ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276 • (217) 782-3397
JB PRITZKER, GOVERNOR **JOHN J. KIM**, DIRECTOR

DATE: April 18, 2024

TO: Jocelyn Stakely, Working Supervisor, State/FESOPs Unit, Permits/BOA

FROM: David Mihelsic, Modeling Unit, Permits/BOA

SUBJECT: Crysalis Biosciences Inc, Sauget, IL – 163121ABS, Permit Application #23090009

Crysalis Biosciences Inc (Crysalis) has submitted a construction permit application on September 8, 2023, for its proposed restart and operation of an existing dry mill ethanol facility located at 231 Monsanto Avenue, Sauget, Illinois. Centering coordinates for this facility are UTM Zone 15 coordinates 745,878 m Easting and 4,275,658 m Northing. The facility has a nominal design capacity of 57 million gallons per year denatured ethanol, but the anticipated annual ethanol production will be 55 million gallons per year.

Crysalis is located in an Environmental Justice (EJ) community. Due to this, the Illinois EPA requested that the facility submit an air quality analysis in support of its construction permit application to confirm the project will not threaten or compromise existing National Ambient Air Quality Standards (NAAQS). In response to this request, Crysalis had Weaver Consultants Group North Central, LLC (WCG) perform an air quality dispersion modeling analysis to assess the environmental impact of carbon monoxide (CO), particulate matter (PM_{10} and $PM_{2.5}$), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), as well as certain hazardous air pollutants (HAPs).

Modeling Unit Review

The air quality analysis was performed by WCG, and the initial modeling report was submitted on February 23, 2024. The initial analysis required refinements to the ambient air boundary, emission calculations, stack heights, and operating schedule, and WCG submitted a refined analysis on March 16, 2024. Further refinements to the emission calculations and operating schedule required further analysis, and a final version of their modeling report was submitted on March 28, 2024. This final analysis relied upon several control measures being implemented as follows:

- Limiting undenatured ethanol production to 55 million gallons per year with a nominal design capacity of 57 million gallons per year denatured ethanol
- Limiting annual natural gas usage from the boilers

- Limiting operating hours for the grain receiving and handling, dry feed (grain) conveyance, DDGS baghouses and DDGS loadout operations to 7 am to 3 pm on Monday through Friday

- Requiring all roads to be paved with implementation of control measures such as watering, sweeping, or treatment of roadways as necessary

- Increasing stack heights for the boilers, hammermills, vent gas scrubber, and diesel emergency generator

- Use of a drift eliminator designed to limit the drift loss of fugitive emissions from the cooling towers to 0.001 percent or less

- Use of good engineering practices and replacement of baghouse filters to ensure emissions are less than 0.002 grains/dscf from baghouses

- Requiring all grain receiving operations to be via truck. All doors to be kept closed to the receiving house upon receipt of grain and loadout of trucks

- Allowing limited rail loadout of spent material from the DDGS. Requiring all doors to be kept closed during loadout of spent materials from the facility into trucks

- Limiting operation of the emergency generator fire pump to no more than 100 hours per year of operation.

The following dot entries identify key aspects of the modeling methodology used in this analysis:

- WCG used AERMOD (version 23132). AERMOD is a federally approved regulatory model appropriate for use in an air quality analysis of this nature. The audit runs conducted by the IEPA Modeling Unit used the same version of AERMOD. Modeling inputs utilized IEPA and USEPA recommended regulatory options, which simulate phenomena such as atmospheric stability, plume rise and downwash. Five years of locally representative meteorology were applied to the modeling. National Weather Service meteorological data files for years 2018 through 2022 were obtained from the National Centers for Environmental Information (NCEI) and consisted of surface data collected at the St. Louis – Lambert International Airport and upper air data collected at the National Weather Service in Lincoln, Illinois. The applicant's meteorological data was processed with AERMET, version 22112. The IEPA Modeling Unit audit runs used meteorological data from the same surface and upper air stations but the data was processed with AERMET, version 23132, for years 2018 through 2022.

- AERMOD's terrain preprocessor AERMAP (version 18081) was employed to determine receptor, source and building mean sea level elevations and hill height scales used by AERMOD. The program read National Elevation Database (NED) GeoTiff electronic maps downloaded from USGS in 1/3 arc-second resolution. The domain matched the extent of the maps, following USEPA guidance. The approximate site elevation at the

Crysalis facility is 125 meters above mean sea level.

- WCG made use of a Cartesian grid in their distribution of receptors. The following receptor grid densities were used:

    - 50 meter spacing of receptors along the facility's property boundary

    - 50 meter spacing of receptors from the facility's boundary out to 100 meters

    - 100 meter spacing of receptors from 100 meters to 1 kilometer

    - 250 meter spacing of receptors from 1 to 5 kilometers

    - 500 meter spacing of receptors from 5 to 10 kilometers

- Crysalis' property boundary was determined from a search on the St. Clair County Tax Assessor's GIS website, and it was found that the perimeter fence encompasses an adjacent property owned by a third party. Receptors were placed on the adjacent property as defined in the grid densities above.

- Building downwash effects on plumes emitted from the stacks at the facility were accounted for in the model by processing the building and structure dimensions and locations with USEPA's Building Profile Input Program (BPIPPRM version 04274). Building and structure dimensions, including heights and coordinates, were provided by the facility.

- The urban option was selected in AERMOD based on an Auer's Analysis showing land use to be developed for approximately 51% of the area within a 3 km radius from the center of the facility.

- WCG included the following source types in its modeling runs to appropriately characterize different emission-generating activities associated with the facility:

    - Thirty point sources to represent emissions released through the stacks.

    - A total of 58 volume sources were used to represent the fugitive emissions from the grain receiving and Distiller's Dried Grains with Solubles (DDGS) loadout and storage, which are not venting through control equipment or a stack.

    - A series of volume sources[1] were placed along the facility's roadways to represent emissions generated from the paved roads from use of employee vehicles and maintenance trucks.

[1] Representation of roadway emissions through a series of volume sources follows the USEPA memorandum *Haul Road Workgroup Final Report* dated December 6, 2011, that outlines an approach for modeling fugitive emissions from haul roads.

- NO_2 modeling options consist of multiple tiers. Tier 1 assumes that all NOx emitted from emission units at the source converts to NO_2. Tier 2 is based upon a representative atmospheric equilibrium default value that was developed using conversion ratios generated from monitored concentrations of NOx and NO_2. Tier 3 allows the user to perform a detailed analysis using either the Ozone Limiting Method (OLM) or the Plume Volume Molar Ratio Method (PVMRM) regulatory screening options in AERMOD. These options consider the chemical mechanism of ozone titration and the resulting NO_2 concentrations. Based on the submitted modeling files, WCG used a Tier 2 approach to model NO_2. WCG selected the regulatory default Ambient Ratio Method (ARM2) option in AERMOD which uses a range of ambient NO_2/NOx ratios, with 0.5 as the lower limit and 0.9 as the upper limit.

- WCG is proposing to increase the stack height of several sources based on good engineering practices. The stacks with proposed height increases are included in the following table:

Table 1
Stacks with Proposed Height Increases

Unit Description	Unit ID	Model ID	Stack Height (ft)	
			Existing	Proposed
Boiler 1	SV010A	STCK1	50	90
Boiler 2	SV010B	STCK2	50	90
Hammermilling #1	SV003A	STCK11	40	90
Hammermilling #2	SV003B	STCK14	40	90
Process Vent Gas Scrubber	SV005	STCK7	45	95
Emergency Generator	SV016	STCK3	10	16

- WCG utilized the variable emission factors option (EMISFACT) in AERMOD for certain sources within the model. This option allows for variable emission rate factors for individual sources to be applied on an hour-of-day and day-of-week basis. The following sources were limited in the model to operate Monday through Friday from 7am to 3pm:

Table 2
Units with Modeled Operating Hours
(Monday – Friday; 7:00am – 3:00pm)

Unit Description	Emission Point ID	Model ID
Dry Feed (DDGS) Bucket Elevator Baghouse	SV008A	STCK12
Dry Feed (DDGS) Loadout Baghouse	SV008B	STCK13
Dry Feed (Grain) Conveyor #1	SV001C	STCK24
Dry Feed (Grain) Conveyor #2	SV001D	STCK25
Truck Receiving and Handling (Filter 1)	SV001B	STCK8
Rail Receiving and Handling (Filter 2)	SV001A	STCK9
Dry Feed (Grain) Truck Receiving Fugitives	FS002	VOL12 & 13
Dry Feed (DDGS) Truck Loadout Fugitives	FS005	VOL12 & 13
Dry Feed (DDGS) Rail Loadout Fugitives	FS006	VOL10 & 11

- WCG modeled the emergency generator fire pump (Emission Point ID SV016) based on an averaged hourly rate, as opposed to the maximum hourly rate, for both 1-hour NO_2 and 1-hour SO_2. WCG will operate this emergency equipment for a maximum of 100 hours per year. For the modeled emission rate, they multiplied the maximum hourly rate times a ratio of 100 hours per year over 8760 hours per year. This approach is outlined in guidance issued by the USEPA in 2011.[2]

Significant Impact Analysis

WCG performed a significant impact analysis to determine whether more detailed modeling would be required for any of the criteria pollutants (NO_2, SO_2, CO, $PM_{2.5}$, and PM_{10}) associated with this project. The IEPA Modeling Unit also independently evaluated the project's precursor emission impacts on ozone (O_3) formation.

The results of this analysis are displayed in Table 3 below. The results indicated that further analysis would be required for 1-hour NO_2, 24-hour $PM_{2.5}$, and 24-hour PM_{10} to demonstrate compliance with their respective NAAQS.

Table 3
Significant Impact Modeling Results

Pollutant	Averaging Period	Maximum Modeled Impact (μg/m^3)	Significant Impact Level (μg/m^3)
NO_2	1-hour	12.01	7.52
	Annual	0.63	1
SO_2	1-hour	0.46	7.85
	3-hour	9.20[(a)]	25
CO	1-hour	69.93	2000
	8-hour	51.77	500
$PM_{2.5}$	24-hour	7.09[(b)]	1.2
	Annual	0.1998[(b)]	0.2
PM_{10}	24-hour	9.47	5
O_3	8-hour	0.85[(c)]	1.96

(a) The IEPA Modeling Unit audit value is reported in Table 3. WCG reported 3-hour SO_2 impacts of 9.67 μg/m^3, however, their analysis utilized the existing stack heights as opposed to the proposed stack heights. The IEPA Modeling Unit audit utilized the proposed stack heights reported in Table 1 for consistency with all other modeling runs.
(b) Maximum Modeled Impact includes primary and secondary $PM_{2.5}$ impacts.
(c) This value is from the IEPA Modeling Unit audit, as O_3 impacts were not considered in the modeling submitted by WCG.

The $PM_{2.5}$ results displayed in Table 3 include both primary and secondary $PM_{2.5}$ impacts. Details of the secondary $PM_{2.5}$ and ozone analysis are discussed in the following section.

[2] USEPA (2011). *Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO2 National Ambient Air Quality Standard.*

Ozone and Secondary $PM_{2.5}$ formation

To estimate the ozone and secondary $PM_{2.5}$ impacts, a demonstration was performed utilizing guidance from a 2019 EPA memorandum[3]. NOx, SO_2, and VOM emissions are ozone and $PM_{2.5}$ precursors, meaning they each contribute to ambient air concentrations of ozone and $PM_{2.5}$. This method utilizes a hypothetical source and modeled concentrations generated by a photochemical grid model to predict concentrations of ozone and secondary $PM_{2.5}$ from precursor emissions.

The hypothetical source selected for this analysis was Source 7, located in Perry County, IL based on a 500 tpy emission level and 10-meter stack height. MERPs for NOx, SO_2, and VOM were obtained from USEPA[4] and are based upon a ratio of emissions and impacts from the photochemical grid model. Table 4 below shows the calculated impacts for the project. The table considers Crysalis project emissions of 52.37 tpy of NOx, 0.88 tpy of SO_2, and 73.58 tpy of VOM.

Table 4
Tier I MERPs Analysis Results for $PM_{2.5}$ and Ozone

Pollutant	Averaging Time	SIL	MERP Values			Total Concentration
			NO_2	SO_2	VOM	
$PM_{2.5}$	24-Hour	1.2 μg/m^3	4,796	808	-	0.014 μg/m^3
	Annual	0.2 μg/m^3	9,214	10,078	-	0.0011 μg/m^3
O_3	8-Hour	1 ppb	126	-	4,485	0.432 ppb

The secondary $PM_{2.5}$ concentrations displayed in Table 4 were added to the primary $PM_{2.5}$ modeled concentrations for each averaging period. The primary 24-hour $PM_{2.5}$ impacts are 7.0853 μg/m^3; the primary annual $PM_{2.5}$ impacts are 0.1987 μg/m^3. The $PM_{2.5}$ results displayed in Table 3 are the sum of the primary and secondary impacts; the O_3 results displayed in Table 3 are only the secondarily formed impacts.

Cumulative Impact Analysis

The results of the significant impact analysis show further analysis is required to evaluate the project's impact against the 1-hour NO_2, 24-hour $PM_{2.5}$, and 24-hour PM_{10} NAAQS. WCG developed a cumulative modeling analysis that incorporated background concentrations based on nearby monitored concentrations and emission inventory sources that were not accounted for by the local monitoring data.

[3] U.S. Environmental Protection Agency, 2019. Guidance on the Use of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program. Publication No. EPA 454/R–19–003. Office of Air Quality Planning and Standards, Research Triangle Park, NC.
[4] USEPA (2019). MERPs View Qlik. *Support Center for Regulatory Atmospheric Modeling (SCRAM).* Retrieved from: https://www.epa.gov/scram/merps-view-qlik

WCG utilized representative background data collected from Illinois and Missouri's air monitoring network. Background values included:

- NO_2 and $PM_{2.5}$ data for use in the 1-hour NO_2 and 24-hour $PM_{2.5}$ modeling collected from the monitor in East St. Louis, Illinois (ID 17-163-0010). This monitor is located approximately 2 km from the facility, and it was selected as the most representative background monitoring site due to its proximity to the facility.

- PM_{10} data for use in the 24-hour PM_{10} modeling was collected from the monitor located in Arnold West, Missouri (ID 29-099-0019). This monitor is located approximately 26 km southwest of the facility.

WCG was provided an inventory of sources from the IEPA Modeling Unit that included sources located within a 10km radius from the facility. The IEPA Modeling Unit also obtained inventory sources from the Missouri Department of Natural Resources Modeling Unit to include in this analysis since the Sauget facility is located in close proximity to the Missouri border.

For the NO_2 and $PM_{2.5}$ NAAQS analysis, it was assumed the East St. Louis monitor was representative of sources located up to 4km upwind of the monitor. The East St. Louis monitor is a neighborhood monitor located in close proximity to and upwind of the Crysalis facility. A wind rose from the area showed winds were equally predominant from the south, southeast, southwest, and northwest directions, and therefore, it is assumed the monitor is representative of sources located up to 4km away from the monitor in those directions. Winds were not predominant from the northeast quadrant, and therefore, all sources located to the northeast of the monitor were included in the nearby source inventory. Sources further than 4km away from the monitor were still included in the NO_2 and $PM_{2.5}$ modeling analysis.

Additionally for the 1-hour NO_2 analysis, intermittent sources were excluded from the nearby source inventory based on guidance issued by the USEPA in a 2011.[5]

For PM_{10}, all inventory sources were included in the NAAQS analysis as the PM_{10} monitor is not located in close proximity to the Crysalis facility and does not adequately represent the nearby PM_{10} emission sources.

The modeled concentrations included impacts from the facility and any nearby emission inventory sources not represented by the background monitor. The total impact from the modeled concentrations, background concentrations, and any secondary concentrations are compared to the respective NAAQS, as shown in Table 5. The modeled concentrations for 1-hour NO_2, 24-hour $PM_{2.5}$, and 24-hour PM_{10} were below their respective NAAQS.

[5] USEPA (2011). *Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO2 National Ambient Air Quality Standard.*

Table 5
NAAQS Modeling Results

Pollutant	Averaging Period	Modeled Concentration (μg/m³)	Background Concentration (μg/m³)	Secondary Concentration (μg/m³)	Total Concentration (μg/m³)	NAAQS (μg/m³)
NO_2	1-Hour	39.77	73.30	-	113.07	188.14
$PM_{2.5}$	24-Hour	6.87	22.70	0.01	29.58	35
PM_{10}	24-Hour	57.05	62.00	-	119.05	150

Air Toxics Analysis

As part of the air quality analysis for Crysalis, the IEPA Modeling Unit requested the facility evaluate the impacts of toxic air pollutant emissions from the facility. WGC provided the IEPA Modeling Unit with emission calculations for potential HAP emissions from the facility. The emission calculations provided by WGC reported HAP emissions from the boilers, emergency generator, fermentation CO2 scrubber, process vent gas scrubber, RTO, wet cake loadout, ethanol tanks, ethanol loading rack, and equipment leaks. The IEPA Modeling Unit performed a screening analysis using the Air Emissions Risk Analysis (AERA) Guidance[6]. It was determined from the use of the MPCA Risk Assessment Screening Spreadsheet (RASS) that Crysalis should conduct a dispersion modeling analysis for the following five pollutants: acetaldehyde, acrolein, benzene, formaldehyde, and xylene.

The IEPA Modeling Unit provided WCG with federal- and state-level reference concentration levels for these pollutants. The standards provided were from USEPA's Integrated Risk Information System (IRIS)[7], California's Office of Environmental Health Hazard Assessment (OEHHA)[8], and Minnesota's Department of Health (MDH)[9]. The results of WCG's analysis are displayed in Table 6. All modeled concentrations were below their respective reference concentrations.

[6] Minnesota Pollution Control Agency. (2024) Air Emissions Risk Analysis (AERA) Guidance. Retrieved from https://www.pca.state.mn.us/sites/default/files/aq9-18.pdf.
[7] USEPA (2023). IRIS Assessments. Retrieved from: https://iris.epa.gov/AtoZ/?list_type=alpha.
[8] California OEHHA (2023). OEHHA Acute, 8-hour and Chronic Reference Exposure Level (REL) Summary. Retrieved from: https://oehha.ca.gov/air/general-info/oehha-acute-8-hour-and-chronic-reference-exposure-level-rel-summary.
[9] MDH (2023). Air Guidance Values. Retrieved from: https://www.health.state.mn.us/communities/environment/risk/guidance/air/table.html.

Table 6
HAPs Modeling Results

Pollutant	CAS	Averaging Period	Modeled Concentration ($\mu g/m^3$)	Standard ($\mu g/m^3$)	Reference
Acetaldehyde	75-07-0	1-hour	21.44	470	OEHHA REL[1]
		8-hour	7.98	300	
		Annual	0.24	9	IRIS RfC[2]
Acrolein	107-02-8	24-hour	0.17	5	MDH HRV[3]
		Annual	0.01	9	
Benzene	71-43-2	24-hour	10.40	30	MDH HRV[3]
		Annual	1.05	30	IRIS RfC[2]
Formaldehyde	50-00-0	24-hour	0.17	50	MDH HRV[3]
		Annual	0.01	9	
Xylene	1330-20-7	1-hour	110.20	22,000	OEHHA REL[1]
		Annual	4.95	100	IRIS RfC[2]

(1) OEHHA Reference Exposure Levels (REL) are established for pollutants based on exposure durations.
(2) IRIS reference concentrations for inhalation exposure (RfCs) provide an estimate of concentrations that human populations could inhale over a lifetime without an appreciable risk of negative health outcomes.
(3) MDH Health Risk Values (HRV) are concentrations of a chemical that are likely to pose little or no risk to human health during that exposure duration.

Summary

Based upon the applicant's submittal and the IEPA Modeling Unit's review of WCG's modeling results, the air quality analysis demonstrates the proposed operations will comply with all NAAQS and toxics-based HAP standards so long as the operations are restricted in the permit as outlined in this memorandum.

cc: Azael Ramirez, FESOPs Unit Manager, Permits/BOA
Bill Marr, Section Manager, Permits/BOA
Cari Rutherford, Modeling Unit Working Supervisor, Permits/BOA