Section 4
Preliminary Technology Review

Screening Process Overview

The project consulting team developed a preliminary screening process to analyze a wide range of high capacity transit (HCT) technology options for the SR 305 Corridor in May 2006. This process was similar to that required in early stages of a the "Alternatives Analysis" process required by the Federal Transit Administration. The preliminary screening document was presented to the public at a series of workshop meetings and evaluated and approved by the SR 305 Corridor Vision steering committee, a group of local officials and agency staff. The preliminary evaluation of alternatives for the SR 305 Corridor Vision includes three basic screens:

1. A physical *suitability* screen to determine whether modal options were viable within the known physical constraints of the project corridor.
2. A *policy screen* to determine whether remaining options were within the bounds of key local and regional policy goals.
3. An *impacts screen* to ensure that the alternatives resulting from the physically suitability screen and policy screen did not have obvious undesired impacts on the local communities or the environment.

Several policy considerations identified by the steering committee, public outreach and past planning efforts helped shaped potential options for HCT in the SR 305 corridor:

- The proposed transit system should **fit within existing right-of-way** (**ROW**) where possible.
- The proposed transit system should be **compatible with ferry system demand and loading** requirements.
- The proposed transit system should be **compatible with urban components** of the study area.
- The proposed transit system should **minimize visual impacts** to the rural portions of the corridor.
- The proposed transit system should **improve local mobility** and **reduce future travel demand growth on SR 305**.

Initial Screening

The SR 305 study process included an initial screening of a broad range of high capacity transit options for the corridor. Several options were evaluated initially. This screening process yielded a narrower range of potential alternatives that were studied in greater detail. The results of the initial screening process are described later in this section. The results of evaluation of the narrowed range of potential HCT alternatives that moved forward in the study process are described in Sections 5, 6 and 7 of this document.

Future light rail station in Phoenix, Arizona

High Capacity Transit Characteristics

This section introduces a set of characteristics common to all HCT modes. In addition to the technology options highlighted in this Section, these common characteristics differentiate HCT from conventional, local bus service and help build and retain ridership.

Limited Stops & Enhanced Stations and Shelters

Rider boarding areas are the single most important customer interface, affecting accessibility, comfort, safety, security, and system image. HCT Stations are more than bus stops. Many are often branded along with the HCT service in order to market the service. Built-out stations provide a sense of permanence, even for HCT systems not employing fixed guideways. Enhanced stations help catalyze transit oriented development.

Bus Rapid Transit (BRT) station in Boston, Mass.

Key elements of HCT stations include:

- Ample space for waiting passengers;
- Protection from inclement weather;
- Traveler information (static and real-time);
- Improvements to speed up boarding and reduce dwell time; and
- Limited number of stations to reduce overall travel speed and control system costs.

Fast Boarding and Alighting

The ability to quickly board and alight high numbers of riders is vital to HCT operation. System performance in terms or reliability or schedule adherence is greatly improved when vehicles are not detained at stations. Multiple-door boarding and alighting speeds up the process by not restricting boarding to one door at the front of the vehicle. This operation may require fare purchase prior to entering the HCT station boarding area or fare inspectors on vehicles if the station does not provide barriers to vehicle access. Low floor vehicles also speed up the boarding and alighting process by not requiring riders to navigate steps immediately upon entering or leaving the vehicle.

Off-board Payment

Expedited boarding procedures require riders to get on vehicles without making a fare transaction. Even the use of smart fare cards can slow down the process. Typical HCT systems offer ticket vending machines (TVM) at stations for passengers not in possession of a pass. Stations

Ticket vending machines (TVMs) can also speed the process at each stop.

BRT vehicles can operate in a designated right-of-way or on ordinary streets.

with barriers restricting access to boarding areas concentrate TVMs at station entrance locations. These installations can provide single trip fare media, validate pass holders or time stamp smart cards based on system operation. Systems without barriers to boarding areas may deploy TVMs around the platform or boarding area. In some systems, stations are not conducive to the deployment of TVMs. The need to quickly transfer from a ferry to a HCT vehicle at the ferry terminal may require special attention. TVMs are often associated with ticket validators that quickly time stamp prepaid tickets for immediate, one-time use. This would require the sale of Kitsap Transit tickets onboard the ferry or in Seattle ahead of boarding the ferry. Ticket validators can also be deployed on the HCT vehicle in proof-of-purchase systems. As a last resort, TVM can be provided onboard vehicles but this complicates the fare collection/cash handling process and increases operating costs.

Intelligent Transportation Systems

Intelligent transportation systems (ITS) elements are typical in HCT systems. All modes of operation benefit from the acquisition and display of real-time arrival information to riders, both prior to boarding and while riding. This information reduces rider anxiety, provides travelers with options and therefore increases ridership.

In addition, transit signal priority (TSP) relies on intelligent transportation systems (ITS) infrastructure to communicate HCT vehicle status to traffic signals in order to expedite their travel through congested intersections.

Modes Considered in Initial Screening

Definition of Transit Modes

As mentioned, the first step in determining the appropriate range of HCT alternatives for the SR 305 corridor was to identify a wide-range of transit technologies or modes to be considered for the project. A mode is a system for carrying transit passengers that can be described by specific features that include vertical and horizontal right-of-way requirements, vehicle technology, and operational elements such as service frequency and stop spacing.

Seven potential high capacity transit technologies were identified for screening at the outset of this study: bus rapid transit (BRT), light rail transit (LRT), automated fixed guideway (which includes the LEVX® technology), monorail, maglev, diesel multiple unit (DMU), and heavy rail. A brief description of each mode follows:

Bus Rapid Transit (BRT)

Bus Rapid Transit (BRT) is a form of rapid transit that uses a system of rubber-tired vehicles operating either on dedicated right-of-way or in mixed traffic on ordinary streets. BRT vehicles operate on roadways and do not require tracks or other fixed guideway technology. However, dedicated busways or bus guideways can be incorporated into BRT operations to improve speed and reliability. Although BRT vehicles vary by provider, the typical BRT vehicle ranges between 40 to 60 feet long and can include the use of articulated coaches or double-decker buses where higher vehicle capacity is required. Vehicle capacities range from approximately 60 to 120 passengers per vehicle, based on a combination of seated and standing passengers. A BRT vehicle can typically operate in an 11- or 12-foot travel lane.

Light Rail Transit (LRT)

Light rail transit (LRT) is a fixed guideway technology that uses electrically powered vehicles. Light rail can operate in mixed traffic, semi-exclusive or exclusive right-of-way. LRT typically uses vehicles that receive power from an overhead electric wire. Light Rail Vehicles (LRVs) generally average between 50 and 90-feet long, between 8.5 to 9.5 feet wide, and 8 to 20-feet high. LRVs have a capacity of up to 250 passengers (combination of seated passengers and standees), and can be linked to form multi-car trains. Amenities and characteristics vary by vendor. This type of technology requires between 24 and 28 feet of right-of-way (two tracks).

Automated Fixed Guideway Transit (Including LEVX®)

Automated fixed guideway (AFG) transit systems are entirely grade separated and run on a dedicated right-of-way either underground or on aerial alignment. Automated systems consist of automated driverless vehicles on fixed guideways and provide a high level of service in terms of service frequency. This technology is typically used for circulation service in airports, recreational parks and central business districts. Depending on the car size, passenger capacity ranges between 70 and 100 persons. Automated fixed guideway transit typically requires 8 to 16 feet of right-of-way (single track).


Light Rail Transit (LRT) is a popular option as an addition to most transportation systems.


LEVX® concept image – photo simulation in the SR 305 corridor

An important focus of this study is the emerging LEVX® technology, which in most regards falls under the broader category of automated fixed guideway technology. LEVX® uses magnetic levitation and is powered by a magnetic system driven by a small natural gas or diesel powered engine. The magnetic suspension system utilized in LEVX® provides the key to overall system efficiency resulting in lowered operating costs as well as reduced maintenance issues. The LEVX® magnetic suspension system virtually eliminates static drag associated with weight bearing wheels, thereby requiring far less energy to propel and brake the carriage.

A full-scale LEVX® prototype has not yet been tested under rigorous operating requirements, so it is unknown if and when the technology will be approved for passenger service. The system developer is planning to develop a private system in the Southeastern United States in coming years, which could help establish the viability of the product for public use.

Monorail

Monorail systems require an entirely grade separated and dedicated right-of-way and are typically on aerial alignment. It is an electric railway of guided transit vehicles operating singly or in multiple-car trains. The vehicles are suspended from, or straddle, a guideway formed by a single beam, rail, or tube. Monorails can be operated by a driver, but most are fully automated. Monorail trains are about 120 feet in length and vehicles are propelled by electricity. Each car can carry between 35 and 90 passengers. This technology requires approximately 8 to 16 feet of right-of-way (single track). Station stops are on aerial alignment along with the tracks and therefore require vertical movement of passengers by way of stairs, escalators or elevators.

MagLev

Like monorail, maglev systems require an entirely grade-separated right-of-way. A maglev train floats about 10mm above its guideway supported by an electro-magnetic field. It is propelled by the guideway itself rather than an onboard engine by changing magnetic fields. Once the train is pulled into the next section the magnetism switches so that the train is pulled on again. The magnets provide support without contact or friction, allowing for fast, quiet operation. Maglev trains are about 120 feet and can typically carry up to 90 passengers per car. This technology requires approximately 10 to 16 feet of right-of-way (single track). Relatively few maglev systems have been constructed and most have since closed due to operational problems.

Monorails and their stations are completely aerial.

MagLev systems, like monorails, are an aerial technology.

Diesel Multiple Unit (DMU)

DMU technology uses a self-propelled, diesel powered vehicle that may operate on both railroad and in-street tracks. The DMU uses a diesel engine and is more fuel efficient than typical locomotive/passenger cars when carrying lower passenger volumes. In addition, DMU cars tend to be quieter and have lower emissions than diesel locomotives. DMUs range from 90 to 125 feet in length for one car, are generally 9.5 to 10 feet wide, and between 15 and 20 feet in height. Passenger capacity ranges from 90 to 410 people depending on design features; for example, the bi-level coach from the Colorado Railcar system has a capacity of 190 seated passengers or 410 passengers including standees. Like LRT, this type of technology requires between 24 and 28 feet of right-of-way (two tracks).

Commuter rail, or heavy rail, has a high capacity and can run on existing freight mainlines.

Commuter Rail/Heavy Rail

Heavy Rail systems are entirely grade-separated and are on a dedicated right-of-way, either at the surface, underground or on aerial alignment. For example, Sound Transit's Sounder service operates on a freight mainline that includes surface and underground (tunnel) segments. Heavy rail provides a high level of service and is typically found in densely populated urban centers and in the suburbs as commuter service. The capacity of heavy rail vehicles varies widely. Heavy rail vehicles are 75-feet long and 10-feet wide, with a capacity of between 68 and 81 seated passengers and 175 passengers including standees. Cars are typically linked in sets of four or six cars, yielding a capacity of up to 1,050 passengers per six car train (seated and standing).

Results of Initial Screening

Table 4-1 summarizes key results from the initial screening process and indicates which modes were retained for further evaluation.

Modes Eliminated from Further Consideration - First Screening Results

Based on the initial screening analysis, three modes were eliminated from further consideration: DMU/commuter rail/heavy rail, monorail, and maglev (electromagnetic).

Modes Selected for Further Evaluation

The modes selected for further consideration in the study process include the following:

- No Action/Baseline Option
- Fixed Guideway Option – Including Light Rail Transit (LRT) and Automated Fixed Guideway (AFG), which could be LEVX® or another type of technology
- Bus Rapid Transit (BRT) Option – Including a range of sub-options

Table 4-1 High Capacity Transit Modes Initially Considered and Screening Decisions

Technology	Physical Screen	Policy Screen	Suitability Screen	Retained for Further Evaluation
Light Rail (LRT)	Low – two way system may require significant ROW expansion in corridor; new rail bridge required	Medium –fits scale of urban/rural environment; clean operations; high costs	Medium – typically urban/high density suburban mode; demand may be too low to justify; suitable for peak ferry loading	**Yes (As part of fixed guideway)**
Monorail	Medium – elevated structure feasible in corridor/ reduces potential ROW expansion needs	Low -high aesthetic impacts; not desired by community; very high costs	Low – reliability issues; typically mode for high density urban environment	No
Automated Fixed Guideway (AFG) Transit (Includes LEVX®)	Medium – elevated structure feasible in corridor/ reduces potential ROW expansion needs	High – significant community interest in AFG (LEVX®)	Low to Medium – (LEVX® is an untested technology)	**Yes (As part of fixed guideway)**
MagLev	Medium – elevated structure feasible in corridor/ reduces potential ROW expansion needs	Low – low community acceptance; very high costs	Low – poor reliability in previous applications	No
Commuter Rail/ Heavy Rail or Diesel Multiple Unit	Low – no existing rail corridor/ trackage; new rail bridge required	Low- not conducive to terminal; high aesthetic impacts safety concerns; high costs	Low – poor integration at ferry terminal; roadway crossing issues	No
Bus Rapid Transit (Busway)	Low – two way system requires significant roadway widthe expansion in corridor	Medium* – provides flexibility to travel off corridor; scaleable to demand; moderate costs	Medium* – reversible lane option in particular	**Yes**
Bus Rapid Transit (In-Corridor Enhancements)	High – can operate in mixed traffic limiting need for roadway expansion	Medium* – provides flexibility to travel off corridor; scaleable to demand	High – one of few modes that would not require new bridge	**Yes**

Rankings: Low = poor application in corridor, Medium = reasonable application in corridor/may have some issues, High = good application in corridor

* Note: Certain BRT technologies have better applicibility in various segments of the corridor (i.e. the reversible lane concept works better on Bainbridge Island where there is limited access).