



**Memorandum**

To: Mr. Arthur Holmes  
Director  
Montgomery County Department of  
Transportation

Date: September 20, 2013

Project 11735.02  
No.:

From: Christopher Conklin  
Director of Transportation Systems  
Mid-Atlantic Region

Re: Countywide Transit Corridors  
Functional Master Plan – Long Range  
Planning Cost Estimate

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The Montgomery County Department of Transportation (MCDOT), recognizing the unique cost estimating requirements of the Planning Board Draft of the *Countywide Transit Corridors Functional Master Plan (CTCFMP)*, engaged VHB to develop capital and operating cost estimates for the proposed Master Plan. VHB developed an approach to the cost estimating drawing upon our experience with transit and highway projects on the East Coast, the previous estimates developed as part of the previous *Countywide Bus Rapid Transit Study* prepared for MCDOT, and other ongoing work by the Maryland Transit Administration for the Corridor Cities Transitway.

VHB has worked closely with MCDOT Division Chiefs and other key staff to develop a preliminary capital and operating cost for the system of BRT corridors proposed in the CTCFMP. We have collaborated with MCDOT Division of Transportation Engineering staff to adjust unit prices to reflect recent experience with county projects and to develop estimates of the land value associated with the right-of-way requirements for the CTCFMP. Our work has also been coordinated with the Montgomery County Department of Planning to align our assumptions with the intentions of the CTCFMP.

The following memorandum describes the methodology employed to develop the preliminary cost estimate and is followed by corridor-level capital, operations and maintenance cost estimates. Finally, this memorandum is supported by a list of key assumptions that form the basis of our estimate.

### **Basis of Estimate – Functional Master Plan**

Estimates of capital and operating costs are often based on a preliminary, schematic, or more advanced level of design. In the case of the CTCFMP, there is no design basis for this estimate. The CTCFMP provides ridership data, recommended treatments for corridors, or portions of corridors, and station locations. These treatments are generic, without specific layouts, dimensions, or other key variables defined. Additionally, the CTCFMP does not account, in detail, for impacts to the existing infrastructure present on the roadway corridors.

As a result, there is more potential variability between the estimate provided than there would be at a more advanced level of planning and design. The County Council should be aware of the substantial likelihood of changes as designs are advanced for any of the proposed corridors during the Facility Planning Process. Our work has relied directly on the recommendations for the corridor treatments and ridership estimates per corridor contained in the CTCFMP. Other work is proceeding concurrently with the Council's review of the CTCFMP that may suggest changes to the treatments and service plans; however, this estimate does not include any of those recommendations.

## **Capital Cost Estimate Methodology**

Developing a cost estimate at the master plan level has required an approach specifically developed to account for the recommendations and absence of a specific design. Basic templates for guideway and station areas reflecting the recommendations of the CTCFMP have been developed. Additional costs related to reconfiguring the existing streets, utility relocation, bridges, retaining walls and intersection improvements were also developed for locations where implementation of the recommended treatments were likely to necessitate this additional work.

To estimate the unit prices applied to the corridors, a series of areas and quantities for components of the RTS system were developed using unit prices for elements of construction. For stations, templates for the layout of the stations (including left-turn lanes and traffic signal reconstruction at intersections) and station elements (canopies, fare vending machines, benches, etc.) were developed. For guideway, per linear foot costs were developed (including curbing, drainage and stormwater management, paving, etc.) The costs for the basic elements of guideway and stations were developed in collaboration with MCDOT's Division of Transportation Engineering staff. The additional elements (utility relocation, other street work, signal modifications, bridge work, retaining walls) were then applied to the corridor estimates as appropriate using per linear foot, or per location measures.

Right-of-way needs were also estimated. Using County-provided GIS data, additional right-of-way beyond that currently owned by the State, County or Municipalities was estimated using parcel-data along each corridor. Additionally, the increment of right-of-way between the current master plan and the proposed CTCFMP recommendations is also estimated. MCDOT Property Acquisition Section staff applied appropriate land values for these areas based on their location within the county. Right-of-way required in Prince George's County is not included in this estimate.

In addition to costs associated with the corridor applications themselves, capital costs associated with the fleet requirements and for the maintenance facility were also developed. The operating and maintenance cost estimate (described below) was used to develop the fleet requirement. A per-bus estimate for maintenance facilities was developed using the most recent, large bus maintenance facility project in the region (Cinder Bed Road in Fairfax County) as a basis. This per-bus estimate, inclusive of project capital and land costs, is applied to the fleet requirement to develop a maintenance facility cost estimate per

corridor). Other factors to account for project management and design costs are added separately to this estimate.

From these assumptions a capital cost estimate was developed for each corridor, to which a 50-percent contingency is applied to account for changes likely to occur if specific designs are developed.

## **Operations and Maintenance Cost Estimate Methodology**

Operations and maintenance costs are an important component in understanding the on-going cost implications of the CTCFMP recommendations. Based on conversations with Montgomery County Department of Planning, peak hour, peak segment ridership estimates for each corridor were used as the basis for determining the service level for each corridor. The ridership estimates were developed from a hybrid of the Model Run 2 and 2A. Using a policy assumption of 70 percent of crush capacity for a 60-foot articulated bus, a peak period capacity of 85 passengers per bus was used on the peak load segment to determine the required peak period frequency of service for each corridor. This frequency, combined with the travel time for each corridor, and a spare ratio of 1.2 is used to develop the fleet requirement for each corridor.

Using estimates of peak period to mid-day and off-peak service, 20-hours of service per-day, estimates of corridor speeds, and driver-break and out-of-service travel times, the total hours of bus service were estimated for each corridor. An hourly cost of operation is applied to the hours of bus service on each corridor.

In addition to bus operations, O&M estimates were developed for the guideway and station components of the system. The guideway O&M cost is based on Maryland SHA-derived per-lane mile costs, adjusted upward (from \$11,000) to \$15,000 per lane mile to reflect the constrained, urban nature of the CTCFMP corridors. For the stations, an annual O&M estimate of \$12,000 per station, derived from LRT unmanned station estimates in another project in the Northeastern U.S. were applied. An additional increment for expanded operations at the County Transportation Operations Center is also included in the operating and maintenance cost estimate.

To reflect potential changes in service plans and operating requirements, a contingency of 20% is applied to the resulting corridor operating and maintenance cost estimates.

## **CTCFMP Corridor Cost Estimates**

The capital and operations and maintenance cost estimates for each of the corridors are presented on the following page. These estimates identify the major cost elements for each corridor and provide cost-per-mile estimates. The estimates are presented in current-year values, not including escalation.

	Georgia Avenue North	Georgia Avenue South	355 North	355 South	New Hampshire Avenue	North Bethesda T-way	Randolph Road	University Boulevard	US 29	Veirs Mill Road
<b>Metrics</b>										
Guideway (mi)	9.64	3.92	14.13	9.35	8.46	2.72	10.08	5.80	11.02	6.16
Signal Reconst.	16	0	25	28	19	4	0	5	6	10
Stations	13	7	20	14	12	7	10	9	11	11
Buses	17	16	57	47	24	8	29	15	40	9
R.O.W. (ac)	24.7	5.3	99.9	38.0	20.6	7.3	7.9	15.2	13.7	20.0
<b>Capital Costs (\$M)</b>										
Guideway	\$78.600	\$0.622	\$155.000	\$132.000	\$53.900	\$42.500	\$1.600	\$11.500	\$114.000	\$91.400
Intersections	\$32.800	\$1.010	\$43.000	\$47.300	\$32.800	\$7.710	\$0.338	\$8.000	\$11.500	\$16.700
Stations	\$63.400	\$9.160	\$84.000	\$71.700	\$49.000	\$28.300	\$13.100	\$33.300	\$32.100	\$51.800
Buses	\$20.400	\$19.200	\$68.400	\$56.400	\$28.800	\$9.600	\$34.800	\$18.000	\$48.000	\$10.800
R.O.W.	\$23.469	\$11.026	\$58.215	\$73.341	\$19.960	\$5.760	\$7.337	\$19.025	\$10.614	\$17.186
Maintenance Fac.	\$10.300	\$9.720	\$34.600	\$28.600	\$14.600	\$4.860	\$17.600	\$9.110	\$24.300	\$5.470
Traffic Maint.	\$41.099	\$7.942	\$76.966	\$67.226	\$35.789	\$18.592	\$13.486	\$15.968	\$46.077	\$35.233
Mobilization	\$20.550	\$3.971	\$38.483	\$33.613	\$17.895	\$9.296	\$6.743	\$7.984	\$23.038	\$17.617
PM/Design Costs	\$47.300	\$4.620	\$71.200	\$62.900	\$33.800	\$18.800	\$7.340	\$13.900	\$41.000	\$37.200
<b>Total</b>	<b>\$338.000</b>	<b>\$67.300</b>	<b>\$630.000</b>	<b>\$573.000</b>	<b>\$286.000</b>	<b>\$145.000</b>	<b>\$102.000</b>	<b>\$137.000</b>	<b>\$351.000</b>	<b>\$283.000</b>
<b>Per-mile</b>	<b>\$35.000</b>	<b>\$17.200</b>	<b>\$44.600</b>	<b>\$61.300</b>	<b>\$33.900</b>	<b>\$53.400</b>	<b>\$10.200</b>	<b>\$23.600</b>	<b>\$31.900</b>	<b>\$46.000</b>
<b>O&amp;M Cost (\$M)</b>										
Bus Operations	\$8.619	\$6.768	\$27.325	\$22.409	\$11.212	\$3.704	\$12.964	\$7.138	\$18.250	\$4.175
Guideway	\$0.129	\$0.000	\$0.320	\$0.246	\$0.114	\$0.051	\$0.000	\$0.041	\$0.168	\$0.093
Stations	\$0.156	\$0.084	\$0.240	\$0.156	\$0.144	\$0.084	\$0.120	\$0.096	\$0.108	\$0.108
Ops Center	\$0.129	\$0.060	\$0.217	\$0.144	\$0.130	\$0.042	\$0.155	\$0.089	\$0.170	\$0.095
Sub-total	\$9.033	\$6.912	\$28.101	\$22.955	\$11.600	\$3.881	\$13.239	\$7.364	\$18.695	\$4.471
Contingency	\$1.807	\$1.382	\$5.620	\$4.591	\$2.320	\$0.776	\$2.648	\$1.473	\$3.739	\$0.894
<b>Total</b>	<b>\$10.900</b>	<b>\$8.300</b>	<b>\$33.800</b>	<b>\$27.600</b>	<b>\$14.000</b>	<b>\$4.700</b>	<b>\$15.900</b>	<b>\$8.900</b>	<b>\$22.500</b>	<b>\$5.400</b>
<b>Per-mile</b>	<b>\$1.13</b>	<b>\$2.12</b>	<b>\$2.39</b>	<b>\$2.95</b>	<b>\$1.65</b>	<b>\$1.73</b>	<b>\$1.58</b>	<b>\$1.53</b>	<b>\$2.05</b>	<b>\$0.88</b>

## Assumptions List

Given the planning-level nature of the CTCFMP and the limited detail provided with regard to specific operational and design elements of the system, VHB was required to apply a range of assumptions in our approach to developing costs for the system as a whole and each corridor specifically. VHB reviewed key assumptions with MCDOT staff and received feedback and refinement during the development of the cost estimate. This memorandum summarizes the key assumptions related to overall RTS system characteristics, unit cost calculations, calculation of quantities, and overall cost estimation approach.

### RTS System Assumptions:

- RTS corridor attributes specifically identified in the CTCFMP, including guideway treatments, corridor lengths, segment locations, lane repurposing, right-of-way recommendations, etc. are estimated as shown in the CTCFMP, unless otherwise specified in the following assumptions.
- Total system cost reflects removal of overlapping treatments for routes operating along the same segments (i.e. Randolph Road RTS corridor overlapping briefly with the Georgia Avenue RTS corridor in Glenmont).
- At intersections where median guideway stations are planned, the cost estimate assumes full depth and width reconstruction of approximately 1,400 feet of roadway (700 feet to either side of intersection) to accommodate station platforms, one turning lane, transitions/tapers, and RTS guideway. Specific quantities for roadway/intersection reconstruction within these station areas are based on the median station concept developed for each type of median guideway treatment.
- For two-lane side running guideway stations, specific quantities for station areas are based on the two-lane side running station concept. This concept assumes the guideway and stations will be constructed without reconstructing the adjacent roadway.
- Cost estimate assumes full reconstruction of turning lanes and traffic signal equipment at all signalized intersections where median guideway is recommended.
- Cost estimate assumes no reconstruction of unsignalized median breaks where median guideway is recommended.
- Cost estimate does not include reconstruction of adjacent service roads or ramps connecting to RTS corridors where widening is planned.

- Cost estimate includes construction of the recommended cycle track in the Georgia Avenue North median, but otherwise does not include new pedestrian or bicycle facilities supporting RTS corridors discussed in Appendix F of the CTCFMP.

### **Unit Cost Calculation Assumptions**

- Costs are based on 2013 weighted average unit bid prices.
- Unit costs for utility pole relocation were provided by MCDOT based on other recent county roadway construction projects. This estimate does not include costs for the relocation of underground utilities.
- Costs for the relocation of street lights or new street lights are not included.
- New closed stormwater management and drainage treatments are assumed necessary for all median guideways and unit costs for these elements were provided by MCDOT based on other recent county roadway construction projects.
- Unit per square foot costs for bridge widening were provided by MCDOT.
- Unit costs for managed lane segments assume existing signal infrastructure is adequate for installation of new bus lane identification signals without need for replacement of strain poles, electrical equipment, etc. New signal heads (2 per span) were added for the bus lanes only.
- Maintenance facility costs are based on a unit cost of \$405,000 per bus (prior to application of an additional 50% contingency applied to all capital costs). This unit cost includes land acquisition.
- For estimating purposes, terminus stations are assigned a station type consistent with the guideway type for the roadway segment where the station is located. No special station treatments or features have been assumed for terminus stations.
- The number of RTS vehicles (60-foot articulated buses at \$1.2 million per bus) required for this project was determined based on a ridership demand forecast prepared by M-NCPPC Montgomery County Department of Planning.
- Capital costs are not included in this estimate for new or expanded centralized traffic control center facilities.

### **Calculation of Quantities Assumptions**

- Roadway widening is assumed to be necessary only for segments designated for median guideways where the CTCFMP recommends no lane repurposing and the specified guideway treatment exceeds the existing median width by more than four

feet. Below this amount, it is assumed that lane re-striping or other low-cost measures will be sufficient to maintain an adequate operational roadway width.

- Where the existing median width is inadequate for the specified median treatment by 5-15 feet, one lane of roadway widening is assumed necessary. Where the existing median width is inadequate for the specified median treatment by 16+ feet, two lanes of roadway widening are assumed necessary.
- Where a range or no recommendation for the number of lanes is provided in the CTCFMP, the cost estimate assumes the existing number of lanes will be maintained.
- Structural reconstruction/widening is assumed necessary for all bridges and underpasses where a median guideway is recommended, except for the following locations, which were excluded because bridge/underpass modifications were assumed to be too disruptive:
  - New Hampshire Avenue underpass at I-495
  - Route 355 northbound bridge over I-495
  - Route 355 northbound underpass below Metro Redline tracks
  - Route 355 southbound bridge over I-495
- Station types (i.e. median vs. curbside) are determined by the guideway type for each specific corridor. Where a station is located at the boundary of a median guideway with any other guideway type, the station is assumed to be a median station.
- Utility pole relocations and retaining walls are assumed necessary only where roadway widening is required. Specific locations for utility pole relocations and retaining walls are based on visual inspections, from aerial photography or site visits, of existing above-ground utilities and significant roadside slopes.
- Terminus stations are counted for each corridor, which conservatively results in capital costs applied to some terminus stations on multiple corridors (i.e. Rockville Metro Station for Route 355 North, Route 355 South, and Veirs Mill Road).
- Recommended rights-of-way (ROW) for each corridor are specified for individual segments in the CTCFMP and this cost estimate assumes the ROW is a consistent width throughout each segment. For segments listing a range of ROW, the higher value was generally used.
- GIS roadway data was used to establish RTS corridor centerlines and the limits of the recommended ROW were established by buffering the centerline equally by half the CTCFMP recommended ROW width to each side.
- The land acquisition estimates only consider a portion of all publicly or privately owned parcels, as identified in the publicly available Montgomery County GIS

Property Layer file ([http://www.mcmmaps.org/images/MoCo\\_property\\_layer.zip](http://www.mcmmaps.org/images/MoCo_property_layer.zip)), within the CTCFMP recommended ROW limits.

- Land costs were provided by the MCDOT Property Acquisition Section based on a review of parcel takings (a.k.a. clipped areas) within the recommended ROW limits.
- The CTCFMP-recommended ROW does not account for additional land required for intersection treatments, such as median station platforms, signalized left turn lane reconstruction, or queue jump lanes. The cost for additional land takings related to these intersection treatments is based on the land area required for each type of treatment and the land costs for the CTCFMP-recommended ROW provided by MCDOT at the segment level.
- The CTCFMP does not specify ROW for segments of Route 355 passing through the City of Rockville or City of Gaithersburg. ROW limits for these segments were assumed based on the most similar neighboring segment within the County's control.
- No parcel or land cost data were available for segments of New Hampshire Avenue passing through Prince George's County.
- ROW acquisition along Route 355 in the White Flint Sector Planning Area and University Boulevard (MD 193) where the RTS overlaps the Purple Line (including property in Prince George's County) is excluded from this cost estimate and assumed to be acquired by others.
- The public 40-foot easement along the North Bethesda Transitway was assumed to be adequate to accommodate the proposed 2-Lane side guideway so additional land acquisition was not required.

#### **Overall Cost Estimation Approach Assumptions**

- A 50% contingency is applied to all capital and land costs included in the estimate.
- Soft costs are estimated at 23% and include Project Management, Design, Construction Management, Insurance, Permits, Testing & Inspection & Startup Costs.
- Maintenance of Traffic is estimated at 20%
- Mobilization is estimated at 10%
- Capital cost for terminal stations are applied to each station for each corridor, resulting in some overlap for shared stations on multiple corridors.
- No costs are included for the excavation, removal, handling and disposal of hazardous or contaminated materials.
- Escalation is not reflected in the estimates.