Strategic Environmental Assessment

for the proposed Boegoebaai Port, SEZ and Namakwa Region

Briefing note for research partners

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South African National Energy Development Institute

nceda
Northern Cape Economic Development Trade and Investment Promotion Agency

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national ports authority

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Touching lives through innovation

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1 Purpose of this document

The purpose of this document is to provide an outline of the scope of work and methodologies to be applied across two Work Packages for the Boegoebaai port, Special Economic Zone (SEZ) and regional Strategic Environmental Assessment (SEA). The purpose of this document is to brief the teams of specialists working as Research Partners on the Strategic Environmental Assessment (SEA) process.

2 Background to the SEA

Green hydrogen[1] (GH_2), and its derivative products (e.g., green ammonia and green methanol), provide an opportunity to decarbonise the South African energy economy, generate new revenues, create jobs and skills, and facilitate a Just Energy Transition[2]. As part of South Africa's ambition to become a player in the globally emerging green hydrogen market, a substantial programme of greenfield infrastructure has been proposed in the Northern Cape consisting of three main components:

1. New deepwater port at Boegoebaai, dry and liquid bulk berths, and multi-purpose terminals.
2. Mixed-use Special Economic Zone (SEZ) located in the region adjacent to the proposed Boegoebaai port.
3. Expansive regional renewable energy (wind and solar PV) generation and transmission infrastructure.

GH_2 production, at the scale envisaged in the Northern Cape, will be a diverse and multifaceted process with many direct and indirect impacts, both positive and negative. All programme components, including their interconnected transport corridors, will require substantial areas of land surface, as well as other resource intensive inputs, all proposed in a sparsely populated but ecologically sensitive region. Existing, and potentially competing, land uses in the region include conservation, agriculture, fishing, tourism, mining, and other subsistence livelihoods.

[1] There are many different definitions and perspectives on the concept of "green". Here, we use the term in the narrow sense, meaning a product developed where upstream production facilities are supplied by renewable energy.

[2] The Just Energy Transition is a South African policy framework for managing the shift from a high-carbon to a low-carbon, economy in a manner that is socially equitable and inclusive.

A SEA has been initiated through a collaboration between the South African National Energy Development Institute (SANEDI), Northern Cape Economic Development Trade and Investment Promotion Agency (NCEDA), and Transnet National Ports Authority (TNPA) (the Project Steering Committee (PSC)). The Council for Scientific and Industrial Research (CSIR) has been appointed to undertake an independent SEA. The overarching purpose of the **SEA is to develop an integrated decision-making framework to guide the planning of the proposed Boegoebaai Port, Special Economic Zone, and wider Namakwa region in a sustainable manner.**

This will be undertaken through two Work Packages (Table 1).

Table 1: SEA Work Packages across different clients, spatial scales, methods, and data collection practices

	Work Package 1	Work Package 2
Spatial scale	Local (33 500 ha) covering the extent of the proposed port and SEZ.	Regional (>5 million ha) across four Local Municipalities, including the 33 500 ha extent covered by WP 1.
Principal client/audience	TNPA, to meet their requirement of the Ports Act to conduct an SEA for current and future planned ports; and national and Northern Cape government to inform the planning and potential establishment of the SEZ.	Northern Cape and national government, to meet aspirations of national energy and carbon reduction policies
Methodological focus	High resolution determination of receiving environment sensitivity with a view to practicing avoidance (top of the mitigation hierarchy).	Determination of the cumulative social and ecological impacts of a regional GH_2 economy across two development scenarios in view of a dynamic baseline scenario.
Fieldwork and data collection	Fieldwork in most instances, coupled with desktop reviews (peer reviewed and grey literature) and other sources where necessary (e.g., interviews).	Desktop reviews (peer reviewed and grey literature) and other sources e.g. regional, or national databases, planning documents (Infrastructure Development Plans (IDPs), Environmental Management Frameworks (EMFs), Spatial Development Frameworks (SDFs), interviews etc.

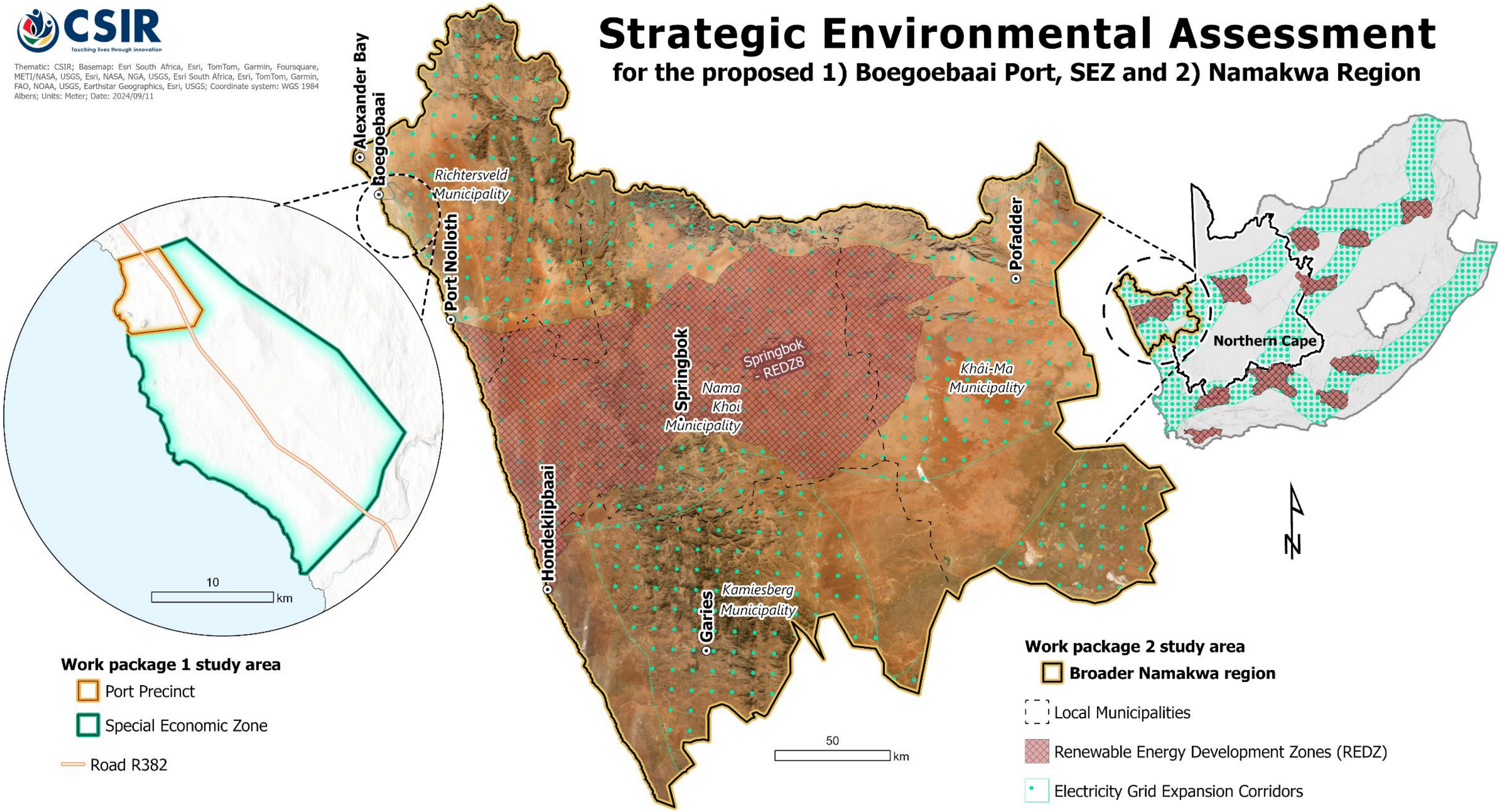

Figure 1: The spatial extent of the two SEA Work Packages

3 Specialist research teams

The PSC for the SEA (SANEDI, TNPA, and NCEDA), in consultation with government agencies and other stakeholders, such as academic institutions and NGOs, initiated an evaluation and nomination process to identify suitable researchers to collaborate with CSIR on the SEA. It is crucial that the environmental and socio-economic assessments conducted as part of this study are undertaken with the utmost **credibility, diligence and accuracy**, since:

- The Boegoebaai Port, SEZ and Namakwa Region Project holds significant importance, particularly for the communities and ecosystems within the region; occurring in a sparsely populated but ecologically sensitive arid region.
- Official comments gathered from several sources reveal that only a small number of specialists have the required niche knowledge of this remote region, together with knowledge of strategic impacts associated with the proposed project infrastructure, and the academic credibility and experience in strategic assessments of this nature.

Resultingly, the experts cited in Table 2 were identified and appointed as Research Partners on the SEA process.

Table 2: Identified specialist research teams for the Boegoebaai SEA.

Theme	Lead author	Contributing authors	Nominated peer reviewers (tbd)
Marine ecology & biodiversity (including coastal birds)	Andrea Pulfrich	Barry Clark	
Sustainable (green) port planning study	Susan Taljaard	Steven Weerts	
Fisheries & coastal livelihoods	Louise Gammage	Catherine Ward, Zanne Zeeman-du Toit, Annastacia Mpala, Marieke Norton	
Terrestrial ecology (including fauna, birds & bats)	Local Port & SEZ: Noel and Gretel van Rooyen Regional: Philip Desmet	Pieter van Wyk, Corné Niemandt, Albert Froneman, Werner Marais, Mark Botha	
Biodiversity offset framework	Mark Botha	Philip Desmet	
Heritage	Jayson Orton	Vanessa Maitland, Lita Webley, John Pether	
Water / aquatic ecology (including groundwater)	Liz Day	Zita Harilall, Simon Lorentz	
Socio-economics (including local/macro-economics, agriculture, tourism & institutional capacity)	Doreen Atkinson	Elmarie Slabbert, Andrea Saayman, Hannes Gerber, Johann Kirsten, Steve Robins, Stephanie Borchardt	
Regional infrastructure & planning	Johan Maritz	Jabulani Jele, Nonjabulo Malinga, Elsona van Huyssteen, Michelle Audouin	

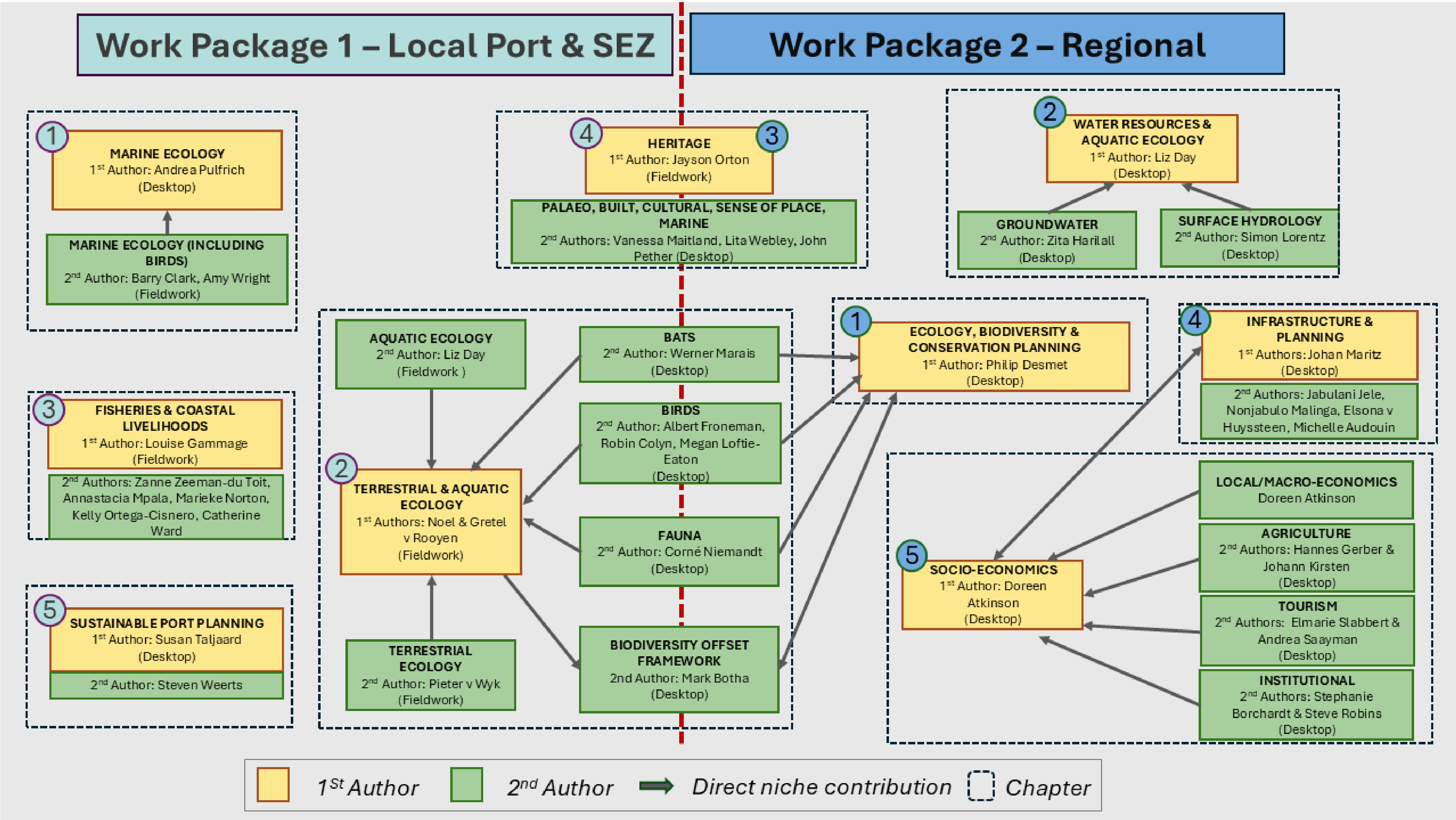

Figure 2: Specialist chapters split across the two Work Packages with points of collaboration and overlap.

4 Project aspects and SEA Work Packages

This section describes the types and scale of infrastructure and development activities to be considered within the scope of Work Package 1 and Work Package 2.

4.1 Work Package 1 – Local

An initial conceptual layout for the port (3 378 ha) and Boegoebaai SEZ (30 122 ha) is provided by NCEDA in Figure 3. This conceptual layout shows the envisaged phases of the SEZ development, starting with development closest to the port on the coastal side of the R382 road and potential later phases moving inland of the road. The total potential footprint is 33 500 ha.

The project scope for the specialist assessments for Work Package 1 includes:

- Port precinct (3 378 ha), with a focus on the short-term (Phase 1A) port layout. A long-term (2050) port layout (Phase 1B) has been broadly conceptualised by TNPA. The future expansion is currently envisaged within the confines of the currently proposed port precinct.
- SEZ (30 122 ha), focussing on both shorter term and future development zones.

4.1.1 Port

The proposed short-term port layout, indicated within the 2 187 ha port precinct boundary (Figure 3), is intended to accommodate bulk liquid items such as green ammonia and diesel oil, dry bulk materials such as manganese and iron ore, and assorted break bulk cargo, which arrives in bulk and is then separated into individual components, such as lead and zinc. A phased approach will be followed for constructing the infrastructure and facilities for the Boegoebaai port development layout. This approach includes a short-term (Phase 1A) and long-term (Phase 1B) development plan for the port.

TNPA will oversee the management of the Boegoebaai Port project proposed on Farm No. 1[3] and Rietfontein 589[4]. Farm No. 1 is owned by the Richtersveld Community Property Association (CPA), and Rietfontein is a small portion around the Rietfontein 55 kV substation owned by Eskom. Farm No. 1 has servitudes registered against its title deed, potentially affecting the intended use for the port construction.

[3] Surveyor General code: C05300000000000100000
[4] Surveyor General code: C05300000000058900000

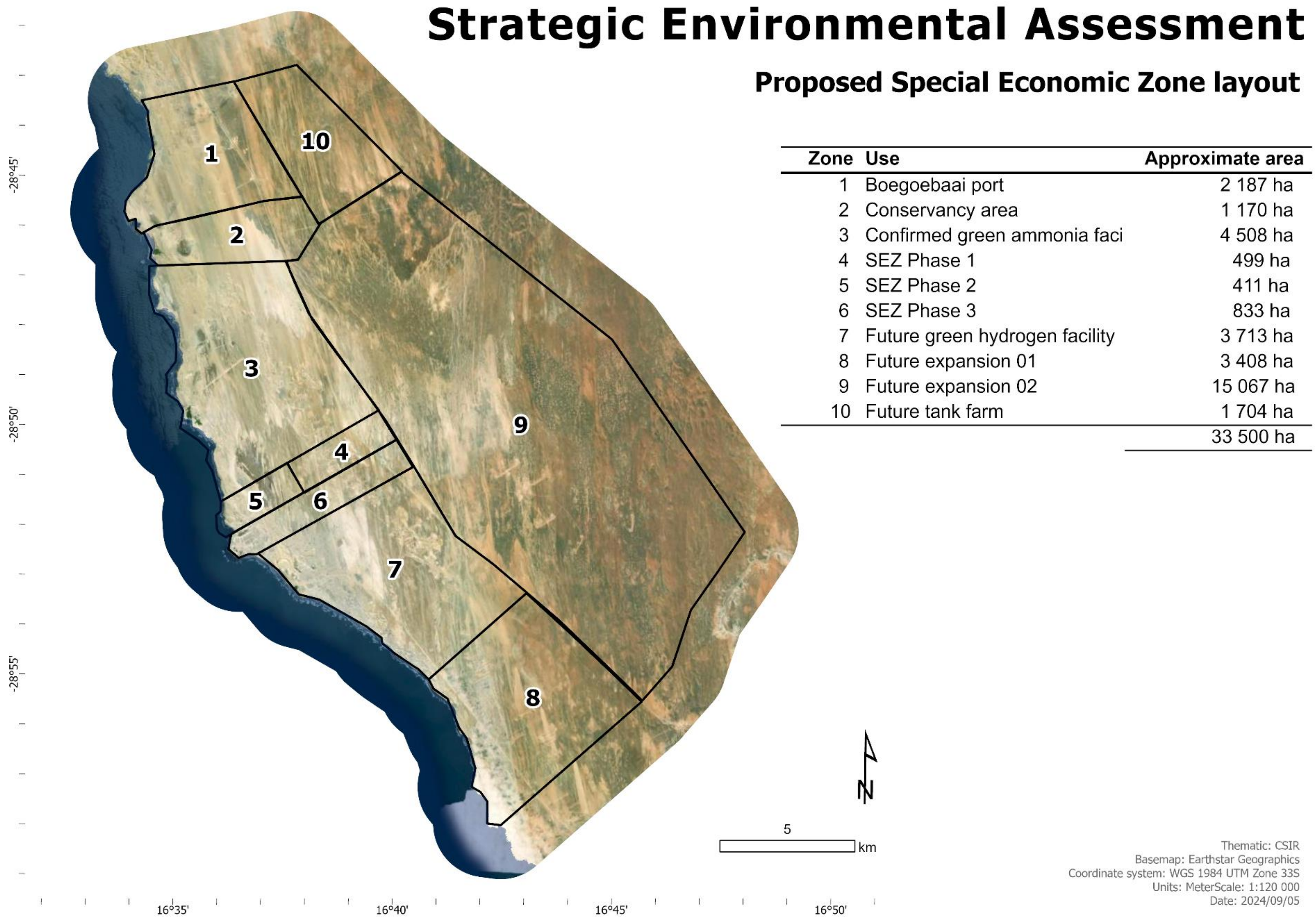

Figure 3: The port footprint and Boegoebaai Special Economic Zone Layout, showing the TNPA Port Precinct, initial phases of the SEZ on the coastal side of the R382 road and commencing from closest to the Port precinct. (Source: NCEDA, 2024)

For Phase 1A, an estimated 5 Mtpa of dry bulk (manganese) and 1.0 Mtpa of break bulk (lead and zinc) are expected to be exported by 2030/31. There are also plans to export 1.4 Mtpa of GH_2 derivatives and various agricultural products (0.2 Mtpa). Diesel imports are expected to reach around 1.3 Mtpa by 2030. All exports and imports will be transported mainly through the road network in the first phase of the new port.

The port will include a two-berth jetty connected to the land via an access trestle; a sea-side berth dedicated to dry bulk and liquid cargo and a conventional multi-purpose berth (landside). The berths are sheltered from wave energy by a concrete armoured breakwater. The bulk berth will be fitted with a ship loader and a conveyor system connected to landside closed stockpiles. The bulk berth will be capable of liquid bulk import and export, and fitted with pipelines that are connected to diesel and ammonia storage tanks. The multi-purpose berth will handle containerised cargo and break bulk using two mobile cranes. Multi-purpose cargo will be stored in a dedicated multi-purpose terminal (MPT). An Admin Craft Basin (ACB) will initially store equipment for breakwater construction and will be used to berth the marine fleet once the port is operational. The ACB will be designed as a dig-out basin within the main breakwater, protected by a secondary breakwater. The short-term port layout also involves constructing the required dry bulk terminal, multi-purpose terminal, and port administration and control buildings. Security fencing, port entrance facilities, fire station and clinic will be required. Internal port roads and rail, and truck staging facility will also be required to respond to the needs of the first phase of development.

Figure 4: Artist's impression of the Phase 1A Boegoebaai port layout (Source: TNPA, 2024)

Table 3: Infrastructure aspects and description for the proposed short-term Boegoebaai port layout (Phase 1A).

Infrastructure aspect	Description
Jetty	The jetty structure will act as a multi-use berth facility, designed to handle dry bulk, liquid bulk and multi-purpose cargo. The main jetty will consist of two berths: a 295 m long multi-purpose berth designed to accommodate Panamax vessels and a 350m long bulk berth that can accommodate Capesize vessels. The main jetty is connected to the shoreline via a 160m long access trestle. The main jetty and access trestle are founded on circular reinforced concrete piles with a sacrificial steel tubular casing. The superstructure includes reinforced concrete precast beams and slabs with in-situ concrete casts and topping to stitch the structure together. The main jetty supports ship loaders, conveyor and mobile cranes which service the bulk and MPT berths respectively., Vehicular access is provided via a single carriageway located beneath the ship loaders with turning circles provided at the ends of both the dry bulk and MPT jetty. The access trestle comprises of a single carriageway for vehicular access with the conveyor and ancillary services running adjacent.
Breakwaters	The rubble mound main and secondary breakwaters protect against wave energy at the berths and in vessel turning areas. The primary armour will be an appropriately designed, requiring an estimated 2,785 million m^3 of rock, 63,150 m^3 of reinforced concrete, and approximately 13,150 armour units.
Admin Craft Basin (Harbour)	A dig-out admin craft basin provides additional wave protection inside the main breakwater for marine fleet. The structure comprises a concrete deck supported on vertical concrete piles cast into steel casings, with a transverse beam supported by an anchored concrete abutment on the land side.
Materials Handling Equipment	The equipment will be defined by the terminal operator based on operational requirements and contracted volumes. For the bulk berth, this includes a travelling shiploader, conveyors, and stacker/reclaimers for dry bulk cargos like manganese, lead, and similar break bulk. The MPT berth will use mobile cranes, trucks, and front-end loaders for break bulk and containers.
Dry Bulk Material Handling	Manganese will be stored in closed stockpiles, similarly, to lead and zinc which require enclosed warehouses. Dust suppression systems, which involves water spraying the stockpile and conveyor cargo, are specified for manganese storage. A mobile stacker and bucket wheel will handle stacking and reclaiming operations.
Quayside Material Handling Equipment	Travelling ship loaders are selected for efficiency in handling large volumes of dry bulk cargo, with spatial dimensions allowing truck passage underneath during operations.
Conveyor Belts	Systems handling zinc and lead must be fully enclosed, while those handling manganese require arched coverage. Elevated belt conveyors are designed with handrailed walkways for safe access and maintenance.
Dust Control	Dust suppression and collection systems are incorporated, with all material handling equipment designed to prevent material accumulation outside the dust collection system.

Infrastructure aspect	Description
Buildings	Proposed port buildings include a Port Access Gateway and Induction Centre, Port Authority Building (with a Wellness Centre and Emergency Services Building), and Terminal Operator's Building (with workshops and satellite ablution buildings).
Bulk Services: Water	Average daily water demand is estimated at 660 kL/day. Two options were considered: a pipeline from Alexander Bay with a water treatment plant, or an onsite desalination plant. The desalination plant (1ML capacity) is considered more feasible. Elevated reservoirs will provide pressure for fire suppression discharge.
Bulk Services: Sewer	The site will be divided into separate drainage areas with isolated reticulation systems, on-site treatment, and disposal. Drainage areas will use a combination of wastewater treatment plant, septic tank and soak-away systems.
Stormwater	The drainage system will separate clean and dirty water, with clean water runoff diverted around the site. High-risk dirty runoff water will flow into concrete-lined channels, and low-risk dirty runoff water will flow into block and vegetated channels. Pollution control ponds will be lined with HDPE, attenuated to the 1:50 year pre-development condition and discharged to the receiving natural environment, such as the ocean.
Electrical	The internal electrical network will include an intake substation (22kV), primary and secondary substations, distribution substations, street and area lighting, and small power and lighting for buildings.
Electronics	Security systems include fencing, CCTV coverage, access control, and coastal/railway protection systems, and will comply with the International Ship and Port Facility Security requirements. General electronic systems include fire detection, public address, evacuation systems, building management system, and security control room. Information and Communication Technology services include fibre connections, server rooms, network equipment, microwave links, and manhole and sleeve infrastructure.
Fuel storage	A liquid bulk storage facility with two 35,000 m^3 tanks and tanker loading facilities is included. Tanker vessels will discharge into storage tanks via pipeline at the MPT berth. This represents the first phase of the liquid bulk terminal development.
Internal Port Roads and Bridges	Port Access Interchange: Located 60 km north of Port Nolloth off the R382, designed to accommodate large volumes of heavy vehicle traffic for continuous flow. Port Access Control: Separate entrances with an access gateway and a combined weighbridge and access gateway, allowing multiple trucks to queue without causing congestion. Truck Offloading Area: Designed with three offloading terminals operating independently to prevent congestion and ensure continuous offloading.
External Roads	Development of the port in the short-term will attract mining ore transported by trucks along the R382, serving as the primary route for transporting mining commodities until rail transport viability is considered for future port expansion phases.

4.1.2 Special Economic Zone

The Northern Cape Provincial Government envisions the establishment of a Boegoebaai SEZ as a multifaceted hub, primarily focusing on the GH_2 project's downstream activities and facilitating the export orientation of commodities through the proposed Boegoebaai port. The focus will also include opportunities in manufacturing, logistics, and agro-processing to deliver a broad range of products and services (NCGHM, 2023). The Boegoebaai SEZ area, encompassing approximately 31 300 ha, will be developed in phases and is envisaged to consist of eight subzones (refer to Figure 3):

- Conservancy area – 1 170 ha
- Confirmed green ammonia facility – 4 508 ha
- SEZ Phase 1 – 499 ha
- SEZ Phase 2 – 411 ha
- SEZ Phase 3 – 833 ha
- Future green hydrogen facility – 3 713 ha
- Future expansion 01 – 3 408 ha
- Future expansion 02 – 15 067 ha
- Future tank farm – 1 704 ha

Two entrances to the SEZ are proposed: a northern entrance for commercial, socio-service, and private traffic, and a southern entrance for industrial traffic. The truck staging area and the SEZ desalination plant are planned to be located near the southern entrance, facilitating road freight to and from the N14 and N7 highways.

Table 4: Proposed infrastructure and development activities per SEZ subzone

SEZ subzone	Description of infrastructure
1) TNPA port precinct	See Section 4.1.1.
2) Conservancy area	Conservancy area of approximately 1 170 ha that has been roughly demarcated based on initial inputs on conservation priorities such as the Boegoeberg koppies and seal colony on the Boegoebaai point. A habitat unit known as Swartvygie Heuweltjie Strandveld, located just inland of Boegoebaai, has suffered extensive damage from mining over the past century. The only intact areas are protected by the Buchuberg twins and hardened roads, which prevent sand scour. It is crucial for any port and GH_2 projects to avoid these intact portions, as they cannot be offset. There is also an interesting archaeological site at the proposed development – the Boegoebaai cave/lair.
3) Green ammonia facility	Sasol's green ammonia facility will be located near the TNPA port precinct to minimize pipeline length and enhance efficiency. The site is adjacent to the coast to facilitate desalination processes and house Sasol's 188 ML/day desalination plant. Infrastructure will include desalination plant and associated infrastructure (including seawater intake infrastructure and discharge pipeline) (see Work Package 2 for estimated desalinated water volumes); Water treatment unit and water reservoir; Containerised units for the electrolysers; Air separation unit; Liquid air energy system (LAES) for nitrogen storage; Hydrogen and oxygen storage; Ammonia processing unit and liquid ammonia storage tank; Pipelines required for hydrogen, its' derivatives and by-products, and a control room. Seawater will be desalinated through a Reverse Osmosis (RO) process and then further processed to Demineralized water, which is needed for the production of GH_2 via water electrolysis. Cooling tower blowdown will be disposed of back to sea with the RO brine and other treated wastewater streams. It is expected that the blended total dissolved solids (TDS) of the cooling tower blowdown stream and the RO brine and waste streams will be acceptable for seawater discharge. Firewater will be provided through firewater tanks on site. There is an opportunity to combine firewater and desalinated water storage on site. Seawater will be the backup source of firewater in case of an emergency and the stored firewater is not adequate. Lye solution purge from the GH2 Plant will be discharged with the other return streams to the sea. Other effluent is oxygen and small quantities of off-gas which are expected to be safe to vent to atmosphere.
4-6) SEZ Industrial Park	The Industrial Park will be designated for mixed-use purposes, a manufacturing cluster, logistics and warehousing, offices. The SEZ will also include a 2.7 ML/day desalination plant, including pump station, supply pipelines, feeder pipelines etc. Sasol will extract and filter seawater, with some of the filtered water being sold to the SEZ Industrial Park for its use and for supplying Port Nolloth. The SEZ Industrial Park will further desalinate this water through its plant. The remaining filtered water will go through Sasol's desalination plant for use in their operations.

SEZ subzone	Description of infrastructure
7) Future GH2 facility	This will be a replication of the work that is anticipated at the initial Green Ammonia Facilities: Water treatment unit and water reservoir; Containerised units for the electrolysers; Air separation unit; Liquid air energy system (LAES) for nitrogen storage; Hydrogen and oxygen storage; Ammonia processing unit and liquid ammonia storage tank; Pipelines required for hydrogen, its' derivatives and by-products, and a control room.
8) Future expansion area 01	This will be a replication of the work that is anticipated at the initial Green Ammonia Facilities: Water treatment unit and water reservoir; Containerised units for the electrolysers; Air separation unit; Liquid air energy system (LAES) for nitrogen storage; Hydrogen and oxygen storage; Ammonia processing unit and liquid ammonia storage tank; Pipelines required for hydrogen, its' derivatives and by-products, and a control room.
9) Future expansion area 02	This will be a replication of the work that is anticipated at the initial Green Ammonia Facilities: Water treatment unit and water reservoir; Containerised units for the electrolysers; Air separation unit; Liquid air energy system (LAES) for nitrogen storage; Hydrogen and oxygen storage; Ammonia processing unit and liquid ammonia storage tank; Pipelines required for hydrogen, its' derivatives and by-products, and a control room.
10) Future tank storage	Proposed area of approximately 1 704 ha inland of the R382 road.

4.1.3 SEA reporting and outputs

Work Package 1 chapters should follow something like the structure below, as far as practicable, although some chapters may be different:

1. **Executive Summary**: of 2 pages with headline findings/recommendations (including one iconic image/map to assist communication of findings to policymakers).
2. **Description of the receiving environment**:
    - Describe the land use dynamics and change trends of the receiving environment and broader region as it relates to your topic. This will feed into the dynamic baseline scenario (Sc0) used in WP2 "Regional SEA".
    - Describe the local receiving environment per SEZ subzone (where materially different / appropriate to differentiate). Include detailed field data as Annexes to the chapter.
3. **Sensitivity mapping**: Spatial classification of receiving environments across the study area. E.g. tiered sensitivity map, verified by field work. Sensitivity classes: Low, Medium, High, Very High.

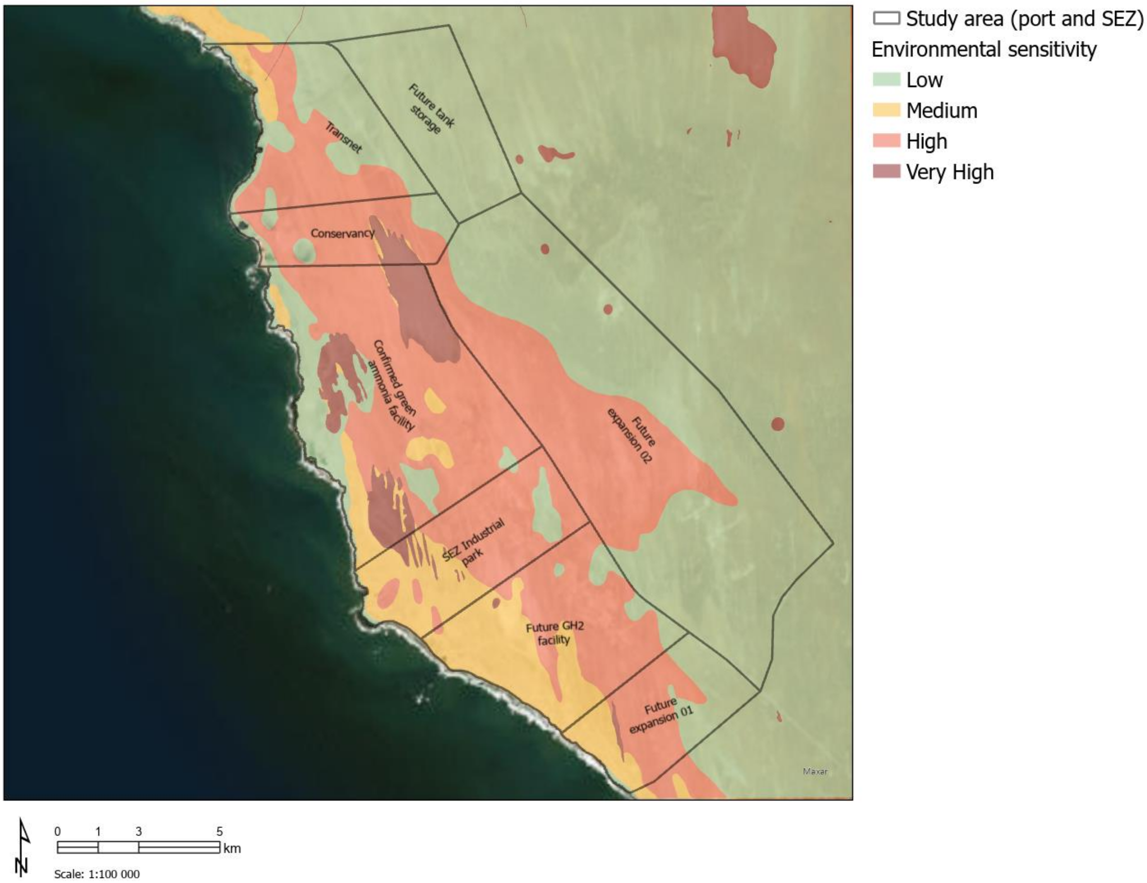

Figure 5: Example sensitivity map.

4. **Aspects and impacts register**: Describe the impacts that may occur for the identified infrastructure aspect / SEZ subzone and cite the primary receiving environment of concern

Table 5: Example aspects / impacts register

Port infrastructure aspect / SEZ subzone	Potential impact	Receiving environment of concern (spatially explicit)
Desalination plant located within the green ammonia facility subzone	Brine discharge from desalination plant causing increased salinity and loss of species	50m radius from diffuser points located along marine outfall
Expansion of development into Future expansion area 01	Vegetation clearance causing loss of biodiversity and species	Areas mapped Very high sensitivity for intact Richtersveld Coastal Duneveld habitat, as in Figure 5 (example)

5. Recommended Strategic Management Actions:
    - Recommendations to: guide -
        - Enhance positive impact and reduce negative impacts.
        - Guide future Port/SEZ planning and layouts.
        - Guide future site- and project-specific Environmental Impact Assessments (EIAs) undertaken within the study area.

Other guidance for authors:

- Aim for a report not longer than 20 pages (excluding Annexes, which may be more detailed).
- Synthesise results as far as possible into visually useful diagrams or images.
- The most important part of the chapter is the Executive Summary (don't complete this as an afterthought).
- Please allow for a peer review at the draft report stage (to be nominated, facilitated and remunerated by the Chapter lead author/s), and thereafter a review by CSIR and other stakeholders (to be facilitated by CSIR).

- Chapters will be formatted, desktop published and integrated into one report and published on the SEA website by CSIR.
- Spatial data (e.g. of ground-truthed environmental features and sensitivity) can be provided in .shp or .kmz format.

4.2 Work Package 2 – Regional

The Northern Cape targets include an initial 1.2 GW of electrolyser capacity to be completed by 2028, scaling up to 5 GW by 2030, and reaching 40 GW by 2050. If GH_2 products were to be produced at scale in the Northern Cape, the macro socioeconomic benefits could be substantial. Likewise, the local benefits across the entire value chain of GH_2 production, storage, transportation (rail, pipelines, powerlines, roads, ports) could help to create new opportunities, jobs and skills. The technologies and infrastructure required to create the electricity and water inputs, such as wind turbines and solar PV panels, seawater desalination plants (plus the hundreds of kilometres of linear infrastructure), are major infrastructure developments (Figure 6), with a complex array of social and environmental impacts. If undesirable impacts are not properly avoided and mitigated in the project planning phases, individually or in accumulation, they could result in unacceptable social and ecological consequences.

4.2.1 Scope

The spatial scope is delimited by four local municipalities; the Richtersveld, Nama Khoi, Kamiesberg and Khâi Ma Local Municipalities, including the Boegoebaai port precinct and SEZ (see Figure 1).

The scope of the SEA focusses on all the positive and negative social / ecological impacts associated with a regional GH_2 economy in the Northern Cape. Two GH2 development scenarios are considered in relation to (or in addition to) a dynamic baseline which includes other development and change trends in the region over a 25-year time horizon from 2025 to 2050.

4.2.2 Regional infrastructure

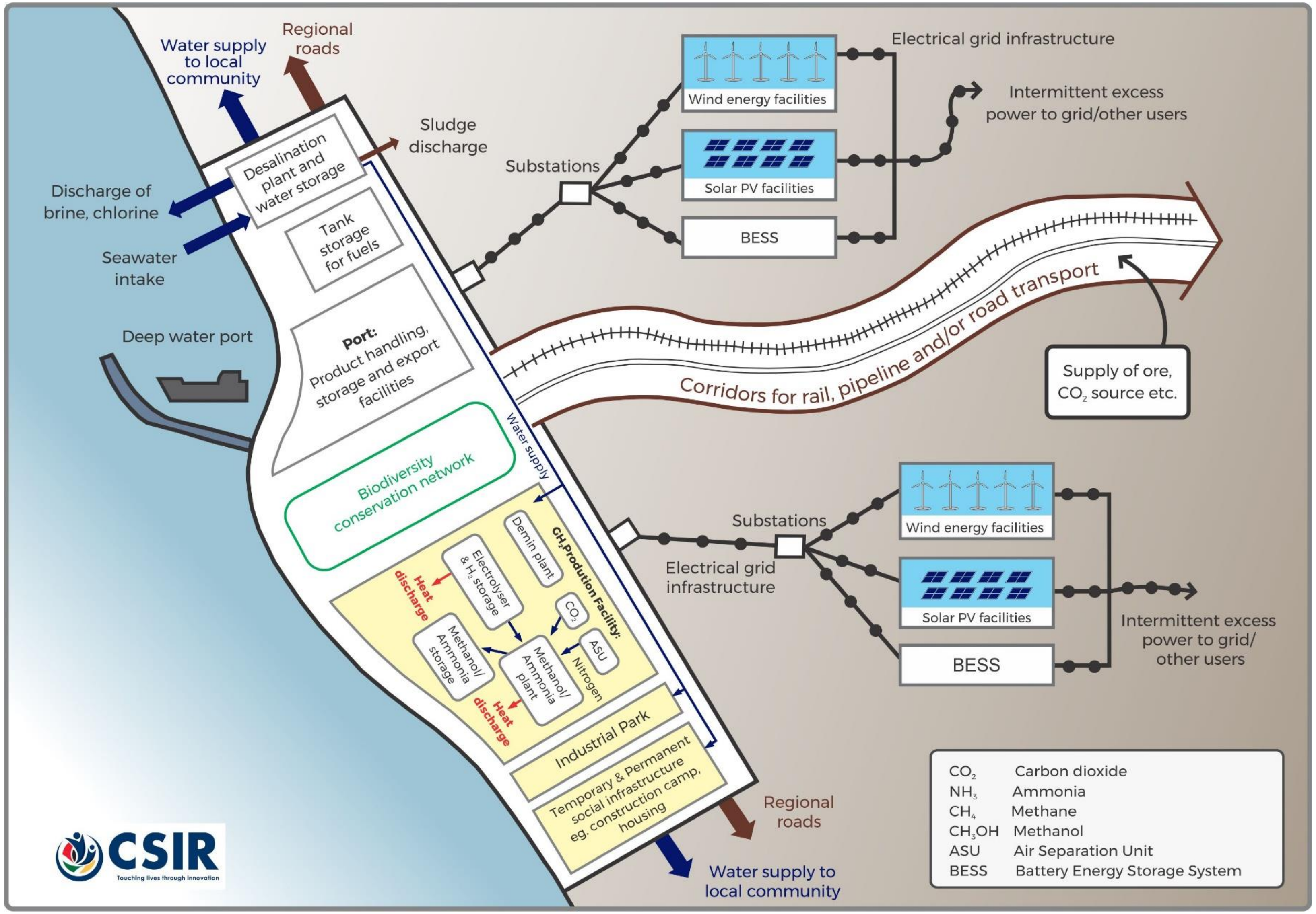

Figure 6: Schematic of the typical main infrastructure components for the Northern Cape regional GH2 programme (notional drawing, not to scale)

4.2.2.1 Port and SEZ expansion

The long-term port layout (Phase 1B) has been designed to remain flexible and adaptable to any future changes in commodity mix, operations, and planning. The masterplan development assumes that the port will continue to primarily export commodities from Phase 1A, with the potential for other GH_2 derivatives such as methanol, naphtha and e-kerosene. The projected export volumes of green ammonia, combined with methanol, naphtha and e-kerosene is expected to increase to 2.15 Mtpa from 2035. By 2050, TNPA plans to extend the breakwater required for the provision of additional multi-purpose and liquid bulk berths. This will include the development of additional port infrastructure, such as the Boegoebaai Container Terminal (BCT), a ship repair yard, as well as the expansion of stockpiling warehouses. Enclosed warehouses will be used for dust suppression, ensuring that the manganese is adequately covered during storage and transportation via conveyor belts. The port expansion will also require rail connectivity, road-over-rail bridges, and rail marshalling and tippler facilities.

Future SEZ activities are outlined in Table 4.

Ancillary infrastructure required in support of the port and SEZ include:

- Additionally, Infrastructure for the disposal and management of chemical and hazardous waste generated by the port and SEZ.
- Domestic water and waste infrastructure throughout the port and SEZ.
- Utility water infrastructure between throughout the port and SEZ.
- Internal roads, pipelines, ICT, security, and office infrastructure.
- Accommodation for workers during the construction and (potentially) operations phases.

4.2.2.2 Renewable energy and transmission lines

Some power generation infrastructure (wind and solar PV) will be located in reasonably close proximity to the SEZ, however, due to the sensitivity of the local receiving environment and potential impacts of the coastal environment on the generation facility (e.g. corrosion), in most cases, power will be generated from dispersed renewable energy projects (each requiring their own EIA processes), in some cases, several hundred kilometers away. Electricity will then be delivered to the GH_2 production plant using a combination of new and existing transmission and distribution infrastructure. In such cases the development and permitting of the generation components will be undertaken by 3rd parties, and the developer may not have control of the whole project. The project owner will purchase power from 3rd parties (or purchase the projects outright and own and operate them) and negotiate with the utility to wheel the power using the existing or new build grids. The project components are likely to be permitted separately, with the hydrogen developer permitting the electrolyser, ammonia plant, desalination plant and, in some cases, the export port facilities, and the generation (wind and solar PV) and transmission being permitted by several other 3rd party entities such as Independent Power Producers (IPPs) and Eskom.

Table 6: Brief description of the main renewable energy aspects.

Renewable energy	Aspect	Description
Wind	Turbines	Rotor with blades, nacelle, tower; sizes 4-8 MW, hub height 150-180 m, blade length ~100 m.
	Other	Foundations (~32 m^2), access roads, Battery Energy Storage System (BESS), on-site electrical system, substation, transmission lines, construction camp, operations & maintenance facilities, meteorological towers.
Solar PV	Solar panels	Monocrystalline/polycrystalline silicon cells; height ~6 m. Fixed or dual-axis tracking. Single or bifacial modules.
	Other	Inverters, mounting structures, BESS, foundations, access roads, electrical system, substations, transmission lines, electrical components, construction camp, operations & maintenance facilities.

1.2.1.1. Transport infrastructure

- New pipelines for the bulk transportation of GH_2 to and from Namibia, Saldanha Bay (Sc1) and Prieska (Sc2).
- New rail between Boegoebaai and Kenhardt connecting to the existing Saldanha-Sishen railway route.
- Upgrade and expansion of roads to and from Alexander Bay.
- Roads associated with the construction, operation and maintenance of new RE facilities, railways and pipelines.

4.2.3 Development scenarios

What is lacking from the knowledge- and decision-making base regarding GH_2 development in the Northern Cape, is an integrated, cumulative, long-term picture of what a medium to large-scale GH_2 economy might look like. The only way to achieve this is by undertaking an interdisciplinary scenarios assessment.

The scenarios assessment will help to 1) concretize how a large Northern Cape GH_2 economy might look in terms of the nature and scale of infrastructure and development footprints; and 2) estimate what the positive and negative cumulative impacts might be and suggest how positive impacts might be best enhanced and negative ones best mitigated.

Two GH_2 development scenarios will be assessed, each compared to an existing dynamic baseline (Figure 7), where no GH_2 development occurs but other anthropogenic and climate changes continue, described as follows:

- **SCENARIO 0 – DYNAMIC BASELINE (2023 – 2050):** Boegoebaai Port and SEZ remains undeveloped. No GH_2 is produced in the Northern Cape. The region proceeds on current social (e.g. migration), ecological, climatic (e.g. desertification, storm surges) and developmental trends, including all other non-GH_2 activities (e.g renewable energy development). This scenario will be developed with input from specialist research partners as the dynamic baseline relates to their field of expertise.
- **SCENARIO 1 – "SMALL GH_2" (by 2035):** 5 GW electrolyser producing **0.5 mtpa GH_2** and derivatives supported by 10 GW of renewable energy (assume 60% solar / 40% wind)
- **SCENARIO 2 – "BIG GH_2" (by 2050):** Upscaled GH_2 development to a 40 GW electrolyser producing a total of **4 mtpa GH_2** and derivatives supported by 80 GW of renewable energy (assume 60% solar / 40% wind)

Each of the GH_2 development scenarios will be associated with different development footprints and scales of infrastructure (Table 7).

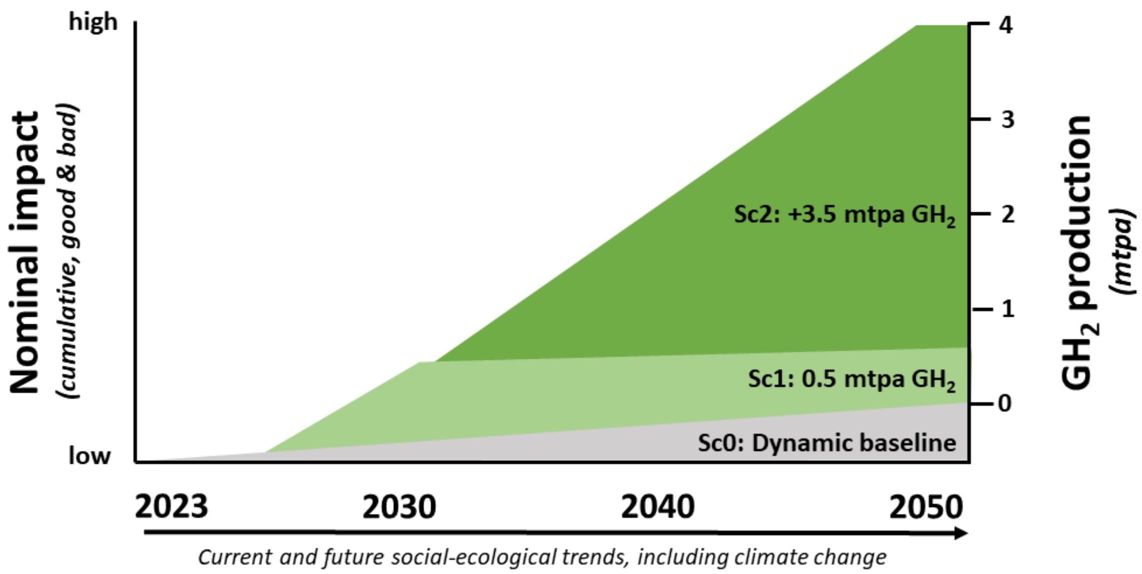

Figure 7: Indicative diagram of the scenarios approach for assessing cumulative impacts

Table 7: GH_2 development scenario quantifications (Sc1 and Sc2) for the regional assessment *(draft, currently being verified by the PSC).*

	Aspect	Unit	Sc1: Small GH_2	Sc2: Big GH_2	*Assumptions*
SEZ	Electrolyser capacity	GW	5	40	Northern Cape Green Hydrogen Master Plan ambition
	Electrolyser footprint	ha	75	600	15 ha per 1 GW
	GH2 volume	mtpa	0,5	4,0	10 GW electrolyser = 1 mpta GH2
	GH2 storage footprint	ha	250	2 000	10 ha per 20 000 tpa (500 ha for 1 mpta)
	Ammonia volume	mtpa	2,8	22,7	1 mt H2 for 5,67 mt NH3 (1Mt of ammonia contains 176.5 kg (just 17.65%))
	Ammonia footprint	ha	57	454	1 ha per 50 000 tpa NH3 (e.g. Enertrag Hendrina) (20 ha for 1 mtpa)
	Ammonia storage footprint	ha	28	227	0,5 ha per 50 000 tpa NH3 (e.g. Enertrag Hendrina) (10 ha for 1 mpta)
	Desalination output volume	Ml/day	36	286	25 kg water per 1 kg GH2 (considering electrolysis and cooling). 1Mtpa GH2 output required 25 Mtpa (=25000 MLpa) water / 350 operational.
	Desalination footprint	ha	7	57	5 Ml/day output needs 1 ha
	Desalination discharge	Ml/day	48	387	Ratio of desalinated water to brine discharge water to be 42.5:57.5. (i.e 42.5% of intake sea water is converted to desalinated water and 57.5% is discharged as brine).
	Pipeline intake volume	Ml/day	84	672	Output + discharge
REGION	RE capacity total	GW	10	80	1 Mt/yr of H2 needs 10 GW electrolyser, that is powered by 20 GW
	RE capacity - solar	*GW*	*6*	*48*	60 % solar : 40 % wind
	RE footprint - solar	*ha*	*12 000*	*96 000*	0,5MW/ha
	RE extent - solar		*12 000*	*96 000*	Footprint = extent
	RE facilities - solar	*no of facilities*	*6*	*48*	Clusters of 1 GW facilities
	RE capacity - wind	*GW*	*4*	*32*	60 % solar : 40 % wind
	RE footprint - wind	*ha*	*4 000*	*32 000*	1 MW/ha
	RE extent - wind	*ha*	*40 000*	*320 000*	0,1 MW/ha
	RE facilities - wind	*no of facilities*	*3*	*21*	Clusters of 1,5 GW facilities
	Road length	km	300	600	New roads and upgrades same distances / routes as pipelines
	Road footprint	ha	1 200	2 400	40 m (Rural class 2 road 40-70 m. TRH26 Road Classification and Access Management)
	Rail length	km	550	550	Boegoebaai – Kenhardt. New rail direction south-east to connect to the existing Saldanha-Sishen route.
	Rail footprint	ha	1 600	1 650	30 m for rail and service track
	Pipeline length	km	300	600	Sc1: NAM<BB>SB (300km); Sc2: BB>Prieska (300km)
	Pipeline footprint	ha	600	1 200	20 m servitude
	Powerline length	km	260	1 387	Assume grid strengthening / shared infrastructure 30 km TX associated with each RE cluster.
	Powerline footprint	ha	1 300	6 933	50 m servitude (TRH 27 South African Manual for Permitting Services in Road Reserves)
	Main infrastructure components footprint	**ha**	**21 082**	**142 240**	
Units: GW = gigawatt; mtpa = million tonne per annum; ha = hectare; Ml/day = million litres per day; km = kilometre					

4.2.4 Risk / opportunity assessment

Each Chapter will undertake a systematic risk/opportunity assessment of the impacts relating to GH_2. The approach is based on a transparent expert judgement process, allowing for the considering impacts of an issue in a common way, and (where possible) within a spatial context. Risk and opportunity are determined by estimating the likelihood of events or trends occurring, in relation to their negative or positive consequences i.e., likelihood x consequence (Figure 8).

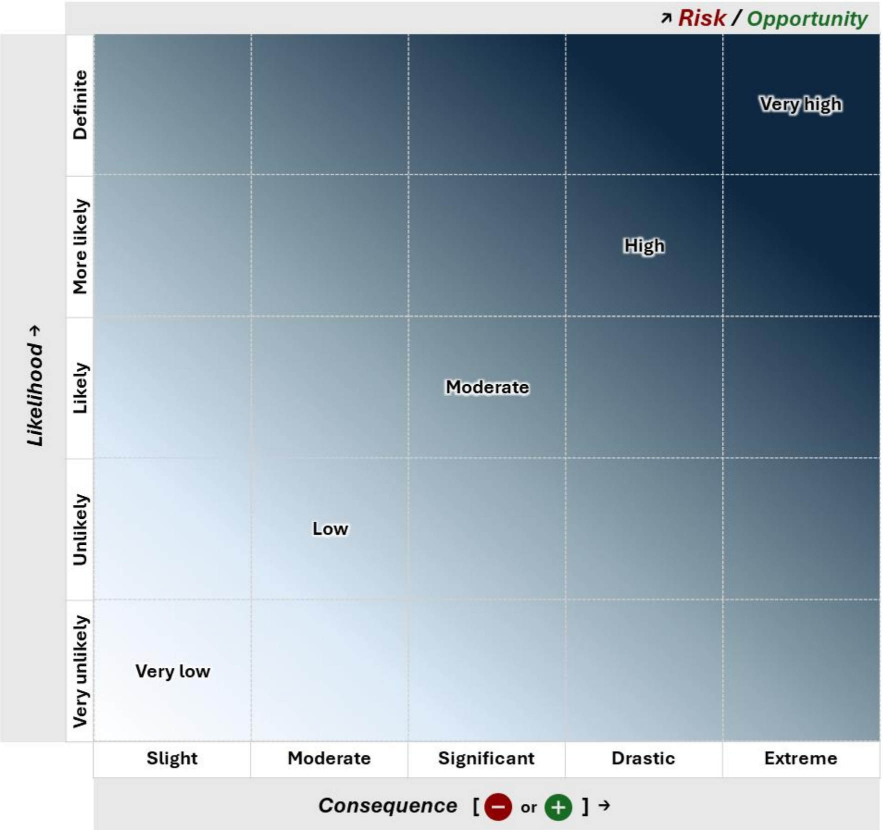

Figure 8: Risk and opportunity is qualitatively measured by multiplying the likelihood of an impact (negative or positive) by the severity of the consequence or benefit.

Consequence / benefit thresholds must be defined by each chapter per specific theme or receptor (i.e. extreme consequence means *x* or significant benefit means *y*) (Table 8).

The risk/opportunity framework is based on an interpretation of existing spatial and non-spatial data in relation to the proposed activities described in the scenarios, to generate an integrated picture of the risk/opportunity related to a specified activity in a given location, with and without mitigation.

Risk/opportunity is assessed for each impact, on each different type of receiving environment or entity (e.g., the rural poor, a sensitive wetland etc.), qualitatively against a predefined set of criteria (Table 9).

Table 8: Examples of defined consequence / benefit categories.

Theme / receptor	Negative consequence (-)				
	Slight	Moderate	Significant	Drastic	Extreme
Terrestrial fauna and flora	*XX*	*XX*	*XX*	*XX*	80% reduction in population / area of occupancy of threatened species.
Job-seeker in-migration	Minimal additional strain on service delivery.	*XX*	*XX*	*XX*	High levels of homelessness and severely strained service delivery.
Water resources	*XX*	*XX*	*XX*	Impacts only reversable through human intervention over decades	*XX*
Theme / receptor	**Positive consequence (+)**				
	Slight	**Moderate**	**Significant**	**Drastic**	**Extreme**
Water resources	*XX*	*XX*	*XX*	Increased water security from desalinated seawater	*XX*
Employment and skills	Very few local opportunities created	*XX*	*XX*	*XX*	High demand for local workers.
Infrastructure	*XX*	*XX*	*XX*	*XX*	New / Significant upgrade to existing municipal infrastructure

Table 9: Predefined risk/opportunity categories.

RISK (-)		OPPORTUNITY (+)	
VERY LOW	Almost indiscernible negative impact.	Almost indiscernible positive impact.	**VERY LOW**
LOW	Slight negative impact, limited extent, and short duration, well within tolerance.	Slight positive impact, very localised, well below expectations.	**LOW**
MODERATE	Substantial impact, but less than major; within tolerance and below limits of acceptable change.	Substantial positive impact, but mostly short term, and spatially limited.	**MODERATE**
HIGH	Major consequence, approaching tolerance and limits of acceptable change.	Highly desirable impact, major medium to long term positive impacts across a broad range of stakeholders at local or regional scales.	**HIGH**
VERY HIGH	Extremely negative impact, persistent/long lasting, beyond tolerance and limits of acceptable change.	Highly desired, grandiose long term positive impacts across a broad range of stakeholders at local, regional, national, and/or international scales.	**VERY HIGH**

Table 10: Example of table showing risk associated with a negative impact.

Negative impact	Scenario	Spatial receiving environment / receptor	Without management			With management		
			Consequence (-)	Likelihood	Risk	Consequence (-)	Likelihood	Risk
Ecological and biodiversity loss	S0: BASELINE	VERY HIGH SENSITIVITY	SLCIGHT	LIKELY	VERY LOW	SLIGHT	LIKELY	VERY LOW
	S1: SMALL GH2		MAJOR	LIKELY	HIGH	MAJOR	NOT LIKELY	MODERATE
	S2: BIG GH2		EXTREME	VERY LIKELY	VERY HIGH	EXTREME	NOT LIKELY	MODERATE
	S0: BASELINE	HIGH SENSITIVITY	SLIGHT	LIKELY	VERY LOW	SLIGHT	LIKELY	VERY LOW
	S1: SMALL GH2		SUBSTANTIAL	LIKELY	MODERATE	SUBSTANTIAL	NOT LIKELY	LOW
	S2: BIG GH2		MAJOR	VERY LIKELY	HIGH	MAJOR	NOT LIKELY	MODERATE
	S0: BASELINE	MEDIUM SENSITIVITY	SLIGHT	LIKELY	VERY LOW	SLIGHT	LIKELY	VERY LOW
	S1: SMALL GH2		SLIGHT	LIKELY	VERY LOW	SLIGHT	LIKELY	VERY LOW
	S2: BIG GH2		MODERATE	VERY LIKELY	LOW	MODERATE	LIKELY	LOW
	S0: BASELINE	LOW SENSITIVITY	SLIGHT	LIKELY	VERY LOW	SLIGHT	LIKELY	VERY LOW
	S1: SMALL GH2		SLIGHT	LIKELY	VERY LOW	SLIGHT	LIKELY	VERY LOW
	S2: BIG GH2		SLIGHT	LIKELY	VERY LOW	SLIGHT	LIKELY	VERY LOW

Table 11: Example of table showing opportunity associated with a positive impact.

Positive impact	Scenario	Spatial receiving environment / receptor	Without management			With management		
			Consequence (+)	Likelihood	Opportunity	Consequence (+)	Likelihood	Opportunity
Job and skills creation	S0: BASELINE	Port and SEZ	SLIGHT	LIKELY	VERY LOW	SLIGHT	LIKELY	VERY LOW
	S1: SMALL GH2		DRASTIC	LIKELY	HIGH	DRASTIC	NOT LIKELY	MODERATE
	S2: BIG GH2		EXTREME	VERY LIKELY	VERY HIGH	EXTREME	NOT LIKELY	MODERATE
	S0: BASELINE	XX Municipality	SLIGHT	LIKELY	VERY LOW	SLIGHT	LIKELY	VERY LOW
	S1: SMALL GH2		SUBSTANTIAL	LIKELY	MODERATE	SUBSTANTIAL	NOT LIKELY	LOW
	S2: BIG GH2		DRASTIC	VERY LIKELY	HIGH	DRASTIC	NOT LIKELY	MODERATE
	S0: BASELINE	XX municipality + XX municipality	SLIGHT	LIKELY	VERY LOW	SLIGHT	LIKELY	VERY LOW
	S1: SMALL GH2		SLIGHT	LIKELY	VERY LOW	SLIGHT	LIKELY	VERY LOW
	S2: BIG GH2		MODERATE	VERY LIKELY	LOW	MODERATE	LIKELY	LOW
	S0: BASELINE	Northern Cape	SLIGHT	LIKELY	VERY LOW	SLIGHT	LIKELY	VERY LOW
	S1: SMALL GH2		SLIGHT	LIKELY	VERY LOW	SLIGHT	LIKELY	VERY LOW
	S2: BIG GH2		SLIGHT	LIKELY	VERY LOW	SLIGHT	LIKELY	VERY LOW

4.2.5 SEA reporting and outputs

Work Package 2 chapters should follow something like the structure below, as far as practicable, although some chapters may be different:

1. Executive Summary of 2 pages with headline findings/recommendations (including one iconic image/map to assist communication of findings to policymakers)
2. Spatial classification of receiving environments across the study area (e.g., tiered sensitivity map - LOW, MEDIUM, HIGH, VERY HIGH)
3. Description of the likely baseline receiving environment up to 2050 (Sc0) in view of current social and ecological trends e.g., mining activities, rising unemployment, decreased rainfall and water supply, other land use changes, increased tourism etc.
4. Brief description of the potential impacts, positive and negative, associated with a regional GH2 economy and other developments in the Port and SEZ.
5. Define consequence / benefit categories.
6. Description of what would constitute best-practice for effective management/mitigation/enhancement of positive and negative impacts
7. Assess the risk/opportunity of the impacts across each of the scenarios (before & after management) according to methodology provided.
8. Recommended Strategic Management Actions to guide policymakers and regional planning in, for example, Environmental Management Frameworks (EMFs), Spatial Development Frameworks (SDFs), Infrastructure Development Plans (IDPs) and future EIAs.

Other guidance:

- Aim for a report not longer than 40 pages (excluding Annexes, which may be more detailed).
- Look to aggregate and synthesize impacts so that your chapter has 1-3 impacts max. Each impact needs to be assessed per scenario, per receiving environment. Many impacts will translate into pages and pages of risk tables, which we don't want. Synthesize. For example, if you are drafting the chapter on terrestrial ecology, don't look at individual impacts on different species and processes – rather have one impact e.g. "GH2 development impact on ecological and biodiversity", then assess that per scenario, per receiving environment.
- Synthesise results as far as possible into visually useful diagrams or images.

- The most important part of the chapter is the Executive Summary (don't complete this as an afterthought).
- Please allow for a peer review at the draft report stage (to be nominated and facilitated by the Chapter lead author/s at the expense of the Chapter lead author/s), and thereafter a review by CSIR and other stakeholders (to be facilitated by CSIR).
- Chapters will be formatted, desktop published and integrated into one report and published on the SEA website by CSIR.
- Spatial data can be provided in .shp or .kmz format.

5 Project schedule and deliverables

In order for the project to benefit from a broad range of views from experts in the field, a Working Group (WG) has been established. The WG consists of individuals representing organisations, including constituents who have an interest in the Northern Cape, GH_2, PtX etc., and representatives of CPAs in the area.

There will be opportunities for plenary-type engagements at certain intervals, serving as knowledge-sharing sessions, and ensuring a cohesive and collaborative approach assessment of the project's environmental impacts. These plenaries will be three-hour sessions and will likely be virtual, with at least one physical working session in Stellenbosch. The date and time of the sessions will be arranged and finalised based on the availability of the specialist research partner teams.

The draft specialist reports are due by:

- WP1: January 2025
- WP2: February 2025

The final reports are due by:

- WP1: March 2025
- WP2: April 2025

6 Data repositories and information sharing

All relevant project information and available desktop baseline information (spatial data, reports etc.), including data generated based on initial screening, will be collated. Research partners will have access to the data and reports repository.