AURORA
ENERGY

February 6, 2017

Dear Ms. de Lima:

My time has freed up, so I wanted to get this out to you sooner than I had told you I would. I appreciate your patience and understanding. You have asked for the documentation as per 40CFR.257.53 that shows that environmental releases from the Coal Combustion Residuals (CCR) from the Chena Power Plant to groundwater, surface water, soil and air are comparable to or lower than those from analogous products made without CCR, or that environmental releases to groundwater, surface water, soil or air will be at or below relevant regulatory and health-based benchmarks for human and ecological receptors during use. You have asked for information specifically for structural fill at two sites, one off the Johansen Expressway, and one off the Van Horn Road extension.

When this rule came out, Aurora contracted Dr. Lisa Bradley of Haley & Aldrich in Northbridge, Ma. to test and analyze the CCR from the Chena Plant to determine specifically if Aurora's coal ash meets criteria (4) under the definition of Beneficial use of CCR in 40 CFR.257.53. By the way, this information has been provided to the ADEC Solid Waste Division. Rather than attempting to "translate" the findings, I will just pass on to you the entire study. If you have difficulty with any of it, let me know and I'll try to help.

Bottom line: Any environmental releases due to the beneficial use of coal ash from the Chena Power Plant will be at or below relevant regulatory and health-based benchmarks for human and ecological receptors during its use.

If you have any questions concerning the provided material, please let me know.

Sincerely,

Buki Wright

President

Aurora Energy, LLC

HALEY & ALDRICH, INC.
360 Quaker Street
Northbridge, MA 01534
978-846-3463

MEMORANDUM

31 March 2016
File No. 42507-000

TO: Aurora Energy, Inc.
Buki Wright; President & CEO

CC: Aurora Energy, Inc.
David Fish; Environmental Manager

FROM: Haley & Aldrich, Inc.
Jay Peters
Lisa JN Bradley, Ph.D., DABT

SUBJECT: Evaluation of Beneficial Use Evaluation of Coal Combustion Residuals as Structural Fill – CCR Rule Component 4

Haley & Aldrich, Inc. (Haley & Aldrich) has evaluated information provided by Aurora Energy, Inc. (Aurora) to evaluate the management of coal combustion residuals (CCR) as structural fill with respect to the requirements of the U.S. Environmental Protection Agency (USEPA) 2014 Final Rule: Disposal of Coal Combustion Residuals for Electric Utilities1 (CCR Rule).

In accordance with the approved Haley & Aldrich Proposal for the Beneficial Use Evaluation of Coal Combustion Residuals as Structural Fill, Haley & Aldrich is evaluating Component 3 and Component 4 of USEPA's definition of "beneficial use of CCR".

Component 3 requires the owner to demonstrate that the use of the CCR meets:

a) Relevant product (i.e., structural fill material) specifications; and
b) Regulatory standards or design standards when available, and when such standards are not available, the CCR is not used in excess quantities.

Component 4 requires the owner to demonstrate that placement of CCR in non-roadway applications will not cause releases to groundwater, surface water, or soil that will exceed applicable regulatory and health-based benchmarks.

This memorandum provides our evaluation for Component 4. Our evaluation for Component 3 was provided under separate cover.

Conceptually, precipitation that percolates through CCR used as structural fill can leach metals out of the fill. The metals can then migrate with infiltrating water to underlying groundwater, and then migrate with groundwater flow, downgradient, to potential receptors. Potential receptors could include people who use groundwater as a source of drinking water, and aquatic life and wildlife that use downgradient surface water bodies where groundwater may discharge.

To evaluate the potential for leaching of metals out of CCR material uses as structural fill, analytical data describing the leachable concentrations of the CCR material are needed. To satisfy this data requirement, Aurora provided Haley & Aldrich with leachable metals analytical data for Aurora's CCR, as follows:

1) Toxicity characteristics leaching procedure (TCLP) data that was previously provided to the State of Alaska, and
2) Synthetic precipitation leaching procedure (SPLP) data for analyses that were performed specifically to support this evaluation.

Based on the TCLP data that Aurora had provided to the State, the State had previously determined that CCR from Aurora did not pose a leaching concern to groundwater[1]. To supplement the data that Aurora had provided to the State, Aurora performed SPLP analyses on an expanded list of constituents. The SPLP analyses were performed for 30 parameters on six samples of CCR material that is representative of the CCR that is used for structural fill applications.

Samples were submitted under chain of custody to Pollen Environmental, LLC of Fairbanks, AK. SPLP analyses were performed by Pace Analytical Laboratories of Minneapolis, MN, under subcontract to Pollen Environmental. The laboratory analytical report is attached.

A simple and conservative method of initially evaluating SPLP analytical data is to compare the data to groundwater standards. A comparison of SPLP data directly to groundwater standards incorporates the assumption that the constituent concentrations in groundwater directly beneath the structural fill are equal to the SPLP (i.e., leachate) concentrations. In reality, leachate is diluted with infiltrating precipitation, and then again when the infiltrating precipitation mixes with groundwater, such that actual groundwater concentrations beneath fill would be substantially lower than leachate concentrations. In fact, USEPA recommends the Industrial Waste Management Evaluation Model Version 3.1 (IWEM) to evaluate the mixing of leachate with groundwater. The model provides a schematic for the fate and transport of leachable constituents from a source (e.g., structural fill) through subsurface soils to groundwater, and in doing so accounts for the dilution and attenuation of leachate concentrations that occur through these fate and transport processes. Consequently, direct comparison of SPLP data to groundwater standards provides an approach that is conservative (i.e., more protective

[1] See for example, letter authorizing use of coal ash fill material, dated October 28, 2013 from Douglas Buteyn, Northern/Southeastern Program Coordinator Solid Waste Program, Alaska Department of Environmental Conservation with Daniel Himebauch, President North Side Management, Inc., concerning use of Coal Ash as Fill Material on Tract D-1 North Side Business Park 2nd Addition Section 2, T1S, R1W, Fairbanks Meridan, Fairbanks Alaska.

than necessary) for evaluating whether CCR fill may cause releases to groundwater, surface water, or soil that will exceed applicable regulatory and health-based benchmarks.

Groundwater standards were obtained from the following sources (listed in the order in which they were used):

- Alaska Drinking Water Levels (Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances, as amended through December 12, 2008 (http://dec.alaska.gov/water/wqsar/wqs/)
- USEPA Maximum Contaminant Levels and Secondary Maximum Contaminant Levels (USEPA 2012 Edition of the Drinking Water Standards and Health Advisories, Spring 2012 (https://www.epa.gov/dwstandardsregulations/drinking-water-contaminant-human-health-effects-information#dw-standards)
- ADEC Groundwater Cleanup Standards (State of Alaska Department of Environmental Conservation. 18 AAC 75. Oil and Other Hazardous Substances Pollution Control, revised as of June 17, 2015 (https://dec.alaska.gov/commish/regulations/pdfs/18%20AAC%2075.pdf).
- USEPA Tapwater RSLs (USEPA Risk-Based Screening Levels (RSLs), November 2015, values for tapwater (https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-november-2015)

Table 1 provides a comparison of the SPLP analytical data to the standards. As indicated in Table 1, only one metal, aluminum, was detected at concentrations in leachate at concentrations greater than the standard. However, the standard for aluminum is a secondary MCL which is based on aesthetic qualities of water. None of the leachate results are above the health-based standard for aluminum (tapwater RSL) of 20,000 ug/L. Leachate values for pH are also higher than the screening value. However, leachate pH would be buffered through dilution into groundwater.

CCR used as structural fill will typically be covered by site improvements (e.g., cover soil, buildings, parking areas), indicating that potential direct contact exposures to the CCR will not occur. However, during construction activities, potential exposures to CCR could hypothetically occur by construction workers and trespassers by direct contact (incidental ingestion and dermal exposure), and via inhalation of dusts that could hypothetically be released from CCR during active filling and grading. To evaluate the significance of these potential exposure pathways, analytical results from bulk analysis of ash samples were compared to conservative risk-based screening levels (Table 2).

The bulk ash analyses were performed by SGS Laboratories of Fairbanks, Alaska. The laboratory analytical report is attached. The risk-based screening levels used in this evaluation are the USEPA residential and industrial soil RSLs, November 2015 (https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-november-2015). The residential RSLs are based on the assumption that children and adults are exposed to soil by direct contact and dust inhalation pathways nearly every day over a 26 year period. The industrial RSLs are based on the assumption that adult employees are exposed to soil by direct contact and dust inhalation pathways nearly every work day over a 25 year period. The RSL values provided in Table 2 are based on a target hazard index (HI) of 1 and an excess lifetime cancer risk (cancer risk) of $1x10^{-5}$. A target HI of 1 is used because most of the constituents in

Table 2 have different target organs, indicating that each constituent can be evaluated against an HI of 1 and still remain protective for additive risks. The State of Alaska uses a target cancer risk of $1x10^{-5}$ to set cleanup levels[2]. Only one constituent (arsenic) has RSL values based on cancer risk (other constituents that are potentially carcinogenic by inhalation, such as cadmium, cobalt, and nickel, have cancer-based RSLs that are much higher than the non-cancer based RSLs). Therefore, establishing the screening level based on a target risk of $1x10^{-5}$ remains protective for additive risks.

The CCR will be used as structural fill at a commercial development. Consequently, the industrial RSLs are the applicable screening values. Residential RSL values in Table 2 are provided only as a point of reference. Since CCR used as structural fill will remain covered, and is potentially accessible for direct contact or dust inhalation pathways only during the active construction period, application of the industrial RSLs represents an extremely conservative approach to evaluating CCR used as structural fill. As indicated in Table 2, none of the constituents in ash were detected at concentrations above conservative risk-based screening levels for industrial use.

In conclusion, the results of this evaluation indicate that CCR used as structural fill is unlikely to cause releases to groundwater, surface water, or soil that will exceed applicable regulatory and health-based benchmarks.

[2] 18 AAC 75. Oil and Other Hazardous Substances Pollution Control. Revised as of January 1, 2016

TABLE 1
COMPARISON OF SPLP ANALYTICAL RESULTS TO GROUNDWATER SCREENING LEVELS
AURORA ENERGY

Sample Designation Sampling Date Lab Sample ID Sample Type	Selected Groundwatwer Screening Level and Source (a) (µg/L)		Maximum Concentration (µg/L)	AE12032015-01 12/3/2015 10332936001 / 10332936007 Coal Ash/Leachate	AE12032015-02 12/3/2015 10332936002 / 10332936008 Coal Ash/Leachate	AE12032015-03 12/3/2015 10332936003 / 10332936009 Coal Ash/Leachate	AE12032015-04 12/3/2015 10332936004 / 10332936010 Coal Ash/Leachate	AE12032015-05 12/3/2015 10332936005 / 10332936011 Coal Ash/Leachate	AE12032015-06 12/3/2015 10332936006 / 10332936012 Coal Ash/Leachate
Constituent (µg/L)									
Aluminum	50	(2)	**17100**	**13500**	**14500**	**11100**	**14100**	**15700**	**17100**
Antimony	6	(1)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)
Arsenic	10	(1)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)
Barium	2000	(1)	837	837	ND(1000)	ND(1000)	ND(1000)	ND(1000)	ND(1000)
Beryllium	4	(1)	ND(2)	ND(2)	ND(2)	ND(2)	ND(2)	ND(2)	ND(2)
Boron	4000	(4)	148	101	108	ND(50)	148	76.4	106
Cadmium	5	(1)	ND(0.8)	ND(0.8)	ND(0.8)	ND(0.8)	ND(0.8)	ND(0.8)	ND(0.8)
Calcium	NA		109000	104000	104000	107000	109000	102000	103000
Chromium	100	(1)	10.1	9	10	7.9	9.4	10.1	8.7
Cobalt	6	(4)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)
Copper	1300	(2)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
Iron	300	(2)	ND(500)	ND(500)	ND(500)	ND(500)	ND(500)	ND(500)	ND(500)
Lead	15	(2)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
Lithium	40	(4)	30.8	11.9	12.8	30.8	7.9	9.8	8.3
Magnesium	NA		ND(100)	ND(100)	ND(100)	ND(100)	ND(100)	ND(100)	ND(100)
Manganese	50	(2)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)
Mercury	2	(1)	ND(0.6)	ND(0.6)	ND(0.6)	ND(0.6)	ND(0.6)	ND(0.6)	ND(0.6)
Molybdenum	100	(4)	65.8	40.7	42.5	65.8	29.5	35.5	33.5
Nickel	100	(3)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)
Potassium	NA		19900	6480	7360	19900	5050	6350	4810
Selenium	50	(1)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)
Silver	100	(2)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)
Sodium	NA		15300	5510	6070	15300	4060	5680	3520
Thallium	2	(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
Vanadium	280	(3)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
Zinc	5000	(2)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)
Chloride	250000	(5)	3100	2300	2500	3100	2400	2400	1700
Fluoride	4000	(1)	910	710	680	910	470	460	370
pH (std)	6.5 - 8.5	(5)	**11.1**	**10.9**	**11**	**11.1**	**11**	**11**	**10.8**
Sulfate	250000	(5)	48700	44200	46800	28200	38100	42700	48700

Notes:
ADEC - Alaska Department of Environmental Conservation.
CAS - Chemical Abstracts Service.
HI - Hazard Index.
L - liter.
MCL - Maximum Contaminant Level.
ug - microgram.
NA - Not Available.
RSL - Regional Screening Level.
SMCL - Secondary Maximum Contaminant Level.
USEPA - United States Environmental Protection Agency.

ND(1): Analyte not detected, number in parentheses is the laboratory reporting limit
(a) **Bold** values indicates an exceedance of the groundwater screening level. Screening levels were selected based on the following hierarchy:
(1) - ADEC Drinking Water Levels. State of Alaska Department of Environmental Conservation. Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances. As amended through December 12, 2008. http://dec.alaska.gov/water/wqsar/wqs/
(2) - USEPA MCLs, or SMCLs where no MCL available. USEPA 2012 Edition of the Drinking Water Standards and Health Advisories. Spring 2012. https://www.epa.gov/dwstandardsregulations/drinking-water-contaminant-human-health-effects-information#dw-standards
(3) - ADEC Groundwater Cleanup Standards. State of Alaska Department of Environmental Conservation. 18 AAC 75. Oil and Other Hazardous Substances Pollution Control. Revised as of June 17, 2015. https://dec.alaska.gov/commish/regulations/pdfs/18%20AAC%2075.pdf
(4) - USEPA Tapwater RSLs. USEPA Regional Screening Levels (November 2015). Values for tapwater. HI = 1.0. http://www2.epa.gov/risk/regional-screening-table
(5)- USEPA SMCLs. USEPA 2012 Edition of the Drinking Water Standards and Health Advisories. Spring 2012.

TABLE 2
COMPARISON OF BULK ASH RESULTS TO SOIL SCREENING LEVELS
AURORA ENERGY

Sample ID[1]	Residential	Industrial	Maximum	AE12032015-01A	AE12032015-04A	AE12042015-05A
Material	Soil RSL (a)	Soil RSL (a)	Concentration (b)	Ash	Ash	Ash
Sample Date	(mg/kg)	(mg/kg)	(mg/kg)	12/3/2015	12/3/2015	12/3/2015
Ash Analysis Basis				Weight %	Weight %	Weight %
SiO2	NA	NA	180370	38.59	38.15	38.51
Al2O3	77000	1100000	85111	16.08	15.75	15.77
TiO2	NA	NA	4676	0.78	0.76	0.77
Fe2O3	55000	820000	48678	6.74	6.48	6.96
CaO	NA	NA	115281	15.51	15.26	16.13
MgO	NA	NA	16944	2.71	2.74	2.81
K2O	NA	NA	10793	1.3	1.21	1.2
Na2O	NA	NA	2226	0.28	0.25	0.3
SO3	NA	NA	6929	1.65	1.22	1.73
P2O5	NA	NA	393	0.09	0.08	0.09
SrO	47000	700000	1099	0.12	0.12	0.13
BaO	15000	220000	3583	0.39	0.38	0.4
MnO2	1800	26000	885	0.14	0.14	0.14
Chlorine (mg/kg)	NA	NA		18	16	18
Trace Analysis Basis				(mg/kg)	(mg/kg)	(mg/kg)
Antimony	31	470	<9	<9	<9	<9
Beryllium	160	2300	2.8	2.8	2.6	2.7
Cadmium	71	980	<1.8	<1.8	<1.7	<1.8
Cobalt	23	350	**31**	31	28	31
Chromium	120000	1800000	581	581	488	570
Copper	3100	47000	152	152	136	144
Lithium	160	2300	24	24	22	24
Molybdenum	390	5800	78	78	65	77
Nickel	1500	22000	373	373	328	371
Lead	400	800	19	19	<17	<18
Silver	390	5800	<1.8	<1.8	<1.7	<1.8
Thallium	0.78	12	<9	<9	<9	<9
Vanadium	390	5800	252	252	234	241
Zinc	23000	350000	45	45	35	42
Arsenic	6.8	30	18	18	14	16
Boron	16000	230000	33	33	28	31
Selenium	390	5800	<1	<1	<1	<1
Mercury	23	350	0.25	0.25	0.11	0.21
pH (S.U.)	NA	NA	11.13	11.13	10.97	11.12
pH Temp (deg C)	NA	NA	21	20.5	21	20
Fluorine	4700	70000	300	300	250	270
Carbon (%)	NA	NA	16.32	14.00	16.32	13.88
LOI (%)	NA	NA	17.45	15.64	17.45	15.07

TABLE 2
COMPARISON OF BULK ASH RESULTS TO SOIL SCREENING LEVELS
AURORA ENERGY

Notes:
HI - Hazard Index.
Kg - kilogram.
USEPA - United States Environmental Protection Agency.
mg - milligram.
NA - Not Available.
RSL - Regional Screening Level.
ELCR - Excess Lifetime Cancer Risk.

(<) denote sample result less than the laboratory reporting limit.
1 - The coal ash samples were taken from the same vicinity as samples AE12032015-01, AE12032015-04, and AE12032015-05..
(a) **Bold** values indicates an exceedance oaf soil screening level. Screening levels were selected from the following source:
USEPA Soil RSLs. USEPA Regional Screening Levels (November 2015). Values for residential and industrial soil. HI = 1.0 and ELCR = 1E-05. http://www2.epa.gov/risk/regional-screening-table
The screening values used for chromium and mercury were for chromium (III) and mercuric chloride, respectively.
(b) Value is concentration of the elemental form, calculated as:
mass concentration (mg/kg) = weight % x percentage elemental weight of oxide x units conversion
Percentage elemental weights are as follows:

SiO2	46.74%	Si
Al2O3	52.93%	Al
TiO2	59.95%	Ti
Fe2O3	69.94%	Fe
CaO	71.47%	Ca
MgO	60.30%	Mg
K2O	83.02%	K
Na2O	74.19%	Na
SO3	40.05%	S
P2O5	43.64%	P
SrO	84.56%	Sr
BaO	89.57%	Ba
MnO2	63.19%	Mn