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Critical Metals

CRITICAL METALS LTD.

VANADIUM RECOVERY PLANT, PORI
ENVIRONMENTAL IMPACT ASSESSMENT (EIA) REPORT

Cover photo by Einari Vuorinen

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PUBLIC DISPLAY AND CONTACT INFORMATION

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ABSTRACT

Project description and alternatives

Australian registered company Critical Metals Ltd (CMS, www.criticalmetals.eu) started the environmental impact assessment procedure (EIA procedure) for the Vanadium Recovery Project (VRP) in April 2021. The aim of the VRP is to produce high-purity vanadium pentoxide for the needs of the European industry. Vanadium will be recovered from slag, a by-product of the steel industry via a hydrometallurgical process. The VRP will also produce two by-products, calcium carbonate rich stabilised slag material (SSM) and sodium sulphate.

The plan is to locate the VRP at the Port of Pori in Tahkoluoto, Finland. In addition to port operations, there are plenty of other industrial activities in the Tahkoluoto area. The total size of the VRP area, which consists of the southern and northern VRP area, is approximately 23.65 hectares.

The alternatives to be assessed in the EIA procedure are:

Alt.1:	Construction of the VRP in Tahkoluoto, Pori. The plant is expected to produce vanadium pentoxide powders or flakes at the rate of up to 9,000 tonnes per year. In addition, two by-products will be produced including calcium carbonate $CaCO_3$ rich stabilised slag material (SSM) at the rate of 415,000 dry tonnes per year and sodium sulphate at 30,000 dry tonnes per year. As a raw material, the plant will use slag feedstock from steel industry with a maximum throughput of 300,000 dry tonnes per year.
Alt. 1a:	Slag feedstock from steel industry, which is used as raw material in the VRP, has not received the status of by-product for vanadium recovery.
Alt. 1b:	SSM produced in the VRP has not yet received the status of by-product, in which case it is transported to be stored in an existing area authorised for an equivalent type of activity.
Alt. 0:	The project will not be implemented, so-called zero alternative.

Environmental impact assessment and interaction

According to the EIA Act, environmental impacts caused by the operation are assessed in the EIA procedure. Decisions on the project are not made in the EIA procedure, but it aims at producing information as a basis for decision making.

Interaction between different stakeholders and citizen participation are a central part of the EIA procedure. Public hearings will be organized both in the EIA programme and EIA report phases, in which nearby residents and other interested parties have an opportunity to express their opinions on the project planning and the environmental impact assessment of the project. Opinions can be submitted by the deadline provided in the public notice to the Southwest Finland ELY Centre, which acts as the coordinating authority. The

ELY Centre requests statements from the main authorities regarding the EIA programme and the EIA report.

Environmental impacts

Based on the environmental impact assessment, the project can be considered feasible with regard to environment. No impacts were identified during the assessment, which would prevent the implementation of the VRP or its alternatives. Harmful impacts identified in the assessment are acceptable or impacts can be reduced to the acceptable level through mitigation measures.

The impact assessment is prepared based on preliminary planning information of the VRP. The assessment is based on information about the current state of environment and the estimated changes to the environment caused by the VRP.

A summary of the results of the impact assessment is presented in the table on the following page. Various impacts are described by each impact in more detail in chapter 7.

Timetable

The timetable of the EIA procedure and the project is as follows:

- EIA programme phase was completed on June 10, 2021, when the Southwest Finland ELY Centre provided its statement;
- EIA report was completed in late September 2021 and it will be on public display during September-November 2021, when the second public hearing will be organized;
- EIA procedure will be completed in January 2022, when the Southwest Finland ELY Centre will provide its reasoned conclusion on the EIA report.

In addition, the implementation of the project requires the granting of an environmental permit, a chemical permit and a building permit.

The aim is to start the detailed design of the VRP in 2022 and subject to positive permit decisions and a positive final investment decision commence construction during 2023. The estimated duration of the construction phase is about two years. Testing phase would to start in the mid 2024 with commercial production planned for commencement in late 2024.

Significance of impact	Large positive impact (+++)	Large positive impacts: – Expected to reduce CO_2 emissions by sourcing CO_2 that has been sequestered from industry before it reports to atmosphere – Saves natural resources,as vanadium is recovered from existing stockpiles without opening a new mine – Reduces the need for opening new mines to supply European industry – Positive multiplier effects on the development of industrial infrastructure, jobs and regional economy especially during the construction phase
	Moderate positive impact (++)	Moderate positive impacts on community structure and land use: – Promotes circular economy – Promotes employment and regional economy during the construction phase – Promotes the achievement of the national land use objectives – Reinforces and supports the operations in the existing port and industrial area In addition, social impacts as a whole are estimated as moderate and positive (large positive impacts on employment and business life as well as minor negative impacts on health, living conditions and comfort)
	Minor positive impact (+)	-
	Neutral/No impact	No impacts on: – Soil and bedrock or groundwater in normal operation – Quality of sea water, water organisms and fish stock in normal operation
	Minor negative impact (-)	Minor negative impacts on: – Air quality due to dust emissions from slag and SSM stockpiles and minor process emissions – Soil and bedrock during the construction phase – Landscape and cultural environment – Natural values In addition, significance of impact is estimated as minor on: – Impacts related to accidents and disturbances – Impacts related to the treatment of slag, products and waste (dusting) – Impacts related to health, living conditions and comfort
	Moderate negative impact (- -)	Moderate negative impacts: – Growing road, vessel and rail traffic volumes as well as impacts on the level of service of traffic and traffic safety – Impacts related to the treatment of slag, by-products and waste (dusting, stormwater discharge to the water system in rare exceptional situation as well as need for a stockpile area and impacts related to disposal activities (needed capacity for waste disposal will increase in alternative Alt.1b, in which SSM material is waste)
	Large negative impact (- - -)	-

USED TERMS AND ABBREVIATIONS

Abbreviation	Description
a	Year (1 year = 365 days), time unit
Alt.0	Alternative 0, so-called zero alternative, non-implementation of the project
Alt.1	Alternative 1, implementation of the project, construction of a vanadium recovery plant in Tahkoluoto, Pori, which uses slag feedstock with a maximum capacity of 300,000 dry tonnes per year.
AMV	Ammonium metavanadate, by-product
BAT	Best Available Technique
BOF Slag	Basic Oxygen Furnace
CaO	Calcium oxide
$CaCO_3$	Calcium carbonate
°C	Celcius-degree, temperature unit
C_6H_6	Benzene
CLP	Regulation EC No 1272/2008 on the Classification, Labelling, and Packaging of substances and mixtures (CLP regulation)
CMS	Critical Metals Ltd
CO_2	Carbon dioxide
CO	Carbon monoxide
COD	Chemical Oxygen Demand, quality parameter for waste water
Coagulant	A substance which causes particles in a liquid to curdle and clot together.
Colloid	Type of mixture that can be considered as an intermediate between a homogeneous and heterogeneous mixture. In a colloidal solution, the particles are so finely divided that the mixture cannot be considered heterogeneous, but still larger than the molecular-level particles of a homogeneous mixture.
Condensate	Product of the condensation process. In condensation, the gaseous substance becomes a liquid.
Contactor	A device, in which a solution impregnated with vanadium is treated.
d	Day (1 day = 24 hours), time unit
dB	Decibel, sound level unit of measurement

Abbreviation	Description
EC	European Community (now EU)
EC50	Effective concentration. Concentration, in which half of the test animals suffer from some effect (immobility, prevention of growth).
ECHA	European Chemicals Agency
EEC	European Economic Community
EIA	Environmental Impact Assessment
ELY	Centre for Economic Development, Transport and the Environment
EMMA	Ecologically significant underwater area of marine environment in Finland
Extraction	Way to separate a desired substance from its mixture by selective solubility.
EU	European Union
Fe_2O_3 or Fe_3O_4	Iron oxide
FINIBA-areas	Important Bird Areas in Finland (IBA-areas, internationally important bird areas)
Flocculant	Chemical that promotes flocculation by causing colloids and other suspended particles in liquids to aggregate.
g	Unit of mass: 1 000 mg 0,001 kg
GTK	Geological Survey of Finland
GWh	Gigawatt hour, energy unit
H_2SO_4	Sulphuric acid
Hydrocyclone	A device to classify, separate or sort particles in a liquid suspension based on the ratio of their centripetal force to fluid resistance. Hydrocyclones can also be used for separating liquids of different densities.
Hydrometallurgy	One of the manufacturing techniques of metal. It includes the use of aqueous solutions for the recovery of metals from ores, concentrates and recycled or residual materials.
IBA-areas	Important Bird and Biodiversity Areas, IBA
Ion exchange	Ion exchange (IX). Process, in which ions, cations and anions in solution are exchanged to anions and cations in solid matrix.
kg	Unit of mass, 1 000 g
KPU	National park, code for the National Conservation Programme of state-owned areas.

Abbreviation	Description
kWh	Kilowatt hour, energy unit
LAeq	Equivalent continuous sound level, unit decibel (dB)
LC50	Lethal concentration, concentration, in which half of the test animals die during a test with a certain duration
LD Slag	A by-product of the Linz-Donawitz process
LNG	Liquefied natural gas
Lipasto	Calculation system for traffic exhaust emissions and energy use in Finland (maintained by the Technical Research Centre of Finland, VTT)
MAALI-areas	Regionally important bird areas
MAO	Nationally valuable landscape area
MARA	Government Decree on the Recovery of Certain Wastes in Earth Construction (843/2017)
MATTI	Soil condition data base
MEA	Monoethanolamine
mg	Unit of mass: 1 000 µg, 0,001 g
$MgAl_2SO_4$	Magnesium aluminate
µg	Unit of mass: 0,000001 g
µm	Unit of length: 0,000001 m
MJ	Megajoule, energy unit
MML	National Land Survey of Finland
MnO	Manganese oxide
MWh	Megawatt hour, energy unit
MRL	Land Use and Building Act
mS/m	Unit of electrical conductivity, 1 Siemens = 1 A/V
m/s	Unit of speed, for example wind speed or flow speed
N2000	Height system
Na_2SO_4	Sodium sulphate
NAOH	Sodium hydroxide
Natura area	Natura 2000 area network protects important habitats and species in the European Union.
NH_3	Ammonia
$(NH_4)_2SO_4$	Ammonium sulphate
NMT	Neometals Ltd
NO_2	Dinitrogen oxide

Abbreviation	Description
NO_x	Nitrogen oxides
NOEC	No observed effect concentration, maximum concentration, which will not have significant harmful impacts on test animals.
Organic	Biogenic, biotic, of natural origin
pH	Degree of acidity
Phase	State of matter, distinct form in which matter can exist, which is separated by an interface from another phase. Generally, three types of phases can be defined: gas phase, liquid phase and solid phase.
PIMA	Contaminated soil
PIMA Decree	Government Decree on the Assessment of Soil Contamination and Remediation Needs (214/2007)
PM_{10}	Inhaled particles, size max. 10 µm
PLS	Vanadium-bearing Pregnant Leach Solution
PNEC	Predicted no-efficient concentration. Non-harmful concentration which is not expected to have impacts on organisms.
Pulpering	Mass decomposition
Pyrometallurgy	Metal manufacturing by high temperatures.
Raffinate	Solution, which has had a component or components removed
REACH regulation	Regulation of the European Union for regulation, evaluation, authorisation and restriction of chemicals (2006/1907/EC).
reagent	Substance or compound added to a system to cause a chemical reaction forming a part or whole of the end product. Solvents and catalysts are not classified as reagents.
RISAB	Recycling Industries Scandinavia AB, Swedish subsidiary of Critical Metals Ltd
RSO	Code for the coast protection programme
SAC	Special Area of Conservation
SEVESO II	Directive, which aims at controlling of major accident hazards involving hazardous substances, especially chemicals.
SiO_2	Silicon dioxide
Slag	Converter slag, slag product used as raw material in the process
SO_2	Sulphur dioxide
SPA	Special Protection Area pursuant to the Bird Directive
SSAB	Steel producer, provides slag used as raw material in the process

Abbreviation	Description
SSM	Calcium carbonate rich stabilised slag material, by-product from the process
SIA	Social Impact Assessment
SOTE	Social and health services
Stripping	Physical separation process where one or more components are removed from a liquid phase by a gas or vapor stream.
SYKE	Finnish Environmental Institute
t	Unit of mass, tonne (1000 kg)
Teams	Hub for team collaboration
TiO_2	Titanium dioxide
TUKES	Finnish Safety and Chemical Agency
TVOC	Total Volatile Organic Compounds
V_2O_5	Vanadium pentoxide, end product from the process
VELMU	Inventory programme for underwater marine biodiversity
VNa	Government Decree
VNp	Government Decision
VRP	Vanadium Recovery Project
YSA	Environmental Protection Decree or private nature conservation area
YSL	Environmental Protection Act

1 Project description

The aim of the Vanadium Recovery Project (VRP) is to produce high-purity vanadium pentoxide for European industry. Vanadium will be recovered from slag, a by-product of the steel industry via a hydrometallurgical process. The VRP will also produce calcium carbonate rich slag material (SSM) and sodium sulphate as by-products.

1.1 Project developer

Critical Metals Ltd (CMS) (www.criticalmetals.eu) and its wholly owned subsidiary company Recycling Industries Scandinavia AB (RISAB) are responsible for the VRP. A Finnish company will be established for the project.

Australian registered company Neometals Ltd (NMT) is the largest shareholder in CMS (holding 19.9 %) (www.neometals.com.au). NMT and its wholly owned subsidiary company Avanti Materials Ltd are the financial and technology partners for the VRP.

Subject to the parties making a positive investment decision (FID), CMS will transfer a 50 % equity interest in RISAB to NMT.

1.2 Aim and background

Vanadium is a critical raw material, according to the European Commission. Critical raw materials refer to raw materials that are of great economic importance to industry in the EU region, but with high risk to availability (Ministry of Employment and Economy 2019).

In 2020 the total global vanadium production by raw material type was 114 000 tonnes. Raw materials supply comprised primary vanadium ores (18 %), vanadium as a co-product of steel production (68 %) and other sources (14 %) (Vanitec Ltd. 2021, Vanadium Market Analysis March 2021). China produced the most vanadium (63 %) followed by Russia (8 %), South Africa (8 %), Europe (7 %) and Brazil (6%).

By 2025 global vanadium consumption is estimated to reach 170,000 tonnes/year. This rate of consumption will be driven by continued growth in global steel production, higher specific vanadium consumption rates (kilograms of vanadium consumed per metric tonne of steel produced) in China, the world's largest steel producer, and the development of VRFB and other energy storage technologies utilizing vanadium. It is estimated that vanadium demand for energy storage applications will increase from 1 881 tonnes in 2020 to 24 500 tonnes in 2025, nearly 15 % of global consumption (TTP Squared Inc).

According to the National Battery Strategy 2025 published by the Finnish Ministry of Employment and Economy in 2021, the Working Group sets out seven objectives for the 2021-2025 strategy period: growth and renewal of the battery and electrification cluster, growth of investments, promotion of competitiveness, increase notoriety in the world, accountability, key roles in new value chains in the industry, and the promotion of circular economy and digital solutions. The change requires large quantities of critical raw materials, in which Finland can provide not only mineral reserves and raw material processing, but also technology solutions and know-how in production technologies (Ministry of Employment and Economy 2021).

CMS entered into an agreement with the steel producer, SSAB, to purchase slag from steel production plants in Oxelösund and Luleå, Sweden, and from Raahe, Finland. CMS aims to extract vanadium from slag and produce high-purity vanadium pentoxide to meet the needs of the European industry.

Under this scenario vanadium would be sourced from slag rather than by mining and processing vanadium-rich ore from the earth. The VRP will contribute to the decreasing reliance of European industry for the supply of vanadium produced elsewhere. A significant volume of CO_2 is used in the vanadium recovery process, and the aim is to source CO_2 from emitters before CO_2 goes into the atmosphere. The VRP is an example of the circular economy in action and is therefore an important project within the European region. The VRP will bring along cooperation in research and development, investments and employment benefits.

Several potential locations in England, Sweden and Finland were considered for the VRP. Tahkoluoto in Pori, Finland was selected as the most suitable location for the project, due to good logistical connections to international markets, existing infrastructure and proximity to markets.

1.3 Current status and timeline of the project

Technical feasibility and scoping studies for the VRP have been conducted and further investigations, project planning and engineering are ongoing. A pilot plant was commissioned in Perth, Australia in June 2021. A final investment decision will be made in late 2022 and if positive, detailed engineering, procurement and project execution are scheduled to commence in 2023 with commissioning scheduled for mid 2024. Commercial production is scheduled to commence in late 2024 (Figure 1.3-1).

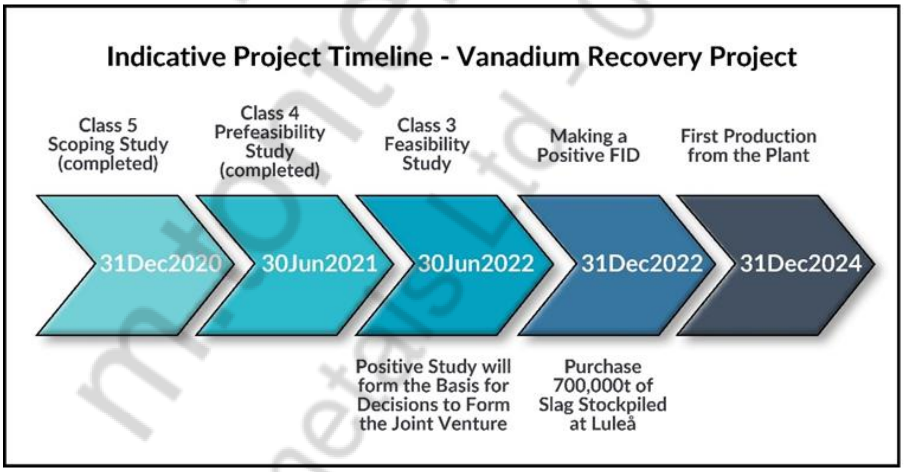

Figure 1.3-1. Vanadium Recovery Project, indicative timeline. The Class 5 and 4 studies have been completed.

1.4 Alternatives to be assessed

The alternatives assessed in the EIA procedure were:

Alt.1: Construction of the VRP in Tahkoluoto, Pori. The plant is expected to produce vanadium pentoxide chemical powders or flakes at the rate of up to 9,000 tonnes per year. In addition, two by-products will be produced including calcium carbonate $CaCO_3$ rich stabilised slag material (SSM) at the rate of 415,000 dry tonnes per year and sodium sulphate at 30,000 dry tonnes per year. As a raw material, the plant will use slag feedstock from steel industry with a maximum throughput of 300,000 dry tonnes per year.

Alt. 1a: Slag feedstock from steel industry, which is used as raw material in the vanadium recovery plant, has not received the status of by-product for vanadium recovery.

Alt. 1b: Calcium carbonate $CaCO_3$ rich slag material (SSM) produced in the vanadium recovery plant has not yet received the by-product status, in which case it is transported to be stored in an existing area authorised for an equivalent type of activity.

Alt. 0: The project will not be implemented, so-called zero alternative.

1.5 Connections to other projects, plans and programmes

The construction of the vanadium recovery plant in Pori is an independent project and it does not have connections to other projects except for cooperation with the existing industry.

The construction of the VRP will support the existing operations near the VRP site, such as deep-water port operations.

Carbon dioxide along with other reagents will be delivered to site by a supplier by either trucks, vessels, pipeline or a combination thereof.

The project is related to the national land use objectives, which aim at assuring that the nationally significant issues in the land use planning of regions and municipalities and in authority operations will be considered. The achievement of the key land use objectives must be evaluated in the project.

The project is also related to the strategic programme to promote circular economy, as slag from steel industry is used as a raw material in the project. The goal of the programme is to strengthen the export-oriented industry and employment in Finland and at the same time reduce the use of natural resources and related carbon dioxide emissions and other environmental impacts. (Government principal decision on the strategic programme to promote a circular economy, March 30, 2021).

The National Waste Plan to 2023 contains the objectives for waste treatment and prevention of the generation of waste as well as measures for meeting the objectives. The National Waste Plan will be updated during the year 2021. At the same time, the period of validity will be extended to the year 2027 (Ministry of the Environment, Finnish Environment 1/2018). For its part, the project supports the achievement of the objectives of the waste plan by efficient utilization of raw materials, enabling the use and sale of by-products and recycling of process chemicals.

2 Alternative 1 (Alt.1)

2.1 Location and land use

The plan is to locate the VRP at the Port of Pori in Tahkoluoto, Finland (Figure 2.1-1). In addition to port operations, there are plenty of other industrial activities in the Tahkoluoto area. The total size of the VRP area is approximately 23.65 hectares.

The final location of the process facility and stockpiles will be specified during the design phase. Based on the current plan, the process facility would be in the southern part of the southern project area. Storage tanks for the primary process chemicals would be located adjacent to the plant. Slag stockpiles would mainly be in the northern project area and SSM stockpiles in the southern area. In addition, ponds for stormwater collection from stockpiles would be located both in the southern and northern areas.

The maximum amount of stored slag and SSM will be in total 2.4 million dry metric tonnes. In addition to the actual VRP area, SSM transported out of the plant can be stored in areas authorised for an equivalent type of activity, for example in the Peittoo re-cycling park. The current state of the southern VRP area is presented in Figures 2.1-2 and 2.1-3.

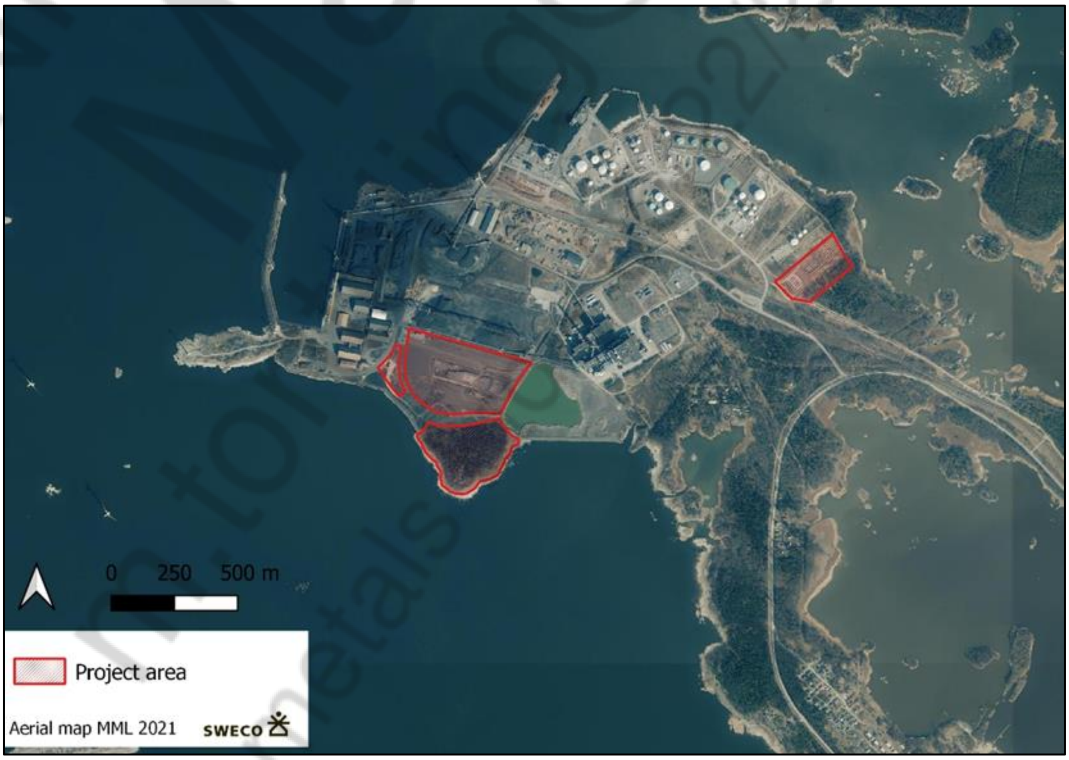

Figure 2.1-1. The VRP area is outlined in red (includes southern and northern area).

Figure 2.1-2. View over the VRP area looking north-east.

Figure 2.1-3. View over the VRP looking north-west.

2.2 Project plant description

2.2.1 General process description

The VRP is designed to process up to 300 000 dry tonnes of slag feedstock per year.

A significant amount of carbon dioxide (CO_2) is needed as a reagent in the treatment process (leaching). In addition, sulphuric acid, sodium hydroxide, sodium carbonate and ammonium sulphate are needed as reagents in the process.

The primary product is high-purity (minimum of 98.5 %) vanadium pentoxide (V_2O_5) chemical powder or flake. The maximum production of V_2O_5 will be 9 000 dry tonnes per year. The by-products are expected to be SSM and anhydrous sodium sulphate or Glaubers salt.

The simplified process flowsheet is presented in Figure 2.2-1.

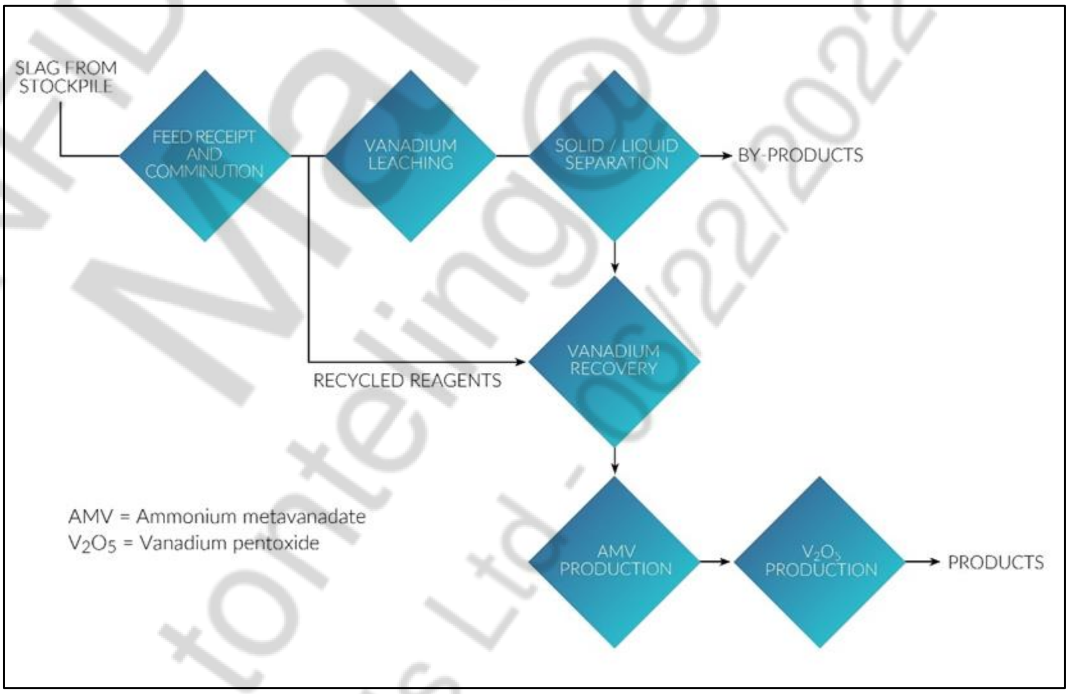

Figure 2.2-1.Simplified process flowsheet.

2.2.2 Project plant balance

The preliminary mass balance of the plant is presented in Table 2.2-1.

Table 2.2-1 Preliminary mass balance of the plant.

INPUTS: Raw materials, chemicals and other utilities	**Approximate / estimated usage per year**
Slag	300 000 dry tonnes (plus about 10 % moisture content)
Carbon dioxide (CO_2)	85 000 – 100 000 tonnes
Other chemicals	circa 70 000 tonnes
Diesel	1 800 m^3
Natural gas	400 000 GJ
Electricity	90.4 GWh
Raw water and potable water	180 000 tonnes
OUTPUTS: Products and by-products	**Volume per year**
Vanadium pentoxide chemical powder or flake (V_2O_5)	9 000 tonnes
Calcium carbonate $CaCO_3$ rich stabilised slag material (SSM)	415 000 dry tonnes (plus about 30 % moisture content)
Sodium sulphate (Na_2SO_4)	30 000 tonnes

It is possible that some steel / iron rich material may be scalped from the slag to improve the process outcomes and protect the mill from damage. If steel / iron rich material is recovered in a saleable form it will be sold to third parties. No further metal recovery from slag feedstock is planned at this phase.

2.2.3 Processes

The recovery process design is a low energy – low emission – low carbon footprint hydrometallurgical flowsheet when compared to traditional pyrometallurgical recovery processes. The general control philosophy for the plant includes a high level of automation and control.

The main process steps of the plant are:

- Feed receipt and pre-treatment (comminution);
- Integrated leach and regrind circuit;
- Solid/liquid separation;
- Solvent extraction vanadium purification circuit; and
- Vanadium pentoxide (V_2O_5) production.

The main process steps of the plant and products are presented in Figure 2.2-2.

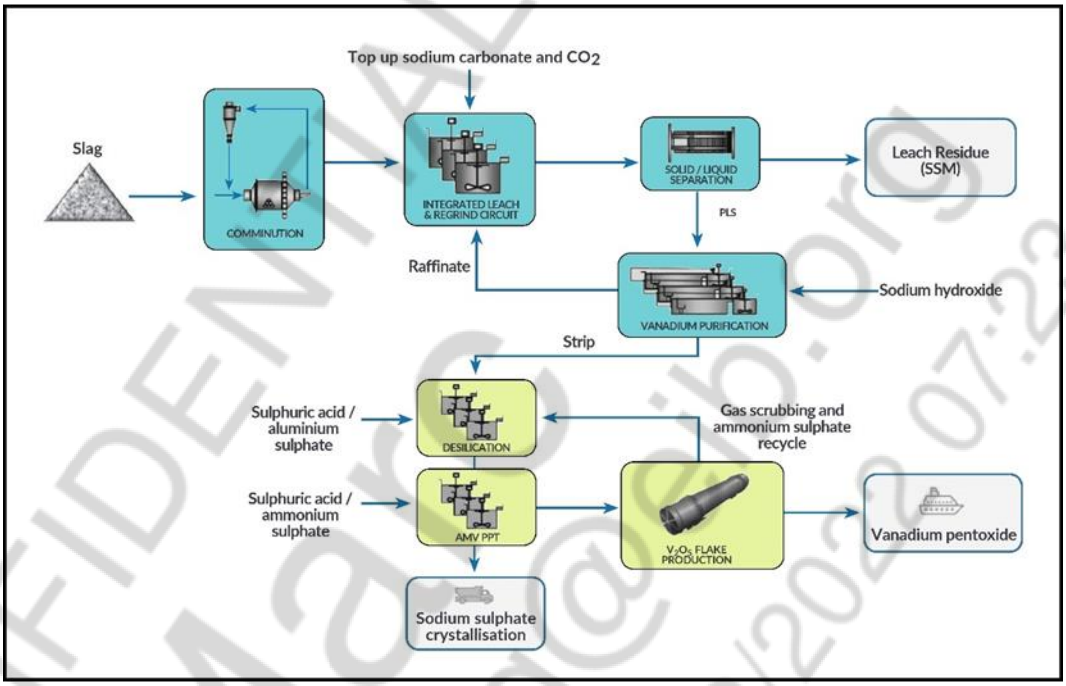

Figure 2.2-2. Main process steps, material flows and products.

The process description for carbonate leach and calcined high-grade vanadium pentoxide (V_2O_5) chemical powder or flake product is described in the following paragraphs.

Comminution

The feed is expected to be delivered to the plant as predominately < 10 mm particles and will be screened to remove oversize material prior to any comminution. A magnetic separation circuit will be installed prior to comminution for removing iron-rich material. Scalping steel / iron rich material from the slag will improve process outcomes and protect the mill from damage. The target particle size for the primary leaching stage is P80 of 75 µm or less. The particle size will be controlled by classification. The fine fraction will progress to the first primary leach tank (or a primary leach feed holding tank), while coarse (oversize) is returned to the comminution circuit.

Leach and regrind

Alkaline leaching occurs in at least two stages with inter-stage regrinding to provide fresh mineral surfaces for leaching to occur.

After the primary alkaline leaching with sodium carbonate solution, primary leach discharge is subjected to further particle size reduction and exposure of fresh leachable mineral surfaces.

This is followed by secondary leaching with a sodium carbonate solution under similar moderate temperature and atmospheric pressure leaching.

Through the leaching process the calcium in the slag (excess lime from the steel mill) reacts with the carbonate to produce calcite (calcium carbonate). During this process the vanadium is made available for leaching and deports into the leach solution.

Carbon dioxide gas is sparged into the leach reactors to maintain the required pH by regenerating carbonate ions (carbonate ions are consumed in the calcite precipitation) and ensure selective leaching of the vanadium. Additional regrind and leach stages could be added if needed to ensure an optimum portion of the vanadium is recovered from the slag feed.

Solid/liquid separation

During the above leaching process carbon dioxide is sequestered and calcium carbonate is formed causing an increase in the mass of solids in the leach slurry. Consequently, it is important to separate the leach residue from the vanadium-bearing Pregnant Leach Solution (PLS). A combination of a thickener and a pressure filter (with multiple stages of washing) is used to separate the PLS from the leach residue. The well washed leach residue contains a calcium carbonate rich fine material and insoluble and weakly soluble minerals. The leach residue is the SSM.

The wash water (containing low levels of vanadium and reagents) is re-used in the circuit to ensure optimal retention of any remaining soluble vanadium and any sodium reagents.

The SSM is repulped in hot water at a high liquid to solid ratio to further remove any residual soluble vanadium and sodium containing ions. The repulped SSM is again filtered and washed in three stage counter current manner with hot water to ensure minimal soluble species remain in the SSM. The SSM is filtered to reduce residual moisture and transferred to a temporary storage before being transported to subsequent applications.

SSM repulp water and primary wash water may be processed through an ion exchange system to recover vanadium and be reused in the SSM wash stage. A bleed stream of SSM repulp and wash water is also taken directly or through the evaporator (to increase sodium concentration) prior to recycle to the leach circuit to manage sodium increases and ensure the water balance is maintained in the wash circuit. Condensate is used as hot water in the SSM wash circuit.

Once the ion exchange (IX) columns are fully loaded they are stripped with sodium hydroxide solution and the small volume is used to make up strip liquor for use in the solvent exchange (SX) system.

Vanadium purification

The PLS is treated with CO_2 to adjust the pH to the optimal value for solvent extraction (SX) and a small quantity of coagulant is added. The PLS is then passed through a polishing filter to remove any colloidal silica and the SX feed is ready for purification.

Solvent extraction uses an organic extractant to selectively extract vanadium from the PLS and leave the sodium and other ions in the raffinate. The raffinate is returned to the process water tank and reused in the comminution and leaching circuit.

The organic loaded with vanadium is scrubbed with dilute sodium hydroxide scrub solution to ensure entrained PLS is removed from the organic phase. The scrubbed organic is then contacted with a strip solution to recover the vanadium in a clean strip solution for onward processing. The stripped organic is recycled to the extraction stage and used continuously in the SX circuit.

The organic chemicals used in the process gradually degrade during re-circulation in the circuit. As organic chemicals degrade, they are likely to from "Crud" – fine dispersed aggregate phases, which are removed from the organic phase in filtering and blended to the SSM. Aqueous soluble organic degradation product is transferred to process water until it is removed by organic filters.

Desilication, ammonium metavanadate precipitation and V_2O_5 production

Desilication of the PLS (strip liquid) is achieved by reduction in the PLS pH through the controlled addition of sulphuric acid and aluminium sulphate. The combined aluminium/silicon precipitate is removed by filtration. The small amount of solids collected in this filtration will be well washed and either separately redisolved in acid to allow return of vanadium rich acid solution to the desilication stage or returned to the SSM repulp washing stage for further vanadium recovery before the inert silicon/aluminium solids are combined with the SSM.

The filtrate is further treated with a combination of sulphuric acid and ammonium sulphate to precipitate ammonium metavanadate (AMV) and leave a sodium sulphate solution. The AMV is collected by filtration and thoroughly washed with dilute ammonium sulphate solution to be free of sodium salts to improve the quality of the AMV cake. The barren sodium sulphate solution is transferred to a sodium sulphate crystallisation circuit whereby the sodium sulphate by-product can be obtained, and any residual crystalliser liquor is recycled back to the AMV precipitation circuit. Filtrate from the AMV product filter is heated using steam in a crystallisation circuit and reaches super saturation with respect to sodium sulphate and crystallises to produce Glaubers salt. This is then dried to produce anhydrous sodium sulphate for sale. Alternatively, a direct anhydrous sodium sulphate crystalliser may be considered.

Steam from the evaporator/crystalliser is passed through a heat exchanger to transfer energy to other process solutions and the condensate is captured at 50 – 70 °C to be reused as SSM wash water.

AMV feed material (containing up to 25 % moisture) is heated to its drying temperature in a flash dryer. Next, feed material is heated to its process temperature in a calciner (deammoniator), and the temperature maintained for the required time, to obtain vanadium pentoxide. Vanadium pentoxide chemicals (powder) are the potential final products. Alternatively, dried vanadium pentoxide powder is sent to a fusion furnace and flaking wheel for the production of V_2O_5 flake. V_2O_5 product is packaged for sale and stored in a product shed until shipment.

Off gas from the kiln will contain ammonia and sulphur gases which will be scrubbed by sulphuric acid to form ammonium sulphate which can be recycled back to the AMV reactor thus recovering valuable reagents and reducing emissions.

The carbonate leaching has achieved 70 % to 80 % vanadium recovery in bench scale and mini pilot scale test work.

Process equipment is located in an enclosed building.

2.2.4 Raw materials

Slag for feedstock from the steel industry (referred to as a converter slag, LD-slag or BOF-slag) will be transported to the plant from slag stockpiles located in Sweden (Oxelösund and Luleå) and Finland (Raahe).

In the port, a grab collects slag from the vessel and transfers it either to a stockpile on the quay or loading chute, prior to the slag being transported to the VRP area by trucks.

The vanadium pentoxide grade at the slag stockpile in Luleå is about 4 % V_2O_5 and about 3 % V_2O_5 in Oxelösund and Raahe making them some of the highest-grade vanadium feedstock sources in the world.

Based on the analysis results, the slag in Luleå also includes calcium oxide (CaO), silica dioxide (SiO_2), magnesium aluminate ($MgAl_2O_4$), manganese oxide (MnO), titanium oxide (TiO_2) and iron oxide (Fe_2O_3) (Table 2.2-2).

Table 2.2-2. Typical slag composition (Luleå slag).

Component	Assay (% w/w)
V_2O_5	4.40
CaO	41.93
SiO_2	9.16
MgO	8.7
Al_2O_3	1.7
MnO	3.15
TiO_2	1.35
Fe_2O_3	24.91

The properties and storage of slag for feedstock are discussed in more detail in chapter 6.5.

SSAB steel manufacturing in Finland and Sweden produces vanadium-rich slag at a rate of approximately 200 000 tonnes per year. A large percentage of the slag produced in the steel making process is returned to the blast furnaces. Slag that is not useful in the blast furnaces has been used in construction materials and or stockpiled. Today, the amount of slag stockpile is about 1.76 million tonnes (chapter 2.2.9, Table 2.2.8).

By-product classification of converter slag

Converter slag has been defined as a by-product in the environmental permit (granted on 22.3.2016) of the SSAB plant in Raahe, Finland. According to the Swedish legislation, the status of converter slag, which is transported from the facilities in Luleå and Oxelösund, is defined as a by-product by the decision of the operator. This is controlled by the supervisory authority of the facility.

Regarding converter slag both in Raahe and Oxelösund, suppliers consider the material as a valuable product, which is supplied to customers as a registered product having a by-product status in accordance with the REACH Regulation (EU/1907/2006).

According to section 5a of the Waste Act (646/2011), a substance or object is not waste but a by-product, if it results from a production process whose primary aim is not the production of that substance or object, and:

1) further use of the substance or object is certain;
2) the substance or object can be used directly as is, or without any further processing other than normal industrial practice;
3) the substance or object is produced as an integral part of a production process; and
4) the substance or object fulfils all relevant product requirements and requirements for the protection of the environment and human health for the specific use thereof and, when assessed overall, its use would pose no hazard or harm to human health or the environment.

The following paragraphs deal with the preconditions for meeting the by-product criteria of slag.

The operation of the entire facility is based on the utilisation of slag. The procurement of raw material for the vanadium recovery plant is based on completed agreements between the project developer and the suppliers of converter slag. Based on these agreements, the project developer will purchase the raw material.

Slag is not processed or treated with the exception of occasional crushing, if needed, before feeding it to the process. During steel production, slag is tapped into a slag pot, which is transferred to the cooling yard of the steel smelter, where slag is cooled down with water. With no other prior actions, slag is transported to the vanadium recovery process.

Regardless of steel plant, converter slag is an inseparable and essential part of the steel production process, however, without being the main product of the steel plant.

According to the regulation on the Classification, Labelling, and Packaging of substances and mixtures (so-called CLP Regulation, EC No 1272/2008), slag has no hazard classification.

Both SSAB Europe Oy (Raahe) and SSAB EMEA AB (Oxelösund and Luleå) as manufacturers of the substance have registered converter slag pursuant to the REACH Regulation. It is not possible to register waste pursuant to the REACH Regulation. Converter slag is treated according to the prepared safety data sheet. Along with the REACH registration, it meets the requirements regarding environmental and health protection.

The use of converter slag as a raw material for vanadium production in the designed plant meets the by-product criteria provided in section 5a of the Waste Act (646/2011 (summary in Table 2.2-3).

Table 2.2-3. Comparison of the by-product criteria provided in section 5a of the Waste Act with the by-product used in the designed plant.

Criteria	**By-product**
	Slag
Further use of the substance or object is certain	Used in the vanadium recovery plant
The substance or object can be used directly without any further processing other than normal industrial practice	Yes
The substance or object is produced as an integral part of a production process	Yes, converter slag (slag) is produced in steel manufacturing process
Further use is lawful, i.e. the substance or object fulfils all relevant product, environmental and health protection requirements for the specific use and will not lead to overall adverse environmental or human health impacts	Yes, product with the REACH registration (properties of slag, chapter 6.5.4.1)

Transport of slag from Sweden to Finland is assessed in accordance with the international legislation regarding waste transports. The Finnish Environmental Institute has considered in its statement that it will not object to the by-product status, if converter slag is considered as a by-product in Sweden. Based on the description above, the product is fundamentally a by-product in Sweden.

Regarding slag transported from Sweden, it is possible that full confirmation of the by-product status of slag will not be achieved during the EIA procedure, and therefore slag may have to be treated as waste in the EIA phase.

Slag is transported by vessels to Tahkoluoto. Slag will then be transported from the port by a combination of trucks, and/or conveyors to the plant.

Slag is stockpiled uncovered on site. The maximum height of the stockpiles is 15 metres. In accordance with the environmental permits, slag has been stockpiled uncovered in the SSAB steel plants of Luleå, Oxelösund and Raahe for several years.

2.2.5 **Reagents[1] and consumables**

A significant amount of carbon dioxide (CO_2) is needed as a reagent in the leaching process.

Other reagents used in the process include:

- sulphuric acid (H_2SO_4) reactant in AMV precipitation, for adjusting pH and for gas scrubber for ammonium rich exhaust gas;
- sodium carbonate (Na_2CO_3) as a make-up reagent in leaching;
- sodium hydroxide (NaOH) used in the CO_2 scrubber, in the vanadium strip solution and as needed in leach solution make-up; and
- ammonium sulphate ($(NH_4)_2SO_4$) precipitant to form AMV, coagulant used in desilication and flocculant used in thickeners.

The chemical consumptions and maximum storages are presented in Table 2.2-4. Chemicals will be stored in closed tanks in the plant. The aim is to use non-aromatic compounds as diluents.

Table 2.2-4..Used and produced chemicals, estimated consumptions and maximum storages in the plant.

Chemicals	**Estimated used volume / produced volume (tonnes/year)**	**Maximum storage (tonnes)**	**Chemical Abstract Service (CAS)**	**Hazard statement**
Used chemicals				
Carbon dioxide (CO_2)	80 000 – 100 000	1 350	124-38-9	H281
Sulphuric acid (H_2SO_4 94 %)	18 000	1 500	7664-93-9	H314, H290
Sodium hydroxide (NaOH 50 %)	32 500	2 700	1310-73-2	H290, H314
Sodium carbonate ($NaCO_3$)	12 000	1 000	497-19-8	H319
Ammonium sulphate ($(NH_4)_2SO_4$)	5 300	450	7783-20-2	not classified
Aluminium sulphate ($Al_2(SO_4)_3$)	450	40	10043-01-3	H290, H318

[1] Substance, which is consumed in the course of a chemical reaction and which forms part of the end products or full end product. Solvents and catalysts are not classified as reagents.

Chemicals	Estimated used volume / produced volume (tonnes/year)	Maximum storage (tonnes)	Chemical Abstract Service (CAS)	Hazard statement
Organic diluent (aliphatic hydrocarbon)	71	10	64742-47-8	H226
Organic extractant (quaternary ammonium)	22	5	63393-96-4	H226
Phase modifier	18	5	112-70-9	H226
Coagulent	99	2	-	H226
Diesel	1 806 m^3	20	68334-30-5	H351
Natural gas	11 000 000 m^3		74-82-8	H220
Produced chemicals				
Vanadium pentoxide (V_2O_5)	9 000	4 500	1314-62-1	H302, H332, H341, H361d, H335, H372, H411
Calcium carbonate rich by-product (SSM, about 30 % moisture content)	415 000 (plus 30 % moisture content	1 245 000 (plus 30 % moisture content		
Sodium sulphate (Na_2SO_4)	30 000	7 500	7757-82-6	not classified

H220: Extermely flammable gas
H226: Flammable liquid and vapour
H281: Contains refrigerated gas; may cause cryogenic burns or injury
H290: May be corrosive to metals
H302: Harmful if swallowed
H314: Causes severe skin burns and eye damage
H318: Causes serious eye damage
H319: Causes serious eye irritation
H332: Harmful if inhaled
H335: May cause respiratory irritation
H341: Suspected of causing genetic defects
H351: Suspected of causing cancer
H361d: Suspected of damaging the unborn child
H372 Causes damage to organs through prolonged or repeated exposure (if chemical is inhaled)
H411 Toxic to aquatic life with long-lasting effects

Carbon dioxide used in the vanadium recovery plant is transported by vessels, trucks and/or pipeline to the VRP project area from outside of Tahkoluoto.

In addition to reagents, other consumables required in the plant include water, instrument air, process compressed air, diesel, electrical power and natural gas.

Hot water and chilled water systems are designed to ensure all process waters are re-used in the plant.

Similarly, the majority of water run-off from stockpiles are captured and re-used in the process.

To minimize process water top-up with scheme water there will be no process water discharge from site. The use of heat exchangers will optimize heat energy retention and use in the process.

2.2.6 **Products**

The primary product is a high-purity (> 98.5 %) vanadium pentoxide (V_2O_5) chemical powder or flake. Up to 9 000 tonnes of the primary product will be produced each year.

The by-products are SSM (calcium carbonate $CaCO_3$ rich material) and anhydrous sodium sulphate (Na_2SO_4).

At maximum capacity about 415 000 dry tonnes of SSM will be produced per year. Particle size of the SSM is < 10μm, typically about 7μm, pH is about 11 with a moisture content of about 25 – 35 % depending on the filtration method and the level at which the material is dried during filtration.

The properties and storage of the by-product on site is discussed in more detail in chapter 6.5.

The SSM is unique in that it is a calcium-carbonate rich material that stores or "locks up" the carbon used in the hydrometallurgical process and in this way it is acting as a "carbon bank". The SSM is significantly more inert than the slag feedstock and can potentially be used as filler, for example, in the production of cement clinker and cement, concrete or asphalt. The SSM can also be used as a neutralising agent. The metal content of the SSM is similar in the slag feedstock, but diluted by the increase in volume and the removal of most of the vanadium. Results of the leaching tests for SSM are presented in chapter 6.5.4.

SSM characterization and market research into the many potential uses of the SSM is ongoing.

Unique aspects of the SSM include "carbon bank" property as well as very fine grained homogenous physical characteristics. Sustained and secured avalability provides for the planning of investments into new processes. The SSM is a new product and it is believed to gain market acceptance via the provision of data, samples, and customer test work. This process takes time, but the SSM is expected to be highly sought after. CMS therefore requests SSM 3 years of intermediate storage time to develop the market and move the SSM to customers. As the market develops, the quantities of SSM stored on site will decrease.

The SSM produced in the plant is expected to meet the by-product criteria provided in section 5a of the Waste Act (Table 2.2.5). The properties of SSM are described in chapter 6.5.4.2. Meeting the requirements regarding the product, environment and health protection related to special use is secured during the registration in accordance with the REACH

Regulation (EU/1907/2006). Information on the properties of the product is delivered to the European Chemicals Agency (ECHA) for registration, which is necessary for securing the achievement of the above mentioned requirements.

At maximum capacity about 30 000 tonnes of anhydrous sodium sulphate (Na_2SO_4) will be produced each year. Options exist to produce the anhydrous sodium sulphate or the decahydrate sodium sulphate (Glaubers salt). Sodium sulphate can be used, for example, in the paper manufacturing process, in glass production and as a filler in detergent powders. In addition to the above mentioned use, sodium sulphate is accepted to be used for several other purposes, e.g. for plant protection products and cosmetics. Currently, Europe produces hundreds of thousands of tonnes of sodium sulphate every year.

The SSM and sodium sulphate produced in the plant meet the by-product criteria provided in section 5a of the Waste Act (Table 2.2-5).

Table 2.2-5. Comparison of the by-product criteria provided in section 5a of the Waste Act with the by-products produced in the plant.

Criteria	**By-product**	
	SSM	Sodium sulphate
Further use of the substance or object is certain	Testing by third parties is ongoing	Yes
The substance or object can be used directly without any further processing other than normal industrial practice	Yes	Yes
The substance or object is produced as an integral part of a production process	Yes, description of the facility is presented in chapter 2.2	Yes, description of the facility is presented in chapter 2.2
Further use is lawful, i.e. the substance or object fulfils all relevant product, environmental and health protection requirements for the specific use and will not lead to overall adverse environmental or human health impacts	Yes (properties of SSM, chapter 6.5.4.2). Achievement of requirements is secured during the REACH registration.	Yes

Product storage and treatment

The treatment and storage of vanadium pentoxide and sodium sulphate occurs in closed facilities.

Vanadium pentoxide may be produced as either a chemical powder or flake and stored in bulk bags and/or sealed 44-gallon (200 kg) drums in a packaging shed before transportation. Bulk bags are loaded into 25 tonne sea containers for transport. The form and packaging of the product will depend on the customers' requirements. The maximum storage of the primary product will be approximately 4 500 tonnes (Table 2.2-4).

SSM will be transported by conveyor and / or trucks to a storage area. The maximum storage of the SSM will be about 1 245 000 dry tonnes (plus about 30 % moisture content), which covers three (3) years of intermediate storage. The maximum height of SSM stockpiles is 15 metres.

Sodium sulphate (Na_2SO_4) will be stored in bags in a lockable shed. The maximum storage is three (3) months capacity, 7 500 tonnes.

2.2.7 Water supply

Raw water will be sourced from the public water utility provider and stored in raw water storage tanks. The amount of raw water used in the process each year is estimated to be about 180 000 tonnes maximum.

Potable water will be sourced from the public water utility provider. The amount of potable expected to be used each year is about 4 500 tonnes. This includes, for example, water for safety showers, laboratory use, drinking water and ablutions.

2.2.8 Emissions to the environment and waste

Dust and gas emissions

Dust from the stockpiles (slag and SSM) will be suppressed via a water reticulation system. The moisture content of SSM is about 30 % so dust emissions are not likely to be very high, but the surface of stockpiles can dry up especially in summertime when water reticulation can be necessary.

Slag can occasionally be crushed on site, but related dust emissions will be minor. Milling in the process will be performed in such a way as to contain potential dust from the operation.

The product bagging facility will be equipped with dust filters and dust collectors. Closed bags/barrels are used for storage, and thus dust emissions will be minor.

Separate gas scrubber systems are allowed for the alkaline leach circuit to capture any unused CO_2 and return it to the process, and the calcine circuit to capture NH_3 emissions and return them as ammonium sulphate to the AMV circuit, respectively. Small amounts of emissions are caused by natural gas combustion (nitrogen oxides NO_X), use of solvents (volatile organic compounds, TVOC), dust filters and drying of AMV and sodium sulphate (particle emissions) (Table 2.2-6). Clearing heights of process emissions are mainly about 20–30 metres.

Table 2.2-6. Emissions to air from the plant, preliminary estimate.

Process phase	TVOC (tonnes/ year)	NOx (tonnes/ year)	SO_2 (tonnes/ year)	Particles (tonnes/ year)	NH_3 (tonnes/ year)	CO_2 (tonnes/ year)
Solvent change	0.6	-	-	-	-	-
Sodium carbonate, dust filter	-	-	-	0.2-	-	-
Natural gas boiler	-	2	-	-	-	17 500
Recovery of vanadium pentoxide (natural gas)	-	2.5	-	-	-	12 000
Recovery of vanadium pentoxide						- 85 000 - - 100 000
Drying of ammoniumvanadate	-	-	-	< 3.5	-	-
Calcine circuit	-	-	4.5		2	-
Fusion furnace	-	-	-	< 3.9	-	-
Drying of sodium sulphate	-	0.3		< 3.5	-	-
Total	1	5	4.5	< 11	2	- 61 000

Transport and handling of the slag and SSM may potentially generate dust. Dust will be reduced by using covered trucks and covering and enclosing conveyor belts and crushers, where possible. Emissions related to the treatment of slag is discussed in more detail in chapter 6.5.

The Best Available Techniques (BAT) are used in the VRP to manage dust emissions from storing, handling and transporting of materials.

Process water discharge

The only water leaving the process will be sequestered into the SSM (as moisture content associated with the material due to small particle size). Excess process water will be evaporated, and condensate is used in the process. All heating and cooling water is added to process water tanks for reuse in the process.

Rain and snow melt from the stockpiles and paved areas will be captured in ponds and will be re-used in the process to reduce the demand for raw water. The foundations of slag and SSM storage areas will be equipped with waterproof coatings. Stormwater ponds will have sufficient capacity to manage stormwaters based on regional statistics on precipitation and snow fall. The small amount of suspended matter which may settle in stormwaters released from slag and SSM stockpiles will be removed from ponds by drain cleaners and transferred to the process or removed by a contractor authorised for such activities. Water treatment in storage areas is discussed in more detail in chapter 6.5.

Preparations will be made for heavy rain by inclinations to direct water flows to the largest ponds. As a result, only very rarely occurring heavy rainfall, stormwaters can flow to the sea.

Firefighting wastewater will be collected into ponds and delivered to treatment plants, which have a permit for equivalent wastewater treatment or removed by a contractor authorised for such activities.

Waste

No waste is produced in the process in alternatives Alt.1 and Alt.1a. Only conventional municipal waste is generated in the plant, such as organic waste, energy waste, paper and cardboard waste.

SSM produced in the plant in alternative Alt.1b has not yet received a by-product status, and then it is regarded as waste. For quality, SSM material matches inert, non-hazardous waste.

Noise and vibration

Grinding and crushing plant can generate noise and vibration. Permissible noise levels are considered in the design. Normal traffic noise is caused by traffic on site, vessel transports, truck transports, conveyors, and bucket loaders.

2.2.9 Traffic

The VRP area has good transport connections. Public roads lead to the industrial area and electrified railway and port are located in the immediate vicinity.

Transport volumes to the plant area are presented in Table 2.2-7.

Table 2.2-7. Transport volumes to the VRP area and from the VRP area to customers.

TO THE TAHKOLUOTO PORT	**Volume (wet tonnes/year)**	**Vessels/ week**	**Additional information**
From Luleå, Oxelösund and Raahe to the Tahkoluoto port	max. 330 000	about 1	During 5–6 month time period (20 vessels/year)
TO THE VRP AREA	**Volume (wet tonnes /year)**	**Trucks/day (one direction)**	**Additional information**
Slag from the deep-water port to the southern (or northern) VRP area	330 000	100–200 (250–350)	Around the clock after slag arrives to port
CO_2	100 000	5	From outside of Tahkoluoto
Other chemicals	130 600	11	75 % from chemical port, 25 % outside of Tahkoluoto (daytime transports)
Total to the VRP area from port		158	
Total to the VRP area from outside of Tahkoluoto		17	
FROM THE VRP AREA			
	Volume (dry tonnes /year)	**Trucks/day**	**Additional information**
Vanadium pentoxide chemical powder or flakes	9 000	1	Daytime
SSM	415 000	30	By trucks to customers (Alt.1 and Alt.1a) or to stockpile area (Alt.1b): 24/7, every day, continuous transports
Sodium sulphate	30 000	3–4	To customers, daytime
Total from the VRP area to customers		**35**	
TOTAL VOLUME ON ROADS LEADING TO TAHKOLUOTO		**52**	

Raw material and chemical transports

Approximately 2 million tonnes of slag will be transported to the VRP area by vessels from Luleå and Oxelösund in Sweden and from Raahe in Finland (Table 2.2-8). Slag can also be transported by rail from Raahe.

Table 2.2-8. Storages of slag feedstock to be transported to the VRP area in Tahkoluoto.

	Luleå	Oxelösund	Raahe
Slag currently stored (estimate)	745 000 t	571 000 t	475 000 t
Vanadium pentoxide grade V_2O_5 (estimate)	4 %	3 %	3 %
Net slag added (estimate)	120 000 t/a	50 000 t/a, decreasing to zero in 2026	80 000 t/a

The estimated transport volume of raw materials is about 20 vessels/year during summer, which indicates about one arriving vessel/week (Table 2.2-7).

Carbon dioxide (CO_2) will be transported to the plant by a third party provider by trucks. If all the carbon dioxide is transported by road, 5 trucks will be required each day. Other chemicals needed in the process will be transported by trucks and about 10 trucks are likely to be needed per day. Most likely a major part of the chemicals will be transported to the plant from the storages of the Tahkoluoto chemical port.

Transport operations in Tahkoluoto

Bucket loaders and trucks are used for the internal traffic on site, for example, in transports between the plant and port and storage areas.

When the freight vessels arrive at the port, typically about 100–200 truck loads of slag are transported from the deep-water port to the southern VRP area (Table 2.2-7). If larger quantities of slag for feedstock are transported to Tahkoluoto in the early phases of operation, slag will be transported to the northern VRP area and the daily traffic volume can be 250–350 trucks/day (Table 2.2-7).

Transport of final products (vanadium, SSM and sodium sulphate)

Final products are probably transported to the customers either by vessels, trucks or trains or by a combination of them.

In a typical situation, when products would only be transported by trucks, the transport volume would be about 35 truck loads/day.

2.2.10 Connections

Electricity needed at the plant will be obtained from local power grid.

The VRP will be connected to the local water and sewer network. Raw water will be supplied from local water supply system and stored in tanks located on site and directly fed into the process. Potable water will also be supplied from the local water supply system.

In addition, services in the industrial area, such as fire brigade and security can be associated with.

2.2.11 Energy use

Electricity consumption of the plant is estimated to be approximately 90.4 GWh per year. Most of the electricity is consumed in the production process.

A total of about 400 000 GJ of natural gas is used for steam production needed in the process. Electrical power is used for heating the buildings or district heating can potentially be acquired from the Pori Energy. In addition, natural gas and diesel fuel will be used for vanadium pentoxide production equipment.

2.3 Construction phase

On site construction works include the production facilities, storage areas for raw materials and products, chemical storages, road connections and internal road network as well as service and office buildings.

The maximum height of the production facilities is less than 30 metres. Storage areas for slag and SSM as well as stormwater collection systems are described in chapter 6.5.

The duration of the construction of the plant is about two years. It is estimated that a maximum of two hundred persons will work on site in the construction phase.

Construction works will mainly occur in daytime, during 6–22.

3 Alternative 0 (Alt.0)

If the VRP is not implemented, slag stockpiles in Luleå, Oxelösund and Raahe will continue to grow and up to 80 000–100 000 tonnes of carbon dioxide (CO_2) per year, which will potentially be used in the recovery plant, will continue to report to the atmosphere.

The lack of vanadium production in Europe results in the increase of procurement from outside of Europe for the growing needs of industry, which will reduce the internal security of supply and increase environmental impacts related to transport operations.

New mines will be required to produce vanadium for the needs of the European industry. The CO_2 emissions from ore processing in mines through traditional mining and processing techniques are significant.

Other vanadium recovery processes, for example, the energy consumption and emissions of pyrometallurgical processes (> 30 tonnes CO_2/tonne V_2O_5, data from CMS) are significantly higher than the designed hydrometallurgical process in the plant (-0.6 tonnes CO_2/ tonne V_2O_5). The production of vanadium in a vanadium recovery plant has a reducing impact on carbon dioxide emissions, as a significant amount of carbon dioxide produced and captured in other industrial facilities is used in the process.

If the VRP is not implemented, traffic volumes will not increase in the area, and there will be no environmental impacts caused by the VRP.

It is possible that some other industrial activity will be planned for the particular area with its own specific environmental impacts depending on the industry.

4 Environmental impact assessment procedure (EIA)

4.1 Objectives and content of the EIA Procedure

Initially, the Environmental Impact Assessment (EIA) Directive (85/337/EEC) adopted by the Council of the European Communities (EC) was implemented in Finland in 1995. The regulations governing the EIA procedure have since been reformed. The current Act on Environmental Impact Assessment 252/2017 (EIA Act) and Decree 277/2017 pursuant to it (EIA Decree) came into force in May 2017.

So-called Espoo Convention (Convention on Environmental Impact Assessment in a Transboundary Context), which was approved by a Decree, regulates the transboundary environmental impact assessment. The nations as parties of the convention have a right to participate in an ongoing EIA procedure or SIA procedure in another nation, if the environmental impacts of the assessed project, plan or programme will be extended to the particular nation. With regard to the vanadium recovery project in Tahkoluoto, Pori, this issue has been tentatively discussed with the Ministry of the Environment, and based on preliminary view, it is not assumed that the environmental impacts of the project would extend outside of Finland.

The goal of the EIA procedure is to promote the environmental impact assessment and uniform consideration of impacts in planning and decision making.

All interested parties can participate in the EIA procedure. Citizens' access to information and participation are the cornerstones of the EIA procedure. The environmental impacts of the project must be examined in a legal assessment procedure before taking essential actions considering environmental impacts.

The authority cannot grant a permit for the implementation of the project until it has received the EIA report and the reasoned conclusion prepared by the coordinating authority. Decisions on the project are not made in the EIA procedure, but it aims at producing information as a basis for decision making.

The EIA procedure includes the programme and the report phases (Figure 4.1-1). These phases have been described in more detail in Chapters 4.1.1 and 4.1.2. The environmental impact assessment programme (EIA programme) is a plan for the coordination of the environmental impact assessment procedure and the related necessary studies. The environmental impact assessment report (EIA report) presents the features of the project, technical solutions, and an integrated assessment of the environmental impacts of the project as a result of the evaluation procedure.

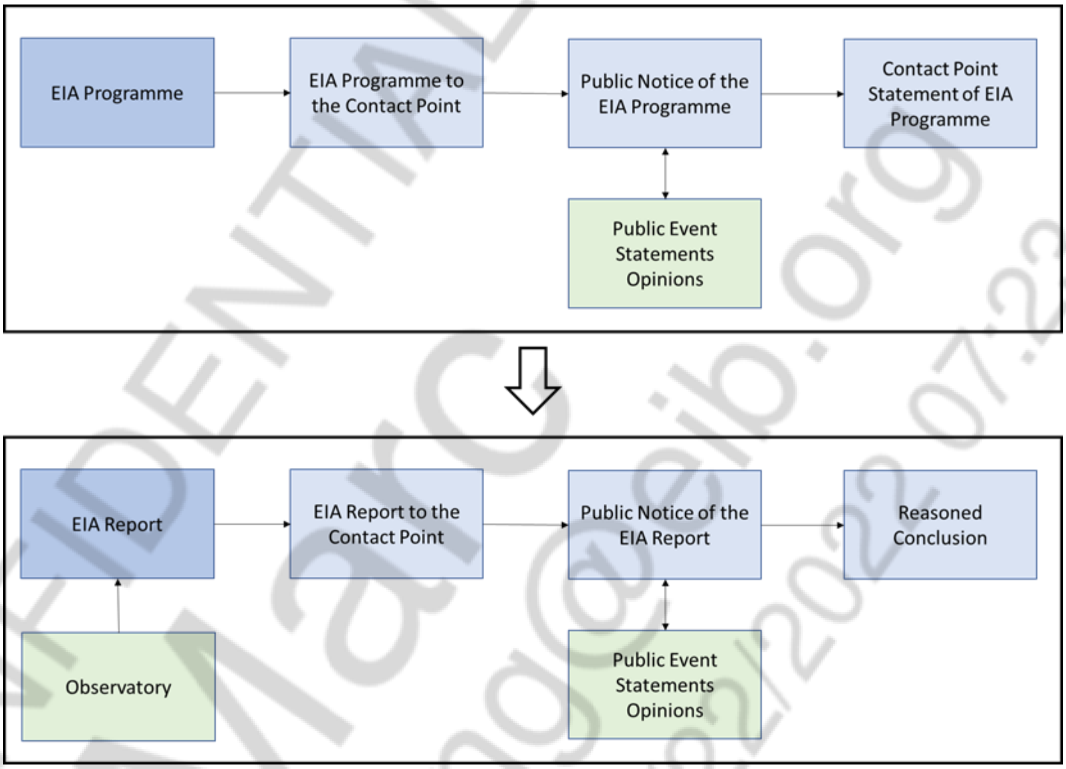

Figure 4.1-1. Phases of the EIA procedure.

4.1.1 Parties in the EIA procedure

CMS is the project developer in the EIA procedure. The project developer is an actor, who is responsible for the preparation and implementation of the planned project. CMS is also responsible for the implementation of the EIA procedure. The EIA consultant is Sweco Industry Ltd.

The coordinating authority for the EIA procedure is the Centre for Economic Development, Transport and Environment for Southwest Finland (ELY Centre). The coordinating authority refers to the authority that ensures that the environmental impact assessment procedure for a project is managed as required by the EIA Act. The coordinating authority is responsible for publishing the environmental impact assessment programme and report and for compiling statements and opinions. The coordinating authority provides a statement on the environmental impact assessment programme (EIA programme) taking a position on the scope and accuracy of the programme. The coordinating authority will review the adequacy and quality of the environmental impact assessment report and then will prepare its reasoned conclusion on the significant environmental impacts of the project.

4.1.2 **EIA programme**

The EIA programme provides a description of the environmental baseline conditions in the project area as well as a plan, which impacts will be assessed and how the assessments will be carried out (Vanadium recovery plant, Environmental impact assessment programme, Sweco 2021a). The programme provides, among other things, basic information on the project, alternatives to be evaluated, a communication plan during the project and an estimated project timetable.

The EIA procedure officially starts when the EIA programme is submitted to the coordinating authority. In this project the coordinating authority is the ELY Centre for Southwest Finland.

The coordinating authority will announce the assessment programme by posting a public notice in the notice boards of the municipalities in the likely impact area of the project, in electronic format and at least in one common newspaper in general circulation in the impact area of the project.

The assessment program will be put on public display. Citizens can present their opinions on the EIA programme to the coordinating authority. The coordinating authority requests necessary statements on the programme from the authorities. The time period for providing opinions and statements is a minimum of 30 days starting from the publication date of the public notice.

The coordinating authority compiles the opinions and statements provided on the EIA programme and based on them, provides its own statement to the project developer within one month after the deadline for providing statements and presenting opinions.

4.1.3 **EIA report**

The EIA report must contain, on a sufficient scale, the following information, which is necessary for the preparation of the reasoned conclusion, considering the knowledge and assessment methods available at each time:

1) description of the project, its purpose, location, size, land use needs, major characteristics including the acquisition and consumption of energy, materials and natural resources, likely emissions and residues, such as noise, vibration, light, heat and radiation, and such emissions and residues, which may cause contamination of water, air, soil or subsoil, as well as the quantity and quality of the amount of waste, taking into account the construction and operation phases of the project, including potential dismantling and exceptional situations;

2) information on the project developer, the planning and implementation schedule of the project, the plans, permits and coordinated decisions required for implementation, and the project's affiliation with other projects;

3) report on the relation of the project and its alternatives to land use plans and on plans and programmes regarding the use of natural resources and environmental protection, which are relevant to the project;

4) description of the current state of the environment in the impact area and its likely development, if the project is not implemented;
5) assessment of potential accidents and their consequences considering the susceptibility of the project to major accident and natural disaster risks, related emergency situations and measures of preparedness for these situations including prevention and mitigation measures;
6) assessment and description of the likely significant environmental impacts of the project and its reasonable alternatives;
7) where applicable, an assessment and description of transboundary environmental impacts;
8) comparison of the environmental impacts of the alternatives;
9) information on the main reasons leading to the selection of the selected alternative or alternatives, including environmental impacts;
10) proposal for measures to avoid, prevent, limit, or eliminate significant identified harmful environmental impacts;
11) where applicable, a proposal for monitoring arrangements related to significant potential harmful environmental impacts;
12) study on the phases of the evaluation procedure including the participation procedures and connection to project planning;
13) list of sources used for compiling descriptions and assessments included in the report, a description of the methods used for identifying, predicting, and assessing significant environmental impacts, and information on the identified shortcomings when compiling the required data, and the main uncertainties;
14) information on the qualifications of the persons preparing the assessment report;
15) explanation of how the coordinating authority's statement on the EIA programme has been considered; and
16) general and illustrative summary of the information described in items 1 to 15.

The assessment and description of likely significant environmental impacts must include the direct and indirect, cumulative, short-term, medium-term and long-term permanent and temporary, positive and negative impacts of the project as well as the cumulative impacts with other existing and approved projects.

The coordinating authority will announce the completed EIA report, request the necessary statements and provide an opportunity to present opinions. The EIA report will be put on public display and the deadline for submitting opinions and statements is at least 30 days from publication date of the public notice.

4.1.4 **Reasoned conclusion**

The coordinating authority will review the adequacy and quality of the EIA report and then will prepare its reasoned conclusion on the significant environmental impacts of the project. The reasoned conclusion must be submitted to the project developer within two months after the deadline for submitting statements and presenting opinions. The reasoned conclusion must include a summary of other opinions and statements on the EIA report.

The coordinating authority must deliver the reasoned conclusion and other statements and opinions to the project developer. At the same time, the reasoned conclusion must be delivered for information to the authorities involved in the project, the municipalities in the impact area of the project and, if necessary, to the Regional Councils and other relevant authorities, and must be published on the website of the coordinating authority.

The permit authorities and the project developer use the EIA report and the reasoned conclusion provided by the coordinating authority as basic material for their decision making. It must be de-scribed in the permit decision of the project, how the EIA report and the statement re-garding the report have been considered in the decision.

4.2 Timetable for the EIA procedure

The key phases of the EIA procedure and timetable are presented in the following figure (Figure 4.2-1).

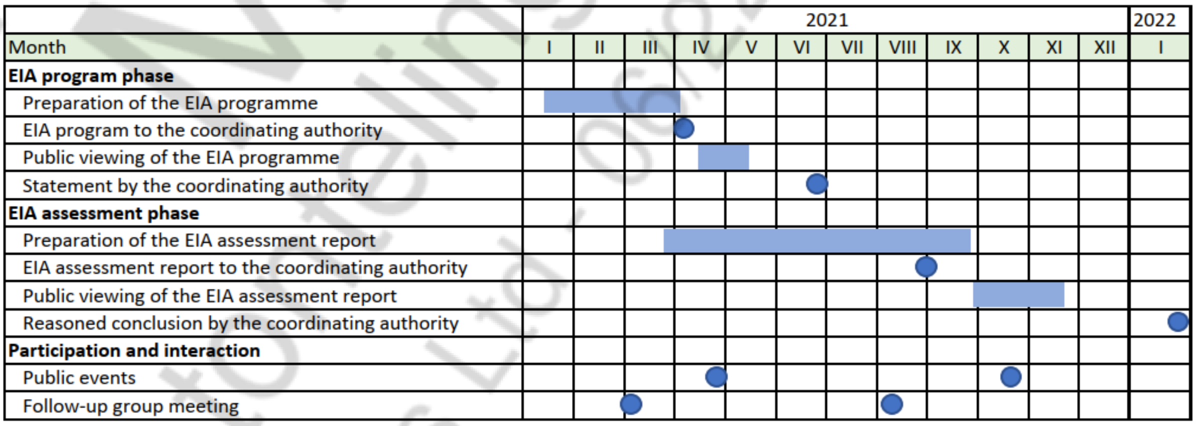

Figure 4.2-1. Timetable of the EIA procedure.

4.3 Communication and participation

The EIA procedure is an open process, in which various interest groups and the public can participate.

Residents in the local area and other interested parties may participate in the project by submitting official feedback to the Southwest Finland ELY Centre, which acts as the coordinating authority, and also directly to the project developer. Compiling of the opinions of different parties is the one of fundamental goals of participation.

4.3.1 **Public hearings and discussions**

Following the announcement of the EIA programme, an open public event was organized through remote access on April 21, 2021 to present the project and the plan for the environmental impact assessment. The public had the opportunity to ask questions and express their views on the project and the implementation of the assessment procedure. The representatives of the project developer, the coordinating authority and the experts involved in the preparation of the EIA programme attended the public event.

Three participants attended in the event and a link to the recording of the event was put on display on the project developer's website and on the website of the Southwest Finland ELY Centre. In the public hearing the focus of discussion was mostly on carbon dioxide used in the VRP and where carbon dioxide is transported to the VRP.

Similar open event will be held tentatively in mid-October 2021 to present the results of the environmental impact assessment and the EIA report. The public will then have access to additional information and they can provide feedback on the performed assessment and its adequacy. More information on this event will be published in the newspapers of the area.

The EIA programme and EIA report, public notice and statements of the coordinating authority can be viewed on the coordinating authority's website www.ymparisto.fi > Asiointi, luvat ja ympäristövaikutusten arviointi > YVA-hankkeet and the project developer's web site https://criticalmetals.eu/public-consultation-documents.php.

4.3.2 **Follow-up group**

A follow-up group has been assembled to monitor the EIA procedure of the vanadium recovery plant. The aim is to promote the flow and exchange of information with the project developer, the authorities and other stakeholders. The representatives of the follow-up group will monitor the progress of the environmental impact assessment and submit their opinions on the preparation of the EIA programme, the EIA report and the supporting studies.

Invited parties to the follow-up group include the representatives of the City of Pori, the ELY-Centre and other authorities and local stakeholders. The project developer and the EIA consultant participated in the work of the follow-up group. The follow-up group convened in the program phase and in the assessment phase. The following organizations were invited to the follow-up group:

- Southwest Finland ELY Centre
- Regional State Administrative Agency for Southern Finland
- City of Pori (environmental services, land use planning)
- Finnish Safety and Chemical Agency (TUKES)
- Satakunta Rescue Department
- Finnish Transport and Communications Agency (Traficom)
- Satakunta Regional Council

- Finnish Association for Nature Conservation/Satakunta District
- Pori Ornithological Association
- Reposaari Association ry
- Reposaari School Parents’ Association
- Port of Pori Oy
- Fortum Power and Heat Oy
- Oy M. Rauanheimo Ab
- Metsähallitus
- Finnish Heritage Agency
- Bothnian Sea Professional Fishermen ry
- Puhtaan meren puolesta ry

The follow-up group convened on March 9, 2021 through remote access to discuss the draft of the EIA programme. Comments and question were received from the members of the follow-up group regarding the consideration of e.g. the following issues in the assessment: changing climate, exceptional weather conditions and natural conditions, potential chemical risk, migrating and resting birds in the area, clarifying the storage volumes of slag and SSM, waste water from the facility, stormwater treatment, volume of stormwater ponds and potential cumulative impacts with the wind farm project.

Comments and specifications received from the members of the follow-up group were considered in the assessment and preparation of the EIA report. The follow-up group convened for the second time on August 10, 2021 through remote access to discuss the draft of the EIA report.

4.3.3 Public display of the EIA programme and EIA report

After the EIA programme was completed, the Southwest Finland ELY Centre made an announcement by posting a public notice on 9.4.2021. The public notice described, where the EIA programme was displayed during 12.4.-12.5.2021 and how opinions and statements should be submitted by the deadline. The coordinating authority provided its statement on the EIA programme on 10.6.2021. The EIA report will be put on public display and statements and opinions can be provided in a similar way.

4.3.4 Resident survey

A resident survey was performed during the EIA procedure, which aimed at promoting participation and interaction. The survey was open during May 2021 and it provided information to the project developer regarding the attitude and opinions of residents on the project, and at the same time it will provide information to the residents about the project and related impacts on their living environment. The survey provided information for the social impact assessment of the project.

4.3.5 Other communication

The project developer has organized separate Teams-meetings with the parties that are interested in the project and the impact assessment.

The project and environmental impact assessment are also notified in context with public communication, such as press releases, newspaper articles and through the website (www.criticalmetals.eu) of the project developer.

The EIA documents have been prepared according to the Directive on the Accessibility of Websites and Mobile Applications of the Public Sector Bodies so that they would be equally accessible to as many people as possible.

4.4 Feedback from the EIA programme

4.4.1 Statements and opinions

A total of ten statements on the EIA programme were submitted to the coordinating authority.

The statement of the coordinating authority is attached to this EIA report (Appendix 1). Consideration of this statement in the preparation of the EIA report is presented in Table 4.4.1.

A summary table including feedback from other statements and opinions has been attached to the EIA report (Appendix 2).

4.4.2 Statement of the coordinating authority and consideration of the statement in the impact assessment

Needed specifications to the EIA programme presented in the statement of the coordinating authority are summarized in Table 4.4-1. The table also shows, how these specifications have been considered in the assessment.

Table 4.4-1. Specifications presented in the statement of the coordinating authority and consideration of the specifications in the EIA report.

Section	Statement of the coordinating authority	Consideration in the EIA report
Project description		
	Detailed location of single project activities in the project area have been presented on a very general level. All activities in the area must be adequately described in the EIA report so that impacts can be sufficiently assessed. Efficient land use and consideration of natural values must be taken into account in the location of activities.	Location of activities is described in chapter 2.1. Land use in the project area will be as efficient as possible. Potential natural values are intended to be considered.

Section	Statement of the coordinating authority	Consideration in the EIA report
	The technical description of the project is for the most part simplified and insufficient, e.g. the description of the technical solutions of storage areas and material transports are insufficient. All central operations, parts and technical solutions of the entire project including the life cycle assessment must be described in detail in the EIA report. Regarding buildings and structures in the VRP area, it must be unambiguously described in the EIA report, which activities are located in covered spaces and which are not.	Structures of storage areas are described in chapter 6.5.4.1 and 6.5.4.2. Bucket loaders and trucks are used for internal traffic on site and, for example, in transports between the plant area, port and storage areas. Slag and SSM by-product are stored in open storage. Process equipment is located in a closed building. Chemicals are stored in tanks outside. Vanadium pentoxide and sodium sulphate are treated and stored in closed facilities.
Raw materials, by-products and waste		
	The following information on waste must be specified in the EIA report: volume, quality, classification, storage, final deposit, potential future use as well as the location, size, storage time and volume of storage areas and final deposit sites so that impacts can be sufficiently assessed. The general obligation to comply with the order of priority pursuant to section 8 of the Waste Act (646/2011) must be considered in operational planning of the project.	'Information on the volume, quality, classification, storage and final deposit of waste is presented in chapters 6.5.4.4 and 6.5.4.2. Information on the potential future use of SSM is presented in chapter 2.2.6. The aim is to deliver all materials produced in the plant to be recycled as products.
	The status of waste regarding slag and SSM by-product and potential changes to the assessment of this status must be described thoroughly in the EIA report. Location of storage areas of slag and SSM by-product must also be presented in the EIA report, if they will not be stored in the southern and northern VRP area in Tahkoluoto, as described in the EIA report. The EIA report must also include the description of slag and SSM volumes in cubic metres, size of storage areas and height of stockpiles. Information on the location of all activities in the southern and northern VRP area must also be described in the EIA report.	The status of waste regarding slag and SSM is described in chapter 2.2.4 and 2.2.6. Slag and SSM can be stored outside of the VRP area in an existing area authorised for an equivalent type of activity, for example, in the deep-water port area or in the Peittoo recycling park. Information on the location of activities is presented in chapter 2.1.

Section	Statement of the coordinating authority	Consideration in the EIA report
Construction		
	Impacts during construction are described on a very general level in the EIA programme. The coordinating authority considers it important that environmental impacts of all alternatives will be assessed during the entire life cycle of operations (construction, operation, decommissioning, restoration).	Impacts during operation are described in chapter 6 in respective sub-chapters. Impacts during construction are described in respective sub-chapters in context with each impact. Measures and impacts related to decommissioning are presented in chapter 6.16. The assessed project alternatives have been considered in the impact assessment.
Project alternatives and comparison of alternatives		
	Arguments behind the presented alternatives must be presented in the EIA report, or how the presented alternatives were selected and why other alternatives have not been examined (for example project alternatives of different scope). It should also be presented in the EIA report, which other potential alternatives have been examined already prior to the EIA procedure and why other alternatives were rejected. It must be considered in the impact assessment that the impacts of the zero alternative (Alt.0) are properly assessed and described. The description of only the current state of environment is not sufficient, but environmental impacts caused by the existing operations and future long-term impacts must be taken into account.	The alternative locations and the final location of the facility are described in the end of chapter 1.2. The project alternative (Alt.1), which is assessed in the EIA procedure, is most probably the implemented and permitted alternative by scope. The zero alternative is described in chapter 3 and in context with each impact.
	The comparison of alternatives Alt.1a and Alt.1b must be performed objectively and with similar accuracy regarding the implementation alternatives with focus on the essential environmental impacts for the project provided in the EIA Act. The comparison must provide an accurate overall view of the impacts and differences of the project alternatives. Regarding the comparison of alternatives, the EIA report must also include verbal descriptions of alternatives and related impacts in addition to summary tables. Comparison of all project alternatives and their positive and negative impacts must be performed in the EIA report for the support of decision making. The comparison	Alternatives Alt.1a and Alt.1b have been assessed and compared in context with each impact. The significance of impact has also been assessed.

Section	Statement of the coordinating authority	Consideration in the EIA report
	must be analytic and comprehensive. The significance of impact must also be assessed in the comparison of alternatives, and the feasibility of different alternatives and solutions must also be evaluated based on the significance of impact.	
	It must also be considered that the studies prepared during the EIA procedure can provide information, based on which the alternatives or related parts or definitions presented in the EIA programme may have to be modified. Introduction of new alternatives and sub-alternatives during the EIA procedure can be a positive matter with regard to impacts.	During the assessment there was no need to modify the alternatives, which were presented in the EIA programme.
Permits and decisions required by the project		
	The project developer states that this is a critical project with regard to the project schedule, and the aim is the simultaneous consultation on the EIA report and environmental permit. The coordinating authority states that pursuant to section 22a of the EIA Act, the precondition for the the simultaneous consultation is that regarding the location, scope and technical features, the project has no other alternatives than the feasible alternative presented in the permit application.	Regarding its location, scope and technical features, the project has no other alternatives than the feasible alternative presented in the permit application.
	Different technical alternatives e.g. for the transport of raw materials and products (truck transport or conveyor belt) have been described in the EIA programme. Technical alternatives have also been presented for CO2 delivery. The location of activities in the VRP area has not been decided in the EIA programme. The coordinating authority considers that based on the information presented in the EIA programme and review of the EIA Act, the simultaneous consultation denoted in section 22 a of the EIA Act cannot be applied to the project. The alternatives described in the sub-alternatives of the project can be different by scope. The decision on the by-product status of SSM in the vanadium recovery plant will not be made until with the environmental permit decision.	Transport of raw materials and products as well as CO_2 delivery to the facility have been specified in the EIA report (chapter 2.2.9). Location of activities has also been specified in the EIA report (chapter 2.1).
	The environmental permit application of an installation covered by the directive must include a clarification of the adoption of the BAT-techniques, if the Bref document has been published. It should be evaluated in the EIA report, which BAT-conclusions are applied to the operation of the plant. When applicable, BAT-techniques should provide guidelines for selecting processes and device, and the plant should be designed based on the best available technique.	The BAT-conclusions regarding waste water and waste gas of chemical industry would probably be best applied to the operation of the plant. If the status of slag is waste, the BAT-conclusions regarding "metal industry using other than ferrous metals" or BAT-conclusions regarding

Section	Statement of the coordinating authority	Consideration in the EIA report
		waste treatment would be applied to the operation, depending on the status of slag (chapter 5.2).
	Both Tukes and the Finnish Transport Infrastructure Agency stated that hazard classifications and hazardous properties of chemicals have not been presented in the EIA programme. More detailed information on hazard classifications, hazardous properties, volumes and storage of chemicals must be presented in the EIA report.	Hazard classifications of chemicals and more detailed information are presented in chapter 2.2.
	Regarding transport of materials, the Finnish Transport Infrastructure Agency has stated that a separate permit is needed for special transport. Similarly, a crossing permit is needed, if infrastructure crossing the transport infrastructure of the Finnish Transport Infrastructure Agency is used in transport operations of the project. The need for the above mentioned permits must be identified in the EIA report.	Need for permits is described in chapter 5.5.
Current state of environment		
	All plan symbols in the regional plans concerning the impact area of the VRP have not been taken into account in the EIA programme. The presentation of valuable cultural environments, landscape areas, architectural heritage, archaeological sites and nationally significant cultural environments has been inadequate. Related data input and processing must be completed and clarified. Shortcomings and corrections presented in the statements of the Satakunta Regional Council and the Satakunta Museum must be considered in the EIA report.	Information regarding the current state of environment has been supplemented and corrected, see chapters 6.2.3, 6.11.3.
	In addition to the Satakunta regional plan and the Satakunta phase regional plan 2, the Satakunta phase regional plan 1 is valid in the area. It is not mentioned in the EIA programme. Otherwise, the existing land use plans in the VRP area and in its surrounding area have been properly considered. More concrete description should be included in the EIA report regarding the suitability of operations to the land use plan symbols in the area.	Reference to the Satakunta phase regional plan 1 has been added to chapter 6.10. The suitability of operations to the land use plan symbols in the area is discussed in chapter 6.2.5.
	Detailed description of data collection methods used in the assessment and preparation of illustrative maps for different themes must be considered in the EIA report. The baseline description must be specified based on studies prepared during the assessment procedure.	Considered in the EIA report.

Section	Statement of the coordinating authority	Consideration in the EIA report
Assessed impacts and scope of assessment		
	It is important to present clear arguments behind the conclusions of each impact (magnitude of impact: large-minor). It should be clarified, if mitigation measures are considered in the assessment of the significance of impact. Otherwise, a separate assessment must be prepared with and without mitigation measures.	Considered in the EIA report in context with the assessment of each impacts.
	The variable extent of the impact area for different project impacts, which is presented in the EIA programme, is justified. The preliminary impact areas presented in the EIA programme must be specified in the EIA report, when needed. The coordinating authority states that the proposal for delimiting the impact areas is extensive enough considering that impact areas will be specified during the assessment. The coordinating authority considers that the assessed impact areas should also be presented in maps in addition to verbal description.	The distance of impact areas from the VRP area has been illustrated in Figure 8-2 of the EIA programme.
Impacts on land use, landscape and land use planning		
	Location and size of slag and SSM storage areas as well as the height of stockpiles and volumes of stored materials must be clearly presented in the EIA report. In addition, the height of stockpiles and cumulative impacts with other nearby activities must be considered in the landscape impact assessment. Storage of carbon dioxide and related impacts must also be assessed in the EIA report.	Information regarding storage areas is presented in chapter 6.5. Relevant issues have been considered in the landscape impact assessment. Risks related to the storage of carbon dioxide are discussed in chapter 6.14.
	The suitability of the detailed plan to the project should also be evaluated in the EIA report.	The suitability of the detailed plan to the project has been evaluated in chapter 6.2.5.
	The desciption of the land use plan in the EIA programme includes a note regarding sea water floods and the lowest construction heights, but sea water flood risk in the VRP area must be considered more thoroughly in the impact assessment and in the EIA report. This was only briefly discussed in the EIA programme. The coordinating authority considers that the impact of waves in the VRP area is very significant due to the location next to the open sea.	Consideration of sea water flood risk and impact of waves in further planning are described in chapter 6.14.

Section	Statement of the coordinating authority	Consideration in the EIA report
Impacts on soil, bedrock and groundwater		
	Preliminary surveys were performed in the VRP area in spring 2021 to examine the quality of soil. Results of the survey must be considered in the EIA report. The environmental permit application of an installation covered by the directive must also include the baseline screening assessment.	Results of the soil studies performed in spring 2021 are presented in chapter 6.9. The baseline screening assessment will be attached to the environmental permit application.
	It is described in the EIA programme that groundwater follows the sea water level in the area and groundwater mainly flows towards the sea. The impacts of accidents on ground water and perched ground water in the area must be evaluated in the risk assessment in the EIA report.	A risk assessment has been prepared for the vanadium recovery plant and potential risks are discussed in chapters 6.14 and 6.5.
Impacts on surface water		
	The quality of stormwater flowing to the sea in exceptional situations should be evaluated in the EIA process and stormwater should be able to be directed to the sea so that its quality can be monitored.	The treatment and quality of stormwaters are discussed in chapter 6.5.
	The VRP area is bounded by water area, which is part of the Reposaari-Outoori water body. Neither the ecological and chemical state of the water body nor the significance of the project from the viewpoint of water management and marine management planning have not been evaluated in the EIA programme. The environmental impact assessment must also be conducted regarding these issues, as it will be required in the permit procedure.	The state of the Reposaari-Outoori water body is described in chapter 6.8.3. The goals of water management and marine management planning from the viewpoint of the project are also presented in the chapter and impacts are assessed in chapter 6.8.5.
Impacts on fish stock		
	Potential impacts of stormwater from heavy rain and increasing vessel transports on fish stock must be assessed in the EIA report.	Impacts are presented in chapters 6.8.5 and 6.5.4.
Impacts on vegetation, animals and nature reserves		
	Potential endangered natural habitats and species designated in the nature study of the Tahkoluoto-Paakarit component master plan, which will be completed in 2021, must be considered in operational planning so that natural values of valuable areas will not be deteriorated by using them, for example, as slag storage areas. Earlier bird observations must be used in assessing impacts on nature, and these observations must be considered in operational planning.	Endangered and valuable natural habitats and species will be considered in operational planning. Impacts are assessed in chapter 6.9 and the assessment includes available information from the nature study conducted in summer 2021.

Section	Statement of the coordinating authority	Consideration in the EIA report
		Information on bird observations in the area is presented in chapter 6.9.3.1.
	Impacts of vessel transports and the potential impacts of noise and air emissions on protected areas must also be assessed in the EIA report.	Impacts are presented in chapter 6.9.4.
	The ELY Centre considers that the presented conclusions are correct and the Natura assessment pursuant to section 65 of the Nature Conservation Act is not necessary.	Noted in chapter 6.9.
Impacts on landscape and cultural environment		
	The scope of construction works and construction height must be described in more detail in the EIA report, which is significant for the impacts related to landscape and cultural environment. Regarding cultural environment, potential noise and lighting impacts and cumulative impacts with the extension of the Tahkoluoto wind farm project should also be assessed.	The scope of construction works and construction height as well as noise and lighting impacts have been considered in the impact assessment related to landscape and cultural environment (chapter 6.11). Cumulative impacts with other projects are assessed in chapter 6.15.
Impacts on the use of natural resources		
	Regarding the use of natural resources, arguments as well as adequate background and source data must be presented for the claim that "the project is estimated to have positive impacts on the use of natural resources". Sufficient methodological description must be presented in the assessment regarding the use of natural resources. From the viewpoint of circular economy, arguments and discussion should be presented regarding the requirements for separating titanium and manganese from slag in the process and potential recycling.	Positive impacts of the project on the use of natural resources with arguments are presented in chapter 6.13. It is not planned to separate titanium and manganese from slag.
Traffic impacts		
	Heavy traffic volumes will grow in the area due to the implementation of the project, and therefore the traffic impact assessment must be conducted thoroughly. Estimates of the growing total traffic volumes and heavy traffic volumes in the nearby road network due to the project should be presented in the EIA report. Especially, the existing and future traffic volumes should be estimated on the Reposaari main road (regional road 269) and the Pori archipelago road (regional road 272) leading to the Tahkoluoto port and industrial area. The destination and	Traffic impacts are assessed in chapter 6.3. Road network condition and e.g. carrying capacity can require upgrading measures due to growing heavy traffic volumes, and the need for road maintenance and the costs of road infrastructure

Section	Statement of the coordinating authority	Consideration in the EIA report
	route for transporting slag from the VRP area to the disposal site must be described in the EIA report. If slag is transported by heavy vehicles along the road network, heavy traffic volumes in the area will significantly increase. Furthermore, it should be evaluated, how the condition, carrying capacity and maintenance of the road network will meet the needs of growing heavy traffic.	management will increase. The needs of road infrastructure management must be evaluated by taking into account changes in traffic volumes caused by all projects in the area. The Satakunta ELY Centre is responsible for road infrastructure management in the area and it evaluates the situation and conducts necessary studies and measures together with the City of Pori.
	Based on traffic volumes, it can be estimated, which will be the potential upgrading measures on regional roads in the future. In general, measures can include, for example, road widening, upgrading of the pedestrian and bicycle network, game fence and noise abatement.	Mitigation measures of traffic impacts are discussed in chapter 6.3.6.
	Furthermore, the level of service on road transport routes and performance of junctions as well as traffic safety and the needs of large special transports must be considered. A supplementary route for special transports leads from highway 8 to the Tahkoluoto port along the regional roads 272 and 269. More detailed impacts on the use of transport infrastructure and transport infrastructure management must be presented in the EIA report.	Considered in chapter 6.3.
Noise and vibration impacts		
	Regarding noise impacts, the number of residents/sites to be exposed and potential sensitive sites to noise, such as schools, day-care centres, medical institutions etc. must be presented. In addition, noise impacts from traffic due to the project must be considered in the assessment. With regard to noise levels, noise from the operation only and combined noise with other noise sources in the area must be presented. Noise abatement measures during construction and the impacts of the presented noise abatement measures must be assessed in the EIA report. An adequate noise monitoring programme for disturbed sites must also be presented.	Considered in chapter 6.4.
Impacts related to air emissions and air quality		
	The EIA Directive requires more strongly that the EIA procedure must include the climate impacts of projects and their susceptibility to climate change. The Finnish Environment Agency has recently published a guidebook on the assessment of climate impacts in the EIA- and SIA procedure. (https://julkaisut.valtioneuvosto.fi/handle/10024/163178).	Information included in the guidebook introduced by the coordinating authority has been applied in chapter 6.7.

Section	Statement of the coordinating authority	Consideration in the EIA report
	In addition to the mitigation viewpoint related to the greenhouse gas emissions and carbon sequestration of climate change, it should be assessed, how climate change will affect the operation of the plant in the long run.	Preparations for the impacts of climate change are discussed in chapter 6.14.
	An adequate presentation (including the scope, background material and methodology) of the impacts on air emissions must be provided so that the reader can get an adequate view of the air emissions from the operation and related uncertainties. For example, plenty of fossil fuels and electricity are consumed in operation, and there are also alternatives for transporting masses – how the impacts caused by them can be reduced and which are the most efficient measures for the operator to reduce generated emissions? These themes should be highlighted in the assessment. If and when the operation is compared to non-renewable vanadium production, a sufficient methodological description must be presented for the comparison including background information, assumptions and uncertainties. It should also be specified in calculations, how critical is the significance of receiving carbon dioxide from other facilities on total impacts.	A life cycle estimate has been prepared for the project, which has been used in the assessment of climate impacts. Mitigation of impacts is discussed in chapter 6.7.
	The summary of the results of the climate impact assessment must be comprehensive and include a description of climate impacts during different phases and operations.	Climate impacts are described in chapter 6.7.
	Air emissions have only been slightly examined in the EIA programme. Impacts on air emissions must be assessed more thoroughly in the EIA report so that the generated environmental impacts can be assessed reliably. Special attention must be paid to the generation, prevention and mitigation of dust emissions. With regard to stored raw material and slag, location of storage areas, foundation structure, cover structure and other structures preventing dust spill as well as estimated diffuse dust emissions from stored materials must be presented for evaluating dust problems.	Air emissions are discussed in chapter 2.2.8. Management of dust impacts is discussed in chapter 6.6. Estimate of diffuse emissions is presented in chapter 6.6.5.2. Location of storages is described in chapter 2.1.
Impacts on human health, living conditions and comfort		
	Social impacts have been well highligted in the EIA programme and it is desirable that sensitive groups are considered in the impact assessment. Change in accessibility is a significant social impact and accessibility should also be examined with regard to the sensitive groups.	Accessibility is considered and mentioned in chapter 4.3.

Section	Statement of the coordinating authority	Consideration in the EIA report
Risks and exceptional situations		
	Special attention must be paid to chemical safety in the planning and implementation of the project. An environmental risk assessment must be prepared for the project, which also includes the transport and storage of hazardous chemicals. The prepared environmental risk assessment, assessment methods and results must be presented transparently and comprehensively in the EIA report.	Environmental risks have tentatively been assessed and they are presented in chapter 6.14.
	Potential spreading of accidents from one facility to another must be considered in the location of the facility and in the impact assessment of accidents. The guidebook by Tukes "Joint operation of chemical facilities for preventing accidents" should be used in the assessment, when applicable.	Considered in chapter 6.14.
	Flood risks and measures for minimizing these risks must be examined in project planning and in the impact assessment of accidents and incidents.	Considered in chapter 6.14.
	Climate change has to be considered as a risk related to the operation. It must be assessed as an expert evaluation, how exceptional weather conditions (especially heavy rain) will affect the operations and how this can be prepared for. With regard to all impacts, main uncertainties related to the impact assessment and their significance regarding the use of the assessment results must be presented in the EIA report.	Preparations are made in planning for heavy rain occurring once in 50 years (chapter 6.5.4.1). Preparations for changing weather conditions due to climate change are presented in chapter 6.14. Uncertainties related to the assessment are examined in respective sub-chapters in context with the assessment of each impact.
Cumulative impacts		
	Cumulative impacts of the project with other ongoing and planned industrial projects and existing industrial operations must be assessed in the EIA report.	Considered in chapter 6.15.
	Special attention must be paid to the identification and assessment of cumulative impacts. It must be considered in the assessment that existing operations and planned projects can cause significant cumulative impacts, particularly, in case of simultaneous construction.	Considered in chapter 6.15.

Section	Statement of the coordinating authority	Consideration in the EIA report
Mitigation and monitoring of harmful impacts		
	The prevention and mitigation measures for harmful impacts of the project should be summarized in a table format. This will provide for easier flow of information and consideration of measures.	Considered in chapter 7.2.
	A monitoring plan for the environmental impacts of the project must be presented in the EIA report, even though facility-specific emission and impact monitoring will be decided in the environmental permit. Based on the feedback received from the monitoring plan presented in the EIA report, the plan can be specified for the environmental permit application. The need and methods for monitoring such impacts, which are not examined in the environmental permit, must be sufficiently assessed in the EIA report.	Considered in chapter 8.
	Special attention must be paid to the monitoring of impacts and mitigation measures of harmful impacts in the planning and construction phase of the project. It is important to include a preliminary monitoring programme in the EIA report for monitoring the most significant environmental impacts of the project during construction and operation.	Considered in chapter 8.
Information on the qualification of persons involved in the preparation of the EIA report		
	It must be presented in the EIA report, if other specialists than those listed in the EIA programme are used due to meeting the project schedule or for other reasons.	Considered in chapter 6.1.4.
Communication, participation and completion of the EIA report		
	Resident surveys and other methods of participation must be extensively organized, and it is important that information from citizen participation is used comprehensively during the impact assessment.	Mentioned in chapter 4.3. Received feedback has been utilised in the impact assessment.
Transboundary environmental impacts		
	The coordinating authority also considers that the project has no transboundary environmental impacts pursuant to section 5 of the EIA Act.	
Summary and guidelines for further work		
	The EIA report must provide answers to the fundamental questions, which were presented in the statement of the coordinating authority and other statements and opinions. The EIA report should be as illustrative as possible and visual material must be versatile and of good quality. This is important especially in the description of operations and impacts as well as in the comparison of alternatives.	Considered in the EIA report.

Section	Statement of the coordinating authority	Consideration in the EIA report
	The desciption of calculatory methods and modelling as well as technical details must be easily understandable.	
	During the assessment, contact must be maintained with the Southwestern Finland Centre for Economic Development, Transport and the Environment and other expert authorities involved in the EIA procedure, when needed. It should be considered in the assessment that sufficient time is reserved for necessary studies and the timing for performing particular studies is appropriate. It must be explained in the EIA report, how the statement of the coordinating authority on the EIA programme has been considered.	Meetings have been organized during the assessment with e.g. the Southwestern Finland Centre for Economic Development, Transport and the Environment and the Regional State Administrative Agency for Southern Finland. The consideration of the statement of the coordinating authority is described in this table.

5 Permits, plans and decisions required by the project

5.1 Environmental impact assessment

In accordance with the EIA Act (252/2017), the construction of the vanadium recovery plant requires an environmental impact assessment procedure.

The project developer has initiated the EIA procedure by preparing the EIA programme. The EIA report and the reasoned conclusion from the coordinating authority are the prerequisites for granting the required permits for the project (among others, the environmental permit, the building permit and the chemical permit).

5.2 Environmental permit

The operations requiring a permit are based on the Environmental Protection Act (YSL 527/2014), and pursuant to it, on the Environmental Protection Decree (YSA 713/2014). The environmental permit covers all issues related to environmental impacts, such as emissions to air and water, waste issues, noise issues and other issues related to environmental impacts.

According to the Environmental Protection Act (527/2014), permit provisions must be based on the BAT-level (Best Available Techniques) in accordance with the EU Industrial Emissions Directive. Emission threshold values, monitoring and other permit provisions must be based on so-called BAT-conclusions. The BAT-conclusions regarding the “treatment of waste waters and waste gases in chemical industry” would probably be best suited to the operation of the plant. If the status of slag is waste, the BAT-conclusions regarding waste treatment would be applied.

The environmental permit authority for the project is the Regional State Administrative Agency of Southern Finland. The permit authority will grant the environmental permit, if the operation meets the requirements set by the Environmental Protection Act and other legislation. A reasoned conclusion on the environmental impact assessment procedure must be provided by the coordinating authority before the permit can be granted.

No construction in the water system is included in the project and so there is no need for a permit according to the Water Act.

5.3 Building permit

According to the Land Use and Building Act, a building permit is applied from the city building permit authority, which when granting the permit, verifies that the plan complies with the ratified city plan and building regulations. The building permit is required prior to starting the construction. The building permit can be granted after the environmental impact assessment procedure has been completed.

5.4 Chemical permit

The VRP includes extensive chemical processing and the plant requires a permit according to the Act on Chemical Safety (390/2005). The permit is applied from the Finnish Safety and Chemical Agency (TUKES) and it contains the requirements of the Seveso Directive. The permit must be applied well before commissioning.

In context with the application of the chemical permit, a list of used chemicals in the facility is recorded in the KemiDigi system.

Among others, the following acts and regulations related to chemicals concern the project:

- Decree on the control of handling and storage of hazardous chemicals 685/2015;
- Act on safety in handling hazardous chemicals and explosives 390/2005;
- Decree on the industrial treatment and storage of hazardous chemicals 856/2012;
- Chemicals Act 599/2013;
- REACH Regulation EC 1907/2006;
- CLP Regulation EC 1272/2008; and
- Act on the Transport of Dangerous Goods 719/1994.

TUKES will inspect the production facility prior to commissioning.

TUKES must also be notified of the used and produced chemicals in accordance with the REACH Regulation (2006/1907/EC).

5.5 Other permits and obligations

Obligations to operations according to the REACH Regulation (EC/1907/2006) will be fulfilled based on the REACH action plan, which will be prepared later. The necessary REACH registrations will be prepared for manufactured products and the other obligations of the REACH Regulation will be complied with.

The SSM, which is produced along with vanadium pentoxide products, is intended to be registered as a by-product according to the REACH Regulation.

The by-product status of slag is discussed in chapter 2.2.4.

When slag is treated as a by-project, obligations regarding e.g. waste transport and waste accounting are not applied to slag and the environmental permit procedure of the facility is not based on professional waste treatment.

A special transport permit pursuant to the Road Traffic Act must be applied to potential special transports related to the construction phase of the plant (transport of equipment and materials). The need for special transports is unlikely, but necessary permits will be obtained most likely by the transport company, when needed.

Related statutes and regulations will be considered in the transport of hazardous goods including e.g. the Act on the Transport of Dangerous Goods (719/1994) and the Government Decree on the Conformity of Packages, Tanks and Bulk Containers Used in the Transport of Dangerous Goods (124/2015).

A crossing permit is needed for potential crossings related to the project with the transport infrastructure of the Finnish Transport Infrastructure Agency. The need for this permit is not likely at the moment.

According to preliminary view, an amendment is not needed for the existing detailed plan for implementing the project pursuant to the Land Use and Building Act.

Other permits and procedures related to environmental issues are mainly technical, such as, for example, the inspections of pressure vessels.

In the decommissioning phase, operation subject to environmental permit requires a decision on the lapse of the environmental permit.

6 Environmental impact assessment

6.1 Implementation of the assessment

6.1.1 Alternatives in the assessment

The EIA legislation requires sufficient assessment of alternatives in the EIA procedure. One of the assessed alternatives must be non-implementation of the project or so-called zero alternative, unless it is unnecessary for some reason. This EIA procedure has two alternatives, alternative 0 (Alt.0) and alternative 1 (Alt.1) as well as sub-alternatives 1a (Alt.1a) and 1b (Alt.1b) (chapter 1.4).

6.1.2 Assessed impacts

According to the EIA Act, the environmental impacts caused by the VRP are assessed on:

- soil and bedrock, water system, air, climate, vegetation, organisms and biodiversity;
- use of natural resources;
- community structure, buildings, landscape, cityscape and cultural heritage;
- population and human health, living conditions and comfort;
- interaction between these factors.

Potential transboundary environmental impacts will also be considered.

The focus of the assessment is on the evaluation of impacts during operation. Impacts during operation and construction are presented by each impact in chapters 6.2–6.15. Impacts of decommissioning are assessed in chapter 6.16. The focus of the impact assessment was on the estimated and observed significant impacts.

Based on preliminary estimate, the most significant impacts of the VRP are related to the transport of raw materials and final products as well as noise from operation. Key environmental aspects also include dust emissions and potential accidents and disturbances.

The following studies have been prepared during the EIA procedure:

- Natura Screening Assessment (Sweco 2021b, attachment to the EIA programme)
- Resident survey (Appendix 3)
- Noise modelling (Sweco 2021c)
- Preliminary surveys on the construction condition and quality of soil (Sweco 2021d).

6.1.3 **Scope of the assessment, used materials and methods**

The assessment is based on information about the current state of environment and the estimated changes to the environment caused by the VRP. More detailed description of the used assessment methods, materials, scope, uncertainties and description of the potential prevention of harmful impacts is presented in context with the assessment of each impact. The following includes a description of the assessment of the significance of impact.

Assessment of the significance of impact

The significance of impact is assessed by using the approach developed in the Imperia -project (Improving Environmental Assessment by Adopting Good Practices and Tools of Multi-criteria Decision Analysis, LIFE11 ENV/FI/905). The sensitivity of the target and the magnitude of change are considered in assessing the significance of impact (Figure 6.1-1).

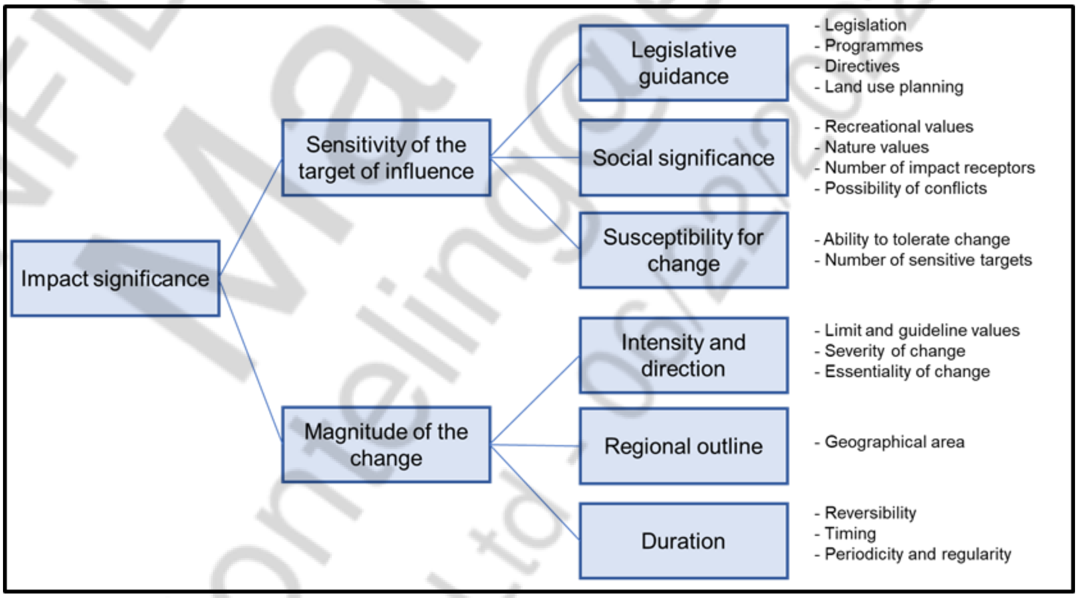

Figure 6.1-1. Approach to the assessment of the significance of impact (Marttunen et. al. 2015).

The significance of environmental impacts is assessed e.g. by comparing the volume of a certain load factor to the environmental tolerance taking e.g. the existing environmental load of the impact area into consideration. When assessing the environmental tolerance, provided guideline values, such as air quality and noise level guideline values as well as available research information are utilised.

The factors that have been considered in the assessment of significance for each impact are described in the EIA report. The sensitivity of the target of influence describes the characteristics of the target of influence or features of the impact area. The sensitivity of the target is influenced by e.g. existing environmental load compared to the guideline values provided by legislation as well as by proximity to residences and other sites susceptible to impacts. The magnitude of change is composed of the intensity and direction of change, regional scale and duration. Direction of change can be either negative or positive.

Table 6.1.-1 is utilized in the assessment of the significance of impact, which shows both the sensitivity of the receptor and the magnitude of the change (positive, neutral or large on the scale minor, moderate or large). The estimated significance of impact is illustrated by different colours.

Table 6.1-1. Assessment of impacts.

Significance of the impact		Magnitude of the change						
		Negative			No change	Positive		
		Large	Moderate	Minor	No change	Minor	Moderate	Large
Sensi-tivity of the target	Minor	Reasona-ble	Minor	Minor	No effect	Minor	Minor	Reasona-ble
	Neutral	Large	Reasona-ble	Minor	No effect	Minor	Reasona-ble	Large
	Large	Large	Large	Reasona-ble	No effect	Reasona-ble	Large	Large

The significance of impact can be positive, neutral or negative and minor, moderate or large. The significance of impact is presented by colours and signs (+/-) in the summary chapters of the impact assessment based on the following scale (Table 6.1-2).

Table 6.1-2. Assessment of the significance of impact.

Significance of impact	Large positive impact (+++)
	Moderate positive impact (++)
	Minor positive impact (+)
	No impact
	Minor negative impact (-)
	Moderate negative impact (- -)
	Large negative impact (- - -)

In the assessment of environmental impacts, emphasis is placed on the impacts which are assessed and perceived as significant. Information on issues that citizens and various stakeholders consider important is obtained from the communication and hearing procedures.

6.1.4 Know-how and expertise

In accordance with the EIA Act, adequate expertise must be available for the preparation of the EIA programme and the EIA report. The persons involved in the impact assessment of the EIA procedure are presented in the following Table 6.1-3.

Table 6.1-3. Persons involved in the impact assessment.

Name	Education	Role	Qualification
Sirpa Torkkeli	M.Sc. (Industrial engineering) 1993	Project Manager Traffic impacts, Impacts of the treatment of slag, by-products and waste, Air quality impacts, Accidents and disturbances, Cumulative impacts	Over 20 years of experience for working in the environmental and energy industry sector. Participated in several EIA Procedures both as a project manager/coordinator and a specialist.
Vilma Skinnari	M.Sc.	Assistant Project Manager	Over 12 years of experience in industrial environmental tasks, including 8 years as an environmental expert in the metal production industry. Specific areas of expertise are environmental permitting processes and BAT.
Sanna Jaatinen	D.Sc. (Environmental technology) 2016	Specialist Impacts on soil and groundwater, Greenhouse gas emissions, Use of natural resources, Social impacts, Impacts on water system, Impacts on landscape and cultural environment	Over 9 years of experience in the environmental sector. Participated in the EIA Procedures.
Aija Degerman	M.Sc. (Biology) 2001	Impacts on nature, Natura screening assessment	More than 10 years of experience in the environmental field of nature and impact studies. Participated in several EIA procedures.
Pinja Mäkinen	M.Sc. (Ecology) 2012	Impacts on endangered species	Nearly 10 years of experience in nature studies and environmental impact studies.
Pekka Lähde	B.Sc., Environmental planner 2005	Noise modelling and noise impacts	More than 10 years of experience in the environmental field. Participated in over 20 EIA procedures as an air quality and noise expert.
Johanna Lehto	M.Sc. (Planning geography)	Resident survey and social impacts	More than 10 years of experience in social impact assessment.
Alina Reiman	M.Sc. (Construction engineering) 2019	Vibration and structure-borne noise	Several vibration and structure-borne noise studies related to railway traffic.

6.2 Community structure and land use

6.2.1 Summary

The project will promote the achievement of the national land use objectives by e.g. supporting the existing development of the industrial and port area, maintaining the vitality and attractiveness of the area, reinforcing existing regional structure and creating opportunities for circular economy.

The implementation of the project will reinforce and support the operations of the existing port and industrial area and will not change the community structure.The surrounding environment of the VRP area has been for a long time in the impact area of the port and industrial area and related heavy traffic, noise and potential emissions. Residential areas and other sensitive sites are located so far from the VRP area that impacts will not significantly increase due to the implementation of the project. However, impacts will be significant along traffic routes and in their vicinity.

The project conforms to the valid Satakunta regional plan, the component master plan with no legal effect or the pending draft component master plan. The area has a valid detailed plan.

Comparison of alternatives and significance of impact

In alternative Alt.1b, the area needed for disposal will probably increase in the Pori area. Otherwise, there is no fundamental difference between alternatives Alt.1, Alt.1a and Alt.1b with regard to impacts on land use and community structure. If the project is not implemented, the needs of industry are considered anyway in the land use planning of the area.

The overall impact of the project is assessed as moderate and positive.

Construction phase

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Community structure and land use			No impact.

Operation phase

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Community structure and land use	The project will promote the achievement of the national land use objectives by e.g. supporting the vitality of the area and reinforcing the existing regional structure. The project conforms to the existing land use plans and pending plan proposal.	In any case, the needs of industry are considered in the land use planning of the area.	There is no fundamental difference between alternatives Alt.1, Alt.1a and Alt.1b. Significance of impact of the project is assessed as moderate and positive (++).

6.2.2 **Assessment method**

The impacts of the project on the land use plans and land use development in the nearby area were assessed as an expert evaluation by examining the relation of the VRP to the existing regional and community structure, valid land use plans in the industrial area and nearby areas as well as pending land use planning projects and other known land use plans. It was examined in the assessment, whether the construction and impacts of the VRP have been addressed in the valid plans in the area, whether the designated land use in the valid plans has a fundamental effect on the feasibility of the VRP, whether the implementation of the VRP requires an alteration to the valid plans or preparation of new plans, and how the project has been or can be considered in the land use plans in the area. The assessment took especially into account the nearest residential and recreation areas, sites of cultural historical value and other potential disturbed sites.

The impacts of the project on the achievement of the national land use objectives were also assessed.

6.2.3 **Environmental baseline description**

6.2.3.1 Activities in the area

The southern VRP area is located on the southern side of the Tahkoluoto port area and the northern VRP area is located in the eastern/north-eastern part of Tahkoluoto (Figure 2.1-1, Chapter 2.1). A railway leads to the central part of the southern VRP area.

The Tahkoluoto Port consists of two operational parts, the Tahkoluoto deep-water port and the oil and chemical port, which includes the LNG terminal (Gasum Ltd) and storage area for liquefied natural gas (Skangas Ltd). The annual freight traffic volume to the oil and chemical port is about 800 000 tonnes (City of Pori 2020, City of Pori 2018).

Plenty of industrial activity is located in the Tahkoluoto port area (Figure 6.2-1). The Meri-Pori power plant owned by Fortum Power and Heat Oy, which currently operates as a power reserve plant, and reserve power station owned by Fingrid Ltd are located on the eastern side to the VRP area. In addition, other companies that operate in the Tahkoluoto Port area include Teboil Oy (oil tanks), Boliden Harjavalta Oy (sulphur acid tanks), LSPÖ Ltd (storage and handling of bitumen and other bulk products), Kemira Chemicals Oy (sodium hydroxide tank) and NEOT Oy (liquid fuels). The Tahkoluoto offshore wind farm of Suomen Hyötytuuli Ltd is located on the western side of the deep-water port.

Bulk-terminal operations by Oy Rauanheimo Ab and stowage, storage and shipping operations of Hacklin Port Service Ltd are located in the port area. The processing and storage area for recycled metal of Stena Recycling is located on the northern side of the coal storage areas of the deep-water port. Ahtauskone Oy handles peat and recycled metals of Stena.

PVO Lämpövoima Oy (office and storage spaces), Finland Tank Storage Oy, FTS (underground storage for oil products), Nordic Bulk Oy (ammonium sulphate storage) and Gaudium Oy (storage tanks for hazardous and inflammable liquids) also operate in the port area.

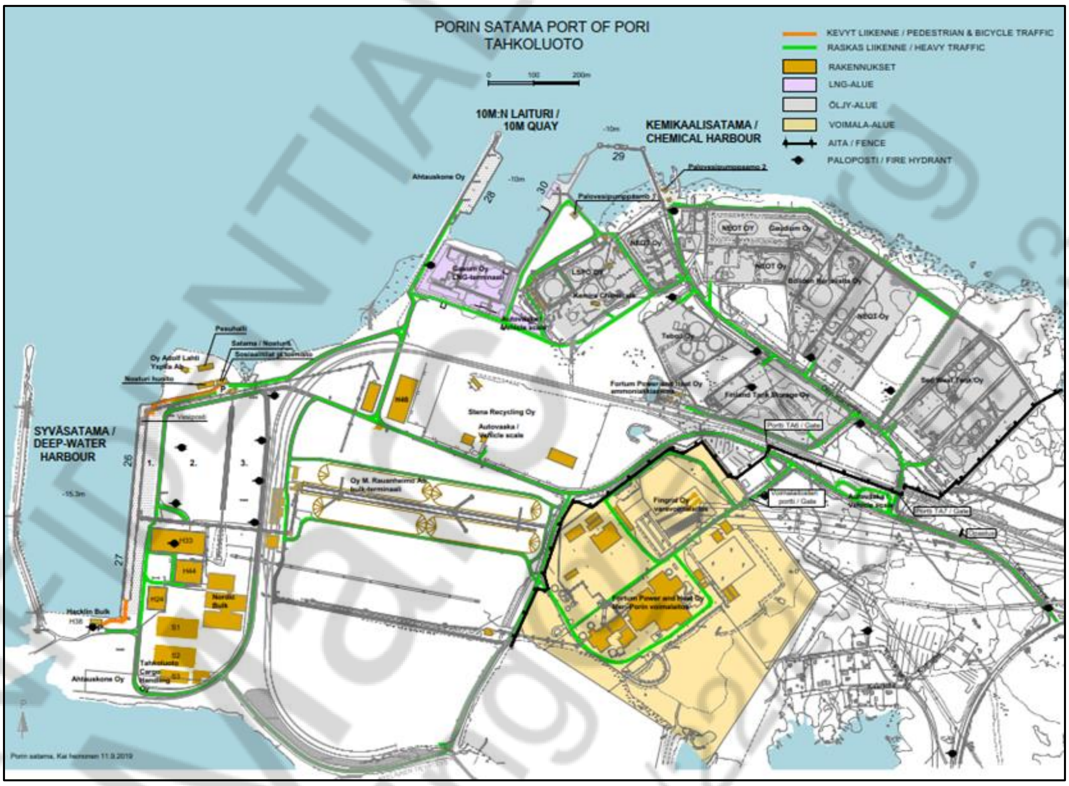

Figure 6.2-1. Tahkoluoto port site map (Port of Pori 2021).

Figure 6.2-2 and Figure 6.2-3 illustrate the surrounding area of the southern VRP area. Points, where the photos were taken, are presented in Figure 6.2-4. The pond in the figure is the ash pond owned by the Port of Pori, Fortum Power and Heat Oy and Pohjolan Voima Oy.

Figure 6.2-2. Water pond and filling area on the eastern edge of the VRP area. The Meri-Pori power station can be seen in the background. Photo taken towards northeast. Point B in Figure 6.2-4.

Figure 6.2-3. Road and the end of rail line in the planned VRP area. Wind farms of Suomen Hyöty-tuuli Oy can be seen in the background. Photo taken towards west. Point A in Figure 6.2-4.

Figure 6.2-4. Points, where Figure 6.2-2 and 6.2-3 were taken (Critical Metals Ltd).

6.2.3.2 Residential areas and sensitive sites

Residential areas and sensitive sites are described in chapter 6.12.3.

6.2.3.3 Recreational use

Recreational use of the environment is described in chapter 6.12.3.

6.2.4 **Land use planning and other plans**

According to the Land Use and Building Act, the land use planning system is based on a statutory plan system, which proceeds from general plans to more detailed plans (so-called hierarchical plan system). The principle is that more extensive and general land use plans or other plans guide more detailed land use planning and different plans cannot be in conflict with each other. The national land use objectives and regional plans are implemented at more general level. Master plans and city plans are more detailed, while city plans are the most accurate and binding forms of land use planning.

6.2.4.1 National land use objectives

The national land use objectives are part of the land use planning system according to the Land Use and Building Act (132/1999). State and municipal authorities must consider these objectives in their operations and promote the implementation of the objectives. The authorities must also evaluate the impacts of their measures in relation to the national land use objectives.

The Government has made a decision on new national land use objectives on December 14, 2017. The decision replaces the Government decision made in 2000 and verified in 2008. The Government decision took effect on April 1, 2018.

The central themes of the new national land use objectives include:

- functional communities and sustainable mobility
- efficient transport system
- healthy and safe living environment
- vital natural and cultural environment and natural resources
- regenerative energy supply.

6.2.4.2 Regional plan

The Satakunta Regional Plan, which was adopted on December 17, 2009 and ratified by the Ministry of the Environment on November 30, 2011, is valid in Pori (Figure 6.2-5). In the regional plan, Tahkoluoto is designated as a port area (LS), an area of industrial and warehousing activities (T), most of which is reserved for the manufacture, storage, and transport of hazardous chemicals (T-1), and an area for energy supply (EN). A regional road (thick black line) leads to the area, and there is an electrified interconnecting/branch rail line (black cross line) and fairways (black dotted line, open dotted line), a power line (thin black line) or a recommended, indicative power line route (400 kV + 110 kV and a reserve for 400 kV) and a natural gas network connection from land and sea (purple dashed line). The entire system is included in the development area of port operations (ls, red/black line with brackets inwards) and additionally in the nationally significant development zone of multi-centric regional structure (kk1, bright red line with brackets inwards)) of the Kokemäenjoki River valley. The SV 1 plan symbol designates the safety zone (so-called consulting zone, black dashed dotted line) of the hazardous chemicals in the Tahkoluoto port. According to the plan provision, the potential risks to nearby environment and activities caused by facilities in the area or manufacture, storage and transport of hazardous chemicals must be considered in the planning of the area. When planning to locate risky operations in the safety zone, the fire and rescue authority and the Finnish Safety and Chemicals Agency (TUKES), if needed, must be reserved an opportunity to provide a statement.

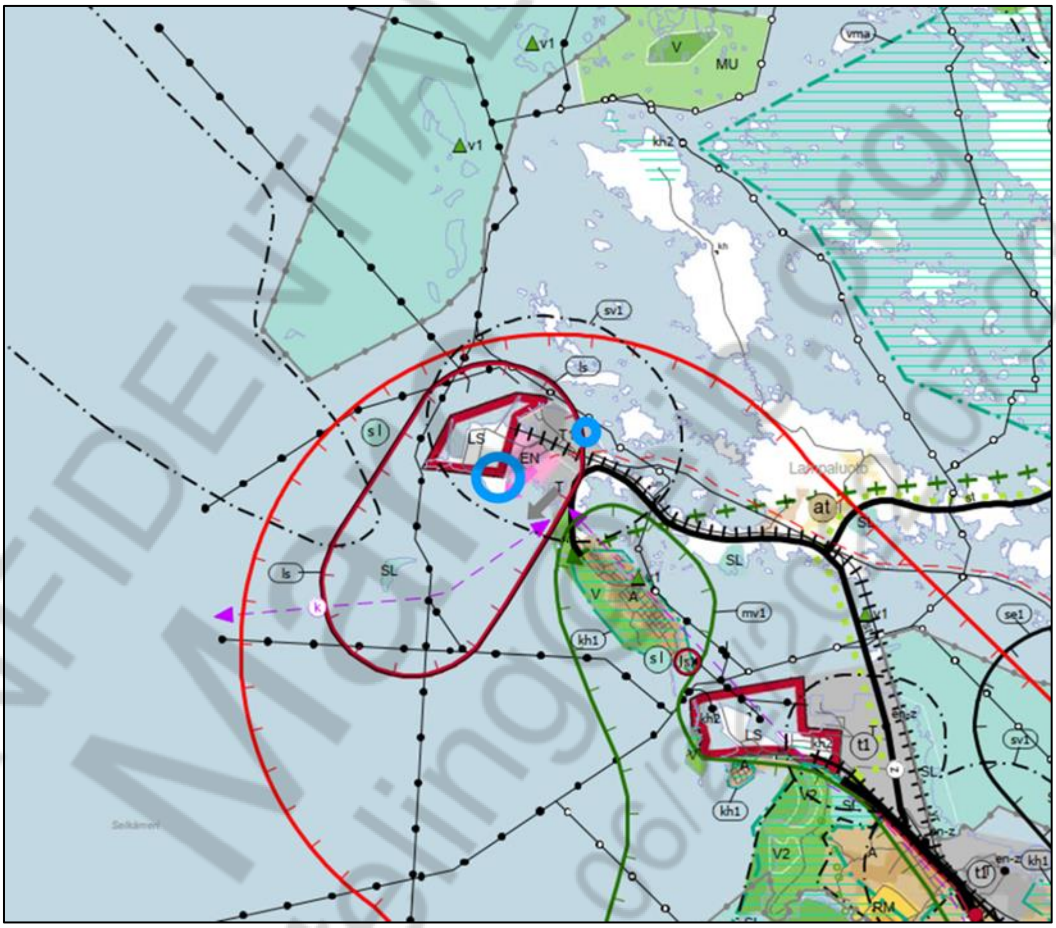

Figure 6.2-5. An extract from the Satakunta regional plan, 2009. The VRP areas are indicated with blue circles. Regional road (thick black line), railway (black cross line), fairway (black dotted line, open dotted line), power line (thin black line), indicative power line route (thin red line), natural gas network connection from land and sea (purple dashed line), development area of port operations (red/black line with brackets inwards), nationally significant development zone of multi-centric regional structure of the Kokemäenjoki River valley (bright red line with brackets inwards), safety zone of hazardous chemicals (consulting zone, black dashed dotted line).

In the Satakunta regional plan, the southern side of the road in the southern VRP area and small western part are designated for port operations (LS), southern part of the VRP area in Törnikari is located in white area (no area reservation). The plan symbol LS indicates the warehouse and terminal areas immediately associated with the port and port operations. The area has a building restriction pursuant to Section 33 of the Land Use and Building Act. When preparing plans for the area, the Transport Infrastructure Agency, the Port Authority and the Finnish Heritage Agency must be reserved an opportunity to provide a statement. The port area is surrounded by an area with the plan symbol sv-1 designated as the safety zone for a facility manufacturing or storing hazardous chemicals (consulting zone).

The southern VRP area is also partly located in energy supply and industrial expansion area (EN). The plan symbol designates energy supply areas. The area has a building restriction pursuant to Section 33 of the Land Use and Building Act, according to which a building permit may not be granted, if it hinders the implementation of the regional plan.

In the regional plan, the northern VRP area is located in an area having the plan symbol T1. The plan symbol designates significant industrial and warehouse areas, where plants manufacturing and storing hazardous chemicals can be located, and which must comply with the EU Directive 96/82/EY regarding the control of major accident hazards involving hazardous substances (SEVESO II Directive). The potential risks to nearby environment and activities caused by facilities in the area or manufacture, storage and transport of hazardous chemicals must be considered in the planning of the area. When preparing plans for the area, the fire and rescue authority and the Finnish Safety and Chemicals Agency (TUKES), if needed, must be reserved an opportunity to provide a statement.

The Satakunta phase regional plan 1 (gained legal force on May 6, 2016) does not have plan symbols in the VRP area.

The Satakunta phase regional plan 2 took effect on July 1, 2019. The phase regional plan 2 does not have plan symbols in the VRP area. The symbols in the plan (Figure 6.2-6) are base map symbols. The regional plans of Satakunta have no designated area reservations in the Törnikari area.

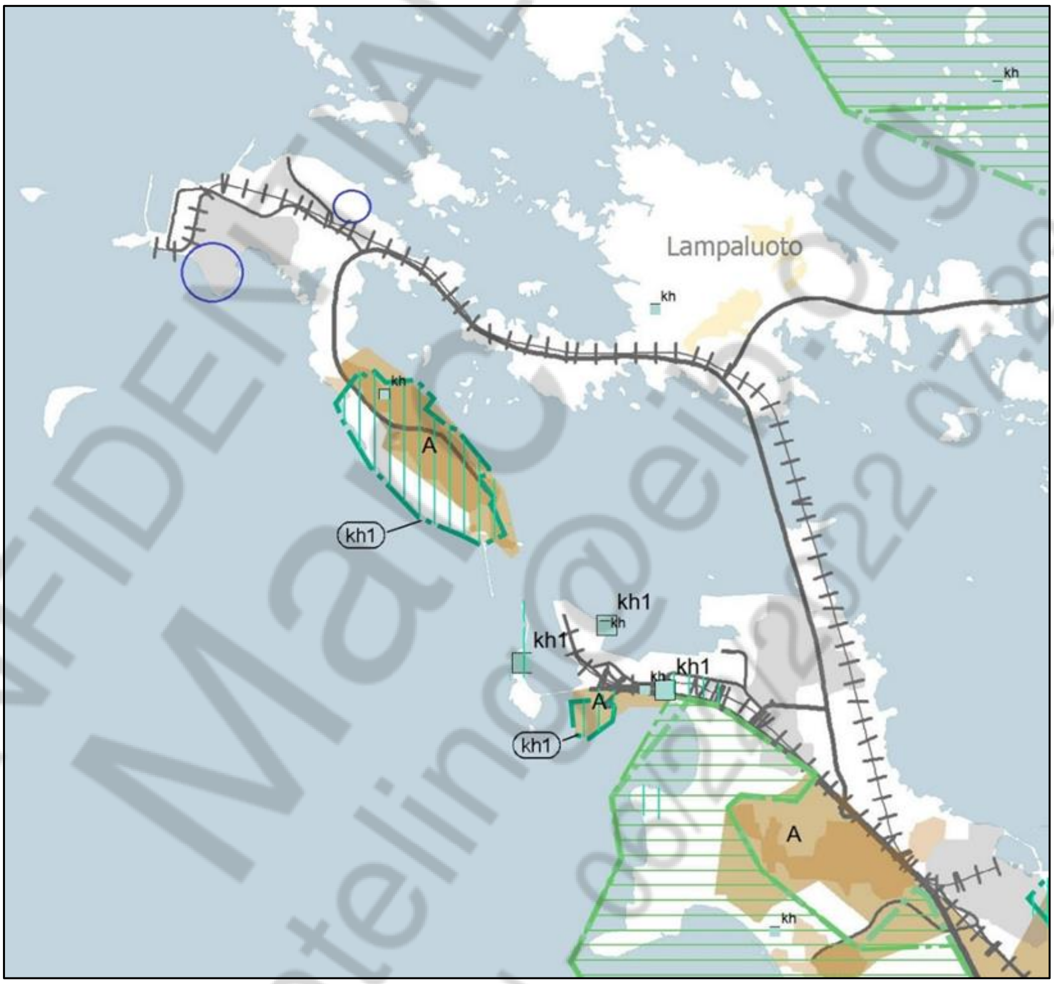

Figure 6.2-6. An extract from the Satakunta phase regional plan 2, 2019. The VRP areas are indicated with blue circles. The symbols in the map are base map symbols. Railway (grey cross line), road (grey line), nationally important cultural environment (green dashed dotted line). Brown colour: densely populated area. Grey colour: industrial and service area. White colour: area with no land use plan. kh1 symbol: sites of nationally significant built cultural environment.

Provisions have been provided in the Satakunta regional plan regarding flood control, road traffic, shore construction and the status of waters for the whole regional plan area. The provisions provided in the Satakunta regional plan regarding flood control and the status of waters include the following:

- Flood hazard areas and flood risks based on authority studies must be considered in land use planning. New construction must not be located in flood hazard areas. Exceptions can only be made, if it can be proved based on feasibility studies that flood risks can be controlled and construction is performed in a sustainable way. When planning activities in an area sensitive to flooding, the regional environmental authority responsible of flood control must be reserved an opportunity to provide a statement.

- Detailed land use planning in the entire regional plan area must contribute to the implementation of the water management plans and action programmes for the area. Regarding the shores of water areas, which are inclined, susceptible to erosion and flooding and sensitive with regard to water protection, land use must be planned pursuant to the Land Use and Building Act so that the leaching of substrates, solid substances and pollutants to the water system will be prevented or reduced.

6.2.4.3 Master plans

There is no legally binding master plan in the area. The area has the Reposaari-Tahkoluoto-Lampaluoto-Ämttöö component master plan, which is approved by the city council on March 24, 1997, and which has no legal effect (Figure 6.2-7). In the component master plan, both the southern and the northern VRP area are designated as industrial areas (T, grey area).

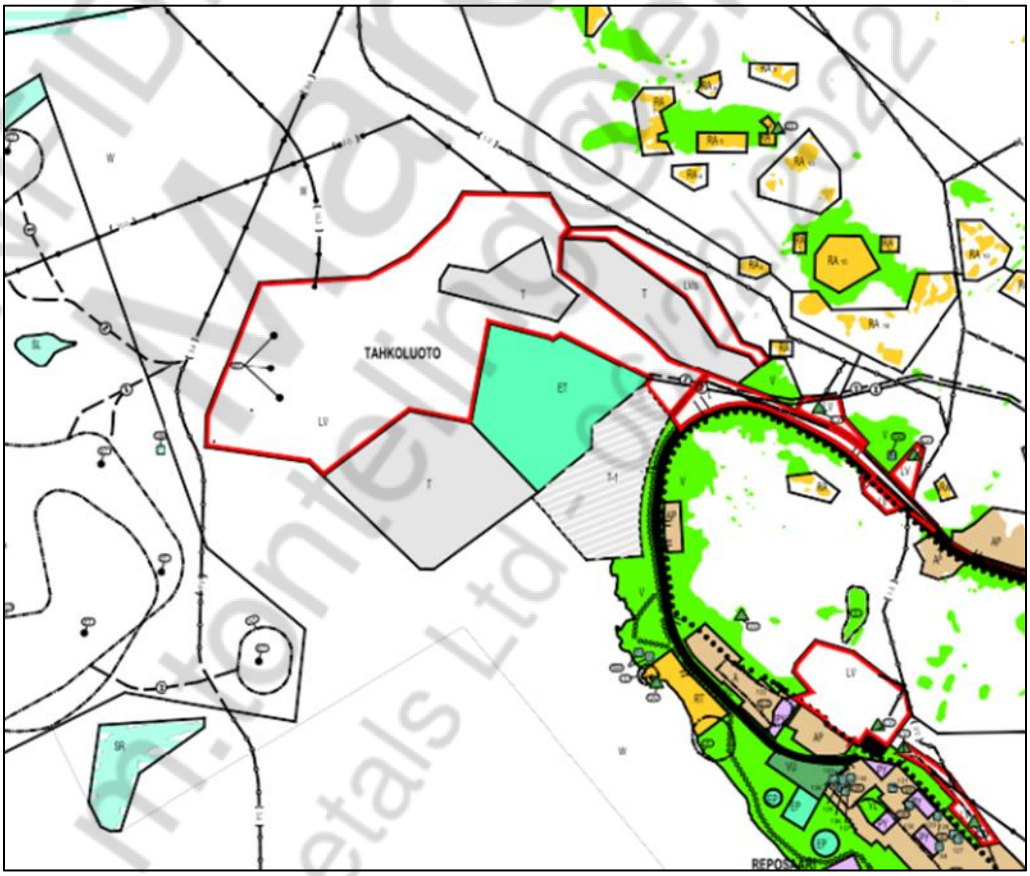

Figure 6.2-7. An extract from the Reposaari-Tahkoluoto-Lampaluoto-Ämttöö component master plan (Pori Map Service).

The Tahkoluoto−Paakarit component master plan is currently under preparation in the Tahkoluoto area (Figure 6.2-8). The main idea of the pending master plan is to secure the operations and enable the development of the Tahkoluoto deep-water port and chemical port in the future, while making preparations for port extension.

The plan is prepared as a legally binding area reservation plan. It replaces the component master plan prepared with no legal effect in the demarcated area. The draft component master plan has been on public display during 1.7–31.8.2020 (Pori City Board 2019). The proposal for the Tahkoluoto–Paakarit component master plan will likely to be processed during autumn 2021.

The “Reposaari-Tahkoluoto-Lampaluoto-Ämttöö” component master plan (1997) will be revised to a legally binding master plan for Tahkoluoto and its surrounding area as well as for its northern, predominantly city-owned islands. For the preparation of the master plan, the integration of port and industrial activities, recreational use and holiday settlement will be clarified for the revision of the Tahkoluoto detailed plan and for the repeal of the Reposaari archipelago detailed plan. The Tahkoluoto master plan and the revision of the detailed plan are urgent for the development and permit procedure of the port, industry, and other business activities. (Pori City Board 2019).

The aim of the Tahkoluoto-Paakarit component master plan 2040 (Figure 6.2-8) is to secure the development opportunities for the port and related activities, and to maintain the existing use of the leisure home areas in the Reposaari archipelago, where possible.

The area for the extension of the port is provided by designating the shallow area south of Tahkoluoto as an industrial, warehousing and energy supply area of community structure expansion, where a significant hazardous chemical storage facility (LS-TEN/kem) can be located. Depending on need, the use the area is resolved in connection with detailed planning. The area reserve extends to the edge of the deep-water area enabling the construction of a new deep-water port, if necessary (City of Pori 2020).

Risk mapping for a major accident has been performed for the preparation of the master plan and for the revision of the consulting zone sv1 by Gaia Consulting Oy (City of Pori 2020).

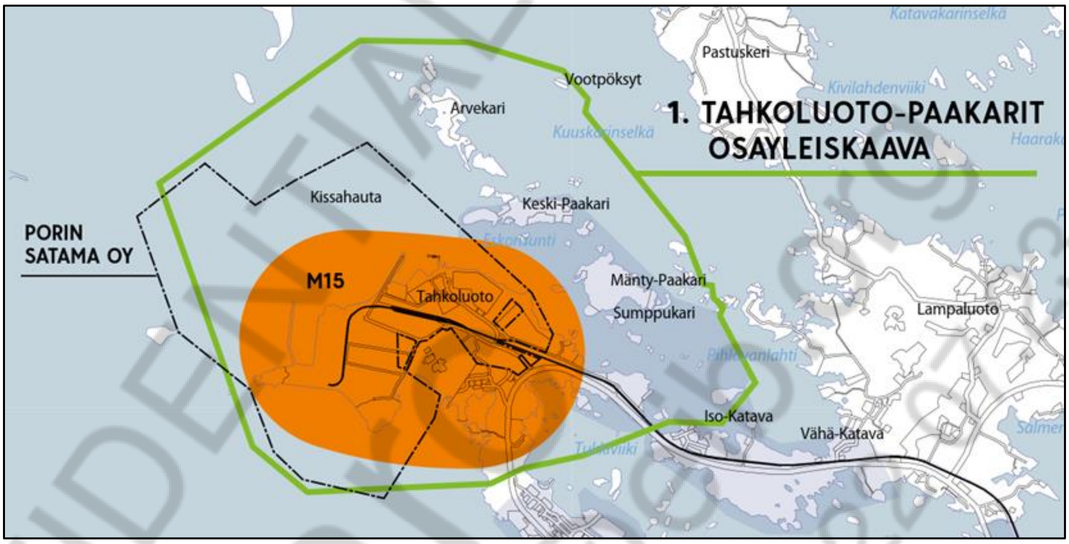

Figure 6.2-8. An extract from the land use planning review 2021-2023 by the City of Pori (Pori City Board 2019). Green colour denotes the planned area of the Tahkoluoto-Paakarit component master plan. Orange colour denotes the timing of detailed planning, which will be started in a time span of 1-3 years. (Pori City Board 2021*).*

In the draft component master plan (Figure 6.2-9), the southern VRP area is located in an area with plan symbol TEN/kem (Industrial, storage and energy supply area, where a significant facility producing or storing hazardous chemicals is located/can be located. The Finnish Heritage Agency must be contacted prior to water construction works in the area so that the need for underwater inventory can be assessed). The northern VRP area is located in an area with the plan symbol TY (Industrial area, where environment imposes special requirements to the type of operations).

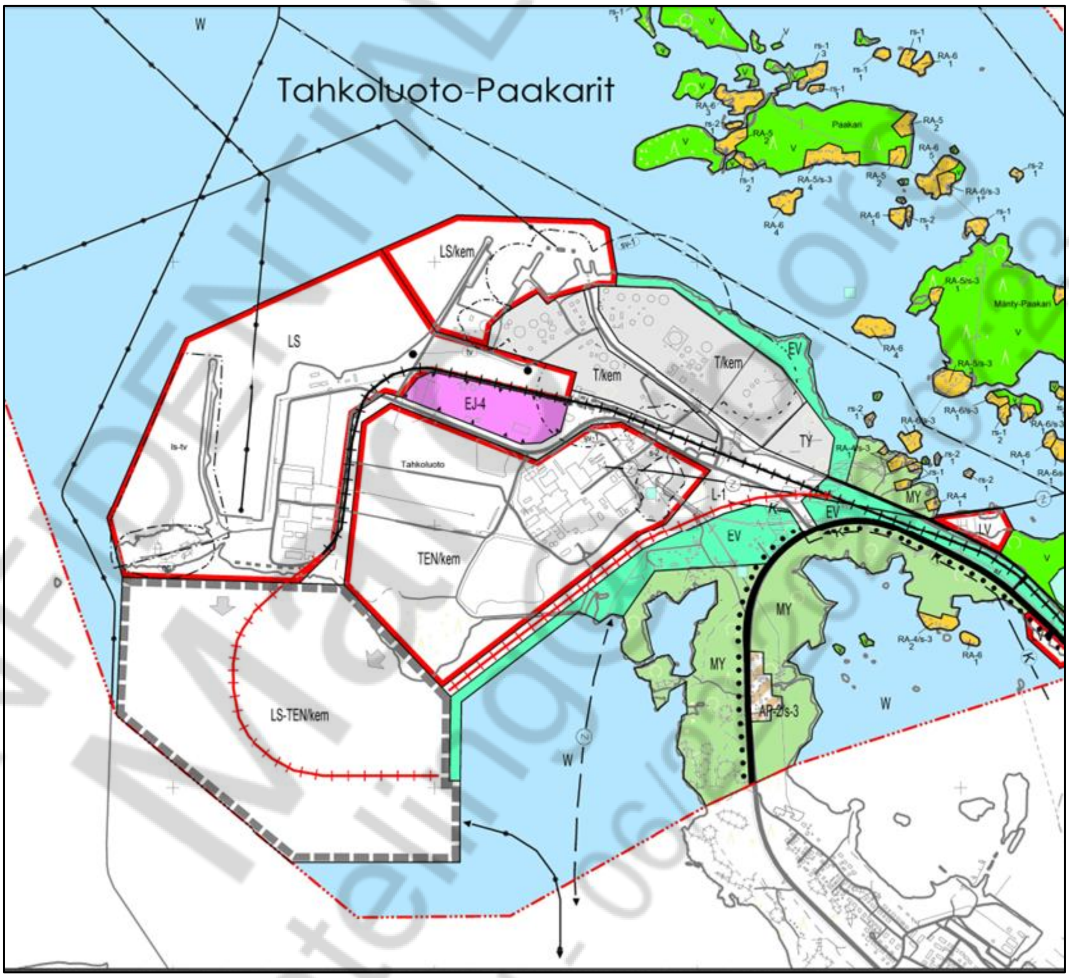

Figure 6.2-9. Tahkoluoto-Paakarit draft component master plan (City of Pori 2021).

In the plan proposal, valuable sites of built environment are designated with a plan symbol /s-3 supplementing block area symbol indicating an area, where cultural historical values must be preserved. Sites of archaeological cultural heritage are designated with plan symbols SM-1, sm and s-2. The nearest sites of cultural environment marked in the plan proposal are located at a minimum distance of 300 metres to the north-east from the northern VRP area and over 700 metres to the north-east from the southern VRP area.

In the authority meeting held in November 2020, the Southwest Finland ELY Centre, the Satakunta Regional Council and the Satakunta Museum required supplementary surveys regarding e.g. natural values, update of the building inventory on the islands and noise study.

The Tahkoluoto-Paakarit draft component master plan presents regulations and recommendations for the whole plan area (City of Pori 2020):

- the lowest recommended construction height is 2.1 m (N2000) due to the risk of flooding. In addition, a local ripple margin due to the steepness and location of the coastline should be considered.
- forests in the area should be managed considering the landscape values of the area. The shoreline tree stand should be preserved.
- the compiler of a more detailed plan or the developer of a construction project shall determine the effects of noise and vibration caused by rail and road traffic prior to project implementation.

Significant plans and measures in the LS/kem, LS-TEN/kem, T/kem and TEN/kem-areas involving chemical hazards should be notified to TUKES.

6.2.4.4 Detailed plans

Most of the Tahkoluoto area and e.g. Törnikari are in the area of a detailed plan, which became valid on 21.8.2021 (plan ID 609 928) (Figure 6.2-10). In addition, the following detailed plans are valid in the Tahkoluoto area: Chemical port and Vasikkakari detailed plan, plan ID 609 721/1, gained legal effect on 30.4.1981; detailed plan extending to the Iso-Katava area, plan ID 609 721/2, gained legal effect on 30.4.1981; detailed plan in the Katainniemi area, plan ID 609 V181, gained legal effect on 30.8.1962; detailed plan in the LNG terminal area, plan ID 609 1630, gained legal effect on 17.1.2014.

Based on the report (7.4.1986) regarding the alteration of the Törnikari area detailed plan, the aim of the plan is to provide for the construction of two 500-megawatt coal power stations in the Törnikari area. An area designated for industrial and warehouse buildings having a size of 58 hectares has been established for the power stations. The aim is to e.g. store coal in the block area. It was noted that high power stations create a significant landscape element. Planning of a power station area next to the major port and existing power station area was considered appropriate for environmental reasons.

In the detailed plan, the VRP area is designated by the plan symbol T-9 "Block area of Industrial and Warehouse Buildings" (grey area in the map). Power plants, buildings and structures related to power generation, distribution and transfer, as well as buildings serving the storage of inflammable liquids up to 5 000 m3 can be built in the block area. Activities in the block area must not generate a noise level greater than 45 LAeq dB (A) for the residences in the detailed plan. The project area has the plan symbol of t+42 indicating the maximum permitted approximate height position for open storage allowed in the area. In addition, the VRP area has plan symbols +50.0 and +130.0 indicating the height position of the rooftop of the building. However, buildings may be built for up to four hectares in the construction sector with a maximum height position of the rooftop of +100.0 m. In addition, 60 parking spaces must be assigned to the area.

In the detailed plan, the northern VRP area is designated by the plan symbol TV-1 "Block area of Warehouse Buildings" (grey area in the map). Buildings serving the storage of inflammable liquids and related necessary office, social service and other service buildings as well as related residences for emergency and service personnel can be built in the block area. The area has the plan symbol +30.0, which indicates the height position of the rooftop of the building.

An alteration of the detailed plan M15 in the port area is planned for the Tahkoluoto area in a time span of 1–3 years (see Figure 6.2-10). It will consider the changing needs of port and industrial activities. The plan symbol for the site is ‘LS’. (Pori City Board 2019). The alteration of the detailed plan is waiting for the completion of the master plan.

Figure 6.2-10. An extract from the Tahkoluoto detailed plan (Pori Map Service). Grey area: industrial area, White area: no land use plan, Light green area: forest area, Dark green area: park area.

According to the new land use planning review (15.2.2021), a new road and street network plan is being prepared in Pori, in which the desired motor vehicle network is identified. It serves as the guideline for transport network and land use planning for the next 20 years. Planning has started in February 2020.

In the land use planning review, the most significant current measures of flood risk management in the City of Pori include the water economy project of Harjunpäänjoki River in Sunniemi area and finalization of the upgrading works of Tikkula urban area and embankments.

Fire safety has improved significantly due to the measures implemented during the past years. The statement by the Southwest Finland ELY Centre on 24.6.2015 regarding the lowest recommended construction heights is valid in Pori. The detailed plans provide more provisions on building elevations and stormwater management, if needed.

A stormwater programme is also being prepared in Pori, which guides stormwater management. Stormwater management must be addressed and, if needed, a reservation must be made for stormwater treatment in detailed planning and other projects. In the context of applying the building permit, a stormwater system implementation plan and stormwater management plan during construction should be prepared.

6.2.5 Impacts

National land use objectives

The themes of the national land use objectives (VnP 2017), which are relevant for this project, include well-functioning communities and sustainable mobility as well as vibrant natural and cultural environments and natural resources.

<u>Well-functioning communities and sustainable mobility</u>

Goals:

- Promote a nationwide regional structure that is polycentric, networked and based on good connections, and support the vibrancy of the various regions and the utilisation of their strengths. Create capacities for the development of economic and enterprise activities and sufficient and diverse housing production required by demographic development.
- Create capacities for low-carbon and resource-efficient community development based primarily on the existing structure.

Impacts of project:

- The project will create opportunities for the development of economic and business life. This will maintain the vitality and attractiveness of the area and promote the national polycentric regional structure. The VRP area is located in the industrial zone of Satakunta, which has both national and international significance.
- In addition to the impacts on climate and circular economy, the project will generate a significant number of new jobs (both direct and indirect). Thus, the project will continue the industrial tradition of Pori by utilizing the already existing strong industrial infrastructure of Meri-Pori.
- The project will support the development of the regional metal cluster in technology and the national battery cluster and attract traffic to the port of Pori.
- The project will strengthen the international competitiveness of Pori, Satakunta and Finland and create preconditions for further processing of materials.
- The development of the industrial and port area will support the vitality of the area and utilisation of the existing strengths.
- Location of the project in the vicinity of existing industrial operations will support and reinforce existing regional structure.

Vibrant natural and cultural environments and natural resources

Goals:

- Create capacities for the bioeconomy and circular economy and promote the sustainable utilisation of natural resources. Ensure the preservation of contiguous farmland and forest areas that are important for agriculture and forestry and of areas that are important for Saami culture and livelihoods.
- Take care of safeguarding the nationally valuable cultural environments and natural heritage values.

Impacts of the project:

- The project will create preconditions for circular economy and promote the sustainable utilisation of natural resources and sustainable development. The project will utilize used raw materials, and the SSM produced in the process can be used as recycled raw material by several different operators.
- The nearest nationally significant landscape areas and nationally or regionally significant built cultural environments are located far from the VRP area. It is estimated that the project will not have a significant impact on the preservation of the values in these areas (see chapter 6.11.4).

The project conforms to all national land use objectives.

Land use plans

The project conforms to the valid regional plan. Construction reinforces and supports the existing operations of the port and industrial area. The planned operations are well suited to the area, which is reserved for industrial operations in land use plans, and there are no areas in the immediate vicinity that are reserved for housing or have significant natural values, landscape values or cultural values. The operations are well suited to the area reserved for facilities manufacturing or storing hazardous chemicals in the pending component master plan.

The project conforms to the valid component master plan with no legal effect and to the pending component master plan proposal. Both the southern and northern VRP area are designated as industrial areas in the component master plan with no legal effect. Continuous industrial and port operations, housing as well as natural and recreational values are integrated in the Tahkoluoto-Paakarit component master plan, which is prepared for the Tahkoluoto area and the surrounding area. It has been stated during the preparation of the component master plan that the Tahkoluoto residential area will not be designated as a residential area any more in land use planning, but certain recreational use is preserved in the area. In the draft component master plan (June 22, 2020), the southern VRP area has a plan symbol TEN/kem, which enables industrial and energy supply use, and in which a significant facility manufacturing or storing hazardous chemicals can be located.

The project conforms to the valid detailed plan. The detailed plan is relatively old, but it is in line with the existing regional plan and the new master plan proposal and it enables the planned operations. In the valid detailed plan, the VRP area is located in area, where a construction of a large coal power station and open coal stockpile have been planned during the preparation of the land use plan.

Based on the statement by TUKES regarding the EIA programme (May 12, 2021), the existing plan symbols in the area T-9 “block area for industrial and storage buildings” and TV-1 “block area for storage buildings” provide for the treatment and storage of hazardous chemicals.

Based on current plans, significant changes in land use are not expected in the VRP area or its immediate vicinity during the life cycle of the vanadium recovery plant, and the project will not require changes to the valid land use plans.

Land use and community structure

The implementation of the project will support, for its part, the preservation of existing services. The impacts of the project will be directed to the nearby area of the VRP area. Traffic volumes will grow. Impacts on air quality and noise will be relatively minor.

The project will not change the community structure of the area. The vanadium recovery plant is located in an existing port and industrial area and changes to the built environment mostly concentrate inside the area. The surrounding environment of the VRP area has been for a long time in the impact area of the port and industrial area and related heavy traffic, noise and potential emissions.

Residential areas and other sensitive sites are located so far from the VRP area that impacts will not significantly increase due to the implementation of the project. However, impacts will be significant along traffic routes and in their vicinity. In alternative Alt.1b, the capacity needed for disposal activities will probably increase in the Pori area.

A so-called consulting zone is established by TUKES around the chemical sites under its control. Special attention must be paid to land use planning and construction withih the consulting zone, and an expert statement procedure aiming at safety must be followed in operations within the zone. The radius of the consulting zones of facilities currently operating in Tahkoluoto varies between 0.2–1.0 kilometres.

6.2.6 Prevention and mitigation of harmful impacts

The project will not have significant impacts on land use in the area.

6.3 Traffic

6.3.1 Summary

Temporary traffic impacts during construction will be relatively significant. Passenger traffic volumes can especially grow as a result of a maximum of almost 200 commuters. Maximum heavy traffic volumes are not estimated to be higher than in the operating phase of the plant.

As a result of the operation of the plant, vessel traffic volumes and road traffic volumes will grow, and it is also possible that train traffic volumes will increase.

Due to the vessel traffic generated by the project, it is estimated that the vessel traffic volumes directed to the Tahkoluoto port, about 120 vessels/year, will grow by 20 vessels/year.

The potential growth of heavy traffic volumes is significant, about 30 %, on the Reposaari main road and about 50 % on the Pori archipelago road. Total traffic volume can also grow by 10 – 20 % on these roads. In alternative Alt.1b, a higher share of heavy traffic can use the Pori archipelago road.

As traffic volumes grow, the level of service of traffic will decrease and accident risk can increase. Growing traffic volumes will have an impact on traffic safety and performance of the junction of Reposaari main road (regional road 269) and Tahkoluoto road, and the impacts on the Reposaari main road and Pori archipelago road will be significant. Traffic impacts related to the operation of the plant can be reduced by e.g. optimization of transport logistics and considering other port traffic operations in the logistics planning of the plant, if possible.

Traffic conditions and safety could be improved by widening the Reposaari main road (regional road 269) leading to Tahkoluoto or constructing a pedestrian and bicycle way on the Reposaari main road between Mäntyluoto and Tahkoluoto, which could also serve as an alternative route in accident situations.

Comparison of alternatives and significance of impact

In alternative Alt.1b, a higher share of the heavy traffic volume can use the Pori archipelago road, but otherwise there is no difference between alternatives Alt.1, Alt.1a and Alt.1b. In alternative Alt.0, traffic impacts are caused by another potential project implemented in the area.

Impacts are assessed as moderate and negative.

Construction phase

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Traffic	Temporary traffic impacts will be relatively significant.	No traffic impacts from this project.	No difference between alternatives Alt.1, Alt.1a and Alt.1b. Significance of impact is assessed as moderate and negative (--).

Operating phase

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Traffic	Vessel traffic volume, 120 vessels/year, will grow by 20 vessels/year. Potential growth of heavy traffic volumes is about 30 % on the Reposaari main road and about 50 % on the Pori archipelago road. Potential impacts on traffic safety and the level of service of traffic can require measures for improving traffic conditions and traffic safety.	No traffic impacts from this project. Traffic impacts will be caused by another project potentially implemented in the area.	In alternative Alt.1b, a higher share of the heavy traffic volume can use the Pori archipelago road, but otherwise there is no difference between alternatives Alt.1, Alt.1a and Alt.1b. Without road upgrading measures the significance of impact is assessed as moderate and negative (--).

6.3.2 Assessment method and uncertainties

The impacts of the changing traffic volumes generated by the project on the level of service of traffic and traffic safety have been assessed as an expert evaluation based on existing traffic volumes, transport network and available accident statistics from the impact area. The most significant transport plans and projects were considered in the assessment.

Impacts of traffic generated by the project on the noise situation in the area are assessed in chapter 6.4. Impacts of traffic on air quality are assessed in chapter 6.6.

Uncertainties are related to the existing traffic volumes, which are used as source data in the assessment, as road-, vessel- and train traffic volumes to the port vary according to changing port operations.

6.3.3 Existing traffic conditions and traffic volumes

Road traffic between Pori and Tahkoluoto is directed along the Mäntyluoto road (highway 2) as well as the Reposaari main road (regional road 269) or from highway 8 via the Pori archipelago road (regional road 272). For potential special transports, a supplementary transport route leads to the Tahkoluoto port from highway 8 along regional roads 272 and 269 (Figure 6.3-4).

The average daily traffic volume on the Reposaari main road between Mäntyluoto and Tahkoluoto is about 1,900 – 2,500 vehicles and about 800 vehicles on the Pori archipelago road (regional road 272) at Lampaluoto providing a connection to the Reposaari main road. Heavy traffic volume is about 320 vehicles/day on this road section of the Reposaari main road and about 130 vehicles/day on the Pori archipelago road. On the Reposaari main road, a pedestrian and bicycle way exists only between Reposaari and Tahkoluoto port junction. There is no pedestrian and bicycle way on the Pori archipelago road (Finnish Transport Infrastructure Agency 2020).

The speed limit is 80–100 km/h on regional road 272 and 60–80 km/h on regional road 269. Regional road 272 does not have road lighting, and neither of the regional roads have a continuous pedestrian and bicycle way.

Traffic volumes in 2019 on the Reposaari main road leading to Tahkoluoto are presented in Figure 6.3-1.

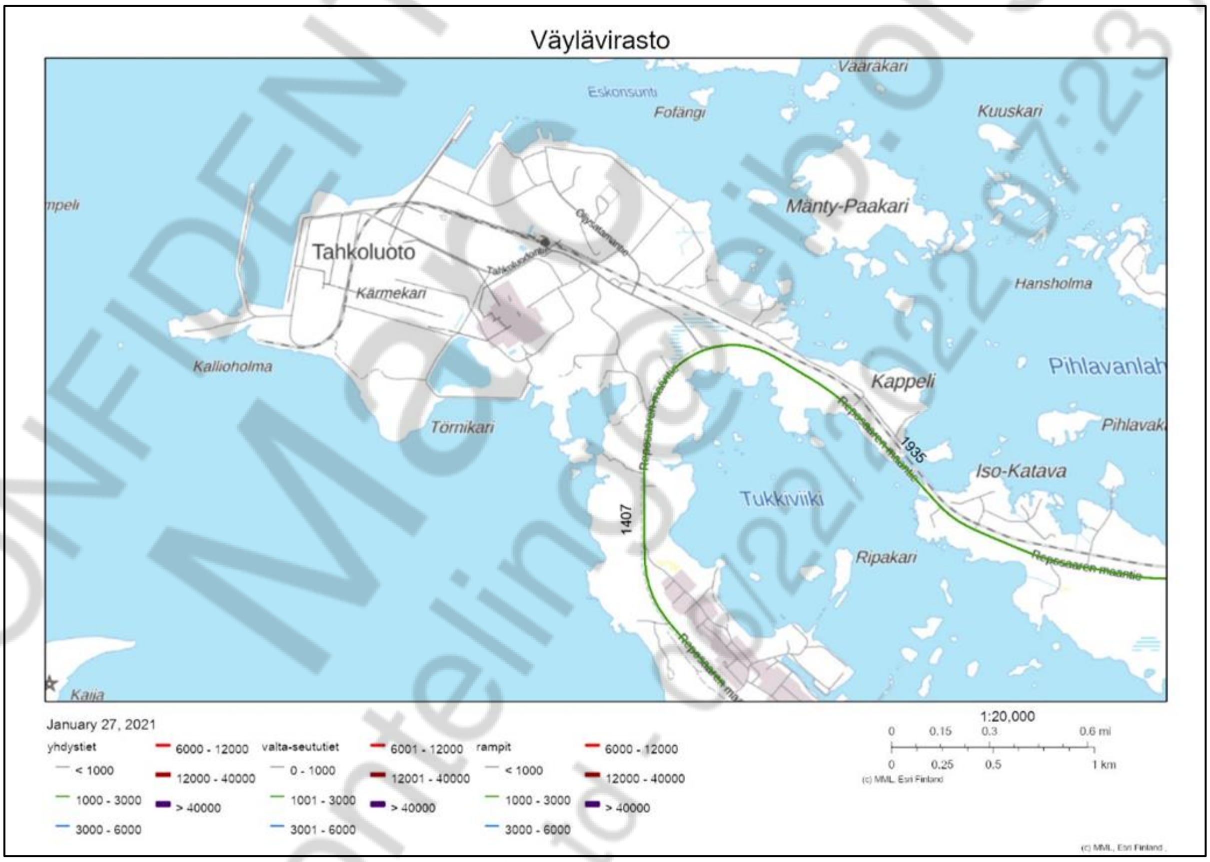

Figure 6.3-1.Total traffic volumes in 2019 on the Reposaari main road leading to Tahkoluoto (Finnish Transport Infrastructure Agency).

Pori-Mäntyluoto-Tahkoluoto is a single track rail section for freight traffic operations. The rail section has been upgraded several times. The electrification of the Pori–Mäntyluoto rail section has been completed in 2019-2020 and the electrification of the Mäntyluoto–Tahkoluoto rail section will be completed in 2021.

The freight traffic volume in 2017 on the Pori–Mäntyluoto rail section was 3.7 million gross tonnes and the corresponding volume was 1.8 million gross tonnes on the Mäntyluoto–Tahkoluoto rail section. There were 14 daily freight trains between Pori and Mäntyluoto and four daily freight trains between Mäntyluoto and Tahkoluoto. Railway traffic volumes, transported freight tonnes and the number of trains directed to Tahkoluoto during the years

2017-2020 are presented in Table 6.3-1. (Finnish Transport Infrastructure Agency 2021, project sheet). The maximum speed on the rail section is 50 km/h.

Table 6.3-1. Freight transport volumes in tonnes and the number of trains to Tahkoluoto in Pori during the years 2017-2020 (Finnish Transport Infrastructure Agency 2021, Fintraffic 2021).

Year	Freight transport volume (million tonnes)	Number of trains/freight trains/year	Number of trains/other trains/year
2017	0.135	142	22
2018	1.017	984	30
2019	0.776	740	60
2020	0.033	50	15

Previously, a large number of trains loaded with coal were running to Tahkoluoto. In 2020, rail freight traffic operations to Tahkoluoto occurred only in January-April (Fintraffic 2021). The Tahkoluoto port is strongly developing into a transit port. Coal is transported by rail wagons from Russia. The maximum freight traffic volumes have been about 120 wagons/day, but the goal is to increase the freight traffic volume to 180 wagons/day (City of Pori 2020). Along with the commissioning of the Tahkoluoto coal terminal, the number of trains can increase by three trains/day (about 150 wagons/day and about 1 000 trains/year) (Rauanheimo 2021).

There are two deep-water channels leading to the Tahkoluoto port (Figure 6.3-2). A 10.0 metre fairway leads from the south-west to the oil and chemical port and a 15.3 m fairway leads from the north-west to the deep-water port. A 3.4 metre fairway bypasses Tahkoluoto on the western side and runs from the ports in Ostrobothnia to the ports in southwest Finland.

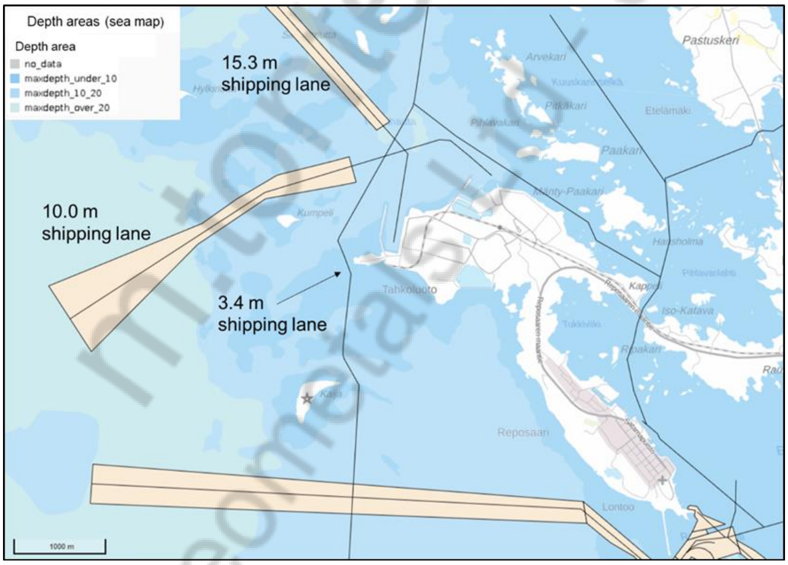

Figure 6.3-2. Fairways and depth zones in the Tahkoluoto area (Paikkatietoikkuna).

The fairway coming from the north-west passes through the Natura area of Gummandoora Archipelago (FI0200075). On average, 250-350 vessels visit the Tahkoluoto port every year. Based on the statistics of import freight traffic in the port of Pori (City of Pori 2018), the share of the traffic volume in the Tahkoluoto deep-water port is estimated to be about 70 – 80 % of the total traffic volume (250-350 vessels/year) in the Tahkoluoto port. The operation of the deep-water port has previously been linked especially to the import of coal to two power plants in Tahkoluoto. One of the plants has already been closed and the remaining plant is only used as a reserve power station, and it will possibly be completely shut down by the year 2029. Along with coal, the port has handled e.g. ores and concentrates as well as salt for the needs of the chemical industry (City of Pori 2020).

The number of vessels and freight volumes to the Tahkoluoto deep-water port (quays 26 and 27) during 2018–2020 are presented in 6.3-2. The number of vessels and freight volumes have significantly decreased during the past 10 years (year 2019: 376 vessels and 2 134 667 tonnes).

Table 6.3-2. Number of vessels directed to the Tahkoluoto deep-water port during the years 2018–2020 (Fintraffic 2021).

Year	Number of vessels /year	Tonnes/year
2018	119	1 637 691
2019	119	1 228 933
2020 *	62	291 306

* Transit traffic of coal from Russia was discontinued for the whole year

6.3.3.1 The most significant transport plans and projects in the area

There are no ongoing road traffic development projects in the area. In context with the preparation of the existing master plan (no legal effect), the need for a pedestrian and bicycle way was introduced between Mäntyluoto and Reposaari. This connection is also listed as a necessary connection for the cycling network in the Walking and Cycling Development Programme for the Pori urban area (City of Pori 2020).

Funding has been granted for the removal of level crossings on the Pori–Tampere rail section. Upgrading project on the Pori–Mäntyluoto–Tahkoluoto rail section is ongoing in 2021. The railway development needs are partly related to the objective to increase e.g. transit traffic of coal transport and shipping of coal for export from the Tahkoluoto port (City of Pori 2020).

In the Pori road and street network plan 2040, connections to highways and ports are listed as one deficiency in the network. It is proposed that the implemented projects during the years 2020-2040 include the upgrading measures for highway 2 (Mäntyluoto road) and highway 8 passing through Pori. On Mäntyluoto road, measures are proposed for the Ulasoori and Rieskala interchanges. No measures are planned for the area between Mäntyluoto and Tahkoluoto. The population of Pori and the Pori region is not estimated to grow in the future, and traffic forecasts for the road and street network are not higher than the existing traffic volumes. However, regional and national traffic volumes are estimated to grow, which will increase traffic volumes on highways 2, 8, 11 and 13, which pass through Pori or lead to Pori.

6.3.3.2 Traffic safety

About 15 traffic accidents have occurred during the years 2016–2020 on the roads leading to Tahkoluoto within a distance of about 10 km from Tahkoluoto. There were no fatality accidents and about five personal injury accidents (Figure 6.3-3).

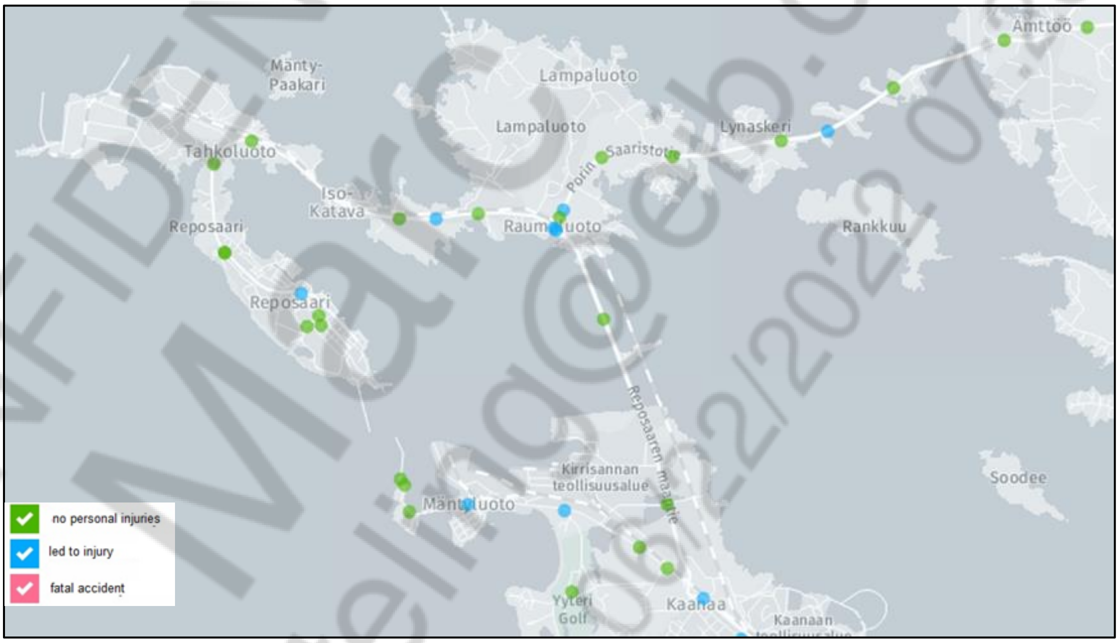

Figure 6.3-3. Traffic accidents on roads leading to Tahkoluoto during the years 2016-2020 (Traffic accident statistics 2016-2020).

In the traffic impact area within a distance of about 10 km from the VRP area, there are no junctions with especially high accident concentration (City of Pori 2021).

6.3.4 Impacts during construction

A significant number of different types of heavy transports enter the area in the construction phase of the plant. Traffic volumes in the construction phase depend e.g. on necessary earth material transports to and from the VRP area. Earth materials extracted from the area during earth works are intended to be used in construction works on site or in the surrounding area. Some earth materials must probably be transported to the area from elsewhere. The highest passenger traffic volumes to the VRP area occur in the construction phase, when hundreds of persons commute to the area.

The maximum heavy traffic volumes on roads are estimated not to be higher than in the operating phase of the plant. Temporary traffic impacts during construction will be relatively significant.

6.3.5 **Impacts during operation**

Vessel traffic

Due to the vessel traffic generated by the project, it is estimated that the vessel traffic volume directed to the Tahkoluoto deep-water port, about 120 vessels/year, will grow by 20 vessels/year.

Road traffic

Chemicals are transported to the plant by road mainly from the Tahkoluoto chemical port. In addition, slag for feedstock is transported by trucks from the deep-water port.

In addition to road transports, products delivered from the plant to customers can also be transported by trains, but train transports have so far not been planned. However, it is assumed in the traffic impact assessment that all products are transported by trucks (Table 2.2.7).

It is assumed in the traffic volume estimates that less than hundred commuters to the plant will mainly use passenger cars.

It is estimated that the total traffic volume will grow by less than 15 % and heavy traffic volume by more than 30 % on the Reposaari main road leading to Tahkoluoto (Figure 6.3-4).

Impacts on traffic volumes on the Reposaari main road south of Lampaluoto and on the Pori archipelago road specifically depend on the distribution of departing traffic from the VRP area. If a major share of the truck traffic running between the plant area and traffic routes outside of Tahkoluoto uses the Reposaari main road and Mäntyluoto road, the increase of traffic volumes on the southern section of the Reposaari main road would be equivalent to the increase on the Tahkoluoto section of the Reposaari main road, and the growth of traffic volumes would be minor on the Pori archipelago road.

If a major share of the traffic (70 %) related to the operation of the plant uses the Pori archipelago road, the total traffic volume on the Reposaari main road (south of Lampaluoto) would only grow by 3 % and heavy traffic volume would grow by about 10 %. The total traffic volume on the Pori archipelago road leading to the Reposaari main road would grow by about 20 % and heavy traffic volume would grow by about 50 %. A significant share of the traffic volume from the plant could use the Pori archipelago road, for example, in a situation where slag would be transported to the Peittoo stockpile area (alternative Alt.1b).

The internal traffic volumes in Tahkoluoto will also increase corresponding to the truck transport volumes entering and departing Tahkoluoto, transport volumes between the deep-water port and the southern and northern VRP area as well as transport volumes between the chemical port and the southern VRP area (Table 6.3-3). Heavy traffic volumes can increase by hundreds of trucks on the roads within Tahkoluoto.

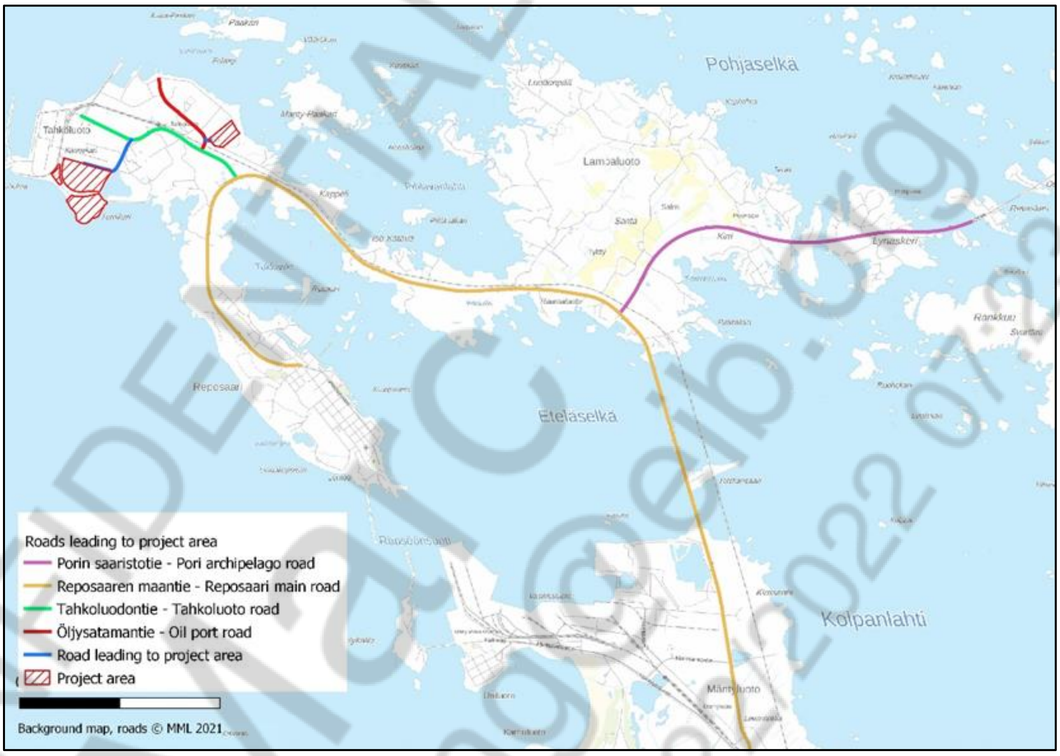

Figure 6.3-4. Traffic routes leading to the VRP area.

Table 6.3-3. Growth of traffic volumes on the traffic routes to the VRP area.

All numbers presented in the table are vehicles/day **Road section**	**Existing total traffic volume**	**Existing heavy traffic volume**	**Project related traffic volume, total**	**Project related traffic volume, heavy**	**Increase of total traffic volume**	**Increase of heavy traffic volume**
Assumption: All traffic volumes related to the project are directed via Mäntyluoto road to the Reposaari main road and Tahkoluoto						
Reposaari main road (south of Lampaluoto)	2 440	319	240	104	10 %	33 %
Reposaari main road (west of Lampaluoto) – Tahkoluoto road	1 877	321	240	104	13 %	32 %
Pori archipelago road – Reposaari main road	795	139	-	-	0 %	0 %
Assumption: 70 % of all traffic volumes related to the project are directed via Pori archipelago road to the Reposaari main road and Tahkoluoto						
Reposaari main road (south of Lampaluoto)	2 440	319	72	31	3 %	10 %
Pori archipelago road - Reposaari main road	795	139	168	73	21 %	52 %

The estimated potential growth of heavy traffic volumes is significant, about 30 % on the Reposaari main road and about 50 % on the Pori archipelago road. Total traffic volume can also grow by 10 – 20 % on these roads.

As traffic volumes grow, the level of service of traffic can decrease and accident risk can increase. Growing traffic volumes can have an impact on traffic safety and performance of the junction of Reposaari main road (regional road 269) and Tahkoluoto road.

A pedestrian and bicycle way along the Reposaari main road has been constructed between Reposaari and Tahkoluoto port junction. Road leading to Tahkoluoto is narrow and traffic to and from Tahkoluoto can be restricted in an accident situation. Traffic conditions and traffic safety could be improved by widening the road or constructing a pedestrian and bicycle way on the Reposaari main road between Mäntyluoto and Tahkoluoto, which could also serve as an alternative route in accident situations. The construction of a continuous pedestrian and bicycle way as well as road lighting on the Pori archipelago road would improve traffic conditions and traffic safety. In the pending Tahkoluoto-Paakarit draft component master plan a pedestrian and bicycle way is proposed from the Tahkoluoto junction towards both Reposaari and Mäntyluoto direction.

Road network condition and e.g. carrying capacity can require upgrading measures due to growing heavy traffic volumes, and the need for road maintenance and the costs of road infrastructure management can increase. The needs of road infrastructure management must be evaluated by taking into account changes in traffic volumes caused by all projects in the area. The Satakunta ELY Centre is responsible for road infrastructure management in the area and it evaluates the situation and conducts necessary studies and measures together with the City of Pori.

Chemicals are transported to the plant mostly from the chemical port and the transport distance by trucks is short. Raw materials are transported by vessels to Tahkoluoto, and thus truck transports are not needed.

The most significant transport volumes of hazardous chemicals related to the operation of the plant include the potential transports of pressurized carbon dioxide and transports of the main product of the plant, vanadium pentoxide chemical flakes as well as also transports of sulphuric acid and sodium hydroxide. Risks related to the transport of hazardous goods are discussed in chapter 6.14 (Accidents and disturbances).

Potential cumulative impacts with other projects also with regard to traffic impacts are discussed in chapter 6.15.

6.3.6 Prevention and mitigation of harmful impacts

The level of service of traffic and traffic safety could be improved on the road leading to Tahkoluoto by widening the road or constructing a pedestrian and bicycle way along the Reposaari main road between Mäntyluoto and Tahkoluoto. The construction of road lighting on the Pori archipelago road would improve traffic safety for its part. The construction of a pedestrian and bicycle way would be necessary in the area despite the implementation of the VRP.

Generally, traffic safety can be improved by e.g. speed limits and improved visibility on roads. The condition of road surface is also significant for traffic safety, and the share of heavy traffic must be taken into account in the carrying capacity of the road.

Traffic impacts related to the operation of the plant can be reduced by e.g. optimization of transport logistics so that transport capacity is used as efficiently as possible and the number of loads is minimized. The capacity and other features of transport vehicles must be adapted to particular needs. Potential harmful impacts on the level of service of traffic in Tahkoluoto area can be mitigated by considering other port traffic operations in the logistics planning of the plant, if possible. Passenger traffic to the VRP area could be reduced, for example, by rideshare programmes.

Accidents related to transports are prevented by requiring functional quality assurance systems from transport companies, sufficient professional skills from drivers as well as knowledge about risks related to transports and risk factors specific to the traffic environment.

6.4 Noise and vibration

6.4.1 Summary

Noise impacts caused by the operation of the plant, transport volumes related to operation and total traffic volume (including existing traffic volumes) were assessed through noise modelling.

The most significant source of noise is the machinery working on the slag stockpiles and around the process plant. The result of noise modelling is a maximum situation, which does not take into account the impact of the slag stockpiles on the propagation of noise from the plant area to environment. Actual noise emissions from the operation of the plant to environment will probably be lower.

Based on modelling, the daytime guideline values of equivalent continuous sound level generated by the operation of the plant and total traffic volumes were not exceeded in the nearby residential areas located Parkkiluoto and Reposaari. Both the daytime and night guideline values can be exceeded regarding a few residential buildings located in the immediate vicinity of the Reposaari main road and the Pori archipelago road. The noise level in the Siikaranta camping area will be less than 45 dB at night and also mostly in daytime. With regard to few holiday homes located in the north-eastern part of Tahkoluoto, the noise level generated by total traffic volume will not exceed the guideline value for built-up areas in daytime and at night.

The average equivalent continuous sound level in Parkkiluoto and Reposaari areas caused by the port, existing wind farms, operation and traffic of the vanadium recovery plant and existing traffic volumes is estimated to be less than 50 dB both in daytime and at night.

The soil in the area between Tahkoluoto and Raumaluoto is not very sensitive to vibration. If the operation of the plant includes train traffic, potential vibration and structure-borne noise would probably not extend to a larger area.

Comparison of alternatives and significance of impact

There is no difference between alternatives Alt.1, Alt.1a and Alt.1b with regard to impacts on noise and vibration. In alternative Alt.0, no noise impacts are generated by the project. Noise can be generated by the operation of another potential facility constructed in the area.

Impact is assessed as minor.

Construction phase

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Noise and vibration	Noise generated during construction is short-term and the most significant impacts will occur in the early phases of construction, e.g. during piling and earth works. Guideline values are not estimated to be exceeded in disturbed sites.	No noise impacts generated by the project.	No difference between alternatives Alt.1, Alt.1a and Alt.1b. Significance of impact is assessed as minor and negative (-).

Operating phase

Impact	Alternatives Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Noise and vibration	Noise levels will not mainly exceed the guideline values in daytime and at night in the nearest residential area and nearby recreation area. Noise level guideline values can be exceeded regarding a few residential buildings located in the immediate vicinity of the road. Vibration impacts in the area are not very likely.	No noise impacts caused by the project. Noise can be generated from the operation of another potential facility constructed in the area.	No difference between alternatives Alt.1, Alt.1a and Alt.1b. Significance of impact is assessed as minor and negative (-).

6.4.2 Assessment method and uncertainties

Noise

Noise impact assessment was implemented by performing noise modelling (Sweco 2021c). Noise generated by the operation of the plant and related transport volumes were assessed by the model. The assessment was based on the tentative design of the plant and transport volumes, existing traffic volumes and data on existing noise levels in the impact area of the VRP.

The sound levels generated to environment by industrial operations and traffic were estimated by using the environmental noise calculation software CadnaA, which includes the Nordic calculation models for road and industrial noise. The software calculates noise propagation to environment based on a three-dimensional terrain model. The software takes into account e.g. the shape of terrain, traffic volumes on roads, location and height of buildings as well as reflections from structures and ground based on the defined absorption characteristics. Potential noise prevention impacts from the stockpiles of raw materials and by-products or facilities were not considered in modelling in order to show maximum impacts.

Weather information included in the model was as follows: temperature was 10 °C, relative humidity was 70 % and wind speed was 3 m/s.

The uncertainty of calculated noise from road traffic is typically in the order of 2 dB. Uncertainties are related to industrial noise emissions, as e.g. equipment has not been selected in this planning phase and the detailed noise level or exact location of the source of noise emissions are not known.

Vibration and structure-borne noise

The occurrence of vibration and structure-borne noise was assessed near residential areas between Mäntyluoto and Tahkoluoto based on soil maps and information regarding the generation of vibration and structure-borne noise.

6.4.3 Noise and vibration, current state

Noise

In the Tahkoluoto area noise is generated by the operation of the deep-water port, oil and chemical port and related transport activities as well as by the operation and related transport activities of power plants and industrial plants (crushing plant, LNG terminal, loading and unloading activities in the rock storage area). The operation and transport activities in the port are variable and the number of vessels to be loaded or unloaded at different quays of the port have the greatest impact on the noise level.

The environmental noise study for the Tahkoluoto port and industrial area has been updated in 2016. Noise levels in the surrounding area of the Tahkoluoto port and industrial area have been assessed based on noise emission measurements and noise modelling (Lahti & Gouatarbès 2016). Noise levels were assessed both in average and maximum situations (average week and busiest day).

The total noise levels resulting from the operations were monitored at the following sites: 1) Katainiemi residential area 2) Parkkiluoto 3) Räyhä, Köylönen 4) Keski-Paakari (Figure 6.4-1). The total noise levels at the monitored points are presented in Table 6.4-1.

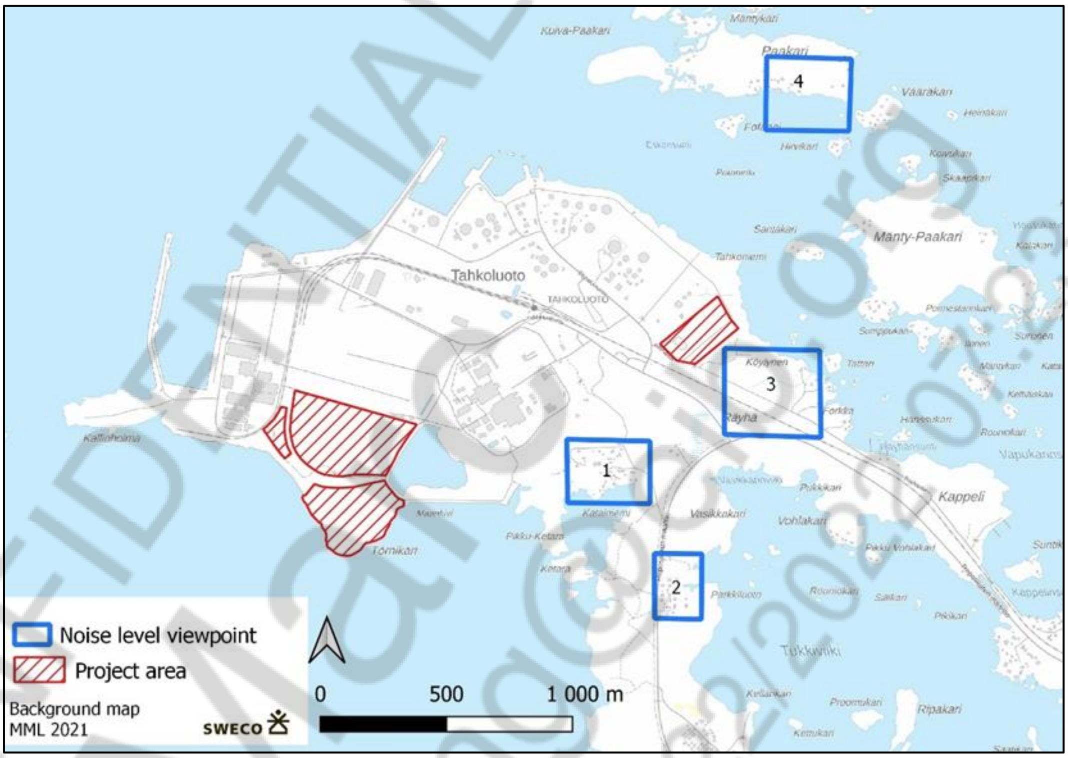

Figure 6.4-1. Sites, where noise levels were monitored in the Tahkoluoto noise study.

During the study there were permanent residences in Katainiemi (1) and Parkkiluoto (2) and holiday homes in Räyhä (3), Köylönen (3) and Keski-Paakari (4) area. According to the information from the City of Pori, there are currently three permanent residents in the Tahkoluoto area.

Table 6.4-1. Noise study of Tahkoluoto, total noise levels of all operators (A-medium sound level LAeq, DB) at four monitoring sites) (Lahti & Gouatarbès 2016).

Calculation		**V1 average week**		**V2 busiest day**	
Site		day	night	day	night
1	Katainiemi	49	41	51	46
2	Parkkiluoto	43	35	46	39
3	Räyhä, Köylynen	43	35	44	36
4	Keski-Paakari	46	38	49	44

The most significant source of noise in the Tahkoluoto area is the Stena Recycling crushing facility. The port and vessels at the quays of the chemical port are major sources of noise towards the islands on the northeastern side (Figure 6.4-2). The operation of the Fortum power plant is audible in Katainiemi, but it is only rarely in operation. Other activities and traffic operations are practically irrelevant sources of noise.

Based on studies, the equivalent continuous sound level generated by the facilities in the area does not exceed the limit values of noise defined in the environmental permits even in the busiest day calculations in the nearby residential and recreation areas.

Figure 6.4-2. Tahkoluoto port and industrial area, busy 24 hours, all noise sources, equivalent continuous sound levels (Lahti & Gouatarbès 2016).

Based on the noise monitoring obligation, noise measurements have been performed on June 2 and June 11, 2021 in the nearest residential and leisure home areas around the Tahkoluoto port area (Figure 6.4-3 and Table 6.4-2). For example in the Parkkiluoto area, the equivalent continuous sound level during the measurement period (30 min., between 10-11) was 42 dB. The main sources of noise were by-passing road traffic and sounds of nature. The equivalent continuous sound levels at measuring points 1-3 (residential buildings in mainland) were between 42-44 dB with uncertainty of ± 7 dB. The guideline value of 55 dB for the equivalent continuous sound level based on the VnP 993/92 was not exceeded. The equivalent continuous sound levels at measuring points 5-7 (leisure homes on islands) were between 43-44 dB. The uncertainty of measurements is 8 dB due to the long distance between measuring points and sources of noise. The measured equivalent continuous sound level does not exceed the guideline value of 45 dB based on the VnP 993/92, but considering the uncertainty in measurement, the measured value cannot be verified in accordance with the guideline for measuring environmental noise (Sitowise 2021).

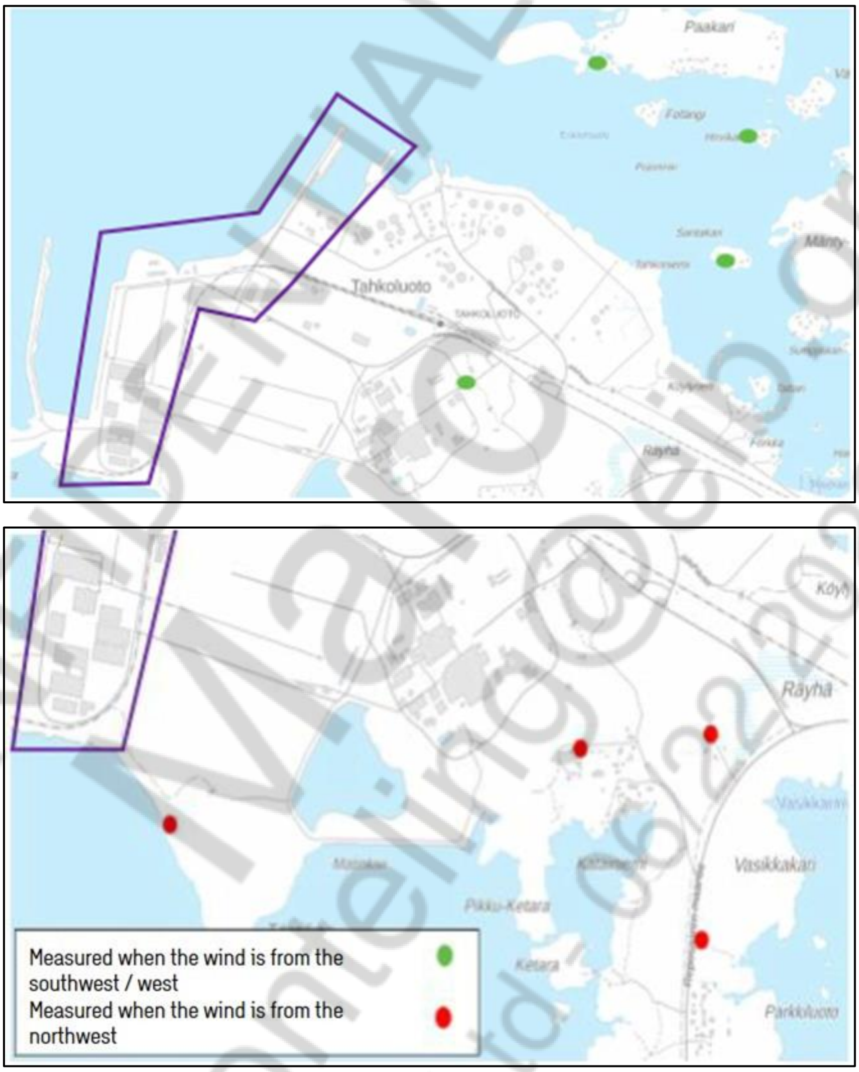

Figure 6.4-3. Measuring points in north-east/west (upper map), measuring points in south-east (lower map).

Based on the measurement results, the noise level guideline values (VnP 993/92) will probably not be exceeded in the nearest residential areas in mainland due to the noise impacts from the port operations. The guideline values were not exceeded on islands during the measurement period, but uncertainties are related to the measurements.

Table 6.4-2. Preliminary results of the noise measurements in the port of Pori (Sitowise 2021).

Measuring site		Measured equivalent continuous sound level LAeq dB, measurement period 30 min	Remarks
1	Reposaari main road 927 (Räyhä)	44 (± 7)	Sounds of nature are dominant, industrial noise can be detected as well as traffic noise.
2	Reposaari main road 982 (Parkkiluoto)	42 (± 7)	Noise from by-passing traffic and sounds of nature are dominant.
3	Reposaari road 10 (Katainniemi)	43 (± 7)	Sounds of nature are dominant, industrial noise can be detected.
4	Törnikari	44 (± 7)	Industrial noise can be detected as well as sounds of birds and boats.
5	Paakari	43 (± 8)	Dull industrial noise can be detected mixed with the sounds of waves.Sounds of birds and summer residents.
6	Hirvikari	43 (± 8)	Dull industrial noise can be detected as well as bird sounds.
7	Santakari	44 (± 8)	Dull industrial noise can be detected as well as bird sounds.
8	Power station gate	46 (± 6)	Dull industrial noise can be detected as well as bird sounds.

Based on the noise modelling of 11 wind power stations in the existing wind farm of Suomen Hyötytuuli Oy and 6 inland wind power stations (Figure 6.4-4), the calculated equivalent continuous sound levels (LAeq) caused by existing the wind power stations are 36–39 dB at nearest receptor points (disturbed sites) R7–R10 to the VRP area (distance of about 1–1.5 km from the southern VRP area and 0.5– more than 2 km from the northern VRP area).

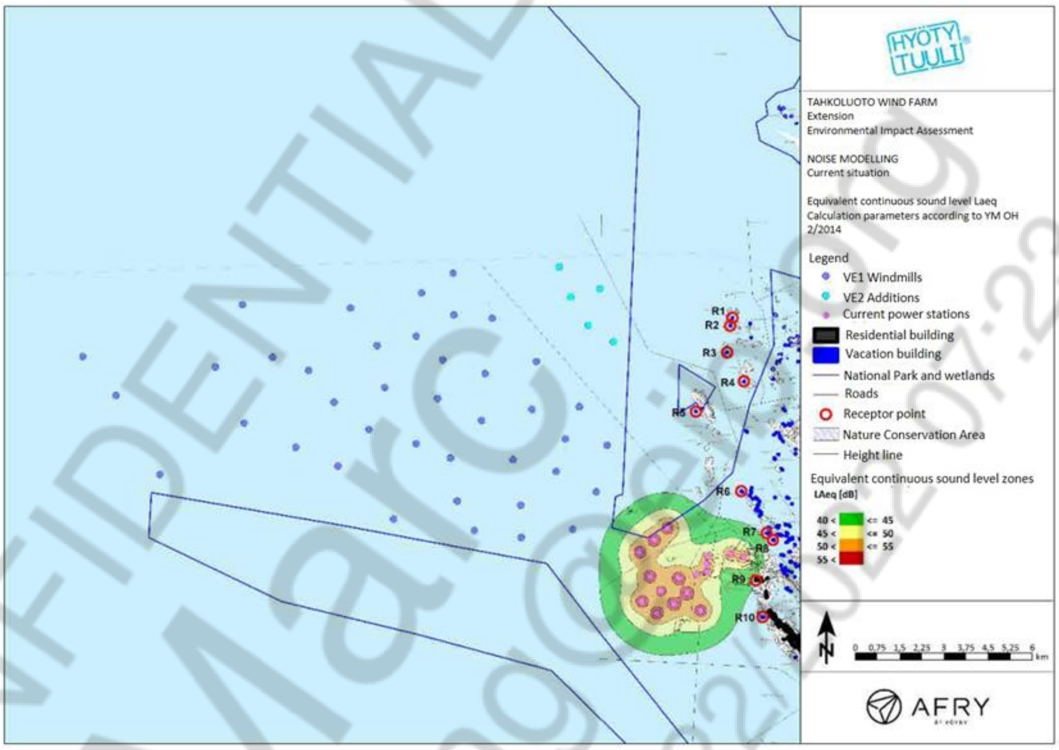

Figure 6.4-4. Results of noise modelling for the existing 11 power stations in the Tahkoluoto wind farm and 6 inland wind power stations (Suomen Hyötytuuli Oy 2021). The southern VRP is located approximately at point “R9” and the northern VRP area approximately at point “R8”.

Vibration and structure-borne noise

Rail traffic has significantly increased in the Pori area in recent years and feedback related to vibration has also increased. Based on surveys during the railway upgrading project, vibration protection was proposed on the rail section between Pori station and Tahkoluoto railway exit. Based on drilling, soil along the Pori–Mäntyluoto rail section is more fine-grained and softer, which makes the area more susceptible to vibration.

6.4.4 Impacts during construction

In addition to traffic, noise is generated in the construction phase from e.g. piling works related to the foundation construction of the plant as well as from other activities related to construction. Piling works also cause vibration. Minor noise is generated from other construction works and tank installation works.

6.4.5 Noise impacts during operation

Noise impacts of the project were assessed based on modelling (Sweco 2021c). Noise from the equipment and machinery in the process facility as well as traffic volumes to the plant were taken into account in modelling. The situation, in which existing traffic volumes are taken into account, was separately modelled (traffic volumes chapter 6.3.5, Table 6.3-3).

The process equipment of the vanadium recovery plant are located indoors, and minor noise is generated by the process facility. The most significant source of noise includes the machinery working on stockpiles and around the process facility.

Stockpiles were not taken into account in modelling which, depending on location, will probably at least to some degree reduce noise propagation. More exact location and operations of the machinery working around the process facility were not known either, and the model was designed so that the process facility will not prevent noise propagation. As it turns out, the process facility will probably also prevent noise propagation to environment. Maximum transport volumes to the plant were input to the model. The result of noise modelling is the maximum situation, which will probably not occur, but noise emissions generated by the operation of the plant will actually be lower.

In the noise model, the following machinery was located in the southern VRP area:

- two wheel loaders, operating time 24/7, loading of slag from stockpile to the charging hopper of conveyor;
- one excavator, 9 hours/daytime, 9 hours/night, transfer of slag from stockpile closer to the loading site;
- one wheel loader, 9 hours/daytime, 9 hours/night, stockpiling;
- three forklifts, 12 hours/daytime, 6 hours/night, surroundings of process facility;
- three shovel loaders, operating time 24/7, surroundings of process facility;
- one bulldozer, 9 hours/daytime, 9 hours/night, surroundings of process facility;
- one crane loader (20 t), 3 hours/daytime, 3 hours/night, surroundings of process facility;
- one service truck (10 t), 3 hours/daytime, 3 hours/night.
- one dump truck (38 t), operating time 24/7, transfer of SSM from the plant to the stockpile area
- one crusher, 9 hours/daytime

Machinery located in the northern VRP area includes:

- one wheel loader, operating time 6 hours in daytime; and
- one dump truck (38 t), 6 hours in daytime.

Generally applied noise level guideline values are presented in Table 6.4-3.

In addition, according to the valid detailed plan in the VRP area, the noise level caused by the operation cannot exceed 45 dB in the residential areas designated in the detailed plan[2].

Table 6.4-3. General noise level guideline values (VnP 993/1992). Weighted A-medium sound level L_{Aeq} (equivalent level).

	L_{Aeq}, maximum	
	Day (07-22)	**Night (22-07)**
Outside		
Residential areas, recreation areas in built-up areas and in their immediate vicinity and in hospital and school areas.	55 dB	50/45 dB [1)]
Holiday housing areas [3)], camping areas, recreation areas and nature protection areas outside of built-up areas.	45 dB	40 dB [2)]
Inside		
Residences, patient rooms and accommodations.	35 dB	30 dB
Education and meeting facilities.	35 dB	-
Business and office premises.	45 dB	-

[1)] Guideline value at night is 45 dB in new areas. Night time guideline values are not applied in school areas.
[2)] Night time guideline values are not applied in such nature protection areas, which are not commonly used for visits or nature observation at night.
[3)] Guideline values for residences can be applied to holiday housing in built-up areas.

Operation of the facility and traffic volumes to the facility

Based on modelling, noise generated in daytime by the operation of the plant and traffic volumes to the plant is presented in Figure 6.4-5. Noise level is slightly lower at night, as part of the transports to the plant area only operate in daytime.

[2] In the decision of the Supreme Administrative Court of Finland (18.9.2008, number 08/0293/1) regarding the appeal against the environmental permit decision of the operation of the Meri-Pori power plant owned by Fortum Power and Heat Oy, it is stated as follows: “It cannot be concluded from the phrasing of the plan provision or the plan report that the noise level referred to in the plan provision would jointly concern all operators in the mentioned block area. When also considering the guidelines for the noise level, which were available during the preparation of the plan, the plan provision regarding the block area for industrial buildings (TT-1) must be interpreted so that the referred noise level of 45 dB concerns each operator alone, not all operators jointly in the block area”.

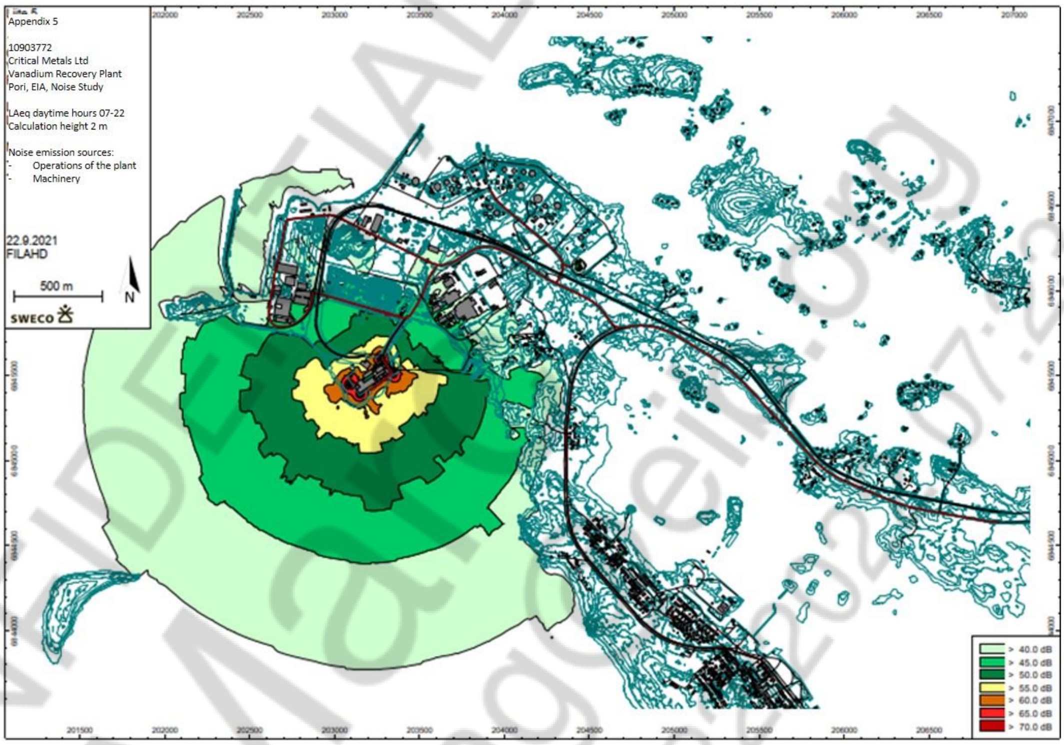

Figure 6.4-5. Noise generated in daytime by the operation, machinery and traffic volumes of the plant. Maximum situation, in which the impacts of slag stockpiles on noise propagation from the facility site to the environment are not taken into account.

Based on modelling, the noise level generated both in daytime and at night by the operation of the facility and traffic is under 50 dB in the nearest residential areas in Katainniemi, Parkkiluoto and Reposaari, which means that the daytime guideline value (maximum of 55 dB) and night time guideline value (maximum of 50 dB) will not be exceeded. Regarding the nearest residential building to the VRP area in Katainniemi area, the noise level generated by the operation of the plant is just below 44 db at the front of the building both in daytime and at night. The night time guideline value will be exceeded regarding one residential building in the immediate vicinity of the Reposaari main road due to noise from heavy traffic volumes at Iso-Katava. Noise generated by the operation of the plant is below 40 dB in the Siikaranta camping area in Reposaari, and the daytime and night time guideline values will not be exceeded.

The equivalent continuous sound level generated by traffic in an area having a few holiday homes located at a distance of about 500 – 800 metres from the chemical port in the northeastern part of Tahkoluoto will not exceed 45 dB in daytime and will be a maximum of 40 dB at night with the exception of the nearest buiding to the road.

The equivalent continuous sound level generated by the operation of the facility is 45–55 dB in the water area around Törnikari.

Very sensitive sites to noise, such as schools, day-care centres and medical institutions are located in the Reposaari area, where noise impacts from the operation of the facility will not extend.

Operation of the facility, traffic volumes to the facility and total traffic volumes

Based on modelling, noise generated in daytime and at night by the operation of the plant, traffic volumes to the plant and total traffic volume (considering existing traffic volumes) is presented in Figures 6.4-6 and 6.4-7.

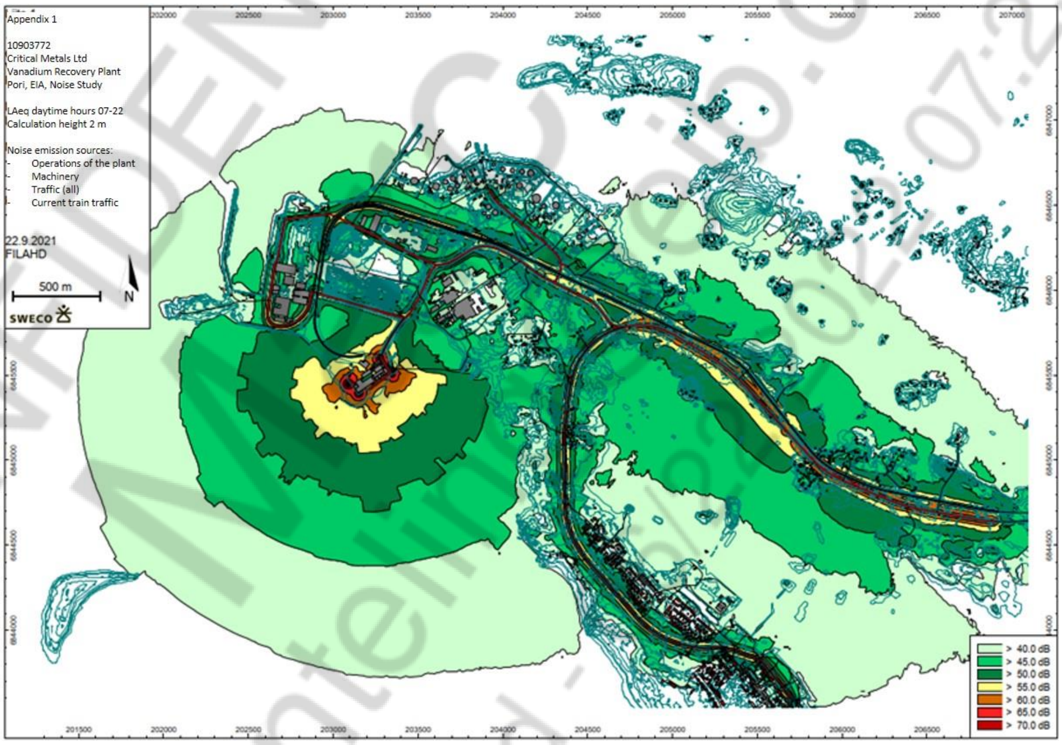

Figure 6.4-6. Noise generated in daytime by the operation of the plant taking into account existing road traffic volumes and railway traffic volumes. Maximum situation, in which the impacts of slag stockpiles on noise propagation from the facility site to the environment are not taken into account.

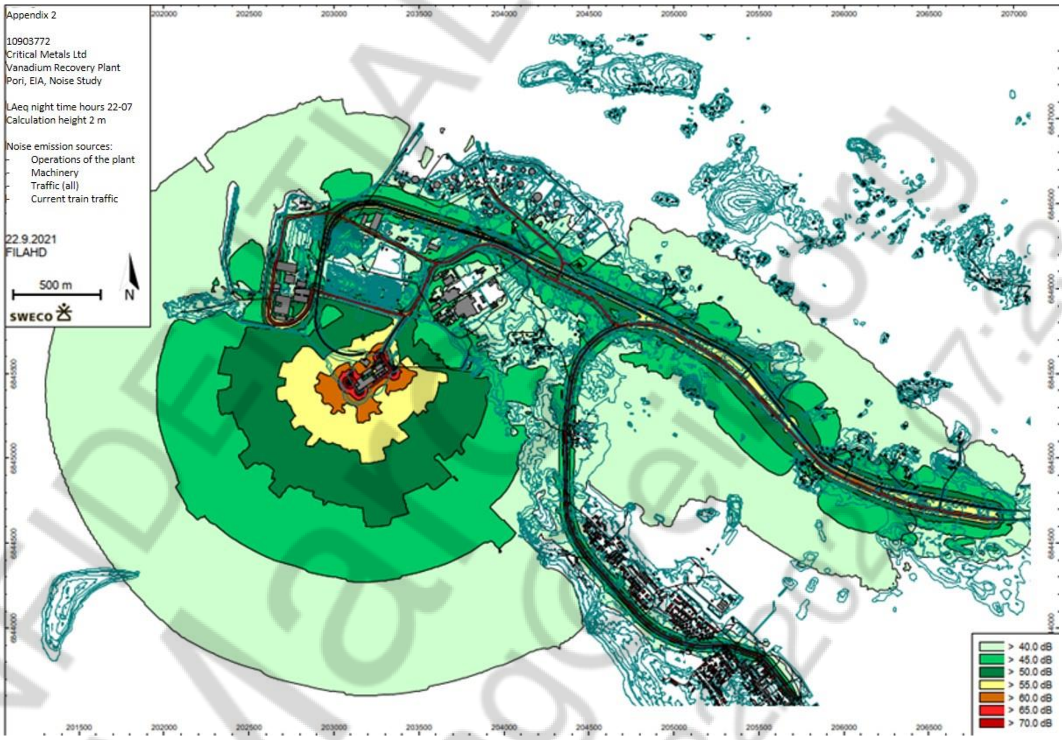

Figure 6.4-7. Noise generated at night by the operation of the plant taking into account existing road traffic volumes and railway traffic volumes. Maximum situation, in which the impacts of slag stockpiles on noise propagation from the facility site to the environment are not taken into account.

The equivalent continuous sound level in the Siikaranta camping area will not exceed 40 dB both in daytime and at night, thus also being lower than the guideline values applied to a recreation area outside of built-up area (daytime 45 dB, night 40 dB). The equivalent continuous sound level in the camping area is affected by the traffic volume on the Reposaari main road, which runs on the eastern side of the camping area.

With regard to a few holiday homes located at a distance of about 500–800 m from the chemical port in the northeastern part of Tahkoluoto, daytime equivalent continuous sound level generated by total traffic volume will probably be lower than 50 dB or a maximum of 55 db. At night, noise level of 50 dB will not be exceeded. Daytime equivalent continuous sound levels of less than 45 dB can be generated in Mäntypaakari area.

Guideline values can be exceeded both in daytime and at night due to noise generated by total traffic volume with regard to residential buildings in the Iso-Katava and Reposaari area in the immediate vicinity of the Reposaari main road (Table 6.4-4). Noise guideline values can also be exceeded in the south along the Reposaari main road for residential buildings located in the immediate vicinity of the road. Noise guideline values are probably exceeded in these particular areas already today.

If a significant share of traffic volumes related to the operation of the plant uses the Pori archipelago road, the equivalent continuous sound levels will increase in the immediate vicinity of the road. Guideline values can be exceeded already today with regard to a few leisure homes and residential buildings in the immediate vicinity of the road (Table 6.4-4).

Table 6.4-4. Probable exceedance of the guideline values (noise from the facility, related traffic volumes and total traffic volumes) and residential buildings along the roads south of Iso-Katava and along the Pori archipelago road.

Potential exceedance of guideline values	day > 55 dB	night > 50 dB	day > 45 dB	night > 40 dB
Modelled area, vicinity of roads (facility and total traffic, including existing traffic)	Residential buildings		Leisure homes	
Reposaari main road, Iso-Katava	approximately 5	< 10 residential buildings	-	-
Reposaari main road, Reposaari	approximately 10	approximately 10	-	-
Residential areas in the vicinity of road (outside of the modelled area)	Residential buildings		Leisure homes	
Distance from road	50 m	200 m	50 m	200 m
Reposaari main road, between Iso-Katava and Mäntyluoto	approximately 10	approximately 20	< 5	approximately 15
Pori archipelago road	< 5	10	approximately 5	approximately 20

Cumulative impact with current operators

Based on the modelling of the port operations in 2016 (chapter 6.4.3, Table 6.4-1), the average equivalent continuous sound level in Parkkiluoto area caused by the port operations is 43 dB in daytime and 35 dB at night. Higher noise emissions are generated during a busy day.Based on the noise monitoring measurements in the port in summer 2021, the equivalent continuous sound level in the Parkkiluoto area is also 43 (± 7) dB.

Based on the noise modelling of the existing offshore wind power stations in Pori (chapter 6.4.3, Figure 6.4-4), the equivalent continuous sound level in Parkkiluoto area caused by wind power stations is less than 40 dB and 36 dB towards south in the Reposaari area (receptor point 10). By applying the addition rule for sound levels, the equivalent continuous sound levels in these particular areas caused by the port and existing wind power stations would be below 45 dB in daytime and a maximum of 40 dB at night with the exception of the nearest residential buildings to the road.

Based on modelling, the equivalent continuous sound levels in these particular areas caused by the vanadium recovery plant and related traffic operations and existing traffic volumes vary from less than 40 dB to 45 dB in daytime and are slightly lower at night.

By applying the addition rule for sound levels, the average cumulative noise level in Parkkiluoto and Reposaari areas caused by the port, existing wind power stations, operation and traffic of the vanadium recovery plant and existing traffic volumes would be less than 50 dB in daytime and at night.

Noise caused by the port, wind power stations and the vanadium recovery plant will slightly increase noise levels also in the water area around the southern VRP area.

In addition to the noise impacts described above, vessel traffic generates underwater noise, which is discussed in chapter 6.8.5.

Potential cumulative impacts with other projects are discussed in chapter 6.15.

6.4.6 Vibration impacts

Used rolling stock (e.g. total weight, train speed, suspension and length as well as condition of rolling stock), rail structure and condition of railway as well as soil characteristics affect the magnitude of vibration. Vibration caused by low frequencies, which can be felt in the body and in the building, is usually harmful in soft land areas. Rumble or structure-borne noise caused by vibration, which can be heard with ears, is typically harmful in hard land areas (Talja 2011).

The type of foundation of buildings, number of floors and location of building affect the detected magnitude of vibration. (Törnqvist & Talja 2006, Kiuru 2007). The speed of trains in Tahkoluoto is relatively low, between 30– 50 km/h, which reduces the generation of vibration and structure-borne noise.

Based on the soil map (1:20 000) by the Geological Survey of Finland (GTK), the soil mainly consists of sandy moraine and fine sand below and next to the railway in the Iso-Katava area and in Raumaluoto. These are considered coarse and hard soil types, and thus vibration impacts are not very likely.

The weight, speed and length of trains potentially related to the transport operations of the vanadium recovery plant would probably not be greater than the features of the existing trains operating to Tahkoluoto. Thus, it is unlikely that harmful vibration and structure-borne noise impacts would extend to a larger area. If train traffic volumes grow in the area, harmful vibration and structure-borne noise impacts will increase. If the coal transport volumes by train decrease from the Tahkoluoto port, vibration will also decrease. Based on the soil type in the area, train speeds and received feedback, vibration impacts will not be very harmful in the area.

6.4.7 Prevention and mitigation of noise and vibration impacts

Noise propagating from the machinery on site to the environment can be reduced by e.g. layout planning of the facility site and machinery as well as location of slag stockpiles. Noise from machinery can be reduced by operational planning and optimal use of machinery.

Harmful impacts from traffic noise can be mitigated by noise protection measures, if needed.

Rail transports have so far not been planned in the project, but harmful vibration and structure-borne noise impacts from train traffic can generally be reduced by structural solutions between the railway and buildings.

6.5 Treatment of slag, by-products and waste

6.5.1 Summary

Conventional inorganic construction waste is generated in the construction phase of the vanadium recovery plant. The aim is to recycle the waste generated during construction as efficiently as possible. There is no difference between alternatives Alt.1, Alt.1a and Alt.1b.

In the operating phase, the environmental impacts of storage, use and final disposal of used raw materials and produced materials in the process on site were assessed as an expert evaluation. In addition, impacts were assessed on a general level outside of the plant area. The assessment was based on the available information on the properties of SSM material, which is produced along with slag.

Potential dusting is assessed as the most significant environmental impact related to the treatment and storing of slag. Dusting is managed by watering, when needed.

Water collection from the structures and stockpiles of slag and SSM prevents the entry of materials from these areas directly or indirectly via stormwaters and seepage waters to the soil and water system.

In alternative Alt.1a, slag from steel industry treated in the plant is “waste”, but its storage and treatment as well as environmental impacts are not different from alternative Alt.1, in which slag is a by-product.

There is no difference in the storage of SSM between the alternatives, in which SSM is defined as a by-product (Alt.1a) or waste (Alt.1b).

If environmental load dissolved from slag or SSM enters the water system in exceptional overflow situation of the stormwater pond, significant harmful impacts are not estimated to occur based on information about the solubility of materials and non-harmful concentrations of soluble substances.

It is estimated that the storage of sodium sulphate in closed facilities and handling of it on site will not have significant impacts.

No process waste or environmental impacts related to waste treatment will be generated in alternative Alt.1a. In alternative Alt.1b, the capacity needed for waste disposal will probably increase in the Pori area. Potential environmental impacts related to the treatment of SSM in the final disposal site will be managed under the environmental permit of this activity.

Comparison of alternatives and significance of impact

The differences between alternatives Alt.1a and Alt.1b regarding the treatment of slag or SSM include the need for a stockpile area and impacts related to disposal activities (Alt.1b). Also, the alternative use of SSM has so far not been confirmed (Alt.1b). There is difference in transport distances to customers or to a stockpile area.

Overall impacts are assessed as minor and negative in alternative Alt.1a and moderate and negative in alternative Alt.1b.

In alternative Alt.0 the plant is not constructed and there is no need for the treatment of materials.

Construction phase

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Treatment of slag, by-products and waste	Typical construction waste is generated in the construction phase, which will be recycled as efficiently as possible.	No new construction or impacts during construction phase.	No difference between alternatives Alt.1a and Alt.1b. Significance of impact is assessed as minor and negative (-).

Operating phase

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Treatment of slag, by-products and waste	Dust from the treatment of slag will be managed by watering, when needed (chapter 6.6). Entry of load to the water system dissolved to stormwaters from slag and SSM stockpiles will be prevented by proper structures. In exceptional situation, short-term entry of load to the water system is not estimated to have detectable harmful impacts. It is estimated that proper waste treatment will not have significant environmental impacts.	The plant is not constructed and there is no need for the treatment of materials.	The differences between alternatives Alt.1, Alt.1a and Alt.1b include the need for a stockpile area, impacts related to disposal activities (Alt.1b) and transport distances to customers or to a stockpile area. Also, the alternative use of SSM product has so far not been confirmed (Alt.1b).
			Significance of impact in alternative Alt.1 and Alt.1a. is assessed as minor and negative (-).
			Significance of impact in alternative Alt.1b is assessed and as moderate and negative (--).

6.5.2 Assessment method and uncertainties

In addition to the used slag produced in the plant,

The environmental impacts of slag used in the plant and treatment of produced SSM were assessed based on available test results of the properties of slag and SSM. Furthermore, empirical information was used which was available from the facilities processing slag.

Impacts related to the treatment, recycling and final disposal of raw materials, by-products and waste were assessed in the vanadium recovery plant area, and on a more general level outside of the vanadium recovery plant area.

A German DIN 38414-S4 leaching test at extraction ratio of L/S 10 was used in the leaching analysis of slag. It is a one-stage leaching test, and the studied substance is dissolved for 24 hours in de-ionised water in a vertical drum mixer. The results of the one-stage leaching test at extraction ratio of L/S 10 are not directly comparable to the results of the two-stage batch leaching test pursuant to the EN 12547 standard.

The two-stage batch leaching test (EN 12547-3) has been used in the leaching analysis of SSM. The batch leaching test can be used for assessing the impacts of varying pH conditions on solubility. Sample pretreatment (granular size distribution, sample storage) and test conditions (leaching solution, shake-flask method, presence of oxygen, filtration method) have a fundamental impact on the test results. The test indicates the solubility of different substances in prevailing test conditions (VTT 2012). The use of the results from the batch leaching test in assessing the leaching of metal concentration into stormwaters probably overestimates the emission. The amount of concentration leaching from SSM to stormwaters is actually lower than the concentration indicated by the results of the batch leaching test, as stormwater and SSM material do not mix as efficiently as in test conditions. Furthermore, the mixing time of water and SSM is shorter than in test conditions and the actual amount of emission is probably lower. Uncertainties are related to the laboratory analyses of SSM also due to small sample size. The properties of SSM will still be specified.

The potential alternatives for use and final deposit of SSM identified during project planning have been presented in the assessment. These alternatives will be examined in more detail during project planning.

The volumes of stored slag and SSM on site are presented as maximum volumes, but the actual volumes can be significantly lower.

6.5.3 Impacts during construction

Conventional construction waste is generated in the construction phase of the vanadium recovery plant. The aim is to utilise leftover land and material, for example leftover concrete, near the VRP area. The regulations of e.g. the MARA Decree (843/2017) for using crushed concrete are considered in the utilization of leftover concrete. According to the MARA Decree, crushed concrete can be used for e.g. field structures as well as for foundation structures of industrial and storage buildings and as stabilizer.

Components to be used are stored by waste type in the immediate storage area when they can be used in construction projects and landscaping of filling areas or delivered for recycled use outside of the VRP area. When using construction waste, the regulations of the Decree on Recovery of the Certain Wastes in Earth Construction (so-called MARA Decree 843/2017) will be complied with.

Waste generated during construction, which is not suitable for recycling, is delivered to the final disposal site. The nearest treatment and final disposal site to the VRP area is the Peittoo recycling park, which is located in Ahlainen less than 10 km from Tahkoluoto.

Heavy metal concentrations detected in the soil of the area that exceed the lower guideline value of the Decree on the Assessment of Soil Contamination, are considered in occupational safety when handling the land masses in the area (see chapter 6.10).

It is estimated that proper recycling and final disposal of construction waste will not have significant environmental impacts.

6.5.4 **Impacts during operation**

6.5.4.1 Slag

Properties

The particle size of slag is < 10 mm and moisture content is about 10 %.

Slag is not classified as a hazardous substance according to the CLP Regulation. Based on the safety data sheet (SSAB Merox Ab 2016), storing of slag does not require special measures regarding environmental safety, and it can be stored outside. In SSAB facilities slag has been stored in slag storage areas for several years. For example, in Oxel-ösund, one of the slag storage areas is located in the immediate vicinity of the sea.

The pH of slag is about 11.8. In addition to vanadium pentoxide (3–4 %), slag includes calcium oxide (CaO), silicon oxide (SiO_2), magnesium aluminate ($MgAl_2SO_4$), manganese oxide (MnO), titanium dioxide (TiO_2) and iron oxide (Fe_3O_4) (chapter 2.2.4, Table 2.2-2). It does not include organic matters due to the high temperature in slag formation process.

According to tests, the solubility of substances included in slag is presented in Table 6.5-1 (SSAB Merox 2018). Based on research, very minor quantities of metals dissolve from slag (Chand ym. 2016).

Table 6.5-1. Solubility of metals from slag to water (SSAB Merox 2018).

Water solubility, substance	**Concentration in water, mg/l (DIN 38414-S4, 10:1 liquid/solid)**	**Reference value**
As	< 0.002	
Cd	< 0.0005	10 µg/l[1)]
Co	< 0.005	
Cr (total)	0.03	
Cu	< 0.005	
Fe	<0.01	
Hg	< 0.0002	5 µg/l[1)]
Mn	< 0.001	
Mo	0.4	
Ni	< 0.01	8.6/34 µg/l[2)]
Pb	0.004	1.3/14 µg/l[2)]
Se	0.001	
V	< 0.002	
Zn	0.02	

1) Maximum permitted emission limit values, Decree 2022/2006
2) Environmental quality standards, concentration in sea water (annual average / maximum concentration, Decree 2022/2006)

The PNEC values of slag or maximum non-harmful concentrations, which are not expected to have impacts on biota, are presented in Table 6.5-2.

Table 6.5-2. PNEC concentrations of slag in different environmental niches of exposure (SSAB Merox Ab 2016).

Target	PNEC
Sea water	0.5 g/l
Water (intermittent emission)	5 g/l
Air	Not relevant, slag is not volatile
Soil	1 000 mg/kg

Based on ecotoxicological research, the hazardous concentrations of slag to water organisms are tens or hundreds of milligrams/litre (Table 6.5-3). In exceptional situations, such concentrations in sea water are not caused by stormwaters directed from stockpiles to the sea.

Table 6.5-3. Toxicity of slag to water organisms (SSAB Merox Ab 2016). LC50 = concentration, in which half of the test animals die during a test with a certain duration. EC50 = concentration, in which half of the test organisms suffer from some effect (immobility, prevented growth).

Research	Route and time for exposure	Result
Immediate toxic response	Fish (*Leuciscus idus*), 96 h	LC50 ≥ 100 g/l LC50 ≥ 1000 g/l
Immediate toxic response	Crustacean (*Daphnia magna*), 48 h	EC50 ≥ 50 g/l EC50 ≥ 1 000 g/l
Immediate toxic response	Micro-organism (*Vibrio fischeri*), 30 min	EC50 > 80 g/l

Treatment and storage

The maximum volumes of stored slag are presented in Table 6.5-4. The ratio of slag to SSM stored on site will fluctuate throughout the life of the project depending on production rates and sales of final products.

Table 6.5-4. Volumes of stored slag.

Slag	
Size of area reserved for storage	Southern VRP area 12 ha Northern VRP area 5 ha
Height of stockpile (maximum)	15 m
Stored volume	Southern VRP area: - maximum volume 1.27M m^3 (1.9M drytonnes) Northern VRP area: - maximum volume 0.33M m^3 (0.5M dry tonnes)

Stormwater management will be planned so that harmful substances included in slag or SSM cannot enter the water system via stormwaters.

Waterproof foundation of slag and SSM storage areas can be achieved by using, for example, dense-graded asphalt or geosynthetic material, for example HDPE-coating. The waterproof material is defined in more detail during the construction design of storage areas.

An embankment will be constructed on the edge of the storage area in order to secure that material will not flow to the environment in any case. Inclinations in the area are constructed so that water flows to the stormwater ponds. Preliminary principles for the structures of the storage area are presented in Figure 6.5-1 and 6.5-2.

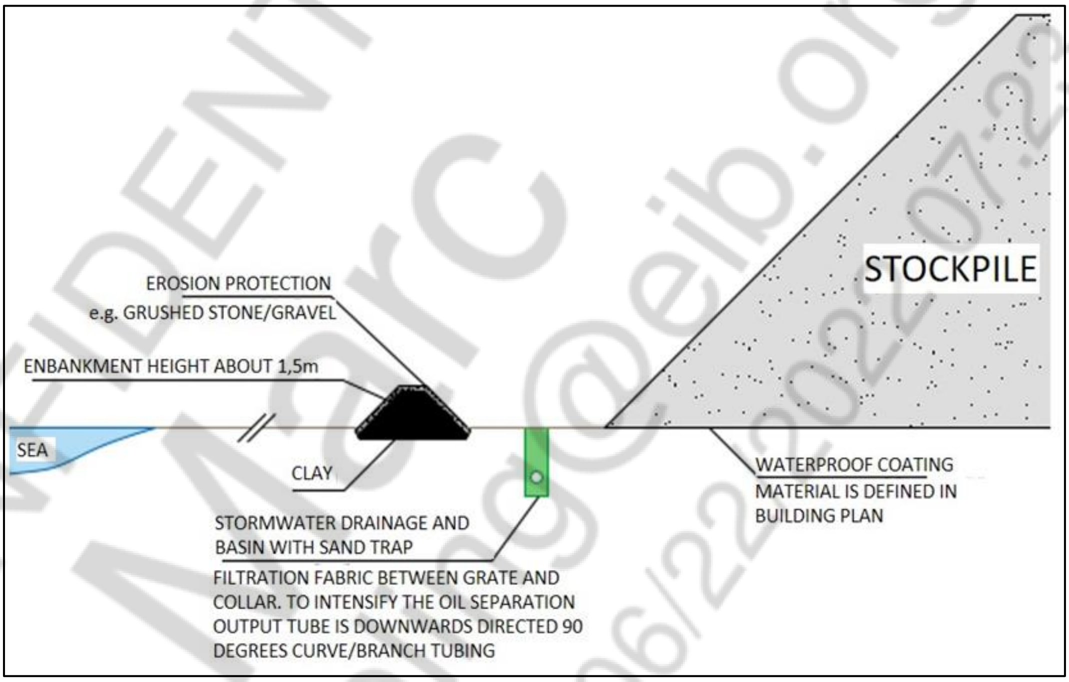

Figure 6.5-1. Structure of the storage area of slag and SSM (waterproof coating, when needed).

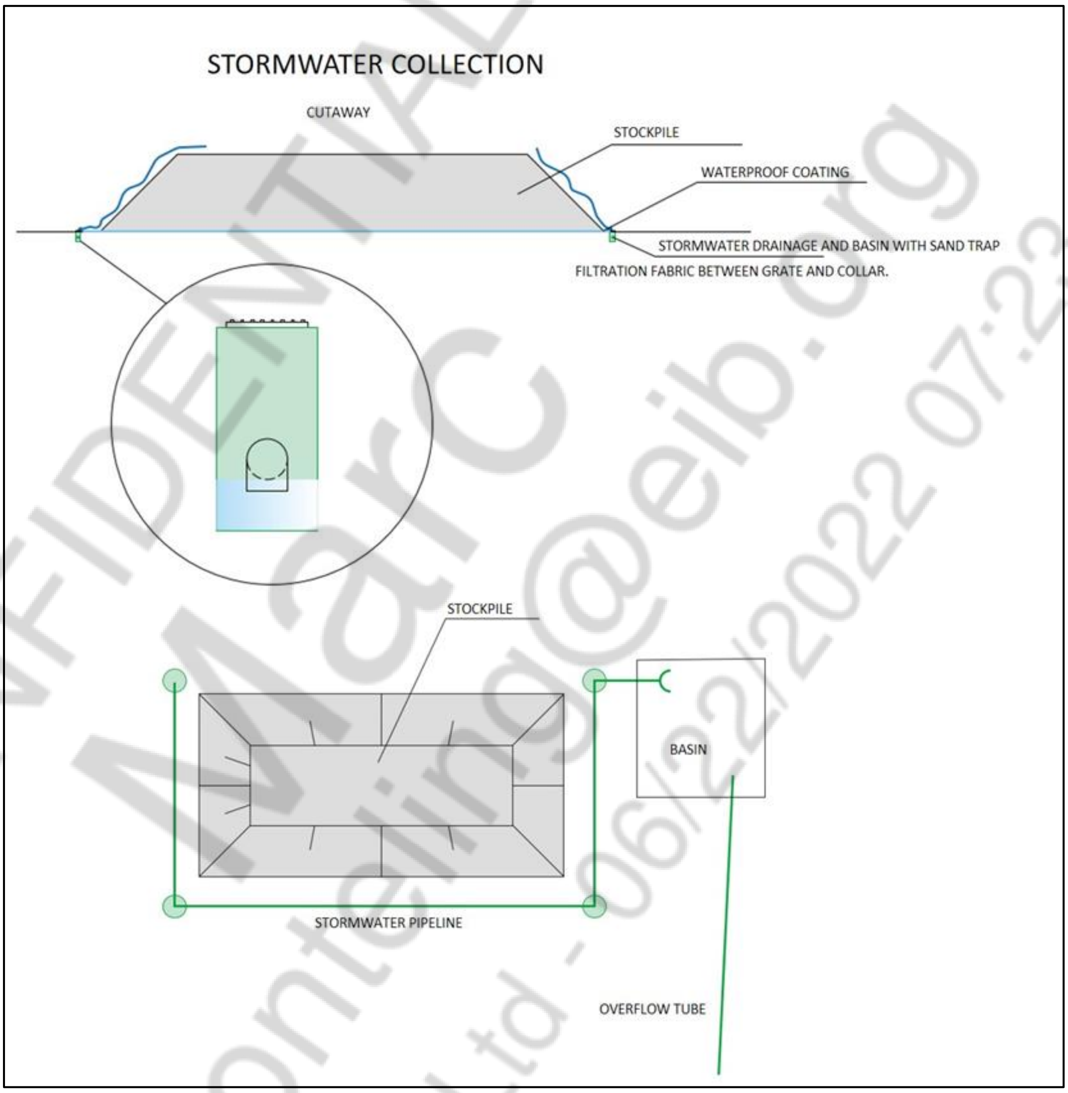

Figure 6.5-2. Water collection in the storage area of slag and SSM.

According to preliminary plan, stormwaters and seepage waters from stockpiles are collected from around stockpiles through stormwater drainage pipes and ponds equipped with grate and filtration fabric to stormwater ponds, from where the waters are directed to the process. In the southern VRP area, preparations have been made for constructing a pond having a capacity of about 10 000 m^3. In the northern VRP area, the tentative size of the pond is about 1 500 m^3. The potential concentrations of solid substances and oil in waters are mainly filtered out to the wells and stormwater pond of the water collection system. Solid substance is removed from ponds with excavators and transferred to the process.

Similarly, stormwaters and seepage waters from stockpiles in the northern VRP area are collected to the pond and transported by tank trucks to the process.

Based on average rainfall, the volume of annual accumulated water is about 100 000 m^3 in the southern VRP area. The volume of accumulated water is about 25 000 m^3 in the northern VRP area. The ponds are tentatively designed to hold the water volume from heavy rain occurring once in 50 years. In the southern VRP area, the water volume of a design storm (260 l/s/ha) occurring once in 50 years and having a duration of 10 minutes is estimated to be 2 500 m^3. The water volume of rain (300 l/s/ha) occurring once in 100 years would be about 2 900 m^3. In the northern VRP area, the water volumes are 700 m^3 and 810 m^3, respectively. The volume of the designed stormwater ponds in the VRP area can hold at least the water volume from heavy rain occurring once in 50 years in the VRP area. It will be verified in detailed planning that design values of rainfall correspond to the latest information and e.g. the impacts of climate change on weather conditions have been sufficiently addressed.

Overflow situations of ponds can occur, for example, with the commissioning of the plant, start-up of the plant after a maintenance break or with exceptionally high volumes of rain water and melt water, when the short-term demand for process water can be lower than the generated volume of stormwater. In short-term overflow situations, waters are directed in a controlled way along a drain to the water system, when most of the solid substance falls into the pond.

Experience with the storage and treatment of slag elsewhere

Slag has been stockpiled for several years in Luleå, Oxelösund (Figure 6.5-3) and Raahe. Hundreds of thousands of cubic metres of slag have been used for the infill of water areas in coastal areas of Oxelösund. Coal stockpiles can now be found in the area.

Figure 6.5-3. Slag stockpile (465 000 t) in Oxelösund.

Figure 6.5-4 shows a slag stockpile and a compact surface of the stockpile is presented in figure 6.5-5.

Figure 6.5-4. Slag stockpile covered by snow in Luleå.

Figure 6.5-5. Compact surface of a slag stockpile in Luleå.

Slag produced in the Raahe steel plant (about 200 000 tonnes/year) is transported to the slag treatment area and dumped to the bank, where small volumes of sea water is used to cool it down (SSAB environmental permit application 2014). Water flows from slag stockpiles to earth ponds of the cooling field equipped with filter shafts, from where water flows through pump units and sea drainage pipes to the sea. The load in the cooling water of steel slag is not uniform, but increases in melt waters in spring.

Based on the water monitoring in the slag treatment area, water from stockpiles has solid substance and dissolved metals. Based on the measurements during the years 2006–2012, the average concentration of solid substance in waters has varied between 30 mg/l – 663 mg/l (load is calculated with a maximum of 120 m^3/h). Concentrations of metals in the cooling water of converter slag in Raahe were analysed in 2009 for the study of harmful substances. Concentrations and calculated load with maximum pumping of 120 m^3/h are presented in Table 6.5-5 (SSAB Raahe 2014). The table also shows the average concentration in seepage waters in the slag stockpile area of the SSAB Oxelösund steel plant based on 11 monitoring measurements on 28.3.2018 and 24.3.2021 (SSAB 2021). Concentrations are low e.g. with regard to the emission limit values provided in the Decree on Substances Dangerous and Harmful to the Aquatic Environment (1022/2006) and the environmental quality standards (mercury, cadmium, nickel, lead). The maximum concentration of sulphate corresponds to the level of natural concentration of sulphate in the Baltic Sea (400–500 mg/l).

Table 6.5-5. Concentrations of harmful substances and load in the cooling waters of slag in the SSAB Raahe steel plant (SSAB Raahe 2013) and average concentration in seepage waters in the slag stockpile area of the Oxelösund steel plant based on 11 measurements during 28.3.2018–24.3.2021.

Substance	**Concentration, Raahe, cooling waters of slag**	**Concentration, Oxelösund, seepage waters of slag stockpile area**	**Unit**	**Load, Raahe, cooling waters of slag**	**Unit**	**Reference values (annual average/ maximum concentration)**
Discharge	120		m^3/h	1 051 200	m^3/a	
pH	12.4	11.97	-			
Solid substance	114	7	mg/l	119	t/a	
Aluminum (Al)	0.15		mg/l	155	kg/a	
Aluminum, soluble	0.07	0.083	mg/l	71	kg/a	
Arsenic (As)	0.03		µg/l	29	g/a	
Arsenic, soluble	0.02	0.74	µg/l	17	g/a	
Cadmium (Cd)	0.08		µg/l	84	g/a	
Cadmium, soluble	< 0.1	0.25	µg/l	below limit of determ.		10 µg/l[1)]
Chrome (Cr)	2.66		µg/l	2.8	kg/a	
Chrome, soluble	1.28	245	µg/l	1.2	kg/a	
Copper (Cu)	1.96		µg/l	2.1	kg/a	
Copper, soluble	2.75	16.5	µg/l	2.9	kg/a	
Iron (Fe)	0.14		mg/l	148	kg/a	
Iron, soluble	0.02	0.04	mg/l	16	kg/a	
Mercury (Hg)	<0.1		µg/l	below limit of determ.		
Mercury, soluble	0.02	< 0.02	µg/l	0.02	kg/a	5 µg/l[1)]
Nickel (Ni)	0.47		µg/l	0.49	kg/a	
Nickel, soluble	0.69	3.5	µg/l	0.72	kg/a	8.6/34 µg/l[2)]
Lead (Pb)	0.78		µg/l	0.82	kg/a	
Lead, soluble	0.99	4.9	µg/l	1.04	kg/a	1.3/14 µg/l[2)]
Vanadium (V)	10.75		µg/l	11.3	kg/a	
Vanadium, soluble	10.5	22.5	µg/l	10.7	kg/a	
Zinc (Zn)	<0.005		mg/l	below limit of determ.		
Zinc, soluble	0.01	0.02	mg/l	9.6	kg/a	

Substance	Concentration, Raahe, cooling waters of slag	Concentration, Oxelösund, seepage waters of slag stockpile area	Unit	Load, Raahe, cooling waters of slag	Unit	Reference values (annual average/ maximum concentration)
Discharge	120		m^3/h	1 051 200	m^3/a	
Calcium oxide (CaO)	732		mg/l	769 478	kg (2009)	
Manganium oxide (MgO)	0.34		mg/l	357	kg (2009)	
Silicon dioxide (SiO_2)	2.9		mg/l	3 048	kg (2009)	
Sulphate (SO_4)	141	473	mg/l	148 219	kg (2009)	

1) Maximum permitted emission limit values, Decree 1022/2006

2) Environmental quality standards, concentration in sea water (annual average / permitted maximum concentration, Decree 1022/2006)

As a comparison, based on the results of stormwater monitoring in Tahkoluoto deep-water port in 2020, the concentration solid substance in the deep-water port has varied between 17 – 120 mg/l depending on the sample site.
According to the environmental permit (Nro 34/2016/1, Dnro PSAVI/57/04.08/2013) of the Raahe plant, the following concentrations cannot be exceeded in rain water, melt water and stormwater directed to the water system, which have been in contact with slag products:

- solid substance 20–30 mg/l
- lead 0.5 mg/l
- zinc 2 mg/l
- chrome 0.5 mg/l
- nickel 0.5 mg/l
- iron 5 mg/l

Impacts of the treatment and storage of slag in normal situation

Potential dusting is assessed as the most significant environmental impact related to the treatment and storing of slag. Dusting is managed by watering, when needed. Dust impacts have been assessed in chapter 6.6 regarding impacts on air quality.

The above described structure of the storage area and water collection from stockpiles prevent the entry of slag from the storage area directly or with stormwater or seepage water to the soil or water system. Slag or concentrations included in it will not spread from the stockpile area to environment, and the storage of slag will not have impacts on soil and water system.

Unforeseen and planned exceptional conditions

Waters from exceptionally heavy rain or high volumes of melt water can flow out of the area, and a limited water volume can be directed to the water system as a short-term overflow from the pond. Also, during the commissioning and start-up of the plant after maintenance break, the demand for process water can momentarily be lower than in normal operation, and depending on rainfall, waters may have to be directed to the water system as a short-term overflow.

Metals in slag are strongly bonded to other substance, and the solubility of metals is very low (Table 6.5-5, water solubility). When compared to the maximum emissions provided in legislation (Decree on the Substances Dangerous and Harmful to the Aquatic Environment 1022/2006) (cadmium and mercury) and the maximum concentrations by environmental quality standards (lead and nickel), based on leaching tests the calculated concentrations of metals dissolving from slag to water are significantly lower (see Table 6.5-1). Based on the leaching tests of lead and cadmium, concentrations are of same magnitude as the annual average concentrations by the environmental quality standards. Concentrations in the water system, which are comparable to the annual average concentrations, would require a continuous load, which is not possible in this case. Based on test results, estimated leaching to stormwaters probably overestimates the potential actual leaching, as due to shorter duration, the amount of emission dissolving from slag to stormwater is lower than indicated by the batch leaching test.

If load dissolving from slag enters the water system in the above mentioned overflow situation, it will soon be diluted in high water volume and concentrations in sea water will be significantly lower.

Slag has been stockpiled on site for several years in Luleå, Oxelösund and Raahe, when the leaching of substances is estimated to be lower than in recent slag. In the above mentioned overflow situation, the risk of dissolving of concentrations included in materials to rain water is even lower than usual due to fast water flow. In this case, only very minor, short-term and local impacts on the water system can be estimated to occur. Significant, detectable, long-term and wide-spreading impacts are not estimated to occur.

Due to the alkalinity of slag, the pH of stormwaters from stockpiles can be relatively high, and if slag enters the water environment in significant quantities, this could have impacts on water ecology. Based on the estimate of non-harmful concentration in the ecotoxicity data of slag, harmful impacts could be caused, if the concentration of 500 g/m^3 is continuously exceeded in sea water. Occasional emissions could cause harmful impacts if the concentration reaches 5 kg/m^3 in water. It is highly unlikely, that these kinds of slag volumes would enter the water system during the operation of the vanadium recovery plant.

If slag falls to the ground in an accident situation on site outside of the storage area, it could be recovered and significant amounts of slag or dissolved substances from it would not enter the soil. The maximum non-harmful concentration of slag in soil is 1 gram of slag/1 kg. As a result of accidents, higher concentrations in a large area are highly unlikely.

For example, in an accident situation, the entry of substances to soil with water, which are dissolved from slag, is highly unlikely (see chapter 6.14, "Accidents and disturbances"). In theory, if this happens, the soil in the area is not very acid and the movement of metals in soil and further on to the water system is not very likely.

Exceptional situations and e.g. preparation for flood risks are also discussed in chapter 6.14 “Accidents and disturbances”.

6.5.4.2 SSM

Properties

The particle size of SSM (Figure 6.5-6) is < 10 µm and the moisture content is about 30 %. Most of the elements in SSM can be found as carbonates, oxides or silicate and aluminum minerals (Table 6.5-6).

Figure 6.5-6. SSM sample.

Table 6.5-6. Elemental composition of the SSM (AFRY 2021*)*.

Compound/element	Concentration
$CaCO_3$	50 – 55 %
Fe	13 – 15 %
Si	3.3 – 3.5 %
Mg	4.0 – 4.3 %
Mn	1.8 – 2.2 %
Al	0.7 – 0.8 %
Ti	0.5 – 0.7 %
V	0.3 – 0.5 %
P	0.2 %

Concentrations of harmful substances in SSM were tested and assessed according to the Decree on the Assessment of Soil Contamination and Remediation Needs (so-called

PIMA-Decree 214/2007). Solubility was tested according to the Decree on the Recovery of Certain Wastes in Earth Construction (so-called MARA Decree Vna 843/2017) and the Decree on Landfills (Vna 331/2013), and the results were compared to the limit values provided by the Decrees (AFRY 2021).

Based on laboratory analyses, SSM includes fairly high total concentrations of vanadium (4 060 – 4 340 mg/kg) and chrome (660 – 825 mg/kg) when compared to the applied higher guideline values (vanadium 250 mg/kg, chrome 300 mg/kg) provided by the PIMA Decree. Other analysed heavy metal concentrations were low.

Based on the leaching test, SSM can be disposed to the stockpile area of conventional waste (Table 6.5-10). Limit values for the solubility of vanadium have not been provided by the Decree on Landfills.

Based on test results, the most significant substances dissolving from SSM to water are vanadium and chrome with regard to the use of the material. The solubility of vanadium (about 74.6 – 77.2 mg/kg) exceeded the limit values provided by the MARA Decree for the criteria of using both covered and paved structure, which includes utilized material. The solubility of chrome (< 0.5 – 2.66 mg/kg) exceeded the limit values for covered structure, but not for paved structure.

Data on the toxicity of vanadium and chrome dissolved from SSM is presented in Tables 6.5-7 and 6.5-8. In the REACH registration data of vanadium, data on ecotoxicity is based on the test results of the combination of five vanadium compounds ($NaVO_3$, Na_3VO_4, NH_4VO_3, NH_4V3O_8, V_2O_5). Based on the REACH registration data, vanadium or chrome are not particularly toxic in the water environment or soil. According to the above mentioned PIMA Decree, the threshold value of chrome is 100 mg/kg and the average natural concentration in soil in Finland is 31 mg/kg. The non-harmful concentration will be less and it is not estimated to cause impacts on soil.

Table 6.5-7. Data on the harmful properties of vanadium and chrome included in SSM. Source: ECHA registration document.

Target	**PNEC/NOEC (ECHA)[1)]**
Vanadium (V)[2)]	
Water environment	According to the CLP Regulation (EY 1272/2008), vanadium (metal) is not classified as acutely or chronically hazardous to the water environment, as e.g. the formation of bioavailable vanadium is weak.
Soil	V and V_2O_5: 2 – 960 mg/kg (depending on the tested organism/impact)
Sediment	V: 498 mg/kg
Chrome (Cr)	
Fresh water	6.5 µg/l
Sea water	toxicity in water environment is unlikely
Air	not identified
Soil	21.1 mg/kg
Sediment (fresh water)	205.7 mg/kg

[1)] PNEC (Predicted No Effect Concentration) -value, non-harmful concentration based on toxicity tests, which is not expected have impacts on biota with certain probability. NOEC (No Observed Effect Concentration) -value – or maximum non-harmful concentration based on toxicity test.

[2)] Data on the ecotoxicity of vanadium is based on the test results of a combination of five vanadium compounds ($NaVO_3$, Na_3VO_4, NH_4VO_3, NH_4V3O_8, V_2O_5).

Table 6.5-8. Data on the ecotoxicity of substances included in SSM. LC50 = concentration, in which half of the test animals die during a test with a certain duration. NOEC = maximum concentration, which will not have significant harmful impacts on test animals. Source: ECHA registration document.

Research	Route and time for exposure	Result
Vanadium[1)]		
Immediate toxic response, sea water	Fish (*Limanda l.*), 96 h	LC50 27 800 µg/l
Immediate toxic response, sea water	Invertebrate (*Americamysis bahia*), 48 h	LC50 13 300 µg/l
Toxic in long-term exposure, sea water	Invertebrate (*Crassostrea gigas*), 48 h	NOEC 25 µg/l
Chrome		
	Toxicity of chrome metal to water organisms is unlikely. Solubility of chrome metal to water is an average of about 0.005 µg/l (from chrome oxide) and toxic concentrations are of magnitude milligrams/litre.	

[1)] Toxicity has been determined by dissolving V_2O_5 or $NaVO_3$ to water.

Storage of SSM on site

The SSM produced in the plant is delivered to the customers as quickly as possible. In this case, storage time remains short and stockpiles are small on site.

SSM can be stored before delivery, when needed, in stockpiles of the southern VRP area for a maximum of three years. The capacity of the southern storage area is 1 329 000 tonnes as dry matter (plus about 30 % moisture content). The maximum amount of SSM to be stored will be limited to 1 245 000 dry tonnes.

The maximum stored volumes of SSM are presented in Table 6.5-9. It is assumed that slag is not stored in the northern VRP area. The ratio of slag to SSM stored on site will fluctuate throughout the life cycle of the project depending on production rates and sales of final products.

Table 6.5-9. Volumes of stored SSM.

SSM	
Size of area reserved for storage	Southern VRP area: about 12 ha
Height of stockpile	10 m

SSM	
Stored volume	Southern VRP area: - maximum volume of 0.94M m^3 (1.33M dry tonnes)

The foundation structure of the SSM storage area and water management in the area are implemented so that no harmful substances cannot enter the soil or water system. The preliminary principles of the structures and water collection system of the storage area are presented in chapter 6.4.4.1 “Treatment and storage” regarding the storage of slag.

Impacts of storing SSM in normal situation

It is estimated that SSM hardly generates dust emissions due to its significant moisture content. Dust impacts and their management on site have been assessed in chapter 6.6 regarding air quality impacts.

The above described structure of the stockpile area and collection of water from stockpiles prevent the entry of SSM from storage area directly or with stormwaters or seepage waters to the soil or water system. Based on the testing of SSM, with the compacting of stockpiles a low water permeable layer is formed, and so the water volume infiltrating through the stockpiles is estimated to be minor. In accordance with the industrial standards, the foundation structures of stockpiles will be engineered to minimize any leakage of moisture to the ground as much as practicable. The waterproof coating will be engineered to the required industrial standards.

SSM does not spread to the environment from the stockpile area, and it is estimated that the storage of SSM will not have significant impacts on the water system or soil.

Unforeseen and planned exceptional conditions

Water from exceptionally heavy rain or high volumes of melt water can flow out of the area and a limited water volume can be directed to the water system as a short-term overflow from the pond. Also in context with the start-up of the operation after maintenance break, the short-term demand for process water can be lower than in normal operation, and depending on rainfall, water may have to be directed to the water system as a short-term overflow from the pond.

In the above mentioned situation, due to fast water flow, the risk of dissolving of materials including concentrations of substances to rain water is lower than in normal situation. Significant impacts are not estimated to occur.

Compared to the maximum concentrations (cadmium, mercury) in water directed to the water system provided by legislation (Decree on the Substances Dangerous and Harmful to the Aquatic Environment 1022/2006), the concentrations metals dissolving from SSM to water are low based on leaching tests (see Table 6.5-10). Concentrations of nickel and lead dissolving from SSM to water from stockpiles may exceed the concentrations pursuant to the environmental quality standards (concentrations in water system), but if the load enters the water system in the above mentioned overflow situation, it will soon be diluted in high water volume and concentrations in sea water will be significantly lower. Based on test results, the estimated metal concentrations in water, which have been in touch with SSM, are likely to be significantly overestimated, as in test situation material and water mix efficiently, but actually rain waters do not completely mix with stockpiles.

Table 6.5-10. Calculated concentrations of substances dissolved from SSM to water from stockpiles and comparison to reference values.

Water solubility, substance	**Result of leaching test CSN EN 12457-3 mg/kg**	**Calculated concentration in water**	**Reference value**
Cadmium	< 0.04	< 4 µg/l	10 µg/l[1)]
Mercury	< 0.01	< 1 µg/l	5 µg/l[1)]
Nickel	< 0.4	< 40 µg/l	8.6/34 µg/l[2)]
Lead	< 0.5	< 50 µg/l	1.3/14 µg/l[2)]
Vanadium	74.6	7.5 mg/l	13 mg/l [3)]
Chrome	2.66	0.27 mg/l	toxic concentration is milligrams/litre

1) Maximum permitted emission concentrations in water directed to the water system, Decree 1022/2006

2) Environmental quality standards, concentration in sea water (annual average / permitted maximum concentration (Decree 1022/2006)

3) Immediate toxic response, invertebrate LC50 (Table 6.5-8)

Based on the test results, the calculated/theoretical concentration of vanadium in water from stockpiles (7.5 mg/l) is lower than the clearly toxic concentration of short-term exposure LC 50 of 13 mg/l based on the data on the ecotoxicity of vanadium (ECHA). The calculated concentration of chrome in water (0.27 mg/l) is quite low when compared to the toxic concentrations, milligrams/litre, based on the data on ecotoxicity (ECHA). It should also be noted that based on the test results, it is probable that estimated leaching to stormwaters significantly overestimates the potential actual leaching, as e.g. due to shorter duration, the amount of emission dissolving from SSM to stormwaters is lower than indicated by the batch leaching test.

If load dissolving from SSM enters the water system in the above mentioned overflow situation, the concentration in stormwaters will soon be diluted in high water volume, and the concentrations in sea water will be significantly lower than calculated concentrations based on test results.

In the above mentioned overflow situation, due to fast water flow, the risk of dissolving of materials with concentrations of substances to rain water is even lower than usual. In this case, only very minor, short-term and local impacts on the water system can be estimated to occur. Significant, detectable, long-term and wide-spreading impacts are not estimated to occur.

Any slag falling to the ground on site outside of the storage area will be recovered and not remain on the ground, and significant amounts of slag or dissolved substances from it would not enter the soil. Therefore, the entry of significant concentrations (vanadium 2 – 950 mg/kg and chrome 21 mg/kg) to soil in large area is highly unlikely.

Exceptional situations and e.g. preparation for flood risks are also discussed in chapter 6.14 “Accidents and disturbances”.

6.5.4.3 Sodium sulphate

Sodium sulphate generated in the process can be used in the paper manufacturing process, glass production and as a filler in detergent powders.

It is estimated that storing of sodium sulphate in closed storages and handling of it on site will not have significant impacts.

6.5.4.4 Waste

The goal of the project is to minimise the amount of generated waste

In the implementation alternatives of the project, proper recycling and final disposal of construction waste are not estimated to have significant environmental impacts.

In **alternative Alt.1a** waste is treated (slag), but there is no difference in storing and treatment of waste compared to alternative Alt.1, in which slag is a by-product from steel industry, and there is no difference in environmental impacts.

Process waste is not generated in the operation of the plant in alternative Alt.1a. Particle emissions in dust collectors are directed back to the process. Solid substance accumulated in the sedimentation ponds of stormwaters are removed from ponds and directed to the process. The most significant waste components are hazardous waste from maintenance, such as lubricating oils and domestic waste.

The aim is to classify SSM as a by-product for e.g. alternative use described above (chapter 6.5.4.2), and later potentially also for other recycled use.

In early phases of facility operation, it is possible that SSM, 415 000 dry tonnes/year, has not yet received the status of by-product, and then SSM is classified as waste (**Alternative Alt.1b**). The waste code pursuant to the Waste Decree (179/2012) would the code (06 03 99) of waste generated in the production of metal oxides. In this case, SSM is transported via a maximum of three-year intermediate storage to the final disposal site, which has permits for the treatment of this type of waste. Based on the results of the leaching test, SSM can be disposed to the stockpile area of conventional waste. A potential disposal site for SSM is, for example, the Peittoo waste centre area at a distance of about 10 km from the VRP area. SSM is likely to be transported later from the disposal site to recycled use.

Impacts related to the intermediate storage of SSM are described in chapter 6.5.4.2. There is no difference in impacts, whether SSM is classified as a product or waste. There is no difference between alternatives Alt.1, Alt.1a or Alt.1b regarding the maximum stored volumes of SSM, but in practice the stored volumes on site will probably be larger in alternative, in which SSM is waste when compared to the alternative, in which SSM is a by-product.

Potential environmental impacts related to the disposal of SSM as waste outside of the plant area are managed within the environmental permit for the particular activity. Impacts are described in chapter 6.5.4.5. In alternative Alt.1b, the capacity needed for the disposal of waste will increase.

In alternative Alt.1a SSM is transported to the customer and in alternative Alt. 1b it is transported to the stockpile area located 10 km away, from where it will probably later be transported for recycled use. Thus, the impacts of transport operations will, to some extent, occur in different areas at different time.

Proper waste treatment is not estimated to have significant impacts.

6.5.4.5 Disposal of SSM as waste outside of the plant area

It is very unlikely that SSM should be stored for more than three years, and a stockpile area would be needed outside of the VRP area. In this case, a potential long-term stockpile or final disposal site for SSM classified as waste would be, for example, in the Peittoo waste centre area. SSM is conventional waste by quality.

Peittoo waste centre area

The Peittoo area was founded in early 1990s as a final disposal site for waste from the power plants in Tahkoluoto and chemical industry in Kaanaankorpi. In the component master plans, which were ratified in 1992 and 1996, the Peittoo area is designated for waste disposal activities and as an industrial and storage area. The component master plan of the area was updated in 2012 to correspond with the current needs of waste treatment and recycling operations.

According to the master plan report (City of Pori 2012), the size of the area reserved for waste treatment, final disposal and other massive storage is 276.2 ha in the Peittoo area (Figure 6.5-7, pink areas). The largest single areas include a common area for the coal power plants in Tahkoluoto having a size of 83 ha and the area of Sachtleben Pigments Oy (now Venator Oy) having a size of about 75 ha. An additional common area for Stena Recycling Oy, Kuusakoski Oy and Ekokem-Palvelu Oy (now Fortum Waste Solutions Oy) with a total size of about 84 ha has been designated on the eastern side of the area. Furthermore, other designated areas having a size of 9 ha and 21 ha are located on the southeastern side of the area.

The Peittoo waste treatment area has been authorised for the disposal of e.g. waste from the manufacturing of metal oxides, calcareous waste from forest industry, ash from power plants and other conventional and hazardous waste from industrial processes. The environmental impacts of the disposal activities have been assessed in master planning and in context with the environmental permits of companies having disposal activities. The most important measures for preventing the harmful environmental impacts of operations in the Peittoo waste treatment area focus on the foundation structure of stockpile areas, seepage water treatment, dust control and restoration of stockpile areas.

Figure 6.5-7. Peittoo waste treatment area, extract from the Peittoo component master plan, which was completed in 2012.

Stockpile areas have a compact foundation structure and the condition of structures is monitored. Surface waters from waste treatment and stockpile areas are collected and treated on site, and are directed through the water system to the sea. Seepage waters of stockpile areas have also been used in mass stabilization and watering of the stockpile area. The quality of treated waters is monitored prior to directing the waters to the sea and e.g. heavy metals are analysed from samples. Limit values for the concentration of substances in waste waters directed to the sea are defined in the environmental permits. Provisions are made for disturbances in waste water treatment e.g. by constructing spill ponds. The operators in the area have a common water monitoring system, which includes surface water and groundwater monitoring points.

It is estimated that potential dust impacts related to the mechanical treatment of waste materials are confined to the stockpile area. Dust impacts are managed by watering, when needed. Noise is generated in the area by waste treatment (sieving, crushing), machinery and traffic operations. The area of the waste treatment centre is mainly bounded by agricultural and forest area or protective green area, which block visibility from the area to environment. According to the plan report, several nature studies have been conducted in the area and no special values of vegetation have been observed.

Potential disposal of SSM in the area and related impacts would not differ from the existing operations in the area. The maximum size of the stockpile area needed for the disposal of SSM from 10-year operation of the vanadium recovery plant is 40 ha. If there is a need to deploy a new area for disposal activities in the waste centre area, it is estimated that the construction and operation in the new area would not substantially increase environmental impacts, which have already been caused by the existing waste treatment activities in the area. The new disposal site would be constructed in stages depending on the need for disposal activities.

Transport volumes of SSM along the Pori archipelago road to the Peittoo waste centre area are considered in the traffic impact assessment (chapter 6.3).

Other stockpile area

In alternative Alt.1b, instead of Peittoo area, SSM can also be transported to another stockpile area authorised for an equivalent type of activity. The environmental impacts of the disposal activities in this area will also be managed respectively. The foundation structures of the stockpile area must conform to the Decree on Landfills (331/2013). The stormwaters and seepage waters from the stockpile area will be collected and they must be purified. Limit values are defined in the environmental permit for the concentrations of waters directed to the water system.

6.5.5 Prevention and mitigation of harmful impacts

Waste generated during the construction phase will be properly sorted and treated, and delivered for recycling, if possible. The aim is to recycle waste primarily on site and in the surrounding area.

The structures of the storage areas for slag and SSM will be designed as described in chapter 6.5.4.1, so that significant harmful environmental load will not be generated.

When SSM receives the by-product status, no process waste will be generated in the plant, which would need long-term disposal.

6.6 Air quality

6.6.1 Summary

In the construction phase, emission sources are at ground surface level and impacts will not extend far away from the emission source. It is estimated that the significance of impact will be minor.

Emissions from the process of the vanadium recovery plant and combustion of natural gas will mainly be minor. Based on preliminary estimate, particle emissions will probably be the most significant component of process emissions e.g. in proportion to the existing industrial emissions in the Pori area. Particle emissions to air can be reduced, for example, by scrubbers, when needed. Potential dust emissions from stockpiles mostly remain close to the emission source and harmful impacts will be minor further away. Coal has previously been handled and stored in the port area, which causes dust emissions, respectively. Dust emissions can be prevented and managed in many ways. Emissions from transport operations related to the operation of the plant will be very minor in proportion to the existing emissions from traffic in the Pori area. Emissions from traffic have a minor impact on air quality near traffic routes. Impacts of emissions from machinery are mainly limited to the plant area and its immediate vicinity.

Comparison of alternatives and significance of impact

There is no fundamental difference between alternatives Alt.1, Alt.1a and Alt.1b. In alternative Alt.0, emissions can be caused by by potential construction of other operations in the area.

The significance of air quality impacts from the operation of the plant and traffic is assessed as minor and negative, when necessary mitigation measures regarding particle emissions to air from the process are taken into account.

Construction phase

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Air quality	Impacts of emissions during construction will not extend far away from the VRP area. Impacts of traffic during construction will be similar to the impacts during operation.	No impacts on air quality from the construction of the vanadium recovery plant.	No difference between alternatives Alt.1, Alt.1a and Alt.1b. Significance of impact is assessed as minor and negative (-).

Operating phase

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Air quality	Process emissions will be minor. Emissions and impacts from slag and SSM stockpiles and machinery will mainly remain in the immediate vicinity of the plant area. Emissions from traffic will have a minor impact on air quality near traffic routes.	No emissions and impacts from the construction of the vanadium recovery plant. Emissions will probably be caused by potential implementation of other operations in the area.	No fundamental difference between alternatives Alt.1, Alt.1a and Alt.1b. Significance of impact is assessed as minor and negative (-).

6.6.2 Assessment method and uncertainties

Impacts of emissions from construction works and traffic during the construction of the plant as well as impacts of process emissions have been assessed as an expert evaluation.

Process emissions

The amount of emissions are assessed based on information from preliminary process planning.

Emissions from traffic

The magnitude and significance of emissions from traffic (sulphur dioxide, nitrogen dioxide and particles) related to the operation of the plant are assessed based on traffic volumes, and the amount of emissions has been evaluated in proportion to the existing emissions in the Pori area. Emissions to air from traffic and machinery have been assessed based on traffic volumes and the emission factors of the LIPASTO data base developed by the Technical Research Centre of Finland (VTT 2021).

Diffuse dust emissions

The amount of diffuse emissions from slag stockpiles has been assessed by applying a mathematical formula developed for the assessment of mineral dust generated by wind erosion from the waste piles of mines (Kauppila ym. 2013). The formula is developed for active stockpiles or piles with frequent intervention of surface so that recent and sensitive material for erosion is available. The default values may not necessarily be applicable in the circumstances in Finland as, for example, the formula does not take into account snow cover in winter. Therefore, the calculated values by the formula are probably higher than actual values.

The most significant uncertainties are related to the assessment of dust emissions from slag stockpiles. Based on preliminary data, the amount of process emissions will mainly be so small that uncertainties related to the impact assessment are not very significant. The preliminary estimate of the particle emissions from the process is relatively high and this estimate will be specified during planning.

6.6.3 Current state of air quality

6.6.3.1 Monitoring of air quality

The environment and permit services in the City of Pori measure air quality in cooperation with the cities of Harjavalta and Rauma, as well as with major industry and energy production facilities in the region (City of Pori Environmental and Health Surveillance Department 2021). The environmental and health surveillance department of the City of Pori prepares an annual report each year on the results of air quality measurements in the cities of Pori and Harjavalta. In addition, vegetation impact studies or bioindicator studies and heavy metal dispersal studies have been carried out in the Harjavalta–Pori area since 1990 together with the major industry in the region. The next bioindicator study will be conducted in the South Satakunta and Pori region during the years 2022-2023 (Pori 2021).

In the centre of Pori, air pollutants are measured at Paanaketo street station and weather conditions are measured at the rooftop weather station of the environmental agency in Valtakatu. The Pastuskeri station is located in Meri-Pori and background concentrations of sulphur dioxide are measured at this station (City of Pori Environmental and Health Surveillance Department 2021).

The limit or threshold values pursuant to the Government Decree (79/2017) were not exceeded in 2020 for any measured component in Pori. The air quality guideline values in accordance with the Government Decision (480/96) were exceeded once, the daily quideline value for inhaled particles PM10 (70 µg/m^3) was exceeded on Paanaketo street in Pori, as the value was 79 µg/m^3 in February.

The Government Decree on Airborne Arsenic, Cadmium, Mercury, Nickel and Polycyclic Aromatic Hydrocarbons (113/2017) defines target values for the calendar year calculated as annual averages for arsenic, cadmium and nickel. The target value was slightly exceeded for arsenic and nickel at the Kaleva measurement station in Harjavalta and for arsenic in Pirkkala in Harjavalta. The target values were not exceeded in Pori (City of Pori Environmental and Health Surveillance Department 2021).

Tahkoluoto area

In the Tahkoluoto area emissions to the air are caused by road and vessel traffic. Dust emissions are caused by the operation of the Tahkoluoto recycling terminal, e.g. from crushing and granulation of metal. Dust emissions are managed and monitored in accordance with the environmental permit (Regional State Administrative Agency for Southern Finland on August 22, 2019, decision on the environmental permit for the operation of the Tahkoluoto Recycling Plant). Dust emissions have been caused by, among other things, coal storage and handling. Dust emissions have been managed according to the environmental permit.

6.6.3.2 Climate

In addition to air quality monitoring, the measurement stations in Pori also monitor sea water level (Mäntyluoto Kallo), temperature (Kaijakari) and weather conditions (Tahkoluoto port, railway station and airport).

The Pori region belongs to the South Boreal Climate Class. In Satakunta, the average annual temperature typically varies from about +5 degrees (°C) on the coast between Rauma and Pori to about +3 degrees (°C) towards the north-east. February is usually the coldest month, when the average temperature normally varies between about -5 – -7.5 degrees (°C) on the south-western coast. The warmest month is usually July (average temperature +15.5 – +17 degrees (°C). On average, there are 10-14 very hot days per summer in inland areas of the region, but notably fewer hot days right along the coast and archipelago. Frost is likely to occur in the valleys of Kokemäenjoki River and Karvianjoki River, where frost has occurred even in July. Generally, there are about 1–10 days of night frost in summer (Climate Guide).

The average annual precipitation in Satakunta is slightly under 600 millimetres on the coast of the Bothnian Sea, commonly between 600 and 650 millimeters in the rest of the region and locally about 700 millimetres in higher north-eastern areas. The maximum annual precipitation has been over 900 millimetres. There are 20-30 fewer rainy days per year along the coast than in the rainiest areas of the northeastern corner. The rainiest month is typically July or August when precipitation reaches an average of 75 – 85 millimetres. February is the month with the lowest precipitation, average of 25 – 35 millimetres, but the spring months are also typically dry along the coast (Climate Guide).

Wind speeds are about 7-9 m/s in the coastal areas of Satakunta. The wind direction distribution at the weather station in central Pori is presented in Figure 6.6-1. The shares of westerly, south-westerly and southerly winds were the most significant at the Pori central weather station in 2020 (City of Pori Environmental and Health Surveillance Department 2021).

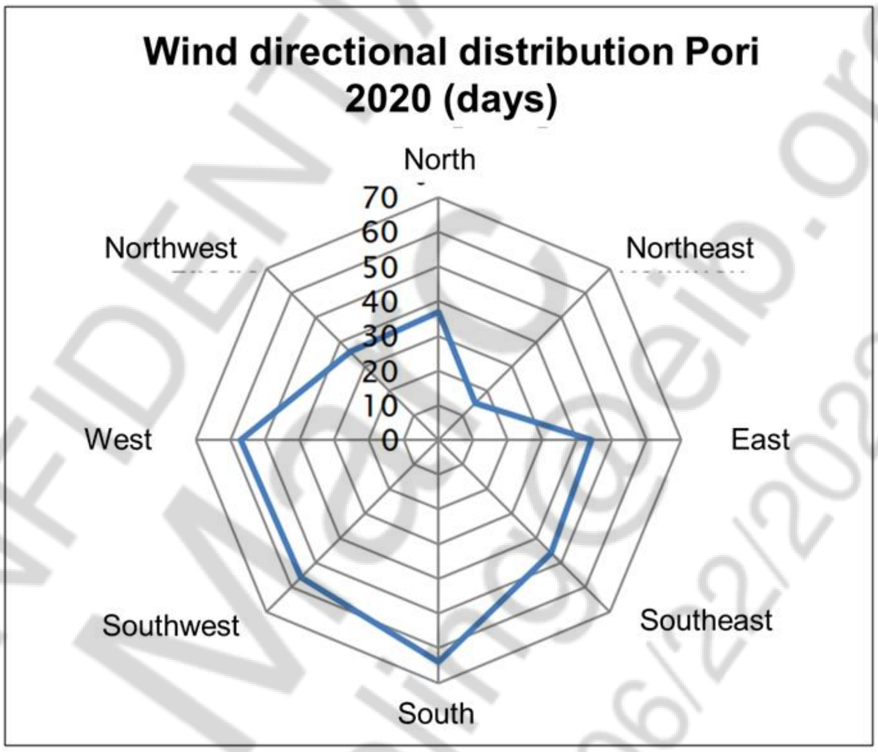

Figure 6.6-1. Wind direction distribution diagram for Pori in 2020 (City of Pori Environmental and Health Surveillance Department 2021).

6.6.3.3 Air emission load in Pori

Energy production and traffic are the most significant factors affecting the air quality in Pori. The most important emission sources in 2020 were Porin Prosessivoima Oy, Fortum Power and Heat Oy, Pori Energy Oy, Boliden Harjavalta Oy and traffic. The emissions from major industry and energy production facilities in 2020 were as follows: sulphur dioxide 198 tonnes (SO_2), nitrogen oxides 371 tonnes (NO_x), particles 7 tonnes (PM) and carbon dioxide 226 428 tonnes (CO_2) (City of Pori Environmental and Health Surveillance Department 2021).

The emissions from traffic in Pori in 2019 were as follows: nitrogen oxides 304 tonnes, particles 8 tonnes and carbon dioxide 115 686 tonnes (latest available information) (City of Pori Environmental and Health Surveillance Department 2021).

6.6.4 **Impacts on air quality during construction**

The estimated duration of the construction phase is 12 to 18 months. The maximum duration of earth works is 3-4 months. Impacts on air quality in the construction phase are mainly caused by traffic and earth works. Emission sources are at ground surface level and the impacts mainly include dusting in the construction site, which will not extend far away from the emission source.

Impacts from traffic are estimated to be similar to the impacts from traffic during operation. It is estimated that the significance of impact on air quality during construction will be minor.

6.6.5 Impacts on air quality during operation

6.6.5.1 Emissions to air

Gases directed to air from the process of the vanadium recovery plant include small amounts of volatile organic compounds, nitrogen oxides, particles and a small amount of ammonia (chapter 2.2.8). Other emissions to air related to the operation of the plant include dust emissions from slag stockpiles and emissions from traffic.

Emissions related to disturbances and preparations to them are discussed in chapter 6.14.

Process emissions and emissions from the combustion of natural gas

The share of nitrogen oxide and sulphur oxide emissions (preliminary estimates in chapter 2.2.8, Table 2.2-4) from the vanadium recovery plant is about 1 % in proportion to the emissions from industry and energy production facilities (chapter 6.6.3) in the Pori area. The preliminary estimate of the amount of ammonia emissions is relatively small and the emissions are directed to air through a 30-metre high smokestack. The preliminary estimate of the amount of particle emissions from the process is relatively large, it is about of same magnitude as the total existing emissions from major industry and energy production in the Pori area. The estimate of the particle emissions will be specified during planning.

Diffuse emissions

The most significant emissions to air from the operation of the plant include potential dust emissions from the transport, open storage and treatment of slag and SSM. Dust impacts can be caused on site by transports of raw materials and products as well as from unloading and storage. Dust impacts can be managed in many different ways.

The estimated amount of dust emissions caused by wind erosion from slag stockpiles is about 8 tonnes/year (northern VRP area) and about 4 tonnes/year (southern VRP area), when calculated per area of stockpile.

The estimated emissions per area from the storage and handling of SSM are considerably smaller than emissions from slag stockpiles, as the moisture content of SSM is relatively high (about 30 %).

The particle size of slag and SSM is < 10 mm. Large-size particles from a mechanical impact with a diameter of over 10 µm typically fall down near the emission source unlike so-called fine particles from combustion processes, which can travel with air flow far away from the emission source. Harmful impacts from larger particles are usually minor at a distance of hundreds of metres from the emission source.

Weather conditions have a considerable impact on the amount and spreading of generated dust emissions. Rain adds to the moisture content of the material and binds dust particles to slag material. Strong wind can throw up dust from the surface of stockpiles, if the material is dry. Sufficient moisture on the surface of slag stockpiles can be provided by watering the stockpiles, when needed.

The presented calculated estimate of the diffuse dust emissions caused by slag probably overestimates dust impacts.

Emissions from traffic and machinery

Emissions from vehicle traffic have been assessed all the way to highway 8 at a distance of about 26 kilometres from the VRP area. Emissions from vessel traffic have been assessed to a distance of about 20 kilometres from Tahkoluoto (Table 6.6-1). The used heavy vehicle type in product transports is a full trailer having a capacity of 50 tonnes. The size of load in vessel transport is expected to be 10 000 – 25 000 tonnes.

The share of emissions from truck transport of the plant are less than 1 % in proportion to the existing emissions from road traffic (nitrogen oxides 304 tonnes/year and particles 7 tonnes/year) in the Pori area. Emissions from the passenger traffic of the plant are less than 0.01 % in proportion to the road traffic emissions in Pori. Exhaust gas emissions are released directly to air at breathing height and so they are generally more significant with regard to health hazards than emissions to air from production facilities. In addition to direct emissions, also indirect particle emissions or street dust slightly increase with growing traffic volumes. It is estimated that the emissions from truck transports and passenger car traffic will have minor impact on air quality near traffic routes.

Nitrogen oxide emissions from machinery have a share of about 4 % and particle emissions have a share of about 8 % of the total emissions (nitrogen oxides 675 tonnes/year and particles 15 tonnes/year) from major industry, energy production and traffic in the Pori area. Emissions from machinery at ground surface level will not extend to a large area and mostly have local impacts on air quality on site and its immediate vicinity.

Table 6.6-1. Estimated annual emissions from traffic and machinery and comparison to the emissions from traffic, industry and energy production in Pori.

Emission component, unit	Machinery	Vessel traffic	Road traffic*	Total	Share of emissions from traffic in Pori (%)	Share of emissions from industry and energy production in Pori (%)**
NO_x (nitrogen oxides), t NO_x	26.4	2.6	0.5	29.4	9.7	7.9
PM (particles), t PM	1.3	0.04	0.01	1.30	16.3	18.6
CO_2 (carbon dioxide), t CO_2	4 248.8	103.7	1 892.5	6 244.9	5.4	2.8
SO_2 (sulphur dioxide), t SO_2	0.01	0.06	0.08	0.08	-	0.04

* includes internal traffic on site and passenger car traffic

**compared to the load generated by major industry and energy production facilities

Particle emissions are the most significant component of process emissions e.g. in proportion to the existing emissions from the industry in the Pori area. Other process emissions will be very minor. Potential dust emissions from slag stockpiles and treatment of slag will probably remain near the storage areas and harmful impacts will be minor further away. Coal has been handled and stored earlier in the port area, which generates dust emissions accordingly. The amount of emissions from machinery will be relatively significant, but impacts will be mostly local on site and in the immediate vicinity.

6.6.6 Prevention and mitigation of harmful impacts

In the treatment of slag, diffuse dust emissions can be prevented by e.g. controlling the moisture content of materials, minimizing necessary treatment, covering transport loads and using enclosed unloading equipment in transport operations as well as enclosed conveyors in the plant.

Dust emissions from stockpiles can be prevented by e.g. watering the surface of piles by water jets, when needed, and using dust binding materials, minimizing the movement of stockpiles and creating wind shelter, for example, by earthfill embankments, when needed.

Spreading of dust can also be prevented by regular cleaning of road and storage environments and by watering as well as planting vegetation on site and the surrounding area, if possible.

Particle emissions to air fronm the process plant can be reduced, for example, by scrubbers, when needed. Potential harmful impacts on outdoor particle concentrations in the nearby area of the plant can be prevented, when needed, by directing emissions to a smokestack, which is high enough.

Emissions from traffic can be reduced by the optimization of transport logistics and use of low-emission transport vehicles.

6.7 Greenhouse gas emissions

6.7.1 Summary

Greenhouse gas emissions (hereinafter CO_2 emissions) will decrease with the implementation of the VRP, as a significant amount of carbon dioxide is used in the process. Carbon dioxide is likely to be produced and recovered in an industrial facility in Finland. Vanadium production in mines with traditional methods generates a significant amount of carbon dioxide (>30 tonne CO_2 / tonne V_2O_5 versus -0.6 tonne / tonne V_2O_5 for the VRP).

Within the life cycle of vanadium pentoxide recovered from slag, the most significant amounts of CO_2 emissions are caused by sodium hydroxide used in the process and natural gas used in the energy production of the plant. Furthermore, CO_2 emissions are produced from exhaust gas emissions from machinery and transport vehicles during the construction phase, and from other chemicals used in the process, electricity consumption and transport operations during the operating phase. The use of SSAB slag and recovered carbon dioxide will mitigate the impacts of CO_2 emissions. Overall, vanadium production in the designed plant will reduce carbon dioxide emissions.

Based on the life cycle assessment, the magnitude of impact of CO_2 emissions is estimated as -0.6 kg of carbon dioxide per a kilogramme of vanadium pentoxide. It was assumed in the life cycle assessment that CO_2 is sequestered from an industrial emission source in Pori.

Comparison of alternatives and significance of impact

In alternative Alt.0, CO_2 emissions can be estimated to be potentially higher than in the implementation alternative of the project, as there is no reducing impact of greenhouse gas emissions caused by the recovery of carbon dioxide. In addition, with regard to the potential alternative use of the SSM, material manufacturing for the possible use of another product instead of SSM will cause greenhouse gas emissions. Otherwise, there is no significant difference between alternatives Alt.1, Alt.1a and Alt.1b. with regard to CO_2 emissions.

The significance of impact, for example, in proportion to the annual CO_2 emissions in the Pori area, is assessed as large and positive.

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Emissions to air (life cycle of plant)	Based on life cycle assessment, the vanadium recovery plant will have negative overall impacts on air emissions, or it will reduce carbon dioxide emissions.	Potentially higher emissions compared to the implementation alternative. Impacts, which reduce CO_2 emissions, will not be generated.	In alternative Alt.1b, material manufacturing for the possible use of another product instead of SSM will cause greenhouse gas emissions, otherwise, no significant difference between alternatives Alt.1, Alt.1a and Alt.1b. Significance of impact is assessed as large and positive (+++).

6.7.2 Assessment methods and uncertainties

Impacts of the VRP on carbon dioxide emissions have been assessed in the designed plant based on the life cycle assessment of produced vanadium pentoxide (Minviro Ltd 2021).

The estimated uncertainty of the initial data used for the life cycle calculation in the preliminary design of the process was -25 % / + 30 %. The uncertainties in emission calculations are also related to e.g. assumptions on the average trip length of transports and used transport vehicles. Initial data for the life cycle assessment was also obtained from public and private data banks (e.g. EcoInvent 3.7) and from other public sources.

The sensitivity of the results from the life cycle assessment was evaluated in relation to varying amount of chemicals in the process and energy consumption (use of natural gas). It was discovered that the most significant factor with regard to the calculation results was the use of sodium hydroxide.

The result from the life cycle assessment is indicative regarding the CO_2 emissions from vanadium pentoxide production in the vanadium recovery plant. A more accurate estimate of the impacts on air emissions caused by the vanadium recovery plant can be prepared during detailed design of the facility.

In addition, carbon dioxide emissions caused by vanadium production in the recovery plant and vanadium production from ore in the mines were compared in the assessment. The comparison was based on literature review of calculations and values of carbon dioxide emissions from the vanadium production cycle using alternative production methods.

6.7.3 Existing situation in the City of Pori

The total greenhouse gas emissions or carbon dioxide emissions of the City of Pori, excluding the emissions from industry and energy production, were 460 ktCO_2-eq in 2019. The shares of total emissions were the following: road traffic 135.9 ktCO_2-eq (29.5 %), water traffic 10.0 ktCO_2-eq (2.2 %), railway traffic 0.7 ktCO_2-eq (< 0.1 %), machinery 24.5 ktCO_2-eq (5.3 %) and industry 13.9 ktCO_2-eq (3.0 %). The sources of total emissions were the following: electricity consumption 44.5 ktCO_2-eq (9.7 %), electric heating 25.3 ktCO_2-eq (5.5 %), district heating 84.3 ktCO_2-eq (18.3 %), oil heating 41.9 ktCO_2-eq (9.1 %) and other heating 38.4 ktCO_2-eq (8.3 %). Emissions caused by agriculture and waste treatment were 28.2 ktCO_2-eq (6.1 %) and 26.3 ktCO_2-eq (5.7 %), respectively. (SYKE, Hinku calculation 2021).

Carbon dioxide emission from traffic in the City of Pori were 115 686 tCO_2-eq in 2019 (City of Pori Environmental and Health Surveillance Department 2021), which means that based on calculations, emissions from traffic have decreased by 18.7 % when compared to the previous year.

Emissions from the large-scale industry and energy production facilities in the City of Pori were 226 428 tCO_2-eq in 2020. Carbon dioxide emissions in the City of Pori have decreased by about 18 % since 2013.

According to the preliminary estimate of the Statistics Finland, carbon dioxide emissions in Finland were 48.3 million tCO_2-eq in 2020 (Statistics Finland 2021).

6.7.4 Impacts of the VRP on greenhouse gas emissions

Life cycle assessment of the VRP

The life cycle assessment (LCA, Minviro Ltd. 2021) prepared for the vanadium recovery plant includes three main phases:

1. Objective and scope of application
    - The objective of the life cycle assessment is to evaluate the environmental impacts of vanadium pentoxide produced from slag including CO_2 emissions.
2. Functional unit
    - Production of one kilogramme of vanadium pentoxide from slag was selected as the functional unit in the life cycle assessment.

3. Scope and assumptions of the assessment

   - Impacts of transporting slag from Luleå and Oxelösund to the vanadium recovery plant were taken into account is the assessment.
   - Assessment included all significant energy and material flows used in the vanadium recovery process.
   - No economic value was assigned to vanadium-rich slag.
   - CO_2 is recovered by using monoethanol amine (MEA). It is assumed that the MEA solution used in the process is fully recovered and recycled. Electricity and waste heat from the process are used in the recovery process.
   - SSM is utilised elsewhere.
   - Low emission electrical power is used in the process and energy from the local power grid is used in CO_2 recovery.
   - Material flows related to equipment and infrastructure were excluded from the assessment.

Useful information for project development was obtained from the implementation of the life cycle assessment.

Life cycle impacts of operation

Based on the life cycle assessment, the main factors affecting the amount of CO_2 emissions from vanadium pentoxide production include the consumption of sodium hydroxide in the process (4.8 kg CO_2-eq/kg V_2O_5) and natural gas combustion (1.7 kg CO_2-eq/kg V_2O_5) (Table 6.7-1). The use of slag (-0.3 kg CO_2-eq/kg V_2O_5) and carbon dioxide recovered from industrial processes elsewhere (-10.3 kgCO_2-eq/kg V_2O_5) have impacts that mitigate global warming potential. A major share of the impacts of transport operations on air emissions are caused by transport of slag from Luleå to Tahkoluoto and transport of sodium hydroxide used in the process.

Based on the results of the life cycle assessment, the overall carbon dioxide emissions of vanadium pentoxide are negative (-0.6 kg CO_2-eq/kg V_2O_5).

A summary of the most significant impacts presented in the life cycle assessment is shown in Table 6.7-1.

Table 6.7-1. Summary of the most significant results of the life cycle assessment.

Activity	Impact on greenhouse gas emissions
Utilisation of carbon dioxide	-10.3 kg CO_2-eq/kg V_2O_5
Utilisation of steel slag	-0.3 kg CO_2-eq/kg V_2O_5
Use of sodium hydroxide	4.8 kg CO_2-eq/kg V_2O_5
Use of sodium carbonate	1.4 kg CO_2-eq/kg V_2O_5
Use of ammonium sulphate	1.1 kg CO_2-eq/kg V_2O_5
Use of natural gas	1.7 kg CO_2-eq/kg V_2O_5
Use of process water	<0.1 kg CO_2-eq/kg V_2O_5
Transport operations	0.6 kg CO_2-eq/kg V_2O_5, for which Luleå-Tahkoluoto 0.2 kg CO_2-eq/kg V_2O_5

Activity	Impact on greenhouse gas emissions
	sodium hydroxide 0.1 kg CO_2-eq/kg V_2O_5

6.7.5 Total emissions from production and comparison of alternative production methods

CO_2 emissions from the annual production of 9 000 t of V_2O_5 in the vanadium recovery plant are presented in Table 6.7-2. The table also includes data on the impacts of CO_2 emissions from vanadium mining and treatment as well as from vanadium production in steel industry. Carbon dioxide emissions from literature review and from different actors are not directly comparable with the results of the life cycle assessment prepared for this project, as emissions have been calculated for ferrovanadium production. Ferrovanadium is produced by mixing vanadium and iron in an aluminothermic reaction, in which aluminum is used as a catalyst.

Table 6.7-2. Climate impacts of vanadium production in the project and data on greenhouse gas emissions caused by alternative vanadium production methods.

Impacts	Amount	Unit	Source
Vanadium recovery plant, total climate impact			
Global warming potential (GWP)	**- 5 400**	**t CO_2-eq**	CMS
Vanadium as a by-product from steel industry			
Steel production	1.8	kg CO_2-eq/kg of steel	IPCC (2006)
Ferrous metal (including ferrovanadium) production*	2.8	kg CO_2-eq/kg of product	IPCC (2006)
Ore mining and enrichment of vanadium			
Ore mining and ferrovanadium production**	63.4	kg CO_2-eq/kg FeV	AMG Vanadium (2017)
Ferrovanadium production	11.04	kg CO_2-eq/kg V_2O_5	AMG Advanced Metallurgical Group N.V., (2021)
Vanadium pentoxide production	6.14	kg CO_2-eq/kg V_2O_5	AMG Advanced Metallurgical Group N.V., (2021)
Vanadium produced from secondary source			
Ferrovanadium production (AMG)	12.6	kg CO_2-eq/kg FeV	AMG Vanadium (2017)
Critical Metals Ltd.			
Vanadium pentoxide production	-0.6	kg CO_2-eq/kg V_2O_5	CMS

* average amount of carbon dioxide emissions from different ferrous metal production
** e.g. quarrying, comminution, separation, grinding, heating, leaching, desilication, precipitation, filtering, drying, ammonium precipitation

In proportion to the greenhouse gas emissions in Pori (690 000 tCO_2-eq), the reducing impact of the project on the amount of carbon dioxide in atmosphere will be significant and positive.

CO_2 emissions from mining

Globally, about 26 % of vanadium is directly produced from vanadium-rich ore by enrichment. In the ore exploration phase, greenhouse gas emissions are caused by fuel consumption in drilling and mining tests and by traffic operations.

In the mine construction phase, CO_2 emissions are caused by energy consumption in construction works and increasing traffic volumes. In addition, emissions are caused from e.g. energy consumption in the extraction and comminution of building stones. In the operating phase, greenhouse gas emissions are caused by using explosives, energy consumption in detonation and gas from detonation (SYKE 2011).

Vanadium production in a pyrometallurgical process in steel industry produces CO_2 emissions from energy consumption in e.g. soda ash roasting (VanadiumCorp 2017). The average greenhouse gas emissions from the production of ferrous alloys (including ferrovanadium) is 2.8 tCO_2/t (IPCC 2006).

Most of the extracted vanadium-rich ore is reprocessed to ferrovanadium. According to one data source, mining in ferrovanadium production causes emissions of 63.4 kg CO_2-eq/kg FeV. Based on the same data source, greenhouse gas emission of ferrovanadium produced from secondary source is 12.6 kg CO_2-eq/kg FeV (AMG Vanadium 2017).

Based on the above mentioned data, CO_2 emissions from vanadium produced in the vanadium recovery plant are significantly lower than from vanadium produced with traditional methods.

6.7.6 Prevention and mitigation of harmful impacts

CO_2 emissions can be reduced by optimizing the use of chemicals in the process, especially sodium hydroxide, optimizing energy consumption and transports, using biofuels and e.g. through the electrification of machinery.

Greenhouse gas emissions from purchased electricity can be reduced by procuring carbon-free electricity.

Based on the life cycle assessment, a 20 % increase in the use of recovered carbon dioxide will provide an additional reduction of -2,6 kg CO_2-eq/kg V_2O_5 in CO_2 emissions.

6.8 Water system and fish stock

6.8.1 Summary

The project does not include construction in the water area and there will be no significant impacts on the water system in the construction phase.

The vanadium recovery plant does not intake process water or cooling water from the sea, and waste waters, cooling waters or stormwaters from the plant are not directed to the water system. Stormwaters from stockpiles of slag and SSM are collected into stormwater ponds and used in the process.

Some environmental load has previously been directed to the nearby water area from the VRP area e.g. from stormwaters of the port area, seepage and runoff waters of the Törnikari filling area and runoff and seepage waters of the southern filling area of Tahkoluoto.

With regard to noise directed to the water area, there will be no significant change compared to the existing situation e.g. regarding recreational use. It is estimated that impacts related to vessel traffic will not significantly increase in the water area.

The project is not estimated to have detectable impacts on sea water quality, water organisms or fish stock.

Along with the implementation of the project, rain or melt water, which would end up to the sea in an uncontrolled way, are not generated any more from areas, which have previously had industrial operations. This is estimated to have a slightly positive impact on the water system.

Comparison of alternatives and significance of impact

There will be no detectable impacts on the water system in the implementation alternatives of the project or in alternative Alt.0.

Construction phase

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Water system	Stormwaters occurring while undertaking construction will be properly managed. Environmental load is not directed from the VRP area to the water system during construction and there will be no impacts on sea water quality, water organisms or fish stock.	No impacts on the water system from the construction of the VRP.	No impact.

Operating phase

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Water system	Environmental load is not directed from the VRP area to the water system. Stormwaters directed from ponds to sea in rare exceptional situations will not cause detectable impacts on sea water quality, water organisms or fish stock. With regard to the recreational use of the water area, there will be no fundamental change in the vicinity of the	No impacts on the water system from the VRP. It is possible that environmental load and impacts on the water system will be generated by another project implemented in the area.	No impact.

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
	port and industrial area compared to current situation. Stormwaters are no longer directed to the water system from industrial area.		

6.8.2 Assessment methods and uncertainties

Impacts on the water system have been assessed as an expert evaluation. In normal situation, there is no environmental load on the water system and impacts will be minor. Consequently, significant uncertainties are not related to the impact assessment.

6.8.3 Current state of the water system

The VRP area is bounded by waters, which are in the marine area outside of Pori, in the coastal region of the Bothnian Sea and in the Reposaari-Outoori water body area (FI_Ses_032). The ecological state of Reposaari-Outoori area has been estimated as satisfactory and physico-chemical state as good in the 3rd planning period of water management. The hydrological-morphological state of the water body is tolerable (Vaikutavesiin.fi).

The chemical state of the Reposaari-Outoori water body is poorer than good (SYKE 2018). The chemical state of surface waters is determined in relation to the environmental quality standards of priority substances listed by the EU. The criteria have changed since the previous classification round, which contributed to the fact that the chemical state changed to poor in whole Finland. The primary reason for this is the change of the environmental quality standard of brominated diphenyl ethers from water to fish, and tightening of the standard (Westerberg 2020). According to the estimate of SYKE, typical concentrations of brominated diphenyl ethers in Finland are hundredfold compared to the standard (SYKE 2018b). The concentrations of brominated diphenyl ethers exceed the quality standard also in the Reposaari-Outoori water body, but the measured or estimated concentrations of other priority substances do not exceed the quality standard (SYKE 2018b).

The seabed and water layers near the seabed in the Bothnian Sea are clearly in better condition than the average conditions in the Baltic Sea due to the mixing of water masses during autumn and winter. Oxygen-rich water is flowing to the seabed also in deep areas and anoxic conditions do not develop in deep basins (Environmental Administration Web Service 2020).

Eutrophication generates problems also in the Bothnian Sea and the strongest signs of eutrophication can be seen outside of river estuaries and cities. The nutrients that end up in the Bothnian Sea mainly originate from diffuse source input of agriculture and forestry, but also from other sources, such as waste water from communities, scattered settlements and industry as well as fish farming that pollutes the Bothnian Sea. A significant amount of nitrogen is also drifted into the Bothnian Sea through air (Environmental Administration web service 2020).

6.8.3.1 Environmental load and water quality

The marine area outside of Pori receives environmental load from the river basin via the Kokemäenjoki River. So-called point source waste water load is directed into the water system of the Kokemäenjoki River and the Pori marine area from the municipal waste water treatment plants, industrial sector and thermal power plants located in Pori. In addition to the point source load, the Kokemäenjoki River is loaded by diffuse load. Currently, waste waters from the Kaanaa industrial area, e.g. small volume of waste water from the pigment factory, are directed to the sea area on the southern side of Mäntyluoto outside of Pori at a distance of about 7 km from the VRP area. Waste waters from the ash treatment plant of Fortum Waste Solutions Oy are also directed to the same water outlet. In addition, waste waters from the planned bioconversion plant in the Kaanaa industrial area are planned to be directed to the same water outlet.

Comprehensive baseline monitoring information is available from the marine area outside of Pori. Joint monitoring of the Kokemäenjoki River and the Pori marine area is used to track the amount of load being directed to the Kokemäenjoki River and the Pori marine area and its impacts on the state of the water system (KVVY Research Oy 2020).

The river water from the Kokemäenjoki River, which discharges off to the Pihlava Bay, flows partly to the north through the Ahlainen archipelago and partly to the south under the Reposaari road bridge and through Mäntykallio mainly to the northern open sea between Kaijakari and Reposaari islands (Alajoki 2017). In marine areas outside of Pori, river waters cause turbidity in the surface water and affect the nutrient concentrations. In the surrounding waters of the Reposaari Island, eutrophication has occasionally been stronger than in the surrounding area, and the area has more clearly belonged to slightly eutrophic waters (Väisänen 2018a.)

The water quality in the marine area outside of Pori has improved over long-term period. As early as in the 1970s, the reduction in phosphorus load significantly reduced the eutrophication. In the mid-1980s, oxygen conditions started to improve both in river and marine areas. Outside of the old waste water discharge site of the Pori pigment factory, iron concentrations were still remarkably high in the 1980s and the pH-value was low. All pigment plant monitoring stations had an average iron concentration of less than 50 µg/L for the first time in 2006. Today, concentrations have occasionally increased mainly by river waters flowing to the southern marine area of Pori (KVY Research Oy 2020).

In accordance with the environmental permit, Port of Pori Ltd monitors the quality of stormwaters directed from the port area to the sea. As a rule, stormwater quality is surveyed every third year starting from 2018 and more frequently, if necessary. (Regional State Administrative Agency for Southern Finland, March 23, 2018, Decision on amending the environmental permit for the Tahkoluoto port). Stormwater survey results from the deep-water port in 2007 are presented in Table 6.8-1. Table 6.8-2 shows the stormwater survey results from the deep-water port in 2020.

Table 6.8-1. Results of the stormwater survey in the Tahkoluoto deep-water port on June 28, 2007 (Decision on the environmental permit for the Tahkoluoto port, Regional State Administrative Agency for Southern Finland 2018).

Survey-point	Fe mg/l	Nitrogen mg/l	Solid matter mg/l	Conductivity mS/m	pH	Ptot µg/l	Mineral oil µg/l
V1	190	6.9	29	139	3.3	21	270
V2	840	5.4	40	293	2.8	25	200
V3	11 000	14 000	550	7 650	3.2	19	640
V4	57	20	85	259	4.4	34	120
V5	5.4	17	150	83	6.9	1 900	770
V6	4.9	27	84	178	6.9	49	390

Flow rate at point V5: 0.2 l/s

Table 6.8-2. Results of the stormwater survey in the Tahkoluoto deep-water port[1] (Juusela 2020*).*

Survey point	T1	T2	T3	T4	T5	T6
conductivity (mS/m)	156	13,4	255	5.8	41.7	61.8
pH	8	3.7	3.2	6.3	7.3	7.4
hydrocarbon index of oil (µg/l)	580	270	530	87	210	370
nickel (µg/l)	620	2 000	870	110	84	3 400
lead (µg/l)	4.6	14	75	2.4	3.3	4
cadmium (µg/l)	0.14	0.34	8.1	0.25	<0.1	0.72
zinc (µg/l)	85	390	5 400	1 100	360	150
chrome (µg/l)	4.5	4.6	20	<1	1.7	3.9
copper (µg/l)	670	4 700	1 400	58	100	430
arsenic (µg/l)	12	30	15	0.76	1.6	3.3
solid substance (mg/l)	17	17	55	23	54	120

[1] Scope of stormwater monitoring causes uncertainty for the assessment of the stormwater results in the Tahkoluoto deep-water port. According to the Port of Pori Oy (Heinonen 2021), a single measurement will not provide a reliable long-term result. Suitable and cost-efficient improved methods should be studied.

Based on the information presented in the application for the environmental permit regarding the Törnikari filling area of the Port of Pori (Monitoring programme, November 22, 2016), the seepage and runoff waters from the Törnikari filling area and the southern Tahkoluoto filling area are directed into a rainwater drain constructed on the western side of the Törnikari filling area. Then waters are directed from the drain to a concrete sedimentation pond constructed facing the open sea on the south embankment, and from there further on to the sea. The sedimentation pond (30 m^2) is located at the end of the southernmost side of the rock berm facing Törnikari. Waters from the ash pond of the power plants of Fortum Power and Heat Oy, Meri-Pori and PVO Lämpövoima Oy are also directed to the concrete sedimentation pond. Currently, the operation of the PVO power plant has ended and the plant has been demolished.

Environmental load from the sedimentation pond to the sea is monitored by taking samples twice per year (May and November) from the observation pipe placed on the southern embankment. The monitoring results of the water directed to the sea in 2017, 2018 and 2019 are presented in Table 6.8-3 (Port of Pori Ltd, Environmental Permit Application for the Törnikari filling area 2020, https://ylupa.avi.fi).

Table 6.8-3. Monitoring results of the environmental load directed to the sea during 2017–2019 from the Törnikari sedimentation pond of the Port of Pori Ltd.

		2017	2018	2019
solid substance	kg/a	245	3 885	7 462
COD_{Cr}	kg/a	1 794	2 904	4 705
tot N	kg/a	48.53	89.76	112.34
tot P	kg/a	2.69	7.28	18.66
SO_4	kg/a	26 506	11 390	49 073
Pb	kg/a	0.11	0.12	0.12
V	kg/a	0.61	0.48	0.79
Mo	kg/a	0.41	3.67	1.68
Cd	kg/a	0.00	0.01	0.02
Cr	kg/a	0.08	0.53	0.20
As	kg/a	0.07	0.15	0.30
Hg	kg/a	0.0002	0.0005	0.0004
Water infiltrated to the sea	m^3	81 558	75 429	121 670

Waste and cooling waters have been directed to the water system from the Tahkoluoto coal power plants. PVO Lämpövoima Oy and Fortum Power and Heat Oy have commissioned an annual study, which presents fishery monitoring, its results and the effects of cooling and waste water discharges in relation to temperatures, currents and ice conditions in the marine area. Monitoring has been carried out in accordance with the programme approved by the Southwest Finland ELY Centre on March 2, 2010. (Regional State Administrative Agency for Southern Finland, Decision on June 25, 2018, PVO-Lämpövoima Oy, revision of the permit provisions of the environmental permit for the Tahkoluoto Power Plant, available at https://ylupa.avi.fi). Only the Meri-Pori power plant is currently part of the power reserve system until June 30, 2022.

In addition, stormwater is directed to the water system e.g. from the recycling terminal of Stena Recycling Oy in Tahkoluoto area. Stormwater is monitored in accordance with the environmental permit. Stormwater contains e.g. small concentrations of metal.

6.8.3.2 Fish stock and fishing as well as the use of the water system and shores

In 2016, 17 professional fishermen were fishing in the marine area outside of Pori (Figure 6.8-1, site 3). The most abundant fish species caught by professional fishermen during the years 2014-2016 was Baltic herring, about 27 % of the total catch. Other caught fish species were bream (18 %), perch (14 %), pike-perch (10 %), whitefish (9 %), roach (8 %) and salmon (5 %). An estimate of the number of households practising free-time fishing was 2079 in 2016 (Väisänen 2018).

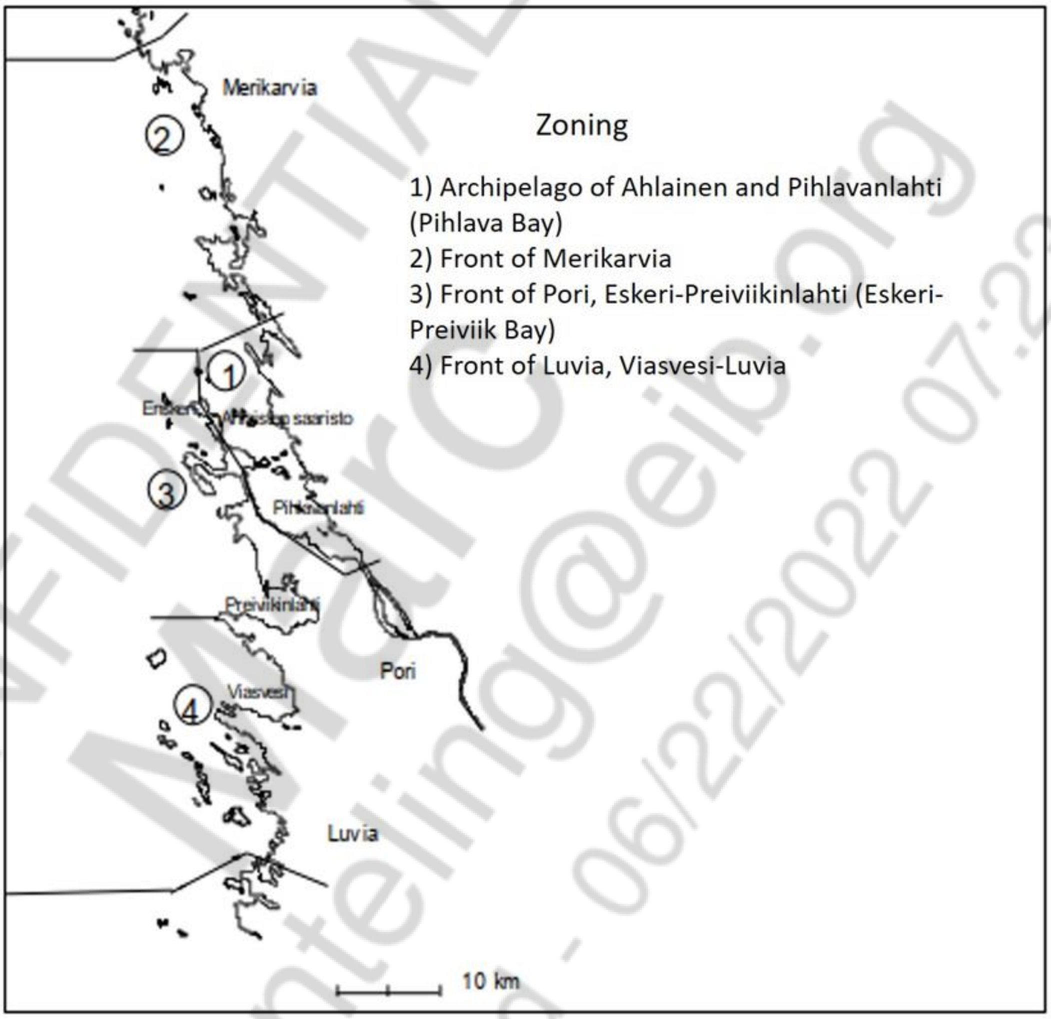

Figure 6.8-1. Sites of fishery monitoring (Väisänen 2018). (The VRP area is located in site 3).

Based on a survey conducted in 2020, which was directed to professional fishermen in the marine area outside of Pori, 15 fishermen practiced full-time or part-time commercial fishing in the study area in 2019 (Afry 2019). The study area included coastal and offshore areas from the Viasvedenlahti Bay in Pori all the way to Merikarvia. The fishing activities practiced in the study area were mainly trap net and net fishing. The estimated total catch of professional fishing in the study area in 2019 was about 500 000 kg, most of which was Baltic herring (83%). Fairly large amounts of catch also included smelt (5 %), roach (5 %), salmon (2 %) and perch (2 %). In addition to the above mentioned fish, catch in the study area also includes trout, whitefish, pike-perch, rainbow trout, bream, burbot, ide, pike and eel.

The most important catch sites of Baltic herring in the nearby area of Tahkoluoto include the surroundings of Ketaranlahti and Kaijakari (City of Pori 2020).

Among other things, recreational fishing and fishing for household needs as well as boating are practised in the marine area outside of Pori. Reposaari has a swimming beach.

Plenty of areas have been reserved for recreational use in the coastal area of Pori. Yyteri is well known for its sand dune area and extensive sandy beaches.

Merikappeli in Räyhänsuntti has boat berths, a boat ramp and a winter storage area for boats. In addition to Räyhänsuntti, boat berths are also located in the eastern shore of Kappeli. The nearest guest marina to Tahkoluoto is in Reposaari (City of Pori 2020).

6.8.3.3 Marine management plan

The goal set in the programme of measures of the Finnish Marine Strategy, which was approved in 2015, was to maintain or achieve good environmental status by the end of the year 2020. The proposal for updating the programme of measures for the years 2022–2027 examines the mitigation of eutrophication, reduction of hazardous and harmful substances, protection of biodiversity, prevention of harmful non-indigenous species, promotion of sustainable use and management of marine resources, reduction of human intervention with seabed, prevention of disturbances caused by alteration of hydrographical conditions and reduction of marine littering and underwater noise.

With regard to the load of hazardous and harmful substances from land and air, the goal is to achieve concentrations provided by the environmental quality standards. It is stated in the new programme of measures that the status of marine area is still poor, as the threshold values of one group of compounds or polybrominated diphenyl ethers (PBDE-compounds) are exceeded in all marine areas in Finland. Also, the concentrations of many other compounds are elevated, but they do not, however, exceed the threshold values for good environmental status.

Heavy metal discharge from rivers to the Baltic Sea is clearly greater than direct emissions from industry and communities. Particularly, acid sulphate soils on the coast of Ostrobothnia are challenging with regard to the washout rate of heavy metals. Due to the drying of these soils, plenty of metals dissolved from the soil, such as cadmium and nickel, end up in the water areas and inner archipelago every year. Fallout coming from elsewhere is a significant source of long-distance substances, such as mercury and PCB-compounds, which are now banned in Finland.

In the report ”State of Marine Environment in Finland 2018” the following common environmental objectives for reducing the load of hazardous and harmful substances are referred to:

- River load and point source load of mercury, cadmium and nickel to sea will decrease
- Fallout of mercury, cadmium, dioxins and polybrominated diphenyl ether to the marine areas of Finland will decrease
- Use of hazardous priority substances will end and entry to the water environment will decrease
- Ability to prevent oil and chemical spills is secured.

6.8.3.4 Kokemäenjoki River–Archipelago Sea–Bothnian Sea water management area

The water management plan for the Kokemäenjoki River–Archipelago Sea–Bothnian Sea water management area includes an action plan and a new estimate of the status of surface waters based on the monitoring data from the years 2012–2017. A proposal for the water management plan for the Kokemäenjoki River–Archipelago Sea–Bothnian Sea water management area 2022–2027 is likely to be approved in the end of the year 2021.

It is stated in the proposal for a new water management plan (Westberg (ed.) 2021) that eutrophication from diffuse load especially contributes to the deterioration of the status of surface waters in the water management area. Point source load of other pollutants enters the water system from paper and pulp industry in the water management area. This mainly organic load consists of several different compounds, which consume oxygen from the water system during decomposition. The amount of point source load in the water management area has decreased during the past decades.

Harmful substances, especially metals, are still treated in several industrial facilities. Furthermore, harmful substances can end up to the water system with seepage waters from industrial stockpiles. Tens of industrial stockpiles as well as several stockpile areas for metal industry and hazardous waste are in the western water management area

Based on the load inventory conducted in 2019, cadmium, mercury, nickel and lead emissions from industrial facilities in the western water management area are higher than emissions from community waste water treatment plants.

Substances, that locally exceed the environmental quality standards in the water management area, mainly include cadmium and nickel, and this is due to the drying of acid sulphate soils.

The most important measures with regard to the environmental objectives of surface waters in the water management area especially include the reduction of nutrient pollution of field cropping and also e.g. more efficient water protection measures in forestry and peat production.

6.8.3.5 Maritime spatial plan

In the maritime spatial plan 2030 pursuant to the Land Use and Building Act (132/1999) (meriskenaariot.info), various interests for using the marine areas are integrated.

Related to the Blue Growth strategy of the Archipelago Sea and Southern Bothnian Sea planning area, the pressure to use the marine area is growing. Metal and maritime industry, robotics, offshore wind power and large ports as well as fishing and aquaculture are emphasized in the area. Great potential can be foreseen, and investments will be made in renewable energy and tourism.

In the plan, part of the Tahkoluoto area belongs to the inner archipelago and inner coastal water area, which includes significant shallow water areas with regard to biodiversity. Another part of the Tahkoluoto area belongs to the outer archipelago and outer coastal water area, which includes significant habitats and significant bird areas.

Fishing port for trawling and coastal fishing in Reposaari, a single trap net site on the southern side of Tahkoluoto and a potential area for fish farming related to aquaculture on the north-western side of Tahkoluoto are mentioned in the planning material. For example, the marine landscape of Pori, villages of Ahlainen and Reposaari, industrial and villa milieus and history of maritime transport are mentioned as cultural values near Tahkoluoto. A potential offshore wind farm area in the Bothnian Sea outside of Pori is also designated in the maritime spatial plan.

6.8.4 Impacts on the water system during construction

The project does not include construction in the water area. Stormwaters generated during construction probably include a small amount of solid substance. Stormwater management will be designed so that harmful substances in stormwaters from soil cannot enter the water system. During construction stormwaters are managed so that there will be no remarkable impacts on the water system. Contaminants can be removed from stormwaters by, for example, decantation, when needed.

6.8.5 Impacts on the water system, fish stock and use of water areas during operation

The vanadium recovery plant does not intake process water or cooling water from the sea, and waste waters, cooling waters or stormwaters from the plant are not directed to the water system in normal operation. Stormwaters from stockpiles of slag and SSM are collected into drainage ponds and used in the process. Chapters 6.5.4.1 and 6.5.4.2 (Treatment of raw materials, products and waste, section “exceptional situations”) include the discussion of potential impacts in a situation, when substances dissolving from slag and SSM could end up in the water system in an exceptional situation.

In exceptional situation, the metal concentrations in stormwaters directed from the slag and SSM storage areas to the water system will not exceed the permitted emission concentrations in water directed to the water system pursuant to the Decree on the Substances Dangerous and Harmful to the Aquatic Environment (1022/2006). In exceptional situation, the metal concentrations in stormwaters directed from the slag storage area to the water system will be clearly lower than the maximum concentrations in sea water pursuant to the environmental quality standards. In exceptional situation, the estimated concentrations of nickel and lead in stormwaters directed from the SSM storage area to the water system will be slightly higher than concentration in sea water pursuant to the environmental quality standards, but concentrations in stormwaters will soon be diluted when mixed with sea water, and concentrations in sea water will be significantly lower. The project is not estimated to have detectable impacts on the water system or on the status classification of the water body surrounding the VRP area pursuant to the EU Water Framework Directive, and it will not jeopardize the achievement of good environmental status or good chemical status of the water body by the end of the year 2027.

Some environmental load has previously been directed to the nearby water area from the VRP area e.g. from stormwaters of the port area, seepage and runoff waters of the Törnikari filling area and runoff and seepage waters of the southern filling area of Tahkoluoto.

Noise impacts are generated already today from the port area to the surrounding water areas of the VRP area, and due to the implementation of the plant, noise emissions will increase to some extent. It is estimated that the change is not significant e.g. with regard to recreational use when compared to the current situation. Underwater noise caused by vessel traffic will also slightly increase. Underwater noise is found to disturb the communication of fish and marine mammals and contribute to changes in their behaviour (SYKE 2016). Noise can have harmful impacts on the survival of fish and marine mammals in marine environment.

The growth in vessel traffic as a result of the project will be minor in relation to the existing number of vessels, and it is estimated that impacts related to vessel traffic (impacts of emissions, waves and currents as well as underwater noise) will not significantly increase in the water area.

The project is not contradictory to the marine management plan, water management plan for the Kokemäenjoki River–Archipelago Sea–Bothnian Sea water management area and maritime spatial plan in the area, as there will be no emissions to the water system from the operation of the plant. The project will have no impacts on the chemical or ecological status of the Reposaari-Outoori water body during construction or operation and the project will not jeopardize the achievement of good status of surface waters by the end of the year 2027.

At present, monitoring includes the quality of stormwaters directed to the sea from the deep-water port area and the environmental load from the Törnikari sedimentation pond to the sea. It is secured by periodical measurements around the plant area that harmful impacts will not be directed to the water system from the VRP area.

The project is not estimated to have detectable impacts on sea water quality, water organisms or fish stock.

Along with the implementation of the project, rain, snow or melt water, which would end up to the sea in an uncontrolled way, are not generated any more from areas, which have previously had industrial operations. Thus, the project is estimated to have minor and positive impact on the water system.

6.8.6 Prevention and mitigation of harmful impacts

Potential emissions to the water system from stockpiles will be prevented by compact and proper structures, through which stormwaters and rain waters from stockpiles can be collected. Among others, heavy rain occurring once in 50 years is considered in planning.

6.9 Vegetation, animals and nature reserves

6.9.1 Summary

In the construction phase, potential impacts on natural environment can be caused directly from the construction of the plant on site or from emissions to air and water related to the construction and operation of the plant or from noise impacts.

Previous industrial operations have largely existed in the VRP area or the VRP area is located in the immediate vicinity of industrial operations, and thus overall direct impacts in the VRP area or environmental impacts from the operation of the implemented plant will be minor. Considering the planned mitigation measures, potential impacts on the endangered species, meadow dwarf, which can be found in the Tahkoluoto area, will also be minor.

Emissions to air from the operation of the plant will be minor and the impacts (dust emissions) will not extend far away from the VRP area. Noise is generated already today in the Tahkoluoto port and industrial area and wind power stations, and it is estimated that increasing noise due to the implementation of the project will not cause significant change to the current situation. Impacts on natural environment can still be prevented and mitigated by measures that reduce noise impacts and air quality impacts.

It is estimated that the project will not have notable direct or indirect impacts on the natural values of the Gummandoora Archipelago Natura area, on the nearest nature conservation areas, on the valuable bird areas, on the bird population in the area or on other valuable natural sites in the Tahkoluoto area and the surrounding area. Impacts of the endangered meadow dwarf will be prevented through the planned mitigation measures.

Comparison of alternatives and significance of impact

There is no difference between alternatives Alt.1, Alt.1a and Alt.1b. In alternative Alt.0, impacts on natural environment will be caused by another potential project implemented in the area. Significance of impact is assessed as minor and negative.

Construction phase

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Vegetation, animals and nature reserves	Construction is located in an industrial area or in its immediate vicinity and thus direct impacts or impacts from air emissions or noise on natural environment will be minor.	No impacts.	No difference between alternatives Alt.1, Alt.1a and Alt.1b. Significance of impact during construction is assessed as minor and negative (-).

Operating phase

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Vegetation, animals and nature reserves	The VRP area is located in an industrial area or in its immediate vicinity and thus direct impacts or impacts from air emissions or noise on natural environment will be minor.	No impacts.	No difference between alternatives Alt.1, Alt.1a and Alt.1b. Significance of impact is assessed as minor and negative (-).

6.9.2 Assessment method

The assessment has been prepared as an expert evaluation and it considers the known nature conservation areas, sites of nature conservation programmes and Natura areas, important bird areas (IBA, FINIBA and MAALI) located in the impact area of the project as well as known valuable natural sites in the surroundings of the VRP area. New information on the natural sites in the VRP area and in its surroundings has been obtained from studies performed during summer 2021. Preliminary results of these studies have been considered in the impact assessment.

The Natura areas, nature conservation areas and sites of nature conservation programmes are presented in the EIA report within a distance of about 10 km.

The impact assessment regarding the natural sites and species has been prepared as an expert evaluation in accordance with the guidelines for nature studies by the Environmental Administration using e.g. the guidebook “Nature surveys and wildlife impact assessment in zoning, EIA procedure and Natura assessment” (Söderman 2003).

6.9.3 Current state

6.9.3.1 Vegetation and animals

The VRP area is located in a port and industrial area. In the surrounding area of Tahkoluoto, the most significant natural values include the natural beach areas of Ketaranlahti, Tukkiviikki, Räyhä and Kappeli, as well as the unbuilt parts of the islands (City of Pori 2020).

Nature study 1996

Based on the study prepared in 1996 in context with the valid component master plan, the Tahkoluoto area has beach groves with common alder in the shore areas of Ketaranlahti and Tukkiviikki, in the area of Räyhä (Köylynen) and on the southern shore of the Mänty-Paakari Island to the northeast of Tahkoluoto. The shores of Ketaranlahti are surrounded by a broad common alder – bird cherry – rowan tree grove with very lush vegetation. The bush floor contains, among other things, red currant, mountain currant, red elderberry and European cranberry bush. The undergrowth contains wood millet, red campion, herb bennet, wood stitchwort, common figwort, herb Robert, valerian, wood sorrel, and woody nightshade. A particularly representative grove was the area extending from the bay bottom to the former swimming beach, as well as the rowan grove on the Pikkuketara cape. Overgrowth, grassing and stooling have occurred in the area after the study. (City of Pori 2020). Part of the beaches include coastal vegetation of stony beaches with sea buckthorn bushes.

Törnikari, where the VRP area locates, is mentioned in the 1996 study as a very rocky low-growth and outer archipelago type of juniper grove surrounded by a narrow common alder belt. For example, insect species of sunny and warm habitats may be found in the fringe areas of Törnikari (City of Pori 2020).

The point of the outermost cape in the western part of Tahkoluoto (Kallioholma) was characterised as a representative area for seaside grasses. The swampy depression with growing crowberry left in the centre of the cape was found to provide a distinct moor-like impression. (City of Pori 2020). It is stated in the book ’Cultural environments of Satakunta yesterday, today, tomorrow’ that the Tahkoluoto meadow is a regionally valuable natural site. Field garlic can be found in the area (City of Pori 2020). The Tahkoluoto meadow is located on the eastern side of the power plant area (see location in Figure 6.11-7, chapter 6.11.3).

Nature study 2020

A comprehensive nature study was prepared in 2020 for the key natural areas of the component master plan (Figure 6.9-1) (Ahlman 2020).

Figure 6.9-1. Area of the nature study prepared in 2020 in context with the Tahkoluoto-Paakarit component master plan (City of Pori 2020).

With regard to vegetation, it was stated in the nature study 2020 that the integrated chains of succession concerning groves and common alder communities on a coast with postglacial rebound constitute the most significant natural value in the area. A typical development on a coast with postglacial rebound is, for example, the following: common reed community, flood/reed meadow, common alder community, common alder/spruce grove or grove type of boreal forest with fir trees/deciduous trees, Correspondingly, the development phase can include, for example, beach shrub and sea buckthorn shrub. There are plenty of these chains of succession in the study area. They are nationally critically endangered (EN).

Moor frogs were examined in field inventories in the nature study 2020, but the species was not observed in the area. Many suitable living environments for flying squirrels were observed in the study area, but no observations of this species were, however, made. It was concluded that the absence of this species in suitable living environments is due to incomplete forest movement routes from the mainland.

In the nature study 2020, nesting bird population in the study area could be examined quite comprehensively through maps and night raven and water bird counts (Figure 6.9-2). The nesting bird population in the area is very diversified including 65 different species. Based on observations, two valuable bird areas were confined in the area. One of them concerns the small coastal zone on the western side of the Räyhänsuntti boat harbour, where e.g. critically endangered common pochard, a small great crested grebe population and other wetland species are nesting. The most significant bird area is Ketaranlahti and the nearby areas of Pikku-Ketara and Ketara. A significant number of notable species are nesting in the area, such as several tufted ducks, common eiders, coots, terns and several other wetland species. It is a very valuable local site.

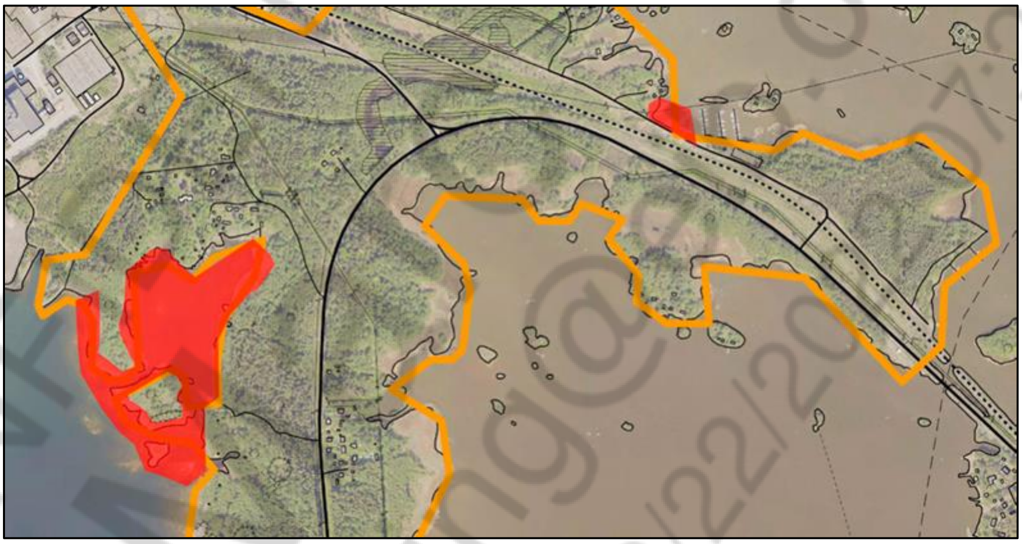

Figure 6.9-2. Valuable areas for birds in the area of the nature study 2020 (red colour).

Based on the observations of bats, two areas in the study area were confined to category II (important feeding areas and migratory routes) and category III (other areas used by bats).

Nature study 2021

The nature study 2020 of the master plan area has been supplemented during summer 2021 with regard to areas shown in Figure 6.9-3 including vegetation and habitat types, bats, nesting bird populations, notable butterfly species, flying squirrel and moor frog. In addition, a separate butterfly study was performed in the area in order to examine the potential species of sunny and warm habitats (meadow dwarf) occurring in the area.

Based on preliminary information from the nature study, no signs of flying squirrel or moor frog occurring in the Tahkoluoto area were found. There were no observations of bats. Specifically valuable nesting bird populations were not found in the Tahkoluoto area. Instead, e.g. seagull populations were found around islands. Regarding vegetation, valuable plant species can mainly be found in the Tahkoluoto meadow area (location shown in Figure 6.11-7, chapter 6.11.3) on the eastern side of the power plant. Old grove forest with natural value can be found near the road on the southern/western side of the Reposaari main road (Ahlman 2021, Mäkelä 2021).

Based on the field studies in summer 2021, a butterfly species, meadow dwarf (*Elachista triatomea*), can be found in the Tahkoluoto area. The species is not included in Annex IV or Annex II of the Habitats Directive. The species has been defined as a threatened species in Appendix 4 of the Nature Conservation Decree, but neither as a specially protected species nor a species under protection pursuant to Appendix 2 of the Nature Conservation Decree. Meadow dwarf has been classified as an endangered species (EN) (Hyvärinen ym. 2019).

Based on the presentation of the species at Laji.fi, known observations of the species can only be found in Pori in addition to the Åland Islands (Laji.fi, 2021). There are also two old observations of meadow dwarf in the Tahkoluoto area from the years 2003 and 2006, but afterwards the species has not been observed on site.

Meadow dwarf lives in fields, hillsides and meadows. It is known that only red fescue (*Festuca rubra*) and sheep fescue (*F. ovina*) are the food plants of meadow dwarf. It is assumed that red fescue and sheep fescue are the main food plants of meadow dwarf in the Tahkoluoto area.

The larvae of the species dig out the leaves of red fescue in April-June.

Red fescue is a loosely tufted, very numerous and widely-spread grass. The habitats of it include e.g. various fresh meadows and road verges. Sheep fescue is also very numerous and widely-spread species, which grows e.g. in dry meadows, fields, moors and rocks (Ahlman Group 2021).

The current state of meadow dwarf in Tahkoluoto, Pori was examined in field surveys during May–mid-July 2021. Field surveys were performed on 16.5., 6.6., 20.6., 4.7. and 15.7. The first two field surveys primarily focused on discovering fescues, which are the food plants for larvae, and potential leaf mines of fescues. The last three surveys included plenty of “sweeping” or netting of previously discovered fescue communities in order to find mature individuals. Furthermore, leaf mines were still surveyed.

The most significant sites of red fescue communities and site of sheep fescue community in the Tahkoluoto area are presented in Figure 6.9-3. In addition, red fescue can also sparsely be found along other roads and around the foundations of wind power stations in Tahkoluoto. The food plant forms a typical small-scale metapopulation network connected by roads and road verges, which also act as flight routes for their part (Ahlman Group Oy 2021). Leaf mines made by the larvae of meadow dwarf were found in the three most significant sites of red fescue communities (Figure 6.9-3, areas 1, 2 and 4), which are located on both sides of the railway and on the northern side of Törnikari.

Figure 6.9-3. Supplementary areas to the nature study 2021 in Tahkoluoto (red outline) and the most abundant red fescue (purple 1-5) and sheep fescue (red 6) communities. Trees in the southern VRP area have mainly been removed after the image was taken.

Bird population

The nearest valuable bird nesting area is in Kaijakari on the south-western side of the plan area, where e.g. lesser black-backed gull and Arctic tern nest.

The bird population in the bird islets outside of Tahkoluoto (Kumpeli, Kaijakari, Silakkariutta and Hylkiriutta, Figure 6.9-4) was previously studied in 2020 in the Tahkoluoto wind farm project (AFRY Finland Oy 2021, Nuotio & Sillanpää 2020). The nesting bird population in 2020 on the nearby islands of Tahkoluoto included 33 bird species. The number of bird species on islands varied from 22 species in Kumpeli to 26 species in Hylkiriutta. The nesting bird population (pairs of birds) was the most abundant on the biggest island of the area, Kaija, where 40 % of the pairs of birds nested. Over a quarter of the pairs of birds in the area returned to nest in Kumpeli, the second smallest island in the area. The most abundant nesting bird species was eider (270 pairs of birds), almost 26 % of the total number of pairs. With regard to the anseriformes, the number of more than 10 nesting pairs was achieved by e.g. graylag goose (13 pairs) and barnacle goose (46 pairs). Graylag goose population remained unchanged, but the number of barnacle geese almost doubled in two years. With regard to the Charadriiformes, the most abundant species was herring gull (259 nesting pairs of birds) and almost 25 % of the total number of pairs. The number of nesting Arctic terns was 157 pairs and the number of nesting lesser black-backed gulls was 118 pairs. 11 pairs of waders were nesting. Based on calculations, the nesting bird population feels comfortable on the nearby islands of Tahkoluoto.

Based on the observations of the bird data base Tiira, with regard to the bird species constituting the protection objective in the Gummandoora Archipelago Natura area, there are hundreds of observations of razorbills, black-throated divers, red-throated divers and black scooters during the past three years in the Kallioholma observation site located on the western side of Tahkoluoto. Several hundreds of individuals have been observed during the observation campaigns. There are tens of observations of smews including tens of individuals. The observation site is located within an existing wind farm area at a distance of about 850 m from the southern VRP area.

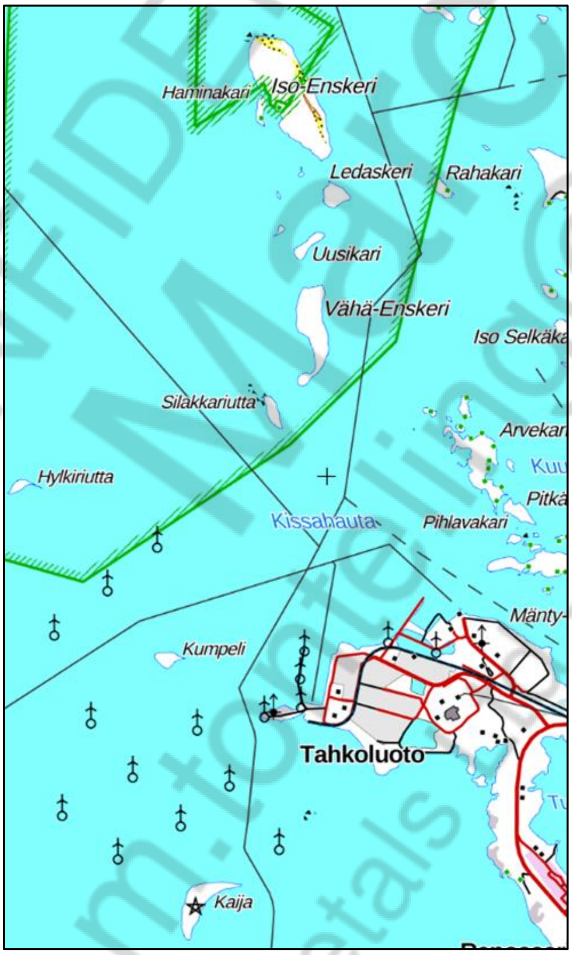

Figure 6.9-4. Bird islets outside Tahkoluoto (Kumpeli, Kaijakari, Hylkiriutta, Silakkariutta, Vähä-Enskeri ja Iso-Enskeri, map extract NLS).

Significant migratory routes of birds pass through on the eastern and western side of Tahkoluoto (Ahlman & Luoma 2013). With regard to water birds, the most abundant moulting species in the outer archipelago area of Satakunta include eider, goldeneye and mute swan. The area outside of Tahkoluoto is one of the most significant congregation areas of water birds in the outer archipelago (Ijäs et al. 2013). According to the bird data service Tiira, there are plenty of observations of these particular bird species, for example, during the past year e.g. in Tahkoluoto and Kallioholma observation sites varying from a few individuals to thousands of individuals per observation.

Migratory routes of birds passing through on the western side of Tahkoluoto have been described in detail in the EIA report of the wind farm extension project of Suomen Hyötytuuli Oy. Spring migration of birds mostly follows the coastline in the area between Pori and Merikarvia. Also outside of Tahkoluoto in Pori, majority of birds migrate by following the coastline, and thus end up very close to the tip of Tahkoluoto. As a rule, the migratory routes of birds do not, however, pass over Tahkoluoto.

Based on the information from the Pori Ornithological Association (PLY 2021), the bird population is diverse in the Tahkoluoto area including the port and industrial area, surrounding area of the Ketaranlahti Bay, Törnikari and several islands, where both nesting and migrating birds can be found year-round. Tahkoluoto, like other capes in the area protruding into the sea, guides the migration of birds and attracts resting birds especially in autumn. Nesting bird population is less abundant by species, and the number of land birds is smaller than the number of birds nesting on shores or islands. The built environment has hardly any specific birdlife values, but the islands and the Ketaranlahti Bay area form their own biotopes including characteristic species. The observations in the area are mainly recorded to the bird data base Tiira by the members of the Pori Ornithological Association. The total number of recordings is so far about 64 000 in the area. Regarding the near threatened species, 354 observations of 2 659 individuals have been recorded. These species include e.g. wheatear, yellow wagtail, meadow pipit, common rosefinch, goshawk, boreal owl, pygmy owl, ringed plover, little ringed plover, dunlin, wood sandpiper, great black-backed gull and rustic bunting. Regarding the endangered species, 489 observations of 3 383 individuals have been recorded. These species include e.g. greenfinch, twite, whinchat, reed bunting, coot and black-headed gull.

Other valuable nature sites

Values of seabed were studied in the 2014 wind farm project. Areas included in the natural value categories 1 and 2 are located outside of Tahkoluoto. According to the VELMU data base regarding underwater biodiversity, underwater reefs are located on the southern side of Tahkoluoto. A significant EMMA-area (ecologically significant underwater area of marine environment in Finland) regarding fish stock in the Kokemäenjoki River delta extends out to the southeastern archipelago area of the master plan area (City of Pori 2020).

6.9.3.2 Conservation areas and nature reserves

6.9.3.2.1 Natura areas

Three Natura areas are located less than 10 km from the VRP area: Gummandoora Archipelago, Kokemäenjoki River Delta and Preiviikinlahti. The Natura area “Pooskeri Archipelago” is located about 11 km to the north-east of Tahkoluoto. Natura areas are presented in Figure 6.9-5.

Gummandoora Archipelago (FI 0200074, SAC/SPA)

The Gummandoora Archipelago Natura area is located about 2 km to the north of the VRP area. The Gummandoora Archipelago Natura area is part of the Bothnian Sea National Park and the internationally valuable bird area (IBA) of the Oura-Enskeri Archipelago. There are several small nature reserves on private land on the islands of the Natura area. The site is almost entirely included in the coast protection programme. The area is protected by the Environmental Protection Act and the Water Act. The Natura area is also part of the Luvia archipelago, which is one of the sites in the coast protection programme. The natural habitats and species, which constitute the protection objectives, are presented in Table 6.9-1 and Table 6.9-2.

Table 6.9-1. Natural habitats, which constitute the protection objectives of the Natura areas.

Code	Name	Area (hectares)
1150	Flads, gloes and coastal lagoons	0.42
1170	Reefs	123.2
1210	Annual vegetation of drift lines	0.12
1220	Perennial vegetation of stony banks	27
1230	Vegetated sea cliffs of the Atlantic and Baltic coasts	1
1610	Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation	2.3
1620	Boreal Baltic islets and islands in outer archipelago and open sea zones	42.2
1630	Boreal Baltic coastal meadows	3.1
1640	Boreal Baltic sandy beaches with perennial vegetation	0.43
9010	Boreal natural forests	3.38
9030	Natural forests of primary succession stages of landupheaval coast	60
9050	Boreal herb-rich forests	6.38
9080	Fennoscandian deciduous swamp woods	0.07

Table 6.9-2. Species, which constitute the protection objectives of the Natura areas.

Species	Scientific name
razorbill	*Alca torda*
northern shoveller	*Anas clypeata*
gadwall	*Anas strepera*
ruddy turnstone	*Arenaria interpres*
tufted duck	*Aythya fuligula*
greater scaup	*Aythya marila*
barnacle goose	*Branta leucopsis*
black woodpecker	*Dryocopus martius*
kestrel	*Falco tinnunculus*
black-throated diver	*Gavia arctica*
red-throated diver	*Gavia stellata*
lesser black-backed gull	*Larus fuscus fuscus*
black-headed gull	*Larus ridibundus*
velvet scoter	*Melanitta fusca*
black scoter	*Melanitta nigra*
smew	*Mergus albellus*
wheatear	*Oenanthe oenanthe*
eider	*Somateria mollissima*
Caspian tern	*Sterna caspia*
common tern	*Sterna hirundo*
Arctic tern	*Sterna paradisea*
common shelduck	*Tadorna tadorna*
black grouse	*Tetrao tetrix*
common redshank	*Tringa totanus*

In addition, one endangered species constitutes the protection objective of the area, but this information is classified.

The following species, which constitute the protection objective of the area, are nesting in the Natura area: northern shoveller, gadwall, ruddy turnstone, tufted duck, greater scaup, barnacle goose, black woodpecker, kestrel, lesser black-backed gull, black-headed gull, velvet scoter, wheatear, eider, Caspian tern, common tern, Arctic tern, common shelduck, black grouse and common redshank. Resting species during migration include northern shoveller, black-throated diver, red-throated diver, black scoter and smew.

Kokemäenjoki River Delta (FI0200079, SAC/SPA)

The Kokemäenjoki River Delta Natura area is located about 6 km to the south-east of the VRP area. The Kokemäenjoki River Delta Natura area is the largest delta formation in the Nordic countries, which includes many different biotopes from submerged plant communities to mowed meadows and groves with common alder. The size of the Natura area is 2 885 hectares. The area is a very significant bird area. The area is part of the water bird habitats protection programme, Project Mar -programme, protection programme of the Nordic biotopes and the SL-area of the regional plan.

10 habitat types, 53 bird species, one insect, one mammal and one plant species constitute the protection objectives of the area.

Preiviikinlahti (FI0200080, SAC)

The Preiviikinlahti Natura area is located about 7 km to the south of the VRP area. Preiviikinlahti is a large and relatively shallow bay. The shores have previously been grazing land and grazing has been started again in some meadows due to bird populations. The following sub-areas of the Natura area are part of the water bird habitats protection programme: Ooviiki area, part of the Lahdenperä area, Isosanta-Riitsaranlahti area and Enäjärvi area. The cape of Herranpäivät and part of the Enäjärvi area are nature conservation areas. 23 habitat types and one mammal (otter) constitute the protection objectives of the area.

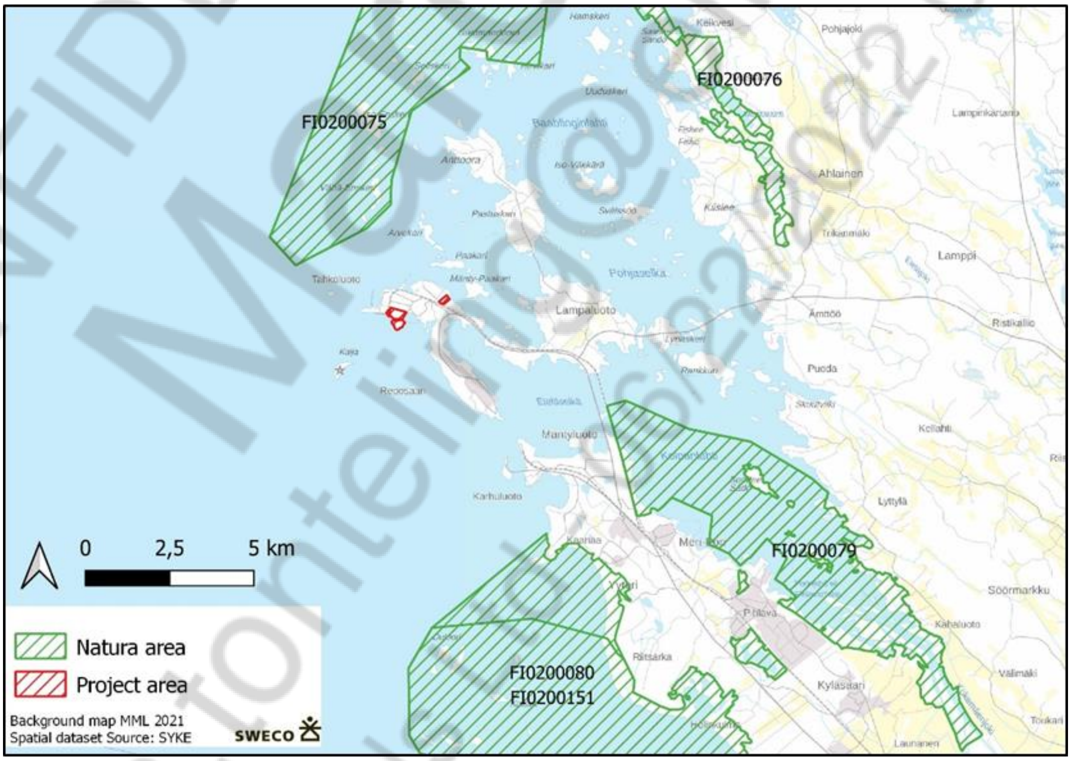

Figure 6.9-5. Natura areas in the vicinity of the VRP area.

6.9.3.2.2 Nature conservation areas

The nearest nature conservation areas are presented in Figure 6.9-6. The coastal area including the archipelago outside of Pori, Rauma, Pyhäranta and Uusikaupunki are part of the Bothnian Sea National Park (KPU020037). The national park is part of the National Conservation Programme of state-owned areas. The shortest distance from the VRP area to the Bothnian Sea National Park is about 3 km. The Natura areas of Gummandoora Archipelago and Preiviikinlahti partly overlap with the area of the national park.

There are several nature reserves on private land in the Natura areas. The nearest nature reserves on private land to the VRP area are the Badstuskär (YSA201568) nature reserve located on Iso-Enskeri island on the northern side of Tahkoluoto at a distance of about 5 km as well as the Loukkukari (YSA240804) and Uusiväkkärä (YSA207171) nature reserves located on Iso-Väkkärä island at a distance of about 5 km to the north-east of the VRP area.

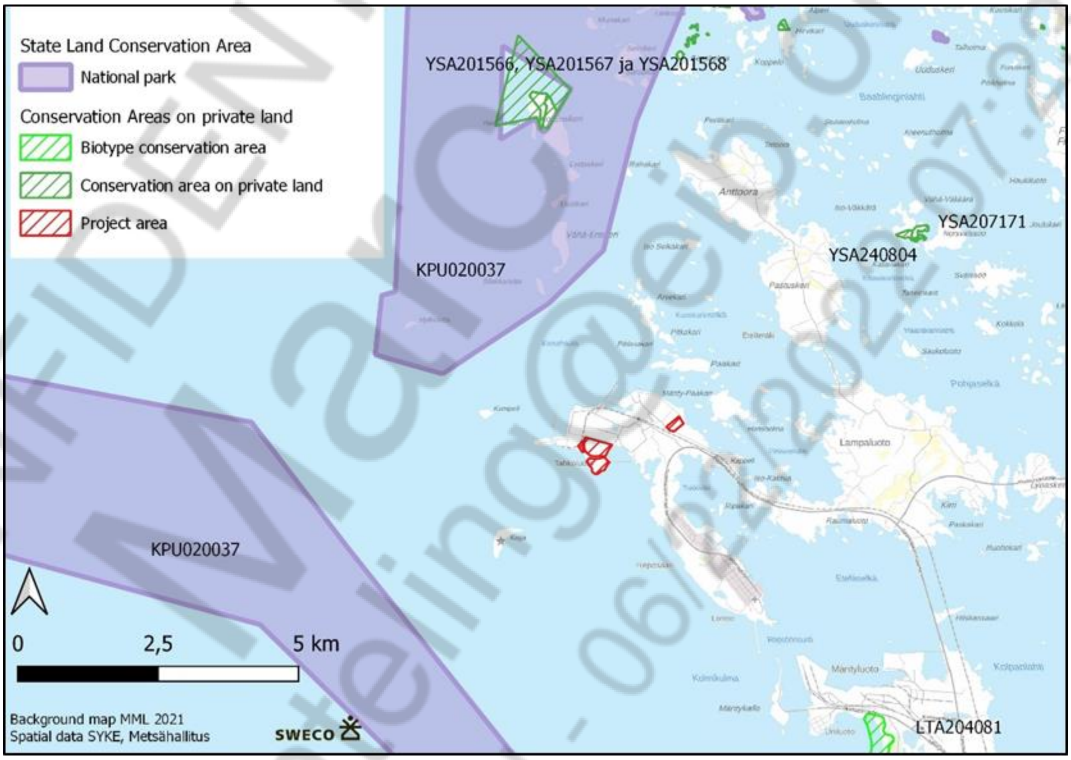

Figure 6.9-6. Nature conservation areas in the vicinity of the VRP area.

6.9.3.2.3 Sites of nature conservation programmes

Sites included in the nature conservation programmes near the VRP area are presented in Figure 6.9-7. The Gummandoora and Pooskeri Archipelagos (RSO020022) are part of the coast protection programme. Kokemäenjoki River Delta (LVO020072) and Preiviikin-lahdenperä, Yyteri-Riitslahti and Enäjärvi (LVO020071) are part of the water bird habitats protection programme. Part of the sites included in the nature conservation programme overlap with the Natura areas.

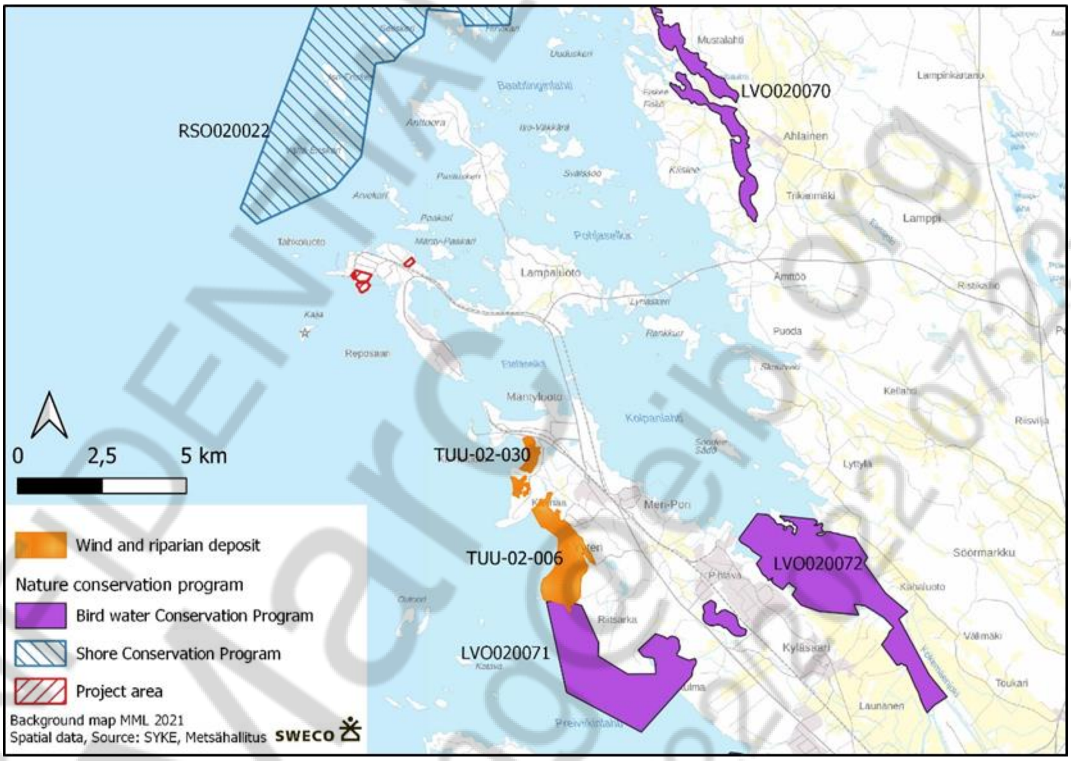

Figure 6.9-7. Sites included in the nature conservation programmes located near the VRP area and nationally valuable wind and riparian deposits.

6.9.3.2.4 Valuable bird areas

Valuable bird areas near the VRP area are presented in Figure 6.9-8. The Pori water bird habitat and coastal area outside of the City of Pori (nearest distance of about 2.5 km), which is an extensive system consisting of archipelago, sea bays, river deltas and eutrophic lakes, is part of the internationally valuable bird areas (IBA). The internationally valuable bird area of the Oura-Enskeri Archipelago is an extensive archipelago area outside of Merikarvia. The Pori water bird habitat as well as the Rauma-Luvia and Pori archipelago are included in the internationally important bird areas (IBA). The IBA and FINIBA -areas are partly overlapping. The regionally important bird area network has been specified as a result of the Satakunta MAALI project (Vilén et. al. 2015). Regionally important bird areas (MAALI) include the areas of Kokemäenjoki River Delta-Kirrinsanta-Levo, Gummandoora-Merikarvia, Kaijakari-Enskeri and Preiviiki fields-Maaviiki. The MAALI-areas are national and more extensive areas than the important bird areas in Finland, and they partly overlap with the above mentioned areas.

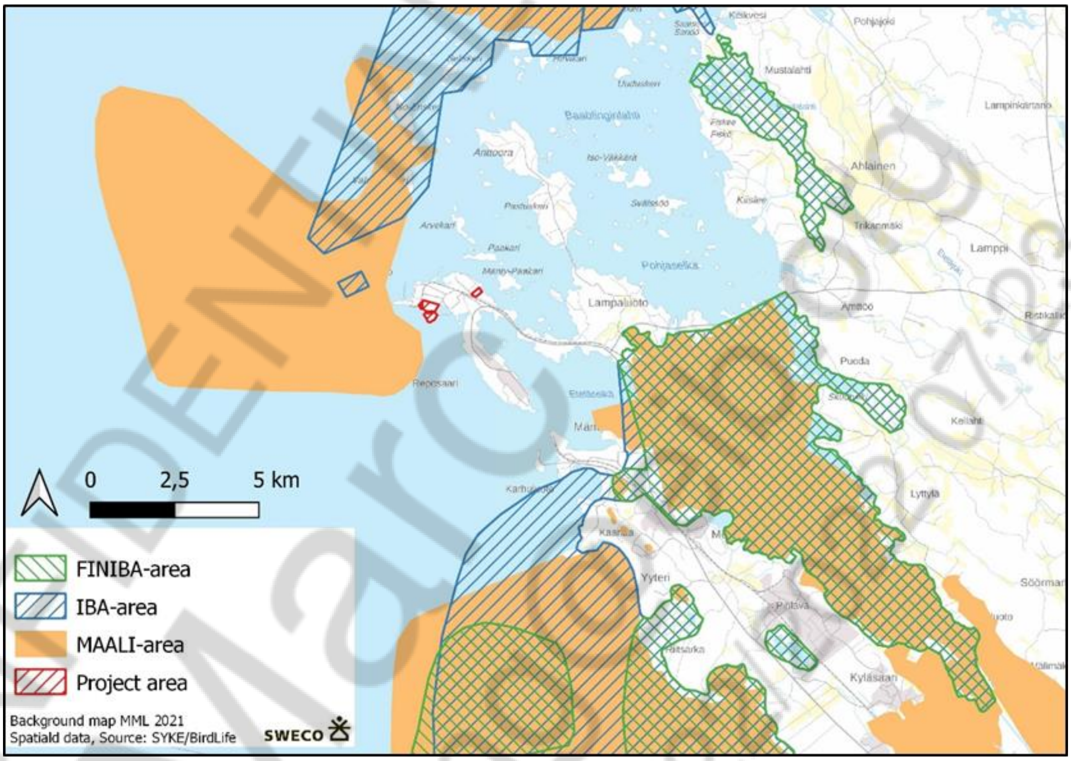

Figure 6.9-8. Regionally important bird areas (MAALI), nationally important bird areas (FINIBA) and internationally important bird areas (IBA) located in the vicinity of the VRP area.

6.9.4 Impact assessment

In the construction phase, potential impacts on natural environment can be generated directly from the construction of the plant on site, or from emissions to air and water related to the construction and operation of the plant or from noise impacst. The project will not have significant impacts on the water system (chapter 6.8).

6.9.4.1 Nature conservation areas, sites of nature conservation programmes and valuable bird areas

Growing vessel traffic on the deep-water channel due to the project is not estimated to have direct or indirect impacts on the bird population, which constitutes the protection objective of the Gummandoora Archipelago Natura area, or impacts on the habitats and species or integrity of the Natura area (Sweco 2021b, Appendix to the EIA programme). The nearest nature conservation area (Bothnian Sea National Park) and sites of nature conservation programmes (Gummandoora and Pooskeri Archipelago) are mostly located in the same area near the VRP area as the above mentioned Natura area, and no impacts are estimated to occur in these particular areas.

Emissions to air from the operation of the plant will be minor and the impacts (dust emissions) will not extend far away from the VRP area. Emissions to air are not estimated to have significant impacts on the nearby nature conservation areas.

There are regionally, nationally and internationally important bird areas in the sea area around the VRP area. Noise emission is the only potential impact on bird population during the operation of the plant. Noise is generated already today from the Tahkoluoto port and industrial area and wind power stations, but regardless, there is a large bird population in the surroundings of Tahkoluoto. Based on studies prepared in 2020, e.g. nesting birds feel comfortable on the nearest bird islets, Kaijakari and Kumpeli. It is estimated that the increasing noise level due to the implementation of the project will neither cause significant changes to the current situation nor significant impacts on the valuable bird areas.

6.9.4.2 Natural habitats and species

Previous industrial operations have existed in most parts of the VRP area or it is located in the immediate vicinity of industrial operations. Overall, the natural values in the VRP area are minor. In the pending Tahkoluoto-Paakarit component master plan the VRP area is designated as a port and industrial area, where a facility storing hazardous chemicals can be located.

Based on the information from the city, a pedestrian and bicycle way, which will potentially be implemented despite the project, and which is proposed in the pending component master plan, would be located in an old grove forest area with natural value (Mäkelä 2021). It is estimated that the overall value of the particular area will not fundamentally decrease due to the construction of the pedestrian and bicycle way.

The most significant valuable bird areas in the Tahkoluoto area can be found on the islands around Tahkoluoto and in the Ketaranlahti Bay. It is estimated that the overall direct impacts of construction on the natural values and bird population in the area will be minor.

In the field surveys during summer 2021 in the Tahkoluoto area, one of the most abundant red fescue (*Festuca rubra*) communities, which is the food plant of meadow dwarf, was found in the VRP area (Figure 6.9-3).

Construction in the area would locally reduce the number of suitable habitats for the endangered meadow dwarf, but will not lead to local extinction of the species in Tahkoluoto. Based on a study of meadow dwarf (Ahlman Group 2021), it is possible that meadow dwarf will disappear from the area due to unfavourable weather conditions, as the total area of Tahkoluoto is not very large, and the species can be found in the area, as if they were in the middle of the sea outside of their main range. Red fescue clearly benefits from open wasteland in the Tahkoluoto area. Normal operations in the port area probably create these open fields.

Without mitigation measures, the reduction of suitable habitats could increase the extinction risk of local species population in the long run. The potential local extinction of this endangered species, which can be found in Pori, Finland in addition to the known observations in Åland Islands, may decrease the favourable conservation status of the species.

Potential impacts of the project on meadow dwarf can be mitigated or totally prevented by the following measures:

- The soil of the red fescue community located in the VRP area will be moved to a similar open area in the Tahkoluoto area.
- A red fescue community will be artificially created in the Tahkoluoto area by planting seeds of the species.
- Other important observed red fescue communities (Figure 6.9-3, numbers 1, 2, 3 and 5) in the Tahkoluoto area will be preserved for the time being.
- Surface soil will be removed from the area of sheep fescue (number 6), when red fescue will probably naturally spread from the nearby community to this area with a favourable growth environment.

Meadow dwarf can be found in several areas in Tahkoluoto and also outside of the VRP area. It is estimated that red fescue will also grow in newly created habitat provided that favourable growth environment will be created. Favourable habitat is a sunny site with infertile and weedless soil. Meadow dwarf can be found in meadows and fields in a similar way as its food plant, red fescue. Suitable living environment requires the maintenance of prevailing meadow-type of environment. It is essential to prevent the entry of nutrients to the area from outside and to maintain of meadow-type of vegetation through mowing and grazing.

Suitable sites for creating a new red fescue community have been evaluated in the Tahkoluoto area and the move from the VRP area is planned to be implemented in October 2021 (Ahlman Group 2021, Sweco 2021e). It is secured by these measures that suitable habitats for meadow dwarf will be preserved in Tahkoluoto, and thus there will be no impacts from the project on the living conditions of meadow dwarf in Tahkoluoto. After the move, the situation of meadow dwarf will be monitored in Tahkoluoto for three years by e.g. surveying the newly created red fescue community.

Emissions to air from the operation of the plant will be minor or the impacts (dust emissions) will not extend far away from the VRP area. Therefore, it is estimated that emissions to air will not have significant impacts on natural habitats and species. It is estimated that the increasing noise level and lighting due to the implementation of the project will neither cause significant changes to the current situation in the port and industrial area nor significant impacts on the bird population in Tahkoluoto.

6.9.5 Prevention and mitigation of harmful impacts

Previous industrial operations have largely existed in the VRP area or the VRP area is located in the immediate vicinity of industrial operations, and thus direct impacts from construction in the VRP area or impacts from the operation of the implemented plant on natural environment will be minor. Impacts can be prevented and mitigated by measures that reduce noise impacts and air quality impacts. Planned mitigation measures regarding the impacts on meadow dwarf have been discussed in previous chapter (6.9.4.2), which will be implemented for preventing the impacts on meadow dwarf.

6.10 Soil, bedrock and groundwater areas

6.10.1 Summary

Typical impacts on soil are caused by earth construction works during the construction phase.

Detected heavy metal concentrations in the soil of the VRP area will be taken into account during the construction works and disposal of land masses.

The vanadium recovery plant is located in an industrial area, the soil of which is mostly reclaimed land. Stockpiles of slag and SSM are located on top of proper protective structures. The normal operation of the plant is not estimated to cause significant impacts on soil and bedrock or groundwater.

Comparison of alternatives and significance of impact

There is no fundamental difference between alternatives Alt.1a and Alt.1b with regard to impacts on soil and groundwater in the construction and operating phase.

There are no impacts in alternative Alt.0. There will be impacts on soil and bedrock from another potential project implemented in the area.

Significance of impact is assessed as minor.

Construction phase

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Impacts on soil, bedrock and groundwater areas	Impacts on soil and bedrock during construction are related to the construction of the foundation structure of the process plant, its yard area as well as the stockpile area for raw materials and SSM.	No impacts on soil, bedrock and groundwater. There will be impacts on soil, bedrock and groundwater from another potential project implemented in the area.	No difference between alternatives Alt.1, Alt.1a and Alt.1b. Significance of impact during construction is assessed as minor and negative (-).

Operating phase

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Impacts on soil, bedrock and groundwater areas	No impacts on soil, bedrock and groundwater in normal operation. Stockpiles of slag and SSM are located on top of protective structures.	No impacts on soil, bedrock and groundwater.	No impacts in normal operation.

6.10.2 Assessment method

Impacts on soil have been assessed as an expert evaluation.

The vanadium recovery plant is located in an industrial area and normal operations will not have impacts on soil and bedrock or geologically significant sites. Thus, there was a minor need for an impact assessment in this respect. Exceptional situations, such as chemical leaks can cause impacts on soil, which will be considered in the risk assessment (see chapter 6.17) and preparations will be made for these situations. The impacts of previous industrial activity on the soil of the area have been considered in the assessment.

6.10.3 Current state of soil and bedrock

The predominant soil type in the Tahkoluoto area is sandy moraine (Figure 6-10-1). Based on the GTK data service, soil has not been surveyed in parts of the area. In addition, areas of fine sand and bedrock can be found in the eastern part. Based on the GTK data service, the planned southern VRP area partly consists of a totally unsurveyed area and a sandy moraine area at the southern point of the cape. The main soil type is sandy moraine in the northern VRP area (GTK Maankamara).

The Tahkoluoto area is almost entirely diabase bedrock, which is clearly reflected in the vegetation of the area with lusher grove vegetation compared to the rest of the environment. The expansion and development of the port has been based on and will be based on the integration of islands, rocks and water areas by embankments, and filling the ponds behind the embankments. There are no geologically valuable areas with the exception of outcrops of bedrock and rocky areas on the shores (City of Pori 2020).

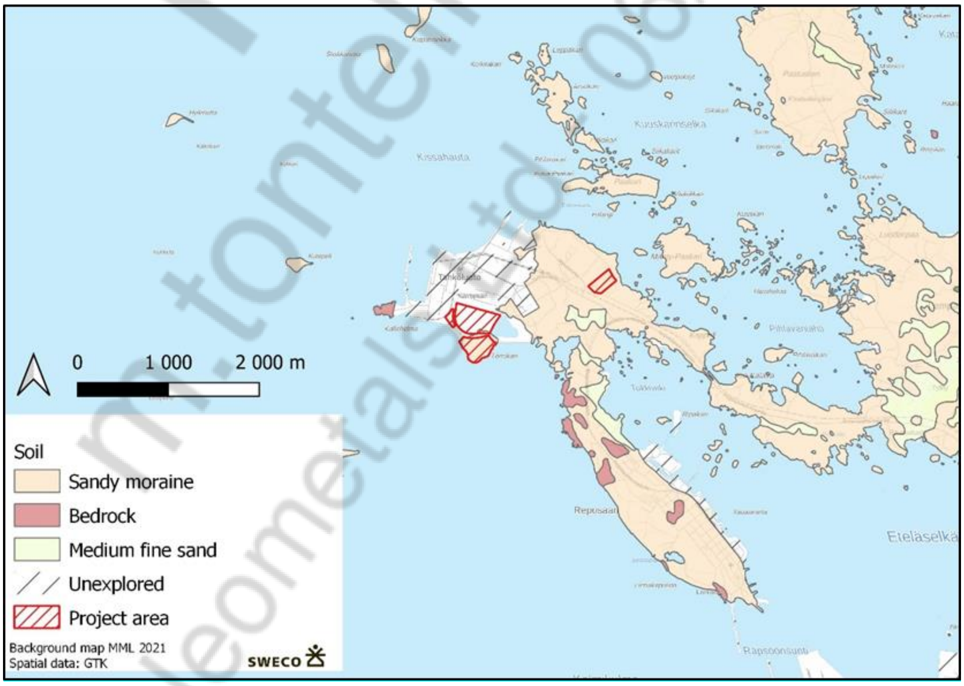

Figure 6.10-1. Soil types in the VRP area and in the surrounding area.

The soil layers above the bedrock in the area consist mainly of filling soil. With regard to granulation, the filling soil is generally gravel-rich sandy moraine, which conducts water very well. The natural soil layer is mainly sandy moraine, which conducts water more ineffectively. The depth of the bedrock surface in the area varies between 1.0–12.0 m, and thus the thickness of the filling soil layers and natural soil layers vary. Groundwater follows the sea water level in an area, where filling soil is very permeable to water. Groundwater flows towards the sea. Due to the variation in the sea water level, water can, however, occasionally flow from the shore towards inland (Ator Consultants Oy 2016, Tahkoluodon Polttoöljy Oy, decision on environmental permit 2008).

The bedrock of Tahkoluoto consists of the Satakunta sandstone and rapakivi granite. In addition, quartz diorite as well as olivine diabase can be found in the area (GTK Maankamara).The planned VRP area is located in a sandstone and rapakivi granite area (Figure 6-10.2) (GTK Maankamara).

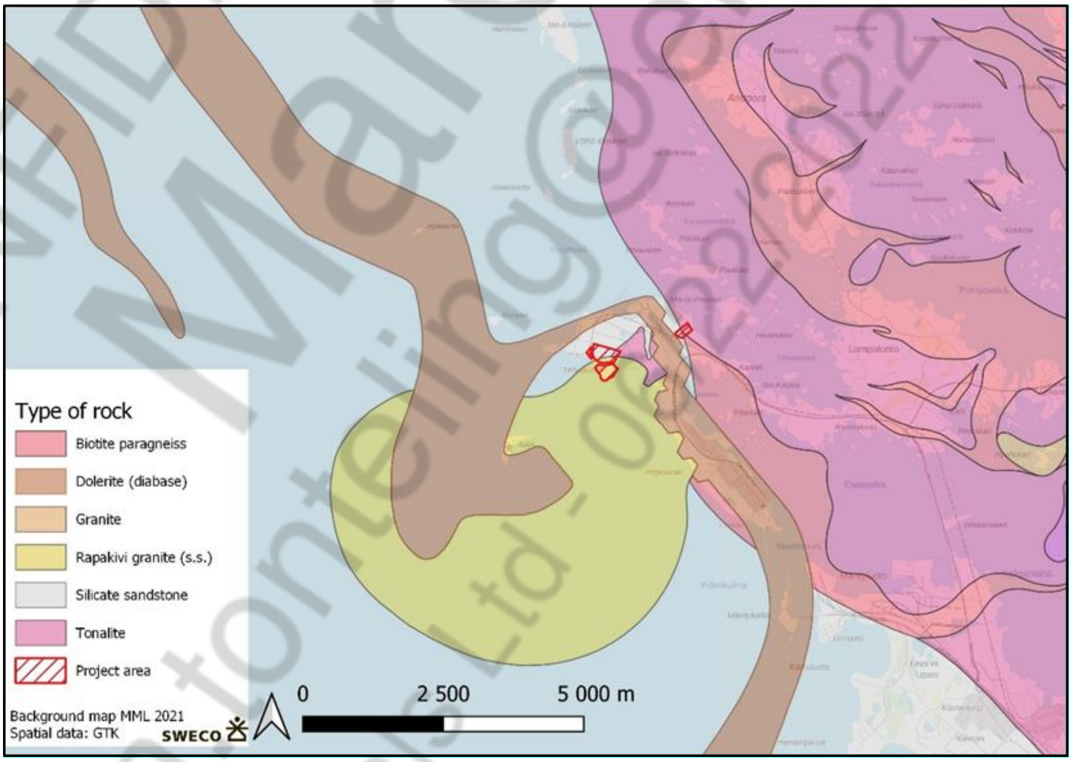

Figure 6.10-2. Bedrock in the VRP area and in the surrounding area.

Based on existing activities, potential contaminated sites of soil in the area are located in the Tahkoluoto power plant, waste treatment and chemical storage area (Figure 6.10-3) (City of Pori 2020).

No sites in the MATTI soil condition data base are located in the southern VRP area (Figure 6.10-3). In MATTI-sites soil contamination has been discovered or there is activity in the area that can cause soil contamination, or there are sites in the area that have already been remediated. Several sites of the MATTI-system are located in the Tahkoluoto port area (see Figure 6.10-3). Most of the sites are located in the chemical port area. Two sites on the eastern and northern side of the VRP area are located in the operating areas of Fortum Power and Heat Oy and Stena Recycling Oy.

One MATTI-site (ID 100312997) is located in the northern VRP area. The site is the eastern part of the storage area of Neste Oy (currently Fortum Oy). There is no need for remediation in the area with existing land use. The area has been remediated. (Ramboll Finland Oy. April 16, 2008.Neste Oil Oyj. Remediation of contaminated soil. Final report. Neste eastern storage area. Tahkoluoto, Pori). It was described in the report that residual contents met with the goals of remediation, and no separate monitoring programme was suggested for the area. Although the property was found to be sufficiently remediated, potential contaminated soil may be found during earthworks and the quality of the soil must be examined before excavation works can be continued.

Preliminary surveys were performed in the VRP area in spring 2021 to examine the quality of soil and construction conditions (Sweco 2021d). The quality of soil was studied from 28 sample sites in the southern VRP area and 4 sample sites in the northern VRP area. Soil samples were taken as composite samples at a depth of 0.5 – 1.5 m, and pursuant to the Vna 214/2007 metals and petroleum hydrocarbons were analysed from all samples. In addition, PAH compounds, PCB compounds, dioxines and furans were analysed from some of the samples. Soil pH value was also analysed from three samples, which was 8.0 – 10.4 or alkaline.

As the land use in the area is designated for industrial and port operations and no sensitive sites are located in the immediate vicinity of the VRP areas, the higher guideline values pursuant to the Vna 214/2007 are applied to the assessment of soil contamination and need for remediation. Based on the results, samples included concentrations of arsenic, cobalt, mercury, nickel, antimony and vanadium that exceeded the threshold values in the southern VRP area. In addition, arsenic concentration exceeded the lower guideline value in one sample site. Concentrations of harmful substances exceeding threshold values were not detected in the northern VRP area. As the higher guideline values were not exceeded, there is no need for soil remediation works considering that the existing insensitive land use (industrial area) will prevail in the area.

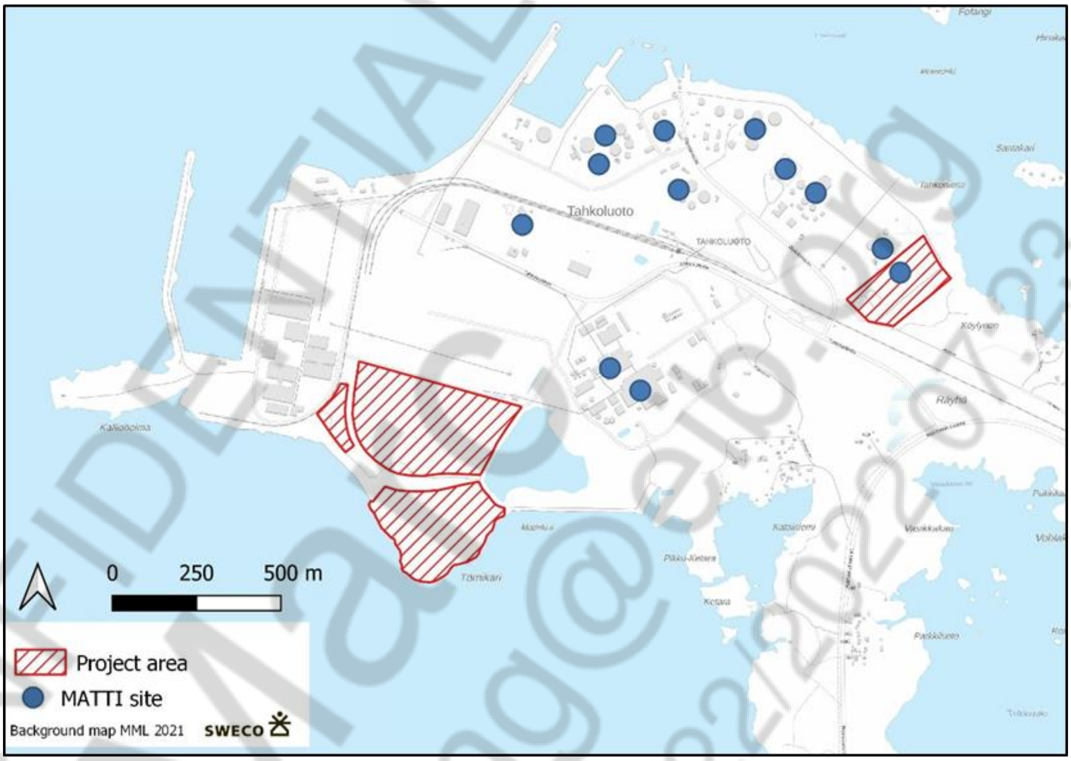

Figure 6.10-3. MATTI-sites near the VRP area.

The southern VRP area is partly located on land, which was filled up and the northern VRP area is filling soil. Even in the 1980s, Törnikari was an island outside of Tahkoluoto (Figure 6.10-4).

Construction condition studies implemented in spring 2021 were focused on the southern VRP area, where the vanadium recovery plant will be constructed. Soil composition and the soil horizon structure were studied with static-dynamic penetration test. In addition, percussion drillings were performed to check the bedrock surface. The type of soil was determined from soil samples. The results confirmed that the area consists of very dense filling soil to a depth of about 1.5 m and patchy filling soil even to a depth of 4.5 m. Moraine layers exist beneath the filling soil. Bedrock surface in the southern VRP area is located at a depth of about 13.0 – 21.6 m depending on the survey site.

Figure 6.10-4. Base map from 1987 ©Maanmittauslaitos

The water area to the northeast of Törnikari, the embankment pond has been filled with fly ash and bottom ash of coal. According to the environment permit and water permit granted in 2010 to the Port of Pori Oy (Regional State Administrative Agency for Southern Finland February 23, 2010), air and bottom ash can be placed in the filling area providing that the concentrations of harmful substances do not exceed the limit values for concentration and solubility defined in the environmental permit.

According to the environmental permit application for the Törnikari filling area of the Port of Pori Ltd (Environmental Permit Information Service, ylupa.avi.fi) and the permit decision (Regional State Administrative Agency for Southern Finland September 23, 2020), a total of approximately 6.8 ha of the filling has been completed and approximately 3.6 ha of the area has not been filled (Figure 6.10-5).

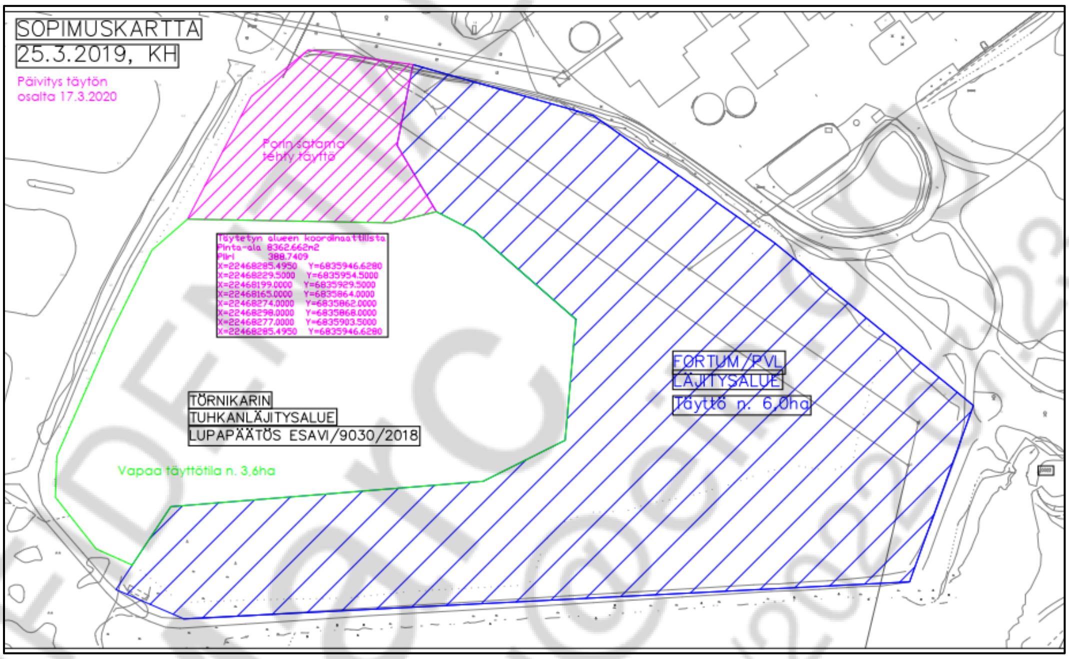

Figure 6.10-5. Implemented ash disposal in the Törnikari filling area (environmental permit application ylupa.avi.fi, submitted by the Port of Pori on February 18, 2020).

6.10.4 **Current state of groundwater**

The nearest important groundwater areas suitable for water supply are located at a minimum distance of 14 km from the VRP area (Figure 6.10-6). No groundwater monitoring standpipes are located in the Tahkoluoto area. Groundwater level in the area is expected to follow sea water level.

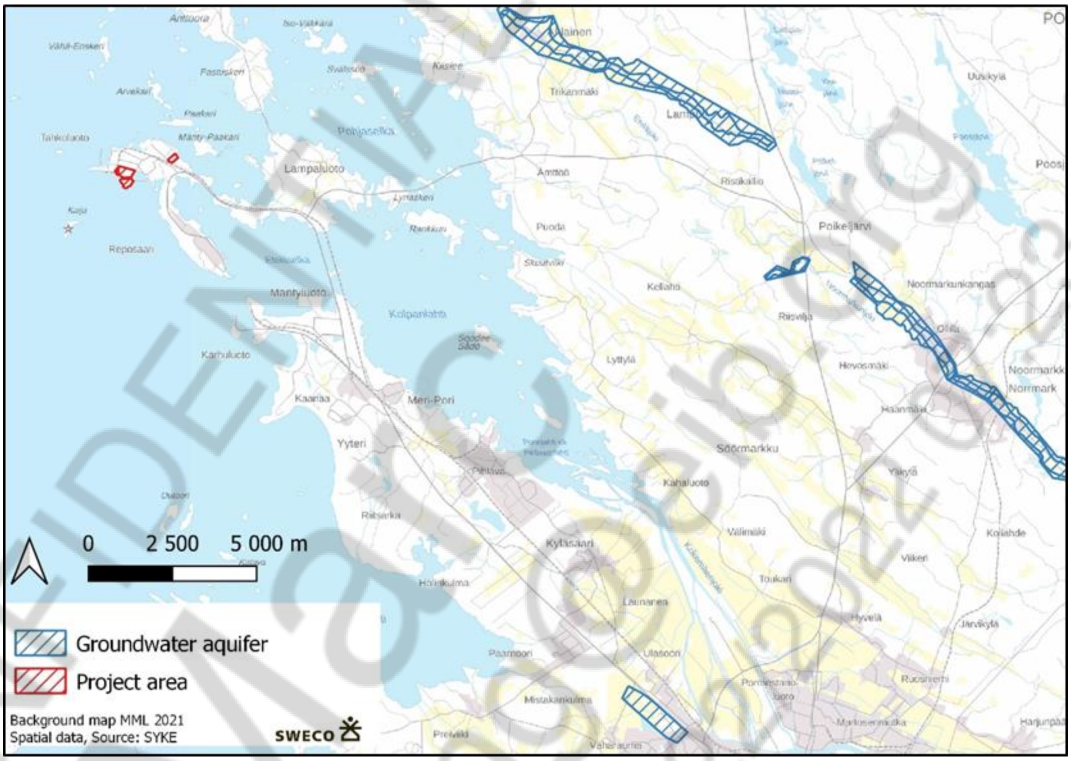

Figure 6.10-6. Groundwater areas in the vicinity of the VRP area.

6.10.5 Impacts during construction

Typical impacts on soil are caused by excavation and piling during the construction phase. At least part of the VRP area is likely to be constructed on pile foundation. Depending on the type of soil, potential impacts of piling on soil can include e.g. the movement of metals. Detected metal concentrations are very low in the VRP area, and based on soil surveys, the soil is alkaline, which often slows down the movement of metals. Impacts on soil will not probably be significant.

The characteristics of replaced land masses during construction works will be taken into account in the treatment and relocation of earth materials. Detected increased heavy metal concentrations in the VRP area will be taken into account during excavations and other construction works as well as with regard to industrial safety and location of land mass deposits.

There is no difference in impacts during construction between the sub-alternatives Alt.1a and Alt.1b. No impacts will be caused during construction in alternative Alt.0, but similar impacts can be caused by another potential project implemented in the area.

6.10.6 Impacts during operation

Planned operations are mainly located in an area, which has previously been in industrial use, and it is estimated that the normal operation of the plant will not have significant impacts on soil and bedrock or geologically significant sites.

The structures of the storage areas of both slag and SSM are designed and implemented so that stormwater from the area and seepage water from stockpiles will not reach the soil (chapter 6.5). Other yard areas will be paved. Potential exceptional situations and risks of chemical leaks will be assessed (chapter 6.14) and prepared for. Environmental risks related to the storage of slag and SSM are also assessed in chapter 6.5 (Impacts of the treatment of raw materials, by-products and waste).

There are no groundwater areas in the immediate vicinity of the VRP area. There will be no impacts on soil or groundwater from normal operation of the project.

6.10.7 Prevention and mitigation of harmful impacts

Potential harmful substances included in land masses that will be removed during construction works will be taken into account in the treatment and relocation of earth materials.

The structures of the storage areas of SSM will be implemented so that harmful substances potentially dissolving to stormwater and seepage water from stockpiles will not enter the soil.

Entry of chemicals to soil in potential disturbances and accidents will be minimized through thorough risk assessment and preparation for exceptional situations (chapter 6.14) as well as by proper construction of chemical storage tanks and areas that comply with legal requirements.

6.11 Landscape and cultural environment

6.11.1 Summary

New construction in the Tahkoluoto area will not fundamentally change the landscape viewed from the sea. Industrial activities have existed for a long time in part of the VRP area and in its immediate vicinity. Port and industrial area with high and relatively large buildings and structures have until now clearly stood out in the landscape. Occurred changes will mainly merge with the existing milieu, and thus impacts will be relatively minor.

Noise impacts and impacts on air emissions from the operation of the plant and traffic will not extend to the nearest nationally and regionally valuable areas. Other valuable sites have located in the impact area of the port for a long time.

It is estimated that the overall impacts of the project on landscape and cultural environment will be minor.

Comparison of alternatives and significance of impact

In alternative Alt.1b the visual impacts of SSM in landscape can be slightly greater than in alternatives Alt.1 and Alt.1a. In alternative Alt.0, impacts on landscape can be caused by another potential industrial activity constructed in the area.

Significance of impact is assessed as minor and negative.

Construction phase

Impact	Alternatives Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Landscape and cultural environment	Impacts are related to visual impacts of the construction site and noise from construction works and traffic.	No impacts on landscape and cultural environment.	There is no difference between the alternatives. Significance of impact on landscape is assessed as minor and negative (-).

Operating phase

Impact	Alternatives Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Landscape and cultural environment	Landscape in the area, which has already been in industrial use, will not change when viewed from the sea. Noise and air emissions from the operation will not have significant impacts on the valuable sites of landscape and cultural environment.	No impacts from the project. Impacts from other potential industrial activities constructed in the area.	In alternative Alt.1b, the visual impacts of SSM on landscape can be slightly greater than in alternatives Alt.1 and Alt.1a. Significance of impact on landscape is assessed as minor and negative (-).

6.11.2 Assessment method and uncertainties

Impacts on landscape and cultural environment was examined through the analysis of current situation, elements of landscape structure, photos and illustrations, which visualize the project plans.

Industrial activities exist already today in part of the VRP area and in its immediate vicinity, and the nature of the area as a whole will not significantly change along with the project. Consequently, the focus of the impact assessment was on the surrounding landscape zone.

The design of the facility is still tentative and there is no detailed information on the size, shape, colour and location of new buildings and structures in the area, which can cause slight uncertainties in the assessment. However, there is adequate information on the scale of construction for the assessment.

6.11.3 Current state of landscape and cultural environment

In the Satakunta Landscape Area division, the Tahkoluoto area belongs to the Southwest Landscape Region and the Satakunta Coastal Landscape Area (Ministry of the Environment 1992). The area is a rugged coastal zone by nature. In the Satakunta coastal region, the archipelago zone narrows from the southwestern archipelago towards north. Nature becomes rugged towards north. Landscape is low-lying and has small-scale features as a consequence of soil versatility. The coast has long, sheltered and reed-filled bays that dry up due to gradual land upheaval. Northwest oriented capes and shallow bays filled with rocks and islets are typical for the region. In sheltered, clay-bottom depressions, vegetation can even be lush. Settlement in the archipelago is scarce and hardly no villages can be found. However, single fishing villages related to fishing industry can be found on the islands and bay bottoms.

Due to land upheaval, landscape features change naturally in the area. However, a more significant change has been caused by the construction of the port, causeway, railway and fillings as well as wind power construction and power lines (City of Pori 2020, Satakunta Regional Council 2014).

Figures 6.11-1 and 6.11-2 show the landscape in the Tahkoluoto port area. In Figure 6.11-1 the southern VRP area is located on the right side of the power plant buildings behind the coal conveyor. In Figure 6.11-2 the northern VRP area is located behind the furthermost tanks.

Figure 6.11-1. Tahkoluoto port area viewed from north (Port of Pori Ltd).

Figure 6.11-2. Tahkoluoto port area viewed from west (Port of Pori Ltd).

The southern VRP area today viewed from Reposaari is presented in Figure 6.11-3. Significant elements in the landscape of the Tahkoluoto area include power plant buildings with a smokestack and a coal conveyor, port cranes, tanks in the oil port and wind power stations.

Figure 6.11-3. Southern VRP area viewed from Reposaari (photo Einari Vuorinen).

Nationally valuable landscape areas

The Ahlainen landscape area (MAO020036) is located approximately 5 km to the northeast of the VRP area (Figure 6.11-4). The Yyteri landscape area (MAO020039) is located approximately 7 km to the southeast of the VRP area. The Ahlainen cultural landscape represents small-scale and variable cultivation and village landscape typical for the Satakunta coastal area. Yyteri is one of the most extensive continuous beach and post-glacial dune areas in southern Finland. The beaches in Yyteri are a famous natural attraction and holiday resort (Ministry of the Environment 1993).

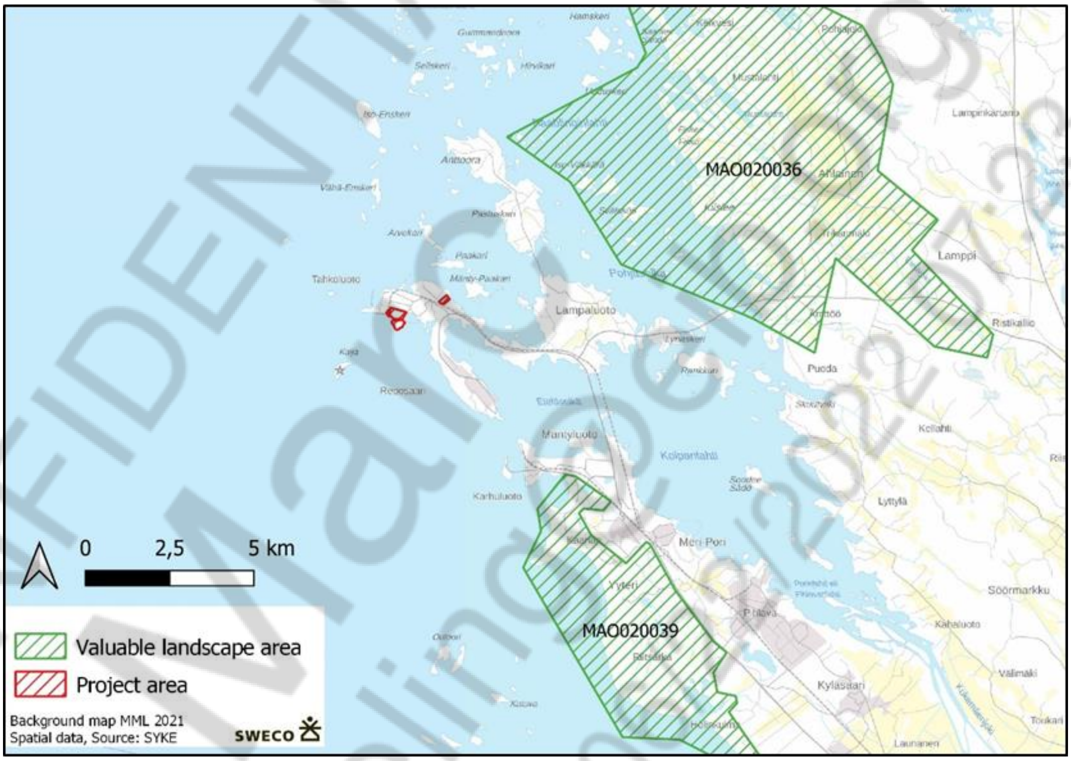

Figure 6.11-4. Nationally valuable landscape areas near the VRP area.

Nationally and regionally significant built-up cultural environments

The Reposaari community located at a minimum distance of 1.5 km to the south/southwest from the VRP area (ID 1497, Figure 6.11-5) is a built-up cultural environment of national significance. Reposaari together with Mäntyluoto form a community outside of the City of Pori that grew up in the second half of the 19th century, and it has been of great local and national importance due to its port operations, shipyard and steam sawmill. The uniform, modest wooden building stock is mainly from the maritime golden age of the second half of the 19th century and the beginning of the 20th century. The oldest part of the building stock in the area constitutes a hotel completed in 1838 and bourgeois villas built in the mid-19th century (Finnish Heritage Agency).

Figure 6.11-5. Nationally significant built cultural environment. The Reposaari community is shown with blue grid in the figure (Finnish Heritage Agency, map service).

A smokestack remains of the nationally important major Reposaari sawmill, which burned down in 1995. The cemetery, founded in 1896, has a common grave and memorial of those who perished in the sinking of the torpedo boat S2 in 1926. The existing fortress park in Reposaari features a concrete bunker station and trenches built in the 1930s. The wooden pilot station in Reposaari belongs to the building stock of the port and is a rare example of the operation of early harbour pilots (Finnish Heritage Agency).

Nationally significant Mäntyluoto pilot and port environment is located at a distance of about 5 km to the south-east of the VRP area. Mäntyluoto port is versatile environment related to port history and navigation together with Reposaari adjacent to it. The cultural environment includes the Kallo island, which is a historically significant pilot station, the Kallo lighthouse (so-called Ryssäntorni), which is now a fixed beacon with no light and the Mäntyluoto railway station milieu with parks related to the port railway. The small, densely built Uniluoto community is also part of the port area (Finnish Heritage Agency).

Regionally valuable cultural environments include Kallo lighthouse and pilot station (96, Figure 6.11-6), Reposaari (97), residential area of the Reposaari sawmill (98), southern coast of Reposaari (99), Uniluoto (92), Mäntyluoto hotel (93), Mäntyluoto railway station (94) and Mäntyluoto lighthouse (95). Other cultural environments of Satakunta near the VRP area include the Brander archipelago village (100) in Lampaluoto about 3 km to the east-southeast from the northern VRP area and the Anttoora and Pastuskeri built-up cultural environments located about 4 km to the north-east. Several old fishing villages are located between Ahlainen River delta, Lampaluoto and Lyttylä. Some of them have been developed into summer cabin areas (Satakunta museum 2012).

Figure 6.11-6. Regionally valuable cultural environments near the VRP area (Satakunta Museum 2012).

Tahkoluoto-Paakarit building inventory

A building inventory was implemented in 2010 in the Tahkoluoto–Paakarit area to meet the needs of the component master plan (Figure 6.11-7). There are residential buildings from the 1920s, 1940s and 1950s as well as probably one fishing farm (Reposaari main road 990) in Parkkiluoto, which is located between Tahkoluoto and Reposaari. The oldest buildings in the area of the Tahkoluoto detailed plan are from the early 20th century and a few buildings are from the 1950s and 1960s (City of Pori 2020).

The buildings were valued as an object to be protected (A), an object to be slightly protected (B) and an object that may be excluded from protection (C) (Figure 6.11-7).

Figure 6.11-7. Objects in the building inventory of Tahkoluoto. Valuation category A with red, B with blue and C with grey. Objects in the Kaartotie area (black border line) are not included in the detailed inventory or valuation. (Pori City 2020)

Archaeological inventory

In connection with the preparation of the master plan in 2010, an archaeological inventory was carried out (see Figure 6.11-9). Based on tradition, Kappelinluoto (ID: 609010022) contains a chapel, a cemetery, and possibly a fishing village or dwelling units. Several foundations of buildings and stone structures associated with fishermen settlement have been discovered in Kappelinluoto. There is a memorial at the site (City of Pori 2020, Finnish Heritage Agency).

In the inventory of the Tahkoluoto area in 2010, a tenant settlement from the year 1745 was identified (Tahkoluoto village ID: 1000024376, Figure 6.11-8), which is located on the eastern side of the power plant. The site was still inhabited in the 1980s, but due to the power plant, the settlement vanished, and the area is partly within the fenced area of the power plant (Finnish Heritage Agency). Due to its historical significance, the village of Tahkoluoto is a cultural heritage site. There is also the Tahkoluoto meadow, which is classified as a regionally significant natural site. (Satakunta Museum 2014). The village of

Tahkoluoto is located at a minimum distance of 300 m to the south-west from the northern VRP area.

Figure 6.11-8. Village of Tahkoluoto (Satakunta Museum 2014).

Fortifications were built to protect the port of Pori during the World War I. The islands contain remnants of structures that have been included in inventories, for example cellars and stone heaps of different age, some of them are stone fences constructed with the cultivation of new land, storm shelters and apparently also wartime shelters (City of Pori 2020).

Vasikkarinkari in Parkkiluoto area is apparently the site of a Second World War artillery battery (ID: 1000024377). There are basements and foundations of buildings as remnants of the original settlement in the area in Tahkoluoto along Kylänmäki road (City of Pori 2020, Finnish Heritage Agency).

Several underwater remains are identified in Tahkoluoto and Parkkiluoto area and in its vicinity, and potential relics are identified in Tukkiviikki. (City of Pori 2020). At a distance of about 1 km west from the VRP area lies a solid relic, the metal wreck 'Lightning' (ID: 1734).

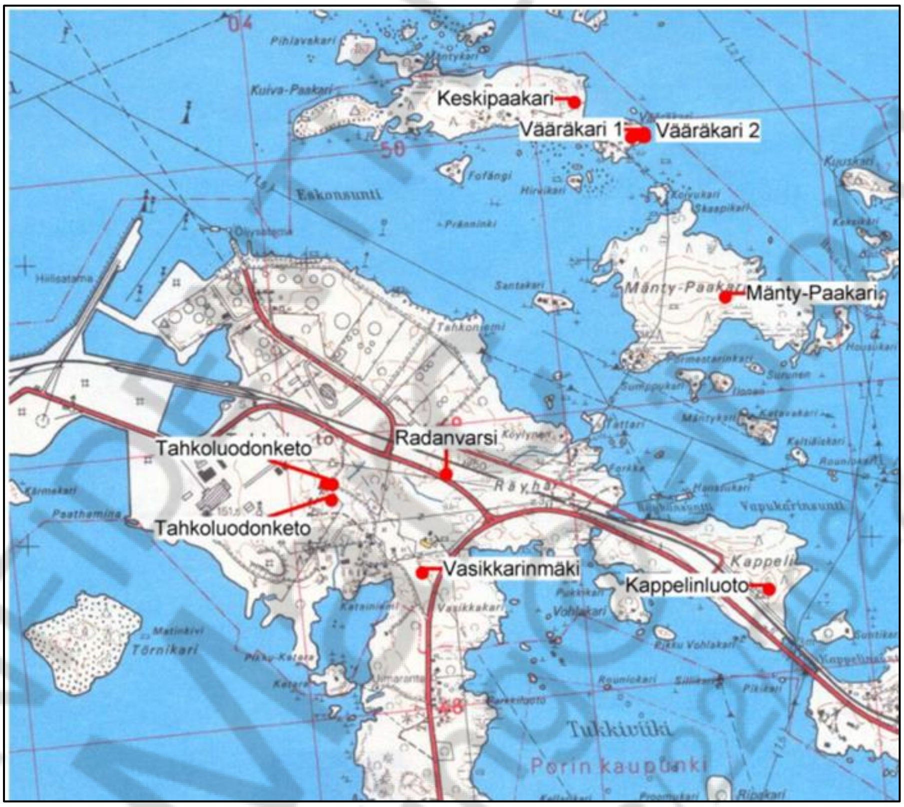

Figure 6.11-9. Archaeological heritage sites in Tahkoluoto area based on the inventory of the year 2020 (City of Pori 2020).

6.11.4 Impacts

New buildings and storage areas for slag and SSM are constructed in the project to the existing port and industrial area and in its immediate vicinity. The production facility of the vanadium recovery plant, slag and SSM stockpiles located in the nearby area can be seen from the southern sea area of Tahkoluoto and from Reposaari direction (Figure 6.11-10). Significant landscape elements viewed from the same direction also include the existing power plant with a smokestack, a coal conveyor and wind power stations.

The maximum height of stockpiles is 15 m. The elevation of new construction is relatively low compared to the elevation of the existing buildings and structures in the port area, for example, the height of smokestack of the power plant is 150 m and the height of coal conveyor is about 30 m.

Slag stockpile in the northern VRP area can be seen from the northern sea area of Tahkoluoto (Figure 6.11-11). The chemical port area is located immediately on the western side of the slag stockpile.

Sites, where photos were taken are presented in Figure 6.11-12.

Figure 6.11-10. Vanadium recovery plant in the southern VRP area viewed from the western coast of Reposaari (illustration, photo Einari Vuorinen). Tree stand is not visible in the photo, which surrounds the edge of the island and provides shelter for the plant from public *view.*

Figure 6.11-11. Northern VRP area, slag storage area (maximum volume of slag stockpile) viewed from north to south (illustration, photo Einari Vuorinen).

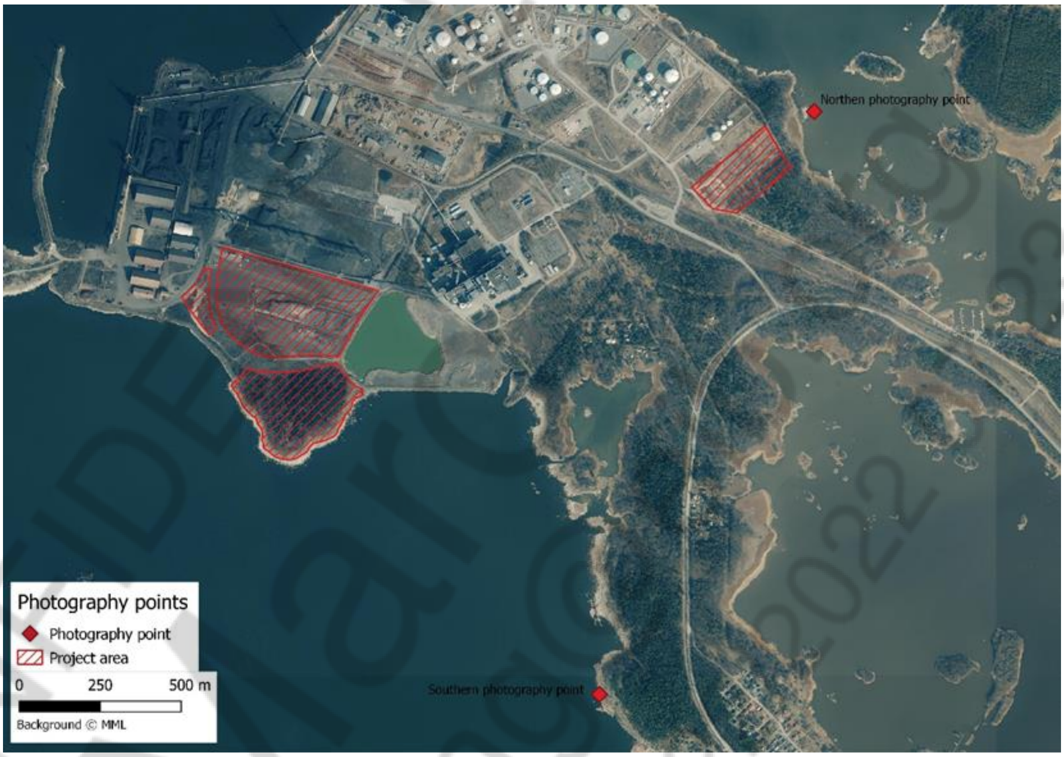

Figure 6.11-12. Sites, where photos were taken.

The tree stand and other vegetation between the northern VRP area and coastline block some of the visibility from the sea water level especially in summer. Attention in landscape illustration is also focused on the tanks in the chemical port.

New construction in the Tahkoluoto area will not fundamentally change the landscape of the area when viewed from the sea. The Tahkoluoto port and industrial area with large and high structures has so far clearly stood out in landscape when viewed from the sea. Tree stand blocks to some extent the visibility from Reposaari to the direction of Tahkoluoto especially in summer.

Changes in the area will obviously be observable changes, when examining the port and industrial area more closely. Occurred changes will mainly merge with the existing milieu, and thus impacts will be relatively minor.

Noise and emissions to air by the operation of the plant and traffic will not affect the nationally and regionally valuable Reposaari community. The cultural historical site of Tahkoluoto village located near the power plant has located in the impact area of the port for a long time, as well as the buildings discovered during the building inventory.

The implementation of the project will not cause significant changes in the structure, features or quality of landscape. The area is perceived as a landscape characterized by industrial and port operations, and the industrial area as a whole will not fundamentally extend from the present state. The overall impacts of the project on landscape and cultural environment are estimated to be minor. In alternative Alt.1b, the size of SSM stockpiles and thus the visual impacts on landscape can be slightly greater than in alternatives Alt.1 and Alt.1a, but otherwise there is no difference between the alternatives.

The nearest nationally significant landscape areas and nationally or regionally significant built cultural environments are located so far from the VRP areas that the environment is not very sensitive to change. Other sites of cultural environment, which were discovered during the inventories of Tahkoluoto environment, are located in the surroundings of a port and industrial area, which will reduce the sensitivity of environment to change. Environmental impacts related to noise and lighting have already previously been caused by the port and industrial area, and the change compared to the previous situation is not significant. The relation between the port and industrial area and the environmental sites will not change. The implementation of the project will not have direct impacts on the features and values of the sites, and the above mentioned landscape impacts or impacts related to emissions, noise and lighting are estimated to be minor. Thus, it is estimated that the significance of impact will be minor.

Subjective factors have an influence on the fact, whether observed changes in landscape are experienced as more harmful in terms of “strengthening” of the industrial area, or positively as a sign of improved vitality of the City of Pori.

If the project by Critical Metals is not implemented, other industrial activities will probably be constructed in the planned area over time, which will have impacts on landscape.

6.11.5 Prevention and mitigation of impacts

Harmful visual impacts on the nearby environment can be mitigated by preserving the tree stand or planting more trees to the terrain between the plant area and shoreline, when needed. Lighting of the plant area can be designed so that light is not directed straight to the residential and recreation areas.

6.12 Social impacts

6.12.1 Summary

The project is in line with the commercial and industrial strategy of the city of Pori, as the project investment will have positive impacts on business development, economic life and employment.

The project is estimated to employ approximately two hundred people on site during the busiest phase of construction. Planning and design of the project will also have an employment effect. There is a positive impact on employment and regional economy in the construction phase. The project will have positive impacts on employment and economic life and impact are assessed as significant and positive.

When completed, the plant will employ about 80 persons. The positive development of business life will also ensure the availability and development of services and local trade.

Minor disturbance can be caused to environment from traffic related to the construction works of the plant, but the impacts will be temporary and the significance of impact is estimated as minor. The nearby residential areas and disturbed sites are located relatively far away from the VRP area.

It is estimated that the operation of the plant and related traffic operations will not have significant harmful impacts on human health. No impacts are estimated to be caused on the comfort of the nearest residential areas and no significant disturbance to the recreational use of the environment. Road traffic related to the operation of the plant will to some extent increase the disturbance from traffic in the immediate vicinity of traffic routes.

The resident survey introduced the concerns of residents about the impacts related to the implementation of the project. The share of respondents having a positive attitude towards the project was also significant. Especially, potential impacts on the vitality, economy, business life and employment of the area were considered as positive impacts.

The implementation of the VRP will have significant direct positive impacts and multiplier effects on the development of industrial structure, number of jobs and regional economy.

It is estimated that the significance of overall impacts on health, living conditions and comfort will be minor and negative.

The project will have positive impacts on employment and business life and the impacts are assessed as large and positive.

Comparison of alternatives and significance of impact

There is no fundamental difference between alternatives Alt.1, Alt.1a and Alt.1b with regard to social impacts. The overall impacts of the project are assessed as moderate and positive.

Construction phase

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Social impacts	Temporary disturbance can be caused to environment from construction works and traffic. Positive impact on employment and regional economy.	No impacts. Similar impacts can be caused by another project implemented in the area.	No difference between alternatives Alt.1, Alt.1a and Alt.1b. Disturbance to environment is estimated as minor and negative. Overall impacts during construction will be minor and positive (+).

Operating phase

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Social impacts	No harmful impacts on human health, no disturbance to nearby residential areas and no significant disturbance to recreational use of the environment. Transport operations will increase disturbance to some degree in the immediate vicinity of traffic routes. Positive impacts on employment and business life. Concern related to the project impacts is a negative impact.	Positive impacts on employment will not be generated.	No fundamental difference between alternatives Alt.1, Alt.1a and Alt.1b. Overall impacts on health, living conditions and comfort are assessed as minor and negative. Impacts on employment and business life are assessed as large and positive. Overall impacts of the project are assessed as moderate and positive (++).

6.12.2 Assessment method

Impacts on humans and the society were assessed as an expert evaluation, and the results of the resident survey performed in the EIA procedure were used in the assessment.

Potential impacts from the operation of the plant on health, living conditions, comfort and services as well as employment and business life were considered in the assessment. Impacts from the operation on health and comfort were assessed based on emissions and risks caused by the operation. Noise and air quality impact assessments as well as traffic impact assessment were used in assessing the impacts on health and comfort.

The special focus of the impact assessment was on the nearest residential areas and recreation areas and other sites susceptible to harmful impacts.

A resident survey was performed as part of the assessment (Appendix 3). Opinions and attitudes on the project and its potential impacts as well as information on the existing use of the area were inquired in the resident survey. The resident survey was an Internet-based survey, but an opportunity to reply by a paper form was also provided. Questions were prepared so that key issues related to the project could be examined. Based on replies, the general acceptability of the project and the concerns of the respondents related to the project were evaluated in the assessment. The survey was open during May 2021 and it was notified by e-mail, social media and advertisements. 160 respondents replied to the survey. With regard to the results of the resident survey, a potential uncertainty is the coverage of a certain group of respondents or if a certain group (for example certain age group) has replied more actively, which can skew the results. The aim was to inform about the survey as comprehensively as possible.

Group discussions were held during the EIA procedure for those persons, who left their contact information during the resident survey and accepted the invitation to group discussions. Contact information was handled in accordance with the GDPR Regulation.

In the public hearing of the EIA procedure, the production facility of carbon dioxide used in the VRP came up for discussion. The statements submitted to the coordinating authority also highlighted emissions to the water system, impacts on bird population, cumulative impacts of the project with the extension of the wind farm and potential impacts on conservation values. A response to the questions and comments from the public is included in the EIA report (chapter 4.4 and Appendix 2).

6.12.3 **Current state**

6.12.3.1 Residential areas and sensitive sites

Three people live in the Tahkoluoto area in 2021. There are also empty residential buildings in the area; three two-dwelling houses and nine single-family houses. Permanent housing is vanishing from the area. In the Katainniemi area, the city has purchased properties vacated from residential use to establish a safety-zone for the port area. According to the building and apartment register, there are also holiday homes on islands. There are a total of 144 leisure home properties or lease parcels of land in the Tahkoluoto-Paakarit area. (City of Pori 2020). Permanent housing is located in the Parkkiluoto and Katainniemi residential areas.

The nearest residential buildings to the southern VRP area are located in the eastern direction and in Parkkiluoto residential area at a minimum distance of 1.0 km to the east and southeast of the VRP area border. The nearest holiday homes to the northern VRP area are located over 200 m and 300 m to the southwest of the VRP area border.

The nearest school, kindergarten and camping site are located about 2 km to the southeast of the VRP area in Reposaari (Figure 6.12-1).

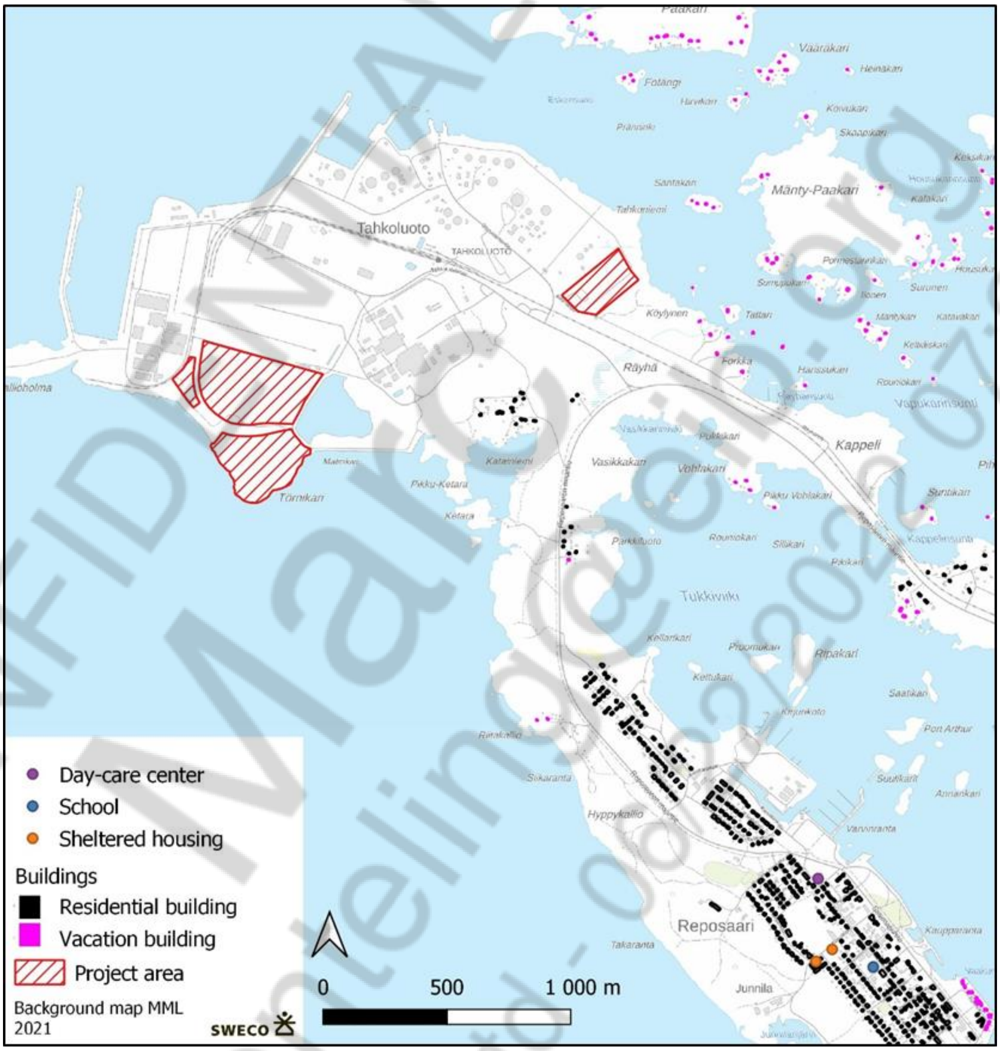

Figure 6.12-1. Residential areas and sensitive sites in the vicinity of the VRP area.

6.12.3.2 Employment and business life

The employment rate in Pori was 69.8 % in 2019. The employment rate in 2019 slightly increased from the year 2018 (69.0 %). There were a total of 35 032 jobs in the Pori area in 2018. The employed labour force residing in the Pori area was 33 207 persons in 2019 (Statistics Finland). In March 2021, the Pori region had the highest unemployment rate in Satakunta (ELY Centre 2021).

The Pori region has one of the most diversified industrial structure in Finland. The share of Satakunta of the industrial jobs in Finland is about 6 % or about 1.5 times larger than the share of population (Satakunta Regional Council 2017).

The largest employers in the Pori region at the end of the year 2015 include social and health services (SOTE) (share of 21 %), industry (17 %) and wholesale and retail trade (11 %). The share of these employers is about half of the jobs in the region. The largest employers in industry include technological industry (share of all jobs is 10 % and over 50 % of industrial jobs, manufacture of basic metals, machinery as well as fabricated metal products and vehicles are well represented), chemical industry (share of industrial jobs 12 %) and food industry (share of industrial jobs 9 %) (Satakunta Regional Council 2017).

6.12.3.3 Recreation areas and recreational use

The Siikaranta camping area is located in Reposaari at a distance of about 1.5 kilometres to the south-east of the southern VRP area. The nearest areas in recreational use to the northern VRP area are located on islands outside of the north-eastern part of Tahkoluoto at a minimum distance of over 200 metres from the border of the VRP area.

There are boat berths, a boat ramp and a winter storage area for boats in Kappelinluoto (Merikappeli) area about 2 km to the east from the southern VRP area and 1 km to the south-east from the northern VRP area. In addition to Räyhänsuntti, boat berths can also be found on the eastern shore of Kappeli. The closest guest marina to Tahkoluoto is located in Reposaari (City of Pori 2020).

According to the existing detailed plan, the fringe areas of the port, Räyhä located in the southeastern part of Tahkoluoto, Kappeli and part of the Tukkiviikki shore area located on the eastern side of Reposaari are designated as park areas. However, the area has been of less recreational use in the Tahkoluoto area due to the expanding port and associated industrial activities. There are some trails created by outdoor hiking in the coastal zone between Ketaranlahti located in the northeastern part of Tahkoluoto and Siikaranta in Reposaari. The Siikaranta camping area can increase the pressure for recreational use in the area. The site of a relic in Kappeli has previously been e.g. a site for open air worships and excursions (City of Pori 2020).

In the draft Tahkoluoto – Paakarit component master plan (2020), the nearest recreation areas to the VRP area are located on islands outside of the north-eastern part of Tahkoluoto.

Recreational fishing and boating are practiced in the marine areas outside of Pori.

6.12.4 **Impacts on human health, living conditions and comfort**

6.12.4.1 Health, living conditions and comfort

The estimated duration of the construction phase is less than two years and social impacts during this phase are temporary. Noise from construction work can occasionally cause some disturbance in the nearby environment. The most significant noise impacts are estimated to be caused by piling during the construction of foundations when noise impacts will occur in the water areas around the VRP area and some noise impacts can also extend to the Reposaari area.

Traffic volumes to the area will be relatively high during the construction phase and especially passenger traffic volumes will be significantly higher when compared to the operating phase. The disturbance caused by traffic will be similar both in the construction and operation phase. It is estimated that dusting from earth works will neither spread far from the construction site nor will cause any harmful impacts on the environment. The project is estimated to employ approximately two hundred persons during the busiest phase of construction. The construction phase will have positive impacts on regional economy and employment.

Process emissions from the plant will have a minor impact on air quality. Health-based limit values of air quality are not at risk of being exceeded. Potential dust emissions from slag stockpiles are not estimated to have detectable impacts either on the permanent residential areas or even on the nearest holiday homes. Exhaust gases related to the operation of the plant promote the impacts which deteriorate air quality near the traffic routes, but these emissions are not estimated to cause detectable health impacts. Impacts on air quality are assessed in more detail in chapter 6.6.

Heavy traffic directed to the port and noise from traffic are likely to cause disturbance to residential buildings located in the immediate vicinity of traffic routes already today, and disturbance from traffic will increase to some extent along with increasing traffic volumes. Risk of traffic accidents can also increase. However, there are no specific risks related to the transport operations of the plant compared to the risks of regular heavy traffic. Traffic impacts are assessed in chapter 6.3 and impacts related to accidents and disturbances are assessed in chapter 6.14.

Water areas and recreation areas surrounding the VRP area have already now suffered from noise impacts from the port area and due to the implementation of the VRP, noise levels will increase to some extent. However, it is estimated that no significant change will occur compared to the current situation. If recreational activities, for example, hiking and boating suffer from significant impacts in the vicinity of the plant, there would be other suitable areas for recreational use in the coastal areas of Pori.

It is estimated that the operation of the plant will not cause detectable noise impacts on the nearest residential area. Noise impacts are assessed in chapter 6.4.

Emissions directed to the water system will not be generated by the process, and stormwaters from the area can only be directed to the water system in rare and exceptional situations. Even in this case, impacts on the water system will be local and minor.

It is estimated that no significant impacts will be caused on the nearest residential area even in a potential accident or disturbance situation occurring in the VRP area (chapter 6.14).

The concerns of local residents as a result of the resident survey (chapter 6.12.4.3) related to the negative impacts of the implementation of the VRP as a harmful social impact. The significance of this impact is estimated as moderate. Based on the resident survey, a considerable share of the residents have a positive attitude towards the project.

The operation of the plant and related transport operations are not estimated to have harmful impacts on human health. The operation of the plant is not estimated to have impacts on the comfort of the nearby residential area or significant disturbance to the recreational use of the environment. Road traffic related to the operation of the plant will cause some increased disturbance in the immediate vicinity of traffic routes. Concerns of the residents about the impacts of the implementation of the project were presented in the resident survey. The share of residents with a positive attitude towards the project is also significant. Overall impacts on health and comfort are estimated to be minor and negative.

There is no significant difference between alternatives Alt.1, Alt.1a and Alt.1b. There will be no actual impacts in alternative Alt.0, but impacts could be caused by another project implemented in the area.

6.12.4.2 Employment and business life

The project is in line with the commercial and industrial strategy of the city of Pori, as the project investment will have positive impacts on business development, economic life and employment.

The project is estimated to employ approximately two hundred persons on site during the busiest phase of construction. Planning and design of the project will also have an employment effect.

When completed, the plant will employ about 100 persons. The positive development of business life will also ensure the availability and development of services and local trade.

The implementation of the VRP will not have harmful impacts on other industrial activities in the Pori area. The Reposaari area is important for e.g.tourism, but the potential impacts of the port and industrial area in Tahkoluoto directed to the Reposaari area will not significantly increase as a result of the implementation of the VRP.

Zero alternative or non-implementation of the project is not in line with the strategies of the city to such degree that it does not support the development of competitiveness in the area. This alternative is not estimated to have a direct impact on employment, but it can have a negative impact in the future unless other activities with an employment effect were to be implemented in the port and industrial area.

The project will have positive impacts on employment and business life, and these impacts are estimated as significant and positive.

There is no significant difference between alternatives Alt.1, Alt.1a and Alt.1b. There will be no positive impacts in alternative Alt.0, but similar impacts could be caused by another project implemented in the area.

6.12.4.3 Resident survey

About a third of the residents who responded to the survey (Appendix 3) estimated that the distance between the VRP area and their permanent home or holiday home is over 10 kilometres, about half of the respondents do not think that they live in visual or hearing distance from the VRP area. Almost all of the respondents had used the nearby areas and waters of Tahkoluoto for many types of recreational use (figure 6.12-2). Slightly over half of the respondents were in the age group of 45–64 years and a share of 25 % of the respondents were over 65 years.

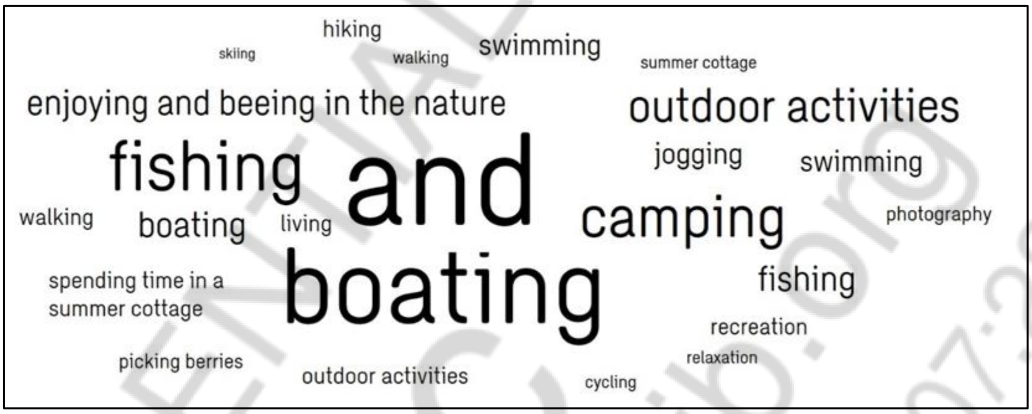

Figure 6.12-2.Resident survey, how the respondents have used the nearby areas of the VRP area for recreational use.

Some of the respondents considered that the project will fit well in the port and industrial area, whereas some considered it not to be suitable at all in the area (Figure 6.12-3).

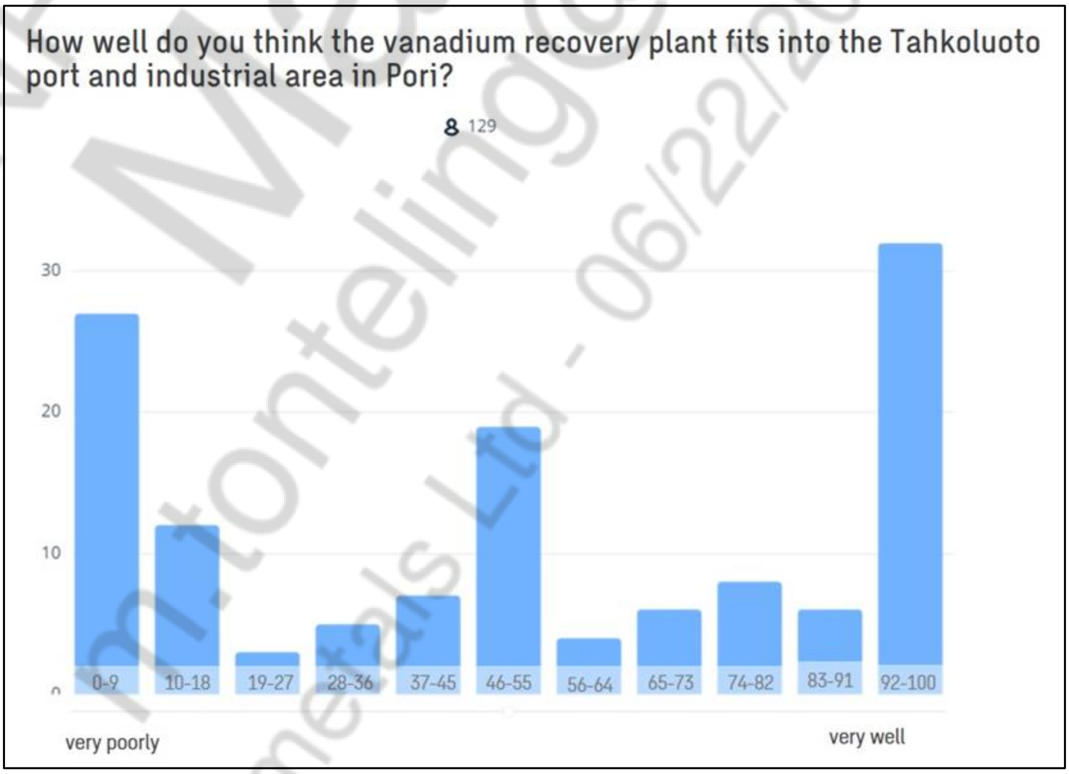

Figure 6.12-3. Received feedback to the question “How well do you think the vanadium recovery plant fits in the Tahkoluoto port and industrial area in Pori?” in the resident survey.

Major reasons for a negative attitude towards the location of the project in the Tahkoluoto area included the fear of different harmful impacts especially on natural environment, impacts related to e.g. waste water and impacts on comfort and recreation of residents. Impacts related to accident situations were also mentioned.

With regard to social impacts, the most concerning effects were the impacts on recreational and leisure time activities, comfort of the residential or holiday home environment, residential opportunities in the nearby areas and financial value of the real estates and residencies in the area or nearby area. Some of the respondents believed that traffic connections and arrangements could be improved along with the project. On average, respondents who live further away from the VRP area had slightly more positive attitude towards the project than respondents who live closer to the VRP area. Respondents living permanently or during free time closest to the VRP area had the most negative attitude towards the project.

It is expected that the project will have positive impacts on the employment, vitality and economy in the area, and to some extent even on other businesses. Negative economic impacts are estimated to be caused to tourism and the image in the area.

With regard to the three most significant impacts, impacts on the employment and vitality of the area were highlighted (Figure 6.12-4). Other significant impacts, which can be considered as negative impacts or threats, were the impacts on the water system and natural environment. Holiday home owners and residents living closest to the VRP area are concerned about the impacts on living conditions in the nearby areas. Also, impacts on comfort, real estate value and air quality were emphasized by respondents living in the nearby area. The respondents living closest to the VRP area were concerned about noise impacts. Respondents of age 45 and older and those living in the nearby area or in hearing distance also considered that traffic impacts will be significant. Respondents, who live further away from the VRP area, took notice of impacts on regional economy.

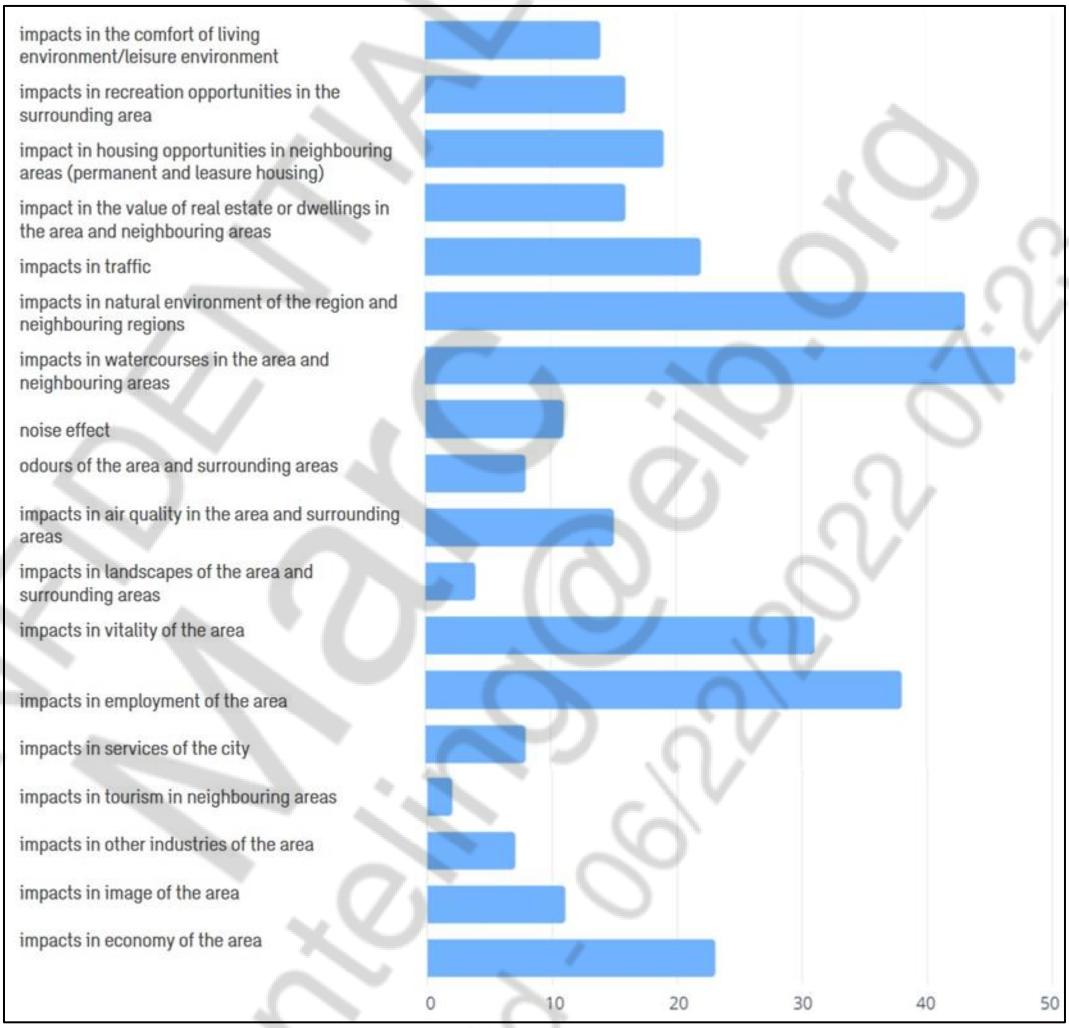

Figure 6.12-4. Based on the feedback from the survey, the three (3) most significant impacts of the construction and operation of the plant. The number of respondents is shown on x-*axis.*

The feelings of the respondents about the project are polarized: Some of the respondents have a very negative attitude towards the project, while some feel very positive about it (Figure 6.12-5). Respondents living close to the VRP area (permanent and leisure time residents) have a more negative attitude towards the project, and the attitude improves with growing distance from the VRP area. The share of respondents with a very positive attitude towards the project was slightly higher than the share of respondents with a very negative attitude.

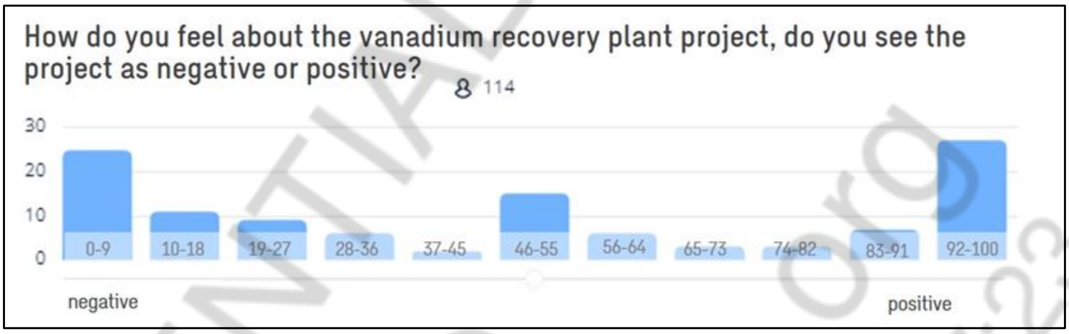

Figure 6.12-5. Overall attitude of the respondents towards the project.

As a summary of the results of the resident survey, some of the respondents were of opinion that the vanadium recovery plant would fit very well in the Tahkoluoto area and some thought that it will fit very poorly in the area. The fear of impacts especially on the nearby valuable natural environment, water system and landscape, as well as the noise, smell, and air quality impacts were emphasized in the results. The impacts on comfort and recreational opportunities in the nearby area are also suspected to be negative. Potential impacts on the vitality, economy, business life and employment in the area were considered as positive impacts.

6.12.4.4 Impacts on regional economy

The implementation of the VRP will have significant direct impacts and multiplier effects on the development of the industrial structure, number of jobs and regional economy. When the plant is completed, it will employ about 100 persons.

The concentration of industrial activities to the existing port and industrial area will bring new opportunities to the Pori area for the development of economic life and employment and it can, for its part, improve the visibility of companies, promote synergies and improve the positive image of the entire Pori region. The employment impact of the project with multiplier effects will also extend to other sectors, for example to trade and services.

6.12.5 Prevention of harmful impacts

When the environmental impacts of the project are managed and significant harmful environmental impacts are prevented, the impacts on human health and living conditions will also be minor.

With regard to social impacts, distribution of information and interaction are important mitigation methods of harmful impacts. The aim is to reduce unnecessary fears related to the impacts of the project by providing information about the project, its progress and impact assessment as well as implementation. The aim is to actively provide information especially to the residents in the nearby area of the VRP area and others interested in the project.

6.13 Natural resources

6.13.1 Summary

In the VRP, vanadium produced in mines from non-renewable sources of raw material is substituted by vanadium produced from slag in steel industry. At the moment, slag in the SSAB steel plants is stockpiled.

Natural resources are used as construction materials in the construction phase of the vanadium recovery plant. Material cut from the ground during construction in the area will be used as fill for the process areas and foundation construction.

The overall impacts of the VRP on the use of natural resources will be positive in the operating phase of the plant, as nearly 7 % of the global vanadium production will come from the VRP, if implemented.

The use of chemicals, energy and other utilities in the vanadium recovery plant as well as the use of fuels in transport vehicles and machinery consume natural resources. Renewable natural resources are preferred in the selection of chemicals and energy, if possible.

Comparison of alternatives and significance of impact

In alternative Alt.1b, the use of SSM does not replace the necessary materials needed for e.g. cement manufacturing and the use of non-renewable materials can be greater. Otherwise, there is no significant difference between the implementation alternatives. If the recovery plant is not constructed (Alt.0), it is possible that vanadium is produced to a greater extent also directly from ore extracted in mines.

Overall impacts of the project are assessed as large and positive.

Construction phase

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Use of natural resources	Natural resources are needed for construction materials.	No impacts on the use of natural resources.	No difference between alternatives Alt.1, Alt.1a and Alt.1b. Significance of impact is assessed as minor and negative (-)

Operating phase

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Use of natural resources	The project will promote circular economy and restrict the use of non-renewable natural resources. Natural resources will be consumed for chemicals, energy and fuels used in the production and transport of vanadium pentoxide.	Natural resources are consumed in the vanadium production from non-renewable raw materials.	In alternative 1b the use of natural resources can be slightly greater, otherwise there is no significant difference between the implementation alternatives. Positive impacts on the use of non-renewable natural resources will likely be significantly greater than in alternative Alt.0. Significance of impact is assessed as large and positive (+++)

6.13.2 Assessment methods and uncertainties

Impacts of the project alternatives on the use of natural resources have been assessed as an expert evaluation. In addition to raw material volumes used in the vanadium recovery plant, the evaluation is based e.g. on studies related to the availability of vanadium.

6.13.3 Impacts during construction

In the construction phase of the project, materials are needed e.g. for the construction of foundations, structures and buildings. Land masses generated during the construction phase are intended to be used on site as a fill.

The use of natural resources is comparable to the typical use of materials and natural resources in construction sites. As the plant has a long operating life, it is estimated that the overall impacts on natural resources during construction will be minor.

The vanadium recovery plant is mostly located in built environment and the implementation of the VRP will not require significant clearance works of natural areas into industrial areas.

6.13.4 Impacts during operation

Vanadium supply and production volumes

Over 95 % of the global vanadium reserves are in China, Russia, South Africa and Australia. Based on latest information, global vanadium resources exceed 63 million tonnes, of which about 15 million tonnes are estimated to be economically recoverable. Vanadium is primarily found in deposits of titaniferous magnetite in which the share of vanadium is less than 2 % of the rock. Significant amounts of vanadium are also recovered from carbon-rich materials, such as black carbonaceous shale (coal stone), coal, crude oil and tar sand (USGS 2021, Vanitec Ltd 2021).

In 2020 primary production from titaniferous magnetite ores and stone coal accounted for 18 % of the global vanadium production (about 20 000 tonnes). Approximately 68 % of global vanadium production (~78,000 tonnes) was a co-product of steel production in the form of vanadium slag. Other sources of vanadium including fly ash, oil residue, aluminum slag and catalysts used in oil production, constituted about 14 % of global vanadium production (~16,000 tonnes) (Vanitec Ltd. 2021, Vanadium Marketing Analysis).

Vanadium production was insignificant between the years 1912 and 1960. Annual production volumes increased from 5 000 tonnes to ~40 000 tonnes between the years 1960 and 2000. Production more than doubled by the year 2014 to 90 000 tonnes/year. In 2020 global vanadium production increased by a further 25 % to 114 000 tonnes/year (Vanadium Marketing Analysis).

Vanadium production volumes are closely connected to steel production: the more steel is produced; the more vanadium is also produced as a by-product (Mining.com 2017). However, in the case of consumption, an increasing share will be attributed to non-steel related applications such as energy storage. It is estimated that vanadium demand for energy storage applications will increase from 1 881 tonnes in 2020 to 24 500 tonnes in 2025, nearly 15 % of global consumption (Vanadium Marketing Analysis).

By 2025 global vanadium consumption is estimated to reach 170,000 tonnes/year. This rate of consumption will be driven by continued growth in global steel production, higher specific vanadium consumption rates (kilograms of vanadium consumed per metric tonne of steel produced) in China, the world’s largest steel producer, and the development of VRFB and other energy storage technologies utilizing vanadium.

In the vanadium recovery plant natural resources are used to produce process chemicals and fuels for energy production, transport operations and machinery (Table 6.13-1). The use of renewable natural resources will be considered in the selection of chemicals and energy sources, if possible. Regarding renewable energy sources, for example, green energy will be preferred. Energy load and chemical consumption in the hydrometallurgical process used in the VRP is low when compared to other processes, for example, to pyrometallurgical vanadium recovery processes. Gas used for e.g. steam production in the plant can be methane, which is produced from renewable sources. Fuels produced from renewable natural resources can also be used in transport operations. Use of fuels will probably also increase the use of fossil raw materials. Vessel transport is efficient regarding the use of natural resources.

The main chemicals used in the process (sulphuric acid, sodium hydroxide and sodium carbonate) are commonly used in industry. Chemical production consumes natural resources. Among others, sulphuric acid can be produced from exhaust gas of metal industry. The production of sodium hydroxide probably requires the highest consumption of natural resources when compared to other used chemicals (Minviro Ltd, 19.3.2021).

Figure 6.13-1. Utilities and chemicals used in the vanadium recovery plant and their impact on the use of natural resources.

Utility	Source/production
Process water and other water	Renewable natural resource
Natural gas	Non-renewable natural resource when produced from fossil sources. Biomethane can be produced from organic materials, for example, from organic waste.
Diesel	In principle, non-renewable natural resource, biodiesel is intended to be used in the plant.
Electricity	Produced from renewable energy sources, if possible.
Chemicals	
Sulphuric acid (H_2SO_4 94 %)	Sulphuric acid can be produced, for example, from pyrite ore or exhaust gas of metal industry.
Sodium hydroxide (NaOH 50 %)	Sodium hydroxide can be affordably produced from sodium chloride as a by-product in chlorine production
Sodium carbonate ($NaCO_3$)	Sodium carbonate is produced both synthetically (77 %, requires energy) and from the Trona mineral (about 23 %). (IHS Markit 2019)
Ammonium sulphate ($(NH_4)_2SO_4$)	Ammonium sulphate is mostly produced as a by-product in industry in flue gas cleaning. (IHS Markit 2019)
Aluminum sulphate $Al_2(SO_4)_3$	Aluminum sulphate is produced in the reaction of sulphuric acid with bauxite mineral.

It is possible that vanadium production from slag will reduce ore mining for vanadium production when, in addition to reduced use of natural resources, also other harmful environmental impacts related to mining will be mitigated.

There is no significant difference in the use of natural resources between the implementation alternatives Alt.1a and Alt.1b of the project. If the recovery plant is not constructed (Alt.0), it is possible that vanadium is produced to a greater extent also directly from extracted ore.

6.13.5 Prevention and mitigation of harmful impacts

Products manufactured from recycled raw materials are used during construction, if possible. Earth materials from construction and levelling works in the plant are used in the nearby area, if possible.

The aim is to optimize the energy and chemical consumption in the process and transport operations. Energy produced from renewable natural resources will be used, if possible.

6.14 Accidents and disturbances

6.14.1 Summary

The most significant risks were identified and related potential environmental impacts were described in the environmental risk assessment of the vanadium recovery plant. Measures for reducing risks and mitigating impacts were also examined in the assessment.

Identified issues in the construction phase, such as underground cable lines and potential harmful substances in water pumped out of the area will be taken into account in construction plans.

Risks related to the storage of slag and SSM will be very unlikely and have minor impacts. Preparations will be made for the fire risk related to organic solvents in the design of the plant. The likelihood of a significant chemical leak is very low and impacts would probably be limited to the plant area. In fire situation flue gases could cause temporary harmful impacts also outside of the industrial area.

Hazardous chemicals used in the plant are mainly transported from the nearby chemical port, where they have already been stored before. Vanadium pentoxide transported out of the plant is a toxic substance, but if the vanadium product ends up in the environment in a serious accident, the impacts would probably be very minor.

The safety of the plant and its operations can be achieved by comprehensive design and implementation, and it is maintained by efficient control and regular maintenance.

Potential flood risk and risk related to high waves as well as potential rise of the sea water level during the operation of the plant are examined and considered in detailed risk assessments and in plant design.

There are plenty of activities in the Tahkoluoto port area that have major accident risk and preparations have been made for accidents. Major accident drill is organized in the area every year. Based on earlier assessment, the domino effects of the most significant accidents in the chemical port area would not spread to the southern and northern VRP area, but impacts could, however, extend out to the transport routes of the vanadium recovery plant and temporarily restrict transport flows to the plant.

Comparison of alternatives and significance of impact

There is no difference between alternatives Alt.1, Alt.1a and Alt.1b with regard to accidents and disturbances and preparations for them.

There are no disturbances in alternative Alt.0, but potential other industrial activities planned in the area can cause accidents and disturbances.

Significance of impact is assessed as minor and negative.

Construction phase

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Accidents and disturbances	E.g. underground cable lines and potential harmful substances in water pumped out of the area will be considered in construction plans.	No impacts during construction.	There is no difference between alternatives Alt.1, Alt.1a and Alt.1b. Significance of impact is assessed as minor and negative (-).

Operating phase

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Accidents and disturbances	In fire situations flue gases could cause temporary harmful impacts also outside of the industrial area. The likelihood of significant chemical leak and fire is very low with implemented precautionary measures.	Risks related to industrial activities will not increase in the Tahkoluoto area.	There is no difference between alternatives Alt.1, Alt.1a and Alt.1b. Identified risks will be prepared for and serious impacts are not estimated to occur outside of the industrial area. Significance of impact is assessed as minor and negative (-).

6.14.2 Assessment method

The assessment was conducted as an expert evaluation. Risk mapping prepared during project planning was used in the identification of environmental risks, which was supplemented by the conclusions from the environmental risk assessment workshop held in May 2021, which was attended by the representatives of the project, planners and environmental experts. For risk identification, the operation of the plant was separately analysed regarding the following sectors: process, chemicals, storage of slag and SSM, transport operations, risks from outside of the plant, such as flood risk, exceptional weather conditions and potential accidents in other facilities in the Tahkoluoto area.

Available information on other projects was also used in the assessment. Potential accidents and incidents include, for example, accidental emissions, chemical leaks and fires. The report “Environmental risk analysis of accidental emissions” (Finnish Environmental Institute 2006) was used to support the assessment.

Uncertainty in the assessment is caused by the fact that several issues will not be specified until later in the facility design. On the other hand, the aim in risk assessment is to identify potential risks already in the earliest possible planning phase and as extensively as possible so that risks can be avoided as efficiently as possible.

6.14.3 Construction phase

In the construction phase, the following issues have been identified in the risk assessment, which could cause harmful environmental impacts. Provisions must be made for them in construction plans:

- Treatment of soil material which includes harmful substances;
- Potential harmful substances in water, which is pumped out of the area in the construction phase;
- Accident risks related to transport operations during construction also considering other actors in the area;

- Potential oil leaks from machinery and other leaks from chemicals and fuels stored during construction; and
- Existing underground cable lines and pipelines.

6.14.4 Operating phase

Risks related to the storage of slag and SSM

Risks related to the quality and storage of stormwaters and seepage waters from stockpiles regarding the water system and soil are examined in chapter 6.4. It also describes the solubility data of slag and information on the harmful impacts of soluble substances included in slag in relation to the estimated non-harmful concentrations in the water system and soil as well as to the environmental quality standards of sea water.

Stormwaters from stockpiles of slag and SSM may have to be directed to sea as an overflow from the water collection ponds, for example, during exceptionally heavy rain or as a result of melting water. Other exceptional situations, in which stormwater from stockpiles could end up in the water system, are very unlikely. Structures of water collection ponds and especially the embankment structure between the pond and the sea are planned and constructed to be durable, and the condition of structures is controlled and maintained so that the risks of breaking structures are avoided.

In case, where stormwaters from stockpiles are directed to the sea for a short time, only minor, temporary and local impacts on the water system can be estimated to occur. Significant, detectable, long-term and more extensive impacts are not estimated to occur.

The structures of the storage area are planned and constructed to be durable, and operation on stockpiles is conducted in a designed way according to the guidelines. Extensive breakdown of the foundation structure of storage areas, so that significant amounts of very contaminated stormwater and seepage water in contact with slag could infiltrate in the soil, is highly unlikely.

Potential clogging of the water collection system can be prevented, for example, by filter structures as well as by regular inspections and service.

The height of slag stockpiles is limited and inclinations are designed so that uncontrolled movement of stockpiles is prevented, for example, also during heavy and continuous rain, and working on the stockpiles is safe. It is secured by embankment on the edge of the storage area that material cannot flow to the environment in any case.

The construction height of the facility and slag storage areas will be designed so that sea water level cannot rise to the facility area or slag stockpiles even in the flood situation or from the impact of waves. Potential increase of heavy rain will be taken into account in the stormwater management planning of the facility and storage areas (see chapter “Flood risk and risks related to the impacts of climate change” below).

Chemical risks

The following includes a short description of the properties of stored chemicals in the plant (chapter 2.2.5, Table 2.2-3).

Liquid chemicals used in the plant include sulphuric acid, sodium hydroxide, organic solvents and diesel fuel. Carbon dioxide is also transported and stored as a liquid.

- Sulphuric acid transported and stored as a solution (94 %) is not flammable, but if strong sulphuric acid is in contact with flammable material, there is a potential fire risk. Sulphuric acid reacts very vigorously with water in an exothermic reaction. Due to strong acidity, sulphuric acid is harmful to water organisms.
- Hazardousness of sodium hydroxide transported and stored as a 50 % solution is based on its corrosiveness, and when ending up in water it is harmful to water organisms. Sodium hydroxide itself is not combustible or explosive.
- Carbon dioxide delivered and stored in the plant as a liquid is not flammable and does not maintain combustion. Carbon dioxide tank can, however, be ruptured when heated with fire.
- Organic diluents and extractants used in the plant have a high ignition point and they are poorly dissolved to water. The amount of organic substances used in the plant is small.
- Liquid diesel is a flammable liquid, which is toxic to water organisms.
- Natural gas can form a flammable/explosive gas-air mixture with air, which can explode when heated.

Leaks of liquid or gaseous chemicals can occur with tank fillings and loading of tanker trucks as a result of hose damage, overflow or flange leak, equipment failure in process or from collisions with pipelines.

Legal structure and location requirements as well as leak management systems will be considered in the design of the loading and unloading sites of storage tanks. Provisions are made for liquid chemical leaks by e.g. surface impoundment and drain shut-off system. Surface levels of tanks are monitored by alarm gauges.

Adequate safety distances are provided in the storage of flammable and combustible liquids, and first extinguishing equipment is located near the loading and unloading site.

Leak in low pressure natural gas pipeline on site could cause mechanical damage, for example, as a result of collision with machinery. Pipeline damages are prevented through planning, warning systems, maintenance and periodic inspections in accordance with standards. Potential collisions can be minimized in transport route planning.

Substances used and produced in solid form or as particles or flakes include:

- Sodium carbonate, ammonium sulphate and aluminium sulphate delivered to the plant in solid form, and ammonium sulphate solution and aluminium sulphate solution produced in the plant, when needed, are not especially harmful to environment.
- Vanadium pentoxide is acutely toxic to humans e.g. when inhaled, and it is also toxic to water organisms.

- SSM with particle size of < 10 µm, very low solubility, soluble substance concentrations are not very harmful.
- Slag is not classified as a hazardous substance according to the CLP Regulation. No special measures are needed in the treatment of slag with regard to environmental safety, and it can be stored outside.
- Sodium sulphate in solid form is not especially harmful to environment.

Vanadium pentoxide flakes could end up in the environment in incidents related to equipment and storage or in transport accidents. Vanadium pentoxide is stored in compact packages, and for securing the safety of personnel, it is treated so that the danger of finding the product uncontrolled outside of the product shed, product packages, product storage or shipping containers is minimized.

Potential impacts

Due to precautionary measures, entry of significant amounts of chemicals to air, soil or water system in context with accidents is highly unlikely. If sulphuric acid, sodium hydroxide, diesel or vanadium pentoxide as a result of a leak or other accident would enter the soil or water system through stormwater drain, potential impacts on water organisms could occur.

Sulphuric acid, sodium hydroxide and diesel used in the plant are stored and handled in the chemical port for other operations also at this moment. The stored volumes in the chemical port are at least about ten times higher than the stored volumes in the plant.

Vanadium pentoxide flake does not have dust impacts, and so the spreading of it to the environment in a potential accident situation could most likely be limited to a small area and the environmental impacts of the chemical would be minor. Spreading of vanadium pentoxide powder to the environment would be more difficult to restrict.

Personnel in the plant could be exposed to suffocating gas as a result of a gas leak (CO_2) from the process and in this case personal injuries inside the plant are possible. In a situation of a leak from carbon dioxide tank with a volume of hundreds of thousands tonnes, exposure to gas and explosion of the tank, the danger zone could extend to a distance of hundreds of metres. The danger zone of a leak and explosion related to a traffic accident is about 20 metres (Fortum Oslo Varme 2020). Leak and explosion of a carbon dioxide tank as well as carbon dioxide leak in a traffic accident are very unlikely incidents.

Chemical storage areas are bunded to contain and capture potential spillage. With precautionary measures, the probability of a significant chemical leak is very low. Impacts from chemical accidents would most likely be limited to the plant area. The most significant risk is related to the ignited fire in a chemical accident.

Fires and explosions

Provisions are made for fire situations in the facility by developing fire fighting systems, which are defined in more detail in the fire safety plan. Fire fighting water management in the area is planned according to the regulations so that fire fighting waste water contaminated by chemicals cannot spread to the environment.

In explosion and fire situations, material damage and also potential personal injuries could be caused mainly on site. Fire gases could cause temporary harmful impacts also outside of the plant area. Pressure impacts and cast material related to a potential explosion would probably occur on site.

Other activities in the Tahkoluoto area are located so far from the vanadium recovery plant that it is very unlikely that direct impacts from heat radiation or explosions would extend to the area of other activities.

Process failures and failures in emission control equipment

Failures in process and purification equipment are prevented by good planning, process monitoring and regular service and inspections of equipment. Provisions are made for e.g. blackouts in the plant design.

Fire risk related to the use of solvents is low. The organic solvent used in the leaching process of the vanadium recovery plant has a high ignition temperature (> 70 ^{o}C). When process temperature is under 40 ^{o}C, evaporation and gasification of the solvent is minor. Provisions are made for potential solvent leaks from the solvent extraction equipment surface impoundments. The solvent extraction facility is in an enclosed building, which will reduce potential emissions to air. The amount of solvents in the plant is relatively small. Potential fire risk is considered in the design of the facility and necessary fire protection systems will be constructed for the process.

Emissions to air from the process will be so low in normal situation that even scrubber failure would not generate a significant environmental load. The amount of ammonia removed from the process through the scrubber, and the amount of particle emissions generated from the drying of crystallized sodium sulphate are low.

Risks related to transport operations

With regard to transport operations, the most hazardous chemicals transported by road include carbon dioxide, sulphuric acid (94 %), sodium hydroxide (50 %) and vanadium pentoxide chemical powder or flake transported to customers. In addition, diesel fuel and natural gas are transported to the plant. Road transports are marked with proper warning signs.

Hazardous chemicals used in the plant are mainly transported from the Tahkoluoto chemical port. The Decree on the Transport and Temporary Storage of Dangerous Goods in a Port Area (251/2005) is applied to the internal transport operations in the port. The international IMDG Code regarding the safety of maritime transport is applied to internal port transfers and loading of packages, tanks and transport units used in road and railway transport.

Transports of hazardous chemicals from the plant are mainly road transports, but products can also be transported by rail. Regulations provided by the Act on the Transport of Dangerous Goods (719/1994) and decrees by the law are complied with in transport operations.

Transport accidents of hazardous goods rarely occur in proportion to transport volumes. On the other hand, transport accidents have occurred in uncontrolled environment outside of terminal and storage areas, which can increase the impacts from accidents. The most typical transport accident is an overturned tank truck and resulting liquid leak to the ground. In most of the accidents leaks to environment are relatively small (Häkkinen ym. 2010).

Hazardous goods transported in vehicles have rarely caused transport accidents, but the reason for an accident is often wrong actual speed or other surprising incident with on-coming traffic. However, hazardous goods can significantly increase the severity of accidents.

Transport of vanadium pentoxide and potential transport of liquid carbon dioxide constitute the most significant transport flows of hazardous chemicals in the plant. Vanadium pentoxide flake has no dust impacts, and so the spreading of it to the environment in a potential accident could most probably be limited to a small area, and the environmental impacts of the chemical would be minor. Spreading of vanadium pentoxide powder to the environment would be more difficult to restrict. Product packaging, bulk bags and sea containers provide additional protection in a potential transport accident.

Tahkoluoto area is a significant transport hub of hazardous goods. The most significant chemical transport volumes by road include the LNG transports of Gasum, liquid fuel transports of NEOT as well as transports of chlorate and lye to Kemira. About 100 LNG tank trucks per month was loaded in Gasum in 2020 and the plan is to load even 2–20 tank trucks per day in the future. In NEOT, a daily average of about 25–35 tank trucks of liquid fuel and a maximum of even 45 tank trucks of liquid fuel per day are loaded. About 20 tank trucks of chlorate per week arrive at Kemira, and about 50 tank trucks of lye per week depart from Kemira. Ammonia to Fortum is transported by rail and one shipment includes about 40–45 tonnes of ammonia. Ammonia is also stored in wagons (Gaia Consulting Oy 2020).

Issues related to the safety of transport operations are discussed in chapter 6.2. In addition, the safety of transport of hazardous goods can be promoted by adopting driving bans on certain roads or road sections.

Other activities in Tahkoluoto and spreading of accidents

There are plenty of activities in the Tahkoluoto area, which have a major accident hazard, and preparations have been made for accidents. Impacts from potential disturbances or accidents in the VRP area would probably not extend to the area of other operators in Tahkoluoto.

More significant impacts could be caused outside of the plant area only in considerably large fire situation or explosion. Due to precautionary measures, the event of an accident with significant impacts is very unlikely.

According to the chemical safety legislation, so-called cooperation obligation is applied to operators, when a potential accident in their production plant could cause damage in an area of another plant (TUKES 2014). Production plants located close to each other must 1) provide information to other production plants about potential major accident hazards and other accident hazards in their production plant, 2) consider major accident hazards and other accident hazards of other production plants in their operating principles, safety management system, security clearance, internal emergency plan and other plans, 3) co-operate in providing public information and submitting information to the rescue authority for the preparation of an external emergency plan, 4) prepare common principles for mutual activities, such as mutual communication between operators and arrangements for access control and traffic operations in the area 5) agree on mutual major accident training with the rescue department.

According to the major accident risk mapping prepared for land use planning in 2020 (Gaia Consulting Oy 2020), recommendations for land use restrictions due to a major accident hazard do not include the southern VRP area. The northern VRP area is included in a zone where, according to recommendations, only industrial operations with a major accident hazard and port operations with only a small number of persons can be located. According to recommendations, production and storage facilities as well as workplaces, which are not related to port operations or industrial operations with a major accident hazard, cannot be located in the area. Single-family houses and other vulnerable activities can neither be located in the area.

Potential domino effects related to accidents have been assessed in the Tahkoluoto area in 2018. Major accidents were identified in the oil and chemical port area, which could have impacts outside of the areas of single operators, and thus cause a domino effect. Accidents, which could most probably have impacts outside of the area of a single operator, were selected for the assessment. Based on performed modelling, the domino effects of the most significant accidents in the chemical port area would not extend to the southern and northern VRP area. The impacts of accidents in the Tahkoluoto area could, however, extend to the transport routes of the vanadium recovery plant and temporarily restrict transport operations to the plant.

According to the rescue department, major risks in the Tahkoluoto area include fires in fuel tanks and bund walls as well as a massive leak in ammonia tank (Gaia Consulting Oy 2020). An external emergency plan has been prepared for the Tahkoluoto port by the rescue department, which guides the operation of the rescue department in a potential major accident situation.

Flood risk and risks related to the impacts of climate change

Part of the Pori area belongs to one of the most significant flood risk areas in Finland, but Tahkoluoto is outside of this area. River water has occasionally risen to a high level e.g. in Pori city centre and delta area. The sea water flood map for the Tahkoluoto area, which can be obtained from the flood map service of the Environmental Administration, only includes the northern side of Tahkoluoto, but the southern side of the island has not been mapped. Based on the sea water flood map (Figure 6.14-1), the northern VRP area is located in a flood hazard area.

Figure 6.14-1. Sea water flood map, flood occurring once in every 100 years. Map is a general flood map, not for examination of buildings (red text). There is no flood map around the southern VRP area (green text) (ympäristö.fi/tulvakartat).

Both short-term variations in water level related to weather conditions and changes occurring during decades and centuries affect the flood risk of buildings in the coastal areas of the Baltic Sea.

Related to climate change, the rise of sea water level in the Pori area is compensated by land upheaval, about 0.5 metres in 100 years. The Finnish Meteorological Institute has estimated the probabilities for sea water flood levels in the Baltic Sea until the year 2100 taking into account the impact of climate change, land upheaval and short-term variation in water level (Pellikka et.al. 2018). In Mäntyluoto, the 1/20 years annual maximum sea water level was 134 cm (N2000) in 2010 and the forecasts for the years 2050 and 2100 are 127 cm and 163 cm (N2000), respectively. The 1/100 years annual maximum in Mäntyluoto was 157 cm in 2010 and the forecasts for the years 2050 and 2100 are 150 cm and 192 cm (N2000), respectively. Based on the above estimates, the rise of sea water level due to climate change by the year 2050 will be lower than the impact of land upheaval, but after that sea water level will rise from the existing level. The potential rise of sea water level during the operational life of the plant will be considered in planning. The Finnish Meteorological Institute has defined the minimum recommended construction heights in coastal areas of Finland based on rarely expected flood water levels (Kahma et.al. 2014). Information on the rise of ocean water level and its regional impacts on the water level in the Baltic Sea, land upheaval, changes in wind conditions and short-term variation in water level have been considered in the recommendations.

Recommended construction heights have been defined for the sites of water level measurement stations. The recommended lowest construction height is 200 cm in Mäntyluoto, which the closest measurement station to the VRP area. Recommendations can be applied to other sites primarily by linear integration. Recommendations concern conventional construction, which has a designed life-time of about two hundred years and which can be accepted to be exposed to flood once during the life-time.

The above mentioned recommendations must include a local provision for wave activity, which considers the rise in water level due to wave activity. The provision for wave activity is very dependent on the local circumstances, as it is not only affected by wave height but also by the steepness, shape and structure of the shore. Gently sloping shore attenuates the impact of waves, but wave height increases on steep shores (Kahma et.al. 2014).

Potential flood risk and impacts related to sea waves are examined and considered in more detailed risk assessments and in plant design, e.g. in defining the construction height. Particularly, the safety of tank structures, slag storage areas and ponds is secured in all expected situations.

Impacts related to climate change in the Gulf of Bothnia area have been studied in the SmartSea project in cooperation with the Finnish Meteorological Institute, the Finnish Environmental Institute, the Natural Resources Institute Finland, the Swedish Meteorological and Hydrological Institute, the Geological Survey of Finland, the Technical Research Centre of Finland VTT and the Universities of Turku and Helsinki (SmartSea 2018). By the year 2050, precipitation in winter is estimated to increase by 2–3 % per decade and precipitation in summer by less than 1 % per decade in the Bothnian Bay and the Bothnian Sea. The increase in the Bothnian Sea is estimated to be smaller than in the Bothnian Bay. Changes in wave height are estimated to occur within the limits of natural variation in the Bothnian Sea.

According to the Climate guide (https:/ilmasto-opas.fi/en/) maintained by the Finnish Meteorological Institute, the Finnish Environmental Institute and the Natural Resources Institute Finland, the highest precipitation will occur in summer also in the future. As a result of the climate change, precipitation in summer will most probably increase than decrease: It is estimated that the expected increase is about 5-10 % (average of model results) by the end of the century when compared to the time period 1981-2020. The reason for this is strengthening precipitation. Even though heavy rains will strengthen relatively less in summer than in winter, the heaviest rainfall will probably continue to occur in summer and early autumn. In summer the heaviest rainfall can strengthen by 10–25 %.

Estimates on the increase of precipitation as well as increasing and heavier rainfall in forthcoming decades will be considered in the stormwater management planning of the plant.

General risk preparedness

Safety can be achieved in the plant by comprehensive planning and implementation, and it is maintained with efficient control and regular maintenance. Important requirements for the safety of the plant include sufficient training and guidance of personnel to safe operations. Procedures for different disturbances and exceptional situations are described in the management system of the plant, which also includes procedures for e.g. exceptional weather conditions and start-up and shut-down situations of the plant.

An internal emergency plan will be prepared for the plant, which includes guidelines for preparation to accident situations within the plant. An external emergency plan will be prepared in cooperation with the rescue department for preventing major accidents and minimizing damages.

Potential risks related to the process and operation of the plant will be identified in more detailed design and re-evaluated in different phases of the project, and necessary measures will be planned for risk management. More detailed risk assessments and issues related to securing safety will be presented in context with the chemical permit applied from TUKES (Finnish Safety and Chemicals Agency) well before the commissioning of the plant.

6.15 Cumulative impacts with other projects

6.15.1 Summary

The planned new offshore wind farm is located so far from the vanadium recovery plant that there will hardly be any cumulative noise impacts in the Reposaari area and the sea area around Törnikari. The minimum distance between the wind power stations and the vanadium recovery plant is almost 5 km, and thus significant cumulative impacts are not estimated to occur with regard to lighting or impacts on landscape and cultural environment.

The VRP will significantly increase traffic volumes on the roads leading to Tahkoluoto. If several projects are implemented, the growth of traffic volumes and related impacts will be even more significant during the construction of the wind farm and a new oil quay. In addition, vessel traffic to the Tahkoluoto port will increase to some degree, and cumulative impacts on sea traffic can be generated with other vessels using the fairways to Tahkoluoto. The construction and operation of the offshore wind farm may occasionally cause harmful impacts on vessel traffic.

The bird population is abundant in the surrounding area of Tahkoluoto despite the existing industrial operations.

Overall, the impacts of human activities in the surroundings of Tahkoluoto will increase slightly more due to the implementation of both projects when compared to the implementation of only one project.

Comparison of alternatives and significance of impact

There is no difference between alternatives Alt.1, Alt.1a and Alt.1b with regard to cumulative impacts. No cumulative impacts will occur in alternative Alt.0.

Significance of impact is estimated as minor and negative.

6.15.2 Known projects having potential cumulative impacts

Other known projects in the vicinity of the VRP area include:

- Tahkoluoto offshore wind farm extension project by Suomen Hyötytuuli Oy. Based on preliminary estimates, the significant impacts of the project include the impacts on water environment as well as the impacts on birds and landscape (Statement of the coordinating authority on the EIA programme June 26, 2020). Based on the preliminary timetable presented in the EIA report, which was on public display in March 2021, the construction of the wind farm could not start earlier than in 2023 and operation could not start earlier than 2025.
- Construction of a new oil quay in the Tahkoluoto chemical port, dredging and filling of the water area. The project will have impacts on water environment.

Potential cumulative impacts with the wind farm project could be related to the noise generated from the operation of the wind power stations and the vanadium recovery plant as well as from the lighting of facilities and impacts during construction, e.g. growing traffic volumes.

6.15.3 Noise impacts

Cumulative noise impacts caused by the operations of the existing Tahkoluoto wind farm, the port and the vanadium recovery plant are discussed in chapter 6.4. The planned new offshore wind farm is located so far from the vanadium recovery plant that there will hardly be any cumulative noise impacts in the Reposaari area and the sea area around Törnikari (Figure 6.15-1).

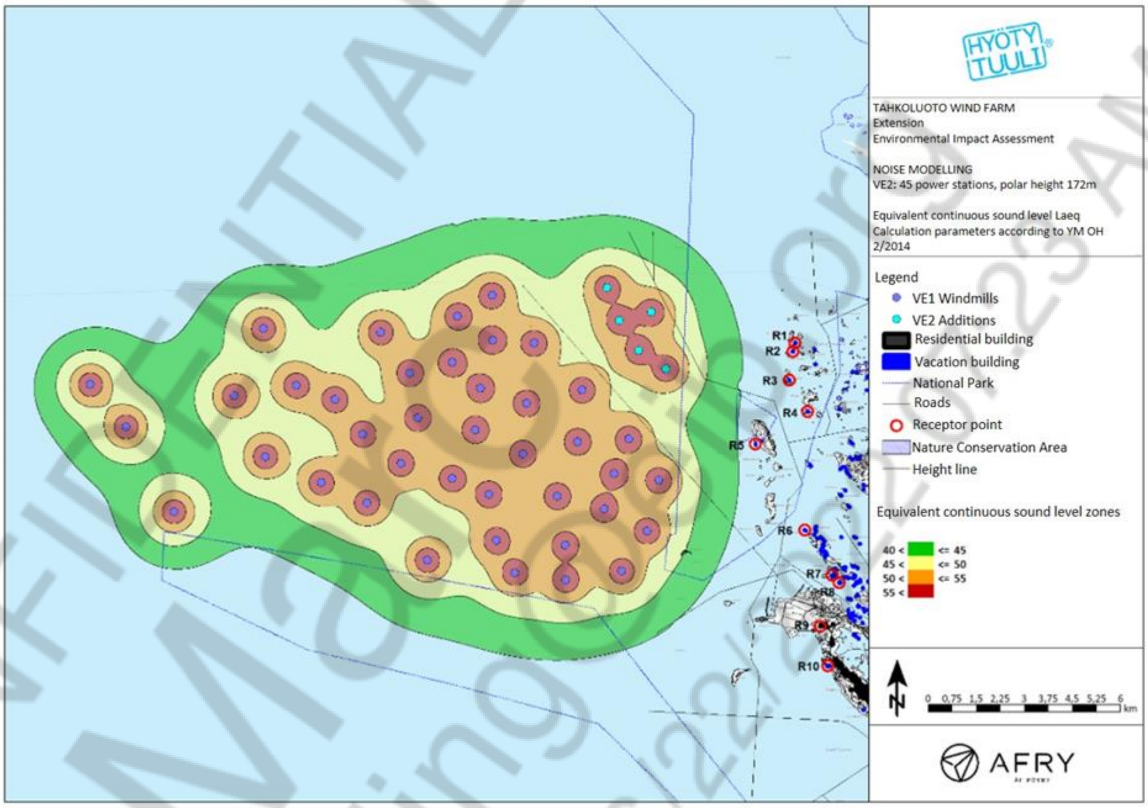

Figure 6.15-1. Results of the noise modelling for the Tahkoluoto wind farm extension project (alternative Alt.2, extended alternative).

6.15.4 Traffic impacts

According to the preliminary construction schedule of the wind farm, construction works would not start earlier than in 2023. The estimated duration of construction will be about 2–3 open water seasons and actual production would not start earlier than in 2025. Based on the tentative plans of the vanadium recovery plant, construction would be scheduled for the year 2023 that production would start in December 2024. Traffic during the construction of both projects could at least partly occur during the same time period.

A major share of traffic volumes consists of vessel traffic during the construction phase of the wind farm, but rock material can also be transported to Tahkoluoto by road, and passenger traffic to Tahkoluoto will also grow. The highest traffic volumes will occur during the construction and installation of foundations for the power stations. During the construction phase of the vanadium recovery plant, traffic volumes consist of transports of earth materials, other construction materials and machinery as well as passenger traffic. During the operation of the plant, both road transport and vessel transport will be directed to the plant. The VRP will significantly promote the growth of traffic volumes on the roads leading to Tahkoluoto. If both projects are implemented, the growth of traffic volumes will be even more significant during the construction of the wind farm. Growing traffic volumes will increase emissions, noise and disturbance from traffic near traffic routes, and the impacts on traffic conditions and traffic safety will be more significant.

During the construction phase of the wind farm extension project, it may be necessary to impose temporary traffic restrictions to the deep-water channel, for example, during the installation of cables, but this is not estimated to have significant impacts on the vessel traffic of the VRP. The additional vessel traffic volumes induced by the VRP will be relatively low.

In the operating phase, vessel traffic to the Tahkoluoto port will increase to some degree, and cumulative impacts on sea traffic can be generated with other vessels using the fairways to Tahkoluoto. In addition, the construction and operation of the offshore wind farm may occasionally cause harmful impacts on vessel traffic, for example during maintenance works.

6.15.5 Lighting

The amount of light will increase in the Tahkoluoto area due to the vanadium recovery project. Due to the wind farm project, the amount of light will increase in the sea area. Lighting attracts insects and birds to fly towards the sources of light, and this will increase bird collision risk with buildings and wind power stations. The impacts of lighting on bird population can be prevented by e.g. using light, which has as low UV-frequency as possible. Generally, the harmful impacts of lighting can be reduced by correct adjustment of lights to avoid unnecessary projection of light in the environment.

The minimum distance between the vanadium revovery plant and the wind power stations is almost 5 km, and thus significant cumulative impacts are not estimated to occur.

6.15.6 Impacts on bird population

The bird population is abundant e.g. in the bird islets in the surrounding area of Tahkoluoto despite the impacts of the port and industrial operations and the existing wind power stations in Tahkoluoto. The distance between the project areas of the vanadium recovery plant and the new wind farm is almost 5 km, and it is estimated that these projects will not have special cumulative impacts on bird population. Overall, the impacts of human activities in the surroundings of Tahkoluoto will increase slightly more due to the implementation of both projects when compared to the implementation of only one project.

6.15.7 Other cumulative impacts

With regard to the construction of a new oil quay, cumulative impacts can mostly be generated from growing traffic volumes.

The distance between the project areas of the vanadium recovery plant and the wind farm is almost 5 km, and it is estimated that the projects will not have significant cumulative impacts on landscape and cultural environment.

6.16 Decommissioning

Impacts related to decommissioning are of similar type than the impacts during construction, but they will probably be smaller. In context with decommissioning, the facilities, structures and machinery of the plant will probably be demolished. The foundations of the plant and the foundation structures of stockpile areas can potentially be utilized for the needs of subsequent activites implemented in the area.

When the operation of the plant ends, slag has been used up and SSM has been delivered to customers. Potential remains of slag and SSM stockpiles will be transported from the area to be recycled or to a disposal site authorised for an equivalent type of activity.

In the decommissioning phase, the impacts from operation will stop. Heavy traffic volumes especially directed to Tahkoluoto will significantly decrease.

Air and noise emissions will be caused by demolition measures and e.g. traffic from transporting demolished materials. Emissions caused during the demolition works typically include dust emissions and emissions from the fuel of machinery.

During decommissioning demolished materials and equipment are intended to be delivered for recycling. Crushed concrete and rock material generated during the demolition works can potentially be utilized in further construction of the area.

The quality of soil in the plant area will be verified during decommissioning and prior to the reuse of the area.

According to the Nature Conservation Act, after the completion of the permitted operations, the operator is still responsible for complying with permit provisions and regulations provided by the Nature Conservation Decree for preventing environmental pollution and monitoring of impacts.

A plan will be prepared for the decommissioning and demolition of the plant as well as potential monitoring of impacts during demolition works and after operation, which is approved by the environmental permit authority. A demolition permit will be applied for the demolition works from the building supervision of the City of Pori.

There is no difference between alternatives Alt.1, Alt 1a and Alt. 1b with regard to decommissioning. It is estimated that the impacts of decommissioning will be minor.

6.17 Transboundary environmental impacts

It is estimated that there will be no transboundary environmental impacts from the project.

7 Comparison of alternatives and assessment of significance

7.1 Summary of environmental impacts, significance and mitigation of impacts

7.1.1 Impacts during construction

Impacts are temporary in the construction phase. The most significant negative impacts during construction in the VRP area and its surroundings are related to traffic and noise.

Air quality impacts and waste are also generated during construction. Typical impacts on soil are caused by construction works. Significant positive impacts include the employment impacts.

Impacts during construction are described in more detail in context with the assessment of different impacts in chapter 6.

7.1.2 Impacts during operation

A summary of the results of the impact assessment by each impact during operation is presented in Table 7.1-1. The key impacts of each alternative are recorded in the table. The table also shows the comparison of impacts between the alternatives and the assessed significance of impact compared to the current situation (alternative Alt.0). The overall significance of impact is shown with colours (Table 6.1-2).

The significance of the environmental impacts of the project is mostly estimated as minor. The most significant positive impacts (large impact) are related to the climate impacts during the life cycle of the plant, carbon sequestration and impacts on the use of non-renewable natural resources. Moderate and positive impacts are related to the impacts on community structure and land use as well as to the social impacts of the project.

It is estimated that moderate and negative impacts are related to traffic during the operation of the plant, treatment of slag, by-products and waste in alternative Alt.1b and noise caused by the operation of the plant and traffic. It is estimated that minor negative impacts are related to air quality; vegetation, animals and nature reserves; soil and bedrock; impacts on landscape and cultural environment; impacts related to the treatment of slag, by-products and waste in alternative Alt.1a as well as to accidents and disturbances. Impacts on the water system are also estimated as minor and negative, even though minor and positive impacts are also related to the collection of stormwaters in the area.

Table 7.1-1. Summary and comparison of impacts during operation.

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Community structure and land use	The project will promote the achievement of the national land use objectives by e.g. supporting the vitality of the area and reinforcing the existing regional structure. The project conforms to the existing land use plans and pending plan proposal.	The needs of industry are considered anyway in land use planning of the area.	No fundamental difference between alternatives Alt.1, Alt.1a and Alt.1b. Significance of impact is assessed as moderate and positive (++).
Traffic	Vessel traffic volume, 120 vessels/year, will grow by 20 vessels/year. Potential growth of heavy traffic volumes is about 30 % on the Reposaari main road and about 50 % on the Pori archipelago road. Potential impacts on safety and the level of service of traffic can require measures for improving traffic conditions and traffic safety.	No traffic impacts from this project. Traffic impacts will be caused by potential implementation of another project in the area.	In alternative Alt.1b, a higher share of the heavy traffic volume can use the Pori archipelago road, but otherwise there is no difference between alternatives Alt.1, Alt.1a and Alt.1b. Without road upgrading measures impact is assessed as moderate and negative (--).
Noise and vibration	Noise levels will not mainly exceed the guideline values both in daytime and at night in the nearest residential area and nearby recreation area. Noise levels can be exceeded regarding a few residential buildings located in the immediate vicinity of the road. Vibration impacts in the area are not very likely.	No noise impacts caused by the project. Noise can be generated from the operation of a potential other plant constructed in the area.	No difference between alternatives Alt.1, Alt.1a and Alt.1b. Considering the planned mitigation measures the impact is assessed as minor and negative (-).
Treatment of slag, by-products and waste	Dust from the treatment of slag will be managed by watering, when needed. Entry of load to the water system dissolved to stormwater from slag and SSM stockpiles will be prevented by proper structures. In exceptional situations, short-term entry of load to the water system is not estimated to have detectable harmful impacts. It is estimated that proper waste treatment will not have significant environmental impacts.	The plant will not be constructed and there is no need for treatment of materials.	The differences between alternatives Alt.1, Alt.1a and Alt.1b include the need for a stockpile area, impacts related to disposal activities (Alt.1b) and transport distances to customers or to a stockpile area. Also, the alternative use of SSM has so far not been confirmed (Alt.1b). Considering the planned mitigation measures the impact in alternative Alt.1 and Alt.1a. is assessed as minor and negative (-). Considering the planned mitigation measures the impact in alternative Alt. 1b is assessed and as moderate and negative (--).

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Air quality	Process emissions will be minor. Emissions and impacts from slag stockpiles and machinery mainly remain in the immediate vicinity of the plant area. Emissions from traffic will have a minor impact on air quality near traffic routes.	No emissions and impacts from the construction of the vanadium recovery plant. Emissions will probably be caused by potential implementation of other operations in the area.	No fundamental difference between alternatives Alt.1, Alt.1a and Alt.1b. Considering the planned mitigation measures the impact is assessed as minor and negative (-).
Emissions to air (life cycle of plant)	Based on the life cycle assessment, the vanadium recovery plant will have negative overall impacts on air emissions, or it will reduce carbon dioxide emissions.	Potentially higher emissions compared to the implementation alternative. Impacts, which reduce CO_2 emissions, will not be generated.	In alternative Alt.1b, material manufacturing for the potential use of another product instead of SSM will cause greenhouse gas emissions. Otherwise, no significant difference between alternatives Alt.1, Alt.1a and Alt.1b. Significance of impact is assessed as large and positive (+++).
Water system	Environmental load is not directed from the VRP area to the water system. Stormwaters directed from ponds to the sea in rare exceptional situations will not cause detectable impacts on sea water quality, water organisms or fish stock. With regard to the recreational use of the water area, there will be no fundamental change in the vicinity of the port and industrial area from current situation. Stormwaters are no longer directed to the water system from the industrial area.	No impacts on the water system from the project. It is possible that environmental load and impacts on the water system will be generated by another project implemented in the area.	No impact.
Vegetation, animals and nature reserves	The VRP area is located in an industrial area or in its immediate vicinity, and thus direct impacts from the construction of the facility or increasing impacts from air emissions or noise on natural environment will be minor.	No impact.	No difference between alternatives Alt.1, Alt.1a and Alt.1b. Impact is assessed as minor and negative (-).
Impacts on soil, bedrock and groundwater areas	No impacts on soil, bedrock and groundwater from normal operation. Stockpiles of slag and SSM are located on top of protective structures.	No impacts on soil, bedrock and groundwater.	No impacts in normal operation.

Impact	Alternatives Alt.1, Alt.1a and Alt.1b	Alt.0	Comparison of alternatives and significance of impact
Landscape and cultural environment	Landscape in the area, which has already been in industrial use, will not change when viewed from the sea. Noise and air emissions from the operation will not have significant impacts on the valuable sites of landscape and cultural environment.	No impacts from the project. Impacts from potential other industrial activities constructed in the area.	In alternative Alt.1b the visual impacts of SSM in landscape can be slightly greater than in alternatives Alt.1 and Alt.1a. With planned mitigation measures the impacts on landscape are assessed as minor and negative (-).
Social impacts	No harmful impacts on human health, no disturbances to nearby residencies and no significant disturbance to recreational use of the environment. Transport operations will increase disturbance to some degree in the immediate vicinity of traffic routes. Positive impacts on employment and business life. Concern related to the impacts of the project is a negative impact.	Positive impacts on employment will not be generated.	No fundamental difference between alternatives Alt.1, Alt.1a and Alt.1b. With planned mitigation measures the overall impacts on health, living conditions and comfort are assessed as minor and negative. Impacts on employment and business life are estimated as large and positive. Overall project impacts are assessed as moderate and positive (++).
Use of natural resources	The project will promote circular economy and restrict the use of non-renewable natural resources. Natural resources will be consumed for chemicals, energy and fuels used in the production and transport of vanadium pentoxide.	Natural resources are consumed in the vanadium production from non-renewable raw materials.	In alternative 1b the use of natural resources can be slightly greater, otherwise there is no significant difference between the implementation alternatives. Positive impacts on the use of non-renewable natural resources will likely be significantly greater than in alternative Alt.0. Impacts are assessed as large and positive (+++).
Accidents and disturbances	In fire situations flue gases could cause temporary harmful impacts also outside of the industrial area. The likelihood of a significant chemical leak and fire is very low with implemented precautionary measures.	Risks related to industrial activities will not increase in the Tahkoluoto area.	No difference between alternatives Alt.1, Alt.1a and Alt.1b. Identified risks will be prepared for and serious impacts are not estimated to occur outside of the industrial area. With planned mitigation measures the significance of impact is assessed as minor and negative (-).

7.2 Mitigation of harmful impacts

The mitigation measures for the harmful impacts of the project are summarised in Table 7.2-1.

Table 7.2-1. Summary of the mitigation measures for the harmful impacts of the project.

Impact	**Planned impact mitigation measures**	**Potential additional measures for mitigating impacts**
Community structure and land use	No significant impacts from the project on the implementation of planned land use.	Case-specific impact mitigation measures will be adopted.
Traffic	Transport logistics is optimized. Use of suitable transport vehicles with regard to capacity and other features. Accidents related to transports are prevented by requiring functional quality assurance systems from transport companies, sufficient professional skills from drivers as well as knowledge about risks related to transports and risk factors specific to the traffic environment.	The level of service of traffic and traffic safety could be improved on the road leading to Tahkoluoto by widening the road or constructing a pedestrian and bicycle way along the road. Generally, traffic safety can be improved by e.g. speed limits and improved visibility on roads. The condition of road surface is also significant for traffic safety, and the share of heavy traffic must be taken into account in the carrying capacity of the road.
Noise and vibration	Noise from machinery will be reduced by operational planning and optimal use of machinery. Use of machinery, which generates less noise, if possible. Good condition of machinery is maintained.	Noise propagating from the machinery to environment can be prevented by e.g. layout planning and location of slag stockpiles. Harmful impacts from traffic noise can be mitigated by noise protection measures, when needed. The project will probably not increase rail traffic volumes to Tahkoluoto. Harmful vibration and structure-borne noise impacts from train traffic can generally be reduced by structural solutions between the railway and buildings, when needed.
Treatment of slag, by-products and waste	Waste generated during the construction phase will be properly sorted and treated, and delivered for recycling, if possible.	

Impact	Planned impact mitigation measures	Potential additional measures for mitigating impacts
	The structures of the storage areas for slag and SSM will be designed so that significant harmful environmental load will not be generated. Recycling of generated waste is primarily conducted on site or in its vicinity.	
Air quality	Diffuse dust emissions from slag will be prevented by e.g. controlling the moisture content of materials, minimizing necessary treatment, covering transport loads and using enclosed unloading equipment in transport operations as well as enclosed conveyors in the plant. Dust emissions from stockpiles will be prevented by e.g. watering the surface of piles by water jets, when needed. Spreading of dust will also be prevented by regular cleaning of road and storage environments and by watering, when needed. Mitigation measures regarding particle emissions to air from the process will be implemented so that impacts on air quality will be minor in this respect. Emissions from traffic will be reduced by the optimization of transport logistics and use of low-emission transport vehicles.	Dust binding materials can be used in the dust management of stockpiles, when needed, or wind shelter can be created by, for example, earthfill embankments. Potential dust impacts can also be reduced by planting vegetation on site and the surrounding area, if possible.
Greenhouse gas emissions	Use of carbon-free electricity, if possible. Optimization of chemical and energy use in the process as well as transports.	CO_2 emissions can be reduced by using biofuels and e.g. through the electrification of machinery.
Water system and fish stock	Potential emissions to the water system from stockpiles will be prevented by compact and proper structures, through which stormwaters and rain waters from stockpiles can be collected.	
Vegetation, animals and nature reserves	Impacts on endangered meadow dwarf will be prevented by creating a new habitat for red fescue in the nearby area in Tahkoluoto.	Impacts can be prevented and mitigated by measures reducing noise impacts and air quality impacts.

Impact	Planned impact mitigation measures	Potential additional measures for mitigating impacts
Soil, bedrock and groundwater areas	Potential harmful substances included in removed land masses during construction works will be taken into account in the treatment and relocation of earth materials. The structures of the storage areas of slag and SSM will be implemented so that harmful substances potentially dissolving to stormwater and seepage water from stockpiles will not enter the soil. Entry of chemicals to soil in potential disturbances and accidents will be minimized through thorough risk assessment and preparations to exceptional situations as well as by proper construction of chemical storage tanks and areas that comply with legal requirements.	
Landscape and cultural environment	Lighting of the plant area will be designed so that light is not directed straight to the residential and recreation areas.	Harmful visual impacts on the nearby environment can be mitigated by planting trees or other vegetation to the terrain between the plant area and shoreline, when needed.
Social impacts	Information on the project, its progress and impact assessment will be provided to different stakeholders.	Information is actively provided especially to the residents living in the nearby area and others interested in the project.
Natural resources	Earth materials from construction and levelling works in the plant area will be used on site, if possible. Products manufactured from recycled raw materials will be used during construction, if possible. Energy and chemical consumption in the process will be optimized. Energy produced from renewable natural resources will be used, if possible.	
Accidents and disturbances	Potential risks related to the process and operation of the plant will be identified and necessary measures will be planned for risk management.	
Cumulative impacts	The project is not estimated to have significant cumulative impacts with other projects.	Mitigating measures will be planned in cooperation with other project developers, when needed.

Impact	Planned impact mitigation measures	Potential additional measures for mitigating impacts
Decommissioning	Impacts will be minimised by proper planning of the decommissioning.	

7.3 Feasibility of the project

Based on the environmental impact assessment, the project including the sub-alternatives assessed in the EIA procedure can be considered feasible regarding environment. Such impacts were not identified during the assessment, which would prevent the implementation of the project or its alternatives. Harmful impacts identified in the assessment are acceptable or impacts can be reduced to the acceptable level through mitigation measures.

8 Monitoring of impacts

8.1 Goals of monitoring

The goal of monitoring the operation, emissions and environmental impacts of the project is to provide information about the actual impacts caused by the project and the success of measures for mitigating the actual impacts. By monitoring the environmental impacts of the project, comparative data can be obtained to assess the correlation between the estimated impacts and observed impacts. Monitoring can also provide advance information in order to manage unexpected impacts.

This proposal for monitoring programme presents the guidelines for monitoring regarding the most significant impacts. A more detailed monitoring programme will be prepared for the environmental permit procedure, and environmental monitoring will be implemented pursuant to the provisions of the environmental permit.

The monitoring programme will include, among others, the monitoring of air emissions, stormwaters and groundwater.

8.2 Monitoring during construction

Monitoring during construction includes:

- quality of stormwaters directed to the water system.
- potential impacts on the groundwater level and quality of groundwater, when needed.

8.3 Monitoring of the operation of the plant

The monitoring measures of operation include e.g. operational control and monitoring of the manufacturing process as well as quality control of raw materials and final products.

A more detailed plan for the monitoring of operation will be prepared for the permit application.

8.4 Monitoring of emissions to air and air quality

8.4.1 Monitoring of emissions

Emissions to air will be measured in the commissioning phase of the facility and emissions will be monitored by periodical measurements, when needed.

Potential dust emissions related to slag treatment and storage are monitored during regular inspection rounds by sensory analysis of potential dust generation on site and in the immediate vicinity.

With regard to air emissions, monitoring also includes the sensory analysis of potential odour impacts.

8.4.2 Monitoring of air quality

Industrial facilities are obliged to participate in the joint monitoring of air quality in cities and municipalities pursuant to their decisions on the environmental permit. Joint monitoring can include fixed measuring points, indicative measuring campaigns or modelling of the spreading of emissions. In addition, vegetation studies can be periodically commissioned, such as different bioindicator studies for assessing emission impacts and identifying potential development trends.

The impacts of emissions from the VRP on air quality will be minor. The most significant emission to air from the process probably includes particle emissions.

8.5 Monitoring of sea water quality

There is no discharge from the plant to the water system. Occasional measurements of sea water quality are performed around the plant area. The Port of Pori monitors the quality of stormwaters directed from the port area to sea pursuant to the environmental permit.

8.6 Monitoring of waste

The eligibility to deliver potential process waste (SSM, alternative Alt.1b) to a stockpile area for final disposal will be clarified in accordance with the Government Decree on Landfills (332/2013) prior to delivering waste to the stockpile area. This will be renewed, if there will be changes in the process which can affect the quality of waste.

Generated amounts of waste will be followed through waste accounting, and data regarding the further processing of waste components will be recorded.

8.7 Monitoring of soil and groundwater

The project is not located in a classified groundwater area and no emissions on soil or groundwater will be generated from the normal operation of the plant. This will be verified by regular monitoring of the quality of groundwater, for example, by taking samples annually from few monitoring standpipes located on site. Heavy metals will be analysed from the samples.

8.8 Meadow dwarf

After moving the red fescue community, the situation of meadow dwarf will be monitored in Tahkoluoto for three years by e.g. surveying the newly created red fescue community.

8.9 Disturbances and reporting of monitoring results

Data on service measures, maintenance and disturbances will be recorded in the data system of the facility. Person in charge of daily monitoring will report potential disturbances to the supervising authority.

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Vanadium Recovery Plant, Pori

Survey carried out as a part of the environmental impact assessment (EIA)

Results 15.6.2021

Summary and conclusion (page 1/2)

- The Australian company Critical Metals Ltd. (CMS) is planning to establish a vanadium recovery plant at Tahkoluoto Port, in Pori, Finland. A survey was carried out as a part of the environmental impact assessment (EIA) procedure. On one hand, the survey contributed to drawing up the social impact assessment within the EIA process, and on the other hand it provided a means to communicate information about the project and to engage stakeholders. The questionnaire was conducted in May, 2021, and it was promoted by means of e-mail, social media platforms and newspaper advertisments. The aim was to inform all permanent and leisure residents, other users of the area, stakeholders, and those that are otherwise interested in the matter, on how to participate and express their opinions on the project.
- The survey was answered 160 times. 85 % of the respondents are permanent residents of Pori, whereas 23 % are leisure dwellers. Approximately a third of those surveyed estimated that the distance between their home/holiday residence and the location of the project is more than 10 kilometres. Similarly, nearly half of the respondents assessed that they reside out of visual and hearing range of the site.
- A little more than half of those that replied are between the ages 45 and 64, a little over half (53 %) are men and nearly half of them are women. Most of the respondents had heard of the project before the survey, but many of them were not familiar with the company behind the enterprise. Many of the respondents also feel that they have not received enough information on the project.

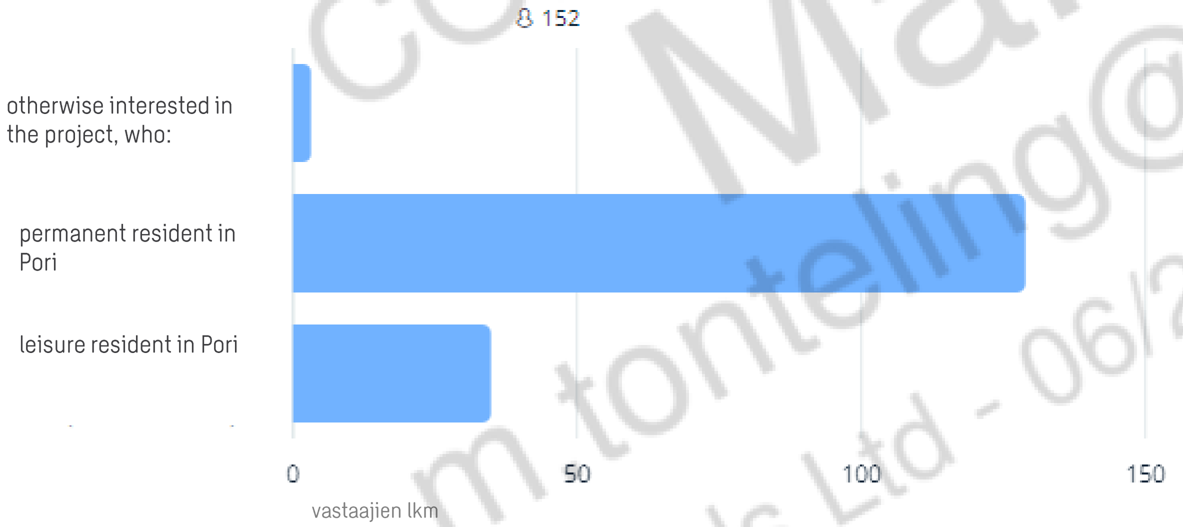
SWECO

Summary and conclusion (page 2/2)

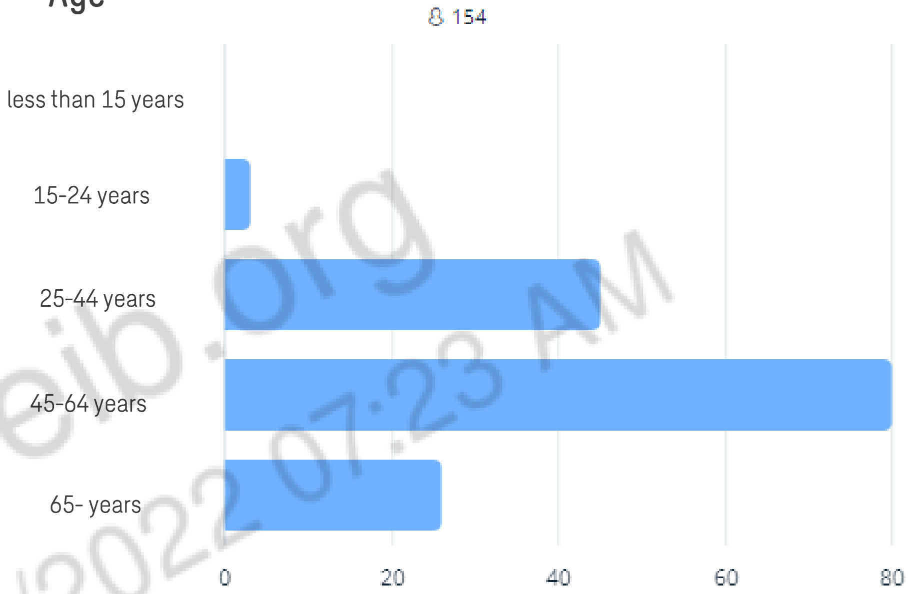
- The planning site, Tahkoluoto in Pori, is situated close to residential and weekend home areas, as well as recreational and tourist areas. Nearly all of the respondents have used the surrounding areas and the nearby sea for a variety of recreational activities.
- Those that answered the questionnaire were divided by the question on how well a vanadium recovery plant fits in the Tahkoluoto port and industrial area. Some of them think that the enterprise fits the area poorly, whereas others feel it fits the location very well. The replies signal a fear of harmful impact especially on the nearby valuable natural environments, water systems and landscape as well as adverse effects on noise, smell and air quality. Some of those surveyed also worry about possible negative effects on the enjoyability and recreational opportunities of the surrounding area. On the other hand, some respondents believe that transport connections and traffic arrangements may improve as a consequence of the project. Some of those that took part in the survey also think that the enterprise may bring positive effects on employment, economy and the dynamism in a larger area, and possibly also on other businesses and services. Respondents expect that the impact on tourism will be adverse.
- Those respondents who reside closest to the project area, and may be within sight or earshot of it, express the most critical view of the construction of the recovery plant. This can be interpreted to be a case of the NIMBY (not in my backyard) phenomenon; even though the partaking residents may find the project beneficial, they do not wish it to be located in their own immediate vicinity. It should be noted, however, that their concerns are justified and real, as they are the ones who are most likely to experience the adverse effects the enterprise may cause on noise, dust, landscape and traffic, outside the immediate project area.
- Open communication and interaction are in a crucial role as the project progresses, especially from the viewpoint of those residing closeby and with regard to broader recreational circumstances.

BACKGROUD

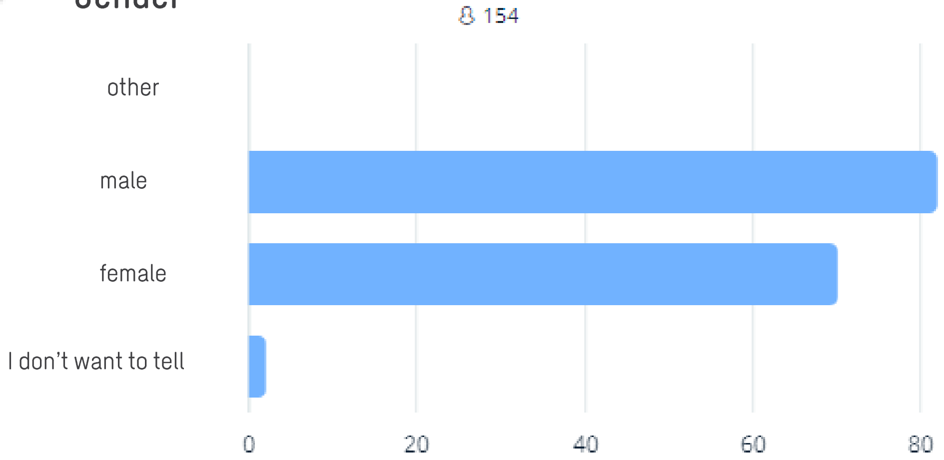
Are you



Age

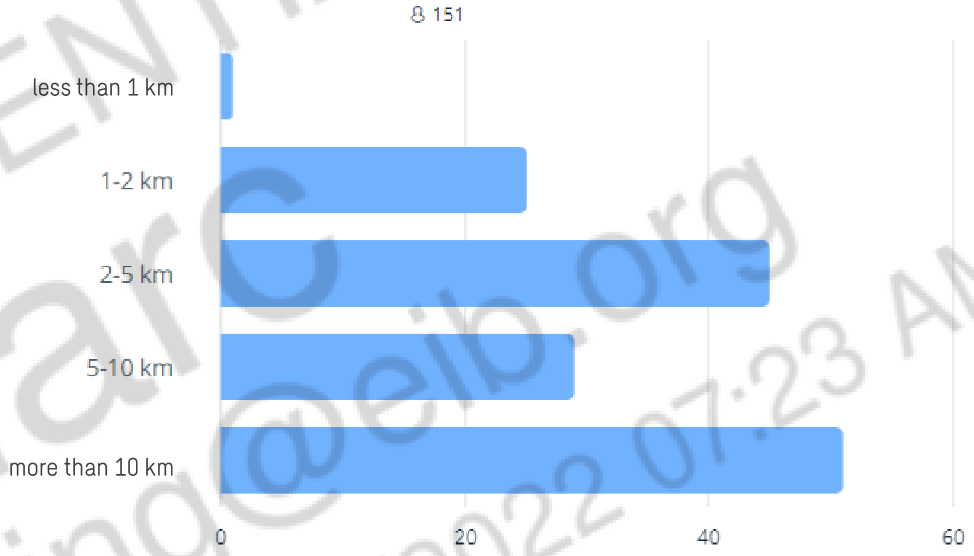


Gender

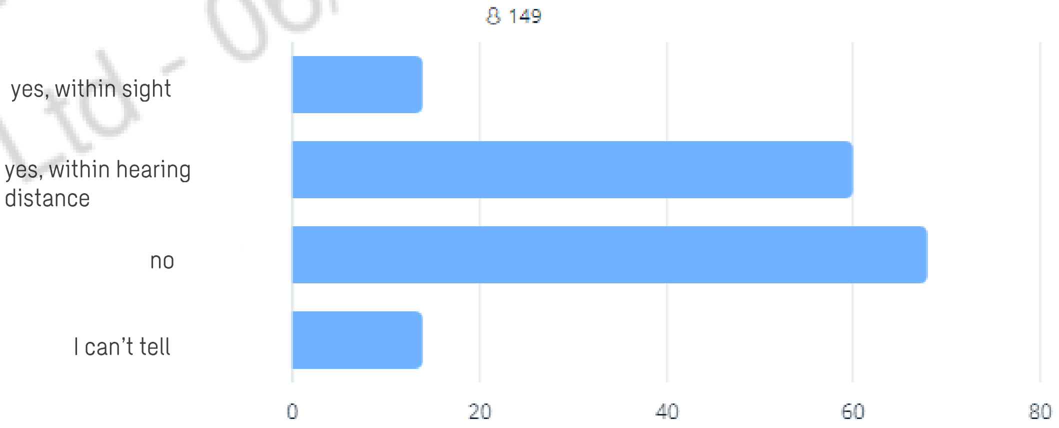


BACKGROUD

Based on your assessment, how far away is your apartment or leisure home from the area of the project?

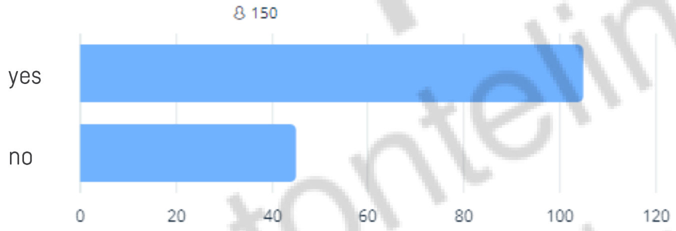


Based on your assessment, is your apartment or leisure home within sight or hearing distance to the area of the project?



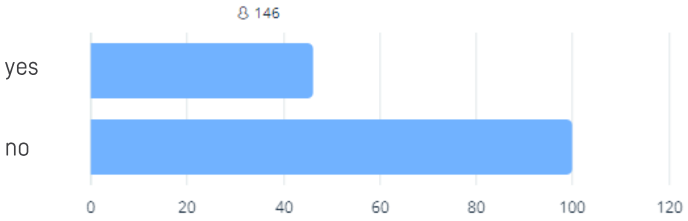
BACKGROUD

Have you heard of the project before this survey and its information?



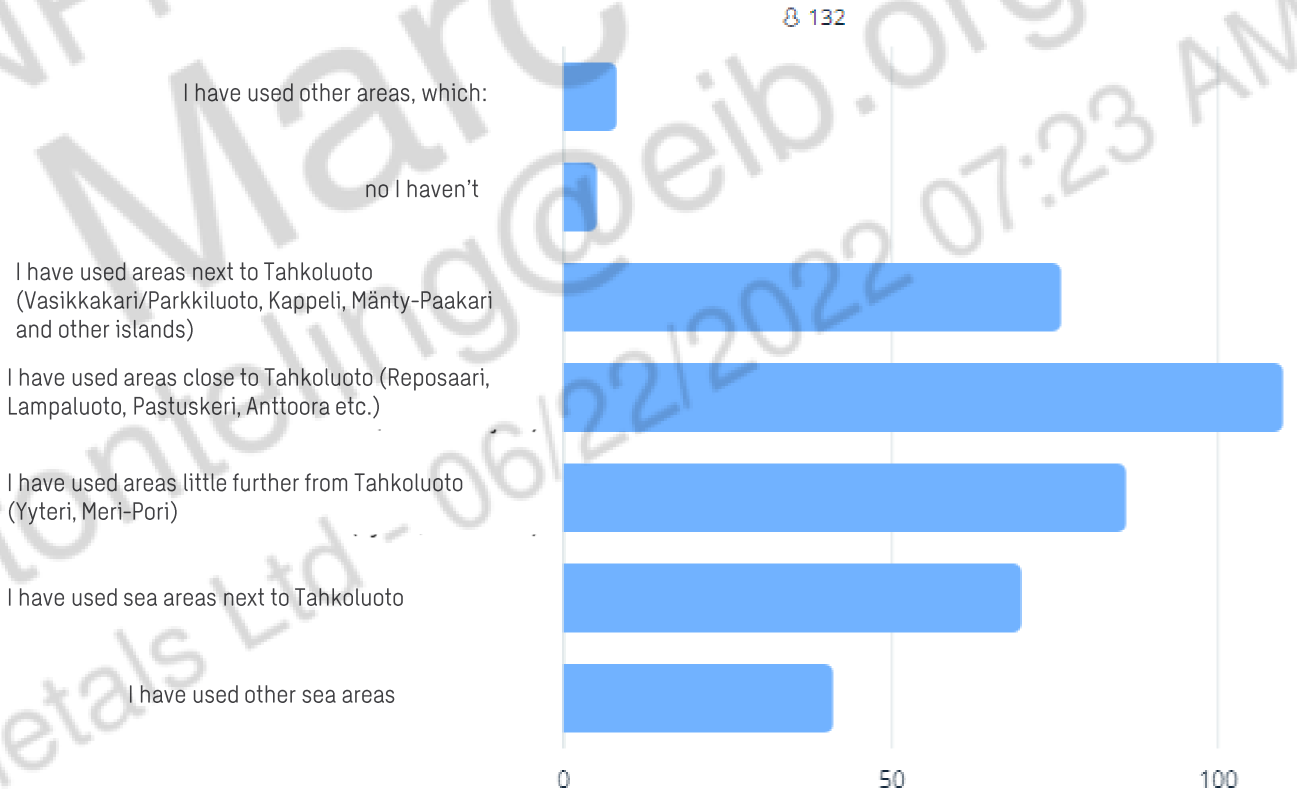
Have you previously heard of Critical Metals Ltd. (CMS), a company planning the project?

Have you received enough information about the vanadien recovery plant project?



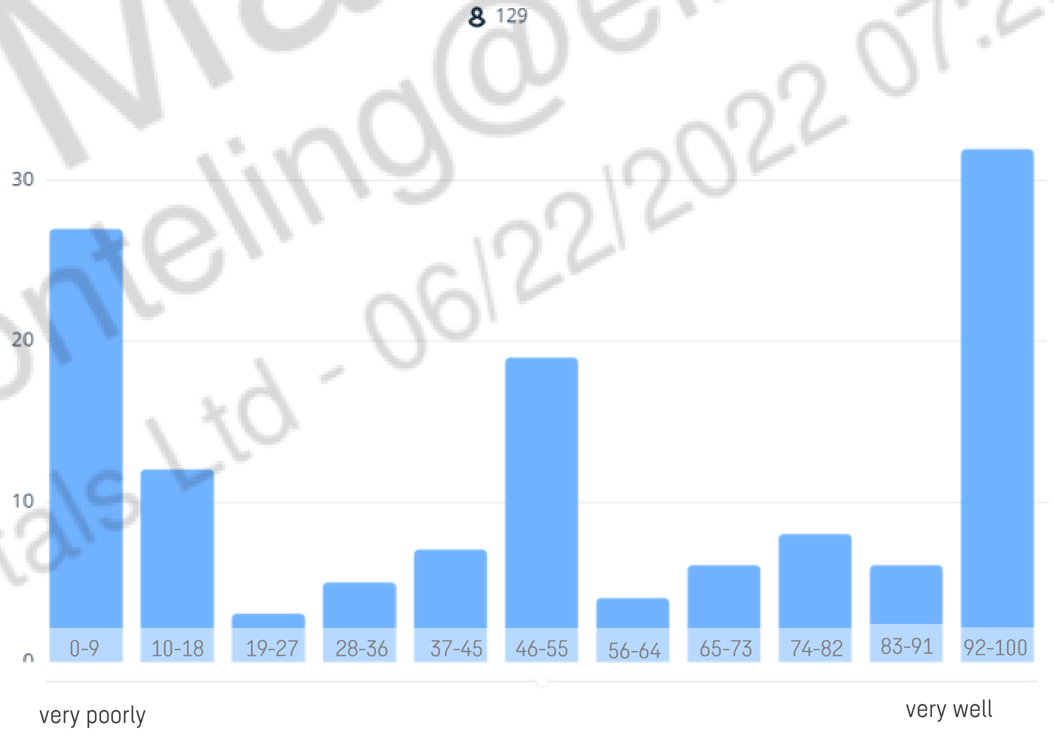
DESIGN AREA

Have you used the surrounding areas of the planned recovery facility for recreation, etc.?

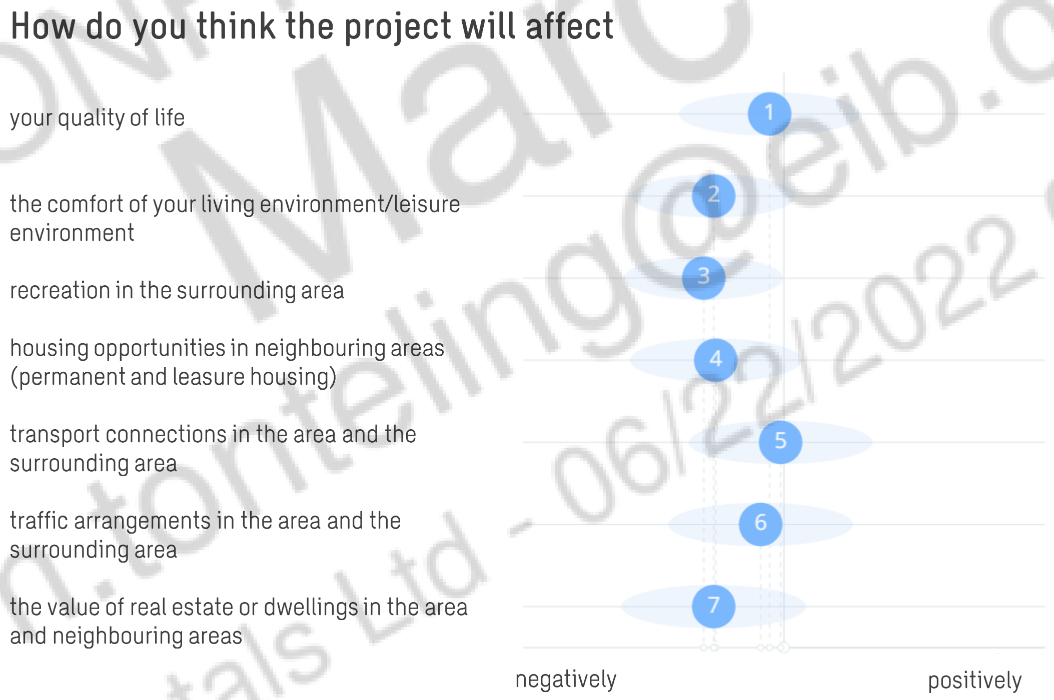


DESIGN AREA

How well do you think the vanadium recovery plant fits into the Tahkoluoto port and industrial area in Pori?



IMPACT ASSESSMENT: social impacts



IMPACT ASSESSMENT: Environmental impacts

How do you think the project will affect

the natural environment of the region and neighbouring regions

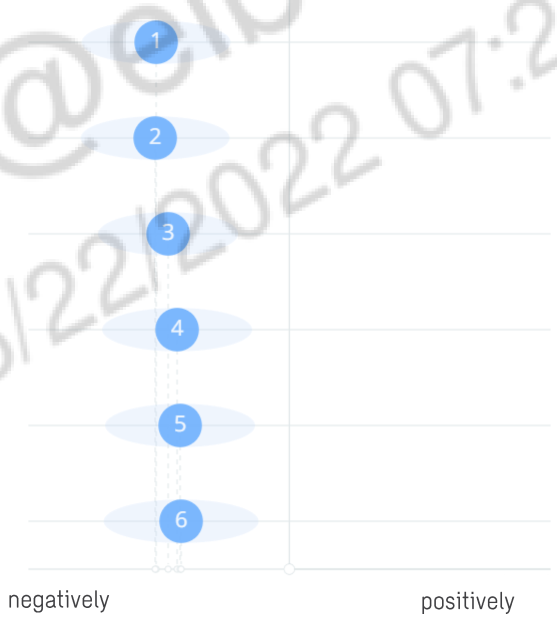
the status and use/usability of watercourses in the area and neighbouring areas

the soundscape of the area and surrounding areas (noise effect)

odours of the area and surrounding areas (compared to the current)

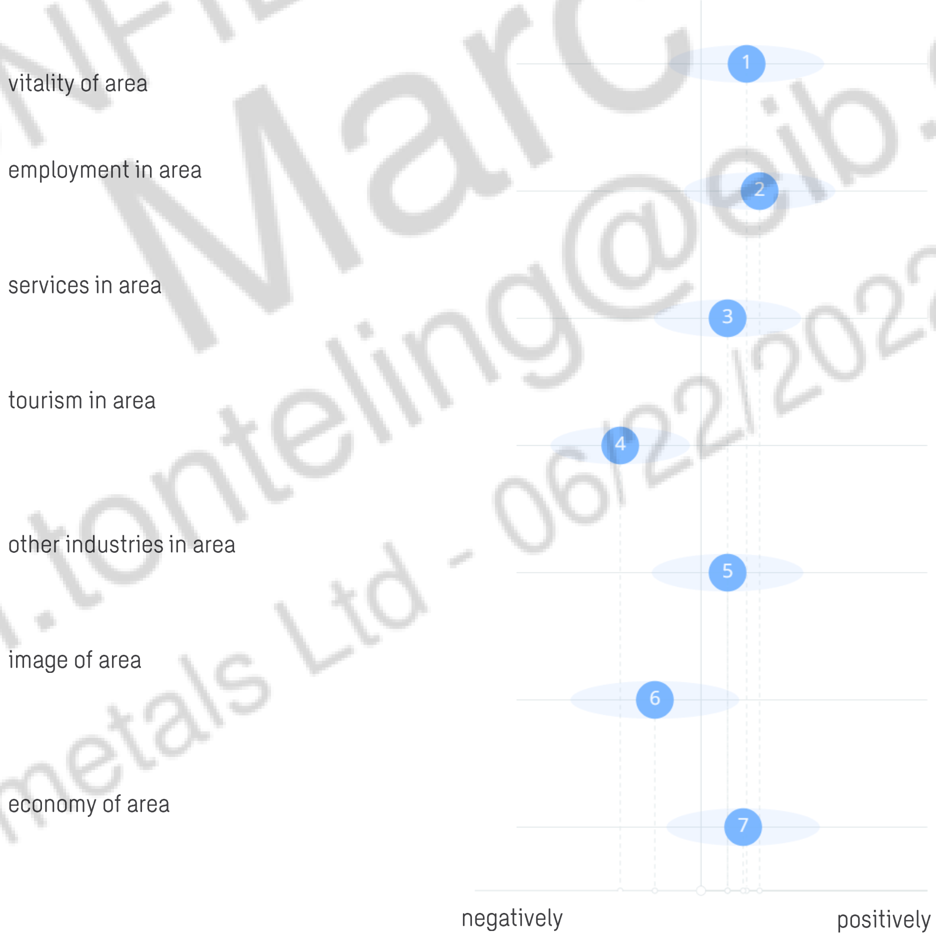
air quality in the area and surrounding areas

landscapes of the area and surrounding areas



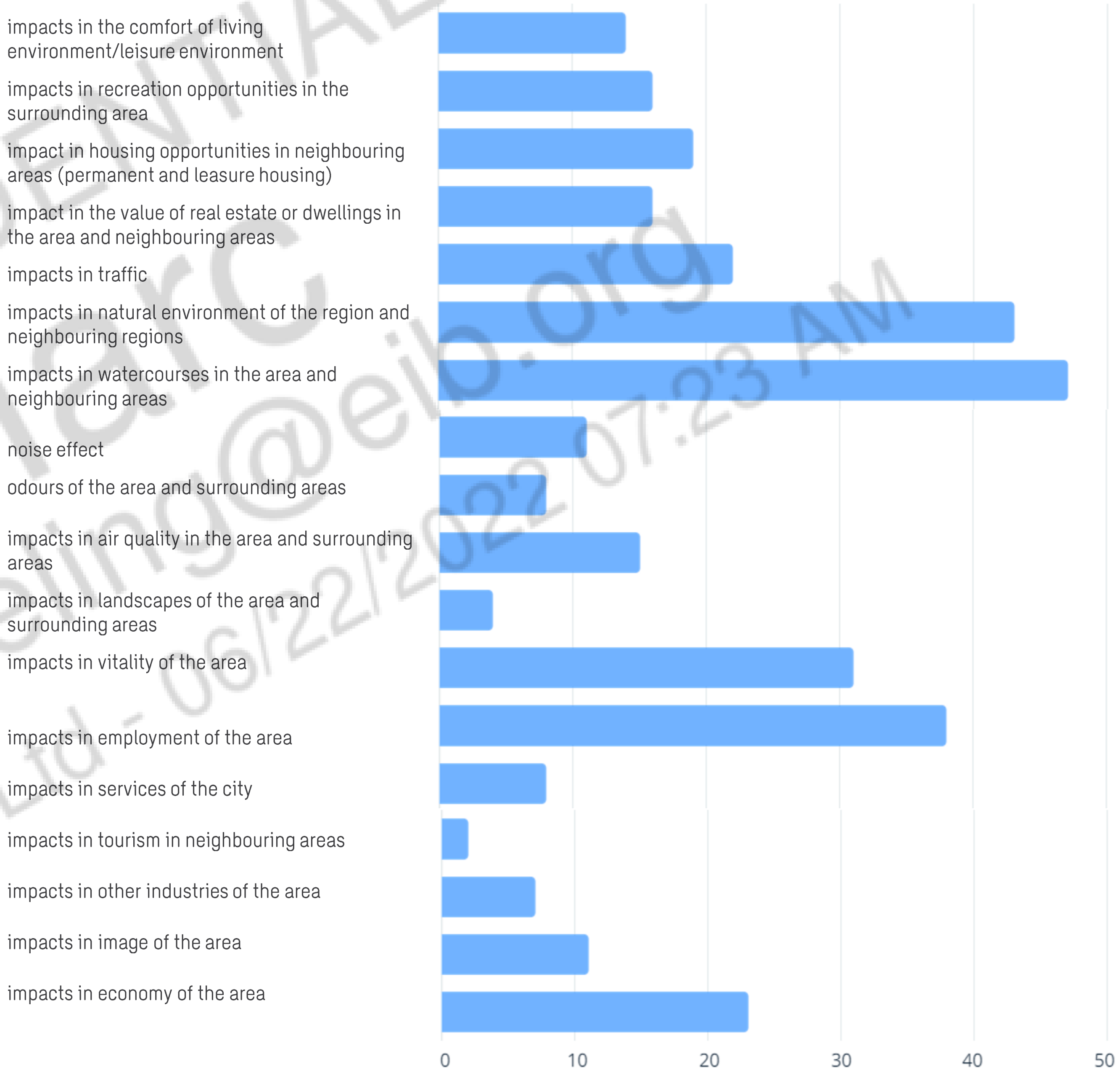
SWECO

IMPACT ASSESSMENT: employment and economic effects



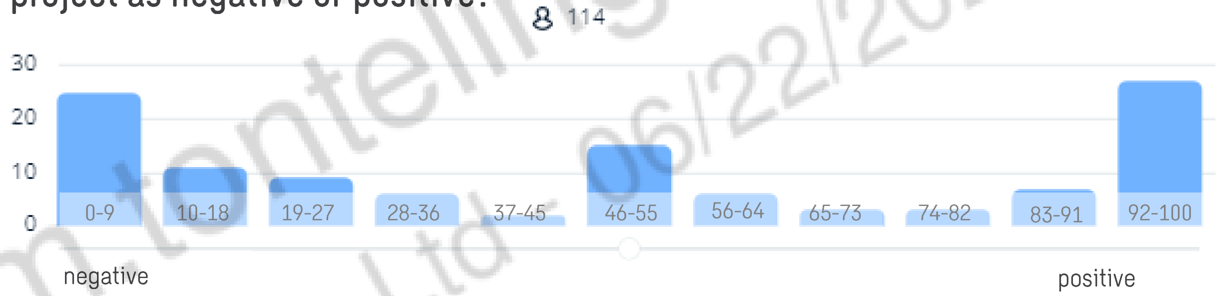
SWECO

What do you think are the three (3) most important impacts of the project, the construction of a vanadium recovery plant in Tahkoluoto, Pori?



SWECO

How do you feel about the vanadium recovery plant project, do you see the project as negative or positive?



SWECO