


Infrastructure Vision 2050 Challenge
“Dream” Phase

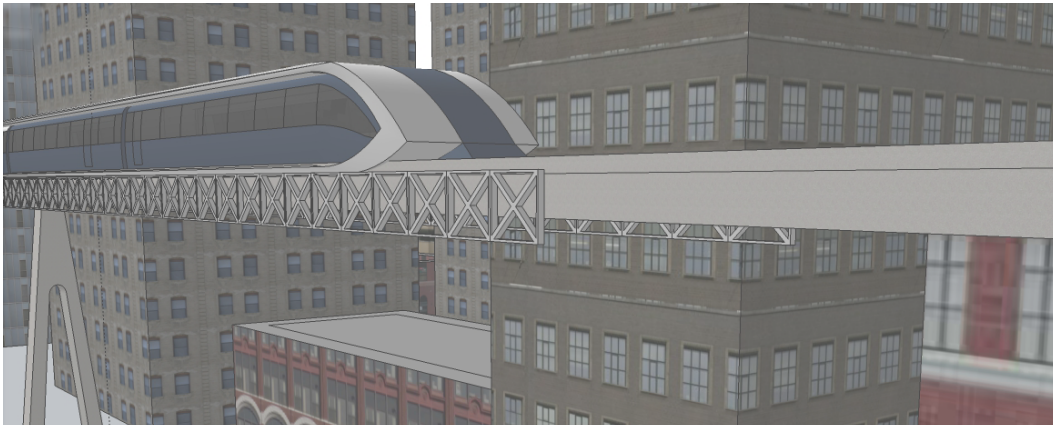


Monorail 2050: Transit Oriented Development (TOD)

The Hub-and-Spoke Model

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Executive Summary



This proposal addresses the metropolitan needs for housing, retail, public spaces, and efficient transportation. The monorail is an efficient transit source, especially for short distances in cities that are already heavily developed. Only a small footprint is required for monorail track stays. In this proposal, monorail trains connect mixed-use transit hubs hosting retail and residential real estate. These hubs, which also include parks, museums, and art installations, are connected by the spokes of the monorail transit system. In order to fund this large-scale project, retail and residential developers will subsidize the creation of the transit system as part of the cost of ownership of mixed-use transit hubs. This paradigm allows for cost-efficient and rapid development of the project, without needing to impose taxes or extract other public funding. This creates a win-win situation for the developers and the public. In this way, the city gains access to a new transportation system with additional housing and employment, while decreasing vehicular traffic in the city. This proposal also makes suggestions for implementation and explores possible metrics for determining the project's success. Both implementation and evaluation phases are designed to assure political and public support for the project.

Background

The Problem and Past Solutions

In the past, young families opted for the suburbs, as an escape from the grind of city life. The current generation of young Americans has begun a movement back into cities, with a preference for mixed-use developments that afford life necessities in walkable range. While this ability to walk to the nearest store is a tremendous benefit, many continue to drive to work and use their cars to visit other parts of the city. Mixed-use housing has led to increased traffic and parking problems in many cases.

Automobile traffic capacity is also limited. In fact, as more roads are built, the number of cars driving on them increases. Economists Duranton and Turner call this “The Fundamental Law of Road Congestion.”¹ As an example, in 2016, Los Angeles was given the dubious distinction of having the worst traffic of any city in the United States.² This comes despite significant freeway widening projects in the city funded by the American Recovery and Reinvestment Act of 2009. Traffic engineers call this problem “induced demand,” which means more people opt to drive when roadways are enlarged, rather than take public transportation. More roads are clearly a nonproductive solution to the traffic problem.

Traffic congestion contributes to a number of health problems, both for individuals and the planet. Los Angeles Drivers lose over \$1,700 in productivity each year,³ or time that might be spent with friends and family. A 2012 study from the American Journal of Preventative Medicine showed those who drive in traffic weigh *almost 7 pounds more* than those who take public transportation.⁴ On the environmental side, Los Angeles traffic produced over 33 million metric tons of carbon dioxide (CO₂) in 2015,⁵ a greenhouse gas that contributes to climate change.

There is a need for short-distance transport that does not require the automobile. For the health of Americans and the environment, improving transportation infrastructure has become critical.

Another solution to traffic congestion has been the creation of light rail systems. Light rail is an efficient mode of transportation to shuttle people across cities. In fact, most light rail systems in the United States are limited by *demand* more than *capacity*.⁶

Unfortunately, there are several hindrances to the rapid development of these transportation systems. The first is cost: new light rail construction requires over \$70 million per mile.⁷ This is expensive compared to freeway construction, which may cost as little as \$1 million per lane-mile.⁸ Another significant problem for new rail construction is the need for *land*. As seen the attempted expansion of the Purple Line in Los Angeles, lawsuits and NIMBY have halted construction through areas such as Beverly Hills.⁹ There is clearly a need for mass transit to accommodate the capacity of commuters, but light rail development has been slow and expensive (sometimes for legal reasons).

An additional concern with rail systems is safety. Accidents related to light rail have recently attracted attention. The U.S. Department of Transportation recently released a report showing light rail fatalities are higher than other forms of transportation (second only to motorcycle travel) with 31.5 fatalities per 100 million miles.¹⁰

Despite these limitations, light-rail remains an important and efficient part of mass transit. There is a need however, for short-distance mass transit that is safe, inexpensive, and rapidly deployed.

The Monorail as Transportation

Capacity to Meet the Demand

While the monorail is often seen as a Disneyland-type amusement, there are reasons to seriously consider the monorail as a means of public transport.

The largest expense and concern for the development of mass transit in US cities has been the acquisition of land for construction. By utilizing narrow pylon supports, monorail tracks can be suspended with minimal demolition of existing structures. Limiting the demolition required during construction helps avoid legal entanglements and the objections of NIMBYites. In general, public opinion has shown support for monorail projects, including Seattle¹¹ and past favorable votes in Los Angeles.¹² Why a monorail has not been constructed in Los Angeles is a point of much speculation, perhaps due to political lobbying against the projects.¹² Regardless, a grand opportunity exists to create new infrastructure with short-distance transit to complement existing public transportation.

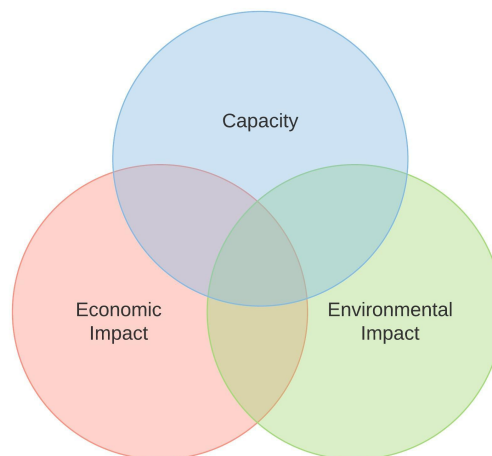


Figure 1. Transportation solutions must consider Capacity, Economic, and Environmental Impact

An additional benefit to monorail transport is capacity. As with light rail, this form of transportation is only limited by *demand*, not by *capacity* (as are roads and freeways). China is home to the largest volume of monorail riders, with Line 3 in Chongqing hosting 682,800

passengers per day, with 32,000 passengers/hour at its peak.¹³ The Chongqing Rail Transit (CRT) has also shown that distance can be covered effectively with monorail lines. The CRT has over 125 miles of track to handle its average daily ridership of 1.73 million people.¹⁴

In regard to safety, modern monorails have a stellar record. Since there are no intersections with people, cars, or bikes, the chance of a collision is almost nil. Today's monorails have the best safety statistics of any mode of transportation, having carried over two billion riders worldwide without a single passenger fatality.¹⁵

Environmental impact is another benefit of these transit systems. Clean, electric running monorails will decrease carbon emissions from vehicles idling in traffic. The track supports of monorail systems exhibit efficient land-use and limit the environmental impact created by demolition of existing structures.

The cost of monorail projects is similar to light rail at an average of \$77 million/mile vs. \$78 million/mile. Therefore, cost considerations should not be a hindrance to implementing monorail over light-rail systems.

Light Rail Line	Cost per Mile (millions)
Dallas	\$41.38
San Diego-Mission Valley	\$73.05
Denver	\$46.45
Kansas City	\$44.23
Minneapolis	\$47.70
New Jersey: Hudson-Bergen II	\$182.43
Orange County	\$68.57
Orlando	\$41.10
San Diego-Mid Coast	\$30.76
San Francisco	\$79.59
Seattle	\$208.33
Average	\$78.51

Table 1 - Light Rail Construction Average Cost per Mile¹⁶

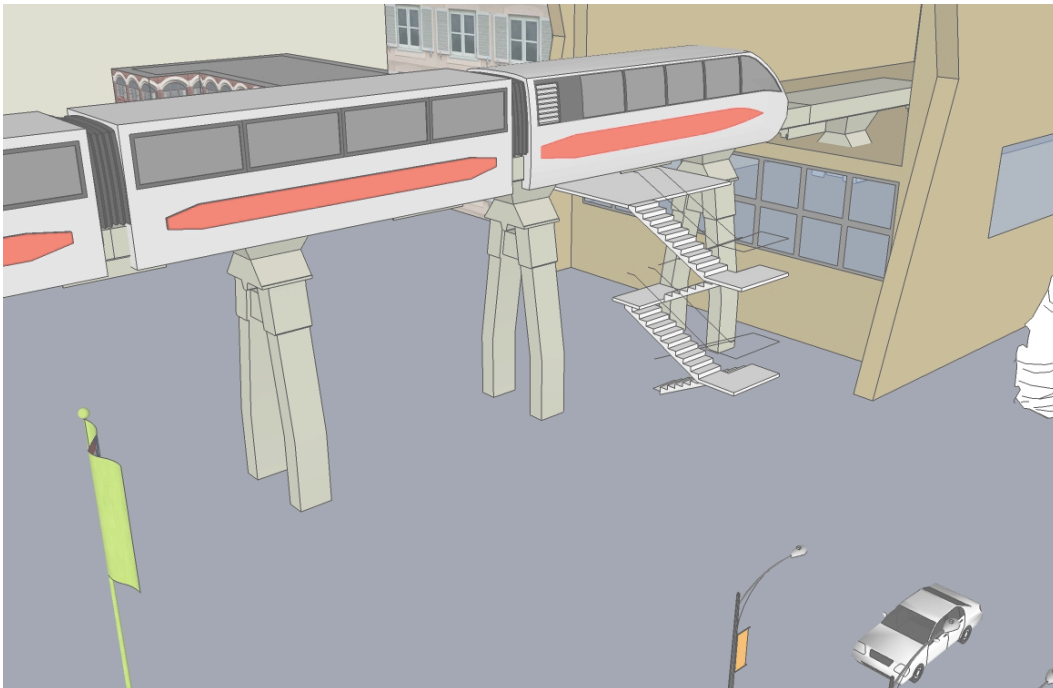
Monorail Line	Cost per Mile (millions)
Okinawa	\$44.00
Kuala Lumpur	\$57.92
Las Vegas	\$88.00
Palm Jumeirah, Dubai	\$118.10
Average	\$77.01

Table 2 - Monorail Average Construction Costs per Mile¹⁷

“The Dream”

Transit Oriented Development (TOD): The Hub-and-Spoke Model

The working population is no longer escaping to the suburbs, instead people are moving into cities, where they can live, work, play, and dream. “The Dream” is an evolution of the modern city, using the monorail as a connection to novel live-work structures. This new city has hubs of residential units, retail, and public spaces that are connected by efficient monorail trains. Monorail will not replace existing light-rail, but complement it with short-haul movement of riders between retail/residential hubs.



As a response to an influx of individuals from suburbs to cities, there has been movement toward Transit Oriented Development (TOD) or “Transit Proximate Development.” TOD consists of residential or retail centers that act as hubs, with transportation systems as the spokes. This hub-and-spoke model has been successful in many parts of the world. The oldest example is Curitiba, Brazil where 85% of its population uses its Bus Rapid Transit System.¹⁸ Another TOD is located in the Bridgeland Community of Calgary, Canada. Here, a system called *The Bridges* interconnects condominium developments, restaurants, retail shops, and parks. As a result, Bridgeland has been called one of the most “livable” cities in Calgary.¹⁹ Not only do residents of Calgary enjoy the “walkable” nature of this community, TOD has produced new jobs and an increase in average household incomes by 22%.²⁰ In the United States, the Bay Area Rapid Transit (BART) connects San Francisco to outlying areas, and has helped create “Transit Villages,” including the development of cities such as Fremont, Union City, and Hayward.²¹ This is another example of the positive economic impact of such projects.



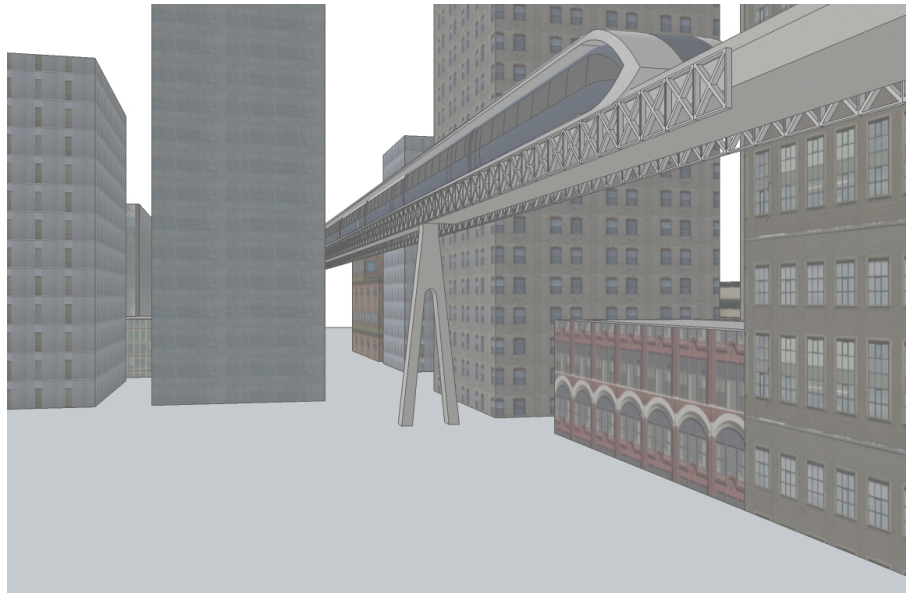
Residential/Retail Development: “The Hubs”

In this model, the “Hub” will be a self-contained mixed-use development project. Multi-story residential units will anchor each Hub. Several commercial spaces within the Hub will allow for the addition of retail and services. These Hubs will also provide public spaces such as parks, museums, or art installations. The Hub will be a home for many, and a retail destination for others. Creating such a development allows for the provision of employment alongside housing.

The monorail will enter these transit hubs aboveground, improving safety for pedestrians, by avoiding vehicular traffic. Retail will be opened at rail-level, making purchases convenient for both residents and visitors. Residential units will occupy the highest floors of the buildings, with office spaces residing in the mid-to-lower levels. These office spaces will host professional services or smaller companies like tech “start-ups.” At the street level, additional retail spaces are made available, which are easily accessed by the general public.



The budgeting for these developments will include open and public spaces. These might be parks, outdoor athletic facilities, or sculpture gardens. There will be a requirement for the planting of green foliage in these open spaces, contributing to a pleasant park-like atmosphere. One example of an existing transportation hub in a TOD development can be seen here: [The Milton Residences - Brisbane, Australia.](#)



The Monorail as “Spokes”

There are a number of features that differentiate this project from existing transit options. One is the focus on short-distance travel between pre-designed transit hubs. This proposal creates new microcosms within the existing infrastructure of the city. The monorail trains provide lightweight, safe, and efficient travel between destinations.

Again, monorail does not replace light-rail trains, but complements them, intersecting these lines in key areas, providing alternative transportation to alternative living and working hubs. Light-rail and commuter trains will shuttle passengers longer distances, including inter-city travel. The monorail trains provide passage in approximately 1-mile increments within the urban environment. When we look at ridership from similar established TOD projects, residents and employees from the surrounding community show an increase in public transit use.²⁰ It could be predicted that about 37% of residents within ½ mile of the hub will begin using the rapid transit system.²² These hubs have been shown to effectively produce ridership when located within a ½ mile of the rider’s residence; similarly, highest levels of ridership for commuters is seen when the hub is located within ¼ mile.²² These figures highlight the need for short-distance transportation to attract passengers.

Implementation of “The Dream”

Enlisting Developer Support

The implementation of this project is unique in that it enlists the funding of developers to cover the costs associated with the project. This includes the costs of building the monorail system, property purchases, and the physical development of mixed-use hubs. The initial project will start with 8 transit hubs, with interconnected trains. A single developer who commits to the development of one transit hub also shares 1/8 of the costs involved in building the monorail system. In this way, the investors will benefit from ownership of concentrated retail and residential property, while the public benefits from the development of an efficient transit system, also providing additional jobs and housing.

A key consideration for implementation is developing key relationships not only with developers, but also with local government officials. The design and planning process will include input from multiple stakeholders during the implementation phase. Designs will be completed and finalized with the input of the city planning office, board of supervisors, and other city or county officials. This will aid in the efficient processing of environmental impact reports, permits, etc. Developers will be heavily involved in the design process and will be tasked with property purchases and leases. For this reason, developers will need to agree on the path of monorail tracks and the location of mixed-use developments.

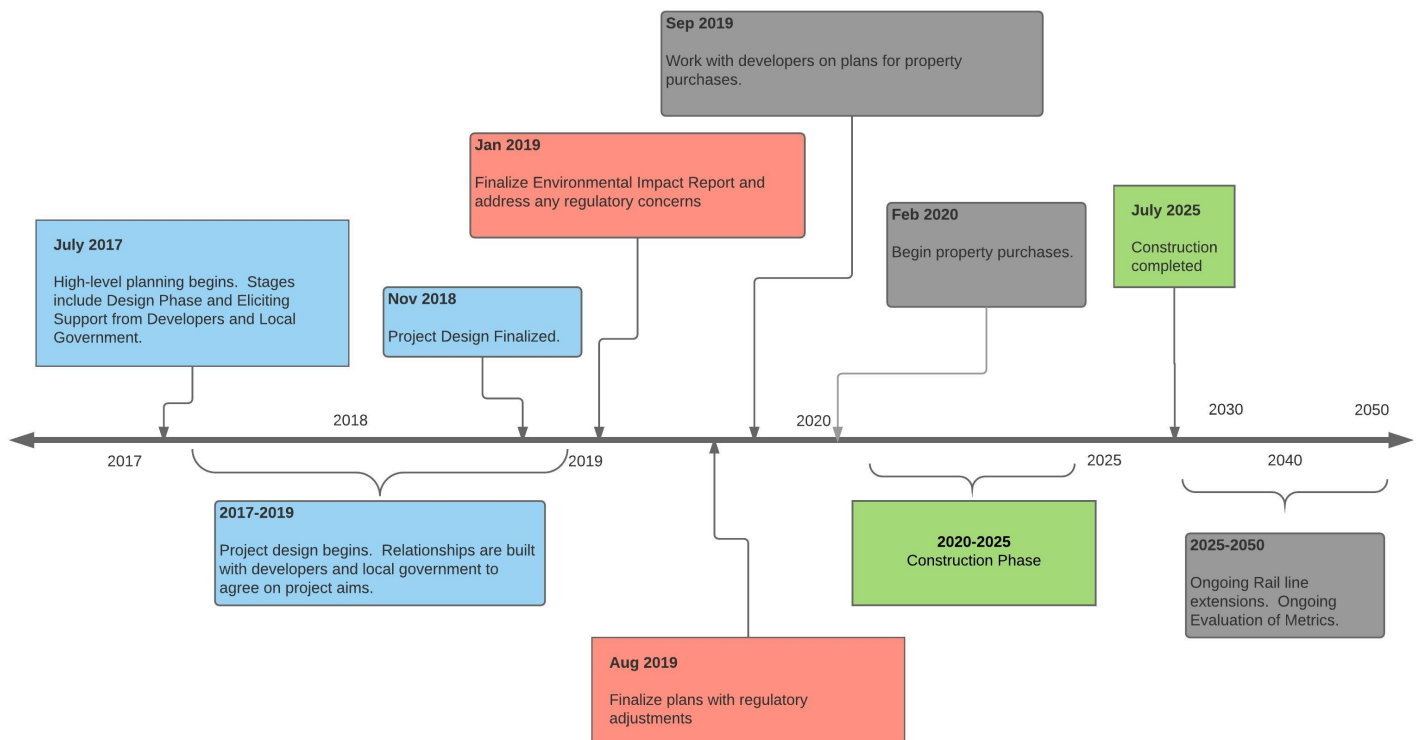


Figure 2 - Sample Project Timeline

To build environmentally friendly and efficient trains, requests for proposals (RFPs) will be elicited from major firms. These will be overseen by the creation of a transit board comprised of developers and local officials. This board will have the ultimate decision-making authority for the design and construction of the entire development.

Evaluation Metrics

Broad Success Measures

A wide array of metrics will be investigated to evaluate the success of the project. The first is ridership, with calculated Equivalent of Vehicle Miles Traveled. Housing capacity and traffic impact will be measured as well. Metrics will also be designated for Transit Quality and Rider Satisfaction. The cost effectiveness of the project can be evaluated from a number of angles. In addition to Fare Collection, Operating Expense Per Passenger Mile will be calculated. This metric is exemplified by U.S. buses, which cost an average of \$1.00 per passenger mile, compared to \$0.60 per passenger mile for rail operations.²² Economic Impact can also be measured; this may include average household income within a 0.1 mi, 0.25 mi, 0.5 mi, and 1 mi radius of the transit hub. From an environmental standpoint, reduction in energy use and carbon emissions may also be tracked. Detailed and varied metrics provide holistic measures of success for the project, assuring public and political support for the development.

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