

6. Locally Preferred Alternative

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Capital Cost Estimate

Capital cost estimates for the Urban Rail system plan were prepared consistent with the Standard Cost Categories used for Federal Transit Administration (FTA) New Starts projects. The project team developed the estimates using three general steps:

- The team prepared a number of conceptual engineering documents, including a Basis of Design, conceptual design (to approximately 10-15% complete), and utility conflict estimation for the proposed system plan, which is sufficient for budget-level cost estimates. **These conceptual engineering documents are published separately** and will be available from the City's Austin Strategic Mobility Plan website, <http://www.austinstrategicmobility.com/resources/urban-rail-project>.
- The project team identified system components, quantities, and localized unit cost data. System components and quantities were compiled from individual alignment segment estimates, which will facilitate future project phasing discussions.
- Finally, the project team applied additional factors such as contingencies, engineering and administration (E&A) costs, and year-of-expenditure escalation to the cost subtotals in order to generate the final estimates. For year-of-expenditure estimates, the team used a conceptual construction schedule predicated on a project start date in mid-2011, with actual construction running from late 2011 through mid-2014. **At the time of this publication (July 2010), City leaders have extended the project development timeline so that these calendar assumptions are no longer appropriate. Therefore, the timeline assumptions will be updated prior to seeking public funding. The current estimates do, however, provide a basic estimate of cost for on-going discussion.** The assumed construction schedule is based on a design-build, or similar, delivery method can help ensure a higher quality product due to the integration of design and construction efforts. This approach can be more expensive – and conservative – because it accounts for the assumption of risk by the contractor, which is otherwise held by the owner under a conventional design-bid-build delivery method. Year-of-expenditure costs were developed using a straight-line projection based on a calculated mid-point of construction, according to the schedule noted above and included in the conceptual engineering documents. An inflation rate of 5.25% per year was used for escalation and reflects uncertainty and unpredictability of inflation in the construction industry.

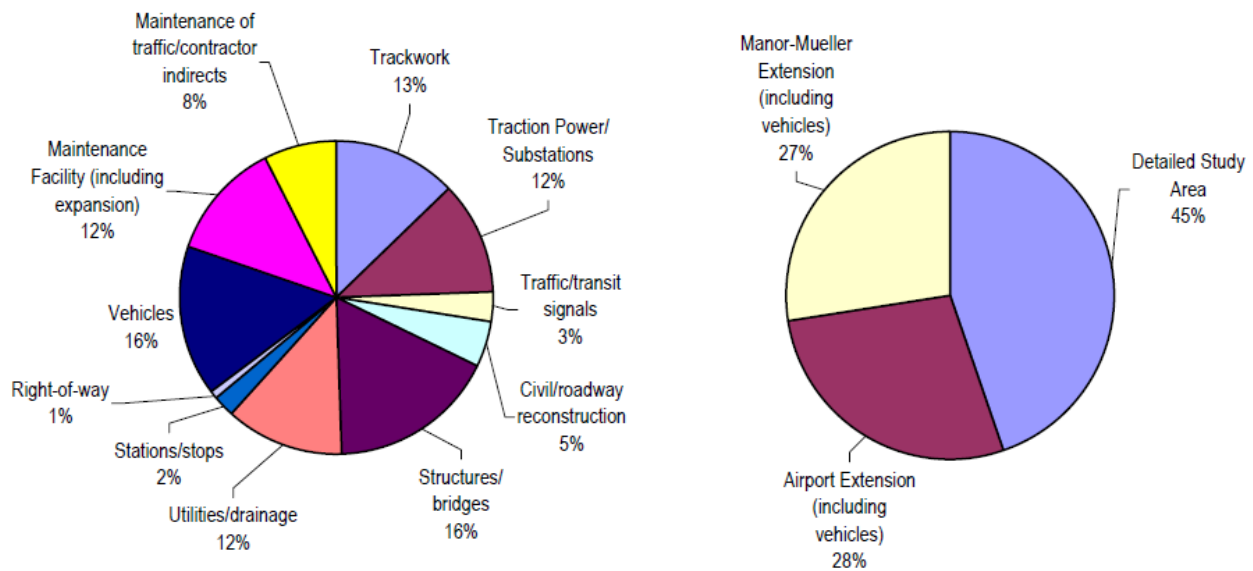
The capital cost estimate includes a cost for building a new multi-modal bridge over Lady Bird Lake, as a “worst case” scenario given that it is likely to be somewhat more expensive than rehabilitating either of the existing downtown bridges, for a total cost of \$33.8 million after application of contingencies. At 33.8 track miles, the recommended Urban Rail Locally Preferred Alternative, as shown in Figure 5.2, is estimated to cost \$955.1 million in first quarter 2010 dollars (\$1.3 billion in year-of-expenditure dollars). This equates to \$37.2 million per track mile. Table 6-1 and Figure 6-2 summarize the system plan cost by major cost category.

Table 6-1. Summary of Capital Cost Estimate by Major Category

Capital Cost Category	Estimated Capital Cost		
DETAILED STUDY AREA			
Trackwork	\$56,840,000	12.8%	
Traction Power/Substations	\$51,485,000	11.6%	
Traffic/transit signals	\$13,165,000	3.0%	
Civil/roadway reconstruction	\$21,625,000	4.9%	
Structures/bridges	\$76,385,000	17.2%	
Utilities/drainage	\$54,065,000	12.2%	
Stations/stops	\$9,680,000	2.2%	
Right-of-way	\$3,735,000	0.8%	
Vehicles	\$68,835,000	15.5%	
Maintenance Facility (including expansion)	\$54,590,000	12.3%	
Maintenance of traffic/contractor indirects	\$33,445,000	7.5%	
SUBTOTAL	\$443,850,000	100.0%	44.8%
EXTENSIONS			
Airport Extension (including vehicles)	\$275,355,000		27.8%
Manor-Mueller Extension (including vehicles)	\$271,625,000		27.4%
SUBTOTAL	\$990,830,000		100.0%
Unallocated contingencies (15%)	\$148,625,000		
Contractor/risk markup (12%)	\$118,900,000		
TOTAL	\$1,258,355,000		

Source: URS Corporation, 2010.

Figure 6-2. Summary of Capital Cost Estimate by Major Category



The previous system cost estimate developed for the 2008 *Modern Streetcar/LRT Proposal* was \$537 to 622 million in mid-2008 dollars (depending upon alignment and design components). This updated cost estimate of \$955 million in first quarter 2010 dollars (\$1.3 billion YoE) is consistent with the previous estimate and differs for the following reasons:

System Plan Length

- A longer system plan at 33.8 track miles (vs. 30.6 track miles for the 2008 *Modern Streetcar/LRT Proposal*) due to the addition of the West CBD, or Lavaca-Guadalupe, alignment into West Campus, as well as the Maintenance Facility and Palmer/Long Center Spur.
- An increase in the number of vehicles anticipated, from 20 in the 2008 study to 33 in this study, based upon the proposed operating plan for this longer system.
- An assumption of \$53 million for the Urban Rail maintenance facility in this most recent estimate vs. \$15 million in the 2008 proposal to include contingencies and other add-ons and to reflect the larger fleet proposed herein.

Timing/Year-of-Expenditure (YoE)

- A change in the base year from 2008 to 2010, escalated at 5.25% per year.
- The use of year-of-expenditure (YoE) dollars instead of current year dollars, consistent with CAMPO requirements, which more accurately reflects the anticipated costs at the time of construction.

Risk/Delivery Method

- A contractor, or risk, markup of 12%, which is typical of FTA-funded projects and a realistic accounting for risk (i.e., cost overruns). This markup is an actual cost that is paid up front to the contractor under a design-build contract, which is generally lump sum, or it is held by the owner under a conventional design-bid-build delivery method.
- An increase in engineering and administration costs (E&A) from 20% of construction under the 2008 proposal to 31% under this Urban Rail estimate, to more accurately reflect typical FTA assumptions, and a more detailed (and conservative) estimation of contingencies, both allocated and unallocated, consistent with FTA requirements.

NOTE TO READER: It is important to recognize that these cost estimates are conceptual in nature and reflect the level of design appropriate for this *Transit Study*. These estimates are subject to change due to more detailed planning and design activities, changes to the program development schedule, and public and agency reviews.

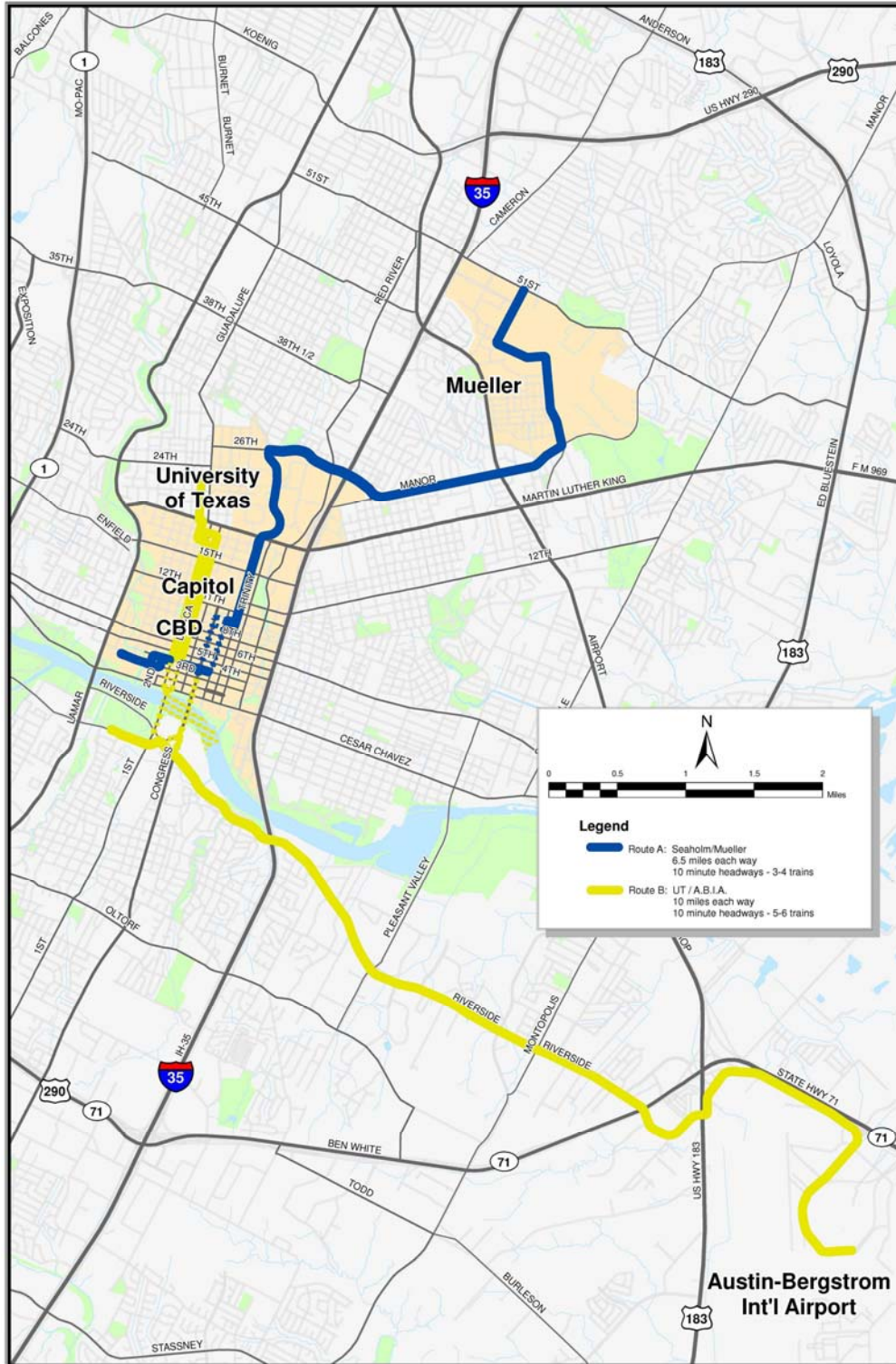
Operating Plan

For this concept plan, the Urban Rail system is assumed to operate with two 'legs' that cross downtown on Fourth Street, as shown in Figure 6-3. Additional operations assumptions include:

- Two crossing routes:
 - Route A links Seaholm Redevelopment to Mueller Redevelopment using the East CBD alignment (Congress-San Jacinto) through downtown and the UT campus. This route is 6.5 miles each way or 13 total track miles.
 - Route B links West Campus to ABIA using the West CBD alignment (Guadalupe-Lavaca) and crosses Lady Bird Lake, on either of the two existing bridges or a new bridge, and continues down East Riverside Drive to the airport. This route is 10 miles in each direction or 20 track miles.
- 10-minute peak and off-peak headways (time between train arrivals) for 16 hours per day.
- Annualization factor of 300 applied to daily vehicle miles and vehicle hours to account for reduced service on weekends and holidays.
- Average operating speeds of 12 miles per hour on shared right-of-way segments (typical of local streets due to effects of traffic lights, etc.) and 25 miles per hour on semi-exclusive segments (such as East Riverside Street to ABIA).
- Vehicle is comparable to the Siemens S70 Ultra Short model, which can accommodate up to 269 total passengers (seated and standing) at AW4 loading.¹ The peak hour passenger capacity used to develop the operating plan is 165 passengers at AW2 loading.

¹ AW0 refers to total car weight, in a ready for revenue service condition, without passengers; AW1 refers to car weight plus fully seated passenger load (at 155 pounds per passenger); AW2 (Design Load) is seated load plus standing passengers at 4 per square meter of suitable standing space; AW3 (Crush Load) is seated load plus standing passengers at 6 per square meter of suitable standing space; and AW4 (Structure Design) is seated load plus standing passengers at 8 per square meter of suitable standing space. Source: TCRP 57, 2000, "Track Design Handbook for Light Rail Transit," Transit Cooperative Research Program Report 57, National Academy Press, 2000.

Figure 6-3. Proposed System Operation Plan



Source: URS Corporation, 2010.

Operations and Maintenance Cost Estimate

As noted above, the proposed Urban Rail system is assumed to operate at 10-minute peak/off-peak headways for 16 hours a day, with a three-hour peak period in both the morning and evening. An annualization factor of 300 was applied to daily vehicle miles and vehicle hours to account for reduced service hours on weekends; this figure is a typical annualization factor used in FTA New Starts applications and calculations.

In order to validate the operating assumptions, three alternative scenarios were evaluated for passenger capacity and cost. A typical planning assumption is that a system's peak hour ridership is equal to approximately 15% of its average daily ridership. This system's estimated daily ridership in 2030 is 27,600 passengers (as detailed later in this chapter); therefore, the operating plan should be able to accommodate approximately 4,140 passengers during peak hour operations.

The three operating scenarios, for the full 33.8 track-mile system, that were evaluated used the following headways:

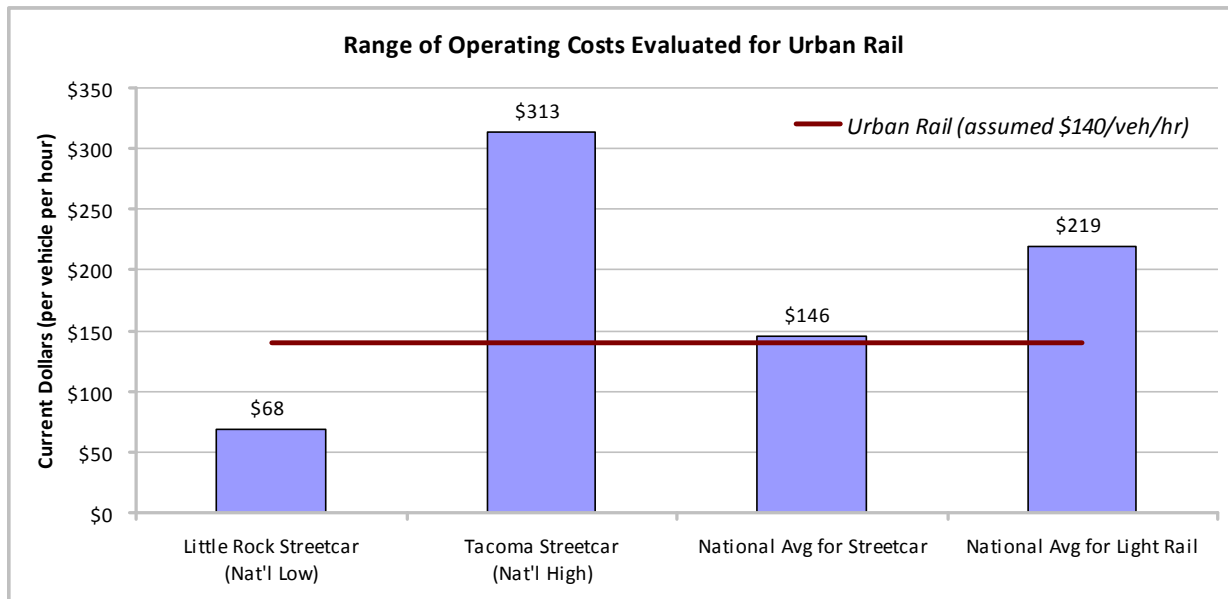
- 12.5-minute peak/12.5-minute off-peak.
- 10-minute peak/10-minute off-peak;
- 7.5-minute peak/10-minute off-peak; and

The methodology for estimating operations and maintenance costs is based on an assumed typical cost per vehicle revenue hour for modern streetcar systems, which are sufficiently similar to the proposed Urban Rail alternative. According to FTA's 2008 National Transit Database², operating costs per vehicle revenue hour for streetcar systems in Portland, Seattle, Tacoma, Little Rock, and Tampa range from a high of \$313/vehicle/hour in Tacoma to a low of \$68/vehicle/hour in Little Rock, for a national average of \$146 per vehicle revenue hour. According to the U.S. Department of Labor's *Davis-Bacon Wage Determinations*³, labor costs in the Austin area are lower than the national average; consequently, this study uses a cost per vehicle revenue hour of \$140/vehicle/hour for operations and maintenance costs estimation. By way of comparison, the 2008 National Transit Database shows that the national average for operating costs for light rail is \$219/vehicle/hour. Figure 6-4 illustrates the comparative cost basis data used to develop the proposed Urban Rail system plan operating cost estimate.

² Federal Transit Administration, 2010, *National Transit Database*, <http://www.ntdprogram.gov/ntdprogram/>, accessed June 15, 2010.

³ U.S. Department of Labor, 2010, *Davis-Bacon Wage Determinations*, <http://www.gpo.gov/davisbacon/>, accessed June 17, 2010.

Figure 6-4. Range of Operating Costs Evaluated for Urban Rail



Source: FTA National Transit Database, 2010.

Similar to the capital cost estimate, current dollar operating costs need to be escalated to the anticipated year-of-expenditure (YoE). Consistent with the full system ridership projection year of 2030, the operating cost of \$140/vehicle/hour was escalated at an assumed rate of 1.50% for 22 years (2008 – 2030) to arrive at an estimated operating cost of \$195/vehicle/hour. This escalation rate is consistent with the historical trends in operating costs for the systems noted above in the National Transit Database.⁴

Tables 6-2 through 6-4 contain the operations and maintenance cost estimation parameters and calculations for the three operating scenarios considered.

Table 6-3 shows that the base operating scenario, 10-minute peak/off-peak headways, meets the projected system capacity demands in 2030 using two-car consists (i.e., two trains coupled together) for an estimated cost of \$25.3 million. In comparison, Table 6-2 shows that for \$20.6 million (about 19% less), a 12.5-minute peak/off-peak service could still meet nearly 88% of the projected demand. On the other hand, Table 6-4 shows that increasing the peak service from 10- to 7.5-minute headways is quite expensive and overshoots the demand considerably. This range of estimated annual operating costs for 10- and 12.5-minute service is consistent with the \$21-\$23 million estimate from in the 2008 *Modern Streetcar/LRT Proposal*, especially given the escalation for YoE costs and additional vehicles.

The vehicles in this exercise are assumed to be comparable to the Siemens S70 Ultra Short model, which can accommodate 165 passengers seated and standing under AW2 loading (4 passengers standing per square meter plus seated). This peak hour service capacity is typical for planning purposes.

⁴ Federal Transit Administration, 2010, *National Transit Database*, <http://www.ntdprogram.gov/ntdprogram/>, accessed June 15, 2010.

Note also that these two viable scenarios equate to approximately \$640,000 to \$785,455 per track mile; this compares with the national average for the five most recent streetcar systems (Portland, Seattle, Tacoma, Little Rock, and Tampa) of \$822,000 per track mile.⁵

Table 6-2. Operating Plan and Costs: 12.5-Minute Peak/12.5-Minute Off-Peak Headways

	Route A	Route B	Totals
Length (one-way route miles)	6.5	10	16.5
Round-trip travel time (minutes)*	65.0	66.2	
Vehicles needed (does not include 2 spares)	11	11	22
Peak-hour capacity (165/vehicle)	1,815	1,815	3,630
Peak-hour capacity needed			4,140
Difference			-510 (-12%)
Passenger Trips/day	154	154	
Vehicle miles/day	998	1,536	2,534
Annual vehicle miles (Annualization = 300)			760,320
Vehicle hours/day (16 hr/day)			352
Annual vehicle hours (Annualization = 300)			105,600
Annual O&M costs (\$195/veh/hr YoE)			\$20,592,000
Annual O&M cost/track mile (34 track miles)			\$640,000

Source: COA & URS Corporation, 2010.

*12 mph average speed on shared segments and 25mph average speed on semi-exclusive segments.

Table 6-3. Operating Plan and Costs: 10-Minute Peak/10-Minute Off-Peak Headways

	Route A	Route B	Totals
Length (one-way route miles)	6.5	10	16.5
Round-trip travel time (minutes)*	65.0	66.2	
Vehicles needed (does not include 2 spares)	13	14	27
Peak-hour capacity (165/vehicle)	2,145	2,310	4,455
Peak-hour capacity needed			4,140
Difference			315 (+8%)
Passenger Trips/day	192	192	
Vehicle miles/day	1,248	1,920	3,168
Annual vehicle miles (Annualization = 300)			950,400
Vehicle hours/day (16 hr/day)			432
Annual vehicle hours (Annualization = 300)			129,600
Annual O&M costs (\$195/veh/hr YoE)			\$25,272,000
Annual O&M cost/track mile (34 track miles)			\$785,455

Source: COA & URS Corporation, 2010.

*12 mph average speed on shared segments and 25mph average speed on semi-exclusive segments.

⁵ Federal Transit Administration, 2010, *National Transit Database*, <http://www.ntdprogram.gov/ntdprogram/>, accessed June 15, 2010.

Table 6-4. Operating Plan and Costs: 7.5-Minute Peak/10-Minute Off-Peak Headways

	Route A	Route B	Totals
Length (one-way route miles)	6.5	10	16.5
Round-trip travel time (minutes)*	65.0	66.2	
Vehicles needed (does not include 2 spares)	18	18	36
Peak-hour capacity (165/vehicle)	2,970	2,970	5,940
Peak-hour capacity needed			4,140
Difference			1,800 (+43%)
Passenger Trips/day	256	256	
Vehicle miles/day	1,664	2,560	4,224
Annual vehicle miles (Annualization = 300)			1,267,200
Vehicle hours/day (16 hr/day)			576
Annual vehicle hours (Annualization = 300)			172,800
Annual O&M costs (\$195/veh/hr YoE)			\$33,696,000
Annual O&M cost/track mile (34 track miles)			\$1,047,273

Source: COA & URS Corporation, 2010.

*12 mph average speed on shared segments and 25mph average speed on semi-exclusive segments.

Operations Summary

The operations analysis shows that a typical 10-minute peak/off-peak headway scenario running two-car consists (or train sets) meets capacity needs in 2030 under standard loading assumptions, while a 12.5-minute peak headway scenario does not quite meet capacity requirements. Both scenarios have reasonable operating costs, both in absolute terms (\$21 million to \$25 million), and on a per-track-mile basis when compared with the national average for recent streetcar systems. The 7.5-minute peak headway scenario is not needed for capacity requirements and is considerably more expensive than the other two scenarios.

As noted earlier, vehicles in this exercise are assumed to accommodate 165 passengers at AW2 loading during peak hour service. Changes to this assumption can improve the ability of the 12.5-minute peak scenario to meet the projected demand in 2030.

These scenarios should be subject to more analysis in future phases of the project to more accurately forecast ridership and to determine capacity.

Outstanding Issues

Despite the arrival at a recommended Locally Preferred Alternative, this study, as well as its predecessors, still has some unresolved issues. The Locally Preferred Alternative map shown in Figure 6-1 includes two alignment segments (indicated by dashed line) with viable alternatives. Additionally, a potential maintenance facility site has been identified, but further investigation is recommended before a final selection is made.

Alignment Options

As noted, there are two alignment segments for which there remain alternatives:

- The use of either Congress Avenue or Brazos Street as a primary route for the Urban Rail alignment on the east side of downtown; and
- How to cross Lady Bird Lake, whether on one of the existing bridges or constructing a new bridge.

East CBD – Congress Avenue vs. Brazos Street

One issue involves the designation of a core alignment through the east side of downtown. Previous studies have designated Congress Avenue as the spine of the system; however, subsequent public outreach and evaluation by the project team have established Brazos Street as a viable alternative. Table 6-5 documents the advantages and disadvantages of these two alignment options.

Table 6-5. Analysis of Using Congress Avenue vs. Brazos Street

Alignment	Advantages	Disadvantages
Congress Ave.	<ul style="list-style-type: none"> • More retail and activity center focus. • Considered as Texas’ “Main Street”. • Closer to newly developing residential complexes and hotels. • Closer to employment core of downtown. • Provides opportunity to shift bus traffic off Congress to Brazos or other parallel streets. • Allows focus of development and redevelopment in already developed corridor. • Has support of downtown stakeholders. • Designated as “First Phase Urban Rail Priority Street” under Downtown Austin Plan. 	<ul style="list-style-type: none"> • Parades on Congress could interfere with Urban Rail operations and vice versa. • An Urban Rail system on Congress could displace buses to other streets, requiring rider adjustments to a new system. • Angled parking on Congress is incompatible with Urban Rail operations (though the parking scheme could be modified). • Crown and changes in the street’s profile present design challenges. • Farther from Red Line commuter rail station. • Focuses significant amount of new transit activity on Congress in addition to existing traffic.
Brazos St.	<ul style="list-style-type: none"> • Closer to commuter rail station • Provides opportunity to limit additional transit traffic on Congress. • Provides additional new development opportunities to another street in downtown. • Assumed as a “mixed mode” street under the Great Streets Master Plan. • Designated as an “Alternative Urban Rail Alignment” under Downtown Austin Plan. 	<ul style="list-style-type: none"> • Abundance of parking garage entrances and exits could be problematic. • One-way traffic on Brazos would require the loss of at least one traffic lane for contraflow Urban Rail operations. • Contains alleys and delivery entrances for buildings that front on Congress.

Source: URS Corporation, 2010.

Recommendation

This study recommends that Congress Avenue be used for the primary Urban Rail alignment on the east side of downtown. Its proximity to activity centers and businesses provides a built-in ridership base. Its perception as Texas’ “Main Street” gives it a unique ability to integrate an Urban Rail system that will enhance ridership, development, and support among local residences, businesses, and visitors. If Brazos undergoes a two-way conversion, its viability as the East CBD alignment would be enhanced.

Lady Bird Lake Crossing – Existing Bridge vs. New Bridge

Another key issue is the alignment across Lady Bird Lake. This study includes only a conceptual examination of advantages and disadvantages associated with the identified options: retrofit/rehabilitate either existing bridge (Congress Avenue or South 1st Street) or construct a new bridge (potentially transit, bicycle, and pedestrian modes only) between South 1st Street and Trinity Street. Table 6-6 summarizes some of the key issues



surrounding the use either of the existing bridges or the development of a new bridge.

Table 6-6. Consideration of Lady Bird Lake Crossing Options

Option	Advantages	Disadvantages
Existing Bridge	<ul style="list-style-type: none"> • Potentially lower costs unless major reconstruction required • Provides direct access to Auditorium Shores area and other activity centers • Could be implemented more quickly than construction of a new bridge 	<ul style="list-style-type: none"> • Potential impacts to bat habitat for Congress Ave. bridge • Major traffic engineering issues at intersections with Cesar Chavez • Addition of a new transit mode on already-congested bridges could increase congestion • Construction disruption on severely-congested auto facility • Construction may require extended closing of bridge • Higher risk that construction problems would have significant impacts to vulnerable network
New Bridge	<ul style="list-style-type: none"> • Could connect with potential new developments • Could allow buses to use new facility and lessen congestion on existing bridges • Would provide major new pedestrian/bicycle facility across Lady Bird Lake • Fewer construction impacts on traffic • Provides redundancy to existing corridor • Does not require extensive closure during construction. • Potential for signature multi-modal structure crossing LBL • Lower risk that construction problems would impact network 	<ul style="list-style-type: none"> • Likely higher cost than reconstructing existing bridge • Longer construction time than reusing existing bridge

Source: URS Corporation, 2010.

Recommendation

At this point in the study process, no recommendation is made on the use of either existing bridge or the development of a new bridge. It is recommended that the structural and potential environmental impacts for any option be studied further during the NEPA process.

Maintenance Facility Options

An Urban Rail system, like other passenger rail systems, requires one or more maintenance and storage facilities; the exact number



and location will depend on the specific alignment and length of the system. Traditionally, maintenance facilities for similar systems have been located on parcels from two to five acres in size depending on the number of vehicles in the fleet. Activities that could be performed at such a facility include:

- Vehicle storage and layover;
- Operator reporting and dispatching;
- System operations supervision;
- Daily maintenance, such as interior and exterior cleaning;
- Inspections, including daily safety inspections, and long-term periodic inspections;
- Running repairs or light maintenance such as replacing broken glass or indicator lights, door malfunctions, and similar activities;
- Component change-out, including major components such as motors;
- Vehicle unscheduled and daily repairs; and
- Parts and materials storage.



Maintenance facilities generally include interior track, repair pits, jacks and cranes as needed, and related facilities. As with stations, exterior design of maintenance facilities can be as simple or sophisticated as budgetary resources allow or as local design standards dictate.

Consideration should be given to neighborhood acceptance of Urban Rail maintenance facilities by integrating other community-based uses into the facility or parcel. Transit maintenance facilities of any type often encounter community resistance, so that facilities usually are located in less-desirable quasi-industrial or underutilized areas. Owners can enhance the desirability of such facilities by including public amenities such as streetcar museums or maintenance viewing rooms or by adding functions to the building such as police substations, recreation centers, community meeting rooms, or even other transit-oriented development components such as retail, office, or residential development.



As part of this project, Baer Engineering was tasked with examining potential locations for an Urban Rail maintenance facility site. In late 2009, Baer staff developed a long list of 22 potential sites for a facility using basic criteria developed by URS as part of its *Basis of Design Memo*. After consultation with City staff, 19 of the 22 sites were eliminated from further consideration due to price, alternative non-transit development potential, and size. The three remaining sites are:

- 10th to 11th Streets between Guadalupe and Lavaca;
- 9th to 10th Streets between Guadalupe and Lavaca; and
- One Texas Center parking lot.

Both sites between Guadalupe and Lavaca have the same key issues. They both encompass entire city blocks (approximately two acres each), which allows for proper configuration and adequate space for the facility; and they border the potential Urban Rail alignments on Guadalupe and Lavaca, providing easy vehicular flow into and out of the facility without requiring a non-revenue track. Both sites are in the Woolridge Park Capitol View Corridor, which restricts the height of buildings on these parcels. If either of the sites were selected, the City would need to consider requesting a variance from the City ordinance (City Council Chapter 25-2, Appendix A) and the State law (Texas Government Code Chapter 3151) to allow development of an Urban Rail facility.

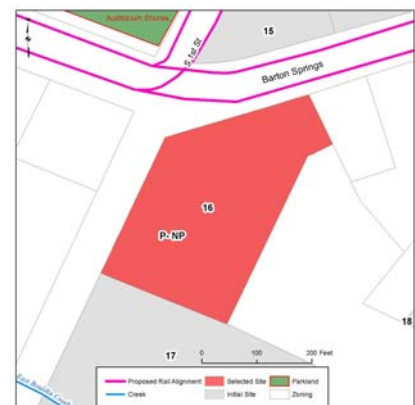
The site at One Texas Center on the south side of Lady Bird Lake is approximately 2.13 acres in size. The site’s linear configuration (compared with the roughly square configurations of the two sites between Guadalupe and Lavaca) provides more facility access and design flexibility. The City owns this parcel, which contains a customer parking lot at present, so substantial time (in terms of land acquisition) and financial savings could be realized here. Given the potential for savings and the significant constraints at the two Guadalupe and Lavaca sites, this site was used for system planning and cost estimation purposes. Further consideration should be given to incorporating additional City uses into a facility at this site, including replacement of the displaced customer parking with possibly integrated, structured parking. It is worth noting that there is considerable un-met demand for special event parking in this area of the city. As there is also a need for affordable housing near downtown, a facility at this site also presents an opportunity to integrate a residential component.



10th to 11th Streets between Guadalupe and Lavaca



9th to 10th Streets between Guadalupe and Lavaca



One Texas Center

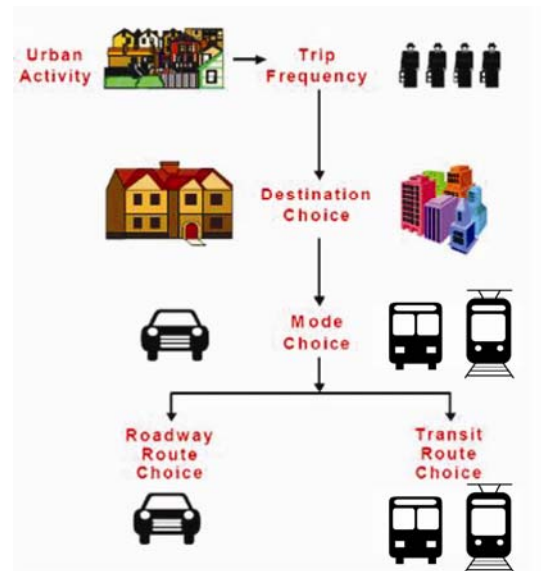
Recommendation

Given the significant financial challenges the City faces to acquire and develop any property within the CBD, the One Texas Center site presents the best option identified thus far. It is advised that additional study be conducted to provide a final recommendation. The *Urban Rail Conceptual Engineering Documents*, published separately and available from www.austinstrategicmobility.com, include the initial maintenance facility site selection report developed for the *Central Austin Transit Study*.

Ridership

Introduction

The methodology used for estimating ridership of the proposed Urban Rail system involves the use of a derivative of Capital Area Metropolitan Planning Organization’s (CAMPO) 2035 regional Travel Demand Model (TDM). The CAMPO model is a complex multimodal tool that can be used to help predict where trips are going to occur within the transportation network and where the demand is for increased infrastructure and improvements. In the simplest terms, the CAMPO model turns people and employees into trips, finds their origin and destination and assigns them a path to complete their trip (see adjacent graphic). The trips are daily so it accounts for home to work, home to shopping and back to home. The most current version of the travel demand model includes the entire transit network, including the City of Austin’s proposed Urban Rail line, Capital Metro’s Red and Green Lines, and Lone Star Rail District’s Regional Rail Line. This transit network forms the foundation of the ridership estimates prepared for Urban Rail.



The following section describes the basic theory of the travel demand model. Later sections will describe the specific assumptions and adjustments that were made based on a post processing technique called “5D”.

Basic Model Theory

By creating and using a travel demand model, one is attempting to produce a mathematical representation of an individual’s actual decision-making process:

Why to make a trip → When to make the trip → Where to make the trip → How to make the trip → What route to follow to complete the trip.

These individual choices are then combined so that aggregate impacts can be determined. The model structure should also be manageable and supported with obtainable data.

As a project develops, travel demand models may be used to make planning level decisions regarding future transportation needs. The models estimate the overall demand on roadway and transit systems

based on the proposed land uses. Models are also used to answer questions such as capacity required within a given roadway or transit route. However, travel demand models are best suited to provide a relative comparison between different alternatives.

Four-Step Modeling Process

The model is comprised of a series of mathematical equations that simulate travel across the overall transportation network. This macroscopic process encompasses the four (4) primary steps taken to estimate travel demand from a given land use and transportation network. The four steps in this approach are as follows:

- *Trip Generation* – the estimation of the number of trip-ends for each zone within the model. More detail on the trip generation process is included in the following section.
- *Trip Distribution* – the estimation of the number of trips between each zone pair.
- *Modal Split* – the prediction of the number of trips made by each mode of transportation between each zone pair. Prior to the assignment process the combined 24-hour person-trip transit table is factored to produce 24-hour peak and off-peak person-trip tables and a peak 3-hour person-trip table.
- *Traffic/Transit Assignment* – this trip assignment step determines the amount of traffic trips that is loaded onto the transportation network through path-building, and is also used to determine network performance. Likewise during this trip assignment step, the model examines transit and walkable trips, tabulating those according to a person’s ability to walk between transit stops and trip origin/destinations. The resulting transit person-trip tables are then assigned to the appropriate off-peak or peak transit modes.

Overview of 5D Transit Post Process

To assist in the planning process for the proposed Urban Rail System the consultant team completed a series of alternative travel demand model runs to determine future ridership potential. In order to produce greater detail from the base travel demand model, the team conducted additional post processing, using the 5D process. The 5D’s – Density, Diversity, Design, and Distance/Destination – were developed from over 50 national case studies completed by Metropolitan Planning Organizations, Council of Governments, and Federal agencies looking at the effects that these basic characteristics have on transit ridership. Currently, a majority of these case studies are being aggregated in the active NCHRP Report 08-61, “Travel Demand Forecasting: Parameters and Techniques.”⁶

In the 5D mode choice, each of the five characteristics affects ridership according to its elasticity. For instance, the closer a person is to transit the more likely they are to ride transit. These characteristics are then used to determine travel times and to estimate ridership. The process adds additional refinement to the person-to-vehicle trip conversion step that exists within the travel demand model. The process was developed as an additional layer to the person-to-vehicle trip conversion step that exists within the travel demand model since many of these local system elements are not accounted for in the current travel demand model.

⁶ NCHRP, 2010, "Travel Demand Forecasting: Parameters and Techniques ", NCHRP 08-61 [Active], <http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=937>

The travel demand model produces person trips for the entire region then distributes these trips amongst all travel modes (auto, transit, bike, and walk), based primarily on travel time and cost. The 5D process further refines the regional transit trip distributions according to additional factors used to determine potential transit ridership along the Urban Rail line. They include:

Distance/Destination

After each model run, predicted travel times were used to generate trip tables of constrained travel times (often called skims). These skims were used as input into a mode choice routine and compared with transit travel times. These travel times were used to evaluate the likelihood that individuals will select transit over a personal vehicle based on the total travel time of the trip. The distance factor also looks at the availability of alternative modes near the traveler’s beginning or end point.

Density

Each demographic scenario contains household and employment density which plays a major role in the time it takes to get to a transit station. Less dense developments often have fewer streets and larger lot sizes which translate to reduced access to transit.

Diversity

The diversity factor evaluates the balance of housing and jobs, in the vicinity of the traveler, as well as demographic inputs, such as the number of available vehicles per household, to determine if travelers are more or less likely to be transit-dependent.

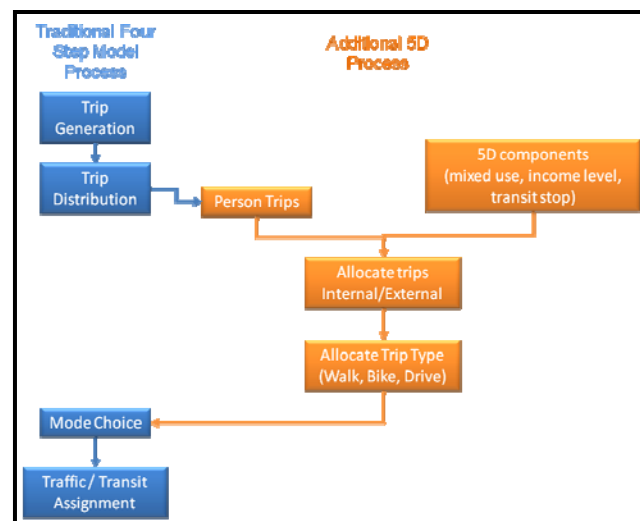
Design

Developments that have a mix of uses (i.e., residential, employment, retail, etc.) within walking or biking distance from each other have the ability to reduce overall auto travel demand and often result in increased transit trips. Standard practice assumes that on average, a single household generates ten auto trips per day. Of those ten trips only two to four are home to work trips. In walkable, mixed-use developments, typically between 12 to 40 percent of the remaining trips are satisfied by walking or biking. The 5D process refines the mode choice development step by applying design characteristics (intensity/density, walkability/mixed-use, etc.) to the outputs with factors based on national and localized data.

The resulting person trip shift derived from the 5D process is then reintroduced into the travel demand model as the “Transit Assignment”.

Application of 5D Post Process

The adjacent graphic illustrates how the 5D process fits into typical four step model process. Specifically the process begins by targeting the unassigned model-generated person trips. These trips have not yet been assigned to Walk, Transit, or Vehicle but are distributed by type. The process starts when the model selects areas that are within a walk, bike or drive shed (¼ mile, ½ mile, 1 mile, respectively). The process then targets specific trip types in the model. For instance Home Based Work Trips tend to favor transit more



than a Non Home Based Other trip type. Therefore the 5D process will assign a higher percentage of trips from the Home Base Work Trips to transit. The additional factor that 5D adds includes development. At this point in the process Traffic Analysis Zones are given increased transit capture rates based on Density, Diversity, Design, and Distance/Destinations.

This process yields more realistic ridership numbers than the regional model alone, providing better information to decision makers. Table 6-7 below compares the results obtained directly from the CAMPO TDM (i.e., no post processing) with those generated from the 5D process.

Ridership Forecast

A derivative CAMPO TDM was used to estimate ridership for the Urban Rail and Better Bus (i.e., Build and TDM) alternatives at a point in the future – 2030 – in which the full system, or LPA, would be in operation, and according to the CAMPO TDM 2030 demographics. The forecast year is also consistent with that used for the CMTA Alternatives Evaluation and Downtown Austin Plan, which provides for realistic comparisons. Both the Urban Rail and Better Bus alternatives were modeled along the same alignments with the same basic operating assumptions.

Table 6-7 shows the full system ridership estimates for both the Build and TSM alternatives.

Table 6-7. Ridership Estimates by Mode and Post Processing Method

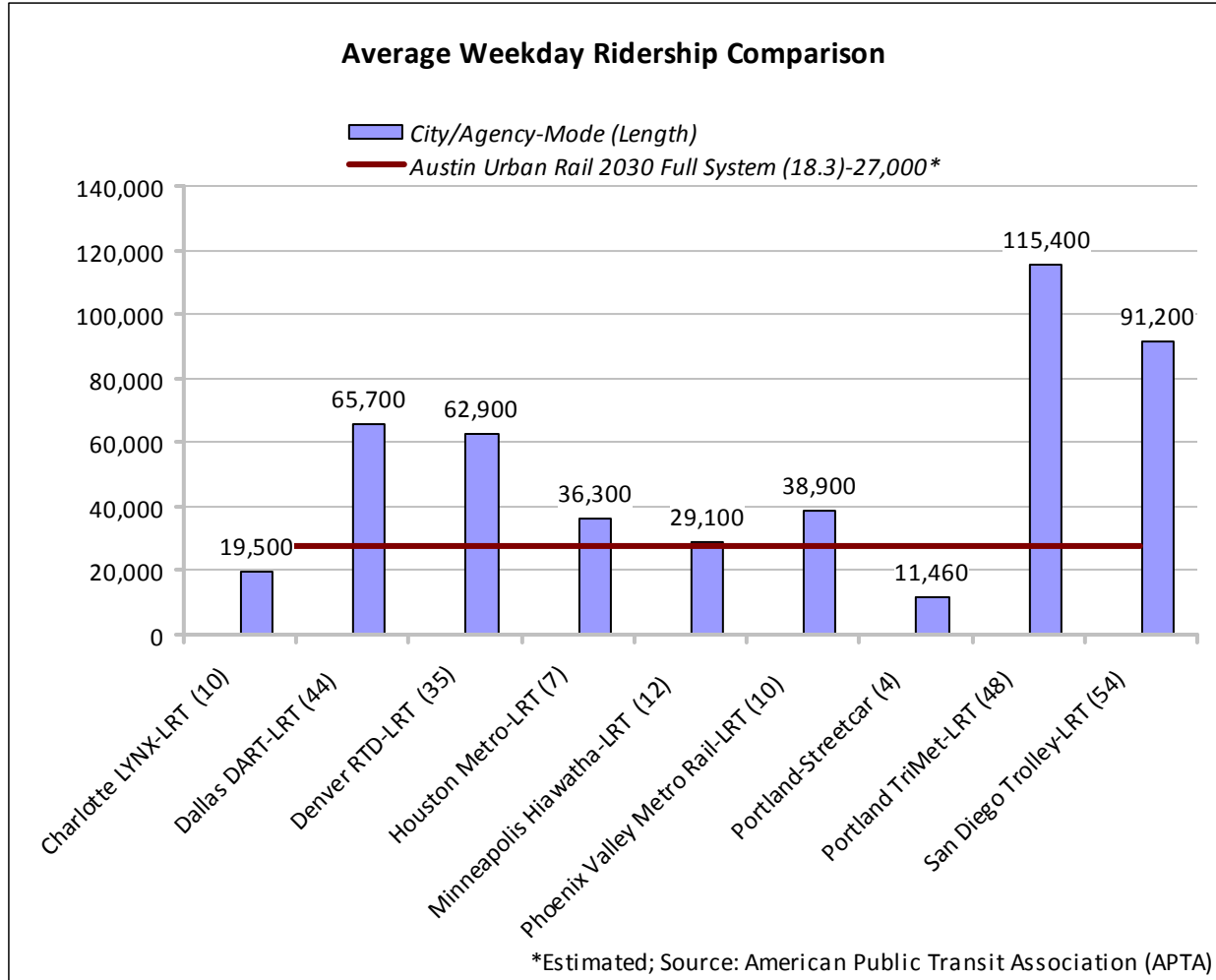
Route	CAMPO TDM	With 5D Post Process	Segment Length
2030 Full System			16.5 route miles
Urban Rail	17,800	27,600	
Better Bus	5,500	9,000	

These ridership forecasts are viewed as conservative and could be surpassed in Austin. Similar cities and metro areas have successfully implemented urban rail-type transit systems that have exceeded these ridership projections in Austin.

Comparison with Other Cities

When comparing the Urban Rail alternative's ridership projections with actual ridership numbers from similar U.S. cities, it is clear that estimations generated via the 5D process are realistic. Figure 6-5 compares average weekday ridership numbers for various Urban Rail-type streetcar and light rail systems with the estimate for Austin. These represent good benchmarks for Urban Rail's ridership potential.

Figure 6-5. 2009 Average Weekday Rail Ridership Comparison



Source: COA & Kimley-Horn and Associates, Inc., 2010.

Ridership Summary

This analysis builds upon a derivative of the 2035 CAMPO forecasting model and its demographic forecasts to provide a conceptual ridership estimation. The findings are indicative of the general scale of ridership attainable by the proposed Urban Rail system and are valid for comparison of investment alternatives. This realistic, though preliminary, forecast indicates there is good overall ridership potential for the Urban Rail alternative versus Better Bus. The addition of the 5D process does appear to capture the well-documented ability of rail transit to encourage compact, higher-density development along its route.

Locally Preferred Alternative Summary Characteristics

As a result of the conceptual and detailed evaluations, the recommended Locally Preferred Alternative (LPA) is Urban Rail, on the alignment as illustrated above in Figure 6-1, with the following characteristics:

Length:	33.8 track miles, 16.5 route miles
Capital Cost:	\$955 million in first quarter 2010 dollars or \$1.3 billion in year-of-expenditure (YoE) dollars* at \$37.2 million YoE per track mile.
Operations Cost:	Approximately \$25 million YoE per year.
Ridership:	Average weekday ridership projected to be approximately 27,600 by 2030.
Operations Plan:	Two crossing routes (6.5 and 10 route miles each), with 10-minute peak/off-peak headways, using 27 vehicles (plus 2 spares), with service 16 hours a day/5 days a week and reduced service on weekends and holidays.
Travel Time:	Approximately 32 – 33 minutes from end-to-end for both routes.

(* Regional transportation plans require year of expenditure (YoE) estimates that account for inflation.)

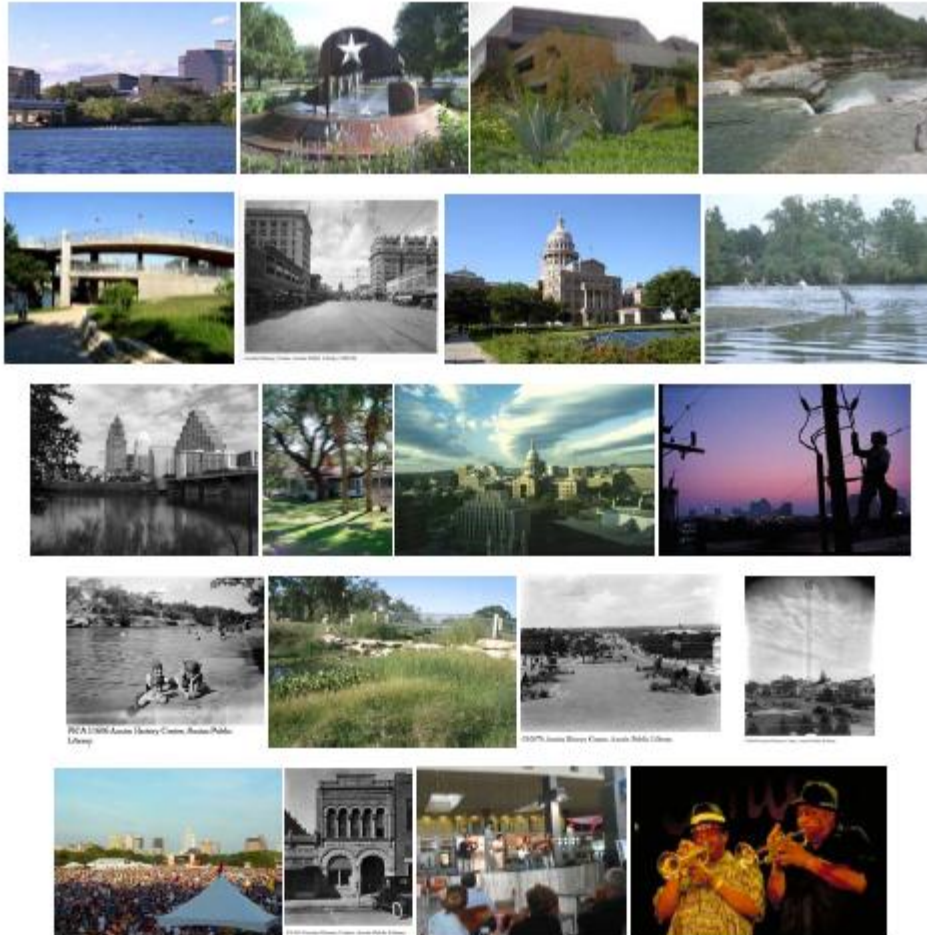


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