DATE	March 31, 2013
TO	South Coast Air Quality Management District
CONTACT	Ian McMillan
FROM	Cathy Fitzgerald and Steve Bush
SUBJECT	Near-Roadway Mitigation Modeling Report
PROJECT NO.	SCA-03.0E

Numerous health studies indicate an increase in adverse health effects for populations living, working, or going to school near large volume roadways (Baldauf, 2008). In addition, research efforts are investigating how roadside sound walls, vegetation, and other mitigation technologies can effectively reduce the concentration of air pollutants to near-roadway populations. Based on a comprehensive literature review performed by The Planning Center/DC&E to determine the availability of various passive and active mitigation technologies, computer modeling was performed to evaluate the effectiveness of selected near-roadway pollutant mitigation technologies.

1. NEAR-ROADWAY MODELING

1a. Roadway Selection and Characterization

To determine the effects of various near-roadway mitigation measures on upwind and downwind receptors, a representative roadway was selected that had a wind direction predominantly perpendicular to the roadway. Meteorological data provided by the South Coast Air Quality Management District (SCAQMD) were reviewed to determine local prevailing wind directions. According to the wind rose for the Long Beach Monitoring Station (2005-2007), presented in Appendix A, the prevailing wind direction in the area of the Long Beach Station is to the east with an average wind speed of 1.83 meters per second (m/s). Therefore, a section of Interstate 710 (I-710) that is approximately one mile southwest from the Long Beach Monitoring Station was selected for this modeling effort. The straight quarter-mile section of I-710 that was used for most of the models run is bounded by West 33rd Street to the north and West Spring Street to the south. A separate 2,000 foot long section of I-170, encompassing the Willow Street on-ramps and off-ramps, was selected to model a representative cloverleaf freeway interchange.

1b. Selected Mitigation Technologies

Based on the literature review performed by The Planning Center/DC&E, and consultation with the SCAQMD, a list of mitigation technologies and modeling scenarios were selected and are presented in Table 1. The mitigation technologies were selected to investigate the 1) impacts for different configurations of sound walls along the freeway (Model Runs 01 – 04); 2) impacts for different configurations of sound walls at freeway interchanges configurations (Model Runs 05 – 06), 3) adding fans to the tops of sound walls to improve vertical air dispersion (Model Runs 07 – 12), and 4) the effect of sound walls on buildings with various heights next to the freeway (Model Runs 13-15). Additionally, the impacts with a vegetative barrier were assessed, assuming a percent of the roadway emissions were filtered through vegetation and a percent bypassed the barrier and was affected by downwash (Model Runs 16-18). Finally, biofiltration was investigated, assuming the installation of a biofiltration system inside the vegetated area of a cloverleaf interchange (Model Runs 19-21).

Table 1 - Mitigation Technology Scenarios

Model Runs	Mitigation	Description
01	Sound Wall	Sound walls: 5 meters high, 1,000 feet long
02	Sound Wall	Sound walls: 5 meters high, 500 feet long
03	Sound Wall	Sound walls: 5 meters high, 100 foot gaps in wall, 1,000 feet total length
04	Sound Wall	Sound walls: 1.8 meters high, 1,000 feet long
05	Cloverleaf, Sound Wall	Sound walls along outer ramps
06	Cloverleaf, Sound Wall	Sound walls along freeway
07	Sound Wall with Fans	Fans: 75% intake, 3.3 m separation; Sound walls: 5 m high, 1,000 ft long
08	Sound Wall with Fans	Fans: 50% intake, 3.3 m separation; Sound walls: 5 m high, 1,000 ft long
09	Sound Wall with Fans	Fans: 25% intake, 3.3 m separation; Sound walls: 5 m high, 1,000 ft long
10	Sound Wall with Fans	Fans: 75% intake, 15 m separation; Sound walls: 5 m high, 1,000 ft long
11	Sound Wall with Fans	Fans: 50% intake, 15 m separation; Sound walls: 5 m high, 1,000 ft long
12	Sound Wall with Fans	Fans: 25% intake, 15 m separation; Sound walls: 5 m high, 1,000 ft long
13	3-Story Building and Sound Wall	Sound walls: 5 m high, 1,000 ft long
14	5-Story Building and Sound Wall	Sound walls: 5 m high, 1,000 ft long
15	10-Story Building and Sound Wall	Sound walls: 5 m high, 1,000 ft long
16	Vegetation	Filtered air/bypassed air ratio: 75%
17	Vegetation	Filtered air/bypassed air ratio: 50%
18	Vegetation	Filtered air/bypassed air ratio: 25%
19	Biofiltration, cloverleaf	Filtered air/bypassed air ratio: 75%
20	Biofiltration, cloverleaf	Filtered air/bypassed air ratio: 50%
21	Biofiltration, cloverleaf	Filtered air/bypassed air ratio: 25%

1c. AERMOD Roadway Modeling

Air dispersion modeling, using the AERMOD computer model, was conducted to quantify maximum ground-level concentrations for near-roadway receptors. The model is a steady state Gaussian plume model that is recommended by SCAQMD for estimating ground level impacts from point and mobile sources in simple and complex terrain. The model requires additional input parameters, including chemical emission data and local meteorology. To accommodate the model's Cartesian grid format, direction-dependent calculations were obtained by identifying the UTM coordinates for the roadway, receptors, and mitigation technologies.

For the purposes of comparing roadway emissions utilizing various near-roadway mitigation technologies, it was important to create roadway modeling scenarios with uniform roadway emission rates, elevations, and locations of receptors and mitigation technologies. The following modeling scenario assumptions were used:

- Total roadway emission rate of 1 pound per hour (lb/hr)
- Flat terrain
- Analyzed pollutant - carbon monoxide, except for the vegetation model scenarios where PM2.5 was used

Carbon monoxide (CO) was selected as the analyzed pollutant for all the modeling scenarios, based on input from SCAQMD and the fact that CO is a non-reactive pollutant. Particulate matter of average diameter 2.5 microns (PM2.5) was selected as the analyzed pollutant for the vegetation scenarios due to the lack of studies analyzing the effect of vegetation on gases.

1d. Roadway Configuration

In AERMOD, I-710 was modeled as a roadway using volume sources. The I-710 roadway width and source separation was 40 meters (Google Earth, Version 7, 2013). The roadway width of on- and off-ramps involved in the cloverleaf modeling configuration was 8 meters. To remove potential variances in emission contours due to roadway geometry, I-710 was modeled as a straight stretch of highway along a constant y-coordinate in AERMOD. In the cloverleaf roadway configuration, the on- and off-ramps were created to be uniform on all sides of I-710, equidistant from the roadway.

Because the AERMOD model does not consider downwash effects with volume sources, the volume sources were replaced with point sources at the same locations to account for downwash effects of the various mitigation technologies. The point source input specifications were determined using recommended modeling assumptions for diesel trucks (CARB, 2000) as described below:

- Stack release height - 4.15 meters
- Stack release temperature - 298 Kelvin
- Stack release velocity - 1 meter per second (m/s)
- Stack release diameter - 6 inches.

The assumed roadway emission rate of 1 lb/hr was divided by the total number of roadway sources for each modeling scenario. For on- and off-ramps, the emission rate was reduced using the average ramp traffic fractions for the Willow Street interchange (CalTrans, 2008). Traffic volumes were determined from data available through the California Department of Transportation, Traffic Data Branch for the I-710 and Willow Street interchange. In comparison to the annual average daily traffic of the I-710, the average ramp travel fraction was 0.024 in 2008 and the calculations are included in Appendix A. Roadway modeling specifications are included in Table 2.

Table 2 - Roadway Modeling Specifications

Roadway Type	No. of Sources	Emission Rate (lb/hr)	Width (m)
I-710, straight configuration	11	9.09E-02	40
I-710, cloverleaf configuration	15	6.67E-02	40
Inner on- and off-ramps	19	1.27E-03	8
Outer on- and off-ramps	26	9.30E-04	8

1e. Receptor Configuration

Receptor grids were created in AERMOD both upwind and downwind of the roadway. The receptor grid began at a distance of 2 meters from the edge of the roadway and extended to a width of 500 meters (away from the roadway, x-coordinate). The receptor grid was 400 meters long (y-coordinate) to represent the quarter-mile stretch along the freeway. The receptor grid spacing between receptors was 50 meters. In addition to the 500 m by 400 m grid, two additional columns of receptors were created on either side of the roadway at a distance of 50 feet and 100 feet from the edge of the roadway to better assess near-roadway concentrations.

For the multi-story building model scenarios, discrete receptors were placed at the mid-points of all four building sides and on the roof at the center of the building. To determine the pollutant concentrations for each floor of the building, discrete receptors were placed at the mid-point elevation of each floor, between the ceiling and the floor. The modeling assumptions used for building specifications are included below:

- Height for each story of the building - 10 feet
- Building dimensions - 50 meters by 50 meters
- Building distance from edge of roadway - 5 meters
- Building location along roadway - centered along length of sound wall.

1f. Mitigation Technology Configurations

Specific mitigation technology assumptions for each modeling scenario are listed in Table 3.

Table 3 - Mitigation Technology Assumptions

Model Runs	Mitigation	Assumptions
01 - 15	Sound Walls	1 foot wide
07 – 12	Fans	Elevation of 5 m (on sound wall), positioned 0.8 m (2.6 feet) inside of each sound wall; Stack: height 2 ft, velocity 7 m/s, diameter 2 ft, temp. 298K
16 - 18	Trees	30 ft high, 10 m separation, radius of 10 ft (modeled as circular building with 10 vertices); 34 trees placed on each side of roadway
19 - 21	Biofilters	Area 2,379 m^2 (25,611 SF); 90% removal rate for CO; roadway modeled as volume sources (no sound walls or downwash) (Fujita, 2013)

For the sound walls with the fan model scenarios (Model Runs 07-12), the assumed fan dimensions and exit velocity were selected, based on research performed at the University of California, Riverside (UCR). During their study of fans in a simulated flow regime, the UCR research group indicated that an axial fan 18 inches by 24 inches can achieve a desired outlet velocity of 7 m/s to increase vertical dispersion of roadway particulate matter. The fan separation was selected based on the UCR research which suggests the number and size of fans needed is dictated not only by the volume but also by the required air changes per hour (ACH).

In this approach, a segment of roadway is viewed as a box, with the height of the box being the height of the sound wall. When the height is specified, the volume becomes a function of roadway width (W) and the number of fans required is a function of length (L). Based on fans providing 3,000 cubic feet per minute (cfm) at 1/4 horsepower (hp), UCR determined that 0.015 fans/m^2 were needed for 10 ACH. For example, in order to exhaust a segment of roadway that is 40m wide by 305m long (1,000 feet), 183 fans would be needed for an exchange rate of 10ACH or 92 fans would be needed per wall. For a sound wall length of 1,000 feet, the fan separation would be 3.3 m for 92 fans. The 3.3 m fan separation (for 10 ACH) was evaluated in model run Nos. 07-09. For comparison, a fan separation of 15 m was evaluated in model run Nos. 10-12. For the two fan configurations that were modeled, three ratios of fan air intake to bypassed air were evaluated: 75 percent, 50 percent, and 25 percent.

For the vegetation model scenarios (Model Runs 16-18), the assumed tree size and separation were selected based on the literature review performed by The Planning Center/DC&E. The fraction of roadway emissions which filter through the vegetative barrier was evaluated using volume sources in AERMOD. The remaining fraction of roadway emissions which bypasses over the top of the barrier and is affected by downwash was evaluated with point sources. The evaluated ratios of filtered air to bypassed air were assumed to be 75 percent, 50 percent, and 25 percent.

For the biofiltration model scenarios (Model Runs 19-21), the assumed removal rate of CO (90 percent) is based on the work of Fujita Corporation (Fujita, 2013). According to a press release for the Fujita Earth Air Purifier (EAP) system (Fujita, 2012), the EAP biofiltration system filters out harmful particulates and other atmospheric pollutants by pumping polluted air through installed vegetated areas. The polluted air is collected through a network of blowers and vented beneath the vegetated areas. The EAP systems have been applied to intersections with heavy traffic volume, ventilating towers of roadway tunnels, tunnel entrances, and underground parking lots. However, the volume of air from which emissions can be pulled into the biofilters was not specified by Fujita. For this modeling effort, it was assumed that the biofilter intakes can pull roadway emissions from the entire modeled roadway length, as well as the on-ramps and off-ramps. The evaluated ratios of filtered air to bypassed air were assumed to be 75 percent, 50 percent, and 25 percent. The filtered air was evaluated as area sources in the vegetated areas of the cloverleaf interchange with uniform emission rates. The bypassed air was evaluated as volume sources.

1g. Mitigation Technology Evaluation

Changes in roadway emissions for the various mitigation technologies were evaluated by comparing the emissions of a particular mitigation scenario to emissions of the same roadway configuration with no mitigation. Due to differences in roadway emission contours for each model scenario, the receptor locations (x- and y-coordinates) where AERMOD predicted the highest pollutant concentrations were used to compare scenarios. In the model scenarios, the receptor location x-coordinate represents the distance upwind or downwind from the roadway, and the y-coordinate represents the receptor distance along the roadway. Once the receptor location of the highest concentration was determined for a particular model scenario, the concentrations along the same x-coordinate at varying distances from the roadway were determined. The concentrations were compared to the baseline (no mitigation) scenario to determine the percent change in concentrations due to a particular mitigation technology. The percent changes in pollutant concentrations were then compared between mitigation model scenarios.

2. MODELING RESULTS

2a. Sound Walls, Straight Configuration – Model Runs 01 - 04

The results of the model scenarios featuring a straight roadway and sound walls are presented in Figures 1 – 4. Overall, the addition of 5 meter tall sound walls to each side of the roadway increased downwind pollutant concentrations up to 500 meters away from the roadway. For the 1,000 foot long sound wall (Model Run 01), near-roadway pollutant concentrations (2 m to 50 m downwind of the roadway) increased between 23 and 36 percent compared to a roadway with no sound wall. At 100 meters downwind of the roadway, the increase in pollutant concentrations was only 12 percent, before rising up to a 45 percent increase at 250 meters from the roadway. At 500 meters downwind of the roadway, the change in pollutant concentration reduced to only a 15 percent increase compared to pollutant concentrations without a sound wall.

The highest predicted increase in pollutant concentrations was 67 percent behind a 500 foot long sound wall at a distance of 2 meters from the roadway (Model Run 02). However, the 500 foot sound wall (Model Run 02) and 1,000 foot sound wall with 100 foot gaps (Model Run 03) displayed smaller increases (5-16 percent) in pollutant concentrations at distances of 350 m to 500 m from the roadway as compared to the 1,000 foot sound wall with no gaps (Model Run 01, 15-39 percent increase).

Additionally, changing the placement of the 500 foot sound wall in AERMOD resulted in different pollutant concentrations. When the 500 foot sound wall was moved further north along the roadway (Model Run 02b), the highest increase in pollutant concentration was predicted at 200 meters from the roadway instead of directly behind the sound wall at 2 m (Model Run 02).

For the 1.8 meter high sound wall (Model Run 04), no change in pollutant concentrations were predicted in AERMOD as compared to the no sound wall scenario. This suggests that the downwash effects due to taller sound walls (5 meters) strongly affect downwind pollutant concentrations. When the height of the sound walls is reduced to 1.8 meters, downwind pollutant concentrations are not increased between 2 meters and 500 meters from the roadway.

2b. Sound Walls, Cloverleaf Configuration – Model Runs 05 - 06

The results of the model scenarios featuring a cloverleaf roadway configuration with sound walls are presented in Figures 5 – 6. Overall, the addition of 5 meter tall sound walls increased downwind pollutant concentrations up to 400 or 500 meters away from the roadway, depending on the placement of the sound walls. When the sound walls are placed along the outer ramps of the cloverleaf (Model Run 05), the highest increase in pollutant concentrations was predicted at 15 m downwind from the roadway (19 percent increase). The increase in pollutant concentrations reduces to 1 percent at 400 m downwind. A decrease in pollutant concentration was predicted at downwind distances of 450 and 500 meters (1-2 percent decrease).

When the sound walls are placed along the edge of the I-710 instead of the outer ramps of the cloverleaf interchange (Model Run 06), the highest increase in pollutant concentrations was predicted at 100 m downwind on the roadway (29 percent increase). The increase in pollutant concentrations reduces to 1 percent at 500 m downwind. This suggests that the placement of sound walls farther away from a highly trafficked roadway (Model Run 05) reduces downwash effects on roadway emissions, and reduces the potential increase in pollutant concentrations due to the presence of the sound walls.

2c. Sound Walls with Fans – Model Runs 07 - 12

The results of the model scenarios featuring axial fans attached to the tops of sound walls are presented in Figures 7 – 12. Overall, the addition of fans on 5 meter tall sound walls increased downwind pollutant concentrations up to 500 meters away from the roadway. The highest increase in pollutant concentrations was predicted between 150 and 300 m downwind from the roadway for all model scenarios. When 75 percent of roadway emissions are passed through the fans (Model Runs 07 and 10), pollutant concentrations decreased at downwind distances of 2 m and 15 m (2-14 percent decrease), but showed the largest increase in pollutant concentrations between 100 and 400 m downwind of the roadway (52-91 percent increase). When the percent of roadway emissions passed through the fans was reduced to 25 percent (Model Runs 09 and 12), the pollutant concentrations increased for all downwind distances between 2 and 500 m, but did not increase as much between the distances of 100 and 400 m as predicted when the fan intake was 75 percent (Model Runs 07 and 10). This suggests that as the amount of air that is passed through the fans increases, pollutant concentrations between 100 and 400 m increase while near-roadway concentrations (<30 m downwind) may decrease.

When the separation distance between the fans was increased to 15 m (Model Runs 10-12) as compared to 3.3 m (Model Runs 07-09), very little difference in pollutant concentrations was observed between model runs with similar fan intake percentages. This suggests that the amount of roadway emissions that are passed through the fans, and not the specific number of fans, affects the downwind pollutant concentrations.

2d. Buildings adjacent to Sound Walls – Model Runs 13 - 15

The results of the model scenarios featuring multi-story buildings adjacent to sound walls are presented in Figures 13 – 20. Overall, the presence of multi-story buildings and sound walls decreased pollutant concentrations on all sides of both upwind and downwind buildings as compared to concentrations when no buildings and sound walls were present. As the number of stories increases from 3 to 10, the first floor concentrations decrease. For a 3-story building (Model Run 13), the largest downwind reduction in first floor concentrations was 28 percent (north side of downwind building). For a 10-story building (Model Run 15), the largest downwind reduction in first floor concentration was 51 percent (west side of downwind building). This suggests that as building height increases, there is a corresponding increase in the dispersion of roadway emissions around the building.

Additionally, Figures 13-20 show pollutant concentrations decrease as the floor elevation increases. Overall, the largest jump in percent reduction in pollutant concentration occurred between the second floor and third floor for all building scenarios. And similar to first floor pollutant concentrations, the second floor and higher pollutant concentrations decreased as the number of building stories increased from 3 to 10 stories.

The only location where pollutant concentrations increased as compared to concentrations when no buildings and sound walls were present was the scenario with a 3-story building downwind of the roadway. The east side first floor of the 3-story building had an increased pollutant concentration of 6 percent. As the height of the building increases to 10 stories, the east side first floor of the downwind building showed a reduced pollutant concentration of 38 percent. This suggests that a downwash effect is present for the 3-story building (i.e., increased concentrations on the leeward side of the building) but the effect disappears as the number of stories increases.

Lastly, the downwash effects of adding a sound wall to the 3-story building model scenario was evaluated. In this model comparison, the pollutant concentrations from a scenario with 3-story buildings on either side of the roadway and no sound walls were compared to concentrations from a scenario with upwind and downwind sound walls and 3-story buildings (Figures 19 and 20). For the upwind 3-story building, the addition of sound walls to the model scenario reduced pollutant concentrations for all sides, floors, and the roof of the building. For the downwind 3-story building, the addition of sound walls increased pollutant concentrations on the roof and third floor of the south side of the building. However for the remaining sides and floors of the downwind building, pollutant concentrations decreased. In contract to the previous model comparisons to ground level concentrations with no buildings and no sound walls (Figurers 13-18), the percent reduction in pollutant concentration with increased floor height was not observed. With the addition of sound walls, the third floor pollutant concentrations showed a smaller percent reduction compared to second floor concentrations. This suggests that the presence of 5 meter tall sound walls does not affect third floor concentrations as much as first and second floor concentrations.

Overall, the range of pollutant concentration percent reductions was lower for the model comparison to buildings with no sound walls (0-30 percent, Figures 19-20) than for the comparison to baseline levels (no buildings or sound walls; 0-62 percent, Figures 13-14). This suggests that the addition of sound walls mostly reduces pollutant concentrations when buildings are initially present, but the concentration reductions are not as large as when no buildings and no sound walls are initially present. Additionally, the effects of downwash to increase downwind pollutant concentrations over the sound wall were not observed when buildings were initially present.

2e. Vegetation – Model Runs 16 - 18

The results of the model scenarios featuring a vegetative barrier are presented in Figures 21 – 23. Overall, the addition of a vegetative barrier increased downwind pollutant concentrations up to 500 meters away from the roadway. The highest increase in pollutant concentrations was predicted between 250 and 350 m downwind from the roadway for all model scenarios. When 75 percent of roadway emissions were filtered through the vegetative barrier (Model Run 16), pollutant concentrations decreased at upwind and downwind distances of 2 m (31 percent decrease), but showed the largest increase in pollutant concentrations at 250 m downwind of the roadway (11 percent increase). When the percent of roadway emissions passing through the vegetative barrier was reduced to 25 percent (Model Run 18), pollutant concentrations increased for all downwind distances. The reported increases were 8 percent at 2 m and 45 percent at 300 m. This suggests that as the amount of air filtered through the vegetative barrier increases, the pollutant concentrations downwind of the barrier decreases.

2f. Biofiltration – Model Runs 19 - 21

The results of the model scenarios featuring biofiltration systems in the vegetated areas of cloverleaf roadway interchanges are presented in Figures 24 – 26. Assuming the entire model length of roadway and on- and off-ramps can be filtered through the vegetated areas, the addition of biofilters decreased downwind pollutant concentrations up to 500 meters away from the roadway. The reductions in pollutant concentrations are greater with increasing distance downwind of the roadway for all model scenarios. When 75 percent of roadway emissions are filtered through the biofilter (Model Run 19), pollutant concentrations decreased at a downwind distance of 2 m (48 percent decrease), and the reduction in concentrations continued to decrease at distances of up to 500 m downwind of the roadway (66 percent decrease). When the percent of roadway emissions passed through the biofilter was reduced to 25 percent (Model Run 21), pollutant concentrations decreased by a smaller amount for all downwind distances, with an 11 percent decrease at 2 m and a 25 percent decrease at 500 m. This suggests that as the amount of air passed through the biofilters increases, the pollutant concentrations downwind of the roadway decreases. Without the presence of a barrier such as a sound wall or vegetation, the effects of downwash to increase downwind concentrations were not predicted in AERMOD.

3. CONCLUSIONS AND RECOMMENDATIONS

Various near-roadway mitigation technologies were evaluated using AERMOD to investigate the downwash impacts for different sound wall configurations, freeway configurations, fans on the top of sound walls, and vegetative barriers. Additionally, the downwash effect around multi-story buildings and the effects of a biofiltration system were evaluated. For most model scenarios, the addition of sound walls and vegetative barriers increased downwind pollutant concentrations due to downwash effects. The only scenarios that exhibited decreases in downwind pollutant concentrations were the scenarios featuring multi-story buildings and biofiltration systems.

Based on the modeling results, the use of biofiltration systems should be further investigated to reduce near-roadway pollutant concentrations. We recommend future studies using AERMOD to evaluate roadway mitigation technologies incorporate the following modeling improvements:

3.1 – Calculate roadway emissions using CARB's EMFAC2011 emission factor model and compare model predicted pollutant concentrations to collected air quality data near roadways.

3.2 – Re-evaluate model scenarios with meteorological data with predominantly parallel or oblique wind directions to compare potential effects of wind on mitigation technology impacts.

3.3 – Refine biofiltration model through contact with Fujita Corp. to determine the actual length and width of roadway which EAP system can pull roadway emissions.

4. REFERENCES

Baldauf, R., E. Thoma, A. Khlystov, V. Isakov, G. Bowker, T. Long, and R. Snow. (2008). Impacts of noise barriers on near-road air quality. In, *Atmospheric Environment,* Vol. 42, pp. 7502-7507.

California Air Resources Board (CARB). 2000. Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles.

California Department of Transportation (CalTrans). 2008. *Traffic Data Branch.*
Website: http://traffic-counts.dot.ca.gov

Fujita. 2013. Earth Air Purification (EAP). Website: http://www.fujita.com/technology/1

———. 2012. *Air purification system using soil (EAP) was introduced overseas for the first time*. News release. Website: http://www.fujita.com/news_release/13

South Coast Air Quality Management District (SCAQMD). 2009. *AERMOD Monitoring Station Site Coordinates and Elevation.* Website: http://www.aqmd.gov/smog/metdata/AERMOD_Table3.html

———. 2005-2007. *Meteorological Data Set for Long Beach Monitoring Station*.

Appendix A.
Figures and Emissions Inventory

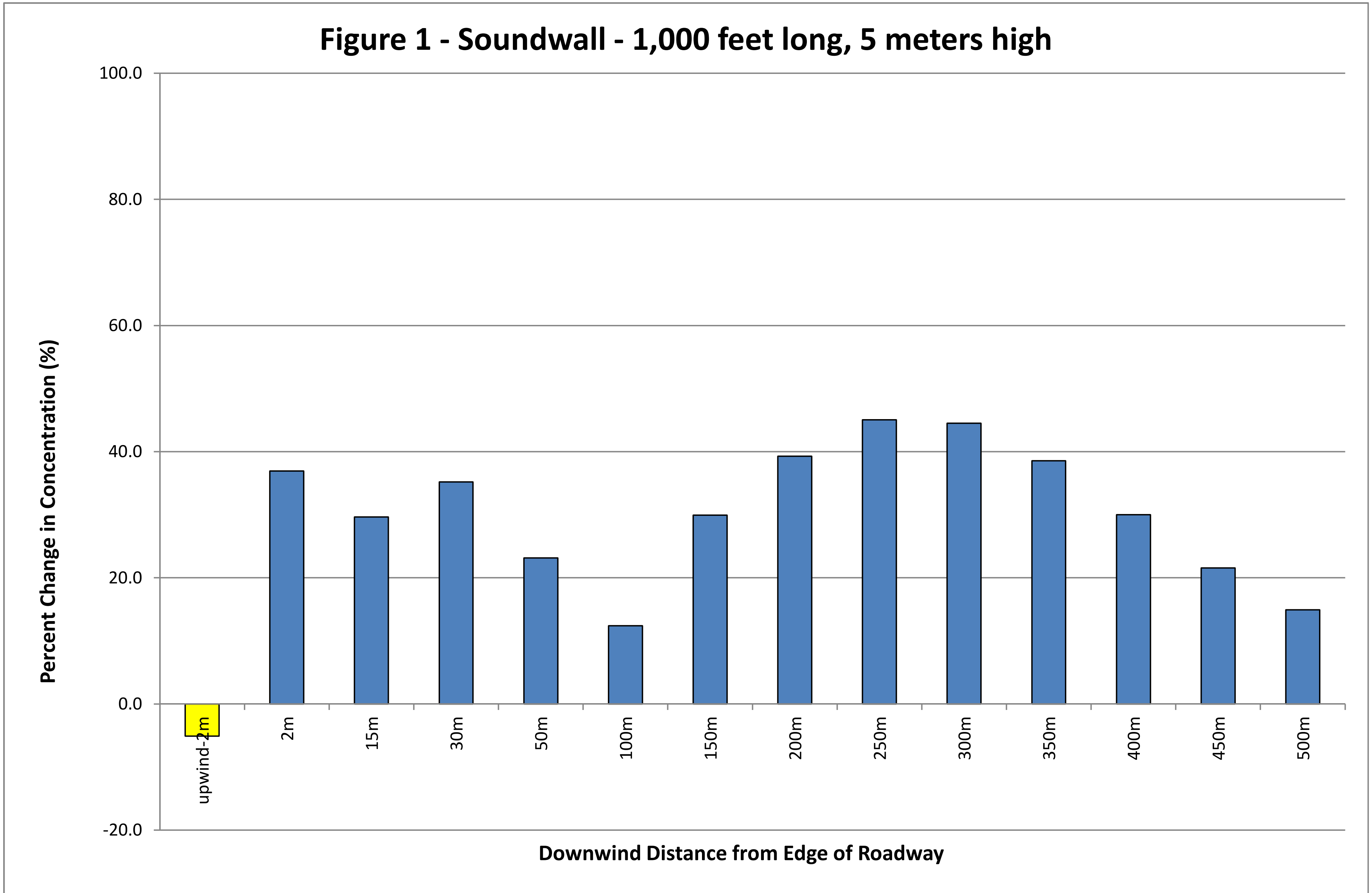


Figure 1 - Soundwall - 1,000 feet long, 5 meters high
Percent Change in Concentration (%)
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
upwind-2m
2m
15m
30m
50m
100m
150m
200m
250m
300m
350m
400m
450m
500m
Downwind Distance from Edge of Roadway

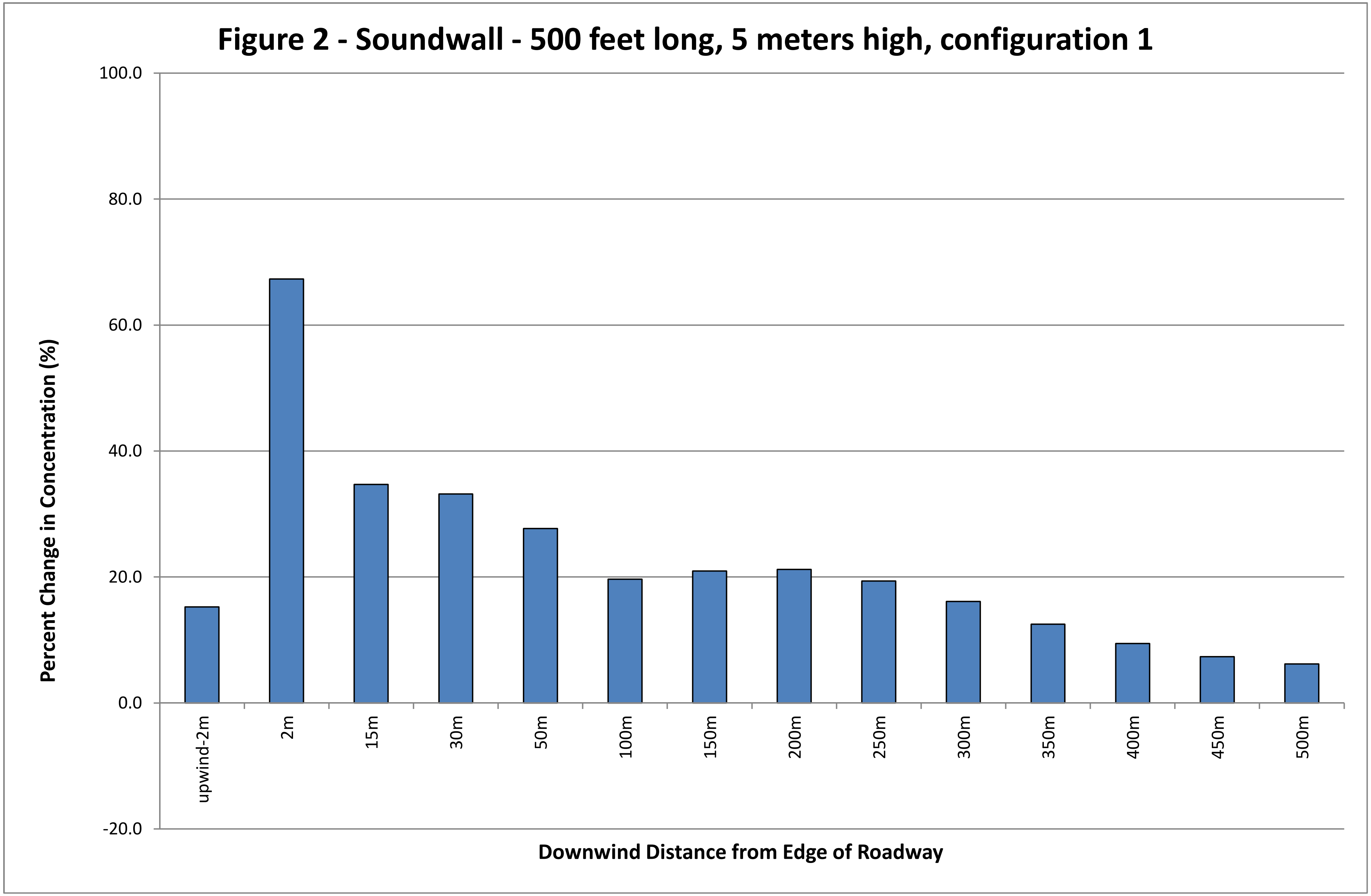


Figure 2 - Soundwall - 500 feet long, 5 meters high, configuration 1
Percent Change in Concentration (%)
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
upwind-2m
2m
15m
30m
50m
100m
150m
200m
250m
300m
350m
400m
450m
500m
Downwind Distance from Edge of Roadway

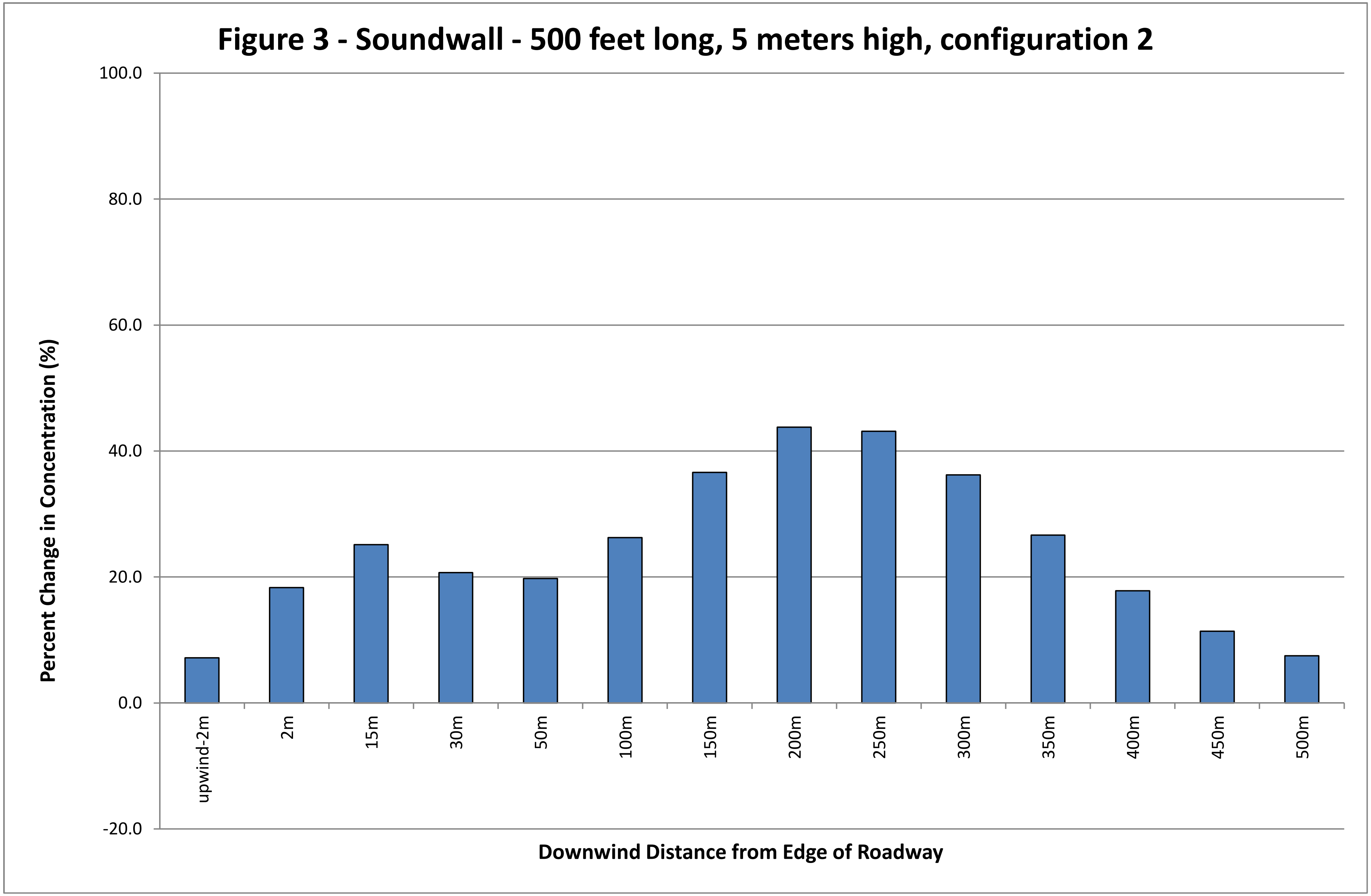


Figure 3 - Soundwall - 500 feet long, 5 meters high, configuration 2
Percent Change in Concentration (%)
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
upwind-2m
2m
15m
30m
50m
100m
150m
200m
250m
300m
350m
400m
450m
500m
Downwind Distance from Edge of Roadway

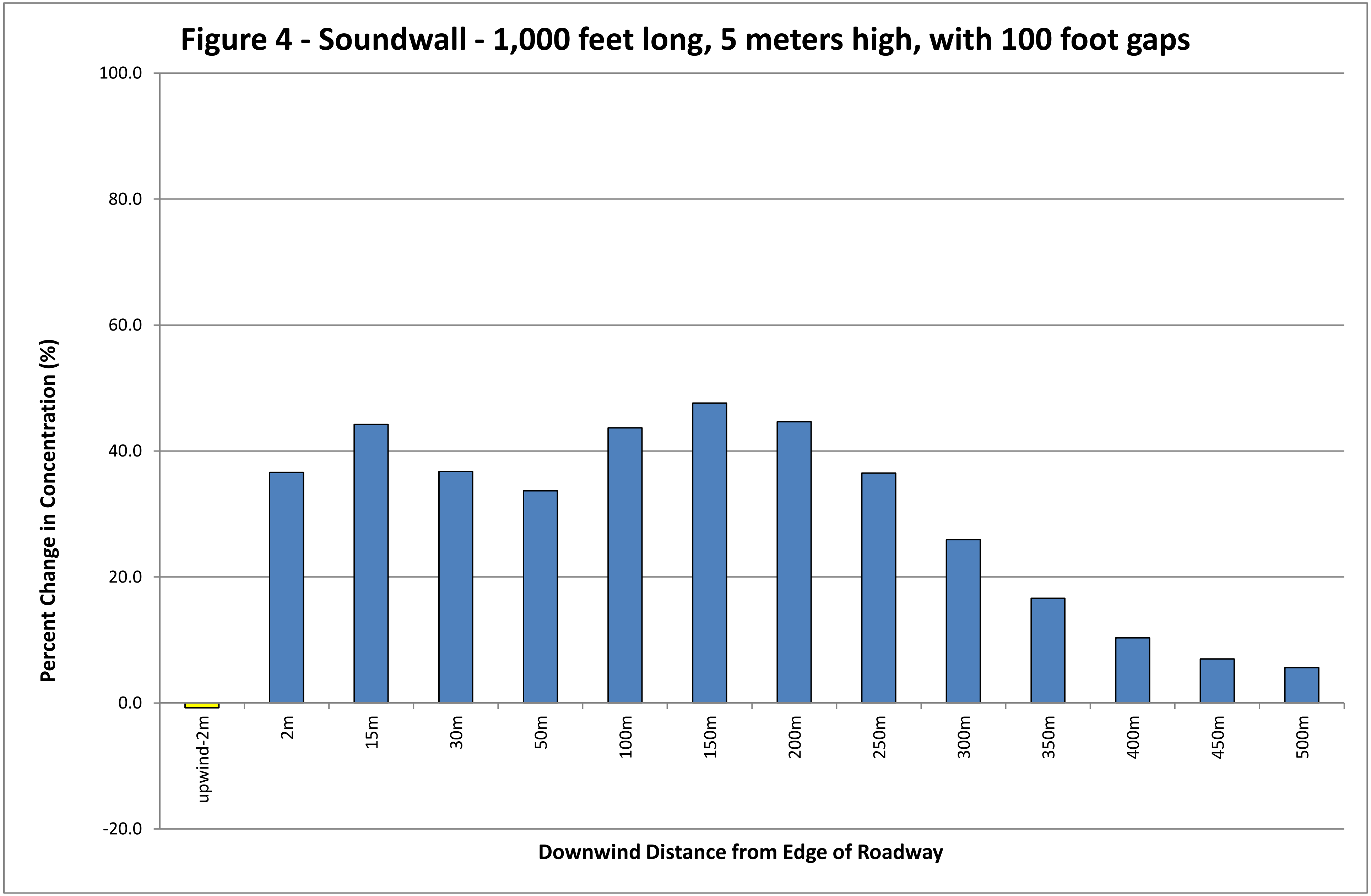


Figure 4 - Soundwall - 1,000 feet long, 5 meters high, with 100 foot gaps
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
Percent Change in Concentration (%)
upwind-2m
2m
15m
30m
50m
100m
150m
200m
250m
300m
350m
400m
450m
500m
Downwind Distance from Edge of Roadway

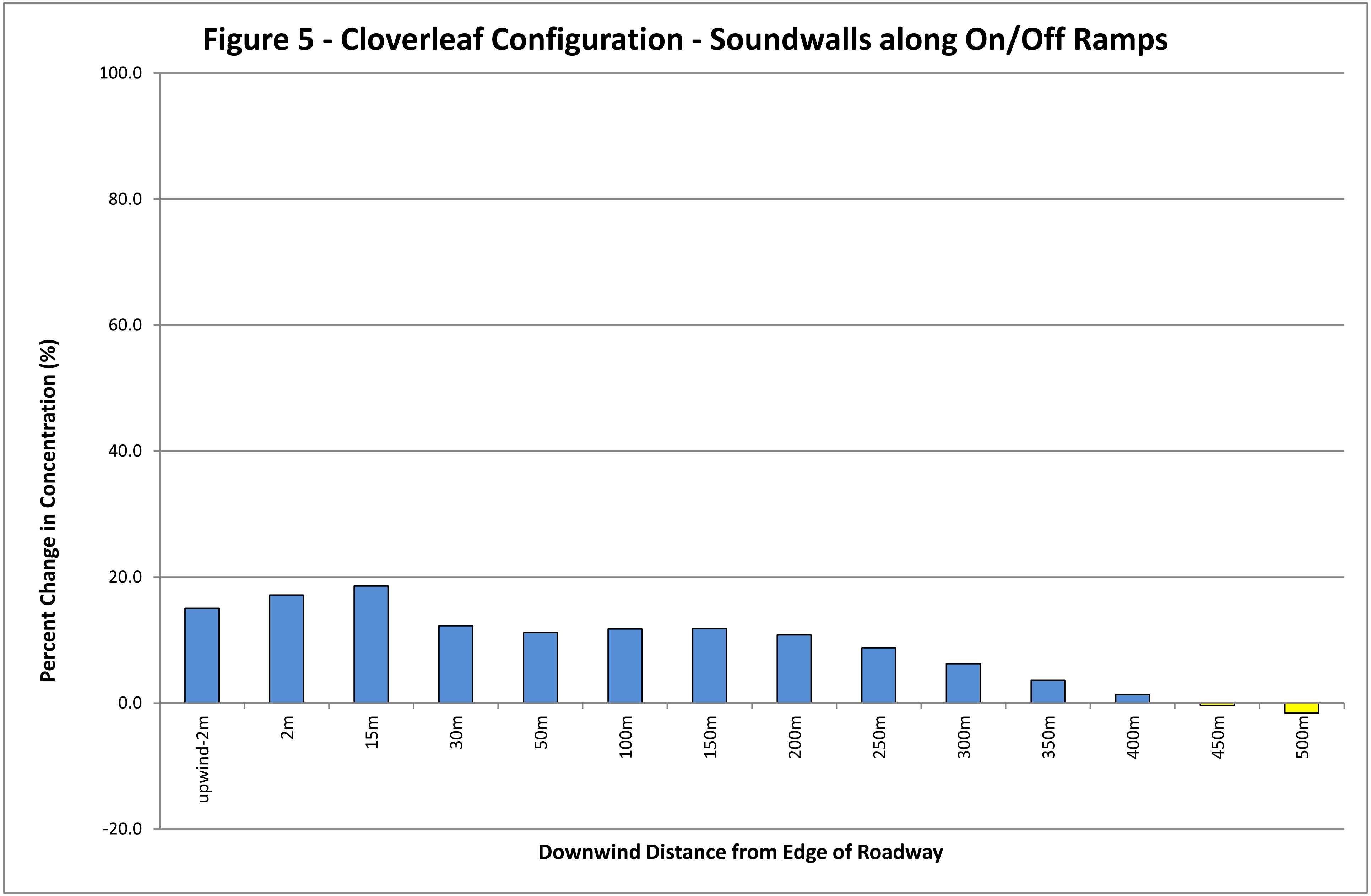


Figure 5 - Cloverleaf Configuration - Soundwalls along On/Off Ramps
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
Percent Change in Concentration (%)
upwind-2m
2m
15m
30m
50m
100m
150m
200m
250m
300m
350m
400m
450m
500m
Downwind Distance from Edge of Roadway

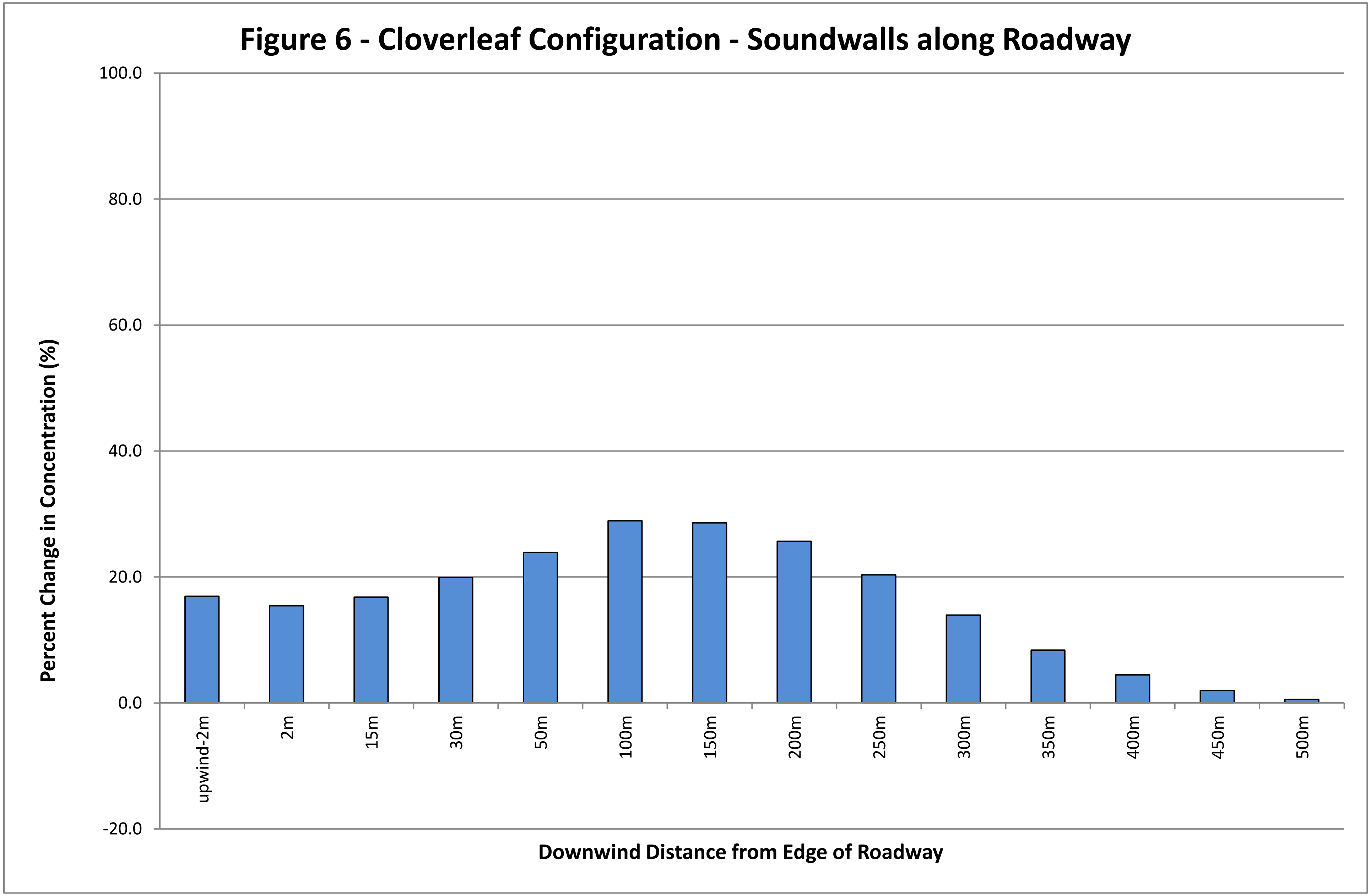


Figure 6 - Cloverleaf Configuration - Soundwalls along Roadway
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
Percent Change in Concentration (%)
upwind-2m
2m
15m
30m
50m
100m
150m
200m
250m
300m
350m
400m
450m
500m
Downwind Distance from Edge of Roadway

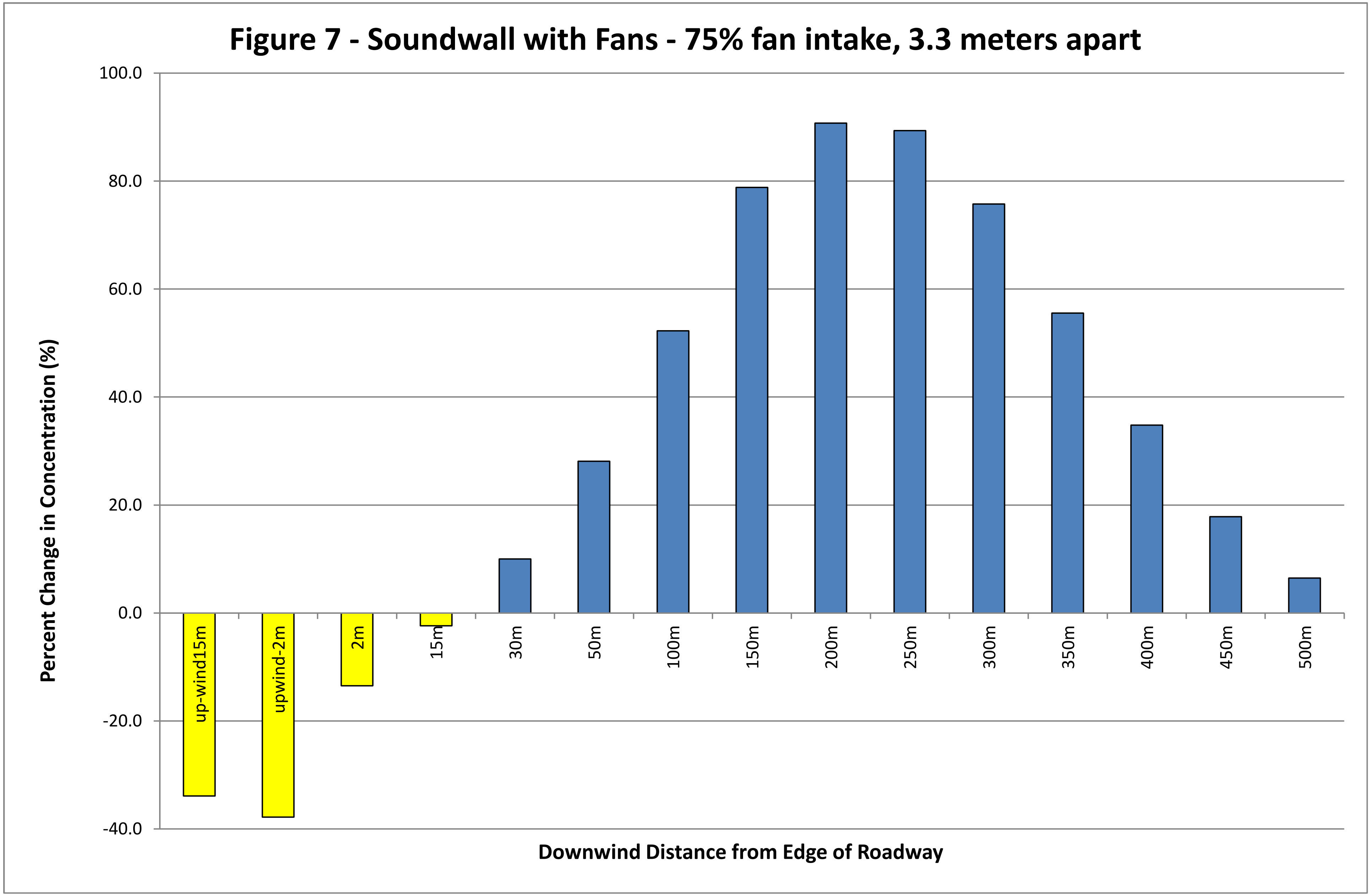


Figure 7 - Soundwall with Fans - 75% fan intake, 3.3 meters apart
Percent Change in Concentration (%)
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
up-wind15m
upwind-2m
2m
15m
30m
50m
100m
150m
200m
250m
300m
350m
400m
450m
500m
Downwind Distance from Edge of Roadway

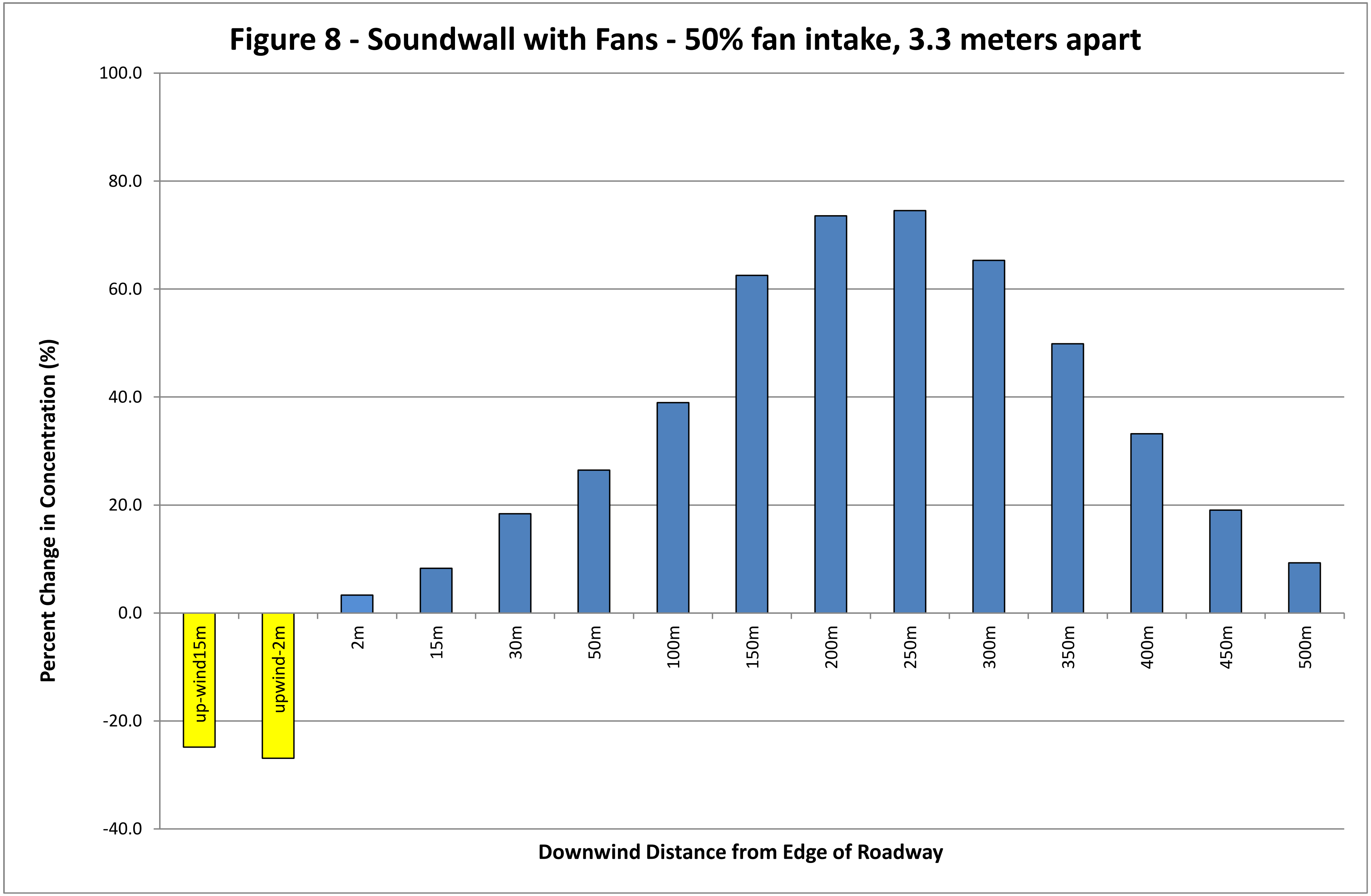


Figure 8 - Soundwall with Fans - 50% fan intake, 3.3 meters apart
Percent Change in Concentration (%)
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
up-wind15m
upwind-2m
2m
15m
30m
50m
100m
150m
200m
250m
300m
350m
400m
450m
500m
Downwind Distance from Edge of Roadway

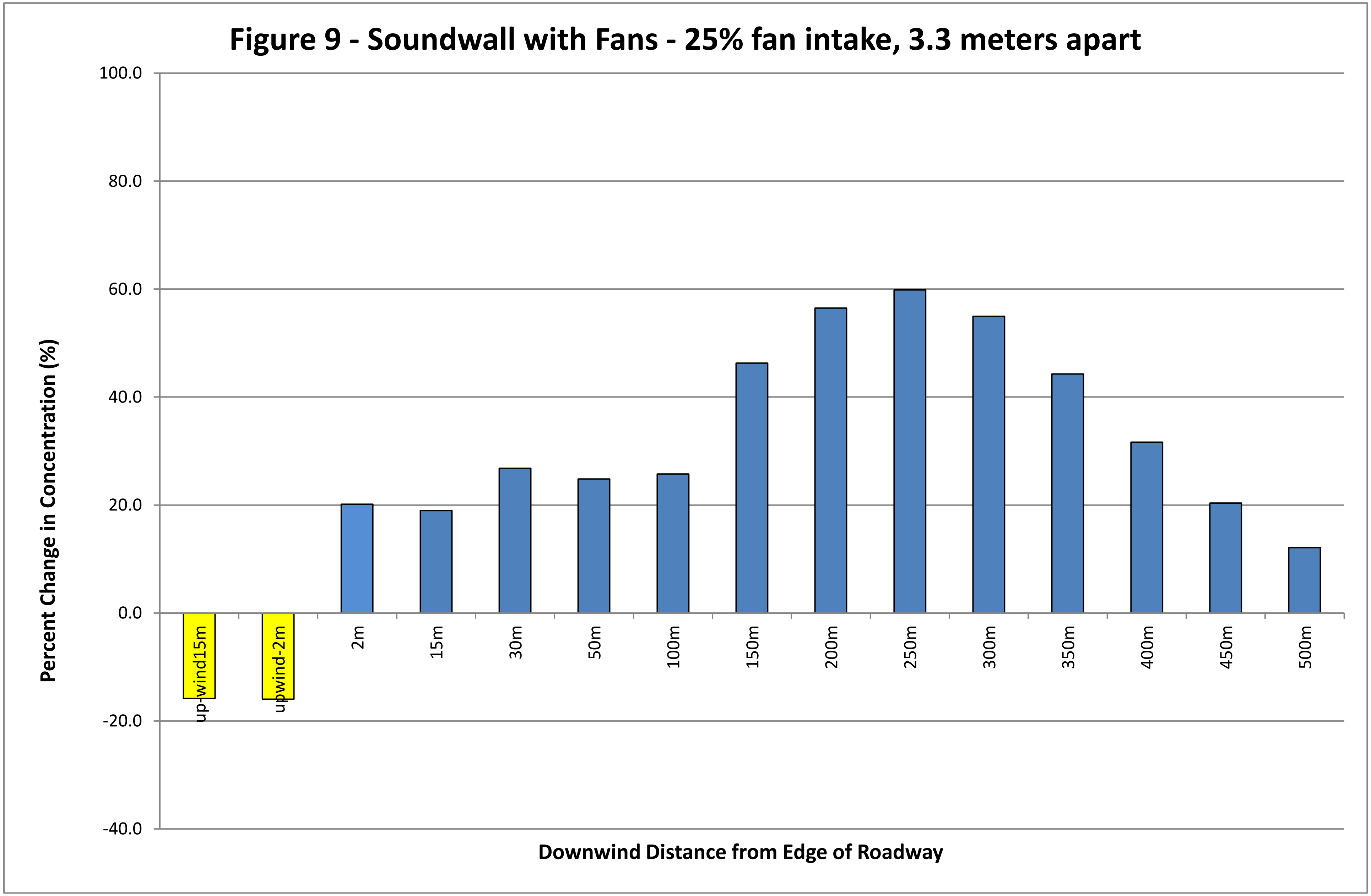


Figure 9 - Soundwall with Fans - 25% fan intake, 3.3 meters apart
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
Percent Change in Concentration (%)
up-wind15m
upwind-2m
2m
15m
30m
50m
100m
150m
200m
250m
300m
350m
400m
450m
500m
Downwind Distance from Edge of Roadway

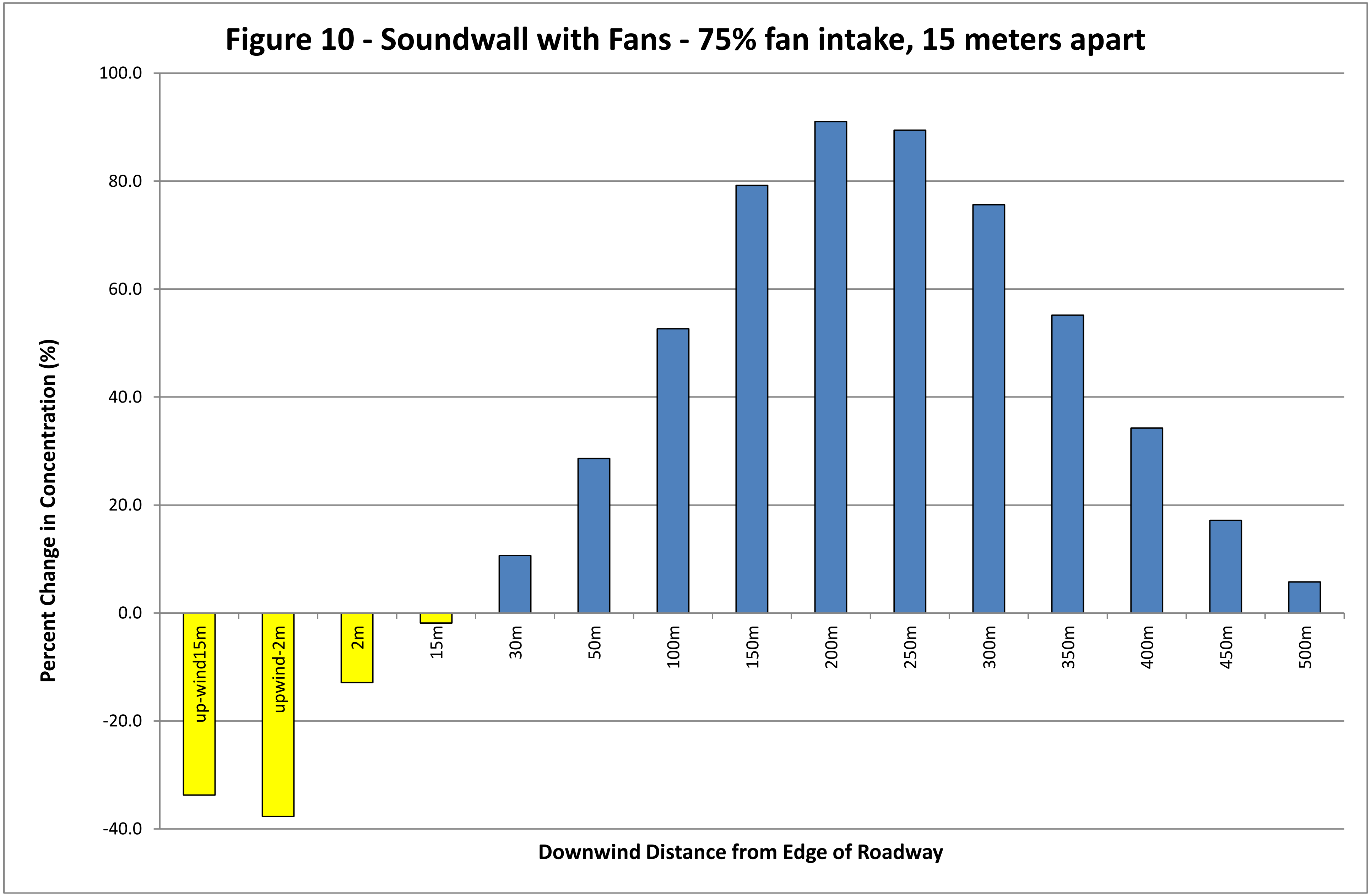


Figure 10 - Soundwall with Fans - 75% fan intake, 15 meters apart
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
Percent Change in Concentration (%)
up-wind15m
upwind-2m
2m
15m
30m
50m
100m
150m
200m
250m
300m
350m
400m
450m
500m
Downwind Distance from Edge of Roadway

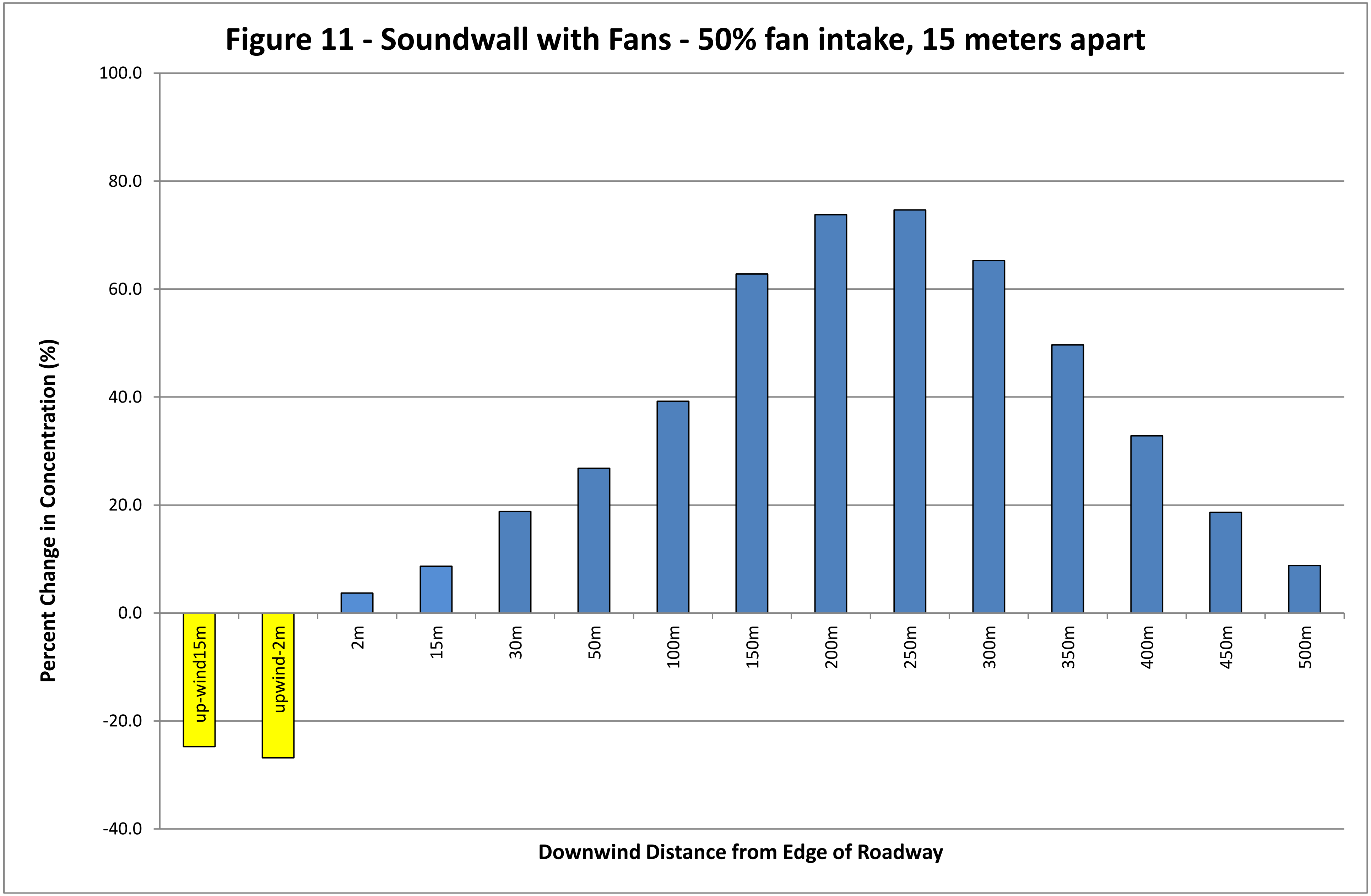


Figure 11 - Soundwall with Fans - 50% fan intake, 15 meters apart
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
Percent Change in Concentration (%)
up-wind15m
upwind-2m
2m
15m
30m
50m
100m
150m
200m
250m
300m
350m
400m
450m
500m
Downwind Distance from Edge of Roadway

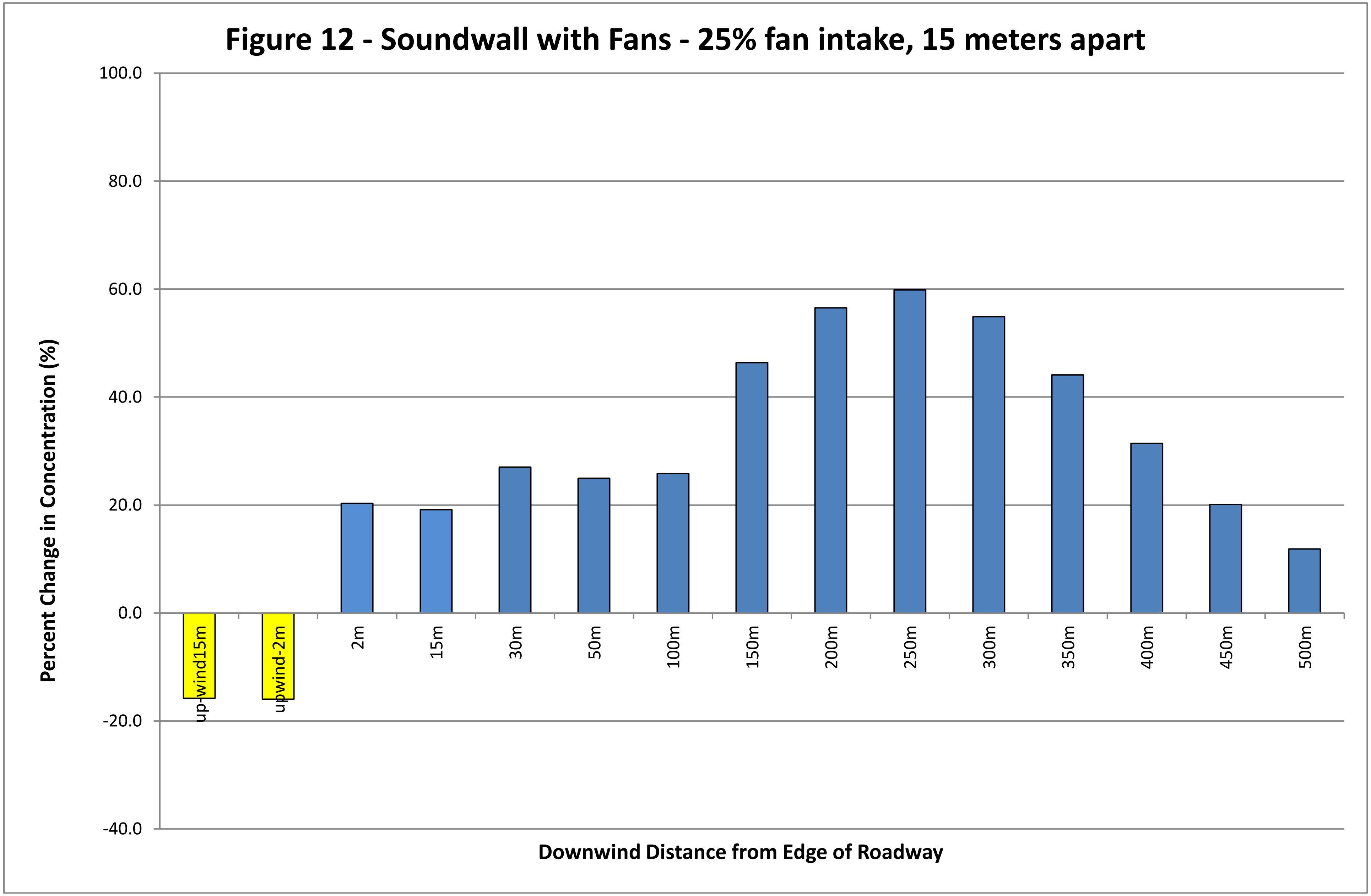


Figure 12 - Soundwall with Fans - 25% fan intake, 15 meters apart
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
Percent Change in Concentration (%)
up-wind15m
upwind-2m
2m
15m
30m
50m
100m
150m
200m
250m
300m
350m
400m
450m
500m
Downwind Distance from Edge of Roadway

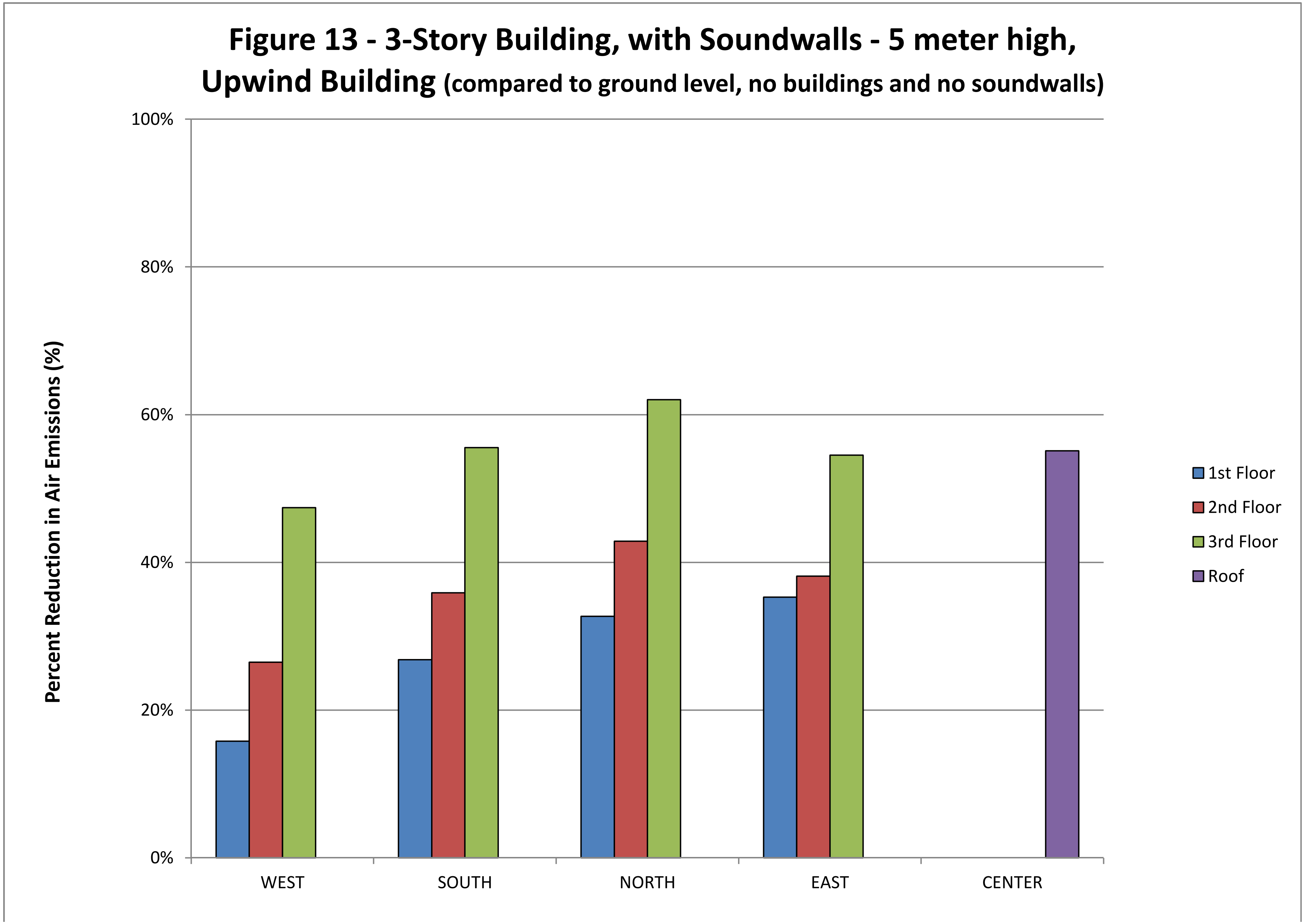


Figure 13 - 3-Story Building, with Soundwalls - 5 meter high,
Upwind Building (compared to ground level, no buildings and no soundwalls)
100%
80%
60%
40%
20%
0%
Percent Reduction in Air Emissions (%)
WEST
SOUTH
NORTH
EAST
CENTER
1st Floor
2nd Floor
3rd Floor
Roof

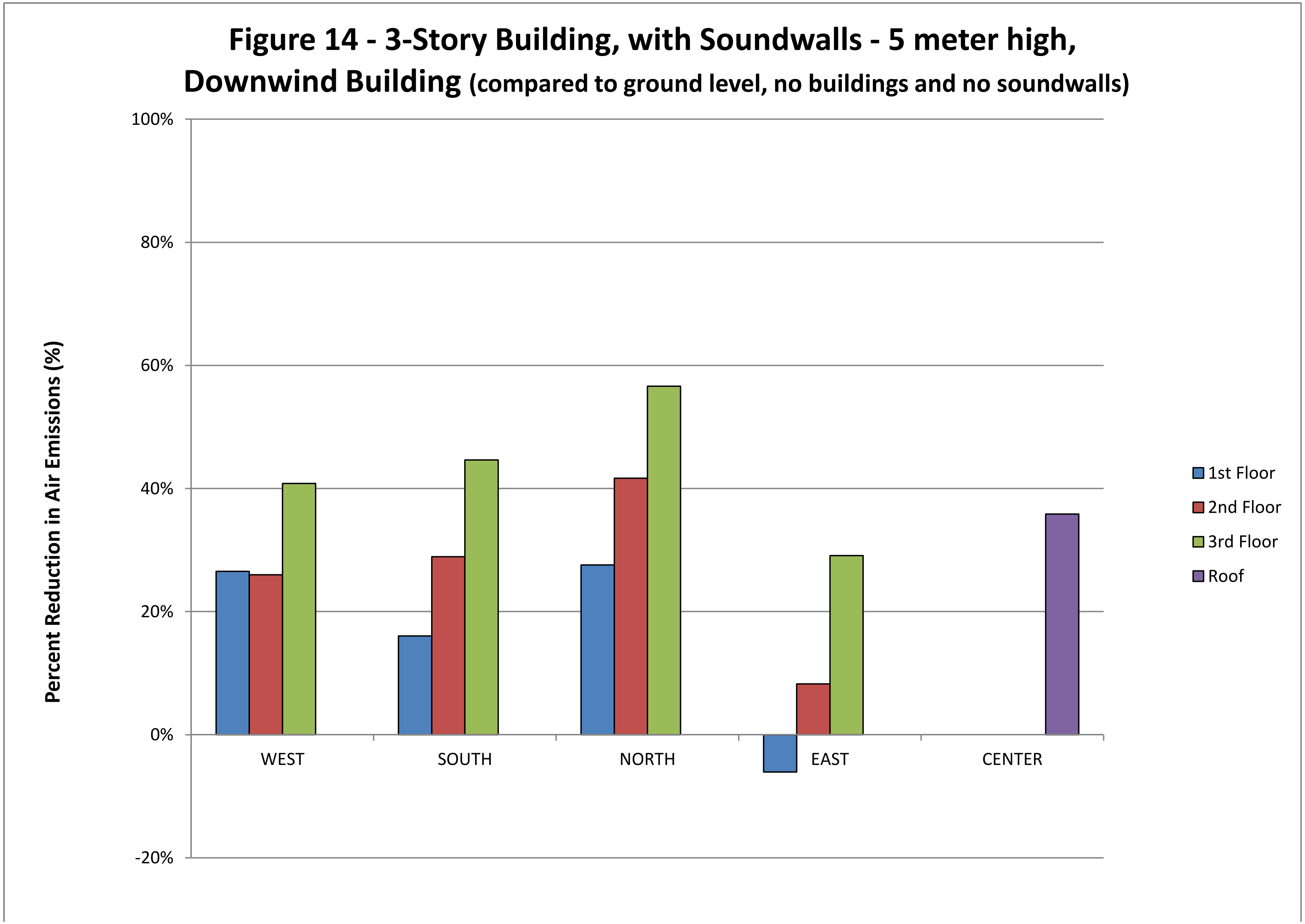
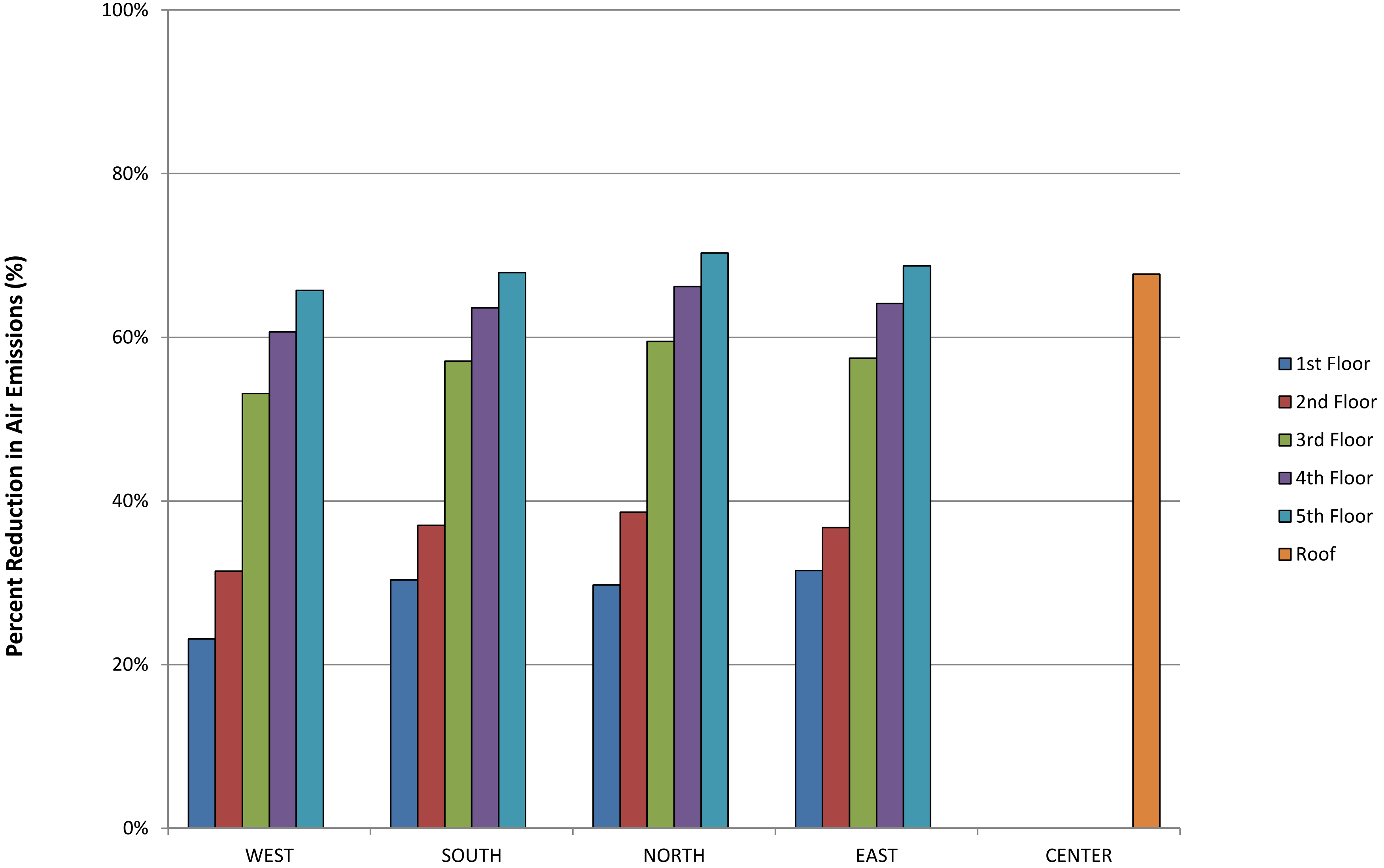


Figure 14 - 3-Story Building, with Soundwalls - 5 meter high, Downwind Building (compared to ground level, no buildings and no soundwalls)
Percent Reduction in Air Emissions (%)
100%
80%
60%
40%
20%
0%
-20%
WEST
SOUTH
NORTH
EAST
CENTER
1st Floor
2nd Floor
3rd Floor
Roof

Figure 15 - 5-Story Building, with Soundwalls - 5 meter high, Upwind Building (compared to ground level, no buildings and no soundwalls)



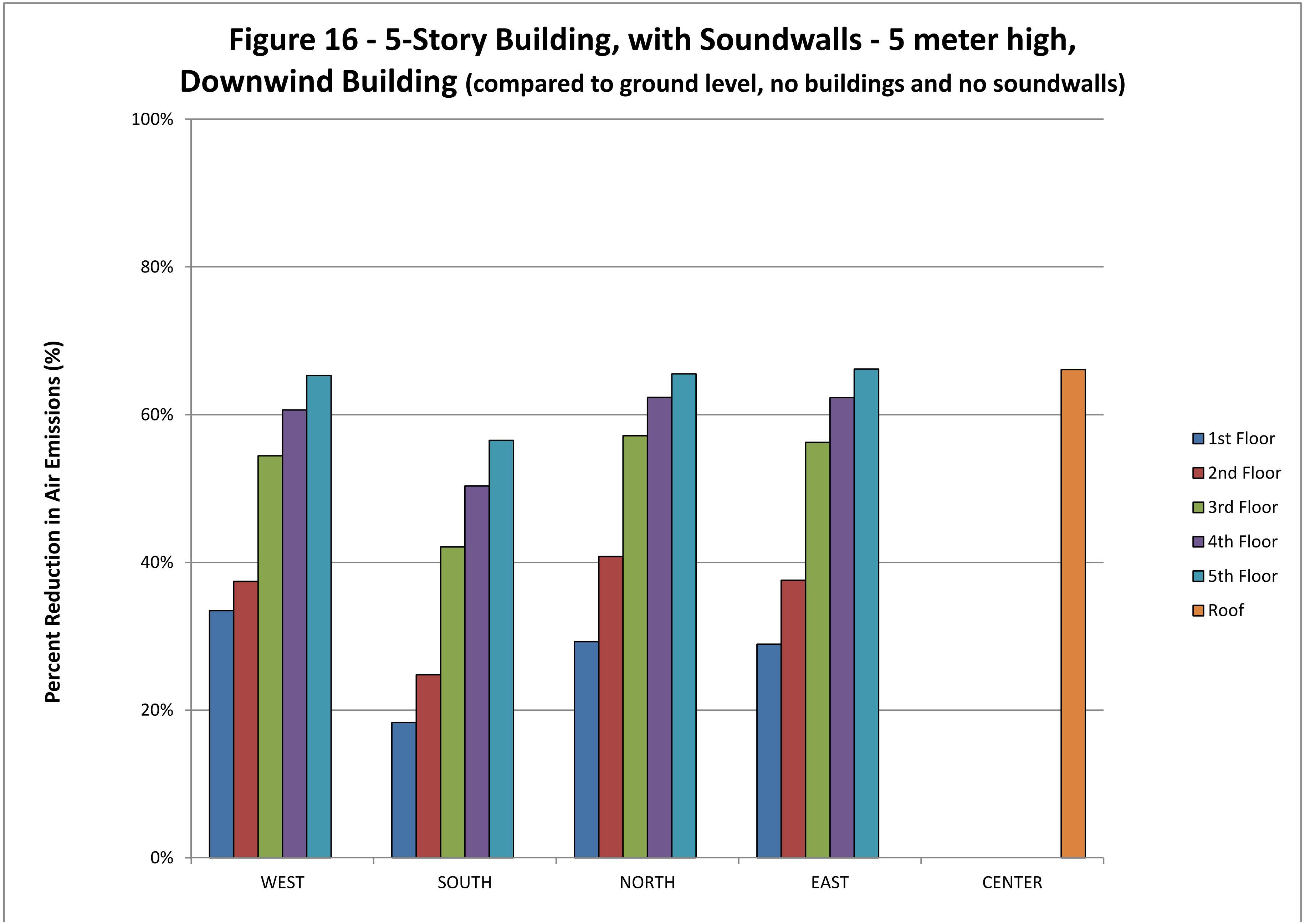
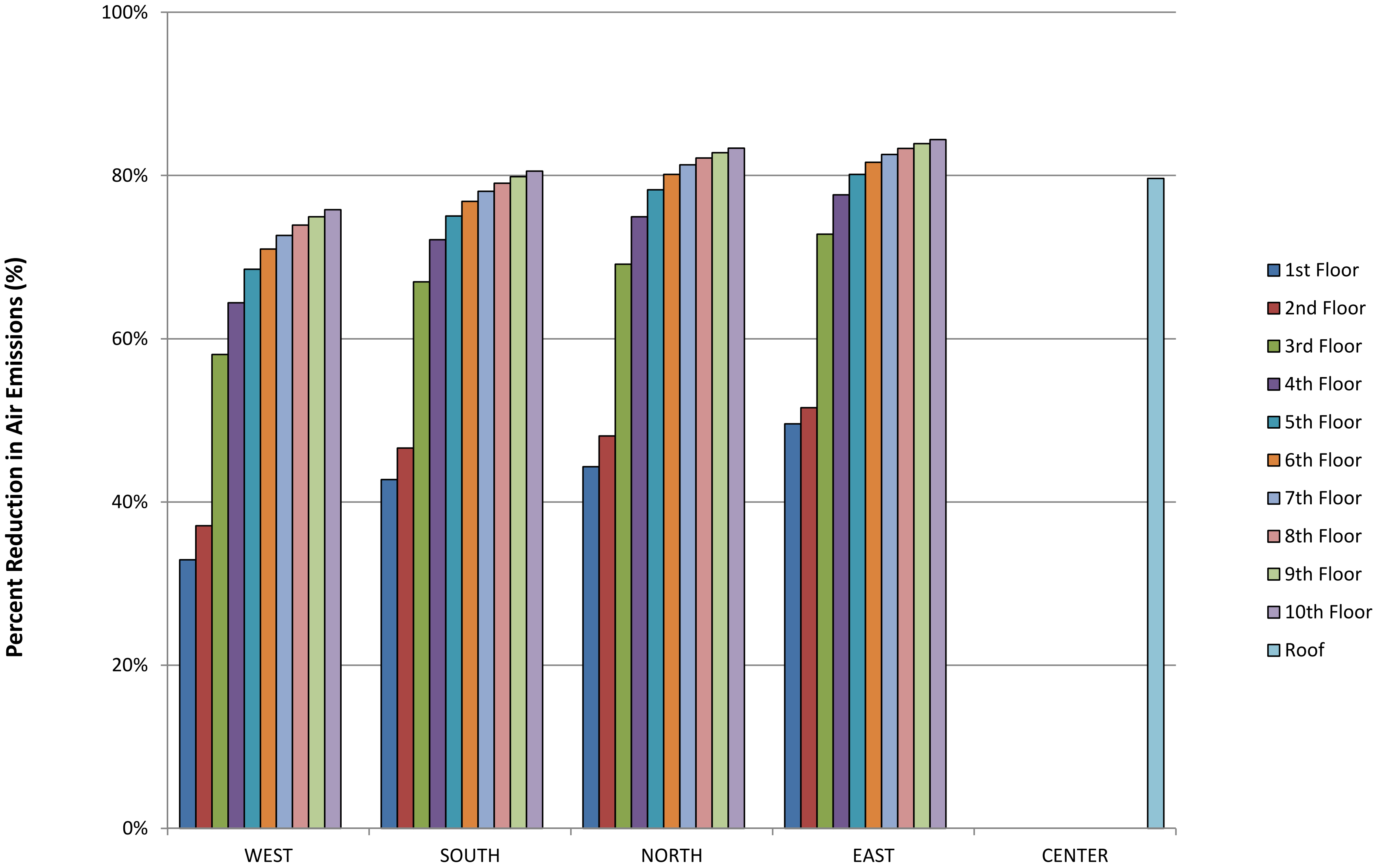


Figure 16 - 5-Story Building, with Soundwalls - 5 meter high,
Downwind Building (compared to ground level, no buildings and no soundwalls)
100%
80%
60%
40%
20%
0%
Percent Reduction in Air Emissions (%)
WEST
SOUTH
NORTH
EAST
CENTER
1st Floor
2nd Floor
3rd Floor
4th Floor
5th Floor
Roof

Figure 17 - 10-Story Building, with Soundwalls - 5 meter high, Upwind Building (compared to ground level, no buildings and no soundwalls)



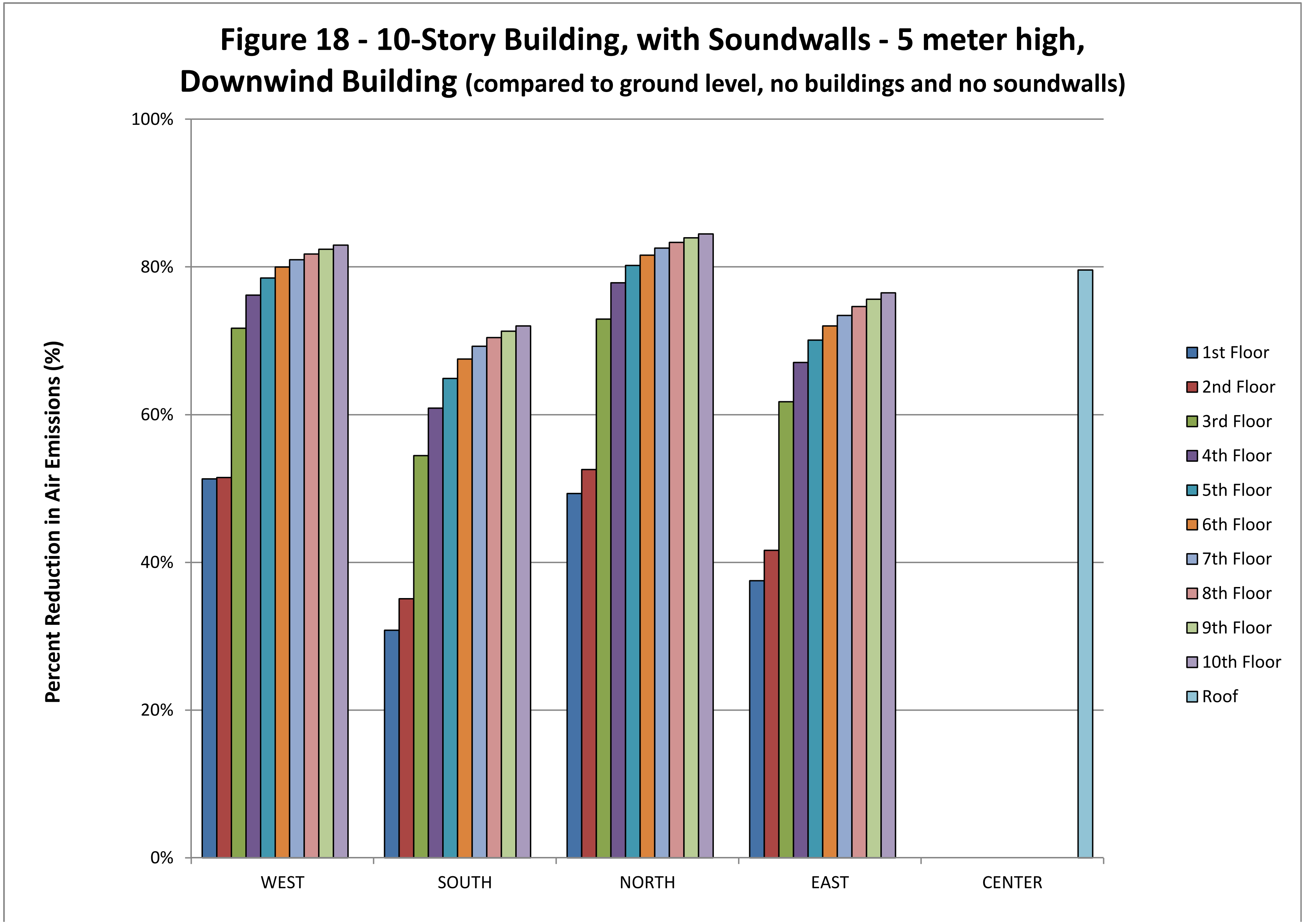


Figure 18 - 10-Story Building, with Soundwalls - 5 meter high, Downwind Building (compared to ground level, no buildings and no soundwalls)
Percent Reduction in Air Emissions (%)
100%
80%
60%
40%
20%
0%
WEST
SOUTH
NORTH
EAST
CENTER
1st Floor
2nd Floor
3rd Floor
4th Floor
5th Floor
6th Floor
7th Floor
8th Floor
9th Floor
10th Floor
Roof

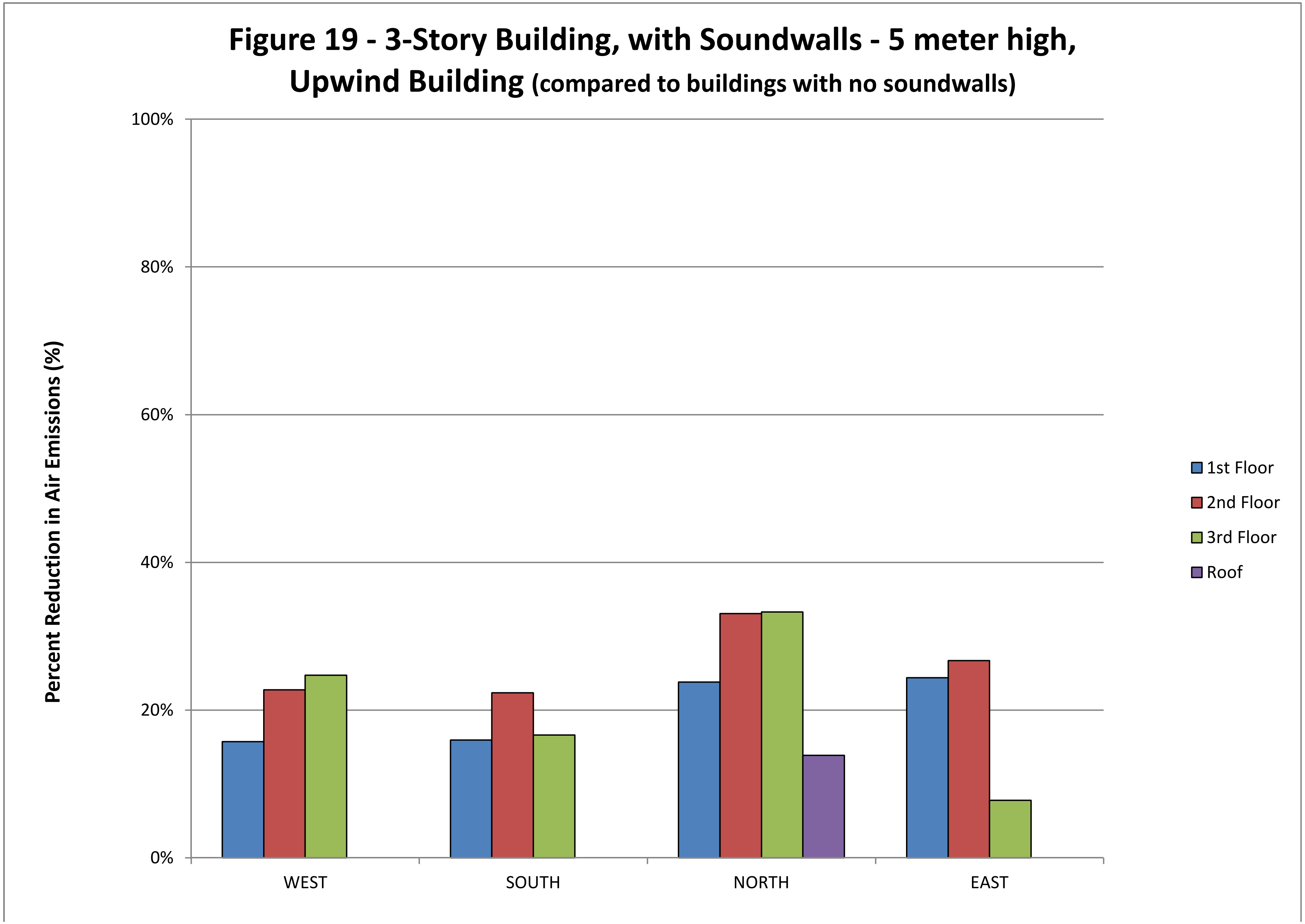


Figure 19 - 3-Story Building, with Soundwalls - 5 meter high, Upwind Building (compared to buildings with no soundwalls)
Percent Reduction in Air Emissions (%)
100%
80%
60%
40%
20%
0%
WEST
SOUTH
NORTH
EAST
1st Floor
2nd Floor
3rd Floor
Roof

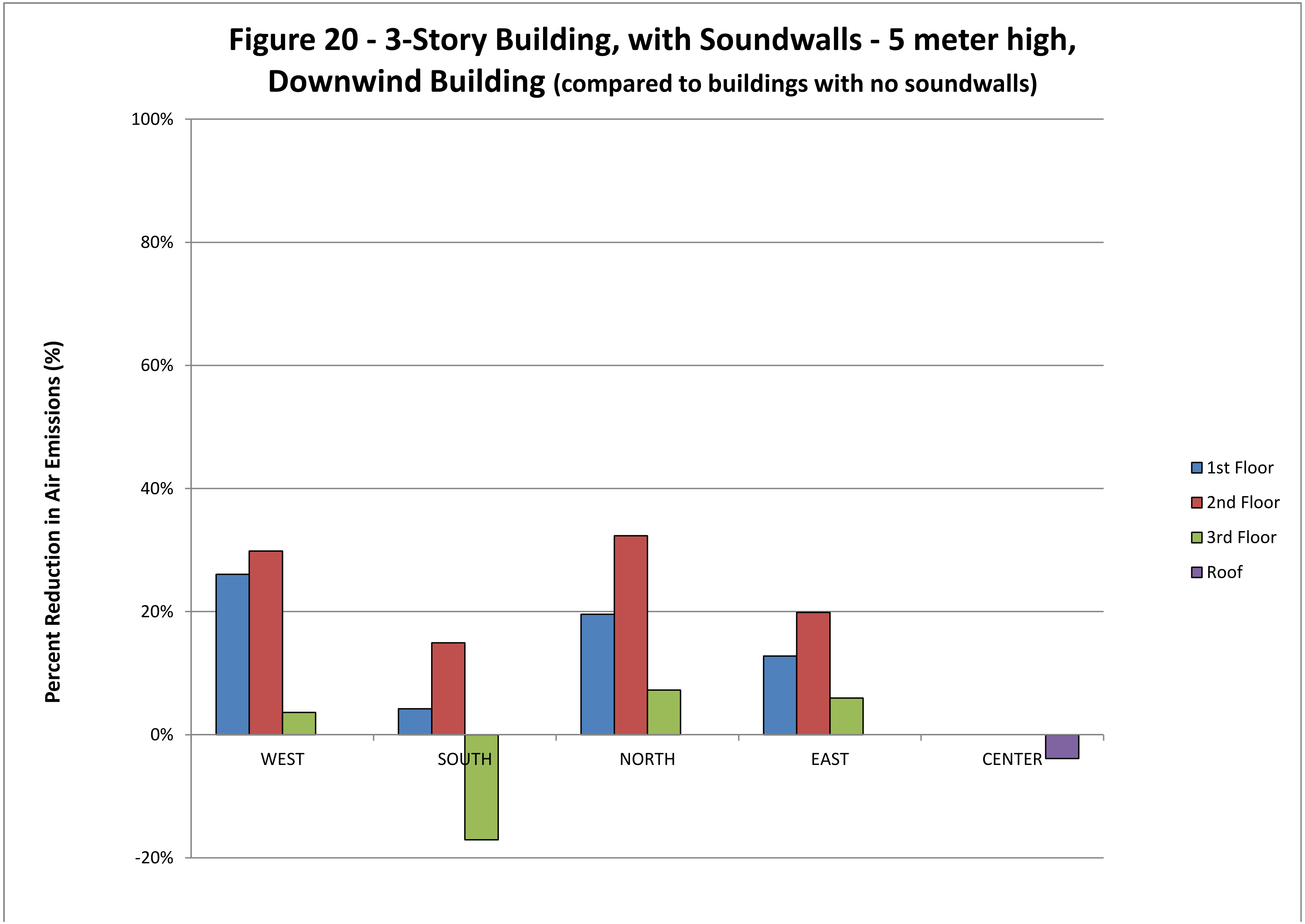


Figure 20 - 3-Story Building, with Soundwalls - 5 meter high, Downwind Building (compared to buildings with no soundwalls)
Percent Reduction in Air Emissions (%)
100%
80%
60%
40%
20%
0%
-20%
WEST
SOUTH
NORTH
EAST
CENTER
1st Floor
2nd Floor
3rd Floor
Roof

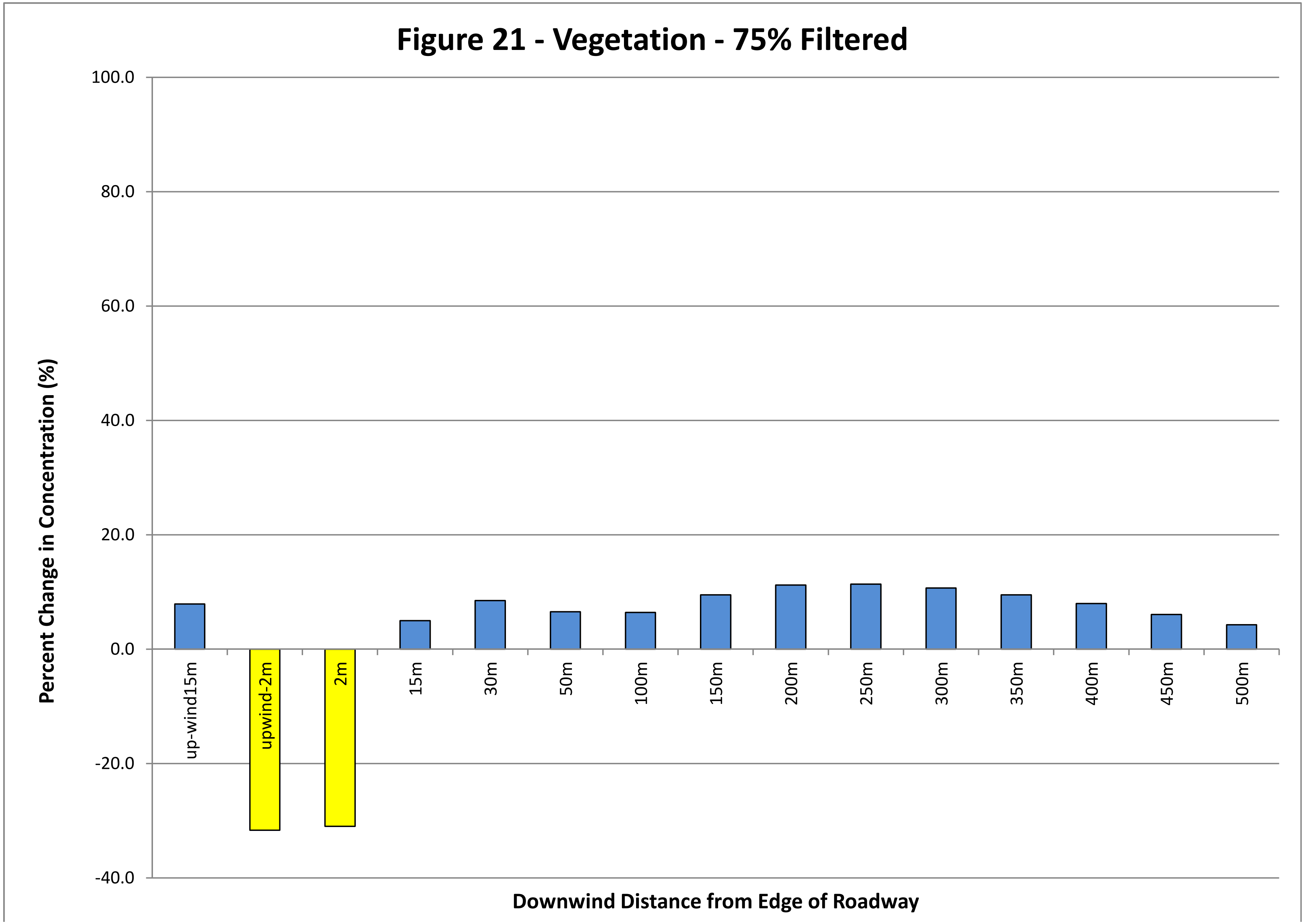


Figure 21 - Vegetation - 75% Filtered
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
Percent Change in Concentration (%)
up-wind15m
upwind-2m
2m
15m
30m
50m
100m
150m
200m
250m
300m
350m
400m
450m
500m
Downwind Distance from Edge of Roadway

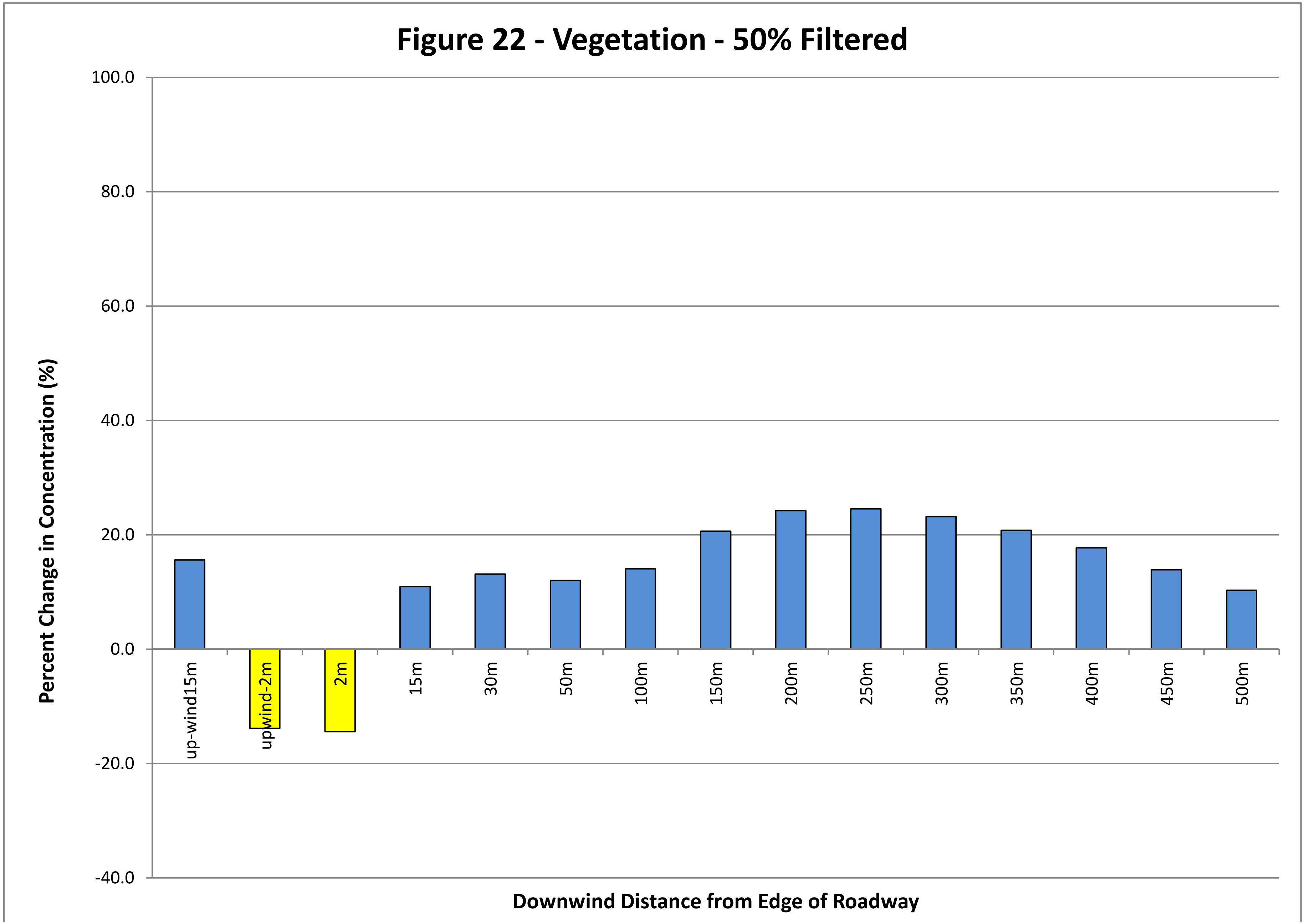


Figure 22 - Vegetation - 50% Filtered
Percent Change in Concentration (%)
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
up-wind15m
upwind-2m
2m
15m
30m
50m
100m
150m
200m
250m
300m
350m
400m
450m
500m
Downwind Distance from Edge of Roadway

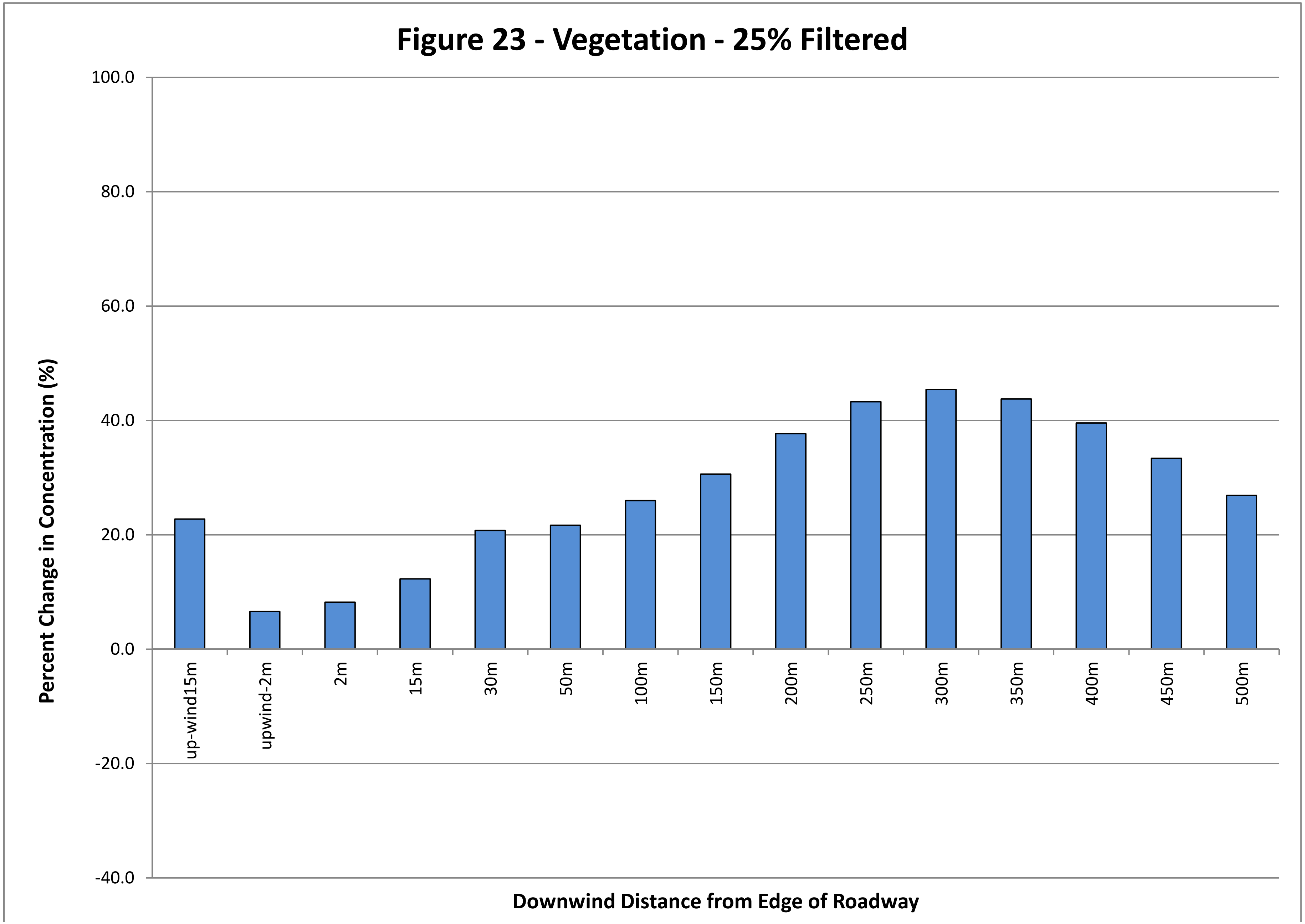


Figure 23 - Vegetation - 25% Filtered
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
Percent Change in Concentration (%)
up-wind15m
upwind-2m
2m
15m
30m
50m
100m
150m
200m
250m
300m
350m
400m
450m
500m
Downwind Distance from Edge of Roadway

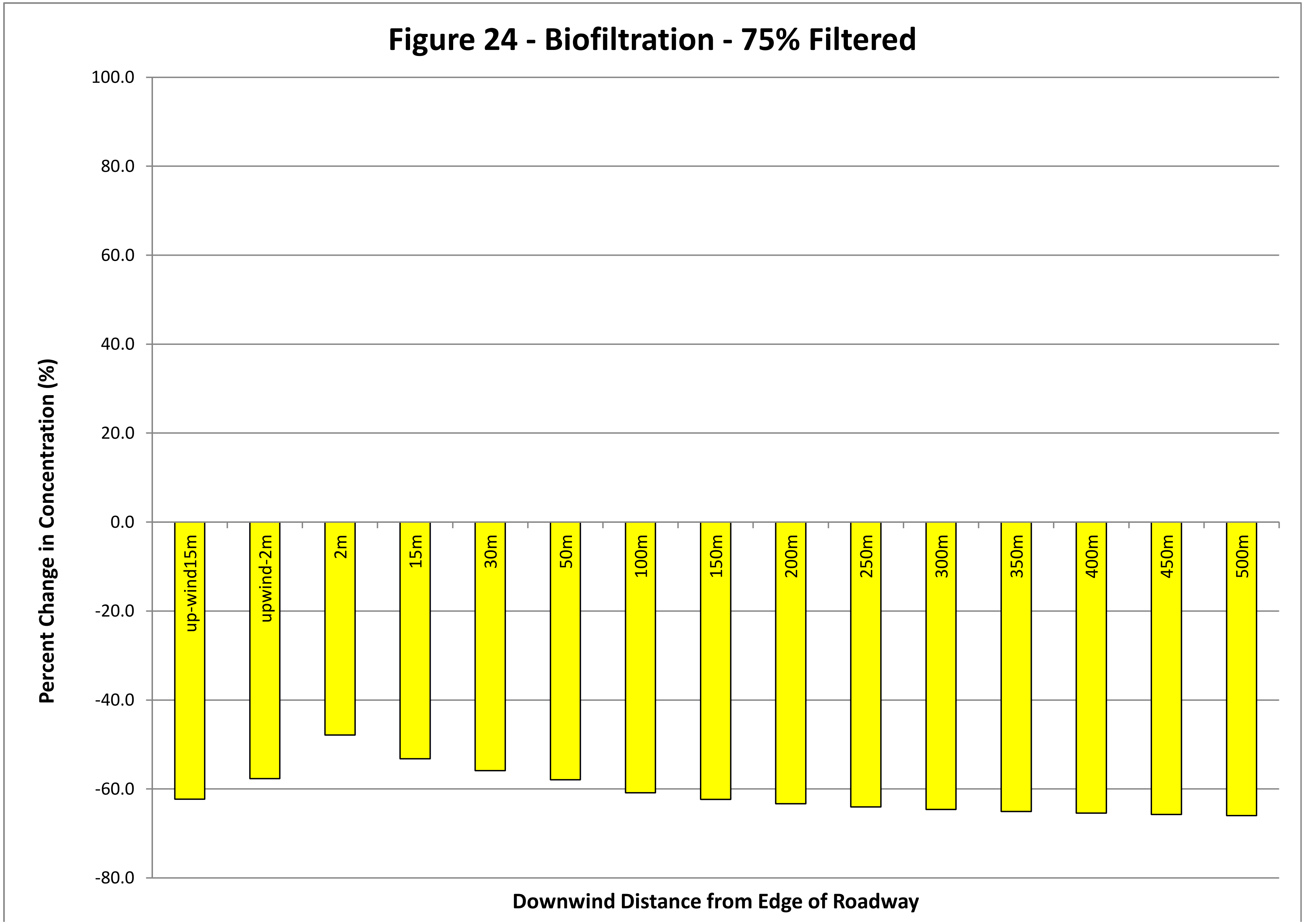


Figure 24 - Biofiltration - 75% Filtered
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
-60.0
-80.0
Percent Change in Concentration (%)
up-wind15m
upwind-2m
2m
15m
30m
50m
100m
150m
200m
250m
300m
350m
400m
450m
500m
Downwind Distance from Edge of Roadway

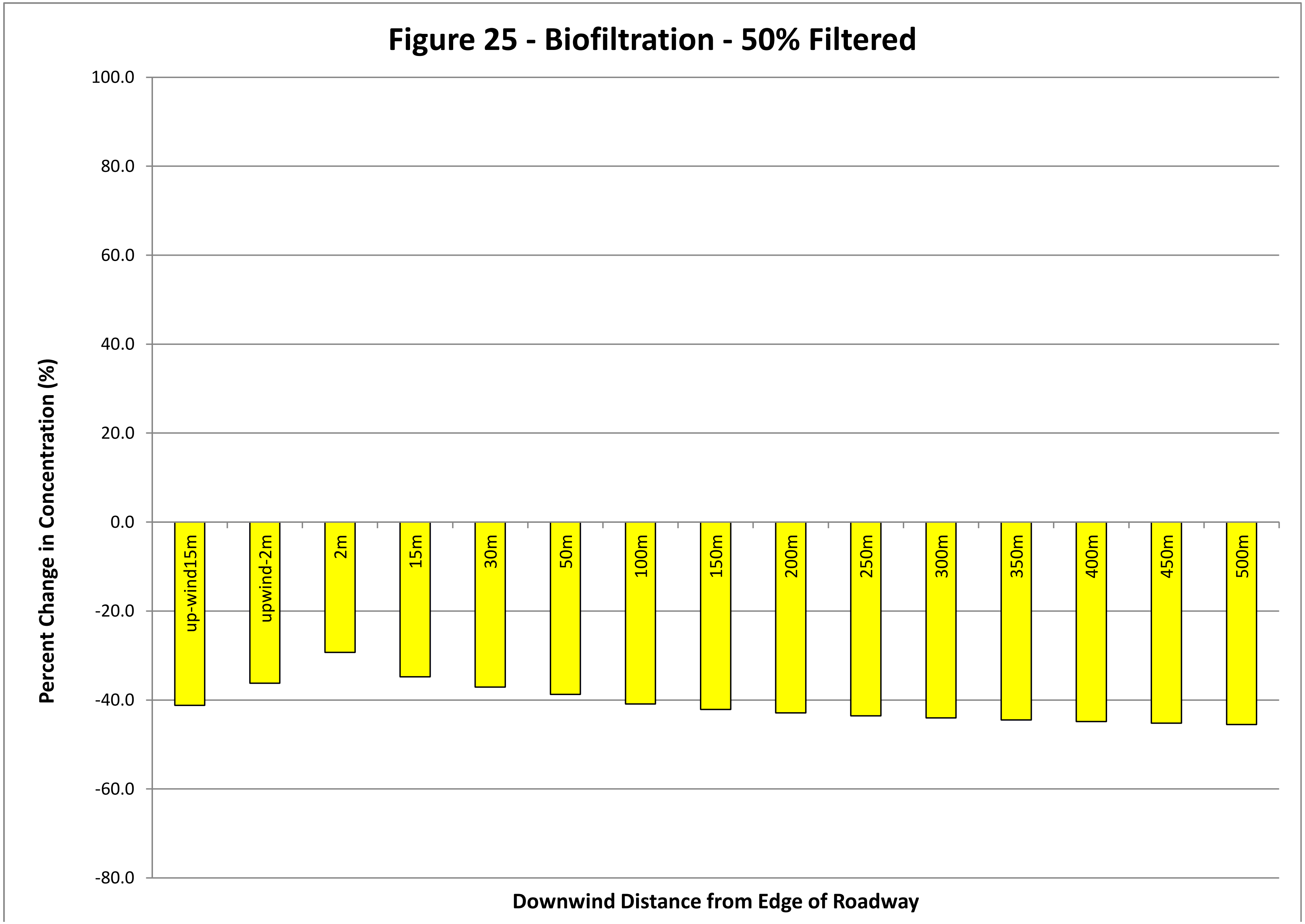


Figure 25 - Biofiltration - 50% Filtered
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
-60.0
-80.0
Percent Change in Concentration (%)
up-wind15m
upwind-2m
2m
15m
30m
50m
100m
150m
200m
250m
300m
350m
400m
450m
500m
Downwind Distance from Edge of Roadway

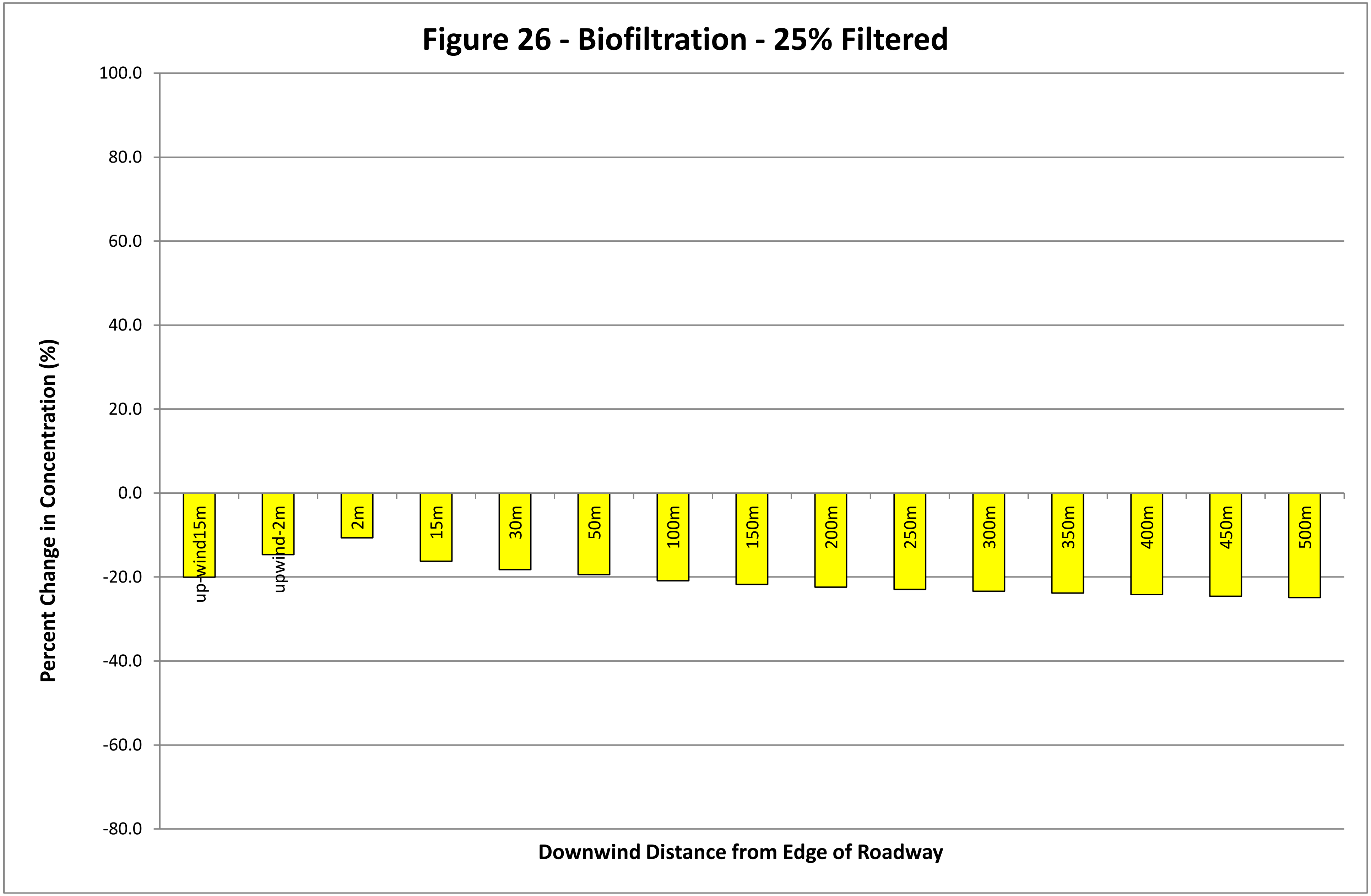


Figure 26 - Biofiltration - 25% Filtered
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
-60.0
-80.0
Percent Change in Concentration (%)
up-wind15m
upwind-2m
2m
15m
30m
50m
100m
150m
200m
250m
300m
350m
400m
450m
500m
Downwind Distance from Edge of Roadway

Source Emissions Calculations

Based on assumed roadway emission rate of: 1 lb/hr

ID	ID Description	Source Set	No. Sources	Type of Source	Emission Rate (lb/hr)	Source Separation (m)	Road Width (m)
0	Ground level concentrations	Roadway	11	point	9.09E-02	40	40
0.1	Ground level conc. - cloverleaf	Roadway	11	point	9.09E-02	40	40
1	Soundwall 1000 ft	Roadway	11	point	9.09E-02	40	40
2	Soundwall 500 ft, 1st configuration	Roadway	11	point	9.09E-02	40	40
2b	Soundwall 500 ft, 2nd configuration	Roadway	11	point	9.09E-02	40	40
3	Soundwall with 100 ft gaps	Roadway	11	point	9.09E-02	40	40
4	Soundwall, 1.8 m tall	Roadway	11	point	9.09E-02	40	40
5	Cloverleaf, soundwalls-ramps	Roadway	15	point	6.67E-02	40	40
		Inner Ramps	19	point	1.27E-03	8	8
		Outer Ramps	26	point	9.30E-04	8	8
6	Cloverleaf, soundwalls-roadway	Roadway	15	point	6.67E-02	40	40
		Inner Ramps	19	point	1.27E-03	8	8
		Outer Ramps	26	point	9.30E-04	8	8
7	Fans, 75% fan intake, 3.3 m sep	Roadway	11	point	2.27E-02	40	40
		Fans	184	point	4.08E-03	3.3	
8	Fans, 50% fan intake, 3.3 m sep	Roadway	11	point	4.55E-02	40	40
		Fans	184	point	2.72E-03	3.3	
9	Fans, 25% fan intake, 3.3 m sep	Roadway	11	point	6.82E-02	40	40
		Fans	184	point	1.36E-03	3.3	
10	Fans, 75% fan intake, 15 m sep	Roadway	11	point	2.27E-02	40	40
		Fans	40	point	1.88E-02	15.2	
11	Fans, 50% fan intake, 15 m sep	Roadway	11	point	4.55E-02	40	40
		Fans	40	point	1.25E-02	15.2	
12	Fans, 25% fan intake, 15 m sep	Roadway	11	point	6.82E-02	40	40
		Fans	40	point	6.25E-03	15.2	
13	3-Story Building	Roadway	11	point	9.09E-02	40	40
14	5-Story Building	Roadway	11	point	9.09E-02	40	40
15	10-Story Building	Roadway	11	point	9.09E-02	40	40

Source Emissions Calculations

Based on assumed roadway emission rate of: 1 lb/hr

ID	ID Description	Source Set	No. Sources	Type of Source	Emission Rate (lb/hr)	Source Separation (m)	Road Width (m)
16	Vegetation, 75% filtered	Bypassed Air	11	point	2.27E-02	40	40
		Filtered Air	11	volume	6.82E-02	40	40
17	Vegetation, 50% filtered	Bypassed Air	11	point	4.55E-02	40	40
		Filtered Air	11	volume	4.55E-02	40	40
18	Vegetation, 25% filtered	Bypassed Air	11	point	6.82E-02	40	40
		Filtered Air	11	volume	2.27E-02	40	40
19	Biofiltration, 75% filter intake	Roadway	15	volume	1.67E-02	40	40
		Inner Ramps	19	volume	3.18E-04	8	8
		Outer Ramps	26	volume	2.32E-04	8	8
		Biofilters	4	area	7.32E-07		
20	Biofiltration, 50% filter intake	Roadway	15	volume	3.33E-02	40	40
		Inner Ramps	19	volume	6.36E-04	8	8
		Outer Ramps	26	volume	4.65E-04	8	8
		Biofilters	4	area	4.88E-07		
21	Biofiltration, 25% filter intake	Roadway	15	volume	5.00E-02	40	40
		Inner Ramps	19	volume	9.54E-04	8	8
		Outer Ramps	26	volume	6.97E-04	8	8
		Biofilters	4	area	2.44E-07		

Model Inputs

Sources

Roadway Configuration		x	y	elevation (m)	emission (lb/hr)	release height (m)	temp (K)	stack velocity (m/s)	stack diameter (ft)
Regular	1st Source	388272.8	3741928.0	0	varies	4.15	298	1	0.5
Cloverleaf	1st Source	388235.8	3740835.2	0	varies	4.15	298	1	0.5

Sources separated by 40 meters. Source locations determined by creating a roadway in AERMOD and replacing the created volumes sources with point sources.

Fans		x	y	(m)	(lb/hr)	(ft)	(K)	(m/s)	(ft)
	Upwind	388253.6	3741966.0	5	varies	2	298	7	2
	Downwind	388292.0	3741966.0	5	varies	2	298	7	2

	fans/m2	length (m)	width (m)	roadway area (m2)	No. Fans Needed	No. Fans per Wall	Wall Length (ft)	Fan Separation (m)
10 AC/hr	0.015	305	40	12200	183	92	1000	3.3

Fan separation of 3.3 m was used to simulate 10 air changes per hour. For comparion, a AERMOD scenario was created with a fan separation of 15 m.

Buildings and Structures

Soundwalls		x	y	elevation (m)	height (m)	x-length (ft)	y-length (ft)	angle
	Upwind	388252.8	3741966.0	0	5	1	1000	0
	Downwind	388292.8	3741966.0	0	5	1	1000	0

Buildings		SW Corner Coordinates		elev (m)	height (m)	x-length (m)	y-length (m)	angle
	Upwind	388197.8	3742093.4	0	varies	50	50	0
	Downwind	388297.8	3742093.4	0	varies	50	50	0

Building height based on 10 feet per story.

Trees		x	y	elev (m)	height (ft)	radius (ft)	corners	separation (m)
	Upwind	388252.8	3741966.0	0	30	10	10	10
	Downwind	388292.8	3741966.0	0	30	10	10	10

A total of 34 trees are placed on each side of the roadway.

Receptors	x	y	elev (m)	separation (m)	x-length (m)	y-length (m)
Upwind Grid	387750.8	3741936.0	0	50	500	400
50ft from roadway	388235.6	3741936.0	0	50	0	400
100ft from roadway	388220.3	3741936.0	0	50	0	400
Downwind Grid	388294.8	3741936.0	0	50	500	400
50ft from roadway	388310.0	3741936.0	0	50	0	400
100ft from roadway	388325.3	3741936.0	0	50	0	400

Model Inputs

Building Receptors

3-Story Building	x	y	elev (ft)		x	y	elev (ft)
Upwind	388197.8	3742118.4	5	Downwind	388297.8	3742118.4	5
	388197.8	3742118.4	15		388297.8	3742118.4	15
	388197.8	3742118.4	25		388297.8	3742118.4	25
	388222.8	3742093.4	5		388322.8	3742093.4	5
	388222.8	3742093.4	15		388322.8	3742093.4	15
	388222.8	3742093.4	25		388322.8	3742093.4	25
	388222.8	3742118.4	30		388322.8	3742118.4	30
	388222.8	3742143.4	5		388322.8	3742143.4	5
	388222.8	3742143.4	15		388322.8	3742143.4	15
	388222.8	3742143.4	25		388322.8	3742143.4	25
	388247.8	3742118.4	5		388347.8	3742118.4	5
	388247.8	3742118.4	15		388347.8	3742118.4	15
	388247.8	3742118.4	25		388347.8	3742118.4	25
10-Story Building	x	y	elev (ft)		x	y	elev (ft)
Upwind	388197.8	3742118.4	85	Downwind	388297.8	3742118.4	85
	388197.8	3742118.4	75		388297.8	3742118.4	75
	388197.8	3742118.4	65		388297.8	3742118.4	65
	388197.8	3742118.4	55		388297.8	3742118.4	55
	388197.8	3742118.4	45		388297.8	3742118.4	45
	388197.8	3742118.4	35		388297.8	3742118.4	35
	388197.8	3742118.4	25		388297.8	3742118.4	25
	388197.8	3742118.4	15		388297.8	3742118.4	15
	388197.8	3742118.4	5		388297.8	3742118.4	5
	388197.8	3742118.4	95		388297.8	3742118.4	95
	388222.8	3742093.4	85		388322.8	3742093.4	85
	388222.8	3742093.4	75		388322.8	3742093.4	75
	388222.8	3742093.4	65		388322.8	3742093.4	65
	388222.8	3742093.4	55		388322.8	3742093.4	55
	388222.8	3742093.4	45		388322.8	3742093.4	45
	388222.8	3742093.4	35		388322.8	3742093.4	35
	388222.8	3742093.4	25		388322.8	3742093.4	25
	388222.8	3742093.4	15		388322.8	3742093.4	15
	388222.8	3742093.4	5		388322.8	3742093.4	5
	388222.8	3742093.4	95		388322.8	3742093.4	95
	388222.8	3742118.4	100		388322.8	3742118.4	100
	388222.8	3742143.4	85		388322.8	3742143.4	85
	388222.8	3742143.4	75		388322.8	3742143.4	75
	388222.8	3742143.4	65		388322.8	3742143.4	65
	388222.8	3742143.4	55		388322.8	3742143.4	55
	388222.8	3742143.4	45		388322.8	3742143.4	45
	388222.8	3742143.4	35		388322.8	3742143.4	35
	388222.8	3742143.4	25		388322.8	3742143.4	25
	388222.8	3742143.4	15		388322.8	3742143.4	15
	388222.8	3742143.4	5		388322.8	3742143.4	5
	388222.8	3742143.4	95		388322.8	3742143.4	95
	388247.8	3742118.4	85		388347.8	3742118.4	85
	388247.8	3742118.4	75		388347.8	3742118.4	75
	388247.8	3742118.4	65		388347.8	3742118.4	65
	388247.8	3742118.4	55		388347.8	3742118.4	55
	388247.8	3742118.4	45		388347.8	3742118.4	45
	388247.8	3742118.4	35		388347.8	3742118.4	35
	388247.8	3742118.4	25		388347.8	3742118.4	25
	388247.8	3742118.4	15		388347.8	3742118.4	15
	388247.8	3742118.4	5		388347.8	3742118.4	5
	388247.8	3742118.4	95		388347.8	3742118.4	95

Note: 5-Story building parameters identical to the lower 5 floors from 10-Story building parameters, with roof 50 ft high.

On- and Off-Ramp Traffic Fraction Calculation

710 Freeway - Willow Street Interchange
Year 2008

		Traffic Volumes		Ramp Traffic Fraction	
Description	Milepost	Back AADT	Forward AADT	Back AADT	Forward AADT
710	7.887	151000	165000		
NB off to EB Willow St	7.719	1700	1700	**0.011**	0.010
SB on from EB Willow St	7.728	2550	2550	**0.017**	0.015
NB on from EB Willow St	7.811	5600	5600	**0.037**	0.034
SB off to EB Willow St	7.825	5400	5400	**0.036**	0.033
NB off to WB Willow St	7.945	1850	1850	**0.012**	0.011
SB on from WB Willow St	7.964	1550	1550	**0.010**	0.009
SB off to WB Willow St	8.055	5600	5600	**0.037**	0.034
NB on from WB Willow St	8.061	4950	4950	**0.033**	0.030
Average Ramp		3650	3650	**0.024**	0.022

To be conservative, the larger ramp traffic fraction was used for analysis (0.024).

Biofiltration Model Specifications

Volume Sources

	Release Height	Width	Init. Lat.	Init. Vert.
Freeway	4.15	40	18.6	3.86
On/Offramp	4.15	8	3.72	3.86

Map Mid Point

x	y
388235.8	3741115.2

NW Biofilter			NE Biofilter			SW Biofilter			SE Biofilter		
	x	y	adj	x	y	adj	x	y	adj	x	y
	388189.2	3741137.4	46.6	388282.4	3741137	22.2	388189.2	3741093	22.2	388282.4	3741093
	388177.8	3741146.8	58	388293.8	3741147	31.6	388177.8	3741084	31.6	388293.8	3741084
	388172.7	3741172	63.1	388298.9	3741172	56.8	388172.7	3741058	56.8	388298.9	3741058
	388181.4	3741197.6	54.4	388290.2	3741198	82.4	388181.4	3741033	82.4	388290.2	3741033
	388195.3	3741202.1	40.5	388276.3	3741202	86.9	388195.3	3741028	86.9	388276.3	3741028
	388210.2	3741197.2	25.6	388261.4	3741197	82	388210.2	3741033	82	388261.4	3741033
	388217.3	3741173.3	18.5	388254.3	3741173	58.1	388217.3	3741057	58.1	388254.3	3741057
	388217.3	3741137.4	18.5	388254.3	3741137	22.2	388217.3	3741093	22.2	388254.3	3741093
Area (m2, AERMOD)		2377.234			2376.277			2382.488			2381.523

Average Area (m2)	2379
Area (SF)	25611

Assumed removal fraction of CO, using Biofilters (Fujita, 2013).

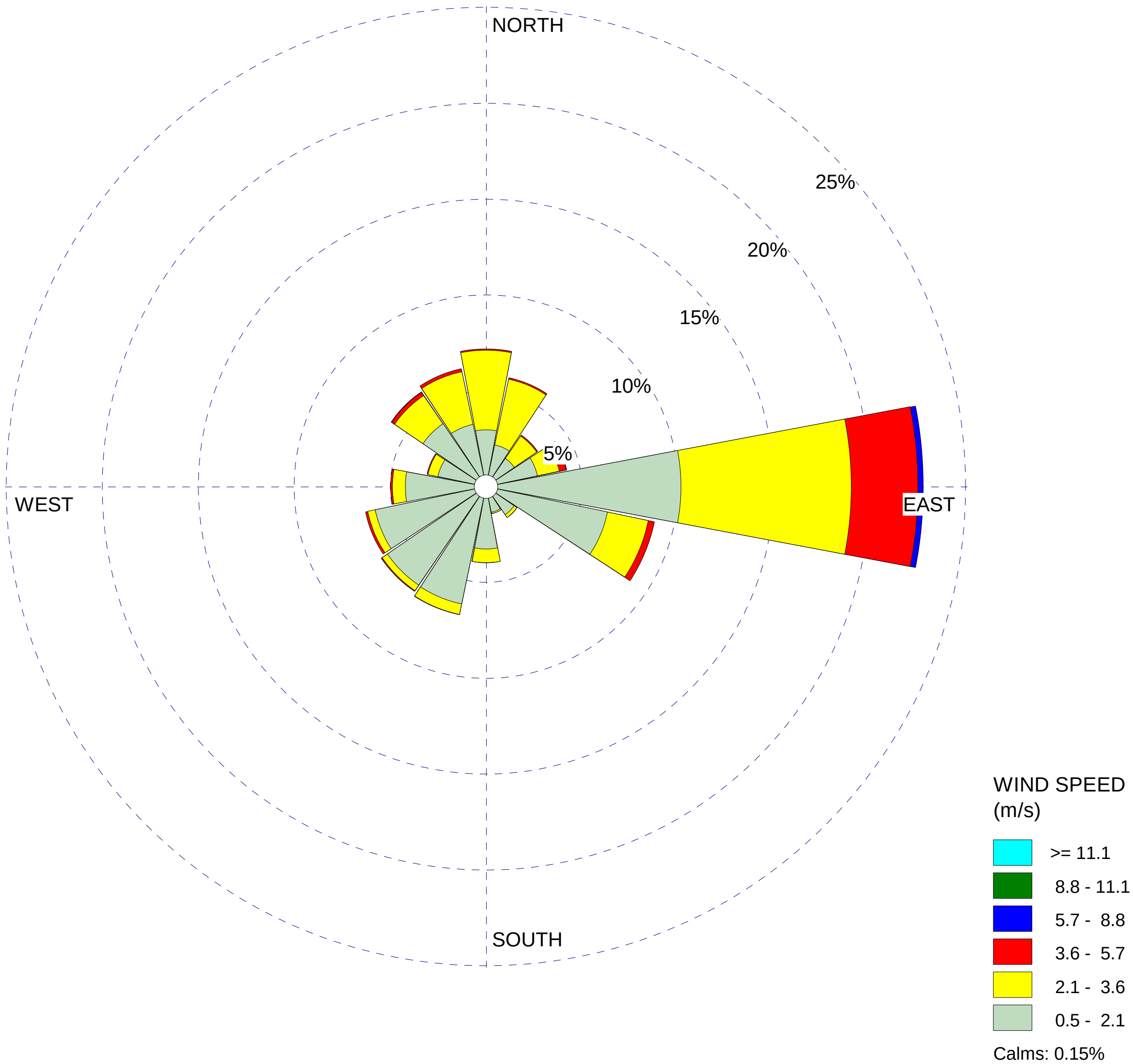
0.90

District	Route	Rte Suf	County	PM Prefix	Postmile	Description	Back Peak Hour	Back Peak Month	Back AADT	Ahead Peak Hour	Ahead Peak Month	Ahead AADT
7	710		LA		4.960	LONG BEACH, BEGIN ROUTE 710, LONG BEACH FREEWAY				4200	53000	51000
7	710		LA		5.459	LONG BEACH, OCEAN BOULEVARD/HARBOR SCENIC DRIVE/PICO AVENUE INTERCHANGE	4200	53000	51000	4700	59000	57000
7	710		LA		6.058	LONG BEACH, SHORELINE DRIVE INTERCHANGE	4700	59000	57000	9600	121000	115000
7	710		LA		6.384	LONG BEACH, ANAHEIM STREET INTERCHANGE	9600	121000	115000	10800	136000	130000
7	710		LA		6.881	LONG BEACH, JCT. RTE. 1, PACIFIC COAST HIGHWAY INTERCHANGE	10800	136000	130000	11200	156000	151000
7	710		LA		7.887	LONG BEACH, WILLOW STREET INTERCHANGE	11200	156000	151000	12600	169000	165000
7	710		LA		9.410	LONG BEACH, JCT. RTE. 405, SAN DIEGO FREEWAY INTERCHANGE	12600	169000	165000	14300	191000	184000
7	710		LA		10.823	LONG BEACH, DEL AMO BOULEVARD INTERCHANGE	14300	191000	184000	14300	193000	186000
7	710		LA		12.012	LONG BEACH, LONG BEACH BOULEVARD INTERCHANGE	14300	193000	186000	14800	203000	194000
7	710		LA		12.970	LONG BEACH, JCT. RTE. 91, ARTESIA FREEWAY INTERCHANGE	14800	203000	194000	17100	222000	218000
7	710		LA		13.945	COMPTON, ALONDRA BOULEVARD INTERCHANGE	17100	222000	218000	17400	229000	225000
7	710		LA	R	15.692	LYNWOOD, JCT. RTE. 105, GLENN ANDERSON FREEWAY INTERCHANGE	17400	229000	225000	17400	237000	232000
7	710		LA		16.986	SOUTH GATE, IMPERIAL HIGHWAY INTERCHANGE	17400	237000	232000	15800	222000	215000
7	710		LA		18.440	SOUTH GATE, FIRESTONE BOULEVARD INTERCHANGE	15800	222000	215000	15100	218000	211000
7	710		LA		19.730	BELL, FLORENCE AVENUE INTERCHANGE	15100	218000	211000	15100	216000	209000
7	710		LA		21.915	BELL, ATLANTIC BOULEVARD INTERCHANGE	15100	216000	209000	16200	228000	221000
7	710		LA		22.452	COMMERCE, WASHINGTON BOULEVARD INTERCHANGE	16200	228000	221000	16600	229000	223000
7	710		LA		23.282	COMMERCE, JCT. RTE. 5, SANTA ANA FREEWAY INTERCHANGE	16600	229000	223000	14500	192000	185000
7	710		LA		23.770	WHITTIER BOULEVARD INTERCHANGE	14500	192000	185000	15800	207000	199000
7	710		LA		24.627	JCT. RTE. 60, POMONA FREEWAY INTERCHANGE	15800	207000	199000	10300	137000	130000
7	710		LA		26.497	MONTEREY PARK, JCT. RTE. 10, SAN BERNARDINO FREEWAY INTERCHANGE	10300	137000	130000	4250	54000	50000
7	710		LA	T	27.475	LOS ANGELES, VALLEY BOULEVARD; TEMPORARY END OF LONG BEACH FREEWAY	4250	54000	50000			
7	710		LA			BREAK IN ROUTE						
7	710		LA	T	30.953	PASADENA, ON PASADENA AVENUE AT COLUMBIA STREET				3000	25500	23000
7	710		LA	T	31.402	PASADENA, ON PASADENA AVENUE SOUTH OF BELLEFONTAINE STREET	3000	25500	23000			
7	710		LA	T		COUPLET--NORTHBOUND--ONE WAY TRAVEL						
7	710		LA	T	31.402	PASADENA, ON PASADENA AVENUE SOUTH OF BELLEFONTAINE STREET				1700	14900	13200
7	710		LA	T	31.474	PASADENA, ON PASADENA AVENUE AT BELLEFONTAINEINE STREET	1700	14900	13200	2100	18300	16200
7	710		LA	T	31.761	PASADENA, ON PASADENA AVENUE AT CALIFORNIA STREET	2100	18300	16200	3300	30000	26000
7	710		LA	T	32.130	PASADENA, ON PASADENA AVENUE AT END OF NORTHBOUND COUPLET	3300	30000	26000			
7	710		LA	T		COUPLET--SOUTHBOUND--ONE WAY TRAVEL						
7	710		LA	T	31.403	PASADENA, ON ST. JOHN AVENUE AT BELLEFONTAINE STREET				1700	14900	13200
7	710		LA	T	31.475	PASADENA, ON ST JOHN AVENUE AT BELLEFONTAINE STREET	1700	14900	13200	2000	17200	15200
7	710		LA	T	31.761	PASADENA, ON ST JOHN AVENUE AT CALIFORNIA STREET	2000	17200	15200	3300	30000	26000
7	710		LA	T	32.080	PASADENA, TEMPORARY BEGIN LONG BEACH FREEWAY	3300	30000	26000			

07-LA-710

P P	POST MILE	P S	DESCRIPTION	2002 ADT	2003 ADT	2004 ADT	2005 ADT	2006 ADT	2007 ADT	2008 ADT	2009 ADT	2010 ADT	2011 ADT
	006.956		NB OFF TO NB PCH (RTE 1)			3200				2500			
	006.958		SEG SB OFF TO SB PCH (RTE 1			6800				6100			
	006.959		SEG SB OFF TO NB PCH (RTE 1			8100				8200			
	007.010		NB ON FROM NB PCH (RTE 1)			7200				6900			
	007.014		SB OFF TO PCH (RTE 1)			15000				14300			
	007.719		NB OFF TO EB WILLOW ST			1550				1700			
	007.728		SB ON FROM EB WILLOW ST			2550				2550			
	007.811		NB ON FROM EB WILLOW ST			5000				5600			
	007.825		SB OFF TO EB WILLOW ST			5700				5400			
	007.945		NB OFF TO WB WILLOW ST			2500				1850			
	007.964		SB ON FROM WB WILLOW ST			1450				1550			
	008.055		SB OFF TO WB WILLOW ST			4300				5600			
	008.061		NB ON FROM WB WILLOW ST			4800				4950			
	009.034		SB ON FR NB RTE 405/WARDLOW			17200				17200			
	009.048		SEG SB OFF TO WARDLOW RD			1350				1300			
	009.143		NB TO 405/710 FROM WARDLOW			32000				34500	41000		
	009.161		DUM NB OFF TO RTE 405			31000				33500	40000		
	009.163		SEG NB ON FROM WARDLOW RD			830					1050		
	009.240		DUM SB ON FROM SB RTE 405	16900		17400		16700		19600			
	009.305		SEG NB OFF TO SB RTE 405			14800				15100			
	009.306		SEG NB OFF TO NB RTE 405			17700				18500			
	009.408		SEG NB/SB OFF TO SB RTE 405			34000				34000			

WIND ROSE PLOT:	DISPLAY:
Long Beach Station **2005-2007**	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	Start Date: 1/1/2005 - 00:00 **End Date: 12/31/2007 - 23:00**		
		MODELER:	
	CALM WINDS: **0.15%**	TOTAL COUNT: **52442 hrs.**	
	AVG. WIND SPEED: **1.83 m/s**	DATE: **3/27/2013**	PROJECT NO.:

Annual Average Concentrations - AERMOD

Based on roadway emission rate of 1 pound per hour

Highest model predicted concentration

		High Point Location		Upwind (ug/m3)		Downwind Concentrations (ug/m3)												
ID	Description	x-coord	y-coord	up-wind15m	upwind-2m	2m	15m	30m	50m	100m	150m	200m	250m	300m	350m	400m	450m	500m
0	Ground level concentrations	388250.8	3742186	28.7	34.3	29.7	26.6	22.9	18.8	12.2	8.71	6.59	5.20	4.23	3.52	2.98	2.57	2.24
0.1	Ground level conc. - cloverleaf	388143.3	3741065.2	15.4	17.7	17.1	15.2	13.4	11.6	8.46	6.56	5.30	4.39	3.72	3.21	2.80	2.48	2.21
1	Soundwall 1000 ft	388294.8	3742086	26.7	32.6	40.7	34.5	30.9	23.1	13.7	11.3	9.18	7.54	6.11	4.88	3.88	3.12	2.57
2	Soundwall 500 ft, 1st 500 ft	388294.8	3742086		39.6	49.7	35.8	30.4	24.0	14.6	10.5	7.99	6.21	4.91	3.96	3.27	2.76	2.38
2b	Soundwall 500 ft, 2nd 500 ft	388250.8	3742136		36.8	35.1	33.3	27.6	22.5	15.4	11.9	9.48	7.44	5.76	4.46	3.51	2.86	2.41
3	Soundwall with 100 ft gaps	388294.8	3742086		34.1	40.6	38.3	31.3	25.1	17.5	12.9	9.53	7.10	5.32	4.10	3.29	2.75	2.37
4	Soundwall, 1.8 m tall	388250.8	3742186		34.3	29.7	26.6	22.9	18.8	12.2	8.71	6.59	5.20	4.23	3.52	2.98	2.57	2.24
5	Cloverleaf, soundwalls-ramps	388143.3	3741165.2		20.3	20.1	18.0	15.1	12.9	9.46	7.34	5.87	4.78	3.96	3.32	2.84	2.47	2.17
6	Cloverleaf, soundwalls-roadway	388143.3	3741115.2		20.7	19.8	17.7	16.1	14.4	10.9	8.44	6.65	5.29	4.24	3.48	2.93	2.53	2.22
7	Fans, 75% fan intake, 3.3 m sep	388310	3742086	18.9	21.4	25.7	25.9	25.1	24.0	18.6	15.6	12.6	9.84	7.43	5.47	4.02	3.03	2.38
8	Fans, 50% fan intake, 3.3 m sep	388294.8	3742086	21.5	25.1	30.7	28.8	27.1	23.7	17.0	14.1	11.4	9.07	6.99	5.27	3.97	3.06	2.45
9	Fans, 25% fan intake, 3.3 m sep	388294.8	3742086	24.1	28.9	35.7	31.6	29.0	23.4	15.3	12.7	10.3	8.31	6.55	5.08	3.93	3.09	2.51
10	Fans, 75% fan intake, 15 m sep	388310	3742086	19.0	21.4	25.9	26.1	25.3	24.1	18.6	15.6	12.6	9.85	7.42	5.46	4.01	3.01	2.37
11	Fans, 50% fan intake, 15 m sep	388294.8	3742086	21.6	25.1	30.8	28.9	27.2	23.8	17.0	14.2	11.5	9.08	6.99	5.27	3.96	3.05	2.44
12	Fans, 25% fan intake, 15 m sep	388294.8	3742086	24.1	28.9	35.7	31.7	29.0	23.5	15.4	12.7	10.3	8.31	6.55	5.07	3.92	3.09	2.51
16	Vegetation, 75% filtered	388235.6	3742186	30.9	23.5	20.5	27.9	24.8	20.0	13.0	9.53	7.33	5.79	4.68	3.85	3.22	2.72	2.34
17	Vegetation, 50% filtered	388235.6	3742186	33.1	29.6	25.4	29.5	25.9	21.0	13.9	10.5	8.19	6.47	5.21	4.25	3.51	2.93	2.47
18	Vegetation, 25% filtered	388250.8	3742086	35.2	36.6	32.1	29.8	27.6	22.8	15.4	11.37	9.07	7.45	6.15	5.06	4.16	3.43	2.84
19	Biofiltration, 50% filter intake	388328.3	3741165.2	9.1	11.3	12.1	9.90	8.44	7.10	5.00	3.80	3.02	2.48	2.08	1.78	1.55	1.36	1.20
20	Biofiltration, 25% filter intake	388328.3	3741165.2	12.3	15.1	15.3	12.7	11.0	9.34	6.69	5.13	4.11	3.39	2.85	2.44	2.13	1.87	1.66
21	Biofiltration, 75% filter intake	388328.3	3741165.2	5.81	7.48	8.93	7.10	5.92	4.87	3.31	2.47	1.94	1.58	1.32	1.12	0.97	0.85	0.75

Concentration Changes

		High Point Location		Upwind (%)		Downwind Concentration Change (%)												
ID	Description	x-coord	y-coord	up-wind15m	upwind-2m	2m	15m	30m	50m	100m	150m	200m	250m	300m	350m	400m	450m	500m
1	Soundwall 1000 ft	388294.8	3742086		-5.1	36.9	29.6	35.2	23.1	12.4	29.9	39.3	45.0	44.5	38.6	30.0	21.6	14.9
2	Soundwall 500 ft, 1st 500 ft	388294.8	3742086		15.3	67.3	34.7	33.2	27.7	19.7	20.9	21.2	19.4	16.1	12.5	9.4	7.4	6.2
2b	Soundwall 500 ft, 2nd 500 ft	388250.8	3742136		7.2	18.3	25.1	20.7	19.8	26.2	36.6	43.8	43.2	36.2	26.6	17.8	11.4	7.5
3	Soundwall with 100 ft gaps	388294.8	3742086		-0.8	36.6	44.2	36.7	33.7	43.7	47.6	44.6	36.5	25.9	16.6	10.3	7.0	5.6
4	Soundwall, 1.8 m tall	388250.8	3742186		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	Cloverleaf, soundwalls-ramps	388143.3	3741165.2		15.0	17.1	18.6	12.3	11.2	11.7	11.8	10.8	8.8	6.2	3.6	1.3	-0.4	-1.6
6	Cloverleaf, soundwalls-roadway	388143.3	3741115.2		16.9	15.4	16.8	19.9	23.9	28.9	28.6	25.7	20.3	14.0	8.4	4.5	2.0	0.6
7	Fans, 75% fan intake, 3.3 m sep	388310	3742086	-33.9	-37.8	-13.5	-2.4	10.0	28.1	52.3	78.8	90.8	89.3	75.8	55.5	34.8	17.8	6.5
8	Fans, 50% fan intake, 3.3 m sep	388294.8	3742086	-24.9	-26.9	3.3	8.3	18.4	26.5	39.0	62.5	73.6	74.6	65.3	49.9	33.2	19.1	9.3
9	Fans, 25% fan intake, 3.3 m sep	388294.8	3742086	-15.8	-16.0	20.1	19.0	26.8	24.8	25.7	46.3	56.5	59.8	55.0	44.3	31.6	20.4	12.1
10	Fans, 75% fan intake, 15 m sep	388310	3742086	-33.7	-37.7	-12.9	-1.8	10.6	28.6	52.7	79.2	91.0	89.4	75.6	55.2	34.2	17.2	5.7
11	Fans, 50% fan intake, 15 m sep	388294.8	3742086	-24.8	-26.8	3.7	8.7	18.8	26.8	39.2	62.8	73.8	74.6	65.3	49.6	32.8	18.6	8.8
12	Fans, 25% fan intake, 15 m sep	388294.8	3742086	-15.8	-16.0	20.3	19.1	27.0	25.0	25.8	46.4	56.5	59.8	54.9	44.1	31.4	20.1	11.9
16	Vegetation, 75% filtered	388235.6	3742186	7.9	-31.7	-31.0	5.0	8.5	6.5	6.4	9.5	11.2	11.4	10.7	9.5	8.0	6.1	4.3
17	Vegetation, 50% filtered	388235.6	3742186	15.6	-13.9	-14.4	10.9	13.1	12.0	14.0	20.6	24.2	24.5	23.2	20.8	17.7	13.9	10.3
18	Vegetation, 25% filtered	388250.8	3742086	22.8	6.6	8.2	12.3	20.8	21.7	26.0	30.6	37.7	43.2	45.4	43.7	39.5	33.4	26.9
19	Biofiltration, 50% filter intake	388328.3	3741165.2	-41.2	-36.2	-29.3	-34.8	-37.1	-38.7	-40.9	-42.1	-42.9	-43.5	-44.1	-44.5	-44.9	-45.2	-45.5
20	Biofiltration, 25% filter intake	388328.3	3741165.2	-20.0	-14.7	-10.7	-16.3	-18.2	-19.4	-20.9	-21.8	-22.4	-23.0	-23.4	-23.8	-24.2	-24.6	-24.9
21	Biofiltration, 75% filter intake	388328.3	3741165.2	-62.3	-57.7	-47.9	-53.2	-55.9	-58.0	-60.8	-62.4	-63.3	-64.1	-64.6	-65.1	-65.4	-65.8	-66.0

3-Story Building Results

Downwash Effects from Building and Sound Wall Addition

Comparing scenario with buildings and sound walls
to ground concentrations with no buildings and no sound walls.
(Model ID 13, Figures 13 and 14)

Upwind 3 Story Building

NORTH	Conc	Difference
Ground	24.9	
1st Floor	16.8	32.69%
2nd Floor	14.2	42.86%
3rd Floor	9.46	62.03%

WEST	Conc	Difference
Ground	18.9	
1st Floor	15.9	15.80%
2nd Floor	13.9	26.48%
3rd Floor	9.93	47.40%

CENTER	Conc	Difference
Ground	25.0	
Roof	11.2	55.09%

EAST	Conc	Difference
Ground	33.7	
1st Floor	21.8	35.28%
2nd Floor	20.9	38.15%
3rd Floor	15.3	54.53%

SOUTH	Conc	Difference
Ground	24.9	
1st Floor	18.2	26.82%
2nd Floor	16.0	35.87%
3rd Floor	11.1	55.54%

Downwind 3 Story Building

NORTH	Conc	Difference
Ground	23.7	
1st Floor	17.2	27.57%
2nd Floor	13.8	41.67%
3rd Floor	10.3	56.60%

WEST	Conc	Difference
Ground	31.8	
1st Floor	23.4	26.55%
2nd Floor	23.5	26.00%
3rd Floor	18.8	40.82%

CENTER	Conc	Difference
Ground	24.0	
Roof	15.4	35.84%

EAST	Conc	Difference
Ground	18.5	
1st Floor	19.6	-6.04%
2nd Floor	17.0	8.25%
3rd Floor	13.1	29.12%

SOUTH	Conc	Difference
Ground	23.9	
1st Floor	20.0	16.06%
2nd Floor	17.0	28.92%
3rd Floor	13.2	44.64%

Comparing Scenario with Buildings and no Soundwalls
to ground concentrations with no buildings and no soundwalls.

Upwind 3 Story Building, No Soundwall

NORTH	Conc	Difference
Ground	24.9	
1st Floor	22.0	11.65%
2nd Floor	21.3	14.61%
3rd Floor	14.2	43.09%

WEST	Conc	Difference
Ground	18.9	
1st Floor	18.9	0.09%
2nd Floor	18.0	4.83%
3rd Floor	13.2	30.12%

CENTER	Conc	Difference
Ground	25.0	
Roof	13.1	47.85%

EAST	Conc	Difference
Ground	33.7	
1st Floor	28.9	14.42%
2nd Floor	28.5	15.61%
3rd Floor	16.6	50.68%

SOUTH	Conc	Difference
Ground	24.9	
1st Floor	21.7	12.94%
2nd Floor	20.6	17.43%
3rd Floor	13.3	46.68%

Downwind 3 Story Building, No Soundwall

NORTH	Conc	Difference
Ground	23.7	
1st Floor	21.4	9.92%
2nd Floor	20.5	13.82%
3rd Floor	11.1	53.20%

WEST	Conc	Difference
Ground	31.8	
1st Floor	31.6	0.65%
2nd Floor	33.5	-5.47%
3rd Floor	19.5	38.59%

CENTER	Conc	Difference
Ground	24.0	
Roof	14.8	38.22%

EAST	Conc	Difference
Ground	18.5	
1st Floor	22.5	-21.60%
2nd Floor	21.2	-14.48%
3rd Floor	13.9	24.64%

SOUTH	Conc	Difference
Ground	23.9	
1st Floor	20.9	12.35%
2nd Floor	19.9	16.46%
3rd Floor	11.3	52.71%

Effects of Sound Wall Addition to Existing Building

Comparing Scenario with Buildings and Soundwalls
to scenario with buildings and no soundwalls.
(Figures 19 and 20)

Upwind 3-Story Building

NORTH	Difference
1st Floor	23.81%
2nd Floor	33.08%
3rd Floor	33.29%

WEST	Difference
1st Floor	15.73%
2nd Floor	22.74%
3rd Floor	24.72%

CENTER	Difference
Roof	13.88%

EAST	Difference
1st Floor	24.38%
2nd Floor	26.70%
3rd Floor	7.79%

SOUTH	Difference
1st Floor	15.95%
2nd Floor	22.34%
3rd Floor	16.63%

Downwind 3-Story Building

NORTH	Difference
1st Floor	19.59%
2nd Floor	32.32%
3rd Floor	7.26%

WEST	Difference
1st Floor	26.06%
2nd Floor	29.84%
3rd Floor	3.64%

CENTER	Difference
Roof	-3.86%

EAST	Difference
1st Floor	12.80%
2nd Floor	19.85%
3rd Floor	5.94%

SOUTH	Difference
1st Floor	4.24%
2nd Floor	14.92%
3rd Floor	-17.08%

5-Story Building Results

Downwash Effects from Building and Sound Wall Additior

Comparing scenario with buildings and sound walls
to ground concentrations with no buildings and no sound walls.
(Model ID 14, Figures 15 and 16)

Upwind 5 Story Building

NORTH	Conc	Difference
Ground	24.9	
1st Floor	17.5	0.30
2nd Floor	15.3	0.39
3rd Floor	10.1	0.59
4th Floor	8.42	0.66
5th Floor	7.39	0.70

WEST	Conc	Difference
Ground	18.9	
1st Floor	14.5	0.23
2nd Floor	12.9	0.31
3rd Floor	8.85	0.53
4th Floor	7.42	0.61
5th Floor	6.47	0.66

CENTER	Conc	Difference
Ground	25.0	
Roof	8.08	0.68

EAST	Conc	Difference
Ground	33.7	
1st Floor	23.1	0.31
2nd Floor	21.3	0.37
3rd Floor	14.3	0.57
4th Floor	12.1	0.64
5th Floor	10.5	0.69

SOUTH	Conc	Difference
Ground	24.9	
1st Floor	17.3	0.30
2nd Floor	15.7	0.37
3rd Floor	10.7	0.57
4th Floor	9.06	0.64
5th Floor	7.99	0.68

Downwind 5 Story Building

NORTH	Conc	Difference
Ground	23.7	
1st Floor	16.8	0.29
2nd Floor	14.1	0.41
3rd Floor	10.2	0.57
4th Floor	8.94	0.62
5th Floor	8.19	0.66

WEST	Conc	Difference
Ground	31.8	
1st Floor	21.2	0.33
2nd Floor	19.9	0.37
3rd Floor	14.5	0.54
4th Floor	12.5	0.61
5th Floor	11.0	0.65

CENTER	Conc	Difference
Ground	24.0	
Roof	8.15	0.66

EAST	Conc	Difference
Ground	18.5	
1st Floor	13.1	0.29
2nd Floor	11.5	0.38
3rd Floor	8.08	0.56
4th Floor	6.97	0.62
5th Floor	6.25	0.66

SOUTH	Conc	Difference
Ground	23.9	
1st Floor	19.5	0.18
2nd Floor	17.9	0.25
3rd Floor	13.8	0.42
4th Floor	11.8	0.50
5th Floor	10.4	0.57

10-Story Building Results

Downwash Effects from Building and Sound Wall Addition

Comparing scenario with buildings and sound walls
to ground concentrations with no buildings and no sound walls.
(Model ID 15, Figures 17 and 18)

Upwind 10 Story Building

NORTH	Conc	Difference
Ground	24.9	
1st Floor	13.9	0.44
2nd Floor	12.9	0.48
3rd Floor	7.69	0.69
4th Floor	6.24	0.75
5th Floor	5.42	0.78
6th Floor	4.95	0.80
7th Floor	4.66	0.81
8th Floor	4.45	0.82
9th Floor	4.28	0.83
10th Floor	4.15	0.83

WEST	Conc	Difference
Ground	18.9	
1st Floor	12.7	0.33
2nd Floor	11.9	0.37
3rd Floor	7.92	0.58
4th Floor	6.72	0.64
5th Floor	5.94	0.69
6th Floor	5.48	0.71
7th Floor	5.16	0.73
8th Floor	4.92	0.74
9th Floor	4.73	0.75
10th Floor	4.57	0.76

CENTER	Conc	Difference
Ground	25.0	
Roof	5.09	0.80

EAST	Conc	Difference
Ground	33.7	
1st Floor	17.0	0.50
2nd Floor	16.3	0.52
3rd Floor	9.17	0.73
4th Floor	7.54	0.78
5th Floor	6.70	0.80
6th Floor	6.20	0.82
7th Floor	5.87	0.83
8th Floor	5.63	0.83
9th Floor	5.43	0.84
10th Floor	5.26	0.84

SOUTH	Conc	Difference
Ground	24.9	
1st Floor	14.3	0.43
2nd Floor	13.3	0.47
3rd Floor	8.23	0.67
4th Floor	6.94	0.72
5th Floor	6.21	0.75
6th Floor	5.77	0.77
7th Floor	5.46	0.78
8th Floor	5.22	0.79
9th Floor	5.02	0.80
10th Floor	4.85	0.81

Downwind 10 Story Building

NORTH	Conc	Difference
Ground	23.7	
1st Floor	12.0	0.49
2nd Floor	11.3	0.53
3rd Floor	6.43	0.73
4th Floor	5.26	0.78
5th Floor	4.70	0.80
6th Floor	4.37	0.82
7th Floor	4.14	0.83
8th Floor	3.96	0.83
9th Floor	3.82	0.84
10th Floor	3.69	0.84

WEST	Conc	Difference
Ground	31.8	
1st Floor	15.5	0.51
2nd Floor	15.4	0.51
3rd Floor	9.00	0.72
4th Floor	7.58	0.76
5th Floor	6.84	0.79
6th Floor	6.37	0.80
7th Floor	6.05	0.81
8th Floor	5.81	0.82
9th Floor	5.60	0.82
10th Floor	5.42	0.83

CENTER	Conc	Difference
Ground	24.0	
Roof	4.91	0.80

EAST	Conc	Difference
Ground	18.5	
1st Floor	11.5	0.38
2nd Floor	10.8	0.42
3rd Floor	7.07	0.62
4th Floor	6.09	0.67
5th Floor	5.53	0.70
6th Floor	5.17	0.72
7th Floor	4.91	0.73
8th Floor	4.69	0.75
9th Floor	4.50	0.76
10th Floor	4.34	0.76

SOUTH	Conc	Difference
Ground	23.9	
1st Floor	16.5	0.31
2nd Floor	15.5	0.35
3rd Floor	10.9	0.54
4th Floor	9.34	0.61
5th Floor	8.37	0.65
6th Floor	7.75	0.68
7th Floor	7.34	0.69
8th Floor	7.06	0.70
9th Floor	6.85	0.71
10th Floor	6.68	0.72