APPENDIX K
Air Quality Study

AIR QUALITY STUDY

FOR THE PROPOSED

MAUI RESEARCH & TECHNOLOGY PARK
MASTER PLAN UPDATE

KIHEI, MAUI, HAWAII

Prepared for:

Maui Research & Technology Partners, LLC

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1.0 SUMMARY

Maui Research & Technology Partners, LLC is proposing a Master
Plan Update for the Maui Research & Technology Park at Kihei,
Maui. The proposed project will consist of two phases which
include a total of up to about 2,000,000 square feet of
commercial and retail space, 1,250 residential units, a 150-room
hotel and a school. This study examines the potential short- and
long-term air quality impacts that could occur as a result of
construction and use of the proposed facilities and suggests
mitigative measures to reduce any potential air quality impacts
where possible and appropriate.

Both federal and state standards have been established to maintain
ambient air quality. At the present time, seven parameters are
regulated including: particulate matter, sulfur dioxide, hydrogen
sulfide, nitrogen dioxide, carbon monoxide, ozone and lead.
Hawaii air quality standards are generally comparable to the
national standards although the state standards for carbon
monoxide are more stringent than the national standards.

Regional and local climate together with the amount and type of
human activity generally dictate the air quality of a given
location. The climate of the project area is very much affected
by its elevation near sea level and by nearby mountains.
Haleakala shelters the area from the northeast trade winds, and
local winds (such as land/sea breezes and upslope/downslope winds)
affect the wind flow in the area much of the time. Temperatures
in the project area are generally very consistent and warm with
average daily temperatures ranging from about 63°F to 86°F. Rain-

fall in the project area is minimal with an average of only about 12 inches per year.

Except for periodic impacts from volcanic emissions (vog) and possibly occasional localized impacts from traffic congestion and local agricultural sources, the present air quality of the project area is believed to be relatively good. There is very little air quality monitoring data from the Department of Health for the project area, but the limited data that are available suggest that concentrations are generally well within state and national air quality standards.

If the proposed project is given the necessary approvals to proceed, it may be inevitable that some short- and/or long-term impacts on air quality will occur either directly or indirectly as a consequence of project construction and use. Short-term impacts from fugitive dust will likely occur during the project construction phases. To a lesser extent, exhaust emissions from stationary and mobile construction equipment, from the disruption of traffic, and from workers' vehicles may also affect air quality during the period of construction. State air pollution control regulations require that there be no visible fugitive dust emissions at the property line. Hence, an effective dust control plan must be implemented to ensure compliance with state regulations. Fugitive dust emissions can be controlled to a large extent by watering of active work areas, using wind screens, keeping adjacent paved roads clean, and by covering of open-bodied trucks. Other dust control measures could include limiting the area that can be disturbed at any given time and/or mulching or chemically stabilizing inactive areas that have been worked. Paving and landscaping of project areas early in the construction schedule will also reduce dust emissions. Monitoring dust at the project boundary during the period of construction could be

considered as a means to evaluate the effectiveness of the project dust control program. Exhaust emissions can be mitigated by moving construction equipment and workers to and from the project site during off-peak traffic hours.

After construction, motor vehicles coming to and from the proposed development will result in a long-term increase in air pollution emissions in the project area. To assess the impact of emissions from these vehicles, a computer modeling study was undertaken to estimate current ambient concentrations of carbon monoxide at intersections in the project vicinity and to predict future levels both with and without the proposed project. During worst-case conditions, model results indicated that present 1-hour and 8-hour carbon monoxide concentrations are well within both the state and the national ambient air quality standards. In the year 2034 without the project, carbon monoxide concentrations were predicted to decrease (improve) somewhat in the project area despite an increase in traffic volumes, and worst-case concentrations should remain well within air quality standards. This is primarily due to the assumed retirement of older motor vehicles with less efficient emission control equipment with the passage of time. With the project in the year 2034 after full build-out and with the mauka collector road, carbon monoxide concentrations compared to the without-project case were projected to be slightly lower (better), and worst-case concentrations should remain well within air quality standards. With or without the project, carbon monoxide concentrations in the project area during the next 20 years will likely decrease (improve) somewhat compared to existing concentrations. Implementing mitigation measures for traffic-related air quality impacts is probably unnecessary and unwarranted.

Depending on the demand levels, long-term impacts on air quality are also possible due to indirect emissions associated with a development's electrical power and solid waste disposal requirements. The estimated electrical power requirement amounts to about 24 megawatts; thus it is not insignificant. Quantitative estimates of these potential impacts were not made, but based on the estimated demand level and assuming that power continues to be derived mostly from fuel oil, sulfur dioxide emissions could increase by about 275 tons per year and nitrogen oxides emissions could increase by about 93 tons per year. Renewable energy sources, if developed, could reduce these emissions substantially. Incorporating energy conservation design features and promoting energy conservation programs within the proposed development could also serve to reduce any associated emissions. Presently, all solid waste on Maui is landfilled, and any associated air pollution emissions are relatively negligible. Nevertheless, promoting conservation and recycling programs within the proposed development could serve to further reduce any associated impacts.

2.0 INTRODUCTION

Maui Research & Technology Partners, LLC is proposing a Master Plan Update for the Maui Research & Technology Park (MRTP) at Kihei on the island of Maui. The 432-acre project site is located in Kihei mauka of Piilani Highway near Lipoa Street (see Figure 1 for project location). Presently, the MRTP is approximately 10 percent built-out with about 175,000 square feet of structures in five buildings with a total of approximately 400 employees. The proposed Master Plan Update will be implemented in two phases. Phase 1 will consist of adding 723,000 square feet of commercial space plus an additional 100,000 square feet of retail space, 750 residential units, a 150-room hotel, and a 102,000 square-foot school. Phase 2 will include an additional 1,000,000 square feet

of commercial space and an additional 500 residential units. Full
build-out of the project is expected to be achieved by 2034.

The purpose of this study is to describe existing air quality in
the project area and to assess the potential short- and long-term
direct and indirect air quality impacts that could result from
construction and use of the proposed facilities as planned.
Measures to mitigate potential project impacts are suggested where
possible and appropriate.

3.0 AMBIENT AIR QUALITY STANDARDS

Ambient concentrations of air pollution are regulated by both
national and state ambient air quality standards (AAQS).
National AAQS are specified in Section 40, Part 50 of the Code of
Federal Regulations (CFR), while State of Hawaii AAQS are defined
in Chapter 11-59 of the Hawaii Administrative Rules. Table 1
summarizes both the national and the state AAQS that are speci-
fied in the cited documents. As indicated in the table, national
and state AAQS have been established for particulate matter,
sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone and
lead. The state has also set a standard for hydrogen sulfide.
National AAQS are stated in terms of both primary and secondary
standards for most of the regulated air pollutants. National
primary standards are designed to protect the public health with
an "adequate margin of safety". National secondary standards, on
the other hand, define levels of air quality necessary to protect
the public welfare from "any known or anticipated adverse effects
of a pollutant". Secondary public welfare impacts may include
such effects as decreased visibility, diminished comfort levels,
or other potential injury to the natural or man-made environment,
e.g., soiling of materials, damage to vegetation or other econom-
ic damage. In contrast to the national AAQS, Hawaii State AAQS

are given in terms of a single standard that is designed "to protect public health and welfare and to prevent the significant deterioration of air quality".

Each of the regulated air pollutants has the potential to create or exacerbate some form of adverse health effect or to produce environmental degradation when present in sufficiently high concentration for prolonged periods of time. The AAQS specify a maximum allowable concentration for a given air pollutant for one or more averaging times to prevent harmful effects. Averaging times vary from one hour to one year depending on the pollutant and type of exposure necessary to cause adverse effects. In the case of the short-term (i.e., 1- to 24-hour) AAQS, both national and state standards allow a specified number of exceedances each year.

The Hawaii AAQS are in some cases considerably more stringent than the comparable national AAQS. In particular, the Hawaii 1-hour AAQS for carbon monoxide is four times more stringent than the comparable national limit.

The national AAQS are reviewed periodically, and multiple revisions have occurred over the past 30 years. In general, the national AAQS have become more stringent with the passage of time and as more information and evidence become available concerning the detrimental effects of air pollution. Changes to the Hawaii AAQS over the past several years have tended to follow revisions to the national AAQS, making several of the Hawaii AAQS the same as the national AAQS.

4.0 REGIONAL AND LOCAL CLIMATOLOGY

Regional and local climatology significantly affect the air quality of a given location. Wind, temperature, atmospheric turbulence, mixing height and rainfall all influence air quality. Although the climate of Hawaii is relatively moderate throughout most of the state, significant differences in these parameters may occur from one location to another. Most differences in regional and local climates within the state are caused by the mountainous topography.

The topography of Maui is dominated by the great volcanic masses of Haleakala (10,023 feet) and the West Maui Mountains (5,788 feet). The island consists entirely of the slopes of these mountains and of a connecting isthmus. Haleakala is still considered to be an active volcano and last erupted about 1790. The project site is located in the isthmus area between the West Maui Mountains and Haleakala at an elevation of about 200 feet.

Maui lies well within the belt of northeasterly trade winds generated by the semi-permanent Pacific high pressure cell to the north and east. Because the project area is located on the leeward side of Haleakala, it is sheltered much of the time from the northeast trade winds. Occasionally, when the trade winds are more northerly, the winds will sweep through the valley between the mountains and into the Kihei area. Local winds such as land/sea breezes and/or upslope/downslope winds also influence the wind pattern for the area. During the daytime, winds can typically be expected to move onshore because of seabreeze and/or upslope effects or because of the aerodynamic cavity caused by the trade winds flowing around Haleakala. At night, winds are often drainage winds that move downslope from Haleakala and out to sea.

During winter, occasional strong winds from the south or southwest occur in association with the passage of winter storm systems.

Air pollution emissions from motor vehicles, the formation of photochemical smog and smoke plume rise all depend in part on air temperature. Colder temperatures tend to result in higher emissions of contaminants from automobiles but lower concentrations of photochemical smog and ground-level concentrations of air pollution from elevated plumes. In Hawaii, the annual and daily variation of temperature depends to a large degree on elevation above sea level, distance inland and exposure to the trade winds. Average temperatures at locations near sea level generally are warmer than those at higher elevations. Areas exposed to the trade winds tend to have the least temperature variation, while inland and leeward areas often have the most. The project site's lower elevation and leeward location results in warmer temperatures compared with many other parts of the island. At Puunene, which is a few miles to the north of the project area and at an elevation of about 130 feet, average daily minimum and maximum temperatures are 63°F and 86°F, respectively [1]. Temperatures at the project site can be expected to be similar to this or slightly cooler due to the slightly higher elevation.

Small scale, random motions in the atmosphere (turbulence) cause air pollutants to be dispersed as a function of distance or time from the point of emission. Turbulence is caused by both mechanical and thermal forces in the atmosphere. It is often measured and described in terms of Pasquill-Gifford stability class. Stability class 1 is the most turbulent and class 6 is the least. Thus, air pollution dissipates the best during stability class 1 conditions and the worst when stability class 6 prevails. In the Pukualani area, stability classes 5 or 6 typically occur during

the nighttime or early morning hours when temperature inversions form due to radiational cooling or to drainage flow from the nearby mountains. Stability classes 1 through 4 occur during the daytime, depending mainly on the amount of cloud cover and incoming solar radiation and the onset and extent of the sea breeze.

Mixing height is defined as the height above the surface through which relatively vigorous vertical mixing occurs. Low mixing heights can result in high ground-level air pollution concentrations because contaminants emitted from or near the surface can become trapped within the mixing layer. In Hawaii, minimum mixing heights tend to be high because of mechanical mixing caused by the trade winds and because of the temperature moderating effect of the surrounding ocean. Low mixing heights may sometimes occur, however, at inland locations and even at times along coastal areas early in the morning following a clear, cool, windless night. Coastal areas also may experience low mixing levels during sea breeze conditions when cooler ocean air rushes in over warmer land. Mixing heights in Hawaii typically are above 3,000 feet (1,000 meters).

Rainfall can have a beneficial effect on the air quality of an area in that it helps to suppress fugitive dust emissions, and it also may "washout" gaseous contaminants that are water soluble. Rainfall in Hawaii is highly variable depending on elevation and on location with respect to the trade wind. The climate of the project area is relatively dry due to the leeward location. Historical records from Kihei show that this area of Maui averages about only 12 inches of precipitation per year with the summer months being the driest [1].

5.0 PRESENT AIR QUALITY

Present air quality in the project area is mostly affected by air pollutants from vehicular, industrial, natural and/or agricultural sources. Table 2 presents an air pollutant emission summary for the island of Maui for calendar year 1993. This is the most recent year for which an island-wide emission inventory is available. The emission rates shown in the table pertain to manmade emissions only, i.e., emissions from natural sources are not included. As suggested in the table, most of the manmade particulate and sulfur oxides emissions on Maui originate from point sources, such as power plants and other fuel-burning industries. Nitrogen oxides emissions are roughly equally divided between point sources and area sources (mostly motor vehicle traffic). The majority of carbon monoxide emissions occur from area sources (motor vehicle traffic and sugar cane burning), while hydrocarbons are emitted mainly from point sources. Emissions today are probably higher than those shown in the table, but the proportional relationships are likely about the same.

The largest sources of air pollution in the immediate project area are most likely agricultural operations and automobile traffic using local roadways. Emissions from these sources consist primarily of particulate, carbon monoxide and nitrogen oxides. Power plants burning diesel fuel are located several miles away. These sources mostly emit sulfur dioxide, nitrogen oxides and particulate. Volcanic emissions from distant natural sources on the Big Island also affect the air quality at times during kona wind conditions. By the time the volcanic emissions reach the project area, they consist mostly of fine particulate sulfate.

The State Department of Health operates a network of air quality monitoring stations at various locations around the state, but

only very limited data are available for Maui Island. The only
air quality data for the project area consists of particulate
measurements collected at Kihei. Table 3 summarizes the data from
the Kihei monitoring station. Annual second-highest 24-hour
PM-10 particulate concentrations (which are most relevant to the
air quality standards) ranged from 60 to 93 μg/m^3 between 2006
and 2008. Average annual concentrations ranged from 20 to
26 μg/m^3. One exceedance of the state standard was recorded
during 2007. This was considered an exceptional event due to a
brush fire nearby. Monitoring of PM-10 at the Kihei monitoring
station was discontinued in 2009.

As indicated in Table 3, PM-2.5 particulate is also monitored at
the Kihei monitoring station. Annual 24-hour 98th percentile
PM-2.5 particulate concentrations (which are most relevant to the
air quality standards) ranged from 10 to 16 μg/m^3 between 2006
and 2010. Average annual concentrations ranged from 4 to
6 μg/m^3. One relatively high value was flagged during 2006 due
to fireworks. No exceedances of the state standard were recorded
during this period.

Given the limited air pollution sources in the area, it is likely
that air pollution concentrations are near natural background
levels most of the time, except possibly for locations adjacent to
agricultural operations or near traffic-congested intersections.
Present concentrations of carbon monoxide in the project area are
estimated later in this study based on computer modeling of motor
vehicle emissions.

6.0 SHORT-TERM IMPACTS OF PROJECT

Short-term direct and indirect impacts on air quality could potentially occur due to project construction. For a project of this nature, there are two potential types of air pollution emissions that could directly result in short-term air quality impacts during project construction: (1) fugitive dust from vehicle movement and soil excavation; and (2) exhaust emissions from on-site construction equipment. Indirectly, there also could be short-term impacts from slow-moving construction equipment traveling to and from the project site, from a temporary increase in local traffic caused by commuting construction workers, and from the disruption of normal traffic flow caused by lane closures of adjacent roadways.

Fugitive dust emissions may arise from the grading and dirt-moving activities associated with site clearing and preparation work. The emission rate for fugitive dust emissions from construction activities is difficult to estimate accurately. This is because of its elusive nature of emission and because the potential for its generation varies greatly depending upon the type of soil at the construction site, the amount and type of dirt-disturbing activity taking place, the moisture content of exposed soil in work areas, and the wind speed. The EPA [2] has provided a rough estimate for uncontrolled fugitive dust emissions from construction activity of 1.2 tons per acre per month under conditions of "medium" activity, moderate soil silt content (30%), and precipitation/evaporation (P/E) index of 50. Uncontrolled fugitive dust emissions at the project site would likely be somewhere near that level, depending on the amount of rainfall that occurs. In any case, State of Hawaii Air Pollution Control Regulations [3] prohibit visible emissions of fugitive dust from

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construction activities at the property line. Thus, an effective dust control plan for the project construction phase is essential.

Adequate fugitive dust control can usually be accomplished by the establishment of a frequent watering program to keep bare-dirt surfaces in construction areas from becoming significant sources of dust. In dust-prone or dust-sensitive areas, other control measures such as limiting the area that can be disturbed at any given time, applying chemical soil stabilizers, mulching and/or using wind screens may be necessary. Control regulations further stipulate that open-bodied trucks be covered at all times when in motion if they are transporting materials that could be blown away. Haul trucks tracking dirt onto paved streets from unpaved areas is often a significant source of dust in construction areas. Some means to alleviate this problem, such as road cleaning or tire washing, may be appropriate. Paving of parking areas and/or establishment of landscaping as early in the construction schedule as possible can also lower the potential for fugitive dust emissions. Monitoring dust at the project property line could be considered to quantify and document the effectiveness of dust control measures.

On-site mobile and stationary construction equipment also will emit air pollutants from engine exhausts. The largest of this equipment is usually diesel-powered. Nitrogen oxides emissions from diesel engines can be relatively high compared to gasoline-powered equipment, but the annual standard for nitrogen dioxide is not likely to be violated by short-term construction equipment emissions. Also, the new short-term (1-hour) standard for nitrogen dioxide is based on a three-year average; thus it is unlikely that relatively short-term construction emissions would

exceed the standard.   Carbon monoxide emissions from diesel
engines are low and should be relatively insignificant compared to
vehicular emissions on nearby roadways.

Project construction activities will also likely obstruct the
normal flow of traffic at times to such an extent that overall
vehicular emissions in the project area will temporarily increase.
The only means to alleviate this problem will be to attempt to
keep roadways open during peak traffic hours and to move heavy
construction equipment and workers to and from construction areas
during periods of low traffic volume.   Thus, most potential short-
term air quality impacts from project construction can be
mitigated.

7.0   LONG-TERM IMPACTS OF PROJECT

7.1   Roadway Traffic

After construction is completed, use of the proposed facilities
will result in increased motor vehicle traffic in the project
area, potentially causing long-term impacts on ambient air
quality.   Motor vehicles with gasoline-powered engines are
significant sources of carbon monoxide.   They also emit nitrogen
oxides and other contaminates.

Federal air pollution control regulations require that new motor
vehicles be equipped with emission control devices that reduce
emissions significantly compared to a few years ago.   In 1990, the
President signed into law the Clean Air Act Amendments.   This
legislation required further emission reductions, which have been
phased in since 1994.   More recently, additional restrictions were
signed into law during the Clinton administration, and these began

to take effect during the past decade. The added restrictions on emissions from new motor vehicles will lower average emissions each year as more and more older vehicles are retired and leave the state's roadways. It is estimated that carbon monoxide emissions, for example, will go down by an average of about 20 percent per vehicle during the next 10 years due to the replacement of older vehicles with newer models.

To evaluate the potential long-term indirect ambient air quality impact of increased roadway traffic associated with a project such as this, computerized emission and atmospheric dispersion models can be used to estimate ambient carbon monoxide concentrations along roadways leading to and from the project. Carbon monoxide is selected for modeling because it is both the most stable and the most abundant of the pollutants generated by motor vehicles. Furthermore, carbon monoxide air pollution is generally considered to be a microscale problem that can be addressed locally to some extent, whereas nitrogen oxides air pollution most often is a regional issue that cannot be addressed by a single new development.

For this project, three scenarios were selected for the carbon monoxide modeling study: (1) year 2011 with present conditions, (2) year 2034 without the project, and (3) year 2034 with the project. To begin the modeling study of the three scenarios, critical receptor areas in the vicinity of the project were identified for analysis. Generally speaking, roadway intersections are the primary concern because of traffic congestion and because of the increase in vehicular emissions associated with traffic queuing. For this study, several of the key intersections identified in the traffic study were also selected for air quality analysis. These included the following five intersections:

- Piilani Highway at East Waipuilani Road
- Piilani Highway at Piikea Avenue
- Piilani Highway at East Lipoa Street
- Piilani Highway at East Welakahao Road (north)
- Piilani Highway at East Welakahao Road (south)

The traffic impact report for the project [4] describes the existing and projected future traffic conditions and laneage configurations of these intersections in detail. In performing the air quality impact analysis, it was assumed that all recommended traffic mitigation measures would be implemented.

The main objective of the modeling study was to estimate maximum 1-hour average carbon monoxide concentrations for each of the three scenarios studied. To evaluate the significance of the estimated concentrations, a comparison of the predicted values for each scenario can be made. Comparison of the estimated values to the national and state AAQS was also used to provide another measure of significance.

Maximum carbon monoxide concentrations typically coincide with peak traffic periods. The traffic impact assessment report evaluated morning and afternoon peak traffic periods. These same periods were evaluated in the air quality impact assessment.

The EPA computer model MOBILE6.2 [5] was used to calculate vehicular carbon monoxide emissions for each year studied. One of the key inputs to MOBILE6.2 is vehicle mix. Unless very detailed information is available, national average values are typically assumed, which is what was used for the present study. Based on

national average vehicle mix figures, the present vehicle mix in the project area was estimated to be 34.3% light-duty gasoline-powered automobiles, 52.8% light-duty gasoline-powered trucks and vans, 3.6% heavy-duty gasoline-powered vehicles, 0.2% light-duty diesel-powered vehicles, 8.6% heavy-duty diesel-powered trucks and buses, and 0.5% motorcycles. For the future scenarios studied, the vehicle mix was estimated to change slightly with fewer light-duty gasoline-powered automobiles and more light-duty gasoline-powered trucks and vans.

Ambient temperatures of 59 and 68 degrees F were used for morning and afternoon peak-hour emission computations, respectively. These are conservative assumptions since morning/afternoon ambient temperatures will generally be warmer than this, and emission estimates given by MOBILE6.2 generally have an inverse relationship to the ambient temperature.

After computing vehicular carbon monoxide emissions through the use of MOBILE6.2, these data were then input to an atmospheric dispersion model. EPA air quality modeling guidelines [6] currently recommend that the computer model CAL3QHC [7] be used to assess carbon monoxide concentrations at roadway intersections, or in areas where its use has previously been established, CALINE4 [8] may be used. Until a few years ago, CALINE4 was used extensively in Hawaii to assess air quality impacts at roadway intersections. In December 1997, the California Department of Transportation recommended that the intersection mode of CALINE4 no longer be used because it was thought the model has become outdated. Studies have shown that CALINE4 may tend to over-predict maximum concentrations in some situations. Therefore, CAL3QHC was used for the subject analysis.

CAL3QHC was developed for the U.S. EPA to simulate vehicular movement, vehicle queuing and atmospheric dispersion of vehicular emissions near roadway intersections. It is designed to predict 1-hour average pollutant concentrations near roadway intersections based on input traffic and emission data, roadway/receptor geometry and meteorological conditions.

Although CAL3QHC is intended primarily for use in assessing atmospheric dispersion near signalized roadway intersections, it can also be used to evaluate unsignalized intersections. This is accomplished by manually estimating queue lengths and then applying the same techniques used by the model for signalized intersections. Currently, only two of the study intersections are signalized: Piilani Highway at Piikea Avenue and Piilani Highway at East Lipoa Street. For the future scenario without the project, in accordance with the traffic report, this was assumed to remain the case. For the future scenario with the project, it was assumed that the intersection of Piilani Highway and East Welakahao Road (south) would also become signalized.

Input peak-hour traffic data were obtained from the traffic study cited previously. This included vehicle approach volumes, saturation capacity estimates, intersection laneage and signal timings (where applicable). All emission factors that were input to CAL3QHC for free-flow traffic on roadways were obtained from MOBILE6.2 based on assumed free-flow vehicle speeds corresponding to the posted speed limits.

Model roadways were set up to reflect roadway geometry, physical dimensions and operating characteristics. Concentrations predicted by air quality models generally are not considered valid

within the roadway-mixing zone. The roadway-mixing zone is usually taken to include 3 meters on either side of the traveled portion of the roadway and the turbulent area within 10 meters of a cross street. Model receptor sites were thus located at the edges of the mixing zones near all intersections that were studied for all three scenarios. This implies that pedestrian sidewalks either already exist or are assumed to exist in the future. All receptor heights were placed at 1.8 meters above ground to simulate levels within the normal human breathing zone.

Input meteorological conditions for this study were defined to provide "worst-case" results. One of the key meteorological inputs is atmospheric stability category. For these analyses, atmospheric stability category 6 was assumed for the morning cases, while atmospheric stability category 4 was assumed for the afternoon cases. These are the most conservative stability categories that are generally used for estimating worst-case pollutant dispersion within suburban areas for these periods. A surface roughness length of 100 cm and a mixing height of 1000 meters were used in all cases. Worst-case wind conditions were defined as a wind speed of 1 meter per second with a wind direction resulting in the highest predicted concentration. Concentration estimates were calculated at wind directions of every 5 degrees.

Existing background concentrations of carbon monoxide in the project vicinity are believed to be at low levels. Thus, background contributions of carbon monoxide from sources or roadways not directly considered in the analysis were accounted for by adding a background concentration of 0.5 ppm to all predicted concentrations for 2011. Although increased traffic is expected to occur within the project area during the next several years with or without the project, background carbon monoxide

concentrations may not change significantly since individual emissions from motor vehicles are forecast to decrease with time. Hence, a background value of 0.5 ppm was assumed to persist for the future scenarios studied.

Predicted Worst-Case 1-Hour Concentrations

Table 4 summarizes the final results of the modeling study in the form of the estimated worst-case 1-hour morning and afternoon ambient carbon monoxide concentrations for 2011 and for each of the two future alternatives that were studied. The locations of these estimated worst-case 1-hour concentrations all occurred at or very near the indicated intersections.

As indicated in the table, the highest estimated worst-case 1-hour concentration for the present (2011) scenario was 4.7 parts per million (ppm), and this occurred during the morning at the intersection of Piilani Highway and Piikea Avenue. Worst-case values for other locations and times ranged from 2.0 to 4.5 ppm. These concentrations are well within both the national AAQS of 35 ppm and the state standard of 9 ppm.

In the year 2034 without the proposed project, the predicted highest worst-case 1-hour concentration occurred during the morning at the intersection of Piilani Highway and East Lipoa Street with a value of 4.6 ppm. Other concentrations for this scenario at other times and locations ranged between 1.6 and 4.5 ppm. Without the project, carbon monoxide concentrations in the year 2034 were predicted to decrease somewhat at most locations in the project area compared to the existing case. Although traffic volumes are expected to be higher than the existing case, this will be offset by the retirement of older motor vehicles with less

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efficient emission control equipment. Worst-case carbon monoxide concentrations should remain well within the state and federal standards for this scenario.

Similar to the 2034 without-project scenario, the highest worst-case concentration with the project in the year 2034 was predicted to occur during the morning at the intersection of Piilani Highway and East Lipoa Street. A worst-case 1-hour concentration of 4.4 ppm was predicted to occur at this location and time. Worst-case concentrations at other locations and times ranged between about 1.5 4.0 ppm. In the year 2034 with the project, carbon monoxide concentrations in the project area were generally predicted to decrease compared to the without project scenario at most of the locations studied, but it should be noted that these two alternatives are not directly comparable. This is because the traffic analysis assumes a mauka collector road for the 2034 with-project case. A mauka collector road is <u>not</u> assumed for the 2034 without-project scenario. The predicted worst-case 1-hour concentrations for the 2034 with-project alternative at all locations studied continued to remain well within both the national and state standards.

Predicted Worst-Case 8-Hour Concentrations

Worst-case 8-hour carbon monoxide concentrations were estimated by multiplying the worst-case 1-hour values by a persistence factor of 0.5. This accounts for two factors: (1) traffic volumes averaged over eight hours are lower than peak 1-hour values, and (2) meteorological conditions are more variable (and hence more favorable for dispersion) over an 8-hour period than they are for a single hour. Based on <u>monitoring</u> data, 1-hour to 8-hour persistence factors for most locations generally vary from 0.4 to 0.8 with 0.6 being the most typical. One recent study based on

modeling [9] concluded that 1-hour to 8-hour persistence factors could typically be expected to range from about 0.4 to 0.5. EPA guidelines [10] recommend using a value of 0.6 to 0.7 unless a locally derived persistence factor is available. Recent monitoring data for Honolulu reported by the Department of Health [11] suggest that this factor may range between about 0.35 and 0.55 depending on location and traffic variability. Considering the location of the project and the traffic pattern for the area, a 1-hour to 8-hour persistence factor of 0.5 will likely yield reasonable estimates of worst-case 8-hour concentrations. However, it should be noted that the 8-hour concentration estimates are generally less reliable than the 1-hour values due to the prediction methodology involved.

The resulting estimated worst-case 8-hour concentrations are indicated in Table 5. For the 2011 scenario, the estimated worst-case 8-hour carbon monoxide concentrations for the study locations ranged from 1.6 to 2.4 ppm, with the highest concentration occurring at the intersection of Piilani Highway and Piikea Avenue. The estimated worst-case concentrations for the existing case were well within both the national limit of 9 ppm and the state standard of 4.4 ppm.

For the 2034 without project scenario in comparison to the existing case, worst-case concentrations generally decreased slightly or remained about the same. Concentrations ranged from 1.4 ppm to 2.3 ppm with the highest concentration occurring at the intersection of Piilani Highway and East Lipoa Street. All predicted 8-hour concentrations for this scenario were well within both the national and the state AAQS.

For the 2034 with-project scenario in comparison to the 2034 without-project case, worst-case concentrations decreased slightly at the intersections studied, but as noted in the table, the with-project case assumes a mauka collector road whereas the without-project case does not. Worst-case concentrations ranged from 1.2 ppm to 2.2 ppm with the highest concentration occurring at the intersection of Piilani Highway and East Lipoa Street. All predicted 8-hour concentrations for this scenario were well within both the national and the state AAQS.

Conservativeness of Estimates

The results of this study reflect several assumptions that were made concerning both traffic movement and worst-case meteorological conditions. One such assumption concerning worst-case meteorological conditions is that a wind speed of 1 meter per second with a steady direction for 1 hour will occur. A steady wind of 1 meter per second blowing from a single direction for an hour is extremely unlikely and may occur only once a year or less. With wind speeds of 2 meters per second, for example, computed carbon monoxide concentrations would be only about half the values given above. The 8-hour estimates are also conservative in that it is unlikely that anyone would occupy the assumed receptor sites (within 3 m of the roadways) for a period of 8 hours.

7.2 Electrical Demand

The proposed project also will cause indirect air pollution emissions from power generating facilities as a consequence of electrical power usage. The peak electrical demand of the project when fully developed is expected to reach about 24 megawatts [12]. Assuming the average demand is approximately one-half the peak demand, the annual electrical demand of the

project will reach approximately 105 million kilowatt-hours. Electrical power for the project will most probably be provided mainly by oil-fired generating facilities, but some of the project power may also be derived from photovoltaic systems, wind power or other alternative energy sources, especially if the state's initiative for renewable energy is realized. In order to meet the electrical power needs of the proposed project, power generating facilities will likely be required to burn more fuel and hence more air pollution will be emitted at these facilities. Given in Table 6 are estimates of the indirect air pollution emissions that would result from the project electrical demand assuming all power is provided by burning more fuel oil at local power plants. These values can be compared to the island-wide emission estimates for 1993 given in Table 2. The estimated indirect emissions from project electrical demand amount to about 4 percent or less of the present air pollution emissions occurring on Maui Island if all power is assumed to be derived from oil.

7.3 Solid Waste Disposal

Solid waste generated by the proposed development when fully completed and occupied is not expected to exceed about 7,785 tons per year assuming a waste diversion rate of 30 percent is achieved [12]. Currently, all solid waste on the island is buried at solid waste landfills. Thus, assuming this continues to be the method for solid waste disposal, the only associated air pollution emissions that will occur will be from trucking the waste to the landfill and burying it. These emissions should be relatively minor.

8.0   CONCLUSIONS AND RECOMMENDATIONS

Existing Conditions

Although very little ambient air quality data are available to
characterize existing conditions, it is likely that state and
federal ambient air quality standards are currently being met in
the project area, except perhaps for occasional exceedances of the
stringent state carbon monoxide standards within small areas near
traffic-congested locations.   Locations adjacent to large-scale
agricultural activities may also be occasionally affected by dust.

Short-Term Impacts and Mitigation

The major potential short-term air quality impact of the project
will occur from the emission of fugitive dust during construction
phases. Uncontrolled fugitive dust emissions from construction
activities are estimated to amount to about 1.2 tons per acre per
month, depending on rainfall.   To control dust, active work areas
and any temporary unpaved work roads should be watered at least
twice daily on days without rainfall. Use of wind screens and/or
limiting the area that is disturbed at any given time will also
help to contain fugitive dust emissions. Wind erosion of inactive
areas of the site that have been disturbed could be controlled by
mulching or by the use of chemical soil stabilizers. Dirt-hauling
trucks should be covered when traveling on roadways to prevent
windage. A routine road cleaning and/or tire washing program will
also help to reduce fugitive dust emissions that may occur as a
result of trucks tracking dirt onto paved roadways in the project
area.   Paving of parking areas and establishment of landscaping
early in the construction schedule will also help to control dust.
Monitoring dust at the project boundary during the period of
construction could be considered as a means to evaluate the

effectiveness of the project dust control program and to adjust the program if necessary.

During construction phases, emissions from engine exhausts (primarily consisting of carbon monoxide and nitrogen oxides) will also occur both from on-site construction equipment and from vehicles used by construction workers and from trucks traveling to and from the project. Increased vehicular emissions due to disruption of traffic by construction equipment and/or commuting construction workers can be alleviated by moving equipment and personnel to the site during off-peak traffic hours.

Long-Term Impacts and Mitigation

After construction of the proposed project is completed and it is fully occupied, carbon monoxide concentrations in the project area should remain nearly unchanged with or without the project compared to the existing case, and worst-case concentrations should remain well within both the state and the national ambient air quality standards. Implementing any air quality mitigation measures for long-term traffic-related impacts is probably unnecessary and unwarranted.

The electrical demand of the project, which is estimated at about 24 megawatts, is not inconsequential compared to the current island-wide electric power generation. Supplying the project with electric power will result in indirect (off site) emissions of air pollution at electric utility facilities. Emissions of sulfur dioxide would be the most significant if most of the power is provided from fuel oil. If the state's goals for renewable energy are achieved, any air pollution emissions from supplying the project with electric power could be substantially reduced.

Nevertheless, indirect emissions from project electrical demand could likely be reduced somewhat by incorporating energy-saving features into project design requirements. This might include the use of solar water heaters; using energy-efficient lighting system; designing building space so that window positions maximize indoor light without unduly increasing indoor heat; using landscaping where feasible to provide afternoon shade to cut down on the use of air conditioning; installation of insulation and double-glazed doors to reduce the effects of the sun and heat; providing movable, controlled openings for ventilation at opportune times; and possibly installing automated room occupancy sensors.
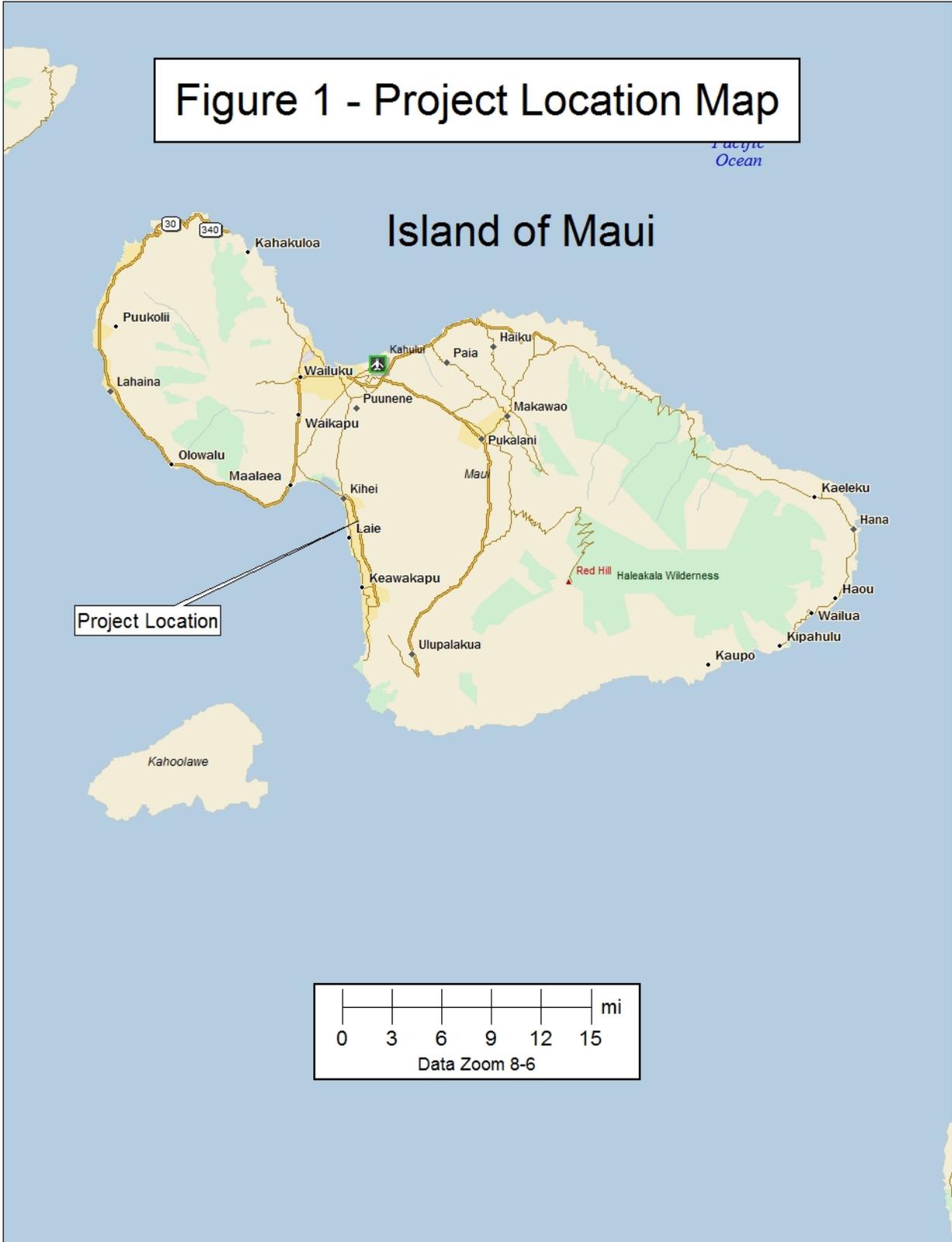
Any long-term impacts on air quality due to indirect emissions from the disposal of solid waste materials generated by the project will likely be small assuming all solid waste on Maui continues to be landfilled. Any solid waste related air pollution could likely be reduced somewhat by the promotion of conservation and recycling programs within the proposed development.

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Figure 1 - Project Location Map

Pacific
Ocean

Island of Maui

30 340

Kahakuloa

Puukolii

Kahului ✈

Haiku

Wailuku

Paia

Lahaina

Puunene

Makawao

Waikapu

Pukalani

Olowalu

Maui

Kaeleku

Maalaea

Kihei

Hana

Laie

Red Hill ▲ Haleakala Wilderness

Keawakapu

Haou

Wailua

Project Location

Kipahulu

Ulupalakua

Kaupo

Kahoolawe

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0    3    6    9    12   15   mi
Data Zoom 8-6
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MN (9.8° E)

Table 1

**SUMMARY OF STATE OF HAWAII AND NATIONAL
AMBIENT AIR QUALITY STANDARDS**

Pollutant	Units	Averaging Time	Maximum Allowable Concentration		
			National Primary	National Secondary	State of Hawaii
Particulate Matter (<10 microns)	$\mu g/m^3$	Annual	–	–	50
		24 Hours	150^a	150^a	150^b
Particulate Matter (<2.5 microns)	$\mu g/m^3$	Annual	15^c	15^c	–
		24 Hours	35^d	35^d	–
Sulfur Dioxide	ppm	Annual	–	–	0.03
		24 Hours	–	–	0.14^b
		3 Hours	–	0.5^b	0.5^b
		1 Hour	0.075^e	–	–
Nitrogen Dioxide	ppm	Annual	0.053	0.053	0.04
		1 Hour	0.100^f	–	–
Carbon Monoxide	ppm	8 Hours	9^b	–	4.4^b
		1 Hour	35^b	–	9^b
Ozone	ppm	8 Hours	0.075^g	0.075^g	0.08^g
Lead	$\mu g/m^3$	3 Months	0.15^h	0.15^h	–
		Quarter	1.5^i	1.5^i	1.5^i
Hydrogen Sulfide	ppm	1 Hour	–	–	0.025^b

[a] Not to be exceeded more than once per year on average over three years.
[b] Not to be exceeded more than once per year.
[c] Three-year average of the weighted annual arithmetic mean.
[d] 98th percentile value of the 24-hour concentrations averaged over three years.
[e] Three-year average of annual fourth-highest daily 1-hour maximum.
[f] 98th percentile value of the daily 1-hour maximum averaged over three years.
[g] Three-year average of annual fourth-highest daily 8-hour maximum.
[h] Rolling 3-month average.
[i] Quarterly average.

Table 2

**AIR POLLUTION EMISSIONS INVENTORY FOR
ISLAND OF MAUI, 1993**

Air Pollutant	Point Sources (tons/year)	Area Sources (tons/year)	Total (tons/year)
Particulate	63,275	7,030	70,305
Sulfur Oxides	6,419	nil	6,419
Nitrogen Oxides	7,312	8,618	15,930
Carbon Monoxide	4,612	20,050	24,662
Hydrocarbons	1,991	234	2,225

Source: Final Report, "Review, Revise and Update of the Hawaii Emissions
Inventory Systems for the State of Hawaii", prepared for Hawaii
Department of Health by J.L. Shoemaker & Associates, Inc.,
1996

Table 3

**ANNUAL SUMMARIES OF AIR QUALITY MEASUREMENTS FOR
MONITORING STATIONS NEAREST MAUI RESEARCH & TECHNOLOGY PARK PROJECT**

Parameter / Location	2006	2007	2008	2009	2010
Particulate (PM-10) / Kihei					
24-Hour Averaging Period:					
No. of Samples	337	326	331	–	–
Highest Concentration ($\mu g/m^3$)	72	281[a]	78	–	–
2nd Highest Concentration ($\mu g/m^3$)	66	93	60	–	–
No. of State AAQS Exceedances	0	1[a]	0	–	–
Annual Average Concentration ($\mu g/m^3$)	22	26	20	–	–
Particulate (PM-2.5) / Kihei					
24-Hour Averaging Period:					
No. of Samples	109	78	58	358	332
Highest Concentration ($\mu g/m^3$)	30[b]	11	16	26	24
98th Percentile Concentration ($\mu g/m^3$)	10	10	15	16	14
No. of State AAQS Exceedances	0	0	0	0	0
Annual Average Concentration ($\mu g/m^3$)	5	5	6	4	5

[a]**Exceptional event (brush fire)**

[b]**Data flagged due to fireworks**

Source: State of Hawaii Department of Health, "Annual Summaries,
Hawaii Air Quality Data, 2006 – 2010"

Table 4

**ESTIMATED WORST-CASE 1-HOUR CARBON MONOXIDE CONCENTRATIONS
ALONG ROADWAYS NEAR MAUI RESEARCH & TECHNOLOGY PARK PROJECT
(parts per million)**

Roadway Intersection	Year/Scenario					
	2011/Present		2034/Without Project		2034/With Project[a]	
	AM	PM	AM	PM	AM	PM
Piilani Highway at East Waipuilani Road	4.2	2.4	4.0	2.1	3.0	1.7
Piilani Highway at Piikea Avenue	4.7	2.9	4.5	2.6	4.0	2.5
Piilani Highway at East Lipoa Street	4.5	2.9	4.6	2.4	4.4	2.7
Piilani Highway at E. Welakahao Rd (North)	3.1	2.0	2.9	1.6	2.5	1.5
Piilani Highway at E. Welakahao Rd (South)	3.3	2.0	2.9	1.6	2.6	1.6

Hawaii State AAQS: 9
National AAQS: 35

[a]Assumes mauka collector road.

Table 5

**ESTIMATED WORST-CASE 8-HOUR CARBON MONOXIDE CONCENTRATIONS
ALONG ROADWAYS NEAR MAUI RESEARCH & TECHNOLOGY PARK PROJECT
(parts per million)**

Roadway Intersection	Year/Scenario		
	2011/Present	2034/Without Project	2034/With Project[a]
Piilani Highway at East Waipuilani Road	2.1	2.0	1.5
Piilani Highway at Piikea Avenue	2.4	2.2	2.0
Piilani Highway at East Lipoa Street	2.2	2.3	2.2
Piilani Highway at E. Welakahao Rd (North)	1.6	1.4	1.2
Piilani Highway at E. Welakahao Rd (South)	1.6	1.4	1.3

Hawaii State AAQS: 4.4
National AAQS: 9

[a]Assumes mauka collector road.

Table 6

**ESTIMATED INDIRECT AIR POLLUTION EMISSIONS FROM
MAUI RESEARCH & TECHNOLOGY PARK ELECTRICAL DEMAND**[a]

Air Pollutant	Emission Rate (tons/year)
Particulate	8
Sulfur Dioxide	275
Carbon Monoxide	20
Nitrogen Oxides	93

[a]Based on U.S. EPA emission factors for utility boilers [2].
Assumes demand of 105 million kw-hrs per year of electrical
power use, 33% energy conversion efficiency and low-sulfur
distillate oil used to generate power.

APPENDIX K-1
Letter from Air Quality Consultant

February 25, 2013

Attn: Mr. Brett Davis
Chris Hart and Partners, Inc.
115 N. Market St.
Wailuku, HI 96793

Subject: Maui Research & Technology Park
            Review of Air Quality Study (Rev. 1)

Dear Mr. Davis:

I have reviewed the Traffic Impact Analysis Report (TIAR) dated February 2013 for the subject project and compared this to the TIAR prepared previously in February 2012. The February 2012 TIAR was the basis for the analysis of traffic-related air quality impacts that we prepared for this project in May 2012. Although the revised TIAR includes additional roadway intersections and additional future scenarios, the expected future traffic volumes with or without the project have not changed significantly. Hence, although the air quality study for this project has not been revised to specifically reflect the revised TIAR, based on the relatively small differences in the expected traffic volumes, it is unlikely that the air quality results and conclusions would change significantly. That is, we would expect that carbon monoxide concentrations along roadways in the project area will remain well within state and federal ambient air quality standards with or without the project at least through the year 2034.

Based on my review of the updated traffic study dated February 2013, it is my professional opinion that further air quality analysis for this project is unnecessary because it is unlikely that the air quality results and conclusions would change significantly. Please call me if you would like to discuss this matter further.

                            Very truly yours,

                            Barry D. Neal
                            Certified Consulting
                            Meteorologist