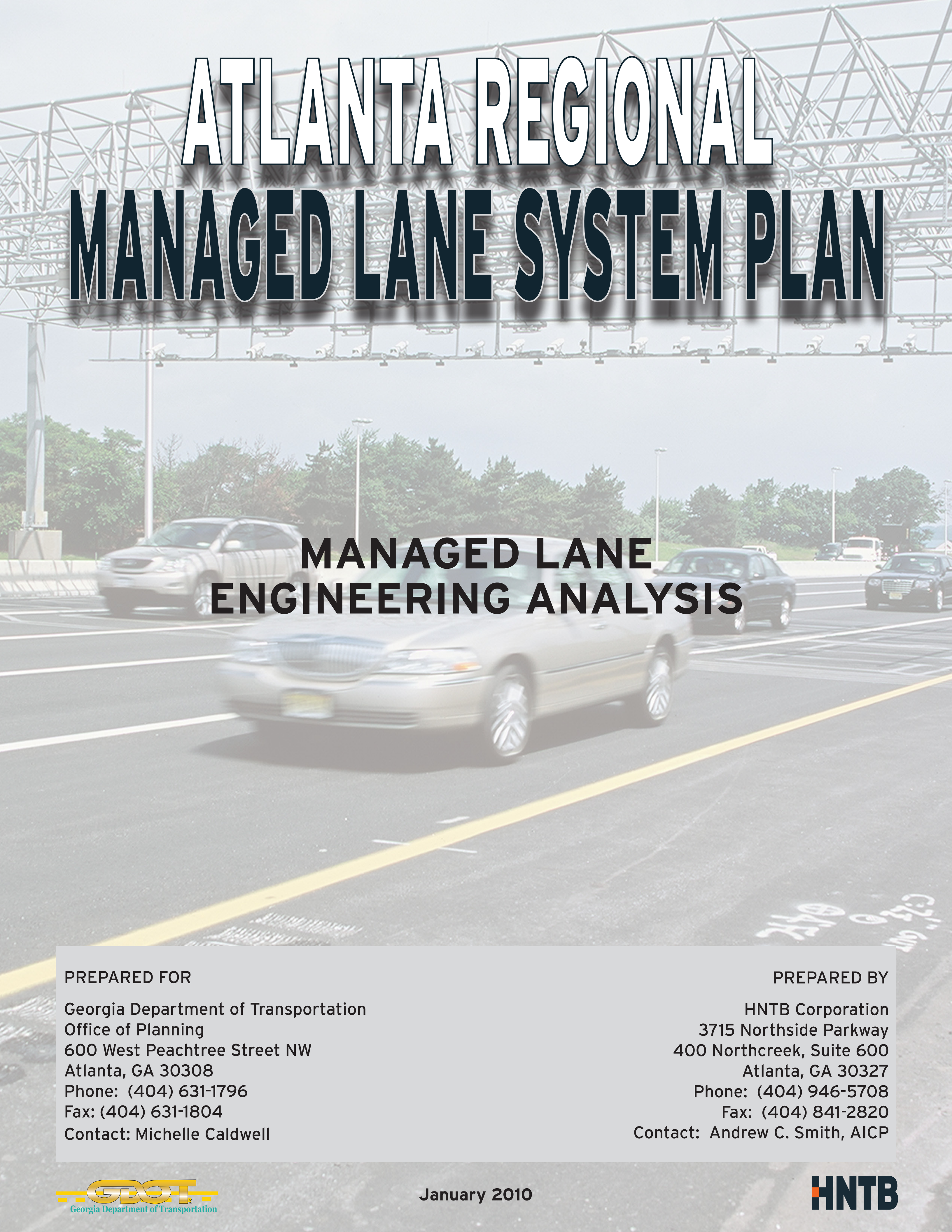

ATLANTA REGIONAL
MANAGED LANE SYSTEM PLAN

MANAGED LANE ENGINEERING ANALYSIS

PREPARED FOR

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January 2010

Atlanta Regional Managed Lane System Plan

Technical Memorandum 8: Managed Lane Engineering Analysis

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MANAGED LANE ENGINEERING ANALYSIS

This chapter presents information on the basic elements of design for Managed Lane facilities, including desired design values and cross sections. The section addresses typical design issues but does not attempt to address every possible design that may arise during detailed engineering analysis. Further materials regarding the design issues of managed lanes and high-occupancy vehicle facilities are contained in the HOV Systems Manual1 and the Guide for High-Occupancy Vehicle (HOV) Facilities2.

A. Geometric Considerations for Managed Lanes

When any transportation project reaches final design, the project owner and its partners must engage in even more detailed planning and design to ensure all aspects of Managed Lane operational strategies are considered and assessed for a particular corridor and facility. The following sections describe the components of initial project design criteria considered during this initial planning study. By understanding and addressing some fundamental design criteria at this stage in the development process, future larger issues can be avoided. Further, in an era experimenting with innovative project delivery, generating preliminary design concepts during the planning phase reduces the unknowns and exposes risk early in the project development process.

Design parameters directly impact project design. Careful consideration of these issues at the facility level can help ensure that the Managed Lane's operational strategy is effective in meeting the goals and objectives of the corridor, enhance operational flexibility, and optimize use over the life of the project. These parameters include, but are not limited to, the following:

- Design vehicle;
- Design speed;
- Access control, design, and spacing;
- Signing;
- Driver information;
- Safety;

[1] Texas Transportation Institute, Parsons, Brinckerhoff, Quade, and Douglas, and Pacific Rim Resources. NCHRP Report 414: HOV Systems Manual. TRB, National Research Council, Washington, D.C., 1998.

[2] Technical Committee on Public Transportation Facilities Design, AASHTO Subcommitee on Design. Guide for High-Occupancy Vehicle (HOV) Facilities. American Association of State Highway and Transportation Officials, Washington, D.C., 2004.

- Design exceptions;
- Toll collection;
- Interoperability;
- Incident management; and
- Design flexibility for future needs.

Consideration of these design factors is necessary to ensure critical design features are considered during preliminary design. A summary of each design element is presented in the follow sections.

Context

The design of any major roadway facility considers broad ranging criteria, standards, controls, and even desires. Managed Lanes investments are envisioned to be retrofitted into existing Interstate corridors making right-of-way constraints and existing operations key challenges when considering ideal design standards. There are numerous entities that have a vested interest in how Managed Lanes are designed and operated. Individual interests could conflict with each other or engineering, operational, or financial realities. In many circumstances competing interests will have to be negotiated and a compromise reached. Table 1 list groups potentially involved in the design and operation of Managed Lanes.

Table 1: Agencies and Groups Involved in Designing Managed Lanes Facilities[3]

Agency or Group	Potential Roles and Responsibilities
Georgia Department of Transportation	▪ Overall project management responsibilities for Interstate projects ▪ Responsible for design of facilities on interstate rights of way ▪ Staffing of multi-agency or multi-division team
Federal Agencies (Federal Highway Administration and Federal Transit Administration)	▪ Funding support for facility design ▪ Technical assistance ▪ Possible approval of design or steps in design process ▪ Participate on multi-agency team
Trucking Industry	▪ Provide information on trucking origins and destinations ▪ Training of drivers on facility use for trucks

[3] Adapted from: C.A. Fuhs, High-Occupancy Vehicle Facilities: A Planning, Design, and Operation Manual. Parsons Brinckerhoff, Incorporated, New York, New York, 1990.

Agency or Group	Potential Roles and Responsibilities
Toll Authority (Georgia State Road and Toll Authority)	▪ Introduce tolling technologies ▪ Revenue generation ▪ Pre-operational testing
Metropolitan Planning Organization (Atlanta Regional Commission)	▪ Assist in facilitating meetings and multi-agency coordination ▪ Ensure that projects are included in necessary planning and programming documents ▪ May have policies relating to lane management policies ▪ Synchronize regional planning and programming efforts.
Georgia Regional Transportation Authority	▪ Assist in facilitating meetings and multi-agency coordination ▪ Ensure that projects are included in necessary planning and programming documents
Local Municipalities	▪ Assist with design of projects ▪ Coordinate with local managed lane facilities ▪ Participate on multi-agency team ▪ Synchronize local planning and programming efforts.
State and Local Police	▪ Assist with design, especially enforcement elements ▪ Participate on multi-agency team
Other Groups	▪ EMS, fire, and other emergency personnel ▪ Tow truck operations ▪ Businesses ▪ Neighborhood groups

Design and operations go hand-in-hand. As mentioned previously, due to corridor realities a full design may not be possible given the constraints. If this is the case, operational management should be examined early to ensure a safe and efficient managed lane facility. While full designs are the goal of each project, right-of-way, financing, etc. are major ideal design standards. A summary of the relationships between design standards and operational management is presented in Table 2. Taking these realities into consideration, the following sections describe ideal standards but also introduce opportunities for design exceptions. Reduced designs must be considered on an individual basis and be acceptable to those with a stake in the facility.

Table 2: Operational Treatments Needed for Full and Reduced Design Standards[4]

Design Standards	Level of Operational Treatments	Examples of Operational Treatments
Full	Low	▪ Minimal enforcement ▪ Visual detection by police, truck drivers, motorist assistance patrols, or agency personnel ▪ Calls from motorists using cellular telephones ▪ Reports from roadside call boxes ▪ Information from commercial traffic reporters ▪ Flow metering not required ▪ Consistent speed limit
Reduced	High	▪ Items noted above for full standards ▪ Automatic vehicle identification (AVI) or induction loop detectors for vehicle detection ▪ Closed-circuit television cameras ▪ Full advanced transportation management systems or integrated transportation management systems ▪ Dedicated tow trucks with limited turning radius for narrow managed lane width ▪ Changeable message signs (CMS) ▪ Entry ramp metering ▪ Significant enforcement efforts ▪ Lower speed limits at constricted points

Design Vehicle

The physical and operating characteristics of the design vehicle influence the design of the Managed Lane facility. The users of the proposed facility are a mix of vehicles, including cars, vans, buses and trucks. Table 3 lists the vehicles dimensions of various vehicle types. The typical dimensions and turning radii for design vehicles are included in the American Association of State Highway and Transportation Officials (AASHTO) Green Book.

The design vehicle is used to control the geometrics of the Managed Lanes facilities. Acceleration and deceleration lengths, curve radii and sight distance (horizontal and vertical) are the most critical factors. In summary, horizontal design features should consider larger vehicles (buses and trucks) whereas vertical features should consider smaller vehicles (passenger cars).

[4] Adopted from: Texas Transportation Institute, Parsons, Brinckerhoff, Quade, and Douglas, and Pacific Rim Resources. NCHRP Report 414: HOV Systems Manual. TRB, National Research Council, Washington, D.C., 1998.

Table 3: Managed Lanes Facility Vehicle Dimensions[5]

Design Vehicle Type	Height	Width	Length	Overhang		Wheelbase	
				Front	Rear	WB1	WB2
Passenger Car	4.25 ft.	7 ft.	19 ft.	3 ft.	5 ft.	11 ft.	-
Inter-city Bus	12 ft.	8.5 ft.	45 ft.	6 ft.	8.5 ft.	26.5 ft.	4.0 ft.
Interstate Semitrailer Truck	13.5 ft.	8.5 ft.	73.5 ft.	4 ft.	2.5-4.5 ft.	21.6 ft.	43.4-45.4 ft.

Design Speed

In the majority of the segments, it is anticipated that the design speed on the Managed Lanes will be the same as the General Purpose lanes. There may be specific locations where design features dictate a slower speed. The design speed is closely related to the anticipated posted speed limit and the anticipated maximum speed the facility will experience.

Table 4 summarizes design speeds associated with various managed lanes applications as reported in NCHRP Report 141. These design speeds offer typical speeds under generic conditions; however, the design speed of a specific facility should consider the user groups, design criteria, gradients, and local operating conditions.

Table 4: Examples of Typical Design Speeds for Managed Lanes Facilities[6]

Types of Managed lanes	Typical Design Speed (mph)	
	Reduced	Desirable
Barrier Separated	50	70
Concurrent Flow	50	60
Contraflow	30	50

Horizontal Clearance

[5] Adopted from: American Association of State Highway and Transportation Officials. *A Policy on Geometric Design of Highways and Streets.* American Association of State Highway and Transportation Officials, Washington, D.C., 2004.

[6] Adopted from: Texas Transportation Institute, Parsons, Brinckerhoff, Quade, and Douglas, and Pacific Rim Resources. NCHRP Report 414: HOV Systems Manual. TRB, National Research Council, Washington, D.C., 1998.

For horizontal clearances, 10 feet is the desired clearance; however, in limited circumstances this could be reduced, at a minimum 2 feet, to accommodate barriers and signing columns.

Vertical Clearance

In the application of Managed Lanes as complementary lanes to interstate General-Purpose lanes, a standard vertical clearance of 16 feet applies.

Stopping Sight Distance

The design of Managed Lanes facilities should provide adequate stopping sight distance for all vehicle types using the facility. Due to the lower driver's eye height, automobiles are typically used in the determination of stopping sight distance.

Superelevation

Superelevation rates on Managed Lanes will be based on the design speed and number of lanes on an urban interstate. Table 5 presents allowable and desirable superelevation rates.

Table 5: Managed Lanes Superelevation Rates[7]

Design Speed	Maximum Superelevation, *e* (ft/ft)	
	Allowable	Desirable
40 - 50	0.06	0.04
50 – 70	0.06	0.04

Cross Slope

The normal crown cross slope of the Managed Lanes facility should generally conform to that of the adjacent General Purpose lanes, typically 2 percent. For roadway cross-sections with five or more lanes, the typical uniform cross slope of 2 percent may not be sufficient, requiring the outside lane(s) to be modified.

Horizontal Curvature

The horizontal alignment of the Managed Lanes should be designed to ensure all design vehicles can safely negotiate all curves. Table 6 presents desirable and reduced radii for horizontal curves. These reduced radii are based on e_{max}= 6 percent and the desirable radii are based on e_{max} = 4 percent. Values for minimum horizontal curve radii should be used sparingly and only when justified.

[7] Adopted from: American Association of State Highway and Transportation Officials. *Guide for High-Occupancy Vehicle (HOV) Facilities.* Highway and Transportation Officials, Washington, D.C., 2004.

Table 6: Minimum Radii for Managed Lane Horizontal Curvature[8]

Design Speed	Radii (ft.)	
	Reduced	Desirable
45	643	711
50	833	926
55	1060	1190
60	1330	1500
65	1660	1880
70	2040	2330
75	2500	2880
80	3050	3560

Vertical Curvature

It is anticipated that Managed Lane facilities will follow existing vertical curvature.

Gradients

Managed Lanes gradients should be consistent with current AASHTO guidance to ensure both safety and consistency. Table 7 presents maximum desirable grades by facility type. In critical locations, grades could exceed the recommended values if deemed necessary, however, grades in excess of those recommended would require a design variance.

Table 7: Recommended Maximum Grades[9]

Facility Type	Grade	
	Freeway Level	Freeway Rolling
Mainline (70 mph)	3 percent	4 percent

Summary of Managed Lane Mainline Design Criteria

Table 8 provides a summary of the design features discussed in the previous sections.

[8] Adopted from: American Association of State Highway and Transportation Officials. *A Policy on Geometric Design of Highways and Streets.* American Association of State Highway and Transportation Officials, Washington, D.C., 2004.

[9] Adopted from: American Association of State Highway and Transportation Officials. *Guide for High-Occupancy Vehicle (HOV) Facilities.* Highway and Transportation Officials, Washington, D.C., 2004.

Table 8: Summary of Managed Lane Mainline Design Criteria

Design Speed	Desirable	Reduced
	70 mph	50 mph
Alignment		
Stopping Distance	730 ft	425 ft
Horizontal Curvature	2040-2330 ft	823-926 ft
Superelevation	0.04 ft/ft	0.06 ft/ft
Gradients		
Maximum	5 percent	6 percent
Minimum	0.5 percent	0.5 percent
Clearance		
Vertical	16 ft	14 ft
Lateral	10 ft	2 ft
Widths		
Travel Lanes	12 ft	12 ft
Shoulders	10 ft	2 ft
Cross Slopes		
Maximum	0.020 ft/ft	0.020 ft/ft
Minimum	0.015 ft/ft	0.015 ft/ft

B. Cross Section for Managed Lanes

This section describes desirable and reduced cross sections for Managed Lane facilities. Cross section design considerations must account for efficient and effective operation, safety, and enforcement.

Managed Lanes as envisioned in this study are exclusive facilities that are separated from the General Purpose lanes by either a barrier or buffer.

In this application, Managed Lane facilities would be constructed in the existing right-of-way where applicable but are physically separated and are managed through eligibility, access, and price. Design considerations are similar to that of traditional freeway or HOV lane design with the exception of a barrier or buffer. The following design components were considered:

- Median Component;
- Lane Component; and
- Lane Separation.

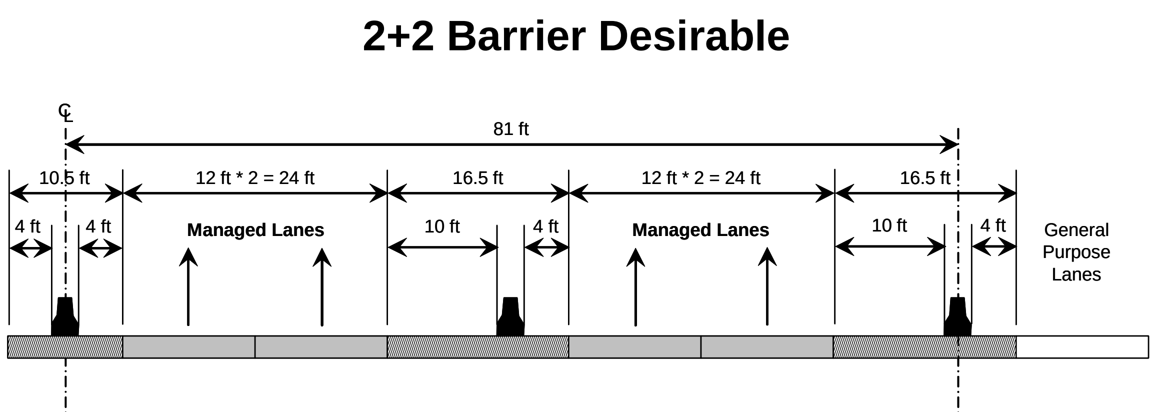
The illustrations below describe typical cross sections followed by a brief description of each design component.

Bi-Directional At-Grade

The cross sections shown in Figure 1 on the following pages are for the bi-directional at –grade alternatives.

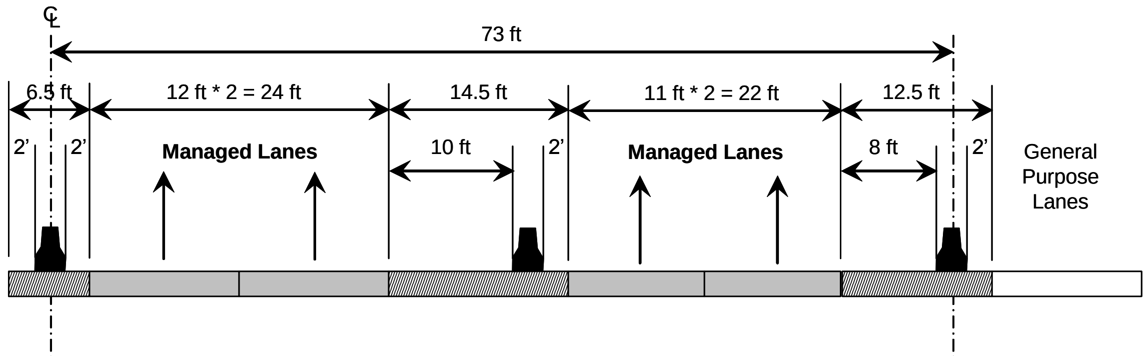
The bi-directional at-grade alternatives are comprised of three primary typical sections and four variations of each of those, for a total of twelve typical sections. The 2+2[10] lane alternative includes a total of four at-grade managed lanes in each direction, two truck only lanes and two lanes for other eligible vehicles. The 3-lane alternative provides three managed lanes in each direction. It is assumed the three lanes will be a mixture of eligible vehicles, including trucks. The 2-lane alternative includes two managed lanes in each direction. For this alternative, the two lanes would be designated either truck only lanes or other eligible vehicle lanes. Using these three basic alternatives, the next consideration was lane separation, i.e. if the managed lanes would be barrier or buffer separated from the general purpose lanes. In the 2+2 lane barrier alternatives, the managed lanes would also be separated by barrier. The final progression in developing the bi-directional at-grade typical sections was to consider the desirable and reduced alternatives for each. In the desirable case, the typical sections were developed using the recommended dimensions. In the reduced case, reduced shoulder widths and lane widths were considered. However, in the 2+2 lane reduced alternatives, the lane widths for one set of the managed lanes could not be reduced due to truck usage.

Figure 1: Bi-Directional At-Grade Cross Sections

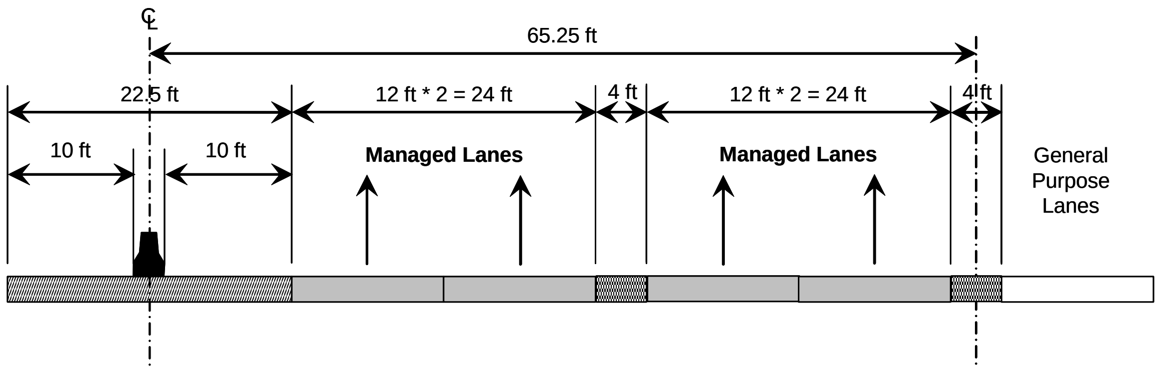


[10] 2+2 means parallel systems of managed lanes, one with tolled passenger cars and the other with tolled trucks.

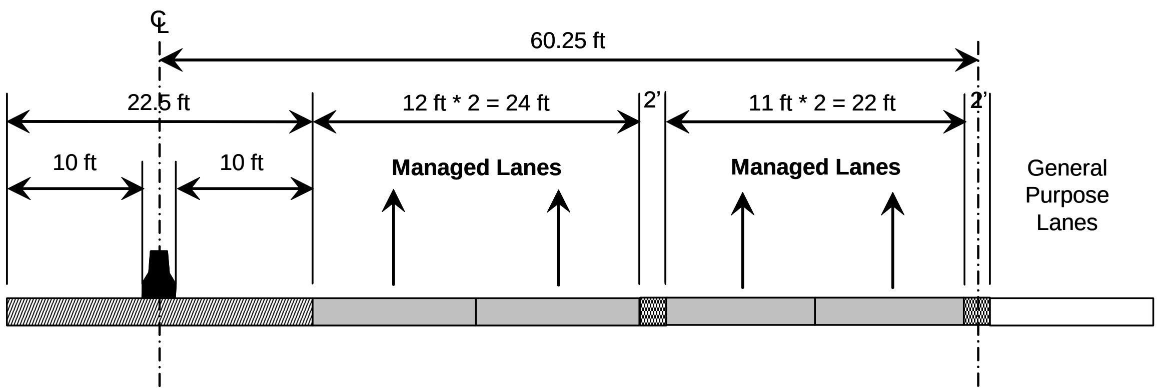
2+2 Barrier Reduced



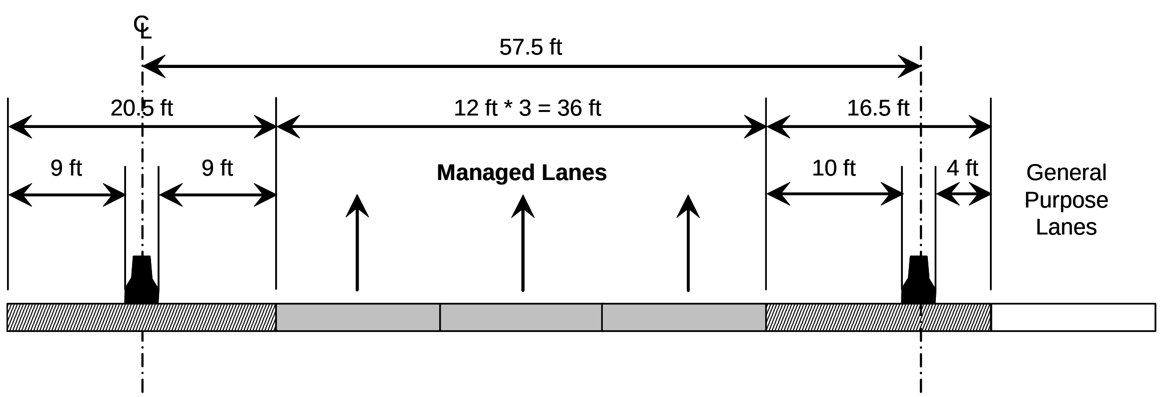
2+2 Buffer Desirable



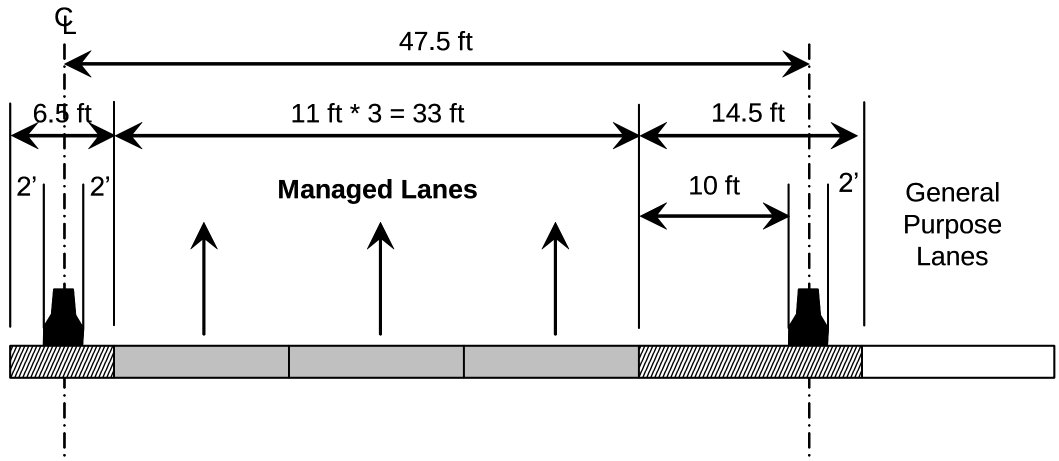
2+2 Buffer Reduced



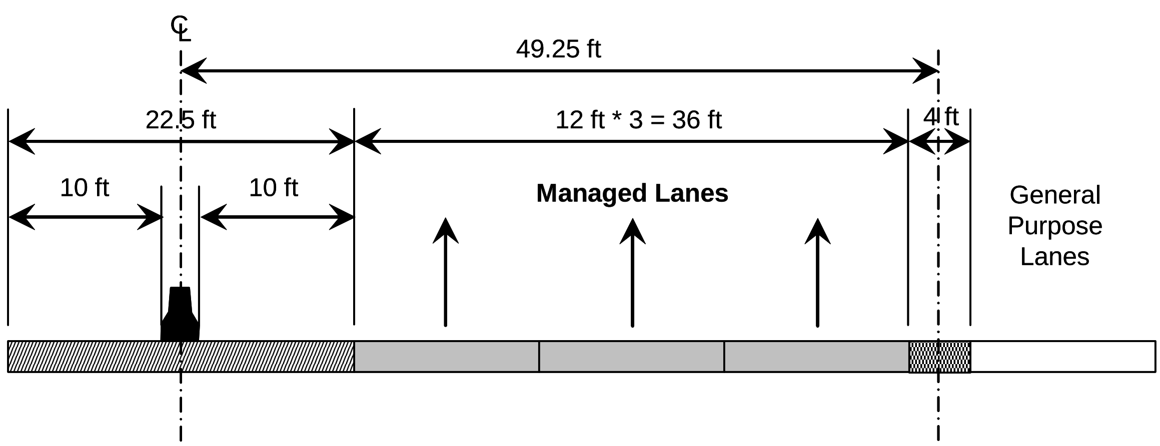
3 Lane Barrier Desirable



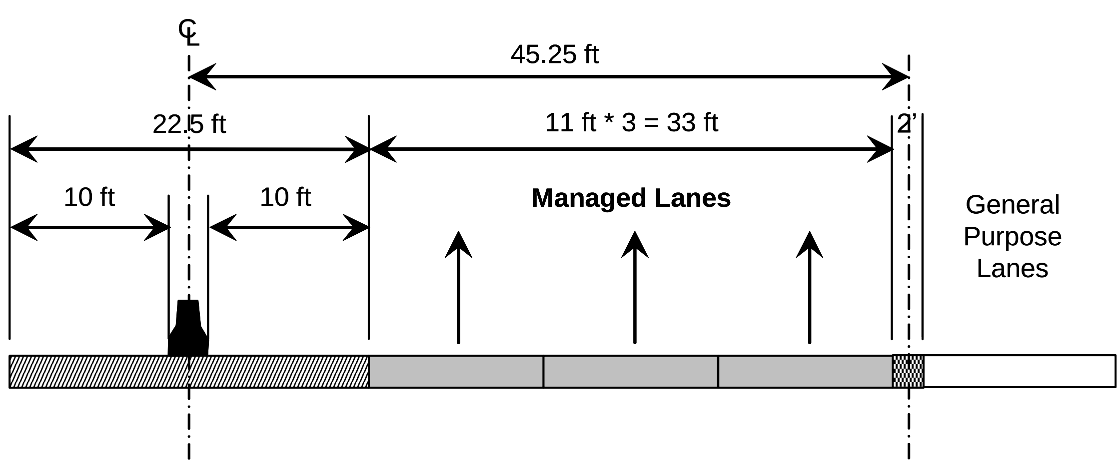
3 Lane Barrier Reduced



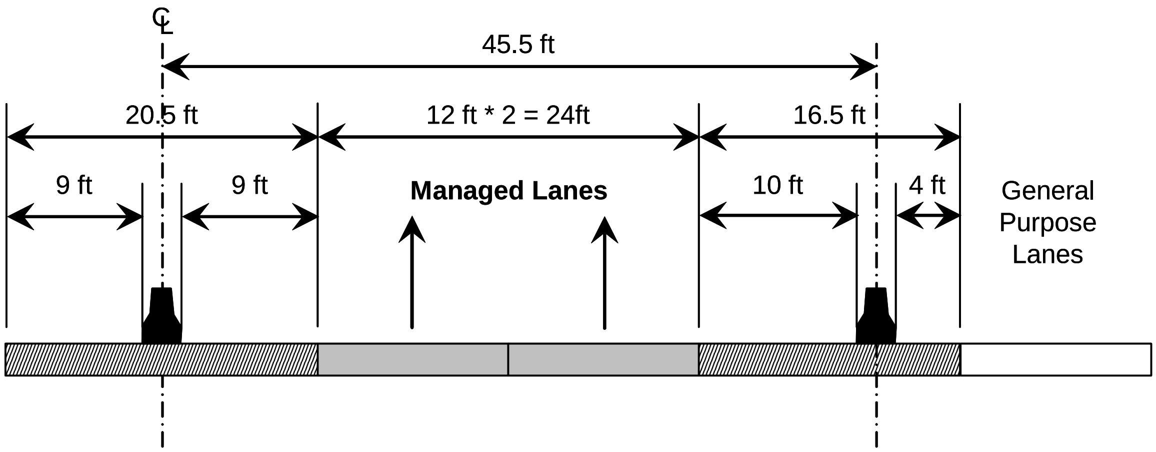
3 Lane Buffer Desirable



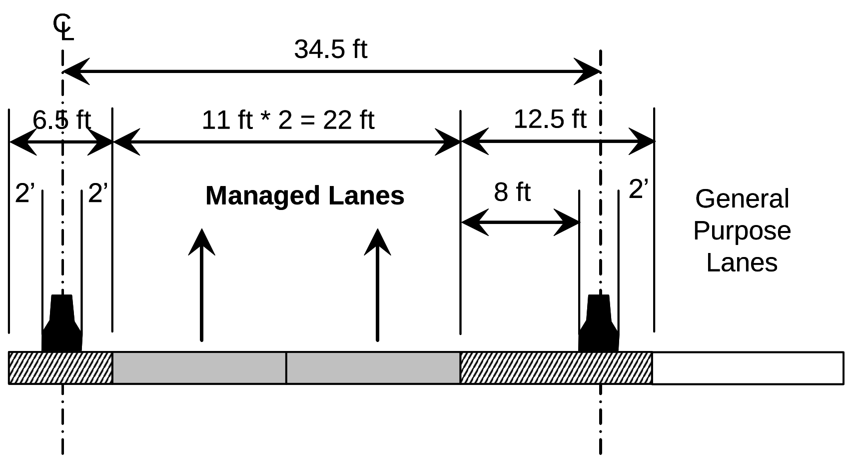
3 Lane Buffer Reduced



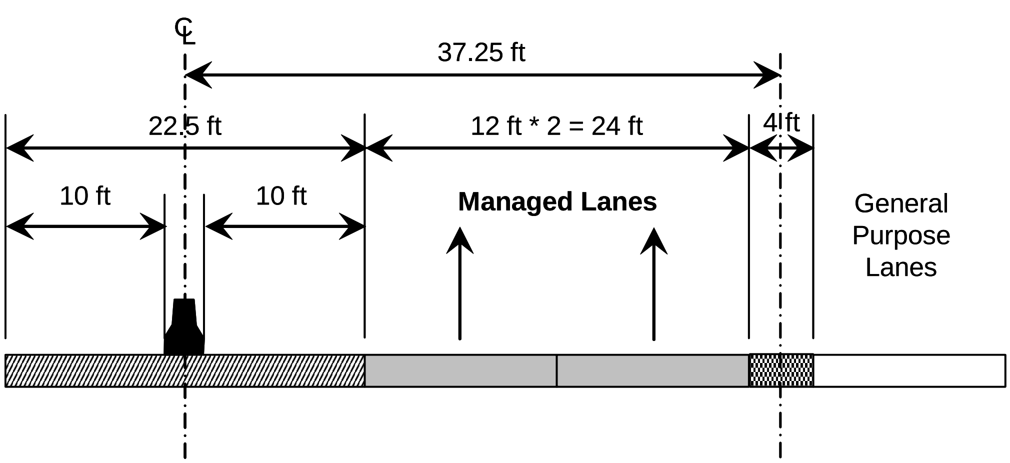
2 Lane Barrier Desirable



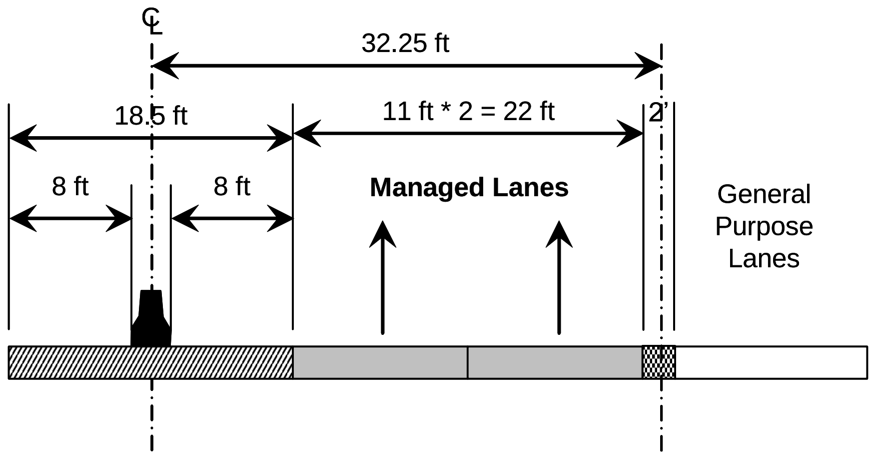
2 Lane Barrier Reduced



2 Lane Buffer Desirable



2 Lane Buffer Reduced



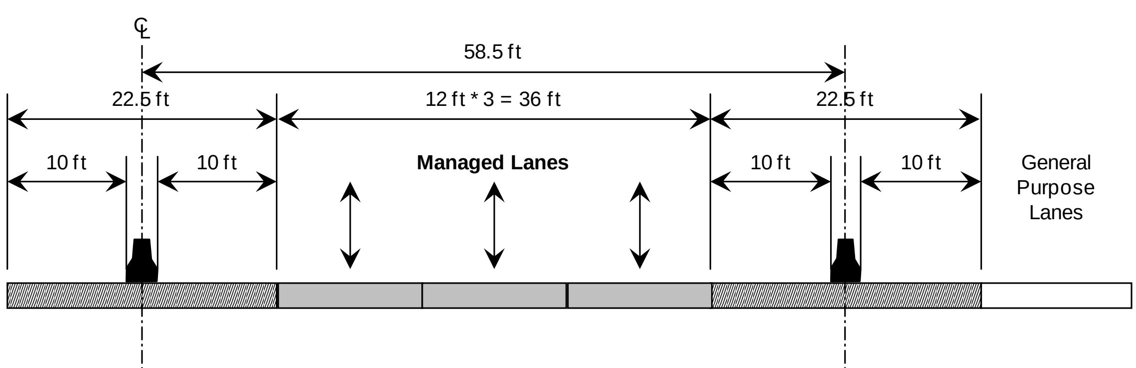
Reversible At-Grade

The cross sections shown in Figure 2 on the following pages comprise the reversible at-grade alternatives.

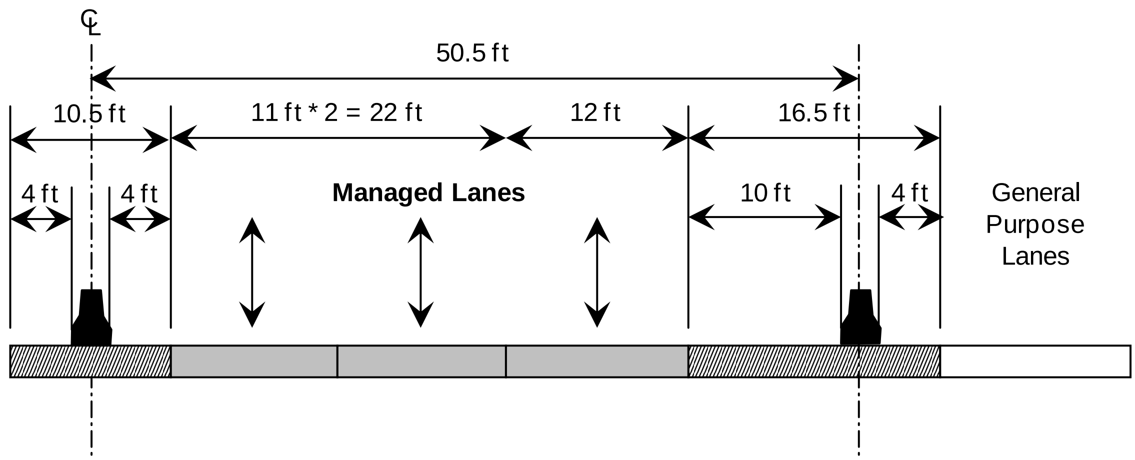
The reversible at-grade alternatives are comprised of three primary typical sections and two variations of each of those, for a total of six typical sections. The 3-lane alternative provides three reversible managed lanes; the 2-lane alternative includes two reversible managed lanes; and the 1-lane alternative includes one reversible lane in each direction. All reversible at-grade alternatives are barrier separated from the general purpose lanes. The final progression in developing the reversible at-grade sections was to consider the desirable and reduced alternatives for each. In the desirable case, the typical sections were developed using the recommended dimensions. In the reduced case, reduced shoulder widths and lane widths were considered.

Figure 2: Reversible At-Grade Cross Sections

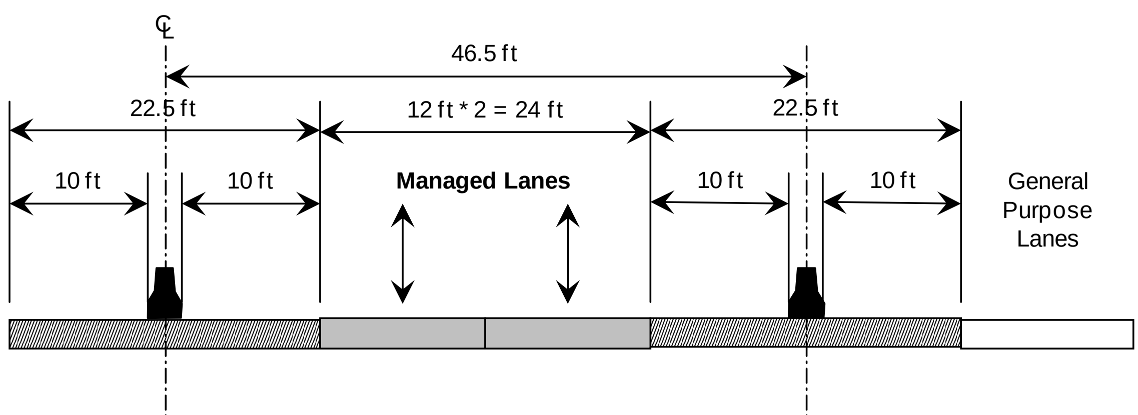
3 Lane Desirable



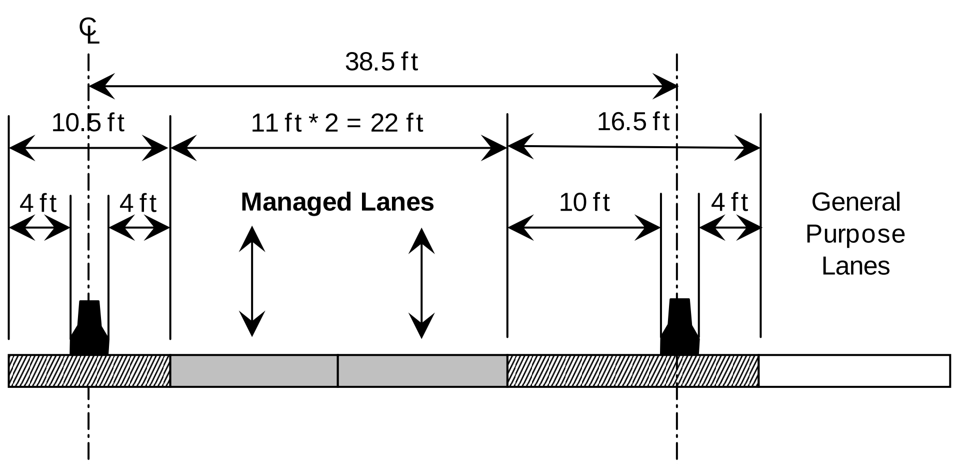
3 Lane Reduced



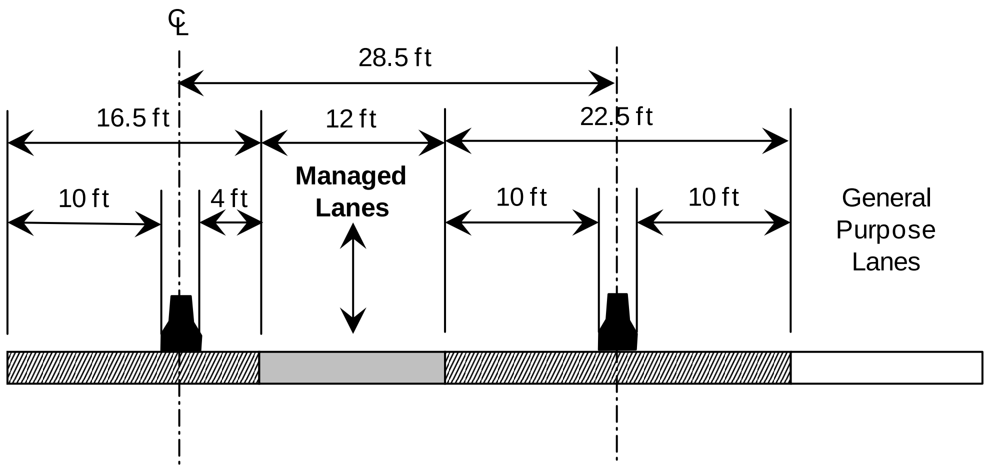
2 Lane Desirable



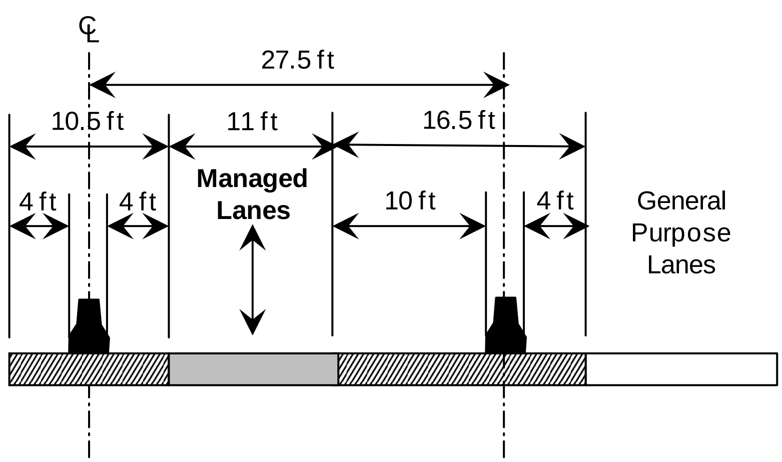
2 Lane Reduced



1 Lane Desirable



1 Lane Reduced



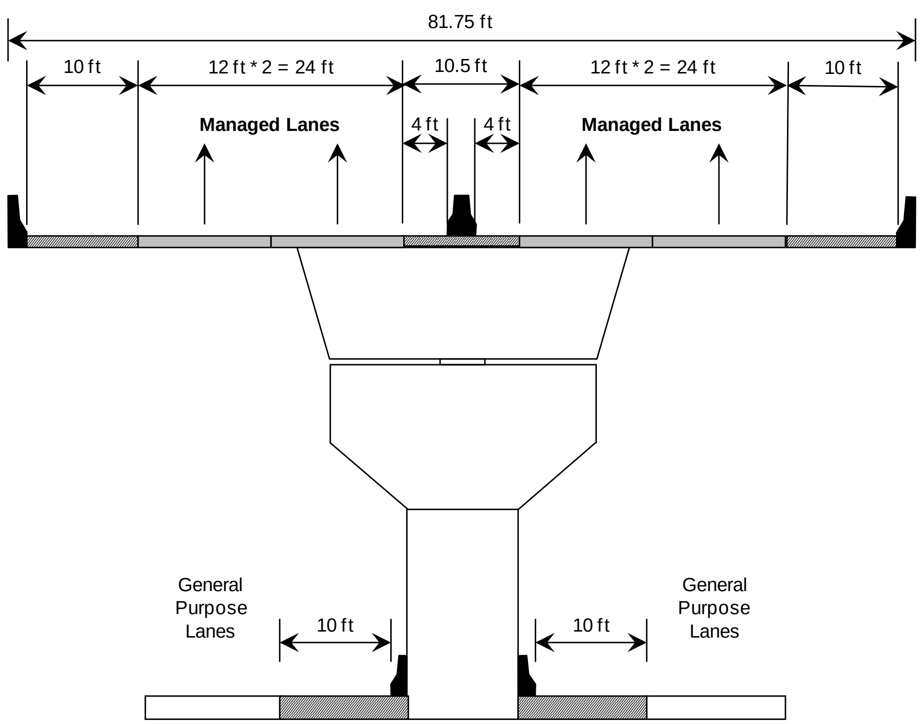
Bi-Directional Elevated

The bi-directional elevated alternatives are comprised of two primary typical sections and four variations of each of those, for a total of eight typical sections. The 2+2 lane alternatives are the only alternatives included in the bi-directional elevated sections. The first primary typical section is a single shaft pier used where the center median area is restricted. The second primary typical section is a dual shaft pier used in areas with adequate median area. Using the two primary alternatives, the next consideration was the location of the elevated structure, either in the median or along the outside of the corridor. The final progression in developing the bi-directional typical sections was to consider the desirable and reduced alternatives for each. In the desirable case, the typical sections were developed using the recommended dimensions. In the reduced case, reduced shoulder widths and lane widths were considered.

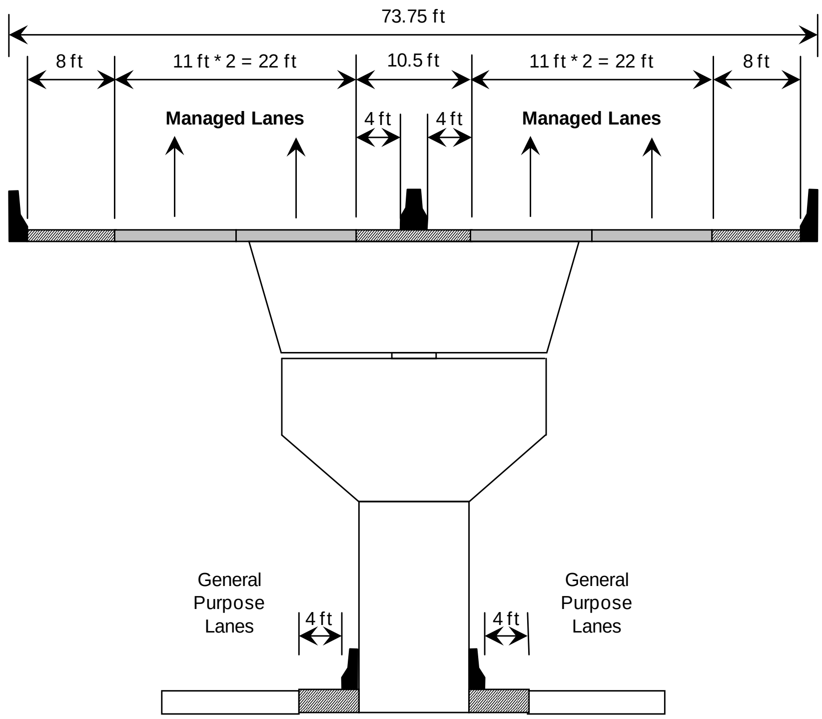
The cross sections shown in Figures 3 and 4 on the following pages comprise the bi-directional elevated alternatives. Figure 3 contains the single shaft pier alternatives and Figure 4 contains the dual shat pier alternatives.

Figure 3: Bi-Directional Elevated Cross Sections–Single Shaft Pier

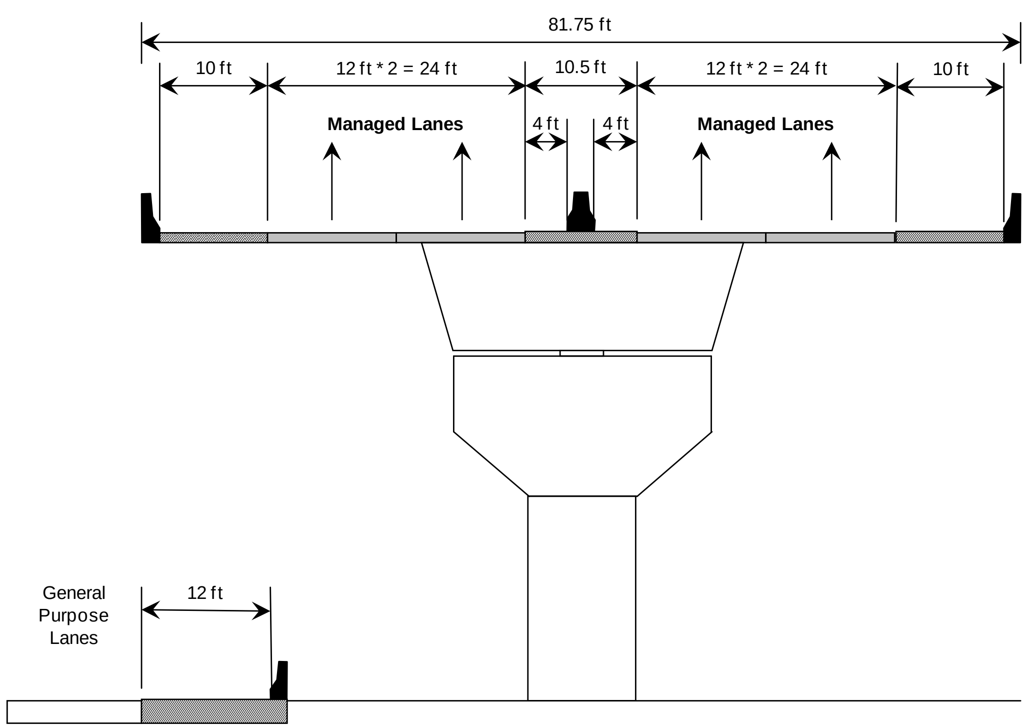
2+2 Lane Desirable



2+2 Lane Reduced



2+2 Lane Desirable – Outside



2+2 Lane Reduced – Outside

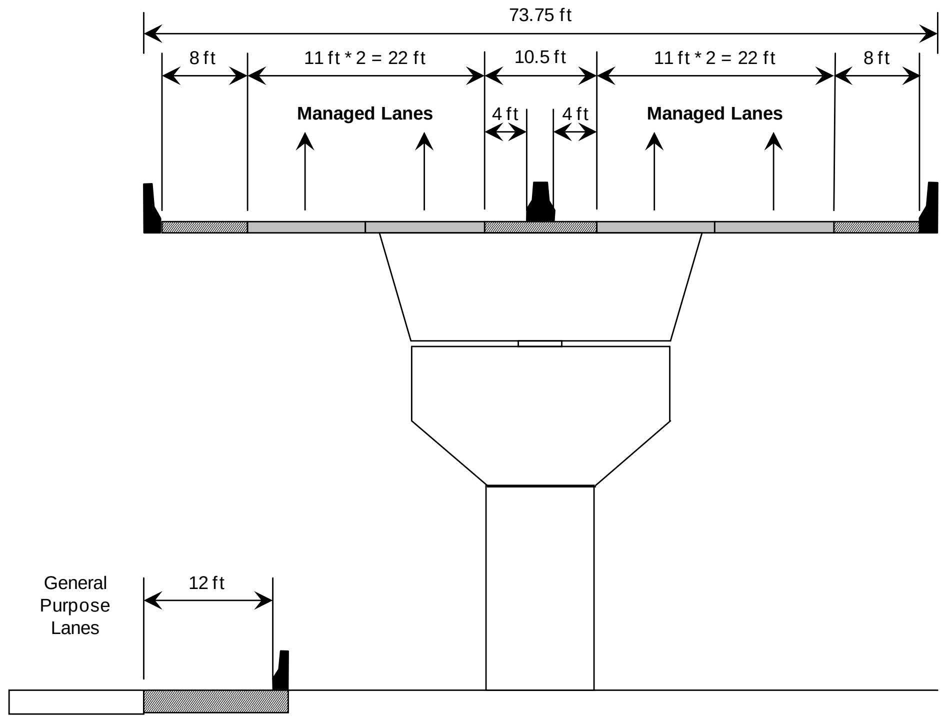
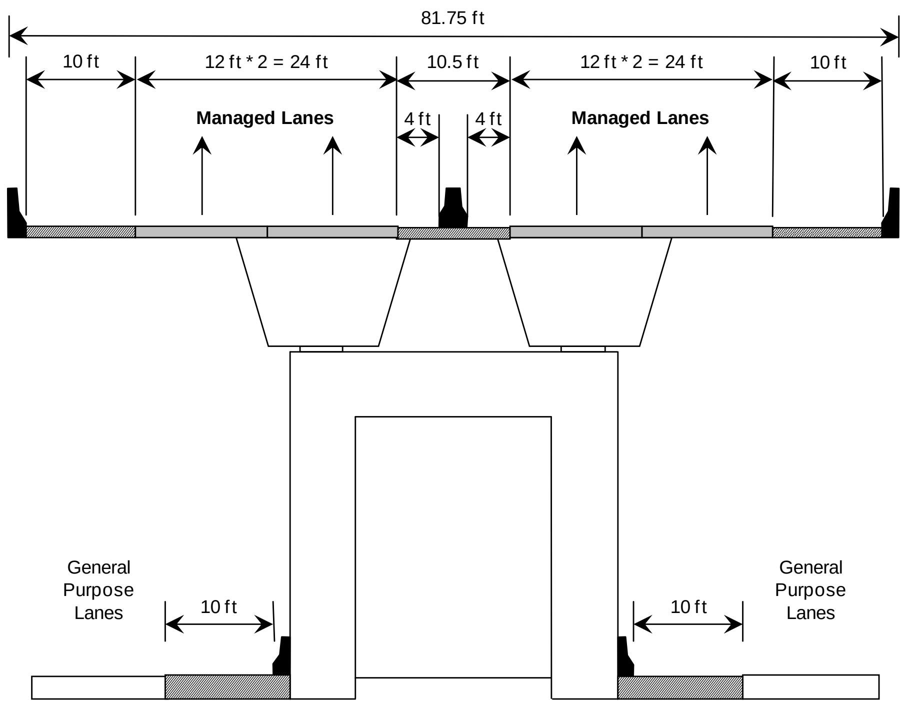
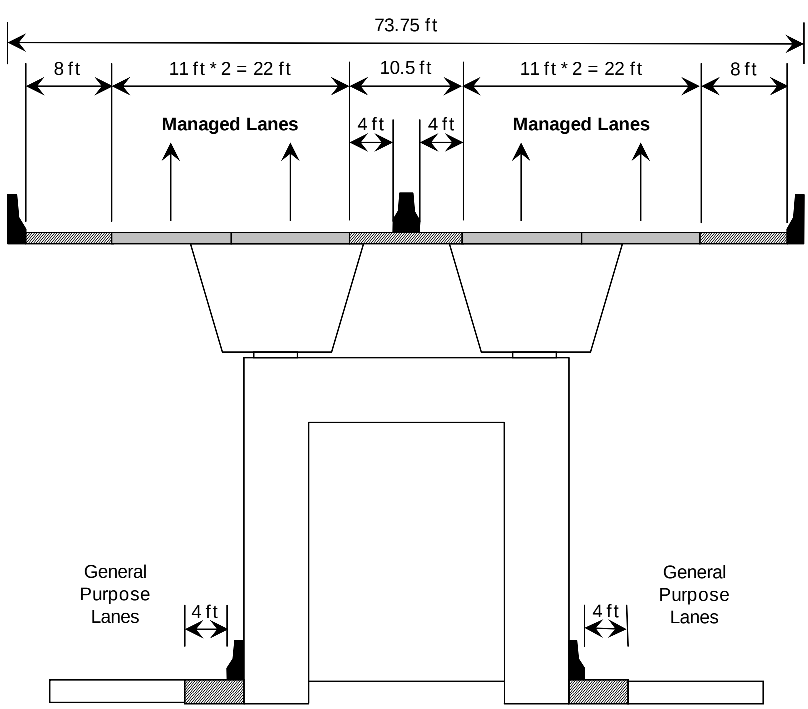


Figure 4: Bi-Directional Elevated Cross Sections–Dual Shaft Pier

2+2 Lane Desirable



2+2 Lane Reduced



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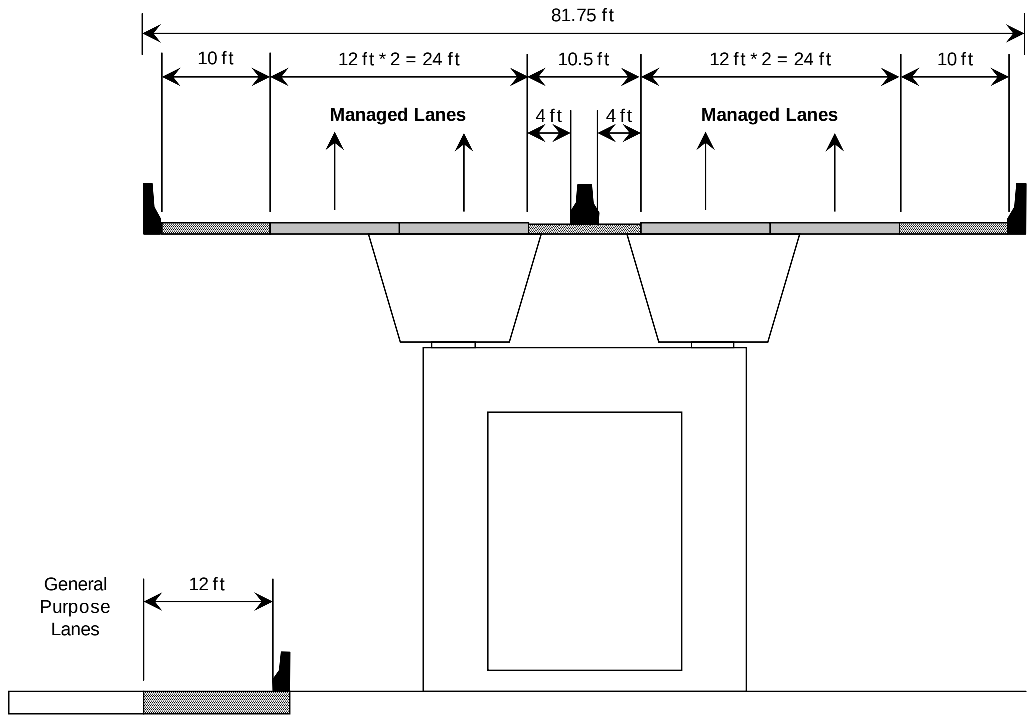
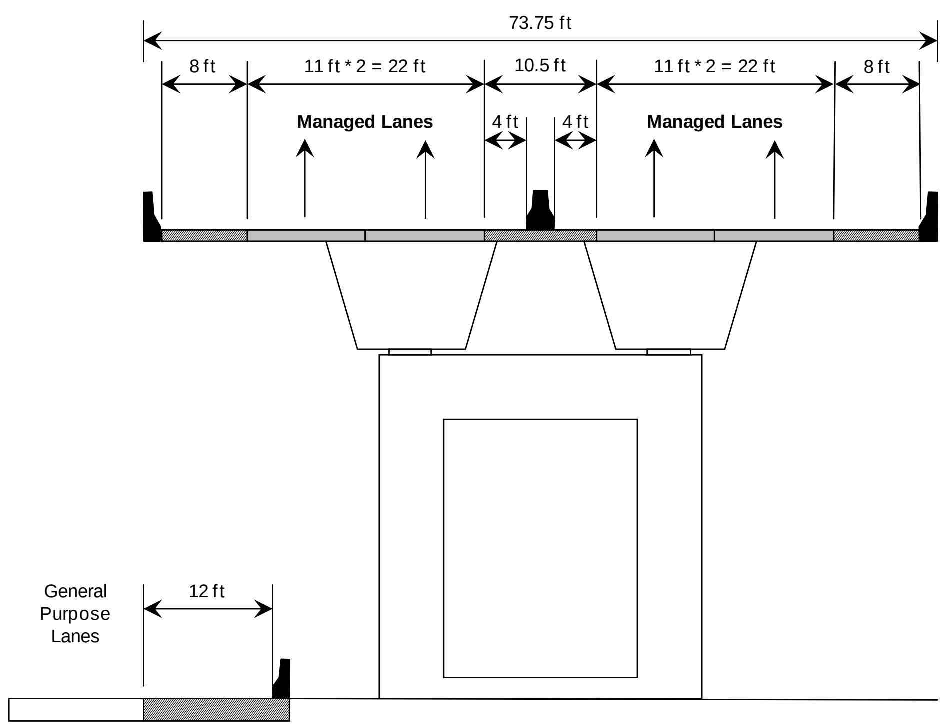


2+2 Lane Reduced – Outside



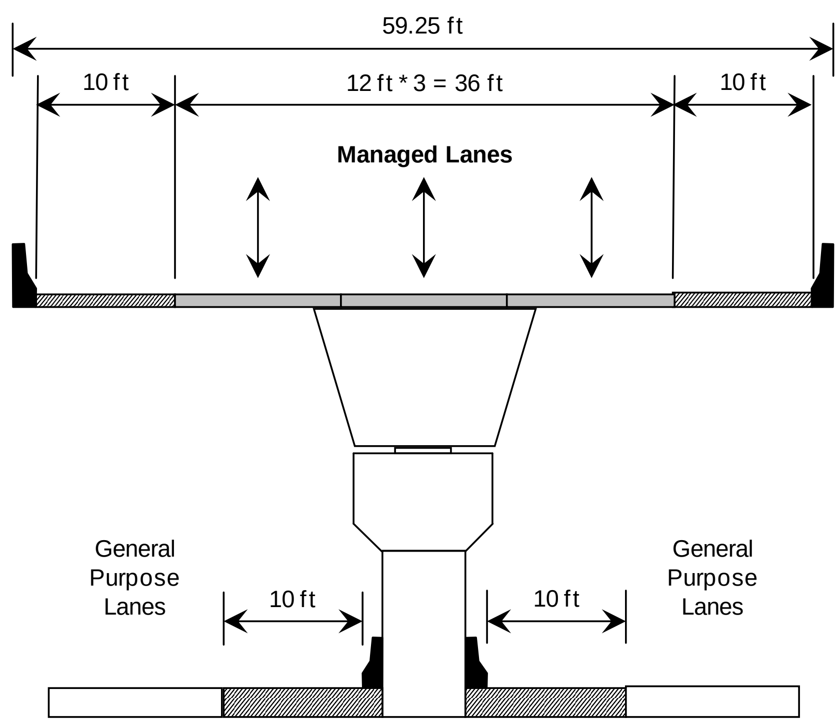
Reversible Elevated

The cross sections shown in Figure 5 on the following pages comprise the reversible elevated alternatives.

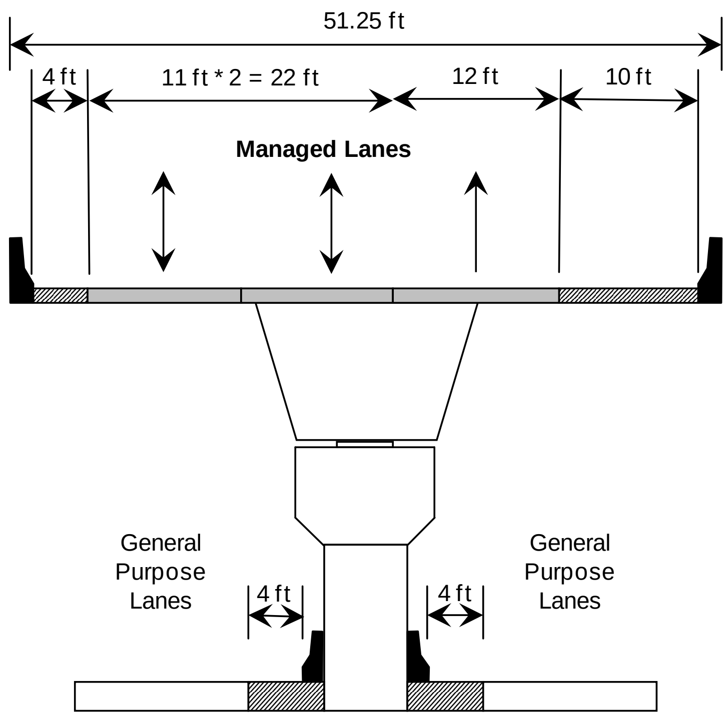
The reversible at-grade alternatives are comprised of two primary typical sections and four variations of each of those, for a total of eight typical sections. The 3-lane alternative provides three reversible managed lanes and the 2-lane alternative includes two reversible managed lanes in each direction. The next consideration was the location of the elevated structure, either in the median or along the outside of the corridor. The final progression in developing the reversible at-grade sections was to consider the desirable and reduced alternatives for each. In the desirable case, the typical sections were developed using the recommended dimensions. In the reduced case, reduced shoulder widths and lane widths were considered.

Figure 5: Bi-Directional Elevated Cross Sections–Dual Shaft Pier

3 Lane Desirable



3 Lane Reduced



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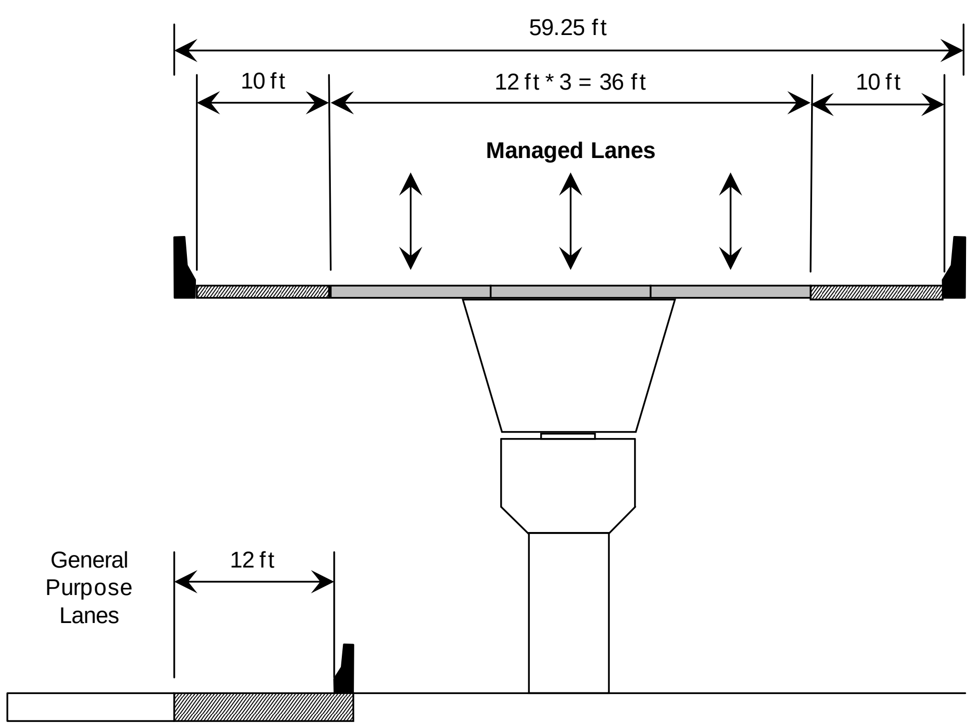
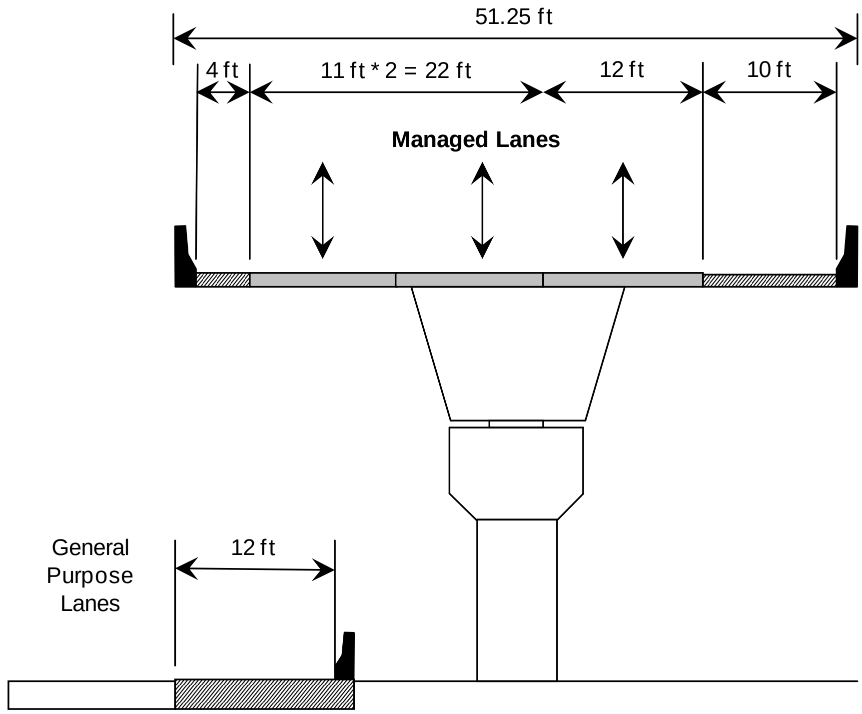
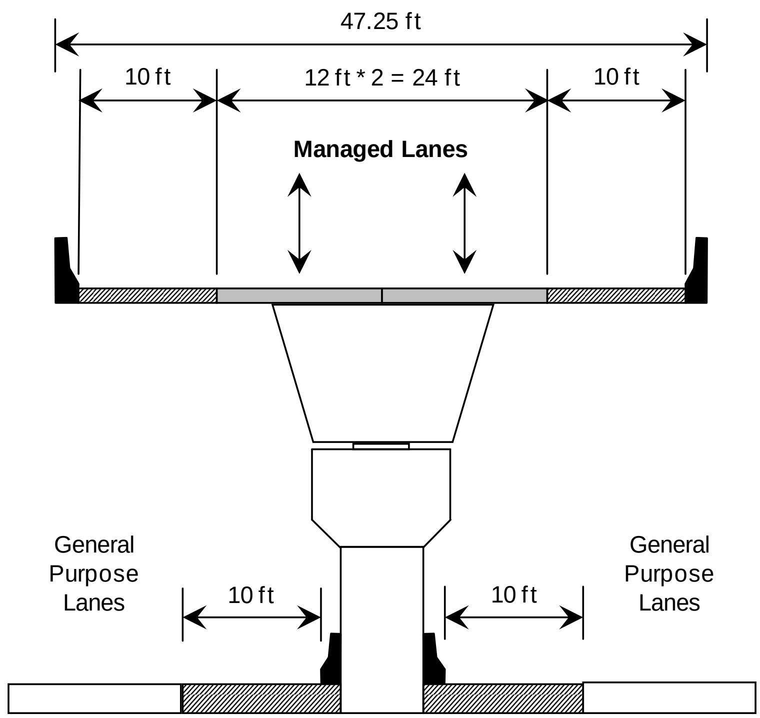


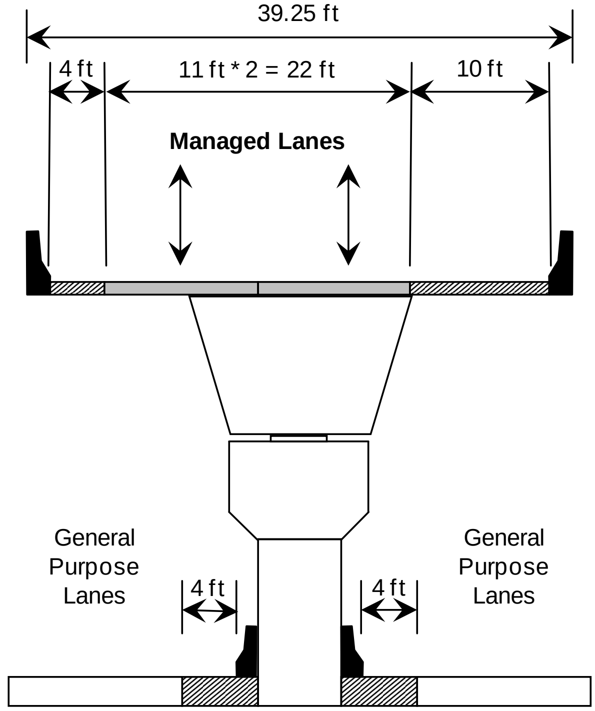
3 Lane Reduced – Outside



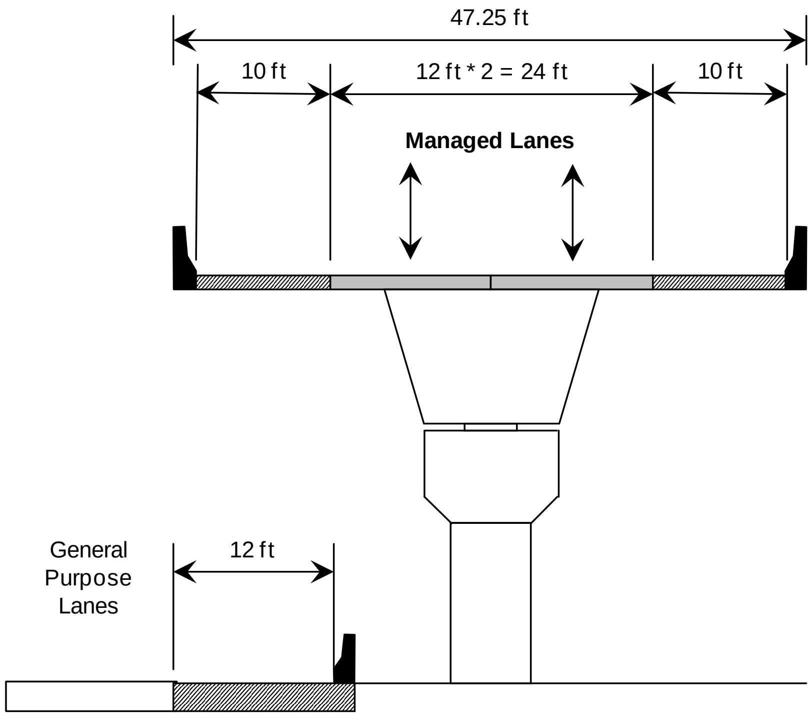
2 Lane Desirable



2 Lane Reduced



2 Lane Desirable – Outside



2 Lane Reduced – Outside

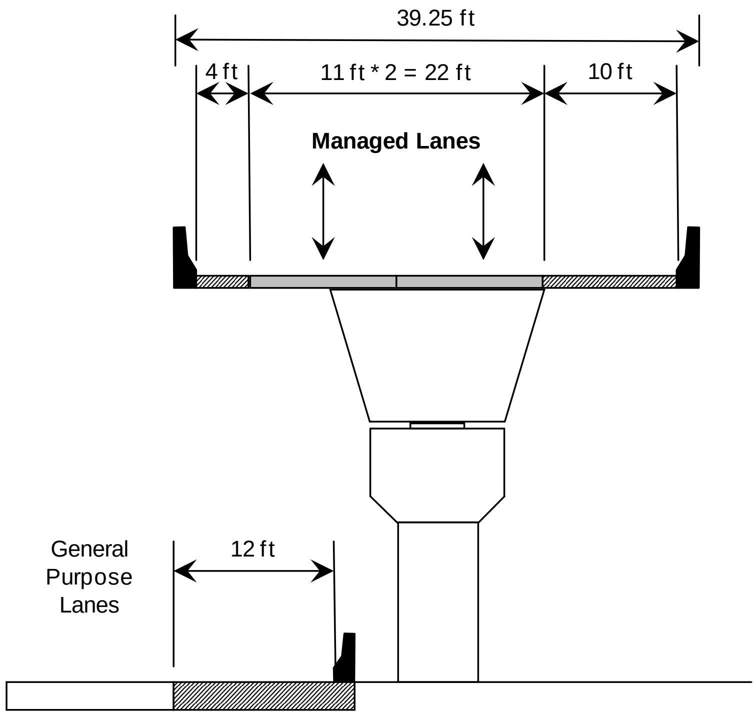


Table 9: Summary of Bi-directional At-Grade Typical Cross Sections

	Inside Shoulder & Barrier	Managed Lanes	Outside Shoulder & Barrier or Buffer	Total
2+2 Barrier Desirable	5.25 ft.	64.5 ft.	11.25 ft.	81 ft.
2+2 Barrier Reduced	3.25 ft.	60.5 ft.	9.25 ft.	73 ft.
2+2 Buffer Desirable	11.25 ft.	52 ft.	2 ft.	65.25 ft.
2+2 Buffer Reduced	11.25 ft.	48 ft.	1 ft.	60.25 ft.
3 Lane Barrier Desirable	10.25 ft.	36 ft.	11.25 ft.	57.5 ft.
3 Lane Barrier Reduced	3.25 ft.	33 ft.	11.25 ft.	47.5 ft.

	Inside Shoulder & Barrier	Managed Lanes	Outside Shoulder & Barrier or Buffer	Total
3 Lane Buffer Desirable	11.25 ft.	36 ft.	2 ft.	49.25 ft.
3 Lane Buffer Reduced	11.25 ft.	33 ft.	1 ft.	45.25 ft.
2 Lane Barrier Desirable	10.25 ft.	24 ft.	11.25 ft.	45.5 ft.
2 Lane Barrier Reduced	3.25 ft.	22 ft.	9.25 ft.	34.5 ft.
2 Lane Buffer Desirable	11.25 ft.	24 ft.	2 ft.	37.25 ft.
2 Lane Buffer Reduced	9.25 ft.	22 ft.	1 ft.	32.25 ft.

Table 10: Summary of Reversible At-Grade Typical Cross Sections

	Inside Shoulder & Barrier	Managed Lanes	Outside Shoulder & Barrier	Total
3 Lane Desirable	11.25 ft.	36 ft.	11.25 ft.	58.5 ft.
3 Lane Reduced	5.25 ft.	34 ft.	11.25 ft.	50.5 ft.
2 Lane Desirable	11.25 ft.	24 ft.	11.25 ft.	46.5 ft.
2 Lane Reduced	5.25 ft.	22 ft.	11.25 ft.	38.5 ft.
1 Lane Desirable	5.25 ft.	12 ft.	11.25 ft.	28.5 ft.
1 Lane Reduced	5.25 ft.	11 ft.	11.25 ft.	27.5 ft.

Table 11: Summary of Bi-Directional Elevated Typical Cross Sections – Single Shaft Pier

	Inside Shoulder & Barrier	Managed Lanes	Outside Shoulder & Barrier	Total
2+2 Desirable	5.25 ft.	24 ft.	11.625 ft.	40.875 ft.
2+2 Reduced	5.25 ft.	22 ft.	9.625 ft.	36.875 ft.
2+2 Desirable – Outside	5.25 ft.	24 ft.	11.625 ft.	40.875 ft.
2+2 Reduced - Outside	5.25 ft.	22 ft.	9.625 ft.	36.875 ft.

Table 12: Summary of Bi-Directional Elevated Typical Cross Sections – Dual Shaft Pier

	Inside Shoulder & Barrier	Managed Lanes	Outside Shoulder & Barrier	Total
2+2 Desirable	5.25 ft.	24 ft.	11.625 ft.	40.875 ft.
2+2 Reduced	5.25 ft.	22 ft.	9.625 ft.	36.875 ft.
2+2 Desirable – Outside	5.25 ft.	24 ft.	11.625 ft.	40.875 ft.
2+2 Reduced - Outside	5.25 ft.	22 ft.	9.625 ft.	36.875 ft.

Table 13: Summary of Reversible Elevated Typical Cross Sections

	Inside Shoulder & Barrier	Managed Lanes	Outside Shoulder & Barrier	Total
3 Lane Desirable	11.625 ft.	36 ft.	11.625 ft.	59.25 ft.
3 Lane Reduced	5.625 ft.	34 ft.	11.625 ft.	51.25 ft.
3 Lane Desirable – Outside	11.625 ft.	36 ft.	11.625 ft.	59.25 ft.

	Inside Shoulder & Barrier	Managed Lanes	Outside Shoulder & Barrier	Total
3 Lane Reduced – Outside	5.625 ft.	34 ft.	11.625 ft.	51.25 ft.
2 Lane Desirable	11.625 ft.	24 ft.	11.625 ft.	47.25 ft.
2 Lane Reduced	5.625 ft.	22 ft.	11.625 ft.	39.25 ft.
2 Lane Desirable – Outside	11.625 ft.	24 ft.	11.625 ft.	47.25 ft.
2 Lane Reduced - Outside	5.625 ft.	22 ft.	11.625 ft.	39.25 ft.

Median Component

For Managed Lane facilities located in the center of the roadway facility, a barrier is provided separating the traveling directions. AASHTO provides guidance on the specific design of median treatments. A 2 to 4 foot lateral clearance should be provided adjacent to the median treatment.

Lane Components

Managed Lane facilities should include 12-foot travel lanes in all applications. In select locations, engineers could reduce lane widths to 11-foot due to right-of-way, or other constraints. Ideally lane width reductions should not be considered for lanes used by buses or trucks.

Lane Separation Component

Lane separation treatment is in the form of a barrier or a buffer. Lateral clearance on either side of the barrier is required. As the figures above illustrate, with a barrier treatment, a refuge area is provided adjacent to the lane separation treatment. In the case of a buffer, the refuge area is located in the center of the alignment and also serves as the lateral clearance for the median treatment. Buffer areas can be augmented with plastic delineators to further illustrate the different lane sets.

Cross Section Design Summary

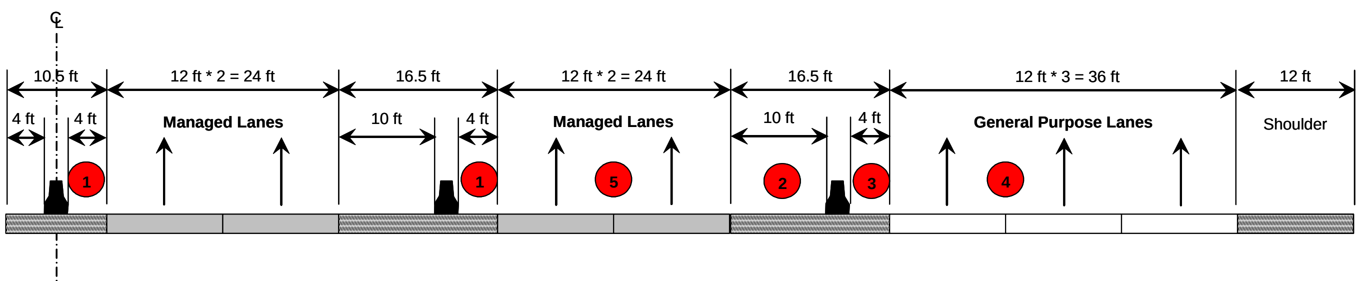
The Managed Lane design envelope ranges from 162 feet for a 2+2 lane desirable barrier condition to 27.5 feet for a 1-lane reversible reduced condition. Whether buffer or barrier, reduced design standards should only be considered in select situations

Design Tradeoffs

In an ideal world, all Managed Lanes will be constructed to desirable specifications. However, constraints such as right-of-way, costs, etc. are realities that need to be addressed during preliminary engineering. In select locations, design tradeoffs will be required to ensure implementation while still meeting investment goals. Table 14 provides a step-wise progression of adjustments that could be followed to reduce the overall cross section. **These design tradeoffs are for discussion purposes only.** Designers should consult with all of the involved agencies for final approval.

Table 14: Design Tradeoffs

Step	Cross-Section Design Change
First	Reduce left & right managed lanes inside shoulder widths to no less than 2 feet, if possible.
Second	Reduce the right managed lane outside shoulder width to no less than 8 feet, if possible.
Third	Reduce the freeway inside shoulder width to no less than 2 feet, if possible.
Fourth	Reduce select lane widths to no less than 11 feet. Maintain one or two outside lanes at 12 feet for trucks, if possible.
Fifth	Reduce select managed lane widths to no less than 11 feet. Maintain one or two outside lanes at 12 feet for trucks, if possible.



C. Terminal and Access Treatments

This section explores the design elements of various access and terminal treatments for Managed Lanes facilities. Vehicles can access the Managed Lanes via terminal treatments at the beginning and end of the facilities or through intermediate dedicated access points along the facility. General guidelines for the design of terminal and access points include:

- Managed Lane ramps should be designed to the same standard as freeway ramps.
- Sight distance is particularly critical due to the proximity of the barriers to the Managed Lanes and the access locations. Modification of the barrier system might be necessary to provide adequate sight distance.
- Locate direct access/egress points on facilities that are not operating at or near capacity.
- Access points should provide spacing for storage, metering and enforcement.
- All maneuvers entering and exiting the Managed Lanes should be overt.
- Advanced signing should be provided in a clear and concise fashion.

- Direct Access Ramps

Grade separated or direct access ramps are desirable treatments for Managed Lane facilities to eliminate at-grade access and the associated complex weaving conditions. A variety of direct access types exist. Examples include:

- T-ramps;
- Drop ramps;
- Flyover ramps; and
- Y-ramps.

T-Ramps and Drop Ramps

These facilities provide direct access to the local roadway network. These facilities are designed to access the Managed Lanes exclusively. T-Ramps are located at strategic points on the Managed Lanes network to provide direct, congestion free access to arterial streets. Figures 6-8 show examples of a T-ramp, a half drop, and a full drop design.

Figure 6: Typical T-Drop Ramp

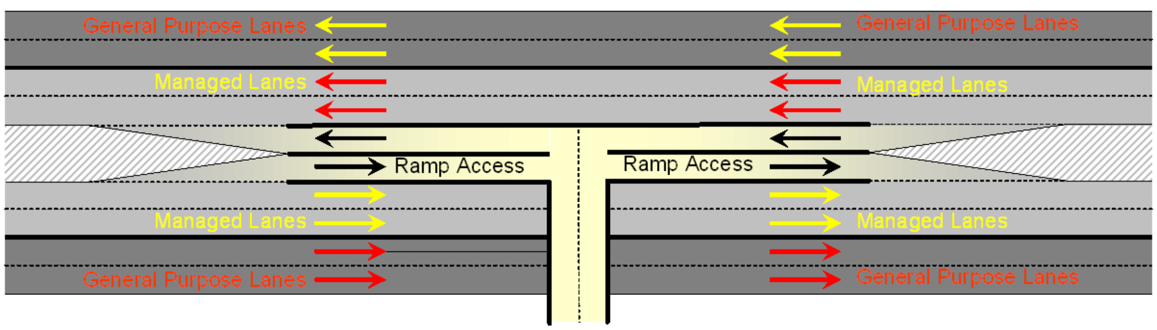


Figure 7: Typical Half Drop Ramp

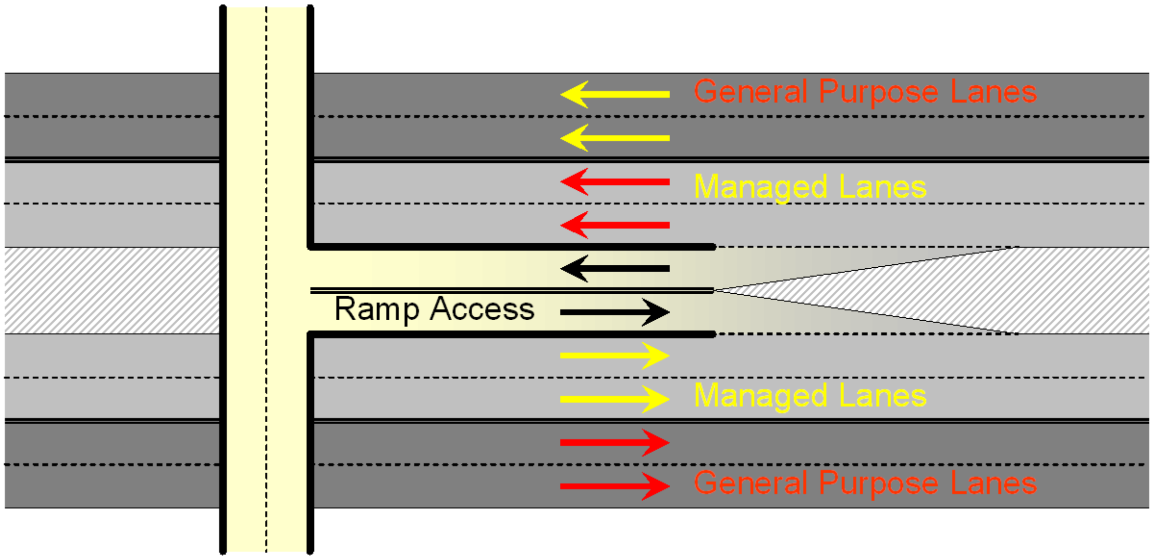
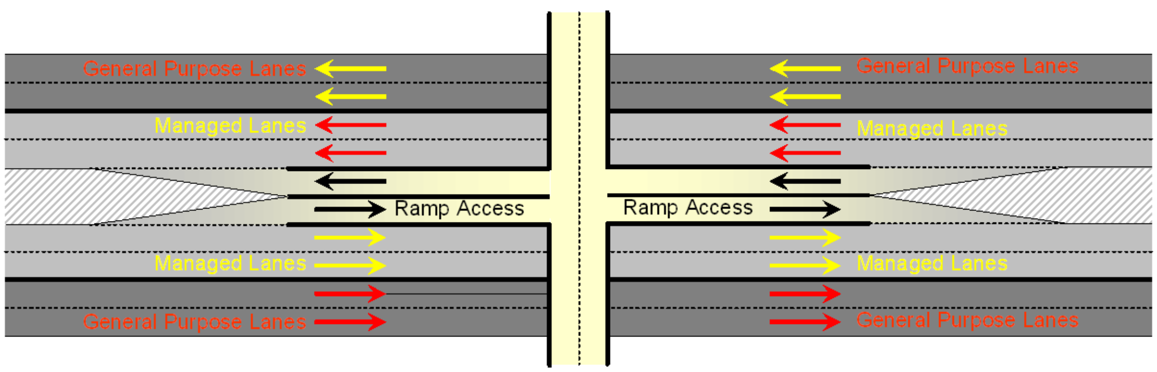


Figure 8: Typical Full Drop Ramp



Design Considerations

Design Speed

Design speed for a Drop or T-ramp should be dictated by the operating conditions on the mainline. Mainline operations should not be adversely impacted by ramp operations. This requires appropriate acceleration and deceleration lanes to ensure trucks can merge into and out of the Managed Lanes efficiently.

Signing and Marking

More than adequate signing and marking to clearly identify the ramps from travel lanes.

Shoulders

It is important to provide a full shoulder on the ramp facility wherever possible. For two way operations a center barrier is recommended.

Cross Section

A cross section of 54 ft is desirable for a two-way ramp. A reduced cross section may be considered in select locations where operational impacts can be managed.

Flyover and Y-Ramps

This ramp design accommodates high speed, high volume access to and from the Managed Lanes. The purpose of these types of ramp configurations is to provide direct connections to the General Purpose lanes.

System to System Connections

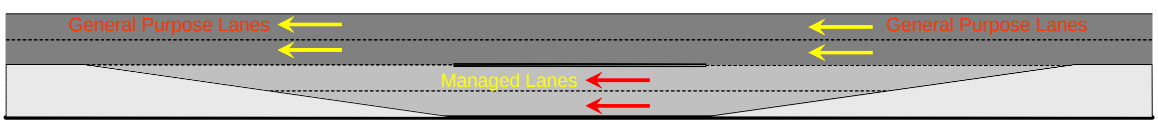
The development of a fully integrated system of Managed Lanes requires linking Managed Lanes on multiple interstate highways. System-to-system connections will be challenging from engineering and capital cost perspectives, however, the benefits to the system are critical. Understanding the challenges associated with providing these critical connections should be tackled initially at the planning stage. Valuable travel time savings accumulated by utilizing Managed Lanes can quickly evaporate if efficient connections are not provided at system-to-system interchanges.

The design of Managed Lane to Managed Lane connections is similar to General Purpose lanes connections. Similar design speeds, geometrics and cross sections that are employed for General Purpose lanes connections are applicable for Managed Lane connections.

Slip Ramps

Slip ramps are an alternate to direct access and provide connections from the Managed Lanes to the General Purpose lanes via breaks in the barrier. Figure 9 shows an example of a slip ramp design.

Figure 9: Typical Slip Ramp



Application of these design parameters can be seen in the preliminary concepts developed during this study.

D. Corridor Evaluations

Potential Challenges to Managed Lane Construction

Each corridor was evaluated to identify any potential challenges to managed lane construction. As a result of the screening, not all of the base case alternatives could be applied to every corridor. Table 15 lists the corridor and any identified flaws/constraints.

Table 15: Potential Physical Challenges to Managed Lane Construction

Corridor	Physical Constraint or Fatal Flaw
I-85 North	SP316 Interchange Project (Reconstruction of recently built C-D system)
I-285 North	MARTA overpass near Ashford Dunwoody Road MARTA & railroad bridges near Buford Highway
I-285 South	Close proximity of airport runways 5th Runway Structures
I-75 North (Inside of I-285)	Tanyard Combined Sewer Overflow Facility Rail bridges near historic Amtrak Station C-D system near Arts Station
I-85 North (Inside of I-285)	Historic rail station near I-75/I-85 Merge MARTA overpass near Peachtree Street MARTA rail parallel alignment near Buford Highway Exit Ramp from Peachtree Street to I-85 N SR 13 parallel alignment Long mainline structure near MARTA yard and Piedmont Road
I-85 South (Inside of I-285)	Close proximity of airport runways Two MARTA overpasses APM Bridge
I-20 East (Inside of I-285)	Several historic neighborhoods and parks
I-20 West (Inside of I-285)	Railroad and Westside Cemetery Historic Neighborhoods Double MARTA track parallel to I-20 near Northside Drive Double MARTA track crosses I-20 near Windsor Street
GA 400	Railroad and MARTA lines Atlanta Financial Center Tunnel Buckhead MARTA station Single Point Interchange at Lenox Road Existing Toll plaza

Corridor	Physical Constraint or Fatal Flaw
Downtown Connector	17th Street Bridge 14th Street Bridge and Project 10th Street Bridge 5th Street Bridge Historic Properties Major high rise buildings HOV direct connect ramps into downtown MARTA Civic Center Station & Emory Parking Deck Intersection bridge structures HOV direct connect ramps to Piedmont Avenue Freedom Parkway Interchange Railroad bridges near Decatur Street & near University Avenue Pratt Street and Grady Hospital

Any widening in these corridors would impact the constraints listed in the table above. In the I-85 N, I-285 N, and I-285 S corridors, costs were developed for each of the base case alternatives. The estimates for these corridors reflect additional costs being applied to account for the constraints. For GA 400, cost estimates were not developed for the 3-lane and 2+2 lane bi-directional base case alternatives. For corridors inside of I-285, with the exception of I-20 W and the Downtown Connector, an estimate was only developed for the 2-lane, buffer reduced alternative and the elevated alternative. Based on the limiting constraints along the I-20 W and Downtown Connector corridors, estimates were only developed for the elevated base case alternatives. For these two corridors other alternatives, including adding only one lane and General Purpose lane conversions were considered.

Elevated Structure Evaluation Criteria

The reversible cases were evaluated initially as a direct comparison to the at-grade alternatives along the centerline of the roadway. The existing median with (barrier plus shoulders) determined if a General Purpose lane take was required. The proposed elevated substructure requires a minimum of 18' width (using 4' shoulders).

The reversible cases evaluated locations on the left or right side of the existing roadway. Existing conditions, such as reduced median widths, impacts to existing bridges, and, if split profiles were used resulting to differences in elevations between the left and right sides, were reviewed. For corridors with a reduced median width, and where an existing HOV or General Purpose lane take was not possible, the reversible lane was located on the outside of the corridor to eliminate the need for extensive reconstruction of the existing roadway. This was also done in areas where extensive bridge replacements would be necessary and where profile differences between the left and right sides would result in significant construction costs. Cost comparisons were done to determine if the right-of-way and construction costs of placing the reversible lanes on the outside would offset the bridge replacement and reconstruction costs. The most cost effective solution was used.

The bi-directional cases were evaluated similarly to the reversible cases. The alignment was analyzed along the centerline where existing HOV lanes exist. The left or right alternative was evaluated as a single structure of four lanes and as a two lane structure on both sides of the road\way. The most cost effective solution was used.

E. Base Case Cost Estimates

The capital costs of proposed Managed Lanes are categorized into discrete cost elements: construction costs, right-of-way costs, utility costs, engineering and inspection costs and corridor contingencies. In general, the capital costs were estimated by determining the appropriate unit costs for the identified cost elements and the cost element quantities from conceptual alignments and interchange/access plans prepared for each corridor. Each cost element is defined below along with the methods and assumptions applied in each case. The programming costs for this project were developed to provide a conceptual level estimate in Year 2008 construction dollars. These numbers do not include any inflation. Two major factors in cost variations for major projects that were not developed specifically for this level of cost estimate are environmental impacts and existing soil/site conditions. However, these factors are accounted for in the contingency. Mitigation costs and encountering unforeseen geological features such as rock can drive up costs. While significant engineering analysis went into developing project costs, the estimates are still planning grade and primarily employed for comparative analysis. Key assumptions and development parameters are discussed below.

Construction Costs

The construction cost estimates are divided into four major components: linear mile costs, block costs, corridor-specific costs and system-to-system interchange costs. Improvements to existing General Purpose deficiencies (defined as variations from ideal design standards) were not considered. System-to-system interchanges were estimated separately. At this stage in the process, design exceptions were also not considered.

Linear Mile Costs

Linear mile costs include unit costs and lump sum costs. The unit costs were developed based on quantities and lengths of the existing and proposed typical section. The lump sum costs were computed as a percentage of the sub-construction costs (total of the unit costs). Each of the items included in the linear mile costs and their assumptions are described below.

Pavement Items:

- Full depth pavement replacement was assumed based on unknown existing pavement conditions and a potential concession life-cycle.
- Travel lanes and outside shoulders are proposed to have a full depth pavement design structure as follows:

- Asphaltic Concrete 19mm Superpave, 3”
- Bituminous Tack Coat
- Portland Cement Concrete Pavement, 12”
- Graded Aggregate Base, 12”

Drainage Items:

- Assumed 24-inch concrete drainage pipes.
- One-half of the total length of 24-inch pipes was assumed to be in the 1-10 foot depth category, while the other half is assumed to be in the 10-15 foot depth category.
- Longitudinal concrete pipes were assumed to be along the median and general-purpose outside shoulders.
- Cross drains are assumed every 800 feet.
- Drainage inlet structures are assumed to be at a 100 foot longitudinal spacing and are located along the general-purpose outside shoulders and along the median.
- One-half of the total number of drainage inlets was assumed to have an average additional depth of 5 feet per structure.
- The total length of existing pipe to be plugged with flowable material was assumed to be approximately 10% of the total length of proposed drainage pipes for the corridor, if the existing system was not maintained.
- Assumed two 7 ft x 7 ft culvert extensions per mile. Culverts are regarded as the outfalls for the proposed longitudinal drainage systems and were assumed to be extended by a length to match the proposed typical section widths. Existing box culverts were assumed to cross the entire existing interstate. Required rip rap for each culvert was estimated to be 49 square yards.

Signing and Marking Items:

- Signing and marking, including overhead signs, was assumed to be $554,874 per mile.

Median Barrier Items:

- New median barriers were assumed along the centerline of all corridors in every alternative.
- Additional cost for barrier separated alternatives is included.

Lighting Items:

- Highway lighting installation was assumed to be $1,541,300 per mile.

ITS Application Items:

- ITS applications were assumed to be $1,000,000 per mile for barrier separated alternatives.
- ITS application items were assumed to be $1,500,000 per mile for buffer separated alternatives.

Tolling Technology Items:

- Toll technology items were assumed to be $1,000,000 per mile for barrier separated alternatives.
- Toll technology items were assumed to be $1,500,000 per mile for buffer separated alternatives.

Existing Pavement Removal Items:

- Existing pavement removal is assumed for all alternatives at a rate of $12 per square yard.

Lump Sum Items:

- Traffic control costs are assumed to be 10 percent of the total sub-construction cost (unit costs total). For the elevated alternatives located on the outside, the costs were assumed to be 4 percent.
- Clearing and grubbing costs are assumed to be 10 percent of the total sub-construction cost (unit costs total). For the alternatives in which no widening was required, the cost was assumed to be $0.
- Erosion control costs are assumed to be 2 percent of the total sub-construction cost (unit costs total).
- Earthwork costs are assumed to be 5 percent of the total sub-construction cost (unit costs total). For the alternatives in which no widening was required, the cost was assumed to be $0.
- Mobilization costs are assumed to be 5 percent of the total sub-construction cost (unit costs total).

Block Costs

Block costs include Managed Lane access points and General Purpose interchanges. Block costs do not include improvements to existing bridge structures. Bridges are evaluated separately as part of corridor-specific items.

Three types of Managed Lane access points were proposed: full-drop ramp access, half-drop ramp access and direct merge access. The following assumptions were used in calculating the Managed Lane access costs:

- Full-Drop Ramp Access: This type of access requires widening the mainline to allow for exit and entrance ramps in both directions. The block costs include pavement, drainage, signing and marking, lighting, lump sum items, and retaining walls. In addition, new bridge and connecting road costs were added at access points where no bridge and/or road connections exist. In situations where access is desirable to service roads crossing under the Interstate highway, additional costs were assumed for a depressed access location. Additional costs were added for constructability issues, including excavation and tie-back walls being used instead of retaining walls. The impacts to traffic patterns on connecting facilities, and the associated improvements required to mitigate these changes were not included in the cost estimate.

- Half-Drop Ramp Access: This type of access is essentially half of the full-drop ramp configuration and includes two ramps instead of four. The block costs were assumed to be two-thirds the cost of the full-drop ramp access, and not one-half to account for items such as signing and marking, lighting, traffic control and mobilization that would be higher than 50 percent of the full-drop ramp access cost.
- Direct-Merge Access: This type of access does not involve any widening of the mainline, and would only include minor signing and marking adjustments. Therefore, a separate block cost was not developed for direct-merge access. The cost would be included in the corridor signing and marking cost.

Existing General Purpose interchanges will require modifications to accommodate the various typical section alternatives. Four specific General-Purpose interchanges were identified: full diamond, half-diamond, full cloverleaf and partial cloverleaf. The following assumptions were used in developing the improvement and modifications costs for each interchange type.

- Full Diamond Interchange: Block costs were developed using linear mile and lump sum costs. Block costs, based on the typical section and the geometric configuration of the existing interchange (typical or tight), vary. Key assumptions include:
- An existing tight urban diamond interchange will require total reconstruction if two, three or four Managed Lanes per direction are proposed
- Partial impact was assumed for a typical diamond interchange if two or three Managed Lanes per direction are proposed
- Total reconstruction was assumed for a typical diamond interchange if four Managed Lanes per direction are proposed
- Half-Diamond Interchange: The estimating procedure for a half-diamond interchange is the same as a full-diamond interchange.
- Full Cloverleaf Interchange: This type of interchange is not a desirable configuration based on current design standards. Therefore, it was assumed to be replaced by a partial cloverleaf with two loop ramps. Block costs were developed using linear mile and lump sum costs.
- Partial Cloverleaf Interchange: A block cost was developed for this type of interchange in a similar manner as the full cloverleaf interchange, assuming only one loop ramp. For a partial cloverleaf with two loop ramps, an increase of 25 percent in the one loop ramp block cost was assumed. In one special case, an existing 3 loop cloverleaf was maintained. A 50 percent increase to the one loop cost was applied for this case.

Corridor Specific Costs

Corridor specific costs were identified and calculated based on the unique characteristics of each corridor. Below are the items considered as corridor specific and the assumptions associated with each.

Bridges

- Total bridge replacement and widening costs were assumed to be $120 per square foot.

Bridge Demolition

- Bridge demolition was assumed to be 20 percent of the total bridge replacement cost.

Retaining Walls

- In general, MSE walls were assumed on both sides in all based cases in urban areas.
- When the difference between the existing and proposed footprint is less than 10 feet, the MSE walls are assumed to replace only existing walls.
- MSE walls were assumed to be an average height of 10 feet.
- A traffic barrier is assumed to be mounted on all MSE walls.
- It is assumed any existing retaining walls outside of urban areas will be replaced with MSE walls.

Guardrail

- In areas considered suburban or rural, fill slopes are proposed at tie-ins with existing ground. It was assumed that half of these slopes would require guardrail treatments.

Collector Distributor and Side Roads

- The replacement cost was calculated for collector-distributor roads and other side roads impacted by implementing the proposed typical section alternatives
- Collector distributor and side road costs were calculated using a line-foot cost based on their existing typical section.

Railroads

- Rail bridge replacement cost was computed using a $150 per square foot rate.
- Additional costs were assumed to tie the existing rail track with the new bridge. The track cost was assumed to be $150 per linear foot.

- Incidental road and right-of-way impacts were also included and were based accordingly on each location. The road cost was assumed to be $3.1 million per mile and the right-of-way costs were assumed to be $100,000 per acre.

System-to-System Interchange Costs

System-to-system interchanges connecting Managed Lane sets were considered stand-along items and were evaluated independently. Schematic layouts for each system-to-system interchange were generated to determine bridge lengths, minimum radii, and entrance and exit points. The construction cost estimate for each interchange was tailored to each Managed Lane investment scenario. Listed below are the assumptions used in computing the system-to-system interchange costs.

- Managed Lanes were added to the center of the existing typical section
- Existing HOV lanes were replaced with Managed Lanes
- Managed Lane ramps were direct connect ramps
- Managed Lane ramps were designed for 45 mph

Right-of Way Costs

Right-of-way costs include the purchase of land and/or easement rights for the Managed Lanes. This includes relocation assistance and demolition costs. Property values and acquisition costs can range from quite modest in undeveloped areas, to quite significant in areas of high-value commercial properties. These costs include title searches, appraisals, legal fees, title insurance, surveys, and various other processes.

Land use types and existing property lines were determined using county and GIS maps. The land use categories identified were residential, commercial and undeveloped land for urban and suburban area types.

Right-of-way impacts were calculated based on existing right-of-way and the proposed typical sections. The cost of right-of-way was estimated by taking the number of additional acres required for the Managed Lanes multiplied by the cost per acre. In addition to the cost of land, some parcels were occupied by residents and business. The cost of displacements was estimated based on appraisal costs indicated in county databases. When appraisal values were not available, the cost per type of displacement was assumed. Using the footprints of the proposed barrier-desirable typical sections for the 2-lane, 3-lane and 2+2-lane alternatives, the proposed right-of-way lines were outline to depict the amount of right-of-way to be acquired and the potential displacements to accommodate each barrier-desirable case. The right-of-way cost for reduced and buffer separated alternatives was calculated based the footprint reduction from the original estimate.

The right-of way assumed costs are presented in Table 16.

Table 16: Right-of-Way Cost Assumptions

Area Type	Cost per Acre	Cost per Displacement
Urban, Undeveloped	$150,000	$0
Urban, Residential	$265,000	$265,000
Urban, Commercial	$865,000	$1,000,000
Suburban, Undeveloped	$50,000	$0
Suburban, Residential	$150,000	$150,000
Suburban, Commercial	$620,000	$620,000
DOT Owned	$0	$0

A contingent right-of-way cost of $1,000,000 per mile was assumed on corridors in areas where no required right-of-way is needed per the typical section footprint. A 3.5 factor was applied to right-of-way costs. This factor is typical for this level of estimate.

Utility Costs

Utility costs were assumed to be 2.6 percent of the total construction cost, plus a 30 percent contingency. For the elevated alternatives located on the outside the costs were assumed to be 1 percent.

Engineering and Inspection Costs

Engineering and inspection costs were assumed to be 5 percent of the total construction cost.

Corridor Contingencies

A corridor contingency was applied to the total cost, which included the construction costs, right-of-way costs, utility costs and engineering and inspection costs. The cost was assumed to be 6 percent of the total cost.

Elevated on the Outside Cost Reduction

For the elevated alternatives in which the structure(s) was located on the outside of the existing roadway, a 2.77 percent reduction was applied to the final cost estimate. This reduction was to allow for a shorter construction duration.

Bi-Directional At-Grade Corridor Cost Estimates

Table 17: I-75 North Corridor Cost Estimates

I-75 North					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,879.39	$92.14	$46.54	$121.08	$2,139.14
2-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,645.17	$55.49	$40.74	$104.48	$1,845.88
2-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,642.28	$65.09	$40.67	$104.88	$1,852.92
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,549.64	$44.90	$38.37	$97.98	$1,730.89
3-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,920.32	$112.46	$47.55	$124.82	$2,205.15
3-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,691.96	$76.45	$41.90	$108.62	$1,918.93
3-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,682.38	$87.86	$41.66	$108.71	$1,920.62
3-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,607.29	$65.87	$39.80	$102.78	$1,815.73
2+2 Lane	Bi-Directional	At-Grade	Barrier	Desirable	$2,208.53	$357.97	$54.69	$158.35	$2,797.54
2+2 Lane	Bi-Directional	At-Grade	Barrier	Reduced	$2,090.60	$230.20	$51.77	$142.35	$2,514.91
2+2 Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,919.01	$162.92	$47.52	$127.77	$2,257.21
2+2 Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,840.18	$110.72	$45.57	$119.79	$2,116.25
2-Lane	Reversible	At-Grade	Barrier	Desirable	$1,482.01	$62.53	$36.70	$94.87	$1,676.10
2-Lane	Reversible	At-Grade	Barrier	Reduced	$1,385.92	$37.01	$34.32	$87.43	$1,544.68
3-Lane	Reversible	At-Grade	Barrier	Desirable	$1,593.90	$73.46	$39.47	$102.41	$1,809.24

I-75 North					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
3-Lane	Reversible	At-Grade	Barrier	Reduced	$1,435.11	$47.95	$35.54	$91.12	$1,609.71
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$2,118.21	$84.40	$37.66	$134.42	$2,344.06
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$1,800.97	$62.32	$31.87	$113.71	$1,982.69
2-Lane	Reversible	Elevated	Barrier	Desirable	$1,365.59	$31.33	$25.72	$85.36	$1,491.95
2-Lane	Reversible	Elevated	Barrier	Reduced	$1,229.89	$31.33	$23.49	$77.08	$1,347.94
3-Lane	Reversible	Elevated	Barrier	Desirable	$1,561.21	$31.33	$29.08	$97.48	$1,703.03
3-Lane	Reversible	Elevated	Barrier	Reduced	$1,366.01	$31.33	$25.31	$85.36	$1,491.15

Table 18: I-75 South Corridor Cost Estimates

I-75 South					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,780.45	$162.62	$44.09	$119.23	$2,106.39
2-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,573.44	$100.88	$38.96	$102.80	$1,816.08
2-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,567.59	$114.36	$38.82	$103.25	$1,824.02
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,496.96	$82.00	$37.07	$82.00	$1,712.99

I-75 South					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
3-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,821.77	$186.56	$45.11	$123.21	$2,176.64
3-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,636.77	$133.75	$40.53	$108.66	$1,919.71
3-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,615.93	$149.72	$40.01	$108.34	$1,914.00
3-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,541.76	$114.86	$38.18	$114.86	$1,796.49
2+2 Lane	Bi-Directional	At-Grade	Barrier	Desirable	$2,205.20	$438.48	$54.60	$161.90	$2,860.18
2+2 Lane	Bi-Directional	At-Grade	Barrier	Reduced	$2,096.70	$332.43	$51.92	$148.86	$2,6229.92
2+2 Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,930.33	$265.45	$47.80	$134.62	$2,378.20
2+2 Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,857.01	$200.89	$45.98	$126.23	$2,230.12
2-Lane	Reversible	At-Grade	Barrier	Desirable	$1,514.21	$98.02	$37.49	$98.98	$1,748.70
2-Lane	Reversible	At-Grade	Barrier	Reduced	$1,372.39	$50.78	$33.98	$87.43	$1,544.59
3-Lane	Reversible	At-Grade	Barrier	Desirable	$1,531.55	$115.94	$37.92	$101.13	$1,786.55
3-Lane	Reversible	At-Grade	Barrier	Reduced	$1,389.63	$68.71	$34.41	$89.57	$1,582.32
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$2,053.51	$149.93	$35.53	$134.34	$2,340.49
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$1,768.52	$109.10	$30.76	$114.50	$1,995.19
2-Lane	Reversible	Elevated	Barrier	Desirable	$1,493.23	$43.13	$28.76	$93.91	$1,642.14
2-Lane	Reversible	Elevated	Barrier	Reduced	$1,318.11	$35.93	$25.56	$82.78	$1,447.93
3-Lane	Reversible	Elevated	Barrier	Desirable	$1,605.41	$53.91	$29.83	$101.35	$1,769.97
3-Lane	Reversible	Elevated	Barrier	Reduced	$1,430.29	$46.72	$26.63	$90.22	$1,575.76

Table 19: I-85 North Corridor Cost Estimates

I-85 North					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,953.43	$326.43	$48.37	$139.69	$2,467.92
2-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,779.97	$160.12	$44.08	$119.05	$2,103.21
2-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,801.02	$205.79	$44.60	$123.08	$2,174.49
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,617.56	$112.91	$40.05	$106.23	$1,876.75
3-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$2,010.31	$373.45	$49.78	$146.01	$2,579.55
3-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,842.30	$270.76	$45.62	$129.52	$2,288.20
3-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,856.38	$323.42	$45.97	$133.55	$2,359.31
3-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,790.71	$223.55	$44.34	$123.52	$2,182.12
2+2 Lane	Bi-Directional	At-Grade	Barrier	Desirable	$2,327.14	$604.70	$57.62	$179.37	$3,168.83
2+2 Lane	Bi-Directional	At-Grade	Barrier	Reduced	$2,180.29	$481.00	$53.99	$162.92	$2,878.19
2+2 Lane	Bi-Directional	At-Grade	Buffer	Desirable	$2,073.39	$419.39	$51.34	$152.65	$2,696.76
2+2 Lane	Bi-Directional	At-Grade	Buffer	Reduced	$2,000.98	$354.08	$49.55	$144.28	$2,548.88
2-Lane	Reversible	At-Grade	Barrier	Desirable	$1,718.53	$163.27	$42.55	$115.46	$2,039.82
2-Lane	Reversible	At-Grade	Barrier	Reduced	$1,529.51	$31.86	$37.87	$95.95	$1,695.70
3-Lane	Reversible	At-Grade	Barrier	Desirable	$1,745.70	$223.33	$43.23	$120.74	$2,132.99
3-Lane	Reversible	At-Grade	Barrier	Reduced	$1,645.02	$88.18	$40.73	$106.44	$1,880.37
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$2,360.15	$13.29	$58.44	$145.91	$2,577.80

I-85 North					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$1,997.93	$7.24	$49.47	$123.28	$2,177.91
2-Lane	Reversible	Elevated	Barrier	Desirable	$1,550.76	$13.29	$38.40	$96.15	$1,698.60
2-Lane	Reversible	Elevated	Barrier	Reduced	$1,363.12	$13.29	$33.75	$84.61	$1,494.77
3-Lane	Reversible	Elevated	Barrier	Desirable	$1,738.85	$13.29	$43.06	$107.71	$1,902.91
3-Lane	Reversible	Elevated	Barrier	Reduced	$1,551.11	$13.29	$38.41	$96.17	$1,698.98

Table 20: I-20 East Corridor Cost Estimates

I-20 East					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$972.42	$106.18	$24.08	$66.16	$1,168.84
2-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$913.62	$67.82	$22.62	$60.24	$1,064.31
2-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$909.86	$84.67	$22.53	$60.42	$1,067.48
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$882.20	$55.49	$21.84	$57.57	$1,017.10
2-Lane	Reversible	At-Grade	Barrier	Desirable	$955.29	$61.65	$23.65	$62.44	$1,103.04
2-Lane	Reversible	At-Grade	Barrier	Reduced	$910.86	$28.77	$22.55	$57.73	$1,019.92

I-20 East					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$1,381.56	$94.53	$13.16	$89.35	$1,534.88
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$1,118.02	$72.61	$10.65	$72.08	$1,238.08
2-Lane	Reversible	Elevated	Barrier	Desirable	$755.69	$15.00	$7.20	$46.67	$801.72
2-Lane	Reversible	Elevated	Barrier	Reduced	$649.82	$15.00	$6.19	$40.26	$691.57

Table 21: I-20 West Corridor Cost Estimates

I-20 West					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,003.91	$65.76	$24.86	$65.67	$1,160.20
2-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$902.17	$42.00	$22.34	$57.99	$1,024.50
2-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$896.56	$46.25	$22.20	$57.90	$1,022.91
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$842.01	$34.37	$20.85	$53.83	$951.06
2+2 Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,139.30	$157.59	$28.21	$79.51	$1,404.61
2+2 Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,047.00	$116.24	$25.93	$71.35	$1,260.51
2+2 Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,007.03	$100.01	$24.94	$67.92	$1,199.89

I-20 West					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2+2 Lane	Bi-Directional	At-Grade	Buffer	Reduced	$952.05	$73.41	$23.57	$62.94	$1,111.98
2-Lane	Reversible	At-Grade	Barrier	Desirable	$917.10	$38.18	$22.71	$58.68	$1,036.67
2-Lane	Reversible	At-Grade	Barrier	Reduced	$842.66	$21.07	$20.87	$53.08	$937.67
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$1,223.97	$63.19	$21.36	$78.51	$1,369.00
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$1,122.59	$19.45	$20.39	$72.08	$1,258.53
2-Lane	Reversible	Elevated	Barrier	Desirable	$888.63	$37.69	$17.10	$56.61	$990.11
2-Lane	Reversible	Elevated	Barrier	Reduced	$790.75	$24.51	$15.37	$49.84	$871.98

Table 22: I-285 South Corridor Cost Estimates

I-285 South					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,179.29	$106.31	$29.20	$78.89	$1,393.69
2-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$998.71	$65.16	$24.73	$65.32	$1,153.91
2-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$999.97	$74.76	$24.76	$65.97	$1,165.46
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$954.55	$52.81	$23.64	$61.86	$1,092.86
3-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,232.29	$144.99	$30.51	$84.47	$1,492.26

I-285 South					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
3-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,160.18	$95.34	$28.73	$77.05	$1,361.30
3-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,152.66	$107.92	$28.54	$77.35	$1,366.47
3-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,020.51	$82.99	$25.27	$67.73	$1,196.49
2+2 Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,392.65	$220.37	$34.48	$98.85	$1,746.36
2+2 Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,333.77	$181.88	$33.03	$92.92	$1,641.59
2+2 Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,254.29	$159.42	$31.06	$86.69	$1,531.45
2+2 Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,213.10	$130.48	$30.04	$84.42	$1,456.03
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$1,528.22	$94.65	$37.84	$99.64	$1,711.59
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$1,292.74	$72.70	$32.01	$83.85	$1,440.26

Table 23: I-285 East Corridor Cost Estimates

I-285 East					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$866.36	$79.84	$21.45	$58.06	$1,025.71
2-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$798.33	$48.93	$19.77	$52.02	$919.05

I-285 East					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$798.43	$56.15	$19.77	$52.46	$926.81
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$764.82	$39.66	$18.94	$49.41	$872.83
3-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$911.98	$135.44	$22.58	$64.20	$1,134.21
3-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$851.45	$71.60	$21.08	$56.65	$1,000.79
3-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$844.07	$82.16	$20.90	$56.83	$1,003.95
3-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$817.66	$62.33	$20.25	$54.01	$954.25
2+2 Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,021.58	$286.29	$25.30	$79.99	$1,413.15
2+2 Lane	Bi-Directional	At-Grade	Barrier	Reduced	$972.16	$209.26	$24.07	$72.33	$1,277.82
2+2 Lane	Bi-Directional	At-Grade	Buffer	Desirable	$904.90	$164.33	$22.41	$65.50	$1,157.13
2+2 Lane	Bi-Directional	At-Grade	Buffer	Reduced	$870.63	$114.59	$21.56	$60.41	$1,067.19
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$1,146.59	$71.08	$28.39	$74.76	$1,284.24
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$967.50	$54.60	$23.96	$62.76	$1,078.11

Table 24: I-285 North Corridor Cost Estimates

I-285 North					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,174.41	$83.85	$29.08	$77.24	$1,364.59
2-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,096.36	$49.23	$27.15	$70.36	$1,243.10
2-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,100.73	$58.97	$27.26	$71.22	$1,258.17
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,059.68	$39.49	$26.24	$67.52	$1,192.94
3-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,223.72	$121.12	$30.30	$82.51	$1,457.65
3-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,153.88	$73.03	$28.57	$75.33	$1,330.81
3-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,150.03	$85.40	$28.48	$75.83	$1,339.75
3-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,117.19	$63.29	$27.66	$72.49	$1,280.64
2+2 Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,353.58	$384.18	$33.52	$106.28	$1,877.55
2+2 Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,296.03	$238.65	$32.09	$94.01	$1,660.78
2+2 Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,229.09	$171.49	$30.43	$85.86	$1,516.88
2+2 Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,188.02	$104.04	$29.42	$79.29	$1,400.76
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$1,213.33	$74.65	$30.04	$79.08	$1,358.41
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$1,032.08	$57.34	$25.56	$66.90	$1,149.14

Table 25: I-285 West Corridor Cost Estimates

I-285 West					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,305.21	$112.95	$32.32	$87.03	$1,537.51
2-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,195.77	$69.23	$29.61	$77.68	$1,372.28
2-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,197.23	$79.43	$29.65	$78.38	$1,384.68
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,138.30	$56.11	$28.19	$73.36	$1,295.95
3-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,377.41	$150.18	$34.11	$93.70	$1,655.40
3-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,277.51	$101.29	$31.63	$84.63	$1,495.06
3-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,269.37	$114.50	$31.43	$84.92	$1,500.22
3-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,227.27	$88.17	$30.39	$80.75	$1,426.58
2+2 Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,600.09	$396.62	$39.62	$122.18	$2,158.51
2+2 Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,518.88	$279.78	$37.61	$109.64	$1,936.90
2+2 Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,415.86	$197.37	$35.06	$98.90	$1,747.18
2+2 Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,361.72	$136.22	$33.72	$91.90	$1,623.56
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$1,866.48	$100.56	$46.22	$120.80	$2,074.94
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$1,589.05	$77.24	$39.35	$102.34	$1,757.90

Table 26: I-575 Corridor Cost Estimates

I-575					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$917.18	$18.30	$22.71	$57.49	$1,015.68
2-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$784.47	$11.47	$19.43	$48.92	$864.29
2-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$779.37	$12.69	$19.30	$48.68	$860.04
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$727.95	$9.27	$18.03	$45.31	$800.56

Table 27: SR 400 Corridor Cost Estimates

SR 400					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,247.16	$74.72	$30.88	$81.17	$1,433.94
2-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,123.47	$48.88	$27.82	$72.01	$1,272.18
2-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,128.63	$54.47	$27.95	$72.66	$1,283.71
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,041.77	$40.96	$25.80	$66.51	$1,175.03
2-Lane	Reversible	At-Grade	Barrier	Desirable	$1,025.36	$39.63	$25.39	$65.42	$1,155.80
2-Lane	Reversible	At-Grade	Barrier	Reduced	$948.13	$25.16	$23.48	$59.81	$1,056.58
3-Lane	Reversible	At-Grade	Barrier	Desirable	$1,045.99	$46.73	$25.90	$67.12	$1,185.74

SR 400					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
3-Lane	Reversible	At-Grade	Barrier	Reduced	$968.56	$31.02	$23.98	$61.40	$1,084.75
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$1,888.07	$60.77	$28.83	$118.66	$2,060.27
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$1,573.08	$46.68	$24.35	$98.65	$1,713.43
2-Lane	Reversible	Elevated	Barrier	Desirable	$1,129.10	$25.26	$18.24	$70.36	$1,208.52
2-Lane	Reversible	Elevated	Barrier	Reduced	$993.21	$25.26	$16.21	$62.08	$1,066.37
3-Lane	Reversible	Elevated	Barrier	Desirable	$1,308.16	$25.26	$20.66	$81.24	$1,395.57
3-Lane	Reversible	Elevated	Barrier	Reduced	$1,178.77	$25.26	$18.74	$73.37	$1,260.23

Note: Inside of I-285, the cost estimates assume one lane in each direction.

Table 28: Downtown Connector Corridor Cost Estimates

Downtown Connector					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$835.76	$0	$20.69	$51.39	$907.84
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$685.35	$0	$16.97	$42.14	$744.46

Table 29: I-85 North Inside of I-285 Corridor Cost Estimates

I-85 North Inside of I-285					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$757.67	$150.37	$18.76	$55.61	$982.41
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$754.31	$0	$18.68	$46.38	$819.37
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$645.73	$0	$15.99	$39.70	$701.42

Table 30: I-85 South Inside of I-285 Corridor Cost Estimates

I-85 South Inside of I-285					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$548.20	$29.69	$13.57	$35.49	$626.95

Table 31: I-75 North Inside of I-285 Corridor Cost Estimates

I-75 North Inside of I-285					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$476.22	$87.75	$11.79	$34.55	$610.31

Table 32: I-75 South Inside of I-285 Corridor Cost Estimates

I-75 South Inside of I-285					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$295.86	$17.83	$7.33	$19.26	$340.28

Table 33: I-20 East Inside of I-285 Corridor Cost Estimates

I-20 East Inside of I-285					Capital Costs (In Millions $1,000,000)				Total Capital Costs
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$516.28	$19.68	$12.78	$32.93	$581.68

Table 34: I-75 North at I-575 System-to-System Interchange Cost Estimate

I-75 North at I-575	Capital Costs (In Millions $1,000,000)				Total Capital Costs
	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2+2 Lane	$32.93	$0.00	$0.82	$2.02	$35.77
3-Lane	$32.93	$0.00	$0.82	$2.02	$35.77
2-Lane	$32.93	$0.00	$0.82	$2.02	$35.77

Table 35: I-75 South at I-675 System-to-System Interchange Cost Estimate

I-75 South at I-675	Capital Costs (In Millions $1,000,000)				Total Capital Costs
	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2+2 Lane	$40.07	$0.00	$0.99	$2.46	$43.53
3-Lane	$40.07	$0.00	$0.99	$2.46	$43.53
2-Lane	$40.07	$0.00	$0.99	$2.46	$43.53

Table 36: I-85 North at I-985 System-to-System Interchange Cost Estimate

I-85 North at I-985	Capital Costs (In Millions $1,000,000)				Total Capital Costs
	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2+2 Lane	$34.04	$0.00	$0.84	$2.09	$36.98
3-Lane	$32.93	$0.00	$0.82	$2.02	$35.77
2-Lane	$32.93	$0.00	$0.82	$2.02	$35.77

Table 37: I-285 at I-85 South System-to-System Interchange Cost Estimate

I-285 at I-85 South	Capital Costs (In Millions $1,000,000)				Total Capital Costs
	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2+2 Lane	$526.27	$0.00	$13.03	$32.36	$571.66
3-Lane	$488.16	$0.00	$12.09	$30.02	$530.27
2-Lane	$470.78	$0.00	$11.66	$28.95	$511.39

Table 38: I-285 at I-75 South System-to-System Interchange Cost Estimate

I-285 at I-75 South	Capital Costs (In Millions $1,000,000)				Total Capital Costs
	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2+2 Lane	$382.78	$0.00	$9.48	$23.54	$415.79
3-Lane	$362.09	$0.00	$8.97	$22.26	$393.32
2-Lane	$351.53	$0.00	$8.70	$21.61	$381.85

Table 39: I-285 at I-675 System-to-System Interchange Cost Estimate

I-285 at I-675	Capital Costs (In Millions $1,000,000)				Total Capital Costs
	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2+2 Lane	$87.42	$0.00	$2.16	$5.38	$94.96
3-Lane	$86.40	$0.00	$2.14	$5.31	$93.85
2-Lane	$85.88	$0.00	$2.13	$5.28	$93.28

Table 40: I-285 at I-20 East System-to-System Interchange Cost Estimate

I-285 at I-20 East	Capital Costs (In Millions $1,000,000)				Total Capital Costs
	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2+2 Lane	$439.50	$0.00	$10.88	$27.02	$477.41
3-Lane	$420.35	$0.00	$10.41	$25.85	$456.60
2-Lane	$410.57	$0.00	$10.17	$25.24	$445.98

Table 41: I-285 at US 78 System-to-System Interchange Cost Estimate

I-285 at US 78	Capital Costs (In Millions $1,000,000)				Total Capital Costs
	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2+2 Lane	$146.97	$0.00	$3.64	$9.04	$159.64
3-Lane	$143.41	$0.00	$3.55	$8.82	$155.78
2-Lane	$141.59	$0.00	$3.51	$8.71	$153.81

Table 42: I-285 at I-85 North System-to-System Interchange Cost Estimate

I-285 at I-85 North	Capital Costs (In Millions $1,000,000)				Total Capital Costs
	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2+2 Lane	$444.29	$0.00	$11.00	$27.32	$482.61
3-Lane	$440.18	$0.00	$10.90	$27.06	$478.15
2-Lane	$438.09	$0.00	$10.85	$26.94	$475.87

Table 43: I-285 at Peachtree Industrial Boulevard System-to-System Interchange Cost Estimate

I-285 at Peachtree Industrial Boulevard	Capital Costs (In Millions $1,000,000)				Total Capital Costs
	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2+2 Lane	$196.60	$0.00	$4.87	$12.09	$213.56
3-Lane	$194.41	$0.00	$4.81	$11.95	$211.18
2-Lane	$193.30	$0.00	$4.79	$11.88	$209.97

Table 44: I-285 at SR 400 System-to-System Interchange Cost Estimate

I-285 at SR 400	Capital Costs (In Millions $1,000,000)				Total Capital Costs
	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2+2 Lane	$446.80	$0.00	$11.06	$27.47	$485.34
3-Lane	$397.14	$0.00	$9.83	$24.42	$431.40
2-Lane	$377.75	$0.00	$9.35	$23.23	$410.33

Table 45: I-285 at I-75 North System-to-System Interchange Cost Estimate

I-285 at I-75 North	Capital Costs (In Millions $1,000,000)				Total Capital Costs
	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2+2 Lane	$548.30	$0.00	$13.58	$33.71	$595.59
3-Lane	$531.16	$0.00	$13.15	$32.66	$576.97
2-Lane	$522.41	$0.00	$12.94	$32.12	$567.47

Table 46: I-285 at I-20 West System-to-System Interchange Cost Estimate

I-285 at I-20 West	Capital Costs (In Millions $1,000,000)				Total Capital Costs
	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2+2 Lane	$513.49	$0.00	$12.72	$31.57	$557.78
3-Lane	$441.05	$0.00	$10.92	$27.12	$479.09
2-Lane	$407.86	$0.00	$10.10	$25.08	$443.04

Table 47: I-285 at Langford Parkway System-to-System Interchange Cost Estimate

I-285 at Langford Parkway	Capital Costs (In Millions $1,000,000)				Total Capital Costs
	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2+2 Lane	$104.65	$0.00	$2.59	$6.43	$113.67
3-Lane	$103.22	$0.00	$2.56	$6.35	$112.13
2-Lane	$102.50	$0.00	$2.54	$6.30	$111.34

Table 48: I-85 at I-75 (Brookwood Split) System-to-System Interchange Cost Estimate

I-85 at I-75 (Brookwood Split)	Capital Costs (In Millions $1,000,000)				Total Capital Costs
	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	$61.11	$0.00	$1.51	$3.76	$66.38

Table 49: I-85 at I-75 Split System-to-System Interchange Cost Estimate

I-85 at I-75 Split	Capital Costs (In Millions $1,000,000)				Total Capital Costs
	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	$73.19	$0.00	$1.81	$4.50	$79.50

Table 50: I-85 at SR 400 System-to-System Interchange Cost Estimate

I-20 at Downtown Connector	Capital Costs (In Millions $1,000,000)				Total Capital Costs
	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	$233.79	$0.00	$5.89	$14.63	$258.51

Table 51: I-20 at Downtown Connector System-to-System Interchange Cost Estimate

I-20 at Downtown Connector	Capital Costs (In Millions $1,000,000)				Total Capital Costs
	Cost of Construction	Right-of-Way	Cost of Utilities	Corridor Contingencies	
2-Lane	$386.45	$0.00	$9.57	$23.76	$419.78

F. Cost Savings and Additional Opportunities Cost Estimates

On some of the corridors analyzed in the Managed Lanes System Plan, physical constraints make implementation of some or all of the base case proposed alternatives unfeasible from a perspective of cost, environmental impacts, displacements, infrastructure relocation, etc. and other alternatives had to be considered. In response, additional alternatives were considered and revised costs developed applied. The additional opportunities explored included: considering a General Purpose lane conversion, overlaying existing pavement in lieu of full depth reconstruction, widening as needed with no overlay, reducing shoulder widths at bridge locations to minimize bridge replacement costs, and implementing a one-lane per direction alternative in select corridors.

Attaining these options entailed revising some of the base case costing assumptions. Each of these opportunities is discussed in more detail below and any assumptions varying from the base case cost estimate assumptions are noted. For all of the additional opportunity cost estimates, the corridor contingency was assumed to be 10 percent, instead of 6 percent as in the base case.

General Purpose Lane Conversion

This opportunity evaluated corridors in which a general-purpose lane could be converted to a Managed Lane and still achieve an appropriate balancing between General Purpose and Managed Lane capacity. In corridors with existing HOV lanes, converting a General Purpose lane in the 2-lane buffer reduced alternative would require no additional pavement to be constructed. For all of the 2-lane, 3-lane, and 2+2-lane alternatives, the cost assumptions were the same as the base case.

Overlay Existing Pavement

This cost savings opportunity evaluated the potential of milling and an overlaying the existing pavement instead of applying full depth reconstruction. Full depth pavement was assumed only in the new construction portion of the proposed typical section. If the corridor shoulders were not full depth, the shoulder was assumed to be removed and replaced with full depth pavement. The assumptions listed below were used in the cost estimates and vary from the base case assumptions.

- The overlay pavement design structure was as follows:
- Asphaltic Concrete 12.5 mm PEM, 1.5”
- Asphaltic Concrete 12.5 mm SMA, 2”
- 3.5 inches Milling
- Bituminous Tack Coat
- Existing central longitudinal drainage systems and existing median drainage inlet structures were assumed to be maintained.
- Existing box culverts and cross drains were assumed to be maintained and extended as required.
- Existing median barriers assumed to remain in place.
- Existing lighting was assumed in areas with existing medians. This lighting was assumed to be maintained.

One-Lane Alternative

This opportunity evaluated a one managed lane buffer-reduced alternative in some of the corridors. In corridors with an existing depressed median being replaced with flush pavement the following assumptions were used:

- Drainage inlet structures were assumed to be placed at 200 foot longitudinal spacing

- 24-inch longitudinal concrete drainage pipes were assumed to be added along the median
- A new median barrier was assumed
- New lighting was assumed

Bridge Shoulder Width Reduction

In order to minimize bridge replacement costs, this cost savings opportunity evaluated reduced shoulder widths under overpass bridges. The inside and outside shoulders for each alternative were reduced to 2 feet. This opportunity was only evaluated for the 2-lane alternatives.

Special Cases

The corridors listed below were special cases, in which none of the at-grade base case alternatives could be applied due to physical constraints. One or a combination of the above opportunities was utilized in determining the cost estimate for the corridor.

- SR 400 inside of I-285: No widening was possible along this corridor. Therefore, a cost estimate was developed for a 1-lane, buffer reduced, General Purpose lane conversion alternative. In this case, no change in the typical section width was assumed; therefore, milling and overlay was assumed for the existing pavement.
- I-20 West Inside of I-285: Additional at-grade lanes could not be added to this corridor. Therefore a cost estimate was developed for a 1-lane, buffer reduced, General Purpose lane conversion alternative. In this case, no change in the typical section width was assumed.
- Downtown Connector: No at-grade widening was possible along this corridor. A cost estimate was developed for a 2-lane buffer reduced alternative, in which the existing HOV and a General Purpose lane were converted. In this case, no change in the typical section was assumed.

Corridor Cost Estimates

Shown in the tables below are the corridor cost estimates with the opportunities and cost savings discussed above applied. For each of the cost savings opportunities, a 10 percent corridor contingency was applied. The overlay existing pavement savings cost estimates were only developed for the buffer alternatives. In addition, the estimates reflecting the shoulder reduction at bridges were only developed for the 2-lane alternatives.

Table 52: I-75 North Corridor Cost Estimates (millions)

I-75 North					Base Case	1 GP Lane Conversion	Overlay Existing Pavement		Bridge Shoulder Width Reduction
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced			Base	1 GP Lane Conversion	
1-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,409.80		$841.84		$1,387.87
2-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$2,139.14	$2,071.13			$2,067.10
2-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,845.88	$1,771.96			$1,820.20
2-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,852.92	$1,773.40	$1,340.30	$1,256.79	$1,816.74
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,730.89	$1,529.13	$1,220.65	$1,015.23	$1,697.17
3-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$2,205.15	$2,147.43			
3-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,918.93	$1,864.60			
3-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,920.62	$1,861.40	$1,411.98	$1,349.26	
3-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,815.73	$1,761.40	$1,310.14	$1,252.59	
2+2 Lane	Bi-Directional	At-Grade	Barrier	Desirable	$2,797.54	$2,612.81			
2+2 Lane	Bi-Directional	At-Grade	Barrier	Reduced	$2,514.91	$2,334.70			
2+2 Lane	Bi-Directional	At-Grade	Buffer	Desirable	$2,257.21	$2,161.90	$1,734.09	$1,633.09	
2+2 Lane	Bi-Directional	At-Grade	Buffer	Reduced	$2,116.25	$2,050.48	$1,595.50	$1,526.08	
2-Lane	Reversible	At-Grade	Barrier	Desirable	$1,676.10	$1,620.62	$1,255.68	$1,196.68	
2-Lane	Reversible	At-Grade	Barrier	Reduced	$1,544.68	$1,427.74	$1,097.01	$1,002.75	
3-Lane	Reversible	At-Grade	Barrier	Desirable	$1,809.24	$1,753.56	$1,402.87	$1,343.69	

I-75 North					Base Case	1 GP Lane Conversion	Overlay Existing Pavement		Bridge Shoulder
3-Lane	Reversible	At-Grade	Barrier	Reduced	$1,609.71	$1,480.62	$1,189.45	$1,083.05	
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$2,344.06	$2,383.20			
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$1,982.69	$1,999.41			
2-Lane	Reversible	Elevated	Barrier	Desirable	$1,491.95	$1,580.24			
2-Lane	Reversible	Elevated	Barrier	Reduced	$1,347.94	$1,435.25			
3-Lane	Reversible	Elevated	Barrier	Desirable	$1,703.03	$1,801.51			
3-Lane	Reversible	Elevated	Barrier	Reduced	$1,491.15	$1,588.69			

Table 53: I-75 South Corridor Cost Estimates (millions)

I-75 South					Base Case	1 GP Lane Conversion	Overlay Existing Pavement		Bridge Shoulder Width Reduction
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced			Base	1 GP Lane Conversion	
1-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,363.87		$924.14		$1,312.60
2-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$2,106.39	$2,018.82			$2,047.98
2-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,816.08	$1,746.46			$1,814.28
2-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,824.02	$1,748.07	$1,471.69	$1,391.80	$1,821.95
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,712.99	$1,522.23	$1,352.37	$1,159.00	$1,711.51
3-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$2,176.64				

I-75 South					Base Case	1 GP Lane Conversion	Overlay Existing Pavement		Bridge Shoulder
3-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,919.71				
3-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,914.00		$1,565.61		
3-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,796.49		$1,440.46		
2+2 Lane	Bi-Directional	At-Grade	Barrier	Desirable	$2,860.18	$2,749.11			
2+2 Lane	Bi-Directional	At-Grade	Barrier	Reduced	$2,629.92	$2,528.13			
2+2 Lane	Bi-Directional	At-Grade	Buffer	Desirable	$2,378.20	$2,295.46	$2,053.75	$1,967.08	
2+2 Lane	Bi-Directional	At-Grade	Buffer	Reduced	$2,230.12	$2,166.40	$1,897.38	$1,830.05	
2-Lane	Reversible	At-Grade	Barrier	Desirable	$1,748.70	$1,673.25	$1,506.16	$1,423.66	
2-Lane	Reversible	At-Grade	Barrier	Reduced	$1,544.59	$1,502.90	$1,280.07	$1,232.80	
3-Lane	Reversible	At-Grade	Barrier	Desirable	$1,786.55	$1,786.54	$1,547.53	$1,547.53	
3-Lane	Reversible	At-Grade	Barrier	Reduced	$1,582.32	$1,582.31	$1,321.32	$1,321.32	
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$2,340.49	$2,383.89			
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$1,995.19	$2,066.84			
2-Lane	Reversible	Elevated	Barrier	Desirable	$1,642.14	$1,832.70			
2-Lane	Reversible	Elevated	Barrier	Reduced	$1,447.93	$1,519.35			
3-Lane	Reversible	Elevated	Barrier	Desirable	$1,769.97	$1,961.25			
3-Lane	Reversible	Elevated	Barrier	Reduced	$1,575.76	$1,647.77			

Table 54: I-85 North Corridor Cost Estimates (millions)

I-85 North					Base Case	1 GP Lane Conversion	Overlay Existing Pavement		Bridge Shoulder Width Reduction
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced			Base	1 GP Lane Conversion	
1-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,701.19		$1,006.54		$1,162.05
2-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$2,467.92	$2,267.79			$2,427.73
2-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$2,103.21	$1,602.86			$2,077.94
2-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$2,174.49	$1,807.47	$2,035.32	$1,659.75	$2,148.11
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,876.75	$1,284.07	$1,748.46	$1,110.82	$1,860.12
3-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$2,579.55	$2,500.80			
3-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$2,228.20	$2,140.18			
3-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$2,359.31	$2,205.52	$2,247.71	$2,086.68	
3-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$2,182.12	$2,038.13	$2,022.72	$1,871.80	
2+2 Lane	Bi-Directional	At-Grade	Barrier	Desirable	$3,168.83	$2,984.32			
2+2 Lane	Bi-Directional	At-Grade	Barrier	Reduced	$2,878.19	$2,710.98			
2+2 Lane	Bi-Directional	At-Grade	Buffer	Desirable	$2,696.76	$2,557.57	$2,622.11	$2,473.16	
2+2 Lane	Bi-Directional	At-Grade	Buffer	Reduced	$2,548.88	$2,406.54	$2,413.55	$2,261.98	
2-Lane	Reversible	At-Grade	Barrier	Desirable	$2,039.82	$2,039.81	$1,583.42	$1,583.42	
2-Lane	Reversible	At-Grade	Barrier	Reduced	$1,695.70	$1,695.19	$1,218.73	$1,218.73	

I-85 North					Base Case	1 GP Lane Conversion	Overlay Existing Pavement		Bridge Shoulder
3-Lane	Reversible	At-Grade	Barrier	Desirable	$2,132.99	$1,976.14	$1,682.21	$1,518.50	
3-Lane	Reversible	At-Grade	Barrier	Reduced	$1,880.37	$1,695.28	$1,408.34	$1,219.12	
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$2,577.80				
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$2,177.91				
2-Lane	Reversible	Elevated	Barrier	Desirable	$1,698.60				
2-Lane	Reversible	Elevated	Barrier	Reduced	$1,494.77				
3-Lane	Reversible	Elevated	Barrier	Desirable	$1,902.91				
3-Lane	Reversible	Elevated	Barrier	Reduced	$1,698.98				

Table 55: I-20 East Corridor Cost Estimates (millions)

I-20 East					Base Case	1 GP Lane Conversion	Overlay Existing Pavement		Bridge Shoulder Width Reduction
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced			Base	1 GP Lane Conversion	
1-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$766.18		$543.94		$747.23
2-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,168.84				$1,131.69
2-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,064.31				$1,026.58
2-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,067.48		$897.27		$1,029.40
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,017.10		$803.67		$969.76
2-Lane	Reversible	At-Grade	Barrier	Desirable	$1,103.04		$952.53	$952.53	
2-Lane	Reversible	At-Grade	Barrier	Reduced	$1,019.92		$859.81	$859.81	
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$1,534.88				
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$1,238.08				
2-Lane	Reversible	Elevated	Barrier	Desirable	$801.72				
2-Lane	Reversible	Elevated	Barrier	Reduced	$691.57				

Table 56: I-20 West Corridor Cost Estimates (millions)

I-20 West					Base Case	1 GP Lane Conversion	Overlay Existing Pavement		Bridge Shoulder Width Reduction
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced			Base	1 GP Lane Conversion	
1-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$799.11		$530.97		$766.17
2-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,160.20				$1,136.93
2-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,024.50				$1,009.59
2-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,022.91		$864.51		$1,007.70
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$951.06		$783.66		$946.43
2+2 Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,404.61				
2+2 Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,260.51				
2+2 Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,199.89		$1,053.31		
2+2 Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,111.98		$954.40		
2-Lane	Reversible	At-Grade	Barrier	Desirable	$1,036.67	$1,036.67	$857.44	$857.44	
2-Lane	Reversible	At-Grade	Barrier	Reduced	$937.67	$937.67	$745.24	$745.24	
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$1,369.00				
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$1,258.53				
2-Lane	Reversible	Elevated	Barrier	Desirable	$990.11				
2-Lane	Reversible	Elevated	Barrier	Reduced	$871.98				

Table 57: I-285 South Corridor Cost Estimates (millions)

I-285 South					Base Case	1 GP Lane Conversion	Overlay Existing Pavement		Bridge Shoulder Width Reduction
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced			Base	1 GP Lane Conversion	
1-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$837.08		$161.11		$812.31
2-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,393.69	$1,192.71			$1,378.77
2-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,153.91	$1,064.81			$1,145.12
2-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,165.46	$1,068.76	$834.54	$755.83	$1,156.02
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,082.86	$837.08	$781.28	$519.99	$1,089.33
3-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,492.26				
3-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,361.30				
3-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,366.47		$1,065.56		
3-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,196.49		$891.92		
2+2 Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,746.36	$1,647.90			
2+2 Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,641.59	$1,551.37			
2+2 Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,531.45	$1,432.94	$1,238.56	$1,134.03	
2+2 Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,456.03	$1,367.42	$1,158.47	$1,064.35	
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$1,711,59	$1,792.20			
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$1,440.26	$1,490.72			

Table 58: I-285 East Corridor Cost Estimates (millions)

I-285 East					Base Case	1 GP Lane Conversion	Overlay Existing Pavement		Bridge Shoulder Width Reduction
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced			Base	1 GP Lane Conversion	
1-Lane	Bi-Directional	At-Grade	Buffer	Reduced					
2-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,025.71	$949.95			$1,016.41
2-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$919.05	$850.44			$915.33
2-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$926.81	$852.00	$738.46	$655.36	$922.57
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$872.83	$682.28	$678.26	$479.85	$870.02
3-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,134.21				
3-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,000.79				
3-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,003.95		$823.90		
3-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$954.25		$769.15		
2+2 Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,413.15	$1,281.71			
2+2 Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,277.82	$1,157.31			
2+2 Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,157.13	$1,040.18	$988.14	$862.89	
2+2 Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,067.19	$977.42	$891.78	$794.40	
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$1,284.24	$1,326.78			
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$1,078.11	$1,097.52			

Table 59: I-285 North Corridor Cost Estimates (millions)

I-285 North					Base Case	1 GP Lane Conversion	Overlay Existing Pavement		Bridge Shoulder Width Reduction
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced			Base	1 GP Lane Conversion	
1-Lane	Bi-Directional	At-Grade	Buffer	Reduced					
2-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,364.59	$1,283.52			$1,356.73
2-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,243.10	$1,159.01			$1,244.56
2-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,258.17	$1,167.33	$989.12	$893.57	$1,238.93
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,192.94	$997.19	$919.96	$719.91	$1,086.70
3-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,457.65	$1,364.59			
3-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,330.81	$1,256.50			
3-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,339.75	$1,258.17	$1,075.39	$989.12	
3-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,280.64	$1,206.30	$1,013.15	$934.50	
2+2 Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,877.55	$1,681.59			
2+2 Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,660.78	$1,485.48			
2+2 Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,516.88	$1,385.25	$1,258.79	$1,122.46	
2+2 Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,400.76	$1,319.93	$1,138.75	$1,053.62	
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$1,358.41	$1,400.47			
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$1,149.14	$1,168.43			

Table 60: I-285 West Corridor Cost Estimates (millions)

I-285 West					Base Case	1 GP Lane Conversion	Overlay Existing Pavement		Bridge Shoulder Width Reduction
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced			Base	1 GP Lane Conversion	
1-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$947.71		$563.75	$196.22	$851.86
2-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,537.51	$1,422.03			$1,522.86
2-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,372.28	$1,262.02			$1,355.17
2-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,384.68	$1,264.50	$1,010.00	$882.66	$1,367.01
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,295.95	$947.71	$918.54	$563.75	$1,256.25
3-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,655.40				
3-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,495.06				
3-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,500.22		$1,132.69		
3-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,426.58		$1,057.52		
2+2 Lane	Bi-Directional	At-Grade	Barrier	Desirable	$2,158.51	$19,46.31			
2+2 Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,936.90	$1,742.82			
2+2 Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,747.18	$1,594.11	$1,389.18	$1,228.96	
2+2 Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,623.56	$1,516.21	$1,262.84	$1,148.4	
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$2,074.94	$2,149.74			
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$1,757.90	$1,799.38			

Table 61: I-575 Corridor Cost Estimates (millions)

I-575					Base Case	1 GP Lane Conversion	Overlay Existing Pavement		Bridge Shoulder Width Reduction
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced			Base	1 GP Lane Conversion	
1-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$730.94		$422.30		$722.78
2-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,015.68				$950.19
2-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$864.29				$847.39
2-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$860.04		$603.96		$841.79
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$800.56		$536.27		$782.31
1-Lane	Reversible	At-Grade	Barrier	Desirable	$856.02		$629.83		
1-Lane	Reversible	At-Grade	Barrier	Reduced	$810.36		$575.87		

Table 62: SR 400 Corridor Cost Estimates (millions)

SR 400					Base Case	1 GP Lane Conversion	Overlay Existing Pavement		Bridge Shoulder Width Reduction
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced			Base	1 GP Lane Conversion	
1-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$981.32		$636.21		$959.95
2-Lane	Bi-Directional	At-Grade	Barrier	Desirable	$1,433.94	$1,372.19			$1,386.63
2-Lane	Bi-Directional	At-Grade	Barrier	Reduced	$1,272.18	$1,216.54			$1,239.57

SR 400					Base Case	1 GP Lane Conversion	Overlay Existing Pavement		Bridge Shoulder
2-Lane	Bi-Directional	At-Grade	Buffer	Desirable	$1,283.71	$1,223.55	$963.52	$895.25	$1,250.75
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$1,175.03	$1,045.93	$843.96	$707.47	$1,146.35
2-Lane	Reversible	At-Grade	Barrier	Desirable	$1,155.80	$1,099.05	$908.39	$841.02	
2-Lane	Reversible	At-Grade	Barrier	Reduced	$1,056.58	$1,031.62	$792.37	$759.04	
3-Lane	Reversible	At-Grade	Barrier	Desirable	$1,185.74	$1,185.74	$943.63	$943.63	
3-Lane	Reversible	At-Grade	Barrier	Reduced	$1,084.75	$1,084.75	$825.86	825.86	
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$2,060.27	$1,989.06			
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$1,713.43	$1,767.73			
2-Lane	Reversible	Elevated	Barrier	Desirable	$1,208.52	$1,375.61			
2-Lane	Reversible	Elevated	Barrier	Reduced	$1,066.37	$1,221.00			
3-Lane	Reversible	Elevated	Barrier	Desirable	$1,395.57	$1,577.86			
3-Lane	Reversible	Elevated	Barrier	Reduced	$1,260.23	$1,421.87			

Table 63: Downtown Connector Corridor Cost Estimates (millions)

Downtown Connector					Base Case	1 GP Lane Conversion	Overlay Existing Pavement		Bridge Shoulder Width Reduction
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced			Base	1 GP Lane Conversion	
2-Lane*	Bi-Directional	At-Grade	Buffer	Reduced				$84.72	
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$907.84				
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$744.46				

* Convert existing HOV lane and one GP lane

Table 64: I-85 North Inside of I-285 Corridor Cost Estimates (millions)

I-85 North Inside of I-285					Base Case	1 GP Lane Conversion	Overlay Existing Pavement		Bridge Shoulder Width Reduction
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced			Base	1 GP Lane Conversion	
1-Lane*	Bi-Directional	At-Grade	Buffer	Reduced	$380.36		$169.56		
2-Lane**	Bi-Directional	At-Grade	Buffer	Reduced	$982.41		$812.97		$975.55
2-Lane	Bi-Directional	Elevated	Barrier	Desirable	$819.37				
2-Lane	Bi-Directional	Elevated	Barrier	Reduced	$701.42				

** Convert existing HOV lane only

** Convert existing HOV lane and add 1 lane

Table 65: I-85 South Inside of I-285 Corridor Cost Estimates (millions)

I-85 South Inside of I-285					Base Case	1 GP Lane Conversion	Overlay Existing Pavement		Bridge Shoulder Width Reduction
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced			Base	1 GP Lane Conversion	
1-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$429.61		$349.00		$409.66
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$626.95		$529.29		$496.59
1-Lane	Bi-Directional	Elevated	Barrier	Desirable	$434.35	$484.12			
1-Lane	Bi-Directional	Elevated	Barrier	Reduced	$396.15	$444.10			

Table 66: I-75 North Inside of I-285 Corridor Cost Estimates (millions)

I-75 North Inside of I-285					Base Case	1 GP Lane Conversion	Overlay Existing Pavement		Bridge Shoulder Width Reduction
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced			Base	1 GP Lane Conversion	
1-Lane*	Bi-Directional	At-Grade	Buffer	Reduced			$122.10		
2-Lane**	Bi-Directional	At-Grade	Buffer	Desirable	$610.31		$459.52		$560.46
1-Lane	Bi-Directional	Elevated	Barrier	Desirable	$800.92				
1-Lane	Bi-Directional	Elevated	Barrier	Reduced	$567.25				

* Convert existing HOV lane only

** Convert existing HOV lane and add 1 lane

Table 67: I-75 South Inside of I-285 Corridor Cost Estimates (millions)

I-75 South Inside of I-285					Base Case	1 GP Lane Conversion	Overlay Existing Pavement		Bridge Shoulder Width Reduction
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced			Base	1 GP Lane Conversion	
1-Lane*	Bi-Directional	At-Grade	Buffer	Reduced			$38.20		
2-Lane**	Bi-Directional	At-Grade	Buffer	Reduced	$340.28		$247.58		$340.28
1-Lane	Bi-Directional	Elevated	Barrier	Desirable	$289.98				
1-Lane	Bi-Directional	Elevated	Barrier	Reduced	$265.88				

* Convert existing HOV lane only

** Convert existing HOV lane and add 1 lane

Table 68: I-20 East Inside of I-285 Corridor Cost Estimates (millions)

I-20 East Inside of I-285					Base Case	1 GP Lane Conversion	Overlay Existing Pavement		Bridge Shoulder Width Reduction
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced			Base	1 GP Lane Conversion	
1-Lane	Bi-Directional	At-Grade	Buffer	Reduced			$122.03		
2-Lane	Bi-Directional	At-Grade	Buffer	Reduced	$581.68		$425.86		$559.66
1-Lane	Bi-Directional	Elevated	Barrier	Desirable	$1000.67				
1-Lane	Bi-Directional	Elevated	Barrier	Reduced	$678.81				

* Convert existing HOV lane only

** Convert existing HOV lane and add 1 lane

Table 69: I-20 West Inside of I-285 Corridor Cost Estimates (millions)

I-20 West Inside of I-285					Base Case	1 GP Lane Conversion	Overlay Existing Pavement		Bridge Shoulder Width Reduction
Lanes	Bi-Directional/ Reversible	At-Grade/ Elevated	Separation	Desirable/Reduced			Base	1 GP Lane Conversion	
1-Lane*	Bi-Directional	At-Grade	Buffer	Reduced			$68.24		
1-Lane	Bi-Directional	Elevated	Barrier	Desirable	$547.73	$472.012			
1-Lane	Bi-Directional	Elevated	Barrier	Reduced	$500.73	$433.16			

* Convert 1 GP lane