

MEMORANDUM

To: Joe Grengs

From: Joel M. Batterman

Re: Woodward Avenue light rail mainline alternatives – Part 1

Date: December 19, 2010

Summary

The Detroit and U.S. Departments of Transportation are considering two alternatives for the downtown segment of the city's proposed Woodward Avenue light rail line: a center-running alignment, running the trains down the road's middle, and a curb-running alignment, running the trains down the two outer travel lanes. In deciding the appropriate alternative, its effects on transit, pedestrian, bicycle and motor vehicle mobility and accessibility should all be considered, as well as the overall effect of the alignment on community quality of life, sustainability, and social equity. This review represents the first portion of that more extensive analysis. It concludes that the center-running alignment would provide significantly more effective transit service, offering both faster, more reliable travel and safer access to stations. A truly comprehensive review, comparing the alternatives' implications for other transportation modes and their more general effects, will be forthcoming before the public hearing scheduled for spring 2011.

Introduction: Project History

Public Origins

For decades, citizens, elected leaders and transportation planners have advocated and debated plans for rapid transit on Woodward Avenue, the Detroit region's historic spine (Batterman 2010). In 2006, building on rising public support for urban reinvestment and transportation alternatives to the automobile, the Detroit Department of Transportation (DDOT) conducted an analysis of possible new transit systems, the Detroit Transit Options for Growth Study (DTOGS). Based on public comments, DDOT in March 2008 selected a center-running light rail line, as shown in Figure 1, as the preferred transit alternative for Woodward Avenue. This action also placed the line in the long-range plan of the Southeast Michigan Council of Governments (SEMCOG), the metropolitan policy organization charged with coordinating regional transportation planning (URS 2009).

Among other findings, the DTOGS study noted that enough people already rode transit along Woodward to justify a light rail line, notwithstanding the additional riders which faster transit service would attract. The amount of bus riders per mile along Woodward between downtown Detroit and the Eight Mile city limit exceeded the amount of bus riders per mile on modern light rail systems in a number of U.S. cities, including Los Angeles, Portland, St. Louis, Denver, Dallas, and San Jose. A 2001 SEMCOG survey of southeast Michigan residents provided additional support for transit investments, showing that 77 percent would likely use a new rapid transit system. 59 percent of respondents would support additional funding for public transit, over five times as many as the 11 percent opposed (URS 2008).

Unfortunately, the financially distressed City of Detroit could not commit local funding to the light rail line. In other cities, a regional transit authority would typically provide local funds,

but Michigan Governor John Engler vetoed legislation for a Detroit Area Regional Transit Authority (DARTA) in 2002. Without the ability to draw on the entire region for funds, no transit line appeared likely.

Private Alternative

Into this vacuum stepped private investors, who had begun work on a parallel project, named The Regional Area Initial Link (TRAIL) in 2007. TRAIL backers included many of the region's leading businessmen, including Penske Corporation founder Roger Penske, Compuware Corporation founder Peter Karmanos Jr., Little Caesar's founder and Detroit Tigers and Red Wings owner Mike Ilitch, Quicken Loans founder Dan Gilbert, and Matt Cullen, a General Motors executive and president of Gilbert's Rock Enterprises holding company. The Kresge Foundation of Troy and the Detroit Downtown Development Authority also volunteered \$35 million and \$9 million, respectively (Gallagher 2009). This private coalition would construct the line and turn over operations to a public transit authority at a future date.

Despite its name, the TRAIL project differed from the DTOGS proposal, most obviously in its more limited scope. TRAIL would extend a 3.4-mile rail line from downtown Detroit, home to Compuware, Quicken, and the Ilitch sports franchises, to the Midtown (Cass Corridor) and New Center areas which have been a focus of new residential real estate investment (UCCA 2010). The line would thus provide a direct transit link for the employees and patrons of TRAIL's sponsors, as well as connecting other major cultural institutions and employment centers along the corridor. However, it would not serve transit riders in the denser areas of the Woodward corridor north of Grand, which are almost exclusively African American with the exception of the Chaldean Town area near Eight Mile (US Census Bureau, 2000). Perhaps in recognition of the proposal's local focus, sponsors changed the name from TRAIL to M1-Rail, a reference to Woodward's state highway designation. Less obviously, but perhaps no less significantly, the private investors also proposed a different design for the rail line, shown in Figure 2. Instead of running the train down the middle of Woodward in its own right-of-way, M1 called for running tracks down the outer travel lanes of Woodward, without closing them to motor vehicles, and positioning stations flanking Woodward, instead of in the median.

Federal Recombination

In August 2010, however, after M1 found that it too lacked sufficient funds, the project came under public control once again when the federal government committed money. Legislation permitted M1's contribution to be used as the local funding source for a U.S. Department of Transportation-funded rail line to the Eight Mile city limit, in accordance with the City's original plan (Shea 2010). However, the contrasting M1 and City plans for the downtown-New Center segment must still be reconciled. City and U.S. transportation staff are considering both the center-running City proposal and the curb-running M1 proposal as alternatives for that section. The two are described as Mainline Design Option A and Mainline Design Option B, respectively. Staff will complete a draft environmental impact statement in late January of 2011, and select a "preferred alternative" in the spring, after a public hearing and 45-day comment period (FTA 2010).

The alternatives analysis process does not mandate a strong role for the public in choosing a preferred alternative, which remains the prerogative of the lead agencies involved

(FHWA 2006). However, given the strong interest of U.S. Department of Transportation leadership in effective transit service that reduces the need for automobile travel (Schor 2009), and the historic significance of a rapid transit system in the preeminent automobile manufacturing center, public comment regarding alternatives' relative potential to further that goal could play a significant role in the decision, despite the local funder's prior commitment to Mainline Design Option B. Public education on the implications of the two alternatives, which has not occurred to date, is therefore crucial to the selection of an alternative that best serves the people of Detroit, Michigan, and the United States.

Implications and Recommendations

Principles for Comprehensive Transportation Planning

In choosing between alternative transportation designs, officials and citizens should adopt a comprehensive approach to the question that considers a range of factors. Efficient and effective mobility for users of the transportation system under development is obviously a paramount concern. Mobility, however, has been defined in broader ways as transportation planning has evolved. Transportation professionals today stress the importance of planning for multiple modes of transportation—including walking, bicycling, and other modes in addition to transit and private motor vehicles—and of integrating these multiple modes to produce a single “multi-modal” transportation system (Zielinski 2006). Moreover, Michigan's 2010 Complete Streets law requires that roadways be “planned, designed, and constructed to provide appropriate access to all legal users,” including pedestrians, bicyclists, and people with disabilities (State of Michigan 2010). Light rail on Woodward would fundamentally change the nature of travel on the roadway for all its users. For this reason, this analysis of Woodward mainline design option alternatives considers the implications of each design for all modes of travel.

Mobility is not the only metric of efficient transportation. Many transportation experts also call for considering accessibility as a transportation policy goal. They note that mobility is merely a means to an end. Most travel occurs because people seek to reach predetermined places (Grengs 2010). Levels of mobility clearly affect accessibility, since people can rarely satisfy all their needs at a single site, but the two are not identical. As a result, this analysis considers the alternatives' effects on both mobility and accessibility for each mode of travel.

Finally, transportation planners and the public increasingly recognize that transportation decisions have broad implications for the environment and human society, above and beyond their effects on accessibility and mobility for users, and that these effects should be considered in making those decisions. Increasing numbers of U.S. transportation agencies, including the Michigan Department of Transportation, have adopted “context-sensitive solutions” (CSS) principles (MDOT 2005), which move them beyond a narrow focus on moving traffic to emphasize enhancing safety, protecting the environment, and improving community quality of life (ICF 2009). In 2009, the U.S. Department of Housing and Urban Development (HUD), Department of Transportation (DOT), and Environmental Protection Agency (EPA) initiated a “partnership for sustainable communities,” which aims to ensure that “housing and transportation goals are met while simultaneously protecting the environment, promoting equitable development, and helping to address the challenges of climate change” (EPA 2009). Leading scholars have also emphasized the need for considering the intersection of environmental and social equity effects in transportation decisions (Bullard 1997, Sanchez 2008). After considering

the alternatives' implications for specific transportation modes, then, this analysis continues to compare their relative performance on environmental sustainability and social equity goals.

Transit Considerations: Vehicle Operation

Transit Operation

As originally defined by the Detroit Department of Transportation, the goal of a Woodward light rail line is to provide Detroiters with rapid transit for the first time in history. The center-running and curbside alternatives would use identical vehicles. However, their differing right-of-way designs, station spacing, and alignments would provide radically different types of transit service on the crucial segment between downtown and New Center. So the choice between the alternatives is much more significant than it first appears.

Importantly, the center-running alternative would provide light rail trains with a separated right-of-way north of Grand River Avenue in downtown, while the curb-running alternative would not. Under the center-running alternative, a barrier would block private motor vehicles from the light rail right-of-way, ensuring that motor traffic would not delay the trains. Under the curb-running alternative, the trains would run in mixed traffic, mingling in the outside lane with DDOT buses and private motor vehicles, for over 3 miles.

The spacing of light rail stations on the downtown-New Center segment also varies significantly between the two alternatives. Between Grand Boulevard and the downtown terminus, the center-running alternative would include 10 stations (Figure 7), including six between Grand and Washington Boulevard, where it would jog west to connect to the Rosa Parks Transit Center before continuing on to the foot of Woodward under the original DDOT plan. The curb-running alternative would include 16 stations on the segment, including 10 between Grand and Washington (Figure 8), where it would continue directly along Woodward to Hart Plaza under the original M1 curb-running plan. (The decision on an in-downtown alignment alternative, largely a decision on whether to connect to the Rosa Parks Transit Center, is being considered separately from the curb-running or center-running question.) Under the center-running alternative, the three stations between Interstate 74 and Interstate 75 would be 0.9, 0.7, and 0.7 miles apart. Under the curb-running alternative, the average distance between the stations over that segment would be approximately four blocks, while the Fox Theater and Adams Street stations to the south would be only two blocks apart (Parsons Brinckerhoff 2009).

Transit Speed

As might be expected, official studies by consultants to the project show that curb-running trains, traveling in mixed traffic and stopping at stations significantly more often than they would under the separated center-running alternative, would take significantly longer to travel between Grand Avenue and the downtown. Projected travel times between these stations are shown in Figure 4. During morning peak hours, project consultant Parsons Brinckerhoff estimates that the curbside alternative would add 2 minutes 41 seconds and 2 minutes 51 seconds to the southbound and northbound trains' travel times, respectively. During afternoon peak hours, it would add 1 minute 40 seconds and 2 minutes 31 seconds. "Dwell times," the time the train would spend stopped at each station, are estimated at 20 seconds, so the three additional stations between Grand and Grand Circus Park would account for over one minute of the added time.

Overall, the curbside-running option would increase travel times between Eight Mile and the downtown by approximately 10% over the center-running option.

Moreover, these estimates do not account for potential delays due to buses and other service vehicles which obstruct the outer lane for longer periods. Comparing the alternatives, the DTOGS Traffic and Parking Technical Report notes that “the Center-Running Alternative would not be influenced by an increase in vehicular volumes from special events,” whereas the side-running alternative might be substantially delayed in such cases. “Travel time is predictable,” the report notes of the center-running alternative, whereas for the side-running alternative, it is “dependent on traffic” (Parsons Brinckerhoff 2009).

The cumulative cost of the curbside-running alternative’s longer travel times and unreliable schedules is great. The longer times alone—barring additional delays—would cost round-trip commuters about five minutes each day. For daily commuters, this would amount to an additional 30 hours annually. The precise extent of unreliable service is more difficult to estimate, but the congestion caused by special events such as football games would reduce the effectiveness of the transit line precisely when it would be of greatest utility. In Michigan’s winter climate, snow can be a particular impediment to automobile traffic, which the light-rail trains would not be able to bypass under the curbside-running alternative.

In effect, the curbside-running alternative would remove, between New Center and downtown, the majority of the speed advantage over buses which the center-running light rail option enjoys. The length of a current DDOT bus trip between New Center (Grand Avenue) and the north edge of downtown (Winder Street) during morning peak hours is approximately 14 minutes (DDOT 2010). The center-running light rail alternative would cut more than 5 minutes off that time, reducing trip length to about 8 minutes 58 seconds. The curbside-running alternative, however, would add over two and a half minutes back onto that time, for a total time of 11 minutes 39 seconds, scarcely two minutes shorter than the current bus trip (Parsons Brinckerhoff 2009). The interaction of light rail trains and buses could slow both types of transit still further.

Streetcars, Light Rail, and System Goals

Given the figures above, the curbside-running alternative scarcely qualifies as rapid transit. Indeed, by most definitions it is not. Its close station spacing and alignment running in mixed traffic identify it as a modern streetcar. The precise distinction between streetcar and light rail technology is contested. Streetcars run on the same type of track, and the vehicles they use are similar, though typically smaller. In general, however, streetcars tend to run primarily in mixed traffic, like the curbside-running alternative, whereas light rail vehicles have their own separated right-of-way, like the center-running alternative (Freemark 2010).

The key difference between light rail and streetcar, however, is the purpose they aim to serve. Streetcars are essentially downtown circulators, like the Detroit People Mover: a form of local transit which moves people inside dense central cities, generally at low rates of speed. Downtown circulator streetcars can serve useful purposes in enabling dense redevelopment. Indeed, the builders of Portland, Oregon’s new streetcar, a public-private partnership which has attracted national attention since opening the first modern streetcar line in North America in 2001, describe it as “development oriented transit” (Portland Office of Transportation 2008). The Portland streetcar, shown in Figure 5, runs primarily in mixed traffic, albeit on streets much smaller than Woodward and with some intervals of separated right-of-way, with curbside stations roughly 2-3 blocks apart. Streetcars can be potentially lucrative for adjacent real estate, perhaps

explaining the Detroit private investors' interest. In the wake of the decision on a Portland alignment, more than \$3.5 billion was invested within two blocks of the line, most of it in luxury development which has made the Pearl District, formerly an industrial area, "the leading residential and retail district in the city" (Portland Office of Transportation 2008, Urban Works 2009).

However, streetcar lines are neither true "mass transit" nor "rapid transit." The passenger loads they carry are far smaller than those carried by many bus lines. The Portland Streetcar opened with an average 3,500 riders predicted each weekday, about one-tenth the number currently riding buses on Woodward; seven years later, it still carried merely one-third of the Woodward figure. Streetcars are also relatively slow, since they make frequent stops and travel in mixed traffic. Portland's streetcar takes about 13 minutes to travel 1.5 miles through the downtown, for an average speed of about 7 miles per hour. While this almost halves the walking time, it is comparable to the bicycling time for the same trip, according to the Google Transit tool. It should be noted that the Portland streetcar opened decades after Portland had constructed a regional rapid transit system, the Metropolitan Area Express (MAX) light rail (Figure 6), which performed the function envisioned for Detroit light rail.

To be sure, it is not unknown for regional light rail lines to adopt a streetcar-like character as they pass through densely populated downtown areas. There, stop spacing may be shorter and transit vehicles may operate in mixed traffic, given the more constricted streets (Freemark 2010). The center-running Detroit light rail alternative, for example, follows this pattern in the downtown south of Grand Circus Park. At fully 3.4 miles, however, the curb-running Woodward alternative would extend streetcar-like service well past its usual extent. Moreover, unlike the Portland Streetcar, the curb-running Woodward alternative would exact a substantial cost in time to riders of regional transit, bringing them to multiple additional standstills on their way in and out of the downtown area. For all these reasons, in fact, the 2008 DTOGS study specifically rejected modern streetcar technology as an alternative for the Woodward corridor, noting that like the People Mover's automated guideway system and other alternative technologies, the technology failed to "sufficiently address key transportation and mobility goals of the Study" and "[b]etter serves longer or shorter trips than what is envisioned in the DTOGS project" (URS 2008).

Summary: Mobility and Accessibility Effects

To summarize, the curb-running Woodward alternative would maximize development potential along the three-mile section of Woodward between New Center and downtown, at least in the near term. By providing additional stops, it would offer marginally improved local access to some sites compared to the center-running alternative. However, since buses already serve these sites, the curb-running alternative would have a minimal effect on mobility and accessibility for those making trips within the downtown-New Center segment. At the same time, for those riders making trips between the downtown-New Center segment and the northern reaches of Woodward, the curb-running alternative would substantially reduce accessibility and mobility by reducing speeds.

The center-running alternative, by contrast, would maximize speeds along the entire corridor, substantially enhancing mobility and accessibility along its entire length. For local trips within the downtown-New Center segment, the center-running alternative would provide slightly reduced access to destinations, at least for those riders whose physical conditions prevent them

from walking more than a few blocks, compared to the curb-running alternative. However, local bus service already exists to serve these trips. As a result, the center-running alternative would enhance local mobility in the downtown-New Center segment without affecting local accessibility, and while providing enhanced regional mobility and accessibility along the entire length of Woodward.

Any transportation decision is inevitably a value judgment. The relative benefit of the center-running alternative and the curb-running alternative varies according to the goals one is seeking to advance. However, the clearly stated goal of all partners in the Woodward project, including the United States federal government, City of Detroit, and M1 Rail, is to construct Woodward light rail as the first phase of a regional rapid transit system. The curb-running alternative would maximize development potential on some sites, but it would not provide rapid transit service on the crucial segment between New Center and downtown. The added time it would cost transit riders would substantially impair the utility of the line itself and future extensions many years into the future. If Woodward light rail is to provide rapid transit, the center-running alternative is decidedly superior.

It should be noted that transit vehicle operations alone are not the only component in transit operation. In addition to the type of transit service provided, the design of stations is important as well, since each transit trip begins and ends at a station. The next section addresses the relative merits of the two alternatives' station design.

Transit Considerations: Access to Stations

Station and Crossing Design

Between the downtown and New Center, under the curb-running alternative, stations would be located at both curbs, adjacent to sidewalks, while under the center-running alternative they would be located in the median, between the two light rail lines. As a result, the curb-running alternative would actually increase the number of stations between Grand and Washington not from 6 to 10, but from 6 to 20, since facilities would be required on either side of the roadway. This could potentially increase total costs, depending on the design of the station facility itself. In addition, the differing placement of stations between the alternatives would substantially affect the ease of pedestrian access to the rail line.

An apparent benefit of the curb-running alternative is that it would not require all transit riders to cross the roadway in order to reach the station. An individual on the east side of Woodward, for example, could catch a northbound train without entering the roadway. However, approximately half of all riders would need to cross the entire width of Woodward to reach their station. This situation would repeat itself for pedestrian access from the final station stop to the final destination. Applying simple rules of probability, there is then a 75% chance that a transit trip on the curb-running line would require a crossing of Woodward's six travel lanes.¹ In contrast, under the center-running alternative, all transit riders would need to cross only half the roadway to reach the median station. With the rail lines occupying Woodward's two center travel

¹ The probability of the rider's point of origin being on the same side of Woodward as the station for the intended direction of travel is 0.5. The probability of the rider's destination being on the same side of Woodward as the nearest station for that direction of travel is also 0.5. Since these are independent events, the probability of both occurring is thus $(0.5)(0.5)=0.25$.

lanes , a full crossing would never be required to access a station north of the downtown, and the half-crossing would require crossing only two lanes of motor vehicle traffic.

The relative ease and safety of pedestrian access to transit stations along Woodward necessarily demands close scrutiny. Despite the primarily urban land uses, interspersed with vacant lots, which the road traverses between New Center and the downtown, the segment currently has the character of a suburban arterial (Figure 3), with narrow sidewalks and no medians. Although the posted speed limit is 30 miles per hour, much traffic operates at considerably faster speeds, and both pose significant dangers for transit riders who must cross the road to access the stations. As vehicle speeds increase from 20 to 30 to 40 miles per hour, pedestrian survival rates plunge from 95% to 55% to 15% (Ernst and Shoup 2010). Clearly, providing for safe pedestrian access to the rail stations is critical for the project's success.

Crossing Safety

The curb-running alternative would have no effect on pedestrians' ability to cross Woodward. However, by adding rail stations at two intersections where no pedestrian crossing exists (Ferry and Temple), it would tend to increase the risk of pedestrian injury and death at those locations, and create unsafe conditions for transit riders in accessing stations. The establishment of transit stations creates a natural desire for pedestrians to cross the street in order to use them, and the lack of such facilities would substantially increase the risk to transit riders at these two locations. The greatest proportion of pedestrian fatalities in the urban United States occurs at locations where no crossing facility is available (Ernst and Shoup 2010). Indeed, all five traffic fatalities in the Woodward corridor south of Eight Mile from 2005 to 2008 involved a pedestrian killed by a motor vehicle at an intersection without a traffic signal. All occurred north of Grand Avenue (Parsons Brinckerhoff 2010). However, adding rail stations without safe crossing facilities creates additional opportunities for such fatalities when transit riders seek to access stations.

In contrast, the center-running alternative would enable significantly safer pedestrian access to rail stations, all of which would be accessed by crosswalks with signals. All stations north of Grand would be in the median. The stations would create a new median pedestrian refuge island, accessed with the crosswalks, as an extension of the station. As a result, the center-running alternative would essentially break pedestrian trips across Woodward into two trips: a trip from sidewalk to median refuge, and a trip from median refuge to sidewalk. Transit riders would need to complete only the first trip, significantly reducing the distance of roadway they would need to traverse, and the amount of time they would need to spend there.

Since the pedestrian crossings would all be signalized in the center-running alternative, pedestrians crossing Woodward would never be exposed to motor vehicle traffic in an ideal situation, in which pedestrians crossed only during the "walk" signal phase. In reality, however, pedestrians frequently disregard signals if they perceive a gap in traffic (Zegeer 2010). As a result, the median refuges will significantly reduce the exposure to motor vehicle traffic of both transit riders and other pedestrians. An Oregon State University study found that four-lane roads with median refuges experienced less than half the number of pedestrian crashes at intersections than did four-lane roads without them (Center for Transportation Research and Education 2010). A Florida study found that six-lane arterial roads without medians – such as Woodward Avenue – experienced 6.5 times as many overall pedestrian crashes as arterial roads without medians (Wilson 2008). By splitting pedestrian trips into two more manageable segments, the center-

running alternative would make pedestrian crossings of Woodward considerably safer, and it would particularly enhance safety for transit riders, who would only need to make one of the trips at either end of their transit journey.

The center-running alternative would further enhance station access safety and general pedestrian safety by removing two lanes of motor vehicle traffic, and perhaps by slowing motor vehicle speeds. In effect, each additional lane of motor traffic a pedestrian must cross presents an additional risk. While pedestrians would also need to cross light rail vehicle travel lanes, the gaps between successive light rail trains would be exponentially greater than those between successive motor vehicles. The precise effect of the center-running line on actual motor vehicle speeds is uncertain. In some cases, median barriers may produce higher speeds, perhaps by giving motorists a greater sense of security (Tay 2007). In general, however, lane removal and roadway narrowing can be expected to reduce average speeds. Case studies have shown that “road diets” converting four-lane streets to three-lane streets can bring significant reductions in speeding behavior (Zykofsky 2009).

Summary: Mobility and Accessibility Effects

Every transit trip begins and ends with another trip, so the ease and safety of these connecting trips strongly affects the overall viability of transit. Rapid transit service has no utility unless transit stations can be accessed comfortably. Under both the center-running and side-running alternatives, most transit trips would require crossing Woodward as a pedestrian. On a micro scale, the center-running alternative would enhance the mobility of riders seeking to reach stations, enabling safer access to them than the curb-running alternative. On a macroscopic scale, this would enhance overall mobility and accessibility. In providing safer access to stations, then, the center-running alternative is again superior.

Some elements of the center-running alternative would, however, impede other types of pedestrian travel. It is possible, however, that these impacts could be dampened by design modifications; they will be discussed in the following section.

Recommendation of Alternative

This initial analysis has considered the implications of Woodward light rail alignment alternatives for transit travel alone, specifically on its two most important elements: operation of transit vehicles and access to transit stations. A comprehensive analysis of the alternatives’ relative effects on all types of transportation in the corridor, and their more general implications for community livability, environmental sustainability, and social equity, must be completed in its entirety before a final recommendation can be made. However, improved transit service is obviously the primary goal of the Woodward light rail project, and there is little doubt that the center-running alternative would provide more effective transit service, including both faster transit travel and enhanced access to stations, from a review of project documents and other relevant literature. Unless the studies yet to be completed predict other severe adverse impacts under the center-running alternative, the City and Federal Transit Administration should select it as the preferred alternative for this uniquely important project.

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Appendix



Fig. 1. Center-running line. DTOGS



Fig. 2. Curb-running alignment. M1 Rail



Fig. 3. Woodward Avenue in 2010. Photo by author

Table 4-20. Comparison of Center-Running and Side-Running north of Downtown*

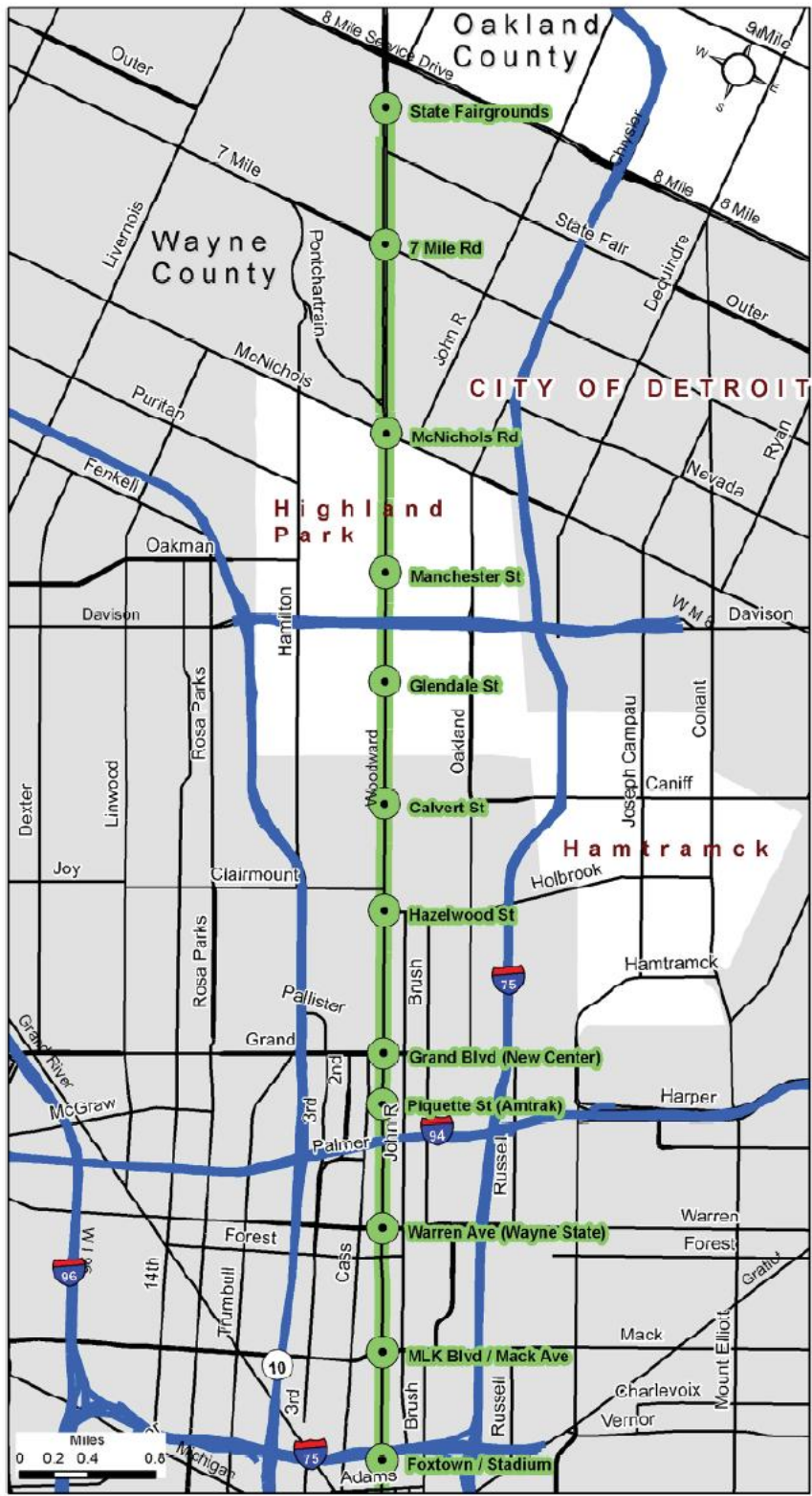
Direction	Type of Rail	AM Peak Hour	PM Peak Hour
Southbound	Center-Running	8 min 58 sec	9 min 42 sec
	Side-Running	11 min 39 sec	11 min 22 sec
	Difference	2 min 41 sec	1 min 40 sec
Northbound	Center-Running	8 min 33 sec	8 min 57 sec
	Side-Running	11 min 24 sec	11 min 28 sec
	Difference	2 min 51 sec	2 min 31 sec

*Between Grand Boulevard and Grand Circus Park

Fig. 4. Alternative travel times on downtown-New Center segment. *Parsons Brinckerhoff*



Fig 5. Portland Streetcar. *MSI Design* Fig 6. Portland MAX light rail. *Light Rail Big Photos*



**Woodward Light Rail
Project Location Map:
Mainline
Design Option A**

Legend

- Interstate
- Major Road
- Minor Road
- Median Running
Traffic Separated
- Proposed Station



July 2010

Figure 7. Center-running alternative map. FTA

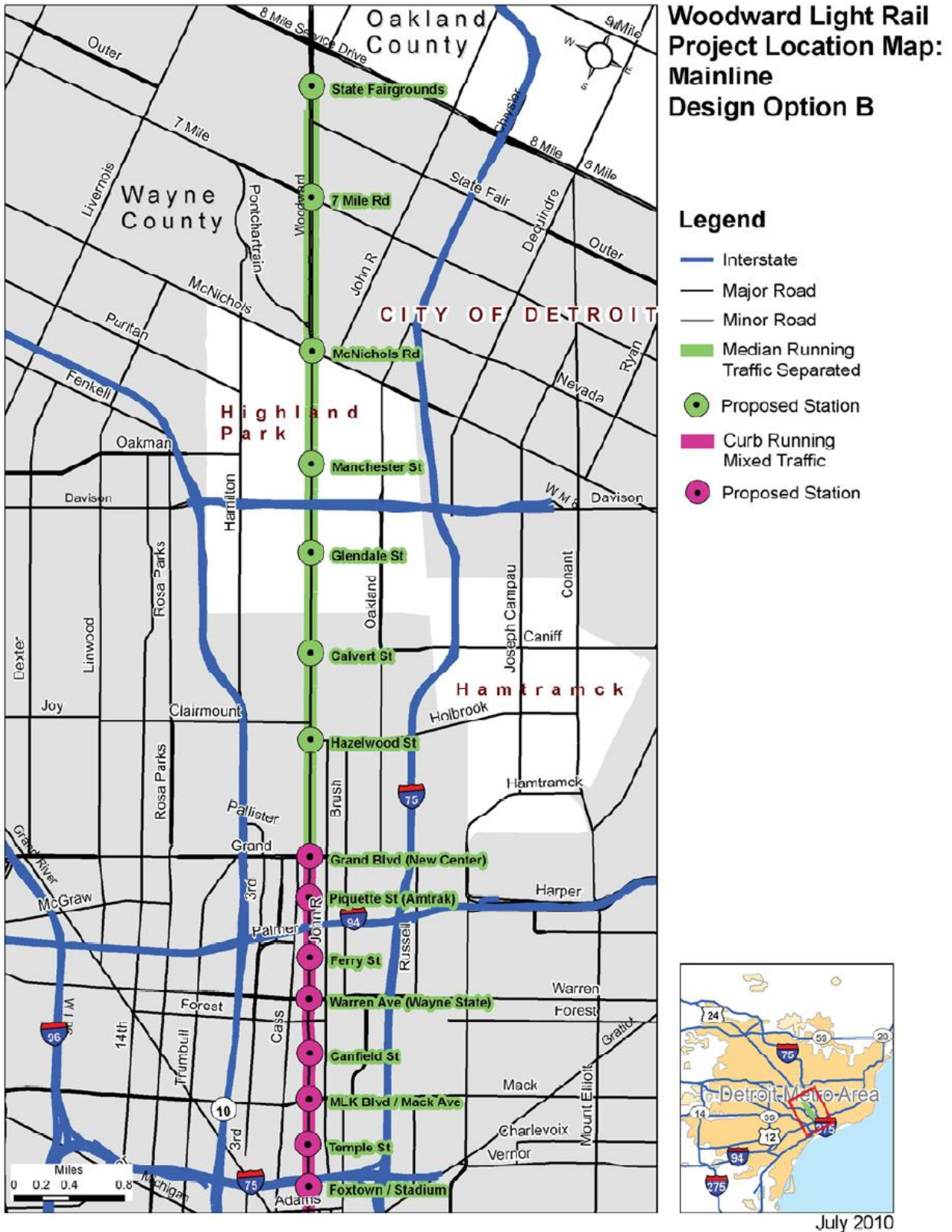


Figure 8. Curb-running alternative map. FTA