Chapter 4 Construction Effects and Mitigation

This chapter discusses the direct and indirect effects of project-related construction on the elements of the built and natural environments. Direct effects are effects caused by the proposed action (i.e., construction of the seawall and associated improvements) and occur at the same time and place. Indirect effects are reasonably foreseeable effects of the proposed action that occur later in time or are farther removed in distance from the direct effects.

The potential effects of construction associated with each of the three build alternatives are considered in detail. A list of mitigation measures that would avoid or minimize the potential adverse effects are included at the end of each section. Mitigation commitments will also be included in Chapter 8 of this Final EIS, as well as in permits issued by resource agencies. The effects of build alternatives during construction are summarized at the end of this chapter (Table 4-25).

No construction is proposed for the No Action Alternative; therefore, there are no anticipated construction effects. The potential operational effects of the No Action Alternative on each element of the environment are discussed in Chapter 5.

4.1 Transportation

This section describes how construction of the project would affect all modes of transportation. To understand the potential effects, forecasted traffic conditions for each build alternative were compared to the conditions that would exist if the Elliott Bay Seawall Project were not implemented. The latter are referred to as "traffic baseline conditions" and are the same as the No Action Alternative.

Transportation effects during construction are challenging to describe because traffic baseline conditions will change substantially over the 7-to 9-year project construction duration as other projects in the area are built. The most substantial change in traffic baseline conditions will occur with the opening of the bored tunnel in 2016 and the closure of the Alaskan Way Viaduct. At the time the traffic modeling assumptions for the Elliott Bay Seawall Project were developed, no decision had been made regarding tolling the vehicles using the tunnel, and the traffic modeling for the Draft EIS assumed that no tolls would be in place. Tolling of the bored tunnel was authorized by the Washington State Legislature in 2012. Also, the Elliott/Western Connector was not assumed to be operational for the North Seawall traffic baseline conditions. In response to several comments on the Draft EIS, the City also qualitatively evaluated the effects of tolling the bored tunnel during

Transportation Key Points

Traffic operations during construction of the Central Seawall would shift to the temporary road, which would have fewer lanes and reduced capacity. Some travelers are anticipated to divert to other parallel streets to avoid construction.

The temporary road south of Madison Street is expected to be congested during the evening peak hour, and other nearby intersections are likely to have increased delays.

Traffic conditions during construction of Alternative B would be different from those of Alternatives A and C due to its longer construction schedule which has more overlap with the opening of the bored tunnel.

A pedestrian/bicycle corridor would be maintained throughout construction.

Transit buses may have limited access throughout the seawall construction, and some bus stops may be temporarily closed.

Central and North seawall construction and of having the Elliott/Western Connector operational during North Seawall construction.

To account for these changes in traffic baseline conditions during seawall construction, the traffic analysis considered three baseline years: 2010 (which reflects construction associated with the Alaskan Way Viaduct Replacement Project), 2017 (which reflects conditions after the bored tunnel begins operating), and 2020 (which represents the approximate midpoint of the North Seawall).

As described in Chapter 2, the Central Seawall phase of the project would be built first, followed by the North Seawall phase. Construction for the Central Seawall is expected to generally progress from Virginia Street southward over three to five construction seasons, depending on the build alternative. To take advantage of the current closure of Alaskan Way for the bored tunnel south portal construction, work in Zone 1 may be done concurrently with Zone 4 during the first construction season. Then North Seawall construction would follow the same progression from Broad Street southward to Virginia Street over four construction seasons.

Over the full construction timeframe, traffic conditions would be influenced by a wide array of constantly changing factors related to seawall construction, such as the type of equipment operating, the amounts of materials that are coming to and leaving the site (e.g., concrete trucks, drilling rigs, excavators, dump trucks, etc.), where construction is occurring during each construction season, and how traffic is routed around the construction work zone. The traffic analysis looks at four snapshots of traffic conditions over the full duration of seawall construction—two for the Central Seawall and two for the North Seawall. These snapshots are referred to as traffic analysis phases and they generally represent traffic conditions while construction is occurring in areas show on Figure 4-1. Figure 4-2 shows the relationship between each traffic analysis phase for the build alternatives and the baseline years used for evaluating construction effects on traffic. A more detailed discussion of traffic baseline conditions, including the full modeling results, is provided in the Transportation Discipline Report (Appendix C). As discussed above, the Transportation Discipline Report assumes southward progression for the central seawall construction. However, an option that would take advantage of the closure of Alaskan Way is under consideration.

Traffic Modeling for the Elliott Bay Seawall Project

Two analytical tools were used to estimate how intersections would operate during construction: Synchro/SimTraffic 7 and Visual Simulation Model (VISSIM).

The two models have complementary capabilities. Synchro/SimTraffic 7 is a planning-level tool that applies standard calculations to estimate how traffic will operate. VISSIM is a detailed microsimulation tool that can evaluate the interaction between different travel modes (such as pedestrians and heavy vehicles) and the effects of congestion and queuing between intersections. VISSIM also more accurately evaluates non-standard situations, such as the signal operations at the entrance to Colman Dock Ferry Terminal.

Additional detail about these models can be found in the Transportation Discipline Report (Appendix C).

Central Seawall

Central Seawall construction is expected to extend from fall 2013 until either early 2016 (Alternatives A and C) or spring 2018 (Alternative B). The longer duration of construction for Alternative B is due to the substantially greater seawall setback proposed under this alternative (refer to Chapter 2 for a description of the proposed construction methods) and more complex upland amenities, such as the land plaza or the water plaza.

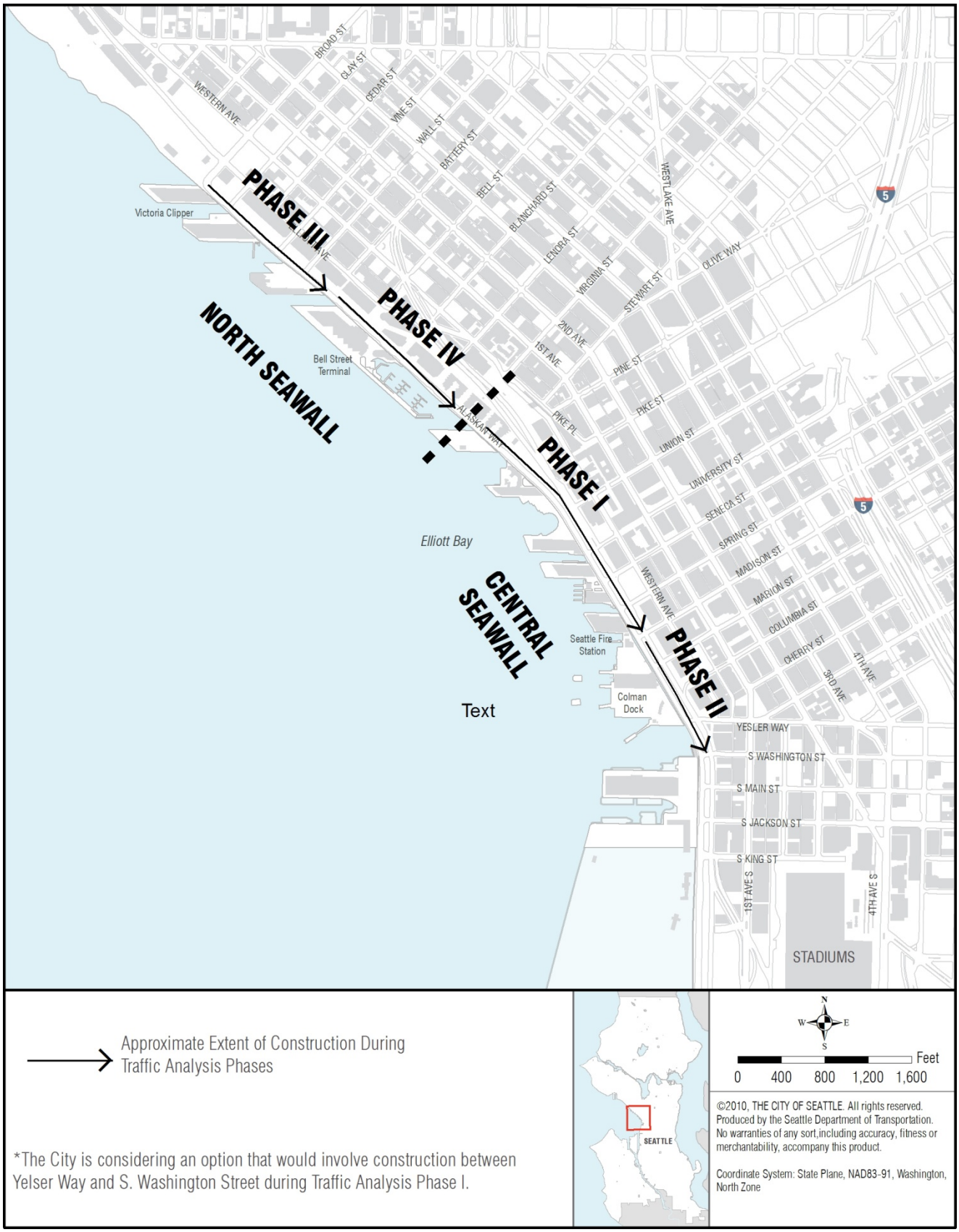


Figure 4-1. Central and North Seawall traffic analysis phases

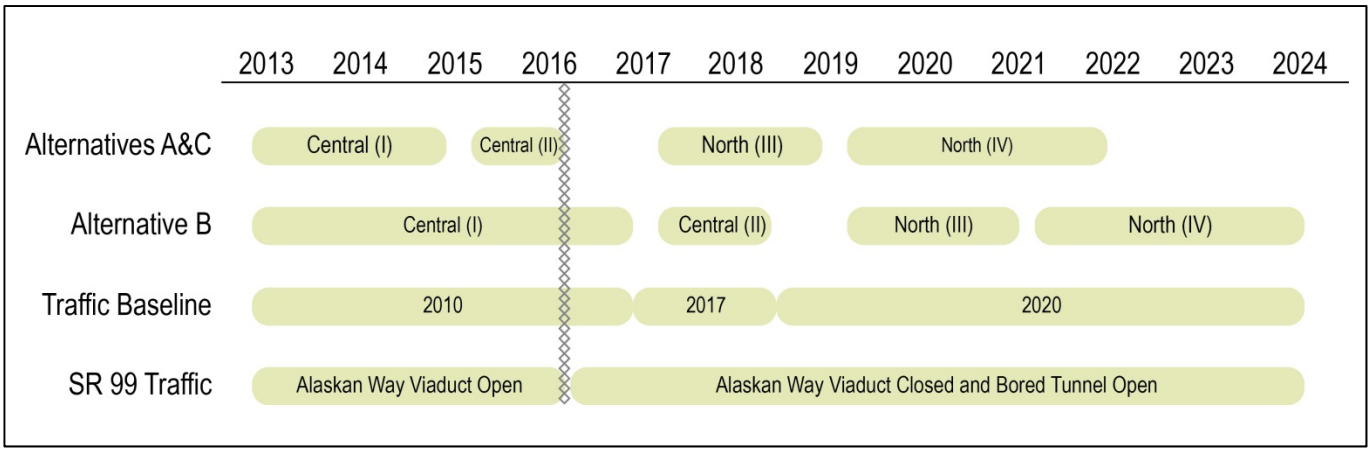


Figure 4-2. Central Seawall and North Seawall traffic analysis phases and baseline years

Central Seawall construction for Alternatives A and C would be largely completed before the opening of the bored tunnel, so the two traffic analysis phases for these alternatives were compared to baseline conditions in 2010 (Figure 4-2). However, Alternative B construction would extend an additional two construction seasons after the bored tunnel opens, so the second traffic analysis phase for Alternative B was compared to the 2017 baseline. It should be noted that the current Alaskan Way Viaduct Replacement Project schedule includes a 5-month period in which the bored tunnel would be open and the Elliott Bay Seawall Project Phase II construction would still be occurring under Alternatives A and C. For this 5-month period, operations would be similar to the conditions described in Alternative B. The option to construct Zone 1 earlier may provide additional flexibility to accommodate traffic south of Colman Dock.

Despite some variation between the alternatives in timing of construction during each traffic analysis phase, the roadway configuration during Central Seawall construction is assumed to be nearly identical under all three build alternatives. General traffic in the Central Seawall portion of the project area would be detoured off Alaskan Way to the temporary road, located under the Alaskan Way Viaduct, for the full duration of Central Seawall construction. The temporary road would consist of two through lanes (one northbound and one southbound lane) as well as one center-turn/emergency-access lane that begins mid-block between Yesler Way and S. Washington Street and continues north through the Central Seawall construction zone. The temporary road would be connected with the south portal detour roads for the bored tunnel via a two-lane Railroad Way to connect with First Avenue S.

In addition to the temporary road, a minimum of two additional lanes would be provided west of the Alaskan Way Viaduct between Madison Street and Yesler Way to facilitate ingress and egress at Colman Dock Ferry Terminal. However, the number of lanes provided west of the viaduct would be contingent on space constraints related to

construction work zones for the Elliott Bay Seawall Project and the Alaskan Way Viaduct Replacement Project.

The temporary roadway system would be a flexible network that could be modified throughout Central Seawall construction. Additional detail is provided in the Transportation Discipline Report (Appendix C).

Roadway Operations

Traffic Congestion

Traffic during Traffic Analysis Phase I would generally operate within acceptable levels on the temporary road. Although the temporary road would have fewer lanes and reduced capacity compared to the current Alaskan Way, it is expected that many travelers would shift routes and use parallel roadways to the east.

Northbound traffic on the temporary road would be congested south of Madison Street during a portion of the PM peak hour. This is because demand on the temporary road would reach the capacity of the single northbound lane, resulting in a queue extending from S. Jackson Street through the S. King Street intersection and onto Railroad Way. Outside the Alaskan Way corridor, other intersections are likely to experience increased delays but would operate within acceptable levels of service.

Traffic conditions for Alternative B would be quite different from those of Alternatives A and C. Under Alternative B, two-way volumes on the temporary road just north of Yesler Way would be about 1,300 vehicles during the PM peak hour, compared to the 1,900 vehicles that are expected to travel on Alaskan Way in 2017 under baseline conditions. Although this would be a decrease in overall traffic volume compared to baseline conditions, the reduced capacity during construction would result in more traffic demand per travel lane, causing congestion.

Construction vehicles would be able to access the work site from the north and south ends of the construction work zone via the planned haul route. Therefore, no impacts related to construction vehicles on the general-purpose roadway are expected.

During Traffic Analysis Phase II, the northbound queues and congestion observed along the temporary road in the PM peak hour construction would be diminished under Alternatives A and C compared to Phase I. This is primarily because all vehicles exiting the ferry terminal at Yesler Way would be forced to turn south. Because these vehicles would not merge into the northbound lane of the temporary road, demand would be more in line with the available northbound capacity. The traffic modeling results indicated no substantial northbound queues on either the temporary road or Railroad Way.

Under Alternative B during Traffic Analysis Phase II, some construction vehicles would need to access the work zone via the temporary road. Although the number of construction vehicles would be relatively small compared to general-purpose traffic, their effect would be disproportionate because of their size and slow speeds. In addition, the

closure of the Alaskan Way Viaduct is expected to increase travel demand along the Alaskan Way corridor because the bored tunnel will not provide as many connections to downtown Seattle as the viaduct. As a result, Alternative B construction would contribute to heavy congestion on the temporary road, particularly near the ferry terminal, where travel demand would exceed the road's reduced capacity. South of Seneca Street, during the PM peak hour, it is expected that there would be substantial queuing both northbound and southbound. Congestion would be severe in the northbound lane south of S. Washington Street because vehicles would be funneled from three lanes into one. Southbound queues would extend back from the Spring Street intersection to Bell Street.

Outside the Alaskan Way corridor, other intersections are likely to experience increased delays during Traffic Analysis Phase II. PM peak-hour delays would increase at the First Avenue S. and Yesler Way intersection. The deterioration of traffic operations at this intersection would be the result of an increased number of travelers avoiding the Alaskan Way corridor.

Figure 4-3 provides an overview of how intersections would operate during Traffic Analysis Phases I and II under Alternatives A, B, and C. Detailed information on projected intersection levels of service during peak hours is provided in the Transportation Discipline Report (Appendix C).

As noted earlier, construction of the seawall between Yesler Way and S. Washington Street may occur at the beginning of the construction schedule rather than at the end. However, the fundamental configuration of the temporary roadway would remain the same as was analyzed in the Transportation Discipline Report. The revised construction schedule may benefit traffic operations by increasing the flexibility of the roadway network south of Yesler Way when the bored tunnel opens.

Travel Times

Travel times were estimated for six north-south and east-west routes in the project area (shown in Figure 4-4 and Figure 4-5). Travel times during Central Seawall construction are expected to be longer during the PM peak hour than the AM peak hour, regardless of direction. This would be due to the higher level of congestion and vehicle volumes projected for the PM peak hour. The only exception is for eastbound traffic on Marion Street during Traffic Analysis Phase I, which would be slightly faster during the PM peak hour than the AM peak hour due to a lower volume of vehicles exiting the ferry terminal.

During Traffic Analysis Phase I, travel times would increase in almost all instances for all three build alternatives when compared to the traffic baseline conditions (Figure 4-3 and Figure 4-5). The increases in travel time would be moderate, with the largest increase (1 minute and 39 seconds in the PM peak hour) expected on the northbound route

from S. Royal Brougham Way to Broad Street via First Avenue S. and Railroad Way S. This route assumes a slightly longer travel distance because Alaskan Way would be closed south of Yesler Way due to construction of the Alaskan Way Viaduct Replacement Project and drivers would have to use Railroad Way.

During Traffic Analysis Phase II for Alternatives A and C, longer delays are expected at the south portal construction work zone for the Alaskan Way Viaduct Replacement Project, south of S. King Street. Once past this work zone, vehicles would travel at speeds not substantially below the construction speed limit on the temporary road. Because some traffic would divert to other parallel routes, travel times would increase by less than 1 minute over the baseline.

The most noticeable increases in travel times would occur during Traffic Analysis Phase II for Alternative B, after the bored tunnel is open. Although AM peak-hour travel times would be similar to 2017 baseline conditions, PM peak-hour southbound speeds for several of the routes would be very low (in the range of 3 to 8 miles per hour), and travel times would be much longer than under the baseline conditions. During Traffic Analysis Phase II, the routes with the largest increases in travel times compared to baseline conditions would include the southbound routes from the Seattle Aquarium and Bell Street Pier Cruise Terminal to Colman Dock, the southbound route from Broad Street to S. Royal Brougham Way, and the westbound route from Interstate 5 to Colman Dock (PM peak hour). The northbound travel time from S. Royal Brougham Way to Yesler Way would be 4.5 minutes, which translates to just over 8 miles per hour, reflecting substantial traffic congestion.

Freight and Overlegal Vehicles

During the construction period, temporarily altered roadway configurations may restrict access for overlegal vehicles. Additionally, the turning radius for the southbound right turn into the Colman Dock Ferry Terminal may be too tight for trucks larger than a semi-trailer with a 50-foot wheelbase. This constraint would be mitigated through operational changes, including allowing trucks of this size to make the northbound left turn at Yesler Way from the center emergency lane. Movements of overlegal vehicles would need to be scheduled to minimize queuing in this lane and to avoid impacts on emergency vehicles. To the extent that the temporary road under the Alaskan Way Viaduct cannot accommodate overlegal loads, provisions would be made during the City's overlegal truck permitting process whereby such trucks could use the construction haul route west of the viaduct.

An exception to the above would occur for Alternative B during Phase II of Central Seawall construction. There would be no construction haul route to provide alternate access, so an impact on overlegal freight is expected. However, the majority of freight vehicles would not be affected because they have a shorter wheelbase that can effectively navigate the temporary roadway.

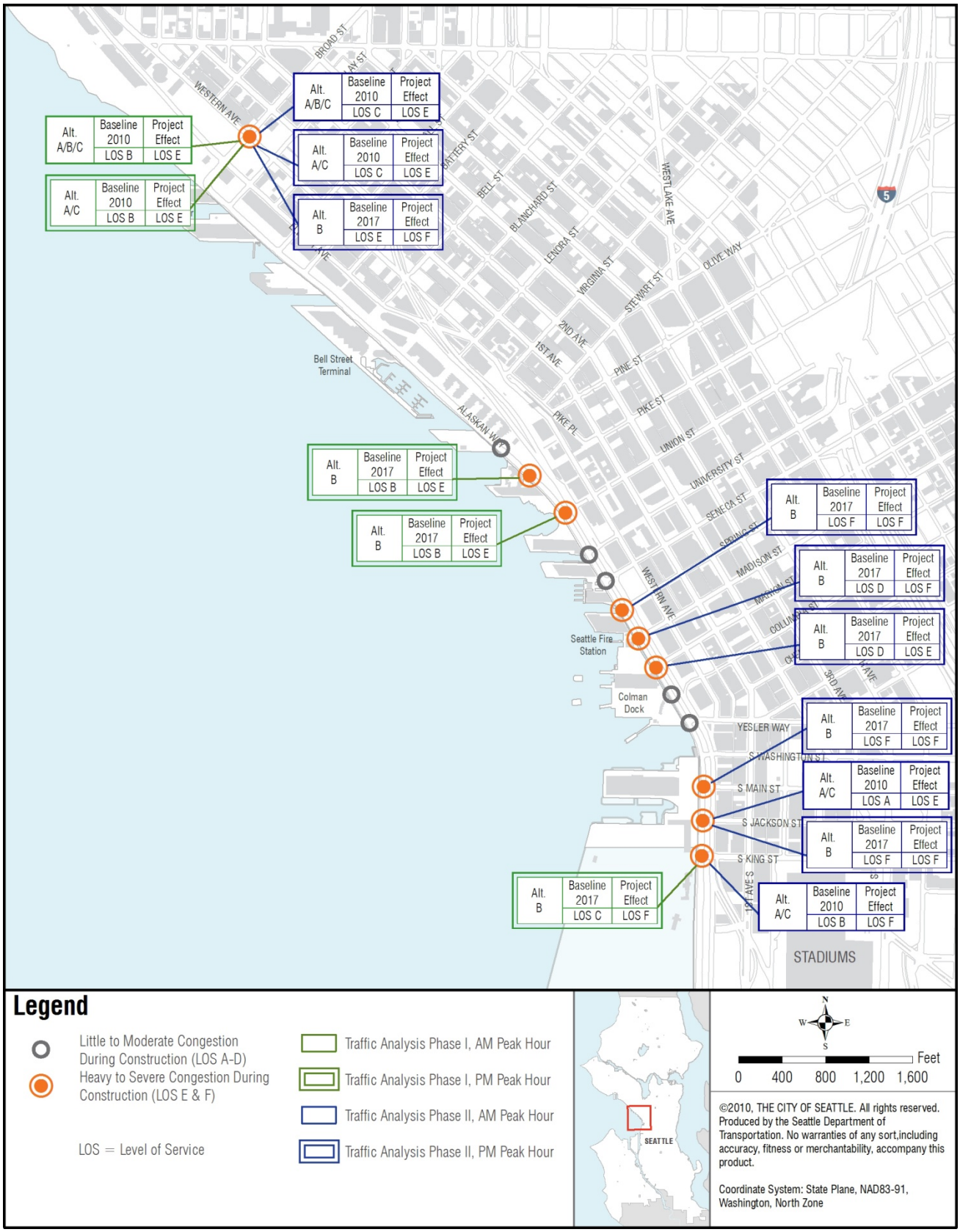


Figure 4-3. Intersection congestion during Central Seawall construction

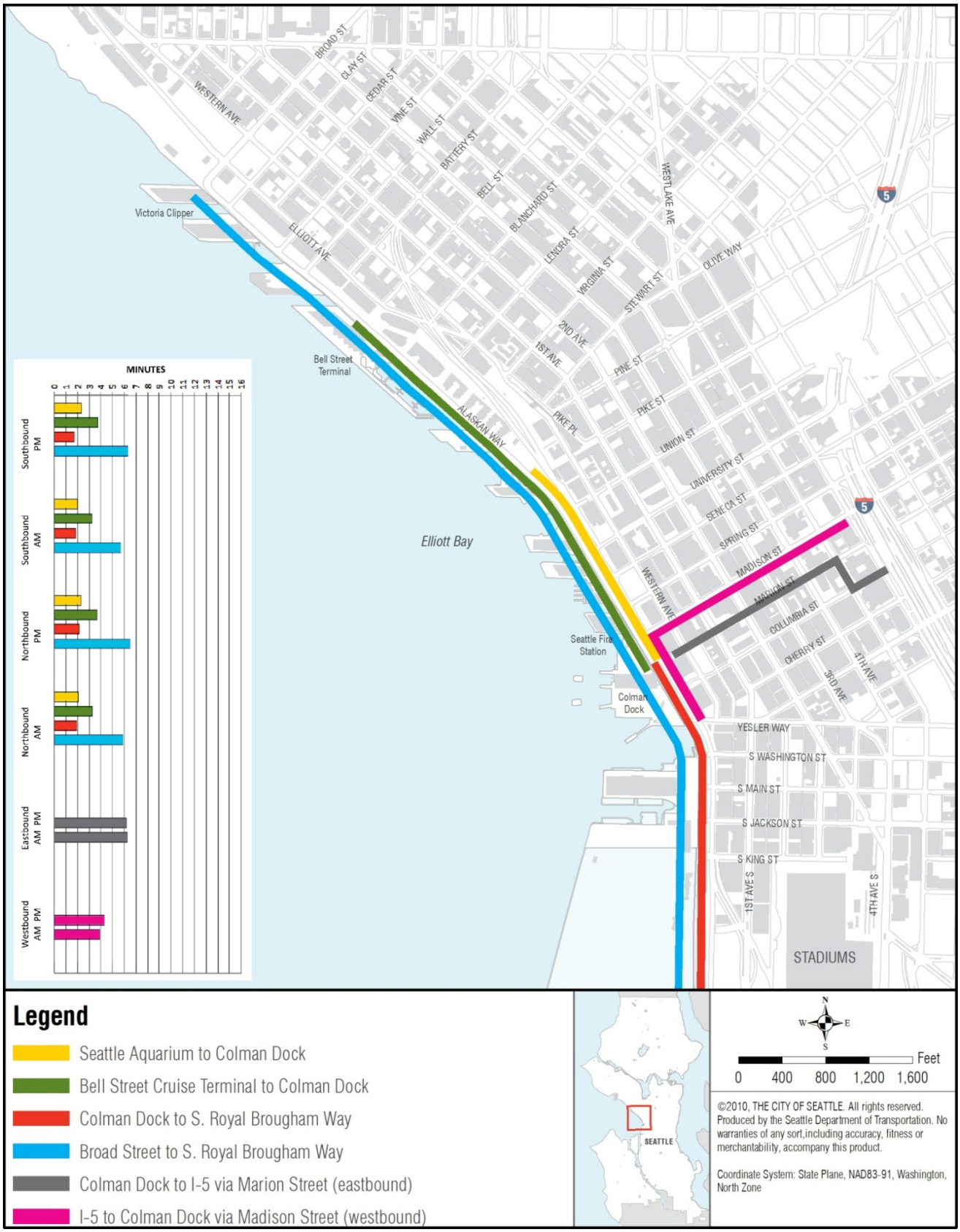


Figure 4-4. Travel times during Central Seawall construction on Alaskan Way, Phase II, Alternatives A and C

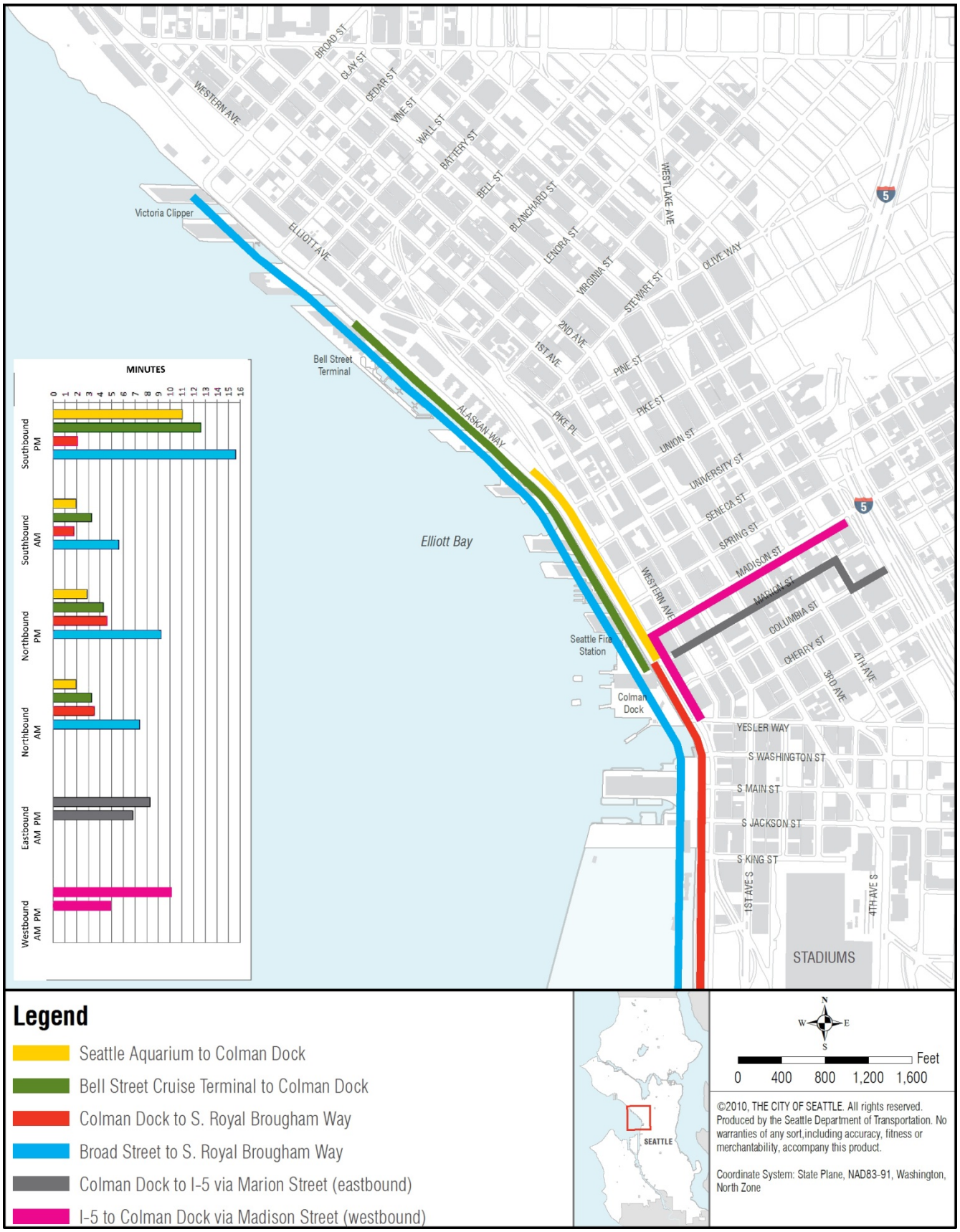


Figure 4-5. Travel times during Central Seawall construction on Alaskan Way, Phase II, Alternative B

Business Access and Parking

There are currently 2,557 surface parking spaces in the area bounded by Broad Street (north), Elliott Bay (west), First Avenue/Occidental Avenue S. (east), and S. King Street (south). This total includes a combination of off-street surface lots selling public parking, spaces serving individual businesses, and metered and pay station spaces located on the street and under the Alaskan Way Viaduct that are owned and operated by the City. Project construction staging and placement of the temporary road during Central Seawall construction would temporarily eliminate a total of 381 to 421 City-owned spaces, including 371 metered spaces under the Alaskan Way Viaduct and between 10 and 50 on-street spaces as project construction progresses.

As construction work proceeds along the waterfront, vehicle access to the waterfront piers and to properties on the east side of Alaskan Way would be provided, but could be temporarily relocated or revised to accommodate construction conditions. When work is occurring in the immediate vicinity of driveways, the driveways may need to be closed temporarily, depending on their width and the availability of alternative vehicle access points.

Pedestrian and Bicycle Facilities

The function of the pedestrian/bicycle trail west of the Alaskan Way Viaduct would be maintained throughout Central Seawall construction. Its width may be reduced in segments during some periods of time, and it is possible that some sections of the pedestrian and bicycle facilities along Alaskan Way would be temporarily closed as Central Seawall construction progresses. For areas where facilities would need to be removed, temporary replacement facilities would be installed to ensure that impacts to pedestrians or bicyclists are avoided or minimized. Existing ADA compliant connections will be maintained and any newly constructed pedestrian paths and connections will be ADA compliant. High-visibility marked crosswalks would be provided on all legs of intersections.

As Central Seawall construction progresses, some sidewalk closures and reroutes would be necessary, but detours and wayfinding would be provided in all of these locations to help pedestrians and bicyclists safely navigate through the project area. The Marion Street overpass would remain in operation during construction, with a temporary foundation used to support the structure. Temporary closures may be required; during such closures, suitable temporary replacement facilities would be provided to ensure safe pedestrian access to the ferry terminal.

Safety

Speeds along the temporary road would be lower than those allowed on the existing Alaskan Way, which would increase safety and could reduce the severity of any collisions. However, the columns that support the Alaskan Way Viaduct would reduce the sight distances from the

temporary road to the vehicles on the side streets at some intersections. While traffic volumes along Alaskan Way are expected to be lower as drivers choose to avoid the construction work zone, driver unfamiliarity with the new roadway configurations may affect safety for all modes of travel.

Transit

Buses may have limited access on Alaskan Way during Traffic Analysis Phase I. At times, it may be necessary to close some bus stops and reroute buses (Routes 16, 66, and 99) along Western Avenue and/or First Avenue. This could result in both adverse and beneficial effect for transit riders, depending on whether their rerouted bus stops are farther away or closer to their destinations. When work is occurring directly in front of Colman Dock, an alternative location for the layover areas for Routes 16 and 66 would need to be identified. Clearly marked, ADA-accessible routes would be provided from relocated transit stops to destinations along Alaskan Way. SDOT would work closely with Metro to ensure that impacts on transit users are minimized.

Water Transit Services

Access points to Colman Dock (Marion Street exit and Yesler Way entrance/exit) during Traffic Analysis Phase I are expected to be relatively uncongested during the PM peak hour. Despite the acceptable overall level of service at Marion Street, the traffic simulation suggested vehicles exiting the ferry at Marion Street would experience long delays, particularly when two boats arrive simultaneously. However, actual operations may be better because traffic signals are programmed to extend the length of the eastbound green light when vehicles are exiting the ferry terminal. The operations analysis considered congestion over the course of the entire peak hour; because ferries discharge vehicles only at certain times during any given hour, intersection operations can vary substantially at intersections near the ferry terminal over the course of the peak hour.

The on-street ferry holding lane, critical to Washington State Ferries operations especially during the summer, would be accessed from the south via a northbound U-turn route on Alaskan Way, from the east via Madison Street, or from the north via Alaskan Way. The temporary holding lane would be 1,075 feet long, while the former northbound ferry holding lane (before the Alaskan Way Viaduct Replacement Project construction) was approximately 840 feet long. Spillover from the temporary holding lane could have severe effects on operations along the temporary road because there would be only one through lane in each direction.

Ferry queuing issues are magnified in the summer and on holiday weekends, particularly on Friday afternoons and Saturday midday, when demand is highest. Construction on the Elliott Bay Seawall Project would not occur in the summer months, during which time special

accommodations would be made for ferry operations. The construction work zone could allow space for additional queuing or parked cars.

During Traffic Analysis Phase II, water transit services would be directly affected because the construction work zone would extend along the entire length of Colman Dock. However, under Alternatives A and C, access points to Colman Dock are expected to be relatively uncongested during the peak hours, although the eastbound exit from the ferry terminal at Marion Street would operate at LOS E during both the AM and PM peak hours. The existing bus stops, loading zones, and taxi stands in front of Colman Dock would be moved to Yesler Way, Western Avenue, and/or First Avenue, resulting in longer travel distances for some walk-on ferry passengers. When two boats arrive simultaneously, exiting vehicles are expected to experience delays.

With Alternative B, travelers to and from Colman Dock Ferry Terminal would experience substantially longer travel times through the Alaskan Way corridor during Traffic Analysis Phase II, given the level of overall congestion projected during this period. At Yesler Way and Marion Street, the intersections that serve as access points to Colman Dock, the overall intersection level of service would be LOS D and LOS E during the PM peak hour. However, the eastbound Marion Street exit from the ferry terminal would operate at LOS F. Effects at these intersections might be moderated by congestion elsewhere in the Alaskan Way corridor, which would meter volumes into the intersections adjacent to the dock, and by the signal preemption used during ferry unloading. However, when two boats arrive simultaneously, it is expected that exiting vehicles would encounter delays.

Traffic conditions at Alaskan Way and Wall Street, near the Bell Street Pier Cruise Terminal (Pier 66), are not expected to affect cruise ship operations during Central Seawall construction. Level of service would be LOS A during the AM peak hour and LOS B and LOS C during the PM peak hour, for Phases I and II, respectively. However, it should be noted that the level of service would be degraded during cruise ship loading/unloading if the current Street Use Permits are still in place. These permits allow the Port to use two of the through lanes, which reduces general purpose traffic to one lane in each direction between Wall and Lenora Streets.

Work vessels and barges may be used to bring materials to the work site, haul materials from the work site, and serve as work platforms for some in-water activities. Such operations would be sited and timed to avoid vessel traffic lanes and minimize effects on water transit operations to the greatest extent possible.

Rail

Construction of the Central Seawall would not affect any of the at-grade rail crossings along Alaskan Way at Broad, Clay, Vine, and Wall Streets.

Emergency Services

For all of the build alternatives, travel times during Traffic Analysis Phase I would decrease for emergency vehicles heading north (Table 4-1) because they could use the emergency-access lane for several blocks and could bypass congestion. For traffic heading south, travel times are expected to increase by about 13 seconds between Fire Station No. 5 and S. King Street because vehicles turning left from the temporary road to S. King Street could impede emergency vehicles.

Table 4-1. Phases I and II (Central Seawall), PM Peak-Hour Travel Time for Emergency Vehicles (Minutes)

Route	Phase I Virginia to Madison			Phase II Madison to S. Washington		
	Baseline	Alternatives A, C	Alternative B	Alternatives A, C	Baseline	Alternative B
	2010 Relevant Baseline Year				*2017 Relevant Baseline Year*	
Fire Station No. 5 to Broad Street	3:58	3:28	3:28	3:28	4:28	4:34
Fire Station No. 5 to S. King Street	0:58	1:11	1:11	1:15	0:56	1:09

Note: Baseline year information is shaded.

During Traffic Analysis Phase II, travel times for Alternatives A and C would also decrease for emergency vehicles heading north. For traffic heading south, travel times would increase by about 17 seconds between Fire Station No. 5 and S. King Street. Although this increase in the southbound travel time for emergency vehicles is considered an impact, it could be mitigated by installing signal controls such as emergency vehicle signal preemption. This would improve southbound travel times for emergency vehicles compared to existing conditions. Alternative B would also increase travel times by about 13 seconds for emergency vehicles, but this delay could be similarly reduced by installing preemptive signals.

Event Traffic

Congestion along Alaskan Way would make it more difficult to accommodate peak demands such as those caused by large events at the stadiums immediately south of the project area. Pedestrians and vehicles accessing the stadiums from Colman Dock would also be affected when work is occurring in the immediate vicinity of the ferry terminal. Therefore, impacts on vehicle and pedestrian systems are expected for event traffic.

North Seawall

Construction of the North Seawall would occur after the Central Seawall is completed and Alaskan Way is restored in the Central Seawall area. North Seawall construction for all of the build alternatives is expected to continue for about 4 years.

For North Seawall construction, the temporary road would be located on the existing Alaskan Way right-of-way with two through lanes (one northbound and one southbound) and a center emergency-access/turn lane. South of the construction work zone, Alaskan Way would be restored to its current configuration (as of 2010) and would accommodate a vehicle capacity equivalent to what is currently provided south of Virginia Street. An additional northbound through lane from S. Washington Street to Spring Street would be included for Alternatives A and C. Despite the variation in construction schedule, roadway operations are assumed to be nearly identical under all three build alternatives.

By the time North Seawall construction begins, the bored tunnel would be open and the Alaskan Way Viaduct would be closed to traffic. Construction effects for North Seawall construction are compared to year 2020 baseline conditions.

Roadway Operations

Traffic Congestion

Traffic operations and intersection congestion during North Seawall construction are shown on Figure 4-6. Only intersections along temporary facilities or those that would be affected by construction are included.

In the northernmost portion of the study area, including the intersection at Vine Street, the reduced capacity of the temporary road would not have a noticeable effect on traffic operations during Traffic Analysis Phase III, and traffic would be free-flowing. At Wall Street, however, the capacity constraints imposed by North Seawall construction, as well as travel shifts that are expected to occur because of the construction, would lead to substantial traffic delays during this construction phase, with operations at LOS F during the PM peak hour under all alternatives.

During Traffic Analysis Phase IV, the work zone would shift to the south, with Alaskan Way north of Battery Street resurfaced to previously existing conditions. Traffic conditions at the Wall Street intersection would improve in the AM peak hour because the construction work zone would be south of that intersection. However, congested traffic operations are expected at several intersections along Alaskan Way during PM peak hours. These impacts would be the result of congestion along southbound Alaskan Way as vehicles merge to a single lane south of Wall Street. The resulting queue would extend north, affecting the intersections of Clay, Vine, and Wall Streets.

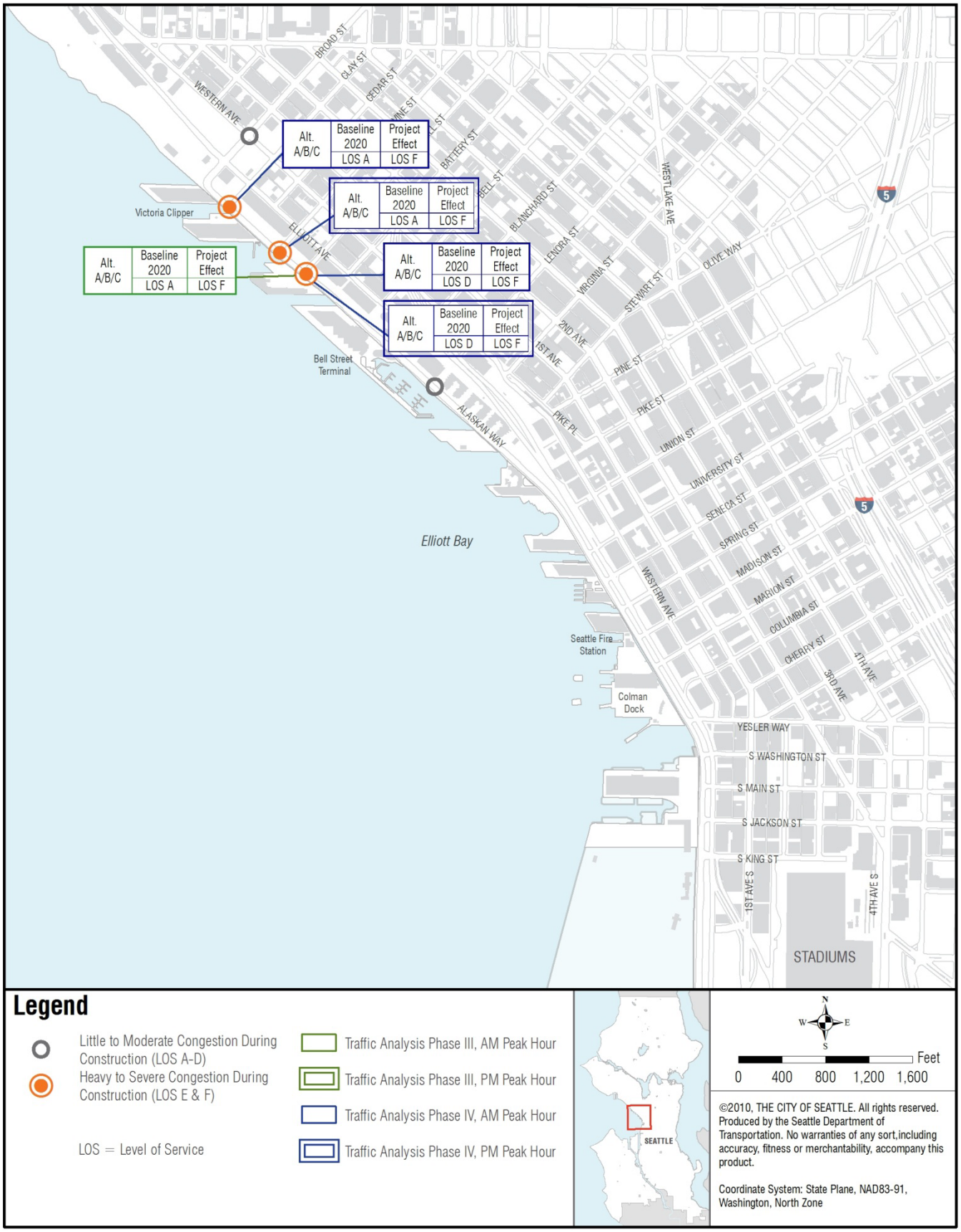


Figure 4-6. Intersection congestion during North Seawall construction

Travel Times

In general, travel times throughout North Seawall construction are expected to be longer during the PM peak hour than the AM peak hour, regardless of the direction of travel. When construction is north of Battery Street, most travel times would be similar to or less than they are under existing conditions because some drivers would seek alternate routes to avoid congestion on Alaskan Way. However, travel times on the northbound routes between Colman Dock and the Bell Street Pier Cruise Terminal (Pier 66) and between S. Royal Brougham Way and Broad Street would increase substantially during both the AM and PM peak hours due to the congestion at Wall Street.

When construction shifts south of Battery Street, southbound travel times generally would be substantially longer than northbound but not substantially longer than the baseline travel times. The greatest increase along Alaskan Way would occur southbound from Broad Street to S. Royal Brougham Way, which would take 1 minute and 40 seconds longer during this phase of construction.

Freight and Overlegal Vehicles

The turning radii that would present problems for some overlegal trucks during Central Seawall construction would no longer be an issue during North Seawall construction. Alaskan Way would be resurfaced to provide a vehicle capacity equivalent to its existing configuration plus a northbound lane from S. Washington Street to Spring Street. Although there would be no construction haul route to provide alternate access, a minor impact on a small portion of freight vehicles is expected.

Business Access and Parking

Of the 2,557 surface parking spaces in the project area, approximately 36 to 48 City-metered and pay station on-street parking spaces on Alaskan Way are expected to be removed temporarily. The locations of the affected parking spaces would change as construction progresses. Vehicle access to the waterfront piers and to properties on the east side of Alaskan Way would be maintained during construction, although brief temporary closures may be required in some locations depending on the width of the affected driveways and the availability of alternate vehicle access points.

Pedestrian and Bicycle Facilities

Sidewalks along Alaskan Way would be maintained during North Seawall construction between Broad Street and Battery Street, although they may be relocated in some instances.

The pedestrian/bicycle trail east of Alaskan Way would be maintained throughout this phase of construction, although its width may be reduced on limited portions during some periods of time. For areas where facilities would need to be relocated, temporary replacement facilities would be provided to minimize impacts on pedestrians and bicyclists. Existing ADA compliant connections will be maintained and

any newly constructed pedestrian paths and connections will be ADA compliant. High-visibility marked crosswalks would be provided on all legs of intersections.

Safety

Speeds through the construction area would be reduced, which could reduce both the frequency and severity of collisions for all travel modes. In addition, traffic volumes along Alaskan Way would be reduced by drivers avoiding the construction area. However, some of this benefit may be offset by the unfamiliarity of drivers, pedestrians, and bicyclists with the revised roadway configurations, which could increase the potential for accidents.

Transit

When North Seawall construction begins, Routes 16 and 66 would have returned to their existing routes on Alaskan Way following Central Seawall construction. Route 99, which runs along the length of Alaskan Way, may need to be modified or rerouted to avoid the construction work zone because of the constrained conditions along the temporary road. If rerouting is necessary, the route likely would run along Western Avenue, Elliott Avenue, and/or First Avenue. This would require riders to travel longer distances between Alaskan Way and their bus stops. Likewise, travel times would increase.

Water Transit Services

Water transit services would largely return to normal operations after Central Seawall construction is completed. During the beginning stages of North Seawall construction, an additional northbound lane from S. Washington Street to Spring Street would ease congestion through the downtown Seattle waterfront under Alternatives A and C. Ferry-bound traffic may experience delays if vehicles approach Colman Dock from the North Seawall area, but other less-congested routes would be available. Access to and from Colman Dock would return to current operations.

Two cruise lines use Pier 66: Celebrity Cruises and Norwegian Cruise Line. Currently, Celebrity Cruises docks its ships on Fridays and Norwegian Cruise Line docks its ships on Saturdays and Sundays. In addition, various lines make occasional weekday calls at the beginning and end of the season. On Fridays, peak activity occurs during the AM peak hour and early afternoon. Therefore, congestion at Alaskan Way and Wall Street is likely to have a negative effect on weekday (particularly Friday) cruise-related travel when construction focused north of Battery Street. This effect may worsen when construction shifts south of Battery Street, as a result of PM peak hour congestion at Clay, Vine, and Wall Streets. In addition, construction at the northern edge of the Bell Street Terminal may require relocation of drop-off and pickup locations for taxis, transit, and personal vehicles. However, since construction would not take place during summer months, these effects would be limited to off-peak months. SDOT would work with cruise ship

operators to maintain access and traffic flow to ensure that effects on cruise ship access are minimized.

Work vessels and barges may be used to bring materials to the work site, haul materials from the work site, and serve as work platforms for some in-water activities. Such operations would be sited and timed to avoid vessel traffic lanes and minimize effects on water transit operations to the greatest extent possible.

Rail

Construction of the North Seawall between Broad and Battery Streets would be close to the at-grade rail crossings along Alaskan Way. However, the construction activities would not encroach upon the railroad right-of-way. North Seawall construction would not affect any of the at-grade crossings at Broad, Clay, Vine, or Wall Streets.

Emergency Services

While North Seawall construction is underway from Broad to Battery Streets, the roadway configuration and level of accommodation for emergency vehicles on Alaskan Way south of Battery Street would be similar to what exists now, with two northbound and two southbound lanes. The additional northbound through lane provided by Alternatives A and C would likely improve the ability of emergency vehicles to move along the roadway segment between Spring Street and Yesler Way. North of Battery Street, emergency services would have access to an emergency-access/turn lane that would be impeded only by queued left-turning vehicles.

Travel times would increase slightly for emergency vehicles heading north during Traffic Analysis Phase III (Table 4-2). Although these vehicles would have the benefit of the emergency-access lane through the construction work zone, they would likely experience some congestion as two lanes merge into a single lane. Heading south, travel times would be identical to 2020 baseline conditions because the roadway configuration would be identical.

Table 4-2. Phases III and IV Travel Times for Emergency Vehicles (Minutes)

Route	Baseline Conditions (2020) PM Peak Hour	Alternatives A, B, C Phase III PM Peak Hour	Alternatives A, B, C Phase IV PM Peak Hour
Fire Station No. 5 to Broad Street	4:41	4:49	3:29
Fire Station No. 5 to S. King Street	0:56	0:56	0:56

As construction moves south of Battery Street during Traffic Analysis Phase IV, a center emergency-access/turn lane would continue to be provided through the work zone. Although response times would be improved by the additional northbound lane from Yesler Way to Spring

Street under Alternatives A and C, the bottleneck caused by construction could adversely affect response times for emergency services. Signal preemption could be used to help emergency services reach their destinations in a timely manner.

Travel times would decrease for emergency vehicles heading north during Traffic Analysis Phase IV, because these vehicles could use the emergency-access lane through the construction work zone, and northbound queues are not expected south of the construction work zone. Southbound travel times would be identical to 2020 baseline conditions because the assumed roadway configuration would be identical. Therefore, no adverse effects are expected for emergency services during the last phase of North Seawall construction.

Event Traffic

The North Seawall construction is the farthest removed from stadium events, but the reduced capacity along the northern portion of the downtown Seattle waterfront may affect people who plan to travel along this section of the temporary road to access the stadiums. Similarly, these delayed conditions could also occur if travelers are moving through this area to access events at Key Arena and at Seattle Center.

Effects with Tolling of the SR 99 Bored Tunnel

This section discusses how tolling may influence the traffic forecasts used in the project's traffic analysis.

The Alaskan Way Viaduct Replacement Project Final EIS includes an analysis of how tolling the bored tunnel would affect traffic operations throughout Seattle, including traffic on Alaskan Way. Some drivers could divert to I-5 and arterial City streets to avoid paying the toll to use the bored tunnel. The Final EIS states that Second and Fourth Avenues are expected to see the greatest increases in traffic. In 2030, Alaskan Way is expected to carry 4,900 to 6,100 more vehicles per day compared to the number it would carry if the bored tunnel were not tolled, which equates to approximately 490 to 610 vehicles during the PM peak hour.

Since publication of the Alaskan Way Viaduct Replacement Project Final EIS, studies and modeling related to tolling the bored tunnel have continued. All of these studies indicated that tolling would result in substantial diversion of traffic, with resulting congestion on the downtown Seattle arterial street network. However, there is a high level of uncertainty regarding the amount of the toll (which would need to be approved by the Legislature) as well as the resulting rate of diversion.

As described earlier in this section and in Figure 4-3, seawall construction would result in traffic congestion on Alaskan Way with levels of service generally at E or F because Alaskan Way would be limited to one through lane in each direction. Because of this pre-existing congestion, the intersections along Alaskan Way are also expected to operate at LOS E and F with tolling in place. The range of

uncertainty regarding the rate of diversion from tolling makes it impractical to quantify the impacts of tolling the bored tunnel on the downtown street network as part of the Elliott Bay Seawall Project analysis. The Advisory Committee on Tolling and Traffic Management (ACTT) is analyzing alternative tolling scenarios, their diversion effects, and approaches to mitigation. The ACTT's initial recommendations are expected no earlier than summer 2013. The Washington State Transportation Commission is expected to set the final toll rate schedule in 2015.

Effects with Elliott/Western Connector

During North Seawall construction (Stages III and IV), the traffic modeling indicates that the temporary roadway through the construction zones would be congested and traffic movement would be slow. The Elliott/Western Connector, once in place, would provide a bypass route around the North Seawall construction zones. Although the City's current expectation is that the connector would be in place before North Seawall construction, the construction schedule for the connector has not been determined; therefore, the connector was not assumed for the modeling included in the Draft EIS.

Similar to the Central Seawall, construction of the North Seawall would result in congestion on Alaskan Way, with levels of service generally at F, because Alaskan Way would be limited to one through lane in each direction (Figure 4-6). Because of this pre-existing congestion, the intersections along Alaskan Way are also expected to operate at LOS F with tolling in place. The availability of the Elliott/Western Connector as a bypass would lower traffic volumes and ease congestion on Alaskan Way in the vicinity of North Seawall construction, with or without tolling of the bored tunnel, although the congestion would likely be worse with tolling in place because more vehicles would divert onto arterial streets.

Indirect Effects

No indirect effects related to transportation have been identified.

Avoidance, Minimization, and Mitigation Measures

This section describes measures that would be used to reduce the impacts of the seawall construction on the transportation system. The measures are organized by the same categories as the transportation impact discussion.

Roadway Operations

To minimize impacts on traffic operations during construction, the City will implement a construction traffic management plan that meets current City standards and requirements and addresses the needs of all modes of travel during all phases of construction. The City will implement specific measures to reduce impacts on traffic operations, including the following:

- Provide detours that provide drivers with clear directions for routes along alternative roadways, including access to Colman Dock Ferry Terminal. This effort will be coordinated with the Alaskan Way Viaduct Replacement Project and Washington State Ferries' Seattle Multimodal Terminal at Colman Dock Project to ensure that the detour plans are consistent with other construction activities.
- Improve traffic operations along Alaskan Way during the summer construction shutdown by reclaiming portions of Alaskan Way to accommodate ferry-queuing space, parking, and/or bicycle and pedestrian travel.
- Modify signal timing and phasing, additional turn lanes, and coordinated signals at key intersections along Alaskan Way, including the temporary road.
- Provide signing and wayfinding to help travelers access key destinations along the waterfront. This effort will be coordinated with the Alaskan Way Viaduct Replacement Project to ensure that this strategy is consistent with other construction activities.
- Provide flaggers and/or uniformed police officers at key intersections when needed to facilitate the movements of freight and general-purpose traffic and expedite emergency vehicles.
- Accommodate overlegal vehicles along alternate routes (such as the construction haul route) if they cannot travel along the temporary road.
- Identify appropriate haul routes. Timing of travel will be determined in advance to minimize effects on surrounding facilities. Construction vehicles will also be required to adhere to current City weight restrictions.
- Accommodate vehicles that require access to loading zones, such as business delivery vehicles, taxis, charter and school buses, and garbage pickup vehicles.

Freight and Overlegal Vehicles

To minimize impacts on freight traffic, including overlegal vehicles, the following mitigation measure will be implemented:

- Overlegal vehicles that are too large to travel on the temporary road will be allowed to use the construction haul route, which will be coordinated with the Contractor through the normal City permitting process.

Business Access and Parking

To reduce impacts on business access and parking, the City will implement the following mitigation measures:

- Maintain property access during construction.
- Coordinate with adjacent businesses and property owners during each stage of construction to identify the location and amount of temporary parking that will be put in place, manage temporary and permanent parking supplies during construction, and identify strategies for making parking both convenient and accessible to waterfront businesses and their patrons.
- Perform outreach in cooperation with business owners to provide pedestrian and parking maps in advance of and during construction, and information about parking options by means of e-Park and the Seattle Parking Map website.
- Incorporate new on-street parking along existing Alaskan Way, where it is not used for construction activities.
- During the summer construction shutdown, provide additional temporary on-street parking spaces.
- After Labor Day, begin mobilization and construction gradually to minimize effects during September, which is a busy month for many waterfront businesses, in order to preserve as much parking as possible.
- Provide appropriate off-site parking options for construction workers and prohibit their use of short-term visitor/customer parking near the project area.
- Throughout project construction, coordinate with the Seattle Police Department for enforcement of the short-term parking regulations in the immediate project area (two- to three-block radius).
- Provide curb space for commercial deliveries, taxis, and vehicle loading.

The City will work with surrounding businesses to identify additional mitigation measures and strategies that could include:

- Institute pricing measures that encourage short-term parking.
- Implement e-Park and locate dynamic message signs on key access points to downtown Seattle, Pioneer Square, and the downtown Seattle waterfront.
- Use parking vouchers that businesses can give to customers to park in designated parking lots.

e-Park

A component of the Center City Parking Program, e-Park is an electronic guidance system that displays real-time parking availability on facility signs, right-of-way signs, and the Seattle Parking Map website: *http://www.seattle.gov/transportation/epark/*

Pedestrian and Bicycle Facilities

To minimize impacts on bicycle and pedestrian travel, the City will implement the following mitigation measures:

- Maintain a continuous sidewalk on the west side of Alaskan Way during the summer construction shutdown.
- Provide bicycle and pedestrian routes during construction with detour signage and other wayfinding elements. Distribute information on construction activity and alternative routes to bicycle and pedestrian organizations and stakeholders.
- Provide temporary sidewalks, as needed for specific construction activities.
- Provide east-west pedestrian access from Western Avenue to the waterfront piers with distances between crossings no larger than those that are currently provided.
- Existing ADA-compliant connections will be maintained and any newly constructed pedestrian paths and connections will be ADA compliant.

Safety

Project construction is not expected to adversely affect safety. However, the City will implement the following measures to maximize traveler safety during construction:

- Reduce speed limits on the temporary road from those currently in place on Alaskan Way.
- Provide pedestrian signals on the temporary road in all locations where they are provided on Alaskan Way.
- Place stop bars (stop lines on the pavement used to indicate the point behind which vehicles are required to stop) at crosswalks on side streets intersecting with the temporary road.
- Provide wayfinding and clear signage to allow drivers to navigate safely through the construction zone.

Transit

To minimize or compensate for impacts on transit operations, the City will implement the following mitigation measures:

- Coordinate with Metro to provide alternate transit stop and route locations, as appropriate, for Routes 16, 66, and 99.
- Provide clearly marked and ADA-accessible pedestrian connections between any new transit stops and key destinations along Alaskan Way, including Colman Dock Ferry Terminal, the Seattle Aquarium, and the Bell Street Pier Cruise Terminal.
- Provide alternate bus layover zones on streets near the existing zones.

Water Transit

To minimize or compensate for impacts on water transit services, the City will implement following mitigation measures:

- In coordination with Washington State Ferries, provide for ferry queuing and access to Colman Dock, with storage provided on Alaskan Way during the summer construction shutdown.
- Provide passenger drop-off/pickup and taxi space for Colman Dock on Yesler Way.
- In coordination with Washington State Ferries, provide terminal access during each construction traffic stage that addresses construction impacts on parking, drop-off/pick up, and access by bicycles, pedestrians, and transit vehicles.
- In coordination with the Port of Seattle, provide cruise terminal access for drop-off/pickup, and access by bicycles, pedestrians, and transit vehicles.
- Require the contractor to follow applicable regulations for operating work vessels or barges along the downtown Seattle waterfront, including coordination with the Port of Seattle, Washington State Ferries, other boat operators, and pier owners.

Emergency Service

To reduce impacts on emergency services, the City will implement the following mitigation measures:

- Designate the center lane on the temporary road (including the portions located under the Alaskan Way Viaduct) as a space for emergency vehicles, with the exception of certain intersections that will permit vehicles to turn.
- If the use of the center lane does not provide for appropriate response times, implement signal controls (such as signal preemption) at signalized intersections to mitigate the effects on the response times of fire and emergency medical services during construction. In addition, at the intersection of Alaskan Way and Madison Street along the temporary roadway in front of Fire Station No. 5, provide striping and signage to prohibit blockage of the intersection.

Event Traffic

The strategies described above for detours, signage, and wayfinding measures will also serve to minimize impacts on event traffic. The City will coordinate with event authorities using existing forums as appropriate.

4.2 Economics

Effects Common to All Build Alternatives

The economic analysis used the IMpact Analysis for PLANning (IMPLAN) input-output model to determine effects. Construction of any of the build alternatives would result in temporary substantial economic effects, both adverse and beneficial, at the local and regional level. The key construction effects common to all three build alternatives would be the following:

- Employment and spending within the local economy from construction activities and supply procurement would increase temporarily.
- State and local sales taxes would be generated through the purchase of local goods and materials related to construction.
- Parking supply and parking revenue would decrease temporarily.
- Local business revenues during construction would decrease temporarily.

Employment

Project construction would increase employment throughout many economic sectors within the central Puget Sound region and Washington State. This increase was calculated by applying a "multiplier effect" to the estimated capital expenditures for the project. Capital expenditures include the direct hiring of temporary construction workers, the purchase of construction materials and equipment, and the expenditure of funds to acquire temporary and permanent easements.

Project construction also would result in a temporary reduction of employment at local businesses near the Elliott Bay Seawall alignment. Table 4-3 shows the anticipated changes in local business employment and construction employment as a result of project-related construction.

Alternative B would generate the most jobs within the central Puget Sound region due to its higher construction costs and longer construction duration. For the same reason, it would result in the greatest reduction in employment at project-area businesses.

Economics Key Points

Project construction would result in increased employment and economic stimulation (purchasing supplies and construction activities) for the local economy.

Project construction may result in a temporary loss of employment at businesses near the seawall and construction zones.

Of the three build alternatives, Alternative B would generate the most jobs.

Construction would temporarily and adversely affect the parking supply in the area, and the longer construction duration for Alternative B would result in a greater loss of parking revenues during construction than for Alternatives A and C.

There would be significant impacts on local businesses with any of the build alternatives, but the impacts would be greatest for Alternative B because of the longer construction duration.

To mitigate for adverse economic effects, the City of Seattle would shut down construction during peak summer tourism months.

Table 4-3. Changes in Employment during Project Construction

	Alternative A (FTEs)	Alternative B (FTEs)	Alternative C (FTEs)
Local Business Employment	-1,104	-1,380	-1,104
Regional Construction Employment	+5,103	+7,140	+5,386
Net Change in Employment	+3,999	+5,760	+4,282

Source: IMPLAN input-output model results; see the Economics Discipline Report (Appendix D)
Note: FTEs – full-time equivalents

Sales Tax Revenue

Estimates of project-related sales tax revenue are based on the construction cost estimates that were used as input to the IMPLAN model. Table 4-4 shows the estimated changes in combined state and local sales tax revenue for each of the build alternatives.

Table 4-4. Changes in State and Local Sales Tax Revenue during Project Construction

	Alternative A	Alternative B	Alternative C
Local Business Sales Tax Revenue[1]	-$7,508,000	-$9,035,000	-$7,508,000
Construction Sales Tax Revenue[1]	+$13,619,000	+$20,096,000	+$14,365,000
Net Change in Sales Tax Revenue[1]	+$6,111,000	+$11,061,000	+$6,587,000

Source: IMPLAN input-output model results; see the Economics Discipline Report (Appendix D)
Note: [1] Net present value over the life of the seawall construction.

Parking Revenue

Construction would temporarily and adversely affect parking supply and parking revenue in the study area. The adverse effects would result from the combined construction work in the vicinity, not solely from the construction related to the seawall replacement. However, to obtain a conservative estimate of the effects on parking revenue, the analysis assumes that the effects on parking supply would result from the seawall replacement alone.

The bulk of the losses in parking revenue would occur where the required construction staging, detours, and construction work zones would reduce the parking supply. The number of affected parking spaces would be similar among the build alternatives. The differences in parking revenue between the build alternatives are due primarily to the longer construction duration for Alternative B. Table 4-5 compares the change in parking revenue by build alternative. For a discussion of specific parking losses, see Section 4.1, Transportation.

IMpact Analysis for PLANning

IMpact Analysis for PLANning (IMPLAN) is a regional economic model that is based on the principles of input-output analysis. The IMPLAN database contains county, state, zip code, and federal economic statistics which are specialized by region, not estimated from national averages, and can be used to measure the effect on a regional or local economy of a given change or event in the economy's activity.

Table 4-5. Changes in Parking Revenue during Project Construction

	Alternative A	Alternative B	Alternative C
Change in Parking Revenue[1]	-$16,200,000	-$23,100,000	-$16,200,000

Source: IMPLAN input-output model results; see the Economics Discipline Report (Appendix D)
Note: [1] Net present value over the life of the seawall construction.

Local Business Impacts

Any major construction project, public or private, has the potential to disturb the residents, businesses, and business customers adjacent to the construction. The area within one block of the existing seawall alignment and the proposed detour route contains 480 businesses, which are likely to experience varying degrees of disruption during construction as a result of noise, traffic, detour routes, freight movements, parking losses, and reduced business access. Local businesses that may be affected by project construction are in the food service, hospitality, recreation, tourism, and retail sectors. There would be substantial impacts on local businesses with any of the build alternatives, but the impacts would be greatest for Alternative B because of its longer construction duration.

Temporary construction effects on businesses would include the following:

- Presence of construction workers and materials
- Temporary road closures, traffic diversions, and changes in property access (see the Transportation Discipline Report [Appendix C])
- Loss of parking, especially on-street, short-term parking (see the Transportation Discipline Report [Appendix C])
- Airborne dust (see the Air Quality Discipline Report [Appendix G])
- Noise and vibration from construction equipment and vehicles (see the Noise and Vibration Discipline Report [Appendix E])
- Reduced visibility of businesses to their customers

Four businesses whose only entrance is located within the construction work zone may not have access for part or all of a construction season. These businesses are The Frankfurter (Pier 54½), the ticket kiosk for Let's Go Sailing (Pier 54), Frankly Sweets (Pier 55), and Starbucks (Pier 55). Three kiosks associated with the Colman Dock Ferry Terminal (Subway, Café Appassionato, and the former World Wraps) would lose street-side business access for a period of time, although they could maintain access from the ferry holding area. Access to McDonald's at Colman Dock Ferry Terminal may also be limited to the ferry holding area, unless access to Alaskan Way can be provided through the outdoor patio area.

Net Present Value

Net Present Value is the difference between the present value of all anticipated future cash flows and the amount of actual cash investment or cost. It compares the value of a dollar today to the value of that same dollar in the future, taking inflation and returns into account. For example, assuming a discount or inflation rate of 5 percent, the net present value of $2,000 10 years from now would be $1,227.83.

The economic analysis assumed that all retail businesses within the area directly affected by construction would lose an average of 15 percent of their revenue during the construction period. This revenue loss in the immediate construction area would in turn result in indirect effects on the economy in the larger study area. For example, restaurant suppliers may experience revenue losses due to fewer orders from waterfront restaurants. Although individual losses by directly affected businesses could exceed 15 percent, especially during peak construction periods, some of these localized effects may be absorbed by transfers to other businesses within the regional economy. Table 4-6 provides the estimated change in regional retail revenue during construction.

Table 4-6. Changes in Regional Retail Revenue during Project Construction

	Alternative A	Alternative B	Alternative C
Estimated Change in Regional Retail Revenue[1]	-$79,358,000	-$95,501,000	-$79,358,000

Source: IMPLAN input-output model results; see the Economics Discipline Report (Appendix D)
Note: [1] Net present value over the life of the seawall construction.

Regional Effects of Construction Expenditures

Construction expenditures would occur over a number of years and would directly create new demand for construction materials and labor. Construction expenditures cause firms to employ more workers in order to meet increases in demand; this leads to indirect impacts as the additional wages and salaries paid to workers result in greater consumer spending. These direct and indirect impacts were calculated at the regional level using the IMPLAN model.

The cost associated with constructing any of the build alternatives would result in additional economic activity throughout all economic sectors within the central Puget Sound region. IMPLAN generates estimates of this economic activity by using a multiplier on the estimated capital expenditures for the project, similar to how regional employment was estimated above. Alternative A, with the lowest estimated capital cost, would generate the least amount of economic activity in the study area during construction, while Alternative B, with the highest capital cost, would generate the most economic activity. Table 4-7 shows the estimated regional economic impact of each build alternative.

Table 4-7. Estimated Regional Economic Impact of Project Construction

	Alternative A	Alternative B	Alternative C
Regional economic impact (net present value)	+$240,631,000	+$354,765,000	+$253,524,000

Source: IMPLAN input-output model results; see the Economics Discipline Report (Appendix D)

Indirect Effects

Because indirect economic impacts are so closely tied to direct impacts, they are covered in the previous section.

Avoidance, Minimization, and Mitigation Measures

The City will implement the following mitigation for adverse economic effects during construction:

- Shut down construction during the peak summer months (Memorial Day weekend through Labor Day weekend) to minimize impacts on visitor-oriented businesses. After Labor Day, begin mobilization and construction gradually to minimize effects during September, which is a busy month for many waterfront businesses, in order to preserve as much parking as possible.
- Coordinate with individual businesses and other stakeholders concerning detours, pedestrian and roadway access, utility disruptions, access limitations, and other critical activities. Public information campaigns to encourage people to visit the waterfront during construction could also be implemented.
- Maintain access to properties during construction. If access to a business with a single entrance must be blocked for an extended period, coordinate with building owners and tenants to determine appropriate compensation or to provide relocation assistance under the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended.
- Coordinate with adjacent businesses and property owners during each stage of construction to identify the location and amount of temporary parking that will be put in place, manage temporary and permanent parking supplies during construction, and identify strategies for making parking both convenient and accessible to waterfront businesses and their patrons.
- Perform outreach in cooperation with business owners to provide pedestrian and parking maps in advance of and during construction, and information about parking options by means of e-Park and the Seattle Parking Map website.
- Locate or direct stationary equipment such as lighting, generators, air compressors, and similar equipment away from sensitive receiving properties.
- Prohibit the use of impact tools such as impact pile drivers between the hours of 10 p.m. and 7 a.m. on weekdays and 10 p.m. and 9 a.m. on weekends and legal holidays.
- Provide a 24-hour hotline for complaints about noise.

- Notify nearby residents and businesses before periods of intense nighttime construction.
- As vibration monitoring may be required at nearby historic structures, the City will compare monitoring data to the vibration criteria established for the project to ensure that construction vibration levels do not exceed the damage risk criteria for buildings.

4.3 Noise and Vibration

Effects Common to All Build Alternatives

Construction Equipment Noise

The most prevalent source of noise would be heavy construction equipment and pile drivers. Pile driving for the temporary sheet pile containment wall (installed to provide a barrier between active construction and Elliott Bay) and pile-supported sections of the sidewalk would generate the most intense construction noise. Pile driving can be an impact-type activity, which generates noises of high intensity and very short duration that can be particularly intrusive. Other noise sources would include tools such as compressors, generators, pumps, and jackhammers. Noise generated by mobile equipment would occur intermittently, while stationary equipment (e.g., pumps, generators, and compressors) would generate sound fairly constantly. Typical noise levels of construction equipment anticipated for the project at a distance from the source of the sound of 50 feet are presented in Table 4-8.

The construction equipment would not be fixed in one location; it would be moved along the seawall from construction work zone to work zone as construction progresses. Construction noise would be temporary and would subside in any particular location as activities progress to subsequent phases of seawall construction.

Critical distances within which the construction noise would exceed the daytime limits outlined in the Seattle Noise Ordinance (SMC 25.08) were estimated. Table 4-9 provides the critical distance for land uses in each land use category by type of construction equipment. Land uses closer than these distances to the construction activities would likely be exposed to noise levels higher than those outlined in the noise ordinance.

Short-term, moderate, adverse effects on the noise environment would be expected from construction activities under any of the build alternatives. Although heavy equipment and pile-driving noise would end once construction is completed and would not be concentrated in any one area over the duration of construction, the construction would take place over several years and affect a wide variety of both residential and commercial properties; therefore, these effects would be moderate to substantial.

Noise Key Points

Any build alternative would result in short-term, moderate to substantial, adverse effects on the noise environment.

For all build alternatives, the construction activities would not result in substantial changes in local traffic noise.

Construction noise mitigation requirements would be developed and specified in a noise variance obtained for the project.

Table 4-8. Sound Levels Produced by Construction Equipment

Equipment	Maximum Sound Level at 50 Feet	Impact Device
Backhoe	85	No
Compressor	80	No
Concrete pump	82	No
Concrete saw	90	No
Cement mixer	80	No
Crane	85	No
Drill rig	84	No
Dump or boom truck	84	No
Excavator	85	No
Fork lift	65	No
Generator	82	No
Jet grouter	70	No
Light plant	70	No
Front-end loader	80	No
Pickup truck	55	No
Pile driver (Impact)	101	Yes
Pump	81	No
Street sweeper	80	No
Vibratory hammer	95	No
Water truck	84	No
Welder	74	No

Source: FHWA 2006.

Table 4-9. Critical Distances for Construction Equipment with Various Sound Levels, by Land Use Category

Land Use Category	Estimated Critical Distance (feet)			
	Average Construction Equipment[1]	Loud Construction Equipment[2]	Very Loud Construction Equipment[3]	Impact Pile Driver
Residential	200	250	600	300
Commercial	175	195	500	300
Industrial	155	175	400	300

Source: FHWA et al. 2011.

Notes: [1] Examples of equipment: backhoe, compressor, loader, concrete pump, generator, dump truck, tractor, crane, dozer, excavator, grader, paver, roller, scraper, and vibrating hopper. [2] Examples of equipment: Hydra break ram, mounted impact hammer, and clam shovel. [3] Examples of equipment: concrete saw and vibratory pile driver.

The number of sites (noise receptors) where construction noise could exceed the noise limits specified in the Seattle Noise Ordinance during daytime hours (SMC 25.08.425) are provided in Table 4-10. The potential exceedances are for noise receptors where monitoring and construction noise modeling was conducted, and the results are organized by the four categories of construction equipment (average, loud, very loud, and impact pile driver). Locations of these potential exceedances are shown in Figure 4-7.

Unmitigated daytime and nighttime noise levels are expected to exceed the noise-level limits. Construction activities during both daytime and nighttime hours that exceed these levels require a noise variance from the City. The estimated noise levels were in most cases appreciably greater than the average background noise levels, and it is expected that they would not be substantially masked, particularly during quiet periods.

Impact pile drivers are further analyzed in Section 4.3, under Vibration, because the impact can produce noticeable vibration effects as well.

Table 4-10. Number of Sites where Estimated Construction Noise Could Exceed Seattle Noise Ordinance Noise-Level Limits during Daytime Hours

	Average Construction Equipment	Loud Construction Equipment	Very Loud Construction Equipment	Impact Pile Driver
Central Seawall				
Alternative A	8	10	16	14
Alternative B	9	11	16	14
Alternative C	9	11	17	14
North Seawall				
Alternative A	1	3	7	3
Alternative B	1	4	8	4
Alternative C	1	4	7	3

Note: For a detailed description of the locations, zones, receptors, and noise levels, see the Noise and Vibration Discipline Report (Appendix E).

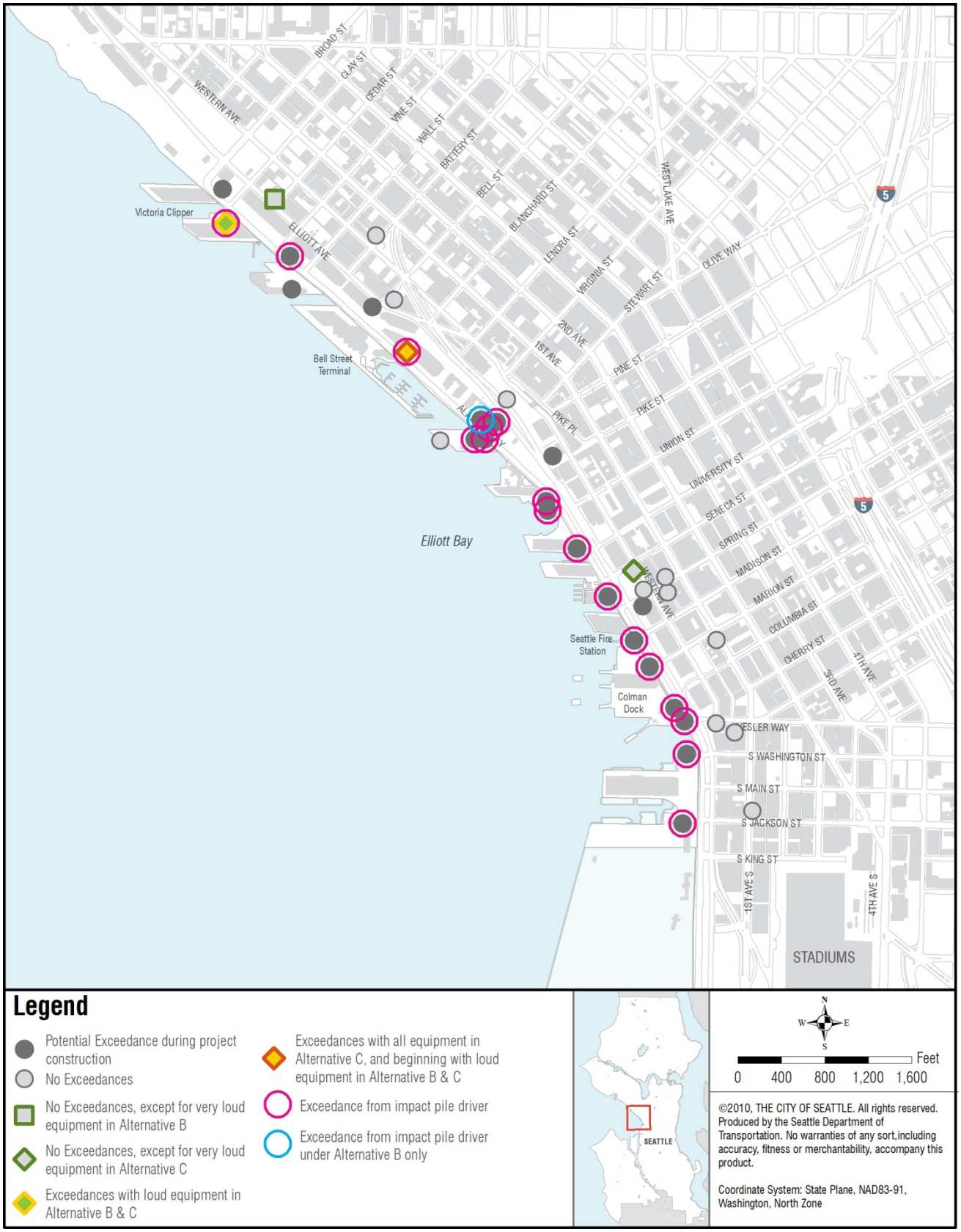


Figure 4-7. Potential exceedances at noise monitoring locations within the study area

Traffic Noise

Overall changes in local traffic noise levels due to construction activities would not be substantial (less than 1 dBA). The study area and, in particular, the Alaskan Way Viaduct currently has heavy traffic conditions. The additional traffic volume due to the construction activities in both the construction work zone and the staging areas would be small relative to the existing traffic in the area. The realignment of the temporary road from S. Washington Street to Pike Street would result in a slight decrease in noise around the seawall and piers and a slight increase in noise toward the Alaskan Way Viaduct. Changes in traffic noise due to construction would be temporary and the effects would be minor.

Perceptible Changes in Noise Level

In the heavy traffic conditions of the project area, an increase in traffic noise of 3 dBA would be barely perceptible to the human ear. This amount of traffic noise increase would require a doubling of traffic volumes in the study area.

Vibration

Ground vibration conditions associated with construction equipment and construction activities were evaluated using analysis procedures recommended by Caltrans (see the Noise and Vibration Discipline Report [Appendix E]). This is a widely accepted method for vibration analysis, which takes into account the repetition pattern of vibration events, the human response, and the potential for cosmetic building damage. Particular attention was given to potential impacts on historic structures near the construction work zone.

Critical distances within which construction vibration would exceed the human response and structural damage thresholds are presented in Table 4-11. The closer a person or building is to the source of vibration, the higher the potential is to be perceptible to humans and to cause structural damage to buildings. Lead-jointed water mains are also susceptible to vibration damage when at a close range. For example, ground vibration associated with impact pile driving would be barely perceptible to people standing 333 feet from the pile driving and distinctly perceptible if they are standing 53 feet away. Similarly, pile driving could occur much closer to newer buildings than historic and fragile buildings without causing damage. Impact pile driving within 26 feet of a historic structure could cause cosmetic damage; however, there are no fragile buildings within critical distances of the construction work. Ground vibration associated with general construction equipment (i.e., non-impact equipment) would dissipate more quickly (over a shorter distance) than vibration from pile driving, therefore general construction equipment could operate closer to people and building without risk of harm.

The Seattle Aquarium is located within the human response threshold critical distances for general construction equipment, vibratory pile drivers, and impact pile drivers. While construction occurs in this area, vibration from pile-driving activities would range from barely perceptible to distinctly perceptible by patrons, staff, and animals at the aquarium, depending on the type of activity and the distance from the facility.

Vibration Key Points

Vibration from pile driving activities could range from barely to distinctly perceptible by patrons, staff, and animals at the Seattle Aquarium.

Vibration effects of impact pile drivers could result in cosmetic damages to nearby historic structures, though effects are expected to be minor.

Pile cushioning or predrilling could be used to minimize ground vibrations during impact pile driving.

Vibration monitoring may be required at nearby historic structures to minimize damage.

The potential vibration effects of impact pile drivers on nearby historic structures are indicated in Table 4-12. Fire Station No. 5 and Piers 54, 55, 56, 57, and 59 are within the critical distance for damage to historic structures from the proposed pile-driving activities. The damage would likely be cosmetic; and if it were to occur, it would likely be in the form of cracked plaster and broken windows. Notably, not all historic buildings are the same. Although they are historic structures, none of these buildings would be considered fragile because they are constructed of heavy timber, and they are set on pilings and have no plaster or ornamental façade, such as terra cotta, to be damaged. If general construction equipment were to operate within 11 feet of a historic structure, it could possibly cause similar cosmetic effects. This analysis assumes that the piers would be affected as if they react in a similar manner as the other structures built directly on the ground. The effects of vibration on historic structures would be moderate.

Table 4-11. Critical Distance for Human Response and Structural Damage from Construction Vibration

	Critical Distance (feet)		
	Vibratory Pile Driver	**Impact Pile Driver**	**General Construction Equipment**
Human Response Thresholds			
Barely perceptible	315	333	112
Distinctly perceptible	59	53	21
Strongly perceptible; may be annoying to some people in buildings	18	14	6
Severe; unpleasant for people in buildings; unacceptable to pedestrians on bridges	9	6	3
Structural Damage Thresholds			
Extremely fragile historic buildings, ruins, and ancient monuments	116	111	41
Fragile buildings	73	66	26
Historic and some old buildings	31	26	11
Older residential structures	31	26	11
Newer residential structures	16	13	6
Modern commercial/industrial buildings	9	6	3

Sources: Caltrans 2002, 2004, and 2007

Table 4-12. Vibration Effects of Impact Pile Driver on Nearby Historic Structures

Zone	Current (Historic) Name of Receptor	Structural Damage Threshold (inches/ second)	Estimated Vibration (inches/ second)	Exceeds Vibration Damage Threshold (Yes/No)	Distance between Pile Driving and Structure (feet)	Human Response
Central Seawall						
1–4	Alaskan Way Viaduct and Battery Street Tunnel	0.5	0.237	No	164	Barely perceptible
1	1 Yesler Building (Bedford Hotel)	0.5	0.237	No	164	Barely perceptible
2	Western Building	0.5	0.124	No	295	Barely perceptible
2	Polson Building	0.5	0.194	No	197	Barely perceptible
3	Fire Station No. 5[1]	0.5	1.391	Yes	33	Strongly perceptible
3	Maritime Building	0.5	0.111	No	328	Barely perceptible
3	Pier 54[2] (Northern Pacific Railroad 3/Galbraith Dock)	0.5	1.391	Yes	33	Strongly perceptible
3	Pier 55[2] (Northern Pacific Railroad 4/Arlington Dock)	0.5	1.391	Yes	33	Strongly perceptible
3	Pier 56[2] (Frank Waterhouse House)	0.5	1.391	Yes	33	Strongly perceptible
3	(Olympic Warehouse)	0.5	0.111	No	328	Barely perceptible
3	(Pacific Net and Twine Building)	0.5	0.164	No	230	Barely perceptible
3	Pier 57[2] (John P. Agen's/ Milwaukee Dock)	0.5	1.391	Yes	33	Strongly perceptible
4	Pier 59[2]	0.5	1.391	Yes	33	Strongly perceptible
4	Fix Building	0.5	0.124	No	295	Barely perceptible
4	Heritage House/garage	0.5	0.090	No	394	Barely perceptible
North Seawall						
5, 6	Burlington Northern Railroad Tunnel	0.5	0.071	No	492	Barely perceptible
6	Old Spaghetti Factory (Ainsworth & Dunn)	0.5	0.105	No	344	Barely perceptible

Sources: Caltrans 2002, 2004, and 2007.

Notes: [1] Fire Station No. 5 is a modern (1963) concrete building that probably falls in the sturdiest category of buildings in the table, with a damage threshold of 2 rather than 0.5 inch per second. [2] Piers 54 through 59 are all heavy timber structures sitting on pilings.

Indirect Effects

No indirect effects related to noise and vibration have been identified. Noise and vibration generated by project construction would be primarily confined to the waterfront commercial/residential district, and would end once the construction is completed.

Avoidance, Minimization, and Mitigation Measures

The City will operate under appropriate noise variances. In coordination with the Seattle Department of Planning and Development, construction noise mitigation requirements will be developed and specified in the noise variance(s). The following are examples of mitigation measures that the City will incorporate into the construction plans, specifications, and variance requirements to reduce construction noise at nearby noise receptors:

- SDOT will notify all adjacent residential use properties 72 hours in advance of starting nighttime work.
- All trucks performing export haul during the variance window (10 p.m. to 7 a.m. weekdays and 10 p.m. to 9 a.m. weekends) will have bed lining approved by the engineer such as, but not limited to, soil, gravel, or rubber.
- All backup warning devices used on site will be the least intrusive broadband type, or the contractor will use backup observers as permitted by law.
- Radios will be used for all long-range communication on site; no yelling or honking between trucks will be permitted except in the case of an emergency.
- Impact tools such as jackhammers, chipping hammers, and impact pile drivers will not be used between the hours of 10 p.m. and 7 a.m. on weekdays and 10 p.m. and 9 a.m. on weekends and legal holidays.
- Soil improvement batch plants located within 150 feet of noise-sensitive receivers will not be permitted to operate between 10 p.m. and 7 a.m. on weekdays and 10 p.m. and 9 a.m. on weekends and legal holidays.
- Any material or debris that spills on the pavement will be removed by hand sweeping; no scraping type equipment or activity will be used to clean pavement surfaces during nighttime hours. In addition, no street sweeping machinery will operate between the hours of 10 p.m. and 7 a.m. on weekdays and 10 p.m. and 9 a.m. on weekends and legal holidays.
- Engine idling will be limited to not more than 2 minutes when vehicle or equipment is not directly engaged in work activity, such as on-site pickup trucks and cued export haul trucks.

- Vibratory pile driving methods will be utilized instead of impact pile driving whenever feasible.
- Construction activities associated with this project could generate noise impacts resulting in a noise complaint; the project will assist the Department of Planning and Development (DPD) to resolve it by contacting DPD within 24 hours of receipt of any noise-related complaints.

Impact pile driving will be the most prominent source of vibration during project construction. The City will implement the following measures to reduce ground vibrations when appropriate for the specific pile installation conditions:

- Use jetting techniques—a mixture of air and water pumped through a high-pressure nozzle to erode the soil adjacent to the pile—to facilitate the placement of the pile.
- Predrill a hole for a pile to place the pile at or near its design depth, eliminating most or all impact driving.
- Place resilient pile cushioning material between the driving hammer and the pile.
- Use alternative non-impact, proprietary pile-driving systems to reduce the impact-induced vibration.
- Restrict other construction activities to predetermined distances from historic structures or other sensitive receivers, or use alternative equipment or construction methods.
- Monitor vibration as needed, at nearby historic structures. The monitoring data will be compared to the vibration criteria established for the project to ensure that the vibration levels do not exceed the damage risk criteria for buildings.

4.4 Cultural, Historic, and Archaeological Resources

Effects Common to All Build Alternatives

Archaeological Resources

Pre-Contact, ethnohistoric, and historical archaeological resources could be affected by the removal and construction of the seawall, as well as construction related to habitat restoration and access improvements. Any near-surface ground disturbance that affects Holocene-aged sediments and historical fill deposits has the potential to affect archaeological resources. The potential effects of construction on archaeological resources in the APE are summarized in Table 4-13. As the lead federal agency, USACE in coordination with DAHP will make the final effect determinations.

Archaeological Resources Key Points

Construction of any of the three build alternatives could have a potential adverse effect on two existing archaeological sites in the project area.

The greater excavation quantities for Alternative B, and Alternative C to a lesser extent, would result in a greater risk of encountering archeological deposits.

Pile cushioning or predrilling could be used to minimize ground vibrations during impact pile driving.

Table 4-13. Potential Construction Effects on Archaeological Sites within the Area of Potential Effects

Site No.	Description	NRHP Eligibility	Effect Alternative A	Effect Alternative B	Effect Alternative C
45KI456	Baba'kwob Site: midden, human remains, trade beads	Recommended not eligible	No effect	No effect	No effect
45KI482	World Trade Center North Site: historical debris	Not evaluated	No effect	No effect	No effect
45KI1011	Pier 54 Submerged Debris Scatter	Recommended eligible	No adverse effect	No adverse effect	No adverse effect
45KI1012	Washington State Ferry Submerged Pier Site	Recommended eligible	Potentially adverse effect	Potentially adverse effect	Potentially adverse effect
45KI1013	Washington Street Submerged Historic Scatter	Recommended eligible	Potentially adverse effect	Potentially adverse effect	Potentially adverse effect
45KI1084	Wood Wall under the Alaskan Way Viaduct	Recommended not eligible	No effect	No effect	No effect
45KI1085	Concrete Wall	Recommended not eligible	No effect	No effect	No effect
45KI1099	Pier 62/63 Historic Debris Scatter	Recommended not eligible	No effect	No effect	No effect

Notes: NRHP – National Register of Historic Places. Federal and state regulations limit the amount of detail about potential archaeological sites that can be shared with the general public.

Construction of any of the three build alternatives could have a potentially adverse effect on two of the existing archaeological sites in Zones 1 and 2 (Sites 45KI1012 and 45KI1013), primarily as a result of in-water activities, if these sites are determined eligible for the NRHP. In-water activities would include the construction of confined-substrate habitat benches, subtidal cobble-reef patches (except under Alternative C), and subtidal substrate enhancements.

Construction of the landward portion of the new seawall could affect potentially significant archaeological sites within and beneath the historic fill landward of the existing seawall. In particular, the fill in the vicinity of historic Yesler's Wharf contained evidence of wharf activity between 10 and 48 feet bgs, and Ballast Island sediments have been identified between 10 and 18 feet bgs at the foot of S. Washington and S. Main Streets. Similarly, cinder and charcoal deposits in Zone 3 possibly associated with the White Star Dock or Seattle Coal and Iron have been encountered between 10 and 48 feet bgs. Native beach deposits in Zones 1, 2, 3, and 4 where potentially significant archaeological sites may be present would be intersected by soil improvements that extend to 58 feet bgs.

Other landward activities that may adversely affect archaeological resources in Zones 1 and 2, where the gravity wall is located, include utility relocation and other infrastructure improvements.

Adverse Effects under Section 106

Under Section 106 of the National Historic Preservation Act, a project adversely affects a historic property if it alters the characteristics that qualify the property for inclusion in the National Register of Historic Places in a manner that would diminish the integrity of the property. Integrity is defined as the ability of a property to convey its significance, based on its location, design, setting, materials, workmanship, feeling, and association.

Potential benefits of construction could include the identification and future analysis of previously unknown archaeological sites that would inform professional and tribal communities and the public about Pre-Contact and historic settlement of the area. Identification of those sites could provide information that would otherwise be unavailable for interpretation.

Historic Resources

Two types of effects on historic properties in the built environment may occur during construction: (1) physical effects, and (2) effects due to noise, dust, mud, traffic congestion, construction traffic, loss of parking, and limited access to buildings. These effects would occur to some degree in all locations where demolition and/or construction occurs. However, effects on historic properties are considered adverse under Section 106 of the NRHP Act of 1966, as amended, only if the effects are so severe that they threaten the ability of the property owner to adequately maintain the property, possibly leading to loss of the property or its significant features through deterioration. Construction effects such as noise and reduced access would affect users of historic buildings, but they would not be severe enough to be considered adverse.

The downtown Seattle waterfront, Pike Place Market area, and Pioneer Square depend on tourist and recreational traffic; therefore, even the perception of reduced access could have notable economic effects. Experience with the Nisqually earthquake showed that a prolonged period of traffic disruption and construction could potentially result in the loss of the distinctive character and economic base of historic neighborhoods. These results could occur under any of the three build alternatives if the construction effects are severe enough that businesses and property owners are unable to maintain the economic viability of their businesses and are unable to maintain the buildings in good condition. Without appropriate mitigation, prolonged traffic disruption and construction ultimately could lead to a loss of character-defining features of the buildings.

Construction of any of the three build alternatives could have a potential adverse effect on the Washington Street Boat Landing pergola, which would be removed for the duration of construction in that area. The pergola would be restored and replaced in an appropriate location on a new overwater structure at the foot of S. Washington Street. Construction could also have a potential adverse effect on the existing seawall, a facility eligible for the NRHP, which would be partially demolished.

Construction in the vicinity of the downtown Seattle waterfront piers (Piers 54 to 59) is not expected to damage the piers because of the proposed mitigation measures. Activities near the piers that are designated Seattle landmarks (Piers 54 to 59, the Waterfront Historic Character area) would be reviewed as needed by the Seattle Landmarks Preservation Board under the Seattle Landmarks Preservation

Historic Resources Key Points

Even the perception of reduced access could have notable economic impacts on waterfront historic districts, resulting in a loss of distinctive character and economic base.

Construction of any of the three build alternatives could have a potential adverse effect on the Washington Street Boat Landing pergola, which would be removed for the duration of construction in that area. The pergola would be restored and replaced in an appropriate location on a new overwater structure at the foot of S. Washington Street. All three build alternatives could also have a potential adverse effect on the existing seawall.

The shorter construction duration for Alternatives A and C, relative to Alternative B, would result in a shorter period of potential economic impact on historic properties.

Ordinance (SMC 25.12) (see Chapter 7 for additional details) and would be performed only with a certificate of approval if it is required. These activities include minor alterations to the piers or buildings located on the pier (piersheds), alterations that contact the piers, and alterations to pier access or views of the piers. Activities adjacent to the historic piers would be reviewed by the City Historic Preservation Officer under the City's SEPA policies (SMC 25.05.675). Activities within the Waterfront Historic Character area would be reviewed as needed by the Seattle Landmarks Preservation Board under SMC 23.60.704. Activities in the Pioneer Square Preservation District would be reviewed and granted certificates of approval, as needed, from the Pioneer Square Preservation Board (SMC 23.66.115).

Other historic properties in the APE that are located farther away from the construction activities are not expected to be damaged (Table 4-14).

Table 4-14. Potential Construction Effects on Historic Properties within the Area of Potential Effects

Address	Current Name (Historic Name)	Historic Designation	Alternative A	Alternative B	Alternative C
Alaskan Way	Elliott Bay Seawall	Eligible NRHP	Partially demolished; potentially adverse effect	Partially demolished; potentially adverse effect	Partially demolished; potentially adverse effect
Alaskan Way/Battery Street	Alaskan Way Viaduct and Battery Street Tunnel	Eligible NRHP	No adverse effect	No adverse effect	No adverse effect
S. Main Street to Bell Street	Burlington Northern Railroad Tunnel (Great Northern Railway Tunnel)	Eligible NRHP	No adverse effect	No adverse effect	No adverse effect
Foot of S. Washington Street	Washington Street Boat Landing Pergola	NRHP, PSPD	Removed during construction; potentially adverse effect	Removed during construction; potentially adverse effect	Removed during construction; potentially adverse effect
1 Yesler Way	1 Yesler Building (Bedford Hotel)	PSHD, PSPD	No adverse effect	No adverse effect	No adverse effect
619 Western Avenue	Western Building	PSHD, PSPD	No adverse effect	No adverse effect	No adverse effect
61 Columbia Street	Polson Building	PSHD, PSPD	No adverse effect	No adverse effect	No adverse effect
925 Alaskan Way	Fire Station No. 5	Eligible NRHP and SL	No adverse effect	No adverse effect	No adverse effect
911 Western Avenue	Maritime Building	Eligible NRHP	No adverse effect	No adverse effect	No adverse effect

Address	Current Name (Historic Name)	Historic Designation	Alternative A	Alternative B	Alternative C
1001 Alaskan Way	Pier 54 (Northern Pacific Railroad 3/ Galbraith Dock)	SL; eligible NRHP	No adverse effect	No adverse effect	No adverse effect
1101 Alaskan Way	Pier 55 (Northern Pacific Railroad 4/ Arlington Dock)	SL; eligible NRHP	No adverse effect	No adverse effect	No adverse effect
1201 Alaskan Way	Pier 56 (Frank Waterhouse House)	SL; eligible NRHP	No adverse effect	No adverse effect	No adverse effect
1203–1207 Western Avenue	(Olympic Warehouse)	NRHP, SL	No adverse effect	No adverse effect	No adverse effect
51 University Street	(Pacific Net and Twine Building)	SL; eligible NRHP	No adverse effect	No adverse effect	No adverse effect
1301 Alaskan Way	Pier 57 (John P. Agen's/ Milwaukee Dock)	SL; eligible NRHP	No adverse effect	No adverse effect	No adverse effect
1483 Alaskan Way	Pier 59/Seattle Aquarium (Ainsworth and Dunn Pike St. Wharf)	SL	No adverse effect	No adverse effect	No adverse effect
1507 Western Avenue	Fix Building	Eligible NRHP and SL	No adverse effect	No adverse effect	No adverse effect
1527–1531 Western Avenue	Heritage House/garage	PPMHD (local)	No adverse effect	No adverse effect	No adverse effect
2800 Elliott Avenue	Old Spaghetti Factory (Ainsworth and Dunn)	Eligible NRHP and SL	No adverse effect	No adverse effect	No adverse effect

Notes: NRHP – National Register of Historic Places, PPMHD – Pike Place Market Historic District, PSHD – Pioneer Square Historic District, PSPD – Pioneer Square Preservation District (local), SL – Seattle Landmark

Unique Effects of the Build Alternatives

Construction of Alternatives B and C would require excavation between 46 and 76 feet bgs, with project activities extending up to 265 feet west and 34 feet east of the existing seawall. Because the minimum project excavation depth would be 46 feet bgs, archaeological deposits associated with Yesler's Wharf and with Ballast Island in Zone 1 could be encountered, as could the cinder and charcoal deposits in Zone 3 and the native beach deposits in Zones 1, 2, 3, and 4.

Under Alternative B, the longer construction duration would subject historic properties to prolonged construction effects, increasing the likelihood of economic effects that could possibly affect the owners' ability to maintain the property, although minimization measures would be implemented to reduce this possibility.

Indirect Effects

No indirect effects related to archaeological, cultural, or historic resources have been identified.

Avoidance, Minimization, and Mitigation Measures

The process for determining adverse effects on archaeological resources is ongoing. If adverse effects on archaeological resources are determined, the City will comply with all measures for adverse effects to historic and archaeological resources stipulated in a memorandum of agreement signed by the City, DAHP, and USACE.

The City will also implement the following mitigation measures for potential adverse effects on cultural, historic, and archaeological resources:

- Conduct construction under the auspices of an Unanticipated Discovery Plan, including provisions for inadvertent discovery of cultural materials or human remains.
- Restore and replace the Washington Street Boat Landing pergola in its existing location on new pilings at the foot of S. Washington Street. The restoration and replacement will be performed in coordination with the Seattle Department of Neighborhoods Historic Preservation Program and will have the required certificates of approval from the Pioneer Square Preservation Board (SMC 23.66.115).
- Use best management practices (BMPs) to control noise and vibration, air pollution, dust, and mud.
- Ensure continued access to businesses and residences.
- Coordinate with property owners and utility providers to minimize disruptions to utility services.

Consulting Parties

Consulting parties under the Section 106 process include the State Historic Preservation Officer, Indian tribes, local government agencies, the applicant for a federal permit, and certain other parties with demonstrated interest.

4.5 Energy Resources

Effects Common to All Build Alternatives

Energy

Construction energy constitutes most of the overall project-related energy use. Energy would be consumed during construction to manufacture materials, transport materials, and operate construction equipment. On-site energy and fuel consumption depends on the construction activity, net working days, the acreage subject to disturbance, the type of equipment and the number of pieces, and the hours of equipment use, in addition to construction truck and worker trips to and from the work site. Fuel use by on-site equipment was calculated by calendar year for each build alternative.

Energy Resources Key Points

Construction energy makes up the bulk of the project-related energy use.

Construction energy consumption for Alternatives A and C is similar because the two alternatives have similar construction schedules, equipment needs, and material requirements.

Peak energy consumption for Alternative B would be less than that for Alternatives A and C because construction would be spread out over a longer time period.

None of the build alternatives would have a significant impact on energy resources in the Seattle area, and would not require mitigation.

The results of the construction energy analyses for the three build alternatives are summarized in Table 4-15. The estimate of energy content and carbon dioxide equivalents in the table include energy use and GHG emissions from on-site construction activity, off-site construction-related truck traffic, and off-site construction worker commute traffic. The results for Alternative A are similar to the effects expected for Alternative C because the two alternatives are assumed to have the same construction schedule, equipment needs, and material requirements. Under Alternative B, the peak energy consumption would be less than that that for Alternatives A and C because the construction would be spread out over a longer period of time, though total energy consumption over the construction period would be higher.

Seattle Climate Protection Initiative

In 2008, the City of Seattle reached the goal of the Seattle Climate Protection Initiative of reducing GHG emissions to 7 percent below 1990 levels by 2012, to approximately 6,770,000 metric tons per calendar year.

Table 4-15. Results of Construction Energy Analysis

	Alternatives A and C	Alternative B
Average annual construction energy (MMBTU/year)	442,668	537,934
Average annual CO_2e construction emissions (metric tons/year)	32,869	39,995
Peak annual construction energy consumption (metric tons/year)	80,742	63,156
Year of peak construction energy use	2014	2018

Note: CO_2e – carbon dioxide equivalents, MMBTU – million British thermal units

For comparison, Seattle City Light delivered a total of 20,057,872 million British thermal units (MMBTU)[1] of energy in 2009. While the figures in the table represent construction energy uses not associated with Seattle City Light's distribution capacity, the greatest annual construction energy consumption for any of the build alternatives corresponds to less than 0.5 percent of Seattle City Light's 2009 output. Disregarding the potential for electricity use by contractor trailers and dewatering pumps, all non-fuel-based primary energy consumed for construction is anticipated to be produced by on-site generators, rather than drawn off the Seattle City Light electricity grid; therefore, it would not have a significant impact on Seattle City Light's electrical distribution capacity or the availability of energy resources in the project area.

[1] Based on an "energy delivered" conversion factor of 3,412,141.6 British thermal units per megawatt-hour (or 3.4121416 MMBTU per megawatt-hour). Electricity delivered is the amount of electrical energy delivered to the final customer after electrical losses.

Greenhouse Gas Emissions

Project construction would contribute to GHG emissions through the burning of fossil fuels to operate construction machinery and transport workers. GHG emissions would also result from the use of electrical energy during construction because some of Seattle City Light's purchased power comes from fossil fuels. Seattle City Light offsets all of its GHG emissions by mitigation programs to achieve equivalent emission reductions.

The three build alternatives would differ slightly in terms of their construction emissions, proportional to the difference in the amount of work associated with each alternative. GHG emissions for on-site construction vehicle and equipment use, as well as construction-related vehicle and worker trips, were calculated by calendar year and by zone, and expressed as metric tons per year in carbon dioxide equivalents. Table 4-16 compares the total estimated construction GHG emissions resulting from the three build alternatives.

Table 4-16. Total Estimated Project Construction Greenhouse Gas Emissions by Greenhouse Gas Pollutant

	Total On-Site Construction GHG Emissions (metric tons/year)				Total GHG Emissions from Construction-Related Traffic (metric tons/year)				Total (metric tons/year)
	CO_2	CH_4	N_2O	CO_2e	CO_2	CH_4	N_2O	CO_2e	CO_2e
Alternatives A and C (total)	**23,280**	**1**	**1**	**23,562**	**9,188**	**0**	**0**	**9,308**	**32,870**
Central Seawall	11,929	1	0	12,075	4,194	0	0	4,249	16,325
North Seawall	11,351	1	0	11,486	4,994	0	0	5,059	16,545
Alternative B (total)	**28,515**	**1**	**1**	**28,841**	**11,010**	**1**	**0**	**11,155**	**39,996**
Central Seawall	16,384	1	1	16,570	4,800	0	0	4,863	21,433
North Seawall	12,132	1	0	12,271	6,211	0	0	6,293	18,563

Notes: CH_4 – methane, CO_2 – carbon dioxide, CO_2e – carbon dioxide equivalents, GHG – greenhouse gas, N_2O – nitrous oxide, GWP multipliers are as follows: CO_2 GWP multiplier = 1, CH_4 GWP multiplier = 25, N_2O GWP multiplier = 298, where GWP is the global warming potential as CO_2e from the Intergovernmental Panel on Climate Change fourth assessment report 100-year timeframe (IPCC 2007).Columns may not sum to 100 due to rounding.

The greatest annual GHG emissions predicted to result from project construction for the three build alternatives (5,996 metric tons [Mg] carbon dioxide equivalents [CO_2e] for Alternatives A and C in 2014 and 4,709 Mg CO_2e for Alternative B in 2018) correspond to less than 1 percent of the City's proposed emissions for the 2030 annual GHG emissions target. Based on the estimated construction GHG emissions in comparison to the City's GHG emissions targets, none of the build alternatives would have a significant effect on GHG conditions in the Seattle area.

In addition to the construction activities themselves, GHG emissions would also occur in the production of concrete and steel for the project. The emissions are listed in Table 4-17 by build alternative. The embodied GHG emissions in the concrete and steel used for any of the build alternatives would be spread over the lifecycle of the selected alternative.

Table 4-17. Concrete and Steel Production Greenhouse Gas Emissions (by Alternative)

Alternative	Cubic Yards of Concrete	Mg of Cement / Cubic Yard of Concrete	Mg CO_2e / Metric Ton of Cement	Total Mg CO_2e for Cement Use
A	198,245	0.272	0.97	52,305
B	111,226	0.272	0.97	29,346
C	199,870	0.272	0.97	52,734
Alternative	**Pounds of Steel**	**Mg of Steel**	**Mg CO_2e / Metric Ton of Steel**	**Total Mg CO_2e for Steel Use**
A	11,486	0.907	0.92	9,584
B	17,788	0.907	0.92	14,843
C	11,608	0.907	0.92	9,686

Notes: CO_2e – carbon dioxide equivalents, Mg – metric tons

Indirect Effects

There are no tools currently available for clearly and meaningfully discerning which emissions are attributable to a specific project and which emissions would have occurred without the project. Because the project involves replacing existing infrastructure in more or less the same location, it is not likely to result in indirect effects on energy. The build alternatives would result in indirect GHG emissions that would not be the direct result of project construction, but would nonetheless be caused by the project. For example, GHGs would be emitted during the production of materials acquired for project-related construction.

Avoidance, Minimization, and Mitigation Measures

No mitigation will be required.

4.6 Land Use, Shorelines, and Parks and Recreation

Effects Common to All Build Alternatives

Land Use and Shorelines

The seawall construction, habitat improvements, and restored roadway would result in temporary changes in traffic patterns, changes in business and residential access, increased noise, and increased dust that would affect the adjacent land uses. The specific effects on traffic, access, noise, and air quality are discussed in other sections of this chapter.

Under any of the build alternatives, temporary construction easements would be required waterward of the existing seawall along the entire length of the alignment. These easements would be needed to allow work to proceed on project elements, including the removal of the seawall, placement of temporary sheet piles, and construction of habitat benches. The easements would need to be obtained primarily from government agencies, although temporary easements from private land owners would also be needed. Table 4-18 indicates the square footage of temporary and permanent easements that would be necessary for each build alternative.

Table 4-18. Estimated Temporary Construction Easements

	Temporary Easement (square feet)	
	Central Seawall	**North Seawall**
Alternative A	100,000	81,000
Alternative B	94,000	81,000
Alternative C	100,000	81,000

Parks and Recreation

Throughout the duration of construction, the multi-use trail would continue to operate in its existing location from S. Washington Street to Pike Street, providing recreational opportunities for walkers and bicyclists, in addition to its primary transportation role. Pedestrian access to Waterfront Park, the Seattle Aquarium, and Pier 62/63 would be provided to the maximum extent possible. See Chapter 3, Figure 3-12 for the location of the parks and recreational facilities in the study area.

When construction work is occurring immediately adjacent to a specific pier, there may be temporary reroutings of and restrictions in access. If access is not possible for short periods of time, access to specific recreational amenities including shoreline public access points may be temporarily suspended. Parking and deliveries to recreation venues on

Land Use, Shoreline, and Parks and Recreation Key Points

For all build alternatives, temporary easements would be needed from some private landowners to construct the project.

The waterfront multi-use trail would remain open and would operate in its existing location for the duration of construction.

Access to piers may be temporarily rerouted or restricted when construction work is occurring immediately adjacent to the pier.

Public access to the Seattle Aquarium would be provided throughout construction.

The longer construction period required for Alternative B means employees, visitors, and residents of the historic piers, Waterfront Park, and the Seattle Aquarium would experience effects for up to 2 years longer than for Alternatives A and C.

piers would be temporarily inaccessible or restricted during portions of the construction period. Public art adjacent to construction work zones would be protected in place or temporarily removed and stored to reduce the likelihood of damage.

Regular boat services from Pier 55 to Blake Island State Park, as well as the Argosy harbor cruises would continue to be accessible during construction. Access to portions of the overwater plaza between Piers 55 and 56 that connects to the Argosy boat docks may be closed for short periods, but access to the docks should be available at all times.

Public access to the Seattle Aquarium would remain available throughout construction. When work is occurring in the immediate vicinity of the main entrance, visitors may have to access the aquarium via an alternate route, such as through Waterfront Park, for a short period. The temporary loss of parking and more distant bus loading/unloading areas may dissuade some patrons and school groups from visiting the Seattle Aquarium during the construction period. Construction activities in the vicinity of the Seattle Aquarium are also likely to have a temporary adverse effect on aquarium revenue.

The Washington Street Boat Landing pergola would be removed during construction in this area. The pergola would be restored and replaced in an appropriate location on a new overwater structure at the foot of S. Washington Street in Zone 1; this would likely occur at the end of the construction period.

During construction of the Central Seawall, a vehicle detour would be provided east of the existing surface street, with three lanes under the existing Alaskan Way Viaduct and a fourth lane just west of the viaduct structure. During this period, parking would be removed from under the viaduct. This loss of parking would reduce the supply of available parking that serves the various parks and recreational venues.

Unique Effects of the Build Alternatives

The 2-year-longer construction period for Alternative B would particularly affect historic piers, Waterfront Park, and the Seattle Aquarium. The construction activities in Zone 1 to install a new gangway to short-stay boat moorage and for construction of a new intertidal habitat bench and boulders or a boardwalk (depending on the option) for seating and viewing could also disturb recreational activities during construction.

Because of the complexity of construction and the resulting longer construction period in the vicinity of the Seattle Aquarium and other waterfront park and recreation facilities, Alternative B would have a greater effect on parks and recreation than Alternatives A and C.

Indirect Effects

No indirect effects related to land use, shorelines, or parks and recreational facilities have been identified.

Avoidance, Minimization, and Mitigation Measures

Appropriate compensation will be provided for any temporary easements required for project construction. No additional mitigation specific to land use is proposed.

The City will implement the following mitigation for adverse effects on parks and recreational facilities:

- Shut down construction activity from Memorial Day weekend through Labor Day weekend to minimize effects to parks and recreational facilities. Restore parking along the waterfront during these summer months to minimize the adverse effect during the period of greatest parking demand along the waterfront.
- Provide noise attenuation to minimize the effect on pedestrians seeking to enjoy Waterfront Park, artwork along the waterfront, or the views along the waterfront. See the Noise and Vibration measures listed above.
- Coordinate with Seattle Aquarium staff to minimize construction-related impacts on the animals in the collection from noise and vibration, airborne dust, and interruption of the water supply due to construction activity. Measures will include noise attenuation, dust suppression measures, and a contingency plan for addressing issues related to water quality or supply issues.
- Coordinate with the Aquarium as construction commences to allow for proper preparation of the saltwater intake in order to prevent any uptake of sediment.
- Conduct public outreach to let residents and visitors know how to access the waterfront during construction, where parking is available, and how to reach the area by transit. During the active construction season, the City will work with the Seattle Aquarium and other affected recreational sites to provide alternative parking sites and convenient loading zones for school and other charter buses. See the Transportation measures listed earlier in this chapter for additional details on access and parking mitigation.
- During construction in the vicinity of the Aquarium, provide a marked detour at all times with appropriate signage at both Pike Place Market and the Seattle Aquarium. Pedestrian links between the waterfront and Western Avenue/First Avenue will be provided at least every two blocks during construction to minimize significant out-of-direction pedestrian movements.

- Provide a continuous pedestrian/bicycle corridor along Alaskan Way throughout construction to facilitate linkages among the various waterfront parks and recreational facilities. In addition, provide a continuous pedestrian corridor on the west side of Alaskan Way during the peak summer months. During construction in any given zone, a safe, clean, well-lit pedestrian detour route will be provided to facilitate access to the various facilities along the waterfront.
- Protect artwork within the construction work zone from damage due to construction activity. The protection could include encapsulation of the artwork in place or its temporary removal and storage.

4.7 Public Services and Utilities

Effects Common to All Build Alternatives

Public Services

During construction, public services would be temporarily affected by increased traffic congestion. Delays on the primary roads and roads around the construction area would also temporarily affect public services. The seawall construction, the construction staging areas, and the modified roadway for construction would all have moderate effects on public services. Construction activities could result in potential disruptions in access, increases in emergency response times, and restricted mobility in the corridor. Generally, the potential project-related effects on public services fall into two main categories: (1) increased travel time (also referred to as response time) and (2) access to and demand for public services. These two categories of effects are described for emergency response services (fire suppression, emergency medical, and law enforcement services) and for non-emergency services (solid waste, postal, and school services).

Fire Suppression and Emergency Medical Response

Impacts on fire suppression and emergency medical services can best be assessed by examining emergency vehicle travel times during construction. Increased travel time for emergency vehicles can be a serious problem during life-safety emergencies and for disaster preparedness. Travel times for emergency vehicles differ from travel times for general traffic because emergency response vehicles have the right-of-way over general traffic, can use emergency travel lanes, and may be able to preempt traffic signals. Travel times for emergency vehicles and their specific causes resulting from roadway configuration and roadway congestion are assessed in detail in Section 4.1 of this Final EIS, Transportation. Changes in emergency vehicle travel times are summarized in this section.

Travel time for emergency vehicles would increase in some locations during portions of seawall construction (Table 4-19). During Central

Public Services Key Points

During construction of all build alternatives, response times for police, fire, and emergency medical aid would increase to locations within and near the project area.

Project-related effects on public services include increased travel times and increased demand for public services.

Fire Station No. 5 would be directly affected by project construction. Construction would interfere with the normal emergency response functions provided out of this station, particularly the ingress, egress, and parking for the engine company vehicles.

There is an increased potential for casualties during a major earthquake if there are damages to the existing Alaskan Way Viaduct and the temporary road underneath. This would also put additional demands on emergency service responders.

Solid waste haulers could experience delays or disruptions during construction, and temporary waste collection locations may need to be established.

Seawall construction, travel times from Fire Station No. 5 for southbound emergency vehicles would increase for all of the build alternatives. Travel times would also increase for Alternative B in the northbound direction when construction is occurring between S. Washington Street and Madison Street. During North Seawall construction, emergency vehicle travel times would increase in the northbound direction for all alternatives when construction is occurring between Battery Street and Broad Street.

Table 4-19. Changes in Travel Times for Emergency Vehicles for Two Representative Trips Originating at Fire Station No. 5 (in Minutes)

Route	Central Seawall				North Seawall			
	Traffic Analysis Phase I Virginia to Madison		Traffic Analysis Phase II Madison to S. Washington		Traffic Analysis Phase III Broad to Battery		Traffic Analysis Phase IV Battery to Virginia	
	Alts A and C	Alt B	Alts A and C	Alt B	Alts A and C	Alt B	Alts A and C	Alt B
Northbound Fire Station No. 5 to Broad Street	-0:30	-0:30	-0:30	+0:06	+0:08	+0:08	-1:12	-1:12
Southbound Fire Station No. 5 to S. King Street	+0:13	+0:13	+0:17	+0:13	0	0	0	0

In addition to impacts on response times, there are four issues for emergency responders related to service access and demand: (1) the ability to safely and adequately reach structures adjacent to the construction work zone; (2) the potential for increased demand for emergency services related directly to the construction activities; (3) maintenance of the minimum requirement for exiting from the buildings through the construction work zone; and (4) maintenance of utilities during construction for essential fire and life-safety systems, including electricity, water, and telecommunications.

Access to properties on the west side of Alaskan Way could be revised when construction work is occurring in the immediate area. This would result in potentially complicated access, especially for large fire department vehicles, such as ladder trucks, and may also increase response times.

The impacts on demand for fire suppression and emergency medical services during construction are expected to be relatively small. Spills of fuel, flammable fluids, or hazardous-substance would require emergency response, although the likelihood and/or frequency of such events are expected to be quite small.

Fire Station No. 5 would be directly affected by project construction when seawall work is occurring in front of the station. The station provides support not only for the engine company but also for the fire boat; therefore, access to the station would need to be provided at all times. Construction would interfere with the normal emergency response functions provided out of this station, particularly the ingress, egress, and parking for the engine company vehicles.

During construction, fire hydrants along the seawall alignment would need to be relocated. There may also be short-term planned disruptions in water lines during switchovers that could temporarily affect fire suppression. The City would need to work closely with the Seattle Fire Department and the contractor(s) to coordinate such disruptions and ensure that public safety is maintained at all times.

Law Enforcement

Construction traffic congestion would have an impact on law enforcement services. Traffic mobility during construction in heavily traveled areas is difficult, especially during peak hours, and travel times for emergency calls may increase. The preceding discussion on fire suppression and emergency services, and Section 4.1 of this Final EIS (Transportation), provide additional information on roadway congestion and travel times. Construction detours may require traffic control officers during peak periods to facilitate both through movements and turning movements (especially U-turns to Colman Dock Ferry terminal). The construction contractor(s) would be responsible for on-site security.

Construction could affect disaster preparedness and result in delayed response times, which may affect the operations of Seattle Emergency Management, the Port of Seattle, and Washington State Ferries, especially during peak hours.

With the use of the temporary road under the existing Alaskan Way Viaduct structure during construction, there is an increased potential for casualties if a major earthquake occurs during construction and damages all or a portion of the viaduct.

Solid Waste Collection, Disposal, and Recycling

Solid waste haulers could experience delays or disruptions in collection routes during construction activities, especially along route sections that include curbside, driveways, or other collection points that could be closed or more difficult to access. Collection and haul routes outside the study area also may be affected due to changes in traffic patterns on local roads. Access to the waterfront piers, in particular, could be more difficult when construction activity is occurring, which could result in more time-consuming collection. Temporary waste collection locations may need to be established to provide necessary services to businesses.

In addition, waste and debris generated during construction would need to be collected for disposal. Spoils removed from the construction work zone would be hauled away in trucks or railcars to a predetermined disposal site.

Public Schools

Delays for school buses and other vehicles used for field trips to the project vicinity could occur due to traffic congestion and lane or roadway closures. Construction would delay buses traveling on, crossing, or making turns on the roadway under construction. Major north-south school bus thoroughfares, including the Alaskan Way surface street and adjacent surface streets, would likely be affected at key intersections along these roads. School buses that use Alaskan Way for field trips would experience some traffic delays, although the traffic analysis indicated that average travel time would increase no more than 2.5 minutes (see the Transportation Discipline Report [Appendix C]). Loading, unloading, and parking could be more difficult and take place farther away from the desired destinations, especially when construction work is occurring in Zone 3 (Central Piers) and Zone 4 (Seattle Aquarium/Parks).

Postal Services

There would be no direct impacts on post offices during project construction. Postal deliveries along Alaskan Way would be subject to some delays during construction; although the traffic analysis indicated average travel time increases of no more than 2.5 minutes (see the Transportation Discipline Report [Appendix C]). Delivery locations could be subject to variation as construction proceeds along the waterfront.

Utilities

The three build alternatives would have similar impacts on the utilities in the project area. Under Alternatives A and B, the proposed structural replacement methods would require excavation into the area currently occupied by multiple utilities. Under Alternative C, the depth of excavation would be less. The impact zone used in the following descriptions is based on an assumed slope of 2 feet horizontal to 1 foot vertical (2H:1V) from the bottom of the excavation to the existing grade east of the project area.

Electrical Power

Exact locations for utility relocations would be identified during design development and through coordination with the Seattle Department of Planning and Development for compliance with the Shoreline Master Program. Temporary lines across the construction area would be required to provide continuous power to the commercial and pier facilities along the waterfront.

The linear feet of affected electrical systems for the build alternatives would be nearly the same (less than 100 feet of difference; see the Public Services and Utilities Discipline Report [Appendix J]). Facilities

Utilities Key Points

The three build alternatives would have similar impacts on area utilities.

Many utilities would be temporarily disrupted and would have to be protected in place or relocated during project construction.

All build alternatives would temporarily affect the 12-inch water main near Columbia Street and the 21-inch water main between Union and Pine Streets. Alternatives B and C would have the greatest effect on the 21-inch water main.

The functions of stormwater outfalls and control structures would be maintained throughout construction to maintain compliance with existing permits.

must also be accessible to trucks and equipment at all times for maintenance during and after construction. This would include access for unanticipated service disruptions.

Electrical service connections could be disrupted during construction, including unanticipated service disruptions. It is anticipated that new connections would be provided, and the existing and new connections would be sequenced and protected during construction to provide continuous service. Repair response to unanticipated service disruptions and customer service requests could be affected by construction activities and traffic congestion.

Water Supply

All three build alternatives would require full replacement of the 21-inch-diameter water main between Union Street and Pine Street, and relocation where in conflict with the restored roadway north of Union Street. Approximately 60 percent of the 21-inch-diameter water main could be protected in place under Alternative A; the remainder would need to be replaced. Under Alternatives B and C, the 21-inch-diameter water main would require full replacement. Temporary services and fire-protection systems would be required throughout construction.

Other impacts of the build alternatives would be on lateral pipelines crossing the construction work zone to service connections, fire-protection laterals, and water-service meter vaults. The existing water system contains some sections of old cast-iron pipe. Vibration associated with seawall construction may lead to operational issues if the brittle pipe joints are damaged.

Water service connections would be disrupted during construction. It is anticipated that new connections would be provided as a part of construction, and existing connections, new connections, and meter vaults would be sequenced to provide continuous service.

Sewer, Combined Sewer, and Storm Drainage

The three build alternatives would have similar impacts on the gravity-pipeline systems that penetrate the seawall. Currently, the approach for the build alternatives calls for protecting the combined sewer outfalls (CSO) in place or relocating within the immediate proximity. Affected stormwater outfalls and storm drains would be relocated within close proximity of existing locations. Outfalls may be slightly modified to meet the proposed alignments of the seawall. Some outfalls have drop structures at the face of the existing seawall that lower the discharge elevation from where it actually penetrates the wall. The design of the outfall replacements was evaluated for compatibility with the proposed habitat features.

The function of outfalls and control structures must be maintained throughout construction in order for the City to be in compliance with the NPDES permit requirements. The number of affected outfalls and

control structures would be the same for all three build alternatives. Temporary facilities may need to be designed to provide continuous service during construction; it is expected that facilities would be relocated only once during construction, with minimal use of bypasses. There are several locations where mitigation of impacts on existing gravity pipelines may be possible in the upland-slope transition zones. Lateral connections for both stormwater and wastewater flows could be disrupted during construction. It is anticipated that new connections would be provided, existing and new connections would be protected or sequenced, and sequencing would provide continuous service.

Natural Gas

The natural gas systems in Zones 1 through 4 that are owned by Puget Sound Energy are supplied by a 12-inch-diameter, high-pressure gas main that enters the construction work zone between Union Street and Pike Street. The gas main would be affected by Alternatives B and C but is located outside the zone of disturbance for Alternative A. In Zones 5 and 6, the 2-inch-diameter gas main north of Vine Street would be affected by all three build alternatives. The build alternatives would have a moderate impact on service laterals serving commercial and pier activities on the west side of the waterfront corridor.

Capping lines during construction could affect the operation of the intermediate-pressure gas grid. During the design phase, Puget Sound Energy would develop designs to provide continuous operation of its system throughout construction (FHWA et al. 2004).

Natural gas service connections could be disrupted during construction. It is anticipated that new connections would be provided, existing and new connections would be protected or sequenced, and sequencing would provide continuous service.

Steam

Virtually the entire steam system along the waterfront would be affected by the project construction activities required for all three build alternatives. The active steam line that services the waterfront is attached to the existing seawall face, and it would need to be relocated to provide continuous service. A collection of steam lines that cross the proposed excavation is currently not in service and would be removed.

Steam service to customers, which include the Colman Dock Ferry Terminal, Anthony's Homeport Restaurant, and the Seattle Aquarium, may be disrupted during construction. Options for minimizing the effects would be investigated during design, including the use of temporary boilers or laying pipe to bypass construction.

Telecommunications

The infrastructure owned and operated by communications providers in the study area is aerial, underground, and suspended from the Alaskan Way Viaduct. These systems use fiber-optic, coaxial, and copper-cable materials and have associated conduits, risers, vaults, manholes, and

other appurtenances. Underground lines have been direct-buried, installed in open-cut trenches, or directionally drilled. Other lines are pulled through pipelines formerly used for other utility purposes, such as gas and water conveyance (FHWA et al. 2004).

Lines from multiple communication providers run in parallel along the west side of the corridor from S. Washington Street to Pine Street and from Bell Street to Broad Street. These systems would be affected equally by all three build alternatives. In the area north of Pine Street extending to Bell Street, a system of duct banks and utility vaults is located in the slope-transition zone of the construction work zone for all three build alternatives. The section between Pine Street and Bell Street will be protected in place.

Some of the communications systems are referred to as long haul or transport systems, while others are distribution systems and include lateral lines and service lines to customers. In general, all of the active systems are vital to the customers and cannot be taken out of service during project construction, except during planned cutovers required by construction activities. Each communications provider would need to consider operational impacts on its system during the design phase. Coordination between the City, the contractor(s), and the communications providers would be necessary.

Unique Effects of the Build Alternatives

The major difference among the build alternatives is the construction duration. Construction under Alternative B would take up to 2 years longer than construction under either Alternative A or C. Therefore, under Alternative B, the potential impacts and risks associated with public services and utilities during construction would occur for a longer period.

Two additional unique effects are related to specific, main utility lines. Approximately 60 percent of the 21-inch-diameter water main could be protected in place under Alternative A; the remainder would need to be replaced. Under Alternatives Band C, the 21-inch-diameter water main would require full replacement.

The natural gas main is located outside the zone of disturbance for Alternative A but would be affected by Alternatives B and C.

Indirect Effects

No indirect effects related to public services and utilities have been identified.

Avoidance, Minimization, and Mitigation Measures

The City will implement the following mitigation for adverse effects on public services during construction:

- Work closely with the Seattle Police Department and Seattle Fire Department to ensure that reliable access is provided for emergency services during construction and minimize delays in response times due to construction activities and detours. A center emergency-access/left-turn lane will be provided along the temporary road to facilitate the movement of emergency vehicles.
- If the use of the center lane does not provide for appropriate response times, SDOT will implement signal controls (such as signal preemption) at signalized intersections to mitigate the effects on the response times of fire and emergency medical services during construction. In addition, provide striping and signage at the intersection of Alaskan Way and Madison Street in front of Fire Station No. 5, to prohibit blockage of the intersection.
- Develop safety protocols and provide on-site first aid personnel during active construction phases. Provide 24-hour security if needed to minimize the likelihood that anyone other than an employee will gain access to potentially dangerous areas within the construction work zone.
- Provide a temporary secured parking spot for the Fire Station No. 5 fire engine vehicle if the current building bay is inaccessible. Fire department employees who currently park on site during their 24-hour shift will be accommodated with temporary parking at a nearby location during this period.
- Coordinate with the Seattle Police Department to ensure that adequate traffic control is provided during construction for pedestrian and vehicle movements and to facilitate emergency access.
- Coordinate between the Seattle Fire Department and Seattle Public Utilities on water-line relocations that may affect the availability of water for fire suppression. Alternative water-supply lines would be provided if needed to ensure that no significant disruption of service occurs.
- Coordinate with solid waste service providers to minimize effects on solid waste collection and recycling activities. The City and the contractor(s) will properly dispose of construction materials and spoils according to all applicable regulations. Additional details about the disposal of construction materials and spoils are provided in the mitigation measures discussed under Sections 4.12 and 4.13.

- Notify the Seattle School District of construction detours that may affect school bus routings to and through the project area.
- Notify the U.S. Postal Service of construction detours and access changes that may affect postal deliveries. Access for postal deliveries will be provided to all buildings during construction.
- Provide timely communications to waterfront businesses, property owners, and other stakeholders as construction activities proceed, along with details about detours, utility disruptions, and other critical activities.

The City will implement the following mitigation for adverse effects on utilities during construction:

- Comply with all federal, state, and local utility standards and criteria. The City will work closely with utility owners to coordinate each utility's criteria and coordinate space planning and construction sequencing to reduce overall risks, costs and impacts. The City will work with utility owners to develop acceptable alternatives for protecting utilities in place where possible.
- Outfall-replacement design will be evaluated for compatibility with proposed habitat elements as details for these features become available.
- Coordinate with public and private utilities to schedule and sequence utility work with the overall project construction schedule. This will include relocation of some utilities to a clear corridor in the summer preceding start of seawall construction and will be coordinated with future utility relocations and improvements along the downtown Seattle waterfront.
- Coordinate with utility providers to provide continuous service to customers and maintain critical services such as fire protection and emergency communications.
- Require standard industry protection measures to reduce direct construction impacts on utilities. Identify construction techniques to limit vibration impacts on utilities. Vibration monitoring will be conducted where required.
- Coordinate with utility purveyors to provide maintenance and emergency access to all utilities throughout construction. If any inadvertent damage occurs, the City will immediately contact the utility owner.

4.8 Social Resources and Environmental Justice

Effects Common to All Build Alternatives

Generally speaking, the specific impacts of construction on social resources adjacent to the project area would be similar under all three build alternatives, except they would last longer under Alternative B on account of the longer duration of construction. The effects of the build alternatives on social resources and environmental justice populations are expected to be the same, except where noted.

Construction activities could have several different types of adverse effects on residents living in and near the construction work zone. The construction traffic, road detours, light and glare, noise, and dust would certainly affect residents living within approximately one to two blocks of the construction. Residents living across the street or adjacent to potential construction staging areas would also be affected. The extent of these effects would depend on the stage of construction and the proximity to residents and businesses.

Isolation of the construction activities to ensure public safety would require corridor fencing, temporary road closures, and traffic detours. The closures and detours would likely be needed for varying periods of time, some for a number of years and others for perhaps only months. Construction impacts may cause temporary hardships and/or stress for some residents, especially the elderly, persons with disabilities, and transit-dependent persons who tend to be more affected by access issues because of their more extensive use of public transportation.

In the immediate construction area, noise from specific construction equipment may be heard up to a few blocks away from the construction work zone. Residents living across the street would be able to view construction activities and equipment storage areas within the fencing, especially from top floors of buildings. Lights would be directed at construction activities and shielded, but residents may experience some additional lighting and glare. Construction vehicles would enter and exit the construction work zone at gates in the perimeter fencing surrounding the construction work zone where feasible. In addition, direct access to and from some buildings may be disrupted, although not eliminated, for short periods of time.

Community Facilities

The project area includes a number of community facilities (see Chapter 3, Figure 3-17). Potential construction effects on community facilities would likely be less severe than the effects on residents because those using community facilities are typically at the facility only during daytime hours. Most people have higher thresholds for loud noises, light and glare, and dust during daytime hours. Therefore, the primary concerns would be related to building access, (i.e., doors, garages, driveways, and walkways). In addition, people would be

Social Resources and Environmental Justice Key Points

Construction may cause temporary hardship or stress for some residents–especially the elderly, persons with disabilities, and transit-dependent persons–due to disruptions to access and public transportation in the project area.

Construction traffic, noise, and construction lighting and glare would affect residents, community facilities, and religious institutions in or near the construction area. These effects could also have a substantial adverse effect on minority and low-income populations in the project and the organizations that serve them.

The social fabric of neighborhoods could be affected by the long duration of the construction schedules and the loss of parking resources.

There would be some impacts on tribal fishing during construction.

Construction activities would affect the homeless population who are living in and near the project area.

Although construction effects may be substantial, the project would not cause disproportionately high and adverse effects on minority and low-income populations.

concerned about their ability to access their neighborhood and building by means of vehicles and transit. Community facilities would experience some adverse effects, but they would not be substantial adverse effects once mitigation measures are implemented.

Potential construction effects on the two education facilities located at the north end of the study area—the Art Institute of Seattle and the Seattle School of Theology and Psychology—would be similar to the effects on other community facilities. The effects would include construction traffic, noise, and construction lighting and glare. Most lectures and classes occur during the day when most of the construction would occur; therefore, some adverse effects on teachers and students could result.

Potential construction effects on religious institutions would be more similar to the effects experienced by residents than those experienced by people at community facilities. Loud construction noises would disrupt the experience normally expected at such institutions. Potential adverse construction effects may be experienced by the Ministry of Saints Martha and Mary, which is located just outside the construction work zone.

Potential adverse construction-related effects on social and employment services would be similar to those described for community facilities. Workers, clients, volunteers, and others would primarily be inside buildings during daytime hours. Therefore, they would be less sensitive to noise, light and glare, and dust than if they were outside. As a result, the effects would be adverse but not likely to be perceived as substantial. However, social and employment services also must be able to continue to provide services to their clients during the construction period. This may include referring their clients to other social or employment service agencies. Clients most likely would take public transportation or walk to the location of the other service agency. In addition, some service agencies may provide transportation for their clients. However, plans could be made in advance to ensure that services would not be compromised. Therefore, the effects on social and employment services likely would be considered minor.

The project area encompasses several areas where cultural and/or social institutions are located in proximity to the construction work zone. The Seattle Aquarium, the Bell Harbor International Conference Center, the Seattle World Trade Center, and Olympic Sculpture Park are all located adjacent to the construction work zone along the waterfront. Depending on the type of event, construction effects could be perceived as an inconvenience or a potentially adverse effect. Vehicle, transit, and pedestrian access to social and cultural institutions to attend events could be affected by construction activities, particularly construction-related congestion, road closures, and traffic detours.

Activities along the waterfront could be affected, depending on the types of construction activities. The Alaskan Way roadway detour would affect those attending events along the waterfront. Such adverse effects

would be particularly severe when events begin during or close to rush-hour traffic periods. The inconvenience caused by reroutes and additional travel time could deter some patrons from attending some events. The actual event, however, may not be affected by construction-related disruptions. If there are events that require a quiet environment, patrons may not be able to hear the words or music. However, because construction would be suspended during the summer months, only events that occur after Labor Day weekend and before Memorial Day weekend would potentially be adversely affected.

Potential construction effects on key government office buildings are expected to be similar to those described for other community facilities. There are a number of government institutions that are adjacent to the construction work zone. The Port of Seattle Terminal 46, Colman Dock Ferry Terminal (Pier 52), Bell Street Pier Cruise Terminal (Pier 66), and the Port of Seattle Marine Headquarters (Pier 69) are located adjacent to the construction work zone. Building occupants would primarily be inside during daytime hours, when people generally have a higher threshold for construction-related noise, light and glare, and dust. No significant adverse effects are expected.

Neighborhood Cohesion

A key project construction impact would be the temporary loss of parking under the Alaskan Way Viaduct that would not be available for use by residents, workers, or visitors for an estimated 3 to 5 years during Central Seawall construction (depending on the build alternative). Construction activities are proposed to occur up to 6 days per week, with two 10-hour shifts per day to meet proposed construction schedules. However, for some construction activities, work could occur up to 7 days per week, 24-hours per day. Construction activities may also occur concurrently in a number of locations throughout the project area.

These activities would create ongoing hardship and stress upon residents, workers, visitors, and businesses. The social fabric of neighborhoods could be affected by the long duration of the construction schedules. Some residents may decide to move. Some businesses would suffer few adverse effects, while others may experience a noticeable decline in patronage and/or sales, increased operating costs, and/or decreased operational efficiency. These construction-related effects could adversely affect the comfort and daily life of residents and inconvenience and/or disrupt the flow of customers, employees, and materials/supplies to and from businesses.

These effects could adversely affect those located in and near the study area during construction, but the effects would be mostly localized to where construction is occurring and only while construction is in progress. Timeframes for potential effects from construction are exclusive of the 3-month annual summer shutdowns, and the length of disruption depends on the build alternative.

Employment and Housing

Among the three build alternatives, the average number of construction jobs would range between approximately 20 and 50 workers per shift, depending on the alternative and the duration of construction. The required skills would be those typical of construction workers. The average annual number of workers employed on the project would be only a very small percentage of the forecasted number of workers in the region's construction sector. Therefore, the demand for project construction workers and their needs for housing are not expected to directly affect population or the demand or price of housing in the Puget Sound region.

Environmental Justice

Environmental justice analysis is not required under SEPA regulations. However, the City is including an analysis that meets and exceeds the requirements of the City's Race and Social Justice Initiative (RSJI) and SDOT's RSJI Annual Work Plan to complete equity analyses of SDOT projects, programs, and policies. This analysis also meets the federal requirement for projects with a federal nexus and those receiving federal funds, which are required under Environmental Justice Presidential Executive Order 12898 to evaluate potential "equity effects" of a proposal. Protection of the community's civil rights and the fair distribution of a project's burdens and benefits lie at the heart of the issue. An analysis of environmental justice looks at the potential disproportionate impacts of project alternatives on federally protected groups, which include the following:

- Minorities (Black, Hispanic, Asian, Pacific Islander, American Indian or Alaskan Native)
- Low income (households below the federally designated poverty level as defined by the U.S. Health and Human Services)

Special classes also included in an environmental justice analysis include the following:

- Transit-dependent populations
- Populations over 65 years old
- Persons with disabilities
- Populations with limited English proficiency

Within the project area, 25 percent of the population are minority/non-White, and almost 29 percent are living below the poverty level. Construction activities would adversely affect homeless persons by removing informal places of shelter. Similarly, construction-related activities may also cause a shifting of locations currently used by homeless persons to congregate.

Construction effects on minority and low-income populations in the general project area would include increased congestion, travel delays, increased response time for emergency services, changes in transit

services, and decreased parking. These changes could have substantial adverse effects on the minority and low-income populations in the study area and the organizations that serve them. These populations and organizations rely heavily on transit services, which could be hampered by traffic congestion. Many service providers require clients to arrive in time to get their names on a waiting list for shelter that night or to arrive by a certain time for other services. If individuals accessing services are unable to reach these providers by certain times, they may not have access to needed services or a safe place to sleep. Traffic congestion could also delay access for emergency services and make deliveries to service providers more difficult. Providing safe pedestrian routes to and from service providers and other central locations is critical.

A summary of the concerns relating to construction that were noted during interviews with social service agencies are:

- Transit service disruptions or reroutes (low-income populations depend on public transportation as a primary means of transportation)
- Utility disruptions
- Increased stress, anxiety, and accidents for homeless people
- Construction site hazards
- Service outages for power and other utilities
- Increased traffic congestion and decreased access, which could affect services, deliveries, staff, volunteers, and emergency service response times
- Changes in pedestrian access to services and usual pedestrian routes
- Construction and detours around customary routes, which may disorient persons who are blind or partially sighted and may pose potential hazards for them
- Displacement of homeless persons who find nighttime shelter under the viaduct
- Increased demand for social services
- Increased pressure on shelter capacity
- Elimination of parking used by homeless persons with cars
- Noise, vibration, and degraded air quality at shelters (FHWA et al. 2010)

Several social service providers could be temporarily affected by the seawall construction due to their proximity to the construction activities. Located on Alaskan Way, The Compass Center provides shelter, meals, and a shower facility. It has just one door for public access to the facility that is located very close to Alaskan Way. Access to

the facility and noise levels could be affected during construction. Heritage House, Bread of Life Mission, Pike Market Senior Center, Plymouth Housing Group, Catholic Seamen's Club, and Rose of Lima House are also close to the construction area and have similar concerns. Sidewalks may be periodically closed to pedestrian traffic for many months during construction; however, alternative pedestrian access to businesses and residences would be available at all times.

Construction activities would affect homeless people who are living on the streets. During interviews, social service providers indicated that areas under certain portions of the Alaskan Way Viaduct are known to be encampments and sleeping places for the homeless. The lack of availability of long-term parking for car-camping and the displacement of shelter under the viaduct are concerns for the homeless population. People congregate or spend the night in these informal places of shelter. For some, these locations may be areas in which they are accustomed to seeking shelter on a regular basis. Therefore, they may attempt to continue using these areas, even though the areas have become part of a construction work zone. Homeless people may try to climb over or otherwise gain access through fences surrounding the construction work zone to return to their habitual nighttime shelter locations, at potential risk to themselves. However, these activities are illegal and, therefore, are not protected by the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended.

Depending on the location and severity of the construction effects, homeless people may decide to move elsewhere in the project area, leave the downtown area for adjacent neighborhoods, or obtain shelter inside existing homeless shelters. An increase in demand for beds in homeless shelters could substantially decrease the availability of beds in the downtown homeless shelters, which already cannot meet current demand.

The right of tribal members to take salmon at all of their "usual and accustomed" fishing sites is explicitly guaranteed by treaty. Tribal fishing is for commercial and personal use and there are various individuals who may fish for subsistence from piers (nontribal). There would be some impacts on fishing during construction due to increased noise levels, increased levels of light and glare, reduced access to the piers, barge traffic, and in-water work.

The environmental justice analysis has determined that although the effects on environmental justice populations may be substantial, the project would not cause "disproportionately high and adverse" effects on minority and low-income populations. The extent of any effects on environmental justice populations would depend on the stage and proximity of construction. Mitigation would be implemented in order to avoid and minimize any effects.

The City has worked to ensure the full and fair participation by all potentially affected communities in its decision-making process through

extensive public involvement and numerous outreach efforts that focused on minority and low-income groups as documented in the Social Resources and Environmental Justice Discipline Report (Appendix B). The City will continue to reach out to minority and low-income populations and respond to their concerns regarding the construction effects of the build alternatives.

The results of the analysis of environmental justice included in the environmental review process for the build alternatives indicate that disproportionately high and adverse effects on environmental justice populations would be avoided, minimized, or mitigated through careful planning and design or through individual choices to use alternate routes or transit. Continued outreach to minority and low-income populations, to employees of the displaced businesses, and to others would identify additional mitigation measures.

Indirect Effects

No indirect effects related to social resources or environmental justice populations have been identified.

Avoidance, Minimization, and Mitigation Measures

The City will implement the following measures to mitigate the construction impacts on social resources and environmental justice populations:

- Engage in timely communications with social service agencies and providers as the construction activities proceed. Provide them with details on access, detours, utility disruptions, and other construction activities.
- Before construction begins and periodically during construction, hold neighborhood public meetings to advise the public of planned construction activities, road closures, traffic detours, changes in pedestrian walkways, and other construction-related activities.
- Publish a project newsletter and special news bulletins to alert members of the public of planned construction activities, road closures, traffic detours, changes in transit routes, changes in pedestrian access routes, and other information. Publish the newsletters in different languages.
- Provide representatives of social services in the study area with the name(s) of one or more contacts at the City to call with concerns related to construction activities.
- Establish a community telephone information line to allow members of the public to directly report problems related to construction activities and have these problems addressed promptly.

- Monitor the effectiveness of pedestrian pathways and signage in the construction area to ensure public safety and access. All pedestrian detours shall comply with ADA accessibility guidelines and meet the safety needs of those who have disabilities.
- Coordinate with neighborhood groups, including residents close to construction and staging areas, to implement activity-specific mitigation measures for extended durations of 24-hour effects from construction-related noise, vibration, light, glare, and dust.
- Coordinate with representatives of religious institutions located close to construction work zones to address potential noise that could adversely affect services, meditation sessions, or other events.
- Coordinate with cultural and social institutions to identify specific access needs during construction, and provide transportation and building access.
- Coordinate with social service agencies to identify the best means to mitigate construction effects on low-income and homeless populations.
- Include government agencies located near the project construction area on distribution lists for general notifications about planned construction activities.
- Shut down construction during the peak summer months, thus minimizing impacts on visitor-oriented businesses and eliminating construction noise during the period when businesses and residences are most likely to have their windows open.
- Coordinate with and notify Native American tribes of all barging and other vessel use to avoid and minimize interference with tribal fishing.

4.9 Visual Resources

Effects Common to All Build Alternatives

The construction of any of the build alternatives would alter the visual character and quality of the project area throughout the duration of construction due to the operation of equipment, demolition, presence of staging areas, storage of materials, closures of access, and blockage or impedance of views by equipment and materials. Construction would require the removal and temporary relocation of Alaskan Way and the removal and replacement of existing sidewalks, railings, street trees, furnishings, and the seawall face. Signs, awnings, and other architectural features extending from the existing piers may be temporarily removed for construction access. A construction fence surrounding the construction work zone and temporary pedestrian

Visual Resources Key Points

Construction for all build alternatives would alter the visual character of the project area throughout the duration of construction.

The effects would be greater for Alternative B because the longer construction duration would result in longer periods of views being blocked or impeded by construction equipment, fences, and materials.

walkways accessing the existing piers would obscure views for all viewer exposures. Cranes, trucks, heavy equipment, and construction materials would be visible. Construction equipment and activity would be most intense in a 500-foot-long construction work zone that would progress along the seawall. Construction activity would be concentrated in the fall, winter, and spring, with a shutdown period implemented between Memorial Day weekend and Labor Day weekend each summer. The construction impacts may be partially mitigated by providing screening, alternative circulation paths, and view areas and by capitalizing on the visual interest of construction.

Unique Effects of the Build Alternatives

In addition to the effects common to all build alternatives, Alternative B construction would be approximately 2 years longer, primarily due to the greater seawall setback and plaza construction in the vicinity of the Seattle Aquarium, which would constrain the construction work zone. The longer construction duration would result in longer periods of blocked or impeded views and an altered visual environment. A temporary increase in visual obstructions and change in visual character would occur at the south end of the project, where construction of intertidal habitat features, short-stay boat moorage, and access features would extend farther into the water.

Alternative C would cause a temporary increase in visual obstructions and change in visual character at the south end of the project (Zone 1), where construction of the intertidal habitat would extend further into the water. The short-stay boat moorage that is part of Alternative B would not be constructed under this alternative.

Indirect Effects

No indirect effects related to visual resources have been identified.

Avoidance, Minimization, and Mitigation Measures

The City will include the following mitigation for adverse effects on visual resources during construction:

- Construct temporary installations that interpret the site's history, current construction, and future completed state to stimulate public curiosity and provide visual interest.
- Provide viewing "windows" and areas to allow the public to safely view the construction.
- Remove construction equipment and materials during the summer shutdown to minimize visual impacts during the peak season for visitors.

4.10 Fish, Wildlife, and Vegetation

Effects Common to the Build Alternatives

The construction effects on fish, wildlife, and vegetation are divided into three main categories—effects on marine organisms from underwater noise and vibration, aquatic habitat disturbance and water quality changes, and effects on upland organisms. Each category of effects has causal factors associated with in-water and upland construction activities. For example, pile driving in the water and in upland areas would generate underwater noise that affects marine organisms. Similarly, heavy construction activity associated with placement of in-water habitat could disturb both marine and upland species.

Underwater Noise and Vibration

The primary construction activity of concern for noise effects on fish and wildlife is pile driving. Pile driving, both in the water and in upland areas immediately adjacent to the water, would generate underwater noise levels that are higher than existing ambient underwater noise levels in a large area of Elliott Bay. Where underwater noise exceeds noise levels that are known to cause injury or behavioral effects on fish and wildlife, an adverse effect is assumed to occur. The sensitivity of fish and wildlife to noise is defined by threshold noise levels for potential injury and behavioral effects developed by USFWS and NOAA (see Fish, Wildlife, and Vegetation Discipline Report [Appendix L]).

The potential effects of underwater noise on fish and wildlife are determined by three primary factors:

- The type and level of noise generated by the activity
- The sensitivity of fish and wildlife to underwater noise
- The distances that high levels of noise travel underwater

The type and level of noise depends on the piling material and type (steel sheet pile or concrete octagon piles), the method of installation (impact or vibratory pile driving), and the sound attenuation methods used, if any. Table 4-20 provides the unattenuated noise levels for installation of the proposed concrete and steel sheet pilings. The noise levels shown represent actual measurements made during construction of other projects.

The majority of the concrete piles included in project design would be installed landward of the sheet pile containment wall. The steel sheet piles of a temporary containment wall (installed to provide a barrier between active construction and Elliott Bay) would be driven in water primarily by vibratory means, although up to 20 percent of the sheet piles may require final setting with an impact pile driver. Use of sound attenuation devices such as cushion blocks would reduce in-water noise levels.

Fish, Wildlife, and Vegetation Key Points

Noise, vibration, and sediment movement caused by construction activities could alter the behavior of all fish and wildlife (including marine mammals) near the construction area.

Organisms unable to relocate away from the construction area could be hurt or killed directly by construction activities like riprap removal and temporary containment wall installation.

No federally protected or state-listed upland species are expected to be affected by project construction.

The in-water work window would require most work to be performed during the fall and winter months when the densities of protected salmonids would be at their lowest, and marine plants would be seasonally dying back.

Construction of all build alternatives would result in the same impacts on biological resources, and would require the same minimization and mitigation measures.

Table 4-20. Unattenuated Noise Levels Associated with Installation of the Proposed Pilings

Measured Noise Levels in Decibels			
Piling Type	**Peak Level (dB_{PEAK})**	**Sound Exposure Level (dB_{SEL})**	**Root Mean Squared Level (db_{RMS})**
Concrete octagonal pile, 24-inch-diameter (impact)	188	166	176
Steel sheet pile, 24-inch-diameter (vibratory)	182	165	165
Steel sheet pile, 24-inch-diameter (impact)	205	180	190

Sources: Caltrans 2007, 2009.
Notes: dB_{RMS} – decibel root mean squared, dB_{PEAK} – decibel peak level, dB_{SEL} – decibel sound exposure level

Noise Measurements and Calculations

dB_{PEAK}: Peak Level is the maximum instantaneous sound level in decibels.

dB_{SEL}: Sound Exposure Level is the sound level in decibels as if the acoustic event took place in a single second.

dB_{RMS}: Root Mean Square is the average sound level in decibels.

The entire study area has high levels of ambient noise due to ferry traffic and other boat traffic, with ambient noise conditions assumed to be 126 decibel root mean squared (dBRMS; Laughlin 2011). All types of pile driving would cause underwater noise greater than the ambient conditions. The use of attenuation devices such as cofferdams (without dewatering) or steel sleeves (when impact hammering is conducted) is estimated to decrease the sound levels by 0 to 10 dB (Caltrans 2007, 2009). Attenuation is not very feasible for the installation of steel sheet piles because of their linear nature.

In general, the properties of in-water noise allow it to propagate at ever-diminishing levels until it strikes dry land or other structures. Therefore, it is expected that both in-water and upland pile-related construction noise would extend throughout the nearshore and open-water environments and a limited distance into the East Waterway mouth of the lower Duwamish River (a highly industrialized former estuary channel within the Duwamish River). Appendix L contains detailed estimates of how far various types of in-water construction noise would spread from the noise source. Noise generated by both vibratory and impact driving of steel sheet piles reaches the highest peaks and spreads the farthest.

Noise and vibration caused by construction could alter the behavior of all fish and wildlife (including marine mammals) near the construction area, likely causing them to flee if they can. As shown in Table 4-21, impact pile driving could result in behavioral effects on fish and marbled murrelets for a distance of 2.88 in-water miles from the construction activity. Vibratory pile driving could cause behavioral effects in marine mammals up to 2.5 in-water miles from the construction activity. Noise-

Underwater Noise Analysis

Calculators developed by U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration were used to understand and calculate the potential area in which noise generated from project construction could propagate noise greater than the ambient underwater noise levels (see the Noise and Vibration Discipline Report [Appendix E]). Unlike noise levels in the air, which are typically weighted to correspond to the same frequency range that humans hear, underwater noise levels are not weighted and account for the entire frequency range of interest.

caused injury to fish from vibratory pile driving is not expected; however, noise from impact pile driving has the potential to exceed the injury threshold for fish weighing less than 2 grams up to 1,784 feet from the construction activity.

Currently, nothing is known about how these disturbances affect sessile (permanently attached) marine organisms. Although sessile organisms do not have ears like vertebrates, they may sense vibrations to some limited extent. If disturbed, they do not have the capability to flee the area; consequently, they are vulnerable to further disturbance. However, because these species are plentiful and able to quickly rebound after disturbance, the only long-term effect would be a healthier community due to the habitat improvements associated with the build alternatives.

Guidelines implemented by the National Marine Fisheries Service related to sound characteristics in the context of the Marine Mammal Protection Act and the Endangered Species Act would be followed throughout project construction to ensure minimal or no disturbance of marine mammals.

Sessile Organisms

Sessile organisms are permanently attached to a substrate and are not free to move about, Examples of sessile marine organisms in the project area include benthic invertebrates such as barnacles and mussels.

Table 4-21. Distances from Project that Unattenuated Underwater Noise Would Affect Fish and Wildlife

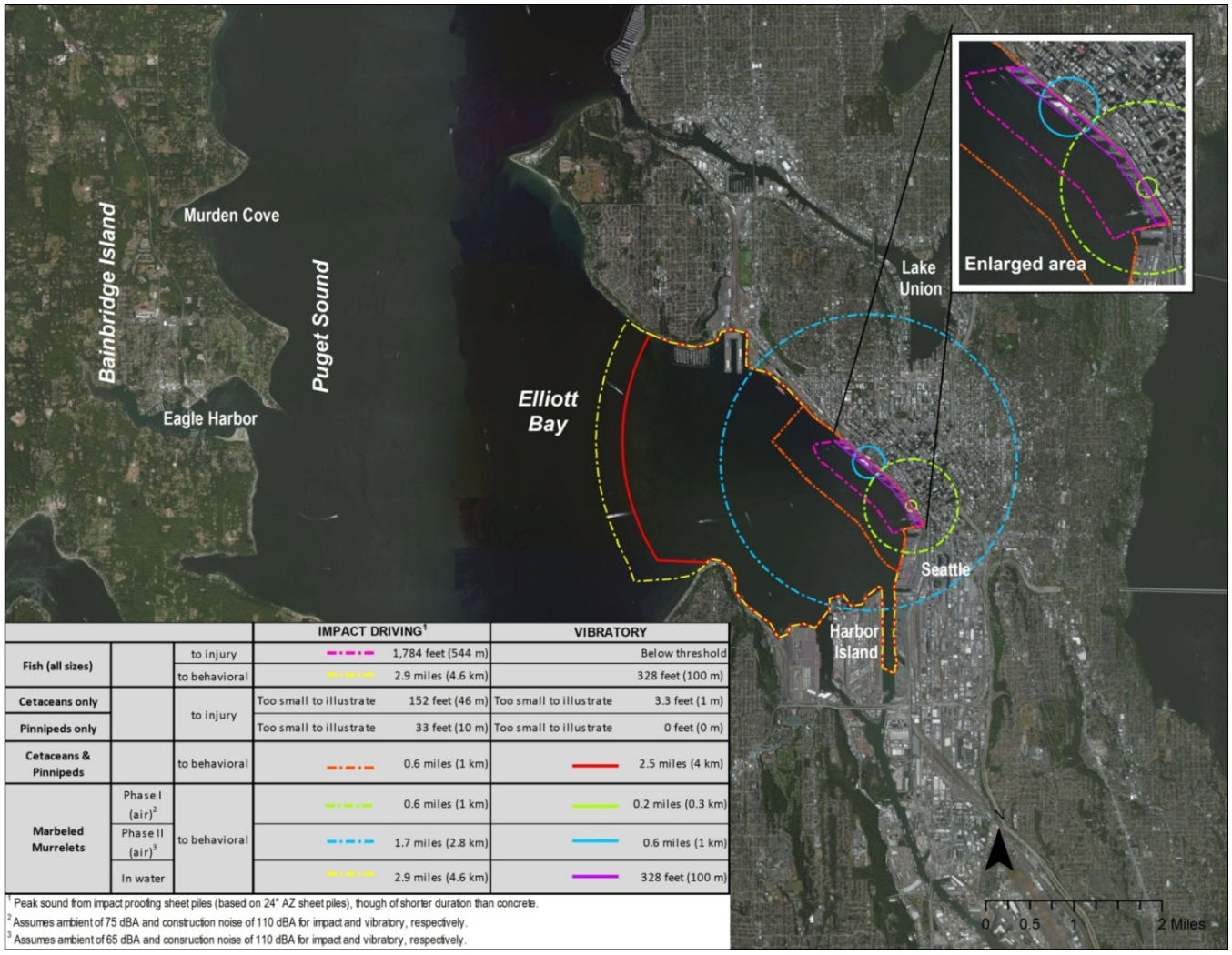
Type of Effect	Distance		
	Fish	Marine Mammals	Marbled Murrelets
Injury – Vibratory pile driving	0 feet	3.3 feet	0 feet
Injury – Impact pile driving	1,784 feet	152 feet	95 feet
Behavior – Vibratory pile driving	328 feet	2.5 miles	328 feet
Behavior – Impact pile driving	2.88 miles	3,280 feet	2.88 miles

Aquatic Habitat Disturbance and Water Quality

In-water construction activities would directly disturb marine habitat and affect water quality for fish, wildlife, and vegetation. These activities include excavation of riprap, pile driving to install the temporary containment wall and restore Washington Street Boat Landing, removal of the temporary containment wall, installation of concrete piles (via vibratory means) and construction of in-water habitat features. Additionally, some construction activities landward of the temporary containment wall and in urban upland areas, including excavation for the seawall setback and seawall construction, could also affect marine organisms (Figure 4-8).

All in-water construction activities would likely disturb sediments and result in at least partial resuspension of sediments that may contain low to moderate concentrations of associated pollutants (including the PAHs benzo(a)pyrene, benzo(a)anthracene, chrysene, fluoranthene, naphthalene, phenanthrene, or pyrene and the metals arsenic,

cadmium, copper, lead, mercury, silver, or zinc) and potentially increase the bioavailability of these contaminants to fish and wildlife. These sediments and pollutants could be redistributed in the nearshore area by tidal and wave action. Recent video footage taken during nearshore surveys have suggested that sediment resuspension due to disturbance would be minimal to moderate (sand, silt, and shell-hash-mixed sediments become resuspended but settle quickly). Regardless, any resuspension of pollutants may increase the potential for their transfer to the water column or to marine organisms, including some federal and state protected species.



			IMPACT DRIVING[1]		VIBRATORY	
Fish (all sizes)		to injury		1,784 feet (544 m)		Below threshold
		to behavioral		2.9 miles (4.6 km)		328 feet (100 m)
Cetaceans only		to injury	Too small to illustrate	152 feet (46 m)	Too small to illustrate	3.3 feet (1 m)
Pinnipeds only			Too small to illustrate	33 feet (10 m)	Too small to illustrate	0 feet (0 m)
Cetaceans & Pinnipeds		to behavioral		0.6 miles (1 km)		2.5 miles (4 km)
Marbeled Murrelets	Phase I (air)[2]	to behavioral		0.6 miles (1 km)		0.2 miles (0.3 km)
	Phase II (air)[3]			1.7 miles (2.8 km)		0.6 miles (1 km)
	In water			2.9 miles (4.6 km)		328 feet (100 m)

[1] Peak sound from impact proofing sheet piles (based on 24" AZ sheet piles), though of shorter duration than concrete.
[2] Assumes ambient of 75 dBA and construction noise of 110 dBA for impact and vibratory, respectively.
[3] Assumes ambient of 65 dBA and consruction noise of 110 dBA for impact and vibratory, respectively.

Figure 4-8. Potential noise effect distances to marine organisms

Similar to the potential effects of noise and vibration described previously, in-water construction activity and sediment disturbance could cause fish and wildlife to flee if they can. Organisms that are unable to flee from the area, such as benthic invertebrates, marine plants (e.g., sea lettuce and rockweed), and slow-moving species (e.g.,

starfish and crabs), could be hurt or killed directly by the activities. Organisms that are attached to riprap could die of exposure if they remain attached to excavated riprap. Because the riprap removal is slated to occur throughout the nearshore portion of the project area, the adverse effects would occur along the entire length of the seawall.

Machinery and techniques that could be used in-water to install the temporary containment wall sheet piles, such as vibratory and impact hammers, are known to disturb or, in extreme instances, kill nearby organisms such as fish. This activity would have temporary effects only during the installation and removal of the temporary containment wall but would not substantially affect the nearshore area once the sheet piles are in place or after it is removed.

In-water activities associated with the placement of confined-substrate habitat benches, subtidal substrate enhancements, subtidal cobble reefs (not part of Alternative C) and aquatic vegetation, habitat benches between piers, and a boulder seawall toe would all be considered in-water work. The construction of habitat enhancement features is expected to disturb and bury some existing habitats and associated sessile or slow-moving organisms in the nearshore area; however, the effects would not be substantial overall. Marine nearshore habitats have been shown to be resilient after major disturbances, such as from large storms, and can reestablish themselves quickly.

The requested in-water work window from September 1 to March 1 would require in-water work to occur in the fall and winter when the densities of protected salmonids would be at their lowest and marine plants would be seasonally nearing their natural die-back.

The temporary containment wall would isolate most construction work from Elliott Bay. It is possible that fish could be entrapped behind the temporary containment wall, either during its construction or from tidal fluctuations over the timeframe of seawall construction. Fish and other organisms that become entrapped could be harmed or killed.

Excavation for the seawall setback and construction of the new seawall could result in the movement of water into the work area from rain, groundwater, tidal fluctuations, and construction sources, which could mix with and mobilize contaminated sediments. The temporary containment wall is intended to help restrict this construction water to the immediate work area. Materials used to construct the new seawall have the potential to result in the entry of uncured concrete materials into nearshore waters and raise the pH of the water. This potential is greater with jet grout seawall construction (Alternatives A and C) than with braced soldier piles seawall construction (Alternative B). The intention is to make sure the jet grout is fully contained landward of the existing seawall face, in the area of soil improvement activities, and to prevent it from being released and affecting the surrounding areas. The construction water would be managed and prevented from moving into the nearshore area where it could adversely affect aquatic communities by causing temporary violations of the water quality standards. The

management of construction water would likely keep adverse effects on marine organisms moderate and short term.

Construction over or near the nearshore area would increase the risk of inadvertent spills or leaks of toxic construction materials, such as paint or solvents, and the inadvertent deposition of solid waste and construction debris into the water.

Nighttime street lighting and other artificial light sources used during construction of any of the build alternatives would emit high levels of light that would adversely affect fish movements (for example, a high shadow line that casts a narrow shadow in the water would likely reduce the migration of salmon under piers).

Fish and aquatic mammals in the Seattle Aquarium may be sensitive to construction noise and vibration and would be affected by any disruption of the water supply and electrical service. Dust and other airborne contaminants may also have an impact on some of the fish and aquatic mammals in the collection, especially those in the more open area in the northernmost building of the Seattle Aquarium complex.

Upland Organisms

Construction behind the temporary containment wall and in urban upland areas for the new seawall, sidewalks, roadways, and public amenities would directly affect upland vegetation and disturb upland wildlife. Additionally, pile driving for the temporary containment wall and other noisy in-water construction activity, such as excavation of riprap and placement of habitat enhancements, likely would disturb upland wildlife.

The disturbance of birds would likely be the most substantial impact of construction on upland wildlife. Noise and other disturbances due to construction activities would undoubtedly displace birds from the area. Because seawall construction is slated to occur almost continuously (except during the summer shutdown period) over multiple years, migratory birds as well as wintering and breeding birds would be affected. However, most birds are nonbreeders and would not necessarily have biological needs unique to the study area. If birds are displaced by the construction, they would move from the area and experience little direct effect. Project construction would be planned so as to avoid hurting or killing migratory birds, consistent with the provisions of the Migratory Bird Treaty Act.

Disturbance of other upland wildlife such as rodents would likely also occur; however, these species are primarily nonnative and assumed to be well adapted to the human-induced disturbance in the area. No federally protected or state-listed upland species are expected to be affected by the project construction.

Many upland plants in the project area would be removed during construction; approximately 56 trees would be removed on the west side of Alaskan Way and approximately 160 trees would be removed on

the east side for the Central Seawall. For the North Seawall, approximately 8 trees would be removed on the west side and approximately 127 trees would be removed on the east side. Most of these plants, however, are ornamental, provide little natural-type habitat, and support few native wildlife species.

Unique Effects of the Build Alternatives

Most effects of the build alternatives on fish, wildlife, and vegetation would be similar in character, consistent with the previous description. There are a few notable differences between the build alternatives related to the extent and duration of construction, and some differences in proposed project elements.

With Alternative A, the reconstructed seawall in Zone 3 would be 3 feet waterward of the existing seawall, in an area currently occupied by nearshore habitat. This would eliminate the biological resources in the area (approximately 3,000 square feet). Alternatives B and C would place the reconstructed seawall landward of the existing seawall and would not directly eliminate any biological resources. Of the three build alternatives, Alternative A includes the smallest seawall setback and least associated excavation, the least upland habitat disturbance, and the least amount of in-water work to construct habitat enhancements.

Alternative B includes the largest seawall setback and most associated excavation, the most upland habitat disturbance, the most in-water work to construct habitat enhancements, additional support piles for the short-stay boat moorage and boardwalk in Zone 1, potential relocation of the Washington Street Boat Landing 15 feet waterward of its current location, and the longest construction schedule. More adverse construction effects on fish, wildlife, and vegetation are expected; however, the difference is unlikely to be substantial. Augering in the steel casings is a large component of the braced soldier pile method proposed for Alternative B, but it would occur entirely landward of the temporary containment wall and the existing seawall. The process is likely to generate less noise than the typical pile driving that would occur with all of the build alternatives.

Alternative C would require somewhat more excavation than that required for Alternative A, because of the additional seawall setback in Zones 1 and 3, and the increased scope of habitat enhancement, but less than the excavation required for Alternative B. The construction associated with Alternative C likely would result in more adverse effects than that associated with Alternative A and fewer adverse effects than Alternative B; however, the difference is unlikely to be substantial.

Indirect Effects

No indirect effects related to fish, wildlife, and vegetation have been identified.

Avoidance, Minimization, and Mitigation Measures

The City will implement the following key mitigation measures:

- Restrict in-water construction to the approved in-water work window for salmonids to reduce the likelihood of adverse effects on protected (listed) species. Restrict fish removal/handling to low tides.
- Install temporary containment west of the existing seawall to protect Elliott Bay from the construction activities.
- Develop and follow an approved Construction Stormwater and Erosion Control Plan (CSECP) and Stormwater Pollution Prevention Plan (SWPPP), which include requirements for controlling runoff onto and from the construction site.
- Ensure that appropriate protective measures are in place to minimize the potential that wet cement or grout enters Elliott Bay and, if it does, have a plan to remedy the situation.
- Maintain a clean construction work zone to reduce the potential for debris to enter surface waters.
- Develop and implement a Spill Plan, which will include the requirement for maintaining spill response materials on site for emergency deployment.
- Provide on-site training for all construction staff on species and habitats to protect, implementation of BMPs, and on-going maintenance to ensure that the BMPs are properly used and functioning.
- Maintain construction equipment and vehicles to prevent them from leaking fuel or lubricants.
- Use nonpetroleum lubricants for equipment used in and over water, whenever possible.
- Remove immediately and properly dispose of any floating debris within the containment area.
- Monitor turbidity and pH to ensure that the water quality standards are achieved.
- Deploy turbidity curtains, when necessary, during in-water work to ensure water quality standards are achieved.
- Use a vibratory hammer rather than an impact hammer, whenever possible, to minimize disturbance due to the installation and removal of piles and sheet piles.
- Gradually place new habitat substrate to minimize the disturbance of existing bottom sediments.

Turbidity

Turbidity is the cloudiness or haziness of a fluid caused by individual particles (suspended solids) that are generally invisible to the naked eye, similar to smoke in air. The measurement of turbidity is a key test of water clarity, and is a regulated parameter in state water quality standards for marine and fresh water.

- Ensure that all materials placed in the nearshore area will be clean and free of pollutants.
- Properly dewater excavated material prior to disposal.
- Ensure that fish have been removed prior to closure of the temporary containment wall.
- Position construction lighting away from the water to the maximum extent feasible to minimize effects on aquatic species.
- Comply with all requirements of the permits and approvals.
- Stop pile-driving activities if any listed species enters a specified exclusion zone, as part of the marine mammal monitoring requirements.
- Coordinate with the Seattle Aquarium to implement any necessary measures for the protection of the fish and wildlife collection, such as noise/vibration monitoring and, if needed, veterinary services.

4.11 Water Resources

Effects Common to All Build Alternatives

Sediment Resuspension and Turbidity

All forms of in-water construction could disturb marine sediments, and resuspension of contaminated marine sediments could result in locally elevated concentrations of pollutants in the water column that exceed the state water quality standards for short periods.

Riprap and other large debris that is present along the alignment of the wall would be removed by excavation to allow the temporary containment wall to be placed through finer marine substrate. This rock/debris removal work and subsequent sheet pile driving into the relatively soft marine substrate would likely cause localized resuspension of marine sediments. Eventual removal of the temporary containment wall also would disturb marine sediments. These activities could result in a short-term, localized turbidity plume in the surrounding water column that would be difficult to prevent.

Removal of the existing seawall, including riprap and debris along the base of the wall, could affect water quality in Elliott Bay, although the work would be primarily isolated behind the temporary containment wall. Construction would require work in and adjacent to open waters of the bay. Without effective isolation of the work area, disturbed sediments could enter Elliott Bay.

Installation of some or all of the proposed habitat features would require the placement of substrates ranging in size from sand to large rocks (up to 24 inches in diameter) in open water. During the habitat substrate placement, marine substrate would potentially be disturbed,

Water Resources Key Points

Construction effects on water quality from all build alternatives could include increased turbidity during in-water work, increased pH, increased pollutants and sediments to stormwater runoff, and increased risk of solid waste and pollutant spills. Proper use of Best Management Practices would minimize or eliminate water quality effects.

During construction, the differences in effects to water quality between the build alternatives are related to the duration of construction, the extent of seawall setback, and the addition of a short-stay boat moorage (Alternative B).

causing short-term, localized turbidity. However, the associated construction activities and localized turbidity would be contained within a turbidity curtain. No other water quality effects are expected to result from this construction activity.

Construction of the nearshore habitat improvements would not alter the overall water circulation in Elliott Bay and would not likely affect water temperatures in nearshore areas because of the tidal interaction with deeper, cooler offshore water.

Installation of the support pilings for the new short-stay boat moorage dock and boardwalk (Alternative B only) and other features in the water could cause short-term, localized turbidity.

Stormwater Runoff

Stormwater runoff from a construction site can readily mobilize disturbed soil and carry it into receiving waters, resulting in violations of the water quality standards for the receiving water body. If erosion and sediment control measures are not adequately implemented and maintained in areas of disturbed soils on the construction site, high concentrations of suspended sediment in runoff discharged to Elliott Bay could result in elevated turbidity offshore during rain events. Because much of the seawall construction would be scheduled to occur during the fall and winter, these water quality effects could occur on numerous occasions over the course of several wet seasons. Measures outlined in the required SWPPP/CSECP developed for the project would be expected to effectively mitigate any substantial impacts on receiving waters.

Part of the proposed temporary road would be covered by the Alaskan Way Viaduct, and this covered area would not generate significant volumes of runoff during storm events. However, rainfall that blows or flows into this area would be discharged to Elliott Bay untreated (same as under existing conditions). The reduced volume of untreated rainfall runoff generated on the temporary road surface areas (compared to the existing conditions in which Alaskan Way is fully exposed) would likely result in a slight reduction in pollutant loading in stormwater runoff to the bay for the period of time that the temporary road is in use. Stormwater runoff would be generated from the exposed sections of the temporary road in the northern portion of the project area and enter Elliott Bay via existing storm drainage outfalls.

The construction work associated with the permanent northbound roadway(Alternatives A and C) could introduce suspended sediments and a variety of pollutants into stormwater runoff if the required erosion and sediment control and other pollution control BMPs are not adequately implemented. Examples include (1) high-pH runoff due to leachate from uncured concrete, (2) runoff containing asphalt emulsion that has leaked from construction equipment, (3) runoff containing spilled paint materials, (4) turbid runoff resulting from freshly placed or stockpiled crushed rock surfacing material for use as a pavement

subbase, and (5) runoff conveying suspended sediments from stockpiles of topsoil used for landscaping areas. These impacts could occur intermittently over several wet seasons as the finished roadway is sequentially completed.

Throughout construction, discharges of stormwater runoff and CSOs to Elliott Bay would be maintained by the installation of temporary pipes, as needed. For example, if an existing outfall pipe segment must be removed, a parallel pipe would be installed nearby and connected to the upstream pipe to be retained before the existing outfall pipe segment is removed. Therefore, no disruption of stormwater runoff discharge capacity is expected.

Construction (Dewatering) Water Discharges

Substantial dewatering of excavations would be required for all of the build alternatives. The amount of required daily dewatering would vary, depending on the construction methods, the extent of open excavations, and the location within the project area. Dewatering activities may be performed intermittently over the full duration of project construction. When major excavation work is ongoing, it would be typical for thousands of gallons of water to be managed on a typical workday. Groundwater and surface water that collects in open excavation areas or construction areas landward of the containment walls would likely have high turbidity and suspended sediment concentrations requiring treatment to improve the water quality before disposal and/or discharge.

Dewatering
Construction dewatering is the removal or draining of groundwater from a construction site by piping or pumping.

In addition, this water could contain petroleum products due to leaks from on-site construction equipment, or it could contain suspended sediment and have a high pH resulting from shallow groundwater discharges that have come in contact with concrete from seawall construction. The water encountered in below-ground construction work areas may also contain other contaminants such as trace organic pollutants that may require additional treatment and/or discharge requirements.

If dewatering is not carefully managed, large volumes of discharges with elevated turbidity and potentially other contaminants could reach Elliott Bay, degrading nearshore water quality for a short period coinciding with each discharge event. If such discharges occur repeatedly for a long period, the water quality effects would be more severe and could spread farther out into Elliott Bay.

Construction water would be collected, treated, and discharged according to the applicable permit conditions and regulations. The proposed dewatering collection and treatment options and groundwater reinjection methods would be implemented with the use of water quality treatment and other BMPs as necessary to avoid and minimize potential impacts on surface water and groundwater resources.

Solid Waste and Pollutant Spills

Construction over the water and adjacent to the water could result in inadvertent spills or leaks of paint and other toxic materials and/or inadvertent deposition of solid waste and construction debris in the water. Oil, grease, and petroleum products could leak or spill from construction equipment or petroleum product storage facilities. If an uncontrolled spill occurs, petroleum products could possibly reach Elliott Bay or groundwater adjacent to the work area. If at high concentrations, these products could pose a risk to aquatic life. In addition, demolition of the existing seawall facing could generate concrete waste that would enter Elliott Bay. During loading and unloading, demolition debris or excavated materials that are transported on barges would have the potential to spill into Elliott Bay or into another water body at the off-site barge destination. If any of this spilled material is contaminated, it could potentially affect local water quality conditions.

Unique Effects of the Build Alternatives

There are a few important differences between the build alternatives in their effects on water resources. These differences are related to the following factors: duration of construction; seawall construction methods (soil improvement and braced soldier piles); the extent of seawall setback (with associated excavation and construction dewatering); and the addition of a short-stay boat moorage and boardwalk to Alternative B.

Construction duration for Alternative B would be 2 years longer than Alternatives A and C. This is due primarily to the substantially greater extent of seawall setback for Alternative B and the addition of more habitat enhancements and public amenities. The longer construction duration would correspondingly increase the duration of potential risk to water resources due to stormwater runoff from the construction site, construction dewatering, and construction water reinjection.

The two primary construction methods proposed for the seawall replacement would affect water resources in slightly different ways. Jet grouting would be the primary construction method used to replace the seawall under Alternatives A and C. This method would likely entail mixing the grout using an on-site batching operation before pumping it into the ground. If grout leaks or spills occur in areas subjected to rainfall and runoff and adequate containment measures are not in place, the pH of the runoff from the work area could be elevated enough to cause short-term violations of the pH standard for marine water quality in Elliott Bay. A violation of the pH standard would potentially harm aquatic life. The construction method proposed for Alternative B is braced soldier piles. Each individual drilled shaft would be dewatered in the process of pouring concrete into it (from the bottom up), displacing the groundwater pooled within the drilled shaft casing. With more dewatering occurring during the deep shaft construction, the potential for occasional violations of permitted water

quality standards in Elliott Bay could be greater in comparison to the potential under Alternatives A and C.

The greater extent of seawall setback for Alternative B would require substantially more excavation and construction site dewatering in open excavations than Alternatives A and C, which would result in larger volumes of dewatering discharges. The dewatering discharges from the open excavation would need to be managed separately from the dewatering discharges from the drilled shafts. The combined extent of groundwater reinjection required to prevent ground settling would be greater for Alternative B than for the other build alternatives. The larger construction area also could require the management of higher volumes of stormwater runoff, with the potential to cause more frequent violations of water quality standards in Elliott Bay than Alternatives A and C, if the required runoff control BMPs are not completely effective. Although the volumes of dewatering water and stormwater runoff to be managed for Alternative B would be much greater than Alternatives A and C, the probable methods of construction water management, groundwater reinjection, and stormwater runoff control would be the same as those described in the section Effects Common to All Build Alternatives.

The total area of aquatic habitat improvements and corresponding in-water work in Elliott Bay would be largest for Alternative B, second largest for Alternative C, and the smallest for Alternative A, Similarly, the potential for short-term, localized turbidity plumes in these work areas would be proportional to the area and duration of in-water work for each alternative.

The addition of a short-stay boat moorage facility and boardwalk and the potential addition of a water plaza in Zone 4 are unique features of Alternative B that would increase the in-water and overwater construction duration and spatial requirements, compared to Alternatives A and C. The effects of in-water construction would be the same as those described for all build alternatives, but on a larger scale and for a longer duration than Alternatives A and C.

Indirect Effects

No indirect effects related to water resources have been identified.

Avoidance, Minimization, and Mitigation Measures

Mitigation Measures Common to All Build Alternatives

The City will require the contractor to implement the following mitigation measures to address the specific impacts of the project on water resources during construction:

- Monitor stormwater runoff discharges and water quality in Elliott Bay near the construction work zone to ensure that it meets all permit requirements and water quality standards. If adverse effects are detected, the City will be required to take immediate corrective actions to limit and mitigate the impact.
- Install temporary containment west of the existing seawall to protect Elliott Bay from the construction activities. Deploy turbidity curtains during in-water work, when necessary, to ensure water quality standards are met.
- During soil improvement activities, the following BMPs could be implemented to reduce a potential release of grout into Elliott Bay:
    - Filling or plugging voids or holes in the existing seawall prior to beginning soil improvement, as feasible
    - Directing jets away from the existing seawall during installation of the westernmost row of jet grout columns to reduce the velocity of grout directed towards the wall face, thereby reducing the potential for grout to displace unconsolidated materials and to migrate closer to the existing seawall and Elliott Bay
    - Visual monitoring of the area between the existing seawall and the temporary sheet pile containment wall for any releases during soil improvement
- Develop and implement a CSECP and SWPPP to comply with NPDES and City permitting requirements. These plans will be continually updated during construction to address evolving site conditions and any water quality problems that are observed in Elliott Bay. The plans will focus on the following:
    - Erosion and sediment control BMPs tailored to specific site work activities
    - Measures to collect, treat, and discharge dewatering water
    - Measures to prevent, contain, and control spills and leaks of toxic materials during construction

- Use one or more of the following methods to control construction dewatering:
    - Install an on-site treatment facility and reinject water into the ground coordinated with Ecology's UIC program
    - Use tanks to temporarily store water coupled with a water treatment collection service to collect and transport it to an off-site certified facility
    - Install an on-site treatment facility and discharge treated water to Elliott Bay and/or the combined sewer system as permitted by King County
- Use appropriate dewatering systems to limit the drawdown of the local groundwater table to limit the potential for ground surface settlement in the areas adjacent to the excavation. Use a recharge/reinjection system as necessary to avoid the potential for drawdown-induced ground surface settlement that could damage nearby buildings and/or infrastructure. This will be coordinated with Ecology's UIC program.
- Contain all excavated material before off-site disposal to prevent seepage of silt-laden runoff back into the water.
- Develop and implement upland construction stormwater BMPs tailored to specific work activities to control erosion and sedimentation during construction. These measures shall include some or all of the following:
    - Silt fencing
    - Temporary sedimentation tanks/ponds/traps
    - Storm drain inlet protection
    - Street sweeping
    - Straw or compost-filled wattles to contain and filter turbid water
    - Temporary mulch covers on areas of exposed soils
    - Temporary plastic or other covering on erodible material stockpiles
    - Active runoff treatment, if needed
- Load excavated soils and demolition debris onto trucks, train cars, or barges to quickly and efficiently remove them from the project area. Within the project area, minimize stockpiling of excavated soils and debris.

- Use biodegradable petroleum products or vegetable-based oil and in construction equipment operating in the water and over the water to prevent the potential release of toxic materials into the water column resulting from minor leaks or accidental ruptures of hydraulic lines.
- Contain, collect, reuse, recycle, and/or dispose of all materials generated during demolition of the existing seawall in a manner that is consistent with the permit requirements. This includes any concrete debris in the construction work zone inside of the containment walls. The containment system shall not allow concrete to fall into Elliott Bay.
- The temporary containment walls used for isolating the shoreline work areas shall be tall enough and constructed tightly enough to prevent fast-moving water from entering the work area where it could result in the sluicing of soil and possible contaminants in the soil and their escape from containment.
- Provide water quality treatment for any temporary or permanent newly constructed pollutant-generating impervious surface area on roadways by means of BMPs approved for use in the City's stormwater regulations. This includes the exposed portion of the temporary road that is not underneath the Alaskan Way Viaduct, north of approximately University Street.
- Implement pollution source control BMPs during construction, such as the following measures listed in the Seattle Stormwater Manual:
    - Minimize storage of toxic and hazardous materials on site, store those materials in a designated area when they must be on site, and install secondary containment.
    - Contain and dispose of concrete wash water off site.
    - Vacuum slurry and cuttings during pavement saw cutting to prevent off-site migration and make sure they do not remain on permanent concrete or asphalt paving overnight.
    - Collect and contain all solid waste for off-site disposal.
    - Provide a wheel wash for all equipment leaving the worksite.
    - Treat site runoff as necessary to meet all permit requirements for surface water and groundwater protection.

- Temporarily isolate in-water work areas for the construction of habitat features using turbidity curtains or silt booms (or similar devices) to contain short-term turbidity plumes.
- Implement standard pollution prevention BMPs for construction equipment operating in the water, such as barges and cranes, to minimize the potential for spills and leaks of petroleum products or other toxic materials into Elliott Bay.
- Gradually place new habitat substrate to minimize the disturbance of existing bottom sediments.

4.12 Contaminated Materials

Effects Common to All Build Alternatives

The build alternatives include several typical elements of construction that would affect contaminated soils, groundwater, sediments, and building materials. These elements include upland excavation and seawall setback areas, new wall construction techniques, offshore habitat improvements, outfall reconstruction, use of in-water construction equipment, and demolition or relocation of existing structures and utilities.

In general, soils and groundwater in the study area are not contaminated enough to affect how the project elements are designed or constructed. The contaminant concentrations in soil and groundwater are generally less than MTCA Method A cleanup levels (one of three approaches for establishing cleanup levels) for unrestricted land use. There are some areas within the study area where concentrations of specific priority COCs, for example heavy metals, are greater than the MTCA cleanup levels. It is typical in urban environments to encounter soils with COCs greater than MTCA cleanup levels, but using appropriate construction BMPs and protocols for handling materials would allow the contaminated soils to be managed without risk to the environment or to worker health and safety.

There are a few active cleanup sites, regulated by Ecology, adjacent to the project area in both the upland and sediment areas; however, the proposed project work should not be affected by the presence of these cleanup sites. Additional detail is provided in the Contaminated Materials Discipline Report (Appendix O). It is not expected that the excavations associated with the build alternatives would encounter any significant areas of contamination requiring special handling methods. Potential impacts on water quality resulting from the excavation of contaminated soil are further discussed in the Water Resources Discipline Report (Appendix M).

During construction of the build alternatives, excavation and management of contaminated materials related to the required

Contaminated Materials Key Points

In general, soils and groundwater in the study area are not contaminated enough to affect how the project elements are designed or constructed.

Ground excavations for all build alternatives would remove moderately contaminated materials from the environment, providing an overall benefit.

Excavations associated with the build alternatives would not encounter any significant areas of contamination requiring special handling methods.

If contaminated materials requiring cleanup are encountered during construction, SDOT would submit an independent cleanup action report to Ecology as required by the Model Toxics Control Act rules.

The soil stabilization construction method proposed for Alternatives A and C would solidify contaminated soils in the seawall structural area, reducing contaminate mobility and providing an overall environmental benefit.

excavations would stop at the boundary of the project area. Contaminated material would not be pursued beyond the established limits of project work.

For any necessary cleanup work conducted by the City as part of the project construction, SDOT would submit an independent cleanup action report to Ecology, as required by the MTCA rules. The report would describe areas where identifiable contaminated materials have been determined to be present by sight and/or smell (such as the presence of free petroleum product) at the edge of project excavation. The project construction is not expected to impede or preclude any future cleanup activities on adjacent properties.

Ground excavation associated with any of the build alternatives would remove moderately contaminated materials from the environment, thereby providing an overall benefit. Excavation is not expected to encounter any significant areas of contamination requiring special handling methods. The excavations would not be in locations within Zones 1 through 4 that have been identified as areas of concern. Excavation and construction in the seawall setback areas would be performed as upland work that is fully separated from Elliott Bay by a temporary containment wall that would separate the work and discharges from within the seawall setback areas from the aquatic environment. Seawall construction would generate potentially contaminated construction dewatering water and spoils brought to the surface by the seawall construction methods (jet grouting or drilled shafts). Potentially contaminated water and spoils would be handled according to the protocols for groundwater, surface water, and materials management (see Avoidance, Minimization, and Mitigation Measures).

The installation of clean fill and aquatic substrates in the seawall setback areas and offshore of the existing seawall above existing seafloor sediments would provide new uncontaminated surfaces, thereby reducing the overall risk due to contamination for nearshore aquatic species. Some of the fill used to create habitat areas would be placed within or adjacent to active MTCA/SMS sediment cleanup sites: the Colman Dock Sediments Cleanup Site, south of the Colman Dock Ferry Terminal and the Central Waterfront Cleanup Site between Piers 54 and 59. No fill placement is proposed above existing areas with sediment caps. Adjacent to the new habitat features, contaminated sediments would remain and be addressed under separate regulatory processes by the appropriate owners. In general, placement of in-water habitat substrates would result in an environmental benefit and should not adversely affect existing sediment remediation or prevent adjacent sediment sites from meeting their regulatory objectives.

The estimated quantities of disturbed sediments associated with the three build alternatives are provided in Table 4-22.

Installation of marine mattresses near a sheet pile wall (top and middle; Source: Hughes 2006); Driving sheet piles to form a cofferdam, Broadway Bridge, Ann Arbor, Michigan (bottom; Source: RICarr 2003)

Table 4-22. Estimated Quantities of Contaminated Soil and Sediment Disturbance During Construction

Type of Work	Alternative A	Alternative B	Alternative C
Total upland excavation (cubic yards)	455,000	563,000	493,300
Contaminated material excavation for seawall setback (cubic yards)	43,000	96,000	60,300
Potentially contaminated spoils from seawall construction (cubic yards)	102,000	103,000	102,000
Contaminated sediment coverage for habitat enhancement (square feet)	84,000	140,000	138,100
Riprap removal for habitat construction (cubic yards)	1,000	200	1,570

Structures that must be demolished or modified for seawall construction could contain contaminated building materials. The scope of the structure demolition generally would not vary among the three build alternatives. Substantially more utility demolition could occur with Alternative B because of the larger seawall setback. The work is anticipated to include the demolition of the existing seawall structure and associated pavements and removal and replacement of minor ancillary features associated with waterfront buildings (such as signs and awnings), as well as selected utility vaults, duct banks, and underground utilities. Dust may be generated during excavation and/or during the transport of construction-related spoils. During demolition, asbestos-containing material and lead-based paint could be released into the air in the dust.

Unique Effects of the Build Alternatives

Alternatives A and C would be constructed with the soil improvement method. This soil improvement would solidify the contaminated soils in the full area of the underground seawall structure, thereby reducing the mobility of contaminants and providing a substantial overall environmental benefit. The grout would be mixed on site and injected into the subsurface, during which time some amount of grout would be brought to the surface and would be present on the surface within the contained jet-grouting area. An estimated 102,000 cubic yards of jet-grout spoils (a mixture of water, soil, and cement) would be generated during the jet-grouting operation for both alternatives. The amounts of potentially contaminated soil that would be removed due to seawall

setback range from 43,000 cubic yards for Alternative A to 60,300 cubic yards for Alternative C.

Alternative B would be constructed using a braced soldier pile method. An estimated 103,000 cubic yards of shaft excavation spoils (essentially the same quantity as Alternatives A and B) would be generated during the drilled shaft construction and installation. However, water would also be brought to the surface during the concrete placement for the drilled shafts. This potentially contaminated water would be handled according to the protocols for groundwater and surface water management. The drilled shaft construction would remove a substantial quantity of moderately contaminated soil from the subsurface near the shoreline, thereby providing an overall environmental benefit. Alternative B also includes substantial greater seawall setback areas than Alternatives A and C. An estimated 96,000 cubic yards of potentially contaminated material would be removed from the seawall setback areas, providing some additional environmental benefit compared to Alternatives A and C. The seawall setback excavation adjacent to Pier 57 would be closer to the Seattle Steam Company site than it would be under Alternatives A and C but still far enough away from the area of concern that no significant contamination is expected to be encountered in the seawall excavation.

As noted previously, placement of fills for habitat enhancements would also benefit the environment by providing new uncontaminated surfaces and thereby reducing the overall risk due to contamination for nearshore aquatic species. Alternatives B and C would provide substantially more new uncontaminated surfaces than Alternative A (Table 4-22). The proposed habitat fill area south of Colman Dock Ferry Terminal would provide a thick protective cover above the contaminated sediments in that area.

Indirect Effects

No indirect effects related to contaminated materials have been identified.

Avoidance, Minimization, and Mitigation Measures

The City will implement the following measures before any demolition and/or dismantling work begins:

- Conduct hazardous materials surveys for the presence of PCBs, asbestos-containing materials, or lead-based paint, with follow-up sampling if needed to identify equipment, materials, and structures that require special handling or disposal.
- Notify the Puget Sound Clean Air Agency prior to any demolition activities involving removal of any asbestos containing material.

- Appropriately handle and segregate any demolition debris that may be a potential contaminant source; remove for disposal as required by the applicable regulations.
- Install temporary containment west of the existing seawall to prevent the transport of contaminated materials into Elliott Bay.
- Use appropriate procedures to manage and handle contaminated materials including soil, groundwater, and surface water in accordance with applicable regulations.
- Provide advanced planning and notification of appropriate authorities for work adjacent to known regulated cleanup sites, both in the upland area and in the water.
- Determine sampling, field screening, and monitoring requirements for worker safety and exposure to contaminated soil and groundwater prior to construction.
- In order not to disturb contaminated sediments, use effective BMPs for in-water placement of habitat substrate materials, in-water removal of riprap if needed, outfall reconstruction, and operation of in-water and overwater construction equipment.
- Comply with all regulatory permit requirements, including water quality monitoring requirements for in-water work specified in the 401 Water Quality Certification and the related water quality monitoring and protection plan approved for the project by Ecology.
- Continue to coordinate with applicable regulatory and land management agencies, as well as responsible parties, regarding in-water work with the potential to disrupt existing contaminated sediments or existing areas with sediment caps.

4.13 Geology and Soils

Effects Common to All Build Alternatives

Construction effects are related primarily to earthwork and occur during construction or within a short time thereafter. Subsurface soils behind the existing seawall consist mostly of unconsolidated and liquefiable soil fills with a high groundwater table. The inherent character of these soils complicates the construction process and poses environmental risks related to erosion and sediment transport, excavation stability and ground settlement, and construction dewatering, and their effects potential effects on existing features such as roads, utilities, and buildings.

Earthwork Quantities

Construction of the seawall would involve excavations of soils behind the existing seawall, placement of the new seawall structure, and new

Geology and Soils Key Points

Any areas that are disturbed during construction would be subject to increased erosion, and Best Management Practices would be required.

Ground settlement from dewatering could cause settlement of utilities, roadways, and other facilities adjacent to project excavations.

The primary differences in potential effects of the build alternatives are related to the construction methods used for building the new seawall.

The existing ground could settle beneath fill materials used to create the habitat benches. Nearby existing pile foundations for Colman Dock Ferry Terminal and Pier 48 could be subjected to additional forces due to the soil settlement, causing settlement of the docks and facilities.

The braced soldier pile construction method identified for Alternative B would result in greater ground settlement than for Alternatives A and B.

fill to restore the street grade behind the seawall. The amounts of earthwork necessary for each of the build alternatives would depend on the location of the new seawall face compared to the existing seawall location. Table 4-23 summarizes the excavation volumes and new materials for the build alternatives. The differing amounts of earthwork do not equate directly to different kinds of effects on geology and soil resources. Instead, the effects are related to the unconsolidated and liquefiable nature of the existing soils, the specific construction methods used for the project, and how excavated and imported soils are handled.

Construction Spoils
Spoils consist of soil or other debris, such as wood and concrete, removed by construction activity.

Table 4-23. Excavations and Jet Grouting Spoils by Alternative

	Material to be Excavated (cubic yards)	Spoils Generate by Jet Grouting (cubic yards)
Alternative A	111,000	102,000
Alternative B	248,000	0
Alternative C	125,000	102,000

Large quantities of construction spoils would be generated. Most of the construction spoils would likely require off-site disposal. Spoils that are removed from the site would be hauled in trucks or rail cars to a predetermined disposal site. During transport, the spoils could spill, which could result in deposition of dust or debris on the roadways, on rail corridors, or in water unless appropriate BMPs are implemented. Some of the spoils would contain debris, wood, and potential contaminants. Disposal and volume estimates of these types of soils are discussed further in the Contaminated Materials Discipline Report (Appendix O).

Erosion and Sediment Transport

Surficial areas in the vicinity of the new seawall and beneath new sidewalks or roadways would be cleared of all existing pavement, vegetation, and debris, and stripped of organic soils. The debris resulting from these clearing activities would be removed from the area. The prepared ground surface would have a high erosion potential if exposed during the rainy season or in the presence of surface water. Any areas that are disturbed during construction would be subject to increased erosion if proper control measures are not implemented.

Within the construction work zone, the tires and tracks of heavy equipment may sink into the soft surface soil if no work pad is present. The tires of the construction vehicles could also carry soil onto roadways when the trucks leave the construction work zone and travel along haul routes unless appropriate BMPs are implemented.

Exposed stockpiles of material to be used as landscaping or structural fill would be susceptible to erosion by surface water if they are not

adequately protected, which could result in the deposition of sediment on adjacent properties, on streets, and in stormwater drains. These materials also could become wet and unsuitable for use as fill if left uncovered during rainy periods or if appropriate BMPs are not implemented.

Ground Instability and Settlement

Soil instability during construction has the potential to damage utilities, structures, and pavement. These effects could result from a wide range of construction activities, such as movements of heavy equipment, ground vibration, ground excavation, fill placement, and ground improvement as part of seawall construction.

Construction traffic and heavy equipment may cause settlement, potholes, cracks, and other damage to existing roadways and sidewalks. Haul routes between staging areas and the construction work zone may sustain this type of damage. The degree of damage to existing pavements would depend on the condition of the pavement subgrade, the strength of the pavement section, and the weight of the construction traffic.

Vibration of the ground would result from pile installation (either by impact or vibratory methods), seawall construction and associated ground improvement (soil improvement or braced soldier pile methods), and removal of existing structures and their foundations. The vibrations could cause ground settlement and damage to structures and utilities, which may result in service outages. The potential for this effect to occur and the severity of damage to adjacent structures and utilities would depend on soil conditions and the proximity of the structures. For example, when a pile encounters obstructions during driving, the vibrations that can be expected under typical conditions could increase above a typical level because of harder driving conditions. Potential effects related to vibrations are discussed further in Section 4.3 of this Final EIS, Noise and Vibration.

Fill materials about 10 to 15 feet thick would be placed above the new seawall structure to restore the street grade landward of the seawall. Placement and compaction of fill materials adjacent to existing structures could cause damage to the walls or structures because of the forces that are applied during the fill placement and compaction process. If backfilling and compacting operations are performed during wet weather, the fill materials may not achieve the desired degree of compaction, and improperly compacted fills could settle over time. Differential settlement also could occur where there are hard spots below new fills or roadways (such as refoundation elements that remain in place after structures are removed).

Imported structural fill may be stored in stockpiles at staging areas located within the study area. The effects of stockpiles may include settlement of the ground surface in the stockpile areas and erosion and sediment transport. Utilities and pavement beneath the stockpiles could

be damaged due to settlement and lateral movement caused by the weight of the stockpiled materials. If stockpiles are placed adjacent to the existing seawall or shoring walls, lateral movement of the structures could occur.

Various types of shoring walls may be used to support the temporary excavations, including soldier pile and lagging walls, sheet pile walls, or diaphragm walls. Depending on the excavation depths and subsurface conditions, the walls could be cantilevered, tied back, or internally braced. Improper design or construction of shoring walls and tiebacks or braces could result in excessive lateral displacement. The displacement could result in settlement of the adjacent ground, which could, in turn, damage nearby roadways, railways, utilities, and structures.

Ground anchors such as tiebacks or micropiles would be installed to supplement the lateral resistance for the new seawall system. Installation of ground anchors typically involves drilling a hole with a casing through unstable soils and then drilling farther into the ground without a casing. During the drilling of anchor holes, potential ground settlement in soft soils, sandy soils, and/or water-bearing soils could migrate to the ground surface and result in settlement of adjacent structures, utilities, and pavements. Soil testing indicates that large amounts of wood and debris are present in some locations along the seawall alignment. Installation of anchors through this material may be difficult and could result in improper grouting and ground loss. The presence of wood could also result in misalignment of the anchors.

Offshore habitat-related materials would be used for all three build alternatives. Depending on the soil conditions, weight of the materials, and the mudline slope, the submarine slope could become unstable during the placement of fill. In addition, fill placement could result in settlement of the underlying sediments. This potential instability and settlement could cause damage to adjacent features, including existing pile-supported structures and the new seawall structure. Settlement could also impose down-drag forces on the piles, which could result in settlement of the structures that they support.

Construction Dewatering

The water table along the seawall is located at about 7 to 15 feet bgs and varies with the tide level in Elliott Bay. In areas where excavations would extend below the water table, dewatering of soils within and below the excavation may be necessary. Dewatering activities also could draw down the water table outside the excavation, depending on the subsurface soil and groundwater conditions, the wall type, and the amount of dewatering required. If the excavation dewatering effort fails or is inadequate for any reason, or if the amount of drawdown outside the excavation is greater than the existing seasonal or tidal fluctuation of the groundwater, settlement of the ground surface could occur. Ground settlement from dewatering could cause settlement of utilities, roadways, and other facilities adjacent to the excavations. Where

existing structures are supported on timber piles, extended groundwater lowering over time could contribute to pile decay.

Construction dewatering would not affect public or private groundwater supplies because groundwater is not used as a water supply in the study area.

Unique Effects of the Build Alternatives

The primary differences in potential effects of the build alternatives on geology and soil resources are related to the construction methods used for building the new seawall.

Soil improvement, the proposed seawall construction method for Alternatives A and C, can be complicated by the presence of underground obstructions. Incomplete grouting of an area can occur if soils that do not easily erode (e.g., clay) are encountered or is underground obstructions cause a gap in the jet grout. Gaps could also be created by misalignment of the grout columns. There is a high potential for gaps because of the numerous existing timber piles that would be left in place.

Utilities and foundation elements may settle or be raised or displaced laterally when jet-grout operations are performed nearby. Grout injected into the soil may also travel through open soil layers or through the existing seawall and enter Elliott Bay. The jet-grouting process also may exert additional forces on the seawall structure, which could put physical stress on the seawall or result in localized failures of the seawall. Jet grouting is not expected to cause the destabilization of adjacent facilities.

Jet-grout operations typically produce spoil volumes equal to about 50 to 70 percent of the volume of treated soil. These spoils would consist of a mixture of eroded soil and cement grout that is flushed to the ground surface during jet-grouting operations. If not properly contained, the spoils may migrate onto adjacent streets, properties, or Elliott Bay.

Alternative B would be constructed using braced soldier piles. The potential for ground settlement during construction would be somewhat greater with this method. Unstable soil and unfavorable groundwater conditions (seasonal and tidal fluctuations, potential contamination among other conditions) are present below the ground surface in numerous locations along the alignment of the new seawall. The 8-foot-diameter deep drilled shafts may be installed at a 10–foot center-to-center spacing, resulting in a 2-foot-wide gap between the drilled shafts. Depending on the soil and groundwater conditions, if the seawall face is exposed to air or water, soil behind (landward of) the seawall could cave or slough in between the shafts, resulting in ground loss. The ground settlement could expand to the ground surface as settlement and result in damage to adjacent pavements, utilities, and structures. Migration of concrete into Elliott Bay could occur through open soil layers.

Alternatives B and C also includes the construction of an intertidal habitat bench north of the Washington Street Boat Landing, adjacent to the seawall. Creation of this bench would require the placement of about 15 to 25 feet of granular fill and riprap in the water. The existing ground could settle several feet as the fill is placed. Additional settlement could occur over the long term as fine-grained soil deposits are compressed. This fill would extend near the existing pile-supported docks north and south of the habitat bench (Colman Dock Ferry Terminal and Pier 48). Depending on the proximity and height of the fill, the existing pile foundations could be subjected to additional forces due to the soil settlement (down-drag forces), which could result in settlement of the overlying docks and facilities.

Most of the existing topography adjacent to the habitat bench is gently sloping. However, localized steeper areas may become unstable when the fill is placed; resulting in localized ground movement around the habitat beach. This ground movement could result in additional forces on nearby pile foundations and settlement of the bench.

Alternative B includes an option to build a land plaza in Zone 4 near the Seattle Aquarium. The land between the existing seawall and the new seawall would remain, the ground would be stabilized to minimize potential liquefaction and lateral spreading, and a new retaining wall would be constructed along the west side of the ground improvement zone. Ground stabilization methods that may be used include jet grouting and vibro-replacement (also referred to as stone columns). Vibro-replacement may be performed in areas where vibrations would not substantially affect adjacent facilities. Vibro-replacement typically produces spoil volumes equal to about 5 to 10 percent of the volume of treated soil. These spoils would consist of a mixture of eroded soil and water that is generated during the vibro-replacement operation. If not properly contained, the spoils may migrate onto adjacent streets or properties.

Installation of the stone columns could cause vibrations that could adversely affect buildings and utilities. In addition, settlement and lateral movements caused by the densification of the ground could affect adjacent structures. If soft soils are encountered during the column installation, a large amount of gravel may be required to achieve adequate interlocking with the soil. If obstructions are encountered, progress of the column installation could be impeded. It is unlikely that stone columns would be able to penetrate below the level of the relieving platform.

Vibro-Replacement (Stone Columns)

Stone columns are constructed using a vibratory probe that penetrates the ground, either under its own weight or aided by water jetting. Vibrations are generated close to the tip of the probe and emanate radially away from the tip. Gravel backfill is placed, either from the top through the annulus created by penetration of the probe (top feed) or through feeder tubes directed to the tip of the probe (bottom feed). Compaction of the gravel backfill by the vibratory probe forces the gravel radially into the surrounding soil, forming a stone column that is tightly interlocked with the soil.

Indirect Effects

No indirect effects related to geology and soils have been identified.

Avoidance, Minimization, and Mitigation Measures

Measures Common to All Build Alternatives

The City will implement the following measures for adverse effects on geology and soils during construction:

- Comply with stormwater design and treatment procedures in the current version of the Seattle Stormwater Code (SMC 22.800).
- Obtain an NPDES construction stormwater general permit for the project and list specific BMPs required for the project.
- Put erosion and sediment control measures in place before any clearing, grading, or construction. Construction BMPs include construction staging barrier berms, filter fabric fences, temporary sediment detention basins, and use of slope coverings to contain sediment on site.
- Route construction traffic onto City-approved haul routes, which include roadways that are capable of handling heavy loads. The contractor shall take measures to reduce dust during hauling, such as covering loads during transport or allowing 1 foot of freeboard above the transported material.
- Establish allowable vibration levels for critical structures and utilities near the construction activities. Preconstruction surveys will be performed to establish a baseline. During construction, vibrations will be monitored to confirm that the allowable vibration levels are not being exceeded. In areas where vibration cannot be tolerated.
- Avoid placing fill adjacent to walls or other structures that are sensitive to settlement unless the structures can accommodate the increased pressures due to the placement and compaction of the fill. Suitable structural fill materials will be used to construct the fills, and the material will be compacted to achieve the compaction criteria required by the City.
- Adequately support temporary excavations to mitigate potential sloughing of soils and lateral movement or settlement of nearby existing roadways, railways, structures, and utilities.
- Minimize the entry of water into excavations to the extent feasible. Minimization measures could include the use of groundwater recharge wells, dewatering in small sections, or the installation of barriers (e.g., sheet piles and diaphragm walls) to isolate the water table within the excavation.
- Monitor the water table and settlement outside the excavation to confirm that the dewatering system is working as designed.

- Install temporary containment west of the existing seawall to protect Elliott Bay from the construction activities.
- Include construction BMPs related to the disposal of soils such as cleaning tires and tracks on heavy equipment before they travel along haul routes and covering truck loads to prevent sediment deposition on roadways.
- Locate stockpiles to allow access to utilities for maintenance and repairs by the owners.
- Cover stockpiles to prevent erosion and sediment transport. Where feasible, the stockpiles will not be placed directly over utilities or pavements that should not be damaged. In areas where this is not possible, the stockpile height will be limited so that excessive settlement or damage of underlying utilities or pavements does not occur.
- Monitor adjacent utilities or structures for movement during jet-grouting activities.
- Contain and properly handle spoils generated during jet-grouting activities in accordance with permit requirements.
- Carefully control jet-grouting pressure near the ground surface, near existing outfalls and other utilities that will be supported in place, and near the face of the existing seawall in order to mitigate excessive pressure on or leakage of jet grout into adjacent utilities or structures. The temporary containment wall will be installed on the water side of the ground improvement area to prevent jet-grout migration into Elliott Bay. Jet grouting will also be performed in a semicircular pattern adjacent to the protective sheet piles to control potential migration of the grout. Utilities will be inspected in advance and any holes observed will be repaired before jet grouting begins.
- Avoid using vibratory methods for sheet pile installation areas where vibrations may affect adjacent facilities. Depending on the soil conditions, the sheet piles could be pushed into the ground without vibration. If the soil conditions are too dense, predrilling will be performed to prepare holes for the sheet piles.
- Avoid using vibratory methods for removal of deep foundations in areas where adjacent structures or utilities would be substantially affected. Non-vibratory techniques (e.g., excavation of the foundation element) will be used in areas where adjacent utilities or structures cannot tolerate vibration or settlement.

The following additional mitigation measures would apply to Alternative B:

- Anchor holes would be drilled in a manner that would minimize ground loss and not endanger previously installed anchors or undermine existing pavement, foundations, or utilities.
- Vibro-replacement methods would not be used in areas where vibrations and settlement could substantially affect adjacent facilities or where significant obstructions are anticipated. Spoils generated from the vibro-replacement method would be properly contained by constructing berms or other barriers around the construction work zone. Proper containment would mitigate migration of spoils onto adjacent streets or properties.

4.14 Air Quality

Effects Common to All Build Alternatives

Emissions during construction are influenced by construction techniques, types of equipment used, and construction duration. Other factors that affect air quality include the number of construction workers, construction truck trips, and commute trips by construction workers. The types of effects are similar between the build alternatives, although the emission quantities vary somewhat. The quantities of emissions within the construction work zone and offsite would vary by calendar year. Peak annual emissions for all pollutants would be well below the Clean Air Act conformity thresholds set for most pollutants at 100 tons per year per pollutant. Additionally, peak annual emissions for each of the build alternatives would represent a fraction of 1 percent of the King County 2005 emissions for the corresponding pollutant. The peak overall annual construction emissions for Alternatives A and C are shown in Table 4-24. Based on the magnitude of the estimated construction emissions relative to the Clean Air Act conformity thresholds and the magnitude of total King County emissions, construction of any of the build alternatives would not have a significant effect on air quality in the Seattle area. None of the build alternatives would not require a formal Clean Air Act conformity determination.

Air Quality Key Points

Peak annual emissions for all pollutants would be well below the Clean Air Act conformity thresholds set for most pollutants.

Construction of any of the build alternatives would not have a significant effect on air quality in the Seattle area.

Table 4-24. Estimated Annual On-site and Off-site Air Emissions for Peak Construction Year

Substance	Alternatives A and C		Alternative B	
	Annual Project-Related Emissions (in tons)	Percentage of Annual King County Emissions	Annual Project-Related Emissions (in tons)	Percentage of Annual King County Emissions
Off-site Emissions				
Reactive organic gas	11.37	0.014	6.58	0.008
Nitrogen oxide	24.11	0.032	6.58	0.021
Carbon monoxide	86.51	0.015	52.40	0.009
Sulfur oxide	4.35	0.101	3.05	0.071
On-site Emissions				
PM_{10}	3.66	NA	2.69	NA
$PM_{2.5}$	2.17	0.026	1.49	0.018
Diesel particulate matter	1.83	NA	1.37	NA

Notes: NA – not applicable, PM_{10} – inhalable particulate matter (diameter less than or equal to 10 micrometers), $PM_{2.5}$ – fine particulate matter (diameter less than or equal to 2.5 micrometers)

Unique Effects of the Build Alternatives

The highest annual on-site construction emissions for Alternatives A and C would occur in 2014 (for most pollutants) or 2015 (for inhalable particulate matter (diameter less than or equal to 10 micrometers) [PM_{10}] and fine particulate matter (diameter less than or equal to 2.5 micrometers) [$PM_{2.5}$]). Annual on-site construction emissions for North Seawall construction (from 2016 through 2022) would be substantially less than those for Central Seawall (from 2013 through 2015). Annual emissions associated with construction-related traffic would be much less than the corresponding emissions from on-site construction activities. The highest annual off-site emissions from construction-related traffic would occur in 2014 (for most pollutants) or 2015 (for sulfur oxides). The peak annual carbon monoxide emissions (86.5 tons) would occur in 2014.

Under Alternative B, the peak overall annual construction emissions under Alternative B would occur in 2014 (for most pollutants) or 2013 (for PM_{10} and $PM_{2.5}$). The peak annual carbon monoxide emissions (52.4 tons) would occur in 2014.

Indirect Effects

No indirect effects related to air quality have been identified.

Avoidance, Minimization, and Mitigation Measures

The City will carry out the following mitigation measures for adverse effects on air quality during construction:

- Implement fugitive dust control practices (primarily periodic sprinkling of exposed open areas by water trucks and street sweeping).
- Limit construction vehicle idling, requiring the contractor to use well-maintained equipment or newer equipment.

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Table 4-25. Temporary Construction Effects of the Build Alternatives by Discipline

Discipline	Alternative A			Alternative B			Alternative C		
	Effect	Duration	Degree of Effect	Effect	Duration[1]	Degree of Effect	Effect	Duration	Degree of Effect
TRANSPORTATION	Adverse	Temporary	Substantial	Adverse	Temporary	Substantial	Adverse	Temporary	Substantial
ECONOMICS	Adverse	Temporary	Substantial	Adverse	Temporary	Substantial	Adverse	Temporary	Substantial
NOISE AND VIBRATION	Adverse	Temporary	Moderate to substantial	Adverse	Temporary	Moderate to substantial	Adverse	Temporary	Moderate to substantial
CULTURAL, HISTORIC, AND ARCHAEOLOGICAL RESOURCES									
Historic resources	Adverse	Temporary	Minor	Adverse	Temporary	Minor to moderate	Adverse	Temporary	Minor
Archaeological and cultural resources	Adverse	Temporary	Moderate	Adverse	Temporary	Moderate	Adverse	Temporary	Moderate
ENERGY RESOURCES AND GREENHOUSE GAS EMISSIONS									
Energy resources	Adverse	Temporary	Minor	Adverse	Temporary	Minor	Adverse	Temporary	Minor
Greenhouse gas emissions	Adverse	Temporary	Minor	Adverse	Temporary	Minor	Adverse	Temporary	Minor
LAND USE, SHORELINES, AND PARKS AND RECREATION									
Land use and shorelines	Adverse	Temporary	Minor	Adverse	Temporary	Minor	Adverse	Temporary	Minor
Parks and recreation	Adverse	Temporary	Moderate	Adverse	Temporary	Moderate	Adverse	Temporary	Moderate
PUBLIC SERVICES AND UTILITIES									
Public services	Adverse	Temporary	Moderate	Adverse	Temporary	Moderate	Adverse	Temporary	Moderate
Utilities	Adverse	Temporary	Moderate	Adverse	Temporary	Moderate	Adverse	Temporary	Moderate
SOCIAL RESOURCES AND ENVIRONMENTAL JUSTICE	Adverse	Temporary	Minor	Adverse	Temporary	Minor	Adverse	Temporary	Minor
VISUAL RESOURCES	Adverse	Temporary	Moderate	Adverse	Temporary	Moderate	Adverse	Temporary	Moderate
FISH, WILDLIFE, AND VEGETATION	Adverse	Temporary	Substantial	Adverse	Temporary	Substantial	Adverse	Temporary	Substantial
WATER RESOURCES	Adverse	Temporary	Moderate to substantial	Adverse	Temporary	Moderate to substantial	Adverse	Temporary	Moderate to substantial
CONTAMINATED MATERIALS	Adverse	Temporary	Minor	Adverse	Temporary	Minor	Adverse	Temporary	Minor
GEOLOGY AND SOILS	Adverse	Temporary	Minor	Adverse	Temporary	Minor	Adverse	Temporary	Minor
AIR QUALITY	Adverse	Temporary	Minor	Adverse	Temporary	Minor	Adverse	Temporary	Minor

Note: [1] Duration up to 2 years longer than Alternatives A and C.

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