Transit Options
for the
Central Waterfront Redevelopment

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Background

Transit is key in ensuring that the Vision Plan become successful and specific forms of transit has specific demands (land use, density, and urban design) that must be met to ensure their viability. Understanding the different characteristics and constraints of a particular transit system early on can ensure that proposed changes to the Central Waterfront do not preclude potential premium transit technologies from being successful in the future.

The following list includes transit systems that are applicable in the short-term, before build-out population and employment densities are established, as well longer term transit solutions that the Central Waterfront area can "grow" into.

1. **Standard Transit Buses**

   Standard transit buses are useful in areas of moderate to high-volume and short-to-medium distance travel. The design of these buses provides for efficient loading and unloading in areas with frequent stops and complex visitor travel patterns. The floor of standard transit buses is typically 25 to 30 inches above the pavement, although low floor buses are also available.

General Characteristics of Standard Transit Buses

Characteristic	Advantages	Disadvantages
Durability	▪ Long life span of 12 to 15 years. ▪ Many models have diesel engines that can be rebuilt to extend vehicle life.	
Operator Availability	▪ Ready supply of operators.	
Noise		▪ Internal combustion engine may produce significant sound levels.
Fuels	▪ Wide fuel type availability.	
Cost	▪ Moderate operating costs relative to number of passengers that can be served.	▪ May not be cost effective for low to moderate passenger loads.
Vehicle, Parts, Service Availability	▪ Ready supply of manufacturers & mechanics. ▪ Ready supply of lease/rent/ charter opportunities. ▪ Active bus rebuilding and used bus market.	
Vehicle Features	▪ Variety of seating arrangements. ▪ Ready availability of equipment for ADA service. ▪ Designed for frequent stops. ▪ Multiple doors for easy boarding.	▪ Not designed for sustained high-speed operation.

Vehicle Data

Length: 35 to 42 feet
Width: 8.0 to 8.5 feet
Height: 10 to 12 feet
Weight: 30,000 to 45,000 pounds
Rear Axle Weight: 26,000 pounds
Power Source: Diesel, methanol, liquefied natural gas, compressed natural gas, and hybrid
Vehicle Cost: $200,000 to $300,000
Vehicle Life: 12 to 15 years (500,000 miles to 1,000,000 miles)

Operating Data

Maximum Operating Speed: 60 mph
Maximum Grade: 15%
Turn Radius: 28 to 40 feet
Passengers: 50 to 68 (including standees)

2. Trolley (Historic Trolley)

Historic trolleys continue to operate in many locations, especially outside of the United States. Historic trolleys feature electrically-powered rail cars with an overhead electric wire (catenary) as the power source. Most trolleys are single-unit vehicles and do not typically operate in trains. Stations or stops are generally ¼ to ½ mile apart. The average costs of historic trolley system range from $5 to $40 million per mile and can have a capacity of up to 100 passengers per car (including standees).

General Characteristics of Trolleys

Characteristic	Advantages	Disadvantages
Maneuverability	▪ At slow speeds, trolleys are able to make right turns at typical urban roadway intersections.	▪ Relatively difficult to change routes and boarding points in response to varying demand.
Durability	▪ Long life span possible with continued rehabilitation.	▪ Rehabilitation efforts rely on the availability of historic parts.
Operator Availability		▪ Requires special operator training for safety.
Noise	▪ Electric motors provide a similar noise level to passenger autos.	
Fuels	▪ Electric and gasoline.	
Cost	▪ Moderate operating cost relative to the number of passengers that can be served. ▪ Lower capital cost relative to LRT.	▪ High initial/capital cost relative to bus vehicles. ▪ Requires high cost investment in the physical system of rails, overhead wires, and stations. ▪ Right-of-way maintenance costs higher than for buses due to overhead wire, tracks & switches.
Vehicle, Parts, Service Availability		▪ Requires specialized maintenance facilities and skilled personnel. ▪ Vehicles and parts available only on used market.
Vehicle Features	▪ Multiple doors for easy boarding/alighting. ▪ Historic appearance appropriate for tourist areas/historic districts	▪ More complex mechanically than standard buses. ▪ Not typically ADA compliant without modifications.

Vehicle Data

- Length: 30 to 50 feet
- Width: 7 to 9 feet
- Height: 8 to 12.5 feet (vehicle only); 108 to 20 feet (with overhead wire)
- Weight (empty): 30,000 to 50,000 lbs.
- Power Source: Overhead Electricity
- Right of Way: 16 to 25 feet (single track); 22 to 40 feet (double track)
- Low Floor: Not typically available
- Vehicle Cost: $150,000 - $350,000 restored original; $600,000 - $900,000 new replica
- Vehicle Life: 20-30 years

Operating Data

- Maximum Operating Speed: 30 to 40 mph
- Maximum Grade: 4 to 8%
- Turn Radius (minimum): 34 to 50 feet
- Passengers (per car): 31 to 100 (including standees)

Cities that use Historic Trolleys: Philadelphia, San Francisco, Dallas, Memphis, New Orleans

Examples of Historic Trolleys

3. Modern Streetcar

The modern streetcar is essentially a hybrid that combines features of heritage trolley lines, traditional downtown streetcar lines, and light rail. Unlike LRT which runs mostly in exclusive lanes, the modern streetcar tracks and trains run along the streets and share space with road traffic. Modern streetcars are intended to go shorter distances compared to LRT, have smaller vehicles, and are not intended to carry the same high volumes of rush hour passengers as inter-urban commuter trains. Modern streetcar service is frequent, stop spacing is relatively short, and average operating speed is low. Modern streetcars are estimated to carry between 1,400 to 4,000 passengers per hour.

Unlike a historic trolley, the modern streetcar employs new technology that allows it to operate quietly, smoothly and efficiently in harmony with other vehicles. Streetcar vehicles are of a new European, low floor design, and are essentially smaller versions of light rail cars.

Characteristic	Advantages	Disadvantages
Maneuverability	▪ At slow speeds, streetcars are able to make right turns at urban roadway intersections.	▪ Relatively difficult to change routes and boarding points in response to varying demand.
Durability	▪ Long life span (25 to 30 years).	
Operator Availability		▪ Requires special operator training for safety.
Noise	▪ Electric motors provide a similar noise level to passenger autos.	
Fuels	▪ Electric	
Cost	▪ Moderate operating cost relative to the number of passengers that can be served. ▪ Lower capital cost relative to LRT.	▪ High initial/capital cost relative to bus vehicles. ▪ Requires high cost investment in the physical system of rails, overhead wires, and stations. ▪ Right-of-way maintenance costs higher than for buses due to overhead wire, tracks & switches.
Vehicle, Parts, Service Availability		▪ Requires specialized maintenance facilities and skilled personnel.
Vehicle Features	▪ Multiple doors for easy boarding/alighting. ▪ Low-floor designs are available	▪ More complex mechanically than standard buses. ▪ Smaller vehicles than LRT and thus carry less number of passengers

Vehicle Data

- Length: 35 to 60 feet
- Width: 8 feet
- Height: 11 feet and 3.5 inches (vehicle only); 108 to 120 feet (with overhead wire)
- Power Source: Overhead Electricity
- Right of Way: 11-13 (Single Track); 19-24 (Double Track)
- Vehicle Life: 20-30 years
- Costs per Mile: $4-$40 Million

Operating Data

- Maximum Operating Speed: 30 to 40 mph
- Maximum Grade: 6 to 8%
- Turn Radius (minimum): 40 to 80 feet
- Passengers (per car): 127 (35 seated, 92 standing)
- Stops are located every 1/5 of a mile and are no bigger than a bus stop

Cities that use Modern Streetcar: Portland, Seattle (Under Construction), Washington DC (Under Construction)

Examples of Modern Streetcar

4. Bus Rapid Transit (BRT)

BRT is a term for urban mass transportation services utilizing buses to perform premium services on existing roadways or dedicated rights-of-way. BRT lines are projected to cost between $4 and $40 Million per mile and transports an average of 4,000 to 12,000 passengers per hour.

General Characteristics of BRT

Characteristic	Advantages	Disadvantages
Maneuverability		▪ Require 11- to 12-foot wide lanes for safe operation.
Durability	▪ Long life span of 12 to 15 years.	
Operator Availability	▪ Ready supply of operators.	
Noise		▪ Internal combustion engine may produce significant sound levels.
Fuels	▪ Wide fuel type availability.	
Cost	▪ Moderate operating costs relative to number of passengers that can be served.	▪ Exclusive right-of-way adds to costs
Vehicle Features	▪ Variety of seating arrangements. ▪ Ready availability of equipment for ADA service. ▪ Designed for frequent stops. ▪ Multiple doors for easy boarding.	▪ Not designed for sustained high-speed operation.

Vehicle Data

Length: Typically 40 feet; can go up to 60 feet for articulated buses
Width: 8.0 to 8.5 feet
Height: 10 to 12 feet
Power Source: Diesel, methanol, liquefied natural gas, compressed natural gas, and hybrid
Vehicle Cost: $300,000 to $1.2 million

Operating Data

Maximum Operating Speed: 60 mph
Maximum Grade: 15%
Turn Radius: 40 to 70 feet
Passengers: 50 to 200 (including standees)

Cities that use BRT Systems: Boston, Pittsburgh, Cleveland, Eugene

Examples of BRT Systems

5. Light Rail Transit (LRT)

LRT features electrically-propelled rail cars operating in single cars or in short trains and uses an overhead electric wire (catenary) as the power source. Two light rail vehicle types are in service: single unit cars or articulated cars. As a system, LRT generally has stations spaced 2 to 3 miles apart (closer in major activity areas), with total corridor lengths not generally exceeding 15 to 20 miles.

There is a significant amount of overlap between light rail and streetcar technologies, although in general, LRT trains tend to run along their own right-of-way and are often separated from road traffic. Because LRT lines focus on speed and travel time savings through high travel corridors, LRT stops are generally less frequent compared to streetcars. Tracks are highly visible and in some cases, significant effort is expended to keep traffic away through the use of special signaling, level crossings with gate arms or even a complete separation with non-level crossings. Many light rail systems have some sections of tracks running with mixed-traffic as they go through city centers and denser areas.

A typical LRT system would cost between $20 million to $40 million per mile and would be able to transport between 6,000 to 20,000 passengers per hour.

Examples of LRT Systems

General Characteristics of LRT

Characteristic	Advantages	Disadvantages
Maneuverability	▪ At slow speeds LRT is able to make tight turns at typical urban roadway intersections.	▪ Relatively difficult to change routes and boarding points in response to varying demand.
Durability	▪ Long life span (25 to 30 years).	
Operator Availability		▪ Requires special operator training for safety. ▪ Operators less available than for standard buses.
Noise	▪ Electric motors provide a similar noise level to passenger autos.	
Fuels	▪ Electric	
Cost	▪ Low to moderate operating costs relative to the number of passengers that can be served. ▪ Lower capital cost relative to elevated rail technologies.	▪ High initial/capital cost relative to bus systems. ▪ Higher right-of-way maintenance costs compared to buses due to overhead wire, tracks & switches.
Vehicle, Parts, Service Availability	▪ Wide range of suppliers. ▪ Standard equipment proven in U.S. operations.	▪ Requires specialized maintenance facilities and skilled personnel.
Vehicle Features	▪ Variety of seating arrangements. ▪ Multiple doors for easy boarding/alighting.	▪ Difficult to implement in areas with steep grades. ▪ More complex mechanically than standard buses.

Vehicle Data (Per Car)

Length: 50 to 90 feet
Width: 7 to 9 feet
Height: 8 to 12.5 feet (vehicle only)
Weight (empty): 67,000 to 103,000 pounds
Power Source: Overhead electric
Right of Way: 16 to 25 feet (single); 22 to 40 feet (double)
Low Floor: Becoming available though not as common in the U.S.
Vehicle Cost: $2.0 to $3.0 Million
Vehicle Life: 25 to 30 years

Operating Data

Maximum Operating Speed: 35 to 60 mph
Maximum Grade: 4% to 8%
Turn Radius: 47 to 82 feet
Passengers (per car): 72 to 200 (including standees)
System Cost: $20 to $40 Million per mile (surface)

Cities that use LRT Systems: Denver, Dallas, Minneapolis, Houston, Salt Lake City