

Coastal Infrastructure Accounting

Provides technical guidance for accounting for coastal infrastructure assets within the ocean accounting framework.

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OUTCOME

This Circular provides technical guidance for accounting for coastal infrastructure assets within the ocean accounting framework. It establishes methods for recording and valuing physical structures that protect, modify, or interact with coastal and marine environments, including both traditional engineered (“grey”) infrastructure and nature-based (“green” or “blue”) solutions. Grey infrastructure refers to conventional engineered structures such as seawalls, breakwaters, and port facilities. Green infrastructure refers to terrestrial nature-based solutions such as dune restoration and riparian planting. Blue infrastructure refers to marine and coastal nature-based solutions such as mangrove forests, coral reefs, and living shorelines. Some literature uses “blue-green” interchangeably. This Circular distinguishes the two where the distinction matters for accounting treatment.

Upon completing this guidance, practitioners will be able to:

- Classify coastal infrastructure assets by function and characteristics, applying the framework from [TG-3.1 Asset Accounts](#)
- Apply perpetual inventory methods and depreciation to produced coastal assets, following [TG-3.1 Asset Accounts](#) Section 3.3
- Account for nature-based solutions as ecosystem enhancement investments, linking to [TG-2.9 Disaster Risk](#)
- Integrate hybrid infrastructure systems combining engineered and natural components
- Link infrastructure accounting to climate adaptation investment tracking in [TG-2.8 Climate Indicators](#)
- Compile coastal infrastructure asset accounts from construction records, asset registers, and spatial data sources

The SNA classifies many coastal infrastructure assets as “other structures” (AN1122) under produced non-financial assets, including “the construction of sea walls, dykes, flood barriers etc. intended to improve the quality and quantity of land adjacent to them.” The accounting treatment must recognise the distinction between produced assets created through human activity and natural capital assets that provide similar services. A concrete seawall represents produced capital subject to depreciation, whilst a mangrove forest providing equivalent coastal protection constitutes an ecosystem asset valued through the net present value of expected ecosystem service flows. Hybrid infrastructure combining both elements requires careful attribution of values to each component.

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ABOUT THIS CIRCULAR

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DRAFT

1. Outcome

¶1 This Circular provides technical guidance for accounting for coastal infrastructure assets within the ocean accounting framework. It establishes methods for recording and valuing physical structures that protect, modify, or interact with coastal and marine environments, including both traditional engineered (“grey”) infrastructure and nature-based (“green” or “blue”) solutions. Grey infrastructure refers to conventional engineered structures such as seawalls, breakwaters, and port facilities. Green infrastructure refers to terrestrial nature-based solutions such as dune restoration and riparian planting. Blue infrastructure refers to marine and coastal nature-based solutions such as mangrove forests, coral reefs, and living shorelines. Some literature uses “blue-green” interchangeably. This Circular distinguishes the two where the distinction matters for accounting treatment.

¶2 Upon completing this guidance, practitioners will be able to:

- ¶3 Classify coastal infrastructure assets by function and characteristics, applying the framework from **TG-3.1 Asset Accounts**¹
- ¶4 Apply perpetual inventory methods and depreciation to produced coastal assets, following **TG-3.1 Asset Accounts** Section 3.3²
- ¶5 Account for nature-based solutions as ecosystem enhancement investments, linking to **TG-2.9 Disaster Risk**
- ¶6 Integrate hybrid infrastructure systems combining engineered and natural components
- ¶7 Link infrastructure accounting to climate adaptation investment tracking in **TG-2.8 Climate Indicators**
- ¶8 Compile coastal infrastructure asset accounts from construction records, asset registers, and spatial data sources

¶9 The SNA classifies many coastal infrastructure assets as “other structures” (AN1122) under produced non-financial assets, including “the construction of sea walls, dykes, flood barriers etc. intended to improve the quality and quantity of land adjacent to them.”³ The accounting treatment must recognise the distinction between produced assets created through human activity and natural capital assets that provide similar services. A concrete seawall represents produced capital subject to depreciation, whilst a mangrove forest providing equivalent coastal protection constitutes an ecosystem asset valued through the net present value of expected ecosystem service flows.⁴ Hybrid infrastructure combining both elements requires careful attribution of values to each component.

1.1 Decision Use Cases

¶1 Coastal infrastructure accounts support three categories of policy decisions:

¶2 **Coastal resilience investment allocation:** Asset accounts provide the analytical framework for comparing engineered and nature-based protection options – engineered structures appear as gross fixed capital formation with annual depreciation, whilst nature-based solutions appear as environmental protection expenditure with ecosystem asset enhancement. The accounts enable annualised equivalent cost comparisons accounting for different service lives and maintenance requirements.

¶3 **Climate adaptation planning and monitoring:** Coastal infrastructure accounts quantify adaptation investment flows (seawall raising, drainage improvement, mangrove restoration) and track the resulting changes in asset stocks. Where adaptation retrofits extend the useful life of existing infrastructure, the accounts distinguish between consumption of fixed capital under original design assumptions and revised depreciation schedules. This feeds directly into **TG-2.8 Climate Indicators**, enabling countries to track SDG target 13.1 and report adaptation finance to UNFCCC

processes. The 2025 SNA now treats climate change as “a major risk affecting current and future wellbeing.”⁵

¶4 **Infrastructure maintenance and budget prioritisation:** Asset condition data from infrastructure accounts inform trade-offs between competing maintenance claims – breakwater repair, channel dredging, mangrove buffer rehabilitation. The accounts ensure transparent classification between intermediate consumption (routine maintenance) and gross fixed capital formation (life-extending rehabilitation).

1.2 Upward Connections

¶1 **TG-1.1 National Ocean Budgets:** Asset accounts demonstrate the scale of public capital formation in coastal infrastructure, informing capital budget allocations and depletion-adjusted income measures.

¶2 **TG-2.9 Disaster Risk:** Infrastructure extent and condition compiled here feed directly into exposure and vulnerability assessments. The combined presentation of produced and ecosystem protective assets enables calculation of total protective capacity and identification of protection gaps.

¶3 **TG-3.1 Asset Accounts:** This Circular applies the TG-3.1 framework to coastal infrastructure, populating physical and monetary asset accounts for AN1122 structures. The worked examples in Section 3.7 illustrate the full compilation chain.

¶4 ⓘ Framework Position

¶5 This Circular owns the **produced-asset accounts for coastal infrastructure** within the territorial sea and on land: classification, valuation, depreciation, service life, and the capital formation and adaptation investment those assets generate.

¶6 It cross-refers for the produced asset framework (**TG-3.1**), spatial delineation (**TG-4.1**), asset registers and consent records (**TG-4.3**) and valuation principles (**TG-1.9**).

¶7 Three boundaries are load-bearing. The **coastal protection service flow** from an ecosystem asset is recorded by the ecosystem circular (**TG-6.1**, **TG-6.2**, **TG-6.3**), not here; this Circular records the produced-asset cost stream and the avoided-expenditure interface. The **ecosystem side of a placed structure** follows the M4.1 rule owned by **TG-6.9** Section 3.5.2. And where an intervention qualifies as a nature-based solution, its ledger, additivity, permanence and lifecycle cost are **TG-6.15**, which also supplies the method for comparing engineered and nature-based options against this Circular’s cost stream.

2. Requirements

¶1 This Circular requires familiarity with:

- ¶2 **TG-4.1 Remote Sensing and Geospatial Data** – spatial delineation of coastal infrastructure footprint and shoreline change.
- ¶3 **TG-4.3 Administrative Data Sources** – asset registers, consent records and public works accounts are the primary source for the asset valuation in Section 3.2.
- ¶4 **TG-0.1 General Introduction to Ocean Accounts** – foundational concepts including spatial boundaries and integration with national accounts.⁶
- ¶5 **TG-3.1 Asset Accounts** – asset classification, balance sheet construction, and the produced/non-produced asset distinction.⁷

¶6 **Scope note on offshore structures:** This Circular focuses on coastal infrastructure within the territorial sea and on land. For infrastructure associated with offshore energy operations beyond the territorial sea, see TG-6.9 Offshore Energy and TG-6.10 Maritime Transport. Where port approach channels or breakwaters extend into the exclusive economic zone, apply the same institutional unit (resident port authority) and asset classification (AN1122) used for the landward components, noting the geographic extent in spatial metadata.⁸

¶7 Related circulars:

- ¶8 **TG-6.2 Mangrove and Coastal Wetland Accounting** – mangrove extent, condition, and service accounting relevant to Section 3.3.2. Practitioners are strongly encouraged to consult TG-6.2 as a co-requisite.
- ¶9 **TG-2.4 Environmental (including Ecosystem) Goods and Services** Section 3.10 – valuation methods; **TG-3.1 Asset Accounts** Section 3.3 – discount rate selection and the NPV approach used in Section 3.2.
- ¶10 **TG-2.9 Disaster Risk** – coastal hazard exposure, vulnerability, and infrastructure protection capacity.
- ¶11 **TG-2.8 Climate Indicators** – climate-related indicators for adaptation investment tracking in Section 3.5.
- ¶12 **TG-6.9 Offshore Energy** – infrastructure associated with offshore energy operations beyond the territorial sea.
- ¶13 **TG-6.10 Maritime Transport and Ports** – maritime transport infrastructure including off-shore port elements.

2.1 Data Requirements

¶1 Physical infrastructure data:

- ¶2 Asset registers for ports, harbours, and marine terminals
- ¶3 Coastal protection structure inventories (seawalls, breakwaters, groynes, revetments)
- ¶4 Reclaimed land area and construction records
- ¶5 Dredging and channel maintenance records⁹

¶6 Ecosystem asset data:

- ¶7 Mangrove extent and condition assessments (see **TG-6.2 Mangrove and Coastal Wetland Accounting**)
- ¶8 Coral reef coverage and health indicators
- ¶9 Seagrass meadow extent
- ¶10 Salt marsh and coastal wetland boundaries¹⁰

¶11 Remote sensing platforms provide essential data for consistent time-series monitoring of ecosystem extent. Landsat (30 m resolution, records from 1972) and Sentinel-2 (10 m resolution, from 2015) offer freely available multispectral imagery suitable for detecting changes in mangrove, seagrass, and salt marsh coverage. The Global Mangrove Watch initiative demonstrates how satellite-derived extent data can be integrated into accounting frameworks.¹¹

¶12 Financial data:

- ¶13 Capital expenditure on coastal construction
- ¶14 Maintenance and rehabilitation costs
- ¶15 Insurance valuations and damage assessments
- ¶16 Market transactions for coastal land and facilities¹²

2.2 Classification Frameworks

¶1 This guidance aligns with the SEEA Central Framework (AN1122 Other structures), Central Product Classification (CPC) for construction services, Classification of the Functions of Government (COFOG) for coastal protection expenditure, and IUCN Global Ecosystem Typology for coastal ecosystem types.¹³

¶2 **Readiness and sequencing.** Whether a country is positioned to compile this account at all – mandate, data architecture, capacity and the order in which to build – is assessed under **TG-0.8 Implementation Readiness Assessment**, and is not restated here.

3. Guidance Material

3.1 Coastal Infrastructure Types

3.1.1 Port and Harbour Infrastructure

¶1 Ports and harbours represent major produced assets within the coastal zone. The 2025 SNA classifies harbour facilities under “other structures” (AN1122), including:

“harbour bottoms and harbour channels, breakwaters, quays, piers, jetties, docks, wharves and similar structures”¹⁴

¶2 Key infrastructure categories include:

¶3 **Structural facilities:** quay walls and wharves; piers and jetties; breakwaters and wave barriers; dry docks and slipways; cargo handling facilities.¹⁵

¶4 **Navigation infrastructure:** dredged channels and basins; navigation aids (lighthouses, buoys, beacons); vessel traffic management systems.

¶5 **Supporting facilities:** storage and warehousing; road and rail connections; utilities and services.¹⁶

¶6 Port infrastructure valuation should apply the perpetual inventory method (PIM) using acquisition costs, service lives, and appropriate depreciation profiles. The SEEA Central Framework notes that “consumption of fixed capital (commonly known as depreciation) should be deducted from income and recognized as a cost of production.”¹⁷

¶7 To illustrate the PIM approach: a concrete quay wall constructed in 2010 at USD 50 million with a 60-year service life and 3.3 per cent geometric depreciation would, by 2025, have a net value of roughly USD 30 million in constant 2010 prices after approximately 40 per cent accumulated depreciation.¹⁸

3.1.2 Coastal Protection Structures

¶1 Coastal protection infrastructure comprises engineered structures designed to defend shorelines from erosion, flooding, and storm damage.

¶2 Seawalls and Revetments

¶3 Seawalls are vertical or near-vertical structures providing a hard barrier between land and sea. Revetments are sloped structures armoring the shoreline using rock, concrete blocks, or similar materials.¹⁹ Both are classified as produced assets under AN1122, recorded at construction cost less accumulated depreciation. Typical service lives range from 25 to 75 years depending on materials, design, and environmental exposure. Major rehabilitation that extends useful life should be recorded as gross fixed capital formation.²⁰

¶4 Breakwaters and Groynes

¶5 Breakwaters are offshore or nearshore structures that reduce wave energy reaching protected areas. Groynes extend perpendicular to the shoreline to trap sediment and control longshore drift.²¹ CPC 53262 covers dredging services and other water-associated construction relevant to breakwater construction and maintenance.²²

¶6 Flood Barriers and Tidal Gates

¶7 Movable flood barriers and tidal gates manage water levels in estuaries and tidal zones. These assets combine structural elements with mechanical and electrical systems, requiring separate depreciation schedules for each component category.²³ Notable systems include the Thames Barrier

(operational since 1984), the Maeslantkering (part of the Netherlands Delta Works), and Venice's MOSE barrier (completed 2020, 78 mobile gates). These examples illustrate capital values in the billions of dollars, design lives of 50–100 years, and ongoing maintenance that must be classified between intermediate consumption and capital formation.²⁴

3.1.3 Reclaimed Land

¶1 Land reclamation creates new terrestrial area through the deposition of fill material and conversion of seabed or intertidal zones to dry land. The SEEA Central Framework recognises that land area may increase "owing to reclamation of land through the construction of dykes and other barriers."²⁵ Reclaimed land represents a produced asset distinct from the underlying natural seabed.

¶2 Accounting treatment records:

- ¶3 Initial construction costs as gross fixed capital formation
- ¶4 The resulting land area as an addition to produced assets
- ¶5 Ongoing maintenance costs (pumping, drainage, structural repairs)
- ¶6 Ecosystem service losses from converted marine or intertidal areas²⁶

¶7 **SNA classification of reclamation works and reclaimed land:** The engineered works (dykes, fill structures, drainage, containment walls) are recorded as gross fixed capital formation in AN1122. Once reclamation is complete and the land functions as a productive asset, the land area itself is reclassified to AN.211 (Land underlying buildings and structures) or AN.212 (Land under cultivation) as a non-produced asset, whilst the engineered works retain their AN1122 classification. The two components – engineered structures (produced) and land area (non-produced) – must be recorded separately to avoid double counting. Cross-reference SNA 2025 paragraph 11.85 and **TG-3.1 Asset Accounts**.²⁷

¶8 When coastal ecosystems are converted to reclaimed land, the framework captures both sides: the new produced land asset is recorded as gross fixed capital formation, whilst the ecosystem asset loss is recorded as ecosystem degradation and conversion in extent and condition accounts. The SEEA EA provides that "the value of losses in ecosystem services that result from ecosystem degradation should be recorded as an ecosystem degradation cost,"²⁸ enabling a structured comparison between the produced asset gain and the ecosystem capital loss.

3.2 Asset Valuation

3.2.1 Capital Stock Measurement

¶1 Coastal infrastructure assets should be valued following SNA principles for produced non-financial assets using the perpetual inventory method (PIM). For PIM principles and price index selection, see **TG-3.1 Asset Accounts**.

¶2 The PIM requires:

1. ¶3 **Historical investment series** – gross fixed capital formation in coastal infrastructure over the expected asset life
2. ¶4 **Price indices** – construction cost indices to express investments in current prices
3. ¶5 **Service life assumptions** – expected useful life by asset type
4. ¶6 **Depreciation functions** – geometric, linear, or other profiles reflecting loss of productive capacity²⁹

¶7 The 2025 SNA specifies that "consumption of fixed capital in the SNA is calculated on the basis of the estimated opportunity costs of using the assets at the time they are used, as distinct from the prices at which the assets were acquired."³⁰

3.2.2 Depreciation and Service Lives

¶1 Consumption of fixed capital for coastal infrastructure should reflect physical wearing out, normal obsolescence, and expected terminal costs.

¶2 *Table 3.2.2: Indicative service lives and depreciation profiles for coastal infrastructure*

Asset Type	Typical Service Life	Depreciation Profile	Typical Maintenance (% of replacement cost per year)
Quay walls (concrete)	50–75 years	Geometric	1–2%
Steel sheet piling	30–50 years	Geometric	2–3%
Breakwaters (rock)	50–100 years	Linear	0.5–1%
Seawalls (concrete)	40–60 years	Geometric	1–2%
Groynes (timber)	15–25 years	Linear	3–5%
Navigation dredging	1–5 years	Full write-off	N/A (recurring)
Reclamation structures	50–75 years	Geometric	1–2%
Beach nourishment	1–5 years	Straight-line (full write-off over cycle)	N/A (recurring placement)
Living shoreline – engineered component	10–20 years	Geometric	2–4%
Living shoreline – ecosystem component	N/A (ecosystem asset)	N/A – record under ecosystem accounts	N/A

¶3 **31**

¶4 The maintenance cost column assists compilers in distinguishing routine maintenance expenditure (intermediate consumption) from major rehabilitation (capital formation). Where annual maintenance expenditure exceeds the indicative percentages by a material margin, the excess may indicate capital improvements that should be classified as gross fixed capital formation.

¶5 Service life estimates should be adjusted based on local environmental conditions including wave climate, storm frequency, sediment dynamics, and water quality factors.³²

3.2.3 Asset Classification for Coastal Protection

¶1 *Table 3.2.1: Coastal protection asset classification*

Infrastructure Type	SNA Asset Class	SEEA Asset Class	Depreciation	Co-benefits
Seawall	Produced (AN.1122)	N/A	Yes (40–60 yr)	Minimal
Breakwater	Produced (AN.1122)	N/A	Yes (50 yr)	Artificial reef
Beach nourishment	Produced (inventory)	N/A	Yes (annual)	Recreation
Mangrove forest	N/A	Ecosystem asset	No	Carbon, fisheries, biodiversity
Coral reef	N/A	Ecosystem asset	No	Fisheries, tourism, biodiversity
Living shoreline	Hybrid	Hybrid	Mixed	Moderate

¶2 Produced assets are valued at construction cost less accumulated depreciation. Ecosystem assets are valued through the net present value of expected ecosystem service flows. Hybrid assets require attribution between their produced and ecosystem components.³³

3.2.4 Maintenance and Rehabilitation

¶1 Routine maintenance that sustains current productive capacity should be recorded as intermediate consumption, not capital formation. Major rehabilitation extending asset life or materially improving capacity constitutes gross fixed capital formation.³⁴

¶2 Dredging presents particular accounting challenges. Maintenance dredging to restore design depths is typically treated as intermediate consumption. Capital dredging creating new or expanded facilities represents gross fixed capital formation.³⁵ The SEEA Central Framework includes “dredgings” within the physical flow accounts for material resources.³⁶

3.3 Nature-Based Solutions

3.3.1 Living Shorelines

¶1 Living shorelines use natural materials and ecosystem features to provide coastal protection while maintaining ecological function.³⁷ Components may include planted vegetation (salt marsh grasses, mangroves, dune vegetation), oyster reef structures, submerged aquatic vegetation, natural or placed rock features, and biodegradable erosion control materials.³⁸

¶2 Accounting treatment depends on primary purpose and ownership:

¶3 **Ecosystem restoration expenditure** – where the primary objective is habitat restoration, costs should be recorded as environmental protection expenditure under CEPA classification and tracked through ecosystem extent and condition accounts.³⁹

¶4 **Coastal protection investment** – where the primary objective is shore protection with ecological co-benefits, engineered components may be capitalised as produced assets whilst ecosystem elements are tracked through ecosystem accounts.⁴⁰

3.3.2 Where the ecosystem protection service is recorded

¶1 Mangroves, salt marshes, coastal wetlands, seagrass meadows and coral reefs all provide coastal protection through wave attenuation, sediment stabilisation and storm surge reduction. Five circulars in this publication touch that service, so the recording point has to be stated rather than left to the compiler. Protection is a final ecosystem service distinct from fisheries habitat and recreation, so recording it once does not suppress the other services the same asset supplies.⁴¹

¶2 ⓘ **Recording rule – coastal protection service**

¶3 The **ecosystem circular records the protection service flow** from the ecosystem asset, once, in the ecosystem service supply and use table: **TG-6.1** Section 3.3 for coral reefs, **TG-6.2** Section 3.4 for mangroves and coastal wetlands, **TG-6.3** Section 3.3 for seagrass.

¶4 **This Circular records the produced-asset side** – the capital cost, depreciation profile and service life of engineered and hybrid protection works – and cross-refers to the ecosystem circular for the service. It does not independently estimate protection service values for areas an ecosystem circular already covers.

¶5 **TG-6.15** Section 3.8 supplies the method for comparing the two, drawing the produced-asset cost stream from here and the risk-adjusted ecosystem stream from the ecosystem circulars.

¶6 The valuation methods themselves – avoided damage cost, replacement cost, benefit transfer, and the expected damage function procedure they rest on – are set out in **TG-6.2** Section 3.6 and **TG-3.2 Flows from Environment to Economy** Section 3.5, and are not restated here.^{42, 43, 44}

¶7 What this Circular adds is the **interface**: where a protection service recorded in an ecosystem circular is the reason an engineered work was deferred, reduced in scope or avoided altogether, that avoided capital expenditure is recorded in the infrastructure investment account with a note identifying the ecosystem asset and the circular carrying its service value. The avoided expenditure and the ecosystem service value are two views of one benefit and must not be summed.

3.3.3 Condition variables that carry protection capacity

¶1 The condition variables governing protection capacity are recorded in the ecosystem condition account under the relevant ecosystem circular, but infrastructure planners are their main user, so the dependency is stated here.

¶2 Coral reef protection capacity depends on three measurable condition indicators: reef crest depth relative to sea level determines the degree of wave breaking, structural complexity (rugosity) affects energy dissipation, and reef width determines the distance over which wave energy is absorbed. These should be tracked alongside biological condition metrics such as live coral cover, since declines in biological condition translate into reduced structural complexity and diminished protection capacity. The Allen Coral Atlas and the GCRMN Status of Coral Reefs reports provide standardised approaches at national and regional scales.⁴⁵ For mangroves and saltmarsh the equivalent variables are canopy width, stem density and surface elevation relative to sea level; for seagrass, meadow width and shoot density.

¶3 A compiler planning protection infrastructure should read these variables as a forward signal: an ecosystem asset on a declining condition trajectory will deliver less protection over the life of the works being appraised, which is a change in the counterfactual and not a change in the discount rate. Changes in condition affecting protection capacity are recorded as ecosystem degradation or enhancement in the ecosystem asset account, and restoration investment as environmental protection expenditure, in both cases under the ecosystem circular.⁴⁶

3.4 Blue-Grey Integration

3.4.1 Hybrid Infrastructure Systems

¶1 Hybrid infrastructure combines engineered structures with natural ecosystem elements to achieve coastal protection objectives.⁴⁷ Examples include breakwaters designed to support coral growth, seawalls with integrated mangrove planting, groyne fields with saltmarsh restoration, and artificial reefs for wave attenuation and habitat.

¶2 Accounting for hybrid systems requires clear attribution between:

1. ¶3 **Produced asset components** (engineered structures) – valued at construction cost less depreciation
2. ¶4 **Ecosystem asset components** (natural or restored ecosystems) – valued through NPV of expected ecosystem service flows
3. ¶5 **Land area changes** resulting from infrastructure or restoration⁴⁸

¶6 Components that are clearly engineered should be recorded as produced assets, and components that are clearly natural should be recorded as ecosystem assets.

¶7 Where a placed structure has developed confirmed ecological function – an artificial reef that derives wave attenuation jointly from the placed substrate and biological growth is the standard case – the two sides are separated by ecosystem type rather than by apportionment. **TG-6.9**

Offshore Energy Thematic Methods Section 3.5.2 owns this rule for the publication and it applies inside the territorial sea exactly as it does beyond it: the structure remains a produced asset at construction cost less depreciation, and the ecological function it acquires is recorded as a separate **IUCN GET M4.1 Submerged artificial structures** ecosystem extent entry, sized at structure footprint plus a defined ecological halo, reversible if the ecological function is not confirmed. The capital-expenditure proportion is used only where the *produced* asset itself must be split between coastal-protection and other purposes; it is not a method for dividing value between the produced and ecosystem sides.⁴⁹

3.4.2 Ecosystem Enhancement Investment

¶1 Where infrastructure investments improve ecosystem condition, the SEEA EA provides for recording ecosystem enhancement:

“Ecosystem enhancement is the increase in the value of an ecosystem asset over an accounting period that is associated with an improvement in the condition of the asset during that accounting period.”⁵⁰

¶2 Enhancement activities in coastal zones include rehabilitation of degraded mangroves and wetlands, reef restoration and transplantation, seagrass meadow replanting, sediment management improving habitat quality, and water quality improvements benefiting coastal ecosystems.⁵¹

¶3 Restoration, rehabilitation, and reclamation activities have different implications:

- ¶4 **Restoration** aims to re-establish pre-existing structure and function including biotic integrity
- ¶5 **Rehabilitation** aims to reinstate ecosystem functionality with a focus on supplying ecosystem services
- ¶6 **Reclamation** aims to return degraded land to a useful state⁵²

¶7 The value of ecosystem enhancement should be measured through changes in the NPV of expected ecosystem service flows, not simply as expenditure incurred. There should be “no prior expectations regarding the results of such a comparison” between enhancement value and expenditure levels.⁵³

3.5 Climate Adaptation

3.5.1 Sea Level Rise Resilience

¶1 Climate change affects the required performance and expected service life of coastal infrastructure. The SEEA EA recognises that “changes at the edges of the realms and associated transition areas, particularly between the marine and terrestrial realms, are likely to occur, for example, through coastal erosion, sediment deposition and aggradation and sea level rise.”⁵⁴

¶2 Infrastructure accounting should address:

¶3 **Design standard adjustments** – new infrastructure designed for higher sea levels or increased storm intensity should be fully capitalised as gross fixed capital formation.⁵⁵

¶4 **Asset life reappraisal** – existing infrastructure may face shortened useful lives if design standards are exceeded by changed conditions. Downward reappraisal of remaining service potential should be recorded in the other changes in volume account.⁵⁶

¶5 **Adaptation retrofits** – modifications maintaining function under changed conditions should be recorded as gross fixed capital formation where they extend useful life or maintain capacity.⁵⁷

¶6 **Stranded asset recognition** – infrastructure that becomes functionally obsolete due to sea level rise or permanent inundation may require accelerated depreciation or full write-off. Where sea level rise projections indicate specific infrastructure will be rendered obsolete before the end of its originally estimated service life, compilers should revise the depreciation schedule to write off the remaining value over the shortened horizon. Where infrastructure is abandoned due to managed retreat, the residual book value should be written off through the other changes in volume account.⁵⁸

3.5.2 Adaptation Investment Tracking

¶1 Coastal climate adaptation investment spans multiple asset categories:

¶2 **Grey infrastructure:** raised seawall heights; strengthened flood defences; upgraded drainage systems; relocated facilities.⁵⁹

¶3 **Nature-based solutions (green and blue):**

¶4 *Terrestrial (green)*: dune restoration and stabilisation; coastal riparian planting; inland wetland creation contributing to coastal flood attenuation.⁶⁰

¶5 *Marine and coastal (blue)*: mangrove restoration and expansion; coastal wetland creation; beach nourishment; seagrass and oyster reef establishment.⁶¹

¶6 **Hybrid solutions**: integrated defence systems combining structural and natural elements; managed realignment creating new intertidal habitat; building with nature approaches.⁶²

¶7 The Framework for the Development of Environment Statistics (FDES) identifies relevant indicators including “sea level” and “flood/storm surge, sea level rise, coastal storm risk” for tracking climate-related changes affecting coastal infrastructure.⁶³

¶8 Investment tracking should link to⁶⁴:

- ¶9 Government expenditure accounts (COFOG – coastal protection expenditure)⁶⁵
- ¶10 Environmental protection expenditure accounts (CEPA/CREMA classifications)⁶⁶
- ¶11 Infrastructure asset accounts showing capital stock and changes
- ¶12 Ecosystem accounts showing condition and extent changes from nature-based interventions⁶⁷

3.6 Compilation Procedure

Step 1: Identify and classify infrastructure assets

¶1 Assemble an inventory of coastal infrastructure assets within the accounting area using the sources in Table 3.6.1.

Source	Description
Port authority asset registers	Detailed inventories of quays, breakwaters, dredged channels, cargo handling equipment, and warehouses, typically maintained for operational management and financial reporting.
Coastal zone management databases	Spatial datasets maintained by environmental agencies documenting seawalls, groynes, revetments, and tidal barriers, often linked to permit records and inspection programmes.
Public works departments	Construction and maintenance records for coastal roads, drainage systems, and shore protection works funded through government capital budgets.
Spatial data repositories	National geographic databases and cadastral systems documenting reclaimed land, port boundaries, and infrastructure footprints.

¶2 **Privately owned coastal infrastructure**: Infrastructure owned by private enterprises and households (resort seawalls, private marina structures, industrial facility protection) should be included where material, consistent with SNA’s balance sheet coverage of all institutional sectors. In many tourism-dependent and SIDS contexts, privately owned coastal protection constitutes a substantial share of total coastal resilience infrastructure. Data sources include construction permit records, property insurance databases, sector surveys, and cadastral records. Where private infrastructure cannot be directly measured, estimation using construction permit volumes combined with sector-specific asset intensity ratios provides a practical approach, with all assumptions documented in metadata.⁶⁸

¶3 For each identified asset, record:

1. ¶4 **Physical characteristics**: type, dimensions, materials, location
2. ¶5 **Ownership and institutional unit**: government, port authority, private, or mixed
3. ¶6 **Construction date and original cost**: for PIM application
4. ¶7 **Current condition**: inspection reports, condition ratings
5. ¶8 **Functional status**: operational, partially operational, decommissioned, or planned

¶9 Map each asset to AN1122 Other structures and relevant sub-categories consistent with the national chart of accounts.

Step 2: Assemble financial data

¶1 Collect historical and current financial data for each asset or asset category:

¶2 **Historical investment series** (for PIM):

- ¶3 Annual GFCF in coastal infrastructure over the maximum service life (typically 100 years for long-lived breakwaters)
- ¶4 Source from government finance statistics, port authority financial statements, and construction industry surveys
- ¶5 Express in current prices using construction cost indices

¶6 **Current-period expenditure:**

- ¶7 Capital formation: new construction and major rehabilitation
- ¶8 Maintenance: routine repair, classified as intermediate consumption
- ¶9 Disposals and retirements with any scrap value

¶10 **Valuation data:** insurance valuations, market transactions, replacement cost estimates from engineering studies.

¶11 Where financial data for individual assets are unavailable, apply average cost factors by asset type and size category calibrated to available benchmark observations.

Step 3: Apply perpetual inventory method

¶1 Apply the PIM framework from Section 3.2.1, using the indicative service lives from Table 3.2.2, geometric depreciation for structural assets, and construction cost indices for price revaluation.

¶2 Key account identity:

- ¶3 Closing stock = Opening stock + GFCF - Depreciation - Retirements ± Other volume changes

¶4 Record catastrophic losses from storms and reappraisals of service life in the other-changes-in-volume sub-account.

Step 4: Record ecosystem asset changes

¶1 Where hybrid or blue-grey infrastructure systems involve ecosystem components, compile parallel ecosystem extent and condition accounts:

¶2 **Extent changes** (from mangrove restoration, coral transplantation, living shoreline establishment):

- ¶3 Opening extent (hectares) at start of accounting period
- ¶4 Managed expansion: area established or restored through deliberate investment
- ¶5 Natural expansion: area of natural colonisation or accretion
- ¶6 Closing extent (hectares) at end of period

¶7 **Condition changes:**

- ¶8 Select condition variables relevant to coastal protection function: mangrove canopy density, coral structural complexity, seagrass shoot density (see **TG-3.1 Asset Accounts**, Section 3.5.2 for guidance)
- ¶9 Record opening and closing values for each variable
- ¶10 Where monetary asset accounts exist, record ecosystem enhancement as the change in NPV of expected future ecosystem service flows

¶11 **Expenditure attribution:**

- ¶12 Environmental protection expenditure: costs of restoration, rehabilitation, and ongoing management
- ¶13 Ecosystem enhancement: value change in ecosystem assets due to improved condition
- ¶14 Cross-reference produced asset investment (engineered components) and ecosystem investment to avoid double counting

Step 5: Integrate with balance sheets

¶1 Balance sheet position:

- ¶2 Coastal infrastructure (produced) appears under AN1122 Other structures
- ¶3 Coastal ecosystem assets appear under SEEA EA ecosystem asset classification

¶4 Accumulation accounts:

- ¶5 Capital account: GFCF in coastal infrastructure and environmental protection expenditure
- ¶6 Other changes in volume: catastrophic losses, reappraisals, ecosystem conversions
- ¶7 Revaluation account: holding gains/losses due to price changes

¶8 Cross-account consistency:

- ¶9 Depreciation in capital account equals consumption of fixed capital in production account
- ¶10 GFCF recorded in capital formation agrees with construction output in supply-use tables
- ¶11 Ecosystem enhancement expenditure appears in environmental protection accounts (CEPA)

Step 6: Quality assurance and documentation

¶1 Internal consistency:

- ¶2 Asset account identity: Closing stock = Opening stock + Additions - Reductions ± Revaluations
- ¶3 Cross-check depreciation rates against observed asset lifetimes
- ¶4 Compare maintenance expenditure percentages (Table 3.2.2) against actual port authority accounts

¶5 External benchmarking:

- ¶6 Compare total infrastructure capital stock to international port statistics and infrastructure benchmarks
- ¶7 Validate ecosystem asset values against comparable restoration cost or avoided damage studies
- ¶8 Cross-reference climate adaptation investment totals with government climate finance reporting to UNFCCC

¶9 Documentation:

- ¶10 Record all classification decisions, service life assumptions, and depreciation profiles
- ¶11 Document data sources and estimation methods for each asset category
- ¶12 Prepare metadata describing coverage, quality, and limitations

3.7 Worked Example

Scenario description

¶1 The accounting area is Coastal City, population 250,000, with a container port, 12 km of urban seawall, and a 150-hectare mangrove restoration project. The accounting period is calendar year 2025. Key infrastructure includes:

1. ¶2 **Port infrastructure:** Quay walls and cargo handling equipment (original construction 2005–2015)

2. ¶3 **Seawall:** Concrete barrier protecting low-lying urban areas (constructed 1980–1990, with major rehabilitation in 2010)
3. ¶4 **Mangrove restoration:** 150 hectares established 2018–2022, now providing measurable coastal protection

Asset inventory and classification

¶1 *Table 3.7.I: Coastal City infrastructure asset inventory*

Asset Type	Classification	Original Investment	Service Life	Depreciation Profile
Port quay walls	AN1122 Other structures	USD 85 million (2005–2015)	60 years	Geometric (3% p.a.)
Port cargo handling equipment	AN1123 Machinery & equipment	USD 40 million (2010–2020)	20 years	Geometric (10% p.a.)
Urban seawall	AN1122 Other structures	USD 60 million (1980–1990), USD 15 million rehab (2010)	50 years	Geometric (4% p.a.)
Mangrove forest	Ecosystem asset (MFT1.2)	Restoration cost USD 2.5 million (2018–2022)	N/A (natural asset)	No depreciation

Physical asset account (quay walls)

¶1 To demonstrate the PIM approach, this worked example calculates the 2025 asset account for port quay walls constructed progressively from 2005–2015. All current-price columns are stated in 2025 prices unless otherwise noted.

¶2 Step 1: Revalue historical investment to 2025 prices

¶3 Assume construction cost inflation of 3% per annum. Investment in constant 2025 prices:

Vintage Year	Original Cost (USD million)	Construction Cost Index (2025=100)	Revalued Cost (USD million, 2025 prices)
2005	8.5	$100 \times 1.03^{20} = 181$	$8.5 \times 1.81 = 15.4$
2010	25.5	$100 \times 1.03^{15} = 156$	$25.5 \times 1.56 = 39.8$
2015	51.0	$100 \times 1.03^{10} = 134$	$51.0 \times 1.34 = 68.3$
Total	85.0		123.5

¶4 Step 2: Calculate accumulated depreciation by vintage

¶5 Geometric depreciation at 3% per annum. Accumulated depreciation = $1 - (1 - 0.03)^{\text{age}}$:

Vintage	Age in 2025 (years)	Accumulated Depreciation (%)	Net Value (USD million, 2025 prices)
2005	20	46%	$15.4 \times 0.54 = 8.3$
2010	15	37%	$39.8 \times 0.63 = 25.1$
2015	10	26%	$68.3 \times 0.74 = 50.5$
Total opening stock (1 Jan 2025)			83.9

¶6 Step 3: Record current-period changes

¶7 During 2025:

- ¶8 GFCF: No new quay construction (USD 0)
- ¶9 Depreciation: 3% of opening stock = USD 2.5 million

- ¶10 Catastrophic losses: Cyclone damage requiring USD 1.2 million write-off (recorded as other changes in volume)
- ¶11 Revaluation: 3% construction cost inflation = USD 2.5 million holding gain

¶12 **Physical asset account for port quay walls (USD million, current prices)**

Entry	Value
Opening stock (1 Jan 2025)	83.9
Transactions	
Gross fixed capital formation	0.0
Consumption of fixed capital (depreciation)	-2.5
Other changes in volume	
Catastrophic losses (cyclone damage)	-1.2
Revaluation	
Holding gains (construction cost inflation)	2.5
Closing stock (31 Dec 2025), current prices	82.7

¶13 **Reconciliation between current-price and constant-price closing stock:** The USD 82.7 million current-price closing stock includes the USD 2.5 million holding gain from construction cost inflation. Removing the revaluation effect yields $83.9 - 2.5 - 1.2 = \text{USD } 80.2$ million, which is the figure presented in the constant-price integrated Table 3.7.2 below.

¶14 **Interpretation:** The net capital stock of quay walls declined by USD 1.2 million during 2025 on a current-price basis despite a holding gain of USD 2.5 million, because depreciation and cyclone damage exceeded the revaluation. In constant 2025 prices, the real decline was USD 3.7 million, the combined effect of capital consumption and storm damage.

Ecosystem asset account (mangrove restoration)

¶1 The 150-hectare mangrove restoration provides coastal protection, carbon sequestration, and fisheries nursery services.

¶2 **Extent account (hectares)**

Entry	Value
Opening extent (1 Jan 2025)	145
Managed expansion (new planting)	5
Natural expansion (seedling colonization)	2
Natural reduction (edge erosion)	1
Closing extent (31 Dec 2025)	151

¶3 **Condition assessment**

Variable	Opening (Jan 2025)	Closing (Dec 2025)	Reference Value	Interpretation
Canopy density (%)	62	68	85	Improving, but below reference
Prop root height (cm)	45	52	70	Maturing structure
Sediment accretion (mm/yr)	8	9	10	Approaching reference

¶4 The condition improvements reflect the maturing of the restored forest. By 2025, the restoration ranges from 3 to 7 years old (established 2018–2022), with the oldest sections approaching functional equivalence with natural mangroves.

¶5 **Methodological note on condition index construction:** The condition index used in this worked example is an unweighted arithmetic mean of three normalised condition ratios (canopy density, prop root height, sediment accretion). In national compilation, condition weighting schemes should reflect the relative contribution of each variable to the specific service being valued. Where coastal protection is the primary service, structural complexity variables (canopy density and prop root architecture) should be assigned higher weights than biogeochemical variables (sediment accretion). Compilers should document the weighting scheme and reference a published condition scoring framework. See **TG-2.1 Aggregate Biophysical Indicators of Environmental State** for condition variable selection guidance.⁶⁹

¶6 Monetary valuation

¶7 Ecosystem service valuation (annual flow):

- ¶8 Coastal protection: Replacement cost of equivalent seawall = USD 8,000 per hectare per year
- ¶9 Carbon sequestration: 10 tonnes CO₂ per hectare per year × USD 50 per tonne = USD 500 per hectare per year
- ¶10 Fisheries nursery: Productivity contribution = USD 400 per hectare per year
- ¶11 **Total annual service flow:** USD 8,900 per hectare per year

¶12 Adjusted for current condition:

- ¶13 Condition index = $(68/85 + 52/70 + 9/10) / 3 = (0.80 + 0.74 + 0.90) / 3 = \mathbf{0.81}$ (81% of reference condition)
- ¶14 Adjusted service flow = USD 8,900 × 0.81 = USD 7,209 per hectare per year

¶15 **Discount rate selection and sensitivity:** A social discount rate of 4% per annum is applied, consistent with indicative rates used in multilateral development bank cost-benefit analyses. National compilers should select a rate consistent with national fiscal guidelines or central bank long-run real rates. See **TG-1.9 Valuation** for selection criteria.⁷⁰

¶16 Asset value (NPV at 4% discount rate, perpetual horizon):

- ¶17 Asset value per hectare = Annual service flow / discount rate = USD 7,209 / 0.04 = **USD 180,225 per hectare**
- ¶18 Total asset value (151 ha) = **USD 27.2 million**

¶19 *Note on the perpetuity assumption:* The perpetuity formula treats the adjusted annual service flow as continuing indefinitely. For recently restored ecosystems subject to sea level rise, cyclone mortality, and management uncertainty, a finite horizon may be more appropriate. For comparison, a 50-year finite-horizon NPV at 4% yields approximately USD 154,800/ha – materially below the USD 180,225/ha perpetuity figure. Compilers should select horizon assumptions appropriate to the maturity and risk profile of the restored ecosystem and present sensitivity ranges. See TG-1.9 for guidance.⁷¹

¶20 *Sensitivity table – per-hectare mangrove asset value at alternative discount rates (perpetual horizon, USD per hectare):*

Discount Rate	Asset Value per Hectare (USD)	Total Asset Value, 151 ha (USD million)
2%	360,450	54.4
4% (central)	180,225	27.2
6%	120,150	18.1

¶21 The sensitivity table illustrates that a 1-percentage-point change in the discount rate alters the asset value by approximately 25–50%. This magnitude makes explicit discount rate justification and sensitivity testing important to any compilation that reports mangrove asset values.

¶22 **Monetary ecosystem asset account (USD million)**

Entry	Value
Opening value (1 Jan 2025, 145 ha)	23.4
Ecosystem enhancement (condition improvement)	2.7
Ecosystem conversions (net extent increase, 6 ha)	1.1
Revaluation (service price changes)	0
Closing value (31 Dec 2025, 151 ha)	27.2

¶23 **Interpretation:** The mangrove asset value increased by USD 3.8 million during 2025, driven by both extent expansion (6 hectares net, contributing USD 1.1 million) and condition improvement (canopy density increased from 62% to 68%, contributing USD 2.7 million).

Integrated infrastructure and ecosystem account

¶1 *Table 3.7.2: Coastal City total coastal protection asset value (USD million, constant 2025 prices)*

Asset Category	Opening Stock	GFCF / Enhancement	Depreciation / Degradation	Other Changes (incl. ecosystem conversions) ⁷²	Closing Stock
Port quay walls (produced)	83.9	0	-2.5	-1.2 (cyclone)	80.2
Urban seawall (produced)	45.6	3.2 (raising)	-1.8	0	47.0
Mangrove forest (ecosystem)	23.4	2.7 (enhancement)	0	1.1 (ecosystem conversions – net extent increase)	27.2
Total	152.9	5.9	-4.3	-0.1	154.4

¶2 Note: Values shown at constant 2025 prices (revaluation effects removed for clarity). The port quay walls closing stock of USD 80.2 million corresponds to the USD 82.7 million current-price closing stock shown above, with the USD 2.5 million holding gain removed.

¶3 **Policy implications:**

¶4 This integrated account reveals three findings:

1. ¶5

Capital maintenance gap: Produced infrastructure depreciation (USD 4.3 million) exceeded new investment (USD 3.2 million), indicating net capital consumption. The cyclone damage compounded this gap.

2. ¶6

Ecosystem asset performance: The mangrove restoration generated USD 3.8 million in asset value increase. At an establishment cost of USD 2.5 million over 2018–2022 (amortised to USD 500,000 per year), the ecosystem enhancement exceeds annual expenditure.

3. ¶7

Portfolio diversification: The combined portfolio of grey and blue infrastructure maintained nearly constant total value despite the cyclone impact. The mangrove asset was unaffected by the storm that damaged the quay. Hybrid protection systems spread risk across asset types that do not share the same failure mode.

Budget implications

¶1 *Infrastructure maintenance and adaptation budget request (2026)*

Item	Amount (USD million)	Justification from Asset Accounts
Port quay rehabilitation	2.5	Accelerated depreciation and cyclone damage require intervention to prevent further deterioration
Seawall climate adaptation (raising)	4.0	Continue 2025 programme; projected sea level rise of 0.5m by 2050 requires raising 12km seawall by 1.5m
Mangrove expansion and maintenance	0.6	Extend restoration to additional 50 ha; condition monitoring and maintenance for existing 151 ha
Total request	7.1	

¶2 The asset accounts provide the evidence base. Produced infrastructure is depreciating faster than it is being replaced, cyclone damage demonstrates exposure to climate hazards, and mangrove investment has delivered measurable returns.

4. Summary

¶1 Coastal infrastructure accounting integrates produced asset measurement with ecosystem accounting approaches to cover the full range of assets that protect and modify coastal zones.

¶2 Key principles:

1. ¶3

Classification – distinguish produced assets (ports, seawalls, reclaimed land) from ecosystem assets (mangroves, coral reefs, wetlands) whilst recognising functional equivalence in service provision, as summarised in Table 3.2.1

2. ¶4

Valuation – apply perpetual inventory methods to produced assets and net present value of ecosystem services to natural assets, following **TG-1.9 Valuation**

3. ¶5

Integration – account for hybrid systems through clear attribution of produced and ecosystem components, avoiding double counting whilst capturing full asset values

4. ¶6

Adaptation – track climate adaptation investments across grey, green, and hybrid infrastructure with linkages to **TG-2.8 Climate Indicators**

5. ¶7

Cross-references – maintain consistency with related circulars, particularly **TG-6.2 Mangrove and Coastal Wetland Accounting** and **TG-2.9 Disaster Risk**

Cross-Reference Summary

Related Circular	Relevance to TG-6.11
TG-0.1 General Introduction	Prerequisite – foundational concepts
TG-3.1 Asset Accounts	Prerequisite – asset classification and balance sheets
TG-6.2 Mangrove and Coastal Wetland Accounting	Detailed mangrove extent, condition, and service accounting
TG-2.4 Environmental (including Ecosystem) Goods and Services Section 3.10	Valuation methods for ecosystem services and assets
TG-2.9 Disaster Risk	Coastal hazard exposure assessment, vulnerability, and infrastructure protection capacity
TG-2.8 Climate Indicators	Climate-related indicators for adaptation tracking

Related Circular	Relevance to TG-6.11
TG-1.1 National Ocean Budgets	Budget integration and fiscal planning applications
TG-6.9 Offshore Energy	EEZ-located offshore infrastructure beyond the territorial sea
TG-6.10 Maritime Transport and Ports	Port infrastructure classification and dredging

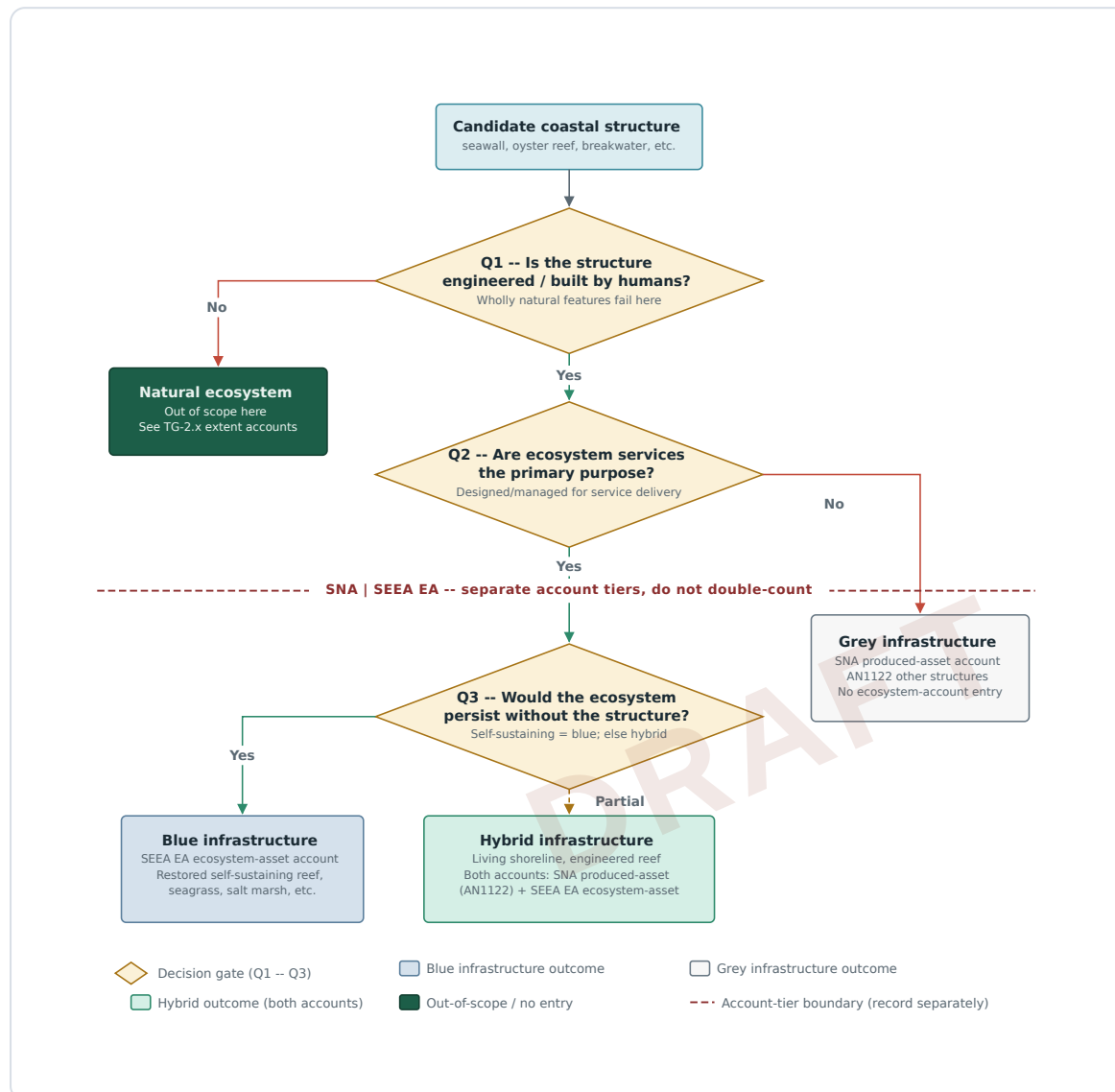


Figure 6.11.1 Three-gate decision tree classifying coastal or offshore structures as natural, grey, blue, or hybrid across SNA and SEEA EA account tiers. Edge colour: green Yes, coral No, ochre-dashed Partial. Dashed double-rule = account-tier boundary (no double-count).

Source: TG-6.11, Section 3.4 (blue-grey integration) and Table 3.2.1 (coastal protection asset classification); SEEA EA (2021), Chapter 5 (ecosystem assets and extent accounts) and Chapter 10 (monetary asset accounts); SNA 2025, Chapter 11, para. 11.85 (AN1122 other structures).

5. Acknowledgements

¶1 **Authors:** [To be confirmed]

¶2 **Reviewers:** [To be confirmed]

6. References

1. ¶1 SEEA Central Framework (2012), Chapter 5, Environmental Assets.
2. ¶2 2025 SNA, Chapter 11, The Capital Account, paragraphs 11.85–11.89 on other structures and land improvements.
3. ¶3 2025 SNA, paragraph 11.85: “Other structures (AN1122) include structures other than buildings, including the cost of the streets, sewer, etc... the construction of sea walls, dykes, flood barriers etc. intended to improve the quality and quantity of land adjacent to them.”
4. ¶4 SEEA EA (2021), Chapter 10, Monetary Asset Accounts, on NPV approach for ecosystem asset valuation.
5. ¶5 2025 SNA, Chapter 35, paragraph 35.3: “Climate change can be considered as one of the major risks affecting current and future wellbeing.”
6. ¶6 This Circular assumes familiarity with ocean accounting boundaries including territorial seas and exclusive economic zones as defined in the United Nations Convention on the Law of the Sea (UNCLOS), Part V.
7. ¶7 SEEA Central Framework (2012), Chapter 5, provides the core asset accounting framework extended in this guidance.
8. ¶8 UNCLOS Article 56 defines the rights, jurisdiction, and duties of coastal States in the EEZ, including sovereign rights for economic exploitation and exploration of natural resources and jurisdiction over artificial islands, installations, and structures. See United Nations (1982), UNCLOS, Article 56. For infrastructure associated with offshore energy operations, see TG-6.9 Offshore Energy; for maritime transport infrastructure in the EEZ, see TG-6.10 Maritime Transport and Ports, Section 3.2.
9. ¶9 CPC Ver.2.1, Class 53262 “dredging services, rock and silt removal and other water-associated construction services.”
0. ¶10 SEEA EEA Technical Recommendations (2022) provides guidance on ecosystem extent measurement.
1. ¶11 Bunting, P. et al. (2018). The Global Mangrove Watch—A New 2010 Global Baseline of Mangrove Extent. *Remote Sensing*, 10(10), 1669. Sentinel-2 and Landsat data are available through the Copernicus Open Access Hub and USGS EarthExplorer respectively.
2. ¶12 Financial data requirements align with government finance statistics and business accounting standards.
3. ¶13 Classification frameworks: SEEA Central Framework (2012), paragraph 5.46 (AN1122); CPC Ver.2.1, Division 53 (Construction services); COFOG groups 04.5 (water transport) and 05.6 (protection of biodiversity and landscape) – see footnote 67 for COFOG classification guidance; Keith, D.A. et al. (2022), A function-based typology for Earth’s ecosystems, *Nature*, 610, 513–518 (IUCN Global Ecosystem Typology).
4. ¶14 2025 SNA, paragraph 11.85. Other structures (AN1122) include “harbour bottoms and harbour channels, breakwaters, quays, piers, jetties, docks, wharves and similar structures.”
5. ¶15 ISIC Rev.4, Division 52 (Warehousing and support activities for transportation).
6. ¶16 Port infrastructure classification aligns with UNCTAD port statistics frameworks.
7. ¶17 SEEA Central Framework (2012), paragraph 4.199.
8. ¶18 OECD (2009). *Measuring Capital: OECD Manual*, 2nd edition, Chapter 6, provides detailed guidance on applying the PIM to infrastructure assets.
9. ¶19 Coastal engineering classification following CIRIA (2007). *The Rock Manual: The Use of Rock in Hydraulic Engineering*, 2nd edition.
0. ¶20 2025 SNA, paragraph 11.87 on major improvements constituting gross fixed capital formation.
1. ¶21 Breakwater and groyne classifications follow coastal engineering standards.
2. ¶22 CPC Ver.2.1, Class 53262.
3. ¶23 Complex assets with multiple components should be depreciated by component where values are material.
4. ¶24 Environment Agency (2018). *Thames Estuary 2100 Plan*; Deltacommissie (2008). *Working Together with Water: A Living Land Builds for its Future*; Consorzio Venezia Nuova (2020). *MOSE: Experimental Electromechanical Module*.
5. ¶25 SEEA Central Framework (2012), paragraph 5.265.
6. ¶26 SEEA EA (2021), Chapter 4, Ecosystem Extent Accounting, for recording conversions.
7. ¶27 SNA 2025, paragraph 11.85 on AN1122 “other structures” (covering sea walls, dykes, flood barriers, and engineered land-improvement works); SNA non-produced asset classifications AN.211 (Land underlying buildings and structures) and AN.212 (Land under cultivation). The two-component recording approach – produced engineered works as GFCF in AN1122 and the resulting land area as a non-produced asset in AN.211/AN.212 once the land begins to function as a productive asset – preserves the SNA produced/non-produced boundary while recognising both the human-made structures and the resulting usable land area. See also TG-3.1 Asset Accounts for general land accounting principles.
8. ¶28 SEEA EA (2021), paragraph 10.23, on ecosystem degradation costs.
9. ¶29 OECD Manual on Measuring Capital (2009) provides detailed PIM guidance.
0. ¶30 2025 SNA, Chapter 7, paragraphs 7.60–7.65, on consumption of fixed capital at opportunity cost. See also SEEA Valuation (2023), paragraph 3.3.
1. ¶31 Service life estimates based on engineering literature and asset management practices. Maintenance cost percentages are indicative and should be calibrated to local conditions. Actual lives depend on design, materials, and environmental conditions. Beach nourishment is typically written off over the renourishment cycle (1–5 years) since placed sand is progressively lost to longshore transport and storm dispersal. Living shoreline engineered components (placed rock, oyster-reef substrate, sills) follow a shorter service life than fully-engineered breakwaters because of

their interaction with biological growth and intentional partial submergence; the associated ecosystem components are recorded under ecosystem accounts rather than as produced assets.

2. ¶32 Asset condition assessment should follow standard infrastructure management protocols.
3. ¶33 Table 3.2.1 draws on SEEA Central Framework (2012) Chapter 5 for produced asset classification and SEEA EA (2021) Chapter 10 for ecosystem asset valuation approaches.
4. ¶34 2025 SNA distinguishes intermediate consumption (current expenditure maintaining capacity) from capital formation (investment extending capacity).
5. ¶35 PIANC guidelines distinguish maintenance from capital dredging.
6. ¶36 SEEA Central Framework (2012), paragraph 3.267.
7. ¶37 NOAA (2015). *Living Shorelines: From Barriers to Opportunities*.
8. ¶38 Living shoreline components classification follows NOAA and coastal management guidance.
9. ¶39 CEPA 2000, Class 6 (Protection of biodiversity and landscapes).
0. ¶40 Hybrid classification requires judgment on primary purpose and asset characteristics.
1. ¶41 Reef protection services are distinct from fisheries and recreation services, avoiding double counting.
2. ¶42 World Bank (2016). *Managing Coasts with Natural Solutions: Guidelines for Measuring and Valuing the Coastal Protection Services of Mangroves and Coral Reefs*.
3. ¶43 SEEA Valuation (2023) recommends avoided damage cost method using expected damage functions where data permit.
4. ¶44 Menendez, P. et al. (2020). The Global Flood Protection Benefits of Mangroves. *Scientific Reports*, 10, 4404.
5. ¶45 Ferrario, F. et al. (2014). The effectiveness of coral reefs for coastal hazard risk reduction and adaptation. *Nature Communications*, 5, 3794. The Allen Coral Atlas provides globally consistent reef mapping at ~5 m resolution.
6. ¶46 SEEA EA (2021), Chapter 10, on ecosystem enhancement and degradation accounting.
7. ¶47 “Building with Nature” and “Engineering with Nature” approaches integrate ecological and engineering objectives. See Waterman, R.E. (2010). *Integrated Coastal Policy via Building with Nature*, The Hague.
8. ¶48 Attribution between produced and ecosystem asset components requires clear documentation.
9. ¶49 This classification approach follows the general SNA principle that assets should be classified according to their primary economic function. Where multiple functions are inseparable, proportional allocation based on capital expenditure provides a practical basis.
0. ¶50 SEEA EA (2021), paragraph 10.15.
1. ¶51 Enhancement activities following SEEA EA classification in paragraph 10.18.
2. ¶52 SEEA EA (2021), paragraph 10.18 distinguishes restoration, rehabilitation, and reclamation.
3. ¶53 SEEA EA (2021), paragraph 10.19.
4. ¶54 SEEA EA (2021), paragraph 4.21.
5. ¶55 Climate-adapted design costs should be fully capitalized as part of asset value.
6. ¶56 SEEA Central Framework (2012), Chapter 5, other changes in volume account entries.
7. ¶57 Adaptation retrofits extending useful life constitute gross fixed capital formation.
8. ¶58 2025 SNA, Chapter 12, on other changes in the volume of assets, provides the general framework for recording unforeseen asset value changes including catastrophic losses. Application to climate-related stranded coastal assets is an area where international guidance is expected to develop further.
9. ¶59 Grey infrastructure adaptation following coastal engineering guidance.
0. ¶60 Terrestrial (green) nature-based solutions for adaptation, consistent with the Section 1 distinction between green (terrestrial NbS) and blue (marine/coastal NbS) infrastructure.
1. ¶61 Marine and coastal (blue) nature-based solutions for adaptation. Mangroves, coastal wetlands, beach nourishment, seagrass, and oyster reef interventions are classified as blue infrastructure under the Section 1 definitions and accounted for through ecosystem extent, condition, and (where applicable) monetary ecosystem asset accounts following SEEA EA.
2. ¶62 Hybrid adaptation approaches combining structural and natural elements.
3. ¶63 FDES (2013), Component 1, Environmental Conditions and Quality.
4. ¶64 G20 Data Gaps Initiative, Third Phase (2022–2025), Recommendation 4 on climate change indicators. TNFD (2023). *Recommendations of the Taskforce on Nature-related Financial Disclosures*, particularly Recommended Disclosure Strategy C on risk management for nature-related dependencies and impacts.
5. ¶65 COFOG Group 05.6 (Protection of biodiversity and landscape) is the standard classification for coastal protection expenditure where the primary purpose is environmental protection (for example, nature reserve buffer works, dune stabilisation, residential seawall protection of community assets), as set out in the COFOG scope note: “Outlays on protection of nature and landscape (species, habitats, erosion protection, coastal protection, dune stabilization...)”. Coastal protection structures that primarily serve transport infrastructure functions (port breakwaters, navigation channel protection) should instead be classified under COFOG Division 04 (Economic affairs), Group 04.5 (Transport), water-transport class. Where a structure serves both functions (for example, a breakwater protecting both a port and a residential coastline), classify by primary purpose and document the secondary function in compilation metadata. Compilers should verify the precise COFOG class codes against the COFOG edition in use (UN 2000 COFOG manual or its IMF GFSM 2014 adaptation), since class-level numbering and any current revisions may differ. See also CEPA/CREMA classifications for environmental protection expenditure (footnote 68).
6. ¶66 CEPA/CREMA classifications for environmental protection and resource management expenditure.

7. ¶67 Integration across expenditure, asset, and ecosystem accounts enables coherent adaptation tracking.
8. ¶68 SNA institutional sector balance sheet coverage includes non-financial assets owned by all institutional sectors (general government, non-financial corporations, financial corporations, households, and NPISH). Coastal protection structures owned by private enterprises and households fall within this scope and should be recorded where material. See also Section 2.1 (Data Requirements) on financial data sources.
9. ¶69 SEEA EA (2021), Chapter 5, paragraphs 5.20–5.32, on ecosystem condition measurement, transparent weighting, and reference-value selection. Weighting schemes used in condition index construction should be transparent, justifiable in terms of the service being valued, and documented in compilation metadata.
0. ¶70 SEEA EA (2021), Chapter 10 (paragraphs in the range 10.30–10.42 cover discount rate selection for monetary ecosystem asset valuation, including the distinction between private market-based and social discount rates and the recommendation to present asset values under alternative discount rate assumptions). World Bank (2016) and indicative rates used in multilateral development bank cost-benefit analyses for natural-capital and infrastructure investments. See TG-1.9 Valuation for national rate selection criteria.
1. ¶71 SEEA EA (2021), Chapter 10, paragraphs in the range 10.35–10.42 on NPV calculation for ecosystem assets, including finite-horizon NPV where there is material uncertainty about asset persistence. The 50-year illustrative figure is provided for comparison; appropriate horizons vary with restoration age, climate risk, and management arrangements.
2. ¶72 For produced assets, “Other Changes” covers catastrophic losses and reclassifications, consistent with the SEEA Central Framework other-changes-in-volume account. For ecosystem assets, this column records “ecosystem conversions” – a distinct SEEA EA concept. Both types of entry are shown here for presentational compactness; compilers should record them in the appropriate sub-account in detailed compilations.

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