

# CEF CBA grade separated crossings Heerhugowaard and Castricum

Analysis of the social costs and benefits  
Final report

Client: Municipality Alkmaar and Dijk en Waard

Rotterdam, 4 December 2023



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In cooperation with Movares

Jeroen Bozuwa

Rotterdam, 4 December 2023

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# Summary

## Background

Ecorys has been asked to analyse the social costs and benefits (in short SCBA) of building a grade separated crossing at Zuidtangent and studying safety measures that could be taken to reduce the risk of incidents and maximize the number of trains passing at the level crossing near train station Castricum.

These elements are part of an upgrade of the HST connection Alkmaar – Amsterdam project, also known as the Zaancorridor<sup>1</sup>. This project consists of changes to a national railway, with the objective to improve the usability of the railway connection.

Heerhugowaard railway station is currently served by 12 trains per hour (two directions) during rush hour and 8 trains outside rush hours including weekends and holiday periods. In 2018 approximately 8,000 persons per day travelled by train to, from or via Heerhugowaard railway station. Until 2030 an increase up to 10,000 travellers per day is expected (an increase of approximately 25% compared to the 2018 figure). With an extension of the platforms from 270 meters to the maximum required length of 340 meters, capacity could further increase to 12,000 travellers per day (50% rise compared to the 2018 level and 20% rise compared to the current maximum capacity). With 2 extra intercity trains between Zaandam and Heerhugowaard, transport capacity could rise to 18,400 travellers per day (123% rise compared to the 2018 level and 84% compared to the current maximum capacity) provided that the two platforms are extended to 340 meters, trains can turn at shunting yard De Vaandel (to be constructed), and service hours of the bridges between Heerhugowaard and Alkmaar can be adjusted enabling unhindered train operations between Heerhugowaard and Alkmaar. With sharp rising numbers of travellers as presented here, risk of accidents at the level crossing Zuidtangent will rise as well. Moreover, waiting time for local traffic at this level crossing will also increase. Therefore, a tunnel at this level crossing is considered.

## Business as Usual (BaU) and Project

*Business as Usual (BaU)* is the future situation without the project. The level crossing at Zuidtangent will be maintained. This means that the current platforms (270 metres) cannot be extended to 340 metres, and trains cannot drive at maximum length. Further, when trains need to pass, the level crossing at Zuidtangent will be closed for local traffic for about 20 minutes each hour.

Assuming that *Programma Hoogfrequent Spoor* (PHS) will be introduced in the coming years and the frequency of trains will increase, the average waiting time for local traffic at the level crossing will increase as well (assessed at an average of 26 minutes each hour). The maximum transport capacity in this situation is 10,000 travellers per day<sup>2</sup>.

The *Project* includes the construction of a tunnel under the railway line (immediately south of the station) to replace the Zuidtangent level. In this situation the platforms can be extended to 340 metres allowing trains driving at maximum length in future. Extension of the platforms up to 340 metres is not part of the project (investment) however. With a grade separated crossing risks of

<sup>1</sup> [https://www.noord-holland.nl/Onderwerpen/Ruimtelijke\\_inrichting/Projecten/OV\\_Knooppunten/Zaancorridor](https://www.noord-holland.nl/Onderwerpen/Ruimtelijke_inrichting/Projecten/OV_Knooppunten/Zaancorridor)

<sup>2</sup> Until 2030, the municipality of Heerhugowaard expects an increase in the number of travellers via railway station Heerhugowaard up to approximately 10,000 per day. That means an increase of approximately 25% compared to the 2018 figure of 8,000 travellers. Movares concluded that this increase of 25% can be accommodated within the current capacity, assuming that the 25% rise in number of travellers is distributed evenly amongst the two train types (intercity and sprinter), see *Station Heerhugowaard, Analyse toekomstvastheid 2-sporig station*, Movares, 22 april 2020.

accidents at the rail crossing Zuidtangent will be zero. Further, local traffic is not hindered when trains are passing. The project also includes costs for a study into safety measures that could be taken to reduce the risk of incidents at the level crossing near train station Castricum in combination with the maximization of the possible number of trains passing this crossing.

### CBA outcome

The following table provides an overview of the balance of costs and benefits for the period 2023-2052. Costs and benefits are expressed in the net present value (NPV) on January 1, 2023 (price level 2023). The balance of benefits and costs is positive (+ € 20.7 million), which means that the benefit/cost ratio is also greater than 1. The project is therefore profitable in terms of social costs and benefits. Benefits due to time savings for local traffic have a share of approximately 39% in total benefits. Safety benefits due to less accidents at the Zuidtangent intersections (excluding the two railway crossings) have a share of 60% in the total benefits.

**Table S.1 Results indicators Social CBA (in million €, NPV)**

	Million €
Project investment cost	-36.7
Project O&M costs	-0.3
Hindrance local traffic during construction works	-
<b>Total economic costs</b>	<b>-37.0</b>
Time savings passenger car traffic Zuidtangent	12.1
Time savings freight traffic Zuidtangent	10.4
Time savings train passengers via Heerhugowaard	0.6
Safety - reduction of casualties at intersections Zuidtangent	13.9
Safety - reduction of severely injured at intersections Zuidtangent	19.7
Safety - reduction of slightly injured at intersections Zuidtangent	0.3
Safety - reduction of damaged cars	0.7
Safety - reduction of casualties at rail crossing Zuidtangent	+
Safety - reduction of severely injured at rail crossing Zuidtangent	+
Time savings train passengers PHS Alkmaar-Amsterdam	++
<b>Total economic benefits</b>	<b>57.7</b>
<b>ENPV / Net benefits</b>	<b>20.7</b>
<b>ERR</b>	<b>5.8%</b>
<b>B/C RATIO</b>	<b>1.56</b>

Some of the benefits could not be quantified, because there is no objective measurable method or validated statistics to quantify the benefits (the reduction of casualties and severely injured at the railway crossing in the future), or benefits could not be attributed solely to the grade separated crossing in Heerhugowaard (time savings for train passengers PHS Alkmaar-Amsterdam). These effects have therefore been assessed qualitatively. We would like to emphasize that these effects may be substantial though. In order to get an impression how the CBA outcome is impacted by the improved safety at the level crossing, we have assumed that the project can prevent one accident with a seriously injured or fatal victim once every 10 years. The results are presented in the following table.

**Table S.2 Impact of improved safety at railway crossings**

SCBA indicators	Base case	Preventing 1 severely injured every 10 years	Preventing 1 casualty every 10 years
<b>ENPV / Net benefits</b>	<b>€ 20.7 million</b>	<b>€ 22.2 million</b>	<b>€ 34.7 million</b>
<b>ERR</b>	<b>5.8%</b>	<b>6.1%</b>	<b>7.9%</b>
<b>B/C RATIO</b>	<b>1.56</b>	<b>1.60</b>	<b>1.94</b>

The figures demonstrate that the impact of safety measures are significant. Prevention of 1 severely injured at the railway crossing every 10 years results in an extra benefit of €1.5 million (NPV) compared to the base case. Prevention of 1 casualty every 10 years generates an extra benefit of €14 million (NPV) compared to the base case. In general, analyses<sup>3</sup> show that investments in road safety are cost-effective and that safety measures have higher benefits than costs.

<sup>3</sup> Kosten van verkeersongevallen, SWOV-factsheet, november 2022.

# 1 Introduction

## 1.1 Background

### *High Speed Train (HST) connection Alkmaar-Amsterdam<sup>4</sup>*

The HST connection Alkmaar – Amsterdam project also known as the Zaancorridor<sup>5</sup> consists of changes to a national railway, with the objective to improve the usability of the railway connection. The measures are necessary for a reliable timetable in the context of the High-Frequency Rail Transport Programme (in Dutch: ‘*Programma Hoogfrequent Spoorvervoer*’) on the Alkmaar – Amsterdam corridor. To implement the HST timetable and improve reliability, an extension and improvement of the capacity, robustness of the track and the transfer facilities for passengers are absolute conditions. Measures include adjustments of tracks and an extra platform at Station Uitgeest, a shunting yard at Heerhugowaard (called De Vaandel), grade separated crossings at 14 other locations along the corridor, and measures to reduce noise levels of trains.

### *Railway stations Heerhugowaard and Castricum*

Heerhugowaard railway station is currently served by 12 trains<sup>6</sup> per hour (two directions) during rush hour and 8 trains<sup>7</sup> outside rush hours including weekends and holiday periods. In 2018 approximately 8,000 persons per day travelled by train to, from or via Heerhugowaard railway station, around 500 made a transfer at Heerhugowaard and 7,500 started or ended their journey at Heerhugowaard. Until 2030, the municipality of Heerhugowaard expects an increase in the number of travellers via railway station Heerhugowaard up to approximately 10,000 per day (an increase of approximately 25% compared to the 2018 figure). Movares<sup>8</sup> concluded that this increase of 25% can be accommodated within the current capacity, assuming that the 25% rise in number of travellers is distributed evenly amongst the two train types (intercity and sprinter (local service)). In the event of a further increase in the number of travellers or an unequal distribution of the number of travellers between intercity trains and sprinter services, an increase in the capacity of station and railway infrastructure is required as well.

The municipality of Dijk en Waard is currently developing a plan together with ProRail (infrastructure manager) and NS (Dutch Railways) for improving the station and surroundings in Heerhugowaard. The parties appear to agree on the following measures<sup>9</sup>:

1. The construction of a road tunnel under the railway line immediately south of the station to replace the Zuidtangent level crossing.
2. Removal of the third platform track, allowing a shorter tunnel to be built<sup>10</sup>.
3. Extending the platforms from 270 metres to 340 metres so that longer trains can stop in Heerhugowaard.
4. Construction of a shunting yard 'De Vaandel' for passenger trains north of Heerhugowaard.<sup>11</sup>

The current and new situation (that will arise around 2025) is outlined in the following figures.

<sup>4</sup> <https://www.prorail.nl/programmas/programma-hoogfrequent-spoorvervoer/phs-alkmaar-amsterdam>

<sup>5</sup> [https://www.noord-holland.nl/Onderwerpen/Ruimtelijke\\_inrichting/Projecten/OV\\_Knooppunten/Zaancorridor](https://www.noord-holland.nl/Onderwerpen/Ruimtelijke_inrichting/Projecten/OV_Knooppunten/Zaancorridor)

<sup>6</sup> In each direction: 4 intercity trains and 2 so-called sprinters. Valid for Timetable 2023.

<sup>7</sup> In each direction: 2 intercity trains and 2 so-called sprinters. Valid for Timetable 2023.

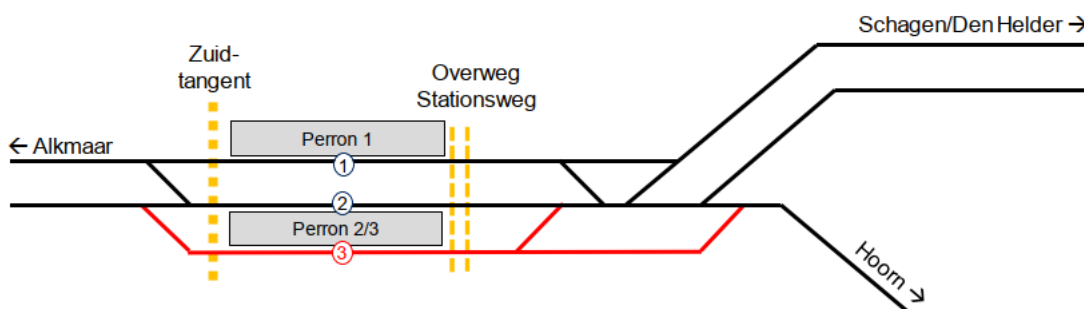
<sup>8</sup> Station Heerhugowaard, Analyse toekomstvastheid 2-sporig station, Movares, 22 april 2020.

<sup>9</sup> Station Heerhugowaard, Analyse toekomstvastheid 2-sporig station, Movares, 22 april 2020.

<sup>10</sup> <https://www.prorail.nl/nieuws/swietelsky-verwijdert-spoor-3-in-heerhugowaard>.

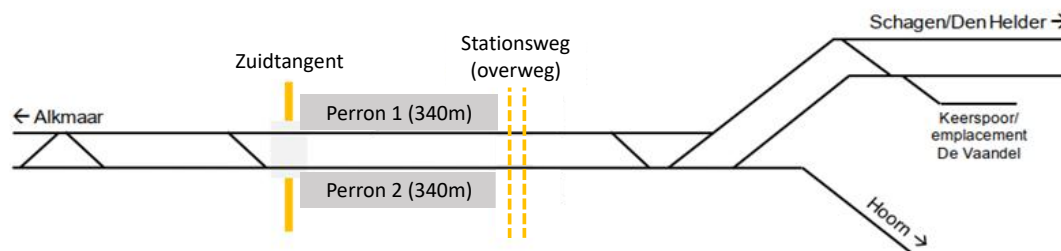
<sup>11</sup> MIRT overzicht 2022- Meerjarenprogramma Infrastructuur, Ruimte en Transport, PHS Alkmaar-Amsterdam.

Figure 1.1 Current situation of railway station Heerhugowaard



Source: Movares.

Figure 1.2 Future situation (around 2025) of railway station Heerhugowaard



Source: Movares, bewerking door Ecorys

Movares<sup>12</sup> analysed the capacity in the future situation with only 2 tracks and platforms instead of 3 and concluded:

- With the future 2-track station of Heerhugowaard with platforms of 270 meters and the current train operation with 12 trains per hour (namely 4 intercity trains and 2 sprinters in each direction) a transport capacity of 10,000 travellers per day can be offered.
- With an extension of the platforms to the maximum required length of 340 meters<sup>13</sup>, capacity could further increase to 12,000 travellers per day (50% rise compared to the 2018 level and 20% rise compared to the current maximum capacity).
- With 2 extra intercity trains between Zaandam and Heerhugowaard, transport capacity could rise to 18,400 travellers per day (123% rise compared to the 2018 level and 84% compared to the current maximum capacity) provided that the two platforms are extended to 340 meters, trains can turn at shunting yard De Vaandel (to be constructed), and service hours of the bridges between Heerhugowaard and Alkmaar can be adjusted enabling unhindered train operations between Heerhugowaard and Alkmaar.

With sharp rising numbers of travellers as presented here, risk of accidents at the level crossings (Zuidtangent and Stationsweg) will rise. Moreover, waiting time for local traffic at both level crossings will also increase. Construction of a tunnel at Zuidtangent will decrease the risk of accidents and waiting time for traffic at this level crossing. There is a similar situation at train station Castricum with a level crossing at short distance from the train station. There is a need for a study into possible safety measures that could be taken to minimize the risk of incidents at this level crossing in combination with the maximization of the possible number of trains passing this

<sup>12</sup> Station Heerhugowaard, Analyse toekomstvastheid 2-sporig station, Movares, 22 april 2020.

<sup>13</sup> In this case Intercity trains up to 12 coaches can be used. This is in most cases the maximum length used in regular services.



crossing. This will match the objective to improve the usability of the Zaancorridor<sup>14</sup> railway connection.

Ecorys has been asked to analyse the social costs and benefits (in short SCBA) of building a grade separated crossing at Zuidtangent, and studying safety measures that could be taken to reduce the risk of incidents at the level crossing near station train station Castricum in combination with the maximization of the possible number of trains passing this crossing.

## 1.2 How to read this report

In this report we describe the costs and benefits of building a grade separated crossing at Zuidtangent. The report starts with a description of the methodology of a SCBA. We briefly outline the most likely situation that will arise if the project, building a grade separated crossing at Zuidtangent, is not realised, the Business As Usual (or BaU). The differences between the BaU and the project alternative (a grade separated crossing at Zuidtangent) result in the expected (social) effects, which form the basis of this SCBA. Specifically, in the following chapters we will discuss:

- [Chapter 2](#) - SCBA methodology: the explanation of the SCBA methodology and the principles of the economic analysis;
- [Chapter 3](#) - Business as usual and Project: the description of the BaU and the Project alternative;
- [Chapter 4](#) - Project Effects: the determination and valuation of the Project effects;
- [Chapter 5](#) - SCBA Outcome: the SCBA results and their interpretation.

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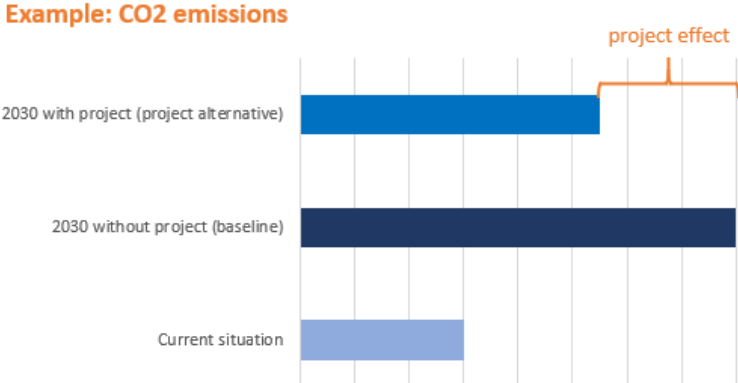
<sup>14</sup> [https://www.noord-holland.nl/Onderwerpen/Ruimtelijke\\_inrichting/Projecten/OV\\_Knooppunten/Zaancorridor](https://www.noord-holland.nl/Onderwerpen/Ruimtelijke_inrichting/Projecten/OV_Knooppunten/Zaancorridor)

# 2 SCBA Methodology

## 2.1 What is a SCBA

A SCBA describes the positive and negative effects of a project investment, here the construction of a grade separated crossing at Zuidtangent. To ensure an objective analysis of the project, only effects that can be directly attributed to the project should be considered. In the SCBA, the effects of a tunnel at Zuidtangent (the Project) are therefore compared with the effects in a business as usual (BaU) situation. The BaU refers to the most likely situation that occurs without the investments. It is important to realize here that in fact two future situations are compared. In this way, the SCBA only includes the effects that can be directly allocated to the project investments and are not considered autonomous effects. Figure 2.1 illustrates this by means of an example.

**Figure 2.1** Illustration of BaU and Project

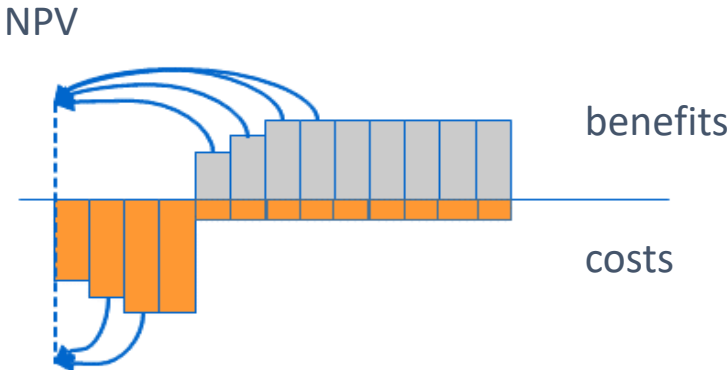


Source: Ecorys (2021)

### Price level and discount rate

In a SCBA, the effects are expressed in euros (monetized) where possible. The costs and benefits are expressed in constant prices with a fixed price level (in this study 2023) and are included for a longer period. In order to compare the costs and benefits, these are calculated back to the first investment year (discounted) in a SCBA. In this way a comparison can be made between effects that take place now and effects that take place in the future. This is illustrated in the following figure.

**Figure 2.2** Illustration of discounting



NPV = net present value  
Source: Ecorys (2021)

A fixed percentage per year is used; the discount rate. For the *economic* analysis the European Commission recommends a 3% discount rate<sup>1516</sup> for Member States. Member States are free to establish and use their own country-specific social discount rate. For the Netherlands a discount rate of 2.25% is used<sup>17</sup>. This discount rate has been applied in this report.

### *Time horizon*

When determining the effects, the (economic) lifespan of the project is taken into account. For infrastructural projects, a reference period of 50 years is often used in SCBAs. In accordance with the SCBA Guide we use a reference period of 30 years (2023 – 2053) that is applied for railways<sup>18</sup>.

In practice, the long-term effects have a limited influence on the results of a SCBA. This is due to the discounting of effects. An extension of the life span therefore has a relatively smaller effect on the outcome.

## 2.2 SCBA outcome

For CEF appraisals, two different analyses need to be carried out:

- **Financial Analysis:** This analysis assesses the need of co-financing particularly, with the calculation of the Financial Net Present Value and the Financial Rate of Return of the Investment (FNPV(C) and FRR(C) respectively). To gain a contribution from the Funds, the FNPV(C) should be negative and the FRR(C) should be lower than the discount rate used for the analysis.
- **Economic Analysis:** This analysis assesses if from a socio-economic perspective a project is desirable or not. This is demonstrated by the economic analysis result and particularly by a positive Economic Net Present Value (ENPV). This means that not only the effects for those stakeholders directly involved are looked at, but also the social effects for all stakeholders. This does not only concern financial costs and benefits, but also, for example, effects on the environment and climate. These effects are expressed in monetary terms (monetisation) as much as possible. The ratio of all these costs and benefits gives a picture of the socio-economic return.

In this report only the outcome of the Economic Analysis is provided as no direct revenue for the investor (municipality of Dijk en Waard) can be identified in this project.

Not all effects can be expressed in euros. Despite the fact that these effects are not monetized, they are social costs and benefits that lead to changes in prosperity. These effects are described qualitatively.

The monetized and the non-monetized effects must be considered integrally as the outcome of the SCBA.

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<sup>15</sup> See 'Economic Appraisal Vademecum 2021-2027', DG REGIO 2021, section 2.3

<sup>16</sup> See 'Social Discount Rate – The European Commission Benchmark', page 55, Guide to Cost-Benefit Analysis of Investment Projects – Economic appraisal tool for Cohesion Policy 2014-2020, December 2014

<sup>17</sup> For public physical investments with substantial fixed costs, such as (transport) infrastructure, (energy) networks, power plants and ports, the 'discount rate working group' recommends a discount rate of 2.25 percent.

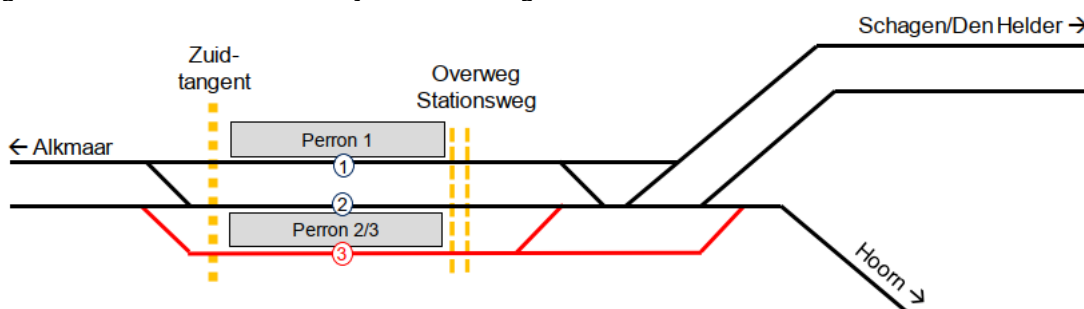
<sup>18</sup> See table 2.1 'European Commission's reference period by sector', Guide to Cost-Benefit Analysis of Investment Projects – Economic appraisal tool for Cohesion Policy 2014-2020, December 2014.

### 3 Business as Usual and Project

#### 3.1 Business as Usual (BaU)

Business as Usual (BaU) is the future situation without the project. The level crossings at Zuidtangent and Stationsweg will be maintained. This means that the current platforms (270 metres) cannot be extended to 340 metres, and trains cannot be made longer to accommodate more passengers. Further the level crossings at Zuidtangent and Stationsweg will be closed for local traffic for about 20 minutes each hour. Assuming that *Programma Hoogfrequent Spoor* (PHS) will be introduced in the coming years and the frequency of trains will increase, the average waiting time for local traffic at the two level crossings will increase as well (assessed at an average of 26 minutes each hour). The maximum transport capacity in this situation is 10,000 travellers per day<sup>19</sup>.

Figure 3.1 Current situation of railway station Heerhugowaard

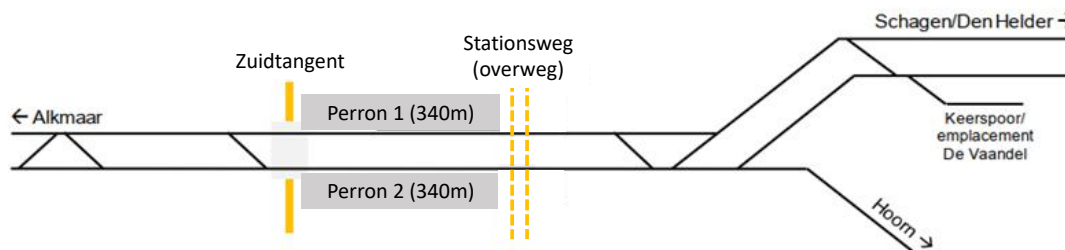


Source: Movares.

#### 3.2 Project

The Project includes the following infrastructural measure: The construction of a road tunnel under the railway line immediately south of the station to replace the Zuidtangent level crossing. The new situation is outlined in the following figure.

Figure 3.2 Future situation (around 2025) of railway station Heerhugowaard (source: Movares)



Source: Movares, bewerkt door Ecorys

<sup>19</sup> Until 2030, the municipality of Heerhugowaard expects an increase in the number of travellers via railway station Heerhugowaard up to approximately 10,000 per day. That means an increase of approximately 25% compared to the 2018 figure of 8,000 travellers. Movares concluded that this increase of 25% can be accommodated within the current capacity, assuming that the 25% rise in number of travellers is distributed evenly amongst the two train types (intercity and sprinter), see Station Heerhugowaard, Analyse toekomstvastheid 2-sporig station, Movares, 22 april 2020.

### *Grade separated crossing Zuidtangent Heerhugowaard*

The grade separated crossing at Zuidtangent enables the extension of the platforms to 340 metres. Extension of the platforms up to 340 metres is not part of the project however. Longer platforms are an absolute requirement to schedule trains with the maximum length of 12 intercity coaches. If trains can run at maximum length, total transport capacity can rise to 12,000 travellers per day<sup>20</sup> or even 18,400 travellers per day in case 2 extra intercity trains (on top of 4 IC trains and 2 sprinters) will be added to the rail transport service between Heerhugowaard and Zaandam. With a grade separated crossing at Zuidtangent the risk of accidents at this rail crossing will be zero. Moreover, local traffic is not hindered when trains are passing Zuidtangent.

### *Train station Castricum*

There is a similar situation at train station Castricum with a level crossing at short distance from the train station. There is a need for a study into safety measures that could be taken to minimize the risk of incidents at this level crossing in combination with the maximization of the possible number of trains passing this crossing. The project also includes the costs for a study into these safety measures near train station Castricum.

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<sup>20</sup> As on many intercity services in the Netherlands intercity trains used on this line are double-decker trains to ensure the highest number of places per meter train length.

## 4 Project effects

### 4.1 Direct costs

In this section we present the costs involved in the project. The direct costs of the infrastructural measures consist of investment costs and annual maintenance costs. The tables below show the one-off investment costs and annual maintenance costs of the various project elements. Costs are presented excluding VAT.

#### 4.1.1 Investment costs

The investment costs (excluding VAT) for the project have been estimated by Movares. It concerns the investments in the construction of the tunnel at level crossing Zuid-tangent.

From a technical point of view, the investments will be implemented in phases. The following costs distribution is considered feasible for both tunnels: 3% in 2023, 30% in 2024, 45% in 2025 and 22% in 2026.

There is a similar situation at train station Castricum with a level crossing at short distance from the train station. There is a need for a study into possible safety measures that could be taken to minimize the risk of incidents at this level crossing. The risk of incidents could increase taking into account the growth in the number of trains (as a result of PHS) and the expected increase in local traffic at this level crossing. Total study costs are assessed at € 480,000 (50/50% in 2025 and 2026).

**Table 4.1 Investment costs per alternative (excluding VAT, total amount and NPV)**

In million €	Project investment costs
Investment costs Tunnel Zuid-tangent (total amount)	€ 37.8 million
Study costs safety measures level crossing Castricum	€ 0.5 million
Investment costs (NPV)	€ 36.7 million

Source: Movares, SSK HHW Investeringskosten

#### 4.1.2 Annual maintenance costs

In addition to the investment costs, the intended project also entails maintenance costs. Instead of paying the maintenance costs per year, there is also an option to buy off maintenance costs for a longer period. The one-time buy off costs for the annual maintenance of the Zuidtangent tunnel for a 25 year period (2027 to 2051) is estimated at approximately €279,000<sup>21</sup>. These costs will occur in 2027, the first year after the constructions works have been finalised.

**Table 4.2 Maintenance costs per alternative (yearly costs and NPV)**

In million €	Project maintenance costs
Buy off costs yearly maintenance Tunnel Zuidtangent (2027)	€ 279,056
Maintenance costs (in NPV)	€ 337,296

Source: Movares

<sup>21</sup> Buy off costs for the Zuidtangent were assessed at € 258,002 for a 23-year period (Source: Gemeente Dijk en Waard).

#### 4.1.3 Other costs

During the construction period there will be hindrance for local traffic at the level crossings Zuidtangent<sup>22</sup>. During the construction works of the tunnel, local traffic will be diverted (see map with diversion routes, the Zuidtangent will be blocked for all traffic). This will result in extra kilometres and/or waiting time for local traffic. Due to the lack of quantitative data on the extra kilometres and waiting time, the extra costs could not be quantified. This effect has been scored qualitatively with '-' (negative effect).

Figure 4.1 Diversion routes during construction works at Zuidtangent



Source: Memo Impactanalyse afsluiting Zuidtangent ter hoogte van spoorwegovergang Heerhugowaard, Arcadis, 13 december 2021.

## 4.2 Direct benefits

### 4.2.1 Grade separated crossings condition for PHS Alkmaar-Amsterdam<sup>23</sup>

A grade separated crossing at Zuidtangent is an absolute condition to enable high frequency and longer trains along the corridor Amsterdam-Alkmaar, called *Programma Hoogfrequent Spoor Alkmaar-Amsterdam (PHS Alkmaar-Amsterdam)*. Other absolute conditions to enable PHS Alkmaar-Amsterdam are adjustments of tracks and an extra platform at Station Uitgeest, a shunting yard at Heerhugowaard (called De Vaandel), grade separated crossings at 14 other locations along the corridor, and measures to reduce noise levels of trains. With PHS Alkmaar-Amsterdam realised, the number of rail passengers on an average working day could rise to 66,000-69,000 in 2030 (low and high growth scenario respectively). This is an increase of approximately 25-30% compared to the pre-Covid level of 53,000 rail passengers per day in 2019. Assuming an average travel time

<sup>22</sup> Memo Impactanalyse afsluiting Zuidtangent ter hoogte van spoorwegovergang Heerhugowaard, Arcadis, 13 december 2021

<sup>23</sup> <https://www.prorail.nl/programmas/programma-hoogfrequent-spoorvervoer/phs-alkmaar-amsterdam>

reduction of 5 minutes<sup>2425</sup> for each passenger travelling by train along the corridor, total time savings per year could arrive at 1.4 million hours. With a value of time of € 8.64<sup>26</sup> per person per hour, total time savings would arrive at € 12.4 million per year (corresponding to an NPV of € 200 million). It is clear that this advantage can only occur when PHS Alkmaar-Amsterdam has been realised, and all investments previously mentioned (adjustments of tracks, an extra platform at Station Uitgeest, a shunting yard De Vaandel at Heerhugowaard, grade separated crossings at 14 other locations along the corridor) have been implemented. Therefore, this benefit cannot be attributed solely to the grade separated crossing at Zuidtangent. Because building a grade separated crossing at Zuidtangent is an absolute condition for realising PHS Alkmaar-Amsterdam with significant benefits for rail passengers, we have rated this effect qualitatively with ‘+++’.

#### 4.2.2 Travel time reduction – local traffic

In the current situation traffic at Zuidtangent has to wait when trains are passing. The crossing is closed 8 times per hour, each closing takes about 130 seconds, which results in a total average closing time of about 20 minutes every hour<sup>27</sup>. This will increase to 26 minutes every hour if the frequency of the trains will rise as result of *Programma Hoogfrequent Spoor* (12 closings per hour). At Zuidtangent it concerns fast traffic (cars, buses, lorries) and slow traffic (bicycles, pedestrians). The traffic intensity at Zuidtangent is estimated at 23,000 vehicles per 24 hours<sup>28</sup>. Traffic intensity is expected to grow further, which will result in a further increase of waiting time hours at the level crossing. The growth in traffic intensity has been assessed using forecasts for *MIRT-Noordwest* as presented in the *Intergrale Mobiliteitsanalyse 2021* (see following table).

**Table 4.3 Development of movements per type of transport (2018=100)**

High	2018	2030	2040	2050
Car	100	118	138	149
Bicycle	100	114	119	122
Pedestrian	100	112	120	125

Source: Integrale Mobiliteitsanalyse 2021, hoofdstuk 3 Ontwikkeling van mobiliteit, personen- en goederenvervoer.

With the grade separated crossing at Zuidtangent local traffic does not have to wait any longer when trains are passing. This will save approximately 72,000 hours in the first year (2027) after the construction works at the Zuidtangent have been finalised. With rising traffic intensity the number of hours per year will also rise. The following table presents the number of waiting hours in 2030, 2040 and 2050 which could be saved.

**Table 4.4 Potential savings of waiting hours per level crossing**

	2030	2040	2050
Zuidtangent	75,397	88,176	95,205

Source: Ecorys

<sup>24</sup> NOWA MIRT onderzoek Noordwestkant Amsterdam – Oplossingsrichtingenfase, Verdiepingslag RO en Mobiliteit, 31 mei 2017.

<sup>25</sup> Groei op het spoor – waardecreatie knooppunt Heerhugowaard, Movares, 18 januari 2019.

<sup>26</sup> <https://www.rwseconomie.nl/kengetallen/kengetallen-bereikbaarheid-map>; this is the value for 2030 calculated as the average of the WLO Low and High scenario, excluding VAT. This value rises further to €10.46 in 2051.

<sup>27</sup> This an average, the minimum is 5 closings per hour, the maximum is 12 closings per hour (see report: Zuidtangent Heerhugowaard, Probleemverkenning en inventarisatie oplossingen, Goudappel Coffeng, 15 september 2015).

<sup>28</sup> Memo Impactanalyse afsluiting Zuidtangent ter hoogte van spoorwegovergang Heerhugowaard, Arcadis, 13 december 2021



At Zuidtangent a distribution of 15% freight vehicles and 85% passenger cars was assumed to calculate waiting hours for both categories. Last, value of time ratios were applied in order to arrive at the total potential costs savings of waiting times.

**Table 4.5 Value of time road traffic (€ per person per hour, excluding VAT)**

Type of traffic	2010	2020	2030	2040	2050
Passenger	7.64	7.99	8.54	9.21	10.09
Freight	37.32	39.03	41.70	44.98	49.27

Source: <https://www.rwseconomie.nl/kengetallen/kengetallen-bereikbaarheid-map>, modified by Ecorys

Total potential time savings are presented in the following table (absolute cost savings and NPV).

**Table 4.6 Potential time saving costs per level crossing (in million € and NPV)**

In million €	Zuidtangent - passenger	Zuidtangent – freight
Absolute savings (2026-2051)	17.6	15.2
NPV	12.1	10.4

Source: Ecorys

#### 4.2.3 Travel time reduction – train passengers Heerhugowaard

In the current situation the average dwelling time of trains at railway station Heerhugowaard is approximately one minute. Before trains can depart again, they must first receive a notification that the barriers at the level crossing are closed. With a grade separated crossing at Zuidtangent this notification process can be avoided, which result in some time savings for rail passengers. ProRail<sup>29</sup> has assessed that the so-called *Sprinter* trains could have some benefit and dwelling time can be shortened with 12 seconds per train. The number of train passengers travelling from, to or via railway station Heerhugowaard is estimated at 18,400 per working day in 2030. Based on the share of *Sprinter* trains in total future capacity of trains (including the *Intercity* trains) via Heerhugowaard, we have assessed that approximately 22% of total train passengers per working day may benefit from the time savings. Total number of hours saved per year is approximately 3,400 hours. With a current value of time of € 7.99<sup>30</sup> per person per hour, total time savings in the period 2022-2051 would arrive at € 0.8 million (corresponding to an NPV of € 0.6 million).

#### 4.2.4 Risk reduction of accidents at Zuidtangent intersections

The grade separated crossing at Zuidtangent might also diminish the number of accidents on this local road, in particular on the Zuidtangent between intersections Zuidtangent-Westtangent and Zuidtangent-N242. In the period 2014-2021 145 accidents were registered<sup>31</sup> at Zuidtangent between N242 and Westtangent. This is an average of 18 accidents per year, with a total of 5 injured persons per year and 1 casualty once in three years. Most accidents happen at the intersection with Stationsplein: an average of 9 accidents per year with 16 persons involved, of which 3 injured persons per year and 1 casualty once in ten years. An overall reduction of 50-60% in the number of accidents and injured persons is considered feasible<sup>32</sup>, and a 30% reduction in the number of casualties (see detailed figures in Annex 1).

The following costs ratios on accidents were applied, in order to arrive at the total potential cost savings of accidents at the Zuidtangent intersections:

<sup>29</sup> Source: Email Prorail 30 November 2022.

<sup>30</sup> <https://www.rwseconomie.nl/kengetallen/kengetallen-bereikbaarheid-map>; this is the value for 2020 (excluding VAT) calculated as the average of the WLO Low and High scenario. This value rises further to €10.46 in 2051.

<sup>31</sup> VIA STAT, gemeente Dijk en Waard.

<sup>32</sup> Memo Opties voor procedure cie MER, Movares, 24 november 2022.

- casualty: € 6.7 million per casualty<sup>33</sup>;
- severely injured: € 0.7 per injured person<sup>34</sup>;
- slightly injured: € 10,500 per injured person<sup>35</sup>;
- damages (vehicles): €2.500 per accident<sup>36</sup>.

Total potential costs savings related to accidents at the Zuidtangent intersection Stationsplein are presented in the following table.

**Table 4.7 Potential saving accident costs per level crossing (in million € and NPV)**

In million €	Casualty	Injured	Vehicle damage
Absolute savings (2026-2051)	20.0	28.4	1.0
NPV	13.9	20.0	0.7

Source: Ecorys

#### 4.2.5 Risk reduction of accidents at level crossing Zuid-tangent

In ProRail's incident registration dating back to 1975, no incidents are registered for the level crossing Zuidtangent<sup>37</sup>. However, with an increase in train traffic (as a result of PHS) a higher probability of incidents cannot be ruled out. The level crossing at Zuidtangent has been rated amongst the level crossings with a relatively high risk (6% of the 2,000 level crossings in the Netherlands are rated as crossings with a relatively high risk)<sup>38</sup>. An important aspect here is, that the level crossing is close to the station where both slow trains and non-stop intercity trains pass. This has an effect on the closing times which may significantly vary in duration. With a large variation in closing times, travellers will show riskier behaviour, which could result in a higher risk of accidents. With a grade separated crossing at Zuidtangent the probability of incidents will be reduced to zero, and therefore the project effect will be positive.

If the chance of accidents is assessed at one casualty and one severely injured person every ten years, total savings would arrive at approximately € 22 million or an NPV of € 15 million. Because there is no objective measurable method yet to quantify this higher risk, and validated statistics as proof of a higher risk are missing as well, the effect cannot be quantified. We have therefore rated this effect qualitatively with '+'.

#### 4.2.6 External effects

##### CO<sub>2</sub> and NO<sub>x</sub> emissions

During the construction period (1.5-2 years, starting in 2023) local traffic will be diverted. This will temporarily result in extra vehicle kilometres and thus extra emissions. Due to lack of quantitative data on the extra kilometres, the extra emissions could not be quantified. As the construction period is relatively short, the effect of extra emissions will be negative, however small.

<sup>33</sup> Kosten van verkeersongevallen, SWOV factsheet 2022 (updated to 2021 price level with consumer price index CBS)

<sup>34</sup> Kosten van verkeersongevallen, SWOV factsheet 2022 (updated to 2021 price level with consumer price index CBS)

<sup>35</sup> <https://www.rwseconomie.nl/documenten/publicaties/2016/februari/18/waarderingskengetallen-verkeersveiligheid> (price level 2009); updated to 2021 with CPI (Statline)

<sup>36</sup> <https://www.anwb.nl/verzekeringen/autoverzekering/schade-aan-de-auto-wat-kost-dat>

<sup>37</sup> PHS Alkmaar – Amsterdam, bijlage 12 – deelrapport overwegveiligheid, Movares & Arcadis, 15 maart 2019.

<sup>38</sup> Zuidtangent Heerhugowaard, Probleemverkenning en inventarisatie van oplossingen, Goudappel Coffent, 15 september 2015.



## 5 CBA outcome

### 5.1 Economic analysis

The Economic Analysis assesses if from a socio-economic perspective a project is desirable or not. This means that not only the effects for those stakeholders directly involved are looked at, but also the social effects for all stakeholders, for example, effects on (traffic) safety or the climate. These effects are expressed in monetary terms (monetisation) as much as possible. The ratio of all these costs and benefits gives a picture of the socio-economic return.

The following table provides an overview of the balance of costs and benefits for the period 2023-2053. Costs and benefits are expressed in the net present value (NPV) on January 1, 2023 (price level 2023).

The balance of benefits and costs is positive (+ € 20.7 million), which means that the benefit/cost ratio is also greater than 1. The project is therefore profitable in terms of social costs and benefits.

Benefits due to time savings for local traffic have a share of approximately 39% in total benefits. Safety benefits due to less accidents at the Zuidtangent intersections (excluding the two railway crossings) have a share of 60% in the total benefits.

**Table 5.1 Results indicators Social CBA (in million €, NPV)**

	Million €
Project investment cost	-36.7
Project O&M costs	-0.3
Hindrance local traffic during construction works	-
<b>Total economic costs</b>	<b>-37.0</b>
Time savings passenger car traffic Zuidtangent	12.1
Time savings freight traffic Zuidtangent	10.4
Time savings train passengers via Heerhugowaard	0.6
Safety - reduction of casualties at intersections Zuidtangent	13.9
Safety - reduction of severely injured at intersections Zuidtangent	19.7
Safety - reduction of slightly injured at intersections Zuidtangent	0.3
Safety - reduction of damaged cars	0.7
Safety - reduction of casualties at rail crossing Zuidtangent	+
Safety - reduction of severely injured at rail crossing Zuidtangent	+
Time savings train passengers PHS Alkmaar-Amsterdam	++
<b>Total economic benefits</b>	<b>57.7</b>
<b>ENPV / Net benefits</b>	<b>20.7</b>
<b>ERR</b>	<b>5.8%</b>
<b>B/C RATIO</b>	<b>1.56</b>

As already presented in chapter 4 some of the benefits could not be quantified, because there is no objective measurable method or validated statistics to quantify the benefits (the reduction of casualties and severely injured at the railway crossing Zuidtangent in the future), or benefits could not be attributed solely to the grade separated crossing (time savings for train passengers PHS Alkmaar-Amsterdam). These effects have therefore been assessed qualitatively. We would like to emphasize that these effects may be substantial though. In order to get an impression how the CBA outcome is impacted by the improved safety at the level crossing Zuidtangent, we have assumed that the project can prevent one accident with a seriously injured or fatal victim once every 10 years. The results are presented in the table below.

**Table 5.2 Impact of improved safety at railway crossings**

SCBA indicators	Base case	Preventing 1 severely injured every 10 years	Preventing 1 casualty every 10 years
<b>ENPV / Net benefits</b>	<b>€ 20.7 million</b>	<b>€ 22.2 million</b>	<b>€ 34.7 million</b>
<b>ERR</b>	<b>5.8%</b>	<b>6.1%</b>	<b>7.9%</b>
<b>B/C RATIO</b>	<b>1.56</b>	<b>1.60</b>	<b>1.94</b>

The figures demonstrate that the impact of safety measures are significant. Prevention of 1 severely injured at the railway crossing every 10 years results in an extra benefit of €1.5 million (NPV) compared to the base case. Prevention of 1 casualty every 10 years generates an extra benefit of €14 million (NPV) compared to the base case. In general, analyses<sup>39</sup> show that investments in road safety are cost-effective and that safety measures have higher benefits than costs.

<sup>39</sup> Kosten van verkeersongevallen, SWOV-factsheet, november 2022.

## Annex 1 Statistics accidents Zuidtangent

<b>Aantal ongevallen Zuidtangent tussen N242 en Westtangent</b>							
Jaar (Code)	Jaar (Omschrijving)	Ongevallen	Partijen	Betrokkenen	Slachtoffers	Gewonden	Doden
2014	2014	13	22	20	2	2	0
2015	2015	6	12	12	0	0	0
2016	2016	22	45	42	7	6	1
2017	2017	23	44	39	6	6	0
2018	2018	22	46	45	9	9	0
2019	2019	25	47	47	10	9	1
2020	2020	17	35	34	6	6	0
2021	2021	17	36	33	3	3	0
gemiddeld/jaar		18	36	34	5	5	0,3
<b>Aantal ongevallen Zuidtangent kruising met Stationsplein</b>							
Jaar (Code)	Jaar (Omschrijving)	Ongevallen	Partijen	Betrokkenen	Slachtoffers	Gewonden	Doden
2014	2014	8	13	11	2	2	0
2016	2016	9	19	17	3	3	0
2017	2017	14	26	23	6	6	0
2018	2018	9	20	20	5	5	0
2019	2019	9	17	17	4	3	1
2020	2020	12	24	23	6	6	0
2021	2021	9	17	15	1	1	0
gemiddeld/jaar		9	17	16	3	3	0,1
<i>Bron: VIA STAT, gemeente Dijk en Waard</i>							

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P.O. Box 4175  
3006 AD Rotterdam  
The Netherlands

Watermanweg 44  
3067 GG Rotterdam  
The Netherlands

T +31 (0)10 453 88 00  
F +31 (0)10 453 07 68  
E [netherlands@ecorys.com](mailto:netherlands@ecorys.com)  
Registration no. 24316726

**W** [www.ecorys.nl](http://www.ecorys.nl)

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