Greater Vancouver, Calgary, Gatineau, Ottawa, Toronto, Montreal ISSUE PAPER 54

High Occupancy Vehicle Lanes in Canada

Overview

High Occupancy Vehicle (HOV) lanes are restricted travel lanes on highways and major arterials that are reserved at peak travel times or longer for exclusive use by multi-occupant vehicles, including carpools, vanpools and transit buses. Currently, the approximately 35 Canadian HOV facilities, are divided between arterial HOV lanes on signalized major arterial roads and highway HOV lanes on controlled access highways.

Local, provincial and regional governments in Canada's major urban centres have been developing and slowly expanding the number and type of HOV facilities for the past twenty years. Both arterial and highway HOV lanes are widely regarded as an important transportation demand management tool that can reduce traffic congestion, encourage and facilitate more sustainable transportation mode choice such as carpools, and help reduce vehicle-related automobile emissions.

This issue paper summarizes the successes and challenges of HOV facility development in Canada and their utility as transportation demand management tools. Recent research undertaken in both Canada and the United States, where HOV systems are far more common, is also briefly reviewed.

Selected Resources

There are numerous HOV resource sites in both Canada and the U.S.

Greater Toronto's facilities are summarized at: www.mto.gov.on.ca/english/traveller/hov/

The US Transportation Research Board maintains an HOV Committee at www.hovworld.com.

The Washington State Department of Transportation has excellent resources available at: www.wsdot.wa.gov/hov

The U.S. Federal Highway Administration maintains a highway HOV forum site at: http://hovpfs.ops.fhwa.dot.gov/index.cfm

References are found at the end of this issue paper.

Context

Traffic congestion on the nation's highways and major arterials in and around urban centres has become a serious issue, affecting everything from efficient goods movement and urban air quality to bus transit travel times. To counter these challenges, the development of High Occupancy Vehicle (HOV) lanes has grown to become a major component of many regional transportation demand management programs and transportation plans in Canada's major cities.

Often referred to as carpool lanes, HOV lanes are restricted vehicle travel lanes reserved for the use of multi-occupant vehicles and vanpools. Transit buses are often permitted on HOV lanes, while some facilities also permit other vehicles, such as motorcycles and taxis.

Typically, HOV lanes are either dedicated, 24-hour facilities or they are reserved at peak travel times for HOVs and transit buses in some locations. Some lanes are only small multi-block segments (<1 kilometre) that are used to bypass or "queue jump" particularly congested areas or traffic bottlenecks, such as bridges and tunnels. Other HOV lanes are much longer, running for many kilometres along controlled access highways in more densely populated urban and suburban communities. Two, three or four or more occupants (indicated as 2+, 3+ or 4+) may be required for HOV lane use depending on the location and local conditions, although 2+ HOV lanes are the most common.

HOV lanes are created through the conversion of existing lanes or, particularly in the case of dedicated facilities, involve the construction of new lanes and associated infrastructure. The lanes

themselves are typically separated from other general purpose traffic lanes by markings (i.e., single or double white lines) and are identified by signs and the universal HOV diamond symbol painted on the pavement.

A shared bus and HOV lane sign

On arterial routes, HOV facilities typically occupy the curb lane and sometimes revert to parking lanes during off-peak times. Some lanes are reverse flow or counter-flow, meaning that a lane will be used for one direction of travel during the morning rush hour and the reverse during the evening commute. Occasionally, particularly in larger U.S. cities, HOV lanes are physically separated from other lanes and often function as express travel lanes.

Policy context

HOV facilities are supported by various provincial, regional and municipal transportation plans, policies and programs in the locations they are found.

In the early- and mid-1990s, numerous HOV policy reports and plans were generated in the Greater Vancouver and Great Toronto areas. With regard to municipally and regionally administered arterial HOV lanes, several key policy documents are worth noting.

In Vancouver, a 1992 report called *Clouds of Change* triggered City Council to approve guidelines for the implementation of bus and HOV lanes in the city. These routes were then formalized by the city's Downtown Transportation Plan in1997 which approved queue jump locations and priority arterial HOV locations.

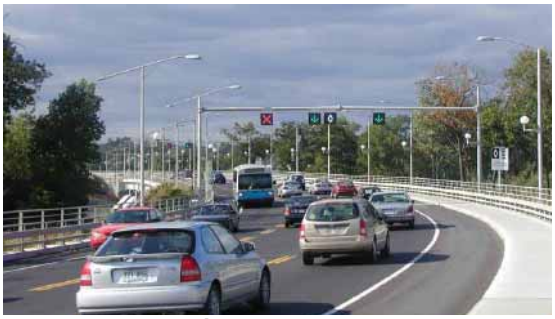
Vancouver's work was supported by both the Greater Vancouver Regional District and the regional transportation authority, TransLink whose 1993 *Transport 2021* long range transportation plan included the development of a HOV network as part of the region's TDM strategy.

In Toronto, *The Metropolitan Toronto High Occupancy Vehicle Network Plan* was completed in 1992. Considered by some as one of the most comprehensive arterial-based HOV plans in North America, the plan proposed a 300 lane-kilometre system incorporating Toronto's existing 60 kilometre network. In 1995, a similar study was carried out for the then City of York.

As part of the new City of Toronto Official Plan process, several background reports were carried out, including one entitled *Reducing Car Dependence: Transportation Options for the City of Toronto*. While none of the report's recommendations were carried over into Toronto's *Official Plan* when it was released in 2002, HOV priority will still be maintained and expanded on both arterial and highway facilities in the Toronto area.

The incorporation of HOV lanes on Highways 403 and 404 in Toronto required provincial enabling legislation. In December 2003, Bill 169 was passed which enabled the siting of facilities and their enforcement by provincial police.

The short Centre Street arterial HOV lane in Calgary is a product of the 1995 *Calgary Transportation Plan*. City Council passed an amendment to the traffic by-law on the day before the facility's scheduled opening to define a High Occupancy Vehicle.



Counter-Flow HOV Lane, Ottawa

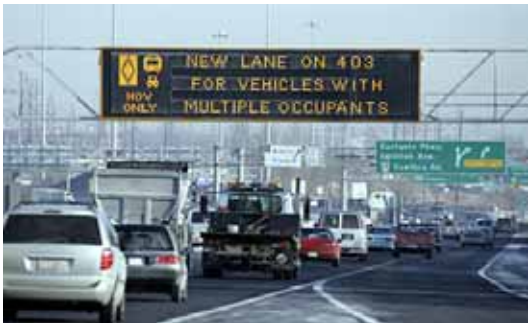
Rationale and objectives

Both arterial and highway HOV facilities are intended to encourage a modal shift away from

single occupant vehicles to multi-occupancy vehicles to preserve and increase the people-moving capacity of the freeway or arterial. This shift results in:

- Optimization of travel speeds for vehicles in the HOV lanes and adjoining lanes;
- Faster and more reliable travel times for carpool commuters;
- A reduction in energy consumption and vehicle emissions due to the reduced number of vehicles on the road and congestion-related delays; and,
- The enhancement and expansion of more sustainable personal mobility options for travelers.

HOV facilities represent a more efficient allocation of road space, use of road capacity and use of infrastructure. While a typical highway lane can carry 1,500 to 2,200 vehicles per hour, an HOV lane can move, on average, at least 1.5 times more people than a general traffic lane, as at least two people are in each of the vehicles. Through active marketing of the HOV lanes, development of supporting carpool programs and the active and ongoing enforcement of them, the performance of HOV lanes can be even better.



HOV signage on Highway 403 in Toronto

Many HOV proponents also highlight the personal, qualitative benefits of HOV lanes and the car and van pools they support. In particular, it is argued that HOV lanes indirectly support increased productivity by easing and reducing the commute for HOV lane users which can result in less stressed, more productive, more reliable workers and students. Only limited public polling and research work has been carried out on this aspect of HOV facilities.

Actions

Today there are over 4,000 lane kilometres of HOV facilities and 130 HOV programs operating in more than 30 North American cities. While the first HOV lanes were constructed in the U.S. in the early 1970s, Canada's first facilities were developed in Greater Vancouver and Toronto in the early 1990s. These were followed shortly afterwards by HOV facilities in Ottawa, Gatineau, Montreal and later in Calgary, Alberta.

There are now approximately 150 lane kilometres of highway HOV facilities in 11 locations in B.C., Ontario and Quebec. There are also over 130 lane kilometres of arterial HOV facilities in 24 locations in Greater Vancouver, Calgary, Toronto, Ottawa and Gatineau. Additional highway and arterial facilities are being studied or are planned in locations across Canada, including large-scale extensions of existing HOV lanes and new facilities in Toronto and Vancouver.

In the U.S., there are newer dedicated highway facilities in some states that include dedicated HOV on- and off-ramps that make it unnecessary for users to merge into general traffic lanes to exit or enter the highway.

To ensure that HOV lanes are used only by appropriate multi-occupant vehicles, Canadian HOV lanes are monitored and enforced by traffic authorities. Currently, the penalty for HOV lane violation in the Toronto area varies according to the jurisdiction responsible for enforcement and the type of HOV facility. For example, highway HOV infractions cost $110 and 3 demerit points on the driver's license. On Toronto's arterial HOVs the penalties range between $80 and $100. In the York Region the fine includes two demerit points on the driver's license. In BC, drivers are fined $98 and two demerit points on the driver's license. On arterial HOV lanes in Ottawa and Gatineau, the fine is $100.

Enforcement of HOV varies widely across Canada. Some facilities, notably some arterial facilities in

Toronto and Ottawa/Gatineau, are no longer actively or effectively enforced. Accordingly peak hour violation rates vary between a high of over 80% on poorly enforced facilities, to a low of less than 10% on properly enforced HOV lanes. Here it should be noted that enforcement rates are not actively monitored or tracked in many Canadian HOV facilities.

Across Canada, various organizations and services have made it easier for commuters to utilize HOV lanes in their region. The Jack Bell Foundation in Vancouver, SmartCommute in the Toronto area and Covoiturage allégo in Montreal all assist drivers and passengers form car and van pools.

Results

In general, most researchers and transportation practitioners agree that the majority of arterial and highway HOV facilities in Canada have met their primary objectives of reducing congestion, encouraging carpooling and improving travel times for multi-occupant vehicles (and buses where they are permitted on HOV facilities). Unfortunately, the quality and quantity of data to support these finding is relatively limited, particularly from Canadian sources.

Currently, only a few centres in both Canada and the U.S. have established ongoing regular monitoring programs for their HOV facilities. In Canada, the most recent statistics are available from Ontario's Ministry of Transportation from their monitoring of new HOV facilities on Highways 403 and 404. The table in the next column illustrates the success of this project in particular.

Unfortunately, the limited evaluation data for Canadian HOV facilities makes a more comprehensive assessment of their impacts difficult to carry out. Given the limited amount of evaluation and assessment carried out, this section provides a summary overview of key results of both arterial and highway HOV facilities in Canada and the U.S.

Highway 403 and 404: Results

	Hwy 403 East Bound	**Hwy 403 West Bound**	**Hwy 404 South Bound**
Projected peak hour use: 1 year after opening	650	650	1100
Initial results: peak hour volume after first 2 weeks	650	650	900
Latest results: June 2006	1100	1150	1250

Source: Ontario Ministry of Transportation, 2006

Some of the more relevant and recent research findings include the following:

- Across Canada and the U.S., HOV traffic is estimated at 7% of total traffic volume. *(Martin, 2004)*
- In Toronto, commuters using the new facilities on Highways 403 and 404 are saving 14 to 17 minutes per trip compared to their travel time before HOV lanes opened. *(Ontario Ministry of Transportation, 2006)*
- *N*early 40% of commuters are now carpooling on Highway 403 eastbound in the morning peak hour compared to only 14% in 2003. *(Ontario Ministry of Transportation, 2006)*
- 37% of commuters carpool on Highway 403 westbound in the afternoon peak hour compared to only 22% in 2003. *(Ontario Ministry of Transportation, 2006)*
- 37% of commuters carpool on Highway 404 southbound in the morning peak compared to fewer than 16% in 2004. *(Ontario Ministry of Transportation, 2006)*
- Average rush hour speed on Ontario's new highway HOV lanes is 100 kilometres per hour compared to 60 kilometres per hour in general traffic lanes on Highway 403. *(Ontario Ministry of Transportation, 2006)*

- Average rush hour speed is 70 kilometres per hour in the HOV lane compared to 50 kilometres per hour in general purpose lanes on Highway 404 southbound. *(Ontario Ministry of Transportation, 2006)*
- A 1999 evaluation of HOV lanes along sections of Highway 1 (Trans Canada) in B.C. found that person throughput in the central portion of the HOV section increased by approximately 40% (4,500 persons) in the morning westbound peak direction, and 72% (6,700 persons) in the evening peak direction since the HOV lanes were implemented. *(BC Ministry of Transport, 1999)*
- The same study found that overall traffic volumes in the central portion of the HOV section increased by approximately 55% in the peak hour directions and about 15% in the off-peak hour directions. *(BC Ministry of Transport, 1999)*
- The same study determined that HOV lane travel time reliability increased by 24% in the morning westbound peak hour direction, and 13% in the afternoon eastbound peak hour direction. *(BC Ministry of Transport, 1999)*
- HOV lanes can provide time savings from 0.7-minute per kilometre on arterial streets up to 2.5-minutes per kilometre on congested freeways. *(Collier, 2004)*
- In the U.S., HOV lanes in Atlanta, Houston, Los Angeles, Washington, D.C., and Seattle regularly carry more people than adjacent regular lanes of travel. *(US Transportation Research Board, 2004)*
- On average, California's HOV lanes carry 2,518 persons per hour during peak hours, substantially more people than a congested mixed-flow lane and roughly the same number of people as a typical mixed-flow lane operating at maximum capacity. *(California Department of Transportation, 2006)*
- In terms of vehicles carried, California's HOV lanes are operating at only two-thirds of their capacity. *(California State Department of Transportation, 2006)*
- Regional data in California indicates that HOV lanes do induce people to carpool, but the statewide impact on carpooling is unknown due to lack of data. *(California State Department of Transportation, 2006)*
- In California, the jurisdiction with the most stringent air quality guidelines in North America, the exact impact of HOV lanes on air quality is unknown. *(California State Department of Transportation, 2006)*
- Recent research by the Washington State Department of Transportation (WDOT) indicates that HOV lanes move one-third of the people on rush hour freeways in only about 18% of the vehicles. *(Washington State Department of Transportation, 2002)*
- WDOT research shows HOV users saving up to 16 minutes per corridor on their commutes. *(Washington State Department of Transportation, 2002)*
- A 2004 WSDOT public opinion poll showed that 78% of freeway drivers who do not usually use the HOV lanes still thought HOV lanes were a good idea. *(Washington State Transportation Center, 2004)*
- The same WSDOT survey showed that 66% of the same non-user group felt that HOV lane construction should continue, and disagreed with the idea of opening the HOV lanes to everyone all the time. *(Washington State Transportation Center, 2004)*
- In Greater Seattle, the HOV system has been a victim of its own success. Most of their HOV lanes are now so congested during rush hours that they no longer maintain WSDOT's 45 mph performance standard. *(Washington State Department of Transportation, 2006)*

The success of Toronto's recent highway HOV lanes, in particular, is supporting the planned rapid expansion of highway HOVs in the province. The next anticipated HOV lane on Highway 404 from Highway 401 to Highway 7 is scheduled to open in summer 2007. An HOV lane will also be introduced on Highway 417 in Ottawa. Ontario is also working to build HOV lanes on other highways, including the Queen Elizabeth Way (QEW).

Challenges

While proponents of HOV lanes recognize them as a cost-effective solution to managing congestion and an important TDM tool, support for HOV

facilities is not universal. Some projects in both Canada and the U.S. have received minimal public support and have faced resulting political pressure. According to recent research, there are three main areas where HOV lane projects run the risk of posting negative results *(Schijns, 2006)*:

- Where implementation has a severe negative impact on general purpose lane operations;
- Where the HOV lane usage does not live up to expectations; and,
- Where non-compliance threatens the operational viability of the lane.

One of the interesting challenges HOV facilities face, particularly highway HOV lanes, is that a well-used, successful HOV lane will appear to be less full than an adjoining general purpose lane. HOV detractors will point to this fact and claim that the HOV lanes are underutilized, despite the fact that they may be carrying the same amount of people or more than the adjoining general purpose lanes.

In Canada, the challenge of so-called "Empty Lane Syndrome" is compounded by the relative lack of data collected by transportation agencies across the country that illustrates the "real" traffic volumes carried by HOV lanes. It also highlights the need for ongoing public education and marketing of HOV facilities.

An HOV lane in Toronto (on the right): even a successful HOV lane can look underutilized compared to a regular traffic lane.

Another challenge faced with HOV lanes is the pressure from other driver groups who want to use them. Taxis, motorcycles, couriers and commercial truck drivers have all lobbied with varying degrees of success to be permitted in HOV lanes in different locations across the country.

More recently, drivers of hybrid vehicles have lobbied successfully to use HOV lanes in some jurisdictions as a "reward" for purchasing the highly fuel efficient and less polluting vehicles. In California, a vehicle that meets specified emissions standards may be issued Clean Air Vehicle Stickers that permits the vehicle to be operated by a single occupant in all of the state's HOV lanes.

Where HOV lanes are seen to be underperforming, High Occupancy Toll lanes, or HOTs, have recently been proposed. HOT lanes permit single occupant vehicles (SOVs) to use the HOV lane by paying a toll. For proponents, HOT lanes are seen as a viable way of introducing more free marketplace principals into the realm of transportation infrastructure and services. There are currently three HOT lanes in use in the U.S. and several more in planning and development.

One of the most recent HOT projects is a 12 kilometre HOV lane conversion that occurred in Minneapolis, Minnesota in May 2005. The U.S. $12 million project costs U.S. $1.2 million annually to operate, although a large portion of this is meant to be recouped through the tolls collected. The high tech system uses an electronic toll collection system with tolls based on the real time congestion levels on the highway (i.e., the more congested the highway, the higher the toll on the HOT). The maximum toll is U.S. $8, with tolls averaging between U.S. $1.00 and $4.00 during peak times and $0.25 during off-peak periods.

Despite their popularity and relative success, the development HOTs has been limited by their additional costs. Most of the additional cost is due to their technology and associated infrastructure requirements, including more complex enforcement (enforcement vehicles have to be fitted with special electronics to detect whether or not an SOV operating in the HOT has the required electronic tolling transponder).

While there have been far more successful HOV projects developed than unsuccessful ones, one of the leading HOV researchers has identified the following characteristics of a "successful" facility *(Schijns, 2006)*:

- Adequate HOV lane usage (either carrying more people than the equivalent general purpose lane, or carrying enough vehicles to generate public acceptance)
- HOV lane travel time advantage over general purpose lanes
- Positive effect of HOV lane on total person-moving capacity of corridor
- Demonstrated effect of HOV project on travel mode choice in corridor
- Motorist compliance with HOV lane rules

A single occupant hybrid vehicle in an HOV lane

Best Practices

While no authoritative best practices guide has been produced, the Victoria Transportation Institute in B.C. surveyed recent research to generate the following list of guidelines for the establishment of HOV facilities.

- More than one million people in the metropolitan region;
- High levels of traffic congestion in the corridor;
- Access to an employment center with 100,000 or more workers (i.e., a major transportation destination);
- Supporting transportation demand management programs and policies; and,
- A co-operative community of responsible transportation agencies, departments and governments.

The Oregon Department of Transportation has also developed the following criteria to guide transportation agencies in their evaluation and monitoring of HOV facility performance in the state. The same criteria can easily be applied to Canadian facilities.

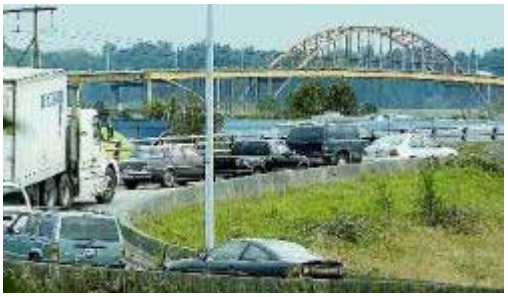
- **Total Person Throughput.** This is a measure of how many people move past a point in a given period in time. Traditionally transportation agencies measure only the number of vehicles, but on HOV lanes they measure the number of vehicles, number of people per vehicle, and the number of people using transit. Increased person throughput and higher average vehicle occupancy are goals.
- **Travel Times.** Transportation agencies measure travel time to determine how long it takes HOVs, single occupant vehicles (SOVs) and freight vehicles to travel on roads with HOV lanes. No net increase in travel times during the afternoon rush hour is a goal.
- **Safety.** Agencies measure the accident and incident rates on sections of highway before and after HOV lanes are established. No increase in incident and crash rates is a goal.
- **Enforcement.** This is a qualitative measure of how enforceable a HOV lane is. Agencies will track the number of tickets issued, the HOV lane violation rate and observations of police enforcing the lane. Minimal violation rate and maximum perception that users obey HOV rules is a goal.
- **Beginning and Ending Transitions.** The beginning and ending of an HOV lane can create weaving movements or other traffic flow problems. Agencies will monitor the traffic operations to evaluate how HOV lanes affect traffic flow.
- **Traffic Diversion.** There is a concern that excessive delays in general purpose lanes may cause traffic to divert to parallel routes. Traffic counts will be taken before and after HOV lanes are established to determine if significant traffic is diverted. The goal is to minimize traffic diversion.
- **HOV Lane Utilization.** This is a measure of how many vehicles are using the HOV Lane in a given time period, and how this compares with their maximum capacity.
- **Transit Ridership.** Agencies will track how many people ride transit during peak periods when the HOV lane is in service.

- **Increase in Transit Service.** Agencies will measure the increase in transit service and compare it to the increase in transit ridership. This would help understand the increase in transit ridership due to the HOV project compared to normal increases in ridership that result from an increase in transit service (without an HOV lane).
- **Number of People per Vehicle.** Agencies will observe traffic to determine the number of people per vehicle during peak periods.
- **Park-and-Ride Use, Van Pools and Employer Programs.** Agencies will track the use of the Park-and-Ride and vanpools.
- **Public Perception.** Agencies will survey commuters and compare responses before and after HOV lanes are established.

Resources

The costs of developing either an arterial or highway HOV lane vary widely and by jurisdiction. Costs include project development and planning, construction, management and enforcement. Dedicated, lane separated, highway HOV facilities are the most expensive to construct.

In Canada, costs have ranged from a low of $50,000 (in 1991 dollars) for a 1.1 kilometre arterial HOV lane project in Ottawa, to $20 million (in 2002 dollars) for reversible central HOV lane on the 3-lane inter-provincial Champlain Bridge in Ottawa/Gatineau.



Short queue jump HOV lanes can be a cost effective congestion management approach at common traffic choke points, such as this bridge approach in Vancouver.

Lessons Learned

Based on recent research and HOV facility successes, the following lessons learned can be applied to new facility development:

- **Regional coordination and integration is key:** Different levels of government, various municipal jurisdictions, and multiple agencies need to work together to develop and achieve regional HOV network objectives and enforcement standards. As an example, Seattle, Washington has developed one of North America's premier highway and arterial HOV networks by integrating arterial and highway facilities region-wide and coordinating the larger system with transit, preferential carpool parking and an extensive network of park-and-ride lots.
- **HOV enforcement is critical**: A recurring issue with HOV lanes is the need to actively monitor and enforce them to maintain facility efficiency, competitiveness with general traffic lanes, and to establish good driver habits (both HOV and SOV). Where facilities are not enforced, the number of carpools has declined and transit times have been impacted (where the facility is shared with buses). In addition to regular police or traffic authority enforcement, jurisdictions can consider establishing a program similar to a program in Seattle where drivers can report an SOV in HOV lanes on their cell phones using a widely advertised 1-800 number.
- **Long-term monitoring is important:** To better prove the effectiveness of HOV lanes, jurisdictions need to commit to better collection and evaluation of facility usage data, including vehicle volumes (both directions, peak and non-peak times), destination travel time savings (HOV versus general traffic lanes), comparative vehicle speeds (HOV versus general traffic lanes), passengers per vehicle and transit ridership. Better data supports the development and implementation of new facilities and can be used to identify service improvements for existing facilities.

- **Ongoing marketing and public awareness is necessary:** HOV lanes need to be marketed like any other transportation option or program, particularly in new markets where drivers are unfamiliar with how they work. Cities with more effective systems regularly promote their HOV networks through all types of media (radio, TV, internet, newspapers, etc.) to encourage more users, link potential users with carpool networks and organizations, and to show the linkages between system elements (e.g., park-and-ride lots, transit stations, etc.). Some jurisdictions have websites where users can calculate the potential time savings and gasoline savings for travel to and from locations using the HOV network.

- **Arterial HOV lanes pose design challenges:** Unlike highway HOV lanes, arterial HOVs typically share lanes with transit buses and, increasingly, bicycles which can reduce travel speeds, create safety issues and cause some delays. Most arterial HOV lanes are also located next to the curb to allow for passenger boarding and exiting. These bus stops act as congestion points along arterial HOV lanes. Designers and engineers need to consider these operational design problems and explore potential solutions where feasible (e.g., bus stop pull-ins, limiting the number of bus stops, using the HOV lane for express buses only, etc.).

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