

# THE BAY LINE

A case study in the adaptive reuse of abandoned bridges for landscape and urbanism.



The Historic Bridges of the United States website lists 1,788 bridges that have been classified as “closed” to traffic and 321 classified as “abandoned”. According to the website, “with all of the Federal stimulus money sloshing around, it’s no surprise that bridge replacement projects are quite common this summer.” Many of the bridges that have been abandoned are largely former railroad bridges--a testament to the decline of rail as a means of freight and passenger transportation. As rail bridges, the structures have the capacity to support tremendous structural loads. This proposal seeks to repurpose abandoned and closed bridges as sites of potential for parks, cultural centers and housing.

This proposal seeks to demonstrate the potential for re-purposing the historic American bridge infrastructure as possible sites for sustainable urban housing and linear parks. The eastern section of the historic James “Sunny Jim” Rolph Bridge, commonly known as the Bay Bridge, in San Francisco/Oakland, which is currently being replaced by a new concrete bridge structure, serves as a prototype for considering the potential of re-utilizing bridge infrastructure to create new social, housing and sustainable infrastructures.

Rails-to-Trails Conservancy is a nonprofit organization based in Washington, D.C., whose mission it is to create a nationwide network of trails from former rail lines and connecting corridors to build healthier places for healthier people. As evidenced by the increasing interest to convert abandoned railways into linear parks, mostly in rural and suburban areas, there is also increasing interest to re-use this abandoned rail infrastructure in urban areas. This proposal goes a step further in suggesting the possibility for housing to be included in the re-thinking of abandoned bridges. The immense load capacity of rail bridges allows for the support of program beyond that of parks, suggesting the urbanization of bridges. While the current economic climate suggests a surplus of housing, the economic reality also suggests a push towards urbanization and often the “affordable” housing constructed in suburban environments, which encroaches on the rural is not what is needed. Instead, by using abandoned bridges in urban areas, we are creating opportunities for sustainable low-cost housing within the urban realm--creating the potential for creative speculation among housing developers by expounding upon the nascent potential of a layered housing-park-bridge typology.

Imagine housing, recreational and cultural facilities connected to a continuous, lushly planted, green strip, floating above the water – an aerial garden, as the city’s newest park through which you could walk and wander and enjoy the most spectacular views of the bay.

## CASE STUDY: THE JAMES “SUNNY JIM” ROLPH BRIDGE

The James “Sunny Jim” Rolph Bridge and known locally as the Bay Bridge) is a complex of toll bridges in the San Francisco Bay Area of California, in the United States. Forming part of Interstate 80 and of the direct road route between San Francisco and Oakland, it carries approximately 270,000 vehicles per day. It has one of the longest spans in the world and has been called one of the seven engineering wonders of the modern world.

When the bridge first opened, the upper deck consisted of three lanes of traffic in each direction and was restricted to automobiles only. The lower deck carried three lanes of truck and auto traffic on the north side. Two railroad tracks were built on the south side of the lower deck for the electric commuter trains of the Southern Pacific, the Key System, and the Sacramento Northern. Rail service on the bridge ended in April 1958.

In 1989, the powerful Loma Prieta earthquake collapsed a section of the east span of the San Francisco-Oakland Bay Bridge. Although the bridge was quickly repaired, the event prompted Caltrans to pursue a replacement that would meet current seismic standards.

The initial proposal for the eastern span involved the construction of substantial concrete pylons to replace or supplement the existing supports at a cost of \$200 million. It was originally thought that a replacement bridge would be a less expensive alternative, costing only a few hundred million more, however the most recent estimates put the price tag on the current bridge replacement at \$6.2 billion. The eastern span is scheduled for demolition in 2013.

*-Sources: Wikipedia, Metropolitan Transit Commission Website*



San Francisco-Oakland Bay Bridge Plan



Eastern span replacement with historic truss-bridge on right

## THE BAY LINE

### Core Premise and Objectives

The objective of The Bay Line is to, specifically, re-imagine the replaced eastern span of the Bay Bridge as a linear park with bicycle and pedestrian access, housing and cultural activities, such as theaters, commerce and museums, as well as 1.92 miles of bicycle lanes, sporting facilities, such as tennis courts, climbing walls, squash courts, and skate parks in addition to orchards, gardens and meadows, that are easily accessible and interconnected to the larger Bay Area. More broadly, we hope that this project is the genesis for creating a series of prefabricated prototypes and widely applicable concepts that can help others realize the potential in abandoned bridge infrastructure world-wide.

### Viability

The eastern span of The Bay Bridge can support a load of 1,400 lbs./Linear foot. This is equal to the weight of 37,041 3-bedroom modular homes.

Seismic upgrade of the eastern span was completed after the Loma Prieta earthquake in 1989 and almost 2 million vehicles cross the bridge each week.

The Bay Bridge is a historic Icon that connects two major metropolitan areas by automobile, but does not accommodate bicycle and pedestrian traffic.

Unsurpassed views coupled with a culture of health and fitness in the Bay Area would make the Bay Line a desirable destination.

A continued demand for low-cost housing in the Bay Area, even during the housing crisis, is justification for the addition of housing.



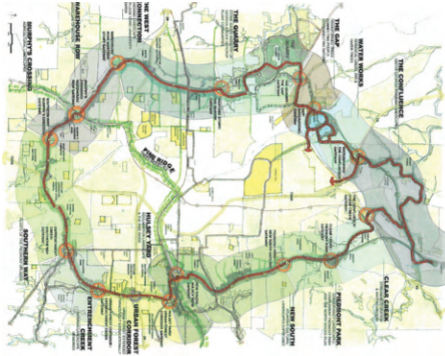
The Bay Trail, a bicycle and pedestrian trail surrounding the Bay, would connect to the Bay Line creating a more direct trans-bay access.



The Promenade Plantee in Paris, also built upon an elevated rail, at 2.8 miles is 1 mile longer than the proposed Bay Line and twice as long as The High Line.



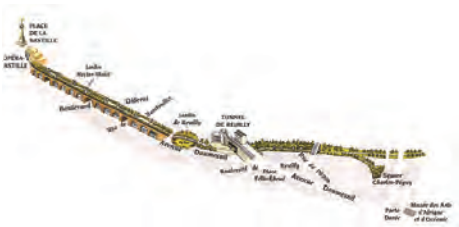
## PRECEDENTS: LINEAR PARKS



Park: The Belt Line  
Location: Atlanta, Georgia  
Highlights: Combines greenspace, trails, transit, and new development along 22 miles of historic rail segments that encircle the urban core  
Program: 1200 acres of new greenspace through a linear park alongside trails  
Date: 1999-Present, ground-breaking in 2008  
Architect: Ryan Gravel



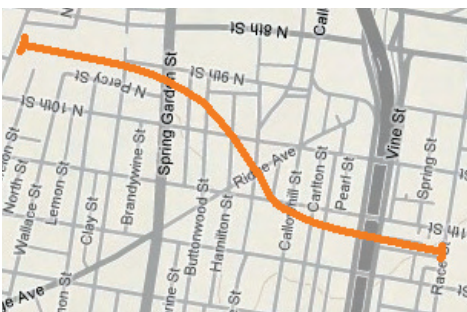
Bridge: Bloomingdale Trail  
Location: Chicago, Illinois  
Highlights: A 3-mile-long elevated linear park running through the heart of Chicago  
Program: Park  
Date: Unrealized  
Architect: Arup North America, Ltd.



Bridge: Promenade Plantée  
Location: Paris, France  
Highlights: Constructed on an abandoned 19th-century railway viaduct, which connected the Bastille area to the eastern suburbs of Paris  
Program: Pedestrian and Bicycle Trail, Gardens, Park  
Date: 1990  
Architect: Jacques Vergely and Philippe Mathieux



Bridge: The High Line  
Location: New York, New York  
Highlights: Linear Park through section of Manhattan  
Program: Mosslands, meadows, wetlands, woodlands, sun decks, plazas, concessions  
Date: 2009  
Architect: Diller, Scofidio + Renfro, James Corner



Bridge: Reading Viaduct Project  
Location: Philadelphia, Pennsylvania  
Highlights: Park through Philadelphia  
Program: Park through economically and culturally diverse communities, intended to provide a catalyst for the redevelopment of this section of North Philadelphia  
Date: Unrealized  
Architect: Unknown

## PRECEDENTS: BRIDGE HOUSING

### The Ponte Vecchio

Built in Florence, Italy between 996-1345 by the architect Taddeo Gaddi. The bridge is Europe's oldest wholly-stone, closed-spandrel segmental arch bridge. In order to connect the Palazzo Vecchio (Florence's town hall) with the Palazzo Pitti, in 1565 Cosimo I de' Medici had Giorgio Vasari build the famous Vasari Corridor above it. To enforce the prestige of the bridge, in 1593 the Medici Grand Dukes prohibited butchers from selling there; their place was immediately taken by several gold merchants. The corporative association of butchers had monopolized the shops on the bridge since 1442.



### London Bridge

Constructed in London, England between 1176-1209, nearly 200 places of business lined both sides of the bridge with merchants living above—reaching up to 7 stories in height. The bridge also has a chapel and contained water wheels to power water pumps and grain mills. An Act of Parliament dated June 1756, permission was obtained to demolish all the shops and houses on London Bridge.



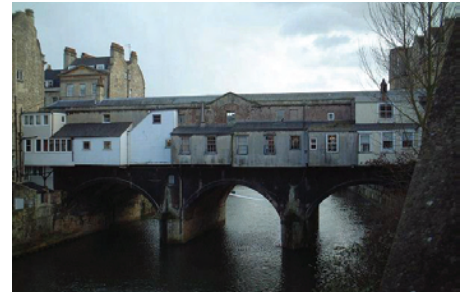
### Chateau Chenonceau

Located in the Loire Valley, France this castle, chapel and fortified mill bridge was constructed between 1515-1521 by the architect Thomas Bohier. The bridge was essential for travel and commerce during the French Revolution—one reason it was not destroyed. The chateau was used as a hospital during the first World War and during the second was a conduit for people escaping the occupied zone of France. One end of the gallery was in the occupied zone while the other end was in the Free Zone. Today the Chateau is a major tourist attraction.



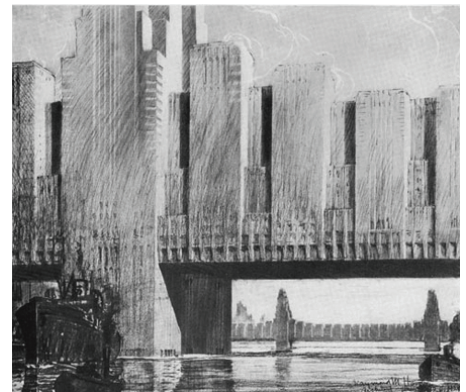
### Pulteney Bridge

Crossing the River Avon, in Bath, England, it was completed in 1773 and closely follows Palladio's rejected design for the Rialto in Venice. Pulteney Bridge stood for less than 20 years in the form that Adam created. In 1792 alterations to enlarge the shops marred the elegance of the façades. 19th-century shopkeepers altered windows, or cantilevered out over the river as the fancy took them. The western end pavilion on the south side was demolished in 1903 for road widening and its replacement was not an exact match. In 1936 the bridge became scheduled as a national monument.



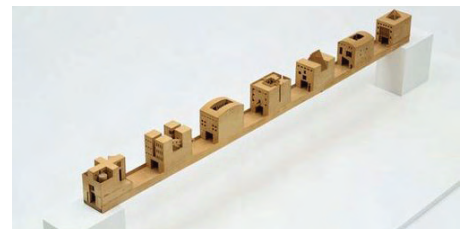
### Skyscraper Bridges

Architect Raymond Hood was fascinated with the idea of residential skyscraper bridges, which he believed could both help solve the problems of traffic congestion and offer an ideal lifestyle on the waterfront. His first proposal appeared in an article in The New York Times Magazine in February 1925, illustrated with a drawing by Hugh Ferriss. Hood described a great bridge across the Hudson River ten thousand feet long, where the supporting pylons were apartment buildings of 50 or 60 stories. There would eventually be dozens of these luxury waterside communities for fifty thousand residents, he predicted. Hood reprised the proposal in a 1926 article in the magazine Liberty, describing the bridges as 20,000 feet long, with a center road beds as wide as Park Avenue and predicted that there would be a hundred of them.



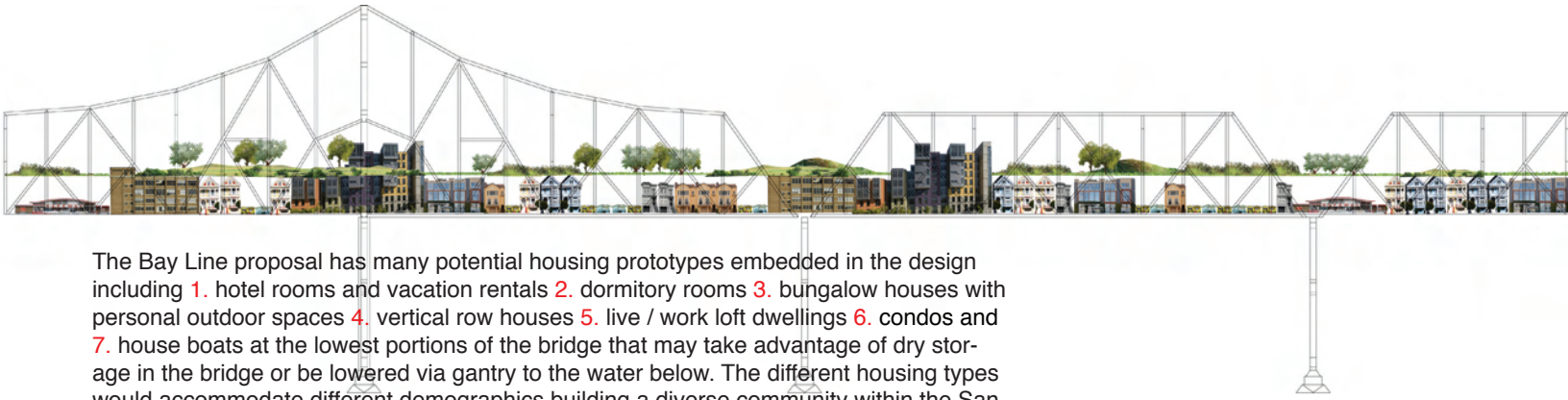
### Bridge of Houses

Architect Steven Holl envisioned a series of varying housing typologies in 1981 to accommodate several demographics in a project for the elevated train line now known as The High Line in New York City. All proposed houses were to be built to align with the existing block front at the street walls, reinforcing the street pattern. The ornamental portions of the rail bridge which pass over the streets remain open and the spaces between provide elevated courtyards for the housing.





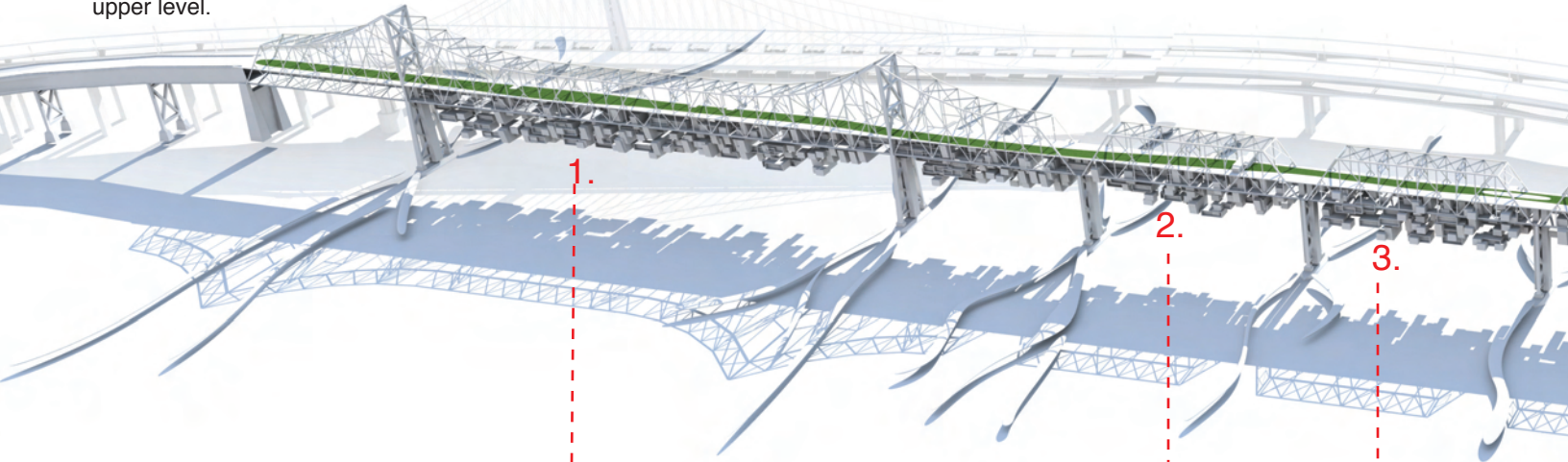
## BRIDGE HOUSING ALONG THE LOWER DECK



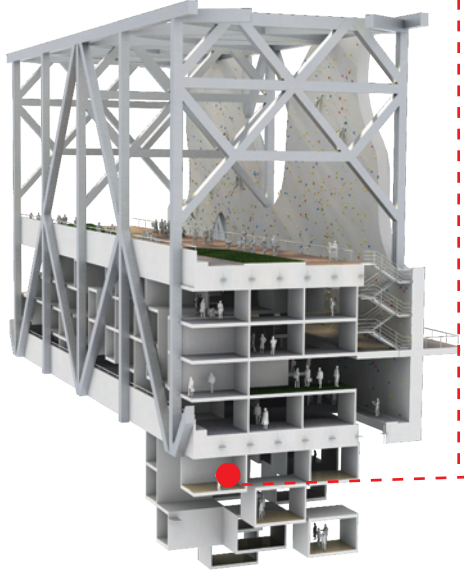
The Bay Line proposal has many potential housing prototypes embedded in the design including 1. hotel rooms and vacation rentals 2. dormitory rooms 3. bungalow houses with personal outdoor spaces 4. vertical row houses 5. live / work loft dwellings 6. condos and 7. house boats at the lowest portions of the bridge that may take advantage of dry storage in the bridge or be lowered via gantry to the water below. The different housing types would accommodate different demographics building a diverse community within the San Francisco County line.

Each house type on the Bay Line would be prefabricated off site and hoisted into place, the housing units could also be installed on other bridges all across the country.

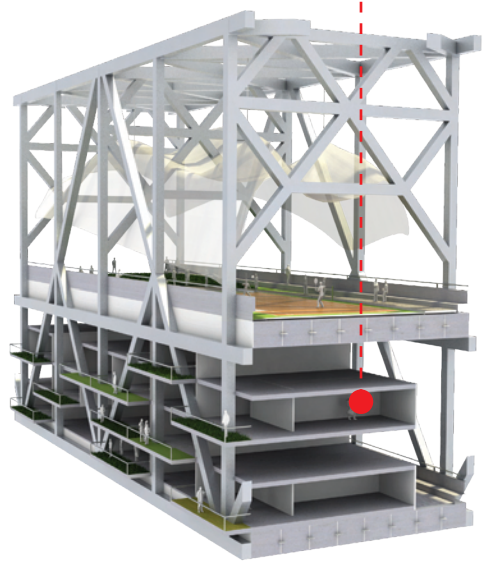
The Bay Line will generate new sustainability practices for the Bay area in that each house along the Bay Line will be **geothermally** and radiantly heated and cooled by circulating water brought up from the San Francisco Bay. Additionally, **water recycling** from each house will be used as gray water to irrigate the gardens and orchards on the upper level.



Hotel rooms + outdoor amphitheater



Dormitories + climbing wall



Bungalow house + tennis courts



ramped meadow above / bicycle rental below

bicycle path  
pedestrian path

badminton courts

solar panels on south side

dry docked house boats

bicycle path below

house boat being lowered to water below

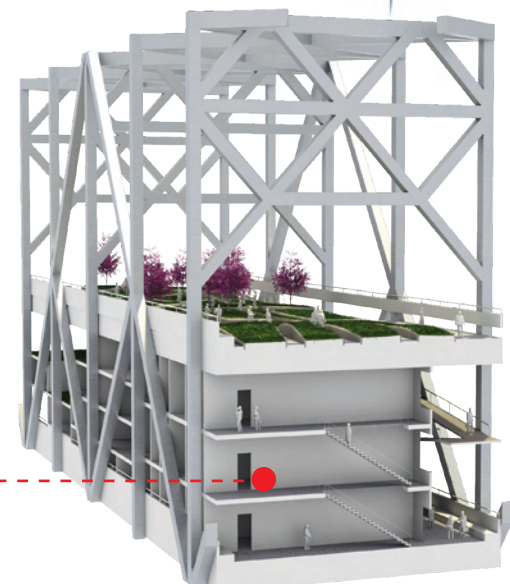
House boat +  
volley ball courts

4.

5.

6.

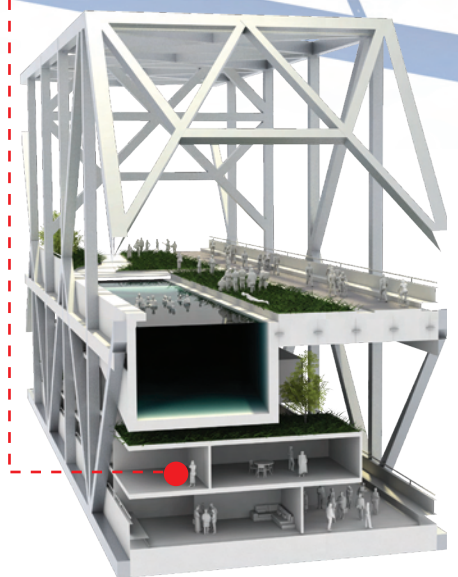
7.



Row houses + gardens



Live / work lofts + orchards



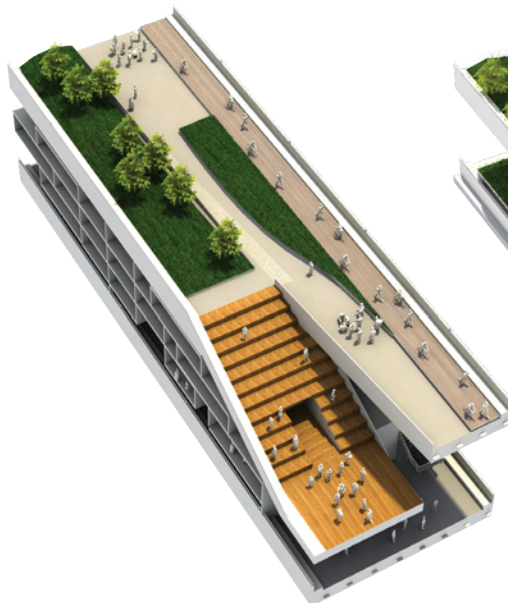
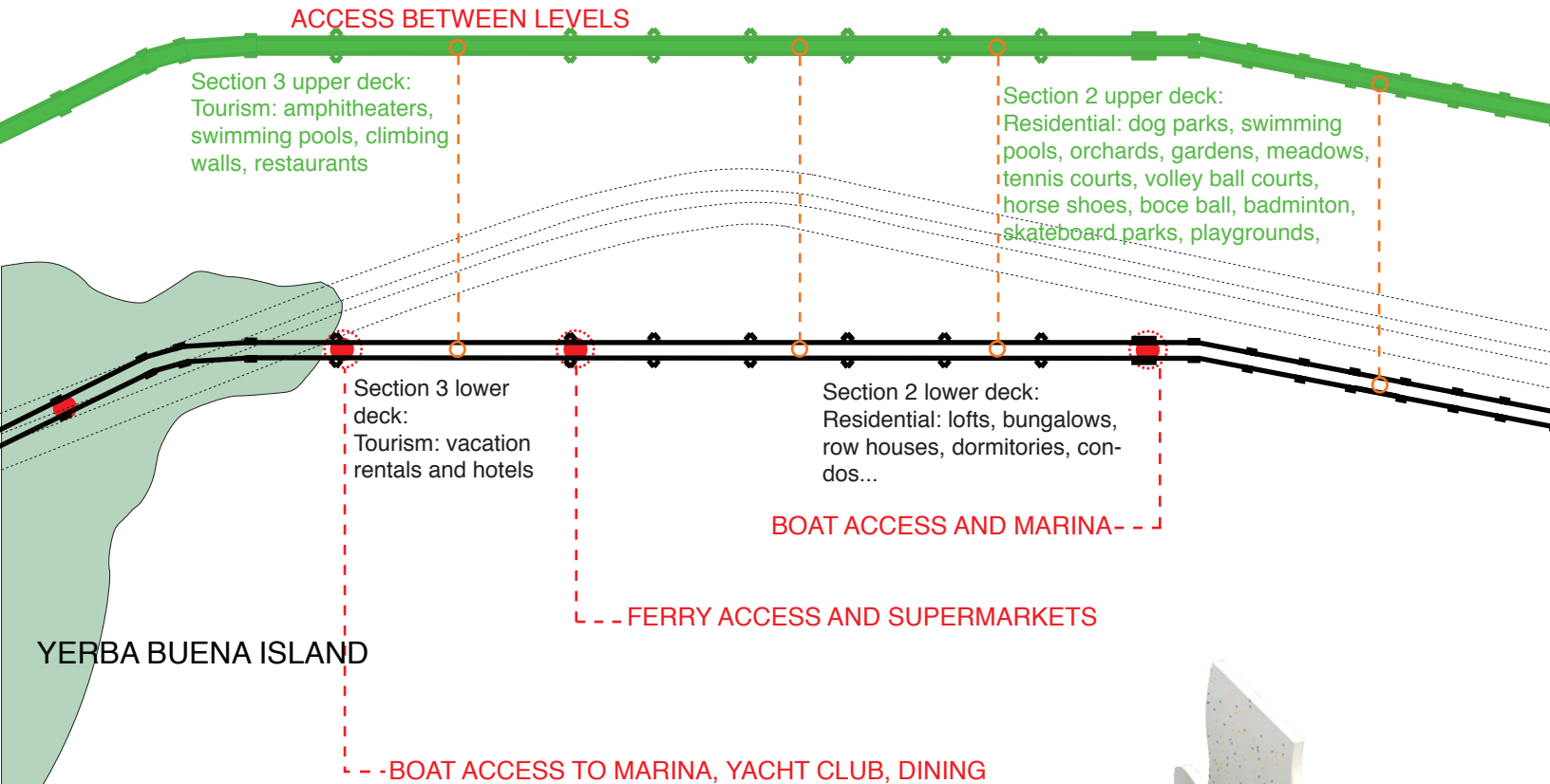
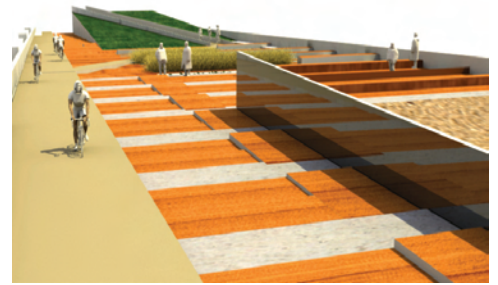
Condos + swimming pool



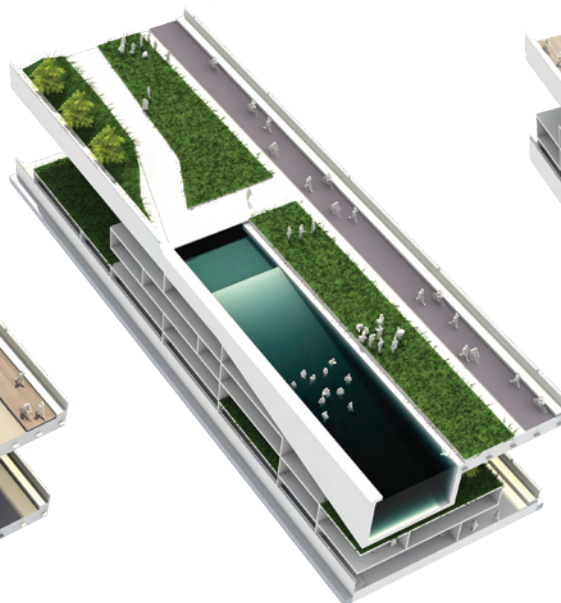
## LINEAR PARKS ALONG THE UPPER DECK

The upper deck of the Bay Line will be re appropriated as an urban park. The park will include sports facilities that are often quite difficult to find in dense urban centers such as tennis courts, swimming pools and skate parks. It will include edible gardens and orchards as part of the urban agriculture network established in the Bay area by organizations such as the League of Urban Gardeners, there will also be gardens, meadows and woodlands for leisure activities and amphitheaters and museums to support local culture. A system of prefabricated terraces will be constructed to build the different programs and to smoothly allow one program to sequeway into the next.

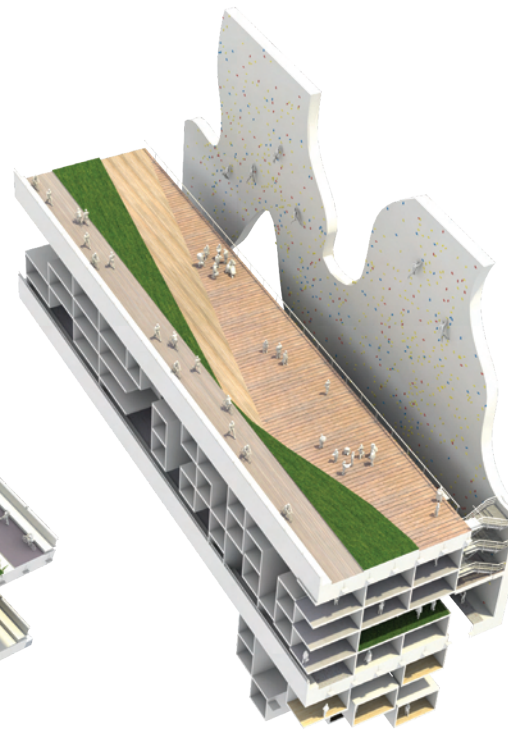
The recreational, cultural, leisure and agricultural programs will promote diverse user groups along the bridge. The continuous bicycle path that runs the length of the bridge will become a part of the growing bay trail which connects cities along the perimeter of the bay.



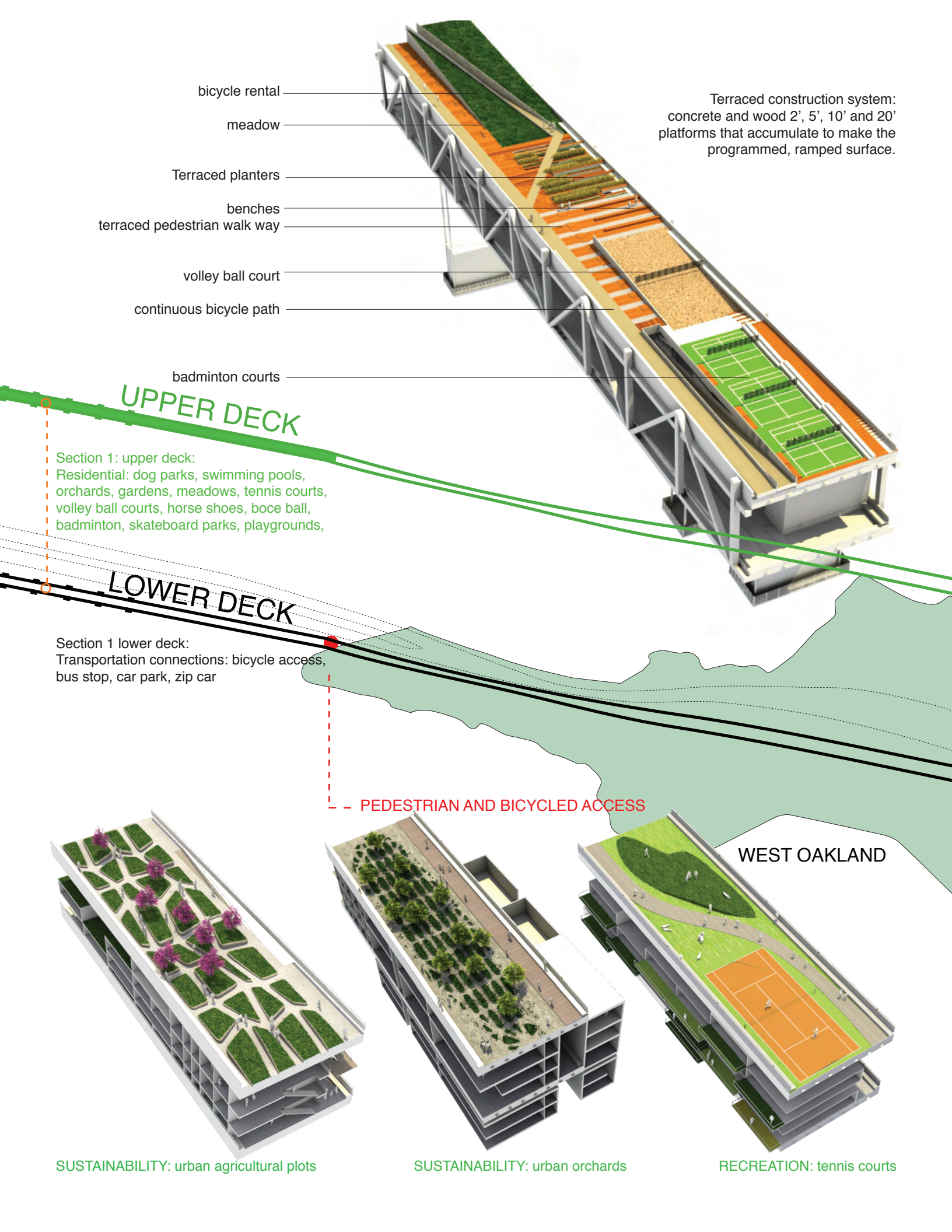
**CULTURE:** outdoor amphitheater



**RECREATION:** swimming pools



**COMMUNITY:** dog park



bicycle rental

meadow

Terraced planters

benches

terraced pedestrian walk way

volley ball court

continuous bicycle path

badminton courts

Terraced construction system:  
concrete and wood 2', 5', 10' and 20'  
platforms that accumulate to make the  
programmed, ramped surface.

UPPER DECK

Section 1: upper deck:

Residential: dog parks, swimming pools,  
orchards, gardens, meadows, tennis courts,  
volley ball courts, horse shoes, boce ball,  
badminton, skateboard parks, playgrounds,

LOWER DECK

Section 1 lower deck:

Transportation connections: bicycle access,  
bus stop, car park, zip car

-- PEDESTRIAN AND BICYCLED ACCESS

WEST OAKLAND

SUSTAINABILITY: urban agricultural plots

SUSTAINABILITY: urban orchards

RECREATION: tennis courts



## SOCIAL INFRASTRUCTURE AND INVESTMENT OPPORTUNITIES

### Community: Recreation and Sports

Sports are inherently very social activities where networks between people with common interests are formed. These networks form social capital which is the underpinning and core fabric of communities. Social capital has a stream of benefits, including safety and security, friendship and community, a sense of civic identity and economic value. Over time, social capital builds what may be termed as social infrastructure which is key for any successful and healthy community.

### Sustainability: Gardens and Agriculture

Recently there has been a large movement to bring agriculture back into the city. The Bay Line has up to 15 acres of "land" that can potentially be used for edible gardens and orchards. These gardens may be incorporated by institutions such as non profit community organizations such as SLUG (San Francisco League of Urban Gardeners) who currently run 40 small gardens in the city that generate it's \$1.6 million dollar annual budget. The gardens not only provide food but they are economically self sustainable.

### Public Presence: Leisure and Culture

Like the Golden Gate Park, the Bay Line would be a destination for tourist and locals alike. The Bay Line would be suitable for hotels, restaurants and museums as well as picnickers, walkers and kids in search of playgrounds.

### Investment Strategies:

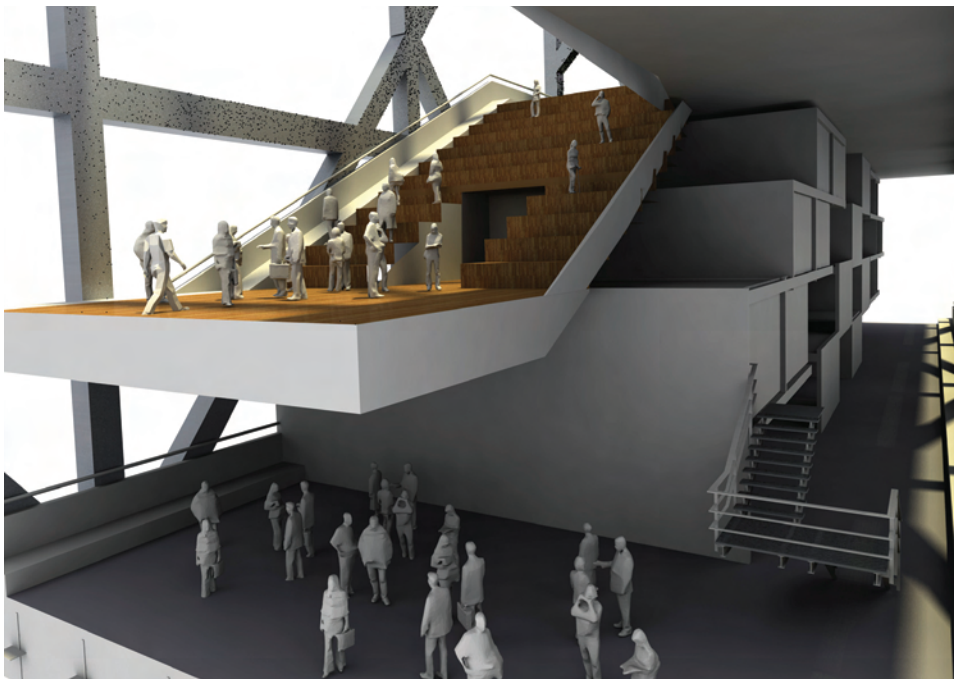
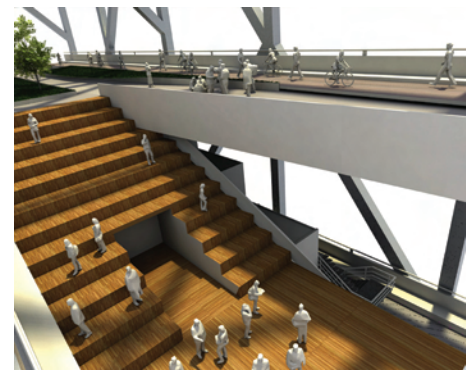
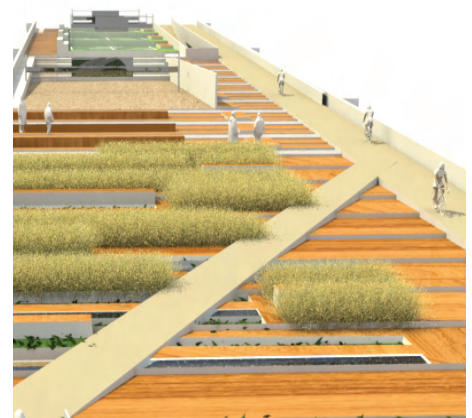
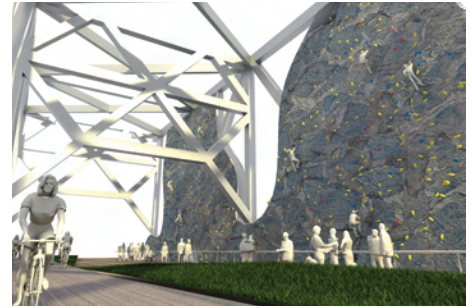
The two layers on the Bay Line combined equal approximately 1,306,800 SF therefore the costs associated with building this proposal would be:

653,400 sf dedicated to park activities on upper deck @ \$200/sf	= \$131 million
980,100 sf dedicated to housing, commercial and buildings @ \$400/sf	= \$392 million
additional seismic reinforcement of the bay bridge	= \$200 million
Total Cost of Construction for Bay Line	= \$723 million

Consider a 6:1 ratio of Residential to Non-Residential on the lower deck, this would yield residential square footage of 717,600sf and non-residential square footage of 163,500sf. The average sales price/sf for residential real estate in San Francisco is \$513/sf if

717,600 sf of residential real estate sold	= \$368 million
Total Construction Costs	= \$723 million
Total Residential Profit	= \$368 million
Balance	= \$355 million

The balance could be recouped by commercial rental which at \$4.50 a sf in San Francisco would be recovered in 40 years, or with tolls for cars using the new bridge for example.



## POSSIBLE ADDITIONAL SITES: ABANDONED BRIDGES



### Seven Mile Bridge

These bridges - the two largest pictured here and many shorter spans between Islamorada and Boca Chica Key - are all that remains of the "Overseas Railroad," the Florida East Coast Railway Key West Extension. The railroad was built between 1904 and 1912, and operated for 23 years until it was wiped out by the Labor Day Hurricane of 1935. The right of way and bridges were then converted for use by the Overseas Highway. In 1982, these narrow highway bridges were replaced by modern structures.



### Big Four Railroad Bridge

An abandoned six-span railroad truss bridge that crosses the Ohio River, connecting Louisville, Kentucky and Jeffersonville, Indiana. It was completed in 1895, and updated in 1929. Access to the Big Four Bridge is currently limited, as the access ways onto the bridge for the general public were removed in 1969, earning the Big Four Bridge the nickname "Bridge That Goes Nowhere". The bridge is presently being converted into a bicycle/pedestrian crossing; the George Rogers Clark Memorial Bridge downstream, which carries U.S. 31 across the river, is presently the only bridge allowing bicyclists and pedestrians travel between Louisville and its Indiana suburbs of New Albany, Clarksville, and Jeffersonville.



### The Bahia Honda Rail Bridge

A scenic bridge built in 1912 in the lower Florida Keys connecting Bahia Honda Key with Spanish Harbor Key. Originally part of the Overseas Railway, the State of Florida purchased it after the 1935 Labor Day Hurricane and converted it to automobile use as part of the Overseas Highway in 1938. After a replacement Bahia Honda Bridge was opened in 1972, two sections of the Rail Bridge were removed, but the rest remain standing. Today, the former bridge is now used as a fishing pier, as well as providing a scenic overview of the area for tourists.



### The Prince of Wales Bridge

A rail bridge built in 1880 and named for Albert Edward, Prince of Wales. It is a multi-span Pratt truss bridge, consisting of six equal spans over the south channel, and seven spans over the north channel. At the time, it was one of the few crossings of the Ottawa River, and was one of the most valuable assets of the line, which was owned by the Quebec provincial government. The City of Ottawa purchased the CPR line, including the Prince of Wales Bridge, during the early 2000s for a light rail transit project, however, the bridge has remained unused and the track east of the Bayview Station to the bridge is overgrown.



### The Beverly Railroad Bridge

Constructed in 1909, the bridge crosses over the Columbia River and was built on concrete piers 85 feet above the water to provide clearance for any river traffic. The spans include 14 Warren deck trusses, one Parker through truss, and deck plate girders on the approaches. When the railroad electrified in the 1920s, supports for the catenary were added to the bridge. When the railroad ceased using electric locomotives in 1972, the catenary was removed, the supports were kept in place. After the railroad went bankrupt in the mid-1970s and abandoned its lines in the Pacific Northwest in 1980,