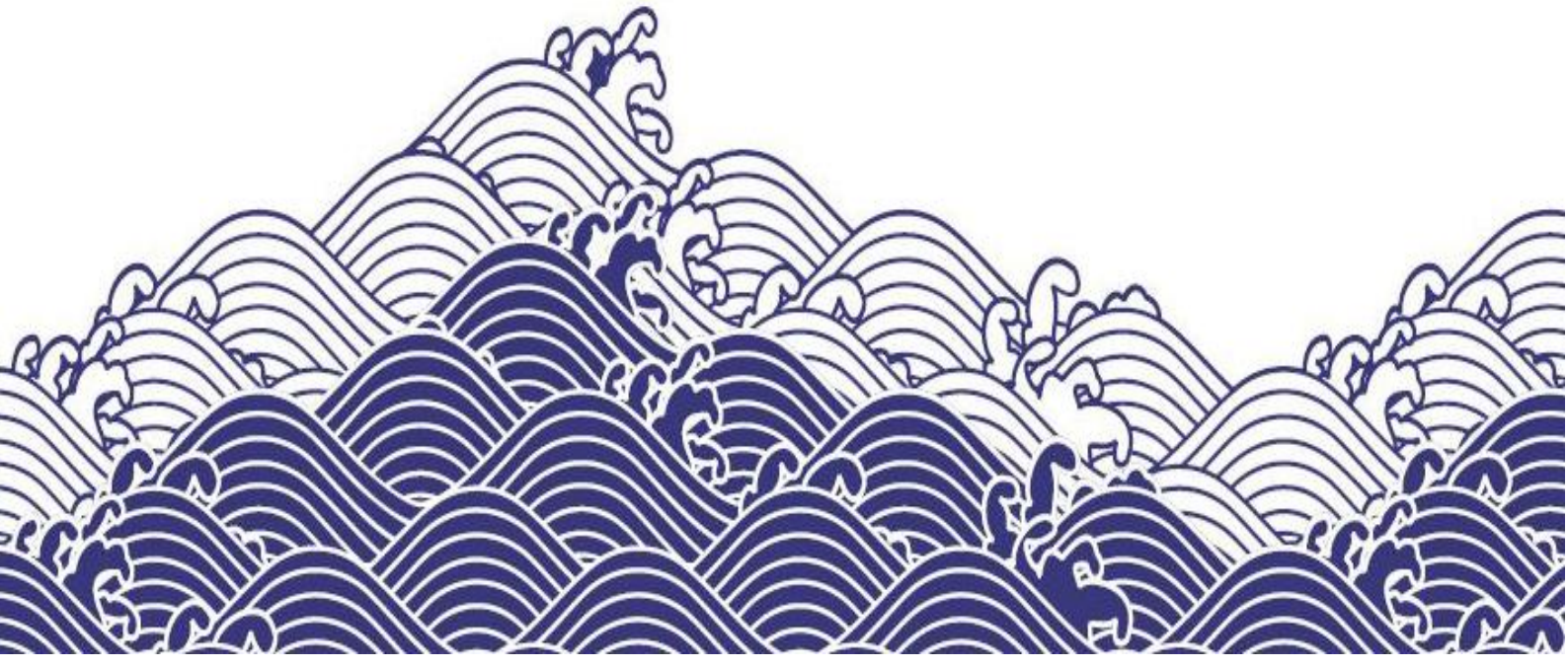
Ichthys Carbon Capture and Storage Project – Referral Report



RECORD OF AMENDMENT

Revision	Section	Amendment

DOCUMENT DISTRIBUTION

	Name
00	Document Control
01	
02	
03	
04	
05	
06	
07	
08	
09	
10	

NOTICE

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

TABLE OF APPENDICES

Terms, abbreviations and acronyms

Term, abbreviation or acronym	Meaning
AAPA	Aboriginal Areas Protection Authority
AGI	acid gas incinerator
AGRU	acid gas removal unit
AHD	Australian Height Datum
Air NEPM	Ambient Air Quality National Environment Protection Measure
ALA	Atlas of Living Australia
ALARP	as low as reasonably practicable
AMP	Australian marine park
ASS / PASS	acid sulphate soil / potential acid sulphate soil
BCCS	Bonaparte Carbon Capture and Storage Project
BCM	bank cubic metre
BESS	battery energy storage system
BIA	biologically important area
BOM	Bureau of Meteorology
Bq/g	becquerels per gram
BTEX	benzene, toluene, ethylbenzene and xylenes
CCES	CO_2 compression and export system
CCPP	combined cycle power plant
CCS	carbon capture and storage
CEMP	construction environment management plan
CO_2	carbon dioxide
Cwlth	Commonwealth
DCCEEW	Department of Climate Change, Energy, the Environment and Water (Cwlth)

Term, abbreviation or acronym	Meaning
DN	diameter nominal
DO	dissolved oxygen
EcOZ	EcOz Environmental Consultants
EIS	Environmental Impact Statement
ENVID	environmental hazard identification
FEED	front end engineering design
FRP	filterable reactive phosphorus
GEP	gas export pipeline
GTG/AGTG	gas turbine generator/aeroderivative gas turbine generator
GHG	greenhouse gas
ha	hectare
HAT	highest astronomical tide
HDD	horizontal directional drilling
HIL	health investigation levels
HV	high voltage
HVAC	heating, ventilation, and air conditioning
H_2S	hydrogen sulphide
IBRA	Interim Biogeographic Regionalisation for Australia
IECA	International Erosion Control Association
IMMR	inspection, monitoring, maintenance and repair
INPEX	INPEX Operations Australia Pty Ltd
IUCN	International Union for Conservation of Nature
km	kilometre
kPa	kilopascals

Term, abbreviation or acronym	Meaning
kV	kilovolt
LAT	lowest astronomical tide
LER	local electrical room
LIR	lighting Local instrument room
LNG	liquified natural gas
LOR	laboratory limits of reporting
MAOP	maximum allowable operating pressure
m	metre
m^2	square metres
m^3	cubic metres
MASDP	Middle Arm Sustainable Development Precinct
MHWN	mean high water neaps
MHWS	mean high water springs
mL	millilitre
MLWN	mean low water neaps
mm	millimetre
MNES	matters of national environmental significance
mmscfd	million standard cubic feet per day
MOF	materials offloading facility
MPN/100 mL	most probable number per 100 millilitres
MSL	mean sea level
MVF	major vegetation subgroup
MW	megawatt
NEMP	Nearshore Environmental Monitoring Plan

Term, abbreviation or acronym	Meaning
N_2	nitrogen
NIW	nationally important wetland
NO_x	nitrogen oxides (NO and NO_2)
NO_2	nitrogen dioxide
NR	natural resources
NT	Northern Territory
NT EPA	Northern Territory Environment Protection Authority
NTU	nephelometric turbidity unit
O_3	ozone
OCP	organochlorine pesticide
OPP	organophosphate pesticides
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PFAS	per- and polyfluoroalkyl substances
$PM_{2.5}$	particulate matter less than 2.5 microns in diameter
PM_{10}	particulate matter less than 10 microns in diameter
PMST	protected matters search tool
ppm	parts per million
ppmv	parts per million by volume
ppt	parts per thousand is a unit of measurement for salinity, specifically indicating the number of grams of salt per kilogram of seawater
PSV	pressure safety valve
PWC	Power Water Corporation
RNE	Register of the National Estate

Term, abbreviation or acronym	Meaning
ROW	right of way
SEC	The NT EPA *Stakeholder Engagement and Consultation: Environmental Impact Assessment Guidance for Proponents* (NT EPA 2021)
SGM	safeguard mechanism
SO2	sulphur dioxide
SPRAT	species profile and threats
SQGV	sediment quality guideline value
T/yr	tonnes per year
TBT	tributyltin
tCO_2e	tonnes of carbon dioxide equivalent
TN	total nitrogen
TP	total phosphorus
TPH	total petroleum hydrocarbons
TRH	total recoverable hydrocarbons
TSS	total suspended solids
TSSC	Threatened Species Scientific Community
UXO	unexploded ordnance
V	volt
VOC	volatile organic compound
WoNS	weeds of national significance
XLPE	cross-linked polyethylene
%	per cent

EXECUTIVE SUMMARY

Proposal Description

INPEX Operations Australia Pty Ltd (INPEX) is actively working to decarbonise its operations and deliver a stable supply of diverse and clean energy sources. Carbon capture and storage (CCS) is a safe and proven emissions reduction technology that can be applied to liquefied natural gas (LNG) production to capture naturally occurring carbon dioxide (CO_2) from the hydrocarbon reservoir stream.

INPEX is proposing to develop a buried onshore pipeline system between Ichthys LNG facility and the inlet to potential CO_2 sequestration projects. Furthermore, it includes the operation of capture, dehydration and compression facilities within Ichthys LNG facility as part of an integrated CCS system.

The proposed onshore pipeline system would be comprised of two sections. The first section would extend from the Ichthys LNG facility boundary on Bladin Point to the proposed pipeline tie-in station located in proximity to the proposed Bonaparte CCS Project inlet station infrastructure. The subsequent section would extend from this location to a pipeline tie-in station located adjacent to the Darwin LNG facility on Wickham Point. In total, the Project includes the construction and operation of approximately 12 kilometres of interlinking 16-inch CO_2 pipelines and associated utilities infrastructures.

In addition to the pipeline system on Middle Arm, the proposal includes the hot commissioning of the Ichthys LNG facility CO_2 compression and export system (CCES) and upgraded AGRUs, and the operations of the integrated CCS system to the point of custody transfer at a CCS sequestration project CO_2 onshore inlet station within the region.

The following infrastructure is proposed to be installed for the Project:

- a CO_2 export pipeline extending from the Ichthys LNG facility boundary to the Ichthys CCS pipeline tie in station and through to a pipeline tie-in station located adjacent to the Darwin LNG facility boundary
- a pipeline tie-in station, including a PIG (pipeline inspection gauge) launcher / receiver located in an area adjacent to the existing Ichthys gas export pipeline beach valve precinct
- a pipeline tie-in station that would be designed to allow for flow of CO_2 in either direction, located adjacent to the Darwin LNG facility boundary
- a supplementary power intake substation and associated fibre optic and high voltage electrical cables

Activities required to be undertaken to support the proposed Project include:

- site establishment works (vegetation clearing, ground improvement activities, earthworks, dewatering activities, etc.)
- CO_2 export pipeline installation and connection
- construction and installation of pipeline tie-in stations
- construction and installation of an intake substation for connection to a third party external renewable power provider
- installation of power transmission cables from the substation to the Ichthys LNG facility construction (civil works, piling, drainage installation, etc.)
- road and utilities crossing construction
- drainage and dewatering from excavations and trenches

- pre-commissioning including pipeline cleaning, gauging, flooding, testing, dewatering, drying and preservation of the pipelines, tie-in stations and supplementary power substation and cabling
- commissioning and start-up
- operations, including Ichthys LNG facility upgraded AGRUs and CCES
- decommissioning.

Environmental assessment and management

An assessment of the potential impacts of the proposed Project on the Northern Territory Environment Protection Authority (NT EPA) environmental factors identified nine of the listed 14 environmental factors may be impacted (Table ES-1).

An assessment of the potential for significant impacts on relevant matters of national environmental significance (MNES) has been undertaken in accordance with the *Matters of National Environmental Significance: Significant impact guidelines 1.1 — Environment Protection and Biodiversity Conservation Act 1999* (Significant Impact Guidelines; Commonwealth of Australia 2013) (Table ES-2 and Table ES-3).

A systematic risk assessment process was adopted for the environmental management of the activities required under this proposal. This process aligns with INPEX's Environmental Policy, which requires the identification of environmental hazards and risks associated with business activities, and management of these to levels that are 'as low as reasonably practicable' (ALARP). Environmental management frameworks have been developed and are proposed to be implemented to manage potential impacts to ALARP; and include a suite of management actions/controls. A summary of proposed management actions/controls applicable to each of the nine NT EPA environmental factors is provided in Table ES-1.

Figure ES-1: Location of proposed activities

Table ES-1: NT Environmental factors potentially impacted by proposed activities

NT EPA factor	Environmental values and sensitivities	Potential impact	Key management controls
Land – terrestrial environmental quality	Quality of soils, including chemical, physical, biological and aesthetic qualities that support life.	Impacts to the quality and integrity of land and soils due to ASS disturbance	• A geotechnical program will be undertaken to confirm the presence/absence of ASS/PASS, prior to commencement of construction. • Where suspected ASS/PASS is encountered during excavations it will be kept separate from other spoil material. Any suspected ASS/PASS will be transferred to a dedicated treatment pad for stockpiling. • Where onsite stockpiling/treatment of ASS is required, dedicated ASS/PASS treatment pads will be constructed in accordance with National Guidance (Shand et al. 2018). • If excavating is unavoidable, management of ASS option include neutralising and re-covering with clean fill or disposing off site.
		Impacts to the quality and integrity of land and soils due to erosion and topsoil migration	• Clearing to be undertaken preferentially in dry season conditions to avoid erosion risk associated with monsoon rains in the wet season. • A site-specific Erosion and Sediment Control Plan (ESCP) will be prepared in accordance with the IECA Best Practice Erosion and Sediment Control Guidelines (IECA 2008) and endorsed by a Certified Professional Erosion and Control Specialist, to manage erosion risk. The ESCP will include: - temporary and permanent control measures - protection of stockpiles and exposed soil areas - ongoing inspection and maintenance of controls when in effect. • Erosion protection infrastructure (e.g. silt fencing, contouring, etc.) will be installed in accordance with developed ESCP to ensure that sediment is contained within the construction area as far as is practicable. • All stormwater discharge from within the construction area will be in accordance with water quality criteria within the ESCP.
		Impacts to the quality and integrity of land and soils due to unplanned loss of hazardous and non-hazardous waste or spills	• Personnel who routinely handle hazardous materials or wastes (e.g. refuelling personnel, pump operators, mechanics, and stores personnel) will receive training in handling, transporting and storing hazardous materials or wastes; in reporting and documentation requirements; and in spill clean-up techniques and practices. • Use, handling, storage and disposal of all hazardous materials and dangerous goods will be in accordance with the *Dangerous Goods Act 1998* and the *Waste Management and Pollution Control Act 1998* (WMPC Act). • A variety of temporary bunding will be available for use around the site, including bunded pallets and drip trays. • Refuelling of vehicles will occur within dedicated areas. • Chemicals and substances used during the Project will be selected in accordance with the INPEX chemical selection process. • Spill kits will be located on site in accessible locations and will be regularly inspected and maintained.
		Impacts to the quality and integrity of land and soils due to unplanned CO_2 pipeline rupture	• The CO_2 export pipeline would be designed to protect against threats to integrity including impact, corrosion, running ductile fracture and embrittlement. Design codes and material specifications would be compliant with the relevant Australian and international standards for transporting CO_2. • Testing would be undertaken prior to commissioning to confirm integrity of the CO_2 export pipeline. • IMMR activities would be conducted throughout operations, including monitoring the pipeline corrosion protection system. • Compliance with obtained pipeline licences in accordance with the Energy Pipelines Act.
Land – terrestrial ecosystems	Migratory or threatened species, including shorebirds utilising woodland communities within the Project area.	Impacts to terrestrial habitats resulting from vegetation removal	• Siting of the CO_2 export pipeline and other infrastructure to be predominantly within previously disturbed areas and areas zoned for utilities and development. • Areas to be cleared would be clearly identified prior to work commencing. Clearing boundaries would be marked in the field and on-site plans and register of clearing activities will be maintained. • Mangroves would be cleared in such a way that minimises disturbance of the root system (such as cutting off the mangroves at root level or pushing the vegetation over). • Cleared vegetation would be mulched and stockpiled on site boundaries (outside the intertidal zone) or off site. Where possible, the mulch would be used for both rehabilitation and soil stabilisation to prevent erosion.

NT EPA factor	Environmental values and sensitivities	Potential impact	Key management controls
			• Temporarily disturbed areas within the Project area would be revegetated and rehabilitated following completion of construction activities.
		Indirect impacts to terrestrial habitats (e.g., from erosion, dust, spills, ASS disturbance, etc.)	• Personnel who routinely handle hazardous materials or wastes (e.g. refuelling personnel, pump operators, mechanics, and stores personnel) will receive training in handling, transporting and storing hazardous materials or wastes; in reporting and documentation requirements; and in spill clean-up techniques and practices. • Use, handling, storage and disposal of all hazardous materials and dangerous goods will be in accordance with the *Dangerous Goods Act 1998* and the WMPC Act. • A variety of temporary bunding will be available for use around the site, including bunded pallets and drip trays. • Refuelling of vehicles will occur within dedicated areas. • Chemicals and substances used during the Project will be selected in accordance with the INPEX chemical selection process. • Spill kits will be located on site in accessible locations and will be regularly inspected and maintained.
		Impacts due to disturbance of and interaction with fauna (e.g., vehicle movements, trenches, vegetation removal, etc.)	• Removal of vegetation to be supervised by a suitably qualified wildlife handler to ensure safe handling of fauna. • "High-risk" entrapment areas would have sloping egress ramps to prevent fauna entrapment. • Regular monitoring of construction areas to identify any trapped fauna, with removal to be completed by a suitably qualified wildlife handler. • Where possible, vehicle traffic would be limited during high-risk times (dawn, dusk) to minimise chances of vehicle strikes with wildlife. • Enforcement of speed limits in construction areas.
		Impacts to terrestrial habitats from introduction new weed species	• Existing weed and pest fauna species to be controlled and minimised before construction, with on-going management during and post-construction. • The construction of a temporary washdown area for earth-moving and vegetation clearing vehicles during the construction phase. • Topsoil containing high densities of weed seeds would not be used in rehabilitation.
		Impacts to terrestrial habitats from an increased bushfire risk	• Fire-fighting equipment would be available at the work sites. • Designated smoking areas would be assigned. • Hot work procedures would be implemented for cutting, welding and any other work considered to have a high potential to start a fire.
		Impacts to terrestrial habitats from construction and operational noise emissions	• Compliance with the requirements of the: - *Waste Management and Pollution Control Act 1998* (NT) - *Work Health and Safety (National Uniform Legislation) Act* 2011 (NT) - National code of practice for noise management and protection of hearing at work [NOHSC: 2009 (2004)] (Commonwealth of Australia 2004). • Community notifications and hotline for feedback. • Additional modelling studies would be undertaken to evaluate the noise emission levels and extent from the operation of Ichthys LNG facility CCES equipment.
		Impacts to terrestrial habitats from construction and operational lighting	• Lighting during construction would be limited to the minimum to meet personnel safety requirements.
		Impacts to terrestrial habitats due to unplanned CO_2 export pipeline rupture	See Land – terrestrial environmental quality

NT EPA factor	Environmental values and sensitivities	Potential impact	Key management controls
Water – hydrological processes	Hydrological regimes of groundwater and surface water	Alteration to surface and groundwater flow patterns due to construction activities and the presence of infrastructure	• Erosion and sediment control management: - clearing to be undertaken preferentially in dry season conditions to avoid erosion risk associated with monsoon rains in the wet season. - a site-specific Erosion and Sediment Control Plan (ESCP) will be prepared in accordance with the IECA Best Practice Erosion and Sediment Control Guidelines (IECA 2008) and endorsed by a Certified Professional Erosion and Control Specialist, to manage erosion risk. The ESCP will include: • temporary and permanent control measures • protection of stockpiles and exposed soil areas • ongoing inspection and maintenance of controls when in effect. - erosion protection infrastructure (e.g. silt fencing, contouring, etc.) will be installed in accordance with developed ESCP to ensure that sediment is contained within the construction area as far as is practicable. • All stormwater discharge from within the construction area will be in accordance with water quality criteria within the ESCP.
Water – Inland water environmental quality	Quality of groundwater or surface water	Surface water or groundwater contamination due to unplanned spills and leaks	• Personnel who routinely handle hazardous materials or wastes (e.g. refuelling personnel, pump operators, mechanics, and stores personnel) will receive training in handling, transporting and storing hazardous materials or wastes; in reporting and documentation requirements; and in spill clean-up techniques and practices. • Use, handling, storage and disposal of all hazardous materials and dangerous goods will be in accordance with the *Dangerous Goods Act 1998* and the WMPC Act. • A variety of temporary bunding will be available for use around the site, including bunded pallets and drip trays. • Refuelling of vehicles will occur within dedicated areas. • Chemicals and substances used during the Project will be selected in accordance with the INPEX chemical selection process. • Spill kits will be located on site in accessible locations and will be regularly inspected and maintained.
		Increased erosion and sedimentation of waterways	• Clearing to be undertaken preferentially in dry season conditions to avoid erosion risk associated with monsoon rains in the wet season. • A site-specific Erosion and Sediment Control Plan (ESCP) will be prepared in accordance with the IECA Best Practice Erosion and Sediment Control Guidelines (IECA 2008) and endorsed by a Certified Professional Erosion and Control Specialist, to manage erosion risk. The ESCP will include: - temporary and permanent control measures - protection of stockpiles and exposed soil areas - ongoing inspection and maintenance of controls when in effect. • Erosion protection infrastructure (e.g. silt fencing, contouring, etc.) will be installed in accordance with developed ESCP to ensure that sediment is contained within the construction area as far as is practicable. • All stormwater discharge from within the construction area will be in accordance with water quality criteria within the ESCP.
		Acidic runoff from ASS disturbance	• Development and implementation of an ASS management plan, including standard controls to apply during the construction phase and measures to avoid and minimise disturbance of ASS, plus details of how to manage, treat and dispose of ASS should it be encountered. • In situ mass soil mixing of ASS neutralisation is proposed in areas of higher ASS disturbance risk. • General ASS management approach proposed during construction would be: - treat in-situ in conjunction with earthworks, where suitable. - treat in a temporary ASS treatment area. - geochemical investigation of areas outside GEP corridor prior to commencing excavation, to quantify the potential ASS areas that require treatment. - an unexpected finds procedure for ASS would be included in the CEMP.

NT EPA factor	Environmental values and sensitivities	Potential impact	Key management controls
Sea – coastal processes	Mangrove ecosystems and coastal morphology. Coastal processes in Darwin Harbour include wave action, tidal action, longshore drift, cyclones, surface water drainage and sea level rise.	Physical presence of infrastructure changes local geophysical and hydrological processes	• Erosion and sediment control management: - clearing to be undertaken preferentially in dry season conditions to avoid erosion risk associated with monsoon rains in the wet season - a site-specific Erosion and Sediment Control Plan (ESCP) will be prepared in accordance with the IECA Best Practice Erosion and Sediment Control Guidelines (IECA 2008) and endorsed by a Certified Professional Erosion and Control Specialist, to manage erosion risk. The ESCP will include: • temporary and permanent control measures • protection of stockpiles and exposed soil areas • ongoing inspection and maintenance of controls when in effect. - erosion protection infrastructure (e.g. silt fencing, contouring, etc.) will be installed in accordance with developed ESCP to ensure that sediment is contained within the construction area as far as is practicable. • All stormwater discharge from within the construction area will be in accordance with water quality criteria within the ESCP. • Temporary structures required for construction of the pipeline would be removed following installation. • Areas would be reinstated to match the existing topography following installation of the CO_2 export pipeline.
		Coastal disturbance during trenching activities changes coastal topography and sedimentation	See above, Sea – coastal processes potential impact "physical presence of infrastructure changes local geophysical and hydrological processes."
		Onshore site preparation, trenching and pipelay activities cause temporary changes in geophysical and hydrological processes	See above, Sea – coastal processes potential impact "physical presence of infrastructure changes local geophysical and hydrological processes."
Sea – marine environmental quality	Quality of the marine waters, sediment and biota. Ecosystem health condition.	Pollution of marine water (Darwin Harbour). Bioaccumulation and toxicity effects. Alteration of the marine environment through wastewater discharges.	Hydrotest water management (If the option to dispose of wastewater via a temporary MOF outfall is pursued): • The outfall design will incorporate use of a multiport diffuse to allow for sufficient near-felid dilution within proximity of the discharge point. • Modelling will be undertaken to determine the extent of the required mixing zone, to enable effective dispersion of wastewater. • A waste discharge licence will be applied for under the *Water Act 1992* (NT). • Any wastewater discharged via the MOF outfall will comply with WDL wastewater quality limits. • A receiving environment water quality monitoring program will be implemented to verify modelling outputs and determine if receiving water is being adversely impacted. • Wastewater generated during Project activities (e.g. hydrotest water) will be re-used where it remains fit for purpose.
		Unplanned loss/spills of chemicals, hydrocarbons, and hazardous substances resulting in contamination of marine environment adjacent to Project activities	• Personnel who routinely handle hazardous materials or wastes (e.g. refuelling personnel, pump operators, mechanics, and stores personnel) will receive training in handling, transporting and storing hazardous materials or wastes; in reporting and documentation requirements; and in spill clean-up techniques and practices. • Use, handling, storage and disposal of all hazardous materials and dangerous goods will be in accordance with the *Dangerous Goods Act 1998* and the WMPC Act. • A variety of temporary bunding will be available for use around the site, including bunded pallets and drip trays. • Refuelling of vehicles will occur within dedicated areas. • Chemicals and substances used during the Project will be selected in accordance with the INPEX chemical selection process. • Spill kits will be located on site in accessible locations and will be regularly inspected and maintained.
Sea – marine ecosystems	Mangrove community ecological functions and processes.	Impacts on marine ecosystems from intertidal disturbance	• Pre-lay surveys would be undertaken to inform the final pipeline route.
		Impacts on marine ecosystems from noise	• Compliance with the requirements of the:

NT EPA factor	Environmental values and sensitivities	Potential impact	Key management controls
			- *Waste Management and Pollution Control Act 1998* (NT) - *Work Health and Safety (National Uniform Legislation) Act* 2011 (NT) - National code of practice for noise management and protection of hearing at work [NOHSC: 2009 (2004)] (Commonwealth of Australia 2004). • Community notifications and hotline for feedback.
		Impacts on marine ecosystems from light emissions	• Lighting during construction and operations would be limited to the minimum to meet personnel safety requirements.
		Impacts on marine ecosystems from potential ASS disturbance	• A geotechnical program will be undertaken to confirm the presence/absence of ASS/PASS, prior to commencement of construction. • Where suspected ASS/PASS is encountered during excavations it will be kept separate from other spoil material. Any suspected ASS/PASS will be transferred to a dedicated treatment pad for stockpiling. • Where onsite stockpiling/treatment of ASS is required, dedicated ASS/PASS treatment pads will be constructed in accordance with National Guidance (Shand et al. 2018). • If excavating is unavoidable, management of ASS option include neutralising and re-covering with clean fill or disposing off site.
		Impacts on marine ecosystems from unplanned loss of hazardous or non-hazardous waste	• Personnel who routinely handle hazardous materials or wastes (e.g. refuelling personnel, pump operators, mechanics, and stores personnel) will receive training in handling, transporting and storing hazardous materials or wastes; in reporting and documentation requirements; and in spill clean-up techniques and practices. • Use, handling, storage and disposal of all hazardous materials and dangerous goods will be in accordance with the *Dangerous Goods Act 1998* and the WMPC Act. • A variety of temporary bunding will be available for use around the site, including bunded pallets and drip trays. • Refuelling of vehicles will occur within dedicated areas. • Chemicals and substances used during the Project will be selected in accordance with the INPEX chemical selection process. • Spill kits will be located on site in accessible locations and will be regularly inspected and maintained.
		Impacts on marine ecosystems from unplanned CO_2 release	See Land – terrestrial environmental quality
Air – air quality	The nearest sensitive receptors are the residential areas of Palmerston, approximately 4 km to the northeast of the Ichthys LNG facility at the nearest point. Other sensitive receptors to construction-related dust emissions include the surrounding vegetation, including sensitive mangrove communities.	Impacts on air quality from operational venting such that environmental values are not maintained	• A detailed assessment of operational venting scenarios, including modelling of CO_2 dispersion, would be conducted to inform an assessment of potential impacts and appropriate management controls implemented. • Emissions control options would be reviewed for operational venting. • An assessment of best practice control options would be undertaken against the requirements of the EPA Waste Management Guidelines to inform selection of best available techniques and technologies. • Development and implementation of an air quality management and monitoring plan for the operations phase.
		Impacts on air quality from Construction related dust emissions such that environmental values are not maintained	• Dust management: - revegetation of exposed areas as soon as practicable - covering of soil stockpiles as soon as practicable - application of dust suppression/binding agents to exposed stockpiles - use of water carts during dry and windy conditions. • Construction equipment and vehicles would be maintained in accordance with manufacturer specifications and turned off when not in use.
		Impacts on air quality due to unplanned CO_2 pipeline rupture such that environmental values are not maintained	• A detailed assessment of leak scenarios, including modelling of CO_2 dispersion, would be conducted to inform an assessment of potential impacts and appropriate management controls implemented.

NT EPA factor	Environmental values and sensitivities	Potential impact	Key management controls
			• The CO_2 export pipeline would be designed to protect against threats to integrity including impact, corrosion, running ductile fracture and embrittlement. Design codes and material specifications would be compliant with the relevant Australian and international standards for transporting CO_2. • Testing would be undertaken prior to commissioning to confirm integrity of the CO_2 export pipeline. • IMMR activities would be conducted throughout operations, including monitoring the pipeline corrosion protection system • Compliance with obtained pipeline licences in accordance with the *Energy Pipelines Act 1981* (Northern Territory).
People – culture and heritage.	Sacred sites. Previously unidentified heritage objects/sites.	Accidental disturbance to a sacred site or heritage object/site	• Undertake a heritage field survey of the Project footprint prior to undertaking construction works. • Undertake ongoing consultation with Larrakia people to inform heritage management measures to be applied to aboriginal sites/objects. • Implementation the following additional management measures onshore to reduce and minimise impacts on cultural and heritage values: - consultation with Larrakia people and organisations, including Larrakia Development Corporation, Larrakia Nation Aboriginal Corporation, Gwalwa Daraniki Association and the INPEX Larrakia Advisory Committee, during planning of geotechnical surveys and construction works - planning pre-construction surveys, in consultation with Larrakia people and their representatives - site protection measures, such as flagging/fencing off any heritage sites within proximity of the proposed impacts areas to avoid damage to sites during works (as determined in consultation with Larrakia representatives) - implementation of a chance find protocol and stop work procedure during ground disturbance activities - contractor and work site cultural heritage inductions for all employees and contractors to outline the importance of sites to Larrakia people and the legislative protection of sites.
People – human health	Community receptors adjacent to the Project area	Impacts on human health due to unplanned CO_2 release	See Land – terrestrial environmental quality
		Impacts on human health due to operational venting	• A detailed assessment of operational venting scenarios, including modelling of CO_2 dispersion, would be conducted to inform an assessment of potential impacts and appropriate management controls implemented. • Emissions control options would be reviewed for operational venting. • An assessment of best practice control options would be undertaken against the requirements of the EPA Waste Management Guidelines to inform selection of best available techniques and technologies. • Development and implementation of an air quality management and monitoring plan for the operations phase.

Table ES-2: Summary of the significant impact assessment outcomes – threatened species

	Avifauna	Terrestrial mammals	Terrestrial reptiles	Marine reptiles	Marine mammals	Fish and sharks
Significant impact criteria			**Assessment of significant impact**			
An action likely to have a significant impact on a threatened species if there is a real chance or possibility that it will:						
Lead to a long-term decrease in the size of a population	Unlikely to have a significant impact	Unlikely to have a significant impact	Unlikely to have a significant impact	No significant impact	No significant impact	No significant impact
Reduce the area of occupancy of the species.	Unlikely to have a significant impact	Unlikely to have a significant impact	Unlikely to have a significant impact	No significant impact	No significant impact	No significant impact
Fragment an existing population into two or more populations.	Unlikely to have a significant impact	Unlikely to have a significant impact	Unlikely to have a significant impact	No significant impact	No significant impact	No significant impact
Adversely affect habitat critical to the survival of a species.	Unlikely to have a significant impact	Unlikely to have a significant impact	Unlikely to have a significant impact	No significant impact	No significant impact	No significant impact
Disrupt the breeding cycle of a population.	Unlikely to have a significant impact	Unlikely to have a significant impact	Unlikely to have a significant impact	No significant impact	No significant impact	No significant impact
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	Unlikely to have a significant impact	Unlikely to have a significant impact	Unlikely to have a significant impact	No significant impact	No significant impact	No significant impact
Result in invasive species that are harmful to a Critically Endangered or Endangered species becoming established in the Endangered or Critically Endangered species' habitat.	Unlikely to have a significant impact	Unlikely to have a significant impact	Unlikely to have a significant impact	No significant impact	No significant impact	No significant impact
Introduce disease that may cause the species to decline.	Unlikely to have a significant impact	Unlikely to have a significant impact	Unlikely to have a significant impact	No significant impact	No significant impact	No significant impact
Interfere with the recovery of the species.	Unlikely to have a significant impact	Unlikely to have a significant impact	Unlikely to have a significant impact	No significant impact	No significant impact	No significant impact

Table ES-3: Summary of the significant impact assessment outcomes – migratory species

	Avifauna	Marine mammals	Marine reptiles	Fish and sharks
Significant impact criteria	**Assessment of significant impact**			
An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:				
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	Unlikely to have a significant impact	Unlikely to have a significant impact	Unlikely to have a significant impact	Unlikely to have a significant impact
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	Unlikely to have a significant impact	Unlikely to have a significant impact	Unlikely to have a significant impact	Unlikely to have a significant impact
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	Unlikely to have a significant impact	Unlikely to have a significant impact	Unlikely to have a significant impact	Unlikely to have a significant impact

Stakeholder engagement

Pre-referral stakeholder consultation for the proposed Ichthys CCS Project was undertaken to obtain advice on appropriateness of the proposed management controls within the referral and obtain advice on requirement notifications and ongoing engagement requirements for the Ichthys CCS Project Stakeholder Engagement Plan. Once the proposed project activities have commenced, ongoing engagement would be undertaken to:

- Provide sufficient notice to key stakeholders prior to the commencement of the Project to ensure effective communication of the timing of works, and the associated safety and environmental measures
- Provide information throughout the Project, to support safety outcomes and manage potential community impacts; and
- Provide confirmation of completion of the above to communicate the Project outcomes.

Conclusion

Based on the systematic risk assessment process, the residual risk for the majority of potential impacts associated with the proposed activities are considered low. Where potential impacts have a residual risk of "moderate", they are presented in Table ES-4.

Table ES-4: Summary of potential impacts with residual risk moderate

Potential impact	Consequence	Likelihood	Residual risk
Impacts to terrestrial habitats due to unplanned CO_2 export pipeline rupture	Moderate (D)	Highly Unlikely (5)	Moderate (5)
Acidic runoff from ASS disturbance	Minor (E)	Possible (3)	Moderate (7)
Unplanned loss/spills of chemicals, hydrocarbons, and hazardous substances resulting in contamination of marine environment adjacent to Project activities	Minor (E)	Unlikely (4)	Moderate (8)
Accidental disturbance to a sacred site or heritage object/site	Moderate (D)	Highly Unlikely (5)	Moderate (5)
Impacts on human health due to unplanned CO_2 release	Significant (C)	Highly Unlikely (5)	Moderate (7)

1 INTRODUCTION

INPEX is actively working to decarbonise its operations and deliver a stable supply of diverse and clean energy sources. Carbon capture and storage (CCS) is a safe and proven emissions reduction technology that can be applied to liquefied natural gas (LNG) production to capture naturally occurring carbon dioxide (CO_2) from the hydrocarbon reservoir stream.

To support this, INPEX Operations Australia Pty Ltd is referring the Ichthys CCS Project (herein referred to as the Project), located at Middle Arm peninsula, Darwin to the Northern Territory government as a proposed action, through this referral submission. INPEX Operations Australia Pty Ltd is the Proponent of the Project, as the operator on behalf of Ichthys LNG Pty Ltd, an incorporated joint venture.

The Project comprises the development of a buried onshore pipeline system between Ichthys LNG facility and the inlet to potential CO_2 sequestration projects. Furthermore, it includes the operation of capture, dehydration and compression facilities within Ichthys LNG facility as part of an integrated CCS system.

The proposed onshore pipeline system would be comprised of two sections. The first section would extend from the Ichthys LNG facility boundary on Bladin Point to the proposed to a pipeline tie-in station located in proximity to proposed Bonaparte CCS Project inlet station infrastructure. The subsequent section would extend from this location to a pipeline tie-in station located adjacent to the Darwin LNG facility on Wickham Point. In total, the Project includes the construction and operation of approximately 12 kilometres of interlinking 16-inch CO_2 pipelines and associated utilities infrastructures.

In addition to the pipeline system on Middle Arm, the proposal includes the hot commissioning of the Ichthys LNG facility CO_2 compression and export system (CCES) and upgraded AGRUs, and the operations of the integrated CCS system to the point of custody transfer at a CCS sequestration project CO_2 onshore inlet station within the region.

1.1 Purpose

The purpose of this document is to support the referral of a proposed action under Section 68 of the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act), and a referral of a proposed action under Section 48 of the *Environment Protection Act 2019* (Northern Territory) (EP Act).

The proposed action that would be assessed as part of this referral submission includes:

- The construction, commissioning, operation and decommissioning of approximately 12 kilometres of interlinking 16-inch CO_2 pipelines and associated utilities infrastructures.
- The hot commissioning, operation, maintenance and decommissioning of the Ichthys LNG facility AGRU and CCES components, including the cessation of operation of the currently operational acid gas incinerators.

1.2 Overview of the proposed action

A high-level summary of the Project is provided in Table 1-1, with a detailed description provided in Section 2.

Table 1-1: Summary of the Project

Element	Details
Location	Works and activities, associated with the action would occur within the existing Ichthys LNG facility site boundary and on the broader Middle Arm peninsula.
Schedule	Construction works are expected to commence in Q2 2028. Works would progressively occur until completed; provisionally in Q2 2031 (refer to Section 2.1). The Project is anticipated to have an operational life of approximately 30 years.

Proposed infrastructure/activities	The following new infrastructure/equipment is proposed to be installed on the Middle Arm peninsular, as part of the Project:
	• A high-pressure carbon steel CO_2 export pipeline comprised of two independent sections connected to two separate pipeline tie-in stations:
	  - a pipeline extending from the Ichthys LNG facility boundary to a pipeline tie-in station located near the existing Ichthys gas export pipeline beach valve precinct on Middle Arm
	  - a pipeline extending from the Ichthys CCS pipeline tie-in station to a pipeline tie-in station located adjacent to the Darwin LNG facility boundary on Wickham Point. This pipeline would be designed to allow for flow of CO_2 in either direction between the two pipeline tie-in stations.
	• Two pipeline tie-in stations:
	  - the Ichthys CCS pipeline tie-in station, located near the existing Ichthys gas export pipeline beach vale precinct on Middle Arm.
	  - The Darwin LNG pipeline tie-in station, located adjacent to the Darwin LNG facility boundary on Wickham Point
	• power and communications cables between the Ichthys LNG facility, Ichthys CCS pipeline tie-in station and the Darwin LNG pipeline tie-in station.
	• a supplementary power intake substation (located near the Ichthys LNG facility), and associated power and communications cables connecting back to the Ichthys LNG facility to facilitate the future import of green power from a third-party source.
	The location of the proposed infrastructure on Middle Arm peninsula is shown in Figure 2-3 and described in Section 2.2, with further detail of the infrastructure provided in Section 2.3.1.
	The following activities are required to be undertaken to support the Project:
	• Construction of 12 km CO_2 export pipeline on Middle Arm. The CO_2 export pipeline comprised of two sections, with one section designed to provide flow of CO_2 in either direction to accommodate the two storage options being considered.
	• Commissioning of entire CO_2 pipeline (pipeline components within the Ichthys LNG facility and on Middle Arm peninsula).
	• Construction and commissioning of two pipeline tie-in stations on Middle Arm Peninsula (in proximity to the existing Darwin LNG facility and proposed Bonaparte CCS Project inlet station).
	• Hot commissioning of Ichthys LNG facility CCES assets.

Element	Details
	• Operations of all Ichthys CCS enabling infrastructure (located on both Middle Arm peninsula and within the Ichthys LNG facility). • Construction, commissioning and operations of a supplementary power intake substation and cabling on Middle Arm • Hot commissioning and operations of supplementary power infrastructure and cabling within the Ichthys LNG facility. • Hot commissioning of and operations of upgraded AGRUs. • Decommissioning of the Project infrastructure at the end of project life. Further information on the activities required to support the Project is provided in Section 2.4.
Workforce	• The workforce required to support Project activities would fluctuate over time. Peak workforce is estimated to be approximately 200 persons

*Commissioning includes pre-commissioning, cold commissioning and hot commissioning activities. Cold commissioning includes all activities which could be completed prior to the introduction of process fluids or CO_2, while hot commissioning is the is the operational testing when these are introduced to a system for the first time to test and validate functionality and performance under operating conditions.

1.3 Proponent details

INPEX Operations Australia Pty Ltd (INPEX), a wholly owned subsidiary of INPEX CORPORATION, is the proponent and operator for the Project on behalf of Ichthys LNG Pty Ltd (an incorporated joint venture).

The addresses of INPEX offices in Australia are as follows:

Perth office	Darwin office
INPEX Operations Australia Pty Ltd Level 22, ENEX 100 100 St Georges Terrace PERTH WA 6000	INPEX Operations Australia Pty Ltd Level 8, Mitchell Centre 59 Mitchell Street Darwin NT 0800

1.4 Publication statement

This Referral Report has been prepared by suitably qualified persons as outlined in Table 1-2.

Table 1-2: Suitably qualified persons involved in the preparation of the referral and impact assessment

Name	Experience
Glenn Murray	Glenn is a Principal Consultant at ERM that has 15 years' experience in environmental impact assessment and project approvals, including consulting and regulatory roles for major projects across the energy, water, transport and mining sectors. Beyond his technical expertise, Glenn has considerable project management experience, including proponent-

Name	Experience
	side approvals management roles. He has recent government regulatory experience as a Senior Impact Assessor for the Victorian Department of Transport and Planning, including contributions to Victorian government regulatory planning policy for new energy projects.
Sebastian Ulrichs	Sebastian is a Principal Consultant at ERM. He is an IEMA certified environmental impact assessment and consenting practitioner with over 10 years of industry experience delivering environmental approvals. He has worked on projects offshore and onshore in the US Gulf region, Eastern Africa, Cote d'Ivoire and Europe. In Australia, he has experience with State/Territory and Commonwealth regulatory frameworks. Sebastian is experienced in management of environmental and planning approvals work streams, overseeing technical assessments, and integration of design development with approvals and stakeholder consultation work streams.
Josh Corbett	Josh Corbett is the Environment Team Lead – Biodiversity, Offsets and Science at INPEX with over 17 years of experience developing, implementing and managing environmental monitoring programs, offsets and state/territory and Commonwealth approvals. Mr Corbett has worked on the Ichthys LNG Development project t for over a decade, both offshore and onshore, and has a comprehensive knowledge of Darwin Harbour: • implementing the $48M Nearshore Environmental Management Plan for the Projects 16.1 Mm3 capital dredging campaign, including presentations to an independent dredge expert panel consisting of nine specialists • developing and implementing onshore and nearshore monitoring programs for the operations of the onshore processing plant on Bladin Point • manages the $20M Darwin Harbour Integrated Marine Monitoring and Research Program with the Northern Territory Government • is a member of the Darwin Harbour Advisory Committee and Darwin Harbour Integrated Monitoring and Research Coordination Committee.

Name	Experience
	Mr Corbett has also co-authored and/or provided technical reviews of numerous Ichthys LNG Development project environmental approvals, including but not limited to, onshore and offshore construction and operations environmental approvals.

1.5 Background

1.5.1 Ichthys LNG Development project

Primary approvals

The existing Ichthys LNG facility is located on Bladin Point, on the northern side of Middle Arm Peninsula in Darwin Harbour, approximately:

- 4 kilometres from Palmerston (the nearest residential zone)
- 10 kilometres south-east of the Darwin CBD, across Darwin Harbour waters; and
- 35 kilometres by road (or 4 kilometres by sea) from East Arm Wharf.

The Ichthys LNG Development project was referred for environmental approval under the Northern Territory *Environmental Assessment Act 1982* (since superseded by the EP Act) and the Commonwealth EPBC Act in 2007 and 2008, respectively, and the level of assessment was set as an Environmental Impact Statement (EIS).

The Ichthys LNG Development project involved the full development of the Ichthys Field (comprising the Brewster and Plover reservoirs). The Ichthys LNG Development project offshore infrastructure falls under Commonwealth jurisdiction, and is made up of the following components:

- approximately 50 subsea production wells in the Ichthys Field, drilled from between 12 and 15 drill centres and developed over a period of 40 years
- a central processing facility (CPF) permanently moored for the life of operations at the Ichthys Field
- subsea wellheads and manifolds and the wet gas, corrosion resistant infield flowlines connecting them to the CPF
- control umbilicals and service lines
- a floating production, storage and offloading facility (FPSO) permanently moored 3.5 km from the CPF for the life of operations
- subsea flowlines connecting the CPF to the FPSO
- that portion of the subsea gas export pipeline (GEP) from underneath the CPF to the entrance to Darwin Harbour, some 856 km long.

The Ichthys LNG Development project nearshore and onshore infrastructure, which lies within NT Government jurisdiction, is made up of the following components:

- approximately 27 km of the subsea GEP from the mouth of Darwin Harbour to the pipeline shore crossing on the western side of Middle Arm Peninsula north of Channel Island
- a module offloading facility on the north-eastern side of Bladin Point
- a two-berth product offloading jetty at the north-western end of Bladin Point

- a dredged shipping channel (including the approach area and a turning basin) and the jetty pocket berthing area and jetty pocket for the product tankers.
- two gas liquefaction trains, each capable of producing approximately 4.45 Mtpa of LNG
- liquified petroleum gas (LPG; propane and butane) recovery units and fractionation units
- condensate stabilisation units
- seven product storage tanks (two cryogenic tanks for LNG, one cryogenic tank for propane, one cryogenic tank for butane, and three ambient-temperature tanks for condensate)
- a combined-cycle power plant
- flare systems
- a wastewater treatment system
- an operations complex
- laydown areas, warehousing facilities, field workshops and hazardous material storage areas
- temporary office facilities.

INPEX prepared the Ichthys Gas Field Development Project: Draft EIS, which was submitted to the Northern Territory and Commonwealth governments on 15 July 2010. After a period of public and government review, the Ichthys Gas Field Development Project: Supplement to the Draft EIS, was developed and submitted on 5 April 2011 for a final approval decision by the commonwealth minister and assessment by the Northern Territory Minister. Collectively, the Draft EIS and the EIS Supplement documents are referred to as the Final EIS.

The Northern Territory Department of Natural Resources, Environment, the Arts and Sport issued an Environmental Assessment Report and Recommendations (Assessment Report 65) for the Ichthys Project on 17 May 2011. Assessment Report 65 documents the findings of the environmental assessment completed under the *Environmental Assessment Act* (Northern Territory).

Commonwealth approval was granted under the EPBC Act by the commonwealth minister for Sustainability, Environment, Water, Population and Communities on 27 June 2011 (Commonwealth Ministerial approval EPBC 2008/4208).

The Ichthys LNG facility has been operational since 2018. The CO_2 stream from the Ichthys Development Project is currently separated at an AGRU on each LNG train and treated via an acid gas incinerator prior to venting. The current operating philosophy to vent CO_2 would change under this proposal, to export CO_2 for sequestration by a third-party.

Ichthys LNG facility secondary approvals

Existing operations at the Ichthys LNG facility are undertaken in accordance with:

- EPBC 2008/4208 (Commonwealth) approval conditions (as applicable) and the following approved management plans:
  - Ichthys Onshore LNG Facilities Liquid Discharge Management Plan: Operations
  - Ichthys LNG Project Nearshore Operations Oil Pollution Emergency Plan
- the Ichthys LNG facility environment protection licence (NT; EPL228 as amended) conditions

- commitments within the Onshore Operations Environmental Management Plan.

1.6 Relationship with other proposed actions

1.6.1 Ichthys LNG AGRU Upgrades and CCS Preparedness Project

As part of INPEX wider efforts to decarbonise its operations, to provide a stable supply of diverse and clean energy sources, INPEX Operations Australia Pty Ltd is proposing upgrades to the existing AGRUs to improve their capacity to separate CO_2 from feed gas. This includes the installation of new equipment to be added to existing LNG processing systems to connect a new CCES, as well as the on-plot section of the CO_2 export pipeline to connect to the Project at Ichthys LNG facility boundary. These additions would enable Ichthys LNG facility CO_2 to be compressed and transported for geological sequestration.

The construction of these assets and associated activities are currently proposed under a separate Ichthys LNG AGRU Upgrades and CCS Preparedness referral, under which the infrastructure would be constructed, pre-commissioned (including hydrotesting) and cold commissioned. Once constructed and pre-and cold-commissioned, infrastructure would be preserved.

A referral application supporting this project was submitted to the NT EPA and DCCEEW in September 2025.

Add in context for split referral/staged action.

The commissioning and operation of the on-plot CO_2 pipeline, and hot commissioning and operation of the upgraded AGRU and the CCES within the Ichthys LNG facility is considered under this referral (refer to Sections 2.3.2, 2.4.2 and 2.4.3).

1.6.2 Bonaparte CCS Project

INPEX, as operator of the Bonaparte CCS Assessment Joint Venture is proposing to develop the Bonaparte CCS Project, a large-scale multi-user CCS facility partly located in the Northern Territory of Australia.

The Bonaparte CCS Project is proposing to develop infrastructure to receive, transport and sequester CO_2 within a geological storage formation located approximately 2,000 m below the seabed.

The proposed infrastructure for sequestration would be located approximately 250 km west of Darwin in the Joseph Bonaparte Gulf. The transport infrastructure would comprise of a CO_2 pipeline and control cable extending between the Joseph Bonaparte Gulf and the Middle Arm peninsula in Darwin where the onshore inlet station (to receive and gather CO_2 streams) is proposed to be developed.

Third-party CO_2 sources are intended to be received from potential customers in the region through commercial agreements, including reservoir CO_2 from Ichthys LNG facility. The interface between the proposed Bonaparte CCS Project and the proposed Ichthys CCS Project is shown in Figure 1-1.

A referral application supporting this Bonaparte CCS Project is planned to be submitted in Quarter 4, 2025.

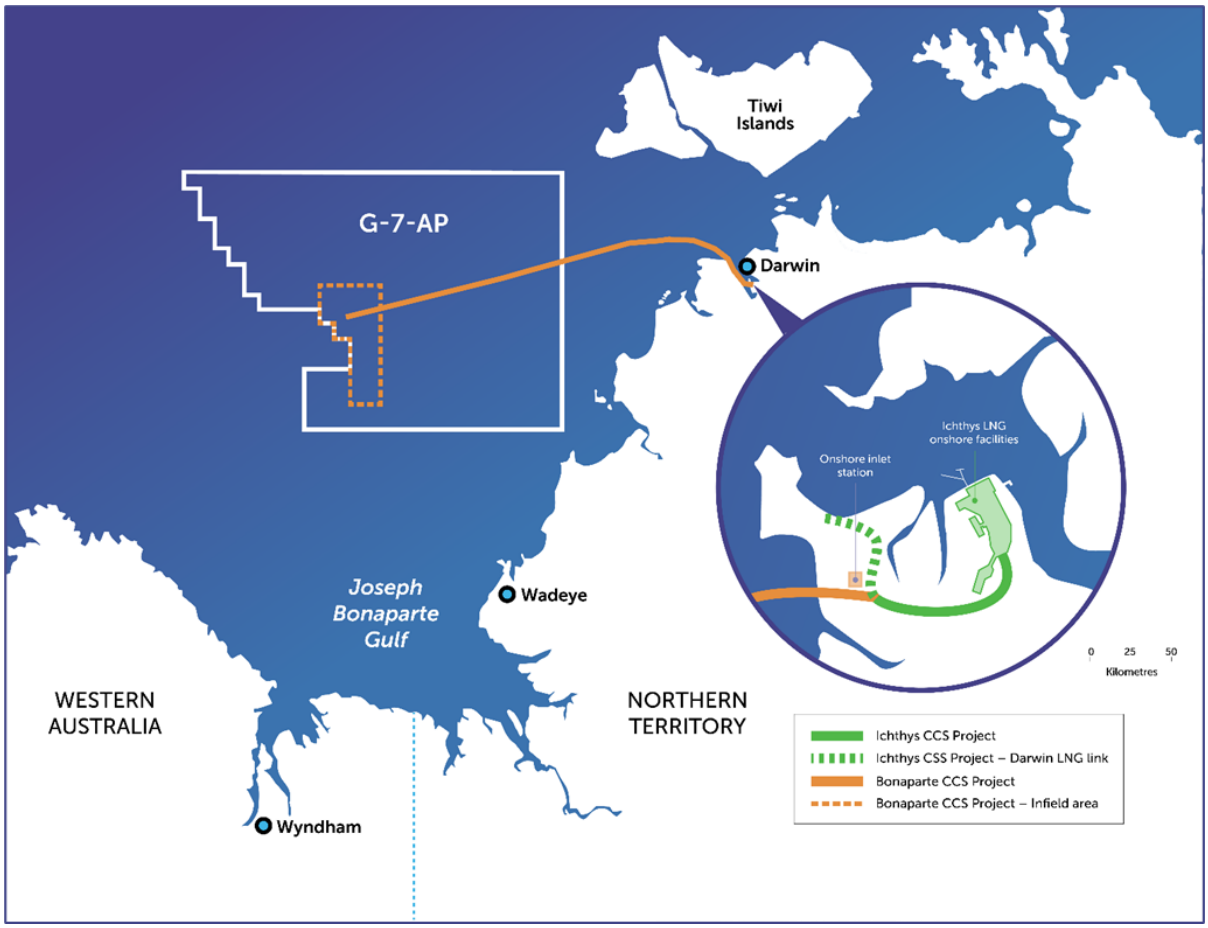


Figure 1-1: Overview of interface between the proposed Ichthys CCS Project and the proposed Bonaparte CCS Project

2 PROJECT DESCRIPTION

2.1 Schedule

Key phases of the Project are proposed to be undertaken in line with the following indicative program:

- site preparation works (commence Q2, 2028)
- pipeline/cable excavation and backfill (commence Q3, 2028)
- pipeline and transmission cable installation/Ichthys CCS pipeline tie-in station construction (commence Q3, 2028)
- CO_2 pipeline pre-commissioning (commence Q2, 2030)
- AGRU and CCES hot commissioning – brownfields modifications and modules (commence Q2, 2028)
- AGRU and CCES start-up and operation (commence Q1, 2030)
- Operational life of approximately 30 years.

The overall indicative schedule is depicted in Figure 2-1.

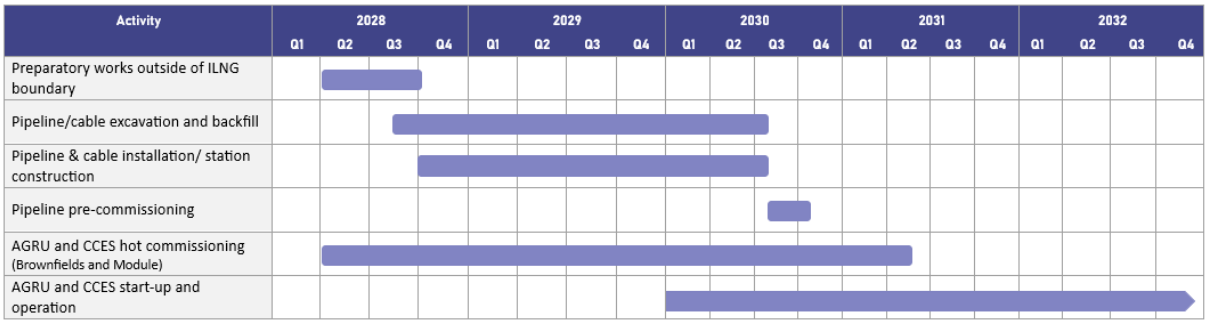


Figure 2-1: Indicative schedule of proposed activities

2.2 Project location

The Project is wholly located on Middle Arm peninsula. The area encompasses locations within the existing Ichthys LNG facility located on Bladin Point on the northern side of Middle Arm peninsula, and on the western side of Middle Arm Peninsula (Refer to Figure 2-2)

In addition, an existing offsite laydown area located on Middle Arm Peninsula (on land Section 1949; refer to Figure 2-5) and currently utilised by the Ichthys LNG facility, may also be used in accordance with Crown Land Licence terms and conditions.

The Project at it is closest point is located approximately:

- four kilometres from Palmerston (the nearest residential zone)
- four kilometres from East Arm Wharf
- seven kilometres south-east of the Darwin central business district (CBD), across Darwin Harbour waters
- the Santos operated Darwin LNG processing and export facility is directly adjacent to the Project development area (refer to Section 2.2.1).

Figure 2-2: Project location

2.2.1 Project area

The "Project area" is defined as the area where activities associated with the Project may occur. The Project area encompasses all of the following:

- areas required to be disturbed as a result of construction and commissioning activities required to support the installation of new infrastructure
- areas which may be utilised for temporary laydown, siting of plant equipment and other facilities required for construction and commissioning activities
- the operational area of the Project, including any buffers required to protect infrastructure.

The "Project footprint" is defined as the area that would be disturbed, either temporarily or permanently, as a result of the construction activities required to support the installation of new infrastructure on Middle Arm peninsula.

The Project area and Project footprint are shown in Figure 2-3.

The Project footprint comprises a total area of approximately 77 hectares and incorporates areas of previously disturbed land.

The Project footprint includes the following five defined areas:

- the Ichthys CCS pipeline area
- the Ichthys CCS pipeline tie-in station area
- the Ichthys CCS (Darwin LNG link) pipeline area
- the Darwin LNG pipeline tie-in station area
- the supplementary power intake substation area.

The locations of these discrete areas within the footprint are shown in Figure 2-4, with a further description of these areas provided in the following sections.

Where possible, construction and commissioning activities will utilise pre-disturbed areas.

Figure 2-3: Project area and Project footprint

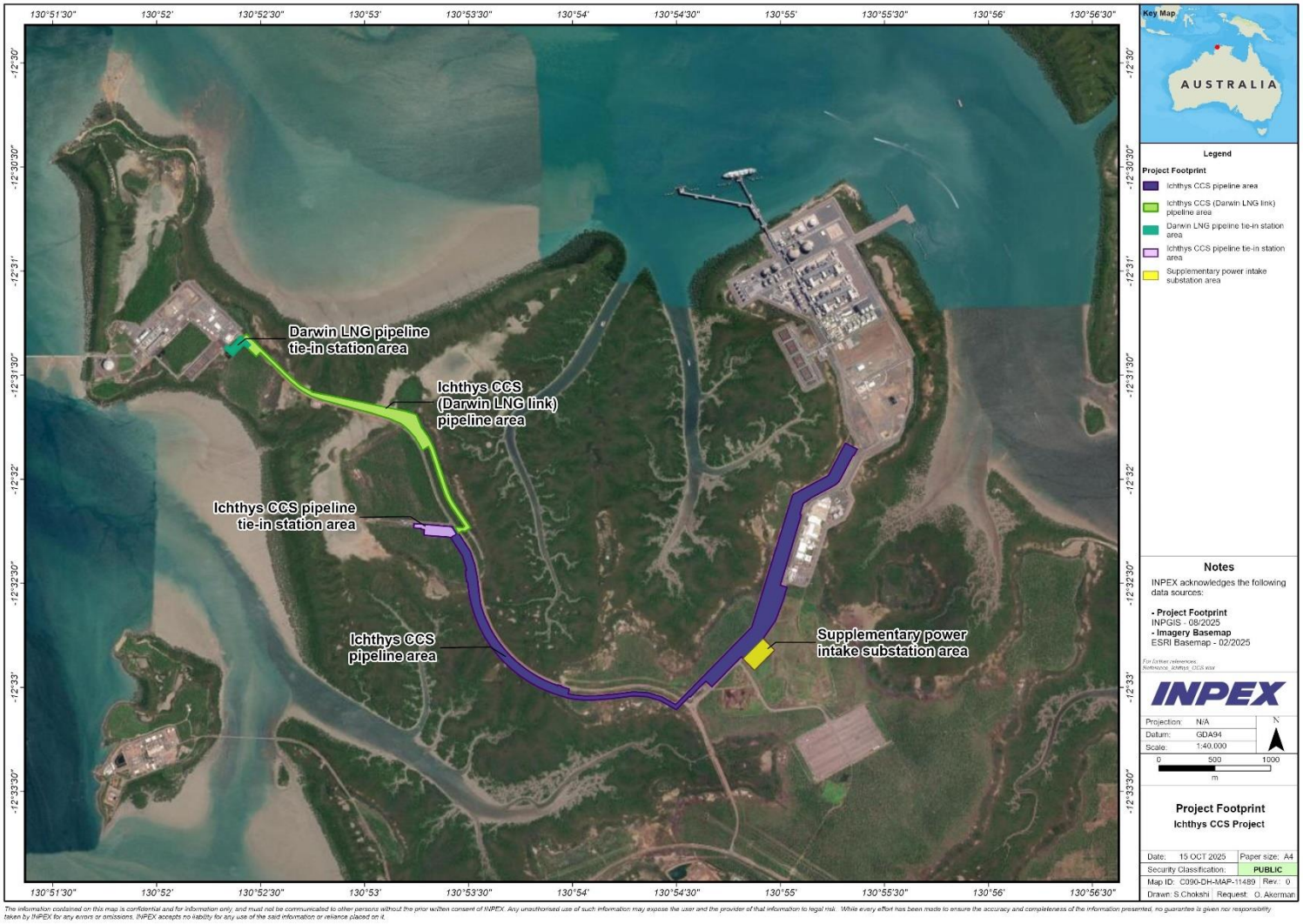


Figure 2-4: Defined areas within the Project footprint

Ichthys CCS pipeline area

The Ichthys CCS pipeline area commences at the Ichthys LNG facility boundary and terminates at the Ichthys CCS pipeline tie-in station (refer to Figure 2-3). The area includes areas previously disturbed during the construction of the Ichthys Project (refer to Section 1.5). The total area is approximately 53 ha, which encompasses areas of both permanent disturbance and temporary disturbance.

The following permanent infrastructure would be installed within the area:

- the proposed Ichthys CCS pipeline (from the Ichthys LNG facility boundary to the Ichthys CCS pipeline tie-in station)
- power and communications cables to facilitate both operation of the pipeline and associated infrastructure (i.e. pipeline tie-in stations), and the supplementary power substation.

In addition, temporary work areas required to support construction and commissioning activities would also be established within the area. Temporary work areas that would be established within the area include:

- equipment and material laydown areas
- batching plants
- access roads for construction equipment.

Any temporary disturbance areas required for these activities would be reinstated following completion of these activities.

A description of the proposed Project infrastructure is described within Section 2.3.1.

Ichthys CCS pipeline tie-in station area

The Ichthys CCS pipeline tie-in station area would be located, adjacent to the existing Ichthys LNG Development project GEP beach valve station on the western side of Wickham Point Road (Figure 2-3). The area includes areas previously disturbed during the construction of the Ichthys Project (refer to Section 1.5). The total area is approximately 3.5 ha and encompasses both areas of permanent disturbance and temporary disturbance.

The following infrastructure would be installed within the area:

- Ichthys CCS pipeline tie-in station

In addition, temporary work areas required to support construction and commissioning activities would also be established within the area. Temporary work areas that would be established within the area include:

- equipment and material laydown areas
- access roads for construction equipment
- acid sulphate soil treatment pad/s
- a water holding pond or temporary tanks (for storage of hydrotest water).

Temporary disturbance areas required to support construction and commissioning activities, would be reinstated following completion of these activities.

A description of the proposed Project infrastructure is described within Section 2.3.1.

Ichthys CCS (Darwin LNG link) pipeline area

The Ichthys CCS (Darwin LNG link) pipeline area commences at the Ichthys CCS pipeline tie-in station and terminates at the Darwin LNG pipeline tie-in station (refer to Figure 2-3).

The area includes areas previously disturbed during the construction of third-party pipelines associated with the Darwin LNG facility. The total area is approximately 16 ha, which encompasses areas of both permanent disturbance and temporary disturbance.

It should be noted that in some locations the area has been expanded to encompass several alternative pipeline routes that are being considered. The final pipeline route would be determined during detailed design and would likely result in a reduction of the size of the footprint.

The following infrastructure would be installed within the area:

- the proposed Ichthys CCS pipeline from the Ichthys CCS pipeline tie-in station to the Darwin LNG pipeline tie-in station
- power and communications cables to facilitate both operation of the pipeline and associated infrastructure (i.e. pipeline tie-in stations).

In addition, temporary work areas required to support construction and commissioning activities would also be established within the area. Temporary work areas that would be established within the area include:

- equipment and materials laydown areas
- access roads for construction equipment.

Temporary disturbance areas required to support construction and commissioning activities, would be reinstated following completion of these activities.

A description of the proposed Project infrastructure is described within Section 2.3.1.

Darwin LNG pipeline tie-in station area

The Darwin LNG pipeline tie-in station area would be located adjacent to the Darwin LNG facility boundary on the southwestern side of Wickham Point Road (Refer to Figure 2-3). The total area is approximately 1.5 ha, which encompasses areas of both permanent disturbance and temporary disturbance.

The following permanent infrastructure is proposed to be installed in this area:

- the Darwin LNG pipeline tie-in station
- access road connecting the station to Wickham Point Road.

In addition, temporary work areas required to support construction and commissioning activities would also be established within the area. Temporary work areas that would be established within the area include:

- equipment and materials laydown areas
- access roads for construction equipment
- a water holding pond or temporary tanks (for storage of hydrotest water).

Temporary disturbance areas required to support construction and commissioning activities, would be reinstated following completion of these activities.

A description of the proposed Project infrastructure is described within Section 2.3.1.

Supplementary power intake substation area

The supplementary power intake substation area would be located near the Ichthys LNG facility on land in Section 1888 (refer to Figure 2-3 and Figure 2-5). The area includes areas previously disturbed during the construction of Ichthys Project (refer to Section 1.5). The total area is approximately 3.5 ha, which encompasses areas of both permanent disturbance and temporary disturbance.

The following permanent infrastructure is proposed to be installed in this area:

- supplementary power intake substation for future import of green power from a third-party source
- power and communications cables.

In addition, temporary work areas required to support construction and commissioning activities would also be established within the area. Temporary disturbance areas required to support construction and commissioning activities, would be reinstated following completion of these activities.

A description of the proposed Project infrastructure is described within Section 2.3.1.

Land Section 1888 has been identified as the preferred location for the supplementary power intake substation, as it provides sufficient space whilst avoiding the congested pipeline and utilities areas to the west of the Ichthys LNG facility access road. Whilst the location within Section 1888 is preferred, alternative locations in comparable land areas are still being considered. The final location would be in proximity to the Ichthys LNG facility and be determined following design and assessment of comparable land areas.

2.2.2 Land tenure, planning and zoning

The Middle Arm peninsula lies within the Litchfield Council region. The Project area encompasses land zoned under the Northern Territory Planning Scheme 2020 as either Development, Future Development, Utilities, Main Road and Proposed Main Road. Surrounding land is mostly zoned as Conservation.

The land use zones for Middle Arm peninsula applicable project components within the Project area are presented in Table 2-1 and shown in Figure 2-5.

Table 2-1: Land use zoning and tenure

Project component	NT land section/ portion	Northern Territory Planning Scheme land use zone	Tenure
Ichthys LNG facility	NT Portion 7002	Development	Freehold land
Supplementary power intake substation	Section 1888	Development	Crown land
Ichthys CCS pipeline	Section 1908	Development	Freehold land
	Road reserve	Main Road	Crown land
	Road reserve	Proposed Main Road	Crown land
	Section 1958	Utilities	Freehold land
Ichthys CCS pipeline tie-in station	Section 1896	Utilities	Freehold land
Ichthys CCS (Darwin LNG link) pipeline	Section 1958	Utilities	Freehold land
	Road reserve	Main Road	Crown land

Project component	NT land section/ portion	Northern Territory Planning Scheme land use zone	Tenure
	Section 1860	Future development	Freehold land
Darwin LNG pipeline tie-in station	Section 1860	Future development	Freehold land

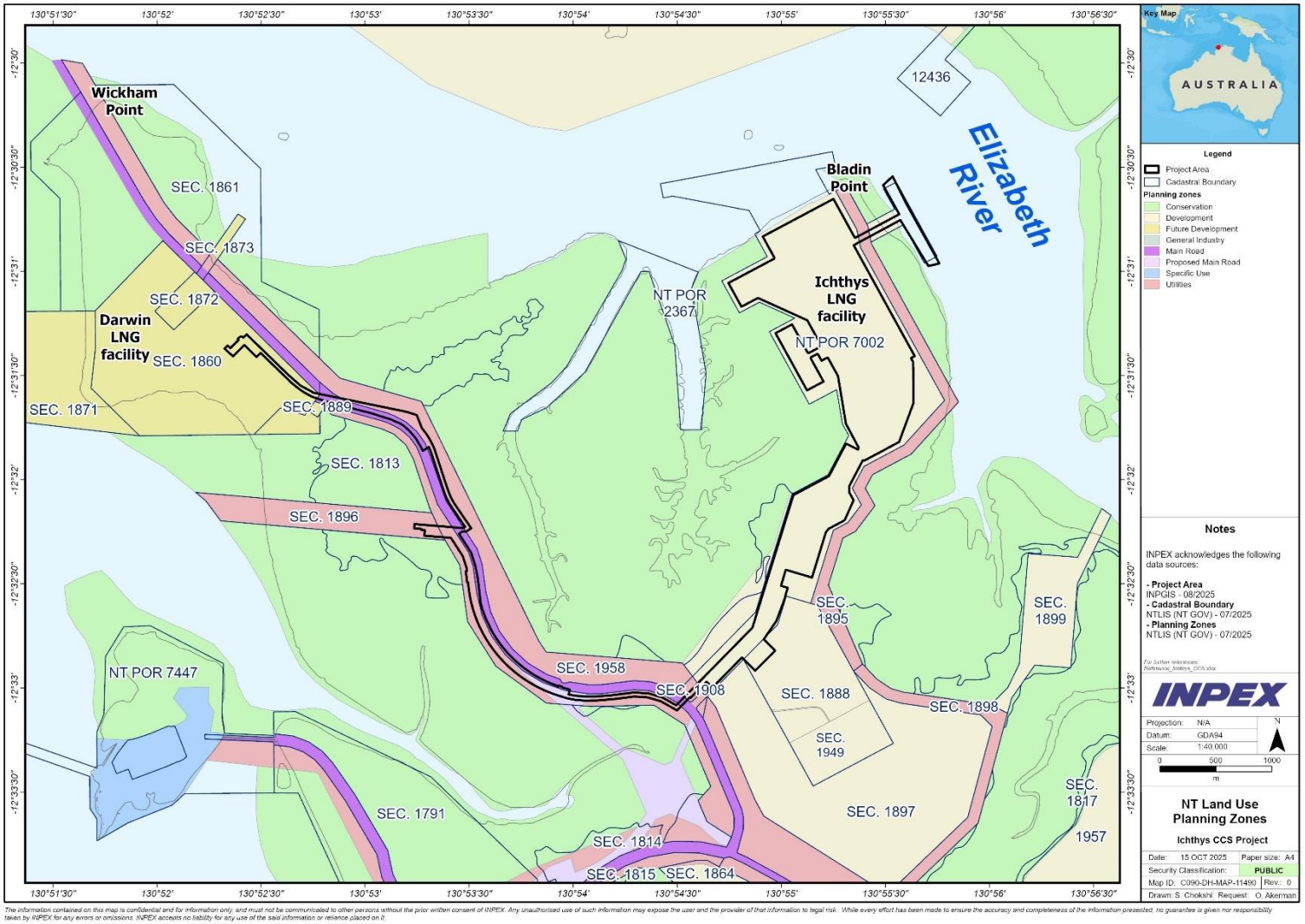


Figure 2-5: Middle Arm peninsula land use zoning

2.3 Project infrastructure, utilities and workforce

The following sections provide an overview of the Project infrastructure and the temporary facilities, utilities and workforce required to support the Project.

The description of infrastructure within this section represents the Project "base-case" and the worst-case for assessing the potential impacts of the Project. The base-case assumes CO_2 is gathered from both the Ichthys LNG facility and the Darwin LNG facility for export to the proposed Bonaparte CCS Project (subject to separate referrals; refer to Section 1.6.2).

An alternative where the proposed Santos operated Bayu-Undan CCS Project would be used as the storage option for captured CO_2 from the Ichthys LNG facility has also been presented in Section 2.4.4.

2.3.1 Proposed infrastructure on Middle Arm peninsula

CO_2 export pipeline

A high-pressure carbon steel CO_2 export pipeline comprised of two independent sections and is proposed on Middle Arm peninsula, as follows:

- a pipeline extending from the Ichthys LNG facility boundary to the Ichthys CCS pipeline tie-in station (Refer to Figure 2-4). This section of pipeline is referred to as the "Ichthys CCS pipeline"
- a pipeline extending from the Ichthys CCS pipeline tie-in station to a pipeline tie-in station located adjacent to the Darwin LNG facility boundary (Refer to Figure 2-4). This section of pipeline is referred to as the "Ichthys CCS (Darwin LNG link) pipeline"

These and the overall design specifications of the CO_2 export pipeline are further described in the following sections.

Ichthys CCS pipeline

The proposed Ichthys CCS pipeline route commences at the Ichthys LNG facility boundary and continues along the Ichthys LNG facility access road to the intersection at Wickham Point Road, where it crosses to the western side of Wickham Point Road and continues to the termination point at the Ichthys CCS pipeline tie-in station (Figure 2-4).

The selected pipeline route runs parallel to the existing Ichthys GEP and the pipeline would be constructed within the existing Ichthys GEP easement. To ensure a safe distance during construction and operations, the pipeline would be offset (~10 m) from the existing GEP infrastructure.

The pipeline route would cross a number of existing utilities, including:

- crossing of DN250 gas pipeline
- crossing (approximately 70 metres) of Wickham Point Road, the 22-kilovolt overhead powerline easement, buried HV cable, DN300 underground water pipeline and Telstra cable
- crossing (approximately 15 metres) of the Ichthys GEP.

The CO_2 pipeline would be approximately 8.5 kilometres in length and would be constructed from carbon steel DN400 (16 inch, subject to optimisation) high-pressure gas pipe capable of transporting compressed CO_2. External corrosion protection would be provided by both an external coating and a cathodic protection system[1]. The pipeline has been sized to accommodate the Ichthys LNG facility's current and potential future CO_2 flow rates.

The pipeline would be constructed within a pipeline right of way (ROW) corridor. The width of the ROW would range between 20 metres and 40 meters dependent on presence of existing services or environmental sensitivities within adjacent areas. The pipeline would be laid in a trench, approximately two to three metres deep and buried.

During pipeline installation activities (refer to Section 2.4.1) the pipeline would be connected to the following assets:

- the proposed CO_2 pipeline located within the Ichthys LNG facility boundary. The construction of the CO_2 pipeline within the Ichthys LNG facility is subject to a separate referral (refer to Section 1.6.1).
- the Ichthys CCS pipeline tie-in station.

Ichthys CCS (Darwin LNG link) pipeline

The Ichthys CCS (Darwin LNG link) pipeline has been described for the purposes of completeness; however, the construction, installation and subsequent operation of this pipeline section is subject to future commercial arrangements/agreements between third-parties. In the event that this section of pipeline is determined not to be required, the potential impacts associated with construction, installation and operational activities would not occur.

The proposed Ichthys CCS (Darwin LNG link) pipeline route commences at the Ichthys CCS pipeline tie-in station, before crossing to the eastern side of Wickham Point Road where it continues for a number of kilometres within an existing easement, before crossing back over to the western side of Wickham Point Road and terminating at the Darwin LNG pipeline tie-in station (Figure 2-4).

A number of alternative routes are currently being considered for a small section of the pipeline (approximately 1 kilometre) where the pipeline route traverses a salt flat. The location where alternate routes are being considered is shown in Figure 2-6. The selection of the final route in this location is subject to ongoing consultation and future surveys (heritage, geotechnical and geophysical) and would be determined during detailed design.

The pipeline route would cross a number of existing utilities, including:

- crossing (approximately 60 m) of Wickham Point Road, within Santos' lease area, a buried high voltage (HV) cable, DN300 underground water pipeline, DN 250 underground gas pipeline and Telstra cable
- crossing (approximately 60 m) of Wickham Point Road, the 22-kilovolt overhead powerline easement, DN300 underground water pipeline and Telstra cable
- crossing (approximately 15 m) of a DN 250 APA gas pipeline
- crossing (approximately 15 m) of the GEP and associated power and communication cables.

[1] A system that typically uses electrical current to protect submerged and underground metallic structures from corrosion.

The CO_2 pipeline would be approximately 3.5 kilometres in length and would be constructed from carbon steel DN300 - DN400 (12 to 16 inch) high-pressure gas pipe capable of transporting compressed CO_2. External corrosion protection would be provided by both an external coating and a cathodic protection system[1].

In addition, this section of the CO_2 export pipeline would be designed to allow for flow of CO_2 in either direction. This is to accommodate the two potential CO_2 storage locations/projects being considered by INPEX for storage of Ichthys LNG facility CO_2 (Refer to Section 2.6.1).

The pipeline would be constructed within a pipeline ROW corridor. The width of the ROW would range between 20 metres and 40 meters dependent on presence of existing services or environmental sensitivities within adjacent areas. The pipeline would be laid in a trench, approximately two to three metres deep and buried.

During pipeline installation activities (refer to Section 2.4.1) the pipeline would be connected to the following assets:

- the Darwin LNG CCS pipeline tie-in station
- the Ichthys CCS pipeline tie-in station.

Figure 2-6: Location where alternative pipeline routes are being considered

CO_2 export pipeline design

The *Energy Pipelines Act 1981* (NT) requires petroleum pipelines to be designed and constructed in accordance with a "prescribed standard". For existing onshore high-pressure petroleum pipelines in the Northern Territory, AS/NZS 2885.1: Pipelines - Gas and liquid petroleum (AS/NZS 2885.1) has been used as the prescribed standard for the construction of pipelines. More recently, this standard has been updated to include specific requirements for CO_2 pipelines.

The *Energy Pipelines Act 1981* (NT) does not currently consider the regulation of CO_2 pipelines; however, the Northern Territory Department of Mining and Energy have advised INPEX that amendments to the Act are proposed to address this gap within the legislation (refer to Section 3). In anticipation of the amendments, INPEX has considered the minimum requirements of the relevant prescribed standards when designing the proposed CO_2 export pipeline.

The design of the proposed CO_2 export pipeline has been refined to include specifications and guidance under the AS/NZS 2885.1 (i.e. pipeline diameter and wall thickness, damage prevention controls such as signage, marker tape, etc.). In addition, the following characteristics of the treated CO_2 for current operation and expected future operations that would be transported via the pipeline were also considered:

- the disposal stream
- fluid composition
- impurities of CO_2
- maximum allowable operating pressure (MAOP)
- pressure cycling
- temperature (expected maximum and minimum)
- flowrates.

In addition to AS/NZS 2885.1, other factors and standards were considered during design, including:

- interactions between changes in groundwater levels and the pipeline
- general risk assessment along the full length of the pipeline would be undertaken to consider location scenarios (i.e. road crossings, remote areas, areas approaching other infrastructure, etc.).

In consideration of the above the following were incorporated into the design:

- The pipeline would be buried at a depth and weighted as required to ensure sufficient buoyancy control under all operating and installed conditions.
- To account for all the location scenarios above the design applies relevant issued specific criteria, for example:
  - buried at a depth that meets the minimum backfill cover requirements specified in AS 2885: the standard for high pressure pipeline systems (AS 2885)
  - meet the minimum wall thickness of a pipeline under a road (as determined by the road vehicle load limit) as specified in AS 2885 and API RP 1102: Steel Pipelines Crossing Railroads and Highways.

Ichthys CCS pipeline tie-in station

The Ichthys CCS pipeline tie-in station would be located in an area adjacent to the existing Ichthys GEP beach valve precinct on the western side of Wickham Point Road (refer to Figure 2-4 and Figure 2-7).

The Ichthys CCS pipeline tie-in station would include the following infrastructure:

- a pig receiver for the Ichthys CCS pipeline, with localised venting facilities for small volumes of CO_2
- a pig launcher/receiver for Ichthys CCS (Darwin LNG link) pipeline, with localised venting facilities for small volumes of CO_2
- manifold piping and valving for isolations for both the above
- a local equipment and instrument room
- stormwater runoff management measures
- provision for an emergency blowdown vent
- operational and emergency lighting (as required)
- closed-circuit television and security fencing.

The permanent infrastructure of the Ichthys CCS pipeline tie-in station would occupy an area of approximately one hectare.

The battery limit of the Project relative to the interfacing Bonaparte CCS Project is the isolation valve within the Ichthys CCS pipeline tie-in station.

Figure 2-7: Location of the Ichthys CCS pipeline tie-in station

Darwin LNG pipeline tie-in station

The Darwin LNG pipeline tie-in station would be located adjacent to the Darwin LNG facility boundary on the southwestern side of Wickham Point Road (Refer to Figure 2-4 and Figure 2-8).

The Darwin LNG pipeline tie-in station would include the following infrastructure:

- a pig launcher/receiver for Ichthys CCS (Darwin LNG link) pipeline, with localised venting facilities for small volumes of CO2
- a metering skid for custody transfer measuring
- manifold piping and valving for isolations
- a local equipment and instrument room
- stormwater runoff management measures
- operational and emergency lighting (as required)
- closed-circuit television and security fencing.

The Darwin LNG tie-in station would be designed to allow for flow of CO_2 in either direction (i.e. to receive or export). This is to accommodate the two potential CO_2 storage locations/projects being considered by INPEX for storage of Ichthys LNG facility CO_2 (Refer to Section 2.6.1).

The permanent infrastructure of the Darwin LNG pipeline tie-in station would occupy an area of approximately 1.5 hectares.

The battery limit of the Project relative the interfacing Darwin LNG facility would be an isolation valve adjacent to the Darwin LNG facility boundary.

Figure 2-8: Location of Darwin LNG pipeline tie-in station

Supplementary power intake substation

The supplementary power intake substation is proposed to be located on land within Section 1888 (refer to Figure 2-4 and Figure 2-9). Several options for the location of the intake substation have been considered; however, land Section 1888 has been identified as the preferred location as it provides sufficient space whilst avoiding the congested pipeline and utilities areas to the west of the Ichthys LNG facility access road.

The permanent infrastructure of the supplementary power intake substation includes:

- substation building/s and high voltage switchgear
- battery energy storage system (BESS)
- power transformers with bunding
- underground and above ground cable infrastructure
- lighting and boundary fencing.

The permanent infrastructure of the supplementary power intake substation would occupy an area of approximately 5 hectares.

As noted, in Section 2.2.1, alternative locations for intake substation are still under consideration. Any final location would be in proximity to the Ichthys LNG facility and be determined following design and assessment of comparable land areas (Refer to Section 2.6.3).

The supplementary power intake substation would be connected to the Ichthys LNG facility via power and communications infrastructure, described in the following section.

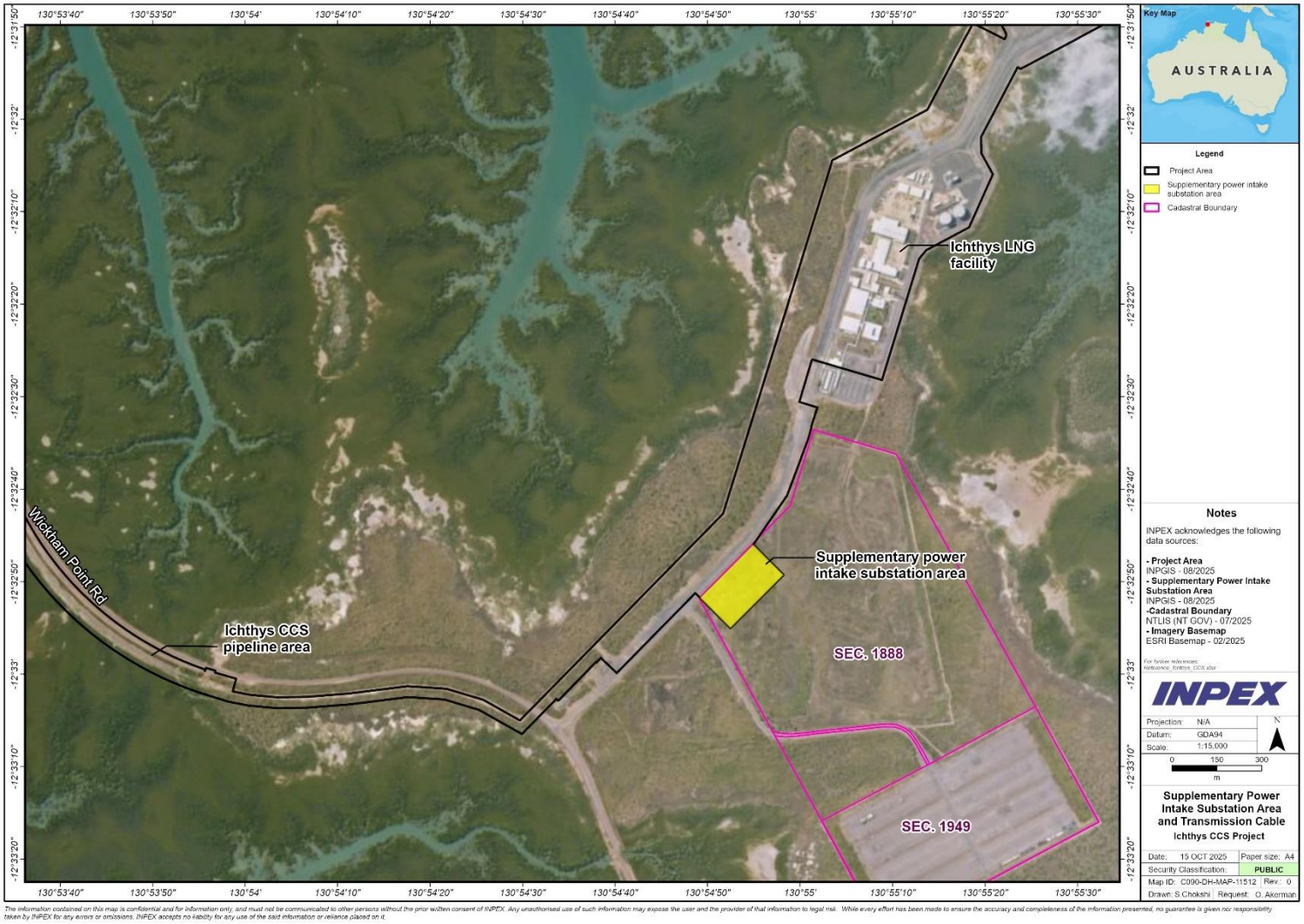


Figure 2-9: Location of supplementary power intake substation

Power and communications infrastructure

Power and communications infrastructure includes buried fibre optic cables and high voltage electric cables.

Power and communication infrastructure associated with the operation of the CO_2 export pipeline and the associated Ichthys CCS and Darwin LNG pipeline tie-in stations, would be installed within the pipeline ROW corridor. Power and communications cabling would be either installed within the CO_2 export pipeline trench or in small trenches adjacent to this. An alternative option utilising the existing power network is also being considered (Refer to Section 2.6.2).

Installation of power and communications infrastructure is also required to connect the supplementary power intake substation to the Ichthys LNG facility. The power transmission cables from the intake substation to the Ichthys LNG facility would be installed primarily underground, either direct buried or within ducts.

Auxiliary and temporary infrastructure

From the commencement of site preparation and throughout the construction phase, areas within the Project area would be needed for laydown or to cater for other temporary facilities. These may include, but are not limited to, storage areas for equipment and materials, batching plants, water holding ponds, acid sulphate soil treatment areas. Where possible, these would be located within previously disturbed areas within the Project area.

Roads and temporary construction access to the CO_2 export pipeline, Ichthys CCS pipeline tie-in station and the Darwin LNG pipeline tie-in station would also be required.

Further, laydown areas located on Middle Arm peninsula and currently utilised by the Ichthys LNG facility, would also be utilised for storage of construction materials in accordance with Crown Land Licence arrangements.

2.3.2 Ichthys LNG facility infrastructure

The following section describes the equipment and infrastructure associated with the Ichthys LNG facility upgraded acid gas removal units (AGRUs), CCES and internal CO_2 pipeline.

The construction, installation, pre-commissioning and cold commissioning of upgraded AGRUs and CCES is subject to a separate referral (refer to Section 1.6.1); however, the hot commissioning and operations of this equipment and infrastructure is considered within the scope of this Project.

The construction and installation of the internal CO_2 pipeline is also subject to a separate referral (refer to Section 1.6.1); however, the commissioning and operations of this infrastructure is considered within the scope of this Project.

Acid gas removal units

The purpose of the AGRUs is to remove acid gases (primarily reservoir CO_2, as well as trace quantities of hydrogen sulphide and mercaptans) from the feed gas received at the Ichthys LNG facility. Each AGRU comprises two subsystems; the first absorbs the acid gases into the AGRU solvent (i.e. aMDEA) and the second is a solvent regeneration system that uses a combination of pressure reduction and higher-temperature to separate the acid gases back out of the AGRU solvent to enable solvent re-use within the closed-loop system.

Upgrades to the existing Ichthys LNG facility AGRUs are required to accommodate the gradual introduction of higher CO_2 feed gas from the approved Ichthys LNG Development project (i.e. gas from Plover wells). The construction, installation and cold commissioning of the upgraded AGRUs is subject to a separate referral (refer to Section 1.6.1).

Once operational, the upgrades would increase the existing AGRU capability to remove reservoir CO_2 from the feed gas received at the Ichthys LNG facility. The CO_2 stream extracted via the AGRUs would be directed to the new CCES for processing/treatment prior to export to third-party infrastructure and sent to an offshore storage site for sequestration.

CO_2 compression and export system

The CCES consists of the following:

- a common inlet manifold which transports CO_2 rich feed gas from the AGRU's associated with Ichthys LNG Train 1 and Train 2 to the CCES
- two compressors each driven by electrical motors (including associated cooling modules)
  - associated local vents (two – three) to support operational requirements (sampling or machine protection – See Vent arrangements)
- a common dehydration unit
- a common recovered water treatment unit
  - an associated single local vent to support operational requirements (waste gas from the recovered water treatment – refer to Vent arrangements)
- a compressor outlet manifolding, export metering station and PIG launcher
- two vent stacks, each with multiple vents per stack to serve specific operating modes
- a combined local electrical/instrument room building and transformers
- interconnecting pipe racks and other various small structures and equipment to support the above.

A brief description of key components of the CCES is provided in the following sections. The hot commissioning and operations of the CCES and the interface with proposed infrastructure on Middle Arm peninsula is described in Section 2.4.2 and Section 2.4.3.

CO_2 compressor units

The CO_2 extracted via the AGRUs would be directed to the CO_2 compression units (each sized for 50 per cent of maximum duty) from both Ichthys LNG trains (1 and 2). Once received by the compressor units the CO_2 stream would be initially compressed to a suitable pressure for dehydration (termed low-pressure compression). At commencement of this stage the CO_2 feed stream contains significant water vapour (~92 per cent CO_2: ~8 per cent water vapour). Following initial low-pressure compression, most of the water is removed due to condensation and physical removal during the low-pressure compression step. However, the stream still contains residual water (~99.7 per cent CO_2: ~0.3 per cent water vapour). The CO_2 stream is directed to a common dehydration unit to remove this residual water. Once the water is removed the CO_2 is directed back to the compressor and further compressed to high pressure (termed high-pressure compression), resulting in a dense phase gas which can be exported.

Common dehydration unit

Acid gas received at the common dehydration unit from the AGRU is water saturated at the entry condition (~0.3 per cent water vapour). The purpose of the dehydration unit is to remove residual water vapour from the CO_2 stream to achieve a suitable dryness specification for export via pipeline (40 ppmv - parts per million by volume). It is necessary to dehydrate CO_2 streams prior to transporting these via carbon steel pipelines, as moisture within the streams can result in corrosion and hydrate formation. As such, the dehydration unit plays an important role in maintaining the integrity of the CO_2 pipeline, which is predominantly made from carbon steel.

The dehydration unit consists of three parallel beds configured as two in operation and one in regeneration mode. The feed CO_2 from both compressors is comingled in a common manifold before entering the online beds. The dehydrated CO_2 discharge flow is analysed for moisture specification and filtered to remove dust, etc. prior to being directed to the high-pressure section of the compressors. Wastewater from the dehydration unit would be captured and managed within in the existing Ichthys LNG facility wastewater system.

Common recovered water treatment unit

Extracted water from the compression and dehydration processes is recovered, which is then directed to the common recovered water treatment unit. Water entering the unit is collected in an "untreated water" buffer tank prior to being directed to a stripper column. The stripper column uses nitrogen gas to remove contaminants (e.g. dissolved CO_2) from the water. Once contaminants are removed, the treated recovered water is then directed to a treated water tank prior to being pumped back to the operational AGRUs for re-use.

CO_2 export metering

Dry compressed (dense phase) CO_2 from the compression unit is directed via a common discharge manifold to the export metering location. Metering is required to measure equipment performance as a means of demonstrating compliance with environmental regulations, and to provide a basis for payment under future transportation and sequestration commercial arrangements.

CO_2 pipeline

A ~2.5 km long section of CO_2 pipeline is proposed to be installed within the perimeter fence of the Ichthys LNG facility. The CO_2 pipeline would be constructed from carbon steel DN400 (16 inch, subject to optimisation) high-pressure gas pipe capable of transporting compressed CO_2. Further, the CO_2 pipeline would be designed to meet the minimum requirements of prescribed standards for CO_2 pipelines described in previous sections.

The CO_2 pipeline would be fitted with a "pig launcher" facility to support commissioning, and future inspection and maintenance activities once operational. This facility would also include a localised vent system to allow for safe depressurisation during a pigging campaign.

The Ichthys facility CO_2 pipeline has been sized to accommodate the Ichthys LNG facility's current and potential future CO_2 flow rates.

Supplementary power infrastructure

Supplementary power will be required to support future operations of the upgraded AGRUs and CCES. The supplementary power infrastructure includes:

- a small BESS, to provide virtual spinning reserve
- supporting infrastructure (i.e. transformers, switchgear, etc.)
- high voltage cabling.

2.3.3 Utilities

Water demand and supply

Construction

Water is required to support construction and commissioning activities described in Section 2.4. Water would be either sourced from a third-party provider and brought to site via road transport or temporary pipe connections used to connect to the existing scheme water network (PWC water).

Water used for commissioning activities would be re-used where possible. Disposal options being considered for wastewater generated during construction and commissioning are described in Section 2.5.1.

It is estimated that ~126,000 m^3 of scheme water would be required for construction and commissioning activities.

Operations

Scheme water sourced under existing Ichthys LNG facility arrangements would be used to support any additional water needs during operations.

Power demand and supply

Construction

Power would be required for temporary offices, laydown facilities and temporary equipment spreads located within the Project area. During construction and commissioning temporary power needs would be delivered via portable diesel-powered generators.

Operations

Energy requirements

Operations of the new infrastructure (i.e. upgraded AGRUs and CCES) within the Ichthys LNG facility would result in an incremental power demand estimated to be up to approximately 90 megawatts.

Power demand for the CCES is driven primarily by the compressor power load with additions from associated ancillaries and smaller processing equipment. The load at any time is dependent on the CO_2 flow rate and compressor characteristics. The CO_2 flow rate would change both daily with variation in feed gas receival and processing rate (associated with ambient temperature impacts on LNG processing capacity), and over time depending on the feed gas CO_2 content. Peak power consumption at design capacity may be up to approximately 80 megawatts. Minimum power is estimated to be approximately 20 megawatts for a single compressor operating at minimum turndown, plus minimum associated ancillaries.

The power demand increase as a result of upgrades to AGRUs is up to be approximately 10 megawatts per LNG train when the respective train is operating. The demand is constant regardless of the feed gas rate whenever the AGRUs are required to operate (i.e. when CO_2 extraction rate exceeds 90 mmscfd in each LNG Train).

The CCES would operate continuously to export available CO_2 up to the design capacity. Available CO_2 is based on feed gas flow rate and CO_2 content, for which long term forecasts are based on expected production from existing and future Ichthys reservoir development, and INPEX's future forecast for backfill scenarios. As stated above, gas flow rate also varies according to both the seasonal and daily ambient temperature variations. Therefore, the power demand for the CCES would vary daily, seasonally and over the longer term.

Power consumption for current operation of the existing Ichthys LNG facility can be up to 260 megawatts. This is presently supplied from on-site generation consisting of a combined cycle power plant (CCPP) with a reliable capacity up to ~300 megawatts.

During operations, power demand of the combined existing Ichthys facility infrastructure and new infrastructure (i.e. upgraded AGRUs and CCES) is expected to exceed the current CCPP capacity (when operating with operational sparing) for a period of up to approximately 10 years and by up to approximately 50 megawatts at its peak.

To meet the shortfall in energy requirements, supplementary power would be required from early 2030, following the start-up of the CCES infrastructure. Supplementary power may be required for a period of 10 years or longer, depending on backfill scenarios. The supplementary power solution to meet this need is described further in the following section.

Supplementary power

To meet the shortfall in energy demand once new infrastructure (i.e. upgraded AGRUs and CCES) is operational, supplementary power would be integrated in the existing Ichthys LNG facility power generation and distribution system and changes made to the current CCPP operating philosophy.

The supplementary power solution encompasses the following:

- Changes in operating philosophy of the existing Ichthys LNG facility CCPP: This involves operating the CCPP generators at higher outputs and includes the utilisation and operation of existing spare CCPP generator units. This would increase overall net capacity of the CCPP; however, results in an increased system reliability risk.
- Installation of a battery energy storage system (BESS) within the Ichthys LNG facility: The BESS would provide virtual spinning reserve for CCPP stabilisation to address the reliability risk associated with the proposed change to the operating philosophy.
- Import of third-party renewable energy power: To support this, a supplementary power intake substation and associated cabling would be installed on Middle Arm. This would tie-in to power transmission cables installed within the Ichthys LNG facility.

The above constitutes the key defining aspects of supplementary power; however, the scope of each option may include additional equipment/facilities yet to be defined.

The construction and commissioning of infrastructure required within the Ichthys LNG facility is considered under a separate referral (Refer to Section 1.6.1). This Project considers the operation of this infrastructure, and includes the construction, commissioning and operations of the supplementary power intake substation located on land within Section 1888 (Refer to Figure 2-9).

Sewage and greywater management

The sewage management requirements for the Project temporary workforce would fluctuate over time. During construction and commissioning activities, dependent on the work location, requirements for this may be met by the existing Ichthys LNG facility permanent sewage treatment plant (sized to cater for operational shutdown workforce requirements) at the Ichthys LNG facility or self-contained ablution blocks. Where self-contained ablution blocks are required, wastewater generated will be transported and disposed offsite via suitability licenced contractor.

During operations the sewage and greywater management requirements would be met by the existing Ichthys LNG facility permanent sewage treatment plant.

2.3.4 Temporary workforce

The workforce required to support the construction, installation and commissioning activities would fluctuate over time. Peak workforce requirements are anticipated to gradually increase from early civil works and peak during installation activities, when an estimated workforce of approximately 200 persons may be required.

The workforce would consist of a mix of appropriately skilled local employees and fly-in and fly-out (FIFO) workforce which would be resourced based on skill set availability and applicability through key execution stages of the Project.

It is currently proposed that the existing Bladin Village accommodation facility (located four kilometres from the Ichthys LNG facility) would be utilised to accommodate the temporary FIFO workforce. Further, Bladin Village would incorporate a park and ride facility which would be used, in conjunction with other localised park and ride facilities, by local workforce. A shuttle service would be established for the transport of workers from Bladin Village to Project work areas.

2.4 Project activities

The following sections describe the construction, commissioning, operations and decommissioning activities that would be undertaken during the life of the Project.

As noted in Section 2.3.2, the construction, installation, pre-commissioning and cold commissioning of the Ichthys LNG facility upgraded AGRUs and CCES is subject to a separate referral (refer to Section 1.6.1); however, the hot commissioning and operations of this equipment and infrastructure is considered within the scope of this Project.

The construction and installation of the internal CO_2 pipeline is also subject to a separate referral (refer to Section 1.6.1); however, the commissioning and operations of this infrastructure is considered within the scope of this Project.

For ease of reference, Table 2-2 outlines the Project activities applicable to the Project infrastructure described in Section 2.3.

Table 2-2: Project activities

Project infrastructure	**Project activities**					
	Construction and installation	Pre-commissioning	Cold commissioning	Hot commissioning	Operations	Decommissioning
Middle Arm infrastructure						
CO_2 export pipeline	✓	✓	✓	✓	✓	✓
Ichthys CCS pipeline tie-in station	✓	✓	✓	✓	✓	✓
Darwin LNG pipeline tie-in station	✓	✓	✓	✓	✓	✓
Supplementary power intake substation	✓	✓	✓	✓	✓	✓
Power and communications infrastructure	✓	✓	✓	✓	✓	✓
Ichthys LNG facility infrastructure						
Acid gas removal units (upgraded)	×	×	×	✓	✓	✓
CO_2 compression and export system	×	×	×	✓	✓	✓
Supplementary power infrastructure	×	×	×	✓	✓	✓
CO_2 pipeline	×	✓	✓	✓	✓	✓

2.4.1 Construction

The following construction activities are required to be undertaken:

- site establishment works (e.g. vegetation clearing, ground improvement activities, earthworks, dewatering activities, etc.).
- installation of the infrastructure (CO_2 export pipeline, supplementary power intake substation, associated cabling, etc.)

These are further described in the following sections.

The Darwin area has two distinct seasons, the "wet" during November to April and the "dry" from May to October. Large volumes of surface runoff are anticipated during the wet season. As far as practicable, site preparation activities requiring ground disturbance in uncleared and unprepared areas, would occur within the dry season. Further, installation of the proposed CO_2 export pipeline, Ichthys CCS and Darwin LNG pipeline stations, and supplementary power intake station is proposed to be staged across two consecutive dry seasons.

Site establishment works

Vegetation clearing

During site establishment works vegetation clearing would be undertaken to facilitate the construction and installation of the CO_2 export pipeline, the Ichthys CCS and Darwin LNG pipeline tie-in stations, the supplementary power intake substation, and temporary areas required during the construction and commissioning stages of the Project (i.e. turn-around areas, laydown areas, temporary work-spread area, access roads, etc.).

Most of the area required to be cleared is located in previously disturbed areas (i.e. construction ROWs of the Ichthys GEP or other pipelines on Middle Arm or locations used during the initial construction of the Ichthys LNG facility). However, some areas of native vegetation would need to be cleared. A total combined area of approximately 40 hectares is proposed to be cleared.

Vegetation would be cleared using industry standard practices to remove trees, shrubs and grasses followed by grubbing the soils to remove roots and organic matter. The topsoil would be stockpiled in windrows on the boundary of the CO_2 export pipeline construction ROW or boundary of the Ichthys CCS and Darwin LNG pipeline tie-in stations, for reuse during rehabilitation. Limited vegetation would be stored to provide seed stock for rehabilitation. Excess vegetation would be mulched and disposed offsite.

Prior to commencement of site-establishment works and vegetation clearing, weed surveys would be undertaken and appropriate weed management measures employed.

Earthworks and civil

Earthworks are typically conducted using heavy machinery such as graders, front-end loaders and diggers.

Access to the proposed corridor would be via road. Earth works would be completed to establish the CO_2 export pipeline ROW (of varying width between 20-40 m) and foundation for pipeline installation and utilities corridor.

Grading shall be performed in a manner to minimise interference with existing natural drainage or utilities without compromising the drainage of surrounding areas.

Cut and fill in areas needed, laying of engineered fill and compacting to load bearing status, deep excavations for pipelaying or foundations, surface finishing (temp or perm) for roads laydown areas, concreting for foundations, etc.

Erosion and sediment control

Site establishment works would include the installation of temporary sedimentation and stormwater control and management measures, including silt fences, sediment traps, and diversion channels to manage discharge and prevent sediment runoff. These measures would be implemented prior to construction and would align with good industry practice and regulatory requirements, as applicable.

Ground improvement activities

During site-establishment some ground improvement activities would be required at various locations along the CO_2 export pipeline route and at the Ichthys CCS and Darwin LNG pipeline tie-in station locations. Ground improvement methods the would be used include:

- Mass soil mixing – Where a cement / lime binder is injected into the weak bearing capacity soils with the aim to provide neutralisation (partial or fully) of acid sulphate soils/potential acid sulphate soils and to increase soil strength.
- Imported fill – Where the ground is raised above the natural level to provide an area that is above flood levels. This may be temporary (aid to pipeline installation) or permanent (finished levels at the Ichthys CCS pipeline tie-in station or Darwin LNG pipeline tie-in station).

CO_2 export pipeline installation

CO_2 export pipeline installation activities include line pipe receipt, handling and on-site logistics, stringing and welding, field joint coating, pipeline bedding, laying and backfill, installation of cathodic protection cables and test points and installation and termination of earthing facilities. All works associated with the installation of the pipeline would occur within the proposed pipeline construction ROW (varying in width between 20 and 40 metres dependent on location).

The installation method of the pipeline would vary slightly dependent on the location within the Project area and the environmental conditions. The key steps undertaken during pipeline installation in terrestrial areas are as follows:

- mass soil mixing to improve soil conditions and reduce trench volumes required to be excavated (where required; refer to *Ground improvement activities*)
- excavation of soil to create a trench (in locations of previously undisturbed or improved soil)
- pipe stringing, wielding and coating
- lowering/laying pipe strings into the trench
- backfilling the trench using excavated spoil.

In intertidal/salt flat areas a "float-in" installation method would be used. The key steps using this method are as follows:

- excavation of soil to create a trench
- flooding of the trench with water won from the surrounding area
- push-pull pipe string (capped ends with buoyancy control) through water-filled trench
- dewatering of the trench
- addition of buoyancy control (e.g., geofabric for saddle-bag effect)
- backfilling using trench spoil.

An alternative "trenchless" method for installing the CO_2 export pipeline may also be used in geotechnically high-risk areas (e.g. salt flat areas) or beneath existing roadways. This would involve horizontal directional drilling. The key steps using this method area as follows:

- site preparation
- pilot hole drilling
- hole enlargement (reaming)
- pipe installation (pullback)
- site restoration.

Further details on these methods are described in the following sections.

Trenching method

The CO_2 export pipeline would predominantly be installed using an open cut trenching method. This is a common method used to allow for pipelines and cables to be buried. A trench between two and three metres deep and about two metres wide, accommodating the pipeline, associated power and control cables and other necessary utilities, bedding and protection would be excavated along the proposed route. An additional trench of about one metre depth and width may be required for auxiliary power and communication cables.

In intertidal areas (salt pan and mangrove areas), mass soil mixing would be used to improve soil conditions, prior to the commencement of trenching activities. Further, a temporary bog mat access road would be installed to allow for access during trenching and installation.

Line pipe joints would be transported by trucks to the pipeline construction ROW, where they would be laid out and welded into long pipe strings (up to ~800 metres). Pipe strings would then be either lifted or floated (dependent on location) into the excavated trench.

Float-in installation involves flooding the trench using water won from the surrounding environment, and pulling a prefabricated pipe string in a "floated" condition along the pre-excavated flooded trench. The water is then removed from the trench and the pipeline lowered as the water level drops. Water removed from the trench is discharged back to extraction source.

Once the pipeline is laid within the trench the trench would be backfilled with excavated trench spoil.

Following construction of the pipeline, a permanent ROW, three metres each side of the pipeline, would be maintained to avoid vegetation growth and allow access along the pipeline for monitoring purposes.

Horizontal directional drilling method

As noted previously, the in certain areas along the proposed CO_2 export pipeline route the pipeline may be installed using horizontal directional drilling (HDD).

In these areas an approximate 70 m x 40 m area would need to be cleared (within the Project footprint) at the commencement location of the HDD to allow for the HDD rig and mud recycling system. In order to stabilise the HDD rig, an anchor restraint would be installed, this may be achieved by either a concrete block or sheet piles. At the termination point of HDD (i.e. where the drill would exit). At its extremity the HDD would extend an approximately 25 m below the existing ground level.

Pits are required to excavated at both the HDD entry and exit points to:

- provide access to the drill

- allow for the drill pipe to be retrieved and pipe to be installed
- capture drilling fluids and excavated soil.

HDD is executed using a mix of water and bentonite clay as a drilling lubricant and stabilisation fluid. A pilot hole is drilling using a steerable drill head which is launched from the entry point and guided along a pre-designed drill path, using tracking and guidance systems to maintain depth and alignment. Once the pilot hole is complete, it is gradually enlarged using reamers to accommodate the desired pipe diameter.

Drilling mud and excavated soil, which is generated during HDD drilling, will be temporarily stored within HDD entry pit. Following completion of drilling this would be collected by vacuum truck and transported to an offsite location by a suitably licenced contractor.

Once the hole has reached the desired diameter, the pipe is attached to the drill string and pulled back through the drilled hole from the HDD exit point to the entry point. Once installed the HDD entry and exit pits are backfilled and the surface is restored to its original condition.

Pipeline tie-in stations installation

The following construction activities would be undertaken within the areas of the Ichthys CCS and Darwin LNG pipeline tie-in stations:

- surveying
- marking underground asset identification
- earthworks and foundations construction (including fill import and compaction)
- installation of assets, access roads and local site drainage.
- asset installation.

Following construction an area around the perimeter of the each of the pipeline tie-in stations would be left cleared of vegetation.

Supplementary power intake station and cabling installation

Supplementary power construction activities include:

- installation of an intake substation for connection to a third party external renewable power provider; and
- installation of power transmission cables from the substation to the Ichthys LNG facility; two circuits would be installed with each circuit comprising of three cables of single core 132 kilovolt cables with associated accessories.

The intake substation construction will involve the following:

- surveying
- earthworks and foundations construction (including fill import and compaction)
- installation of buildings and equipment
- construction of site service, drainage, roads, fencing etc

Following construction an area around the perimeter of the each of the pipeline tie-in stations would be left cleared of vegetation

The cable design and installation comprises the following:

- trenching to a depth of between two to three metres, or at greater depth for short sections where required to clear other buried services

- installation of buried pull pits, through which the cables would be later pulled.
- installation of power cables and fibre optic cables, including junction boxes
- trenches would be backfilled to grade using the spill soil from the excavation.

Cable routes would be clearly marked by the installation of signposts at regular intervals along the route, as well as locations such as changes in direction, duct banks, etc.

Road and utilities crossings

Road crossings

As outlined in Section 2.3.1 the CO_2 export pipeline crosses the Wickham Point Road at various locations along the pipeline route and the cabling associated with the supplementary power intake substation crosses the access road to the Ichthys LNG facility.

The construction method for crossing roads (including Wickham Point Road) will be by open cut where possible. A temporary bypass will be installed around the crossing points for roads that are required to maintain 100 per cent traffic flows at all times.

Alternatively, road crossings may be installed by trenchless techniques, such as micro-tunnelling thrust-bore. HDD may be used for installation of conduits for the associated cables.

Utility crossings and offsets

As outlined in Section 2.3.1 the CO_2 export pipeline crosses a number of existing utilities at various locations along the pipeline route. These include the APA pipeline, a PWC water pipeline and a Telstra cable.

The CO_2 export pipeline will generally be installed below other existing utilities. However, in scenarios where existing utilities are buried at a sufficient depth which allows for both the minimum pipeline depth of cover to be achieved and clearance between assets, then the pipeline may be installed above existing utilities. In all cases, the clearance between other utilities and the CO_2 export pipeline will be ≥300 millimetres.

In cases where the CO_2 export pipeline runs parallel to other utilities, a minimum offset distance would be established to enable safe working.

Acid sulphate soils management

The CO_2 export pipeline traverses' areas where acid sulphate soils (ASS) are likely to be encountered, including:

- mangrove habitat between Ichthys LNG facility entrance intersection and the Ichthys CCS pipeline tie-in station (approximately 1,200 metres length)
- salt mud flats with mangrove habitat between the Ichthys CCS pipeline tie-in station and Darwin LNG pipeline tie-in station (approximately 750 metres length).

In these areas, mass soil mixing for in situ ASS neutralisation is proposed (Refer to *Ground improvement activities*). This method was also used during the construction of the onshore component of the Ichthys GEP. Mass soil mixing would involve:

- soil improvement by injection in situ with a mix design consisting of cement and lime
- in situ neutralisation (partial or fully) by selection of the appropriate mix design.

In addition to mass soil mixing in key areas, ASS may be encountered in other areas along the pipeline route. The general ASS management approach proposed during construction would be:

- geochemical investigation of areas outside GEP corridor prior to commencing excavation, to quantify the potential ASS areas that require treatment
- treat in-situ in conjunction with earthworks, where suitable
- treat in a temporary designated ASS treatment area and disposal of treated material offsite
- an unexpected finds procedure for ASS would be included in the construction environment management plan (CEMP) as a precaution.

Drainage and dewatering

During the Project additional drainage and dewatering activities may be required to remove water within open excavations/trenches due to groundwater seepage or storm events, to ensure safe construction work.

Dewatering may involve relatively simple removal of small amounts of water at bottom of an excavation by diesel driven sludge pumps or flex drive pumps or may involve large volumes of water where the excavation/penetration is situated below the level of water table or during significant deluge events resulting in increased run-off. However, for large volumes of water, a de-watering system consisting of large diesel driven pumps may be required.

Several options are being considered for the management of construction wastewater (including wastewater generated from dewatering activities) during Project execution. These include, but are not limited, the following:

- transfer and discharge into approved locations specifically designed for dewatering of excavations
- transfer to a temporary holding pond (i.e. constructed of earth berm walls and a liner, which can be progressively moved)
- temporary onsite storage for offsite disposal by a suitably licenced contractor.

2.4.2 Commissioning

Commissioning is a series of dynamic and energised checks and tests that need to be carried out to demonstrate and ensure that the pipeline and associated equipment are ready to operate safely and steadily in compliance with Project specifications and standards, prior to the first treated CO_2 product being transported through the pipeline.

The commissioning scope covers:

- Pre-commissioning including pipeline cleaning, gauging, flooding, testing, dewatering, drying and preservation of the following infrastructure:
  - the CO_2 export pipeline and the Ichthys LNG facility CO_2 pipeline
  - the pipeline inlet stations located
  - the supplementary intake power substation and cabling.
- Commissioning and start-up of the following infrastructure:
  - the CO_2 export pipeline and the Ichthys LNG facility CO_2 pipeline
  - the supplementary intake power substation and cabling (cold-commissioning only)
  - Ichthys LNG facility upgraded AGRUs, CCES and supplementary power assets (hot-commissioning and start-up only)

Pre-commissioning

CO_2 export pipeline and Ichthys LNG facility internal CO_2 pipeline

Pre-commissioning activities will be undertaken for following pipeline infrastructure:

- the Ichthys CCS pipeline section
- the Ichthys CCS (Darwin LNG link) pipeline section
- Ichthys LNG facility CO_2 pipeline.

All pipeline infrastructure would be hydrostatic pressure tested (hydrotested) to test its integrity and verify that it is mechanically complete. The testing of the pipeline infrastructure would be undertaken using portable water, which may be chemically treated to prevent corrosion. An estimated volume of approximately 1,500 m^3 of portable water would be required during testing. The necessary test equipment (test spread) would be transported to site by road and removed following completion of testing.

For the purposes of hydrotesting the pipeline infrastructure would be tested as two sections. One section compromising the Ichthys CCS pipeline and Ichthys LNG facility CO_2 pipeline; the other section being the Ichthys CCS (Darwin LNG link) pipeline.

Hydrotesting of each section is anticipated to occur for a period of two hours (strength test), and a period of 24 hours (leak test), as per the requirements of Australian Standards (AS2885.5). Hydrotesting would be performed at a sufficient pressure to achieve the future maximum allowable operating pressure.

During completion activities small volumes of water may be incidentally discharged inside the Ichthys CCS pipeline tie-in station and the Darwin LNG pipeline tie-in station piping within the vicinity of the construction areas.

Following successful pressure and leak testing, the pipeline infrastructure would be dewatered, dried and preserved with dry nitrogen. Dewatering and drying would utilise temporary pigging facilities to displace and discharge approximately 1,000 m^3 of test water to Ichthys LNG facility and 500 m^3 of test water to Darwin LNG. Spent test water would be filtered and sampled for compliance prior to discharge at approved waste disposal locations (refer to options described in Section 2.5.1).

Internal walls would be dried using a combination of further pigging, dry air and vacuum generation equipment.

Once dry, residual oxygen content is reduced through purging with dry nitrogen. Nitrogen would remain within the pipeline at a nominal pressure as a preservation measure in preparation for commissioning and start-up.

Pipeline tie-in stations

Water or air cleaning may be used to remove debris and loose material within pipework of pipeline tie in stations. Follow initial cleaning activities, chemical cleaning using an acid solution to remove free iron and other contaminants from the surface may be undertaken.

Pipeline tie in station systems equipment and pipework would be hydrostatic pressure tested. The testing of the pipework and equipment would be undertaken using potable water as a test medium. Following hydrotesting the pipework will be dried using dry air or vacuum generation equipment.

Supplementary power intake substation and cabling

The installed substation equipment, including buildings and ancillary equipment would be tested and pre-commissioned to verify equipment integrity and completion and conformity of construction activities. Activities include pre- and post-installation checks on all civil and structural works, mechanical equipment, HVAC, instrumentation and control system equipment and cables, electrical equipment and cables. Specialised high voltage test equipment would be used for electrical testing.

The installed power transmission cables and ancillary equipment would be tested and pre-commissioned to verify equipment integrity and completion and conformity of construction activities. Activities include pre- and post-installation checks on all civil works, excavations, pits, compaction and reinstatement, communications and control cables, electrical cables and associated splices and link boxes. Specialised test equipment would be used for high voltage cable testing and optical time-domain testing of fibre optic cables.

Temporary/portable power generation would support the testing and pre-commissioning activities, including the energisation of support systems (lighting, HVAC, etc.).

No emissions or discharges are associated with pre-commissioning activities required for the supplementary power intake substation or cabling.

Hot commissioning of the supplementary power intake substation and power transmission circuits for green power import would be undertaken only once a third-party interface facility was connected, this is subject to separate approvals.

Commissioning and start-up

CO_2 export pipeline and Ichthys LNG facility internal CO_2 pipeline

Commissioning activities on the pipeline would commence with initial pressurisation with either nitrogen, imported dry CO_2, or CO_2 exported from Ichthys LNG facility. Pigging activities may be required to displace and vent preservation or start-up nitrogen.

Following initial commissioning, the pipeline would be gradually brought to operating pressure using CO_2 exported from Ichthys LNG facility via the CCES.

Export rates would be controlled to align with the start-up sequence and operational requirements of the downstream carbon sequestration system, with a gradual ramp-up to the full Ichthys LNG facility CO_2 export rate.

Pipeline tie-in stations

Pipeline tie in station systems would be initially pressured with nitrogen, imported dry CO_2, or CO_2 exported from Ichthys LNG facility through the CO_2 export pipeline.

Ichthys LNG facility AGRUs

Hot commissioning of the upgraded AGRUs would involve circulation of solvent through the new equipment to increase overall solvent rate and verify system safeguarding and functionality.

The system would be operated to match incoming feedstock rates within the design envelope.

Ichthys LNG facility CCES

Hot commissioning of the CCES would involve diverting CO_2 from the existing acid gas incinerators or hot vent system through the CCES equipment and infrastructure. This would initially be completed in full recycle to prove all control logic and safeguarding functionality.

Final testing of the CCES, including the verification of rotating equipment performance and operability, would require controlled venting of CO_2 at designated vent locations within Ichthys LNG facility. This would occur prior to the commencement of continuous CO_2 export via the pipeline.

Ichthys LNG facility supplementary power assets

Hot commissioning activities would be conducted to verify safe operability of installed Supplementary Power equipment within design envelopes. Hot commissioning at Ichthys LNG facility would comprise, but is not limited to, the following:

- Instrumentation and control system energisation and loop/function testing (power management system, power distribution control system, fire and gas detection system, safety instrumented system) including interfaces to existing Ichthys LNG facility systems.
- Electrical equipment energisation and function testing, including control and protection (switchgear, transformers, uninterruptible power supply, etc,) including tie-ins to existing Ichthys LNG facility electrical systems.
- Execution of operational test procedures for system functioning and operational testing, performance testing and the like.

Specialised test equipment would be used for high voltage equipment and cable testing and optical time-domain testing of fibre optic cables.

Temporary/portable power generation would support the testing and commissioning activities.

2.4.3 Operations

Key operational activities include:

- operations of the pipeline tie-in stations described in Section 2.3.1
- operations of the pipeline infrastructure described in Section 2.3.1 and Section 2.3.2
- operations the Ichthys LNG facility upgraded AGRUs, integrated CCES and internal CO_2 pipeline infrastructure described in Section 2.3.2
- inspection, maintenance and repair activities for all assets.

Ichthys LNG facility operations

During operations acid gases removed by the AGRUs would be sent to a CCES where the CO_2 would be compressed, prior to being sent to a common dehydration unit where water vapour would be removed to achieve the CO_2 pipeline entry specification. Following dehydration, the gas is directed back to the compressor for further compression (high-pressure). The treated CO_2 (i.e. compressed/dehydrated) would then be metered and transported from the Ichthys LNG facility via the internal facility pipeline to the Ichthys CCS pipeline before being transferred to third-party infrastructure and directed to an offshore storage site for sequestration.

An overview of the Ichthys LNG facility CCES and the interface with the AGRU systems is shown in Figure 2-10.

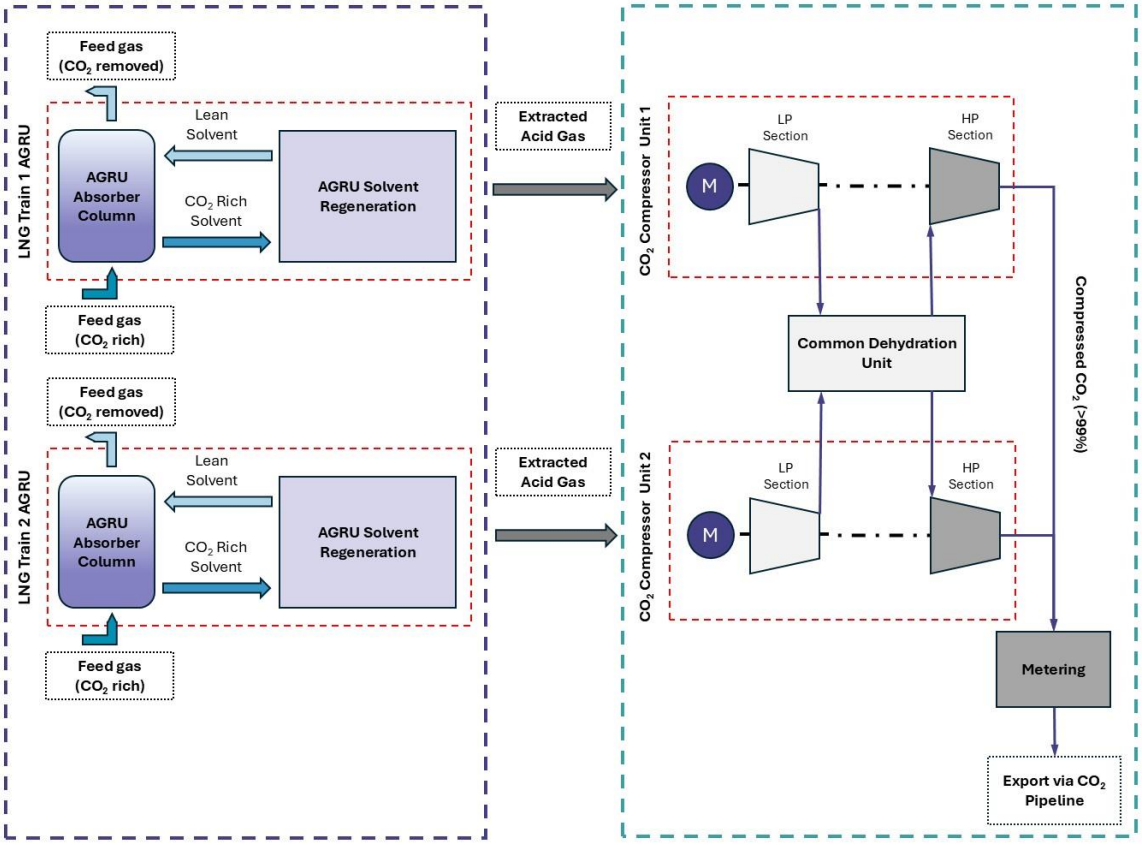


Figure 2-10: Overview of Ichthys LNG facility CCES infrastructure (the blue dashed line indicates existing/upgraded AGRU infrastructure; the green dashed line indicates the new CCES infrastructure)

Acid gas incinerators cessation of operations

The current function of the Ichthys LNG facility acid gas incinerators is to oxidise trace amounts of benzene, toluene, ethylbenzene, and xylene (BTEX) and H_2S contained in the CO_2 stream received from the AGRU's. Once the CCES system is operational, the acid gas incinerators would no longer be required as this CO_2 stream (including all contaminants) would be diverted to the CCES and transported via pipeline to an offshore storage site for sequestration. The acid gas incinerators would be removed from operational service once the CCS system is performing as planned.

Physical removal of the AGI infrastructure would occur during decommissioning of the Project infrastructure at the end of Project life (refer Section 2.4.4).

Operational venting

During operations venting of CO_2 would be required in the following scenarios:

- During launch and receipt of pigs. Pigging is premised for inspection purposes and if there is an upset condition. The volume of release would be equivalent to the volume of the pig trap. There would be no operational pigging.
- For pressure safety valve relief as part of the CCES system process safeguarding.
- During a CCES system blowdown associated with either a CCES unit shutdown or planned maintenance, where the venting quantity is relatively small, due to either it being a short-term event, limited to constrained source volumes, or the rate is relatively small.

- When the CCES is not operating, or is operating at reduced capacity, then any CO_2 produced that exceeds the CCES capacity at the time would continue to be vented via the existing hot vents associated with either LNG Train 1 or Train 2.

Note, venting arrangements and frequency are still being investigated and quantified. Preliminary operational venting volume estimates are described in Section 2.5.2.

Pipeline tie-in stations and CO_2 export pipeline

The pipeline tie-in stations are a normally unattended location which are controlled remotely from the Ichthys LNG facility. Routine activities that would occur at the tie-in stations and along the CO_2 export pipeline include ROW patrols, vegetation clearing, cathodic protection monitoring and other inspection, monitoring, maintenance and repair (IMMR) activities.

Planned and unplanned shutdown

In the event of a planned or unplanned shut down event, in line with INPEX operation procedure, the Ichthys CCS CO_2 pipelines would be shut in and remain pressurised. Any shutdown events and associated activities would be coordinated between Ichthys CCS and the third-party CO_2 export pipeline Project.

Emergency scenarios/ upset condition scenarios

A number of unlikely potential upset condition and emergency scenarios could occur for the Project. An overview of these scenarios, including principal responses and responsibilities is outlined in Table 2-3. Detailed Emergency scenario/ upset condition management measures would be developed as part of the Project approvals. Any shutdown events and associated activities would be coordinated between INPEX and the third-party CCS project operators.

Table 2-3: Potential upset conditions and emergency scenarios

Scenario	Response	Responsibility
Production of off-spec CO_2	Shutdown export of CO_2 to the Ichthys CCS CO_2 pipeline and diverting AGRU off-gas to vent(s).	Cease off-spec CO_2 export from the Ichthys CCS CO_2 pipeline and third-party CO_2 transport pipeline. Export would be restrained until the exporting party can confirm the export specification is restored.
Blowdown venting / de-inventory of CO_2 from Ichthys CCS CO_2 pipeline (only)	Operation of the vent(s) within Ichthys LNG facility and emissions.	If only blowdown of onshore CO_2 pipeline is required, then it is an activity performed by INPEX via Ichthys LNG facility only. Ichthys LNG facility and third-party exporters are responsible to shut-in CO_2 export at respective facilities.

Scenario	Response	Responsibility
Blowdown venting / de-inventory of CO_2 from third party CO_2 transport pipeline and Onshore CO_2 pipeline	Operation of the vent(s) within Ichthys LNG facility and emissions.	Ichthys LNG facility and third-party exporters are responsible to shut-in CO_2 export at respective facilities. If blowdown of third-party CO_2 transport pipeline is required, then it is a combined activity from the third-party CO_2 export pipeline Project and INPEX to vent inventory of CCS system back to Ichthys LNG facility vent point.
Equipment / pipeline infrastructure damage, leak or rupture	Blowdown of system would be as per above blowdown venting line item. Damage repair / replacement responsibility as per standard operation procedures.	INPEX will blow-down what can be safely disposed of at the Ichthys LNG facility.

2.4.4 Decommissioning

Upon completion of Project operations, the Project (including the Ichthys LNG CCES components) would be decommissioned in line with then applicable regulatory requirements and best practice.

INPEX's principal approach to decommissioning would be to remove all Project infrastructure as far as reasonably practicable. This approach would be balanced with considerations to potential environmental impacts of removal, when compared to leaving particularly below ground infrastructure in situ. As such some below ground infrastructure, after safeguarding, may remain in-situ.

Principal decommissioning activities include:

- decommissioning of all Ichthys CCS and Ichthys LNG CCES facilities
- removal of all above ground infrastructure
- removal of below ground infrastructure, where practicable
- safeguarding and leaving below ground infrastructure in-situ, where necessary.

2.5 Waste, discharges and emissions

2.5.1 Waste

Waste management

INPEX anticipates a number of wastes, emissions and discharges, as part of the Project. These would be managed in line with the INPEX waste control hierarchy (Figure 2 8) to ensure the sustainable management of waste generated during the Project.

The hierarchy entails the following practices (in order of preference):

1. Avoid - modify design and construction practices so that waste is not generated. Waste prevention is achieved through the consideration of alternative products, the implementation of alternative technologies, engagement of companies that

encourage sustainable waste management practices, and the procurement of prefabricated materials

2. Reduce - generate less waste by better management and by material substitution or choose the least hazardous chemicals (if not cost prohibitive) fit for purpose. Waste minimisation is typically applied in the procurement stage (i.e. the tendering and contracting process) and aims to reduce consumption of resources by minimising the amount of packaging material purchased and by increasing demand for recycled content.
3. Reuse, recycle and/or recover - reuse item in its original form, or recycle or reprocess the item to incorporate it into a new product or new use, or extract materials or energy from a waste material or item. Reuse is achieved initially by identifying reuse opportunities and subsequently through identifying the market demand for various waste items. To maximise reuse opportunities, wastes are segregated according to type. Recycling represents an important component of the waste management strategy, and wastes are segregated to enable recycling.
4. Treat - mitigate the hazard of the waste by destruction, detoxification, neutralisation, etc. Waste treatment aims to mitigate hazards posed by the waste through means such as destruction, detoxification or neutralisation of residues through processing.
5. Dispose - remove the waste to an approved location such as a landfill site or disposal facility. Waste is disposed of to landfill where no other practical option is available.

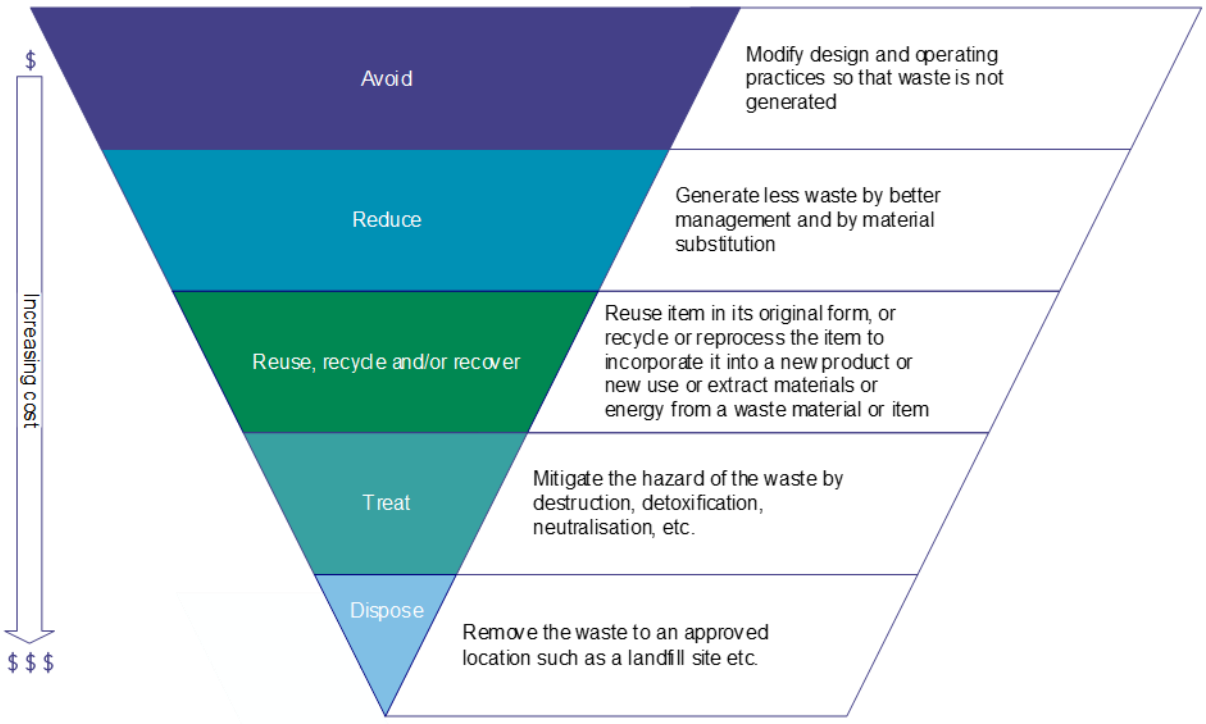


Figure 2-11: Waste control hierarchy

Waste streams

Solid non-hazardous and hazardous waste

The waste streams expected to be generated during the Project can be categorised into four broad categories:

- recyclable (non-hazardous) waste: where cost effective recyclable opportunities can be achieved, recyclable non-hazardous wastes are segregated from other water types and sent to appropriate recycling facilities.
- non-recyclable (non-hazardous) waste: all non-recyclable, non-hazardous waste can be disposed at licensed facilities in the Northern Territory. These wastes are segregated and transferred to a licensed waste contractor for disposal at a licensed landfill waste facility.
- recyclable (hazardous) waste: these wastes are handled and treated as a hazardous waste and are segregated from non-hazardous wastes. Where cost effective recyclable opportunities can be achieved, recyclable hazardous waste are transferred to a licensed waste contractor for treatment and recycling at a licensed waste facility.
- non-recyclable (hazardous) waste: these waste streams are typically sent to appropriately classed landfills, or for high temperature incineration. Non-recyclable hazardous wastes are segregated and transferred to a licensed waste contractor for treatment to comply with threshold criteria for acceptance to landfill at a licensed waste facility, or for direct disposal to a licensed waste facility.

Types of waste that may be generated include but are not limited to, scrap sections of redundant equipment, packing and preservation materials used to protect equipment during transportation to site, wood pelleting, soft plastics, cardboard, garnet/sand blasting wastes, spent chemicals and food refuse.

All waste would be segregated and removed from site by a licenced waste contractor to be recycled or disposed of locally.

Listed wastes

"Listed" wastes are those waste streams classified under Schedule 2 of the Waste Management and Pollution Control (Administration) Regulations (NT). Listed (controlled) wastes are subject to special monitoring and reporting requirements and can only be disposed of at licensed landfill sites or sent for treatment or destruction.

Construction, pre-commissioning wastewater

Wastewater would be generated throughout the construction and pre-commissioning phase of the Project. Wastewater generated during Project activities may be treated (e.g. neutralised) on site prior to disposal. All wastewaters would be tested to determine the appropriate disposal option.

Several options are being considered for the management of wastewater generated during Project activities (i.e. construction, pre-, cold-commissioning). These include, but are not limited to, the following:

- transfer to the existing Ichthys LNG facility evaporation basin (where seasonal conditions permit) for concentration prior to offsite disposal of the resulting liquor by a suitably licenced contractor
- discharge via temporary outfall at the Ichthys LNG facility materials offloading facility (MOF) (subject to issuance of a waste discharge licence under the Northern Territory *Water Act 1992*) or other approved temporary locations
- temporary onsite storage for treatment (as required), transport and disposal by a suitably licenced contractor (subject to testing to determine the appropriate disposal method).

Black/grey wastewater associated with temporary ablution blocks, would be collected and disposed of offsite via suitability licenced contractor.

Summary of wastes and wastewater discharges

A summary of estimated quantities/volumes of wastes and wastewater associated with the Project construction and commissioning activities which may require disposal are presented in Table 2-4. A summary of estimated quantities/volumes of wastes, emissions and discharges associated with the operation phase of the Project which may require disposal are presented in Table 2-5.

Table 2-4: Summary of construction and commissioning wastes and wastewater discharges

Waste or wastewater	Activity	Disposal options	Estimated quantities
Spoil	Civil construction - Earthworks	• Re-use of spoil where it meets appropriate re-purpose requirements. • Offsite disposal	5,000 m^3
Spoil (treated/neutralised ASS/PASS)	Civil construction - Earthworks	• Onsite treatment prior to offsite disposal	1,000 m^3
Hydrotest water	Pre-commissioning	• Ichthys LNG evaporation basin. • Discharge at temporary outfall at the Ichthys LNG module offloading facility. • Offsite disposal	1,500 m^3
Pump, vessels and pipework system testing	Commissioning	• Offsite disposal	200 m^3
Black/grey water	Throughout the execution of the Project	• Offsite disposal	20,000 m^3
Solid waste – hazardous (recyclable and non-recyclable)	Throughout the execution of the Project	• Offsite disposal	5,000 m^3
Solid waste – non-hazardous (recyclable and non-recyclable)	Throughout the execution of the Project	• Offsite disposal	10,000 m^3

Table 2-5: Summary of operational wastes and wastewater discharges

Waste or wastewater	Activity	Disposal options	Estimated quantities
Black/grey water	Throughout the operation of the Project	• Offsite disposal	1,000 m^3
Solid waste – hazardous (recyclable and non-recyclable)	Throughout the operation of the Project	• Offsite disposal	1,000 m^3
Solid waste – non-hazardous (recyclable and non-recyclable)	Throughout the operation of the Project	• Offsite disposal	2,000 m^3
Liquid waste – hazardous (non-recyclable)	During major maintenance (every 8 years)	• Offsite disposal	65 m^3
Solid waste – hazardous (non-recyclable)	During major maintenance (every 8 years)	• Offsite disposal	10 m^3

2.5.2 Emissions

Construction and commissioning

Dust and particulates would be generated, as result of:

- civil construction activities (earthworks, trenching and stockpiling of spoil)
- operations of concrete batching plants
- operation of diesel-powered generators to support temporary office/laydown areas and specialist temporary equipment spreads
- operation of vehicles and machinery
- air blowing of new pipework and equipment.

During commissioning testing activities inert gases (e.g. nitrogen and helium) may be used as a test medium. During these activities such gases would be released to atmosphere.

Operations

During operations venting of CO_2 would be required in the following scenarios:

- During launch and receipt of pigs. Pigging is premised for inspection purposes and if there is an upset condition. The volume of release would be equivalent to the volume of the pig trap. There would be no operational pigging.
- For pressure safety valve relief as part of the CCES system process safeguarding.
- During CCES system blowdown associated with either a CCES unit shutdown or planned maintenance, where the venting quantity is relatively small, due to either it being a short-term event, limited to constrained source volumes, or the rate is relatively small.

- When the CCES is not operating, or is operating at reduced capacity, then any AGRU off-gas that exceeds the CCES capacity at the time would continue to be vented via the existing hot vents associated with either LNG Train 1 or Train 2.

CO_2 export pipeline and Ichthys LNG facility CO_2 pipeline venting

As described in Section 2.3, the Ichthys LNG facility CO_2 pipeline, Ichthys CCS pipeline tie-in station and Darwin LNG pipeline tie-in station have associated pig launchers and receivers to facilitate maintenance of the pipeline sections. Localised vents associated with the pig traps which would be used to vent CO_2 to atmosphere following launch and receipt of pigs. The volume released would be equivalent to the pig trap volume (approximately. 1.5 m^3). Pigging is premised for inspection purposes and if there is an upset condition. There would be no operational pigging.

These emissions from occasional venting during the operational phase from launch and receipt of pigs (for inspection purposes or during upset conditions) are considered to be negligible in quantity compared to the volume of CO_2 that would be sequestered once operation commences.

Ichthys LNG facility venting

During operations, CO_2 emissions from the AGRUs would be directed to the CCES for treatment and processing prior to transport and sequestration at an offshore storage location. However, there will be occasions when CO_2 is unable to be exported and in these circumstances the CO_2 stream would be required to be vented. A conservative estimate of CO_2 volumes for all likely venting scenarios has been undertaken and is presented in Figure 2-12. Note, the operational lifespan of the Project is approximately 30 years and extends beyond 2042 projection presented in Figure 2-12.

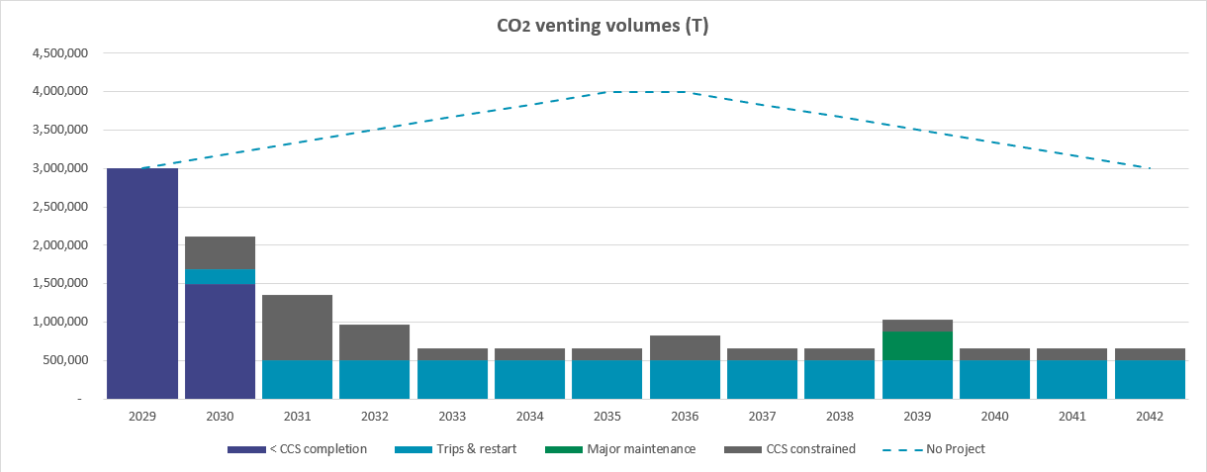


Figure 2-12: Estimated volumes of CO_2 to operationally vented during operations

Venting would be required, if the CCES is not operating, or is operating at reduced capacity, where any AGRU off gas CO_2 that exceeds the CCES capacity at the time would continue to be vented via the existing vents associated with either LNG Train 1 or Train 2. These venting estimates are summarised as follows:

- Operating venting from trips and system events that prevent CCES export that effect either one or both CCES compressor units have been estimated to occur throughout the operational period. Each single or double unit shut down has been estimated to take 2.5 days to resolve. This is estimated to total to an equivalent to 40 days system downtime over the year resulting in up to 505,000 T/yr of venting.

- During the initial years of operation (2030 to mid-2032) the lack of power firming from renewable power import is estimated to affect the reliability of the Ichthys LNG facility power system, which results in either of the CCES units being unable to be run. A conservative estimate for the range of impact is between 60 mmscfd to 120 mmscfd for a period of 35 per cent of each affected year (equivalent to up to 760,000 T/yr).
- An estimate of up to 150,000 tonnes has been assumed for other occasions where the CCES cannot export, which includes issues with the availability of the third-party CO_2 injection system.
- An estimate of up to 240,000 tonnes has also been assumed for the scenario where the AGRU emissions peak exceeds the capacity of the CCES system. This is estimated to occur for a period of one year in ~2036 resulting in up to five per cent of capacity for one year (i.e. 12 mmscfd for the affected year) unable to be exported.
- Major maintenance of the CCES system is expected to occur after every eight years of operation. During this time AGRU off gas would be vented as required during the 30-day maintenance outages for each CCES unit. Up to 380,000 tonnes have been estimated per event.

Small volumes of CO_2 (less than 3,000 T/yr) from compressor/dehydration blowdowns, analyser metering, seal vents, dehydration/metering start up and pressure safety valve (PSV) relief events would be directed to dedicated cold vents.

In an event of an emergency, venting of the pipelines may be required to affect a pipeline repair. The following volumes are estimated to be released on this rare event:

- the Ichthys CCS pipeline = 890 m^3
- the Ichthys CCS (Darwin LNG link) pipeline = 360 m^3.

It is noted that the CO_2 stream composition is >99.5 percent CO_2, with the remaining portion made up of trace amounts of incidental gases including benzene, toluene, ethylbenzene, and xylene (BTEX) and H_2S.

2.6 Alternatives

2.6.1 Bayu-Undan CCS Project CO_2 storage option

The Project considers an alternative scenario where the proposed Santos operated Bayu-Undan CCS Project would be used as the storage option for captured CO_2 from the Ichthys LNG facility. Table 2-6, outlines the changes to the base-case design and infrastructure, if this alternative was pursued.

Table 2-6: Changes to base-case design

Aspect/asset	Change to base-case design
CO_2 export pipeline	The CO_2 export pipeline route would not change. While more direct routes have been considered the base-case pipeline route remains the most suitable due to: • existing infrastructure corridors and access • limited clearing requirements • pipeline constructability and reduced interactions with acid sulphate soils. The Ichthys CSS pipeline tie-in station separating the two independent sections of pipeline (i.e. Ichthys CCS and Ichthys CCS (Darwin LNG link) sections).

Aspect/asset	Change to base-case design
	The Ichthys CCS (Darwin LNG link) pipeline section is being designed to allow for the flow of CO_2 in both directions. No other changes to the design are required.
Ichthys CCS pipeline tie-in station	Infrastructure would still be required within the pipeline Ichthys CCS pipeline tie-in station area, including pigging facilities. However, the infrastructure requirements would not be to the extent presented in Section 2.3.
Darwin LNG pipeline tie-in station	The Darwin LNG pipeline tie-in station is being designed to accommodate both the receival and export of CO_2 from the Ichthys CCS (Darwin LNG link) pipeline. No other changes to the design or proposed infrastructure are required.
Project area and disturbance footprint	No change to the Project area or Project footprint; although, the Project footprint may decrease marginally within certain areas.

2.6.2 Power infrastructure

As noted in Section 2.3.1, alternative option for sourcing of electrical power required for the operations of Ichthys CCS pipeline tie-in and Darwin LNG tie-in stations and CO_2 export pipeline is being investigated.

The alternative would involve sourcing power from the existing Power and Water Corporation overhead power network that is local to the Ichthys CCS pipeline tie-in and Darwin LNG tie-in stations; negating the need for installation of power cabling between these areas.

2.6.3 Supplementary power intake substation location

As noted in Sections 2.2.1 and 2.3.1, the location of the supplementary power intake substation on land within Section 1888 has been identified as the preferred location for the supplementary power intake substation. Whilst the location within Section 1888 is preferred, alternative locations in comparable land areas are still being considered. The final location would be in proximity to the Ichthys LNG facility and be determined following design and assessment of comparable land areas.

3 RELEVANT LEGISLATION

The relevant Commonwealth and Northern Territory legislation applicable to the Project is described in Table 3-1 and Table 3-2 respectively.

Table 3-1: Summary of relevant Commonwealth legislation

Legislation	Relevance to the Project
Biosecurity Act 2015	The *Biosecurity Act 2015* manages biosecurity risks in Australia, in particular diseases and pests that may cause harm to human, animal or plant health or the environment. This Act sets out requirements on goods, aircraft, and vessels from overseas that enter Australian territory and implements the Ballast Water Convention, regulating ballast water of certain vessels.
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	The EPBC Act provides for the protection and management of nationally and internationally important flora, fauna, ecological communities, and heritage places. Matters of National Environmental Significance (MNES) are protected under Part 3 of the Act and projects require approval under the Act if they are likely to result in a significant impact on MNES. While INPEX does not believe the Project will have a significant impact on MNES, a referral will be submitted to DCCEEW to determine whether formal assessment is required.
National Greenhouse Gas and Energy Reporting Act 2007 (NGER Act)	The NGER Act establishes a national framework mandating corporations meeting specific thresholds to report their greenhouse gas emissions, energy production and energy consumption.
National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015	The safeguard mechanism (SGM) is a Commonwealth Government mechanism for reducing emissions at industrial facilities. It sets legislated limits—known as baselines—on the greenhouse gas emissions of these facilities. According to information published by the Clean Energy Regulator (regulator for the SGM), these baselines will decline, predictably and gradually, on a trajectory consistent with achieving Australia's emission reduction targets of 43% below 2005 levels by 2030 and net zero by 2050.

Table 3-2: Summary of relevant Northern Territory legislation

Legislation	Relevance to the Project
Dangerous Goods Act 1998 and Dangerous Goods Regulations 2017	The *Dangerous Goods Act 1998* is aimed at protecting the safety, health, and welfare of people and the environment. The Act establishes duties for the safe handling, storage, and transport of dangerous goods, outlines the responsibilities of manufacturers, handlers, and transporters. The associated Dangerous Goods Regulations 2017 complement the Act by providing detailed requirements for the classification, packaging, labelling, and transport of dangerous goods.

Legislation	Relevance to the Project
Energy Pipelines Act 1981	The *Energy Pipelines Act 1981* regulates the construction, operation, and maintenance of pipelines used for conveying hydrocarbons for energy production. The Act outlines requirements for permits, licenses, and registration, as well as standards for construction, operation, and maintenance. Whilst the Act does not currently regulate CO_2 pipelines. The Northern Territory Department of Mines and Energy have advised INPEX that amendments to the Act are being proposed to address this gap and that relevant licence and standards would apply to the proposed CO_2 export pipeline.
Environment Protection Act 2019	The Act aims to promote ecological sustainable development, manage significant disturbances through an environmental approval process, provide for broader community involvement and recognise the importance of participation of Aboriginal people and communities in environmental decisions. Under the Act, the Northern Territory Environment Protection Authority (NT EPA) regulates the environment impact assessment process to identify potential environmental impacts of development proposals. Pre-referral screening determined the Project has the potential to impact on ten environmental factors (refer to Appendix A). As such, the Project is being referred to the NT EPA to determine whether formal assessment is required.
Heritage Act 2011	The Act provides for the conservation of the Northern Territory's cultural and natural heritage. All Aboriginal or Macassan archaeological places or objects are automatically declared heritage places or objects under the Act. Other places or objects can be nominated, and if accepted, can be declared heritage places or objects under the Act. A works approval is required to carry out work on a heritage place or object.
Northern Territory Aboriginal Sacred Sites Act 1989	The Act provides protection from unauthorised entry or damage to all sacred sites in the Northern Territory. Under the Act those wishing to undertake works on land or sea are required to obtain an Authority Certificate. Authority Certificates are a legal document that protects sacred sites from damage by setting out the conditions for carrying out specific works on an area of land and/or sea. INPEX has been issued with relevant AAPA certificates that cover Project area and proposed activities (refer to Section 4.3.3)
Planning Act 1999	The following permits may be required for the Project: • Land clearing permit - required for any native vegetation clearing in the Northern Territory on zoned and unzoned land more than one hectare in aggregate land (including any area already cleared of native vegetation). • Development permit (planning permit) – required if a building type or land use requires consent under the Northern Territory Planning Scheme 2020.

Legislation	Relevance to the Project
Territory Parks and Wildlife Conservation Act 1976 (TPWC Act)	The Act forms a framework for the establishment and management of parks and reserves and declaration of protected wildlife. Assessment is required to confirm whether listed threated flora and fauna species are likely to be impacted by the Project and a permit may be required to take or interfere with protected wildlife.
Waste Management and Pollution Control Act 1998 (WMPC Act) and Waste Management and Pollution Control (Administration) Regulations 1998	The Act provides for the protection, and where practicable the restoration and enhancement of the quality of, the Territory environment. Specifically, by preventing pollution, reducing the likelihood of pollution occurring, effectively responding to pollution, avoiding and reducing the generation of waste, increasing the re-use and recycling of waste, and effectively managing waste disposal. It also to encourages ecologically sustainable development and facilitates the implementation of national environment protection measures. Schedule 2 of Act outlines activities that require an approval or licence under the Act, which requires approvals and licences for activities that relate to processing of hydrocarbons to produce, store and/or despatch liquefied natural gas or methanol. INPEX will engage with the NT EPA on the requirement for approvals under the WMPC Act for construction activities associated with the Project. Waste management during the Project will be incompliance with the requirements of the Act.
Water Act 1992	The Act Provides for the investigation, allocation, use, control, protection, management and administration of water resources, including extraction of ground water, wastewater management and water pollution. Under the Act waste discharge licences are required where an activity could affect a declared beneficial use of a water resource. A waste discharge licence may be required if wastewater associated with commissioning activities is required to be discharged to Darwin Harbour.
Weeds Management Act 2001	The Act allows for the declaration of weeds into classifications for the purposes of preventing a plant entering into, or managing the plant in, the Territory or a part of the Territory. The Act provides for statutory weed management plans, which prescribe management actions for high priority weeds. The Act also gives powers to authorised officers, including the power to order certain activities in relation to declared weeds.

4 EXISTING ENVIRONMENT

The following sections describe the existing and surrounding environment relative to Project area.

An EPBC Protected Matters Search Tool (PMST) report was generated on the 12 May 2025 with a 20 km buffer surrounding the Project area to determine the presence of MNES within or adjacent to the Project area (refer Appendix A). A summary of the of the MNES relevant to the Project is presented in Table 4-1; with further information provided in subsequent sections as applicable.

Table 4-1: Summary of MNES identified to be of relevance to the Project area

Matter of national environmental significance	Relevance	Summary statement
World heritage properties	Not relevant	There are no world heritage properties within or adjacent to the Project area.
National heritage places	Not relevant	There are no National heritage places within or adjacent to the Project area.
Wetlands of international importance (Ramsar wetlands*)	Not relevant	There are no wetlands of international importance within or adjacent to the Project area.
Listed threatened ecological communities	Not relevant	There are no listed threatened ecological communities within or adjacent to the Project area.
Listed threatened species	Relevant	56† listed threatened species were known or likely to occur within the vicinity of the Project area. The likelihood of occurrence of these threatened species has been further assessed in Section 4.2.3 and Appendix B.
Listed migratory species	Relevant	71† listed migratory species were known or likely to occur within the vicinity of the Project area. The likelihood of occurrence of these migratory species has been further assessed in Section 4.2.3 and Appendix B.
Commonwealth marine areas	Not relevant	The Project is not located in or adjacent to any Commonwealth marine areas.
Great Barrier Reef Marine Park	Not relevant	The Project is not located in or adjacent to the Great Barrier Reef Marine Park.
Nuclear actions (including uranium mining)	Not relevant	The Project is not a nuclear action.

Matter of national environmental significance	Relevance	Summary statement
A water resource in relation to coal seam gas development and large coal mining development	Not relevant	The Project is not a coal seam gas development or large coal mining development requiring use of water resource.

* Internationally recognised wetlands of ecological significance, listed under the Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat.

† 28 of the listed species were both threatened and migratory

4.1 Physical environment

4.1.1 Climate and meteorology

The Project area lies in the monsoonal tropics of northern Australia, which has two distinct seasons - a hot wet season from November to April and a warm dry season from May to October. April and October are transitional months between the wet and dry seasons. Darwin has a mean annual rainfall of 1,724 millimetres, with rain falling on an average of 113 days (mainly in the wet season). The mean annual evaporation rate is 2,444 millimetres. The average monthly conditions for Darwin are presented in Table 4-2 (BOM 2022).

During the wet season, which has an official start date of 1 November each year, prevailing winds are westerly and west-north-westerly. Winds in the dry season, which has an official start date of 1 May each year, vary from south-easterly to northerly. Wind roses for Darwin are shown in Figure 4-1.

The area is subject to tropical low-pressure systems and cyclones, particularly from November to April. Tropical cyclones bring strong winds, heavy/squally rainfall, local flooding and storm surges.

Table 4-2: Average monthly weather conditions for Darwin (BOM 2022)

Month	Average maximum temperature (°C)	Average minimum temperature (°C)	Average monthly rainfall (mm)	Average relative humidity (9 am; %)	Average relative humidity (3 pm; %)
January	31.8	24.9	431.3	81	70
February	31.5	24.8	369.0	83	72
March	32.0	24.6	310.8	82	67
April	32.8	24.1	101.7	74	52
May	32.1	22.2	20.4	65	43
June	30.7	20.0	1.8	60	38
July	30.7	19.3	1.1	60	37
August	31.5	20.3	4.6	64	40

Month	Average maximum temperature (°C)	Average minimum temperature (°C)	Average monthly rainfall (mm)	Average relative humidity (9 am; %)	Average relative humidity (3 pm; %)
September	32.7	23.0	16.5	68	47
October	33.3	24.9	71.2	69	52
November	33.4	25.3	143.2	72	58
December	32.7	25.3	252.0	76	65

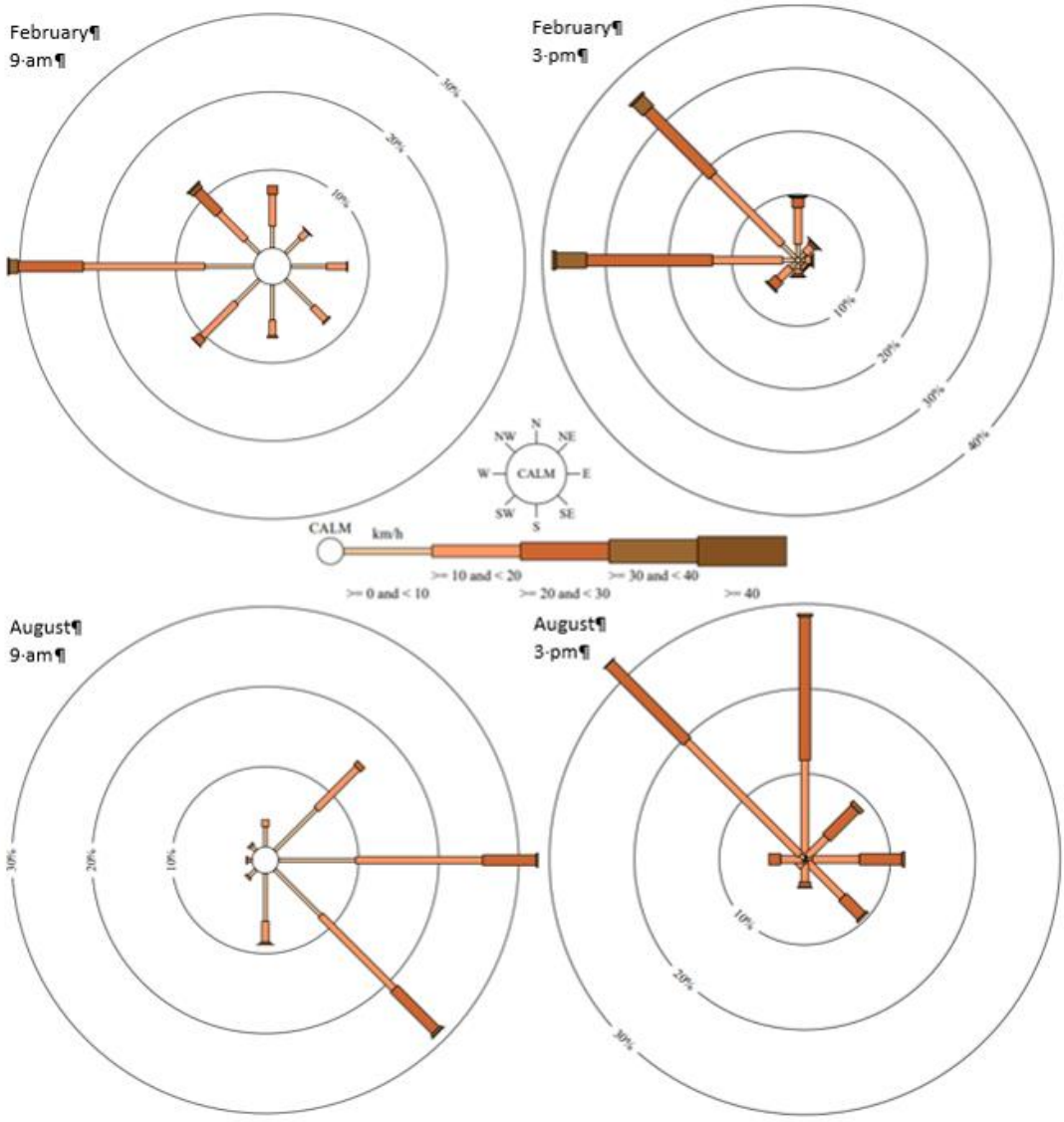


Figure 4-1: Wet season (February) and dry season (August) indicative wind roses for the Darwin area (BOM 2022)

4.1.2 Noise

Given the location of Ichthys LNG on Bladin Point, there are limited off-site noise sensitive receptors in proximity to the facility. Nonetheless, as part of good industry practice, noise has been monitored and assessed during the Project planning, construction and operation phases.

Ambient noise levels were measured prior to construction of Ichthys LNG at O'Farrell's Road, Bayview Haven and Constance Court, Palmerston (SVT Engineering Consultants 2009). During construction, continuous airborne noise monitoring was undertaken at Ichthys LNG site as well as at Palmerston. Minor noise exceedances were recorded in Palmerston; however, none were considered to be attributable to the construction project (URS 2013; AEC Environmental 2014 2015). The ambient and construction noise level measurements provided a baseline for the operational phase of the Ichthys LNG facility. Noise monitoring undertaken during operations has confirmed measured noise levels at Ichthys LNG facility boundary is within the recommended noise limits (70dB(A)) for industrial premises (NT EPA 2018).

4.1.3 Air quality

Ambient air quality in the Darwin airshed is influenced by several sources, including biogenic sources (soil, natural and agricultural vegetation), smoke from bushfires, vehicles and industrial sources. Generally, the concentrations of nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and photochemical oxidants (as measured by ozone, O_3) in the Darwin airshed are relatively low. Particulate levels in the Darwin airshed vary seasonally due to annual backburning and bushfires; the 2024 Darwin Harbour Integrated Report Card (DHIRC 2024) reported that 94 per cent of days in the wet season were below the $PM_{2.5}$ good air quality indicator, compared to only 39 per cent of days in the dry season.

The nearest sensitive receptors for air quality impacts from the Project area are the residential areas of Palmerston. The Ambient Air Quality National Environment Protection Measure (Air NEPM) specifies maximum acceptable ground-level concentrations for a range of common parameters relevant to airsheds across Australia. Of these, the parameters relevant to Ichthys LNG context in Darwin are NO_2, O_3, SO_2 and particulates (measured as $PM_{2.5}$ and PM_{10}). A cumulative air quality assessment was undertaken for the Draft EIS in 2010 (Sinclair Knight Merz 2010) and updated to incorporate revised plant configuration in 2014 (Pacific Environment 2014).

The 2010 air quality assessment included establishment of the background air quality using air emissions from biogenic sources (soil and vegetation), vehicles, shipping traffic and industrial sources already present on Middle Arm Peninsula prior to construction of Ichthys LNG facility (i.e. ConocoPhillips Darwin LNG facility, Channel Island power station and Weddell power station) (Sinclair Knight Merz 2010). The background air quality was found to be good; the maximum ground level pollutant concentrations for NO_2 (1 hr average), O_3 (1 hr average), SO_2 (1 hr average) and PM_{10} (1 day average) were found to be 27 per cent, 20 per cent, 12 per cent and 22 per cent of the Air NEPM criteria, respectively. Ambient air quality monitoring completed for compliance against the Ichthys LNG facility environmental protection licence, has primarily detected seasonal exceedances of Air NEPM criteria for particulates, related to planned and unplanned burning activities. No exceedance of Air NEPM at receptors has been attributed to Ichthys LNG facility operations.

4.1.4 Hydrology and hydrogeology

The Project area is generally flat and varies only 10 m in topography. After rainfall, the majority of surface water will flow into either the adjacent creeks (Lightning, Cossack or Jones creeks) Elizabeth River that feed in Darwin Harbour or directly into Darwin Harbour.

Groundwater levels are generally shallow, with recharge mainly occurring by rainfall infiltration during the wet season. A semi-confined aquifer in the clayey sand/gravel horizons of the Darwin Formation generally follows the topography of the Project area with the lowest levels located near the coast. The groundwater levels in this aquifer fluctuate seasonally between 0.5 and 5 metres and are also influenced by the Darwin Harbour tides in coastal areas. Groundwater level contours indicate that groundwater flows radially from the central part of Ichthys LNG site towards low lying area typically inundated by tides (AEC Environmental 2015). The construction of the Ichthys LNG facility has altered the topography of Bladin Point and the recharge of groundwater through decreased permeability associated with compacted soil and fill, sealed surfaces and storm water drainage system. Ongoing groundwater monitoring throughout operations has measured both increases and decreases in seasonal groundwater levels compared to the baseline (AECOM 2024).

Groundwater quality

Aquifers in the Darwin Formation are typically acidic to neutral, with a pH ranging from 4.1 to 7.6 (Radke et al. 1998). Sampling of groundwater at the Ichthys LNG site prior to construction recorded fresh to saline water with pH levels of 4.6 to 6.4. The natural acidity of groundwater reflects the natural acidic soils found within the Project area. Reported concentrations of aluminium, arsenic, cadmium, copper, manganese, nickel and zinc were higher than ANZG (2018) trigger values prior to commencement of construction. Reported concentrations are a likely result of historic groundwater interaction at different depths within the aquifer with soil stratigraphy for some time under acidic conditions resulting in metal mobilisation. Nutrients have likely been released into the uppermost aquifer by rainwater interaction with organic rich surface material, organic muds and inorganic minerals in rocks and soils (AEC Environmental 2015).

Under the *Water Act 1992* (Northern Territory), beneficial uses for groundwater have been declared for the Darwin Rural Adelaide River Water Control District which includes the Project area. These are listed as agriculture, aquaculture, environment, public water supply, cultural, Aboriginal economic development, industry, rural stock and domestic, mining activity and petroleum activity.

Groundwater monitoring carried out throughout Ichthys LNG facility construction phase analysed a large number of bores and parameters. Groundwater parameters were not uniform across Ichthys LNG site, with natural pockets of acidic groundwater and variable metal concentrations. Natural groundwater pH values were consistently lower than pH 7 (median of 5.5) and in some cases were as low as pH 3, with no notable decreasing trend over the construction monitoring (AEC Environmental 2018). Groundwater monitoring along the proposed Ichthys CCS pipeline route showed similar trends to that seen within the Ichthys LNG site, with pH varying between 3.5 and 7.2 (median of 5.6). The groundwater levels during construction rose and fell in accordance with the season, with the lowest levels in October (dry season end) and the peak levels being reached in late-March/early-April (wet season end) (AEC Environmental 2018). Measured salinity levels also indicated that majority of bores are brackish to hypersaline. Naturally elevated concentrations of metals and nutrients were consistently reported throughout construction. Majority of nutrient samples (88 per cent of ammonia, 73 per cent of total nitrogen (TN), 67 per cent of total phosphorus (TP) and 61 per cent of oxides of nitrogen) exceeded water quality objectives for Darwin Harbour (Palmer 2010). Similarly, metals frequently exceeding their relevant trigger values (41 per cent of aluminium, 63 per cent of arsenic, 25 per cent of cadmium, 80 per cent of cobalt, 22 per cent of copper, 66 per cent of manganese, 52 per cent of nickel, 58 per cent of zinc).

4.1.5 Geology and geomorphology

The area is underlain by Early Proterozoic and Burrell Creek Formation rocks, with some Cretaceous Darwin Formation rocks along the shoreline. Soils over half of the site are very gravelly, massive earths that range in depth from shallow (<0.25 metre) to moderately deep (0.25 to <0.5 metre) (Fogarty et al. 1984).

Subsurface conditions along the Project pipeline corridor are highly variable, reflecting a mix of coastal, estuarine, and residual geological environments. The stratigraphy generally transitions from soft, compressible marine deposits in mangrove and tidal zones to residual soils and weathered rock in elevated or inland areas.

The main soil and rock types encountered along the alignment include:

- Mangrove Mud Very soft to soft, high-plasticity clay or clayey silt with organic content, often fibrous or peaty. These materials are prevalent in low-lying, tidally influenced areas and present significant geotechnical challenges for stability and settlement.
- Alluvium: Ranges from loose clayey gravel to sandy clay, often weakly cemented. Both fine- and coarse-grained alluvium are present, with stiffness and density increasing inland.
- Lateritic Soils: Sandy or gravelly clays with low to high plasticity, often overlying residual rock. These are typically medium-dense to dense and offer improved bearing capacity compared to marine sediments.
- Residual Soils and Phyllite: Residual phyllite soils (silty clays or sands) are stiff to hard and transition into shallow phyllite bedrock with low to medium strength. Weathered phyllite and siltstone are commonly found beneath lateritic crusts or alluvium.

There are currently no beneficial uses or soil quality objectives for land legislated by the Northern Territory Government. INPEX will refer to the relevant Health Investigation Levels (HILs) (D (commercial/industrial land)) as described by the National Environment Protection (Assessment of Site Contamination) Measure for the Project land (ID category for the pipeline route and crossing) as this aligns with the Litchfield Council land use zoning of Industrial Development.

4.1.6 Harbour hydrodynamics and metocean conditions

Darwin Harbour is classed as a macro-tidal estuary, with maximum tidal range reaching 7.8 m (Padovan 2003; Li 2013). The Darwin region experiences a semidiurnal tidal cycle (i.e. two highs and two lows per day) with a slight diurnal inequality between the successive tides (INPEX Browse 2010). The daily tidal range is characterised by a pronounced variation in magnitude, repeating approximately every 15 days (spring-neap tide cycle). The average daily tidal range is ~6 metres during the spring phase and ~3 metres during neap phase of the tidal cycle (Cardno 2014). There is also considerable annual variability, with the largest spring tides typically occurring in March and September/October.

Tidal excursions range from 8 to 15 kilometres during spring tides and 2 to 8 kilometres during neap tides (Hanley and Caswell 1995; Semeniuk 1985). The large tidal ranges produce strong currents that peak at speeds of up to 2 to 2.5 m/s.

Darwin Harbour is considered well protected from waves. Waves during the wet season can reach heights of up to one metre, although average wave height are generally less than 0.5 metres with short mean periods of 2 to 5 seconds. Average wave heights and periods during the dry season are even lower. Tsunamis and swell waves (long–period waves) are unlikely to occur in Darwin Harbour due to its orientation and the protection from ocean swells by the Tiwi Islands.

4.1.7 Harbour sediment quality

Numerous sediment quality surveys have been undertaken in Darwin Harbour (RHDHV 2022; Cardno 2022; Radke et al. 2020a, 2020b, 2021, 2023, 2024; AECOM 2020; INPEX 2019, 2020, 2021, 2023; GHD 2019; Munksgaard et al 2013; URS 2009; Fortune 2006). Results from published monitoring studies in East Arm have found the sediment to be primarily comprised of sand with varying amounts of gravel, silt and clay, depending on the sample location (e.g. intertidal areas or channels).

Analysis of potential inorganic contaminants in Darwin Harbour such as metals (including metalloids) found that arsenic concentrations commonly exceed the ANZG (2018) sediment quality guideline values (SQGV) of 20 mg/kg. However, these high concentrations have been attributed to local geology (weathering of arsenic rich coastal substrata) rather than anthropogenic sources (Fortune 2006). Furthermore, previous bioavailability testing has indicated that only a small proportion is bioavailable indicating that it is unlikely to be toxic in the marine environment.

A range of other metals (e.g. antimony, chromium, copper, lead, mercury, nickel and silver) have also been recorded to infrequently exceed SQGVs; however, their mean concentrations have always remained below SQGVs. Exceedances are typically associated with individual samples or samples collected adjacent to urbanised or developed areas. Notably, sampling near the existing Ichthys LNG facility MOF (INPEX 2023) indicated no exceedances of the SQGV for any tested analyte.

Until recently few sediment sampling programs have analysed samples for other contaminants such as organic compounds. Sediment sampling to inform dredging activities at Coonawarra (GHD 2019), Mandorah (Cardno 2022), the proposed ship lift in East Arm (AECOM 2020) and Middle Arm Sustainable Development Precinct (MASDP) (RHDHV 2022) have all included various analysis of organics. However, the most recent comprehensive surveys were undertaken by the Northern Territory Government in 2019, 2020 and 2023 (Radke et al. 2020a, 2020b, 2021, 2023, 2024), as part of the Ichthys LNG Darwin Harbour Integrated Marine Monitoring and Research Program environmental offset. These surveys cover the entire Darwin Harbour extent and include tributyltin (TBT), per- and polyfluoroalkyl substances (PFASs), polychlorinated biphenyls (PCBs), organophosphate pesticides (OPPs), organochlorine pesticide (OCPs), polycyclic aromatic hydrocarbons (PAHs), total recoverable hydrocarbons (TRHs) and benzene, toluene, ethylbenzene and xylenes (BTEX). INPEX (2023) also tested the Ichthys LNG facility MOF berth pockets for organics (TPH, TRH, PAH, BTEX).

Of the aforementioned organics, PCBs, OPPs and BTEX have been below laboratory limits of reporting (LORs) in all surveys for which they have been analysed. Results for TBT were all below LOR in East Arm in Radke et al. (2020a) and RHDHV (2022), while a single TBT result was reported in AECOM (2020) adjacent to the multi-user barge ramp facility in East Arm. Sampling at Coonawarra (GHD 2019) and Mandorah (Cardno 2022) reported eight and two samples with TBT respectively. Coonawarra is known to contain legacy TBT contaminated sediments, with TBT identified in all previous sediment surveys (GHD 2019). Following detection of TBT at Mandorah, twelve additional targeted TBT samples were collected, all of which were below LOR (Cardno 2022), indicating highly localised source.

Widespread occurrence of PFASs in Darwin Harbour was reported in Radke et al. (2023), with 15 different PFASs detected across 32 sites with detection frequencies highest adjacent urban catchments. Sampling sites within tidal creeks contiguous with Royal Australian Air Force Base Darwin had the largest number of PFASs and the highest concentrations. Dieldrin was the only OCP identified in Radke et al. (2021) and was reported at two locations: the highly urbanised Rapid Creek and adjacent to Fisherman's Wharf. In all other surveys, OCPs have been below LOR (URS 2009; GHD 2019; RHDHV 2022). Polycyclic aromatic hydrocarbons have been reported sporadically in Darwin Harbour, with PAH concentrations well below SQGVs. Elevated PAH concentrations have

typically been associated with urbanised or developed areas (e.g. Coonawarra, Rapid Creek, Fisherman's Wharf). Similar to PAH, some elevated TRHs concentrations have been associated with urbanised or developed areas with a single reported exceedance of SQGVs in Buffalo Creek. However, unlike other organic contaminants, trace levels of TRHs have been reported at the majority of sites throughout Darwin Harbour and likely reflect the presence of biogenic hydrocarbons throughout Darwin Harbour. No organic compounds were detected above SQGVs within the Ichthys LNG facility MOF berth pockets (INPEX 2023)

Three surveys have included analysis for radionuclides, URS (2009), AECOM (2020) and RHDHV (2022), with all results well below interim sediment quality guideline values from the National Assessment Guidelines for Dredging 2009 (35 Bq/g; Commonwealth of Australia 2009) with average concentrations of 0.6, 1.2 and 0.9 Bq/g respectively.

4.1.8 Harbour water quality

Darwin Harbour is a naturally turbid environment due to the large tidal ranges and associated currents, with clearest water occurring during neap tides while the spring tides are associated with increased turbidity due to increased current velocities.

During the wet season, monsoonal troughs and tropical cyclones (events) significantly influence water quality, in particular turbidity. These events increase metocean conditions (wind and waves) which suspend sediments resulting in high turbidity levels (>150 NTU daily average) in coastal waters outside the harbour, while waters within the harbour are typically sheltered. If these events coincide with spring tides, the tidal currents can affect the highly turbid coastal waters into the harbour resulting in increased turbidity (>100 NTU daily average) (Cardno 2015a; URS 2009). Turbidity inside the harbour would also be increased by increased sediment loading from surface runoff associated with increased rainfall during such events.

Conversely, metocean conditions in the dry season are relatively benign, with water quality primarily driven by tides. As a result, clearer waters are measured inside and outside the harbour, with turbidity typically between one and seven NTU (median daily average).

Water temperatures typically vary from 24 °C in the dry season to over 30 °C in the wet season; however, the timing, duration and frequency of wet season events can significantly influence water temperature causing declines of 2 °C to 4 °C. The rainfall associated with these events can also drive fluctuations in salinity within Darwin Harbour.

Salinity within Darwin Harbour is generally slightly lower in the wet season when compared to the dry season due to rainfall; however, in either season there can be strong local gradients in salinity. During the wet season, salinity can range from approximately 30 to 35 ppt in the mid-Harbour down to near 0 ppt further up rivers (Makarynska 2019), where there are significant freshwater inflows. During the dry season, a lack of rainfall and increased evaporation can lead to salinities between 35 and 40 ppt in upstream waters where there is limited tidal flushing (Cardno 2014; Makarynska 2019).

Dissolved oxygen in Darwin Harbour typically ranges from 74 to 96 per cent (mean 84 per cent), with no seasonal effects (INPEX 2011; Padovan 1997).

A seasonal summary of mean water quality is provided in Table 4-3.

Table 4-3: Mean water quality levels recorded near Bladin Point

Parameter	Dry season	Wet season
Temperature	24.5 °C*	30.6 °C *

Parameter	Dry season	Wet season
Salinity	35.5 ppt *	29 ppt *
Dissolved oxygen	(median 35.83 g/L) †	(median 32.37 g/L) †
pH	93.3% of saturation *	87.8% of saturation *
Turbidity	(median 88.3% in July 2017) †	(median 75.9% in February 2017) †

* URS 2009

† AEC Environmental 2017

The *Water Act 1992* (Northern Territory) defines several beneficial uses for water bodies in the Northern Territory. Beneficial uses describe how a community values and uses a water resource. These are then used to set water quality objectives relevant to the beneficial uses declared for a particular water body. The declared beneficial uses for the Darwin Harbour Region – High Water Mark and Darwin Harbour Region – Natural Waterways are as follows:

- aquaculture: water for commercial production of aquatic animals, including related research
- environment: water to maintain the health of aquatic ecosystems
- cultural: water to meet aesthetic, recreational and cultural needs

Water Quality Objectives for Darwin Harbour have been set by the Northern Territory government for several water types; those relevant to the saline waters around Bladin Point are the objectives for upper estuary waters as listed in Table 4-4.

Table 4-4: Water quality objectives for Darwin Harbour upper estuary

Indicator	Upper estuary water quality objectives
Indicator for environmental use: aquatic ecosystem protection	
Dissolved oxygen (DO)	Maintain DO between 75 to 100% saturation
pH	Maintain pH between 7–8.5
Total nitrogen (TN)	Maintain TN <300 µg/L
NOx	Maintain NOx <20 µg/L
Ammonia	Maintain Ammonia <20 µg/L
Total phosphorus (TP)	Maintain TP <30 µg/L
Filterable reactive phosphorus (FRP)	Maintain FRP <10 µg/L
Chlorophyll a	Maintain Chlorophyll a <4 µg/L
Total suspended solids (TSS)	Maintain TSS <10 mg/L

Indicator	Upper estuary water quality objectives
Toxicants	Refer to ANZG (2018)
Indicator for protection of cultural use: recreation primary contact	
Enterococci	All samples to be less than or equal to 50 Enterococci/100 mL
Escherichia coli	No single sample greater than 200 E. coli/100 mL
Pathogenic protozoans	<10 pathogenic protozoans/100 mL
Indicator for protection of cultural use: aquatic foods	
Guideline for water in shellfish growth harvest areas	Median concentration of faecal coliform should not exceed 14 MPN/100 mL (no more than 10% of the samples exceeding 43 MPN/100 mL)
Standard in edible tissue	Fish for human consumption should not exceed a limit of 2.3 MPN *E. coli*/g of flesh with a standard plate count of 100 000 organisms/g
Toxicants	Refer to ANZG (2018)

4.2 Biological environment

The Middle Arm Peninsula area has been subject to a number of terrestrial vegetation, flora and fauna surveys over the past two decades, such that the terrestrial ecological values of the peninsula are well described. The relevant survey information has been reviewed and summarised in the following sections, as applicable.

The Project area is located within the East Asian-Australasian Flyway an internationally recognised migratory bird pathway that covers the whole of Australia and its surrounding waters. 'Flyway' is the term used to describe a geographic region that supports a group of populations of migratory waterbirds throughout their annual cycle.

4.2.1 Flora and ecological communities

The Project area lies within the Darwin Coastal Bioregion, which is characterised by mangroves, monsoon vine forest and tall open eucalypt forest (Figure 4-2). The large portions of the Project area were previously cleared during the construction of Ichthys LNG Development project. There is no remaining native vegetation within the Ichthys LNG facility site boundaries.

A ground-truth vegetation survey of the Project area was undertaken in December 2023 to verify existing vegetation within the corridor. There were five broad vegetation systems within the Project area identified: eucalypt woodland, drainage, grassland, mangrove and mixed monsoon forest (EcOz 2023a). There were 24 vegetation units within the broader communities.

The mangrove communities were the dominant vegetation community within the Project area, followed by monsoon forest, Eucalypt woodland communities and areas of regrowth, with less than one per cent coverage of drainage communities, grasslands or disturbed land. The majority of vegetation communities were consistent with existing mapping.

The most predominant vegetation units recorded within the Project area included:

- *Rhizophora stylosa*/*Camptostemon schultzii* low to mid closed-forest / open-forest (tidal creek forest).
- *Ceriops tagal* low closed-forest / low open-forest (tidal flats).
- *Avicennia marina* / *C. tagal* low open-forest / low closed-forest.
- mixed species low closed-forest (hinterland).
- salt flats (+/- samphire).
- MVF (Major Vegetation Subgroup) mid closed forest (Dry Monsoon Forest).
- *Sonneratia alba* low woodland / low open forest.
- *E.s miniata*, *Erythrophleum Chlorostachys* +/- *Corymbia confertiflora* mid woodland with a low open tussock grassland / shrubland understorey.

Whilst there are no threatened ecological communities in the vicinity of the Project area, the mangrove communities and the monsoon vine forest near the Project area are considered to have high conservation value in Darwin Harbour for biological and cultural reasons.

Significant vegetation types recorded on Middle Arm Peninsula include:

- mangrove communities
- monsoon vine forest / vine thicket
- wetlands
- riparian vegetation
- sandsheet heath
- old-growth forest supporting large, hollow-bearing trees.

Figure 4-2: Vegetation communities

Mangroves

Large areas of mangrove communities are zoned for "Conservation" under the Northern Territory Planning Scheme (Northern Territory Government 2020) in recognition of their ecological importance. They are important to the ecological health of Darwin Harbour and provide food and shelter for a wide range of animals (e.g. nursery grounds for juvenile fish and crabs). Mangroves in the Darwin Harbour area constitute approximately 44 per cent of the mangrove communities in the Darwin Coastal Bioregion and about five per cent of the total mangrove area of the Northern Territory, with 80 per cent of these mangroves found in the "inner" Harbour between Sadgroves Creek and Mandorah (INPEX 2010).

Recent habitat mapping (Brocklehurst and Edmeades 2018) using high resolution aerial imagery between Charles Point and Gunn Point has reported mangrove extent as 26,729 hectares with an additional 4,846.8 hectares of salt flats. Darwin Harbour is also recognised for its mangrove diversity, containing 36 of the 50 known mangrove species worldwide.

In Darwin Harbour there are four key mangrove assemblages distributed along the tidal profile as illustrated in Figure 4-3 (Cardno 2014). The seaward assemblage grows between three and four metre LAT (typically between mean low water neaps (MLWN) and mean sea level (MSL)) and experiences tidal inundation twice every day at high tide. It is most commonly found adjacent to the open Harbour next to expansive mud flats rather than in riverine or creek system settings. It is dominated by open woodland of mature *S. alba* trees and in many places an understorey of the river mangrove *Aegiceras corniculatum* (Cardno 2014).

The tidal creek assemblage is typically found between MSL and MHWN and is inundated at least once every day. This assemblage is dominated by *R. stylosa* and is found throughout Darwin Harbour often fringing creeks that lack a seaward assemblage (Cardno 2014). Adjacent to the tidal creek assemblage, is the tidal flat assemblage (typically located between MHWN and mean high water springs (MHWS) is only inundated during spring high tide and as such and contains hyper saline salt flats. The tidal flats support a low closed but patchy forest dominated by *C. australis*, while the surrounding the salt flats typically occupied by the most salt tolerant species *A. marina* (Cardno 2014).

At the landward edge of the mangroves, above the MHWS, lies the generally narrow hinterland margin assemblage, which is inundated only a few times a year during the highest spring tides. This assemblage is commonly dominated by *C. australis*; however, contains a greater variety of mangrove species than in other assemblages, including *Lumnitzera racemosa* and varieties of the deciduous *Excoecaria* sp.

Harbour-wide mangrove health monitoring using remote sensing (normalised difference vegetation index) as part of the Ichthys Project Nearshore Environmental Monitoring Plan showed a distinct seasonality in mangrove condition. Mangroves are typically healthiest in the late wet (February to April) to early dry (May to July) season and most stressed in the late dry (August to October) to early wet (November to January) season (Datt and Staben 2020; Cardno 2015b). This seasonality in mangrove condition is likely to be linked to the effects of increased wet season rainfall and lower evaporation and inversely low rainfall and higher evaporation during the dry season, along with other seasonal changes in temperature, light regime and salinity (Cardno 2015b).

Mangrove mapping by Brocklehurst et al (2018) indicates that the mangrove communities present adjacent to the Project area include the following species:

- *R. stylosa*/*Camptostemon schultzii* low to mid closed-forest / open-forest (shoreline forest and tidal creek forest).
- *R. stylosa*/*Bruguiera* spp/*Ceriops* spp low closed-forest / low open-forest (transition zone).

- *C. tagal* low closed-forest / low open-forest (tidal flats).
- mixed species low closed-forest (hinterland).
- *C. tagal* low closed-forest / open-forest (hinterland).
- *A. marina*/*Ceriops* spp low open-forest / low closed-forest.
- mixed species low open-forest / low closed-forest.
- *S. alba* low woodland / low open forest.

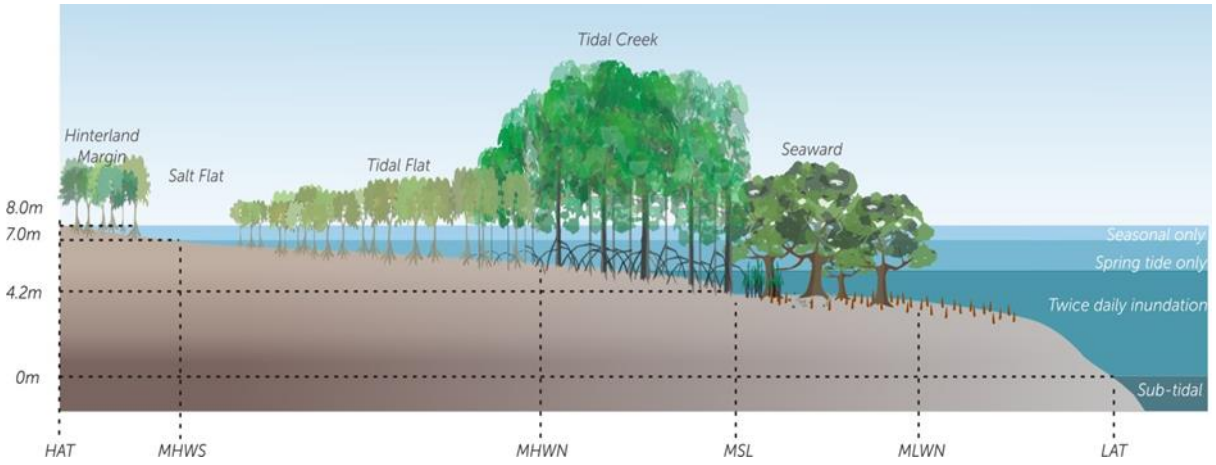


Figure 4-3: Major mangrove assemblages of Darwin Harbour and their position in the tidal profile (adapted from Brocklehurst and Edmeades 1996) (Cardno 2014)

Threatened Flora

The PMST search identified three EPBC Act listed threatened plant species as having potential to occur within the Project area; *Atalaya brevialata*, *Stylidium ensatum* (a triggerplant) and *Typhonium taylorii*. A ground-truth vegetation survey of the Project area was undertaken in December 2023 to verify existing vegetation mapping of the area and identify suitable habitat for the TPWC Act listed threatened flora species, *Cycas armstrongii* (Darwin cycad) and *Typhonium praetermissum/Typhonium* sp. Cox Peninsula (EcOZ 2024b).

Targeted surveys have focused on determining the density of the Darwin cycad across Middle Arm Peninsula, and suitable habitat (savanna woodland) for the species has been detected within the Project area (EcOz 2023a).

Typhonium praetermissum is endemic to the Greater Darwin region and is listed as Vulnerable under the TPWC Act. *Typhonium* sp. Cox Peninsula is only known from three sub-populations on Cox Peninsula and a sub-population within the Middle Arm Peninsula. The species currently has no threatened status, however Department of Environment, Parks and Water Security (now the Department of Lands, Planning and Environment) has advised it qualifies for listing for Vulnerable, if not Endangered. No suitable habitat was identified within the survey footprint; however, the Project area may overlap known *Typhonium* distribution identified directly adjacent (EcOZ 2024b).

4.2.2 Terrestrial fauna and habitats

Past fauna surveys conducted for the Ichthys LNG Development project EIS found a range of species within the Project area. Overall, 148 vertebrate species, including nine mammal species, 106 bird species, 22 reptile species and 11 frog species (GHD 2009) were recorded.

The local Eucalyptus woodland habitat contained the highest species richness for animals during the surveys. No trees within the proposed corridor met the threshold for large, hollow-bearing trees to support hollow-dependent native fauna species. However, the surveyed corridor transects other suitable habitat for the following terrestrial fauna species:

- bare-rumped sheath-tailed bat (*Saccolaimus saccolaimus nudicluniatus*) (savanna woodland)
- black-footed tree-rat (*Mesembriomys gouldii gouldii*) (savanna woodland)
- northern brushtail possum (*Trichosurus vulpecula arnhemensis*) (savanna woodland)
- Mitchell's water monitor (*Varanus mertensi*) (mangroves).

Further, the Ichthys CCS (Darwin LNG link) pipeline transects areas of saltpans, near Wickham Point Road up to the Ichthys CCS pipeline tie-in station, which are known to be important roosting habitat for threatened shorebirds (refer to Section 4.2.3).

A survey of biting insects at Bladin Point found that biting midges were much more abundant than mosquitoes (Department of Health and Families 2009). The most common biting midge recorded was Culicoides ornatus (mangrove biting midge) and the most common mosquito species recorded was Aedes vigilax (northern salt marsh mosquito).

4.2.3 Listed threatened communities and species

There are a number of threatened species, listed under both the EPBC Act and TPWC Act, which may be present in the Project area.

A search using the EPBC protected matters search tool (PMST) for matters of national environmental significance (MNES) was conducted for the Project area and a 20 kilometres buffer on 12 May 2025 (Appendix A).

The PMST search identified 56 listed threatened species and 71 migratory species, which may be present in or adjacent to the Project area. Twenty-eight of the listed species were listed as both threatened and migratory. Further, forty species were also listed under the TPWC Act.

A likelihood of occurrence assessment (Appendix B) was undertaken to determine which species have the potential to occur in the vicinity of the Project area. A summary of the results of the PMST search and likelihood of occurrence assessment are presented in Table 4-5. A search of the NR Maps database in a 20 kilometres radius returned observations of a further 18 species listed either under the EPBC Act or the TPWC Act; these species have also been considered in the likelihood of occurrence assessment.

Threatened and/or migratory species that 'may' occur or are 'likely' or 'known' to occur within the vicinity of the Project are further described in subsequent sections.

Other MNES identified in the PMST report relate to the surrounding Darwin Harbour, these include:

- a wetland of national significance in the Directory of Important Wetlands in Australia (Port Darwin NT029).

- a biologically important area (BIA) for breeding and foraging, for Australian snubfin dolphin (*O. heinsohni*), Indo-Pacific humpback dolphin (*S. chinensis)* and Indo-Pacific bottlenose dolphin (*T. Aduncus*); and
- considered a BIA for flatback turtle internesting and habitat critical to the species survival.

Table 4-5: Listed Terrestrial Threatened and/or Migratory species (EPBC and TPWC Act) predicted to occur within the Project area or within the 20 km buffer

Common name	Scientific name	EPBC Act status*		TPWC Act status*	PMST result	Likelihood of occurrence
		Threatened	Migratory			
Land birds						
Alligator rivers yellow chat	*Epthianura crocea tunneyi*	E	-	E	Species or species habitat may occur within 20 km buffer area	Unlikely to occur
Barn swallow	*Hirundo rustica*	-	✓*	-	Species or species habitat known to occur within Project area	May occur
Gouldian finch	*Chloebia gouldiae*	E	-	V	Species or species habitat known to occur within Project area	May occur
Grey falcon	*Falco hypoleucos*	V	-	V	Species or species habitat known to occur within Project area	Unlikely to occur
Grey wagtail	*Motacilla cinerea*	-	✓*	-	Species or species habitat known to occur within Project area	May occur
Masked owl (northern)	*Tyto novaehollandiae kimberli*	V	-	V	Species or species habitat known to occur within Project area	Unlikely to occur
Oriental cuckoo	*Cuculus optatus*	-	✓	-	Species or species habitat known to occur within Project area	Likely to occur
Osprey	*Pandion haliaetus*	-	✓	-	Breeding known to occur within Project area	Known to occur

Common name	Scientific name	EPBC Act status*		TPWC Act status*	PMST result	Likelihood of occurrence
		Threatened	Migratory			
Partridge pigeon (eastern)	*Geophaps smithii smithii*	V	-	-	Species or species habitat known to occur within Project area	Unlikely to occur
Red goshawk	*Erythrotriorchis radiatus*	E	-	V	Species or species habitat known to occur within Project area	Unlikely to occur
Red-rumped swallow	*Cecropis daurica*	-	✓ *	-	Species or species habitat known to occur within Project area	May occur
Yellow wagtail	*Motacilla flava*	-	✓ *	-	Species or species habitat known to occur within Project area	May occur
Seabirds						
Christmas Island frigatebird	*Fregata andrewsi*	E	-	E	N/A - Records from NR Maps	Unlikely to occur
Common noddy	*Anous stolidus*	-	✓	-	Species or species habitat likely to occur within Project area	May occur
Great frigatebird	*Fregata minor*	-	✓	-	Species or species habitat known to occur within Project area	May occur
Lesser frigatebird	*Fregata ariel*	-	✓	-	Species or species habitat known to occur within Project area	May occur
Little tern	*Sternula albifrons*	V	✓	-	Species or species habitat likely to occur within Project area	Likely to occur

Common name	Scientific name	EPBC Act status*		TPWC Act status*	PMST result	Likelihood of occurrence
		Threatened	Migratory			
Streaked shearwater	*Calonectris leucomelas*	-	✓	-	Species or species habitat known to occur within Project area	Unlikely to occur
White-tailed Tropicbird	*Phaethon lepturus*	-	✓	-	Species or species habitat may occur within Project area	Unlikely to occur
Shorebirds						
Asian dowitcher	*Limnodromus semipalmatus*	V	✓ *	-	Species or species habitat known to occur within Project area	Likely to occur
Australian painted snipe	*Rostratula australis*	E	-*	E	Species or species habitat known to occur within Project area	May occur
Bar-tailed godwit	*Limosa lapponica*	-	✓	-	Species or species habitat known to occur within Project area	Likely to occur
Black-tailed godwit	*Limosa limosa*	E	✓ *	-	Roosting known to occur within Project area	Likely to occur
Broad-billed sandpiper	*Limicola falcinellus*	-	✓ *	-	Roosting known to occur within 20 km buffer area	May occur
Common greenshank	*Tringa nebularia*	E	✓ *	-	Species or species habitat known to occur within project area	Likely to occur
Common sandpiper	*Actitis hypoleucos*	-	✓	-	Species or species habitat known to occur within Project area	Known to occur

Common name	Scientific name	EPBC Act status*		TPWC Act status*	PMST result	Likelihood of occurrence
		Threatened	Migratory			
Curlew sandpiper	*Calidris ferruginea*	CE	✓ *	CE	Species or species habitat known to occur within Project area	Likely to occur
Far eastern curlew	*Numenius madagascariensis*	CE	✓	CE	Species or species habitat known to occur within Project area	Known to occur
Fork-tailed swift	*Apus pacificus*	-	✓ *	-	Species or species habitat likely to occur within Project area	Likely to occur
Great knot	*Calidris tenuirostris*	V	✓ *	CE	Roosting known to occur within Project area	Known to occur
Greater sand plover	*Charadrius leschenaultii*	V	✓	V	Species or species habitat known to occur within Project area	Likely to occur
Grey plover	*Pluvialis squatarola*	V	✓ *	-	Roosting known to occur within Project area	Likely to occur
Grey-tailed tattler	*Tringa brevipes*	-	✓	-	Roosting known to occur within 20 km buffer area	Likely to occur
Latham's snipe	*Gallinago hardwickii*	V	-	-	N/A - Records from NR Maps	Unlikely to occur
Lesser sand plover	*Charadrius mongolus*	E	✓	E	Roosting known to occur within Project area	Likely to occur
Little curlew	*Numenius minutus*	-	✓ *	-	Roosting known to occur within 20 km buffer area	Likely to occur

Common name	Scientific name	EPBC Act status*		TPWC Act status*	PMST result	Likelihood of occurrence
		Threatened	Migratory			
Little ringed plover	*Charadrius dubius*	-	✓ *	-	Roosting known to occur within 20 km buffer area	May occur
Long-toed stint	*Calidris subminuta*	-	✓ *	-	Roosting known to occur within 20 km buffer area	May occur
Marsh sandpiper	*Tringa stagnatilis*	-	✓ *	-	Roosting known to occur within 20 km buffer area	Known to occur
Nunivak bar-tailed godwit	*Limosa lapponica baueri*	E	-	V	Species or species habitat known to occur within Project area	Likely to occur
Oriental plover	*Charadrius veredus*	-	✓ *	-	Roosting known to occur within Project area	Likely to occur
Oriental pratincole	*Glareola maldivarum*	-	✓ *	-	Roosting known to occur within Project area	Likely to occur
Oriental reed-warbler	*Acrocephalus orientalis*	-	✓ *	-	Species or species habitat may occur within Project area	May occur
Pacific golden plover	*Pluvialis fulva*	-	✓	-	Roosting known to occur within 20 km buffer area	Known to occur
Pectoral sandpiper	*Calidris melanotos*	-	✓ *	-	Species or species habitat known to occur within Project area	Likely to occur
Pin-tailed snipe	*Gallinago stenura*	-	✓ *	-	Roosting likely to occur within 20 km buffer area	Unlikely to occur

Common name	Scientific name	EPBC Act status*		TPWC Act status*	PMST result	Likelihood of occurrence
		Threatened	Migratory			
Red knot	*Calidris canutus*	V	✓ *	E	Species or species habitat known to occur within Project area	Likely to occur
Red-necked stint	*Calidris ruficollis*	-	✓ *	-	Roosting known to occur within 20 km buffer area	Likely to occur
Ruddy turnstone	*Arenaria interpres*	V	✓	-	Roosting known to occur within Project area	Likely to occur
Sanderling	*Calidris alba*	-	✓	-	Roosting known to occur within Project area	Likely to occur
Sharp-tailed sandpiper	*Calidris acuminata*	V	✓	-	Roosting known to occur within Project area	Likely to occur
Swinhoe's snipe	*Gallinago megala*	-	✓ *	-	Roosting known to occur within 20 km buffer area	Likely to occur
Terek sandpiper	*Xenus cinereus*	V	✓ *	-	Roosting known to occur within 20 km buffer area	Likely to occur
Wandering tattler	*Tringa incana*	-	✓	-	Roosting known to occur within 20 km buffer area	Unlikely to occur
Whimbrel	*Numenius phaeopus*	-	✓	-	Roosting known to occur within Project area	Known to occur
Wood sandpiper	*Tringa glareola*	-	✓ *	-	Roosting known to occur within 20 km buffer area	Likely to occur

Common name	Scientific name	EPBC Act status*		TPWC Act status*	PMST result	Likelihood of occurrence
		Threatened	Migratory			
Fish, amphibians, reptiles and invertebrates						
Atlas moth	*Attacus wardi*	-	-	V	N/A - Records from NR Maps	May occur
Dwarf sawfish	*Pristis clavata*	V	✓ *	-	Species or species habitat known to occur within Project area	May occur‡
Flatback turtle	*Natator depressus*	V	✓ *	-	Species or species habitat known to occur within Project area	Known to occur‡
Freshwater sawfish	*Pristis pristis*	V	✓	V	Species or species habitat known to occur within Project area	Unlikely to occur
Giant manta ray	*Mobula birostris*	-	✓	-	N/A - Records from ALA Maps	Unlikely to occur
Green sawfish	*Pristis zijsron*	V	✓	V	Species or species habitat known to occur within Project area	May occur‡
Green turtle	*Chelonia mydas*	V	✓	-	Species or species habitat known to occur within Project area	Known to occur‡
Grey nurse shark	*Carcharias taurus*	-	✓	-	N/A - Records from ALA Maps	Unlikely to occur
Hawksbill turtle	*Eretmochelys imbricata*	V	-	V	N/A - Records from NR Maps	Unlikely to occur
Howard river toadlet	*Uperoleia daviesae*	V	-	V	Species or species habitat known to occur within Project area	Unlikely to occur

Common name	Scientific name	EPBC Act status*		TPWC Act status*	PMST result	Likelihood of occurrence
		Threatened	Migratory			
Leatherback turtle	*Dermochelys coriacea*	E	✓	-	N/A - Records from ALA Maps	Unlikely to occur
Loggerhead turtle	*Caretta caretta*	E	-	V	N/A - Records from NR Maps	Unlikely to occur
Merten's water monitor	*Varanus mertensi*	E	-	V	Species or species habitat known to occur within Project area	Unlikely to occur
Mitchell's water monitor	*Varanus mitchelli*	CE	-	V	Species or species habitat known to occur within Project area	May occur
Narrow sawfish	*Anoxypristis cuspidate*	-	✓	-	Species or species habitat known to occur within Project area	May occur‡
Northern blue-tongued skink	*Tiliqua scincoides intermedia*	CE	-	-	Species or species habitat known to occur within Project area	Unlikely to occur
Northern river shark	*Glyphis garricki*	E	-	E	Species or species habitat known to occur within Project area	May occur‡
Oceanic whitetip shark	*Carcharhinus longimanus*	-	✓	-	N/A - Records from ALA Maps	Unlikely to occur
Olive ridley turtle	*Lepidochelys olivacea*	E	-	V	N/A - Records from NR Maps	Unlikely to occur
Pig-nosed Turtle	*Carettochelys insculpta*	V	-	-	N/A - Records from NR Maps	Unlikely to occur

Common name	Scientific name	EPBC Act status*		TPWC Act status*	PMST result	Likelihood of occurrence
		Threatened	Migratory			
Plains death adder	*Acanthophis hawkei*	V	-	V	Species or species habitat known to occur within Project area	Unlikely to occur
Reef manta ray	*Mobula alfredi*	-	✓	-	N/A - Records from ALA Maps	Unlikely to occur
Salt-water crocodile, estuarine crocodile	*Crocodylus porosus*		✓*	-	Species or species habitat likely to occur within area	Likely to occur
Scalloped hammerhead	*Sphynra lewini*	C	-	-	N/A - Records from ALA Maps	Unlikely to occur
Whale shark	*Rhincodon typus*	V	✓	-	N/A - Records from ALA Maps	Unlikely to occur
White shark	*Carcharodon*	V	✓	-	N/A - Records from ALA Maps	Unlikely to occur
Yellow-snouted ground gecko	*Lucasium occultum*	E	-	V	N/A - Records from NR Maps	Unlikely to occur
Yellow-spotted monitor	*Varanus panoptes*	-	-	V	N/A - Records from NR Maps	Unlikely to occur
Plants						
A bladderwort	*Utricularia dunstaniae*	-	-	V	N/A - Records from NR Maps	Unlikely to occur
A bladderwort	*Utricularia singeriana*	-	-	V	N/A - Records from NR Maps	Unlikely to occur

Common name	Scientific name	EPBC Act status*		TPWC Act status*	PMST result	Likelihood of occurrence
		Threatened	Migratory			
A triggerplant	*Stylidium ensatum*	E	-	E	Species or species habitat known to occur within 20 km buffer area	Unlikely to occur
Darwin cycad	*Cycas armstrongii*	-	-	V	N/A - Records from NR Maps	Likely to occur
Hibiscus	*Hibiscus brennanii*	V	-	V	N/A - Records from NR Maps	Unlikely to occur
N/A (herb)	*Cleome insolata*	-	-	V	N/A - Records from NR Maps	Unlikely to occur
N/A (herb)	*Typhonium praetermissum*	-	-	V	N/A - Records from NR Maps	Likely to occur
N/A (herb)	*Typhonium taylorii*	E	-	E	Species or species habitat likely to occur within 20 km buffer area	Unlikely to occur
N/A (subshrub)	*Atalaya brevialata*	CE	-	CE	Species or species habitat known to occur within 20 km buffer area	Unlikely to occur
Marine mammals						
Australian humpback dolphin	*Sousa sahulensis*	V	✓	-	Species or species habitat known to occur within Project area	Known to occur‡
Australian snubfin dolphin	*Orcaella heinsohni*	V	✓	-	Species or species habitat known to occur within Project area	Known to occur ‡
Blue whale	*Balaenoptera musculus*	E	✓	-	N/A - Records from ALA Maps	Unlikely to occur

Common name	Scientific name	EPBC Act status*		TPWC Act status*	PMST result	Likelihood of occurrence
		Threatened	Migratory			
Bryden's whale	*Balaenoptera edeni*	-	✓	-	N/A - Records from ALA Maps	Unlikely to occur
Dugong	*Dugong dugong*	-	✓	-	Species or species habitat known to occur within Project area	May occur
Humpback whale	*Megaptera novaeangilae*	-	✓	-	N/A - Records from ALA Maps	Unlikely to occur
Killer whale/Orca	*Orcinus orca*	-	✓	-	N/A - Records from ALA Maps	Unlikely to occur
Spotted bottlenose dolphin	*Tursiops aduncus*	-	✓	-	Species or species habitat known to occur within Project area	Known to occur‡
Terrestrial mammals						
Bare-rumped sheath-tailed bat	*Saccolaimus saccolaimus nudicluniatus*	V	-	-	Species or species habitat known to occur within Project area	Likely to occur
Black-footed tree-rat (Kimberley and mainland Northern Territory)	*Mesembriomys gouldii gouldii*	E	-	E	Species or species habitat known to occur within Project area	Likely to occur
Brush-tailed rabbit-rat	*Conilurus penicillatus*	V	-	E	Species or species habitat may occur within Project area	Unlikely to occur
Fawn antechinus	*Antechinus bellus*	V	-	E	Species or species habitat known to occur within Project area	Unlikely to occur

Common name	Scientific name	EPBC Act status*		TPWC Act status*	PMST result	Likelihood of occurrence
		Threatened	Migratory			
Ghost bat	*Macroderma gigas*	V	-	-	Species or species habitat likely to occur within Project area	Unlikely to occur
Nabarlek (Top End)	*Petrogale concinna canescens*	E	-	E	Species or species habitat likely to occur within Project area	Unlikely to occur
Northern brushtail possum	*Trichosurus vulpecula arnhemensis*	V	-	-	Species or species habitat known to occur within Project area	Known to occur
Northern brush-tailed phascogale	*Phascogale pirata*	V	-	E	Species or species habitat likely to occur within Project area	Unlikely to occur
Northern quoll	*Dasyurus hallucatus*	E	-	CE	Species or species habitat known to occur within Project area	Unlikely to occur
Pale field-rat	*Rattus tunneyi*	-	-	V	N/A - Records from NR Maps	Unlikely to occur
Water mouse	*Xeromys myoides*	V	-	-	Species or species habitat likely to occur within Project area	Unlikely to occur

* CE= Critically Endangered, E= Endangered, V= Vulnerable

† Species with a marine status of "Listed – Overfly marine area"

‡ Species is only relevant if a temporary outfall is required at the Ichthys LNG MOF, for the purpose of disposal of hydrotest water into the marine environment.

Avifauna

There are 54 species of migratory shorebirds that are known to specifically follow migration paths within the East Asian-Australasian-Flyway (Bamford et al. 2008). Migratory shorebird species are mostly present in Australia during the non-breeding period, from as early as August to as late as April/May each year. After arrival in Australia at the end of long migrations, they disperse throughout the country to a wide variety of habitats including coastal wetlands, mudflats, reefs and sandy beaches (DoEE 2017a).

Avifauna that could potentially use or pass through the Project area are identified in Table 4-5. A description of individual avifauna species with the potential to occur within the Project area is presented in the likelihood of occurrence assessment (Appendix B). In addition to six species of seabirds, the search of the EPBC Act Protected Matters database identified 36 species of shorebirds potentially present within the Project area. These species may migrate through the Project area to wetland habitats on the mainland and/or larger coastal islands (DoEE 2017a).

Targeted shorebird survey data available from 2018 to 2022 from the Middle Arm Peninsula and surrounds were compiled as part of the MASDP environmental assessment (EcOz 2023b). A summary of the shorebird surveys completed are presented below.

The shorebird habitat availability and distribution within the Middle Arm Peninsula is relatively well understood (EcOz 2023b). The Middle Arm Peninsula is surrounded by an extensive intertidal zone, with previous targeted surveys showing that shorebirds are distributed throughout this zone at low tide in a manner that does not indicate strong preferential use of available foraging habitat (EcOz 2023b).

Twelve shorebird species were recorded on the Middle Arm Peninsula during the targeted shorebird surveys from 2018 to 2022 (EcOz 2023b). Of the 12 species recorded, seven shorebird species are currently listed as threatened under the EPBC Act, including (EcOz 2023b):

- common greenshank (*T. nebularia*) (Endangered)
- far eastern curlew (*N. madagascariensis*) (Critically Endangered)
- greater sand plover (*C. leschenaultii*) (Vulnerable)
- grey plover (*P. squatarola*) (Vulnerable)
- bar-tailed godwit (*L. lapponica baueri*) (Endangered)
- sharp-tailed sandpiper (*C. acuminata*) (Vulnerable)
- terek sandpiper (*Z. cinereus*) (Vulnerable).

Shorebird count data for Middle Arm between 2018 and 2022 is presented in Figure 4-4.

The intertidal areas along Middle Arm from Lightning Creek to the north-west of the Peninsula – including Cossack Creek – represent one of three key foraging sites within Darwin Harbour (EcOz 2023b). Large congregations of shorebirds have been recorded during low tide aerial surveys on the intertidal mudflat between the Bladin Point and the Darwin LNG facility (Lilleyman et al. 2020 in EcOz 2023b). However, survey records show that areas immediately surrounding the Ichthys LNG facility (within one kilometre buffer) are not core habitat in context to surrounding areas of the Middle Arm Peninsula.

The saltpans (used as roost sites) surrounding Ichthys LNG facility are not used by the shorebirds and fewer shorebirds have been observed within the intertidal foraging habitat in comparison to the broader Middle Arm Peninsula.

Figure 4-4: Migratory shorebird count data for Middle Arm between 2018 and 2022 (EcOz 2023b)

Terrestrial mammals

Bare-rumped sheath-tailed bat

The bare-rumped sheath-tailed bat is widely distributed across Oceania, Southeast Asia and South Asia (Bonaccorso 1998; Brosset 1962; Nowak and Paradiso 1983). In Australia, the bare-rumped sheath-tailed inhabits northeastern Queensland, the Northern Territory and the Kimberley in Western Australia (Milne et al. 2009). Within the Northern Territory, the bare-rumped sheath-tailed bat is typically found in the floodplain area of Kakadu National Park. In Australia, habitat preference for this species is typically eucalypt forests and woodlands in near-coastal areas (Friend and Braithwaite 1986; Dennis 2012).

Not much is known about the roosting habitat of the bare-rumped sheath-tailed bat, however a small number of confirmed roost sites in Australia have been confirmed, all of which located in tree hollows (Churchill 1998; Compton and Johnson 1983). Similarly, little is known about reproduction and gestation of this species, however females are known to give birth to a single young between December to April in the Northern Territory (Churchill 1998; Compton and Johnson 1983).

Black-footed tree-rat (Kimberley and mainland Northern Territory)

The black-footed tree-rat (Kimberley and mainland Northern Territory) is restricted to forests and woodlands in the north Kimberley in Western Australia and mainland Northern Territory. It occurs mostly in lowland open forests and woodlands dominated by Eucalyptus species (Friend 1987). In the Northen Territory, this species has been located in Kakadu National Park, Litchfield National Park, Gunak Gurig Barlu National Park, Charles Darwin National Park, Berry Springs Nature Park and Manton Dam Recreation Area (Woinarski et al. 2014; Northen Territory Government 2021). The black-footed tree-rat is a nocturnal species that predominantly dens in tree hollows, but occasionally in dense foliage or in buildings (Woinarski et al. 2014). Foraging occurs both on the ground and in trees, and individuals can forage more than 500 m from roost sites (Friend et al. 1992). Breeding may occur throughout the year, but in the Northern Territory peaks in August to September (Friend 1987). Litter size is between one and three young, with a known gestation period of approximately 43 days (Crichton 1969).

Northern brushtail possum

The northern brushtail possum has a patchy distribution ranging from the Kimberley in Western Australia to the Gulf of Carpentaria in the Northern Territory but is predominantly found in the Northern Territory (McKenzie 1981. Morris et al. 2008). This marsupial is nocturnal and semi-arboreal, occurring mostly in tall eucalypt forests with large hollow-bearing trees but has also been recorded in some mangrove communities and rainforests. (Kerle 1985; Friend and Taylor 1985, Woinarski et al. 2011). The northern brushtail possum has no distinct breeding season (Kerle and Howe 1992). Sexual maturity is achieved at around 12 to 15 months, and longevity is presumed to be up to ten years (Kerle and Howe 1992).

Terrestrial reptiles

Mitchell's water monitor

Mitchell's water monitor is endemic to northwestern Australia, the Northern Territory, and northwest Queensland (Wilson and Knowles 1988). This species inhabits freshwater and saline wetlands, including rivers, creeks, swamps and mangroves, and is both arboreal and semi-aquatic, moving between trees and the water for habitation (Shine 1986; de Laive et al. 2021; Wilson and Swan 2021). Habitat choice and diet for Mitchell's water monitor has been found to correlate to seasonality, with populations in the Magella catchment of the

Northern Territory found to have diet dominated by fish in the wet season, whereas in the dry season, Mitchell's water monitor predominantly feeds of terrestrial invertebrates (Shine 1986). Nesting sites are unknown, but this species has been found to develop eggs late into the wet season and early in the dry season (April to June) (Shine 1986).

Plants

Darwin cycad

Darwin cycad (*C. armstrongii*) is a medium cycad endemic to the Northern Territory. Preferred habitat consists of open grassy woodlands. Prime cycad habitat has deep loamy, well-drained soil and the species is frequently associated with E. miniata and E. tetrodonta (Liddle 2009).

Typhonium praetermissum

Typhonium praetermissum is a small ground herb, found during the wet season. Preferred habitat includes open *E. miniata* woodland with well-draining soil. It is endemic to the Northern Territory, with a distribution across the greater Darwin region.

Invertebrates

Atlas moth

The atlas moth (*Attacus atlas*) is a large insect, with a range restricted to coastal areas in the north-western Northern Territory and the Kimberley. Preferred breeding habitat includes the edges of large patches of monsoon forests, with semi-deciduous vine thickets being critical habitat. The atlas moth depends on *Croton habrophyllus* as a larval food plant. The species is present during the latter half of the wet season, typically January to March.

Marine reptiles

Six species of marine turtles are known to occur in Northern Territory waters, although the green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*) and flatback (*Natator depressus*) turtles are the only species known to frequent Darwin Harbour regularly.

Green turtles inhabit areas of coral and rocky reefs and inshore seagrass and algal beds. Adult green turtles are herbivorous feeding primarily on seagrasses and algae, while juveniles are carnivorous (NTG 2021a; DCCEEW 2025a). The hawksbill turtle prefers rocky and coral reef habitats where it feeds on a wide variety of plants and animals including sponges, gastropods, seagrass and algae (NTG 2021b; DCCEEW 2025b). Flatback turtles inhabit shallow, soft-bottomed seabeds and feed on soft corals and soft bodied animals such as jellyfish and sea cucumbers (NTG 2021c).

Aerial turtle surveys undertaken by INPEX during the execution of the Ichthys Project estimated a population size of between 500 and 1,000 for the Darwin region (Cardno 2014). Turtles were primarily observed in shallow waters (<10 m), with the highest densities recorded between East Point and Lee Point, and near Gunn Point (Cardno 2015b). Turtles were also sighted throughout Darwin Harbour, although at lower densities. It is likely that the majority of turtles observed in the Harbour during these surveys were green turtles, as they accounted for 74% of sightings during fine scale land-based observations.

No turtle nesting sites are known to occur in Darwin Harbour, with the closest nesting site in the Darwin region located at Casuarina Beach. Other turtle nesting sites include Bare Sand Island and Quail Island located near the mouth of Bynoe Harbour (~50 km from Darwin). Within the Darwin region most turtle nesting is associated with flatback turtles, with only small numbers of other turtle species occasionally nesting in the area. A study undertaken by Chatto and Baker (2008) found that flatback turtle nesting predominately occurred between May and October; however, it was noted that at locations such as Casuarina Beach nesting was recorded in small numbers throughout the year.

The saltwater crocodile (*Crocodylus porosus*) is a common resident of Darwin Harbour and surrounds. In 2020 a total of 246 crocodiles were removed from Northern Territory waters with a majority of these being caught within Darwin Harbour (NTG 2021d). Saltwater crocodiles breed during the wet season between October and May. Preferred nesting habitat of the saltwater crocodile includes elevated, isolated freshwater swamps that do not experience the influence of tidal movements (DCCEEW 2025c). Nesting within Darwin Harbour is limited (INPEX 2010).

Marine mammals

A number of marine mammal species frequent or are known to inhabit Darwin Harbour and its surrounds, including coastal dolphins, dugongs and whales. Of these, the most commonly recorded marine mammals in Darwin Harbour are dolphin species.

The Australian snubfin (*Orcaella heinsohni*), the Australian humpback (*Sousa sahulensis*) and the Indo-Pacific bottlenose (*Tursiops aduncus*) are all dolphin species known to have resident populations within Bynoe Harbour, Darwin Harbour and Shoal Bay. Long-term monitoring (2011 to 2019) highlighted a small, mobile and variable nature of dolphin populations in the Darwin region (Griffiths et al. 2020). Population estimates for the Darwin region between surveys varied between 75 and 169 dolphins with an average of 141 dolphins. Darwin Harbour has been identified as a biological important area (BIA) for breeding and foraging, for all three dolphin species.

Dugongs (*Dugong Dugon*) are also known to occur in the Darwin region. Dugong monitoring using aerial surveys was undertaken during execution of the Ichthys Project, population estimates calculated from sightings observed during these surveys suggest that approximately 180 to 300 individuals inhabit the Darwin region (Cardno 2014). Dugongs feed almost exclusively on seagrass and their distribution is broadly coincident with seagrasses in tropical and sub-tropical waters (DCCEEW 2025d).

Fish and sharks

Three threatened sawfish species, one migratory sawfish and one threatened shark species may occur within Darwin Harbour. These include the dwarf sawfish (*Pristis clavata*), large toothed/freshwater sawfish (*Pristis pristis*/*Pristis microdon*), green sawfish (*Pristis zijsron*), the narrow sawfish (*Anoxypristis cuspidata*) and the northern river shark (*Glyphis garricki*).

The dwarf sawfish generally occur in shallow waters (0-20 m) in coastal and estuarine areas of tropical Australia, extending some distance up rivers almost into freshwater. In the Northern Territory, it has been recorded in several catchments, including the Keep River, Victoria River, South Alligator River and in Buffalo and Rapid Creek located in Darwin Harbour (NTG 2025a).

The large toothed/freshwater sawfish generally occur in waters 0-60 m depth, preferring muddy substrate in the upper reaches of estuaries and freshwater areas. It is primarily a marine/estuarine species, that spends its first three to four years in freshwater. In the Northern Territory, it is known to occur in the Keep, Victoria, Adelaide, East Alligator, South Alligator, Daly, Goomadeer, Roper, Katherine, Limnen Bight, Wearyan, McArthur and Robinson rivers (NTG 2025b).

The green sawfish is the most commonly encountered sawfish species in Australian tropical waters. It occurs in shallow waters in areas with a muddy substrate. The species has been reported to inhabit marine inshore waters, estuaries, lagoons and freshwater, but most records are from marine and estuarine areas. In the Northern Territory, it has only been recorded in Buffalo Creek in Darwin Harbour (NTG 2025c).

The narrow sawfish is found mainly in inshore coastal waters, to depths of around 40m, where it is thought to spend most of its time on or near the bottom. It may also enter estuaries and river deltas, and has been reported to move upstream into rivers, although its occurrence in freshwater has yet to be verified (Last & Stevens 2009).

Northern river sharks utilise rivers, tidal sections of large tropical estuarine systems and macrotidal embayments, as well as inshore and offshore marine habitats. In the Northern Territory, records have come from the Adelaide, South and East Alligator rivers, and the Wessel Islands (CoA 2015; NTG 2025d).

4.2.4 Biological important areas

Darwin Harbour has been identified as a BIA for breeding and foraging, for Australian snubfin dolphin (*O. heinsohni*), Indo-Pacific humpback dolphin (*S. chinensis*) and Indo-Pacific bottlenose dolphin (*T. aduncus*). Darwin Harbour is also considered a BIA for flatback turtle internesting. While Darwin Harbour is a known BIA for dolphins and the flatback turtle, there are no significant marine turtle nesting beaches or dolphin feeding habitats in the vicinity of the Project area.

4.2.5 Protected areas

Northern Territory reserves and parks

The Northern Territory Parks and Wildlife Commission are responsible for the conservation care, control and management of parks and reserves in the Northern Territory. No protected reserves or parks overlap the Project area; however, there are a number of parks and reserves within proximity to the Project area these are presented in Table 4-6 and shown on Figure 4-5.

Table 4-6: Protected areas and International Union for Conservation of Nature (IUCN) categories (in proximity to Project area).

Protected area	Jurisdiction	IUCN category	Distance to Project area
Casuarina Coastal Reserve	State (Northern Territory)	V (protected landscape or seascape)	15 km
Charles Darwin National Park	State (Northern Territory)	V (protected landscape or seascape)	6 km
Holmes Jungle Nature Park	State (Northern Territory)	V (protected landscape or seascape)	11 km
Knuckey Lagoons Conservation Reserve	State (Northern Territory)	IV (habitat or species management area)	8 km
Howard Spring Nature Park	State (Northern Territory)	V (protected landscape or seascape)	13 km

Protected area	Jurisdiction	IUCN category	Distance to Project area
Howard Spring Hunting Reserve	State (Northern Territory)	VI (protected area with sustainable use of natural resources)	16 km

Figure 4-5: Parks and reserves in proximity to the Project area

Wetlands

There are no RAMSAR wetlands within or in proximity to the Project area; however, a national important wetland (NIW), Port Darwin NIW, overlaps the Project area (refer to Figure 4-6).

Port Darwin NIW comprises of the entire embayment of Port Darwin and encompasses over 48,000 ha, including at least 16,000 ha of mangroves (DCCEEW 1993). The site is characterised by a megascale embayment, with macroscale and microscale islands, fringing reefs and subtidal coral platforms. Port Darwin is a major nursery area for estuarine and offshore fish and crustaceans and supports a variety of seabirds and migratory shorebirds that breed, roost and stop-over in the wetland. The mangroves of this site are the most extensive and species-rich of any Northern Territory embayment, supporting at least 36 species of flora, including several Northern Territory endemics (DCCEEW 1993).

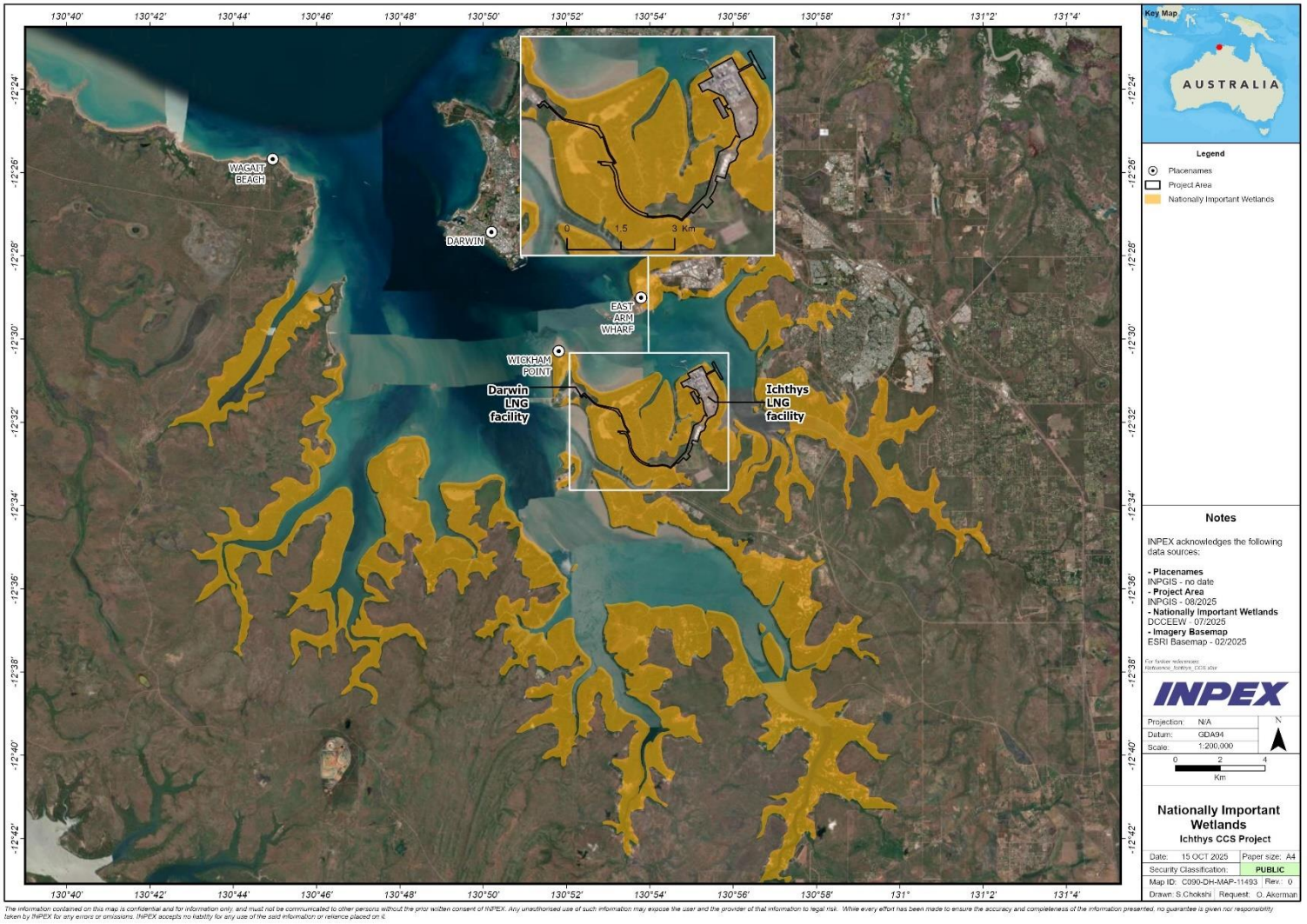


Figure 4-6: Nationally important wetlands

4.2.6 Invasive Species

Introduced terrestrial fauna species recorded on Bladin Point include the cane toad (*Rhinella marina*), feral pigs (*Sus scrofa*), cats (*Felis catus*), black rat (*Rattus rattus*) and insect pest species. The cane toad is the most widely occurring pest species recorded on Bladin Point. Feral cats were recorded along the GEP in December 2013 (AEC Environmental 2014). The tracks of dogs or dingoes were also recorded in December 2013; however, no animals were sighted (AEC Environmental 2014).

Annual weed surveys have been undertaken on Middle Arm Peninsula for environmental monitoring compliance. Weed surveys undertaken in and around Ichthys LNG facility between November 2018 and May 2023 recorded 12 weed species (Table 4-7), some of which are listed as declared weeds under the *Weeds Management Act 2001* (Northern Territory).

Some species of introduced flora are declared to be weeds under the Northern Territory Weeds Management Act 2001 because of the environmental and/or economic harm they can cause. Class A weeds are to be eradicated by landowners and occupiers. Class B weeds must have their growth and spread controlled by landowners and occupiers.

The remaining introduced flora species are referred to as environmental weeds. The Commonwealth Government has also categorised some species as Weeds of National Significance (WoNS). WoNS are a significant problem in the Northern Territory and pose multiple threats to the savanna woodlands, resulting in intense wildfires and tree canopy destruction. Weed distribution is often related to environmental disturbances caused by the construction of roads and tracks and feral animals.

Thirty-two incidental weed records were obtained during field investigations in December 2023 (EcOZ 2023a). Gamba grass (*Andropogon gayanus*) was the most common weed species (nine occurrences), followed by wild passionfruit (*Passiflora foetida*) and hyptis (*Mesosphaerum suaveolens*) (both six occurrences). There were two WoNS present within the Project area – gamba grass and lantana (*Lantana camara*). Weeds were most prominent along the edges of tracks and disturbed areas that had been previous cleared.

Table 4-7: Weed species recorded within the Project area

Common name	Scientific name	WoNS*	Northern Territory *Weeds Management Act 2001* Class†
Annual mission grass	*Cenchrus pedicellatus*	No	-
Barnyard grass	*Echinochloa colona*	No	C
Gamba grass	*Andropogon gayanus*	Yes	B
Hyptis	*Mesosphaerum suaveolens*	-	B
Lantana	*Lantana camera*	Yes	B
Lion’s tail	*Leonotis nepetifolia*	No	B
Mimosa	*Mimosa pigra*	Yes	A

Common name	Scientific name	WoNS*	Northern Territory *Weeds Management Act 2001* Class†
Perrennial mission grass	*Cenchrus polystachios*	No	B
Sicklepod	*Senna obtusifolia*	No	B
Sida - flannel weed	*Sida cordifolia*	No	B
Stylo - carribbean	*Stylosanthes hamata*	-	-
Wild passionfruit	*Passiflora foetida*	No	-

* Weeds of National Significance (WoNS) are weeds identified as a threat to Australian environments based on their invasiveness, potential for spread, and socioeconomic and environmental impacts; There are currently 20 species listed as WoNS.

† Weeds under the Northern Territory *Weeds Management Act 2001* may be declared within the following classes, defined as Class A (To be eradicated), Class B (Growth and spread to be prevented), Class C (Not to be introduced to the Territory), Class D (Not to be spread by the actions of persons) or Unclassified (Declared but not classed as above). All Class A and B weeds are also considered to be Class C weeds. All weeds, regardless of classification, are subject to the general duties of the Act.

4.3 Cultural environment

4.3.1 Traditional owners

Aboriginal and Torres Strait Islander peoples' continuing connection to country is recognised in Australia under both State/Territory and Commonwealth legislation. At a national level, the *Native Title Act 1993* (Cwlth) establishes Native title, which recognises, under Australian common law, pre-existing Indigenous rights and interests according to traditional laws and customs. Native title is different from land rights as it is not a grant or right created by governments.

Aboriginal land in the Northern Territory is defined by the *Aboriginal Land Rights (Northern Territory) Act 1976* (Cwlth), which affords Traditional Owners sovereign rights to country. In some instances, where Native Title exists it may extend over land and sea.

Two Aboriginal land councils represent Aboriginal communities in the region: the Northern Land Council and Tiwi Land Council in Northern Territory. There are also a number of Prescribed Bodies Corporates that represent Aboriginal peoples in the Northern Territory.

The Larrakia people are recognised as Traditional Owners and custodians of the Darwin region, including Middle Arm Peninsula, whose country stretches from Finnis River in the West to Adelaide River in the east, and inland along the Charlotte River. Both historic and present cultural places are located throughout Darwin Harbour, and the Larrakia people continue to maintain culture and uphold links to the land and sea country (Earth Sea Heritage Survey 2024).

It has been established that human presence in the Northern Territory dates back 65,000 years, and continuous occupation of the Tiwi Islands of at least 6,000 years, pending further archaeological investigation (Burns 1994). Archaeological sites and evidence, including shell mounds and rock art, found throughout Darwin and Middle Arm Peninsular in the harbour provides evidence for Aboriginal occupation of this area over time and throughout landscape changes (O'Brien et Al. 2025).

Aboriginal and Torres Strait Islander peoples have passed down their culture through generations over the past 65,000 years. Historically, Aboriginal people lived in small family groups and were semi-nomadic, with each family group living in a defined territory, systematically moving across a defined area following seasonal changes. Aboriginal people built semi-permanent dwellings; as a nomadic society emphasis was on relationships to family, group and country. Membership within each family or language group was based on birthright, shared language, and cultural obligations and responsibilities. Groups had their own distinct history and culture and at certain times, family groups would come together for social, ceremonial and trade purposes (Working with Indigenous Australians 2023).

4.3.2 Cultural heritage sites and objects

Since the 1980's, over 30 terrestrial and maritime related heritage studies have been undertaken at Middle Arm (Earth Sea Heritage Survey 2024). These studies identified several archaeological features, including shell mounds on Channel Island and on Coastal areas of Darwin Harbour (Burns 1994, Bourke 1996), petroglyphs at Middle Arm (Bourke and Mulvaney 2003), skeletal remains at Middle Arm (Richardson 1996) and shell middens at Wickam Point (Crassweller 2002).

A 2024 draft heritage desktop study investigated the area between the current INPEX operated Ichthys LNG facility and the Darwin LNG facility. It found that the northern section of the wider Middle Arm Peninsula contains some 123 recorded archaeological / heritage sites and isolated artefacts.

A small number of these sites intersect with the Project area, most notably around the Darwin LNG pipeline tie-in station, to the south of the salt flats in the Ichthys CCS pipeline (Darwin LNG link) area and at the intersection of Wickham Point Road and the Ichthys LNG facility access road. There are no known Aboriginal heritage sites remaining within the fence line of the Ichthys LNG facility.

In the Northern Territory Aboriginal heritage sites/objects are automatically protected under the *Heritage Act 2011* (Northern Territory).

4.3.3 Sacred sites

Sacred sites are places within the landscape that have a special meaning or significance under Aboriginal tradition. In coastal and sea areas, sacred sites may include features that lie both below and above the water (AAPA 2023). There are several sacred sites in Darwin Harbour and the surrounding waters. All sacred sites within the Northern Territory are protected under the *Northern Territory Aboriginal Sacred Sites Act 1989*.

Anyone proposing to use or work on land in the Northern Territory may apply to the AAPA for an Authority Certificate to cover their proposed activities. Authority Certificates are issued following consultation with traditional custodians and include conditions on what can and cannot be done in and around identified sacred sites. The Larrakia people are acknowledged as the traditional owners of the area in and around Darwin.

INPEX currently holds three Authority Certificates which cover the Project area and works associated with the Project (refer to Table 4-8).

The Project through its infrastructure design, including construction and decommissioning methodologies would seek to avoid and minimise the impacts on known heritage sites as far as reasonably practicable, implement robust chance finds procedures, leverage its stablished mechanisms to facilitate consultation and heritage management with Larrakia people and organisations, as well as ensure compliance with regulatory heritage requirements.

Table 4-8: AAPA Authority Certificates relevant to Project activities

Certificate reference	Subject land	Proposed work or use
C2011/166	Section 1813 Hundred of Ayres, Section 1814 Hundred of Ayers, NT Portion. 2367 and Middle Arm, inclusive of adjacent areas of mangroves and Darwin Harbour waters.	All works necessary to plan, develop, operate and maintain an industrial estate for gas-based industry, including but not limited to seabed dredging activities.
C2025/082	Part of Sections 1860, 1861, 1889 Hundred of Ayres, Darwin NT.	Works for the planning, development, construction, installation, operation, inspection and maintenance of a carbon dioxide gas pipeline facility up to 50 m wide with a nominal pipeline burial depth of up to 1.5 m (with a maximum depth of 25 m) comprising: • geotechnical, terrestrial flora and fauna surveys, site surveying for levelling; • ground disturbance and improvement; • land and vegetation clearing; • vehicle and construction equipment access; • excavation and backfilling; and • ongoing inspection and maintenance activities.
C2014/007	Part of Darwin Harbour.	Environmental monitoring programs involving one or more of the following general activities: soft bottom benthos monitoring, water quality and sedimentation, marine pest monitoring, fish and invertebrate monitoring.

4.3.4 Historic Heritage

Archaeological surveys undertaken to support the Ichthys Project identified World War II objects on Bladin Point. Objects found within the vicinity of Ichthys LNG facility were deemed to not be of heritage value and were removed following consultation with the Northern Territory Heritage Branch. There are no known World War II heritage sites within the fence line of the Ichthys LNG facility, where Project activities are planned to be undertaken.

A search of the Australian Heritage Database shows that there are two places as part of the Register of the National Estate (RNE), a non-statutory database of sites of significance around Australia, within vicinity of the Project area, as shown in Figure 4-7.

- Channel Island Leprosarium: Site Status – Registered (14/05/1991)
- Channel Island Reefs: Site Status – Registered (30/06/1992)

In the Northern Territory Heritage register The Channel Island Leprosarium and Reefs (approximately two kilometres southwest of the Project area) have been declared and are protected under the *Heritage Act 2011* (Northern Territory), as per Figure 4-7.

The Channel Island Leprosarium was the site of a Quarantine Station, completed in September 1914, in the Northern Territory. It was one of four stations which were considered as "first-aid" or minor stations which were required to provide accommodation for all cases of actual quarantinable disease likely to require action. In 1930 a new Quarantine Station was opened on East Arm and Channel Island was converted to a Leprosarium.

The Leprosarium is considered culturally significant as it provides a unique view of a compulsorily isolated group of people, existing under extreme physical and in some cases mental conditions. It also demonstrates the official policy of enforced segregation of diseased people. The ruins are evidence of the Quarantine requirements of the period including the segregation of inmates on the island. Its social significance is further enhanced by the fact that while the rest of the world was modifying its compulsory isolation laws, in Australia they were strengthened.

The Channel Island Reefs have been designated for their unique position and species diversity in a large ria (drowned river valley) system characterised by stressors (high turbidity, currents, sedimentation and depressions in salinity) that are not normally considered conducive to coral growth or presence (DTFHC 2021).

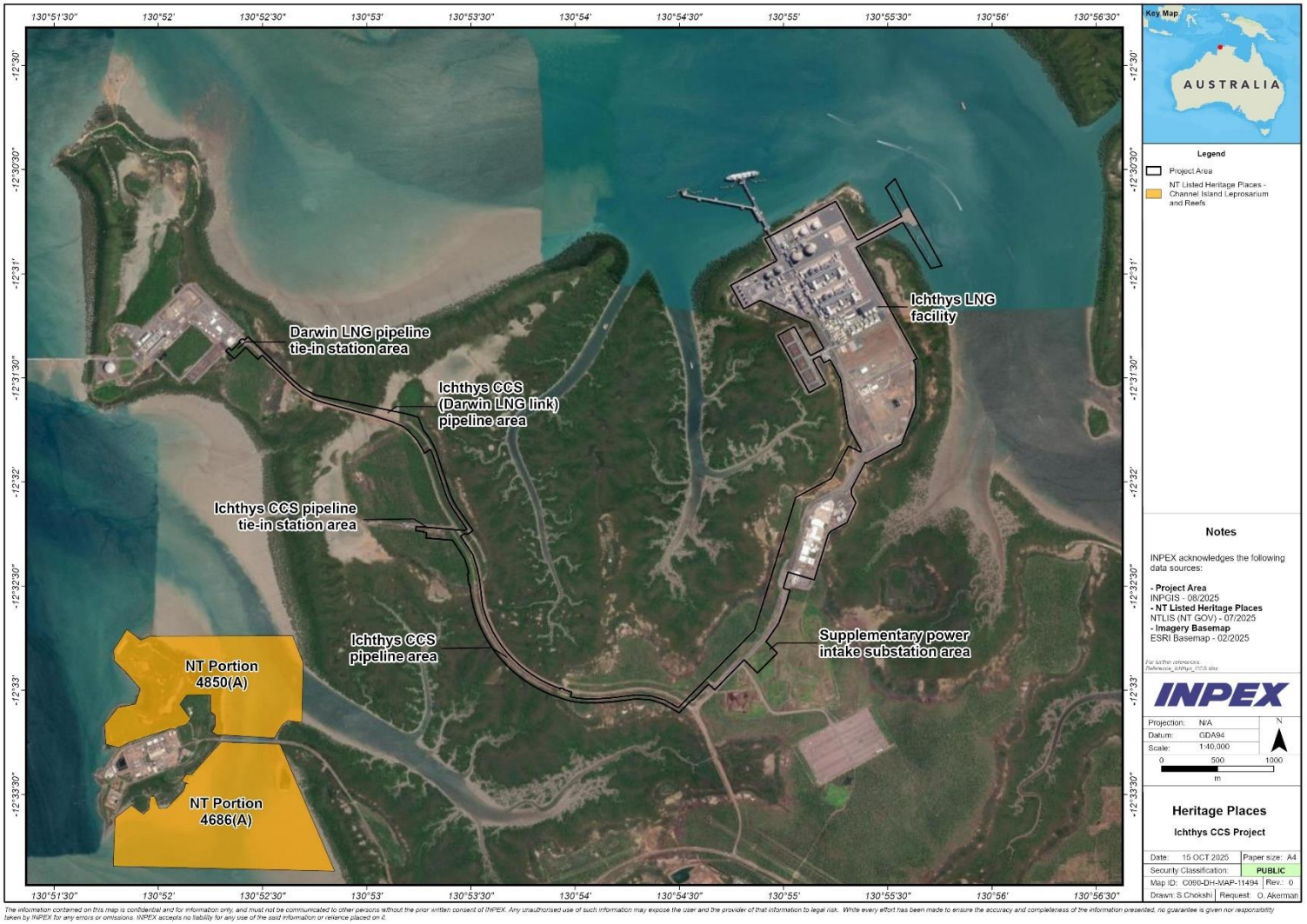


Figure 4-7: Heritage places in proximity to the Project area

4.4 Socio-economic environment

4.4.1 Existing land use and infrastructure

The Project area is located within the Middle Arm Precinct, which provides an area for processing and transmission of utilities, particularly gas. This includes most notably the Ichthys LNG and Darwin LNG facilities and their associated infrastructure. Oil and gas infrastructure in proximity to the Project area, as well as current land uses of Middle Arm Peninsula are presented in Table 4-9.

Wickham Point Road and Channel Island Road are public access roads providing entry to the industrial premises, with associated parallel utility corridors.

Table 4-9: Current land uses of Middle Arm Peninsula

Land use	Operator/owner	Distance from the Project area
Darwin LNG facility	Santos	200 m north of Project area
Channel Island power station	Territory Generation	2 km south-west of Project area
Weddel power station	Territory Generation	5 km south-east of Project area
Bladin village	Trepang Services Pty Ltd	2 km south-east of Project area
Darwin aquaculture centre	Northern Territory Government	2 km south-west of Project area

Darwin Port

Darwin Port is a working port and is developing into a major service centre for the mining and energy sectors. Darwin Port operations consist of marine traffic of non-commercial vessels (e.g. recreational anglers) and trading vessels, including commercial ships carrying cargo and passengers, rig tenders, tankers and bulk-cargo vessels that regularly utilise East Arm Wharf and Hudson Creek.

Defence areas and Unexploded Ordnances

The Project area does not overlap any defence areas or Unexploded Ordnances (UXO), however there are several defence training areas and bases in the Darwin area, including:

- Larrakeyah Barracks (9 kilometres north-west of the Project area)
- Robertson Barracks (10 kilometres north-east of the Project area)
- Naval base HMAS Coonawarra (9 kilometres north-west of the Project area)
- Defence Establishment Berrimah (8 kilometres north of the Project area)
- RAAF Base Darwin (11 kilometres north of the Project area)

Tourism and recreation

Most recreational and tourism activities in the region occur predominantly in State/Territory waters adjacent to population centres, such as Darwin. Tourism in the region typically peaks during the dry season (May to October), which includes activities such as recreational fishing, diving, snorkelling, wildlife watching and boating (DEWHA 2008).

Darwin Harbour supports a range of commercial and recreational maritime uses, including fisheries, tourism and recreational shipping/boating activities. Fishing tourism is important to the Northern Territory's economy and there are several fishing clubs that utilise Darwin Harbour.

The water surrounding Middle Arm Peninsula is used for recreational fishing, sailing and general boating. Boat ramps in proximity to the Project area include Channel Island, Palmerston and East Arm (Errity 2022). However, tour boats in Darwin tend to avoid the Middle Arm because of navigational hazards in the shallow nearshore waters (URS 2002).

Fisheries

Surveys over an eight-month period recorded up to a total of 56370 hours of fishing effort in the Middle Arm "fishing region" and 44,509 hours in the East Arm "fishing region," consisting mostly of snapper and mullet (Errity et al. 2022).

Fish species commonly targeted in Darwin Harbour by recreational fishers include snapper, mud crab, barramundi, small bait fish and some game fish. Boat ramps in the inner Darwin Harbour include Channel Island, Dinah Beach, East Arm and Palmerston.

5 STAKEHOLDER CONSULTATION

INPEX believes effective stakeholder consultation is essential in maximising the safety of Company and Contractor personnel, and the community; and in establishing, building and maintaining community support and trust. INPEX works closely with identified stakeholders to provide integrated, timely and effective information to the community and provide mechanisms for feedback and response.

INPEX's approach to integrated stakeholder consultation is based on five key principles:

- regular personal contact with key stakeholders
- consistent, timely, coordinated and responsive communication across all stakeholder groups
- upfront communication about issues and impacts
- easily accessible information; and
- ongoing monitoring and improvement.

A stakeholder engagement plan has been prepared to meet the regulatory requirements for consultation under the EPBC Act (Cwlth) and the NT *Environment Protection Act 2019* (EP Act), and subordinate legislation (refer to Appendix C).

Schedule 2 of the Environment Protection and Biodiversity Conservation Regulations 2000 outlines the requirements of information that needs to be included within a referral. Clause 4.01(l) of the schedule requires the following:

A description of any public consultation undertaken or occurring, including with indigenous persons that may be affected by the action, and copies of documents recording the outcomes of any consultations.

Section 43 of the EP Act (NT) outlines the general duty of proponents and includes specific requirements for stakeholder consultation. Specifically, the EP Act requires the following:

A proponent of an action has the following general duties under an environmental impact assessment process:

a. *To provide communities that may be affected by a proposed action with information and opportunities for consultation to assist each community's understanding of the proposed action and its potential impacts and benefits;*

b. *To consult with affected communities, including Aboriginal communities, in a culturally appropriate manner; and*

c. *To seek and document community knowledge and understanding (including scientific and traditional knowledge and understanding) of the natural and cultural values of areas that may be impacted by the proposed action.*

In addition to the EP Act requirements, the NT EPA *Stakeholder Engagement and Consultation: Environmental Impact Assessment Guidance for Proponents* (SEC) outlines the expectations of the NT EPA with regards to stakeholder consultation. The SEC outlines that proponents are responsible for undertaking stakeholder consultation from the earliest stage of the environmental impact assessment process, and that stakeholder consultation would continue throughout the life of an activity.

An overview of INPEX's approach to stakeholder consultation, the stakeholder consultation undertaken to inform the development of the supporting approval applications, and the ongoing stakeholder consultation activities that would be undertaken throughout the execution of the Project is described in the following sections.

5.1 Overview of stakeholder consultation process

An overview of INPEX's approach to stakeholder consultation is presented in the following sections. A full description of the approach is provided in the Ichthys Carbon Capture and Storage (CCS) Project Stakeholder Engagement Plan (refer to Appendix C).

5.1.1 Stakeholder mapping

INPEX has undertaken a stakeholder mapping exercise to identify relevant stakeholders and ensure they are engaged in the most effective manner with targeted and responsive engagement activities for the purposes of the Project.

Stakeholders were initially screened to establish if their functions or activities could be potentially impacted as result of either overlap with the Project area or as a result of Project activities. Where there was no perceived effect on a stakeholder's functions or activities the stakeholder was not considered further.

It is acknowledged that through the process of consulting with identified stakeholders, additional stakeholders may be brought to INPEX's attention.

5.1.2 Timing

Timing of stakeholder engagement will be implemented during the following key stages, as follows:

- Pre-referral engagement - the purpose of the engagement was to:
  - obtain advice on appropriateness of proposed management controls; and
  - obtain advice on required notifications and ongoing engagement requirements.
- Ongoing engagement – the purpose of this engagement is to:
  - provide sufficient notice to key stakeholders prior to the commencement of the Project to ensure effective communication of the timing of works, and the associated safety and environmental measures
  - provide information throughout the Project, to support safety outcomes and manage potential community impacts; and
  - provide confirmation of completion of the above to communicate the Project outcomes.

5.1.3 Engagement tools

A range of tools will be used to target and engage with stakeholder groups in an appropriate manner. INPEX considers industry best practice standards and codes of conduct in designing project specific engagement. These tools build on the successful activities employed by INPEX in the NT since 2009 and are informed by stakeholder needs and requirements. INPEX will continue to maintain and develop stakeholder relationships given the long-term operational life of the Project.

Engagement tools may include formal briefings for stakeholders, public information forums, advertising and media (including social media), fact sheets, INPEX website, INPEX 1800 community feedback line and INPEX enquiries email account.

5.2 Stakeholder consultation – Pre-referral

The complete stakeholder register, outlining stakeholders who were consulted during the pre-referral stage and any relevant information that was provided to them for consideration, is presented in Appendix D. Where feedback was received a summary of this and how it has been addressed in this supporting document is provided in Table 5-1.

Table 5-1: Summary material matters raised

Stakeholder	Summary of material stakeholder feedback	Summary of INPEX response or actions
DME	The Northern Territory Department of Mines and Energy advised INPEX that amendments to the *Energy Pipelines Act 1981* (NT) are being proposed to address this gap and that relevant licence and standards would apply to the proposed CO_2 export pipeline.	The design of the pipeline adheres to the standards applied to pipelines under the Energy Pipelines Act 1981 (Refer to *CO2 export pipeline design*).
Larrakia Development Corporation (LDC)	LDC assisted INPEX to arrange a series of Larrakia family meetings. Feedback was Larrakia families would like to remain informed and gave INPEX feedback on how to continue consultation with the as the project progresses.	INPEX will incorporate feedback into the design of ongoing consultation activities to be implemented under the Stakeholder engagement plan (Appendix C).
Larrakia Nation Aboriginal Corporation (LNAC)	LNAC hosted Larrakia family meetings to facilitate communication between INPEX and the families.	Feedback received during the meetings informed the ongoing consultation program.
City of Palmerston	The City of Palmerston raised concerns about workers utilising parking within community areas.	Early consideration in Project planning to manage potential for localised impacts to community parking amenity, traffic, bussing used to minimise traffic (refer to Section 2.3.4).

5.3 Stakeholder consultation – Ongoing

Stakeholder engagement that will be undertaken throughout the life of the Project is described in the Ichthys Carbon Capture and Storage (CCS) Project Stakeholder Engagement Plan (refer to Appendix C).

6 ENVIRONMENTAL IMPACT ASSESSMENT METHODOLOGY

The assessment of potential environmental impacts involved the following:

1. desktop review of available information, to provide a description of the existing environment relevant to the Project area (Section 4)
2. a likelihood of occurrence assessment for threatened species (Section 4.2.3 and Appendix B)
3. a preliminary assessment of the potential for the Project to result in significant impacts on NT EPA environmental factors (Section 7).
4. a preliminary assessment of the potential for the Project to result in significant impacts on MNES protected under the EPBC Act (Section 8).
5. determining a proposed program of future investigations and studies (Section 9).

6.1 Desktop review

A desktop review was conducted to inform the description of the existing environment in and around the Project area (Section 4), and was informed by the following publicly available data sources:

- Species Recovery Plans, Conservation Management Plans and Threatened Species Scientific Committee (TSSC) approved conservation advice
- Peer reviewed scientific papers
- Previous environmental studies within or in proximity to the Project area, including INPEX technical reports relevant to the footprint area
- Publications and resources from relevant organisations, including:
- Geoscience Australia
- Birdlife Australia
- Databases, including:
  - Protected Matters Search Tool (PMST) (DCCEEW 2025a)
  - Species Profile and Threats Database (DCCEEW n.d.).
  - Atlas of Living Australia (ALA)
  - Flora Atlas – Nature Resources (NR) Maps
  - Fauna Atlas – NR Maps.

The 2025 EPA draft guidelines for the assessment of impacts on terrestrial biodiversity (NT EPA 2025c), recommend a desktop review search radius of 20 kilometres outside the proposal area, even where extensive field studies have already been undertaken.

Therefore, a conservative 20 kilometres buffer was applied to the PMST for the Project areas within this referral to ensure alignment with the draft guidelines.

In addition, existing INPEX commissioned studies and reports have been used to inform the assessment:

- EcOZ: Bladin Point Pipeline Corridor – Ecology Survey Report 2023 (2024a)
- EcOZ: Bladin Point Pipeline Corridor Typhonium survey report (2024b)
- EcOZ: Bladin Point Pipeline Corridor Ecology Studies (2023a)

- Earth Sea Heritage Surveys: INPEX Cultural Heritage Desktop Study: Carbon Capture and Storage Pipeline Project, 2024
- Ichthys Gas Field Development Project Draft EIS (INPEX Browse 2010), including Appendix 16 – Onshore flora and fauna study

6.2 Likelihood of occurrence assessment

The likelihood of occurrence was assessed for threatened and migratory species identified from the PMST report to further identify those that could potentially interact with Project infrastructure or activities within the Project area.

At a high level, the assessment identified key habitats that support resident and migratory species within the Project area and matched the habitat requirements and reported occurrence for each species based on the following sources of information:

- PMST report
- Atlas of Living Australia (ALA)
- Publicly available peer-reviewed literature
- Conservation Advice and Recovery Plans via DCCEEW species profile and threats (SPRAT) database
- Northern Territory Parks and Wildlife Conservation (TPWC) Act species status
- Existing Project-related technical reports.

The following criteria were used to define the likelihood of occurrence for each species based on the above searches:

- Known to occur – species that have been reported to occur based on ALA records or actual surveys within the Project area in the last 30 years.
- Likely to occur – species that have not been reported to occur in the Project area but known to occur within the local area (within 20 kilometres of Project area) based on nearby Biologically Important Areas (BIA) and/or important habitat requirements (including breeding, foraging, or roosting) within the species known distribution.
- May occur – species that have not been reported to occur in the Project area, have a broader distribution, utilise a variety of habitats across the region and may transit the Project area.
- Unlikely to occur – species that have not been reported to occur in the Project area and are not likely to occur within the Project area due to the lack of suitable habitat and their known distribution does not overlap with the Project area.

Only those species that are known to occur or, likely to occur or may occur (as summarised in Section 4.2.3, were considered further.

6.3 INPEX impact and risk assessment methodology

An environmental risk assessment was undertaken to evaluate impacts and risks arising from the activities described in Section 2. This section describes the process in which impacts, and risks were identified.

A project-wide environmental hazard identification and risk assessment workshop was undertaken for the activity. The workshop involved environmental, compliance, health, safety, emergency response, drilling and engineering personnel.

The workshop was undertaken in accordance with INPEX HSE Risk Management processes. The approach generally aligned to the processes outlined in International Standards Organisation (ISO) 31000:2018 Risk Management – Principles and guidelines (Standards Australia/ Standards New Zealand, 2018) and Handbook 203:2012 Managing environment-related risk (Standards Australia/Standards New Zealand 2012).

The environmental impact and risk evaluation process has been undertaken in the following distinct stages:

- The establishment of context (including a review of legislative requirements, definition of the Project scope and description of the existing environment).
- The identification of aspects, hazards and threats relevant to Project activities during various stages based on the Project Description in Section 2, that can result in environmental effects and impacts.
- The identification of potential consequences and the key receptor groups that may be impacted (the consequence is defined using the INPEX risk matrix shown in Figure 6-1).
- The identification of key mitigation measures.
- An assessment of the likelihood (the likelihood of a particular consequence occurring was identified using one of the six likelihood categories shown in Figure 6-1).
- An assessment of the residual risk.

Project aspects include those associated with both planned activities and unplanned events (e.g. spills). Effects are identified as those that are direct effects from aspects and activities, or indirect effects.

The identified mitigation measures include those legislated and those considered standard industry practice in Australia. These are considered the minimum measures that would be implemented during the Project. Note that a comprehensive suite of additional mitigation measures will also be implemented for the Project which will be informed by the more detailed assessment process.

Risk Matrix

Refer to the Risk Matrix Guideline [0000-A0-GLN-70019] for guidance on how to apply the risk matrix.

LIKELIHOOD TABLE

Experience History of occurrence in Company or Industry with a similar context and/or timeframe	Unheard of in the industry or in Projects	Has occurred once or twice in the industry or rarely occurs in Projects	Has occurred many times in the industry but not in the company	Has occurred once or twice in the company or Projects	Has occurred frequently in the company or in many Projects	Has occurred frequently at the location or in every Project
Frequency Continuous Operation	Once every 10,000 – 100,000 years at location	Once every 1,000 – 10,000 years at location	Once every 100 – 1,000 years at location	Once every 10 – 100 years at location	Once every 1 – 10 years at location	More than once a year at location or continuously
Qualitative probability* Based on expert judgement	< 1% Less than 1 in 100	1% - 5% Up to 1 in 20	> 5% - 20% Up to 1 in 5	> 20% - 50% Up to 1 in 2	50% - 80% Up to 4 in 5	> 80% Greater than 4 in 5

* Qualitative probability is not to be used for Health & Safety or Environment risk assessments

CONSEQUENCE TABLE

Severity Level		Financial (USD)	Ichthys Production	Health & Safety	Environment	Reputation	Community	Legal	Severity	Likelihood Level 6 Remote	5 Highly Unlikely	4 Unlikely	3 Possible	2 Likely	1 Highly Likely
Consequences	A	> $1B	> 30 days Ichthys full shutdown	> 20 fatalities or permanent total disabilities	Regional scale event, permanent impact on environment. Eradication of local populations of protected species	Prolonged international multi-NGO and media condemnation and public protests. Loss of host government support and/or social licence to operate. Company reputation severely tarnished	Catastrophic and long-term impact, and destruction of highly valued social and cultural matters	Prosecution, potential jail sentences for directors and senior officers. Prolonged litigation, heavy fines (>$50M), threat to license to operate and future approvals	A Catastrophic	6	5	4 **Critical Risk**	3	2	1
	B	$100M – $1B	> 10 days Ichthys full shutdown	2 – 20 fatalities or permanent total disabilities	Large scale event, long term impact on environment. Extensive impact on populations of protected species	International multi-NGO and media condemnation. Host government registers concerns. Prolonged large protests. Company reputation seriously impacted	Major and widespread disruption to a number of communities with damage to highly valued social and cultural matters	Prosecution of company, directors or senior officers. Prolonged litigation, heavy fines (<$50M), significant restrictions on license to operate	B Major	7	6	5	4	3	2
	C	$10M – $100M	3 – 10 days Ichthys full shutdown	Serious injury or fatality	Medium to large scale event, medium term impact on environment. No threat to overall population viability of protected species	Serious public or national media outcry. Damaging NGO campaign. Large protests. Company reputation impacted	Significant disruption and impact to a community, regional communities, and to social and cultural matters of significant value	Significant, or multiple moderate breaches of legislation, regulation, contract or license conditions. Significant litigation and fines (<$5M)	C Significant	8	7	6 **High Risk**	5	4	3
	D	$1M – $10M	1 – 3 days Ichthys full shutdown	Permanent partial disability, serious illness or lost time injury	Local to medium scale event with short to medium term impact on environment. No threat to overall population viability of protected species	Major adverse national media, public or NGO attention. Significant protests. Asset reputation impacted	Regional community concern or disruption with moderate impact on social and cultural values	Moderate breach of legislation, regulation, contract or licence condition. Investigation by regulatory authorities. Potential litigation and moderate fines (<$1M)	D Moderate	9	8	7	6	5	4
	E	$100K – $1M	Production Trip with immediate restart < 1 day Ichthys full system lost production	Alternate duties injury, medical treatment injury, minor illness	Local scale event with short term impact on the environment. Minor and temporary impact on a small portion of the population of protected species	Attention from regional media with heightened concern of local community. Criticism by community or NGOs	Minor and localised community concern or disruption with limited and short-term impact on social and cultural values	Minor breach of legislation, regulation, contract or licence condition. Report provided to regulatory authorities. Potential for minor fines (<$100K)	E Minor	10	9	8 **Moderate Risk**	7	6	5
	F	< $100K	Insignificant production impact	First aid case	Local scale event with temporary impact on environment. Behavioural responses inconsequential ecological significance to protected species	Short term local concern or complaints. Low level media or regulatory issue – potential for community or union concerns	Isolated community concern with no lasting effect on social and cultural values	Breach of internal standards. Potential scrutiny by regulatory authorities	F Insignificant	10	10	9 **Low Risk**	8	7	6

Document no.: 0000-A0-TPL-60003
Security Classification: Unrestricted

Revision: 4
Date: January 2025

Figure 6-1: INPEX risk matrix

6.4 Preliminary assessment – NT EPA environmental factors and values

The Northern Territory EPA has identified 14 environmental factors categorised under five themes of Land, Water, Sea, Air and People. These environmental factors are broad divisions of the environment that may be impacted by a proposed action and provide for a systematic approach for organising information for the purpose of environmental impact assessment (NT EPA 2025b).

The preliminary assessment of significant impacts to NT EPA environmental factors and objects involved the following:

1. Screening of Project activities and potential impacts against the Northern Territory's environmental objectives, consistent with Northern Territory EPA Environmental factors and objectives (NT EPA 2025b).
2. Identification of potential impacts and key mitigation measures – potential impacts associated with Project activities during all Project stages are identified and summarised, and key mitigations are included. Potential impacts to environmental values, associated mitigation methods and risk assessment outcomes resulting from the Project activities were evaluated using the INPEX risk assessment process (refer to Section 6.3).
3. Preliminary assessment of potential impacts on Northern Territory environmental factors against the Northern Territory's environmental objectives, consistent with NT EPA Environmental factors and objectives (NT EPA 2025b).

The preliminary screening identified the following NT EPA environmental factors may be potentially impacted by Project activities (Refer to Appendix E):

- Land – Terrestrial environmental quality
- Land – Terrestrial ecosystems
- Water – Hydrological processes
- Water – Inland water environmental quality
- Sea – Coastal processes
- Sea – Marine environmental quality
- Sea – Marine ecosystems
- Air – Air quality
- People – Culture and heritage
- People – Human Health.

An assessment of potential impacts on NT EPA environmental factors and objectives is presented in Section 7.

6.5 Preliminary assessment – Significant impacts on EPBC Act MNES

Under the EPBC Act an action requires approval from the minister if it has, will have, or is likely to have, a significant impact on a MNES. A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment, which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts (Commonwealth of Australia 2013).

An assessment of the potential for significant impacts on relevant MNES (limited to listed threatened and migratory species; refer to Table 4-1) has been undertaken in accordance with the *Matters of National Environmental Significance: Significant impact guidelines 1.1 — Environment Protection and Biodiversity Conservation Act 1999* (Significant Impact Guidelines; Commonwealth of Australia 2013).

The assessment was informed by the information presented in Section 4 and Appendix B. The criteria used to determine whether a significant impact was likely to occur is presented in Table 6-1. A summary of the assessment is presented in Section 8 with further detail provided in Appendix F.

Table 6-1: Significant impact criteria for listed threatened and migratory species

MNES	Significance criteria (Commonwealth of Australia 2013)
Listed threatened species	An action is likely to have a significant impact on a species listed in any of the following categories if there is a real chance or possibility that it will:
	Extinct in the wild • adversely affect a captive or propagated population or one recently introduced/re-introduced to the wild, or • interfere with the recovery of the species or its re-introduction into the wild.
	Critically Endangered and Endangered • lead to a long-term decrease in the size of a population • reduce the area of occupancy of the species • fragment an existing population into two or more populations • adversely affect habitat critical to the survival of a species • disrupt the breeding cycle of a population • modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline • result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat • introduce disease that may cause the species to decline • interfere with the recovery of the species.
	Vulnerable • lead to a long-term decrease in the size of an important population of a species • reduce the area of occupancy of an important population, fragment an existing important population into two or more populations, adversely affect habitat critical to the survival of a species • disrupt the breeding cycle of an important population • modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline • result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat • introduce disease that may cause the species to decline • interfere substantially with the recovery of the species.

MNES	Significance criteria (Commonwealth of Australia 2013)
Listed migratory species	An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will: • substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species • result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species • seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

6.6 Proposed program of investigations

A proposed program of investigations to be undertaken to improve understanding of the baseline environmental conditions, as well as impact assessment studies, is provided in Section 9. The outcomes of these studies would inform a more detailed environmental impact assessment and identify the specific mitigation and monitoring that would be required to manage potential impacts from the Project.

7 PRELIMINARY ASSESSMENT – NT EPA FACTORS AND VALUES

The preliminary screening assessment (Appendix E) identified the Project has the potential to impact on the following ten environmental factors:

- Land – Terrestrial environmental quality
- Land – Terrestrial ecosystems
- Water – Hydrological processes
- Water – Inland water environmental quality
- Sea – Coastal processes
- Sea – Marine environmental quality
- Sea – Marine ecosystems
- Air – Air quality
- People – Culture and heritage
- People – Human Health.

A detailed assessment of the potential impacts and their significance, and proposed controls to manage and mitigate these is provided in within the following sections.

7.1 Land – Terrestrial environmental quality

Project activities have the potential to impact on the following environmental factor - terrestrial environmental quality. Specifically, inappropriate erosion and sediment control during civil construction, ASS/PASS disturbance or accidental loss/spills or mismanagement of chemicals and hazardous substances. The following sub-sections provide a description of the potential impacts and proposed key management controls to mitigate any potential impacts.

7.1.1 Relevant policy and guidelines

The following conventions, legislation, policy and guidelines are relevant:

- Guideline for the Preparation of an Environmental Management Plan (NT EPA 2015b)
- Erosion and sediment control plans for rural development (NT DLRM, n.d.)
- *Waste Management and Pollution Control Act 1998 Act* (Northern Territory)
- *Dangerous Goods Act 1998* (Northern Territory)
- International Erosion Control Association (IECA) Best Practice Erosion and Sediment Control Guidelines (IECA 2008)
- National Acid Sulfate Soils Sampling and Identification Methods Manual (Sullivan et al. 2018)
- National Acid Sulfate Soils Guidance: Guidance for the dewatering of ASS in shallow groundwater environments (National Guidance; Shand et al. 2018)
- National Strategy for the Management of Coastal Acid Sulfate Soils (National Working Party on Acid Sulfate Soils 2000)
- Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines Version 5.1 (Dear et al. 2024).

7.1.2 Environmental context

The geology and soils of the terrestrial environment are described in Section 4.1.5. The Project area contains areas of ASS and PASS, and geotechnical investigations in the area have also reported acidic soils with natural non sulphuric acidity.

7.1.3 Potential impacts

The following Project activities have the potential to result in impacts to the terrestrial environmental quality, specifically:

- vegetation clearance
- direct and indirect disturbance of soils from project construction and maintenance activities.
- unplanned release leaks of hazardous materials from batteries, transformers or other infrastructure.

Potential impacts associated with these activities include:

- erosion and topsoil migration of cleared areas
- contamination of soils
- disturbance of potential ASS.

Erosion and topsoil migration of cleared areas

Vegetation clearing and earthworks would be required within the Project area. The Project infrastructure would largely be built within an existing, previously cleared and in parts rehabilitated corridor, however clearing of some areas of previously undisturbed native vegetation would be required.

The total area cleared would be determined and refined during the project design and approvals process and depend on the final construction methodology chosen, with a large portion only planned as temporary clearance to support construction works followed by rehabilitation.

Erosion and the subsequent release of sediment, following the vegetation clearing and /or ground disturbance can result in a reduction in surface water quality due to increased sediment load from turbid runoff. High levels of run-off water turbidity may result in increased sedimentation in associated waterways and connected intertidal habitats. It may reduce levels of light availability in the environment, which may adversely impact habitats of listed marine species. Erosion risk is dependent on the likelihood and intensity of expected rainfall, the estimated rate of soil loss and the anticipated disturbance period.

The pipeline and cable construction works would be designed to minimise construction footprint and soil disturbance. The risk that the erosion hazard results in environmental harm has previously been assessed for the Ichthys GEP route adjacent to the proposed CO_2 export pipeline according to IECA 2008 guidelines. An erosion risk was identified, as follows:

- a very low to low hazard exists for land-based disturbance activities which within the dry season between May and September
- a high to extreme hazard exists for land-based disturbance activities within the wet season between October and April.

Therefore, the potential risks of erosion are limited to the construction and construction surrounding areas predominantly during the wet season. These potential erosion risks would be controlled via diversion drains, rock filter dams and a retention basin.

Contamination of soils

During project activities, including vegetation clearing, ground disturbance and unplanned release leaks of hazardous materials, contamination of the soils could occur.

Clearing activities can result in the release of fine sediment particles (silts and clays), which can remain suspended in the runoff, and the connected water column under moderate to high current speeds and cause turbid plumes. They can be resuspended by successive tidal currents to travel long distances before settling.

Sediment deposition is likely to be naturally reworked into surface sediment layers through bioturbation. The localised and temporary displacement of sediment and subsequent sediment deposition would not result in any lasting change to particle size distribution or the physio-chemical composition of sediment. As such, no lasting changes to soils, including quality is expected to occur.

Hazardous wastes associated with project activities may include hydrocarbon liquid wastes, spent solvents and chemicals. Unplanned discharges or spills to the terrestrial environment may lead to the contamination of soil. Potential indirect impacts would relate to contact of flora, vegetation and fauna with discharges.

While measures to prevent the release of hydrocarbons into the environment would always be in place, there is potential for spills and leaks on land to occur through accidents and/or failure of equipment. The potential impact from an accidental spill or leak is dependent on the location of the event and the type and volumes of materials released. Typically, however, these would be small scale.

Due to the limited spatial extent of hydrocarbons from a spill on land and limited window for exposure, potential significant impacts to receptors are not expected.

An unplanned CO_2 release from the buried section of the CO_2 export pipeline may result in impacts to surrounding substrates. A pipeline rupture would temporarily result in sub-zero temperatures, high CO_2 concentrations and hypoxic conditions with the potential for acute impacts to vegetation (He et al. 2019; Lake and Lomax 2019u). This is likely to be significant for organisms utilising the immediate substrate.

Disturbance of potential ASS

Acid sulphate soils have the potential to occur within the Project area and may lead to impacts on the surrounding environment when the soil is exposed to oxygen for a prolonged period of time.

This exposure can be caused in the following ways:

- removal of vegetation resulting in exposure and disturbance of surface soils
- excavation of the CO_2 export pipeline trench resulting in:
  - exposure of the excavated trench base and trench batters / walls to air
  - drawdown of the groundwater table from trenching activities
  - exposure of excavated material to air.
- civil works within the pipeline tie-in station areas, resulting in:
  - exposure of excavated material to air.

If storm water runoff or discharge off site occurs, water containing ASS may have detrimental effects on pH levels and heavy metal concentrations of surrounding surface water.

Excavation of the trench below the groundwater table range could contribute to groundwater contamination from nearby soil to drain into the trench. Any ASS adjacent to the trench may become oxidised and generate acid. Release of acids and heavy metals may result in potential contamination of soil and groundwater.

Given that Project activities could encounter ASS, activities would allow for segregation and treatment prior to reuse or disposal. Additional detailed chemical testing of ASS would be conducted on site during the final design phase and prior to construction.

7.1.4 Management

NT EPA environmental objective:

Protect the quality and integrity of land and soils so that environmental values are supported and maintained.

To meet the NT EPA environmental objective for terrestrial environmental quality, the following measures would be implemented to avoid and minimise potential impacts:

- Erosion and sediment control management:
  - Clearing to be undertaken preferentially in dry season conditions to avoid erosion risk associated with monsoon rains in the wet season.
  - A site-specific Erosion and Sediment Control Plan (ESCP) will be prepared in accordance with the IECA Best Practice Erosion and Sediment Control Guidelines (IECA 2008) and endorsed by a Certified Professional Erosion and Control Specialist, to manage erosion risk. The ESCP will include:
    - temporary and permanent control measures
    - protection of stockpiles and exposed soil areas
    - ongoing inspection and maintenance of controls when in effect.
  - Erosion protection infrastructure (e.g. silt fencing, contouring, etc.) will be installed in accordance with developed ESCP to ensure that sediment is contained within the construction area as far as is practicable.
  - All stormwater discharge from within the construction area will be in accordance with water quality criteria within the ESCP.
- Chemicals and hazardous substances management:
  - Personnel who routinely handle hazardous materials or wastes (e.g. refuelling personnel, pump operators, mechanics, and stores personnel) will receive training in handling, transporting and storing hazardous materials or wastes; in reporting and documentation requirements; and in spill clean-up techniques and practices.
  - Use, handling, storage and disposal of all hazardous materials and dangerous goods will be in accordance with the *Dangerous Goods Act 1998* and the WMPC Act.
  - A variety of temporary bunding will be available for use around the site, including bunded pallets and drip trays.
  - Refuelling of vehicles will occur within dedicated areas.
  - Chemicals and substances used during the Project will be selected in accordance with the INPEX chemical selection process.

  - Spill kits will be located on site in accessible locations and will be regularly inspected and maintained.

- ASS management:
  - A geotechnical program will be undertaken to confirm the presence/absence of ASS/PASS, prior to commencement of construction.
  - Where suspected ASS/PASS is encountered during excavations it will be kept separate from other spoil material. Any suspected ASS/PASS will be transferred to a dedicated treatment pad for stockpiling.
  - Where onsite stockpiling/treatment of ASS is required, dedicated ASS/PASS treatment pads will be constructed in accordance with National Guidance (Shand et al. 2018).
  - If excavating is unavoidable, management of ASS option include neutralising and re-covering with clean fill or disposing off site.
- Unplanned CO_2 release:
  - The CO_2 export pipeline would be designed to protect against threats to integrity including impact, corrosion, running ductile fracture and embrittlement. Design codes and material specifications would be compliant with the relevant Australian and international standards for transporting CO_2.
  - Testing would be undertaken prior to commissioning to confirm integrity of the CO_2 export pipeline.
  - IMMR activities would be conducted throughout operations, including monitoring the pipeline corrosion protection system.
  - Compliance with obtained pipeline licences in accordance with the *Energy Pipelines Act 1981* (Northern Territory).

7.1.5 Residual risk statement

Given the proposed mitigation measures to be implemented during construction and operations, the expected residual impact associated with terrestrial environmental quality is considered low (Table 7-1).

Table 7-1: Terrestrial environmental quality – residual risk

Potential impact	Consequence	Likelihood	Residual risk
Impacts to the quality and integrity of land and soils due to ASS disturbance	Insignificant (F)	Unlikely (4)	Low (9)
Impacts to the quality and integrity of land and soils due to erosion and topsoil migration	Insignificant (F)	Unlikely (4)	Low (9)

Potential impact	Consequence	Likelihood	Residual risk
Impacts to the quality and integrity of land and soils due to unplanned loss of hazardous and non-hazardous waste or spills	Insignificant (F)	Unlikely (4)	Low (9)
Impacts to the quality and integrity of land and soils due to unplanned CO_2 pipeline rupture	Minor (E)	Highly Unlikely (5)	Low (10)

7.2 Land – Terrestrial ecosystems

Project activities have the potential to impact on the following environmental factor - terrestrial ecosystems. Specifically, clearing of vegetation during construction. The following sub-sections provide a description of the potential impacts and proposed key management controls to mitigate any potential impacts.

7.2.1 Relevant policy and guidelines

The following conventions, legislation, policy and guidelines are relevant:

- Guidelines for Assessment of Impacts on Terrestrial Biodiversity (NT EPA 2013a)
- Preparation of an Environmental Management Plan (NT EPA 2015b)
- Environmental impact assessment and environmental approval under the Environment Protection Act 2019: Environmental impact assessment guidance (NT EPA 2025a)
- Land Clearing Guidelines, Northern Territory Planning Scheme (NT DEPWS 2024)
- Australian Weeds Strategy 2017-2027 (DAWR 2017)
- EPBC Act
- TPWC Act
- *Biosecurity Act 2015* (Cwlth)
- *Weeds Management Act 2001* (Northern Territory)
- National Light Pollution Guidelines for Wildlife (DCCEEW 2023a).

7.2.2 Environmental context

The terrestrial environment is described in Section 4.2. Relevant terrestrial habitats and environmental values include woodland communities, significant flora and fauna species and migratory shorebird species.

7.2.3 Potential impacts

The following activities have the potential to impact on terrestrial habitats if not managed appropriately:

- clearance of vegetation for construction of infrastructure, and for ongoing maintenance, as required for easements
- direct and indirect disturbance of vegetation from project construction and maintenance activities
- unplanned leaks of hazardous materials from batteries, transformers or other infrastructure
- unplanned introduction of, or increase in, weed species and pathogens due to construction, operation, or maintenance activities.
- unplanned introduction of, or increase in, pest animal species due to construction, operating, maintenance activities, or edge effects from disturbed areas.

Potential impacts associated with these activities include:

- Direct vegetation and habitat impacts:
  - direct loss of flora/native vegetation, habitat for EPBC Act and TPWC Act listed threatened or migratory species, and ecological communities
  - fragmentation of habitat for listed threatened or migratory species, and ecological communities
- indirect vegetation and habitat disturbance, degradation or loss to flora and native vegetation and habitat for listed threatened or migratory species through dust deposition, smothering, uprooting contamination and site condition changes

Disturbance or harm to listed threatened or migratory fauna species, through:

- construction, operation and decommissioning noise emissions
- construction, operation and decommissioning light emissions
- accidental entrapment or injury to terrestrial fauna, where fauna may become entrapped in trenches or other construction activities or may be injured in the vegetation removal process or by vehicle strike.
- disturbance or harm to vegetation, habitat and listed flora and fauna species through the unplanned introduction of invasive species and pests.
- changes in bushfire risk (fire frequency and intensity) due to vegetation clearing for Project infrastructure.
- unplanned fire events, from lightning, third party fire events from outside the Project area spreading into the Project area, or construction activities including machinery, sparks, and hot works.
- Unplanned rupture of the CO_2 export pipeline

Direct and indirect vegetation and habitat impacts

Direct loss and fragmentation of flora, native vegetation and habitat

Vegetation clearing and earthworks are required within the Project area. The Project infrastructure would largely be built within an existing, previously cleared and in parts rehabilitated corridor, however clearing of some areas of previously undisturbed native vegetation would be required. The total area cleared would be determined and refined during the project design and approvals process and depend on the final construction methodology chosen, with a large portion only planned as temporary clearance to support construction works followed by rehabilitation.

The construction and ongoing maintenance of pipelines and associated onshore infrastructure is anticipated to result in the direct loss of some native vegetation and habitat, potentially including areas important to species listed under the EPBC Act and TPWC Act.

Vegetation clearance for easements and infrastructure footprints leads to the removal of flora and potential disruption of ecosystems, with potential consequences for threatened or migratory species that may rely on the habitat for foraging and breeding.

Indirect vegetation and habitat disturbance, degradation or loss

Beyond the immediate footprint, infrastructure development can cause indirect disturbance and degradation of surrounding vegetation and habitats. This includes uprooting or smothering of vegetation through erosion events interfering with plants gas exchange and potentially suffocating vegetation, dust deposition interfering with plants gas exchange, and the disturbance of ASS which can alter soil and water conditions.

Unplanned releases of hazardous material associated with Project activities may include hydrocarbon liquid wastes, spent solvents and chemicals. Unplanned discharges or spills to the terrestrial environment may lead to the contamination of flora and fauna, potential resulting in harm to the species.

An atmospheric CO_2 plume may result from an unplanned CO_2 release from the onshore inlet station or the buried or above ground components of the CO_2 transport pipeline. As CO_2 is denser than air, it can quickly displace oxygen. For human health an exposure limit of 40,000 ppm (the industry standard exposure concentration for 'immediately dangerous to life or health') is considered to represent the level at which multiple fatalities can occur.

The extent of impacts of a CO_2 release on the respiratory system of fauna such as mammals, birds, reptiles and some amphibians are expected to be similar to that of the zones presented for human exposure. Small mammals, reptiles, and burrowing animals are particularly vulnerable to CO_2 accumulation near the ground or underground. High concentrations can lead to disorientation, loss of consciousness or death due to asphyxiation. Sub-lethal CO_2 exposure may cause stress responses, including altered foraging behaviour and reduced reproductive success.

Elevated CO_2 concentrations in the soil from a buried pipeline leak can displace oxygen, leading to hypoxic conditions that impair root respiration and ultimately cause reduced plant growth and potential mortality (Lake and Lomax 2019). A pipeline rupture would also result in very low temperatures (sub-zero). This is likely to be significant for all vegetation types as a result of sudden exposure beyond the normal temperature range and may result in structural impacts to stomata and cell membranes of vegetation in the immediate vicinity of a CO_2 leak. An atmospheric plume is expected to rapidly disperse, and impacts are expected to be highly localised. Detailed assessment of leak scenarios, including modelling of CO_2 dispersion, would be conducted to inform an assessment of potential impacts.

The creation of exposed vegetation edges can also introduce 'edge effects', such as increased sunlight and wind exposure, which modify microclimates and facilitate weed incursion. These changes can degrade habitat quality, harm native vegetation including listed species, and further diminish the usability of the habitat by listed threatened species.

Unplanned introduction of invasive species and pests

Project activities also have the potential to introduce new terrestrial species of plants and animals into the Middle Arm Peninsula area from the mobilisation of clearing and excavation vehicles. The introduction and establishment of invasive species and weeds can change the floristic structure of a vegetation community, reducing the diversity and ecological value of that area. Encroachment of invasive species and weeds can also reduce the area of native vegetation, by out-competing the native species.

Flora species, and particularly threatened flora species, have the potential to be impacted by weeds. Loss of habitat due to weed encroachment and change in floristic structure can reduce the range of occupancy of flora species. Native flora is often out-competed by more aggressive weed species, limiting the space and resources available for the establishment and persistence of native species.

The introduction of invasive pests can have a deleterious effect on native species through competition for food and habitat and by predation.

Fauna species, and particularly threatened fauna species, have the potential to be impacted by invasive species. Loss of habitat due to weed encroachment and change in floristic structure can reduce the range of occupancy of fauna species. Fauna species are also vulnerable to predation, particularly by invasive species such as feral cats and feral pigs, both of which have been recorded on Middle Arm Peninsula.

Given the existing presence of invasive species (flora and fauna; see Section 4.2.6) on the Middle Arm Peninsula impacts from Project activities are considered low.

Unplanned spills

While measures to prevent the release of hydrocarbons into the environment would always be in place, there is potential for spills and leaks on land to occur through accidents and/or failure of equipment. The potential impact from an accidental spill or leak is dependent on the location of the event and the type and volumes of materials released. Typically, however, these would be small scale.

Due to the limited spatial extent of hydrocarbons from a spill on land and limited window for exposure, potential significant impacts to receptors are not expected.

Impacts and disturbances to listed threatened or migratory fauna species

Light emissions

Light would be emitted from project machinery and from temporary lighting during construction activities. The existing context for the onshore environment includes multiple existing onshore sources of light, including East Arm Wharf, the Darwin LNG facility on Wickham Point, the Ichthys LNG facility on Bladin Point and lower intensity lighting from residential and urban areas throughout the northern and eastern shores of Darwin Harbour.

Light emissions can affect fauna in two main ways:

- Behaviour: Many organisms are adapted to natural levels of lighting and the natural changes associated with the day and night cycle as well as the night-time phase of the moon. Artificial lighting has the potential to create a constant level of light at night that can override these natural levels and cycles.
- Orientation: Organisms such as marine turtles and marine avifauna may also use lighting from natural sources to orient themselves in a certain direction at night. In instances where an artificial light source is brighter than a natural source, the artificial light may act to override natural cues, leading to disorientation or mis-orientation.

Terrestrial fauna that may be affected by light emissions include mammals, birds, reptiles and amphibians.

Artificial light has the potential to disrupt the natural day-night cycle of birds, potentially leading to disorientation during migration and changes in foraging and mating behaviours. Many species rely on natural light cues for navigation and timing of biological processes. It also increases the risk of predation and collisions with lit structures. Given the existing levels of artificial light surrounding the Project area, the temporary nature of lighting for construction works and the low level of lighting required at the Ichthys CCS pipeline tie-in station during operations, impacts are expected to be low.

Potential impacts to terrestrial mammals associated with artificial lighting from construction / operational activities include an increased risk of predation, decrease in food consumption, impact to foraging patterns, disruption to dispersal patters for taxa, disruption to circadian rhythms and avoidance from the Project area (habitat displacement).

Given the existing levels of artificial light adjacent to the Project area, the temporary nature of lighting for construction works and the low level of lighting required at the pipeline tie-in stations during operations, it is considered unlikely that the artificial light would significantly impact terrestrial mammals at a regional scale.

Artificial light from construction activities has the potential to impact various terrestrial reptiles and amphibians. These potential impacts include disruption to circadian rhythms, disrupting sleep patterns, interference with reproduction via reducing breeding season or breeding call activity, increased risk of predation, and habitat avoidance. Although artificial light can cause various potential impacts to reptile and amphibian taxa, the impact from the Project is considered to be low, due to the existing levels of artificial light adjacent to the onshore Project area, the temporary nature of lighting for construction works and the low level of lighting required at the tie-in stations during operations.

Airborne noise and vibration

Airborne noise and vibration from activities associated with the project could result in the following potential impacts on terrestrial reptiles, amphibians, mammals and avifauna:

- Habitat displacement of various reptiles and amphibians that usually inhabit in proximity to the proposed pipeline corridor.
- Foraging and dispersal patterns, thereby changing where they are present.
- Changes in reproduction patterns, potentially impacting population dynamics.
- Additional or elevated stress for taxa, being on high alert constantly.
- Impacted vocal production and perception of acoustic communication between taxa.
- Potentially impacting a species ability to predate upon other species due to increased noise or vibration levels.

Airborne noise and vibration can also have the potential to impact to marine reptiles (turtles and crocodiles) in the nearshore or onshore environment.

While there are numerous potential impacts that could arise due to the construction of the project, the area already experiences some noise disturbance (although minimal) from the ongoing operation of nearby gas plants. It is considered unlikely that the construction noise associated with the proposed pipeline and tie-in stations would significantly impact species listed above.

The operation of the Ichthys LNG CCES operational components has the potential to add to the noise levels of the existing Ichthys LNG facility. Site specific airborne noise modelling has been identified as a future study (refer to Section 9), to better understand to the potential impacts.

Entrapment or injury to terrestrial fauna

Vehicle movements, vegetation clearing and major earthworks, such as the onshore trenching, may pose potential risks to terrestrial fauna such as removal of habitat causing displacement, potential injury due to physical interactions with vehicles or equipment and entrapment within trenches. Given the vast area of habitat at Middle Arm, the vegetation clearing and earthworks are anticipated to result in limited disturbance to fauna and are not considered to cause long-term impacts on faunal communities in the area.

Open trenches and excavation sites created during pipeline construction can act as unintentional traps for terrestrial fauna. Animals such as reptiles, amphibians, small mammals, and ground-dwelling birds may fall into these structures while foraging or migrating, becoming unable to escape due to the steep and slippery sides.

Temporary fencing installed to delineate work areas or protect sensitive habitats can inadvertently block the natural movement of terrestrial fauna. There are no plans to install temporary fencing along the construction ROW; however, should this change there is a risk that fauna may become trapped.

Vehicle strikes pose an increased risk to terrestrial fauna during the construction phase, as machinery and vehicles operate in and traverse natural habitats with increased frequency. Particularly, wildlife may be struck while attempting to cross access roads or construction zones. This risk is higher during dawn and dusk, when many species are most active.

The improper management of food scraps and/or workforce personnel encouraging fauna to the onshore Project area may lead to fauna behavioural change.

Change in fire risk

The key environmental impacts and risks due to fire events include loss and/or degradation of vegetation and fauna habitat, and injury/death of fauna due to fire in surrounding vegetation. A number of conservation significant terrestrial fauna species have been recorded in the Project area. The habitat types associated with these species are considered to be well represented within the locality and in the wider region.

7.2.4 Management

NT EPA environmental objective:

Protect terrestrial habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.

To meet the NT EPA environmental objective for terrestrial ecosystems, the following measures would be implemented to avoid and minimise potential impacts:

- Vegetation clearing:
  - Siting of the CO_2 export pipeline and other infrastructure to be predominantly within previously disturbed areas and areas zoned for utilities and development.
  - Areas to be cleared would be clearly identified prior to work commencing. Clearing boundaries would be marked in the field and on-site plans and register of clearing activities will be maintained.
  - Mangroves would be cleared in such a way that minimises disturbance of the root system (such as cutting off the mangroves at root level or pushing the vegetation over).

  - Cleared vegetation would be mulched and stockpiled on site boundaries (outside the intertidal zone) or off site. Where possible, the mulch would be used for both rehabilitation and soil stabilisation to prevent erosion.
  - Temporarily disturbed areas within the Project area would be revegetated and rehabilitated following completion of construction activities.
- Invasive/weed species:
  - Existing weed and pest fauna species to be controlled and minimised before construction, with on-going management during and post-construction.
  - The construction of a temporary washdown area for earth-moving and vegetation clearing vehicles during the construction phase.
  - Topsoil containing high densities of weed seeds would not be used in rehabilitation.
- Accidental entrapment or injury to terrestrial fauna:
  - Removal of vegetation to be supervised by a suitably qualified wildlife handler to ensure safe handling of fauna.
  - "High-risk" entrapment areas would have sloping egress ramps to prevent fauna entrapment.
  - Regular monitoring of construction areas to identify any trapped fauna, with removal to be completed by a suitably qualified wildlife handler.
  - Where possible, vehicle traffic would be limited during high-risk times (dawn, dusk) to minimise chances of vehicle strikes with wildlife.
  - Enforcement of speed limits in construction areas.
- Light emissions:
  - Lighting during construction would be limited to the minimum to meet personnel safety requirements.
- Noise emissions:
  - Compliance with the requirements of the:
    - Waste Management and Pollution Control Act 1998 (NT)
    - Work Health and Safety (National Uniform Legislation) Act 2011 (NT)
    - National code of practice for noise management and protection of hearing at work [NOHSC: 2009 (2004)] (Commonwealth of Australia 2004).
  - Community notifications and hotline for feedback.
  - Additional modelling studies would be undertaken to evaluate the noise emission levels and extent from the operation of Ichthys LNG facility CCES equipment.
- Chemicals and hazardous substances management:
  - Personnel who routinely handle hazardous materials or wastes (e.g. refuelling personnel, pump operators, mechanics, and stores personnel) will receive training in handling, transporting and storing hazardous materials or wastes; in reporting and documentation requirements; and in spill clean-up techniques and practices.

  - Use, handling, storage and disposal of all hazardous materials and dangerous goods will be in accordance with the *Dangerous Goods Act 1998* and the WMPC Act.
  - A variety of temporary bunding will be available for use around the site, including bunded pallets and drip trays.
  - Refuelling of vehicles will occur within dedicated areas.
  - Chemicals and substances used during the Project will be selected in accordance with the INPEX chemical selection process.
  - Spill kits will be located on site in accessible locations and will be regularly inspected and maintained.
- Accidental bushfire:
  - Fire-fighting equipment would be available at the work sites.
  - Designated smoking areas would be assigned.
  - Hot work procedures would be implemented for cutting, welding and any other work considered to have a high potential to start a fire.
- Unplanned CO_2 release:
  - The CO_2 export pipeline would be designed to protect against threats to integrity including impact, corrosion, running ductile fracture and embrittlement. Design codes and material specifications would be compliant with the relevant Australian and international standards for transporting CO_2.
  - Testing would be undertaken prior to commissioning to confirm integrity of the CO_2 transport pipeline.
  - IMMR activities would be conducted throughout operations, including monitoring the transport pipeline corrosion protection system, to manage the integrity of subsea infrastructure.
  - Compliance with obtained pipeline licences in accordance with the *Energy Pipelines Act 1981* (Northern Territory).

7.2.5 Residual risk statement

Given the proposed mitigation measures to be implemented during construction and operations, the expected residual impact associated with terrestrial ecosystems is considered low to moderate (Table 7-2).

Table 7-2: Terrestrial ecosystems – residual risk

Potential impact	Consequence	Likelihood	Residual risk
Impacts to terrestrial habitats resulting from vegetation removal	Insignificant (F)	Highly Unlikely (5)	Low (10)
Indirect impacts to terrestrial habitats (e.g., from erosion, dust, spills, ASS disturbance, etc.)	Insignificant (F)	Unlikely (4)	Low (9)

Potential impact	Consequence	Likelihood	Residual risk
Impacts due to disturbance of and interaction with fauna (e.g., vehicle movements, trenches, vegetation removal, etc.)	Insignificant (F)	Unlikely (4)	Low (9)
Impacts to terrestrial habitats from introduction new weed species	Minor (E)	Highly Unlikely (5)	Low (10)
Impacts to terrestrial habitats from an increased bushfire risk	Minor (E)	Highly Unlikely (5)	Low (10)
Impacts to terrestrial habitats from construction noise	Insignificant (F)	Highly Unlikely (5)	Low (10)
Impacts to terrestrial habitats from operational noise	Insignificant (F)	Remote (6)	Low (10)
Impacts to terrestrial habitats from construction and operational lighting	Insignificant (F)	Highly Unlikely (5)	Low (10)
Impacts to terrestrial habitats due to unplanned CO_2 export pipeline rupture	Moderate (D)	Highly Unlikely (5)	Moderate (5)

7.3 Water – Hydrological processes

Project activities have the potential to impact on the following environmental factor – hydrological processes. Specifically, impact on hydrological regimes of groundwater or surface water during excavation activities for construction. The following sub-sections provide a description of the potential impacts and proposed key management controls to mitigate any potential impacts.

7.3.1 Relevant policy and guidelines

The following conventions, legislation, policy and guidelines are relevant:

- Erosion and sediment control plans for rural development (NTDLRM, n.d.)
- A Stormwater Strategy for the Darwin Harbour Region (NT EPA 2014)
- Preparation of an Environmental Management Plan (NT EPA 2015b).

7.3.2 Environmental context

The local hydrological and hydrogeological context is described in Section 4.1.4.

7.3.3 Potential impacts

The following activities have the potential to impact on hydrological processes if not managed appropriately:

- Creation of additional temporary or permanent hardstand areas, including in previously vegetated areas.
- Temporary and permanent alteration of surface-water drainage direction and volumes.

Potential impacts associated with these activities include:

- Increase in or alteration of runoff from surface areas, with potential to alter flood conditions.
- Reduction in groundwater recharge through infiltration.

Surface water

Construction and operation of the Project would lead to minor localised changes in the natural catchment due to the creation of some hardstand surfaces. These changes may contribute to the reduction or concentration of surface flows in these areas.

Erosion and the subsequent release of sediment, following the vegetation clearing and /or ground disturbance could result in a reduction in surface water quality due to increased sediment load from turbid runoff. High levels of run-off water turbidity may result in increased sedimentation in associated waterways and connected intertidal habitats. It may reduce levels of light availability in the environment, which may adversely impact habitats of listed marine species. Erosion risk is dependent on the likelihood and intensity of expected rainfall, the estimated rate of soil loss and the anticipated disturbance period.

According to storm surge mapping of the Darwin Harbour, parts of the Project area are located within the secondary storm surge zone.

Given the small footprint of these changes for this project, any impacts are expected to insignificant in the context of the region with the implementation of management measures.

Groundwater

Small changes in hardstand areas may have an impact a small, localised impact on groundwater recharge to aquifers in those areas. Given the small footprint of these changes for the project, any impacts are expected to insignificant in the context of the region with the implementation of management measures outlined below.

7.3.4 Management

NT EPA environmental objective:

Protect the hydrological regimes of groundwater and surface water so that environmental values including ecological health, land uses and the welfare and amenity of people are maintained.

To meet the NT EPA environmental objective for hydrological processes, the following measures would be implemented to avoid and minimise potential impacts:

- Erosion and sediment control management:
  - Clearing to be undertaken preferentially in dry season conditions to avoid erosion risk associated with monsoon rains in the wet season.
  - A site-specific Erosion and Sediment Control Plan (ESCP) will be prepared in accordance with the IECA Best Practice Erosion and Sediment Control Guidelines (IECA 2008) and endorsed by a Certified Professional Erosion and Control Specialist, to manage erosion risk. The ESCP will include:
    - temporary and permanent control measures
    - protection of stockpiles and exposed soil areas
    - ongoing inspection and maintenance of controls when in effect.
  - Erosion protection infrastructure (e.g. silt fencing, contouring, etc.) will be installed in accordance with developed ESCP to ensure that sediment is contained within the construction area as far as is practicable.
- All stormwater discharge from within the construction area will be in accordance with water quality criteria within the ESCP.

7.3.5 Residual risk statement

Given the proposed mitigation measures to be implemented during design and construction, the expected residual impact associated with hydrological processes is considered low (Table 7-3).

Table 7-3: Hydrological processes – residual risk

Potential impact	Consequence	Likelihood	Residual risk
Alteration to surface and groundwater flow patterns due to construction activities and the presence of infrastructure	Insignificant (F)	Highly Unlikely (5)	Low (10)

7.4 Water – Inland water environmental quality

Project activities have the potential to impact on the following environmental factor – inland water environmental quality. Specifically, impact on the quality of groundwater or surface water during site preparation and construction activities, e.g., as a result of ASS disturbance and soil erosion and sedimentation. The following sub-sections provide a description of the potential impacts and proposed key management controls to mitigate any potential impacts.

7.4.1 Relevant policy and guidelines

The following conventions, legislation, policy and guidelines are relevant:

- Australia and New Zealand Guidelines for Fresh and Marine Water Quality (CoA 2018)
- Erosion and sediment control plans for rural development (NT DLRM, n.d.)
- A Stormwater Strategy for the Darwin Harbour Region (NT EPA 2014)

- Preparation of an Environmental Management Plan (NT EPA 2015b).

7.4.2 Environmental context

Regional groundwater and surface water are described in Section 4.1.4. Cossack Creek and Lightning Creek catchments are located between the Project area and Ichthys LNG facility and drain northwards into East Arm. Jones Creek catchment is located to the south of the Project area and drains westwards towards Channel island and Middle Arm.

7.4.3 Potential impacts

The following activities have the potential to impact on groundwater and surface water quality in the Project area if not managed appropriately:

- disturbance of soils, including ASS
- unplanned hydrocarbon or chemical leaks and spills
- vegetation clearing and earthworks contributing to soil erosion from cleared areas.

Potential impacts associated with these activities include:

- Erosion from cleared areas leads to increased sedimentation of waterways.
- Leaks of hazardous materials from hydraulic fluids, fuels and oils from construction equipment, batteries, transformers or other infrastructure leading to the contamination of surface and groundwater.
- Ground disturbance activities for the pipeline may lead to exposure of ASS leading to acidification of surface water and groundwater.

ASS

Areas of PASS are known to be present within the Project area, giving rise to the potential for ASS disturbance and localised acidification of surface water and groundwater. Based on prior knowledge gained from the construction of the gas export pipeline for the Ichthys LNG Development project, the project has been designed with consideration of ASS treatment as outlined in Section 2.4.1 and captured in the mitigation measures below. With these measures in place, there is potential for minor localised and temporary impacts on water quality.

Erosion and sediment control

To minimise the risk of sedimentation impacts on local inland water quality, construction activities would be undertaken as outlined in Section 2.4. While construction activities could contribute to erosion and sedimentation of runoff, these impacts would be managed at the source through implementation of standard construction management measures for erosion and sediment control, in accordance with relevant Northern Territory guidelines. With these measures in place, only minor localised impacts are expected.

Other contaminants

There is a risk of surface water or groundwater contamination from chemicals and hydrocarbon spills during the construction and operations phase of the Project. With the implementation of standard measures to reduce the likelihood of spills and measures to reduce the consequences in the case that spills occur, the consequences are considered to be insignificant.

7.4.4 Management

NT EPA environmental objective:

Protect the quality of groundwater and surface water so that environmental values including ecological health, land uses and the welfare and amenity of people are maintained.

To meet the NT EPA environmental objective for inland water environmental quality, the following measures would be implemented to avoid and minimise potential impacts:

- Development and implementation of an ASS management plan, including standard controls to apply during the construction phase and measures to avoid and minimise disturbance of ASS, plus details of how to manage, treat and dispose of ASS should it be encountered.
- In situ mass soil mixing of ASS neutralisation is proposed in areas of higher ASS disturbance risk.
- General ASS management approach proposed during construction would be:
  - treat in-situ in conjunction with earthworks, where suitable.
  - treat in a temporary ASS treatment area.
  - geochemical investigation of areas outside GEP corridor prior to commencing excavation, to quantify the potential ASS areas that require treatment.
  - an unexpected finds procedure for ASS would be included in the CEMP.
- Erosion and sediment control management:
  - Clearing to be undertaken preferentially in dry season conditions to avoid erosion risk associated with monsoon rains in the wet season.
  - A site-specific Erosion and Sediment Control Plan (ESCP) will be prepared in accordance with the IECA Best Practice Erosion and Sediment Control Guidelines (IECA 2008) and endorsed by a Certified Professional Erosion and Control Specialist, to manage erosion risk. The ESCP will include:
  - temporary and permanent control measures
  - protection of stockpiles and exposed soil areas
  - ongoing inspection and maintenance of controls when in effect.
  - Erosion protection infrastructure (e.g. silt fencing, contouring, etc.) will be installed in accordance with developed ESCP to ensure that sediment is contained within the construction area as far as is practicable.
  - All stormwater discharge from within the construction area will be in accordance with water quality criteria within the ESCP.
- Chemicals and hazardous substances management:
  - Personnel who routinely handle hazardous materials or wastes (e.g. refuelling personnel, pump operators, mechanics, and stores personnel) will receive training in handling, transporting and storing hazardous materials or wastes; in reporting and documentation requirements; and in spill clean-up techniques and practices.
  - Use, handling, storage and disposal of all hazardous materials and dangerous goods will be in accordance with the Dangerous Goods Act 1998 and the WMPC Act.

  - A variety of temporary bunding will be available for use around the site, including bunded pallets and drip trays.
  - Refuelling of vehicles will occur within dedicated areas.
  - Chemicals and substances used during the Project will be selected in accordance with the INPEX chemical selection process.
  - Spill kits will be located on site in accessible locations and will be regularly inspected and maintained.
- Design of a stormwater runoff management measures at hardstand areas for the operations phase of the project, e.g., at the Ichthys CCS and Darwin LNG pipeline tie-in stations, with consideration of the Stormwater Strategy for the Darwin Harbour Region.

7.4.5 Residual risk statement

Given the proposed mitigation measures to be implemented during design and construction, the expected residual impact associated with inland water environmental quality is considered moderate (Table 7-4).

Table 7-4: Inland water environmental quality – residual risk

Potential impact	Consequence	Likelihood	Residual risk
Surface water or groundwater contamination due to unplanned spills and leaks	Insignificant (F)	Unlikely (4)	Low (9)
Increased erosion and sedimentation of waterways	Insignificant (F)	Unlikely (4)	Low (9)
Acidic runoff from ASS disturbance	Minor (E)	Possible (3)	Moderate (7)

7.5 Sea – Coastal processes

Project activities have the potential to impact on the following environmental factor – coastal processes. Specifically, clearing of mangroves, trenching and material stockpiles within intertidal areas. The following sub-sections provide a description of the potential impacts and proposed key management controls to mitigate any potential impacts.

7.5.1 Relevant policy and guidelines

The following key conventions, legislation, policy and guidelines are relevant:

- The Coastal and Marine Management Strategy 2019 to 2029
- Darwin Harbour Regional Plan of Management
- Darwin Harbour Strategy 2020 to 2025 (Darwin Harbour Advisory Committee 2020).

7.5.2 Environmental context

The physical and biological marine and coastal environment are described in Sections 4.1 and 4.2. Relevant environmental values in the Project area include mangrove ecosystems and coastal morphology. Coastal processes in Darwin Harbour include wave action, tidal action, longshore drift, hurricanes and cyclones, surface water drainage and sea level rise.

7.5.3 Potential impacts

The following activities have the potential to impact on coastal geophysical and hydrological processes through seabed disturbance and physical presence of infrastructure if not managed appropriately:

- Construction works in and adjacent to coastal areas.
- Vegetation clearing and earthworks contributing to soil erosion from cleared areas.

The potential impacts associated with these activities include:

- Temporary changes in hydrodynamic processes resulting in impacts to intertidal mangrove areas.
- Temporary changes in hydrodynamic processes resulting in impacts from increased erosion and sedimentation affecting coastal and benthic habitats.

7.5.4 Management

NT EPA environmental objective:

Protect the geophysical and hydrological processes that shape coastal morphology so that the environmental values of the coast are maintained.

To meet the NT EPA environmental objective for coastal processes, the following measures would be implemented to avoid and minimise potential impacts:

- Erosion and sediment control management:
  - Clearing to be undertaken preferentially in dry season conditions to avoid erosion risk associated with monsoon rains in the wet season.
  - A site-specific Erosion and Sediment Control Plan (ESCP) will be prepared in accordance with the IECA Best Practice Erosion and Sediment Control Guidelines (IECA 2008) and endorsed by a Certified Professional Erosion and Control Specialist, to manage erosion risk. The ESCP will include:
    - temporary and permanent control measures
    - protection of stockpiles and exposed soil areas
    - ongoing inspection and maintenance of controls when in effect.
  - Erosion protection infrastructure (e.g. silt fencing, contouring, etc.) will be installed in accordance with developed ESCP to ensure that sediment is contained within the construction area as far as is practicable.
  - All stormwater discharge from within the construction area will be in accordance with water quality criteria within the ESCP.
- Temporary structures required for construction of the pipeline would be removed following installation.
- Areas would be reinstated to match the existing topography following installation of the CO_2 export pipeline.

7.5.5 Residual risk statement

Given the proposed mitigation measures to be implemented during design and construction, the expected residual impact associated with coastal processes is considered low (Table 7-5).

Table 7-5: Coastal processes – residual risk

Potential impact	Consequence	Likelihood	Residual risk
Physical presence of infrastructure changes local geophysical and hydrological processes.	Insignificant (F)	Unlikely (4)	Low (9)
Coastal disturbance during trenching activities changes coastal topography and sedimentation.	Insignificant (F)	Possible (3)	Low (8)
Onshore site preparation, trenching and pipelay activities cause temporary changes in geophysical and hydrological processes.	Insignificant (F)	Possible (3)	Low (8)

7.6 Sea – Marine environmental quality

Project activities have the potential to impact on the following environmental factor – marine environmental quality. Specifically, discharge of hydrotest water to Darwin Harbour and accidental loss/spills or mismanagement of chemicals and hazardous substances. The following sub-sections provide a description of the potential impacts and proposed key management controls to mitigate any potential impacts.

7.6.1 Relevant policy and guidelines

The following legislation, policy and guidelines are relevant:

- WMPC Act (NT)
- *Water Act 1992* (NT)
- Australian and New Zealand guidelines for fresh and marine water quality (ANZG 2018)
- Declaration of Beneficial Uses and Objectives, Darwin Harbour Region, NT Government Gazette No. G27, 7 July 2010
- Water Quality Objectives for the Darwin Harbour Region - Background document (NRETAS 2010)
- Darwin Harbour Water Quality Protection Plan (DLRM 2014)
- Guidelines on Mixing Zones. (NT EPA 2013b).

7.6.2 Environmental context

Darwin Harbour water and sediment quality is described in Section 4.1.8 and Section 4.1.7.

7.6.3 Potential impacts

The following activities have the potential to impact on the marine environmental quality in Darwin Harbour if not managed appropriately:

- Discharge of hydrotest water to Darwin Harbour resulting a reduction in local water quality.
- Mishandling of chemicals, hydrocarbons and other hazardous substances resulting in a reduction in water quality.
- Accidental loss of containment/spills to the environment resulting in a reduction in water quality.

Hydrotest water discharges to Darwin Harbour

The discharge of hydrotest wastewater (refer Section 2.5.1) into the environment could potentially cause impacts to the beneficial uses of Darwin Harbour – Water Quality (NRETAS 2010). Although hydrotest wastewater is predominantly scheme water (and therefore likely clean), it has the potential to absorb contaminants remaining in pipework and infrastructure. The most likely contaminant is nickel, which was found to be absorbed from infrastructure being hydrotested during Ichthys LNG construction (JKC 2015).

Impacts to the water quality objectives will be minimised through the use of an appropriate diffuser, which will diffuse wastewater (and any contaminants within) to less than the Darwin Harbour Water Quality Objectives (NRETAS 2010) prior to the edge of an approved mixing zone. The wastewater is fresh, and therefore is more buoyant than the receiving water, and will rise up towards the surface which results in enhanced mixing of the wastewater and Darwin Harbour waters. The wastewater plume will also oscillate and change direction with each flood and ebb tide event.

Diffuser design and subsequent plume modelling will be undertaken prior to the generation of hydrotest water. Modelling for Ichthys LNG construction hydrotest water (with volumes of water approximately 10 times larger expected for this project) indicated a 65-fold dilution was required, and this was met in the nearfield (approximately 8 m 95% of the time). A conservative mixing zone of 50 m surrounding the diffuser was established for monitoring purposes.

7.6.4 Management

NT EPA environmental objective:

Protect the quality and productivity of water, sediment and biota so that environmental values are maintained.

To meet the NT EPA environmental objective for marine environmental quality, the following measures would be implemented to avoid and minimise potential impacts:

- Hydrotest water management (If the option to dispose of wastewater via a temporary MOF outfall is pursued):
  - The outfall design will incorporate use of a multiport diffuse to allow for sufficient near-felid dilution within proximity of the discharge point.

  - Modelling will be undertaken to determine the extent of the required mixing zone, to enable effective dispersion of wastewater.
  - A waste discharge licence will be applied for under the *Water Act 1992* (NT).
  - Any wastewater discharged via the MOF outfall will comply with WDL wastewater quality limits.
  - A receiving environment water quality monitoring program will be implemented to verify modelling outputs and determine if receiving water is being adversely impacted.
  - Wastewater generated during Project activities (e.g. hydrotest water) will be re-used where it remains fit for purpose.
- Chemicals and hazardous substances management:
  - Personnel who routinely handle hazardous materials or wastes (e.g. refuelling personnel, pump operators, mechanics, and stores personnel) will receive training in handling, transporting and storing hazardous materials or wastes; in reporting and documentation requirements; and in spill clean-up techniques and practices.
  - Use, handling, storage and disposal of all hazardous materials and dangerous goods will be in accordance with the *Dangerous Goods Act 1998* and the WMPC Act.
  - A variety of temporary bunding will be available for use around the site, including bunded pallets and drip trays.
  - Refuelling of vehicles will occur within dedicated areas.
  - Chemicals and substances used during the Project will be selected in accordance with the INPEX chemical selection process.
  - Spill kits will be located on site in accessible locations and will be regularly inspected and maintained.

7.6.5 Residual risk statement

Given the proposed mitigation measures to be implemented during design and construction, the expected residual impact associated with marine environmental quality is considered low to moderate (Table 7-6).

Table 7-6: Marine environmental quality – residual risk

Potential impact	Consequence	Likelihood	Residual risk
Pollution of marine water (Darwin Harbour). Bioaccumulation and toxicity effects. Alteration of the marine environment through wastewater discharges.	Minor (E)	Highly Unlikely (5)	Low (9)

Potential impact	Consequence	Likelihood	Residual risk
Unplanned loss/spills of chemicals, hydrocarbons, and hazardous substances resulting in contamination of marine environment adjacent to Project activities	Minor (E)	Unlikely (4)	Moderate (8)

7.7 Sea – Marine ecosystems

Project activities have the potential to impact on the following environmental factor – marine ecosystems. Specifically, clearing of mangroves, trenching and dewatering trenches in intertidal areas. The following sub-sections provide a description of the potential impacts and proposed key management controls to mitigate any potential impacts.

7.7.1 Relevant policy and guidelines

The following legislation, policy and guidelines are relevant:

- WMPC Act (NT)
- *Water Act 1992* (NT)
- Australian and New Zealand guidelines for fresh and marine water quality (ANZG 2018)
- Declaration of Beneficial Uses and Objectives, Darwin Harbour Region, NT Government Gazette No. G27, 7 July 2010
- Water Quality Objectives for the Darwin Harbour Region - Background document (NRETAS 2010)
- Darwin Harbour Water Quality Protection Plan (DLRM 2014)

7.7.2 Environmental context

Marine ecosystems, including mangroves and marine fauna are described in Section 4.2. Environmental values of relevance to the Project include mangrove community ecological functions and processes.

7.7.3 Potential impacts

The following activities have the potential to impact on marine ecosystems if not managed appropriately:

- trenching activities, including potential disturbance of coastal ASS within the intertidal area
- dewatering for 'float in' pipeline installation
- unplanned hydrocarbon releases from equipment
- unplanned CO_2 release from a pipeline leak during operations.
- noise from construction activities

- light emissions from equipment and in the Project area

Potential impacts to marine ecosystems associated with these activities include:

- intertidal habitats (mangroves)
- seabirds and migratory shorebirds.

Direct loss and fragmentation of flora, native vegetation and habitat

Vegetation clearing and earthworks are required within the Project area, including areas of mangroves within the Ichthys CCS pipeline and Ichthys CSS (Darwin LNG link) pipeline areas. The Project infrastructure would largely be built within an existing, previously cleared and in parts rehabilitated corridor; however, clearing of some areas of previously undisturbed mangroves would be required. The total area cleared would be determined and refined during the project design and approvals process and depend on the final construction methodology chosen, with a large portion only planned as temporary clearance to support construction works.

Indirect vegetation and habitat disturbance, degradation or loss

Beyond the immediate footprint, infrastructure development can cause indirect disturbance and degradation of surrounding habitat. This includes uprooting or smothering of mangroves through erosion events interfering with pneumatophore gas exchange, dust deposition interfering with leaf gas exchange, and the disturbance of ASS which can alter soil and water quality.

Unplanned releases of hazardous material associated with Project activities may include hydrocarbon liquid wastes, spent solvents and chemicals. Unplanned discharges or spills to mangroves may lead to the contamination of mangroves.

An atmospheric CO_2 plume may result from an unplanned CO_2 release from the onshore inlet station or the buried or above ground components of the CO_2 transport pipelines. As CO_2 is denser than air, it can quickly displace oxygen. For human health an exposure limit of 40,000 ppm (the industry standard exposure concentration for 'immediately dangerous to life or health') is considered to represent the level at which loss of life can occur. The extent of impacts of a CO_2 release on the respiratory system of fauna are expected to be similar to that of the zones presented for human exposure. Small and burrowing animals are particularly vulnerable to CO_2 accumulation near the ground or underground. High concentrations can lead to disorientation, loss of consciousness or death due to asphyxiation. Sub-lethal CO_2 exposure may cause stress responses, including altered foraging behaviour and reduced reproductive success.

Elevated CO_2 concentrations in the soil from a buried pipeline leak can displace oxygen, leading to hypoxic conditions that impair root respiration and ultimately cause reduced plant growth and potential mortality (Lake and Lomax 2019). A pipeline rupture would also result in very low temperatures (sub-zero). This is likely to be significant for all mangroves as a result of sudden exposure beyond the normal temperature range and may result in structural impacts to stomata and cell membranes in the immediate vicinity of a CO_2 leak. An atmospheric plume is expected to rapidly disperse, and impacts are expected to be highly localised. Detailed assessment of leak scenarios, including modelling of CO_2 dispersion, would be conducted to inform an assessment of potential impacts.

Impacts and disturbances to listed threatened or migratory fauna species

Light emissions

Light would be emitted from project machinery and from temporary lighting during construction activities. The existing context for the onshore environment includes multiple existing onshore sources of light, including the East Arm Wharf, the Darwin LNG facility at Wickham Point, the Ichthys LNG at Bladin Point and lower intensity lighting from residential and urban areas throughout the northern and eastern shores of Darwin Harbour.

Light emissions can affect fauna in two main ways:

- Behaviour: Many organisms are adapted to natural levels of lighting and the natural changes associated with the day and night cycle as well as the night-time phase of the moon. Artificial lighting has the potential to create a constant level of light at night that can override these natural levels and cycles.
- Orientation: Organisms such as marine turtles and marine avifauna may also use lighting from natural sources to orient themselves in a certain direction at night. In instances where an artificial light source is brighter than a natural source, the artificial light may act to override natural cues, leading to disorientation or mis-orientation.

Artificial light has the potential to disrupt the natural day-night cycle of birds, potentially leading to disorientation during migration and changes in foraging and mating behaviours. Many species rely on natural light cues for navigation and timing of biological processes. It also increases the risk of predation and collisions with lit structures. Given the existing levels of artificial light surrounding the Project area, the temporary nature of lighting for construction works and the low level of lighting required at the Ichthys CCS inlet station during operations, impacts are expected to be low.

Given the existing levels of artificial light adjacent to the Project area, the temporary nature of lighting for construction works and the low level of lighting required at the pipeline tie-in stations during operations, it is considered unlikely that the artificial light would significantly impact terrestrial mammals at a regional scale.

Airborne noise and vibration

Airborne noise and vibration from activities associated with the project could result in the following potential impacts on avifauna:

- Habitat displacement.
- Foraging and dispersal patterns.
- Changes in reproduction patterns, potentially impacting population dynamics.
- Additional or elevated stress for taxa, being on high alert constantly.
- Impacted vocal production and perception of acoustic communication between taxa.
- Potentially impacting a species ability to predate upon other species due to increased noise or vibration levels.

While there are numerous potential impacts that could arise due to the construction of the Project, the area already experiences some noise disturbance (although minimal) from the ongoing operation of nearby gas plants. It is considered unlikely that the construction noise associated with the proposed pipeline and tie-in stations would significantly impact species listed above.

7.7.4 Management

NT EPA environmental objective:

Protect marine habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.

To meet the NT EPA environmental objective for marine ecosystems, the following measures would be implemented to avoid and minimise potential impacts:

- Intertidal habitat disturbance:
  - pre-lay surveys would be undertaken to inform the final pipeline route.
- ASS management:
  - A geotechnical program will be undertaken to confirm the presence/absence of ASS/PASS, prior to commencement of construction.
  - Where suspected ASS/PASS is encountered during excavations it will be kept separate from other spoil material. Any suspected ASS/PASS will be transferred to a dedicated treatment pad for stockpiling.
  - Where onsite stockpiling/treatment of ASS is required, dedicated ASS/PASS treatment pads will be constructed in accordance with National Guidance (Shand et al. 2018).
  - If excavating is unavoidable, management of ASS option include neutralising and re-covering with clean fill or disposing off site.
- Light emissions:
  - Lighting during construction and operations would be limited to the minimum to meet personnel safety requirements.
- Noise emissions:
  - Compliance with the requirements of the:
    - *Waste Management and Pollution Control Act 1998* (NT)
    - Work Health and Safety (National Uniform Legislation) Act 2011 (NT)
    - National code of practice for noise management and protection of hearing at work [NOHSC: 2009 (2004)] (Commonwealth of Australia 2004).
  - Community notifications and hotline for feedback.
- Chemicals and hazardous substances management:
  - Personnel who routinely handle hazardous materials or wastes (e.g. refuelling personnel, pump operators, mechanics, and stores personnel) will receive training in handling, transporting and storing hazardous materials or wastes; in reporting and documentation requirements; and in spill clean-up techniques and practices.
  - Use, handling, storage and disposal of all hazardous materials and dangerous goods will be in accordance with the *Dangerous Goods Act 1998* and the WMPC Act.
  - A variety of temporary bunding will be available for use around the site, including bunded pallets and drip trays.
  - Refuelling of vehicles will occur within dedicated areas.
  - Chemicals and substances used during the Project will be selected in accordance with the INPEX chemical selection process.
  - Spill kits will be located on site in accessible locations and will be regularly inspected and maintained.

- Unplanned CO_2 release:
  - The CO_2 export pipeline would be designed to protect against threats to integrity including impact, corrosion, running ductile fracture and embrittlement. Design codes and material specifications would be compliant with the relevant Australian and international standards for transporting CO_2.
  - Testing would be undertaken prior to commissioning to confirm integrity of the CO_2 export pipeline.
  - IMR activities would be conducted throughout operations, including monitoring the pipeline corrosion protection system
  - Compliance with obtained pipeline licences in accordance with the *Energy Pipelines Act 1981* (Northern Territory).

7.7.5 Residual risk statement

Given the proposed mitigation measures to be implemented during design and construction, the expected residual impact associated with marine ecosystems is considered low (Table 7-7).

Table 7-7: Marine ecosystems – residual risk

Potential impact	Consequence	Likelihood	Residual risk
Impacts on marine ecosystems from intertidal disturbance	Insignificant (F)	Possible (3)	Low (8)
Impacts on marine ecosystems from noise	Insignificant (F)	Unlikely (4)	Low (9)
Impacts on marine ecosystems from light emissions	Insignificant (F)	Unlikely (4)	Low (9)
Impacts on marine ecosystems from potential ASS disturbance	Insignificant (F)	Possible (3)	Low (8)
Impacts on marine ecosystems from unplanned loss of hazardous or non-hazardous waste	Insignificant (F)	Unlikely (4)	Low (9)
Impacts on marine ecosystems from unplanned hydrocarbon release	Insignificant (F)	Possible (3)	Low (8)
Impacts on marine ecosystems from unplanned CO_2 release	Minor (E)	Highly Unlikely (5)	Low (9)

7.8 Air – Air quality

Project activities have the potential to impact on the following environmental factor – air quality. Specifically, impact on air quality within the Project area and surrounds due to the trace amounts of pollutants (including BTEX and H_2S) contained within the CO_2 stream to be vented to atmosphere during operations and dust from fugitive emissions. The following sub-sections provide a description of the potential impacts and proposed key management controls to mitigate any potential impacts.

7.8.1 Relevant policy and guidelines

The following key conventions, legislation, policy and guidelines are relevant:

- *Waste Management and Pollution Control Act 1998*
- National Environment Protection (Ambient Air Quality) Measure 1997
- National Environment Protection (Air Toxics) Measure 2004
- Guideline: Recommended Land Use Separation Distances (Northern Territory EPA 2017)
- Environment Protection (National Pollutant Inventory) Objective 2004 (Northern Territory)

7.8.2 Environmental context

Local air quality is described in Section 4.1.3. The nearest sensitive receptors are the residential areas of Palmerston, approximately four kilometres to the northeast of the Ichthys LNG facility at the nearest point. Other sensitive receptors to construction-related dust emissions include the surrounding vegetation, including sensitive mangrove communities.

7.8.3 Potential impacts

The following activities have the potential to impact on air quality if not managed appropriately:

- hydrocarbon combustion to operate the vessels and vehicles
- fugitive dust emissions during construction activities
- emissions of fine particulate matter from diesel combustion associated with the operation of vessels, vehicles and construction equipment.
- operational venting of CO_2 from the Ichthys LNG facility during either maintenance activities, launch and receipt of PIGs (for inspection purposes) and unplanned events.
- Unplanned CO_2 release from the onshore inlet station or CO_2 export pipeline.

Potential impacts associated with these activities include:

- construction phase: temporary and localised reduction in ambient air quality due to dust and particulate matter resulting impacts to amenity and vegetation
- operations phase:
  - Primary air pollutants of concern are:
    - Particulate matter (total suspended particulates, PM_{10} and $PM_{2.5}$) from fugitive dust and diesel particulate emissions during construction.
    - VOCs from venting, including BTEX and H_2S, during operations.

  - Of these, the main source of potential air quality impacts is the operational venting of CO_2 from the CCES operations, as described in Section 2.4.3.
  - Assuming constant operability of the CCS system, CO_2 emissions from the LNG facility via the AGRU would reduce significantly from current operations once CCS operations commence.
  - The dispersion of air emissions will be modelled to determine the extent, magnitude and duration of change in CO_2 stream emissions (including the trace amounts of VOCs, BTEX and H_2S, contained in the CO_2 stream). Impacts to any sensitive receivers within the modelled extent of dispersion will be assessed with consideration of the difference between predicted emissions during Project operations and emissions from existing Ichthys LNG facility operations.
- an unplanned leak of CO_2 into the atmosphere would contribute to GHG emissions. Any atmospheric plume is expected to rapidly disperse, and impacts are expected to be highly localised.

Cumulative impacts

Cumulative air quality impacts would be assessed with consideration of other industrial facilities in the region, including Ichthys LNG and Darwin LNG facilities. Other construction Projects on Middle Arm and surrounds (e.g. East Arm) would also be considered in the assessment, depending on the potential for simultaneous Project activities.

7.8.4 Management

NT EPA environmental objective:

Protect air quality and minimise emissions and their impact so that environmental values are maintained.

To meet the NT EPA environmental objective for air quality, the following measures would be implemented to avoid and minimise potential impacts:

- Construction particulate emissions:
  - Dust management:
    - revegetation of exposed areas as soon as practicable
    - covering of soil stockpiles as soon as practicable
    - application of dust suppression/binding agents to exposed stockpiles
    - use of water carts during dry and windy conditions.
  - Construction equipment and vehicles would be maintained in accordance with manufacturer specifications and turned off when not in use.
- Operational venting:
  - A detailed assessment of operational venting scenarios, including modelling of CO_2 dispersion, would be conducted to inform an assessment of potential impacts and appropriate management controls implemented.
  - Emissions control options would be reviewed for operational venting.
  - An assessment of best practice control options would be undertaken against the requirements of the EPA Waste Management Guidelines to inform selection of best available techniques and technologies.

  - Development and implementation of an air quality management and monitoring plan for the operations phase.

- Unplanned CO_2 release:
  - A detailed assessment of leak scenarios, including modelling of CO_2 dispersion, would be conducted to inform an assessment of potential impacts and appropriate management controls implemented.
  - The CO_2 export pipeline would be designed to protect against threats to integrity including impact, corrosion, running ductile fracture and embrittlement. Design codes and material specifications would be compliant with the relevant Australian and international standards for transporting CO_2.
  - Testing would be undertaken prior to commissioning to confirm integrity of the CO_2 export pipeline.
  - IMMR activities would be conducted throughout operations, including monitoring the pipeline corrosion protection system
  - Compliance with obtained pipeline licences in accordance with the *Energy Pipelines Act 1981* (Northern Territory).

7.8.5 Residual risk statement

Given the proposed mitigation measures to be implemented during design and construction, the expected residual impact associated with air quality is considered low (Table 7-8).

Table 7-8: Air quality – residual risk

Potential impact	Consequence	Likelihood	Residual risk
Impacts on air quality from operational venting such that environmental values are not maintained	Minor (E)	Highly Unlikely (5)	Low (9)
Impacts on air quality from Construction related dust emissions such that environmental values are not maintained	Insignificant (F)	Highly Unlikely (5)	Low (10)
Impacts on air quality due to unplanned CO_2 pipeline rupture such that environmental values are not maintained	Insignificant (F)	Highly Unlikely (5)	Low (10)

7.9 People – Culture and heritage

Project activities have the potential to impact on the following environmental factor – culture and heritage. Specifically, impacts to cultural heritage may result of ground disturbance and clearing activities during construction. The following sub-sections provide a description of the potential impacts and proposed key management controls to mitigate any potential impacts.

7.9.1 Relevant policy and guidelines

The following conventions, legislation, policy and guidelines are relevant:

- EPBC Act (Cwlth)
- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cwlth)
- *Aboriginal Land Rights (Northern Territory) Act 1976* (Cwlth)
- *Northern Territory Aboriginal Sacred Sites Act 1989* (Northern Territory)
- *Heritage Act 2011* (Northern Territory)
- *Native Title Act 1993* (Cwlth).

7.9.2 Environmental context

The existing environmental context in relation to cultural and heritage is described in Section 4.3.2 and 4.3.3. A preliminary desktop study was undertaken for the CO_2 export pipeline route by Earth Sea Heritage Surveys in 2024. The scope of the assessment included:

- a study area covering the entire pipeline route from the boundary of the Ichthys LNG facility to the Darwin LNG pipeline tie-in station
- consultation with the heritage branch of Northern Territory Department of Territory Families, Housing and Communities
- consultation with Larrakia Nation Aboriginal Corporation, Larrakia Development Corporation and the INPEX Larrakia Advisory Committee
- desktop analysis of previous archaeological work undertaken in the area to inform any requirements for additional survey work
- identification of management measures to mitigate risks to places and objects protected by the *Heritage Act 2011* and developing a chance find protocol and stop work procedures.

The study found that the northern section of the wider Middle Arm Peninsula contains some 123 recorded archaeological / heritage sites and isolated artefacts.

A small number of these sites intersect with the Project area, most notably around the Darwin LNG pipeline tie-in station, to the south of the salt flats in the Ichthys CCS pipeline (Darwin LNG link) area and at the intersection of Wickham Point Road and the Ichthys LNG facility access road. There are no known Aboriginal heritage sites remaining within the fence line of the Ichthys LNG facility.

The majority of these recorded sites were identified to be pre-contact sites, such as shell middens and scatters, shell mounds, isolated stone artefacts and stone artefact scatter, with site density higher within mangrove margins adjacent to shallow mud flats.

Obtained AAPA certificates have determined there are no sacred sites on Middle Arm Peninsula.

7.9.3 Potential impacts

The following activities have the potential to impact on Aboriginal values if not managed appropriately:

- construction activities, including site establishment works, earthworks and excavation.

Aboriginal heritage sites/objects have been identified within and adjacent to the Project area. Project activities, such as ground disturbance and vegetation clearing activities, have the potential to disturb and potentially destroy known heritage sites and/or previously unidentified heritage sites. Potential impacts associated with these activities include disturbance, damage or destruction of:

- declared heritage sites
- unrecorded heritage sites
- loss of heritage values.

7.9.4 Management

NT EPA environmental objective:

Protect sacred sites, culture and heritage

To meet the NT EPA environmental objective for culture and heritage, the following measures would be implemented to avoid and minimise potential impacts:

- Undertake a heritage field survey of the Project footprint prior to undertaking construction works.
- Undertake ongoing consultation with Larrakia people to inform heritage management measures to be applied to aboriginal sites/objects.
- Implementation the following additional management measures onshore to reduce and minimise impacts on cultural and heritage values:
  - consultation with Larrakia people and organisations, including Larrakia Development Corporation, Larrakia Nation Aboriginal Corporation, Gwalwa Daraniki Association and the INPEX Larrakia Advisory Committee, during planning of geotechnical surveys and construction works
  - planning pre-construction surveys, in consultation with Larrakia people and their representatives
  - site protection measures, such as flagging/fencing off any heritage sites within proximity of the proposed impacts areas to avoid damage to sites during works (as determined in consultation with Larrakia representatives)
  - implementation of a chance find protocol and stop work procedure during ground disturbance activities
  - contractor and work site cultural heritage inductions for all employees and contractors to outline the importance of sites to Larrakia people and the legislative protection of sites.

7.9.5 Residual risk statement

Given the proposed mitigation measures to be implemented during design and construction, the expected residual impact associated with culture and heritage is considered moderate (Table 7-9).

Table 7-9: Culture and heritage – residual risk

Potential impact	Consequence	Likelihood	Residual risk
Accidental disturbance to a sacred site or heritage object/site	Moderate (D)	Highly Unlikely (5)	Moderate (5)

7.10 People – Human Health

Project activities have the potential to impact on the following environmental factor – human health. Specifically, impacts that have the potential for temporary and localised air quality impacts. The following sub-sections provide a description of the potential impacts and proposed key management controls to mitigate any potential impacts.

7.10.1 Relevant policy and guidelines

The following key conventions, legislation, policy and guidelines are relevant:

- *Public and Environmental Health Act 2011* (Northern Territory)
- *Work Health and Safety (National Uniform Legislation) Act 2011* (Northern Territory).

7.10.2 Environmental context

The socio-economic environment is described in Section 4.4. The Project area is located on the Middle Arm Peninsula in Darwin Harbour. The nearest local community is the residential area of Palmerston, approximately four kilometres to the north-east of the Ichthys LNG facility at the nearest point.

7.10.3 Potential impacts

The following activities have the potential to impact on human health if not managed appropriately:

- Unplanned release of due to:
  - a CO_2 transport pipeline leak or rupture.
  - a discharge of CO_2 from a leak or rupture at a pipeline tie-in station.
- Operational venting

For a pipeline CO_2 leak onshore, impacts may occur from the resultant atmospheric plume. As CO_2 is denser than air, it can quickly displace oxygen, leading to altered cognitive function, loss of consciousness, and asphyxiation which can result in loss of life. If the leak was to occur from CO_2 transport pipeline, human health may be impacted.

For human health an exposure limit of 40,000 ppm (the industry standard exposure concentration for 'immediately dangerous to life or health') is considered to represent the level at which loss of life can occur. Detailed assessment of leak scenarios from the CO_2 transport pipeline will be conducted to inform an assessment of potential impacts.

During the operational venting the primary air pollutants of concern are VOCs from venting, including BTEX and H_2S, during operations.

Of these, the main source of potential air quality impacts is the operational venting of CO_2 from the CCES operations, as described in Section 2.4.3.

Assuming constant operability of the CCS system, CO_2 emissions from the LNG facility via the AGRU would reduce significantly from current operations once CCS operations commence.

The dispersion of air emissions will be modelled to determine the extent, magnitude and duration of change in CO_2 stream emissions (including the trace amounts of VOCs, BTEX and H_2S, contained in the CO_2 stream). Impacts to any sensitive receivers within the modelled extent of dispersion will be assessed with consideration of the difference between predicted emissions during Project operations and emissions from existing Ichthys LNG facility operations.

7.10.4 Management

NT EPA environmental objective:

Protect the health of the Northern Territory population.

To meet the NT EPA environmental objective for human health, the following measures would be implemented to avoid and minimise potential impacts:

- Unplanned CO_2 release:
  - The CO_2 export pipeline would be designed to protect against threats to integrity including impact, corrosion, running ductile fracture and embrittlement. Design codes and material specifications would be compliant with the relevant Australian and international standards for transporting CO_2.
  - Testing would be undertaken prior to commissioning to confirm integrity of the CO_2 export pipeline.
  - IMMR activities would be conducted throughout operations, including monitoring the pipeline corrosion protection system
  - Compliance with obtained pipeline licences in accordance with the *Energy Pipelines Act 1981* (Northern Territory).
- Operational venting:
  - A detailed assessment of operational venting scenarios, including modelling of CO_2 dispersion, would be conducted to inform an assessment of potential impacts and appropriate management controls implemented.
  - Emissions control options would be reviewed for operational venting.
  - An assessment of best practice control options would be undertaken against the requirements of the EPA Waste Management Guidelines to inform selection of best available techniques and technologies.
  - Development and implementation of an air quality management and monitoring plan for the operations phase.

7.10.5 Residual risk statement

Given the proposed mitigation measures to be implemented during design and construction, the expected residual impact associated with human health is considered low to moderate (Table 7-10).

Table 7-10: Human health – residual risk

Potential impact	Consequence	Likelihood	Residual risk
Impacts on human health due to unplanned CO_2 release	Significant (C)	Highly Unlikely (5)	Moderate (7)
Impacts on human health due to operational venting	Insignificant (F)	Possible (3)	Low (8)

7.11 Cumulative impacts

In the case of construction occurring concurrently with other developments in the area, potential cumulative impacts include:

- construction disturbance and amenity impacts (e.g., traffic, air quality, noise and light emissions)
- disturbance of intertidal mudflats providing habitat for shorebirds
- direct removal of mangrove and woodland vegetation
- social, economic and cultural impacts.

Post-construction, there are likely to be cumulative impacts to the community and environmental values related to land use changes and industrialisation of the Darwin Harbour environment due to the presence of infrastructure for this Project and other existing and potential projects in the vicinity of the Project.

The Northern Territory EPA's guidance on referring a proposal to the Northern Territory EPA (NT EPA 2022) guides proponents to describe potential cumulative impacts of a proposal taking into account the combined impact of the action or proposal and other actions, including those that are currently under assessment or have already been approved.

Projects of relevance for the consideration of cumulative impacts include:

- Darwin LNG facility
- the Bonaparte CCS Project
- the Middle Arm Sustainable Development Precinct enabling works.

Cumulative impacts will be considered in greater detail as part of the assessment process for the Project.

8 PRELIMINARY ASSESSMENT – SIGNIFICANT IMPACTS TO EPBC ACT MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

Table 4-1 provides a screening of MNES that may be impacted by the Project. Relevant MNES have been described in Section 4.2.3.

A likelihood of occurrence assessment has been undertaken to identify the threatened and migratory species identified from the PMST report that could potentially interact with the Project (Section 4.6.6). The species discussed in this preliminary assessment of potential significant impacts on MNES include those assessed as known to occur, likely to occur or may occur.

A preliminary assessment of the potential for significant impacts on relevant MNES is evaluated in this section. This assessment has been undertaken in accordance with MNES Significant Impact Guidelines 1.1 (CoA 2013), with the relevant significant impact criteria for each MNES being evaluated. These guidelines define a significant impact as "an impact which is important, notable, or of consequence, having regard to its context or intensity". Whether or not an action is likely to have a significant impact depends upon a range of factors including the sensitivity, value, and quality of the environment, which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts. In the context of the above, the guideline defines 'likely' as having a "real or not remote chance or possibility".

To assist in assessing whether a significant impact to MNES is likely to occur, the guidelines provide a set of significant impact criteria unique to each MNES group. The assessment presented in the tables below, utilises these criteria.

Each significant impact criterion is assessed as 'Potential for significant impact', 'Unlikely to have significant impact' or 'No significant impact'. Project aspects are assessed as having 'Potential for significant impact' if a significant impact is either likely or there is currently uncertainty about the Project or the potential impacts that prevents it from being determined as 'Unlikely to have significant impact' or 'No significant impact'.

The outcomes of the assessment of significant impacts on threatened and migratory species that are known to or likely to be present either within or adjacent to the Project area is presented in Appendix F, with a summary provided in following sections.

8.1 Threatened species

8.1.1 Avifauna

Seventeen (17) threatened avifauna species were identified as 'May', 'Likely', or 'Known' to occur within the Project area (Table 8-1). Of these species, two are listed as critically endangered, six are listed as endangered, and nine are listed as vulnerable. A summary of the significant impact assessment is provided in Table 8-1.

Table 8-1: Summary of preliminary assessment of potential impacts to threatened avifauna

Significant impact criteria	Assessment of significant impact
An action likely to have a significant impact on a threatened species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of a population	Unlikely to have a significant impact

Significant impact criteria	Assessment of significant impact
Reduce the area of occupancy of the species.	Unlikely to have a significant impact
Fragment an existing population into two or more populations.	Unlikely to have a significant impact
Adversely affect habitat critical to the survival of a species.	Unlikely to have a significant impact
Disrupt the breeding cycle of a population.	Unlikely to have a significant impact
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	Unlikely to have a significant impact
Result in invasive species that are harmful to a Critically Endangered or Endangered species becoming established in the Endangered or Critically Endangered species' habitat.	Unlikely to have a significant impact
Introduce disease that may cause the species to decline.	Unlikely to have a significant impact
Interfere with the recovery of the species.	Unlikely to have a significant impact

8.1.2 Mammals

Terrestrial mammals

Three threatened terrestrial mammal species were identified as 'May', 'Likely', or 'Known' to occur within the Project area (Table 4-5). Of these species, one is listed as endangered, and two are listed as vulnerable. A summary of the significant impact assessment is provided in Table 8-2.

Table 8-2: Summary of preliminary assessment of potential impacts to threatened terrestrial mammals

Significant impact criteria	Assessment of significant impact
An action likely to have a significant impact on a threatened species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of a population	Unlikely to have a significant impact
Reduce the area of occupancy of the species.	Unlikely to have a significant impact
Fragment an existing population into two or more populations.	Unlikely to have a significant impact
Adversely affect habitat critical to the survival of a species.	Unlikely to have a significant impact

Significant impact criteria	Assessment of significant impact
Disrupt the breeding cycle of a population.	Unlikely to have a significant impact
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	Unlikely to have a significant impact
Result in invasive species that are harmful to a Critically Endangered or Endangered species becoming established in the Endangered or Critically Endangered species' habitat.	Unlikely to have a significant impact
Introduce disease that may cause the species to decline.	Unlikely to have a significant impact
Interfere with the recovery of the species.	Unlikely to have a significant impact

Marine mammals

Three threatened terrestrial mammal species were identified as 'May', 'Likely', or 'Known' to occur within the Project area (Table 4-5). Of these species, one is listed as endangered, and two are listed as vulnerable. A summary of the significant impact assessment is provided in Table 8-3.

Table 8-3: Summary of preliminary assessment of potential impacts to threatened marine mammals

Significant impact criteria	Assessment of significant impact
An action likely to have a significant impact on a threatened species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of a population	No significant impact
Reduce the area of occupancy of the species.	No significant impact
Fragment an existing population into two or more populations.	No significant impact
Adversely affect habitat critical to the survival of a species.	No significant impact
Disrupt the breeding cycle of a population.	No significant impact
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No significant impact

Significant impact criteria	Assessment of significant impact
Result in invasive species that are harmful to a Critically Endangered or Endangered species becoming established in the Endangered or Critically Endangered species' habitat.	No significant impact
Introduce disease that may cause the species to decline.	No significant impact
Interfere with the recovery of the species.	No significant impact

8.1.3 Reptiles

Terrestrial reptiles

One threatened reptile species was identified as 'May', 'Likely', or 'Known' to occur within the Project area (Table 4-5). Of these species, one is listed as endangered, and two are listed as vulnerable. A summary of the significant impact assessment is provided in Table 8-4.

Table 8-4: Summary of preliminary assessment of potential impacts to terrestrial reptiles

Significant impact criteria	Assessment of significant impact
An action likely to have a significant impact on a threatened species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of a population	Unlikely to have a significant impact
Reduce the area of occupancy of the species.	Unlikely to have a significant impact
Fragment an existing population into two or more populations.	Unlikely to have a significant impact
Adversely affect habitat critical to the survival of a species.	Unlikely to have a significant impact
Disrupt the breeding cycle of a population.	Unlikely to have a significant impact
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	Unlikely to have a significant impact
Result in invasive species that are harmful to a Critically Endangered or Endangered species becoming established in the Endangered or Critically Endangered species' habitat.	Unlikely to have a significant impact
Introduce disease that may cause the species to decline.	Unlikely to have a significant impact

Significant impact criteria	Assessment of significant impact
Interfere with the recovery of the species.	Unlikely to have a significant impact

Marine reptiles

Two threatened marine reptile species were identified as 'May', 'Likely', or 'Known' to occur within the Project area (Table 4-5). Of these species, one is listed as endangered, and two are listed as vulnerable. A summary of the significant impact assessment is provided in Table 8-5.

Table 8-5: Summary of preliminary assessment of potential impacts to marine reptiles

Significant impact criteria	Assessment of significant impact
An action likely to have a significant impact on a threatened species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of a population	No significant impact
Reduce the area of occupancy of the species.	No significant impact
Fragment an existing population into two or more populations.	No significant impact
Adversely affect habitat critical to the survival of a species.	No significant impact
Disrupt the breeding cycle of a population.	No significant impact
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No significant impact
Result in invasive species that are harmful to a Critically Endangered or Endangered species becoming established in the Endangered or Critically Endangered species' habitat.	No significant impact
Introduce disease that may cause the species to decline.	No significant impact
Interfere with the recovery of the species.	No significant impact

8.1.4 Fish and sharks

Three threatened marine reptile species were identified as 'May', 'Likely', or 'Known' to occur within the Project area (Table 4-5). Of these species, one is listed as endangered, and two are listed as vulnerable. A summary of the significant impact assessment is provided in Table 8-6.

Table 8-6: Summary of preliminary assessment of potential impacts to threatened fish and sharks

Significant impact criteria	Assessment of significant impact
An action likely to have a significant impact on a threatened species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of a population	No significant impact
Reduce the area of occupancy of the species.	No significant impact
Fragment an existing population into two or more populations.	No significant impact
Adversely affect habitat critical to the survival of a species.	No significant impact
Disrupt the breeding cycle of a population.	No significant impact
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No significant impact
Result in invasive species that are harmful to a Critically Endangered or Endangered species becoming established in the Endangered or Critically Endangered species' habitat.	No significant impact
Introduce disease that may cause the species to decline.	No significant impact
Interfere with the recovery of the species.	No significant impact

8.2 Migratory species

Forty-five threatened marine reptile species were identified as 'May', 'Likely', or 'Known' to occur within the Project area (Table 4-5). Of these species, one is listed as endangered, and two are listed as vulnerable. A summary of the significant impact assessment is provided in Table 8-7.

Table 8-7: Summary of the preliminary assessment of potential impacts to MNES: migratory species

Significant impact criteria	Assessment of significant impact
An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:	

Significant impact criteria	Assessment of significant impact
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	Unlikely to have a significant impact
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	Unlikely to have a significant impact
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	Unlikely to have a significant impact

9 PROPOSED PROGRAM OF INVESTIGATIONS

INPEX plans to conduct an extensive program of investigations to support the detailed assessment process. A gap analysis will be conducted to determine additional environmental baseline studies required to inform a detailed evaluation of impacts and risks and future monitoring. An outline of indicative desktop assessments is identified in Table 9-1.

Table 9-1: Indicative desktop assessments to support a detailed assessment

Study	Study Objectives	Potential Methods Being Considered
CO_2 release modelling	• Evaluate the fate and effect of unplanned CO_2 leaks from the Project infrastructure.	• Numerical/quantitative modelling - credible CO_2 leak scenarios.
Air quality assessment	• Undertake an assessment of the potential influence of the Project changes on air emissions and ambient air quality.	• Numerical/quantitative dispersion modelling assessment.
Noise modelling	• To evaluate the noise emission levels and extent from the operation of Project equipment	• Numerical/quantitative modelling to generate noise contours to assess cumulative noise risks
Social impact assessment	• Identification of socio-economic uses within and adjacent to the Project area. • Assessment of potential social impacts.	• Stakeholder consultation. • Desktop assessment.
Cultural heritage assessment	• Identify tangible and intangible cultural heritage within the Project area and surrounds through consultation, desktop assessment and field surveys. • Development of a Cultural Heritage Management Plan.	• First nations consultation. • Terrestrial cultural heritage investigations (field surveys).

10 REFERENCES

Aboriginal Areas Protection Authority [AAPA]. 2023. Regions of Sacred Sites in the NT accessed online 08/02/2023 at https://www.aapant.org.au/sacred-sites/regions-sacred-sites-nt

AEC Environmental. 2014. Annual Environmental Monitoring Report 2014: Environmental Impact Monitoring Program, Ichthys On-Shore LNG Facilities Bladin Point. Prepared for JKC Australia LNG Pty Ltd, August 2014. Winnellie, NT.

AEC Environmental, 2015. Report for Bladin Point Conceptual Groundwater Model: Environmental Impact Monitoring Program, Ichthys On-Shore LNG Facilities Bladin Point. Prepared for JKC Australia LNG Pty Ltd, January 2015. Winnellie, NT.

AEC Environmental. 2017. EPA7 Annual Report 2017: Environmental Impact Monitoring Program, Ichthys On-Shore LNG Facilities Bladin Point. Prepared for JKC Australia LNG Pty Ltd, July 2015. Winnellie, NT.

AEC Environmental. 2018. Annual environmental monitoring report 2018: Environmental impact monitoring program, Ichthys on-shore LNG facilities Bladin Point. Report prepared for JKC Australia LNG Pty Ltd.

AECOM, 2020. *Marine sediment geochemical assessment*. Report for the Department of the Chief Minister and Cabinet, Darwin, Northern Territory by AECOM Australia Pty Ltd, Darwin, Northern Territory.

AECOM 2024. Ichthys LNG Project Groundwater Investigation – Groundwater Trend Analysis. Report prepared by AECOM Australia Pty Ltd for INPEX Operations Australia Pty Ltd

Adams PJ (2003). Parasites of feral cats and native fauna from Western Australia: the application of molecular techniques for the study of parasitic infections in Australian wildlife. PhD Thesis. Murdoch University. Western Australia.

Australian and New Zealand Guidelines [ANZG] for Fresh and Marine Water Quality. 2018. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Accessed online 25/02/2022 at www.waterquality.gov.au/anz-guidelines

Australian Standard AS/NZS 2885.1 Pipelines - Gas and liquid petroleum

Australian Standard AS/NZS ISO 31000:2009 Risk management – Principles and guidelines

Baker, B., Price, O., Woniarski, J., Gold, S., Connors, G., Fisher, A., and Hempel, C., 2005. *Northern Territory Bioregions – assessment of key biodiversity values and threats*. Northern Territory Government. Department of Natural Resources, Environment and the Arts, Northern Territory, Darwin., Department of Natural Resources, Environment and the Arts.

Bamford M., Watkins D., Bancroft W., Tischler G. and Wahl, J. 2008. Migratory Shorebirds of the East Asian–Australasian Flyway; Population Estimates and Internationally Important Sites. etlands International. Oceania. Canberra, ACT.

BirdLife International. 2022. Important Bird Areas factsheet: Fog Bay and Finniss River Floodplains. Birdlife International, Cambridge, United Kingdom. Accessed online 04/03/2022 at http://www.birdlife.org.

Bonaccorso, F.J. 1998. Bats of Papua New Guinea. *Conservation International Tropical Field Guide Series 2*. Washington D C: Conservation International.

Bourke [Burns], P 1996, *Northern Territory archaeological survey Stage 1, Darwin catchment region,* [Unpublished report to the Australian Heritage Commission], Museums and Art Galleries of the Northern Territory, Darwin.

Bourke, PM & Mulvaney, KJ 2003, 'Archaeology of the first recorded petroglyphs for the Darwin region', *The Beagle: Records of the Museums and Art Galleries of the Northern Territory,* vol. 19, pp.1-6.

Bowman DMJS & Mcdonough L (1991) Feral pig (Sus scrofa) rooting in a monsoon forest-wetland transition, Northern Australia. Wildlife Research 18, 761–765.

Brocklehurst. P. and Edmeades, B. 2018. *Development of an integrated long-term mangrove monitoring program for Darwin Harbour*. Sub-project A: Mangrove community mapping: Charles Point to Gunn Point 2016. Technical Report 19/2018D, Department of Environment and Natural Resources, Darwin, Northern Territory

Brosset, A. 1962. The bats of Central and Western India. Part 1. *Journal of the Bombay Natural History Society*. 59:1-57.

Bruton M, Hoggett A, Woods T, Cameron S, Kanowski J (2020) *Yampi Sound Training Area Conservation Land Management Plan.* Review of Year 2019 Activities, and Plan for 2020. Page 36. Report by the Australian Wildlife Conservancy for the Commonwealth Department of Defence.

Bureau of Meteorology. 2022. Monthly climate statistics – Darwin Airport. Bureau of Meteorology, Canberra, ACT. Accessed 15 December 2022 at http://www.bom.gov.au/climate/averages/tables/cw_014015_All.shtml

Burns, T. 1994. Mound over matter: Origins of shell and earth mounds of northern Australia: An evaluation of mounds on Channel Island and Middle Arm mainland, Darwin Harbour. BA(Hons) Thesis, Northern Territory University, Darwin.

Cardno. 2014. Darwin Harbour: A summary of the Ichthys LNG Project nearshore environmental monitoring program. Report prepared by Cardno (NSW/ACT) Pty Ltd, Sydney, New South Wales for INPEX Operations Australia Pty. Ltd., Perth, Western Australia.

Cardno. 2015a. Water Quality and Subtidal Sedimentation Post-dredging Report –Ichthys Nearshore Environmental Monitoring Program. Prepared for INPEX by Cardno Pty Ltd.

Cardno. 2015b. *Intertidal sedimentation and mangrove community health post-dredging report.* Ichthys Nearshore Environmental Monitoring Program. Report prepared by Cardno (NSW/ACT) Pty Ltd, Sydney, New South Wales for INPEX Operations Australia Pty. Ltd., Perth, Western Australia

Cardno. 2022. *New marine facilities to service Mandorah and Cox Peninsula*. Report prepared for Northern Territory Government Department of Infrastructure, Planning and Logistics by Cardno (NT) Pty Ltd.

Chatto, R., and Baker, B. 2008. *The distribution and status of marine turtle nesting in the Northern Territory-Technical Report 77/2008*. Parks and Wildlife Service, Department of Natural Resources, Environment, The Arts and Sport. Northern Territory Government.

Churchill, S. 1998. Australian Bats. Reed New Holland, Sydney.

CoA – See Commonwealth of Australia

Commonwealth of Australia [CoA]. 2009. *National assessment guidelines for dredging.* Commonwealth of Australia, Canberra, ACT. Viewed online on 5 March 2025 at https://www.dcceew.gov.au/sites/default/files/documents/guidelines09.pdf

Commonwealth of Australia [CoA], 2013. Matters of National Environmental Significance. Significant impact guidelines 1.1. *Environmental Protection and Biodiversity Conservation Act 1999.* Department of the Environment, Canberra, ACT.

Commonwealth of Australia [CoA]. 2015. *Wildlife Conservation Plan for Migratory Shorebirds.* Commonwealth of Australia, Canberra, ACT. Available at: https://www.dcceew.gov.au/sites/default/files/documents/widlife-conservation-plan-migratory-shorebirds.pdf

Commonwealth of Australia [CoA], 2017a. Recovery Plan for Marine Turtles in Australia. Commonwealth of Australia, Canberra, ACT.

Commonwealth of Australia [CoA]. 2018. *Australian and New Zealand guidelines for fresh and marine water quality*. Commonwealth of Australia, Canberra, ACT. Available at: https://www.waterquality.gov.au/

Commonwealth of Australia [CoA]. 2022. *Wildlife Conservation Plan for Seabirds.* Commonwealth of Australia, Canberra, ACT. Available at: https://www.dcceew.gov.au/sites/default/files/documents/wildlife-conservation-plan-for-seabirds.pdf

Commonwealth of Australia [COA]. 2025. *Avian Influenza (bird flu).* Australian Government. 07 April 2025. Department of Agriculture, Fisheries, and Forestry.

Compton, A., & Johnston, P. M. 1983. Observations on the sheath-tailed bat, *Taphozous saccolaimus* Temminck (Chiroptera: Emballonuridae), in the Townsville region of Queensland. *Australian Mammalogy* 6, 83-87.

Crassweller, C 2002, The excavation of two shell middens at Wickham Point, Darwin Harbour, A Report to URS (Aust) Pty Ltd on behalf of Phillips Petroleum Company Australia Pty Ltd, Begnaze Pty Ltd, Darwin.

Crichton, E. G. 1969. Reproduction in the pseudomyine rodent *Mesembriomys gouldii* (Gray) (Muridae). *Australian Journal of Zoology* 17, 785-797.

Darwin Harbour Integrated Report Card [DHIRC], 2024. Darwin Harbour Integrated Report Card 2024. Accessed 18 February 2025 at < https://dhirc.org.au/>.

Datt, B. and Staben, G. 2020. *Monitoring mangrove forests using satellite imagery: mangrove monitoring sub-project D*. Technical Report No. XX/2020, Department of Environment and Natural Resources, Darwin, Northern Territory

DAWE – See Department of Agriculture, Water and the Environment

DCA – See Department of Communications and the Arts

DCCEEW – See Department of Climate Change, Energy, the Environment and Water

de Laive A, Schembri B & Jolly C. 2021. Novel habitat associations and seasonality in threatened Mitchell's water monitors (*Varanus mitchelli*): implications for conservation. *Austral Ecology* 46, 871–875.

Dear SE, Williams KM, McElnea AE, Ahern CR, Dobos SK, Moore NG, and O'Brien LE 2024, *Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines, Version 5.1*, Department of Resources and Department of Environment, Science and Innovation, Queensland

DEH – See Department of Environment and Heritage

del Hoyo, J., Elliott, A. and Sargatal, J. (eds). 1996. *Handbook of the Birds of the World, Vol. 3: Hoatzin to Auks*. Lynx Edicions, Barcelona, Spain.

Department of Agriculture, Water and the Environment [DAWE], 2022. Australian Ramsar Wetlands Database: Finniss Floodplain and Fog Bay System. Available at http://www.environment.gov.au/cgibin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NT025

Department of Climate Change, Energy, the Environment and Water [DCCEEW]. 1993. *Directory of Important Wetlands in Australia.* Department of Climate Change, Energy, the Environment and Water.

Department of Climate Change, Energy, the Environment and Water [DCCEEW], 2019 (Adelaide floodplain) Directory of Important Wetlands in Austrlaia – Informaiton Sheet. Access online 28/08/2025 Available online at Australian Wetlands Database - Directory Wetland Information Sheet

Department of Climate Change, Energy, the Environment and Water [DCCEEW], 2021. Predation, habitat degradation, competition and disease transmission by feral pigs. Australian Government. 03 October 2021.

Department of Climate Change, Energy, the Environment and Water [DCCEEW], 2023a, *National Light Pollution Guidelines for Wildlife*, Department of Climate Change, Energy, the Environment and Water, Canberra, May. CC BY 4.0

Department of Climate Change, Energy, the Environment and Water [DCCEEW] 2023b, Conservation Advice for Varanus mitchelli (Mitchell's water monitor), Canberra.

Department of Climate Change, Energy, the Environment and Water [DCCEEW], 2024. *Conservation Advice for Calidris canutus (red knot).* Australian Government.

Department of Climate Change, Energy, the Environment and Water [DCCEEW], 2025a. *Protected Matters Search Tool* [Interactive map]. Australian Government.

Department of Climate Change, Energy, the Environment and Water [DCCEEW], 2025b. Australia's bioregions (IBRA). Australian Government.

Department of Climate Change, Energy, the Environment and Water [DCCEEW], 2025c. *Conservation Advice for Sternula albifrons (little tern)*. Australian Government.

Department of Climate Change, Energy, the Environment and Water [DCCEEW], n.d. *Species Profile and Threats Database*. Australian Government. Available at: https://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

Department of Health and Families. 2009. Mosquito breeding and sewage pond treatment in the Northern Territory. Medical Entomology, Centre for Disease Control, Northern Territory Department of Health. Darwin 2009

Department of the Environment and Energy [DoEE]. 2017a. EPBC Act Policy Statement 3.21. Industry guidelines for avoiding, assessing and mitigating impacts on EPBC listed migratory shorebird species. Commonwealth of Australia, Canberra, ACT.

Department of the Environment, Water, Heritage and the Arts [DEWHA]. 2008. North Marine Bioregional Plan bioregional profile: a description of the ecosystems, conservation values and uses of the North Marine Region. Commonwealth of Australia, Canberra, ACT.

Department of Territory Families, Housing and Communities [DTFHC]. 2021. *NT Heritage Register. Channel Island Leprosarium and Reefs*. Department of Territory Families, Housing and Communities, Darwin, Northern Territory. Viewed online on 21 September 2021 at http://www.ntlis.nt.gov.au/heritageregister/f?p=103:303:::::NO:P303_PLACE_ID:22

Dennis, A.J. 2012. Bare-rumped Sheathtail Bat. **In:** Curtis, L.K., A.J. Dennis, K.R. McDonald, P.M. Kyne & S.J.S. Debus, eds. *Queensland's Threatened Animals*. CSIRO Publishing.

Director of National Parks. 2018. North-west Marine Parks Network Management Plan 2018. Director of National Parks, Canberra, ACT.

DoEE – See Department of Energy and Environment

DTFHC – See Department of Territory Families, Housing and Communities

Earth Sea Heritage Surveys, 2024. INPEX Cultural Heritage Desktop Study Carbon Capture Pipeline Project 2024. Report prepared by Earth Sea Heritage Surveys, EarthSea Pty Ltd, The Gap, QLD.

EcOZ. 2023a. *Bladin Point Pipeline Corridor ecology studies*. Prepared for INPEX Operations Australia Pty Ltd [unpublished].

EcOZ. 2023b. *Middle Arm Sustainable Development Precinct – Migratory Shorebird Assessment*. Prepared for the Northern Territory Department of Infrastructure, Planning and Logistics

EcOZ. 2024a. *Bladin Point Pipeline Corridor – Ecology Survey Report 2023*. Prepared for INPEX Operations Australia Pty Ltd [unpublished].

EcOZ. 2024b. *Bladin Point Pipeline Corridor - Typhonium survey report.* Prepared for INPEX Operations Australia Pty Ltd [unpublished].

Errity, C., Penny, S. S. and Steffe A., 2022. A Survey of Recreational Fishing in the Greater Darwin area 2017. Northern Territory Government, Australia. Fishery Report No 125

Finlayson C, Storrs M, Hall R & Bayliss B (1999) *Wetland management issues.* Chapter 4 (pp 143- 167) in CM Finlayson & AG Spiers (eds) A compendium of information for managing and monitoring wetlands in tropical Australia.

Friend, G.R. and Braithwaite, R.W., 1986. Bat fauna of Kakadu National Park, Northern Territory. Aust. Mammal. 9, 43–52.

Friend, G. R. 1987. Population ecology of *Mesembriomys gouldii* (Rodentia: Muridae) in the wet-dry tropics of the Northern Territory. *Australian Wildlife Research* 14, 293-303.

Friend, G. R., Kemper, C. M., & Kerle, J. A. (1992). Rats of the tree tops. *Landscope* 8, 10-15.

Friend G & Taylor J (1985) Habitat preferences of small mammals in tropical open-forest of the Northern Territory. *Australian Journal of Ecology* 10, 173-185.

Fogarty PJ, Lynch B and Wood B. 1984. *The Land Resources of the Elizabeth, Darwin and Blackmore River*s. Land Conservation Unit, Conservation Commission of the Northern Territory.

Fortune, J., 2006. T*he grainsize and heavy metal content of sediment in Darwin Harbour*. Report No 14/2006D of the Aquatic Health Unit, Environmental Protection Agency, Department of Natural Resources, Environment and the Arts, Darwin, Northern Territory

GHD Pty. Ltd. 2009. Ichthys Gas Field Development Project: onshore flora and fauna study. Report prepared by GHD Pty Ltd, Darwin Northern Territory, for INPEX Browse, Ltd., Perth, Western Australia.

GHD, 2019. *Marine sampling analysis and quality plan implementation report*. Report prepared by GHD, Perth, Western Australia, for Department of Defence.

Hanley, J.R. & Caswell, G.M., 1995. *East Arm Port: Stage 1 water quality monitoring program—report on setup phase and baseline data collection*. Marine Ecology Technical Report 95/1. Darwin Port Authority, Darwin, Northern Territory.

He, W., Yoo, G., Moonis, M., Kim, Y., Chen, X., 2019. Impact assessment of high soil CO_2 on plant growth and soil environment: a greenhouse study. PeerJ. Jan 25;7:e6311.

Hollings T, Jones M, Mooney N, and McCallum H 2013. Wildlife disease ecology in changing landscapes: Mesopredator release and toxoplasmosis. International Journal for Parasitology: Parasites and Wildlife 2(110-118) https://doi.org/10.1016/j.ijppaw.2013.02.002

International Erosion Control Association [IECA] 2008. *Best practice erosion and sediment control: For building and construction sites*. Witheridge, G. (Ed.). International Erosion Control Association (Australasia).

INPEX Browse, 2010. Ichthys Gas Field Development Project, Ichthys Gas Field Development Project: draft environmental impact statement and the Supplement to the draft environmental impact statement. Report prepared by INPEX Browse, Ltd., Perth, WA.

INPEX Operations Australia Pty Ltd. 2016. *Ichthys LNG Project maintenance dredging sediment sampling and analysis report*. Report prepared by INPEX Operations Pty Ltd., Perth, Western Australia.

INPEX, 2019. *EPL228 Annual Environmental Monitoring Report 2018-2019*. Report prepared by INPEX Operations Pty Ltd., Perth, Western Australia.

INPEX, 2020. *EPL228 Annual Environmental Monitoring Report 2019-2020*. Report prepared by INPEX Operations Pty Ltd., Perth, Western Australia.

INPEX, 2021. EPL228 Annual Environmental Monitoring Report 2020-2021. Report prepared by INPEX Operations Pty Ltd., Perth, Western Australia.

INPEX, 2023. Ichthys LNG module offloading facility sediment sampling and analysis report Sampling and analysis plan exemption justification. Report prepared by INPEX Operations Pty Ltd., Perth, Western Australia.

Invasive Plants and Animals Committee 2016, Australian Weeds Strategy 2017 to 2027, Australian Government Department of Agriculture and Water Resources, Canberra

Jackson MV, Fuller RA, Gan X, Li J, Mao D, Melville DS, Murray NJ, Wang Z, Choi C. 2021. Dual threat of tidal flat loss and invasive Spartina alterniflora endanger important shorebird habitat in coastal mainland China. 278(2). Journal of Environmental Management. https://doi.org/10.1016/j.jenvman.2020.111549

Johnsgard, P.A. 1981. *The Plovers, Sandpipers and Snipes of the World*. Lincoln: Nebraska Press.

Kerle J (1985) Habitat preference and diet of the northern brushtail possum *Trichosurus arnhemensis* in the Alligator Rivers Region, N.T. *Proceedings of the Ecological Society of Australia* 13, 161-176

Kerle, J. & Howe, C. 1992. The breeding biology of a tropical possum, *Trichosurus vulpecula arnhemensis* (Phalangeridae: Marsupialia). *Australian Journal of Zoology* 40, 653-665.

Lake, J. and Lomax, B. (2019) Plant responses to simulated carbon capture and storage (CCS) CO_2 pipeline leakage: the effect of soil type. *Greenhouse Gases: Science and Technology*, 9 (2). pp. 397-408.

Li, L., 2013. Modelling the Tidal and Sediment Dynamics in Darwin Harbour, Northern Territory, Australia. PHD thesis, University of new South Wales, Canberra, ACT.

Liddle, D.T. 2009. *Management Program for Cycads in the Northern Territory of Australia 2009-2014*. Northern Territory Department of Natural Resources, Environment, the Arts and Sport, Darwin

Lilleyman, A., Millar, G., Hunt Lew-Fatt, K., Yunupingu, B., Anderson, J., Que-Noy, J., Williams, B., Bray, T., Burn, S., Dawson, S., Talbot, A., Smith, B., and Garnett, S.T. 2020. *Shorebird values and knowledge gaps in Darwin Harbour, Northern Territory – Report II*. A report to the Department of Environment and Natural Resources, Northern Territory Government. By Research Institute for the Environment and Livelihoods, Charles Darwin University.

Limpus, C.J. (1995). *Conservation of marine turtles in the Indo-Pacific region*. Brisbane: Queensland Department of Environment and Heritage.

Makarynska, D. 2019. *Water Quality Pilot Project WP2: Intra-annual water quality variability.* Department of Environment and natural Resources, Palmerston, Northern Territory.

Mayer M, Brown GP, Zimmermann B, Greenlees MJ, Shine R 2015. Habitat use of the introduced cane toad (Rhinella marina) and native frog species in tropical Australia. Journal of Tropical Ecology 31(6):531-540. doi:10.1017/S0266467415000474

McKenzie N (1981) Mammals of the Phanerozoic south-west Kimberley, Western Australia: biogeography and recent changes. *Journal of Biogeography* 8, 263-280.

Mihailou H & Massaro M (2021) An overview of the impacts of feral cattle, water buffalo and pigs on the savannas, wetlands and biota of northern Australia. Austral Ecology 46, 699– 712.

Milne, D. J., Jackling, F. C., Sidhu, M., & Appleton, B. J. 2009. Shedding new light on old species identifications: morphological and genetic evidence suggest a need for conservation status review of the critically endangered bat Saccolaimus saccolaimus. *Wildlife Research* 36, 496-508.

Morris K, Woinarski J, Friend T, Foulkes J, Kerle A & Ellis M (2008) *Trichosurus vulpecula.* In 'IUCN red list of threatened species.' Version 2012.1. <www.iucnredlist.org>.

Munksgaard, N.C., Kaestli, M., Gibb, K., Dostine, P. and Townsend, S., 2013. *Darwin Harbour sediment survey 2012*. Environmental Chemistry and Microbiology Unit (ECMU) Research Institute for the Environment and Livelihoods, Charles Darwin University, Darwin, Northern Territory.

National Working Party on Acid Sulfate Soils. 2000. National Strategy for the Management of Coastal Acid Sulfate Soils. NSW Agriculture Wollongbar Agricultural Institute Bruxner Highway Wollongbar NSW 2477, Australia

Northern Territory Department of Land Resource Management [NT DLRM] n.d. Erosion and Sediment Control Plans For Rural Development, Northern Territory Government. Available at: https://nt.gov.au/_media/docs/environment/soil,-land-and-vegeation/erosion-and-sediment-control/escp-for-rural-development.pdf

Northern Territory Department of Environment, Parks and Water Security [NT DEPWS] 2024. *Land Clearing Guidelines: Northern Territory Planning Scheme*. Northern Territory Government. Available at: https://nt.gov.au/_media/docs/housing,-property-and-land/land-clearing/freehold-land/apply-to-clear-freehold-land/land-clearing-guidelines.pdf

Northern Territory Environment Protection Authority [NT EPA], 2013a. *Guidelines for assessment of impacts on terrestrial biodiversity.* Northern Territory Government. Available at: https://ntepa.nt.gov.au/_resources/documents/eia/guidelines-fact-sheets/guideline_assessment_terrestrial_biodiversity.pdf

Northern Territory Environment Protection Authority [NT EPA], 2013b. *Guidelines for the preparation of an economic and social impact assessment.* Northern Territory Government. Available at: https://ntepa.nt.gov.au/?external-uuid=a71dc871-d1bf-442b-b077-dc39b2f55da8

Northern Territory Environment Protection Authority [NT EPA], 2013c. *Guidelines for the environmental assessment of marine dredging in the Northern Territory.* Northern Territory Government. Available at: https://ntepa.nt.gov.au/_resources/documents/eia/guidelines-fact-sheets/guideline_assessments_marine_dredging.pdf

Northern Territory Environment Protection Authority [NT EPA], 2014. *A stormwater strategy for the Darwin Harbour Region.* Northern Territory Government. Available at: https://ntepa.nt.gov.au/consultation/stormwater-strategy-for-darwin-harbour-region/documents/current-documents/draft_stormwater_strategy_darwin_harbour_region.pdf

Northern Territory Environment Protection Authority [NT EPA], 2015a. *Guidelines to prevent pollution from building sites.* Northern Territory Government. Available at: https://ntepa.nt.gov.au/__media/waste-and-pollution/pdf/guidelines/guideline_prevent_pollution_building_sites.pdf

Northern Territory Environment Protection Authority [NT EPA], 2015b. *Guideline for the preparation of an environmental management plan.* Northern Territory Government. Available at: https://ntepa.nt.gov.au/__media/about-ntepa/publications/2015/guideline_prep_emp.pdf

Northern Territory Environment Protection Authority [NT EPA], 2017. *Guideline: Recommended Land Use Separation Distances.* Northern Territory Government. Available at: https://ntepa.nt.gov.au/__media/waste-and-pollution/pdf/guidelines/guideline_recommended_land_separation_distances_oct.pdf

Northern Territory Environment Protection Authority [NT EPA], 2018. *NT Noise Management Framework guideline.* Northern Territory Government. Available at: https://ntepa.nt.gov.au/news/2018/nt-noise-management-framework-guideline

Northern Territory Environment Protection Authority [NT EPA], 2021. *NT EPA Stakeholder Engagement and Consultation: Environmental Impact Assessment GuiAECdance for Proponents*. Northern Territory Government. Available at https://ntepa.nt.gov.au/__data/assets/pdf_file/0005/884696/guidance-proponents-stakeholder-engagement-and-consultation.pdf

Northern Territory Environment Protection Authority [NT EPA], 2022. *Referring a proposal to the NT EPA*. Northern Territory Government. Available at: https://ntepa.nt.gov.au/?external-uuid=0675eec6-d77e-4847-b848-432c040b902a

Northern Territory Environment Protection Authority [NT EPA], 2025a. *Environmental impact assessment and environmental approval under the Environment Protection Act 2019*. Northern Territory Government. Available at: https://environment.nt.gov.au/media/docs/environment/documents/environmental-impact-assessment-and-approval-in-the-nt.pdf

Northern Territory Environment Protection Authority [NT EPA], 2025b. *NT EPA Environmental factors and objectives*. Northern Territory Government. Available at: https://ntepa.nt.gov.au/?external-uuid=046ebe2b-c1ca-465a-837a-63c1cc2a3471

Northern Territory Environment Protection Authority [NT EPA], 2025c. Guidelines for assessment of impacts on terrestrial biodiversity, NT EPA. Available at https://ntepa.nt.gov.au/__data/assets/pdf_file/0011/1487738/guidelines-aassessment-impacts-terrestrial-biodiversity.pdf

Northern Territory Government, 2020. Northern Territory Planning Scheme Part 4: Zones & Assessment Tables. Available at: https://nt.gov.au/_media/docs/housing,-property-and-land/planning-and-development/nt-planning-scheme-2020/part-4-zones-and-assessment-tables-nt-planning-scheme-2020.pdf

Nowak, R.M. & J.L. Paradiso (1983). *Walker's Mammals of the World*. Baltimore: The John Hopkins University Press.

NT DEPWS – See Northern Territory Department of Environment, Parks and Water Security

NT EPA – See Northern Territory Environment Protection Authority

NT – See Northern Territory

O'Brien, P., Coroneos, C., Goodwin, I.D. and Hook, F. 2025. Bonaparte Carbon Capture & Storage Underwater Cultural Heritage Desktop Gap Analysis and Risk Assessment. Draft report prepared by Cosmos Archaeology.

Olsen B, Munster VJ, Wallensten A, Waldenström J, Osterhaus ADME, Ron A M Fouchieret RAM (2006) *Global patterns of influenza A virus in wild birds*. Science, 312(5772): 384-388 https://doi.org/10.1126/science.1122438

Pacific Environment. 2014. *Updated air modelling for normal operations at Ichthys onshore plant*. Report prepared by Pacific Environment Ltd, Darwin, Northern Territory for INPEX Operations Australia Pty Ltd, Perth, Western Australia.

Padovan, A.V. 1997. The water quality of Darwin Harbour: October 1990–November 1991. Water Quality Branch, Water Resources Division, Department of Lands, Planning and Environment, NT Government, Report No. 34/1997D December 1997

Padovan, A.V. 2003. *Darwin Harbour water and sediment quality*. Proceedings of the Darwin Harbour Public Presentations. February 2003, pp. 5-18.

Palmer, C. 2010. Darwin Harbour Coastal Dolphin Project. Biodiversity Unit, Department of Natural Resources, Environment, the Arts and Sport (NRETAS). Interim report.

Price-Rees, S. J., Brown, G. P. and Shine, R. 2013. Habitat selection by bluetongue lizards (Tiliqua, Scincidae) in tropical Australia: a study using GPS telemetry. Animal Biotelemetry 1:7.

Radke, B., Watkins, K.L. & Bauld, J. 1998. A Groundwater Quality Assessment of Shallow Aquifers in the Darwin Rural Area, Northern Territory – Volume 1: Text. In Australian Geological Survey Organisation and Department of Primary Industries and Energy, Australian Groundwater Quality Assessment Project Report No. 4. Canberra, ACT: Australian Geological Survey Organisation.

Radke, L.C., Fortune, J., Majid, M. and Mummery, A., 2020a. *Sediment quality assessment of East Arm, Darwin Harbour (2019): Survey record and data report*. Technical Report No. 9/2020, Department of Environment and Natural Resources, Palmerston, Northern Territory.

Radke, L., Majid, M., Mummery, A., Lambrinidis, D., Logan, M, and Wyatt, J., 2020b. *Sediment quality assessment of Outer Darwin Harbour (2020): Survey record and data report*. Technical Report No. 38/2020. Department of Environment and Natural Resources, Northern Territory Government, Darwin, Northern Territory

Radke, L.C., Smit, N. and Fortune, J., 2021. Assessment of sediment quality indicators for long term monitoring in Darwin Harbour: Final report. Technical Report No. 32/2021, Department of Environment, Parks and Water Security, Palmerston, Northern Territory

Radke, L.C., Majid, M. and Choy, D.L., 2023. Darwin Harbour Integrated Marine Monitoring and Research Program Benthic Sediment Monitoring Report 2022-23 and Ambient Per- and Polyfluoroalkyl Substance (PFAS) Study. Technical Report No. 06/2023, Department of Environment, Parks and Water Security, Palmerston, Northern Territory.

Radke, L.C., Majid, M. and Choy, D.L., 2024. *Darwin Harbour Integrated Marine Monitoring and Research Program Benthic Sediment Monitoring Report 2023-24*. Technical Report No. 008/2024, Department of Environment, Parks and Water Security, Palmerston, Northern Territory.

Reiss A, Jackson A, Gillespie G, Stokeld D & Warren K (2015) *Investigation of Potential Diseases Associated with Northern Territory Mammal Declines.* Charles Darwin University, Darwin.

Richardson, N 1996, *Archaeological site survey and documentation - Darwin Region*, [Unpublished report to the Australian Heritage Commission, Museums and Art Galleries of the Northern Territory], Darwin.

Rossiter NA, Setterfield SA, Douglas MM & Hutley LB (2003) *Testing the grass-fire cycle: alien grass invasion in the tropical savannas of northern Australia*. Diversity and Distributions 9, 169–176.

Royal Haskoning DHV [RHDHV]. 2022. Middle Arm sustainable development precinct: Sediment quality interpretive report. Report prepared by Haskoning Australia Pty Ltd, North Sydney, New South Wales for Department of Infrastructure, Planning and Logistics, Darwin, Northern Territory.

Semeniuk, V., 1985. Development of mangrove habitats along ria shorelines in north and northwestern tropical Australia. *Vegetation* 60:3–23.

Shand, P, Appleyard, S, Simpson, SL, Degens, B, Mosley, LM 2018, National Acid Sulfate Soils Guidance: Guidance for the dewatering of acid sulfate soils in shallow groundwater environments, Department of Agriculture and Water Resources, Canberra, ACT. CC BY 4.0.

Shine R. 1986. Food habits, habitats and reproductive biology of four sympatric species of varanid lizards in tropical Australia. *Herpetologica* 42, 346–360

Sinclair Knight Merz. 2010. *Ichthys Gas Field Development Project – Onshore air quality study*. Prepared for INPEX Browse Ltd., Perth, Western Australia.

Smith JG & Phillips BL (2006) Toxic tucker: the potential impact of Cane Toads on Australian reptiles. Pacific Conservation Biology 12, 40–49.

Smith J, Morton A & Kanowski J (2019) *Kimberley Feral Pig Control Project: Final Report*. Australian Wildlife Conservancy.

Spring, C.S. 1982. Status of marine turtle populations in Papua New Guinea. In Biology and Conservation of Sea Turtles, Bjorndal KA, Ed. Smithsonian Institution Press, Washington, D.C. pp 281-289.

Sullivan, L., Ward, N., Toppler, N. and Lancaster, G. 2018. *National acid sulfate soils guidance: National acid sulfate soils sampling and identification methods manual.* Department of Agriculture and Water Resources, Canberra, ACT.

SVT Engineering Consultants, 2009. Ichthys Gas Field Development Project – Onshore Airborne Noise Study. Prepared for INPEX Browse Ltd. INPEX Document number C036-AH-REP-0031. November 2009.

Threatened Species Scientific Committee. 2015. Conservation Advice for Mesembriomys gouldii gouldii - Black-footed tree-rat (Kimberley and mainland Northern Territory. Department of Climate Change, Energy, the Environment and Water. Australian Government.

Threatened Species Scientific Committee. 2016a. Conservation Advice *Erythrura gouldiae* Gouldian finch. Canberra: Department of the Environment. Available from: https://www.environment.gov.au/biodiversity/threatened/species/pubs/413-conservation-advice-07122016.pdf

Threatened Species Scientific Committee. 2016b. Conservation Advice for Charadrius mongolus, Lesser sand plover. Department of Climate Change, Energy, the Environment and Water. Australian Government.

Threatened Species Scientific Committee. 2016c. *Conservation Advice for Saccolaimus saccolaimus nudicluniatus - bare-rumped sheathtail bat.* Department of Climate Change, Energy, the Environment and Water. Australian Government.

Threatened Species Scientific Committee. 2021. *Conservation Advice for Trichosurus vulpecula arnhemensis - Northern Brushtail Possum.* Department of Climate Change, Energy, the Environment and Water. Australian Government.

Ujvari B, Mun H-C, Conigrave AD, Bray A, Osterkamp J, Halling P & Madsen T (2013) Isolation breeds naivety: island living robs Australian varanid lizards of toad-toxin immunity via four-base-pair mutation. Evolution 67, 289–294.

Underwater Cultural Heritage Act 2018

URS, 2009. *Ichthys Gas Field Development Project: nearshore marine water quality and sediment study*. Report prepared for INPEX Browse Ltd by URS Australia Pty Ltd, Perth, Western Australia.

URS Australia Pty Ltd., 2013. Environmental Impact Monitoring Program: Ichthys On-Shore Liquefied Natural Gas (LNG) Facilities. Prepared for JKC Australia LNG Pty Ltd, June 2013. East Perth, WA.

Walker, T.A. (1994). Post-hatchling dispersal of sea turtles. **In:** James, R., ed. *Proceedings of the Australian Marine Turtle Conservation Workshop, Gold Coast 14-17 November 1990*. Page(s) 79-94. Qld Dept Env. & Heritage. Canberra, ANCA.

Ward, I., Elliott, M. and Guilfoyle, D. 2022. 'Out of sight, out of mind' - towards a greater acknowledgment of submerged prehistoric resources in Australian science-policy as part of a common heritage. Front. Mar. Sci. Volume 9 https://doi.org/10.3389/fmars.2022.959000

Wilson SK and Knowles DG. 1988. Australia's Reptiles: A Photographic Reference to the Terrestrial Reptiles of Australia. Collins Publishers.

Wilson, S and Swan, G. 2021, A Complete Guide to Reptiles of Australia, Sixth edition, Sydney, Australia, New Holland Press.

Woinarski JCZ, Armstrong M, Price O, McCartney J, Griffiths T and Fisher A (2004). The terrestrial vertebrate fauna of Litchfield National Park, Northern Territory: monitoring over a 6-year period, and response to fire history. Wildlife Research 31: 1–10.

Woinarski J, Ward S, Mahney T, Bradley J, Brennan K, Ziembicki M & Fisher A (2011) *The mammal fauna of the Sir Edward Pellew Islands, Northern Territory: refuge and death-trap.* Wildlife Research 38, 307-322.

Woinarski, J., A. Burbidge & P. Harrison (2014). *The Action Plan for Australian Mammals 2012*. CSIRO Publishing, Victoria, Australia.

Work Health and Safety (National Uniform Legislation) Act 2011 (NT)

Working with Indigenous Australians. 2023. *60,000+ years ago to 1788*. History. Working with Indigenous Australians. Accessed online on 16/02/2023 at http://www.workingwithindigenousaustralians.info/content/History_2_60,000_years.html

Wyatt KB, Campos PF and Gilbert MTP (2008). Historic mammal extinction on Christmas Island (Indian Ocean) correlates with introduced infectious disease. PLoS ONE 3: 11

Zangerl, R., Hendrickson, L. P., and Hendrickson, J. R. (1988). A redescription of the Australian flatback sea turtle, *Natator depressus*. Bishop Museum Bulletin in Zoology 1, 1-69.

APPENDIX A: EPBC ACT PROTECTED MATTERS SEARCH

Submitted as a separate appendix.

APPENDIX B: LIKELIHOOD OF OCCURRENCE ASSESSMENT

Submitted as a separate appendix.

APPENDIX C: ICHTHYS CARBON CAPTURE AND STORAGE (CCS) PROJECT STAKEHOLDER ENGAGEMENT PLAN

Submitted as a separate appendix.

APPENDIX D: PRE-REFERRAL CONSULTATION

Submitted as a separate appendix.

APPENDIX E: PRELIMINARY SCREENING ASSESSMENT - NT EPA ENVIRONMENTAL FACTORS AND VALUES

The purpose of the preliminary screening assessment is to determine whether the Project has the potential for significant environmental impact under the EP Act. A significant environmental impact is defined by Section 11 of the EP Act as:

An impact of major consequence having regard to:

- *the context and intensity of the impact*
- *the sensitivity, value and quality of the environment impacted on, and the duration, magnitude and geographic extent of the impact.*

The preliminary screening assessment was undertaken using the pre-screening tool provided in the Guideline – Referring a Proposal to the NT EPA (Referring a proposal to the NT EPA). Each of the NT EPA identified environmental factors/objectives were assessed in context of the specific questions outlined in the NT EPA guidance document (refer Figure E-1).

The outcomes of the preliminary assessment are presented in Table E-1.

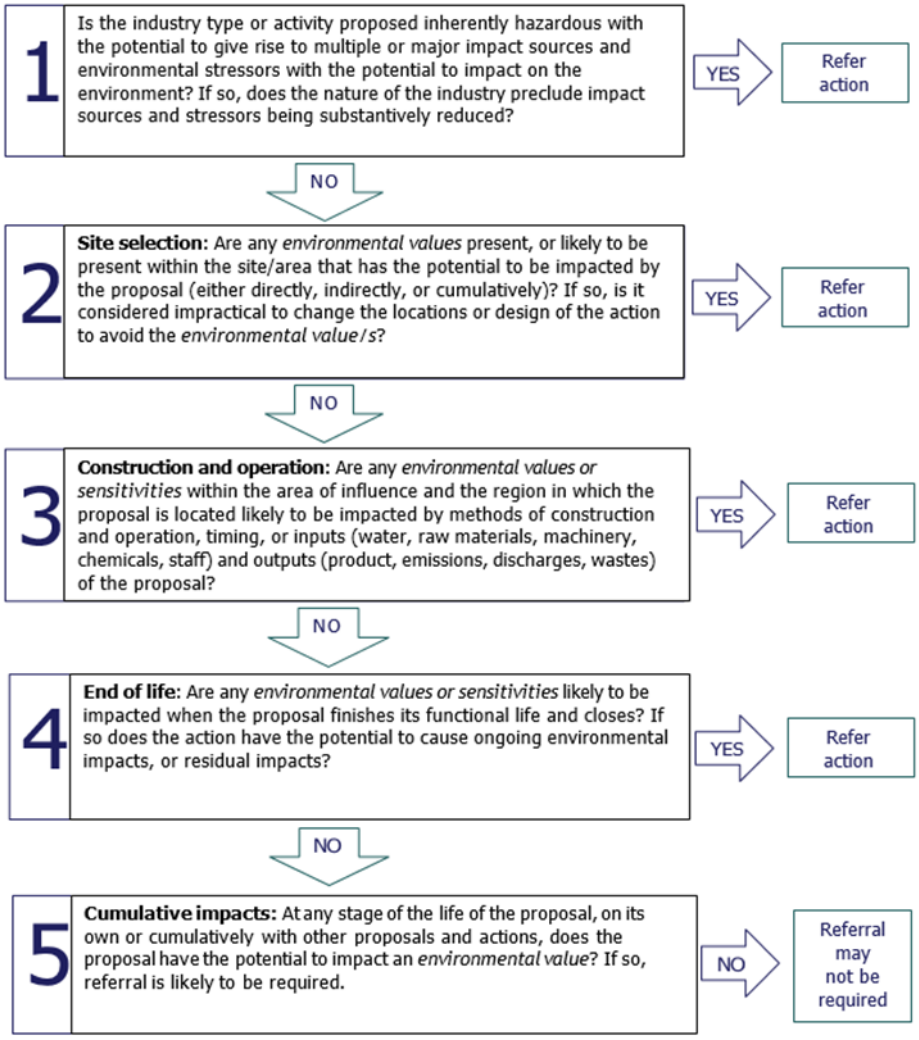


Figure E-1: Preliminary assessment screening questions

Table E-1: Preliminary assessment of Project activities potential to impact on NT EPA environmental factors and values

Theme	Factor	Environmental objective	Indicative values and sensitivities relevant to each environmental factor	Environmental context	Potential to be impacted (Proponent's answer to screening questions 1-5)	Q2	Q3	Q4	Q5
Is the industry type or activity proposed inherently hazardous with the potential to give rise to multiple or major impact sources and environmental stressors with the potential to impact on the environment?					Yes ☐ No ☒				
If so, does the nature of the industry preclude impact sources and stressors being substantively reduced?					Yes ☐ No ☒				
Land	Landforms	Conserve the variety and integrity of distinctive physical landforms.	• distinctive features in the landscape, either geological or anthropogenic • subterranean karstic terrain and faults • craters, gorges, ranges, caves, massifs, escarpments, plateaus • monuments • tourism related to landform	Refer to Section 4.1.5 - Geology and geomorphology.	Yes No Uncertain Not applicable	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐
	Assessment statement: The Project would not impact on the integrity of existing terrestrial landforms. The Project disturbance footprint is mostly located in previously disturbed areas or co-located with existing infrastructure in areas designated for utilities and development. There are no distinct unique landscapes or features within the Project area.								
	Terrestrial environmental quality	Protect the quality and integrity of land and soils so that environmental values are supported and maintained.	• high quality soils, including chemical, physical, biological and aesthetic qualities that support life • the biological processes that depend on soil quality	Refer to Section 4.1.5 - Geology and geomorphology.	Yes No Uncertain Not applicable	☒ ☐ ☐ ☐	☒ ☐ ☐ ☐	☐ ☐ ☒ ☐	☐ ☒ ☐ ☐
	Assessment statement: The Project has the potential to impact on the quality and integrity of terrestrial land and soils. PASS or ASS are known to exist in the Project area and would be disturbed during construction activities. There is also the potential for unplanned hydrocarbon spills during construction that could impact on the quality of soils. Standard construction and environmental management measures would be applied to minimise the risk of environmental impacts, but some impacts are possible.								
	Terrestrial ecosystems	Protect terrestrial habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.	• sensitive or significant' vegetation or buffers (as defined in the NT Land Clearing Guidelines) • listed threatened species and their habitat (NT and Commonwealth) • listed migratory species and their habitat (Commonwealth) • listed threatened ecological communities (Commonwealth) • locally endemic species or species with restricted habitat • locally endemic or restricted species and their habitat • species that are data deficient with unknown protection status • protected area or reserve, including Indigenous Protected Area • biosecurity • high quality biological and functional diversity, integrity and services	Refer to Section 4.2.1 – Flora and ecological communities, Section 4.2.2 – terrestrial fauna and habitats, Section 4.2.3 – Listed threatened communities and species, Section 4.2.4 – Biological important areas and Appendix B.	Yes No Uncertain Not applicable	☒ ☐ ☐ ☐	☒ ☐ ☐ ☐	☐ ☐ ☒ ☐	☐ ☐ ☒ ☐

Theme	Factor	Environmental objective	Indicative values and sensitivities relevant to each environmental factor	Environmental context	Potential to be impacted (Proponent's answer to screening questions 1-5)				
						Q2	Q3	Q4	Q5
	Assessment statement: The Project is expected to impact on terrestrial ecosystems during site preparation and construction. While construction activities are mostly limited to the previously disturbed envelope for the GEP on land zoned for Development and for Utilities, some previously undisturbed vegetation would need to be removed to facilitate the Project. This includes areas of mangroves and dry rainforest. A ground-truth vegetation survey of the pipeline corridor was undertaken in December 2023 to verify existing vegetation mapping of the corridor and identify suitable habitat for threatened flora species with the potential to occur within the footprint. High likelihood areas for *Typhonium* species were identified near the onshore pipeline corridor along Wickham Point Road and the access road to the Ichthys LNG facility. Identified *Typhonium* patches were pegged with star pickets to ensure avoidance during future construction and survey works. Given the highly disturbed nature and limited extent of the Project area, native fauna of conservation significance are considered unlikely to depend on the habitat or be present in significant numbers.								
Water	Hydrological processes	Protect the hydrological regimes of groundwater and surface water so that environmental values including ecological health, land uses and the welfare and amenity of people are maintained.	• the supply and quantity of water in surface water features including rivers, lakes, wetlands, swamps, creeks, billabongs, intermittent streams, floodplains, mangroves and drainage lines • the supply and quantity of water in groundwater features including aquifers, aquitards and water tables • declared beneficial uses • present and future uses, and users of water • current or potential water supplies, including regional scale aquifers • culturally important water features or other features affected by water level	Refer to Section 4.1.4 – Hydrology and hydrogeology.	Yes No Uncertain Not applicable	☐ ☐ ☒ ☐	☐ ☐ ☒ ☐	☐ ☐ ☒ ☐	☐ ☐ ☒ ☐
	Assessment statement:								
	Inland water environmental quality	Protect the quality of groundwater and surface water so that environmental values including ecological health, land uses and the welfare and amenity of people are maintained.	• the quality of water in surface water features including rivers, lakes, wetlands, swamps, creeks, billabongs, intermittent streams, floodplains, mangroves and drainage lines • the quality of water in groundwater features including aquifers and water tables • declared beneficial uses • present and future uses and users of water • current or potential water supplies, including regional scale aquifers • potability / drinkability • culturally important water features	Refer to Section 4.1.4 – Hydrology and hydrogeology.	Yes No Uncertain Not applicable	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐
	Assessment statement: The Project may impact on hydrological regimes of groundwater or surface water during excavation activities for construction. Further assessment is required to understand potential impacts and to inform management controls to protect groundwater and surface water during construction.								
	Aquatic ecosystems	Protect aquatic habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.	• threatened species • the health of the biota in inland waterways • the habitats that support the lifecycle of aquatic biota • groundwater dependent ecosystems • Ramsar wetlands	Not applicable	Yes No Uncertain Not applicable	☐ ☐ ☐ ☒	☐ ☐ ☐ ☒	☐ ☐ ☐ ☒	☐ ☐ ☐ ☒

Theme	Factor	Environmental objective	Indicative values and sensitivities relevant to each environmental factor	Environmental context	Potential to be impacted (Proponent's answer to screening questions 1-5)				
						Q2	Q3	Q4	Q5
			• high quality biological and functional diversity, integrity and services						
	Assessment statement: Impacts to aquatic ecosystems from the Project are not applicable. No freshwater aquatic ecosystems are located within the Project footprint or directly adjacent to the footprint.								
Sea	Coastal processes	Protect the geophysical and hydrological processes that shape coastal morphology so that the environmental values of the coast are maintained.	• processes that support marine ecosystems such as coral reefs and mangroves • processes that support coastal morphology such as beaches, rock bars, and sandbars • tidal creeks, deltas and river mouths • storm surge protection • unique coastal landforms	Refer to Section 4.1.6 – Harbour hydrodynamics and metocean conditions, Section 4.2.1 – Flora and ecological communities.	Yes No Uncertain Not applicable	☒ ☐ ☐ ☐	☒ ☐ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐
	Assessment statement: The Project will potentially temporarily impact on marine ecosystems during site preparation and construction activities, directly as a result of clearing of mangroves and trenching activities. As the majority of the proposed activity is within the previous disturbance corridors, the Project is not expected to impact on geophysical and hydrological processes that shape coastal morphology. Further assessment is required to understand potential indirect impacts to the coastal processes and to inform management controls to protect geophysical and hydrological processes during and post construction.								
	Marine environmental quality	Protect the quality and productivity of water, sediment and biota so that environmental values are maintained.	• quality of the water, sediment and biota • physical parameters that support fishing and aquaculture • physical parameters that support recreation and aesthetics • industrial water supply • cultural and spiritual values	Refer to Section 4.1.7 – Harbour sediment quality, Section 4.1.8 – Harbour water quality, Section 4.2 – Biological environment and Section 4.3 – Cultural environment.	Yes No Uncertain Not applicable	☐ ☒ ☐ ☐	☐ ☐ ☒ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐
	Assessment statement: Proposed project activities within and adjacent to mangroves have the potential to impact quality of water, sediment and biota. Water won for 'float in' pipeline installation with subsequent discharge back to the marine environment, and discharge of hydrotest water (1,500 m^3) during pre-commissioning to the marine environment have the potential to impact marine environmental quality.								
	Marine ecosystems	Protect marine habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.	• conservation significant marine and coastal fauna and critical habitat such as nesting, breeding or foraging habitat • conservation significant marine and coastal benthos (seagrass meadows, sponge gardens, coral reefs, mangrove communities and salt marshes) • ecological functions and processes • high quality biological and functional diversity, integrity and services	Refer to Section 4.2 – Biological environment	Yes No Uncertain Not applicable	☒ ☐ ☐ ☐	☒ ☐ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐
	Assessment statement: Proposed project activities within and adjacent to mangroves have the potential to impact on marine ecosystems during site preparation and construction activities directly as a result of clearing of mangroves and trenching activities.								

Theme	Factor	Environmental objective	Indicative values and sensitivities relevant to each environmental factor	Environmental context	Potential to be impacted (Proponent's answer to screening questions 1-5)				
						Q2	Q3	Q4	Q5
Air	Air quality	Protect air quality and minimise emissions and their impact so that environmental values are maintained.	• ambient air quality in the local airshed • the chemical, physical and biological characteristics of quality air • the biological processes that depend on the air quality	Refer to Section 4.1.3 – Air quality	Yes No Uncertain Not applicable	☐ ☐ ☒ ☐	☐ ☐ ☒ ☐	☐ ☒ ☐ ☐	☒ ☐ ☐ ☐
	Assessment statement: The Project has the potential to result in a temporary, localised impact on air quality within the Project area and surrounds due to the trace amounts of pollutants (including BTEX and H_2S) contained within the CO_2 stream to be vented to atmosphere during operations. Fugitive dust emissions during construction may also temporarily impact on local air quality. Construction-related air emissions such as dust and equipment/vehicle exhaust are not predicted to be significant and are readily manageable. Dust would be generated during onshore stockpiling. Standard dust control management measures would be implemented.								
	Atmospheric processes	Minimise greenhouse gas emissions so as to contribute to the NT Government's goal of achieving net zero greenhouse gas emissions by 2050.	• a contribution to the NT's greenhouse gas emissions through nearing or reaching emission thresholds for: - industrial projects of 100 000 $tCO_{2\text{-}e}$ scope 1 emissions per year not counting emissions generated from land clearing - land use projects of 500 000 $tCO_{2\text{-}e}$ scope 1 emissions from single or cumulative land clearing actions	Not applicable.	Yes No Uncertain Not applicable	☐ ☐ ☐ ☒	☐ ☐ ☐ ☒	☐ ☐ ☐ ☒	☐ ☐ ☐ ☒
	Assessment statement: The Project would result in an overall reduction in greenhouse gas (GHG) emissions in the Northern Territory resulting from the sequestration of CO_2 from Ichthys LNG facility operations, which is currently vented to atmosphere. While operational venting of CO_2 would still be required, the Project would still result in an overall reduction in GHG emissions. Emissions from occasional venting during the operational phase from launch and receipt of pigs (for inspection purposes or during upset conditions) would also be negligible in quantity compared to the volume of CO_2 that would be avoided from release to the atmosphere through the Project. Other GHG emissions associated with the activity include the operation of a construction machinery, which are marginal and are not enough to offset the reduction in overall GHG emissions.								
People	Community and economy	Enhance communities and the economy for the welfare, amenity and benefit of current and future generations of Territorians.	• communities, towns and suburbs where people live • community aspirations for liveable environment and healthy lifestyles: - affordable access to food, water, electricity, transport and communication networks. - good amenity – air quality, noise, aesthetics - access to social infrastructure and services including transport and logistics - access to natural resources including bush food - recreational use of the natural or built environment (e.g. fishing, cycling, sports, picnics) - species of social, cultural, livelihood and or economic importance (terrestrial, aquatic and marine biota) • participation in jobs, businesses and education • existing industries such as agriculture, pastoralism, tourism, fisheries • vulnerable sectors of the community	Refer to Section 4.4 – Socio-economic environment	Yes No Uncertain Not applicable	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐
	Assessment statement:								

Theme	Factor	Environmental objective	Indicative values and sensitivities relevant to each environmental factor	Environmental context	Potential to be impacted (Proponent's answer to screening questions 1-5)				
						Q2	Q3	Q4	Q5
	The proposed action would not significantly impact on the economy or welfare, amenity of the community (both current and future generations). Any impacts to amenity would be temporary and localised. The nearest communities are located at Palmerston, approximately 4 km away. Construction activities would be within areas zoned for development and utilities (onshore). Operational activities, including potential noise emissions during operation (including potential BESS) are anticipated to remain in line with current profiles. The increased economic activity during construction and operation of the Project is expected to be beneficial to communities and the economy.								
	Culture and heritage	Protect sacred sites, culture and heritage.	• Aboriginal cultural values • sacred sites • the Territory's natural and built heritage • declared heritage places and objects protected under the *Heritage Act 2011* (NT) such as: - any Aboriginal or Macassan archaeological place or object (coastal mounds and middens, rock art, stone arrangements, quarries, artefacts, graves, burial sites and ancestral remains) - underwater cultural heritage (isolated objects, shipwrecks, plane wrecks, - underwater cables and evidence of Aboriginal occupation prior to sea level rise) - built heritage (colonial buildings and other historic buildings) - defence structures (defensive positions and airfields) - natural features (meteorite impact sites, palaeontological sites, springs, trees) - world heritage • underwater cultural heritage protected under the *Underwater Cultural Heritage Act 2018* (Cwth) • Aboriginal rights and interests, including right of access	Refer to Section 4.3 – Cultural environment.	Yes No Uncertain Not applicable	☐ ☐ ☒ ☐	☐ ☐ ☒ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐
	Assessment statement: The Project has the potential to impact on culture and heritage, particularly as a result of ground disturbance activities for construction. Potential impacts would be managed through avoidance to be informed by the following measures: Consultation with Larrakia, pre-construction surveys, site inductions, a chance finds procedure, reporting of any potential cultural heritage finds to relevant stakeholders and authorities, and involving cultural heritage monitors during construction.								
	Human health	Protect the health of the Northern Territory population.	• drinking water • air quality • bush tucker • radiological limits • biting insects	Not applicable	Yes No Uncertain Not applicable	☐ ☐ ☒ ☐	☐ ☐ ☒ ☐	☐ ☐ ☒ ☐	☐ ☐ ☒ ☐
	Assessment statement: While the Project has the potential for localised air quality impacts, the impacts would be temporary and localised, and no impacts are expected on the health of the local community. Should further air quality identify any potential issues for public health, additional control measures would be applied to ensure there are no impacts.								

APPENDIX F: PRELIMINARY ASSESSMENT - SIGNIFICANT IMPACTS TO EPBC ACT MNES

F.1 Listed threatened species

F.1.1 Avifauna

Critically endangered, endangered or vulnerable avifauna species that have been assessed as known to occur, likely to occur or may occur in the Project area are listed in Table F-1. An assessment of potential impacts and risks from the Ichthys Project against the significant impact criteria for these species is presented in Table F-2.

Table F-1: Threatened avifauna species identified as 'May,' 'Likely' or 'Known' to occur within the Project area

Species	Likelihood of occurrence
Critically endangered	
Curlew sandpiper (*Calidris ferruginea*)	Likely to occur
Far eastern curlew (*Numenius madagascariensis*)	Known to occur
Endangered	
Australian painted snipe (*Rostratula australis*)	May occur
Black-tailed godwit (*Limosa limosa*)	Likely to occur
Common greenshank (*Tringa nebularia*)	Likely to occur
Gouldian finch (*Chloebia gouldiae*)	May occur
Lesser sand plover (*Charadrius mongolus*)	Likely to occur
Nunivak bar-tailed godwit (*Limosa lapponica baueri*)	Likely to occur
Vulnerable	
Asian dowitcher (*Limnodromus semipalmatus*)	Likely to occur
Great knot (*Calidris tenuirostris*)	Known to occur
Greater sand plover (*Charadrius leschenaultii*)	Likely to occur
Grey plover (*Pluvialis squatarola*)	Likely to occur
Little tern (*Sternula albifrons*)	Likely to occur
Red knot (*Calidris canutus*)	Likely to occur

Species	Likelihood of occurrence
Ruddy turnstone (*Arenaria interpres*)	Likely to occur
Sharp-tailed sandpiper (*Calidris acuminata*)	Likely to occur
Terek sandpiper (*Xenus cinereus*)	Likely to occur

Table F-2: Assessment of potential significant impacts to listed threatened avifauna species

Significant impact criteria	Assessment of significant impact
An action likely to have a significant impact on a threatened species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of a population	*Unlikely to have a significant impact* 17 listed threatened avifauna species have a potential to occur within the Project area. Critically endangered species that have a likelihood of occurring within the Project area (Table F-1) include the following shorebirds: curlew sandpiper (*Calidris ferruginea*), eastern curlew (*Numenius madagascariensis*), Endangered species that have a likelihood of occurring within the Project area (Table F-1) include the following shorebirds: Australian painted snipe (*Rostratula australis*) black-tailed godwit (*Limosa limosa*), common greenshank (*Tringa nebularia*), lesser sand plover (*Charadrius mongolus*), and the nunivak bar-tailed godwit (*Limosa lapponica baueri*). Endangered species that have a likelihood of occurring within the Project area also include the Gouldian finch (*Chloebia gouldiae*), a passerine bird. Vulnerable species that have a likelihood of occurring within the Project area include the following shorebirds: Asian dowitcher (*Limnodromus semipalmatus*), great knot (*Calidris tenuirostris*), greater sand plover (*Charadrius leschenaultia*), grey plover (*Pluvialis squatarola*), red knot (*Calidris canutus*), ruddy turnstone (*Arenaria interpres*), sharp-tailed sandpiper (*Calidris acuminata*) and terek sandpiper (*Xenus cinereus*). Vulnerable species that have a likelihood of occurring within the Project area also include the little tern (*Sternula albifrons*), a migratory seabird. Potential impacts to these avifauna from Project activities include localised light emissions, dust emissions, atmospheric emissions (including venting during Project operations), construction activities related habitat disturbance, fragmentation, and removal, noise and vibrations, introduction of invasive species, and the physical presence of the pipeline and other associated infrastructure resulting in habitat and behaviour changes. However, the nature of these impacts is considered to be localised and/or temporary in nature and are expected to cause negligible behavioural impacts to threatened avifauna.

Significant impact criteria	Assessment of significant impact
	The Project area does not overlap with any habitats that host important populations of critically endangered, endangered or vulnerable avifauna species. However, suitable habitat for foraging, roosting and migration of the shorebirds is present on Middle Arm Peninsula, within and adjacent to the Project area, where individuals may utilise the Project area for these lifecycle aspects. The little tern, a migratory sea bird, utilises similar terrestrial habitat to the shorebird species, and suitable habitat such as mangroves are present within the Project area. The Gouldian finch, a land bird, utilises open Eucalyptus woodlands with a grassy understorey, and requires hollows for breeding. Recent surveys have recorded no hollow trees on site (EcOz 2023a), as such only foraging habitat for the Gouldian finch is considered present within the Project area. Given the identified threatened shorebird species and the little tern are highly mobile in nature and suitable habitat is present throughout the wider Darwin and northern Australian region, it is considered unlikely that the Project activities would result in a long-term decrease in the size of a population of threatened avifauna. Habitat for the alligators rivers yellow chat and the Gouldian finch is present throughout the wider Darwin region, and it is unlikely that the Project activities would result in a long-term decrease in the size of a population of the threatened avifauna.
Reduce the area of occupancy of the species.	*Unlikely to have a significant impact* Potential impacts to avifauna from Project activities include localised light emissions, dust emissions, atmospheric emissions (including venting during Project operations), habitat disturbance, fragmentation, and removal, noise and vibrations, introduction of invasive species, and the physical presence of the pipeline and other associated infrastructure, resulting in potential habitat and behaviour changes. The nature of these impacts is considered to be localised and/or temporary and are anticipated to cause negligible behavioural impacts to threatened avifauna (i.e. avoidance). The Project area does not overlap with any habitats that hosts important populations of critically endangered, endangered or vulnerable avifauna species. Suitable habitat for foraging, roosting and migration of shorebirds and the Little Tern is present on Middle Arm Peninsula, adjacent to the Project area and as such individuals may also utilise the Project area for these lifecycle aspects.

Significant impact criteria	Assessment of significant impact
	Suitable habitat for foraging is present for the Gouldian finch. However, most of the Project footprint was previously cleared of vegetation during the construction of Ichthys gas export pipeline, which was approved as part of the Ichthys LNG Development project and construction activities would almost entirely be limited to the previously disturbed envelope for the GEP on land zoned for Development and for Utilities. Given the highly disturbed nature of the Project area, native fauna of conservation significance is unlikely to depend on the habitat or be present in significant numbers. The threatened shorebird species and the Little Tern identified are highly mobile and suitable habitat is present throughout the wider Darwin and northern Australian region. The Gouldian finch is also mobile and partly migratory during the non-breeding season, and there is no suitable breeding habitat within the Project area. In addition, with Project activities largely confined to previously disturbed areas, it is considered unlikely that Project activities would significantly reduce the area of occupancy for threatened avifauna.
Fragment an existing population into two or more populations.	*Unlikely to have a significant impact* As previously discussed, the Project area does not consist of habitat that hosts important populations of the threatened avifauna species identified in Table F-1. The Project area is not located where it would present a complete barrier across a population's distribution or migration route. Potential impacts to these species are expected to cause negligible behavioural disturbance. Most of the Project footprint was previously cleared of vegetation during the construction of Ichthys GEP, which was approved as part of the Ichthys LNG Development project and construction activities would almost entirely be limited to the previously disturbed envelope for the GEP on land zoned for Development and for Utilities. Given the highly disturbed nature of the Project area, including previously fragmented habitat, threatened native fauna are unlikely to be further fragmented into two or more populations.
Adversely affect habitat critical to the survival of a species.	*Unlikely to have a significant impact* According to the Wildlife Conservation Plan for Seabirds (CoA 2022) and the Wildlife Conservation Plan for Migratory Shorebirds (CoA 2015), seabird and shorebird habitats defined as critical habitats under the EPBC Act in Australia include those recognised as nationally or internationally important. The Conservation Plans do not define other areas as habitat critical to the survival of a species.

Significant impact criteria	Assessment of significant impact
	The Darwin area has been identified as an internationally important site for a number of species predicted to occur in the Project area, including the greater sand plover, grey plover and lesser sand plover. The Middle Arm Peninsula represents a small part of the Darwin area and has historically been disturbed through its industrial use. The PMST tool identified that the Port Darwin Nationally Important Wetland (NIW) is directly adjacent to the Project area. There are no Ramsar sites located in close proximity to the Project area, the nearest site being Kakadu NP, located over 100 km inland from the Project area. The nature of the Projects proposed Ichthys CCS pipeline tie-in station to Darwin LNG pipeline tie-in station section pipeline construction activities have potential for the Project to adversely impact suitable habitat for these species, via potential exposure of and contamination through ASS, and/or construction run-off into surrounding waterways, and therefore affect habitat critical to the survival of these migratory shore- and seabirds. This section of the pipeline crosses saltpans/mudflats, which is critical habitat that may be utilised by many species for roosting and foraging. However, this is anticipated to be very local and short term, and as such is not anticipated to affect the broader population scale. No habitat critical to the survival of the Gouldian finch is present within the Project area, and the Project is not anticipated adversely affect critical habitat for the Gouldian finch.
Disrupt the breeding cycle of a population.	*Unlikely to have a significant impact* None of the shorebird species identified in Table F-1 breed in Australia and therefore, would not utilise the Project area for breeding purposes. The little tern breeds in Australia, with colonies of the northern subpopulation located across northern Australia from Cape York Peninsula to Broome (DCCEEW 2025c). Breeding occurs on sandy beaches, often with shell or coral rubble (DCCEEW 2025c), with colonies occurring on both the mainland and on the beaches of small and large islands. Breeding colonies are widespread along coastal Northern Territory and more broadly Australia, with at least 44 colonies in the Northern Territory alone (DCCEEW 2025c). No known colonies are present on Middle Arm Peninsula, with the breeding habitat on Middle Arm Peninsula (sandy beaches) being located outside of the Project area footprint. The Gouldian finch requires hollows in Eucalyptus woodlands for breeding, and no hollows have been reported in suitable habitat through previous surveys. Overall, suitable foraging habitat for the Gouldian finch has only been recorded as present within the Project area.

Significant impact criteria	Assessment of significant impact
	Impacts from the Project activities are not expected to be significant enough to disrupt breeding related behaviours or breeding cycles of the broader populations.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	*Unlikely to have a significant impact* Project activities that may modify, destroy, remove, isolate or decrease the availability or quality of habitat include: • Habitat disturbance due to the fragmentation of sensitive vegetation types, removal of mangrove habitat, disturbance to sensitive or significant vegetation types, and impacts to threatened avifauna species habitat (nesting sites, hollows, burrows, large trees with hollows suitable for avifauna). • Exposure of ASS as a result of excavation of mangrove mud, installing coffer dam, trenching, and pipelay activities can lead to the reduction in surface water quality and lead to 'downstream' impacts. • Ground disturbance from excavation and pipelay activities can result in dust emissions, noise and vibration, erosion and sedimentation. • Routine and non-routine atmospheric emissions (including venting during Project operations), can lead to a reduction in ambient air quality and contribute to GHG emissions, which can have adverse effects on the natural environment, as well as potential localised behavioural disturbances to avifauna. • Routine noise and vibration emissions during all phases of the Project may result in a change in ambient noise and vibration conditions, and behavioural disturbance to avifauna from commissioning activities, vehicles, plant, process equipment, IMMR activities, and decommissioning activities. • Contamination of groundwater, surface water and soil, as a result of construction including ground disturbance activities, may result in impacts to avifauna, attraction of fauna or pests to waste, indirect impacts to avifauna through predation, generation of odour, bioaccumulation and toxicity, and contribute to landfill. • Construction and routine light emissions onshore from the plant, vehicles, machinery lighting, and night works may lead to light pollution (e.g. light glow, light spill), behavioural disturbance to avifauna, loss of visual amenity, and disruption to local residents.

Significant impact criteria	Assessment of significant impact
	Considering that no BIAs or habitats critical to the survival of avifauna species overlap Project area and anticipating that the potential impacts would be short-term during construction/installation, it is considered unlikely that habitat for these species would be modified, destroyed, removed, isolated, or the availability or quality of the habitat would be decreased to the extent that the species are likely to decline. Given the highly disturbed nature of the habitat overlapping the Project area, native avifauna of conservation significance are considered unlikely to depend on the habitat within the onshore corridor or be present in significant numbers.
Result in invasive species that are harmful to a Critically Endangered or Endangered species becoming established in the Endangered or Critically Endangered species' habitat.	*Unlikely to have a significant impact* A number of invasive flora and fauna species have previously been recorded within the Project area, including seven declared weeds under the Northern Territory Weeds Management Act 2001, two of which are classed as weeds of national significance (gamba grass; Andropogon gayanus and lantana; Lantana camara). Introduced fauna species recorded on Middle Arm Peninsula include the cane toads (Rhinella marina), feral pigs (Sus scrofa), feral cats (Felis catus), black rats (Rattus rattus) and several pest insects. Habitat critical to the survival of the shorebirds and seabirds listed in Table F-1 includes a mosaic of feeding and roosting habitat. Feeding habitat includes areas of mud or soft, wet sand within sandflats, intertidal mudflats, saltmarshes, and the beaches of oceanic coastlines, bays, and estuaries (Johnsgard 1981; del Hoyo et al. 1996). Roosting habitat typically occurs along platforms and shelves of rock, shingle, or gravel beaches, often with shallow tidal pools nearby. No BIAs and habitat critical to the survival of shore- and seabirds was identified as overlapping the Project area. A number of studies have revealed significant losses of mudflats and coastal saltmarshes to mangroves and cordgrass across Australia (DCCEEW 2024). Incursion by mangroves reduces feeding habitat availability for avifauna and may force species away from traditional feeding sites. Spartina alterniflora, also known as smooth cordgrass or salt marsh cordgrass, is an invasive species in coastal and estuarine wetlands in Australia, including the Northern Territory. The prolific growth of S. alterniflora reduces the availability of foraging and roosting habitat for avifauna and hinders their movement through the environment (Jackson et al. 2021).

Significant impact criteria	Assessment of significant impact
	Impacts from the incursion of invasive species into Gouldian finch foraging habitat largely relate to the potential changes in fire regime from a modified vegetation structure, and the presence of invasive herbivores grazing on grassy food sources. Gamba grass, an invasive flora species already present in the Project area, can increase fuel loads and the intensity of fires, which Gouldian finches are sensitive to (TSSC 2016a). Grazing by herbivores can restrict the availability of important food grasses and reduce the availability of seed. However, most of the Project footprint was previously cleared of vegetation during the construction of Ichthys GEP, which was approved as part of the Ichthys LNG Development project and construction activities would almost entirely be limited to the previously disturbed envelope for the GEP on land zoned for Development and for Utilities. Furthermore, although Gamba grass is already established on-site, Project activities would include weed control measures to reduce and remove the weeds established on site. As such, the Project activities are not expected to significantly increase the effects of invasive species on the threatened species discussed.
Introduce disease that may cause the species to decline.	*Unlikely to have significant impact* Australian birds can contract diseases from other animals, including avian influenza (bird flu), and diseases caused by bacteria like Mycobacterium and Salmonella, among others (CoA 2025). Charadriiformes (gulls, terns and shorebirds) are considered the main natural reservoirs for all avian influenza A viruses (Olsen et al. 2006). However, since 1992, the viral disease testing of Charadriiformes from coastal northwest Australia has not detected any evidence of avian influenza virus excretion in the shorebird species tested (TSSC 2016b). With the consideration that avifauna may become infected with avian influenza viruses through direct contact with infected waterfowl or other bird species, it is unlikely that pathogens, viruses or other causes of disease would be introduced by the Project specific activities. With the implementation of regulatory requirements, as well as typical industry standard mitigation measures, it is considered unlikely that the Project activities would introduce diseases associated with avifauna that may cause the population of avifauna to decline.
Interfere with the recovery of the species.	*Unlikely to have a significant impact* Recovery plans and conservation advice for listed avifauna species identify climate change, habitat loss and degradation, invasive species, altered fire regimes, human disturbances, barrier effects, artificial light, deterioration of water quality, and disturbance at nesting sites as key threatening processes for avifauna.

Significant impact criteria	Assessment of significant impact
	Based on the identified aspects, effects, and with the implementation of typical industry standard mitigation measures, including weed and pest management plans, it is expected that most effects can be managed such that threats would not interfere substantially with any species or affect the recovery of individual threatened avifauna species.

F.1.2 Terrestrial mammals

Critically endangered, endangered or vulnerable terrestrial mammal species that have been assessed as known to occur, likely to occur or may occur in the Project area are listed in Table F-3. An assessment of potential impacts and risks from the Ichthys Project against the significant impact criteria for these species is presented in Table F-4.

Table F-3: Threatened terrestrial mammal species identified as 'May,' 'Likely' or 'Known' to occur within the Project area.

Species	Likelihood of occurrence
Endangered	
Black-footed tree-rat (Kimberley and mainland Northern Territory) (*Mesembriomys gouldii gouldii*)	Likely to occur
Vulnerable	
Bare-rumped sheath-tailed bat (*Saccolaimus saccolaimus nudicluniatus*)	Likely to occur
Northern brushtail possum (*Trichosurus vulpecula arnhemensis*)	Known to occur

Table F-4: Assessment of potential significant impacts to listed threatened terrestrial mammal species

Significant impact criteria	Assessment of significant impact
An action likely to have a significant impact on a threatened species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of a population	*Unlikely to have a significant impact* No critically endangered terrestrial mammal species have been identified during the PMST and literature review in relation to the Project area. One endangered terrestrial mammal has a likelihood to occurring within the Project area, the black-footed tree-rat (Mesembriomys gouldii gouldii). Vulnerable terrestrial mammals that have a likelihood of occurring within the Project area include the bare-rumped sheath-tailed bat (*Saccolaimus saccolaimus nudicluniatus*) and the northern brushtail possum (*Trichosurus vulpecula arnhemensis*). The Project area does not overlap with any habitats that host important populations of threatened mammal species. Recent pipeline corridor ground-truthing surveys (EcOz 2023) indicate that no trees, recorded within the Project area, meet the threshold for potential hollow-bearing trees that could support breeding and roosting threatened mammals. The bare-rumped sheath-tailed bat, northern brushtail possum, and black-footed tree-rat all utilise hollows for shelter and roosting. Potential Project impacts to these species include construction activity related habitat fragmentation (i.e. via vegetation clearance, earth work and civil works), the physical presence of the pipeline and associated infrastructure, light emissions, noise and vibrations, introduction of invasive species, and other unplanned events such as fire, spills and the exposure of ASS during construction and / or decommissioning. These impacts are expected to be localised and/or temporary and as such are anticipated to only cause negligible behavioural impacts to terrestrial mammals in the Project area. This is not anticipated to result in a long-term decrease in the size of the species' population.
Reduce the area of occupancy of the species.	*Unlikely to have a significant impact*

Significant impact criteria	Assessment of significant impact
	The Project area does not overlap with any habitat that hosts important populations of threatened mammal species. Recent pipeline corridor ground-truthing surveys (EcOz 2023a) indicate that no trees within the Project area meet the threshold for potential hollow-bearing trees that support hollow-dependent threatened mammals. Furthermore, most of the Project footprint was previously cleared of vegetation during the construction of Ichthys GEP, which was approved as part of the Ichthys LNG Development project and construction activities would almost entirely be limited to the previously disturbed envelope for the GEP on land zoned for Development and for Utilities. Potential impacts to this species within the Project area include habitat fragmentation, the physical presence of the pipeline and associated infrastructure, light emissions, noise and vibrations, introduction of invasive species, and other unplanned events such as fire, spills and ASS. These impacts are expected to cause negligible behavioural impacts to terrestrial mammals in the Project area and given the highly disturbed nature of the Project area, and with the proposed activities largely confined to already disturbed areas, it is considered unlikely that the activities would reduce the habitat available for these threatened fauna species.
Fragment an existing population into two or more populations.	*Unlikely to have a significant impact* As previously discussed, the Project area does not consist of habitat that hosts important populations of the threatened fauna species identified in Table B-3. The Project area is not located where it would present a complete barrier across a population's distribution or migration route. Potential impacts to these species are expected to cause negligible behavioural disturbance. Most of the Project footprint was previously cleared of vegetation during the construction of Ichthys GEP, which was approved as part of the Ichthys LNG Development project and construction activities would almost entirely be limited to the previously disturbed envelope for the GEP on land zoned for Development and for Utilities. Given the highly disturbed nature of the Project area, including previously fragmented habitat, threatened native fauna are unlikely to be further fragmented into two or more populations.
Adversely affect habitat critical to the survival of a species.	*Unlikely to have a significant impact* Critical habitat value relates generally to areas that enable foraging, breeding and dispersal for the long-term maintenance of species survival and genetic diversity Areas of habitat critical to the survival of the threatened mammals has not been identified in the respective conservation plans due to the lack of data on these species.

Significant impact criteria	Assessment of significant impact
	Although no critical habitat has been formally identified for these species, there are some areas that could support suitable foraging and dispersal habitat within the Project area. However, the Project activities and potential impacts, as previously identified are unlikely to further fragment or reduce the species dispersal. The Project is considered unlikely to significantly and adversely affect habitat critical to the survival of these threatened mammals.
Disrupt the breeding cycle of a population.	*Unlikely to have a significant impact* Breeding habitat for the threatened terrestrial mammals identified above has not been identified within the Project area. Potential impacts to this species within the Project area include pre-construction and construction activities related habitat fragmentation, the physical presence of the pipeline and associated infrastructure, light emissions, noise and vibrations, introduction of invasive species, and other unplanned events such as fire, hydrocarbon release and the exposure of ASS. These impacts are expected to be localised in scale and temporary in nature and therefore to cause negligible behavioural impacts to terrestrial mammals in the Project area. In addition, given the already highly disturbed nature of the Project area, is it is considered unlikely that the Project activities would be significant enough to affect breeding behaviours or breeding cycles of the broader populations.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	Unlikely to have a significant impact Project activities that may modify, destroy, remove, isolate or decrease the availability or quality of habitat include: • Habitat disturbance due to the fragmentation of sensitive vegetation types, removal of mangrove habitat, disturbance to sensitive or significant vegetation types, and impacts to threatened species habitat (nesting sites, hollows, burrows, large trees with hollows suitable for mammals). • Exposure of ASS as a result of excavation of mangrove mud, installing coffer dam, trenching, and pipelay activities can lead to the reduction in surface water quality and lead to 'downstream' impacts. • Ground disturbance from excavation and pipelay activities can result in dust emissions, noise and vibration, erosion and sedimentation.

Significant impact criteria	Assessment of significant impact
	• Routine and non-routine atmospheric emissions (including venting during Project operations), can lead to a reduction in ambient air quality and contribute to GHG emissions, which can have adverse effects on the natural environment and human health, as well as potential localised behavioural disturbances to mammals. • Routine noise and vibration emissions during all phases of the Project may result in a change in ambient noise and vibration conditions, disruption to nearby residents, and behavioural disturbance to mammals from commissioning activities, vehicles, plant, process equipment, IMMR activities, and decommissioning activities. • Contamination of groundwater, surface water and soil, as a result of construction including ground disturbance activities, may result in impacts to mammals, attraction of fauna or pests to waste, indirect impacts to mammals through predation, generation of odour, bioaccumulation and toxicity, and contribute to landfill. • Construction and routine light emissions onshore from the plant, vehicles, machinery lighting, and night works may lead to light pollution (e.g. light glow, light spill), behavioural disturbance to mammals, loss of visual amenity, and disruption to local residents. Considering that no BIAs or habitats critical to the survival of terrestrial mammal species overlap the Project area, and anticipating that the potential impacts would be short-term during construction/installation, it is considered unlikely that habitat for these species would be modified, destroyed, removed, isolated, or the availability or quality of the habitat would be decreased to the extent that the species are likely to decline. Given the highly disturbed nature of the habitat overlapping the Project area, native fauna of conservation significance is considered unlikely to depend on the habitat within the Project area or be present in significant numbers.
Result in invasive species that are harmful to a Critically Endangered or Endangered species becoming established in the Endangered or Critically Endangered species' habitat.	*Unlikely to have a significant impact* A number of invasive flora and fauna species have previously been recorded within the Project area, including seven declared weeds under the Northern Territory Weeds Management Act 2001, two of which are classed as weeds of national significance (gamba grass; *Andropogon gayanus* and lantana; *Lantana camara*). Introduced fauna species recorded on Middle Arm Peninsula include the cane toads (*Rhinella marina*), feral pigs (*Sus scrofa*), feral cats (*Felis catus*), black rats (*Rattus rattus*) and several pest insects.

Significant impact criteria	Assessment of significant impact
	Several invasive grasses – such as gamba grass (*Andropogon gayanus*), grader grass (*Themeda quadrivalvis*) and mission grass (*Cenchrus* spp.) – are spreading through the terrestrial mammals' preferred habitat, with high biomass fuelling higher intensity fires, and probably making ground movement more difficult in some parts of the species distribution (Woinarski 2004; Woinarski et al. 2014). Invasive grasses would change the ability of this species to forage effectively on the ground and result in fires that are far more intense. Gamba grass is a serious threat to northern Australia's savannas. Invasion by gamba grass has resulted in fuel loads up to seven times higher than those dominated by native grasses and supported fires about eight times more intense than those recorded in native grass savannas at the same time of year (Rossiter et al. 2003). Changes to the vegetation structure from the incursion of invasive species such as gamba grass pose a threat to the black-footed tree-rat. Invasive grasses can limit the black-footed tree-rat's ability to forage, and a modified fire regime from gamba grass invasions can exacerbate changes in the vegetation structure and habitat suitability (TSSC 2015). Increases in fire intensity are also a threat to the bare-rumped sheath-tailed bat, as it can reduce prey abundance and the availability of hollows (TSSC 2016c), however no hollows are currently present within the Project area. The northern brushtail possum is similarly facing threats from habitat modification from gamba grass and similar invasive flora species (TSSC 2021). However, most of the Project footprint was previously cleared of vegetation during the construction of Ichthys GEP, which was approved as part of the Ichthys LNG Development project and construction activities would almost entirely be limited to the previously disturbed envelope for the GEP on land zoned for Development and for Utilities. Furthermore, although gamba grass is already established on-site, Project activities would include weed control measures to reduce and remove the weeds established on site. As such, the Project activities are not expected to significantly increase the effects of invasive species on the threatened species discussed.
Introduce disease that may cause the species to decline.	*Unlikely to have a significant impact* Feral cats are known to be vectors of some diseases that are known to affect some native wildlife (Hollings et al. 2013). In particular, toxoplasmosis is a significant protozoa carried by feral cats that can be transmitted to native wildlife, particularly mammals (Adams 2003).

Significant impact criteria	Assessment of significant impact
	There has been an observed increase in the Northern Territory of the prevalence and abundance of exotic black rats, which are known vectors for some diseases that have caused mammal extinctions elsewhere (Wyatt et al. 2008). While Reiss et al. (2015) found that there is no current evidence that a single pathogen is responsible for the decline of small mammals in the Northern Territory's Top End (the northern component of the state, encompassing Darwin, Kakadu National Park, Arnhem Land and the Katherine area), this does not remove infectious diseases from the list of potentially significant factors that have driven population declines. There is potential for feral cats and black rats to occur within the Project area, albeit in transient numbers, however, it is considered unlikely that pathogens, viruses or other causes of disease would be introduced by the Project specific activities and activities are not anticipated to result in the introduction of diseases associated with feral cats or black rats that may cause the population of terrestrial mammals to decline.
Interfere with the recovery of the species.	*Unlikely to have a significant impact* The general decline in native mammals in the Northern Territory suggests that terrestrial mammals listed in Table F-3 are likely to be affected by similar threats including habitat loss, invasive or introduced species, climate change, competition for tree hollows, and changed fire regimes. As discussed above, Project activities such as habitat disturbance, ground disturbance, routine and non-routine atmospheric emissions, routine noise and vibration emissions, and routine light emissions during all stages of the Project, has the potential to affect habitat critical to the survival of a species. However, potential impacts are expected to be temporary and local in the context of the broader distributions and habitat utilisation of the terrestrial mammals and therefore, the interference with the recovery of terrestrial mammals is not expected to be significant.

F.1.3 Terrestrial reptiles

Critically endangered, endangered or vulnerable terrestrial reptile species that have been assessed as known to occur, likely to occur or may occur in the Project area are listed in Table F-5. An assessment of potential impacts and risks from the Ichthys Project against the significant impact criteria for these species is presented in Table F-6.

Table F-5: Threatened terrestrial reptile species identified as 'May,' 'Likely' or 'Known' to occur within the Project area.

Species	Likelihood of occurrence
Critically endangered	
Mitchell's water monitor (Varanus mitchelli)	May occur

Table F-6: Assessment of potential significant impacts to listed threatened terrestrial reptile species

Significant impact criteria	Assessment of significant impact
An action likely to have a significant impact on a threatened species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of a population	*Unlikely to have a significant impact* One critically endangered reptile species has a likelihood to occur within the Project area, the Mitchell's water monitor (*Varanus mitchelli*). An important population of this species is not known to exist within the Project area. Given the highly disturbed nature of the Project area, threatened reptile species are considered unlikely to depend on that habitat, or to be present in significant numbers. Potential impacts to this species include light and noise emissions, the clearing of vegetation, habitat disturbance during construction, physical presence of pipeline and other infrastructure, invasive species, other unplanned events such as fire, spills and the exposure of ASS. These impacts are expected to be localised and/or temporary in nature and as such to only cause negligible behavioural impacts to reptiles in the Project area. This is not anticipated to result in a long-term decrease in the size of the species' population.
Reduce the area of occupancy of the species.	*Unlikely to have a significant impact* The Project area does not consist of habitat that hosts important populations of the threatened fauna species identified in 4.2.2. However, the habitat present within the Project area can be considered critical habitat for the Mitchell's water monitor, as the species has persisted after the introduction of cane toads. However, given the size and history of the vegetation proposed for impacts and removal, the Project activities are unlikely to significantly reduce the area of occupancy of the species. Potential impacts to this species include light and noise emissions, the clearing of vegetation, habitat disturbance during construction, physical presence of pipeline and other infrastructure, invasive species, other unplanned events such as fire, spills and exposure of ASS. These impacts are expected to be localised and/or temporary in nature and as such to only cause negligible behavioural impacts to reptiles in the Project area. Given the highly disturbed nature of the Project area, and with the proposed activities largely confined to already disturbed areas, it is unlikely that the activities would further reduce the habitat available for this threatened fauna species.

Significant impact criteria	Assessment of significant impact
Fragment an existing population into two or more populations.	*Unlikely to have a significant impact* As previously discussed, the Project area does not consist of habitat that hosts important populations of this threatened fauna species. The Project area is not located where it would present a complete barrier across a population's distribution or migration route. Potential impacts to these species are expected to cause negligible behavioural disturbance. Most of the Project footprint was previously cleared of vegetation during the construction of Ichthys GEP, which was approved as part of the Ichthys LNG Development project and construction activities would almost entirely be limited to the previously disturbed envelope for the GEP on land zoned for Development and for Utilities. Given the highly disturbed nature of the Project area, including previously fragmented habitat, threatened native fauna are unlikely to be further fragmented into two or more populations.
Adversely affect habitat critical to the survival of a species.	*Unlikely to have a significant impact* The Project area does not consist of habitat that hosts important populations of the threatened fauna species identified in 4.2.2. However, the habitat present within the Project area can be considered critical habitat for the Mitchell's water monitor, as the species has persisted after the introduction of cane toads. However, given the size and history of the vegetation proposed for impacts and removal, the Project activities are unlikely to significantly reduce the area of occupancy of the species. Given the highly disturbed nature of the Project area, and with the proposed activities largely confined to already disturbed areas, it is unlikely that the activities would further reduce the habitat available for this threatened fauna species.
Disrupt the breeding cycle of a population.	*Unlikely to have a significant impact* The Project area does not consist of habitat that hosts important populations of the threatened fauna species identified in 4.2.2. Breeding and nesting habitat for Mitchell's water monitor species has not been identified in the conservation advice, however it is considered that there may potentially be suitable habitat present in the Project area that could host the species during their breeding cycle, as habitat generally aligns with the conservation advice of the species persistence after the establishment of cane toads. As such there is a potential for the Project to impact the local population breeding cycles. However, this is anticipated to be local and short term, and as such is not anticipated to affect the broader population scale.

Significant impact criteria	Assessment of significant impact
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	*Unlikely to have a significant impact* Project activities that may modify, destroy, remove, isolate or decrease the availability or quality of habitat include: • Habitat disturbance due to the fragmentation of sensitive vegetation types, removal of mangrove habitat, disturbance to sensitive or significant vegetation types, and impacts to threatened species habitat (nesting sites, hollows, burrows, large trees with hollows suitable for reptiles). • Exposure of ASS as a result of excavation of mangrove mud, installing coffer dam, trenching, and pipelay activities can lead to the reduction in surface water quality and lead to 'downstream' impacts. • Physical presence of the pipeline, temporary groyne, and coffer dam can lead to local changes to sedimentation and hydrodynamic processes affecting hydrodynamic processes and benthic habitats. • Ground disturbance from excavation and pipelay activities can result in dust emissions, noise and vibration, erosion and sedimentation. • Routine and non-routine atmospheric emissions (including venting during Project operations), can lead to a reduction in ambient air quality and contribute to GHG emissions, which can have adverse effects on the natural environment and human health, as well as potential localised behavioural disturbances to reptiles. • Routine noise and vibration emissions during all phases of the Project may result in a change in ambient noise and vibration conditions, disruption to nearby residents, and behavioural disturbance to reptiles from commissioning activities, vehicles, plant, process equipment, IMMR activities, and decommissioning activities. • Contamination of groundwater, surface water and soil, as a result of construction including ground disturbance activities, may result in impacts to reptiles, attraction of fauna or pests to waste, indirect impacts to reptiles through predation, generation of odour, bioaccumulation and toxicity, and contribute to landfill. • Construction and routine light emissions onshore from the plant, vehicles, machinery lighting, and night works may lead to light pollution (e.g. light glow, light spill), behavioural disturbance to reptiles, loss of visual amenity, and disruption to local residents.

Significant impact criteria	Assessment of significant impact
	However, it is anticipated that the potential impacts would be short-term during construction/installation, and as such it is considered unlikely that habitat for this species would be modified, destroyed, removed, isolated, or the availability or quality of the habitat would be decreased to the extent that the species are likely to decline. Given the highly disturbed nature of the habitat overlapping the Project area, Mitchell's water monitor are considered unlikely to depend on the habitat within the Project area or be present in significant numbers.
Result in invasive species that are harmful to a Critically Endangered or Endangered species becoming established in the Endangered or Critically Endangered species' habitat.	*Unlikely to have a significant impact* A number of invasive flora and fauna species have previously been recorded within the Project area, including seven declared weeds under the Northern Territory Weeds Management Act 2001, two of which are classed as weeds of national significance (gamba grass; *Andropogon gayanus* and lantana; *Lantana camara*). Introduced fauna species recorded on Middle Arm Peninsula include the cane toads (*Rhinella marina*), feral pigs (Sus scrofa), feral cats (Felis catus), black rats (Rattus rattus) and several pest insects. Although no Critical Habitat as defined under section 207A of the EPBC Act has been identified or included in the Register of Critical Habitat for Mitchell's water monitor, habitats where Mitchell's water monitor persists after the introduction of cane toads is considered critical to their survival. According to the conservation advice for Mitchell's water monitor, cane toads, cattle, and feral pigs are the main exotic invasive species that pose a threat. These reptile species are highly sensitive to cane toad toxin (Smith and Phillips 2006; Ujvari et al. 2013) and live and feed in wetland areas that are core habitat for the cane toad (Mayer et al. 2015). There is an unambiguous relationship between the arrival of the cane toad and severe declines and potential extirpations of Mitchell's water monitor. Grazing and trampling by cattle and Asian water buffalo removes thick grass and reduces shrub growth (Mihailou and Massaro 2021). Loss of these shelter resources, and degradation of critical habitat, can expose these reptile species to predation and thermal extremes (Price-Rees et al. 2013a). Feral pigs cause significant structure and vegetation damage to riparian areas, ephemeral wetlands and swamps, and permanent wetland verges (Bowman and Mcdonough 1991; Finlayson et al. 1999; Smith et al. 2019; Bruton et al. 2020), which are critical habitat for these reptile species.

Significant impact criteria	Assessment of significant impact
	Considering the highly disturbed nature of the Project area, including the pipeline corridor, previous introduction or pre-establishment of several invasive species such as those mentioned above, and with the implementation of typical industry standard mitigation measures, including weed and pest management plans, it is considered unlikely that a new invasive species would become established as a result of the proposed Project activities.
Introduce disease that may cause the species to decline.	*Unlikely to have a significant impact* Feral pigs are listed as a threat to reptile species and habitat degradation by feral pigs is a listed key threatening process under 'Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs'. They provide reservoirs for endemic diseases, can be vectors of exotic diseases, spread the root-rot fungus *Phytophthora cinnamomi*, and physically damage plants, providing entry points for infection (DCCEEW 2021). Feral pigs are distributed throughout the Top End of the Northern Territory wherever their basic requirements of water, food and shade are met and therefore have the potential to occur within the Project area, however, it is unlikely that pathogens, viruses or other causes of disease would be introduced by the Project specific activities and activities are not anticipated to result in the introduction of diseases associated with feral pigs that may cause the population of reptiles to decline. Based on the identified aspects, effects, and with the implementation of typical industry standard mitigation measures, including weed and pest management plans, it is considered unlikely that pathogens, viruses or other causes of disease would be introduced by the Project activities and cause a species decline. It is also considered unlikely for the Project activities to introduce a disease that may cause the population of terrestrial fauna to decline.
Interfere with the recovery of the species.	Potential to have a significant impact One critically endangered reptile species has a likelihood to occur within the Project area, Mitchell's water monitor (*Varanus mitchelli*). Habitat critical to the survival of the Mitchell's water monitor is present within the Project area and may be adversely affected by the Project activities, as discussed previously. Conservation advice for the Mitchell's water monitor identifies exotic invasive species, fire regimes that cause declines in biodiversity, habitat loss, disturbance, and modification, the depletion of natural water resources, and human intrusion as key threatening processes for these reptile species. Based on the identified aspects and effects identified above, further development within the Project area has the potential to interfere with the recovery of these species.

F.1.4 Marine reptiles

Critically endangered, endangered or vulnerable marine reptile species that have been assessed as known to occur, likely to occur or may occur in the Project area are listed in Table F-7. An assessment of potential impacts and risks from the Ichthys Project against the significant impact criteria for these species is presented in Table F-8.

Table F-7: Threatened marine reptile species identified as 'May,' 'Likely' or 'Known' to occur within the Project area.

Species	Likelihood of occurrence
Vulnerable	
Green turtle (*Chelonia mydas*)	Known to occur
Flatback turtle (*Natator depressus*)	Known to occur

Table F-8: Assessment of potential significant impacts to listed threatened marine reptile species

Significant impact criteria	Assessment of significant impact
An action likely to have a significant impact on a threatened species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of a population	*No significant impact* There is no credible pathway that could lead to the long-term decrease in the size of the population of threatened marine reptile species that may be using areas adjacent to the Project area. Project disturbance activities and are largely contained within a terrestrial footprint, with only discharge of small volumes commissioning water being proposed to be potentially discharged at a temporary outfall near Ichthys LNG facility module offloading facility (Refer to Section 2.5.1). There are no significant marine turtle feeding or breeding habitats in the vicinity of the Ichthys LNG facility (Refer to Section 4.2.3).
Reduce the area of occupancy of the species.	*No significant impact* There is no credible pathway that could lead to the reduction in the area of occupancy of threatened marine reptile species that may be using areas adjacent to the Project area. Project disturbance activities and are largely contained within a terrestrial footprint, with only discharge of small volumes commissioning water being proposed to be potentially discharged at a temporary outfall near Ichthys LNG facility module offloading facility (Refer to Section 2.5.1). There are no significant marine turtle feeding or breeding habitats in the vicinity of the Ichthys LNG facility (Refer to Section 4.2.3).
Fragment an existing population into two or more populations.	*No significant impact* There is no credible pathway that could lead to the fragmentation of an existing population of threatened marine reptile species that may be using areas adjacent to the Project area. Project disturbance activities and are largely contained within a terrestrial footprint, with only discharge of small volumes commissioning water being proposed to be potentially discharged at a temporary outfall near Ichthys LNG facility module offloading facility (Refer to Section 2.5.1).
Adversely affect habitat critical to the survival of a species.	*No significant impact*

Significant impact criteria	Assessment of significant impact
	Darwin Harbour has been identified as a BIA for flatback turtle internesting and is considered habitat critical to the survival of the species. Whilst Darwin Harbour itself is considered a biological important area/habitat critical (internesting/nesting) for flatback turtles, there are no nesting beaches or suitable habitat for nesting or internesting in the vicinity of the Project area (refer to Section 4.2.3 and 4.2.4). The Project has the potential to impact on the quality of adjacent habitat critical to the survival of the species as a result of discharge of hydrotest water. The discharge of hydrotest wastewater (refer Section 2.5.1) into the environment could potentially cause impacts to the beneficial uses of Darwin Harbour – Water Quality (NRETAS 2010). Although hydrotest wastewater is predominantly scheme water (and therefore likely clean), it has the potential to absorb contaminants remaining in pipework and infrastructure. The most likely contaminant is nickel, which was found to be absorbed from infrastructure being hydrotested during Ichthys LNG construction (JKC 2015). Impacts to the water quality objectives will be minimised through the use of an appropriate diffuser, which will diffuse wastewater (and any contaminants within) to less than the Darwin Harbour Water Quality Objectives (NRETAS 2010) prior to the edge of an approved mixing zone. The wastewater is fresh, and therefore is more buoyant than the receiving water, and will rise up towards the surface which results in enhanced mixing of the wastewater and Darwin Harbour waters. The wastewater plume will also oscillate and change direction with each flood and ebb tide event. Diffuser design and subsequent plume modelling will be undertaken prior to the generation of hydrotest water. Modelling for Ichthys LNG construction hydrotest water (with volumes of water approximately 10 times larger expected for the Project) indicated a 65-fold dilution was required, and this was met in the nearfield (approximately 8m 95% of the time). A conservative mixing zone of 50 m surrounding the diffuser was established for monitoring purposes. The discharge of hydrotest water to the marine environment may result in temporary and short-term impact on the quality of the marine environment (water) in the immediate vicinity of the discharge. Given the transient nature of marine turtles and the absence of suitable nesting habitat adjacent to the Project area any impact associated with additional lighting would be localised and temporary and would only result in negligible behavioural impacts (i.e. avoidance) to threatened marine turtle species.

Significant impact criteria	Assessment of significant impact
Disrupt the breeding cycle of a population.	*No significant impact* There is no credible pathway that could result in disruption of the breeding cycle of a population of threatened marine reptile species. Project disturbance activities would occur largely occur within terrestrial areas of Middle Arm (Refer to Section 2). Darwin Harbour has been identified as a BIA for flatback turtle internesting and is considered habitat critical to the survival of the species. Whilst Darwin Harbour itself is considered a biological important area/habitat critical (internesting/nesting) for flatback turtles, there are no nesting beaches or suitable habitat for nesting or internesting in the vicinity of the Project area (refer to Section 4.2.3 and 4.2.4).
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	*No significant impact* The Project has the potential to impact on the quality of marine environment adjacent to the Project area as a result of discharge of hydrotest water. Refer to the assessment of significant impact above (hydrotest water discharge). It is highly unlikely/remote that the quality of threatened marine reptile species habitat in adjacent areas to the Project area would be impacted and result in the decline of species.
Result in invasive species that are harmful to a Critically Endangered or Endangered species becoming established in the Endangered or Critically Endangered species' habitat.	*No significant impact* There is no credible pathway that could result in Project activities introducing a disease that may cause the population of threatened marine reptile species to decline.
Introduce disease that may cause the species to decline.	*No significant impact* There is no credible pathway that could result in Project activities introducing a disease that may cause the population of threatened marine reptile species to decline. Project disturbance activities and are largely contained within a terrestrial footprint; there is no credible pathway for a disease to be introduced into the marine environment.
Interfere with the recovery of the species.	*No significant impact* The Recovery Plan for Marine Turtles in Australia (CoA 2017) lists the following threats to marine turtles that are potentially relevant to the Project:

Significant impact criteria	Assessment of significant impact
	• chemical discharges Assessments associated with hydrotest water discharge are presented above. Given the transient nature of marine turtles and the absence of suitable nesting habitat within or adjacent to the Project area any impacts associated with changes in water quality (marine discharges) would be localised and temporary and would only result in negligible behavioural impacts.

F.1.5 Marine mammals

Two vulnerable marine mammal species have been assessed as known to occur in the Project area are listed in Table F-9. An assessment of potential impacts and risks from the Ichthys Project against the significant impact criteria for these species is presented in Table F-10.

Table F-9: Threatened marine mammal species identified as 'May,' 'Likely' or 'Known' to occur within the Project area.

Species	Likelihood of occurrence
Vulnerable	
Australian/Indo-Pacific Humpback Dolphin (*Sousa sahulensis* /*S. Chinensis*)	Known to occur
Australian Snubfin Dolphin (*Orcaella heinsohni*)	Known to occur

Table F-10: Assessment of potential significant impacts to listed threatened marine mammal species

Significant impact criteria	Assessment of significant impact
An action likely to have a significant impact on a threatened species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of a population	*No significant impact* There is no credible pathway that could lead to the long-term decrease in the size of the population of threatened marine mammal species that may be using areas adjacent to the Project area. Project disturbance activities and are largely contained within a terrestrial footprint, with only discharge of small volumes commissioning water being proposed to be potentially discharged at a temporary outfall near Ichthys LNG facility module offloading facility (Refer to Section 2.5.1). There are no significant dolphin feeding or breeding habitats in the vicinity of the Ichthys LNG facility (Refer to Section 4.2.3).
Reduce the area of occupancy of the species.	*No significant impact* There is no credible pathway that could lead to the reduction in the area of occupancy of threatened marine mammal species that may be using areas adjacent to the Project area. Project disturbance activities and are largely contained within a terrestrial footprint, with only discharge of small volumes commissioning water being proposed to be potentially discharged at a temporary outfall near Ichthys LNG facility module offloading facility (Refer to Section 2.5.1). There are no significant dolphin feeding or breeding habitats in the vicinity of the Ichthys LNG facility (Refer to Section 4.2.3).
Fragment an existing population into two or more populations.	*No significant impact* There is no credible pathway that could lead to the fragmentation of an existing population of threatened marine mammal species. Project disturbance activities and are largely contained within a terrestrial footprint, with only discharge of small volumes commissioning water being proposed to be potentially discharged at a temporary outfall near Ichthys LNG facility module offloading facility (Refer to Section 2.5.1).
Adversely affect habitat critical to the survival of a species.	*No significant impact*

Significant impact criteria	Assessment of significant impact
	There is no credible pathway that could result in habit critical to the survival of threatened marine mammal species being adversely impacted by Project activities. Project disturbance activities and are largely contained within a terrestrial footprint, with only discharge of small volumes commissioning water being proposed to be potentially discharged at a temporary outfall near Ichthys LNG facility module offloading facility (Refer to Section 2.5.1). Darwin Harbour has been identified as a BIA for breeding and foraging, for Australian snubfin dolphin (*O. heinsohni*), Indo-Pacific humpback dolphin (*S. chinensis*) and Indo-Pacific bottlenose dolphin (*T. aduncus*); however, there are no significant dolphin feeding or breeding habitats in the vicinity of the Ichthys LNG facility (Refer to Section 4.2.3).
Disrupt the breeding cycle of a population.	*No significant impact* There is no credible pathway that could lead to the disruption of the breeding cycle of a population of threatened marine mammal species that may be using areas adjacent to the Project area. Project disturbance activities and are largely contained within a terrestrial footprint, with only discharge of small volumes commissioning water being proposed to be potentially discharged at a temporary outfall near Ichthys LNG facility module offloading facility (Refer to Section 2.5.1). Darwin Harbour has been identified as a BIA for breeding and foraging, for Australian snubfin dolphin (*O. heinsohni*), Indo-Pacific humpback dolphin (*S. chinensis*) and Indo-Pacific bottlenose dolphin (*T. aduncus*); however, there are no significant dolphin feeding or breeding habitats in the vicinity of the Ichthys LNG facility (Refer to Section 4.2.3).
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	*No significant impact* The Project has the potential to impact on the quality of the marine environment adjacent to the Project area as a result of discharge of hydrotest water. The discharge of hydrotest wastewater (refer Section 2.5.1) into the environment could potentially cause impacts to the beneficial uses of Darwin Harbour – Water Quality (NRETAS 2010). Although hydrotest wastewater is predominantly scheme water (and therefore likely clean), it has the potential to absorb contaminants remaining in pipework and infrastructure. The most likely contaminant is nickel, which was found to be absorbed from infrastructure being hydrotested during Ichthys LNG construction (JKC 2015).

Significant impact criteria	Assessment of significant impact
	Impacts to the water quality objectives will be minimised through the use of an appropriate diffuser, which will diffuse wastewater (and any contaminants within) to less than the Darwin Harbour Water Quality Objectives (NRETAS 2010) prior to the edge of an approved mixing zone. The wastewater is fresh, and therefore is more buoyant than the receiving water, and will rise up towards the surface which results in enhanced mixing of the wastewater and Darwin Harbour waters. The wastewater plume will also oscillate and change direction with each flood and ebb tide event. Diffuser design and subsequent plume modelling will be undertaken prior to the generation of hydrotest water. Modelling for Ichthys LNG construction hydrotest water (with volumes of water approximately 10 times larger expected for the Project) indicated a 65-fold dilution was required, and this was met in the nearfield (approximately 8m 95% of the time). A conservative mixing zone of 50 m surrounding the diffuser was established for monitoring purposes. The discharge of hydrotest water to the marine environment may result in temporary and short-term impact on the quality of the marine environment (water) in the immediate vicinity of the discharge. Whilst Darwin Harbour has been identified as a BIA for breeding and foraging, for the Australian snubfin dolphin (*O. heinsohni*) and the Indo-Pacific humpback dolphin (*S. chinensis*), there are no significant dolphin feeding or breeding habitats in the vicinity of the Ichthys LNG facility (Refer to Section 4.2.3).
Result in invasive species that are harmful to a Critically Endangered or Endangered species becoming established in the Endangered or Critically Endangered species' habitat.	*No significant impact* There is no endangered or critically endangered marine mammal species habitat within or adjacent to the Project area (Refer to Section 4.2.1). Project disturbance activities and are largely contained within a terrestrial footprint; there is no credible pathway for invasive species to be introduced into the marine environment.
Introduce disease that may cause the species to decline.	*No significant impact* There is no credible pathway that could result in Project activities introducing a disease that may cause the population of threatened marine mammal species to decline. Project disturbance activities and are largely contained within a terrestrial footprint; there is no credible pathway for a disease to be introduced into the marine environment.
Interfere with the recovery of the species.	*No significant impact*

Significant impact criteria	Assessment of significant impact
	Conservation advice for the Australian snubfin dolphin (*O. heinsohni*), the Indo-Pacific humpback dolphin (*S. chinensis*) list the following threats to that are potentially relevant to the Project (DCCEEW 2025f, 2025g): • habitat degradation (marine pollution) An assessment of the impact of hydrotest water discharge and unplanned loss of containment to the marine environment is presented above. The discharge of hydrotest water and accidental loss of containment to the marine environment may result in temporary and short-term impact on the quality of the marine environment (water) in the immediate vicinity of the discharge. Whilst Darwin Harbour has been identified as a BIA for breeding and foraging, for the Australian snubfin dolphin (*O. heinsohni*) and the Indo-Pacific humpback dolphin (*S. chinensis*), there are no significant dolphin feeding or breeding habitats in the vicinity of the Ichthys LNG facility (Refer to Section 4.2.1).

F.1.6 Fish and sharks

Three endangered or vulnerable fish and shark species that have been assessed as may occur in the Project area are listed in Table F-11. An assessment of potential impacts and risks from the Ichthys Project against the significant impact criteria for these species is presented in Table F-12.

Table F-11: Threatened marine mammal species identified as 'May,' 'Likely' or 'Known' to occur within the Project area.

Species	Likelihood of occurrence
Endangered	
Northern river shark (*Glyphis glyphis*)	May occur
Vulnerable	
Green sawfish (*Pristis zijsron*)	May occur
Dwarf sawfish (*Pristis clavata*)	May occur

Table F-12: Assessment of potential significant impacts to listed threatened fish and shark species

Significant impact criteria	Assessment of significant impact
An action likely to have a significant impact on a threatened species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of a population	*No significant impact* There is no credible pathway that could lead to the long-term decrease in the size of the population of threatened fish and shark species that may be using areas adjacent to the Project area. Project disturbance activities and are largely contained within a terrestrial footprint, with only discharge of small volumes commissioning water being proposed to be potentially discharged at a temporary outfall near Ichthys LNG facility module offloading facility (Refer to Section 2.5.1).
Reduce the area of occupancy of the species.	*No significant impact* There is no credible pathway that could lead to the reduction in the area of occupancy of threatened fish and shark species that may be using areas adjacent to the Project area. Project disturbance activities and are largely contained within a terrestrial footprint, with only discharge of small volumes commissioning water being proposed to be potentially discharged at a temporary outfall near Ichthys LNG facility module offloading facility (Refer to Section 2.5.1).
Fragment an existing population into two or more populations.	*No significant impact* There is no credible pathway that could lead to the fragmentation of an existing population of threatened fish and shark species that may be using areas adjacent to the Project area. Project disturbance activities and are largely contained within a terrestrial footprint, with only discharge of small volumes commissioning water being proposed to be potentially discharged at a temporary outfall near Ichthys LNG facility module offloading facility (Refer to Section 2.5.1).
Adversely affect habitat critical to the survival of a species.	*No significant impact* There is no habitat critical to the survival of the threatened fish/shark species within or adjacent to the Project area (Refer to Section 4.2.4).
Disrupt the breeding cycle of a population.	*No significant impact*

Significant impact criteria	Assessment of significant impact
	There is no credible pathway that could result in the disruption of the breeding cycle of a population of threatened fish and shark species that may be using areas adjacent to the Project area. Project disturbance activities and are largely contained within a terrestrial footprint, with only discharge of small volumes commissioning water being proposed to be potentially discharged at a temporary outfall near Ichthys LNG facility module offloading facility (Refer to Section 2.5.1).
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	*No significant impact* The Project has the potential to impact on the quality of the marine environment adjacent to the Project area as a result of discharge of hydrotest water. The discharge of hydrotest wastewater (refer Section 2.5.1) into the environment could potentially cause impacts to the beneficial uses of Darwin Harbour – Water Quality (NRETAS 2010). Although hydrotest wastewater is predominantly scheme water (and therefore likely clean), it has the potential to absorb contaminants remaining in pipework and infrastructure. The most likely contaminant is nickel, which was found to be absorbed from infrastructure being hydrotested during Ichthys LNG construction (JKC 2015). Impacts to the water quality objectives will be minimised through the use of an appropriate diffuser, which will diffuse wastewater (and any contaminants within) to less than the Darwin Harbour Water Quality Objectives (NRETAS 2010) prior to the edge of an approved mixing zone. The wastewater is fresh, and therefore is more buoyant than the receiving water, and will rise up towards the surface which results in enhanced mixing of the wastewater and Darwin Harbour waters. The wastewater plume will also oscillate and change direction with each flood and ebb tide event. Diffuser design and subsequent plume modelling will be undertaken prior to the generation of hydrotest water. Modelling for Ichthys LNG construction hydrotest water (with volumes of water approximately 10 times larger expected for the Project) indicated a 65-fold dilution was required, and this was met in the nearfield (approximately 8m 95% of the time). A conservative mixing zone of 50 m surrounding the diffuser was established for monitoring purposes. Any impacts associated with changes to water quality as a result of hydrotest discharge would be temporary and short-term in nature and would highly unlikely result in impacts to the quality of the habitat of threatened fish/shark species, such that they would decline.

Significant impact criteria	Assessment of significant impact
Result in invasive species that are harmful to a Critically Endangered or Endangered species becoming established in the Endangered or Critically Endangered species' habitat.	*No significant impact* There is no endangered or critically endangered marine mammal species habitat within or adjacent to the Project area (Refer to Section 4.2.1). Project disturbance activities and are largely contained within a terrestrial footprint; there is no credible pathway for invasive species to be introduced into the marine environment.
Introduce disease that may cause the species to decline.	*No significant impact* There is no endangered or critically endangered marine mammal species habitat within or adjacent to the Project area (Refer to Section 4.2.1). Project disturbance activities and are largely contained within a terrestrial footprint; there is no credible pathway for a disease to be introduced into the marine environment.
Interfere with the recovery of the species.	*No significant impact* The Multispecies Recovery Plan for Sawfish and River Sharks (CoA 2015) lists the following threats to marine turtles that are potentially relevant to the Project: • habitat degradation. Assessments associated with hydrotest water discharge are presented above. Given the transient nature of fish/sharks and the absence significant breeding habitat within or adjacent to the Project area any impacts associated with changes in water quality (marine discharges) would be localised and temporary and would only result in negligible behavioural impacts.

F.1.7 Listed migratory species

Migratory species that have been assessed as known to occur, likely to occur or may occur in the Project area are listed in Table F-13. An assessment of potential impacts and risks from the Ichthys Project against the significant impact criteria for these species is presented in Table F-14.

Table F-13: Migratory species identified as 'May,' 'Likely' or 'Known' to occur within the Project area

Species	Likelihood of occurrence
Asian dowitcher (*Limnodromus semipalmatus*)	Likely to occur
Barn swallow (*Hirundo rustica*)	May occur
Bar-tailed godwit (*Limosa lapponica*)	Likely to occur
Black-tailed godwit (*Limosa limosa*)	Likely to occur
Broad-billed sandpiper (*Limicola falcinellus*)	May occur
Common greenshank (*Tringa nebularia*)	Likely to occur
Common noddy (*Anous stolidus*)	May occur
Common sandpiper (*Actitis hypoleucos*)	Known to occur
Curlew sandpiper (*Calidris ferruginea*)	Likely to occur
Eastern curlew (*Numenius madagascariensis*)	Known to occur
Fork-tailed swift (*Apus pacificus*)	Likely to occur
Great frigatebird (*Fregata minor*)	May occur
Great knot (*Calidris tenuirostris*)	Known to occur
Greater sand plover (Charadrius leschenaultii)	Likely to occur
Grey plover (Pluvialis squatarola)	Likely to occur
Grey wagtail	May occur
Grey-tailed tattler (Tringa brevipes)	Likely to occur
Lesser frigatebird (Fregata ariel)	May occur
Lesser sand plover (Charadrius mongolus)	Likely to occur
Little curlew (Numenius minutus)	Likely to occur

Species	Likelihood of occurrence
Little-ringed plover (Charadrius dubius)	May occur
Little tern (Sternula albifrons)	Likely to occur
Long-toed stint (Calidris subminuta)	May occur
Marsh sandpiper (*Tringa stagnatilis*)	Known to occur
Oriental cuckoo (*Cuculus optatus*)	Likely to occur
Oriental plover (*Charadrius veredus*)	Likely to occur
Oriental pratincole (*Glareola maldivarum*)	Likely occur
Oriental reed-Warbler (*Acrocephalus orientalis*)	May occur
Osprey (Pandion haliaetus)	Known to occur
Pacific golden plover (*Pluvialis fulva*)	Known to occur
Pectoral sandpiper (*Calidris melanotos*)	Likely occur
Red knot (Calidris canutus)	Likely to occur
Red-necked stint (*Calidris ruficollis*)	Likely to occur
Red-rumped swallow (*Cecropis daurica*)	May occur
Ruddy turnstone (*Arenaria interpres*)	Likely to occur
Sanderling (Calidris alba)	Likely to occur
Sharp-tailed sandpiper (*Calidris acuminata*)	Likely to occur
Swinhoe's snipe (*Gallinago megala*)	Likely to occur
Terek sandpiper (*Xenus cinereus*)	Likely to occur
Whimbrel (Numenius phaeopus)	Known to occur
Wood sandpiper (*Tringa glareola*)	Likely to occur
Yellow wagtail (*Motacilla flava*)	May occur
Marine reptiles	
Salt-water crocodile (*Crocodylus porosus*)	Likely to occur
Flatback turtle (*Natator depressus*)	May occur

Species	Likelihood of occurrence
Green turtle (*Chelonia mydas*)	May occur
Marine mammals	
Australian/Indo-Pacific Humpback Dolphin (*Sousa sahulensis* /*S. Chinensis*)	Known to occur
Australian Snubfin Dolphin (*Orcaella heinsohni*)	Known to occur
Spotted bottlenose dolphin (*Tursiops aduncus*)	Known to occur
Fish/sharks	
Green sawfish (*Pristis zijsron*)	May occur
Dwarf sawfish (*Pristis clavata*)	May occur
Northern river shark (*Glyphis garricki*)	May occur

Table F-14: Assessment of potential significant impacts to listed migratory species

Significant impact criteria	Assessment of significant impact
An action likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:	
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	*Unlikely to have a significant impact* Avifauna Several avifauna species have a likelihood of occurring within the Project area and are listed in Table F-13. The Darwin area has been identified as an internationally important site for a number of species predicted to occur in the Project area, the greater sand plover, grey plover and lesser sand plover. Potential impacts to these migratory shorebirds within the Project area include habitat use and behaviour changes related to localised light emissions, dust emissions, atmospheric emissions (including venting during Project operations), habitat disturbance and fragmentation, noise and vibrations, introduction of invasive species, and the physical presence of the pipeline and other associated infrastructure. These impacts are expected to be localised and/or temporary in nature and cause negligible behavioural impacts to threatened avifauna. Most of the Project footprint was previously cleared of vegetation during the construction of Ichthys GEP, which was approved as part of the Ichthys LNG Development project and construction activities would almost entirely be limited to the previously disturbed envelope for the GEP on land zoned for Development and for Utilities. Given the highly disturbed nature of the Project area, threatened avifauna are considered unlikely to depend on this habitat or be present in significant numbers. The Project area is not located where it would present a complete barrier across a population's distribution or migration route. Threatened shorebird species are highly mobile and suitable habitat for identified species is present throughout the wider Darwin and northern Australia region. It is considered unlikely that the Project activities would further reduce the suitable habitat available for migratory avifauna. The highly disturbed nature of the Project area, including previously fragmented habitat, migratory native fauna are considered unlikely to be further fragmented or isolated as a result of the Project activities. Marine reptiles, mammals and shark/fish species

Significant impact criteria	Assessment of significant impact
	There is no credible pathway that could result in the modification, destruction or isolation of an area of important habitat for migratory marine mammal, reptile species or shark/fish species. Project disturbance activities and are largely contained within a terrestrial footprint, with only discharge of small volumes commissioning water being proposed to be potentially discharged at a temporary outfall near Ichthys LNG facility module offloading facility (Refer to Section 2.5.1).
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	*Unlikely to have a significant impact* Terrestrial avifauna and reptiles Several invasive flora and fauna species have previously been recorded in within the Project area, including seven declared weeds under the Northern Territory *Weeds Management Act 2001*, two of which are classed as weeds of national significance (gamba grass; *Andropogon gayanus* and lantana; *Lantana camara*). Introduced fauna species recorded on Middle Arm Peninsula include cane toads (Rhinella marina), feral pigs (Sus scrofa), feral cats (Felis catus), black rats (Rattus rattus) and several pest insects. Given the highly disturbed nature of the Project area, previous introduction of several invasive species, and with the implementation of mitigation measures, it is unlikely that a new invasive species would become established as a result of the proposed Project activities. Migratory species are not expected to be further isolated from the Project area as a result of invasive species being present. Marine reptiles, mammals and shark/fish There is no credible pathway that could result in Project activities introducing an invasive species that would result in harm to marine reptile, mammals or fish/shark migratory species important habitat. Project disturbance activities and are largely contained within a terrestrial footprint; there is no credible pathway for an invasive species to be introduced into the marine environment.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species	*Unlikely to have a significant impact*

Significant impact criteria	Assessment of significant impact
	Several avifauna species have a likelihood of occurring within the Project area and are listed in Table F-13. Potential impacts to these migratory shorebirds within the Project area include habitat and behaviour changes related to localised light emissions, dust emissions, atmospheric emissions, habitat disturbance and fragmentation, noise and vibrations, introduction of invasive species, and the physical presence of the pipeline and other associated infrastructure. The nature of these impacts is considered to be localised and/or temporary in nature and are expected to cause negligible behavioural impacts to migratory avifauna. Migratory avifauna identified with a likelihood of occurring with the Project area may utilise the region for feeding, migration or resting, but not breeding. An ecologically significant population of migratory avifauna is not known to exist within the Project area, and therefore the impacts as a result of Project activities are considered unlikely to seriously disrupt their lifecycles and related behaviours. <u>Marine reptiles, mammals and shark/fish species</u> There is no credible pathway that could result in disruption of the breeding cycle of a population of migratory marine mammal, reptile species or shark/fish species. Project disturbance activities and are largely contained within a terrestrial footprint, with only discharge of small volumes commissioning water being proposed to be potentially discharged at a temporary outfall near Ichthys LNG facility module offloading facility (Refer to Section 2.5.1).