2040 Long Range Transportation Plan

Adopted: April 15, 2013

APPENDIX B
POPULATION & EMPLOYMENT PROJECTION DATASET & METHODOLOGY

FAMPO
Fredericksburg Area Metropolitan Planning Organization

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REGIONAL COMMISSION

Fredericksburg Area Metropolitan Planning Organization

Population and Employment Projection Dataset and Methodology

FAMPO
Fredericksburg Area Metropolitan Planning Organization

FAMPO 2040 Long-Range Transportation Plan Update

Socio-Economic Data Element

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1. Overview

The socio-economic portion of the Long Range Plan is an essential and often overlooked part of the Plan. As is the national practice, FAMPO employs population and employment data as inputs to its travel demand model and to therefore predict future transportation congestion deficiencies. Once identified, these deficiencies on the surface transportation system are a major factor in recommending what improvements should be made with scarce resources. Other factors include condition, environmental impacts, community support, project readiness, impact on land use, cost and the other factors included in the adopted FAMPO project prioritization methodology.

To arrive at population and employment data with which to populate the FAMPO travel demand model, a rigorous process is undertaken. This process is described in subsequent sections of this Appendix, below, in a highly detailed, academic manner, so as to demonstrate the disciplines employed. At each step of the process, the FAMPO Technical Committee, Transportation Advisory Group (TAG) and, ultimately, the FAMPO Policy Committee, with the FAMPO Policy Committee voting to adopt the socio-economic inputs to the FAMPO travel demand model for the Long Range Plan.

Generally speaking, first, a baseline of population and employment, the current situation, was established. The 2010 Census was utilized for this, including some manual adjustments to data which the Census did not include. To establish the baseline FAMPO employed its own staff, as well as staff from GWRC, local governments, VDOT and DRPT in a collaborative effort. The Census showed a Regional population of 327,773 and employment total of 149,939. Once the current situation was established, the team needed to place the population and employment spatially across the Region in Traffic Analysis Zones (TAZs), the basic building blocks for the travel demand model. In simple terms this means that current population and employment in specific areas of each local government had to be assigned. Again this was done and agreed to in collaboration with local government staff and the other team partners. Following development of the baseline, the travel demand model was run to show current conditions and congestion deficiencies.

The next step was to develop population and employment forecasts for the interim and horizon years for the 2040 Plan. The interim years were 2020 and 2030, while the horizon year was 2040. For this a number of sources were utilized, including the Virginia Employment Commission (VEC), Woods and Poole, Global Insight, Economic Modeling Specialists (EMSI), Parsons Brinkerhoff and staff at GWRC. The 2040 Regional population figure of 617,340 was projected as somewhat conservative, and an employment total of 252,290. Interim year population and employment projections were also provided. The FAMPO Policy Committee adopted these projections.

It should be noted that population projections, like any projections, are often controversial, opposed by those who think they are too high or too low. As stated above, the full methodology for development of the 2040 Long Range Plan is provided in academic fashion in sections of this Appendix below. Perhaps this will help to allay these potential controversies. It should also be noted that, of the forecast sources cited above, four predict a 2040 Regional population of between 660,000 and 590,000, while one is an outlier at about 440,000. Moreover, long

after this work was completed and used in the 2040 Plan Update, VEC provided an updated Regional, 2040 population total forecast of over 700,000. FAMPO will consider this new VEC forecast in its next Long Range Plan Update.

As with the baseline data, the next step in the projected population and employment forecasts was to allocate them spatially across the various TAZs within the local government boundaries. Again as with the baseline, this was done in collaboration and consensus with local government staff and the other partners.

From this the data was loaded into the FAMPO travel demand model, and the outputs of that model showed was run show the congestion deficiencies for the Needs and Constrained portions of the 2040 Long Range Plan Update.

2. Base Year (2010) Data Elements

The 2010 U.S. Decennial Census of Population and Housing provided the primary source for population and housing estimates for the 2010 base year of the Plan Update. The various component data elements are detailed further below.

2.1 Demographic (Population & Housing) Data

a. Data Variables

1. Total Population
2. Total Group Quarters Population
3. Total Household Population
4. Total Housing Units
5. Occupied Housing Units
6. Vacant Housing Units
7. Average Household Size

b. Sources

1. U.S. Census Bureau, 2010 Census, PL94-171 Redistricting Data file
2. U.S. Census Bureau, 2010 Census, 2010 Census Advance Group Quarters Summary File
3. Local Government Building Structures spatial data files (shp)

c. Methodology

1. General Methodology of Demographic Estimates

The PL94-171 redistricting data file provided the earliest release of 2010 Census block-level census counts of the number of persons, housing units and occupied housing units. The Advance Group Quarters (AGQ) Summary file, once merged with the PL94-171 file, adds to the block-level summary the number of persons living in group quarters facilities (both institutionalized and non-institutionalized), allowing GWRC staff to compute household populations and average household size at the block level.

The 2010 merged PL94-171/AGQ file was processed to assign each census block to the corresponding 2007 FAMPO TAZ area that encompassed the centroid of each census block. The census blocks were then merged based on their TAZ attribute to aggregate all block data to the new TAZ geography. The resulting 2010 TAZ polygon file was then reviewed to compare the 2007 and 2010 TAZ geographies and identify TAZs whose boundaries were re-shaped to conform to the outlines of the component 2010 census blocks. In some instances, large rural blocks could not be assigned to any one 2007 TAZ. In such instances, a manual adjustment method (see below) was applied to create estimated demographics for the original TAZ (or the remaining portion of the TAZ or TAZs if the previous procedure created a large sub-TAZ).

2. Manual Adjustments Methodology

FAMPO and local transportation planners indicated a strong desire to retain the same number and the general conformity of 2010 TAZs to those used in the 2035 CLRTP. Consequently, it was necessary to manually re-define certain TAZ and create estimates of population, households and group quarters populations for these manually-defined areas, which would conform to the 2010 Census count for the larger surrounding area (i.e. census block(s)).

The majority of the manual TAZ estimation was done for select TAZs in Stafford County. In these areas, the 2007 TAZ geography was superimposed on the revised draft 2010 TAZ boundaries; artificial TAZ boundaries were re-drawn to conform to the historic 2007 TAZ outline, and the demographic data for these TAZs was manually estimated by using the County's building structure file, adding the number of residential structures within each TAZ and then adjusting these totals to conform to the component TAZ area share of the entire larger census block total. The block level vacancy rate and average household size was applied to each component TAZ to produce estimates of the equivalent 2010 Census population and numbers of households in each area. In all cases, there were no reported qroup quarters (GQ) populations in the affected census blocks, so no allocation of block GQ population was necessary.

2.2 Economic/Employment Data

a. Data Variables

Employment by Place of Work Estimates, 2010, by 2-digit NAICS economic Sector

NAICS Code	Description
11	Agriculture, Forestry, Fishing and Hunting
21	Mining, Quarrying, and Oil and Gas Extraction
22	Utilities
23	Construction
31-33	Manufacturing
42	Wholesale Trade
44-45	Retail Trade
48-49	Transportation and Warehousing
51	Information
52	Finance and Insurance
53	Real Estate and Rental and Leasing
54	Professional, Scientific, and Technical Services
55	Management of Companies and Enterprises
56	Administrative and Support and Waste Management and Remediation Services
61	Educational Services
62	Health Care and Social Assistance
71	Arts, Entertainment, and Recreation
72	Accommodation and Food Services
81	Other Services (except Public Administration)
92	Government
99	Sector Unknown

b. Sources

ESRI/InfoUSA Business Points datafile, 2010 (re-seller of Infogroup www.infousa.com data), providing an initial 10,019 business establishment records within the PD 16 area

Variable Name	Variable Description	Variable Type	Variable Width	Decimal Places

	Variable Name	Variable Description	Variable Type	Variable Width	Decimal Places
1	CONAME	Company Name	Char	30	
2	ADDR	Address	Char	30	
3	CITY16	City	Char	16	
4	STATE	State Abbreviation	Char	2	
5	STATE_NAME	State Name	Char	50	
6	ZIP	5-Digit ZIP Code	Char	5	
7	SIC	Primary SIC	Char	6	
8	**NAICS_EXT**	**8-Digit NAICS Code**	Char	8	
9	**SALES_VOL**	**Estimated Sales Volume***	Num	10	0
10	HDBRCH	Business Status code	Char	1	
11	**NUMBER_EMP**	**Number of Employees (Actual)**	Num	10	0
12	**EMPSIZ**	**Employee Size Code**	Char	1	
13	FRNCOD	Franchise Code	Char	6	
14	ISCODE	Type of Business	Char	1	
15	SQFT	Square Footage Code	Char	1	
16	**MATCH_CODE**	**ESRI Geocoder Match Code**	Char	5	
17	LOCNUM	Location Number (Unique Number)	Char	9	
18	LONG	Longitude	Num	11	6
19	LAT	Latitude	Num	10	6

**in Thousands*

c. Methodology

1. ESRI/InfoUSA Business Point Data File Enhancement

- **Identification of Additional Missing Business Records**

GWRC staff conducted on-line searches with www.manta.com to identify business establishments located in the region that did not appear in the supplied ESRI/InfoUSA database of 10,019 records. These searches were run at the zip-code level, focusing primarily on outlying rural and suburban zip codes, where it was suspected that more small establishments may exist than were reported in the ESRI/InfoUSA database.

Additional searches run for the primary, more urban zipcodes in the Region (i.e. 22401, 22407, 22408, 22551, 22553, 22554, etc) yielded far too many listings to try to enhance the database further through this laborious process. However, for the more rural areas, this comparison and the resulting additional establishment records created (where the www.Manta.com record provided sufficient detail to estimate the firm's employment size, location and business sector) added several hundred records to the database. This enhancement of the original data became important to the subsequent employment allocation process to produce the final traffic zone-level employment estimates by NAICS 2-digit code.

- **Employment Estimation for Records with No Reported Employment (NUMBER_EMP)**

In the original database of 10,019 records, 2,885 (or 28.8 percent) had 0 employment reported for the business. However, the ESRI/InfoUSA business establishment file had 3 other key attributes useful for estimating the number of employees working with these establishments. First, virtually all of these records had an "EMPSIZE" code,

indicating an employment size range for these firms (e.g. 1-4, 5-9, 10-19, etc) and estimated sales volume. GWRC staff used the EMPSIZE code, combined with the NAICS code and SALES_VOL code to compare the businesses missing the number of employees with comparable businesses (by NAICS, EMPSIZE and SALES_VOL) with reported employment. Missing data for "NUMBER_EMP" was replaced with the average number of employees reported for comparably sized firms with common NAICS, EMPSIZE and SALES_VOL values in PD16. For establishments lacking any "comparables" in the region, the average for such establishments statewide was used as a surrogate value.

Additionally, for some records, the establishment listing on www.manta.com oftentimes provided an "EMPSIZE" estimate that could be used, along with the firm's NAICS code and SALES_VOL estimate to provide a reasonable employment estimate for the establishment.

- **Identification and Deletion of Duplicate Records**

Establishment listings were sorted by address, phone (obtained from www.manta.com listings or local phone book), NAICS code, business name, etc to find occurrences of duplicate establishment records that shared a common NAICS code and address (and perhaps business name). In such instances, the record with the smaller employment estimate or no estimate at all was deleted from the database.

- **Geocoding Corrections**

The accuracy of the business address location and the associated lat/lon map coordinates for that location are critical to the accurate coding of the businesses to the proper traffic analysis zone (TAZ). The ESRI/InfoUSA record had an important "MATCH_CODE" field that identified whether the supplied map coordinates were based on the street address or some approximation thereof (e.g. zipcode centroid). Moreover, some records had either local delivery addresses with map coordinates that located the establishment outside the PD 16 area or "PO Box" addresses representing locations off-site from the physical establishment street address.

The locational accuracy issues were addressed as follows:

- PO Boxes: Businesses with PO Box addresses were researched in local telephone book and through the www.Manta.com website and local street addresses, when found, where substituted for the PO Box address. These records were tagged for later geo-coding update to correct the lat/lon map coordinates for their location. If no street addresses could be located for the PO Box address, the business location was randomly assigned within the 5-digit zip code area. While only applied to a relatively few number of records, all of these businesses were smaller establishments with fewer than 5 employees.

- Off-Site "MATCH_CODE" values: Business establishment records with "match_code" values indicating something other than the exact street address being used for the location coordinates were selected, tagged and researched to find a local street address for as many records as possible. Once updated addresses were determined for these records, they were tagged for later geo-coding update to correct the lat/lon map coordinates for their location.

- Businesses using administrative address (sometimes outside the region) rather than local physical street address: The ESRI/InfoUSA business establishment database was cross-referenced with

other secondary sources (such as the www.manta.com website, a Virginia Health Dept listing of all licensed food service locations, the regional "critical facilities" list developed for and recently updated for the regional all-hazards mitigation plan update and the on-line business directory maintained by The Free Lance Star (http://biz.fredericksburg.com/) to find usable local street addresses for geo-coding purposes.

- Assigning Lat/Lon map coordinates to identified records was done in a series of operations. Many new records were assigned approximate map coordinates using the geocoder tool in Maptitude, assigning an arbitrary 50 foot setback from the street centerline based on the interpolated location from the address ranges for the PD 16 regional street file. Other records were located by using the 911 street address files provided by local governments for the map coordinates associated with addressable structures. Any remaining unfound records were assigned their map coordinate values through the use of Google Earth searches on the street address and the copying/pasting of the map coordinates for the found address (and image of the building) from Google Earth to the ESRI/InfoUSA database.

2. Additional Local Survey and Employment Verification

Due to their relative importance as large employers in the local economy, GWRC contacted the three military establishments (MCB Quantico, NSWC Dahlgren and Fort A.P Hill) to determine how many employees (in the aggregate) there were at each base.[1] Moreover, GWRC attempted to contact local government and local school board human resources departments to try to verify and update employment estimates for all local government sector employment locations.

3. Assigning TAZ codes to Business Establishment Records

The final TAZ code assignment for all records was performed in a batch operation where each business establishment record was "tagged" with the TAZ code for the surrounding area using the Maptitude GIS "point in polygon" tagging function. Additionally, the local jurisdiction FIPS code was assigned to every record to enable aggregation of records at the local government level.

4. Summary of Enhancement Results

The net result of the combined efforts to enhance the ESRI/InfoUSA data file to achieve more accurate sub-jurisdictional aggregate employment estimates is summarized in Table 1.

[1] The aggregate estimates supplied provided control estimates for verifying the accuracy of the aggregate estimates at the TAZ level derived from the enhanced ESRI/InfoUSA database.

Table 1. Comparison of Original and Enhanced ESRI/InfoUSA Business Points File

Locality	Original ESRI Data		Enhanced ESRI Data		Net Change	
	No. of Records	Total Employment	No. of Records	Total Employment	Record Count Difference	Employment Change
Caroline Co	731	5,982	1,011	7,604	280	1,622
City of Fredericksburg	2,097	23,573	1,817	23,579	-280	6
King George Co	679	5,494	1,276	9,337	597	3,843
Spotsylvania Co	3,349	32,762	3,322	37,748	-27	4,986
Stafford Co	3,161	35,756	3,043	39,787	-118	4,031
PD 16 Total	**10,017**	**103,567**	**10,469**	**118,051**	**452**	**14,484**

While the increases in Caroline and King George Counties are mostly due to the extra research to find additional business establishments, the net changes in the other jurisdictions resulted from all of the research efforts described above. The 3 FAMPO localities all saw a reduction in the total number of establishment records as a result of deleting many duplicates and redistributing businesses throughout the Region based on their actual physical location. However, they also all realized a net increase in the total employment estimated as compared to the reported figure from the original data.

d. Producing Aggregate Data for Each Locality and TAZs

The final enhanced ESRI/InfoUSA business establishment database was exported into five separate Excel worksheets (for each of the five local governments). The EXCEL Pivot Tables function was used to produce a cross-tabulation table by 2-digit NAICS code of all business records in each jurisdiction and TAZ. These spreadsheet workbooks became the basis for the employment allocation models described further below.

e. Allocating Employment by Sector to Match Jurisdiction-level Control Estimates

Overall for the regional planning study area, the enhanced ESRI/InfoUSA business establishment database accounted for over 78% of all employment based on the Woods and Poole Inc. estimates. In some cases, the aggregate total for selected sectors exceeded the estimated total for that sector as reported in the Woods and Poole employment estimates preferred by FAMPO planning consultant (Parsons Brinkerhoff) staff as the basis for employment projections. In such instances, the higher local aggregated employment estimate was used in place of the W&P control estimate.

For the other sectors, the local aggregated employment estimate was subtracted out of the W&P control estimates. What remained is the 22% of W&P employment that was not represented by the local aggregated employment estimate. Since some sectors were under-estimated by W&P (based on the local aggregated employment estimate), it has been assumed by GWRC and PB staff that the other sectors could have been over-estimated. Therefore the remaining W&P employment was adjusted (scaled back) so when added to the local aggregated employment estimate, the sum of all sectors would equal the original W&P total employment. This remaining W&P employment was allocated to the TAZs. This sector-specific spatial allocation was done by one of two methods described below.

➢ Method A: Existing Establishment Ratio-Share Allocation Method

The first sector-specific employment allocation method relied on the spatial distribution (at the TAZ level) of each sector's estimated employment. In other words, if a TAZ had (for example) 10% of the locality's reported distribution of employment in a given sector, it received a 10% share of the amount of that sector's additional

employment allocated to equal the total reported in the W&P control estimate for that locality. The logic behind this allocation process is that the enhanced ESRI/InfoUSA represents a large sample of the location pattern for that sector in the locality and remaining jobs in that sector are presumed to follow a similar location pattern.

This allocation method was done region-wide and is the only methodology used for allocating additional employment in Caroline and King George Counties.

➢ Method B: Building Inventory-Based Allocation Method

For the other three FAMPO jurisdictions (i.e. the City of Fredericksburg and Stafford and Spotsylvania Counties), in addition to the first allocation method, a second, more robust method was developed for spatial distribution of allocated employment by economic sector. In this approach, the allocation was based on the distribution of various land uses that support or accommodate the allocated employment sector. The assumptions and the land use variables used for this allocation are summarized in the table on the following page.

Table 2. Method B Employment Allocation Assumptions by Sector and Building Type

		Sector Share for Employment Allocation				
NAICS	**Description**	**Households**	**Ag Land**	**Office**	**Retail**	**Industrial**
11	Agriculture, Forestry, Fishing and Hunting		100%			
21	Mining					100%
22	Utilities			25%		75%
23	Construction	33%		34%		33%
31-33	Manufacturing					100%
42	Wholesale Trade			34%	33%	33%
44-45	Retail Trade				100%	
48-49	Transportation and Warehousing			50%		50%
51	Information	25%		50%	12.5%	12.5%
52	Finance and Insurance	25%		75%		
53	Real Estate and Rental and Leasing	25%		75%		
54	Professional, Scientific, and Technical Services			100%		
55	Management of Companies and Enterprises			100%		
56	Administrative and Support and Waste Management and Remediation Services	25%		50%		25%
61	Educational Services			50%	50%	
62	Health Care and Social Assistance			100%		
71	Arts, Entertainment, and Recreation			25%	75%	
72	Accommodation and Food Services				100%	
81	Other Services (except Public Administration)	25%		75%		
92	Public Administration			100%		

Source: Assumptions developed by GWRC staff.

For select sectors, the zonal share of total households was used in the allocation to help account for home-based occupations which are more prevalent in certain sectors (e.g. real estate, accounting, private trash collection, etc.).

The zonal share of the supply of working farmland[2] was used to allocate jobs in NAICS sector 11 (Agriculture, Forestry, Fishing and Hunting). The assumptions for the other sectors were based on GWRC staff professional judgment based on the available aggregate building data at the TAZ level. (see Table 2 on next page). Some sectors would have been allocated to light-industrial/office-flex space; however, this property type had been included in the land use category during the aggregation of building data and was subsequently not available to be included without considerable additional effort for uncertain marginal improvement in the allocation outcome. Consequently, GWRC chose to use the aggregated building data without trying to include the office-flex space as a unique space category.

The resulting allocation model, in this instance, took a weighted average of the percentage shares which each TAZ had of the eligible occupied building square footage in the jurisdiction.

In order to develop the alternative "Building Inventory-Based" employment distribution methodology (i.e. "Method B") , GWRC staff assembled real estate, land use and building inventory data from many sources to develop the data variables, sources and methodology for this allocation process. Details of this method follow below in this section.

a. Data Variables

1. Building Structures by Land Use Type
2. Total, Occupied and Vacant Commercial/Industrial Building Square Footage, by Major Property Type (Retail, Office, Office-Flex, Industrial)

b. Data Sources

1. Building Structures and Tax Parcels by Land Use Type: local government GIS departments
2. Total, Occupied and Vacant Commercial/Industrial Building Square Footage and Vacancy Rates, by Major Property Type (Retail, Office, Office-Flex, Industrial): CoStar[3] historic real estate reports provided by the Fredericksburg Regional Alliance.
3. American Planning Association: the Land Based Classification Standards project (http://www.planning.org/lbcs/background/index.htm)

c. Methodology

1. City of Fredericksburg, Spotsylvania and Stafford Counties

The APA functional land use classification was available as a property attribute in the City of Fredericksburg and Stafford County parcel file which provided the building locations and estimated square footages of building area. For these 2 communities, the APA-LCBS function dimension code was converted to an assumed property type using the following cross-walk:

[2] The "Working Farmlands" spatial dataset was developed in the related Regional Scenario Land Use Planning Study. The zonal share of all working farm land area was used to allocate agriculture and forestry sector jobs.

[3] See http://www.costar.com/Products/Property.aspx

Building Type	APA LCBS Functional Dimension Code(s)
Office Space	2400 to 2550
Office-Flex	No identified comparable LCBS codes
Retail Space	2000-2400
Industrial Space	3000

For Spotsylvania County data, the County land use and zoning codes (along with building attribute information) were used to assign APA functional land use codes to building structures.

2. King George and Caroline Counties

After considerable effort working with the building structures and parcel data files provided by these 2 local governments, GWRC staff concluded that the disparity in land-use classifications from the coding systems used in the other three communities made it virtually impossible to create comparable data within the schedule and budget parameters of this project. As a result, later employment allocations by traffic zone were only done using the estimated existing employment by traffic zone, based on the GWRC-enhanced ESRI/InfoUSA business establishment database (i.e. "Method A").

3. Determining Estimated Occupied Building Space, by Building Type by TAZ

A set of Excel spreadsheets were developed to summarize the extracted 3rd Quarter 2010 average total square footage, occupied square footage, vacant square footage and vacancy rate for each of four building types (office, office-flex, retail and industrial) at the zip code level[4]. The resulting zipcode dataset was linked to a zipcode polygon file and the appropriate building occupancy rate by zip code was assigned to the building data supplied by local governments in a building structures spatial dataset for all buildings. The estimated occupied building data was aggregated by TAZ and the TAZ's share of the locality's occupied building inventory was calculated to be used in the Method B employment allocation process.

d. Accounting for Sector Classification Differences between Data Sources

When the aggregated ESRI-enhanced data were compared to the original Woods and Poole estimates, it was apparent that Woods and Poole had classified local government school employees in Sector 92 (Government), while the ESRI business establishments data had classified these employment locations as Educational Services. Since local school board administrative staff had been directly surveyed to enhance the list of school employment sites and employment levels, and local government human resources departments had been contacted as well; GWRC decided to hold the enhanced ESRI data estimate as the better estimate for Sector 61 (Educational Services). The sum of W&P estimates for Sectors 61 (Educational Services) and 92 (Government) was compared to the sum of the same sectors from the ESRI-enhanced data and the net difference was allocated in Sector 92 (Government) by TAZ using either allocation method.

e. Results and Final Adjustments (See Sections 2, 4 and 5)

The final results of the allocation models produced 2 Excel datasets, one based on the region-wide application of Method A and the second including Method A results for Caroline and King George Counties and Method B results

[4] These CoStar zipcode level historical building data reports were provided by the Fredericksburg Regional Alliance (FRA). The cooperation and assistance of the FRA in supplying these data is greatly appreciated.

for the remainder of the FAMPO study area. GWRC staff anticipates local government staff review (at least in the latter case) to determine which method produces generally more acceptable results for use in the LRTP travel demand model.

The 2 comparative data sets reflecting the results of the two allocation methodologies were shared with local government planning staff, requesting local review and feedback on the preferred allocation method. Only Spotsylvania County transportation planning staff commented, noting the preference for the land-use based allocation method but expressing concern that the total employment estimate appeared to be inflated[5], given the current regional and local depressed economy. No specific downward adjustment was proposed in this feedback and no response was given to GWRC staff observations that the current difficulty economy is believed to exacerbate the pattern of multiple job-holding by individuals.

4. Use of "Hybrid" Allocation Model

GWRC staff re-evaluated the two employment allocation methods and concluded that the land use-based method was more appropriate for most economic sectors, but not the government (NAICS 92) sector. Consequently, a "hybrid" allocation model was applied, using the enhanced ESRI data distribution to allocate the remaining government jobs and the land use allocation model to allocate the other sectors, as necessary.

5. Manual Adjustments for Military Installations

GWRC staff then examined the specific resulting employment estimates for the Stafford traffic zones that cover Marine Corps Base-Quantico and the King George traffic zones that cover Naval Surface Weapons Center (NSWC)-Dahlgren. In Stafford County, the total employment for Quantico-affected traffic zones was under the total estimates provided by John Rosewarne, Chief of Staff to the Quantico Base Commander, Col. Dan Choike. However, it was determined that FBI Academy employment (2,500 persons) had been mis-coded to TAZ #9. After re-assigning this employment from education to government and moving it from TAZ #9 to TAZ #28, the resulting on-base discrepancy was significantly reduced and the total allocation adjustment was reduced as well. For MCB-Quantico, GWRC increased the remaining government employment (1,450) to be allocated in Stafford to coincide with the Quantico employment estimates reported for the West Side (TAZ 28) and the Main Base (Stafford portion) (TAZ 152).

This supplemental increase inflated Stafford County employment over the total Woods & Poole control estimate by a total of 277 employees. However, GWRC staff believe this adjustment is necessary in order to reflect the recent growing employment base at Quantico resulting from the BRAC employment expansion in 2010 which would be difficult for Woods & Poole estimates to accurately reflect. By making this adjustment to the 2010 base year estimates, it is assumed that there will be no impact on the employment projections, reflecting a slower growth rate for the 2010 – 2020 period.

For NSWC-Dahlgren, the remaining government employment was manually allocated to TAZ 284 where NSWC base employment activity is concentrated.

[5] City of Fredericksburg Planning Dept. staff expressed similar concerns, but did not ask for any specific adjustment, citing the well-developed methodology to estimate and allocate employment as accurately as possible.

3. Future Year (2020, 2030, 2040) Data Elements

3.1 Demographic Data

a. Control Forecasts

The population control forecasts used for future allocation to the TAZ level were developed by Parsons Brinkerhoff as consultants to FAMPO. Their final projection methodology report is included herein.

Table 3. Total Population Projections (Rounded)

	Decennial Census Counts					Projections		
	1970	**1980**	**1990**	**2000**	**2010**	**2020**	**2030**	**2040**
Caroline	13,925	17,904	19,217	22,121	28,545	34,870	41,220	46,600
King George	8,039	10,543	13,527	16,803	23,584	30,230	37,820	44,700
Spotsylvania	16,424	34,435	57,403	90,395	122,397	161,470	202,740	240,570
Stafford	24,587	40,470	61,236	92,446	128,961	169,780	212,680	251,850
Fredericksburg	14,450	15,322	19,279	19,279	24,286	27,160	30,570	33,620
PD 16	**77,425**	**118,674**	**170,662**	**241,044**	**327,773**	**423,510**	**525,030**	**617,340**

b. Data Variables

The Parsons Brinkerhoff team was tasked with generating additional future demographic forecast data consistent with the 2010 total population estimates provided by the 2010 Census. These data elements included:

1. Group Quarters Population
2. Household Population
3. Persons per Household
4. Total Households
5. Income by Household Size

c. Sources

1. Woods and Poole, Inc., Annual Population and Economic Projections, 2011.
2. Global Insight, Inc., 2011
3. Virginia Employment Commission, Local Population Projections, 2007.
4. Economic Modeling Specialists, Inc. (EMSI)
5. Parsons Brinkerhoff (PB) project team.
6. GWRC Staff

d. Methodology

For Total Population control total, see Parsons Brinkerhoff project narrative in Section 7. Discussion of the conversion of the population forecast to forecasts of group quarter populations, household population, numbers of households, average household size, etc. is summarized in Section 9: Other Related Control Totals.

e. Results

Exhibit 1 provides the group quarters population by jurisdiction for each horizon year.

Exhibit 1: Group Quarters Population

Jurisdiction	2010	2020	2030	2040
Caroline County	513	627	741	838
King George County	301	333	369	402
Spotsylvania County	524	691	868	1,030
Stafford County	3,593	4,126	4,687	5,199
Fredericksburg City	2,596	2,904	3,267	3,593
Total	**7,527**	**8,681**	**9,932**	**11,061**

2010 Data Source: U.S. Census Bureau, 2010 Census of Population and Housing.

Exhibit 2 provides the household population by jurisdiction for each horizon year.

Exhibit 2: Household Population

Jurisdiction	2010	2020	2030	2040
Caroline County	28,032	34,240	40,476	45,764
King George County	23,283	29,901	37,450	44,299
Spotsylvania County	121,873	160,782	201,867	239,537
Stafford County	125,368	165,652	207,991	246,653
Fredericksburg City	21,690	24,259	27,298	30,022
PD 16 Total	**320,246**	**414,834**	**515,082**	**606,276**

2010 Data Source: U.S. Census Bureau, 2010 Census of Population and Housing.

Exhibit 3 provides the projected number of persons per household.

Exhibit 3: Persons Per Household

Jurisdiction	2010	2020	2030	2040
Caroline County	2.68	2.55	2.45	2.40
King George County	2.78	2.66	2.61	2.59
Spotsylvania County	2.91	2.82	2.77	2.78
Stafford County	3.00	2.89	2.83	2.81
Fredericksburg City	2.28	2.21	2.18	2.19

2010 Data Source: U.S. Census Bureau, 2010 Census of Population and Housing.

Exhibit 4 provides the number of households by jurisdiction for each horizon year.

Exhibit 4: Households

Jurisdiction	2010	2020	2030	2040
Caroline County	10,456	13,452	16,511	19,074
King George County	8,376	11,234	14,360	17,127
Spotsylvania County	41,942	57,096	72,847	86,092
Stafford County	41,769	57,390	73,388	87,677
Fredericksburg City	9,505	10,970	12,544	13,740
PD 16 Total	**112,048**	**150,142**	**189,649**	**223,709**

2010 Data Source: U.S. Census Bureau, 2010 Census of Population and Housing.

Exhibit 5 (next page) summarizes the regional forecast of numbers of households by household income. Additional detail on the five localities in the study area can be found in Section 9.

Exhibit 5: Regional Households by Household Income by Household Size Forecasts

Year	Income	1-Person	2-Person	3-Person	4-Or-More	Total
2010	**Less Than $24,999**	5,799	2,653	1,210	1,365	11,027
	$25,000-$49,999	6,883	5,786	2,619	3,507	18,795
	$50,000-$74,999	4,158	6,870	3,557	6,075	20,659
	$75,000 Or More	4,361	19,916	13,376	23,909	61,561
	Totals	**21,201**	**35,225**	**20,762**	**34,855**	**112,042**
2020	**Less Than $24,999**	7,164	3,068	1,452	1,476	13,160
	$25,000-$49,999	8,657	6,838	3,199	3,867	22,562
	$50,000-$74,999	5,373	8,411	4,544	7,031	25,359
	$75,000 Or More	6,503	29,080	20,390	33,082	89,054
	Totals	**27,697**	**47,396**	**29,585**	**45,456**	**150,135**
2030	**Less Than $24,999**	8,245	3,016	1,378	1,331	13,969
	$25,000-$49,999	10,279	6,928	3,129	3,613	23,948
	$50,000-$74,999	6,654	9,006	4,682	6,869	27,210
	$75,000 Or More	10,501	41,615	28,180	44,218	124,513
	Totals	**35,678**	**60,564**	**37,367**	**56,030**	**189,640**
2040	**Less Than $24,999**	8,287	2,568	1,155	1,083	13,094
	$25,000-$49,999	10,646	6,062	2,679	3,025	22,412
	$50,000-$74,999	7,106	8,229	4,151	5,890	25,377
	$75,000 Or More	16,012	54,700	36,137	55,969	162,817
	Totals	**42,051**	**71,560**	**44,122**	**65,967**	**223,699**

3.2 Economic Data

a. Control Forecasts of Total Employment

The total employment control forecasts by locality used for future allocation to the TAZ level were developed initially by Parsons Brinkerhoff (PB) as consultants to FAMPO and GWRC. The final PB projection report is included Section 7. Following PB's completion of the forecast series, GWRC staff found it necessary to adjust the 2010 base year estimates (see "Manual Adjustments for Military Installations", page 12) as well as make other relatively-minor adjustments to certain local sector forecasts.

See Section 9, Exhibit 4, page 33 for comparison between control forecasts produced by Parsons Brinkerhoff and the GWRC-revised forecast.

Exhibit 6. Total Employment Estimate (2010) and Control Forecast (2020-2040)

Locality	2010	2020	2030	2040
Caroline County	9,902	12,270	14,640	17,460
King George County	16,241	19,360	22,480	25,700
Spotsylvania County	45,376	52,620	59,870	70,170
Stafford County	46,929	57,500	70,180	84,140
Fredericksburg City	31,491	39,640	47,780	54,820
PD 16 Total	**149,939**	**181,390**	**214,950**	**252,290**

b. Data Variables

2-digit level NAICS industry classification for each county and the City of Fredericksburg.

c. Sources and Methodology

See the final PB projection report is included herein as Section 7.

d. Results and Adjustments

Upon increasing the base year employment in the government sector for Stafford and King George Counties to account for additional 2010 military employment at MCB-Quantico and NSWC-Dahlgren above the control total for the government sector, GWRC staff realized that the projected employment growth in these jurisdictions for the balance of the 2010-2020 decade would appear to be inconsistent with growth forecasts for the region overall. Consequently, the PB-control forecasts for 2020 were adjusted to apply a linear interpolation of employment growth from the adjusted 2010 estimate through 2030.

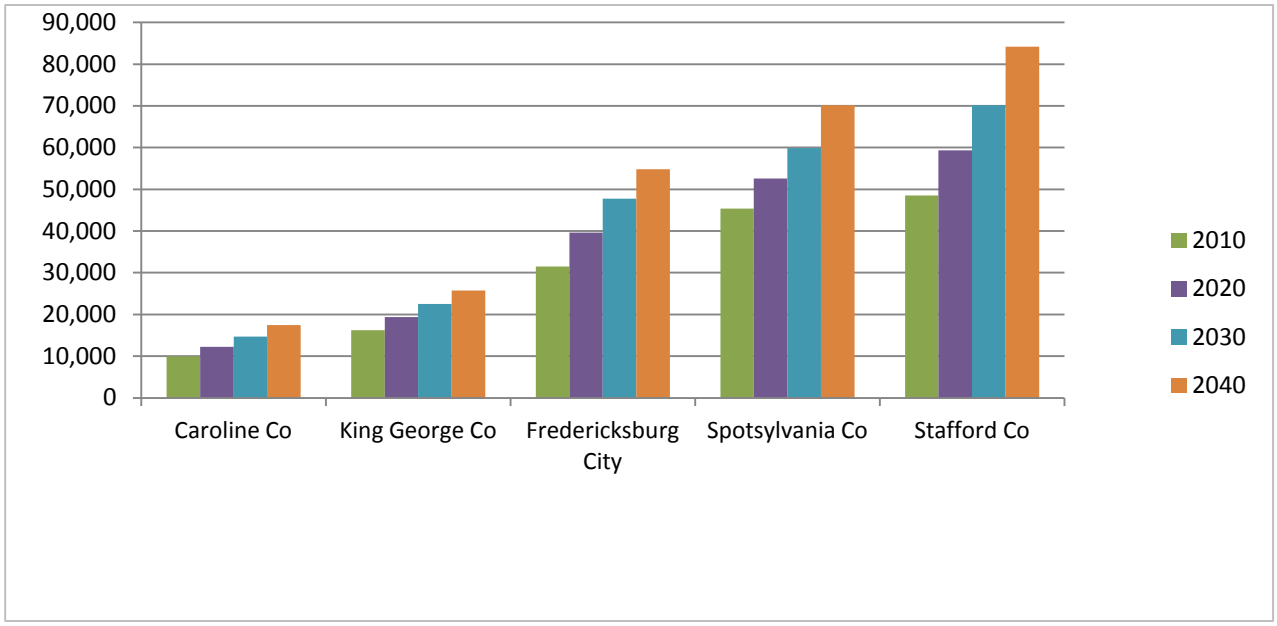
During this process, GWRC staff also noticed that, despite the projected population growth for Caroline County over the 2010-2040 period, retail employment in Caroline County was projected to remain flat and even experience a decline from 2030-2040. While Caroline County has no aggressive plans to pursue or expectations of attracting strong retail sector growth[6], an absolute decline in this sector seemed inconsistent with the forecasted population trend. To adjust the retail sector forecast, GWRC calculated the 2010 retail employment to total population ratio and applied this constant ratio to the County's projected population for 2020, 2030 and 2040. In order to hold the regional control forecast constant, the additional retail employment added in Caroline was deducted from Spotsylvania County's retail employment projection. The resulting downward adjustment in Spotsylvania County's total projected employment level for 2020, 2030 and 2040 revised these projections modestly in a manner consistent with expressed original County staff concerns of unrealistically-high employment projections for the County.

Another adjustment to the PB control forecast resulted from the re-allocation of the 2,500 employees of the FBI Academy in Stafford County from "Education Services" to "Government". Since the PB W&P adjusted forecast was based on W&P's mis-classification of the FBI Academy, the resulting forecast was inconsistent with the base year estimate. GWRC staff adjusted Stafford County's Education Services sector forecast by applying constant (2010 Education Services employment/Total County Population) multiplied by the future County population to increase Education Services sector employment for each horizon year (2020-2040). The net difference in this sector over the original W&P adjusted sector forecast was added to the Government sector employment, to maintain the County employment forecast for each decade.

The final adjusted total employment forecasts (see Exhibit 4, Section 8) and sector-level employment forecasts (see Exhibits 15-20, Section 8) were rounded by GWRC to provide a more appropriate forecast series for long-range modeling use.

[6] Per presentation on Caroline County economic development strategies by Caroline Co. Economic Development Director Gary Wilson to GWRC Board at November 21, 2011 GWRC Board meeting.

Exhibit 6. Comparative Local Employment Growth Projections, 2010-2040



4. Future Land Use Forecasts

The land use forecasting for the 2040 Long-Range Plan was completed utilizing the Community Plans Scenario that was developed as a part of FAMPO's Land Use Scenario Planning Study: ***Your Vision, Our Future***. The Community Plans Scenario examined how the Region would develop if all of the localities' comprehensive plans were fully implemented.

This scenario was developed by coding each parcel in the Region according to its future land use designation found in each of the GW Region's jurisdictions. In those designations there is information regarding the maximum population and employment densities and intensities that each land use can support could support, according to local zoning ordinances. The population and employment forecasts that are described in this document were used as control totals (by locality and Region-wide). *Community Viz* software was then used to allocate the population and employment parcel-by-parcel throughout the entire region. Then, the population and employment data was aggregated up to the Traffic Analysis Zone (TAZ) level for the years 2020, 2030 and the horizon year, 2040; 2010 decennial Census data was used as the base year. This aggregated TAZ data was then used as the input to the FAMPO travel demand model.

5. Demographic Data Summary

PD 16 Regional Population Table

George Washington Region: Total Population Projections (Rounded)

	1970*	1980*	1990*	2000*	2010*	2020	2030	2040
Caroline	13,925	17,904	19,217	22,121	28,545	34,870	41,220	46,600
King George	8,039	10,543	13,527	16,803	23,584	30,230	37,820	44,700
Spotsylvania	16,424	34,435	57,403	90,395	122,397	161,470	202,740	240,570
Stafford	24,587	40,470	61,236	92,446	128,961	169,780	212,680	251,850
Fredericksburg	14,450	15,322	19,279	19,279	24,286	27,160	30,570	33,620
PD 16	**77,425**	**118,674**	**170,662**	**241,044**	**327,773**	**423,510**	**525,030**	**617,340**

** Census*

6. Comparative Employment Estimates

Woods & Poole, Inc. vs. GWRC Local & Regional Control Estimates

Item	Description	Page
B.1	PD 16 Regional Summary: 2010 Employment Estimates	20
B.2	Caroline County: 2010 Employment Estimates (TAZs 720 – 878)	21
B.3	King George County Summary: 2010 Employment Estimates (TAZs 220 – 311)	22
B.4	City of Fredericksburg: 2010 Employment Estimates (TAZs 320 – 371)	23
B.5	Spotsylvania County: 2010 Employment Estimates (TAZs 400-698)	24
B.6	Stafford County Summary: 2010 Employment Estimates (TAZs 1 – 202)	25

6.1 PD 16 Regional Employment Table

REGION: GWRC-PD 16

Description: Va Planning District 16

County Areas: Caroline, Virginia (51033), King George, Virginia (51099), Spotsylvania, Virginia (51177), Stafford, Virginia (51179), Fredericksburg City, Virginia (51630)

		2010 EMPLOYMENT ESTIMATES				
NAICS Code	**Description**	**Woods & Poole Estimate**	**GWRC-Enhanced ESRI Business Points Estimate**	**Allocation Balance**	**Final GWRC Estimate**	**GWRC vs W&P Difference**
11	Agriculture, Forestry, Fishing and Hunting	1,512	371	923	**1,294**	-218
21	Mining, Quarrying, and Oil and Gas Extraction	245	158	114	**272**	27
22	Utilities	477	512	100	**612**	135
23	Construction	8,639	8,466	739	**9,205**	566
31-33	Manufacturing	3,610	2,865	673	**3,538**	-72
42	Wholesale Trade	4,206	3,492	659	**4,151**	-55
44-45	Retail Trade	18,710	20,533	657	**21,190**	2,480
48-49	Transportation and Warehousing	2,942	2,628	485	**3,113**	171
51	Information	1,894	2,166	248	**2,414**	520
52	Finance and Insurance	8,400	6,828	1,443	**8,271**	-129
53	Real Estate and Rental and Leasing	7,669	3,512	3,201	**6,713**	-956
54	Professional, Scientific, and Technical Services	12,375	7,237	4,522	**11,759**	-616
55	Management of Companies and Enterprises	1,281	70	1,083	**1,153**	-128
56	Administrative and Support and Waste Management and Remediation Services	6,749	2,999	3,091	**6,090**	-659
61	Educational Services	2,283	11,032	0	**11,032**	8,749
62	Health Care and Social Assistance	15,833	12,231	3,500	**15,731**	-102
71	Arts, Entertainment, and Recreation	3,069	1,865	976	**2,841**	-228
72	Accommodation and Food Services	11,898	13,223	581	**13,804**	1,906
81	Other Services (except Public Administration)	9,092	7,251	2,031	**9,282**	190
90	Government	28,700	9,551	7,844	**17,395**	-11,305
99	Sector Unknown		131	0	**0**	0
	Total	**149,584**	**117,121**	**32,870**	**149,860**	**276**

Source: GWRC, 2040 Long-Range Transportation Plan Update, Socio-Economic Data, Aug, 2011; Revised Feb. 2012

6.2 Caroline County Employment Estimates Table

CAROLINE COUNTY

NAICS Code	Description	2010 EMPLOYMENT ESTIMATES				
		Woods & Poole Estimate	GWRC-Enhanced ESRI Business Points Estimate	Allocation Balance Adjusted	Final GWRC Estimate	GWRC vs W&P Difference
11	Agriculture, Forestry, Fishing and Hunting	248	54	120	**174**	-74
21	Mining, Quarrying, and Oil and Gas Extraction	16	30	0	**30**	14
22	Utilities	138	131	4	**135**	-3
23	Construction	1,088	495	366	**861**	-227
31-33	Manufacturing	308	174	83	**257**	-51
42	Wholesale Trade	160	215	0	**215**	55
44-45	Retail Trade	898	1,344	33	**1,377**	479
48-49	Transportation and Warehousing	454	229	139	**368**	-86
51	Information	53	49	2	**51**	-2
52	Finance and Insurance	548	323	142	**470**	-78
53	Real Estate and Rental and Leasing	686	125	348	**473**	-213
54	Professional, Scientific, and Technical Services	813	439	236	**675**	-138
55	Management of Companies and Enterprises	58	70	0	**70**	12
56	Administrative and Support and Waste Management and Remediation Services	667	116	341	**457**	-210
61	Educational Services	59	538	0	**538**	479
62	Health Care and Social Assistance	491	546	0	**546**	55
71	Arts, Entertainment, and Recreation	294	78	134	**212**	-82
72	Accommodation and Food Services	410	872	0	**872**	462
81	Other Services (except Public Administration)	793	1,091	0	**1,091**	298
90	Government	1,714	675	356	**1,030**	-684
99	Sector Unknown		10			0
	Total	**9,896**	**7,604**	**2,305**	**9,902**	7

Source: GWRC, 2040 Long-Range Transportation Plan Update, Socio-Economic Data, Aug, 2011

6.3 King George County Employment Table

KING GEORGE COUNTY

NAICS Code	Description	2010 EMPLOYMENT ESTIMATES				
		Woods & Poole Estimate	GWRC-Enhanced ESRI Business Points Estimate	Allocation Balance Adjusted	Final GWRC Estimate	GWRC vs W&P Difference
11	Agriculture, Forestry, Fishing and Hunting	335	203	107	**310**	-25
21	Mining, Quarrying, and Oil and Gas Extraction	6	16	0	**16**	10
22	Utilities	44	54	0	**54**	10
23	Construction	783	1432	0	**1,432**	649
31-33	Manufacturing	205	291	0	**291**	86
42	Wholesale Trade	196	161	28	**189**	-7
44-45	Retail Trade	907	1497	0	**1,497**	590
48-49	Transportation and Warehousing	192	133	48	**181**	-11
51	Information	397	155	196	**351**	-46
52	Finance and Insurance	432	196	191	**387**	-45
53	Real Estate and Rental and Leasing	1,008	213	643	**856**	-152
54	Professional, Scientific, and Technical Services	2,961	981	1,601	**2,582**	-379
55	Management of Companies and Enterprises	0	0	0	**0**	0
56	Administrative and Support and Waste Management and Remediation Services	1,002	360	519	**879**	-123
61	Educational Services	181	967	0	**967**	786
62	Health Care and Social Assistance	589	462	103	**565**	-24
71	Arts, Entertainment, and Recreation	278	122	126	**248**	-30
72	Accommodation and Food Services	472	568	0	**568**	96
81	Other Services (except Public Administration)	755	970	0	**970**	215
90	Government	5,499	476	3,425	**3,900**	-1,599
99	Sector Unknown		80			0
	Total	**16,242**	**9,337**	**6,985**	**16,241**	-1

Source: GWRC, 2040 Long-Range Transportation Plan Update, Socio-Economic Data, Aug, 2011; Revised Feb. 2012

6.4 City of Fredericksburg Employment Table

CITY OF FREDERICKSBURG

NAICS Code	Description	2010 EMPLOYMENT ESTIMATES				
		Woods & Poole Estimate	GWRC-Enhanced ESRI Business Points Estimate	Allocation Balance Adjusted	Final GWRC Estimate	GWRC vs W&P Difference
11	Agriculture, Forestry, Fishing and Hunting	52	10	37	**47**	-5
21	Mining, Quarrying, and Oil and Gas Extraction	0	34	0	**34**	34
22	Utilities	121	75	40	**115**	-5
23	Construction	690	901	0	**901**	211
31-33	Manufacturing	650	440	185	**625**	-24
42	Wholesale Trade	782	405	333	**738**	-44
44-45	Retail Trade	3,969	3,226	657	**3,883**	-86
48-49	Transportation and Warehousing	226	429	0	**429**	203
51	Information	531	974	0	**974**	443
52	Finance and Insurance	886	889	0	**889**	3
53	Real Estate and Rental and Leasing	1,355	875	424	**1,299**	-56
54	Professional, Scientific, and Technical Services	1,352	1,499	0	**1,499**	147
55	Management of Companies and Enterprises	588	0	520	**520**	-68
56	Administrative and Support and Waste Management and Remediation Services	1,090	427	586	**1,013**	-77
61	Educational Services	380	1,742	0	**1,742**	1,362
62	Health Care and Social Assistance	7,912	5,158	2,434	**7,592**	-320
71	Arts, Entertainment, and Recreation	519	368	133	**501**	-18
72	Accommodation and Food Services	4,388	3,731	581	**4,312**	-76
81	Other Services (except Public Administration)	1,530	1,191	300	**1,491**	-39
90	Government	4,472	1,200	1,688	**2,887**	-1,585
99	Sector Unknown		5			0
	Total	**31,491**	**23,579**	**7,918**	**31,491**	0

Source: GWRC, 2040 Long-Range Transportation Plan Update, Socio-Economic Data, Aug, 2011; Revised, Feb, 2012

6.5 Spotsylvania County Employment Table

SPOTSYLVANIA COUNTY

NAICS Code	Description	2010 EMPLOYMENT ESTIMATES				
		Woods & Poole Estimate	GWRC-Enhanced ESRI Business Points Estimate	Allocation Balance Adjusted	Final GWRC Estimate	GWRC vs W&P Difference
11	Agriculture, Forestry, Fishing and Hunting	553	63	376	**439**	-115
21	Mining, Quarrying, and Oil and Gas Extraction	161	27	103	**130**	-31
22	Utilities	98	232	0	**232**	134
23	Construction	3,341	2,858	370	**3,228**	-113
31-33	Manufacturing	1,828	1,298	406	**1,704**	-124
42	Wholesale Trade	1,432	1,182	191	**1,373**	-58
44-45	Retail Trade	7,896	9,094	0	**9,094**	1,198
48-49	Transportation and Warehousing	1,475	1,086	298	**1,384**	-91
51	Information	397	332	50	**382**	-15
52	Finance and Insurance	1,244	1,207	28	**1,235**	-9
53	Real Estate and Rental and Leasing	3,173	890	1,748	**2,638**	-535
54	Professional, Scientific, and Technical Services	2,911	1,858	807	**2,665**	-247
55	Management of Companies and Enterprises	305	0	305	**305**	1
56	Administrative and Support and Waste Management and Remediation Services	2,018	955	814	**1,769**	-249
61	Educational Services	795	3,441	0	**3,441**	2,646
62	Health Care and Social Assistance	4,153	2,895	963	**3,858**	-295
71	Arts, Entertainment, and Recreation	1,114	696	320	**1,016**	-98
72	Accommodation and Food Services	3,550	4,840	0	**4,840**	1,290
81	Other Services (except Public Administration)	3,157	1,946	927	**2,873**	-284
90	Government	5,700	1,832	936	**2,769**	-2,932
99	Sector Unknown		16			0
	Total	**45,303**	**36,748**	**8,643**	**45,376**	73

Source: GWRC, 2040 Long-Range Transportation Plan Update, Socio-Economic Data, Aug, 2011

6.6 Stafford County Employment Table

STAFFORD COUNTY

NAICS Code	Description	2010 EMPLOYMENT ESTIMATES				
		Woods & Poole Estimate	GWRC-Enhanced ESRI Business Points Estimate	Allocation Balance Adjusted	Final GWRC Estimate	GWRC vs W&P Difference
11	Agriculture, Forestry, Fishing and Hunting	324	41	283	324	0
21	Mining, Quarrying, and Oil and Gas Extraction	62	51	11	62	0
22	Utilities	76	20	56	76	0
23	Construction	2,737	2,783		2,783	46
31-33	Manufacturing	619	661		661	42
42	Wholesale Trade	1,636	1,529	107	1,636	0
44-45	Retail Trade	5,040	5,339		5,339	299
48-49	Transportation and Warehousing	595	751		751	156
51	Information	516	656		656	140
52	Finance and Insurance	5,290	4,192	1,098	5,290	0
53	Real Estate and Rental and Leasing	1,447	1,409	38	1,447	0
54	Professional, Scientific, and Technical Services	4,338	2,449	1,889	4,338	0
55	Management of Companies and Enterprises	330	0	330	330	0
56	Administrative and Support and Waste Management and Remediation Services	1,972	1,141	831	1,972	0
61	Educational Services	868	4,344		4,344	3,476
62	Health Care and Social Assistance	2,688	3,170		3,170	482
71	Arts, Entertainment, and Recreation	864	601	263	864	0
72	Accommodation and Food Services	3,078	3,212		3,212	134
81	Other Services (except Public Administration)	2,857	2,053	804	2,857	0
90	Government	11,315	5,367	1,450	6,817	-4,498
99	Sector Unknown		20			0
	Total	**46,652**	**39,789**	**7,160**	**46,929**	**277**

Source: GWRC, 2040 Long-Range Transportation Plan Update, Socio-Economic Data, Aug, 2011; Revised Feb. 2012

7. Develop Jurisdictional Level Population Control Totals

Parsons Brinkerhoff was tasked to evaluate a set of population forecasts (and their respective methodologies) and recommend population control totals for the Long Range Transportation Plan (LRTP) horizon years (2010, 2020, 2030, and 2040) for Caroline County, King George County, Spotsylvania County, Stafford County and the City Fredericksburg.

Economic Modeling Services Inc. (EMSI), Virginia Employment Commission (VEC)[7], Woods & Poole (W&P), and Global Insight (GI) are the four forecasts reviewed as part of this analysis.

EMSI: The analysis of the EMSI forecast is based on a review of the information presented in Miller (2011)[8]. We did not get access to the actual forecasting model or any supporting spreadsheets; and as such are unable to verify the described methodology or its underlying assumptions. Some key characteristics of the forecasts are listed below (albeit based on the review of limited information).

A. EMSI forecasts developed on 2011 and they pivot off US Census Bureau data.
B. EMSI forecasts cover only two forecast periods 2010, and 2020.
C. EMSI forecasts use a cohort-component method for population forecasting (i.e., use a combination of birth rates, death rates and migration to forecast population).
D. Survival and migration rates (birth rates minus death rates plus migration) are regionalized by county.
E. Each county population forecasts (disaggregated by cohort, i.e., age group, sex, ethnicity, etc.) are forecasted based on historical data using a statistical forecasting method (i.e., sum of squares). Subsequently, these statistically forecasted rates are changed (reduced) manually, thereby overriding the original forecasts. There is no justification for or documentation on how and why the statistically forecasted rates were manually reduced. Obtaining further documentation is recommended.
F. Miller (2011) extrapolates the EMSI forecasts to obtain 2030 and 2040 forecasts. The extrapolation method cannot be validated without a review of the supporting spreadsheets. However, a review of the summary table (Table 9 of Miller report) shows a possible error in the EMSI forecast extrapolations. The 2030 and 2040 decennial percent change for the individual counties are exactly the same for each county and is similar to the statewide decennial growth rates of 10.1781% and 9.0933% for 2030 and 2040 respectively. Given the extrapolation methodology described by Miller (2011), it is unlikely that all counties and state would have the exact same decennial growth rate. Further analysis of this potential extrapolation error is recommended.
G. Miller (2011) asserts that the rapid growth in the region observed from 2000-2010 was due to the study region becoming a 'bedroom community' for residents commuting to Washington DC. While this may have had some effect, becoming a 'bedroom community' to Washington DC is not a driving factor for the observed high growth in population from 2000-2010. See following table (data from U.S Census Bureau as shown in VEC County Profiles[9]), which show that only a small share (9%) of the total commuters in the study area commute to Washington DC.

[7] Forecasts accessed via the County Profiles, http://www.vawc.virginia.gov/gsipub/index.asp?docid=300
[8] Miller, John (2011), "Population Projections for the State of Virginia, Caroline, King George, Spotsylvania, and Stafford Counties, and Fredericksburg City: 2010 to 2040." Prepared on behalf of Economic Modeling Specialists, Inc. (EMSI).
[9] VEC County Profiles, page 10, http://www.vawc.virginia.gov/gsipub/index.asp?docid=300

Exhibit 1: Percent Share of Commuters Traveling to Washington DC (2010)

	% Share of Commuters to Washington DC (2010)
Caroline County	3%
Fredericksburg City	7%
King George County	8%
Spotsylvania County	8%
Stafford County	11%
Total	**9%**

- Miller (2011) does not provide any justification for using EMSI forecasts or its validity; and does not substantially refute the VEC forecasts. Without such an analysis it is unclear why a blended forecast (one that averages EMSI and VEC forecasts) is recommended.

VEC: VEC forecast documentation, model, or supporting spreadsheets were not available for evaluation. The information on VEC forecasts were obtained from Miller (2011) and VEC website. Some key characteristics of the forecasts are discussed below.

- The VEC forecasts pivot off 2000 US Census Bureau data.
- Original forecast covers three forecast periods 2010, 2020, and 2030.
- Miller (2011) extrapolates the VEC forecasts to obtain 2040 forecasts (using historical shares as proxies).
- VEC will be updated their population projections in 2012 to reflect the 2010 Census counts, but this was long after the deadline required for projections in the FAMPO 2040 Long Range Plan Update. Newer VEC forecasts will be used by FAMPO going forward.
- The cohort-component method is used for population forecasting (i.e., use a combination of birth rates, death rates and migration to forecast population).
- The survival rates (birth rates minus death rates) are state specific.
- Migration rates are locality specific (i.e., varies by county).

Woods & Poole: these economic and demographic forecasts are developed by Woods & Poole Economics Inc., a firm that specializes in long term county economic and demographic projections. W&P provides detailed documentation on it forecasting methodology, which is the primary source used to evaluate its suitability for use in the LRTP. Some key characteristics of the forecasts are highlighted below.

- Population forecasts are available at the county level for years 2010, 2020, 2030, and 2040. Unlike EMSI and VEC forecasts, the W&P forecasts could be used in the LRTP without any extrapolations.
- The cohort-component method is used for population forecasting (i.e., use a combination of birth rates, death rates and migration to forecast population).
- In the W&P model population migration is a function of employment opportunities, and as such reflects the economic growth potential of a region.
- W&P does simultaneous projections for each county in the US. Such a comprehensive modeling methodology minimizes the error of regional models where growth/declines in external regions are not considered.
- W&P methodology is tied to the Bureau of Labor Statistics employment methodology, which makes it more intuitive for practitioners to understand.

- Forecast data is released annually, in October. The forecasts used in this report were released in October 2010. Given the release date, the current W&P forecasts are almost a year old and do not appear to capture the economic trends nor does it incorporate the latest US Census data. Generally this is not an issue; however, this year it is somewhat of an issue because (1) of the volatility of the US economy (where forecasters are continually revising short term growth projections); and (2) the release of 2010 census numbers would replace the current estimates for 2010. It is widely anticipated that with this release of actual census data, W&P would decrease its population estimates for 2020, 2030 and 2040.
- Forecasts are relatively inexpensive to purchase.

Global Insight: these economic and demographic forecasts are developed by IHS Global Insight (GI), a global forecasting firm that provides forecasts covering over 200 countries and spanning more than approximately 170 industries. GI is considered one of the premier forecasting firms, and is consistently rated as one of the most consistently accurate forecasting firm (see http://www.ihs.com/products/global-insight/accolades.aspx for recent accolades on forecasting accuracy). Unlike W&P, GI's methodology is somewhat of a 'black-box' and documentation is not readily available. Some key characteristics of the forecasts are described below.

1. Population forecasts are available at the county level for years 2010, 2020, 2030, and 2040. Unlike EMSI and VEC forecasts, the GI forecasts could be used in the LRTP without any extrapolations.
2. The cohort-component method is used for population forecasting (i.e., use a combination of birth rates, death rates and migration to forecast population).
3. Similar to W&P, the 'demand' for total population s estimated from the economic model; and as such, population (i.e., in-migration) is a function of the regions employment potential.
4. GI forecasts are consistently updated; and as such reflect the most recent market trends and data updates (such as 2010 US Census data). Our ability to access GI forecasts on a real-time basis (via our online subscription) allows us to provide GWRC/FAMPO with the most up-to-date forecasts.
5. GI methodology is a hybrid between the employment methodologies of the Bureau of Labor Statistics and Bureau Economic Analysis, which makes it harder for practitioners to understand.
6. One-time purchase of these forecasts is expensive; and could provide a significant cost burden on to the project.

Comparisons

The following exhibits provide comparisons of the four forecasts discussed before (i.e., EMSI, VEC, W&P, and GI).

As illustrated in Exhibit 2, of the four forecasts, EMSI is an obvious outlier. As highlighted in the previous section, EMSI forecasts seem to have several methodological discrepancies. Unless these discrepancies are resolved (by obtaining further documentation and access to supporting models), it is our recommendation that EMSI forecasts should not be considered as a candidate for use in the LRTP.

VEC forecasts for 2010 seem to be higher than US Census estimates, and that difference (approximately 17,000, which translates to a 5% overestimation) appear to permeate through to the entire forecast. Given this overestimation, we do not recommend the use of VEC forecasts in the LRTP.

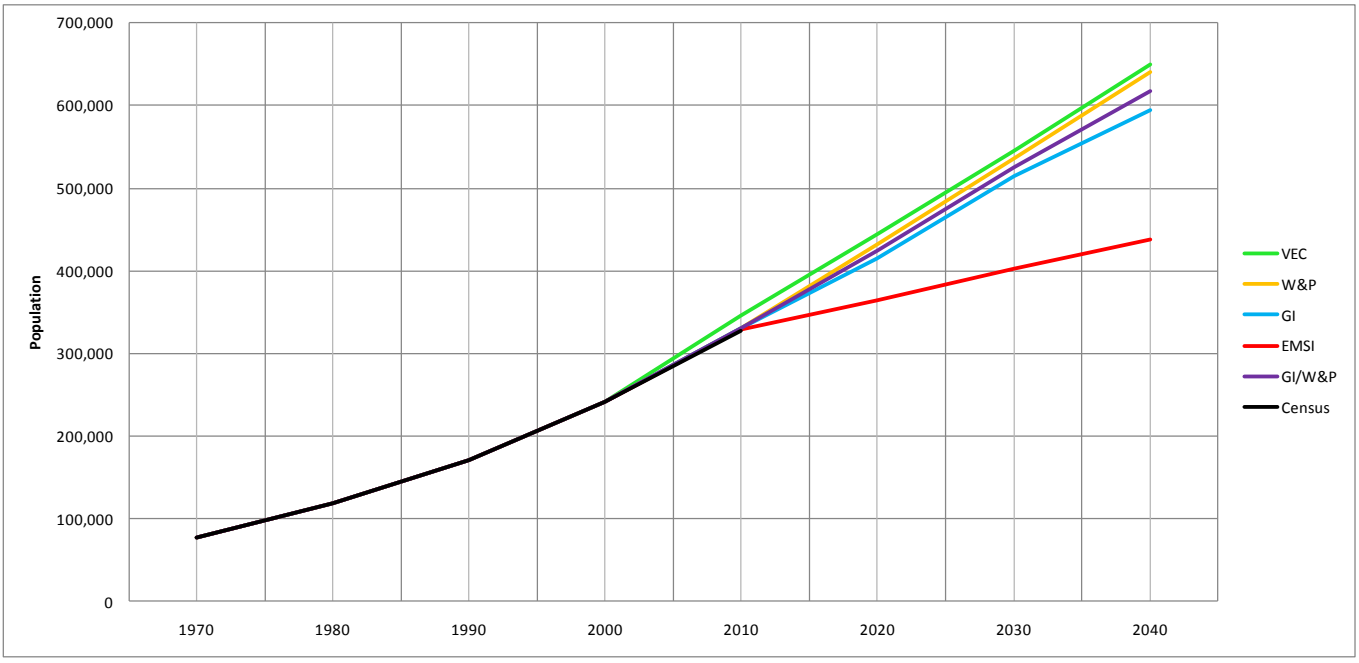
The remaining two forecasts (W&P and GI) appear to widen over time (W&P is 8% higher than GI in 2040). Both W&P and GI are reputed independent third party forecasting firms, which have no observable methodological flaws.

As such, we recommend the use of a W&P/GI composite forecast (i.e., an average of the two forecasts) in the LRTP. The W&P/GI average forecast is shown in purple in Exhibit 2.

Neither W&P nor GI provides separate projections for Spotsylvania County and Fredericksburg City. Both sources combine these jurisdictions in their forecasts. To derive separate projections for these jurisdictions, the Fredericksburg 2010-2020, 2020-2030, and 2030-2040 absolute change derived from the VEC data was applied to the new Fredericksburg 2010 Census figure (see Exhibit 3). The Fredericksburg projections were then subtracted from the W&P/GI composite Spotsylvania County/Fredericksburg City forecast to derive separate forecasts for Spotsylvania County. This gives Fredericksburg a healthier outlook than what VEC originally projected but the suggested growth of 9,329 over a 30 year period is certainly within reason. This approach also has a minimal effect on the population growth outlook for Spotsylvania County.

Exhibit 4 summarizes the W&P/GI average forecast for the 5 jurisdictions – Caroline County, King George County, Spotsylvania County, Fredericksburg City, and Stafford County. As expected the highest growth in population is forecasted for Spotsylvania County and Stafford County, which are both closer to Washington DC and Northern Virginia.

Exhibit 2: Total Population Forecasts (entire study region), 1970-2040



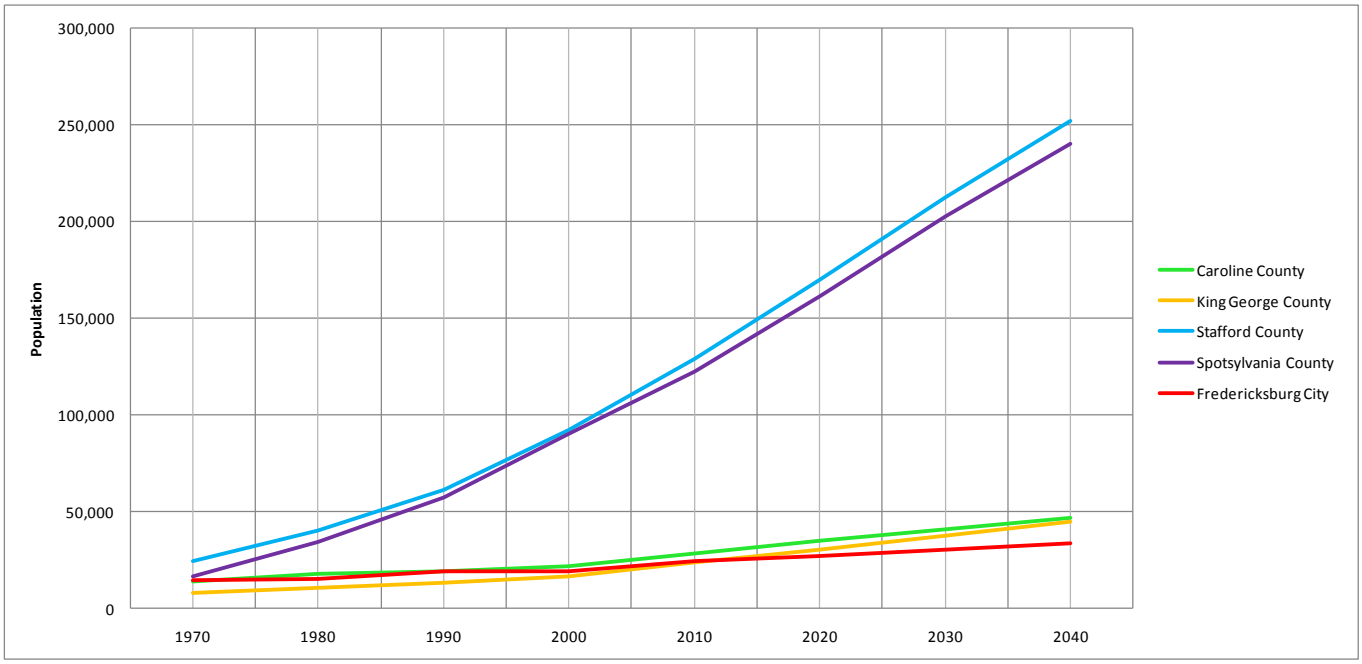
	1970	1980	1990	2000	2010	2020	2030	2040
Census	77,425	118,674	170,410	241,044	327,773			
EMSI	77,425	118,674	170,410	241,044	329,015	364,900	402,040	438,599
VEC	77,425	118,674	170,410	241,044	345,022	443,412	546,114	650,091
W&P	77,425	118,674	170,410	241,044	329,827	431,845	535,918	640,733
GI	77,425	118,674	170,410	241,044	330,459	415,186	514,108	593,941
GI/W&P	**77,425**	**118,674**	**170,410**	**241,044**	**330,142**	**423,515**	**525,014**	**617,337**

Exhibit 3: Fredericksburg/Spotsylvania Population Projection Split

	VEC Absolute Change			Census	Projection		
	2010-2020	2020-2030	2030-2040*	2010	2020	2030	2040
Spotsylvania County/Fredericksburg				146,683	188,636	233,300	274,182
Fredericksburg	2,877	3,402	3,050	24,286	27,163	30,565	33,615
Spotsylvania				122,397	161,473	202,735	240,567

The VEC 2010, 2020, and 2030 projections were extended out to 2040 using a regression analysis.

Exhibit 4: W&P/GI Average Population Forecast (by Jurisdiction)



	1970	1980	1990	2000	2010	2020	2030	2040
Caroline County	13,925	17,904	19,217	22,121	28,603	34,867	41,217	46,602
King George County	8,039	10,543	13,527	16,803	23,827	30,234	37,819	44,701
Spotsylvania County	16,424	34,435	57,403	90,395	122,397	161,473	202,735	240,567
Stafford County	24,587	40,470	61,236	92,446	129,300	169,778	212,678	251,852
Fredericksburg City	14,450	15,322	19,027	19,279	24,286	27,163	30,565	33,615

8. Developing Jurisdictional-Level Employment Control Totals

PB was tasked to evaluate a set of employment forecasts (and their respective methodologies) and recommend employment totals for the Long Range Transportation Plan (LRTP) horizon years (2010, 2020, 2030, and 2040) for Caroline County, King George County, Spotsylvania County, Stafford County, and the City of Fredericksburg

Employment forecasts from Woods & Poole (W&P) and Global Insight (GI) were reviewed as part of this analysis.

Woods & Poole

- Employment data are historical for the years 1969-2008 and projected for the years 2009-2040.
- W&P employment estimates are higher than other sources [such as Bureau of Labor Statistics (BLS), Bureau of the Census, and National Income and Product Accounts (NIPA)] because W&P measures more kinds of employment. For example, BLS estimates does not account for agricultural workers, the military, proprietors, households, and miscellaneous employment; Census data is based on the 'employment by place of residence' whereas W&P data is based on the 'employment by place of work'; and NIPA does not include part-time proprietors and certain miscellaneous employees.
- W&P employment estimates are tied to BLS methodology, and as such are easier to understand.
- The employment forecasts are available for Caroline County, King George County, Spotsylvania County/Fredericksburg, and Stafford County for 2010, 2020, 2030, and 2040. This data is available by the two-digit North American Industry Classification System (NAICS) industry.
- Forecast data is released annually, in October. The forecasts used in this report were released in October 2010.

Global Insight

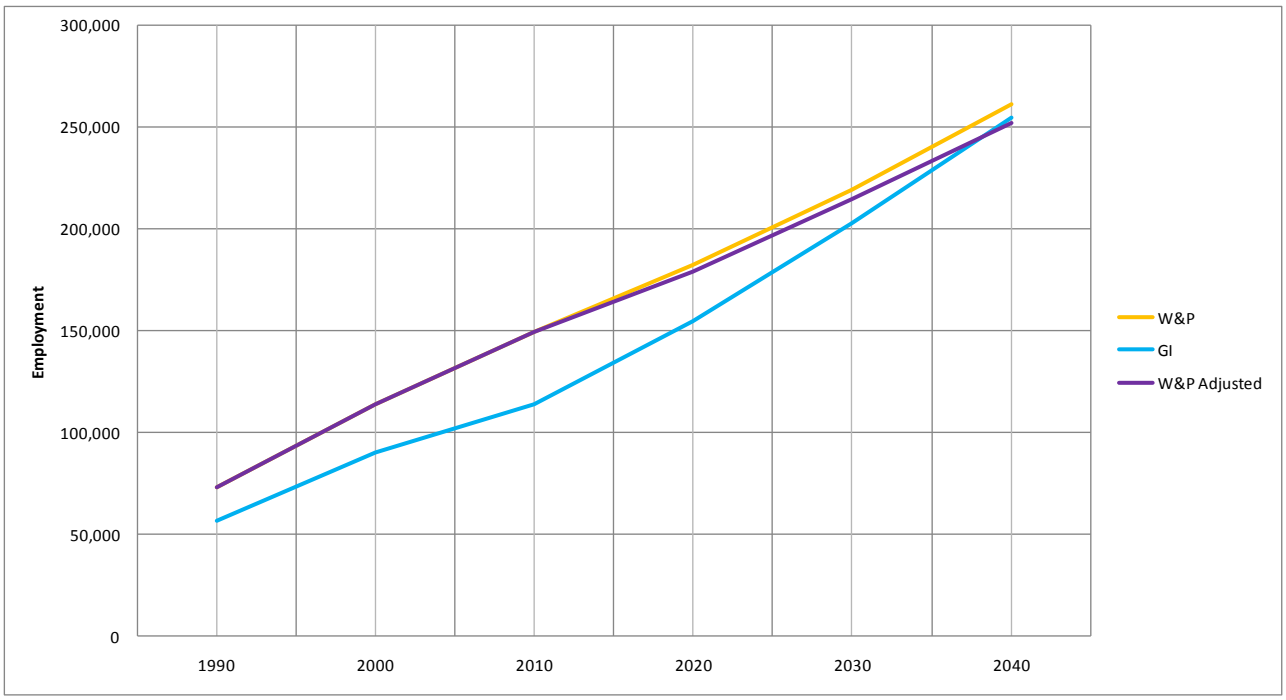
- Employment data is historical for the years 1975-2009 and projected for the years 2009-2041.
- GI employment forecasting methodology is a hybrid between BLS and Bureau of Economic Analysis (BEA) and is not intuitive to understand.
- The employment forecasts are available for Caroline County, King George County, Spotsylvania County/Fredericksburg, and Stafford County for 2010, 2020, 2030, and 2040. The employment industry classifications are not as disaggregate as W&P.
- Forecast data is consistently updated. The forecasts used in this report were last updated in June 30, 2011.

Comparisons

The following exhibits provide comparisons of the two forecasts discussed before (i.e., W&P, and GI).

As illustrated in Exhibit 1, W&P employment estimates are higher than GI. As discussed before, W&P is a more complete measure of the number of full (and part-time) jobs by place of work; as such their employment estimates are almost always higher than other sources. Given the completeness of the data and disaggregate nature of its industry classifications, the use of adjusted W&P employment estimates in the LRTP is recommended. The original W&P employment estimates were adjusted to mirror the adjustments made to the W&P population estimates that were recommended in Task 2. The adjusted W&P employment forecast is shown in purple in Exhibit 1.

Exhibit 1: Total Employment Forecasts (entire study region), 1990-2040



	1990	2000	2010	2020	2030	2040
W&P	73,228	113,735	149,551	182,640	219,003	261,124
GI	56,477	90,373	114,263	154,721	202,749	254,655
W&P Adjusted	73,228	113,735	149,551	179,138	214,950	252,289

Neither W&P nor GI provides separate projections for Spotsylvania County and Fredericksburg City. Both sources combine these jurisdictions in their forecasts. To derive separate projections for these jurisdictions, previous FAMPO forecasts were used to obtain the percent distribution between Fredericksburg and Spotsylvania County (see Exhibit 2). These percentages were applied to the W&P/GI composite Spotsylvania County/Fredericksburg City forecast to derive separate forecasts for Spotsylvania County and the City of Fredericksburg.

Exhibit 2: Fredericksburg/Spotsylvania Employment Projection Split

	1990*	2000	2010**	2020	2030	2040*
Previous Projections						
Spotsylvania Co/Fredericksburg	45,825	57,990	79,627	93,302	108,453	125,791
Fredericksburg	24,183	26,777	37,155	41,914	47,001	53,913
Spotsylvania	19,652	29,213	40,462	49,368	59,422	69,838
Percent Distribution						
Fredericksburg	45%	52%	52%	54%	56%	56%
Spotsylvania County	55%	48%	48%	46%	44%	44%
Adjusted Projections						
Spotsylvania Co/Fredericksburg	40,023	59,484	76,794**	90,860	108,195	125,835
Fredericksburg	22,080	28,448	36,761**	41,720	47,784	54,821
Spotsylvania County	17,943	31,036	40,033**	49,140	60,411	71,014

*The 1990 and 2040 projections were derived from the FAMPO data using a regression analysis.

** See adjusted allocations based on 2010 employment estimate research below

Exhibit 3 summarizes the adjusted W&P employment forecast for the Region's 5 localities – Caroline County, King George County, Spotsylvania County, Stafford County, and Fredericksburg City. As expected the highest growth in employment is forecasted for Spotsylvania County and Stafford County, which are both closer to Washington DC and Northern Virginia.

Exhibit 3: PB's Adjusted W&P Employment Forecast (by Region)

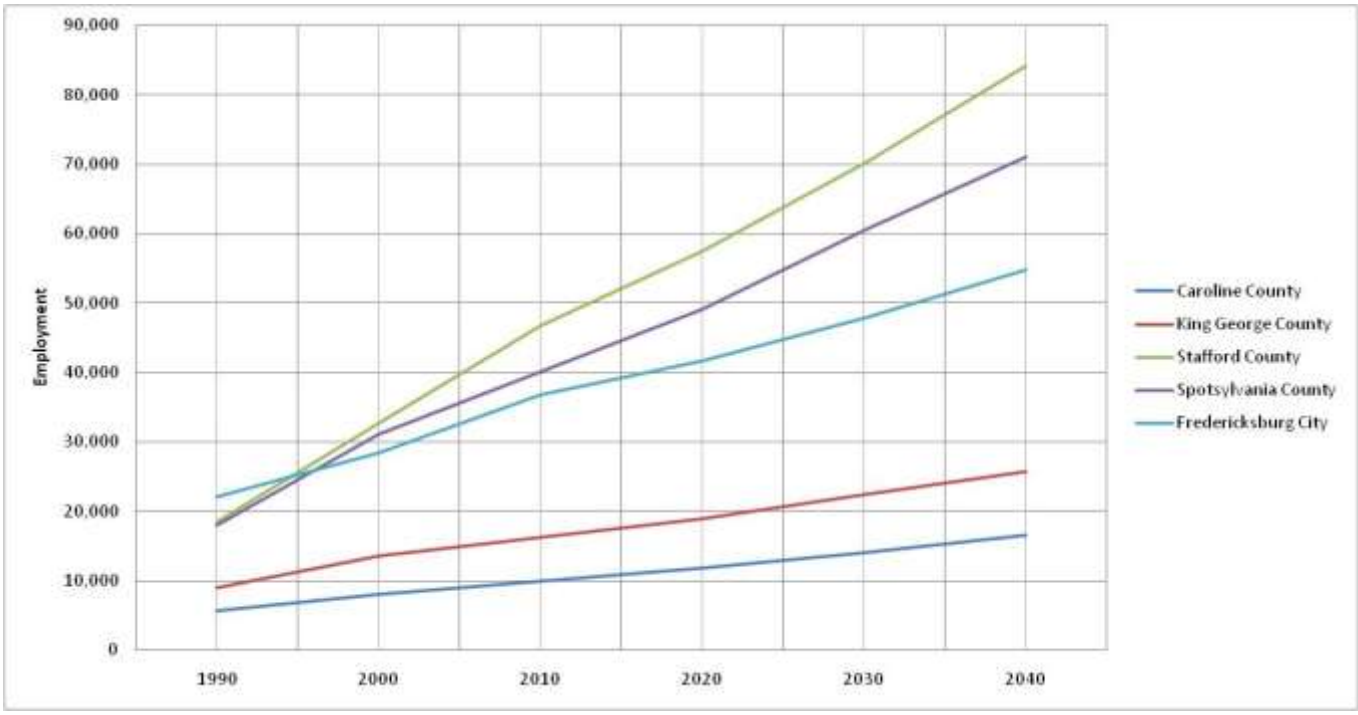


Exhibit 4 provides a comparative summary of the original employment control totals proposed by PB consultants and the resulting revisions made by GWRC staff while conforming to the regional control forecast.

Exhibit 4: Comparative Summary of PB-Proposed and GWRC-Revised Final Total Employment Control Totals

	1990	2000	2010	2020	2030	2040
Caroline County (PB)	**5,698**	**8,021**	**9,896**	**11,824**	**14,099**	**16,615**
Caroline Co (GWRC Rev)			9,902	12,270	14,640	17,460
King George County (PB)	**9,059**	**13,501**	**16,209**	**18,988**	**22,481**	**25,698**
King George County (GWRC Rev)			16,241	19,360	22,480	25,700
Spotsylvania County (PB)	**17,943**	**31,036**	**45,303**	**49,140**	**60,411**	**71,014**
Spotsylvania County (GWRC Rev)			45,376	52,620	59,870	70,170
Stafford County (PB)	**18,448**	**32,729**	**46,652**	**57,463**	**70,174**	**84,141**
Stafford County (GWRC Rev)			46,929	57,500	70,180	84,140
Fredericksburg City (PB)	**22,080**	**28,448**	**31,491**	**41,720**	**47,784**	**54,821**
Fredericksburg City (GWRC Rev)			31,491	39,640	47,780	54,820
GWRC/PD 16 Area (PB)	**73,228**	**113,735**	**149,551**	**179,135**	**214,949**	**252,289**
GWRC/PD 16 Area (GWRC Rev)			149,939	181,370	214,960	252,290

9. Other Related Control Totals

In addition to developing jurisdictional control totals for total population and employment, PB was tasked to create control totals for other population and employment variables. These variables pivot off the control totals for population and employment so any changes in total population and/or employment will require adjustments to these other related control totals.

9.1 Population-Related Control Totals

The other related population control totals for the Long Range Transportation Plan (LRTP) horizon years (2010, 2020, 2030, and 2040) for Caroline County, King George County, Spotsylvania County, Stafford County, and the City Fredericksburg are as follows:

- Group Quarters Population
- Households Population
- Persons per Household
- Total Households
- Income by Household Size

Below is a brief description of how each variable was developed.

a. Group Quarters Population

Group quarters population for the horizon years were derived by applying total population to group quarters population ratios from the 2010 census to the horizon year total population. These ratios excluded military group quarters. Based on discussions with GWRC staff, it is assumed that military group quarters are less influenced by changes in total population. The military group quarters from 2010 were added back into the total group quarters after the ratios were applied. The jurisdictions with military group quarters in 2010 include King George County (188) and Stafford County (1,908). Exhibit 1 provides the group quarters population by jurisdiction for each horizon year.

Exhibit 1: Group Quarters Population

Jurisdiction	2010*	2020	2030	2040
Caroline County	513	627	741	838
King George County	301	333	369	402
Spotsylvania County	524	691	868	1,030
Stafford County	3,593	4,126	4,687	5,199
Fredericksburg City	2,596	2,904	3,267	3,593
Total	**7,527**	**8,681**	**9,932**	**11,061**

**Source 2010 Census.*

b. Household Population

Household population was calculated by subtracting the group quarters population derived above from the total population control totals previously established by PB and presented to FAMPO. Exhibit 2 provides the household population by jurisdiction for each horizon year.

Exhibit 2: Household Population

Jurisdiction	2010*	2020	2030	2040
Caroline County	28,032	34,240	40,476	45,764
King George County	23,283	29,901	37,450	44,299
Spotsylvania County	121,873	160,782	201,867	239,537
Stafford County	125,368	165,652	207,991	246,653
Fredericksburg City	21,690	24,259	27,298	30,022
PD 16 Total	**320,246**	**414,834**	**515,082**	**606,276**

**Source 2010 Census.*

c. Persons per Household

Persons per household ratios were derived by using growth rates based on the change in person per household ratios from W&P and applying these rates to the 2010 census person per household ratios. Exhibit 3 provides the persons per household ratios by jurisdiction for each horizon year.

Exhibit 3: Persons Per Household

Jurisdiction	2010*	2020	2030	2040
Caroline County	2.68	2.55	2.45	2.40
King George County	2.78	2.66	2.61	2.59
Spotsylvania County	2.91	2.82	2.77	2.78
Stafford County	3.00	2.89	2.83	2.81
Fredericksburg City	2.28	2.21	2.18	2.19

**Source 2010 Census.*

d. Total Households

Total households were developed by dividing the household population (Exhibit 2) by the persons per household ratios (Exhibit 3). Exhibit 4 provides the number of households by jurisdiction for each horizon year.

Exhibit 4: Households

Jurisdiction	2010*	2020	2030	2040
Caroline County	10,456	13,452	16,511	19,074
King George County	8,376	11,234	14,360	17,127
Spotsylvania County	41,942	57,096	72,847	86,092
Stafford County	41,769	57,390	73,388	87,677
Fredericksburg City	9,505	10,970	12,544	13,740
PD 16 Total	**112,048**	**150,142**	**189,649**	**223,709**

**Source 2010 Census.*

e. Income by Household Size

Several steps were required to develop the number of households by income category and household size. The first step was to identify a source that has similar data that can be used as a benchmark. The most recent data that was found to have this information at the jurisdictional level was the 2000 Census Transportation Planning Package

(CTPP). The CTPP provides the number of households by ten (10) income categories and four (4) household sizes. The CTPP data for all jurisdictions in the region is shown in Exhibit 5 below.

Exhibit 5: 2000 CTPP Households by Household Income by Household Size

Income Category (1999 Dollars)	1-Person	2-Person	3-Person	4-Or-More	All Households
Less Than $10,000	2,000	645	340	380	3,365
$10,000-$14,999	1,730	760	390	244	3,124
$15,000-$29,999	4,485	3,545	1,675	1,915	11,620
$30,000-$39,999	2,460	3,215	1,540	2,195	9,410
$40,000-$49,999	1,675	2,895	1,485	2,465	8,520
$50,000-$59,999	1,030	2,905	1,795	3,080	8,810
$60,000-$74,999	1,020	3,590	2,655	4,435	11,700
$75,000-$99,999	550	4,300	3,285	5,730	13,865
$100,000-$124,999	165	2,150	1,615	2,620	6,550
$125,000 Or More	254	2,185	1,445	2,700	6,584
Totals	**15,369**	**26,190**	**16,225**	**25,764**	**83,548**

Since FAMPO indicated that the household income data should be in 2010 dollars, the CTPP data needed to be adjusted from 1999 dollars to 2010 dollars before it could be used as a benchmark. There are two options for making this adjustment. One option is to adjust the income ranges so they reflect 2010 dollar values. For example, using the U.S. Price (CPI-U, Annual Average) 1999 to 2010 inflation rate of 31.5%, the first income category shown in Exhibit 5 would be "Less Than $7,605" and the last category would be "$95,057 Or More". The distribution of households by household size in each category using this option would not change. The second option is to keep the income categories the same as provided in the CTPP but adjust the number of households under each range. This will cause the number of households in each category to shift. This was the option used.

Exhibit 6 shows the distribution of the CTPP data using the same income categories but in 2010 dollars. Note that the totals may be slightly different than Exhibit 5 due to rounding. The data in Exhibit 6 is for the entire region but the same process was performed for each jurisdiction.

Exhibit 6: Adjusted 2000 CTPP Households by Household Income by Household Size

Income Category (2010 Dollars)	1-Person	2-Person	3-Person	4-Or-More	All Households
Less Than $10,000	1,521	490	259	289	2,559
$10,000-$14,999	966	368	191	160	1,685
$15,000-$29,999	3,579	2,393	1,153	1,173	8,298
$30,000-$39,999	2,251	1,832	867	1,009	5,959
$40,000-$49,999	1,871	2,445	1,171	1,669	7,156
$50,000-$59,999	1,429	2,264	1,140	1,821	6,654
$60,000-$74,999	1,457	3,309	1,912	3,244	9,922
$75,000-$99,999	1,348	4,631	3,325	5,588	14,892
$100,000-$124,999	418	3,270	2,498	4,357	10,544
$125,000 Or More	528	5,185	3,709	6,453	15,875
Totals	**15,368**	**26,189**	**16,224**	**25,763**	**83,543**

The next step is to identify a source that can be used to help forecast the number of households by household income. In this case W&P was used since it has eleven (11) income categories and projections out to the year 2040.

Similar to the CTPP data, the data from W&P had to be adjusted before it could be used. First, the categories from W&P are in 2000 dollars so they had to be adjusted to 2010 dollars. Second, the number of households had to be adjusted for each horizon year so they would match the jurisdictional control totals shown in Exhibit 4. Exhibit 7 shows the adjusted W&P data for the entire region. Note that the totals may be slightly different than Exhibit 4 due to rounding. The same process was used for each jurisdiction.

Exhibit 7: Adjusted W&P Households by Household Income

Income Category (2010 Dollars)	2010	2020	2030	2040
Less Than $10,000	2,957	3,532	3,746	3,506
$10,000-$19,999	4,880	5,816	6,175	5,792
$20,000-$29,999	6,380	7,624	8,096	7,591
$30,000-$44,999	11,528	13,831	14,673	13,732
$45,000-$59,999	12,228	14,756	15,682	14,652
$60,000-$74,999	12,507	15,522	16,755	15,608
$75,000-$99,999	21,022	28,975	34,788	35,989
$100,000-$124,999	17,116	25,342	36,680	46,127
$125,000-$149,999	9,422	13,971	21,112	31,109
$150,000-$199,999	8,762	12,991	20,005	31,141
$200,000 Or More	5,239	7,774	11,929	18,452
PD 16 Total	**112,042**	**150,135**	**189,640**	**223,699**

While W&P provides useful data to help project the number of households by income category, it does not provide forecasts of the number of households by household size. These forecasts were developed using historical census data from 1970 to 2010 and a trend analysis using persons per household ratios from the 1970 to 2010 census and the ratios presented in Exhibit 3. Exhibit 8 shows the distribution of households by household size for the entire region. The same process was used for each jurisdiction.

Exhibit 8: Households by Household Size

Year	1-Person	2-Person	3-Person	4-Or-More	All Households
1970	2,944	6,301	4,321	8,524	22,090
1980	6,435	10,673	7,522	13,476	38,106
1990	9,631	17,275	11,875	18,396	57,177
2000	15,387	26,337	16,316	25,669	83,709
2010	21,270	35,216	20,746	34,816	112,048
2020	27,746	47,391	29,574	45,432	150,142
2030	35,844	60,538	37,323	55,944	189,649
2040	42,226	71,526	44,076	65,881	223,709

The final step is to use the households by household income by household size data from Exhibit 6 as a benchmark and develop forecasts using the combination of data from Exhibit 7 and Exhibit 8. The procedure takes several iterations for each horizon year so that the total number of households by income category matches the values from Exhibit 7 and the total number of households by household size matches the values from Exhibit 8.

Since FAMPO specified four (4) income categories that need to be used in forecasting this data, the income categories from Exhibit 6 and Exhibit 7 where condensed first to match these four categories before going through the iteration process. Exhibits 9 through 14 show the distribution of households by household income and

household size for the year 2010 and horizon years 2020, 2030, and 2040 for each jurisdiction and region. All income categories are in 2010 dollars.

Exhibit 9: Caroline County Households by Household Income by Household Size Forecasts

Year	Income	1-Person	2-Person	3-Person	4-Or-More	Total
2010	Less Than $24,999	894	416	171	173	1,654
	$25,000-$49,999	688	793	449	509	2,439
	$50,000-$74,999	427	915	518	755	2,615
	$75,000 Or More	283	1,418	785	1,262	3,748
	Totals	**2,292**	**3,540**	**1,924**	**2,699**	**10,455**
2020	Less Than $24,999	1,064	455	192	171	1,882
	$25,000-$49,999	849	899	522	521	2,792
	$50,000-$74,999	600	1,180	686	878	3,343
	$75,000 Or More	457	2,099	1,193	1,686	5,435
	Totals	**2,969**	**4,633**	**2,593**	**3,257**	**13,451**
2030	Less Than $24,999	1,186	437	180	145	1,948
	$25,000-$49,999	1,001	916	518	469	2,904
	$50,000-$74,999	798	1,356	766	891	3,811
	$75,000 Or More	787	3,123	1,726	2,213	7,848
	Totals	**3,771**	**5,832**	**3,189**	**3,718**	**16,510**
2040	Less Than $24,999	1,123	332	134	100	1,690
	$25,000-$49,999	1,016	744	413	347	2,521
	$50,000-$74,999	851	1,156	643	693	3,343
	$75,000 Or More	1,448	4,599	2,499	2,974	11,520
	Totals	**4,439**	**6,830**	**3,689**	**4,115**	**19,073**

Exhibit 10: King George County Households by Household Income by Household Size Forecasts

Year	Income	1-Person	2-Person	3-Person	4-Or-More	Total
2010	Less Than $24,999	472	275	124	108	979
	$25,000-$49,999	613	494	276	407	1,790
	$50,000-$74,999	259	742	409	516	1,926
	$75,000 Or More	311	1,271	721	1,377	3,681
	Totals	**1,655**	**2,783**	**1,530**	**2,408**	**8,376**
2020	Less Than $24,999	596	286	135	103	1,120
	$25,000-$49,999	803	533	314	404	2,053
	$50,000-$74,999	371	877	509	561	2,318
	$75,000 Or More	591	1,986	1,187	1,979	5,742
	Totals	**2,361**	**3,681**	**2,144**	**3,046**	**11,233**
2030	Less Than $24,999	721	318	148	107	1,294
	$25,000-$49,999	991	604	350	427	2,371
	$50,000-$74,999	469	1,018	582	607	2,677
	$75,000 Or More	914	2,822	1,662	2,619	8,017
	Totals	**3,094**	**4,763**	**2,743**	**3,759**	**14,359**
2040	Less Than $24,999	796	325	151	105	1,376
	$25,000-$49,999	1,110	627	361	425	2,522
	$50,000-$74,999	537	1,080	613	617	2,846
	$75,000 Or More	1,284	3,676	2,148	3,273	10,381
	Totals	**3,727**	**5,708**	**3,273**	**4,419**	**17,126**

Exhibit 11: Spotsylvania County Households by Household Income by Household Size Forecasts

Year	Income	1-Person	2-Person	3-Person	4-Or-More	Total
	Less Than $24,999	2,370	1,185	493	680	4,728
	$25,000-$49,999	2,663	2,522	1,004	1,403	7,591
2010	$50,000-$74,999	1,280	2,808	1,251	2,422	7,762
	$75,000 Or More	1,020	6,919	4,985	8,935	21,859
	Totals	**7,333**	**13,434**	**7,733**	**13,440**	**41,940**
	Less Than $24,999	2,937	1,357	588	726	5,608
	$25,000-$49,999	3,344	2,926	1,214	1,518	9,003
2020	$50,000-$74,999	1,644	3,332	1,548	2,681	9,205
	$75,000 Or More	1,705	10,681	8,023	12,869	33,277
	Totals	**9,629**	**18,296**	**11,374**	**17,795**	**57,093**
	Less Than $24,999	3,420	1,317	540	645	5,922
	$25,000-$49,999	4,025	2,937	1,152	1,395	9,509
2030	$50,000-$74,999	2,079	3,513	1,543	2,587	9,722
	$75,000 Or More	3,039	15,875	11,273	17,504	47,691
	Totals	**12,563**	**23,642**	**14,508**	**22,131**	**72,843**
	Less Than $24,999	3,464	1,111	440	526	5,540
	$25,000-$49,999	4,202	2,554	967	1,171	8,894
2040	$50,000-$74,999	2,271	3,196	1,354	2,273	9,093
	$75,000 Or More	4,826	20,996	14,386	22,353	62,562
	Totals	**14,763**	**27,856**	**17,147**	**26,322**	**86,088**

Exhibit 12: Stafford County Households by Household Income by Household Size Forecasts

Year	Income	1-Person	2-Person	3-Person	4-Or-More	Total
	Less Than $24,999	1,356	609	308	322	2,594
	$25,000-$49,999	1,994	1,559	699	1,002	5,255
2010	$50,000-$74,999	1,481	1,828	1,135	2,155	6,598
	$75,000 Or More	1,677	8,550	5,992	11,101	27,320
	Totals	**6,508**	**12,546**	**8,134**	**14,579**	**41,767**
	Less Than $24,999	1,766	775	413	399	3,353
	$25,000-$49,999	2,609	1,992	943	1,247	6,791
2020	$50,000-$74,999	1,947	2,347	1,539	2,694	8,527
	$75,000 Or More	2,426	12,077	8,941	15,272	38,716
	Totals	**8,747**	**17,191**	**11,837**	**19,612**	**57,387**
	Less Than $24,999	1,996	728	375	352	3,451
	$25,000-$49,999	3,042	1,929	884	1,136	6,991
2030	$50,000-$74,999	2,361	2,364	1,500	2,553	8,778
	$75,000 Or More	4,162	17,210	12,324	20,470	54,166
	Totals	**11,560**	**22,231**	**15,083**	**24,511**	**73,385**
	Less Than $24,999	1,906	567	286	264	3,022
	$25,000-$49,999	2,998	1,552	694	878	6,122
2040	$50,000-$74,999	2,424	1,981	1,227	2,055	7,687
	$75,000 Or More	6,690	22,575	15,780	25,798	70,843
	Totals	**14,018**	**26,674**	**17,986**	**28,995**	**87,673**

Exhibit 13: Fredericksburg City Households by Household Income by Household Size Forecasts

Year	Income	1-Person	2-Person	3-Person	4-Or-More	Total
2010	Less Than $24,999	707	168	115	82	1,072
	$25,000-$49,999	926	418	190	186	1,720
	$50,000-$74,999	711	577	243	227	1,759
	$75,000 Or More	1,069	1,758	893	1,235	4,954
	Totals	**3,412**	**2,921**	**1,441**	**1,730**	**9,505**
2020	Less Than $24,999	801	196	123	78	1,197
	$25,000-$49,999	1,053	488	205	177	1,922
	$50,000-$74,999	812	675	263	216	1,966
	$75,000 Or More	1,324	2,236	1,046	1,276	5,884
	Totals	**3,990**	**3,596**	**1,637**	**1,747**	**10,969**
2030	Less Than $24,999	923	216	134	82	1,354
	$25,000-$49,999	1,220	542	225	187	2,174
	$50,000-$74,999	947	755	290	231	2,223
	$75,000 Or More	1,600	2,586	1,196	1,411	6,793
	Totals	**4,690**	**4,098**	**1,844**	**1,911**	12,543
2040	Less Than $24,999	998	233	145	89	1,466
	$25,000-$49,999	1,319	587	244	204	2,354
	$50,000-$74,999	1,024	817	315	252	2,407
	$75,000 Or More	1,764	2,854	1,323	1,570	7,511
	Totals	**5,105**	**4,491**	**2,027**	**2,116**	**13,739**

Exhibit 14: PD 16 Regional Households by Household Income by Household Size Forecasts

Year	Income	1-Person	2-Person	3-Person	4-Or-More	Total
2010	Less Than $24,999	5,799	2,653	1,210	1,365	11,027
	$25,000-$49,999	6,883	5,786	2,619	3,507	18,795
	$50,000-$74,999	4,158	6,870	3,557	6,075	20,659
	$75,000 Or More	4,361	19,916	13,376	23,909	61,561
	Totals	**21,201**	**35,225**	**20,762**	**34,855**	**112,042**
2020	Less Than $24,999	7,164	3,068	1,452	1,476	13,160
	$25,000-$49,999	8,657	6,838	3,199	3,867	22,562
	$50,000-$74,999	5,373	8,411	4,544	7,031	25,359
	$75,000 Or More	6,503	29,080	20,390	33,082	89,054
	Totals	**27,697**	**47,396**	**29,585**	**45,456**	**150,135**
2030	Less Than $24,999	8,245	3,016	1,378	1,331	13,969
	$25,000-$49,999	10,279	6,928	3,129	3,613	23,948
	$50,000-$74,999	6,654	9,006	4,682	6,869	27,210
	$75,000 Or More	10,501	41,615	28,180	44,218	124,513
	Totals	**35,678**	**60,564**	**37,367**	**56,030**	**189,640**
2040	Less Than $24,999	8,287	2,568	1,155	1,083	13,094
	$25,000-$49,999	10,646	6,062	2,679	3,025	22,412
	$50,000-$74,999	7,106	8,229	4,151	5,890	25,377
	$75,000 Or More	16,012	54,700	36,137	55,969	162,817
	Totals	**42,051**	**71,560**	**44,122**	**65,967**	**223,699**

9.2 Employment- Related Control Totals

The other control totals required for the Long Range Transportation Plan (LRTP) horizon years (2020, 2030, and 2040) for Caroline County, King George County, Spotsylvania County, Stafford County, and the City Fredericksburg are 2-digit NAICS sector employment totals as follows:

1. Agriculture, Forestry, Fishing and Hunting
2. Mining, Quarrying, and Oil and Gas Extraction
3. Utilities
4. Construction
5. Manufacturing
6. Wholesale Trade
7. Retail Trade
8. Transportation and Warehousing
9. Information
10. Finance and Insurance
11. Real Estate and Rental and Leasing
12. Professional, Scientific, and Technical Services
13. Management of Companies and Enterprises
14. Administrative and Support and Waste Management and Remediation Services
15. Educational Services
16. Health Care and Social Assistance
17. Arts, Entertainment, and Recreation
18. Accommodation and Food Services
19. Other Services (except Public Administration)
20. Government

W&P provides estimates and projections for all 20 employment sectors listed above. However, the GWRC/FAMPO staff has developed 2010 estimates for the same sectors that are based on a thorough review of current employment data. The 2010 estimates from GWRC/FAMPO therefore are more accurate than the W&P 2010 estimates. Consequently, rather than using the employment by sector forecasts directly from W&P for the horizon years, only the growth rates between horizon years were used. The results were then adjusted so the sum of all employment sectors would match the total employment control totals previously established by PB and presented to FAMPO. Additional adjustments were later made by GWRC staff as explained in the main body of this report. Exhibits 15 through 20 provide the projections by employment sector for each jurisdiction and region.

Exhibit 15: Caroline County Employment by Sector Forecasts

Employment Sector	2010	2020	2030	2040
Agriculture, Forestry, Fishing & Hunting	174	180	180	170
Mining, Quarrying, & Oil & Gas Extraction	30	30	30	20
Utilities	135	130	120	110
Construction	861	1,040	1,230	1,400
Manufacturing	257	260	260	250
Wholesale Trade	215	200	190	170
Retail Trade	1,377	1,650	1,920	2,200
Transportation & Warehousing	368	420	460	500
Information	51	50	50	50
Finance & Insurance	470	520	580	620
Real Estate & Rental & Leasing	473	680	890	1,170
Prof., Scientific, & Technical Services	675	1,110	1,550	2,220
Management of Companies & Enterprises	70	70	80	80
Admin & Support & Waste & Remediation Serv.	457	710	970	1,340
Educational Services	538	700	860	1,040
Health Care & Social Assistance	546	770	1,000	1,300
Arts, Entertainment, & Recreation	212	240	280	300
Accommodation & Food Services	872	970	1,070	1,140
Other Services (except Public Admin)	1,091	1,470	1,850	2,290
Government	1,030	1,060	1,090	1,090
Total	**9,902**	**12,260**	**14,660**	**17,460**

Note: Table reflects adjustments by GWRC staff as discussed in the body of this report.

Exhibit 16: King George County Employment by Sector Forecasts

Employment Sector	2010	2020	2030	2040
Agriculture, Forestry, Fishing & Hunting	310	340	370	390
Mining, Quarrying, & Oil & Gas Extraction	16	20	20	20
Utilities	54	60	70	70
Construction	1,432	1,630	1,820	1,950
Manufacturing	291	290	300	290
Wholesale Trade	189	200	220	220
Retail Trade	1,497	1,820	2,140	2,440
Transportation & Warehousing	181	200	210	220
Information	351	400	460	500
Finance & Insurance	387	480	580	680
Real Estate & Rental & Leasing	856	1,160	1,460	1,830
Prof., Scientific, & Technical Services	2,582	3,100	3,620	4,040
Management of Companies & Enterprises	0	0	0	0
Admin & Support & Waste & Remediation Serv.	879	1,370	1,860	2,580
Educational Services	967	1,220	1,470	1,740
Health Care & Social Assistance	565	720	870	1,030
Arts, Entertainment, & Recreation	248	290	330	370
Accommodation & Food Services	568	650	730	800
Other Services (except Public Admin)	970	1,430	1,890	2,530
Government	3,898	3,990	4,080	4,040
Total	**16,241**	**19,370**	**22,500**	**25,740**

Note: Table reflects adjustments by GWRC staff as discussed in the body of this report.

Exhibit 17: Spotsylvania County Employment by Sector Forecasts

Employment Sector	2010	2020	2030	2040
Agriculture, Forestry, Fishing & Hunting	439	430	420	420
Mining, Quarrying, & Oil & Gas Extraction	130	120	110	110
Utilities	232	210	180	160
Construction	3,228	3,790	4,350	5,080
Manufacturing	1,704	1,600	1,500	1,430
Wholesale Trade	1,373	1,460	1,540	1,650
Retail Trade	9,094	10,140	11,200	12,510
Transportation & Warehousing	1,384	1,320	1,250	1,200
Information	382	410	430	460
Finance & Insurance	1,235	1,280	1,320	1,380
Real Estate & Rental & Leasing	2,638	2,940	3,250	3,660
Prof., Scientific, & Technical Services	2,665	3,410	4,150	5,160
Management of Companies & Enterprises	305	290	280	310
Admin & Support & Waste & Remediation Serv.	1,769	2,160	2,560	3,090
Educational Services	3,441	4,760	6,080	8,140
Health Care & Social Assistance	3,858	5,050	6,240	7,960
Arts, Entertainment, & Recreation	1,016	1,110	1,200	1,320
Accommodation & Food Services	4,840	5,680	6,530	7,680
Other Services (except Public Admin)	2,873	3,510	4,140	5,050
Government	2,769	2,960	3,140	3,390
Total	**45,376**	**52,630**	**59,870**	**70,160**

Note: Table reflects adjustments by GWRC staff as discussed in the body of this report.

Exhibit 18: Stafford County Employment by Sector Forecasts

			(Rounded)	
Employment Sector	**2010**	**2020**	**2030**	**2040**
Agriculture, Forestry, Fishing & Hunting	279	280	280	270
Mining, Quarrying, & Oil & Gas Extraction	60	60	60	50
Utilities	67	60	60	60
Construction	2,783	3,460	4,140	4,860
Manufacturing	661	660	660	650
Wholesale Trade	1,619	1,740	1,850	1,920
Retail Trade	5,339	7,050	8,760	10,730
Transportation & Warehousing	751	760	760	740
Information	656	940	1,230	1,630
Finance & Insurance	5,116	5,780	6,440	6,970
Real Estate & Rental & Leasing	1,441	1,950	2,450	3,100
Prof., Scientific, & Technical Services	4,038	6,510	8,980	12,740
Management of Companies & Enterprises	278	360	450	540
Admin & Support & Waste & Remediation Serv.	1,840	2,440	3,040	3,750
Educational Services	6,842	9,270	11,700	14,700
Health Care & Social Assistance	3,170	3,460	3,750	3,900
Arts, Entertainment, & Recreation	822	790	770	710
Accommodation & Food Services	3,212	3,630	4,060	4,410
Other Services (except Public Admin)	2,729	3,570	4,420	5,440
Government	4,950	5,640	6,320	7,000
Total	**46,653**	**58,410**	**70,180**	**84,170**

Note: Table reflects adjustments and final rounding by GWRC staff as discussed in the body of this report.

Exhibit 19: Fredericksburg City Employment by Sector Forecasts

			(Rounded)	
Employment Sector	**2010**	**2020**	**2030**	**2040**
Agriculture, Forestry, Fishing & Hunting	47	50	50	50
Mining, Quarrying, & Oil & Gas Extraction	34	30	30	30
Utilities	115	110	100	90
Construction	901	1,120	1,340	1,500
Manufacturing	625	610	600	550
Wholesale Trade	738	820	910	940
Retail Trade	3,883	4,700	5,510	6,030
Transportation & Warehousing	429	430	430	390
Information	974	1,090	1,200	1,240
Finance & Insurance	889	970	1,050	1,050
Real Estate & Rental & Leasing	1,299	1,530	1,760	1,900
Prof., Scientific, & Technical Services	1,499	2,040	2,570	3,070
Management of Companies & Enterprises	520	610	690	740
Admin & Support & Waste & Remediation Serv.	1,013	1,310	1,610	1,870
Educational Services	1,742	2,570	3,390	4,360
Health Care & Social Assistance	7,592	10,550	13,510	16,570
Arts, Entertainment, & Recreation	501	580	650	690
Accommodation & Food Services	4,312	5,360	6,400	7,230
Other Services (except Public Admin)	1,491	1,930	2,370	2,770
Government	2,887	3,250	3,610	3,750
Total	**31,491**	**39,660**	**47,780**	**54,820**

Note: Table reflects adjustments and final rounding by GWRC staff as discussed in the body of this report.

Exhibit 20: PD 16 Regional Employment by Sector Forecasts

Employment Sector	2010	2020	2030	2040
Agriculture, Forestry, Fishing & Hunting	1,249	1,280	1,300	1,310
Mining, Quarrying, & Oil & Gas Extraction	270	260	250	230
Utilities	603	570	530	490
Construction	9,205	11,040	12,920	14,860
Manufacturing	3,538	3,420	3,320	3,180
Wholesale Trade	4,134	4,420	4,720	4,910
Retail Trade	21,190	25,360	29,600	34,030
Transportation & Warehousing	3,113	3,130	3,130	3,070
Information	2,414	2,890	3,370	3,880
Finance & Insurance	8,097	9,030	9,990	10,730
Real Estate & Rental & Leasing	6,707	8,260	9,840	11,720
Prof., Scientific, & Technical Services	11,459	16,170	20,930	27,350
Management of Companies & Enterprises	1,173	1,330	1,500	1,670
Admin & Support & Waste & Remediation Serv.	5,958	7,990	10,080	12,700
Educational Services	13,530	18,520	23,540	30,030
Health Care & Social Assistance	15,731	20,550	25,410	30,820
Arts, Entertainment, & Recreation	2,799	3,010	3,240	3,410
Accommodation & Food Services	13,804	16,290	18,830	21,320
Other Services (except Public Admin)	9,154	11,910	14,740	18,200
Government	15,526	16,900	18,280	19,330
Total	**149,655**	**182,330**	**215,510**	**253,170**

Note: Table reflects adjustments by GWRC staff as discussed in the body of this report.