Appendix L Air Quality Technical Appendix

This appendix documents the air quality technical analysis to support the impact analysis in the EIS.

L.1 Background Information

This section describes the area of analysis and ambient air quality and conditions in the study area.

The discussion in this appendix is organized by the action areas and air basins. The counties, air basins and air quality management districts in California, including those in the action area, do not specifically align with the action areas, as noted below and in the description of each air basin (California Air Resources Board [ARB] 2019a, 2019b). The action areas include the following air basins and counties.

- Trinity River region: Trinity Reservoir and Trinity River downstream of Lewiston Reservoir
  - This region is located within the North Coast Air Basin.
  - This region is located within Humboldt and Trinity Counties.
- Sacramento River region: Sacramento River from Shasta Lake downstream to and including the Sacramento-San Joaquin Delta
  - This region is located within the Sacramento Valley Air Basin.
  - This region is located within Shasta, Tehama, Glenn, Colusa, Sutter, Yolo, and Sacramento Counties.
- Clear Creek region: Clear Creek from Whiskeytown Reservoir to its confluence with the Sacramento River
  - This region is located within the Sacramento Valley Air Basin.
  - This region is located within Shasta County.
- Feather River region: Feather River from the FERC boundary downstream to its confluence with the Sacramento River
  - This region is located within the Sacramento Valley Air Basin.
  - This region is located within Butte, Yuba, and Sutter Counties.
- American River region: American River from Folsom Reservoir downstream to its confluence with the Sacramento River
  - This region is located within the Sacramento Valley Air Basin.
  - This region is located within Placer, Sacramento, and Yolo Counties.
- Stanislaus River region: Stanislaus River from New Melones Reservoir to its confluence with the San Joaquin River
  - This region is located within portions of the San Joaquin Valley and Mountain Counties Air Basins.

  - This region is located within Calaveras, Tuolumne, Stanislaus, San Joaquin, and Merced Counties.
- San Joaquin River region: San Joaquin River from Friant Dam downstream to and including the Sacramento-San Joaquin Delta
  - This region is located within the San Joaquin Valley Air Basin.
  - This region is located within Fresno, Madera, Merced, Stanislaus, and San Joaquin Counties.
- Bay-Delta region: San Francisco Bay, Suisun Marsh, and Delta
  - This region is located within portions of the Sacramento Valley, San Joaquin Valley, and San Francisco Bay Air Basins.
  - This region is located within Solano, Sacramento, San Joaquin, Contra Costa, San Francisco, and Alameda Counties.
- CVP and SWP Service Areas region: CVP and SWP service areas (south to Diamond Valley)
  - This region is located within portions of the San Francisco Bay, North Central Coast, San Joaquin Valley, Mojave Desert, South Coast, San Diego, and Salt on Sea Air Basins.
  - This region is located within Santa Clara, San Benito, Kings, Kern, Ventura, Los Angeles, San Bernardino, Orange, Riverside, San Diego, and Imperial Counties.
- Nearshore Pacific Ocean region: nearshore Pacific Ocean on the coast from Point Conception to Cape Falcon in Oregon
  - This region is located within portions of the South Central Coast, North Central Coast, San Francisco Bay, and North Coast Air Basins.
  - This region borders Santa Barbara, San Luis Obispo, Monterey, Santa Cruz, San Mateo, San Francisco, Marin, Sonoma, Mendocino, Humboldt, and Del Norte Counties.

L.1.1 Ambient Air Quality

Air quality conditions and potential impacts in the action area are evaluated and discussed qualitatively. The following subsections briefly describe the existing air quality environmental setting by air basin for the action area. The counties within each air basin in the action area are presented in Table L.1-1, along with nonattainment designations to characterize existing ambient air quality. Nonattainment designations indicate that concentrations of pollutants measured in ambient air exceed the applicable ambient air quality standards. As shown in Table L.1-1, Areas and Pollutants Designated as Nonattainment for Federal and State Ambient Air Quality Standards, many of the counties included in the action area are designated as nonattainment for the federal and/or state ozone and particulate matter standards. Particulate matter issues may be exacerbated under dry conditions because when irrigation water supplies are decreased, there is increased potential for the formation and transport of fugitive dust.

Table L.1-1. Areas and Pollutants Designated as Nonattainment for Federal and State Ambient Air Quality Standards

County	Air Basin	Air Quality Management District	Federal Nonattainment Designations[1]	State Nonattainment Designations[2]
Trinity River Region				
Humboldt	North Coast	North Coast Unified	–	PM_{10}
Trinity	North Coast	North Coast Unified	–	–
Sacramento River Region				
Shasta	Sacramento Valley	Shasta	–	Ozone
Tehama	Sacramento Valley	Tehama	Ozone (Tuscan Buttes)	Ozone, PM_{10}
Glenn	Sacramento Valley	Glenn	–	PM_{10}
Colusa	Sacramento Valley	Colusa	–	PM_{10}
Sutter	Sacramento Valley	Feather River	Ozone (Sutter Buttes)	Ozone, PM_{10}
Yolo	Sacramento Valley	Yolo-Solano	Ozone, $PM_{2.5}$	Ozone, PM_{10}
Sacramento	Sacramento Valley	Sacramento Metro	Ozone, $PM_{2.5}$	Ozone, PM_{10}
Clear Creek Region				
Shasta	Sacramento Valley	Shasta	–	Ozone
Feather River Region				
Butte	Sacramento Valley	Butte	Ozone	Ozone, $PM_{2.5}$, PM_{10}
Yuba	Sacramento Valley	Feather River	–	Ozone, PM_{10}
Sutter	Sacramento Valley	Feather River	Ozone (Sutter Buttes)	Ozone, PM_{10}
American River Region				
Placer	Sacramento Valley, Mountain Counties, Lake Tahoe	Placer	Ozone (Sacramento Metro AQMD portion), $PM_{2.5}$ (Sacramento Metro AQMD portion)	Ozone, PM_{10}
Sacramento	Sacramento Valley	Sacramento Metro	Ozone, $PM_{2.5}$	Ozone, PM_{10}
Yolo	Sacramento Valley	Yolo-Solano	Ozone, $PM_{2.5}$	Ozone, PM_{10}
Stanislaus River Region				
Calaveras	Mountain Counties	Calaveras	Ozone	Ozone, PM_{10}
Tuolumne	Mountain Counties	Tuolumne	Ozone	Ozone
Stanislaus	San Joaquin Valley	San Joaquin Valley Unified	Ozone, $PM_{2.5}$	Ozone, $PM_{2.5}$, PM_{10}
San Joaquin	San Joaquin Valley	San Joaquin Valley Unified	Ozone, $PM_{2.5}$	Ozone, $PM_{2.5}$, PM_{10}
Merced	San Joaquin Valley	San Joaquin Valley Unified	Ozone, $PM_{2.5}$	Ozone, $PM_{2.5}$, PM_{10}

County	Air Basin	Air Quality Management District	Federal Nonattainment Designations[1]	State Nonattainment Designations[2]
San Joaquin River Region				
Fresno	San Joaquin Valley	San Joaquin Valley Unified	Ozone, $PM_{2.5}$	Ozone, $PM_{2.5}$, PM_{10}
Madera	San Joaquin Valley	San Joaquin Valley Unified	Ozone, $PM_{2.5}$	Ozone, $PM_{2.5}$, PM_{10}
Merced	San Joaquin Valley	San Joaquin Valley Unified	Ozone, $PM_{2.5}$	Ozone, $PM_{2.5}$, PM_{10}
Stanislaus	San Joaquin Valley	San Joaquin Valley Unified	Ozone, $PM_{2.5}$	Ozone, $PM_{2.5}$, PM_{10}
San Joaquin	San Joaquin Valley	San Joaquin Valley Unified	Ozone, $PM_{2.5}$	Ozone, $PM_{2.5}$, PM_{10}
Bay-Delta Region				
Solano	Sacramento Valley, San Francisco Bay	Yolo-Solano, Bay Area	Ozone (Bay Area AQMD portion)	Ozone, PM_{10}
Sacramento	Sacramento Valley	Sacramento Metro	Ozone, $PM_{2.5}$	Ozone, PM_{10}
San Joaquin	San Joaquin Valley	San Joaquin Valley Unified	Ozone, $PM_{2.5}$	Ozone, $PM_{2.5}$, PM_{10}
Contra Costa	San Francisco Bay	Bay Area	Ozone, $PM_{2.5}$	Ozone, $PM_{2.5}$, PM_{10}
San Francisco	San Francisco Bay	Bay Area	Ozone, $PM_{2.5}$	Ozone, $PM_{2.5}$, PM_{10}
Alameda	San Francisco Bay	Bay Area	Ozone, $PM_{2.5}$	Ozone, $PM_{2.5}$, PM_{10}
CVP and SWP Service Areas Region				
Santa Clara	San Francisco Bay	Bay Area	Ozone	Ozone, $PM_{2.5}$, PM_{10}
San Benito	North Central Coast	Monterey Bay Unified	–	Ozone, PM_{10}
Kings	San Joaquin Valley	San Joaquin Valley Unified	Ozone, $PM_{2.5}$	Ozone, $PM_{2.5}$, PM_{10}
Kern	San Joaquin Valley, Mojave Desert	San Joaquin Valley Unified, Kern	Ozone (Eastern Kern), $PM_{2.5}$, PM_{10} (Eastern Kern)	Ozone, $PM_{2.5}$ (Eastern Kern), PM_{10}
Ventura	South Central Coast	Ventura	Ozone	Ozone, PM_{10}
Los Angeles	South Coast, Mojave Desert	South Coast, Antelope Valley	Ozone, $PM_{2.5}$	Ozone, $PM_{2.5}$ (Eastern Los Angeles), PM_{10}
San Bernardino	South Coast, Mojave Desert	South Coast, Mojave Desert	Ozone, $PM_{2.5}$	Ozone, $PM_{2.5}$ (South-Eastern San Bernardino), PM_{10}
Orange	South Coast	South Coast	Ozone, $PM_{2.5}$	Ozone, $PM_{2.5}$, PM_{10}
Riverside	South Coast, Salt on Sea, Mojave Desert	South Coast, Mojave Desert	Ozone, $PM_{2.5}$, PM_{10} (Coachella Valley)	Ozone, $PM_{2.5}$ (Eastern Riverside), PM_{10}
San Diego	San Diego	San Diego	Ozone	Ozone, $PM_{2.5}$, PM_{10}
Imperial	Salt on Sea	Imperial	Ozone, $PM_{2.5}$, PM_{10}	Ozone, PM_{10}

County	Air Basin	Air Quality Management District	Federal Nonattainment Designations[1]	State Nonattainment Designations[2]
Nearshore Pacific Ocean Region				
Santa Barbara	South Central Coast	Santa Barbara	–	Ozone, PM_{10}
San Luis Obispo	South Central Coast	San Luis Obispo	Ozone (eastern portion)	Ozone, PM_{10}
Monterey	North Central Coast	Monterey Bay Unified	–	Ozone, PM_{10}
Santa Cruz	North Central Coast	Monterey Bay Unified	–	Ozone, PM_{10}
San Mateo	San Francisco Bay	Bay Area	Ozone, $PM_{2.5}$	Ozone, $PM_{2.5}$, PM_{10}
San Francisco	San Francisco Bay	Bay Area	Ozone, $PM_{2.5}$	Ozone, $PM_{2.5}$, PM_{10}
Marin	San Francisco Bay	Bay Area	Ozone, $PM_{2.5}$	Ozone, $PM_{2.5}$, PM_{10}
Sonoma	North Coast, San Francisco Bay	Northern Sonoma, Bay Area	Ozone (Bay Area AQMD portion), $PM_{2.5}$ (Bay Area AQMD portion)	Ozone (Bay Area AQMD portion), $PM_{2.5}$ (Bay Area AQMD portion), PM_{10} (Bay Area AQMD portion)
Mendocino	North Coast	Mendocino	–	PM_{10}
Humboldt	North Coast	North Coast Unified	–	PM_{10}
Del Norte	North Coast	North Coast Unified	–	–

Sources: USEPA 2019; ARB 2018a.
AQMD = Air Quality Management District
Bay Area = San Francisco Bay Area
PM2.5 = particulate matter of 2.5 microns diameter and smaller
PM10 = particulate matter of 10 microns diameter and smaller
[1] Areas designated as nonattainment by U.S. Environmental Protection Agency related to National Ambient Air Quality Standards as of January 31, 2019.
[2] Areas designated as nonattainment by California Air Resources Board related to California Ambient Air Quality Standards as of December 28, 2018. Changes to the state area designations were proposed for 2019.

L.1.1.1 *North Coast Air Basin*

The North Coast Air Basin includes Humboldt, Del Norte, Trinity, and Mendocino Counties, and northern Sonoma County (ARB 2019a). This air basin contains the Trinity River region and portions of the nearshore Pacific Ocean region of the action area. The basin is sparsely populated and stretches along the northern coastline through forested mountains. Prevailing winds blow clean air inland from the Pacific Ocean, and air quality is typically good. Del Norte, Trinity, and north Sonoma Counties are designated attainment for the federal and state air quality standards while the remainder of the air basin is designated nonattainment for at least one criteria pollutant (USEPA 2019; ARB 2018a).

L.1.1.2 *Sacramento Valley Air Basin*

The Sacramento Valley Air Basin encompasses 9 air districts and 11 counties, including all of Shasta, Tehama, Glenn, Colusa, Butte, Sutter, Yuba, Sacramento, and Yolo Counties; the westernmost portion of Placer County; and the northeastern half of Solano County. The air basin is bounded by tall mountains: the Coast Ranges to the west, the Cascade Range to the north, and the Sierra Nevada to the east. This air basin contains the Sacramento River, Clear Creek, Feather River, and American River regions, and portions of the Bay-Delta region of the action area.

Winters are wet and cool, and summers are hot and dry. When air stagnates, or is trapped by an inversion layer in the valley, ambient pollutant concentrations can reach or exceed ambient air quality standards. On-road vehicles are the largest source of smog-forming pollutants, and particulate matter emissions are primarily from area sources, such as fugitive dust from paved and unpaved roads and vehicle travel (ARB 2013a).

To characterize the existing ambient air quality in the Sacramento Valley Air Basin, analysts reviewed data from area monitoring stations (ARB 2019c, 2019d). For the three years of 2015–2017, monitoring data indicated the following:

- Concentrations of 8-hour ozone (O_3) and 24-hour $PM_{2.5}$ have exceeded the National Ambient Air Quality Standards (NAAQS) and California Ambient Air Quality Standards (CAAQS).
- Concentrations of 24-hour PM_{10} have exceeded the CAAQS. Concentrations of 24-hour PM_{10} were below the NAAQS in 2015 and 2016, but exceeded the NAAQS in 2017.
- Measured concentrations of nitrogen dioxide (NO_2) have complied with the NAAQS and CAAQS.
- Monitored sulfur dioxide (SO_2) and lead concentrations are extremely low.

L.1.1.3 *Mountain Counties Air Basin*

The Mountain Counties Air Basin includes the mountainous areas of the central and northern Sierra Nevada range, from Plumas County south to Mariposa County, including Plumas, Sierra, Nevada, Central Placer, West El Dorado, Amador, Calaveras, Tuolumne, and Mariposa Counties (ARB 2019a). This air basin includes portions of the Stanislaus River region of the action area.

The area is sparsely populated, and motor vehicles are the primary source of emissions in the air basin. Air quality issues often result when eastward surface winds transport pollution from more populated air basins to the west and south. Wood smoke from stoves and fireplaces contributes to elevated ambient PM_{10} concentrations during winter. Amador, Calaveras, El Dorado, Nevada, Placer, Mariposa, and Tuolumne Counties are designated as nonattainment for the state ozone standards (ARB 2018b). El Dorado, Nevada, Placer, Plumas, and Sierra Counties are designated as nonattainment for the state PM_{10} standards (ARB 2018b).

L.1.1.4 *San Francisco Bay Area Air Basin*

The San Francisco Bay Area Air Basin consists of a single air district and nine counties, including all of Napa, Marin, San Francisco, Contra Costa, Alameda, San Mateo, and Santa Clara Counties; the southern portion of Sonoma County; and the southwestern portion of Solano County (ARB 2019a). The hills of the Coast Ranges bound the San Francisco and San Pablo Bays and the inland valleys of the air basin. This air basin includes portions of the Bay-Delta and nearshore Pacific Ocean regions of the action area.

The San Francisco Bay Area Air Basin includes the second largest urban area in California, hosting industry, airports, international ports, freeways, and surface streets. On-road vehicles are the largest source of smog-forming pollutants, and PM_{10} emissions are primarily from area sources, such as fugitive dust from paved and unpaved roads and vehicle travel (ARB 2013a). Air quality in the San Francisco Bay Area (Bay Area) is often good, as sea breezes blow clean air from the Pacific Ocean into the air basin, but transport of pollutants from the San Francisco Bay Area can exacerbate air quality problems in the downwind portions of the San Francisco Bay Area Air Basin, as well as in the Sacramento Valley and San Joaquin Valley air basins.

To characterize the existing ambient air quality for the San Francisco Bay Area Air Basin, analysts reviewed data from area monitoring stations (ARB 2019c, 2019d). For the three years from 2015 to 2017, monitoring data indicated the following:

- Concentrations of 8-hour O_3 and 24-hour $PM_{2.5}$ have exceeded the NAAQS and CAAQS.
- Concentrations of 24-hour PM_{10} exceeded the CAAQS in 2015 and 2017, but were below the CAAQS in 2016. Concentrations of 24-hour PM_{10} were below the NAAQs. Concentrations of 1-hour O_3 exceeded the CAAQS. Concentrations of 1-hour O_3 were below the NAAQS in 2015 and 2016, but exceeded the NAAQS in 2017.
- Measured concentrations of NO_2 have complied with the NAAQS and CAAQS.
- Monitored SO_2 and lead concentrations are extremely low.

L.1.1.5 *San Joaquin Valley Air Basin*

The San Joaquin Valley Air Basin encompasses eight counties, including all of San Joaquin, Stanislaus, Madera, Merced, Fresno, Kings, and Tulare Counties; and western Kern County. It is bounded on the west by the Coast Range, on the east by the Sierra Nevada, and in the south by the Tehachapi Mountains. This air basin contains the San Joaquin River Region and portions of the Stanislaus River and Bay-Delta regions of the action area.

Winters are cool and wet and summers are dry and very hot. The area is heavily agricultural, and hosts other localized industries such as forest products, oil and gas production, and oil refining. On-road vehicles are the largest source of smog-forming pollutants, and PM_{10} emissions are primarily from sources such as agricultural operations and fugitive dust from paved and unpaved roads and vehicle travel (ARB 2013a). Air quality issues may be exacerbated under dry conditions. When water supplies and irrigation levels are decreased in urban, rural, and agricultural areas, there is increased potential for the formation and transport of fugitive dust.

To characterize the existing ambient air quality for the San Joaquin Valley Air Basin, data from area monitoring stations were reviewed (ARB 2019c, 2019d). For the three years of 2015–2017, monitoring data indicated the following:

- Concentrations of 8-hour O_3, 1-hour O_3, and 24-hour $PM_{2.5}$ have exceeded the NAAQS and CAAQS.
- Concentrations of 24-hour PM_{10} have exceeded the CAAQS. Concentrations of 24-hour PM_{10} were below the NAAQS in 2015 and 2016 but exceeded the NAAQS in 2017.
- Measured concentrations of NO_2 have complied with the NAAQS and CAAQS.
- Monitored SO_2 and lead concentrations are extremely low.

Concentrations of PM_{10} and $PM_{2.5}$ have been a continuing concern in the San Joaquin Valley Air Basin. The San Joaquin Valley Air Pollution Control District (SJVAPCD) is the local regulatory agency with jurisdiction over air quality issues in the San Joaquin Valley area. In response to the area's historical air quality problems with dust and particulate matter, the SJVAPCD was the first agency in the state to regulate emissions from on-field agricultural operations. In 2004, the agency adopted Rule 4550, the Conservation Management Practices rule, and Rule 3190, the Conservation Management Practices Fee rule. To comply with these rules, farmers with 100 acres or more of contiguous land must prepare and implement biennial Conservation Management Plans to reduce dust and particulate matter emissions from on-farm sources, such as unpaved roads and equipment yards, land preparation, harvest activities, and other farming activities. The SJVAPCD published a handbook titled *Agricultural Air Quality Conservation Management Practices for San Joaquin Valley Farms* and a list of conservation management practices in 2004 to provide guidance to farmers (SJVAPCD 2004a, 2004b). Examples of conservation management practices include activities that reduce or eliminate the need for soil disturbance, activities that protect soil from wind, use of dust suppressants, alternatives to burning agricultural wastes, and reduced travel speeds on unpaved roads and equipment yards. Lands not currently under cultivation or used for pasture are exempt from Rule 4550, other than recordkeeping to document the exemption. Fees vary depending on the size of the farm, and include an initial application fee, and a biennial renewal fee.

In addition to requirements for on-field agricultural practices, the SJVAPCD rules and regulations address avoidance of nuisance conditions (Rule 4102), prohibitions on opening burning (Rule 4103), and fugitive-dust control (Regulation VIII). Specifically, the SJVAPCD dust-control rules include Rule 8021 for control of PM_{10} from construction, demolition, excavation, extraction, and other earthmoving activities; Rule 8031 for control of PM_{10} from handling and storage of bulk materials; Rule 8051 for control of PM_{10} from disturbed open areas; Rule 8061 for control of PM_{10} from travel on paved and unpaved roads; Rule 8071 for control of PM_{10} from unpaved vehicle and equipment traffic areas; and Rule 8081 for off-field agricultural sources, such as bulk materials handling and transport and travel on unpaved roads. Each of these rules requires fugitive dust control, often through application of water, gravel, or chemical dust stabilizers.

L.1.1.6 *South Central Coast Air Basin*

The South Central Coast Air Basin includes San Luis Obispo, Santa Barbara and Ventura Counties. It is bordered by the Pacific Ocean on the south and west and lies just north of the highly populated South Coast Air Basin. This air basin includes portions of the nearshore Pacific Ocean region of the action area.

Sources of pollutants in the air basin include powerplants, oil production and refining, vehicle travel, and agricultural operations. San Luis Obispo, Santa Barbara, and Ventura Counties are designated as nonattainment for the state PM_{10} standards. San Luis Obispo and Ventura Counties are designated as nonattainment for the state ozone standards while Santa Barbara County is designated as nonattainment-transitional for the state ozone standard. Eastern San Luis Obispo and Ventura Counties are designated as nonattainment for the federal ozone standard (USEPA 2019). Wind patterns link Ventura and Santa Barbara Counties, resulting in pollutant transport between the South Central Coast Air Basin and South Coast Air Basin. San Luis Obispo County is separated from these counties by mountains, and the air quality in San Luis Obispo County is linked more with conditions in the San Francisco Bay Area Air Basin and San Joaquin Valley Air Basin. Additionally, air emissions from the South Coast Air Basin can be blown offshore, and then carried to the coastal cities of the South Central Coast Air Basin. Under some conditions, the reverse air flow can carry pollutants from the South Central Coast Air Basin to the South Coast Air Basin and contribute to ozone violations there (ARB 2013a).

L.1.1.7 *North Central Coast Air Basin*

The North Central Coast Air Basin includes Santa Cruz, San Benito and Monterey Counties (ARB 2019a). This air basin includes portions of the nearshore Pacific Ocean region of the action area.

The North Central Coast Air Basin is in attainment for all NAAQS, and is designated as nonattainment for the state ozone and PM_{10} standards (ARB 2019b). Although the air basin is separated from the Bay Area by the Santa Cruz Mountains and Coast Ranges to the north, wind can transport air pollution from the San Francisco Bay Area Air Basin and contribute to elevated ozone concentrations in the North Central Coast Air Basin (ARB 2013a).

L.2 Evaluation of Alternatives

This section describes the technical background for the evaluation of environmental consequences associated with the action alternatives and the No Action Alternative.

L.2.1 Methods and Tools

Potential air quality impacts were assessed for each component of each alternative. Where possible, the direction (positive or negative effect on air quality) and magnitude of change were identified for emissions of criteria pollutants, which are seven common pollutants for which the U.S. Environmental Protection Agency (USEPA) has set NAAQS according to health-based criteria. The criteria pollutants are carbon monoxide (CO), nitrogen dioxide (NO_2), ozone, particulate matter of 10 microns diameter and smaller (PM_{10}), particulate matter of 2.5 microns diameter and smaller ($PM_{2.5}$), reactive organic gases (ROG), and sulfur dioxide (SO_2). Ozone emissions are not calculated because ozone is not emitted directly from sources but is formed in the atmosphere from chemical reactions of the ozone precursor chemicals nitrogen oxides (NO_x) and ROG. Therefore, potential ozone impacts are assessed based on emissions of NO_x and ROG. The primary actions that could affect emissions are described as follows.

Potential changes in emissions from fossil-fueled powerplants (hydropower generation)

The action alternatives would change operations of the CVP and SWP, which could change river flows and reservoir levels. These changes could affect the amount of power the hydroelectric facilities in the system could generate. Where flows increase on rivers that have hydroelectric facilities then hydropower generation could increase. The additional hydroelectric power is expected to displace power that must be purchased from suppliers connected to the regional electric system (grid). To the extent that the displaced power would have been generated by fossil-fueled powerplants, emissions of criteria pollutants from these plants would decrease. (In 2016, approximately 50% of grid electricity in California was generated by fossil-fueled plants [USEPA 2018].) Conversely, if hydropower generation decreases, the decrease must be offset by purchased power from the grid to meet demand for power. To the extent that the additional purchased power would have been generated by fossil-fueled powerplants, emissions from these plants would increase.

Operations of the CVP and SWP also entail transfers of water. Many, but not all, transfers require water to be pumped. For those transfers that require pumping, changes in the quantities of water transferred could affect emissions by changing the amount of electricity required. If the amount of water transferred increases, the electrical energy required for pumping also would increase. To the extent that the increased electricity would be purchased from the grid and would be generated by fossil-fueled powerplants, emissions from these plants would increase. Conversely, if the amount of water transferred decreases, the electrical energy required for pumping also would decrease. To the extent that the amount of purchased electricity that is generated by fossil-fueled powerplants decreases, emissions from these plants would decrease. Under Alternatives 1, 2, 3, and 4, the quantities of water transferred would be the same as under the No Action Alternative. Consequently, there would be no change in emissions associated with water transfers, and the air quality impacts of the project would not be affected by water transfers.

Air quality effects resulting from changes in hydropower generation (including power required for water transfers), and consequently in the demand for grid power, were evaluated on a project-wide basis in terms of air pollutant emissions from fossil-fueled powerplants. For the details of the power modeling on which the air quality analysis was based, see Appendix U, *Power and Energy Technical Appendix*. The power modeling estimated energy usage in terms of net generation, defined as the difference between the amount of electricity generated by CVP/SWP hydropower facilities and the amount of electricity used by CVP/SWP for water transfers and facility operations. A positive value for net generation means that CVP/SWP generated more power than it used, and the excess was sold to the grid. A negative value for net generation means that CVP/SWP used more power than it generated, and offset the deficit by purchasing the additional power from the grid. Table L.2-1, Summary of Power Modeling Results, summarizes the results of the power modeling and shows the estimated net generation for each alternative for a long-term average year. The emissions calculations reflect net generation for the entire CVP/SWP system, as shown in the last line in the table.

Table L.2-1. Summary of Power Modeling Results

		Energy (Gigawatt-hours per average year)				
Facilities	**Energy Component**	**No Action**	**Alt 1**	**Alt 2**	**Alt 3**	**Alt 4**
CVP	Energy Generation[1]	4,533	4,539	4,609	4,610	4,489
	Energy Use[2]	1,207	1,322	1,420	1,415	1,117
	Net Generation[3]	3,326	3,217	3,189	3,195	3,372
SWP	Energy Generation[1]	4,074	4,349	4,679	4,658	3,971
	Energy Use[2]	7,304	8,377	9,630	9,557	6,972
	Net Generation[3]	-3,230	-4,028	-4,951	-4,898	-3,001
Total	Energy Generation[1]	8,607	8,888	9,288	9,269	8,459
	Energy Use[2]	8,511	9,698	11,050	10,972	8,088
	Net Generation[3]	96	-810	-1,762	-1,703	371

Source: Appendix U, Power and Energy Technical Appendix.
1 Hydropower generated
2 Energy used for facility operation and water transfers
3 Net generation equals hydropower generation minus energy use. Net generation of zero would indicate that hydropower generation exactly equals energy use. Negative net generation values indicate that energy use exceeds energy generation and the additional energy needed is purchased from the grid. Positive net generation values indicate that energy generation exceeds energy use and the additional energy generated is sold to the grid.
Alt = Alternative
CVP = Central Valley Project
SWP = State Water Project
1 gigawatt-hour = 1,000 megawatt-hours = 1,000,000 kilowatt-hours

The changes in annual net generation estimated by the power modeling were multiplied by emission factors (mass of pollutant emitted per unit of energy generated) to derive annual emissions. Emission factors for NO_x and SO_2 were obtained from the USEPA eGRID model and represent averages for the

California statewide mix of powerplants in 2016, which is the most recent year of data available (USEPA 2018). eGRID does not provide emission factors for CO, PM_{10}, $PM_{2.5}$, and ROG, so emission factors for these pollutants were derived from data for the electric utility sector in the ARB emission inventory for 2012, which is the most recent year of data available (ARB 2013b). Table L.2-2, Emission Factors Used in Air Quality Analysis, lists the emission factors that were used in the air quality analysis.

Table L.2-2. Emission Factors Used in Air Quality Analysis

Pollutant	Electric Generation (lb/Mwh)	Diesel Pump Engines (g/hp-hr)
CO	0.850	3.449
NO_x	0.475	3.497
PM_{10}	0.169	0.217
$PM_{2.5}$	0.152	0.217
ROG	0.073	0.429
SO_2	0.037	0.006

Sources: electric generation – ARB 2013b, USEPA 2018; diesel pump engines – SCAQMD 2017.
g/hp-hr = grams per horsepower-hour
lb/Mwh = pounds per megawatt-hour
CO = carbon monoxide
NO_x = nitrogen oxides
PM_{10} = particulate matter of 10 microns diameter and smaller
$PM_{2.5}$ = particulate matter of 2.5 microns diameter and smaller
ROG = reactive organic gases
SO_2 = sulfur dioxide

Table L.2-3, Emissions from Net Generation, shows the estimated emissions from fossil-fueled grid powerplants associated with net generation, based on the net generation values given in Table L.2-1. Figure L.2-1, Emissions from Grid Power Generation, and Figure L.2-2, Changes in Emissions from Grid Power Generation Compared to the No Action Alternative, show the emissions of each pollutant for grid power generation and the changes compared to the No Action Alternative, respectively.

Table L.2-3. Emissions from Net Generation

	Emissions (U.S. tons per average year)				
Pollutant	No Action	Alt 1	Alt 2	Alt 3	Alt 4
CO	-41.0	344.6	749.0	724.1	-157.7
NO_x	-22.9	192.5	418.4	404.5	-88.1
PM_{10}	-8.1	68.5	149.0	144.1	-31.4
$PM_{2.5}$	-7.3	61.7	134.2	129.8	-28.3
ROG	-3.5	29.8	64.7	62.5	-13.6
SO_2	-1.8	15.0	32.6	31.5	-6.9

Values represent the emissions effects of net generation, i.e., CVP/SWP hydropower generation minus CVP/SVP energy use. Emissions of zero would indicate that CVP/SWP hydropower generation exactly equals CVP/SWP energy use. Negative emission values indicate decreases in emissions because net generation is positive and displaces grid power; positive emission values indicate increases in emissions because net generation is negative and CVP/SWP purchases the needed power from the grid.
Alt = Alternative
CO = carbon monoxide
NOx = nitrogen oxides
PM_{10} = particulate matter of 10 microns diameter and smaller

$PM_{2.5}$ = particulate matter of 2.5 microns diameter and smaller
ROG = reactive organic gases
SO_2 = sulfur dioxide

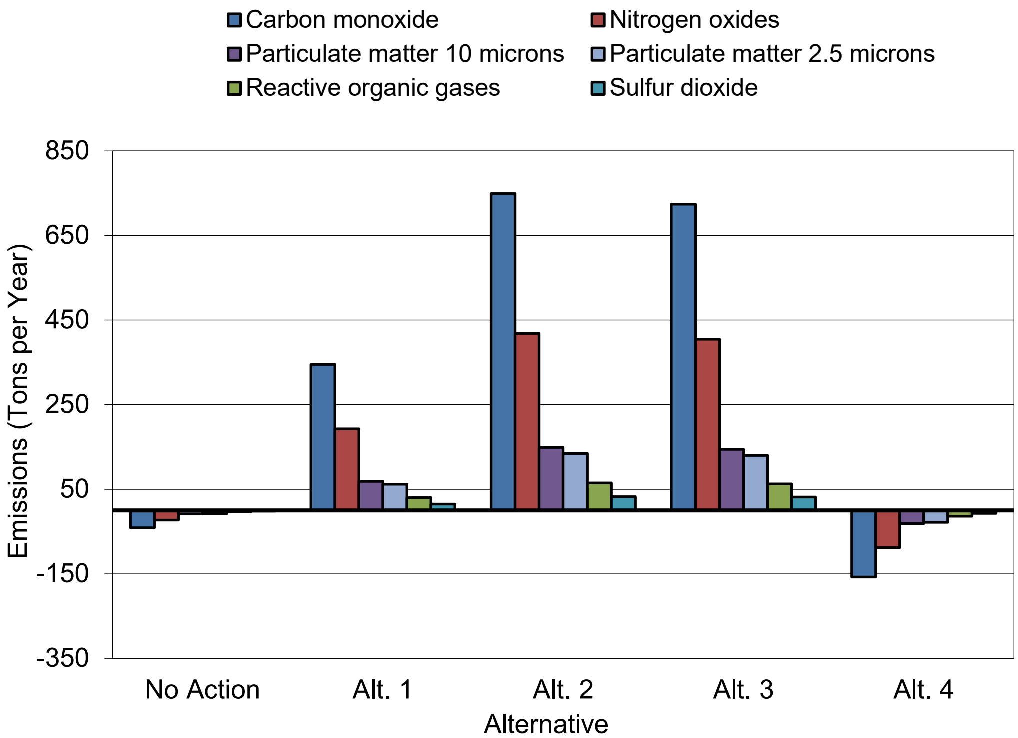

Figure L.2-1. Emissions from Grid Power Generation

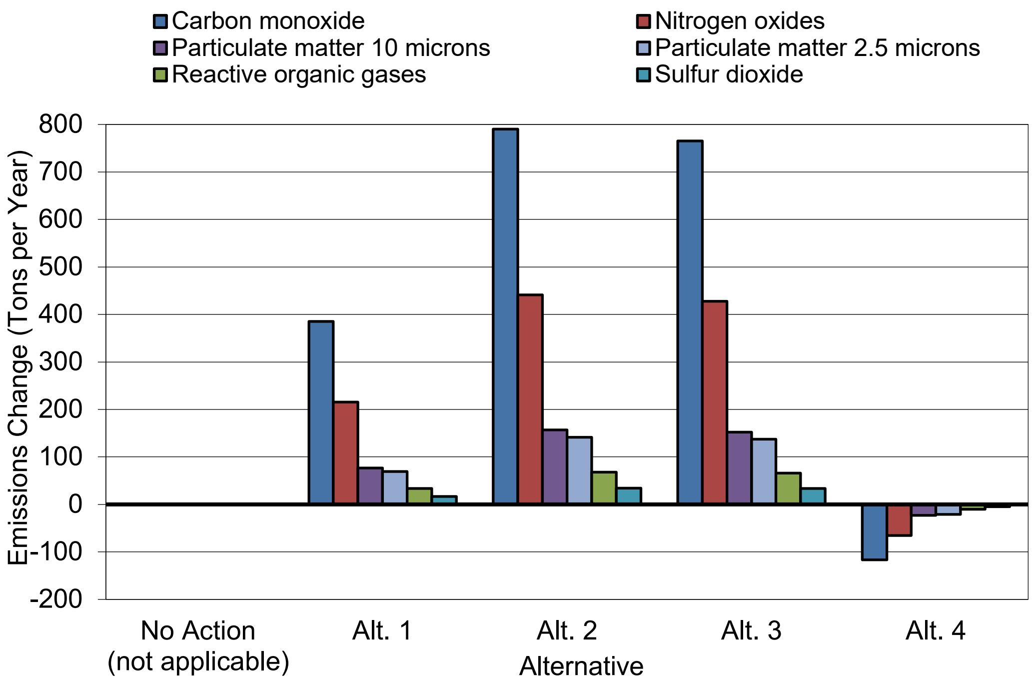

Figure L.2-2. Changes in Emissions from Grid Power Generation Compared to the No Action Alternative

Under Alternative 1 in an average year, net generation would decrease compared to the No Action Alternative, as shown in Table L.2-1. As a result, emissions from fossil-fueled grid powerplants would increase, as shown in Table L.2-3. Under Alternative 2 in an average year, net generation would decrease more than under Alternative 1 and emissions would increase more. The emissions increase under Alternative 2 would be roughly twice that under Alternative 1, compared to the No Action Alternative. Under Alternative 3 in an average year, net generation would decrease and emissions would increase compared to the No Action Alternative. The emissions increases under Alternative 3 would be greater than under Alternative 1 but less than under Alternative 2. In contrast with the other action alternatives, under Alternative 4 in an average year, net generation would increase compared to the No Action Alternative. As a result, emissions from fossil-fueled grid powerplants would decrease.

Potential changes in emissions from fossil-fueled powerplants (groundwater pumping)

The action alternatives would change operation of the CVP and SWP, which could change river flows and reservoir levels. These changes could affect the amount of water available for agricultural irrigation. If surface water availability decreases, farmers could make up the difference in water supply by increasing groundwater pumping. Approximately 85% of groundwater pumps are electric (USDA 2014), so increased pumping would increase the demand for grid power. To the extent that the additional purchased power would be generated by fossil-fueled powerplants, emissions from these plants would increase. Although the specific power purchases that water users may make in the future are not known, approximately 50% of the grid electricity in California was generated by fossil-fueled plants in 2016, as noted above. Approximately 15% of groundwater pumps are powered by engines (USDA 2014), so increased use of these pumps would increase engine exhaust emissions. Conversely, if surface water availability increases, farmers could decrease the amount of groundwater they pump, which would lead to a decrease in emissions.

Air quality effects resulting from changes in groundwater pumping were evaluated on a project-wide basis in terms of air pollutant emissions from the fossil-fueled powerplants (for electrically-powered pumps) and from engines (for engine-powered pumps). For the details of the groundwater modeling on which the air quality analysis was based, see Appendix H, *Groundwater Technical Appendix*. The groundwater modeling estimated that for a long-term average year, the project-wide quantities of water pumped would be 7,111,000 acre-feet (ac-ft) under the No Action Alternative, 6,847,000 ac-ft under Alternative 1, 6,577,000 ac-ft under Alternative 2, 6,598,000 ac-ft under Alternative 3, and 7,137,000 ac-ft under Alternative 4.

The quantities of water pumped estimated by the groundwater modeling were converted to the amounts of energy required and the result was multiplied by emission factors to derive annual emissions. The amount of energy required to pump water varies widely due to several factors, among them the depth to groundwater (the amount of lift) that the pump has to overcome, which varies greatly spatially; the design of the well; the efficiency of the pump engine or motor; and the efficiency of the pump itself. A reasonable range for the average amount of energy required in California is 400 to 1,200 kilowatt-hours per acre-foot (Kwh/ac-ft) (CEC 2015). For this analysis the midpoint of the range (800 Kwh/ac-ft) was assumed.

For an electric pump, the energy requirement of 800 Kwh/ac-ft represents the electricity usage at the pump motor. There are energy losses in the electric distribution system from the powerplant to the motor, so that in order to deliver a particular amount of energy to the pump, the powerplant must generate slightly more energy. The California statewide average loss rate is approximately 4.23% (USEPA 2018). The energy requirements for electric pumps were adjusted by this percentage for this analysis. The resulting emissions from fossil-fueled powerplants were calculated in the same way as explained above, using the number of acre-feet of water pumped, the adjusted energy requirement, the fraction of pumps that are electric (85%), and the emission factors listed in Table L.2-2.

For an engine-powered pump, the energy requirement of 800 Kwh/ac-ft represents the energy supplied to the pump by the engine, and is expressed in horsepower-hours per acre-foot (hp-hr/ac-ft). As noted above, approximately 15% of groundwater pumps are powered by engines: 13% diesel-fueled and 2% fueled by natural gas, LP gas, propane, and butane (USDA 2014). Of these fuels, diesel generally has the highest emissions, so to produce a conservative (high) estimate of emissions all engine-powered pumps were assumed to be diesel-fueled.

Table L.2-4, Estimated Energy Usage for Groundwater Pumping, shows the estimated energy usage for groundwater pumping. For engines, Table L.2-4 displays the energy requirements in both kilowatt-hours per year (Kwh/yr) consistent with the unit for electric pumps, and horsepower-hours per year (hp-hr/yr) consistent with the emission factor unit in Table L.2-4 for engines.

Table L.2-4. Estimated Energy Usage for Groundwater Pumping

Energy Source	Unit	No Action	Alt 1	Alt 2	Alt 3	Alt 4
Electric pumps (energy at powerplant)	Kwh/yr	5,040,094,139	4,852,660,662	4,661,214,163	4,676,309,490	5,058,617,807
Pump engines (energy at pump)	Kwh/yr	853,332,416	821,598,275	789,184,693	791,740,465	856,468,637
	hp-hr/yr	1,144,318,770	1,101,763,286	1,058,296,673	1,061,723,963	1,148,524,442
Sum	Kwh/yr	5,893,426,556	5,674,258,937	5,450,398,855	5,468,049,955	5,915,086,444

Source: Appendix H, Groundwater Technical Appendix.
Water quantities were converted to energy usage using an average rate of 800 Kwh/ac-ft (CEC 2015).
Alt = Alternative
Kwh/ac-ft = kilowatt-hours per acre-foot
Kwh/yr = kilowatt-hours per year
hp-hr/yr = horsepower-hours per year

The energy usage for groundwater pumping shown in Table L.2-4 was multiplied by the emission factors shown in Table L.2-2 to derive annual emissions. Emission factors given in Table L.2-2 for engines were obtained from the ARB-approved CalEEMod model (SCAQMD 2017). CalEEMod provides emission factors specific to calendar year and horsepower range, and the values corresponding to 2019 and an average pump rating of 96 horsepower (USDA 2014) were used in this analysis.

Table L.2-5, Emissions from Groundwater Pumping, shows the estimated emissions from groundwater pumping. Figure L.2-5, Emissions from Groundwater Pumping, and Figure L.2-4, Changes in Emissions from Groundwater Pumping Compared to the No Action Alternative, show the emissions of each pollutant and the changes compared to the No Action Alternative for groundwater pumping, respectively.

Table L.2-5. Emissions from Groundwater Pumping

Pollutant	Emissions (U.S. tons per average year)				
	No Action	Alt 1	Alt 2	Alt 3	Alt 4
Electric Pumps					
CO	2,143	2,063	1,982	1,988	2,151
NO_x	1,197	1,153	1,107	1,111	1,201
PM_{10}	426	410	394	396	428
$PM_{2.5}$	384	370	355	356	385
ROG	185	178	171	172	186
SO_2	93	90	86	87	94
Diesel Pumps					
CO	4,351	4,189	4,024	4,037	4,367
NO_x	4,411	4,247	4,080	4,093	4,427
PM_{10}	274	264	253	254	275
$PM_{2.5}$	274	264	253	254	275
ROG	541	521	500	502	543
SO_2	8	7	7	7	8
Total Pumping Emissions[1]					
CO	6,493	6,252	6,005	6,025	6,517
NO_x	5,608	5,400	5,187	5,203	5,629
PM_{10}	700	674	647	650	703
$PM_{2.5}$	658	633	608	610	660
ROG	726	699	672	674	729
SO_2	101	97	93	94	101

[1] Sum of individual values may not equal total due to rounding.
Alt = Alternative
CO = carbon monoxide
NO_x = nitrogen oxides
PM_{10} = particulate matter of 10 microns diameter and smaller
$PM_{2.5}$ = particulate matter of 2.5 microns diameter and smaller
ROG = reactive organic gases
SO_2 = sulfur dioxide

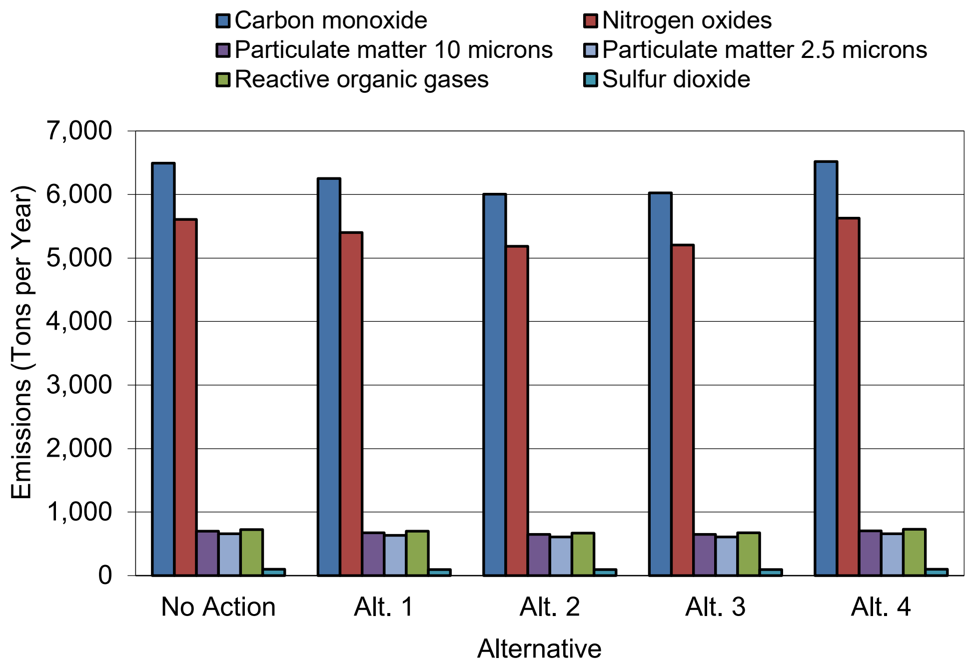

Figure L.2-3. Emissions from Groundwater Pumping

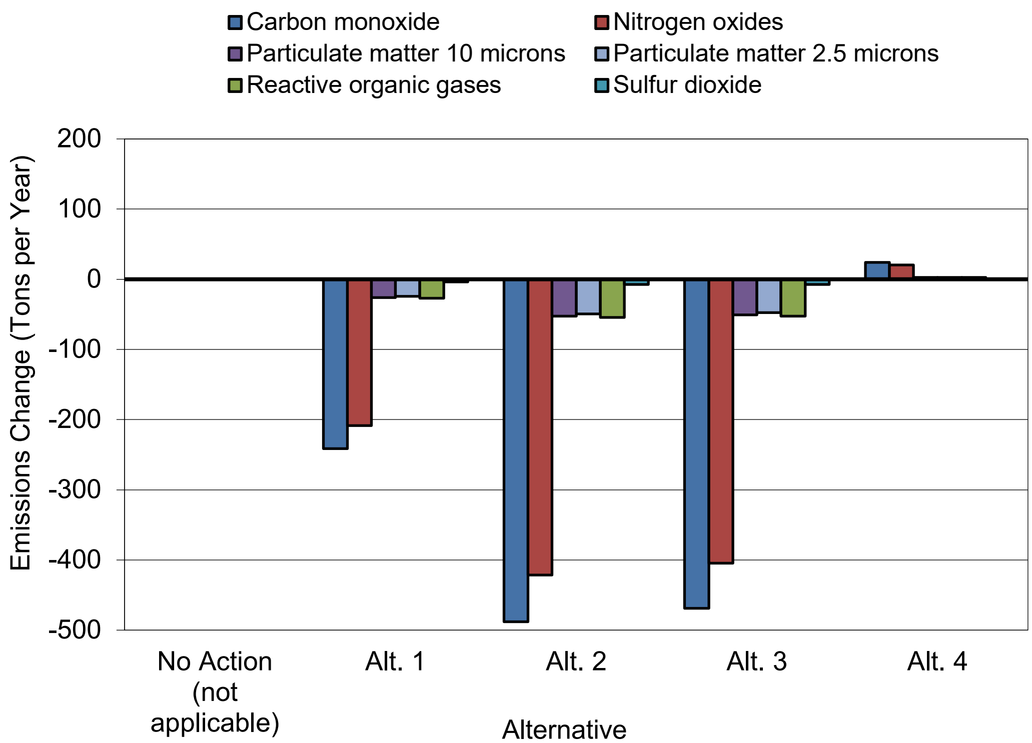

Figure L.2-4. Changes in Emissions from Groundwater Pumping Compared to the No Action Alternative

Under Alternative 1 in an average year, groundwater pumping would decrease compared to the No Action Alternative. As a result, the associated emissions also would decrease, as shown in Table L.2-5. Under Alternative 2 in an average year, groundwater pumping and emissions would decrease more than under Alternative 1. The emissions decrease under Alternative 2 would be roughly twice that under Alternative 1, compared to the No Action Alternative. Under Alternative 3 in an average year, groundwater pumping and emissions would decrease compared to the No Action Alternative. The emissions decreases under Alternative 3 would be greater than under Alternative 1 but less than under Alternative 2. In contrast to the other action alternatives, under Alternative 4 in an average year, groundwater pumping would increase compared to the No Action Alternative. As a result, the associated emissions also would increase.

The total emissions associated with the project are the sum of the emissions from net generation (Table L.2-3) and groundwater pumping (Table L.2-5). Table L.2-6, Total Project Emissions, shows the estimated total project emissions for a long-term average year. Figure L.2-5, Emissions from All Sources, and Figure L.2-6, Changes in Emissions from All Sources Compared to the No Action Alternative, show the overall emissions of each pollutant for all emission sources, and the changes in emissions compared to the No Action Alternative, respectively.

Table L.2-6. Total Project Emissions

	Emissions (U.S. tons per average year)				
Pollutant	**No Action**	**Alt 1**	**Alt 2**	**Alt 3**	**Alt 4**
CO	6,452	6,597	6,754	6,749	6,360
NO_x	5,585	5,592	5,605	5,608	5,541
PM_{10}	692	743	796	794	671
$PM_{2.5}$	650	695	743	740	632
ROG	723	729	736	736	715
SO_2	99	112	126	125	94

Values represent the sum of emissions from fossil-fueled powerplants (for CVP/SWP purchases of grid power and for electrically-powered groundwater pumps) and emissions from diesel engines (for engine-powered groundwater pumps).
Alt = Alternative
CO = carbon monoxide
NO_x = nitrogen oxides
PM_{10} = particulate matter of 10 microns diameter and smaller
$PM_{2.5}$ = particulate matter of 2.5 microns diameter and smaller
ROG = reactive organic gases
SO_2 = sulfur dioxide

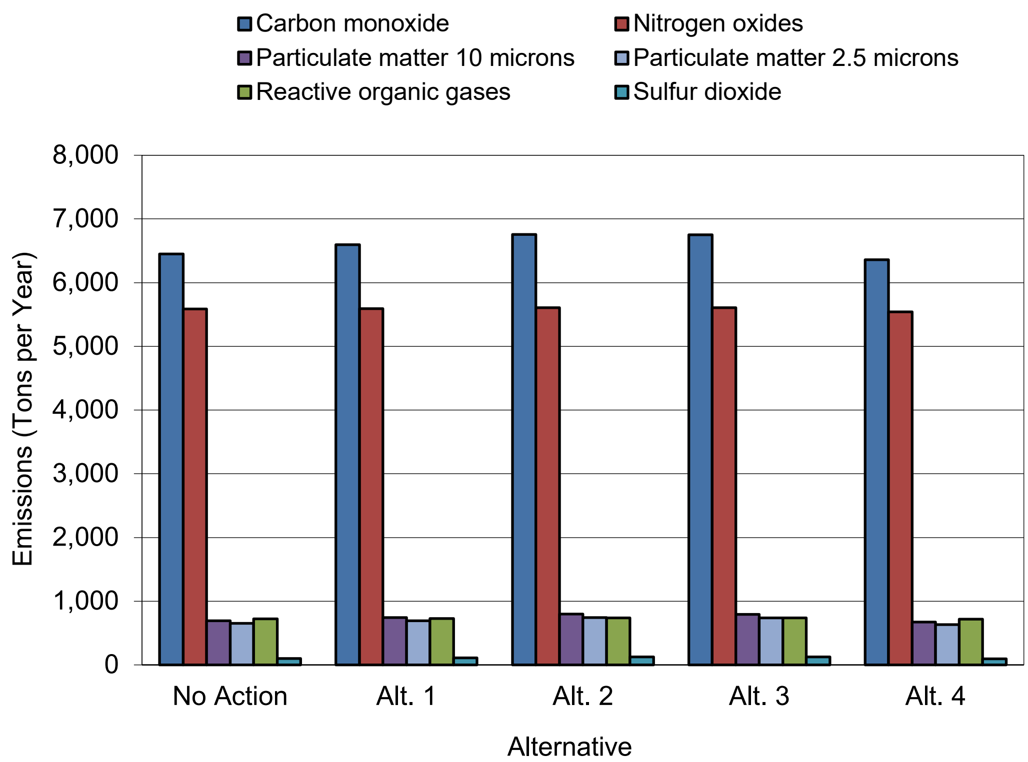

Figure L.2-5. Emissions from All Sources

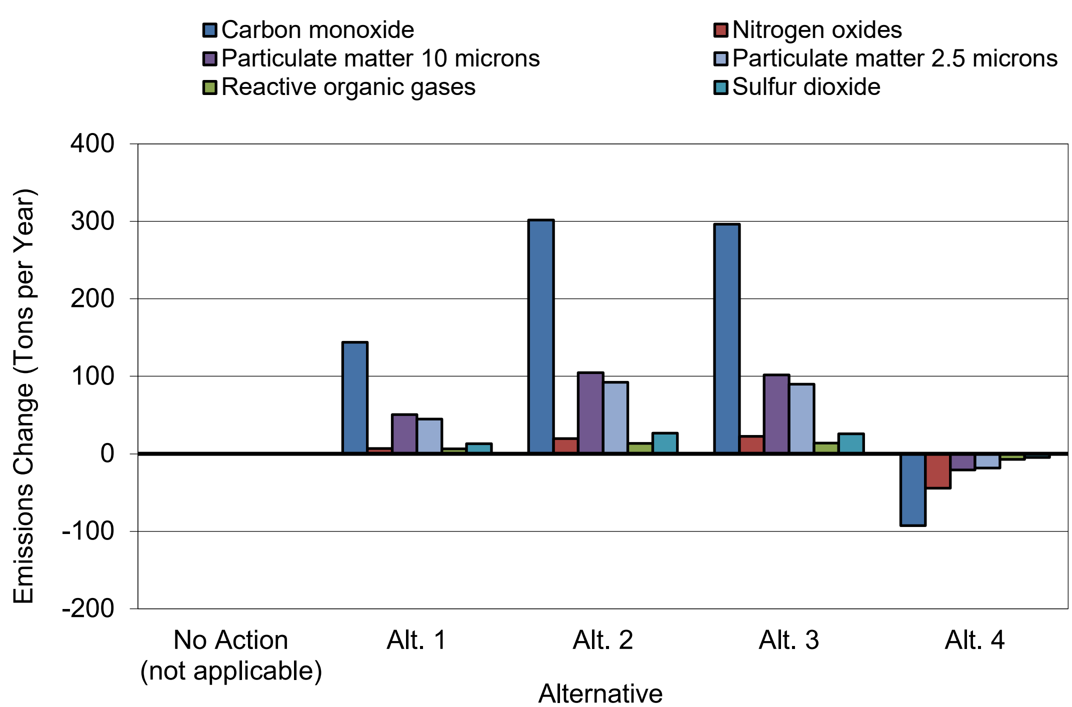

Figure L.2-6. Changes in Emissions from All Sources Compared to the No Action Alternative

Under Alternative 1 in an average year, overall emissions would increase compared to the No Action Alternative, as shown in Table L.2-6. Under Alternative 2 in an average year, emissions would increase more than under Alternative 1. Under Alternative 3 in an average year, emissions would increase compared to the No Action Alternative. The emissions increases under Alternative 3 would be greater than under Alternative 1 but less than under Alternative 2. In contrast to the other action alternatives, under Alternative 4 in an average year, overall emissions would decrease compared to the No Action Alternative.

Potential for exhaust emissions from engines of construction equipment and vehicles, and fugitive particulate matter (dust) from the action of tires on the ground surface. Exposed earth surfaces and material stockpiles also could produce fugitive dust emissions from wind action

Because the details of construction and transport activities are unknown at present, construction-related impacts were assessed qualitatively. Construction activities would produce temporary, localized increases in emissions. These increases can be lessened through implementation of mitigation measures/best management practices (BMPs). Section L.2.7.2, *Construction*, provides a list of typical BMPs that could be implemented to reduce emissions from construction.

L.2.2 No Action Alternative

Under the No Action Alternative, the actions described under Alternatives 1 through Alternative 4 would not take place. The CVP/SWP system would continue to be managed in accordance with current plans and programs. The population of the regional study area is expected to grow over time. Development in the region to accommodate the population growth, including residential, commercial, industrial, transportation, and other projects, would continue under the No Action Alternative and result in associated effects on air quality. These effects would contribute to regional air quality conditions. Air quality plans and emission control programs administered by the State and the respective air quality management districts are expected to result in slowly improving air quality over time despite the effects of regional growth and development.

L.2.3 Alternative 1

The potential air quality effects of Alternative 1 are described in the following sections.

L.2.3.1 *Project-Level Effects.*

Potential changes in emissions from fossil-fueled powerplants (hydropower generation)

Under Alternative 1, CVP/SWP-Wide Actions could have air quality effects to the extent that Shasta Critical Determinations would result in reduced releases to contractors in critical years, which could reduce hydropower generation, leading to increases in grid power generation and the associated emissions. Estimated increases in emissions for an average year are included in Table L.2-3.

Actions in the upper Sacramento Trinity/Clear Creek, Feather River, American River, Stanislaus, and Bay-Delta regions, and actions associated with operations, could increase or decrease releases and flows, depending on conditions in a particular region, year, and season. Hydropower generation could change accordingly, leading to either increases or decreases in emissions. Under Alternative 1 in an average year, net generation would decrease compared to the No Action Alternative. As a result, emissions from fossil-fueled powerplants would increase compared to the No Action Alternative, as shown in Table L.2-3.

If the Summer-Fall Delta Smelt Habitat action includes operations of the SMSCG or a Fall X2 action, the water requirements in summer and fall could be greater than estimated for Alternative 1. Increased water releases could increase the amount of hydropower generated and decrease the demand for grid electricity and the associated emissions. Alternative 1 estimates increased emissions compared to the No Action Alternative. In years with operations of the SMSCG or a Fall X2 action, actual emissions may be less than those estimated in Table L.2-3.

Fish intervention actions would not change the amount of hydropower generation, so there would be no change in emissions due to these actions under Alternative 1.

There would be no project-level effects on hydropower generation associated with actions in the San Joaquin River region or with habitat restoration or facility improvements actions under Alternative 1.

Potential changes in emissions from fossil-fueled powerplants (groundwater pumping)

CVP/SWP-wide actions could have air quality effects to the extent that Shasta Critical Determinations would result in reduced releases to contractors in critical years, which could reduce the amount of available irrigation water and lead to increased groundwater pumping and the associated emissions. Such emissions increases from these actions would be included within the overall decreases shown in Table L.2-5.

Actions in the upper Sacramento River, Trinity/Clear Creek, Feather River, American River, Stanislaus River, and Bay-Delta regions, and actions associated with operations, could increase or decrease releases and flows, depending on conditions in a particular year and season, as described above for hydropower generation. The amount of groundwater pumping could change accordingly, leading to either increases or decreases in emissions. Under Alternative 1 in an average year, groundwater pumping would decrease compared to the No Action Alternative. As a result, the associated emissions also would decrease, as shown in Table L.2-5.

If the Summer-Fall Delta Smelt Habitat action includes operations of the SMSCG or a Fall X2 action, the water requirements in summer and fall could be greater than estimated for Alternative 1. Increased water releases could increase the amount of available irrigation water and lead to decreased groundwater pumping and the associated emissions. Alternative 1 estimates decreased emissions from groundwater pumping actions compared to the No Action Alternative. In years with operations of the SMSCG or a Fall X2 action, actual emissions may be less than those estimated in Table L.2-4.

Fish intervention actions would not change the amount of groundwater pumping, so there would be no change in emissions due to these actions under Alternative 1.

There would be no project-level effects on groundwater pumping associated with actions in the San Joaquin River region or with habitat restoration or facility improvements actions under Alternative 1.

Potential for exhaust and fugitive dust emissions from construction equipment and vehicles.

Under Alternative 1 there would be no construction associated with project-level actions, and therefore, no air quality effects.

L.2.3.2 *Program-Level Effects*

Potential changes in emissions from fossil-fueled powerplants (hydropower generation)

There would be no program-level effects on hydropower generation associated with actions under Alternative 1, and therefore, no air quality effects.

Potential changes in emissions from fossil-fueled powerplants (groundwater pumping)

There would be no program-level effects on groundwater pumping associated with actions under Alternative 1, and therefore, no air quality effects.

Potential changes in emissions from fossil-fueled powerplants (water transfers)

There would be no program-level effects on water transfers associated with actions under Alternative 1, and therefore, no air quality effects.

Potential for exhaust and fugitive dust emissions from construction equipment and vehicles

Program-level actions that include construction or repair of facilities or the transport of fish or materials are proposed in the upper Sacramento River, American River, Stanislaus River, and San Joaquin River regions, as well as for habitat restoration, facility improvements, and fish intervention actions. The details of construction currently are not known in sufficient detail to estimate emissions. Potential construction impacts would not be expected to lead to new exceedance of the CAAQS or NAAQS or to worsen existing exceedances if appropriate BMPs are implemented. Section L.2.7.2 provides a list of typical BMPs that could be implemented to reduce emissions from construction.

There would be no program-level CVP/SWP-wide actions, and no program-level actions in the Trinity/Clear Creek, Feather River, and Bay-Delta regions.

L.2.4 Alternative 2

The potential air quality effects of Alternative 2 are described in the following sections.

L.2.4.1 *Project-Level Effects*

Potential changes in emissions from fossil-fueled powerplants (hydropower generation)

Under Alternative 2, CVP/SWP-wide actions could have air quality effects to the extent that Shasta Critical Determinations would result in reduced releases to contractors in critical years, which could reduce the amount of hydropower generated and increase the demand for grid electricity and the associated emissions. Estimated increases in emissions for an average year are included in Table L.2-3.

Actions in the upper Sacramento River, Trinity/Clear Creek, Feather River, American River, Stanislaus River, and Bay-Delta regions, and actions associated with operations, could increase or decrease releases and flows, depending on conditions in a particular region, year, and season. Hydropower generation could change accordingly, leading to either increases or decreases in emissions. Under Alternative 2 in an average year, net generation would decrease compared to the No Action Alternative. As a result, emissions from fossil-fueled powerplants would increase compared to the No Action Alternative, as shown in Table L.2-3.

There would be no project-level effects on hydropower generation associated with actions in the San Joaquin River region under Alternative 2.

Potential changes in emissions from fossil-fueled powerplants (groundwater pumping)

CVP/SWP-wide actions could have air quality effects to the extent that Shasta Critical Determinations would result in reduced releases to contractors in critical years, which could reduce the amount of available irrigation water and lead to increased groundwater pumping and the associated emissions. Such emissions increases from these actions would be included within the overall decreases shown in Table L.2-5.

Actions in the upper Sacramento River, Trinity/Clear Creek, Feather River, American River, Stanislaus River, and Bay-Delta regions could increase or decrease releases and flows, depending on conditions in a particular year and season, as described above for hydropower generation. The amount of groundwater pumping could change accordingly, leading to either increases or decreases in emissions. Under Alternative 2 in an average year, groundwater pumping would decrease compared to the No Action Alternative. As a result, the associated emissions also would decrease, as shown in Table L.2-5.

There would be no project-level effects on groundwater pumping associated with actions in the San Joaquin River region under Alternative 2.

Potential changes in emissions from fossil-fueled powerplants (water transfers)

Under Alternative 2, the quantity of water transferred would be the same as under the No Action Alternative, so there would be no change in emissions associated with water transfers.

Potential for exhaust and fugitive dust emissions from construction equipment and vehicles

Under Alternative 2 there would be no construction associated with project-level actions, and therefore, no air quality effects.

L.2.4.2 *Program-Level Effects*

Potential changes in emissions from fossil-fueled powerplants (hydropower generation)

There would be no program-level actions under Alternative 2, and therefore, no air quality effects.

Potential changes in emissions from fossil-fueled powerplants (groundwater pumping)

There would be no program-level actions under Alternative 2, and therefore, no air quality effects.

Potential changes in emissions from fossil-fueled powerplants (water transfers)

There would be no program-level actions under Alternative 2, and therefore, no air quality effects.

Potential for exhaust and fugitive dust emissions from construction equipment and vehicles

There would be no program-level actions under Alternative 2, and therefore, no air quality effects.

L.2.5 Alternative 3

The potential air quality effects of Alternative 3 are described in the following sections.

L.2.5.1 *Project-Level Effects*

Potential changes in emissions from fossil-fueled powerplants (hydropower generation)

Under Alternative 3, CVP/SWP-wide actions could have air quality effects to the extent that Shasta Critical Determinations would result in reduced releases to contractors in critical years, which could reduce the amount of hydropower generated and increase the demand for grid electricity and the associated emissions. Estimated increases in emissions for an average year are included in Table L.2-3.

Actions in the upper Sacramento River, Trinity/Clear Creek, Feather River, American River, Stanislaus, and Bay-Delta regions, and actions associated with operations, could increase or decrease releases and flows, depending on conditions in a particular region, year, and season. Hydropower generation could change accordingly, leading to either increases or decreases in emissions. Under Alternative 3 in an average year, net generation would decrease compared to the No Action Alternative. As a result, emissions from fossil-fueled powerplants would increase compared to the No Action Alternative, as shown in Table L.2-3.

Fish intervention actions would not change the amount of hydropower generation, so there would be no change in emissions due to these actions under Alternative 3.

There would be no project-level effects on hydropower generation associated with actions in the San Joaquin River region or with habitat restoration or facility improvements actions under Alternative 3.

Potential changes in emissions from fossil-fueled powerplants (groundwater pumping)

CVP/SWP-wide actions could have air quality effects to the extent that Shasta Critical Determinations would result in reduced releases to contractors in critical years, which could reduce the amount of available irrigation water and lead to increased groundwater pumping and the associated emissions. Such emissions increases from these actions would be included within the overall decreases shown in Table L.2-5.

Actions in the upper Sacramento River, Trinity/Clear Creek, Feather River, American River, Stanislaus River, and Bay-Delta regions, and actions associated with operations, could increase or decrease releases and flows, depending on conditions in a particular year and season, as described above for hydropower generation. The amount of groundwater pumping could change accordingly, leading to either increases or decreases in emissions. Under Alternative 3 in an average year, groundwater pumping would decrease compared to the No Action Alternative. As a result, the associated emissions also would decrease, as shown in Table L.2-5.

Fish intervention actions would not change the amount of groundwater pumping, so there would be no change in emissions due to these actions under Alternative 3.

There would be no project-level effects on groundwater pumping associated with actions in the San Joaquin River region or with habitat restoration or facility improvements actions.

Potential changes in emissions from fossil-fueled powerplants (water transfers)

Under Alternative 3, the quantity of water transferred would be the same as under the No Action Alternative, so there would be no change in emissions associated with water transfers.

L.2.5.2 *Program-Level Effects*

Potential changes in emissions from fossil-fueled powerplants (hydropower generation)

There would be no program-level effects on hydropower generation associated with actions under Alternative 3, and therefore, no air quality effects.

Potential changes in emissions from fossil-fueled powerplants (groundwater pumping)

There would be no program-level effects on groundwater pumping associated with actions under Alternative 3, and therefore, no air quality effects.

Potential changes in emissions from fossil-fueled powerplants (water transfers)

There would be no program-level effects on water transfers associated with actions under Alternative 3, and therefore, no air quality effects.

Potential for exhaust and fugitive dust emissions from construction equipment and vehicles

Program-level actions that include construction or repair of facilities or the transport of fish or materials are proposed in the upper Sacramento River, American River, Stanislaus River, and San Joaquin River regions, as well as for habitat restoration, facility improvements, and fish intervention actions. The details of construction currently are not known in sufficient detail to estimate emissions. Potential construction impacts would not be expected to lead to new exceedances of the CAAQS or NAAQS or to worsen existing exceedances if appropriate mitigation/BMPs are implemented. Section L.2.7.2 provides a list of typical BMPs that could be implemented to reduce emissions from construction.

There would be no program-level actions that include construction of facilities or the transport of fish or materials in the Bay-Delta regions.

There would be no program-level CVP/SWP-wide actions, and no program-level actions in the Trinity/Clear Creek or Feather River regions.

L.2.6 Alternative 4

The potential air quality effects of Alternative 4 are described in the following sections.

L.2.6.1 *Project-Level Effects*

Potential changes in emissions from fossil-fueled powerplants (hydropower generation)

Under Alternative 4, CVP/SWP-wide actions could have air quality effects to the extent that Shasta Critical Determinations would result in reduced releases to contractors in critical years, which could reduce the amount of hydropower generated and increase the demand for grid electricity and the associated emissions. Such emissions increases from these actions would be included within the overall decreases in an average year, as shown in Table L.2-3.

Actions in the upper Sacramento River, Trinity/Clear Creek, Feather River, American River, Stanislaus, and Bay-Delta regions, and actions associated with operations, could increase or decrease releases and flows, depending on conditions in a particular region, year, and season. Hydropower generation could change accordingly, leading to either increases or decreases in emissions. Under Alternative 4 in an average year, net generation would increase compared to the No Action Alternative. As a result, emissions from fossil-fueled powerplants would decrease compared to the No Action Alternative, as shown in Table L.2-3.

There would be no project-level effects on hydropower generation associated with actions in the San Joaquin River region under Alternative 4.

Potential changes in emissions from fossil-fueled powerplants (groundwater pumping)

CVP/SWP-wide actions could have air quality effects to the extent that Shasta Critical Determinations would result in reduced releases to contractors in critical years, which could reduce the amount of available irrigation water and lead to increased groundwater pumping and the associated emissions. Estimated increases in emissions are included in Table L.2-5.

Actions in the upper Sacramento River, Trinity/Clear Creek, Feather River, American River, Stanislaus River, and Bay-Delta regions, and actions associated with operations, could increase or decrease releases and flows, depending on conditions in a particular year and season, as described above for hydropower generation. The amount of groundwater pumping could change accordingly, leading to either increases or decreases in emissions. Under Alternative 4 in an average year, groundwater pumping would increase compared to the No Action Alternative. As a result, the associated emissions also would increase, as shown in Table L.2-5.

There would be no project-level effects on groundwater pumping associated with actions in the San Joaquin River region under Alternative 4.

Potential changes in emissions from fossil-fueled powerplants (water transfers)

Under Alternative 4, the quantity of water transferred would be the same as under the No Action Alternative, so there would be no change in emissions associated with water transfers.

L.2.6.2 *Program-Level Effects*

Potential changes in emissions from fossil-fueled powerplants (hydropower generation)

There would be no program-level effects on hydropower generation associated with actions under Alternative 4, and therefore, no air quality effects.

Potential changes in emissions from fossil-fueled powerplants (groundwater pumping)

There would be no program-level effects on groundwater pumping associated with actions under Alternative 4, and therefore, no air quality effects.

Potential changes in emissions from fossil-fueled powerplants (water transfers)

There would be no program-level effects on water transfers associated with actions under Alternative 4, and therefore, no air quality effects.

Potential for exhaust and fugitive dust emissions from construction equipment and vehicles

Program-level actions to increase water use efficiency for CVP and SWP contractors south of the Delta include construction actions. The details of construction currently are not known in sufficient detail to estimate emissions. Potential construction impacts would not be expected to lead to new exceedances of the CAAQS or NAAQS or to worsen existing exceedances if appropriate mitigation/BMPs are implemented. Section L.2.7.2 provides a list of typical BMPs that could be implemented to reduce emissions from construction.

There would be no program-level actions in the upper Sacramento, Trinity/Clear Creek, Feather River, American River, Stanislaus River, San Joaquin River, or Bay-Delta regions.

L.2.7 Mitigation Measures

L.2.7.1 *Energy*

Grid-generated electric power comprises the output of numerous powerplants across California and in other states, and no specific powerplant can be associated with power purchased by CVP/SVP. Fossil-fueled powerplants are subject to the air quality permitting requirements of the air quality management district in which they are located. To obtain a permit, the plant must demonstrate to the satisfaction of the district that its maximum air quality impacts will not exceed the CAAQS or NAAQS. The plant also may be required to comply with USEPA requirements for Best Available Control Technology or Lowest Achievable Emissions Rate. Therefore, no additional mitigation is proposed for energy-related air quality impacts.

Groundwater pump engines produce exhaust emissions that potentially can affect air quality in the local area around the pump. Pump engines are subject to USEPA and CARB emissions standards for criteria pollutants. Most pump engines are relatively small (less powerful than a typical automobile engine) and usually are located in agricultural areas without dense development in the immediate vicinity. Therefore, human exposure to pump engine exhaust is expected to be low, and no mitigation is proposed.

L.2.7.2 *Construction*

Mitigation measures are recommended to minimize potential air quality impacts from construction activities. The following are common mitigation measures that may be applicable depending on the activity and the equipment being used. These or similar measures are often required by air quality management districts and local jurisdictions to minimize construction air quality impacts.

L.2.7.2.1 Measures to Minimize Generation of Fugitive Dust

Mitigation Measure AQ-1: Develop and Implement a Fugitive Dust Control Plan

Mitigation Measure AQ-2: Pave, Apply Gravel, or Otherwise Stabilize the Surfaces of Access Roads

Mitigation Measure AQ-3: Apply Water or Dust Palliatives to Access Roads as Necessary during High Wind Conditions

Mitigation Measure AQ-4: Post and Enforce Speed Limits on Unpaved Access Roads

Mitigation Measure AQ-5: Stage Activities to Limit the Area of Disturbed Soils Exposed at Any One Time

Mitigation Measure AQ-6: Water, Stabilize, or Cover Disturbed or Exposed Earth Surfaces and Stockpiles of Dust-Producing Materials, As Necessary

Mitigation Measure AQ-7: Install Wind Fences around Disturbed Earth Areas if Windborne Dust Is Likely to Affect Sensitive Areas beyond the Site Boundaries (e.g., Nearby Residences)

Mitigation Measure AQ-8: Cover the Cargo Areas of Vehicles Transporting Loose Materials

Mitigation Measure AQ-9: Inspect and Clean Dirt from Vehicles, As Necessary, at Access Road Exits to Public Roadways

Mitigation Measure AQ-10: Remove from Public Roadways Visible Trackout or Runoff Dirt from the Activity Site (e.g., Using Street Vacuum Sweeping)

L.2.7.2.2 Measures to Minimize Exhaust Emissions

Mitigation Measure GHG-1: Minimize Potential Increases in GHG Emissions from Exhaust Associated with Construction Activities

L.2.8 Summary of Impacts

Table L.2-7 shows a summary of impacts and potential mitigation measures for consideration.

Table L.2-7. Impact Summary

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
Potential changes in hydropower generation could affect emissions from fossil-fueled powerplants (Project-Level)	No Action	No impact	-
	1	Increase in emissions compared to No Action Alternative.	-
	2	Increase in emissions compared to No Action Alternative. Greater increase than under Alternative 1.	-
	3	Increase in emissions compared to No Action Alternative. Greater increase than under Alternative 1 but less than under Alternative 2.	-

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
	4	Decrease in emissions compared to No Action Alternative.	-
Potential changes in the amount of groundwater pumping could affect emissions from fossil-fueled powerplants (Project-Level)	No Action	No impact	-
	1	Decrease in emissions compared to No Action Alternative.	-
	2	Decrease in emissions compared to No Action Alternative. Greater decrease than under Alternative 1.	-
	3	Decrease in emissions compared to No Action Alternative. Greater decrease than under Alternative 1 but less than under Alternative 2.	-
	4	Increase in emissions compared to No Action Alternative.	-
Potential changes in pumping for water transfers could affect emissions from fossil-fueled powerplants (Project-Level)	No Action	No impact	-
	1	Impact is included within that of changes in hydropower generation and grid emissions above.	-
	2	Impact is included within that of changes in hydropower generation and grid emissions above.	-
	3	Impact is included within that of changes in hydropower generation and grid emissions above.	-
	4	Impact is included within that of changes in hydropower generation and grid emissions above.	-
Combined impact of hydropower generation, grid emissions, groundwater pumping, and water transfers (Project-Level)	1	Increase in emissions compared to No Action Alternative.	-
	2	Increase in emissions compared to No Action Alternative. Greater increase than under Alternative 1.	-

Impact	**Alternative**	**Magnitude and Direction of Impacts**	**Potential Mitigation Measures**
	3	Increase in emissions compared to No Action Alternative. Greater increase than under Alternative 1 but less than under Alternative 2.	-
	4	Decrease in emissions compared to No Action Alternative.	-
Actions that include construction of facilities or the transport of fish or materials require the use of construction equipment and vehicles, which would produce exhaust and fugitive dust emissions (Project-Level)	No Action	No impact	-
	1	No impact	-
	2	No impact	-
	3	No impact	-
	4	No impact	-
Potential changes in hydropower generation could affect emissions from fossil-fueled powerplants (Program-Level)	1	No impact	-
	2	No impact	-
	3	No impact	-
	4	No impact	-
Potential changes in the amount of groundwater pumping could affect emissions from fossil-fueled powerplants (Program-Level)	No Action	No impact	-
	1	No impact	-
	2	No impact	-
	3	No impact	-
	4	No impact	-
Potential changes in pumping for water transfers could affect emissions from fossil-fueled powerplants (Program-Level)	No Action	No impact	-
	1	No impact	-
	2	No impact	-
	3	No impact	-
	4	No impact	-
Combined impact of hydropower generation, grid emissions, groundwater pumping, and water transfers (Program-Level)	No Action	No impact	-
	1	No impact	-
	2	No impact	-
	3	No impact	-

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
	4	No impact	-
Actions that include construction of facilities or the transport of fish or materials require the use of construction equipment and vehicles, which would produce exhaust and fugitive dust emissions (Program-Level)	1	The details of construction currently are not known in sufficient detail to estimate emissions. Potential construction impacts would not be expected to lead to exceedance of the CAAQS or NAAQS if appropriate mitigation/BMPs are implemented.	MM AQ-1–MM AQ-10
	2	No impact	-
	3	The details of construction currently are not known in sufficient detail to estimate emissions. Potential construction impacts would not be expected to lead to exceedance of the CAAQS or NAAQS if appropriate mitigation/BMPs are implemented.	MM GHG-1
	4	The details of construction currently are not known in sufficient detail to estimate emissions. Potential construction impacts would not be expected to lead to exceedance of the CAAQS or NAAQS if appropriate mitigation/BMPs are implemented.	MM AQ-1–MM AQ-10

BMP = best management practices
CAAQS = California Ambient Air Quality Standards
NAAQS = National Ambient Air Quality Standards

L.2.9 Cumulative Effects

The cumulative effects analysis considers projects, programs, and policies that are not speculative and that are based upon known or reasonably foreseeable long-range plans, regulations, operating agreements, or other information that establishes them as reasonably foreseeable. Appendix Y, *Cumulative Methodology,* presents a list of actions that could have cumulative effects.

The No Action Alternative would not result in any changes to facility operations and so would not have air quality impacts. Thus, no cumulative effects of the project on air quality would occur under the No Action Alternative.

As described above, Alternative 1 would lead to increases in regional emissions of CO, NO_x, PM_{10}, $PM_{2.5}$, ROG, and SO_2, compared to the No Action Alternative. Past, present, and reasonably foreseeable projects, described in Appendix Y, may have cumulative effects on air quality as well, to the extent that they could increase regional emissions. The cumulative projects include actions across California to develop new water storage capacity, new water conveyance infrastructure, new water recycling capacity, and the reoperation of existing water supply infrastructure, including surface water reservoirs and conveyance infrastructure. The cumulative projects also include ecosystem improvement and habitat restoration actions to improve conditions for special status species whose special status in many cases constrains water supply delivery operations. Some of the projects described in Appendix Y could increase emissions through the same mechanisms discussed above for the action alternatives, that is, if the projects lead to increases in grid power generation, groundwater pumping, and use of construction equipment and vehicles. The emissions from Alternative 1 are expected to be relatively small compared to the emissions from past, present, and reasonably foreseeable projects. Consequently, the emissions from Alternative 1, when combined with emissions from past, present, and reasonably foreseeable projects, are not expected to result in pollutant concentrations that would lead to new exceedances of the CAAQS or NAAQS or to worsen existing exceedances. Therefore, the cumulative air quality impact of Alternative 1 and past, present, and reasonably foreseeable projects would not be substantial. Accordingly, no mitigation is proposed for cumulative air quality impacts of Alternative 1.

Alternatives 2 and 3 would have cumulative impacts similar to those of the Alternative 1. Compared to the No Action Alternative and Alternative 1, Alternative 2 would result in greater emissions of CO, NO_x, PM_{10}, $PM_{2.5}$, ROG, and SO_2. Alternative 3 also would result in greater emissions of these pollutants compared to the No Action Alternative and Alternative 1, but the increases would be less than under Alternative 2. As with Alternative 1, the emissions from Alternatives 2 and 3 are expected to be relatively small compared to the emissions from past, present, and reasonably foreseeable projects. Consequently, the cumulative air quality impacts of Alternatives 2 and 3 along with past, present, and reasonably foreseeable projects are not expected to lead to new exceedances of the CAAQS or NAAQS or to worsen existing exceedances. Therefore, the cumulative air quality impact of Alternatives 2 and 3 and past, present, and reasonably foreseeable projects would not be substantial. Accordingly, no mitigation is proposed for cumulative air quality impacts of Alternatives 2 and 3.

Alternative 4 would lead to decreases in regional emissions of CO, NO_x, PM_{10}, $PM_{2.5}$, ROG, and SO_2, compared to the No Action Alternative. Because emissions would decrease under Alternative 4, the cumulative air quality impacts of Alternative 4 along with past, present, and reasonably foreseeable projects are not expected to lead to new exceedances of the CAAQS or NAAQS or to worsen existing exceedances. Therefore the cumulative air quality impact of Alternative 4 and past, present, and reasonably foreseeable projects would not be substantial. Accordingly, no mitigation is proposed for cumulative air quality impacts of Alternative 4.

Construction air quality impacts are temporary and localized. Because of the long time horizon of the project and the large size of the study area, construction of reasonably foreseeable projects described in Appendix Y is unlikely to overlap in time and space with construction of projects under Alternatives 1, 2, 3, and 4. Therefore, the cumulative air quality impacts of construction under Alternatives 1, 2, 3, and 4 along with past, present, and reasonably foreseeable projects are not expected to lead to new exceedances of the CAAQS or NAAQS or to worsen existing exceedances, and so would not be substantial. Accordingly, no mitigation beyond the BMPs recommended in Section L.2.7.2 above is proposed for cumulative air quality impacts of Alternatives 1, 2, 3, and 4.

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