

Tranvía de Carolina  
 AIRPORT AREA ALIGNMENT ALTERNATIVES - Alternative 3  
 TIER 1 SCREENING

OPTION	Connection Summary						Comments
	Carolina - Airport	Carolina - Hato Rey	Carolina - Isla Verde	Airport - Isla Verde	Airport - Hato Rey	Isla Verde - Hato Rey	
1	○ Transfer	● Direct	○ Transfer	● Direct	○ Transfer	○ Transfer	Long-term service between two branches operating separately would need a transfer point. Isla Verde to Airport segment very short. Requires interconnect track which renders concept similar to Option 4. Dropped
2	● Direct	○ Transfer	○ Transfer	○ Transfer	○ Transfer	● Direct	Long-term service between two branches operating separately would need a transfer point. Requires interconnect track which renders concept similar to Option 4. Dropped
3	○ Transfer	○ Transfer	● Direct	○ Transfer	● Direct	○ Transfer	Long-term service between two branches operating separately would need a transfer point. Requires interconnect track which renders concept similar to Option 4. Dropped
4	○ Transfer	● Direct	● Direct	○ Transfer	● Direct	○ Transfer	Long-term service between two branches operating separately would need a transfer point for some connections. Southeast-to-southwest route connection provides for interconnect track. Airport connection could be deferred to a later time, by operating a shuttle bus service. Retained
5	● Direct	○○ Transfer or Indirect ①	○○ Transfer or Indirect ①	● Direct	● Direct	○○ Transfer or Indirect ①	Airport station would serve as the transfer point between routes. With proper configuration, the airport leg could function as a "pinched loop" with through service to Isla Verde and/or Hato Rey. As Option 6 is identical with an additional future connection to Hato Rey, Option 6 is better and more flexible. Dropped
6	● Direct	● Direct	○○ Transfer or Indirect ①	● Direct	● Direct	○○ Transfer or Indirect ①	Airport station could serve as the transfer point between routes. With proper configuration, the airport leg could function as a "pinched loop" with through service to Isla Verde. Differs from Option 5 in that direct service between Carolina and Hato Rey would be provided in the future. This would require, for example, that trains alternate between the Airport/Isla Verde branch and the Hato Rey branch. Retained
7	● Indirect	● Indirect	● Direct	● Direct	● Direct	● Indirect	Carolina service to the Airport is routed through Isla Verde, and is less direct. Routing at the Airport and Isla Verde may be a loop or a "pinched loop". No direct connection between Hato Rey and Carolina, though service could be operated as a through route via Isla Verde and the Airport. As Option 8 is identical with an additional future connection to Hato Rey, Option 8 is better and more flexible. Dropped
8	● Indirect	● Direct	● Direct	● Direct	● Direct	● Indirect	Similar to Option 7, except that a future interconnect track would allow for direct Carolina-Hato Rey service. Carolina service to the Airport is routed through Isla Verde, and is less direct. Differs from Option 7 in that direct service between Carolina and Hato Rey would be provided in the future. This would require, for example, that trains alternate between the Airport/Isla Verde branch and the Hato Rey branch. Retained
9	● Direct	○○ Transfer or Indirect ①	○○ Transfer or Indirect ①	● Direct	● Direct	○○ Transfer or Indirect ①	Long term service between two branches would need a transfer point for some connections. Southeast-to-southwest connection provides for interconnect track. With proper configuration, the airport leg could function as a "pinched loop" with through service to Isla Verde and/or Hato Rey. Retained
10	● Direct	● Indirect	● Indirect	● Direct	● Indirect	● Direct	Long term service between two branches would need a transfer point for some connections. As Option 11 is identical with an additional future connection to Hato Rey, Option 11 is better and more flexible. Dropped
11	● Direct	● Direct	● Indirect	● Direct	● Indirect	● Direct	Similar to Option 10, except that a future interconnect track would allow for direct Carolina-Hato Rey service and for direct Hato Rey - Isla Verde service. Through service linking Carolina, the airport, Isla Verde, and Hato Rey would also be possible, depending upon how service is structured. Requires two connections between branch routes. Service between Carolina and Isla Verde is slightly indirect; service between Hato Rey and the airport would also be indirect. Retained
LEGEND	●	No Transfer Required					
	○	Indirect Service - Transfer Required					
	×	No Service Connection Possible					
	Direct	Service is without transfer along a relatively direct and short route					
	Indirect	Service is without transfer, but along a less directing routing with a longer travel time than a "direct" connection.					
	Transfer	Service connection requires a transfer					
	①	Whether linkage is indirect or requires a transfer depends on route structure.					

**Tranvia de Carolina  
AIRPORT AREA ALIGNMENT ALTERNATIVES - Alternative 3  
TIER 2 SCREENING**

Connection Summary								EVALUATION FACTORS																	
OPTION	Sub-Option	Carolina - Airport	Carolina - Hato Rey	Carolina - Isla Verde	Airport - Isla Verde	Airport - Hato Rey	Isla Verde - Hato Rey	Comments	Length - Total (Initial and Future) (km)	Length - Below Grade (km)	Length - Elevated (km)	Length - At Existing Grade (km)	Double Track Interconnect Switch Points	Direct Service for Anticipated Dominant Travel Demands	Airport Security and Constructability Issues	High-Level Conceptual Cost Estimate - INITIAL (In millions - 2006)	High-Level Conceptual Cost Estimate - FUTURE (In millions - 2006)	High-Level Conceptual Cost Estimate - TOTAL (In millions - 2006)	Cost Considerations	Ability to Defer Construction	Potential Environmental Issues	CONCLUSIONS			
4		○	●	●	○	●	○	Long-term service between two branches operating separately would need a transfer point for some connections. Southeast-to-southwest route connection provides for interconnect track. Airport connection could be deferred to a later time, by operating a shuttle bus service. <b>Retained</b>							For Option 4A, constructibility on the airfield west end of the north runway will be constrained. Instrumentation near PR-26 for both runways might be affected. No apparent security issues. For Options 4B and 4C, a similar assessment except that both runways would be affected by construction on the west airfield area. Construction impact on the airport entrance road occurs with all options.							Option 4A does not defer any significant construction to the future, but offsets this by the lowest initial and total cost, lower than the initial cost of any other option. Option 4B defers a minimal cost to the future, and Option 4C a greater level.	Option 4A would have some potential impacts in the west airfield area, and to the west of PR-26. Options 4B and 4C would have some potential impacts in the west airfield area, and to a lesser extent along the west of PR-26.	Option 4A identified as preferred option due to low initial cost, low total cost, flexibility to serve dominant travel patterns, and ability to defer the airport connection. Option 4B and 4C are considered inferior due to greater costs and complexity. <b>Option 4A is the PREFERRED OPTION.</b>	
	A	Transfer	Direct	Direct	Transfer	Direct	Transfer		6.00	1.22	1.18	3.60	Option 4A: LOW, 2 required Option 4B: HIGH, 4 required Option 4C: HIGH, 3 required	Direct service from Carolina to Isla Verde and Hato Rey; indirect to Isla Verde. Could be revised (per Option 6A) for direct service to the airport and not Hato Rey, or possibly both.		\$248.7	\$0.0	\$248.7							
	B								3.97	1.85	1.07	1.07				\$279.3	\$23.4	\$302.7							
C								3.97	1.85	1.07	1.07				\$272.4	\$106.8	\$379.2								
6		●	●	○●	●	●	○●	Airport station could serve as the transfer point between routes. With proper configuration, the airport leg could function as a "pinched loop" with through service to Isla Verde. Differs from Option 5 in that direct service between Carolina and Hato Rey would be provided in the future. This would require, for example, that trains alternate between the Airport/Isla Verde branch and the Hato Rey branch. <b>Retained</b>							For Option 6A, constructibility on the airfield west end of the north runway will be constrained. Instrumentation near PR-26 for both runways might be affected. No apparent security issues. For Option 6B, a similar assessment except that both runways would be affected by construction on the west airfield area. Construction impact on the airport entrance road occurs with all options.							Option 6A has a low initial cost, and a low total cost. Option 6B has a second lowest initial and total cost.	Option 6A does not defer any significant construction to the future, but offsets this by matching Alt. 4A with roughly the lowest initial and total cost. Option 6B defers a minimal cost to the future.	Option 6A would have some potential impacts in the west airfield area, and to the west of PR-26. Option 6B would have some potential impacts in the west airfield area, and to a lesser extent along the west of PR-26.	Option 6A is similar to Option 4A except for the area west of PR-26 and its interconnect layout could be adopted, depending on predominant travel patterns. Option 6B is more costly and is not competitive. <b>Option 6A is the PREFERRED OPTION alternate.</b>
	A	Direct	Direct	Transfer or Indirect ○	Direct	Direct	Transfer or Indirect ○		5.77	1.25	1.16	3.36	Option 6A: HIGH, 4 required Option 6B: HIGH, 4 required	Direct service from Carolina to the airport and Hato Rey; indirect to Isla Verde. Could be revised (per Option 4A) for direct service to the airport and not Hato Rey, or possibly both.		\$341.0	\$14.7	\$355.7							
	B								3.97	1.85	1.07	1.07				\$279.3	\$23.4	\$302.7							
8		●	●	●	●	●	●	Similar to Option 7, except that a future interconnect track would allow for direct Carolina-Hato Rey service. Carolina service to the Airport is routed through Isla Verde, and is less direct. Differs from Option 7 in that direct service between Carolina and Hato Rey would be provided in the future. This would require, for example, that trains alternate between the Airport/Isla Verde branch and the Hato Rey branch. <b>Retained</b>							For Option 8A, the principal airport impact would be the construction impacts associated with developing the alignment under both runways and adjacent taxiway and apron areas, as well as under two terminal areas and terminal loop roadway undercrossings. There are security concerns as well with public access to areas under the active runways. For Option 8B, constructibility on the airfield west end of the south runway will be constrained, and there would be construction impact on the airport entrance road. Similar construction and security concerns for underground construction would exist for Option 8B, but are confined to the north side of the airport terminal and north runway. Instrumentation near PR-26 for both runways might be affected.							Option 8A is second lowest in initial and total cost. Option 8B has a low initial cost, but a very high future cost.	Option 8A does not defer any significant construction to the future, but offsets this by matching Alt. 4A with roughly the lowest initial and total cost. Option 8B defers a minimal cost to the future.	Option 8A would minimize environmental disturbance due to its deep below grade alignment, but would have some potential at-grade impacts along the north airport boundary along PR-187 and to the west of PR-26 for the future segment. Option 8B would minimize environmental disturbance due to its deep below grade alignment. However, there are security, constructibility and cost issues with this option. Option 8B is considered inferior to other options because of its indirect path and very high cost.	Option 8A provides direct service to the airport terminal with an expensive but relatively direct alignment. However, there are security, constructibility and cost issues with this option. Option 8B is considered inferior to other options because of its indirect path and very high cost.
	A	Indirect	Direct	Direct	Direct	Direct	Indirect		3.76	1.47	0.18	2.11	Option 8A: LOW, 1 required Option 8B: LOW, 2 required	Option 8A has direct but circuitous service from Carolina to the airport and Hato Rey; indirect to Isla Verde, or with split train destinations. Option 8B is similar more indirect in its path.		\$277.1	\$25.0	\$302.1							
	B								4.03	1.56	0.15	2.32				\$284.0	\$170.4	\$454.4							
9		●	○●	○●	●	●	○●	Long term service between two branches would need a transfer point for some connections. Southeast-to-southwest connection provides for interconnect track. With proper configuration, the airport leg could function as a "pinched loop" with through service to Isla Verde and/or Hato Rey. <b>Retained</b>							For Option 9A, the principal airport impact would be the construction impacts associated with developing the alignment under both runways and adjacent taxiway and apron areas, as well as under two terminal areas and terminal loop roadway undercrossings. There are security concerns as well with public access to areas under the active runways. Construction impact on the airport entrance road would also occur. Instrumentation near PR-26 for both runways might be affected.							Option 9A has a high initial cost, and a relatively high future cost for the highest total cost.	Option 9A defers a significant construction cost to the future.	Option 9A would minimize environmental disturbance due to its deep below grade alignment, but would have some potential at-grade impacts along the north airport boundary along PR-187 and to the west of PR-26 for the future segment. It would also have some possible future phase environmental issues on the west airfield and along the west side of PR-26.	Option 9A is considered inferior to other options because of the high overall cost and overall length, as well as security and constructibility issues.
	A	Direct	Transfer or Indirect ○	Transfer or Indirect ○	Direct	Direct	Transfer or Indirect ○		6.19	2.84	0.82	2.53	Option 9A: LOW, 2 required	Option 9A has direct service from Carolina to the airport, and could have direct service to either or both Isla Verde and Hato Rey.		\$313.7	\$140.8	\$454.5							
	B																								
11		●	●	●	●	●	●	Similar to Option 10, except that a future interconnect track would allow for direct Carolina-Hato Rey service and for direct Hato Rey - Isla Verde service. Through service linking Carolina, the airport, Isla Verde, and Hato Rey would also be possible, depending upon how service is structured. Requires two connections between branch routes. Service between Carolina and Isla Verde is slightly indirect; service between Hato Rey and the airport would also be indirect. <b>Retained</b>							For Option 11A, the principal airport impact would be the construction impacts associated with developing the alignment under both runways and adjacent taxiway and apron areas, as well as under two terminal areas and terminal loop roadway undercrossings. There are security concerns as well with public access to areas under the active runways. For Option 11B, both runways would be affected by below grade construction on the west airfield area, and there would be construction impact on the airport entrance road.							Option 11A has a high initial cost, and a high future cost, for a very high total cost. Option 11B has a high initial cost, but a low future cost, for a moderately high total cost.	Option 11A defers a significant construction cost to the future, while Alt. 11B defers a modest amount.	Option 11A would minimize environmental disturbance due to its deep below grade alignment, but would have some potential at-grade impacts along the north airport boundary along PR-187 and to the west of PR-26 for the future segment. Option 11B would have some possible environmental issues on the west airfield and future impacts along the west side of PR-26.	Option 11A provides direct service to the airport terminal with an expensive but relatively direct alignment. However, there are security, constructibility and cost issues with this option. Option 11B is considered inferior to other options because of its relatively high cost and other complexities.
	A	Direct	Direct	Indirect	Direct	Indirect	Direct		3.69	1.86	0.00	1.83	Option 11A: LOW, 2 required Option 11B: HIGH, 4 required	Option 11A has direct service from Carolina to the airport and Isla Verde, and less direct to Hato Rey. Option 11B has several circuitous linkages and redundancy in connections.		\$306.0	\$154.7	\$460.7							
	B								4.79	2.06	0.89	1.83				\$305.0	\$20.3	\$325.4							
LEGEND		●	No Transfer Required																						
		○	Indirect Service - Transfer Required																						
		✕	No Service Connection Possible																						
		Direct	Service is without transfer along a relatively direct and short routing																						
		Indirect	Service is without transfer, but along a less direct routing with a longer travel time than a "direct" connection.																						
		Transfer	Service connection requires a transfer.																						
		⓪	Whether linkage is indirect or requires a transfer depends on route structure.																						

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## **Memorandum**

**To:** Yahaira Rodriguez - DEPLAN  
**From:** Jack Schnettler - PBS&J Caribe Engineering  
**Copies:** Victor Dominguez, Mark Hitchcock, Maria Navarro  
**Date:** December 19, 2006  
**Subject:** Tranvía de Carolina Route Validation Study  
***Tranvía Alignment Alternatives in the Airport Area***  
**Attachments:** Supporting Graphics and Tables

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### **1. Overview**

The purpose of this memorandum is to summarize the examination of Tranvía alignment alternatives in the airport area. Due to the complexity of the physical setting in this area and the desire to provide initial and future service to several destinations and corridors, a broad range of options was explored. The preferred concept resulting from this analysis was previously presented as part of Alternative 3, with the exception that the rail transit link to the airport terminal area was replaced by an initial shuttle bus service. Alternative 3 plates will be revised to show the added rail transit connection into the airport terminal area. Attached to this memorandum are a Powerpoint file documenting the alignment analysis and an Excel file containing two worksheets summarizing the screening and comparison of options considered in the two tier analysis process - the reader is referred to these two attachments in the review of this information. The following narrative sections discuss background information and the analyses conducted.

### **2. Demand for Airport Access Via Rail Transit**

In the U.S. there are a limited number of airports with rail transit access. These are the airports located in Atlanta, Chicago (Midway), Chicago (O'Hare), Cleveland, Philadelphia, St. Louis, Washington, D.C. (Reagan International), and Baltimore/Washington, D.C. Projects are in advanced planning or construction for rail transit links to the airports in San Francisco, Miami, New York (Kennedy), Dallas/Fort Worth, Oakland, and others.

Useful background on this subject can be found in the report: [Improving Public Transportation Access to Large Airports](#), Transportation Cooperative Research Program - TCCRP Report 62, Transportation Research Board - National Research Council, Leigh Fisher Associates in association with Matthew A. Coogan and MarketSense, Washington, D.C. (2000). This report presents a variety of available data on the use of public transportation at large U.S. airports and selected international airports. It also presents key factors affecting transit use by air travelers and airport employees. The study considered rail service, express bus service, and shared-ride/door-to-door vans. Outside of this definition are taxicabs, courtesy vehicles, pre-arranged limousine or car service, and charter buses or vans.

There are two primary airport market segments for transit travel - air passengers and airport employees. Air passenger markets are typical divided into four subsegments: business vs. non-business, resident and nonresident. In general, meet-and-greet visitors travel by car, partly because of cost considerations and partly because of luggage considerations. Airport employees comprise a diverse market group consisting of airline counter/gate and apron workers, airline flight crews, staff employed by the airport agency, cargo and shipping firm staff, airport vendors and service contractors of various types (food service, maintenance and janitorial, airside apron workers, and concourse retailers).

Airports exhibit trip making patterns for these market segments that can vary from typical urban activity and employment centers:

- Extended work days
- Multiplicity of employers
- Employment distributed widely over a large site
- Air travel with differing peaking patterns over the day, week, month and year
- Different ground travel needs for different air traveler segments: tourism vs. business vs. personal

Federal Aviation Administration data from 2005 for Luíz Muñoz Marin International Airport shows about 5.3 million annual enplanements - this ranked 36th among U.S. airports. An estimated 75 to 80% of these (about 4.0 to 4.2 million) are originating enplanements, meaning that the trip begins in San Juan.

The following information summarizes representative market shares for major airports with rail and other transit access:

- Total transit market share at major airports in Europe and Eastern Asia are in the 20-60% range, with most in the 25-40% range. The rail transit share at these same airports is in the 5-45% range, with most in the 15-35% range.
- There are 8 U.S. airports with direct rail transit access. With the exception of Reagan International in Washington, D.C., which has 17% transit market share and 14% rail transit market share, the remaining airports have transit market shares of 6-11%, and rail transit market shares of 1-8%.
- There are 11 U.S. airports with shuttle bus service to nearby rail transit service. With the exception of Boston, San Francisco and Los Angeles, where total transit market share ranges over 14-21%, for the remaining airports, it ranges from minimal to 8%. Rail transit share in this latter group ranges from minimal to 6%.
- With the exception of certain large airports serving special markets like Reagan International, data suggests that airport workers can comprise the majority of rail transit users, up to as much as 75% of rail transit riders at some airports. Limited data is available, but reported information for a few airports shows a rail transit mode share for airport employees of 5-12%.
- Generally greater acceptance of transit for urban mobility needs, and generally more complete and quality regional transit services.

U.S. successes are generally in airports serving larger, denser urban markets, most with robust regional premium transit service networks. Issues affecting demand for airport transit service are relative cost, destinations served, connecting services, baggage, headways and general convenience. U.S. airport rail transit market capture is low in comparison to Europe and Asia, where capture rates are much higher due to several factors:

- Direct transit service to downtown and the metropolitan area.
- Service to destinations beyond the airport's metropolitan area.
- Quality of the airport-transit interface (ease of access, frequency of service).
- Progressive baggage handling strategies.

An article in the weekly newspaper PassengerTransport (Feb. 12, 2001, Vol. 59, No. 7, Page 1, American Public Transit Association (APTA), Washington, D.C.) entitled "Passenger Mix, Convenience Key to Transit-Airport Connections" underscores this by noting that rail transit access is successful when the airport is used by a large number of nonbusiness travelers and local residents. Nonbusiness travelers are less time sensitive and local residents are more familiar with the transit network. Convenient user connections to the transit stations that avoid traffic conflicts, and are direct and attractive are other pluses. Finally, baggage issues for certain kinds of travelers can preclude transit use. On the other hand, factors such as rail transit's travel time reliability contrasted to congested roadways, and the forecast for increasing numbers of air travelers, are important positive factors.

Premium transit access to airports is usually quite costly to build. The alignments are typically not at-grade (elevated or below ground) and are more expensive to develop - most larger airports have multi-level roadways with elevated ramps and walkways to multi-story parking garages. Transit alignments are

not usually reserved and preserved in advance within the airport landside master plan - use of the public area in front of terminals generally evolves incrementally, with large spaces dedicated to circulation, parking, rental car agency lots, taxi holding lanes and the like.

Potential issues with rail transit service demand at Luis Munoz Marin International Airport includes the following:

- Tranvía will initially serve primarily Carolina: The connecting service to the Carolina Extension of Tren Urbano will provide an indirect link to the rest of the metropolitan region, with a transfer required.
- Tourist travel modes: While data could not be found, it is expected that a significant share of airport users in San Juan are tourists. The introduction of baggage into the mode of travel decision can greatly influence transit demand in this sector, as can the fact that much of the travel needs of these tourists may be satisfied by charter buses and vans (to/from hotels, the cruise port terminals), and by rental cars.
- Positioning airport terminal area transit stations for convenient access to terminal areas: This is a challenge in a constrained terminal area setting. Quality vertical and horizontal connections to the terminals, along with way finding signing are critical.
- Planning for airport employee access: Rail transit stations for terminal building and terminal "infield" area employees should provide relatively straightforward access. However, consideration should be given to transit access for employees working on airside areas and in the cargo and freight-forwarding center east of the passenger terminal area. This would need to be addressed in order to reflect the linkage in the travel demand modeling properly.
- Future light rail to Hato Rey: A future light rail link from the airport to Hato Rey and Tren Urbano could prove attractive. However, there is no demand estimate for transit ridership at this point in time.

### **3. Planning for Rail Access to the Airport**

Airport access is a desirable feature of the light rail system due to the importance of the airport. However, the viability of providing rail transit service to the airport is a function of a technically feasible alignment, the cost of the access, and the demand for the service. Airport transportation access in San Juan is presently accomplished by a mix of personal cars, taxis, rental cars and AMA buses. As conceived and defined, Alt. 1 and Alt. 2 for Tranvía were located in the median of PR-26 and passed through the airport entrance interchange area but did not have a station there. This is due in part to the character of the alignment within PR-26 in particular, and to the variety of physical, geometric, cost and other constraints and considerations around the airport. These factors include:

- Airport Runway Glide Slopes: The defined glide slope clearances for the two airport runways converge in the airport entrance area, severely limited above grade structures, such as a bridge to carry the light rail over PR-26. The existing bridge at the airport entrance is precisely located to satisfy those clearances and locations to either side along PR-26 will not satisfy the criteria.
- Airport Area Constructability: It will be necessary to construct the light rail system with minimal disruption to existing airport landing and take-off operations as well as airport instrumentation, and the same is true for major highways such as the lagoon bridge roadway, the airport entrance roadway and PR-26. For the airport, vertical limitations and safety considerations could significantly limit the daily timelines for construction, and daily traffic volumes along the major roadways could likewise be time-restricted.
- Cross-Runway Taxiway and Drainage Canal: There is a cross-runway taxiway that passes over the airport entrance road, with passes underneath in a depressed roadway section below the water table, and a parallel drainage canal which further affects options.
- Environmentally Sensitive Areas: Within the airport grounds and southwest of PR-26 near the airport entrance interchange are existing mangrove areas and potential wetland areas.
- Airport Instrumentation: There are a variety of airport navigation devices installed in this area, including beacons and runway approach lighting.
- Airport Security: There is a fenced "Air Operations Area" which occupies most of the west end of the airport grounds except for the narrow corridor of the entrance road. Use or penetration of this

area will require close coordination and approval of the airport and the Federal Aviation Administration.

- It is further noted that the provision of premium light rail transit to the airport would need to be coordinated closely with the Ports Authority which oversees the airport, and with airport transportation service providers who may feel threatened by the potential service.

There are two related aspects of rail transit access to the airport. The first is the effective interconnection to multiple activity centers or service corridors, and the second are the complexities of specific alignment corridors to serve the airport, both of which are addressed in the discussion which follows. There obviously will be a light rail corridor extending northwesterly from central Carolina towards the Isla Verde and Airport area, connecting from the south side of airport grounds. It is also clear that the light rail needs to connect to the Isla Verde district, and it is desired to connect to the airport terminal area. Finally, there is the possibility being considered for a connection from the vicinity of the airport entrance interchange across the San José Lagoon to the Tren Urbano station in Hato Rey; such a line could possibly extend westward to the Plaza Las Americas mall, and in the longer term westward to the Plaza San Patricio area. There has been no feasibility review of this Hato Rey / Airport connection for the ridership demand, cost, impacts and alignment options, but it was felt that it should be considered so as to not preclude the future opportunity to pursue it. It was assumed, however, that its alignment should be placed next to the existing lagoon highway bridge to minimize mangrove impacts.

#### **4. *Development and Screening of Alternatives***

An analysis was done to identify potential options for linking Tranvía services into the Isla Verde, airport terminal and future Hato Rey service corridors. This analysis is without the benefit of transit demand analysis that would indicate the relative demand for light rail transit in each target corridor and between these destinations as well. Alternatives 1 and 2 as previously defined used the median lanes of PR-26, without an airport station or a direct rail transit connection to the airport terminal area. Alternative 3 was subsequently developed to potentially address this shortcoming, without using PR-26 travel lanes, and to provide the opportunity for rail transit access directly to the airport terminal area. Alternative 3 does provide that opportunity at a more manageable cost than do other options.

This analysis and screening of potential options to serve the airport was done in two tiers. First, a group of 11 "stickline" touring/service structure strategies to connect the Tranvía route from central Carolina to Isla Verde, the airport terminal, and the future link to Hato Rey were developed. This "four-way" access matrix creates six different interconnection opportunities; without travel demand analysis, it is not possible to know which are greater and which should be served directly. These were screened to a smaller set of five alternatives that were examined in greater detail.

Service structure is also a pertinent consideration, that is, how the rail segments are connecting by through train routes versus interconnecting route connections where a transfer is required. Based on the fact that no information on demand patterns is presently available, this aspect was approached by providing maximum flexibility for future operational patterns. In addition, all identified service segments need the capability for through service or for an interconnecting track in order to permit the movement of rail transit cars between all service corridors.

The question with these points or corridors of interest is how best to interconnect them. While a variety of possible options were reviewed, they are all characterized by constrained vertical or horizontal alignments, with significant associated costs. The development of a light rail alignment to serve the airport has limited approach options for proximity directly to the terminal area. This issue is best answered by travel demand analysis which has not yet occurred. For example, one alignment could run along PR-26 and on to Isla Verde as contemplated by several alternatives. A second line could begin at the airport terminal, and extend westward to a station with the first route, and then continue west to Hato Rey. For travelers going from the middle of Carolina to Hato Rey or the airport, this would mean a transfer. This transfer would be acceptable if those movements requiring a transfer were lower in volume.

Another option is to approach the terminal area via the entrance roadway, using the two center lanes through the depressed "tunnel" under the taxiway. Preliminary review indicates that the affected travel lanes will likely need to be lowered to provide adequate vertical clearance for the light rail, requiring reconstruction of the structural mat section under the main roadway. The vertical profile curves through the depressed roadway section appear to be workable for rail transit. To the east of the "tunnel", the alignment would need to be elevated for many potential alternatives, with either a loop around the central parking garage or a station on either side of the garage, and below grade for a few others. To the west of the depressed roadway section, the connection to a PR-26 alignment as in Alt. 1 and Alt. 2, or south of PR-26 as considered for Alt. 3 is very problematic and costly. Even if two median lanes of the airport entrance road were used, exiting from the median lanes west of PR-26 is highly constrained, and involves potential impact to the lagoon road managed under a toll concession contract.

Another alignment option would be for the alignment of any of the alternatives to assume a below grade alignment and pass under PR-26. The alignment would continue below grade towards the airport entry road, preferably without passing under the south runway. If the alignment turned east toward the terminal, some distance eastward, trains would have to "double back" and then resume on a depressed alignment toward an at-grade crossing with PR-187 and on into Isla Verde on one of several routes. Unless this option could be turned southward to Hato Rey, a light rail route in that corridor would have to connect possibly at a station on the south side of PR-26 where a transfer between routes could be made. The depressed pathway through the airport would be very expensive.

For each of the five final concepts, schematic configurations were developed on an aerial map base of the airport area. At this level, all potential options were explored. These included combinations of alignment corridors along PR-26, across the airport airfield west of the terminal area, and connecting directly to the terminal area via a deeper below grade path. Most routes on airport grounds are below grade unless lying along the airport grounds perimeter or along portions of the airport entrance spine road. In addition, routes connecting directly to the airport terminal area would necessarily have to be relatively deep, very costly tunnel-type installations to avoid disturbance to airport operations, and to reduce or conflict with building foundations and piles. Below grade alignment sections will require a pump drainage system in order to remove seepage and rainfall from the alignment section. These routes together define a full range of possibilities with the intent that they could be technically implemented, albeit some at a relative high cost. However, at this level of detail, it is not possible to explore the wide range of various design facets of every alignment.

The schematic diagrams show the proposed alignment location and profile in terms of elevated, at-grade or below grade condition. For options using the airport entrance road connecting from PR-26 to the terminal area, a closer look was taken regarding placement of the light rail in the median area of that roadway. The airport master plan does depict very conceptually a transit corridor along this path towards the airport terminal area. For this placement in the airport entrance road, there are two options through the depressed segment under the airport taxiways: the first displaces the two center roadway lanes, using the right-side shoulder to retain three travel lanes in each direction, while the second retains the shoulder and provides only two travel lanes in each direction. Future projections of airport entrance road traffic can be obtained from the pending light rail ridership study. Since the roadway is free-flow in this area, two lanes in each direction might be fully serviceable into the future, but with a speed reduction, it is possible to provide the three lanes each way without a shoulder for this short distance, which would essentially retain the existing roadway capacity.

In these five schematics, 10 different routing variations were identified. The schematics show alignment location, profile type and approximate station locations. A companion evaluation matrix was developed to compare these options for factors including length, initial construction cost, future construction cost (with the connection to the lagoon crossing to Hato Rey), deferral of costs to the future, airport impacts, environmental considerations, and others. The cost estimates utilized for this analysis are very conceptual and intended to discriminate between the basic features of the various options for comparative purposes.

## 5. Summary

All factors are important, but the conceptual costs are so significant in scale that selecting the lowest cost option that demonstrates at least adequate functionality is likely the best decision strategy - pending further information on demand levels and demand patterns. This information could help determine whether the airport terminal demand is great enough to warrant rail transit service and how the various connections in this area can be most effectively linked in terms of reducing transfer requirements. Given the long term investment in the Tranvía de Carolina project, it is important that the best reasonable alignment solution be implemented.

Based on this review, the option with the lowest initial cost, and lowest total cost, is Option 4A. While not the shortest total path, it is the least expensive due to minimal amount of below grade alignment. Many options involving significant below grade length can be considered cost-prohibitive, unless of course, they exhibit dramatically higher ridership potential. Option 4A also presents the choice to defer the initial construction of the airport terminal rail transit connection to a later phase and construct a shuttle bus connection on the southwest side of PR-26/PR-17 interchange adjacent to the rail transit, which is not possible or practical with other alternatives. This version of Option 4A (Option 4A-1) was selected because of this added flexibility. If only the Carolina-Isla Verde (southeast-to-northwest) segment were built, the estimated initial cost is on the order of \$80 million within this alternative analysis area. The added cost of the northeast-to-southwest segment from the airport terminal to the lagoon shore is in the order of \$175 million in today's cost. It was judged infeasible to continue the light rail transit within the median of the airport entrance road through the PR-26/PR-17 interchange, partly because the roadway section width is reduced, partly because airport vertical clearance restrictions restrict a grade separation to carry the rail transit out of the median area, and partly because it would not be possible to interconnect with the initial Carolina-Isla Verde route below. It is also noted that Option 6A as it emerged from the process of defining alignment concepts is very similar in layout and in overall characteristics to Option 4A, basically differing in how the trip interchanges are connected by way of the track interconnections to the southwest side of PR-26, and so is considered functionally equivalent to Option 4A and is substitutable depending on what trip interchange linkages become the most important.

Therefore, the Option 4A concept was incorporated into the definition of Alternative 3 for the Tranvía project.

Further recommendations are to:

- Develop a conceptual master plan that identifies a specific rail access alignment and station concepts.
- Assess the demand for airport rail access through a detailed ridership analysis.
- Subsequently refine and coordinate a detailed alignment plan in extensive coordination with the airport.
- Consider institutional issues related to the impacts to existing ground transportation services such as taxicabs.
- Consider the suitability of rail transit access in a phased manner, with potential interim shuttle bus connection to the nearest off-airport transit station.
- If the rail access is confirmed as feasible based on the forecast ridership, include a value engineering component in further alignment develop due to the relative costs involved.

# ***Tranvía de Carolina***

## **Airport Area Alignment Options**

# *Tranvía* Routing Issues in the Airport Area

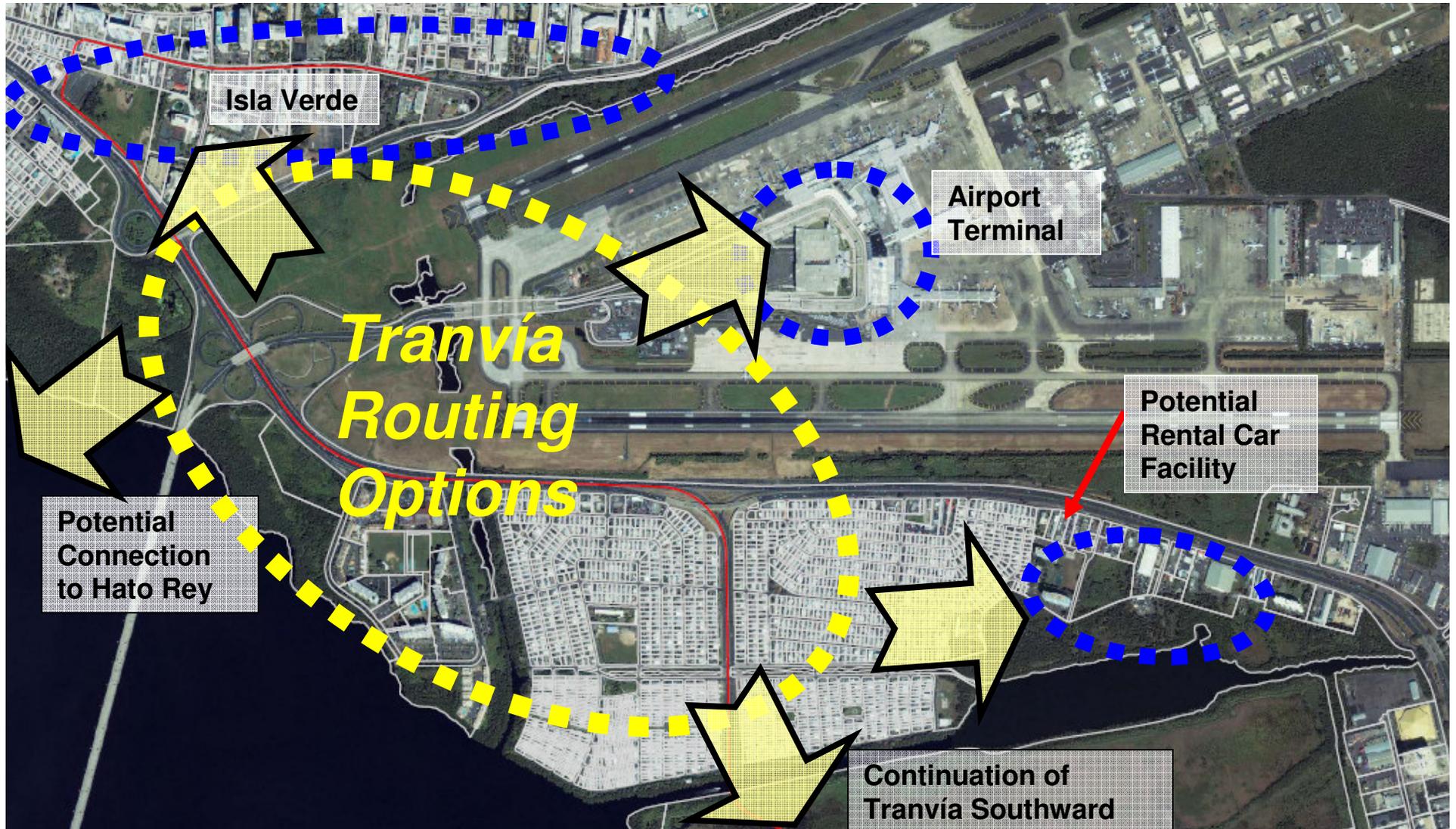
- **Physically constrained area:**
  - Several major highways
  - Airport airfield layout, aviation instrumentation installations, and airport infrastructure
  - Airport airspace (FAA Part 77) constraints
  - Airport security considerations
  - Constructability with regard to aviation operations and security
  - Drainage channels, wetlands, low-lying areas
  - Airport terminal area and Isla Verde district are difficult to reach
  - Land areas fragmented by existing roadways
- **Multiple destinations and corridors to be linked:**
  - Light rail route southward to central Carolina
  - Isla Verde District
  - Airport Terminal Area
  - Potential light rail route to southwest and Hato Rey across lagoon
  - Future airport rental car center off the airport grounds

# *Tranvía* Routing Issues in the Airport Area

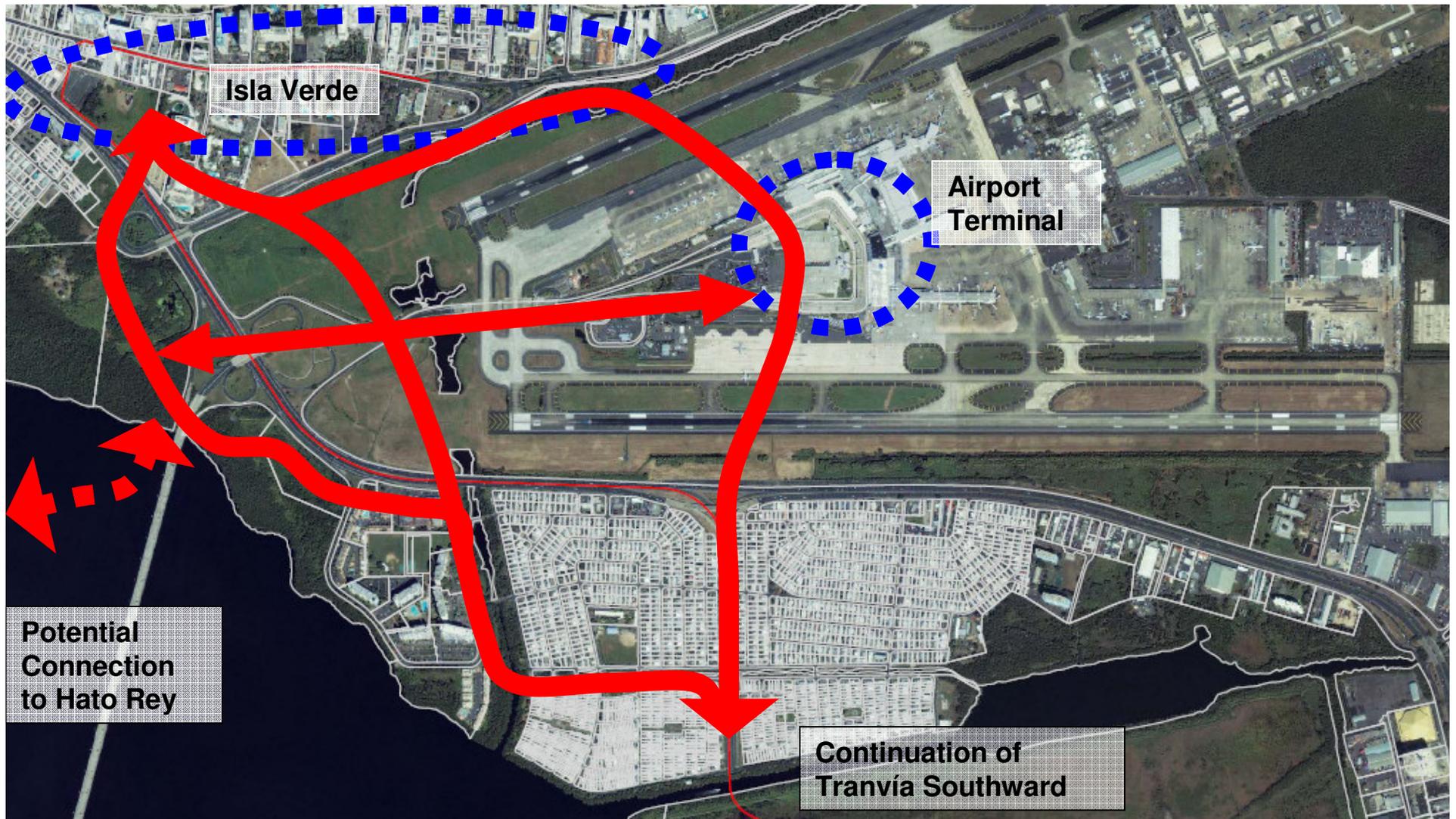
- **Roadway-related issues:**
  - Capacity need for airport entry roadway
  - Temporary and/or permanent impacts to roadways
  - Coordination with San Jose Lagoon bridge concessionaire
- **Travel demand patterns and levels on the system in the airport area:**
  - Not established at this time
  - Would dictate priorities for direct service vs. transfer service
  - Would also influence service operational strategies
- **Transit service operational strategies:**
  - Direct connections vs. transfer connections
  - Single destination routes vs. multiple destination routes
  - Need for interconnect track between separately operating routes
  - Overlapping routes create operational management (safety, headways, costly track connections)
  - Not possible without ridership to gauge the relative value of different configurations (especially multiple direct (no transfer) service connections)



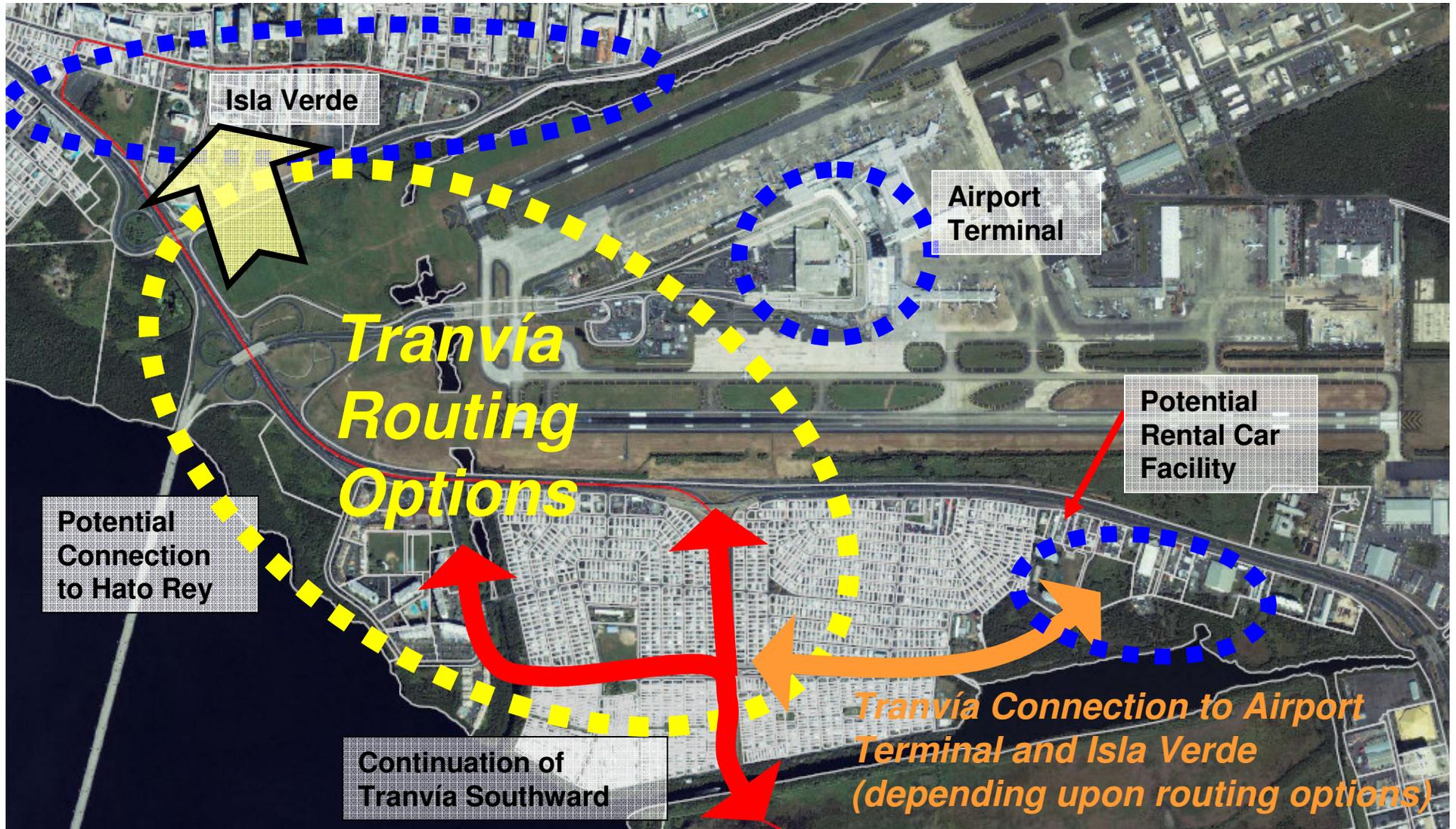
# *Tranvía* Routing Issues in the Airport Area



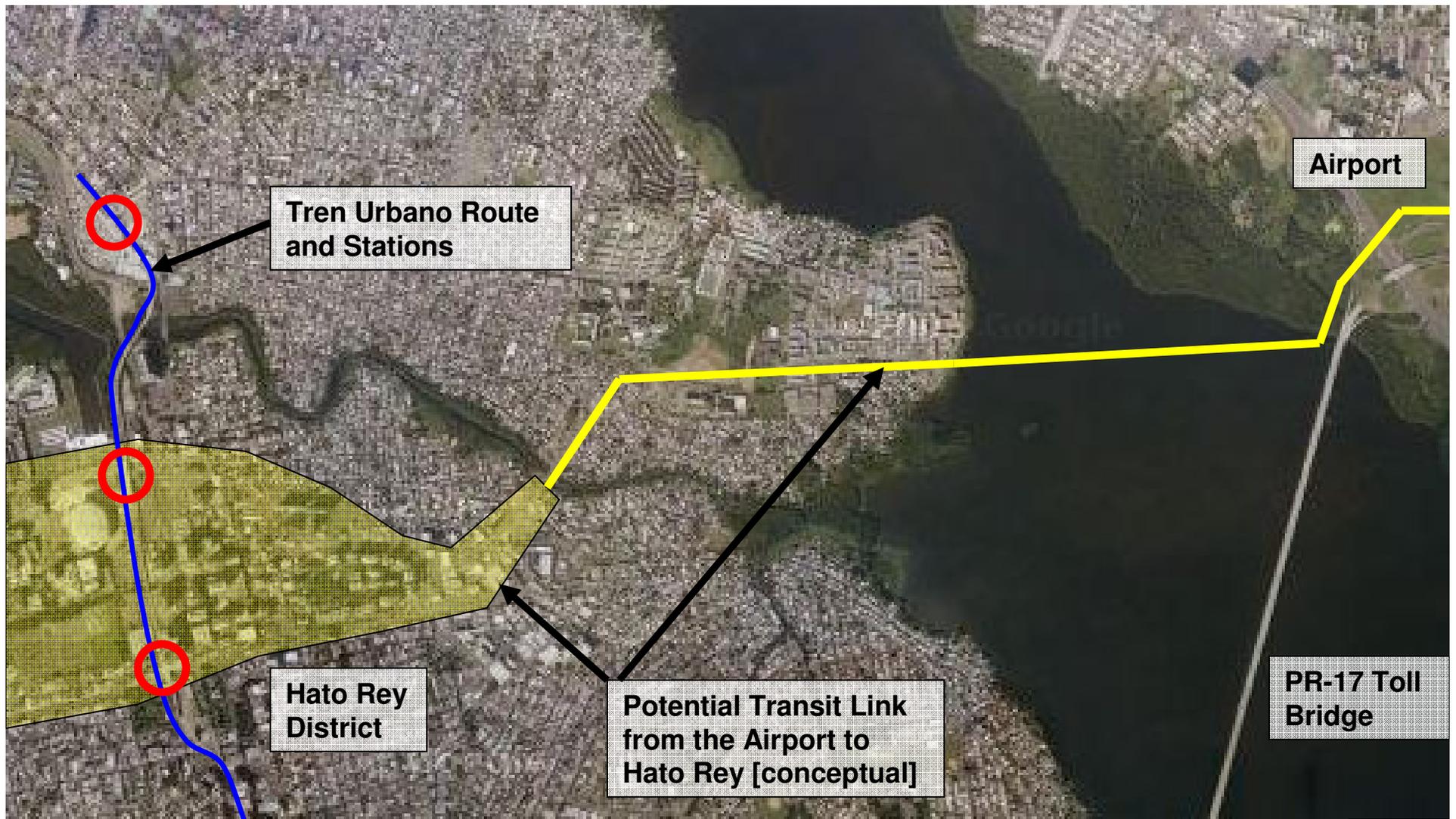
# Conceptual *Tranvía* Routings in the Airport Area



# Potential Rental Car Facility: Possible *Tranvía* Access



# Potential Transit Extension to Hato Rey



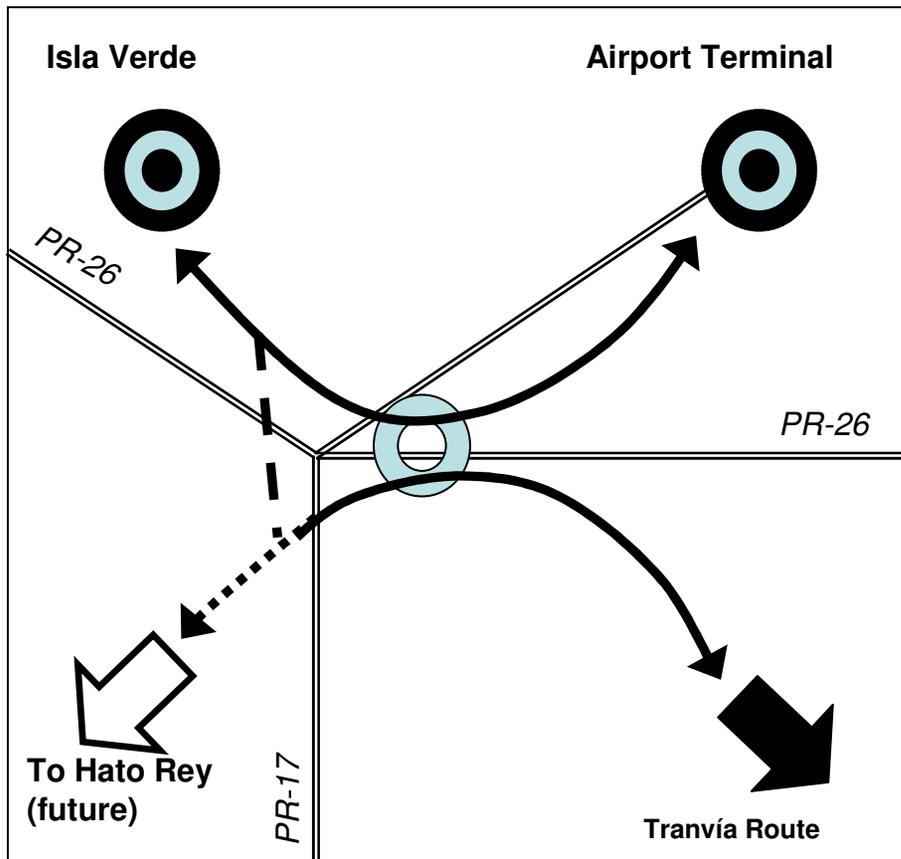
# *Tranvía* Route Options in the Airport Area

- Approach:
  - Identify potential alignment concepts
  - Consider likely priority movements
  - Minimize initial investment while preserving future flexibility and options
  - Screen options based on anticipated ridership patterns, flexibility, and relative costs
  - Identify preferred approach
  - Identify future planning activities

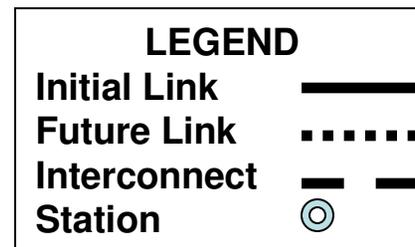
# ***Tranvía*** Routing Options in the Airport Area

# Option 1:

## Airport - Isla Verde Route / Carolina - Hato Rey Route

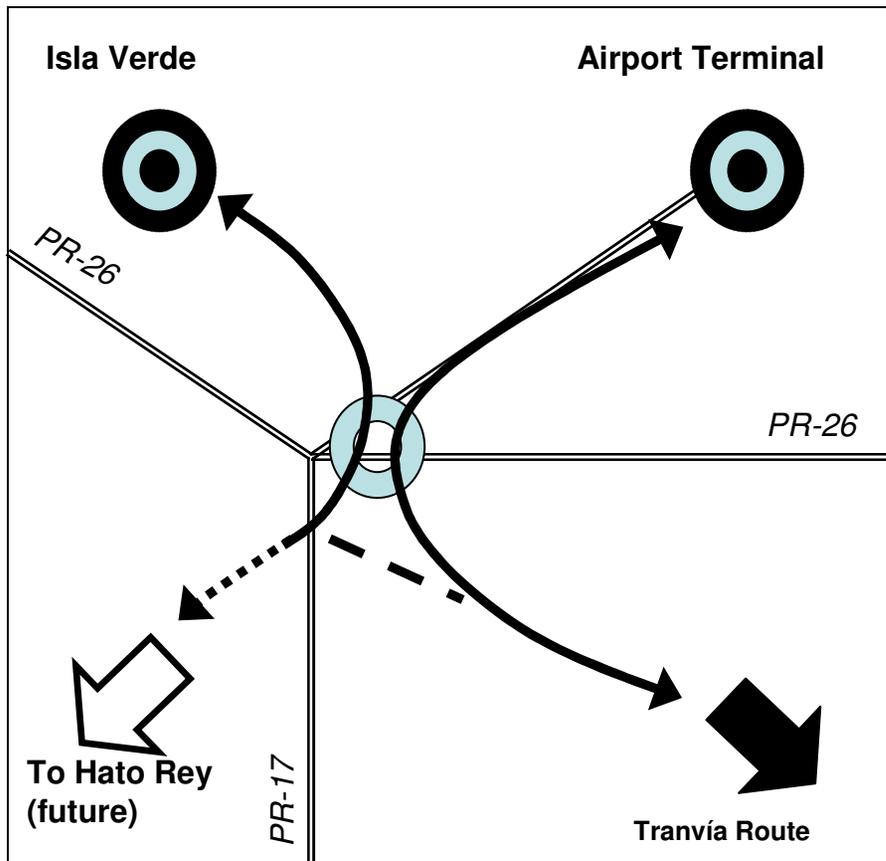


- Long-term service between two branches operating separately would need a transfer point.
- Isla Verde to Airport segment very short.
- Requires interconnect track which renders concept similar to Option 4.
- Drop Option 1 from further consideration.

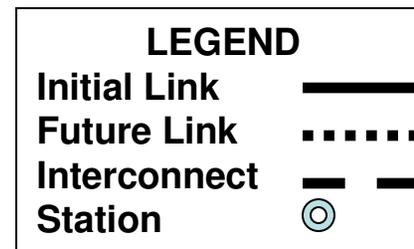


## Option 2:

### Isla Verde - Hato Rey Route / Carolina - Airport Route

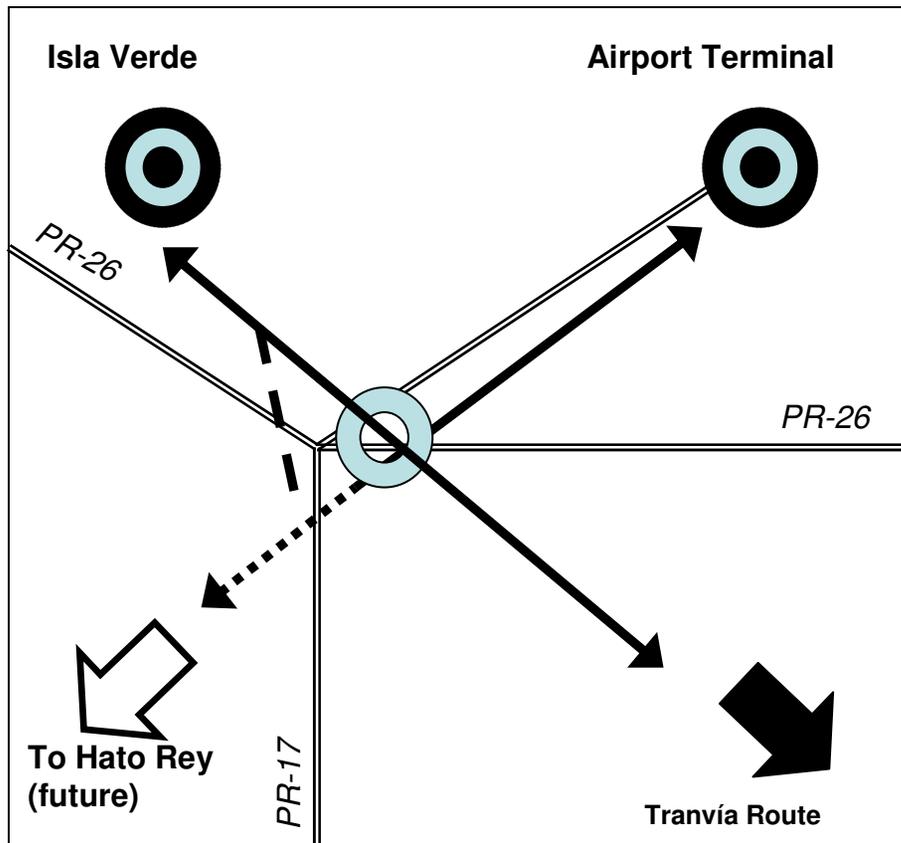


- Long-term service between two branches operating separately would need a transfer point.
- Requires interconnect track which renders concept similar to Option 4.
- Drop Option 2 from further consideration.

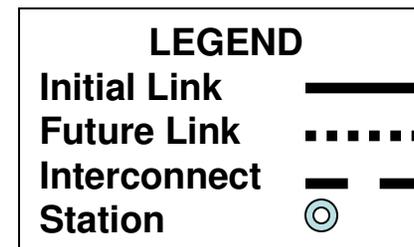


# Option 3:

## Isla Verde – Carolina Route / Hato Rey - Airport Route

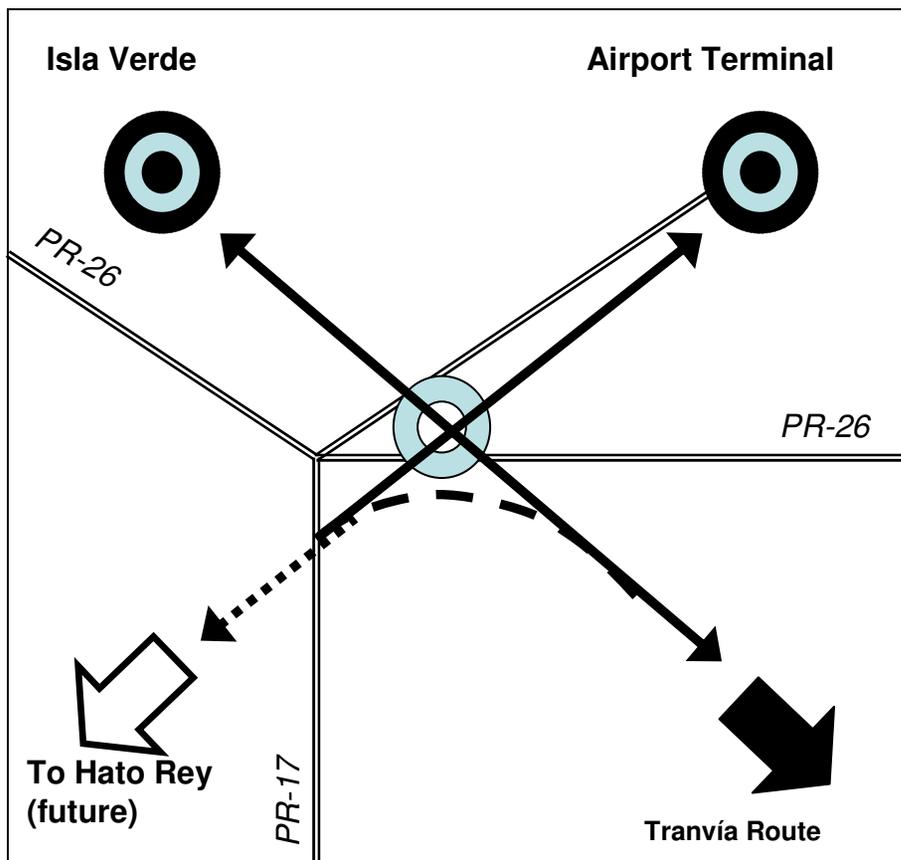


- Long-term service between two branches operating separately would need a transfer point.
- Requires interconnect track which renders concept similar to Option 4.
- Drop Option 3 from further consideration.

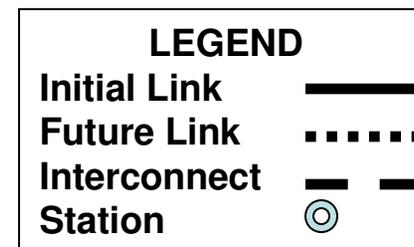


## Option 4:

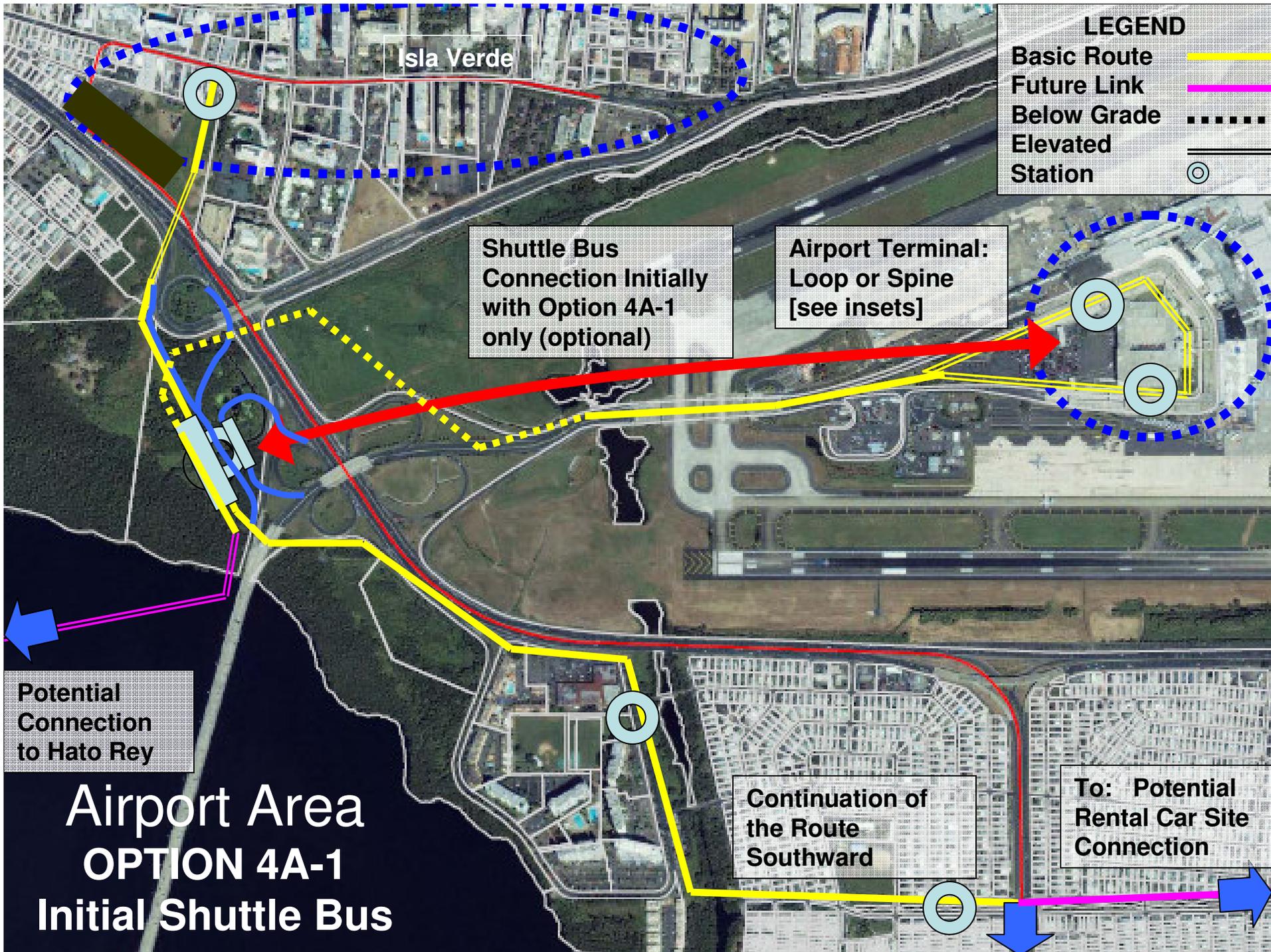
Isla Verde - Carolina Route / Hato Rey - Airport Route /  
Carolina – Hato Rey Route



- Long-term service between two branches operating separately would need a transfer point for some connections.
- Southeast-to-southwest route connection provides for interconnect track.
- Airport connection could be deferred to a later time, by operating a shuttle bus service.







**LEGEND**

Basic Route	
Future Link	
Below Grade	
Elevated	
Station	

Shuttle Bus Connection Initially with Option 4A-1 only (optional)

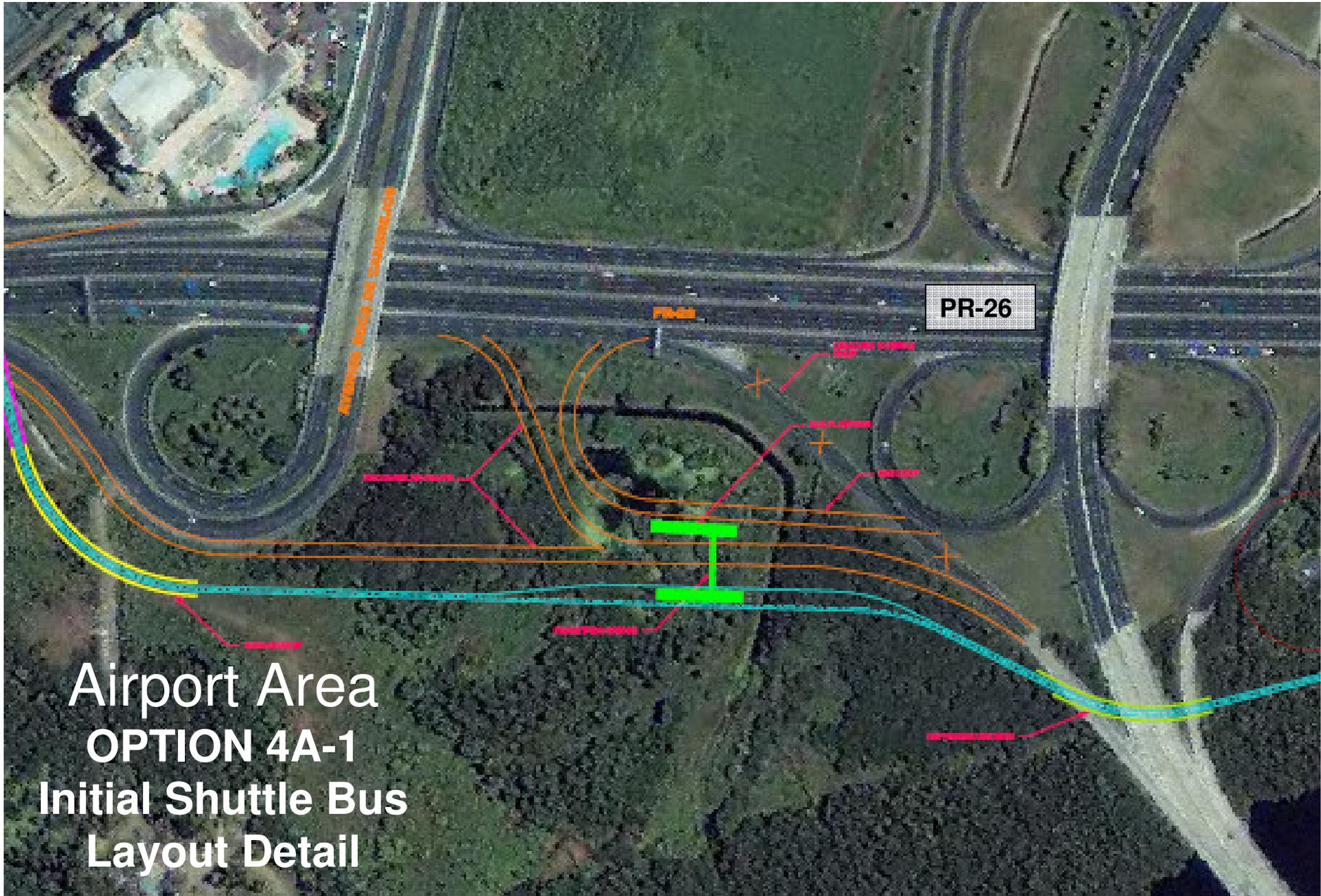
Airport Terminal: Loop or Spine [see insets]

Potential Connection to Hato Rey

**Airport Area  
OPTION 4A-1  
Initial Shuttle Bus**

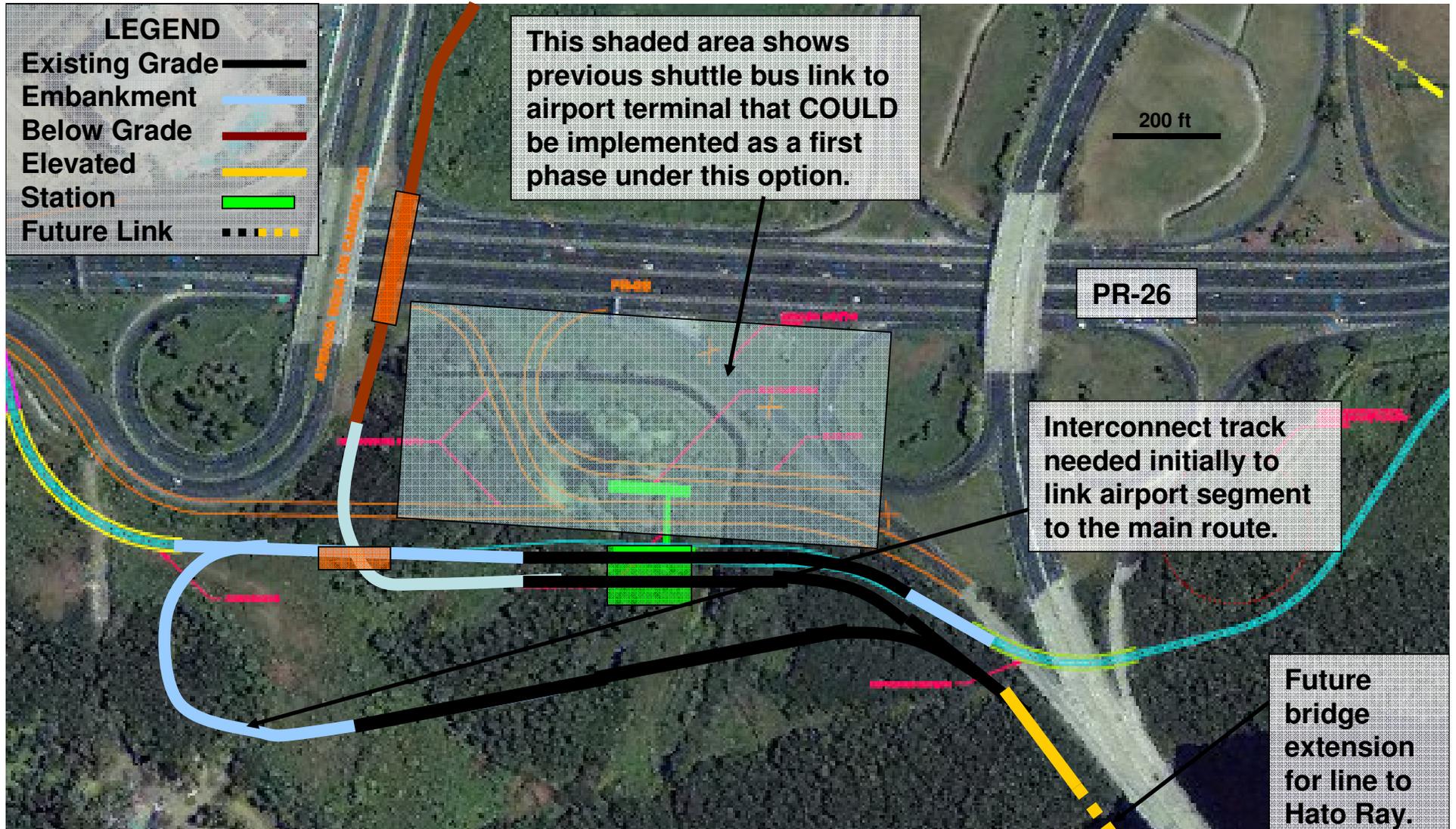
Continuation of the Route Southward

To: Potential Rental Car Site Connection



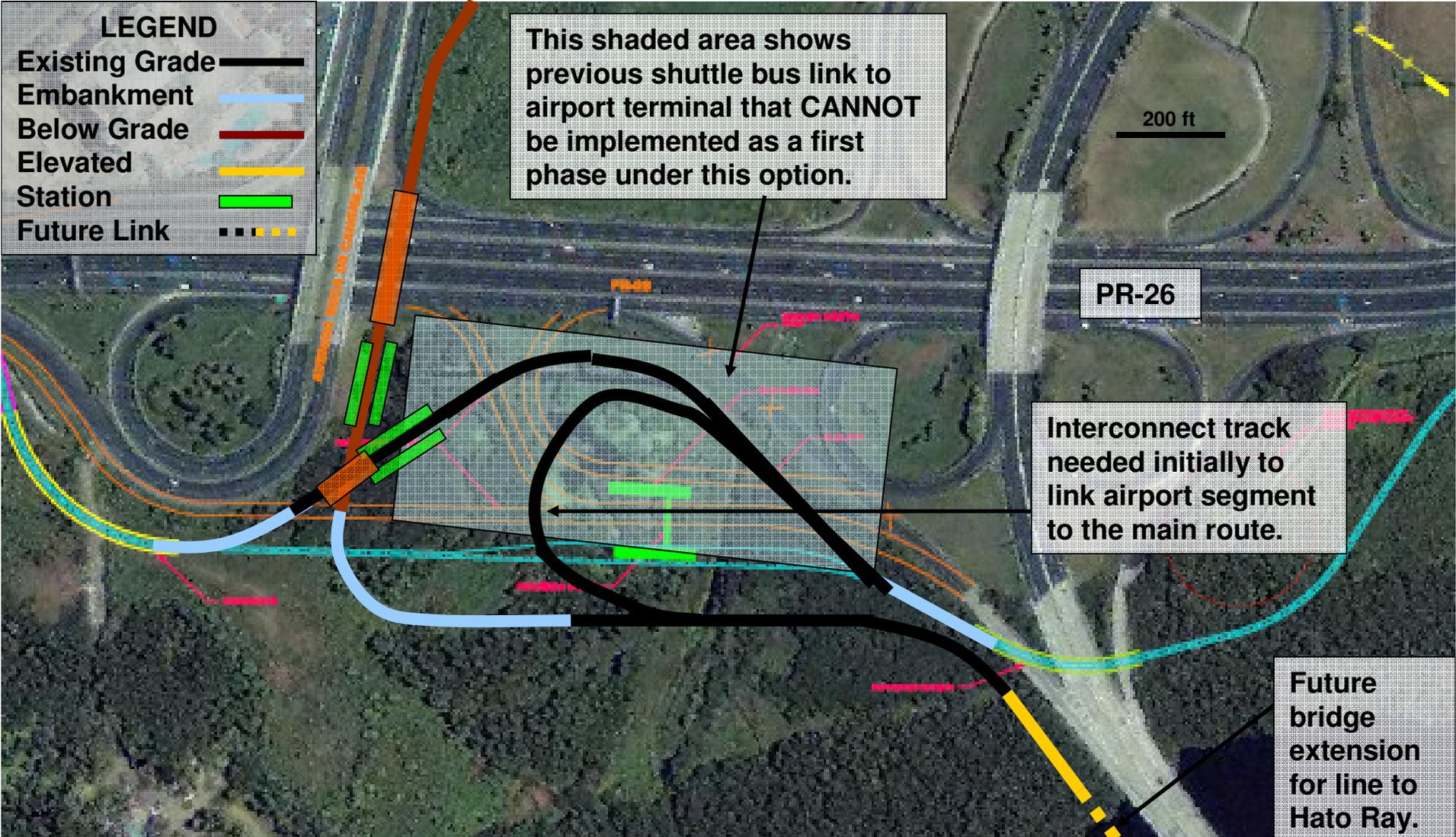
**Airport Area  
OPTION 4A-1  
Initial Shuttle Bus  
Layout Detail**

# Option 4A-1: Inset Detail





# Option 4A-3: Inset Detail







Isla Verde

**LEGEND**

- Basic Route —
- Future Link —
- Below Grade ⋯
- Elevated
- Station ○

Alternate Connection

Airport Terminal:  
Loop or Spine  
[see insets]

Potential  
Connection  
to Hato Rey

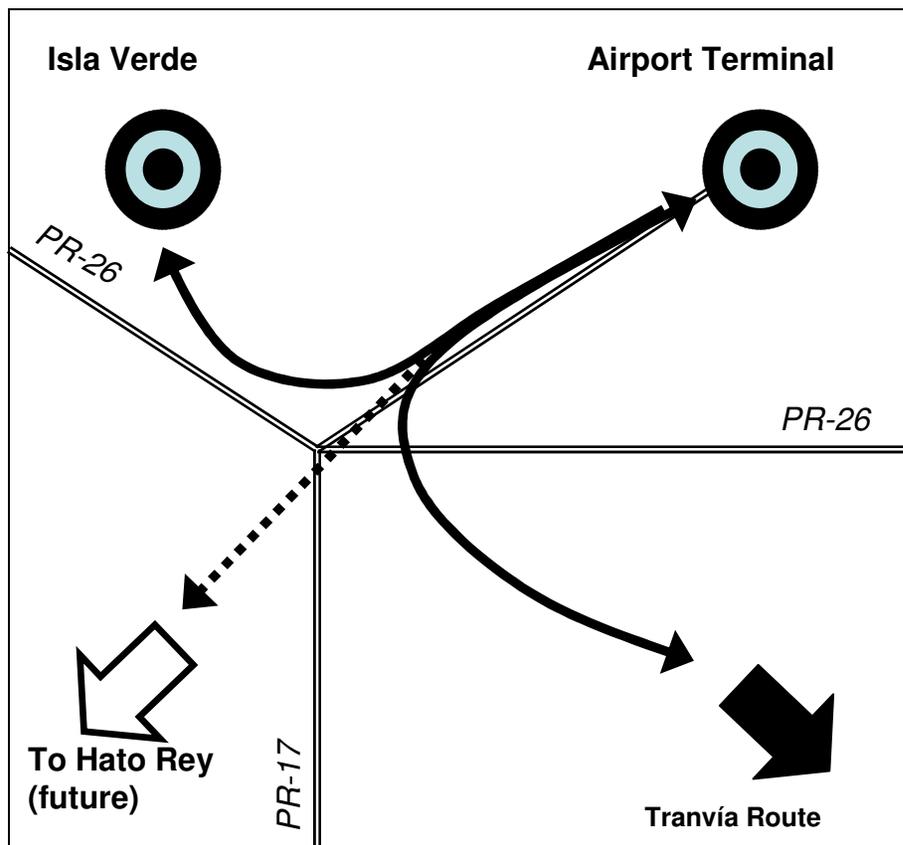
**Airport Area  
OPTION 4C**

Continuation of  
the Route  
Southward

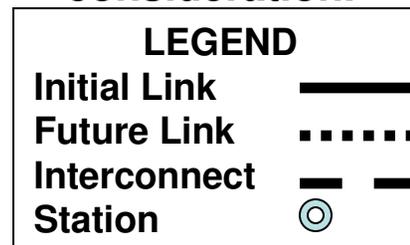
To: Potential  
Rental Car Site  
Connection

## Option 5:

Airport - Carolina Route / Airport - Isla Verde Route /  
Airport - Hato Rey Route

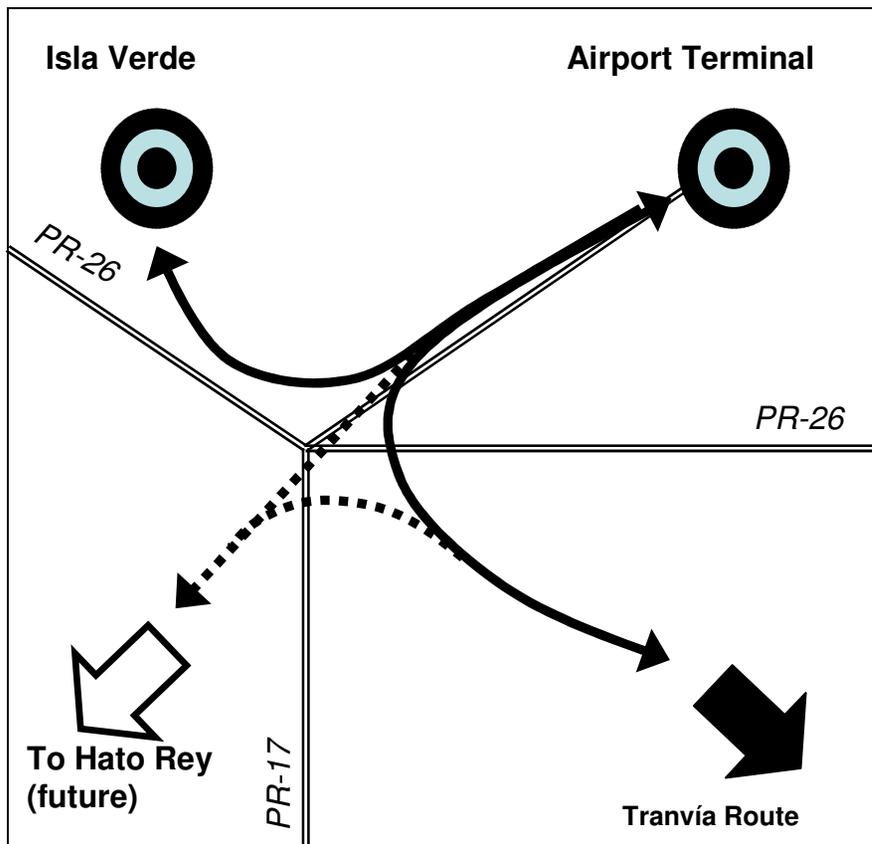


- Airport station would serve as the transfer point between routes.
- With proper configuration, the airport leg could function as a “pinched loop” with through service to Isla Verde and/or Hato Rey.
- As Option 6 is identical with an additional future connection to Hato Rey, Option 6 is better and more flexible.
- Drop Option 5 from further consideration.

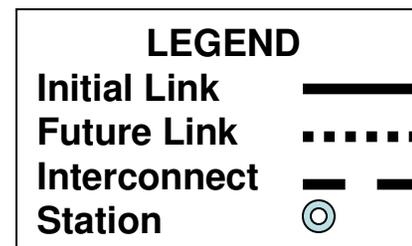


## Option 6:

Carolina - Airport Route / Airport - Isla Verde Route /  
Airport - Hato Rey Route / Carolina – Hato Rey Route /

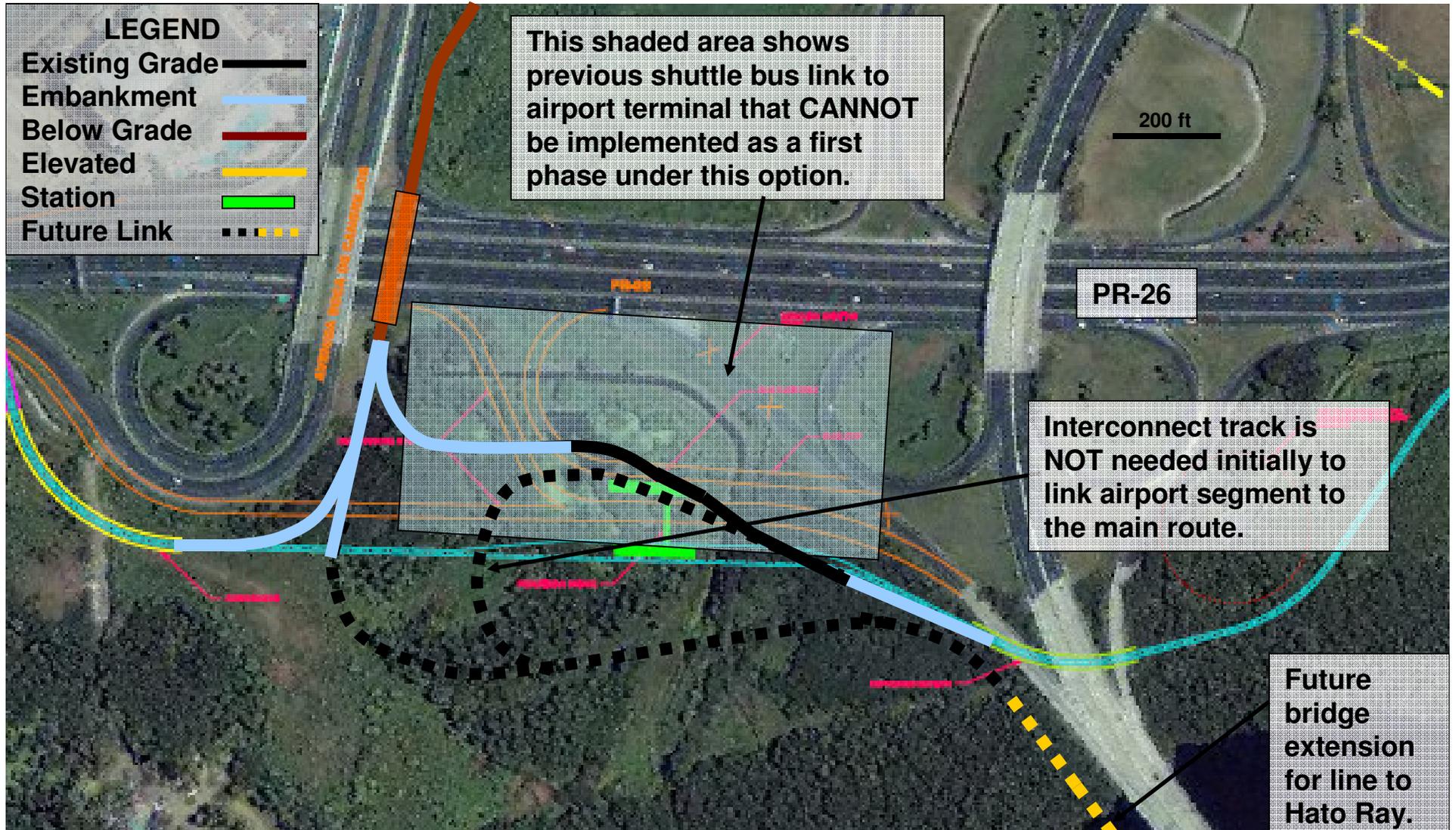


- Airport station could serve as the transfer point between routes.
- With proper configuration, the airport leg could function as a “pinched loop” with through service to Isla Verde.
- Differs from Option 5 in that direct service between Carolina and Hato Rey would be provided in the future. This would require, for example, that trains alternate between the Airport/Isla Verde branch and the Hato Rey branch.





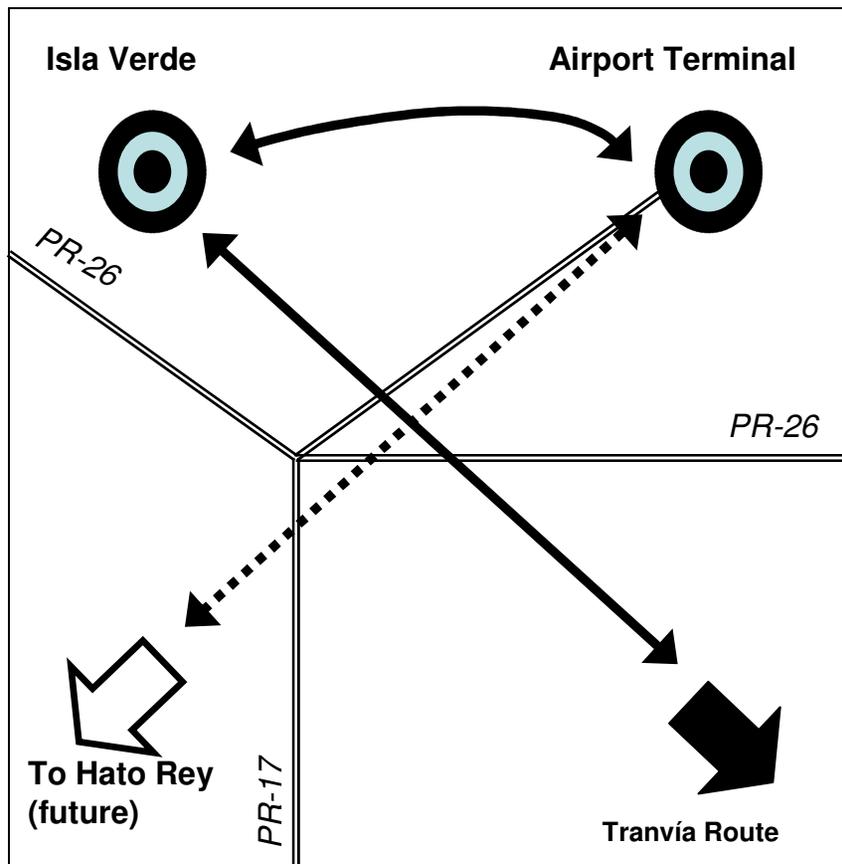
# Option 6A: Inset Detail





# Option 7:

## Carolina – Isla Verde - Airport - Hato Rey Route

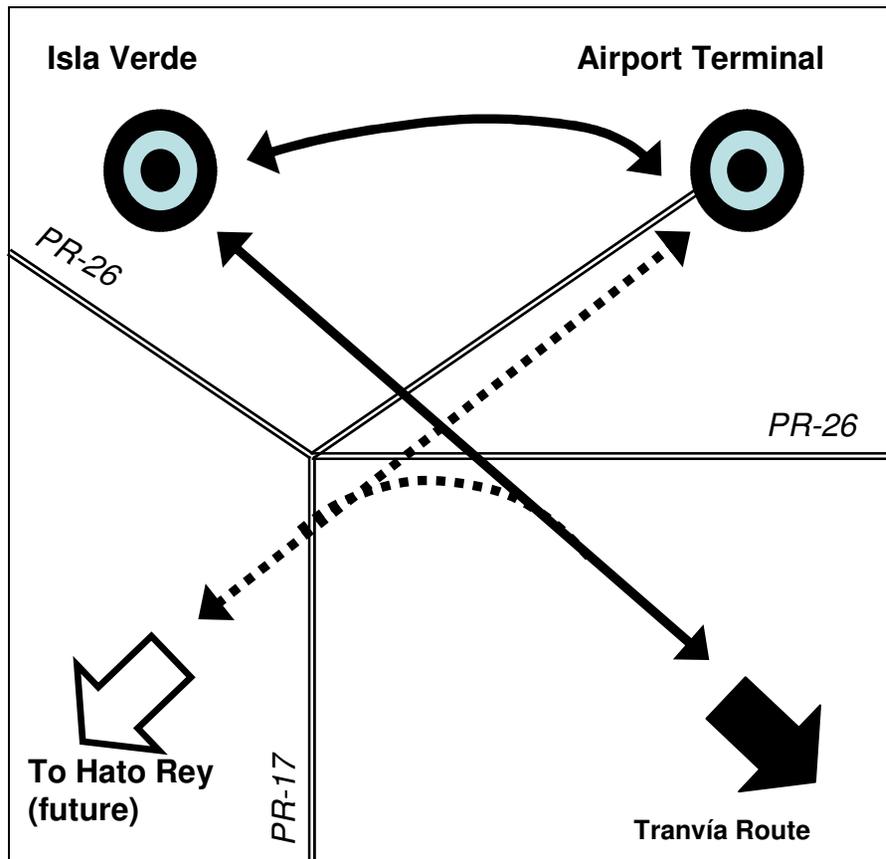


- Carolina service to the Airport is routed through Isla Verde, and is less direct.
- Routing at the Airport and Isla Verde may be a loop or a “pinched loop”.
- No direct connection between Hato Rey and Carolina, though service could be operated as a through route via Isla Verde and the Airport.
- As Option 8 is identical with an additional future connection to Hato Rey, Option 8 is better and more flexible.
- Drop Option 7 from further consideration.

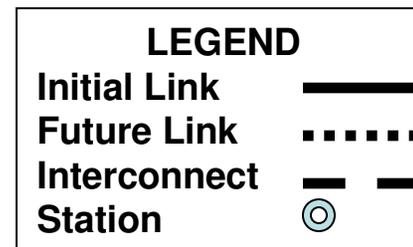
LEGEND	
Initial Link	—————
Future Link	.....
Interconnect	— — —
Station	◎

## Option 8:

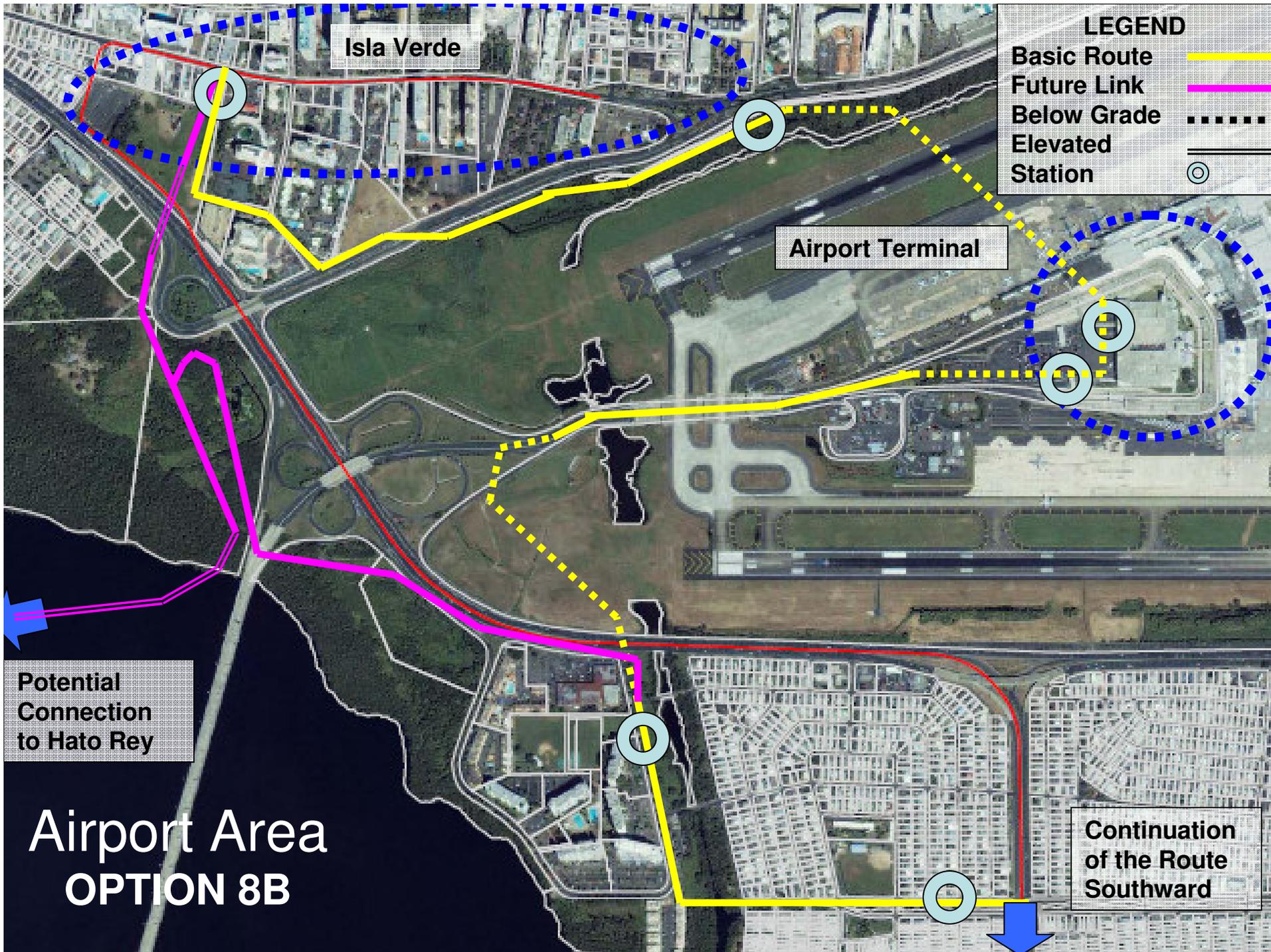
Carolina – Isla Verde - Airport - Hato Rey Route /  
Carolina – Hato Rey Route



- Similar to Option 7, except that a future interconnect track would allow for direct Carolina-Hato Rey service.
- Carolina service to the Airport is routed through Isla Verde, and is less direct.
- Differs from Option 7 in that direct service between Carolina and Hato Rey would be provided in the future. This would require, for example, that trains alternate between the Airport/Isla Verde branch and the Hato Rey branch.

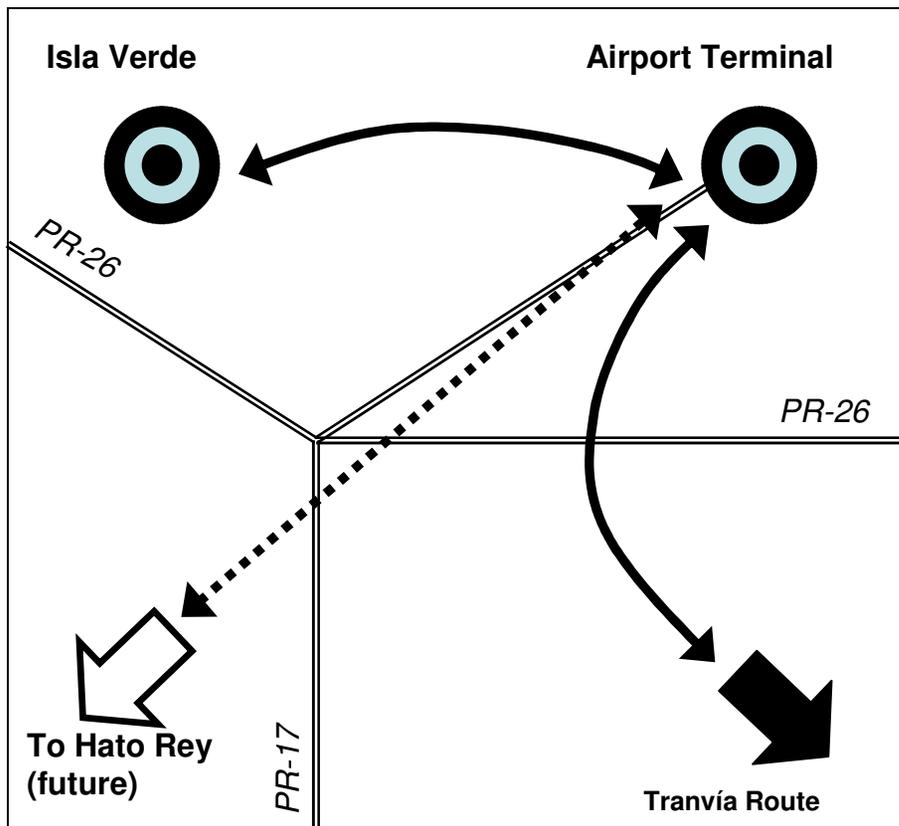




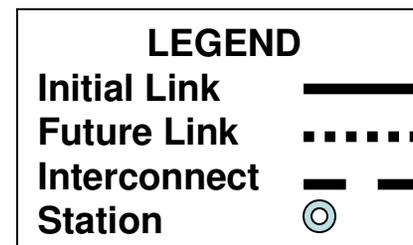


## Option 9:

Airport - Carolina Route / Airport - Isla Verde Route /  
Airport - Hato Rey Route

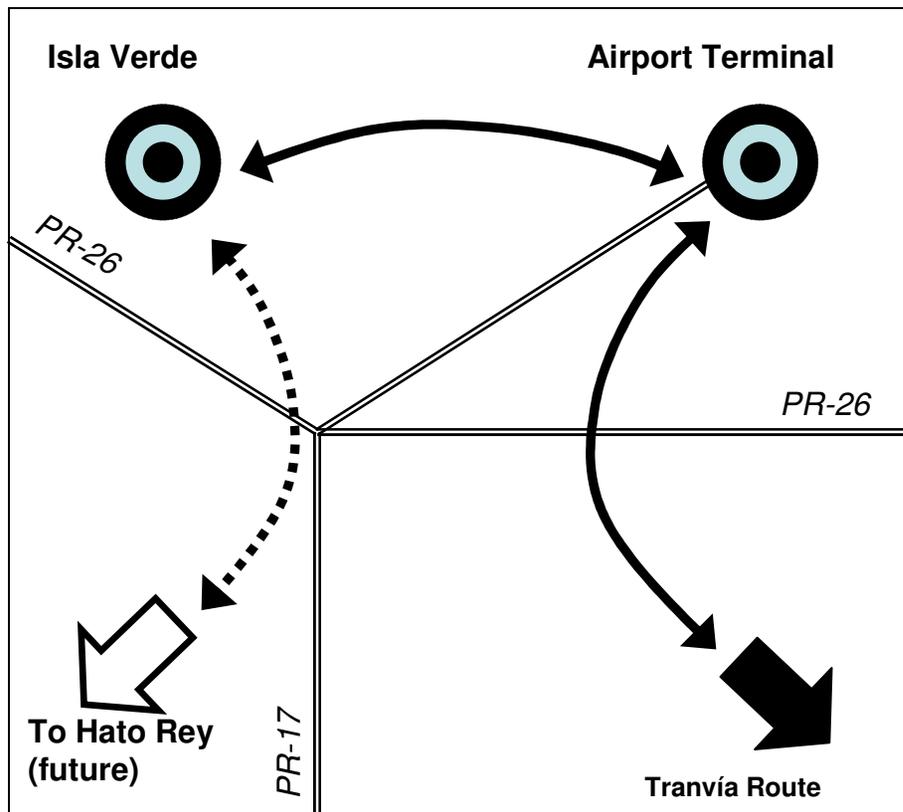


- Long term service between two branches would need a transfer point for some connections.
- Southeast-to-southwest connection provides for interconnect track.
- With proper configuration, the airport leg could function as a “pinched loop” with through service to Isla Verde and/or Hato Rey.

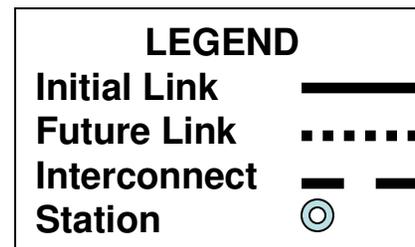




# Option 10: Carolina - Airport - Hato Rey Route



- Long term service between two branches would need a transfer point for some connections.
- As Option 11 is identical with an additional future connection to Hato Rey, Option 11 is better and more flexible.
- Drop Option 10 from further consideration.

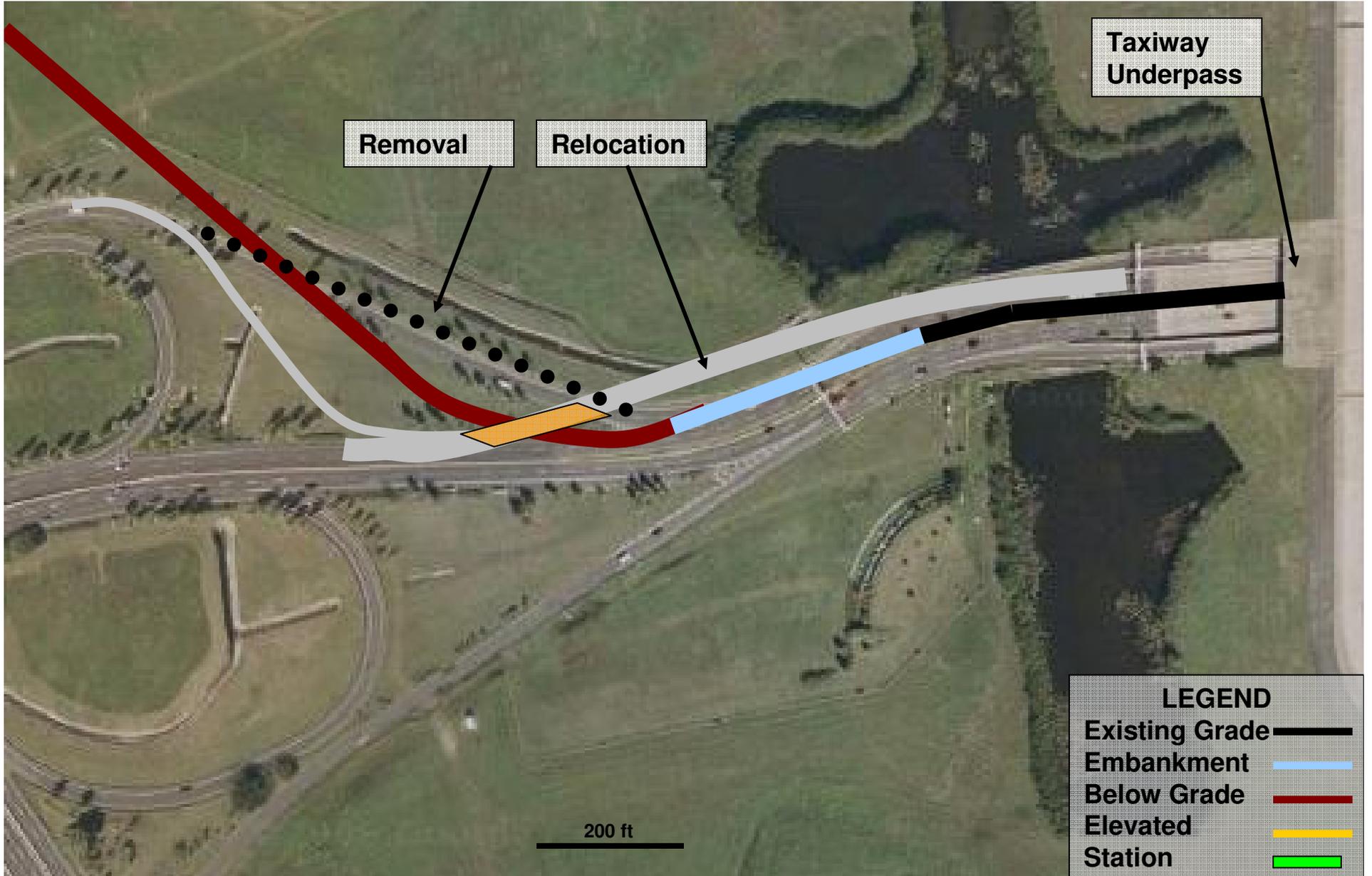






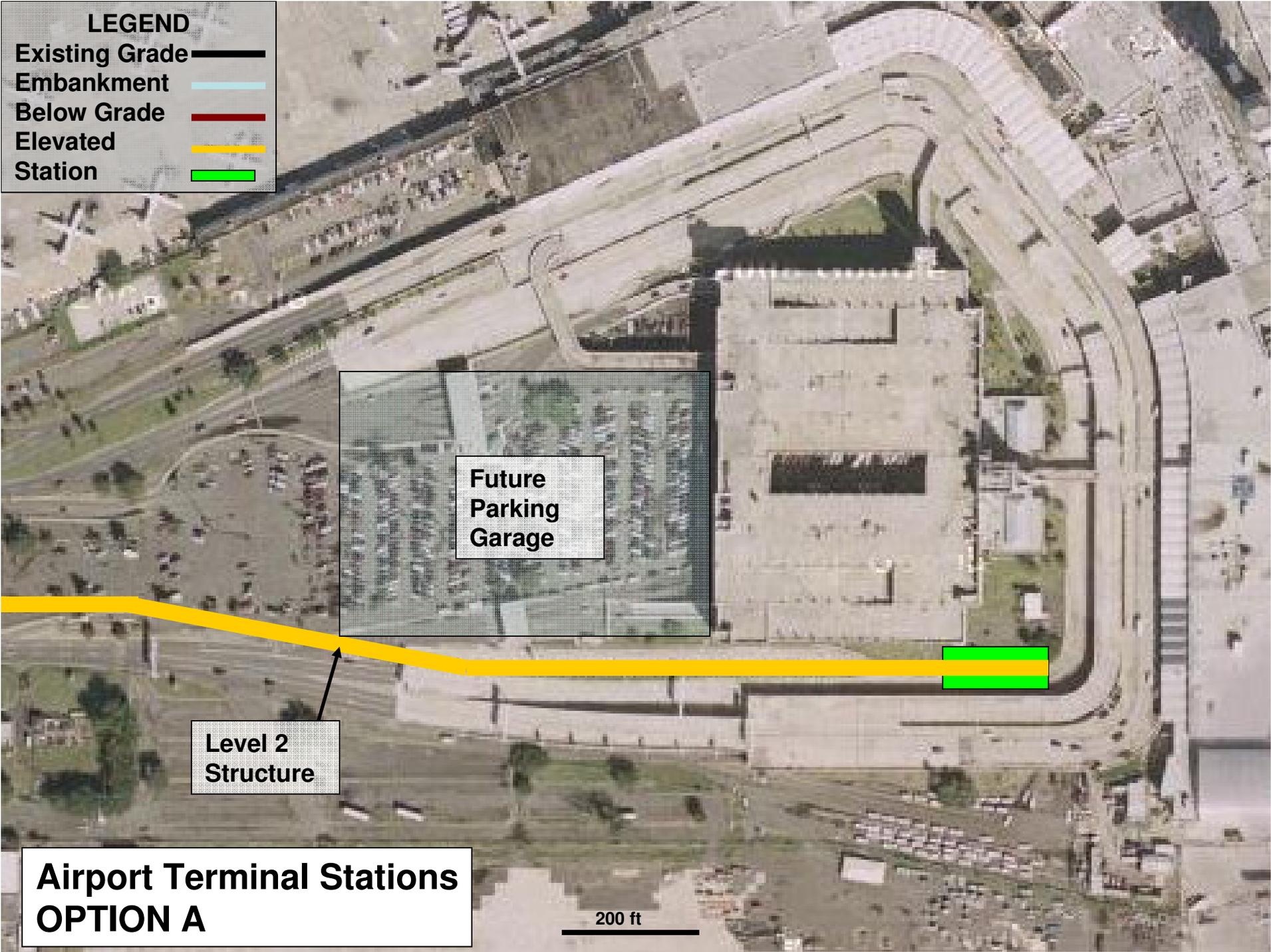


***Tranvía* Access Along  
Airport Terminal Access Road**





LEGEND	
Existing Grade	
Embankment	
Below Grade	
Elevated	
Station	

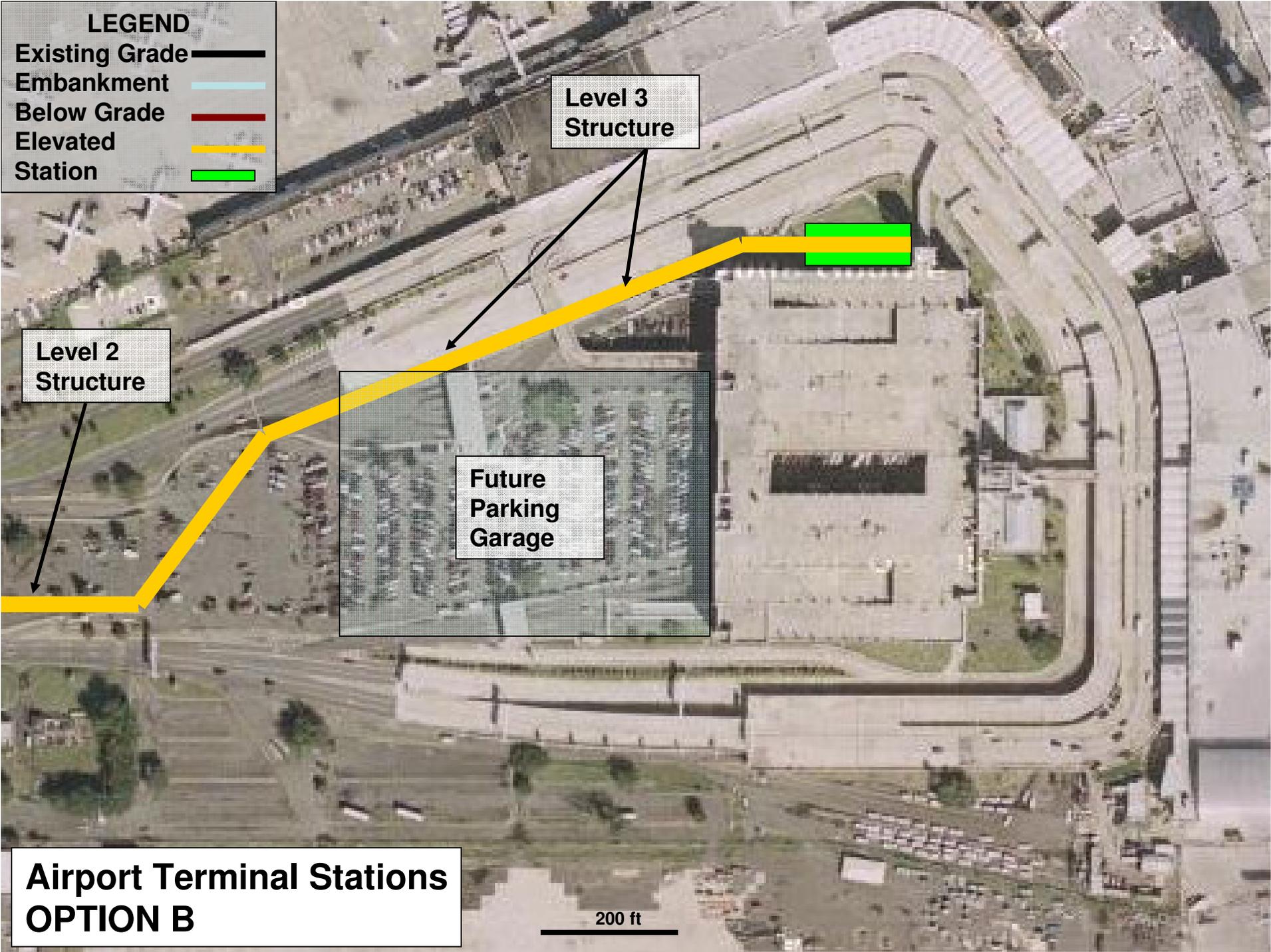


**Airport Terminal Stations  
OPTION A**

200 ft

**LEGEND**

- Existing Grade ———
- Embankment ———
- Below Grade ———
- Elevated ———
- Station ———

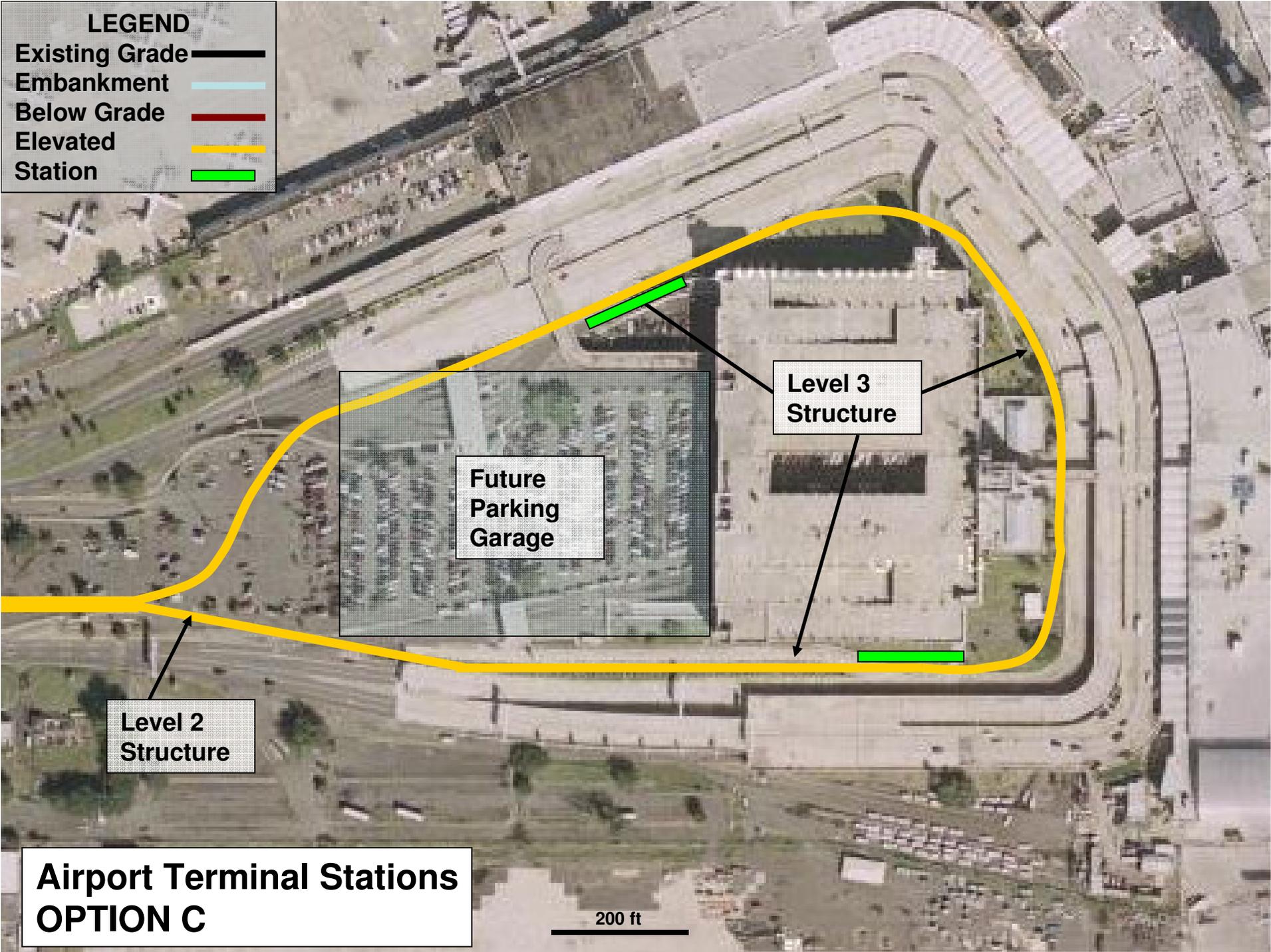


**Airport Terminal Stations  
OPTION B**

200 ft

**LEGEND**

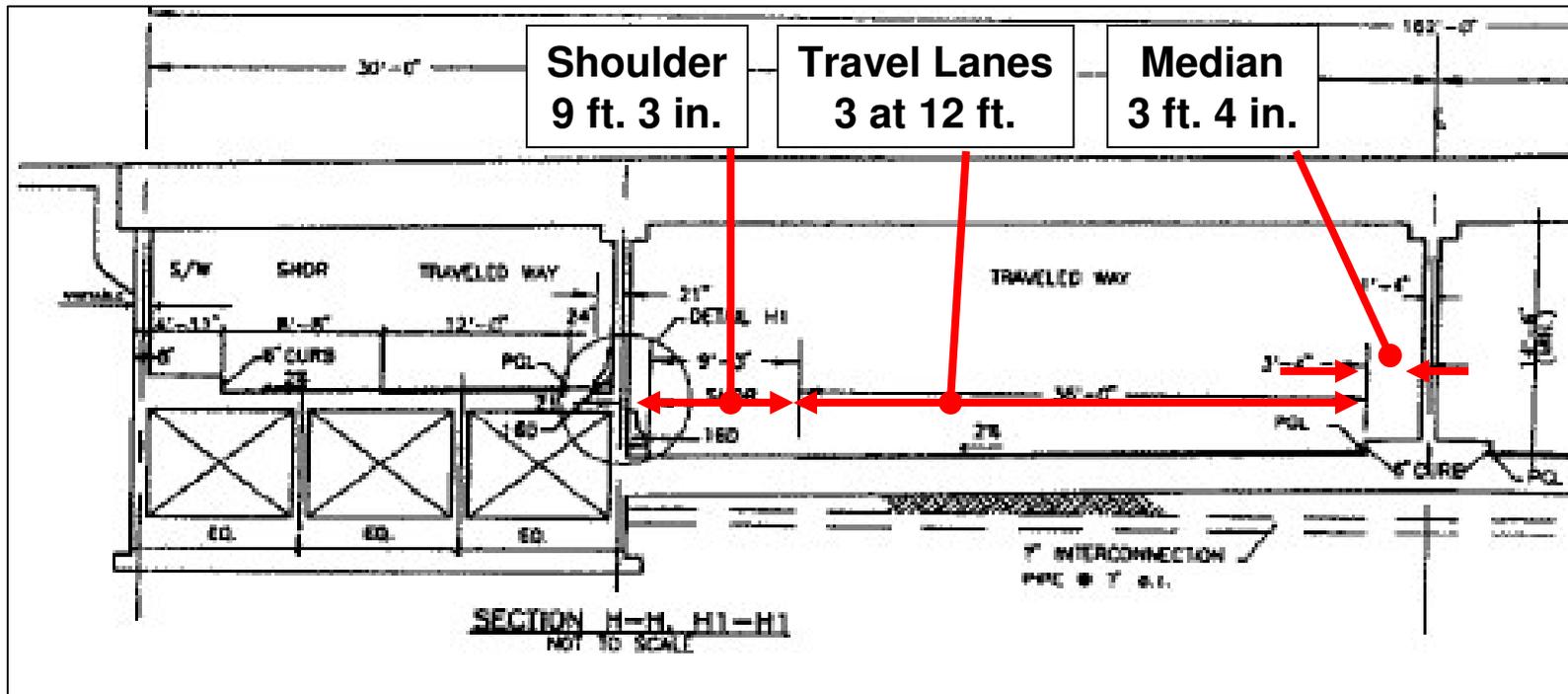
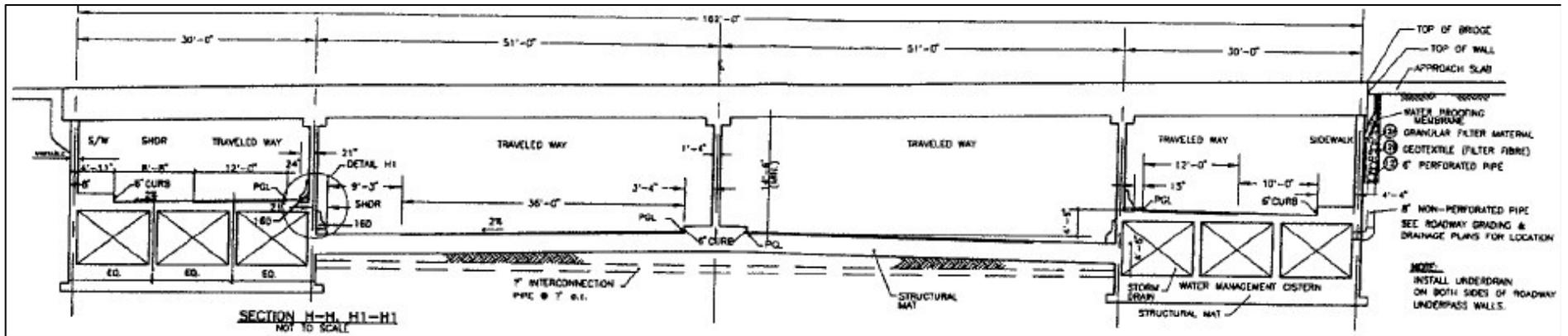
- Existing Grade 
- Embankment 
- Below Grade 
- Elevated 
- Station 



**Airport Terminal Stations  
OPTION C**

200 ft

# Airport Entrance Road at "Tunnel" Section with Tranvía - Existing



# Airport Entrance Road at "Tunnel" Section with Tranvía - Proposed

