TRAFIKVERKET
SWEDISH TRANSPORT ADMINISTRATION

Environmental Product Declaration for

power, signalling and telecom systems on the Bothnia Line

Title: Environmental Product Declaration for power, signalling and telecom systems on the Bothnia Line
Publication number: 2016:152
Date of publication: November 2014
Registration number: S-P-00201, UN CPC 53212
Publisher: The Swedish Transport Administration
Production cover: Grafisk form och event, the Swedish Transport Administration
Cover photo: Göran Fält
Printed by: Ineko
Distributor: The Swedish Transport Administration

EPD®

En EPD® (Environmental Product Declaration; miljövarudeklaration) är ett oberoende verifierat och registrerat dokument som ger transparent och jämförbar information om produkters miljöpåverkan i ett livscykelperspektiv.

Introduction

This Environmental Product Declaration (EPD), describes, from a lifecycle perspective, the total environmental impact of power, signalling and telecom systems on the Bothnia Line. The EPD is entirely restricted to power, signalling and telecom systems; substructure (tunnels, bridges, track foundations) and the track are not included.

Within the International EPD system based on ISO standard 14025, this EPD was drawn up on accordance with Product Category Rules (PCR) 2013:19 for Railways (see www.environdec.com for further information about the EPD-system).

The aim of this EPD is that it should provide experts and scientists (in the construction and infrastructure sectors) with objective and reliable information on the environmental impact of constructing, operating and maintaining power, signalling and telecom systems.

This EPD was developed by Trafikverket (the Swedish Transport Administration). It has been certified by Bureau Veritas Certification AB and the certification is valid for three years (after which it can be prolonged).

Botniabanan AB has been responsible for the financing, detailed planning and building of the Bothnia Line. After completion, ownership of the infrastructure has been transferred to Trafikverket. Trafikverket has an implemented management system in accordance with the Swedish government's regulation (SFS 2009:907) on environmental management in state agencies. One focus area for Trafikverket's environmental work is to reduce climate gas emissions from construction, operation and maintenance of infrastructure and Trafikverket has therefore developed a tool for carbon footprint calculations for infrastructure projects (*Klimatkalkyl*, available at www.trafikverket.se). Inventory data for this EPD has been included in Klimatkalkyl, and the results for Global Warming and Energy Resources in this EPD is comparable to results in Klimatkalkyl for corresponding infrastructure parts.

This EPD describes the environmental performance of power, signalling and telecom systems on the Bothnia Line. The following EPDs are also available for other Bothnia Line systems:

- EPD for the railway infrastructure on the Bothnia Line.
- EPD for railway tunnels on the Bothnia Line.
- EPD for railway track foundations on the Bothnia Line.
- EPD for railway bridges of the Bothnia Line.
- EPD for railway track of the Bothnia Line.

As this EPD is based on data relating to Bothnia Line infrastructure, the results might not be representative of other railway power, signalling and telecom systems. In order to decide if the result can be representative for other railway power, signalling and telecom systems, the most important areas that should be checked to be comparable with the Bothnia Line are:

- Railway functionality (e.g. type of traffic, single or double track etc.).
- Technical systems (e.g. power and signalling system, etc.).
- Origin of materials (mainly metals and concrete).

Comparison towards previous EPD

This EPD is an updated version of the original EPD from 2010. The reason for the update is that the PCR has been revised. In the revision, the declared unit was changed:

Old declared unit: *1 km railway (main line) over a calculation period of 60 years*
New declared unit: *1 km railway (main line) and year*

Inventory data for LCA-calculations have not been changed, but the change of declared unit gives results in other units compared to previous EPD. The declared environmental performance in this EPD is therefore not comparable to previous EPD since it is presented in other units.

Facts about the infrastructure of the Bothnia Line

The Bothnia Line is a new Swedish railway running from Nyland (north of Kramfors) to Umeå. It is routed via Örnsköldsvik and comprises 190 km of new single-track railway with 22 sidings (each 1 km long) and 7 travel centres/stations. The latter have good connections for pedestrians, cyclists, local and regional bus traffic and private vehicles. There is a large freight terminal in Umeå and a smaller container terminal in Örnsköldsvik.

The line has 90 railway bridges (total length of 11 km) and 16 tunnels (25 km main railway tunnels and16 km service and access tunnels). Designed for combined passenger and heavy freight traffic the Bothnia Line offers maximum speeds of 250 km/h for passenger trains and 120 km/h for freight trains with a maximum axle load of 25 tonnes. The groundbreaking for the project took place on 14 August 1999, and the railway is operational since autumn 2010.

Technical Data Infrastructure:

- Minimum radius of curvature: 3200 m
- Maximum gradient: 10 ‰
- Track gauge: 1435 mm
- Power-supply voltage: 15 kV, 16 2/3 Hz, AT-system
- Track: ballasted, concrete sleepers,UIC 60 rail (continuous welded)
- Signalling system: ERTMS level 2
- Maximum axle load: 25 tonnes (30 tonnes on bridges)

The power supply system
A catenary system and an auxiliary power system are the Bothnia Line´s main power supply systems. The catenary system supplies the trains with propulsion power. Signalling telecom, switch heating, illumination and other systems are supplied by the auxiliary power system. An automatic transformer system (AT system) is used for distributing power in the catenary system. Approximately 3500 catenary posts, 150 transformers and more than 200 km of electric cabling have been used in building of the Bothnia Line.

Signalling system
The Bothnia Line is the first railway in Sweden to be built using the new European rail traffic management system (ERTMS- level 2 in this case). This is a radio based system. Consequently there are no optical signals along the line. ERTMS makes it possible for passenger trains to go faster (up to 250 km/h on the Bothnia Line) than with conventional signalling systems. It also increases railway capacity in terms of number of train services.

Telecom system
To facilitate communication between different parts of the railway system, telecom systems are installed all along the Bothnia Line. The main parts of the telecom system are tele cables (mostly optocables), telephony systems (emergency and service telephones), transmission facilities, radio equipment (GSM-R), detectors and information systems.

Location of the Bothnia Line

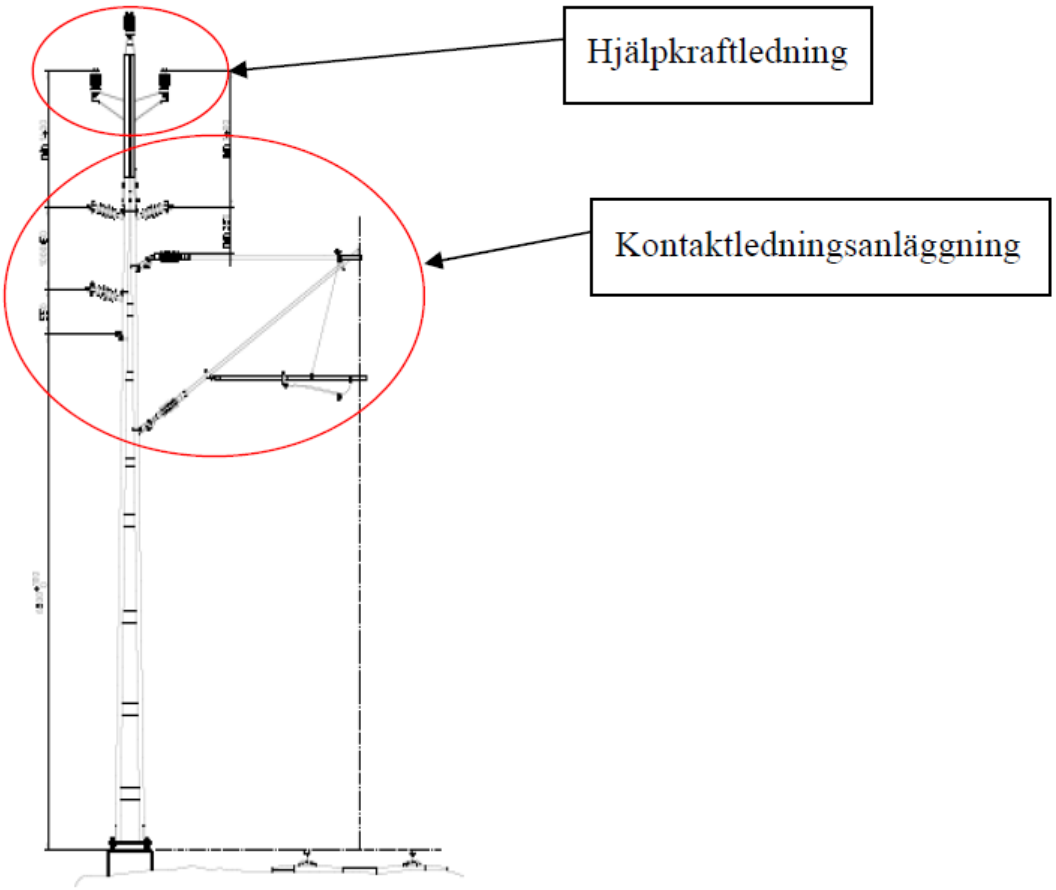
Environmental performance

Resource use and emissions

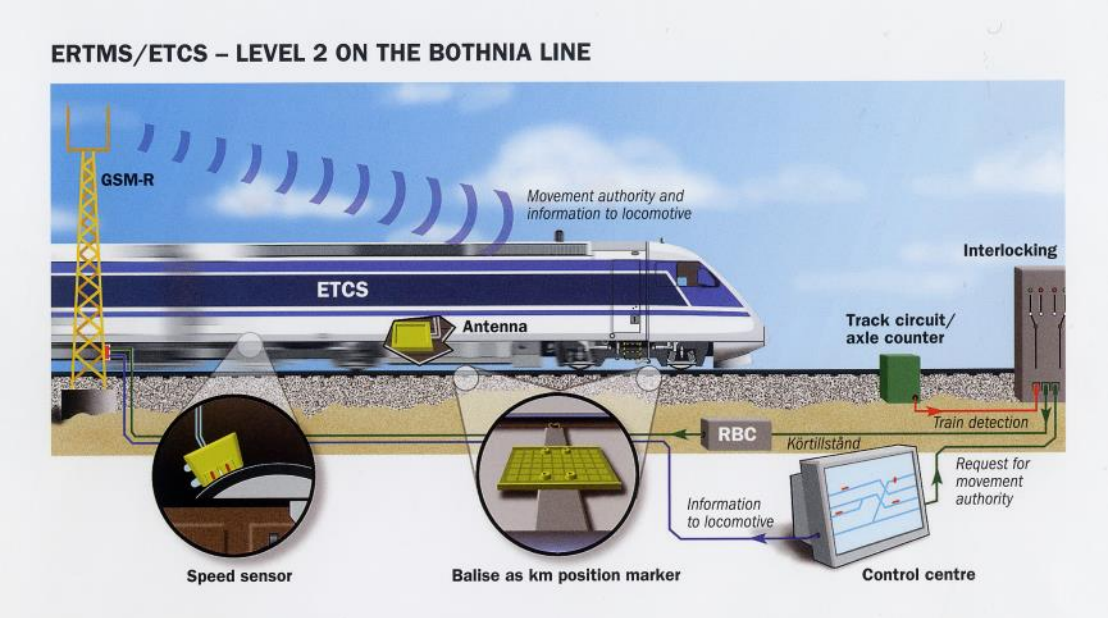
The environmental performance section of the declaration is based on a lifecycle assessment (LCA) carried out by WSP in 2014. The LCA was largely based on ecoinvent-data for materials and processes, and implemented in the software SimaPro. Inventory data was collected from the LCA for the Bothnia Line made by IVL Swedish Environmental Research Institute in 2009. An overview of system boundaries and included processes is given in the text, figures and tables below.

Extraction and production of raw materials, transportation of materials and manufacturing of products were included in the LCA calculations. The data in respect of infrastructure-related processes and quantities of materials was collected from the building of the Bothnia Line.Selected generic data for material production have been used according to the calculations rules in PCR 2013:19. The electricity used in construction processes and for production of materials was calculated as the average electricity mix for the countries hosting the processes.

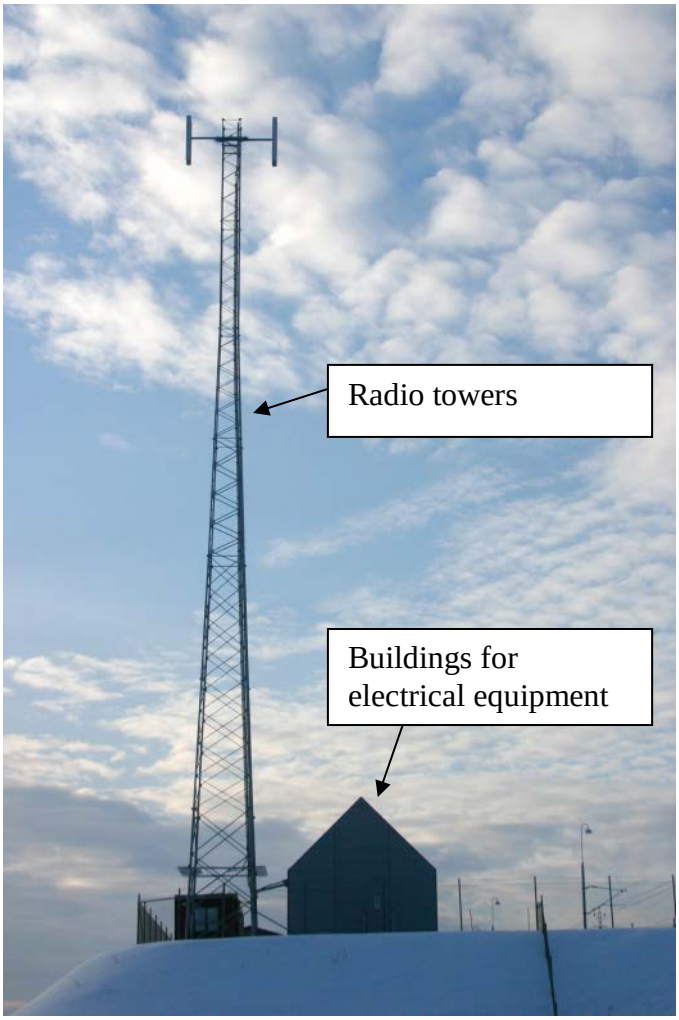
The LCA calculations are based on the technical life times of all included components and results in a yearly contribution to all impact categories. All construction, reinvestment, operation and maintenance processes are included in that. All results are presented in the declared unit per kilometre of track foundations (main line) and year. As a complement, the impact from the construction phase is presented separately per kilometre of track foundations (main line).



Power supply system



Signalling system



Telecom system

All processes and elements needed to construct, operate and maintain the Power, signalling and telecom system have been included in the LCA. However, note that substructure (tunnels, bridges, track foundations) and track system are not included. The figures show some of the most important structural elements.

Overview of processes and elements included in the LCA for power, signalling and telecom systems on the Bothnia Line.

Power, signalling and telecom system construction			**Power, signalling and telecom systems operation**	**Power, signalling and telecom systems maintenance**
Power supply system construction	**Signalling system construction**	**Telecom system construction**		
Catenary posts (including all fastening equipment)	Interlocking system	Radio towers with foundations	Operation of electrical equipment	Reinvestments according to life times of components/constructions
Cables	Balises	Computer equipment		
Transformers	Cables	Cables		
UPS-system	UPS-system	UPS-system		
Buildings for electrical equipment	Buildings for electrical equipment	Buildings for electrical equipment		
Construction work				

The following processes and parts of the system have been excluded from the LCA due to negligible contribution to environmental impact categories according to rules in PCR 2013:19. For processes excluded by default, see 2013:19.

- Platform equipment
- Train heating posts
- Waste handling processes
- Train control center

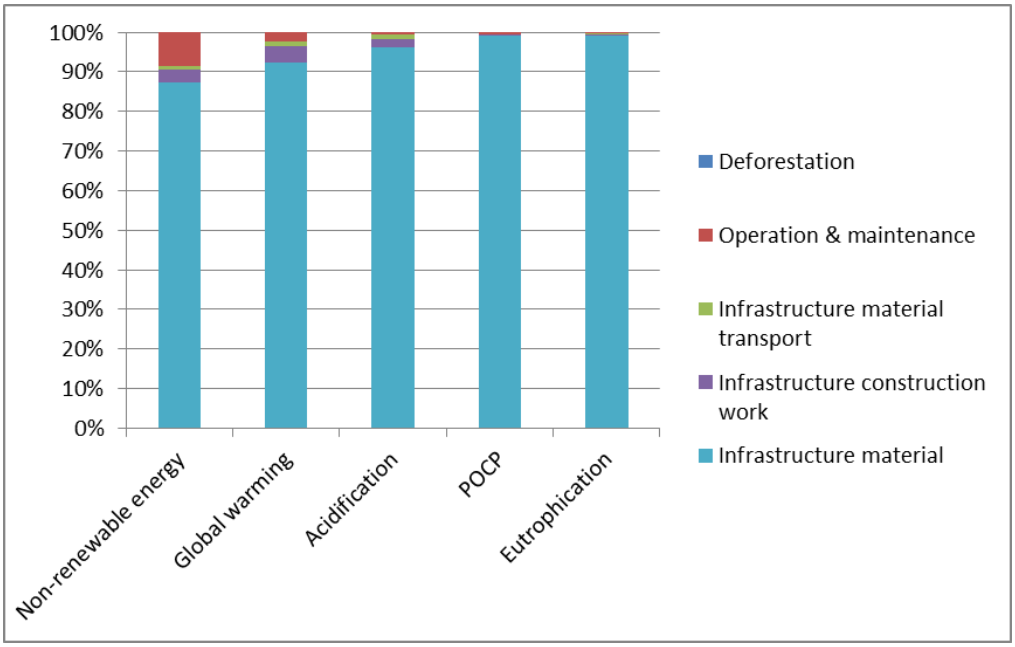
Annual environmental impact of 1 km of power, signalling and telecom systems (main line) on the Bothnia Line. All construction, reinvestment, operation and maintenance activities are included for the power, signalling and telecom systems. Impact from construction phase is presented separately per km (not annually). Note that the substructure and track system are not included.

		Declared unit per km and year			
Impact category	**Unit**	**Construction & reinvestment**	**Operation & Maintenance**	**Total**	**Construction per km**
Use of resources					
Non-renewable materials	kg	1 045	10	1 054	45 837
Renewable materials	kg	0,041	0,00018	0,041	1,8
Non-renewable energy	MJ	38 768	3 603	42 371	1 600 650
Renewable energy	MJ	4 008	973	4 981	163 025
Secondary materials	kg	925	0	925	40 012
Secondary energy	MJ	1 223	2 032	3 255	48 940
Water, total	kg	36 236	9 587	45 822	1 471 072
Water, direct	kg	0	0	0	0
Land use	m2	205	3,7	208	9 680
Potential environmental impacts					
Global warming	kg CO_2-eq.	2 176	50	2 226	90 425
Acidification	kg SO_2-eq.	23	0,15	23	920
POCP (Photochemical oxidant formation)	kg C_2H_4-eq.	1,3	0,0078	1,3	54
Eutrophication	kg PO_4^{3-}-eq.	22	0,041	22	881
Waste and outflows					
Output of materials for recycling	kg	925	0	925	0
Waste, hazardous	kg	0,96	0,0016	0,96	38
Waste, excess soil	kg	0	0	0	0
Waste, other	kg	433	7,1	440	18 433

Specification of resources making the largest contributions to the different resource use categories

Resource use category	%
Non-renewable materials	
Gravel	44%
Iron	18%
Calcite	15%
Aluminium	9%
Copper	7%
Clay	3%
Nickel	1%
Chromium	1%
Other	1%
Renewable materials	
Wood	100%
Non-renewable energy	
Fossil	81%
Nuclear	19%
Renewable energy	
Hydropower	94%
Biomass	5%
Wind, solar, geothermal	1%

Dominance analysis



Emission impact categories and the relative contributions (in %) made by the process groups relevant to the Bothnia Line's power, signalling and telecom systems. The process groups include all activities during the lifetime of the infrastructure. For example, "Infrastructure material" covers all materials used during construction, maintenance and reinvestment.

Upstream processes

Infrastructure material = Emissions from raw material acquisition and production of materials such as steel, concrete etc.

Infrastructure material transport = Emissions from vehicles (e.g. trucks and trains) used for transporting infrastructure material (e.g. towers and cables) from suppliers to the construction site.

Core processes

Infrastructure construction work = Emissions from machines (trucks, locomotives etc.) used in constructing the infrastructure

Deforestation = Net emissions of CO_2 resulting from forest land being permanently changed to railway land. Not applicable for power, signalling and telecom systems.

Downstream processes

Operation & maintenance = Emissions from production of electricity used for operation of the infrastructure, (e.g. operation of interlocking system) and from use of fuels for maintenance work.

Additional environmental information

The impact that the building and operation of the Bothnia Line has on land use, biodiversity and environmental risk-related issues has been analysed and is described in the EPD for railway infrastructure. However, it is not possible or relevant to relate the results of the impact analyses to the individual infrastructure elements. Consequently, this EPD contains no such details.

Recycling declaration

The main infrastructure elements that are relevant as regards waste management and recycling are track, power, signalling and telecom equipment. For older signalling systems, Trafikverket has listed strategic components that should be returned to Trafikverket Material Service for revision when they are replaced. For other materials, there is currently no general national strategy for recycling materials that are replaced during maintenance. Such materials often become the property of the contractor. Trafikverket's environmental strategy contains the following prioritised goals for the future:

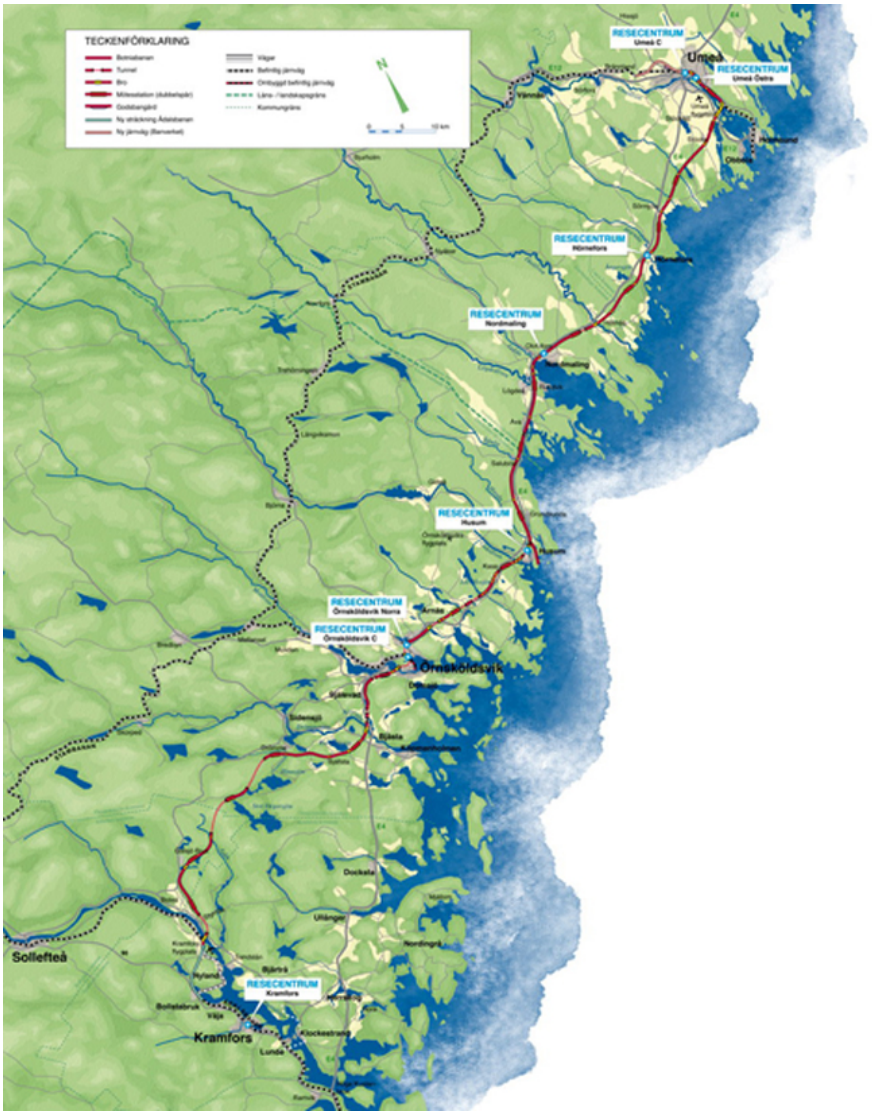
- Development, from an environmental perspective, of long-term reutilisation plans for strategic materials.
- Development of environmentally sound and effective management procedures for prioritised categories of waste.

Management of materials and substances

Throughout the construction of the Bothnia Line, all contractors have, as regards any chemical products and potentially environmental harmful materials they use, been required to obtain the approval of Trafikverket's Chemicals Board. Another requirement has been that PVCs and certain other materials (a number of specified harmful substances included therein) must not be used before the contractor has made an environmental risk assessment and Botniabanan AB has agreed with the use. If the use of any of these substances could not be avoided, the location of the components containing the substances has been documented by the contractor.

The satisfaction of these requirements has been checked in audits of all major contractors.

Hazardous waste generated in all contracts for the building of the Bothnia Line has been collected in environmental stations supplied by Botniabanan AB and managed by companies accredited for management of hazardous waste.



Route and travel centers/stations of the Bothnia Line (tunnels and bridges also shown)

EPDs from different programmes may not be comparable

See www.trafikverket.se for more information on the EPD and background material

PCR review was conducted by the Technical Committee (TC) of the International EPD Consortium (IEC).
See www.environdec.com for more information and contact for IEC.

Independent verification of the declaration and data, according to ISO 14025:

□ **Internal** X **external**

Third party verifier:

Bureau Veritas Certification AB
Fabriksgatan 13
SE-412 50 Göteborg
SWEDEN

Accredited by: Swedac

THE SWEDISH TRANSPORT ADMINISTRATION. PUBLICATION NUMBER: 2016:152. REVISED MAY 2017. PRODUCTION COVER: GRAFISK FORM OCH EVENT, THE SWEDISH TRANSPORT ADMINISTRATION. COVERPHOTO: TRAFIKVERKET. PRINTED BY: INEKO.

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