CARLSBAD VILLAGE DOUBLE TRACK - RAILROAD TRENCH ALTERNATIVE ECONOMIC ANALYSIS AND FEASIBILITY STUDY

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Prepared for:

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ATTACHMENTS

1. EXECUTIVE SUMMARY

This report documents the study of two additional alternatives for the Carlsbad Village Double Track project. The Carlsbad Village Double Track project constructs a second railroad track from Cassidy Street in Oceanside south to Tamarack Avenue in Carlsbad. The At-Grade Alternative would construct a second track at the existing ground level, modify the at-grade street crossings, and construct a double-track bridge over Buena Vista Lagoon. The two new alternatives would include grade separation of the railroad tracks by constructing them in a trench, beneath the existing street elevations. The first alternative, known as the Short Trench Alternative, would construct the double track railroad lowered in a trench passing under vehicular overpasses at Grand Avenue, Carlsbad Village Drive, and Oak Avenue, with pedestrian overpasses at Beech Ave/Carlsbad Village Station and Chestnut Avenue. The second alternative is the Long Trench Alternative, which would construct a railroad trench passing under vehicular overpasses at Grand Avenue, Carlsbad Village Drive, Oak Avenue, Chestnut Avenue, and Tamarack Avenue, with a pedestrian overpass at Beech Ave/Carlsbad Village Station. Both trench alternatives would require replacement of the Carlsbad Boulevard Overcrossing with a new bridge spanning the tracks.

Current conditions include only four locations for pedestrians and vehicles to cross the railroad tracks in the 1.8 miles between Buena Vista Lagoon and Agua Hedionda Lagoon, one grade separated and three at-grade. By grade separating the tracks in a trench, additional crossings can be added at Oak Avenue and Chestnut Avenue, and potentially others along the railroad Right-of-Way. The Long Trench Alternative would construct a vehicular crossing at Chestnut Avenue, while the Short Trench Alternative would construct a pedestrian crossing at Chestnut Avenue. The grade separated crossings will eliminate delays to traffic and emergency responders caused by at-grade crossing gate arms that remain down as trains approach and pass by.

Construction of either trench alternative would first require a temporary shoofly track be constructed to allow railroad operations to continue throughout construction. An impact of the temporary shoofly track is a temporary loss of parking at the station and in the area east of the tracks between Grand Avenue and Oak Avenue. The historic Carlsbad Santa Fe Depot located between Grand Avenue and Carlsbad Village Drive would need to be relocated prior to construction.

Based on geotechnical borings taken in the project area from 2013 and 2016, the trench would be located below the water table and require specialized design and construction techniques for trench retaining walls and waterproofing of the trench in groundwater. Several options were studied for the trench structure. The most viable retaining wall structure type is a secant pile wall system with horizontal struts for bracing in the deepest portion. This type of wall creates an effective seal from groundwater and can be constructed prior to excavation which reduces the volume of dewatering needed. A sealed trench floor is required which will result in a buoyant force trying to lift the trench structure. A mass concrete base is proposed to withstand the buoyant force due to the groundwater. Additional options presented in the report are deep soil mixing walls or slurry diaphragm walls, and the use of tie-down anchors in the trench floor to reduce the weight of concrete needed. Future phases of the project would require an extensive groundwater monitoring program and analysis to confirm the proper design groundwater depth.

The Long Trench Alternative would require the acquisition of three single family residential parcels located east of existing railroad Right-of-Way, just south of Tamarack Avenue. The existing Right-of-Way is narrow in this location and there are utilities (a 48-inch sewer and 84-inch storm drain) located on the east side of the tracks which must be relocated to construct this alternative. A feasible place to relocate them is to shift them east into the subject parcels. The Short Trench Alternative does not require any Right-of-Way acquisitions.

The Short Trench Alternative would have a total project investment between $215 million and $235 million (2016), while the Long Trench Alternative would have a total project investment between $320 million and $350 million (2016). These costs include a 30% contingency on the estimated construction cost to account for the preliminary nature of the design. Future maintenance costs due to the trench alternatives would include maintenance of storm drain pump stations required to drain the trench, maintenance of bridges and retaining walls, and elevator maintenance at the train station.

The preferred minimum vertical clearance on the Los Angeles-San Diego-San Luis Obispo (LOSSAN) corridor is 26 ft. North County Transit District (NCTD) has indicated that, with concurrence from Burlington Northern and Santa Fe (BNSF) Railway, the minimum vertical clearance may be reduced to 24 ft. If the minimum clearance used for design were 24 ft., the construction cost of the project would be reduced by an estimated $14 million for the Long Trench Alternative, and $8 million for the Short Trench Alternative.

2. PROJECT DESCRIPTION

The City of Carlsbad (City), in cooperation with the San Diego Association of Governments (SANDAG), has initiated this Feasibility Study for the Carlsbad Village Double Track project. The Study documents the feasibility of two additional alternatives for this project. These two alternatives would include grade separation of the railroad tracks and construction of the second track. In addition, the City commissioned a detailed economic analysis of the alternatives as a companion document to the Feasibility Study (Attachment A).

2.1 Project Location

The project study area is in San Diego County in the cities of Carlsbad and Oceanside along approximately 2.6 miles of the railroad corridor from Agua Hedionda Lagoon to Cassidy Street. See Attachment B for a larger location map.

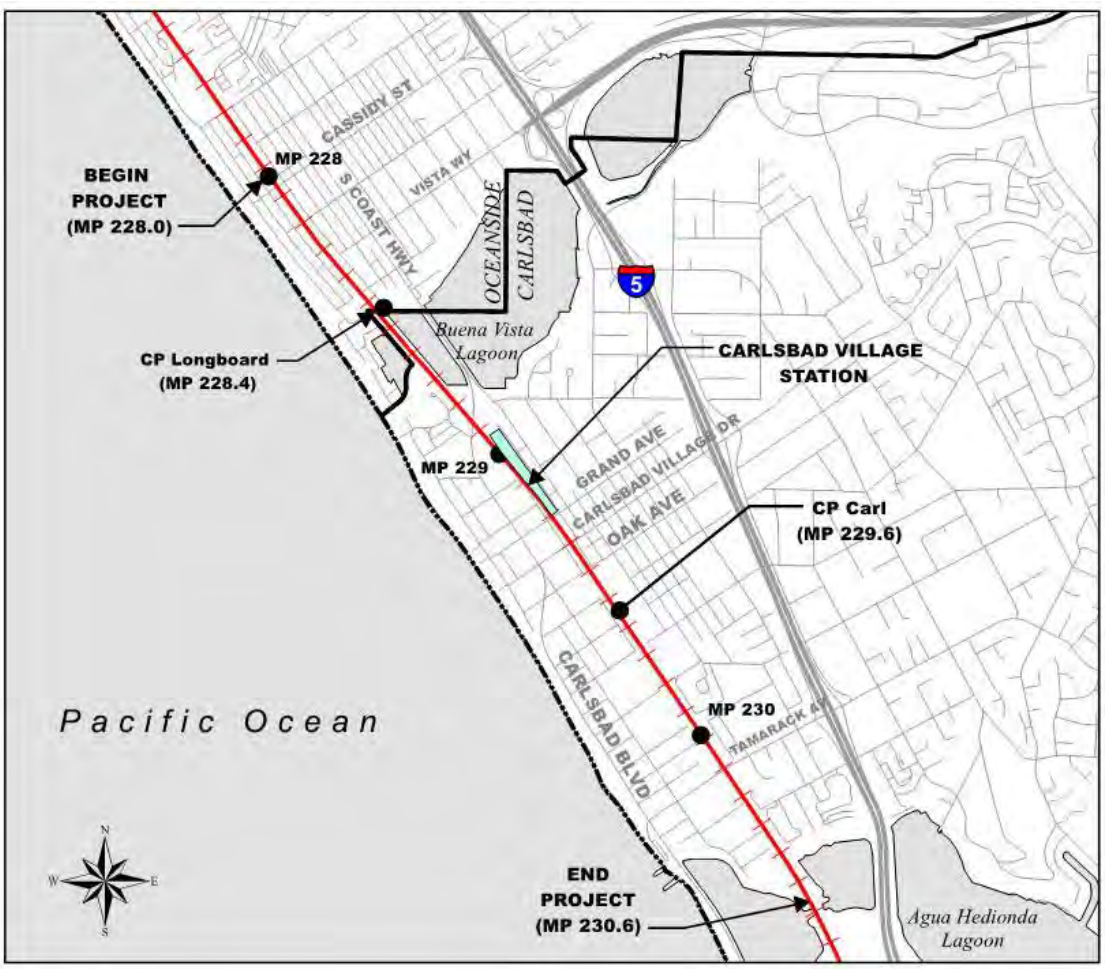


Figure 2.1: Location Map

2.2 Existing Facilities

The California Southern Railroad, a subsidiary of the Atchison, Topeka, and Santa Fe Railway, was constructed from 1881 to 1885. It provided a connection between what is now the City of Barstow and San Diego. At its most southern end the railway began in what is now National City proceeding northward to the City of Oceanside, then northeast through Temecula Canyon and on toward Barstow. The California Southern Railroad formed the original railroad right-of-way through the City of Carlsbad that is still in use today. The San Diego Northern Railway, a subsidiary of NCTD, purchased the tracks from Atchison, Topeka, and Santa Fe Railway in 1994. NCTD dissolved the San Diego Northern Railway Corporation in 2002.

Currently, NCTD, Amtrak, and BNSF Railway operate rail services through the LOSSAN Corridor, operating through the project site. NCTD's COASTER trains and six Amtrak Pacific Surfliner trains stop at the Carlsbad Village station.

The existing tracks consist of a double track section from the Agua Hedionda railroad bridge to Control Point (CP) Carl, located at Pine Avenue. At CP Carl the tracks are reduced to a single track going north through Carlsbad Village Station, under the Carlsbad Boulevard Overpass and across Buena Vista Lagoon to CP Longboard. The tracks return to double track north of the turnout at CP Longboard continuing north through Oceanside.

The area surrounding the railroad right-of-way between Carlsbad Boulevard and Oak Avenue has developed into the downtown commercial area of Carlsbad and is known as Carlsbad Village. The area between Oak Avenue and Tamarack Avenue is known as the Barrio and is considered Carlsbad's first neighborhood, initially settled in the early 1900s. The City has completed several revitalization projects in the area with more planned in the future.

Within the Carlsbad Village area there are three at-grade railroad crossings: one at Carlsbad Village Drive, one at Grand Avenue, and one at the Carlsbad Village Station platform; and one grade separated crossing at Carlsbad Drive. Farther south there is one more at-grade crossing located at Tamarack Avenue. There is approximately 0.8 miles between the crossings at Carlsbad Village Drive and Tamarack Avenue where there is no access for pedestrians or vehicles across the railroad tracks.

The Carlsbad Village Station is located just north of Grand Avenue on the east side of the railroad tracks. It includes a parking lot and a station building with restrooms. Across the tracks there is a bus depot operated by NCTD with six saw-tooth bus bays. Near the center of the station platform there is an at-grade pedestrian crossing leading from the bus depot to the train station.

Between Grand Avenue and Carlsbad Village Drive, the existing track is bordered by a green space known as Rotary Park to the west and the current location of the historic Carlsbad Santa Fe Depot to the east. The historic Carlsbad Santa Fe Depot is currently utilized by the City of Carlsbad as a Visitor's Center. North of the bus station and immediately west of the NCTD right-of-way is the Army/Navy Academy athletic fields. Farther north, beyond Buena Vista Lagoon, the track corridor is located between single family home developments.

2.3 Current Rail Services

Current rail services that run through the project area include NCTD COASTER, Amtrak Pacific Surfliner, and BNSF freight trains. The following table provides typical numbers of trains per day passing through the project area.

Table 2.1: LOSSAN Service Levels (Oceanside to San Diego)

Operator/Line	2016 Service Levels
Intercity (All Stop)	22
Commuter	22
BNSF Freight	6
TOTAL	50

Current passenger service schedules are available at
octa.net/OCTA2015/Components/SurflinerLanding/assets/Pacific-Surfliner-Schedule.pdf.

There are typically 4-6 freight trains operating on the San Diego Subdivision daily.

SANDAG provides an Assistance to Transit Operations and Planning (ATOP) program that monitors the performance of the region's transit system. The latest data available for fiscal year 2013 showed an average of 620 daily riders departing and arriving on the COASTER at the Carlsbad Village Station with the vast majority of riders departing the station travelling south on the COASTER.

2.4 Previous Studies

At-Grade Double-Tracking Alternative

Previous studies of the Carlsbad Village Double Track project have focused on at-grade alternatives for double-tracking. A Project Study Report prepared by RailPros, Inc. in August 2011 recommended that an at-grade second track alignment be constructed to the east of the existing track maintaining 18 ft. track centers through the station area, Grand Ave, and Carlsbad Village Drive.

An Alternatives Analysis Report was prepared by T.Y. Lin International in April 2014 that studied various alternatives for at-grade double-tracking and recommended a preferred alternative that shifted the existing track 3 ft. west and constructed a new track 15 ft. east of the existing track. The project limits for an At-Grade Alternative would be similar to the trench alternatives on the north end, however to the south the at-grade double-tracking would end north of Chestnut Avenue where it meets up with existing double-track.

Regional Planning

San Diego Forward: The Regional Plan, approved by SANDAG in October 2015 evaluated regional grade separations providing rankings based on certain criteria. The grade separation of Grand Avenue/Carlsbad Village Drive received a relative ranking of 23rd among railroad grade separation projects, and had an estimated cost of $110 million (2014$). The grade separation of Tamarack Avenue was evaluated separately and given a ranking of 25th with an estimated cost of $90 million (2014$). See Attachment C for a summary of the evaluations from The Regional Plan.

Local Planning

The City of Carlsbad is currently in the process of completing the Village and Barrio Master Plan. The plan was released for public review in November 2015 and in January 2016 the public review period concluded. Hearings before the Planning Commission and City Council were scheduled to take place in May and June 2016. One of the most transformative concepts in the Draft Village and Barrio Master Plan is supporting trenching of the railroad tracks along with double tracking to create a more connected network of streets across the tracks. The Draft plan also includes transit oriented development opportunities at the Carlsbad Village Station site, and the Village Central Green concept introduced in the Plan would cover the trenched railroad tracks with a park area.

3. PURPOSE AND NEED

Project Need

The 351-mile Los Angeles-San Diego-San Luis Obispo (LOSSAN) rail corridor serves as a vital link for passenger and freight movements in San Diego County. The LOSSAN corridor is the second busiest intercity passenger rail line in the United States. Additionally, the corridor is the only viable freight rail link between San Diego and the rest of the nation. Currently, because of single track through the northern part of the project area, trains must wait at a siding whenever a COASTER train is loading or unloading passengers at the Carlsbad Village Station. Additionally, meeting or passing trains must take turns using the single track, which reduces operational flexibility and results in cascading delays. Double tracking this segment directly supports the objective of SANDAG, NCTD, Amtrak, and BNSF Railway to increase the efficiency of this rail corridor, not only to accommodate existing train volumes, but also to provide for future demand for rail services on the LOSSAN corridor.

In a letter addressed to the California Coastal Commission on July 17, 2014, the City of Carlsbad provided comments on the draft North Coast Corridor Public Works Plan and Transportation and Resource Enhancement Program (PWP/TREP). Included in the comments was a request to require SANDAG to conduct environmental review of both an at-grade railroad option and a trench alternative.

Project Purpose

Double tracking this segment directly supports the objective of SANDAG, NCTD, Amtrak and BNSF Railway. In addition to supporting mobility in the region the City of Carlsbad would like to address and improve the items noted in the letter by studying trench alternatives. Trenching through the City of Carlsbad will provide much improved and safer connections to coastal resources and the coastline for residents, visitors, and train riders; as well as allow increases in railroad volumes without negatively impacting the on-street traffic in the City.

4. SCOPE OF WORK

The scope of this study is to evaluate the feasibility of constructing a grade separated double track railroad in a trench structure through Carlsbad Village. This report evaluates two alternatives:

Short Trench Alternative

- Lower the railroad in a trench to pass under an overpass at Carlsbad Boulevard, Beech Avenue, Grand Avenue, Carlsbad Village Drive, Oak Avenue, and Chestnut Avenue.

- Maintain Tamarack Avenue as an at-grade crossing.
- Minimize impacts to on-street traffic during construction.
- Minimize impacts to railroad operations during construction.
- Provide double-tracking from Cassidy Street in Oceanside to the Agua Hedionda Lagoon Bridge.

Long Trench Alternative

- Lower the railroad in a trench to pass under an overpass at Carlsbad Boulevard, Beech Avenue, Grand Avenue, Carlsbad Village Drive, Oak Avenue, Chestnut Avenue, and Tamarack Avenue.
- Minimize impacts to on-street traffic during construction.
- Minimize impacts to railroad operations during construction.
- Provide double-tracking from Cassidy Street in Oceanside to the Agua Hedionda Lagoon Bridge.

5. PROJECT BENEFITS

The benefits of trenching the railroad tracks through Carlsbad Village include roadway circulation, improved beach access, public safety, first response, and railroad operations, environmental benefits such as noise reduction and visual improvements, and economic benefits.

5.1 Roadway Circulation and Beach Access

By grade separating the railroad tracks and eliminating the at-grade crossings, traffic circulation on the roads within the Carlsbad Village area will see a reduction in delays due to crossing gates. Certain vehicles such as commercial buses, passenger-carrying vehicles, and vehicles carrying hazardous materials are required to stop at all at-grade railroad crossings, per Section 22452 "Railroad Crossings", of the California Vehicle Code. This restriction imposes further delay on following vehicles, especially since there are two bus routes, NCTD Breeze routes 321 and 325, which cross the railroad tracks at Grand Avenue. Grade separation of these crossings would eliminate these delays for both the NCTD buses and following vehicles.

With the tracks lowered in a trench, bridges can be constructed at Oak Avenue and Chestnut Avenue where there is currently no access across the tracks; and there is potential to connect other streets west of the tracks to the Coastal Rail Trail via bike/pedestrian overpasses. The Long Trench Alternative provides a vehicular crossing at both Oak Avenue and Chestnut Avenue. This will provide a greater benefit to vehicular traffic when compared to the Short Trench Alternative, which would provide only one new vehicular crossing at Oak Avenue.

Beach access for residents east of the tracks will be improved by adding the additional crossings, allowing bikes and pedestrians additional safe access points over the railroad tracks. Currently, residents who live between Carlsbad Village Drive and Tamarack Avenue cross the tracks at Carlsbad Village Drive and Tamarack Avenue, requiring them to travel up to an additional 0.4 miles to cross the tracks. If grade separated crossings were made at Chestnut Avenue and Oak Avenue, it would reduce the distance required for many of these residents east of the tracks to access the beach and downtown areas.

5.2 Public Safety and First Response

Emergency access response times would also improve with the grade separation of the tracks and the addition of grade separated crossings at Oak Avenue for the Short Trench Alternative or both Oak Avenue and Chestnut Avenue for the Long Trench Alternative. The nearest fire station is located about 0.8 miles east of the railroad tracks on Carlsbad Village Drive. At times emergency response to locations west of the railroad tracks can be impeded by trains sitting idle at the station and as trains pass through the at-grade crossings. Elimination of the at-grade crossings would provide improved reliability for emergency response west of the railroad tracks.

Elimination of the at-grade crossings would provide safety benefits for pedestrians and vehicles crossing the tracks. Certain express trains travel through the existing at-grade crossings at up to 90 miles per hour without stopping. Railroad related incidents are tracked by the Federal Railroad Administration (FRA), San Diego Sheriff's Office Train Deputies, and Carlsbad Computer Aided Dispatch. Since the year 2000 there have been 22 incidents involving trains and either pedestrians or vehicles, resulting in 19 fatalities and 4 injuries in the Carlsbad area. Grade separation will eliminate these types of incidents.

5.3 Railroad Operations

Grade separating the tracks will lessen maintenance needs at grade crossings and yield security benefits for NCTD. The grade separated crossings would no longer require maintenance for the grade crossing warning devices and crossing arms. The tracks would be made more secure because the trench would create a positive barrier preventing trespassers from fouling the tracks and possibly endangering themselves and disrupting railroad operations.

The benefits of double tracking the area from CP Longboard to CP Carl are the removal of the single track bottleneck where trains currently must wait for trains travelling in the opposite direction to clear the single track section prior to entering. This project combined with others in the corridor, will reduce travel times for passengers, improve system reliability, facilitate goods movement, help to reduce passenger and truck volumes on Interstate 5, and provide for increased passenger and freight rail services in the future.

5.4 Environmental Benefits

The railroad trench alternative will provide benefits to the area including visual and noise. The visual aesthetics of the area will be improved by placing the railroad tracks in a trench. The road crossings will no longer require crossing arms, and will be lined by architectural features such as decorative iron fencing rather than the railroad tracks.

With the railroad tracks lowered in a trench, the trench walls will provide a reduction in noise impacts from passing trains when compared to tracks at grade. Additionally, crossing bells will no longer be required once the tracks are grade separated.

5.5 Economic Benefits

Economic benefits of trenching the railroad tracks were detailed in the Economic Study: LOSSAN Corridor Improvement Options – Carlsbad Area by RSG, Inc./Kimley-Horn and Associates, Inc./dBF Associates (See Attachment A). Benefits listed in the study include increased property values, additional interest in redevelopment in the area, increased development density near transit, increased property taxes, and job creation. Additionally, the study relates an economic benefit to lives saved by grade separating the railroad tracks and to the reduction in delay at the railroad crossings.

The reduction in traffic congestion and noise, as well as increased walkability could make property in the area more desirable, which can raise property values and improve the experience of visitors to the area. Higher property values would increase property taxes and be more attractive to developers. Lower noise levels and improved walkability may increase the number of visitors to the area and lead to generation of higher sales tax revenues.

6. DESIGN CONSIDERATIONS

6.1 Trench Cross Section and Clearance Requirements

The proposed railroad trench would consist of two railroad tracks with 15 ft. track center spacing, a 15-foot-wide access road, and drainage ditches on each side. The drainage ditches are shown as grated to allow them to be incorporated into the access road width, thereby reducing the overall trench width. According to NCTD requirements the minimum horizontal distance from a retaining wall to the nearest track centerline is 15 ft. The edge of the access road must be located a minimum of 10 ft. clear from the nearest track centerline.

Within the station area the minimum track centerline spacing would be 18 ft. to allow for an inter-track fence. Platform edges are set at 5'-5" from track centerlines and the minimum width required by NCTD for station platforms is 16 ft. Additional width would be added to the trench at specific locations for stairs, ramps, and other improvements.

The minimum vertical clearance required at all overpasses and from permanent overhead struts would be 26 ft. from top of rail.

Access to the trench would be provided at either end of the trench through an access road running along the west side of the tracks. The access road could include a turn-around location prior to or after the station. A turn-around area (if provided) should accommodate up to a 35-foot-long vehicle, preferably able to turn around without fouling the tracks. If no turn-around is included the access road should be continuous through the station to allow maintenance vehicles to pass through the trench and exit the opposite end. Access through the station could be provided by adding crossing panels through the station and allowing maintenance vehicles to drive over the tracks.

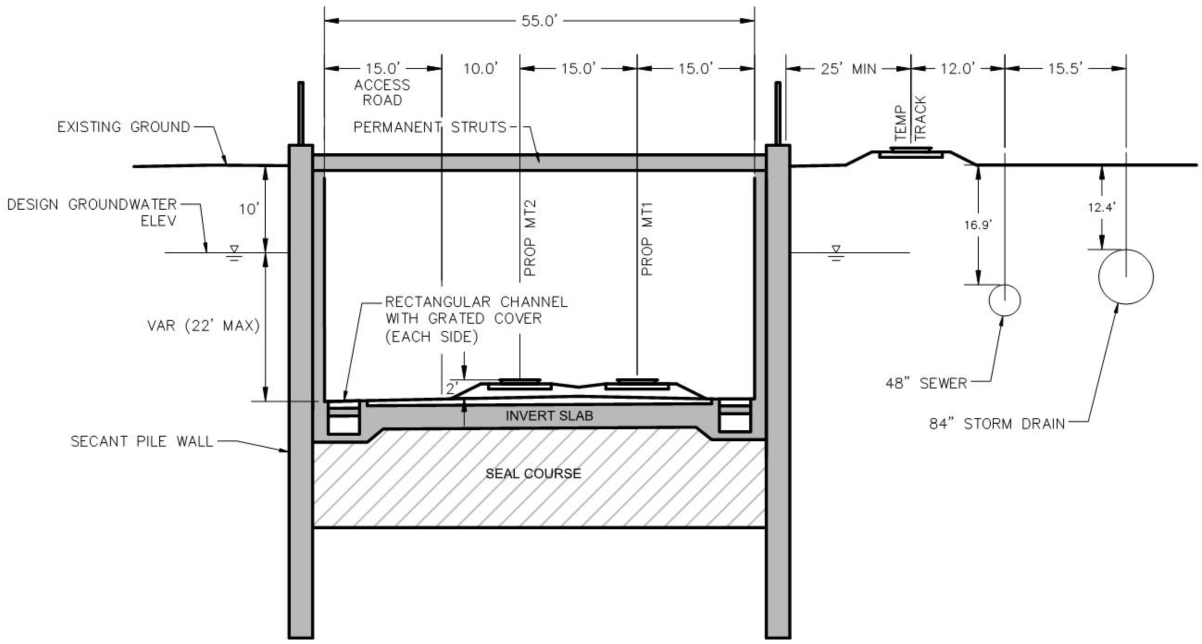


Figure 6.1: Typical Section of Trench (Looking North)

6.2 Track Geometry

The design speed used for both permanent and shoofly track designs shall be 90 mph for passenger and 55 mph for freight. The track geometry shall be designed per the latest revision of the SANDAG Design Criteria Volume III LOSSAN Corridor in San Diego County.

Vertical Profile

The track profile shown in the plan and profile exhibits represents the top of rail elevation. The trench floor slab would be set approximately 2 ft. below top of rail to allow for ties and ballast. Both the Short Trench Alternative and the Long Trench Alternative have generally similar vertical profiles for the trench section, but differ in the northerly approach to Tamarack Avenue. Beginning at the south end of the project limits, the existing double tracks cross Agua Hedionda Lagoon at a 0.00% grade for both alternatives.

Short Trench Northbound Approach

Because Tamarack Avenue remains as an at-grade crossing, similar to existing conditions, moving north the profile increases at a 0.79% grade up through a reverse vertical curve up to the Tamarack Avenue at-grade crossing. The short trench alternative matches the existing grade across Tamarack Avenue. The profile then transitions to -1.15% grade through a 1,000 ft. crest vertical curve, then begins to flatten out after transitioning out of a 675 ft. sag curve.

Long Trench Northbound Approach

Tamarack Avenue becomes a grade-separated crossing with the long trench alternative. North of the Agua Hedionda Lagoon Bridge, the profile transitions to -1.09% grade through an 800 ft. crest vertical curve south of Tamarack Avenue then passes under an overpass at Tamarack in a 900 ft. sag vertical curve.

Trench Profile

The proposed track profile through the trench section was set based on the required vertical clearance of 26 ft. between the top of rail and overpass structures. A roadway bridge structure depth of 2.25 ft. was assumed for design of the trench profile beneath each overpass. The preliminary track profiles were designed with the assumption that the existing road profiles will be raised 1.5 ft. at Grand Avenue and Carlsbad Village Drive, and 0.5 ft. at Tamarack Avenue to reduce the depth of the trench. This can be accomplished by modifications to the roadway profile on Washington Street, and the driveways east of the tracks. This requires the struts to be shifted higher by extending the top of the retaining wall above the existing grade about 2 ft.

With the track elevations set beneath each overpass profile grades were extended out to vertical curves at each end of the trench. The minimum top of rail elevation is 13.65 ft. for the Long Trench and 14.38 ft. for the Short Trench. Through the station the track profile is set at 0.39% coming out of the trench. Passing under Carlsbad Boulevard, the track profile is proposed to be about 3 ft. lower than the existing track elevation. This requires the replacement of the existing bridge structure at Carlsbad Boulevard due to the existing spread footings at the bridge, which would be undermined by the proposed track elevation under the bridge.

Buena Vista Lagoon Crossing

The profile grade across Buena Vista Lagoon was set based on the required bridge depth and results of the *Buena Vista Lagoon Bridge Fluvial Hydraulics Analysis* (Everest International Consultants, February 2014). This study analyzed the 100-year flood depth in the lagoon, including the effects of tidal influences, scour, and sea level rise, and required the proposed track elevation to be set about 5 ft. higher than the existing lagoon bridge. North of the lagoon the track profile matches back into existing near Cassidy Street in Oceanside.

Horizontal Alignment

The horizontal alignment of the tracks is constrained by the narrow right-of-way at two locations: near Tamarack Avenue and on the west side of the existing station. At the station the tracks would need to be constructed in the existing location with one track set 18 ft. to the east in order to avoid significant impacts to existing Washington Street and infrastructure, as well as an existing church located on the south side of Carlsbad Village Drive. The existing right-of-way between Carlsbad Village Drive and Tamarack Avenue is 200-foot-wide, however south of Tamarack it becomes 100-foot-wide for around 300 ft. then gradually widens closer to the Lagoon.

The short trench alternative would shift the tracks west at Tamarack to avoid impacting an existing 48-inch sewer line and 84-inch storm drain. Since the short trench option would be at-grade where the existing right-of-way narrows south of Tamarack there are no additional right-of-way requirements for this option.

The long trench alternative would shift the tracks to the east at Tamarack to provide space between the trench walls and the existing right-of-way line for a sewer and storm drain line, without impacting the properties on the west side of the right-of-way. As a result of shifting the tracks to the east the existing 48-inch sewer and 84-inch storm drain would need to be relocated farther east. This requires additional right-of-way along the east side, south of Tamarack.

6.3 Station Design

The proposed grade separation would require a below grade station. The current NCTD standard is to provide a 1,000-foot-long platform on each side. The tracks would be separated by 18 ft. within the platform area to allow for construction of an inter-track fence. The inter-track fence would be a barrier to prevent pedestrians from crossing the tracks to access the opposite platform. A pedestrian overpass would provide access between the platforms. Access across the tracks would also be available on the Grand Avenue overpass. Elevators and stairs would be included on each platform. The minimum platform width would be 16 ft. with small portions narrowed to a minimum of 12 ft.

The existing station building would be demolished. The new station design could include a restroom facility to replace the restrooms located within the existing building and platform shelters or covered areas. Station amenities should be consistent with other recent station projects completed on the corridor.

A portion of the existing parking lot would be temporarily removed during construction of the trench and temporary shoofly track and station platform. The final design would enable a new parking configuration that better utilizes the property.

6.4 Drainage

Several options for providing drainage of storm water from the trench were discussed during the preparation of this report. Typically, a gravity flow swale would be preferred but in this case the middle of the trench is lower than the ends, so a swale would not work.

Another solution was to bore a storm drain line west out of the trench at the low points to an ocean outfall. The benefit of this is that it requires less future maintenance than a pump station would. There are a number of challenges associated with this. First, the environmental permitting of a new ocean outfall would be very difficult, if allowed at all. If this were pursued it would be beneficial to modify an existing outfall location. The second issue is that the elevation of the low point in the trench would place the storm drain around 9 ft. above sea level at the trench. High tides have reached up to 7 ft. recently and with the possibility of sea level rise the storm drain may not function in the future during high tides. The pipe would also need to be constructed at a very flat slope, roughly 0.15%, in order to stay above sea level. This can be problematic for trenchless installation because it requires a very high degree of accuracy that is not always achievable with trenchless installation methods. Third, the construction of the storm drain by boring would require the contractor to bore through the trench wall, creating an entry point for groundwater. It would be difficult to maintain a sealed condition at the pipe connections.

Another approach that has been used on other railroad trench projects, and is recommended in this report, is to provide storm drain pump stations at low points. Since each end of the trench is at a higher elevation than the middle of the trench, water would be collected at low points into underground sumps, then pumped out to existing City storm drains. The design of the pump systems would maintain the 100-year headwater depths below the railroad ballast. The proposed Long Trench Alternative would require two pump stations, while the proposed Short Trench Alternative would require one pump station. Sub-drains consisting of pervious pipes would be constructed within the track bed allowing for drainage of the sub-grade.

Offsite drainage from the west would be conveyed parallel to the tracks along the top of the wall in either open channels or buried storm drain. The short trench alternative would connect the parallel storm drain into the existing storm drain system in Tamarack Drive. The long trench would require the parallel storm drain to continue south past Tamarack to the end of the retaining walls where it could cross the tracks and join the existing 84-inch storm drain. A 20-foot wide area between the right-of-way line and the retaining walls would be provided south of Tamarack for storm drain and sewer.

Near the station existing storm drains that cross the tracks would be re-routed to flow north parallel the tracks along the outside of the trench to the end of the retaining walls where the runoff would enter a ditch along the side of the tracks, eventually entering Buena Vista Lagoon.

Due to the expected groundwater level being higher than the trench floor the use of infiltration BMPs would not be feasible. Water quality within the trench could be maintained through the use of media filters prior to pumping the storm water. Additionally, runoff from low flow storms could be stored then released via a low flow pump at a specified flow rate to minimize increases in runoff. An additional option for enhanced water quality is to pump low flows into the City sewer system, to then be treated at the Encina Water Pollution Control Facility. This would require concurrence from the City of Carlsbad, and verification that the treatment facility and sewer system have sufficient capacity for added flows. The next phase of the project should explore this further in a Water Quality Technical Report and Preliminary Drainage Report.

6.5 Utilities

Utility information was requested and obtained from AT&T, Carlsbad Municipal Water District (CMWD), City of Carlsbad, City of Oceanside, Cox Communication, Crown Castle International, Southern California Gas Co., San Diego Gas and Electric (SDG&E), Time Warner Cable (TWC), and Verizon. Letters were sent to each utility owner requesting electronic media or hard copies of record as-built drawings.

AT&T Transmission, Crown Castle International, and City of Oceanside Traffic Signals provided response letters stating that they have no active facilities within the project vicinity. The remaining utility companies provided mapping of their facilities in the area (the City of Carlsbad and Carlsbad Municipal Water District provide access to as-built drawings online through its Document Management System. As-built research in the City of Oceanside was completed at the City Engineering Counter).

Existing utilities in the project area were mapped based on the provided as-built drawings, aerial topography, aerial photos, site visits, and survey data. The existing utilities mapped were overlaid onto the proposed design and all mapped impacts were noted.

It is anticipated that all water lines, gas lines, underground electrical, and communication lines crossing the trench can be relocated to either be attached to the proposed overpass bridges, or placed on separate utility structures. Where gravity sewer lines cross the trench the system would be modified to flow parallel the trench to a point where the track profile is high enough for the sewer to pass under while maintaining the proper slope and clearances.

An existing 48-inch sewer line exists along the east side of the existing tracks. The pipe has approximately 16 ft. of cover. In certain locations the temporary shoofly track would be placed over the existing pipe. The depth is such that live loads from railroads are diminished and it is anticipated that the pipes can accommodate the railroad tracks. During the design phase of the project this assumption should be validated by structural calculations. Where manholes are located under the shoofly track they will require modifications to lower the rim, and possibly provide additional structural support.

There is a Verizon fiber optic line that runs parallel the existing tracks which will require relocation. This relocation would occur through the trench and also at the Buena Vista Lagoon crossing where the line would be relocated from the existing bridge to the new bridge.

A 12-inch gas line owned by SDG&E parallels the tracks within the right-of-way. Between Carlsbad Blvd and the proposed station, the gas line would need to be relocated. A new storm drain line is required between the right-of-way and retaining wall, as well as an existing sewer line. This does not leave enough room for the gas line and therefore it is anticipated that the gas line would be relocated between Carlsbad Blvd. and Grand Ave.

6.6 Right-of-Way

Between Carlsbad Village Drive and Tamarack Avenue, the existing railroad Right-of-Way width is 200 ft. South of Tamarack Avenue the Right-of-Way is 100-foot-wide for a short distance, then gradually widening moving south toward Agua Hedionda Lagoon. The narrowed segment of Right-of-Way south of Tamarack Avenue is insufficient to construct the Long Trench Alternative. In addition to fitting the proposed trench in the Right-of-Way there is a 48-inch sewer and an 84-inch storm drain, along with several smaller utilities that parallel the tracks and need to be located outside the trench. The Long Trench Alternative would require acquisition of three single family residential properties located along the east side of the existing Right-of-Way south of Tamarack Avenue. The Short Trench Alternative does not require the acquisition of any new Right-of-Way.

6.7 Railroad Signaling

Signal improvements would include wayside signals within the trench and associated signal houses located outside the trench, temporary grade crossing warning devices and instrument houses, temporary control points at each end of the trench, and positive train control (PTC) infrastructure. It is anticipated that wayside signals would be located at either end of the station, near Tamarack Avenue, and near Cassidy Street. PTC is communicated via fiber optic cabling that runs adjacent to the existing tracks within the right-of-way. It will require relocation outside the trench to allow for continuous use during construction. The temporary shoofly track would cross several streets at grade, requiring the modifications to the grade crossing warning devices. This could include relocation of crossing arms and flashing light assemblies as well as relocation of associated signal houses if they are in conflict with the work area or shoofly track alignment.

6.8 Geotechnical

The Technical Memorandum included in Attachment H was prepared by Earth Mechanics, Inc. (EMI) in May 2016 to discuss the geotechnical setting of the proposed trench alternatives as well as the feasibility of retaining wall types. Data from borings taken by Southern California Soil Testing in 2016, EMI at the station in 2013 along with data from as-built log of test borings at the Carlsbad Boulevard Overpass, and info from the State Water Resources Control Board Geotracker website were utilized as sources of information for the geotechnical memorandum.

The proposed trench alternatives are anticipated to be excavated primarily through the shallow terrace deposits and Santiago Formation. The soil types expected to be encountered during trench excavation will be predominantly medium dense to dense clayey sand and soft sandstone with occasional claystone and siltstone interlayering. Site soils are not expected to present a rippability problem and can be excavated using conventional earthmoving equipment.

The borings encountered groundwater as high as elevation +28 ft. mean sea level (about 13 ft. below ground level). As-builts from the seismic retrofit showed a similar groundwater elevation at about 15 ft. below ground level. The natural grade does not vary significantly with the project limits and it is anticipated that groundwater will generally be between 10 and 20 ft. below natural grade. The final top of rail elevation within the trench will be 10 to 20 ft. below the water table. The trench walls and trench slab will need to be designed to resist hydrostatic earth pressures.

Groundwater is likely to be encountered during excavation for the trench as well as overpass foundations. Groundwater will need to be controlled during construction of retaining walls, retaining wall footings, overpass foundations, and the trench base slab. Any seepage or groundwater removed from an excavation would need to be tested and disposed of in compliance with all applicable local, state, and federal laws. A comprehensive groundwater monitoring program should be conducted as part of the design of either trench alternative. Seasonal variations, variations in groundwater levels along the length of the trench should be monitored as well as potential groundwater flow that might affect design and construction of the trench.

For sidewall support of the trench and at the bridge abutments, both bottom-up and top-down construction methodologies are geotechnically feasible. The most challenging geotechnical issue will be constructing deep cut retaining walls in the presence of shallow groundwater.

For a conventional bottom-up construction method, it is anticipated that there is insufficient right-of-way to lay back the excavations so some form of shoring will be required. Site soils are not conducive to driven sheet piling due to the shallow Santiago Formation and soil nail walls are not suited for construction below the groundwater table. Drilled soldier pile walls with lagging are feasible; however, lagging installation below the groundwater will not be water-tight so the excavation will need to be continually pumped. Additionally, the cut heights are expected to exceed the practical limits for cantilever soldier piles so either ground anchors (tie-backs), internal struts or bracing will be required to resist lateral earth loading.

For top-down construction, site soils are expected to be conducive to both secant pile wall and slurry wall construction. Both secant pile walls and slurry walls are effective methods to seal off water which would eliminate or reduce the expense of pumping and disposal of groundwater from the excavation during construction. Due to the anticipated excavation heights, internal bracing or ground anchors will most likely be required. Secant pile walls are generally more common in the western United States; however, recently slurry walls have started to be used more frequently on the west coast. Projects on the west coast where slurry walls have been used require a substantial quantity of work to offset the mobilization cost of the equipment which is much larger than conventional Cast-In-Drilled-Hole (CIDH) pile construction equipment and usually has to come from the east coast. At this time secant piles are assumed to be the most feasible option for top-down construction.

Recently, ground improvement techniques have been incorporated into secant pile wall design and construction to eliminate the time and expense of shaft stabilization (casing and/or slurry). Jet grouting, Cutter Soil Mixing (CSM), and Cement Deep Soil Mixing (CDSM) are examples of methods that have been used to inject and mix cementous grout with native soils to create a soil grout column of sufficient strength to be used for temporary lateral earth support. The vertical reinforcing in the secondary piles is stabbed into the soil-grout column while the mixture is still wet. Due to the high relative density of the Santiago Formation, site soils are anticipated to be more conducive to CSM and CDSM than jet grouting. Pre-drilling the soil column with a flighted auger can also be used in advance of ground improvement techniques to facilitate grout injection and soil mixing.

At the bridge overpasses, the abutments would be supported on CIDH piles that would provide lateral support for the trench and also carry the axial superstructure loads. The CIDH piles at these locations would need to extend deeper below the trench slab to develop the necessary axial capacity from side friction to support the structural loads.

6.9 Trench Structure

The trench structure will consist of a wall and invert slab system, which will be required to support approximately 32 ft. of trench cut at the grade separations, a temporary shoofly track running along the east edge of the trench and will support abutment loads for the overpass structures. The system also has to work under high ground water conditions both for temporary construction and for permanent configuration. A typical section for the trench is shown in Figure 6.1.

Constraints

Some of the constraints affecting the trench construction include:

- Proximity of existing utilities
- High groundwater table
- At least one temporary shoofly track needs to stay operational during construction
- Vertical clearance under the overpass structures
- Available Right-of-Way
- Dense Santiago formational material at relatively shallow depths

Trench Structural Elements Evaluation Criteria

Structural feasibility of several trench systems and their associated components were evaluated for this project based on the following criteria:

1) *Applicability to Soil conditions*: As discussed in Section 6.7, the proposed trenches are anticipated to be excavated primarily through the shallow terrace deposits and Santiago Formation. The soil types expected to be encountered during trench excavation will be predominately medium dense to dense clayey sand and soft sandstone with occasional claystone and siltstone interlayering. The Santiago Formation was able to be easily excavated with a hollow-stem auger drilling equipment and exhibited soil-like behavior during sampling and did not require rock coring. However, this material is not expected to be conducive to pile driving, per the technical memorandum in Appendix F.

2) *Groundwater Control*: Based on the proximity of the site to the Pacific Ocean and the groundwater elevations encountered in the borings, shallow groundwater is anticipated along the trench alignment. Natural grade does not vary significantly within the project limits and it is anticipated that groundwater will be generally between 10 and 20 ft. below natural grade. During construction, wall systems that require dewatering and treating large volumes of water could be prohibitively expensive. Also in the final configuration, wall system is expected to be watertight. Any seepage water that has to be disposed off-site would have to be treated.

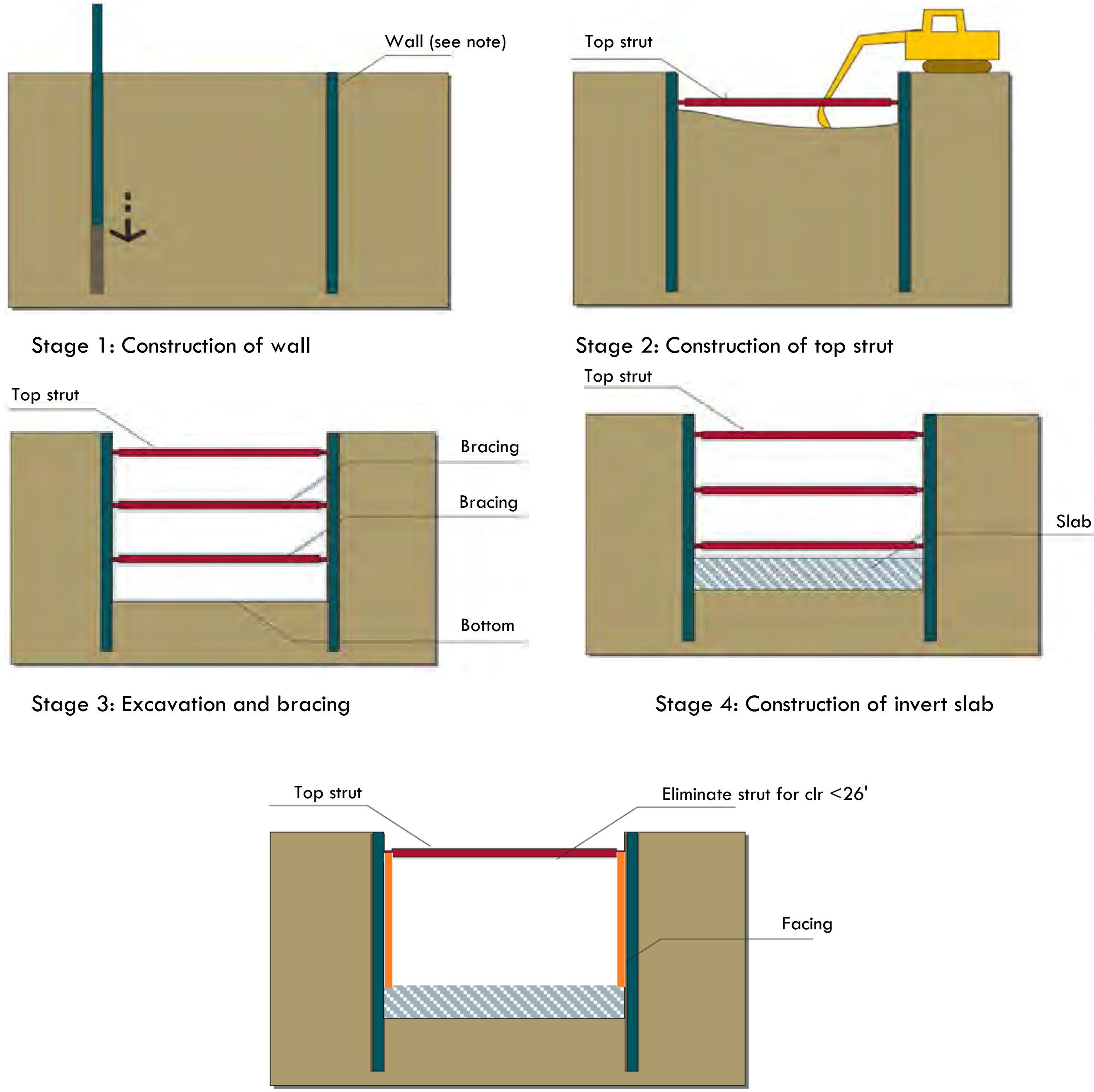
3) *Bridge Abutment Loading*: The long trench option will include construction of 7 overpass structures along the grade-separated trench alignment while the short trench option will include construction of 6 overpass structures. The wall/slab invert system of the trench structure is proposed to be integrated with the bridge abutments at these crossings and should be able to resist the vertical abutment loads from these overpass structures. Thus wall systems requiring fewer modifications to accommodate the bridge abutments are preferred from cost and schedule perspective.

4) *Construction Duration and Impacts*: The trench alignment passes through both business and residential area of the City of Carlsbad and hence the noise and traffic impacts of the construction need to be considered. Wall systems that use construction equipment with smaller impact footprints are preferred. A single shoofly track will be operational during the entire duration of trench construction and hence a wall system is preferred that will minimize the construction duration and lead to early operation of the double tracks.

5) *Utility/Right-of-Way (ROW) conflicts*: The ROW limits and utility layouts are shown in Attachments C & D. The close proximity of the trench walls to the utilities and right-of-way limits precludes the use of tiebacks and soil nails in certain locations.

Wall Systems

Due to close proximity of utilities and ROW limits and the need to maintain a dry excavation to avoid dewatering, a top down construction is proposed for the wall. A schematic of a typical top down construction wall system is shown in Figure 6.2.



Stage 5: Construction of wall facing

Note: The schematics shown above are applicable for any wall system with top down construction in which the wall acts as a structural system and shoring for constructing the trench.

Figure 6.2: Schematic of Construction Staging for Top-down Wall Systems

("Construction of Secant Pile Wall", Land Transport Authority, Singapore, October 2004)

The wall systems considered for feasibility analysis include:

a) *Secant Pile Walls* are formed by top down construction of overlapping concrete piles. The secant piles are reinforced with either steel rebar or with steel beams and are constructed by either drilling under mud or augering. Primary piles are installed first with secondary piles constructed in between primary piles once the latter gain sufficient strength. This wall system provides an effective method to seal off water into an excavation, which will eliminate or reduce the expense of pumping and disposal of groundwater from the excavation during construction.

b) *Slurry-Diaphragm Walls* consist of top down construction of excavated panels which are filled with soil-bentonite slurry to prevent caving. After design depth is reached, the slurry is displaced with concrete pumped through a tremie pipe and steel reinforcement cage is inserted into the panel. However, slurry walls are more suitable as curtain cutoff walls to slow down migration of groundwater and other contaminants and are usually not used as permanent structural elements. Considerable reinforcing and thicker sections will be required to provide the structural strength to hold back soil pressures on the unsupported side of the trench. Secant pile walls are generally more common in the eastern United States; however, recently slurry walls have started to be used more frequently on the west coast. Projects on the west coast where slurry walls have been used require a substantial quantity of work to offset the mobilization cost of the equipment which is much larger than conventional CIDH pile construction equipment (per the technical memorandum in Appendix F).

c) *Deep Soil Mixing (DSM) Walls* also consist of top down construction by creating columns of ground improvement by mechanically mixing the soil with cementitious binder slurry. The process constructs rows of overlapping columns. H-piles are usually inserted into the columns for lateral capacity. A bracing system with tiebacks may also be used as an alternative to the H-piles. At this project location some predrilling may be required into the Santiago formation before the soil mixing operation, which will increase the cost for the DSM walls (per the technical memorandum in Appendix F). Also, similar to the slurry walls, DSM walls are more commonly used as temporary shoring and are usually not used as permanent structural elements.

d) *Cantilever Walls* are cast-in-place reinforced concrete structures. These wall systems consist of constructing a wall stem and footing in stages from the bottom up. A standard benched cut cannot be used at this project since this will require the excavation to be dewatered during construction. The exorbitant costs associated with pumping and treating large volumes of water, combined with the adverse environmental impacts associated with mitigation of water infiltration and the ROW and utility constraints will probably not allow a traditional cantilever wall construction. Sheetpiling is the preferred shoring option for cantilever walls in which the vertical members are typically driven or vibrated from the original ground surface to a specified depth. However, this system is ruled out at the project location due to the shallow Santiago Formation that is not conducive to driving the sheetpiles. The construction operation also will have noise impacts on the neighborhood. Thus a temporary water-sealed shoring system (similar to the three wall systems described above) will be required to get to the bottom of the footing. Thus a standard cantilever wall construction may not be feasible for this project unless a top-down method of construction is used for shoring.

e) *Soil Nail Walls* are constructed through top down excavation in lifts of approximately 5 ft. and the excavated soil is passively reinforced with grouted tension-resisting steel elements (nails) that can be design for permanent or temporary support. The nails increase the shear strength of the reinforced soil mass and limit displacement during and after excavation. A shotcrete facing is constructed to provide local resistance to raveling. Soil nail walls cannot be constructed with anchors below the water table and at locations where the wall is in close proximity to utilities or within the zone of influence of a railroad track. However, soil nail walls may be considered for the beginning and end segments of the trench which are above the ground water table where the proximity of adjacent utilities and right-of-way limits permit. Also for the trench sections with groundwater, it may be possible to come up with a hybrid system consisting of secant piles below the groundwater table and soil nail walls above the water table. Careful consideration will be needed for any seasonal water fluctuations or sea level rise to determine the design water table for such hybrid system.

f) *Soldier Piles with Lagging* is a top down excavation support technique where vertical steel piles are lowered into a drilled hole and grouted at regular intervals along the proposed wall location. Wood lagging is placed between the soldier piles as excavation proceeds. For excavations of small height, the walls are typically cantilevered. The walls can be tied-back or braced where additional lateral support is required. Since the excavation between the piles to install the lagging is open excavation, this system cannot be used without dewatering. Also the installation rate for soldier pile walls is usually slower than other wall systems (per the technical memorandum in Appendix F).

g) *MSE Walls* are gravity structures consisting of alternating layers of granular backfill and linear metallic and/or polymer based, high-adherence soil reinforcing strips to which a modular precast concrete facing is attached. Its strength and stability are derived from the frictional interaction between the granular backfill and the reinforcements that creates a unique composite construction material. A mechanical connection between the facing panels and the soil reinforcing strips is achieved by way of a special tie strip embed and high strength nut/bolt/washer assembly. MSE walls are usually fill walls and hence is not applicable for this project location due to close proximity R/W, utilities and the presence of groundwater.

A comparison of eight different wall systems in terms of the Structural Elements Evaluation Criteria have been summarized in Table 6.1.

Table 6.1: Wall System Evaluation Summary

Wall Type	Applicability to Soil Conditions	Groundwater Control	Bridge Abutment Loading	Construction Duration and Impact	Utility/ROW Conflicts
Secant Pile Wall	✓	✓	✓	✓	✓
Slurry-Diaphragm Wall	✓	✓	✓	✓	✓
Deep Soil Mixing (DSM) Wall	✓	✓	✓	✓	✓
Cantilever Wall without Shoring	✓	×	✓	✓	×
Cantilever Wall with Sheetpile Shoring	×	✓	✓	×	✓
Soil Nail Wall	✓	×	×	✓	×
Soldier Piles and Lagging	✓	×	✓	×	✓
MSE Walls	×	×	✓	✓	×

Legend: × Criteria not satisfied
✓ Criteria satisfied

Invert Slab and Seal Course Systems

Due to the trench depth below the groundwater level a method of keeping the railroad trench dry must be included in the design. There are two ways to dry the trench. One is to provide a drainage system that drains the groundwater into a basin within the trench where it would be pumped out to the lagoon or storm drain system. The other option is to seal off the trench from the water, similar to what has been done in the Alemeda Corridor and Reno ReTrac railroad trench projects. Although the pumping option may have a cost savings, it is not proposed in this report for the following reasons:

- The groundwater would require testing and treatment prior to discharging to the storm drain or lagoon.
- The impacts of permanently lowering the groundwater in the area would need evaluation of the environmental effects as well as impacts to any current uses of the groundwater.

- There would be a risk of flooding the railroad tracks in the case that the pump systems failed, resulting in impacts to commuters, freight movement, and possible damage to the track bed. Pump systems could fail due to mechanical failure or clogging of a drain line.

- NCTD has stated that they would not allow groundwater to enter the trench.

For trench sections below groundwater, a structural concrete invert slab is proposed between the walls to seal off the base of the trench from groundwater. Sealing of the trench would create a buoyant force that would act to lift the approximately 32-foot-tall x 55-foot-wide trench section. The invert slab is proposed to be designed as a strut system at the bottom of the wall which will reduce the embedment length of the piles. Along the majority of the trench, the secant piles/slurry wall will only need to extend far enough below the trench slab to resist the temporary lateral earth loads until the bottom slab is poured. These temporary lateral loads can be reduced by adding temporary bracing systems over the height of the wall. Some of the invert slab options include:

a) *Cast-in-place Concrete Slab*: Designing a cast-in-place invert slab thick enough to resist the buoyancy forces by virtue of dead load only is one of the simplest design approaches. However, the thicker the slab gets, the buoyancy forces also increase proportionally. Thus this approach by itself could result in an uneconomical design for high ground water because of dewatering. A cast-in place slab may be used in combination with a seal course or jet grouting as described below.

b) *Seal Course*: The seal course is a concrete slab placed underwater by the tremie placement method and is constructed thick enough so that its weight is sufficient to resist uplift from buoyant forces. A seal course also seals the entire bottom of an excavation and prevents subsurface water from entering the excavation.

c) *Jet grouting*: Jet grouting is a top-down soil treatment used to create in-situ, cemented soil formations. The method uses pressurized fluids to segregate and remove some of the soil particles and replace them and blend them with a soil/cement mixture that can provide high strength and low permeability. This jet grouted zone then acts as a seal for the invert slab and ballast. The advantage of the jet grouting method, as compared to a seal course, is that the treated zone can be constructed before starting the excavation. This can help to reduce the depth of excavation and wall embedment zone. In some instances, tiedowns may also be used to hold down the treated zone itself against the buoyant forces, thus resulting in a thinner seal course.

Struts

Since the trench will have two opposing walls a strut brace can be used between the walls, with available vertical clearance over 26 ft., to resist the lateral soil pressures. Since wall tiebacks cannot be used due to close proximity of utilities and R/W boundaries, the wall design can be optimized by designing the strut as a beam-column between the two walls of the trench with compression loads produced by the lateral soil pressures and moments produced by the strut self-weight. To speed construction the struts can be precast and connected to the wall over waler beams.

The construction staging for the Alameda Corridor, located in Los Angeles, California, which has similar proportions to the proposed CVDT is shown in Figure 6.3.

(a)

(b)

(c)

(d)

(a) Excavation of the trench after installation of secant piles and top struts
(b) Construction of invert slab and wall facing
(c) Ballast placement
(d) Completed trench

Figure 6.3: Expected Construction Staging

Note: Photos shown are from the of the construction of the Alameda Corridor, in Los Angeles County, CA, which had similar constraints as the Carlsbad Village Double Track Trench project, such as limited right-of-way and close proximity to underground utilities.

(Photos courtesy: Eric Brown, Earth Mechanics)

Trench Typical Section

The trench walls may be divided into several segments based on the following criteria:

- Presence of groundwater
- Presence of utilities in close proximity to wall
- Presence of shoofly track next to excavation
- Adjacent to overpass structure

Wall segments for the long trench option with groundwater, utility and shoofly impacts are summarized in Table 6.2. Typical sections of the trench are shown in Figures 6.4 and 6.5.

Table 6.2: Wall Segments with Groundwater, Utility, and Shoofly Impacts along Long Trench Alignment

Wall Segment Limits	Side of Wall	Utility Conflicts	Groundwater	Live Rail near Excavation	Max. Height of Wall (ft) from Top of Slab
Sta 2357+00 to 2353+28	East	No	No	Yes	10
	West	Yes	No	No	10
Sta 2353+28 to 2341+28	East	No	Yes	Yes	28
	West	Yes	Yes	No	28
Sta 2341+28 to 2334+66	East	No	Yes	Yes	32
	West	No	Yes	No	32
Sta 2334+66 to 2298+50	East	Yes	Yes	Yes	32
	West	No	Yes	No	32
Sta 2298+50 to 2290+75	East	Yes	Yes	Yes	32
	West	No	Yes	No	32
Sta 2290+75 to 2282+65	East	Yes	No	Yes	28
	West	No	No	No	28
Sta 2282+65 to 2279+00	East	No	No	Yes	10
	West	No	No	No	10

Legend: Yes Has design impact
No No design impact

Note: Carlsbad Village Station Platform limits are from STA 2339+50 to STA 2349+50

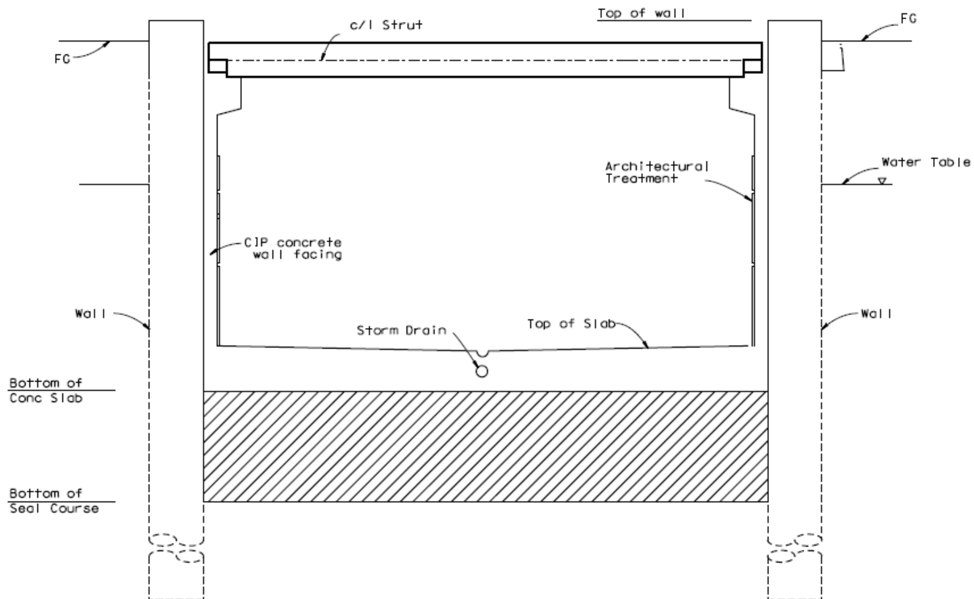


Figure 6.4: Cross Section of Trench System with Walls, Seal Course, and Permanent Strut (Wall height to bottom of ballast, H > 28 ft. only)

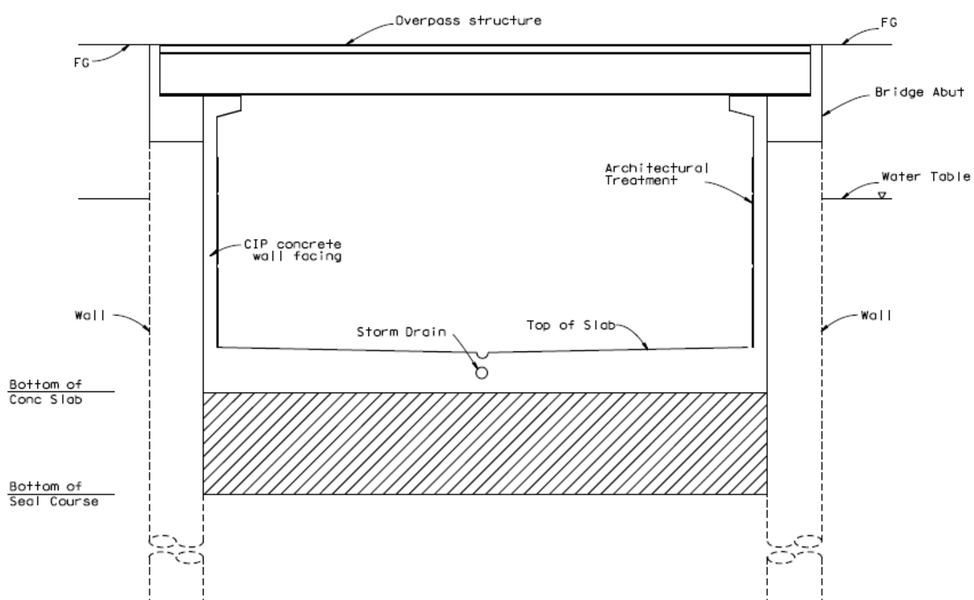


Figure 6.5: Cross Section of Trench System at Overpass Structures

Cost Evaluation

The cost for the trench structure was estimated through discussions with specialty contractors, field experts, and published construction cost data from Caltrans. These wall costs, neglect the costs for temporary construction lateral support systems. The estimated cost in Table 6.3 does not include the cost of roadway excavation, contingency and escalation costs. Contingency and escalation costs should be included to reflect the preliminary level of design at the feasibility study level and are shown later in the overall project cost.

Table 6.3: Estimated Cost for Trench Structure

Wall Height to Bottom of Ballast (ft)	Long Trench Wall Length (ft)	Short Trench Wall Length (ft)	Estimate for Walls / sq ft [1]	Estimate for Invert Slab/cy [2]	Estimate for Seal Course/cy [3]	Estimate for Struts/ft of wall length [4]	Estimated Long Trench Structure Cost [5]	Estimated Short Trench Structure Cost [5]
10 ft max	1,472	1,086	$ 65				$ 800,000	$ 570,000
10 ft to 28 ft	4,020	3,962	$ 110	$ 475	$ 150		$ 18,200,000	$ 21,690,000
28 ft to 32 ft	10,106	3,955	$ 110	$ 475	$ 150	$ 900	$ 74,700,000	$ 28,910,000
TOTAL (without contingencies)							$ 93,700,000	$ 51,170,000

Notes:

1 Estimate for walls is based on $65/sq ft. for soil nail walls for H<15 ft. with no utility impacts (Caltrans Contract Cost Data) and $110/sq ft. for secant pile wall system (Sunil Arora, Senior Project Manager, Hayward Baker Inc.)

2 Estimate for invert slab is based on Caltrans Contract Cost Data

3 Estimate for seal course is based on Caltrans Contract Cost Data

4 Estimate for struts is based on $12,000/precast strut and $500/CY for support beam (bid data from Carroll Canyon DAR Retaining Walls, San Diego, California)

5 Cost estimate backups for the long trench and short trench options are shown in Appendix D and Appendix E. All estimates are in 2016 costs.

Summary of Trench Structure Evaluation

A preliminary structural evaluation of feasible trench systems for the CVDT project has been performed. This includes looking at both wall and invert slab systems considering the relevant project constraints and conflicts. Based on these studies, the feasible wall systems for trench sections under the groundwater level include: a) Secant pile wall; b) Slurry wall and c) Deep-Soil-Mixing Wall. The invert slab is proposed to be a combination of cast-in-place slab and seal course. An opinion of preliminary costs also are provided for the different options. Further detailed structural and geotechnical investigations are necessary to develop a preferred alternative. During final design of the project the trench structure should evaluate the potential of using slope paving above the design groundwater elevation and the recommended wall systems above below the design water table. This could potentially be included where the right-of-way allows enough room for the paved slope.

6.10 Bridge Structures

A total of six overpass structures would be needed for the grade separated short trench option and seven structures would be needed for the long trench option. The overpass structures constructed directly over the trench are proposed to be single span Precast/Prestressed Girder structures supported on abutments which are made integral with the trench walls. The precast structure type is an attractive alternative because of reduced construction time and elimination of falsework. The Carlsbad Boulevard Overpass and the Buena Vista Lagoon Bridge would be multi-span structures which would be constructed outside the limits of the trench.

Tamarack Avenue Overpass (Long Trench Only)

The Long Trench Alternative would construct a vehicular bridge on Tamarack Avenue over the proposed trench. The proposed bridge was assumed to match the existing configuration of the road, with a 5 ft. sidewalk on each side, a 10-foot-wide median, a single 12 ft. lane in each direction, and 6 ft. bike lanes. The overall bridge dimensions would be 60’ wide by 55’ long single span structure. It is assumed that phased bridge construction would be required to allow the road to remain open during construction.

Chestnut Avenue Overpass

The Short Trench Alternative would construct the Chestnut Avenue Overpass as a pedestrian overpass. A vehicular crossing would not work in the Short Trench Alternative because the track profile cannot maintain 26 ft. of vertical clearance to the overpass and still reach the existing grade at Tamarack Avenue. The pedestrian overpass is proposed to be raised approximately 7 ft. above existing grade to provide the clearance to the pedestrian overpass. This would require stairs and an ADA accessible ramp to access the bridge on each side of the trench.

The Long Trench Alternative would construct the Chestnut Avenue Overpass as a vehicular crossing connecting the existing street on each side of the railroad right-of-way. The new crossing would include a sidewalk in each direction and match the width of the existing Chestnut Avenue. The overall bridge dimensions would be 56-foot-wide by 55-foot-long single span structure.

Oak Avenue Overpass

Both the short and long trench alternatives would construct a vehicular crossing connecting the existing street on each side of the railroad right-of-way. The new crossing would include a sidewalk in each direction and match the width of the existing Oak Avenue. The overall bridge dimensions would be 46-foot-wide by 55-foot-long single span structure.

Carlsbad Village Drive Overpass

The existing Carlsbad Village Drive is an at-grade crossing with 2-vehicular lanes in each direction. Both the long and short trench alternatives would match the existing configuration of the road, with a 5 ft. sidewalk on each side, a 10-foot-wide median, two 12 ft. lanes in each direction, and 6 ft. bike lanes. The overall bridge dimensions would be 84-foot-wide by 55-foot-long single span structure. It is assumed that phased bridge construction would be required to allow the road to remain open during construction.

Grand Avenue Overpass

The Grand Avenue Overpass would be similar to the Carlsbad Village Drive Overpass with overall bridge dimensions of 84-foot-wide by 55-foot-long single span structure.

Beech Avenue Pedestrian Overpass

A pedestrian overpass would be constructed at Beech Avenue to connect the Carlsbad Village Station platforms on either side of the tracks. The overpass structure would be 12-foot-wide by 62-foot-long single span structure.

Carlsbad Boulevard Overpass

The existing Carlsbad Boulevard Overpass structure would have to be replaced with both trench alternatives. The track profile for both trench alternatives would undermine the existing spread footings at the bridge piers. The replacement of this bridge was not included in the At-Grade Alternative because that alternative did not undermine the existing spread footings at the bridge piers.

The proposed bridge was assumed to match the existing configuration of the road, with a 5 ft. sidewalk on each side, a 10-foot-wide median, a single 12 ft. lane in each direction, and 6 ft. bike lanes. The overall bridge dimensions would be 60-foot-wide by 170-foot-long three span structure. It is assumed that phased bridge construction would be required to allow the road to remain open during construction.

Buena Vista Lagoon Bridge

The Buena Vista Lagoon Bridge was previously designed to a 30% level in preparation of the Carlsbad Village Double Track Alternative Analysis Report in 2013. The recommended structure type for the Buena Vista Lagoon Bridge was a 7-span Cast-in-Place/Prestressed (CIP/PS) Concrete Box Girder structure. The bridge will consist of 45 ft. maximum span lengths for a total bridge length of 294 ft. The structure depth will be 6 ft. Abutments will be short seat abutments on shaft pile foundations. Bents will be multi-column, 5 ft. diameter circular columns. 7 ft. diameter CIDH piles were the preferred foundation alternative. The potential artesian groundwater condition present at the site will require the contractor to use slurry displacement methods with a weighted drilling fluid during CIDH pile construction.

Overpass Structure Cost Evaluation

The cost for the Buena Vista Lagoon Bridge was estimated in the Carlsbad Village Double Track Alternative Analysis Report in 2013. The cost of the other overpass structures have been estimated based on Comparative Bridge Costs published by Caltrans, January 2015 for PC/PS Girder alternative. The estimated costs for the long trench and short trench alternatives are summarized in Table 6.4.

Table 6.4: Cost Estimate for Overpass Structures, 2016 Costs

Bridge Name	sq ft	$/sq ft	Bridge Removal	Short Trench Total	Long Trench Total
Buena Vista Lagoon	9,899	285	$ 1,200,000	$ 4,020,000	$ 4,020,000
Carlsbad Blvd	10,200	250	$ 750,000	$ 3,300,000	$ 3,300,000
Beech Ave	744	200	$ 0	$ 149,000	$ 149,000
Grand Ave	4,620	225	$ 0	$ 1,040,000	$ 1,040,000
Carlsbad Village Drive	4,620	225	$ 0	$ 1,040,000	$ 1,040,000
Oak Avenue	2,750	200	$ 0	$ 550,000	$ 550,000
Chestnut Ave	2,750	200	$ 0	$ 156,000	$ 550,000
Tamarack Drive	3,300	225	$ 0	$ 0	$ 743,000
			SUBTOTAL	$10,256,000	$11,393,000
			10% Mobilization	$ 1,025,000	$ 1,139,000
			TOTAL	$11,281,000	$12,532,000

6.11 Constructability

Due to the ongoing operations through the LOSSAN corridor, project construction would require phasing to maintain operation of the tracks. Construction of the grade separation would require a temporary shoofly track and temporary station platform. The first phase of construction could include replacement of the Carlsbad Boulevard Overpass, construction of the new double track Buena Vista Lagoon Bridge, installation of a temporary No. 24 turnout on either end of the trench, and construction of a temporary shoofly track. The temporary station platform would be located within the existing station parking lot on the east side of the shoofly track. The second phase of construction could include construction of the trench, overpasses, two new tracks, COASTER station, and then removal of the shoofly track and temporary station.

As a consequence of the construction of the shoofly track and temporary station platform there will be a temporary loss of parking. Approximately half of the existing parking lot at the station would be taken out during construction. This could necessitate the construction of additional parking on a vacant lot just north of the existing parking lot. To construct the temporary shoofly track parking would be temporarily removed adjacent to the Carlsbad Santa Fe Depot between Grand Avenue and Carlsbad Village Drive, and between Carlsbad Village Drive and Oak Avenue.

In addition to keeping railroads operating during construction the on-street traffic must also be maintained. Construction on existing streets crossing the tracks should be planned to minimize disruptions. One possible solution includes the use of precast bridge elements to install bridges over one shorter duration road closure. Construction of the Oak Avenue Overpass first could provide relief during closures of Grand Avenue and Carlsbad Village Drive by maintaining two railroad crossings open at all times, which would be similar to the existing condition. The overpass at Carlsbad Boulevard could be replaced by constructing the bridge in phases, half at a time. This would allow the road to remain open during construction.

The construction of temporary at-grade crossings along the shoofly track would require California Public Utilities Commission (CPUC) GO 88-B authorization to modify an existing public crossing. A GO 88-B application would be required for the crossing at Carlsbad Boulevard, Grand Avenue, Carlsbad Village Drive, Tamarack Avenue, and the pedestrian crossing at the existing station. A Formal Application for a new public crossing would be required at Oak Avenue and at Chestnut Avenue, these would then require a GO 88-B authorization to modify them to grade separated at the end of construction.

The excavation of the trench would require removal of almost 400,000 cubic yards of earth for the Short Trench and over 600,000 cubic yards of earth for the Long Trench. It is anticipated that the removal would be trucked offsite to an approved disposal location by the contractor. The most direct path for trucks removing materials would be along Tamarack Avenue to I-5 or Carlsbad Village Drive to I-5. The export of materials would take roughly eight to twelve months to complete. Additional truck traffic is expected due to the delivery of materials and equipment; however, the volume would be small compared to during export of soil.

6.12 Operation and Maintenance

A benefit of trenching is that the operations and maintenance costs for the grade crossing warning devices and gate arms would be eliminated. The proposed trench alternatives would require maintenance of the retaining walls, overpass structures, elevators at the station, and storm drain pump stations. Estimated annual operation and maintenance costs related to the proposed trench alternatives are shown in the following table. A maintenance agreement to cover these costs would be required between the City and NCTD. The costs shown were based on available public information from various sources, the actual costs of maintenance may vary greatly depending on the agency, final design conditions, and the environment.

Table 6.5: Estimated Annual Operation and Maintenance Costs

Activity	Short Trench Annual Cost (2016$)	Long Trench Annual Cost (2016$)
Bridge Maintenance[1]	$ 6,000	$ 7,000
Retaining Wall/Trench Maintenance[2]	$ 8,000	$ 12,000
Elevator Operation & Maintenance[3]	$ 8,000	$ 8,000
Storm Drain Pump Station Operation & Maintenance[4]	$ 4,000	$ 8,000

Notes:

1 Annual bridge maintenance costs were calculated from Bridge Cost x 4% divided by the life of the bridge (100 years). A discount rate of 4% is currently used by Caltrans for Life Cycle Cost Analysis.

2 Retaining Walls, Trench Slab, and Waterproofing only. Costs were calculated with $0.50/sf divided by the design life of the wall (100 years), based on data from the City of Seattle Asset Management Status and Conditions Report, 2010.

3 Maintenance costs per the Standard Services agreement between KONE Elevator and MTS for Maintenance and Repair of three elevators from 2010 to 2014, reduced by 1/3 for two elevators. The ThyssenKrupp Elevator online energy calculator was used to calculate energy cost (thyssenkruppelevator.com/Tools/energy-calculator)

4 Annual cost per pump were taken from the City of Alameda Capital Improvements Projects Fiscal Years 2013-2014 Annual Maintenance Projects for Storm Drain Pump Station Maintenance, divided by ten pump stations in the City of Alameda.

7. ENVIRONMENTAL CONSTRAINTS

The following discusses the potential environmental impacts to select relevant issue areas associated with construction and operation of a Short or Long Trench Alternative for the Carlsbad Village Double Track Project. The information contained in this section is taken primarily from existing reports prepared for the Carlsbad Village Double Track Project.

7.1 Aesthetics and Scenic Resources

Short Trench or Long Trench Alternative

In comparison to the At-Grade Alternative the implementation of a Short Trench or Long Trench Alternative, the Carlsbad Village area would be improved from its existing visual quality and visual response once construction is completed. Carlsbad Village would maintain office, commercial, and residential development, and could be expanded to include parkland and community meeting spaces around or within the railroad right-of-way. The Proposed Action would modify the railroad infrastructure and alter the existing landform due to the elimination of at-grade crossings and construction of trench throughout the developed segment. It is anticipated construction of the project with either trench alternative would occur over a 40 - 48-month time frame, compared to an 18 – 30-month timeframe for an At-Grade alternative. Upon completion of construction, the rail and trains would not be as visible because they would be below the ground surface.

During construction, the existing setting along the railroad Right-of-Way (ROW) both within Carlsbad Village and in areas to the south, and at the Carlsbad Village Station would be highly disturbed. Construction activities would take place primarily within the railroad ROW with construction-related traffic impacting haul routes into and out of the City. Construction would involve numerous pieces of large, heavy equipment. Tandem dump trucks would be used to haul excavated materials from the site and cement trucks and flatbed trucks would be used to bring in cement and other construction materials. Assuming 18 cubic yards of excavated material per tandem dump truck, between 16,000 and 30,000 round trips would be required for the short trench and long trench alternatives, respectively, just to haul excavated material. Construction activities would last for between 10 and 18 months longer than would construction activities for the at grade project. During much of this time, the train would run on a relocated track (shoofly) along the existing ground surface, east of the existing track. Within the Carlsbad Village, construction activity would be much more pronounced due to the effort required to build a shoofly, excavate the trench, demo and reconstruct City streets, relocate utilities, construct the walls trench bottom, and demo the shoofly. Work on the shoofly would require demolition of the existing station building and a temporary station would be provided to the east.

7.2 Air Quality and Greenhouse Gas Emissions

Short Trench Alternative

Air Quality and Greenhouse Gas Emissions (GHG) during construction would substantially increase with the Short Trench Alternative compared to the At-Grade Alternative due to the increase in truck trips associated with the construction of the shoofly, excavation of the trench, demolition and reconstruction City streets, relocation of utilities, construction of the trench walls, trench bottom, and demolition of the shoofly. Operation of a double track within a trench would result in air quality and GHG offsets due to reduced vehicular idling at railroad at-grade crossings as the vehicular traffic and rail traffic would be separated and the grade crossing would be removed. The LOSSAN Program EIR/EIS recommends several best management practices (BMPs) to ensure that air quality and GHG impacts are minimized during project-level construction phases to the maximum extent practicable. Therefore, BMPs will be implemented during construction.

Long Trench Alternative

Air Quality and GHG impacts associated with the construction of the Long Trench Alternative would be proportionately greater than those associated with the Short Trench Alternative discussed above.

7.3 Biological Resources and Wetlands

Short Trench or Long Trench Alternative

Vegetation Communities

Similar to the At-Grade Alternative the construction of the either the Short Trench or Long Trench Alternative would primarily result in direct, permanent impacts to habitat immediately adjacent to the existing tracks, which is classified as either non-native vegetation, urban/developed, or disturbed habitat. The exception to this is within the immediate vicinity of the lagoon where creation of a second track (inclusive of removal of the existing bridge and construction of a new bridge and wider embankment) would result in permanent impacts to open water and coastal and valley freshwater marsh, predominantly located on the east side of the existing tracks. Note that work in the lagoon would remain the same with an At-Grade alternative or either trench alternative. In addition, construction of the second track south of the lagoon would permanently impact thin portions of disturbed Diegan coastal sage scrub and eucalyptus woodland. Impacts would require mitigation, similar to the At-Grade Project.

Federally Listed Species

Similar to the At-Grade Alternative, the trench alternatives would have the following impacts related to federally listed species.

Light-Footed Clapper Rail. Construction of either the Short Trench or Long Trench Alternative would likely result in the same level of take of the light-footed clapper rail as a result of permanent and temporary loss of habitat associated with the bridge replacement and berm widening, elevated noise levels during construction, and temporary night lighting during construction. The trench alternatives occur south of the Carlsbad Boulevard Overhead; and therefore, impacts to Buena Vista Lagoon and supported species are not expected.

San Diego and Riverside Fairy Shrimp. The federally listed endangered San Diego and Riverside fairy shrimp could potentially be present within low-lying areas, parallel to the railroad tracks. The Potential Area of Impact for either the Short Trench or Long Trench Alternative extends beyond the study area that was previously surveyed for San Diego and Riverside fairy shrimp for the CVDT project. Impacts to fairy shrimp are not expected as the disturbed ROW south of the Carlsbad Village Drive Study Area was previously impacted by the Carlsbad Double Track Project, and no fairy shrimp were reported during environmental clearance for that project. A biologist would be required to conduct surveys to determine if a direct or indirect impact to fairy shrimp would result with the implementation of the Short Trench or Long Trench Alternative.

Coastal California Gnatcatcher (CGN). There is a low potential for federally listed threatened coastal CGN to occupy the isolated patch of Diegan coastal sage scrub (DCSS) south of the lagoon. Based on the low potential for presence and distance to potentially suitable habitat from the project footprint (approximately 68 ft.), elevated noise levels from construction would not be expected to adversely affect CGN individuals by disrupting normal behavioral patterns including, but not limited to breeding, feeding, or sheltering. The trench alternatives occur south of the Carlsbad Boulevard Overhead; and therefore, impacts to any CGN in the isolated DCSS habitat area would not occur.

California Least Tern. The California least tern is an opportunistic forager and was observed foraging over/within the lagoon during the biological surveys. Although there are no potential nesting sites within the Biological Study Area (BSA) and no active nesting in the lagoon, indirect impacts could occur to this species from alteration of foraging habitat as a result of elevated turbidity during construction. In addition, there would be a permanent reduction in available open water surface within which foraging may occur as a result of the addition of the second track. However, the permanent loss of open water foraging habitat would be considered minimal, with only an approximate total loss of 0.07 acres (0.05% of the lagoon). As a result, it is expected that the California least tern would utilize other portions of Buena Vista Lagoon if local foraging habitat losses would occur. If present during construction, the temporary construction activities are expected to reduce local foraging area. While the permanent footprint of the project constitutes a negligible portion of the total open water in the lagoon, inadequate control of turbidity during construction could result in an adverse impact to temporarily affected foraging areas. However, these impacts may be reduced by controlling turbidity generation to a small footprint area around the construction zone during the summer least tern breeding season. In addition, consultation between the FRA and the USFWS under Section 7 of the federal ESA would be required, which would identify mitigation measures to reduce impacts to federally listed species. Section 7 consultation has not yet occurred. The trench alternatives occur south of the Carlsbad Boulevard Overhead; and therefore, impacts to Buena Vista Lagoon and supported species are not expected.

Jurisdictional Waters of the U.S. and Coastal Wetlands.

Similar to the At-Grade Alternative, both trench alternatives will result in impacts to waters of the US and coastal wetlands associated with the bridge and embankment work in the lagoon. The trenches themselves may impact track ditches that are determined to jurisdiction by the Army Corps of Engineers and/or California Coastal Commission. Such impacts would require avoidance, minimization, and mitigation of impacts in accordance with the following permits by regulatory federal agencies:

1) USACE, CWA Section 404 permit for placement of dredged or fill material within waters of the US;

2) RWQCB, CWA Section 401 state water quality certification/waiver for an action that may result in degradation of waters of the US; and

3) CCC, Coastal Zone Management Act Consistency Determination.

Wildlife Movement/Corridors and Nursery Sites

Due to the already limited corridors for wildlife within the project site and the presence of the existing railroad corridor, the Short Trench or Long Trench Alternative are not expected to result in adverse changes to present wildlife movement patterns or intensity.

The project footprint does not include any identified nursery sites. The project would result in direct permanent and temporary impacts to habitat of marsh nesting birds. There are no anticipated adverse impacts to nursery sites as a result of implementation of either the Short Trench or Long Trench Alternative.

Migratory Bird Treaty Act (MBTA)

Avian species could potentially nest in the onsite habitats; therefore, the Short Trench or Long Trench Alternative could result in adverse impacts to active bird and/or raptor nests (if present at time of construction) under the federal MBTA.

7.4 Community Impacts and Environmental Justice

Short Trench or Long Trench Alternative

Substantial community disruption would be expected during construction. Construction of the Short Trench Alternative would occur entirely within NCTD Right-of-Way, while the Long Trench Alternative would require acquisition of three single family residential properties. Community movement opportunities and coastal access would be substantially impacted during construction by construction-related traffic as well as by temporary street and sidewalk closures. The Short Trench or Long Trench Alternative would therefore periodically isolate a neighborhood during construction. It could also periodically separate residences from community facilities near the project area during construction.

The Short Trench or Long Trench Alternative would not isolate any portion of a neighborhood or ethnic group, nor would it separate residences from community facilities near the project area once construction is complete. Likewise, the Short Trench or Long Trench Alternative would not result in any adverse community impacts or disproportionate impacts on minority or low-income populations located within the project area once construction is complete. By replacing at-grade crossings with grade separated crossings, either trench alternative would ultimately enhance community movement opportunities throughout the vicinity of the project. This is in contrast to the At-Grade Alternative which would maintain the division of the community by the approximately 100-year-old railroad ROW. Traffic delays due to grade crossing gate arms would be eliminated by the grade separation of the existing crossings. Additionally, the new vehicular crossings at Oak Avenue in the Short Trench Alternative or Oak Avenue and Chestnut Avenue in the Long Trench Alternative would provide enhanced traffic circulation in the area.

Pedestrian movement across the railroad Right-of-Way would be restricted by the trench, but crossing safety would be improved by the addition of grade separated crossings.

7.5 Cultural and Historical Resources

Short Trench or Long Trench Alternatives

The Short Trench and Long Trench Alternatives include plans to relocate the Carlsbad Santa Fe Depot from its current location. The Carlsbad Santa Fe Depot has been listed in the National Register of Historic Places (NRHP) since 1993. Direct effects to the Carlsbad Santa Fe Depot were not assessed in ASM's 2013 Cultural and Historical Resource Evaluation Report for the CVDT project, as relocating the Carlsbad Depot was not proposed at that time. Moving this structure to a new location would be considered an adverse effect on a historic property.

A formal assessment of effects for the Short Trench or Long Trench Alternative, including preparation of mitigation recommendations will be required should either alternative move forward to environmental clearance. If the relocation of the Carlsbad Depot is determined to be an adverse effect under Section 106 of the NHPA, the State Historic Preservation Officer (SHPO) will require the preparation of a Historic Property Treatment Plan (HPTP) that will detail mitigation measures designed to protect and preserve the structure.

The HPTP will identify the character defining features of the building and assess their current condition. Recommendations will be made pertaining to the best practices to employ in moving the building that will ensure preservation of those features, as well as approaches to minimally impact the historic fabric of the building. Recommendations will also be made pertaining to the siting, foundation construction, building reassembly, and restoration work after the move has taken place. The HPTP will be in compliance with guidance provided in the National Park Service Technical Report, *Moving Historic Buildings* (Curtis 1975).

Mitigation measures appropriate to relocation of a historic building include documentation of the building prior to the relocation in the form of a Historic American Building Survey (HABS) and monitoring of the relocation by a qualified Historic Architect. Rehabilitation of the building following the relocation, if required, should be in accordance with the Secretary of the Interior's *Standards for the Treatment of Historic Properties* and the National Parks Service Preservation Briefs, Bulletins, and Technical Reports.

In addition, due to the depth of excavation that would be required for either trench alternative, there is a greater chance of impacting buried archaeological resources. Therefore, SHPO may require archaeological monitoring during construction.

7.6 Geology and Soils

Short Trench or Long Trench Alternative

Either trench alternative has the potential to result in impacts associated with groundwater, strong seismic shaking, liquefaction, seismically induced settlement, and corrosive soils. In particular, the trenches would be built at a bottom elevation that is below the groundwater table. However, with the implementation of mitigation measures during final design and construction, impacts would be reduced to a negligible level.

7.7 Hazardous Materials and Hazardous Waste

Short Trench or Long Trench Alternative

Similar to the At-Grade Project, due to the intrusive nature of the construction involved for the project, it is recommended that preliminary media sampling (surface and near surface soils in particular) be conducted prior to commencing any intrusive work at the site to confirm whether contaminants are or are not present at the subject property. The subject property's historic use as an active railroad since the 1880's may provide for the presence of creosote, heavy metals (such as arsenic), petroleum based compounds, and other non-metal herbicide compounds. If these contaminants are present, they may pose a risk to human health (site workers and the public within the vicinity of the subject property) from the inhalation of dust or direct contact with skin or eyes. Furthermore, the contaminants may pose a risk to natural habitat or sensitive species in the open area around the lagoon, and may threaten the water quality of the lagoon. As such, potential impacts to human and/or environmental health resulting from exposure to contaminants potentially present on the project site would be considered adverse. However, preliminary media sampling would identify the location, if any, of potential contaminants on the project site and measures to reduce their exposure would be developed at that time.

In addition, an ACM and lead-based paint survey of the Carlsbad Santa Fe Depot is recommended if the building would be disturbed during construction or modified as part of the Short Trench or Long Trench Alternatives.

7.8 Hydrology and Floodplains

Short Trench or Long Trench Alternative

Typical construction related impacts to hydrology and floodplains may include flooding, soil erosion, stormwater runoff, and sedimentation. However, implementation of a Storm Water Pollution Prevention Plan (SWPPP) including the proper use of construction BMPs would reduce construction related hydrology and floodplain impacts to a negligible level. Both the Short Trench and Long Trench Alternative require construction of substantial new areas of impermeable surfaces in the trench bottom. Because the horizontal alignment of the trench bottom necessary to allow for overheads to be constructed at grade, gravity drainage of storm water from the bottom of the trench is not possible. With the Long Trench Option two pump stations will be required to dewater the trench bottom during rain events and one pump station would be required with the Short Trench Option. Long term storm water Best Management Practices will be required for compliance with NCTD's non-traditional small MS4 permit under Order No. 2013-0001-DWQ.

7.9 Land Use, Zoning, and Property Acquisitions

Short Trench or Long Trench Alternative

Construction of the Short Trench Alternative would occur entirely within the NCTD ROW, and no temporary property acquisition would be required. Construction of the Long Trench Alternative would not occur entirely within the NCTD ROW, and property acquisition would be required. Temporary construction access would be provided through existing NCTD maintenance access roads. Implementation of either of the trench alternatives would not result in a significant impact that could not be reduced to a level less than significant with the implementation of mitigation. As such, either trench alternative would support the corresponding elements of the General Plans (i.e. Noise Element, Public Safety Element) for Carlsbad and Oceanside, and there would be no construction-related impacts to existing land uses, zoning, or properties.

7.10 Noise and Vibration

Short Trench or Long Trench Alternative

<u>Construction Related Noise</u>

Temporary noise during excavation of a trench and construction of the new tracks and the stations has the potential of being intrusive to residents and businesses near the construction sites. Most of the construction would consist of trenching and earthwork removal, site preparation, concrete work, and laying new track. Therefore, initially during trenching and earth removing operations, construction noise levels would be higher and would occur for a longer period of time. However, as the trench gets deeper the noise from construction equipment would be shielded from the surrounding community reducing noise that would otherwise occur from construction activities associated with an At-Grade Project.

Due to the increase in truck trips that would be associated with trench construction, it is recommended that additional analysis be completed, should either of the trench alternatives be selected to move forward, to determine if a trench alternative would result in a temporary construction noise impact along likely haul routes to and from the site. In addition, potential vibration impacts to the Carlsbad Santa Fe Depot would need to be evaluated.

Similar to the At-Grade Project, construction activities would be carried out in compliance with all applicable local noise regulations. In addition, specific residential property line noise limits would be developed during final design and included in the construction specifications for the Proposed Action, and noise monitoring would be performed during construction to verify compliance with the limits. Furthermore, the noise control measures identified below would be implemented as needed to meet the noise limit standards.

<u>Operational Noise</u>

Based on FRA criteria moderate noise impacts from train operations were identified at certain residential locations for the At-Grade Project in the year 2030. According to ATS Consulting, an acoustical consulting firm specializing in rail and highway, when compared to an At-Grade Alternative a trench alternative would substantially reduce train noise to the community.

Included in the economic analysis (See Attachment H), is noise analysis by dBF, a noise and vibration consultant. dBF found that construction of a trench alternative would reduce noise levels by up to 12 dBA Leq. For reference, train horn systems required by 49 CFR Part 222 to be blown as trains approach at-grade crossings must provide a minimum sound level of 92 dBA and a maximum of 110 dBA when measured 100 ft. from the centerline of the nearest track.

7.11 Parks and Recreational Areas

Short Trench or Long Trench Alternative

While there would be no direct impacts to other nearby parks by physical encroachment onto the property, the two other nearest parks and athletic fields may be impacted by construction noise and vibration. These include Lions Club Park in Oceanside, and the Army and Navy Academy's athletic fields in Carlsbad. Located at the northern end of the project site, Lions Club Park is within 100 ft. of the permanent and temporary impact areas, and directly across Cassidy Street from the entrance to the temporary access road that would provide ingress/egress for construction vehicles. The Army and Navy Academy's athletic fields are located immediately south of and directly adjacent to the ROW and the permanent impact area. Both parks are close enough to the project site to be potentially impacted by construction noise and vibration as a consequence of implementation of the either trench alternative. However, as further discussed above in Section 1.10, Noise and Vibration, construction activities for the trench alternatives would need to be analyzed to determine compliance with all applicable local noise regulations. Noise and vibration control measures would be required to be implemented, as necessary, to reduce construction-generated noise and vibration impacts to a negligible level.

7.12 Public Health and Safety

Short Trench or Long Trench Alternative

Trench alternatives would allow for the removal of existing railroad related traffic control at intersections. This would reduce wait times at the at-grade railroad crossings when trains are passing through the project area. Separating pedestrians and vehicles from train operations through the project area would substantially reduce the potential for accidents involving pedestrians/vehicles and trains, enhancing public safety.

Traffic control personnel would ensure that protection of vehicles and pedestrians at the railroad crossings would be maintained during work on any safety feature such as crossing gates and signals. Therefore, there would be no construction related impacts to public health or safety as a result of the implementation of the either the Short Trench or Long Trench Alternative.

7.13 Relocation Impacts

Short Trench or Long Trench Alternative

For both the Short and Long Trench Alternatives, the historic Carlsbad Santa Fe Depot would have to be relocated. For the Long Trench Alternative, a few properties south of Tamarack with single family homes would have to be acquired. Relocation of the Depot would be conducted in accordance with a Treatment Plan to be negotiated with the SHPO. The single family residences would receive fair market value and relocation benefits in accordance with federal law.

7.14 Water Quality and Water Resources

Short Trench or Long Trench Alternative

Similar to the At-Grade Alternative, the construction activities associated with the trench alternatives may have the potential to generate runoff that would discharge pollutants into Buena Vista Lagoon and/or Agua Hedionda Lagoon, which are both listed as Section 303(d) impaired water bodies. Construction discharges could result in a water quality impact. However, with the implementation of a SWPPP and construction BMPs, impacts to water quality would be reduced to a negligible level.

Both the Short Trench and Long Trench Alternative require construction of new areas of impermeable surfaces in the trench bottom. Long term storm water Best Management Practices will be required for compliance with NCTD's non-traditional small MS4 permit under Order No. 2013-0001-DWQ.

7.15 Section 4(f) Evaluation

Short Trench or Long Trench

Park and Recreation Areas. Similar to At-Grade Project, a total of 42 acres of parkland within one-half mile of the Project area would qualify for protection as parkland under Section 4(f), however, the parkland is located outside of the either trench alternative's permanent and temporary impact area. There would be no direct impacts to other nearby parks by physical encroachment onto the property. Two other parks may be indirectly impacted by construction noise and vibration. These include Lions Club Park in Oceanside, and the Army and Navy Academy's athletic fields in Carlsbad. However, Lions Club Park is within NCTD's ROW and so is it not a 4(f) resource, and the Army and Navy Academy's athletic fields in Carlsbad is privately-owned and so it is not a 4(f) resource.

Wildlife and Waterfowl Refuges. Similar to the At-Grade Alternative, a total of 100 acres of the Buena Vista Lagoon Ecological Reserve (and adjacent City of Carlsbad open space land) is within one-half mile of the Short Trench or Long Trench Alternative and would therefore qualify for protection under Section 4(f). However, because either trench alternative's permanent and temporary impact area do not encroach on this land, there would be no direct impacts. Construction of the new double-track bridge over Buena Vista Lagoon would be limited to within the NCTD ROW.

Historic and Cultural Resources. As discussed above under Cultural and Historical Resources, a Short Trench or Long Trench Alternative would require the relocation of the Carlsbad Santa Fe Depot. Relocating this structure to a new location would be considered an adverse effect on a historic property, which is also a 4(f) resource.

A formal assessment of effects for the Carlsbad Village Double Track Long and Short Trench alternatives will need to be completed, including preparation of mitigation recommendations. If the relocation of the Carlsbad Depot is determined to be an adverse effect under Section 106 of the NHPA, the State Historic Preservation Officer (SHPO) will require the preparation of a Historic Property Treatment Plan (HPTP) that will detail mitigation measures designed to protect and preserve the structure. The implementation of the mitigation measures developed as part of the HPTP and approved by SHPO would likely reduce Section 4f impacts to below a level of significance.

7.16 Paleontological Resources

Short Trench or Long Trench Alternative

Similar to the At-Grade Project, due to the moderate paleontological sensitivity of the old paralic deposits underlying the site, excavation associated with construction of either the Short Trench or Long Trench Alternative would have the potential to uncover significant paleontological resources. Implementation of paleontological monitoring during construction would ensure that any potential impacts to paleontological resources potentially located within old paralic deposits would be reduced to a negligible level.

8. PROJECT SCHEDULE

Project Milestone	Milestone Target Date
Begin Environmental	12/2017
Circulate Draft Environmental Document	6/2019
PA & ED	5/2020
Begin PS&E	8/2020
Ready to List	8/2022
Award	3/2023
Construction Complete	7/2027

9. PROJECT FUNDING

To date, capital improvement projects along the San Diego section of the LOSSAN rail corridor have been funded through a number of public sources at the federal, state, and local levels. As shown in Section 10 below, costs for either trench alternative are significant and funds would be difficult to secure from any one source, especially in the current financial climate at the federal and state levels in particular. The region's *TransNet* transportation sales tax program funds set aside for the LOSSAN corridor have been programmed for other improvement projects. Given these factors, the City of Carlsbad may wish to fund a portion of the design and/or construction with local resources.

The Carlsbad Village Double Track project, for example, has been funded through a combination of Federal Railroad Administration (FRA) and local *TransNet* funds for the preliminary engineering and environmental documentation stages only ($5.7 million).

10. PROJECT COST

The estimated construction costs were established based on preliminary design data and cost data from Caltrans, recent projects, drilling sub-contractors, field experts and engineers. The project costs shown are inclusive of all of the overpasses listed in this report. A contingency totaling 30% of the construction cost is added to each estimate to account for the preliminary nature of the design included with this report. Costs are escalated from 2016 dollars to 2023 dollars based on the *TransNet* Early Action Program Escalation Rates (transnettrip.com/TrendsRisksIssues/Escalation.aspx).

At this preliminary level of analysis, costs are shown as ranges. However, Attachments A, F, and G use a cost in the middle of each range for planning and analysis purposes.

Short Trench

The total estimated project cost of the Short Trench Alternative, which includes a 30% contingency, ranges between $215 million and $235 million in 2016 dollars, with a construction cost between $145 million and $165 million. The escalated project cost ranges between $260 million and $285 million in 2023, the planned year of expenditure.

Long Trench

The total estimate project cost of the Long Trench Alternative, which includes a 30% contingency, ranges between $320 million and $350 million in 2016 dollars, with a construction cost between $215 million and $235 million. The escalated project cost ranges between $385 million and $425 million in 2023, the planned year of expenditure.

Potential Cost Savings with Change in Vertical Clearance Required

NCTD has indicated that the minimum vertical clearance may be changed to 24 ft. with concurrence from BNSF Railway. The estimated change in costs due to the lower vertical clearance are shown in Table 10.1 below.

Table 10.1: Costs for 24-ft. and 26-ft. Vertical Clearance

	Long Trench		Short Trench	
	26-ft. Vertical Clearance	24-ft. Vertical Clearance	26-ft. Vertical Clearance	24-ft. Vertical Clearance
Construction Cost (2016$)	$215m-$235m	$201m-$221m	$145m-$165m	$137m-$157m
Construction Cost Change	N/A	$14m	N/A	$8m
Project Cost (2016$)	$320m-$350m	$299m-$329m	$215m-$235m	$204m-$224m
Project Cost Change	N/A	$21m	N/A	$11m

Cost Comparison with Other Railroad Trench Projects

Table 10.2 below shows comparison of the estimated construction cost for the proposed CVDT trench project with two other trench structures completed recently for grade separated rail corridors, the San Gabriel Trench Grade Separation Project, San Gabriel, California and the Reno Transportation Rail Access Corridor (ReTRAC) project, Reno, Nevada. Each of these railroad trench projects had similar conditions to the proposed Carlsbad Village Railroad Trench; including construction below groundwater in urban areas and installation of a temporary shoofly track during construction. The San Gabriel Trench was awarded in 2012 and is expected to complete construction in 2017. The Reno ReTRAC project was constructed from 2002 to 2006.

A railroad trench was constructed in Solana Beach, Ca in the late 1990s. This trench is about 6,000-foot-long and lowered the Solana Beach COASTER Station and grade separated Lomas Santa Fe Drive. The construction cost of the Solana Beach trench was $17.7 million in 1998. This translates to a cost of around $43.3 million in 2016 dollars, or $7,214 per foot (2016). Although this trench is the only other railroad trench that has been constructed on the LOSSAN corridor, it is not considered comparable to the proposed trench in Carlsbad because this project was not constructed below the groundwater table which allowed for cheaper construction techniques. Mainly, it was constructed with steep cut slopes rather than walls for the majority of its length, which is not considered a viable option for the Carlsbad Village Trench.

Table 10.2: Comparison of CVDT Proposed Cost with Recently Completed Similar Trench Structures in 2016

Project	Total Construction Cost ($ millions)	Max. Trench Height (ft)[4]	Trench Width (ft)	Trench Length (ft)	Adjusted 2016 Cost / LF of Trench[3]
Reno Transportation Rail Access Corridor[1]	$171 (2002)	33	54	10560	$39,803
San Gabriel Trench Grade Separation[2]	$173 (2012)	30	51	7920	$33,681
CVDT Long Trench (With 30% Contingency)	$226 (2016)	32	55	8100	$27,852
CVDT Short Trench (With 30% Contingency)	$155 (2016)	32	55	5700	$27,263

Notes:

1 ReTRAC trench cost is based on "Digging It", Cover Story, AGC of America, May/June 2005

2 San Gabriel trench cost is based on "California construction authority receives six bids for San Gabriel trench", Rail News, Progressive Railroading, 6/26/2012

3 Cost adjustments are based on Quarterly Highway Construction Cost Index published by the California Department of Transportation from the 2nd Quarter of 2016, see Table 10.3 below.

4 Above top of rail

Table 10.3: Comparison of CVDT Proposed Cost with Recently Completed Similar Trench Structures in 2016

Project	Project Year	Cost Index, Project Year[1]	Cost Index, 2nd Quarter of 2016	Unadjusted Cost/LF	Adjusted 2016 Cost/LF
Reno Transportation Rail Access Corridor	2002	53.1	130.75	$16,165	$39,803
San Gabriel Trench Grade Separation	2012	84.6	130.75	$21,793	$33,681
CVDT At-Grade Alternative	2016	106.2	130.75	$5,106	$5,106

Note:

1 See Quarterly Highway Construction Cost Index published by the California Department of Transportation from the 2nd Quarter of 2016, Price Index for Selected Highway Construction Items 2007=100, Fisher Formula **http://www.dot.ca.gov/hq/esc/oe/cost_index/historical_reports/CCI_2QTR_2016.pdf**

Cost Comparison with At-Grade Double Tracking

The At-Grade Alternative is estimated to have a total construction cost of $42 million and a total project cost of $62 million (in 2016 dollars) based on the previously completed 30% design. The northern limit of the At-Grade Alternative would be the same as that of the trench alternatives, however the southern limit for the At-Grade Alternative would be just north of Chestnut Avenue. The total length of the two trench alternatives would be longer due to the length required to bring the track profiles back to grade and to extend the trench through the Tamarack crossing. The cost per foot for the At-Grade Alternative would be approximately $5,000 per foot. In Table 10.4 below the costs of each trench alternative is compared with the at-grade double tracking alternative based on cost per linear foot (LF) of project. This includes the length of the project outside of the trench since this is the only way to compare the at-grade project with the trench alternatives.

Table 10.4: Comparison of CVDT Trench Construction Cost Estimates with At-Grade Double Tracking in 2016

Project	2016 Total Construction Cost ($ millions)	Project Length (LF)	2016 Cost/LF of Project
CVDT Long Trench (With 30% Contingency)	$226	13,458	$16,763
CVDT Short Trench (With 30% Contingency)	$155	11,116	$13,979
CVDT At-Grade Alternative (With 30% Contingency)[1]	$42	8,226	$5,106

Note:

1 The CVDT At-Grade Alternative cost is based on the 30% Engineer's Estimate of Probable Cost included in the Alternatives Analysis Report from 2014, by T.Y. Lin International

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