TRAFIKVERKET
SWEDISH TRANSPORT ADMINISTRATION

*Environmental Product Declaration for*

# railway track foundations on the Bothnia Line

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EPD®

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## Introduction

This environmental product declaration (EPD) describes, from a life-cycle perspective, the total environmental impact of track foundations on the Bothnia Line. Railway track foundations form what may be called “ordinary” railway (i. e. stretches of rail that do not run across bridges or through tunnels). The EPD covers track foundations substructure only. Track, power, signalling and telecom systems on the track foundations are not included.

Within the International EPD system based on ISO standard 14025, this EPD was drawn up in 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 constructions and infrastructure sectors) with objective and reliable information on the environmental impact of constructing, operating and maintaining railway track foundations.

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 sets out the environmental performance of railway track foundations 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 bridges on the Bothnia Line
- EPD for railway track on the Bothnia Line
- EPD for power, signalling and telecom systems on the Bothnia Line

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

• Railway functionality (single or double track, axleload, etc.).

• Topography (impact on, for example, proportion of rock/soil cuttings, embankments and flatland track foundations).

• Construction methods (e.g. embankments built with soilor rock).

• Origin of materials (mainly steel 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.

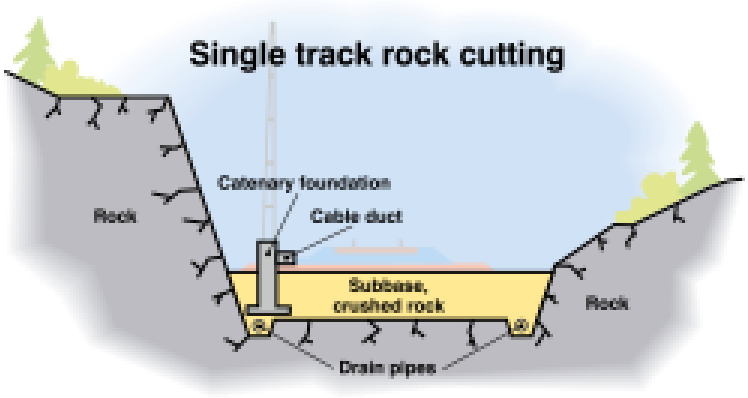
The southern part of the Bothnia Line goes through an area called the High Coast. This is a very hilly part of the Swedish coast line. Consequently, there are many tunnels, bridges, deep cuttings and high embankments here. Approximately 25 % of the Bothnia Line's track foundations (totally 150 km in length) are on flatlands, while 75 % are moderately or highly engineered cuttings and embankments. These latter require far more construction resources than do flatland track foundations. There are

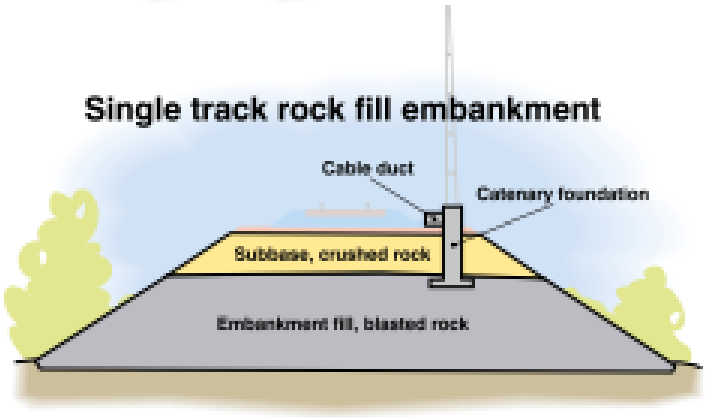
approximately 15 km of rock cuttings. The majority of the embankments were built using crushed rock.

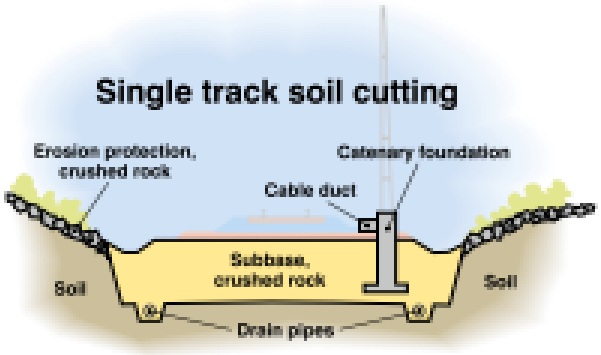
**Technical Data Infrastructure:**

- 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 ton on bridges)


*Location of the Bothnia Line*




*All processes and elements needed to construct, operate and maintain the railway track foundations have been included in the LCA. However, note that track, power, signalling and telecom systems are not included. The figures above show three different track foundations types and some of the most important structural elements.*

## 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, transport 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 was used according to the calculation 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.

Calculation of the environmental impact of track foundations construction was based on data from three selected “typical” track foundations contracts. As regards soil and rock excavation quantities, fuel and electricity consumption, etc., specific data was collected from these contracts and used as a basis for calculating the environmental impact of all the track foundations on the Bothnia Line.

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).

***Overview of processes and elements included in the LCA for railway track foundations on the Bothnia Line.***

| **Track foundation construction** | **Track foundation operation** | **Track foundation maintenace** |
|---|---|---|
| Deforestation | - | Reinvestments determined by lifetimes of components and constructions |
| Service roads | | |
| Soil and rock excavation | | |
| Ground reinforcement | | |

| | | |
|---|---|---|
| Filling with soil and crushed material | | |
| Ducting (cable ducts and manholes) | | |
| Drainage and surface water piping | | |
| Noise barriers | | |
| Fencing | | |
| Foundations for catenary posts | | |

As, under the rules in PCR 2013:19, waste handling processes make a negligible contribution to environmental impact categories (<1 %), they were excluded from the LCA. For processes excluded by default, see PCR 2013:19.

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

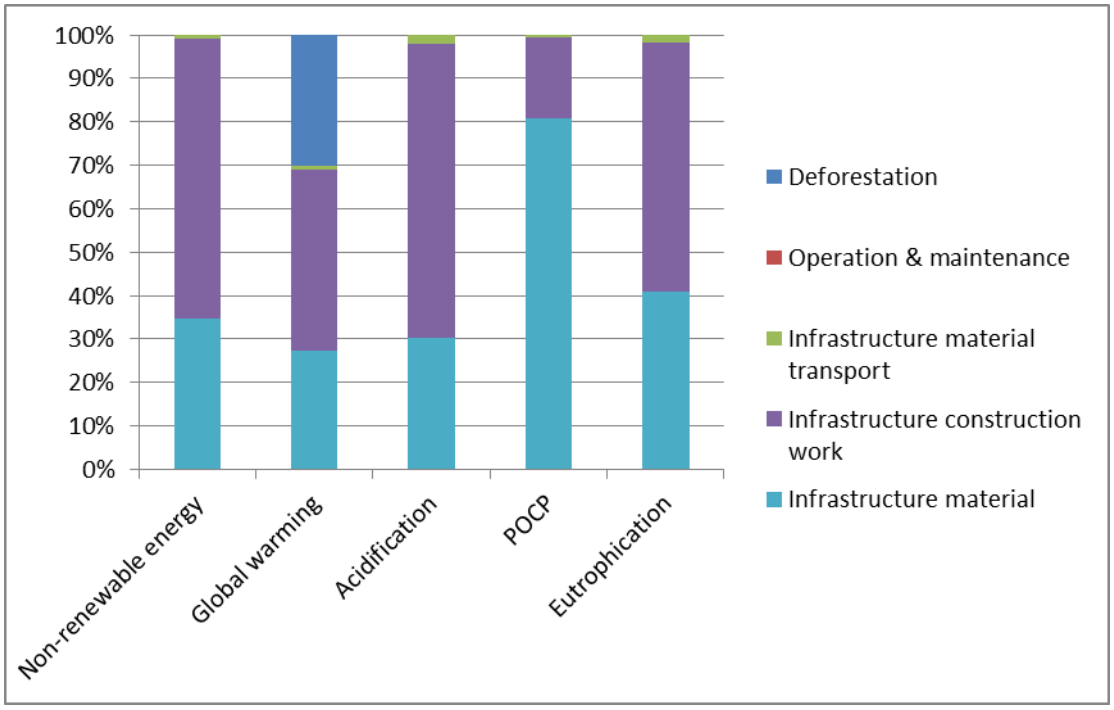
| | | **Declared unit per km and year** | | | |
|---|---|---|---|---|---|
| **Impact category** | **Unit** | **Construction & reinvestment** | **Operation & Maintenance** | **Total** | **Construction per km** |
| **Use of resources** | | | | | |
| Non-renewable materials | kg | 1 808 579 | 0 | 1 808 579 | 218 834 486 |
| Renewable materials | kg | 0,39 | 0 | 0,39 | 19 |
| Non-renewable energy | MJ | 119 034 | 0 | 119 034 | 11 424 452 |
| Renewable energy | MJ | 2 698 | 0 | 2 698 | 208 528 |
| Secondary materials | kg | 12 324 | 0 | 12 324 | 693 265 |
| Secondary energy | MJ | 64 650 | 0 | 64 650 | 7 459 595 |
| Water, total | kg | 18 000 | 0 | 18 000 | 1 349 954 |
| Water, direct | kg | 0 | 0 | 0 | 0 |
| Land use | m2 | 2 565 | 0 | 2 565 | 108 164 |
| **Potential environmental impacts** | | | | | |
| Global warming | kg $CO_2$-eq. | 11 991 | 0 | 11 991 | 1 240 460 |
| Acidification | kg $SO_2$-eq. | 37 | 0 | 37 | 3 665 |
| POCP (Photochemical oxidant formation) | kg $C_2H_4$-eq. | 0,90 | 0 | 0,90 | 62 |
| Eutrophication | kg $PO_4^{3-}$-eq. | 11 | 0 | 11 | 1 001 |
| **Waste and outflows** | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Output of materials for recycling | kg | 117 266 | 0 | 117 266 | 15 794 238 |
| Waste, hazardous | kg | 0,27 | 0 | 0,27 | 28 |
| Waste, excess soil | kg | 608 409 | 0 | 608 409 | 75 605 935 |
| Waste, other | kg | 538 | 0 | 538 | 32 130 |

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

| Resource use category | % |
|---|---|
| **Non-renewable materials** | |
| Rock | 57% |
| Soil | 42% |
| Other | 1% |
| **Renewable materials** | |
| Wood | 100% |
| **Non-renewable energy** | |
| Fossil | 94% |
| Nuclear | 6% |
| **Renewable energy** | |
| Hydropower | 75% |
| Biomass | 22% |
| Wind, solar, geothermal | 3% |

***Dominance analysis***




*Emission impact categories and the relative contributions (in %) made by the process groups relevant to the Bothnia Line's track foundations. 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. sleepers and cables) from suppliers to the construction site.

#### Core processes

**Infrastructure construction work** = Emissions from machines (excavators, trucks, drilling, rigs, etc) used in constructing the infrastructure,. This includes also transportation of excavated soil and rock.
**Deforestation** = Net emissions of $CO_2$ resulting from forest land being permanently changed to railway land.

#### Downstream processes

**Operation & maintenance** = Emissions from production of electricity used for operation of the infrastructure,(e.g. tunnel illumination and swith heating) and from use of fuels for maintenance work (e.g. rail grinding).

### *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. Within Trafikverket, 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:

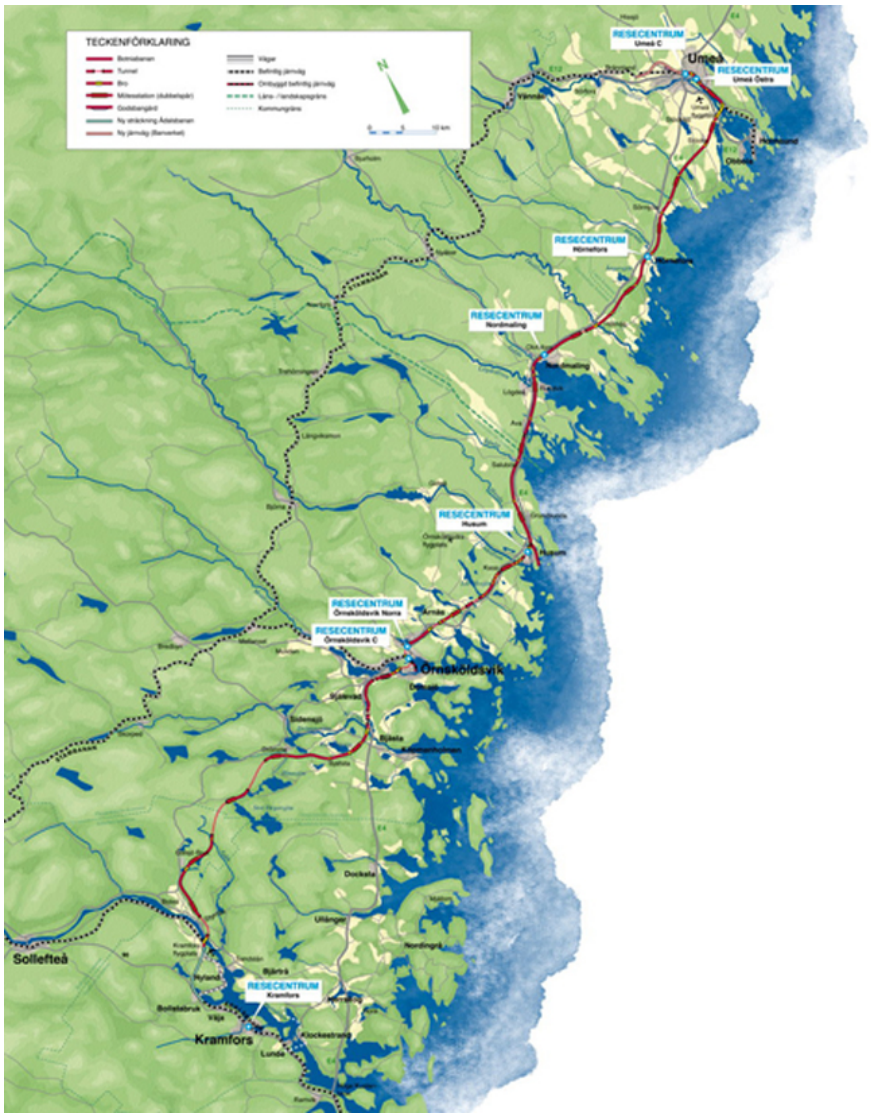
- Development, from an environmental perspective, of long-term reutilisation plans for strategic materials.
- Development of environmentally sound and effective management procedures for prioritised categories of waste.

### *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 centres/stations on 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

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|---|
| **PCR review was conducted by the Technical Committee (TC) of the International EPD Consortium (IEC).**<br>**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:**<br><br>**Bureau Veritas Certification AB**<br>Fabriksgatan 13<br>SE-412 50 Göteborg<br>SWEDEN | *Accredited by: Swedac* |

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