Appendix V: Regional Haze Adjusted Reasonable Progress Goals

Background

40 CFR 51.308(f)(3)(i) requires that states establish reasonable progress goals (RPG), expressed in deciviews (dv), that reflect the visibility conditions that are projected to be achieved by the end of the applicable implementation period (2028) as a result of those enforceable emission limits. Natural (i.e., biogenic, wildland fire), nonpoint source emissions, and agricultural burning emissions from Hawaii were held constant at 2016 levels in the EPA platform, and thus the same emissions are reported for 2016 and 2028 for these categories.

Purpose

The purpose of this appendix is to determine the visibility conditions in 2028 that will result from implementation of the long term strategy (LTS) with enforceable limits set for 2028 and describe DOH-CAB's post-modeling approach to estimate this change in reasonable progress goals (dv) that reflects the reduction in emissions (tpy) through these enforceable emission limits.

Narrative of Methodology Used

The DOH-CAB approach starts from our end goal to determine the adjusted 2028 projections expressed in units of dv to reflect the impact of enforceable regional haze control measures planned for implementation during the second planning period. A framework is used to populate known values for the RPG Projections for 2028[1] in Tables V-1 & V-2 from WRAP's technical support system (TSS) website and to focus on the steps and data needed for estimating the adjusted 2028 projections. The 2028 projections are based on 2016 baseline emissions with emissions from both point and natural sources held constant for the unadjusted 2028 projections. For the adjusted 2028 projections, light extinction values for certain species or extinction components (i.e. sulfates, nitrates, and elemental carbon) were factored down based on estimated reductions in emissions expected from enforceable regional haze control measures planned for implementation on selected point sources (i.e. Kahului, Kanoelehua-Hill, and Puna Generating Stations.

Normalization factors were developed to calibrate DOH-CAB 2028 projections (dv) to the 2028 projections modeling results on WRAP's TSS website to account for differences in assumptions. A major difference in assumption used in developing the RPG 2028 projections between WRAP with Ramboll US Corporation (Ramboll) and DOH-CAB is the level of volcanic activity included with estimating 2028 Projections. Ramboll used 2014 to 2018 IMPROVE data adjusted to screen out impacts from natural episodic events of volcanic activities with high haze levels like how wildfire (organic and elemental carbon) and dust storms (fine crustal and coarse mass) are screened. Volcano emissions were included for determining the RPG adjustment because the impact could not be completely screened out after adjusting the IMPROVE data for episodic events due to the continuous nature of the Kilauea eruption. DOH-CAB included the entire contributions from volcanic activity and used a normalization factor calibrated to align with WRAP's 2028 projected modeling results to account for differences in assumptions with volcanic activities.

DOH-CAB's normalization factors were developed by calculating the ratio of WRAP TSS to DOH-CAB unadjusted 2028 projections. This ratio (or normalization factor) is then applied to DOH-CAB adjusted 2028 projections to account primarily for the difference in assumptions on the impact of volcanic activity between DOH-CAB and Ramboll.

DOH-CAB’s 2028 projections were estimated[2] using 2014-2018 baseline extinction values for each light extinction component downloaded from WRAP’s TSS website.

Light extinction values are adjusted using post-modeling RPG scaling factors for light extinction components of nitrates (AmmNO3), Sulfates (AmmSO4), and elemental carbon (EC) based on relative effect of enforceable control measures used in reducing emissions. Table V-3 starts with 2016 baseline emissions used unadjusted as the 2028 projected for all point and natural source categories. The reductions in emissions are subtracted from the 2016 baseline to determine the 2028 adjusted projected emissions. Scaling factors for NO_x, SO_2, and PM_{10} were developed by dividing the 2028 adjusted projected emission by the unadjusted 2016 baseline emissions and used for adjusting light extinction components of AmmNO3, AmmSO4, and EC respectively in Tables V-1 and V-2.

The 2018 to 2028 reductions in emissions were calculated from taking the difference between 2016 Actual emissions that were reported in the State & Local Emissions Inventory System (SLEIS) as the emissions before enforceable control measures are implemented and the emissions expected after controls are implemented as shown in Table V-4. The emissions expected after boilers are permanently retired were assumed to be zero. A fuel switch from fuel oil No. 6 to ultra-low sulfur diesel (ULSD) is planned for boiler unit no. 1 at Puna Generating Station. The emissions after fuel switching was calculated by multiplying the emissions before fuel switching by the ratio of the emission rates after fuel switching to before fuel switching for the respective pollutants. These emission rates are available in the Project Emissions section of the Permit Amendment's Technical Support Document (TSD) in Appendix P.

Table V-1
Projected 2028 Reasonable Progress Goals (RPG)
For Haleakala NP

LTS RPG Scale Adjusted for Control Measures			No	Yes	No	Yes
MID/Clearest Days			MID	MID	Clearest Days	Clearest Days
RPG Projection in 2028 (dv)[a]			**7.10**	**7.08**	**0.50**	**0.50**
Normalization Factor[b]			0.9600	0.9600	1.0248	1.0248
WRAP TSS 2028 Projection (dv)[1]			7.10		0.50	
DOH-CAB 2028 Projection (dv)[c]			7.40	7.38	0.49	0.48
Light Extinction Components[d]	(a)	AmmNO3 Scale[e]	1.0000	0.9669	1.0000	0.9669
	(b)	Adj AmmNO3 (Mm^{-1}) [(b)=(a)x(c)]	0.650	0.628	0.130	0.126
	(c)	AmmNO3 (Mm^{-1})	0.650	0.650	0.130	0.130
	(a)	AmmSO4 Scale[e]	1.0000	0.9978	1.0000	0.9978
	(b)	Adj AmmSO4 (Mm^{-1}) [(b)=(a)x(c)]	8.990	8.970	0.720	0.718
	(c)	AmmSO4 (Mm^{-1})	8.990	8.990	0.720	0.720
	(a)	CM Scale	1.0000	1.0000	1.0000	1.0000
	(b)	Adj CM (Mm^{-1}) [(b)=(a)x(c)]	0.700	0.700	0.210	0.210
	(c)	CM (Mm^{-1})	0.700	0.700	0.210	0.210
	(a)	EC Scale[e]	1.0000	0.9997	1.0000	0.9997
	(b)	Adj EC (Mm^{-1}) [(b)=(a)x(c)]	0.210	0.210	0.040	0.040
	(c)	EC (Mm-1)	0.210	0.210	0.040	0.040
	(a)	OMC Scale	1.0000	1.0000	1.0000	1.0000
	(b)	Adj OMC (Mm^{-1}) [(b)=(a)x(c)]	0.600	0.600	0.170	0.170
	(c)	OMC (Mm^{-1})	0.600	0.600	0.170	0.170
	(a)	SeaSalt Scale	1.0000	1.0000	1.0000	1.0000
	(b)	Adj SeaSalt (Mm^{-1}) [(b)=(a)x(c)]	0.640	0.640	0.190	0.190
	(c)	SeaSalt (Mm^{-1})	0.640	0.640	0.190	0.190
	(a)	Soil Scale	1.0000	1.0000	1.0000	1.0000
	(b)	Adj Soil (Mm^{-1}) [(b)=(a)x(c)]	0.160	0.160	0.040	0.040
	(c)	Soil (Mm^{-1})	0.160	0.160	0.040	0.040
	(b)	Rayleigh Scattering	9	9	9	9

[1] WRAP TSS, Hawaii - URP Glidepath with Visibility Projections, “TSS Visibility Progress Glide Path and Future-Year Visibility Projections per M.I.D. and Clearest Days - Product #XMTP_VPGP_9010_HIVADJ.” Refer to Tables 8.2-1 and 8.3-1, Chapter 8 of Hawaii’s RH SIP.

Table V-2
Projected 2028 Reasonable Progress Goals (RPG)
For Hawaii Volcanoes NP

		LTS RPG Scale Adjusted for Control Measures	No	Yes	No	Yes
		MID/Clearest Days	MID	MID	Clearest Days	Clearest Days
		RPG Projection in 2028 (dv)[a]	**16.10**	**16.08**	**3.40**	**3.39**
		Normalization Factor[b]	0.9901	0.9901	1.2416	1.2416
		WRAP TSS 2028 Projection (dv)[1]	16.1		3.4	
		DOH-CAB 2028 Projection (dv)[c]	16.3	16.2	2.7	2.7
Light Extinction Components[d]	**(a)**	**AmmNO3 Scale[e]**	1.0000	0.9669	1.000	0.9669
	(b)	**Adj AmmNO3 (Mm^{-1}) [(b)=(a)x(c)]**	0.450	0.435	0.300	0.290
	(c)	**AmmNO3 (Mm^{-1})**	0.450	0.450	0.300	0.300
	(a)	**AmmSO4 Scale[e]**	1.0000	0.9978	1.0000	0.9978
	(b)	**Adj AmmSO4 (Mm^{-1}) [(b)=(a)x(c)]**	37.460	37.378	1.630	1.626
	(c)	**AmmSO4 (Mm^{-1})**	37.460	37.460	1.630	1.630
	(a)	**CM Scale**	1.0000	1.0000	1.0000	1.0000
	(b)	**Adj CM (Mm^{-1}) [(b)=(a)x(c)]**	0.670	0.670	0.600	0.600
	(c)	**CM (Mm^{-1})**	0.670	0.670	0.600	0.600
	(a)	**EC Scale[e]**	1.0000	0.9997	1.0000	0.9997
	(b)	**Adj EC (Mm^{-1}) [(b)=(a)x(c)]**	0.520	0.520	0.070	0.070
	(c)	**EC (Mm-1)**	0.520	0.520	0.070	0.070
	(a)	**OMC Scale**	1.0000	1.0000	1.0000	1.0000
	(b)	**Adj OMC (Mm^{-1}) [(b)=(a)x(c)]**	1.210	1.210	0.300	0.300
	(c)	**OMC (Mm^{-1})**	1.210	1.210	0.300	0.300
	(a)	**SeaSalt Scale**	1.0000	1.0000	1.0000	1.0000
	(b)	**Adj SeaSalt (Mm^{-1}) [(b)=(a)x(c)]**	1.440	1.440	1.220	1.220
	(c)	**SeaSalt (Mm^{-1})**	1.440	1.440	1.220	1.220
	(a)	**Soil Scale**	1.0000	1.0000	1.0000	1.0000
	(b)	**Adj Soil (Mm^{-1}) [(b)=(a)x(c)]**	**0.090**	**0.090**	**0.030**	**0.030**
	(c)	**Soil (Mm^{-1})**	0.090	0.090	0.030	0.030
	(b)	**Rayleigh Scattering**	9	9	9	9

Footnotes to Tables V-1 & V-2:

- [a] **2028 RPG projections are shown both as unadjusted (i.e. no scaling) and adjusted (with scaling).**
- [b] **Normalization factors to account for differences in assumptions (e.g. level of volcanic activity that were screened out) between WRAP TSS 2028 projection and DOH-CAB 2028 projection is determined as follows using the unadjusted Projections:**

  Normalization Factor = [WRAP TSS 2028 Projection (dv)] / [DOH-CAB 2028 Projection (dv)]

- [c] **DOH-CAB 2028 Projection[2] (dv) = [10 x ln(∑each Modeled Light Extinction Component/10)]**

  = [10 x ln(∑(b)/10)]

- [d] **2014-2018 baseline extinction values for each light extinction component downloaded from Western Regional Air Partnership (WRAP) technical support system (TSS) website.[3]**
- [e] **Light extinction values are adjusted using post-modeling RPG scaling factors developed in Table V-3 proportioned to reflect changes in emissions where enforceable control measures are planned for the regional haze second planning period.**

Acronyms used are listed below:

dv	**Deciviews**
AmmNO3	**Nitrates**
AmmSO4	**Sulfates**
EC	**Elemental Carbon**
CM	**Coarse mass**
LTS	**Long term strategy**
MID	**Most impaired days**
Mm^{-1}	**Inverse mega meters**
NP	**National Park**
OMC	**Organic Mass Carbon**

---

[2] Refer to sections 1.4 and 1.5, Chapter 1, of Hawaii's RH SIP.

[3] TSS Ambient Species Composition of Total Light Extinction per 5-Year Period and Percentile with Natural Conditions - Product #XATP_ECSB_P5YA (Visibility Analysis - Express Tools; CIA 5-year Extinction Composition.

Table V-3
Relative Effect of Controls on Total Projected Emissions

Source Category	2016 Baseline Emissions Projected for 2028[a] (tpy)				2018 to 2028 Reductions in Emissions[b] (tpy)				2028 Adjusted Projected Emissions (tpy)		
	NO_x	SO_2	PM_{10}		NO_x	SO_2	PM_{10}		NO_x	SO_2	PM_{10}
	Anthropogenic Sources				Anthropogenic Sources				Anthropogenic Sources		
Point Sources[b]	23,585	19,248	2,280		1,281	4,629	144		22,304	14,619	2,136
Area Sources[c]	469	99	37,950		0	0	0		469	99	37,950
Agricultural Burning[d]	55	30	93		0	0	0		55	30	93
Prescribed Burning[d]	-	-	-		0	0	0		-	-	-
On-Road Mobile Sources	3,221	34	527		0	0	0		3,221	34	527
Non-Road Mobile Sources	2,086	6	212		0	0	0		2,086	6	212
Marine[e]	5,658	357	207		0	0	0		5,658	357	207
Total Anthropogenic	**35,074**	**19,775**	**41,269**		**1,281**	**4,629**	**144**		**33,793**	**15,146**	**41,125**
	Natural Sources				Natural Sources				Natural Sources		
Volcano[f]	-	2,089,368	-		-	-	-		-	2,089,368	-
Sea Spray[g]	-	-	382,637		-	-	-		-	-	382,637
Windblown Dust[g]	-	-	46,808		-	-	-		-	-	46,808
Wildfire[d]	3,374	258	11,340		-	-	-		3,374	258	11,340
Biogenic	237	-	-		-	-	-		237	-	-
Total Natural	**3,611**	**2,089,626**	**440,785**		**-**	**-**	**-**		**3,611**	**2,089,626**	**440,785**
Total Projected Emissions	**38,685**	**2,109,401**	**482,054**		**Reduced Emissions→**				**37,404**	**2,104,772**	**481,910**
					Scaling Factors→				**0.9669**	**0.9978**	**0.9997**

Footnotes to Table V.3:

[a] **Emissions provided by Ramboll's email dated June 14, 2022, are from the 2016 NEI data for Hawaii from the EPA's Emissions Inventory System (EIS) Gateway, which in 2016 only includes point sources. All other emissions are from the EPA 2016 Regional Haze Modeling v1 emissions platform (2016th) for Hawaii (EPA, 2020) unless otherwise noted below. These emissions were extracted directly from the EPA model-ready emission files for the 3 kilometer resolution HI modeling domain, which were provided by Kirk Baker at the EPA on May 20, 2020.**

[b] **Refer to Table V.4 for the estimated reductions in emissions from point sources that are expected to implement regional haze control measures for the second planning period.**

[c] **Area sources include nonpoint sources, fugitive dust, agricultural ammonia sources, and residential wood combustion.**

[d] **The agricultural burning emissions reported here are the point source agricultural fires in the modeling platform. Wildland fire and prescribed burning emissions are provided in a single model emissions file and thus could not be disaggregated. The total wild and prescribed fire emissions are reported as wildfire emissions here.**

[e] **Marine emissions reported here are the domain-wide total from C1 and C2 and C3 commercial marine vessels in the model-ready emission files for the HI 3 km resolution modeling domain, including emissions from outside state waters. This is inconsistent with the emissions reported in the 2014 and 2017 NEI, and thus the 2016 and 2028 marine emissions should not be directly compared to emissions reported for 2014 and 2017.**

[f] **Based on SO2 emission rates reported by USGS for Kilauea volcano in 2016, however, emissions can change drastically as exhibited in Figures 4.1-1 and 4.1-2 of Hawaii's RH SIP. Volcano emissions were included for determining the reasonable progress goal adjustment because the impact could not be completely screened out after adjusting the IMPROVE data for episodic events due to the continuous nature of the Kilauea eruption. Therefore, projections from scaling 2028 modeling results with the observed 2014 to 2017 IMPROVE data on the most impaired days would still be influenced by volcanic activity.**

[g] **Sea spray and windblown dust emissions were estimated for Hawaii as part of emission inventory work by ENVIRON International Corporation for the years 2005 and 2008 (ENVIRON, 2010). These emissions are reported here and are assumed to be representative of all years.**

Table V-4
Apply Relative Control Effect to 2016 Actuals to Obtain 2016-2028 Emissions

Point Sources (by emission units)	Emission Units	2016 Actual[a] Emissions (TPY) (a)			2028 Emissions After Control Measures (TPY) (b)			2016-2028 Reductions in Emissions (TPY) (c) = (a) - (b)		
		NO_x	SO_2	PM_{10}[b]	NO_x	SO_2	PM_{10}	NO_x	SO_2	PM_{10}
Kahului Generating Station	K-1 to K-4	473	1,701	61	0	0	0	473	1,701	61
Kanoelehua-Hill	Hill 5	325	1,036	32	0	0	0	325	1,036	32
Kanoelehua-Hill	Hill 6	467	1,734	43	0	0	0	467	1,734	43
Kanoelehua-Hill	CT-1	6	0	0	6	0	0	0	0	0
Kanoelehua-Hill	D-11	1	0	0	1	0	0	0	0	0
Kanoelehua-Hill	D-15	4	0	0	4	0	0	0	0	0
Kanoelehua-Hill	D-16	1	0	0	1	0	0	0	0	0
Kanoelehua-Hill	D-17	3	0	0	3	0	0	0	0	0
Puna Generating Station[c]	Boiler 1	20	158	9	4	0	0	15	158	8
Puna Generating Station	CT-3	5	2	1	5	2	1	0	0	0
Puna Generating Station	PBSG1	0	0	0	0	0	0	0	0	0
					Total Reductions			1,281	4,629	144

Footnotes to Table V-4

[a] **Actual emissions data from the State & Local Emissions Inventory System (SLEIS).**

[b] **PM_{10} are based on filterable + condensable.**

[c] **Relative Effect of Control Measure for fuel switch for boiler 1 at Puna Generating Station is estimated by taking the ratio of emission rates from the Project Emissions section of the Permit Amendment's Technical Support Document (TSD). The ratio of emissions rates is the emission rates after fuel switching divided the emission rates before fuel switching for the respective pollutants as shown in the table below. The estimated 2028 emissions after control measure is determined by multiplying 2016 Actual Emissions by the ratio in column (c) in the table below.**

Pollutants	Emission Rates (lbs/hr)		Ratio of Emission Rates
	F.O. No. 6	ULSD	
	(a)	**(b)**	**(c)=(b)/(a)**
NO_x	190.98	42.580	0.223
PM_{10}[b]	71.46	3.490	0.049
SO_2	547.80	0.374	0.001