

THORSIL METALLURGICAL GRADE SILICON PLANT HELGUVÍK, REYKJANESBÆR MUNICIPALITY, ICELAND

Planning Agency Ruling on the Environmental Impact Assessment

MAIN CONCLUSIONS

The Planning Agency considers Thorsil to have demonstrated that sulphur dioxide concentrations outside of the dilution zone will lie below the limit values, whether in consideration of hourly or 24-hour values or of annual averages. Nonetheless, the 24-hour values may exceed the limit values in particular locations within the dilution zone.

Even though Thorsil has demonstrated that the concentrations of pollutants other than sulphur dioxide will also remain within the limit values outside of the dilution zone demarcated for the Norðurál aluminium smelter, the Planning Agency feels that air quality in the environs of Helgúvík will deteriorate considerably due to substances from the cumulative exhaust of Thorsil, Norðurál and United Silicon in that area. Since this involves a substantial amount of pollutants entering the atmosphere close to a residential area, the impact will be considerably negative. On the other hand, this impact will mostly be localised and reversible, except for the accumulation of heavy metals which may be expected close to the industrial plants. Previously, a dilution zone was demarcated for the Norðurál operations. This zone is quite large and for instance extends across the Thorsil lot and its vicinity. This dilution zone is shown by pollution dispersion calculations to relate to the Thorsil operations also, because the 24-hour values for sulphur dioxide may be expected to reach the regulatory limit values at several locations within the dilution zone.

The Icelandic Planning Agency suggests the following conditions:

1. Should changes occur in the structures on the Thorsil lot, the company must demonstrate that they will not significantly affect pollutant concentrations outside of the dilution zone. If there is any reason to think such changes might increase pollution outside of the dilution zone, Thorsil shall present revised calculations on pollutant dispersion, asking the Environment Agency for its opinion on this dispersion before Reykjanesbær municipality amends the site plan or grants a permit for these changes.
2. Thorsil's sulphur dioxide emissions must remain below 15 kg of SO₂ per tonne of produced silicon, at least until monitoring reveals that it might be possible to increase the emissions allowed.
3. The monitoring plan must provide for an air pollution measuring point along the line in which the greatest pollutant concentrations will travel towards the nearby town area of Reykjanesbær, based on mathematical modelling.
4. The monitoring plan will have to state that accumulations of the main heavy metals will be measured regularly in local mosses.

Reykjavík, 1 April 2015

1 INTRODUCTION

1.1 EXAMINATION BY THE PLANNING AGENCY

On 20 October 2014, an initial environmental impact statement regarding a Thorsil silicon plant at Helguvík, Reykjanesbær, was sent by the engineering office Mannvit hf. on behalf of Thorsil to the Planning Agency for examination, in keeping with the Environmental Impact Assessment Act, No. 106/2000.

This project and the initial environmental impact statement were publicly advertised on 23 October 2014 in the *Official Gazette* and the newspapers *Fréttablaðið* and *Morgunblaðið*. From 23 October to 5 December 2014, the initial environmental impact statement was available for review at the municipal offices of Reykjanesbær, the Reykjanesbær library, the Planning Agency and the National and University Library of Iceland. In addition, the initial environmental impact statement was accessible online at www.mannvit.is and www.skipulagsstofnun.is. The Planning Agency requested opinions from the municipality of Reykjanesbær, the Suðurnes Health and Environment Office, the Icelandic Construction Authority, the Environment Agency of Iceland, the Icelandic Meteorological Office and the Administration of Occupational Safety and Health. Furthermore, the Planning Agency received five comments during the period of public presentation and sent these opinions and comments to Mannvit.

On 24 February 2015, on behalf of Thorsil, the engineering office Mannvit hf. sent to the Planning Agency an assessment report regarding a Thorsil silicon plant at Helguvík, Reykjanesbær, and requested the Agency's opinion on the environmental impact assessment of the project. While preparing this opinion, the Planning Agency requested an expert opinion from Professor Sigurður Magnús Garðarsson in the Faculty of Civil and Environmental Engineering at the University of Iceland.

1.2 DOCUMENTS SUBMITTED IN CONNECTION WITH THE PLANNING AGENCY EXAMINATION

Initial environmental impact statement. Thorsil Metallurgical Grade Silicon Plant. Helguvík, Reykjanesbær municipality, Iceland. Initial environmental impact statement, including 2 appendices. Capacity of up to 110,000 tonnes per year. Thorsil ehf. and Mannvit, October 2014.

Opinions were received from the following bodies:

- The municipality of Reykjanesbær, in a letter dated 28 October 2014
- Suðurnes Health and Environment Office, in a letter dated 20 November 2014
- Icelandic Construction Authority, in a letter dated 24 November 2014
- Environment Agency of Iceland, in letters dated 21 November and 3 December 2014
- Icelandic Meteorological Office, in letters dated 12 November and 5 December 2014
- Administration of Occupational Safety and Health, in a letter dated 14 November 2014

Comments were received from the following parties:

- Benóný Harðarson, in a letter dated 5 December 2014
- Hörður Einarsson, in an e-mail dated 4 December 2014
- Olíudreifing ehf., in a letter dated 5 December 2014
- Sókn lögmansstofa on behalf of AGC ehf., in a letter dated 6 November 2014
- United Silicon, in a letter dated 3 December 2014

Assessment report: Thorsil Metallurgical Grade Silicon Plant, Helguvík, Reykjanesbær municipality, Iceland. Assessment report, including 7 appendices in a separate folder. Capacity of up to 110,000 tonnes per year. Thorsil ehf. and Mannvit, October 2015.

Other documents: After receiving opinions and comments, the Planning Agency requested further information from the developer and some of those who had expressed comments, in addition to obtaining an expert opinion from Professor Sigurður Magnús Garðarsson. These documents are as follows:

- Olíudreifing's answer to the Planning Agency enquiry, dated 29 December 2014
- United Silicon's answers to the Planning Agency enquiries, dated 22 and 23 January 2015, as well as additional information from United Silicon, in an e-mail dated 12 February 2015
- Thorsil's answers to the Planning Agency enquiries, dated 13 January and 13, 25 and 26 March 2015
- Advisory opinion, "Air quality by Helguvík", dated 11 February 2015. Prepared by Professor Sigurður Magnús Garðarsson, Faculty of Civil and Environmental Engineering, University of Iceland.

2 THE PROJECT AND ITS OBJECTIVES

Thorsil ehf. plans on building and operating a silicon plant at Helguvík, in the municipality of Reykjanesbær, with an expected capacity of up to 110,000 tonnes per year of metallurgical grade silicon. The silicon metal produced by the plant will be sold to companies operating in the chemical and metals industries. Negotiating with the Port of Reykjanes, Thorsil has agreed to lease an approximately 15-hectare site in the zoned industrial area at Helguvík where the intention is to construct the plant. Various businesses already operate in this area, such as the waste incineration plant Kalka, the aluminium recycling plant Alur and the fish processing plant of Síldarvinnslan; in addition, there are plans to build a United Silicon silicon metal plant¹ and a Norðurál aluminium smelter. The Norðurál aluminium smelter will be surrounded by a dilution zone which is described in that company's operating licence, with the zone boundaries appearing in the Norðurál operating licence and in the Reykjanesbær municipal plan. Within the dilution zone, pollutant concentrations are allowed to surpass the limit values in regulations.

Plans call for starting excavation work on the proposed industrial site when the necessary permits are ready. While the plant is eventually to contain four furnaces, the idea is to construct it in two phases of the same size, each producing 55,000 tonnes. The first two furnaces would be put into operation during 2017, but it is not yet clear when the two later furnaces would be built. Selected raw materials are to be used at the plant, which will be constructed in accordance with up-to-date descriptions of the best available technology (BAT), involving high-capacity fume-scrubbing facilities and tall exhaust stacks to ensure the optimal distribution of exhaust and the minimal environmental impact. Plant employees are estimated to number around 130 when only two furnaces are in operation, but will increase to 170 at full capacity. When four furnaces have been taken into service, the plant's energy requirements are estimated to be about 174 MW. Since it is not yet clear where this energy will come from, the construction period will be determined by the time when energy becomes available. As many as 350 people are expected to work at constructing the plant. Table 1 presents the amounts needed of the main raw materials, in relation to a fully constructed Thorsil manufacturing plant producing 110,000 tonnes per year (tpy) of silicon metal.

Raw material	Unit	Quantity
Quartz	tpy	310,000
Coal, coke and anodes	tpy	195,000

¹ The United Silicon plant began environmental impact assessment under the name of Stakksbraut 9, so this name or an abbreviated form, S9, is used in the Thorsil assessment report.

Wood	tpy	185,000
Calcium	tpy	35,000
Water	m ³ / day	300
Power	MW	174
Energy	GWh/year	About 1,500

Table 1 Thorsil's use of raw materials once production has achieved full capacity (based on the assessment report).

By-products and waste The assessment report notes that although the Thorsil plant's main product is to be silicon metal, considerable amounts of silica powder and slag will also result and are to be exported from Iceland. The slag may be used in a variety of ways, for example in different kinds of special cement. Table 2 shows the quantities of the main products.

Product	Unit	Quantity
Silicon	tpy	110,000
Silica powder	tpy	55,000
Slag	tpy	9,000

Table 2 The Thorsil products once production has achieved full capacity (based on the assessment report).

The report explains that since no hazardous substances are formed in the production process, no toxic waste will be left over. Thus the waste developing from machinery and equipment will be the only sort of substances needing to be taken to a hazardous waste collection point. Furthermore, there will be refuse from the office and canteen, and the operations will also yield bag filters, sacks, cardboard, transport pallets and various types of metals suitable for recycling; all of these are to be taken to a recognised central accumulation point.

Principal structures The assessment report describes the lot as being about 15 hectares in size and having buildings of various types and sizes. The lot is said to be quite large because the buildings housing equipment and facilities will be fairly extensive. Space is also required for the storage of quartz, coal and wood, as well as for vehicle routes inside the lot. Table 3 shows the dimensions of the main structures.

Structure	Phase 1, m ²	Phase 2, m ²	Height, m
Scrubbing facility	1,220	1,220	35
Coal storage	4,800	4,800	20
Wood storage	7,000	7,000	20
Quartz storage	3,400	3,400	Unroofed
Crushing and sorting	2,000	2,000	30
Workshop	1,600	-	6
Cooling and casting	2,700	2,700	25
Furnace building	3,500	3,500	43
Offices and staff facilities	1,000	-	6

Scrubbing facility - baghouse	1,220	1,220	35
Stacks	-	-	52

Table 3 Dimensions of the main structures in each phase of the plant (based on the assessment report).

Materials extraction As stated in the assessment report, the plan is to take plant construction materials for the most part from within the company lot, since adequate material for constructing the base layer and for fill can be found there or elsewhere in the industrial area. This material has partly come about through previous construction by the Helguvík harbour. To provide fill material for foundation walls supporting the floor slabs of buildings as well as for roads and open areas, some 70-80,000 m³ of material will have to be moved around on the property. While a small amount of soil will probably be needed for landscaping areas of grass and other vegetation, there is said to be no need to bring in material from quarries outside of the industrial area.

Harbour facilities According to the assessment report, ships with a freight capacity of around 10,000 tonnes will bring to Iceland the raw materials needed for production, which in the first phase is to total about 350,000 tonnes annually. These ships have a berth reserved in the Helguvík harbour, along a 150-metre long section of the breakwater which is opposite the current location of the Aalborg Portland cement silo. An unloading crane will be set up on the pier, together with a hopper and conveyor belt system for transferring the raw materials from the quayside to the Thorsil property. The conveyor belts from the harbour will be enclosed, besides being raised on high pillars, allowing traffic to move freely underneath. The conveyor belt route from the harbour to the Thorsil site will lie east of the oil pipeline, with the conveyor belt supports positioned outside of the pipeline right-of-way so that the oil pipes will not be damaged, and arranged so that the conveyor belts will not have any impact on the pipeline or on servicing it in the future. Upon reaching the Thorsil property, these conveyor belts will transport the raw materials to storage locations, some of which will be roofed but open to the sides. Plans call for having roofs over the coal and the wood storages, but not over the quartz.

The ships bringing bulk raw materials to Thorsil will dock at the north edge of the Helguvík harbour, in a similar location to the ships transporting cement and fishmeal. A lengthening of the wharf front is expected, pursuant to harbour plans. Arriving oil ships will dock at the oil unloading facilities by the harbour's eastern breakwater.

3 WEIGHTING CONCEPTS

When evaluating the effects of the proposed development on individual environmental components, the Thorsil assessment report relies on guidelines issued by the Planning Agency in 2005 on the categories for environmental components and on the criteria, characteristics and weighting of environmental impact. Impact weightings are expressed in the assessment report by weighting concepts, whereby the most negative weighting concept is very negative, the next most negative is considerably negative, then somewhat negative, next negligible, then somewhat positive, after that considerably positive, and finally, as the impact assessed most positively, very positive. Explanations for these concepts can be seen in the table accompanying the guidelines, as well as in Section 4.4 of the Thorsil assessment report. In the present ruling, the Planning Agency applies the weighting concepts in the same way as the assessment report.

4 CONCLUSIONS ON THE ENVIRONMENTAL IMPACT ASSESSMENT

4.1 VISUAL IMPACT

According to the assessment report, the proposed silicon metal plant will involve sizeable structures, rising as high as 45 m and with stacks as high as 53 m. The landscape in the area is considered neither unique nor undisrupted. Along with the final design and building colour selections, the landscaping of the plant surroundings is to aim at minimising visual impact, cf. Article 35 of the Act on Nature Conservation, No. 44/1999, which provides for taking care to adapt structures to the appearance of the land insofar as possible.

The assessment report notes that the visual impact will be negligible from Vogar, as the distance from there to Helguvík is quite considerable. Seen from Njarðvík, the impact is regarded as somewhat negative and from the most northerly residential areas of Reykjanesbær as considerably negative. Due to proximity, the impact viewed from Garðskagavegur road and thereabouts is regarded as very negative. All of these impacts are regarded as direct and permanent, although reversible in the sense that it would be possible to dismantle the plant at some later time.

On account of the size and proximity of the buildings, the Planning Agency believes that the visual impact will be considerably negative from the closest town area of Reykjanesbær, although landscaping and the visual design of the buildings may be able to diminish this impact somewhat. It must be taken into account that the area does not have a high conservation value and that the Thorsil silicon plant is to be erected at a place which has already been disturbed and has long been defined in public planning as an industrial area. There are further plans for manufacturing plants in this area which are also to be large in size, predictably leading to a cumulative impact of structures in the industrial area. On the other hand, the Helguvík industrial area lies lower in the landscape than the environs, which is likely to render the structures less prominent.

4.2 IMPACT ON NOISE LEVELS

The assessment report explains that noise levels due to the proposed silicon plant were calculated with SoundPLAN software, defining the leading sources of noise as the plant and its structures, the conveyor belts from the harbour to the industrial lot, the harbour facilities and the ship unloading equipment. Since part of the overall equipment, such as the unloading equipment and the conveyor belts, will not be running day and night, noise levels were calculated regarding three different scenarios. The report demonstrates that noise reaching nearby residential districts from the proposed silicon plant and landing equipment will be well within the regulatory reference values for noise. On industrial premises in the vicinity of the plant and of the ship unloading equipment, noise will also be well below the reference values.

Regarding operations of the proposed development, the assessment report sets forth the impact on sound levels in residential districts and in the industrial area as somewhat negative, but significantly below the limit values. According to the site plan for the industrial area, earth berms are supposed to be located between the Thorsil structures and the northernmost residential area of Reykjanesbær. The above-mentioned noise level calculations do not provide for these berms, although if they are built, the noise from the proposed silicon plant may be expected to diminish in nearby residential districts.

Even though calculations show the noise levels to lie below the limit values in noise regulations, the Planning Agency feels it is not unlikely that residents will hear plant equipment, in particular when the town is quiet, and thus agrees to what is said in the assessment report, considering the sound level impact of the Thorsil manufacturing plant to be somewhat negative.

4.3 IMPACT ON AIR QUALITY

4.3.1 Impact of the Thorsil silicon plant on air quality

The main substances emitted from the manufacturing process are said in the assessment report to be silica powder and carbon monoxide. Sulphur oxides also form due to the sulphur content of the carbon donors, and nitrogen oxides are created by the reaction of nitrogen with oxygen in the hot air over the furnace. All of the exhaust will be conducted through fume-scrubbing facilities equipped with bag filters, and the baghouse design presupposes a fume-scrubber efficiency which will be in line with up-to-date stipulations on Best Available Technology for this type of industry, with emitted particulates remaining below 5 mg/Nm³ of exhaust gases. In order to accomplish optimum dispersal, exhaust from the filter bags will pass into the atmosphere through 52-m-tall stacks. Table 4 displays the main pollutant quantities on which pollutant dispersion calculations were based.

Substance	Emission per tonne of silicon produced	Annual emissions from the 110,000-tpy plant
Sulphur dioxide SO ₂	15 kg	1,650 tpy
Nitrogen oxides NO _x	18 kg ¹	1,990 tpy
Particulates (PM ₁₀)	0.6 kg	66 tpy
PAH	2 g	0.25 tpy
Carbon monoxide CO	22 kg	2,440 tpy

¹ Calculated as NO₂

Table 4 Main pollutant emissions (based on the assessment report).

The assessment report presents atmospheric dispersion predictions prepared by the engineering office Vatnaskil, which used the mathematical model CALPUFF to calculate the dispersion of air pollution through the environs. The CALPUFF model is said to have been chosen by the Environmental Protection Agency in the USA not only for long-distance distribution but also for near-field dispersion under complex meteorological conditions, for example with strongly space-varying weather (in relation to wind or temperature) on account of the landscape or of water masses near the exhaust source. For these reasons, the base case of the model must be fed with the complete landscape, whether natural or man-made. This is highly relevant for Thorsil, because the industrial lot lies by the sea, separated from it by a coastal bluff and subsequently by high structures in prevailing northeasterly winds. From the southeast, winds also arrive from the ocean, blowing along the harbour en route to Thorsil over the Síldarvinnsan buildings, the AP cement silo and potentially even the United Silicon buildings. The limit values in regulations concerning the main pollutants are indicated in Table 5.

Substance	Reference period	Limit	Protection category	Probability (permissible instances over limits)
Sulphur dioxide SO ₂	1 hr	350 µg/m ³	Health	99.7% (24 times/year)
	24 hrs	50 µg/m ³	Vegetation	98.1% (7 times/year)
	24 hrs	125 µg/m ³	Health	99.2% (3 times/year)
	Year and winter	20 µg/m ³	Vegetation	
Nitrogen dioxide NO ₂	1 hr	110 µg/m ³	Health	98.0% (175 times/year)
	1 hr	200 µg/m ³	Health	99.8% (18 times/year)

	24 hrs	75 µg/m ³	Health	98.1% (7 times/year)
	Year and winter	30 µg/m ³	Health	
Nitrogen oxides NOx	Year	30 µg/m ³	Vegetation	
Carbon monoxide CO	1 hr	30 mg/m ³	Health	98.1% (175 times/year)
	8 hr	6 mg/m ³	Health	98.6% (21 times/year)
	8 hrs	10 mg/m ³	Health	100% (0 times/year)
Particulates PM ₁₀	24 hrs	50 µg/m ³	Health	98.1% (7 times/year)
	Year	20 µg/m ³	Health	
B(a)P	Year	1 ng/m ³	Health	

Table 5 Limit values for the main pollutants according to regulations (based on the assessment report).²

Sulphur dioxide. The assessment report states that, according to the dispersion predictions from Vatnaskil, the 24-hour average for sulphur dioxide from the Thorsil plant will lie below the limit values. According to the regulations respecting plant protection, this average may exceed 50 µg/m³ seven times a year outside of the dilution zone, meaning that the concentration must remain below 50 µg/m³ in at least 98.1% of instances in order to comply with regulatory provisions. The sulphur dioxide concentration is said always to remain below this probability value and to be below 50 µg/m³ in 99% of instances, except for two plots southwest of the Thorsil plant where the sulphur dioxide concentration exceeds 50 µg/m³ three times a year. The 24-hour human health criteria which are established in regulations allow sulphur dioxide concentrations to exceed 125 µg/m³ three times a year, an amount which Thorsil's computed values never exceed. The hourly human health criterion for sulphur dioxide is set at 350 µg/m³, a level which is never reached anywhere, even though regulations would permit it to be exceeded 24 times a year.

Nitrogen oxides and particulates The assessment report states that the calculated emissions of nitrogen compounds and particulates figure everywhere below the limit values in regulations.

Heavy metals, arsenic and PAHs According to the assessment report, there will only be small emissions of heavy metals from silicon manufacturing. Heavy metals enter into the production process together with the raw materials, especially coal, although some metals also accompany quartz. The assessment report applies the procedures submitted by the Nordic countries to the IPPC office for a review of the European Union's BAT descriptions. Since the greater part of the heavy metals will be retained in one of the final products, whether silica powder or silicon, it will be important for improving product quality to utilise selected, pure quartz and coal that have been washed to remove the ash. Washing the coal will lower the amounts of heavy metals and sulphur considerably, though all of the mercury is expected to be organically fixed and impossible to rinse out of the coal. However, minimising the dust in emissions will further reduce the release of any heavy metals accompanying the particulates, and the target is for dust released through stacks to be approximately 0.1% or even less of the total dust formed in the production process. Emissions due to malfunctions or from non-point sources, combined with further such factors, could equal or surpass that. If the potential emission amounts above are compared to the stipulations of Regulation No. 990/2008, on emissions accounting, it is the released amounts of arsenic and mercury which come closest to classification as subject to accounting. The

² This table is based on Regulation No. 251/2002, on sulphur dioxide, nitrogen dioxide and monoxide, benzene, carbon monoxide, lead and particulate matter in the atmosphere, and also on informing the public, except that the provision on B(a)P is based on Regulation No. 410/2008, on atmospheric arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons.

Regulation sets their limit values at 20 kg/year and 10 kg/year, respectively, with the projected Thorsil emissions figuring to about 25% of these amounts. As for cadmium, it is said to amount to about 12% of the limits in this Regulation, while all other metals remain within 10% of the limits, based on 0.5% particulate emissions.

As the assessment report explains, Thorsil has no specific data on the percentage of B(a)P in the PAHs to be emitted by the manufacturing plant, but normally B(a)P has been assumed to comprise 1% of PAHs, permitting the assumption that B(a)P emissions could amount to some 3 kg/year, if the PAH amount is about 250 kg annually. In order to reduce PAH emissions further than what is usually expected from silicon metal production, Thorsil intends to employ bag filters of the optimum sort, so as to minimise the dust in emissions. The highest PAH concentration calculated was 0.0006 µg/m³, which is below the limit values in the Regulation.

The Planning Agency accepts that the emissions of heavy metals and arsenic will not be subject to the rules on emissions accounting, but heavy metals will unavoidably accompany the raw materials, so their accumulation will clearly need monitoring in the vicinity of the manufacturing plant and it is critical to keep up with their concentrations in the environs of Helguvík.

The Planning Agency believes Thorsil to have demonstrated through its calculations that sulphur dioxide concentrations outside of the dilution zone will lie below the limit values, whether in consideration of hourly or 24-hour values or of annual averages. The Thorsil computations are based on releasing less sulphur dioxide than United Silicon's operating licence is based on, i.e. 15 kg SO₂ rather than 20 kg SO₂ per tonne of silicon produced. In this manner, Thorsil's assessment report states that the application for an operating licence presumes emissions of less than 15 kg SO₂ per tonne of silicon produced, and the Planning Agency is of the opinion that the limits in the operating licence must be the reference from the start of operations, at least until monitoring reveals that it might be possible to set more lenient emission allowances. The Planning Agency also considers it critical, should any modifications need to occur in the proposed dimensions and arrangements of the buildings on the Thorsil lot, that a special investigation take place as to whether these modifications call for fresh calculations of pollutant dispersion. Special note is made of this because the downdraught impact on pollutant dispersion exercised by buildings on the Thorsil property seems to be appreciable. Therefore, the Planning Agency suggests to the municipality of Reykjanesbær that no modifications be made in plans for the lot nor any construction and development permits issued for significant modifications to structures on the Thorsil lot unless the developer has demonstrated that such modifications will not significantly change the dispersion of pollutants in the Helguvík area. The Planning Agency feels that the Thorsil silicon plant will have a somewhat negative impact on air quality around Helguvík, though this impact will for the most part be restricted to the close vicinity and for the most part be reversible.

4.3.2 The cumulative impact on air quality of the Thorsil plant together with the Norðurál aluminium smelter and the United Silicon plant

The **assessment report** notes that the evaluation of the cumulative impact on air quality of pollutants from the Thorsil and Norðurál operations together with those of the United Silicon plant was based on Thorsil producing 110,000 tpy of silicon and Norðurál producing 360,000 tpy [of aluminium], while the United Silicon emissions were based on an annual production of 100,000 tonnes of silicon and on the pollutants being distributed according to the assessment report for that development (Stakksbraut 9). The pollutant dispersion calculations regarding Thorsil and Norðurál, which are to be the two biggest firms in the area, were performed jointly, relying on meteorological data for the same five-year period; the calculations regarding United Silicon, however, were performed for a different five-year period. Figuring dispersion over a 5-year period is said to even out dissimilarities between individual years and to increase the precision of weather data. It must nevertheless be kept in mind concerning Helguvík that the waste incineration plant Kalka, Alur aluminium recycling and the fish processor Sildarvinnslan also operate there. Even though these companies release some of the same pollutants as the three

heavy-industry firms mentioned before, the smaller companies put out much less exhaust, with the emission and effects remaining within the margin of error.

The annual average concentrations of sulphur dioxide and nitrogen oxides emitted by the Thorsil, Norðurál and United Silicon plant operations are said in the assessment report always to lie within the limit values of regulations. For Thorsil and Norðurál, the highest calculated annual average concentration for sulphur dioxide is $5.4 \mu\text{g}/\text{m}^3$ and for United Silicon $9.9 \mu\text{g}/\text{m}^3$, whereas the limit values are $20 \mu\text{g}/\text{m}^3$. For nitrogen oxides, Thorsil's highest calculated value is approximately $2 \mu\text{g}/\text{m}^3$ and United Silicon's is $3.4 \mu\text{g}/\text{m}^3$, while the limit values are $30 \mu\text{g}/\text{m}^3$. In addition, all of the computed values for particulates and PAHs are under the limit values, with the computed annual averages for these environmental components comprising even lower proportions of the limit values in regulations.

As stated in the report, the assumption of sulphur dioxide emissions of $15 \text{ kg SO}_2/\text{t Si}$ from Thorsil results in a calculated 24-hour concentration from Thorsil and Norðurál which exceeds the limit values, $50 \mu\text{g}/\text{m}^3$, seven times annually at three locations some 250 m southwest of the more southerly exhaust opening of the Thorsil manufacturing plant. In the same area, the concentration from United Silicon calculates to about $10 \mu\text{g}/\text{m}^3$. Thus it is conceivable that the 24-hour concentration will rise above $50 \mu\text{g}/\text{m}^3$ over seven times a year, thereby bordering on or exceeding the limit values. If the Thorsil emissions are calculated as $20 \text{ kg SO}_2/\text{t Si}$, the combined Thorsil and Norðurál concentration in this same area exceeds $50 \mu\text{g}/\text{m}^3$ over seven times per year. This area is where the highest cumulative concentrations are likely to occur. Taking the lowest published value as the background concentration at all points, three small locations appear on other sides of the Thorsil lot where the concentration might reach $50 \mu\text{g}/\text{m}^3$ over seven times annually. It is partly for this reason, explains Thorsil, that it has decided in its operating licence application to plan on $1,650 \text{ t SO}_2/\text{year}$, or $15 \text{ kg SO}_2/\text{t Si}$, based on full capacity. No other location indicates any likelihood of the 24-hour concentration reaching $50 \mu\text{g}/\text{m}^3$ over 7 times/year (the 98.1% quantile).

The highest calculated hourly average for sulphur dioxide from Thorsil and Norðurál, for their part, and United Silicon, for its part, is said to be $125 \mu\text{g}/\text{m}^3$ and to occur in a location where the United Silicon concentration lies below $100 \mu\text{g}/\text{m}^3$. The environmental limits, in contrast, are $350 \mu\text{g}/\text{m}^3$ and may be exceeded 24 times a year. In the location where the United Silicon concentration calculates to over $150 \mu\text{g}/\text{m}^3$, the concentration from Thorsil and Norðurál approximates $100 \mu\text{g}/\text{m}^3$. Therefore, it is considered improbable that any sulphur dioxide concentrations will reach the limit values for the hourly period.

The assessment report states that the highest 24-hour values for nitrogen oxides never reach the nitrogen dioxide limits when the manufacturing plants are examined cumulatively. Regulations state that the hourly average concentration of nitrogen dioxide may not exceed $110 \mu\text{g}/\text{m}^3$ more than 175 times a year (or must be under that maximum 98.0% of the time). From Thorsil, the highest calculated concentration for the hourly period is $104.6 \mu\text{g}/\text{m}^3$ at a probability limit of 98.0%. From United Silicon, the highest calculated concentration for the hourly period is $13.9 \mu\text{g}/\text{m}^3$ at a probability limit of 98.0%. Based on calculations, the possibility thus exists, where the peak value of Thorsil is located a short distance southwest of the plant, that the cumulative total of nitrogen oxides (NO_x) will reach the hourly limits prescribed by regulations for nitrogen dioxide (NO₂) in a small location inside of the Helguvík dilution zone. Regulations state that the average hourly concentration of nitrogen dioxide may not exceed $200 \mu\text{g}/\text{m}^3$ more than 18 times a year (or must be under that maximum 99.8% of the time).³ From Thorsil, the highest calculated concentration of nitrogen oxides for the hourly period is $156.0 \mu\text{g}/\text{m}^3$ at a probability limit of 99.8%. From United Silicon, the highest calculated concentration for the hourly period is $56.0 \mu\text{g}/\text{m}^3$ at a probability limit of 99.8%. Calculations thus indicate the

³ Regulation No. 251/2002, which has already been referred to, gives two types of limits for hourly values. One limit is $110 \mu\text{g}/\text{m}^3$, in relation to a probability limit of 98%, and the other is $200 \mu\text{g}/\text{m}^3$, in relation to a probability limit of 99.8%, cf. Table 5.

possibility of cumulative nitrogen oxide concentrations reaching the regulatory limits for nitrogen dioxide. Nonetheless, nitrogen dioxide concentrations are unlikely to surpass the limits, because only part of the nitrogen oxides will be present as nitrogen dioxide, so that the nitrogen dioxide limits are considered to be met at all locations.

According to the assessment report, it is improbable that the combined concentrations of heavy metals, PM₁₀ particulates or PAHs will reach the limit values. Assessment of the environmental concentrations of heavy metals is based on the average annual distribution of particulates. Assuming that 0.5% of the Thorsil plant particulates will be carried past the scrubbing facilities, the maximum release of heavy metals will be about 5 kg/year, which is less than 1/10,000 of the particulate emissions. The average yearly arsenic concentration may therefore safely be postulated as the same fraction of the average yearly particulate concentration. It is said to be only at a small location southwest of Thorsil that the average annual particulate concentration will exceed 0.1 µg/m³. The arsenic concentration in that location may be presumed to be less than 1/10,000 of that amount, i.e. less than 0.01 ng/m³, contrasting with the regulatory limit of 6 ng/m³, which is 600 times greater. Since the Norðurál and United Silicon emissions are probably of similar dimensions, there is hardly any reason to evaluate more precisely the concentrations of arsenic and heavy metal, nor any need to go into further detail on the cumulative effects with Norðurál or United Silicon. If all of these companies are operating at capacity, the accumulation of heavy metals can be expected to resemble the patterns around Grundartangi. However, it is suggested that Thorsil, Norðurál and United Silicon sponsor a selection of sampling points in the normally warmer and lighter months of 2015, as well as a collection of moss samples.

The assessment report points out how it may be gathered from the above that the cumulative impact of Thorsil, the United Silicon plant and the Norðurál aluminium smelter will result in the pollution limits being exceeded in particular locations a short distance from the silicon plants. This relates to environmental limits on 24-hour sulphur dioxide concentrations regarding plant protection. Assuming Thorsil emissions of 15 kg SO₂/t Si, the concentrations of the aforementioned pollutants are not expected anywhere outside of this limited area to exceed the environmental limits in regulations. The impact of emissions is therefore regarded as somewhat negative in these particular locations but negligible outside of them as well as outside of the current Norðurál dilution zone and of the dilution zone planned for the Helguvík industrial area.

In his comment, Benóný Harðarson criticises the extensive sulphur emissions from the Thorsil plant. The third industrial plant will increase the pollution load and will release considerable amounts of sulphur dioxide a short distance from a town area of Reykjanesbær. Caution is thus called for, placing special emphasis on ensuring that sulphur dioxide concentrations remain below the limits, particularly by residential districts.

Thorsil's answers are that, based on the emission of 15 kg SO₂/t Si from the Thorsil plant, calculations of the cumulative impact from Thorsil, the United Silicon plant and the Norðurál aluminium smelter can be summarised as indicating that the pollution limits will be exceeded in particular locations within the dilution zone a short distance from the silicon metal plants. This relates to environmental limits on 24-hour sulphur dioxide concentrations regarding plant protection. Nowhere outside of this limited area do the concentrations of the aforementioned pollutants exceed the environmental limits in regulations. The impact of emissions is therefore regarded as somewhat negative within this limited area but negligible outside of it as well as outside of the dilution zone for the proposed Norðurál aluminium smelter.

The United Silicon comment maintains that the initial assessment report did not address the cumulative and synergistic impacts of exhaust pollution from Thorsil's proposed manufacturing plant together with that from other operating industrial plants that have a current operating licence. The cumulative impact will involve not only the pollutants sulphur dioxide, nitrogen oxides and particulates

but also other pollutants carried in considerable amounts from the proposed United Silicon plant, Norðurál's aluminium smelter and Reykjanesbær's waste incineration plant.

United Silicon clarifies that, in order to assess the cumulative impact in the area, it used the AERMOD atmospheric dispersion model. All of the predictable emissions from local operations with a current licence were included, before adding on the proposed exhaust from the Thorsil plant. After including the proposed Thorsil emissions in the mathematical model and assessing the cumulative impact, the results turned out to be entirely different from those presented in Thorsil's initial assessment report. The results of these cumulative impact calculations are said to show the annual average concentration of sulphur oxides to exceed the limit values at three area locations, one of which is in a residential area in the northern part of Reykjanesbær. The results of cumulative impact calculations are also said to show the 24-hour concentration of sulphur oxides to come very close to reaching the limit values, for instance by a residential area. After including the cumulative impact of all the operations and proposed operations that have an operating licence in the area, the atmospheric dispersion calculations indicated the impact to be much greater and much more serious than that stated in Thorsil's initial assessment report and also to exceed the area limit values, thereby causing a considerably negative impact on area air quality.

In light of the above comments from United Silicon and in accordance with Article 22 of Regulation No. 1123/2005, the Planning Agency decided to request an expert opinion regarding the assessment of impact on air quality. The Agency thus turned to Sigurður Magnús Garðarsson, professor in the Faculty of Civil and Environmental Engineering at the University of Iceland.

In his opinion, Sigurður Magnús Garðarsson observes that whereas the CALPUFF model was used in the Thorsil assessment of its plant in order to calculate SO₂ dispersion, United Silicon used the AERMOD model. Both the AERMOD and the CALPUFF models are recognised and have for instance been certified by the US Environmental Protection Agency (EPA), which has long experience in the application of atmospheric dispersion models. While the AERMOD model is constant (time-independent) and involves meteorological parameters derived from boundary layer interpretations, CALPUFF is able to model localised, time-dependent meteorological conditions. Both models offer the opportunity of considering near-field effects in order to assess a downdraught impact.

The expert opinion notes that United Silicon presents calculations which are based on the AERMOD model and include examples of locations where maximum concentrations occur. One of these examples shows the maximum SO₂ concentration from Thorsil to be about 2000 m from the point of emission. These computations are built on conventional AERMOD calculations of the plume from the point of emission, without including any downdraught effects (or any effects of buildings in the near-field). Thorsil, on the other hand, presents the location of the maximum annual average concentration as calculated by CALPUFF; these computations show the maximum 24-hour average to be located much nearer the point of emission, i.e. at a distance of some 200 to 400 m. Thorsil responded that its calculations show consideration for the effects of buildings by the point of emission and that these may exert a significant impact on plume behaviour, due to the downdraught impact and other near-field effects which may also matter. Furthermore, Thorsil responds that CALPUFF, when it is not accounting for the effects of buildings, locates the highest value at a distance of some 3000 m away. From the above, it is clear that United Silicon generally considers the maximum Thorsil concentration to be located much farther from the point of emission than the Thorsil computations indicate. While the United Silicon calculations are not called wrong by Thorsil, they are said not to account for the effects of buildings on the air stream and thus on SO₂ dispersion. It is well known that these effects can frequently be substantial. According to Thorsil, United Silicon says that there is no need to show consideration for buildings, pointing out that the plume height is sufficient and the buildings in the wind shadow not high enough to exercise an influence. There are however yet other aspects which may have an impact, states Thorsil, such as atmospheric stability and buildings on the side facing the wind. Due to the considerable number of buildings in the near-field, as brought out in the initial assessment report, AERMOD model runs would need to include this aspect in order to confirm the

declaration that it does not matter; however, this was not done. Based on its points above, Thorsil finds no reason to cast doubt on the downdraught impact on SO₂, nor is it possible to say that the AERMOD runs indicate no existence of a downdraught impact, since the software component was not applied which would have included this impact in the AERMOD computations. In its answers, Thorsil states that no sensitivity analysis of maximum concentration locations was carried out. Nonetheless, uncertainties may exist in calculations of the location of greatest concentration, giving every reason to contemplate monitoring to check on the predictions. There is also reason to inform regulatory bodies if changes occur in the design of emission equipment and/or building arrangements, because such changes might affect SO₂ distribution.

When the period of public presentation was over, new documentation arrived from United Silicon, accompanied by different calculations of pollutant dispersion that were performed by Force Technology, Denmark. In these, the cumulative pollution from United Silicon, Norðurál and Thorsil was for instance computed and added onto that of the other companies which operate in the area but which release much less sulphur dioxide, i.e. Kalka, the fishmeal plant and Alur. These computations show the sulphur dioxide concentrations, regarding both short- and long-term values, to be below the limit values in Regulation No. 251/2002.

The Planning Agency considers the Thorsil assessment report to have demonstrated that the concentrations of particulates and nitrogen oxides resulting from cumulative impact with the United Silicon plant and the Norðurál aluminium smelter will be within the limits of Regulation No. 251/2002 as regards both the short-term references (hourly and 24-hour values) and the annual averages. Also, the Planning Agency agrees with the assessment report on B(a)P being within the limits of Regulation 410/2008, based on the usual percentage of B(a)P in PAHs.

The Planning Agency is in agreement with the assessment report conclusion that the cumulative heavy metal concentrations from industrial plants in the Helguvík area are unlikely to reach the limit values concerning emissions accounting pursuant to Regulation No. 990/2008. Nevertheless, the Planning Agency considers it evident, as mentioned in the assessment report, that heavy metals will accumulate in the environs of the Helguvík industrial plants, with such accumulation being known in the vicinity of comparable manufacturing plants in Iceland as well as abroad. The raw material throughput at the Thorsil silicon metal plant will definitely be some 700,000 tpy, so even if the concentrations of heavy metals amount to only a trace of these raw materials, they will unavoidably be transported from the manufacturing plant along with dust, rendering it important to keep particulate emissions to the absolute minimum. The Planning Agency thus believes it is necessary to monitor the concentrations of these substances in mosses from the beginning, initially by obtaining base data on local conditions before the manufacturing plants commence production and then continuing in a regular manner to measure area developments once operations have begun there.

Inconsistencies in the calculations which have been presented on the location and concentration of sulphur dioxide illustrate the necessity of examining the calculations and their assumptions carefully. Comparing the two different mathematical models, CALPUFF as used by Thorsil and AERMOD as used by United Silicon, has brought to light that models similar to AERMOD tend to over-calculate concentrations at great distances, so that CALPUFF has proved better for pinpointing maximum concentrations located far from the plant.⁴ Building on the expert opinion from Sigurður Magnús Garðarsson, the Planning Agency finds it probable that the difference between the Thorsil and United Silicon calculations can to some extent be explained by the consideration given in the Thorsil calculations to the impact of buildings in the area.

⁴ Rood, A.S. 2014: Performance evaluation of AERMOD, CALPUFF, and legacy air dispersion models using the Winter Validation Tracer Study dataset. *Atmospheric Environment* 89, pp. 707-720.

Also: http://www.epa.gov/scram001/dispersion_prefrec.htm.

The Planning Agency feels that even though Thorsil has shown the concentrations of pollutants other than sulphur dioxide to remain within the limit values outside of the Helguvík dilution zone which was demarcated for Norðurál, the air quality in the Helguvík environs will deteriorate considerably due to substances from the cumulative exhaust of the proposed operations. Since this involves a substantial amount of pollutants entering the atmosphere, the impact will be considerably negative. On the other hand, this impact will mostly be localised and reversible, except for the accumulation of heavy metals which may be expected in the area. In order to reduce pollutant concentrations in the environs of Helguvík, Thorsil has decided on the one hand to raise its stacks from the 40 m which was proposed in the scoping document to as high as 53 m, and on the other hand to keep its sulphur dioxide emissions below 15 kg SO₂ per tonne of produced silicon.

The Planning Agency finds it necessary to verify the air quality calculations by means of continuous monitoring. Moreover, it will be appropriate to pause after each phase of building the manufacturing plants in the area in order to observe what the environmental effects have been.

When the Environment Agency is carrying out its periodic review of an operating licence, according to Article 20 of the Regulation on operating licences for business activities which may result in pollution, the Planning Agency suggests that Thorsil's operations be reduced if pollution should prove greater than expected and greater than that which is permitted by Article 21 of the Regulation.

The environmental impact assessment of the Norðurál aluminium smelter at Helguvík, which is to have an annual production capacity of 250,000 tonnes, was completed with a ruling by the Planning Agency on 4 October 2007. Although construction is not finished, the company has an operating licence, issued by the Environment Agency on 10 September 2008, to produce 250,000 tpy. The environmental impact assessment of the United Silicon plant (previously called Stakksbraut 9) was completed with a Planning Agency ruling of 10 May 2013; this plant is to have a capacity of 100,000 tonnes. Plans call for constructing this plant in two equal phases, each of 50,000 tonnes, and the plant has an operating licence issued by the Environment Agency on 3 July 2014 for producing 100,000 tpy of silicon. Construction on this manufacturing plant started in 2014. As outlined above, Thorsil plans on erecting its manufacturing plant in two equal phases of 55,000 tonnes each. It must be expected that all of the above manufacturing plants could be built and operated in line with current intentions and the permits obtained through the licences issued. Nonetheless, both the review provisions of the operating licences and the division of the manufacturing plants into phases give the opportunity of evaluating how an earlier phase has turned out before commencing further development. With an eye to the substantial plans for manufacturing operations in the Helguvík industrial area, located close to a residential district of Reykjanesbær, the Planning Agency considers it necessary to study monitoring results carefully when reviewing operating licences and to follow the results of monitoring when deciding the stance on granting operating licences for later phases.

4.4 GREENHOUSE GAS EMISSIONS

The assessment report states that Thorsil will have to acquire emission permits for greenhouse gases through the EU Emissions Trading Scheme (ETS), to which Iceland is party. The Thorsil emissions will have two components as viewed within the Scheme: on the one hand carbon dioxide emissions stemming from fossil fuels and on the other hand carbon dioxide emissions stemming from renewable forests. Thorsil says it will apply to the Environment Agency of Iceland for a permit regarding carbon dioxide emissions stemming from fossil fuels and will obtain licences in compliance with provisions of the pertinent laws and regulations. Given that both the first and second phases of the proposed plant are run at full capacity, the assessment report estimates 600,000 to 650,000 tpy of carbon dioxide to originate from fossil fuels. In the future, Thorsil says it aims to reduce its CO₂ emissions to below 600,000 tpy, which would be comparable to the targets of some other companies now commencing

silicon manufacture and would be only slightly over the reference values, 5 t CO₂/t Si, that appear in the IPCC guidelines pursuant to the United Nations Framework Convention on Climate Change.

When asked by the Planning Agency why it did not figure on being below the IPCC reference values, Thorsil answered that the company would be starting to produce silicon in a new manufacturing plant at a new location. Although contracts with the furnace manufacturers or other parties selling technical equipment had not yet been concluded, such parties did not normally guarantee that emissions would measure below particular values; rather, this would have to be achieved through systematic operations at the plant itself. However, the IPCC reference value was a value which better companies should be able to achieve, so Thorsil also aimed to achieve it once operations had reached an equilibrium, even if the company was unable to guarantee this upon startup.

The Planning Agency points out how the Thorsil operations will add appreciably to Iceland's overall greenhouse gas emissions and considers it imperative for Thorsil to organise its operations in such a manner that the release of greenhouse gases will lie below the IPCC limit values as soon as possible. Even so, significant greenhouse gas emissions will be involved, so the Agency considers the impact resulting from the plant's greenhouse gas emissions to be considerably negative.

4.5 MONITORING OF ENVIRONMENTAL IMPACT

Appendix 2 to the assessment report presents a draft environmental monitoring plan for the Helguvík Thorsil plant, 2015 - 2025. The monitoring plan states that air quality will be monitored at two metering buildings, located by the north and south boundaries of the industrial area. It is the concentrations of sulphur dioxide (SO₂), hydrogen sulphide (H₂S), particulates (PM₁₀ and PM_{2.5}), nitrogen oxides (NO_x) and the PAHs in particulates (PM₁₀) which are to be monitored, as well as the sulphur attached to dust particles. Plans call for continuous sample collecting year round, starting no later than 12 months prior to plant startup.

Moreover, Thorsil says that it will participate in other measurements which might relate to its operations, when and if such measurements are undertaken. Examples might include the monitoring of heavy metals in mosses or freshwater measurements.

The Environment Agency opinion notes the importance of monitoring the environs of Helguvík in the same manner as that which has been carried out at the Grundartangi industrial area, by monitoring the main air pollutants and observing their dispersion and concentrations. Furthermore, the Environment Agency finds it important to monitor the accumulation of heavy metals and PAH substances in the environment.

The municipality of Reykjanesbær supports this view, pointing out that even though pollutant concentrations have been calculated below the limit values, it is imperative to confirm this through the joint monitoring of local manufacturing plants.

Thorsil agrees, stating in its response that it has sought consultation with Norðurál as well as referring to its ideas, which in fact were drawn up in consultation with the Environment Agency, on monitoring the Helguvík area based on the foundational practices from Grundartangi.

The Planning Agency finds it necessary to monitor air quality in the environs of Helguvík and directs in particular to the industrial operators and the Environment Agency that the choice of sites for the measuring points relate to locating such points along the line in which the greatest pollutant concentrations will spread towards the town area of Reykjanesbær, according to mathematical models. Concentrations of the main heavy metals will also need monitoring in local mosses. In agreement with Reykjanesbær, the Planning Agency finds it necessary that the Helguvík industrial plants sponsor the monitoring of environmental impact jointly and suggests to the Environment Agency that the same kind of arrangements be considered as those practised in the Grundartangi area.

5 THE PLANNING AND LICENSING SITUATION

In regard to the status of planning and licensing for the Thorsil silicon metal plant with a capacity of 110,000 tpy at Helguvík, the Planning Agency points out the following:

- The development is in keeping with the Reykjanesbær municipal plan.
- Amendments are being prepared to the site plan for the Helguvík industrial area.
- The project is subject to a construction permit from Reykjanesbær, as provided for in Article 5 of Regulation No. 772/2012, on construction permits.
- The project is subject to a building permit, as provided for in Article 9 of Act No. 160/2010, and to fire design, as provided for in Article 22 of Act No. 75/2000.
- The project is subject to an operating licence from the Environment Agency, as provided for in Act No. 7/1998 and Regulation No. 785/1999.
- The project is subject to an operating licence from the Administration of Occupational Safety and Health, as provided for in Article 95 of Act No. 46/1980.
- The project is subject to an emission permit, as provided for in Article 8 of Act No. 70/2012.

6 CONCLUSIONS

In accordance with Article 11 of the Environmental Impact Assessment Act, No. 106/2000, and Article 24 of Regulation No. 1123/2005, the Planning Agency has examined the Thorsil assessment report that was submitted according to Article 10 of the same Act. The Thorsil assessment report was based on the initial environmental impact statement which had been advertised, as well as opinions and comments that were received during the period of public presentation for the initial statement.

In the opinion of the Planning Agency, the Thorsil assessment report fulfilled the requirements of acts and regulations on environmental impact assessment regarding the aspects mentioned in Article 18 of Regulation No. 1123/2005. The Agency also feels that the assessment report accounted for the comments and opinions which were received during the period of public presentation for the initial environmental impact statement and that the report provided satisfactory answers.

On account of the size and proximity of the buildings, the Planning Agency believes that the visual impact will be considerably negative from the closest town area of Reykjanesbær, although landscaping and the visual design of the buildings may be able to diminish this impact somewhat. The Planning Agency considers Thorsil to have demonstrated that the manufacturing plant will not have any considerably negative impact on sound levels in residential districts and also to have demonstrated that nitrogen oxides and particulate concentrations will remain within the limits of Regulation No. 251/2002, based on both the short-term references (hourly and 24-hour values) and the annual averages. It has also been established that B(a)P will be within the limits of Regulation 410/2008, based on the usual percentage of B(a)P in PAHs. In addition, the Planning Agency agrees with the developer's assessment that the cumulative concentrations of heavy metals and arsenic from industrial plants in the Helguvík area are unlikely to reach the limit values concerning emissions accounting pursuant to Regulation No. 990/2008. Nevertheless, the Planning Agency considers it evident that heavy metals will accumulate in the environs of the Helguvík industrial plants, making it necessary to start collecting base data on local conditions before the manufacturing plants commence production and then to continue to measure in a regular manner how the concentrations of these substances develop once operations have begun.

The Planning Agency considers Thorsil to have demonstrated that sulphur dioxide concentrations outside of the dilution zone will lie below the limit values, whether in consideration of hourly or 24-

hour values or of annual averages. Nonetheless, the 24-hour values may be expected to exceed the limit values in restricted areas within the dilution zone.

The Planning Agency feels that even though Thorsil has shown the concentrations of pollutants other than sulphur dioxide to remain within the limit values outside of the dilution zone demarcated by Helguvík for the Norðurál aluminium smelter, the air quality in the Helguvík environs will deteriorate considerably due to substances from the cumulative exhaust of the proposed local operations. Since this will involve a substantial amount of pollutants entering the atmosphere close to a residential area, the impact will be considerably negative. On the other hand, this impact will mostly be localised and reversible, except for the accumulation of heavy metals which may be expected in the area.

The Planning Agency considers it critical, should any modifications need to occur in the proposed arrangements of the buildings on the Thorsil lot, that a special study be carried out as to whether these modifications call for revised calculations of pollutant dispersion. This is mentioned in particular because the downdraught impact on pollutant dispersion exercised by the Thorsil buildings seems to be appreciable. Therefore, the Planning Agency suggests to the municipality of Reykjanesbær that no modifications be made in plans for the lot nor any construction and development permits issued for significant modifications to structures on the Thorsil lot unless the developer has demonstrated that such modifications will not significantly alter the dispersion of pollutants in the Helguvík area. The Planning Agency feels that the Thorsil silicon plant will have a somewhat negative impact on air quality around Helguvík, though this impact will for the most part be restricted to the immediate vicinity and for the most part be reversible. Previously, a dilution zone was defined for the Norðurál operations which is quite extensive and for instance extends across the Thorsil lot and its immediate vicinity. This dilution zone is shown by pollution dispersion calculations to relate to the Thorsil operations too, because the 24-hour values for sulphur dioxide may be expected to reach the regulatory limit values at several locations within the dilution zone.

Clearly, the Thorsil operations will add appreciably to Iceland's overall greenhouse gas emissions. The Planning Agency considers it imperative for Thorsil to organise its operations in such a manner that the release of greenhouse gases will be below the IPCC limit values at the earliest possible opportunity. Even so, significant greenhouse gas emissions will be involved, so the Agency considers the impact resulting from this release of greenhouse gases to be considerably negative.

The Planning Agency finds it necessary for air quality to be monitored in the environs of Helguvík and suggests in particular to the industrial operator and the Environment Agency that the choice of site for a measuring point be based on one measuring point being located along the line in which the greatest pollutant concentration will spread towards the town area of Reykjanesbær. Concentrations of the main heavy metals in local mosses will also need monitoring. While both of these aspects follow from the monitoring plan in Appendix 2, accompanying the Thorsil assessment report, the Planning Agency considers it necessary to stipulate both aspects in its ruling.

The Icelandic Planning Agency proposes the following conditions:

1. Should changes occur to the structures on the Thorsil lot, the company must demonstrate that these will not significantly affect pollutant concentrations outside of the dilution zone. If there is any reason to suppose that such changes might increase pollution outside of the dilution zone, Thorsil shall present revised calculations on pollutant dispersion, asking the Environment Agency for its opinion on this dispersion before Reykjanesbær municipality amends the site plan or grants a permit for such changes.
2. Thorsil's sulphur dioxide emissions must remain below 15 kg of SO₂ per tonne of produced silicon, at least until monitoring reveals that it might be possible to increase the emissions allowed.

3. The monitoring plan must provide for an air pollution measuring point along the line in which the greatest pollutant concentrations will travel towards the nearby town area of Reykjanesbær, based on mathematical modelling.
4. The monitoring plan will have to state that accumulation of the main heavy metals will be regularly measured in local mosses.

Reykjavík, Iceland
1 April 2015

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Skipulagsstofnun