APPENDIX F: ENERGY

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MEMORANDUM

TO: Brad Shirhall, TLA Engineering & Planning

FROM: Wayne Shijo, KD Anderson & Associates, Inc.

SUBJECT: Quarry Row Subdivision Project Energy Analysis

DATE: June 23, 2017 **PROJECT:** Quarry Row 4530-A-01

Introduction

This memorandum presents an estimate of energy consumption associated with construction and operation of the Quarry Row Subdivision project. The project includes 64 single family dwelling unit lots located in the northeastern portion of the City of Rocklin in Placer County. The project site is located on the southeastern corner of the intersection of Pacific Street and Grove Street.

Our understanding is the energy analysis will be used in a California Environmental Quality Act (CEQA) environmental document prepared by the City of Rocklin, which is the CEQA lead agency for the project. The energy analysis presented in this memorandum applies an approach and format specified by City of Rocklin staff.

The amount of energy used at the residential uses within the project site would directly correlate to the number and size of residential units, the energy consumption of associated unit appliances, garage usage, outdoor lighting, landscape maintenance, and other energy uses associated with project site activities. Other project energy uses include fuel used by vehicle trips generated by the project during its construction and operation, and fuel used by off-road construction vehicles during construction. The following discussion provides calculated levels of energy use expected for the project, based on commonly used modeling software (i.e. CalEEMod and the California Air Resource Board's EMFAC2014). It should be noted that many of the assumptions provided by the CalEEMod model are conservative relative to the proposed project. Therefore, this discussion provides conservative estimates of project energy calculation.

Electricity and Natural Gas

Electricity and natural gas used by the proposed project would be used primarily for residential housing end uses. Additionally, the energy required to pump water and wastewater to and within the project site is included under electricity usage. Total annual electricity and natural gas usage associated with the operation of the project, as provided by the CalEEMod model, are shown in **Table 1**. The CalEEMod model estimates the project would use 2,057,710 thousands of British thermal units (kBTU) of natural gas and 475,987 kilowatt-hours (kWh) of electricity,

Table 1. Project Operational Natural Gas and Electricity Usage

Source	Amount of Use
Natural Gas	2,057,710 kBTU/Year
Electricity	475,987 kWh/Year

Notes: "kBTU" = thousands of British thermal units.
"kWh" = kilowatt-hours.
Source: CalEEMod emissions model.

According to *CalEEMod – California Emissions Estimator Model User's Guide*, the model uses the *California Commercial End Use Survey* (CEUS) database to develop energy intensity value for non-residential buildings. The energy use from residential land uses is calculated based on the *Residential Appliance Saturation Survey* (RASS). Similar to CEUS, this is a comprehensive energy use assessment that includes the end use for various climate zones in California.

On-Road Vehicles (Operation)

The proposed project would generate vehicle trips during its operational phase. According to the traffic data provided by the CalEEMod model, the project would generate approximately 610 daily vehicle trips. This value is a weighted average of values for weekdays, Saturday, and Sunday. To calculate operational on-road vehicle energy usage, default trip lengths generated by the CalEEMod model were used, which are based on the project location and urbanization level parameters.

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Based on factors provided by the CalEEMod model, the weighted average distance per trip is approximately 8.86 miles. Therefore, the proposed project would generate a total of approximately 5,407 average daily vehicle miles travelled (VMT). Using fleet mix data provided by the CalEEMod model, and year 2018 gasoline and diesel miles per gallon (MPG) factors for individual vehicle classes as provided by the EMFAC2014 model, weighted MPG factors of approximately 23.9 for gasoline and 13.5 for diesel were calculated. As shown in **Table 2**, the project would generate vehicle trips that would use a total of approximately 203 gallons of gasoline and 40 gallons of diesel fuel per day, on average, or 74,095 gallons of gasoline and 14,600 annual gallons of diesel fuel per year. The enclosed technical appendix presents detailed calculations of on-road mobile fuel consumed during operation of the project.

Table 2 - On-Road Mobile Fuel Consumed by Project Operations

Time Period	Gallons of Gasoline	Gallons of Diesel Fuel
Daily	203	40
Annual	74,095	14,600

Source: CalEEMod emissions model and EMFAC2014 emissions rate model.

On-Road Vehicles (Construction)

The proposed project would also generate on-road vehicle trips during project construction. These trips would be from construction workers, vendors, and materials haulers. Estimates of vehicle fuel consumed were derived based on the assumed construction schedule, vehicle trip lengths and number of workers per construction phase as provided by the CalEEMod model, and

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year 2018 gasoline MPG factors provided by the EMFAC2014 model. For the purposes of simplicity, it was assumed that all on-road worker vehicles generated by the construction phase of the project would use gasoline as a fuel source (as opposed to diesel fuel or alternative sources). Additionally, it was assumed that all on-road vendor and hauler trucks generated by the construction phase would use diesel fuel. **Table 3** describes gasoline and diesel fuel used by on-road mobile sources during each phase of the construction schedule. The majority of on-road mobile vehicle fuel used during the construction of the project would occur during the demolition and building construction phases. The enclosed technical appendix presents detailed calculations of on-road mobile fuel consumed during the project construction period.

Table 3. On-Road Mobile Fuel Generated by Project Construction Activities - By Phase

Construction Phase	Number of Days	Total Daily Worker Trips	Total Daily Vendor Trips	Total Daily Hauler Trips	Gallons of Gasoline Fuel	Gallons of Diesel Fuel
Demolition	25	15	0	392	150	30,150
Site Preparation	13	18	- -	- -	91	- -
Grading	24	15	- -	- -	144	- -
Paving	25	15	- -	- -	150	- -
Building Construction	301	50	17	0	6,321	5,719
Architectural Coating	26	10	- -	- -	104	- -
TOTAL	414				6,960	35,869

Source: CalEEMod emissions model, EMFAC2014 emissions rate model.

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Off-Road Vehicles (Construction)

Off-road construction vehicles would use diesel fuel during the construction phase of the proposed project. A non-exhaustive list of off-road constructive vehicles that could be used during the construction phase of the project includes: cranes, forklifts, generator sets, tractors, excavators, and dozers. Based on the total amount of carbon dioxide (CO_2) emissions expected to be generated by the off-road mobile vehicles during the construction phase of the project (as provided by the CalEEMod model), and a CO_2-to-diesel fuel conversion factor (provided by the U.S. Energy Information Administration), the project would use approximately 70,160 gallons of diesel fuel for off-road construction vehicles. Detailed calculations are provided in the enclosed technical appendix.

Other

Proposed project landscape maintenance activities would generally require the use of fossil fuel (i.e. gasoline) energy. For example, lawn mowers require the use of fuel for power. As an approximation, it is estimated that gasoline-powered landscape care maintenance would occur 0.25 hours per week for each residential unit proposed. Given a total of 64 dwelling units, landscape maintenance would occur for 832 hours per year. With a conservative estimate of approximately 0.5 gallons of gasoline used per person-hour of landscape maintenance, the project would require the use of approximately 416 gallons of gasoline per year to power landscape maintenance equipment for residential uses.

Closing

Thank you for the opportunity to prepare this energy analysis of the Quarry Row Subdivision project. Please let me know if you have any questions.

enclosures

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Technical Appendix

This technical appendix presents calculation worksheets for the following:

- Operational On-Road Vehicles,
- Construction-Related On-Road Vehicles, and
- Construction-Related Off-Road Vehicles.

On-road Mobile (Operational) Energy Usage

Note: For the sake of simplicity, it was assumed that passenger vehicles, light duty tricks, motorcycles, and mobile homes use gasoline, and all medium-duty trucks, heavy-duty trucks, and buses use diesel fuel.

Step 1: **Total Net Daily Trips (provided by CalEEMod)**

610

Res H-W	*Res H-S*	*Res H-O*
Trip Length (miles) (provided by CalEEMod)		
10.8	7.3	7.5
Trip %		
42.60%	21.00%	36.40%

Average Trip Length (weighted average)

8.8638

Therefore:

Average Daily VMT

5,406.92

Step 2: Given:

Fleet Mix for Workers (provided by CalEEMod)

LDA	LDT1	LDT2	MDV	**LHD1**	**LHD2**	**MHD**	**HHD**	**OBUS**	**UBUS**	MCY	**SBUS**	MH
46.3%	6.5%	18.7%	17.4%	6.0%	0.8%	1.3%	1.5%	0.2%	0.1%	0.8%	0.1%	0.4%

And:

Gasoline MPG Factors for each Vehicle Class (from EMFAC2014) -- Year 2018

LDA	LDT1	LDT2	MDV	MCY	MH
28.20228269	23.9519121	20.97752352	15.5434473	36.93504091	6.500245753

Diesel MPG Factors for each Vehicle Class (from EMFAC2014) -- Year 2018

LHD1	**LHD2**	**MHD**	**HHD**	**OBUS**	**UBUS**	**SBUS**
17.02307271	15.28600558	7.891067671	5.306525419	6.401928287	4.498915702	7.178678959

Therefore:

Weighted Average MPG Factors

Gasoline: **23.9** Diesel: **13.5**

Step 3: Therefore: Therefore:

203 daily gallons of gasoline **40 daily gallons of diesel**

or Therefore:

74,095 annual gallons of gasoline **14,600 annual gallons of diesel**

On-road Mobile (Construction) Energy Usage -- Demolition

Step 1:

Total Daily Worker Trips (provided by CalEEMod)	Total Daily Vendor Trips (provided by CalEEMod)	Total Daily Hauler Trips (provided by CalEEMod)
15	0	392

Worker Trip Length (miles) (provided by CalEEMod	Vendor Trip Length (miles) (provided by CalEEMod)	Hauler Trip Length (miles) (provided by CalEEMod)
10.8	0	20

Therefore:

Average Worker Daily VMT	Average Vendor Daily VMT	Average Hauling Daily VMT
162	- -	7,840

Step 2: Given:

Assumed Fleet Mix for Workers (provided by CalEEMod)

LDA	LDT1	LDT2
0.462600	0.064936	0.186869

Assumed Fleet Mix for Vendors (provided by CalEEMod)

MHD	HHD
0.013398	0.015039

And:

MPG Factors for each Vehicle Class (from EMFAC2014) -- Year 2019

Gasoline:			Diesel:	
LDA	LDT1	LDT2	MHD	HHD
28.20228269	23.9519121	20.97752352	7.891067671	5.306525419

Therefore:

Weighted Average Worker (Gasoline) MPG Factor	Weighted Average Vendor (Diesel) MPG Factor	Weighted Average Hauling MPG Factor
25.9	6.5	6.5

Step 3:

Therefore:		Therefore:		Therefore:	
6	Worker daily gallons of gasoline	- -	Vendor daily gallons of diesel	1,206	Hauler daily gallons of diesel
25	# of Days (see CalEEMod)				

Therefore:		Therefore:	
Result: 150	**Total gallons of gasoline**	30,150	**Total gallons of diesel**

On-road Mobile (Construction) Energy Usage -- Site Preparation

Step 1:

Total Daily Worker Trips (provided by CalEEMod)

18

Worker Trip Length (miles) (provided by CalEEMod)

10.8

Therefore:

Average Worker Daily VMT

194

Step 2: Given:

Assumed Fleet Mix for Workers (provided by CalEEMod)

LDA	LDT1	LDT2
0.462600	0.064936	0.186869

And:

Gasoline MPG Factors for each Vehicle Class (from EMFAC2014) -- Year 2019

LDA	LDT1	LDT2
28.20228269	23.9519121	20.97752352

Therefore:

Weighted Average Worker MPG Factor

25.9

Step 3: Therefore:

7 **Worker daily gallons of gasoline**

Step 4:

13 **# of Days (see CalEEMod)**

Therefore:

Result: 91 **Total gallons of gasoline**

On-road Mobile (Construction) Energy Usage -- Grading

Step 1: **Total Daily Worker Trips (provided by CalEEMod)**

15

Worker Trip Length (miles) (provided by CalEEMod)

10.8

Therefore:

Average Worker Daily VMT

162

Step 2: Given:

Assumed Fleet Mix for Workers (provided by CalEEMod)

LDA	LDT1	LDT2
0.462600	0.064936	0.186869

And:

Gasoline MPG Factors for each Vehicle Class (from EMFAC2014) -- Year 2019

LDA	LDT1	LDT2
28.20228269	23.9519121	20.97752352

Therefore:

Weighted Average Worker MPG Factor

25.9

Step 3: Therefore:

6 **Worker daily gallons of gasoline**

Step 4: 24 **# of Days (see CalEEMod)**

Therefore:

Result: 144 **Total gallons of gasoline**

On-road Mobile (Construction) Energy Usage -- Paving

Step 1: **Total Daily Worker Trips (provided by CalEEMod)**

15

Worker Trip Length (miles) (provided by CalEEMod)

10.8

Therefore:

Average Worker Daily VMT

162

Step 2: Given:

Assumed Fleet Mix for Workers (provided by CalEEMod)

LDA	LDT1	LDT2
0.462600	0.064936	0.186869

And:

Gasoline MPG Factors for each Vehicle Class (from EMFAC2014) -- Year 2019

LDA	LDT1	LDT2
28.20228269	23.9519121	20.97752352

Therefore:

Weighted Average Worker MPG Factor

25.9

Step 3: Therefore:

6 **Worker daily gallons of gasoline**

Step 4: 25 **# of Days (see CalEEMod)**

Therefore:

Result: 150 **Total gallons of gasoline**

On-road Mobile (Construction) Energy Usage -- Building Construction

Step 1:

Total Daily Worker Trips (provided by CalEEMod)	Total Daily Vendor Trips (provided by CalEEMod)	Total Daily Hauler Trips (provided by CalEEMod)
50	17	0

Worker Trip Length (miles) (provided by CalEEMod	Vendor Trip Length (miles) (provided by CalEEMod)	Hauler Trip Length (miles) (provided by CalEEMod)
10.8	7.3	0

Therefore:

Average Worker Daily VMT	Average Vendor Daily VMT	Average Hauling Daily VMT
540	124	- -

Step 2: Given:

Assumed Fleet Mix for Workers (provided by CalEEMod)

LDA	LDT1	LDT2
0.462600	0.064936	0.186869

Assumed Fleet Mix for Vendors (provided by CalEEMod)

MHD	HHD
0.013398	0.015039

And:

MPG Factors for each Vehicle Class (from EMFAC2014) -- Year 2019

Gasoline:			Diesel:	
LDA	LDT1	LDT2	MHD	HHD
28.20228269	23.9519121	20.97752352	7.891067671	5.306525419

Therefore:

Weighted Average Worker (Gasoline) MPG Factor	Weighted Average Vendor (Diesel) MPG Factor	Weighted Average Hauling MPG Factor
25.9	6.5	6.5

Step 3:

Therefore: 21 **Worker daily gallons of gasoline**; 301 **# of Days (see CalEEMod)**

Therefore: 19 **Vendor daily gallons of diesel**

Therefore: - - **Hauler daily gallons of diesel**

Result:

Therefore: 6,321 **Total gallons of gasoline**

Therefore: 5,719 **Total gallons of diesel**

On-road Mobile (Construction) Energy Usage -- Architectural Coating

Step 1: **Total Daily Worker Trips (provided by CalEEMod)**

10

Worker Trip Length (miles) (provided by CalEEMod)

10.8

Therefore:

Average Worker Daily VMT

108

Step 2: Given:

Assumed Fleet Mix for Workers (provided by CalEEMod)

LDA	LDT1	LDT2
0.462600	0.064936	0.186869

And:

Gasoline MPG Factors for each Vehicle Class (from EMFAC2014) -- Year 2019

LDA	LDT1	LDT2
28.20228269	23.9519121	20.97752352

Therefore:

Weighted Average Worker MPG Factor

25.1

Step 3: Therefore:

4 **Worker daily gallons of gasoline**

Step 4: 26 **# of Days (see CalEEMod)**

Therefore:

Result: 104 **Total gallons of gasoline**

Off-road Mobile (Construction) Energy Usage

Note: For the sake of simplicity, and as a conservative estimation,
it was assumed that all off-road vehicles use diesel fuel as an energy source.

Given Factor:

Amount of CO_2 Emissions	712.8631	metric tons of CO_2 Source: CalEEMod output file Section 2.1

Conversion Factor:

Pounds per Metric Ton	2,204.62	

Intermediate Result:	1,571,592	pounds of CO_2

Conversion Factor:

Pounds of CO_2 per Gallon of Diesel Fuel	22.4	Source: U.S. Energy Information Administration (https://www.eia.gov/tools/faqs/faq.php?id=307&t=11)

Final Result:	70,160	gallons of diesel fuel