MODERNIZING MITIGATION

A Demand-Centered Approach to Reducing Car Travel

September 2018

mayors **innovation** project

State **Smart Transportation** *Initiative*

CONTENTS

Preface	**3**
Glossary of terms and acronyms	**3**
Summary	**4**
Introduction	**5**
The basics of mitigation	**10**
Origins of modernized mitigation	**12**
Arlington County, VA	13
Cambridge, MA	15
State of California and Pasadena, CA	16
The foundation	**17**
The modern mitigation program	**18**
Principles	19
Program design	20
Sidebar: Why focus on parking?	26
Adopting a modern mitigation program	**30**
Incumbent residents and businesses	30
Regulated entities (developers and building owners)	33
City staff	35
Community as a whole	36
Conclusion	**39**
Appendix	**40**

ACKNOWLEDGEMENTS

This report was funded by TransitCenter and benefited greatly from input by Senior Program Associate Zak Accuardi and Research Director Steven Higashide. For more information about TransitCenter's programs please go to transitcenter.org.

As part of the project that produced this report, SSTI provided technical assistance to the City of Los Angeles as it developed its modern mitigation program. That interaction provided much of the material for this report. The Los Angeles team includes LADOT General Manager Seleta Reynolds and Planners David Somers and Karina Macias, and City of Los Angeles Mobility Planner Rubina Ghazarian.

PROJECT TEAM

The project team includes staff members of the State Smart Transportation Initiative (SSTI) and the Mayors Innovation Project (MIP), both projects of COWS at the University of Wisconsin-Madison.

From SSTI: Eric Sundquist, Mary Ebeling, Robbie Webber, and Chris McCahill
From MIP: Satya Rhodes-Conway and Katya Szabados

PREFACE

This is a guide for practice, with relevance for technically trained staff and non-technical elected officials and other stakeholders. It is intended to inform policy around mitigating the traffic impacts from land use changes, a major factor in transportation system funding and design. It argues that conventional practice, which focuses on funding increases to roadway capacity, has created many problems and suggests that entities involved in mitigations, whether state or local governments, consider demand-side measures before resorting to roadway capacity increases. The report is general enough that it should apply to practice in most U.S. places, and to state DOTs as well as local units of government, but the reader will need to consider how the program would work in specific settings.

GLOSSARY OF TERMS AND ACRONYMS

EXACTION. A transportation improvement or in-lieu fee intended to mitigate impacts from land use intensification or other changes.

HIGH-OCCUPANCY VEHICLE (HOV). A private motor vehicle carrying more than just the driver.

IMPACT FEE. An exaction that comes in the form of a fee, usually based on a published rate.

LEVEL OF SERVICE (LOS). A mobility measure that can apply to all modes (in incompatible ways) but is usually measured for autos. Speeds at theoretical "free flow," which may be above the speed limit, and intersection wait times less than 10 seconds earn an A; slower times earn lower grades.

MITIGATION. Measures taken to avoid negative impacts. In this report, mitigation refers to actions taken to address transportation impacts from land use changes.

SINGLE-OCCUPANCY VEHICLE (SOV). A private motor vehicle carrying just the driver.

TRANSPORTATION DEMAND MANAGEMENT (TDM). A subfield of transportation that focuses on methods to reduce the number or length of auto trips, sometimes focusing on peak periods (aka "rush hours") and on commuting. In this report we use TDM to refer to measures that reduce traffic regardless of the time of day.

TRANSPORTATION MANAGEMENT ASSOCIATION (TMA). An organization, often made up of employers, that provides TDM services in a neighborhood or region.

TRANSPORTATION NETWORK COMPANY (TNC). A firm that supplies ride-hailing apps to connect travelers with drivers, e.g., Uber and Lyft.

VEHICLE-MILES TRAVELED (VMT). A measure of total auto miles traveled by a person, household, or the population in a place.

SUMMARY

Cities exist to provide people and firms with access to goods, services, employment, and other people. A mark of a city's success is the clustering of complementary land uses to residents' and businesses' mutual benefit; the more people and activities within reach of each other, the greater the benefit from this accessibility.

A problem arises, however, when cities try to address transportation impacts from such clustering. Conventionally, they estimate the motor vehicle trips from a proposed land use in a popular location—often exacerbating the number of trips through requirements for off-street parking—then require the new land use to "mitigate" the resultant traffic impact through roadway capacity increases, either directly or through in-lieu or impact fees.

The conventional approach has significant problems, including:

- Placing expensive burdens on desirable new land uses, possibly pushing them into less-accessible locations—often places that non-auto travelers reasonably cannot reach.
- Inducing more traffic and the resulting environmental, safety, livability, and personal cost problems.
- Reducing the ability of travelers to use non-auto modes because of impediments posed by wider, busier roadways.

In short, the conventional approach degrades the accessibility of cities, undermining their fundamental ability to function.

This report proposes a new approach to assessing and responding to land use-driven transportation impacts, called "modern mitigation." Instead of relying on auto capacity improvements as a first resort, this approach builds on practice around transportation demand management (TDM) to make traffic reduction the priority. Based on programs dating to the 1990s in several cities, a modern mitigation program requires certain new land uses to achieve TDM credits through such means as:

- Improving area walking, biking, and transit infrastructure and service.
- Providing complementary land uses that minimize the need for travel.
- Subsidizing transit, or bikeshare or carshare services.
- Providing first- and last-mile connections to high-capacity transit.
- Implementing monitored TDM measures of their own design.

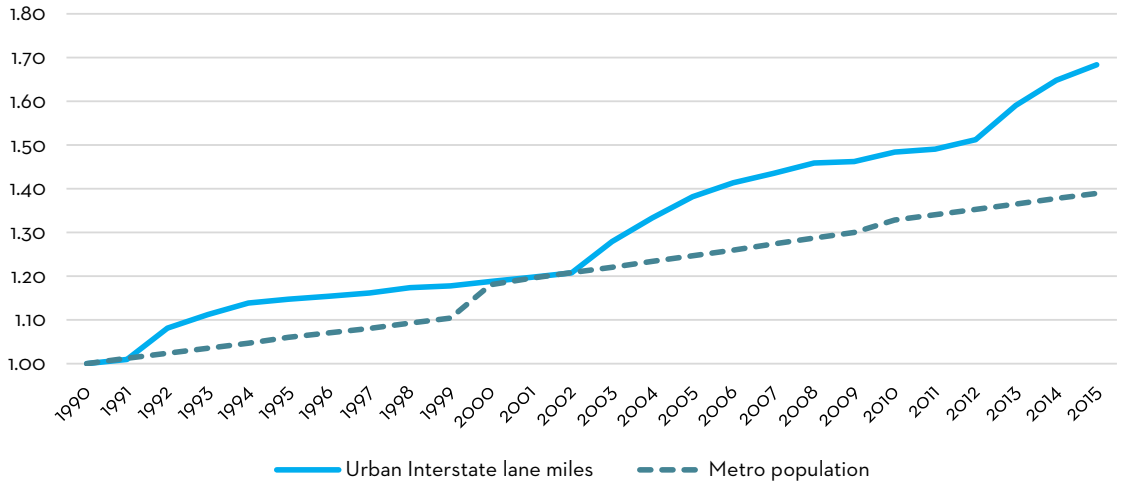
The program as described here provides benefits to the community from reduced impacts of traffic and travel costs, as well as to such particular stakeholders as incumbent land uses, developers and building owners, and staff members administering programs.

The program is described as a function of local government, with requirements triggered by building permits and/or land-use permission changes. However, it may also be adapted by states for use in mitigation they require of land uses that affect the state highway system.

INTRODUCTION

For decades, local, regional and state governments have mostly treated transportation as an auto-infrastructure supply problem. When traffic slows down or backs up—or may do so in the future —roadway capacity should be increased. As a result, since 1990, urban lane-miles have grown by 62 percent while the most expensive form of highway capacity, urban Interstate lane-miles, have grown by 68 percent—both much faster than metropolitan population (Figure 1).

Figure 1. Trends in U.S. urban Interstate lane-miles and metropolitan population, 1990 - 2015



Source: Bureau of Transportation Statistics.

But while we need streets and roads, oftentimes expansions come at great cost to taxpayers, travelers, neighborhoods, and the environment. This report is not intended to provide a lengthy critique of our strong focus on the supply of urban roadway infrastructure, as many authors have already done so. A summary example of the costs of autocentric development, many of them externalized to non-drivers, comes from Todd Litman[1]:

- Vehicle ownership: Fixed costs of owning a vehicle
- Vehicle operation: Variable vehicle costs, including fuel, oil, tires, tolls, and short-term parking fees
- Travel time: The value of time used for travel

1 Summarized by Jeffrey Tumlin in "Sustainable Transportation Planning: Tools for Creating Vibrant, Healthy, and Resilient Communities," John Wiley & Sons, Incorporated, 2011, p. 142.

- Crash: Crash costs borne directly by travelers, and costs a traveler imposes on others
- Parking: Off-street residential parking and long-term leased parking paid by users and others
- Congestion: Congestion costs imposed on other road users
- Road facilities: Roadway facility construction and operating expenses not paid by user fees
- Land value: The value of land used in public road rights-of-way
- Traffic services: Costs of providing traffic services such as traffic policing, and emergency services
- Air pollution: Costs of vehicle air-pollutant emissions
- Greenhouse gas pollution: Life-cycle costs of greenhouse gases that contribute to climate change
- Noise: Costs of vehicle noise-pollution emissions
- Resource externalities: External costs of resource consumption, particularly petroleum
- Barrier effect: Delays and safety costs that roads and traffic cause to non-motorized travel
- Land-use impacts: Increased costs of sprawled, automobile-oriented land uses
- Water pollution: Water pollution and hydrologic impacts caused by transport facilities and vehicles
- Waste: External costs associated with disposal of vehicle wastes

Many of the burdens fall disproportionately on the poor, young, old, or disabled, for whom auto use—and thus access to many destinations—may be out of reach entirely, or at least a very large financial lift. And ironically, the focus on supply can be self-defeating, as it actually tends to induce more driving and traffic.[2] Despite growth in lane-miles that has outpaced population, congestion is worse than ever.[3]

If continually growing supply is problematic, then what about addressing demand instead? In fact, governments have thought of managing auto travel demand by, for example, charging variable tolls to discourage travel at congested periods. In some cases, cities have reduced roadway supply a bit through "road diets," which typically remove a travel lane and facilitate travel by pedestrians and cyclists.

2 Duranton, G., & Turner, M. A. "The Fundamental Law of Road Congestion: Evidence From US Cities." American Economic Review, 101 (6) (2011): 2616-2652. http://dx.doi.org/10.1257/aer.101.6.2616.

3 Texas A&M Transportation Institute and Inrix. Urban Mobility Scorecard. August 2015. https://static.tti.tamu.edu/tti.tamu.edu/documents/mobility-scorecard-2015.pdf.

"Many governments have recognized the drawbacks of autocentric investment and have adopted high-level policy goals around sustainable transportation. Yet in transportation...frequently policy and decision making are not always in sync."

This report proposes another demand-management approach that grows out of longstanding practice around "transportation demand management." TDM is most commonly known as an employer-based program that, for example, provides subsidies for employees who take transit to work. In this report we look at some promising examples of the application of TDM strategies by local governments as part of their regulation of land use—bringing together the two elements of the built environment that too often are considered separately.

In a demand-centered approach a local government instead pursues mitigation by reducing traffic rather than accommodating or even inducing it by requiring parking, adding road capacity, and separating land uses. In this approach, the local government makes it easier for developers to build in a more compact way, generating less sprawl and car travel, through requiring building owners to apply demand-reduction measures. The demand-centered approach allows travelers to meet their needs with fewer and/or shorter car trips at less cost to themselves, to government, to communities, and to the environment. We call this new practice "modern mitigation."

While it is tailored to the local level, where building permit and zoning power generally reside, the method can also apply to states. Even though they do not issue building permits or make zoning decisions, states do impose mitigation requirements in many cases, e.g., driveways on state highways or major land uses in state-highway corridors, and so state DOTs also can shift their approach to the demand side.

Mitigation in context

Many governments have recognized the drawbacks of autocentric investment and have adopted high-level policy goals around sustainable transportation. Yet in transportation—with myriad decisions about what to build and operate, how to design facilities, how to charge for and pay for facilities, how to relate transportation and land use decisions, and many more—frequently policy and decision making are not always in sync. This guide drills down into a particular type of decision-making, the mitigation of transportation impacts from land use projects, to help bring it into alignment with such policy goals.

First, though, for context and to inform the design of modern mitigation practice, it's useful to consider at a high level what types of transportation-related policy levers exist and how they relate to a goal of reducing traffic, or allowing people to meet their needs with fewer and/or shorter car trips. Here are several policy levers, greatly simplified, with their likely general effect on traffic volumes:

1. **ADDING ROADWAY CAPACITY:** As noted, adding more roadway capacity tends to lead to more driving, and can also crowd out other modes, for example by making walking harder and spreading out destinations. Often capacity additions are achieved through mitigation. *Likely effect: More driving.*
2. **ADDING NON-AUTO CAPACITY:** The nature of transit, bike, and pedestrian infrastructure is to encourage more compact development and shorter travel distances, and to take some pressure off of highways through mode-shifting. *Likely effect: Less driving.*
3. **CHANGING ROADWAY OPERATIONS:** This lever would include a variety of roadway operations, from tolls to signal-timing. These may be undertaken for several reasons not directly related to supply and demand. For example, signals may be timed to keep traffic flowing at a reasonable speed in order to reduce crashes. Raising the price of driving, as through tolls, would generally be expected to lower the amount of driving. However, in some cases tolls are imposed simply to reduce driving at peak hours, with minimal effect on overall demand. *Likely effect: Depends.*
4. **TRANSPORTATION DEMAND MANAGEMENT:** This lever has traditionally been used by employers in congested areas to reduce peak-hour auto travel. Some measures, such as staggered work hours, simply shift travel and don't reduce the overall level, while others, such as subsidized transit and carpool incentives, reduce demand. *Likely effect: Neutral to less driving.*
5. **LAND USE REGULATION, CONVENTIONAL:** Conventional "Euclidean" U.S. land use regulation, with separated uses and requirements for lot sizes and off-street parking, tend to spread out uses and orient travel around the auto. *Likely effect: More driving.*
6. **LAND USE REGULATION, MODERNIZED:** Partly in order to reduce the travel-inducing effects of conventional zoning, some local governments have instituted form-based and other mixed-use-friendly forms of zoning, as well as relaxed off-street parking requirements and setback rules. *Likely effect: Less driving.*
7. **SUBDIVISION ORDINANCES:** Rules about street widths, intersection density, presence of sidewalks, connectivity, and the like are, along with land use requirements, the DNA of greenfield development. As with land use, they can either induce driving or make non-auto trips desirable. Likely effect: *Depends.*
8. **PRICING:** The most powerful pricing tools, such as gas taxes, VMT charges, and highway tolls, are generally outside the purview of local government. However, local government does control some prices, such as transportation-network company fees and on-street parking. They also may impose fees on development, which, if structured correctly, may serve to rein in high-travel development—or may induce traffic if the fees are flat and used for new autocentric facilities. *Likely effect: Depends.*

"Mitigation, as considered in this report, is the practice of requiring contributions—in dollars or in-kind—from developers in order to address transportation impacts anticipated from a new or changed land use."

For the public and many decision makers, the conversation around many of these transportation decisions typically occurs when new or expanded roads are debated, designed, and programmed by local governments, Metropolitan Planning Organizations, or state Departments of Transportation. While these processes have flaws, they at least occur out in the open and require public votes. The best of them include consideration of various modes and long-term maintenance needs, rather than simply roadway capacity. Yet when these conversations address the potential levers for improving transportation, they typically take place within conventional boundaries. Even cities with excellent policy aspirations will induce more vehicle travel and attendant costs if their decision rules prioritize vehicle speeds, require separated land uses and wide local roads, and force developers to mitigate impact by adding supply.

These same rules similarly constrain the myriad other decisions made out of the public eye, by city staff, developers and other participants in constructing the built environment, as, for example, when long lists of potential transportation projects are vetted, when relatively routine land use projects are reviewed, or when transportation impacts of land use changes are negotiated.

Fortunately, leaders do step up to reform these decision-making rules. The aim of this guide is to make change easier by providing learning from previous experiences around demand management through mitigation, addressing most of the policy levers above. The remainder of this report describes the basics of mitigation, provides some historical antecedents for the program developed here, gives the outline of that program, and addresses some strategies for getting a program adopted.

THE BASICS OF MITIGATION

Mitigation, as considered in this report, is the practice of requiring contributions—in dollars or in-kind—from developers in order to address transportation impacts anticipated from a new or changed land use. It is used by both local and state governments, and while some of the processes and outcomes are similar, the program described here is tailored for local government, with its land use authority that states generally lack.[4] Mitigation, which can apply to non-auto modes as well as roads, may take the form of a negotiated "exaction" or a formulaic "impact fee." Because mitigation proceeds are often in-kind and never from tax revenues, they are frequently ignored in legislative budget discussions, and it is probably impossible to accurately estimate their annual value across the country. But that value is undoubtedly very high, as individual projects sometimes trigger mitigation projects that run into the many millions of dollars. For example, an exaction agreement with the Potomac Yards project in Northern Virginia is projected to produce $49 million—mainly for transit.[5]

Mitigation for roadway capacity is far more common than for transit, as nearly every building has a driveway and the potential to generate auto trips. For example, since 1961 Los Angeles has enforced a compulsory road-widening process on developers, which has provided roadway right-of-way parcel-by-parcel.

This approach to mitigation has some benefits, at least in theory. It is often considered fair that new development pays its own way rather than relying on general revenues. There are established standards that can be relied on to determine trip generation and effect on level of service. And this kind of mitigation often addresses neighboring residents' and businesses' concerns about maintaining mobility in the area.

However, conventional mitigation has significant drawbacks as well, including:

- While standards exist, estimates of trip generation are based on limited numbers of cases that may not be good indicators of the project under consideration, and hence the projected change in level of service may not be accurate. Projections are only infrequently checked after the fact for validity.
- Except in the case where impact fees are used, the process tends to apply costs unevenly. The first several developments along a road have little effect on LOS, but at some point the road reaches a tipping point where delays begin to occur. The project that comes along at that point may be saddled with the responsibility for paying for capacity improvements for which it is only marginally responsible.
- Developers may avoid infill, where they may have to mitigate for traffic impacts, in favor of greenfields, where there is currently little traffic. Greenfield development tends to increase the amount of driving across the area or region.
- Because conventional mitigation usually affects a small part of the system near a development, it may speed up traffic locally but create a bottleneck down the road.

4 That is not to say that state governments could not enact a similar program that improves outcomes from their own developer exactions.

5 U.S. DOT FHWA Center for Innovative Finance Support. Project Profile: Potomac Yards Metrorail Station. Accessed at https://www.fhwa.dot.gov/ipd/project_profiles/va_potomac_metrorail_station.aspx.

"By modernizing the approach to mitigation, focusing on reducing traffic rather than haphazardly accommodating and inducing new trips, we can reduce the downsides and foster the more efficient, equitable, lower-travel outcomes. "

- Conventional mitigation that is focused on auto speeds and roadway capacity can make non-auto travel more difficult, for example by increasing crossing distances and pedestrians' exposure to traffic hazards when intersections are widened or traffic speeds increased.
- Roadway expansions can induce more traffic, making them unreliable in maintaining auto mobility and adding emissions and other disamenities mentioned above.

Michael Manville of UCLA reviewed the Los Angeles mitigation policy in a 2017 paper. He found that results were quite poor, but that the policy has persisted in part because it is an entrenched standard[6]:

Parcel-level traffic mitigation has the trappings of science. Cities use predictions and manuals purporting to show how much traffic a given development will create, or how much traffic a given street will carry, and then apply formulas that translate these predictions into the various increases in road capacity necessary to offset those vehicle trips. In this way, developers are held responsible for the traffic they create.

There is, however, little reason to believe developers "create" traffic, and little reason to think planners can accurately predict it at the parcel level. Cities adopted parcel-level mitigations not because they were shown to work, but because other ways to address congestion were politically or fiscally unfeasible.

In the case of Los Angeles' highway dedication law, the law's proponents conceded from the outset that it was unlikely to work. The evidence I present here suggests that the standards underlying the law are often in error, and in some cases simply unverifiable. Such immunity to measurement is antithetical to sound policy, but—perversely—the pursuit of a largely unmeasurable goal ensures the law's persistence, because it leads planners to largely ignore the law's nominal purpose and instead emphasize its measurable process. The law, in short, is all tree and no forest; while its intent may be to alter outcomes on the network of streets, all of its stakeholders are focused on individual parcels.

6 Manville, Michael. "Automatic Street Widening: Evidence From A Highway Dedication Law." Journal of Transport and Land Use Vol. 10, No.1 (2011). http://dx.doi.org/10.5198/jtlu.2016.834.

Possibly the implementation troubles I have documented are unique to Los Angeles. But to the extent they are not, they add new evidence to the existing case against parcel-level mitigation. The evidence presented here gives little reason to think parcel-level mitigation is doing good, and good reason to think it is doing harm. An optimist might argue that mitigation, despite its flaws, can be a placeholder for more direct approaches to manage congestion, such as higher gasoline taxes, tolls on larger streets, and direct and accurate prices for street parking. But it is also possible that mitigation, by creating an illusion of sophisticated technical standards deployed to battle congestion, actually deters the adoption of simpler and more effective but politically less palatable policies. If mitigation lets cities and voters dodge the reality that solving congestion will likely involve making driving more expensive, and if it impedes housing development as well, then planners may wish to consider abandoning the practice, rather than attempting incrementally to improve it.

Typically, when a developer seeks land use approval for a project, a traffic study based on the proposed use and size will estimate "trip generation" from the site and with that, the effect of new trips on the nearby roads and intersections, as measured by "level of service" standards. If the projected trips are considered likely to degrade LOS beyond a certain point, the local government will request roadway improvements be constructed or funds be provided for such improvements. (In cases where impact fees are charged rather than exactions negotiated, the fees may be used to cover such improvements.)

By modernizing the approach to mitigation, focusing on reducing traffic rather than haphazardly accommodating and inducing new trips, we can reduce the downsides and foster the more efficient, equitable, lower-travel outcomes. The modern mitigation approach is both more multimodal, more attuned to system-wide outcomes, and more tailored to specific development attributes than is conventional practice. It has emerged, in large part, out of work by pioneering local governments in TDM programs, as described in the next section.

ORIGINS OF MODERNIZED MITIGATION

While transportation supply has received the most attention, many employers and groups of employers have addressed the demand side as well. In many cases such efforts have focused on peak-hour congestion, to make workers' commutes more tolerable and reliable. It is through these programs that researchers have been able to develop a sense of which TDM measures work, and how well. These are summarized in Appendix 1. In addition, a useful resource for understanding cost-effectiveness of TDM is the Oregon DOT Mosaic Tool, which uses a least-cost approach to transportation improvements by comparing the cost of capacity additions to cost of demand-reduction strategies.[7]

7 Oregon DOT Planning and Technical Guidance. Oregon Mosaic: Value and Cost Informed Planning. Accessed at http://www.oregon.gov/ODOT/Planning/Pages/mosaic.aspx.

Some local governments have built on the mainly employer-based TDM track record to include other land uses and to address mitigation from new development. These efforts have provided a sound basis for the modern mitigation program described in the next section. Here we briefly describe these foundational programs, along with some of the takeaways for modern mitigation.

Arlington County, VA: Building owner obligations that run with the land

Since 1990, the county has required certain developments to prepare a TDM plan, including a schedule and details of implementation. The TDM provisions then become part of the adopted site plan conditions and may run for 30 years.

Arlington Memorial Bridge, Arlington County, VA
By Tim Evanson from Washington, D.C., United States of America, CC BY-SA 2.0

Program staff help developers select TDM strategies appropriate for each site and maintain a website[8] to assist developers and property owners in navigating the process. The website has a sample plan template for developers needing guidance on how to prepare a TDM plan. Base TDM requirements are standardized; however, additional negotiated requirements may be added if planning staff feel that unusually heavy trip generation is expected.

Each TDM plan must contain the following:

- Participation and funding. Each building must join a Transportation Management Association and pay fees to said organization. In addition, activities listed below must be funded.
- Facilities and improvements. The plan must spell out exactly what facilities or infrastructure will be provided.
- Carpool and vanpool parking
- Promotions, services, and policies. The plan must indicate what type of outreach and education programs will be provided to tenants or visitors.
- Performance and monitoring

8 Arlington Transportation Partners, "TDM For Site Plans," Accessed at https://arlingtontransportationpartners.com/programs/property-development/tdm-for-site-plans/.

Arlington often requires demand-reducing infrastructure for construction of new and renovated developments. Such infrastructure must be completed prior to issuance of the certificate of occupancy.

After occupancy, the developer is responsible for implementing the plan as a whole, including management components such as an on-site coordinator, programmatic elements such as carpool and vanpool programs, and annual contributions or reporting. Currently the program enforces and monitors over 120 site plans.

Surveys of commuting habits for employees or residents of developments are required at two-, five-, and 10-year intervals, and the county has the option of requiring data collection in five-year increments after year 10. The program monitors compliance and works with property owners and county zoning staff to achieve compliance. Although enforcement action up to and including referral to the Zoning Administrator and escalating fines is allowed, staff say that most non-compliance problems have been resolved by discussions with property managers.

Payments to support the program or a TMA are required for 30 years or the life of building.

The Arlington County Master Transportation Plan[9] aims to keep VMT within five percent of 2005 levels. Between 2008 and 2014, Arlington documented an average weekday reduction in SOV trips of eight percent with a resulting reduction in VMT of 38 percent county wide. The master plan goal for non-SOV commute mode share for 2030 is 60 percent. The county now has a non-SOV commute mode share of 54 percent, so it is on track to hit its goal.

9 Arlington County VA. Master Transportation Plan. 2017. Accessed at https://projects.arlingtonva.us/plans-studies/transportation/master-transportation-plan/.

Cambridge, MA: TDM obligations based on parking capacity

Cambridge's Parking and Travel Demand Management Ordinance,[10] first adopted in 1998, includes requirements aimed at reducing drive-alone rates from new, non-residential land uses. Key to the program is the role of parking; TDM requirements are scaled to the number of parking stalls in a new development or any increase in stalls for existing developments.

Inman Square, Cambridge, MA
By Tim Pierce - Own work, CC BY 3.0

All TDM requirements in Cambridge are pegged to the 1990 journey to work data for the working population of Cambridge, i.e. those who work in Cambridge. The ordinance requires developers of non-residential properties to reduce the drive-alone rate to 10 percent below the 1990 average for the census tract.

Cambridge's ordinance separates affected projects into two categories:

- Small projects (5-19 stalls) require a set of three TDM measures.
- Large projects (20 or more stalls) require a comprehensive set of TDM measures, a reduction of single occupancy mode share compared to area averages—calculated by using the journey to work data for the working population in the census tract, plus annual monitoring and reporting.

TDM measures may include:

- subsidized transit passes and other incentives
- shuttle services
- ride-sharing services
- bicycle and pedestrian facilities
- flexible working hours
- preferential parking for Low Emission Vehicles/Zero Emission Vehicles/bicycles/carpools/vanpools

For employment uses, Cambridge requires annual commute mode surveys for properties with TDM commitments. The city validates these surveys through bi-annual driveway/lot utilization monitoring. If trip reductions goals are not met, the city may enforce the

10 City of Cambridge. Chapter 10.18 - Parking and Transportation Demand Management Planning; Parking Space Registration. Code of Ordinances, Cambridge, MA, Municode Library,1998. Accessed at http://code.cambridgema.gov/2015-12/10/6/.

requirement by charging $10 per parking space per day until the requirements are met. The city is able to shut down a non-compliant parking facility.

The city considers the program to be a success. Many of the projects affected by the ordinance are located in Kendall Square, so it is a good example of what has been achieved. In 1990, the Kendall Square area had a 55 percent drive-alone rate for trips to work. Projects immediately after the ordinance were required to achieve a 50 percent SOV rate. The average SOV rate in affected projects dropped to 42 percent in 2007 and 39 percent in 2018. The city is now considering requiring a commitment of 29 percent SOV for new projects because they see that as achievable.[11]

State of California and Pasadena, CA: Pivoting from supply to demand mitigation

Pasadena, CA
By Adbar - Own work, CC BY-SA 3.0

In 2013, the State of California enacted SB 743, which changed the framework in which mitigation occurs in the state. Many of the details are not important for those outside of California; in brief, the bill ended a longstanding practice whereby conventional LOS-based mitigation took place under the state's environmental review process, often resulting in new roadway capacity. Instead, new rules under SB 743[12] state that environmental impact should be measured in terms of total auto travel, or VMT, largely because that is a better indicator of vehicle emissions—the true environmental impact—and to better support active transportation modes.

11 Email from Stephanie Groll, Cambridge Parking and Transportation Demand Management Planning Officer, June 25, 2018.
12 California Governor's Office of Planning and Research. Analyzing Transportation Impacts. November 2017. Accessed at http://www.opr.ca.gov/docs/20171127_Text_of_15064-3.pdf.

What makes this law important to governments around the country is the resulting policy innovations that are taking place at the local level. While SB 743's transportation mitigation provisions generally apply only to very large projects and not at all to those that are well-served by transit, the new law prompted several cities to broadly rethink supply-side mitigation and reorient their mitigation framework toward demand management, and to apply those principles—mitigation through demand-side management—even where SB 743 doesn't require them.

Concurrently with the enactment and rulemaking under SB 743, Pasadena adopted mitigation metrics that are consistent with the law's intent. All large new developments are required to show, via modeling, that they are consistent with metrics that have been set by the city. The metrics are calculated using a "service population" that is equal to both the population of the city and employees who come into the city but do not live there:

- Must not exceed VMT per capita of 22.6 daily
- Must not exceed vehicle trips per capita of 2.8 daily
- Must not reduce service population located within one-quarter mile of levels 1 and 2 bicycle facilities below 31.7 percent
- Must not reduce the service population located within one-quarter mile of levels 1 and 2 of transit facilities below 66.6 percent
- Must not decrease the citywide Pedestrian Accessibility Score below 3.88

If mitigation is required, the developer must make changes to bring the development back in line with the target metrics. Building permits are not issued until all metrics are satisfactory.

Changes may be made either on-site or off-site, and because the metrics used are citywide, mitigation can take place relatively far from the actual development site. Mitigation may take many forms, depending on where the impact to the metrics occurs. Meeting the requirements is relatively easy in the urban core. For developments that are farther from the urban core, developers may need to add a mixed-use component, build a bike facility, or improve transit access by providing shuttle service or paying for a route modification.

The foundation

This is not an exhaustive list of local-government-run programs that seek to mitigate traffic impacts through demand measures, and it omits many of the details of the programs described. But these examples do provide a historical basis for forming a modern mitigation program. As described in the next section, this program:

- Places runs-with-the-land requirements on building owners at the time development occurs, as in Arlington
- Uses parking capacity as a key indicator of the need for mitigation, as in Cambridge

"While supply-side mitigation is most common, cities have undertaken substantial efforts on the demand side. Each city is approaching the question on its own terms, so there is not yet a one-size-fits-all standard for modern mitigation."

» Focuses mitigation away from spot capacity expansions to systemic SOV demand reduction, as in State of California and Pasadena

The program also borrows from the broader experience with TDM around the country and world, particularly in its selection and calibration of demand-reduction measures. Sources for this information are listed in the appendix.

THE MODERN MITIGATION PROGRAM

As the previous chapter demonstrates, while supply-side mitigation is most common, cities have undertaken substantial efforts on the demand side. Today these reforms are accelerating, especially in California, where SB 743 (2013) has refocused environmental reviews and mitigation away from traffic delay and toward system-wide road use as measured in VMT. The new statute and the pioneering reform in Pasadena have catalyzed activity in localities across the state, including San Francisco, San Jose, Oakland, and Los Angeles. Each city is approaching the question on its own terms, so there is not yet a one-size-fits-all standard for modern mitigation. However, there are enough common themes from these and the earlier examples above that we can begin to generalize about a modern approach to mitigation.

This section covers general principles of modern mitigation, a system by which these principles could be implemented, and an example of how that system could be applied to a project. It is largely based on the work that has gone into early drafts of the emerging Los Angeles TDM program,[13] which in turn was inspired by the award-winning program adopted by San Francisco in 2016 and substantially updated in 2017.[14] The program design presented here does not follow either of those programs exactly but represents SSTI's effort at combining best practices for the benefit of other cities.

13 The grant that funded this report also funded SSTI's technical assistance to the city of Los Angeles in the development of its demand-mitigation program. The report is strongly informed by that policy development work. However, at this writing, the Los Angeles program has not been implemented. Details on the emerging policy can be found at: http://ladot.lacity.org/what-we-do/planning-development-review/transportation-planning-policy/modernizing-transportation.

14 City and County of San Francisco Planning. Standards for the Transportation Demand Management Program. San Francisco, August 2016. Accessed to http://default.sfplanning.org/plans-and-programs/emerging_issues/tsp/tdm_Program_Standards-011917.pdf.

Principles

The principles for shaping a modern mitigation program are designed to address many of the shortcomings of conventional practice. There are five:

1. **REDUCE SOV DEMAND.** Conventional practice seeks to accommodate SOV trips from developments, in order to minimize auto delay, thereby generating traffic and degrading non-auto modes and livability. Modern mitigation, in contrast, seeks to reduce SOV trips, with obvious benefits to other modes, livability, and even traffic flows. This principle dictates that cities put a priority on demand reduction first and accommodate traffic as a last resort.
2. **CONSIDER THE SYSTEM AND THE TOTALITY OF DEMAND.** In contrast to conventional practice that focuses on trips on a particular road segment, state and local agencies implementing California's SB 743 have developed methods for calculating development impact in terms of VMT. These calculators are too complex and not precise enough for small projects, but useful in addressing large ones and may be useful in a program. But such formal VMT calculations are not absolutely necessary in a modern mitigation program; rather the specifics of a program should always ask whether a decision-driving element of the program will raise or lower VMT, and avoid the former to the extent possible. An implication of this principle is that certain TDM measures that move traffic to off-peak times are less desirable than those that lower demand outright.
3. **ADDRESS THE SETTING.** Conventional practice incentivizes high-VMT greenfield development, and penalizes infill, as developers seek to avoid paying for roadway capacity in areas with traffic. Yet siting a development in denser areas with varieties of land uses and, ideally, transit is one of the most powerful ways to reduce SOV demand. A modern mitigation program should acknowledge this benefit and seek to leverage it by minimizing costs it imposes on VMT-light infill.
4. **KEEP IT PREDICTABLE.** A complex new process that adds time and uncertainty to projects, particularly in already-complicated infill settings, does neither cities nor developers any good. If a program can reduce burdens from conventional impact mitigation while not adding back that complexity or uncertainty, everyone wins.
5. **CONSIDER ALL STAKEHOLDER INTERESTS.** It is important that mitigation address local needs as well as more systemic ones, not only to get buy-in to implement but also to actually maintain livability. As such, development may need to provide some local improvements, but these improvements do not need to necessarily be in the form of roadway capacity. (The final chapter in this report addresses stakeholder engagement.)

"Localities, even those in urban areas, vary a lot. Some are coping with growth, while others desperately wish for it. Some have walkable, transit-friendly "bones," while others were developed at a time when it was assumed everyone would always drive."

Program design

Localities, even those in urban areas, vary a lot. Some are coping with growth, while others desperately wish for it. Some have walkable, transit-friendly "bones," while others were developed at a time when it was assumed everyone would always drive. Some have considerable leeway to develop policy, while others are preempted by their state. The program described here is intended to be a generic default with as few barriers to implementation as possible, but it is likely that localities will have to adapt it to their own needs, legal boundaries, and other conditions.

In summary, the program works like this:

- The developer of an applicable project enters basic information—use, size, and parking capacity being sought—into an online tool or spreadsheet.
- The tool calculates the amount of mitigation required. This may be in terms of VMT as in the San Jose example below, or more simply in terms of TDM points.
- The applicant reviews the options available and the points for each, and selects enough measures to meet the requirement.
- The locality reviews the plan and includes it in the file of other building obligations that run with the land.
- The building owner implements the required measures.
- Periodically, the building owner recertifies that the required measures are still in place. Larger projects must provide more frequent and detailed reports, including outcomes.

Specific elements of the program design include:

APPLICABILITY. The modern mitigation program described here is scalable, with straightforward requirements, so it can be broadly applied for the most far-reaching effect in reducing traffic impacts throughout an area. The existing San Francisco program applies to new residential projects of 10 or more units and new non-residential spaces of 10,000 square feet or more, as well as certain changes of use that involve intensification. Los Angeles is considering slightly different thresholds to coincide with categories in its existing land use code. For the greatest effect, all projects requiring a building permit should trigger the mitigation program. Even if these projects need no change in zoning, they will have transportation impacts, and under many conventional mitigation regimes would require an impact assessment and potential mitigation.

Larger projects generally have the greatest transportation impact and also tend to have greater resources in terms of on-site management and economies of scale in assembling TDM mitigation measures. Therefore, it is appropriate to raise the bar on bigger projects, both in terms of measures required and also evaluation and reporting. The emerging Los Angeles program employs three tiers to accomplish this.

While traditional TDM focuses on employment uses, modern mitigation applies measures that address commercial, residential, and institutional land uses as well.

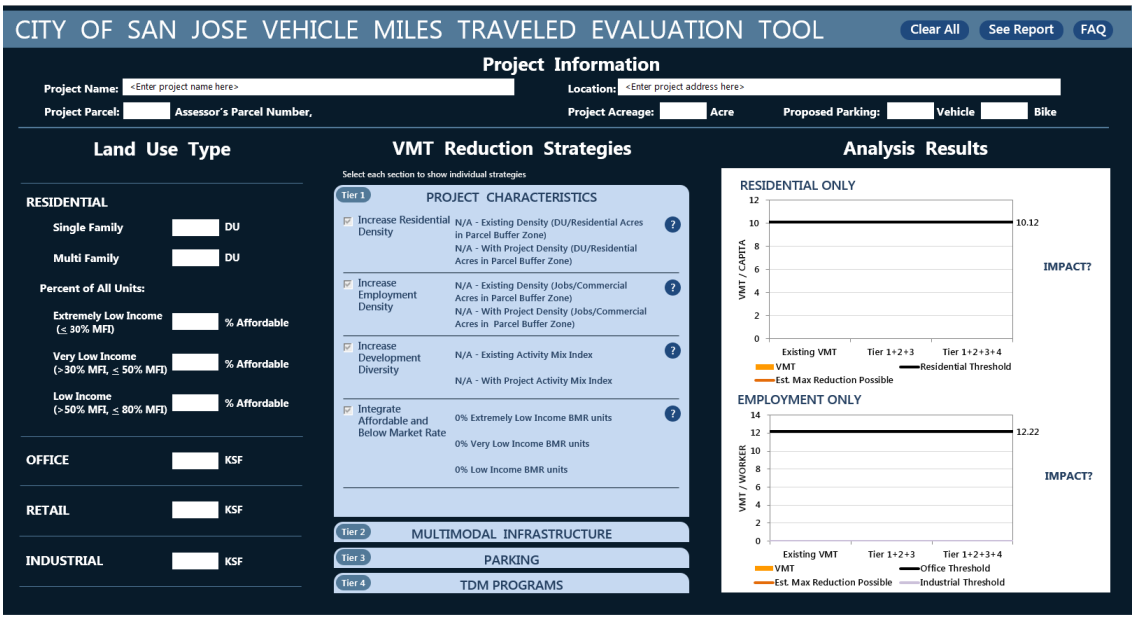
Other policy considerations may affect applicability as well. For example, affordable housing is not only desirable by most cities' policies, but it also tends to generate less traffic than market-rate housing. So the mitigation program may carve out or reduce mitigation requirements for affordable units. And because mixed-use developments reduce traffic impacts through "internal capture" of trips, requirements may be reduced for those projects.

IMPACT ASSESSMENT. One of the key technical questions involved in developing a modern mitigation program is how to calibrate and assign responsibilities to developers.

It is possible, as noted above, to predict VMT from a large development, just as we try to predict trips, based on certain attributes. The city of San Jose, for example, has launched a VMT calculator that takes inputs including use, location, size, parking capacity, and a handful of TDM measures to calculate VMT per capita related to the development. The goal is to get developers, through decisions on those inputs, to reduce VMT impact below thresholds set by the city. The program's approach to measuring impact is consistent with the principles of modern mitigation, by being oriented toward demand, focusing on VMT across the system, and encouraging location efficiency. It is also relatively simple for developers to input variables and understand their impacts in order to understand whether and how much travel demand they must mitigate.

However, the actual-VMT metric has some disadvantages if applied to a wide-ranging mitigation program: 1) It requires some original research to understand VMT generation by use in neighborhoods around the area, 2) even with this research VMT estimates are based on averages and may not reflect commuting, shopping, or residential travel patterns of actual uses, at least to the level of precision implied, and 3) such estimates are intended only for very large projects; the tool does not claim to predict VMT outcomes for small projects that are likely the bulk of development in a city.

Figure 2. VMT estimation tool for large developments in the City of San Jose, CA



Source: City of San Jose, CA

A more generally useful approach in designing a program is one in use in San Francisco and being developed in Los Angeles,[15] which greatly simplifies the assessment in order to come up with mitigation targets. As with the longstanding program in Cambridge, MA, both use parking as the main determinant of new SOV demand, an approach that is both intuitively sensible—car storage opportunity is obviously related to SOV use—and is backed by research. Calibrating mitigation targets with parking could be done in a variety of ways. Cambridge starts adding requirements when a developer adds any stalls, and San Francisco compares an applicant's parking capacity to that seen in existing similar land uses—an approach that requires an existing parking survey—while Los Angeles has developed a table that increases mitigation requirements as a function of parking stalls per housing unit or square foot, making it more flexible than Cambridge's and more portable than San Francisco's. Table 1 shows a hypothetical example of the Los Angeles approach.

15 Los Angeles is also developing a VMT calculator similar to San Jose's for very large projects.

Table 1. Relation of project size and parking capacity to TDM mitigation requirements, based on preliminary program development in Los Angeles.

Parking capacity (stalls per housing unit or 500 sf of non-residential space)			**Mitigation points required**
Small project	Medium project	Large project	
Less than 0.5			5
0.5-.99	Less than 0.5		10
1-1.49	0.5-.99	Less than 0.5	15
1.5-1.99	1-1.49	0.5-.99	20
2 or more	1.5-1.99	1-1.49	25
	2 or more	1.5-1.99	30
		2 or more	35

Source: State Smart Transportation Initiative

Relying on parking to determine mitigation targets will raise some concerns that should be addressed as part of a comprehensive policy strategy. While fewer off-street parking stalls may mean lower auto travel demand, it may also create more parking demand for on-street or off-site parking near a new development. Cities have a variety of tools for addressing on-street parking, including time-limits, pricing, and residential permit parking, and these tools should be deployed to manage potential "spillover" parking. At the same time, the program needs a provision to address off-site, off-street parking as well. Shared parking arrangements may be preferred policy to minimize the total number of stalls in an area, but the program also needs a provision to prevent applicants from avoiding mitigation requirements by using parking on a nearby parcel.

MITIGATION REQUIREMENTS. Unlike traditional supply-based mitigation, which generally specifies capacity improvements required, modern demand-based mitigation provides building owners with options to suit the setting and use of the building. The point system for mitigation measures is based on their relative effectiveness supported by available research (see appendix). Some measures are scalable and may provide more or fewer points depending on the level of implementation.

In addition to point-specific measures, a program may provide for more flexible options:

» A developer-specified plan. TDM measures are evolving, and to provide for innovation the program may allow a building owner to propose a strategy that is not currently outlined in existing TDM policy/requirements/documents/plans. Such strategies should be consistent with the program's principles. The program should specify how such proposals are approved—possibly in the same manner that conditional uses are reviewed —provide standards that the strategy will need to meet, and remedies to be employed should the strategy not meet its standard.

» In-lieu fees. Some developers may wish to provide funding in lieu of some or all of the required measures. In this way the program would act like an impact fee, with an important difference: Most impact fees go into auto infrastructure, while the principles of modern mitigation dictate that they go into demand reduction. A city might put in-lieu fees into improving non-auto facilities in the vicinity of a project, for example.

Borrowing from the Arlington program, the requirements run with the land as a condition of continued occupancy, with monetary penalties for noncompliance as well.

Measures and point values should reflect the principles of modern mitigation, and seek to reduce system-wide traffic. So measures that replace personal vehicle trips with transportation network company (TNC) trips would not pass muster, and those that move trips to less-congested times of day should earn fewer (or no) points compared to those that actually reduce VMT.

Some types of measures that a program might employ include:

ACTIVE TRANSPORTATION ACCESSIBILITY. Physical improvements that encourage people to walk and bicycle to nearby destinations including retail, services, and institutions (such as groceries and schools) reduce vehicular trips and especially SOV use. Enhancements to the accessibility of pedestrian and bicycle facilities are likely to influence incremental travel behavior shifts, in part by allowing better first- and last-mile connections to transit where possible, as well as traffic calming. Such improvements include better sidewalks, bike lanes and paths, and roadway crossings. Unlike other TDM measures, which target building occupants, improved neighborhood accessibility benefits both the immediate residents and potentially thousands of other residents, employees, shoppers, and diners in the impacted area, thereby reducing load on the regional transportation network.

Accessibility improvements, especially those off the building site, are one of the most likely measures to be funded with in-lieu fees. Whether funded in this way or directly constructed by an applicant, the program should specify that improvements be connected to the project in some way, so that they help mitigate local impacts as well as those more system-wide. A simple rule would be to require that they be implemented within a quarter-mile radius of small projects, a half-mile of medium projects, and a mile of larger projects.

Figure 3. Changes to the pedestrian network and the improvement of crosswalks to add connectivity (left) and accessibility improvements from these connections (right) can be quantified in order to provide mitigation credits.

Source: State Smart Transportation Initiative

A program could provide maps and lists of needed improvements or could negotiate the improvements on a case-by-case basis. It could also provide a tool that allows applicants and program staff to evaluate particular improvements quantitatively. The above figure provides a hypothetical example of a before-and-after walking accessibility score, using a GIS tool called Sugar Access (Citilabs).

AFFORDABLE HOUSING. As previously noted, most cities want to encourage development of affordable housing, and lower-income residents tend to drive less than others. So a program may award mitigation points for this measure. Rent or income thresholds can be tied to existing standards for affordability.

BICYCLE FACILITIES. In addition to providing credit for active transportation accessibility, the program may count as mitigation a variety of other measures to facilitate bike use. These include:

- Bike parking and storage (above levels required by code)
- Bike showers and lockers

» Bike share memberships for building users

» Location near a bike share kiosk

» Provision of a bike share kiosk

In addition to crediting these individual measures, the program may provide additional points for combining measures, e.g., bike share memberships and a kiosk.

CARPOOLING AND RIDESHARING. This staple of employer TDM programs can be part of a modern mitigation program as well. Points can be awarded for guaranteed rides home, ride-matching including school carpool organizing, high-occupancy vehicle (HOV) parking, and other outreach efforts.

CARSHARING. While a mile traveled in a shared car is the same as a mile traveled in a personal car, in the former case users pay by the mile or minute and so have an incentive to economize on driving. Therefore, a modern mitigation program could award credit for provision of shared cars on the premises and/or for covering membership fees (not trip fees) for building occupants.

CHILD CARE. Child care at an employment or residential use allows building occupants to avoid some travel, and could be awarded mitigation credit.

WHY FOCUS ON PARKING?

Empirical research supports the claim that when people are guaranteed free or low-cost parking at the beginning and end of their most common trips, they are more likely to drive for most trips. A study of New York residents with and without reserved parking spaces available to them found commuters with a guaranteed parking space at home are more likely to commute by automobile.[16] [17] As part of the same study, researchers compared two similar neighborhoods and found that people with guaranteed parking at home are 45 percent more likely to drive to Manhattan and 28 percent more likely to drive to work in general. A study of transit-oriented developments in New Jersey found that parking availability predicted people's driving habits more than access to transit.[18]

One study of nine U.S. cities over a period of 50 years found that gradual increases in parking supply led to significant increases in driving over time.[19] Most notably, as parking became more prominent in these nine cities, people began driving for short, local trips once served by walking, biking, and local transit.[20] Despite the generally high rate of driving in one of the cities studied, Hartford, CT, only 71 percent of insurance company employees drove alone to work when they were charged a monthly fee for parking, compared to 83 to 95 percent among employees who received free parking.[21] In fact, past research shows that pricing parking is the cornerstone of successful, employer-based TDM programs, which can reduce single-occupancy vehicle use by 12 to 40 percent.[22]

16 Weinberger, Rachel et al. "Guaranteed Parking—Guaranteed Driving," 2008, https://www.transalt.org/sites/default/files/news/reports/2008/Guaranteed_Parking.pdf;

17 Rachel Weinberger, "Death by a Thousand Curb-Cuts: Evidence on the Effect of Minimum Parking Requirements on the Choice to Drive." Transport Policy 20, (2012): 93–102. doi:10.1016/j.tranpol.2011.08.002.

18 Chatman, Daniel G. "Does TOD Need the T?." Journal of the American Planning Association 79, no. 1 (January 2, 2013): 17–31. doi:10.1080/01944363.2013.791008.

19 McCahill, Chris, et al. "Effects of Parking Provision on Automobile Use in Cities: Inferring Causality." Transportation Research Record: Journal of the Transportation Research Board 2543 (2016): 159–65. https://doi.org/10.3141/2543-19.

20 McCahill, Christopher and Norman Garrick. "Parking Supply and Urban Impacts." Parking: Issues and Policies, ed. Stephen Ison and Corinne Mulley, vol. 5 (Emerald Group Publishing Limited, 2014), 33–55. doi:10.1108/S2044-994120140000005017.

21 McCahill, Christopher and Norman Garrick. "Losing Hartford: Transportation Policy and the Decline of an American City." 18th Annual Meeting of the Congress for the New Urbanism (Atlanta, GA, 2010).

22 Higgins, Thomas J. "Demand Management in Suburban Settings." Transportation 17 (1990): 93–116. doi:10.1007/BF02125331.

EDUCATION AND MARKETING. Programs, which could be run by TMAs or site-specific staff and provide hands-on assistance and encouragement for building users who are unfamiliar with transit or other lower-VMT options. Such support could include route-mapping and cycling classes.

INFORMATION. Non-auto transportation options are often lesser known or mapped than are auto options, so information may assist building users in creating less traffic. Such measures include static wayfinding signs, e.g., to nearby transit stations or stops, or to important walkable destinations, live transit arrival information, and outreach and education to building occupants about lower-VMT travel options.

LAND USE MIX. Developments that provide multiple uses also provide opportunities for occupants to reduce travel by combining living, shopping, working, or recreation under one roof. A potential standard, from the forthcoming Los Angeles program draft, is to provide credits for developments that devote less than 85 percent of usable space to a single land use.

PARKING. While the number of stalls provided in a development is a key determinant of the need for mitigation, how the stalls are managed can also be credited as a TDM measure. If building users must pay for parking, through unbundled rents, an employee "cash-out" arrangment, or simple hourly or daily charges, mitigation points are appropriate. Additionally, mitigation may be earned if a development shares parking with another land use. Shared parking does not directly reduce SOV demand, but it does shrink the parking footprint in an area, allowing for more compact land uses, aiding in walkability, or shortening car trips.

TRANSIT. Provision of transit is an obvious measure to reduce SOV impacts, and building owners can take several actions to earn mitigation credits, including:

- Subsidizing transit passes for building users
- Providing shuttles or other connections from the building to a high-capacity transit station
- Funding new or improved transit service

TRANSPORTATION MANAGEMENT ASSOCIATIONS. TMAs are organizations that provide TDM services in a neighborhood or a region so that participating land uses can take advantage of economies of scale. It is appropriate to credit a building for mitigation measures received via TMA membership, with additional credit for supporting the TMA so that others may take advantage of the service and further reduce SOV demand.

The following charts summarize available mitigation measures in the implemented San Franscisco program. Note that the program does not include all measures described above.

Figure 4. San Francisco's TDM point structure, from the city's program standards guide.

Category	Measure	Points
ACTIVE-1	**Improve Walking Conditions:** Option A - D Provide streetscape improvements to encourage walking.	1
ACTIVE-2	**Bicycle Parking:** Options A - D Provide secure bicycle parking, more spaces given more points.	1 - 4
ACTIVE-3	**Showers and Lockers**	1
ACTIVE-4	**Bike Share Membership:** Locations A - B Provide a bike share membership to residents and employees for one point, another point given for each project within the Bike Share Network.	1 - 2
ACTIVE-5A	**Bicycle Repair Station**	1
ACTIVE-5B	**Bicycle Maintenance Services**	1
ACTIVE-6	**Fleet of Bicycles**	1
ACTIVE-7	**Bicycle Valet Parking**	1
CSHARE-1	**Car-share Parking and Membership:** Options A - E	1 - 5
DELIVERY-1	**Delivery Supportive Amenities**	1
DELIVERY-2	**Provide Delivery Services**	1
FAMILY-1	**Family TDM Amenities:** Options A - B	1
FAMILY-2	**On-site Childcare**	2
FAMILY-3	**Family TDM Package**	2
HOV-1	**Contributions or Incentives for Sustainable Transportation:** Options A - D	2 - 8
HOV-2	**Shuttle Bus Service:** Options A - B	7 - 14
HOV-3	**Vanpool Program:** Options A - G	1 - 7
INFO-1	**Multimodal Wayfinding Signage**	1
INFO-2	**Real Time Transportation Information Displays**	1
INFO-3	**Tailored Transportation Marketing Services:** Options A - D	1 - 4
LU-1	**Healthy Food Retail in Underserved Area**	2
LU-2	**On-site Affordable Housing:** Options A - D	1 - 4
PKG-1	**Unbundle Parking:** Locations A - E	1 - 5
PKG-2	**Short Term Daily Parking Provision**	2
PKG-3	**Parking Cash Out: Non-residential Tenants**	2
PKG-4	**Parking Supply:** Option A - K	1 - 11

NOTES:
A project sponsor can only receive up to 14 points between HOV-2 and HOV-3.

One point may be equal to a 1% reduction in VMT.

Source: City and County of San Francisco, CA

MONITORING AND EVALUATION. Unless an applicant satisfies their mitigation requirements upfront, with infrastructure or in-lieu fees, obligations in the program will continue indefinitely and will run with the land. Monitoring is therefore critical. Smaller land uses may self-report by certifying they are in compliance, with penalties for failing to report or reporting falsely. Larger land uses or those employing more complex measures that require explanation, such as education and outreach, should report in more detail. Travel surveys, car trip rates, utilization rates for transit, bikeshare and carshare, and parking occupancy rates provide useful data points for determining the performance of the program as a whole, as well as individual measures, so that localities can revisit and improve various elements.

The largest projects may, in addition to mitigation measure requirements, have performance targets they must meet. For employment uses, these targets may be in the form of average vehicle ridership, or employee vehicles divided by employees at a site. Performance targets for other land uses might include vehicle ownership, parking occupancy, or daily car trips.

ADOPTING A MODERN MITIGATION PROGRAM

As with any public innovation, a grasp of the technical aspects is a necessary but insufficient condition for success. Usually success requires something like a campaign, with concern for messaging, persuasion, and critical stakeholder needs. Fortunately, modern mitigation has a lot to offer stakeholders.

A starting point is to articulate a vision of healthy, connected, accessible neighborhoods where residents can get around easily (regardless of what mode they use), and can access the services and places they need on a daily basis. Setting that vision begs the question of how to create it, and why the policy changes being proposed will help achieve it.

A grand vision, however, does not always address specific stakeholder needs in specific settings. Below we examine a range of stakeholders in modern mitigation policy and projects, and discuss ways to productively engage them during program adoption. In each case we describe some benefits for the stakeholder group, relevant policy considerations, and discussion around engagement strategy.

Incumbent residents and businesses

While infill development has many benefits, including reduced VMT compared to greenfield siting, it also means there will be changes for the people who live and/or work near where those developments may be proposed. Conventional mitigation has sought to relieve fears of congestion but has compounded other problems. Modern mitigation offers more benefits.

Benefits to residents and businesses

- Well-planned infill brings neighborhood opportunities for shopping, employment, living, and meeting other resident needs. This is a key benefit sometimes lost in debates over parking and traffic. With modern mitigation, where demand reduction relieves the pressure to devote space and resources to parking, infill can be even more efficient. In distressed neighborhoods it may make the difference between a project that pencils out and one that doesn't.
- Projects also provide customers for local goods and services. More activity in an area means more resident, commuter, and shopper traffic (not always by car), which can boost existing businesses.
- Modern mitigation reduces traffic. Unlike conventional mitigation, which facilitates and even induces traffic, modern mitigation reduces SOV travel. Stakeholders may be understandably skeptical about this new practice; the results in the appendix may help allay their concerns. More powerful will be local tripmaking data, which is one reason that a sound program should include monitoring and evaluation.
- Project mitigation may include neighborhood improvements. While modern mitigation makes roadway capacity a last resort, it does allow for other developer-provided improvements that benefit local residents and customers, such as biking and walking facilities, traffic calming, bikeshare or carshare, or transit.

Policy considerations

- Modern mitigation does not change other parts of the code. Design guidelines, use, special use, massing, setbacks, noise, historic landmark, and other rules and regulations are not affected by modern mitigation.
- "Spillover parking" can be addressed. Neighbor concerns about competition for parking are common with infill projects, and the way modern mitigation uses parking as an indicator of SOV demand may cause more worry. In some areas, on-street parking management strategies, such as meters and residential permits, may need to be established or adjusted. In addition, neighbors (and standards) frequently overestimate the need for off-street parking. A parking survey may show substantial unused parking capacity.
- Modern mitigation doesn't preclude some auto-oriented improvements. Driveway designs and locations must still pass muster with transportation engineering reviews. In addition, while roadway capacity upgrades are no longer the first option under modern mitigation they may still be necessary, but far less often and with less impact due to reduced SOV demand (which the transportation entity requiring roadway improvements must take into account).
- New policies should generally not impose new restrictions on existing land uses, unless they trigger the mitigation program through expansion or use change. Existing businesses and other land uses, then, can continue to operate as before, while their new neighbors contribute to demand reduction.

"Perhaps the most important element in public engagement is that it be authentic—the community needs to have confidence that its input will be considered."

Discussion

Perhaps the most important element in public engagement is that it be authentic—the community needs to have confidence that its input will be considered. This may seem counter-productive—the goal here is to change policy—but conducting genuine civic engagement avoids cynicism and resistance to future change, instead creating trust and generating constructive feedback that can improve policy design.

Communicating the benefits of modern mitigation and taking feedback on the concept and policy design are ill-suited for the standard "three minutes at a public hearing" model. Other options include:

- Mapping exercises—either tabletop or "in the field" —can help identify what's working and what's not in the local transportation system, and can lead to conversations about how different policies or measures could improve the situation.
- Field trips—virtual or actual—can help stakeholders see various measures in action, to help them better understand the positive (or lack of negative) impacts that are possible. Similarly, testimonials from residents and neighborhoods that have a positive experience with particular measures are helpful.
- Walking or biking audits help stakeholders experience a place from a pedestrian point of view, and highlight the good, the bad, and the ugly of a place.
- Facilitated meetings that promote discussion, rather than a question/answer format, can help diffuse the "us (neighborhood) vs. them (city/developer)" dynamic.
- Small group meetings or meetings that focus on particular constituencies can go deeper on issues and address specific concerns of particular stakeholders, e.g., transit users, commuters, seniors, etc.
- Equitable outreach—seeking out all voices, not just those that are most concerned or have the most access to local government—can help to balance and enrich the conversation. This can include a range of strategies: hosting meetings in non-traditional places; offering childcare, food, and transportation; holding meetings in languages other than English or offering translation services; partnering with community or cultural groups; or conducting surveys that don't require a person to attend a meeting in person.

Two examples: Parking reform was successful in Buffalo, NY, for several reasons. First, city staff were informed and supportive of the efforts. They read literature and attended lectures and conferences. Second, there were active public engagement efforts to gauge support and hear concerns about the reforms. That included a kick-off event called Planning Day in Buffalo where 400 people attended and 150 provided comments on the city's Draft Land Use Plan. Finally, the plans were endorsed by local organizations such as the Bike and Pedestrian Advisory Board and the Elmwood Village Association, which recognized the benefits including potential for economic development. In contrast, similar efforts in Washington, DC, stalled partly because some viewed the reform as an attempt to convince residents they don't need a car or else residents feared the changes would result in parking overflow issues.[23, 24]

Regulated entities (developers and building owners)

Developers dislike uncertainty, and to the extent that modern mitigation is more predictable than negotiated roadway improvements, it may be the chief benefit of the program; hence its importance in the design. However, they have other considerations that program design and outreach should take into account.

Benefits to regulated entities

- Applicants can scope and develop projects faster and with more certainty. A developer can easily calculate TDM credits required and determine measures to meet that requirement.
- Developers and owners can devote space to the highest and best use, with reduced costs. TDM measures reduce the need for parking capacity, increasing space that can be rented and occupied. Developers can also reduce their capital costs, which can be considerable, especially for structured parking; the "Garagenator" app[25] is useful to demonstrate costs and savings. Reduced parking supply also reduces ongoing maintenance costs, which can help offset any ongoing costs of TDM under the program.
- Developers have a menu of choices from which to choose. Applicants can tailor their TDM measures to address neighbor concerns and to best serve building occupants. They can also select measures, including those of their own design or in-lieu fees, that are most cost-effective.

23 Hudson, Kris. "Cities Cut Parking Mandates: To Promote Transit, District of Columbia Considers Easing Rule on Developers." Wall Street Journal. 2013, July 9. Accessed at https://www.wsj.com/articles/SB10001424127887324251504578579982643189770.
24 Ibid.
25 Watry Design Inc, 2018, http://server.wdiparking.com/garagenator/ClientInfo.jsp.

"Developers dislike uncertainty, and to the extent that modern mitigation is more predictable than negotiated roadway improvements, it may be the chief benefit of the program; hence its importance in the design."

Policy considerations

- The benefits from predictability and certainty will diminish to the extent that localities require roadway improvements in addition to TDM. Safety improvements, including those for pedestrians, are a must where needed, but those aimed at vehicle delay should be employed as little as possible.
- For most developers—and their debt and equity partners—it is important that a project be marketable, even if they are planning to hold or occupy the building themselves. At some point conditions may change and they could need to sell. Therefore, a project that is relatively generic in terms of its parking capacity can be seen as a benefit. One way to address this issue is to demonstrate, through parking utilization studies—either from the literature[26] or preferably from a local survey—that buildings with less-than-generic parking can succeed.
- While it can be a benefit to allow for flexibility in TDM measure selection, that puts the onus on the program to monitor and evaluate results, particularly for large projects, and to make adjustments where needed.
- Development pro formas usually focus on capital costs. If the developer plans to sell, then ongoing costs for utilities and maintenance may not be part of the equation at all. Modern mitigation forces this issue by imposing runs-with-the-land requirements. Existing programs have shown that these can work, but program staff should be prepared for questions and pushback from developers to whom this might be new. Developers who want to use in-lieu fees, essentially paying for TDM measures to be administered by the locality or its agents, should be able to do so. But those fees should be set so they can provide meaningful demand reduction that can be evaluated for effectiveness.

26 e.g., parking utilization studies.

Discussion

As with other stakeholders, examples of successful projects and programs will go a long way to educate developers about the benefits of a modern mitigation policy. Other tactics that may be successful include peer-to-peer exchanges, where developers that have successfully used such measures advise or mentor developers new to the idea, and design competitions that require the incorporation of mitigation measures to win. Such a competition could be sponsored by a local civic group or business association. This model has been successfully used to promote the use of low impact design, and could be successful in this case as well.

San Francisco, in implementing their TDM program, had to make provisions to make sure their program didn't impose too much burden on developers. Those include gradually ramping up the program from 50 to 100 percent of targets over three years, lower targets for small projects, and target caps for large projects. The program faced little pushback largely because it was highly technical, well-researched, and thoroughly tested. Those responsible for implementing the program were involved from the beginning and staff were well prepared to answer questions.[27]

City staff

Some staff members may have spent years focusing on infrastructure supply. That work should not be dismissed as wrong, but those staff members may need extensive familiarization with demand-side policy. And modern mitigation policy design should take into account staff needs and capacity for administration and enforcement.

Benefits to city staff

- Modern mitigation's ability to remove some of the negotiation involved in conventional practice can make administration smoother.
- The clear benefits to incumbent land uses of reduced traffic and new travel choices can reduce contentiousness over development that can make life difficult for staff.

27 Conversation with Corey Teague, Assistant Zoning Administrator, April 6, 2017.

"New policy can be uncomfortable for those involved in administering it. Knowing this, cities can proactively promote professional development opportunities, including conferences with staff from other places, that educate staff about modern mitigation and related tools."

Policy considerations

- Requirements and TDM credits should be designed to minimize the needs for time-consuming and contentious staff judgement calls. For example, TDM credits for improvements to bike and pedestrian networks can be evaluated through an accessibility tool, and traffic calming can be based on achieving target speeds.
- Staff, who will hear about compliance and other issues, should have an ongoing role in improving the program design and measure specifications over time. Improvements should focus not only on efficacy (e.g., adjusting credits for TDM measures) but also for issues involved in administration and public acceptance.

Discussion

New policy can be uncomfortable for those involved in administering it. Knowing this, cities can proactively promote professional development opportunities, including conferences with staff from other places, that educate staff about modern mitigation and related tools. Elected leaders can set a clear policy agenda with respect to the transportation vision of their city, and include an emphasis on TDM. And, if need be, developers and advocates can help educate individual staff using case studies and data that demonstrate the benefits of policy change to neighborhoods and cities.

Community as a whole

Everyone in the community, whether or not a member of one of the aforementioned groups, has a stake in rules around the built environment. Modern mitigation offers a compelling case for community benefit, much of which is covered in broad brushstrokes in the section giving the policy rationale. In communicating these benefits, it can be useful to lead with values, especially if a city has an adopted values or goals statement (in a comprehensive plan, for example), as well as the following benefits of a more balanced transportation system:

Safety

- Walkable urban neighborhoods are safer than auto-dependent neighborhoods.[28]
- Policies that increase the number of bicyclists and pedestrians help improve the safety of those on bike and foot.[29]
- Making streets safer for pedestrians and bicyclists makes them safer for everyone.
- More people walking means more "eyes on the street," which helps reduce crime.

Health

- Increasing walkability increases resident health.
- Reduced car use improves local air quality and reduces exposure to harmful pollutants.[30]
- Walkable, bikeable communities help increase social capital.[31]

Economic Impact

- More walkable places are correlated with higher rents, retail revenues, and residential property values.[32]
- Homes in walkable places held their value better during the 2008-11 recession than those in suburbs.[33]
- Households in neighborhoods with access to transit and walkable/bikeable streets tend to spend less on transportation.
- Communities with walkable street networks and well-managed growth are more efficient for local governments to provide services to, so they require less tax revenue for those services.[34]
- Communities that follow smart growth principles tend to generate more tax revenue for local governments.

---

28 Litman, T. and S. Fitzroy. "Safe Travels: Evaluating Mobility Management Traffic Safety Impacts" (18 July 2017, Victoria Transport Policy Institute). Accessed at www.vpti.org/safetrav.pdf.

29 Jacobsen, P L. "Safety in numbers: more walkers and bicyclists, safer walking and bicycling." Injury Prevention 2003; 9: 205–209.

30 Transportation Research Board. Transit Cooperative Research Program Synthesis 84. "Current Practices in Greenhouse Gas Emissions Savings from Transit: A Synthesis of Transit Practice. (2010). doi: 10.17226/14385 Accessed at http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_syn_84.pdf.

31 Kamruzzaman, et al. "Patterns Of Social Capital Associated With Transit Oriented Development." (2010). Accessed at http://www.sciencedirect.com/science/article/pii/S0966692314000271.

32 Alfonzo, M. and C.B. Leinberger. "Walk this Way: The Economic Promise of Walkable Places in Metropolitan Washington, D.C." (May 25, 2012, Brookings). Accessed at https://www.brookings.edu/research/walk-this-waythe-economic-promise-of-walkable-places-in-metropolitan-washington-d-c/.

33 Ibid.

34 National Association of Realtors, Smart Growth in the 21st Century Class, Accessed at https://www.nar.realtor/smart-growth/smart-growth-program/smart-growth-in-the-21st-century-class/.

"The best policies and the best communication plans can be foiled by community organizing—or they can be buoyed by it. Local government often forgets to play the inside/outside game—that is, to plan good projects or policies inside city hall and to work with advocates, supportive organizations, and residents outside city hall."

- Although drivers usually spend more at retail locations per trip, pedestrians and bicyclists make more trips, and thus spend more over time.
- Fewer car trips mean the region is less dependent on imported fossil fuels.

Transportation access

- Trips of less than 2 miles make up about 40% of all trips—trips of this length are easily made on foot, bike, or transit.[35]
- Increases in walking, biking, and transit use can ease traffic congestion and delay or remove the need for auto-related infrastructure.
- TDM helps reduce congestion on streets, which saves people time.
- Reducing vehicle use saves money in household transportation spending.

Discussion

The suggestions here are only a start; a major campaign around a new policy will require not only listening but likely also professional assistance in messaging that is tailored to the specific local audience. Arlington, VA, whose robust TDM efforts we describe above, has used storytelling to communicate the benefits of their program. They collected short stories from a range of businesses and institutions that benefit from having more people bike, walk, and use transit.[36] To get these and other similar messages out, they use websites, social media, earned media, and more. Their efforts are a great example of combining educational efforts with building support over the long term, and of reaching people where they are.

35 Litman, T. "Short and Sweet: Analysis of Shorter Trips Using National Personal Travel Survey Data." (18 July 2017, Victoria Transport Policy Institute).

36 Arlington's Car-Free Diet, Car-Free Diet Partner Stories, Accessed at https://www.carfreediet.com/news-stories/car-free-diet-partner-stories/.

While the data on TDM are persuasive, it's important to remember that people's reactions to new ideas are often influenced by feelings as well as facts. Helping people connect with a story about their neighborhood and how it could be better can help overcome the fear of change. It's also important to acknowledge that the resistance of some neighborhoods to development, and thus TDM, can be rooted in systemic classism and racism. Affluent neighborhoods may view transit and increased density as bringing in people of color or of lower income, and resist the change based on subconscious or overt bias. Poorer neighborhoods with more people of color may view development, bike lanes, and other amenities as gentrification and the beginning of displacement. In either case, the unspoken racial and class dynamics can heavily influence attitudes toward development. Ignoring these dynamics is counterproductive—they should be acknowledged and discussed in a context where there are trained facilitators.

Finally, there are the basics of organizing. The best policies and the best communication plans can be foiled by community organizing—or they can be buoyed by it. Local government often forgets to play the inside/outside game—that is, to plan good projects or policies inside city hall and to work with advocates, supportive organizations, and residents outside city hall. The outside game can benefit from internal knowledge and champions, and can give political cover to staff and elected officials. Finding the people and groups that support modern mitigation policy and working with them is a critical part of overcoming resistance to it.

CONCLUSION

The modern mitigation program described in this guide offers many advantages, as it seeks to reduce auto traffic through demand reduction rather than to induce it through supply increases. It does so based on easily-accessible project data, with transparent and consistent mitigation requirements that address needs and concerns of all stakeholder groups involved.

It does not completely end the practice of addressing the localized effect of auto travel from a land use. Safety concerns about driveway locations and turning movements into and out of a land use must still be addressed. What modern mitigation does, however, is reduce traffic as much as possible before accommodating it.

This approach has roots going back decades, in both employer-driven TDM efforts and in local government programs. California, with its state-level reform that is now driving local innovation in this area, is where most current activity is taking place, and that work deserves attention and evaluation since programs will inevitably experience some issues as well as successes. But transportation mitigation is practiced across the country, with all of the downsides described in this report, so it is not too soon for leaders outside of California to begin their own modernization reforms.

APPENDIX

Evaluations of existing programs and research provide a wealth of information by which to judge the effectiveness of various TDM measures. However, like most research findings related to transportation, these come from a variety of settings and are based on TDM measures that are operationalized in various ways, and they describe results in various ways—VMT reduction, mode shift, parking reduction, etc. The following table summarizes findings related to various categories of measures that local governments can use to develop mitigation requirements or options.

Affordable housing	*CAPCOA: 0.04 to 1.20 percent reduction in VMT for incorporation of 30 percent below-market housing adjacent to transit. The range of VMT reduction represents the percent below market rate housing included in a development.*[1] *Center for Neighborhood Technology (CNT): In metro regions, home to two-thirds of California's population, identically-composed and located low-income households are predicted to drive 10% less than the median, very low-income households 25% less, and extremely low-income households 33% less. By contrast, middle-income households are predicted to drive 5% more and high-income households 14% more. An extremely low-income family in a transit-rich area demands 55% less parking than the median while the average middle-income family in those same transit-rich areas demands 5% more parking.*[2] *San Francisco: Excludes affordable housing projects from TDM requirements. City data show these types of projects typically include very limited accessory parking.*[3]
Bicycle infrastructure/ amenities improvements	*CAPCOA: Estimates VMT reduction of between 3.0 and 21.3 percent based on the land use context and the assumption that measures are grouped together.*[4] *Bike-specific TDM strategies addressed as a "grouped" strategy. Individual measures (bike lanes, bike parking, showers, lockers) have minimal impact implemented alone.* *San Francisco: A project that includes a more comprehensive set of facilities: bike parking, bike lanes and paths, and destination amenities such as showers, is anticipated to get between one- and four-percent reductions in VMT. Additionally there is an estimated one-percent VMT reduction for each of these strategies—valet bike parking for events and bicycle fleet vehicles for businesses or neighborhoods.*[5] *A King County, WA study finds good walking and bicycling infrastructure lowers VMT by 5 to 15 percent.*[6] *A project in downtown Portland, OR, with secure bike parking, showers, and changing rooms reduced VMT by 46,400 miles in one year.*[7]

Bike parking	*CAPCOA: Estimates a 0.625 percent reduction in VMT if bike parking at non-residential destinations is provided as a standalone. However, bike parking should be paired with other bicycle infrastructure for the greatest impact.*[8] *Valet bike parking: Bike corrals at Portland businesses increased the "person capacity" of curb parking by as much as 1,200 percent.*[9] *San Francisco: Estimates up to 4 percent reduction in VMT, depending on surrounding land uses.*[10] *(Transportation Demand Management; Technical Justification, 2016, pp. 25–26)* *A study of bike-and-rides at 9 Metra stations in Chicago found that improved bike parking accounted for an increase in bicycle use and an avoided 1,739 VMT per day.*[11]
Bikeshare program	*CAPCOA: New program with limited studies documenting effects on VMT found. Observed use shows bike share programs have a positive impact on reducing VMT, especially when implemented as a grouped strategy. Complementary strategies include programs and policies to improve bike infrastructure.*[12] *Mosaic: Minneapolis bikeshare reported 23 percent of bikeshare trips would have been made by auto. Denver bikeshare reported 43 percent of trips would have been made by car.*[13] *San Francisco: Bikeshare memberships may result in a 2 percent reduction in VMT. Location of bikeshare station is critical; the maximum benefit is seen if a bikeshare station is within approximately 1,000 feet of a development project.*[14] *Georgetown Public Policy Review: Finds bikeshare systems may result in an annual reduction of up to 200 fewer miles driven per person.*[15]
Carpool, vanpool, and shuttle bus	*CAPCOA: Between 1 and 15 percent reduction in VMT depending on density and land use.*[16] *Mosaic: Portland Metro's carpool matching program achieved approximately 0.07 to 0.1 percent reduction in regional VMT.*[17] *San Francisco: Between a 7 and 14 percent reduction in VMT for carpools and vanpools, depending on land use and program details. Shuttle buses, with longer operating hours, may result in additional VMT reductions.*[18]

Carshare program	*CAPCOA: Identifies a 0.4 to 0.7 percent reduction in VMT.*[19] *San Francisco: "City CarShare membership typically lowered daily travel by 7 vehicle miles. Residing in dense, transit-friendly San Francisco reduced the figure by another 3 vehicle miles."(Cervero, Golub, & Nee, 2007, p. 38)* *Fehr and Peers: Based on a 2007 study, the authors identify a range of intermediate-term VMT reduction of 38 percent (two years) and a long-term (four years) VMT reduction of 67 percent based on a program that includes preferential carshare parking near the destination (usually a workplace) entrance.*[20,21] *Mosaic: 0.05 to 0.2 percent reduction in VMT for short term. Providing increased funding support for carshare may result in a 1.7 percent VMT reduction.*[22]
Connectivity, accessibility, walkability, mixed uses	*CAPCOA: Improving the pedestrian network may increase the walk mode share 2 percent.*[23] *Oregon Sustainable Transportation Initiative: Neighborhoods with pedestrian networks reduce VMT by a minimum of 2 percent.*[24] *San Francisco: Improving the streetscape to encourage walking may increase walking 1 percent.(Transportation Demand Management; Technical Justification, 2016, p. 25)* *TCRP 95 finds the rates of utilitarian walking increases with the presence and completeness of a city's sidewalk network.*[25] *VDOT: Forthcoming research for the Virginia Department of Transportation shows that household auto modeshare drops by 40 percent between neighborhoods with poor walking accessibility to non-work destinations and those with the best walking accessibility to non-work destinations. Similarly, household VMT drops by about 60 percent.*[26] *Mixed-use developments generate significantly less travel demand than separated uses, due to internal capture of trips.(US EPA, 2013)* [27]
Guaranteed ride home program	*CAPCOA: As part of a robust Commute Trip Reduction TDM program GRH contributes to between a 4.2 and 21.0 percent reduction in commute VMT.*[28] *FTA: No specific VMT reductions given. Examples of how Guaranteed Ride Home (GRH) benefits mode shift are cited in a 2007 study. The study notes that a 1999 survey of Tappan Zee Bridge express bus commuters found 16 percent said they would not use transit without the GRH program, and a 2003 study prepared for the Denver Regional Council of Governments that found a GRH program would increase the frequency of carpooling by 17 percent.*[29] *Alameda County Transportation Commission: In 2014, the annual number of weekday vehicle miles avoided because of the GRH totaled 4,100,962.*[30]

Marketing, education, outreach	*CAPCOA: 0.8 to 4.0 percent reduction in VMT.*[31] *Alta Planning and Design's outreach programs resulted in measureable TDM benefits. For example, the community of Juanita in King County, WA, participated in a 16-week program to reduce auto dependence, reducing drive-alone trips in the community by almost 145,000 miles.*[32] *Arlington County, VA: Arlington County Commuter Services (ACCS) provides information and services to increase the use of alternative transportation. Between 2008 and 2014, Arlington documented an average weekday reduction in SOV trips of 8 percent with a resulting reduction in VMT of 39 percent.*[33] *Portland SmartTrips: In 2007, the SmartTrips and TravelSmart projects documented a reduction of 9 to 13 percent in drive-alone car trips by area residents with a corresponding increase in walking, bicycling, and transit mode shares in the SmartTrips areas.*[34] *The SmartTrips Welcome program, targeting new residents in a neighborhood, resulted in a 10.4 percent reduction in drive alone trips for all new residents, not just those that participated in the program.*[35] *San Francisco: Up to 4 percent reduction in VMT.*[36] *Seattle Best Practices: Up to 21 percent transit ridership increase.*[37]
Multimodal wayfinding	*Mosaic: Quality multi-modal wayfinding offered to employees resulted in a 17 percent mode shift from driving to active transportation and transit.*[38] *San Francisco: Notes the dearth of literature on the topic, but acknowledges its potential relevance, estimating a potential 1 percent VMT reduction.*[39]
Neighborhood-supportive services such as grocery stores, delivery services, and non-site childcare	*San Francisco: The city's TDM documentation estimates VMT reductions as follows:*[40] *Delivery and neighborhood-supportive amenities and services: Potential VMT reduction of 1 percent. Delivery "by bicycle, on foot, or in a delivery vehicle that makes multiple stops." No literature was found to document the effectiveness of this strategy but expert opinion is in favor of the utility of this strategy.* *On-site childcare: Estimated 2 percent reduction in VMT due to removing the need to drive a child to daycare at a separate location.*
Parking cash-out program	*CAPCOA: Between 0.6 and 7.7 percent reduction in commute VMT, depending on land uses.(California Air Pollution Control Officers Association, Northeast States Coordinated Air Use Management, National Association of Clean Air Agencies, Eviron, & Fehr & Peers, 2010, p. 66)* *San Francisco: May result in a 2 percent reduction in VMT for non-residential tenants.(Transportation Demand Management; Technical Justification, 2016, p. 31)* *TCRP Report 95: May create a 12 percent reduction in commute VMT.*[41]

Parking management for private, off-street	*CAPCOA: 5 to 12.5 percent VMT reduction, depending on a limit of parking supply.*[42] *Cambridge, MA: The city runs a highly effective TDM program through its Parking Transportation Demand Management ordinance (PTDM).*[43] *The PTDM ordinance is credited with a 5 percent drop in drive-alone trips to work, a 4 percent increase in transit trips, and a doubling of bicycle trips to work. This program is also credited with reduced parking supply, improved air quality, and increased bike, walk, and transit use.*[44] *Mosaic: 0.80 to 1.80 percent VMT reduction.*[45] *Oregon Greenhouse Gas Reduction Toolkit: 5 to12 percent reduction in VMT with effectiveness increasing over time.*[46] *San Francisco: 1 to 11 percent reduction in VMT, depending on land use.*[47]
Parking management for on-street and public	*CAPCOA: 2.8 to 5.5 percent reduction in VMT.*[48] *San Francisco: For non-residential properties, parking passes sold on a daily or hourly basis should produce a 2 percent reduction in VMT.(Transportation Demand Management; Technical Justification, 2016, p. 31)* *Washington State DOT: "When parking charges are increased from approximately $0.28 per hour to $1.19 per hour... [The result is] an 11.52 percent decrease in VMT and a 9.92 percent decrease in CO2. This suggests that parking charge rates generate a substantial influence on VMT and CO2 only when they reach higher-end rates."*[49]
Preferential parking for rideshare	*CAPCOA: Between a 1 and 15 percent commute trip VMT reduction depending on surrounding land use.*[50] *San Francisco bundles this measure under High Occupancy Vehicles; estimating a maximum reduction in VMT of 14 percent, depending on surrounding land use and transportation options.*[51]
Residential area parking permits	*CAPCOA: No effect if used alone. Should be grouped with other trip reduction and parking strategies and subsidized neighborhood transit passes. Surrounding land uses—high, medium, or low density and quality of transit service—will affect the amount of VMT reduced*[52] *San Francisco: Does not assign a specific reduction in VMT for residential parking permits. Notes provision of unregulated off-street parking induces demand for driving of both residents and employees in an area.*[53]
Real-time trip options data	*Mosaic: Real-time arrival information impacts perceived and actual wait time.* *A Seattle study found a 13 percent reduction in perceived wait time and a two-minute reduction in actual wait times. Accurate arrival information also affects ridership.* *A Chicago study recorded a 2 percent bump in ridership a year after the real-time system was implemented.(Oregon Department of Transportation, n.d., p. 2)* *San Francisco: Assigns a 1 percent reduction in VMT.*[54]

Telework, compressed and alternative work schedules	*Mobility Lab: Strategy does not guarantee a reduction in VMT, as the teleworker or employee on an alternative schedule may run home-based errands in their car during the day. Many employers and employees are aware of teleworking options, so TDM agencies and employers are better served focusing on other TDM options.5*[5] *San Francisco: No point values to these options due to the difficulty in monitoring and implementing these programs.*[56]
Transit fares fully or partially subsidized	*CAPCOA: 0.3 to 20 percent reduction in commute trip VMT. The variations stem from the number of eligible employees and worksite land use settings (low-density suburb, suburban center, and urban location).*[57] *Mosaic: Eliminating fares in Corvallis, OR resulted in a 38 percent bump in ridership. Each 1 percent change in bus fares produces a 0.4 percent change in ridership in the short term. A corresponding increase or decrease in rail fares results in a 0.2 percent change in ridership.*[58] *WSDOT: Lowering transit fares in the Puget Sound region resulted in a decrease in VMT from 1.34 to 2.23 percent, depending on land use and intersection densities.*[59]
Transportation network company access	*A study in New York found that the presence of TNCs actually increased VMT and congestion.(Bruce Schaller, 2017)* *A study in the Denver area reached similar conclusions.(Alejandro Henao, 2017)*
Unbundle parking costs from property costs	*CAPCOA: 2.6 to 13 percent commute VMT reduction.*[60] *The range of effectiveness is related directly to the land use and range of available transportation alternatives.* *San Francisco: 1.0 to 5.0 percent depending on land use type as noted for CAPCOA.*[61] *TCRP Report 95: 10 percent VMT reduction in areas with poor transit. 36 percent where transit is high quality.*[62]

APPENDIX FOOTNOTES

1. California Air Pollution Control Officers Association, et al. Quantifying Greenhouse Gas Mitigation Measures, 176.
2. (Gregory L. Newmark & Peter M. Haas, 2015, p. 15) https://chpc.net/wp-content/uploads/2016/05/CNT-Working-Paper-revised-2015-12-18.pdf.
3. Transportation Demand Management; Technical Justification, 11.
4. California Air Pollution Control Officers Association, et al. Quantifying Greenhouse Gas Mitigation Measures. (August 2010): 182, 200. Accessed at http://www.capcoa.org/wp-content/uploads/2010/11/CAPCOA-Quantification-Report-9-14-Final.pdf.
5. Transportation Demand Management; Technical Justification (San Francisco, CA, June 2016): 24-26. Accessed at http://default.sfplanning.org/plans-and-programs/emerging_issues/tsp/TDM_Technical_Justification.pdf.
6. Oregon Department of Transportation. Bicycle and Pedestrian Connectivity, 1-2. Accessed August 7, 2018. https://www.oregon.gov/ODOT/Planning/Documents/SR-Bicycle-Pedestrian-Connectivity.pdf.
7. Oregon Department of Transportation. Bike Parking, 2. Accessed August 7, 2018 at https://www.oregon.gov/ODOT/Planning/Documents/Mosaic-Bike-Parking-Program.pdf.
8. California Air Pollution Control Officers Association, et al. Quantifying Greenhouse Gas Mitigation Measures, 202.

9. Oregon Department of Transportation. Bike Parking, 3.
10. City and County of San Francisco. Standards for the Transportation Demand Management Program, 12. Accessed August 7, 2018, http://default.sfplanning.org/plans-and-programs/emerging_issues/tsp/tdm_Program_Standards-011917.pdf.
11. Kuzmyak, Evans, and Pratt. Traveler Response to Transportation System Changes Handbook, Third Edition: Chapter 16, Pedestrian and Bicycle Facilities, 16–388. Accessed July 7, 2017, at https://www.nap.edu/read/22791/chapter/5#388.
12. California Air Pollution Control Officers Association, et al. Quantifying Greenhouse Gas Mitigation Measures, 256.
13. Oregon Department of Transportation. Bike Sharing, 2. Accessed February 27, 2017, at https://www.oregon.gov/ODOT/Planning/Documents/Mosaic-Bike-Sharing-Program.pdf.
14. Transportation Demand Management; Technical Justification (San Francisco, CA, June 2016), 26. Accessed at http://default.sfplanning.org/plans-and-programs/emerging_issues/tsp/TDM_Technical_Justification.pdf.
15. "Beyond Urban Planning: The Economics of Capital Bikeshare." Georgetown Public Policy Review, April 7, 2014. Accessed at http://gppreview.com/2014/04/07/beyond-urban-planning-the-economics-of-capital-bikeshare/.
16. California Air Pollution Control Officers Association et al. Quantifying Greenhouse Gas Mitigation Measures, 227.
17. Oregon Department of Transportation. Ridesharing, 2. Accessed August 7, 2018 at https://www.oregon.gov/ODOT/Planning/Documents/Mosaic-Ridesharing-Programs.pdf.
18. Transportation Demand Management; Technical Justification, 29.
19. California Air Pollution Control Officers Association, et al. Quantifying Greenhouse Gas Mitigation Measures, 245.
20. Ibid., 25.
21. Chan, Tien-Tien. "TDM Framework for Growth. Summary Findings - Literature Review (Final)." (March 30, 2015): 4. Accessed at http://default.sfplanning.org/plans-and-programs/emerging_issues/tsp/tdm_Final_SF_TDM_Lit_Review_Letter_Summer2014.pdf.
22. Oregon Department of Transportation. Car Sharing, 3. Accessed August 7, 2018, at https://www.oregon.gov/ODOT/Planning/Documents/Mosaic-Carsharing-Programs.pdf.
23. California Air Pollution Control Officers Association, et al. Quantifying Greenhouse Gas Mitigation Measures, 186.
24. Oregon Department of Transportation. Strategy Report: Pedestrian Environment, 1. (Oregon Department of Transportation, 2010). Accessed August 7, 2018 at https://www.oregon.gov/ODOT/Planning/Documents/SR-Pedestrian-Environment.pdf.
25. Kuzmyak, Evans, and Pratt. Traveler Response to Transportation System Changes Handbook, Third Edition: Chapter 19, Employer and Institutional TDM Strategies, 16-20.
26. State Smart Transportation Initiative and Virginia Office of Intermodal Planning and Investment, Accessibility in Practice (July 2017) https://www.ssti.us/2017/07/accessiblity-in-practice/.
27. (Bochner et al., 2011) Accessed at https://static.tti.tamu.edu/tti.tamu.edu/documents/5-9032-01-1.pdf.
28. California Air Pollution Control Officers Association, et al. Quantifying Greenhouse Gas Mitigation Measures, 223.
29. Menczer, William B. "Guaranteed Ride Home Programs: A Study of Program Characteristics, Utilization, and Cost." Journal of Public Transportation 10, no. 4 (2007): 143. Accessed at http://scholarcommons.usf.edu/jpt/vol10/iss4/7.
30. Alameda County Transportation Commission. Guaranteed Ride Home Program Evaluation, Final Report (Alameda County, CA, 2014): 5–1. Accessed at http://grh.alamedactc.org/wp-content/uploads/2015/08/Eval_FINAL_web.pdf.
31. California Air Pollution Control Officers Association, et al. Quantifying Greenhouse Gas Mitigation Measures, 240.
32. Jessica Roberts, "King County Metro In Motion TDM," Alta Planning + Design, August 19, 2015, http://altaplanning.com/projects/king-county-tdm/.
33. "Reduction in SOV Trips." Transportation. Accessed January 5, 2017 at https://transportation.arlingtonva.us/key-performance-measures/mobility/reduction/.
34. Pedestrians and Bicycle Information Center. "PBIC Case Study: Portland Smart Trips." (October 27, 2007). Accessed at http://www.pedbikeinfo.org/cms/downloads/ENC.PortlandSmartTrips.pdf.
35. Cullbridge Marketing and Communications. "Tools of Change: Portland's Smart Trips Welcome Program." Tools of Change. Accessed January 18, 2017 at http://www.toolsofchange.com/en/case-studies/detail/658.
36. Transportation Demand Management; Technical Justification, 30.
37. Seattle Department of Transportation. Best Practices in Transportation Demand Management (Seattle, WA, January 2008): 7C–2-3. Accessed at https://www.scribd.com/document/235793024/07-SEATTLE-Best-Practices-in-Transportation-Demand-Management.
38. Oregon Department of Transportation. Wayfinding and Signage, 2. Accessed July 31, 2018 at https://www.oregon.gov/ODOT/Planning/Documents/Mosaic-Wayfinding-Signage.pdf.
39. Transportation Demand Management; Technical Justification, 29.
40. Transportation Demand Management; Technical Justification, 28.
41. Vaca, Erin and Richard Kuzmyak. TCRP Report 95: Traveler Response to Transportation System Changes:

Parking Pricing and Fees. 2005.
42. California Air Pollution Control Officers Association, et al. Quantifying Greenhouse Gas Mitigation Measures, 207.
43. City of Cambridge. Chapter 10.18 - Parking and Transportation Demand Management Planning; Parking Space Registration. Code of Ordinances, Cambridge, MA, Municode Library,1998. Accessed at http://code.cambridgema.gov/2015-12/10/6/.
44. 2006 - 2010 Cambridge Journey to Work—CDD—City of Cambridge, Massachusetts. Accessed January 5, 2017 at http://www.cambridgema.gov/CDD/factsandmaps/transportationdata/200610jtwtable.
45. Oregon Department of Transportation. Parking Demand Management and Pricing, 3. Accessed August 7, 2018 at https://www.oregon.gov/ODOT/Planning/Documents/Mosaic-Parking-Demand-Management-Pricing.pdf.
46. Oregon Department of Transportation. Parking Management, 1. Accessed August 7, 2018 at https://www.oregon.gov/ODOT/Planning/Documents/SR-Parking-Management.pdf.
47. City and County of San Francisco. Transportation Demand Management Measures, 75. Accessed February 13, 2017 at http://default.sfplanning.org/plans-and-programs/emerging_issues/tsp/tdm_Measures-011917.pdf.
48. California Air Pollution Control Officers Association, et al. Quantifying Greenhouse Gas Mitigation Measures, 213.
49. Frank, Lawrence D., et al. "An Assessment of Urban Form and Pedestrian and Transit Improvements as an Integrated GHG Reduction Strategy." (Washington State: Department of Transportation, April 1, 2011): 34. Accessed at http://www.wsdot.wa.gov/research/reports/fullreports/765.1.pdf.
50. California Air Pollution Control Officers Association, et al. Quantifying Greenhouse Gas Mitigation Measures, 227.
51. (Transportation Demand Management Measures, n.d.).
52. California Air Pollution Control Officers Association, et al. Quantifying Greenhouse Gas Mitigation Measures, 244.
53. Transportation Demand Management; Technical Justification, 31.
54. Transportation Demand Management; Technical Justification, 29.
55. "("Transportation Agencies," 2014)
56. Transportation Demand Management; Technical Justification, 23.
57. California Air Pollution Control Officers Association, et al. Quantifying Greenhouse Gas Mitigation Measures, 230.
58. Oregon Department of Transportation. Decrease or Eliminate Transit Fares, 1-2. Accessed February 27, 2017 at https://www.oregon.gov/ODOT/Planning/Documents/Mosaic-Decrease-or-Eliminate-Transit-Fares.pdf.
59. Frank, Lawrence D. et al. "An Assessment of Urban Form and Pedestrian and Transit Improvements as an Integrated GHG Reduction Strategy," 34.
60. California Air Pollution Control Officers Association et al. Quantifying Greenhouse Gas Mitigation Measures, 210.
61. Transportation Demand Management Measures, PKG-1.
62. (Erin Vaca & Richard Kuzmyak, 2005, Chapter 13)" 13–16.

About the Mayors Innovation Project

The Mayors Innovation Project is a learning network among American mayors committed to "high road" policy and governance: shared prosperity, environmental sustainability, and efficient democratic government. We are a project of COWS.

About SSTI

The State Smart Transportation Initiative promotes transportation practices that advance environmental sustainability and equitable economic development, while maintaining high standards of governmental efficiency and transparency.