Responses to CEC Data Requests Set One: OEHI Extension

Amended Application for Certification for HYDROGEN ENERGY CALIFORNIA (08-AFC-8A) Kern County, California

Prepared for:
Hydrogen Energy California LLC

hydrogen energy california

Submitted to:

California Energy Commission

U.S Department of Energy

Prepared by:

URS

September 2012

RESPONSES TO DATA REQUESTS SET ONE (OEHI EXTENSION)
FROM CALIFORNIA ENERGY COMMISSION (CEC)

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CEC DATA REQUESTS

ATTACHMENTS

LIST OF ACRONYMS AND ABBREVIATIONS USED IN RESPONSES

AFC	Application for Certification
BACT	Best Available Control Technology
Btu	British thermal unit
CARB	California Air Resources Board
CDFG	California Department of Fish and Game
CEC	California Energy Commission
CEQA	California Environmental Quality Act of 1970
CO	Carbon monoxide
CO_2	carbon dioxide
DOE	Department of Energy
	Diesel Particulate Matter
DTSC	Department of Toxic Substances Control
EOR	Enhanced Oil Recovery
EPA	Environmental Protection Agency (see USEPA)
GHG	greenhouse gas
gr/100Scf	grams per 100 standard cubic feet
HDD	horizontal directional drilling
HECA	Hydrogen Energy California
HHV	higher heating value
hr/year	hours per year
Kg/mmBtu	kilograms per million British thermal units
MMBtu	million British thermal units
MMscf/Hr	million standard cubic feet per hour
MMscfpd	million standard cubic feet per day
MRV	Monitoring, Reporting, and Verification
N_2O	nitrous oxide
NSR	New Source Review
OEHI	Occidental of Elk Hills, Inc.
PM	particulate matter
PM_{10}	particulate matter 10 microns in diameter or less
$PM_{2.5}$	particulate matter 2.5 microns in diameter or less
Scf	standard cubic foot
SJVAPCD	San Joaquin Valley Air Pollution Control District
VOC	volatile organic compound

Technical Area: Air Quality/Greenhouse Gases
Authors: William Walters; Nancy Fletcher

DATA REQUESTS FOR THE ENHANCED OIL RECOVERY (EOR) AND CARBON CAPTURE AND SEQUESTRATION (CCS) PROJECT

BACKGROUND: EMISSIONS CALCULATIONS

The emission calculations in Appendix A appear to have several errors, particularly errors in the off-road equipment emissions factors. Specifically, it can be seen by review of the emissions factors that the Carbon Dioxide (CO_2) and Sulfur Dioxide (SO_2) emissions factors, which should be very similar on a gram per horsepower basis for all of the diesel fueled equipment, varies by over three orders of magnitude and those errors translate into the other pollutant emissions estimates. Additionally, not all of the assumptions associated with the emissions calculation are clear. Staff needs information to understand all of the emissions calculation assumptions, and needs the apparent errors in the emissions estimates to be corrected.

DATA REQUEST

A26. Please correct the off-road equipment emissions factors and associated emissions estimates for project construction.

RESPONSE

The emissions factors included in the Hydrogen Energy California (HECA) Project 2012 Amended Application for Certification (AFC), Appendix A-1, Occidental of Elk Hill, Inc. (OEHI) Supplemental Environmental Information, have been reviewed; and the construction emissions have been correspondingly re-estimated. Please refer to Attachment A26-1 (Criteria Air Pollutant Emissions for Construction) and Attachment A26-2 (Greenhouse Gas [GHG] Emissions for Construction) for a summary of updated construction emissions and assumptions. The revised construction emission tables are included in these attachments.

ATTACHMENT A26-1
CRITERIA AIR POLLUTANT EMISSIONS FOR CONSTRUCTION

Table A-1
Estimated Facility Installation Criteria Air Pollutant Emissions (EOR Processing Facility, Tank Batteries, Satellite Stations)
OEHI CO2 EOR PROJECT

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)						Total Emissions (tons)				
Equipment	Number	Fuel Type	BHP	Load Factor (%)	NOX	ROG	CO	PM10	SOX	Hrs/ Day	NOX	ROG	CO	PM10	SOX	Days	NOX	ROG	CO	PM10	SOX
2014																					
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	3.3	0.02	0.00	0.01	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	62.7	0.20	0.01	0.10	0.01	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	62.7	0.04	0.00	0.03	0.00	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	62.7	0.05	0.01	0.04	0.01	0.00
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	13	0.06	0.00	0.03	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	248	0.78	0.04	0.40	0.04	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	248	0.17	0.01	0.12	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	248	0.21	0.04	0.16	0.02	0.00
2015																					
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	14.1	0.07	0.00	0.03	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	267.9	0.85	0.05	0.43	0.04	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	267.9	0.19	0.01	0.13	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	267.9	0.23	0.04	0.17	0.02	0.00
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	13	0.06	0.00	0.03	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	248	0.78	0.04	0.40	0.04	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	248	0.17	0.01	0.12	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	248	0.21	0.04	0.16	0.02	0.00
2016																					
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	17.7	0.09	0.01	0.04	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	336.3	1.06	0.06	0.54	0.05	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	336.3	0.23	0.02	0.16	0.02	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	336.3	0.29	0.05	0.22	0.03	0.00
2017																					
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	11.3	0.05	0.00	0.03	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	214.7	0.68	0.04	0.35	0.03	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	214.7	0.15	0.01	0.10	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	214.7	0.18	0.03	0.14	0.02	0.00
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	10	0.05	0.00	0.02	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	195	0.62	0.04	0.32	0.03	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	195	0.14	0.01	0.09	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	195	0.17	0.03	0.12	0.02	0.00

Table A-1
Estimated Facility Installation Criteria Air Pollutant Emissions (EOR Processing Facility, Tank Batteries, Satellite Stations)
OEHI CO2 EOR PROJECT

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)						Total Emissions (tons)				
Equipment	Number	Fuel Type	BHP	Load Factor (%)	NOX	ROG	CO	PM10	SOX	Hrs/ Day	NOX	ROG	CO	PM10	SOX	Days	NOX	ROG	CO	PM10	SOX
2018																					
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	4.35	0.02	0.00	0.01	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	82.65	0.26	0.01	0.13	0.01	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	82.65	0.06	0.00	0.04	0.00	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	82.65	0.07	0.01	0.05	0.01	0.00
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	15	0.07	0.00	0.03	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	293	0.93	0.05	0.47	0.04	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	293	0.20	0.01	0.14	0.02	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	293	0.25	0.05	0.19	0.02	0.00
2019																					
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	11.75	0.06	0.00	0.03	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	223.3	0.71	0.04	0.36	0.03	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	223.3	0.16	0.01	0.11	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	223.3	0.19	0.04	0.14	0.02	0.00
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	5	0.02	0.00	0.01	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	97	0.31	0.02	0.16	0.01	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	97	0.07	0.00	0.05	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	97	0.08	0.02	0.06	0.01	0.00
2020																					
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	3.25	0.02	0.00	0.01	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	61.75	0.20	0.01	0.10	0.01	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	61.75	0.04	0.00	0.03	0.00	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	61.75	0.05	0.01	0.04	0.01	0.00
2021																					
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	12	0.06	0.00	0.03	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	228	0.72	0.04	0.37	0.03	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	228	0.16	0.01	0.11	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	228	0.20	0.04	0.15	0.02	0.00
2023																					
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	3.6	0.02	0.00	0.01	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	68.4	0.22	0.01	0.11	0.01	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	68.4	0.05	0.00	0.03	0.00	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	68.4	0.06	0.01	0.04	0.01	0.00
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	3	0.01	0.00	0.01	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	62	0.20	0.01	0.10	0.01	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	62	0.04	0.00	0.03	0.00	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	62	0.05	0.01	0.04	0.01	0.00

Table A-1
Estimated Facility Installation Criteria Air Pollutant Emissions (EOR Processing Facility, Tank Batteries, Satellite Stations)
OEHI CO2 EOR PROJECT

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)						Total Emissions (tons)				
Equipment	Number	Fuel Type	BHP	Load Factor (%)	NOX	ROG	CO	PM10	SOX	Hrs/ Day	NOX	ROG	CO	PM10	SOX	Days	NOX	ROG	CO	PM10	SOX
2024																					
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	9.9	0.05	0.00	0.02	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	188.1	0.59	0.03	0.30	0.03	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	188.1	0.13	0.01	0.09	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	188.1	0.16	0.03	0.12	0.02	0.00
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	3	0.01	0.00	0.01	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	60	0.19	0.01	0.10	0.01	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	60	0.04	0.00	0.03	0.00	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	60	0.05	0.01	0.04	0.01	0.00
2025																					
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	13.5	0.07	0.00	0.03	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	237.5	0.75	0.04	0.38	0.03	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	237.5	0.17	0.01	0.11	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	237.5	0.20	0.04	0.15	0.02	0.00
2026																					
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	11.4	0.05	0.00	0.03	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	216.6	0.68	0.04	0.35	0.03	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	216.6	0.15	0.01	0.10	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	216.6	0.19	0.04	0.14	0.02	0.00
2027																					
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	11.3	0.05	0.00	0.03	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	214.7	0.68	0.04	0.35	0.03	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	214.7	0.15	0.01	0.10	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	214.7	0.18	0.03	0.14	0.02	0.00
2028																					
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	9	0.04	0.00	0.02	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	171	0.54	0.03	0.28	0.02	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	171	0.12	0.01	0.08	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	171	0.15	0.03	0.11	0.01	0.00
2029																					
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	8.8	0.04	0.00	0.02	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	167.2	0.53	0.03	0.27	0.02	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	167.2	0.12	0.01	0.08	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	167.2	0.14	0.03	0.11	0.01	0.00

Table A-1
Estimated Facility Installation Criteria Air Pollutant Emissions (EOR Processing Facility, Tank Batteries, Satellite Stations)
OEHI CO2 EOR PROJECT

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)						Total Emissions (tons)				
Equipment	Number	Fuel Type	BHP	Load Factor (%)	NOX	ROG	CO	PM10	SOX	Hrs/ Day	NOX	ROG	CO	PM10	SOX	Days	NOX	ROG	CO	PM10	SOX
2030																					
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	7.35	0.04	0.00	0.02	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	139.7	0.44	0.03	0.23	0.02	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	139.7	0.10	0.01	0.07	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	139.7	0.12	0.02	0.09	0.01	0.00
2031																					
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	1.15	0.01	0.00	0.00	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	21.85	0.07	0.00	0.04	0.00	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	21.85	0.02	0.00	0.01	0.00	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	21.85	0.02	0.00	0.01	0.00	0.00
2032																					
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	1.5	0.01	0.00	0.00	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	28.5	0.09	0.01	0.05	0.00	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	28.5	0.02	0.00	0.01	0.00	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	28.5	0.02	0.00	0.02	0.00	0.00
2033																					
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01	12	0.06	0.00	0.03	0.00	0.00
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	4	6.32	0.36	3.24	0.29	0.00	228	0.72	0.04	0.37	0.03	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	4	1.40	0.10	0.97	0.11	0.00	228	0.16	0.01	0.11	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	228	0.20	0.04	0.15	0.02	0.00

Data Sources/Notes:

Emission factors for NOX, ROG, PM10 from CARB's Offroad 2011, San Joaquin Valley fleet inventory (years 2009-2029)
ROG assumed to be 83.67% of total organic gases reported by OFFROAD 2011
CO emissions estimated using 4.25 grams per brake-horsepower hour
Total PM emissions from OFFROAD 2011 assumed to be PM10
SOX emissions estimated using fuel consumption rates and 15 parts per million by weight
Load factors from CARB's In-Use Off-Road Equipment, 2010 Documentation Appendix D
Facility installation equipment spread includes one motor grader, one crane, one backhoe, and one welding machine

Construction Equipment Exhaust Total (tons)

Year	NOX	ROG	CO	PM10	SOX
2014	**1.54**	**0.13**	**0.89**	**0.09**	**0.00**
2015	**2.57**	**0.21**	**1.48**	**0.15**	**0.00**
2016	**1.67**	**0.14**	**0.96**	**0.10**	**0.00**
2017	**2.04**	**0.17**	**1.17**	**0.12**	**0.00**
2018	**1.87**	**0.15**	**1.08**	**0.11**	**0.00**
2019	**1.59**	**0.13**	**0.92**	**0.10**	**0.00**
2020	**0.31**	**0.03**	**0.18**	**0.02**	**0.00**
2021	**1.13**	**0.09**	**0.65**	**0.07**	**0.00**
2023	**0.65**	**0.05**	**0.37**	**0.04**	**0.00**
2024	**1.23**	**0.10**	**0.71**	**0.07**	**0.00**
2025	**1.19**	**0.10**	**0.68**	**0.07**	**0.00**
2026	**1.08**	**0.09**	**0.62**	**0.06**	**0.00**
2027	**1.07**	**0.09**	**0.62**	**0.06**	**0.00**
2028	**0.85**	**0.07**	**0.49**	**0.05**	**0.00**
2029	**0.83**	**0.07**	**0.48**	**0.05**	**0.00**
2030	**0.69**	**0.06**	**0.40**	**0.04**	**0.00**
2031	**0.11**	**0.01**	**0.06**	**0.01**	**0.00**
2032	**0.14**	**0.01**	**0.08**	**0.01**	**0.00**
2033	**1.13**	**0.09**	**0.65**	**0.07**	**0.00**

Table A-2
Estimated Pipeline Installation Criteria Air Pollutant Emissions
OEHI CO2 EOR PROJECT

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)						Total Emissions (tons)				
Equipment	Number	Fuel Type	BHP	Load Factor (%)	NOX	ROG	CO	PM10	SOX	Hrs/ Day	NOX	ROG	CO	PM10	SOX	Days	NOX	ROG	CO	PM10	SOX
2014																					
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	8	12.65	0.73	6.48	0.58	0.01	85	0.54	0.03	0.28	0.02	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	8	2.79	0.20	1.94	0.22	0.00	32.02	0.04	0.00	0.03	0.00	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	85	0.07	0.01	0.05	0.01	0.00
2015																					
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	8	12.65	0.73	6.48	0.58	0.01	285	1.80	0.10	0.92	0.08	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	8	2.79	0.20	1.94	0.22	0.00	100.2	0.14	0.01	0.10	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	285	0.24	0.05	0.18	0.02	0.00
2016																					
Cranes	2	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	8	25.30	1.45	12.95	1.15	0.02	292	3.69	0.21	1.89	0.17	0.00
Backhoes	2	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	8	5.58	0.41	3.87	0.45	0.00	112.3	0.31	0.02	0.22	0.03	0.00
Welders	2	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	3.44	0.65	2.56	0.34	0.00	292	0.50	0.10	0.37	0.05	0.00
2017																					
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	8	12.65	0.73	6.48	0.58	0.01	310	1.96	0.11	1.00	0.09	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	8	2.79	0.20	1.94	0.22	0.00	149.2	0.21	0.02	0.14	0.02	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	310	0.27	0.05	0.20	0.03	0.00
2018																					
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	8	12.65	0.73	6.48	0.58	0.01	41	0.26	0.01	0.13	0.01	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	8	2.79	0.20	1.94	0.22	0.00	21.71	0.03	0.00	0.02	0.00	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	41	0.04	0.01	0.03	0.00	0.00
2019																					
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	8	12.65	0.73	6.48	0.58	0.01	230	1.45	0.08	0.74	0.07	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	8	2.79	0.20	1.94	0.22	0.00	114.7	0.16	0.01	0.11	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	230	0.20	0.04	0.15	0.02	0.00
2020																					
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	8	12.65	0.73	6.48	0.58	0.01	82	0.52	0.03	0.27	0.02	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	8	2.79	0.20	1.94	0.22	0.00	44.45	0.06	0.00	0.04	0.00	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	82	0.07	0.01	0.05	0.01	0.00
2021																					
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	8	12.65	0.73	6.48	0.58	0.01	230	1.45	0.08	0.74	0.07	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	8	2.79	0.20	1.94	0.22	0.00	128.4	0.18	0.01	0.12	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	230	0.20	0.04	0.15	0.02	0.00

Table A-2
Estimated Pipeline Installation Criteria Air Pollutant Emissions
OEHI CO2 EOR PROJECT

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)						Total Emissions (tons)				
Equipment	Number	Fuel Type	BHP	Load Factor (%)	NOX	ROG	CO	PM10	SOX	Hrs/ Day	NOX	ROG	CO	PM10	SOX	Days	NOX	ROG	CO	PM10	SOX
2023																					
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	8	12.65	0.73	6.48	0.58	0.01	81	0.51	0.03	0.26	0.02	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	8	2.79	0.20	1.94	0.22	0.00	45.33	0.06	0.00	0.04	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	81	0.07	0.01	0.05	0.01	0.00
2024																					
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	8	12.65	0.73	6.48	0.58	0.01	189	1.20	0.07	0.61	0.05	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	8	2.79	0.20	1.94	0.22	0.00	105.8	0.15	0.01	0.10	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	189	0.16	0.03	0.12	0.02	0.00
2026																					
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	8	12.65	0.73	6.48	0.58	0.01	230	1.45	0.08	0.74	0.07	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	8	2.79	0.20	1.94	0.22	0.00	112.8	0.16	0.01	0.11	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	230	0.20	0.04	0.15	0.02	0.00
2027																					
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	8	12.65	0.73	6.48	0.58	0.01	349	2.21	0.13	1.13	0.10	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	8	2.79	0.20	1.94	0.22	0.00	142.7	0.20	0.01	0.14	0.02	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	349	0.30	0.06	0.22	0.03	0.00
2028																					
Cranes	2	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	8	25.30	1.45	12.95	1.15	0.02	187.5	2.37	0.14	1.21	0.11	0.00
Backhoes	2	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	8	5.58	0.41	3.87	0.45	0.00	83.5	0.23	0.02	0.16	0.02	0.00
Welders	2	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	3.44	0.65	2.56	0.34	0.00	187.5	0.32	0.06	0.24	0.03	0.00
2029																					
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	8	12.65	0.73	6.48	0.58	0.01	162	1.02	0.06	0.52	0.05	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	8	2.79	0.20	1.94	0.22	0.00	79.31	0.11	0.01	0.08	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	162	0.14	0.03	0.10	0.01	0.00
2030																					
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	8	12.65	0.73	6.48	0.58	0.01	257	1.63	0.09	0.83	0.07	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	8	2.79	0.20	1.94	0.22	0.00	104	0.15	0.01	0.10	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	257	0.22	0.04	0.16	0.02	0.00
2031																					
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	8	12.65	0.73	6.48	0.58	0.01	14	0.09	0.01	0.05	0.00	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	8	2.79	0.20	1.94	0.22	0.00	5.67	0.01	0.00	0.01	0.00	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	14	0.01	0.00	0.01	0.00	0.00

Table A-2
Estimated Pipeline Installation Criteria Air Pollutant Emissions
OEHI CO2 EOR PROJECT

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)						Total Emissions (tons)				
Equipment	Number	Fuel Type	BHP	Load Factor (%)	NOX	ROG	CO	PM10	SOX	Hrs/ Day	NOX	ROG	CO	PM10	SOX	Days	NOX	ROG	CO	PM10	SOX
2032																					
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	8	12.65	0.73	6.48	0.58	0.01	41	0.26	0.01	0.13	0.01	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	8	2.79	0.20	1.94	0.22	0.00	15.44	0.02	0.00	0.01	0.00	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	41	0.04	0.01	0.03	0.00	0.00
2033																					
Cranes	1	Diesel	300	28.8	1.830E-02	1.049E-03	9.369E-03	8.355E-04	1.102E-05	8	12.65	0.73	6.48	0.58	0.01	230	1.45	0.08	0.74	0.07	0.00
Backhoes	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	8	2.79	0.20	1.94	0.22	0.00	86.6	0.12	0.01	0.08	0.01	0.00
Welders	1	Diesel	50	34.2	1.256E-02	2.383E-03	9.369E-03	1.239E-03	1.323E-05	8	1.72	0.33	1.28	0.17	0.00	230	0.20	0.04	0.15	0.02	0.00

Data Sources/Notes:

Emission factors for NOX, ROG, PM10 from CARB's Offroad 2011, San Joaquin Valley fleet inventory (years 2009-2029)
ROG assumed to be 83.67% of total organic gases reported by OFFROAD 2011
CO emissions estimated using 4.25 grams per brake-horsepower hour
Total PM emissions from OFFROAD 2011 assumed to be PM10
SOX emissions estimated using fuel consumption rates and 15 parts per million by weight
Load factors from CARB's In-Use Off-Road Equipment, 2010 Documentation Appendix D
Backhoe not used for above ground locations and used 50% of days during below ground multi-line installation
Pipeline installation during 2016 & 2028 assume operation of two equipment spreads
Equipment pipeline installation spread includes one crane, backhoe, and welding machine

Construction Equipment Exhaust Total (tons)

Year	NOX	ROG	CO	PM10	SOX
2014	0.66	0.05	0.36	0.04	0.00
2015	2.19	0.16	1.20	0.12	0.00
2016	4.51	0.33	2.48	0.24	0.00
2017	2.44	0.18	1.35	0.13	0.00
2018	0.32	0.02	0.18	0.02	0.00
2019	1.81	0.13	1.00	0.10	0.00
2020	0.65	0.05	0.36	0.04	0.00
2021	1.83	0.13	1.02	0.10	0.00
2022					
2023	0.65	0.05	0.36	0.04	0.00
2024	1.51	0.11	0.84	0.08	0.00
2025					
2026	1.81	0.13	1.00	0.10	0.00
2027	2.71	0.20	1.49	0.15	0.00
2028	2.93	0.21	1.62	0.16	0.00
2029	1.27	0.09	0.71	0.07	0.00
2030	1.99	0.15	1.10	0.11	0.00
2031	0.11	0.01	0.06	0.01	0.00
2032	0.32	0.02	0.17	0.02	0.00
2033	1.77	0.13	0.98	0.10	0.00

Table A-3
Estimated Well Site Preparation, Drilling and Completion Criteria Air Pollutant Emissions
OEHI CO2 EOR PROJECT

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)				
Equipment	Number	Fuel	BHP	% Load	NOX	ROG	CO	PM10	SOX	Hrs/ Rig Day	NOX	ROG	CO	PM10	SOX
2016															
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01
Tracked Tractor	1	Diesel	285	39.5	1.897E-02	1.124E-03	9.369E-03	8.862E-04	1.102E-05	8	17.08	1.01	8.44	0.80	0.01
Backhoe	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	8	2.79	0.20	1.94	0.22	0.00
Compactor	1	Diesel	200	37.5	1.573E-02	1.184E-03	9.369E-03	1.175E-03	1.102E-05	4	4.72	0.36	2.81	0.35	0.00
Generator	2	Diesel	1020	50.3	1.156E-02	4.453E-04	9.369E-03	3.153E-04	1.102E-05	24	284.69	10.97	230.73	7.76	0.27
Criteria Pollutant Emissions per Rig Day											318.93	13.18	248.51	9.67	0.29

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)				
Equipment	Number	Fuel	BHP	% Load	NOX	ROG	CO	PM10	SOX	Hrs/ Rig Day	NOX	ROG	CO	PM10	SOX
2017															
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01
Tracked Tractor	1	Diesel	285	39.5	1.897E-02	1.124E-03	9.369E-03	8.862E-04	1.102E-05	8	17.08	1.01	8.44	0.80	0.01
Backhoe	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	18	6.28	0.46	4.36	0.50	0.01
Compactor	1	Diesel	200	37.5	1.573E-02	1.184E-03	9.369E-03	1.175E-03	1.102E-05	4	4.72	0.36	2.81	0.35	0.00
Generator	2	Diesel	1020	50.3	1.156E-02	4.453E-04	9.369E-03	3.153E-04	1.102E-05	24	284.69	10.97	230.73	7.76	0.27
Criteria Pollutant Emissions per Rig Day											322.42	13.43	250.93	9.95	0.30

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)				
Equipment	Number	Fuel	BHP	% Load	NOX	ROG	CO	PM10	SOX	Hrs/ Rig Day	NOX	ROG	CO	PM10	SOX
2020															
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01
Tracked Tractor	1	Diesel	285	39.5	1.897E-02	1.124E-03	9.369E-03	8.862E-04	1.102E-05	8	17.08	1.01	8.44	0.80	0.01
Backhoe	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	18	6.28	0.46	4.36	0.50	0.01
Compactor	1	Diesel	200	37.5	1.573E-02	1.184E-03	9.369E-03	1.175E-03	1.102E-05	4	4.72	0.36	2.81	0.35	0.00
Generator	2	Diesel	1020	50.3	1.156E-02	4.453E-04	9.369E-03	3.153E-04	1.102E-05	24	284.69	10.97	230.73	7.76	0.27
Criteria Pollutant Emissions per Rig Day											322.42	13.43	250.93	9.95	0.30

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)				
Equipment	Number	Fuel	BHP	% Load	NOX	ROG	CO	PM10	SOX	Hrs/ Rig Day	NOX	ROG	CO	PM10	SOX
2022															
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01
Tracked Tractor	1	Diesel	285	39.5	1.897E-02	1.124E-03	9.369E-03	8.862E-04	1.102E-05	8	17.08	1.01	8.44	0.80	0.01
Backhoe	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	18	6.28	0.46	4.36	0.50	0.01
Compactor	1	Diesel	200	37.5	1.573E-02	1.184E-03	9.369E-03	1.175E-03	1.102E-05	4	4.72	0.36	2.81	0.35	0.00
Generator	2	Diesel	1020	50.3	1.156E-02	4.453E-04	9.369E-03	3.153E-04	1.102E-05	24	284.69	10.97	230.73	7.76	0.27
Criteria Pollutant Emissions per Rig Day											322.42	13.43	250.93	9.95	0.30

Table A-3
Estimated Well Site Preparation, Drilling and Completion Criteria Air Pollutant Emissions
OEHI CO2 EOR PROJECT

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)				
Equipment	**Number**	**Fuel**	**BHP**	**% Load**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**	**Hrs/ Rig Day**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**
2023															
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01
Tracked Tractor	1	Diesel	285	39.5	1.897E-02	1.124E-03	9.369E-03	8.862E-04	1.102E-05	8	17.08	1.01	8.44	0.80	0.01
Backhoe	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	18	6.28	0.46	4.36	0.50	0.01
Compactor	1	Diesel	200	37.5	1.573E-02	1.184E-03	9.369E-03	1.175E-03	1.102E-05	4	4.72	0.36	2.81	0.35	0.00
Generator	2	Diesel	1020	50.3	1.156E-02	4.453E-04	9.369E-03	3.153E-04	1.102E-05	24	284.69	10.97	230.73	7.76	0.27
Criteria Pollutant Emissions per Rig Day											322.42	13.43	250.93	9.95	0.30

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)				
Equipment	**Number**	**Fuel**	**BHP**	**% Load**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**	**Hrs/ Rig Day**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**
2025															
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01
Tracked Tractor	1	Diesel	285	39.5	1.897E-02	1.124E-03	9.369E-03	8.862E-04	1.102E-05	8	17.08	1.01	8.44	0.80	0.01
Backhoe	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	18	6.28	0.46	4.36	0.50	0.01
Compactor	1	Diesel	200	37.5	1.573E-02	1.184E-03	9.369E-03	1.175E-03	1.102E-05	4	4.72	0.36	2.81	0.35	0.00
Generator	2	Diesel	1020	50.3	1.156E-02	4.453E-04	9.369E-03	3.153E-04	1.102E-05	24	284.69	10.97	230.73	7.76	0.27
Criteria Pollutant Emissions per Rig Day											322.42	13.43	250.93	9.95	0.30

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)				
Equipment	**Number**	**Fuel**	**BHP**	**% Load**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**	**Hrs/ Rig Day**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**
2029															
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01
Tracked Tractor	1	Diesel	285	39.5	1.897E-02	1.124E-03	9.369E-03	8.862E-04	1.102E-05	8	17.08	1.01	8.44	0.80	0.01
Backhoe	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	18	6.28	0.46	4.36	0.50	0.01
Compactor	1	Diesel	200	37.5	1.573E-02	1.184E-03	9.369E-03	1.175E-03	1.102E-05	4	4.72	0.36	2.81	0.35	0.00
Generator	2	Diesel	1020	50.3	1.156E-02	4.453E-04	9.369E-03	3.153E-04	1.102E-05	24	284.69	10.97	230.73	7.76	0.27
Criteria Pollutant Emissions per Rig Day											322.42	13.43	250.93	9.95	0.30

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)				
Equipment	**Number**	**Fuel**	**BHP**	**% Load**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**	**Hrs/ Rig Day**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**
2031															
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01
Tracked Tractor	1	Diesel	285	39.5	1.897E-02	1.124E-03	9.369E-03	8.862E-04	1.102E-05	8	17.08	1.01	8.44	0.80	0.01
Backhoe	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	18	6.28	0.46	4.36	0.50	0.01
Compactor	1	Diesel	200	37.5	1.573E-02	1.184E-03	9.369E-03	1.175E-03	1.102E-05	4	4.72	0.36	2.81	0.35	0.00
Generator	2	Diesel	1020	50.3	1.156E-02	4.453E-04	9.369E-03	3.153E-04	1.102E-05	24	284.69	10.97	230.73	7.76	0.27
Criteria Pollutant Emissions per Rig Day											322.42	13.43	250.93	9.95	0.30

Table A-3
Estimated Well Site Preparation, Drilling and Completion Criteria Air Pollutant Emissions
OEHI CO2 EOR PROJECT

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)				
Equipment	**Number**	**Fuel**	**BHP**	**% Load**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**	**Hrs/ Rig Day**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**
2033															
Motor Grader	1	Diesel	150	40.9	1.965E-02	1.307E-03	9.369E-03	1.089E-03	1.102E-05	8	9.64	0.64	4.60	0.53	0.01
Tracked Tractor	1	Diesel	285	39.5	1.897E-02	1.124E-03	9.369E-03	8.862E-04	1.102E-05	8	17.08	1.01	8.44	0.80	0.01
Backhoe	1	Diesel	70	36.9	1.351E-02	9.810E-04	9.369E-03	1.082E-03	1.102E-05	18	6.28	0.46	4.36	0.50	0.01
Compactor	1	Diesel	200	37.5	1.573E-02	1.184E-03	9.369E-03	1.175E-03	1.102E-05	4	4.72	0.36	2.81	0.35	0.00
Generator	2	Diesel	1020	50.3	1.156E-02	4.453E-04	9.369E-03	3.153E-04	1.102E-05	24	284.69	10.97	230.73	7.76	0.27
Criteria Pollutant Emissions per Rig Day											322.42	13.43	250.93	9.95	0.30

Data Sources/Notes:

Emission factors for NOX, ROG, PM10 from CARB's Offroad 2011, San Joaquin Valley fleet inventory (years 2009-2029)

ROG assumed to be 83.67% of total organic gases reported by OFFROAD 2011

CO emissions estimated using 4.25 grams per brake-horsepower hour

Total PM emissions from OFFROAD 2011 assumed to be PM10

SOX emissions estimated using fuel consumption rates and 15 parts per million by weight

Load factors from CARB's In-Use Off-Road Equipment, 2010 Documentation Appendix D

Table A-3
Estimated Well Site Preparation, Drilling and Completion Criteria Air Pollutant Emissions
OEHI CO2 EOR PROJECT

Emissions From Site Preparation (Tons/Year)							
Year	No. Sites	Site Days	NOX	ROG	CO	PM10	SOX
2016	18	36	0.62	0.04	0.32	0.03	0.00
2017	4	8	0.15	0.01	0.08	0.01	0.00
2020	8	16	0.30	0.02	0.16	0.02	0.00
2022	9	18	0.34	0.02	0.18	0.02	0.00
2023	27	54	1.02	0.07	0.55	0.06	0.00
2025	20	40	0.75	0.05	0.40	0.04	0.00
2029	20	40	0.75	0.05	0.40	0.04	0.00
2031	21	42	0.79	0.05	0.42	0.05	0.00
2033	23	46	0.87	0.06	0.46	0.05	0.00
Total	150	300	5.60	0.37	2.99	0.32	0.00

Emissions From Well Drilling (Tons/Year)							
Year	No. Well	Rig Days	NOX	ROG	CO	PM10	SOX
2016	18	252	35.87	1.38	29.07	0.98	0.03
2017	4	56	7.97	0.31	6.46	0.22	0.01
2020	8	112	15.94	0.61	12.92	0.43	0.02
2022	9	126	17.94	0.69	14.54	0.49	0.02
2023	27	378	53.81	2.07	43.61	1.47	0.05
2025	20	280	39.86	1.54	32.30	1.09	0.04
2029	20	280	39.86	1.54	32.30	1.09	0.04
2031	21	294	41.85	1.61	33.92	1.14	0.04
2033	23	322	45.83	1.77	37.15	1.25	0.04
Total	150	2,100	298.92	11.51	242.27	8.15	0.28

Emissions From Well Completion (Tons/Year)							
Year	Well	Rig Days	NOX	ROG	CO	PM10	SOX
2016	18	72	1.43	0.07	1.12	0.05	0.00
2017	4	16	0.32	0.01	0.25	0.01	0.00
2020	8	32	0.63	0.03	0.50	0.02	0.00
2022	9	36	0.71	0.03	0.56	0.02	0.00
2023	27	108	2.14	0.10	1.69	0.07	0.00
2025	20	80	1.58	0.07	1.25	0.05	0.00
2029	20	80	1.58	0.07	1.25	0.05	0.00
2031	21	84	1.66	0.08	1.31	0.05	0.00
2033	23	92	1.82	0.09	1.44	0.06	0.00
Total	150	-------	11.88	0.56	9.37	0.38	0.01

Table A-3
Estimated Well Site Preparation, Drilling and Completion Criteria Air Pollutant Emissions
OEHI CO2 EOR PROJECT

Total Emissions From Well Installation (Tons/Year)							
Year	**Well**	**Total**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**
2016	18	Total =	37.91	1.49	30.52	1.06	0.04
2017	4	Total =	8.44	0.33	6.79	0.24	0.01
2020	8	Total =	16.88	0.66	13.58	0.47	0.02
2022	9	Total =	18.99	0.75	15.28	0.53	0.02
2023	27	Total =	56.96	2.24	45.84	1.60	0.05
2025	20	Total =	42.19	1.66	33.96	1.18	0.04
2029	20	Total =	42.19	1.66	33.96	1.18	0.04
2031	21	Total =	44.30	1.74	35.65	1.24	0.04
2033	23	Total =	48.52	1.91	39.05	1.36	0.05
Total	150	-------	316.40	12.44	254.63	8.86	0.30

NOTE: Total well installation emissions shown above include site preparation, well drilling and well completions. The summary of well installation emissions shown in Table A-3 include the summary of well completion emissions shown in Table A-4. Table A-4 is a detailed supplement to Table A-3.

Table A-4
Estimated Well Completion Criteria Air Pollutant Emissions
OEHI CO2 EOR PROJECT

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)				
Equipment	**Number**	**Fuel**	**BHP**	**% Load**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**	**Hrs/ Day**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**
2016															
Mobile Rig	1	Diesel	425	50.3	1.231E-02	5.798E-04	9.369E-03	3.880E-04	1.102E-05	12	31.58	1.49	24.03	1.00	0.03
Pump	1	Diesel	375	34.20	1.043E-02	4.784E-04	9.369E-03	3.593E-04	1.102E-05	6	8.03	0.37	7.21	0.28	0.01
Criteria Pollutant Emissions per Rig Day											39.60	1.86	31.24	1.27	0.04

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)				
Equipment	**Number**	**Fuel**	**BHP**	**% Load**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**	**Hrs/ Day**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**
2017															
Mobile Rig	1	Diesel	425	50.3	1.231E-02	5.798E-04	9.369E-03	3.880E-04	1.102E-05	12	31.58	1.49	24.03	1.00	0.03
Pump	1	Diesel	375	34.20	1.043E-02	4.784E-04	9.369E-03	3.593E-04	1.102E-05	6	8.03	0.37	7.21	0.28	0.01
Criteria Pollutant Emissions per Rig Day											39.60	1.86	31.24	1.27	0.04

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)				
Equipment	**Number**	**Fuel**	**BHP**	**% Load**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**	**Hrs/ Day**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**
2020															
Mobile Rig	1	Diesel	425	50.30	1.231E-02	5.798E-04	9.369E-03	3.880E-04	1.102E-05	12	31.58	1.49	24.03	1.00	0.03
Pump	1	Diesel	375	34.20	1.043E-02	4.784E-04	9.369E-03	3.593E-04	1.102E-05	6	8.03	0.37	7.21	0.28	0.01
Criteria Pollutant Emissions per Rig Day											39.60	1.86	31.24	1.27	0.04

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)				
Equipment	**Number**	**Fuel**	**BHP**	**% Load**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**	**Hrs/ Day**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**
2022															
Mobile Rig	1	Diesel	425	50.30	1.231E-02	5.798E-04	9.369E-03	3.880E-04	1.102E-05	12	31.58	1.49	24.03	1.00	0.03
Pump	1	Diesel	375	34.20	1.043E-02	4.784E-04	9.369E-03	3.593E-04	1.102E-05	6	8.03	0.37	7.21	0.28	0.01
Criteria Pollutant Emissions per Rig Day											39.60	1.86	31.24	1.27	0.04

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)				
Equipment	**Number**	**Fuel**	**BHP**	**% Load**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**	**Hrs/ Day**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**
2023															
Mobile Rig	1	Diesel	425	50.30	1.231E-02	5.798E-04	9.369E-03	3.880E-04	1.102E-05	12	31.58	1.49	24.03	1.00	0.03
Pump	1	Diesel	375	34.20	1.043E-02	4.784E-04	9.369E-03	3.593E-04	1.102E-05	6	8.03	0.37	7.21	0.28	0.01
Criteria Pollutant Emissions per Rig Day											39.60	1.86	31.24	1.27	0.04

Table A-4
Estimated Well Completion Criteria Air Pollutant Emissions
OEHI CO2 EOR PROJECT

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)				
Equipment	**Number**	**Fuel**	**BHP**	**% Load**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**	**Hrs/ Day**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**
2025															
Mobile Rig	1	Diesel	425	50.30	1.231E-02	5.798E-04	9.369E-03	3.880E-04	1.102E-05	12	31.58	1.49	24.03	1.00	0.03
Pump	1	Diesel	375	34.20	1.043E-02	4.784E-04	9.369E-03	3.593E-04	1.102E-05	6	8.03	0.37	7.21	0.28	0.01
Criteria Pollutant Emissions per Rig Day											39.60	1.86	31.24	1.27	0.04

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)				
Equipment	**Number**	**Fuel**	**BHP**	**% Load**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**	**Hrs/ Day**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**
2029															
Mobile Rig	1	Diesel	425	50.30	1.231E-02	5.798E-04	9.369E-03	3.880E-04	1.102E-05	12	31.58	1.49	24.03	1.00	0.03
Pump	1	Diesel	375	34.20	1.043E-02	4.784E-04	9.369E-03	3.593E-04	1.102E-05	6	8.03	0.37	7.21	0.28	0.01
Criteria Pollutant Emissions per Rig Day											39.60	1.86	31.24	1.27	0.04

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)				
Equipment	**Number**	**Fuel**	**BHP**	**% Load**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**	**Hrs/ Day**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**
2031															
Mobile Rig	1	Diesel	425	50.30	1.231E-02	5.798E-04	9.369E-03	3.880E-04	1.102E-05	12	31.58	1.49	24.03	1.00	0.03
Pump	1	Diesel	375	34.20	1.043E-02	4.784E-04	9.369E-03	3.593E-04	1.102E-05	6	8.03	0.37	7.21	0.28	0.01
Criteria Pollutant Emissions per Rig Day											39.60	1.86	31.24	1.27	0.04

					Emission Factors (lbs/bhp-hr)						Emissions (lbs/day)				
Equipment	**Number**	**Fuel**	**BHP**	**% Load**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**	**Hrs/ Day**	**NOX**	**ROG**	**CO**	**PM10**	**SOX**
2033															
Mobile Rig	1	Diesel	425	50.30	1.231E-02	5.798E-04	9.369E-03	3.880E-04	1.102E-05	12	31.58	1.49	24.03	1.00	0.03
Pump	1	Diesel	375	34.20	1.043E-02	4.784E-04	9.369E-03	3.593E-04	1.102E-05	6	8.03	0.37	7.21	0.28	0.01
Criteria Pollutant Emissions per Rig Day											39.60	1.86	31.24	1.27	0.04

Data Sources/Notes:

Emission factors for NOX, ROG, PM10 from CARB's Offroad 2011, San Joaquin Valley fleet inventory (years 2009-2029)
ROG assumed to be 83.67% of total organic gases reported by OFFROAD 2011
CO emissions estimated using 4.25 grams per brake-horsepower hour
Total PM emissions from OFFROAD 2011 assumed to be PM10
SOX emissions estimated using fuel consumption rates and 15 parts per million by weight
Load factors from CARB's In-Use Off-Road Equipment, 2010 Documentation Appendix D

Table A-4
Estimated Well Completion Criteria Air Pollutant Emissions
OEHI CO2 EOR PROJECT

Emissions From Well Completion (Tons/Year)							
Year	Well	Rig Days	NOX	ROG	CO	PM10	SOX
2016	18	72	1.43	0.07	1.12	0.05	0.00
2017	4	16	0.32	0.01	0.25	0.01	0.00
2020	8	32	0.63	0.03	0.50	0.02	0.00
2022	9	36	0.71	0.03	0.56	0.02	0.00
2023	27	108	2.14	0.10	1.69	0.07	0.00
2025	20	80	1.58	0.07	1.25	0.05	0.00
2029	20	80	1.58	0.07	1.25	0.05	0.00
2031	21	84	1.66	0.08	1.31	0.05	0.00
2033	23	92	1.82	0.09	1.44	0.06	0.00
Total	150	600	11.88	0.56	9.37	0.38	0.01

NOTE: Total well installation emissions shown in Table A-3 include the well completion emissions shown above in Table A-4. Table A-4 is a detailed supplement to Table A-3.

Table A-5
Estimated Well Conversion Criteria Air Pollutant Emissions
OEHI CO2 EOR PROJECT

Average emissions per well conversion (based on annual average of well completion emissions)

Emissions (lbs/day)				
NOX	ROG	CO	PM10	SOX
39.60	1.86	31.24	1.27	0.04

Emissions From Well Conversion (Tons/Year)							
Year	Well	Rig Days	NOX	ROG	CO	PM10	SOX
2014	36	144	2.85	0.13	2.25	0.09	0.00
2015	36	144	2.85	0.13	2.25	0.09	0.00
2016	18	72	1.43	0.07	1.12	0.05	0.00
2017	32	128	2.53	0.12	2.00	0.08	0.00
2018	36	144	2.85	0.13	2.25	0.09	0.00
2019	36	144	2.85	0.13	2.25	0.09	0.00
2020	28	112	2.22	0.10	1.75	0.07	0.00
2021	36	144	2.85	0.13	2.25	0.09	0.00
2022	27	108	2.14	0.10	1.69	0.07	0.00
2023	9	36	0.71	0.03	0.56	0.02	0.00
2024	36	144	2.85	0.13	2.25	0.09	0.00
2025	16	64	1.27	0.06	1.00	0.04	0.00
2026	36	144	2.85	0.13	2.25	0.09	0.00
2027	36	144	2.85	0.13	2.25	0.09	0.00
2028	36	144	2.85	0.13	2.25	0.09	0.00
2029	16	64	1.27	0.06	1.00	0.04	0.00
2030	36	144	2.85	0.13	2.25	0.09	0.00
2031	15	60	1.19	0.06	0.94	0.04	0.00
2032	36	144	2.85	0.13	2.25	0.09	0.00
2033	13	52	1.03	0.05	0.81	0.03	0.00
Total	570	2280	45.14	2.12	35.61	1.45	0.05

TABLE A-6
FUGITIVE DUST CONSTRUCTION EMISSIONS-Tons (Assumes 80% Reduction through Controls)
Main Plant

Location	Const. Days	Period	PM2.5	PM10	PM30
RCF & CTB	522	1/1/2014 - 12/30/2015	0.71	7.08	17.97
EPC & CRP	615	4/1/2017 - 4/30/2019	0.83	8.34	21.18
CTB Phase 2	65	9/1/2023 - 11/30/2023	0.04	0.4	0.83
Additional CTB Tanks & Pumps	313	10/1/2024 - 12/30/2025	0.12	1.2	3.06

$E=0.15(s/12)^a(W/3)^b$
E=Lbs/vehicle mi traveled
s=silt content
W=mean vehicle weight
a & b factors from AP-42

Assumptions RCF & CTB
11 vehicles
8 mi/day/vehicle
3-hvy duty
3-front end loader
5-truck/tractors
silt content 8.5%
10.75 ton mean vehicle weight
80% dust control

Assumptions CTB Phase 2
5 vehicles
8 mi/day/vehicle
2-hvy duty
1-front end loader
2-truck/tractors
silt content 8.5%
10.75 ton mean vehicle weight
80% dust control

Assumptions EPC & CRP
11 vehicles
8 mi/day/vehicle
3-hvy duty
3-front end loader
5-truck/tractors
silt content 8.5%
10.75 ton mean vehicle weight
80% dust control

Assumptions Additional CTB Tanks & Pumps
5 vehicles
5 mi/day/vehicle
2-hvy duty
1-front end loader
2-truck/tractors
silt content 8.5%
10.75 ton mean vehicle weight
80% dust control

TABLE A-7

FUGITIVE DUST CONSTRUCTION EMISSIONS-Tons (Assumes 80% Reduction through Controls)

SATELLITE LOCATIONS AND PIPELINES

Location	Const. Days	Period	PM2.5	PM10	PM30
Satellite 1 & Flow Lines	173	10/1/2014 - 6/30/2015	0.05	0.5	1.28
Trunk Lines - 1&2	283	9/1/2014 - 9/30/2015	0.16	1.64	4.17
Satellite 2 & Flow Lines	151	1/1/2015 - 9/30/2015	0.04	0.44	1.11
Satellite 3 & Flow Lines	151	12/1/2015 - 1/30/2016	0.04	0.44	1.11
Trunk Lines 3	218	9/1/2015 - 6/30/2016	0.13	1.26	3.22
Satellite 4 & Flow Lines	270	2/1/2016 - 3/30/2017	0.08	0.78	1.99
Trunk Lines 4-9	262	3/1/2016 - 3/30/2017	0.61	1.52	3.86
Satellite 5 & Flow Lines	270	2/1/2017 - 3/30/2018	0.08	0.78	1.99
Satellite 6 & Flow Lines	270	2/1/2019 - 3/30/2020	0.08	0.78	1.99
Satellite 7 & Flow Lines	270	11/1/2020 - 12/30/2021	0.08	0.78	1.99
Satellite 8 & Flow Lines	270	9/1/2023 - 10/30/2024	0.08	0.78	1.99
Satellite 9 & Flow Lines	270	2/1/2026 - 3/30/2027	0.08	0.78	1.99
Satellite 10 & Flow Lines	270	4/1/2027 - 5/30/2028	0.08	0.78	1.99
Trunk Lines 10-13	304	3/1/2027 - 5/30/2028	0.18	1.76	4.48
Satellite 11 & Flow Lines	270	8/1/2028 - 8/30/2029	0.08	0.78	1.99
Satellite 12 & Flow Lines	270	6/1/2030 - 6/30/2031	0.08	0.78	1.99
Satellite 13 & Flow Lines	270	11/1/2032 - 12/30/2033	0.08	0.78	1.99

Assumptions

5 vehicles
5 mi/day/vehicle
2-hvy duty
1-front end loader
2-truck/tractors
silt content 8.5%
8.1 ton mean vehicle weight
80% dust control

E=0.15(s/12)a(W/3)b
E=Lbs/vehicle mi traveled
s=silt content
W=mean vehicle weight
a & b factors from AP-42

TABLE A-8
FUGITIVE DUST CONSTRUCTION EMISSIONS-Tons (Assumes 80% Reduction through Controls)
Total Fugitive Dust Emissions

Pollutant	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
PM10	4.21	6.16	2.84	3.98	4.35	2.05	0.30	0.72	0.00	0.64	0.77	1.03	0.66	1.92	1.20	0.48	0.42	0.36	0.12	0.72

TABLE A-9
All Estimated Onroad Vehicle Criteria Air Pollutant Emissions (Construction Personnel, Supply Transport, and Operations Personnel)
OEHI CO2 EOR PROJECT

			NOX		ROG						CO		PM10				SOX		Emissions (lbs/day)					
Vehicle Class	Number (trips)	VMT	Run Exhaust (g/mi)	Start-Up (g/st)	Run Exhaust (g/mi)	Start-Up (g/st)	Hot-Soak (g/trip)	Rest Loss (g/hr)	Run Evap (g/hr)	Diurnal Evap (g/hr)	Run Exhaust (g/mi)	Start-Up (g/st)	Run Exhaust (g/mi)	Start-Up (g/st)	Tire Wear (g/mi)	Brake Wear (g/mi)	Run Exhaust (g/mi)	Start-Up (g/st)	NOX	ROG	CO	PM10	SOX	Days
2014																								
LDA-All	140	60	0.123	0.26	0.031	0.601	0.159	0.041	0.031	0.091	1.497	6.885	0.009	0.0017	0.008	0.013	0.003	0.002	2.44	1.00	31.97	0.56	0.06	250
HDD-All	3	60	9.806	1.286	0.601	1.658	0.007	0	0.001	0	3.344	30.89	0.334	0.003	0.036	0.028	0.017	0.001	3.91	0.26	1.74	0.16	0.01	250
2015																								
LDA-All	256	60	0.109	0.229	0.026	0.529	0.15	0.038	0.029	0.083	1.338	6.184	0.009	0.016	0.008	0.013	0.003	0.002	3.95	1.56	52.29	1.03	0.10	250
HDD-All	5	60	8.599	1.258	0.546	3.896	0.006	0	0.001	0	3.048	29.1	0.295	0.003	0.036	0.028	0.017	0.001	5.71	0.45	2.66	0.24	0.01	250
2016																								
LDA-All	50	60	0.097	0.203	0.022	0.468	0.142	0.036	0.027	0.076	1.21	5.576	0.009	0.016	0.008	0.013	0.003	0.002	0.69	0.27	9.23	0.20	0.02	250
HDD-All	2	60	7.505	1.229	0.495	1.417	0.005	0	0.001	0	2.781	28.39	0.259	0.003	0.036	0.028	0.017	0.001	2.00	0.14	0.99	0.09	0.00	250
2017																								
LDA-All	174	60	0.086	0.179	0.019	0.414	0.135	0.034	0.025	0.07	1.096	5.021	0.009	0.016	0.008	0.013	0.003	0.002	2.12	0.81	29.08	0.70	0.07	250
HDD-All	4	60	6.526	1.202	0.448	1.315	0.004	0	0.001	0	2.537	27.62	0.226	0.003	0.036	0.028	0.017	0.001	3.47	0.26	1.83	0.15	0.01	250
2018																								
LDA-All	186	60	0.078	0.157	0.016	0.367	0.127	0.032	0.023	0.065	0.997	4.521	0.009	0.016	0.008	0.013	0.003	0.002	2.05	0.75	28.24	0.75	0.08	250
HDD-All	4	60	5.666	1.178	0.405	1.237	0.005	0	0.001	0	2.318	27.37	0.197	0.003	0.036	0.028	0.017	0.001	3.02	0.24	1.71	0.14	0.01	250
2019																								
LDA-All	268	60	0.07	0.139	0.014	0.326	0.121	0.03	0.022	0.06	0.914	4.081	0.009	0.016	0.008	0.013	0.003	0.002	2.65	0.95	37.22	1.08	0.11	250
HDD-All	5	60	4.947	1.153	0.368	1.16	0.003	0	0	0	2.134	27.17	0.173	0.003	0.036	0.028	0.017	0.001	3.30	0.27	2.01	0.16	0.01	250
2020																								
LDA-All	46	60	0.064	0.123	0.013	0.291	0.114	0.028	0.021	0.056	0.845	3.659	0.008	0.016	0.008	0.013	0.003	0.002	0.41	0.15	5.88	0.18	0.02	250
HDD-All	2	60	4.362	1.126	0.338	1.084	0.003	0	0	0	1.981	26.93	0.153	0.003	0.036	0.028	0.017	0.001	1.16	0.10	0.76	0.06	0.00	250
2021																								
LDA-All	52	60	0.059	0.109	0.012	0.261	0.109	0.026	0.02	0.052	0.787	3.362	0.009	0.016	0.008	0.013	0.003	0.002	0.43	0.16	6.18	0.21	0.02	250
HDD-All	2	60	3.92	1.105	0.315	1.021	0.003	0	0	0	1.866	26.84	0.139	0.003	0.036	0.028	0.017	0.001	1.05	0.09	0.73	0.05	0.00	250
2022																								
LDA-All	27	60	0.055	0.097	0.011	0.235	0.104	0.025	0.019	0.048	0.736	3.069	0.009	0.016	0.008	0.013	0.003	0.002	0.21	0.07	2.99	0.11	0.01	250
HDD-All	1	60	3.576	1.083	0.297	0.953	0.003	0	0	0	1.775	26.59	0.036	0.003	0.036	0.028	0.127	0.001	0.48	0.04	0.35	0.01	0.02	250
2023																								
LDA-All	31	60	0.051	0.087	0.01	0.212	0.099	0.023	0.019	0.045	0.692	2.813	0.009	0.016	0.008	0.013	0.003	0.002	0.22	0.08	3.22	0.13	0.01	250
HDD-All	2	60	3.305	1.07	0.282	0.81	0.003	0	0	0	1.703	26.51	0.118	0.003	0.036	0.028	0.017	0.001	0.88	0.08	0.68	0.05	0.00	250
2024																								
LDA-All	73	60	0.047	0.079	0.009	0.192	0.094	0.022	0.018	0.041	0.652	0.259	0.009	0.016	0.008	0.013	0.003	0.002	0.48	0.17	6.38	0.29	0.03	250
HDD-All	2	60	3.087	1.057	0.27	0.896	0.003	0	0	0	1.644	26.4	0.11	0.003	0.036	0.028	0.017	0.001	0.83	0.08	0.67	0.05	0.00	250
2025																								
LDA-All	81	60	0.045	0.071	0.008	0.175	0.09	0.02	0.017	0.038	0.62	2.402	0.009	0.016	0.008	0.013	0.003	0.002	0.51	0.17	7.50	0.33	0.03	250
HDD-All	3	60	2.916	1.048	0.26	0.829	0.003	0	0	0	1.597	26.2	0.104	0.003	0.036	0.028	0.017	0.001	1.17	0.11	0.98	0.07	0.01	250
2026																								
LDA-All	28	60	0.042	0.065	0.008	0.161	0.086	0.019	0.017	0.036	0.592	2.24	0.009	0.016	0.008	0.013	0.003	0.002	0.16	0.06	2.47	0.11	0.01	250
HDD-All	1	60	2.779	1.033	0.253	0.777	0.003	0	0	0	1.559	25.63	0.099	0.003	0.036	0.028	0.017	0.001	0.37	0.04	0.32	0.02	0.00	250
2027																								
LDA-All	52	60	0.05	0.059	0.007	0.147	0.082	0.018	0.017	0.033	0.567	2.099	0.009	0.016	0.008	0.013	0.003	0.002	0.36	0.09	4.38	0.21	0.02	250
HDD-All	2	60	2.672	1.032	0.246	0.758	0.003	0	0	0	1.53	25.71	0.095	0.004	0.036	0.028	0.017	0.001	0.72	0.07	0.63	0.04	0.00	250

TABLE A-9
All Estimated Onroad Vehicle Criteria Air Pollutant Emissions (Construction Personnel, Supply Transport, and Operations Personnel)
OEHI CO2 EOR PROJECT

			NOX		ROG						CO		PM10				SOX		Emissions (lbs/day)					
Vehicle Class	Number (trips)	VMT	Run Exhaust (g/mi)	Start-Up (g/st)	Run Exhaust (g/mi)	Start-Up (g/st)	Hot-Soak (g/trip)	Rest Loss (g/hr)	Run Evap (g/hr)	Diurnal Evap (g/hr)	Run Exhaust (g/mi)	Start-Up (g/st)	Run Exhaust (g/mi)	Start-Up (g/st)	Tire Wear (g/mi)	Brake Wear (g/mi)	Run Exhaust (g/mi)	Start-Up (g/st)	NOX	ROG	CO	PM10	SOX	Days
2028																								
LDA-All	89	60	0.038	0.054	0.007	0.136	0.078	0.017	0.016	0.03	0.546	1.975	0.009	0.016	0.008	0.013	0.003	0.002	0.47	0.15	7.20	0.36	0.04	250
HDD-All	2	60	2.587	1.033	0.241	0.736	0.003	0	0	0	1.506	25.72	0.092	0.004	0.036	0.028	0.017	0.001	0.69	0.07	0.63	0.04	0.00	250
2029																								
LDA-All	47	60	0.036	0.05	0.006	0.125	0.075	0.016	0.016	0.027	0.526	1.864	0.009	0.016	0.008	0.013	0.003	0.002	0.23	0.07	3.66	0.19	0.02	250
HDD-All	2	60	2.515	1.027	0.236	0.703	0.003	0	0	0	1.484	25.37	0.089	0.004	0.036	0.028	0.017	0.001	0.67	0.07	0.62	0.04	0.00	250
2030																								
LDA-All	28	60	0.035	0.046	0.006	0.116	0.071	0.014	0.016	0.025	0.51	1.768	0.009	0.016	0.008	0.013	0.003	0.002	0.14	0.04	2.11	0.11	0.01	250
HDD-All	1	60	2.456	1.029	0.233	5.791	0.003	0	0	0	1.467	25.57	0.086	0.004	0.036	0.028	0.017	0.001	0.33	0.06	0.31	0.02	0.00	250
2031																								
LDA-All	46	60	0.034	0.042	0.006	0.108	0.068	0.013	0.015	0.023	0.496	1.684	0.009	0.016	0.008	0.013	0.003	0.002	0.22	0.07	3.36	0.19	0.02	250
HDD-All	2	60	2.405	1.027	0.229	0.675	0.003	0	0	0	1.451	25.69	0.084	0.004	0.036	0.028	0.017	0.001	0.65	0.07	0.61	0.04	0.00	250
2032																								
LDA-All	28	60	0.033	0.039	0.006	0.1	0.065	0.012	0.015	0.021	0.483	1.608	0.009	0.016	0.008	0.013	0.003	0.002	0.13	0.04	1.99	0.11	0.01	250
HDD-All	1	60	2.636	1.023	0.226	0.654	0.003	0	0	0	1.438	25.82	0.083	0.004	0.036	0.028	0.017	0.001	0.35	0.03	0.30	0.02	0.00	250
2033																								
LDA-All	44	60	0.032	0.036	0.045	0.094	0.062	0.012	0.015	0.019	0.472	1.54	0.009	0.016	0.008	0.013	0.003	0.002	0.19	0.29	3.05	0.18	0.02	250
HDD-All	2	60	2.329	1.021	0.224	0.64	0.003	0	0	0	1.427	25.98	0.081	0.004	0.036	0.028	0.017	0.001	0.63	0.06	0.61	0.04	0.00	250

Assumptions/Notes:

Onroad emissions factors from EMFAC 2007
SJVAPCD, 2013-2035, 70 degrees F, 50% RH
Assumes startup after 12 hours
Vehicle speed = 40 mph
20 min hot soak per trip
15 min rest each trip
45 min run time
Light-Duty Automobile (LDA) assumes all fuel types
Heavy-Duty Truck (HDD) assumes all fuel types
VMT = Vehicle Miles Traveled

Total (tons)	NOX	ROG	CO	PM10	SOX
2014	0.79	0.16	4.21	0.09	0.01
2015	1.21	0.25	6.87	0.16	0.01
2016	0.34	0.05	1.28	0.04	0.00
2017	0.70	0.13	3.86	0.11	0.01
2018	0.63	0.12	3.74	0.11	0.01
2019	0.74	0.15	4.90	0.15	0.01
2020	0.20	0.03	0.83	0.03	0.00
2021	0.18	0.03	0.86	0.03	0.00
2022	0.09	0.01	0.42	0.02	0.00
2023	0.14	0.02	0.49	0.02	0.00
2024	0.16	0.03	0.88	0.04	0.00

Total (tons)	NOX	ROG	CO	PM10	SOX
2025	0.21	0.03	1.06	0.05	0.00
2026	0.07	0.01	0.35	0.02	0.00
2027	0.13	0.02	0.63	0.03	0.00
2028	0.15	0.03	0.98	0.05	0.01
2029	0.11	0.02	0.53	0.03	0.00
2030	0.06	0.01	0.30	0.02	0.00
2031	0.11	0.02	0.50	0.03	0.00
2032	0.06	0.01	0.29	0.01	0.00
2033	0.10	0.04	0.46	0.02	0.00

Table A-10
Total Estimated Construction Criteria Air Pollutant Emissions
OEHI CO2 EOR Project

Year	NOX (tons)	ROG (tons)	CO (tons)	PM10 (tons)	SOX (tons)
2014	5.84	0.47	7.71	4.52	0.01
2015	8.81	0.76	11.80	6.68	0.02
2016	45.85	2.07	36.36	4.32	0.04
2017	16.14	0.93	15.17	4.66	0.02
2018	5.68	0.44	7.25	4.68	0.01
2019	7.00	0.55	9.07	2.49	0.02
2020	20.25	0.87	16.70	0.93	0.02
2021	6.00	0.39	4.78	1.01	0.01
2022	21.21	0.86	17.39	0.62	0.02
2023	59.11	2.39	47.62	2.35	0.06
2024	5.75	0.38	4.68	1.06	0.01
2025	44.86	1.85	36.70	2.37	0.05
2026	5.80	0.37	4.22	0.93	0.01
2027	6.76	0.44	4.98	2.25	0.01
2028	6.77	0.45	5.33	1.55	0.01
2029	45.68	1.90	36.67	1.85	0.05
2030	5.60	0.35	4.05	0.68	0.01
2031	45.82	1.83	37.21	1.68	0.05
2032	3.37	0.18	2.79	0.24	0.00
2033	52.56	2.22	41.95	2.29	0.05
TOTALS	418.87	19.70	352.44	47.18	0.48
ANNUAL AVERAGE	20.94	0.98	17.62	2.36	0.02

ATTACHMENT A26-2
GREENHOUSE GAS EMISSIONS FOR CONSTRUCTION

Table B-1
Estimated Facility Installation Greenhouse Gas Emissions (EOR Processing Facility, Tank Batteries, Satellite Stations)
OEHI CO2 EOR PROJECT

				Emissions (metric tonnes/bhp-hr)				Emissions (metric tonnes/day)				Total Emissions (metric tonnes)			Total Emissions (metric tonnes)
Equipment	Number	Fuel Type	BHP	CO2	CH4	N2O	Hrs/ Day	CO2	CH4	N2O	Days	CO2	CH4	N2O	CO2e
2014															
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	3.3	2.084E+00	1.191E-04	5.338E-05	2.10
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	62.7	3.959E+01	2.262E-03	1.014E-03	39.95
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	62.7	9.238E+00	5.279E-04	2.366E-04	9.32
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	62.7	1.467E+01	8.384E-04	3.758E-04	14.81
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	13	8.209E+00	4.691E-04	2.103E-04	8.28
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	248	1.566E+02	8.949E-03	4.011E-03	158.03
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	248	3.654E+01	2.088E-03	9.360E-04	36.87
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	248	5.803E+01	3.316E-03	1.487E-03	58.56
2015															
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	14.1	8.903E+00	5.088E-04	2.281E-04	8.98
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	267.9	1.692E+02	9.667E-03	4.333E-03	170.71
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	267.9	3.947E+01	2.256E-03	1.011E-03	39.83
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	267.9	6.269E+01	3.582E-03	1.606E-03	63.26
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	13	8.209E+00	4.691E-04	2.103E-04	8.28
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	248	1.566E+02	8.949E-03	4.011E-03	158.03
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	248	3.654E+01	2.088E-03	9.360E-04	36.87
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	248	5.803E+01	3.316E-03	1.487E-03	58.56
2016															
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	17.7	1.118E+01	6.387E-04	2.863E-04	11.28
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	336.3	2.124E+02	1.213E-02	5.440E-03	214.30
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	336.3	4.955E+01	2.831E-03	1.269E-03	50.00
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	336.3	7.869E+01	4.497E-03	2.016E-03	79.41
2017															
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	11.3	7.135E+00	4.077E-04	1.828E-04	7.20
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	214.7	1.356E+02	7.747E-03	3.473E-03	136.81
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	214.7	3.163E+01	1.808E-03	8.103E-04	31.92
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	214.7	5.024E+01	2.871E-03	1.287E-03	50.70
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	10	6.315E+00	3.608E-04	1.618E-04	6.37
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	195	1.231E+02	7.036E-03	3.154E-03	124.26
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	195	2.873E+01	1.642E-03	7.360E-04	28.99
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	195	4.563E+01	2.607E-03	1.169E-03	46.05

Table B-1
Estimated Facility Installation Greenhouse Gas Emissions (EOR Processing Facility, Tank Batteries, Satellite Stations)
OEHI CO2 EOR PROJECT

				Emissions (metric tonnes/bhp-hr)				Emissions (metric tonnes/day)				Total Emissions (metric tonnes)			Total Emissions (metric tonnes)
Equipment	Number	Fuel Type	BHP	CO2	CH4	N2O	Hrs/ Day	CO2	CH4	N2O	Days	CO2	CH4	N2O	CO2e
2018															
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	4.35	2.747E+00	1.570E-04	7.036E-05	2.77
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	82.65	5.219E+01	2.982E-03	1.337E-03	52.67
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	82.65	1.218E+01	6.959E-04	3.119E-04	12.29
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	82.65	1.934E+01	1.105E-03	4.954E-04	19.52
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	15	9.472E+00	5.412E-04	2.426E-04	9.56
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	293	1.850E+02	1.057E-02	4.739E-03	186.71
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	293	4.317E+01	2.467E-03	1.106E-03	43.56
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	293	6.856E+01	3.918E-03	1.756E-03	69.19
2019															
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	11.75	7.420E+00	4.240E-04	1.901E-04	7.49
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	223.3	1.410E+02	8.056E-03	3.611E-03	142.26
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	223.3	3.289E+01	1.880E-03	8.426E-04	33.19
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	223.3	5.224E+01	2.985E-03	1.338E-03	52.72
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	5	3.157E+00	1.804E-04	8.088E-05	3.19
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	97	6.125E+01	3.500E-03	1.569E-03	61.81
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	97	1.429E+01	8.167E-04	3.661E-04	14.42
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	97	2.270E+01	1.297E-03	5.814E-04	22.91
2020															
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	3.25	2.052E+00	1.173E-04	5.257E-05	2.07
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	61.75	3.899E+01	2.228E-03	9.988E-04	39.35
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	61.75	9.098E+00	5.199E-04	2.331E-04	9.18
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	61.75	1.445E+01	8.257E-04	3.701E-04	14.58
2021															
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	12	7.577E+00	4.330E-04	1.941E-04	7.65
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	228	1.440E+02	8.227E-03	3.688E-03	145.29
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	228	3.359E+01	1.920E-03	8.605E-04	33.90
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	228	5.335E+01	3.049E-03	1.367E-03	53.84

Table B-1
Estimated Facility Installation Greenhouse Gas Emissions (EOR Processing Facility, Tank Batteries, Satellite Stations)
OEHI CO2 EOR PROJECT

				Emissions (metric tonnes/bhp-hr)				Emissions (metric tonnes/day)				Total Emissions (metric tonnes)			Total Emissions (metric tonnes)
Equipment	Number	Fuel Type	BHP	CO2	CH4	N2O	Hrs/ Day	CO2	CH4	N2O	Days	CO2	CH4	N2O	CO2e
2023															
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	3.6	2.273E+00	1.299E-04	5.823E-05	2.29
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	68.4	4.319E+01	2.468E-03	1.106E-03	43.59
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	68.4	1.008E+01	5.759E-04	2.582E-04	10.17
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	68.4	1.601E+01	9.146E-04	4.100E-04	16.15
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	3	1.894E+00	1.082E-04	4.853E-05	1.91
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	62	3.915E+01	2.237E-03	1.003E-03	39.51
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	62	9.135E+00	5.220E-04	2.340E-04	9.22
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	62	1.451E+01	8.290E-04	3.716E-04	14.64
2024															
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	9.9	6.251E+00	3.572E-04	1.601E-04	6.31
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	188.1	1.188E+02	6.787E-03	3.043E-03	119.86
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	188.1	2.771E+01	1.584E-03	7.099E-04	27.97
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	188.1	4.402E+01	2.515E-03	1.127E-03	44.42
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	3	1.894E+00	1.082E-04	4.853E-05	1.91
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	60	3.789E+01	2.165E-03	9.705E-04	38.23
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	60	8.840E+00	5.052E-04	2.265E-04	8.92
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	60	1.404E+01	8.023E-04	3.596E-04	14.17
2025															
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	13.5	8.525E+00	4.871E-04	2.184E-04	8.60
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	237.5	1.500E+02	8.570E-03	3.842E-03	151.34
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	237.5	3.499E+01	2.000E-03	8.964E-04	35.31
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	237.5	5.557E+01	3.176E-03	1.424E-03	56.08
2026															
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	11.4	7.199E+00	4.113E-04	1.844E-04	7.26
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	216.6	1.368E+02	7.816E-03	3.504E-03	138.02
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	216.6	3.191E+01	1.824E-03	8.175E-04	32.21
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	216.6	5.068E+01	2.896E-03	1.298E-03	51.15
2027															
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	11.3	7.135E+00	4.077E-04	1.828E-04	7.20
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	214.7	1.356E+02	7.747E-03	3.473E-03	136.81
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	214.7	3.163E+01	1.808E-03	8.103E-04	31.92
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	214.7	5.024E+01	2.871E-03	1.287E-03	50.70

Table B-1
Estimated Facility Installation Greenhouse Gas Emissions (EOR Processing Facility, Tank Batteries, Satellite Stations)
OEHI CO2 EOR PROJECT

				Emissions (metric tonnes/bhp-hr)				Emissions (metric tonnes/day)				Total Emissions (metric tonnes)			Total Emissions (metric tonnes)
Equipment	Number	Fuel Type	BHP	CO2	CH4	N2O	Hrs/ Day	CO2	CH4	N2O	Days	CO2	CH4	N2O	CO2e
2028															
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	9	5.683E+00	3.247E-04	1.456E-04	5.74
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	171	1.080E+02	6.170E-03	2.766E-03	108.97
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	171	2.519E+01	1.440E-03	6.454E-04	25.43
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	171	4.001E+01	2.287E-03	1.025E-03	40.38
2029															
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	8.8	5.557E+00	3.175E-04	1.423E-04	5.61
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	167.2	1.056E+02	6.033E-03	2.704E-03	106.54
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	167.2	2.464E+01	1.408E-03	6.310E-04	24.86
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	167.2	3.912E+01	2.236E-03	1.002E-03	39.48
2030															
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	7.35	4.641E+00	2.652E-04	1.189E-04	4.68
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	139.7	8.818E+01	5.039E-03	2.259E-03	88.99
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	139.7	2.058E+01	1.176E-03	5.271E-04	20.76
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	139.7	3.268E+01	1.867E-03	8.371E-04	32.98
2031															
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	1.15	7.262E-01	4.150E-05	1.860E-05	0.73
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	21.85	1.380E+01	7.884E-04	3.534E-04	13.92
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	21.85	3.219E+00	1.840E-04	8.247E-05	3.25
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	21.85	5.113E+00	2.922E-04	1.310E-04	5.16
2032															
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	1.5	9.472E-01	5.412E-05	2.426E-05	0.96
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	28.5	1.800E+01	1.028E-03	4.610E-04	18.16
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	28.5	4.199E+00	2.400E-04	1.076E-04	4.24
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	28.5	6.669E+00	3.811E-04	1.708E-04	6.73

Table B-1
Estimated Facility Installation Greenhouse Gas Emissions (EOR Processing Facility, Tank Batteries, Satellite Stations)
OEHI CO2 EOR PROJECT

				Emissions (metric tonnes/bhp-hr)				Emissions (metric tonnes/day)				Total Emissions (metric tonnes)			Total Emissions (metric tonnes)
Equipment	Number	Fuel Type	BHP	CO2	CH4	N2O	Hrs/ Day	CO2	CH4	N2O	Days	CO2	CH4	N2O	CO2e
2033															
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	6.315E-01	3.608E-05	1.618E-05	12	7.577E+00	4.330E-04	1.941E-04	7.65
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	4	6.315E-01	3.608E-05	1.618E-05	228	1.440E+02	8.227E-03	3.688E-03	145.29
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	4	1.473E-01	8.419E-06	3.774E-06	228	3.359E+01	1.920E-03	8.605E-04	33.90
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	228	5.335E+01	3.049E-03	1.367E-03	53.84

Data Sources/Notes:

CO2, CH4, and N2O emissions factors from:
EPA430-K-08-004 Climate Leaders GHG Inventory Protocol Core Module Guidance for Direct Emissions from Mobile Combustion Sources
Diesel fuel density of 7.079 pounds per gallon
CO2 = 10.15 kg/gallon, CH4 = 0.58 g/gallon, N2O = 0.26 g/gallon
Basic standard fuel consumption = 0.367 lb/bhp-hr for grader, crane and backhoe; 0.408 lb/bhp-hr for welder
CO2e factor conversions: CH4 x 21 = CO2e, N2O x 310 = CO2e
Facility installation equipment spread includes one motor grader, one crane, one backhoe, and one welding machine

Construction Equipment Exhaust Total (metric tonnes)

Year	CO2	CH4	N2O	CO2e
2014	324.97	0.02	0.01	327.94
2015	539.61	0.03	0.01	544.54
2016	351.78	0.02	0.01	354.99
2017	428.39	0.02	0.01	432.31
2018	392.67	0.02	0.01	396.26
2019	334.92	0.02	0.01	337.98
2020	64.59	0.00	0.00	65.18
2021	238.49	0.01	0.01	240.67
2023	136.24	0.01	0.00	137.48
2024	259.42	0.01	0.01	261.79
2025	249.06	0.01	0.01	251.34
2026	226.57	0.01	0.01	228.64
2027	224.58	0.01	0.01	226.63
2028	178.87	0.01	0.00	180.51
2029	174.90	0.01	0.00	176.49
2030	146.08	0.01	0.00	147.41
2031	22.86	0.00	0.00	23.06
2032	29.81	0.00	0.00	30.08
2033	238.49	0.01	0.01	240.67
TOTAL	4,562.31	0.26	0.12	4,604.01

Table B-2
Estimated Pipeline Installation Greehouse Gas Emissions
OEHI CO2 EOR PROJECT

				Emissions (metric tonnes/bhp-hr)				Emissions (metric tonnes/day)				Total Emissions (metric tonnes)			Total Emissions (metric tonnes)
Equipment	**Number**	**Fuel Type**	**BHP**	**CO2**	**CH4**	**N2O**	**Hrs/ Day**	**CO2**	**CH4**	**N2O**	**Days**	**CO2**	**CH4**	**N2O**	**CO2e**
2014															
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	8	1.263E+00	7.217E-05	3.235E-05	85	1.073E+02	6.134E-03	2.750E-03	108.33
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	8	2.947E-01	1.684E-05	7.548E-06	32.02	9.434E+00	5.391E-04	2.417E-04	9.52
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	85	1.989E+01	1.137E-03	5.095E-04	20.07
2015															
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	8	1.263E+00	7.217E-05	3.235E-05	285	3.599E+02	2.057E-02	9.220E-03	363.22
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	8	2.947E-01	1.684E-05	7.548E-06	100.2	2.954E+01	1.688E-03	7.566E-04	29.81
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	285	6.669E+01	3.811E-03	1.708E-03	67.30
2016															
Cranes	2	Diesel	300	5.26E-04	3.01E-08	1.35E-08	8	2.526E+00	1.443E-04	6.470E-05	292	7.375E+02	4.215E-02	1.889E-02	744.28
Backhoes	2	Diesel	70	5.26E-04	3.01E-08	1.35E-08	8	5.894E-01	3.368E-05	1.510E-05	112.3	6.618E+01	3.782E-03	1.695E-03	66.79
Welders	2	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	4.680E-01	2.674E-05	1.199E-05	292	1.367E+02	7.809E-03	3.501E-03	137.90
2017															
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	8	1.263E+00	7.217E-05	3.235E-05	310	3.915E+02	2.237E-02	1.003E-02	395.08
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	8	2.947E-01	1.684E-05	7.548E-06	149.2	4.397E+01	2.512E-03	1.126E-03	44.37
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	310	7.254E+01	4.145E-03	1.858E-03	73.20
2018															
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	8	1.263E+00	7.217E-05	3.235E-05	41	5.178E+01	2.959E-03	1.326E-03	52.25
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	8	2.947E-01	1.684E-05	7.548E-06	21.71	6.397E+00	3.656E-04	1.639E-04	6.46
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	41	9.594E+00	5.482E-04	2.458E-04	9.68
2019															
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	8	1.263E+00	7.217E-05	3.235E-05	230	2.905E+02	1.660E-02	7.441E-03	293.12
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	8	2.947E-01	1.684E-05	7.548E-06	114.7	3.380E+01	1.931E-03	8.658E-04	34.11
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	230	5.382E+01	3.075E-03	1.379E-03	54.31
2020															
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	8	1.263E+00	7.217E-05	3.235E-05	82	1.036E+02	5.918E-03	2.653E-03	104.51
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	8	2.947E-01	1.684E-05	7.548E-06	44.45	1.310E+01	7.485E-04	3.355E-04	13.22
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	82	1.919E+01	1.096E-03	4.915E-04	19.36
2021															
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	8	1.263E+00	7.217E-05	3.235E-05	230	2.905E+02	1.660E-02	7.441E-03	293.12
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	8	2.947E-01	1.684E-05	7.548E-06	128.4	3.783E+01	2.162E-03	9.690E-04	38.17
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	230	5.382E+01	3.075E-03	1.379E-03	54.31

Table B-2
Estimated Pipeline Installation Greehouse Gas Emissions
OEHI CO2 EOR PROJECT

				Emissions (metric tonnes/bhp-hr)				Emissions (metric tonnes/day)				Total Emissions (metric tonnes)			Total Emissions (metric tonnes)
Equipment	Number	Fuel Type	BHP	CO2	CH4	N2O	Hrs/ Day	CO2	CH4	N2O	Days	CO2	CH4	N2O	CO2e
2023															
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	8	1.263E+00	7.217E-05	3.235E-05	81	1.023E+02	5.845E-03	2.620E-03	103.23
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	8	2.947E-01	1.684E-05	7.548E-06	45.33	1.336E+01	7.633E-04	3.422E-04	13.48
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	81	1.895E+01	1.083E-03	4.855E-04	19.13
2024															
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	8	1.263E+00	7.217E-05	3.235E-05	189	2.387E+02	1.364E-02	6.114E-03	240.87
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	8	2.947E-01	1.684E-05	7.548E-06	105.8	3.117E+01	1.781E-03	7.984E-04	31.45
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	189	4.423E+01	2.527E-03	1.133E-03	44.63
2026															
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	8	1.263E+00	7.217E-05	3.235E-05	230	2.905E+02	1.660E-02	7.441E-03	293.12
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	8	2.947E-01	1.684E-05	7.548E-06	112.8	3.323E+01	1.899E-03	8.512E-04	33.53
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	230	5.382E+01	3.075E-03	1.379E-03	54.31
2027															
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	8	1.263E+00	7.217E-05	3.235E-05	349	4.408E+02	2.519E-02	1.129E-02	444.78
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	8	2.947E-01	1.684E-05	7.548E-06	142.7	4.206E+01	2.404E-03	1.077E-03	42.45
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	349	8.167E+01	4.667E-03	2.092E-03	82.41
2028															
Cranes	2	Diesel	300	5.26E-04	3.01E-08	1.35E-08	8	2.526E+00	1.443E-04	6.470E-05	187.5	4.736E+02	2.706E-02	1.213E-02	477.92
Backhoes	2	Diesel	70	5.26E-04	3.01E-08	1.35E-08	8	5.894E-01	3.368E-05	1.510E-05	83.5	4.921E+01	2.812E-03	1.261E-03	49.66
Welders	2	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	4.680E-01	2.674E-05	1.199E-05	187.5	8.775E+01	5.014E-03	2.248E-03	88.55
2029															
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	8	1.263E+00	7.217E-05	3.235E-05	162	2.046E+02	1.169E-02	5.241E-03	206.46
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	8	2.947E-01	1.684E-05	7.548E-06	79.31	2.337E+01	1.335E-03	5.987E-04	23.58
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	162	3.791E+01	2.166E-03	9.710E-04	38.25
2030															
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	8	1.263E+00	7.217E-05	3.235E-05	257	3.246E+02	1.855E-02	8.314E-03	327.53
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	8	2.947E-01	1.684E-05	7.548E-06	104	3.065E+01	1.751E-03	7.850E-04	30.93
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	257	6.014E+01	3.436E-03	1.540E-03	60.69
2031															
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	8	1.263E+00	7.217E-05	3.235E-05	14	1.768E+01	1.010E-03	4.529E-04	17.84
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	8	2.947E-01	1.684E-05	7.548E-06	5.67	1.671E+00	9.548E-05	4.280E-05	1.69
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	14	3.276E+00	1.872E-04	8.392E-05	3.31

Table B-2
Estimated Pipeline Installation Greehouse Gas Emissions
OEHI CO2 EOR PROJECT

				Emissions (metric tonnes/bhp-hr)				Emissions (metric tonnes/day)				Total Emissions (metric tonnes)			Total Emissions (metric tonnes)
Equipment	Number	Fuel Type	BHP	CO2	CH4	N2O	Hrs/ Day	CO2	CH4	N2O	Days	CO2	CH4	N2O	CO2e
2032															
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	8	1.263E+00	7.217E-05	3.235E-05	41	5.178E+01	2.959E-03	1.326E-03	52.25
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	8	2.947E-01	1.684E-05	7.548E-06	15.44	4.550E+00	2.600E-04	1.165E-04	4.59
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	41	9.594E+00	5.482E-04	2.458E-04	9.68
2033															
Cranes	1	Diesel	300	5.26E-04	3.01E-08	1.35E-08	8	1.263E+00	7.217E-05	3.235E-05	230	2.905E+02	1.660E-02	7.441E-03	293.12
Backhoes	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	8	2.947E-01	1.684E-05	7.548E-06	86.6	2.552E+01	1.458E-03	6.537E-04	25.75
Welders	1	Diesel	50	5.85E-04	3.34E-08	1.50E-08	8	2.340E-01	1.337E-05	5.994E-06	230	5.382E+01	3.075E-03	1.379E-03	54.31

Data Sources/Notes:

CO2, CH4, and N2O emissions factors from:
EPA430-K-08-004 Climate Leaders GHG Inventory Protocol Core Module Guidance for Direct Emissions from Mobile Combustion Sources
Diesel fuel density of 7.079 pounds per gallon
CO2 = 10.15 kg/gallon, CH4 = 0.58 g/gallon, N2O = 0.26 g/gallon
Basic standard fuel consumption = 0.367 lb/bhp-hr for crane and backhoe; 0.408 lb/bhp-hr for welder
CO2e factor conversions: CH4 x 21 = CO2e, N2O x 310 = CO2e
Backhoe not used for above ground locations and used 50% of days during below ground multi-line installation
Pipeline installation during 2016 & 2028 assume operation of two equipment spreads due to the total length of piping proposed for installation
Equipment pipeline installation spread includes one crane, backhoe, and welding machine

Construction Equipment Exhaust Total (metric tonnes)

Year	CO2	CH4	N2O	CO2e
2014	136.67	0.01	0.00	137.92
2015	456.16	0.03	0.01	460.33
2016	940.38	0.05	0.02	948.97
2017	508.01	0.03	0.01	512.65
2018	67.77	0.00	0.00	68.39
2019	378.09	0.02	0.01	381.54
2020	135.84	0.01	0.00	137.09
2021	382.12	0.02	0.01	385.61
2022				
2023	134.61	0.01	0.00	135.84
2024	314.08	0.02	0.01	316.95
2025				
2026	377.52	0.02	0.01	380.97
2027	564.48	0.03	0.01	569.64
2028	610.55	0.03	0.02	616.13
2029	265.87	0.02	0.01	268.30
2030	415.35	0.02	0.01	419.15
2031	22.63	0.00	0.00	22.83
2032	65.92	0.00	0.00	66.53
2033	369.81	0.02	0.01	373.19
TOTAL	6,145.86	0.35	0.16	6,202.03

Table B-3
Estimated Well Site Preparation, Drilling and Completion Greenhouse Gas Emissions
OEHI CO2 EOR PROJECT

				Emissions (metric tonnes/bhp-hr)				Total Emissions (metric tonnes/day)			Total Emissions (metric tonnes/day)
Equipment	**Number**	**Fuel**	**BHP**	**CO2**	**CH4**	**N2O**	**Hrs/ Rig Day**	**CO2**	**CH4**	**N2O**	**CO2e**
2016											
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	0.63	0.00	0.00	0.64
Tracked Tractor	1	Diesel	285	5.26E-04	3.01E-08	1.35E-08	8	1.20	0.00	0.00	1.21
Backhoe	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	8	0.29	0.00	0.00	0.30
Compactor	1	Diesel	200	5.26E-04	3.01E-08	1.35E-08	4	0.42	0.00	0.00	0.42
Generator (3 per drill rig)	2	Diesel	1020	5.26E-04	3.01E-08	1.35E-08	24	25.76	0.00	0.00	26.00
Greenhouse Gas Emissions per Rig Day								28.31	0.00	0.00	28.57

				Emissions (metric tonnes/bhp-hr)				Total Emissions (metric tonnes/day)			Total Emissions (metric tonnes/day)
Equipment	**Number**	**Fuel**	**BHP**	**CO2**	**CH4**	**N2O**	**Hrs/ Rig Day**	**CO2**	**CH4**	**N2O**	**CO2e**
2017											
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	0.63	0.00	0.00	0.64
Tracked Tractor	1	Diesel	285	5.26E-04	3.01E-08	1.35E-08	8	1.20	0.00	0.00	1.21
Backhoe	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	18	0.66	0.00	0.00	0.67
Compactor	1	Diesel	200	5.26E-04	3.01E-08	1.35E-08	4	0.42	0.00	0.00	0.42
Generator (3 per drill rig)	2	Diesel	1020	5.26E-04	3.01E-08	1.35E-08	24	25.76	0.00	0.00	26.00
Greenhouse Gas Emissions per Rig Day								28.68	0.00	0.00	28.94

				Emissions (metric tonnes/bhp-hr)				Total Emissions (metric tonnes/day)			Total Emissions (metric tonnes/day)
Equipment	**Number**	**Fuel**	**BHP**	**CO2**	**CH4**	**N2O**	**Hrs/ Rig Day**	**CO2**	**CH4**	**N2O**	**CO2e**
2020											
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	0.63	0.00	0.00	0.64
Tracked Tractor	1	Diesel	285	5.26E-04	3.01E-08	1.35E-08	8	1.20	0.00	0.00	1.21
Backhoe	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	18	0.66	0.00	0.00	0.67
Compactor	1	Diesel	200	5.26E-04	3.01E-08	1.35E-08	4	0.42	0.00	0.00	0.42
Generator (3 per drill rig)	2	Diesel	1020	5.26E-04	3.01E-08	1.35E-08	24	25.76	0.00	0.00	26.00
Greenhouse Gas Emissions per Rig Day								28.68	0.00	0.00	28.94

				Emissions (metric tonnes/bhp-hr)				Total Emissions (metric tonnes/day)			Total Emissions (metric tonnes/day)
Equipment	**Number**	**Fuel**	**BHP**	**CO2**	**CH4**	**N2O**	**Hrs/ Rig Day**	**CO2**	**CH4**	**N2O**	**CO2e**
2022											
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	0.63	0.00	0.00	0.64
Tracked Tractor	1	Diesel	285	5.26E-04	3.01E-08	1.35E-08	8	1.20	0.00	0.00	1.21
Backhoe	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	18	0.66	0.00	0.00	0.67
Compactor	1	Diesel	200	5.26E-04	3.01E-08	1.35E-08	4	0.42	0.00	0.00	0.42
Generator (3 per drill rig)	2	Diesel	1020	5.26E-04	3.01E-08	1.35E-08	24	25.76	0.00	0.00	26.00
Greenhouse Gas Emissions per Rig Day								28.68	0.00	0.00	28.94

Table B-3
Estimated Well Site Preparation, Drilling and Completion Greenhouse Gas Emissions
OEHI CO2 EOR PROJECT

				Emissions (metric tonnes/bhp-hr)				Total Emissions (metric tonnes/day)			Total Emissions (metric tonnes/day)
Equipment	Number	Fuel	BHP	CO2	CH4	N2O	Hrs/ Rig Day	CO2	CH4	N2O	CO2e
2023											
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	0.63	0.00	0.00	0.64
Tracked Tractor	1	Diesel	285	5.26E-04	3.01E-08	1.35E-08	8	1.20	0.00	0.00	1.21
Backhoe	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	18	0.66	0.00	0.00	0.67
Compactor	1	Diesel	200	5.26E-04	3.01E-08	1.35E-08	4	0.42	0.00	0.00	0.42
Generator (3 per drill rig)	2	Diesel	1020	5.26E-04	3.01E-08	1.35E-08	24	25.76	0.00	0.00	26.00
Greenhouse Gas Emissions per Rig Day								28.68	0.00	0.00	28.94

				Emissions (metric tonnes/bhp-hr)				Total Emissions (metric tonnes/day)			Total Emissions (metric tonnes/day)
Equipment	Number	Fuel	BHP	CO2	CH4	N2O	Hrs/ Rig Day	CO2	CH4	N2O	CO2e
2025											
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	0.63	0.00	0.00	0.64
Tracked Tractor	1	Diesel	285	5.26E-04	3.01E-08	1.35E-08	8	1.20	0.00	0.00	1.21
Backhoe	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	18	0.66	0.00	0.00	0.67
Compactor	1	Diesel	200	5.26E-04	3.01E-08	1.35E-08	4	0.42	0.00	0.00	0.42
Generator (3 per drill rig)	2	Diesel	1020	5.26E-04	3.01E-08	1.35E-08	24	25.76	0.00	0.00	26.00
Greenhouse Gas Emissions per Rig Day								28.68	0.00	0.00	28.94

				Emissions (metric tonnes/bhp-hr)				Total Emissions (metric tonnes/day)			Total Emissions (metric tonnes/day)
Equipment	Number	Fuel	BHP	CO2	CH4	N2O	Hrs/ Rig Day	CO2	CH4	N2O	CO2e
2029											
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	0.63	0.00	0.00	0.64
Tracked Tractor	1	Diesel	285	5.26E-04	3.01E-08	1.35E-08	8	1.20	0.00	0.00	1.21
Backhoe	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	18	0.66	0.00	0.00	0.67
Compactor	1	Diesel	200	5.26E-04	3.01E-08	1.35E-08	4	0.42	0.00	0.00	0.42
Generator (3 per drill rig)	2	Diesel	1020	5.26E-04	3.01E-08	1.35E-08	24	25.76	0.00	0.00	26.00
Greenhouse Gas Emissions per Rig Day								28.68	0.00	0.00	28.94

				Emissions (metric tonnes/bhp-hr)				Total Emissions (metric tonnes/day)			Total Emissions (metric tonnes/day)
Equipment	Number	Fuel	BHP	CO2	CH4	N2O	Hrs/ Rig Day	CO2	CH4	N2O	CO2e
2031											
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	0.63	0.00	0.00	0.64
Tracked Tractor	1	Diesel	285	5.26E-04	3.01E-08	1.35E-08	8	1.20	0.00	0.00	1.21
Backhoe	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	18	0.66	0.00	0.00	0.67
Compactor	1	Diesel	200	5.26E-04	3.01E-08	1.35E-08	4	0.42	0.00	0.00	0.42
Generator (3 per drill rig)	2	Diesel	1020	5.26E-04	3.01E-08	1.35E-08	24	25.76	0.00	0.00	26.00
Greenhouse Gas Emissions per Rig Day								28.68	0.00	0.00	28.94

Table B-3
Estimated Well Site Preparation, Drilling and Completion Greenhouse Gas Emissions
OEHI CO2 EOR PROJECT

				Emissions (metric tonnes/bhp-hr)				Total Emissions (metric tonnes/day)			Total Emissions (metric tonnes/day)
Equipment	**Number**	**Fuel**	**BHP**	**CO2**	**CH4**	**N2O**	**Hrs/ Rig Day**	**CO2**	**CH4**	**N2O**	**CO2e**
2033											
Motor Grader	1	Diesel	150	5.26E-04	3.01E-08	1.35E-08	8	0.63	0.00	0.00	0.64
Tracked Tractor	1	Diesel	285	5.26E-04	3.01E-08	1.35E-08	8	1.20	0.00	0.00	1.21
Backhoe	1	Diesel	70	5.26E-04	3.01E-08	1.35E-08	18	0.66	0.00	0.00	0.67
Compactor	1	Diesel	200	5.26E-04	3.01E-08	1.35E-08	4	0.42	0.00	0.00	0.42
Generator (3 per drill rig)	2	Diesel	1020	5.26E-04	3.01E-08	1.35E-08	24	25.76	0.00	0.00	26.00
Greenhouse Gas Emissions per Rig Day								28.68	0.00	0.00	28.94

Data Sources/Notes:

CO2, CH4, and N2O emissions factors from:

EPA430-K-08-004 Climate Leaders GHG Inventory Protocol Core Module Guidance for Direct Emissions from Mobile Combustion Sources

Diesel fuel density of 7.079 pounds per gallon

CO2 = 10.15 kg/gallon, CH4 = 0.58 g/gallon, N2O = 0.26 g/gallon

Basic standard fuel consumption = 0.367 lb/bhp-hr for grader, tractor, compactor, generator and backhoe

CO2e factor conversions: CH4 x 21 = CO2e, N2O x 310 = CO2e

Table B-3
Estimated Well Site Preparation, Drilling and Completion Greenhouse Gas Emissions
OEHI CO2 EOR PROJECT

Emissions From Site Preparation (Metric Tonnes/Year)						
Year	No. Sites	Site Days	CO2	CH4	N2O	CO2e
2016	18	36	91.69	0.01	0.00	92.53
2017	4	8	23.32	0.00	0.00	23.53
2020	8	16	46.64	0.00	0.00	47.07
2022	9	18	52.47	0.00	0.00	52.95
2023	27	54	157.42	0.01	0.00	158.86
2025	20	40	116.61	0.01	0.00	117.67
2029	20	40	116.61	0.01	0.00	117.67
2031	21	42	122.44	0.01	0.00	123.56
2033	23	46	134.10	0.01	0.00	135.33
Total	150	300	861.30	0.05	0.02	869.18

Emissions From Well Drilling (Metric Tonnes/Year)						
Year	No. Well	Rig Days	CO2	CH4	N2O	CO2e
2016	18	252	6492.35	0.37	0.17	6551.70
2017	4	56	1442.75	0.08	0.04	1455.93
2020	8	112	2885.49	0.16	0.07	2911.87
2022	9	126	3246.18	0.19	0.08	3275.85
2023	27	378	9738.53	0.56	0.25	9827.55
2025	20	280	7213.73	0.41	0.18	7279.67
2029	20	280	7213.73	0.41	0.18	7279.67
2031	21	294	7574.41	0.43	0.19	7643.65
2033	23	322	8295.78	0.47	0.21	8371.62
Total	150	2,100	54,102.94	3.09	1.39	54,597.49

Emissions From Well Completion (Metric Tonnes/Year)						
Year	Well	Rig Days	CO2	CH4	N2O	CO2e
2016	18	72	278.70	0.02	0.01	281.25
2017	4	16	61.93	0.00	0.00	62.50
2020	8	32	123.87	0.01	0.00	125.00
2022	9	36	139.35	0.01	0.00	140.63
2023	27	108	418.05	0.02	0.01	421.88
2025	20	80	309.67	0.02	0.01	312.50
2029	20	80	309.67	0.02	0.01	312.50
2031	21	84	325.15	0.02	0.01	328.13
2033	23	92	356.12	0.02	0.01	359.38
Total	150	-------	2,322.53	0.13	0.06	2,343.76

Table B-3
Estimated Well Site Preparation, Drilling and Completion Greenhouse Gas Emissions
OEHI CO2 EOR PROJECT

Total Emissions From Well Installation (Metric Tonnes/Year)						
Year	Well	Total	CO2	CH4	N2O	CO2e
2016	18	Total =	6862.74	0.39	0.18	6925.48
2017	4	Total =	1528.00	0.09	0.04	1541.97
2020	8	Total =	3056.00	0.17	0.08	3083.94
2022	9	Total =	3438.00	0.20	0.09	3469.43
2023	27	Total =	10314.01	0.59	0.26	10408.29
2025	20	Total =	7640.00	0.44	0.20	7709.84
2029	20	Total =	7640.00	0.44	0.20	7709.84
2031	21	Total =	8022.00	0.46	0.21	8095.33
2033	23	Total =	8786.01	0.50	0.23	8866.32
Total	150	-------	57,286.77	3.27	1.47	57,810.43

NOTE: Total well installation emissions shown above include site preparation, well drilling and well completions. The summary of well installation emissions shown in Table B-3 include the summary of well completion emissions shown in Table B-4. Table B-4 is a detailed supplement to Table B-3.

Table B-4
Estimated Well Completion Greehouse Gas Emissions
OEHI CO2 EOR PROJECT

				Emissions (metric tonnes/bhp-hr)				Total Emissions (metric tonnes/day)			Total Emissions (metric tonnes/day)
Equipment	**Number**	**Fuel**	**BHP**	**CO2**	**CH4**	**N2O**	**Hrs/ Day**	**CO2**	**CH4**	**N2O**	**CO2e**
2016											
Mobile Rig	1	Diesel	425	5.26E-04	3.01E-08	1.35E-08	12	2.68	0.00	0.00	2.71
Pump	1	Diesel	375	5.28E-04	3.02E-08	1.35E-08	6	1.19	0.00	0.00	1.20
Greenhouse Gas Emissions per Rig Day								3.87	0.00	0.00	3.91

				Emissions (metric tonnes/bhp-hr)				Total Emissions (metric tonnes/day)			Total Emissions (metric tonnes/day)
Equipment	**Number**	**Fuel**	**BHP**	**CO2**	**CH4**	**N2O**	**Hrs/ Day**	**CO2**	**CH4**	**N2O**	**CO2e**
2017											
Mobile Rig	1	Diesel	425	5.26E-04	3.01E-08	1.35E-08	12	2.68	0.00	0.00	2.71
Pump	1	Diesel	375	5.28E-04	3.02E-08	1.35E-08	6	1.19	0.00	0.00	1.20
Greenhouse Gas Emissions per Rig Day								3.87	0.00	0.00	3.91

				Emissions (metric tonnes/bhp-hr)				Total Emissions (metric tonnes/day)			Total Emissions (metric tonnes/day)
Equipment	**Number**	**Fuel**	**BHP**	**CO2**	**CH4**	**N2O**	**Hrs/ Day**	**CO2**	**CH4**	**N2O**	**CO2e**
2020											
Mobile Rig	1	Diesel	425	5.26E-04	3.01E-08	1.35E-08	12	2.68	0.00	0.00	2.71
Pump	1	Diesel	375	5.28E-04	3.02E-08	1.35E-08	6	1.19	0.00	0.00	1.20
Greenhouse Gas Emissions per Rig Day								3.87	0.00	0.00	3.91

				Emissions (metric tonnes/bhp-hr)				Total Emissions (metric tonnes/day)			Total Emissions (metric tonnes/day)
Equipment	**Number**	**Fuel**	**BHP**	**CO2**	**CH4**	**N2O**	**Hrs/ Day**	**CO2**	**CH4**	**N2O**	**CO2e**
2022											
Mobile Rig	1	Diesel	425	5.26E-04	3.01E-08	1.35E-08	12	2.68	0.00	0.00	2.71
Pump	1	Diesel	375	5.28E-04	3.02E-08	1.35E-08	6	1.19	0.00	0.00	1.20
Greenhouse Gas Emissions per Rig Day								3.87	0.00	0.00	3.91

Table B-4
Estimated Well Completion Greehouse Gas Emissions
OEHI CO2 EOR PROJECT

				Emissions (metric tonnes/bhp-hr)				Total Emissions (metric tonnes/day)			Total Emissions (metric tonnes/day)
Equipment	**Number**	**Fuel**	**BHP**	**CO2**	**CH4**	**N2O**	**Hrs/ Day**	**CO2**	**CH4**	**N2O**	**CO2e**
2023											
Mobile Rig	1	Diesel	425	5.26E-04	3.01E-08	1.35E-08	12	2.68	0.00	0.00	2.71
Pump	1	Diesel	375	5.28E-04	3.02E-08	1.35E-08	6	1.19	0.00	0.00	1.20
Greenhouse Gas Emissions per Rig Day								3.87	0.00	0.00	3.91

				Emissions (metric tonnes/bhp-hr)				Total Emissions (metric tonnes/day)			Total Emissions (metric tonnes/day)
Equipment	**Number**	**Fuel**	**BHP**	**CO2**	**CH4**	**N2O**	**Hrs/ Day**	**CO2**	**CH4**	**N2O**	**CO2e**
2025											
Mobile Rig	1	Diesel	425	5.26E-04	3.01E-08	1.35E-08	12	2.68	0.00	0.00	2.71
Pump	1	Diesel	375	5.28E-04	3.02E-08	1.35E-08	6	1.19	0.00	0.00	1.20
Greenhouse Gas Emissions per Rig Day								3.87	0.00	0.00	3.91

				Emissions (metric tonnes/bhp-hr)				Total Emissions (metric tonnes/day)			Total Emissions (metric tonnes/day)
Equipment	**Number**	**Fuel**	**BHP**	**CO2**	**CH4**	**N2O**	**Hrs/ Day**	**CO2**	**CH4**	**N2O**	**CO2e**
2029											
Mobile Rig	1	Diesel	425	5.26E-04	3.01E-08	1.35E-08	12	2.68	0.00	0.00	2.71
Pump	1	Diesel	375	5.28E-04	3.02E-08	1.35E-08	6	1.19	0.00	0.00	1.20
Greenhouse Gas Emissions per Rig Day								3.87	0.00	0.00	3.91

				Emissions (metric tonnes/bhp-hr)				Total Emissions (metric tonnes/day)			Total Emissions (metric tonnes/day)
Equipment	**Number**	**Fuel**	**BHP**	**CO2**	**CH4**	**N2O**	**Hrs/ Day**	**CO2**	**CH4**	**N2O**	**CO2e**
2031											
Mobile Rig	1	Diesel	425	5.26E-04	3.01E-08	1.35E-08	12	2.68	0.00	0.00	2.71
Pump	1	Diesel	375	5.28E-04	3.02E-08	1.35E-08	6	1.19	0.00	0.00	1.20
Greenhouse Gas Emissions per Rig Day								3.87	0.00	0.00	3.91

Table B-4
Estimated Well Completion Greehouse Gas Emissions
OEHI CO2 EOR PROJECT

				Emissions (metric tonnes/bhp-hr)				Total Emissions (metric tonnes/day)			Total Emissions (metric tonnes/day)
Equipment	**Number**	**Fuel**	**BHP**	**CO2**	**CH4**	**N2O**	**Hrs/ Day**	**CO2**	**CH4**	**N2O**	**CO2e**
2033											
Mobile Rig	1	Diesel	425	5.26E-04	3.01E-08	1.35E-08	12	2.68	0.00	0.00	2.71
Pump	1	Diesel	375	5.28E-04	3.02E-08	1.35E-08	6	1.19	0.00	0.00	1.20
Greenhouse Gas Emissions per Rig Day								3.87	0.00	0.00	3.91

Data Sources/Notes:

CO2, CH4, and N2O emissions factors from:

EPA430-K-08-004 Climate Leaders GHG Inventory Protocol Core Module Guidance for Direct Emissions from Mobile Combustion Sources

Diesel fuel density of 7.079 pounds per gallon

CO2 = 10.15 kg/gallon, CH4 = 0.58 g/gallon, N2O = 0.26 g/gallon

Basic standard fuel consumption = 0.367 lb/bhp-hr for mobile rig; 0.368 lb/bhp-hr for pump

CO2e factor conversions: CH4 x 21 = CO2e, N2O x 310 = CO2e

Table B-4
Estimated Well Completion Greenhouse Gas Emissions
OEHI CO2 EOR PROJECT

Emissions From Well Completion (Metric Tonnes/Year)						
Year	Well	Rig Days	CO2	CH4	N2O	CO2e
2016	18	72	278.70	0.02	0.01	281.25
2017	4	16	61.93	0.00	0.00	62.50
2020	8	32	123.87	0.01	0.00	125.00
2022	9	36	139.35	0.01	0.00	140.63
2023	27	108	418.05	0.02	0.01	421.88
2025	20	80	309.67	0.02	0.01	312.50
2029	20	80	309.67	0.02	0.01	312.50
2031	21	84	325.15	0.02	0.01	328.13
2033	23	92	356.12	0.02	0.01	359.38
Total	150	600	2,322.53	0.13	0.06	2,343.76

NOTE: Total well installation emissions shown in Table B-3 include the well completion emissions shown above in Table B-4.

Table B-5
Estimated Well Conversion Greenhouse Gas Emissions
OEHI CO2 EOR PROJECT

Average emissions per well conversion
(based on annual average of well completion emissions)

Emissions (metric tonnes/rig day)			
CO2	CH4	N2O	CO2e
3.87	0.00	0.00	3.91

Emissions From Well Conversion (Metric Tonnes/Year)			
Year	Well	Rig Days	CO2e
2014	36	144	562.50
2015	36	144	562.50
2016	18	72	281.25
2017	32	128	500.00
2018	36	144	562.50
2019	36	144	562.50
2020	28	112	437.50
2021	36	144	562.50
2022	27	108	421.88
2023	9	36	140.63
2024	36	144	562.50
2025	16	64	250.00
2026	36	144	562.50
2027	36	144	562.50
2028	36	144	562.50
2029	16	64	250.00
2030	36	144	562.50
2031	15	60	234.38
2032	36	144	562.50
2033	13	52	203.13
Total	**570**	**2280**	**8,906.28**

TABLE B-6

All Estimated Onroad Vehicle Greenhouse Gas Emissions
(Construction Personnel, Supply Transport,
and Operations Personnel)
OEHI CO2 EOR PROJECT

				CO2		
Vehicle Class	**Number (trips)**	**VMT**	**Days**	**Run Exhaust (g/mi)**	**Start-Up (g/st)**	**Total CO2 (Metric Tonnes)**
2014						
LDA-All	140	60	250	295.358	207.124	634.75
HDD-All	3	60	250	1738.184	42.305	78.28
2014 TOTAL						713.03
2015						
LDA-All	256	60	250	294.585	206.576	1157.65
HDD-All	5	60	250	1737.649	43.124	130.43
2015 TOTAL						1288.08
2016						
LDA-All	50	60	250	293.965	206.11	225.63
HDD-All	2	60	250	1737.172	44.312	52.16
2016 TOTAL						277.79
2017						
LDA-All	174	60	250	293.425	205.69	783.73
HDD-All	4	60	250	1736.753	45.492	104.30
2017 TOTAL						888.03
2018						
LDA-All	186	60	250	292.781	205.238	835.95
HDD-All	4	60	250	1736.386	46.824	104.28
2018 TOTAL						940.22
2019						
LDA-All	268	60	250	292.23	204.833	1202.21
HDD-All	5	60	250	1736.144	47.913	130.33
						1332.54
2020						
LDA-All	46	60	250	291.753	204.468	206.01
HDD-All	2	60	250	1735.996	48.8	52.13
						258.14
2021						
LDA-All	52	60	250	291.337	204.138	232.55
HDD-All	2	60	250	1735.988	49.596	52.13
						284.68

TABLE B-6

All Estimated Onroad Vehicle Greenhouse Gas Emissions
(Construction Personnel, Supply Transport,
and Operations Personnel)
OEHI CO2 EOR PROJECT

				CO2		
Vehicle Class	**Number (trips)**	**VMT**	**Days**	**Run Exhaust (g/mi)**	**Start-Up (g/st)**	**Total CO2 (Metric Tonnes)**
2022						
LDA-All	27	60	250	290.961	203.833	120.59
HDD-All	1	60	250	1736.02	50.264	26.07
						146.66
2023						
LDA-All	31	60	250	290.616	203.548	138.29
HDD-All	2	60	250	1736.078	50.799	52.13
						190.42
2024						
LDA-All	73	60	250	290.305	203.288	325.30
HDD-All	2	60	250	1736.134	51.199	52.14
						377.44
2025						
LDA-All	81	60	250	290.032	203.059	360.61
HDD-All	3	60	250	1736.174	51.503	78.21
						438.82
2026						
LDA-All	28	60	250	289.79	202.851	124.55
HDD-All	1	60	250	1736.194	51.636	26.07
						150.62
2027						
LDA-All	52	60	250	289.575	202.664	231.14
HDD-All	2	60	250	1736.185	51.928	52.14
						283.28
2028						
LDA-All	89	60	250	289.384	202.495	395.34
HDD-All	2	60	250	1736.161	52.147	52.14
						447.48
2029						
LDA-All	47	60	250	289.215	202.34	208.65
HDD-All	2	60	250	1736.117	52.275	52.14
						260.79

TABLE B-6

All Estimated Onroad Vehicle Greenhouse Gas Emissions
(Construction Personnel, Supply Transport,
and Operations Personnel)
OEHI CO2 EOR PROJECT

				CO2		
Vehicle Class	**Number (trips)**	**VMT**	**Days**	**Run Exhaust (g/mi)**	**Start-Up (g/st)**	**Total CO2 (Metric Tonnes)**
2030						
LDA-All	28	60	250	289.077	202.214	124.24
HDD-All	1	60	250	1736.057	52.519	26.07
						150.31
2031						
LDA-All	46	60	250	288.959	202.106	204.03
HDD-All	2	60	250	1735.987	52.713	52.13
						256.16
2032						
LDA-All	28	60	250	288.858	202.011	124.15
HDD-All	1	60	250	1735.928	52.84	26.07
						150.21
2033						
LDA-All	44	60	250	288.77	201.928	195.03
HDD-All	2	60	250	1735.877	53.01	52.13
						247.16

TOTAL VEHICLE EMISSIONS (Metric Tonnes CO2e)

Assumptions/Notes:

Onroad emissions factors from EMFAC 2007
SJVAPCD, 2013-2035, 70 degrees F, 50% RH
Assumes startup after 12 hours
Vehicle speed = 40 mph
20 min hot soak per trip
15 min rest each trip
45 min run time
Light-Duty Automobile (LDA) assumes all fuel types
Heavy-Duty Truck (HDD) assumes all fuel types
VMT = Vehicle Miles Traveled

Table B-7
Total Estimated Construction Emissions
OEHI CO2 EOR Project

Year	CO2e (Metric Tonnes)
2014	1,741.39
2015	2,855.45
2016	8,788.48
2017	3,874.96
2018	1,967.38
2019	2,614.57
2020	3,981.85
2021	1,473.46
2022	4,037.96
2023	11,012.65
2024	1,518.69
2025	8,650.00
2026	1,322.73
2027	1,642.06
2028	1,806.62
2029	8,665.42
2030	1,279.37
2031	8,631.77
2032	809.33
2033	9,930.46
TOTALS	86,604.61
ANNUAL AVERAGE	4,330.23

DATA REQUEST

A27. Please explain proposed emissions controls or mitigation measures, if any, for the construction off-road and on-road equipment.

RESPONSE

Emissions controls and mitigation measures for the off-road and on-road construction equipment are presented in Appendix A-1 (Supplemental Environmental Information) of the 2012 Amended AFC as Mitigation Measure AQ-3 on pages 4.3-28 and 4.3-29. They are also repeated below for convenient reference.

a. Prohibit the use of heavy-equipment during first- or second-stage smog alerts, and suspend all construction activities during second-stage smog alerts;

b. Maintain equipment engines in proper working order;

c. Limit the hours of operation of heavy-duty equipment and/or the amount of equipment in use, to the extent feasible;

d. Require that all diesel engines be shut off when not in use to reduce emissions from idling;

e. Require that trucks and vehicles in loading or unloading queues have their engines turned off when not in use; and

f. Emissions from off-road mobile source construction equipment will be mitigated by requiring that all contractors comply with the California Air Resources Board (CARB) off-road mobile source regulations.

These controls and mitigation measures are consistent with construction equipment mitigation measures recommended in San Joaquin Valley Air Pollution Control District's Guide for Assessing and Mitigating Air Quality Impacts (SJVAPCD, 2002).

DATA REQUEST

A28. Please explain proposed emissions controls or mitigation measures, if any, for the operation off-road and on-road equipment.

RESPONSE

On-road mobile source emissions can be found in Appendix A-1 (Supplemental Environmental Information) of the 2012 Amended AFC, Section 4.3 Air Quality, on Pages 4.3-24 and 4.3-25. Mobile source emissions are limited to on-road vehicle emissions from operational phase employees transiting between area residences and the Project Site. Emissions were calculated using the factors for "Light Duty Autos" (LDA) for year 2015 within CARB's EMFAC 2007. The calculations assume that the EOR Project will require 25 full time employees (50 one-way trips) with a travel distance of 30 miles per one-way trip. It was assumed that the EOR Project would be "manned" 365 days per year (i.e., 1,500 miles per day x 365 days per year).

As shown in Table 4.3-10 (on Page 4.3-24), estimated emissions resulting from Project operation will not exceed the SJVAPCD significance thresholds for NO_x or PM_{10} and are therefore not expected to result in a significant air quality impact. However, the estimated operational emissions would exceed the SJVAPCD significance criteria for ROG. This is a potentially significant air quality impact. The significance of this impact will be reduced by implementing Mitigation Measure AQ-1. This mitigation includes implementing Best Available Control Technology (BACT) on permitted emissions sources with any emissions, and the provision of ERCs to offset emission increases from permitted emissions sources as required by SJVAPCD Rule 2201. Fugitive ROG emissions will be reduced by the implementation of leak detection and repair requirements pursuant to SJVAPCD Regulation IV. No controls or mitigation measures are proposed for employee vehicles.

Controls for off-road mobile source emissions can be found in in Appendix A-1 (Supplemental Environmental Information) of the 2012 Amended AFC, Section 4.3 Air Quality, on Pages 4.3-25 through 4.3-29. Emissions from off-road equipment are shown in Table 4.3-12 (on Page 4.3-26) for all project years as part of construction emissions since construction will occur at different levels of intensity throughout the project life. Vehicle emissions were calculated using emissions factors for Light Duty Autos and Heavy-Duty Trucks from CARB's EMFAC 2007. Emission factors for construction equipment were obtained from CARB's OFFROAD 2007 model. For each of the 20 years where construction will be occurring, projected activity levels were determined and the emissions factors were applied to the anticipated number of internal combustion engines, brake-horsepower, engine load factor, daily operating hours and operation days per year. Fugitive dust emissions were calculated using emissions factors from AP-42 and assumptions for the silt content of disturbed soils and mean vehicle/equipment weights.

Pursuant to SJVAPCD CEQA guidance, the project will mitigate PM_{10} emissions by complying with Regulation VIII and implementing all applicable control measures presented in the SJVAPCD Guide for Assessing and Mitigating Air Quality Impacts. Mitigation measures for reducing on-site emissions of fugitive dust from on-road and off-road equipment are set forth in Mitigation Measure AQ-2. Mitigation measures for reducing exhaust emissions from off-road equipment and vehicles are set forth in Mitigation Measure AQ-3. Compliance with LORS and Mitigation Measures AQ-1 through AQ-3 will reduce impacts to less than significant.

DATA REQUEST

A29. Please confirm that all of the on-site roads that will be used during project construction and operation are paved, and please identify if any street sweeping activities are proposed.

RESPONSE

All of the primary on-site roads that would be used during Project construction and operation are paved. OEHI currently practices street sweeping on these on-site roads, and will continue to do so during Project construction and operation.

DATA REQUEST

A30. Please provide the source or assumption used for the emergency engine emissions factors.

RESPONSE

Criteria Pollutants

The emissions factors for the emergency use only internal combustion engines were obtained from the engine manufacturer (Cummins) and are for a U.S. Environmental Protection Agency Certified Tier-3 Engine. A copy of the engine manufacturer's specification sheet documenting the factors is provided in Attachment A30-1.

Greenhouse Gas

The GHG Emission factors are from the CARB "Regulations for the Mandatory Reporting of Greenhouse Emissions," Appendix A. The carbon dioxide (CO_2) factor is for natural gas having a higher heating value (HHV) of 1000 to 1025 British thermal units per standard cubic foot (Btu/Scf).

ATTACHMENT A30-1
CRITERIA AIR POLLUTANT EMISSIONS FOR OPERATIONS

Fire Power

EPA Tier 3 Emission Data
Fire Pump NSPS Compliant

CFP7E-F10 Fire Pump Driver

Type: 4 Cycle; In-Line; 6 Cylinder
Aspiration: Turbocharged, Charge Air Cooled

15 PPM Diesel Fuel

		Fuel Consumption		D2 Cycle Exhaust Emissions										Exhaust			
				Grams per BHP - HR					Grams per kW - HR					Temperature		Gas Flow	
RPM	BHP	Gal/Hr	L/hr	NMHC	NOx	NMHC+NOx	CO	PM	NMHC	NOx	NMHC+NOx	CO	PM	°F	°C	CFM	L/sec
1470	153	7.9	29.9											906	486	937	442
1760	175	9.0	34.1											821	438	1061	501
1900	162	9.2	34.8											781	416	1079	509
2100	171	9.0	34.1	0.062	2.475	2.537	1.193	0.111	0.083	3.319	3.402	1.600	0.149	795	424	1255	592
2350	172	9.2	34.8											805	429	1375	649
2600	174	9.8	37.1											886	474	1513	714
2700	127	7.2	27.3											877	469	1392	657

The emissions values above are based on CARB approved calculations for converting EPA (500 ppm) fuel to CARB (15 ppm) fuel.

300-4000 PPM Diesel Fuel

		Fuel Consumption		D2 Cycle Exhaust Emissions										Exhaust			
				Grams per BHP - HR					Grams per kW - HR					Temperature		Gas Flow	
RPM	BHP	Gal/Hr	L/hr	NMHC	NOx	NMHC+NOx	CO	PM	NMHC	NOx	NMHC+NOx	CO	PM	°F	°C	CFM	L/sec
1470	153	7.9	29.9											906	486	937	442
1760	175	9.0	34.1											821	438	1061	501
1900	162	9.2	34.8											781	416	1079	509
2100	171	9.0	34.1	0.075	2.685	2.759	1.193	0.127	0.1	3.600	3.700	1.600	0.170	795	424	1255	592
2350	172	9.2	34.8											805	429	1375	649
2600	174	9.8	37.1											886	474	1513	714
2700	127	7.2	27.3											877	469	1392	657

QSB6.7 Base Model Manufactured by Cummins Inc.
- Using fuel rating 91422

Reference EPA Standard Engine Family: **ACEXL0409AAB**
Reference CARB Executive Order:**U-R-002-0516**

No special options needed to meet current regulation emissions for all 50 states

Test Methods:
EPA/CARB Nonroad emissions recorded per 40CFR89 (ref. ISO8178-1) and weighted at load points prescribed in Subpart E, Appendix A, for Constant Sp
Engines (ref. ISO8178-4, D2).

Diesel Fuel Specifications:
Cetane Number: 40-48
Reference: ASTM D975 No. 2-D

Reference Conditions:
Air Inlet Temperature: 25°C (77°F)
Fuel Inlet Temperature: 40°C (104°F)
Barometric Pressure: 100 kPa (29.53 in Hg)
Humidity: 10.7 g/kg (75 grains H_2O/lb) of dry air; required for NOx correction

Restrictions: Intake Restriction set to a maximum allowable limit for clean filter; Exhaust Back Pressure set to maximum allowable limit.

Tests conducted using alternate test methods, instrumentation, fuel or reference conditions can yield different results.

DATA REQUEST

A31. Please explain the basis, or provide the source(s), for the differing Nitrogen Oxide (NO_X), Volatile Organic Compounds (VOC's) and Carbon Monoxide (CO) emissions factors for the various boilers and heaters.

RESPONSE

The emissions factors proposed for the boilers and heaters vary because of different requirements established by the SJVAPCD for heaters and boilers (via prohibitory rules). The factors also reflect the differences in the SJVAPCD requirements for Best Available Control Technology (BACT). The proposed limits will be included as enforceable permit conditions. Compliance with the proposed limits will be verified by source tests.

DATA REQUEST

A32. Please confirm that the natural gas proposed for use in the boilers and heaters will be pipeline quality natural gas from the local natural gas utility or from the Elk Hills Gas Plant and not unrefined produced gas, and please provide the specifications, range and average, of the Elk Hills Gas Plant pipeline quality natural gas; including heat content, carbon content, and sulfur content. If unrefined produced gas is proposed to be used, please provide the gas specifications for that proposed fuel.

RESPONSE

The natural gas proposed for use as fuel in the boilers and heaters will be pipeline-quality natural gas. Typical properties for the gas are summarized below:

Typical Residue Gas Used as Fuel

Higher Heating Value (Btu/Scf)	Carbon Content (Kg/MMBtu)	Sulfur (gr/100 Scf)
1,000 – 1,025 (≈1,020 Typical)	14.47 to 14.73 (≈14.43 Typical)	0.1 to 1.0 (<= 0.75 Typical)

Notes:

Btu/Scf = British thermal units per standard cubic foot
Kg/MMBtu = kilograms per million British thermal units
gr/100 Scf = grams per 100 standard cubic feet

DATA REQUEST

A33. Please provide the following information regarding the proposed flare.

a. Please provide the sources or explain the sources or explain the basis for the hours per year of emergency flaring events used in the emissions calculations.

b. The pilot gas and purge gas for the flare have the same assumed heat content. Please clarify the basis of this assumption.

c. The flared gas is shown to have an assumed heat content of 250 Btu/SCF. Please provide references for this assumption and references for the assumed carbon and sulfur contents.

RESPONSE

a. The reasonably foreseeable emergency use of the flare is assumed to occur during power outages. The duration of the outages are estimated based on "System Reliability Reports" submitted by the utility company (PG&E, 2008; 2009) for the Project "service area." The time used in the calculations is 7.47 hours per year.

b. The pilot gas and the purge gas have the same heating values because both originate from the same source (pipeline-quality natural gas). Purge gas is required to displace oxygen that could otherwise be introduced to the flare stack.

c. The composition of the flare gas would vary over time as the CO_2 enhanced oil recovery Project matures. However, the flare manufacturer has indicated that the flare would be able to combust gas having a minimum heating value of 250 Btu/Scf. The GHG emissions from the flare are calculated from the total annual heat input to the flare, assuming 7.47 hours per year (Hr/Year) operation, 250 Btu/Scf, and a maximum flow rate of 11.42 Million standard cubic feet per hour (MMScf/Hr). If the gas being flared has a heating value less than 250 Btu/Scf, it would be mixed with supplemental fuel to raise the Btu value to at least 250 Btu (HHV). The total flare volume times 250 Btu/Scf is used to calculate the total heat input to the flare (MMBtu/Hr). The heat input rate is then used with the CARB GHG factors to calculate GHG combustion emissions. The combustion emissions are combined with the CO_2 pass-through emissions to calculate the total emissions from flaring. The CARB GHG emissions factor for natural gas combustions are used in the calculations. There are three factors: CO_2, Methane, and nitrous oxide (N_2O). The CO_2 pass-through emissions resulting from the CO_2 contained in the process are estimated from the average composition of the gas predicted during the period 2015 through 2025.

DATA REQUEST

A34. Please confirm that there would be no potential for venting of CO_2, either recycled CO_2 or HECA delivered CO_2 at the enhanced oil recovery/carbon capture and sequestration (EOR/CCS) project site, and list the controls and measures that will be used to ensure that in the case of electrical failure or other mechanical failures of the compressors that there would be adequate backup capacity to reinject all of the recycled and HECA delivered CO_2.

RESPONSE

The likelihood that venting of recycled or HECA-delivered CO_2 would occur is minimal, due to the inclusion of several layers of protection (in the form of equipment, facilities, procedures, and control systems) to prevent such occurrences. Specifically, these include:

1. Equipment and pipeline design, as described in the June 2012 Oxy Elk Hills CO_2 Enhanced Oil Recovery (EOR) Project's Monitoring, Reporting, and Verification (MRV) Plan Section 3.3.6.

2. Backup compression capacity for recycled CO_2.

3. Low-pressure immiscible reservoir capacity for recycled CO_2 to be injected without compression.

4. Backup pump capacity for HECA CO_2.

5. Automatic and remote shut-down systems to contain CO_2 instead of venting.

Further, in the unlikely event that CO_2 is vented, the amount would be quantified and reported, as described in the MRV Plan.

DATA REQUEST

A35. Please explain why all of the piping component counts on Page 21 of 26 in the GHG emissions appendix to Appendix A are zero even though the emissions estimate summary on Page 12 of 26 shows positive CO_2 and VOC emissions values.

RESPONSE

The GHG emissions included on summary page 12 of 26 include emissions from activities other than just fugitive emissions. The top line-item in the table shows the fugitive emissions estimated for the well flow lines and the CO_2 injection well heads as zero. This is consistent with the table on page 21 of 26. No leaking components are included in the counts in the table on page 21 of 26, because it is assumed that the components used for these activities would be welded.

BACKGROUND: PEAK CO_2 INJECTION RATE AND ANNUAL EMISSIONS

It is unclear if the emissions calculations provided in Appendix A of the Amended AFC show peak daily and annual emissions for EOR/CCS operation. Specifically, staff needs to understand the assumptions on maximum CO_2 recycle and combined injection rates and the associated maximum criteria and GHG pollutant emissions.

DATA REQUEST

A36. Please describe the anticipated maximum CO_2 recycle rate from CO_2 recovered during oil extraction associated with the EOR/CCS process, and the maximum CO_2 injection rate that includes the recycled CO_2 and the CO_2 being piped from the HECA project.

RESPONSE

The project will accept all agreed-upon volumes delivered by the HECA facility and re-inject essentially all that is produced from the reservoir. Thus, the rate of injection will gradually increase to a sustainable peak volume, which will be a function of the size, orientation, and number of patterns in operation throughout the development. If HECA delivers 107 million standard cubic feet per day (MMscfpd), the maximum recycle rate is anticipated to be approximately 400 MMscfpd; consequently, total injection rate is anticipated to be 507 MMscfpd. As OEHI indicated in its MRV Plan previously submitted to the CEC, OEHI and HECA are in discussions regarding possible increased levels of CO_2 delivery. For example, if HECA delivers 135 MMscfpd, the maximum recycle rate anticipated will be approximately 500 MMscfpd and the total injection rate anticipated will be 635 MMscfpd.

DATA REQUEST

A37. As part of the description of the maximum CO_2 recycle rate please identify how long the paired injection/production well site locations will be used before moving to new a location.

RESPONSE

OEHI anticipates injection/production well site locations would be used for approximately 10 years or more.

DATA REQUEST

A38. Please provide the maximum daily and annual criteria pollutant and GHG emissions rates associated with the maximum CO_2 injection rate, including the secondary GHG emissions from electricity consumption.

RESPONSE

Maximum daily and annual criteria and greenhouse gas emissions associated with the maximum CO_2 injection rate for a delivered volume of 107 MMscfpd are contained in Table 4.3-10 and Table 4.18-2, respectively, of the OEHI CO_2 EOR Project Supplemental Environmental Information contained in Appendix A-1 of the Amended AFC. As OEHI indicated in its MRV Plan previously submitted to the CEC, OEHI and HECA are in discussions regarding possible increased levels of CO_2 delivery. In the event that delivery levels are increased, OEHI will provide updated emission figures.

BACKGROUND: OIL AND GAS PRODUCTION

In order for staff to understand, evaluate, and describe the overall project energy efficiency of the HECA and Oxy EOR/CCS projects we need to understand the amount of oil and gas produced due to the EOR/CCS project.

DATA REQUEST

A39. Please provide a current best estimate for the anticipated oil and gas recovery rates for the EOR/CCS project, and the baseline "business as usual" production without this EOR/CCS project.

RESPONSE

CO_2 EOR yields 10 to 25 percent incremental production of original oil in place over "business as usual" water flooding. OEHI expects this project to be within this range.

BACKGROUND: EMISSIONS OFFSET ASSUMPTIONS

In order for staff to understand and describe the emissions offsets issue for the EOR/CCS project, staff needs additional explanation of the exempt emission sources, the CO offset assumptions, and the assumptions for the sources of the emissions reduction credits.

DATA REQUEST

A40. Please describe the rationale for the offset exempt status for the stationary emissions sources for which exemption is claimed.

RESPONSE

Offsets are not required for permit exempt equipment, emergency use only equipment, and carbon monoxide (CO) emissions in CO attainment areas. Regardless of the offset status of the emission sources, all of the emissions resulting from the Project (stationary source, mobile source, and foreseeable emergency use) are included in the operational emission estimates.

1. Permit-Exempt Equipment

   Permit-exempt equipment is not subject to new source review (NSR), and is therefore exempt from offset requirements. This would include the following stationary sources:

   a. Fugitive emissions sources not associated with an emission unit requiring a written permit. If the equipment requires a permit, then the emissions must be included in offset calculations. Refer to SJVAPCD Rule 2020 (Exemptions). (See SJVAPCD Rule 2020, Sections 6.11 through Sections 6.14; also, see Section 6.19.)

   b. Process heaters/boilers having a maximum heat input rate no greater than 5 MMBtu/Hr, burning pipeline-quality natural gas, are exempt from permit requirements (see SJVAPCD Rule 2020, Section 6.1.1).

   c. Burners used in glycol dehydration units that are no greater than 5 MMBtu/Hr, that combust pipeline-quality natural gas, are exempt from offset requirements. Because dehydration units require a permit, the “fugitive emissions” associated with such a unit are subject to SJVAPCD permit requirements (see SJVAPCD Rule 2020, Section 6.1.1).

2. Emergency Use Only Equipment

   The SJVAPCD New Source Review Rule (Rule 2201) exempts emergency use only equipment from offset requirements (see SJVAPCD Rule 2201, Section 4.6.2).

3. The SJVAPCD New Source Review Rule (Rule 2201) exempts CO emissions from offset requirement in CO attainment areas if the applicant demonstrates—to the satisfaction of the Air Pollution Control Officer—that the Ambient Air Quality Standards are not violated in the areas to be affected, and such emissions will be consistent with Reasonable Further Progress, and will not cause or contribute to a violation of Ambient Air Quality Standards (see SJVAPCD Rule 2201, Section 4.6.1).

DATA REQUEST

A41. Please describe the current NSR baseline for all pollutants requiring emissions offsets.

RESPONSE

The NSR baseline emissions from the Project were assumed to be equal to zero. Consequently, all increases in emissions from permitted equipment will be offset (with the possible exception of CO, as discussed in the response to Data Request A42).

DATA REQUEST

A42. Please explain why CO emissions are assumed to be offset, rather than be found to be exempt from offset requirements after the completion of an emissions modeling analysis (SJVAPCD Rule 2201, 4.6.1).

RESPONSE

OEHI will either offset the CO emissions entirely or will conduct dispersion modeling and provide offsets sufficient to ensure that the CO emissions from the Project will not result in a violation of a national ambient air quality standard. The need for offsets and dispersion modeling would be addressed in the SJVAPCD permit application for the Project.

DATA REQUEST

A43. Please describe whether Occidental Petroleum currently owns any emissions reduction credits created from oil field emissions reductions in the general area, or if they currently own enough emission reduction credits to meet the "ERCs Required" values shown in Table 4.3-11, or if they will have to purchase some or all of the ERCs needed for the EOR/CCS project.

RESPONSE

OEHI has sufficient emission reduction credits to offset oxides of nitrogen (NO_x), volatile organic compounds (VOCs), and CO, if required. OEHI may need to purchase or provide a small amount of emission reduction credits for particulate matter 10 microns in diameter or less/ particulate matter 2.5 microns in diameter or less ($PM_{10}/PM_{2.5}$) (3.8 tons/year) and oxides of sulfur (1.4 ton/year). The emission reduction credits are available from other source operators in the San Joaquin Valley.

Technical Area: Biological Resources
Author: Amy Golden

CARBON DIOXIDE PIPELINE ROUTE AND OEHI PROJECT

BACKGROUND

Staff will need to assess the impacts to species and sensitive habitat associated with the Occidental of Elk Hills, Inc. (OEHI) project on Elk Hills since it is a connected action with the HECA project. Appendix A, OEHI Environmental Documents, identifies 13 satellites as broad Enhanced Oil Recovery (EOR) development areas; however, Appendix A does not address specific impacts of the carbon dioxide route or results from 2010 or 2011 botanical surveys, as the Amended AFC indicates. Staff needs to be able to determine the project's impacts to special-status plants and wildlife that occur on Elk Hills in the region of the carbon dioxide route and all EOR activities.

DATA REQUEST

A59. Table 5.2-6 of the applicant's Amended AFC does not include habitat impact acreages for the carbon dioxide pipeline route and refers the reader to Appendix A; however, Appendix A also does not include an impact acreage for this linear facility. Please provide the habitat impact acreage for the currently proposed carbon dioxide route and explain how it was calculated.

Please confirm that the portion of the carbon dioxide (CO_2) pipeline that occurs on the Elk Hills Oil Field (EHOF) is not proposed for lands that are covered under an existing conservation easement or proposed for conservation under the draft Occidental of Elk Hills Habitat Conservation Plan.

RESPONSE

In response to Data Request A56, the Applicant provided Table A56-1, which is a revised version of Table 5.2-6 that also includes the impact acreage for the carbon dioxide routes.

Temporary and permanent disturbance for the CO_2 Supply Pipeline, including the disturbance area associated with the horizontal directional drilling (HDD), was described in Appendix A-2 (Data Gap Analysis) of the 2012 Amended AFC, Section 1.3, on pages 2 and 3. The relevant text is repeated below:

> " The modified CO_2 supply line alignment…is 3.36 miles in linear length and includes two HDDs. One HDD would be approximately 500 feet in length under the levee and the second HDD would be approximately 2,000 feet in length under the West Side Canal and California Aqueduct. The remainder of the CO_2 supply line would be installed using conventional trenching techniques. Calculated disturbance estimates are 28.89 acres of temporary disturbance (which includes two entry and two exit excavations), and 0.11 acres of permanent disturbance. The temporary disturbance estimates are based on a 80-foot-wide construction disturbance along 15,240.8 feet of pipe anticipated to be installed utilizing conventional trenching methods, as well as two HDD entry excavations (120 feet x 100 feet each) and two HDD exit excavations (75 feet x 100 feet each). Temporary disturbances as a result of pipe string fabrication and layout are assumed to occur on lands already disturbed by trenching activities. Permanent disturbances result[ing] from installing two valve boxes (50 feet x 50 feet each). "

The portion of the CO_2 pipeline on the Elk Hills Oil Field is not proposed for lands covered by the Conservation Area. See Attachment A59-1 for a description of the Elk Hills Conservation Easement Property.

ATTACHMENT A59-1
ELK HILLS CONSERVATION AREA
CONSERVATION EASEMENT PROPERTY DESCRIPTION

ATTACHMENT 1

Elk Hills Conservation Area Conservation Easement Property Description

Table 1 - Elk Hills 7,801 Conservation Area - Acreage Allocation

Township/ Range	Section	EHOF Section ID	Undisturbed Acres	Disturbed Acres	Total Acres/Section	Comments
T30S, R22E	12	12Z	635.00	3.00	638.00	Full Section
T30S, R23E	10	10R	640.00	2.00	642.00	Full Section
	12	12R	611.00	22.00	633.00	Full Section, Less Elk Hills Road ROW. See 12R Reconcilation.
	13	13R	318.00	1.00	319.00	NE Diagonal Section (Chevron)
T30S, R24E	17	17S	578.00	8.00	586.00	Full Section, Less State Aqueduct Acreage and Parcel G/9 (Chevron). See 17S Reconciliation.
	18	18S	635.00	5.00	640.00	Full Section
	20	20S	159.00	1.00	160.00	NE/4 Section
	21	21S	319.00	1.00	320.00	N/2 Section (Chevron).
	21	21S	158.00	2.00	160.00	N/2 S/2 Section (Chevron). See 21S Reconciliation.
	22	22S	152.00	8.00	160.00	N/2 S/2 Section. See 22S Reconciliation.
T31S, R23E	2	2B	320.00	4.00	324.00	S/2 Section
	3	3B	322.00	-	322.00	S/2 Section
	4	4B	39.71	0.29	40.00	SE/4 of SE/4. See 4B Reconciliation - Fig. 9.
	4	4B	39.51	0.49	40.00	SW/4 of SE/4. See 4B Reconciliation - Fig. 9.
	4	4B	40.00	-	40.00	SE/4 SW/4
	10	10B	625.00	12.00	637.00	Full Section
	11	11B	632.00	10.00	642.00	Full Section
	12	12B	61.00	-	61.00	NW/4 West of Elk Hills Road
	12	12B	164.00	-	164.00	SW/4 Section
	12	12B	49.00	-	49.00	SE/4 West of Elk Hills Road
	13	13B	309.00	13.00	322.00	N/2 Section
	13	13B	322.00	7.00	329.00	S/2 Section (Chevron)
	14	14B	310.00	12.00	322.00	N/2 Section
	14	14B	121.00	-	121.00	N/2 SE/4 and the SE/4 SE/4
T31S, R24E	18	18G	22.00	1.00	23.00	N/4 West of Elk Hills Road
	18	18G	297.00	37.00	334.00	S/2 Section
Total			**7,878.22**	**149.78**	**8,028.00**	

Note - Green Shaded Cells Indicate Chevron Ownership

	Undisturbed	Disturbed	Total	Delta
OEHI Total Acres	6,183.22	130.78	6,314.00	**98.44**
Chevron Total Acres	1,695.00	19.00	1,714.00	**(21.22)**

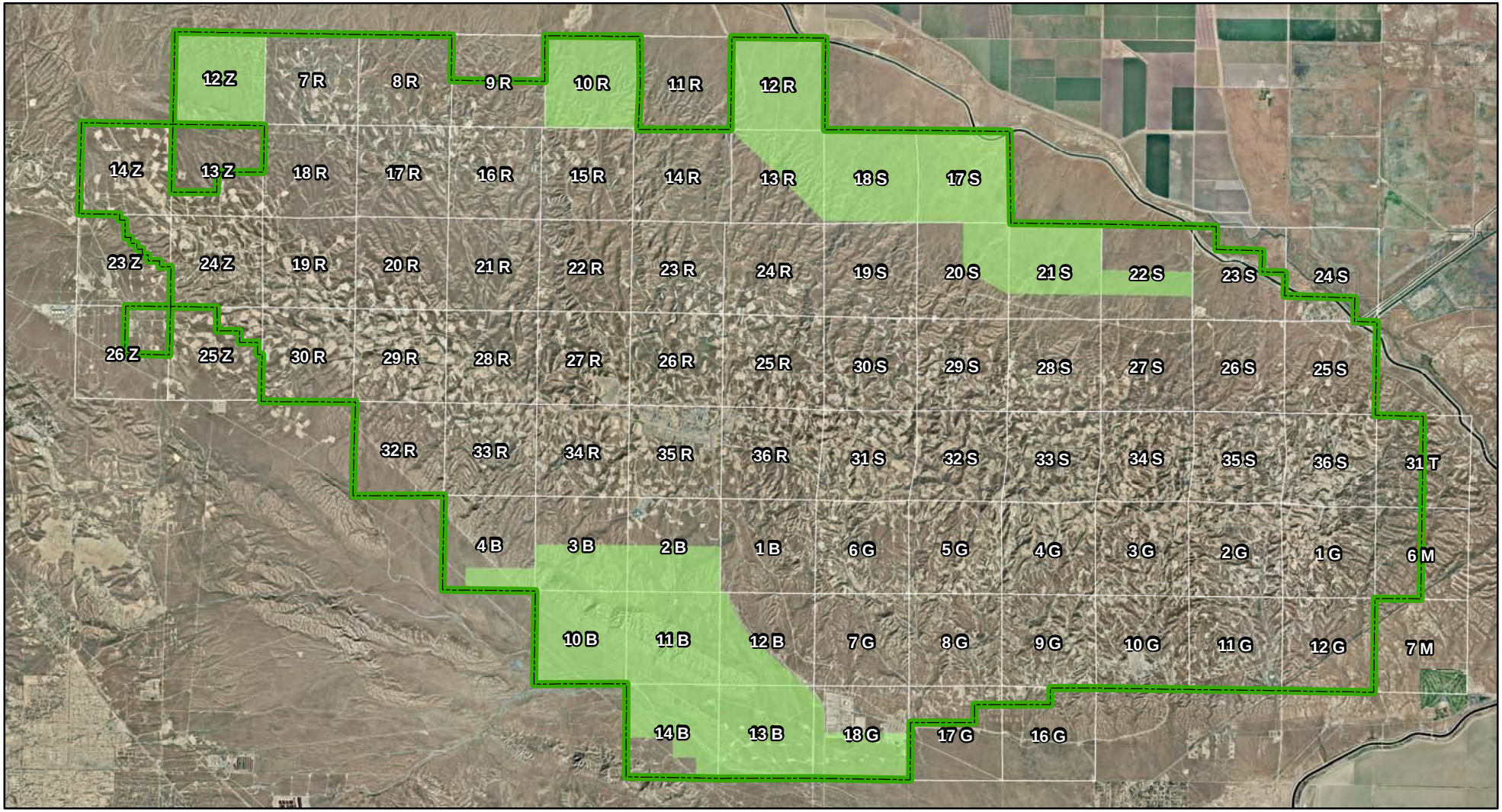
	Percent Allocation	Total Area	Required Contribution	Percent Contribution Per Table 1
OEHI Required Acreage	0.78	7,801.00	6,084.78	**79.26**
Chevron Required Acreage	0.22	7,801.00	1,716.22	**21.73**

SAVE AND EXCEPTED THEREFROM: Within the parcel described below, one hundred (100) feet in width running parallel with, and immediately adjacent to, the eastern Section boundary line of the North Half of the South Half, an easement to lay, construct, maintain, operate, repair, renew, from time to time change the size of, and remove a maximum of three (3) pipelines for the transportation of oil, gas, water, and such other substances as are suitable for transportation through a pipeline, together with such valves, meters, drips, taps, and similar appurtenances thereof (hereinafter referred to as "Said Facilities"), with the right of ingress and egress to and from the same in, under, along and across that certain real property (hereinafter referred to as "Said Premises") situated in the County of Kern, State of California, and described as follows:

Township 30 South, Range 24 East, M.D.B. & M.
Section 22; North Half of the South Half (N/2S/2)

OCCIDENTAL OF ELK HILLS, INC.

Conservation Area - Phase 1 ESA Update
Aerial Map



0 0.5 1 2
Miles
1:100,000

ELK HILLS OIL FIELD BOUNDARY
EHOF CONSERVATION AREA (7,878 ACRES)

Quad Knopf

Attachment 1

FILE: \\bk-server-02\L:\Projects\2006\060008\OEHI Conservation Area Easement\2010 October Phase I Update\Maps\MXD\Fig4_Aerial_111210.mxd

Source: County of Kern/OEHI

DATA REQUEST

A60. Please provide an aerial exhibit(s) at an appropriate scale (e.g. 1 inch: 7,000 feet) showing plant and wildlife species GPS data collected during previous monitoring years. On the exhibit, please also show a conceptual drawing overlay (such as AutoCAD) of the 13 satellites shown in Appendix A.

RESPONSE

A conceptual map with the tentative satellite locations is in progress and will be provided when completed.

DATA REQUEST

A61. Page 5.2-13 indicates that cottony buckwheat, Hoover's eriastrum, and oil nest straw were observed in areas surveyed for the previously proposed carbon dioxide route but not the current pipeline route and details are addressed in Appendix A. Appendix A gives a general overview of occurrences of these plant species on the Elk Hills Oil Field by referring to the Draft Habitat Conservation Plan for the Elk Hills Oil Field but does not include survey results specifically for the currently proposed carbon dioxide route. Please provide the results of the botanical surveys performed on the carbon dioxide pipeline study area. Provide a figure showing the location of these plant populations in relation to the current carbon dioxide pipeline route, approximate number of plants found during surveys, and dates that surveys were performed. Please also describe the potential for direct and indirect impacts to this species during construction and operation.

RESPONSE

A survey was conducted on February 24 and 25, 2011, and the results are summarized in Section 4.1 and Table 2 of the Biological Assessment section of the Data Gap Analysis (Appendix A-2 of the 2012 Amended AFC). A second survey was conducted on April 14, 2011, and results are set forth in Table 4 of the 2012 Amended AFC. Copies of these pages from the Biological Assessment are provided for convenience in Attachment A61-1.

Section 4.1.1 states that no federal and/or State-listed or otherwise sensitive plant species were observed in any portion of the proposed Project Area during biological field surveys.

Table 4 is on Page 19 of the Biological Assessment section of the Data Gap Analysis. This table lists the botanical survey results for the CO_2 Supply Pipeline, and includes the date of the survey.

ATTACHMENT A61-1
BOTANICAL SURVEY RESULTS, FEBRUARY AND APRIL 2011

4.0 RESULTS

The areas covered during the biological surveys conducted on February 24th and 25th, 2011 and the findings are discussed in the following sections.

4.1 VEGETATION

Vegetation observed during the biological survey was limited to common native and invasive plant species found in the EHOF and surrounding areas. These plant species are summarized in **Table 2**. No threatened, endangered, or any other sensitive plant species were observed during the biological survey period. The survey was not conducted during the optimal phenological period and the biologist used common identification methods in order to identify annual forbs and grasses. As such, Table 2 should only be used as a baseline for identifying community type and should not be treated as a comprehensive species list for the CO2 supply pipeline alignment. Additional general vegetation surveys and protocol level rare plant surveys should be conducted during optimal periods once the CO2 supply pipeline alignment is finalized.

The current iteration of the CO2 supply pipeline alignment places it directly through three plant communities and an agricultural zone along a transition from valley floor to foothill communities.

Generally, the project area is flat to gently sloping in the northern portion, moderately sloped in the central portion and steeply sloped in the southern portion. Non-native grassland dominates the steeper slopes of the southern-most portions of the project area. Vegetation associated with valley sink scrub is intermixed in the southern foothill regions in low lying washes and drainages. Vegetation in these areas is comprised of thick carpets of non-native invasive grasses and native grasses and forbs. Significant stands of fiddleneck (*Amsinckia sp.*) and (*Bromus sp.*) were the dominant plant species throughout much of the upland sloped terrain. An occasional saltbush (*Atriplex polycarpa*) stand was interspersed among the grasses and forbs. In general, shrub density increased as slope angle decreased along the foothill-valley transition. Vegetation density was highest in higher elevations and increased slope angles.

In more northerly, shallow sloped areas of the survey, vegetation consists almost entirely of non-native and native grasses and forbs. Very few shrubs were observed in these areas. Vegetation density in these areas was highest in low lying seeps and drainages.

Table 2: Botanical Survey Results for the OEHI CO2 EOR CO2 Supply Pipeline Alignment	
Plant Species Observed	
Scientific Name	**Common Name**
Amsinckia sp.	Fiddleneck
Astragalus lentiginosus	Speckled Milkvetch or Mottled Locoweed
Atriplex polycarpa	Valley/desert Saltbush
Atriplex spinifera	Spiny Saltbush
Avena fatua	Common wild oats
Brassica nigra	Black mustard
Bromus diandrus	Ripgut brome
Bromus madritensis spp. rubens	Red brome
Bromus hordeaceus	Soft chess
Camissonia californica	California Sun Cup
Centaurea melitensis	Tocalote
Eremocarpus setigerus	Turkey mullein
Erodium cicutarium	Red-stemmed filaree
Gutierrezia braceata	Matchweed
Helianthus annus	Annual sunflower
Hemizonia pungens	Common Spikeweed
Hordeum sp.	Barley
Hymenoclea salsola	Cheesebush
Layia glandulosa	White Tidy Tips
Lepidium dictyotum.	Peppergrass
Phacelia tanacetifolia	Tansy Leafed Phacelia
Plagiobothrys sp.	Popcorn flower
Poa sp.	Blue grass
Stephanomeria sp.	Wire Lettuce
Vulpia myuros	Rattail fescue

4.1.1 Listed and Sensitive Plant Species

No federal and/or state listed or otherwise sensitive plant species were observed on any portion of the proposed Project area during biological field surveys. Surveys were not conducted during the proper phenological blooming periods and thus detection is difficult if not impossible. Federally listed plants known to be found in similar habitat in surrounding areas include the federally endangered San Joaquin woollythreads (*Lembertia [Monolopia] congdonii*); Federally endangered Kern mallow (*Eremalche kernensis*); and federally and state endangered California jewelflower (*Caulanthus californicus*). Protocol level rare plant surveys should be conducted following finalization of CO2 supply pipeline alignment. A complete list of listed and sensitive plants, required habitat, and potential to occur within the Project area are located in Table 1.

4.2 WILDLIFE

Wildlife species and/or signs of presence observed during field surveys conducted on February 24th and February 25th, 2011 are presented in ***Table 3***. No visual observations of threatened,

8.0 ADDENDUM RESULTS

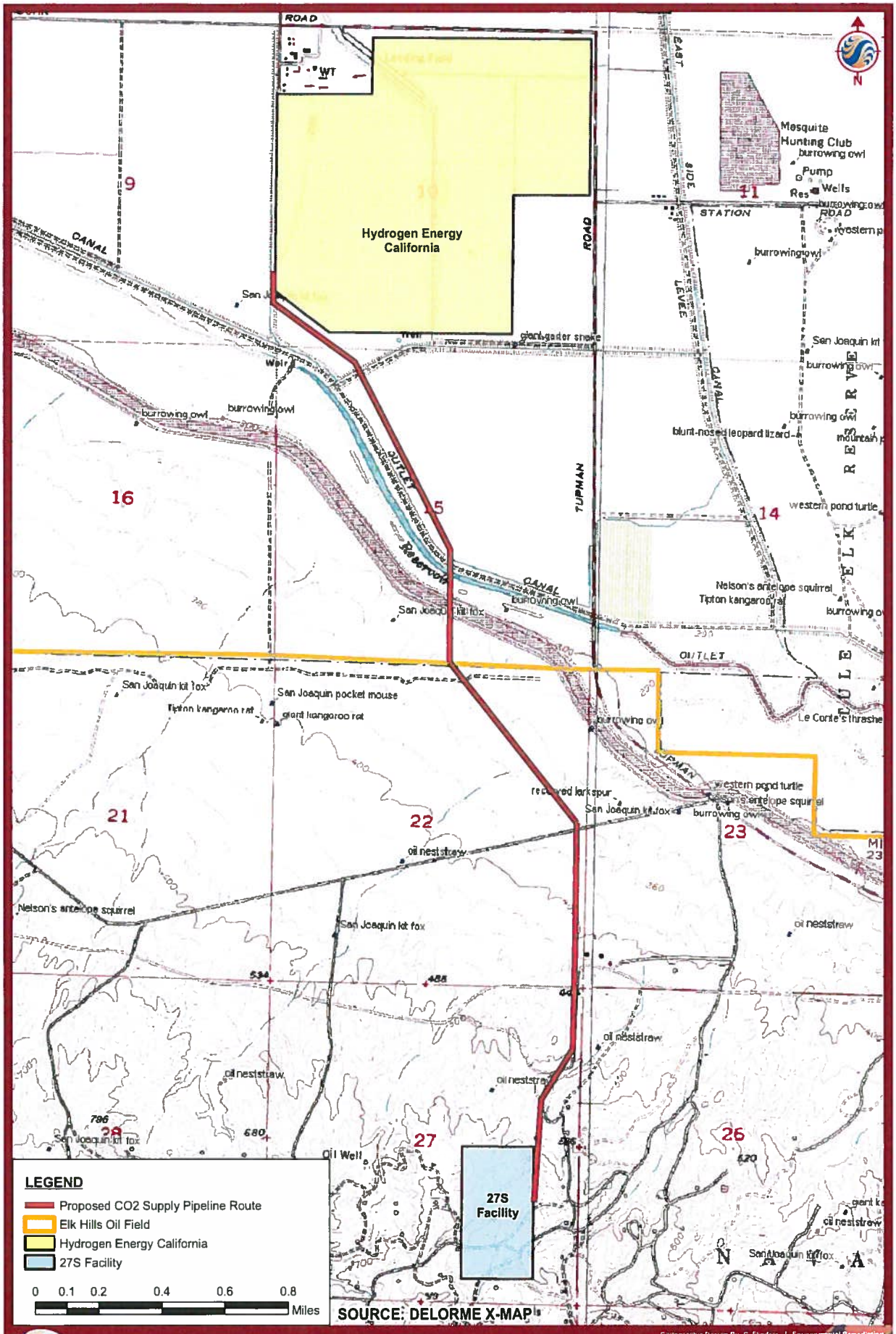
The findings of the April 14, 2011 biological assessment survey are discussed in detail below.

8.1 VEGETATION

Vegetation observed during the terrestrial survey was typical of that found on the EHOF and surrounding lands. A complete list of common plants species observed during the April 2011 survey can be found in ***Table 4*** below.

Table 4: Botanical Survey Results for the OEHI CO2 EOR CO2 Supply Pipeline Alignment

Common Plant Species Observed April 14, 2011	
Scientific Name	**Common Name**
Achracheana mollis	Blow wives
Amsinckia sp.	Fiddleneck
Astragalus lentiginosus	Speckled Milkvetch or Mottled Locoweed
Atriplex polycarpa	Valley/desert Saltbush
Atriplex spinifera	Spiny Saltbush
Avena barbatus	Slender wild oats
Avena fatua	Common wild oats
Brassica nigra	Black mustard
Bromus diandrus	Ripgut brome
Bromus madritensis spp. rubens	Red brome
Bromus hordeaceus	Soft chess
Camissonia californica	California Sun Cup
Castilleja exserta ssp. exserta	Purple owl's clover
Centaurea melitensis	Tocalote
Chamomilla sauveolens	Pineapple weed
Cryptantha sp.	Cryptantha
Cucurbita palmate	Coyote melon
Dichelostemma capitatum	Blue dicks
Eremocarpus setigerus	Turkey mullein
Erodium cicutarium	Red-stemmed filaree
Eastwoodia elegans	Yellow mock aster
Gutierrezia braceata	Matchweed
Filago californica	Filago
Helianthus annus	Annual sunflower
Hemizonia pungens	Common Spikeweed
Hirshfeldia incana	Mustard
Hordeum sp.	Barley
Hymenoclea salsola	Cheesebush
Isomeris arborea	Bladderpod
Layia glandulosa	White Tidy Tips



Cartographic Design By C. Flinders | Environmental Remediation

Stantec does not certify the accuracy of the data. This map is for reference only and should not be used for construction.

Stantec

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Phone: 916 569 2500 Fax: 916 921 9274 www.stantec.com
Project # 185402314

Figure 3

California Natural Diversity Database Map

OEHI CO2 EOR Project - Supplemental Environmental Assessment

DATA REQUEST

A62. Please provide copies of (per Section 4.4 of Appendix A, Amended AFC):

a. Any available wildlife and botanical monitoring reports from Elk Hills history as NPR-1 and NPR-2;

b. Occidental of Elk Hills, Inc. (OEHI) Habitat Conservation Plan, 2006. First Public Draft. Kern County Planning Department;

c. CESA Incidental Take Permit application for draft HCP (OEHI 2009);

d. Memorandum of Understanding and CESA Take Authorization, CDFG and OEHI, 1997;

e. Memorandum of Understanding and CESA Take Authorization, CDFG and OEHI, 1999 MOU amendment;

f. Memorandum of Understanding and CESA Take Authorization, CDFG and OEHI, 2010 second amendment; and

g. USFWS 1995, Biological Opinion.

RESPONSE

a. Copies of annual monitoring reports for 1998 through 2011 are submitted separately on disk to the California Energy Commission (CEC).

b. The earlier draft was never signed or approved and is no longer operative. OEHI is currently working with the California Department of Fish and Game (CDFG) and USFWS to develop any necessary endangered species program updates or authorizations. All necessary authorizations will be finalized before construction of the OEHI CO2 EOR Project is initiated and will govern any such development.

c. Please see response to Data Request A62b.

d. A copy of this document is submitted separately on disk to CEC.

e. A copy of this document is submitted separately on disk to CEC.

f. A copy of this document is submitted separately on disk to CEC.

g. A copy of this document is submitted separately on disk to CEC.

Technical Area: Cultural Resources
Authors: Melissa Mourkas, Elizabeth A. Bagwell, Gabriel Roark

BACKGROUND

Based on staff's examination of the Amended AFC and the supplemental environmental information provided for the Occidental Of Elk Hills, Inc. (OEHI) Project Site (Amended AFC, App. A); (Pursuant to CEQA Section 15378(a)(c) "Project" defined means the whole of the action…), as such the Energy Commission staff requires additional cultural resource information regarding the CO_2 EOR Processing Facility and the associated processing satellites, 150 new wells and 652 miles of pipeline. The missing information includes but is not limited to:

- A discussion of the existing site conditions; the expected direct, indirect, and cumulative impacts due to the construction, operation, and maintenance of the Project; the measures proposed to mitigate adverse environmental impacts of the Project; the effectiveness of the proposed measures; and any monitoring plans proposed to verify the effectiveness of the mitigation.

- A summary of the ethnology, prehistory, and history of the region with emphasis on the area within no more than a 5-mile radius of the Project location. Please note that the Project location includes all access roads and linears, the 13 processing satellites, 150 new wells, and 652 miles of new pipeline identified above.

- The results of a literature search to identify cultural resources within an area not less than a 1-mile radius around the Project Site and not less than 0.25 mile on each side of the linear facilities.

- A report presenting the results of pedestrian surveys of the OEHI Project Site.

- Copies of all technical reports whose survey coverage is wholly or partly within 0.25 mile of the area surveyed for the project.

- Copies of DPR 523 forms for all cultural resources identified in the literature search as being 45 years or older or of exceptional importance.

- Kern County adopted environmental impact reports or related documents for the Occidental Elk Hills Oil Field identifying related cultural resources and associated/required mitigations.

DATA REQUEST

A85. Please conduct a records search and literature review of the OEHI project site. The records search and literature review shall cover an area not less than 1 mile surrounding the OEHI project site and not less than 0.25 mile on each side of linear facilities. Provide copies of all technical reports whose survey coverage is wholly or partly within 0.25 mile of the area surveyed for the project. Also consult any Kern County general or specific plan documents for the Elk Hills for cultural resources information.

RESPONSE

The CO_2 EOR Project Area covers approximately 38 square miles, and approximately half of the area has been surveyed for archaeological and historical resources. Based on recent surveys conducted on other OEHI property, approximately 1 to 2 years would be required to complete the survey and work requested by Data Requests A85 through A88.

Oxy has proposed mitigation measures to avoid known historical resources and to reduce impacts to previously unidentified resources that may be discovered during construction. The proposed mitigation measures are set forth in Appendix A-1 (Supplemental Environmental Information), pages 4.5-14 through 4.5-17, and also provided for convenience in Attachment A85-1.

ATTACHMENT A85-1
CULTURAL RESOURCES MITIGATION MEASURES

4.5 CULTURAL AND PALEONTOLOGICAL RESOURCES

4.5.4.3 Project Impacts

IMPACT CULT-1: Cause a Substantial Adverse Change in the Significance of a Historical Resource

None of the recorded historic period sites or artifacts in the EHOF is regarded as individually eligible for listing in the National Register of Historic Places. Some early development features could be considered significant with reference to their association with individuals important in the early history of the oil industry. The EHOF may be eligible at the local, state or national level, as a rural historic landscape, for its role in the development of the California oil industry and for its relationship to the infamous "Teapot Dome" scandal of the Harding presidential administration (DOE, 1997). However, the proposed project is limited to utilizing CO2 EOR including the construction and operation of supporting facilities that will not cause a substantial adverse change in the significance of a historical resource. This is a less than significant impact.

Mitigation Measures

Mitigation measures are not required.

Level of Significance after Mitigation

Impacts would be less than significant.

IMPACT CULT-2: Cause a Substantial Adverse Change in the Significance of an Archaeological Resource

If all activities are conducted outside of the Elk Hills Conservation Area, no impacts to previously identified prehistoric archaeological resources are anticipated. However, prehistoric archaeological resources without surface indications could exist in the project area. Disturbance to these resources could result in a significant cultural resources impact.

Implementation of the following mitigation measures will lower any potential proposed Project impact to archaeological resources below the threshold of significance. These measures establish procedures to follow in case previously undiscovered archaeological deposits are encountered below the ground surface.

Mitigation Measures

Mitigation Measure CULT-1 Prior to initial ground-disturbing activities the Designated Cultural Resources Specialist will conduct a worker education session for construction supervisory personnel to explain the importance of and legal basis for the protection of known significant archaeological resources.

Mitigation Measure CULT-2 A Native American monitor will be present during Project excavation work in culturally sensitive areas on the EHOF.

4.5 CULTURAL AND PALEONTOLOGICAL RESOURCES

Mitigation Measure CULT-3 If a new prehistoric or historic cultural resource site is discovered during construction and determined to be significant, a qualified Archaeologist will prepare and implement a mitigation plan in accordance with state regulations on private lands. This plan will emphasize the avoidance, if possible, of significant archaeological resources. If avoidance is not possible, recovery of a sample of the deposit from which the archaeologist can define scientific data to address archaeological research questions will be considered an effective mitigation measure for damage to or destruction of the deposit.

The qualified Archaeologist and archaeological monitor will follow accepted professional standards in recording any finds and will submit the standard Department of Parks and Recreation historic site form (Form DPR 523) and locational information to the Southern San Joaquin Valley Information Center of the California Historic Resources Information System at CSUB.

If the qualified Archaeologist determines that the find is not significant, construction will proceed. If the qualified Archaeologist determines that further information is needed to determine whether the find is significant, the County and SHPO will be notified for consultation. Construction will resume at the site as soon as the field data collection phase of any data recovery efforts is completed.

Mitigation Measure CULT-4 If cultural resources are recovered during proposed Project construction, a qualified Archaeologist will contact and offer the resources for curation to a curation facility, that is, a recognized, non-profit archaeological repository with a permanent curator, of any archaeological materials collected during the construction monitoring and mitigation program. The archaeologist shall submit field notes, stratigraphic drawings, and other materials developed as part of the archaeological excavation program to the curation facility along with the archaeological collection.

If buried archaeological deposits are found during construction, the archaeologist will prepare a report summarizing the monitoring and archaeological investigatory program implemented to evaluate the find or to recover data from an archaeological site as a mitigation measure. This report will describe the site soils and stratigraphy, and analyze artifacts and other materials recovered, and explain the site's significance. This report will be submitted to the curation facility with the collection.

Mitigation Measure CULT-5 The qualified Archaeologist should meet the minimum qualifications for Principal Investigator on federal projects under the Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation. The Archaeological Monitor shall be qualified to detect archaeological deposits in the field. The qualified Archaeologist shall be qualified, in addition to site detection, to evaluate the significance of the deposits, consult with regulatory agencies, and plan site evaluation and mitigation activities.

Level of Significance after Mitigation

Although unlikely, significant archaeological resources may be present within various portions of the proposed Project Site outside the conservation set-aside area and could be adversely impacted during

4.5 CULTURAL AND PALEONTOLOGICAL RESOURCES

construction activities. Implementation of the measures described above will mitigate this impact to a less than significant level.

IMPACT CULT-3 Directly or Indirectly Destroy a Unique Paleontological Resource or Site or Unique Geologic Feature

Paleontological resources are prevalent throughout the area and could be discovered during any surface disturbance activity. It is suggested that the mitigation measures that have been required for previous recent projects be implemented. Prior to the certification of the Elk Hills Power Plant, several measures were suggested, and they are relevant to any future development in the oilfield.

Under CEQA Guidelines public agencies must treat all historical and cultural resources as significant unless the preponderance of evidence demonstrates that they are not historically or culturally significant. An individual fossil specimen is considered scientifically important if it is identifiable, complete, well preserved, age diagnostic, useful in paleo-environment reconstruction a type or topotypic specimen, a member of a rare species, a species that is part of a diverse assemblage, or a skeletal element different from, or a specimen more complete than, those now available for that species.

Mitigation Measure CULT-6 Prior to the start of construction, the designated paleontological resource specialist would conduct a training session for all project managers and construction personnel that are responsible for operating heavy equipment. The training would focus upon the identification and reporting procedure for the discovery of any previously unrecorded paleontological resources.

Mitigation Measure CULT-7 If paleontological resources are recovered during proposed Project construction, a qualified individual will contact and offer the resources for curation to a paleontological curation facility.

Mitigation Measure CULT-8 All paleontological investigations during the course of the project would result in a formal report submitted to the appropriate agency.

Level of Significance after Mitigation

Although unlikely, significant paleontological resources may be present within various portions of the proposed Project Site outside the conservation set-aside area and could be adversely impacted during construction activities. Implementation of the measures described above will mitigate this impact to a less than significant level.

IMPACT CULT-4 Disturb any Human Remains, including those interred outside of formal cemeteries

Native American human remains have been encountered during past earth disturbing activities at the EHOF. As such, there is potential for their discovery during proposed Project construction. The

4.5 CULTURAL AND PALEONTOLOGICAL RESOURCES

potential to encounter human remains during construction will be reduced by minimizing disturbances to the degree practical (e.g., use of existing wells and pads, previously disturbed pipeline corridors, and aboveground piping). If human remains were to be discovered during construction, Mitigation Measure CULT-9 would ensure that the remains are treated in accordance with the California Public Resources Code and impacts would be reduced to a less than significant level.

Mitigation Measures

Mitigation Measure CULT-2 identified above.

Mitigation Measure CULT-9 If human remains are found during construction CEQA requires that further work or disturbance of the site be halted. The discovery will be inspected and the remains be handled in a manner consistent with Public Resources Code 5097.98-99, Health and Safety Code 7050.5, and CEQA Section 15064.5.

If the remains are determined to be Native American, the NAHC will be notified within 24 hours as required by Public Resources Code 5097. The NAHC will notify designated Most Likely Descendants who will provide recommendations for the treatment of the remains within 24 hours. The NAHC will mediate any disputes regarding the treatment of remains.

Level of Significance after Mitigation

Impacts would be less than significant.

4.5.5 Cumulative Impacts

Archaeological and paleontological resources are generally not considered subject to cumulative impacts because cultural resources are localized and site-specific and are either individually impacted in a way that changes the significance of the site or are avoided. Therefore, no apparent significant cumulative impacts are anticipated because the resources are generally not considered subject to cumulative impacts, and the proposed Project would not be expected to have a significant impact on archeological or paleontological sites. In addition, if the mitigation measures mentioned above for paleontological resources are followed, the Project would not result in a cumulative impact.

Mitigation Measures

Implementation of the aforementioned mitigation measures would reduce this impact to less than significant.

Level of Significance after Mitigation

The proposed Project would have less than significant cumulative impacts.

DATA REQUEST

A86. Please submit copies of DPR 523 forms for all cultural resources identified in the literature search as being 45 years or older or of exceptional importance.

RESPONSE

Please refer to the response to Data Request A85.

DATA REQUEST

A87. Please conduct a comprehensive cultural resources inventory (archaeological resources, historic built environment, and Native American resources) of those portions of the OEHI project site that have not been surveyed by cultural resource professionals within the last 5 years.

RESPONSE

Please refer to the response to Data Request A85.

DATA REQUEST

A88. Please provide the results of these surveys in a technical report conforming to the Archaeological Resource Management Report format (CA Office of Historic Preservation Feb 1990). The report should include the following information:

a. A summary of the ethnology, prehistory, and history of the region with emphasis on the area within no more than a 5-mile radius of the project location. The report shall fully discuss the findings of the various cultural resource studies conducted in and around the OEHI project site since the 1990s. In particular, the report must discuss the current management status of the Naval Petroleum Reserve-1 Rural Historic Landscape and whether it is a historical resource for the purposes of CEQA.

b. The methods used to identify cultural resources at the OEHI project site.

c. The results of the records search and pedestrian survey of the OEHI project site.

d. Descriptions of previously and newly recorded cultural resources in the proposed OEHI project site.

e. A discussion of the existing site conditions; the expected direct, indirect, and cumulative impacts due to the construction, operation, and maintenance of the project; the measures proposed to mitigate adverse environmental impacts of the project; the effectiveness of the proposed measures; and any monitoring plans proposed to verify the effectiveness of the mitigation.

f. DPR 523 forms for all cultural resources identified at the OEHI project site.

RESPONSE

Please refer to the response to Data Request A85.

Technical Area: Hazardous Materials Management
Technical Area: Visual Resources – Visual Plume
Author: Joseph Hughes

BACKGROUND

Staff is assessing the need to perform a plume modeling analysis for the carbon dioxide (CO_2) recovery plant unit exhausts. The Amended AFC, Appendix A, "Supplemental Environmental Information for the Occidental of Elk Hills, Inc., CO_2 Enhanced Oil Recovery Project" (submitted 5/2/2012) references and states that the addendum supplements "The Preliminary Project Description for the CO_2 enhanced oil recovery (EOR) at the Elk Hills Oil Field" (dated 4/16/2010). The Preliminary Project Description (2010) describes several process systems that may have the potential to create visible plumes or strong thermal plumes, however additional information is needed to make that determination. For example, it is unclear how the heat from the propane refrigeration system and the discharge cooler are used or released.

DATA REQUEST

A120. Please describe all exhaust equipment associated with the CO_2 recovery plant unit (i.e. fractation system, natural gas liquids (NGL) recovery system, demethanizer system, and refrigeration system) including but not limited to the propane refrigeration system and discharge cooler and related heat rejection devices (air cooled or water cooled). Please complete data from the following table that summarizes exhaust parameters and the exhaust conditions that affect visible vapor plume formation and thermal plume strength. Staff assumes that the exhaust parameters are stable under all ambient temperature conditions. Please correct this assumption, if incorrect, by providing data for a range of ambient temperature conditions where appropriate in the same manner as the cooling tower exhaust data provided in Section 5.11 of the Amended AFC.

Parameter	Refrigeration System	Discharge Cooler	Additional Equipment as Needed
Stack Height			
Stack Diameter			
Temperature			
Flow Rate (lbs/sec)			
Moisture Content (wt%)			

RESPONSE

The facility design includes no equipment that would commonly be classified as "exhaust equipment," such as cooling towers or stacks with cooling or heat rejection. The design of the facilities integrates processes that require heating and cooling to ensure the efficient use of energy in operation of the facility. Any required heat rejection is provided by multiple air-cooled "fin-fans" that are distributed throughout the facility; and as a result, strong thermal plumes are not expected to occur. There are no visible plumes associated with sources such as cooling towers.

Technical Area: Waste Management
Author: Ellen Townsend-Hough, REA

BACKGROUND

The Naval Petroleum Reserve Number 1 (NPR-1) is an oil-producing field owned by Occidental of Elk Hills, Inc. (Oxy). The facility was formerly owned by the United States Department of Energy (DOE) and Chevron Oil Company (Chevron). The NPR-1 occupies approximately 47,985 acres or 75 square miles. Petroleum has been produced on NPR-1 since 1919. Occidental of Elk Hills, Inc., is proposing to extend the life of the enhanced oil recovery (EOR) operations by utilizing carbon dioxide from the Hydrogen Energy California (HECA) project to facilitate oil production from the Elk Hills Unit operations.

DOE sold its interest in the NPR-1 to Occidental Petroleum in 1997. As a result of the land transfer to Occidental, California Department of Toxic Substances Control (DTSC) entered into an Agreement for Site Assessment (ASA) with DOE and completed a Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) of NPR-1 in 1998. DOE agreed to head up an environmental and human health risk assessment of the entire site with remediation to address the effects of past practices at the site. The working arrangement with DTSC began with an Agreement for Site Assessment (ASA) starting in 1997. Three amendments have been made to the ASA, the last of which was for a work plan for the assessment of 131 Areas of Concern (AOCs). The AOCs consist of both small and large areas of contamination. The work was stalled for seven years. On December 23, 2008 DOE and DTSC signed a Corrective Action Consent Agreement to complete the work. In December 2011 and early 2012, DOE representatives submitted numerous Pre-Decisional Project Approach documents. The documents include an "overview of the planned approach to achieve site closure" for each of the 131 AOCs (DTSC ENVIROSTOR Occidental of Elk Hills Inc. (80001254)). To ensure that contamination is not spread and that construction workers are not exposed to hazardous materials, safety procedures should be developed and implemented for the construction of the project.

DATA REQUEST

A121. To ensure public health and safety are maintained please identify what steps or methodology the applicant and Oxy propose to avoid impacts from identified Areas of Concern and potential unidentified hazardous waste sites on the Occidental Elk Hills Oil Field project site.

RESPONSE

The areas of concern have all been identified and will be avoided during Project construction. The Department of Energy (DOE) has the responsibility to investigate and clean up all legacy inactive waste sites identified in the Resource Conservation and Recovery Act Facility Investigation conducted for the sale of the former NPR-1. DOE also has responsibility to obtain regulatory closure from the Department of Toxic Substances Control (DTSC). DOE and its contractors are required to implement and follow OEHI and all appropriate and applicable safety measures to limit exposure to hazardous materials.

BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT
COMMISSION OF THE STATE OF CALIFORNIA
1516 NINTH STREET, SACRAMENTO, CA 95814
1-800-822-6228 – WWW.ENERGY.CA.GOV

AMENDED APPLICATION FOR CERTIFICATION FOR THE HYDROGEN ENERGY CALIFORNIA PROJECT

Docket No. 08-AFC-08A
(Revised 8/28/12)

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DECLARATION OF SERVICE

I, Dale Shileikis, declare that on September 12, 2012, I served and filed a copy of the attached Responses to CEC Data Requests Set One: OEHI Extension, dated September, 2012. This document is accompanied by the most recent Proof of Service list, located on the web page for this project at:
http://www.energy.ca.gov/sitingcases/hydrogen_energy/index.html

The document has been sent to the other parties in this proceeding (as shown on the Proof of Service list) and to the Commission's Docket Unit or Chief Counsel, as appropriate, in the following manner:
(*Check all that Apply*)

For service to all other parties:

_x_ Served electronically to all e-mail addresses on the Proof of Service list;

___ Served by delivering on this date, either personally, or for mailing with the U.S. Postal Service with first-class postage thereon fully prepaid, to the name and address of the person served, for mailing that same day in the ordinary course of business; that the envelope was sealed and placed for collection and mailing on that date to those addresses marked *"hard copy required" or where no e-mail address is provided.

AND

For filing with the Docket Unit at the Energy Commission:

_x_ by sending one electronic copy to the e-mail address below (preferred method); OR

___ by depositing an original and 12 paper copies in the mail with the U.S. Postal Service with first class postage thereon fully prepaid, as follows:

CALIFORNIA ENERGY COMMISSION – DOCKET UNIT
Attn: Docket No. 08-AFC-08A
1516 Ninth Street, MS-4
Sacramento, CA 95814-5512
docket@energy.ca.gov

OR, if filing a Petition for Reconsideration of Decision or Order pursuant to Title 20, § 1720:

___ Served by delivering on this date one electronic copy by e-mail, and an original paper copy to the Chief Counsel at the following address, either personally, or for mailing with the U.S. Postal Service with first class postage thereon fully prepaid:

California Energy Commission
Michael J. Levy, Chief Counsel
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I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct, that I am employed in the county where this mailing occurred, and that I am over the age of 18 years and not a party to the proceeding.