Background

On December 7, 2015, staff provided a briefing to this Commission and the Bicycle-Pedestrian Advisory Committee (BPAC) about the Olympic Blvd/Pleasant Hill Rd roundabout design presented to the public at the prior design review open house, held on November 12th. During discussion after the staff briefing, the public, Commission, and BPAC raised additional concerns with the proposed roundabout design, mainly centered on pedestrian and bicycle mobility and safety issues. In turn, staff requested - and the Commission approved - formation of a subcommittee of both boards to work with staff and the design consultants (Omni-Means and MTJ Engineering), to evaluate the feasibility of incorporating alternative features into the roundabout design, and later return to the Commission with final design recommendations. These recommendations are now described in this report as a result of the collaboration between the staff, consultants, and the subcommittee.

Basis for Roundabout Design

At the joint Commission/BPAC meeting, various parties made testimonies and comments regarding ped/bike safety of the proposed roundabout design. To facilitate understanding and resolution of the relevant issues, the consultant and staff compiled some technical background information related to current research, guidelines, and standards that underpin roundabout engineering design in the US. Three publications are relevant to the current design philosophy on ped/bike features in roundabouts:


2. National Cooperative Highway Research Program (NCHRP) Report 672, Chapter 6.8 (Available at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_672.pdf; suggested reading begins on pg. 6-71)

All three documents are consistent in indicating that roundabouts should provide options for bicyclists of varying levels of ability and experience. Research has shown that the experienced and skilled cyclist prefers a direct path of travel through the roundabout intersection by taking a lane to navigate as a vehicle. Vehicular speeds in a properly-designed roundabout will be slow, in the order of 15 mph when circulating. The speed differential between vehicles and bikes are therefore correspondingly low, which facilitates a relatively easy and safe merge or weave, when needed. Importantly, this is similar to what a cyclist does to turn left at a standard signalized intersection, or even for certain movements at the current all-way stop control.

For bicyclists who are uncomfortable sharing the lane with vehicles, the option is to use a marked exit ramp onto the off-street shared-use path to circumvent the intersection. At crosswalks bicyclists have the option of dismounting and crossing as a pedestrian with all the protection afforded by law, or continuing to ride across as a vehicle without the preferential treatment given to pedestrians. The shared-use path concept is a standard design in California. The existing multi-use path that extends further north on both sides of Pleasant Hill Road has been in use successfully for many years, shared by peds and bikes, and were universally lauded as “great” when they first opened. The existing popular Lafayette-Moraga Trail is a shared-use facility. Both the planned bike corridor on Olympic Blvd and the EBMUD aqueduct trail through downtown feature shared-use pathways.

Bike East Bay and other like-minded individuals have been advocating a concept shown in a Massachusetts DOT design guide. Staff would also note that the shared-use path component of the current design in essence accomplishes the same concept underlying the Massachusetts guide. The only difference is that the Massachusetts concept provides a physical separation between pedestrians and bicyclists. It should also be noted that the MassDOT guide is specifically developed for projects contemplating a separated bike lane facility, not a general guide for how to treat ped/bike design at roundabouts. In fact, MassDOT’s own Design Guide for roundabout intersections (Attachment 5) continues to recommend the dual-option bike facility using a shared-use path as proposed in the current Lafayette project.

At the December 7 meeting questions were also raised regarding safety of the visually impaired at roundabouts. This issue is addressed by National Cooperative Highway Research Program (NCHRP) Report 674 (http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_674.pdf; suggested reading begins on Chapter 7). The key design considerations here are: 1) avoid free right turns; and 2) keep motorized vehicular speeds below 20mph at the pedestrian crossing locations. Staff would note that the current design does both.

Subcommittee Recommendations

Based on feedback received at the joint Commission/BPAC meeting, staff, consultants, and the subcommittee documented 11 primary design issues. These issues were then categorized in a matrix to define and organize alternatives and understand potential trade-offs between identified alternatives for further discussion. The final matrix summarizing staff/consultant analysis, recommendation, and the Subcommittee’s decisions on each issue is attached to this report as Attachment 1.

The recommendations opt to generally retain the proposed roundabout layout, including dedicated right-turn lanes in the southbound (SB) and westbound (WB) directions, as well as the
shared-use paths around the perimeter of the intersection. Additionally, the design continues to allow bicyclists to share the roadway with autos, but also provide opportunity for bicyclists to assume a centered position in a vehicular travel lane, as is legal in California. Traffic analysis and related considerations underlying this decision are outlined in the issues matrix.

While retaining the major design features, the Subcommittee recommends some important refinements aimed at further ensuring slow auto speeds in and around the intersection and elevating the visibility of pedestrians and bicyclists, thus enhancing their safety. These features are summarized below and annotated on the revised intersection layout (Attachment 6).

1. Modify the curb line of the WB left turn pocket to shorten the transition taper, thus forcing autos to further reduce speed to negotiate this movement and correspondingly lessen the exposure of bicyclists.

2. Use green marking to accentuate the SB bike lane leading to the bike lane transition to convey to both bicyclists and motorists that they are approaching an area where the roadway should be shared.

3. Add rumble strips to the auto lane as a tactile warning to autos approaching the WB and SB bike lane transition areas.

4. Add sharrows, centered in the auto lane, on the approaches to the roundabout, including the circulatory roadway. This highlights the intent for bike and auto users to have equal rights-of-way.

5. Use bollards with lights and/or reflectivity to mark and elevate the visibility of ped crossing locations, thus inducing a higher probability of yielding by autos.

6. Redesign the “jog” across the NB exit lane on Pleasant Hill Road, so as to maximize the space and time for a NB vehicle and a potential pedestrian or bicyclist utilizing the crosswalk to see and react to each other, particularly after a vehicle has completed turning from the WB right-turn lane. In conjunction, at the crosswalk across the NB lane of PHR, add “shark tooth” yield line to accentuate the need for autos to yield at the crosswalk.

In the subsequent redesign, the consultant now recommends consideration of an alternative treatment using “yield bars” as a potentially more effective means to highlight the crosswalk location to approaching traffic at all exit lanes from the roundabout. Both options are shown in the revised intersection layout (Attachment 6).

Recall that concerns have also been raised that the jog causes pedestrians to walk with their backs to traffic. The diagonal path of travel in the redesign allows approaching traffic to be seen in the pedestrian’s peripheral field of vision as she approaches the crosswalk ahead. This is graphically illustrated on the intersection layout.

7. To enhance accessibility by the visually-impaired, use tactile guide strips in the direction of the crosswalks when they are not orthogonal crossings of the street. Additionally, ensure that vertical curbs are designed to delineate the edges of crosswalk openings.
8. In the intersection lighting design, use people-scale lighting at crosswalks to increase pedestrian visibility.

**Next Steps**

A decision on the Subcommittee’s recommendations is urgently needed to allow the project to proceed. Upon acceptance of these recommendations, final engineering work will commence to complete construction bid documents. Staff’s goal is to break ground on the project by mid-June.

**Recommendation**

Approve final roundabout design recommendations from the Subcommittee.

**Attachments**

1. Design issues matrix
2. Summary of traffic delay resulting from omitting right-turn lanes
3. Visual simulation of typical signage presented to drivers approaching intersection
4. Right-of-way impacts of cycle track design
5. Massachusetts DOT Project Development and Design Guide (Excerpt for Roundabout)
6. Revised project intersection layout
ATTACHMENT 1

DESIGN ISSUES MATRIX
### Design Issues Matrix

**Olympic Blvd/Pleasant Hill Rd Roundabout**

<table>
<thead>
<tr>
<th>#</th>
<th>Design Issues</th>
<th>Analysis/Trade-Off Discussion</th>
<th>Staff/Consultant Recommendation</th>
<th>Subcommittee Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>Whether to remove westbound right-turn lane to avoid bike-auto mixing zone</td>
<td>Without the WB RT lane there is sensitivity to morning delay and queuing for current 2014 traffic. (i.e. Random factors can trigger delay and queuing). For the design-year traffic, queuing and delay are very large and therefore unacceptable. See traffic delay summary in Attachment 2. We’ve designed the RT lanes with a slow speed radii consistent with the objectives of NCHRP 674 addressing pedestrians with vision disabilities, using a “yield right” as opposed to the current “free right.” The mixing zones for cyclists are designed with measures to increase awareness of bikes and enhance their safety. The taper lengths could be evaluated to be reduced to further lessen exposure for cyclists. Inexperienced/casual cyclists can use off-street shared-use path to bypass mixing zones altogether.</td>
<td>Given that design measures are included for bikers of all levels, recommend maintaining “yield right” lane to achieve original project objective of improving current traffic operations and, more importantly, to avoid negative effects of not designing to properly accommodate design-year traffic.</td>
<td>The Subcommittee acknowledges the need for the project to work for design-year traffic as well as existing. There is the option to add the right-turn lane later; however, the funding for such work is available now but not necessarily in the future. For bicyclists who choose to ride in the roadway instead of using the shared-use path, the Subcommittee would like to augment the design as follows, with the intent of ensuring that auto speed is slow approaching the RAB:  - Add rumble strips to auto lane approaching bike/auto transition zone.  - Change the curb line to shorten taper of auto right-turn lane, thus forcing autos to further reduce speed to negotiate the movement and correspondingly lessen exposure of bikes.  - Add sharrows, centered in the auto lane, including the right turn.</td>
</tr>
</tbody>
</table>

| 1b | Whether to remove southbound right-turn lane to avoid bike-auto mixing zone | SB RT lane shows much less sensitivity to delay and queuing compared to the WB entry for both existing and long range traffic; therefore, from an operational perspective it could be removed. However, the RT lane provides a very good and cost effective method to provide lane continuity to match to the existing two lane approach to the north. Estimated additional cost to remove RT lane and reconfigure roadway cross-section conform to the north is $50-75,000. Maintaining the RT lane also provides relief potential queue spillback emanating from Reliez Station/Glenside intersection (located downstream to the west and south) during AM and mid-day peaks. This is mainly an “insurance.” It should be noted that vehicular speeds are forced to slow on approach to roundabout. The design with SB RT lane conforms with current best practices, allowing the cyclists merge to occur where the speed differential between cyclists and autos is very small. Compared to existing conditions, this is an easier and safer movement for higher-level cyclists to merge into vehicular traffic and take their lane as a vehicle. Again, inexperienced or casual cyclists have the option to use the off-street shared-use path to bypass the merge zone entirely. | Given that design measures are included for bikers of all levels, recommend maintaining “yield right” lane to avoid unnecessary additional costs and to retain capacity as an insurance against potential queue spillbacks from downstream anomalies. The Commission could recommend to the City Council the policy decision to eliminate the SB RT lane. | The Subcommittee agrees that it would be a mistake to remove capacity given the projected growth in traffic, especially south of Lafayette. Some are also concerned that potential queue spillback from adjacent intersection to the west and south would affect the RAB operation with a single lane entry. The group recommends additional design strategies, again with the intent of slowing approaching auto traffic and elevating the awareness of bicyclists and pedestrians:  - Augment rumble strip zone approaching bike/auto transition.  - Accentuate the on-street bike lane with additional solid green marking for some appropriate distance leading up to the bike lane transition.  - Add sharrows, centered in the auto lane, including the right turn. |

| 2 | Use of green markings at vehicle/bike transition zones vs. standard striping and marking | Roundabout will work with or without the green paint. It was included as a means of promoting additional awareness of the bicycle path of travel to both cyclists and drivers. | Staff recommends retaining the current design given that this is Lafayette’s first RAB. Over time, the green paint can be allowed to disappear. | Subcommittee agrees that green marking is useful to make bike space more visible to motorists and recommends using it in the design. |

| 3 | Feasibility of cycle track design (Bike East Bay Proposal), and resulting impacts to right-of-way | Additional ROW is required as shown in the concept (Attachment 4). As discussed in Item 1 above, the WB right turn lane is necessary for design-year traffic, and provides desirable benefits to achieve traffic operations improvement objectives. If removed, the ROW impacts to the north-west quadrant can be eliminated but there are still ROW impacts to | The current design offers bicyclists of varying skill levels a choice in the path of travel. The option to use the off-street shared-use path has, in essence, incorporated the underlying concept of the Massachusetts design. Staff | In the Subcommittee discussion, it also became clear that the Massachusetts design recommends a stop for bike at every auto crossing, which would not be preferred by serious cyclists. Yet it offers no obvious significant upgrade for the lesser-skilled bikers who could choose the shared-use path under the current design. In light of the substantial cost and time impacts related to right-of-way... |
4 Design of “Jog” between crosswalks across NB PHR lanes

<table>
<thead>
<tr>
<th>4</th>
<th>Design of “Jog” between crosswalks across NB PHR lanes</th>
</tr>
</thead>
<tbody>
<tr>
<td>The jog could be eliminated by moving the crossing of the exit lane from the RAB closer to the intersection while relocating the crossings of the entry lanes further away.</td>
<td>A sketch showing the elimination of the jog was presented to the Subcommittee for feedback.</td>
</tr>
</tbody>
</table>

5 Sign clutter- Are there too many signs?

<table>
<thead>
<tr>
<th>5</th>
<th>Sign clutter- Are there too many signs?</th>
</tr>
</thead>
<tbody>
<tr>
<td>The existing design includes the minimum requirements by prevailing standards such as MUTCO. See driver perspective view of a typical approach (See simulated view in Attachment 3).</td>
<td>Recommend conformance to minimum standards.</td>
</tr>
</tbody>
</table>

6 Feasibility of raised crosswalks

<table>
<thead>
<tr>
<th>6</th>
<th>Feasibility of raised crosswalks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raised crossings are possible. However, in the current design, all crossings are only single lane and the geometry dictates that approach speeds are very low. Therefore relative benefit to cost ratio in this application is very low. The shared-use pathway will be ramped down to street level prior to the crosswalk to maximize ped/bike user comfort.</td>
<td>Staff does not recommend raised crosswalks due to limited benefits.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>7</td>
<td><strong>Should sharrows be included and where?</strong></td>
</tr>
<tr>
<td>8</td>
<td><strong>Feasibility of augmenting buffered bike lanes with physical devices like oversized pavement markers</strong></td>
</tr>
<tr>
<td>9</td>
<td><strong>Feasibility of making shared-use path minimum 10 feet wide</strong></td>
</tr>
<tr>
<td>10</td>
<td><strong>Address improvements for the visually impaired</strong></td>
</tr>
</tbody>
</table>
ATTACHMENT 2

SUMMARY OF TRAFFIC DELAY FROM OMITTING RIGHT-TURN LANES
## Summary of Traffic Delay
(With Omission of Right-Turn Lanes)

<table>
<thead>
<tr>
<th></th>
<th>AM Peak</th>
<th></th>
<th></th>
<th>PM Peak</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avg Delay</td>
<td>*95th Percentile Queue</td>
<td>Delay Sensitivity (85th Percentile)</td>
<td>Avg Delay</td>
<td>*95th Percentile Queue</td>
<td>Delay Sensitivity (85th Percentile)</td>
</tr>
<tr>
<td><strong>WB</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>16 sec.</td>
<td>9 veh.</td>
<td>62 sec.</td>
<td>9 sec.</td>
<td>4 veh.</td>
<td>17 sec.</td>
</tr>
<tr>
<td>2040</td>
<td>24 sec.</td>
<td>21 veh.</td>
<td>143 sec.</td>
<td>260 sec.</td>
<td>230 veh.</td>
<td>630 sec.</td>
</tr>
<tr>
<td><strong>SB</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>10 sec.</td>
<td>5 veh.</td>
<td>20 sec.</td>
<td>15 sec.</td>
<td>9 veh.</td>
<td>53 sec.</td>
</tr>
<tr>
<td>2040</td>
<td>32 sec.</td>
<td>23 veh</td>
<td>115 sec.</td>
<td>11 sec.</td>
<td>5 veh.</td>
<td>25 sec.</td>
</tr>
</tbody>
</table>

* 95% Q applicable for Average Delay Analysis Only

### Typical Delay Criteria for Various Levels of Service (LOS):

<table>
<thead>
<tr>
<th></th>
<th>LOS &quot;D&quot;</th>
<th>LOS &quot;E&quot;</th>
<th>LOS &quot;F&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal Control</td>
<td>&gt; 35 sec.</td>
<td>&gt; 55 sec.</td>
<td>&gt; 80 sec.</td>
</tr>
<tr>
<td>Stop Sign Control</td>
<td>&gt; 25 sec.</td>
<td>&gt; 35 sec.</td>
<td>&gt; 50 sec.</td>
</tr>
<tr>
<td>Roundabout</td>
<td>&gt; 25 sec.</td>
<td>&gt; 35 sec.</td>
<td>&gt; 50 sec.</td>
</tr>
</tbody>
</table>
ATTACHMENT 3

INTERSECTION VISUALIZATION – TYPICAL SIGNAGE
ATTACHMENT 4

RIGHT-OF-WAY IMPACTS OF CYCLE TRACK DESIGN
EXHIBIT 4T: ELEMENTS OF ROUNDABOUTS WITH SEPARATED BIKE LANES

1) Bicycle Crossing
2) Yield Lines
3) Bicycle Stop Line or Yield Lines
4) 5 ft. Curb Radius
5) Channelizing Island
6) BICYCLE/PEDESTRIAN WARNING Sign
ATTACHMENT 5
MASSACHUSETTS DOT DESIGN GUIDE (EXCERPT)
Chapter 6

Intersections
6.7.9.3 Bicycle Lanes at Roundabouts

Roundabout design should accommodate bicyclists with a wide range of skills and comfort levels in mixed traffic. Bicyclists have the option of either mixing with traffic or using the roundabout as a pedestrian, as illustrated in Exhibit 6-33.

■ Where bike lanes are present, low-speed (approximately 12 to 15 mph) and single-lane roundabouts allow for safe mixing of bicycles and motor vehicles within the roundabout. This option will likely be reasonably comfortable for experienced bicyclists. Bicyclists will often keep to the right on the roundabout; they may also merge left to continue around the roundabout. Motorists should treat bicyclists as other vehicles and not pass them while on the circulatory roadway. The bicycle lane should be discontinued about 100 feet prior to low-speed roundabouts to indicate that bicyclists should either mix with motor vehicle traffic or exit to the shared use path.

■ On the perimeter of roundabouts, there should be a sidewalk that can be shared with bicyclists. Less-experienced bicyclists (including children) may have difficulty and discomfort mixing with motor vehicles and may be more safely accommodated as pedestrians in some instances. Bicycle lanes leading toward a roundabout should be discontinued at the beginning of the entry curve of the roundabout, ending in a ramp leading toward a shared use bicycle pedestrian path around the roundabout. Bicycle lanes should resume on the end of the exit curve, beginning with a ramp from a shared use path.

Bicyclists require particular attention within higher speed and double lane roundabouts, especially in areas with moderate to heavy motor vehicle volume. It may sometimes be possible to provide bicyclists with grade separation or an alternative route along another street that avoids the roundabout, which should be considered as part of overall planning. The provision of alternative routes should not be used to justify compromising the safety of bicycle traffic through the roundabout because experienced bicyclists and those with immediately adjacent destinations will use it.
Exhibit 6-33
Bicycle Accommodations at Roundabouts


6.8 Other Considerations

Several other considerations important for intersection design are described in the following sections including: sight triangles; intersection spacing; bus stop considerations; other types of roadway crossings; mid-block path crossings; and highway-railroad grade crossings; and driveways.

6.8.1 Intersection Sight Triangles

The intersection sight triangle is a triangular-shaped zone, sufficiently clear of visual obstructions to permit drivers entering the intersection to detect any hazards or conflicts and react accordingly. Intersection sight distance and sight triangles are discussed further in Chapter 3.

6.8.2 Intersection Spacing

A primary purpose of intersection spacing guidelines is to minimize the possibility of conflicts in traffic operations between adjacent intersections. Examples of such conflicts are queues of traffic extending from one intersection through an adjacent intersection, or
ATTACHMENT 6

REVISED PROJECT INTERSECTION LAYOUT
High-visibility green-painted bike lane (Similar on WB approach)

Warning "Rumble Strips" approaching bike transition zone (Similar on WB approach)

Marked bike exit ramp to shared-use path (Similar on WB approach)

Sharrows centered on all approaches and circulatory roadway

Ramp to shared-use path at grade with roadway

Reflective bollards marking crosswalks (typical all locations)

"Yield bars" leading to crosswalks across RAB exit lanes

Alternate "Shark Tooth" Yield Line Treatment

Path of Travel through "Jo"n

Shortened turn lane transition to reduce bike exposure