Light-Rail Transit for Miami Beach

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Issues related to the development of a light-rail line in Miami Beach, Florida, as part of a multimodal transportation system for metropolitan Dade County are presented. The Florida Department of Transportation is conducting a study of multimodal transportation improvements in an east-west corridor through Dade County extending to Miami Beach. Service from West Dade to the corridor's terminus in Miami Beach was originally envisioned as a through service using a single transit technology, possibly a hybrid technology combining elements of both heavy-rail and light-rail systems. However, conditions in Miami Beach differ significantly from those in the rest of the corridor. From West Dade to the seaport, a high-speed, exclusive right-of-way, high-capacity service is anticipated, whereas in Miami Beach an at-grade, on-street, slower-speed operation is envisioned. Because of issues related to operations, vehicle floor height, train length, and alignment impacts, the option of using heavy rail in West Dade and light rail between downtown Miami and Miami Beach is gaining momentum. A related issue, the location and features of the transfer between light-rail transit and heavy-rail lines, directly affects the convenience and quality of service provided. The second issue is the integration of the light-rail system within existing street rights-of-way in a dense urban setting. The choice of a route within Miami Beach and the design of trackways and stations are interactive issues. Three basic alignment options are considered along with detailed arrangement of tracks and station platforms within the existing street rights-of-way.

The Florida Department of Transportation (FDOT) is conducting a study of multimodal transportation improvements in an east-west corridor through Dade County. The East-West Multimodal Corridor Study, being conducted by a project team lead by Parsons, Brinckerhoff, Quade & Douglas, is evaluating highway improvements along SR 836 in western Dade County (West Dade) and priority transit improvements from West Dade to the Miami Beach Convention Center via Miami International Airport, downtown Miami, and the Port of Miami (Figure 1). A separate but related FDOT study is examining options for a multimodal facility, the Miami Intermodal Center (MIC), to be located east of the airport terminal area. A special feature of the East-West Multimodal Corridor Study is a proposed direct rail connection for cruise ship passengers between the airport and MIC and the seaport.

Prior transportation planning in Dade County considered the possibility of an elevated transit line in Miami Beach. However, this notion was resoundingly rejected by the residents of Miami Beach for aesthetic reasons. In 1988 a feasibility study for a light-rail transit (LRT) line from the Omni area in downtown Miami to 63rd Street in Miami Beach was conducted for the city of Miami Beach (*1*). This study introduced the idea of an at-grade LRT system in Miami Beach and suggested that its only link to other priority transit in the county would be by transfer to the downtown Metromover

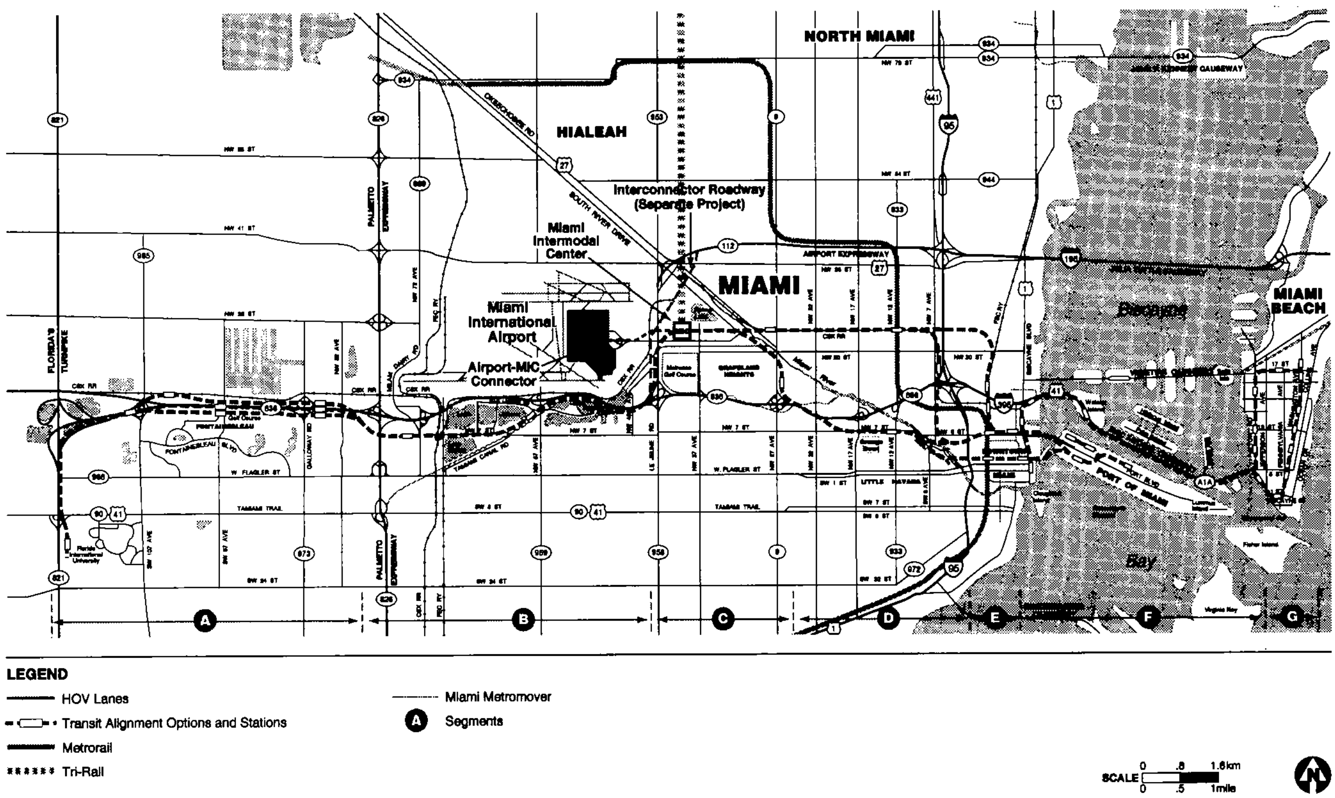

FIGURE 1 East-west multimodal corridor, Miami, Florida.

people-mover system. In 1993, the Transit Corridors Transitional Analysis, conducted for the metropolitan planning organization, continued to develop and evaluate the concept of a separate light-rail line but introduced the idea of a continuous transit line from West Dade to Miami Beach (2). The line would either be light rail or a hybrid, allowing it to operate in a heavy-rail configuration outside of Miami Beach and a light-rail configuration within Miami Beach. The notion of hybrid vehicles was introduced in that study in connection with other corridors that would be extensions of the existing Metrorail heavy-rail system to offer a one-seat ride to the central business district (CBD) without extending the heavy-rail structure.

At the beginning of the East-West Multimodal Corridor Study, service from West Dade to the corridor's terminus in Miami Beach was envisioned as a through service using a single transit technology. However, the physical and service conditions in Miami Beach differ significantly from those in the rest of the corridor. From West Dade to the seaport, a high-speed, exclusive right-of-way, high-capacity service is anticipated, whereas within Miami Beach, an at-grade, on-street, high-frequency operation is envisioned. This difference raised a number of key issues, including whether a through service would best serve the needs of the community, what characteristics a hybrid vehicle should have if chosen, and how to integrate the Miami Beach line into the rest of the transit system if it is separate from the east-west line.

A key aspect of the overall study is to provide an integrated means of travel between Miami Beach and points elsewhere in Dade County. Some of the travel markets that would be served by a connection include

- West Dade and other points on the mainland to Miami Beach destinations for recreation and entertainment,
- Miami Beach hotels and residences to Miami International Airport (including travelers and airport employees),
- Miami Beach residences to downtown and West Dade employment centers, and
- The seaport to Miami Beach hotels and entertainment.

Miami Beach: A Unique Community

Miami Beach is unique in South Florida. It presents a dense urban setting with mixed commercial, residential,

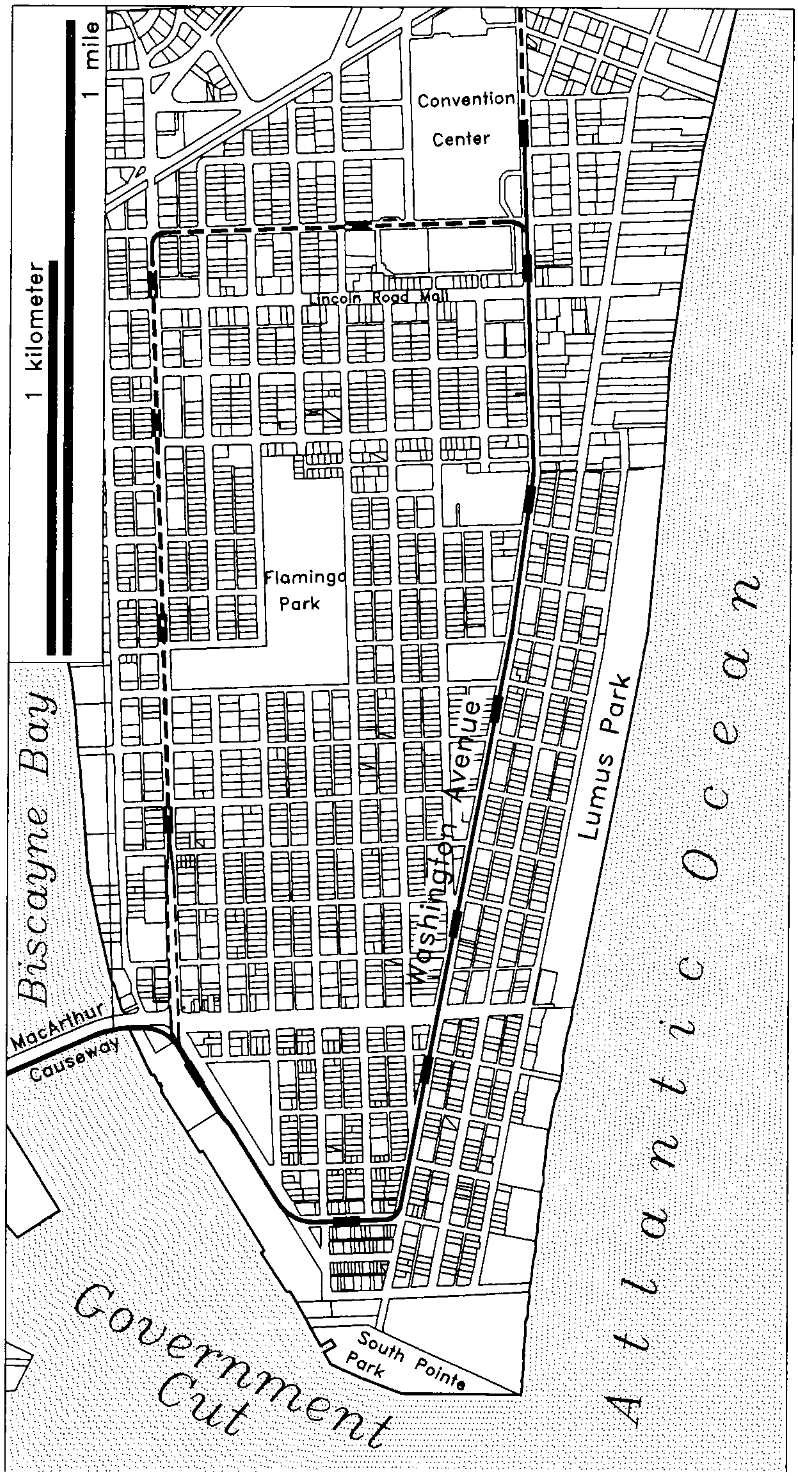

FIGURE 2 Miami Beach: South Pointe to 22nd Street.

hotel, and entertainment uses connected by lively pedestrian activity. Moreover, much of the South Beach area (SoBe) south of 20th Street is designated as the Art Deco Historic District, containing the most concentrated collection of art deco buildings in the world (Figure 2). In the Art Deco Historic District buildings are generally two to five stories tall, although taller apartments and hotels are found elsewhere in Miami Beach. Everywhere, buildings are built right up to the property lines, requiring new transit to both fit within the existing rights-of-way and coexist with the closely spaced buildings.

FIGURE 3 Streetcar on Washington Avenue in Miami Beach, 1930s (courtesy Historical Association of Southern Florida).

Miami Beach was built on a streetcar network (*3*). Streetcars were introduced in 1920 by Carl Fisher, the major developer of Miami Beach, and operated there until 1939 (Figure 3). Much of the development of Miami Beach occurred during this period and was heavily influenced by access to the streetcars. The first line ran across the County Causeway (now MacArthur Causeway) from Miami to Miami Beach where a single-track loop with passing sidings ran on Washington Avenue, Dade Boulevard, and Alton Road. Two lines later extended the system north to 45th and 50th streets. During the 1920s and 1930s, the streetcars had little automobile traffic to contend with. Indeed, few of the older art deco buildings have on-site parking, and many later buildings were built with parking that is inadequate today.

In recent years Miami Beach has seen a rebirth as an eating, entertainment, and tourist destination. Art deco buildings that have been vacant or underutilized for years are being remodeled for apartments and commercial and entertainment uses. New residential and commercial buildings are being constructed on vacant sites or sites previously used for parking, particularly in the South Pointe area below 5th Street. Ocean Drive and Washington Avenue now form one of the greatest concentrations of restaurants, bars, and nightclubs in the state. At the same time, the residential population is increasing, also shifting from an emphasis on retirees to a younger population, more of whom commute to jobs in other parts of the county. The renewed development has contributed to significant parking and traffic problems in Miami Beach, particularly in South Beach. Moreover, these problems will become even more acute as development continues.

These factors suggest a transportation mode that fits into this unique setting and provides attractive service for short trips as well as a connection to the metropolitan transit network.

Through Service or Separate Transit Lines?

Determining whether through service can or should be provided between West Dade and Miami Beach has consequences for the entire east-west transit service and is a critical element in determining the overall service provided.

The key reason to provide through service is the potential to travel between points in West Dade, particularly Miami International Airport, and points in Miami Beach without transferring. Through service also has some additional benefits. First, it would ensure a direct transfer to the existing Stage I Metrorail line, which passes by the west side of downtown Miami. Second, if all Miami Beach vehicles are compatible with the line to West Dade, through service would allow all maintenance and most vehicle storage to be provided at a site in West Dade. Locating a separate LRT storage and maintenance facility for the Miami Beach line has proved difficult because of the density and increasing viability for development of sites in Miami Beach.

Despite the strong desire to provide a one-seat ride where possible and other benefits of through service, many factors weigh against this option. Aesthetic, operational, and technical considerations suggest different solutions for the east-west line and service in Miami Beach. The key reasons for using separate systems are based on the distinct physical and operating characteristics of Miami Beach service versus the service from West Dade and the airport to the CBD and the seaport. Table 1 highlights those distinctions.

Because of the dense urban pattern and architectural character of Miami Beach, residents demand a transit system that fits into the character of the community. In particular, it cannot be elevated and therefore must be at-grade in existing street rights-of-way. Tunneling anywhere in south Florida is expensive because of the high water table. In addition, the pedestrian character and dense development of Miami Beach suggest on-street stations at relatively close spacings to be easily accessible to pedestrians. In contrast, West Dade offers a number of relatively open rights-of-way and potential for elevating the transit alignment, providing an alignment that is completely free of street crossings. Although stations can be located with joint development potential in mind, the spread-out character of Miami suggests more widely spaced stations with good car and bus access. In addition, the potential for very high volumes in the segment between the airport and the seaport suggests an alignment free of street crossings to avoid transit-traffic conflicts and to allow the possibility of automatic train control.

Since Miami Beach requires at-grade operation with electric power, power pickup must be by overhead catenary. In West Dade, although catenary could be used, the exclusive right-of-way allows the use of third rail. Third rail is less costly to install and maintain than catenary and does not present an unsightly appearance, particularly on elevated transit structures where catenary is even more visible.

Transit operating characteristics also differ significantly between West Dade and Miami Beach. In Miami Beach vehicles will never operate faster than the posted speed limits of about 35 mph (55 km/hr) and will usually operate even slower. On the MacArthur Causeway, a higher speed should be attained, but 55 mph (90 km/hr) is sufficient. In West Dade trains need to attain 55 mph on a regular basis to offer service that competes with car travel and could often attain 70 mph (110 km/hr) given the wide station spacings. Transit vehicles in Miami Beach must be able to turn within street rights-of-way, requiring a turning radius of approximately 90 ft (28 m) and short or articulated vehicles. In West Dade a minimum mainline turning radius of 1,000 ft (305 m) is provided, allowing longer, unarticulated vehicles, which are less costly per passenger to purchase and maintain. In Miami Beach train length is dictated by the length of the street blocks. The maximum length for a train in Miami Beach is 220 ft (67 m) or two 90-ft (28-m) vehicles. Train lengths are not limited by right-of-way characteristics in West Dade, and trains of four to six cars or 360 to 540 ft (110 to 165 m) are desirable for general revenue service and trains of six to eight cars or 540 to 720 ft (165 to 220 m) are desirable for airport-seaport service. Finally, operation in Miami Beach must be manual because of the on-street operation and heavy pedestrian movement. In West Dade manual or automatic operation is possible, with potential operating cost savings from an automated system, especially when close headways are offered between the airport and the seaport.

The height of vehicle floors and station platforms has also played a surprisingly important role in consideration of technology. Either low floors and platforms or high floors and platforms could be used in either area, but operational demands and aesthetic concerns suggest different solutions in Miami Beach and West Dade. High miniplatforms, or high-blocks, which give persons with disabilities access to only one door per train were rejected for Miami Beach because they do not fully comply with the Americans with Disabilities Act (ADA) and would obstruct needed circulation areas.

In Miami Beach, where station platforms will be an integral part of the streets and minimal visual intrusion is desirable, low platforms are suggested. As discussed later, stations on the sides or in the center of streets have been considered. High platforms would be unacceptable along the side of a street in Miami Beach because of visual obstruction and relatively poor access. Either high or low platforms could be used in the center of a street, but low platforms are less visually obtrusive and allow pedestrians to cross tracks and roadway when safe and feasible. A low-platform configuration is also suitable for the downtown Miami end of the Miami Beach line where stations would be in the median of Biscayne Boulevard.

TABLE 1 Key Distinctions Between West Dade and Miami Beach Transit Service

ISSUE	WEST DADE TO CBD / SEAPORT	MIAMI BEACH
Right-of-Way	All Grade-Separated, Primarily Elevated	At-grade, on-street operation
Power Pickup	Third Rail or Catenary (Third rail preferred for aesthetics and cost.)	Catenary only
Maximum Vehicle Speed	90 to 110 kph	40 to 55 kph in MB 90 kph on Causeway
Min. Turning Radius	305 m recommended	20 m required
Train Length	4 to 6 cars (110 to 165 m)	1 to 2 articulated cars (28 to 56 m) (absolute maximum is 67 m due to block lengths)
Operation	Automated or manual	Manual only
Station Platforms	High platforms recommended due to aesthetics and function	Low platforms recommended due to aesthetics and function
Vehicle Floor Height	High floor recommended	Low floor recommended
Peak Travel Times	AM & PM peaks, Airport-Seaport: 4-day morning and afternoon	AM and PM peaks, Weekends & all night
Potential Fare Policy (+/-)	$1.25 flat fare (medium to long trips)	$0.25-$0.50 (short trips) $1.25 (to CBD / beyond)
Fare Collection	Control area with turnstiles	Proof-of-payment system, no control area, ticket machines on platform

1 m = 3.28 ft. 1 kph = 0.62 mph

In West Dade and particularly between the airport, downtown, and the seaport, a higher-speed operation on exclusive right-of-way is envisioned. In particular, the efficient operation of the special airport-seaport service is critical. High-platform stations best serve to keep trackways clear of pedestrians and are critical where third rail power pickup is used. Although barriers between tracks could prevent crossing between platforms where low platforms are used, they are not as effective at keeping people off trackways as a high platform. In addition, high-floor vehicles with standard trucks are better proven to provide reliable service at the higher speeds that are possible between West Dade and the seaport.

Another aspect in which anticipated transit service differs between Miami Beach and the remainder of Miami is service pattern. In West Dade a typical pattern providing service between approximately 5:30 a. m. and 1:00 a. m. 7 days a week with frequent service in the morning and evening peak periods is anticipated. In Miami Beach, however, 24-hr service is anticipated for weekends and possibly 7 days a week to serve the late night entertainment and tourists there. Moreover, it may prove desirable to operate services at different headways in Miami Beach than in West Dade during regular service hours. Although short turn service could be operated on portions of a continuous line, this difference in operating patterns supports the notion of separate lines.

Finally, although free transfers would be provided between an east-west line and a Miami Beach line, distinct fare collection methods and fare policies may be desirable in the two areas. In West Dade paid fare control areas with turnstiles like the existing Metrorail line are anticipated. In Miami Beach, because of on-street integration of stations, a proof-of-payment system is desirable. Also in West Dade, a flat fare system equal to the existing Metrorail fare is anticipated. In Miami Beach, where it is particularly desirable to attract shorter trips, a two-tiered fare may be desirable with a low fare for travel entirely within Miami Beach and a higher fare for trips from Miami Beach to downtown or points beyond.

Given the differences between the transit needs of West Dade and Miami Beach and the requirement that transit in Miami Beach be light rail to operate on streets, the only options available are a through service that is entirely light rail, a through service that is a hybrid of light rail and either heavy rail or an automated guideway transit (AGT) technology, or separate lines. A through service that is entirely light rail would not respond well to the requirements or opportunities in the West Dade to seaport portion of the corridor.

A hybrid technology, with vehicles that can operate from either overhead or third rail power, is an attractive concept. However, the relevant issues go beyond the power pickup method in this case. First, hybrid vehicles would have to have high floors to be compatible with a third rail power pickup and to offer the high-speed operation potential in West Dade, forcing all stations to have high platforms, including those in Miami Beach. Second, all vehicles must be the same width, whereas wider vehicles are desirable in West Dade and narrower vehicles in Miami Beach. Third, given the MacArthur Causeway alignment and an elevated east-west line in downtown, the junction between the two lines requires obtrusive transition tracks that climb from grade level to the high elevated line within downtown Miami and extensive additional right-of-way there. Fourth, hybrid vehicles must negotiate the tight curves required in Miami Beach and therefore must be either short or articulated. Finally, the cost to purchase and maintain hybrid vehicles is expected to be greater than that for either heavy-rail or light-rail vehicles since the hybrid vehicles would require all the capabilities of both systems.

Despite the desire to offer a one-seat ride, the option of using heavy rail or a similar technology for the east-west line from West Dade to the seaport and light rail for a line from downtown Miami to Miami Beach is gaining momentum.

Integration of Miami Beach Line into Transit System

If separate transit lines are chosen for service between West Dade and the seaport and for connecting to Miami Beach, the location and character of the transfer station become important elements in providing an attractive and integrated transit system.

The potential locations for a transfer point between an east-west line and a Miami Beach line depend partly on the alignment chosen to connect Miami Beach to downtown Miami. Two basic routes were studied in the East-West Multimodal Corridor Study: along the MacArthur Causeway or through a tunnel under Government Cut and the Port of Miami. Within these two basic alternatives a number of options were also considered. In any case, in order to provide the special through service from the airport to the seaport, the east-west line would extend to the seaport on Dodge Island.

These alignments provided three primary sites for transfer between the two lines:

- South Pointe, Miami Beach (on First Street),
- The seaport (on Dodge Island), and
- Downtown Miami (in the vicinity of Freedom Tower).

If the transfer point were at South Pointe in Miami Beach, passengers from the Miami Beach light-rail line would have to transfer once to reach downtown Miami. However, passengers from the South Pointe area, which is becoming one of the most densely developed areas in Miami Beach, would not have to transfer to reach downtown Miami or points in West Dade, including the airport. Likewise, passengers from bus routes serving the west side of Miami Beach along Alton Road would only have to transfer once at South Pointe to reach destinations in downtown or West Dade. This option corresponds primarily to the Government Cut tunnel alignment.

If the transfer point were at the seaport, all passengers from Miami Beach would have to transfer once to reach the Miami CBD or points in West Dade, including the airport. Passengers from the South Pointe area would also have to transfer once, whereas passengers from bus routes serving the west side of Miami Beach along Alton Road would have to transfer twice. Moreover, the transfer point in this case would not be a significant destination for many of the daily passengers nor a site for potential development. This option occurs only with the Government Cut alignment.

If the Miami Beach line continues on the MacArthur Causeway to downtown Miami with a transfer on Biscayne Boulevard at Freedom Tower, passengers from Miami Beach would not have to transfer to reach the Miami CBD but would have to transfer once to points in West Dade. Passengers from bus routes serving the west side of Miami Beach along Alton Road and the South Pointe area would have to transfer once to reach downtown and twice to reach the airport and West Dade. Extending the

Miami Beach line a bit further south gives Miami Beach passengers direct access to the inner loop of the Metromover system and puts the heart of downtown Miami within walking distance of the line. If the Miami Beach line ends on Biscayne Boulevard, a second transfer would be required to reach the existing Metrorail line on the west side of downtown, but a proposal to continue the line west on Flagler Street or another route would provide a direct transfer between those lines as well.

Despite the operational advantages of a Government Cut route and issues related to a line along the MacArthur Causeway, the cost of the tunnel and impacts for the Port of Miami during construction were deemed too great, and the MacArthur Causeway alignment was chosen, resulting in a downtown transfer because of difficulties in extending the heavy-rail line across the MacArthur Causeway and building a junction downtown.

Alignment and Design Alternatives

The choice of a route and the specific design of trackways and stations are interrelated issues in Miami Beach. Given the limited width of the avenues, proximity of architecturally historic buildings, and existing traffic problems, the arrangement of tracks, traffic lanes, parking, and stations is a critical issue.

Miami Beach Transit Alignment

Three basic alignment options were considered within Miami Beach: two tracks on Washington Avenue, a one-way couplet on Washington and Collins avenues, and a loop around the South Beach area, operating either in one direction or bidirectionally on Washington Avenue, 17th Street, Alton Road, and First Street.

The one-way couplet concept in which both transit and traffic would operate northbound on Collins Avenue and southbound on Washington Avenue was introduced as a means to reduce the impact of the transit line on traffic flow through Miami Beach and to divide the physical impacts of the rail line between two streets. However, Collins Avenue is narrower, contains more residences and hotels, and is lined by more art deco structures than Washington Avenue. Furthermore, community opinion indicated that these avenues should not be one way and that all parking on one side of each street should not be lost as would be required in that plan. Therefore, Collins Avenue was excluded from further consideration.

The notion of a transit loop in South Beach operating on Washington Avenue, 17th Street, and Alton Road was introduced in the study in response to comments by local Miami Beach residents and representatives. It was suggested that a loop would provide improved service to both the east side of South Beach, which is dominated by commercial and hotel uses, and the west side, which is dominated by high-rise apartment buildings. Some suggested a single track, one-way loop to minimize costs and impacts to streets. For some the idea of a loop seemed inherently good beyond any particular benefits it might present.

On further consideration, the hoped-for benefits of the loop proved more illusory. The single-track loop results in excessive travel times for many of the short trips within Miami Beach that the line is hoped to attract. Since the travel time around the loop is approximately 15 min and travel with a single-track loop would be only in one direction, a person wishing to travel a short distance against the direction of travel would have to travel the long way around the loop. This would be particularly onerous for travel from the Miami Beach Convention Center to points along Washington Avenue, a key travel orientation.

In addition, the majority of trips from the west side of South Beach are unlikely to be oriented directly to the east side of South Beach, except on weekends. Travel to employment areas elsewhere in Dade County is more likely to dominate daily travel patterns in this area. Moreover, for many trips from the Alton Road area to points along Washington Avenue, the loop would not offer a significant advantage over walking because of the circuitousness of the trip. Ridership forecasting supported these patterns and suggested that the loop offers little benefit over existing bus service on Alton Road, connecting with a rail line to downtown Miami at 4th Street and with significant costs and street impacts.

Key information comparing the Washington Avenue alternative with the bidirectional loop alternative is as follows (MB = Miami Beach, O&M = operation and maintenance, system = all future bus, Metrorail, and LRT service in the county):

	Washington Avenue	*Miami Beach Loop*
Capital cost (MB only) ($ millions)	59.3	97.6
Annual O&M cost for MB LRT ($ millions)	8.2	10.6
Net annual O&M cost (system) ($ millions)	271.3	273.0
Passenger boardings on MB LRT (millions)	8.1	8.3
Daily transit person trips (system)	368,500	368,100

The loop option adds significantly to the capital and operating costs of the Miami Beach line while drawing a disproportionate part of its ridership from competing bus services. By serving the primary commercial, entertainment, convention center, and hotel areas, as well as a significant portion of the residential population, the Washington Avenue alignment focuses on the area with the greatest potential to attract transit riders and to support appropriate redevelopment in Miami Beach.

The design of the transit line on Washington Avenue is fully compatible with later development of a loop, a northern extension, or both. Since construction of the Washington Avenue alternative does not preclude completion of the loop, both options were retained for further consideration. However, on the basis of the information presented, it was recommended that only the Washington Avenue alignment be pursued at this time. Extensions to that line, either to complete a loop on 17th Street and Alton Road or to continue farther north on Collins Avenue and Indian Creek Drive, can be investigated in the future.

Configuration of Tracks and Stations on Washington Avenue

Detailed design studies were conducted to determine how best to fit tracks and stations on each of the streets and avenues considered while improving pedestrian circulation and accommodating vehicular traffic and parking. In all cases, in order to provide a high-quality, competitive transit service, it was deemed critical that the rail transit line have an exclusive right-of-way, free of traffic except that crossing at intersections. No sharing of lanes for left turns would be allowed since this would significantly impair the movement of transit vehicles. It is assumed, however, that the guideway would be paved and have mountable curbs to allow its use by emergency vehicles if other lanes are tied up with traffic.

Parking in the lane adjacent to a trackway is deemed infeasible unless a separation of at least 3 ft (1 m) and a pedestrian barrier can be provided. Without the separation, people getting out of vehicles would be in the way of oncoming trains and without a barrier they would be unaware that they had wandered into the trackway.

One of the alignment alternatives studied, the Washington–Collins Avenue alternative, would locate one track on each of those avenues with all trains and traffic traveling northbound on Collins Avenue and southbound on Washington Avenue between First and 20th streets. In this scheme it was decided that the tracks would best be located in an exclusive guideway along the left curb of each avenue (the west side of Collins and the east side of Washington). This configuration would allow the minimum right-of-way since the existing sidewalks would serve as the station loading areas on both avenues. It would also allow right turns to be made off both avenues without interference from trains, and left turns would be signal controlled to protect trains and vehicles. This scheme eliminates parking along the side of each avenue adjacent to the tracks but allows uninterrupted parking on the opposite side of the street. As indicated previously, this alternative was rejected by the community because of the impacts of a rail line on Collins Avenue, which is narrower and has more residential uses than Washington, and opposition to a one-way traffic operation on the avenues and the loss of parking.

The remaining alternatives require two tracks on Washington Avenue, a 100-ft (30.5-m) wide right-of-way with buildings abutting on both sides (Figure 4). The avenue is currently a two-way street with a small median but no left-turn lanes. Although there are two through lanes and one parking-and-loading lane in each direction, standing and loading from the second lane is a common problem, often reducing some blocks to one through lane. The sidewalks are approximately 12 ft (3.65 m) wide but vary somewhat from block to block and have expanded areas using part of the curb parking lane at some intersections. Pedestrian volumes often exceed the capacity of the sidewalks, particularly on Friday and Saturday nights when customers crowd the sidewalks in front of clubs and force pedestrians into the curb lanes.

Three general schemes for placement of double tracks and station platforms were considered on Washington Avenue: both tracks on one side of the street, one track along each curb, and both tracks in the center of the street. In each case variations related to the placement of station platforms, parking, and traffic lanes were considered and an overall best scheme was developed.

The scheme with one track along each curb on Washington Avenue minimizes right-of-way requirements by using sidewalks for station platforms in both directions (Figure 5). However, this arrangement would eliminate parking along both sides of the street unless a separation and barrier were provided on each side. Even if parking was provided, no direct access to stores would be possible since barriers would be required to prevent random crossing of tracks. It was also determined that only low platforms and low-floor vehicles could be used with this scheme because of the minimal space available and the visual impacts of high platforms or high-blocks on adjacent buildings in the historic district. However, even low platforms posed a problem here. Since a typical low-floor car requires a platform approximately 14 in. (35 cm) over rail (street) height and sidewalks are typically about 6 in. (15 cm) over the street, the sidewalks would have to be raised approximately 8 in. (20 cm). On most of Washington Avenue, retail stores front directly on the sidewalk, however, and there is usually no rise in the in-

FIGURE 4 Washington Avenue today.

terior floor height. Thus raising the sidewalk would have unacceptable aesthetic and physical impacts. Raising part of the sidewalk or sloping it would cause serious drainage problems, particularly in Miami Beach, which is subject to heavy showers and hurricanes. Therefore, it was necessary to locate stations on blocks that did not have adjacent buildings with floors at sidewalk level.

The concept of locating both tracks on one side of the street was identified in the original feasibility study (*1*). For most of the length of Washington Avenue, the west side was chosen to avoid utility conflicts on the east side and to leave the street activity on the east side of the transit line so that vehicles making turns to and from Collins Avenue would not cross the transit line (Figure 6). The optimal station layout for this configuration uses the west sidewalk for southbound boarding and a platform along the east side of the tracks for northbound stops. This arrangement allows for either two-way traffic flow on Washington Avenue or a one-way pair with Collins Avenue. The two-way configuration would allow one through lane in each direction, parking along the east side in blocks that do not have stations, but no left-turn lanes. In blocks without stations, the space used by the northbound platform would serve as a through lane in a two-way configuration or as a signal-controlled right-turn lane in the one-way configuration. Although this configuration offers the greatest flexibility for configuration of traffic lanes, it eliminates parking along the west side of the avenue and suffers from the same problems of locating station platforms along sidewalks directly in front of buildings. As with the scheme with tracks on both sides of the street, this scheme requires low-level platforms located on blocks without building conflicts. If high platforms are required, they could be arranged by locating a single high platform between the tracks, but this results in a greater visual impact on nearby buildings.

A configuration with tracks in the center of the street locates the station platform and canopies as far from building facades as possible and affects properties on both sides of the avenue equally (Figure 7). A center platform arrangement was selected to reduce the overall width required, provide a streamlined appearance, and locate station elements as far as possible from facades along the avenue. This scheme works equally well with high or low platforms and has no effect on buildings, sidewalks, or drainage. With either type of platform, the station platform would slope down to the crosswalks at both ends of the block at each station to provide barrier-free access at both ends of the station. This scheme significantly reduces the traffic capacity of the avenue but

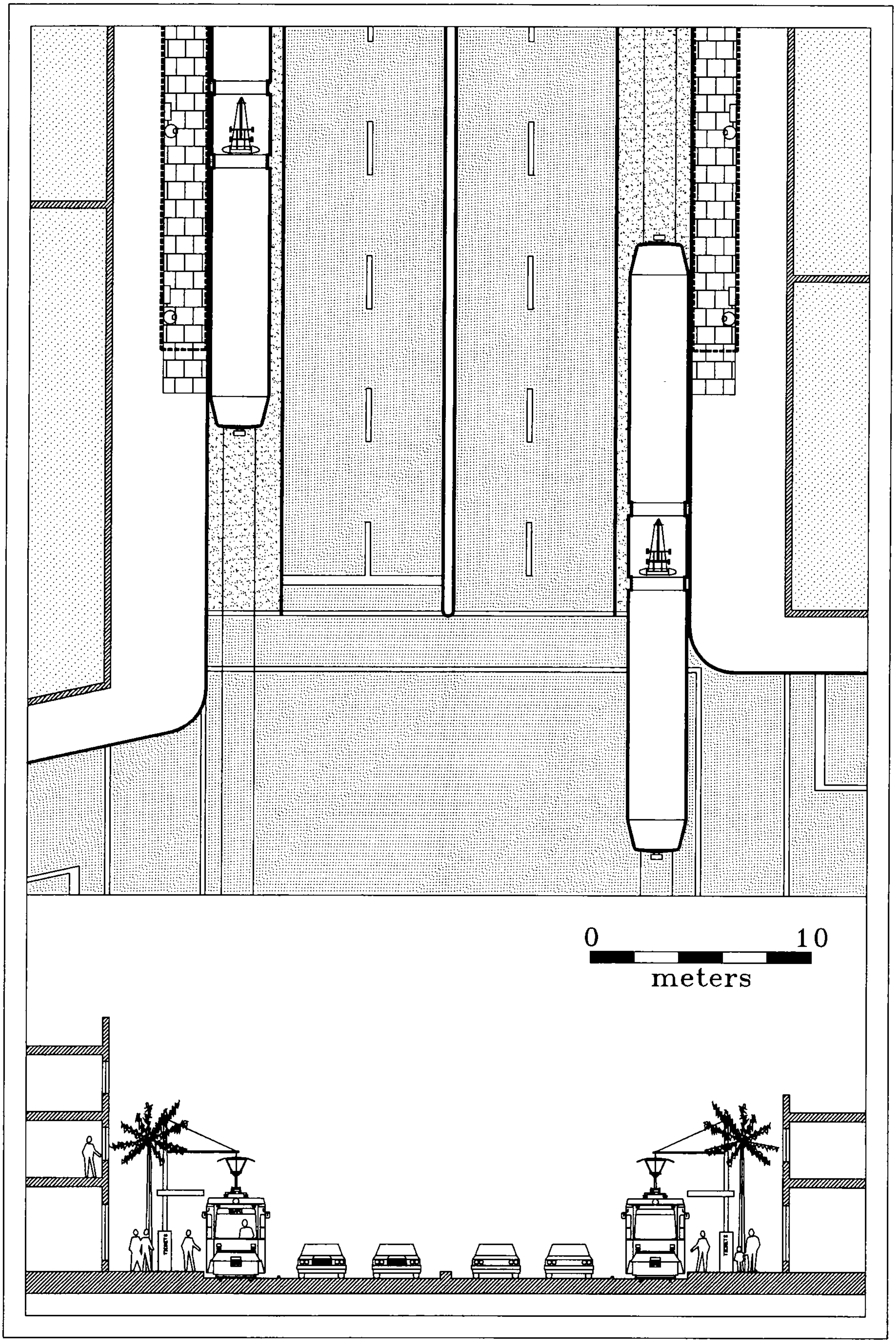

FIGURE 5 Transit on both sides of Washington Avenue.

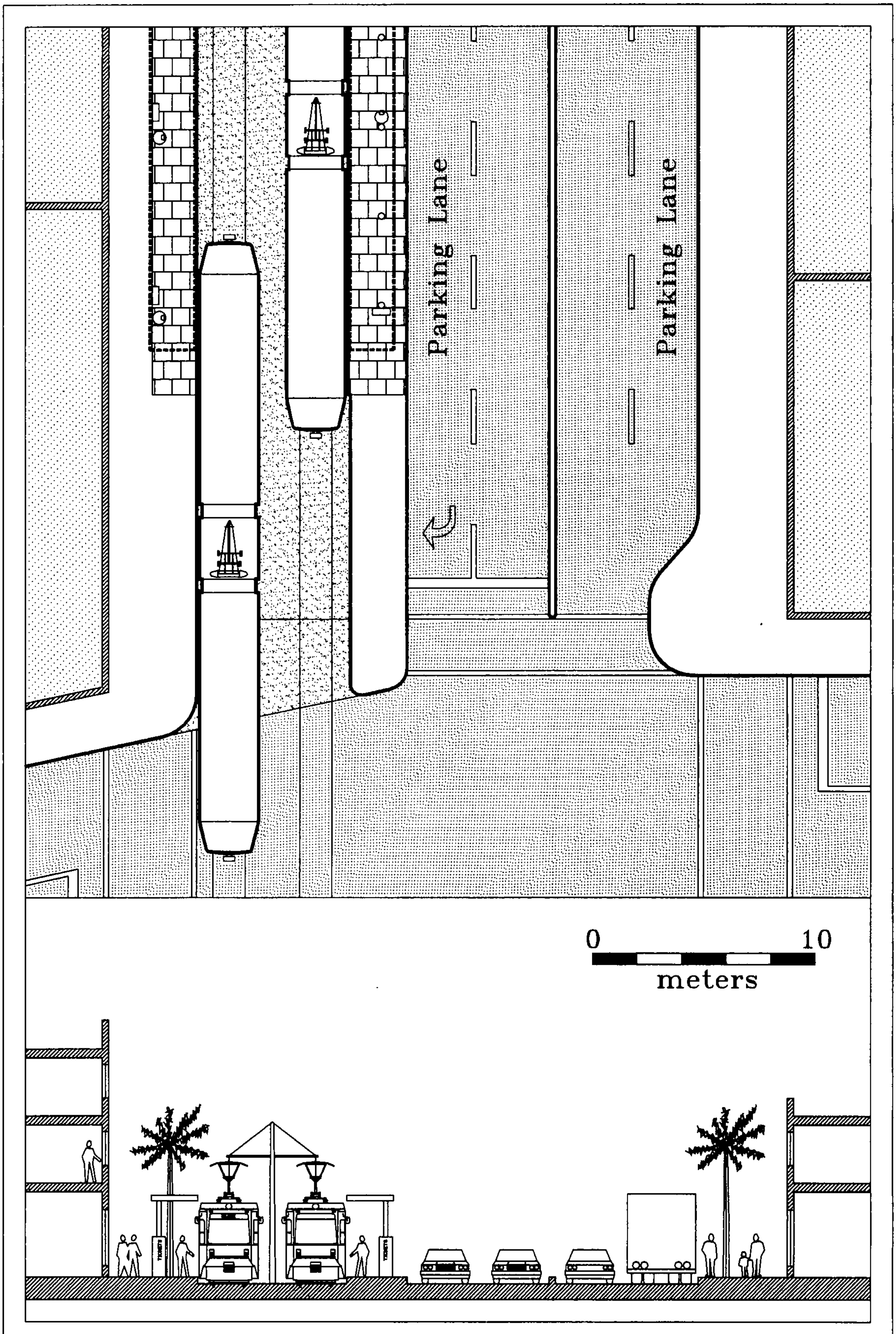

FIGURE 6 Transit on the west side of Washington Avenue.

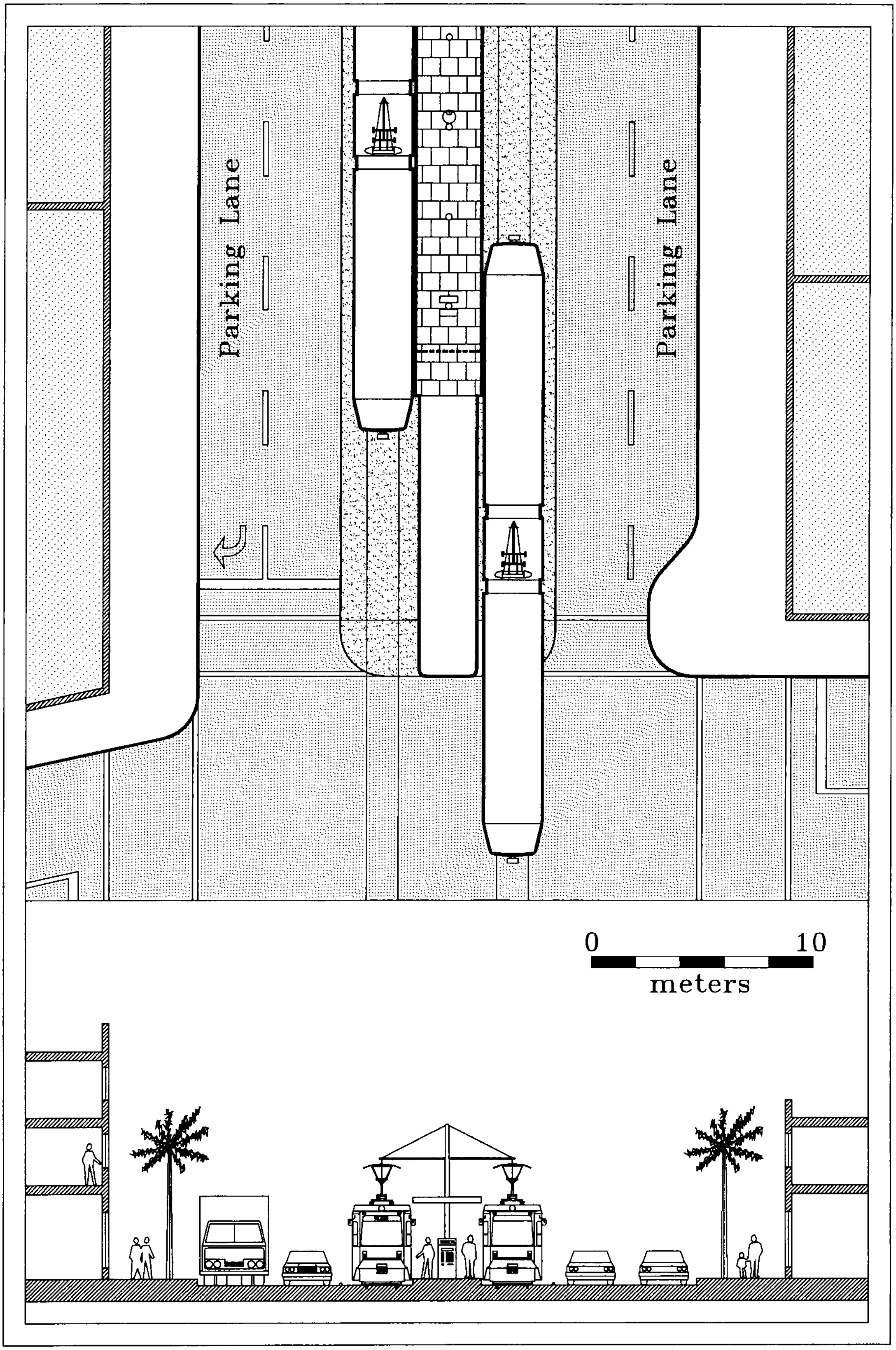

FIGURE 7 Transit in the center of Washington Avenue.

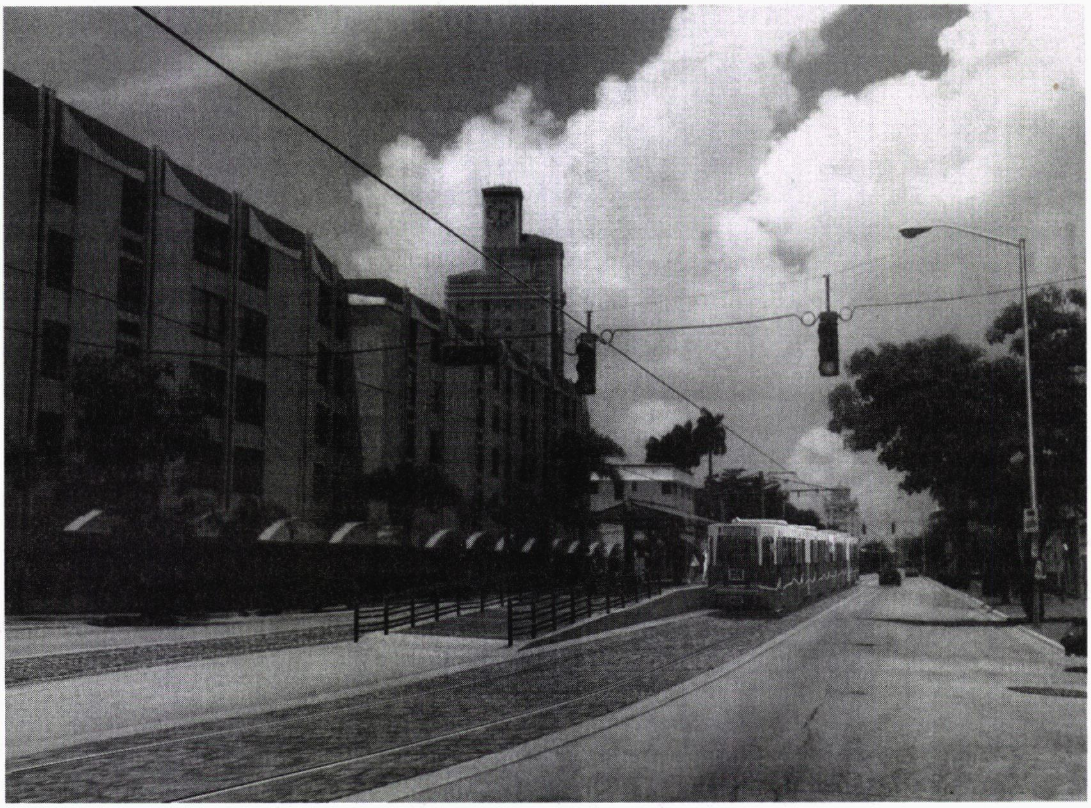

FIGURE 8 Future LRT on Washington Avenue.

creates a slower traffic pattern supportive of the transit-pedestrian focus of the street. One through lane would be provided in each direction. In blocks with stations, no parking or left-turn lanes would be possible. However, the majority of blocks could provide parking and loading along the curb lanes. Left-turn lanes could only be provided in those blocks by eliminating parking near intersections. To avoid train-traffic conflicts and allow maximum parking to remain, it may be desirable to eliminate left turns and require drivers to turn right around the block.

In response to the aesthetic concerns on Washington Avenue and the desire to retain the maximum amount of parking possible, and to keep options for high- or low-floor vehicles open, an alignment in the center of Washington Avenue with center platform stations was selected for further development in Miami Beach (Figure 8).

ACKNOWLEDGMENT

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REFERENCES

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