REPORT

ADDENDUM TO INITIAL APPLICATION FOR A COVERED SOURCE PERMIT TRADEWINDS O'OKALA VENEER MILL

PREPARED FOR:

HAWAII DEPARTMENT OF HEALTH
CLEAN AIR BRANCH

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ADDENDUM TO INITIAL APPLICATION FOR A COVERED SOURCE PERMIT: TRADEWINDS O'OKALA VENEER MILL

Prepared for

Hawaii Department of Health
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SECTION 1 OVERVIEW OF THIS ADDENDUM

This Addendum to the Tradewinds application presents revised project emissions estimates, a revised air quality impacts evaluation, a health risk analysis related to project hazardous air pollutants and proposed permit emission limits for the proposed O'okala Mill. This information supplements, and in some cases, replaces data presented in the Revised Covered Source Permit Application that was submitted to Hawaii DOH in November, 2006. Specific elements of this Addendum include:

- Substitution of biodiesel fuel for diesel as the starter and backup fuel for the cogeneration boiler;
- Relocation of some mill equipment on the project site;
- Operational emission limits that would be accepted by Tradewinds as permit conditions;
- Revised emissions estimates for criteria and hazardous air pollutants reflecting these operational limits;
- Additional air dispersion modeling to reflect revised annual criteria pollutant emission rates from the dryer and changes in the location of some mill equipment; and
- Health risk calculations for the project's hazardous air pollutant emissions (not provided in the November 2006Application.

The following sections discuss each of these topics individually.

SECTION 2 USE OF BIODIESEL AS A BOILER STARTER AND BACKUP FUEL

In the November, 2006 application to DOH, emissions from the cogeneration boiler were calculated based on the following assumptions:

1. Diesel fuel oil with a maximum sulfur content of 0.4% by weight would be used for up to 264 hours per year (about 3% of the time) to support boiler startup operations and for rare periods when wood fuel may temporarily be unavailable.
2. An annual emissions limitation that corresponds to an 89% capacity factor of boiler for the remainder of the year.

In recent months, it has become increasingly likely that biodiesel produced in Hawaii will be available to meet the O'okala Mill boiler startup/backup fuel requirements. Tradewinds will commit to the use of biodiesel, if commercially available. In order to protect against possible periods of non-availability, Tradewinds will accept a condition limiting diesel fuel use to no more than 1% of the time (88 hours per year) to be stated in allowable gallons of diesel fuel per year. Tradewinds understands that current DOH policy is to represent biodiesel emissions of criteria pollutants using diesel emission factors, with the exception that NO_x emissions are assumed to be 15% higher for biodiesel. Since boiler emissions on biodiesel fuel are the same or higher than the corresponding levels for diesel, we have recalculated the boiler's annual criteria pollutant emissions based on assumed biodiesel use for 264 hours per year, as shown in Table 1 below. Emissions will be less if diesel is used during some of those hours. Note that the calculation of emissions on biodiesel assumes a slightly lower fuel energy content (130,000 Btu/gallon versus 140,000 Btu/gallon for diesel).

Biodiesel typically has extremely low sulfur content and can usually meet the 2006 EPA requirements for ultra-low sulfur fuel. However, in order to retain the ability to use some diesel fuel, emissions for SO_2 have been conservatively calculated assuming 264 hours per year of 0.4% sulfur diesel oil usage, although diesel usage actually would not exceed 88 hours per year.

SECTION 3 CHANGES TO MILL PHYSICAL LAYOUT

Proposed changes to the O'okala Mill physical layout that have occurred since submittal of the November 2006 Application to DOH are listed below:

- Move Cooling Tower from the northwest area of property to the northeast;
- Refine the Boiler Building from one building to three separate structures, including Boiler Building, Boiler ESP Building, and Steam Turbine Building;
- Move Boiler stack a few meters to the northwest to align with the ESP structure;
- Split Main Mill Building into two discrete areas (Main Mill Building and Dry End Main Mill Building);
- Revise Fuel Bin Building to reflect that it is a covered area without walls; and
- Remove Chop Saw Building and replace with new Merchandiser Building.

The effects of these changes can be seen by comparing Figure 1 (of this submittal) with the site plan in Figure 1-2 of the November 2006 application. Only the cooling tower location has changed by more than a few feet and its estimated emissions of PM_{10} are unchanged compared with the previous Application. The minor changes that have occurred in the locations of other mill emission sources and in the relationships between stack sources and other mill structures are sufficient to warrant revised air quality dispersion modeling. The results of the remodeling analysis are presented in Section 6 of this Addendum.

SECTION 4 PROPOSED EMISSIONS LIMITATIONS

4.1 PROPOSED ANNUAL VENEER DRYER EMISSION LIMITS

In response to requests from DOH on the November 2006 application regarding proposed operational limits for the veneer dryer, Tradewinds requests the following operating emissions limit for the veneer dryer:

- PM_{10} emissions of 5.00 tons per year
- VOC emissions of 12.42 tons per year

As shown in Table 2, these annual emission limits were derived based on an annual throughput of 90,000 thousand square feet of veneer production (3/8" thickness basis) and the emission factors presented in the table for PM_{10} and VOC. While 83,000 thousand square feet of veneer is the anticipated production, emissions based on the slightly higher production of 90,000 thousand square feet will allow for some operating flexibility to account for variability in the wood moisture and size of the logs being harvested (maximum hourly dryer emissions are not expected to increase above the levels in the November 2006 Application). Since the dryer is designed to use the heat of steam generated by the cogeneration boiler (indirect dryer), there is no additional fuel consumption associated with dryer operation and there are no dryer emissions of NO_x, CO or SO_2. However in anticipation that actual emission rates will be significantly lower, Tradewinds requests that the DOH permit use total annual PM_{10} and VOC emissions as the basis for limiting veneer dryer operations. Dryer source tests will be used to demonstrate actual emissions per unit of throughput (lb/MSf3/8") for each of these pollutants. These source test results will be used along with actual annual veneer production (MSf3/8") to demonstrate compliance with the proposed annual emission limits.

Tradewinds proposes to demonstrate compliance with these pollutant emission limits based on initial source testing results following facility startup and measured annual veneer production (MSF ⅜" per year).

4.2 PROPOSED ANNUAL COGENERATION BOILER EMISSION LIMITS

Tradewinds also proposes that the DOH permit limit annual criteria pollutant emissions from the cogeneration boiler to the values shown in Table 1, as repeated below:

NO_x:	117.98 tons per year
CO:	153.25 tons per year
VOC:	8.52 tons per year
SO_2:	19.09 tons per year
PM_{10}:	12.72 tons per year

Tradewinds proposes to demonstrate compliance with these pollutant emission limits as the product of annual source testing results (lb/MMBtu) and measured annual fuel usage (MMBtu/year).

SECTION 5 REVISED HAP EMISSIONS ESTIMATES

DOH has advised Tradewinds that emissions of HAP from the cogeneration boiler and dryer will be evaluated based on conservative AP-42 emission factors. As described in the November 2006 application, Tradewinds believes that the AP-42 factors significantly overstate emissions for some that will be emitted by the O'okala Mill, because the AP-42 factors are based on source tests that were conducted on units burning treated woods, rather than the clean woods which will be used in veneer manufacturing. DOH has informed Tradewinds that emission factors lower than those provided by AP-42 can be proposed for individual HAPs, provided that Tradewinds is willing to accept permit conditions requiring verification of the lower factors by means of initial source testing of the operational mill after startup.

Accordingly, lower emission rates are hereby proposed by Tradewinds for two HAP which we believe to be represented by unreasonably high emission factors in AP-42. The specific pollutants in question are hydrogen chloride and acrolein, both of which will be emitted only by the cogeneration boiler. The detailed reasons for concluding that emissions of these chemicals are overpredicted by the AP-42 factors are stated in the November 2006 Application. However, the general thrust of the argument is that most of the source tests used in deriving the AP-42 factors for these pollutant were conducted on boilers that either definitely were or may have been burning woods that had been treated by various paints, resins and other chemicals that would be expected to increase the emission rates for hydrogen chloride and acrolein.

Tradewinds will accept a condition limiting emissions of these compounds to 0.008 lb/MMBtu for hydrogen chloride and 0.0026 lb/MMBtu for acrolein, as indicated in Table 3 (bolded values). Compliance with these limits will be demonstrated by initial source tests following facility startup. However, as stated previously, we believe strongly that the AP-42 factors for these pollutants are based on source test results from boilers burning fuels that would be expected to cause much higher emissions of these pollutants than the clean wood fuels that will be combusted in the O'okala cogeneration boiler. Therefore, we request that the permit condition be worded to allow the source testing for hydrogen chloride and acrolein to be discontinued after this difference has been demonstrated by an initial period of source tests.

The proposed hydrogen chloride emission factor of 0.008 lb/MMBtu is just under half the AP-42 factor of 0.019 lb/MMBtu, but still almost 12 times greater than the standard industry emission factor of 0.00067 that was developed by NCASI from source tests conducted on actual forest products industry boilers burning clean wood fuels. Therefore, Tradewinds is confident that source tests will confirm that the actual hydrogen chloride emission rate from the O'okala boiler will be even lower than the value proposed here.

The proposed emission factor of 0.008 lb/MMBtu has been selected to avoid artificially putting the O'okala Mill into the category of a Major Source of HAPs, which is defined as 10 tons of any individual HAP or 25 tons of all HAPs combined. With the substitution of the hydrogen chloride factor, the project's HAP emissions are well below the Major Source Thresholds (see Table 4).

The proposed emission factor for acrolein of 0.0026 lb/MMBtu was selected just below the value that would trigger calculation of a "significant concentration" of this compound, as this term is used in HAR

60.1-179. The calculations presented in Section 7 of this Addendum demonstrate that the health risk resulting from acrolein emissions at the proposed level are below the significance criterion used by DOH. While the proposed factor for this pollutant is 35% below the AP-42 factor, it is still more than 33 times higher than the corresponding standard emission factor that was developed by NCASI from source tests conducted on actual forest products industry boilers burning clean wood fuels. Therefore Tradewinds is confident that initial source test results will confirm that the actual acrolein emission rate from the O'okala boiler will be even lower than the value proposed here.

The emissions estimates for all other HAPs listed in Table 3 are based on AP-42 factors. Annual HAP emissions estimates were obtained by multiplying these emission factors by expected facility throughput levels (see Table 4). These data illustrate that the O'okala Mill will not be a Major Source of HAPs (defined as at least 10 tons per year of any individual HAP or 25 tons per year of all HAPs combined). The HAP emissions in Table 3 were used in the health risk assessment calculations that are presented in Section 7 of this Addendum.

SECTION 6 REVISED AIR DISPERSION MODELING

Section 3 of this Addendum provides a list of the relatively minor changes to the proposed layout of mill facilities that have occurred since the November 2006 submittal of the Tradewinds application to DOH (see also Figure 1). In addition, Sections 4 and 5 present revised emissions data to reflect the use of biodiesel as a backup fuel for the boiler and a proposed increased throughput for the dryer. This section presents the methods and results of a revised air dispersion modeling analysis that has been conducted to capture the effects of these changes on the O'okala Mill's maximum criteria pollutant impacts.

Table 5 shows the revised boiler and cooling tower stack location coordinates (changes from values in the November 2006 application are shown in bold italics).

The revised analysis follows the same screening modeling methodology that was used in the November 2006 Application. The same model version of ISCPrime and BPIP-Prime were employed. Again, the analysis is extremely conservative, using screening meteorological input data. As discussed in Sections 4 and 5 of this Addendum, certain criteria pollutant emission rates for individual sources have undergone slight changes since the November 2006 submittal, and these changes are reflected in this remodeling analysis. However, for dispersion modeling purposes, only the annual emissions of NO_x from the boiler and the annual emissions of PM_{10} from the dryer have actually been affected by these changes. Other source parameters (stack heights and diameters, exit velocities and temperatures) are unchanged from previously submitted data.

The relocations of some sources also change the relationship of the stacks to Mill structures, which will change the aerodynamic downwash effect by which stack emission plumes may be brought rapidly to ground level in the low pressure area immediately downwind of buildings, tanks and other large structures. The changes made to the sources and buildings in this modeling revision appear to have improved the downwash effects for the boiler stack, since maximum predicted impacts for pollutants emitted by the boiler (e.g., NO_2 and CO) are lower than the values presented in the November 2006 Application. Table 6 shows the revised impact results. Except for PM_{10} impacts (the highest of which are dominated by the dryer stack emissions), the predicted maximum impacts were reduced by approximately 25 to 30 percent for each pollutant and averaging period relative to the November 2006 results. The maximum impact location for these pollutants also moved approximately 1000 feet to the south (as compared to the previous maximum impacts), which is further evidence of the reduction in downwash effects for the boiler with the revised mill configuration.

Maximum impacts for PM_{10} are dominated by the dryer emissions. The dryer stack did not change in this model revision; however, the mill building layouts were revised, which had an effect on the downwash for this source. In this case, the modeled maximum impacts for PM_{10} increased compared with the previous modeling results. The maximum PM_{10} impact also moved closer to the plant, to a location approximately 1000 feet east northeast from the dryer (now at the fence line). The maximum predicted concentrations still meet applicable standards, as shown in Table 6.

The conservative screening modeling approach used for criteria pollutants demonstrate that facility emissions will not cause federal or Hawaii ambient air quality standards to be exceeded. According to standard procedures, no further modeling (i.e., with real meteorological measurements) is necessary to demonstrate compliance. As DOH is aware, the facility's actual ambient air impacts are very likely to be much less than the levels that have been predicted by the screening approach.

In order to provide more realistic estimates of the magnitudes and locations of maximum pollutant concentrations due O'okala Mill, a separate set of ISCPrime model simulations was conducted using wind speed/wind direction data collected at Haina about 15 miles northwest from O'okala. The representativeness of the Haina data for conditions at the Tradewinds site is discussed in Section 7. Results of the supplemental modeling are presented in Appendix A.

SECTION 7 HEALTH RISK ASSESSMENT

Overview of Health Risk Assessment

Subchapter 9, Rule 60.1-179 of the Hawaii Administration Rules states that DOH may request an evaluation of potential health risk impacts for a new stationary source that will emit HAPs. Although, not yet formally requested by DOH, Tradewinds has completed a health risk analysis consistent with Rule 60.1-179 in order to avoid possible delays in permit processing. This section describes the methods used to conduct the health risk calculations and presents the results for comparison with applicable significance criteria.

Appendix B presents the Protocol that was provided by DOH to guide the execution of the health risk assessment. Rule 60.1-179 exempts pollutants for which the total facility emissions are below 0.1 lb/hour. Table 7 lists the HAPs that may be emitted by the O'okala cogeneration boiler and dryer. The right hand column in this table contains checkmarks for those pollutants with estimated facility-wide hourly emissions exceeding 0.1 lb/hr, based on the HAP emission factors and operating assumptions described in Section 5.

The Protocol in Appendix B outlines different modeling and analysis requirements for each of three separate groups of HAPs. These pollutant groups and the 11 compounds identified in Table 7 as having maximum potential facility-wide emissions above 0.1 lb/hour are listed in Table 8.

Separate dispersion model simulations were conducted for the health risk analyses. The averaging times for which predicted concentrations were modeled were dictated by the Protocol in Appendix B. Specifically, 8-hour concentrations were determined by modeling for comparison with the (TLV-TWA)/100 significant concentrations for the pollutants in Group 1 and annual concentrations were determined for comparison with the (TLV-TWA)/420 significant concentrations (Group 1 pollutants) and for evaluating compliance with the Hazard Indices for Group 2 pollutant and the allowable cancer risk levels for Group 3 pollutants.

Meteorological Data for Health Risk Modeling

Since the submittal of the November 2006 Application to DOH, Tradewinds has come into possession of a data set consisting of hourly wind speed and direction data for a period covering January 2001 through February 2002 in the town of Haina, approximately 15 miles northwest and further up the coast from O'okala. This data set is from post-construction monitoring of meteorological and air quality parameters that was required by the conditions of the DOH permit for Hamakua Energy Partners (HEP). A formal monitoring plan for this activity was generated by HEP and an audit confirming the accuracy of the resulting data was conducted in February 2002 by RTP Environmental Associates and documented after the end of the monitoring period in a Final Data Report submitted to DOH (July 2002). Tradewinds will provide a copy of this report upon request. Thus, the resulting wind speed and direction data can be considered valid.

The wind data at Haina are also considered to be very representative of wind conditions at O'okala for several reasons:

- As shown in Figure 2 the orientation of the coastline is virtually identical in both locations.
- As also shown in Figure 2, the location of the power plant site relative to rising terrain within the town of Haina toward the south and southwest is also very similar to the O'okala site.
- Daytime and nighttime wind patterns on the Island of Hawaii were documented by the University of Hawaii (UH) by means of mobile meteorological monitoring during an intensive 45 day measurement period. The UH results presented in Figure 3 showed that typical flows during the daytime and nighttime are essentially the same in both locations (O'okala and Haina).

Thus, Tradewinds wishes to use the Haina wind data in the modeling to support the health risk assessment calculations in this section.

The Haina data set received from HEP includes wind speed and direction. Development of a modeling input data set requires additional information on ambient temperature, atmospheric stability category and mixing height, which were not measured by HEP at Haina. Two approaches exist for supplementing the Haina data to create a complete modeling data set. One approach would be to merge the Haina wind data with concurrent temperature, atmospheric stability and mixing depth data from another location such as the National Weather Service station at Hilo airport. The second approach would be to use conservative screening values for temperature, atmospheric stability and mixing height. In a recent telephone conversation with DOH air permitting staff, Tradewinds was advised not to combine the Haina wind data with concurrent Hilo airport data. Thus, Tradewinds decided to conduct the health risk assessment modeling using the Haina wind data in conjunction with the same default temperature and mixing height values that were used in the screening modeling for criteria pollutants (see Section 6). In addition, a decision was made to assign the stability class corresponding to the maximum predicted concentrations from the criteria pollutant screening runs (i.e., Pasquill-Gifford Class F/very stable) to every hour of the one-year wind data record. Modeling with the one-year Haina wind data confirmed that the assumed persistence of Class F stability resulted in higher predicted impacts than would result from assuming any other stability category. This approach allows the true directional variability of wind direction and speed in the project area to be included in the modeling in order to more realistically estimate health risks. While the combined Haina/screening meteorological data set is less conservative than the screening approach used for criteria pollutants, its use retains ensures a high degree of continuing conservatism in the modeling to evaluate health risk impacts. The facility's actual health risk impacts are very likely to be much less than indicated by the model results presented in this addendum.

Modeling Methodology

For the pollutants emitted only by the boiler, it was only necessary to make one model run for the 8-hour and annual averaging periods, because the predicted maximum concentrations of individual pollutants scale linearly on their respective emission rates. Accordingly, a single ISCPrime model run was made with a unit emission rate for the boiler (1 lb/hour), and the maximum predicted 8-hour and annual average concentrations values from this model run have been linearly scaled by the boiler emission rates for each boiler pollutant to obtain the corresponding 8-hour and annual average impacts. The same procedure was followed to estimate the maximum concentrations of pollutants that are emitted only by the veneer dryer. However separate model runs were made to evaluate the combined contributions of pollutants that are emitted by both the boiler and dryer, since the linear relationship between source strength and predicted concentration is not valid for those HAPs. Only the carcinogenic HAPs acetaldehyde and formaldehyde fall into this latter category.

Health Risk Results

The results of the health risk calculations are presented in Tables 9, 10 and 11. These tables contain the actual calculations required by the DOH Protocol for the three Pollutant Groups. Maximum concentrations of individual HAPs are obtained from the model results as described in the previous paragraph, and these values are used to determine whether the health risk tests indicated for Group 1, Group 2 and Group 3 pollutants are met by the proposed facility. The principal findings of the analysis are summarized below:

Table 9 - The maximum 8-hour concentrations for all HAPs except acrolein are below the corresponding TLV-TWA values divided by 100. As shown on the right side of the table, reducing the cogeneration boiler acrolein emission factor from the AP-42 value of 0.004 lb/MMBtu to 0.0026 lb/MMBtu will be sufficient to reduce the 8-hour concentration to an acceptable level. The fact that the reduced emission factor is still well above standard industry data for clean wood combustion is the basis for the Tradewinds acceptance of this emission factor as a permit condition and the responsibility to verify compliance by means of source testing. The maximum annual average concentrations for all Group 1 pollutants are below the corresponding TLV-TWA values divided by 420, thereby demonstrating that the potential health risk is lower than the level required by HAR §11-60.1-179(a) & (b), and is therefore an acceptable level.

Table 10 - The Hazard Index determined by summing the predicted maximum annual average concentrations for all Group 2 pollutants divided by their respective EPA Region IX Preliminary Remediation Goal (PRG) concentrations is 0.625, which is less than the significance level of 1.0. Note that the predicted annual concentration for hydrogen chloride is based on an emission factor of 0.008 lb/MMBtu. As described in Section 5, Tradewinds will accept a condition to limit emissions of this pollutant to this level, with the understanding that verification of compliance by initial source testing will be required.

Table 11 - The Cancer Risk determined by summing the predicted maximum annual average concentrations for all Group 3 pollutants divided by their respective PRG values and multiplying by 1.0E-06 is 5.65E-06, or 5.65 in a million, less than the significance level of 10 in a million.

Thus by accepting conditions requiring boiler emissions to meet the reduced limits for acrolein and hydrogen chloride described above, Tradewinds will be assured that the maximum health risks associated with the O'okala Mill's operation will be below the significance levels specified in HAR 60.1-179.

SECTION 8 GREENHOUSE GAS EMISSIONS OF THE O'OKALA MILL

The O'okala cogeneration boiler will primarily burn biomass fuel, i.e., wood from trees grown locally. Such units are widely regarded by regulatory bodies as being carbon neutral, because all of the carbon contained in the wood fuel and released by its combustion will have been acquired directly from the atmosphere over the previous few years. Therefore, the net boiler production of carbon dioxide (CO_2) is zero.

Moreover, as a solid wood mill producing 41,000 tons of dry carbon-based material annually, the mill will effectively be sequestering approximately 17,000 tons per year of carbon, (based on 8% moisture content and carbon content of 45% of bone dry wood mass) for as long as the structures built with the mill's products remain standing.

Table 1
Revised Maximum Criteria Pollutant Emissions from Cogeneration Boiler

Pollutant	Vendor Guarantee Wood Fuel (lb/MMBtu)	Vendor Guarantee Oil Fuel (lb/MMBtu)	Boiler Emission Rate Wood Fuel (lb/hr)	Boiler Emission Rate Oil Fuel (lb/hr)	Annual Boiler Emissions - Both Fuels (tons per year)
NO_x	0.230	0.196	30.45	21.65	117.98
CO	0.305	0.040	40.38	4.43	153.25
VOC	0.017	0.001	2.25	0.11	8.52
SO_2	0.025	0.450	3.31	49.85	19.09
PM_{10}	0.025	0.014	3.31	1.55	12.72

[a] Boiler NO_x, CO, SO_2 and PM_{10} emission factors for wood and oil fuel firing based on vendor guarantees, with post-combustion electrostatic precipitator to control PM_{10} emissions to the indicated levels. Per DOH policy, NOx emissions for biodiesel fuel are estimated to be 15% higher than the vendor data for distillate oil fuel

[b] Assumed oil sulfur content of 0.40 percent by weight for diesel fuel oil Biodiesel fuel sulfur would be considerably less.

[c] Based on vendor information, the boiler's rated fuel input energy capacity rated at 132.37 MMBtu/hr on wood fuel and 110.78 MMBtu/hr on oil fuel (diesel or biodiesel).

[d] Maximum annual emissions assume 7825 hours of boiler operation, including up to 264 hours on biodiesel fuel at 100% load.

[e.] Assumed biodiesel energy content of 130,000 Btu/gallon

Table 2
Maximum Veneer Dryer VOC and Particulate Emissions

Pollutant	Dryer Heating Zones Emission Factor (lb/Msf$^{3/8}$")	Dryer Cooling Section Emission Factor (lb/Msf$^{3/8}$")	Annual Veneer Throughput (Msf$^{3/8}$")	Annual emissions (lb/year) [a]	Annual emissions (ton/year) [a]
VOC	0.016 [b]	0.26	90,000	24,840	12.42
PM_{10}	0.111 [c]	0	90,000	9,990	5.00

[a] Total dryer emissions are estimated as the sum of emissions in the heating zones and cooling section.

[b] From AP-42c From AP-42

[c] Derived in text presented in November 2006 Covered Source Permit Application. According to Raute, the dryer manufacturer, virtually all of the PM_{10} emissions are released through the stack on the hot side of the dryer.

Table 3
Emission Factors Utilized for Calculation of O'okala Mill HAP Emissions

HAP	Emission Factors				
	Boiler (fired on wood fuel) (lb/MMBtu)	Boiler fired on diesel or bio-diesel (lb/10^3Gallon)	Boiler fired on diesel or bio-diesel (lb/MMBtu)	Dryer (Heated Zones) (lb/MSF ⅜)	Dryer (Cooling Section) (lb/MSF ⅜)
Acetaldehyde	8.30E-04			4.30E-03	3.20E-02
Acrolein	**2.60-03**				
Antimony Compounds	7.90E-06				
Arsenic Compounds	2.20E-05	1.32E-03	1.02E-05		
Benzene (includes that from gasoline)	4.20E-03	2.14E-04	1.65E-06		
Beryllium Compounds	1.10E-06	2.78E-05	2.14E-07		
Bis(2-ethylhexyl)phthalate (DEHP)	4.70E-08				
Cadmium Compounds	4.10E-06	3.98E-04	3.06E-06		
Carbon tetrachloride	4.50E-05				
Chlorine	7.90E-04				
Chlorobenzene	3.30E-05				
Chloroform	2.80E-05				
Chromium Compounds	2.10E-05	8.45E-04	6.50E-06		
Cobalt Compounds	6.50E-05				
2,4-Dinitrophenol	1.80E-07				
Ethylbenzene	3.10E-05				
Formaldehyde	4.40E-03	3.30E-02	2.54E-04	1.10E-03	6.50E-03
Hydrogen Chloride	**8.0E-03**				
Lead Compounds	4.80E-05	1.51E-03	1.16E-05		
Manganese Compounds	1.60E-03	3.00E-03	2.31E-05		
Mercury Compounds	3.50E-06	1.13E-04	8.69E-07		
Methanol				0.041	2.10E-02
Methyl isobutyl ketone (Hexone)				0.0022	2.90E-02
Naphthalene	9.70E-05	1.13E-03	8.69E-06		
Nickel Compounds	3.30E-05	8.45E-02	6.50E-04		
4-Nitrophenol	1.10E-07				
Pentachlorophenol	5.10E-08				
Phenol	5.10E-05			3.00E-03	below detection

Table 3
Emission Factors Utilized for Calculation of O'okala Mill HAP Emissions
(Continued)

HAP	Emission Factors				
	Boiler (fired on wood fuel) (lb/MMBtu)	Boiler fired on diesel or bio-diesel (lb/10^3Gallon)	Boiler fired on diesel or bio-diesel (lb/MMBtu)	Dryer (Heated Zones) (lb/MSF ⅜)	Dryer (Cooling Section) (lb/MSF ⅜)
Phosphorus	2.7ØE-06				
Propionaldehyde	6.10E-05				
Selenium Compounds	2.80E-06	6.83E-04	5.25E-06		
Styrene	1.90E-03				
2,3,7,8-Tetrachlorodibenzo-p-dioxin	8.60E-12				
Toluene	9.20E-04	6.20E-03	4.77E-05		
1,1,1-Tricholorethane		2.36E-04	1.82E-06		
2,4,6-Trichorophenol	2.20E-08				
Vinyl choloride	1.80E-05				
o-Xylenes	2.50E-05	1.09E-04	8.38E-07		
POM		3.30E-03	2.54E-05		

Note:

(1) All emission factors are from EPA AP-42 document, except for those for hydrogen chloride (boiler only), for which a lower value has been used. Tradewinds will commit to meet and verify this proposed hydrogen chloride emission rate by means of source testing per DOH requirements, once the O'okala Mill becomes operational. Boiler emission factors in lb/MMBtu for oil fuel were obtained from the AP-12 factors for diesel (lb/1000 gallons) and converted assuming a fuel energy content of #130,000 BTU/gallon for biodiesel.

(2) In the November 2006 application, emissions data for Acetone were presented. However, since this compound is not a federal HAP and is not listed in HAR 60.1-172, the current listing of HAPS in this table does not include Acetone. DOH substituted Acetophenone for acetone in a draft table of project emissions, since Acetophenone is a listed HAP. However, the AP-42 factors do not list this compound among the pollutants emitted by either the boiler or the dryer, so neither acetone nor acetophenone is a HAP that is emitted by the O'okala Mill.

Table 4
O'okala Mill: Estimated Annual Emission Rates for Hazardous Air Pollutants

HAP	Emissions (tons/year)			
	Boiler fired on wood fuel	Boiler fired on diesel or biodiesel	Dryer	Total Emissions
Acetaldehyde	0.415		1.634	2.049
Acrolein	1.301			1.301
Antimony Compounds	0.004			0.004
Arsenic Compounds	0.011	1.48E-04		0.011
Benzene (includes that from gasoline)	2.102	2.41E-05		2.102
Beryllium Compounds	0.001	3.13E-06		0.001
Bis(2-ethylhexyl)phthalate (DEHP)	0.000			0.000
Cadmium Compounds	0.002	4.48E-05		0.002
Carbon tetrachloride	0.023			0.023
Chlorine	0.395			0.395
Chlorobenzene	0.017			0.017
Chloroform	0.014			0.014
Chromium Compounds	0.011	9.50E-05		0.011
Cobalt Compounds	0.033			0.033
2,4-Dinitrophenol	0.000			0.000
Ethylbenzene	0.016			0.016
Formaldehyde	2.202	3.71E-03	0.342	2.548
Hydrogen Chloride	4.005			4.005
Lead Compounds	0.024	1.70E-04		0.024
Manganese Compounds	0.801	3.37E-04		0.801
Mercury Compounds	0.002	1.27E-05		0.002
Methanol			2.790	2.790
Methyl isobutyl ketone (Hexone)			1.404	1.404
Naphthalene	0.049	1.27E-04		0.049
Nickel Compounds	0.017	9.50E-03		0.026
4-Nitrophenol	0.000			0.000
Pentachlorophenol	0.000			0.000
Phenol	0.026		0.135	0.161
Phosphorus	0.014			0.014

Table 4
O'okala Mill: Estimated Annual Emission Rates for Hazardous Air Pollutants (Continued)

HAP	Emissions (tons/year)			
	Boiler fired on wood fuel	Boiler fired on diesel or biodiesel	Dryer	Total Emissions
Propionaldehyde	0.031			0.031
Selenium Compounds	0.001	7.68E-05		0.001
Styrene	0.951			0.951
2,3,7,8-Tetrachlorodibenzo-p-dioxin	0.000			0.000
Toluene	0.461	6.97E-04		0.461
1,1,1-Tricholorethane		2.65E-05		0.000
2,4,6-Trichorophenol	0.000			0.000
Vinyl choloride	0.009			0.009
o-Xylenes	0.013	1.23E-05		0.013
POM		3.71E-04		0.000
Total HAPs	12.9	0.015	6.3	19.3

Table 5
Revised Stack Parameters for Emission Sources - O'okala Mill

Source ID	Source Type	UTM East (m)	UTM North (m)	Base Elevation (m)	Stack Height (m)	Stack Temp. (K)	Exit Velocity (m/s)	Stack Diameter (m)
BOIL	Boiler	*261170*	*2214954*	104.8	33.53	394	7.57	1.98
COOL1	Cooling Tower Cell 1	*261218*	*2214909*	*110.8*	9.14	311	6.88	5.49
COOL2	Cooling Tower Cell 2	*261225*	*2214906*	*110.8*	9.14	311	6.88	5.49
DRY	Dryer WESP	261095	2214915	108.7	15.24	339	15.24	0.76
FWP	Firewater Pump	260994	2214858	119.8	7.62	622	53.19	0.08

Table 6
O'okala Mill Maximum Predicted Criteria Pollutant Concentrations due to Mill Operations

Pollutant	Averaging Period	Maximum Modeled 1-Hour Concentration			Maximum Concentration for Averaging Time	Measured Background Concentration (µg/m³)	Maximum Total Concentration (µg/m³)	Below NAAQS?	Below HAAQS?	NAAQS	HAAQS
		(µg/m³)	UTM X (m)	UTM Y (m)	(µg/m³)						
PM_{10}	Annual	*112.6*	*260,998*	*2,214,787*	*22.52*	12	*34.52*	yes	yes	50	50
	24-hour	*126.4*	*260,998*	*2,214,787*	*50.56*	36	*86.56*	yes	yes	150	150
SO_2	Annual	*39.94*	*261,100*	*2,214,300*	*7.99*	3	*10.99*	yes	yes	80	80
	24-hour	*456.8*	*261,100*	*2,214,300*	*182.7*	34	*216.7*	yes	yes	365	365
	3-hour	*458.9*	*261,100*	*2,214,300*	*458.9*	91	*549.9*	yes	yes	1,300	1,300
NO_2	Annual	*248.5*	*261,100*	*2,214,300*	*37.28*	2	*39.28*	yes	yes	100	70
CO	8-hour	*371.9*	*261,100*	*2,214,300*	*278.9*	455	*733.9*	yes	yes	10,000	5,000
	1-hour	*386.5*	*261,100*	*2,214,300*	*386.5*	1,022	*1409*	yes	yes	40,000	10,000

Results in bold italics are changed from the values presented in the November 2006 application

Table 7
Identification of HAPs Potentially Subject to Health Risk Analysis Requirements per HAR 60.1-179

HAP	Hourly Emission Rate (lb/hr)				Check, if total exceeds 0.1 lb/hr
	Boiler (fired on wood fuel)	Boiler (fired on bio-diesel oil)	Dryer	Total ER	
Acetaldehyde	1.10E-01		4.18E-01	5.28E-01	√
Acrolein	3.44E-01			3.44E-01	√
Antimony Compounds	1.05E-03			1.05E-03	
Arsenic Compounds	2.91E-03	1.12E-03		2.91E-03	
Benzene (includes that from gasoline)	5.56E-01	1.82E-04		5.56E-01	√
Beryllium Compounds	1.46E-04	2.37E-05		1.46E-04	
Bis(2-ethylhexyl)phthalate (DEHP)	6.22E-06			6.22E-06	
Cadmium Compounds	5.43E-04	3.39E-04		5.43E-04	
Carbon tetrachloride	5.96E-03			5.96E-03	
Chlorine	1.05E-01			1.05E-01	√
Chlorobenzene	4.37E-03			4.37E-03	
Chloroform	3.71E-03			3.71E-03	
Chromium Compounds	2.78E-03	7.20E-04		2.78E-03	
Cobalt Compounds	8.61E-03			8.61E-03	
2,4-Dinitrophenol	2.38E-05			2.38E-05	
Ethylbenzene	4.10E-03			4.10E-03	
Formaldehyde	5.83E-01	2.81E-02	8.76E-02	6.70E-01	√
Hydrogen Chloride	1.06E+00			1.06E+00	√
Lead Compounds	6.36E-03	1.29E-03		6.36E-03	
Manganese Compounds	2.12E-01	2.56E-03		2.12E-01	√
Mercury Compounds	4.63E-04	9.63E-05		4.63E-04	
Methanol			7.15E-01	7.15E-01	√
Methyl isobutyl ketone (Hexone)			3.60E-01	3.60E-01	√
Naphthalene	1.28E-02	9.63E-04		1.28E-02	
Nickel Compounds	4.37E-03	7.20E-02		7.20E-02	
4-Nitrophenol	1.46E-05			1.46E-05	
Pentachlorophenol	6.75E-06			6.75E-06	
Phenol	6.75E-03		3.46E-02	4.13E-02	
Phosphorus	3.57E-03			3.57E-03	

Table 7
Identification of HAPs Potentially Subject to Health Risk Analysis Requirements per HAR 60.1-179 (Continued)

HAP	Hourly Emission Rate (lb/hr)				Check, if total exceeds 0.1 lb/hr
	Boiler (fired on wood fuel)	Boiler (fired on bio-diesel oil)	Dryer	Total ER	
Propionaldehyde	8.08E-03			8.08E-03	
Selenium Compounds	3.71E-04	5.82E-04		5.82E-04	
Styrene	2.52E-01			2.52E-01	√
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1.14E-09			1.14E-09	
Toluene	1.22E-01	5.28E-03		1.22E-01	√
1,1,1-Tricholorethane		2.01E-04		2.01E-04	
2,4,6-Trichorophenol	2.91E-06			2.91E-06	
Vinyl choloride	2.38E-03			2.38E-03	
o-Xylenes	3.31E-03	9.29E-05		3.31E-03	
POM		2.81E-03		2.81E-03	

Table 8
HAP Pollutants Listed by Health Risk Categories and O'okala Mill Emission Sources

Pollutant Group	Emissions Sources	
	Cogeneration Boiler	Dryer
Group 1 Non-carcinogenic HAPs with a threshold limit value-time weighted average (TLV-TWA) industrial pollutant exposure concentration standard for a normal 8-hour work day and forty hour workweek.	Acrolein Manganese Compounds Styrene Toluene	Methanol Methyl Isobutyl Ketone
Group 2 Non-carcinogenic HAPS without a TLV-TWA	Chlorine Hydrogen Chloride	NONE
Group 3 Carcinogenic HAPs	Benzene Acetaldehyde Formaldehyde	Acetaldehyde Formaldehyde

Table 9
Health Risk Calculations for Group 1 Pollutants -- Non-carcinogenic HAPs with a TLV-TWA

Dispersion model inputs and results						
model input & results	model input - emission rate		model result			
			highest 1hr	8-hr	24-hr	Annual
	(grams/sec)	(lb/hr)	ug/m3	ug/m3	ug/m3	ug/m3
boiler only						
F stability met model	0.1260	1.00	14.1200	7.14		0.72
dryer only						
F stability met model	0.1260	1.00	58.1500	33.15	-	2.59

HEALTH RISK RESULTS														
HAP	Carcinogen?	AP-42 EF lb/MMBtu	lb/MSF$^{3/8}$	hourly emissions lb/hr	annual emission rate lb/hr	TLV-TWA ug/m3	TLV-TWA /100 ug/m3	TLV-TWA /420 ug/m3	scaled 8-hr ug/m3	scaled annual ug/m3	PRG value ug/m3	**pass or NO pass**	**proposed Emission Factor**
From the boiler only													
acrolein	No	4.30E-03		0.5693	0.4914	250	2.5	0.60	4.0649	0.3552		**NO pass**	**0.0026**
manganese compounds	No	1.60E-03		0.2118	0.1829	1000	10	2.38	1.5125	0.1322		**pass**	(lb/MMBtu)
Styrene	No	1.90E-03		0.2516	0.2171	215000	2150	511.90	1.7961	0.1569		**pass**	
Toluene	No	9.20E-04		0.1218	0.1051	375000	3750	892.86	0.8697	0.0760		**pass**	
From the dryer only													
methanol	No		6.20E-02	0.7147	0.6370	260000	2600	619.05	23.6930	1.6520		**pass**	
methyl isobutyl ketone	No		3.12E-02	0.3597	0.3205	40000	400	95.24	11.9230	0.8313		**pass**	

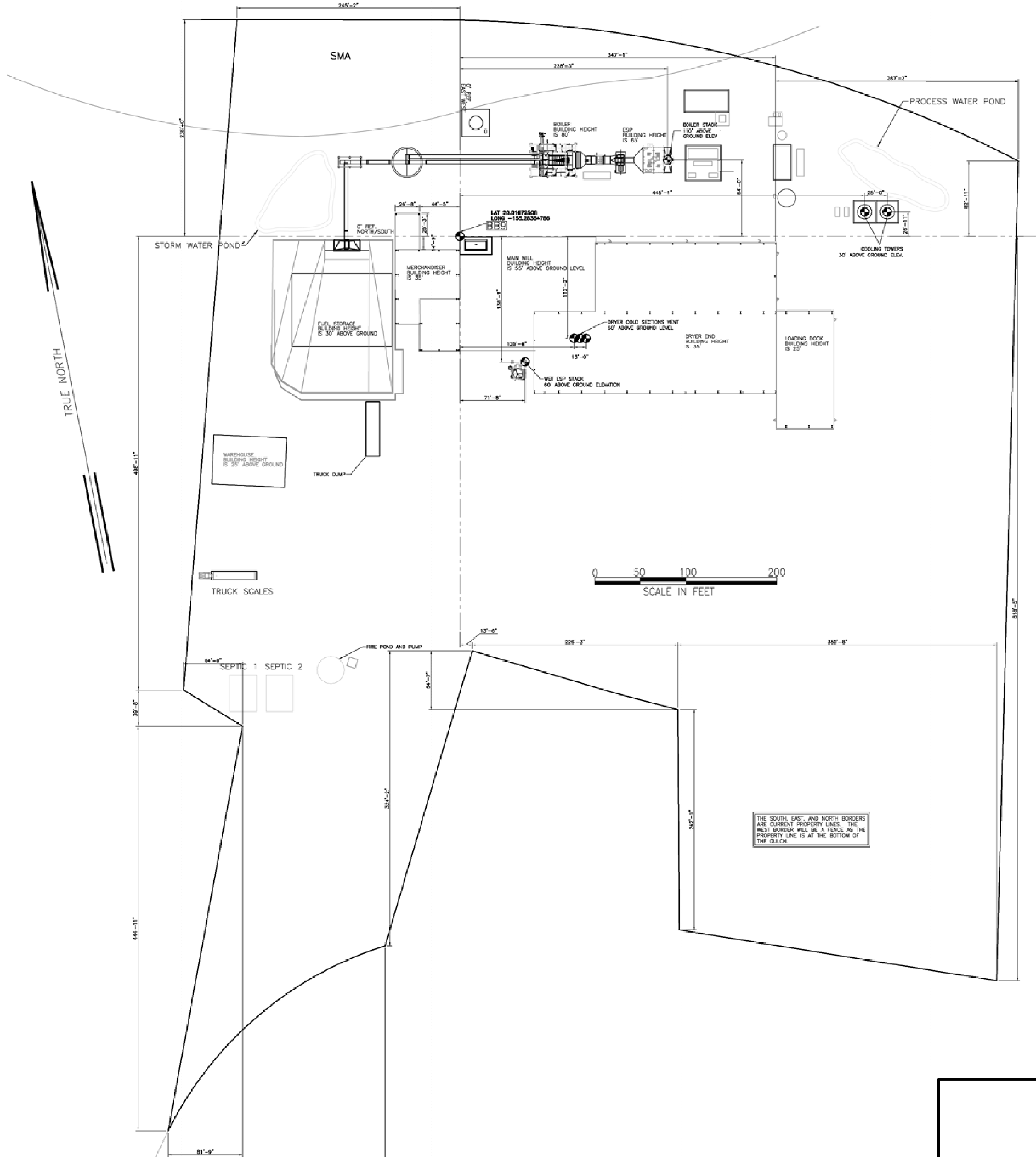
Table 10
Health Risk Calculations for Group 2 Pollutants -- Non-carcinogenic HAPs without a TLV-TWA

Dispersion model inputs and results						
model input & results	model input - emission rate		model results			
			max 1hr	8-hr	24-hr	Annual
	(grams/sec)	(lb/hr)	ug/m3	ug/m3	ug/m3	ug/m3
boiler only						
F stability met model	0.1260	1	14.12	7.14		0.7228

HEALTH RISK RESULTS												
HAP	Carcinogen ?	emission factor lb/MMBtu	hourly emission rate lb/hr	annual emission rate lb/hr	TLV-TWA ug/m3	TLV-TWA /100 ug/m3	TLV-TWA /420 ug/m3	Modeled 8-hr ug/m3	Modeled annual ug/m3	PRG value ug/m3	**pass or NO pass**
From the boiler only											
chlorine	No	7.90E-04	0.1046	0.0903	NA	NA	NA	0.7468	0.0653	0.21	
hydrogen chloride	No	8.00E-03	1.0592	0.9143	NA	NA	NA	7.5627	0.6608	2.1	
Calculated Hazard Index =	**0.625**	**<**	**1.00**	**(Significance threshold)**							**pass**

Table 11
Health Risk Calculations for Group 3 Pollutants -- Carcinogenic HAPs

HEALTH RISK RESULTS											
HAP	Carcinogen ?	emission factor lb/MMBtu	hourly emission rate lb/hr	annual emission rate lb/hr	TLV-TWA ug/m3	TLV-TWA /100 ug/m3	TLV-TWA /420 ug/m3	Modeled 8-hr ug/m3	F Stability - Modeled annual ug/m3	PRG value ug/m3	**pass or NO pass**
From both boiler and dryer											
acetaldehyde	Yes								0.9700	0.87	
formaldehyde	Yes								0.4700	0.15	
From the boiler only											
benzene	Yes								0.3500	0.25	
Cancer Risk Total (acetaldehyde + formaldehyde + benzene) =	**5.65E-06**	**<**	**10.00E-06**	**(Significance threshold)**							**pass**



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ICON	LEGEND
A / 000	DETAIL VIEW OR SECTION FROM DWG NUMBER
A / 00	VIEW LETTER GOTO DWG NUMBER
000 / 00	ITEM NUMBER - DETAIL GOTO DWG NUMBER
A / 02	SECTION LETTER GOTO DWG NUMBER
1	BOM ITEM NUMBER
A	REVISION LETTER
	FLOW ARROWS
123 FPM	FEET PER MINUTE
	WORK POINT
	COLUMNS PLAN VIEW

REVISED O'OKALA MILL EQUIPMENT LAYOUT
TRADEWINDS, HAWAII MILL

URS

CHECKED BY:	DATE: 07-05-07	FIG. NO:
PM: JSL	PROJ. NO: 2569045.00001	1

REFERENCE: West Coast Industrial Systems, Inc. dated 09/11/06

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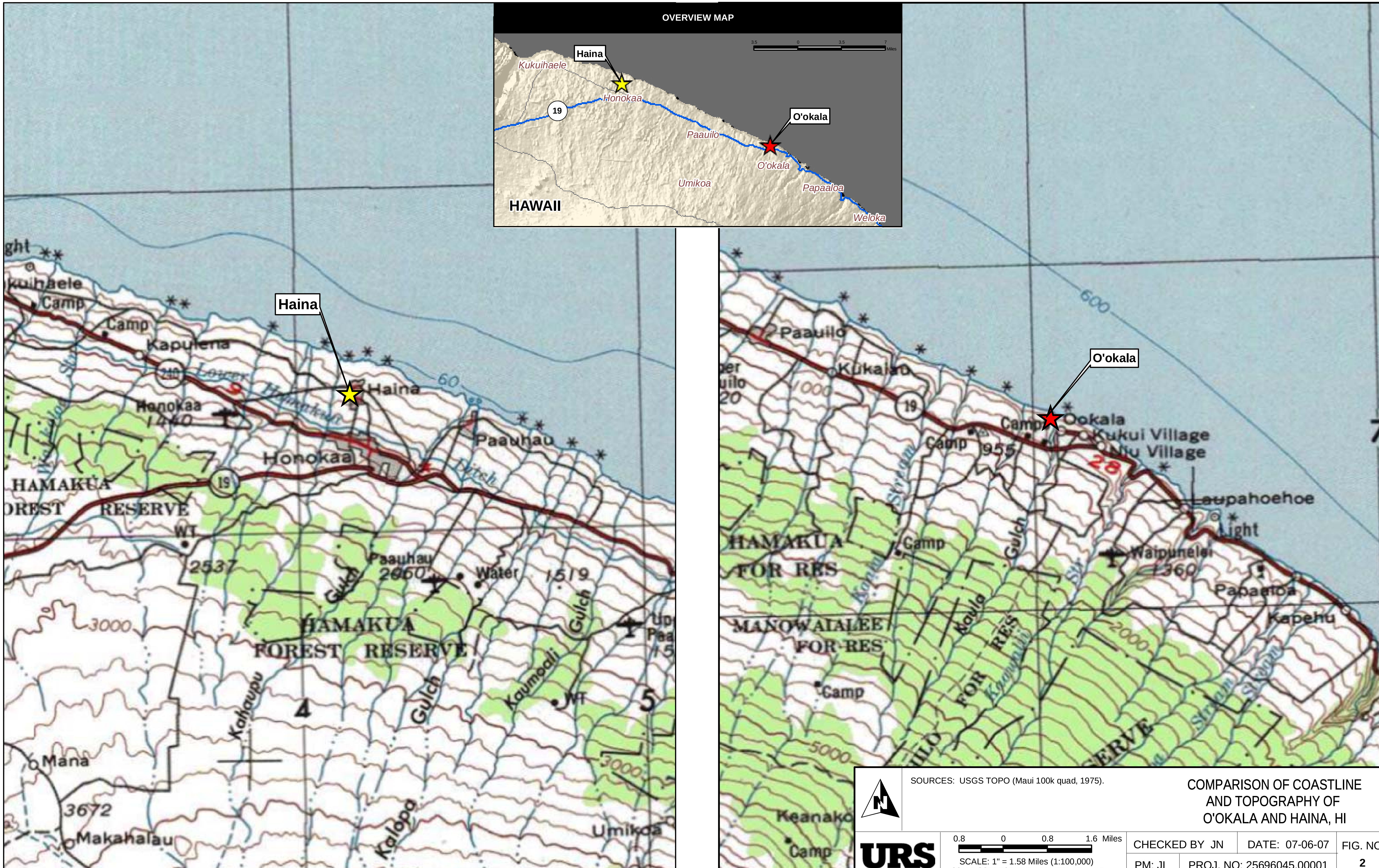

SOURCES: USGS TOPO (Maui 100k quad, 1975).

COMPARISON OF COASTLINE AND TOPOGRAPHY OF O'OKALA AND HAINA, HI

URS

0.8 0 0.8 1.6 Miles

SCALE: 1" = 1.58 Miles (1:100,000)
SCALE CORRECT WHEN PRINTED AT 11X17

CHECKED BY JN	DATE: 07-06-07	FIG. NO:
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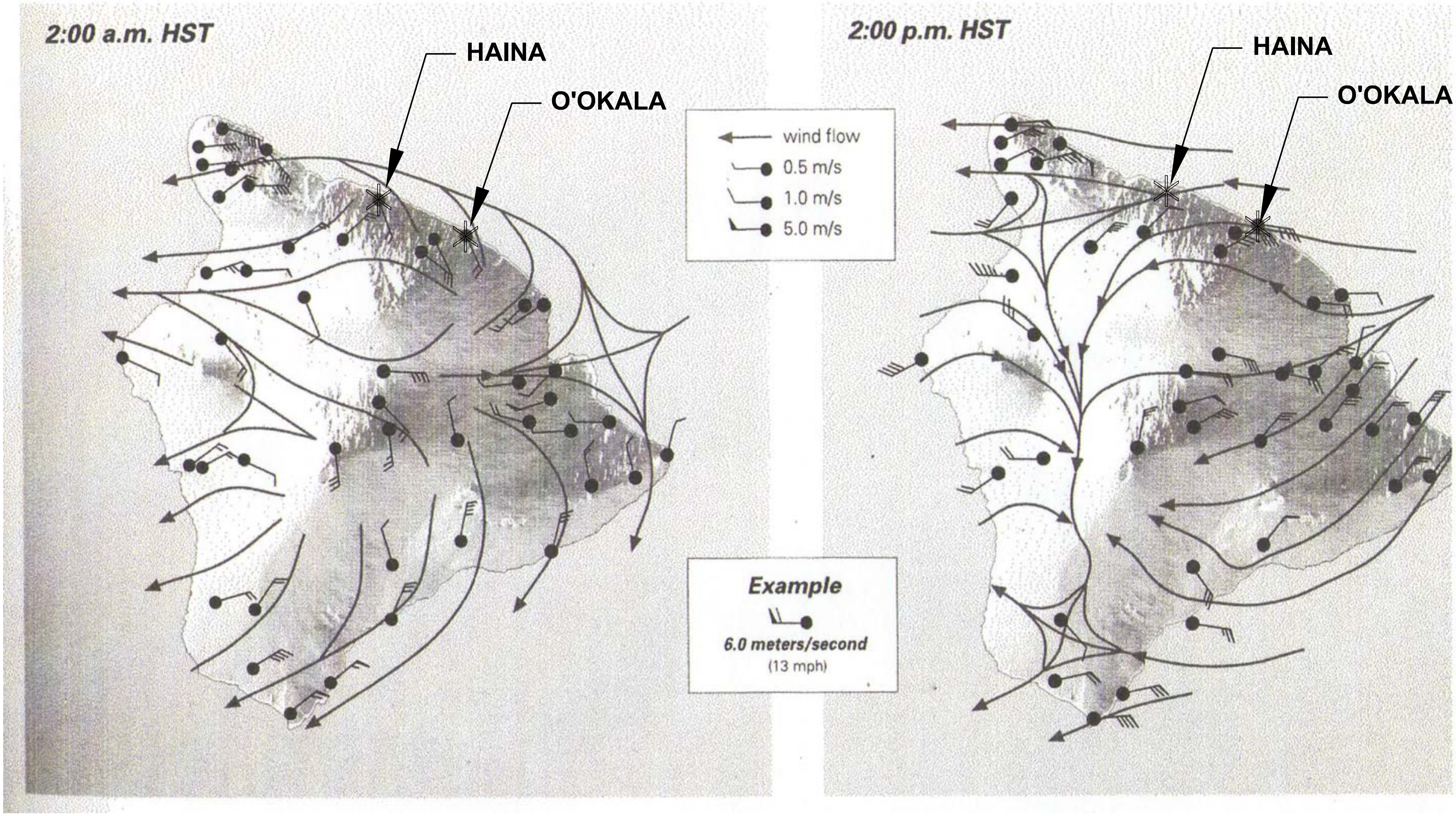

REFERENCE: Atlas of Hawai'i, Thrid Edition

WIND FLOW PATTERNS
TYPICAL DAYTIME AND NIGHTTIME PREVAILING WINDS
TRADEWINDS, HAWAII MILL

URS	NOT TO SCALE	CHECKED BY:	DATE: 07-05-07	FIG. NO: 3
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As described in Section 7, Tradewinds has recently acquired a 14 month record of hourly wind speed and wind direction data collected by Hamakua Energy Partners (HEP). This data set is one product of a post-construction monitoring program required by DOH as a permit condition for the HEP power plant in Haina, about 15 miles northwest of O'oklala. The monitoring program and resulting air quality and meteorological data set were independently audited in 2002, and the wind data from this program are considered by Tradewinds to be very representative of wind flow conditions at O'okala for the following reasons, which are explained and illustrated in Section 7:

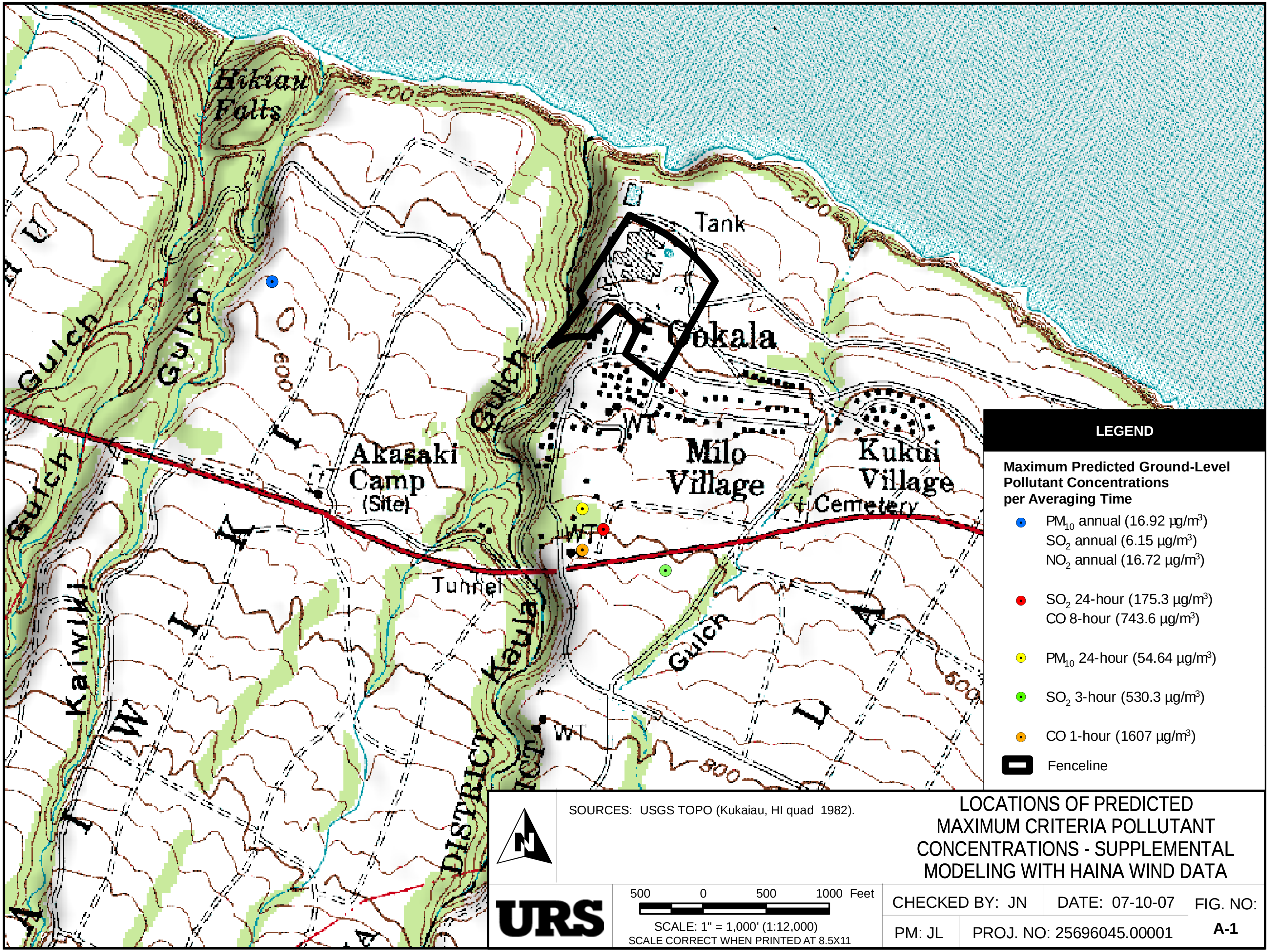
- The orientation of the coastline is virtually identical in O'okala and Haina.
- The location of the HEP power plant site relative to rising terrain within the town of Haina to the south and southwest is very similar to terrain at the O'okala site.
- Daytime and nighttime wind patterns on the Island of Hawaii were documented by the University of Hawaii (UH) by means of mobile meteorological monitoring during an intensive 45 day measurement period. The UH results showed that typical flows during the daytime and nighttime are essentially identical in both locations (O'okala and Haina).

Based on the reasoning shown in Section 7, Tradewinds decided to conduct supplemental dispersion modeling for criteria pollutants using a 12-month record of consecutive hourly Haina wind speed and direction measurements in conjunction with the same default temperature and mixing height values that were used in the original screening modeling described in Section 6. In addition, a decision was made to assign the stability class corresponding to the maximum predicted concentrations from the criteria pollutant screening runs (i.e., Pasquill-Gifford Class F/very stable) to every hour of the one-year wind data record. Modeling with the one-year Haina wind data confirmed that the assumed persistence of Class F stability resulted in higher predicted impacts than would result from assuming any other stability category. This approach allows the variability of wind direction and speed in the project area to be included in the modeling in order to more realistically estimate the project's true air quality impacts. While the combined Haina/screening meteorological data set is less conservative than the screening approach described in Section 6, its use guarantees a high degree of continuing conservatism in the modeling analysis to evaluate the air quality impacts of the operational Tradewinds Mill.

The criteria pollutants were remodeled using the Haina/Screening meteorological data set in order to show more likely impacts and impact locations. Table A-1 shows the results of the modeling analysis using this meteorological data set. Except for the 1-hour and 8-hour impacts for CO, the predicted impacts for all pollutants and averaging periods are significantly lower than they were using the full screening meteorology (see Table 6-in Section 6). All maximum predicted concentrations are well below the NAAQS/HAAQS and the locations of the maximum values, which are illustrated in Figure A-1, are considered much more likely than the locations indicated by the screening modeling reported in the November 2006 application.

Table A-1
O’okala Mill Predicted Air Quality Pollutant Concentrations – Mixed Haina/Screen Met Data

Pollutant	Averaging Period	Maximum Modeled Concentration			Maximum Concentration	Measured Background Concentration (µg/m³)	Maximum Total Concentration (µg/m³)	Under NAAQS?	Under HAAQS?	NAAQS	HAAQS
		(µg/m³)	UTM X (m)	UTM Y (m)	(µg/m³)						
PM_{10}	Annual	4.92	260,200	2,214,900	4.92	12	16.92	yes	yes	50	50
	24-hour	18.64	260,950	2,214,350	18.64	36	54.64	yes	yes	150	150
SO_2	Annual	3.15	260,200	2,214,900	3.15	3	6.15	yes	yes	80	80
	24-hour	141.3	261,000	2,214,300	141.3	34	175.3	yes	yes	365	365
	3-hour	439.3	261,150	2,214,200	439.3	91	530.3	yes	yes	1,300	1,300
NO_2	Annual	19.62	260,200	2,214,900	14.72	2	16.72	yes	yes	100	70
CO	8-hour	288.6	261,000	2,214,300	288.6	455	743.6	yes	yes	10,000	5,000
	1-hour	585.1	260,950	2,214,250	585.1	1,022	1607	yes	yes	40,000	10,000



LEGEND

Maximum Predicted Ground-Level Pollutant Concentrations per Averaging Time

- (blue) PM_{10} annual (16.92 µg/m^3)
  SO_2 annual (6.15 µg/m^3)
  NO_2 annual (16.72 µg/m^3)
- (red) SO_2 24-hour (175.3 µg/m^3)
  CO 8-hour (743.6 µg/m^3)
- (yellow) PM_{10} 24-hour (54.64 µg/m^3)
- (green) SO_2 3-hour (530.3 µg/m^3)
- (orange) CO 1-hour (1607 µg/m^3)
- Fenceline

SOURCES: USGS TOPO (Kukaiau, HI quad 1982).

LOCATIONS OF PREDICTED MAXIMUM CRITERIA POLLUTANT CONCENTRATIONS - SUPPLEMENTAL MODELING WITH HAINA WIND DATA

URS

500 0 500 1000 Feet

SCALE: 1" = 1,000' (1:12,000)
SCALE CORRECT WHEN PRINTED AT 8.5X11

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Appendix B DOH HAP Concentration Screening Protocol

The DOH uses the following screening procedure to determine if a HAP concentration is considered significant and could result in an unacceptable risk to human health.

1. Non-carcinogenic HAP with a TLV-TWA

Significant concentration means an 8-hour average ambient air concentration greater than 1/100 of the TLV-TWA, and any annual average concentration greater than 1/420 of the TLV-TWA. Example:

Phosphine is a non-carcinogenic HAP per the EPA Region 9 PRG Table. (http://www.epa.gov/region09/waste/sfund/prg/)

Phosphine TLV-TWA = 0.42 mg/m3 = 420 ug/m3 Reference: Guide to Occupational Exposure Values, compiled by ACGIH

Significant Concentration:
1/100 TLV-TWA = 4.2 ug/m3, 8-hour
1/420 TLV-TWA = 1.0 ug/m3

2. Non-carcinogenic HAP without a TLV-TWA

Significant concentration is a hazard index greater than 1. Divide the annual concentration of each non-carcinogenic HAP by its respective PRG designated as "nc" and determine the hazard index (HI) by summing the ratios of all non-carcinogenic HAPs.

HI = [(conc x / PRG x) + (conc y / PRG y) + (conc z / PRG z) ...]

conc = annual concentration of each HAP x, y, z... represent each individual non-carcinogenic HAP

Reference: Users' Guide & Background Technical Document for USEPA Region 9's PRG Table, 2004, pg 15.

3. Carcinogenic HAP

Significant concentration for a carcinogenic HAP is a concentration that is a cancer risk greater than 1E-5, assuming continuous exposure for 70 years.

Risk = [(conc x / PRG x) + (conc y / PRG y) + (conc z / PRG z) ...] x 1e-6

conc = annual concentration of each HAP x, y, z... represent each individual carcinogenic HAP

Reference: Users' Guide & Background Technical Document for USEPA Region 9's PRG Table, 2004, pg 15.