NETL Life Cycle Inventory Data
Process Documentation File

Process Name: CBM Well Production Water Burden

Reference Flow: 1 kg of Produced Natural Gas

Brief Description: This unit process covers the produced water associated with the production of a coalbed methane well.

Section I: Meta Data

Geographical Coverage: U.S. Coalbed Methane **Region:** San Juan Basin

Year Data Best Represents: 2016

Process Type: Extraction Process (EP)

Process Scope: Cradle-to-Gate Process (CG)

Allocation Applied: No

Completeness: All Relevant Flows Captured

Flows Aggregated in Data Set:

☒ Process ☐ Energy Use ☐ Energy P&D ☐ Material P&D

Relevant Output Flows Included in Data Set:

Releases to Air:	☐ Greenhouse Gases	☐ Criteria Air Pollutants	☐ Other
Releases to Water:	☒ Inorganic Emissions	☒ Organic Emissions	☐ Other
Water Usage:	☐ Water Consumption	☒ Water Demand (throughput)	
Releases to Soil:	☒ Inorganic Releases	☒ Organic Releases	☐ Other

Adjustable Process Parameters:

Produced_Rate_CC

Rate at which produced water exits the well

Conc_TDS

Concentration of TDS in produced water

Conc_TSS

Concentration of TSS in produced water

Conc_Ag

Concentration of Ag in produced water

Conc_Al

Concentration of Al in produced water

Conc_As

Concentration of As in produced water

Conc_B

Concentration of B in produced water

Conc_Ba

Concentration of Ba in produced water

Conc_Be

Concentration of Be in produced water

Conc_Br

Concentration of Br in produced water

Conc_Ca

Concentration of Ca in produced water

Conc_Cd

Concentration of Cd in produced water

Conc_Cl

Concentration of Cl in produced water

Conc_Co

Concentration of Co in produced water

Conc_Cr

Concentration of Cr in produced water

Conc_Cu

Concentration of Cu in produced water

Conc_F

Concentration of F in produced water

Conc_FeTot

Concentration of FeTot in produced water

Conc_HCO3

Concentration of HCO3 in produced water

Conc_Hg

Concentration of Hg in produced water

Conc_I

Concentration of I in produced water

Conc_K

Concentration of K in produced water

Conc_Li

Concentration of Li in produced water

Conc_Mg

Concentration of Mg in produced water

Conc_Mn

Concentration of Mn in produced water

Conc_Mo

Concentration of Mo in produced water

Conc_NO2

Concentration of NO2 in produced water

Conc_NO3

Concentration of NO3 in produced water

Conc_NO3NO2

Concentration of NO3NO2 in produced water

Conc_NH4

Concentration of NH4 in produced water

Conc_TKN

Concentration of TKN in produced water

Conc_Na

Concentration of Na in produced water

Conc_Ni

Concentration of Ni in produced water

Conc_PO4

Concentration of PO4 in produced water

Conc_Pb

Concentration of Pb in produced water

Conc_S

Concentration of S in produced water

Conc_SO3

Concentration of SO3 in produced water

Conc_SO4

Concentration of SO4 in produced water

Conc_Sb

Concentration of Sb in produced water

Conc_Se

Concentration of Se in produced water

Conc_Si

Concentration of Si in produced water

Conc_Sn

Concentration of Sn in produced water

Conc_Sr

Concentration of Sr in produced water

Conc_Ti

Concentration of Ti in produced water

Conc_Tl

Concentration of Tl in produced water

Conc_Zn

Concentration of Zn in produced water

Conc_ALKHCO3

Concentration of ALKHCO3 in produced water

Conc_Acidity

Concentration of Acidity in produced water

Conc_TOC

Concentration of TOC in produced water

Conc_CN

Concentration of CN in produced water

Conc_Phenols

Concentration of Phenols in produced water

Conc_Sr87Sr86

Concentration of Sr87Sr86 in produced water

Conc_Ra226

Concentration of Ra226 in produced water

Conc_Ra228

Concentration of Ra228 in produced water

Conc_Benzene

Concentration of Benzene in produced water

Conc_Toluene

Concentration of Toluene in produced water

Conc_H2S

Concentration of H2S in produced water

NG_Density

Density of natural gas at NTP

Estimated_Ultimate_Recovery

Estimated Ultimated Recovery of natural gas from one well

OIL_EUR

Estimated Ultimated Recovery of oil co-product from one well

NG_Energy

Energy content of NG

OIL_Energy

Energy content of Oil

Co_Product_Multiplier

The percent of water burdens that should be attributed to NG on an eneryg basis

Produced_Volume_Flow

Volume of water that exits the well as produced water

Spill_Volume

Volume of spilled produced water

Spill_Volume_Allocated

Volume of spilled produced water allocated to natural gas

prob_spill

probability a spill occurs

prob_reach_env

probability the spill reaches the environment

perc_soil

percent of spilled volume that reaches the environment in the form of soil

perc_surfwater

percent of spilled volume that reaches the environment in the form of surface water

Flow_TDS_water

Mass flow of TDS released to surface water

Flow_TSS_water

Mass flow of TSS released to surface water

Flow_Ag_water

Mass flow of Ag released to surface water

Flow_Al_water

Mass flow of Al released to surface water

Flow_As_water

Mass flow of As released to surface water

Flow_B_water

Mass flow of B released to surface water

Flow_Ba_water

Mass flow of Ba released to surface water

Flow_Be_water

Mass flow of Be released to surface water

Flow_Br_water

Mass flow of Br released to surface water

Flow_Ca_water

Mass flow of Ca released to surface water

Flow_Cd_water

Mass flow of Cd released to surface water

Flow_Cl_water

Mass flow of Cl released to surface water

Flow_Co_water

Mass flow of Co released to surface water

Flow_Cr_water

Mass flow of Cr released to surface water

Flow_Cu_water

Mass flow of Cu released to surface water

Flow_F_water

Mass flow of F released to surface water

Flow_FeTot_water

Mass flow of FeTo released to surface water

Flow_HCO3_water

Mass flow of HCO3 released to surface water

Flow_Hg_water

Mass flow of Hg released to surface water

Flow_I_water

Mass flow of I released to surface water

Flow_K_water

Mass flow of K released to surface water

Flow_Li_water

Mass flow of Li released to surface water

Flow_Mg_water

Mass flow of Mg released to surface water

Flow_Mn_water

Mass flow of Mn released to surface water

Flow_Mo_water

Mass flow of Mo released to surface water

Flow_NO2_water

Mass flow of NO2 released to surface water

Flow_NO3_water

Mass flow of NO3 released to surface water

Flow_NO3NO2_water

Mass flow of NO3NO2 released to surface water

Flow_NH4_water

Mass flow of NH4 released to surface water

Flow_TKN_water

Mass flow of TKN released to surface water

Flow_Na_water

Mass flow of Na released to surface water

Flow_Ni_water

Mass flow of Ni released to surface water

Flow_PO4_water

Mass flow of PO4 released to surface water

Flow_Pb_water

Mass flow of Pb released to surface water

Flow_S_water

Mass flow of S released to surface water

Flow_SO3_water

Mass flow of SO3 released to surface water

Flow_SO4_water

Mass flow of SO4 released to surface water

Flow_Sb_water

Mass flow of Sb released to surface water

Flow_Se_water

Mass flow of Se released to surface water

Flow_Si_water

Mass flow of Si released to surface water

Flow_Sn_water

Mass flow of Sn released to surface water

Flow_Sr_water

Mass flow of Sr released to surface water

Flow_Ti_water

Mass flow of Ti released to surface water

Flow_Tl_water

Mass flow of Tl released to surface water

Flow_Zn_water

Mass flow of Zn released to surface water

Flow_ALKHCO3_water

Mass flow of ALKHCO3 released to surface water

Flow_Acidity_water

Mass flow of Acidity released to surface water

Flow_TOC_water

Mass flow of TOC released to surface water

Flow_CN_water

Mass flow of CN released to surface water

Flow_Phenols_water

Mass flow of Phenols released to surface water

Flow_Sr87Sr86_water

Mass flow of Sr87Sr86 released to surface water

Flow_Ra226_water

Mass flow of Ra226 released to surface water

Flow_Ra228_water

Mass flow of Ra228 released to surface water

Flow_Benzene_water

Mass flow of Benzene released to surface water

Flow_Toluene_water

Mass flow of Toluene released to surface water

Flow_H2S_water

Mass flow of H2S released to surface water

Flow_TDS_soil

Mass flow of TDS released to soil

Flow_TSS_soil

Mass flow of TSS released to soil

Flow_Ag_soil

Mass flow of Ag released to soil

Flow_Al_soil

Mass flow of Al released to soil

Flow_As_soil

Mass flow of As released to soil

Flow_B_soil

Mass flow of B released to soil

Flow_Ba_soil

Mass flow of Ba released to soil

Flow_Be_soil

Mass flow of Be released to soil

Flow_Br_soil

Mass flow of Br released to soil

Flow_Ca_soil

Mass flow of Ca released to soil

Flow_Cd_soil

Mass flow of Cd released to soil

Flow_Cl_soil

Mass flow of Cl released to soil

Flow_Co_soil

Mass flow of Co released to soil

Flow_Cr_soil

Mass flow of Cr released to soil

Flow_Cu_soil

Mass flow of Cu released to soil

Flow_F_soil

Mass flow of F released to soil

Flow_FeTot_soil

Mass flow of FeTot released to soil

Flow_HCO3_soil

Mass flow of HCO3 released to soil

Flow_Hg_soil

Mass flow of Hg released to soil

Flow_I_soil

Mass flow of I released to soil

Flow_K_soil

Mass flow of K released to soil

Flow_Li_soil

Mass flow of Li released to soil

Flow_Mg_soil

Mass flow of Mg released to soil

Flow_Mn_soil

Mass flow of Mn released to soil

Flow_Mo_soil

Mass flow of Mo released to soil

Flow_NO2_soil

Mass flow of NO2 released to soil

Flow_NO3_soil

Mass flow of NO3 released to soil

Flow_NO3NO2_soil

Mass flow of NO3NO2 released to soil

Flow_NH4_soil

Mass flow of NH4 released to soil

Flow_TKN_soil

Mass flow of TKN released to soil

Flow_Na_soil

Mass flow of Na released to soil

Flow_Ni_soil

Mass flow of Ni released to soil

Flow_PO4_soil

Mass flow of PO4 released to soil

Flow_Pb_soil

Mass flow of Pb released to soil

Flow_S_soil

Mass flow of S released to soil

Flow_SO3_soil

Mass flow of SO3 released to soil

Flow_SO4_soil

Mass flow of SO4 released to soil

Flow_Sb_soil

Mass flow of Sb released to soil

Flow_Se_soil

Mass flow of Se released to soil

Flow_Si_soil

Mass flow of Si released to soil

Flow_Sn_soil

Mass flow of Sn released to soil

Flow_Sr_soil

Mass flow of Sr released to soil

Flow_Ti_soil

Mass flow of Ti released to soil

Flow_Tl_soil

Mass flow of Tl released to soil

Flow_Zn_soil

Mass flow of Zn released to soil

Flow_ALKHCO3_soil

Mass flow of ALKHCO3 released to soil

Flow_Acidity_soil

Mass flow of Acidity released to soil

Flow_TOC_soil

Mass flow of TOC released to soil

Flow_CN_soil

Mass flow of CN released to soil

Flow_Phenols_soil

Mass flow of Phenols released to soil

Flow_Sr87Sr86_soil

Mass flow of Sr87Sr86 released to soil

Flow_Ra226_soil

Mass flow of Ra226 released to soil

Flow_Ra228_soil

Mass flow of Ra228 released to soil

Flow_Benzene_soil

Mass flow of Benzene released to soil

Flow_Toluene_soil

Mass flow of Toluene released to soil

Flow_H2S_soil

Mass flow of H2S released to soil

Tracked Input Flows:

Tracked Output Flows:

Natural gas [reference flow]

Reference Flow

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_NG_Production_Water_CBM_2018.01*, which provides additional details regarding relevant calculations, data quality, and references.

Goal and Scope

This unit process provides a summary of relevant input and output flows associated with water use in producing a CBM well. No stimulation treatment is considered necessary. Produced water is due to formation waters and is calculated as a function of natural gas production. Water effluent quality is calculated as well and presented as mass flows released to the environment. The reference flow of this unit process is: 1 kg of Produced Natural Gas

Boundary and Description

This unit process estimates the volume of produced water returned from a coalbed methane (CBM) well, calculated per kg of natural gas recovered from the well. This calculation is done over the lifetime of the well, i.e. estimating the total volume of produced water returned from the well and normalizing it to the estimated ultimate recovery of the well. The species makeup of the produced water is estimated as well. The volume of produced water spilled per kg of natural gas produced is calculated. This value is normalized, representing the average volume of produced water released at a given well (not necessarily equal to the volume of water that would be released during a real spill event) and divided by the estimated ultimate recovery of that well. The species makeup of the produced water is then used to calculate the emissions to soil and water. Since wells can produce both oil and natural gas, an allocation is performed on the produced water volumes and emissions based on energy content of the estimated ultimate recoveries of oil and natural gas. This unit process is representative of a coalbed methane well in the San Juan Basin.

Figure 1: Unit Process Scope and Boundary

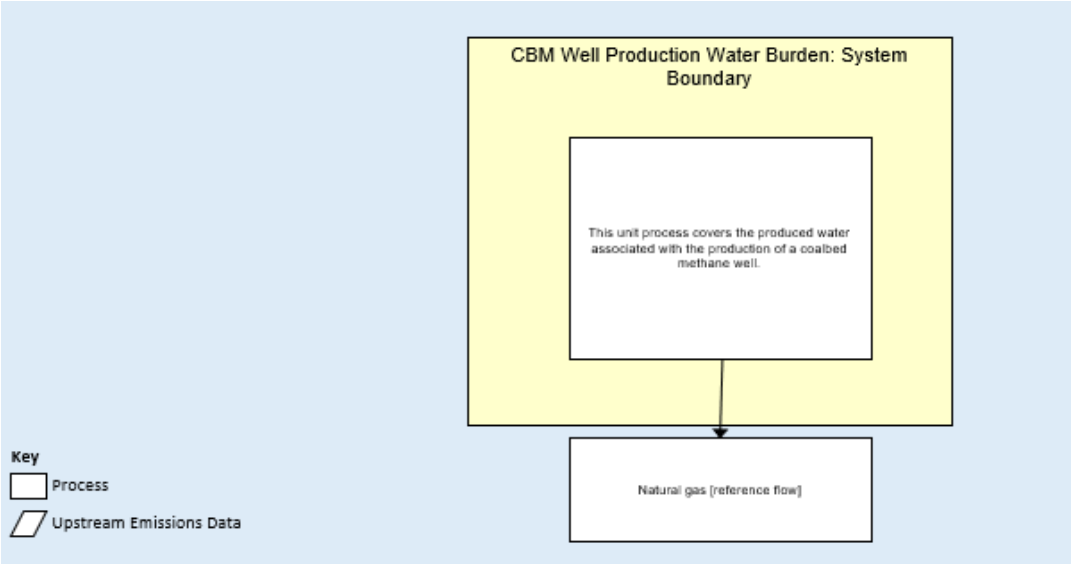

Table 1: Parameter Distributions

Parameter	Expected	Minimum	Maximum	Units
Produced_Rate_CC	3.80E-02	3.80E-02	3.80E-02	[bbl/mcf]
Conc_TDS	4.95E+03	4.61E+03	5.29E+03	[mg/L]
Conc_TSS	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_Ag	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_Al	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_As	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_B	3.83E-01	3.51E-01	4.15E-01	[mg/L]
Conc_Ba	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_Be	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_Br	6.04E+00	5.35E+00	6.73E+00	[mg/L]
Conc_Ca	3.38E+03	3.19E+03	3.57E+03	[mg/L]
Conc_Cd	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_Cl	5.33E+01	3.23E+01	7.43E+01	[mg/L]
Conc_Co	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_Cr	6.07E-02	3.86E-02	8.28E-02	[mg/L]
Conc_Cu	8.63E-02	5.48E-02	1.18E-01	[mg/L]
Conc_F	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_FeTot	9.42E+00	7.79E+00	1.11E+01	[mg/L]
Conc_HCO3	3.54E+03	3.31E+03	3.76E+03	[mg/L]
Conc_Hg	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_I	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_K	1.59E+01	1.35E+01	1.83E+01	[mg/L]
Conc_Li	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_Mg	6.36E+02	5.08E+02	7.63E+02	[mg/L]
Conc_Mn	1.38E-01	1.21E-01	1.55E-01	[mg/L]
Conc_Mo	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_NO2	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_NO3	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_NO3NO2	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_NH4	0.00E+00	0.00E+00	0.00E+00	[mg/L]

Conc_TKN	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_Na	1.61E+03	1.51E+03	1.71E+03	[mg/L]
Conc_Ni	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_PO4	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_Pb	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_S	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_SO3	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_SO4	5.72E+01	3.70E+01	7.75E+01	[mg/L]
Conc_Sb	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_Se	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_Si	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_Sn	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_Sr	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_Ti	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_Tl	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_Zn	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_ALKHCO3	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_Acidity	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_TOC	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_CN	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_Phenols	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_Sr87Sr86	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_Ra226	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_Ra228	0.00E+00	0.00E+00	0.00E+00	[mg/L]
Conc_Benzene	4.93E+00	2.64E+00	7.22E+00	[mg/L]
Conc_Toluene	4.04E+00	3.09E+00	4.98E+00	[mg/L]
Conc_H2S	1.90E-01	1.03E-01	2.76E-01	[mg/L]
OIL_EUR	1.81E+02	1.80E+02	1.82E+02	[bbl/well]
Estimated_Ultimate_Recovery	7.79E+06	7.78E+06	7.79E+06	[mcf/well]

Table 2: Unit Process Input and Output Flows

Flow Name	Value	Units (Per Reference Flow)	DQI
Inputs			
Outputs			
Natural gas [reference flow]	1	kg	2,1,3,1,1
Water (produced) [Water]	0.31928	L	2,1,3,3,3
TDS [emissions to water]	5.45E-10	kg	2,1,3,3,3
TSS [emissions to water]	0.00E+00	kg	2,1,3,3,3
Silver [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Aluminum [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Arsenic [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Boron [inorganic emissions to water]	4.22E-14	kg	2,1,3,3,3
Barium [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Berylium [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Bromine [inorganic emissions to water]	6.65E-13	kg	2,1,3,3,3
Calcium [inorganic emissions to water]	3.72E-10	kg	2,1,3,3,3
Cadmium [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Chlorine [inorganic emissions to water]	5.87E-12	kg	2,1,3,3,3
Cobalt [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Chromium [inorganic emissions to water]	6.69E-15	kg	2,1,3,3,3
Copper [inorganic emissions to water]	9.50E-15	kg	2,1,3,3,3
Fluorine [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Total Iron [inorganic emissions to water]	1.04E-12	kg	2,1,3,3,3
Bicarbonate [inorganic emissions to water]	3.90E-10	kg	2,1,3,3,3
Mercury [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Iodine [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Potassium [inorganic emissions to water]	1.75E-12	kg	2,1,3,3,3
Lithium [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Magnesium [inorganic emissions to water]	7.00E-11	kg	2,1,3,3,3
Manganese [inorganic emissions to water]	1.52E-14	kg	2,1,3,3,3
Molybdenum [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Nitrite [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Nitrate [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
nitrate-nitrite [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Ammonium [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3

Total Kjeldahl Nitrogen [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Sodium [inorganic emissions to water]	1.77E-10	kg	2,1,3,3,3
Nickel [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Phosphate [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Lead [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Sulfur [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Sulfite [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Sulfate [inorganic emissions to water]	6.30E-12	kg	2,1,3,3,3
Antimony [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Selenium [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Silicon [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Tin [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Strontium [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Titanium [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Thalium [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Zinc [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Alkalinity [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Acidity [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
TOC [organic emissions to water]	0.00E+00	kg	2,1,3,3,3
Cyanide [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Phenols [organic emissions to water]	0.00E+00	kg	2,1,3,3,3
Strontium 87 or 86 [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Radium 226 [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Radium 228 [inorganic emissions to water]	0.00E+00	kg	2,1,3,3,3
Benzene [organic emissions to water]	5.43E-13	kg	2,1,3,3,3
Toluene [organic emissions to water]	4.45E-13	kg	2,1,3,3,3
Hydrogen Sulfide [inorganic emissions to water]	2.09E-14	kg	2,1,3,3,3
TDS [emissions to agricultural soil]	4.80E-09	kg	2,1,3,3,3
TSS [emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Silver [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Aluminum [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Arsenic [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Boron [inorganic emissions to agricultural soil]	3.72E-13	kg	2,1,3,3,3
Barium [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Berylium [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3

Bromine [inorganic emissions to agricultural soil]	5.87E-12	kg	2,1,3,3,3
Calcium [inorganic emissions to agricultural soil]	3.28E-09	kg	2,1,3,3,3
Cadmium [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Chlorine [inorganic emissions to agricultural soil]	5.18E-11	kg	2,1,3,3,3
Cobalt [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Chromium [inorganic emissions to agricultural soil]	5.90E-14	kg	2,1,3,3,3
Copper [inorganic emissions to agricultural soil]	8.38E-14	kg	2,1,3,3,3
Fluorine [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Total Iron [inorganic emissions to agricultural soil]	9.15E-12	kg	2,1,3,3,3
Bicarbonate [inorganic emissions to agricultural soil]	3.43E-09	kg	2,1,3,3,3
Mercury [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Iodine [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Potassium [inorganic emissions to agricultural soil]	1.54E-11	kg	2,1,3,3,3
Lithium [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Magnesium [inorganic emissions to agricultural soil]	6.17E-10	kg	2,1,3,3,3
Manganese [inorganic emissions to agricultural soil]	1.34E-13	kg	2,1,3,3,3
Molybdenum [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Nitrite [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Nitrate [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
nitrate-nitrite [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Ammonium [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Total Kjeldahl Nitrogen [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Sodium [inorganic emissions to agricultural soil]	1.56E-09	kg	2,1,3,3,3
Nickel [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Phosphate [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Lead [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Sulfur [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Sulfite [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Sulfate [inorganic emissions to agricultural soil]	5.56E-11	kg	2,1,3,3,3
Antimony [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Selenium [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Silicon [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Tin [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Strontium [inorganic emissions to agricultural soil]	0.00E+00	kg	2,1,3,3,3
Titanium [inorganic emissions toagricultural soil]	0.00E+00	kg	2,1,3,3,3

Thalium [inorganic emissions to agricultural soil]	0.00E+00	**kg**	2,1,3,3,3
Zinc [inorganic emissions to agricultural soil]	0.00E+00	**kg**	2,1,3,3,3
Alkalinity [inorganic emissions to agricultural soil]	0.00E+00	**kg**	2,1,3,3,3
Acidity [inorganic emissions to agricultural soil]	0.00E+00	**kg**	2,1,3,3,3
TOC [organic emissions to agricultural soil]	0.00E+00	**kg**	2,1,3,3,3
Cyanide [inorganic emissions to agricultural soil]	0.00E+00	**kg**	2,1,3,3,3
Phenols [organic emissions to agricultural soil]	0.00E+00	**kg**	2,1,3,3,3
Strontium 87 or 86 [inorganic emissions to agricultural soil]	0.00E+00	**kg**	2,1,3,3,3
Radium 226 [inorganic emissions to agricultural soil]	0.00E+00	**kg**	2,1,3,3,3
Radium 228 [inorganic emissions to agricultural soil]	0.00E+00	**kg**	2,1,3,3,3
Benzene [organic emissions to agricultural soil]	4.79E-12	**kg**	2,1,3,3,3
Toluene [organic emissions to agricultural soil]	3.92E-12	**kg**	2,1,3,3,3
Hydrogen Sulfide [inorganic emissions to agricultural soil]	1.84E-13	**kg**	2,1,3,1,1

* **Bold face** clarifies that the value shown *does not* include upstream environmental flows.

Note: Inventory items not included are assumed to be zero based on best engineering judgment or assumed to be zero because no data was available to categorize them for this unit process at the time of its creation.

Embedded Unit Processes

None.

References

DrillingInfo. 2018. DI Data & Insights.

EPA. 2015. Review of State and Industry Spill Data: Characterization of Hydraulic Fracturing-Related Spills. O.o.R.a.D. U.S. Environmental Protection Agency. EPA/601/R-14/001. https://www.epa.gov/sites/production/files/2015-05/documents/hf_spills_report_final_5-12-15_508_km_sb.pdf Accessed July 18, 2018

NIST Chemistry WebBook. 2017. Isothermal Properties for Methane.

NRC. 2010. Management and Effects of Coalbed Methane Produced Water in the Western United States. N.R. Council. The National Academies Press. https://doi.org/10.17226/12915.

USGS. 2017. US Geological Survey National Produced Waters Geochemical Database v2.3 (PROVISIONAL). U.S.G. Survey. https://energy.usgs.gov/EnvironmentalAspects/EnvironmentalAspectsofEnergyProductionandUse/ProducedWaters.aspx#3822349-data. Accessed July 18, 2018

U.S. Energy Information Administration. 2018. Energy Units and Calculators Explained.

U.S. Energy Information Administration. 2018. Heat Content of Natural Gas Consumed

API. 2009. Compendium of Greenhouse gas Emissions Methodologies for the Oil and Natural Gas Industry. https://www.api.org/~/media/Files/EHS/climate-change/2009_GHG_COMPENDIUM.pdf Accessed January 22, 2019

Section III: Document Control Information

Date Created: December 18, 2018

Point of Contact: Timothy Skone (NETL), Timothy.Skone@NETL.DOE.GOV

Revision History:

Original/no revisions

How to Cite This Document: This document should be cited as:

NETL (2010). *NETL Life Cycle Inventory Data – Unit Process: CBM Well Production Water Burden* U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: December 2018 (version 01). www.netl.doe.gov/energy-analyses (http://www.netl.doe.gov/energy-analyses)

Section IV: Disclaimer

Neither the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) nor any person acting on behalf of these organizations:

A. Makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this document, or that the use of any information, apparatus, method, or process disclosed in this document may not infringe on privately owned rights; or

B. Assumes any liability with this report as to its use, or damages resulting from the use of any information, apparatus, method, or process disclosed in this document.

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by NETL. The views and opinions of the authors expressed herein do not necessarily state or reflect those of NETL.