



NETL Life Cycle Inventory Data

Process Documentation File

Process Name: Steel products
Reference Flow: 1 kg of various steel products
Brief Description: worldsteel and Steel Recycling Institute cradle-to-gate life cycle inventories for various steel products

Section I: Meta Data

Geographical Coverage: Various **Region:** Various
Year Data Best Represents: 2005-2010
Process Type: Manufacturing Process (MP)
Process Scope: Cradle-to-Gate Process (CG)
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 Other

Releases to Water: Inorganic 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:

None.

Tracked Output Flows:

Steel, UO pipe, global [Reference flow]
Steel, welded pipe, global [Reference flow]

Steel, finished cold rolled coil, global	[Reference flow]
Steel, organic coated steel, global	[Reference flow]
Steel, hot-dipped galvanized, global	[Reference flow]
Steel, sections, global	[Reference flow]
Steel, finished cold rolled coil, North American	[Reference flow]
Steel, hot-dipped galvanized, North American	[Reference flow]
Steel, recycled UO pipe, global	[Reference flow]
Steel, recycled welded pipe, global	[Reference flow]
Steel, recycled finished cold rolled coil, global	[Reference flow]
Steel, recycled organic coated steel, global	[Reference flow]
Steel, recycled hot-dipped galvanized, global	[Reference flow]
Steel, recycled sections, global	[Reference flow]

Section II: Process Description

Associated Documentation

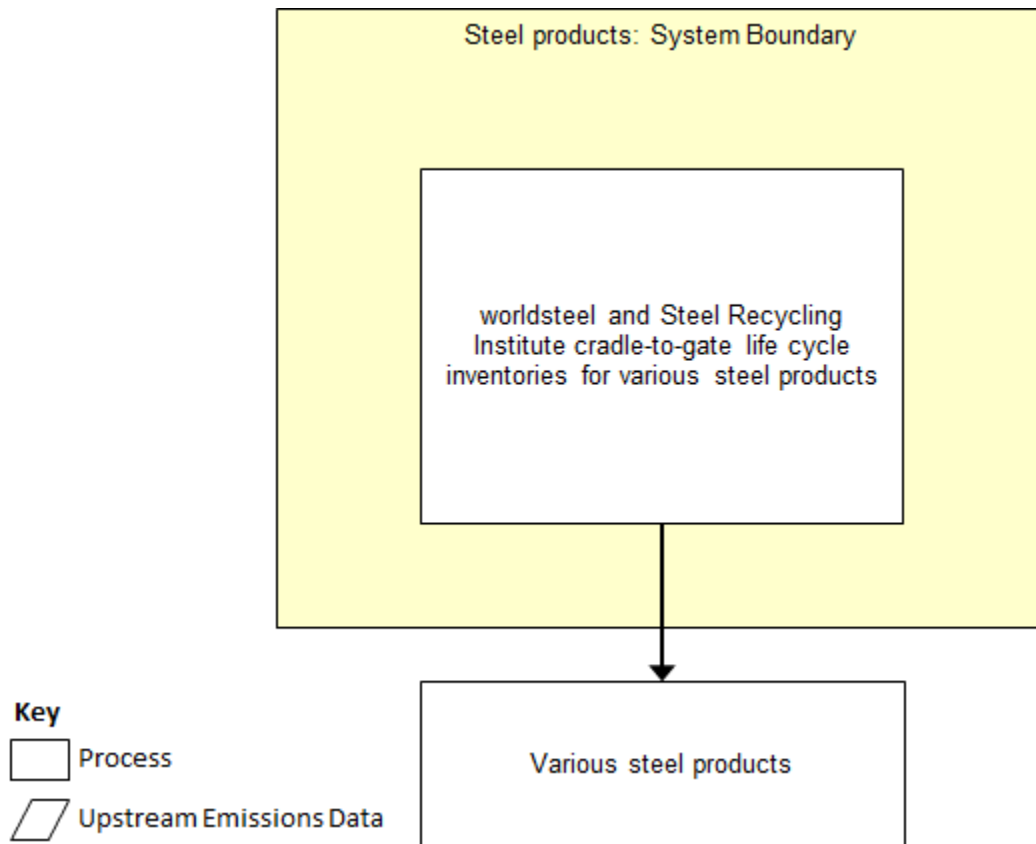
This unit process is composed of this document and the data sheet (DS) *DS_Stage12345_M_Steel_Products_2016.01.xlsx*, which provides additional details regarding relevant calculations, data quality, and references.

Goal and Scope

This unit process provides a summary of relevant input and output flows associated with manufacturing various steel products. Profiles are provided on either global or North American averages.

Boundary and Description

Figure 1 provides an overview of the boundary of this unit process. All upstream emissions and manufacturing emissions are accounted for in this process, with the exception of the iron scrap. The process provides scenarios for UO pipe, welded pipe, finished cold rolled coil, organic coated (i.e., paint or laminated film) coil or sheet, hot-dipped galvanized, and sections (e.g., I-beams). These scenarios can be accessed on the *PS* tab within the DS file.

Figure 1: Unit Process Scope and Boundary

The life cycle presented in this unit process is provided by permission from worldsteel and the Steel Recycling Institute. The methodology used for the life cycle inventory is provided by worldsteel (worldsteel, 2011).

The inventories for steel products do not account for end-of-life (EoL) recycling; however, profiles for EoL recycling credits are also provided in this unit process. The decision as to whether this steel product is recycled at EoL is answered within the larger life cycle model.

Table : Unit Process Input and Output Flows

Flow Name	UO pipe - Global	Welded pipe - Global	Finished cold rolled coil - Global	Organic coated steel - Global	Hot-dip galvanized coil - Global	Sections - Global	Units (Per Reference Flow)
Inputs							
Carbon dioxide	1.13E-02	9.04E-03	1.93E-02	1.66E-02	1.87E-02	1.72E-02	kg
Crude oil	-9.79E-03	3.60E-02	4.91E-03	2.01E-02	2.10E-02	-6.11E-04	kg
Dolomite	5.11E-02	4.29E-02	4.62E-02	4.87E-02	3.71E-02	5.15E-02	kg
Iron scrap	3.86E-02	1.82E-01	9.50E-02	7.14E-02	1.03E-01	6.08E-01	kg
Hard coal	9.34E-01	7.13E-01	8.36E-01	8.95E-01	8.34E-01	5.54E-01	kg
Iron ore	1.39E+00	1.27E+00	1.36E+00	1.31E+00	1.34E+00	8.57E-01	kg
Lignite	-2.03E-03	1.15E-02	2.09E-03	1.31E-02	2.36E-02	4.59E-02	kg
Limestone	7.57E-02	-3.96E-02	-3.32E-03	-1.19E-02	2.94E-02	-1.10E-02	kg
Natural gas	1.27E-02	5.95E-02	3.67E-02	1.02E-01	5.97E-02	6.51E-02	kg
Tin ore	-1.01E-15	8.44E-16	4.76E-16	1.96E-15	1.01E-15	1.57E-16	kg
Uranium	-5.38E-07	1.54E-06	1.24E-06	2.38E-06	2.35E-06	2.82E-06	kg
Water	2.54E+01	1.03E+01	2.48E+01	1.19E+01	2.15E+01	2.42E+00	kg
Zinc ore	5.74E-04	2.84E-03	8.71E-05	1.48E-01	1.07E-01	-2.41E-02	kg
Outputs							
Steel, UO pipe, global	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Steel, welded pipe, global	0.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Steel, finished cold rolled coil, global	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Steel, organic coated steel, global	0.00E+00	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00	kg
Steel, hot-dipped galvanized, global	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	0.00E+00	kg
Steel, sections, global	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	kg
Steel, Finished cold rolled coil, North American	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Steel, hot-dipped galvanized, North American	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Steel, recycled UO pipe, global	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Steel, recycled welded pipe, global	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Steel, recycled finished cold rolled coil, global	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Steel, recycled organic coated steel, global	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Steel, recycled hot-dipped galvanized, global	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Steel, recycled sections, global	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Cadmium (+II) emissions to air	8.29E-08	2.74E-08	6.49E-08	8.49E-08	7.63E-08	4.41E-08	kg
Carbon dioxide emissions to air	2.30E+00	2.18E+00	2.18E+00	2.69E+00	2.34E+00	1.45E+00	kg

Flow Name	UO pipe - Global	Welded pipe - Global	Finished cold rolled coil - Global	Organic coated steel - Global	Hot-dip galvanized coil - Global	Sections - Global	Units (Per Reference Flow)
Carbon monoxide emissions to air	3.72E-02	1.16E-02	2.57E-02	2.50E-02	2.75E-02	1.87E-02	kg
Chromium (unspecified) emissions to air	2.72E-07	1.61E-07	1.89E-07	2.47E-07	2.04E-07	1.95E-07	kg
Dioxins (unspecified) emissions to air	1.76E-12	6.07E-13	1.03E-12	1.16E-12	8.49E-13	6.56E-12	kg
Hydrochloric acid emissions to air	4.85E-05	3.12E-05	4.62E-05	7.93E-05	6.63E-05	4.82E-05	kg
Hydrogen sulfide emissions to air	9.03E-05	6.62E-05	4.24E-04	6.86E-05	2.78E-04	5.94E-05	kg
Lead (+II) emissions to air	4.01E-06	1.09E-06	3.19E-06	3.09E-06	3.32E-06	1.90E-06	kg
Mercury (+II) emissions to air	8.74E-08	3.44E-08	8.29E-08	7.97E-08	8.42E-08	8.18E-08	kg
Methane emissions to air	6.15E-03	5.07E-03	5.80E-03	6.55E-03	6.03E-03	4.06E-03	kg
Nitrogen dioxide emissions to air	0.00E+00	2.74E-06	2.71E-05	2.30E-05	3.17E-05	1.09E-07	kg
Nitrogen oxides emissions to air	3.22E-03	2.50E-03	2.96E-03	4.27E-03	3.26E-03	2.44E-03	kg
Nitrous oxide emissions to air	7.07E-05	3.36E-05	9.00E-06	1.57E-05	1.39E-05	8.05E-05	kg
Non-methane VOCs emissions to air	1.98E-04	2.03E-04	3.02E-04	3.85E-04	3.05E-04	1.61E-04	kg
Particulate matter (unspecified) emissions to air	1.73E-03	9.28E-04	1.53E-03	1.89E-03	1.45E-03	1.24E-03	kg
Sulfur dioxide emissions to air	3.55E-03	3.10E-03	3.95E-03	5.83E-03	4.35E-03	2.58E-03	kg
Ammonia/Ammonium as N emissions to water	4.90E-05	4.09E-05	4.42E-05	3.26E-05	4.05E-05	2.35E-05	kg
Biological oxygen demand emission so water	5.18E-06	5.75E-06	2.06E-06	4.01E-06	2.20E-06	5.14E-06	kg
Cadmium (+II) emissions to water	3.47E-08	3.53E-08	3.31E-08	7.51E-08	6.40E-08	3.17E-08	kg
Chemical oxygen demand emission to water	1.52E-04	2.25E-04	4.08E-04	7.40E-04	6.40E-04	2.88E-04	kg
Chromium (unspecified) emissions to water	1.84E-10	2.94E-08	5.91E-08	1.57E-07	6.89E-08	5.62E-08	kg
Iron (unspecified) emissions to water	2.87E-06	2.71E-05	8.23E-06	4.90E-05	5.11E-05	1.94E-04	kg
Lead (+II) emissions to water	0.00E+00	3.82E-08	1.67E-08	2.55E-07	1.68E-07	2.38E-08	kg
Nickel (+II) emissions to water	1.16E-07	1.14E-07	6.77E-08	1.48E-07	7.76E-08	7.40E-08	kg
Nitrogenous emissions to water	1.62E-04	1.27E-04	6.43E-05	1.14E-04	3.71E-05	7.74E-05	kg
Phosphate emissions to water	4.11E-08	4.70E-08	8.67E-08	1.77E-07	1.10E-07	5.32E-08	kg
Phosphorous emissions to water	3.05E-07	3.17E-07	6.03E-07	6.48E-07	6.40E-07	1.57E-07	kg
Total dissolved solids emissions to water	1.58E-07	1.58E-07	1.43E-05	1.91E-05	3.88E-06	2.85E-06	kg
Zinc (+II) emissions to water	1.15E-07	1.15E-07	1.91E-08	3.74E-06	2.62E-06	9.82E-08	kg

Flow Name	Finished cold rolled coil – North American	Hot-dip galvanized coil – North American	Units (Per Reference Flow)
Inputs			
Carbon dioxide	1.41E-02	1.60E-02	kg
Crude oil	3.34E-02	5.88E-02	kg
Dolomite	1.02E-01	9.48E-02	kg
Iron scrap	1.62E-01	4.39E-01	kg
Hard coal	7.70E-01	6.26E-01	kg
Iron ore	1.31E+00	9.66E-01	kg
Lignite	1.21E-02	3.21E-02	kg
Limestone	-2.13E-02	-2.43E-02	kg
Natural gas	1.05E-01	1.38E-01	kg
Tin ore	4.22E-15	5.31E-15	kg
Uranium	2.11E-06	3.53E-06	kg
Water	2.48E+01	2.15E+01	kg
Zinc ore	-1.10E-03	9.68E-02	kg
Outputs			
Steel, UO pipe, global	0.00E+00	0.00E+00	kg
Steel, welded pipe, global	0.00E+00	0.00E+00	kg
Steel, finished cold rolled coil, global	0.00E+00	0.00E+00	kg
Steel, organic coated steel, global	0.00E+00	0.00E+00	kg
Steel, hot-dipped galvanized, global	0.00E+00	0.00E+00	kg
Steel, sections, global	0.00E+00	0.00E+00	kg
Steel, Finished cold rolled coil, North American	1.00E+00	0.00E+00	kg
Steel, hot-dipped galvanized, North American	0.00E+00	1.00E+00	kg
Steel, recycled UO pipe, global	0.00E+00	0.00E+00	kg
Steel, recycled welded pipe, global	0.00E+00	0.00E+00	kg
Steel, recycled finished cold rolled coil, global	0.00E+00	0.00E+00	kg
Steel, recycled organic coated steel, global	0.00E+00	0.00E+00	kg
Steel, recycled hot-dipped galvanized, global	0.00E+00	0.00E+00	kg
Steel, recycled sections, global	0.00E+00	0.00E+00	kg
Cadmium (+II) emissions to air	3.72E-08	4.02E-08	kg
Carbon dioxide emissions to air	2.17E+00	2.05E+00	kg
Carbon monoxide emissions to air	1.57E-02	1.13E-02	kg

Flow Name	Finished cold rolled coil – North American	Hot-dip galvanized coil – North American	Units (Per Reference Flow)
Chromium (unspecified) emissions to air	1.89E-07	2.31E-07	kg
Dioxins (unspecified) emissions to air	1.12E-12	8.75E-13	kg
Hydrochloric acid emissions to air	4.98E-05	6.19E-05	kg
Hydrogen sulfide emissions to air	1.63E-04	8.20E-05	kg
Lead (+II) emissions to air	1.09E-06	9.47E-07	kg
Mercury (+II) emissions to air	4.21E-08	5.99E-08	kg
Methane emissions to air	5.19E-03	4.55E-03	kg
Nitrogen dioxide emissions to air	1.69E-05	3.24E-05	kg
Nitrogen oxides emissions to air	4.99E-03	6.85E-03	kg
Nitrous oxide emissions to air	1.30E-05	1.52E-05	kg
Non-methane VOCs emissions to air	3.50E-04	3.10E-04	kg
Particulate matter (unspecified) emissions to air	1.66E-03	2.32E-03	kg
Sulfur dioxide emissions to air	3.24E-03	4.88E-03	kg
Ammonia/Ammonium as N emissions to water	4.03E-05	3.18E-05	kg
Biological oxygen demand emission so water	9.16E-06	6.05E-06	kg
Cadmium (+II) emissions to water	6.43E-08	9.07E-08	kg
Chemical oxygen demand emission to water	4.95E-04	6.35E-04	kg
Chromium (unspecified) emissions to water	1.39E-06	1.28E-06	kg
Iron (unspecified) emissions to water	1.79E-04	2.52E-04	kg
Lead (+II) emissions to water	1.27E-07	2.45E-07	kg
Nickel (+II) emissions to water	2.45E-07	2.09E-07	kg
Nitrogenous emissions to water	9.22E-05	6.95E-05	kg
Phosphate emissions to water	7.67E-08	1.87E-07	kg
Phosphorous emissions to water	4.98E-07	4.39E-07	kg
Total dissolved solids emissions to water	7.16E-06	4.60E-06	kg
Zinc (+II) emissions to water	4.93E-07	2.62E-06	kg

Flow Name	UO pipe recycle credit - global	Welded pipe recycle credit - global	Finished cold rolled coil - recycle credit global	Organic coated steel - recycle credit global	Hot-dip galvanised coil - recycle credit global	Sections - recycle credit global	Units (Per Reference Flow)
Inputs							
Carbon dioxide	-5.11E-03	-4.21E-03	-4.76E-03	-4.90E-03	-4.71E-03	-1.52E-03	kg
Crude oil	1.43E-02	1.18E-02	1.33E-02	1.37E-02	1.32E-02	4.26E-03	kg
Dolomite	-2.93E-02	-2.41E-02	-2.72E-02	-2.81E-02	-2.70E-02	-8.72E-03	kg
Iron scrap	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Hard coal	-6.01E-01	-4.94E-01	-5.59E-01	-5.76E-01	-5.53E-01	-1.79E-01	kg
Iron ore	-1.15E+00	-9.45E-01	-1.07E+00	-1.10E+00	-1.06E+00	-3.42E-01	kg
Lignite	4.02E-02	3.30E-02	3.74E-02	3.85E-02	3.70E-02	1.20E-02	kg
Limestone	4.50E-02	3.70E-02	4.19E-02	4.32E-02	4.15E-02	1.34E-02	kg
Natural gas	4.35E-02	3.58E-02	4.05E-02	4.18E-02	4.01E-02	1.30E-02	kg
Tin ore	7.15E-17	5.89E-17	6.66E-17	6.86E-17	6.59E-17	2.13E-17	kg
Uranium	3.08E-06	2.53E-06	2.86E-06	2.95E-06	2.83E-06	9.17E-07	kg
Water	-1.06E+01	-8.73E+00	-9.86E+00	-1.02E+01	-9.76E+00	-3.16E+00	kg
Zinc ore	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Outputs							
Steel, UO pipe, global	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Steel, welded pipe, global	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Steel, finished cold rolled coil, global	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Steel, organic coated steel, global	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Steel, hot-dipped galvanized, global	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Steel, sections, global	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Steel, Finished cold rolled coil, North American	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Steel, hot-dipped galvanized, North American	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Steel, recycled UO pipe, global	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Steel, recycled welded pipe, global	0.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Steel, recycled finished cold rolled coil, global	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Steel, recycled organic coated steel, global	0.00E+00	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00	kg
Steel, recycled hot-dipped galvanized, global	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	0.00E+00	kg
Steel, recycled sections, global	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	kg
Cadmium (+II) emissions to air	-4.09E-08	-3.37E-08	-3.81E-08	-3.93E-08	-3.77E-08	-1.22E-08	kg
Carbon dioxide emissions to air	-1.14E+00	-9.41E-01	-1.06E+00	-1.10E+00	-1.05E+00	-3.41E-01	kg
Carbon monoxide emissions to air	-1.84E-02	-1.51E-02	-1.71E-02	-1.76E-02	-1.69E-02	-5.47E-03	kg

Flow Name	UO pipe recycle credit - global	Welded pipe recycle credit - global	Finished cold rolled coil - recycle credit global	Organic coated steel - recycle credit global	Hot-dip galvanised coil - recycle credit global	Sections - recycle credit global	Units (Per Reference Flow)
Chromium (unspecified) emissions to air	1.19E-07	9.78E-08	1.11E-07	1.14E-07	1.09E-07	3.54E-08	kg
Dioxins (unspecified) emissions to air	8.63E-12	7.11E-12	8.03E-12	8.29E-12	7.95E-12	2.57E-12	kg
Hydrochloric acid emissions to air	-2.55E-05	-2.10E-05	-2.37E-05	-2.45E-05	-2.35E-05	-7.60E-06	kg
Hydrogen sulfide emissions to air	-3.02E-04	-2.49E-04	-2.81E-04	-2.90E-04	-2.78E-04	-9.01E-05	kg
Lead (+II) emissions to air	-1.47E-06	-1.21E-06	-1.37E-06	-1.41E-06	-1.36E-06	-4.39E-07	kg
Mercury (+II) emissions to air	7.97E-09	6.56E-09	7.42E-09	7.65E-09	7.35E-09	2.38E-09	kg
Methane emissions to air	-3.48E-03	-2.87E-03	-3.24E-03	-3.34E-03	-3.21E-03	-1.04E-03	kg
Nitrogen dioxide emissions to air	-1.16E-05	-9.56E-06	-1.08E-05	-1.12E-05	-1.07E-05	-3.46E-06	kg
Nitrogen oxides emissions to air	-1.10E-03	-9.04E-04	-1.02E-03	-1.05E-03	-1.01E-03	-3.28E-04	kg
Nitrous oxide emissions to air	-4.28E-06	-3.52E-06	-3.98E-06	-4.10E-06	-3.94E-06	-1.28E-06	kg
Non-methane VOCs emissions to air	-1.29E-04	-1.07E-04	-1.20E-04	-1.24E-04	-1.19E-04	-3.86E-05	kg
Particulate matter (unspecified) emissions to air	-1.13E-03	-9.33E-04	-1.06E-03	-1.09E-03	-1.04E-03	-3.38E-04	kg
Sulfur dioxide emissions to air	-1.45E-03	-1.20E-03	-1.35E-03	-1.39E-03	-1.34E-03	-4.33E-04	kg
Ammonia/Ammonium as N emissions to water	-3.94E-05	-3.24E-05	-3.67E-05	-3.78E-05	-3.63E-05	-1.17E-05	kg
Biological oxygen demand emission so water	-8.86E-06	-7.29E-06	-8.25E-06	-8.50E-06	-8.16E-06	-2.64E-06	kg
Cadmium (+II) emissions to water	-1.56E-08	-1.28E-08	-1.45E-08	-1.49E-08	-1.43E-08	-4.63E-09	kg
Chemical oxygen demand emission to water	6.27E-06	5.16E-06	5.83E-06	6.02E-06	5.77E-06	1.87E-06	kg
Chromium (unspecified) emissions to water	2.82E-08	2.32E-08	2.63E-08	2.71E-08	2.60E-08	8.42E-09	kg
Iron (unspecified) emissions to water	6.12E-05	5.04E-05	5.70E-05	5.87E-05	5.64E-05	1.82E-05	kg
Lead (+II) emissions to water	8.16E-08	6.71E-08	7.59E-08	7.83E-08	7.51E-08	2.43E-08	kg
Nickel (+II) emissions to water	-4.95E-08	-4.07E-08	-4.60E-08	-4.75E-08	-4.56E-08	-1.47E-08	kg
Nitrogeneous emissions to water	-9.90E-05	-8.15E-05	-9.21E-05	-9.50E-05	-9.12E-05	-2.95E-05	kg
Phosphate emissions to water	1.43E-07	1.17E-07	1.33E-07	1.37E-07	1.31E-07	4.25E-08	kg
Phosphorous emissions to water	4.33E-07	3.56E-07	4.03E-07	4.15E-07	3.99E-07	1.29E-07	kg
Total dissolved solids emissions to water	-5.12E-06	-4.22E-06	-4.77E-06	-4.92E-06	-4.72E-06	-1.53E-06	kg
Zinc (+II) emissions to water	7.27E-07	5.98E-07	6.76E-07	6.97E-07	6.69E-07	2.17E-07	kg

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

Embedded Unit Processes

None.

References

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