Metropolitan Transit Authority
"Nashville Urban Core Light Rail Analysis"
Final Report
June 15, 1999
Prepared by Wilbur Smith Associates

Comments by Malcolm Getz

Should Nashville construct a rail transit system? Wilbur Smith Associates, a consulting firm with extensive experience in the design and construction of rail transit systems across the country, has given a careful analysis of this question under contract to the Metropolitan Transit Authority. The conclusion is given on page 8-10:

> The financial feasibility of the BRT (bus transit) can be affirmed. The financial feasibility of the LRT (light rail transit) needs additional study of the ridership implications of a larger system.

That is to say, the case for even an initial investment in rail hasn't been made.

A reading of the Final Report shows that bus transit dominates rail for Nashville. Here are some of the key points with commentary.

Specific Rail Plan

The Metropolitan Transit Authority asked Wilbur Smith Associates to examine the feasibility of a light rail transit from Downtown Nashville to West End. The Final Report defines a specific alignment and configuration and compares a rail to a bus transit system.

The route begins at Adelphia Coliseum, crosses the Woodland Street Bridge to the Court House Square, up Deadrick, left on Fifth Avenue across Broadway to Demonbreun, right on Demonbreun to near Music Square. From Music Square, the line would connect to West End and proceed out West End to Murphy Road. A spur would go east on Broadway from Fifth to the River Front. The total distance of the service would be 4.2 miles. (Final Report, pp. 3-17 to 3-19)

The rail system would be in single track down West End from 17th to Murphy Road. Trains could operate in only one direction on the track at a time, and so the minimum headways (time from one train to the next going in the same direction) would be 15 minutes. The spur to River Front would also be single track. Because of the short length of blocks downtown, the trains would be limited to two cars with a maximum of 221 passengers per train. Forty-one passengers will have seats, 180 will stand. (Final Report, p. 4-24)

The rail system would operate on surface streets and be given priority control of traffic lights to minimize delays at cross streets. There would be 15 stations on the route with an average dwell time forecast to be 20 seconds. The scheduled run time from Adelphia Coliseum to Murphy Road would be just over 19 minutes. The system requires seven vehicles.

Bus Transit Alternative

Wilbur Smith considers as an alternative an electric bus system that draws power from overhead wires suspended over the route. The bus system (BRT) would offer the same route times as rail with sufficient capacity to meet expected ridership for decades. The electric buses have more maneuverability on streets, can climb steeper slopes, and are quieter than rail systems.

Cost Comparison

The capital cost of the rail system is put at $114 million including the tracks, power system, stations, and rolling stock. (Final Report, p. 5-7)

The capital cost of the electric bus system is $53 million. The bus system avoids $29.3 million in cost because no rails need be installed in streets. The seven bus vehicles are $4.9 million less than seven rail vehicles. The necessary shops and yard for buses are $6.5 million less expensive than a rail yard. The design process for buses costs $8.2 million less and contingencies are $12.2 million less with buses.

The annual operating cost of the rail system would be $4.6 million. The annual operating costs for the bus transit system would be $3.2 million. (Final Report, pp. 6-21,22)

The principal reason that Wilbur Smith Associates finds that a bus transit system is feasible while a rail system is that the bus system delivers comparable service at less than half the capital cost and with 30 percent lower operating costs.

Ridership

The ridership analysis is the same for the rail as the transit bus system that Wilbur Smith analyzed. (Table 8-1, Final Report, p. 7-18.) Riders fall into three categories. First are trips made by persons residing within walking distance of the stations. Second are trips for circulation during the day, that is mid-day trips. Third are commuting trips that originate outside walking distance of the proposed system that involve cars, vanpools, or a proposed commuter rail system. The new downtown transit would distribute these commuters within the urban core.

Persons living and working along the proposed transit line would account for 1,100 trips per day. Relatively few people reside within walking distance of the stations and so it is not surprising that few residents would walk to the train. This source of trips will grow little because little residential development will occur in the urban core.

The circulator trips account for another possible 1,000 trips per day. This category is also not expected to grow very much. Note also that these trips rarely occur at peak hours and so have little effect on traffic congestion.

The third source, the distributor trips, are put at 3,450 given 1999 population and employment with growth expected to 7,125 in 2015. Clearly, the case for a major investment in an expanded transit system in the core of the city is tied to its role in the distribution of commuters within the central city.

The commuters who might use the distribution service arrive in three ways, by car, by proposed commuter rail, and by vanpool.

The Final Report envisions a parking garage offering free parking to commuters who arrive at Murphy Road and perhaps other locations and ride the transit. This service would attract 1,350 rides in 1990 and 1,600 in 2015. Note however, the cost for the transit does not include the cost of the land and structure necessary to offer free parking. A complete analysis would then either include the cost of a parking service in the cost estimate, or delete the rides resulting from offering of free parking from the ridership analysis.

The potential ridership arriving by commuter rail can only materialize as a consequence of unspecified investments in commuter rail services. A complete analysis would either include the cost of the commuter rail service or omit these riders.

The vanpools yield 200 riders at 1999 rates and 500 in 2015. The vanpools now receive free parking at the Landport, a policy assumed to continue.

Given the $114 million cost in the proposed rail system, the average daily rides would be 2,875 in the design year of 2015. This number is about 30 percent of the total ridership Wilbur Smith expects with unspecified investments in parking and commuter rail.

Wilbur Smith gives a rule of thumb that 10 percent of the average daily ridership occurs during the peak hour. Without the unspecified parking and commuter rail investments, the proposed transit system would have less than 300 peak hour passengers. That is to say, about the load of six regular buses. With the unspecified investments in commuter rail and parking, the transit system would attract about 20 bus loads of peak hour riders. That is to say, one regular bus every three minutes could carry the total ridership of the most optimistic projection for 2015.

Effect on Existing Transit Riders

The bus service over the proposed transit route currently averages 1,300 riders per day. With 1999 population and employment characteristics, the Final Report projects 2250 riders per day on the new transit service, assuming no unspecified investment in free parking or commuter rail. The net gain from the new service would then be 950 one-way

rides per day. (Final Report, p. 7-18) The Final Report does not project ridership on the existing bus service if no new transit investment occurs.

Interestingly, the number of persons who now ride buses along the route of the transit would not all be expected to move to the new system. The four bus routes that traverse the proposed route for the new system would be replaced with bus routes that require riders to transfer to the new system at the Murphy Road terminus. Transfers involve walking and waiting time that riders view as substantially less attractive than moving time. Because transfers will be required, some riders will find use of the new system less attractive than the present bus rides that go directly to downtown. Therefore, not all current bus riders would migrate to the new, less convenient service. (Final Report, p. 7-15)

Effect on Automobile Traffic

The Final Report does not contain an analysis of the effect on automobile traffic. A rail line down West End will restrict the flow of automobiles. The rail is limited to one track so as to limit the adverse consequences for traffic. There would be six stations in the West End Avenue median. A station requires a waiting platform and so takes a second lane from automobiles.

West End currently carries 30,000 vehicles per day over five to six lanes. (Final Report, p. 3-12) If two lanes were removed for rail service, the flow would likely be reduced by one-third. Using the rule of thumb of ten percent at the peak hour, 3,000 vehicles flow down West End at peak hour. If the average vehicle occupancy is 1.2 (a rough guess), then 3600 person trips at peak hour by automobile will be sacrificed to install a rail system. Reducing the capacity of the street to carry automobile traffic by one-third would likely reduce the volume peak-hour traffic by 1,200 people. The rail system might attract 300 peak hour riders without parking and commuter rail. With the unspecified investments in parking and commuter rail it might attract 950 peak hour riders. The net effect on automobile travel is then adverse in the area where the new transit system will be installed. Note that the dedicated rail line and stations in West End would provide for at most four trains per hour with a maximum passenger per hour flow of 884 persons. Fewer people in total could traverse West End at peak hour with the rail system than at present.

The bus system will have neither dedicated lanes nor stations and so will have much less adverse effect on automobile traffic.

Both the bus and rail transit systems would be given priority at traffic signals to enhance the route speed of transit at some cost in travel time to automobiles using cross streets.

The adverse effect on traffic might be analyzed separately for the Coliseum—Music Row segment and the Music Row—Murphy Road segment. The latter as a single rail line down West End has less capacity than the dual rail system contemplated on the other segment. Hence, the downtown segment could accommodate more frequent trains. On

the other hand, a dual track system occupies more street space and so poses more restrictions on automobile traffic. For example, Fifth Avenue might become a transit and pedestrian mall with no vehicular traffic allowed. (Previous efforts to restrict vehicular access in favor of more pedestrian access as along Church Street and on Second Avenue have failed.)

Whether a new downtown transit system would affect travel patterns on the arterial roadways and interstates leading to downtown is an open question. Park-ride services next to the downtown transit require travelers to use their automobiles on the arteries and interstates to reach the downtown area. These park-ride services then have no effect on arterial travel. Commuter rail might substitute for arterial travel. However, in other cities comparable to Nashville few automobile riders are attracted to trains.

Federal Grants

The Final Report observes that the Federal Transit Administration has fewer dollars to contribute to the capital costs of new transit systems now than in previous decades. The average Federal share has dropped to 53 percent. (Final Report, p. 8-4) The competition among cities for transit dollars is keen. Cities proposing lower cost systems and that finance more of the costs locally are more likely to get Federal grants. Indeed, several cities have financed transit system with no Federal grants at all. The Final Report also notes that the Federal Transit Administration views bus transit as more attractive than rail in many cities contemplating new systems.

Federal capital grants of less than $25 million are not in the same competition as larger grants. The likely Federal share of the bus transit system discussed in the Final Report might be 0.53 x $53 million = $28 million. Nashville might better plan for less than $25 million of Federal funds that would be more easily attracted by proposing a bus transit system with substantial local finance.

The Final Report casts the prospect for Federal Grants in terms of the cost per new transit rider. Define a service life for each component of the transit system and find the annual flow of funds that would be necessary to pay for a lease of that amount of capital. Such a figure is the annualized value of the capital. Divide the annualized capital cost by the number of new annual rides. The result is the capital cost per new rider. Add the annual operating cost to the annualized capital cost to get the full-annualized cost of the transit. The Federal Transit Administration poses an upper limit of $10 per new rider for consideration for Federal financial participation.

The rail system shows a cost per new rider of $28.58. Note that this figure assumes all of riders that would derive from park-ride and commuter rail even though the cost of the extra facilities for offering such services are not included. (Final Report p. 8-6)

The bus system shows a cost per new rider of $16.22, again based on the park-ride and commuter-rail services that involve extra cost. (Final Report, p. 8-7)

These costs have the following interpretation. What would each rider have to pay in order to yield sufficient revenue to cover the capital and operating costs of the transit system? For a typical commuter working 200 days and making 400 one-way trips, a $28.58 cost per trip comes to $11,432 per year. The bus service would be $6,488 per year per worker.

Actual revenues are much less than the total cost. Indeed, fares are assumed to be comparable to current bus fares and so the fare box revenue will yield about 17 percent of the operating costs of the rail system or about 25 percent of the operating cost of the bus transit system. (My calculations from data on Final Report p. 8-6,7) The Final Report suggests that the new transit service operate with zero fare from Music Row to the Coliseum. If so, revenue would be even less.

Once built, the capital cost and the annual operating cost of the new service become essentially a fixed cost for the Metro budget. In other cities, the operating cost of rail service has grown rapidly.

More Choices

The Final Report mentions in passing that the technology of buses is changing. There are three principle disadvantages of the buses now used for transit in Nashville. First, they are diesel powered and emit unpleasant exhaust. Second, they are noisy. Third, they require riders to ascend three steps to board the bus. Buses of new design are coming into service in other cities for which these disadvantages are much less.

New buses use hybrid power plants similar in philosophy to the hybrid power plants now available on some models of Toyotas in Japan. An internal combustion engine generates electricity. Electric motors at each wheel move the bus. The internal combustion engine on hybrid buses may burn natural gas and have low emissions. The engines are on top of the bus with electricity supplied to the motors at the wheels. In this way, the buses need no undercarriage and so the floor of the bus is just one step off the ground. The electric motors act as electric generators during braking and so some of the energy normally lost in braking remains in the bus. The combustion engine can be smaller and quieter than conventional diesel engines.

Hybrid power buses might then meet the service requirements proposed for the downtown distribution transit system without being tied to overhead powerlines. Hybrid power buses might operate in collection model in residential neighbors, in express mode on arteries, and in distribution mode in the downtown area. Use of the hybrid buses then avoids the inconvenience of walking and waiting that are inherent in transfers between vehicles.

Hybrid buses with systems to give priority at traffic signals might offer better service than the rail and bus transit systems discussed in the Final Report, yet cost much less. Such a system would attract more riders. It would also be more effective as a downtown distribution system because it could extend to more areas without added capital cost.

Note as well that a transit system based on hybrid buses could serve park-ride facilities and link to commuter rail should these prove feasible. Hybrid buses might serve stations outside roadways at high volume locations. Hybrid buses will be less disruptive to automobile traffic.

We should note as well that as the city grows, its transportation needs change. The Final Report notes that the MTA has adjusted its routes and services in light of changing demand over time. A rail system provides no such flexibility. The electric bus alternate provides only modest flexibility in that added mileage is less expensive to install. The hybrid bus approach, however, allows routes to be adjusted as needed and the bus fleet to be used for special events. Over time, as incomes rise and jobs and employment take new geographic patterns, the demand for transit service has been declining. It is increasingly difficult to attract riders to transit and will continue to be so.

Several cities have decided not to pursue rail transit for reasons of cost. Among these are Charlotte, Columbus, and Honolulu. These cities have much higher population density than Nashville and therefore are more attractive for transit than Nashville. (Final Report, p. A-6, A-9) These cities are investing in buses.

If Nashville has $28 million to commit to new capital expenditure for transit and had hopes of attracting an added $25 of Federal transit grants, it might best consider buying a fleet of hybrid buses. At least, a careful evaluation of such a possibility should be undertaken before investing.

The Final Report makes abundantly clear that a rail transit service for a downtown distribution service is much less attractive than rubber tire alternatives.

Malcolm.Getz@vanderbilt.edu
September 13, 1999