

4. Existing Conditions, Opportunities, and Constraints

This chapter summarizes the existing conditions, opportunities, and constraints related to physical site conditions, land use, and traffic conditions within the Study Area for a pathway along the EBMUD Aqueduct ROW. **Section 4.1** identifies the land uses near the EBMUD Aqueduct ROW, including approved land use developments. **Section 4.2** describes EBMUD's structural and maintenance requirements applicable to construction and operation of a pathway along their ROW. EBMUD access needs are discussed in **Section 4.3**. **Sections 4.4** and **4.5** describe topographic conditions along the EBMUD Aqueduct ROW and topographic and ROW constraints associated with use of the ROW, respectively. **Section 4.6** presents the roadway crossings, including information on intersection geometries, roadway volumes and speeds, and pathway crossing opportunities and constraints. The pathway relationship to adjacent land uses and safety and security considerations are discussed in **Sections 4.7** and **4.8** respectively. **Section 4.9** concludes the chapter with a discussion of environmental constraints.

4.1 Surrounding Land Uses

Within the Pathway Study Area, the EBMUD Aqueduct ROW parallels the south side of SR 24 and generally runs along the north side of downtown Lafayette. Figure 4-1 shows the 2005 City of Lafayette General Plan land use designations, location of nearby development projects, DSP boundary, Redevelopment Project Area boundary and key landmarks surrounding the EBMUD Aqueduct ROW. Properties near the EBMUD Aqueduct ROW have been developed with retail, office, civic or residential land uses. Approximately one-third of the EBMUD Aqueduct ROW has a General Plan land use designation and is within the DSP and Redevelopment Project areas.

The western one-third of the portion of the Pathway Study Area and the properties north and south of the EBMUD Aqueduct ROW are designated West End Commercial by the General Plan. This designation accommodates primarily office and other uses that complement the adjacent Downtown Core area, located immediately to the east. The central portion of the EBMUD Aqueduct ROW under study abuts the General Plan's Downtown Core land uses to the south and Caltrans ROW to the north. The eastern portion of the EBMUD Aqueduct ROW under study abuts the General Plan's East End Commercial land use designation to the south and Caltrans ROW to the north. Two properties within the continuation of the pathway corridor (both with Assessor's Parcel Number (APN) 233-040-XXX as shown in **Appendix B**) are designated East End Commercial by the General Plan. The Downtown Core area consists of a mix of uses in a pedestrian-friendly environment. The East End Commercial designation allows for a mix of uses, including retail, auto-oriented commercial, hotel and office uses. Single- and multi-family residential uses exist south of the Downtown Core and West and East End Commercial areas. The Downtown Core also includes multi-family residential uses. The maximum density for multi-family residential uses in these areas is 35.0 dwelling units per acre. Single- and multi-family residential neighborhoods, the BART station parking lots and open space are located north of the Pathway Study Area and SR 24.

The EBMUD Aqueduct ROW is located within four Downtown Districts, as designated by the DSP. The western end of the EBMUD Aqueduct ROW under study and the properties to the north and south, between Risa Road and the west side of the Diamond K parcel (located at 3671 Mt. Diablo Boulevard), are designated

FINAL

West End. Moving east, the ROW is either within or abuts the Downtown Retail District, which extends from the west side of the Diamond K parcel to First Street. The Downtown Civic and Cultural District is located between First Street and the access road to the Post Office Annex (located at 3426 Mt. Diablo Boulevard) and Lafayette Creek. The Downtown Civic and Cultural District abuts the south side of the EBMUD Aqueduct ROW. Two properties within the continuation of the pathway corridor (APN 233-040-XXX) are designated Downtown Civic and Cultural by the DSP. The eastern portion of the EBMUD Aqueduct ROW abuts the Brown Avenue District to the south. Primary land uses within the West End District are office and multifamily residential; however, some medical, retail and civic uses are also located in this District. The Downtown Retail District consists primarily of retail uses. Ancillary uses include office, multifamily and civic uses. Land uses in the Downtown Civic and Cultural District include commercial, retail, auto services, offices, residential and civic uses. Within the Brown Avenue District, retail, office, residential and auto-oriented uses exist.

The Downtown area is continually changing and is anticipated to accommodate additional residential, commercial and office land uses in the future. The DSP Draft EIR projected that build-out of the DSP as currently drafted could result in up to 1,765 new housing units in the DSP area, which would increase the city's population by up to 4,589 residents. The build-out projections in the DSP Draft EIR reflect what City staff and the EIR consultant team believed to be "a realistic estimate of the amount and type of development that is reasonably foreseeable under the [DSP] by 2030, assuming a high rate of redevelopment to ensure that the Draft EIR does not understate environmental impacts" (DSP Final EIR, p. 3-2). The DSP Final EIR states that, "given the historic rate of growth in Lafayette, the high cost of land, and irregular parcel sizes in the [DSP] Area, it is unlikely that the build-out numbers would be fully realized" (p. 3-6).

Near the Pathway Study Area, the development projects listed below have received City approval and are in the pre-construction processes. These projects have not yet submitted for building permits.

- **The Woodbury Condominium project.** This project is located at 3758 Mt. Diablo Boulevard, near Risa Road, behind the Veterans Building, and consists of 80 residential units. An eight-foot-wide asphalt multi-purpose trail with two-foot-wide crushed granite shoulders is proposed within the EBMUD Aqueduct ROW to the south of the project site.
- **Branagh office building.** Located at 3722 Mt. Diablo Boulevard, the vacant lot just east of the Veterans Building, this project consists of 4,000 square feet of office space.
- **Town Center Phase 3.** This project site currently consists of a parking lot and is located between Happy Valley Road and Thompson Road, immediately south of the EBMUD Aqueduct ROW and BART parking lot turn-around. The project proposes 82 residential condominium units.
- **Eden Housing's senior housing project.** This project consists of a 46-unit senior housing development located at 3426 Mt. Diablo Boulevard, in front of the U.S. Postal Annex.

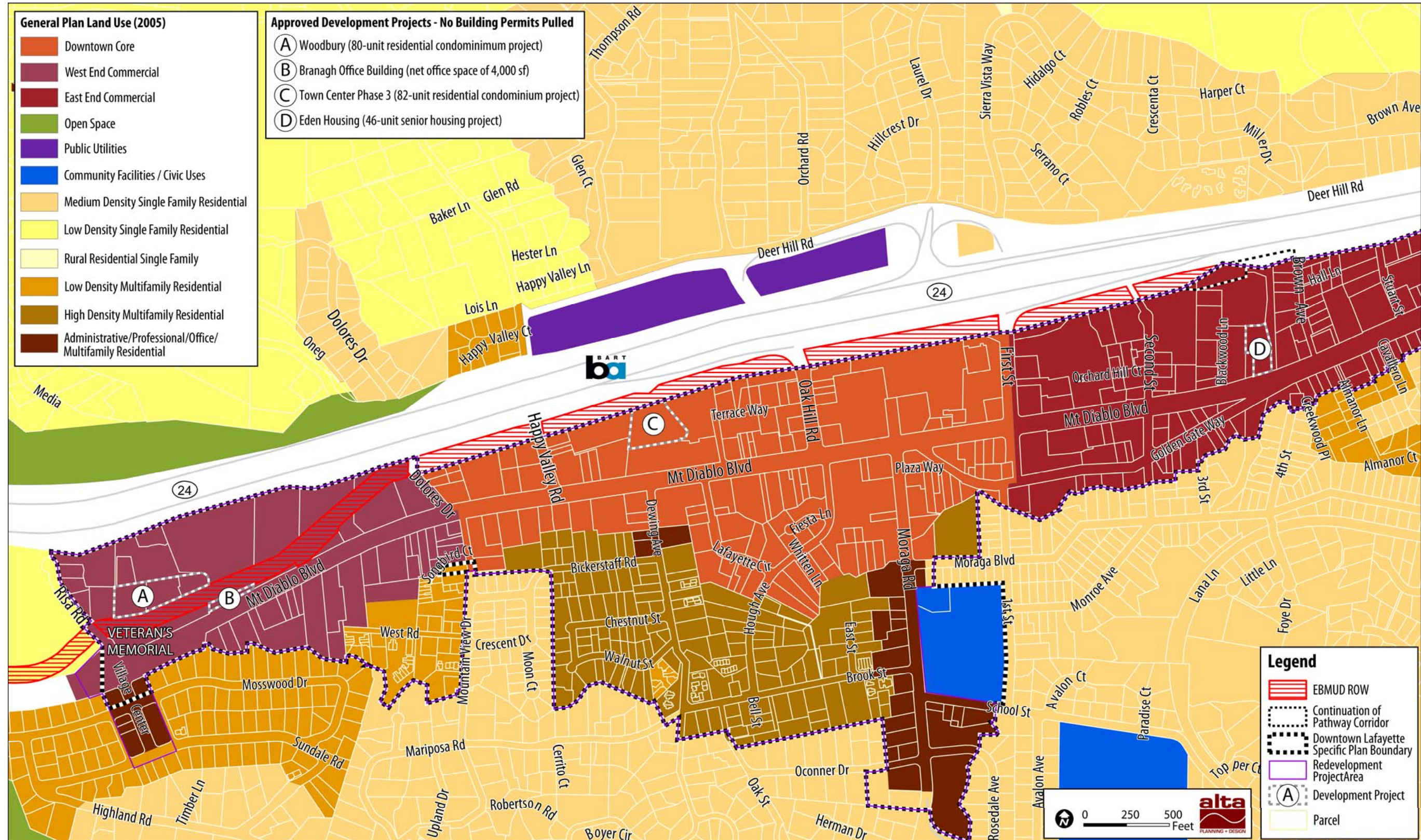


Figure 4-1: Surrounding Land Uses

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4.2 EBMUD Property Ownership and Associated Requirements

This section describes the EBMUD property ownership, and the required administrative, structural and maintenance requirements that a pathway along the EBMUD Aqueduct ROW would need to meet.

4.2.1 Property Ownership

The pathway would be located primarily within the EBMUD Aqueduct ROW, which is owned by EBMUD. SR 24 is within Caltrans ROW to the north. Additional properties adjoining the EBMUD Aqueduct ROW are privately-owned. Appendix B presents property ownership of parcels adjoining the EBMUD Aqueduct ROW.

Planning and design of a pathway through the EBMUD Aqueduct ROW would be carried out in accordance with EBMUD's structural requirements, administrative procedures and maintenance activity needs. These requirements are described below.

4.2.2 EBMUD Structural Requirements

The pathway along the EBMUD Aqueduct ROW would be required to comply with EBMUD's structural requirements for projects proposed within their ROW. EBMUD does not allow construction of any permanent structure foundations (spread footings, piles, etc.) that would be difficult to remove in the event of an unexpected emergency repair. EBMUD may allow a less permanent structure, such as a gravity retaining wall (e.g., a keystone retaining wall), to be installed within their ROW. These less permanent structures can be more easily removed and would not significantly obstruct EBMUD repair crews trying to access the Aqueduct. A paved pathway within the corridor is acceptable in most areas except at certain locations where the Aqueduct is deemed too close to the surface.

4.2.3 Existing Revocable Landscape License

The City of Lafayette's ability to encroach upon the EBMUD Aqueduct ROW and to construct a bicycle and pedestrian pathway are governed by two separate administrative procedures. The first step is to request encroachment rights for the necessary ROW. The second step is the more specific request to construct the actual project.

Encroachment Rights – Revocable Landscaping License

Since 2003, the City of Lafayette has had a Revocable Landscaping License agreement with EBMUD which grants the City the right to use the Aqueduct ROW. A Revocable Landscape License is the standard type of agreement EBMUD requires for public trails, landscaping, or for other crossings or lateral encroachments on its property.

The license specifically gives the City the right to encroach upon the ROW for "the construction, maintenance, and use of public pedestrian and bicycle trails." Limited Land Use Permits and Easements are other types of agreements used by EBMUD. These are generally applicable to agricultural uses and for streets, highways, railroads, and other major, publicly owned encroachments.

The 2003 revocable license spells out the legal rights, obligations, and remedies of both EBMUD and the City. The license prohibits commercial and industrial activities within EBMUD's ROW. It also prohibits vehicular traffic and parking, except as may be required by the City or other authorized persons for maintenance and

FINAL

emergency purposes. Additional topics include weekly and monthly maintenance, landscaping, and policing requirements to maintain the condition of the ROW if it is improved (see *Chapter 6, Funding and Maintenance Strategy and Benefit-Cost Analysis* for a detailed summary of maintenance requirements). Per the revocable license, EBMUD must continue to maintain the unlandscaped portions of the Aqueduct ROW to Fire Marshal standards. The license also describes how EBMUD must go about notifying the City of necessary repairs to the Aqueduct and how EBMUD will be indemnified against potential losses, claims, and liabilities. Section A.3 of the Revocable Landscaping License states that, following any EBMUD work within the portions of the Aqueduct ROW covered by the Revocable Landscaping License, EBMUD shall restore the ground surface to its pre-existing grade and make its best efforts to limit damage to landscaping. The license defines landscaping as including bicycle and pedestrian paths.

If the City decides to construct a pathway along the EBMUD Aqueduct ROW, and following subsequent design-development, the City would pursue renegotiation of the maintenance requirements currently specified in the Revocable Landscaping License to reflect the proposed pathway design.

Application for Use of EBMUD Property

Any specific projects involving the Lafayette Aqueduct ROW are processed by the Water Supply Division in Stockton, CA. Procedure 718 (effective March 15, 2010) and Supplement No. 1 outline the requirements of the application and construction process. The initial application requirements include:

- A completed application containing a description of the project and the work required, plan and profile drawings, details of all county and city permits and approvals required, and any CEQA documentation relating to the project such as a Negative Declaration or Environmental Impact Statement.
- Proof of insurance: liability (\$1,000,000/occurrence bodily damage, property damage, and general and auto liability); and, worker's compensation, as required by California state law.

4.2.4 Existing EBMUD Maintenance Activities

Exhibit B of the Revocable Landscaping License between EBMUD and the City (reproduced in *Chapter 6, Funding and Maintenance Strategy and Benefit-Cost Analysis* as **Table 6-2**) outlines the maintenance activities prescribed to the City if the City were to install a pathway and/or landscaping improvements. The Revocable Landscaping License states that EBMUD will continue to maintain unlandscaped real property to Fire Marshal standards. For the portions of the EBMUD Aqueduct ROW covered by the Revocable Landscaping License, EBMUD must restore the ground surface to its pre-existing grade following any EBMUD work and make its best efforts to limit damage to landscaping, including bicycle and pedestrian paths. If the City constructs a pathway, the City will be responsible for maintenance of the portions of the ROW containing the pathway and/or landscaping associated with the pathway. Currently, most of the ROW within Lafayette is unimproved such that EBMUD performs the majority of maintenance activities listed in the Revocable Landscaping License, including weed abatement, inspection and repair of fences and gates, drainage control and maintenance of culverts, and trash and graffiti removal. Access roads within the ROW are primarily gravel. EBMUD's maintenance of the gravel roads consists of either blading to remedy rough areas or laying down additional gravel. EBMUD's roadway maintenance is carried out once per year, as necessary.

4.3 Impact to EBMUD Aqueduct ROW Access

A gravel EBMUD access road exists along portions of the EBMUD Aqueduct ROW. A pathway along the EBMUD Aqueduct ROW could potentially limit EBMUD access within its ROW in locations where the pathway and maintenance road overlap and the pathway requires grading and/or a gravity retaining wall. In most locations, the pathway alignment would not interfere with the existing access road within the EBMUD Aqueduct ROW. There are two locations where this may be an issue: west of Dolores Drive and east of Oak Hill Road.

The final pathway design must provide EBMUD maintenance access. Access could be provided through a combination of pathway access and adjacent dirt road access. Where the alignment follows or crosses the access road and does not include switchbacks, maintenance access would be provided on the pathway. Where the pathway alignment includes switchbacks, maintenance access would be provided as a separate gravel/dirt roadway adjacent to the pathway. Where EBMUD maintenance vehicles are expected to use the pathway, the paved width of the pathway must be 12 feet to accommodate maintenance vehicles and reduce pathway deterioration. In situations where EBMUD maintenance vehicles would cross the pathway, concrete ramps should be provided to reduce deterioration of the pathway edge. The ultimate alignment of the pathway and maintenance access road would be designed in future stages of the project. The final pathway alignment is subject to approval by EBMUD and, as such, modifications of the proposed alignment to ensure EBMUD access may occur in subsequent design development phases of this project.

4.4 Physical Site Conditions

Physical site conditions include topography and EBMUD Aqueduct and utility locations. These factors have a significant impact on feasibility of a pathway through the Pathway Study Area.

4.4.1 Topography

The EBMUD Aqueduct ROW has varying slopes throughout its length, from a mild 2%± slope to a steep 33%±. The terrain within the corridor consists of mostly disked grassland and brush, some gravel and an occasional patch of maintained lawn. Some sections also have tree canopy. At roadway crossings and at the southern BART parking lot east of Happy Valley Road, asphalt and concrete exist along the alignment. A description of the changes in grade by Pathway Study Area segment is presented below from west to east and illustrated in Figure 4-2. See Figure 2-1 on page 2-3 for a map of the entire Pathway Study Area, showing extents for the individual Pathway Study Areas described below.

- **Pathway Study Area 1.** The westernmost section from Risa Road to just before Dolores Drive is gently sloped staying around 2%±.
- **Pathway Study Area 2.** Just before reaching Dolores Drive, a 20 foot rise increases the slope to 15%± and then is followed by a sharp decline down to Dolores Drive at a slope of 25%± or 4 feet horizontal to 1 foot vertical (4:1). Continuing on to the east, the next 300± feet stay relatively flat until reaching another hill with a 12%± incline that transitions into a 33%± decline down to Happy Valley Road. The descent down to Happy Valley Road represents an elevation change of more than 35 feet.
- **Pathway Study Area 3.** After crossing Happy Valley Road, the corridor flattens out again for another 800± feet at 2%± before starting up a long incline at 12%± east of the BART station and decline at

25%± down to Oak Hill Road. This 55± foot drop down to Oak Hill Road is the most significant elevation change along the EBMUD Aqueduct ROW within the Pathway Study Area.

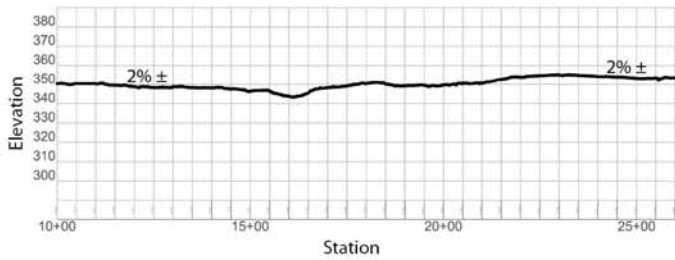
- **Pathway Study Area 4.** Moving east of the Oak Hill Road crossing, the terrain rises again and falls, with slopes on both sides of approximately 22%. After this 500± foot stretch the corridor flattens out to 4%± until reaching First Street.
- **Pathway Study Area 5.** The final stretch between First Street and Brown Avenue consists of multiple hills with little flat area. It starts up from First Street at 10%± and then down to Second Street at 15%±. Then back up from Second Street at 20%± and down to Blackwood Lane at 10%±. The corridor then continues down at 10%± until about 200 feet west of Brown Avenue where it rises again at 5%± until it reaches the east end of the Pathway Study Area.

4.4.2 Aqueduct/Utility Locations

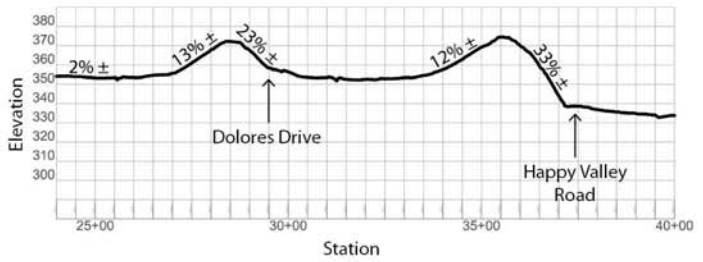
The aqueducts within the Pathway Study Area are part of EBMUD's water supply system, which serves approximately 1.3 million people in a 331-square-mile area extending from Crockett on the north, southward to San Lorenzo, eastward from San Francisco to Walnut Creek and south through the San Ramon Valley. Ninety percent of EBMUD's water supply comes from the Mokelumne River watershed in the Sierra Nevada. EBMUD's water supply system consists of a network of reservoirs, aqueducts, treatment plants, and distribution facilities that extends from the Mokelumne River Basin to the East San Francisco Bay Area.



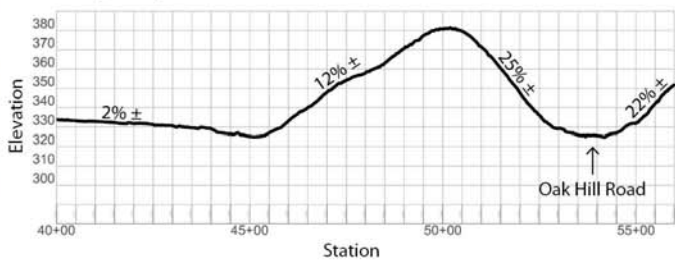
Pathway Study Area 1



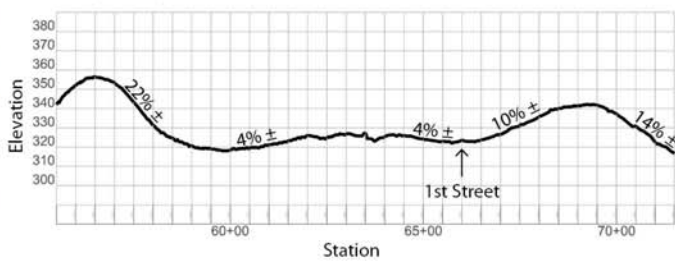
Pathway Study Area 2



Pathway Study Area 3



Pathway Study Area 4



Pathway Study Area 5

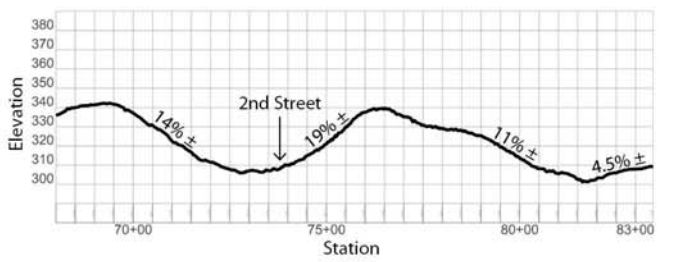


Figure 4-2: Slopes along the EBMUD Aqueduct ROW within the Pathway Study Area

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Within Lafayette, the first pipeline was completed in 1929. Information gained during conversations with EBMUD representatives, through review of available as-built drawings, and during field verification imply that the Aqueducts mostly lie within the southern 50 feet of the 100-foot-wide EBMUD Aqueduct ROW. The horizontal location of the Aqueducts is much easier to determine than the vertical location due to the air release and blow off valves located throughout EBMUD's ROW. The vertical elevation of the Aqueducts is much more difficult to evaluate and potholing to determine the depths of the Aqueducts would be necessary before any construction above them could begin. At some locations within EBMUD's ROW, the Aqueducts have as little as one foot of ground cover over the top of the pipe. Due to the general layout of the Aqueducts within the southern portion of the ROW, the northern portion has been largely untouched by EBMUD. EBMUD has identified this northern area as a potential site for a future Aqueduct, although no official funding has been allocated or any construction date been set.

EBMUD has a planned capital improvement project—the Lafayette Aqueduct No. 1 Relining Project—which is scheduled for the 2015-2020 timeframe. This project will repair the lining on the Lafayette Aqueduct No. 1 from the Walnut Creek Water Treatment Plant to the Lafayette Control Works. If the City decides to pursue construction of the proposed pathway, the timing of this capital improvement project may be advantageous, as it will be easier to construct a pathway in the context of a larger project than in isolation.

Figures 5-6, 5-9, 5-15, and 5-16, in Chapter 5, show the approximate location of the Aqueducts within the Pathway Study Area. Although the Aqueducts typically parallel each other along the corridor, there are a couple locations where they diverge and at one point even cross each other. About midway between Risa Road and Dolores Drive, the northerly Aqueduct #2 diverges from Aqueduct #1 for approximately 1,000 feet before rejoining Aqueduct #1 in a parallel alignment. During this stretch, Aqueduct #2 leaves the EBMUD Aqueduct ROW and is located within an easement for nearly 400 feet. From Dolores Drive to Oak Hill Road the Aqueducts stay parallel to one another and sit within the southern portion of the EBMUD right of way. Just east of Oak Hill Road the Aqueducts cross each other and Aqueduct #2 moves into the southern portion of the ROW with Aqueduct #1 occupying the center of the corridor. Once this switch occurs, the Aqueducts then diverge and converge a few times over the next 1,000 feet until once again becoming parallel at Blackwood Lane.

Conversations with EBMUD indicate that there is a major distribution line in the far northern portion of the EBMUD Aqueduct ROW between Dolores Drive and Happy Valley Road. Additional, smaller domestic water lines lie within the southern portion of the ROW. These lines typically are short longitudinal encroachments serving the residential sections abutting the ROW and do not travel to the north side of the EBMUD Aqueduct ROW.

4.5 Topographic and ROW Constraints

This section discusses the opportunities and constraints for a potential pathway presented by the site conditions and design standards.

4.5.1 Constraints to Meeting Design Standards

In order to evaluate the range of design options, this Study undertook an analysis of four hypothetical pathway alignments along the EBMUD Aqueduct ROW: a Class I bikeway, two ADA-accessible pathways (one with an at-grade crossing at Happy Valley Road and one with a bridge over the roadway) and a multi-use

pathway that is not ADA-accessible. The purpose of this exercise was to select the potential design options to evaluate further in this Study.

As described in Section 4.4.1, the EBMUD Aqueduct ROW has varying slopes throughout its length, from a mild 2%± slope to a steep 33%±. Topography of the EBMUD Aqueduct ROW, EBMUD structural requirements and the constrained ROW make it difficult to meet the design standards required for Class I bikeways and ADA-accessible pathways. EBMUD's structural requirements limit the type of structures and amount of grading that are permitted in the Aqueduct ROW. EBMUD structural requirements additionally limit where structures are permitted on the right-of way. The ROW is further constrained on the north by Caltrans ROW. The following is a description of the hypothetical pathway alignments:

1. **A Class I bikeway/ADA-accessible pathway with a maximum 5 percent slope.** To meet the slope requirements of a Class I bikeway—a maximum 5 percent sustained grade—requires switchbacks, significant grading or bridges. A pathway with a maximum five percent grade would require approximately 75 switchbacks if all roadway crossings are at-grade. Most switchbacks would have a turn radius of one foot. This alignment would require a design exception from Caltrans for turn radii that do not meet Caltrans design standards for Class I bikeways.
2. **A Class I bikeway/ADA-accessible pathway with a maximum 8.3 percent slope and all at-grade roadway crossings.** A pathway with a maximum 8.3 percent slope and all at-grade roadway crossings would have about 42 to 46 switchbacks. Switchbacks would have turn radii generally between one and five feet. This alignment would require a design exception from Caltrans for turn radii that do not meet Caltrans design standards for Class I bikeways.
3. **A Class I bikeway/ADA-accessible pathway with a maximum 8.3 percent slope and a bicycle/pedestrian bridge at Happy Valley Road.** A pathway with a maximum 8.3 percent slope and a bicycle/pedestrian bridge at Happy Valley Road would have approximately 35 switchbacks. Switchbacks would have turn radii generally between one and five feet. This alignment would require a design exception from Caltrans for turn radii that do not meet Caltrans design standards for Class I bikeways.
4. **A multi-use pathway that is not ADA-accessible.** A pathway along the EBMUD Aqueduct ROW that is not ADA-accessible and that does not incorporate switchbacks would experience grade changes between 2 and 33 percent.

The goals for the Study include identification of an alignment that is universally-accessible and minimizes fill and excavation. An alignment that meets these goals would serve pedestrians and bicyclists with a range of ability and skill levels and minimize impacts to the EBMUD Aqueduct. The third option, a Class I bikeway/ADA-accessible pathway with a maximum 8.3 percent slope and a bicycle/pedestrian bridge at Happy Valley Road best meets goals of this Study, and is further explored in *Chapter 5: Options Evaluation and Preferred Options*. The fourth option, a multi-use pathway that is not ADA-accessible, would be a lower cost option to improve access along the EBMUD Aqueduct ROW and is also evaluated further in this Study. The significant number of switchbacks and associated gravity retaining walls and fill required for the Class I bikeway and Class I bikeway/ADA-accessible pathway with all at-grade roadway crossings options would result in less desirable alignments and are not evaluated further in this Study.

4.5.2 Use of Caltrans ROW

The Caltrans ROW for SR 24 runs parallel to the EBMUD Aqueduct ROW that is being studied for the pathway alignment. There are several locations along the pathway alignment where an encroachment into Caltrans ROW may benefit the pathway alignment by reducing the change in grades and associated switchbacks. Although a longitudinal encroachment is typically not allowed for pedestrian facilities or utilities, there is precedence within the SR 24 corridor to the west of the Pathway Study Area in Orinda. Near downtown Orinda the St. Stephens Trail connection lies within Caltrans ROW. Another possible way to use a portion of Caltrans ROW is through a determination of excess ROW. If it can be proved that Caltrans ROW is larger than it needs to be, then Caltrans may declare excess ROW that could be transferred to the City or EBMUD to allow uses other than for state roadway facilities. Caltrans permitting requirements are discussed further in *Chapter 5: Options Evaluation and Preferred Options*.

The first potential encroachment location is just west of the Dolores Drive crossing where there is an existing knoll within the EBMUD Aqueduct ROW. Due to the knoll, adherence to ADA requirements is challenging without using several ramps and/or switchbacks. By encroaching into the Caltrans ROW to the north, the pathway would be able to avoid the knoll and reduce the number of switchbacks needed for the pathway.

The next location that would benefit from an encroachment into Caltrans ROW would be at the Happy Valley Road crossing. If the pathway alignment is constrained to the EBMUD Aqueduct ROW, the steep hill located west of Happy Valley Road would require multiple ramp switchbacks to safely navigate users from the top of the hill down to the intersection of the roadway. The significant elevation drop and steep terrain make this location ideal for a bridge crossing. Due to EBMUD foundation restrictions, it would not be possible to build the bridge within EBMUD Aqueduct ROW. However, if an encroachment within Caltrans ROW were allowed, the bridge foundations and structure could be built entirely within Caltrans ROW, resulting in the need for fewer switchbacks.

The final potential longitudinal encroachment location is located west of the Oak Hill Road crossing as shown in **Figure 4-3**. The hill west of Oak Hill Road presents topographic constraints. At this location an existing five-foot-wide sidewalk runs along the eastbound SR 24 off-ramp from the crest of the ramp down to Oak Hill Road intersection. The pathway alignment could connect to this existing sidewalk. This alignment and design would require some reconfiguration on the north side of the off-ramp and widening of the sidewalk to meet Class I pathway requirements as well as Caltrans' approval. This alignment is discussed further in *Chapter 5: Options Evaluation and Preferred Options*.



**The SR 24 eastbound off-ramp at Oak Hill Road
(looking west)**



Figure 4-3: Potential Encroachment into Caltrans’ ROW West of Oak Hill Road

4.6 Roadway Crossings

The Pathway Study Area crosses several streets including Risa Road, Dolores Drive, Happy Valley Road, Oak Hill Road, and First Street. This section provides an overview of the existing conditions, opportunities, and constraints of the following roadways within the Pathway Study Area:

- Risa Road/Mt. Diablo Boulevard
- Private Driveway/Mt. Diablo Boulevard (located approximately 600 feet east of Risa Road)
- Dolores Drive
- Happy Valley Road
- Oak Hill Road
- First Street

Data collected from field observations and the DSP EIR were used to evaluate each intersection.

4.6.1 Stopping Sight Distance

Due to the surrounding topography and street network within the Pathway Study Area, all the roadways that intersect the EBMUD Aqueduct ROW have grade changes and/or curves that affect sightlines and stopping distances to varying degrees. Table 4-1 describes the appropriate stopping sight distances for level roads and roads at a grade. These recommendations are considered in evaluating conditions where the EBMUD Aqueduct ROW crosses roadways.

Table 4-1: Stopping Sight Distance for Vehicles

Design Speed	Stopping Sight Distance						
	Level Grade	Downgrades			Upgrades		
		3%	6%	9%	3%	6%	9%
20 mph	115 ft	116 ft	120 ft	126 ft	109 ft	107 ft	104 ft
25 mph	155 ft	158 ft	165 ft	173 ft	147 ft	143 ft	140 ft
30 mph	200 ft	205 ft	215 ft	227 ft	200 ft	184 ft	179 ft
35 mph	250 ft	257 ft	271 ft	287 ft	237 ft	229 ft	222 ft

Source: AASHTO: A Policy on Geometric Design of Highways and Streets

4.6.2 Risa Road/Mt. Diablo Boulevard

The EBMUD Aqueduct ROW is accessed from Risa Road on the west end of the Pathway Study Area. The intersection of Risa Road and Mt. Diablo Boulevard is signalized.

Intersection Geometrics

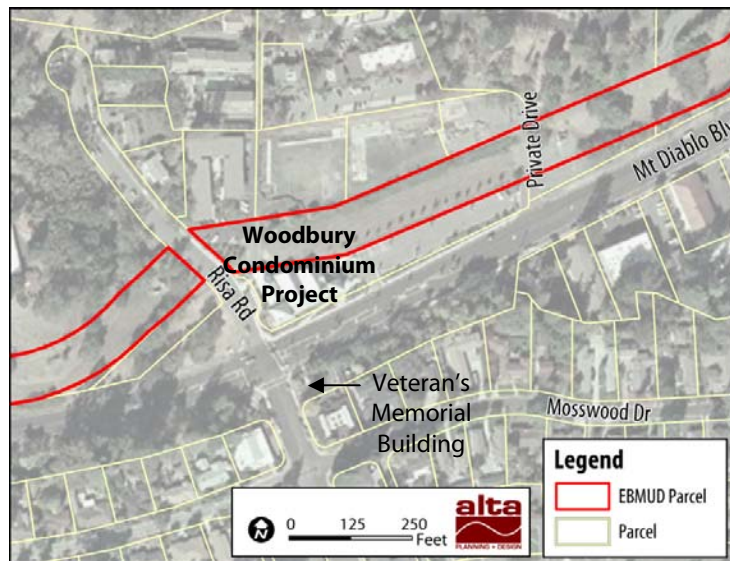
The EBMUD Aqueduct ROW intersects Risa Road 140 feet north of Mt. Diablo Boulevard. Risa Road is a public two-lane collector cul-de-sac that provides local access to multi-family residences, several office buildings and a synagogue. On-street parallel parking is permitted on both sides of the street on either side of the EBMUD Aqueduct ROW. There are existing sidewalks on both sides of Risa Road.

Mt. Diablo Boulevard is a four-lane arterial with a raised, planted median. East of Risa Road, Mt. Diablo Boulevard has a sidewalk on the south side of the street. The sidewalk along the north side of Mt. Diablo Boulevard east of Risa Road terminates at Private Drive. West of Risa Road, a pathway connecting to the Lafayette Reservoir runs along the south side of Mt. Diablo Boulevard. A sidewalk does not exist on the north side of Mt. Diablo Boulevard west of Risa Road within the Pathway Study Area. Class II bicycle lanes are striped along Mt. Diablo Boulevard west of Dolores Drive.

The Risa Road/Mt. Diablo Boulevard intersection has signalized pedestrian crossings and marked crosswalks on the north, south and east legs.

Roadway Volumes & Speeds

Figure 4-4 shows the existing AM and PM peak hour volumes for intersections included in the Pathway Study Area. These data are sourced from the DSP EIR.⁹ While vehicle volumes and travel speeds are low on Risa Road, Mt. Diablo Boulevard is a busy arterial with an 85th percentile speed of 45 mph, ten miles over the posted speed limit.¹⁰



Risa Road/Mt. Diablo Boulevard Intersection (within Pathway Segment 1)



Looking north on Risa Road towards the entrance to the EBMUD Aqueduct ROW

⁹ September 3, 2009 12:30 – 1:30pm.

¹⁰ Data collected by Fehr & Peers on Mt. Diablo Boulevard between Risa Road and Reservoir Driveway, May 2008.

Planned Improvements

As stated in the DSP EIR, the Woodbury development (see Section 4.1 for a description of this project) will affect the existing traffic circulation at the Risa Road/Mt. Diablo Boulevard intersection by creating new vehicle trips. The Woodbury project plans maintain the existing driveway across the EBMUD Aqueduct ROW.

The DSP EIR shows that traffic volumes at the Risa Road/Mt. Diablo Boulevard intersection will increase with future projects in the Downtown area. Future changes to the area surrounding the intersection of Mt. Diablo Boulevard and Risa Road show minimal changes to intersection operations. The projected Level of Service (LOS)¹¹ for vehicles varies between LOS A and LOS B depending on the peak hour.



Looking south on Risa Road towards Mount Diablo Boulevard from the EMBUD right-of-way crossing

Figure 4-5 shows the future AM and PM peak hour volumes for the Pathway Study Area (DSP EIR). Table 4-3 on page 4-29 shows the future LOS and delays for the Pathway Study Area. The LOS criterion follows the Highway Capacity Manual standards for signalized and unsignalized intersections.

Opportunities and Constraints

Observed vehicle speeds are low and stopping sight distance is adequate at the pathway entrance along Risa Road. A slight slope on Risa Road may encourage faster vehicle and bicycle speeds on the southbound approach to Mt. Diablo Boulevard. There is currently no street lighting on Risa Road.

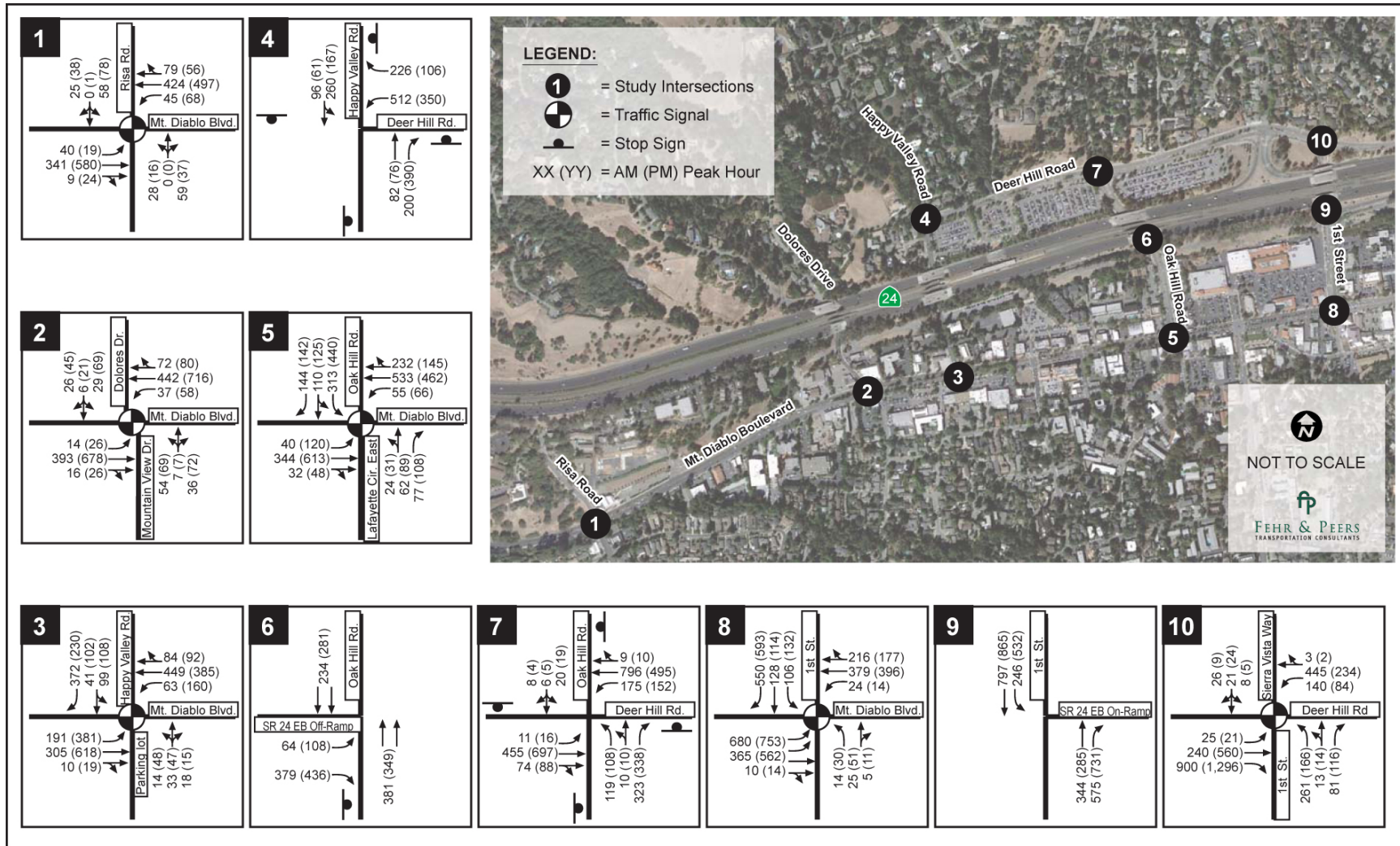
The sidewalks on both sides of Risa Road between the pathway crossing and Mt. Diablo Boulevard are approximately five feet wide. Risa Road does not include dedicated bicycle facilities; the Bikeways Master Plan does not propose dedicated bicycle facilities along Risa Road. Widening of the western sidewalk to accommodate pedestrians and less experienced bicyclists should be considered.

Risa Road will be the primary access point for the west end of the pathway, and serves as a connection to existing trails around the Lafayette Reservoir. To connect to the Lafayette Reservoir trails, pathway users must cross at the Risa Road/Mt. Diablo Boulevard intersection. Currently, the posted speed on Mt. Diablo Boulevard is 35 miles per hour. Although the intersection is signalized with marked crosswalks on three legs, speeds on Mt. Diablo Boulevard will affect both the safety and comfort for pedestrians and bicyclists. Pathway users approaching from the Lafayette Reservoir and bicyclists approaching from the eastbound bike lane on Mt. Diablo Boulevard would need to cross two legs of the intersection to access the pathway. While more experienced bicyclists travelling eastbound on Mt. Diablo Boulevard may feel comfortable merging into the left-turn lane to access the pathway, merging across motor vehicle lanes is more appropriate for streets with lower vehicle volumes such as two-lane roads. Pedestrians are routed across Village Center, and then north across the east leg of Mt. Diablo Boulevard to connect to the existing sidewalk on Risa Road.

¹¹ The Highway Capacity Manual Level of Service is used to determine if the facility design will provide acceptable traffic operations as reported for the peak 15 minutes. The criteria for each level of service for a signalized intersection under HCM standards are depicted in Table 4-3 for unsignalized intersections.

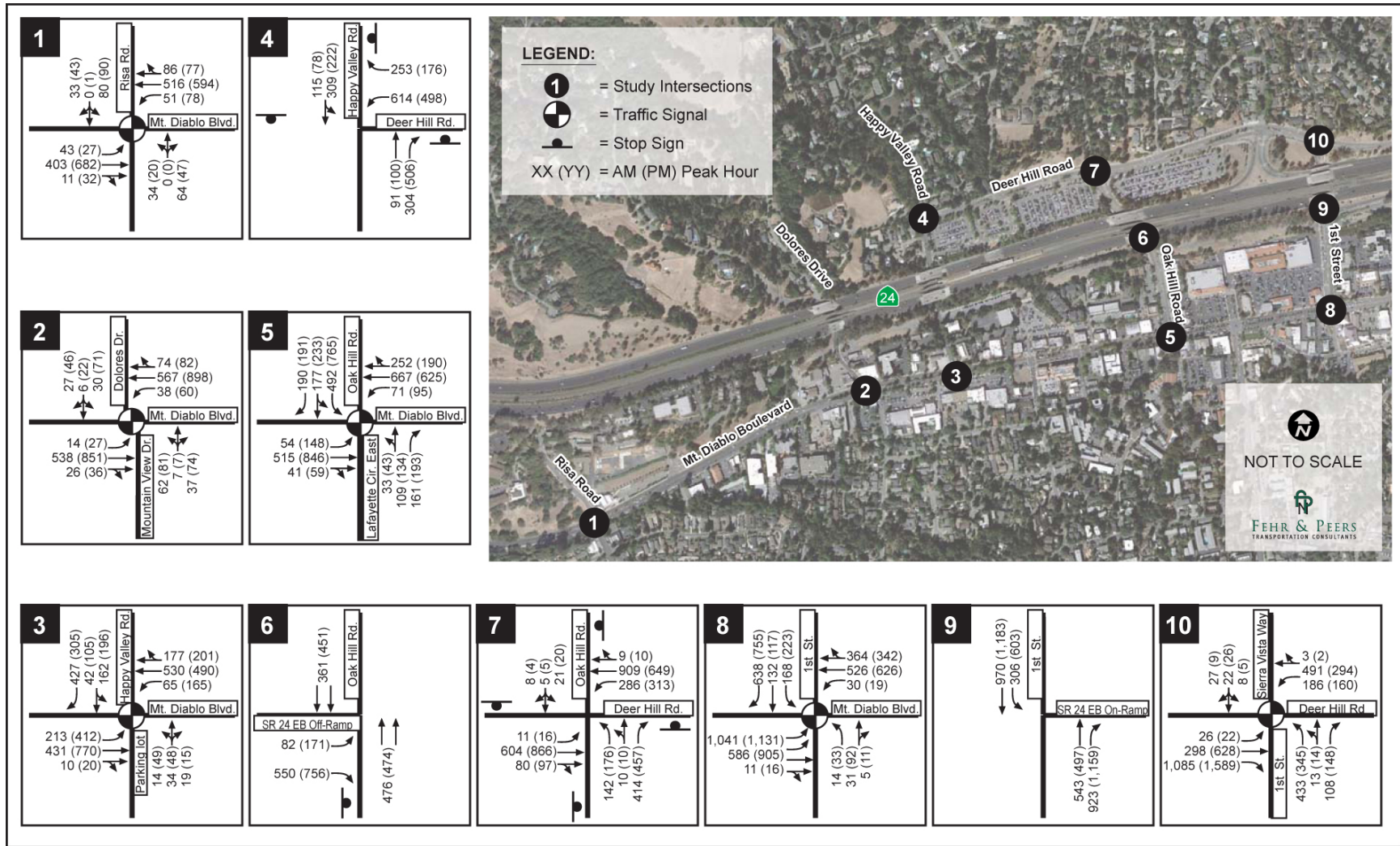
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The current approved design for the Woodbury Development routes pathway users across the development's driveway, potentially creating conflicts between vehicles entering and exiting the driveway and pathway users. Alternatively, if circumstances permit, the proposed pathway alignment could be reevaluated to determine if a more direct route can be used.



Source: DSP EIR, collected on Sept 2007 / Sept 2009

Figure 4-4: Existing Volumes and Lane Configurations



Source: DSP EIR, collected on Sept 2007 / Sept 2009

Figure 4-5: Future Volumes and Lane Configuration

4.6.3 Private Drive/Mt. Diablo Boulevard Crossing

A private driveway, accessed from Mt. Diablo Boulevard, is located between Risa Road and Dolores Drive. The EBMUD Aqueduct ROW crosses the private driveway 65 feet north of Mt. Diablo Boulevard. The driveway provides access to the Veteran's Memorial Building parking lot, residential housing, several commercial spaces, and a large office complex. The driveway will also provide access to the Branagh Office Building development project, when it is constructed, and serve as an exit route from the Woodbury Condominium development's garage.



Private Drive/Mt. Diablo Boulevard Intersection (within Pathway Segment 1)

Intersection Geometrics

The private driveway does not have any lane striping and is 40 feet wide. There is no crosswalk across the private drive and it does not have any sidewalks or parking along its length.

In this section, sidewalks exist on the south side of Mt. Diablo Boulevard and on the north side of Mt. Diablo Boulevard east of the private driveway.

Roadway Volumes & Speeds

While field observations during the mid-day found few vehicles traveling on the private drive or any heavy movements along this intersection, the driveway serves many office buildings and peak volumes for the driveway occur during AM and PM peak hours. Vehicles traveling along the private driveway either come from parking lots on the surrounding property or Mt. Diablo Boulevard. Vehicles traveling from the private driveway onto Mount Diablo Boulevard must yield to the on-coming traffic such that upon entering Mount Diablo Boulevard they have low speeds.

Planned Improvements

The Branagh Office Building development project has been approved at the northeast corner of the Private Drive/Mt. Diablo Boulevard intersection. The site plans show a one-way vehicular entrance to the building's parking area off the private driveway and south of the EBMUD Aqueduct ROW. Vehicles leaving the building would exit onto Mt. Diablo Boulevard using a separate exit located at the eastern end of the building. The site



Looking north on the private drive towards the entrance to the EBMUD Aqueduct ROW

plans include a new median at the entrance of the driveway, south of the EBMUD Aqueduct ROW, and a new sidewalk along Mt. Diablo Boulevard adjacent to the new building. Existing residential signage will be relocated within the median.

Opportunities and Constraints

The private drive slopes downward towards Mt. Diablo Boulevard and curves slightly within the Pathway Study Area. Observed vehicle speeds are low, but the slope of the private drive may encourage faster vehicle speeds on the southbound approach to Mt. Diablo Boulevard. Sightlines and sight stopping distance approaching the pathway crossing are adequate. Existing lighting at the private drive is adequate.

The private drive does not include sidewalks or dedicated bicycle facilities; the Bikeways Master Plan does not propose dedicated bicycle facilities along the private drive. Sidewalks along both sides of the private drive between the pathway entrance and Mt. Diablo Boulevard should be considered. Sidewalk improvements would serve the several apartments and office buildings nearby on the south side of Mt. Diablo Boulevard, which may generate pathway users.

The private drive entrance at Mt. Diablo Boulevard is STOP controlled. Vehicles entering the private drive from Mt. Diablo Boulevard may be traveling at high speeds. Advance signage and a median along the private drive should be considered to slow vehicles approaching the pathway crossing.

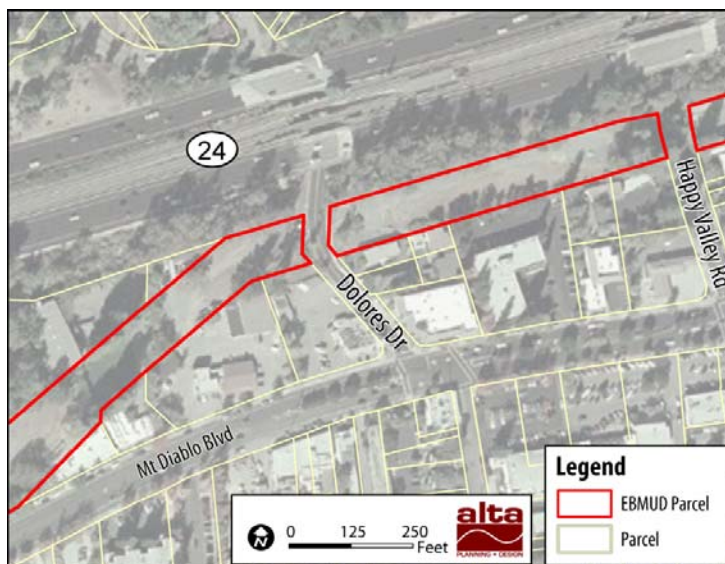
4.6.4 Dolores Drive

Dolores Drive intersects the EBMUD Aqueduct ROW on the west side of Downtown Lafayette, between Mt. Diablo Boulevard and Via Roble. Dolores Drive is a two lane collector that passes under SR 24.

Intersection Geometrics

On-street parking is not permitted on Dolores Drive except on the east side of the street north of the EBMUD Aqueduct ROW. Sidewalks are present on the east side of Dolores Drive between Mt. Diablo Boulevard and Via Roble only.

Dolores Drive approaches Mt. Diablo Boulevard on a downward slope. At the intersection, crosswalks are marked on each approach. West of Dolores Drive, Mt. Diablo Boulevard has Class II bicycle lanes. To the east, the bicycle facility becomes a Class III bike route with sharrows.



Dolores Drive (within Pathway Segment 1)

Roadway Volumes & Speeds

Lane configurations and roadway volumes for Dolores Drive and Mt. Diablo Boulevard are shown in Figure 4-4. The posted speed limit for Dolores Drive is 25 mph and that for Mt. Diablo Boulevard is 35 mph.

Planned Improvements

A future mixed use project is proposed at the northwest corner of Dolores Drive and Mt. Diablo Boulevard. Currently, the lot contains restaurant and retail space. The mixed use project will include residential living, retail and commercial space. The change in land use as well as other development projects in the Downtown area will increase the traffic volumes at the Dolores Drive/Mt. Diablo Boulevard intersection. Given the existing volumes and turning movements at this intersection, it is anticipated that the majority of future vehicle trips will access the new developments on Mt. Diablo Boulevard, away from the Dolores Drive crossing of the EBMUD Aqueduct ROW. Figure 4-5 depicts the future volumes and Table 4-3 on page 4-29 shows the change in LOS for the study intersections.

Opportunities and Constraints

Dolores Drive slopes down from Via Roble to Mt. Diablo Boulevard, which may contribute to increased vehicle speeds. The S-curve of the roadway, SR 24 support columns, and grade changes around the EBMUD Aqueduct ROW crossing on Dolores Drive limit sight lines and present stopping sight distance issues. Sight distances to a crosswalk near the center of the EBMUD Aqueduct ROW would be approximately 170 feet for the southbound approach and 120 feet for the northbound approach. As the northbound stopping sight distance does not meet AASHTO standards, crossing treatments which slow vehicle speeds and improve sightlines should be considered. There is minimal lighting as Dolores Drive passes under SR 24, further limiting visibility for drivers and pathway users. Additional street lights would enhance mid-block crosswalk visibility for drivers.



Looking south where Dolores Drive curves beneath SR 24, limiting stopping sight distances



Looking north on Dolores Drive towards the the EBMUD Aqueduct ROW. Sightlines are limited due to the curvature and grade of the roadway



Looking east across Dolores Drive to the EBMUD right-of-way. Steep slopes may encourage bicyclists to approaching the roadway at high speeds

Bicyclists traveling along the pathway would approach Dolores Drive on a steep downward sloping pathway that would encourage faster speeds. Traffic calming measures along the pathway aimed to slow bicyclists should be considered.

Mt. Diablo Boulevard is 230 feet south of the EBMUD Aqueduct ROW. The sidewalk on the west side of Dolores Drive ends 30 feet from Mt. Diablo Boulevard. Dolores Drive does not include dedicated bicycle facilities; the Bikeways Master Plan does not propose dedicated bicycle facilities along Dolores Drive. Continuing the sidewalk up to the EBMUD Aqueduct ROW would provide a connection on both sides of the street for pedestrians and less experienced bicyclists.

4.6.5 Happy Valley Road

The EBMUD Aqueduct ROW intersects Happy Valley Road between Mt. Diablo Boulevard and Deer Hill Road. Happy Valley Road is a two-lane collector that provides direct access to the Lafayette BART Station and parking lots, and terminates at Mt. Diablo Boulevard in the central Downtown area. The EBMUD Aqueduct ROW to the east of Happy Valley Road is covered by a BART Station parking lot.

Intersection Geometrics

The east side of Happy Valley Road has a sidewalk between Mt. Diablo Boulevard and Deer Hill Road. On the west side of the street, the sidewalk terminates at a private driveway south of the EBMUD Aqueduct ROW. The City has near-term plans to install a mid-block crosswalk with in-pavement flashing lights and overhead lighting that will connect to the BART Station parking lot on the south side of SR 24 and continue the sidewalk to meet Mt. Diablo Boulevard. Sharrows will be installed between Mt. Diablo Boulevard and Deer Hill Road. On-street parallel parking is permitted on both sides of the street.

Roadway Volumes & Speeds

Close proximity to the Lafayette BART Station and central Downtown Lafayette results in high vehicle, pedestrian and bicycle traffic on Happy Valley Road and Mt. Diablo Boulevard. Field



Happy Valley Road (within Pathway Segment 1)



Looking north on Happy Valley Road, adjacent to the EBMUD Aqueduct ROW. Sightlines are limited due to the curvature and grade of the roadway.

observations noted many pedestrians on the east sidewalk of Happy Valley Road heading north to the BART station. Many vehicles use Happy Valley Road to access the BART parking lot on the EBMUD Aqueduct ROW. **Figure 4-4** illustrates the peak hour volumes at the intersections of Happy Valley Road/Mt. Diablo Boulevard and Happy Valley Road/Deer Hill Road.

The posted speed limit on Happy Valley Road is 25 mph. Speed survey data recorded in May, 2008 found that the 85th percentile speed of vehicles traveling on Happy Valley Road was 32 mph southbound and 35 mph northbound.

Planned Improvements

The DSP EIR projects a considerable increase in vehicle volumes along Happy Valley Road. **Figure 4-5** illustrates the future volumes and **Table 4-3** on page 4-29 shows the change in LOS from the existing to the future for the study intersections.

Opportunities and Constraints

The west approach of the EBMUD Aqueduct ROW meets the street at an extremely steep slope, requiring any pathway connection to an at-grade crossing to have stairs or an unmanageable number of switchbacks. A grade-separated crossing could connect pathway users with the BART station and still provide access to Happy Valley Road. As stated in **Section 4.2.2**, EBMUD does not allow construction of any permanent structure foundations (spread footings, piles, etc.) that would be difficult to remove in the event of an unexpected emergency repair. A Caltrans Longitudinal Encroachment would be required in order for the retaining walls, footings, and abutments for a pedestrian and bicycle overcrossing to be placed in Caltrans ROW.

Happy Valley Road is a planned Class III bicycle route. The City's planned mid-block crosswalk with in-pavement flashing lights and overhead lighting at the southern BART parking lot entrance would serve pathway users wishing to access bicycle and pedestrian facilities along Happy Valley Road.

4.6.6 Oak Hill Road

Oak Hill Road is a four lane collector street that provides access to multiple destinations, including the BART Station parking lots on the north side of the station and commercial businesses in the Downtown area. The SR 24 eastbound off-ramp is located on Oak Hill Road to the north of the EBMUD Aqueduct ROW. There is a high amount of pedestrian and bicycle activity along the Oak Hill Road corridor because of its proximity to the BART station and the surrounding commercial land uses.



Oak Hill Road (within Pathway Segment 2)

Intersection Geometrics

Sidewalks are present on both sides of Oak Hill Road between Mt. Diablo Boulevard and Deer Hill Road. On-street parallel parking is permitted on the east side of Oak Hill Road, and on the west side from Deer Hill Road to the SR 24 off-ramp. There are no existing bicycle facilities on Oak Hill Road. Several driveways located along Oak Hill Road provide access to local businesses. There are three key intersections surrounding the EBMUD Aqueduct ROW along the Oak Hill Road corridor:

- Oak Hill Road/Mt. Diablo Boulevard is a signalized intersection 500 feet south of the EBMUD Aqueduct ROW.
- SR 24 eastbound off-ramp runs adjacent to the EBMUD Aqueduct ROW and terminates at a stop-controlled T-intersection on Oak Hill Road, north of the EBMUD Aqueduct ROW.
- Oak Hill Road/Deer Hill Road is an all-way stop-controlled intersection, 550 feet to the north of the EBMUD Aqueduct ROW.

The EBMUD Aqueduct ROW on both sides of Oak Hill Road approach at a steep downward slopes, which may encourage bicyclists to enter the intersection at high speeds. In addition, vehicles exiting the SR 24 off-ramp may have limited sight distance under certain conditions for both southbound and northbound vehicles on Oak Hill Road.

Roadway Volumes & Speeds

Proximity to the BART Station, Downtown destinations, and the SR 24 off-ramp on Oak Hill Road result in high vehicle volumes throughout the day. Figure 4-4 illustrates the volumes at each intersection surrounding the EBMUD Aqueduct ROW on Oak Hill Road.

Oak Hill Road is a collector street with a posted speed limit of 25 mph. The wide travel lanes and downhill slope likely contribute to speeds greater than 25 mph.



Looking south on Oak Hill Road towards the Mt. Diablo Boulevard intersection



The SR 24 eastbound off-ramp at Oak Hill Road (looking west)



Pedestrians are currently not permitted to cross Oak Hill Road at the SR 24 off-ramp. A crosswalk exists across the SR 24 off-ramp to accommodate north-south pedestrian travel.

Planned Improvements

The DSP EIR identifies Oak Hill Road/SR 24 off-ramp and Oak Hill Road/Deer Hill Road intersections as potential locations for signalization. Figure 4-5 shows the future volumes and Table 4-3 on page 4-29 shows the change in LOS for each intersection affected within this portion of the Pathway Study Area. Build out of the DSP area will increase traffic volumes on all the adjacent intersections.

Opportunities and Constraints

Though traffic volumes, number of travel lanes, and width of Oak Hill Road suggest that a grade-separated crossing may be a potential option, the topography at Oak Hill Road would require a very long, and prohibitively expensive overcrossing. As a result, an overcrossing is not considered at this location. However, there is an opportunity for an at-grade signalized crossing of Oak Hill, as the DSP EIR has identified the need for a traffic signal at Oak Hill Road/SR 24 off-ramp to accommodate future vehicle volume increases.

West of Oak Hill Road, the EBMUD Aqueduct falls down to the road at a 25% slope. It is possible to avoid this slope by encroaching on Caltrans ROW and routing the pathway along an existing sidewalk on the south side of the SR 24 off-ramp, where grades are not as steep. If the pathway is routed along Caltrans SR 24 ROW, the off-ramp travel lanes would need to be shifted and realigned to maintain adequate queuing space.

The slope on Oak Hill Road may encourage faster vehicle and bicycle speeds on the southbound approach to Mt. Diablo Boulevard. Although the SR 24 off-ramp is stop-controlled, drivers may not anticipate a mid-block crosswalk so close to the off-ramp. Limited sightlines and grade changes around the EBMUD Aqueduct ROW crossing on Oak Hill Road present stopping sight distance issues. Further, sight lines for vehicles turning south onto Oak Hill Road from the SR 24 off-ramp may be obstructed by vehicles turning north onto Oak Hill Road from the SR 24 off-ramp. The existing lighting on Oak Hill Road south of the eastbound SR 24 off-ramps is not sufficient for a mid-block pedestrian crosswalk.

Due to steep downhill slopes on the EBMUD Aqueduct ROW approaching Oak Hill Road, traffic calming measures along the pathway aimed to slow bicyclists, such as chicanes or bollards, should be considered.

Oak Hill Road has continuous 5- to 10-foot-wide sidewalks on both sides of the street that connect with the EBMUD Aqueduct ROW. Oak Hill Road does not include dedicated bicycle facilities; the Bikeways Master Plan does not propose dedicated bicycle facilities along Oak Hill Road. Wider sidewalks would better accommodate less experienced bicyclists wishing to access the retail uses on either side of the street who may not feel comfortable riding in the street or making left turn movements across traffic.

4.6.7 First Street

First Street is four lanes, with two lanes in each direction, and a raised median. The SR 24 on-ramp has a right-turn and a shared through/right turn lane. This lane configuration presents challenges for bicyclists traveling north on First Street and for pedestrians crossing the on-ramp. There are several driveways on First Street that serve the shopping centers, including a half-signalized driveway that controls vehicles coming out of a shopping center between the SR 24 entrance and Mt. Diablo Boulevard. Sidewalks along First Street are 5 to 10 feet wide. There is a high amount of pedestrian activity along and across First Street because of the surrounding commercial land uses.

Intersection Geometrics

Sidewalks are present on both sides of First Street, though there are no on-street bicycle facilities. There is no on-street parking along First Street from Mt. Diablo Boulevard to Deer Hill Road, except on First Street between the SR 24 on-ramp and under the overpass. Nearby destinations south of the EBMUD Aqueduct ROW include a shopping center and other office and commercial spaces. The driveways along First Street access shopping centers, and so are active throughout the day.



First Street (within Pathway Segment 3)

The half-signal at the Plaza Center parking lot, located south of the EBMUD Aqueduct ROW, controls all movements exiting the shopping center, as well as the southbound movements on First Street. There is a marked crosswalk on the west side of First Street across the shopping center entrance, but no marked crosswalk across First Street at this location. The closest marked crosswalk across First Street is at the First Street/Mt. Diablo Boulevard intersection. A crosswalk exists across the SR 24 entrance along the east side of First Street.



Southbound vehicle traveling on First Street approaching the EBMUD Aqueduct ROW (looking north)

Roadway Volumes & Speeds

First Street is classified as a collector and the posted speed limit is 25 mph. Figure 4-4 shows the existing volumes for the study intersections along First Street. First Street has the highest vehicle volumes of any roadway within the Pathway Study Area, and volumes are expected to increase further with future development in the Downtown area.

The SR 24 eastbound on-ramp is not signalized, and proximity to the highway may encourage vehicles to speed up as they approach the on-ramp. The on-ramp configuration, vehicle volumes and speeds present safety issues for the potential pathway crossing, approximately 30 feet from the on-ramp entrance.

Planned Improvements

The DSP EIR includes improvements at the intersection of Deer Hill Road/First Street intersection to accommodate the increase in vehicles traveling to and from SR 24. Figure 4-5 depicts the future volumes and Table 4-3 on page 4-29 shows the change in LOS for the study intersections. Build-out of the DSP as currently

drafted would increase traffic volumes on First Street and the SR 24 eastbound on-ramp such that the intersection would operate at LOS F for southbound traffic turning left onto the on-ramp. The DSP EIR recommends installing a traffic signal in order to enhance the operational value to LOS C. Whole Foods recently signalized the free-right turn at the Deer Hill Road/First Street intersection to accommodate the employee parking lot and pedestrians crossing at the free-right turn.

Opportunities and Constraints

Though traffic volumes, number of travel lanes, on-ramp configuration, and width of First Street suggest that a grade-separated crossing may be a potential option, the topography at First Street would require a very long, and prohibitively expensive overcrossing. Like Oak Hill Road, the DSP EIR identifies a signal at First Street and the SR 24 on-ramp as mitigation for future increased traffic volumes. Pathway design should take advantage of this opportunity to provide a signalized pathway crossing of First Street.

Other alternative at-grade crossing opportunities include the signalized intersection of First Street and Mt. Diablo Boulevard, 550 feet south of the EBMUD Aqueduct ROW and the half-signal at the Plaza Center parking lot 270 feet south of the EBMUD Aqueduct ROW. First Street has a raised median where the EBMUD Aqueduct ROW intersects. If an at-grade crossing is pursued, the median will need to be retrofitted to provide access across the roadway.

First Street is straight and has a gentler grade change compared to the other roadways within the Pathway Study Area. While the posted speed limit on First Street is 25 mph, the slope on First Street may encourage faster vehicle speeds on the southbound approach to Mt. Diablo Boulevard, especially during non-peak periods when traffic volumes are lower. Vehicles traveling northbound towards the SR 24 eastbound on-ramp may increase their speed as they approach the ramp, which is directly north of the EBMUD Aqueduct ROW. Sightlines and stopping sight distances are adequate around the EBMUD Aqueduct ROW crossing. The existing lighting on First Street is not sufficient for a mid-block pedestrian crosswalk.

The EBMUD Aqueduct ROW on the east side of First Street approaches the roadway on a downhill slope, which would encourage bicyclists traveling along the pathway to approach the intersection at faster speeds. Traffic calming measures along the pathway aimed to slow bicyclists should be considered.

First Street has 5- to 10-foot-wide continuous sidewalks on both sides of the street that connect to the EBMUD Aqueduct ROW. Limited public ROW and the SR 24 overpass make it difficult to widen the sidewalk beyond the street ROW, though sidewalks could be widened with redevelopment.

First Street does not include dedicated bicycle facilities; the Bikeways Master Plan does not propose dedicated bicycle facilities along First Street. The lack of bike facilities, narrow travel lanes, high vehicle volumes and on-ramp configuration along First Street create a challenging environment for bicycling.



On First Street, crossing improvements near the SR 24 eastbound on-ramp access should include accommodation for bicyclists and pedestrians (looking east)

Narrowing or reducing traffic lanes should be considered as a means to widen the sidewalks, which would improve connections for pedestrians and less experienced bicyclists.

4.6.8 Collision History

Data from Statewide Integrated Traffic Records System (SWITRS) Collision Database provides information on police-reported pedestrian-vehicle and bicycle-vehicle collisions within the Pathway Study Area. Table 4-2 lists all pedestrian and bicycle related collisions recorded from 2005 through 2009.

Table 4-2: Police-Reported Pedestrian or Bicyclist-Related Collisions in Pathway Study Area (2005-2009)

Primary Street	Secondary Street	Involved			Collision Factor
		Ped	Bike	Vehicle	
Mt. Diablo Boulevard	Happy Valley Road	1		1	Violation of Pedestrian ROW
Happy Valley Road	N/A	1		2	Unsafe Speeds
Happy Valley Road	N/A		1	1	Not Stated
Deer Hill Road	Oak Hill Road	1		1	Violation of Pedestrian ROW
Oak Hill Road	Mt. Diablo Blvd	1		1	Violation of Pedestrian ROW
Oak Hill Road	Mt. Diablo Blvd	1		1	Pedestrian not in x-walk

Source: SWITRS Collisions Database

ROW: Right-of-Way

According to the SWITRS data, drivers are at fault in more than half of the collisions, such as violating pedestrians' ROW or traveling at unsafe speeds. Although there are no recently reported collisions at the intersections of Risa Road, Dolores Drive or First Street, pedestrian and bicycle activity was observed at all of the Study intersections.

4.6.9 Level of Service

The vehicle Level of Service (LOS) analysis included in the DSP EIR was used to evaluate the Pathway Study Area. LOS is the measure of delay a driver experiences at an intersection, and is graded A through F, with F being the worst. The City of Lafayette deems a LOS D or higher as an acceptable level of service. Table 4-3 shows the existing and future AM and PM peak hour LOS and delays for the Pathway Study Areas based on projected development in the DSP.

Table 4-3: Existing and Future LOS and Delays

Intersection	Type of Intersection	AM/ PM	Existing		Future	
			LOS	Delay (s)	LOS	Delay (s)
Risa Road/Mt. Diablo Blvd	Signal	AM	B	11.9	A	10.0
		PM	A	9.8	B	11.2
Dolores Drive/Mt. Diablo Blvd	Signal	AM	B	11.3	B	12.1
		PM	B	17.1	B	18.0
Happy Valley Road/Mt. Diablo Blvd	Signal	AM	B	17.5	B	27.2
		PM	C	32.5	D	45.4
Happy Valley Road/Deer Hill Road¹	AWSC ²	AM	F	71.4	F	94.6
		PM	C	23.4	F	61.8
Oak Hill Road/Mt Diablo Blvd¹	Signal	AM	C	28.2	D	36.5
		PM	C	31.7	E	55.0
Oak Hill Road/SR 24 EB Off-Ramp¹	SSSC ³	AM	B	13.5	C	18.5
		PM	A	14.6	F	59.2
Oak Hill Road/Deer Hill Road¹	AWSC ²	AM	C	20.0	D	34.5
		PM	C	19.2	E	47.9
First Street/Mt Diablo Blvd	Signal	AM	C	31.9	D	36.0
		PM	C	33.7	D	45.2
First Street/SR 24 EB On-Ramp¹	Unsignalized	AM	A	3.0	A	8.5
		PM	B	13.1	F	132.5
First Street/Deer Hill Road/Sierra Vista Way¹	Signal	AM	B	13.2	B	15.8
		PM	B	16.4	E	57.2

1. Intersections in **bold** indicate intersections that would operate at an unacceptable level of service under existing and/or future conditions

2. AWSC: All way stop control

3. SSSC: Side street stop control

Source: Downtown Lafayette Specific Plan EIR, 2009.

Level of Service	Signalized Intersection	Unsignalized Intersection
A	≤10	≤10
B	>10 and ≤20	>10 and ≤15
C	>20 and ≤35	>15 and ≤25
D	>35 and ≤55	>25 and ≤35
E	>55 and ≤80	>35 and ≤50
F	>80	>50

4.7 Pathway Relationship to Adjacent Land Uses

A pathway along the EBMUD Aqueduct ROW presents both opportunities to improve nonmotorized connectivity within and around downtown Lafayette and the potential need to buffer adjacent, existing land uses from privacy or security impacts. Specific opportunities and constraints associated with these topics are discussed below.

4.7.1 Access Points

If implemented, a pathway along the EBMUD Aqueduct ROW would provide an unparalleled opportunity for improving bicycling and walking access within Lafayette and the surrounding communities. **Figure 4-6** presents potential connections accessible from the EBMUD Aqueduct ROW. The alignment for the pathway would connect the Lafayette Reservoir, the Lafayette BART station, Downtown Lafayette and eventually connect to the Briones-Las Trampas trail. Additional connections include existing and planned residential, office and commercial uses adjacent to the ROW (e.g., the Woodbury development). Persons residing north of SR 24 could access a pathway along the EBMUD Aqueduct ROW using the City's bikeway, trails, and sidewalk network. Existing paths accessible from the EBMUD Aqueduct ROW include a path along Happy Valley Creek that connects Blanche Lane and the BART station and a path connecting the EBRPD trail under SR 24 with the Lafayette-Moraga Trail via Mt. Diablo Boulevard, between Brown Avenue and Golden Gate Way. A proposed Class III bike route on Happy Valley Road and an existing Class III bike route on Brown Avenue would connect a pathway along the EBMUD Aqueduct ROW with additional bike facilities on Mt. Diablo Boulevard and Deer Hill Road.

Though EBMUD's ROW continues west of the Pathway Study Area boundary, extension of a pathway along the ROW may not be feasible due to EBMUD's future filter plant expansion plans. Pathway users traveling west from Risa Road would be directed to cross at the signalized Mt. Diablo Boulevard/Risa Road intersection and travel along the wide sidewalk on the south side of Mt. Diablo Boulevard. At the eastern end of the Pathway Study Area, pathway users traveling east would be directed to either: 1) use the existing EBRPD pathway connector under SR 24 to bike lanes and the existing and planned sidewalk network along Deer Hill Road, or 2) use a pathway segment proposed as part of this Study that connects with Brown Avenue, allowing access to the commercial uses located along Brown Avenue.

Additional opportunities for access may be available through future development project review of properties adjacent to the EBMUD Aqueduct ROW. The City of Lafayette will not pursue acquisition or easements across private property to implement this pathway project without a willing seller and not without clear significant benefits to the project in terms of achieving desired grades and substantially reducing overall construction cost as well as other conceivable benefits. This study further explores these tradeoffs in *Chapter 5: Options Evaluation and Preferred Options*.

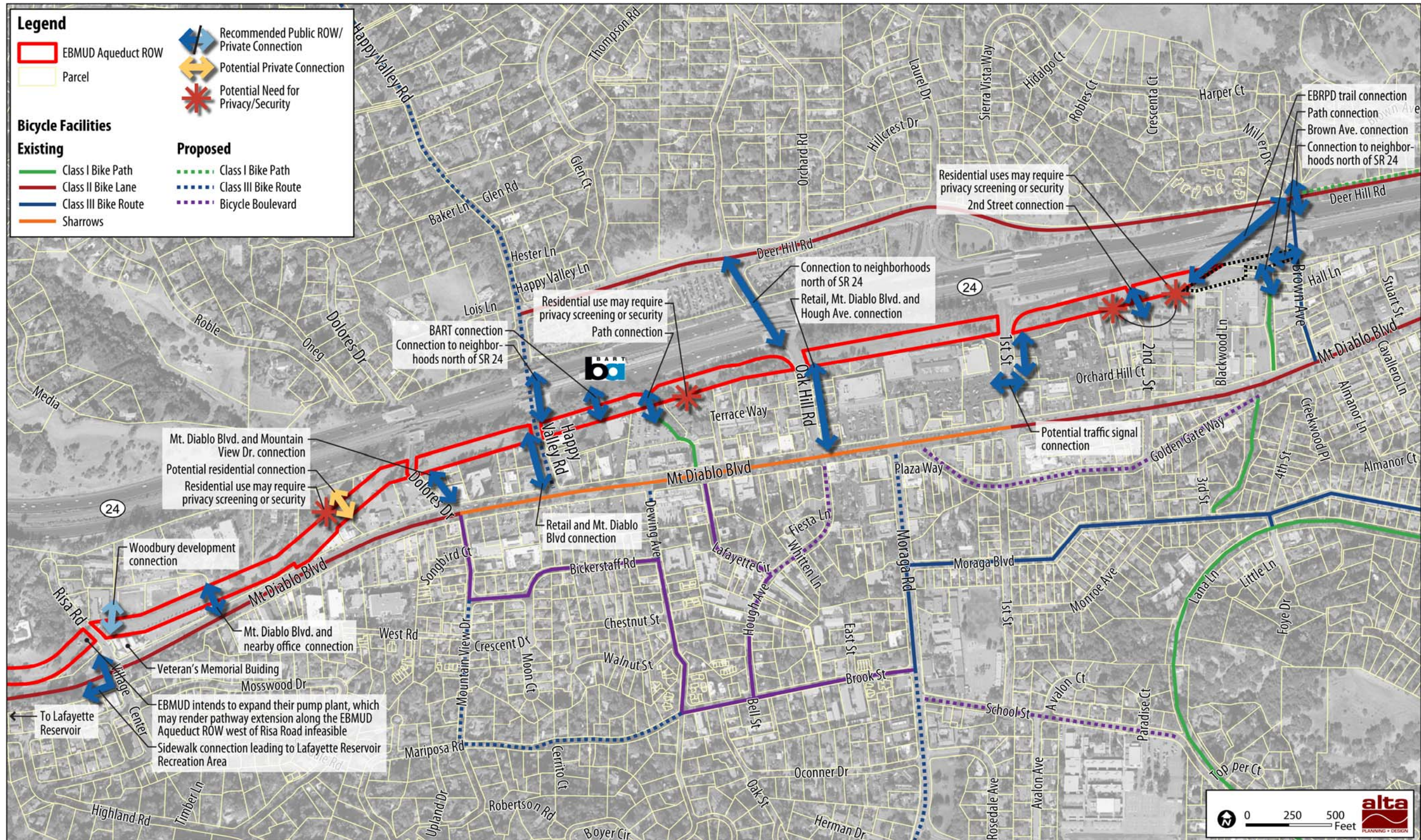


Figure 4-6: Potential Access Points and Locations for Improved Security/Privacy from the EBMUD Aqueduct ROW

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4.8 Safety & Security Considerations

Pathway implementation along the EBMUD Aqueduct ROW would improve access to areas currently not open to the public, but that are used by the public. Safety and security considerations include safety of pathway users and provision of emergency services and private property owner concerns, such as the potential for trespass, vandalism, property damage, theft and noise. Land uses potentially in need of improved privacy or security if the pathway is implemented are identified on Figure 4-6.

4.8.1 Private Property-Owner Concerns

Many properties adjoining EBMUD's ROW are privately-owned. Private property owner concerns associated with pathway implementation include impacts on security, pathway access and the potential for trespass, privacy, funding and maintenance, aesthetic impacts, lighting design and pathway access after dark, parking, traffic operations, and existing easements. Issues summarized below are drawn from several different sources, particularly from the property and business owner Focus Group meeting and the CAC. Some of these concerns will need to be addressed in the revised Revocable Landscaping License between EBMUD and the City.

Security

People are currently using all segments of the EBMUD Aqueduct ROW. From Risa Road to BART, people walk to access BART. On all other segments of the ROW, nearby residents are walking for exercise or to walk dogs. Homeless people use some sections of the ROW, and teens congregate at the west end of the Study Area, under SR 24.

Some meeting and focus group participants voiced concerns that the pathway would increase homeless encampments and other undesirable uses, including crime. It was generally agreed that policing of the pathway would be needed. It was suggested that surveillance cameras be considered along pathway for security. While the unimproved ROW does not appear to be a significant problem for adjacent property owners, it is possible that providing a pathway and identifying approved access points may alleviate concerns related to existing uses.

While these concerns are understandable, studies show that neither public nor private landowners have suffered from trail development. The Rails-to-Trails Conservancy surveyed management agencies overseeing 372 trails throughout the United States for their 1998 report titled "Rail-Trails and Safe Communities." This effort documents the level of crime on trails and identifies mitigation measures used by trail designers and managers to minimize the potential for crime. More specifically, the objectives of the study were to: 1) document the levels of crime on urban, suburban and rural rail-trails with current statistics and comprehensive data, 2) examine trail management strategies that can mitigate crime and improve trail safety, and 3) put crime on trails in perspective. The results from the study indicate that rail-trails are safe places. This can be extrapolated to other types of trails. Correspondence from law enforcement agencies consistently reported that rail-trails do not encourage crime. To the contrary, many agencies found that heavy trail usage is a crime deterrent in areas that were isolated prior to implementation of the trail. The study also found that trail managers often utilize design and maintenance strategies to reduce the potential for crime. Several other studies of trail impacts on neighborhood quality and crime conclude that trails have a negligible effect on crime (the most common infringements include illegal motorized use of the trail, litter and unleashed pets)

and that neighbors to the trail are either satisfied or neutral in their level of satisfaction with the trail once in operation. Close proximity to trails may even result in higher property values. Some of the best-known and heaviest used trails in the country bisect wealthy residential neighborhoods and are considered community assets. Fencing, patrols, and other techniques can address issues of privacy and security.

Additionally, EBMUD has a precedent for working with communities to transform unused EBMUD right-of-way into formalized recreational amenities, and sees this transformation as beneficial to security.¹²

Pathway Access and Trespassing

While adjacent property owners feel it is important to provide access to the pathway, most of them requested fencing or landscaping to separate the pathway from their property. One property owner described how people cross their property to use the ROW despite no trespassing signs. There were specific requests for access to be prohibited through private property north of the Terrace Way/Thompson Road intersection, at the private properties immediately east of Oak Hill Road, between the Town Center project (located east of the existing path) and the pathway, and at the property occupied by Blockbuster (located at 1009 Oak Hill Road). To accommodate these property-owner requests, access is being considered at the Oak Hill Road/pathway crossing and where the existing path along Happy Valley Creek enters the EBMUD Aqueduct ROW.

Clearly-identifiable access points, landscaping, fencing, and signage can direct pathway users to locations where access is desired. Access treatments at a given location will depend on the building design. If the City decides to construct a pathway along the EBMUD Aqueduct ROW, pathway access opportunities in addition to pathway/roadway crossings and the path along Happy Valley Creek, would be identified during review of future redevelopment projects.

Privacy

Most adjacent property-owners want screening or fencing to separate pathway users from the adjacent properties. At the same time, participants noted that residential properties might want access to the pathway. Provision of fences with gates is one way to provide privacy for property-owners and allow controlled access. Adjacent property-owners stated a preference for the pathway to be located closer to SR 24 than to the adjoining residential/office/retail land uses. To the extent feasible, the proposed pathway alignment runs along the central or northern portions of the EBMUD Aqueduct ROW. Potential impacts to adjacent property owners associated with loss of privacy should be addressed during subsequent phases of planning and design development.

Aesthetics

Other concerns include visual changes to the landscape resulting from pathway implementation, including views of the pathway, bridge and landscaping design, and the pathway's effect on the "community gateway" at Happy Valley Road, Oak Hill Road, and First Street. Switchbacks and low gravity retaining walls would be needed along some segments of the pathway in order to navigate steep terrain and provide for universal access. Visual changes can be addressed through planting low landscaping that obscures a pathway bench from view at adjoining properties, but allows for visual access of pathway users for increased user safety and security. If the City decides to pursue the pathway, aesthetic impacts would be further addressed during subsequent phases of planning and design development.

¹² Phone call with Steve Frew, Manager of Security and Emergency Preparedness, January 25, 2011.

Lighting Design and Pathway Access after Dark

Adjacent property owners stated a preference for limiting pathway operating hours to the daylight hours. Some stated that lighting is needed where the pathway would cross under SR 24 (at the eastern end of the pathway). Some community members supported lighting the pathway with the hope that lighting would deter homeless use. This Study recommends lighting at roadway crossings to improve visibility between pathway users and motorists. The design and height of any light standards should reduce light pollution for adjacent properties. Other than at roadway crossings, the pathway is not currently envisioned to be lit. It is anticipated that regular public use and patrolling by pathway maintenance staff would deter any illegal use of the pathway. If the City decides to pursue the pathway, potential lighting impacts would be further addressed during subsequent phases of planning and design development.

Parking

Some participants, particularly the representative for the Veterans Memorial Building and businesses near Brown Avenue, expressed concern about parking for pathway users. EBMUD does not permit parking on the Aqueduct ROW; the Lafayette BART station parking was constructed before this policy was in place. It was suggested that the City consider constructing parking lots on the City-owned vacant property northwest of the Risa Road/Mt. Diablo Boulevard intersection and on Caltrans-owned property near Brown Avenue under SR 24. It is recommended that the City investigate the need for staging facilities during subsequent phases of planning and design development.

Traffic Operations

Adjacent property owners stated their concern about Oak Hill Road and First Street pathway crossings. Some object to the idea of adding another signal, citing current motor vehicle delays. The Brown Avenue and Deer Hill Road intersection was noted as having long afternoon backups. Traffic operations and recommended improvements at intersections within the Pathway Study Area are discussed in **Section 4.6** of this chapter and *Chapter 5: Options Evaluation and Preferred Options*. The DSP EIR calls for signalization of the Oak Hill Road/SR 24 off-ramp and First Street/SR 24 on-ramp intersections to improve future traffic congestion. Signalization of these two intersections is not likely to occur solely to improve pathway crossings through the intersections. If constructed, the pathway may result in a reduction of vehicular trips if persons who would normally drive to destinations near the pathway choose to bike or walk instead.

Existing Private Uses along EBMUD Aqueduct ROW

A couple of adjoining property owners hold easements to use portions of the EBMUD Aqueduct ROW.¹³ Any pathway design would honor the requirements of these privately-held easements. Potential impacts to private uses along the EBMUD Aqueduct ROW should be addressed in subsequent phases of planning and design development.

4.8.2 Homeland Security

Water conveyed through the EBMUD water supply system serves approximately 1.3 million people residing in the San Francisco Bay Area. As such, the Aqueduct is a critically important piece of the San Francisco Bay

¹³ Private easements are held along the EBMUD Aqueduct ROW: 1) between the properties located at 3686 and 3688 Mt. Diablo Boulevard (APNs 241020004 and 241020014), and 2) north of the property located at 3578 Terrace Way (APN 243030023) (see Appendix B).

Area water conveyance infrastructure. The EBMUD Manager of Security and Emergency Preparedness has indicated that the proposed EBMUD Aqueduct Pathway would not be a cause for concern related to Homeland Security issues.¹⁴ More detail is provided in *Chapter 6: Funding and Maintenance Strategy and Benefit-Cost Analysis*.

4.9 Environmental Constraints

4.9.1 Potential Construction-Related Impacts and Required Investigations

Environmental issues associated with construction of the pathway would likely include, but not be limited to, construction-related air quality impacts; pathway adjacency to sensitive animal species' habitats; tree removal; erosion and impacts to water resources; soils and geology impacts associated with construction and use of the pathway; noise impacts to adjoining uses during construction activities; and temporary impacts to traffic operations.

Air Quality

Project construction would have the potential to temporarily increase particulate matter (PM₁₀) from fugitive dust emissions. Given the relatively small amount of earthwork required, this increase would not be expected to result in substantial PM₁₀ concentrations, but could contribute to a violation of the PM₁₀ standard. The Bay Area does not meet State or federal ambient air quality standards for ground level ozone and State standards for particulate matter (both PM₁₀ and PM_{2.5}).¹⁵ Implementation of standard dust control measures during construction activities would likely reduce this impact to a less than significant level.

Biological Resources

Construction of a pathway along the EBMUD Aqueduct ROW would result removal of trees and some vegetation to accommodate the pathway and to improve sight distances. The DSP EIR concluded that no special-status plant species are believed to occur within the DSP Area due to the extent of past development and urbanization. The DSP EIR further states that suitable habitat for most special-status animal species does not occur in the DSP Area and no adverse impacts are anticipated. There remains a remote possibility that one or more species could occur or forage in the undeveloped grasslands and woodland areas. Prior to site preparation and pathway construction in undeveloped areas, detailed biological surveys should be undertaken to ensure that the final pathway alignment avoids any sensitive biological resources. Further environmental review and compliance with applicable General Plan goals and policies, especially related to tree removal, and DSP EIR mitigation measures would be required prior to project approval.

Cultural and Archaeological Resources

No cultural or historical analysis has been carried out for this Study. A significant impact could occur if future construction activities, such as grading and excavation, disturb archaeological resources. However, the likelihood of this occurring is low because the Pathway Study Area is already urbanized. The existing and proposed federal, State, and local regulations, procedures, and policies would protect archaeological resources in the Pathway Study Area. Future assessment of impacts would need to be conducted prior to approval of the pathway project.

¹⁴ Phone call with Steve Frew, Manager of Security and Emergency Preparedness, January 25, 2011.

¹⁵ Downtown Lafayette Specific Plan Draft EIR p. 4.2-16

Soils, Erosion and Water Quality

Pathway implementation would result in new impervious surfaces and drainage structures to collect and convey drainage next to the pathway. The pathway would likely introduce between 1.5 and 2.5-acres of new impervious surface, depending on the chosen alignment and facility type and type of paving. Construction of the pathway could result in erosion associated with the excavation, fill placement, and potential spoils removal and/or stockpiling. In addition, erosion could result from vegetation removal and drainage improvements along the pathway. If not properly mitigated, erosion could result in water quality degradation of local surface waters due to the transport of sediment and silt particles off-site through stormwater runoff. Therefore, precautions must be taken, in the form of best management practices (BMPs), to ensure that the potential for erosion is minimized. If proposed, new landscaping installed along the pathway could also minimize erosion by stabilizing soils.

Between First Street and Brown Avenue, the soil within the EBMUD Aqueduct ROW is waterlogged, due to leaking pipes. The pathway alignment and design should incorporate measures to ensure structural stability of the pathway.

Noise

Equipment noise associated with site preparation and trail construction could disrupt activities at nearby homes, offices or commercial uses on weekdays during daylight hours. City of Lafayette General Plan Program N-1.2.1 specifies use of the City's Noise Ordinance in environmental review of all development proposals and incorporation of project design measures to reduce noise to allowable limits.

Traffic Operations

Temporary traffic operation impacts may occur during construction of path/roadway crossing improvements and/or bicycle/pedestrian bridge construction. Pathway improvements have not yet been determined, but would likely include includes a number of "alerts" for both cyclists and motorists that they are approaching a bicycle and pedestrian crossing, including signage, pavement markings, distinctive surfacing through the crossing and tactile warning strips on the trail adjacent to the roadway crossing.

4.9.2 Potential Air Quality Impacts to Trail Users

Implementation of the project would place sensitive populations (children, elderly persons and those with pre-existing serious health problems affected by air quality) near SR 24, a particulate and ozone generator. Air quality impacts associated with development within the DSP area were discussed and mitigated to a less than significant level in the DSP EIR. Impact AQ-2 of the DSP EIR states the following:

"The proposed Plan could locate sensitive receptors within 250 feet of State Route 24, which would expose sensitive receptors to unhealthy levels of TACs and PM_{2.5} emitted by vehicle traffic on State Route 24. This would result in a significant impact. (DSP Draft EIR p. 4.2-33)"

To mitigate this potentially significant impact, DSP EIR Mitigation Measure (MM) AQ-2 requires utilization of a 250-foot buffer between the sensitive receptor and the edge of the nearest travel lane, unless site specific analysis to determine the level of DPM and PM_{2.5} exposure is conducted. If the site specific analysis identifies significant exposures of DPM or PM_{2.5}, then the DSP EIR requires supplementary measures, including tiered tree plantings. Additional measures outlined in MM AQ-2, such as use of indoor air filters and noticing at

residences, would not be applicable to a pathway project. The DSP EIR concludes that implementation of MM AQ-2 would result in less than significant PM_{2.5} and DPM exposure levels.

Preliminary consultation with Bay Area Air Quality Management District (BAAQMD) staff¹⁶ implies that the air quality standards applied to sensitive receptors, such as residences, are likely too conservative to be applied to pathway use. For example, the DSP EIR modeled increase in cancer risks for potential future residents in the DSP area near SR 24 were assumed to be continuous for 24 hours per day at a breathing rate of 302 liters per kilogram of body weight for a 70-year lifetime exposure. Unlike stationary receptors, pathway users along the EBMUD Aqueduct ROW would likely to be exposed to air pollution associated with SR 24 for a significantly shorter amount of time and experience less exposure.

Little research exists that directly addresses the effects of air pollution on pathway users for a pathway adjacent to a freeway. However, related research looking at bicyclists' exposure to air pollution compared to other modes of transportation (e.g. drivers & transit riders) indicates that exposure to most air pollutants is higher for drivers than for bicyclists (in some cases, 2 to 4 times higher).^{17, 18, 19} The exposure differences are different for different types of pollutants, with PM's typically the only pollutants showing increased exposure rates for bicyclists. A recent study comparing the risks of bicycle commuting to motor vehicle commuting found that the small increase in bicyclist deaths due to air pollution exposure were offset nearly 80 to 1 by the health benefits of increased activity due to bicycling.²⁰

Bicyclist exposure to air pollutants drops significantly even with short distances from motor vehicles (e.g. 22 ft away from a roadway, exposure dropped by 30% (Ultra Fine Particles), 22% (CO), and 14% (PM2.5).)^{10, 21} Even comparisons between standard bike lanes and cycle tracks separated from the roadway by a parked car show significant differences in pollutant exposure.²²

In sum, there are three key points that suggest that air pollution associated with Highway 24 traffic will not pose a significant impact to pathway users. First, as noted by BAAQMD, pathway users are not stationary sensitive receptors—they are exposed to air pollution for a short amount of time compared to people living and working within the EBMUD Aqueduct corridor. Second, research has shown that exposure to air pollutants quickly drops as you travel further from motor vehicles; much of the proposed pathway lies several hundred feet from Highway 24. Third, research has shown that with the exception of PMs, bicyclists traveling adjacent to motor vehicles are exposed to less pollution than motorists, and the health benefits of bicycling significantly outweigh the negative health impacts of increased PM pollution exposure.

¹⁶ Phone conversation with Dave Burch, BAAQMD Senior Environmental Planner on October 12, 2010.

¹⁷ Pattinson, Woodrow. Cyclist exposure to traffic pollution: microscale variance, the impact of route choice and comparison to other modal choices in two New Zealand cities. Master's Thesis in Geography. University of Canterbury. 2009.

¹⁸ Rank, Jette; Jens Folke, Per Homann Jespersen. Differences in cyclists and car drivers exposure to air pollution from traffic in the city of Copenhagen. *The Science of the Total Environment*, Vol 279, Issues 1-3, November 12, 2001, pages 131-136.

¹⁹ Chertok, Michael, et.al. Comparison of air pollution exposure for five commuting modes in Sydney – car, train, bus, bicycle and walking *Health Promotion Journal of Australia* 2004;15:63

²⁰ Rojas-Rueda, David, et.al. The health risks and benefits of cycling in urban environments compared with car use: health impact assessment study. *British Medical Health Journal*. 2011. 343:d4521.

²¹ Hertel, Ole, et al. A proper choice of route significantly reduces air pollution exposure—A study on bicycle and bus trips in urban streets. *The Science of the Total Environment*, Vol 389, Issue 1, January 15, 2008, pages 58-70.

²² Kendrick, C. M. et al. The Impact of Bicycle Lane Characteristics on Bicyclists' Exposure to Traffic-Related Particulate Matter. Portland State University. Submitted to Transportation Research Board Annual Meeting January 23-27, 2011.