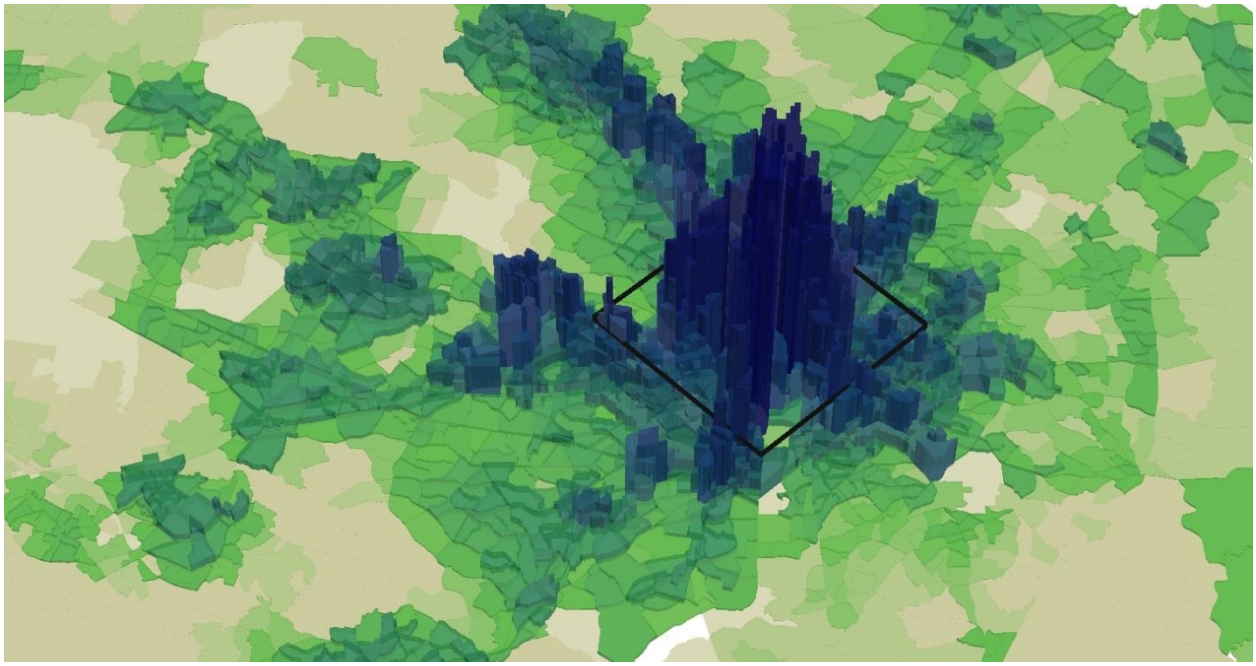
National Capital Planning Commission

National Capital Region Federal Parking Study

An Accessibility-Based Approach for Federal Facilities Parking Policies

September 2017



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List of Abbreviations

APA	American Planning Association
DC	Washington, DC
CEA	Washington, DC Central Employment Area
CLRP	Constrained Long-Range Transportation Plan
GFA	Gross Floor Area
HOT/HOV	High Occupancy Toll/High Occupancy Vehicle
MPO	Metropolitan Planning Organization
MWCOG	Metropolitan Washington Council of Governments
NSF	Naval Support Facility
NCPC	National Capital Planning Commission
NCR	National Capital Region
NSF	Naval Support Facility
SOV	Single-Occupant-Vehicle
TAZ	Transportation Analysis Zones
TIA	Traffic Impact Assessments
TDM	Transportation Demand Management
TMP	Transportation Management Plan or Program
TPB	Transportation Planning Board
U.S. DOT	United States Department of Transportation

1. Executive Summary

Study Purpose and Scope

Background

The National Capital Planning Commission (NCPC or Commission) is responsible for comprehensive planning and development oversight for federal properties and interests in the National Capital Region (NCR). The NCR includes Washington, DC; Montgomery and Prince George's Counties in Maryland; Arlington, Fairfax, Loudoun, and Prince William Counties in Virginia; and the cities contained within. NCPC's mission is to preserve and enhance the extraordinary historical, cultural, and natural resources and federal assets of the National Capital Region to support the needs of the federal government and enrich the lives of the region's visitors, workers, and residents. The Federal Elements of the *Comprehensive Plan for the National Capital* (Comprehensive Plan) are the blueprint on which NCPC evaluates plans and proposals for federal development. The core principles of the Comprehensive Plan include:

1. Accommodate federal and national capital activities.
2. Reinforce smart growth and sustainable development planning principles.
3. Support local and regional planning and development objectives.

NCPC's parking policies are provided in the Comprehensive Plan's federal Transportation Element. The element serves to develop and maintain a multi-modal regional transportation system that meets the travel needs of workers, residents, and visitors, while improving regional mobility and accessibility through expanded transportation alternatives and transit-oriented development.

While travel time, cost, and demographics ultimately determine transportation mode choices that individuals make, perhaps no aspect of the built environment affects travel decisions more than the availability of parking. When coupled with the provision of transit and carpooling infrastructure, financial incentives, and other Transportation Demand Management (TDM) approaches, reducing parking is an effective means to manage travel behavior. Local governments, institutions, and companies across the country utilize a variety of approaches to reduce single-occupant-vehicle (SOV) commuting. For NCPC, parking policies are essential to fulfilling its planning role related to managing air and water quality, energy security, costs, and efficient development in the region.

Study Purpose:

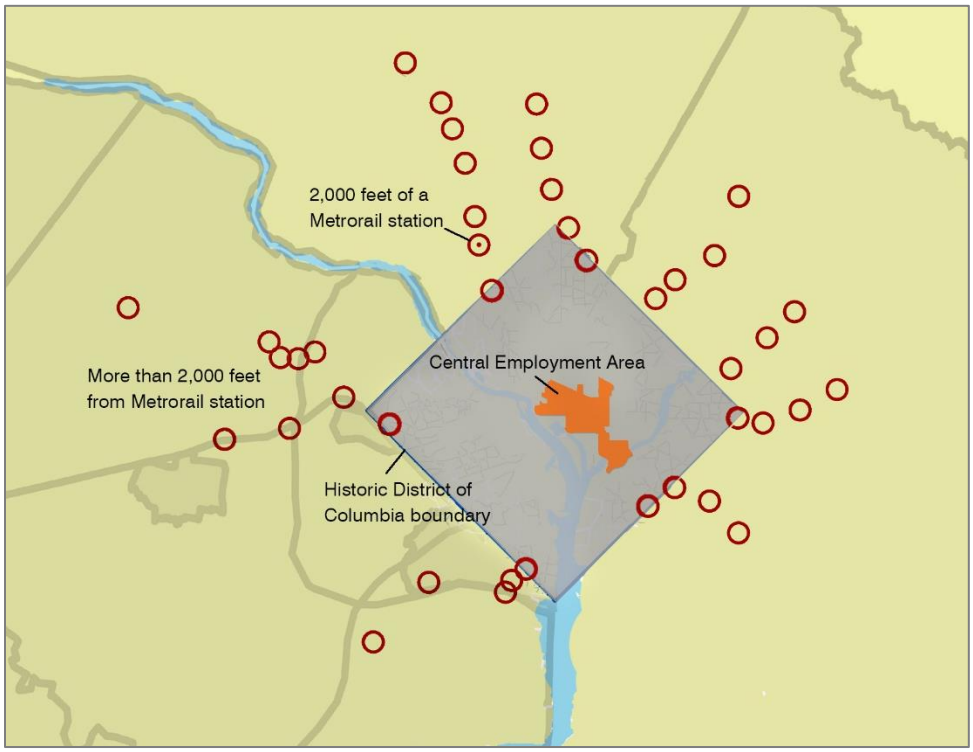
Assess NCPC's parking policies in light of industry best practices and available data.

NCPC tasked the U.S. Department of Transportation's John A. Volpe National Transportation Systems Center (Volpe Center) with conducting a review of its parking policies. NCPC has not updated these policies in over a decade.

The assessment includes an analysis of NCPC Comprehensive Plan parking ratio policies in light of current and predicted future transportation accessibility at a range of federal facility locations throughout the NCR. The underlying analysis is intended to inform potential updates to NCPC's policies, guidelines, and plan development processes.

One primary policy mechanism by which NCPC guides federal facility and transportation planning is through explicit, geographically-based parking ratio policies (see Figure 1). This mechanism has significant implications for travel across the region, significantly increasing regional transit use and carpooling. There are approximately 120 federal properties in the NCR, including approximately 40 major installations and campuses that are subject to this policy. The area's more than 400,000 civilian and military federal employees make up almost 12 percent of the region's workforce.[1] Approximately 40 percent of Metrorail's riders during peak travel times are federal employees.[2]

Figure 1: NCPC Parking Policy Map



Zone Location	Parking Ratio Policies
Central Employment Area	**1:5**
Historic District of Columbia Boundary	**1:4**
Suburban Washington within 2,000 feet of a Metrorail station	**1:3**
Suburban Washington more than 2,000 feet from a Metrorail station	**1:15 - 1:2 (site dependent)**

Each zone approximates regional accessibility based on the distance to downtown Washington, DC and proximity to Metrorail stations and high occupancy vehicle/toll (HOV/HOT) lanes. These policies are designed to reduce parking availability in areas where transit accessibility is high and employee carpooling is more likely, while allowing for more parking spaces in outlying suburban areas. They are intended to be aspirational goals, with 20-30 year time horizons. They range from one parking space per five employees at Downtown Washington facilities, to one space per 1.5 employees at facilities where transit and carpooling may be less practical.

Study Scope

This report is organized into four chapters:

- **Background and Context** reviews key information about existing NCPC policies, current and projected regional land use and transportation conditions, the history and evolution of parking policy both nationally and at NCPC, and the parking policies of NCPC's principal federal partners to inform overall assumptions for the study.

- **Literature Review** examines transportation academic literature, industry best practices, and case studies to understand the state of the practice for determining parking supply and instituting transportation demand management (TDM) policies.

- **Local Parking Comparison** details and contrasts NCPC's parking policies and processes to jurisdictions throughout the region.

- **Modeling Analysis** analyzes NCPC parking policies at a representative sample of federal facilities in the NCR based on transportation accessibility data from the regional transportation model.

Study Findings

The Volpe Center identified several key findings for each study component, summarized below.

Literature Review

The transportation academic literature, industry best practices, and case study examples provide important context for the Commission to consider when revising its transportation and parking policies. The study team identified the following key themes from this research:

- **Accessibility Paradigm**: Since the mid-1990s, the transportation industry is increasingly moving towards an accessibility paradigm focused on moving people to destinations. This is a significant departure from the previous paradigm focused on moving vehicles; resulting in important policy implications for transportation planning, policy, and engineering. This paradigm shift is broadly consistent with NCPC's current approach to transportation and parking policy.

- **Determinants of Mode Choice**: Parking availability, paired with travel time and out-of-pocket costs, is key to mode choice decisions. As such, jurisdictions and large institutions like hospital and universities are limiting parking availability and instituting TDM. Consistent with NCPC's policy framework, prevailing approaches to moderating parking demand include developing transportation alternatives, subsidizing transit commuting, and pricing parking.

- **Use of Analytical Tools**: Parking policy should be considered in light of both data and broader sustainability and multi-modal transportation goals. Therefore, in making parking supply decisions, NCPC and its federal partners should carefully analyze quantitative estimates of parking demand, the relative convenience of alternative transportation modes, and the long-term costs of parking. These tools are designed to inform, rather than prescribe, what parking supply is appropriate for a given location.

- **Ongoing Performance Monitoring**: Consistent oversight and monitoring is key to the success of TDM programs. Without performance monitoring, there is no way to ensure achievement of mode share goals. Most successful TDM programs rely on annual or biennial reporting to ensure compliance. NCPC and its federal partners have limited capacity to engage in ongoing monitoring activities, but ongoing performance monitoring is an essential element of any TDM program.

Local Parking Comparison

NCPC has different review tools and authorities than local jurisdictions. That said, NCR jurisdictions are national leaders in encouraging transit use and more efficient land use patterns. Local jurisdictions are increasingly adopting provisions to reduce the amount of parking built. The study team's survey identified the following local trends, which may be helpful reference points for NCPC:

- **Limiting/Eliminating Parking Requirements**: Local jurisdictions are shifting from parking minimums, which have historically caused parking to be overbuilt, to maximums. In some locations, jurisdictions are eliminating parking requirements altogether (e.g., Downtown Washington).

- **Allowing Flexibility**: Most local jurisdictions have streamlined and transparent variance policies. These data-driven processes allow developers to depart from parking requirements and, pursuant to established criteria, construct less parking than is required by a jurisdictions policy (e.g., Arlington County).

- **Implementing Ongoing Transportation Demand Management Monitoring**: Some jurisdictions set mode share goals in transit rich areas. Successful programs routinely monitor progress towards mode share targets by regularly surveying commuters (e.g., Montgomery County).

- **Pricing/Sharing Parking**: Most jurisdictions price parking in high demand areas or encourage shared parking between nearby developments. These strategies are particularly prevalent in areas where transportation alternatives are available (e.g., Fairfax County).

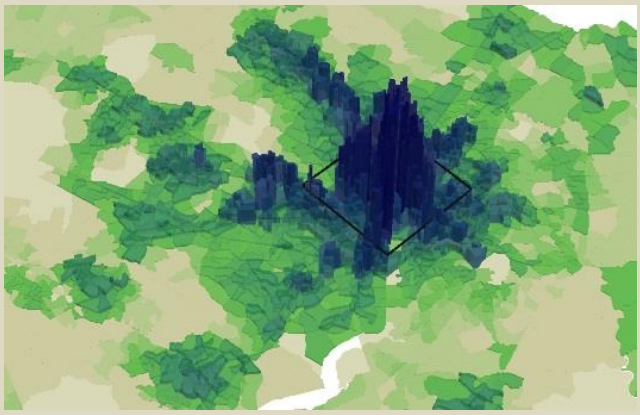
Modeling Analysis

In some cases, federal facilities in the region are providing significantly more parking per employee than established under NCPC's Comprehensive Plan parking ratio policies. The study team sought to explain the variability in parking supply at federal facilities using available, objective data that describes transportation access across the region. This analysis has important implications for NCPC's ability to achieve the core principles in its Comprehensive Plan:

- **Accessibility Predicts Parking**: Using the Metropolitan Washington Council of Government's (MWCOG) regional transportation model, the study team calculated the relative convenience of reaching each location in the region by transit and automobile. Termed the "accessibility ratio," the study team divided the number of households accessible via transit to a particular federal facility by the number of households accessible via automobiles during peak commuting times. Using this ratio, the study team developed a model (termed the Volpe Model) to explain over 90 percent of the variation in parking at 20 sampled federal facilities. The Volpe Model provides an important baseline for understanding parking provision at federal facilities and developing policy. Using this model, the Volpe Center developed an NCPC Parking Supply Tool to assist NCPC staff in determining parking supply at individual federal facilities. The tool can be updated with new accessibility data as MWCOG updates the regional transportation model.

Accessibility:

Number of households that can travel to a particular location, within a given time threshold, during peak commuting times by transit compared to automobile.



- **Variability within the Historic DC Boundary**: Accessibility varies widely within the Historic DC Boundary Zone (1 parking space: 4 employees) from urban, transit-accessible locations adjacent to the Central Employment Area (CEA), to suburban, largely auto-dependent locations further from downtown. This indicates that some federal facilities are more equipped to meet NCPC Comprehensive Plan parking ratio policies than others, depending on their proximity to transportation infrastructure and households. This finding suggests a need to reconsider NCPC policies within this zone to ensure they are not only aspirational, but also realistic and achievable.

- **A Changing Regional Core**: Accessibility will change significantly by 2030 in the region's core due to planned transportation improvements, projected household growth, and changes in congestion. While transit accessibility will increase in suburban locations near planned transit improvements like the Metrorail Silver Line extension and Purple Line light rail, Downtown Washington will experience the most significant increases. This has important implications for federal facilities in or near these locations.

- **Adjusting for Employee Shuttles, Teleworking, and Alternative Work Schedules**: Using the Volpe Model, the NCPC Parking Supply Tool enables staff to estimate parking needs at individual facilities based on regional accessibility metrics during peak commute times. This tool includes adjustments to help NCPC staff and federal partners to estimate the impact of employee shuttles, teleworking, and alternative work schedules on a facility's ability to meet Comprehensive Plan parking ratio policies.

- **Employee Shuttles to Metrorail can provide a significant accessibility boost for some federal facilities, particularly those that are near shoulder Metrorail stations.** The Volpe Center's preliminary analysis based on outputs from the MWCOG model show that federal facilities located near, but not adjacent to, shoulder Metrorail stations benefit the most from shuttles. Therefore, Naval Support Facility (NSF)

Carderock, NSF Arlington, Joint Base Anacostia-Bolling, and the Food and Drug Administration (FDA) White Oak campus could benefit significantly from employee shuttles that connect to nearby Metrorail stations. Facilities near core stations are already in high accessibility ratio areas and therefore do not significantly benefit from additional connections to the Metrorail. Facilities near the edges of the Metrorail, including end-of-line stations, may see some incremental benefit from a shuttle connection, but the potential benefit is small because these Metrorail stations are relatively inaccessible. This analysis is based on the current transit network. Future improvements to the transit network would tend to improve the effectiveness of employee shuttles. NCPC and its federal partner agencies would need to conduct a more robust site-level analysis to predict the long-term impact of prospective shuttle services. Shuttle routes and schedules can be programmed into the MWCOG model to directly estimate accessibility changes. NCPC can use the Volpe Model to predict associated reductions in parking.

Key Study Conclusions

In developing this study, the Volpe Center identified the following key conclusions regarding NCPC parking policy and processes:

NCPC is a national leader in sustainable transportation and parking policy. Jurisdictions across the country are increasingly employing parking policy approaches that NCPC first adopted almost thirty years ago.

NCPC first adopted parking ratio policies, or *parking maximums*, in 1989. These policies focus on limiting parking and managing demand to achieve broader sustainability and economic efficiency policy goals. Taken together, these policies ultimately influence the travel choices of some 400,000 federal employees across the NCR. Undoubtedly, these policies are having a major effect. More traditional approaches tend to oversupply parking at the expense of transit, carpooling, and non-motorized transportation modes; ultimately contributing to congestion, air pollution, and the inefficient use of land and resources. NCPC's approach represented a departure from parking policy and engineering approaches at the time. Since the mid-2000s, land use and transportation planners across the country are increasingly advocating for "efficiency-based" policies similar to NCPC's approach.

The cost and convenience of using different transportation modes are the key determinants of travel mode choice. Using accessibility metrics, NCPC's parking policies could more closely align with regional travel conditions.

The geographic structure of NCPC's Comprehensive Plan parking ratio policies is designed to reflect regional accessibility. Accessibility metrics are a type of analytical tool that policymakers use to understand and communicate the ease of travel between households and workplaces via different modes of transportation. They quantify existing and future travel conditions in the region based on travel time, and other factors. NCPC can use this objective data to inform updates to its parking policies. These updates should ensure that policies reflect both the complexity of transportation access and anticipate future land use and transportation conditions in the NCR. This approach is consistent with NCPC's mission, analytically defensible, and firmly grounded in regional and local transportation and land use plans and policies.

NCPC's plan review process should account for the unique needs and missions of its federal partners through a predictable, flexible, data-driven, and transparent process.

The missions and needs of NCPC's federal partner agencies are varied and complex. While regional models can estimate and predict the accessibility of particular locations, they cannot and will not account for all the

site-specific and installation-specific variables that may affect each facility's parking needs. Facilities should be able to respond rationally to site-specific drivers of parking demand; unique conditions; mission needs; and estimated future demand. To that end, NCPC should consider developing a more standardized and formalized variance process. This could include integrating analytical approaches and data requirements into the master planning process with specific data requirements for master plans and Transportation Management Plans or Programs (TMP). For example, staff could use the NCPC Parking Supply Tool to estimate the impact of potential employee shuttles and account for the prevalence of teleworking, and alternative work schedules for specific facilities. These analyses would enable federal partner agencies to justify requests for parking variances pursuant to industry-standard approaches with analyses performed by private sector contractors.

Technological change is likely to significantly alter the transportation industry over the next 10-20 years. NCPC should consider policies recognizing how technology could change regional travel patterns and reduce the need for parking.

The automobile industry is on the verge of a major technological transformation with the development of advanced automated vehicle technologies. Connected and automated will transform the way people commute and travel in the next 10-20 years, with potentially major implications for parking policy, personal vehicle ownership, congestion, and accessibility. The adoption of autonomous vehicles, coupled with increasing use of ridesharing, may increase the need for designated drop-off areas. These trends could significantly reduce the amount of parking that is needed at federal facilities in the NCR. Pursuant to these trends, many universities are emphasizing transportation demand management strategies to reduce the need for parking spaces that may be obsolete in the next decades. In some cases, universities are building structured parking that can be easily repurposed for other uses.

NCPC is in a unique position to continue to drive federal and local mobility, efficiency, and sustainability goals in the Region. Continued success depends on realistically achievable targets, ongoing partner coordination and performance monitoring.

Data from federal facilities and the Metropolitan Washington Council of Governments (MWCOG) regional model demonstrate that travel time and costs are important determinants of mode choice. When coupled with other transportation options and transportation demand management approaches, NCPC and its federal partners have achieved significant reductions in single occupant vehicle (SOV) use and parking, while increasing transit use, carpooling, and non-motorized transportation. In a federal context, managing parking supply is a critical component of reducing long-term agency costs, mitigating congestion, encouraging efficient land use patterns, and improving regional air and water quality.

Recommendations

The Volpe Center conducted a thorough review of the transportation literature and industry best practices; researched the parking policies and transportation demand management approaches of NCR jurisdictions; and analyzed available data from federal facilities in the region and the regional transportation model. Based on this research and the key findings described above, the study team developed recommendations for the Commission to consider as NCPC explores updates to its policies, guidelines, and plan development processes.

NCPC should carefully consider parking supply in the context of available data, site-specific conditions, and the feasibility of using alternative transportation modes. Based on this analysis, the Volpe Center organized its recommendations for NCPC's parking policies and processes into the following categories:

- Data-Driven Policies
- Standardized Modification Process
- Performance-Based Monitoring

> Parking policies should be both aspirational and realistically achievable.
>
> The analysis indicates that NCPC's Comprehensive Plan ratio policies are too aggressive, including in some parts of the 1:4 Historic DC Boundary Zone.

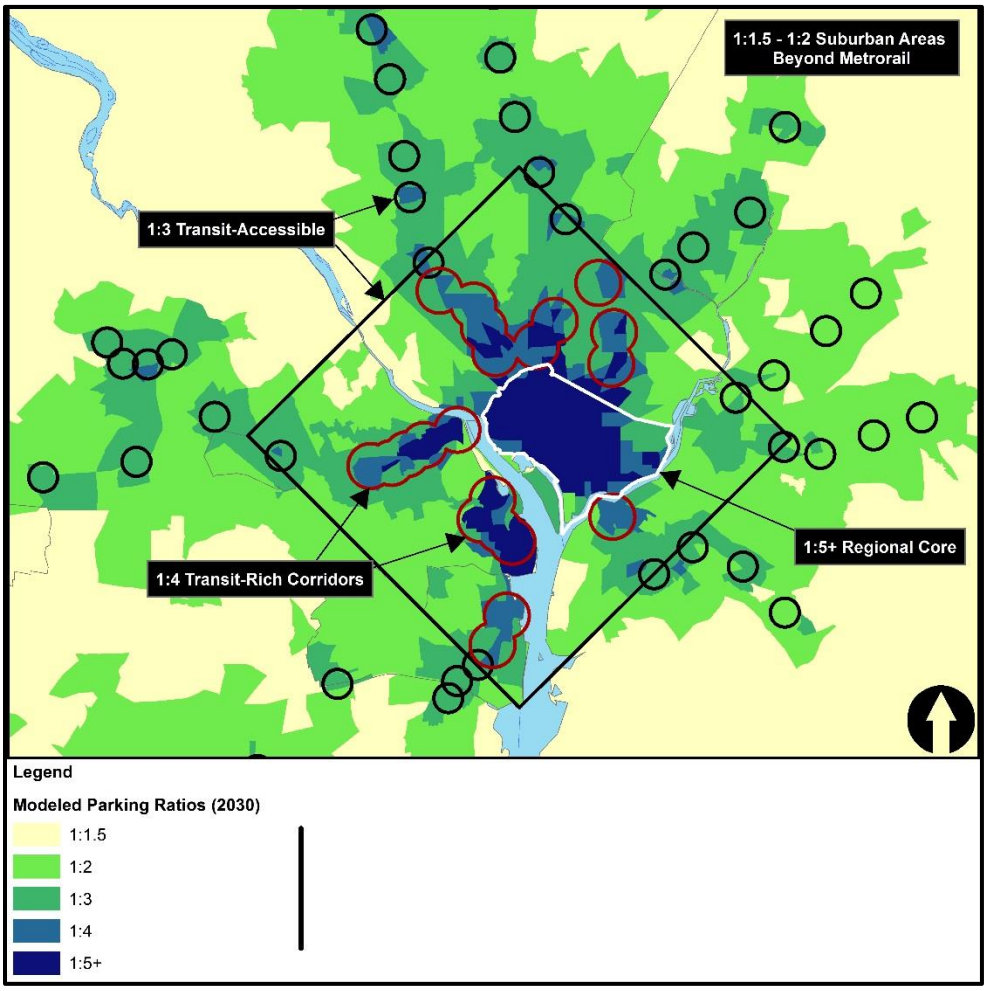
Data-Driven Policies

NCPC should consider adjusting its parking ratio policies to track more closely with regional accessibility, both current and projected. The project team noted that, in some cases, federal facilities are providing two to three times more parking than indicated under NCPC's Comprehensive Plan parking ratio policies. This is particularly true in the Historic DC Boundary Zone (one parking space: four employees), which covers a wide range of built environment contexts. This area includes urban, transit-accessible locations adjacent to the CEA, and suburban, largely auto-dependent locations further from downtown.

While NCPC's Comprehensive Plan parking ratio policies are intended to be aspirational, they should also be realistically achievable. The modeling exercise indicates that the Historic DC Boundary Zone should be broken up into multiple zones based on accessibility. Based on the modeling analysis, NCPC could adjust this zone into two or three zones based on projected 2030 regional land use and transportation changes and/or merged with existing suburban zones (see Figure 2):

- **1:5+ – Regional Core**: The L'Enfant City.
- **1:4 – Transit-Rich Corridors:** Highly Metro-accessible portions of the Historic DC Boundary Zone.
- **1:3 – Transit Accessible**: The remainder of the Historic DC Boundary Zone and suburban locations within 2,000 feet of a Metrorail station.
- **1:1.5 - 1:2 – Suburban Areas Beyond Metrorail**: All other locations in the region, including areas served by HOT/HOV lanes or high-frequency commuter rail.

Figure 2: Map of Suggested New NCPC Parking Ratio Policies



Standardized Modification Process

NCPC's parking policies could be more standardized. Federal facilities in the region have unique needs, including nationally significant research, military, intelligence, and medical functions. Even with the adjustments to parking ratio policies described above, a regional policy map cannot distill the unique needs and context of each of federal facility in the NCR. The study team observed that many local jurisdictions use transparent and data-driven parking variance processes to allow private developers to provide *less* parking than is required. However, federal agencies typically request that NCPC allow them to have *more* parking than that outlined under NCPC parking ratio policies.

> While the Commission routinely approves modified parking ratios, NCPC does not have a standardized process for agencies seeking variances from Comprehensive Plan parking ratio policies.
>
> The analysis points towards opportunities to develop a process that is transparent, predictable, and data-driven.

Variance processes account for unique site-level circumstances, use patterns, and needs of each agency based on data. Indeed, the Commission has received and granted requests that allow applicant agencies to provide more parking than specified in its parking ratio policies over the years.

NCPC could standardize this approach as a formal variance process; one that is consistent with the Commission's goals, available transportation data, and that accounts for the distinct missions of its federal partners. For example, NCPC could modify parking ratios for particular installations pursuant to an objective, criteria-based scoring system. The applicant agency would have to request a variance based on the following:

- Accessibility Analysis: The applicant would demonstrate that the Comprehensive Plan parking ratio policy is inappropriate for the facility. This analysis would show that the facility is more inaccessible by transit than indicated by the NCPC Comprehensive Plan policies, even with a reliable employee shuttle. NCPC staff would use the NCPC Parking Supply Tool to estimate parking needs at individual facilities, exploring adjustments to the Comprehensive Plan parking ratio policies. The tool enables staff to take into account the impact of prospective employee shuttles, teleworking, and alternative work schedules at individual facilities. This analysis would include site-specific factors like security perimeters, the potential for carpooling, and other factors. For example, the applicant agency might show that that an employee shuttle is not feasible because of distance from Metrorail or that employee household locations are too dispersed to feasibly carpool.

- Mission Analysis: The applicant would demonstrate that the Comprehensive Plan parking ratio policy impedes the unique mission of the facility. This analysis would show that the facility has parking patterns and needs that are not accounted for in the policies. For example, the applicant might use a demand study to demonstrate that employees have unusual shifts that require extra parking.

- Lifecycle Cost Analysis: The applicant would quantify the capital and long-term operations cost to taxpayers of providing surface or structured parking to employees. For example, the applicant might show that it has taken steps to reduce the lifecycle cost of providing parking through a partnership with a local jurisdiction.

Performance-Based Monitoring

> Successful transportation demand management programs rely on continuous monitoring programs.
> The analysis indicates that NCPC needs annual or biennial monitoring to ensure that partner agencies are making progress towards Comprehensive Plan parking ratio policies.

The effectiveness of NCPC's parking and transportation policies could be significantly strengthened with more continuous, performance-based monitoring. Typically, successful TDM programs rely on annual or biennial monitoring and surveys to ensure progress towards goals. In NCPC's case, federal partner agencies typically produce TMPs when master plans or projects increase employment levels at a facility by 500 or more. The average age of the data from the selected TMPs in this study was four years, ranging in age from one to eight years. According to NCPC staff, other major facilities in the region have not engaged in the master planning process in over a decade. More continuous follow-up and monitoring, data collection, and commuter surveys are necessary to ensure that agencies are making progress towards achieving performance targets.

To that end, the Volpe Center recommends that NCPC staff collect data annually or biennially to assess each affected federal facility's progress towards Comprehensive Plan parking ratio policies. At a minimum, this data collection would include an updated inventory of employee parking spaces and the number of full-time federal employees who commute regularly to each site. A more robust monitoring program would include commuter surveys from each facility, with uniform questions regarding mode split and travel patterns. This data could be assembled into a periodic parking and transportation performance report to discuss during Commission meetings and share with the public.

2. Background and Context

Introduction

To place the study in context, the Volpe Center and NCPC staff sought to frame the study in light of existing NCPC policies, current and projected regional land use and transportation conditions, the history and evolution of parking policy nationally and at NCPC, and the parking policies of NCPC's principal federal partners.

NCPC Parking Policy

The National Capital Planning Act (40 U.S.C. §8701 et seq.) requires federal agencies to consult with NCPC when preparing plans and programs which affect NCPC's Comprehensive Plan. The Comprehensive Plan is a statement of principles, goals, and planning policies for the growth and development of the national capital during the next 20 years. The Comprehensive Plan's eight Federal Elements include Urban Design, Federal Workplace, Foreign Missions & International Organizations, Transportation, Parks & Open Space, Environment, Historic Preservation, and Visitors & Commemoration. With the exception of the Parks & Open Space Element, which is currently in the process of an update, the Commission adopted the elements in 2016. While each element addresses a specific planning topic, the elements work together to guide federal development in the region.

The Transportation Element establishes the following goal: to develop and maintain a multi-modal regional transportation system that meets the travel needs of workers, residents, and visitors while improving regional mobility and accessibility through expanded transportation alternatives and transit-oriented development. The NCR faces important transportation challenges which impact where people live and work, development patterns, environmental quality, and the overall quality of life. The region is among the most congested in the country and is served by an aging transportation system that operates near capacity. The federal government has long played an influential role in the region's transportation network, including helping to plan and fund the Metrorail system. With employees, federal facilities, and other assets in the NCR, the federal government has a strong interest in improving regional transportation services and infrastructure.

Within this policy context, approximately 40 federal installations and campuses periodically develop master plans. These are comprehensive development proposals covering a planning horizon of at least 20 years. Master plans have important implications for transportation and parking at these facilities. Agencies produce Transportation Management Programs or Plans (TMPs) as part of the master planning process. TMPs document a facility's efforts to foster more efficient employee commuting patterns and meet Comprehensive Plan parking ratio policies through transportation demand management (TDM) techniques.

Master plans consider facility conditions; mission needs; new or changing activities, transportation, workforce and visitor populations; urban design and security; and environmental and cultural resources. NCPC and the federal facilities use master plans to communicate future projects and work with local planning departments to address potential on and off-site impacts. Typically, agencies use these documents to meet compliance responsibilities under National Environmental Policy Act (NEPA) and Section 106 of the National Historic Preservation Act (NHPA). Appendix A describes the master plan review process in more detail.

NCPC's existing Comprehensive Plan parking ratio policies are set on an employee basis for primarily office facilities. The ratios do not specifically address other types of federal uses, such as visitor destinations, retail, or service (hospital) uses.

NCPC requires a TMP for new or updated master plans or when individual projects increase employment at a facility to 500 or more people. NCPC also strongly encourages agencies to prepare TMPs for projects that will increase employment to 100 or more. TMPs includes specific strategies to meet parking ratio policies in NCPC's Comprehensive Plan by encouraging changes in travel modes and routes, and the timing, frequency, and length of trips. The purpose of these strategies is to reduce traffic congestion and improve regional air quality. While master plans typically include a Traffic Impact Assessment that forecasts transportation conditions external to the facility, TMPs do not consider unconstrained parking demand. Appendix B describes NCPC standards for TMPs.

Taken together, master plans and TMPs are the primary mechanism by which NCPC influences employee commuting at federal facilities. Every five years, federal facilities are expected to review master plans and ensure they reflect anticipated changes. If changes are minor, agencies do a modification. If they are major, agencies conduct a full update to their facility master plan and TMP. As agencies update TMPs, NCPC receives new data about commute mode share, parking inventories, and employment levels at different facilities.

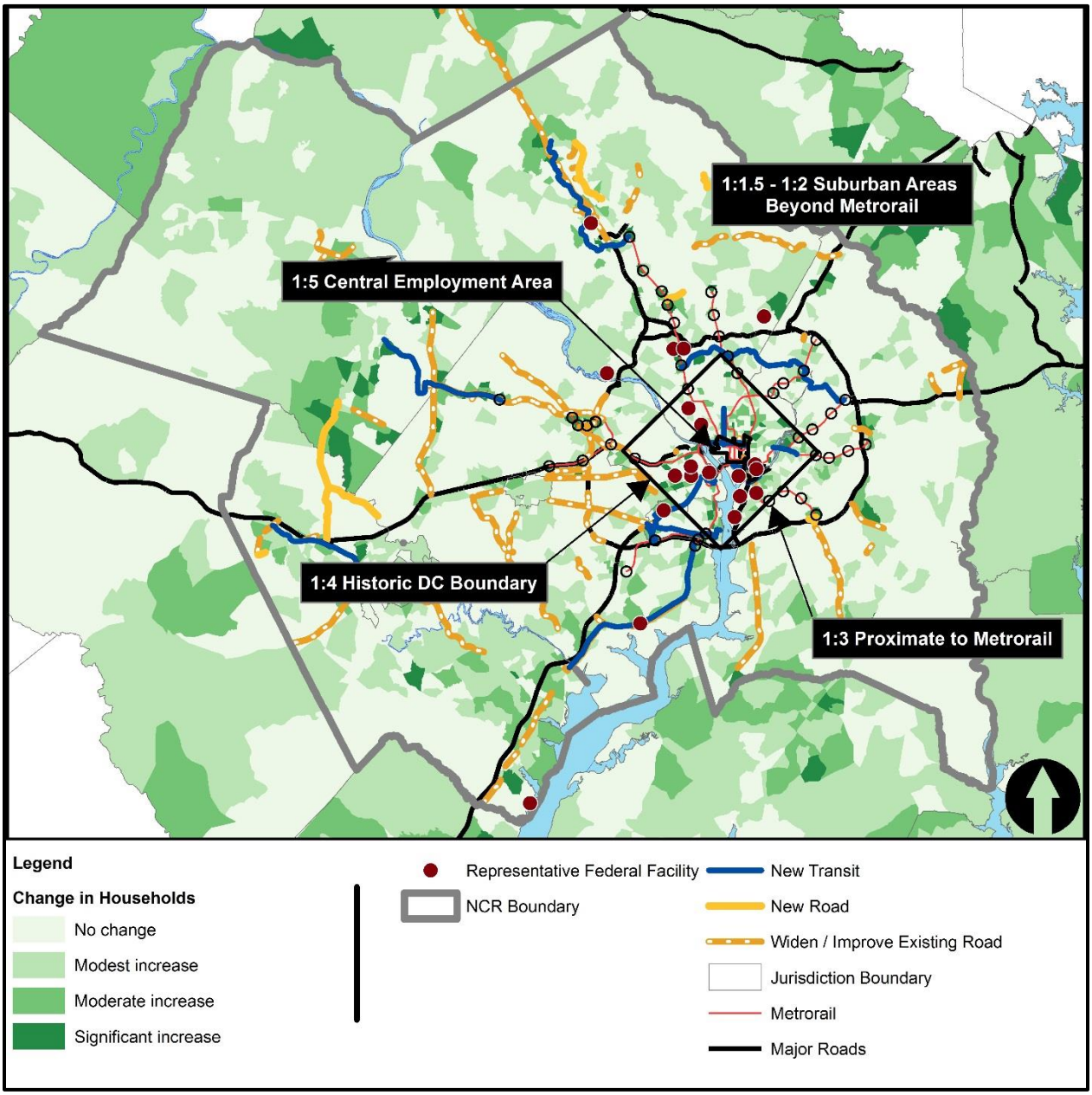
Current and Projected Land Use and Transportation Conditions in the National Capital Region

Based on travel surveys and modeling conducted by MWCOG, the study team identified the following trends and key themes regarding current and projected (2040) regional land use and transportation conditions. According to MWCOG:[3]

The region will experience significant growth in households and jobs by 2040 (particularly in outer jurisdictions), and changes to the transportation network. These changes, combined with associated congestion, will result in increased accessibility in the western part of the region and decreased accessibility in the east.

By 2040, the region's population is expected to increase by 24 percent while the workforce is expected to increase by 36 percent. The majority of growth will occur in the outer jurisdictions, but the inner jurisdictions will retain the majority of the region's population (see Figure 3).

Figure 3: Map of Expected Land Use and Transportation Changes in the Region (2016-2030)



The average number of jobs accessible within a 45-minute automobile commute is expected to decrease slightly over the next 30 years, with the greatest reduction in job accessibility expected to be on the region's eastern side. This is due to a combination of projected increases in automobile congestion in the eastern portion of the region and anticipated greater job growth in the west. Average accessibility by transit is forecast to increase, although overall accessibility to jobs by automobile remain significantly higher (see Figure 4 and Figure 5).

Figure 4: Change in Accessibility to Jobs by Automobile (2016-2040)

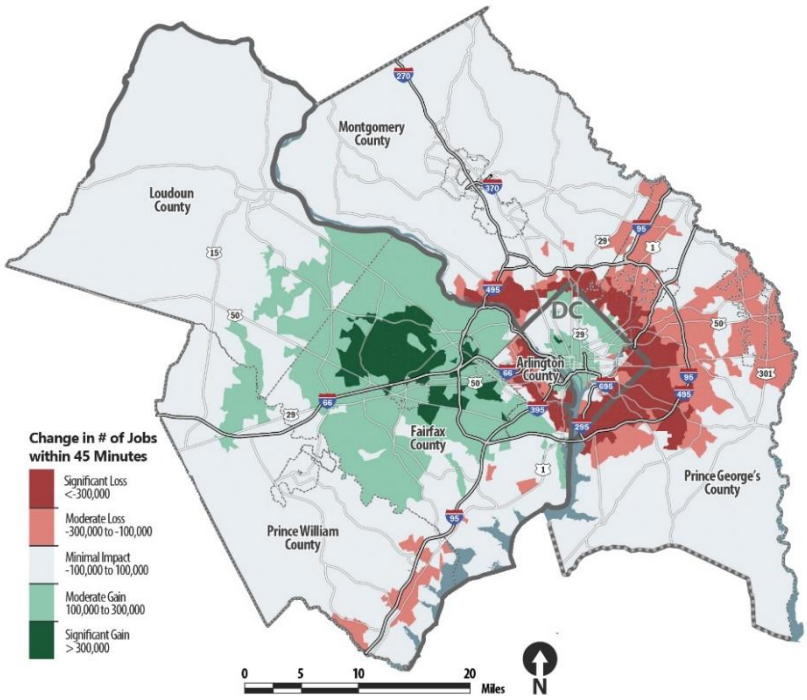
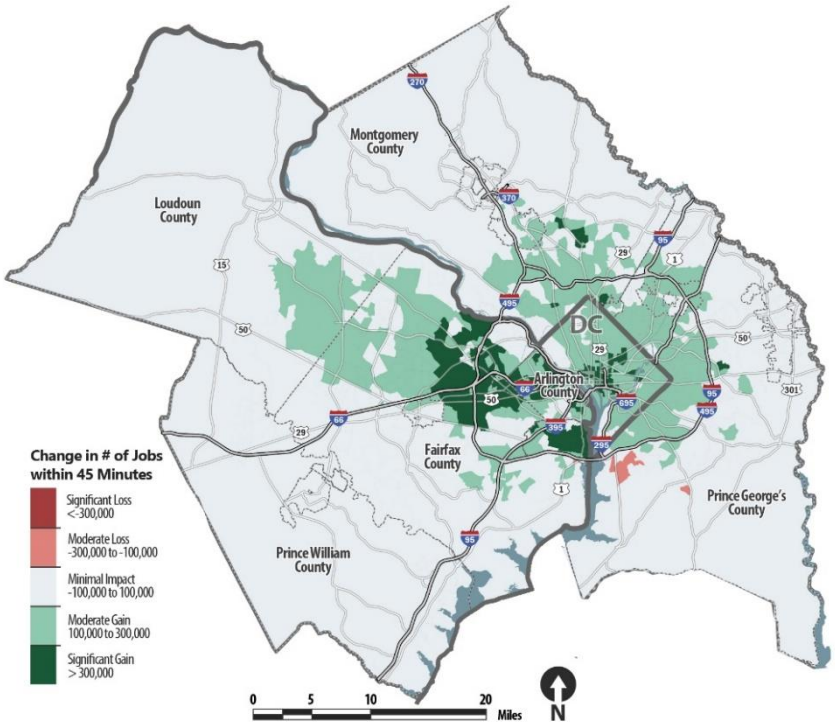


Figure 5: Change in Accessibility to Jobs by Transit (2016-2040)



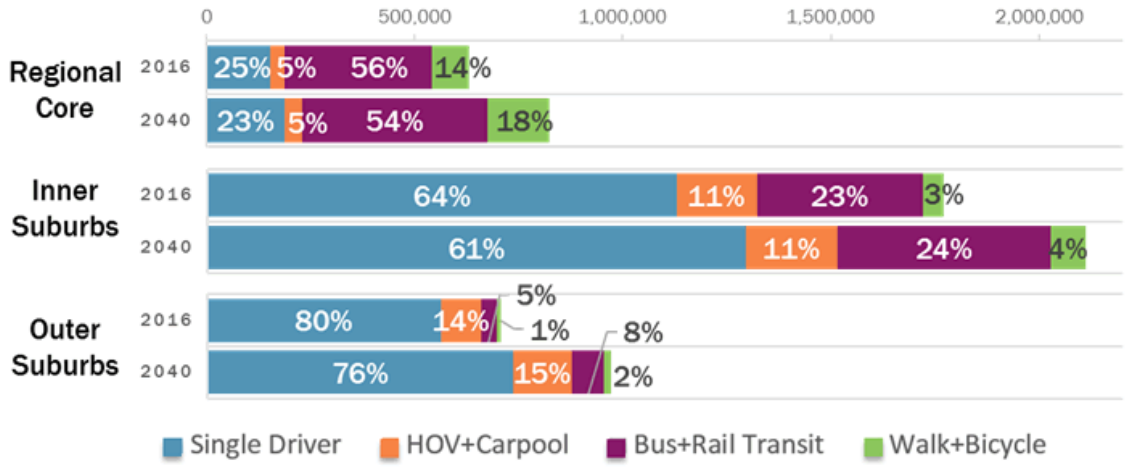
Source: MWCOG

MWCOG adopted its *Region Forward Vision*, in large part, in response to these trends. The plan is focused on "creating a more prosperous, accessible, livable, and sustainable metropolitan Washington." The plan includes goals and targets to guide decision-making and measure progress. As part of the coalition that developed and endorsed this plan, NCPC is encouraged to support the region in meeting performance targets related to regional prosperity, affordability, and wage growth; concentration of household growth in designated activity centers; and other livability and sustainability targets.

The number of commute trips will increase by 2040. Although there is significant regional variation, overall commute mode shares will remain similar.

The majority of the region's current commute trips are drive alone trips (61 percent), followed by transit (23 percent), carpooling (11 percent), and non-motorized (4 percent). Commute mode share is not expected to change significantly by 2040. However, there is considerable variation in commute mode share across the region. For example, in the regional core (DC, Arlington County, and Alexandria), 58 percent of work trips are made by bus or rail and 13 percent by walking or biking. In the inner suburbs (Fairfax, Montgomery, and Prince George's Counties) Single occupant vehicle (SOV) trips account for the largest share of work trips (63 percent) and nearly a quarter of work trips are taken by transit (see Figure 6).

Figure 6: Current and Future Commute Mode Shares Across the Region



Regional Core: Washington, DC, Arlington, and Alexandria Va.

Inner Suburbs: Montgomery: Prince George's, and Fairfax Counties.

Outer Suburbs: Prince William, Loudoun, Frederick, and Charles Counties. Source: MWCOG

MWCOG projects annual work trips will increase from 3.5 million per day to 4.4 million per day by 2040. At the same time, models estimate that the share of trips by driving and carpooling will decrease slightly (three percent and one percent, respectively), while transit and non-motorized trips will increase slightly (both two percent).

In the regional core, the share of transit trips is expected to drop in favor of more walking and bicycle trips. In the inner suburbs, SOV trips are expected to drop slightly, while both transit and non-motorized trips will increase. In the outer suburbs single driver trips are expected to drop, while carpool and transit trips are expected to increase significantly. Projects like expansion of the Silver Line to Dulles Airport, which will bring Metrorail to Loudoun County, and the high occupancy toll (HOT) lanes in northern Virginia, will contribute to this shift in mode choice.

The region will have significant increases in trips, congestion, and emissions. These conditions will be worst in inner suburban jurisdictions but will change most dramatically in outer suburban jurisdictions.

The number of daily trips made by area residents is expected to grow by more than 25 percent between 2013 and 2040, and the number of miles driven will increase by about 25 percent. The increase in demand on the region's roads is expected to outpace increases in roadway capacity, leading to a significant increase in congestion. Funding constraints will limit the increase in new roadway investments. Severe stop-and-go congestion is expected throughout the entire region, although planned HOT lane projects in Virginia will relieve some of the congestion. Outer suburban jurisdictions will experience the greatest increase in congestion, while the already congested inner suburban jurisdictions will experience the worst overall congestion. Making matters worse, congestion will increasingly extend beyond rush-hour periods and affect off-peak weekday and weekend trips.

Increases in traffic volumes, travel distances, and congestion contribute to other problems, including air pollution. This is because ground-level ozone, the prime ingredient in smog, is formed when gases in automobile exhaust react with oxygen. As the number of trips increase in quantity and length, the resulting higher emission levels cause an increase in ozone and smog. These effects will be somewhat mitigated by improvements in fuel efficiency and new fuel technologies.

The region's federal employees drive alone slightly less, and take transit significantly more, than the general population.

MWCOG's Household Travel Survey indicates that, in 2009, 54 percent of federal employees in the region drove alone, which is similar to all employment sectors. At the same time, 33 percent of federal employees commuted by transit, which is two thirds higher than the region as a whole in 2016. Metrorail was designed to serve major federal employment centers and federal employees have generous transit subsides. According to these two data points, carpooling and non-motorized travel is roughly similar between federal employees and other sectors.

The average commute times are longer for transit and carpool commutes.

The average commute time in the region is 39 minutes one-way. Metrorail and carpool commutes average slightly longer (48 and 42 minutes respectively), and drive alone trips are on average slightly shorter (35 minutes). Walk/bike trips are significantly shorter (17 and 22 minutes respectively), while commuter rail trips average significantly longer (72 minutes).

Telework is an increasingly significant factor in regional commuting, particularly for the federal workforce and transit riders.

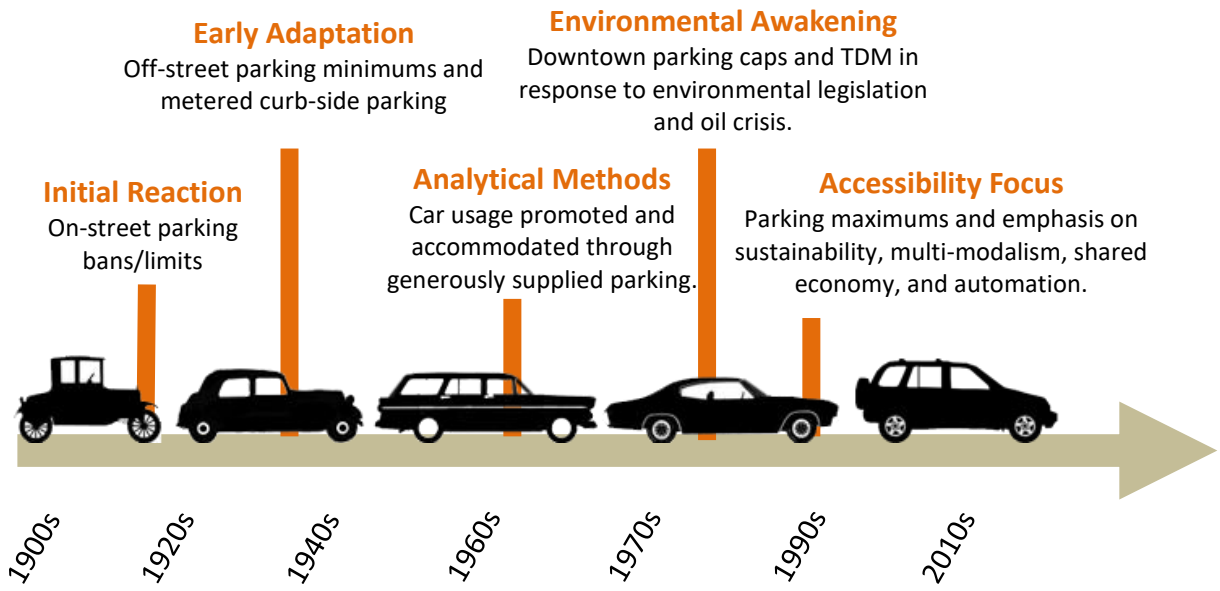
Approximately one-third of area commuters telework an average of 1.5 days a week. Federal employees have the highest incidence of teleworking of any sector in the region (45 percent of all federal employees surveyed). The federal sector also has the fastest growth in teleworking arrangements, increasing from 16 percent of federal employees in 2007 to 45 percent today. Non-SOV commuters are most likely to telework. MWCOG estimates that approximately 10 percent of potential work trips are eliminated through telework and compressed work schedules.

Historical Context of Parking Policy

Evolution of Parking Policy Nationally

Transportation technology and travel patterns have changed dramatically over the last century, moving from more localized travel (walking, horse and buggy, streetcar, etc.) to more regional travel (privately-owned automobiles and regional transit systems). Beginning in the 1990s, the transportation industry began to shift from a focus on "mobility" (moving cars) to "accessibility" (getting people to destinations). This new paradigm does not prioritize a particular mode, but instead emphasizes multi-modal transportation options, supportive land use and urban design. Within this broader context, policymakers, engineers, and planners in the United States have grappled with parking supply and management since the early 1900s. This is particularly true in large cities and metropolitan areas. Like transportation policy, urban parking policy is increasingly data-driven, market-based, and connected to broader multi-modal transportation policy and goals. Furthermore, parking policy is an increasingly important tool for influencing travel behavior. Figure 7 and the chronology below describes the overall trajectory of parking policy from the early 20th Century to present.[4]

Figure 7: Evolution of Parking Policy Nationally



Early 1900s (Initial Reaction) – As a reaction to the introduction of cars, major cities instituted parking bans and strict parking limits on downtown streets. Police departments, planners, and traffic engineers supported these policies and argued that curbside parking was an inefficient use of public space that impeded the mobility of other road users.[5] Cities during this period had strong central business districts with very few competing commercial centers.

1920s–1950s (Early Adaptation) – With car ownership rising dramatically and demand for accessing new destinations, cities made provisions for both curbside and off-street parking to fully accommodate automobile travel. Both the public and private sector funded parking garages. To control parking demand and generate revenue, local governments instituted metered curbside parking. Local governments also instituted (minimum) off-street parking requirements on new residential and commercial development. These policies accommodated increasingly dispersed land use patterns, particularly suburban residential growth in the postwar period.

1950s–1970s (Analytical Methods) – Concurrent with the development of the Interstate Highway System, the U.S. Bureau of Public Roads published an influential pamphlet in 1956 that promoted car use and increased highway capacity. To support parking minimum requirements and avoid spillover parking from adjoining land uses, engineers developed and refined analytical methods to estimate unconstrained parking demand. These tools sought to accommodate peak parking demand, under the assumption that all visitors would arrive by private vehicle and that parking would be free. Urban areas during this period became more "polycentric," with multiple activity centers spread through metropolitan areas.

1970s–2000s (Environmental Awakening) – With the era's environmental movement, policymakers began recognizing a link between the practice of supplying unlimited parking with other policy concerns, including congestion, air pollution, and urban sprawl. Litigation brought under the Clean Air Act forced some major cities to limit the supply of downtown off-street parking. Environmental concerns combined with the 1970s energy crisis pushed policymakers to develop new transit systems and transportation demand management approaches like carpooling. Despite some policy changes, including the adoption of parking maximums in some cities, there was relatively little innovation in parking policy. During this period, most jurisdictions adopted analytical approaches like the Institute for Transportation Engineers' *Parking Generation* to estimate parking demand and set parking policy. Urban areas became increasingly polycentric during this period and dual income households emerged as a major influence on travel patterns and household location.

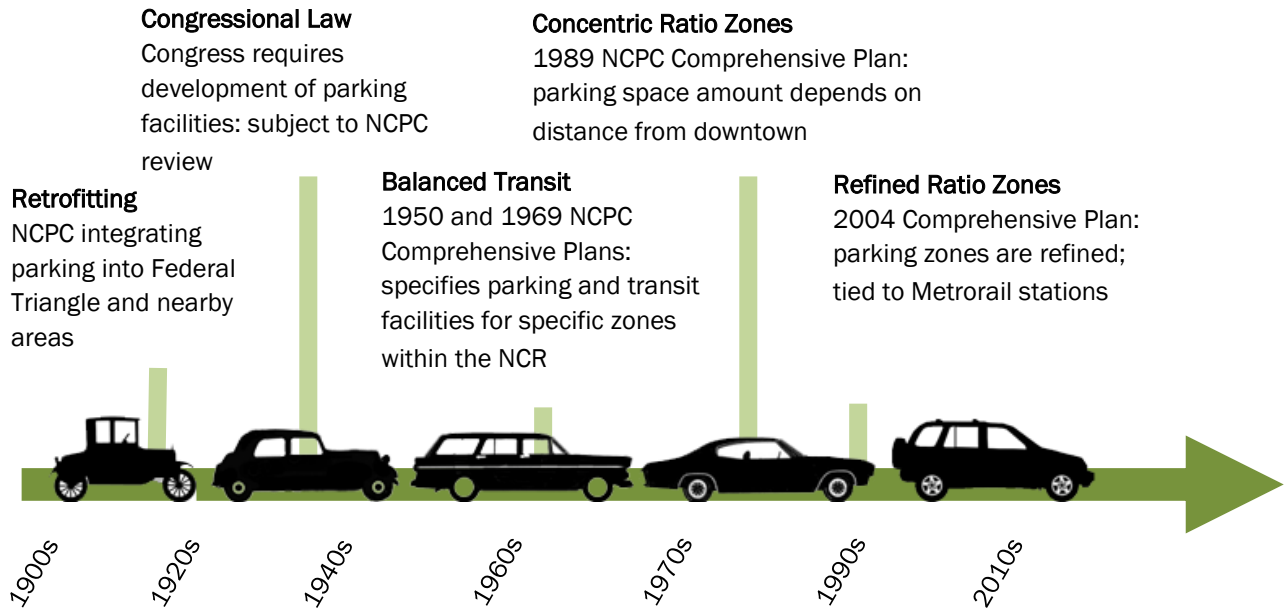
2000s–Present (Accessibility Focus) – A growing focus on sustainability and increasing interest in urban living, land scarcity, and associated higher costs for developing parking led many cities to change parking policies. Cities started experimenting with variable parking pricing, instituting parking maximums, constructing bicycle infrastructure, and expanding the use of other transportation demand management approaches like districts, parking cash-outs, and transit subsidies. These trends coincide with critiques and enhancements to traditional analytical approaches for determining parking demand and identifying parking minimums. Researchers began testing adjustment factors and locally collected data to account for transit and non-motorized modes. Policymakers began supplementing these tools with cost-benefit analyses, parking surveys, and other policy-oriented approaches.

With rising construction costs and stagnant gas tax revenue, jurisdictions today are struggling to maintain existing transportation infrastructure. Their focus is increasingly on repairing existing infrastructure and pursuing relatively low-cost transit system expansions like light rail and bus rapid transit. Private sector innovations like app-based ride hailing services, automated vehicles, and electric vehicles are creating new mobility and accessibility options but also presenting new challenges for policymakers. These trends have significant implications for large transit agencies.

Evolution of NCPC's Parking Policy

NCPC participated in, or sponsored, a variety of transportation surveys, proceedings, and reports over the years. Consistent with trends in parking policy across the country, NCPC and its predecessor developed a series of increasingly sophisticated parking and transportation policies over the 20th century. This included advancing the creation of the Metrorail system, freeway expansion and arterial street enhancement, and express/local bus service to form an integrated circulation network. For parking, NCPC's policies shifted from restricting on-street parking and constructing off-site parking, to encouraging federal facilities to limit parking, prioritize employee use of transit, and pursue transportation demand management techniques. Parking policies were increasingly tied to the location of facilities and proximity to transit and carpooling options. Figure 8 and the chronology below describe major NCPC parking policy milestones. Appendix C describes the history of NCPC's parking policy in more detail.

Figure 8: NCPC Parking Policy Milestones



Early 20th century – The 1901 McMillan Plan predated the automotive age, and therefore did not include provisions for automobiles. By the 1920s, NCPC's predecessor, the National Capital Park and Planning Commission (NCPPC), dealt directly with regulatory and zoning changes in the District of Columbia, including parking and physical changes to the transportation network and restricting on-street parking. By the 1940s, congestion problems in Washington were acute. On-street parking and a lack of off-street parking impeded the movement of traffic. In 1942, Congress authorized the federal body governing the city to ensure adequate parking and called for the creation of public off-street parking facilities, with review from NCPPC.

1950 Comprehensive Plan – NCPC's first Comprehensive Plan identified three transportation strategies:

1. Cut down on the amount of travel needed to get home and to work.
2. Make public transportation so quick and convenient that…fewer will drive; and
3. Create a system of collector and distributor roads…that will redistribute traffic through the region and diminish the volume demand within the Central Area.

Recognizing that these strategies would result in a deficit of vehicular parking spaces in Washington's Central Area, the plan outlined several types of transit- and pedestrian-accessible places suitable to develop vehicle parking spaces.

Subsequent to the 1950 Comprehensive Plan, a 1955-1956 report on federal employee parking ratios[6] surveyed federal parking ratios during an overhaul of Washington's zoning code. It reported that of all federal employees working in buildings under the General Services Administration (GSA) control with 1,000 or more employees per building:[7]

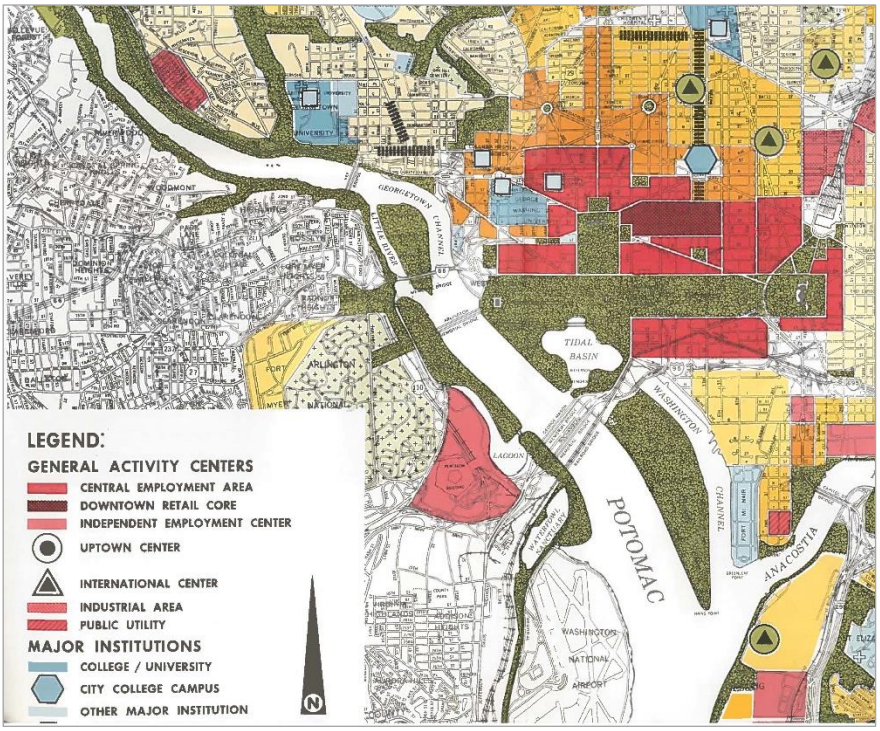
- 4.0 percent had a parking ratio of 1 parking space:3 employees or better
- 32.4 percent had a parking ratio of 1:4 or better
- 44.1 percent had a parking ratio of 1:8 or better
- 62.3 percent had a parking ratio of 1:10 or better

1969 Comprehensive Plan – This plan proposed an integrated circulation network for Washington and advanced the concept for the Metrorail system, a major freeway expansion program, improvements to arterial streets, and improvements in the network of both express and local bus service. The plan specified policies for two types of areas - the center of Washington ("Central Area Parking") and inner suburban and uptown Washington ("Fringe and Uptown Center Parking") (see Figure 9). For each area type, the plan had three categories of policies: 1. basic plan policies, 2. specific numerical targets applicable before Metrorail began operations, and 3. specific numerical targets applicable for after Metrorail began operations.

The basic parking policies for center of Washington were:

- Parking space in the Central Employment Area should be provided in structures located close to freeways and arterial streets.
- The total central area parking system should be managed to encourage equilibrium of parking space, congestion-free highways, and highly utilized transit.
- Central Employment Area parking should be managed to insure reasonable availability of parking space to serve non-work as well as work trips.
- The central area parking system should include parking in high-density residential areas.

Figure 9: Excerpt from 1969 Comprehensive Plan



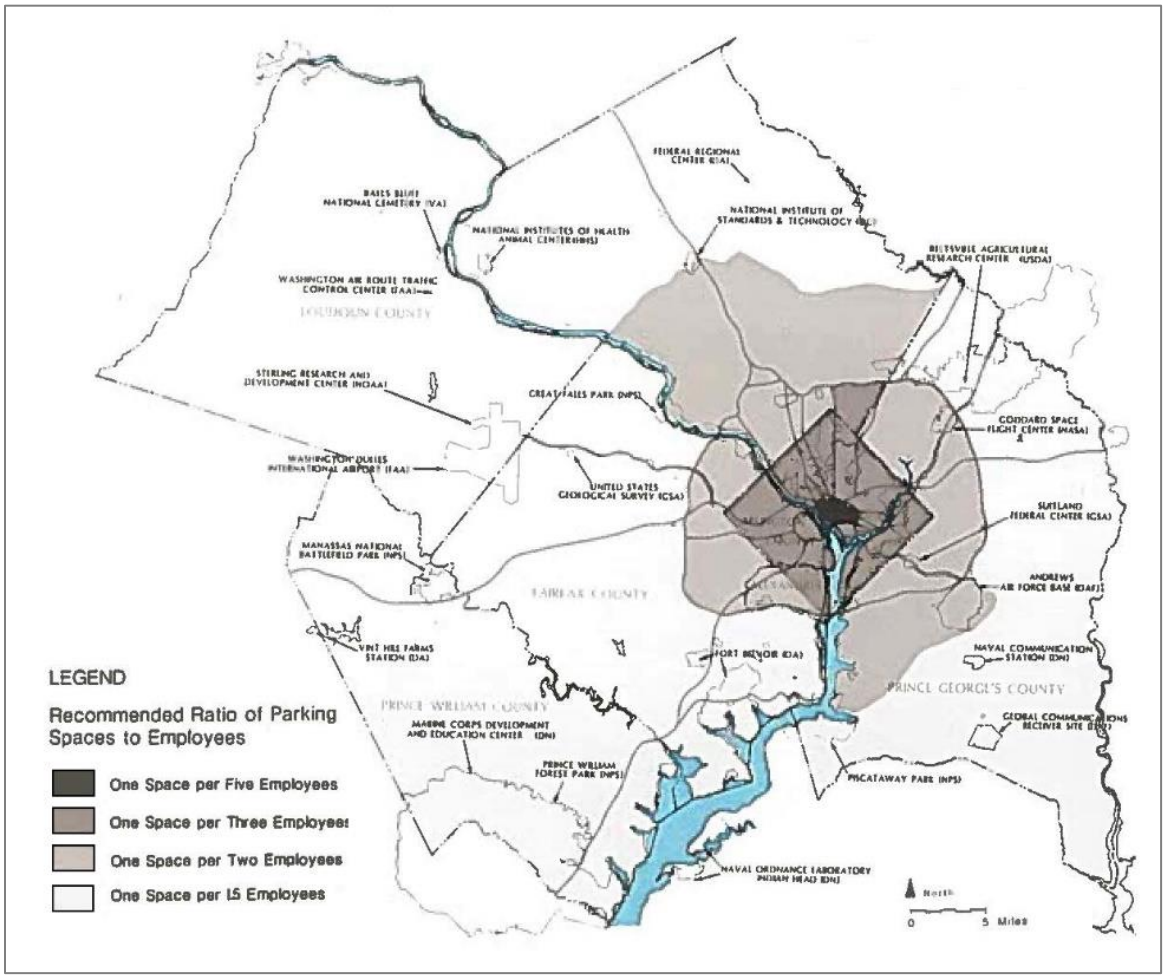
The Central Employment Area

incorporates the federal establishments symbolic and physical heart encompasses the hub of the Metro system, and commuter rail. The Comprehensive Plan specifies that the federal government should prioritize workplace locations within the official Central Employment Area. In accordance with Executive Order 12072, GSA uses the CEA boundary as the delineated area for federal leasing in the District of Columbia. The District also focuses on infrastructure needs within the CEA.

1989 Comprehensive Plan – Anticipating the inauguration of the full Metrorail System, NCPC concluded in the 1980s that federal parking policies should maximize transit use and carpooling. In part, this strategy was intended to protect the federal government's significant investment in developing the Metrorail system. In addition to several related policies, the 1989 Plan established geographically-based maximum employee-to-parking space ratios for the first time. Using jurisdictional boundaries and the highway network, NCPC drew these zones to limit federal parking in urban areas. The zones broadly reflect where transit availability and carpooling opportunities in the region (see Figure 10):

- The Central Employment Area (one parking space: five federal employees) – (1:5)
- The District of Columbia (outside the CEA), Arlington County, City of Alexandria, and portions of Silver Spring inside the Capital Beltway and east of 16th Street extended – (1:3)
- Portions of urbanized Montgomery County (south of Routes 28, 124, 115 and 1), Prince George's County (inside the Capital Beltway), Fairfax County, and the City of Alexandria (inside the Capital Beltway) – (1:2).
- The remainder of the region – (1:1.5).

Figure 10: 1989 Comprehensive Plan Parking Ratio Zone Map



2004 Comprehensive Plan – This plan established a general policy to "provide parking only for those federal employees who are unable to use other travel modes." This policy was a response to increasing congestion and deteriorated air quality in the region, new smart growth provisions in local plans and zoning, and

completion of the Metrorail system. NCPC retained the concept of concentric zones from the 1989 Plan but adjusted parking ratio policies to more closely align with the location of Metrorail stations and High Occupancy Vehicle (HOV) lanes (see Figure 1). The 2004 plan created requirements for agencies to submit TMPs and institute TDM techniques to encourage non-SOV modes.

Changes to parking zones in the 2004 plan included more aggressive parking goals in the more suburban sections of Washington (non-CEA), Arlington County, and the City of Alexandria, while simultaneously relaxing goals in suburban areas not proximate to Metrorail or HOV lanes. These new policies:

- Retained the CEA zone of (1:5).
- Created a new 1:4 zone inside the Historic DC boundary, including the District of Columbia, Arlington, and portions of Alexandria.
- Revised the 1:3 zone to include only locations within 2,000 feet of all suburban Metrorail stations.
- Revised the 1:2 zone for suburban areas served by HOV lanes.
- Retained the 1:1.5 for the remainder of the region.

When submitting plans and projects, agencies may propose alternative (or adjusted) long-term (20-30 year) parking goals pursuant to technical analysis and documentation. These 2004 policies remain in effect today.

Parking Policies at Principal Federal Agencies

The federal government maintains broad parking policies and directives. Specific practices and implementation programs at individual facilities vary due to several factors, including mission requirements, delegation authorities, geographic conditions, and site development patterns. Section 2.5.1 outlines some general federal policies; more background on parking, pricing and related commuting policies is provided in Appendix D. General practices at the three largest landholding agencies, the GSA, Department of Defense (DOD), and National Park Service (NPS) are highlighted in Sections 2.5.2-4.

Government-wide/Nation-wide

Many of the large federal facilities in the NCR were developed before Metrorail, when ample parking was a priority. Two examples are the Pentagon and Suitland Federal Center, which were developed in the early 1940s. Designed to reduce vehicular congestion in central DC and to consolidate facilities, these campuses would influence future federal campus planning within the NCR.

During the past half century, provisions for federal employee parking became increasingly restrictive, reflecting broader policy and transportation developments. An agency now may provide employee parking facilities only if it determines that the lack of parking facilities will significantly impair the operating efficiency of the agency and will be detrimental to the hiring and retention of personnel. However, federal policy continues to allow employees to use parking spaces not required for official needs.

Agencies generally must obtain parking accommodations through the General Services Administration unless they have independent statutory authority or a delegation from GSA. The federal government has long considered employee parking, like other general commuting expenses, a personal expense of the employee. Appropriated funds are generally not available for the purpose of expenses considered personal in nature.

Over the past three decades, Congress and federal agencies are increasingly incentivizing employee alternatives to SOV commuting. Agencies must provide a commuting program. Congress has repeatedly expanded the federal transit benefit program established in 1991 to discourage SOV commuting.

While commuting programs such as the transit subsidy are becoming more popular, their effectiveness is variable and somewhat limited. Agencies are effectively prohibited from using parking revenues to offset other TDM programs, which is a successful strategy used by companies and other organizations. Most agencies do not have an incentive to charge for parking because agencies generally cannot augment their appropriations from outside sources.

Each federal agency allocates transit and parking spaces differently. The value of a transit subsidy is directly associated with the reliability and availability of public transportation in a particular area. Since parking at federal facilities is typically free, the utilization of spaces is determined by supply and demand.[8] Not all employees necessarily are aware of the benefit program.

The federal government also has policies regarding the management of parking spaces. Federal agencies must take all feasible measures to improve parking facility use, including:

- Conducting surveys and studies;
- Periodic review of parking space allocations;
- Providing parking information to occupant agencies;
- Implementing parking incentives that promote ridesharing;
- Using stack parking practices, where appropriate; and
- Employing parking management contractors and concessionaires, where appropriate.[9]

Additionally, GSA's Facilities Standards for the Public Buildings Service specifies that local regulations must be followed without exception in the design of systems that have a direct impact on off-site terrain or infrastructure: including storm water runoff, erosion control, sanitary sewers and storm drains, roads, and bridges.[10]

General Services Administration

The General Services Administration's core mission is to assist federal agencies "buy smarter, reduce their real estate footprint, provide efficient, cost saving technology and create a better, faster federal government."[11] Setting out ambitious goals, GSA seeks to achieve "net zero" energy usage for all new buildings in as little as three years.[12] GSA is purchasing fuel-efficient fleet vehicles, including electric vehicles.[13,14] GSA is also partnering with car sharing services to provide federal employees with short-term access to vehicles.[15]

Since 2012, GSA has maintained a policy of not providing free parking to GSA employees who work in facilities under its jurisdiction, custody, or control in the National Capital Region, except in very limited circumstances as described below. This policy is designed to increase the sustainability of the federal government by discouraging the use of motor vehicles, encourage the use of public transportation and mobile work arrangements, reduce traffic congestion, and improve environmental conditions.[16]

Employees using federal parking facilities who meet the following exceptions are not required to pay for parking:

- GSA employees with bicycles.
- GSA employees with severe disabilities.
- GSA employees who work at facilities not reasonably accessible to public transportation.
- GSA employees who work at facilities where public transportation is not available between the hours of 6:00 am to 7:00 pm may park at no cost in facilities under GSA's jurisdiction, custody, or control in the National Capital Region, as space is available. This provision applies to the accessibility of transportation at the GSA work facility and not the employee's home.
- GSA employees whose job responsibilities involve management or security for a government-owned building and whose functions require that the employee be physically present in the building for maintenance, emergency or security functions, as needed, on a 24 hours a day, 7 days a week basis.

GSA has worked closely with MWCOG and local jurisdictions to locate its facilities in "Activity Centers," winning MWCOG's Regional Partnership Award in 2016, These Centers are recognized because they are aligned with the region's transit network and typically are walkable, reducing vehicle parking demand.

Department of Defense

The DOD Unified Facilities Criteria (UFC) 2-000-02AN Installation Master Planning prescribes the DOD minimum requirements for master planning processes.[17] Among the instructions, installations:

- Must conserve their land resources. This can be achieved through compact development patterns that support an appropriate mix of uses, encourage walking and other alternative modes of transportation, accommodate appropriate residential and commercial densities, and incorporate a more integrated grid network of streets and sidewalks.[18]
- Use on-site natural features to control stormwater runoff quantity and quality in lieu of traditional 'end-of-the-pipe' solutions. These controls include not only open space and natural features, but also manmade features such as building roofs, streets, and parking surfaces. Other examples include bioswales, car parks, and on-street parking, which use substantially less paving per car than off-street parking.[19]
- Shall strive to minimize parking to the maximum extent possible through land-use practices that support shared-use parking, transit, and alternative modes of transportation.[20]

The DOD's Transportation Engineering Agency specifies that short- and long-term parking areas should not be more than 85 and 90 percent full, respectively. If the parking utilization rate exceeds these figures, more parking should be considered.[21] Future parking demand can be determined by using parking generation rates, such as in the Institute of Transportation Engineers' *Parking Generation* manual.

Apart from sustainability reasons, the DOD is also scrutinizing its bases' layouts from an active design perspective and how vehicle parking facilities and other barriers may deter walking, cycling, and working out. For this Healthy Base Initiative, designers developed a rating tool that commanders can use, scoring bases on how well they support active living. Marine Corps Base Quantico, the Defense Logistics Agency at Fort Belvoir, Virginia, and the Defense Health Headquarters in Falls Church were among the fourteen installations in the study.[22]

The DOD has additional guidance documents such as *SDDCTEA Pamphlet 55-15 – Traffic and Safety Engineering for Better Entry Control Facilities*. UFC 4-022-01 states that the visitor center at an installation main gate should be able to process twelve to twenty visitors per hour per processor. This equals three to five minutes per visitor. In reality, the amount of parking needed at a visitor center depends on three things:

- The amount of visitor traffic during the peak hour of visitor activity.
- The amount of staffing at the visitor center.
- Duration for visitors to be processed (dependent on staffing and operating procedures).[23]

Service-specific regulations provide further guidance. The Air Force's Manual 32-1084 lists the number of parking spaces authorized for various facilities, including:

- Administration, headquarters, and office buildings – 60 percent of assigned personnel
- Child development centers – 10 percent of children, 80 percent of staff
- Dormitories – 70 percent of design capacity
- Family housing – 2.5 spaces per living unit
- Guard houses, brigs, military police stations – 30 percent of guard and staff strength

The manual provides that parking spaces for facilities, whether existing or programmed, may be increased where special traffic analyses substantiate the need. Facilities with multiple functions may provide parking for each function.

National Park Service

The National Park Service, one of the largest land holding agencies in the NCR, "preserves park resources unimpaired for the enjoyment of current and future generations by reducing [its] environmental impact through sustainable operations, design, decisions, and management."[24] The National Park Service released its inaugural *Green Parks Plan* in 2012, setting sustainability goals targeting aggressive greenhouse gas emission and other issues. These goals were reaffirmed and further developed in its most recent, 2016 plan.[25]

NPS' sustainability focus increasingly emphasizes transit, non-motorized transportation, and parking management. The Transportation Planning Guidebook calls for reductions in parking spaces by offering a variety of transit alternatives. Removing existing parking spaces, the guidebook advises, can be offset by increasing pedestrian and bicycle access and by providing increased transit services such as shuttle buses for travel to and within the parks.[26] NPS's Management Policies (2006) further advocate for the use of transit alternatives, including the improvement of connections to a variety of sustainable, external transportation systems and "a mix of buses, trains, ferries, trams, and–preferably–non-motorized modes of access" to extend their mission of limiting vehicle use and promoting greener transit alternatives.[27] The NPS Congestion Management Toolkit (2014) provides a list of tools for managing congestion.

NPS advocates not only for the modification of transit routes and parking services for visitors, but also for the adaptation of new technologies and promotion of transportation sustainability among employees. NPS's *Green Parks Plan, Advancing Our Mission through Sustainable Operations* (2016) encourages alternative commuting methods such as employee telework. The plan conveys that the "NPS will prioritize active transportation (human-powered transportation like walking and biking) in planning and design of new transportation-related opportunities, facilities, and infrastructure."[28]

Within the NCR, NPS completed the *National Mall and Memorial Parks Tour Bus Study* in 2015. Recognizing numerous problems associated with tour bus operations, including traffic congestion, residential neighborhood

disruption, air pollution, excessive noise, obstruction of view corridors and major landmarks, the study set forth a plan of action for short-term and long-term improvements in operational efficiency.

Recognizing the increasing demand for non-motorized corridors with in the region, the *NCR Paved Trail Plan* (2016) identifies achievable goals, provides 121 capital and programmatic recommendations, and prioritizes opportunities to expand multi-use trails in NCR national parks.

Study Assumptions

In light of NCPC policy and regional trends identified above, NCPC staff and the Volpe Center coordinated with MWCOG to develop the following list of assumptions for this study:

1. The study's planning horizon will be approximately 15 years (2030) to reflect NCPC's master planning update process.
2. This study is focused on federal facilities in the NCR.
3. NCPC policy will continue to encourage modes other than SOV, such as transit, walking/bicycling, or ride sharing.
4. Given the lack of financial incentives for agencies to charge for parking, parking will remain free of charge to employees at those facilities where it is currently free.
5. Congress will continue to act to ensure that the amount of transit expense that may be excluded from wages matches the amount of parking expense that may be excluded from wages.[29] The latter is indexed for inflation. Federal agencies will continue to offer a transit subsidy capped at this amount (currently $255/month). Therefore, in real dollar terms (adjusted for inflation), the transit subsidy for federal employees will not significantly change.
6. In real dollar terms, auto operating costs will not significantly change (now assumed in the MWCOG model to be $0.10/mile)
7. In real dollar terms, transit fares will change gradually.
8. The study will rely on the MWCOG model, which uses the following assumptions:
    a. Total employment at federally-owned facilities will continue to modestly increase, following the MWCOG land use and employment projections (approximately 1.5 percent per year in the near term).
    b. Future changes in employee home locations based on the land use, trip generation, and trip distribution forecasts.
    c. Employee home locations for a federal facility will be based on overall household distribution.
    d. The amount of walking and bicycling will follow the trip-generation assumptions.
    e. Attractiveness of various modes (auto, shared auto, various forms of transit) will follow the mode-choice results.
    f. In accordance with the model's assumptions, Metrorail in Downtown Washington will be capacity-constrained starting in 2020, thus limiting the number of travelers able to choose that mode.
9. Telework policies and practices will continue to be a major factor for federal commuting the region.
10. The desirability of SOV for employees will depend on
    a. Type and culture of agency (for example, some agencies may place a greater emphasis on non-SOV use than other agencies)
    b. Employee working hours (irregular or nighttime working hours may make SOV more desirable)
    c. Employee home locations

3. Literature Review

Introduction

This chapter identifies and explores industry best practices and case studies for developing parking policies and determining parking supply.

This literature review examines critical transportation concepts and analytical approaches that inform parking supply decisions of both jurisdictions and institutions. After that, the chapter documents case studies with particular applicability to federal campuses, including institutional examples from academic, corporate, and scientific campuses and local jurisdictions with transportation demand management districts/associations. The Volpe Center synthesized this research into findings for NCPC to consider in future updates to parking policies.

Developing Parking Policy

Developing parking policies is part art, part science, and part politics.[30] Traditionally, planners, engineers, developers, institutions, and companies sought to build enough off-street parking to satisfy unconstrained parking demand. This approach ensured that there was adequate parking for employees, visitors, and customers, while avoiding 'spillover' parking at adjoining properties. These policies are supported by analytical tools designed to provide enough spaces for parking for peak demand on the peak hour of the peak day of a year for a particular facility. While many organizations and jurisdictions continue to use this approach, others are implementing transportation demand management (TDM) techniques to actively reduce parking demand (see Appendix E) and encourage non-single occupancy vehicle (SOV) travel. These new approaches help achieve environmental benefits and economic efficiencies by limiting and pricing parking, sharing parking facilities between adjacent land uses, and otherwise encouraging transit use, carpooling, and non-motorized transportation.

Inadequate parking, when other transportation modes are not available or convenient, means that people are either unable to reach their destinations or spend excessive amounts of time circling parking lots in search of available spaces. At the same time, excessive parking supply increases vehicle use and adds to on-site and off-site infrastructure construction and maintenance costs borne by the property owner and/or local jurisdiction.[31] With too much supply, particularly when parking is free, travelers are less likely to carpool, walk, or bicycle to their destinations.[32] Supplying too much parking is also expensive. Land used for empty parking spaces could otherwise be preserved or developed.[33] For example, given that the potential cost of land can be from $1 to $25 per square foot, the land consumed by just one parking space represents an opportunity cost between $300 and $10,000.[34]

This section explores the determinants of trip generation, analytical tools to estimating parking demand, and policies and approaches for managing parking demand.

Determinants of Trip Generation

Parking demand and mode choice are primarily a function of travel time and costs. Costs depend on land use density and mix; transit availability and quality; parking availability and price; and walkability, both at the trip origin and destination. Characteristics of the local area such as weather, culture, and geography can also affect parking demand. Therefore, local data is most useful in developing effective parking regulations.[35] Below are some local-level characteristics that influence mode share.

- **Demographics** – Due to the high cost of automobile ownership relative to the cost of taking public transit, households with lower incomes have lower rates of automobile ownership.[36] Furthermore, studies show that urban dwelling "millennials" have a much lower rate of automobile ownership.[37] If a locality has a disproportionately high population of a demographic with a low automobile ownership rate, the number of vehicle trips will be lower than otherwise anticipated. Taking into account demographics such as age and income can help more accurately determine expected parking demand.[38]

- **Public transportation** – It is important to understand the modal options of people traveling to different destinations. In dense urban environments, public transportation can contribute to a large reduction in parking demand.[39]

- **Climate** – Local weather patterns can affect mode choice. A warm, sunny environment may incentivize walking and bicycling more than an inclement climate which encourages driving.[40]

- **Price of parking** – There is no single formula that will determine how much drivers are willing to pay for parking; driver behavior can vary widely between cities.[41] Municipalities measure the price of parking in dollars per hour for meters and public garages.

- **Usage times** – Different uses may generate parking demand at different times of day. If different uses with different peak hours are situated on the same site, or in close proximity, the same parking supply can satisfy both sites' peak demand.[42]

- **Accessibility to other uses** – If a site is located in a high-density environment close to a variety of other land uses, users will generate fewer trips by parking only once and walking the rest of the trips. In a low-density environment without public transit, where one cannot walk from one destination to another, people must drive to each subsequent destination and more parking is needed.[43]

Estimating Unconstrained Parking Demand

Professional trade groups and academic institutions use a number of parking reference manuals and analytical processes to estimate unconstrained parking demand. These industry resources and approaches are imperfect. They are designed to inform, not determine, the development of policies that govern parking supply. While the distinctions between NCPC and local jurisdictions are significant, the principles, goals, analytical approaches, and processes employed by these entities provide a useful context for NCPC's policies.

When tasked to develop parking guidelines for a particular municipality's zoning code, planners have limited tools, short of a comprehensive parking demand study.[44] Planners generally take one of two standard approaches when developing parking regulations:[45,46]

- Adopt the standards of a neighboring or similar municipality.
- Use industry reference documents to estimate parking demand (see Section 6).

Developing an accurate parking demand assessment is one component of developing appropriate parking standards, but can be expensive and time-intensive.[47] If a demand estimate is only needed to provide a general idea of how many users might require parking and the facility type is common, it is acceptable to use data available in a published study that surveys a similar facility. However, if the estimate is being used for a unique facility or to determine something more concrete like the size of a parking facility or a financial analysis, a more accurate and precise estimate is necessary.[48]

To determine unconstrained parking demand, transportation professionals generally turn to one of two widely cited sources on the topic:[49,50,51]

- Institute of Traffic Engineers' (ITE) *Parking Generation* (currently in its 4th edition)
- American Planning Association's (APA) *Parking Standards*

3.1.1.1 ITE Parking Generation (4th Edition)

Parking Generation is a large collection of parking demand studies that utilize vehicle counts and intercept surveys. Data collected by ITE is provided by land use type and 107 distinct land uses are represented, with the majority of data collected over the last 30 years. The data provided varies based on land use but usually contains parking demand, measured as a percentage of peak demand, by hour and weekday and weekend. Some land uses provide data of demand by month as well. In nearly all cases, descriptive statistics are provided showing the number of study sites, average peak demand, standard deviation, and coefficient of variation among others. *Parking Generation* then provides a chart with the independent variable on the x-axis (i.e. gross square footage, number of employees), peak demand on the y-axis, as well as data points, a line of best fit, and r-squared values.

The publication is an "informational report," with the notice that it "does not provide authoritative findings, recommendations, or standards on parking."[52] In other words, *Parking Generation* is a descriptive collection of what is, not a prescriptive definition of what should be. After compiling the data, ITE provides descriptive statistics for specific land uses. For example, elementary schools and high schools are examined independently. The publication outlines two particular limitations of the data:

- **Orientation to single-use, suburban land uses where parking is free**. The first drawback is that the source of the parking demand studies are often from suburban areas where parking is free.[53,54] The problem this presents is that demand will be inflated when the price is zero. Similarly, a District Department of Transportation (DDOT) study found that the ITE model, as well as other similar approaches that pivot off ITE estimates, were inadequate in predicting trips by mode in an urban context, specifically Washington, DC.[55]

- **Small sample size, particularly for unique or uncommon land uses**. Due to the extreme specificity of land uses presented, some land uses have a very small sample size. The sample size of common land uses can be relatively large: "Office Building" has a sample size of 176 and "Shopping Center" has a sample of 86. This suggests that a variety of sites were sampled and an average can be representative of the whole population. However, the majority of land uses represented illustrate parking demand based on fewer than 20 sampled sites. It is impossible to infer the average parking demand for any given elementary school in the United States (of which there are over 86,000)[56] based on a parking study with a sample size of five. Readers may conclude that the average demand presented is representative of all sites developed for the given land use.[57] For example, the average parking demand for a suburban drive-in bank is taken out to two decimal places, 1.60 vehicles per employee, but the sample size is only two sites and the coefficient of variation is 44 percent.[58]

ITE openly acknowledges the drawback of this resource. For example, *Parking Generation* makes clear that it is not a manual and does not predict parking demand; it is merely a point of reference meant to assist planners in making decisions related to parking. It also makes clear that although the report presents some numbers with a high degree of accuracy, many of the land uses have only a small sample size and that broader conclusions cannot, and should not, be drawn from the data.

3.1.1.2 American Planning Association Parking Standards

Parking Standards by the APA is a similar publication in that it is a large collection of data categorized by land use. While ITE collects data and presents it in an aggregated form of averages and standard deviations of parking demand, APA provides disaggregated data. For example, APA categorizes more than a dozen land uses under educational institutions, including business school, college/university, high school, and private high school, among others. Under each land use, APA listed different regulations found throughout the country that apply to the land use in question. For each regulation, the municipality and the municipality's population are listed. Six to twelve different regulations are listed for most land uses.

The advantage of *Parking Standards* is that there is no risk of misinterpreting the statistics. Instead of focusing on a single parking ratio, APA presents many studies from different contexts. This allows readers to draw their own conclusions on what an appropriate parking ratio might be for the unique context of the subject property.

3.1.1.3 Internal Capture in Mixed-Use Developments

One important element in calculating parking demand is internal trip capture. Internal capture and shared parking between adjacent properties (see section 5.1.1.14) go hand in hand. Internal trip capture measures the percentage of total trips within a large development, when a driver visits multiple places within the same development while only parking once and/or using roads internal to the site in question.[59] Most frequently applied to driving trips, this metric can also be applied to other modes as well; for example, if someone were to take one trip on the subway to visit multiple locations. Internal capture is usually expressed as a percentage of total trips or as a rate.

Efficiency-Based Standards

Efficiency-based standards take into account factors such as geographic, demographic, and economic characteristics of the site that affect parking demand. These standards also incorporate a cost-benefit analysis of options such as supplying less parking where it would be relatively more expensive to build parking or where transportation demand management programs are easy to put in place.[60] For example, an efficiency-based approach to developing parking standards allows developers to build less parking in dense, urban areas where structured parking would otherwise be necessary. Instead, developers could propose a mix of transportation demand management strategies, such as the provision of an employee shuttle, car sharing service, or parking "cash out" program.

Efficiency-based standards can be applied in both urban and suburban areas, but the effect of these standards are different in each context.[61] In urban areas, these standards enable jurisdictions to leverage existing public investment in transit and mitigate potential negative externalities such as congestion and air pollution associated with more vehicles. At the same time, developers avoid the high cost of constructing parking and can more fully utilize the site. Suburban sites can also lend themselves to efficiency-based standards. When it comes to TDM and SOV reduction, these areas generally have more room for improvement than urban sites.[62]

Ultimately, efficiency-based standards are designed to support local strategic planning objectives such as encouraging dense, transit-oriented development. In effect, NCPC is already applying an efficiency-based approach to parking through a combination of parking maximums and requiring transportation management plans.

Contingency-Based Planning

Contingency-based planning entails supplying a lower amount of parking, instead of supplying the amount of parking sufficient to satisfy peak demand. This approach is also helpful in addressing the uncertainty in the effectiveness of other demand management programs employed on the site. Various strategies to increase parking or otherwise mitigate demand are identified in advance, conditions are monitored, and if increased parking becomes necessary, one of the pre-identified strategies is implemented. Having a contingency plan in place that can be implemented relatively quickly allows developers and planners the confidence to build a lower amount of parking than they would be otherwise inclined to provide.[63]

Estimating unconstrained parking demand and using efficiency-based standards and contingency-based planning are not mutually exclusive. When developing parking standards, it is crucial to estimate demand in light of efficiency-based standards and contingency-based approaches. This combined approach leads to informed policy decisions while reducing the need for parking overall and building in flexibility if conditions change.

Case Studies

To further examine parking policy, particularly practical applications to NCPC's review role, the study team reviewed case studies. There are a very limited number of wholly analogous cases applicable NCPC, given its unique federal authority, type of facilities, and location in a growing, highly-urbanized area. Additionally, the scope of the project limited the review to readily-comparable cases in the United States.

The following case studies highlight examples of current parking management approaches at educational, corporate, and health campuses and local government. Underlying these cases studies are efforts to manage parking/vehicular demand in suburban locations that are not within walking distance of rail stations.

Successful programs require active coordination with partnering organizations, communication with commuters, fostering employee support, and performance monitoring. Institutions are uniquely positioned to manage transportation and parking demand by limiting parking and providing incentives to employees.

Educational Campus – University of California, Los Angeles

The University of California, Los Angeles (UCLA) currently has 29,000 employees, 29,000 commuting students, 13,000 residential students. Reflecting a campus with public transit access limited to several bus routes, the campus had a 74 percent drive-alone rate, similar to the surrounding region, as late as 1987.[64] In 1990, partly as a response to community concerns, the university agreed to a "trip cap" of 139,500 vehicles per day and a parking space cap of 25,169.

The University recognized that a "blending the provision of TDM programs with parking policy—the means—leads more directly towards the desired end, which is to balance the provision of parking and the number of parking customers with the use, and increasing use, of alternative modes by commuters. In essence, while customer demand is difficult to predict, it can be swayed by using both ends of the service and program offerings under direct control of the [UCLA Transportation] Department, namely parking policy and TDM program provision."

UCLA is now significantly under the 1990 parking and trip caps. It has reduced the percent of employees driving alone to campus to 51 percent and students to 25 percent. For the first time in campus history, more students who live off campus walk to UCLA than drive.[65] UCLA meets the National Standard of Excellence in commuter benefits—a standard created by the National Center for Transit Research and the US Environmental Protection Agency. It is recognized with Gold Status as 2017's Best Workplaces for Commuters, a program of the Center for Urban Transportation Research.

For UCLA students, faculty and staff who use alternative transportation, the Bruin Commuter Club provides complimentary access to benefits, including 50 percent off daily parking fees, 4 hours of free Zipcar usage per month, monthly prize drawings for logging your commute, monetary biking incentives, and a walking welcome kit that includes monetary incentives

UCLA's program also features:

- a need-based permit allocation process;
- discounted parking and an online ride matching service for carpooling and vanpooling;
- developed several master plans including for parking, bicycles, sustainable transportation, fleet & transit, and a climate action;
- an emerging parking meter system to encourage turnover and maximize space utilization; and
- free bicycle repair and rental.

Corporate Campus – Microsoft Corporation

Microsoft Corporation's commute program for its suburban Seattle, Washington campuses encompasses more than 44,400 full-time Microsoft employees and contingent staff commuters. Microsoft reduced daily SOV commuting by nearly 20 percent from 2004 to 2016.[66] Over the past seven years, Microsoft eliminated more than 4.2 million single-rider trips: or 59 million fewer miles of travel and 56 million fewer pounds of carbon dioxide emitted.[67]

Microsoft has a particularly robust bus and shuttle service for employees, vendors, and guests. Shuttles can be booked via phone or app for a customized trip. As of 2016, Microsoft offered 198 shuttles and an average seven-minute wait time at all scheduled stops, alleviating the need for people to drive personal cars across campus for meetings.

Microsoft's program also features:

- free regional transit passes for all workers (full-time employees, vendors, and contractors), accommodating fifteen percent of employees;
- a subsidy and matching services for its vanpooling program, which accommodates 13 percent of employees;[68]
- a bike/walk reimbursement program, covered and uncovered bicycle parking, a shuttle option, and locker/shower facilities (used by five percent of employees);
- telework facilities, which are used by five percent of employees;[69] and
- a flexible work culture, which permits a large number of employees to arrive after 10 AM and work until 9 PM.[70]

Medical Campus – Providence Portland Medical Center

The Providence Portland Medical Center (PPMC) located east of downtown Portland, Oregon, has more than 1,000 daily commuters. PPMC reduced the SOV mode share from 85 percent in 1996 to 66 percent in 2016.[71]

PPMC has a Good Neighbor Agreement with the surrounding communities and maintains a Transportation Working Group that partner with neighborhoods on transportation improvements. To efficiently use its parking supply, PPMC operates valet service at the parking garages for patients and visitors.

PPMC's program also features:

- shuttle service to the closest transit venter for use by employees, patients, and visitors; and
- secure bicycle parking, changing/showering facilities, self-service bike repair areas, and a periodic free bicycle tune-up service for employees.

Research Campus – Texas Instruments

Texas Instruments (TI) was honored nationally and locally for its Employee Trip Reduction program, including recognition as among the top "Best Workplaces for Commuters" by the U.S. Environmental Protection Agency. TI's trip-reduction efforts kept an estimated 8,400 vehicles off North Texas roads daily, averting ozone-forming NOx as well as CO2 emissions.[72] In 2008, public transit and vanpool/carpool activities combined resulted in nearly 58,000 total travel miles averted every day in the Dallas area.[73]

Texas Instrument's program also features:

- TI offers free shuttle service within TI's Dallas area campuses and to light-rail train stations;
- coordination of riding pools, which receive premium parking spaces;
- TI offers considerable bike-to-work services (the League of American Bicyclists designated TI a "Bicycle-Friendly Business);"[74]
- on-site cafeterias, gyms, and ATMs (to reduce demand for lunch-hour trips); and
- on-site concierge service (assists employees with errands, reservations, event planning, and other services, and sells certain items on premises, such as gift cards and candy).

Military Campus – Hanscom Air Force Base

Hanscom Air Force Base is a non-flying base located twenty miles from Boston. The base supports an Air Force command and several DoD-related organizations: the Massachusetts National Guard, Massachusetts Institute of Technology Lincoln Laboratory, and MITRE Federally Funded Research and Development Centers.

In July 2014, Hanscom Air Force Base and its neighbors, along with MIT Lincoln Laboratory, created a combined commuter management program called "HanscomRIDES." Over the next 18 months, the three entities spent an average of 65 hours each week to build and promote the program through transportation fairs, appreciation picnics, an online ride matching service, newspaper articles, brochures and in-house education. The number of vanpools increased from six in 2014 to 48 as of 2016. This represents nearly half of the 107 registered vanpools in the state.

In 2016, Hanscom Air Force Base was recognized at the 5th Annual Excellence in Commuter Options Awards Ceremony as a Massachusetts Department of Transportation "Rising Star Spotlight Award" recipient. The award recognized the base for significant progress in promoting sustainable transportation options through resourceful actions such as employee outreach and education; commuter options and incentives; innovative concepts; and collaborative efforts.

Hanscom's program also features:

- a Transportation Incentive Program providing employees with funds to cover transportation costs such as bus, train, subway, and vanpool fees; and
- an E-Shuttle service for employees going to Logan Airport on official business.[75]

Hanscom's program also coordinates other services available to employees, including:

- Local bus service;
- shuttle services, organized by the local business district and MIT, provide additional transit access;
- Base Taxi Service sponsored by one of the base units, which is ideal for those who carpool, during inclement weather, or where high-volume parking lots limit parking; and the
- Alternative Commuting Rewards Program sponsored by Massachusetts, where employees receive rewards when they telecommute, walk, bike, carpool, take public transit or work a compressed week. Rewards accrue towards discounts on sporting events, ski lift tickets, restaurants, and other retailers.[76]

Local Government – Montgomery County, Maryland

Montgomery County established Transportation Management Districts (TMD) in the late 1980s, which is a national model for implementing TDM strategies. The county's TMDs provide services that encourage the transit use and other commuting options in major business districts. There are six districts: Bethesda, North Bethesda, Friendship Heights, Silver Spring, Shady Grove, and White Oak (future). Starting in 2002, all employers with 25 or more employees located in these areas are required to actively work with TMD staff. Approximately 95 percent of employers comply with this requirement.[77]

As part of the program, employers designate a coordinator to service the company's employees, implement a traffic mitigation plan to reduce drive along rates, submit annual reports, and participate in the county's annual commuter survey. For their mitigation plans, companies commit to a variety of TDM strategies. These range from distributing and displaying information on transportation alternatives, to free and reduced parking for car/vanpools, and subsidized transit passes. The county also negotiates agreements with developers who are constructing buildings to ensure trip reduction. These agreements run in perpetuity and contain specific performance targets and timelines.

Each district has aggressive targets for non-auto driver mode share, which some are already meeting: Bethesda (38.3 percent), North Bethesda (28.2 percent), Friendship Heights (38.9 percent), Silver Spring (52.2 percent), and Shady Grove (16 percent).[78] Cost of implementing these strategies are borne by employers. Each district provides services and assistance to employers. These services are ultimately paid for through parking revenue and fees assessed on commercial office space in each district.

Literature Review Findings

This literature review underscores the following key themes regarding NCPC's parking policies:

Jurisdictions across the country are increasingly adopting policies that limit parking, particularly where transportation alternatives are available. NCPC employed this approach beginning in the 1980s.

NCPC adopted employee-based parking ratios, or parking maximums, in the 1980s. Most jurisdictions have parking minimums and focus on providing ample and free parking to avoid "spillover" parking at adjacent developments and to maximize access to retail and businesses. NCPC's approach represented a departure from parking policy and engineering approaches at the time. Critics contend that the practical impact of parking minimums is an oversupply of parking, which leads to negative externalities including congestion, air pollution, and inefficient use of land and resources. Since the mid-2000s, land use and transportation planners across the country are following parking approaches similar to NCPC's parking maximums to achieve in order to counteract the negative effects of over-supplying parking. This "efficiency-based" approach reflects broader NCPC goals of reducing traffic and achieving a more compact, economically efficient federal footprint in the region.

There are a variety of analytical tools available to inform parking policies, both new and old. Traditional tools for estimating parking demand are not well-suited for complex federal campuses.

Transportation practitioners use analytical tools to inform, not determine, how much parking to supply at a given location. They are designed to help decision makers assess what parking supply is appropriate given parking demand; the lifecycle cost of providing parking; and the relative cost and convenience of transit, carpooling, and non-motorized commute modes. Typically, parking demand estimates are a primary starting point for determining parking policy. In estimating demand for parking at unique federal facilities and campuses, NCPC's federal partners should conduct site-level demand studies. These studies should measure

existing parking demand and occupancy at the subject site (or similar facilities elsewhere) and account for transit accessibility in the location and account for other policy goals.

Traditionally, local jurisdictions use estimates of unconstrained parking demand to inform parking standards. Typically they are based on reference reports like the Institute for Transportation Engineers' *Parking Generation,* which catalogs empirical parking demand surveys for different land use types from sites across the country. These tools do not take into account transit accessibility and regionally-specific demographic and economic factors. Although ITE and others are collecting more data and testing adjustment factors, surveys are typically based on common land use types in suburban settings where data is more generally available.

Urban jurisdictions and institutions like universities are moving towards limiting parking supply and using pricing to moderate demand. While parking pricing is not currently feasible as a travel demand strategy on federal properties, limiting parking can be an effective tool if used properly.

Parking supply policies are often paired with pricing schemes to manage parking demand and ensure that spaces are available for drivers who are willing to pay. This movement is particularly prevalent in urban areas in the National Capital Region, where transit is plentiful and development pressure is high. The District of Columbia recently updated its Comprehensive Plan to reduce parking minimums throughout the city and eliminate parking requirements downtown and near Metrorail stations. Universities are increasingly experimenting with lifecycle cost accounting of parking spaces, trip reduction agreements with partners, and tiered pricing for parking. However, federal law does not incentivize NCPC's partner agencies to price parking or enable them to change underlying transit subsidies for federal employees. Since parking at most federal facilities is and will continue to be free, the effect of NCPC's parking policies is that agencies directly supply a finite number of free parking spaces. The remaining employees either seek out parking elsewhere (both paid and unpaid, on-street or off-street), or take alternative modes, particularly carpooling and transit. Limiting parking should be pursued in light of the availability and relative convenience of non-SOV modes.

4. Local Parking Comparison

Introduction

This chapter summarizes parking requirements and processes for Washington, DC, the City of Alexandria, and the surrounding counties (Arlington, Fairfax, Loudoun, Montgomery, Prince George's, and Prince William), comparing the jurisdictions and synthesizing relevant findings. Although federal facilities are not subject to these policies, these jurisdictions share NCPC's goal of reducing the number of SOV on the transportation network. National Capital Region (NCR) jurisdictions are considered national leaders in land use and parking policy. This analysis identifies policy trends, analytical approaches, and model processes that can inform updates to the National Capital Planning Commission's (NCPC) parking policies.

Typically, parking standards are developed and administered at the local level through planning and zoning activities within individual jurisdictions. These jurisdictions develop parking policy to manage commercial development in the context of local livability and economic development goals, transit accessibility, and are informed by analytical tools. Depending on the jurisdiction, these standards include some combination of parking supply requirements or guidelines paired with transportation demand management (TDM) tools/strategies that moderate parking demand.

While NCPC is similar to other local jurisdictions and agencies in setting planning policy and reviewing developments and plans, NCPC's mission, authorities, functions, and constraints create important distinctions. Similarly, the applicant federal agencies NCPC works with have distinct characteristics from other private sector developers and asset managers. NCPC is responsible for protecting federal interests and a suite of unique, non-contiguous, nationally significant installations and campuses across a large geographic area. NCPC and its partner agencies are subject to and constrained by federal law, rather than state law or local ordinances. Despite these differences, NCPC and the region's jurisdictions have shared interests and goals regarding the National Capital Region's development. There are relevant lessons NCPC can take from the best practices of regional jurisdictions, including goals, analytical approaches, and processes.

Background and Approach

Reflecting differing authorities, roles, and interests, NCPC and local jurisdictions' policies are not readily comparable. Due to the differences between how NCPC and local jurisdictions approach and develop parking guidelines, the Volpe Center and NCPC staff determined that a quantitative comparison was not feasible or appropriate. Therefore, the Volpe Center undertook a qualitative parking comparison, with a focus on local parking policies and processes.

Parking Policy Frameworks

NCPC's general approach to setting parking policy is both similar to, and different from, local jurisdictions. NCPC's employee parking policies are intended to encourage a gradual shift from SOV commuting to transit, carpooling, and non-motorized transportation. NCPC's Comprehensive Plan parking ratios reflect regional transit availability and distance to Downtown Washington, DC. This translates to less parking where transit accessibility is high, with guidelines for more parking spaces in outlying suburban areas.

NCPC's overall approach is mirrored in local comprehensive plans, zoning codes, and TDM programs, where access to major transportation infrastructure (including transit and highways) and land use/density at a particular location are often the overriding factor in developing parking policies. In addition to transit

accessibility, local jurisdictions use estimates of unconstrained parking demand to inform parking policy and make geographically-based adjustments.

While NCPC's Comprehensive Plan parking ratios generally serve as maximum parking standards, most of the local jurisdictions within the NCR set minimum parking standards. NCPC parking space policies are based on the number of employees. In most jurisdictions, there is a special development review process for larger sites, which are more similar in scale to some of properties under NCPC's jurisdiction. Beyond properties that go through special review processes, most local jurisdiction policies are generally based on gross floor area (GFA). Market pressure and economic development are key driving forces for local jurisdictions. In dense areas with high land values, developers have incentives not to build parking because land is relatively scarce and structured parking is expensive. Conversely, federal facilities often have considerable undeveloped land, and prevailing considerations include environmental sustainability, impacts on the regional transportation network, and availability of financial resources.

Organization Roles and Functions

NCPC is responsible for setting parking policy for federal properties within the NCR. Composed of members from diverse federal and local organizations across the region, including local officials, heads of federal agencies, and members appointed by the President, NCPC is structured to consider both federal and local interests within the region. Federal properties are generally not obligated to abide by local zoning regulations. Instead, through policies in the Comprehensive Plan, NCPC advises federal agencies how to develop their property in a manner that is compatible with local planning policies, programs, and goals. Most federal facilities were built with parking that can be allocated to some employees. Because each facility has a unique mission, ranging from national security to managing federal lands, the Commission must account for distinct parking needs and use patterns.

Local jurisdictions tend to focus on managing residential and commercial growth, pricing or supplying excess parking to ensure access to destinations, and economic development. Local jurisdictions are compact and mostly contiguous; whereas NCPC oversee discrete properties located throughout the region. While NCPC and the surrounding jurisdictions share the common goal of reducing single occupant vehicle trips, particularly during peak commute times, NCPC primarily reviews institutional uses, including large office buildings and research complexes, military installations, educational campuses, and hospitals. Local planning boards are generally composed of elected officials or appointed members that are accountable to interests within one jurisdiction. They are subject to state law and local ordinances.

Recent Zoning Code Updates

Several local jurisdictions are currently, or have recently, updated their comprehensive plans and zoning codes to reduce parking requirements. This change reflects national trends in planning, such as a shift towards promotion of transit, walking, and bicycling; dense, mixed-use development; and a general adoption of the tenets of sustainability.

Taken together, the goal of these comprehensive plan updates is to create transparent, flexible, predictable, and easy to understand parking ratios. The result is reduced parking minimums in most cases. For example, the District of Columbia completed an update of its zoning code in 2016 with the goal of simplifying the parking standards to make them based on proximity to transit and zone (instead of use and zone, and characteristics). Similarly, Montgomery County updated its parking standards in 2014 after a study found that parking is overbuilt and that the standards were overly complicated. In 2013, Arlington County created a Commercial Parking Working Group that was tasked with devising a transparent and predictable methodology

for its parking requirements. The City of Alexandria and Prince George's County are currently in the process of updating and simplifying their zoning codes and parking requirements.

Parking Provision and Variance Processes in the NCR

NCPC uses Transportation Management Programs (TMP) to evaluate a federal facility's ability to comply with prescribed Comprehensive Plan parking ratios at facilities over 100 employees. Factors such as the relative proximity of high occupancy vehicle/toll lanes, the position of the facility's nearest Metrorail station within the overall Metrorail system, facility work hours and shifts, and employee residence locations are considered. When TMPs are submitted to NCPC, the agency consults with applicants to review the document and its recommendations. Modified parking ratios are considered based on site-specific circumstances such as installation land use site access, duty hour schedules, security, and transit proximity. NCPC provides some agencies with specific direction, including long- and short-range parking ratios.

Alternatively, most local jurisdictions have criteria and variance processes where developers can request to build less parking than required by established minimum standards. The degree to which a developer can reduce the amount of parking required for a building or development varies by jurisdiction. These variance requests are often based on criteria such as access to transit and the provision of car-sharing spaces. Each jurisdiction differs in terms of the extent to which the variance process is explicitly laid out in policy, or "by-right," versus at the discretion of staff and local elected officials.

For larger developments, or developments that go outside of the typical review process, some of the local jurisdictions require the creation of TDM plans, which are similar to NCPC's TMPs. Arlington and Montgomery Counties, and the City of Alexandria implement enforceable requirements for TDM Plans on larger developments. These TDM plans have the common goal of reducing vehicle trips during the am and pm peak.

Of all the jurisdictions, the District's parking standards are the most aggressive in limiting the amount of new parking that is built. This is consistent with the District's relatively high transit accessibility and more limited developable land. For example, the District does not require any parking in most of downtown and in other special purpose and campus area zones. Outside of downtown, developers can reduce required parking based on the following criteria: proximity to transit, provision of car sharing, neighborhood historic character, and the presence of a tree canopy. To gain permission to reduce parking, developers must submit a TDM plan for approval to the District Department of Transportation.

Arlington County takes a similar approach for certain land uses in particular locations. For example, there are no parking requirements for grocery stores and restaurants within 1,000 feet of Metrorail stations. Developers can apply for reductions to the parking minimums for other uses, but must submit a traffic impact assessment (TIA), which generally consists of an analysis of the existing traffic conditions around a proposed development site, with a forecast for future traffic volumes and impact on the surrounding area. The TIA also includes projected bicycle, pedestrian, and transit trips (if applicable), and any TDM strategies that will be used to mitigate future traffic impacts (see Appendix F for more information on TIAs). The applicant must also submit a stormwater management and compliance plan, meet requirements for affordable development units, and pay a fee to the County in lieu of providing parking.

Montgomery County takes a more use-based approach. The county has a standard table of parking minimums for rural, industrial, and agricultural areas, and another set of lower minimums that are used for commercial and employment uses, and areas close to transit. The county also has four active Parking Benefit Districts, which are shared parking areas where a developer can opt out of building parking and pay into a county-run public parking fund. Developers can apply for parking reductions in these areas based on the following criteria:

the Non-Auto Driver Mode Share (NADMS) factor; on-street parking in the public or private right-of-way abutting the subject property; and the provision of carpool/vanpool spaces. The NADMS is the percentage of commuters who travel to their worksite by means other than SOV, and is based on the results of an annual commuter survey administered by the area's Transportation Management District. Furthermore, employers in certain locations are required to participate in Transportation Management Districts administered by county or non-profit staff. Developers must enter into binding agreements with the County contain specific performance targets and timelines for reducing trips.

Table 1 summarizes the parking requirements across the local jurisdictions in the NCR. The table contains the population and density of each jurisdiction, the status of the zoning code, a basic description of the parking requirements, and the variance criteria that jurisdictions use to allow developers to reduce the amount of parking.

Table 1: Summary Comparison of NCR Local Parking Standards

Jurisdiction	Population & Density (people per sq. mile)	Zoning Code Status	Brief Description of Parking Requirements	Allowed Reductions to Parking Requirements
District of Columbia	Pop: 672,228 Density: 11,000	Adopted in 2016	There is a minimum parking table that is applicable to most uses. The Downtown, Campus Plan Areas and Special Purpose Areas are not necessarily subject to the standard minimums.	Proximity to transit; shared parking; car-share spaces; mixed use districts; environmental open space impact; historical context; car/van pool/shuttle services
Montgomery County	Pop: 1,040,116 Density: 2,052	Adopted in 2014	There are two sets of parking standards, one for rural, industrial, and agricultural areas, and a second for commercial, employment, and areas close to transit. The County also has four Parking Lot Districts.	Proximity to transit; shared parking; mixed use districts; car/van pool/shuttle services; pay fees to reduce parking
Prince George's County	Pop: 909,345 Density: 1,823	*Updated zoning code pending*	There are standard minimum requirements for parking county-wide, except for in Mixed-Use Transit and Planned Community Zones.	Proximity to transit; shared parking; car-share spaces; environmental open space impact; car/van pool/shuttle services
City of Alexandria	Pop: 148,892 Density: 10,221	*Updated zoning code pending*	The current requirements are organized into six parking districts, along with a standard minimum parking table for the remaining areas.	Historical context; pay fees to reduce parking
Arlington County	Pop: 224,906 Density: 8,814	Adopted in 2015	There is a standard minimum parking requirements table that applies city-wide, except for in select Mixed Use Districts and Overlay Districts.	Proximity to transit; mixed use districts;

Jurisdiction	Population & Density (people per sq. mile)	Zoning Code Status	Brief Description of Parking Requirements	Allowed Reductions to Parking Requirements
Fairfax County	Pop: 1,313,000 Density: 2,813	Adopted in 1978	There are standard minimum requirements for parking county-wide, by land use.	Proximity to transit; shared parking; mixed use districts; pay fees to reduce parking
Loudon County	Pop: 349,679 Density: 721	Adopted in 1993	There are standard minimum requirements for parking county-wide, by land use.	Proximity to transit; shared parking; mixed use districts; car/van pool/shuttle services
Prince William County	Pop. 438,580 Density: 1,298	Adopted in 2006	There are standard minimum requirements for parking county-wide, by land use.	Proximity to transit; shared parking; mixed use districts;

The variance criteria that local jurisdictions use to allow developers to reduce parking varies across the region. The most common reason to allow developers to reduce parking is proximity of transit. Many jurisdictions also allow for reductions in mixed-use districts that are also usually close to transit, or have multi-purpose trips. The District considers whether potential parking would have an environmental/open space impact, or affect the historical context of the area. Furthermore, most jurisdictions allow reductions based on the provision of shared parking nearby, and some require that developers pay fees that are typically used to support TDM measures.

Overview of Local Jurisdiction Parking Regulations/Guidelines

This section provides an overview of parking regulations/guidelines in each NCR jurisdiction. Appendix G provides a more comprehensive overview of approaches in each jurisdiction.

District of Columbia

The District of Columbia adopted a new zoning code in January 2016. The zoning update simplified parking requirements, making them largely based on use and proximity to transit, rather than a combination of zone, use, and other characteristics. The zoning code includes a minimum parking standards table that is applicable to most zones; parking in these areas may be reduced under the following situations:

- Provision of car-share parking spaces
- Proximity to transit (may be reduced by 50 percent within one-half mile of a current or planned Metrorail station
- Located within one-quarter mile of a streetcar line or a priority Metrobus route
- Estimated parking demand is less than minimum parking standards
- Parking would require removal of healthy canopy trees; parking would harm the historic integrity of a property.

The Downtown, Campus Plan Area, and Special Purpose Zones are not necessarily subject to the minimum parking standards. In Downtown Zones, no parking is required (other than areas west of the centerline of 20th Street, NW). Parking requirements for Campus Plan Areas and Special Purpose Zones vary, with select areas requiring no parking. Developers typically submit TDM plans to the District Department of Transportation for any development that is not allowable “by-right” in the zoning code, such as in the zones mentioned above.

Montgomery County

Montgomery County's current zoning code was adopted in 2014. Montgomery County updated its parking standards after a study found that the county's parking minimum standards resulted in an oversupply of parking, and that parking could be shared in mixed-use areas. The Montgomery County Department of Transportation and the Maryland-National Capital Park and Planning Commission, along with a consultant, conducted the study. The updated parking standards—a combination of parking minimums and maximums—are based on land use and transit availability, with parking minimums outlined for three different land use and density types:

- Parking standards for rural, industrial, and agricultural areas are based on the assumption that the employees/residents in those areas will largely be driving and will park at their destination for most of the day.
- Parking standards for commercial and employment areas, and areas close to transit, are based on lowered minimums, with a range of parking minimums and maximums used for Parking Lot Districts.
- Parking Lot Districts feature a shared parking, where developers may choose to opt out of constructing parking if they pay into a county-run public parking fund.

Parking reductions may also be made in the mixed-use and Parking Lot District areas based on several factors:

- The "Non-Auto Driver Mode Share (NADMS) factor"
- On-street parking in the public or private right-of-way abutting the subject property
- The provision of carpool/vanpool spaces

The NADMS factor is the percentage of commuters who travel to their worksite by means other than SOV. NADMS is calculated is based on the results of an Annual Commuter Survey administered by the county's Transportation Management Districts. Depending on the location, each district is managed either by a non-profit or Montgomery County Department of Transportation staff.

As described in section 0, Montgomery County has six Transportation Management Districts where employers with more than 25 employees must work to reduce vehicle trips. These employers must implement TDM strategies to meet modal targets. Example strategies include designating a transportation benefits coordinator, implementing a Traffic Mitigation Plan, submitting an annual report of activities, and participating in the Annual Commuter Survey.

Additional variances to the parking requirements throughout the entire county may be granted if an alternative compliance plan is approved (there is little detail available about what such a plan entails).

Prince George's County

Prince George's County is currently in the process of a comprehensive update. The update process began in 2014, with the goal of adopting the new code in the fall of 2017. The updated zoning will be "more modern and user-friendly."

The current parking standards include:

- A standard table of minimum parking requirements for all zones, except for Mixed-Use-Transit (M-X-T) Zones and Metro Planned Community Zones.
- The standards are based on the gross floor area for all uses, except institutional/educational uses where standards are based on number of building occupants, seats, beds, etc.
- Parking minimums reductions are considered if the site would have a high percentage of impervious surfaces. Reductions for shared parking are allowed in select cases for small sites.

The parking standards in the M-X-T and Metro Planned Community Zones are established in general parking standards. These standards permit relaxed minimums depending on expected trip reductions from different land uses in close proximity (internal capture) and transit availability. Developers request a reduction to minimums and must submit detailed site plans to the Planning Board. The package must include the data, methodology, and assumptions used to calculate the estimated demand parking during each hour of the day and number of proposed parking spaces.

Prince George's County has several Transit District Development Plans—either approved or in progress—in College Park, Prince George's Plaza, New Carrolton, and the West Hyattsville area. In these transit districts, the county has a goal to reduce vehicle trips during the am and pm peaks, and developers may be asked to provide transit amenities and incentives for transit use.

City of Alexandria

In 2014, the City of Alexandria began a study to establish updated parking requirements. Alexandria's last comprehensive update to its zoning code was in 1992 (while the last comprehensive review of the parking standards was in the 1960s). Alexandria is updating its parking standards to reflect an increase in transit, bicycling, and walking, changing demographics, and market trends. The study has two phases:

- Phase 1 resulted in new parking standards for multi-family residential developments, which were approved in 2015.
- Phase 2 of the study, now in progress, will result in updated parking requirements for commercial, office, and retail parking.

In the current parking standards, the Alexandria is divided into six Parking Districts, in addition to the King Street Parking District, the Central Business District, and the Mount Vernon Overlay Zone. For many uses, the parking requirements are standardized across all of the districts. However, there are different parking minimums for retail, office, commercial, governmental, and industrial areas. District 6 surrounds the Metrorail stations and has the lowest parking requirements. In addition, there is no off-street parking requirements for properties abutting the Potomac River in the Federal Waterfront Settlement Restricted Parking Area.

For non-residential uses, the required parking may be reduced through a special use permit, which requires detailed plans of the proposed development site, proposed parking, and an analysis of the use and capacity of the site. For developments that will cause a disproportionately negative traffic impact, developers may be required to obtain a transportation management special use permit. These permits require the creation of a TMP, and applicants may also have to pay fees to the city, which are used in the city-wide TDM funds.

For developments that are over a certain size—50,000 SF for office, 40,000 SF for retail— applicants must also create a TMP and apply for special use permit. The transportation management plan includes a TIA. The TMP remains in place throughout the life of the building, and the city may revoke the special use permit if compliance is not maintained.

Arlington County

Arlington County's current zoning code was adopted in 2015, after an update process that began in 2011. The goal of the update was to make the zoning code easier to understand and administer, and move to a new land use classification system.

As part of the update process, the county completed a Commercial Parking Study in 2013. This study led to the Reduced Parking Policy for Site Plan Offices, which outlines a flexible and consistent approach for developers proposing to build less parking than is required by the zoning code. The policy outlines a contribution formula

for developers to help pay for TDM programs, and potentially transit operating costs, to help offset the additional traffic that will be generated by the new office developments.

A county-sponsored Residential Parking Working Group is currently working with county staff to finalize new policy recommendations for parking at permit projects in Arlington's Rosslyn-Ballston and Jefferson Davis Metrorail corridors. The working group recommended reducing parking minimums for condominiums and apartment buildings based on distance from Metrorail stations. The working group also suggested provisions for 100 percent of residential parking to be provided in shared parking structures and that developments which exceed certain parking thresholds be required to implement TMD strategies.[79]

A general description of Arlington County's current parking requirements follows:

- Parking minimums are based on gross floor area.
- A jurisdiction-wide parking standard is maintained, however, parking minimums are reduced in certain Mixed Use Districts and Overlay Districts.
- There is no parking required for sites within 1,000 feet of a Metrorail station and for restaurant and grocery stores that meet specific hours-of-operation and square footage criteria.
- Any developer can request to supply parking below the parking minimums. Applicants are required to submit a TDM Program, a TIA, a Stormwater Management and Compliance Plan; and meet applicable Affordable Dwelling Units requirements.

Beyond the parking requirements in the zoning code, Arlington County also has a Site Plan Development process, which includes a TDM Program. Participation in the site plan development process is voluntary, but the county provides density bonuses as an incentive to participate. If a developer goes through the site plan development process, they must also include a TDM plan in their application.

Fairfax County

Fairfax County's zoning code was last updated in 1976; the county is currently in the beginning phases of modernizing its zoning code. In Fairfax County, parking standards are governed by one jurisdiction-wide minimum that varies by land use type, rather than geographically-based zoning districts. Parking minimums are based on gross floor area with few exceptions. The zoning board may approve a reduction to the defined minimums for the following reasons:

- If a site is situated "within a reasonable walking distance" to public transit.
- If a site is situated in an area designated as a "Community Business Center" (neighborhood shopping areas) and the developer pays a price per space determined at the discretion of the Zoning Board.
- If public parking is in close proximity to the site and the developer pays a fee to the County.
- If peak periods of demand are non-concurrent, adjacent sites may share parking.

Loudoun County

Loudon County last updated its zoning code in 1993. Similar to Fairfax County, Loudoun County parking is not governed by zoning districts; rather Loudoun County establishes county-wide minimums by land use. Developers may not reduce parking supply by more than 35 percent. Reductions are permissible if:

- Two separate uses occupy the same site and their peak hours of demand are non-concurrent (shared parking).
- Retail and restaurants uses are located within 400 feet of each other (internal capture).
- Nearby public parking is demonstrably under-used and will be so into the foreseeable future.
- The site is located within 1,000 feet of a "regularly scheduled bus stop" sufficient to cover anticipated usage of patronage.
- A building is over 50,000 square feet of GFA and developer maintains a carpooling or vanpooling program.

- Developer maintains a shuttle service.
- The above reductions can be combined as long as the total amount of parking reduced does not exceed 35 percent.

Developers applying for a parking reduction must:

- Submit a Parking Demand Analysis.
- Submit a plan illustrating the proposed arrangement of parking spaces.
- Enter a covenant of 20 years guaranteeing that the owner will provide additional spaces if the Zoning Board subsequently finds that the reduction shall be modified or revoked.

Prince William County

Prince William County's zoning code was adopted in 2006. Similar to parking in Loudoun and Fairfax Counties, Prince William County's parking is not governed by zoning district. Prince William specifies county-wide minimums by land use. While the County provides limited circumstances whereby a developer can request a reduction in the parking supply, potential reductions are quite significant. For example:

- When the land use is "so intense that normal individual demand will not be generated," parking may be reduced up to 30 percent. Consideration is given to proximity to public transit, nearby public parking, and commercial and employment activities in the area.
- Adjacent uses may use shared parking in two circumstances. In each case, a legal agreement is required when multiple property owners are involved:
    - If operating hours are non-concurrent, parking may be reduced up to 75 percent.
    - If operating hours overlap, parking may be reduced up to 25 percent.
- If additional land is readily available, construction of up to 50 percent of parking can be deferred (e.g. land banking). Additional parking must be constructed when Director of Transportation deems additional parking necessary.

The zoning code requires that new developments submit a TIA and TDM plan, including applications requesting reduced parking. The requirements of these documents are thoroughly outlined in the Design and Construction Manual.

Local Parking Comparison Findings

This comparative analysis of local parking standards highlights the following key themes that may inform NCPC's parking policies as the agency considers revisions to its Transportation Element:

NCPC is a regional leader in promoting non-SOV commuting. The agency's parking policies are a significant tool to achieve these goals.

NCPC's Comprehensive Plan parking ratio policies ensure that parking is not overbuilt at federal properties. This has a powerful and direct effect on how federal employee travel. The parking ratios also help federal agencies build in a more efficient, secure manner, which enhances the federal portfolio's urban design quality. Local jurisdictions are in the process of, or have recently completed, updating their parking policies to meet sustainability goals, encourage travel options, and reduce private development costs. In the future, NCPC should highlight its regional leadership in parking policy while ensuring that there is a clear analytical foundation for how parking policies are determined.

NCPC is unique from local jurisdictions. Local policies and approaches can inform NCPC parking policies, but are not directly applicable to a federal context.

NCPC's mission, function, constraints, approach to parking, and federal partner agencies have some similarities to, but are ultimately unique from other institutions and local jurisdictions. NCPC is responsible for federal interests and a suite of unique, non-contiguous, nationally significant facilities across a large geographic area. Federal installations or campuses have very different parking requirements than more traditional land uses that local jurisdictions regulate. The Commission is composed of members from diverse federal and local organizations across the region, including local officials, heads of federal agencies, and members appointed by the President. NCPC and its partner agencies are subject to and constrained by federal law. In contrast, local jurisdictions regulate commercial development. Local planning boards are generally composed of elected officials or appointed members that are accountable to interests within one jurisdiction. They are subject to state law and local ordinances.

Local jurisdictions throughout NCR are revising parking policies and reducing parking requirements. These policies are increasingly flexible and streamlined.

Jurisdictions across the NCR are implementing both lower and more flexible parking minimums, with greater emphasis on transit and non-SOV modes. While NCPC's parking maximum policies have a different basis than local jurisdictions, the intent and effect of its policies are generally the same. The agency may be able to use local policy approaches and processes as models. Recent revisions to local jurisdiction standards point to an opportunity to refine and modernize NCPC's parking guidelines. For example, it is notable that several local jurisdictions have defined and data-driven parking variance processes that allows flexibility in response to site-specific conditions and needs. Such an approach may enable NCPC to implement broad-based standards while accounting for site-specific variability and individual facility needs that cannot be captured in a regional policy map.

NCPC should consider a more formal parking variance process. Similar to local jurisdictions, this process could be data-driven, predictable, and transparent.

Variance processes differ greatly by jurisdiction. Some are more explicit, allowing developers to change parking provision by-right: according to factors such as proximity to transit, area transportation mode share, or land use types. Others are more discretionary, whereby applicants must document conditions at the site, and are subject to case-by-case recommendations and decisions made by jurisdiction staff and local planning boards. While NCPC has a similar case-by-case approach, the Commission's review process may benefit from greater definition and predictability. NCPC could consider implementing policies in certain geographic areas and/or for particular facility types. NCPC could also institute thresholds and limits for modifying parking policies. For example, a facility or campus may be eligible to apply for a modification if they exceed a certain number of employees or are not proximate to transit. Allowable modifications may be capped at a certain percentage above the underlying parking maximum.

Typically, a county or local jurisdiction has its own guidelines for a TIA, which include a description of the proposed development site, the current traffic conditions, a forecast of the trips that will be generated from travel to the new site, and the impacts of the traffic (which includes any changes to the level of service, or delay). Similarly, federal facilities could be eligible for a modified parking ratio based on a TIA, mitigation measures outlined in an agency's Transportation Management Program, or data garnered from commuter surveys and the regional transportation model. Non-SOV trips could be included in a TIA, along with any TDM strategies that are proposed to mitigate the impact of the traffic that the site will generate.

Going forward, NCPC can continue to consider current and future trends that may reduce parking demand at federal facilities. These include alternative workplace arrangements and automated vehicles.

While not mentioned explicitly in any of the local zoning codes reviewed for this analysis, local jurisdictions and the transportation industry are grappling with emerging technologies and new workforce trends. It is currently unclear if the trends below will reduce the need for parking at federal facilities, but NCPC should continue evaluate them:

- **Automated vehicles**: Fully automated vehicles, which operate without human input, have the potential to transform the way people travel. There are two distinct visions for automated vehicles that are often used to understand what may happen if the entire vehicle fleet changes to automated vehicles. In one scenario, the vehicle fleet would consist mostly of shared-automated vehicles, which would reduce the number of vehicles on the road, and reduce private vehicle ownership. In this scenario, there would be a reduced need for parking as more vehicles are shared. In the second scenario, most people would own an automated private vehicle, and have the ability to live farther away from where they work since they will be able to work during their commutes. Although there is no clear consensus on if/when the majority of vehicles on the road will be automated, NCPC can still begin to consider this trend's potential wider impacts on parking and transportation planning.
- **Alternative Workplace Arrangements**: Alternative workplace arrangements include teleworking, hoteling, hot desking, and desk sharing. These arrangements are used when employees work from alternate locations on various schedules, or do not work full time in one facility, and do not necessarily have assigned, permanent work spaces. These alternative workplace arrangements can affect the need for parking due to employees traveling between facilities during the day, or by creating a more inconsistent demand for parking if different numbers of employees are on-site daily. When working with its federal partners to determine parking needs, NCPC should how these policies impact parking utilization.

5. Modeling Analysis

Introduction

This chapter lays out the methodology, limitations, analysis, and findings from the Volpe Center's quantitative review of NCPC's parking policies, specifically those prescribing a numeric ratio system.

Although NCPC's Comprehensive Plan establishes a broad set of parking-related policies, the subset that establishes parking ratios are uniquely suited to a quantitative analysis. Moreover, this set of policies are among NCPC's most significant policies, prompting continual interest from federal applicants, the Commission, local jurisdictions, and members of the public. These policies indirectly affect environmental (air quality, air temperature, stormwater management, aesthetics, etc.), budgetary (funding sources, capital costs, ongoing maintenance burdens), workplace, transportation, and opportunity cost considerations. Therefore this study particularly focuses on parking ratios.

When considering parking policy, understanding accessibility is fundamental. Conceptually, travelers seek to minimize travel time and cost. For destinations that are easier to reach by transit (either bus, rail, or a combination of both), employees require less parking than those that lack transit accessibility. Conversely, for destinations where automobile access is more convenient, employees will use their own vehicles, resulting in a higher demand for parking. The more parking demand exceeds supply, the more difficult it will be for facilities to comply with Comprehensive Plan parking ratio policies.

This chapter assesses NCPC's parking policies and parking inventories at sampled federal facilities in the National Capital Region (NCR) in light of current (2016) and projected future (2030) accessibility in the region. The next section describes the analysis methodology and the underlying data in more detail.

Methodology

The transportation industry defines and measures 'accessibility' in many different ways. In general, the term describes the proximity of origins and destinations via different transportation options. In this study, accessibility is defined as the number of households that can travel to a particular location, within a given time threshold, during morning rush hour (6:00 to 9:00 am)[80] by either transit or automobile. Volpe analyzed peak period travel since this study focuses on daily commuter behavior to and from federal facilities. Using the Metropolitan Washington Council of Government's (MWCOG) regional transportation model, the study team generated an "accessibility ratio" by dividing the number of households accessible via transit by the number of households accessible via automobile. The study team then compared the accessibility ratio for twenty federal facilities with available parking data to explain the variation in parking at different locations (termed the "Volpe Model"). The following section outlines underlying data sets used for this effort. Appendix H describes development of the Volpe Model and its limitations in more detail.

Underlying Data Sets

The study team assessed NCPC's parking policies in light of current (2016) and future (2030) land use and transportation conditions within the NCR. This analysis is grounded in:

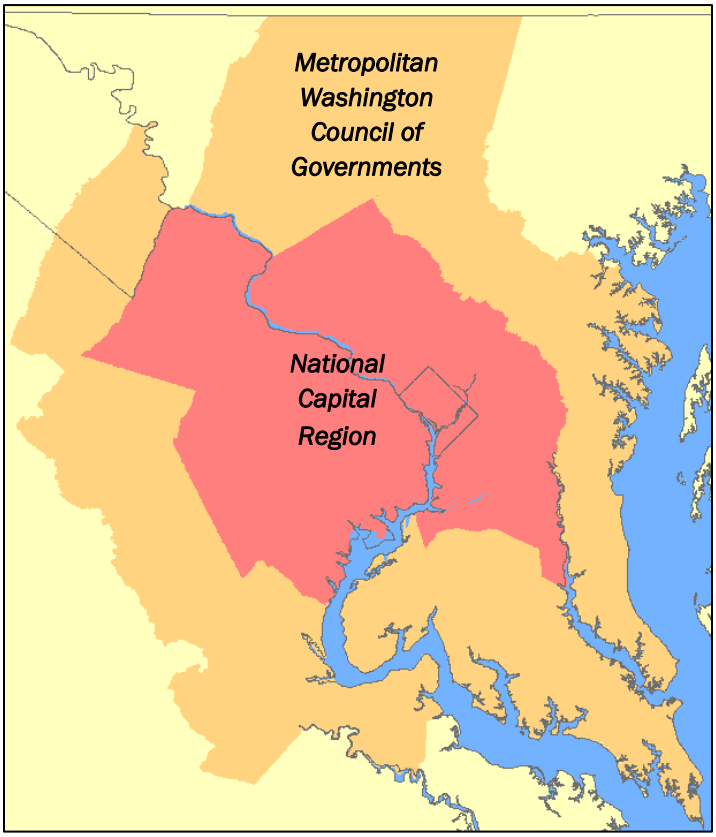
- Transit and automobile accessibility data from the MWCOG regional transportation model. This data is one output of MWCOG's model, which is used for regional transportation planning.

- Facility parking data assembled by NCPC and collected by federal facilities across the region. The study team compiled this data from a representative cross-section of Transportation Management Plans (TMPs) collected as part of NCPC's master plan review process.

5.1.1.1 MWCOG Regional Transportation Model

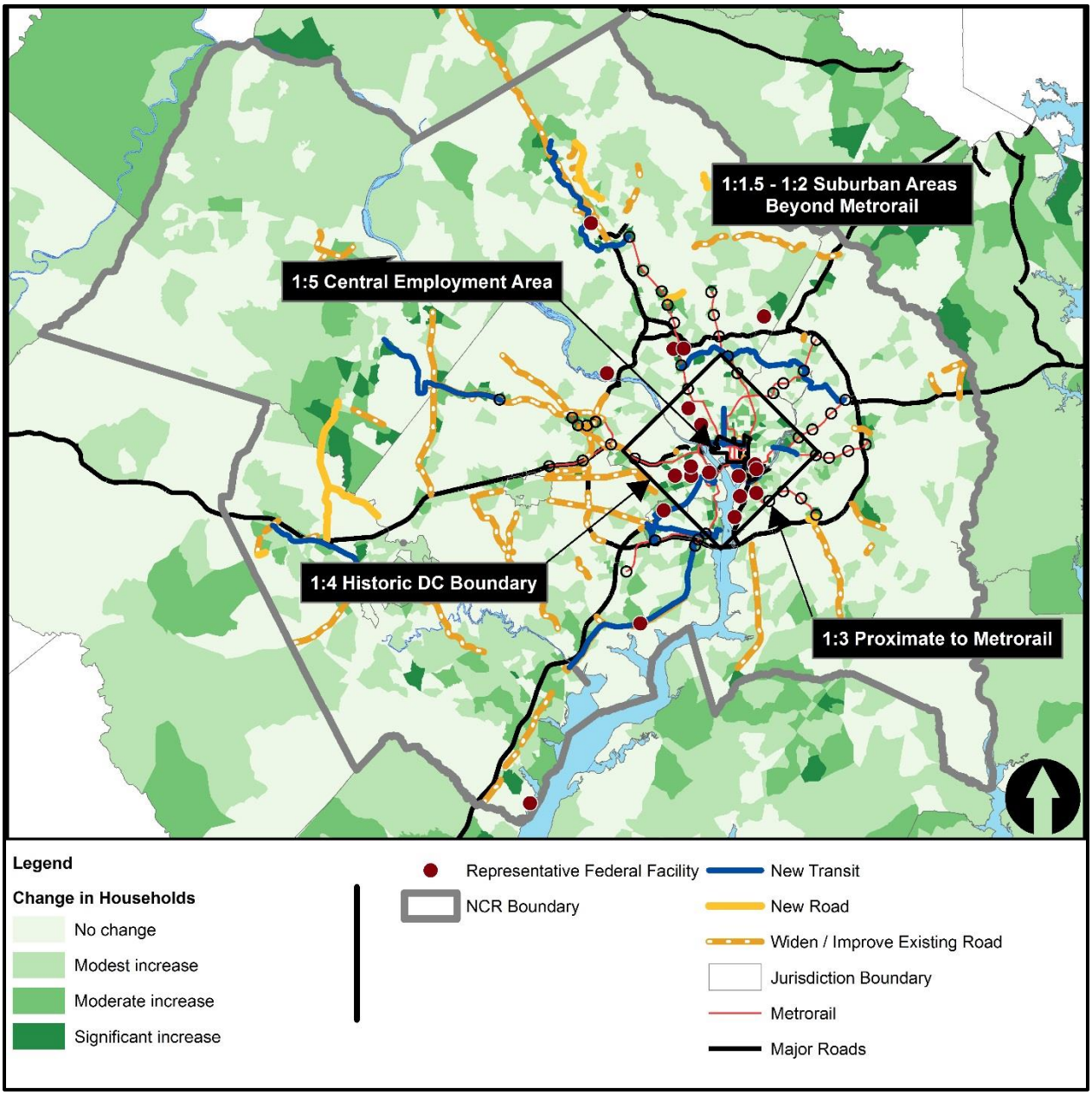
The MWCOG is an independent, non-profit association where leaders address regional issues affecting the District of Columbia, suburban Maryland, and northern Virginia. Its boundaries and purview is slightly larger than the NCR and fully encompasses NCR jurisdictions (see Figure 11). The National Capital Region Transportation Planning Board (TPB), which is part of MWCOG, is the federally designated Metropolitan Planning Organization for the region. The TPB is a regional forum for transportation planning and helps prepare plans and programs.

Figure 11: Map Depicting MWCOG and NCPC Boundaries



TPB develops, maintains, and applies MWCOG's regional transportation model. This model is a mathematical representation of the supply and demand for travel in the area; helping the region describe current and forecast future travel patterns and congestion. The current model projects regional conditions out to 2040 for the anticipated land use and transportation changes, although this study focuses on 2030 (see Figure 12). This forecast is a critical analytical tool that the region uses to develop regional air quality assessments, support long-range transportation planning, and inform the short-term implementation of transportation projects. The federal government requires each of these activities before approving federal-aid transportation funds for projects in the region.[81]

Figure 12: Map of Expected Land Use and Transportation Changes in the Region (2016-2030)



The MWCOG model uses two key inputs:

- Forecasts of population, households, and employment that are regularly updated through a collaborative process with local officials through MWCOG's Cooperative Forecasting Program. The model uses forecasts updated in 2016.
- Planned changes to the region's transit and highway network, which are collaboratively developed in the region's Financially Constrained Long-Range Plan (CLRP). The model uses the most recent CLRP, which MWCOG adopted in 2015.[82]

The MWCOG model relies on discrete zones, known as Transportation Analysis Zones (TAZ), to separate the region into sub-areas, each with demographic and land use information. These data are used to estimate travel demand between TAZs for a given model year. NCPC staff chose to use the 2030 model year for this

analysis because a 15- period is most consistent with the master planning process. Figure 12 shows the extent of the MWCOG model TAZs and expected land use and transportation changes through 2030, and the location of the case study facilities used for this analysis.

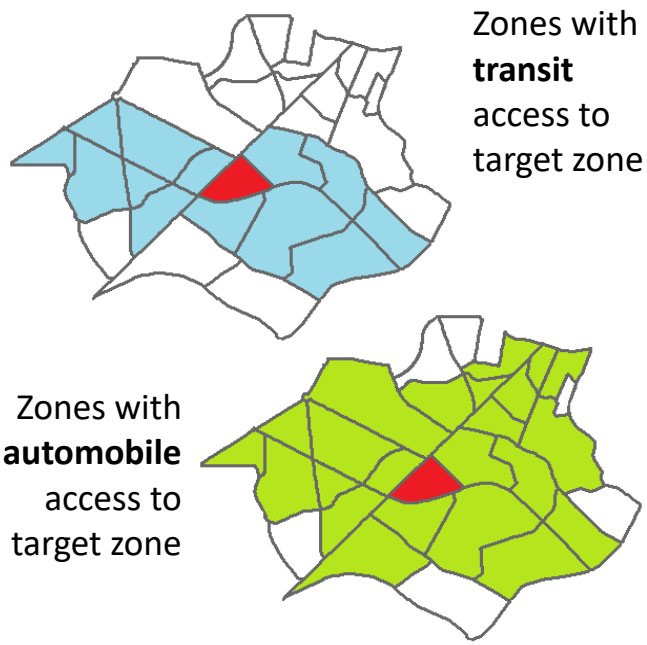
The model uses an 'origin-destination matrix' which estimates travel between TAZs across the region. This matrix is then applied to the transit and highway network, assigning trips to each in order to estimate mode-based travel patterns, congestion, and travel times between households and jobs. Furthermore, the model uses travel time to measure current and projected future accessibility in each TAZ based on the number of households reachable to a given TAZ via automobile or transit.[83,84] Using this data, the Volpe Center generated a ratio comparing the number of households reachable within a certain amount of time for automobile versus transit (see Figure 13).

Figure 13: Calculating the Accessibility Ratio

$$\text{Accessibility Ratio} = \frac{Households\ accessible\ by\ transit}{Households\ accessible\ by\ automobile}$$

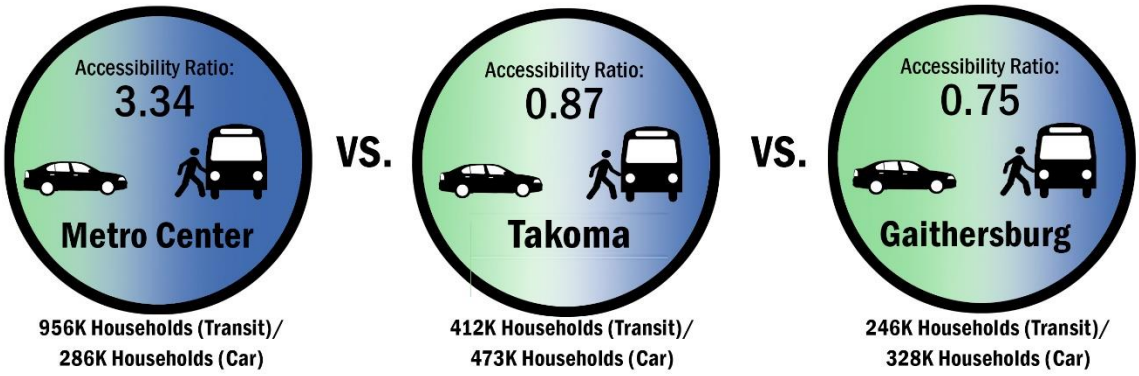
An accessibility ratio of one indicates that the same number of households can be reached by either car or transit. Accessibility ratios under one mean that more households can reach the location by automobile, while accessibility ratios above one mean that more households can reach the location by transit. For example, Figure 14 depicts a TAZ that is accessible to more households by automobile compared to transit (during peak commute periods).

Figure 14: Transit and Automobile Accessibility Concept



Accessibility depends upon a specific travel time window. For example, a longer travel time, means that more households can reach a particular destination. The MWCOG model provides accessibility data for travel times of 5, 15, 25, 35, 45, and 60 minutes. This analysis uses two different travel times based on average commuting times in the Washington, DC area.[85] Transit accessibility is evaluated using a 45-minute travel time while automobile accessibility is evaluated using a 35-minute travel time. Figure 15 applies the accessibility ratio to regional examples.

Figure 15: Accessibility Ratio Concept Applied to Regional Examples



5.1.1.2 Federal Facility Transportation Management Plans

Facility-specific data for this analysis comes from TMPs provided to NCPC for a representative cross-section of federal facilities in the region. Current NCPC guidelines require federal facilities to produce TMPs when facilities update master plans or propose large projects (increase employment levels by 500 or more). TMPs detail parking inventory and traffic conditions at each site, commuting patterns of employees and visitors, transportation demand management (TDM) programs pursued by each facility (including shuttles to transit, programs encouraging transit or ridesharing, etc.), program goals, action steps, and implementation timetables for short-term (five years) and long-term (20+ years) improvements. In particular, the study team utilized the following measures:[86]

- Observed (or current) parking inventory
- Current employment
- Share of employee commuting via single occupancy vehicle (SOV) mode

Table 2: List of Ratios

NCPC Policy	
Comprehensive Plan Parking Ratio	Parking ratio policy in the NCPC Comprehensive Plan (see Figure 16).
Modified Parking Ratio	Commission-approved parking ratio for a specific federal facility.
Built Environment Metric	
Parking Ratio	General term describing the ratio of employees to parking spaces. A higher parking ratio indicates that the number of parking spaces is more restrictive and a larger portion of staff must use other means to reach the site.
Accessibility Ratio	Ratio that represents the number of households accessible to a particular location during peak commuting times by transit compared to automobile.
Analysis Measures	
Observed (Current) Parking Ratio	The most recent parking ratio reported at a facility.
Predicted (Future) Parking Ratio	Expected (2030) parking ratio based on calculated accessibility conditions.
Adjusted Parking Ratio	The observed (current) parking ratio adjusted to reflect the impact of a prospective employee shuttle.

NCPC and Volpe Center staff selected a subset of the total facilities across the NCR with recent master plans. This included 20 master plans (with TMPs) from 2012-2017 to ensure relatively recent information for each of the properties. Several facilities, such as parks and other visitor destinations, were not applicable to an analysis of employee parking ratios. These 20 facilities represent a geographically diverse mix of facilities from civilian and military sectors; urban, suburban, and near-Metrorail station settings; Maryland, Virginia, and the District of Columbia; inside and outside of the Beltway; and with small, medium, and large employee populations (see Figure 16).

Figure 16: NCPC Parking Policy Map and Federal Facilities

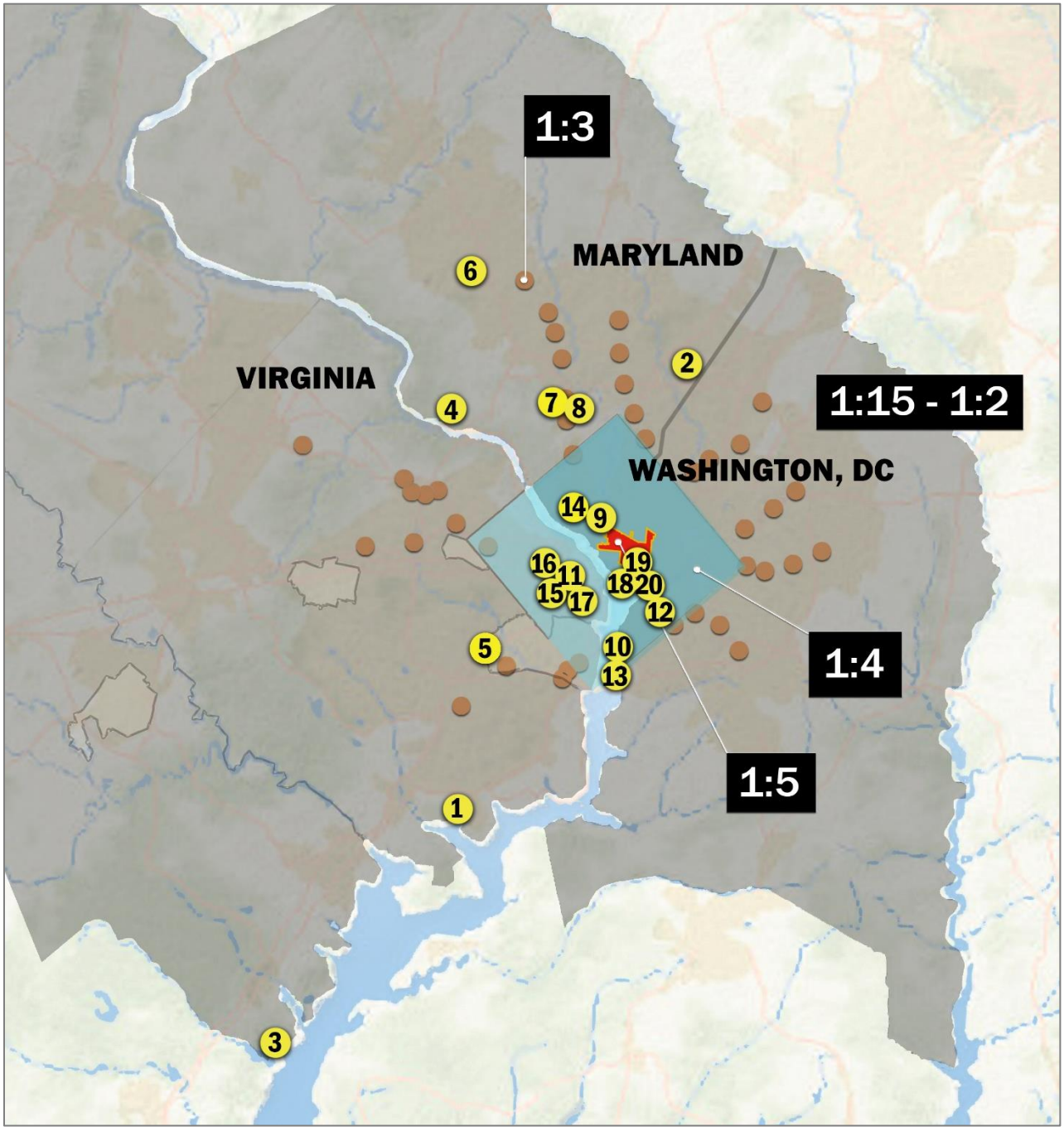


Table 3 summarizes the relevant statistics used for analysis for each of the sampled study facilities.

Table 3: Selected Facility TMP Details[87]

No.	Facility Name	TMP Year	Comprehensive Plan Parking Ratio	Modified Parking Ratio	Observed (Current) Parking Ratio	Current SOV Mode Share
1	Fort Belvoir	2013	1.5 - 2.0	2	1.22	81%
2	Food and Drug Administration (FDA) White Oak	2009	1.5 - 2.0	1.5	1.31	80%
3	Marine Corps Base Quantico	2013	1.5 - 2.0	2	1.36	83%
4	Naval Support Facility Carderock	2014	1.5 - 2.0	2	1.55	86%
5	Mark Center	2010	1.5 - 2.0	2	1.82	55%
6	National Institute of Standards and Technology	2009	1.5 - 2.0	2	1.54	68%
7	National Institutes of Health	2013	3	-	2.15	61%
8	Naval Support Activity Bethesda	2013	3	-	3.32	40%
9	United States Naval Observatory	2014	4	3	1.00	84%
10	Joint Base Anacostia-Bolling	2014	4	-	1.67	81%
11	Naval Support Facility Arlington	2014	4	3	1.72	74%
12	St. Elizabeths Hospital	2012	4	-	1.75	31%
13	Naval Research Laboratory	2015	4	-	1.77	83%
14	Department of Homeland Security (DHS) Nebraska Avenue Complex	2011	4	-	1.93	35%
15	National Foreign Affairs Training Center	2016	4	-	1.95	51%
16	Joint Base Myer-Henderson Hall	2013	4	-	2.68	73%
17	The Pentagon	2015	4	-	2.71	16%
18	Fort McNair	2013	4	-	2.77	73%
19	Marine Barracks Washington DC	2015	4	-	4.27	42%
20	Washington Navy Yard	2014	5	4.5-5.0	3.77	50%

Typically, TMPs define the observed 'parking inventory' available for staff use. However, it is important to note that there is some variation between the parking allocation schemes used by the different study facilities, and employees/staff are categorized differently by the TMPs. For example, some TMPs only provide the total amount of parking and do not specify if certain spaces are reserved for visitors or staff, making it difficult to discern the precise observed (current) parking ratio at a given facility. In addition, TMPs generally provide a total 'current employment' that is inclusive of all facility staff while some TMPs differentiate between full-time and part-time staff or commuting staff (as opposed to 'on-site' or 'on-base' staff that are not commuting from off-site). SOV mode share data was derived from facility population surveys that generally took responses from all staff on site, although one TMP incorporated visitor surveys.

Many of the selected facilities also have some form of shuttle service to encourage staff to use transit options. Shuttle service varies considerably between the various study facilities – some with both internal and external service, some with internal service only, and others with external service only. Quality of service also varies based on wait time (known as "headways") between shuttle vehicles, use restrictions, and route connectivity.

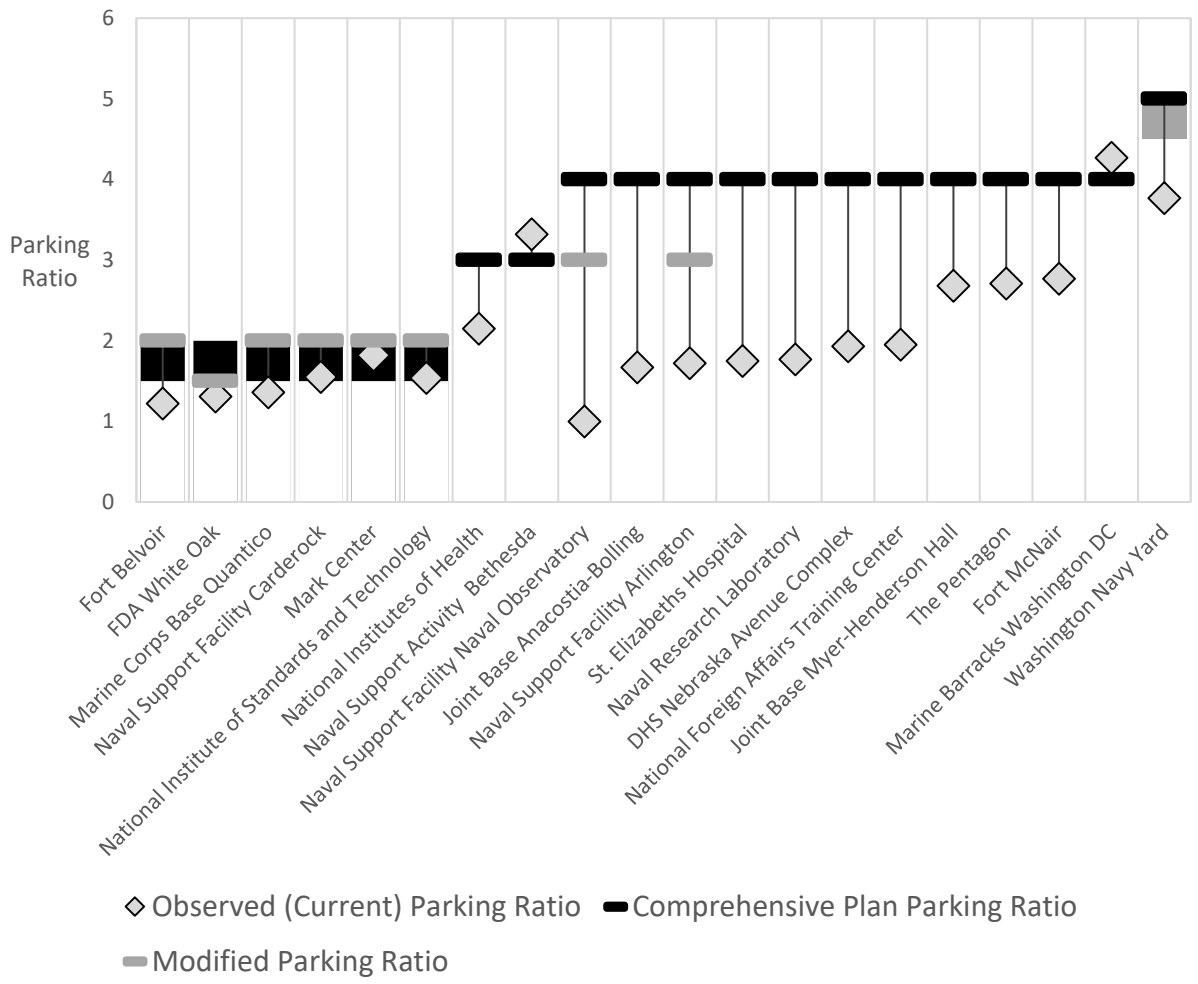
The impact of these shuttle services, or possible addition of shuttle service to those without current options, is explored in a later section.

Analysis

Basic Relationships

Before considering accessibility or other data for each site, Volpe compared the observed (current) parking ratios at each of the sampled federal facilities against the associated NCPC Comprehensive Plan parking ratio policy (see Figure 17).

Figure 17: Comparison of Observed (Current) and Comprehensive Plan Parking Ratios at Select Federal Facilities



This analysis indicates that facilities vary considerably in the parking ratios they are able to achieve. For example, there are a number of facilities that fall short of policies within the Historic District of Columbia Boundary Zone (1:4 ratio). There are likely a number of site-specific factors, including policy decisions and TMP implementation decisions that influence parking supply outcomes at these facilities. Nonetheless, it suggests

the simplified ratio zone based on a historical political boundary may not be the most appropriate determinant of parking ratios, rather than for example, a boundary more defined by land use patterns or transportation accessibility.

NCPC's Comprehensive Plan parking ratios are applied across a series of concentric zones roughly centered on the United States Capitol (see Figure 16). Therefore, the Volpe Center compared the relationship between observed (current) parking ratios at each facility and the distance of each facility from the US Capitol Building. This analysis showed that there is weak relationship between these parameters, with higher parking ratios observed at smaller distances from the Capitol. However, as the distance increases, this relationship is not as clear and, possibly, hits a minimum somewhere between 1 and 1.5 parking spaces per employee. This is expected since the parking for employees need only be as large as the total staff on site – a parking ratio of 1 to 1. However, this relationship is not strong enough to model parking ratios.

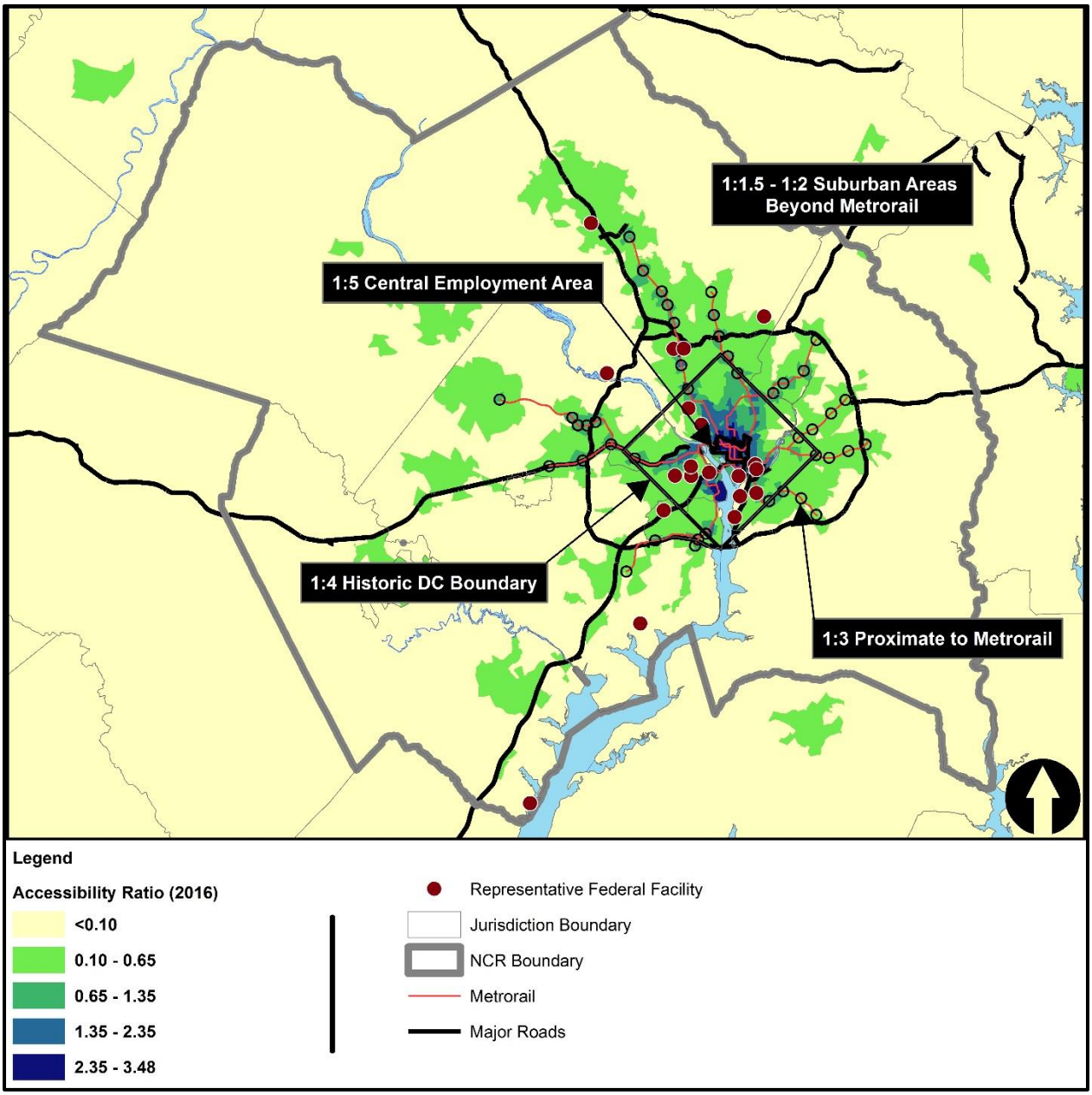
Next, the Volpe Center compared the observed (current) parking ratio at each facility to SOV mode share at each facility. If the staff at a facility tend to drive alone, the study team expected that the total parking demand on site would be a higher, and the parking ratio will drop. As other transportation modes are available and SOV mode share drops, parking demand decreases, leading to a higher observed parking ratio. This analysis showed that the relationship is also observable but not strong.

Accessibility

Analyzing accessibility data against observed (current) parking ratios at each facility is one way to explain the variation in parking at each facility. As described in the methodology section, the Volpe Center used the MWCOG model to calculate an accessibility ratio for each TAZ in the region (see Figure 18).

The accessibility ratio is much higher in the regional core during peak commute times, particularly near the convergence of different Metrorail lines.

Figure 18: Map of the Accessibility Ratio for the NCR (2016)

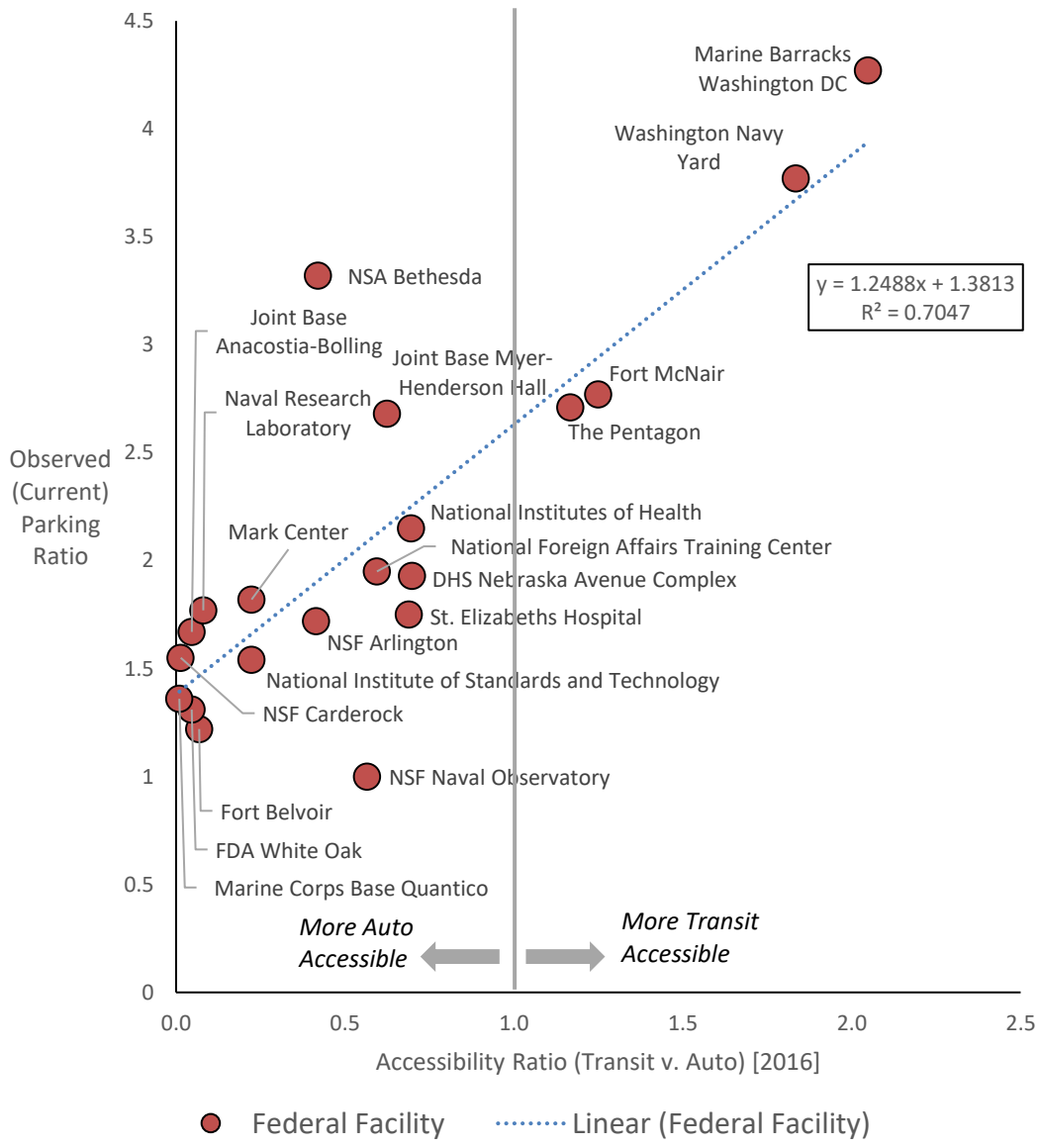


The data indicates much higher transit accessibility in the core of the region during peak commute times when automobile congestion is greatest. This is to be expected considering the systems providing the highest levels of transit service (Metrorail, commuter rail, and bus rapid transit lines) are radial routes connecting in the region's core. The federal government funded Metrorail, in part, to connect residents to stations serving federal facilities. This radial philosophy was developed in NCPC's influential "On Wedges and Corridors" plan.

Comparing against only transit accessibility or automobile accessibility individually, observed (current) parking ratios at the sampled federal facilities do not demonstrate a strong relationship (22 percent and 2 percent respectively). However, there is a much stronger relationship between observed (current) parking ratios and the accessibility ratio (see Figure 19).

Facility parking ratios exhibit a strong relationship with the accessibility ratio.

Figure 19: Observed (Current) Parking Ratio Compared to Accessibility Ratio (Volpe Model)



The Volpe Model, which defines the relationship between two variables (observed parking ratio and 2016 accessibility ratio), shows an R-squared value of 0.70. R-squared is a statistical measure that describes how closely a data set follows a model, fit, or trend line. If all data fall directly on the fitted model, R-squared is equal to 1.0; deviations of data away from the fit decrease the R-squared. The Volpe Model uses a linear

regression and the resulting R-squared indicates a relatively high degree (70 percent) of correlation between parking provision and regional accessibility.

The analysis indicates that facilities are systematically not meeting NCPC's Comprehensive Plan ratio policies. In many cases, facilities also fall short of policies where the Commission agreed to modify parking ratios (see Figure 17). Indeed, the regression indicates that the accessibility ratio is a much better predictor of parking at federal facilities than NCPC's policies.

Although most of the study locations fall near the line of best fit, the model shows two "outlier" facilities—the Naval Observatory and Naval Support Activity (NSA) Bethesda. The Naval Observatory is an outlier with its high parking supply compared to its modeled accessibility level. The Naval Observatory serves as the official residence of the Vice President of the United States and has a significant Secret Service presence. NCPC staff note that parking policies are driven by overriding national security concerns. Conversely, the NSA Bethesda is an outlier with its limited parking compared to its accessibility level.[88] The Volpe Center noted that while NSA Bethesda is proximate to a Metrorail transit station, the facility is bounded by an Interstate and has fewer bus connections than other similarly situated facilities. This results in a lowered accessibility ratio while, due to the adjacent Metrorail station, parking can be effectively restricted to achieve a high parking ratio. If the model does not consider these two facilities, the model is able to predict 92 percent of the data variation: which, from a modeling standpoint, is very strong.

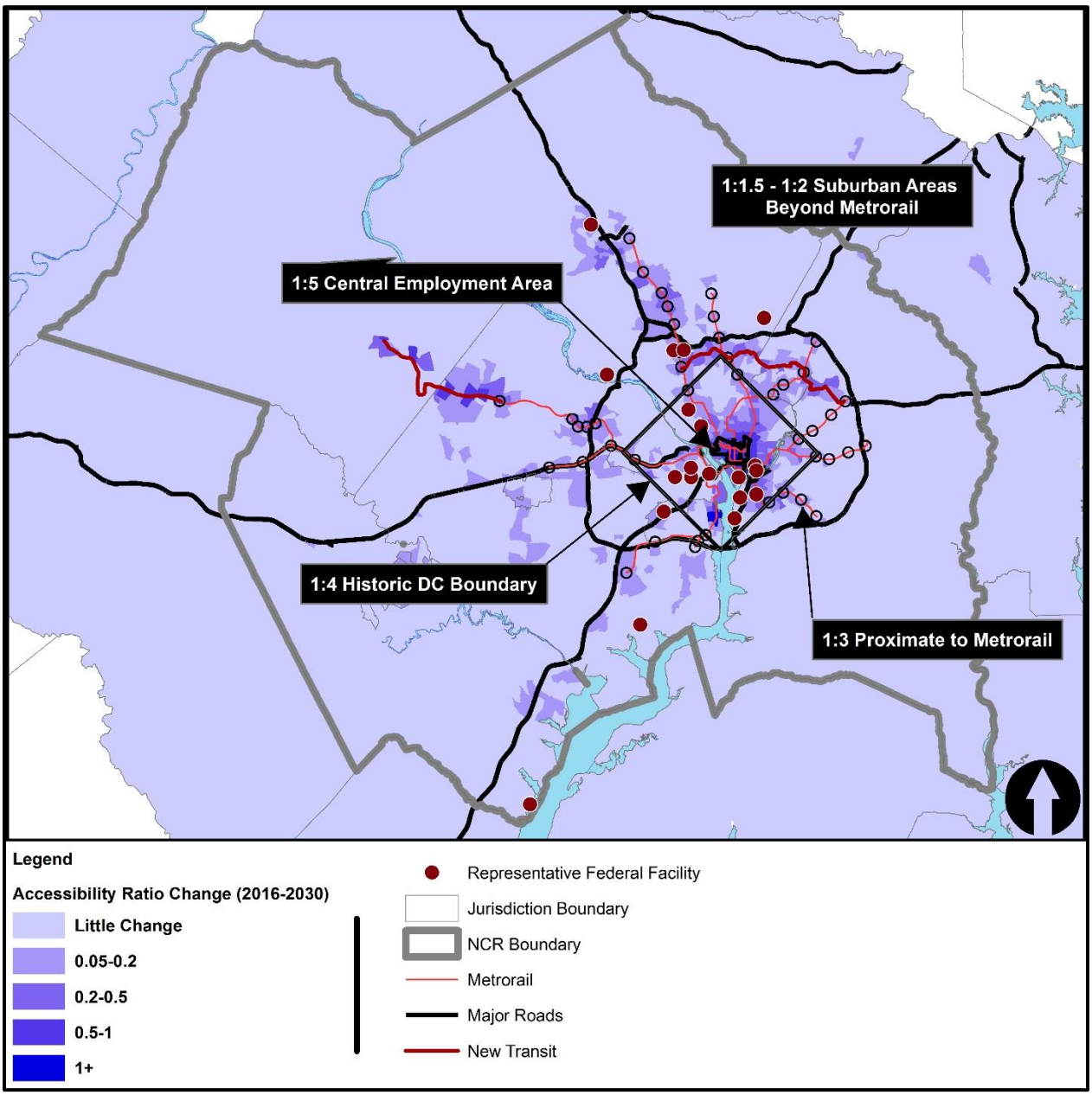
Predicting Future Parking Ratios Based on Changes in Accessibility

As described above, the MWCOG model incorporates projected land use and planned transportation improvements for 2030 (see Figure 12). Based on associated changes in the accessibility ratio, the Volpe Center inferred potential improvements in parking ratios where transit accessibility increased relative to automobile accessibility.

Projected land use changes include significant household growth in all NCR jurisdictions, particularly along major transportation corridors. Transportation improvements include major transit investments like Silver Line Metrorail extension and the Purple Line light rail connecting inner Maryland suburbs between Bethesda and New Carrollton. Significant roadway capacity investments include new and expanded roads and planned HOT/HOV lanes in Maryland and Virginia. These changes are expected to change accessibility across the region (see Figure 20).

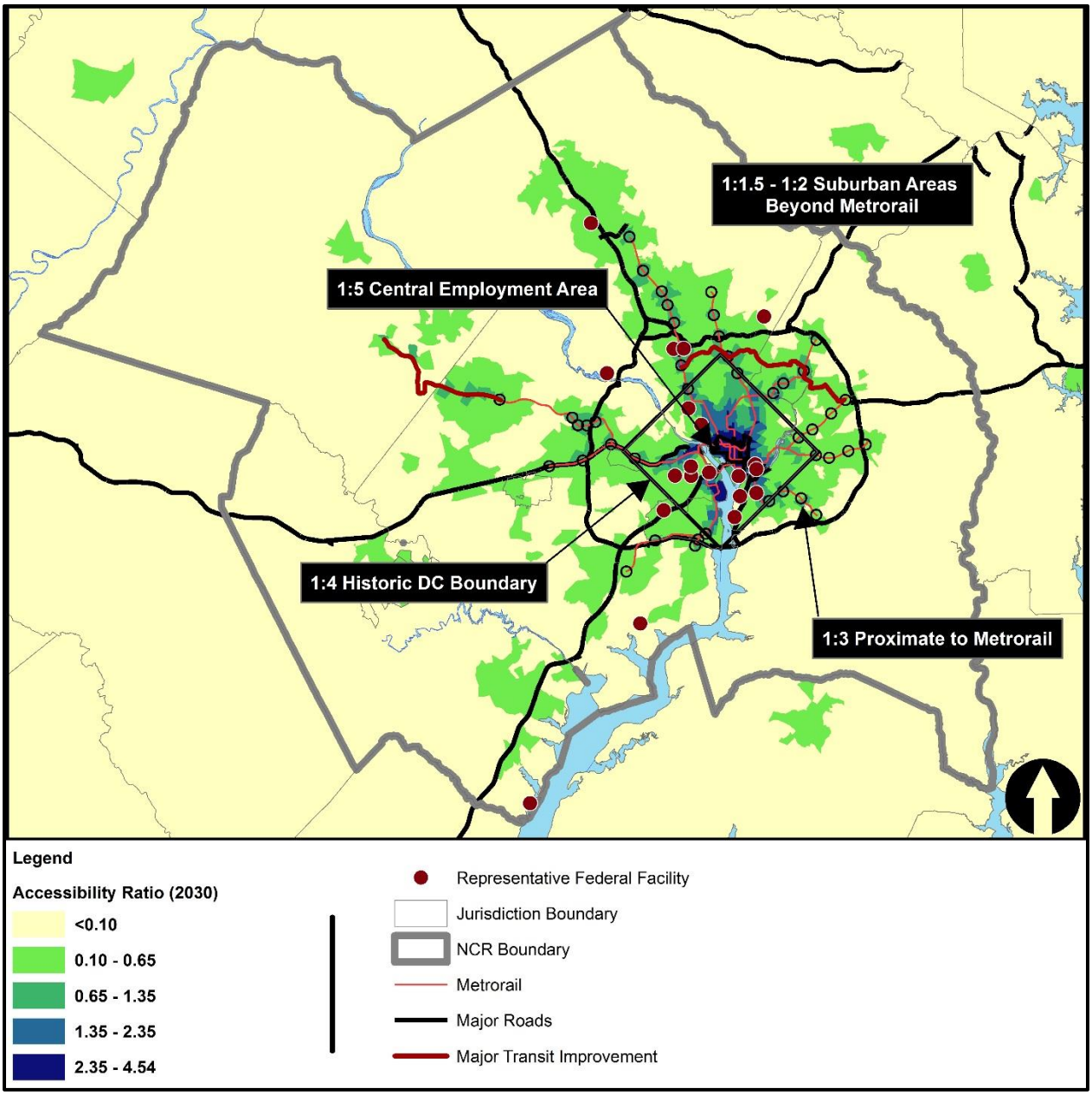
Household growth and transportation investments will increase transit accessibility, particularly in the region's core and along existing and planned transit lines.

Figure 20: Map of the Change in the Accessibility Ratio from Regional Transportation Improvements (2016-2030)



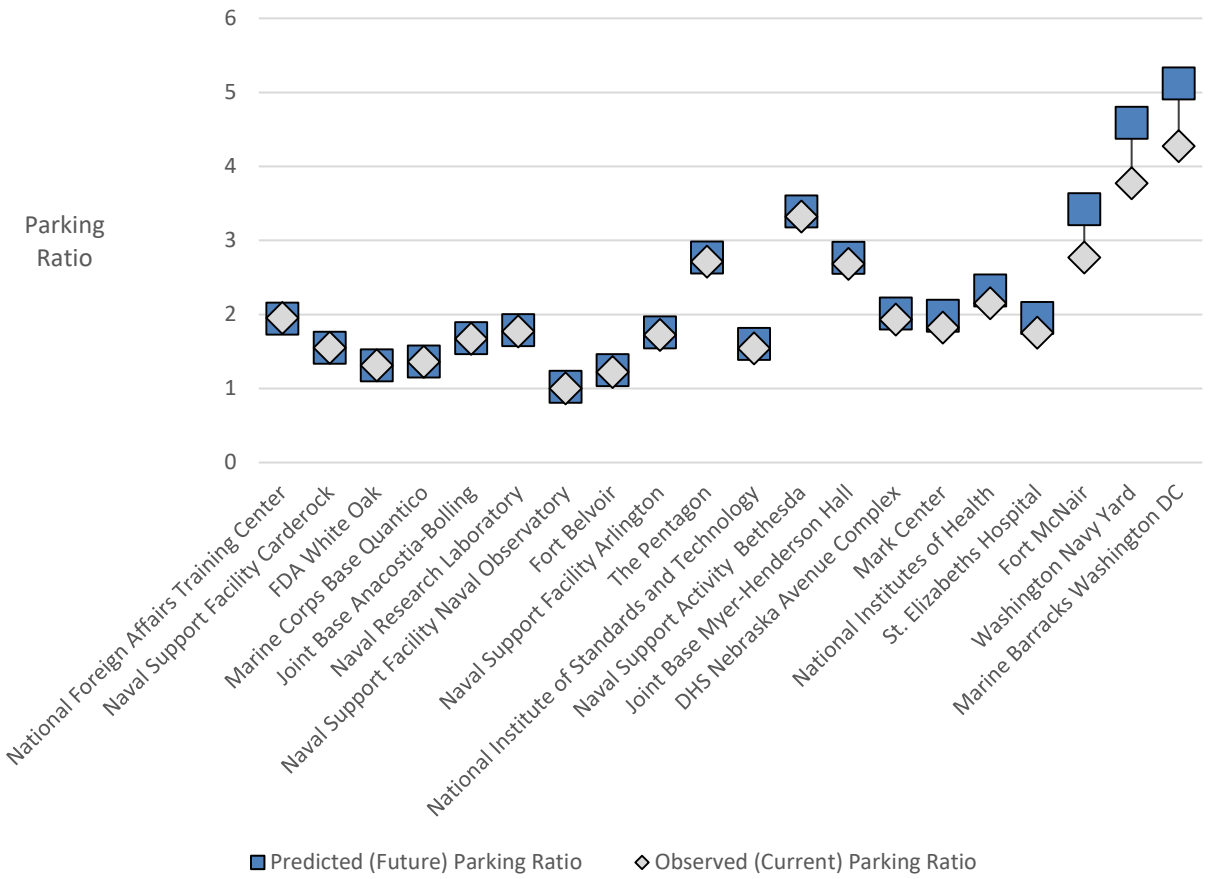
The accessibility ratio is expected to increase in the immediate vicinity of planned transit improvement in suburban areas, including Tyson's Corner and suburban Montgomery and Prince George's County. More significantly, these improvements, combined with projected household growth, produce network effects that significantly bolster accessibility in region's core. Figure 21 shows the predicted accessibility ratio for the region in 2030.

Figure 21: Map of the Accessibility Ratio for the NCR (2030)



Based on this analysis, the Volpe Center predicted 2030 parking ratios for the sampled federal facilities. Figure 22 shows these estimates, sorted according to the projected change in parking ratio (ordered left to right from least to greatest change).

Figure 22: Observed (2016) and Predicted (2030) Parking Ratios for Select Federal Facilities Using the Volpe Model



According to these estimates, projected changes in land use and planned transportation improvements have varied implications for the sampled facilities:

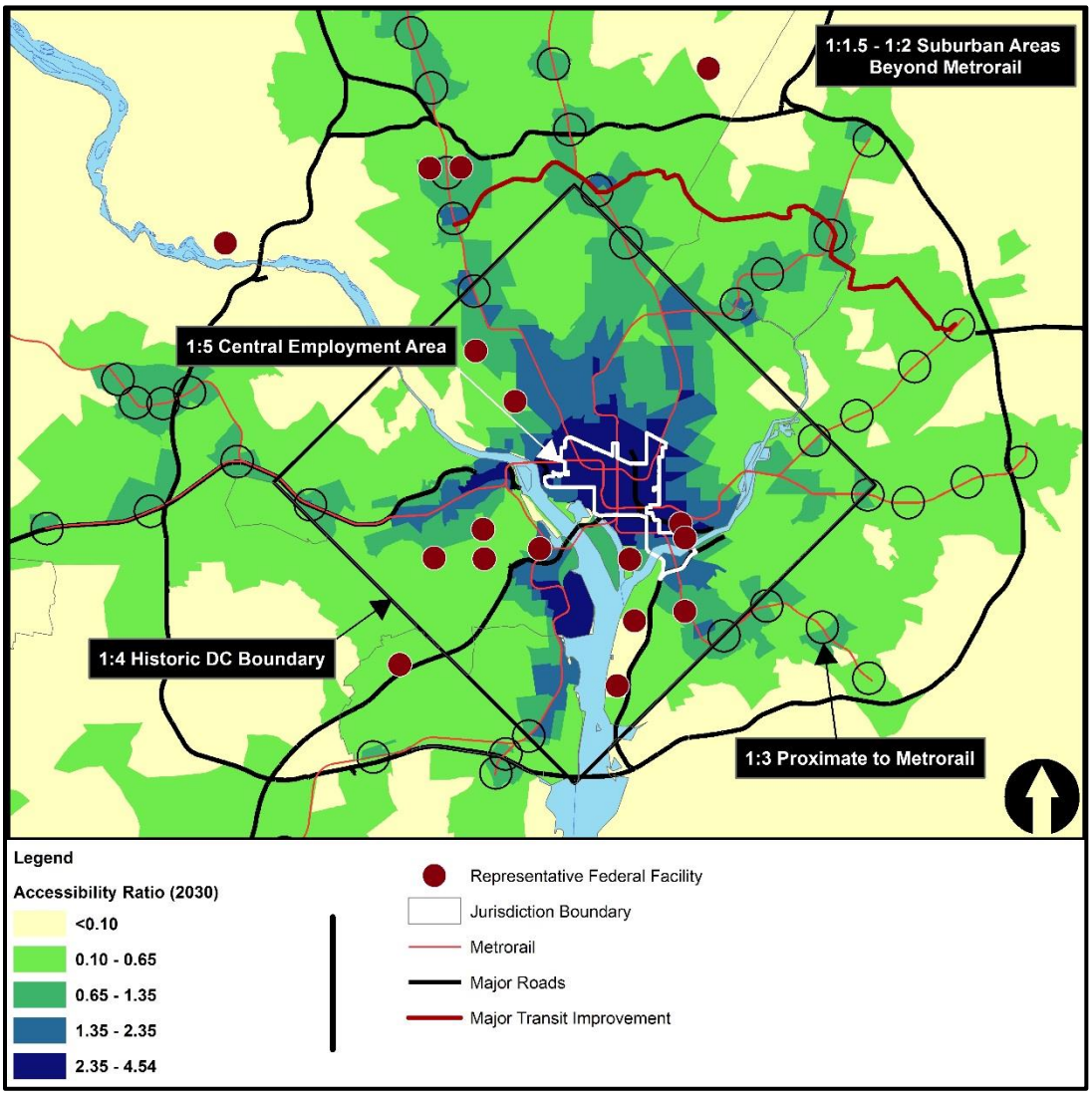
- **Facilities in the region's core**: Facilities that show accessibility improvement in 2030 are centrally located. The three facilities that show the greatest increases (Fort McNair, Washington Navy Yard, and Marine Corps Barracks Washington) are near Downtown Washington and have direct access to the central portions of the Metrorail system. Parking at these facilities could decrease between approximately 15 percent and 20 percent. While the actual parking supply may be relatively static at these facilities over the next several years, the analysis indicates that they could realistically achieve more aggressive parking ratios with existing TDM techniques.
- **Facilities benefiting from suburban transit improvements**: Suburban transit investments benefit adjacent federal facilities, but to a lesser extent than facilities in the core. Six facilities fall in this category, including the National Institutes of Health, the Mark Center, St. Elizabeths Hospital, the Department of Homeland Security Nebraska Avenue Complex, the Naval Observatory, and the National Institute of Science and Technology. Parking at these facilities could decrease between approximately four percent and five percent using existing TDM techniques.
- **Other facilities**: Many of the facilities show predicted (future) parking ratios for 2030 that are very close to their current value. For these locations, the transportation system is not changing significantly – transit and roadway improvements are minimal or roughly balanced out, leading to no shift in the

parking ratio or marginal changes. According to the MWCOG model, there is minimal nearby household growth.

These changes largely align with expectations. Federal facilities near the region's core benefit from forecasted household growth and planned transit improvements across the entire region, including suburban transit improvements. Facilities in suburban areas only leverage nearby improvements. For example, facilities in Maryland and Washington adjacent to the Purple Line or nearby Metrorail stations will see significant improvements in accessibility. However, these facilities do not benefit significantly from the Silver Line extension in Virginia nor broader household growth across the region. Both the Purple Line and Silver Line extension will have a cumulative effect on accessibility for more centrally located sites (see Figure 23).

The Volpe Model predicts that Fort McNair, Washington Navy Yard, and Marine Corps Barracks Washington could reduce parking between 15 and 20 percent by 2030 based on expected changes in accessibility.

Figure 23: Map of the Accessibility Ratio in the NCR Core (2030)



Examination of Accessibility Across the Metrorail System

Metrorail is a key component of regional accessibility. Making direct connections between federal campuses and the Metrorail system, as with the employee shuttles described in the next section, strongly influences the transportation decisions.

Figure 24 shows the accessibility ratio at each Metrorail station (averaged using a 2,000 foot catchment) along each line peaks in the downtown core near Metro Center and Gallery Place/Chinatown. A secondary peak on the Blue/Yellow Lines indicates the secondary hub around Crystal City and Ronald Reagan Washington National Airport (the two spikes are in different places on the figure because the number of stops along each route varies, but the peaks refer to the same location).

The accessibility ratio peaks in the downtown core, in Crystal City, and at the Ronald Reagan Washington National Airport.

Figure 24: Accessibility Ratios Across the Metrorail System (2016)

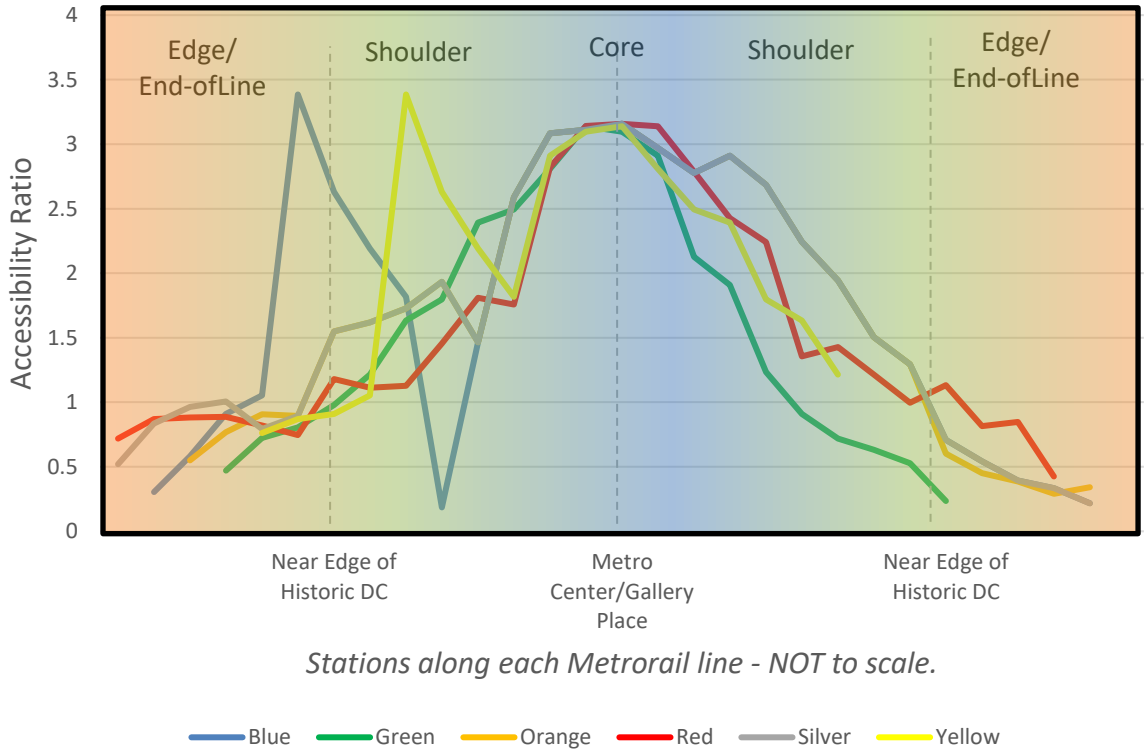


Figure 24 indicates that the Metrorail stations fall into three general categories:

1. **Core Stations** – stations near Metro Center/Gallery Place, accessibility ratio at or near the regional peak
2. **Shoulder Stations** – stations generally between the core and the edge of historic DC, with strong accessibility to transit but not as high a ratio as the core
3. **Edge/End-of-Line Stations** – stations generally outside historic DC with low accessibility ratios (generally under one, indicating that vehicle accessibility is stronger).

These groups become important, and display different characteristics, when examining the impact of potential employee shuttle services in the following section.

Adjusting the Model for Employee Shuttles

Many of the facilities in this study offer some form of external shuttle service. However, a closer examination of these services reveal that many have limited commuting value (do not provide access to Metrorail stations, have limited frequency, and low capacity) based on current (2016) regional conditions (land use patterns, demographic characteristics, and existing transportation network) and service constraints (i.e., existing user limitations/prohibitions). Table 4 describes each service in more detail.

Table 4: Description of Shuttle Services by Facility

No.	Facility Name	Commute-Oriented Shuttle	Description of Service from TMP
1	Fort Belvoir	No	External shuttles were discontinued for commuting use
2	FDA White Oak	Yes*	Shuttles were operating at the time of the TMP, but plans were being pursued to replace shuttle service with expanded public transit which, if implemented, would be captured in the MWCOG 2016 model
3	Marine Corps Base Quantico	No	No shuttle services
4	Naval Support Facility Carderock	No	Limited or no shuttles provided for commuting access
5	Mark Center	No	Shuttle services being planned for commuting but not in operation at the time of TMP
6	National Institute of Standards and Technology	Yes	Shuttles on 30-minute headway to Shady Grove station
7	National Institutes of Health	No	Internal circulators and some external connections, but NIH is already on a Metrorail station limiting the need for shuttles to the rail network
8	Naval Support Activity Bethesda	No	Shuttles mainly for on-campus circulation; NSA Bethesda already on Metrorail
9	United States Naval Observatory	No	No shuttle services
10	Joint Base Anacostia-Bolling	Yes*	Shuttle only operated at one hour headway, providing insufficient service to improve transit accessibility
11	Naval Support Facility Arlington	No	No shuttle services
12	St. Elizabeths Hospital	Yes	Shuttle services planned in the TMP; parking ratio of 1.75 estimated based on current operations with shuttles running
13	Naval Research Laboratory	No	No shuttle services
14	DHS Nebraska Avenue Complex	Yes	10-15 minute headway shuttle to the Red Line Metrorail
15	National Foreign Affairs Training Center	Yes*	Shuttles do connect to Metrorail, but have limited on board capacity and long headways
16	Joint Base Myer-Henderson Hall	Yes*	Shuttle to the Pentagon station in operation, but headways may be too long; additional service on the north side of the facility may be useful
17	The Pentagon	No	Shuttles connecting DOD facilities; Pentagon already on Metrorail
18	Fort McNair	No	No shuttle services
19	Marine Barracks Washington DC	No	No shuttles provided for commuting access
20	Washington Navy Yard	No	No shuttles provided for commuting access

Only three of the facilities, based on information provided in TMPs, operate shuttles, which could significantly affect commuting behavior. According to information provided in TMPs, other facilities that have shuttles lack sufficiently short headways or large enough vehicle capacity to adequately serve commuters.

Only three of the sampled facilities operate employee shuttles which could significantly impact commuting behavior.

Following the approach outlined in the methodology section, the Volpe Center examined the possible impact of new shuttle services to each of the twenty sampled federal facilities. Table 5 describes the scenarios and predicted impact in terms of accessibility ratio and observed (current) parking ratio conditions at each facility. Only those facilities that showed an impact from the prospective shuttle service(s) are included in the table.

Table 5: Prospective Impact of New Employee Shuttle Services

Facility Name	Scenario	Observed (Current) Parking Ratio	Shuttle Adjusted Parking Ratio	Comprehensive Plan Parking Ratio/Modified Parking Ratio
	Shuttle to Red Line	1.31	1.45	
	Shuttle to Green/Yellow Lines	1.31	1.37	
	Both Shuttles	1.31	1.48	
	Shuttle to Red Line	1.55	1.73	
	Shuttle to Silver Line	1.55	1.96	
	Both Shuttles	1.55	2.13	
Mark Center	Shuttle to Blue/Yellow Lines	1.82	1.96	2
National Institute of Standards and Technology	Shuttle to Red Line	1.54	1.77	2
Naval Support Facility Naval Observatory	Shuttle to Red Line	1.00	1.21	3
Joint Base Anacostia-Bolling	Shuttle to Green Line	1.67	1.99	4
	Shuttle to Orange/Silver Lines	1.72	2.52	
	Shuttle to Blue/Yellow Lines	1.72	2.69	
	Both Shuttles	1.72	3.07	
Naval Research Laboratory	Shuttle to Green Line	1.77	1.95	4
DHS Nebraska Avenue Complex	Shuttle to Red Line	1.93	2.18	4
	Shuttle to Orange/Silver Lines	1.95	2.24	
	Shuttle to Blue/Yellow Lines	1.95	2.41	
	Both Shuttles	1.95	2.54	
Joint Base Myer-Henderson Hall	Shuttle to Blue/Yellow Lines	2.68	2.74	4

Roughly, half of the sampled facilities show improved accessibility from a prospective shuttle service to a nearby Metrorail station. In the cases that showed no improvement, either existing public transit services were already sufficient within the MWCOG model to accommodate transit commuters, or the distances from Metrorail are such that a shuttle commute is not viable. For example, there is limited benefit from connecting an edge/end-of-line station to a federal facility if the distances greater than five to seven miles.

The highest performing facility in this analysis was NSF Carderock. A prospective employee shuttle connecting the facility to both the Red and Silver Lines would increase the number of households accessible by transit by more than 30 times. Public bus service to Carderock is extremely limited, so connecting to local Metrorail transit hubs opened large areas to potential transit use. Other facilities which showed notable improvements from a prospective shuttle include Joint Base Anacostia-Bolling (more than 5 times as many transit-accessible households), the Food and Drug Administration (FDA) White Oak campus (a factor of 4.2 with two shuttle options), and Naval Support Facility (NSF) Arlington (nearly a 4-times improvement with both shuttle options explored).

Three facilities could institute an employee shuttle to nearby Metrorail stations that would significantly impact commuting behavior, including NSF Carderock, FDA White Oak, and NSF Arlington.

By using the Volpe Model, these impacts to accessibility conditions were translated into an impact on parking ratios (for the 2016 conditions). In the case of NSF Carderock, implementing these shuttle options is predicted to help the facility achieve much of the gap between observed (current) parking ratio and the NCPC Comprehensive Plan parking ratio policies. Similarly, NSF Arlington and FDA White Oak could achieve their NCPC Comprehensive Plan parking ratio policies with employee shuttle services.

Returning to the groups of stations identified in the previous section (core stations, shoulder stations, and edge/end-of-line stations), federal facilities located near, but not adjacent to, shoulder stations benefit the most from shuttles. These facilities are located in relatively transit-poor areas, but near Metrorail stations with a high accessibility ratio. Facilities near core stations are already in high accessibility-ratio areas and therefore do not significantly benefit from additional connections to the Metrorail. Facilities near the edges of the Metrorail, including end-of-line stations, may see some incremental benefit from a shuttle connection, but the potential benefit is small because these Metrorail stations are relatively inaccessible.

This analysis used the 2016 MWCOG model, but improvements to the transit network through 2030 or beyond would tend to push the shoulder of the Metrorail network further and widen the core of the region. Additional transit lines, such as the Purple Line, could open additional areas to shuttle operations by providing greater access to the mid-point of Metrorail lines connected to the core.

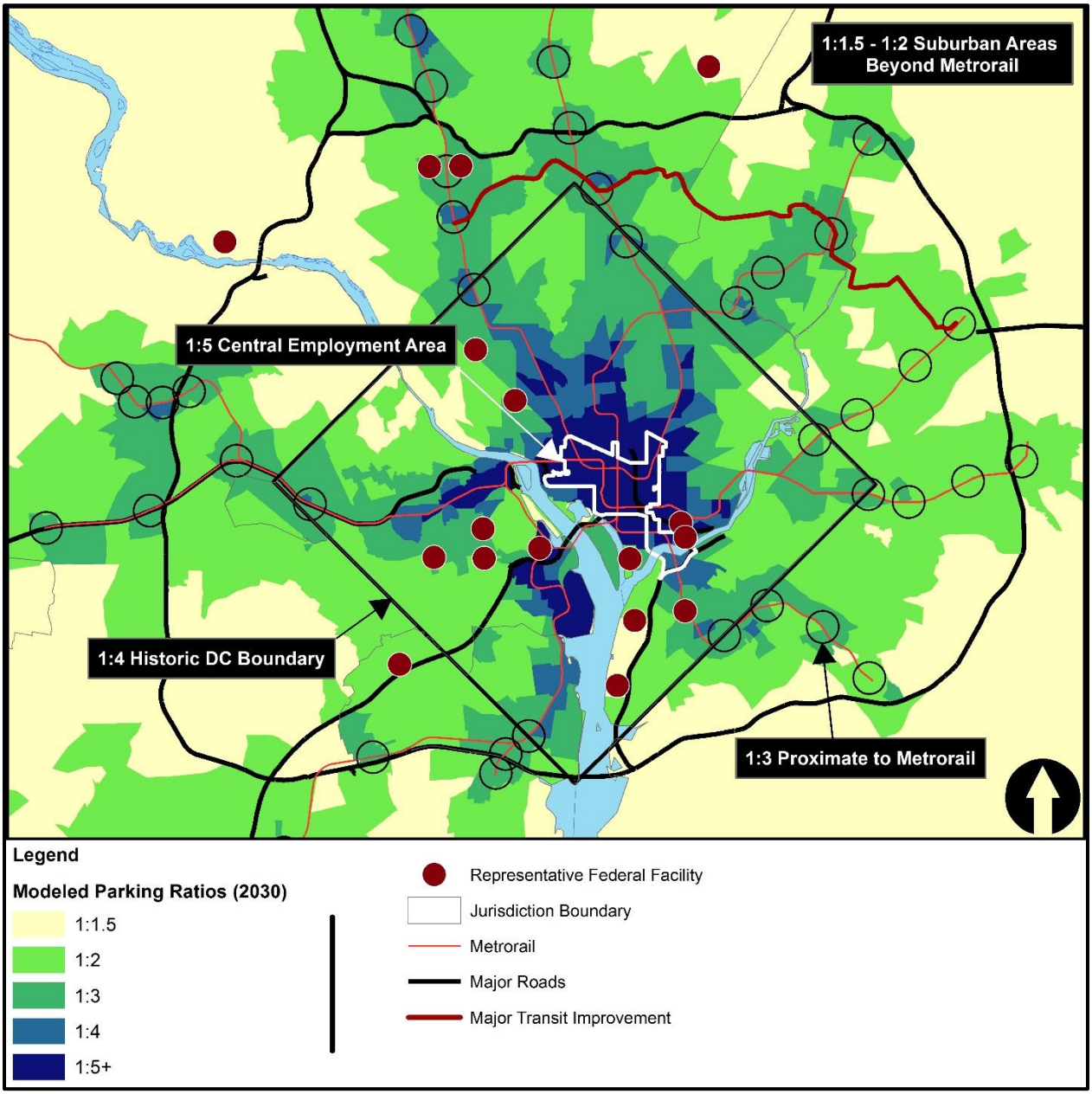
Developing New Parking Policies using the Accessibility Analysis

As shown in previous sections of this chapter, the major issue with NCPC's Comprehensive Plan parking ratio policies is that the 1:4 Historic DC Boundary Zone does not account for wide-ranging built environments and accessibility conditions of the area. Previous master plan reviews resulted in the Commission approving modified parking ratios at seven of the 20 sampled facilities. As such, Volpe believes that there is an opportunity to adjust the parking ratio zones to better reflect existing and future projected regional accessibility conditions.

Using the projected 2030 accessibility ratio from the MWCOG model, the project team applied the Volpe Model to develop a map that visualizes predicted parking ratios. These predicted (future) parking ratios were rounded up to an 'even' value of 1.5, 2, 3, 4, or 5 to represent a realistic target value for each zone. The Volpe Center

developed a map with these parking ratio prospective target values to compare with existing NCPC's parking ratio zones (see Figure 25).

Figure 25: Map of Predicted (Future) Parking Ratios (2030)



The accessibility mapping and predicted (future) parking ratios suggest that NCPC could add significant nuance to its parking policy zones to reflect accessibility across the region. Ideally, zones should include homogeneous regions. Areas with similar predicted parking ratios can be expected to behave similarly and thus achieve similar parking ratios.

The TAZs which were modeled as 1:5 generally represent the core, but exceed the boundaries of the Central Employment Area (CEA) to encompass most of the L'Enfant City. A significant area north of the CEA, and along the two Metrorail corridors to the south and west are also at, near, or significantly above 1:5 and could logically

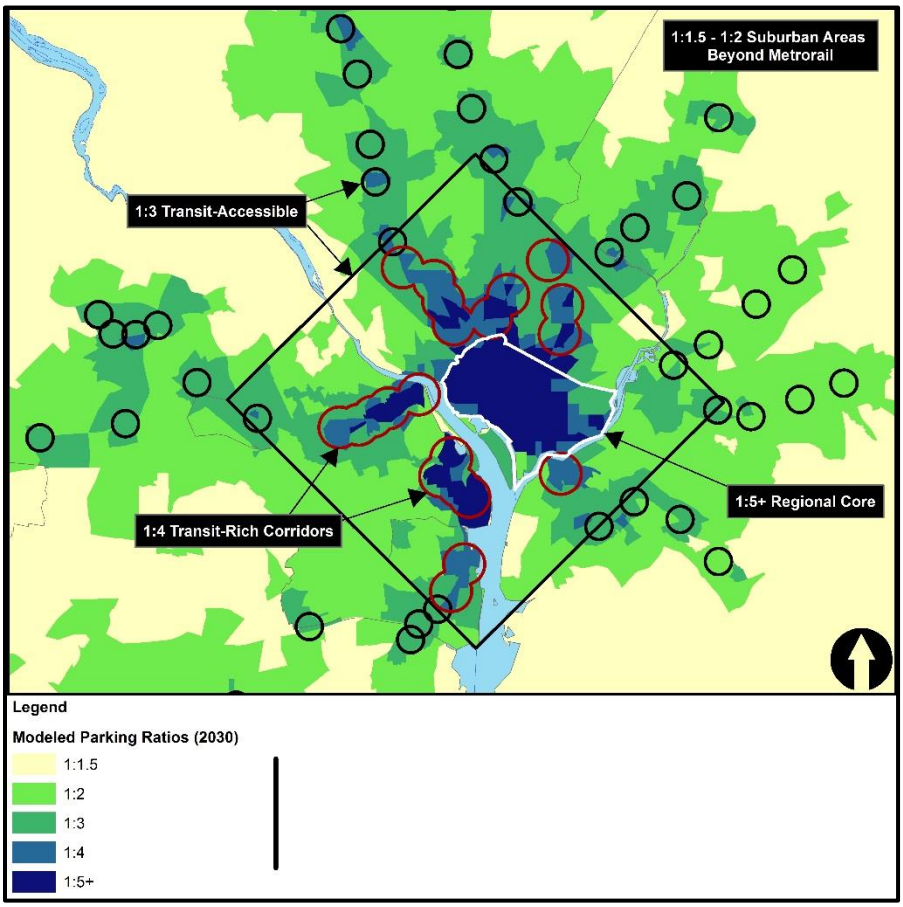
be grouped with the core of DC. Zones with a predicted (future) parking ratio of 1:4 do not represent a cohesive single area. Instead, these TAZs are spread along Metrorail rail lines radiating out from the L'Enfant City but within the historic DC boundary. For the remainder of the historic DC boundary, and areas near suburban Metrorail stations, TAZs are predominantly in the 1:3 category. Some of these areas are in the 1:2 zone but near to the shoulder of Metrorail lines, which could potentially benefit from shuttle services to improve transit access. The remainder of the suburban area is predominantly within the 1:1.5 zone, with certain corridors maintaining a 1:2 predicted (future) parking ratio.

Reviewing the location of the federal facilities that were used for this analysis, a possible revised NCPC parking ratio policy could have four revised zones:

- **1:5+ – Regional Core**: The L'Enfant City.
- **1:4 – Transit-Rich Corridors:** Highly Metro-accessible portions of the Historic DC Boundary.
- **1:3 – Transit Accessible**: The remainder of the Historic DC Boundary Zone and suburban locations within 2,000 feet of a Metrorail station.
- **1:1.5 - 1:2 – Suburban Areas Beyond Metrorail**: All other locations in the region, including areas served by HOT/HOV lanes or high-frequency commuter rail.

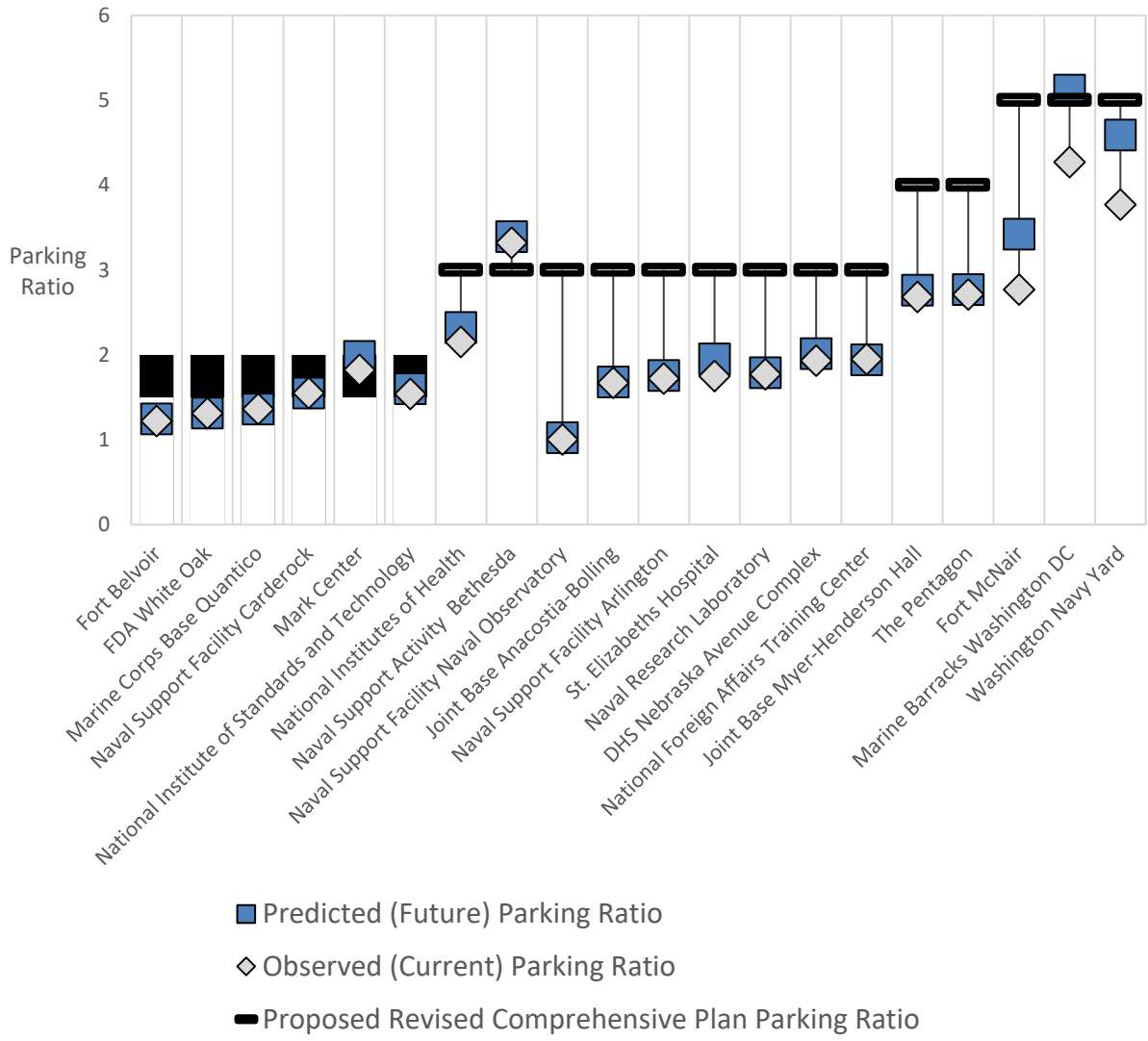
These revised zones translate the predicted accessibility of each part of the region into easily described geographies. The Volpe Center recommends NCPC continue to use stable geographies like Census-designated places and the transportation network to set policy zones. This proposed approach is depicted in Figure 26.

Figure 26: Proposed NCPC Parking Policy Map



This policy map results in more realistically achievable parking ratio policies for the sampled federal facilities. Figure 27 compares the observed (current) parking ratios at each facility to predicted (future) parking ratios (based on anticipated accessibility changes in the region) and proposed new policies.

Figure 27: Observed (2016) and Predicted (2030) Parking Ratios Compared to Proposed Parking Ratio Policies



The proposed policy map would keep NCPC's Comprehensive Plan parking ratio policies aspirational, while making them more realistically achievable than current policy. Table 6 compares existing and proposed parking ratio policies to observed (current) and predicted (future) parking ratios at each sampled facility.

Table 6: Existing Versus Proposed Policy Zones at Sampled Facilities

No.	Facility Name	Observed (Current) Parking Ratio (2016)	Comprehensive Plan Parking Ratio*	Predicted (Future) Parking Ratio (2030)	Proposed Revised Comprehensive Plan Parking Ratio
1	Fort Belvoir	1.22	1.5 - 2 (2)	1.24	No Change
2	Food and Drug Administration (FDA) White Oak	1.31	1.5 - 2 (1.5)	1.31	No Change
3	Marine Corps Base Quantico	1.36	1.5 - 2 (2)	1.36	No Change
4	Naval Support Facility Carderock	1.55	1.5 - 2 (2)	1.55	No Change
5	Mark Center	1.82	1.5 - 2 (2)	1.98	No Change
6	National Institute of Standards and Technology	1.54	1.5 - 2 (2)	1.60	No Change
7	National Institutes of Health	2.15	3	2.32	No Change
8	Naval Support Activity Bethesda	3.32	3	3.39	No Change
9	Naval Support Facility Naval Observatory	1	4 (3)	1.02	3
10	Joint Base Anacostia-Bolling	1.67	4	1.68	3
11	Naval Support Facility Arlington	1.72	4 (3)	1.76	3
12	St. Elizabeths Hospital	1.75	4	1.95	3
13	Naval Research Laboratory	1.77	4	1.79	3
14	Department of Homeland Security (DHS) Nebraska Avenue Complex	1.93	4	2.01	3
15	National Foreign Affairs Training Center	1.95	4	1.94	3
16	Joint Base Myer-Henderson Hall	2.68	4	2.76	No Change
17	The Pentagon	2.71	4	2.77	No Change
18	Fort McNair	2.77	4	3.42	5
19	Marine Barracks Washington DC	4.27	4	5.12	5
20	Washington Navy Yard	3.77	5 (4.5-5)	4.59	5

** - For facilities with modified parking ratios or in the 1.5-2 zone, the approved ratio is included in parenthesis.*

Facilities currently in the 1:4 Historic DC boundary Zone are separated into two groups. The first group includes facilities that lack transit accessibility despite their location in the Historic DC Boundary. These facilities are moved to the lower 1:3 goal, which is more realistically achievable. The second group includes facilities nearer to the core or the two strong transit corridors to the south and east of the Capitol, which are moved into an expanded 1:5 zone.

Modeling Analysis Findings

This modeling analysis highlights the following key themes that may inform future revisions to NCPC's parking policies and processes:

NCPC can utilize accessibility metrics to evaluate its parking policies against current and future conditions. These estimates can inform updates to NCPC's parking policies.

Accessibility metrics help policymakers determine how convenient particular locations are via different modes of transportation. In lieu of more site-specific demand estimates, NCPC can utilize regionally-specific accessibility metrics to determine transit access for federal facilities. Using outputs from MWCOG's Regional Transportation Demand Model, the Volpe Center evaluated NCPC's Comprehensive Plan parking ratios policies against existing and projected accessibility in the region. By breaking data down to the TAZ level, federal facilities can be isolated and their connections to the transit and roadway networks examined. The MWCOG model also produces these data in an easy-to-use format that can be manipulated for analysis. This analysis will help NCPC understand the feasibility of transit access to federal facilities in the region, estimate the impact of its parking policies, and adjust them for different parts of the region for the year 2030.

NCPC can refine its parking policies using data to more closely reflect regional transportation accessibility. In particular, the Historic DC Boundary Zone does not accommodate the wide range of accessibility levels across this geography.

The geographic implementation of NCPC's Comprehensive Plan parking ratio policies is designed to reflect regional accessibility. Transit accessibility is highly dependent upon distance to the Metrorail and other major transit lines and hubs. NCPC can use these metrics to update its parking policies to more closely reflect the complexity of transit access in the region, both now and in the future. Even with employee shuttles connecting to Metrorail, some locations, which are geographically close to Downtown Washington, are difficult to access by transit. These facilities have notably lower accessibility ratios. In several cases, these facilities are falling significantly short of NCPC Comprehensive Plan parking ratio policies.

A consistent relationship between transit and automobile accessibility and observed (current) parking ratios can be used to predict future parking ratios and future conditions

The ratio of transit accessibility to auto accessibility is a strong predictor of facility parking ratio. As noted in the methodology, the Volpe Model using the 20 case study facilities produced an R-squared value of 0.70, which is reasonably strong. When excluding certain unusual facilities, this value rises above 0.92 indicating a very strong correlation. Whether the 'outlier' facilities are included or not, the linear regression between accessibility ratio and parking ratio is stable, further suggesting that the relationship is meaningful.

With a linear relationship between accessibility data and parking ratio defined, NCPC can predict the impact of regional accessibility changes. Transit and roadway improvements in the 2030 MWCOG model are based on projects laid out in the CLRP. NCPC should adjust NCPC Comprehensive Plan parking ratio policies to account for transportation system improvements.

Employee Shuttles to Metrorail can provide a significant accessibility boost for some federal facilities, particularly those that are near shoulder Metrorail stations.

The Volpe Center's preliminary analysis based on outputs from the MWCOG model show that federal facilities located near, but not adjacent to, Metrorail stations benefit the most from shuttles. This is particularly true for facilities located near shoulder stations between the core of the Metrorail system (Metro Center and Gallery

Place) and the terminus of each Metrorail line. For example, NSF Carderock, NSF Arlington, Joint Base Anacostia-Bolling, and the FDA White Oak campus could benefit significantly from employee shuttles that connect to nearby Metrorail stations. Facilities located near core stations are already in highly accessible areas and therefore do not significantly benefit from additional connections to the Metrorail. Facilities near the edges of the Metrorail system, including end-of-line stations, may see some incremental benefit from a shuttle connection, but the potential benefit is small because these Metrorail stations are relatively inaccessible. This analysis is based on the current transit network. Future improvements to the transit network would tend to improve the effectiveness of employee shuttles. NCPC and these facilities would need to conduct a more robust site-level analysis to predict the long-term impact of prospective shuttle services. Shuttle routes and schedules can be programmed into the MWCOG model to directly estimate accessibility changes. NCPC can use the Volpe Model to predict associated reductions in parking.

Appendix A: NCPC Master Plan Review Process Summary

NCPC's Comprehensive Plan sets broad policies. During the master plan review process, the Commission, using staff recommendations, establishes the approved parking ratio. Typically, legacy federal campuses do not meet the comp plan parking ratio, but through the review process and preparation of the TMP, the campus commits to a higher parking ratio policy than is currently provided, and often a longer-term ratio closer to the policy goal. While no formal criteria are used, the Commission considers various factors in setting these approved ratios. Over time, facilities generally improve their observed parking ratio, and this is reinforced by the continuing review of the master plan.

Overview

A master plan is a comprehensive development proposal for federal installations or campuses on which more than one building, structure, or activity is located or is proposed to be located. Master plans consider mission needs and anticipate new or changing activities, workforce and visitor projections, and facility conditions, typically over a 20 year planning horizon. They consider complex planning issues related to accommodating future changes in urban design, perimeter security, landscape, visual and cultural resources, stormwater management, flood protection, transportation, and sustainability. NCPC, the sponsoring agency, and local planning departments use master plans to understand future building and site development projects and potential impacts on and off-site.

Review Authority

40 U.S.C. (a)-(b)(1), the National Capital Planning Act referred to as the Planning Act, requires that each federal and District of Columbia agency consult with the National Capital Planning Commission "in preparation of plans and programs in successive stages, which would affect the *Comprehensive Plan for the National Capital*." A master plan is a preliminary planning tool for the Commission to view development of an installation as a sum of its parts rather than just individual pieces. This comprehensive view provides a context for individual development projects; examines the relationship of an installation's entire development program in accordance with the planning principles and policies of the Comprehensive Plan; and allows an assessment of cumulative, external impacts of the installation within the general vicinity of the installation.

NEPA and Section 106

NCPC's authority for the review of master plans—both in Washington, DC and in the region—is advisory. Therefore, NCPC does not have a National Environmental Policy Act (NEPA) or Section 106 of the National Historic Preservation Act responsibility for master plan submissions. However, NCPC strongly encourages applicant agencies to perform NEPA and Section 106 analyses for the following reasons:

- Several of NCPC's requirements for a master plan submission include analyses typically performed during the NEPA and Section 106 processes (such as viewshed and transportation studies).
- The applicant agency is likely to have its own NEPA and Section 106 responsibilities for the master plan. If this is the case, the applicant should not submit for final review until it has met its NEPA and Section 106 responsibilities. This prevents the applicant from having to come to the Commission if the NEPA or Section 106 outcomes alter the project.
- NCPC has approval authority (and NEPA and Section 106 responsibilities) for individual projects within Washington, DC. If the applicant conducts NEPA and Section 106 analyses on a master plan for land within Washington, they will not need to perform individual NEPA analyses on projects that are

implemented within five years of the final master plan approval by the Commission unless a significant change is proposed.

Typically, master plans are analyzed through an Environmental Impact Statement (EIS) study. However, if the submitting agency determines that an EIS is not required, then an Environmental Assessment (EA) study may be undertaken instead. The decision regarding whether to perform an EIS or EA is based on a number of site-related factors including site size (both area and population), geographic location, planned future development, visibility, and environmental conditions at the site. The applicant agency's environmental review process should be discussed early with NCPC staff to ensure a mutual understanding of the applicant's environmental policies and procedures.

Master plans are typically divided into short-term (approximately five years) and long-term (20 plus years) components with more probable funded projects contained within the short-term component and more aspirational, unfunded projects in the long-term component. NCPC recommends that the NEPA document detail the master plan's short-term component to help plan for potential impacts and necessary mitigation within the framework of the longer-range development. Final master plan submissions should also provide guidance for future project compliance with historic preservation requirements by identifying federal/state preservation guidelines, historic resources (e.g. buildings, landscapes, objects, districts, etc.), standard operating procedures, and campus/installation-wide preservation strategies.

Typical Process

Master plans should be regularly updated and reviewed[89] by the Commission before an agency designs and funds future development. A master plan should be a "living" document that helps guide a federal campus/installation's transition from its current condition into the future. It should address how the proposed plan will serve the agency's mission, meet local and federal planning goals, address changes in number of employees, and protect the natural and built environment.

Applicants should use the following guidance to ensure that a final master plan was developed in a collaborative, effective manner with federal and local stakeholders. Unlike the submission guideline process for individual projects, there are typically only two stages for the review of master plans. These include Draft Review and Final Review. In rare cases, staff may request a Concept Review in addition to Preliminary and Final when a master plan is unusually complex or controversial.

There is also some flexibility with regard to submission requirements for master plans. NCPC's executive director may extend, modify, or waive a requirement pertaining to the scope and content of a master plan on sites when certain requirements cannot be met because of the unique characteristics or quality of the affected federal property. In this circumstance, the executive director shall provide notice to potentially affected public agencies and, if appropriate, provide opportunity for consultation.

There are two stages of review, as described below. In advance of formal submissions, there are typically several consultation meetings or discussions with NCPC staff. These typically focus on the purpose of the master plan or update, the NCPC review process, important issues or interests to be addressed, the NEPA and Section 106 process, and the referral process, if necessary. The level of agency interaction with NCPC staff can vary between master plans.

Draft Review

Draft Review offers the Commission the opportunity to critique and evaluate the plan in detail. The Commission will provide comments and recommendations on the draft that are intended to help guide the applicant agency in the development of the final plan. The applicant should develop general

massing for future buildings and a general landscape plan from the "preferred" alternative in the National Environmental Policy Act analysis to allow meaningful Commission comment. The submission should highlight how future development will attain federal and local goals, objectives, and policies, with metrics/performance measures, if possible.

Final Review
The purpose of Final Review is for NCPC to review any changes based on previous Commission comments and any developments since the Draft Review. Following the Commission's final review, the master plan will be used as a planning tool as part of NCPC's review process for future projects. Typically, the Final Master Plan will include proposed building sites and development envelopes, along with design standards/policies, which will ensure that future development is coordinated in its design.

Referrals

NCPC refers all master plans to affected local planning agencies and regional and state clearinghouses for an intergovernmental review. This process typically requires 90 days. If an affected stakeholder identifies an issue of concern, NCPC staff will engage all parties, including the applicant, to resolve the issue.

Master Plan Updates

Agencies are required to review master plans at least every five years to ensure they accurately reflect anticipated changes to the campus/installation. Applicant agencies should advise the Commission of the results of such reviews, and provide the Commission a proposed schedule to update a master plan if the applicant has determined an update is necessary.

Up-to-date master plans that have fully completed NCPC's review process provide several benefits to applicants:

- Serve as a valuable planning tool for applicants, NCPC, and state and local jurisdictions.
- Allow applicant agencies to forego the 60-day referral process to state and local agencies for individual projects prior to NCPC's regular 35-day review period.
- Result in favorable assessments of projects in NCPC's *Federal Capital Improvement Program*, which is used by the Office of Management and Budget to prepare the President's annual budget.
- Reduce the amount of information needed to review specific projects since the more contextual information is already included in the up-to-date master plan for the federal property.

The process outlined above may also apply to master plan modifications; however, a modification may only require an abbreviated process compared to a complete update of the master plan, depending on the nature of the change, scale, and its anticipated environmental impacts.

Appendix B: NCPC's Transportation Management Plan Standards

What is Required of the Federal Agency?

Federal agencies are encouraged to use existing roles and responsibilities to help influence employee and visitor travel behavior. The National Capital Planning Commission requires Transportation Management Plans (TMP) submissions with all Master Plan updates and for all projects that will increase employment by 100 or more workers. Agencies are encouraged to do the following:

- Meet at an early date with NCPC staff about applicable NCPC policies and guidelines at a consultation meeting during a project's early planning phase. Master Plans and projects, along with their associated TMP's, will likely require multiple consultations due to their comprehensive scale and relative complexity. Applicable NCPC policies and guidelines are available at NCPC's website, both on the Submission Guidelines page and in the Comprehensive Plan's Transportation Element. Early consultation with NCPC is mandated by NCPC' Section 5(a) of the National Capital Planning Act, which requires federal agencies to "advise and consult with NCPC in the preparation of agency plans prior to preparation of construction plans."
- Consult with local jurisdiction planning and transportation officials, either separately or jointly with NCPC staff, to identify current plans and programs, congestion mitigation/travel management techniques, and requisite TMP-related implementation commitments. The Comprehensive Plan encourages federal agencies to coordinate projects, Master Plans, and TMPs with local jurisdictions in its Federal Workplace Element through the following policy.
- Prepare a TMP for all Master Plan updates and relatively large projects, as previously noted. The TMP should be fully integrated with Master Plans for campuses and installations and subsequent projects, directly influencing land use patterns, project orientation, and provision of on-site amenities (e.g. bike racks). If a federal agency—typically the General Services Administration (GSA)—is serving as an agent on behalf of another federal applicant by managing project planning and/or construction, the agent should manage the TMP preparation.
  Submit the TMP as part of the required Master Plan update or project submission for NCPC review and potential referral to appropriate local, regional and state agencies. The applicant should be prepared to consider all comments made by the Commission and local/state agencies as part of the region's federal planning process, and to incorporate new strategies and programs as funding availability, federal requirements, and off-site infrastructure permits. The mandatory federal referral process is described in more detail in NCPC's submission guidelines, under Master Plans

What are Necessary Commitments?

The federal agencies' necessary commitments to TMP implementation (referred to above in section 2.1 A 2) may include some or all of the following:

- Develop a written policy statement that demonstrates the federal agency's commitment to reducing Single Occupant Vehicle (SOV) travel and to show consistency between the TMP and agency mission.
- Provide substantive decision-making authority and strong support to the Employee Transportation Coordinator (ETC) from agency management. Authority can be influenced by agency size, mission, management support, and organizational structure.
- Allocate adequate funding to enable the ETC to conduct regular employee commuter surveys; hold informational meetings/fairs for employees; design and distribute marketing materials; coordinate programs with other nearby federal campus installations, and actively participate in local, regional and national continuing education and training efforts to foster professional development in

Transportation Demand Management (TDM) efforts. These activities are only some of a successful ETC's duties, which are described in detail in Section B.

- Adopt policies that:
    - Encourage employees and visitors to use alternatives to driving alone when traveling between home and the work-site, and on work-related business during the day.
    - Encourage and participate in joint public-private initiatives for managing traffic concerns, such as Transportation Management Associations (TMAs), business improvement districts, and regional or local trip reduction programs.
    - Allow greater flexibility in using agency funding to permit investment in infrastructure, facilities, and services related to non-SOV travel that offers the most cost-effective solutions. An example of this would be the reinvestment of parking revenues into traffic mitigation projects and programs.
    - Explore incentives for cost-effective use of the agency's transportation assets, such as parking pricing differentials for carpools and vanpools.
    - Encourage effective management and use of transportation assets by requiring the evaluation of alternative options and management techniques that enhance performance and capacity of parking and impacted roadways. A usable and effective TMP will enable a federal agency to fully implement this policy.

Appendix C: Historic Context of NCPC's Parking Policies

Development of Parking Policies and Ratios

Since the automobile emerged as a popular mode of transportation, NCPC has participated and sponsored a variety of transportation surveys, proceedings, and reports focusing on the range of issues, from aesthetics to transportation management plans. A review of the comprehensive plans and parking studies illustrates the iterative development of NCPC parking policies.

Emergence of Parking in Project Submissions

Between 1920 and 1930, automobile registrations in Washington, DC quadrupled. Meetings of NCPC's predecessor, the National Capital Park and Planning Commission (NCPPC), dealt directly with street widenings, new road-planning proposals, bridge construction, parking arrangements, and more fundamentally, with regulatory and zoning changes.[90] Regulations were needed to provide direct accommodation—in the form of parking—and to recognize the pervasive shifts in population location and density that were primarily motivated by adjustments to the automobile.

The McMillan Plan[91]

NCPPC weighed heavily into automobile parking in the 1920s when implementing the McMillan Plan. Because the 1901 McMillan Plan predated the automotive age, it didn't include provisions to accommodate cars.

As plans were being drawn up to implement the plan, forecasts projected a need for 7,415 parking spaces. Speaking for the U.S. Commission of Fine Arts, Charles Moore in an annual report termed the parking situation a "nuisance that could well nigh destroy the beauty of the National Capital". As one solution, NCPPC suggested that the north-south thoroughfares pass under the Mall, that a streetcar line form a loop within the Federal Triangle, and that the Federal Triangle be "self-contained to parking." [92]

A proposal commissioned by the Board of Architectural Consultants suggested that provisions be allowed in spaces under the Ellipse (the park area located between the White House and the Washington Monument), under the Federal Triangle, under the Mall, and in two spaces north of Pennsylvania Avenue. John Russell Pope objected to the suggestion that 1,300 spaces be designed under a large plaza. NCPPC Chairman Frederic Delano Roosevelt suggested that a parking lot, enclosed by an eight-foot wall and planted with shrubbery and trees, be allowed at the base of the Washington Monument.

In the last analysis, parking was incorporated into the Federal Triangle building scheme only on a highly restricted basis (as in the Federal Trade Commission's Apex Building basement). Ultimately, it was assumed that 65 percent of the nearly thirty thousand employees then to be located in Federal Triangle would use mass transportation or walk to work. Contributing factors for the limited underground parking were the additional costs and the fear of dangerous ramps and underground driving. Solutions were severely limited by poor soil and drainage conditions in the area.

1940s Congressional Declaration Regarding Parking and NCPPC Review

By the 1940s, the issue of automobile congestion in the central area of DC had become acute. Congress passed the District of Columbia Motor Vehicle Parking Facility Act of 1942, declaring:

"…that the parking of motor vehicles on the highways of the District has contributed to this congestion to such an extent as to interfere seriously with the primary use of such highways for the movement of traffic ; that such parking prevents the free circulation of traffic in, through, and from said District impedes rapid and effective fighting of fires and the disposition of police forces in the District, threatens irreparable loss in valuations of property in the District, which can no longer be readily reached by vehicular traffic, and

endangers the health, safety, and welfare of the general public; that this parking nuisance can be reduced by providing sufficient offstreet parking facilities conveniently located in the several residential, commercial, industrial, and governmental areas of the District ; that adequate off-street parking facilities have not been provided by private enterprise ; that it may be necessary to supplement private parking spaces by off-street parking facilities provided by public undertaking; and that the enactment of this Act, as well as the use of land for the purposes set forth in this Act, is hereby declared to be a public necessity…"

Congress' legislation authorized the body governing the District to ensure that adequate parking provisions are provided – subject to NCPC review:

The Commissioners [of the District of Columbia]…are authorized to exercise all powers necessary and convenient to carry out the purposes of this Act, the said purposes being hereby declared to be the acquisition, creation, and operation, in any manner hereinafter provided, under public regulation, of public off-street parking facilities in the District as a necessary incident to insuring in the public interest the free circulation of traffic in and through said District…Before acquiring any area for parking facilities the Commissioners shall request the National Capital Park and Planning Commission for its recommendations and it shall be the duty of said Commission to report thereon within thirty days of such request.[93]

Comprehensive Plan, 1950

NCPC's first Comprehensive Plan advanced three general transportation strategies:

- Cut down on the amount of travel needed by getting home and work closer.
- Make public transportation so quick and convenient that…fewer will drive.
- Create a system of collector and distributor roads…that will redistribute traffic through the region and diminish the volume demand within the Central Area.

With respect to parking, the plan found a deficit of 9,400 spaces in DC's Central Area and outlined several types of transit- and pedestrian-accessible places for spaces.

1955-1956 Report on Federal Employee Parking ratios[94]

The first comprehensive survey of federal parking ratios was conducted when an overhaul of DC's zoning code was being studied in the 1950s. It reported that of Federal buildings under GSA control with more than 1,000 employees had the following parking ratios:[95]

- 4.0 per cent have a parking ratio of 1:3 or better
- 32.4 per cent have a parking ratio of 1:4 or better
- 44.1 per cent have a parking ratio of 1:8 or better
- 62.3 per cent have a parking ratio of 1:10 or better

The report documented parking ratios for specific civilian facilities were as follows:

- Pentagon: 3.42
- Suitland (Federal Office Building #3, #4): 3.9
- Navy Annex (Federal Office Building #2): 7.9

Identified parking ratios at installations under military or comparable control were as follows:

- Naval Ordinance Laboratory: 1.67
- National Institute of Health: 1.75
- Army Map Service (now the Corp of Engineers' Dalecarlia Reservoir site): 1.93
- National Naval Medical Center (Walter Reed National Military Medical Center site): 2.0[96]
- Bolling Air Force Base (Joint Base Anacostia-Bolling): 2.1[97]
- Nebraska Avenue site: 3.0
- Arlington Hall (now George P. Shultz National Foreign Affairs Training Center site): 3.5
- Naval Gun Factory (Washington Navy Yard): 7.0.
- The Smithsonian reported it had a 3.1 ratio for its five buildings on the Mall.

Fringe Parking National Capital Region, 1965

To help alleviate parking demand in congested areas, reduce traffic congestion, and induce users to take transit rather than drive, NCPC developed *Fringe Parking National Capital Region*. This 1965 study recommended developing commuter parking lots in fringe (suburban) locations.

Comprehensive Plan, 1969

NCPC's second comprehensive plan conveyed that "T[t]he Commission has clear and unmistakable planning responsibilities, both to ensure the efficiency and to preserve the amenities of the Nation's Capital…The automobile, for all its immense contributions to the good life, must be carefully controlled…Too many automobiles overtaking the capacity of central streets can choke the economic heart of the city…can cause severe problems of health…can blight and even destroy neighborhoods." [98]

As a solution, the Commission's 1969 comprehensive plan advanced "a comprehensive mass transit program (Metrorail) and a major freeway expansion program…This, coupled with improvements in arterial streets for the increased flow of local traffic and improvements in the network of both express and local buses, form an integrated circulation network."

The Plan established Basic Plan Policies For The Components Of The Parking System

- *Central Area Parking*
    1. *Parking space in the Central Employment Area should be provided in structures located close to freeways and arterial streets.*
    2. *The total central area parking system should be managed to encourage equilibrium of parking space, congestion-free highways, and highly utilized transit.*
    3. *Central Employment Area parking should be managed to insure reasonable availability of parking space to serve non-work as well as work trips.*
    4. *The central area parking system should include parking in high-density residential areas.*
- *Fringe and Uptown Center Parking*
    1. *Fringe parking for bus riders should be expanded, some at sites of rail transit stations.*
    2. *Parking space should be provided in structures in uptown centers and local business districts.*

In addition to the Basic Plan Policies, the Plan also identified Specific Proposals for Components of the Parking System by Stages for each of the area types. Stage 1 corresponded with 1970-1975 and Stage 2 with 1976-1985 period as the transit system (Metrorail/Metrobus) expanded.[99]

Comprehensive Planning, 1980s

In the processes of preparing a new comprehensive plan, NCPC published a planning report in 1982. It determined:

Parking policies and parking standards for federal facilities should be included that encourage use of public transit and all forms of ride sharing. The parking standards should reflect performance that can be achieved through application of policies for provision and operation of transportation services. Thus, parking ratios should take into account the effects of available transit service and usage of programs of car and van pooling while, at the same time, protecting adjacent neighbor-hoods from spillover of Federal employee parking. Since much of the regional transportation system is operated by state and local governments or other authorities, recommendations pertaining to the Federal interest in the facilities serving federal should be included.[100]

Factoring the prevailing traffic congestion and environmental pollution with inauguration of full service on the basic Metrorail system, NCPC concluded that federal parking policies "should encourage maximum use of transit and all forms of ride sharing." In addition to several related policies[101], the resultant 1983 Comprehensive Plan established the following geographic policies:

- In the Central Employment Area, parking ratios should not exceed one space for five employees (1:5).[102]
- At outlying federal facilities, parking for federal employee parking should not exceed the following ratios.[103]
    - In the District of Columbia, Arlington County, the City of Alexandria, and the Silver Spring area of Montgomery County between the Prince George's County Line and 16th Street Extended, south of the Capital Beltway, one space for three employees (1:3).
    - In Montgomery County south of Routes 28, 124, 115 and 1 in Prince George's County inside the Capital Beltway and west Route 4 and north of Route 223, and Fairfax County and the City of Alexandria inside the Capital Beltway, one space t0 two employees (1:2).
    - In the remainder of the region, not to exceed one to one-and-one half (1:1.5).

Study of Visitor Circulation, Parking and Access in the Monumental Core, 1985

In anticipation of what would become *Extending the Legacy: Planning America's Capital for the 21st Century*, NCPC studied visitor circulation, parking and access in the monumental core. This study reviewed both existing and future parking demand as well as previous and ongoing efforts to increase parking supply.

The study found that while the prevailing parking shortage may result in higher visitor parking prices, it hasn't significantly impacted visitation. Instead of increasing parking supply, the study recommended allowing the parking scarcity to induce more Metrorail trips. At the same time, the study recognized that many visitors wouldn't ride Metro under prevailing conditions, so NCPC proposed a transit service circulating through the area (an idea which resulted in the DC Circulator).

Comprehensive Plan, 2004

NCPC's 2004 Comprehensive Plan found that since the 1989 version, the number of congested lane-miles in the region doubled, the region exceeded federally-mandated air quality levels, and the originally-planned 103-station Metrorail system was complete. The 2004 plan also recognized improvements in the overall quality of available transit services; distribution of commercial parking facilities, walking distances and conditions; and new guidelines established by local zoning ordinances.

Due to these factors, NCPC established a general policy to "*provide parking only for those federal employees who are unable to use other travel modes*."[104] The 1989 parking ratios were adjusted to reflect the location of federal workplaces relative to the Metrorail system as follows.

- Within the Central Employment Area, the parking ratio should not exceed one space for every five employees. Outside of the Central Employment Area, but within the Historic District of Columbia boundaries, the parking ratio should not exceed one space for every four employees.
- For suburban federal facilities within 2,000 feet of a Metrorail station, the parking ratio should not exceed one space for every three employees.
  For suburban federal facilities beyond 2,000 feet of a Metrorail station, the parking ratio will reflect a phased approach linked to planned improvements over time (one parking space to 1.5-1:2 employees).

Appendix D: Federal Employee Commuting Policies

Federal Agency Obligations to Provide Parking Spaces for Employee Commuting

Following determinations clarifying that commuting costs are the responsibility of the employee,[105] the Government Accountability Office has long maintained that parking incident to ordinary commuting is also a personal expense.[106] Otherwise payment for parking and other commuting costs would constitute an increase in the employee's regular salary.[107] Therefore, the government may not be required to provide parking facilities for its employees.[108]

A government employee does not have a right to a parking space, with or without charge, and an agency is under no obligation to furnish one.[109] However an agency may provide employee parking facilities if it determines that the lack of parking facilities will significantly impair the agency's operating efficiency and will be detrimental to the hiring and retention of personnel.[110] From the availability of appropriations perspective, it makes no difference whether the employees work in government-owned space or in leased space.[111]

Agencies are directed to assign spaces in the following order of priority: 1. Official needs, 2. Handicapped, 3. Executive personnel and persons who work unusual hours, 4. Vanpools and carpools, 5. Persons who use their private vehicle regularly for government business, and 6.Other employees. In major metropolitan areas, federal agencies alternatively may determine that allocations by zone would make parking more efficient or more equitably available.

Agencies must generally obtain parking accommodations through the General Services Administration under the Federal Property and Administrative Services Act of 1949, as amended (ch. 288, 63 Stat. 377 (June 30, 1949)), unless they have independent statutory authority or a delegation from GSA.[112] When GSA is leasing office space pursuant to its statutory authority in 40 U.S.C. § 585, it may include parking facilities, and the tenant agency's appropriations are available to reimburse GSA for the parking space to the same extent as for the office space itself.[113]

Federal Agency Authorities to Charge and Collect Revenue for Parking Facilities

The government has the discretionary authority under the Federal Property and Administrative Services Act to charge employees for parking space furnished for their use.[114] However if an agency lacks authority to retain parking fees, this may serve as a disincentive to increase existing parking.

As a general proposition, an agency may not augment its appropriations from outside sources without specific statutory authority. When Congress makes an appropriation, it is establishing an authorized program level, and it is telling the agency that it cannot operate beyond the level. To permit an agency to operate beyond this level with funds derived from some other source without specific congressional authorization amounts to a usurpation of the congressional prerogative or the so called "power of the purse".[115] If an agency derives funds from an outside source without express statutory authority to do so, it must treat the funds as "miscellaneous receipts" and deposit the funds in the General Fund of the U. S. Treasury.[116]

Applying the prohibition against augmentation to parking, an agency may not charge employees for parking and retain the money unless it has express statutory authority to do so. If it has such authority, the ability to charge for parking may serve as a disincentive for a federal agency to reduce parking. It may also encourage investment of money in the provision of additional parking if easily accessible parking facilitates an agency's mission by enhancing employees' accessibility to work. To the contrary, it may also serve as an incentive to reduce parking to render land occupied by parking facilities available for other mission needs.

Development of Federal Government Policies Encouraging Non-SOV Commuting

The following timeline of policies demonstrates the federal government's progression of programs and incentives toward non-SOV commuting.

1980 – Executive Order 12191, *Federal Facility Ridesharing Program* (3 CFR, 1980 Comp., p. 138) specified that executive agencies must actively promote the use of ridesharing (carpools, vanpools, privately leased buses, public transportation, and other multi-occupancy modes of travel) by personnel working at federal facilities to conserve energy, reduce congestion, improve air quality, and provide an economical way for federal employees to commute to work.

1991 – The 1991 Treasury, Postal Service, and General Government Appropriation Act (P. L. 101-509) authorizes federal agencies to participate in state or local government programs designed to encourage employees to use public transportation. Thus, an agency could use its general operating appropriations to subsidize the use of discounted transit passes by its employees. The "subsidy" is not additional pay for purposes of the prohibition in 5 U.S.C. § 5536. Id. See also B-243677, B-243674, May 13, 1991. The legislation had a sunset date of December 31, 1993.

1992 – The *Energy Policy Act of 1992* (P. L. 102-486) contained provisions which affect the tax treatment of transportation benefits provided by an employer. The measures are intended to encourage use of public transportation, reduce highway congestion, and improve air quality. One of these provisions affects employer-provided parking subsidies. Starting January 1, 1993, the value of parking provided by an employer to an employee may be excluded from taxation up to $155 per month. Any amount over this allowable exclusion is a taxable benefit. The exclusion will be indexed for inflation in later years.

1992 – *Treatment of Employer Provided Transportation Benefits* (P. L. 102-486) expanded the term qualified transportation fringe to include transit passes and transportation in commuter highway vehicles (e.g. vanpools) in addition to qualified parking.

1993 – The *Federal Employees Clean Air Incentives Act* (P. L. 103-172) authorized the head of each agency to establish a program to encourage employees of such agency to use means other than single-occupancy motor vehicles to commute to or from work.

1993 - Programs to encourage commuting by means other than single-occupancy motor vehicles (P. L. 102–486) authorized each agency head to establish a program to encourage employees to use means other than single occupancy motor vehicles to commute to and from work. The purposes of this authority are to improve air quality and reduce traffic congestion. 5 U.S.C. § 7905 note. Programs established under section 7905 may include such options as transit passes or cash reimbursements for transit passes; furnishing space, facilities, or services to bicyclists; and nonmonetary incentives. 5 U.S.C. § 7905(b)(2).

1997 – *Taxpayer Relief Act* (P. L. 105-34) allowed parking benefits to be taken in lieu of salary. With this authorization agencies could offer their employees the option of accepting taxable cash income in lieu of a parking space at work, while maintaining the tax-free status of the parking benefit. The employer would only have to pay taxes on the cash payment, not the parking benefit.

1998 – The *Transportation Equity Act for the 21st Century* (P. L. 105-178) required employers, including the federal government, to offer employees transportation fringe benefits.

- Transit and vanpool benefits may be offered in lieu of compensation payable to an employee for taxable years beginning after December 31, 1997. This gives transit and vanpool benefits the same tax treatment that parking benefits receive under the Taxpayer Relief Act of 1997.
- The limit on nontaxable transit and vanpool benefits is increased from $65 to $100 per month for taxable years beginning after December 31, 2001.
- All benefits are indexed for inflation; however, the indexing mechanism is suspended during the taxable year beginning after December 31, 1998. Therefore, the maximum transit/vanpool benefits will remain at $65 per month and parking will remain at $175 per month for calendar year 1999. The indexing mechanism will resume for the taxable year beginning after December 31, 1999.
- Employers (for taxable years beginning after December 31, 1997) will be able to offer employees several options for qualified transportation fringe benefits. These benefits are not, however, permitted to be part of "cafeteria" plans or flexible spending accounts.
- Employers can offer any combination of these benefits (up to the specified limits), either in addition to present compensation or in lieu of compensation, tax-free.
- Employers can also offer a parking cash out program whereby employees may choose to cash out the value of employer-provided parking, forego parking, and receive the taxable cash value of the parking, or receive a tax-free transit or vanpool benefit of up to $65 per month.

2000 – Executive Order 13150, *Federal Workforce Transportation* requires federal agencies located in Washington, DC to implement a transit subsidy fringe benefit pursuant to 5 U.S.C. § 7905 to further the public policy of discouraging commuting by single-occupancy vehicle in order to improve air quality and reduce traffic congestion.[117]

2007 – The *Energy Independence and Security Act* (42 U.S.C. § 17094) places legal requirements on new agency construction projects (i.e., development and redevelopment projects involving a Federal facility with a footprint that exceeds 5,000 square feet) to manage stormwater and preserve and/or restore natural site hydrology. This guidance encourages minimizing parking as part of future building projects, as well as gradually removing existing parking by using previously-developed sites for future projects.

2008 – The *Bicycle Commuter Act* added bicycle commuting to the list of transportation modes eligible for transportation fringe benefits under the US Tax Code. Under this act, bicycle commuters are eligible for a $20 per month pre-tax benefit for costs incurred by bicycle commuting.

2015 – Executive Order (EO) 13693, *Planning for Federal Sustainability in the Next Decade* expands upon requirements established by the 2007 energy act by among other things directing federal agencies to install appropriate green infrastructure features on federally owned property to help with stormwater and wastewater management.

Appendix E: Transportation Demand Management Strategies

There are myriad techniques used to manage parking demand. While the number of tools far exceeds those explored here, the strategies below may be particularly relevant to NCPC and its federal partner agencies.

Policies and Programs

5.1.1.3 Parking Maximums and Minimums

Citing an increase in development costs, among other consequences, some transportation professionals argue that minimum parking requirements are misguided.[118] Many jurisdictions around the country have replaced minimum parking requirements with maximum parking requirements.[119,120] Others implemented parking maximums in addition to parking minimums, a practice particularly popular in the Northwest over the past two decades.[121,122] When both minimums and maximums are used, it creates a range of acceptable parking supply, while providing room for flexibility. If the developer would like to build outside of that range, they may be required to provide a transportation impact assessment to justify the variance from code.

There are three primary ways to establish a parking maximum:

- Regulate based on the square-footage of the building the parking serves.
- Set the maximum on a percentage of the minimum.
- Establish caps on the total maximum number of parking spaces in a particular geographic area.

Even more flexibility can be built in to exempt certain sites from a parking maximum if the development meets specific criteria, for example, including a parking lot with pervious pavement.[123]

Municipalities employ parking maximums for a variety of reasons. In Portland, Oregon, the standard began with the Department of Environmental Quality.[124] Portland implemented a maximum on parking to reduce vehicle trips and therefore limit emissions with the intent to meet air quality standards. Suburban Beaverton, Oregon wanted to increase development density and limit sprawl; they did so by limiting the amount of land area developers were allowed to allocate to parking. Eugene, Oregon implemented parking maximums to reduce impermeable surfaces, reduce storm water runoff, and improve water quality. Seattle introduced maximum parking regulations to incentivize transit-oriented development.

5.1.1.4 Commute Trip Reduction Programs

Commute Trip Reduction (CTR) programs incentivize commuters to reduce Single Occupancy Vehicle (SOV) trips through various incentive programs, such as financial incentives and teleworking policies. State or local governments either encourage or require businesses to participate in these programs, which are generally run by a local government or a geographically based non-profit. In implementing a CTR program, employers establish goals to reduce the number of SOV trips and program evaluation procedures, such as travel surveys, to monitor progress. Some governments implement CTR programs to encourage their own employees to reduce their dependence on SOV.[125]

The State of Washington has one of the longest-running Commute Trip Reduction programs. Established in 1991, businesses located in counties with a population over 150,000 and with 100 or more full-time employees are subject to the law. To date, there are more than 1,000 work sites participating in Washington's CTR program and over 530,000 individual commuters.[126]

Incentives and Disincentives to Change Transportation Choices

5.1.1.5 Encourage Active Commuting

Employees arriving to work by bicycle or walking reduce the demand for parking. Employer, local government, and advocacy groups encourage non-motorized commute modes through both the provision of infrastructure by local and supportive programming. For example, non-profit organizations dedicated to active transportation advocacy organize incentive programs for employers to encourage their employees to take active transportation. Active Commute Week Challenge is one example in Grand Rapids, Michigan where employers can pay to register themselves as participants. Employees who use non-automobile modes of transit are rewarded with daily prizes.[127] The League of American Bicyclists provides technical assistance to employers on how to become more bicycle friendly through their Bicycle Friendly Businesses program.[128]

5.1.1.6 Transit/Parking Allowances

The current transit and parking benefit for federal employees is capped at $255 a month Consolidated Appropriations Act (H.R. 2029) was signed into law on December 18, 2015, which permanently establishes parity between parking benefit and transit/vanpool benefits.
Previously, transit and commuter highway vehicles were limited to $130 per month. With this law, the exclusion amount for 2016, parking, transit and commuter highway vehicles are $255 per month. Commuters can receive both the transit and parking benefits (i.e., up to $510 per month).

The Sustainable DC Omnibus Amendment Act of 2014 includes the DC Commuter Benefits Law, which provides tax incentives for non-federal employees who take public transportation, vanpool, or bike to work. This law requires non-federal employers to offer one or more of the following benefits to employees:[129]

- **Pre-tax Benefit** – This benefit allows employees to allocate up to $255 per month on a pre-tax basis to cover costs associated with commuting by public transportation and vanpools.
- **Direct Benefit** – This benefit is a tax-free employer subsidy of up to $255 per month for employees to cover the cost of public transportation or up to $20 per month to cover the costs associated with bicycling.
- **Provided Transportation** – Employers must provide a shuttle service free to employees.

5.1.1.7 Parking Cash out/Unbundling

Employer-subsidized parking increases the number of commuters in SOV. However, employer-sponsored incentives for other modes of transportation can reduce this.[130] For example, parking cash-out incentives allow drivers to receive cash in lieu of free parking. Seattle Children's Hospital employees this policy. Seattle Children's Hospital values each day an employee does not commute by car at $4, allowing employees to earn over $1,000 in additional income in the course of a year by relinquishing their parking space.[131] Transit benefits, such as those offered to federal employees, which provide a fully or partially subsidized public transportation pass, can help reduce the amount of parking supply necessary.[132]

"Unbundling" parking is when the cost of leasing a property does not include the cost of leasing the associated parking facilities. By allowing occupants to pay for parking separately (or allow them to opt not to pay for and not use the parking), occupants will only use and pay for the parking that they need. This reduces overall parking demand and distributes the parking supply more equitably.[133] This technique is often used in residential developments through rental agreements or condominium associations, although it can also be used in commercial and office development.[134]

Improved Transportation Options

5.1.1.8 Bicycle Parking and Other Provisions

Providing indoor, long-term bicycle parking is a good way to incentivize bicycle use and reduce the need for car parking. Less than one percent of all trips in the United States are made by bicycle and 48 percent of these trips are shorter than three miles.[135] Thus, there is a large potential for a dramatic mode shift. Some cities such as New York, Minneapolis, and San Francisco require bicycle parking for residential and commercial buildings.[136] Minneapolis, for example, requires bicycle parking for all residential and non-residential uses in every part of the city. The only exceptions are residential uses of four units or fewer and non-residential uses less than 1,000 square feet. Schools are required to provide three spaces of bicycle parking per classroom, and offices are required to provide three spaces or one space per 15,000 square feet.[137] Short of requiring bicycle parking, regulators can incentivize developers to provide bicycle parking by reducing the minimum required parking.[138]

5.1.1.9 Improve Walking Conditions

One way to reduce the need for a large parking supply in NCR facilities is to encourage those travelling to them to want to get there by a mode other than an automobile. This can be achieved by making other modes more attractive. One context in which there is regularly heavy congestion during a very narrow window of peak volume is at schools during drop-off and pick-up times. One of the goals of the national Safe Routes to Schools Program, established in 2005, is to reduce automobile congestion.[139] One way that they achieve this goal is by ameliorating the walking and biking conditions in the area around schools. These techniques are largely transferrable and not restrictive to school zones. Rather, they can be used in any setting where walking trips can directly replace automobile trips. Taking a bottom-up approach, the Safe Routes to School Guidebook recommends holding meetings with local stakeholders, agreeing on problem areas and approaches to address them. In addition to policy changes, the program encourages the improvement of sidewalks, painting crosswalks, and improving bicycle infrastructure.[140] Outside of the Safe Routes to School Program, few studies have been done to empirically assess the impact of the encouragement of walking on levels of automobile congestion. However, in a few, mostly international case studies, there has been some success in reducing traffic congestion through pedestrian improvements.[141]

5.1.1.10 Telework/Alternative Working Arrangements

Employers can use teleworking arrangements to reduce the number of commute trips that an employee needs to make by allowing the employee to work from home on a regular basis and forego a trip to the office. Likewise, flexible scheduling allows the employees to shift their commute to non-peak hours, reducing traffic congestion.[142] Federal agencies can take advantage of the Telework Enhancement Act of 2010. This act applies to all employees of executive agencies, and requires federal agencies to establish a telework program for their employees.[143] Employee participation in a telework agreement is voluntary which might make it difficult to predict the number of employees who will not need to commute on any given day. However, the number of employees taking advantage of a telework agreement will reduce the amount of parking supply necessary.

5.1.1.11 Traffic Calming

Traffic calming is a technique by which the physical characteristics of a road segment are altered to improve safety for pedestrians by encouraging more responsible driving as well as improving the flow of traffic. Studies have shown that reducing the speed at which vehicles travel by introducing traffic calming measures have

reduced crashes, injuries, and fatalities.[144] Using inexpensive design materials such as surface paint, traffic bollards, and planters can keep the costs of redesigning a space low. There are many ways to redesign a road segment to reduce the speed of traffic resulting in improved safety. Changing streets from two-way to one-way, including diagonal parking spaces, widening sidewalks, and installing speed humps and other road treatments are common ways to reduce the vehicle speeds.[145]

5.1.1.12 Transit Improvements

Improvements to a city's public transportation system can be an effective way to reduce an individual's dependence on automobiles, and thus reduce parking demand. For example, the introduction of express transit service in Kingston, Ontario resulted in a ridership increase among Queen's University employees, a site that the express service served.[146] Conversely, the biggest indicator of who takes public transit is automobile ownership. It has been shown that increasing the frequency and the area that a transit system covers increases ridership in areas where there is latent demand. Specifically, Edmonton, Alberta found that the most efficient way to boost bus ridership was to service neighborhoods with the lowest car ownership. [147] Another effective way to increase the usage of public transportation infrastructure is to ameliorate the ingress and egress areas of the stations themselves. San Francisco Metro Area's Bay Area Rapid Transit system found that by improving walking, biking, and even parking facilities in the areas immediately adjacent to public transit stations resulted in an increase in system ridership.[148, 149]

Land Use Management

Land use management tools that contribute to a built environment less dependent on automobiles can reduce parking demand. Many local jurisdictions are adopting tenets of return to the "traditional" development pattern of walkable, connected and diverse cities. They seek to achieve these ends through emphasizing compact land use development and a more traditional neighborhood structure.[150]

One way to mitigate the use of automobiles is at the neighborhood level. Street reclaiming is when a neighborhood physically and psychologically reclaims the neighborhood at the local level to increase social, cultural, and economic activities as well as change the way the public thinks about local streets. This can happen through using the street for neighborhood events, or physically changing the streetscape by replacing asphalt with brick and installing works of art.[151] Changes in streetscapes can be paired with car-free planning, which is when a particular area or areas are designed for minimal automobile use. These areas are generally in more dense, urban areas and are designed such that automobiles are unnecessary and/or restricted. Restrictions can be permanent or only on certain days or during events.

Some land use management tools that address parking supply more directly are shared parking and land banking.

5.1.1.13 Shared Parking

When neighboring sites have different uses and different peak demand periods, shared parking can be a useful strategy to employ. Shared parking refers to adjacent or neighboring sites using the same parking spaces, but at different times of the day or week.[152] Traditionally, shared parking is not allowed in most local zoning codes. If two distinct uses are located within the same structure or on the same lot, the parking requirements are cumulative.[153] In many cases, such as an office building adjacent to a bar or restaurant where the peak parking demand of each is not concurrent, a non-shared parking policy leads to oversupply. Some municipalities allow approval by the organization that enforces zoning to implement shared parking. [154] For example, both San Diego and Seattle can approve shared parking if sites are located within 600 or 800 feet of each other respectively.[155]

5.1.1.14 Land Banking

There are formal land banking operations established in many cities across the country with a number of different purposes and objectives.[156] However, land banking as a practice can also be applied to parking. This is an excellent example of a contingency-based planning technique. This technique reserves undeveloped or lightly-developed space to be used for parking if such a need arises. Specifically, this technique can be used during development for projects that are developed in stages. It can also be used in low- or medium-density areas where development moves more slowly and undeveloped land can remain undeveloped for longer periods of time.[157]

Palo Alto, California allows developers to take advantage of land banking, specifically to defer construction of up to 50 percent of the required off-street parking spaces. The land area needed to provide the required parking must be appropriately landscaped pursuant to zoning code and approved by Palo Alto's Architectural Review Board. After ten years, the land area set aside for additional parking may then be developed as an alternate use as long as it does not generate more parking demand.[158]

Appendix F: Traffic Impact Assessments

Traffic Impact Assessments (TIAs) estimate the impact that new developments will have on the traffic conditions in the adjacent area, and propose measures to mitigate those impacts if they are found to be significant. For small developments that will generate few trips, a TIA may not be required. Many jurisdictions have thresholds (trips per hour, etc.) that they use to determine when a development applicant must submit a TIA. For many of the jurisdictions in the NCR, a TIA is required when a developer is proposing to build less parking than the zoning requires. Through the TIA, the applicant must demonstrate that the demand for parking can be met with a reduced supply.

TIAs generally consist of an analysis of the existing traffic conditions around a proposed development site. The primary purpose is to forecast future traffic volumes and estimate impacts to the performance of nearby roads and intersections. TIAs also include projected bicycle, pedestrian, and transit trips (if applicable), and any Transportation Demand Management (TDM) strategies that will be used to mitigate future traffic impacts. TIAs use Level of Service (LOS) measures for roadway segments and intersections to determine whether the traffic from a new development is projected to change the LOS. LOS is measured on a scale of A to F: LOS A indicates that traffic is free flowing, while an LOS F indicates that there is heavy, stop and go traffic that exceeds the capacity of the roadway.[159] When a TIA indicates that there is a change in LOS to the area surrounding the proposed development, engineering mitigation measures such as widening the roadway, changing signal timing or intersection configuration, or introducing a new traffic light, and/or TDM measures that focus on shifting trips to non-SOV modes may be proposed.

While each jurisdiction's requirements for TIAs vary, they are generally similar. As an example, VDOT's requirements for TIAs are outlined below:

- **Introduction and Executive Summary:** This section includes a description of the site location and study area, details of the proposed development, findings, conclusions, and recommendations.
- **Background Information:** Includes a description of the on-site development, the current or proposed zoning, the traffic study area's geographic scope, information about nearby uses, maps of the existing roadways, and information about any planned improvements to transportation facilities in the area.
- **Analysis of Existing Conditions:** This section includes the current daily and peak hour traffic in the area; current LOS and delay; and walking, biking, or transit trips if the new development would have any significant potential for these modes.
- **Analysis of Future Conditions without Development:** This section is an analysis of what the future conditions at the site would be without the development, to serve as a baseline indicator for projecting what the future conditions would be with the proposed development.
- **Trip Generation:** This section includes the estimation of how many trips the proposed development would generate based on rates from the ITE.
- **Site Traffic Distribution and Assignment:** This section shows how the trips generated from the site would be distributed and assigned to the road network throughout the appropriate time periods.
- **Analysis of Future Conditions with Development:** This section is a forecast of the daily and peak-hour traffic around the proposed development, with LOS analyses for the intersections and roadways in the study area. Pedestrian, bicyclist, and transit trips are also included if relevant.
- **Recommended Improvements:** This section includes any proposed roadway or intersection improvements with cost estimates, and TDM measures if proposed. Also included are descriptions and diagrams of the location, nature, and extent of the proposed improvements, with preliminary cost estimates.
- **Conclusions:** Conclusions from the study presented in an easily understood manner.

The assumptions and methodologies used in a TIA must also be identified throughout the assessment.

Sources:

Prince William County's Requirements for TIAs and TDM Plans in the Design and Construction Manual
http://www.pwcgov.org/government/dept/development/ld/Documents/13417.pdf

VODT Level of Service
http://www.virginiadot.org/projects/resources/LOS-defined.pdf

VDOT Traffic Impact Analysis Regulations
http://www.vdot.virginia.gov/info/traffic_impact_analysis_regulations.asp

Appendix G: Detailed Descriptions of Jurisdictional Parking Regulations

District of Columbia

Population: 672,228 (2015 estimate)
Density: 11,000 people per sq. mi.
Area: 68 sq. mi.
Representative Federal Facilities: Joint Base Anacostia-Bolling; Washington Navy Yard; St. Elizabeth's, West Campus; Department of Homeland Security, Nebraska Avenue Complex; Marine Corps Barracks, Washington
Current Zoning Ordinance Adopted: 2016

Figure 28: Washington in the Metro Region

Background

The District of Columbia (see Figure 28) adopted a new zoning code in January 2016, after an update process that began in 2007. The zoning update simplified parking requirements, basing them largely on use and proximity to transit, rather than a combination of zone, use, and other characteristics. The zoning includes a chapter devoted to parking with a minimum standards table that is applicable to the Residential, Residential Flat, Residential Apartment, Mixed Use, Neighborhood Mixed Use, and Production, Distribution, and Repair zones.

The Downtown, Campus Plan Areas, and Special Purpose zones are not necessarily subject to the minimum parking standards. In Downtown Zones, no parking is required (other than areas west of the centerline of 20th Street, NW), while parking requirements for Campus Plan Areas and Special Purpose zones vary, with select areas requiring no parking.

Zoning Districts

Parking standards are generally applied across the following zones: Residential; Residential Flat; Residential Apartment; Mixed Use; Neighborhood Mixed Use; and Production, Distribution, and Repair Zones. Special parking standards apply to Downtown, Special Purpose Zones, and Campus Plan Areas:

- Downtown Zones: Vehicle parking spaces are not required in Downtown Zones, other than areas west of the centerline of 20th Street, NW (Downtown Zones are the areas in pink on Figure 29)
- Special Purpose Zones and Campus Plan Areas: The purpose of the Special Purpose Zones is to provide for single large sites that require a cohesive, self-contained set of regulations to guide site design, building height and bulk, land uses, or other aspects of development. Some of these zones have no parking requirements, while others are subject to the minimum parking standards. Similarly to Special Purpose Zones,

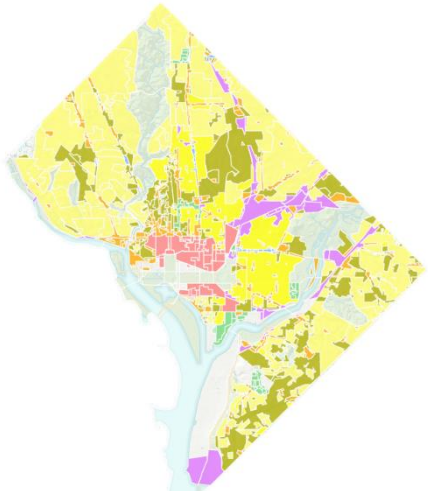


Figure 29: DC Zoning Map (DC Office of Zoning)

parking for Campus Plan Areas is determined on a case by case basis.

Adjustments

Parking reductions may be granted for a number of reasons, which are outlined below:

- **Car-share parking space:** Up to two dedicated car share spaces provided in accordance with this provision may each count as three required parking spaces for the purposes of calculating the provision of required parking pursuant to DC Municipal Regulations Subtitle C § 701.5.
- **Proximity to transit**: Required parking may be reduced by 50 percent if the site is located within one-half mile of a current or planned Metrorail station; within one-quarter mile of a streetcar line; or within one-quarter mile of a priority Metrobus Route.
- **Parking requirements may also be reduced by demonstrating at least one of the following:**
    - Physical constraints of the property does not allow parking to be provided.
    - The site is well served by mass transit, shared vehicle, or bicycle facilities.
    - Required parking would cause excess congestion.
    - Estimated demand for the parking is less than the minimum parking standards.
    - Existing parking can accommodate estimated parking demand.
    - Property does not have access to an open alley, and permission has not been granted for a curb cut.
    - The parking would cause the removal of healthy and mature canopy trees on or directly adjacent to the property.
    - The property is a historic resource and parking spaces would harm the integrity or appearance of the resource.

Process

Applicants submitting a permit for new construction or an addition to an existing structure must also include a detailed parking plan, demonstrating compliance with the parking requirements. The zoning code reiterates that the applicant must design parking to minimize negative impacts on adjacent property, urban design, the pedestrian environment and public spaces. Any request for a reduction of the required parking need to include a TDM plan approved by the District Department of Transportation.

Parking Standards Table

The parking requirements in Table 7 apply to the Residential, Residential Flat, Residential Apartment, Mixed Use, Neighborhood Mixed Use, and Production, Distribution, and Repair Zones; and only as specified within Special Purpose Zones. There are no parking maximums, although surface parking lots cannot exceed 100,000 SF. In addition, for projects with more than 20 required parking spaces, if excess parking is built for more than two times the required parking, the developer must mitigate the parking by including additional bicycle spaces, planting trees in public spaces, providing additional electric car charging stations, and offering higher Green Area Ratio (the ratio of the weighted value of landscape elements to land area).

Table 7. Minimum Parking Standards Table for Select Uses in the District of Columbia

Use Category	Minimum Number of Vehicle Parking Spaces	*Required for uses with over 4,000 SF GFA* Long-Term Spaces	Short-Term Spaces
Community-based institutional facility	1 per 1,000 sq. ft.	1 space for 10,000 SF	1 space for 10,000 SF
Daytime care	0.5 per 1,000 SF, with a minimum of 1 space required	1 space for 10,000 SF	1 space for 10,000 SF
Eating and drinking establishment	1.33 per 1,000 SF in excess of 3,000 SF	1 space for 10,000 SF	1 space for 3,500 SF
Entertainment, assembly, and performing arts	2 per 1,000 SF	1 space for 10,000 SF	1 space for 10,000 SF

Government, large-scale	None	1 space for 7,500 SF	1 space for 40,000 SF but no less than 6 spaces
Government, local	0.5 space per 1,000 SF in excess of 2,0000 SF with a minimum of 1 space required, except: Public recreation and community center: 0.25 space per 1,000 SF in excess of 2,000 SF with a minimum of 1 space required Kiosk public library – no requirement	1 space for 7,500 SF	1 space for 40,000 SF but no less than 6 spaces
Medical care	1 per 1,000 SF in excess of 3,000 SF with a minimum of 1 space required	1 space for 10,000 SF	1 space for 40,000 SF
Institutional, general	1.67 per 1,000 SF in excess of 5,000 SF	1 space for 7,500 SF	1 space for 2,500 SF but no less than 8 spaces
Office	0.5 per 1,000 SF in excess of 3,000 SF, except a medical or dental office, clinic, or veterinary hospital: 1 per 1,0000 SF in excess of 3,000 SF	1 space for 2,500 SF	1 space for 40,000 SF
Parks and recreation	0.5 per 1,000 SF	None	1 space for each 10,000 SF but no less than 6 spaces
Retail	1.33 per 1,000 SF in excess of 3,000 SF	1 for each 10,000 SF	1 space for each 3,500 SF
Service, general	1.33 per 1,000 SF in excess of 3,000 SF	1 for each 10,000 SF	1 space for each 3,500 SF
Service, financial	1.33 per 1,000 SF in excess of 3,000 SF	1 for each 10,000 SF	1 space for each 3,500 SF

Source:
DC Zoning Handbook
http://handbook.dcoz.dc.gov/

Montgomery County

Population: 1,040,116 (2015 estimate)
Density: 2,052 people per sq. mi.
Area: 507 sq. mi. – immediately north of Washington ~ 5-30 miles from the city center (see Figure 30)
Representative Federal Facilities: National Institutes of Health, Main Campus; Food and Drug Administration, White Oak; National Institute of Standards and Technology
Current Zoning Adopted: 2014

Figure 30: Montgomery County in the Metro Region

Background

The Montgomery County Transportation (MCDOT) and the Maryland-National Capital Park and Planning Commission (M-NCPPC) undertook a parking study, completed in 2015, to revise parking standards to better align with policies that promote travel by non-SOV modes.

- Study objectives:
    - Update the county's parking requirements for urban, mixed use districts to reduce current requirements (if appropriate); promote shared parking; support local business; increase flexibility of standards; make standards clear and predictable
    - Update the county's Parking Lot District (PLD) program to assess performance and identify opportunities for improvement. PLDs are located in Bethesda, Montgomery Hills, Silver Spring, and Wheaton. These districts provide public parking spaces, and are funded by the public parking revenue collected in each PLD.
- Study Scope:
    - Examined the parking requirements, reviewed leading and emerging approaches to parking requirement reformation, identified goals and objectives, gathered stakeholder input, identified approach options, and assessed approach options.
    - Once a framework was selected, the approach was applied in three steps: identify land uses, set baseline standards, and weigh the mode share goal impact.
- Findings and Recommendations – Parking Standards
    - Minimum parking standards resulted in an oversupply of parking.
    - Create market incentives to generate efficient, flexible, shared parking supplies within Parking Lot Districts.
    - Increase role of private developers in the provision of publicly-available parking.
    - Make shared spaces the least expensive for developer to provide, and excess reserved spaces the most expensive to provide.

Current Standards Overview

The study informed the current parking standards in Montgomery County, which differ based on land use and density. Montgomery County employs a range of allowable parking standards based on whether the proposed project is located in a commercial, residential, or employment zones. Different standards apply in special Parking Lot Districts. Furthermore, the county allows for parking reductions through shared parking and the provision transit. See Table 8 for the parking standards for the Parking Lot Districts and commercial/residential/employment zones.

5.1.1.15 Commercial/Residential & Employment Zones

- These zones encourage shared parking environments where spaces are used collectively by people who work or live in these areas, and the properties are close to each other.
- The zoning code sets a baseline minimum parking requirement that is lower than it was previously before the zoning update to discourage building underutilized parking.
- Parking requirements can be reduced based on available shared parking, non-auto driver mode-share factor, carpool/vanpool spaces, and unbundled residential parking space (spaces are offered at market rates separately from the purchase or lease of a residential unit).

5.1.1.16 Parking Lot Districts

- PLDs have market incentives for the creation of shared parking supplies in high-density, mixed use environments.
- PLD locations include Bethesda, Montgomery Hills, Silver Spring, and Wheaton where the County owns/can obtain property for the operation of shared public parking (see Figure 31). Parking minimums in these locations do not need to be met on site. Instead, a property owner can provide fewer spaces than required if the owner pays a tax to help pay for the County-provided public parking.

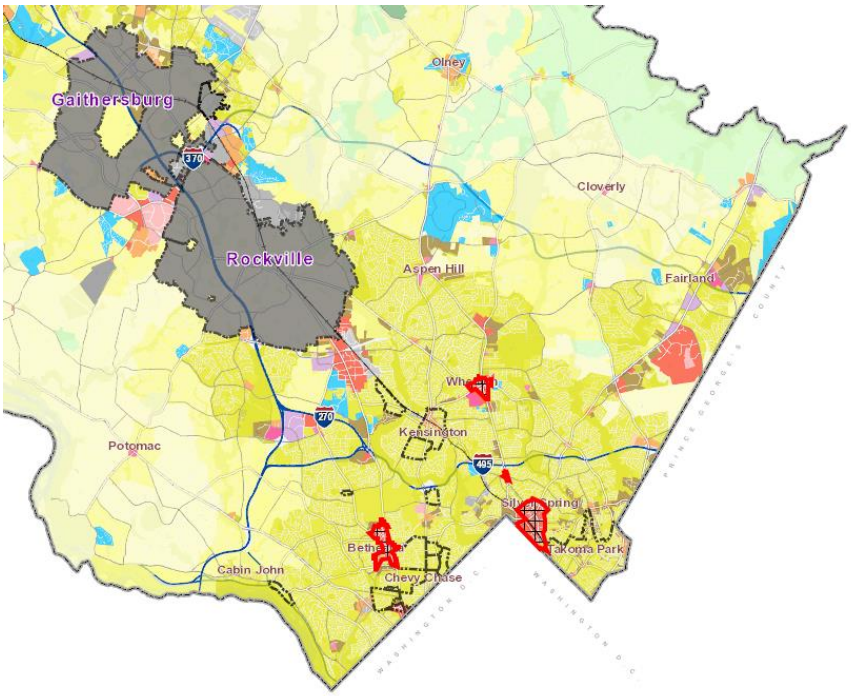


Figure 31: Map of Montgomery County Parking Lot Districts (in red)

Source: http://mcatlas.org/zoning/

5.1.1.17 Bicycle Parking

- Bicycle parking requirements are included for certain uses or use groups. Long-term spaces are focused on residents and employees, while short-term spaces are required for patrons.

5.1.1.18 Adjustments

- Parking in these zones may be reduced through any applicable Non-Auto Driver Mode Share (NADMS) factor, and on-street parking in the public or private right-of-way abutting the subject property. The NADMS factor is the percentage of commuters who travel to their worksite by means other than SOV. NADMS is calculated based on the results of an Annual Commuter Survey administered by one of the county's six Transportation Management Districts. Depending on the location, each district is managed by a non-profit or by Montgomery County Department of Transportation staff.
- Parking may also be reduced by providing preferential carpool/vanpool spaces, which can replace up to six commercial spaces and do not count against the parking maximum. In addition, no parking is required for outdoor patron seating for restaurants located within one mile of transit.

Table 8: Parking Standards for Commercial/Employment Zones and Parking Benefit Districts in Montgomery County

		Vehicle Parking Spaces			Bicycle Parking Spaces		
		Parking Lot Districts (PLDs)		*All Other Locations*	*All Locations*		
Required Parking	Metric	Baseline Minimum	Baseline Maximum	Baseline Minimum	Metric	Spaces Required	% Long Term (for employees)
Civic and Institutional							
Cultural Institution	1,000 SF of GFA	0.50	2.00	1.25	10,000 SF of GFA	1.0	15%
Hospital	1,000 SF of GFA	1.75	5.00	1.75	10,000 SF of GFA	2.0	85%
Day Care Facility	1,000 SF of GFA	3.00	4.00	3.00	10,000 SF of GFA	1.0	85%
Charitable, Philanthropic Institution	1,000 SF of GFA	2.00	4.00	4.00	10,000 SF of GFA	2.0	85%
Commercial							
Office & Professional	1,000 SF of GFA	2.00	4.00	4.00	10,000 SF of GFA	2.0	85%
Eating & Drinking	1,000 SF for Patron Use	4.00	12.00	4.00	10,000 SF of GFA	1.0	15%
Medical Dental	1,000 SF of GFA	2.00	4.00	4.00	10,000 SF of GFA	2.0	85%
Recreation & Entertainment	1,000 SF of GFA	1.00	5.00	2.50	10,000 SF of GFA	1.0	15%
Retail Sales & Service	1,000 SF of GFA	3.5	6.00	5.00	10,000 SF of GFA	1.0	15%

5.1.1.19 Agricultural, Rural, Residential, & Industrial Zones

- Parking in these zones is assumed to be in a non-sharing parking environment where spaces are typically used by people that live or work at the property for the entire day.
- The code sets a baseline minimum parking requirement for each use in the allowed use table (see Table 9.)
- The minimum parking requirements can be reduced by providing on-street space, car share space, and the presence of moderately priced dwelling units, per review of the Director of Permitting Services.

Table 9: Parking Standards Table for Agricultural, Rural, Residential, and Industrial Zones

	Vehicle Parking Spaces		Bicycle Parking Spaces		
	Metric	Baseline Minimum	Metric	Spaces Required	% Long Term (for employees)
Civic and Institutional					
Cultural Institution	1,000 SF of GFA	4.00	10,000 SF of GFA	1.00	15%
Hospital	1,000 SF of GFA	1.75	10,000 SF of GFA	2.00	85%
Day Care Facility	1,000 SF of GFA	3.00	10,000 SF of GFA	1.00	15%
Charitable, Philanthropic Institution	1,000 SF of GFA	5.00	10,000 SF of GFA	2.00	85%
Commercial					
Office & Professional	1,000 SF of GFA	2.80	10,000 SF of GFA	2.00	85%
Eating & Drinking	1,000 SF for Patron Use	10.00	10,000 SF of GFA	1.00	15%
Medical Dental	1,000 SF of GFA	4.00	10,000 SF of GFA	2.00	85%
Recreation & Entertainment	1,000 SF of GFA	10.00	10,000 SF of GFA	1.00	15%
Retail Sales & Service	1,000 SF of GFA	5.00	10,000 SF of GFA	1.00	15%

Additional variances to the parking requirements throughout the entire county may be granted to if an alternative compliance plan is approved.

Sources:
Montgomery County Zoning
http://www.montgomeryplanning.org/development/zoning/documents/FULLCh59APPROVEDclean3.5.14.pdf

Montgomery County Parking Study
https://www.montgomerycountymd.gov/DOT-Parking/Resources/Files/study_summary.pdf

Prince George's County

Population: 909,345 (2015 estimate)
Density: 1,823 people per sq. mi.
Area: 499 sq. mi. immediately north, east, and south of Washington ~ 4-30 miles from the city center (see Figure 32)
Representative Federal Facilities: Suitland Federal Center
Current Zoning Adopted: 2015

Background

Prince George County is currently undergoing a comprehensive rewrite of its Zoning Ordinance and Subdivision Regulations. A process to update the zoning code began in January 2014, and the goal is to have the new zoning code implemented in the fall of 2017. The goals of the zoning code rewrite are to:

- Streamline and simplify the regulations and development approval process.
- Modernize and consolidate our zones and development standards.
- Incentivize economic and transit-oriented, mixed-use development.
- Protect and enhance stable residential neighborhoods.

Specific information on how parking standards will change is not readily available, but the standards will likely be simplified, with more incentives to reduce parking in transit-oriented zones.

Zoning Districts

Prince George's County's current standards establish the number of parking spaces as follows:

- Institutional/Educational Uses: number of building occupants, seats, beds etc.
- Recreational/Entertainment/Social/Cultural Uses: sq. ft. of gross of floor area
- Commercial Trade (Generally Retail) Services Uses**:** sq. ft. of gross of floor area

The general parking minimums apply to all zones, with exceptions outlined for the Mixed Use-Transportation Oriented Zone (M-X-T Zone) and Metro Planned Community Zones.

Parking requirements in M-X-T Zones and Metro Planned Community Zones are based on the general minimums outlined below, with reductions allowed to account for multipurpose trips and the availability of transit. Developers must submit detailed site plans with proposed number of parking spaces to the Planning Board. The data, methodology, and assumptions used to calculate the number of parking spaces must be included in the application. To calculate the number of parking spaces required in these zones, developers must do the following:

- Calculate the base requirement, using the minimum Parking Standards (see Table 10.). This amount is assumed to be the maximum number of parking spaces occupied at any hour as the peak demand for each use. The applicant must also calculate the number of parking spaces occupied during each hour the day.

The total number of parking spaces shall be the greatest number of spaces in any one hour for the combined total uses of the proposed, based on the calculations above.

Reductions

- Impervious Surfaces: Parking may be reduced by up to a maximum of 15 percent to fulfill requirements to reduce impervious surfaces at a site in certain areas (where impervious surfaces are 40 percent of the net lot area in a Developed Tier, Corridor Node or Center, and by when impervious surface exceeds 80 percent of the net lot area of site in a Developing Tier area).
- **Shared Parking:** Parking may be reduced by 20 percent when two or more uses provide a joint parking lot—provided the normal requirement for each use is not more than 20 spaces, and the total reductions does not exceed 40 spaces. This reduction does not apply to integrated shopping centers that have a gross leasable area of 25,000 SF, office buildings, office building complexes, or medical practitioners' offices.
- **Multi-Purpose Trips:** The parking requirements calculated above may be reduced in M-X-T Zones by the number of trips that are estimated to be multi-purpose. The parking spaces must be convenient to all the uses they are serving, and is subject the Planning Board's discretion. The required off-street parking spaces may be required in a lot other than the one a mixed-use development site is located in, given the spaces are in a convenient and safe location.
- **Transit/Carpool/Vanpool**: The base number of parking spaces may be reduced if the site is accessible by transit, carpool, or van pool, and developer-provided services.
- **Car Sharing**: For development proposals between .25 and .5 miles of transit, required parking spaces may be reduced by eight and six spaces, respectively, for each designated car-share space. Net overall reductions are limited to 15 percent.

Parking Standards Table

Table 10 contains parking minimums for uses relevant to NCPC properties:

Table 10: Prince George's County Minimum Parking Standards for Select Uses

Required Parking	*Vehicle Parking Space* Metric	Baseline Minimum
Civic and Institutional		
Cultural Institution	1,000 SF of GFA	2.50
Hospital	Bed	1.50
Day Care Facility	8 children	8.00
Charitable, Philanthropic Institution	1,000 SF of GFA	1.50
Commercial		
	250 SF of first 2,000 GFA	1.00
	400 SF above first 2,000 SF	+1.00
Eating & Drinking	3 seats	1.00
Medical/ Dental	200 SF of GFA	1.00
Recreation & Entertainment (varies)	4 seats	1.00
	150 SF of the first 3,000 SF GFA	1.00
	200 SF of GFA above first 3,000 SF	+1.0

Sources:
Prince George's County Zoning Rewrite
http://zoningpgc.pgplanning.com/

Prince George's County Zoning
https://www.municode.com/library/md/prince_george's_county/codes/code_of_ordinances?nodeId=THE_CO_CODEPRGECOMA

City of Alexandria

Population: 148,892 (2013 estimate)
Density: 10,221 people per sq. mi.
Area: 15.5 sq. mi. immediately southwest of Washington ~ 9 miles from the city center (see Figure 33)
Representative Federal Facility: Mark Center
Current Zoning Adopted: 1992

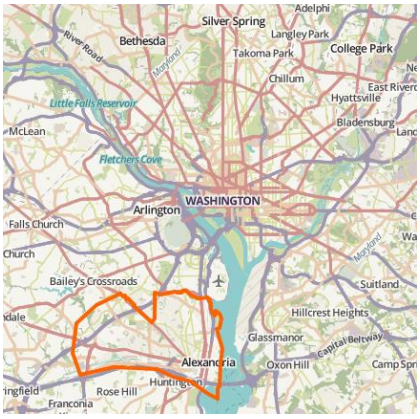


Figure 33: City of Alexandria in the Metro Region

Background

The City of Alexandria's last comprehensive update to its zoning code was in 1992, and in 2014, the city began a study to establish updated parking requirements. Alexandria is updating its parking standards to reflect an increase transit, bicycling, and walking, changing demographics, and market trends. The study has two phases, the first of which is complete. Phase 1, approved in 2015, resulted in new standards for multi-family residential developments. Phase 2 is in progress and will result in updated parking requirements for commercial, office and retail parking.

Zoning Districts

The parking standards for Alexandria are city-wide, rather than by zoning district or overlay; they are defined in the Off-Street Parking and Loading section of the zoning code. The City of Alexandria is divided into six Parking Districts (1-6) as well as the King Street Parking District, the Central Business District, and the Mount Vernon Overlay Zone. District 6 surrounds the Metrorail stations and has the strictest parking requirements. For many uses, the parking requirements are standardized across all of the districts. However, for retail, office, commercial, governmental, and industrial there are different parking minimums for each district (see Table 11.). In addition, there is no off-street parking requirements for properties abutting the Potomac River, in the "Federal Waterfront Settlement Restricted Parking Area."

Reductions

There are no pre-determined criteria that can be met to allow a reduction in off-street parking as there is with other jurisdictions in the area. All reductions in parking are achieved through a special use permit, however there are some exceptions with respect to low- and moderate-income housing development and historic buildings.

To be granted a special use permit, a developer must show that providing the required amount of parking is infeasible. If the requested reduction is for more than five parking spaces, a parking management plan is required. The parking management plan must include measures to mitigate the impacts of the proposed reduction in parking.

All special use permit applications require the following elements:

- A map of the property, including a 300 foot buffer, which shows existing uses, zoning, land use designation in the Master Plan.
- A detailed description of the operation of the proposed use.
- Plans to mitigate negative impacts of changes in noise, trash, safety, etc.

For developments that will cause a disproportionately negative traffic impact, developers may be required to obtain a Transportation Management Special Use Permit. These permits require that a transportation management plan be submitted, with a focus on reducing SOV trips, while encouraging transit use, ridesharing, walking, and bicycling. Applicants may also have to pay fees to the city, which are used for the city-wide TDM funds.

Process

Applications for special use permits are first reviewed by the director of the zoning board who will also share the application with all relevant departments. After review, a public hearing is held in front of the Planning Commission.

Parking Standards Table and District Map

Figure 34 shows the Alexandria's six Parking Districts, and overlay zones. The Mount Vernon Overlay zone is in pink; the King Street Parking District is in green; and, the Central Business District is in blue.

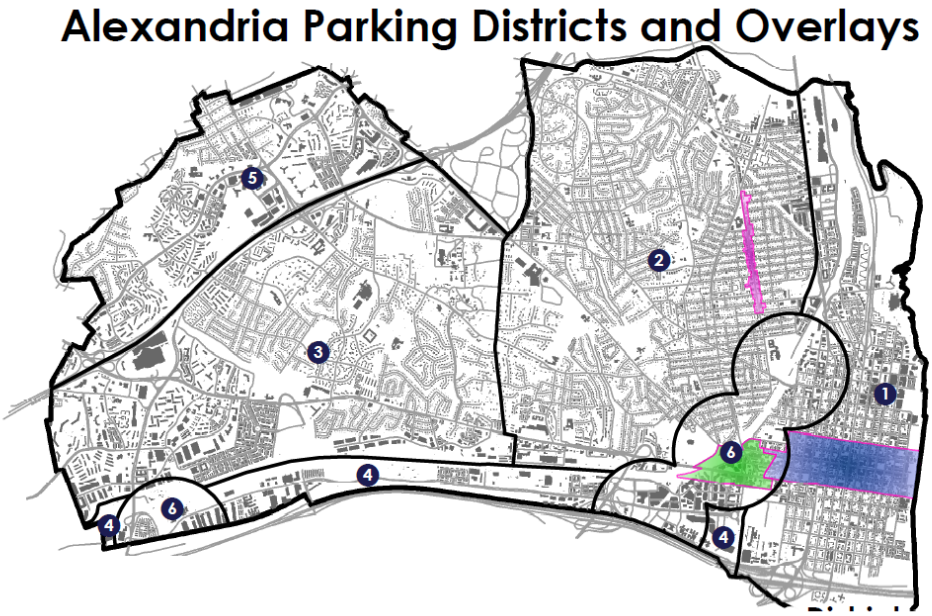


Figure 34: Map of Alexandria Parking Districts
Source: https://www.alexandriava.gov/tes/info/default.aspx?id=76333

Table 11 contains parking minimums for uses relevant to NCPC properties:

Table 11: City of Alexandria Minimum Parking Standards for Select Uses

Land Uses Subject to Parking Districts						
Use Type	Minimum Parking Requirements					
Parking District	1	2	3	4	5	6
Office: Commercial, Governmental, Professional	1 space per 150 sq. ft.	1 space per 450 sq. ft.	1 space per 470 sq. ft.	1 space per 475 sq. ft.	1 space per 475 sq. ft.	1 space per 160 sq. ft.
All parking districts for this use require 5% of spaces to be set aside for carpool						
Land Uses Not Subject to Parking Districts						
Use Type	Minimum Parking Requirements					
Hospitals	1 space per 2 beds					
Community Buildings, Civic Clubs, etc	1 space per 200 sq. ft.					
Medical and Dental Clinics	1 space per 200 sq. ft.					

Sources:
Alexandria Zoning Code
https://www.municode.com/library/va/alexandria/codes/zoning

Alexandria Parking Study
https://www.alexandriava.gov/ParkingStudies
https://www.alexandriava.gov/tes/info/default.aspx?id=76333

Arlington County

Population: 224,906 (2013 estimate)
Density: 8,814 people per sq. mi.
Area: 25.98 sq. mi. – SW of Washington ~ 5 miles from the city center (see Figure 35)
Representative Federal Facilities: Pentagon, Joint Base Myer-Henderson Hall
Current Zoning Adopted: 2015

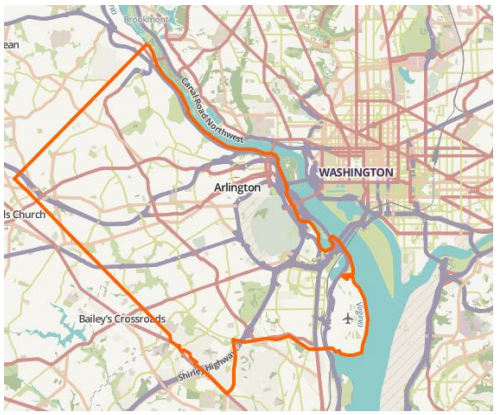


Figure 36: Arlington County in the Metro Region

Background

Arlington County's current zoning code was adopted in 2015, after an update process that began in 2011. The goal of the update was to make the zoning code easier to understand and administer, and move to adopt a new use classification system.

As part of the update process, the county completed a Commercial Parking Study in 2013. This study examines the impacts of developers proposing to build less parking than required for new office buildings, and how to offset the potential impacts. This study led to the Reduced Parking Policy for Site Plan Offices, which outlines a flexible and consistent approach for developers proposing to build less parking than is required by the zoning code. The policy outlines a contribution formula for developers to help pay for TDM programs, and potentially transit operating costs, to help offset the additional traffic that will be generated by the new office developments.

A county-sponsored Residential Parking Working Group is currently working with staff to finalize new policy recommendations for parking at Site Plan and Unified Commercial/Mixed Use Development use permit projects in Arlington's Rosslyn-Ballston and Jefferson Davis Metrorail corridors. The Working Group is evaluating using parking ratios (spaces per residential unit) based on proximity to Metrorail stations in these corridors. The final recommendations are pending and should be available sometime in 2017.

Zoning Districts

Arlington has five standard zoning use districts: Public, Residential, Multiple-Family, Commercial/Mixed Use, and Industrial, and within each district there are a number of specific zones outlined in detail. For these districts, the standard minimum parking requirements table applies (see Table 12.).

In addition to these standard districts, there are also Special Planning Areas, Overlay and Form Based Code Districts, and Unified Residential, Commercial/Mixed Use, and Residential Cluster Developments. For these special planning districts, the parking requirements may vary from what is required in the standard parking minimum table.

Adjustments

Arlington's zoning code cites the promotion of pedestrian-related commercial activity as a justification for eliminating parking requirements in certain situations. No parking is required for uses meeting certain criteria when located within 1,000 feet of a Metrorail station. Examples include:

- Restaurants with daytime operating hours, or restaurants with evening and nighttime hours that have over 200 seats.
- Grocery stores smaller than 15,000 square feet of floor area.

Phased Development Site Plans and Crystal City Block Plans are additional ways the zoning code provides flexibility to provide less parking. These tools are generally limited to hotels, residential, office, and mixed-use developments in the Crystal City area or another high-density zoning district. Each application submitted by a developer to reduce parking is required to include the following:

- A TDM program
- A TIA
- A Stormwater Management and Compliance Plan
- Other requirements pertaining to Affordable Dwelling Units

Parking Standards Table

Table 12 contains parking minimums for uses relevant to NCPC properties:

Table 12: Arlington County Parking Standards for Select Uses

Use Type		Minimum Parking Requirements	Additional Requirements
Colleges and Universities		As determined by the County Board	
Hospitals, rest homes, sanitariums, convalescent homes & institutions		1 per 4 beds	Plus 1 space for each 2 employees (other than staff doctors), plus 1 space for each doctor assigned to the staff.
Libraries, museums and art galleries or studios		1 per each 500 sq. ft. of floor area	
Public assembly & club buildings **(Excluding religious institutions, golf clubs and community centers)**		1 per each 3 seats or other accommodations or other accommodations for attendants or participants	Computed on the basis of one accommodation for each attendant or participant
	Nursery	1 per each staff member or employee	
	Elementary, middle schools		
	High schools	1 per each 10 students of design capacity	Plus 1 space for each 40 students of design capacity for visitor parking
Offices or clinics, medical or dental		1 per each 150 sq. ft. for first 5,000 sq. ft. in each building	Plus 1 per each 200 sq. ft. for next 10,000 sq. ft.; Plus 1 per each 250 sq. feet for area in excess of 15,000 sq. ft.
Other office buildings		1 per each 250 sq. ft. of floor area on the first floor	Plus 1 per 300 sq. ft. of floor area located in the basement or on the 2nd through 5th floors, plus 1 per 400 sq. ft. of floor area located above the fifth floor

Sources:
Arlington Zoning Code
https://projects.arlingtonva.us/zoning-ordinance-update/
https://building.arlingtonva.us/resource/zoning-ordinance/

Commercial Parking Working Group
https://projects.arlingtonva.us/plans-studies/transportation/commercial-parking-study/
https://newsroom.arlingtonva.us/release/arlington-county-board-approves-new-policy-for-site-plan-office-building-parking/

Residential Parking Working Group
https://commissions.arlingtonva.us/residential-parking-working-group/

Fairfax County

Population: 1.131 million (2013 estimate)
Density: 2,813 people per sq. mi.
Area: 406 sq. mi. – west of Washington ~ 6-30 miles from the city center (see Figure 37)
Representative Federal Facility: Fort Belvoir
Current Zoning Adopted: 1978

Figure 37: Fairfax County in the Metro Region

Background

Fairfax County last updated its zoning code in 1976; the county is currently in the beginning phases of modernization of its zoning code.

Zoning Districts

The Fairfax Zoning Code organizes land uses into five types of districts: Residential, Commercial, Industrial, Planned Development, and Overlay Districts. Within each district are specific land uses; all of which are governed under the general, countywide parking standards by use.

Adjustments

The Zoning Board may allow the reduction of parking under the conditions outlined below:

- The site is situated "within reasonable walking distance" to public transit. Specific criteria are outlined in the code: generally, any Metrorail, streetcar, bus rapid transit, or city bus operating at a certain frequency.
- Sites situated in areas designated as "Community Business Centers" (neighborhood shopping centers) may reduce parking or provide parking non-contiguously or off-site if certain criteria are met and the developer pays the county a price determined by the Zoning Board.
- If public parking is—or will soon be—constructed in close proximity to the site and the developer pays a fee to be determined by the Zoning Board.
- If two adjacent uses can share parking—in particular if their peak periods of demand do not coincide. Zoning Board approval and a fee to be determined by the Zoning Board are required.

Parking Standards Table

Table 13 below contains parking minimums for uses relevant to NCPC properties:

Table 13: Fairfax County Parking Standards for Select Uses

Use			Requirement
Financial Institution			Four (4) spaces per 1,000 square feet of gross floor area for customer service, lobby and teller area; plus additional spaces as required herein for any associated offices
	<50,000 GFA		Three and six-tenths (3.6) spaces per 1000 square feet of gross floor area
	50,000 GFA < x < 125,000 GFA		Three (3.0) spaces per 1,000 square feet of gross floor area
	>125,000 GFA		Two and six-tenths (2.6) spaces per 1,000 square feet of gross floor area
Manufacturing Establishment			One (1) space per one (1) employee on major shift, plus one (1) space per company vehicle and piece of mobile equipment
Mini-Warehousing Establishment			3.2 spaces / 1,000 sq ft GFA of office space associated with the use plus one (1) space per employee, and two (2) spaces for a resident manager. The width of travel aisles for vehicular access and loading and unloading shall be subject to the approval of the Director
Scientific R&D Establishment			One (1) space per 1.5 employees based on the occupancy load, plus one (1) space per company vehicle
		<100 children	0.19 space per child
		>=100 children	0.16 space per child
	College or University		Based on a review by the director of each proposal including such factors as the occupancy load of all classroom facilities, auditoriums and stadiums, the availability of mass transportation, and the availability of areas on site that can be used for auxiliary parking in times of peak demand; but in no instance less than one (1) space per faculty and staff member and other full-time employee, plus a sufficient number of spaces to accommodate the anticipated number of students and visitors who will drive to the institution at any one time
	Elementary or Intermediate		Based on a review… [see above]… but in no instance less than one (1) space per faculty and staff member and other full-time employee, plus four (4) spaces for visitors
	High School		Based on a review… [see above]… but in no instance less than three-tenths (0.3) space per student, based on the maximum number of students attending classes at any one time

Source:
Fairfax County Zoning Code
http://www.fairfaxcounty.gov/dpz/zoningordinance/

Loudoun County

Population: 349,679 (2013 estimate)
Density: 721 people per sq. mi.
Area: 521 sq. mi. – northwest of Washington ~ 20-50 mi from the city center (see Figure 38)
Representative Federal Facilities: None
Current Zoning Adopted: 1993

Figure 38: Loudoun County in the Metro Region

Zoning Districts

Land uses fall into one of three districts: Non-suburban, Suburban, and Special & Overlay.

Adjustments

Parking supply may be reduced under certain circumstances. The zoning code does not specify the magnitudes of permissible reductions. Multiple reductions may be combined as long as the total amount of parking is not reduced by more than 35 percent. Developers may take advantage of the following provisions to reduce parking supply:

- **Shared Parking and Loading Facilities**. By-right zoning requires two separate uses on one site to provide the sum of parking required both uses. However, parking spaces may be reduced if the peak hour of demand for each use occurs at a different time.
- **Captive Market.** Parking requirements for retail and restaurant uses may be reduced due to internal capture for land uses within 400 feet of each other.
- **Availability of Public Parking.** Parking requirements may be reduced if under-used public parking is currently available and demonstrably into the future.
- **Transit**. Parking may be reduced by up to 20 percent if the site is within 1,000 feet of a "regularly scheduled bus stop" sufficient to cover usage by the anticipated patronage of that site.
- **Carpooling/Vanpooling**. Parking may be reduced by up to 20 percent based on projections of reduction in parking demand. This reduction is valid only for buildings over 50,000 sq. ft. of gross floor area that maintain a carpooling/vanpooling program.
- **Shuttle Service**. Parking may be reduced by up to 10 percent based on projections of reduction in parking demand. This reduction applies to buildings that maintain a regular shuttle service.

To apply for a parking adjustment an applicant needs to provide:

- A Parking Demand Analysis
- A plan showing how parking spaces will be provided on the site
- A 20-year covenant that guarantees the owner will provide additional spaces if the Zoning Administrator recommends to the Zoning Board of Appeals that reductions be modified or revoked.

Parking Standards Table

Table 14 contains parking minimums for uses relevant to NCPC properties:

Table 14: Loudoun County Parking Standards for Select Uses

Use	Spaces Required	Loading Spaces Required
General Offices and Medical Offices	4/1,000 sq. ft. of GFA for up to 30,000 sq. ft.; 3.3/1,000 sq. ft. of GFA thereafter	None for the first 30,000 sq. ft. then one/100,000 sq. ft. thereafter
Financial Institutions	2.5/1,000 sq. ft. of GFA; stacking space for drive-through windows to be determined by Zoning Administrator	None for the first 10,000 sq. ft. GFA then one/50,000 sq. ft. up to 10,000 sq. ft. plus one/ 10,000 sq. ft. thereafter
Governmental	4/1,000 sq. ft. of G.F.A. administrative offices; other as determined by Zoning Administrator	As determined by Zoning Administrator
Educational	1/Classroom and other room used by students plus .2/student over driving age	1/100,000 sq. ft. GFA
Hospitals	1.5/employee on main shift; plus 1/doctor on staff; plus 1/2 beds for in-patient services; plus 1.5/250 square feet for out-patient services	1/100,000 sq. ft. GFA up to 500,000 sq. ft. plus one/200,000 sq. ft. thereafter.

Source:
Loudoun County Zoning Code
https://www.loudoun.gov/DocumentCenter/View/99645

Prince William County

Population: 438,580 (2013 estimate)
Density: 1,298 people per sq. mi.
Area: 348 sq. mi. – southwest of Washington ~20-35 mi from the city center (see Figure 39)
Representative Federal Facilities: Marine Corps Base Quantico
Current Zoning Adopted: 2006

Figure 39: Prince William County in the Metro Region

Zoning Districts

Parking requirements are not addressed by district; rather they are governed county-wide by land use. Furthermore, the Director of Transportation has the discretion to require additional off street parking when the operation of a site shows a "repeated need for more spaces".

Adjustments

Up to 50 percent of the required parking may be located on an adjacent or abutting property.
The following credit allowances are authorized by the Director of Transportation after requests are submitted in writing. Requests should include "studies, surveys, reports or other evidence to support the request":

- **Land Use Intensity** - Up to 30 percent of required parking may be waived when the land use is "so intense that normal individual demand will not be generated." The factors considered are proximity to public transit, nearby public parking, and commercial and employment activities in the area.
- **Shared parking** - Parking may be reduced when adjacent lots of different uses share the same parking. Code permits up to a 75 percent parking space reduction for two uses with no overlap in operating hours, or 25 percent if the overlap in operating hours is less than four hours. A legal agreement is required when multiple property owners are involved.
- **Land Banking** – Construction of up to 50 percent of the otherwise required parking can be deferred if additional land is readily available. Deferred parking must be constructed if (and when) the Director of Transportation deems necessary.

Process

A TDM plan is required if a development proposal consists of mixed-use urban/suburban activity centers and the applicant is seeking a trip generation credit or reduction. A TIA is required to be submitted in conjunction with or be included within a TDM plan.
Requirements of TDM and TIA are outlined in detail in sections 620 and 630 of the Prince William County Design and Construction Manual. In general, TIAs include the following components:

- The study area, which consists of the proposed development area and the impacted transportation network.
- Existing traffic conditions, and the estimated trip generation for the development (based on the Institute of Transportation Engineers Trip Generation Manual).
- Any potential for trip reductions based on availability of transit service, pedestrian/bicyclist facilities, and TDM programs.
- The projected future traffic conditions, and analysis of impact based on the Highway Capacity Software.
- The trip distribution and assignment to the traffic network, and
- Recommendations for how mitigate significant impacts on the study area.

Parking Standards Table

Table 15 contains parking minimums for uses relevant to NCPC properties:

Table 15: Parking Minimums for Prince William County

Use		Loading	Parking
Note: units are measured in net floor area – net floor area = 75% of gross floor area			
	Hospital – major surgical or short term visits	1 plus 1 per 75,000 net sq. ft.	1.25 per bed
	Medical center, offices and clinics	1 up to 75,000 net sq. ft., then 2	1 per 150 net sq. ft. up to 15,000 net sq. ft., then 1 per 200 net sq. ft. up to 30,000 net sq. ft., then 1 per 250 net sq. ft. above 30,000 net sq. ft.
	Nursing, convalescent or personal care facility	1 up to 75,000 net sq. ft., then 2	1 per 2 beds, by licensed capacity
Office, financial institutions		None for buildings with less than 20,000 net sq. ft. of building area; then 1 for each additional 20,000 net sq. ft. Maximum of 5 loading spaces for each building	1 per 250 net sq. ft. of building area; 10 minimum
Office with ancillary retail or service uses		1 per 20,000 net sq. ft. up to 100,000 net sq. ft., then 1 per 50,000 net sq. ft.	1 per 250 net sq. ft. plus 5%
	Learning center	1	1/seat
	Elementary or middle schools	2	1 space for every 20 classroom seats plus 5 visitor spaces, plus one space for every 5 seats in an auditorium or multipurpose room
	High schools	2	1 space for every 5 students, plus one per faculty member, plus 10 spaces for visitors, plus one space for every 4 seats in an auditorium or multipurpose room
	Junior colleges, colleges, universities	2	1 space for every 5 classroom seats, plus 20 spaces for visitors, plus one space for every 3 seats in an auditorium or multipurpose room
	Suburban/urban facility	1	1 per 200 net sq. ft.
	Rural facility	1	1 per 400 net sq. ft.

Medical or dental laboratory	1 plus 1 per 50,000 net sq. ft.	1 per 300 net sq. ft. to 10,000 net sq. ft., then 1 per 500 net sq. ft.
Research and development	1 plus 1 per 50,000 net sq. ft.	1 per 300 net sq. ft. to 10,000 net sq. ft.; then 1 per 500 net sq. ft.
If office space exceeds fifty (50) percent of net floor area	none	1 per 300 net sq. ft. up to 100,000 net sq. ft.; then as provided above

Sources:
Prince William Zoning Code
http://www.pwcgov.org/government/dept/planning/zoning/pages/zoning-ordinance.aspx
https://www.municode.com/library/va/prince_william_county/codes/code_of_ordinances

Prince William County Design and Construction Manual
http://www.pwcgov.org/government/dept/development/ld/Documents/13417.pdf

Appendix H: Development and Limitations of the Volpe Model

The appendix described development and limitations of the Volpe Model.

Developing the Volpe Model

The Volpe Center sought to define the relationship between observed parking at each facility and the underlying accessibility ratio. Termed the Volpe Model, this analysis defined a linear relationship between accessibility ratio (transit to car) and observed (current) parking ratio (number of employees per parking space provided). NCPC could use this mathematical relationship to:

- Explain the variation in parking at the sampled facilities.
- Estimate the observed (current) parking ratio at non-sampled facilities.
- Predict future (2030) parking ratios based on anticipated changes in the accessibility ratio across the region.

Projecting Future Parking Ratios

In light of projected land use and transportation changes in the region, the Volpe Center adjusted the observed (current) parking ratio values for the facilities in the study to predict future parking ratios. This was done by applying the Volpe Model to produce predicted (future) parking ratios for *both 2016 and 2030* and then comparing the 2016 prediction to the *actual observed 2016 parking ratio*. This proportion (observed parking ratio divided by the modeled 2016 parking ratio) was then applied to the 2030 prediction to adjust for the facility's existing performance. Therefore, facilities which have less parking than predicted by the regression analysis will continue to do better than facilities that have more parking than predicted. Figure 40 shows the equations underlying this process.

Figure 40: Calculating Final Predicted Parking Ratio

$Cur =$ Observed (Current) Parking

$Cur_{Pr} =$ Predicted 2016 Parking Ratio:
f(2016 accessibility ratio) =
1.2488 * accessibility ratio + 1.3813

$Fut_{Pr} =$ Predicted (Future) Parking Ratio:
f(2030 accessibility ratio) =
1.2488 * accessibility ratio + 1.3813

$$Fut_{Final} = Fut_{Pr} * (Cur / Cur_{Pr})$$

For a facility where the observed (current) parking ratio is unknown, the model can still be used to develop a predicted (future_ parking ratio for the future condition. In that case, the future accessibility is used directly and no adjustment is made for the facility's current performance.

To determine the confidence intervals for the predicted (future) parking ratios, the Volpe Center tested various combinations of parameters within each of these ranges and found maximum and minimum predicted (future) parking ratios.

Adjusting for Employee Shuttles

As noted in Table 3, some federal facilities offer a shuttle service to connect staff to nearby Metrorail stations. These shuttle services are not included in the MWCOG model. In other cases, facilities partner with local transit agencies to develop new routes or realign existing routes. Other facilities lack shuttle services, but may benefit from a more direct connection to a Metrorail system.

As part of the overall analysis, the study team developed an adjustment factor to estimate the benefit of potential service for various facilities. This intent is to estimate the impact of existing and future shuttle service to and from each facility.

Conceptually, shuttle service increases the number of households that can reach a facility by adding a new transit route to the campus. This route must be modeled in a similar way to public transit routes included in the MWCOG model. The total travel time from any TAZ to the facility using the shuttle service must be calculated and, if it is within the desired time threshold, the households at the origin of the trip can be included in the accessibility measure.

The Volpe model then integrates two additional factors for each shuttle service:

1. Shuttle travel time between the Metrorail station and the facility.
2. Employee travel time from the origin TAZ to the Metrorail station to make the shuttle connection.

For the shuttle travel time, the Volpe Center developed a simple estimation using a presumed morning peak period traffic level and a reasonable shuttle route to a nearby Metrorail station. Total transit time was limited to 45 minutes to match with the accessibility measures used for the Volpe Model. Subtracting the shuttle travel time from this 45 minute limit, the remaining time could be used to reach the Metrorail station and wait for the shuttle. A small amount of wait time, roughly approximating average wait for shuttles on 10-15 minute headways, was incorporated into the transit travel time from origin TAZ to Metrorail station TAZ. Households in TAZs with transit travel times within this limit, and which could not reach the facility directly using other transit means, were added to the total transit accessibility for the facility. Thus, only the *net benefit* of the shuttle service was isolated. If a shuttle service was essentially matched by a preexisting public transit option, then the shuttle adjustment would show no improvement. The calculation of the factor is as described in Figure 41. Note that if two plausible shuttle connections were examined, each was considered separately *but also together* to assess their cumulative benefit.

Figure 41: Calculating the Shuttle Adjustment

$$Adjusted\ Parking\ Ratio = \frac{Accessibility\ to\ Facility\ with\ Shuttle(s)}{Accessibility\ to\ Facility\ in\ MWCOG\ Model}$$

The study team applied these adjustment factors to accessibility ratios for 2016 in conjunction with the Volpe Model to examine the impact of possible shuttle service on observed (current) parking ratios at the study facilities. Notably, the *potential* simulated service is modeled for present day conditions rather than future conditions. Additional parking ratio improvements (based on future land use, demographic, and transportation system changes) would be expected in ensuing years. Thus, while the adjusted parking ratios may be below current NCPC Comprehensive Plan parking ration policies, shuttle service simulations for 2030 conditions may result in adjusted parking ratios that are closer to or in compliance with the current Comprehensive Plan parking ratio policy.

Other Adjustment Factors

The Volpe Center examined the potential impact of several additional factors which affect parking behavior at the federal facilities. Employees working alternative work schedules or teleworking, or the presence of off-site workings using temporary on-campus office space (often referred to as hoteling) all impact the employee population onsite. Recent increases in federal teleworking have the potential to significantly impact the daily demand for parking at facilities. However these factors are highly specific to individual facilities and therefore cannot be captured in a regional policy map. For example, one facility (such as a military base) may not be conducive to telework, while another may require 24-hour staffing and have a large portion of employees on irregular schedules.

NCPC can further adjust parking ratios to account for these variations. The Volpe Model assumes that the percent of workers who telework, work irregular schedules, or hotel onsite will not change significantly between current and future conditions. If that assumption holds, no adjustment needs to be made—the observed (current) parking ratio as reported by each facility can be used without issue. However, if a facility expects a notable shift in employee work patterns, then adjustment factors can be applied to the predicted (future) parking ratio.

Figure 42 below illustrates this adjustment procedure. Changes to telework, non-regular employees, or hoteling are treated as a modification of the expected total employee population that is considered with the parking ratio.

Figure 42: Adjusting Volpe Model predictions for additional parameters

Volpe Model

$$\text{Predicted (Future) Parking Ratio} = \frac{\text{Employees}}{\text{Parking Supply}} = f(Accessibility, Current\ P.R.)$$

Adjustment

$$\text{Employees} = \text{Regular Shift} - \text{Telework} + \text{Average Hoteling} + \text{Peak Non-Regular}$$

$$\text{Adjustment Factor} = \frac{\text{Employees with Current Telework, Hoteling, Non-Regular Rates}}{\text{Employees with Future Telework, Hoteling, Non-Regular Rates}}$$

$$\text{Adjusted Future P.R.} = (\text{Future P.R.}) * (\text{Adjustment Factor})$$

As teleworking increases, and as the average number of employees hoteling or peak population of non-regular shift employees decreases, then the adjustment factor will be greater than one, leading to an increase in the predicted (future) parking ratio. Conversely, the adjustment factor will be less than one and the predicted (future) parking ratio that a facility can achieve will fall.

Model Limitations

The Volpe Model encompasses several notable assumptions and methodological limitations. The model relies on and shares many of the assumptions and limitations of the MWCOG model. The following list highlights

several factors to consider when reviewing the study. Nevertheless, it is important to understand that all regional Metropolitan Planning Organizations (MPOs) use similar regional models (based on assumptions, with various limitations) which are accepted by the transportation industry:

- **Models change:** The MWCOG model is built on component models which estimate changes to the region in terms of demographics, jobs, planned network changes, etc. These variables are constantly updated to reflect the best knowledge of the region's likely growth and change. This analysis is particularly susceptible to changes to planned transportation improvements, which directly impact the accessibility of portions of the region. While we have confidence that the majority of changes planned in the region's Financially Constrained Long-Range Plan will be implemented for 2030, it is possible that some improvements will be added, removed, or scaled back.
- **Geographic granularity**: Regional transportation models are zone based, so federal facilities across the region are often grouped with other homes or businesses. Each zone aggregates land use and demographic data and makes estimations rather than modeling every individual household or business separately. This can lead to slight deviations in behavior.
- **Modal limitations**: While the MWCOG model incorporates travel modes other than automobile and transit, the Volpe Model does not incorporate those data. As such, carpooling or ride-sharing commuting options and non-motorized modes, such as bicycling or walking, are not considered. In more urbanized areas, these may contribute significantly to the overall mode share for any given facility and have an impact on parking demand.
- **Employer shuttles**: The MWCOG model incorporates public transportation options throughout the region, but some federal facilities in the NCR also have on-site shuttle services to connect with major train or bus stations. These can significantly increase transit accessibility for a facility, but they are <u>not</u> incorporated into the routine accessibility measures produced by the MWCOG model. The Volpe Model does not account for these additional transit services directly, but the Volpe Center developed adjustment factors for off-model analysis at individual facilities.

NCPC's data from federal facilities also presents limitations:

- **Sample size**: As discussed earlier, this model uses data from federal facilities in the NCR that are subject to NCPC review. NCPC staff selected 20 recent master plans (with TMPs). Although the sample size (20) is small for modeling purposes, the number of master plans used in the study represents a majority (77 percent) of NCPC-reviewed master plans within the last five years. Thus, the Volpe Model is sufficient for considering parking ratios of NCPC reviewed facilities, but would require further data to produce a robust generalized model for application to other facilities in other regions. Nevertheless, the underlying relationships revealed show promising descriptive power.
- **Data age**: The transportation data provided by each facility are not all contemporaneous with the MWCOG model. The current conditions provided by each facility range from the late 2000s through to the middle 2010s. The MWCOG 'current conditions' represents 2016 conditions. As such, facility parking condition data do not perfectly align with the accessibility data.

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[84] The MWCOG Model differentiates between a SOV, high-occupancy vehicle (HOV), and various truck types, but generates a single automobile accessibility measure is generated. Similarly, the model differentiates transit accessibility based on the initial mode used to reach transit (e.g., walking or driving). Here, only the total transit accessibility (using any initial mode) is considered.

[85] Average travel times for the region were identified in the TPB's 2016 State of the Commute Survey

[86] Here 'current' refers to the latest data available when each TMP was published, which varies between facilities, as noted in Table 3.

[87] Note that Joint Base Myer Henderson Hall includes the Joint Base McNair facility, but are physically and operationally separate.

[88] The Naval Observatory recently adopted its first Transportation Management Plan in 2014, and the Naval Support Activity Bethesda committed to attaining NCPC's 1:3 parking ratio goal through an aggressive TMP, implemented by the installation in 2009.

[89] The Commission "approves master plans for use by the Commission as a guide for future reviews of individual site and building projects" per U.S.C. §8722(a) and (b)(1)

[90] Excerpts from: Gutheim, Frederick and Antoinette J. Lee; Worthy of the Nation; Johns Hopkins University Press; Second Edition 2006.

[91] Ibid.

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[93] District of Columbia Motor Vehicle Parking Facility Act of 1942, approved February 16, 1942 (56 Stat. 90).

[94] "Off Street Parking and Loading in the District of Columbia Preliminary Report Number 6 of the Rezoning Study of the District of Columbia;" prepared by Harold M. Lewis for the Washington Zoning Revision Office: April 1956.

[95] Of the 34 largest buildings under GSA control, only five are outside the District of Columbia. They are Bureau of Yards end Docks, Tempo 7 (Gravelly Point), the Pentagon, Federal Office Buildings 3 and 4 (Suitland), and Federal Office Building 2 (Navy Annex). Of the remaining 29, two are located in the potential C-5 or Central Office District. These are the Lafayette Building at H Street and Vermont Avenue, N. w., and the Veterans Administration, on the opposite side of Vermont at H Street, N.W. Naturally most of the GSA buildings are located in the Federal Triangle, Federal Rectangle, and north and south Mall areas.

[96] Employees include patients; parking spaces include visitors' parking.

[97] Employees include base population except dependents.

[98] Elements of the Comprehensive Plan for the National Capital; September 30, 1969: NCPC

[99] For example, Stage 1 Central Area Parking policies specified:

1. Control should be established over the amount, kind and location of parking by means of a public parking authority. The program should be managed to balance parking space with the capacity of highways entering the central area.
2. The number of off-street parking spaces in the Central Employment Area should be increased from the existing 70,000 to approximately 90,000 by 1985.
3. Parking should be provided as early as feasible for tourists (4,000 spaces at the National Visitor Center at Union Station and 3,000 spaces under the Mall) and for workers in the Southwest Employment Area (12,000 spaces). The remainder of the Central Employment Area parking program should include 4,000 spaces in the Capitol Hill area, 30,000 spaces for shoppers and downtown worker west of the White House 25,000 spaces for workers, shoppers and visitors in the areas north, south, and west of the White House and 12,000 spaces for residents in the Central Employment Area.

4. Approximately 61,000 spaces would be provided in new off-street parking structures including 41,000 spaces replacing existing surface parking lots and obsolete garage structures. About half of these spaces should be provided through a public parking program; the remainder is expected to be provided as part of private development or in Federal building programs.

[100] Comprehensive Plan for the National Capital Federal Employment and Federal Facilities Planning Report; September 24, 1982: NCPC.

[101] Additional policies:

- *At Federal Facilities where parking is provided, spaces shall be set aside for Visitors and others conducting business at the site. The appropriate number of visitor spaces will vary depending upon the nature of the Federal operation and availability of public transit and commercial parking nearby.*
- *In the Monumental Core, parking for tourists and Visitors, as well as Federal employees, should be provided in accordance with a long range parking plan developed for the entire Core Area. This plan should include provision for tourists and visitors at the Union Station Complex.*
- *Employee parking, when provided at Federal Facilities, should be at a level that assumes maximum use of mass transit, a ratio of car/van pools, and a high number of occupants per car/van pool.*
- *In the deployment of Federal employees, special consideration should be given to employment areas in close proximity to Metrorail stations.*

[102] Policy continues: *"…Federal employee parking should be provided only to the extent that employees' needs cannot be served by public transit or commercial parking. Parking requirements will vary by site and should be established by technical analysis of site characteristics and location."*

[103] Policy continues: *"…automobiles should be accommodated on-site to the extent possible. A technical analysis should be made of the site characteristics, location, and available transit service to determine appropriate parking ratios."*

[104] NCPC. Comprehensive Plan for the National Capital: Federal Elements. 1989

[105] 27 Comp. Gen. 1 (1947); 16 Comp. Gen. 64 (1936).

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[107] 16 Comp. Gen. 64 (1936); 3 Comp, Gen. 433 (1924); 5-216602, Jan. 4, 1985.

[108] GAO-04-261SP Appropriations Law—Vol. I

[109] United States Government Accountability Office, Office of the General Counsel, Principles of Federal Appropriations Law, Third ED., Vol III, pp. 13-145

[110] A 2012 Government Accountability Office decision (72 Comp. Gen. 139 (1993); 49 Comp. Gen. 476 (1970); B-168946, Feb. 26, 1970; B-155372-O.M., Nov. 6, 1964) clarifies that agencies may use appropriated funds to provide parking to its employees when necessary to avoid a "significant impairment to the agency's operating efficiency." In such circumstances, the employee parking expense is considered to be a necessary expense of the agency and the agency head must provide an administrative determination of significant impairment that considers the following factors: (1) The requirement that executive agencies actively promote the use of ridesharing (carpools, vanpools, privately leased buses, public transportation, and other multi-occupancy modes of travel) to conserve energy, reduce congestion, improve air quality, and provide an economical way for federal employees to commute to work. (2) The requirement that federal agencies located in Washington, DC implement a transit subsidy fringe benefit pursuant to 5 U.S.C. § 7905 to further the public policy of discouraging commuting by single-occupancy vehicle to improve air quality and reduce traffic congestion. (3) The requirement that executive agencies make use of their authority to offer flexible arrangements through telework or flexible work schedules. (4) Assess the impact on recruitment and retention in the face of a smaller pool of eligible workers. (5) The extent to which parking is subsidized in like circumstances in the non-federal workplace. (6) Additional GSA factors to consider: the daily hours of employment; the amount of overtime work likely to be necessary; frequency of public transportation during peak periods; the cost of public transportation; the location of the residences of the majority of employees in relation to their place of employment and the estimated time required for travel between home and work; the amount of parking available in the area; and any other relevant factors, including those concerning the safety of the employees using public transportation. If severely disabled employees are forced to

pay parking costs higher than those paid by nondisabled employees working at the same facility, the agency can subsidize the difference. 63 Comp. Gen. 270 (1984).

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B-322337: Aug 3, 2012.

[113] United States Government Accountability Office, Office of the General Counsel, Principles of Federal Appropriations Law, Third ED., Vol III, pp. 13-212

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