Appendix C

Resource Equivalency Analysis Summary

Biglow Canyon Wind Project

1.0 Overview

This appendix provides details on the Resource Equivalency Analysis (REA) we developed to estimate the number of high-risk power poles that would need to be retrofitted to offset the predicted loss of golden eagles. The REAs outlined in this Appendix were executed for the specific purpose of estimating the number of high-risk power pole retrofits that would need to be implemented, should a permit be issued under either action alternative, in order to offset the predicted take at Portland General Electric's (PGE's) Biglow Canyon Wind Project (Project).

Our REA is based on a modeling approach used in natural resource damage assessments to ensure that environmental impacts are mitigated. It is a tool used to account for environmental debits, in this case predicted eagle fatalities, and credits, in this case high-risk power pole retrofits. As described in the ECP Guidance (USFWS 2013), the REA operates under assumptions derived from the current understanding of golden eagle and bald eagle life history. These assumptions are utilized to help calculate direct losses, indirect losses, total debits, productivity of mitigation, and total credits owed to achieve no net loss. Additional information, including assumptions inherent in the REA that are not fully explained here, can be found in our ECP Guidance (Appendix G. *Examples Using Resource Equivalency Analysis to Estimate Compensatory Mitigation for the Take of Golden and Bald Eagles from Wind Energy Development*)

For this Project, we ran the REA for both action alternatives, with each run calculating mitigation owed if retrofit longevity was 10 years and if retrofit longevity was 30 years. REA Model Run #1 represents upfront mitigation required under the Alternative 2, and REA Model Run #2 represents upfront mitigation required under Alternative 3. Thus, the outputs from these REAs reflect the range of high risk power poles that may be required under each action alternative.

For both REA model runs presented here we assumed that a permit, if issued, would be issued in 2020 and that all poles would be fixed before the beginning of the golden eagle breeding season in 2022.

Each of the REA model runs calculated:

1. The total debit (Tables 3 and 5) in bird-years associated with the 76 turbines that require offsetting compensatory mitigation over the course of each permit tenure, including indirect loss from forgone reproduction from eagles killed,
2. The relative productivity of mitigation, including avoided reproductive loss from eagles saved (Tables 7 and 8) and,
3. The credits owed (i.e. number of high-risk power poles retrofitted) to offset the total debit at a 1.2:1 ratio, assuming both 10 and 30 year retrofit longevities (Tables 9 through 12).

Table 1: Summary of Annual Permitted Take Calculations under both action alternatives for the 76 project turbines that require compensatory mitigation. Values in yellow were used as inputs into each REA

	Golden Eagle			
	Annual Fatality Prediction	**Permit Tenure**	**# Eagles to be Offset[1]**	**Annual Permitted Take[2]**
Alternative 2 (REA Model #1)	0.49	5	3	0.60
Alternative 3 (REA Model #2)		30	15	0.50

[1] This is derived by multiplying the Annual Fatality Prediction by the Number of Years to be Offset, and then rounding up to the nearest whole integer if necessary.
[2] This is derived by dividing the Eagles to be Offset by the Permit Tenure, and is the input for Annual Predicted Take in each REA. *Note: this value may not necessarily be the same at the Annual Fatality Prediction, as it divides the eagles to be authorized,* ***after*** *rounding up to the nearest integer.*

Note that the annual fatality prediction is the same for both model runs; but the Annual Permitted Take differs because of the rounding related to the permit tenure (Table 1).

2.0 Model Results

2.1 Total Debit Calculation

The total debit is the same regardless of the anticipated longevity of retrofits; thus, these values are different for each model run, but the same regardless of the retrofit longevity in each model run.

REA MODEL RUN #1: 5 year permit tenure (Alternative 2) – Annual Permitted Take = 0.60

Table 2: Single year Debit	
Source of Bird Years	**Present Value Bird-Years**
Direct Loss:	3.04
Indirect Loss Subtotal (1st Gen + 2nd Gen):	3.09
Indirect Loss – 1st Generation	*(2.18)*
Indirect Loss – 2nd Generation	*(0.91)*
Total Debit (Direct + Indirect)	**6.13**

Table 3: Total Debit; 5-year Permitted Take of Golden Eagles	
Start Year of Take	2020
Debit Present Value Bird-Years	6.13
Year	**Present Value Bird-Years**
2020	6.13
2021	5.95
2022	5.78
2023	5.61
2024	5.45
Total Present Value Bird-Years	**28.92**

REA MODEL RUN #2: 30 year permit tenure (Alternative 3) – Annual Permitted Take = 0.50

Table 4: Single year Debit	
Source of Bird Years	**Present Value Bird-Years**
Direct Loss:	2.53
Indirect Loss Subtotal (1st Gen + 2nd Gen):	2.58
Indirect Loss – 1st Generation	*(1.82)*
Indirect Loss – 2nd Generation	*(0.76)*
Total Debit (Direct + Indirect)	**5.11**

Table 5: Total Debit; 30-year Permitted Take of Golden Eagles	
Start Year of Take	2020
Debit Present Value Bird-Years	5.11
Year	**Present Value Bird-Years**
2020	5.11
2021	4.96
2022	4.82
2023	4.68
2024	4.54
2025	4.41
2026	4.28
2027	4.15
2028	4.03
2029	3.92
2030	3.80
2031	3.69
2032	3.58
2033	3.48
2034	3.38
2035	3.28
2036	3.18
2037	3.09
2038	3.00
2039	2.91
2040	2.83
2041	2.75
2042	2.67
2043	2.59
2044	2.51
2045	2.44
2046	2.37
2047	2.30
2048	2.23
2049	2.17
Total Present Value Bird-Years	**103.55**

2.2 Relative Productivity of Mitigation Calculation

The relative productivity of mitigation per pole (Table 6) is the same regardless of the model run and permit tenure (i.e. the same across alternatives in this EA). This value is used to determine the total mitigation credit for each retrofit longevity.

Table 6: Avoided Loss per power pole retrofit over one year:	
Source of Bird Years	**Present Value Bird-Years per pole**
Avoided Direct Loss:	0.018
Avoided Indirect Loss Subtotal (1st Gen + 2nd Gen):	0.018
Indirect Loss – 1st Generation	*(0.013)*
Indirect Loss – 2nd Generation	*(0.005)*
Total Credit per power pole (Direct + Indirect)	**0.036**

This credit (per power pole) in Table 4 is used to calculate the total Present Value Bird-Years for each retrofit longevity, below (Tables 7 and 8).

Table 7: Relative Productivity of Mitigation for 10-year retrofit longevity	
Start Year of Mitigation	2021
Credit Present Value Bird-Years	0.036
Year	**Present Value Bird-Years per pole**
2021	0.036
2022	0.035
2023	0.034
2024	0.033
025	0.032
2026	0.031
2027	0.030
2028	0.029
2029	0.028
2030	0.027
Total Present Value Bird-Years	**0.314**

Table 8: Relative Productivity of Mitigation for 30-year retrofit longevity	
Start Year of Mitigation	2021
Credit Present Value Bird-Years	0.036
Year	**Present Value Bird-Years per pole**
2021	0.036
2022	0.035
2023	0.034
2024	0.033
2025	0.032
2026	0.031
2027	0.030
2028	0.029
2029	0.028
2030	0.027
2031	0.027
2032	0.026
2033	0.025
2034	0.024
2035	0.024
2036	0.023
2037	0.022
2038	0.022
2039	0.021
2040	0.020
2041	0.020
2042	0.019
2043	0.019
2044	0.018
2045	0.018

2046	0.017
2047	0.017
2048	0.016
2049	0.016
2050	0.015
Total Present Value Bird-Years	**0.721**

2.3 Calculating Mitigation Credit Owed

The number of retrofitted power poles required is calculated by dividing the Total Debit (in Present-Value Bird Years), by the Relative Productivity of the Mitigation (in Present-Value Bird Years).

REA Model Run #1: 5 year permit tenure (Alternative 2)

Table 9: Credit Owed for a 5-Year Permit assuming 10-year retrofit longevity		
Total Debit	28.92	Present Value Bird-Years
Divided by Relative Productivity of Lethal Electric Pole Retrofitting	0.314	Avoided loss of Present Value Bird-Years/Pole
= Credit Owed	92.17	Poles to be retrofitted to achieve no net loss of golden eagle
= Credit Owed	**110.60**	**Poles to be retrofitted to achieve 1.2:1 ratio (mitigation:fatalities)**

Table 10: Credit Owed for a 5-Year Permit assuming 30-year retrofit longevity		
Total Debit	28.92	Present Value Bird-Years
Divided by Relative Productivity of Lethal Electric Pole Retrofitting	0.721	Avoided loss of Present Value Bird-Years/Pole
= Credit Owed	40.11	Poles to be retrofitted to achieve no net loss of golden eagle
= Credit Owed	**48.13**	**Poles to be retrofitted to achieve 1.2:1 ratio (mitigation:fatalities)**

REA Model Run #2: 30 year permit tenure (Alternative 3)

Table 11: Credit Owed for a 30-Year Permit assuming 10-year retrofit longevity		
Total Debit	103.15	Present Value Bird-Years
Divided by Relative Productivity of Lethal Electric Pole Retrofitting	0.314	Avoided loss of Present Value Bird-Years/Pole
= Credit Owed	328.70	Poles to be retrofitted to achieve no net loss of golden eagle

= Credit Owed	**394.44**	**Poles to be retrofitted to achieve 1.2:1 ratio (mitigation:fatalities)**

Table 12: Credit Owed for a 30-Year Permit assuming 30-year retrofit longevity		
Total Debit	103.15	Present Value Bird-Years
Divided by Relative Productivity of Lethal Electric Pole Retrofitting	0.721	Avoided loss of Present Value Bird-Years/Pole
= Credit Owed	143.06	Poles to be retrofitted to achieve no net loss of golden eagle
= Credit Owed	**171.67**	**Poles to be retrofitted to achieve 1.2:1 ratio (mitigation:fatalities)**

3.0 Summary

REA MODEL RUN #1: 5 year permit tenure (Alternative 2)

We determine that 111 high-risk power poles must be retrofitted, with a 10-year retrofit longevity, by the beginning of the 2022 breeding season in order to offset authorized take over a 5-year permit (Table 9). We further determine that 49 high-risk power poles must be retrofitted, with a 30-year retrofit longevity, by the beginning of the 2022 breeding season in order to offset authorized take over a 5-year permit (Table 10).

The actual number of poles needed to offset authorized take under a 5-year permit will depend on the retrofit longevity proposed for each selected power pole. This number could be as low as 49 poles (if 30-year retrofit longevity is proposed for all poles) or as high as 111 poles (if 10-year retrofit longevity is proposed for all poles). The Service will approve the number and location of all poles in order for them to count as offsetting compensatory mitigation under a 5-year permit.

REA MODEL RUN #2: 30 year permit tenure (Alternative 3)

We determined that 395 high-risk power poles must be retrofitted, with a 10-year retrofit longevity, by the beginning of the 2022 breeding season in order to offset authorized take over a 30-year permit (Table 11). We further determine that 172 high-risk poles must be retrofitted, with a 30-year retrofit longevity, by the beginning of the 2022 breeding season in order to offset authorized take over a 30-year permit (Table 12).

As under Alternative 2, the actual number of poles needed to offset authorized take under a 30-year permit will depend on the retrofit longevity proposed for each selected power pole. As described above, this number could be as low as 172 poles (if 30-year retrofit longevity is proposed for all poles) or as high as 395 poles (if 10-year retrofit longevity is proposed for all poles) if mitigation is completed before the beginning of the 2022 breeding season.

Additional poles would be required if PGE chose to implement required compensatory mitigation on a different schedule. For example, if PGE chose to only offset the first 5 years of predicted take under this alternative and provide compensatory mitigation at every 5-year interval for the tenure of the permit, assuming the fatality prediction did not change over time, they would provide the equivalent of 5 times the 5-year permit total (i.e. REA MODEL RUN #1 x 5). Note that no additional mitigation would be required for the 6th check-in period because 15 eagles would have been offset over the course of the first five administrative periods (3 eagles offset x 5 periods = 15 eagles offset). Implementing compensatory mitigation in this way would equate to a requirement of a total of 555 high risk power poles, with a 10-year retrofit longevity, or 245 high risk power poles, with a 30-year retrofit longevity, during the permit tenure (Table 13). It is likely that PGE will elect to provide their compensatory mitigation in this way (in 5-year increments), in hopes that site-specific eagle fatality monitoring will provide additional data that will reduce their fatality prediction and take authorization over time; thus, resulting in a reduced compensatory mitigation requirement over the tenure of the permit. Should such reductions occur, and if they are substantial, PGE could end up providing less compensatory mitigation than is listed in the range above and in Table 2 of the EA. These numbers are difficult to speculate at this time, without future post-construction monitoring data in hand. Therefore, we assume that the fatality prediction and take authorization remain unchanged under this mitigation schedule.

Table 13: Summary of Fatality Predictions, Authorized Take, and Retrofitted Power Poles to offset take at the 22 project turbines that require compensatory mitigation over a 5-year permit under both action alternatives, including two possible mitigation schedules under Alternative 3.

	Golden Eagle			
	Annual Fatality Pred.	**Take Needing to be Offset During Permit Tenure**	**Poles to be Retrofitted, assuming 10-yr retrofit longevity[1]**	**Poles to be Retrofitted, assuming 30-yr retrofit longevity[1]**
Alternative 2 (REA Model #1)	0.49	3	**111**	**49**
Alternative 3 (REA Model #2)		15	**395**	**172**
Alternative 3 (REA Model #2)[$]		15	**555**	**245**

[1] Required to offset take at a 1.2:1 mitigation to fatality ratio. Values have been rounded up to the nearest whole number.

[$] Represents Alternative 3 if PGE decides not to provide all compensatory mitigation up front, and instead elects to provide compensatory mitigation every 5 years throughout the permit tenure (assuming the fatality prediction and take authorization does not change at the 5-year check-ins).