REDCAR ENERGY CENTRE APPENDIX 11.4

Detailed Stack Height Determination

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1 INTRODUCTION

1.1 Stack Height Determination

1.1.1 A stack height determination has been undertaken to establish the height at which there is minimal additional environmental benefit associated with the cost of further increasing the height of the stack. The Environment Agency removed their detailed guidance, Horizontal Guidance Note EPR H1[1], for undertaking risk assessments on 1 February 2016; however, the approach used here is consistent with that Environment Agency guidance which required the identification of *"an option that gives acceptable environmental performance but balances costs and benefits of implementing it."*

Methodology

1.1.2 Model simulations have been run using ADMS 5 to determine what stack height is required to provide adequate dispersion/dilution and to overcome local building wake effects.

1.1.3 The stack height determination considers ground level concentrations over the averaging periods relevant to the air quality assessment, together with the full range of all likely meteorological conditions through the use of five years (2015 to 2019) of hourly sequential meteorological data from Durham Tees Valley. The model was run for a range of stack heights between 50 m and 120 m, in 5 m increments.

1.1.4 For the purposes of stack height determination, the modelled domain was 6 km by 6 km centred on the proposed development and with a grid spacing of 60 m. Results have been reported for the location where the highest concentration is predicted and for the worst-case meteorological conditions.

Stack Height Determination Results

1.1.5 The stack height modelling results have been analysed in two stages:

- **Stage 1** - The maximum predicted Process Contributions (PCs) have been plotted against height to determine if there is a height at which no benefit is gained from increases in stack heights.

- Graph 10.4.1 compares the maximum PCs when the plant is operating at the long-term concentration limits set out in the EU Industrial Emissions Directive (IED) for waste operations.

- Graph 10.4.2 compares the maximum PCs when the plant is operating at the short-term concentration limits set out in the EU IED for waste operations.

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1 Environment Agency (2010) Environmental Permitting Regulations (EPR) – H1 Environmental Risk Assessment, Annex K

Graph 1.1: Maximum Predicted Process Contributions vs Stack Height at Long-term IED Limits
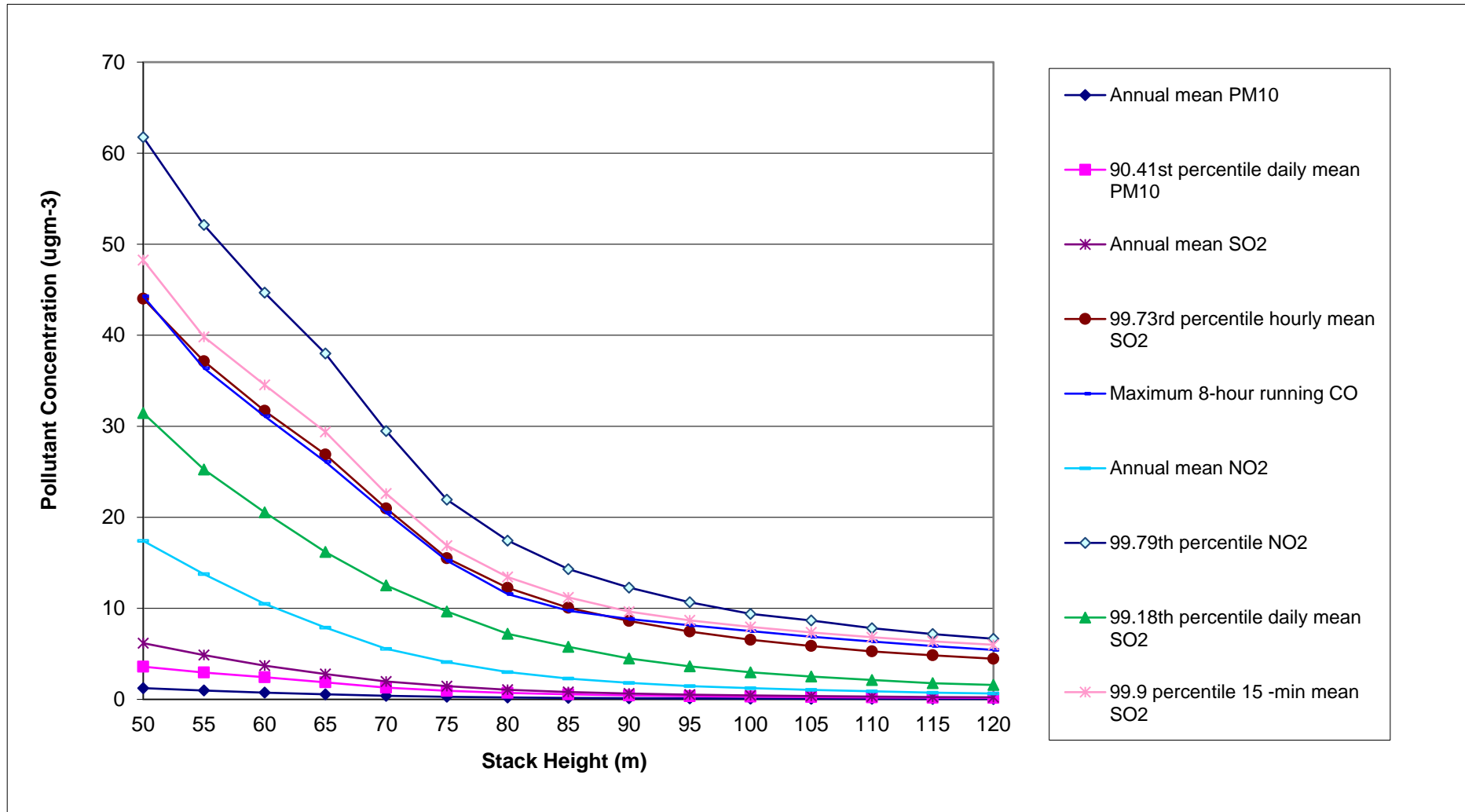
Graph 1.2: Maximum Predicted Process Contributions vs Stack Height at Short-term IED Limits

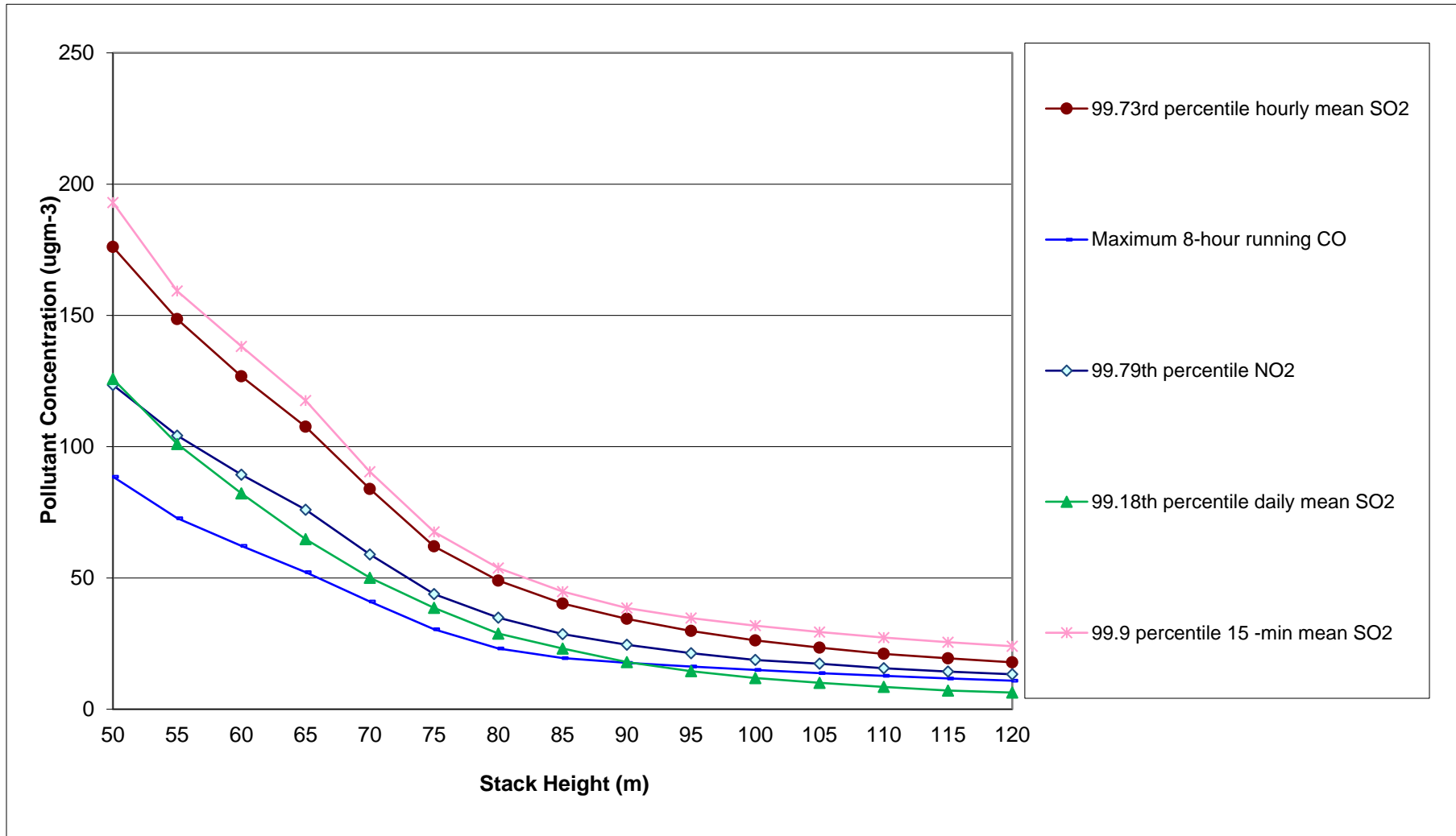1.1.6 The short-term and long-term maximum predicted process contribution plots show some initial steep falloffs in concentrations up to heights of around 75 to 80 m, with falls in concentrations beyond those heights beyond more gradual.

1.1.7 **Stage 2** – The on-line EA guidance is for risk assessments and provides details for screening out substances for detailed assessment. In particular, it states that:

"To screen out a PC for any substance so that you don't need to do any further assessment of it, the PC must meet both of the following criteria:

- *the short-term PC is less than 10% of the short-term environmental standard*

- *the long-term PC is less than 1% of the long-term environmental standard*

If you meet both of these criteria you don't need to do any further assessment of the substance.

If you don't meet them you need to carry out a second stage of screening to determine the impact of the PEC."

1.1.8 The PEC refers to the Predicted Environmental Concentration calculated as the PC added to the Ambient Concentration (AC).

1.1.9 The on-line EA guidance continues by stating that:

"You must do detailed modelling for any PECs not screened out as insignificant."

It then states that further action may be required where:

"your PCs could cause a PEC to exceed an environmental standard (unless the PC is very small compared to other contributors – if you think this is the case contact the Environment Agency)

the PEC is already exceeding an environmental standard"

1.1.10 On that basis, the stack height has been determined as the height at which:

- The impacts are not considered significant if the short-term PC is less than 10 % of the short-term Environmental Assessment Level (EAL);

- The impacts are not considered significant if the long-term PC is less than 1 % of the long-term EAL; and

- The impacts are not considered significant if the PEC is below the EAL.

- The EAL refers to the AQS air quality objective and the EU limit value.

1.1.11 Table 1.1 provides the maximum predicted PC when the plant is operating at the long-term concentration limits set out in the EU IED for waste operations. Table 1.2 provides the maximum predicted PC as a percentage of the EAL when the plant is operating at the long-term concentration limits set out in the EU IED for waste operations.

1.1.12 Table 1.3 provides the maximum predicted PC when the plant is operating at the short-term concentration limits set out in the EU IED for waste operations. Table 1.4 provides the maximum predicted PC as a percentage of the EAL when the plant is operating at the short-term concentration limits set out in the EU IED for waste operations.

Table 1.1: Maximum Predicted Process Contributions (µg.m⁻³) at each Stack Height Modelled – Long-term IED Concentration Limits

Height (m)	Concentration ($\mu g.m^{-3}$)									
	Annual-mean PM_{10}	90.41st percentile daily mean PM_{10}	Maximum hourly HCl	Annual mean SO_2	99.73rd percentile hourly mean SO_2	Maximum 8-hour running CO	Annual-mean NO_2	99.79th percentile NO_2	99.18th percentile daily mean SO_2	99.9th percentile 15-minute mean SO_2
50	1.2	3.6	9.1	6.2	44.0	44.3	17.4	61.8	31.4	48.2
55	1.0	3.0	8.0	4.9	37.1	36.4	13.8	52.1	25.3	39.8
60	0.7	2.4	7.3	3.7	31.7	31.1	10.5	44.7	20.5	34.5
65	0.6	1.9	6.7	2.8	26.9	26.1	7.9	38.0	16.2	29.4
70	0.4	1.3	6.1	2.0	21.0	20.5	5.6	29.5	12.5	22.6
75	0.3	0.9	5.5	1.5	15.5	15.2	4.1	21.9	9.7	16.9
80	0.2	0.7	5.0	1.1	12.2	11.6	3.0	17.4	7.2	13.4
85	0.2	0.6	4.5	0.8	10.1	9.7	2.3	14.3	5.8	11.2
90	0.1	0.4	4.1	0.6	8.6	8.8	1.8	12.3	4.5	9.6
95	0.1	0.4	3.7	0.5	7.5	8.1	1.5	10.7	3.6	8.7
100	0.1	0.3	3.3	0.4	6.6	7.5	1.2	9.4	3.0	8.0
105	0.1	0.3	2.9	0.4	5.9	6.9	1.0	8.7	2.5	7.4
110	0.1	0.2	2.6	0.3	5.3	6.4	0.9	7.8	2.1	6.8
115	0.1	0.2	2.2	0.3	4.8	5.9	0.7	7.2	1.8	6.4
120	0.0	0.2	2.0	0.2	4.5	5.4	0.6	6.7	1.6	6.0

Table 1.2: Maximum Predicted Process Contributions as a Percentage of the Relevant EAL at each Stack Height Modelled – Long-term IED Concentration Limits

Environmental Assessment Level (µg.m-3)	Percentage of Environmental Assessment Level (%)									
	40	50	750	50	350	10000	40	200	125	266
Height (m)	Annual-mean PM10	90.41st percentile daily mean PM10	Maximum hourly HCl	Annual mean SO2	99.73rd percentile hourly mean SO2	Maximum 8-hour running CO	Annual mean NO2	99.79th percentile NO2	99.18th percentile daily mean SO2	99.9th percentile 15-minute mean SO2
50	3.1	7.2	1.2	12.4	12.6	0.4	43.5	30.9	25.2	18.1
55	2.4	5.9	1.1	9.7	10.6	0.4	34.4	26.1	20.2	15.0
60	1.9	4.9	1.0	7.4	9.1	0.3	26.2	22.3	16.4	13.0
65	1.4	3.8	0.9	5.6	7.7	0.3	19.7	19.0	13.0	11.0
70	1.0	2.6	0.8	3.9	6.0	0.2	13.9	14.7	10.0	8.5
75	0.7	1.9	0.7	2.9	4.4	0.2	10.2	11.0	7.7	6.3
80	0.5	1.4	0.7	2.1	3.5	0.1	7.5	8.7	5.8	5.1
85	0.4	1.1	0.6	1.6	2.9	0.1	5.7	7.2	4.6	4.2
90	0.3	0.9	0.5	1.3	2.5	0.1	4.5	6.1	3.6	3.6
95	0.3	0.7	0.5	1.0	2.1	0.1	3.7	5.3	2.9	3.3
100	0.2	0.6	0.4	0.9	1.9	0.1	3.1	4.7	2.4	3.0
105	0.2	0.5	0.4	0.7	1.7	0.1	2.6	4.3	2.0	2.8
110	0.2	0.4	0.3	0.6	1.5	0.1	2.2	3.9	1.7	2.6
115	0.1	0.4	0.3	0.5	1.4	0.1	1.8	3.6	1.4	2.4
120	0.1	0.3	0.3	0.5	1.3	0.1	1.6	3.3	1.3	2.3

Cells are shaded grey where the predicted process contribution is above 1% of EAL for long-term average periods and 10% for short-term average periods

Table 1.3: Maximum Predicted Process Contributions (µg.m-3) at each Stack Height Modelled – Short-term IED Concentration Limits

Height (m)	Concentration (µg.m^{-3})					
	Maximum hourly HCl	99.73rd percentile hourly mean SO$_2$	Maximum 8-hour running CO	99.79th percentile NO$_2$	99.18th percentile daily mean SO$_2$	99.9th percentile 15-minute mean SO$_2$
50	54.7	176.1	88.6	123.5	125.8	193.0
55	47.9	148.6	72.8	104.2	101.0	159.3
60	43.9	126.8	62.2	89.3	82.2	138.2
65	40.2	107.6	52.2	76.0	64.8	117.5
70	36.6	83.9	41.0	59.0	50.1	90.4
75	33.3	62.0	30.5	43.9	38.6	67.6
80	30.2	49.0	23.1	34.9	28.8	53.8
85	27.3	40.3	19.5	28.6	23.1	44.8
90	24.6	34.4	17.7	24.6	18.0	38.6
95	22.0	29.8	16.3	21.3	14.5	34.7
100	19.7	26.2	15.0	18.8	11.9	31.8
105	17.6	23.5	13.8	17.3	10.0	29.4
110	15.7	21.1	12.7	15.6	8.5	27.3
115	12.9	19.4	11.7	14.4	7.1	25.5
120	12.3	17.9	10.9	13.3	6.3	24.0

Table 1.4: Maximum Predicted Process Contributions as a Percentage of the Relevant EAL at each Stack Height Modelled – Short-term IED Concentration Limits

Level Environmental Assessment (µg.m^{-3}) Height (m)	Percentage of Environmental Assessment Level (%)					
	750	350	10000	200	125	266
	Maximum hourly HCl	99.73rd percentile hourly mean SO$_2$	Maximum 8-hour running CO	99.79th percentile NO$_2$	99.18th percentile daily mean SO$_2$	99.9th percentile 15-minute mean SO$_2$
50	7.3	50.3	0.89	61.8	100.6	72.6
55	6.4	42.4	0.73	52.1	80.8	59.9
60	5.9	36.2	0.62	44.7	65.8	52.0
65	5.4	30.7	0.52	38.0	51.8	44.2
70	4.9	24.0	0.41	29.5	40.1	34.0
75	4.4	17.7	0.30	21.9	30.9	25.4
80	4.0	14.0	0.23	17.4	23.1	20.2
85	3.6	11.5	0.19	14.3	18.5	16.8
90	3.3	9.8	0.18	12.3	14.4	14.5
95	2.9	8.5	0.16	10.7	11.6	13.1
100	2.6	7.5	0.15	9.4	9.5	12.0

Level Environmental Assessment (µg.m⁻³)	Percentage of Environmental Assessment Level (%)					
	750	350	10000	200	125	266
Height (m)	Maximum hourly HCl	99.73rd percentile hourly mean SO_2	Maximum 8-hour running CO	99.79th percentile NO_2	99.18th percentile daily mean SO_2	99.9th percentile 15-minute mean SO_2
105	2.4	6.7	0.14	8.7	8.0	11.1
110	2.1	6.0	0.13	7.8	6.8	10.3
115	1.7	5.5	0.12	7.2	5.7	9.6
120	1.6	5.1	0.11	6.7	5.1	9.0

Cells are shaded grey where the predicted process contribution is above 10% of the EAL.

Discussion

1.1.13   The results in Table 1.2 indicate that there are no heights below 120 m at which the impacts can be screened-out as insignificant based on the PC alone when the plant is operating at long-term IED concentration limits. In particular, the maximum predicted PC for annual-mean NO_2 is above 1% at all heights. If the maximum predicted PC for annual-mean NO_2 is disregarded, the maximum PCs are below 1% and 10% for long-term and short-term impacts respectively at heights of 100 m and above.

1.1.14   The results in Table 1.4 indicate that at heights above 115 m the short-term impacts can be screened out as insignificant based on the PC alone when the plant is operating at short-term IED concentration limits.

1.1.15   These are the results of modelling across a grid of receptors. Impacts will only likely have a significant effect if there is relevant exposure at the location of the prediction. In this case, there are few receptors in the surrounding area. The results of modelling at 80 m are presented in chapter 10. Based on an analysis of the impacts at sensitive receptors, the impacts can be screened-out as insignificant.