Report Title: Columbia Road Greenway Design

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Approved for Report Requirement of the Master of Science Degree - Civil Engineering

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Report Supervisor

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INTRODUCTION
Columbia Road in Dorchester is a 2.5-mile long street with 14 signalized intersections (picture 1, from A to B). This street connects two of the biggest parks of Boston: the Dorchester Bay parks including the South Boston beaches and Joe Moakley Park (north of point B) and Franklin Park (west of point A). As originally designed by Olmsted, it was to be a ribbon of green connecting these parks, part of a green ring around Boston that completes the Emerald Necklace. However, as Columbia Road became adapted to the automobile, it has lost most of this green, park-connecting function. It has become a major artery through north Dorchester. Its character is mainly a wide street, with four travel lanes, two parking lanes, a pair of sidewalks, and a median with turning lanes cut into it. Some of the median has trees, but most of it is barren concrete. Recently added bike lanes cover about 50% of the existing Columbia Road; however, bicycling in such a road, as part of traffic, is not adequate for a “park-connecting” function. The sidewalks are complete, but have little tree cover, again failing to meet the original “green ribbon” concept. The goal of this project is to see if it’s possible to give people a greenway with pleasant walking and bicycling paths to go between these two parks, while maintaining Columbia Road’s important traffic-carrying function.

Two main options were dealt with in this project, the Permanent Construction Option and Sunday Closure Option. For the permanent Construction option, there are two alternatives. The first one is the One-Way Cycle Track Plan, which puts cycle tracks on both sides of the Columbia Road, one for each direction. The second alternative is the Two-Way Cycle Track Plan, which puts a two-way bike path along the north side of Columbia Road. In addition to adding bike paths, both of those plans involve expanding the green space and planting more trees. Space for these amenities is found by making the travel lanes and median narrower, while maintaining their functionality. The Sunday Closure Plan is a back-up plan to close half of the street and make it a greenway on summer Sundays until a permanent plan is adopted.

As a rule, the permanent construction options maintain traffic patterns were kept as they are now. The only exception is at Edward Everett Square, where one turn lane was removed in order to create space for cycle tracks. Intersection analysis software was used to ensure there would still be enough traffic capacity after the signals were retimed, using traffic volumes provided by the City of Boston.
Picture 1- Entire overlook of Columbia Road (from A to B)
Layout Design

The existing layout of a typical block of Columbia Road is two travel lanes in each direction, one parking lane, one sidewalk with plants on it. The sidewalks are typically 10-12 feet. However, if the curbs are left where they are, the sidewalk is too narrow to subdivide it into a walking path and a bike path. Space for bicycling and more green space has to be obtained from the road (travel lanes and medians). In order to create more green space while maintaining the level of safety for all road users, the following design aspects are planned:

1. All the travel lane numbers are kept the same, but their widths are allowed to shrink to 10.5 feet
2. Parking lanes are kept, but widths are allowed to decrease to 7 feet
3. The central median, which makes access to driveways and many local street right-turn-in, right-turn-out, is maintained for traffic safety. By limiting vehicular movements across the street, they improve safety for bicycling as well as for motorists. However, this function can be achieved with a narrower median. The minimum width is 4 feet, and the medians can disappear where there are left-turn pockets.
4. Most of the left turn pockets are kept because their significant value to traffic safety and capacity.

Along most of the stretch from Blue Hill Avenue and Edward Everett Square, the width of the street right-of-way is 108+2 feet. Typical plans for lane arrangements are given below for sections with a closed median and for sections with left turn lanes, for both the one-way cycle track and two-way cycle track options (tables 1 and 2).

<table>
<thead>
<tr>
<th>Pair of one-way cycle tracks with medians (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road</td>
</tr>
<tr>
<td>108</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pair of one-way cycle tracks with left turn lanes (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road</td>
</tr>
<tr>
<td>108</td>
</tr>
</tbody>
</table>

**TABLE 1- Layout dimensions with one-way cycle track on typical blocks**

![Image](image.jpg)

**Picture 2 – Sketch of One-Way Cycle Track Plan Street Arrangement where there is a Left Turn Lane**
In order to give pedestrians and bicyclists a more comfortable and greener street, the area of vegetation was made as wide as possible. For walking, 7 foot sidewalks are enough, and 5 feet cycle tracks are enough for two bikers to ride side by side if the cycle track doesn’t border a parking lane, travel lanes, or other barriers (as on Vassar Street in Cambridge). As a result, the one-way cycle track plan has two rows of trees on each side of the street – one row between the sidewalk and the cycle track, and another between cycle track and street – giving pedestrians and cyclists a pleasant green alleé. Where there are left turn lanes, one row of trees on each side of the street is given up to create space for the turn lane, while one row is maintained. With the two-way cycle track option, there are two wide tree lawns on one side of the street (one between sidewalk and cycle track and one between cycle track and street) and one large tree lawn on the other side (between sidewalk and street), again offering a pleasant green environment for walking and bicycling. Where space is needed for left turn lanes, the tree lawns can all be maintained by narrowing them to 6 ft.
**Two-Way Cycle Track Alternative**

With the Two-way Cycle Track Plan, the cycle track could be on either side of the road. Table 3 summarizes the comparison between the two sides at four critical points on the route – the large intersections at the endpoints (Blue Hill Ave and Kosciuszko Circle), the intersection with the I-93 ramps, and Edward Everett Square, where Columbia Road makes a 90 degree turn. On balance, the north side of Columbia Road is the preferable side for a two-way cycle track. At the Blue Hill Avenue intersection, it’s easier for bicyclists to cross to and from Franklin Park if the path is on the North side, because the bike path next to Circuit Drive is on the north side and because of how Columbia Road traffic is split into a pair of one-way streams when it crosses Blue Hill Avenue. At Edward Everett Square, a south side alignment would be preferable because it would give bikes the most direct and simple turn; however, while a north side alignment would force bikes to make a two-stage crossing, it is still feasible if a safe queuing area is provided at the intersection’s northern corner. At Kosciuszko Circle, traffic on the south leg (Morrissey Blvd) is far heavier than traffic on the north leg (Old Colony Ave). Therefore it is reasonable for a north side path to cross the north leg at grade, with the north side leg reduced to one travel lane in each direction. It is not reasonable for a bike path to cross the south side leg at grade, because it has two lanes per direction with heavy and turbulent traffic. A south side path would have to drop from the bridge (over the train tracks) to Mount Vernon Street and use the existing underpass under Morrissey Blvd. This grade-separated treatment is feasible, but would involve a steep grade.

<table>
<thead>
<tr>
<th></th>
<th>North side</th>
<th>South side</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue Hill + Connection to Franklin park</td>
<td>Good</td>
<td>Indirect connection, complicated by 1-way traffic pattern</td>
</tr>
<tr>
<td>Edward Everett Square</td>
<td>2-stage crossing necessary, but can be safe</td>
<td>Good</td>
</tr>
<tr>
<td>Southeast Expressway ramps</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Kosciuszko Circle + Connection to Harbor Walk</td>
<td>Cross one leg of rotary, but the leg can be reduced to 1+1 lane; Requires crossing Day Boulevard</td>
<td>Requires either grade-separated crossing (feasible but steep slope) or dangerous multi-lane crossing; Requires crossing Mount Vernon Street</td>
</tr>
</tbody>
</table>

**TABLE 3- Comparisons of Two-Way Cycle Track Position between South and North Side**

Compared to a one-way cycle track plan, the two-way cycle track plan allows for more green space because when the two different directions’ cycle tracks are put together, they need less overall space than a pair of one-way cycle tracks (8 feet for a two-way path versus 10 feet for a pair of one-way paths).

Raised crossings were also designed in this project for every unsignalized intersection (Picture 4). The raised parts are the sidewalk, the cycle track and the two lanes of trees. Because the trees cannot be planted across the driveways, the vegetation area stops short of the driveways and the vegetation space at the driveways are to be made into hardscape. The curbs end at the edge of the outer tree lane, and they will be made 6” high. In Picture 4, arrows indicate ramps going down from the crossing (at sidewalk level) to street level. The ramps
and raised crossing together serve as a speed table. This kind of treatment is common in the Netherlands and Denmark to make unsignalized crossings safer and more pleasant for bicycles and pedestrians.

![Picture 4— Sample of Raised Sidewalk of Unsignalized Intersection Design](image)

**One-Way Cycle Track Alternative**

The One-way Cycle Track Plan needs more space devoted to bicycling. Both sides of the street need cycle tracks as well as trees and buffers next to them, so for each facility the minimum width will be used: 5 feet for cycle tracks. Moreover, buffers and trees are needed to protect bicyclists from parked vehicles and moving traffic. Between intersections with two lanes, each side of the street can have two rows of trees. Where left turn lanes are needed, the space used for one of the tree lawns has to be narrowed too much to support trees, and will become a hardscape buffer instead.

One weakness of the one-way cycle track plan is that making the south side (eastbound) connection at Kosciuszko Circle requires a grade separated path option, as explained earlier, because of the heavy, multilane traffic using the south leg of the circle (Morrissey Blvd).

While the Two-way Cycle Track Plan saves some space and allows an easier route around Kosciuszko Circle, the One-way Cycle Track does have its own advantage on safety. For example, at an intersection with traffic lights, north side cyclists on a one-way cycle track plan have conflict with northbound right vehicle and southbound left vehicles. But drivers on southbound left vehicle can have a good visibility seeing bikers approaching, which largely decreases the collision possibility. However, in a two-way cycle track situation, Southbound left vehicles will also have a conflict with southbound bicyclists. And in this situation, the drivers have poor visibility seeing the bicyclists, because they pay most of their attention to the northbound though traffic, which distracts their concentration on watching out for bikers. Therefore, it raises the risk of collision in this situation.
However, the safety concerns of intersections can be mitigated. At signalized intersections, there can (should) be protected left turns only (with green and red turn arrows) and marked cycle crossings; that way bikes will only have a green when conflicting left turns have a red. At unsignalized intersections, the raised crossing treatment described earlier lowers the speed of vehicles crossing the cycle track so much that collision risk is very low. Thus, the Two-way Cycle Track Plan is also highly safe.

**Options at Uphams Corner**

There is a special block on Columbia Road which needs a special design, at Uphams Corner. From Hancock Street to Stoughton Street, the right-of-way is only 77 feet wide. The current layout has parking lanes and two travel lanes for each direction. Even if all four travel lanes are reduced to 10 feet, and parking is reducted to 7 feet, there is still not enough space for cycle tracks. Therefore, one parking lane is sacrificed on this block. Because there is a church on the north side of the street, and the existing south side parking seems to be used more often than the north side, the north side parking lane was eliminated. That leaves just enough space for 6-foot sidewalks, a 7-foot parking lane, 5-foot cycle tracks, 3-foot hardscape buffers, and four 10.5-foot travel lanes.

**Road Diet Alternative with Roundabouts**

In order to save even more space as possible for vegetation and pedestrians, a single-lane-per-direction design was considered as a road diet. It would use roundabouts in place of signals at the less important intersections. Roundabouts eliminate the need for left turn lane, and single-lane roundabouts can carry a great deal of traffic (up to 1,100 veh/hour per approach) that it makes it possible for the entire road to be reduced to one lane per direction. That allows more than 30 ft in areas with turn lanes, and more than 20 ft elsewhere, to be converted to green space, not including space gained by shrinking parking and travel lanes. On approaches to the major intersections (e.g., Blue Hill Ave., Washington Street, Geneva Ave.), signals would still be needed because a single lane roundabout could not handle all of the traffic, and multilane roundabouts are not pedestrian-friendly.

However, after doing detailed dimension calculations, it appears that the Road Diet Plan is not feasible for Columbia Road, because the right of way is not wide enough for minimum dimension single-lane roundabout. For example, at Columbia Road meets Seaver Street, the widths of those two streets’ rights of way are 106 and 44 feet, respectively. Therefore, the longest diameter of the Roundabout could be \( \sqrt{108^2 + 44^2} = 117 \) feet. The minimum diameter of single-lane roundabout is 100 ft, counting only the road; with sidewalks and cycle tracks, the minimum is 125 feet, exceeding the available width.

While a mini-roundabout can fit those intersections, the traffic on these intersections is still much higher than mini-roundabout can receive. According to the roundabout design guide, the maximum traffic that a minimum roundabout can receive in one day is 15,000 vehicles, while all of the low volume signalized intersections on Columbia Road have at least 18,000 vehicle/day, most of them are over 20,000 vehicle/day. Also, mini-roundabouts are not widely accepted in America. Therefore, a roundabout plan was not further pursued for this project.
Capacity Analysis of Edward Everett Square

The reason this intersection needs special design is that at Edward Everett Square, Columbia Road is no longer straight. Instead, it has a 100 degree angle. The main approach to Columbia Road makes a northeast to southeast turning movement as it traverses the intersection. (Picture 5 a,b). Currently, the north bound approach on Columbia Road widens to four lanes. A reduction in number of lanes is needed to continue the greenway and cycle tracks.

As can be seen in Picture 5,b. Both Northbound and Westbound movements of Columbia Road on this intersection have two left turning lanes. However, to make space for bike paths and trees, it’s not enough to just shrink the width of travel lanes; removing one of the left turning lane had to be considered. Because the left turning traffic is high during peak hour for both of these approaches, intersection capacity analysis was done using Synchro software at this intersection. The traffic volume used for the analysis is morning peak hour.
volume, because morning peak hour volume is higher than afternoon volume for both directions of Columbia Road at this intersection. The volume data was obtained in February 2005, and was analyzed in Synchro without any change. The only volume adjustment is that the standard peak hour factor of 0.92 was applied, which effectively increases volumes by 8% over what was measured.

Picture 6 – Peak Hour Traffic Volume of Edward Everett Square
Picture 7 and 8 shows the capacity analysis of Edward Everett Square of existing lane arrangement and designed lane arrangement.
### Optimized Synchro Simulation of Existing Edward Everett Square

<table>
<thead>
<tr>
<th>Option</th>
<th>Value</th>
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<tr>
<td>Controller Type</td>
<td>Protocol</td>
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<tr>
<td>Cycle Length</td>
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</tr>
<tr>
<td>Actuated C.L.</td>
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</tr>
<tr>
<td>Natural C.L.</td>
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<tr>
<td>Max v/c Ratio</td>
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<tr>
<td>Int. Delay</td>
<td>29.1</td>
</tr>
<tr>
<td>Int. LOS</td>
<td>C</td>
</tr>
<tr>
<td>ICU LOS</td>
<td>0.65</td>
</tr>
<tr>
<td>Total Split [s]</td>
<td>20.0 - 20.0</td>
</tr>
<tr>
<td>Yellow Time [s]</td>
<td>3.5 - 3.5</td>
</tr>
<tr>
<td>All-Red Time [s]</td>
<td>0.5 - 0.5</td>
</tr>
<tr>
<td>Load/Lag</td>
<td>Lag, Lag</td>
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</tbody>
</table>

### Reference Phase

- **Reference Phase:** 2->6, NBT 58
- **Master Intersection:**

### Timing Window

<table>
<thead>
<tr>
<th>Lane</th>
<th>EB</th>
<th>ET</th>
<th>BR</th>
<th>WB</th>
<th>WT</th>
<th>WR</th>
<th>NB</th>
<th>NB</th>
<th>NR</th>
<th>SB</th>
<th>SB</th>
<th>SB</th>
<th>PB</th>
<th>HOLD</th>
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<tbody>
<tr>
<td>Lanes and Phases</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic Volume [vph]</td>
<td>12</td>
<td>172</td>
<td>120</td>
<td>450</td>
<td>423</td>
<td>47</td>
<td>329</td>
<td>486</td>
<td>320</td>
<td>40</td>
<td>237</td>
<td>30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Lane Phases

- **Phase Type:** Perm, Perm, Prot, Perm, Prot, Perm, Prot, Perm
- **Protected Phases:** 4
- **Ponit Phase:** 5, 6
- **Minimum Time:** 4.0, 4.0, 4.0, 4.0, 4.0, 4.0, 4.0, 4.0
- **Minimum Split [s]:** 20.0 - 20.0
- **Yellow [s]:** 3.5 - 3.5
- **All-Red Time [s]:** 0.5 - 0.5
- **Load/Lag:** Lag, Lag
- **Recall Mode:** Max, Max
- **Actuated Eff.: Green [s]:** 16.0 - 16.0
- **Actuated g/C Ratio:** 0.28
- **Volume to Capacity Ratio:** 0.66
- **Control Delay [s]:** 17.0
- **Level of Service:** B, C
- **Approach Delay [s]:** 17.0
- **Approach LOS:** B
- **Volume Length 50th [%]:** 44
- **Volume Length 95th [%]:** 63
- **Running Penalty:** 0
- **Steps [vph]:** 199
- **Fuel Used [g/ha]:** 17
- **Dilemme Vehicles [v/ha]:** 0

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**Picture 7 - Optimized Synchro Simulation of Existing Edward Everett Square**
As can be seen from the above two pictures, the existing intersection uses 80s for cycle length, and the changed Intersection uses 90s. That’s because space was decreased, so more time is needed to ensure the capacity meets the demand. But if two left turning lanes are kept for the Northbound, while we provide only one left turning lane of Westbound, then the v/c ratios will be reduced to 0.79 for Westbound left and 0.80 for Northbound left (picture 8) respectively, which means capacity is adequate for this intersection using this traffic timing. The existing public space (picture 5,b blue arrow) at the south-east corner of the intersection can be used to create space for the reconfigured intersection.

Optimizing the phasing plan for pedestrians

A signal timing plan is proposed that will provide pedestrians green waves as they make two-stage crossings. The best timing plan, showing the pedestrian green ways, is shown in picture 9. Phases A,B,C1,D1,C2,D2 are the pedestrian crossing phases, referring to crosswalks shown in picture 6. There are green waves for both directions of crossing C (C1-C2 as well as C2-C1). This is better than switching B with C1, because then, the C1 phase will be left alone with no green wave. When it comes to Crossing D, because the heavy traffic volume Northbound right movement is a protected turn that is in conflict with the crosswalk, D1 cannot run together.
with Northbound right. In order to give D1 and D2 a greenwave, Northbound right was split into two phases by putting D1 in the middle of them.

**Picture 9 - Traffic Phase Analysis of Edward Everett Square**

Pedestrian phase lengths are sufficient for a Walk interval at least 7 s long plus a clearance time based on a pedestrian walking speed of 3.5 ft/sec (rather than 4 ft/sec from the old MUTCD). The table below compares the needed pedestrian phase time and the phase length in the proposed signal timing plan.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>D1</th>
<th>D2</th>
<th>B</th>
<th>C1</th>
<th>C2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time needed</td>
<td>22s</td>
<td>14s</td>
<td>18s</td>
<td>22s</td>
<td>25s</td>
<td>19s</td>
</tr>
<tr>
<td>Time proposed</td>
<td>39s</td>
<td>20s</td>
<td>51s</td>
<td>22s</td>
<td>29s</td>
<td>39s</td>
</tr>
</tbody>
</table>

**Table 4 - Comparison of Needed and Calculated Pedestrian Crossing time at Edward Everett Square**

After cycle track design, the length of pedestrian crossing D1 is 24 feet, so the time needed for a pedestrian crossing is $7 + 24/3.5 = 14$ s, so 20 s is enough for it. D2 has 51 s total, so D1 is better to start after 15 s of D2, during which time northbound right will have its first green subinterval. The second northbound right subinterval will be $51 - 15 - 20 + 20 = 36$ s long. A and B crossings are 50 and 55 feet long respectively. Therefore, 21 and 22 seconds are needed to serve them. However, crossing A can go with the entire westbound through traffic, so even though the eastbound through phase gets only 19 s, the actual walking time for A is 39 s, which is totally enough. Therefore, the proposed signal timing plan serves pedestrians well.
Bike Routes around Kosciuszko Circle

At the East end of Columbia Road, there is a big traffic circle at the junction with Old Colony Avenue, William J Day Boulevard, and Morrissey Boulevard. The traffic that passes through this circle is very heavy during the peak hour and it’s dangerous for bicyclists to cross a roundabout leg with heavy traffic and multiple travel lanes per direction. Therefore, a special design to this circle was made.

For the one-way cycle track design, the north side cycle track will cross Old Colony Avenue using at-grade crossings, because the volume of traffic using this leg is low enough that the entry and exit roadways can be decreased to one lane per direction. However, the south side leg has so much traffic that the entry and exit legs will still have two lanes per directions. Therefore, bicyclists riding on the south side cycle track will be using a newly designed ramp leading to an underpass under the south leg instead of crossing the circle’s south leg (picture 10).

![Picture 10 – Overview of the South Side Cycle Track in One-way Cycle Track Plan](image)

In the picture 10, the south side cycle track lane is shown in red. The upper (and eastern) end of this ramp is on the bridge carrying Columbia Road over the train tracks (point 1), and the lower end of the ramp is on the sidewalk of Old Colony Avenue (point 2), which can be widened to allow a cycle track by removing one unnecessary travel lane at the underpass. The ramp in this project will be built across a small hillside, which is now filled with grass and trees on the sloping area (picture 11). The distance of the slope on the grass is 220 feet and the change in elevation of the ramp go through is the height of the bridge (picture 11), which is about 23 feet.
The slope of this ramp is about 10.5%, which is a steep slope, but still usable by bicyclists. The path can use part of the Old Colony Avenue exit and Mount Vemon Street to get to William J Day Bouelvard. Therefore, it can be seen in picture 10, the extra cycle track space should be taken from the travel lane on Old Colony Avenue and Parking lot of Mount Vemon Street. When cyclists get to Mount Vemon Street at William J Day Bouelvard intersection, they have already avoided the heavy traffic from the circle and can easily cross the intersection.

However, because the bike path on William J Day Bouelvard is only located on the Southeast side of the street, the recommended crossing location is close to the existing Mount Vemon Street at William J Day Bouelvard crosswalk (picture 12).
Hence, bikers from the sea will use this crosswalk to get to the cycle track on Columbia Road. The reason for using the new crosswalk instead of using the existing intersection’s crosswalk is that in order to cross the street, using the existing crosswalk requires four stages, while the newly designed crosswalk needs only a two-stage crossing with a median in the middle. Also, using the new designed crosswalk effectively avoids the high speed traffic at the intersection, which increase safety for bicyclists.

Sunday Closure with Two-Way Traffic

For the Sunday Closure plan, one alternative that was considered was to have two-way traffic on one side of the road (the north side) while the south side is closed. The advantage of this plan is that traffic pattern is still unchanged on Sunday. However, this plan has many complications. One is that those passengers of the south-bound bus will have to step on the medians when they get off the bus, because in most parts of Columbia Road, there are only two traffic lanes on south side. What’s more, once the bus stops, the traffic behind of it will have to stop, because of two travel lanes on the south side Columbia Road. The third disadvantage is that when the north side’s traffic is moved to south side, it is very hard for the south bound drivers to see the existing traffic signals. Therefore, new traffic signals would be needed at every intersection. Therefore, this alternative was discarded.

Sunday Closure with One-Way Traffic

In the preferred Sunday Closure plan, northeast-bound traffic is maintained on the south side of the street, while the north part of the street is closed over most of the corridor. This plan also has several complications, but they can be overcome. One problem is providing bus access southbound for Bus Route 21, running from Andrew Square to Forest Hills. A plan with three loops for buses going on Columbia Road is proposed (picture 13).
The northeast-bound buses can still use their original route on Sunday, while the southwest-bound buses will follow the three loops on the picture 9 because of the closure. The loops start from Edward Everett Square and ends at Blue Hill Avenue. The first loop is the red one (picture13), which goes from Edward Everett to East Cottage Street and come back to Columbia Road through Dudley Street. The route of second loop is the green one (picture13), which uses Stoughton Street – Pleasant Street – Bowdoin Street – Quincy Street route. The third loop is the blue one (picture13), which continues Quincy Street and turns to Blue Hill Avenue until it arrives at Columbia Road. Even though the loops travel a further distance than the direct route from Edward Everett Square to Blue Hill Avenue, it allows a transfer of pedestrians at those three points along Columbia Road where the red, blue, and green lines meet in Picture 13. Moreover, Route 16 only operates every 35-40 minutes on Sundays, and the loops will only take 7.8 minutes more to go from Edward Everett Square to Blue
Hill Avenue based on 13mi/h bus speed. Also, buses will make fewer stops, and thus will go faster. Therefore, the loops method is the most suitable for the South bound bus problem.

The second problem is at the exit of the Southeast Expressway. If the West bound route is closed, there is no way for the southbound Southeast Expressway traffic to travel southwest bound along Columbia Road. If the closure of Columbia Road will require the traffic from the Expressway to use the secondary route, then the closure is not worthwhile because this project is made under the assumption that motor vehicles would not be given unneeded delay. Therefore a solution was worked out for this problem as shown below in picture 14.

![Picture 14 – Sunday Closure Plan Treatment for Southeast Expressway](image)

As can be seen from the above picture, the south side is open for all east bound traffic. The green space is closed to motor vehicle traffic and open to bicyclists, pedestrians, and other nonmotorized use. First, two lanes of on the north side of Columbia Road will be open from the exit of the Southeast Expressway to Dorchester Avenue. Between the exit of Southeast Expressway and Dorchester Avenue, there are three travel lanes currently. One lane is still enough for bikers to ride through. After putting cones between the closed lane and the two open lanes, bikes and vehicles can go at the same time. When the traffic arrives at Dorchester Avenue, they can go to their destination through Dorchester instead of continuing to Columbia Road (red route). Second, one lane from Kosciuszko circle to the entry of Southeast Expressway will be kept open. There are two lanes here right now; bicyclists can still use one lane here on Sundays. One key difference is that at the Southeast Expressway exit the vehicles can turn both right and left to Columbia Road, but due to the closure, vehicles can only turn right at the exit and go to Dorchester at Columbia Ave intersection to make a right turn.

The third problem is parking for people who go to churches on Sundays. There are two large churches along Columbia Road. One is Pilgrim Church at Hancock Street at the Columbia Road intersection. The church is on the north side of the street, the closed street. The solution for this church is to open one travel lane on the
north side of the street from Dudley Street to Bird Street. Hence, drivers who want to go to the church can only get to Columbia Road from Dudley Street and leave by Bird Street. Since there is already a parking lane on the existing Columbia Road, drivers can still using the open travel lane. The other church is called Blessed Mother Teresa Church and is located at the northwest corner of Dorchester Street at Columbia Road intersection. The solution is to open one lane from Dorchester Street to Greenhalge Street. There is also an existing parking lane, so people can use the travel lane to park.

Conclusion

In general, three plans have been designed that will allow bicyclists to ride and pedestrians to walk in a green, park-like environment along Columbia Road, providing a needed park ribbon within the inner city and completing a green circle around the city. Those three plans are the One-Way Cycle Track Plan, Two-Way Cycle Track Plan, and the Sunday Closure Plan.

Between the two cycle track plans, even though the One-Way Cycle Track Plan is generally considered a little safer than the Two-way Cycle Track Plan, two-way cycle track plan has more benefits. Its safety can be enhanced by using raised crossings at unsignalized intersections and protected turning phases at the signalized intersections. The wider path creates more of a path-like, park-line environment. Another advantage for Two-Way Cycle Track Plan is it can give more space to sidewalks and trees because it devotes less space to cycle paths than the One-Way Cycle Track option.

All in all, Two-Way Cycle Track Plan is the most suitable one for remaking Columbia Road as a connecting greenway, and the Sunday Closure Plan is a backup plan that can be used until the Cycle Track Plan can be adopted.

Appendix

Full-length plans for the one-way and two-way cycle track options are provided as separate pdf documents, formatted as multiple 8.5 x 11 sheets.
Appendix 1: One-Way Cycle Track Design Plans
Appendix 2: Two-Way Cycle Track Design Plans