travel model's

population synthesizer. The process is integrated with the ARC travel demand model, as impedances (travel costs) from the travel model are a significant influence on small-area allocation of population and job growth.

Population and job levels from each successive single-year forecast become the base for forecasts in the next model year. First, the Activity-Based Model (ABM) analyzes base year traffic patterns and produces accessibility measures (impedances or travel costs) within the 20-county forecasted area. Then, the PECAS model develops socioeconomic forecasts using the previous year's composite impedances from the TDM; the economic activity forecast by its Activity Allocation (AA) module, and resultant built space produced in response to that economic activity (and construction prices/ rents) by its Spatial Development (SD) module. The PECAS output is translated into household income by size and job by sector forecasts at the TAZ level, which then become the input used by the ABM to produce the impedance(s) measure that drives the next iteration of the integrated model run.

All these models are carefully calibrated based on the best and most current data available. Data used in the current small-area modeling effort include 2010 United States Census results, economic data from IMPLAN and REMI, parcel level datasets from local jurisdictions, joined assessor's data, third-party datasets on real estate development and construction costs, ARC annual major jurisdiction estimates of population (using a hybrid method involving building permit information, birth and death data, and American Community Survey data), and ARC semi- annual estimates of employment by industry for counties, superdistricts, tracts and TAZs/blockgroups from the state of Georgia unemployment insurance base file. National forecasts of employment and population were derived from the REMI TranSight model. The results of ARC travel surveys (including the 2011 Household Travel survey, the 2009-2010 Transit On-Board survey, the 2010 Hartsfield air passenger survey, travel time studies, speed studies, and others) shape travel model parameters. Highway projects and the schedule for their completion (primary inputs to the ABM model networks) are developed as part of an extensive discussion between ARC staff, local planners, Georgia Department of Transportation and various federal agencies. Likewise, ARC staff coordinates with local transit and shuttle providers (such as MARTA, GRTA, CCT, GCT, etc) to update and maintain transit networks and schedules.

The area modeled by ARC for transportation/air quality purposes expanded from ten (10) to twenty (20) counties over the last 15 years. To meet current and future data needs, ARC produced employment estimates by county and census block group for the state of Georgia beginning in 2008, and continues to produce these estimates on a semi-annual basis. The county coverage by land-use data produced in the LandPro program expands as needed. Going forward, ARC's population forecast program area will be expanded as required from the current 20 counties, using the decennial and intercensal Census estimates, as well as other available information, as data baselines.

Post- processing adjustments are made to the ARC forecasts to account for expected large scale changes and policy priorities that would not be reflected in model output driven by historical data. Events such as expected construction of a new highway or policy input restricting development within the region are accounted for directly in the PECAS model with parameter changes to the AA module. Factors such as expected job and household growth from the completion of known major development projects (e.g. Atlantic Station) or transit-oriented development are incorporated as post processing adjustments to the model output or via specific site development changes to the parcel layers in the SD module.

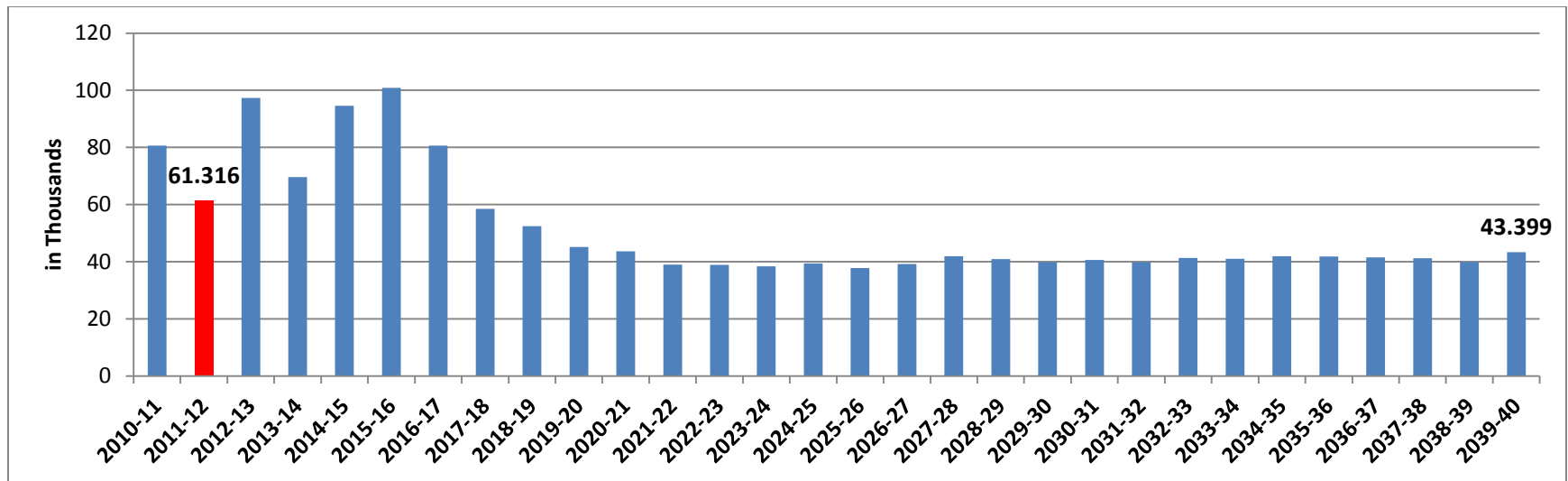# Projected Population and Employment Growth for the 20-County Area
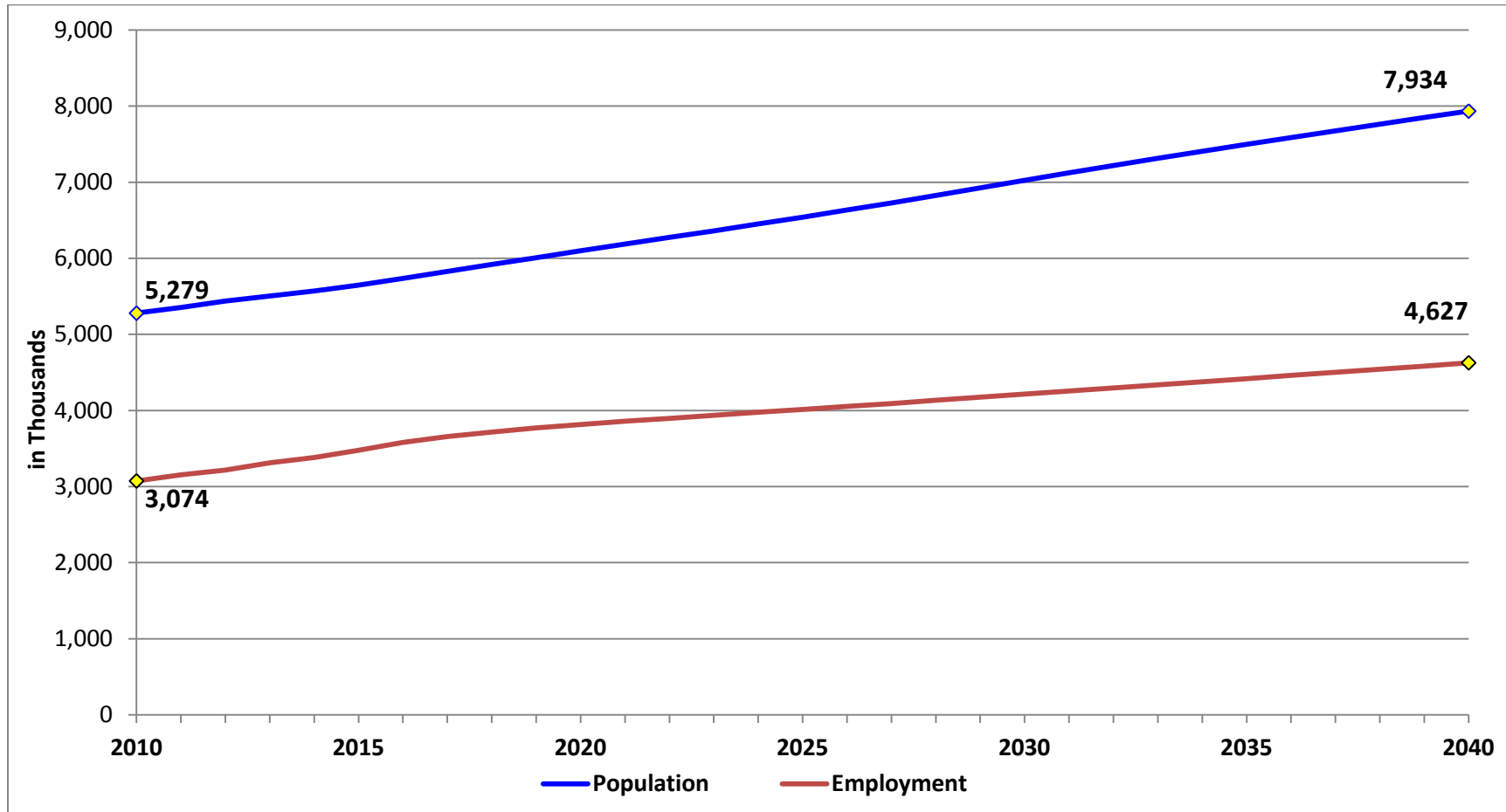
Projected Annual Population Change for the 20-County Area
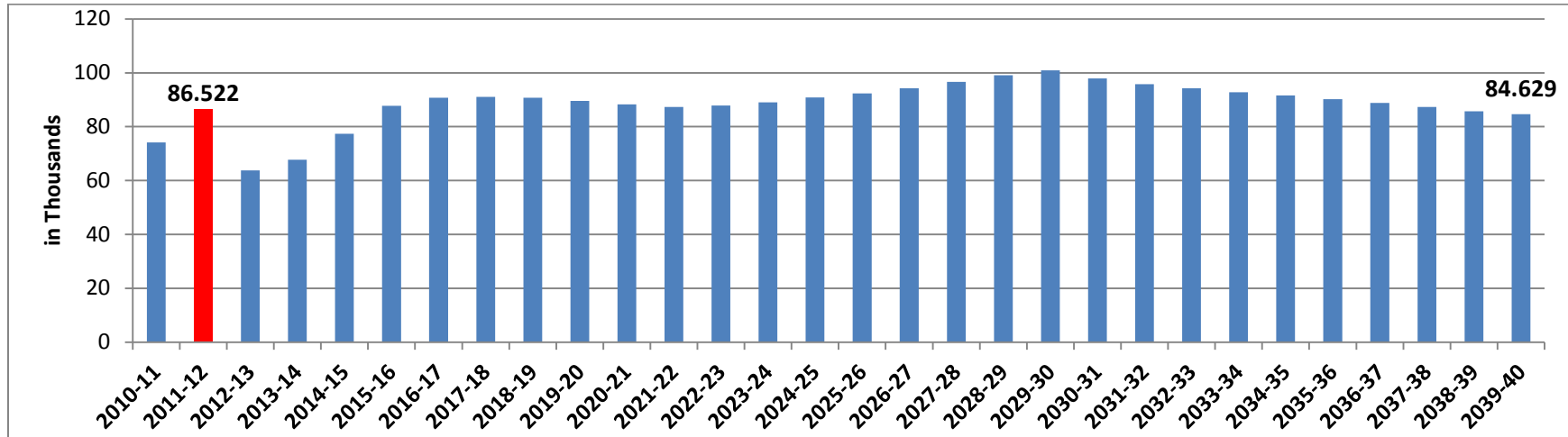
Projected Annual Employment Change for the 20-County Area

APPENDIX C – Model Inputs

In 2016, ARC switched from its 4-step trip-based aggregate regional travel demand model to its newly developed, and recently calibrated disaggregate activity-based model (ABM). The ABM now serves as the major travel forecasting tool in the ARC region. This model has been developed to ensure that the regional transportation planning process can rely on forecasting tools that will be adequate for new socioeconomic environments and emerging planning challenges. It is equally suitable for conventional highway projects, transit projects, and various policy studies such as highway pricing and HOV / HOT analysis. The ARC ABM is based on the CT-RAMP (Coordinated Travel Regional Activity-Based Modeling Platform) family of Activity-Based Models. This model system is an advanced, but operational, AB model that fits the needs and planning processes of ARC.

The ABM has been tailored specifically to meet ARC planning needs, considering current and future projects and policies and also taking into account the special market segments that exist in the Atlanta region. The model system addresses requirements of the metropolitan planning process, relevant federal requirements, and provides support to ARC member agencies and other stakeholders.

1) Calibration Year: 2010 (with some 2015 interim validations and benchmarking thereafter)
2) Project Listing: Project listings will be provided in electronic format to Interagency Consultation Group for review in January 2018 and include:
   a. Regionally Significant and Federally Funded
   b. Regionally Significant and Non-Federally Funded
3) Demographic Data: Provided as separate attachment
4) Speed Data: Free-flow Speed by Area Type and Facility Type[4]

FACTYPE	ABM Area Type							
	CBD	Urban Commercial	Urban Residential	Suburban Commercial	Suburban Residential	Exurban	Rural	Facility Type
1	62	63	63	63	64	65	66	interstate/freeway
2	43	46	49	52	55	58	61	expressway
3	43	46	49	52	55	58	61	parkway
4	64	65	65	65	66	67	68	freeway HOV (concurrent)
5	64	65	65	65	66	67	68	freeway HOV (barrier)
6	62	63	63	63	64	65	66	freeway truck only
7	50	50	50	55	55	55	55	system to system ramp
8	50	50	50	50	50	50	50	exit ramp
9	45	45	45	50	50	50	50	entrance ramp

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[4] Within the ARC travel demand and emission modeling process, free flow speeds are adjusted to reflect the increase in delay and travel time on a roadway segment as traffic volumes build and congestion levels increase. Link-level congested flow speeds are used to estimate NOx and VOC emissions as required by Sections 93.122(b)(i)-(iv) and 93.122(b)(2) of the Transportation Conformity Rule.

FACTYPE	ABM Area Type							
	CBD	Urban Commercial	Urban Residential	Suburban Commercial	Suburban Residential	Exurban	Rural	Facility Type
10	23	26	31	35	41	48	53	principal arterial
11	21	26	29	33	38	43	48	minor arterial
12	21	26	29	33	38	43	48	arterial HOV
13	21	26	29	33	38	43	48	arterial truck only
14	17	23	24	26	30	35	45	collector

5) Transit Modeling
- a. Model recalibrated to 2010 transit ridership estimates, provided by transit operators
- b. Reflects results from the 2009-2010 Transit On Board Survey
- c. Routes updated to reflect current operating plans
- d. Transit mode split is estimated using the mode choice model
  - i. Estimates individual modal trips from the person trip movements developed in the trip distribution model
  - ii. Composed of 15 modes, including auto by occupancy and toll/non-toll choice, walk and bike non-motorized modes, and walk and drive access to different transit line-haul modes:
    1. Auto SOV (Free)
    2. Auto SOV (Pay)
    3. Auto 2-Person (Free)
    4. Auto 2-Person (Pay)
    5. Auto 3+ Person (Free)
    6. Auto 3+ Person (Pay)
    7. Walk
    8. Bike
    9. Walk-All-Transit
    10. Walk-Premium-Only
    11. PNR-All-Transit (PNR = Park and Ride)
    12. PNR-Premium-Only
    13. KNR-All-Transit (KNR = Kiss and Ride)
    14. KNR-Premium-Only
    15. School Bus
  - iii. The mode choice model is organized in terms of seven characteristics:
    1. Mathematical structure;
    2. Trip purposes and choice sets;
    3. Limitations on choice sets;
    4. Analysis of transit access;
    5. Treatment of HOV lanes;
    6. Stratification by income groups; and
    7. Analysis of alternative transit paths.
- e. Transit Fare Modeling
  - i. Transit fares are based on information provided by the local transit operators throughout the Atlanta region
  - ii. The base year for the travel demand model is year 2010; therefore, any costs of traveling incurred within the model are representative of year 2010 dollars

1. The base year calibration utilized transit fares that were in place in 2010; however the majority of local operators have implemented a fare increase since 2010. To reflect these fare increases while maintaining year 2010 dollars, the year 2015 fares were adjusted using the Consumer Price Index (CPI) online calculator[5] which accounts for inflation to calculate the cost of goods.[6]

   iii. A CPI adjustment was applied to all the operator fares and is carried forward for all model years from 2015 and beyond
   iv. The current ARC transit coding approach enables fares to be coded by mode and operator (cases where an operator has a different fare for different modes).
   v. The transit fare structure includes additional fares incurred from transferring from one operator to another
   vi. The fare structure results in a fare matrix which includes the total fare of the trip on a zone-to-zone level

f. 2009-2010 Transit On Board Survey Calibration
   i. Update of regional transit travel targets based on expansion of the on-board survey data
      1. Modifications to express bus and BRT transfer constants
      2. Modifications to travel demand model estimates of zero-car transit work trips
      3. Modifications to travel demand model estimates of kiss-and-ride passenger access and use of transit system
      4. Overall evaluation of all modal constants
      5. Refinement to park-and-ride lot assumptions
      6. Updated walk connector and percent walk procedures
   ii. Modified transit skimming procedures
   iii. Re-calibrated air passenger model
   iv. Assessment of travel demand model understanding of market segments and travel patterns relative to the on-board survey records

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[5] http://data.bls.gov/cgi-bin/cpicalc.pl
[6] For example, the current year 2015 one-way MARTA fare of $2.50 translates to approximately $2.30 in year 2010 dollars. In other words, the MARTA fare increase from $2.00 to $2.50 outpaces inflation. So, using the consumer price index calculator, the 2015 MARTA fare in year 2010 dollars is $2.30.

Appendix D – I/M Program

- Exhaust and Evaporative (OBD and gas cap pressure test) for 1996 and newer vehicles
  - Annual inspection required
  - Computerized test and repair OBD – Exhaust
  - Computerized test and repair OBD & GC - Evaporative
  - Applies to all LDG vehicle types
  - Three year grace period
  - 3% waiver rate for all vehicles – Exhaust test
  - 0% waiver rate for all vehicles – Evaporative test
  - 97% compliance rate
- Exhaust and Evaporative test for 1975 – 1995 vehicles
  - Annual inspection required
  - Computerized test and repair ASM 2525/5015 Phase-in – Exhaust
  - Computerized test and repair GC – Evaporative
  - Applies to all LDG vehicle types
  - 3% waiver rate for all vehicles – Exhaust
  - 0% waiver rate for all vehicles – Evaporative
  - 97% compliance rate
  - 25 year and older model years are exempt

Appendix E – VMT Adjustment Factors

Ozone VMT Adjustment Factors

Functional Class Name	Functional Classifications	Factor for 13 County Area	Factor for 7 County Area
Interstates / Freeways	1, 11, 12	0.99	0.83
Arterials	2, 14	1.02	0.90
Collectors	6, 7, 8, 16, 17	0.84	1.18
Local	9, 19	1.83	2.26