NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Wastewater Treatment Plant, Underground Coal Mine, Construction

Reference Flow: 1 piece (pcs) of Wastewater Treatment Plant, Underground Coal Mine

Brief Description: Includes material requirements for construction of the underground Illinois No. 6 bituminous coal mine wastewater treatment plant, which consists of settling ponds plus minor supporting infrastructure: pumps, pipes, wiring, and cement structures.

Section I: Meta Data

Geographical Coverage: US **Region:** Southern Illinois

Year Data Best Represents: 2005

Process Type: Manufacturing Process (MP)

Process Scope: Gate-to-Gate Process (GG)

Allocation Applied: No

Completeness: All Relevant Flows Recorded

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:

None

Tracked Input Flows:

Polyvinylchloride-tube (PVC) [Plastic parts]	*PVC tubing (pipe) used to carry water in the wastewater treatment plant*

Steel, Stainless, 316 2B (80% Recycled) [Metals]	*316 stainless steel used to construct pumps, assumes 80% recycled/recovery rate*
Stainless Steel Cold Roll, 431 [Metals]	*431 stainless steel used to construct pumps*
Cast iron part [Metal parts]	*Cast iron used to construct pumps*
Coppersheet [Metals]	*Copper metal used to construct pump wiring*
Concrete, ready mix, R-5-0 [Concrete_Cement]	*Concrete used for construction of cement culverts and dissipating structures*
Hot-dip Galvanized Steel [Metals]	*Galvanized steel used to construct pumps*

Tracked Output Flows:

Wastewater Treatment Plant, Underground Coal Mine [Construction]	*Construction of a wastewater treatment plant for an underground Illinois No. 6 bituminous coal mine*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage1_C_Wastewater_Treatment_Plant_Underground_Coal_Mine_2010.01.xls*, which provides additional details regarding relevant calculations, data quality, and references.

Goal and Scope

The scope of this unit process encompasses the materials and weights of those materials necessary to construct a wastewater treatment plant for use at an underground Illinois No. 6 bituminous coal mine located in Southern Illinois. The unit process is based on the reference flow of a single wastewater treatment plant, as described below and shown in **Figure 1.** The layout and materials required for the

wastewater treatment plant are based on a combination of data from the Galatia mine and the Deer Run Mine, two Illinois No. 6 underground (longwall) mines located in southern Illinois.

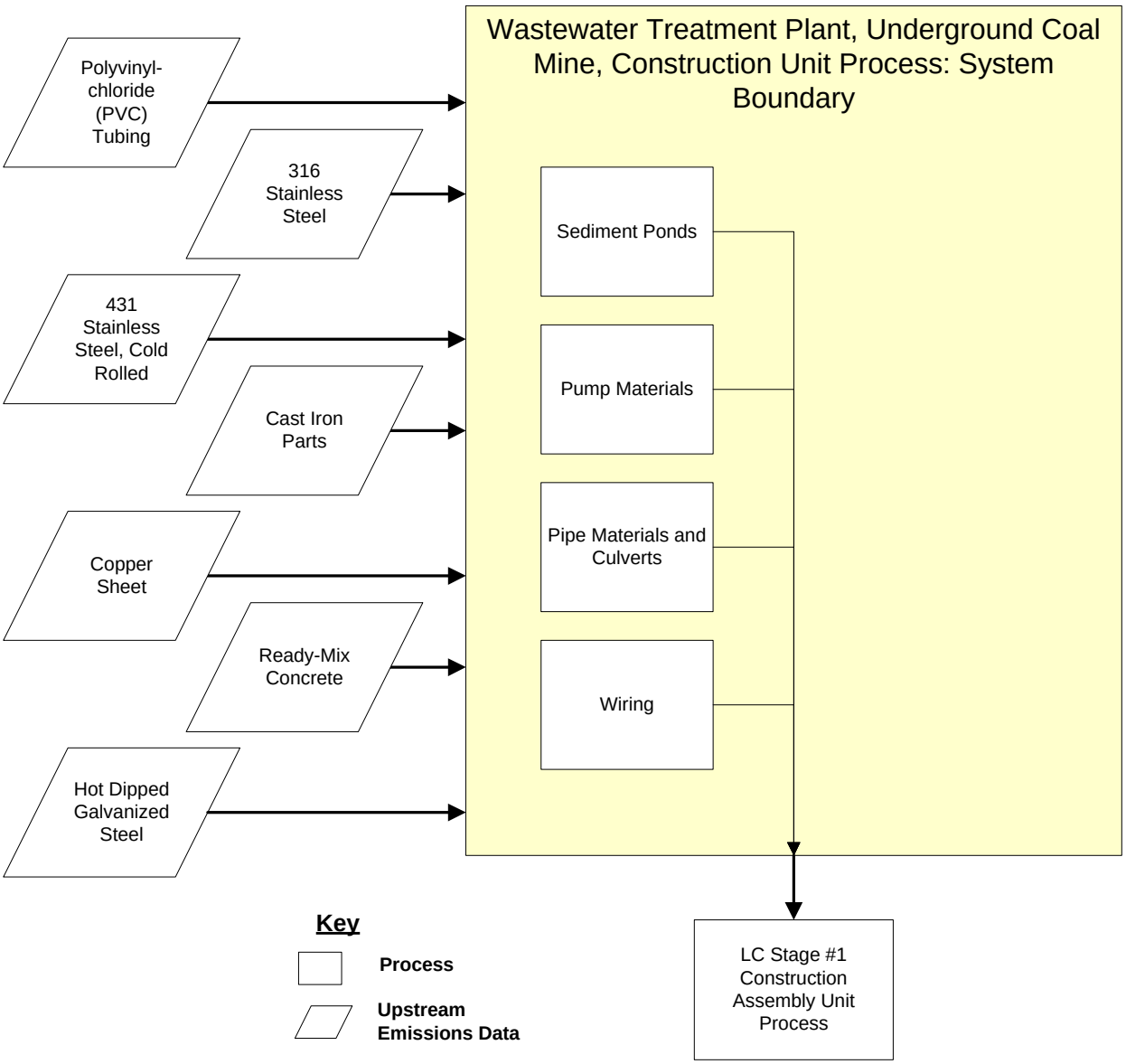
This process is used during Life Cycle (LC) Stage #1 for the production of Illinois No. 6 coal. It is combined with other coal mine equipment construction unit processes in an assembly process for construction of a coal preparation facility, DF_Stage1_C_Assembly_I6_Coal_Prep_2010.01. This assembly unit process quantifies the fraction of each piece of equipment needed under LC Stage #1 to produce 1 kg of Illinois No. 6 bituminous coal ready for transport (LC Stage #2) to an energy conversion facility (LC Stage #3).

Boundary and Description

Construction of the wastewater treatment plant at the underground coal mine is based on the layout and materials required for a combination of the Galatia and Deer Run Mines, two underground Illinois No. 6 bituminous (longwall) mines located in southern Illinois. The coal preparation facility prepares mined coal for transport to the energy conversion facility. Coal preparation activities in the representative mine require the wastewater treatment plant modeled in this unit process, as well as a coal stockpile stacker, a coal crusher facility, a coal cleaning facility, and a coal loading silo.

Figure 1 provides an overview of the boundary of this unit process. Emissions related to the physical assembly of plant components and installation of components at the plant site (e.g., emitted while putting together the components of a wastewater treatment plant, including transport of those components) are not considered in this study. Upstream emissions from the production of raw materials used for the construction of the plant (e.g., polyvinylchloride (PVC) tube) are calculated outside the boundary of this unit process, based on proprietary profiles available within the GaBi model. As shown in **Figure 1** and discussed above, the wastewater treatment plant constructed in this unit process is incorporated into the coal preparation facility assembly processes for LC Stage #1 for Illinois No. 6 bituminous coal.

Figure 1: Unit Process Scope and Boundary



Description of the Wastewater Treatment Plant

The wastewater treatment plant for the study consists of a series of sedimentation ponds that receive storm water flows from coal and refuse storage areas and mining operations areas throughout the mine site. The wastewater treatment plant does not receive discharge water from the coal mine or coal cleaning processes. Note that water treatment for the coal cleaning process consists of a slurry cell that is designed to facilitate re-use of water within the coal cleaning cycle, and the construction of the slurry cell is therefore not included in the wastewater treatment facility.

Characteristics of the wastewater treatment facility, including sizing of sediment ponds and details about their operation, were gathered first from documentation from a proposed expansion of Deer Run Mine. The proposed expansion would be an Illinois No. 6 mine that is also located in southern Illinois. This mine was selected primarily for its reasonable similarity to the mine used for this project, including its geographic location, as well as public availability of sufficient documentation (Hillsboro Energy LLC 2007). To ensure that the resulting assumptions were reasonable, they were cross-checked with Galatia Mine staff, and revised as needed.

As shown in the DS, the wastewater treatment plant includes approximately 15 acres of storm water retention ponds. The Deer Run document includes schematics of the seven on-site settling ponds. Using these diagrams, the size of each was estimated and summed to estimate the total surface area of 15 acres (Hillsboro Energy LLC 2007). These ponds are lined using compacted sediments, which are assumed to be present on site. Water flow into and out of ponds is facilitated by a series of earthen channels/drainages, as well as PVC piping with associated pumps, and cement lined outfall/discharge structures (Hillsboro Energy LLC 2007).

Pumps and Pipes

Pumps are required to convey a portion of the flow to, within, and out of the wastewater treatment facility. For the purposes of this study, we have assumed that 20 percent of maximum storm water flows would require pumps, and scaled pump installation to that amount. The maximum flow rate of the storm water was calculated by summing the total discharges of each of the seven sediment ponds for a total of 1,893 ft^3/sec (Hillsboro Energy LLC 2007). Taking 20 percent of the total resulted in a maximum pump capacity requirement of 169,927 gallons per minute (gpm). Assuming that this flow would be carried using 5,000 gpm pumps, a total of 34 pumps would be necessary to provide for the required storm flow.

The weight of a representative pump was obtained from a table listing the weights of various pumps, and a skid assembly of 7,900 lb was used from a 5,000 gpm DV-300 pump (Power Prime Pumps 2005). Pump materials were estimated based upon literature obtained from the manufacturer (Power Prime Pumps 2005, Power Prime Pumps 2008a, Power 2008b). Each pump is constructed of 316 stainless steel (impeller and wear plates), 431 stainless steel (shaft), cast iron (much of the body and framework), and hot-dip galvanized steel (skid) (Power Prime Pumps 2008b). Based on schematics and vendor information, we estimated that each pump would include, by weight, 10 percent 316 stainless steel, 10 percent 431 stainless steel, 50 percent cast iron, and 30 percent hot-dip galvanized steel. Using the pump weight of 7,900 lb, each pump would include 790 lb of both 316 and 431 stainless steel, 3,950 lb of cast iron, and 2,370 lb of hot-dip galvanized steel. Multiplying by 34 pumps and converting to kilograms gives a total of 12,178.3 kg of 316 stainless steel, 12,178.3 kg of

431 stainless steel, 60,891.5 kg of cast iron, and 36,534.9 kg of hot-dip galvanized steel.

Pumped flows would be conveyed within either 4" or 8" PVC pipes. Based on the design of the Deer Run facility and anticipated proximity to stockpile areas, it was estimated that a total of 8,500 ft of 4" and 3,500 ft of 8" schedule 80 PVC pipe would be required. Each diameter pipe was multiplied by the weight of PVC per 100 feet (275 lb/100 ft for the 4", 805 lb/100 ft for the 8") and then converted to kilograms (Engineering Toolbox 2008). This would result in a mass of 10,603 kg of 4" pipe and 12,780 kg of 8" pipe, for a total of 23,383 kg of PVC required.

Cement Structures

Based on the design of the Deer Run facility, cement would be used for water flow dissipating structures and for a limited amount of canal lining. Based on 12,500 ft^2 of cement at an average thickness of 1.5 ft, we estimate that 18,750 ft^3 of cement would be required (Hillsboro Energy LLC 2007). Assuming a density of 94 lb/ft^3 for Portland cement (Reade Advanced Materials 2006), this is equivalent to 799,456.55 kg of cement.

Wiring

Wiring would be used primarily to supply electricity to pumps, although it was also assumed that wiring would supply minor additional loads such as facility lighting. It was assumed that operations for the facility would be housed separately with operations for the remainder of the mine. Wiring lengths were calculated based upon the design of the Deer Run facility and the anticipated proximity of stockpile areas to the treatment facility (Hillsboro Energy LLC 2007). There were calculated to be 12,000 total feet of piping, so the length of wire necessary to power the pumps was assumed to be half of the required length of pipeline, or 6,000 ft. There was an additional 20 percent of total wire length included to support lights and other auxiliary uses. The 20 percent was broken up into two categories: 20 percent of that number is 2-strand gauge 1 wire (e.g. gauge 1 / 2), and the remaining 80 percent is gauge 12 / 3. Herein, 6,000 ft of gauge 1 / 2 wire would be required for pumps, 240 ft for auxiliary wiring, and an additional 960 ft of gauge 12 / 3 wire for auxiliary wiring. The gauge 1 / 2 wire has a length of 3.947 feet per pound of wire (ft/lb) per strand, while gauge 12 / 3 wire is 50.59 ft/lb (Davis 2008). Each wire was divided by its length per pound and then multiplied by the number of strands in the wire. After converting to kilograms, this gives 1,379 kg of gauge 1 / 2 wire for the main pump wiring, 55 kg of 1 / 2 wire for auxiliary wiring, and 26 kg of 12 / 3 wire for auxiliary wiring. Since all wiring is assumed to be copper, there would be a total mass of approximately 1,460 kilograms.

Other Materials

Clay/sediment lining would be required for the proposed sedimentation ponds. It was assumed that these materials would be available on site, and could be recycled from the pond-digging process. It was also assumed that remaining spoils from pond construction would be used as berms around the ponds to provide flood flow protection, or for grading and fill purposes during construction of other facilities at the mine site.

Table 1 summarizes the relevant properties and assumptions used to calculate the amount of each material used to construct a wastewater treatment plant. **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.

Table 1: Properties of the Wastewater Treatment Plant, Underground Coal Mine

Property	Value	Reference
Total Area of Cement Structures, m^2 (ft^2)	1,161.288 (12,500)	Hillsboro Energy LLC 2007
Average Thickness of Cement Structures, m^2 (ft)	0.139 (1.5)	Hillsboro Energy LLC 2007
Density of Portland Cement, kg/m^3 (lb/ft^3)	1,505.76 (94)	Reade Advanced Materials 2006
Total Length of PVC Pipe, m (ft)	3,657.6 (12,000)	Hillsboro Energy LLC 2007
Total Length of 4” PVC Pipe, m (ft)	2,590.8 (8,500)	NETL Engineering Judgment
Total Length of 8” PVC Pipe, m (ft)	1,067 (3,500)	NETL Engineering Judgment
Proportion of Length of PVC Pipe to Length of Copper Wiring	2:1	NETL Engineering Judgment
Total Length of Copper Wiring, m (ft)	1,828.8 (6,000)	Calculated
Total Discharges of Sediment Ponds, m^3/sec (ft^3/sec)	53.6 (1,893)	Hillsboro Energy LLC 2007
Percent of Maximum Stormwater Flows Requiring Pumps (%)	20	NETL Engineering Judgment
Weight of one Representative Pump, kg (lb)	3,583 (7,900)	Power Prime Pumps 2005
Number of Representative Pumps	34	Calculated

Table 2: Unit Process Input and Output Flows

Flow Name*	Value	Units (Per Reference Flow)
Inputs		
Polyvinylchloride-tube (PVC) [Plastic parts]	**23,382**	**kg**
Steel, Stainless, 316 2B (80% Recycled) [Metals]	**12,178**	**kg**
Stainless Steel Cold Roll, 431 [Metals]	**12,178**	**kg**
Cast Iron Part [Metal parts]	**60,891**	**kg**

Coppersheet [Metals]	**1,460**	**kg**
Concrete, Ready Mix, R-5-0 [Concrete_Cement]	**799,456**	**kg**
Hot-dip Galvanized Steel [Metals]	**36,534**	**kg**
Outputs		
Wastewater Treatment Plant, Underground Coal Mine	1.00	piece

* **Bold face** clarifies that the value shown *does not* include upstream environmental flows. Upstream environmental flows were added during the modeling process using GaBi modeling software, as shown in Figure 1.

Embedded Unit Processes

None.

References

Davis 2008 — Davis, L. 2008. *Reference & Information: AWG Cable Description*. Interfacebus. http://www.interfacebus.com/Copper_Wire_AWG_SIze.html (Accessed January 14, 2010).

Engineering Toolbox 2008 — The Engineering Toolbox. 2008. *PVC and CPVC Pipes – Schedule 40 & 80*. The Engineering Toolbox. http://www.engineeringtoolbox.com/pvc-cpvc-pipes-dimensions-d_795.html (Accessed December 14, 2009).

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Section III: Document Control Information

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