NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Underground Mine, Illinois No. 6 Bituminous Coal, Operation

Reference Flow: 1 kg of Illinois No. 6 Bituminous Coal

Brief Description: Based on Galatia Mine, an Illinois No. 6 underground, bituminous coal mine in Saline County, IL; producing ~6.6 million short tons of coal per year. Assumed 360 cubic feet/short ton coalbed methane (CBM) emissions, adjustable CBM capture rates.

Section I: Meta Data

Geographical Coverage: US **Region:** IL

Year Data Best Represents: 2004

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:

Coalbed methane emissions (CBM)	*Emissions of coalbed methane (CBM) from the coal mine and from mined coal*

Tracked Input Flows:

Diesel Combustion, Mobile Sources, Truck [Refinery products]	*Diesel from crude oil, combusted in trucks*
Power [Electric power]	*Electricity usage for mine operations*

Tracked Output Flows:

Hard Coal (Illinois No. 6) [Hard Coal Products] *Coal mine production flow for Illinois No. 6 bituminous coal*

Section II: Process Description

Associated Documentation

This unit process is comprised of this document, as well as the data sheet (DS) *DS_Stage1_O_Underground_Coal_Mine_I6_2009.03.xls*, which provides additional details regarding calculations, data quality, and references as relevant.

Goal and Scope

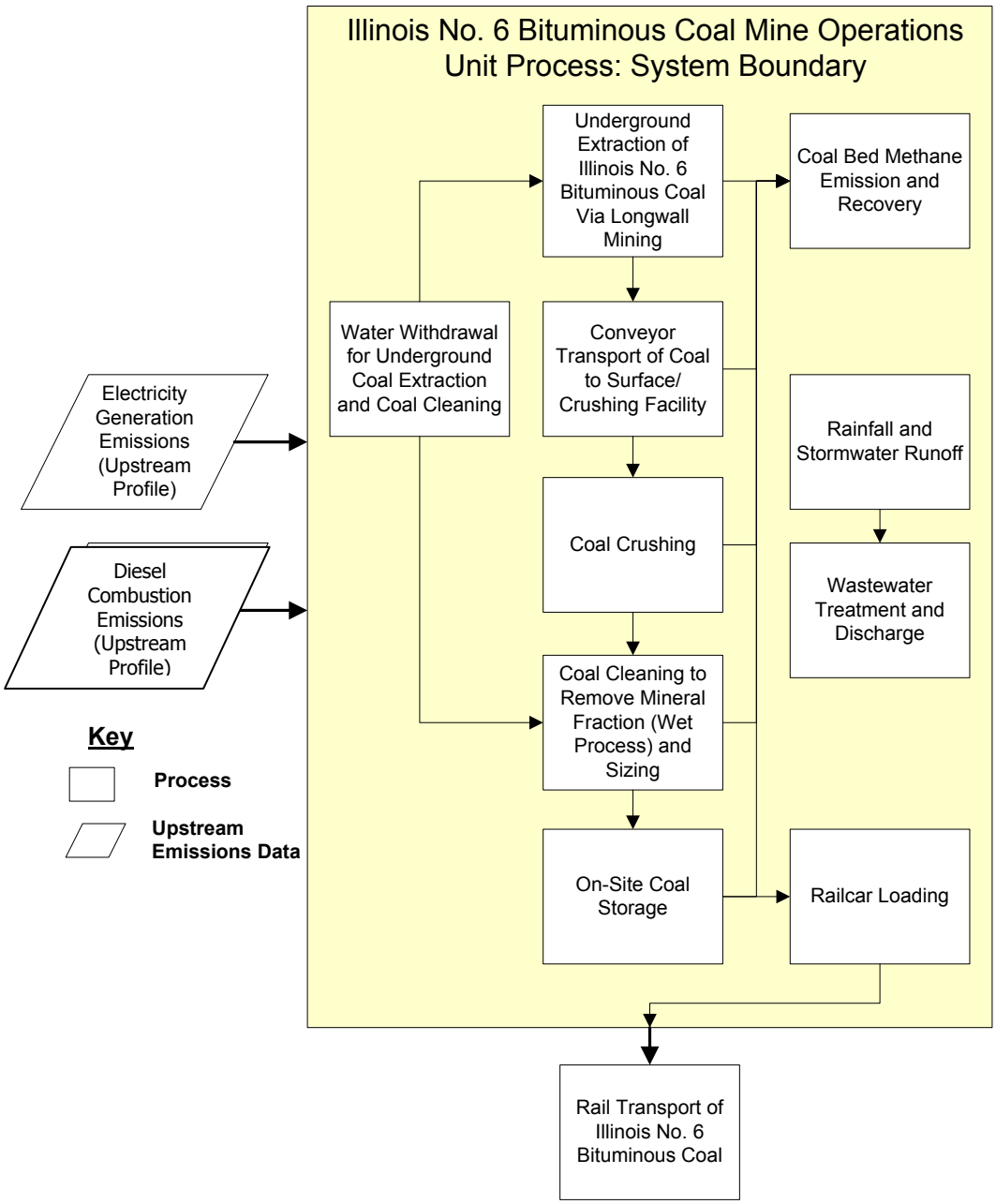
The scope of this process covers the production of coal during operation of an underground coal mine, from resource extraction to the boundary for LC Stage #2 (e.g., transport of coal). The process is based on the reference flow of 1 kg of cleaned, crushed (to approximately 3 inches) Illinois No. 6 bituminous coal, as described below, and in **Figure 1.** Considered are the consumption of electricity, consumption of diesel, emissions of methane associated with off-gassing from the coal/coal mine, particulate matter emissions associated with fugitive coal dust, water input flows required for mining and cleaning operations, wastewater flows including stormwater, emissions of criteria air pollutants, and air emissions of mercury and ammonia. The consumption of diesel is modeled as a tracked input flow in which the associated emissions from diesel combustion are accounted for in an externally linked unit process.

Boundary and Description

Operations of the coal mine are based on operation of the Galatia Mine, an underground, bituminous Illinois No. 6 coal mine, having an average production rate of approximately 6.6 million short tons per year. The Galatia Mine is operated by the American Coal Company and is located in Saline County, IL. Sources reviewed in assessing coal mine operations include Galatia mine facilities and equipment, production rates, electricity usage, particulate air emissions, methane emissions, wastewater discharge permit monitoring reports, and communications with Galatia mine staff. When data from the Galatia mine were not available, surrogate data were taken from other underground mines, as relevant.

Figure 1 provides an overview of the boundary of this unit process. Rectangular boxes represent relevant sub-processes, while trapezoidal boxes indicate upstream data that are outside of the boundary of this unit process. As shown, upstream emissions associated with the production and delivery of electricity and diesel fuel are accounted for outside of the boundary of this unit process.

Figure 1: Unit Process Scope and Boundary



Coal is extracted from the underground Illinois No. 6 coal seam with wet-head longwall and continuous miners using a longwall mining process. Coal is then loaded onto a conveyor for transport to the surface. At the surface, the coal continues along a conveyor to the crushing facility, where the coal is crushed to approximately 3 inch sizing. Coal then continues to the cleaning facility, where the mineral fraction (approximately 45% of total coal mass) of the run-of-the mine coal is removed via a water-based cleaning and sorting process. The coal is then temporarily stored, until it is eventually loaded onto a railcar for rail transport. Stormwater, which generates on-site runoff from coal stockpiles and other facilities, is treated at a wastewater treatment

plant, which discharges to a river. The wastewater treatment plant does not treat mining or coal cleaning process water. These systems are closed-loop in terms of water use, and generate no wastewater discharge.

Coalbed methane emissions from the coal mine, and from the extracted coal during processing and storage, were estimated based on U.S. EPA estimates of methane release for coal mines (U.S. EPA 2008). A 40% methane capture rate was used based on data for existing and potential recovery rates (U.S. EPA 2008), which resulted in a coalbed methane emission factor of 216 standard cubic feet per short ton of coal. For the sensitivity analysis, assuming that no coalbed methane capture method was employed, it was assumed that all emitted methane was released to the atmosphere, for a sensitivity value for coalbed methane emissions of 360 standard cubic feet per short ton.

Electricity use was estimated based on previous estimates made by U.S. EPA for electricity use for underground mining and coal cleaning at the Galatia Mine (U.S. EPA 2008). Diesel use was estimated for the Galatia mine from 2002 U.S. Census data for bituminous coal underground mining operations and associated cleaning operations (U.S. Census Bureau 2004).

The emissions associated with the combustion of diesel are accounted for in an externally linked unit process. Emissions of particulate matter included those due to the fugitive coal dust from the mining process. Total coal dust emissions from the Galatia Mine were used based on data for the mine (U.S. EPA 2005), and were normalized to the reference flow.

Water use was estimated by dividing USGS 2005 county-level water use (U.S. Geological Survey, 2005) by the 2005 Galatia Mine coal production (EIA 2013), which correlates well with an estimate provided by Galatia Mine staff (Personal Communication 2009). Water use for other counties with coal mines is provided to provide a bound for uncertainty. Water emissions data, including flows and concentrations of relevant inorganic constituents and biological oxygen demand, were taken from available National Pollutant Discharge Elimination System permit reporting documentation for Galatia Mine from 2009-2011 (EPA 2013).

Properties of Illinois No. 6 coal relevant to this unit process are indicated in **Table 1**. **Table 2** provides a summary of modeled input and output flows. Additional details regarding input and output flows, including calculation methods, are contained in the associated DS sheet.

Table 1: Properties of Illinois No. 6 Coal (NETL 2007)

Rank	Bituminous	
Seam	Illinois No. 6 (Herrin)	
Source	Old Ben Mine	
Proximate Analysis (weight %) (Note A)		
	As Received	**Dry**
Moisture	11.12	0.00
Ash	9.70	10.91
Volatile Matter	34.99	39.37
Fixed Carbon	44.19	49.72
Total	100.00	100.00
Sulfur	2.51	2.82
HHV, kJ/kg	27,113	30,506
HHV, Btu/lb	11,666	13,126
LHV, kJ/kg	26,151	29,544
LHV, Btu/lb	11,252	12,712
Ultimate Analysis (weight %)		
	As Received	**Dry**
Moisture	11.12	0.00
Carbon	63.75	71.72
Hydrogen	4.50	5.06
Nitrogen	1.25	1.41
Chlorine	0.29	0.33
Sulfur	2.51	2.82
Ash	9.70	10.91
Oxygen (Note B)	6.88	7.75
Total	100.00	100.00

Notes: (A) the proximate analysis assumes sulfur as volatile matter; (B) by difference.

Table 2: Unit Process Input and Output Flows

Flow Name*	Value	Units (Per Reference Flow)	DQI
Inputs			
Power [Electric power]	**3.31E-02**	**kWh**	2,2
Hard Coal (Illinois No. 6) [Hard coal (resource)]	1.01E+00	kg	2,2
Diesel Combustion, Mobile Sources, Truck [Refinery products]	**2.63E-04**	**kg**	2,2
Water (ground water, fresh) [Water]	1.34E-01	L	2,2
Water (ground water, saline) [Water]	5.17E-02	L	2,2
Water (surface water, fresh) [Water]	1.18E-01	L	2,2
Outputs			
Hard Coal (Illinois No.6) [Hard Coal Products]	1.00E+00	kg	2,2
Methane [Organic emissions to air (group VOC)]	7.56E-03	kg	2,2
Dust (PM10) [Particles to air]	2.57E-07	kg	2,2
Water (storm runoff) [Water]	3.78E-01	L	1,1
Total suspended solids [Particles to fresh water]	5.32E-06	kg	1,1
Iron [Heavy metals to fresh water]	9.22E-08	kg	1,1
Alkalinity [Inorganic emissions to fresh water]	6.10E-05	kg	1,1
Acidity [Inorganic emissions to fresh water]	-2.97E-05	kg	1,1
Chloride [Fresh water]	2.44E-03	kg	1,1
Sulphate [Inorganic emissions to fresh water]	3.80E-04	kg	1,1
Biological oxygen demand (BOD) [Analytical measures to fresh water]	7.49E-06	kg	1,1
Ammonia, as N [Inorganic emissions to fresh water]	1.88E-06	kg	1,1

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

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

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U.S. EPA 2008	U.S. Environmental Protection Agency. 2008. *Identifying Opportunities for Methane Recovery at U.S. Coal Mines: Profiles of Selected Gassy Underground Coal Mines 2002-2006.* U.S. Environmental Protection Agency, Coalbed Methane Outreach Program. Report Number: EPA 430-K-04-003.
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EIA 2013	*Historical Detailed Coal Production Data (1983-2011)*. US Energy Information Agency: Washington, DC. (accessed 04/01/2013)

Section III: Document Control Information

Date Created:	February 12, 2009
Point of Contact:	Timothy Skone (NETL), Timothy.Skone@NETL.DOE.GOV
Revision History:	
4/1/2013	Water use and emissions updated to newer data
01/20/2015	PM emissions redefined as PM10 emissions
	Added inventory item level DQI data
	Appropriated diesel combustion emissions to an external UP

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

NETL (2009). *NETL Life Cycle Inventory Data – Unit Process: Underground Mine, Illinois No. 6 Bituminous Coal, Operation*. U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: January 2015 (version 03). www.netl.doe.gov/energy-analyses (http://www.netl.doe.gov/energy-analyses)

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