Australian Government

National Environmental Information Infrastructure

Conformance Framework v1.0

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Purpose of this document

This document describes the conformance framework for the National Environmental Information Infrastructure (NEII). It adopts the standards defined in the NEII Reference Architecture (Bureau of Meteorology 2014), as well as supporting functions—such as licensing and operational elements—to provide a more detailed overview of what constitutes conformance. The framework aligns with the recently released Australian Government's Environmental Information Group's National Principles for Environmental Information and the Australian Government Public Data Policy Statement. A maturity model approach outlining the various degrees of conformity is used. The framework can assist NEII partners to assess the suitability of their data for the NEII (self-assessment), provide high-level guidance to data owners considering NEII participation (guidance), and to provide an indication of overall NEII programme progress (measuring progress). The framework will be reviewed and the content updated periodically to ensure the information remains current.

1 Introduction

1.1 A National Environmental Information Infrastructure

Governments, industry, the research sector and the community need access to comprehensive, trusted and timely environmental information to inform assessments and decisions about how the development of Australia's natural resources might proceed, and what impact any development and use might have on our environmental assets. However users can find it difficult to discover, access and re-use environmental data because it often only exists within individual organisations or environmental domains (e.g. within atmospheric or marine communities). Furthermore, where data can be found, access can be problematic because (a) data may use agency-specific or domain-specific proprietary file formats, (b) increasing data volumes make data delivery difficult, and (c) data licensing may be restricted. The National Environmental Information Infrastructure (NEII) is an initiative to improve discovery, access and re-use of environmental information thereby increasing the value of this significant investment beyond its initial purpose.

1.2 Why is a Conformance Framework necessary?

The NEII Reference Architecture (Bureau of Meteorology 2014) was developed in 2014 to provide a comprehensive description of core standards and components that will be jointly developed to create a distributed environmental information system for Australia. It provides a high-level technical description of a system that improves discovery, access and re-use of national environmental information.

Feedback post the release of the Reference Architecture indicated that stakeholders sought further specificity regarding application of the Reference Architecture and related data policy directions such as the National Principles for Environmental Information and Australian Government Public Data Policy Statement. The NEII Conformance Framework (herein referred to as the framework) has been developed to address this need using a capability maturity model approach. The framework sits within a suite of documents (Figure 1) that describe the NEII and will help guide partners on how to participate.

Neither the Reference Architecture nor the framework mandate specific deployments or provider configurations. These will be determined by individual organisation constraints and preferences and would ultimately take the form of organisation specific technical guides.

Reference Architecture > Conformance Framework > Technical Guides

Figure 1 NEII document suite (technical guides remain organisation specific)

1.3 How to use this framework

To make conformance easier, it should be divided into manageable and meaningful parts using a capability-maturity model that contains distinct elements based on the NEII Reference Architecture. The framework provides a more detailed overview of what is required to be considered NEII conformant (primarily in regard to deploying web data services) with a 'checklist' of requirements presented in tabular form (Appendix A and B). The framework can be used as follows:

- **Self-assessment**: to enable data owners who are already delivering data through web data services to self-assess the data's possible contribution to the NEII (self-assessment)

- **Providing guidance**: provide guidance to data owners who are starting to develop and deploy environmental data through NEII standards—the maturity model, which defines the generic functional and non-functional requirements, and accompanying detailed descriptions for each maturity level provide expectations that can be used, for example, to guide ICT development, licensing requirements and metadata approaches

- **Measuring progress:** as an agreed and common measurement system to assess overall NEII progress—data custodians can periodically self-assess their NEII node conformance, and communicate this to users and the NEII programme to provide a whole-of-system overview of maturity.

2 The framework

2.1 Aligning with the NEII Reference Architecture

This framework expands on the NEII Reference Architecture (Bureau of Meteorology 2014), which uses the Reference Model for Open Distributed Processing (RM-ODP) to guide how information and computational components are integrated to produce robust and sustainable NEII nodes. RM-ODP factors a federated system description into five complementary viewpoints:

- **Enterprise** defines the purpose, scope and policies of the system, and can describe the business processes and how to meet them

- **Information** describes the semantics of information and information processing within the system, and can describe the structure and content type of data

- **Computational** decomposition of data and information into operation, behaviour, flow and interaction

- **Engineering** describes the system infrastructure and mechanisms supporting data federation

- **Technology** focuses on the technology choices selected to realise the system.

Table 1 Overview of NEII Reference Architecture RM-ODP viewpoints showing high-level content. Content in grey is addressed in this version of the framework.

NEII Reference Architecture viewpoints *				
Enterprise	Information	Computational	Engineering	Technology (example technologies only)
National Principles for Environmental Information, Australian Government Public Data Policy Statement, OAIC Principles, FSDF (ANZLIC)	Dataset and service metadata	CSW	Catalogue	GeoNetwork
	Environmental observations	WFS, SOS	Services	GeoServer, Postgres, 52 North SOS
	Information models	SISSVoc	—	—
	Environmental parameters and observables	SISSVoc	Vocabulary	SISSVoc
	Monitoring sites	WFS, WMS	Monitoring Sites Register	GeoServer, Postgres
	Gridded data	WMS, WCS	Services	THREDDS
	Geographies	WFS, WMS	Services	GeoServer, Postgres
	Observing methods	SISSVoc	Observing Methods Register	SISSVoc

*Acronyms are defined in Appendix D

Table 1 provides a high-level overview of the NEII Reference Architecture using these RM-ODP viewpoints. This framework unpacks the Information and Computational viewpoints, and, for release 1.0 only a subset of information types detailed in the reference architecture (dataset and service metadata, gridded data and geographies). The enterprise viewpoint provides context for each NEII node.

2.1.1 What is an NEII node in the context of this framework?

An NEII node consists of the physical data and information, implemented technology or domain content, or a collection of these, that provides discovery, access and re-use of environmental data using NEII standards. Note that the specifics of how each node is engineered, and the supporting technologies employed, are a matter for the implementing organisation, and thus not explicitly within the scope of this framework. The worked example of the framework provided at Section 3 describes the Australian Hydrologic Geospatial Fabric NEII node from the perspective of the Enterprise, Computational and Information viewpoints. Appendix C provides an example conformance assessment for gridded data.

2.2 Conformance principles

The NEII conformance framework aligns with the Australian Government's Environmental Information Group's National Principles for Environmental Information and the recently released Australian Government Public Data Policy Statement. Specific NEII Conformance Framework principles include the following:

- Environmental data are made publically available through machine-readable web data services (Published online).
- Structured metadata will support any NEII data release (Well described).
- Providers will make their data available through under an open licence.
- Data are provided with support structures that provide enduring operational support to users
- Data are defined consistently, and definitions are available to users to support re-use (Governed and managed).

The first principle is mandatory and in the absence of the availability of environmental data through web data services NEII conformance is not possible at any level of maturity.

2.3 The maturity model

The conformance framework adopts a maturity model approach to describe the steady improvement required for NEII nodes to progress from a basic data release (experimental data service with limited operational support) to an operationally robust federated system providing environmental information to multiple application.

The design of the model is informed by other maturity-based approaches for open data such as the Open Data Institute's certification approach (Open Data Institute 2015). Table 2 shows the maturity model structured around elements including discovery, initial information type (metadata, geographies, gridded data) and operational elements that are critical to support re-use (licensing, operational, information). Appendix A provides further detail for each of the levels in the model against individual elements (for example, discovery, geographies, gridded data, licensing). Implementation at each maturity level implies the preceding level has been achieved, noting that for some business requirements a relatively low maturity level may be sufficient. The maturity model is organised around NEII's discovery, access and re-use paradigm, which is described in further detail below. Further iterations of the framework will address other information types such as monitoring sites, vocabularies and environmental observations.

2.3.1 Discovery

The discovery element of the maturity model focuses on providing standards-based metadata to describe information resources in the NEII (for example, geographies, gridded data, observations). Metadata describe an information resource according to standard characteristics, such as its title, abstract, lineage, access and data availability and the custodian information. Web-based catalogues are useful for discovering data. Subject domains have developed their own metadata schemas, including:

- foundation schemas, such as Dublin Core

- schemas for describing geographic information and services, including ISO 19115;

- various domain or community profiles, such as the Marine Community Profile or the Ecological Metadata Language for ecological applications.

Where multiple catalogues are available within an infrastructure, they might also be configured to federate and harvest metadata from one another. Configuration of metadata catalogues to both harvest and federate would occur in mature nodes.

2.3.2 Access

The access element of the framework focuses on delivering environmental information through web data services. Beyond data discovery, most users need access to environmental data directly. Web data services enable software applications and users to access data in federated environments. Through the adoption of standards (for example, those developed by the Open Geospatial Consortium), an NEII node provides web data service access to key environmental data, including:

- geographic features, such as hydrological catchment boundaries, roads, administrative boundaries

- environmental observations, such as time-series data of rainfall observations at a site; and

- gridded data, such as satellite imagery, digital elevation models.

Access is needed to support analysis, interpretation and the modelling requirements of the user, or by making it available to other software applications.

2.3.3 Re-use

The re-use element of the maturity model is essential to providing value beyond the intended purpose of the data. It includes:

- licensing

- operational robustness and support

- information elements, or the amount of formalism in the data

- adherence to open standards is a key enabler of interoperability.

From a licensing perspective, open access licensing frameworks are desirable to maximising re-use and minimising the transaction cost to both users and providers. The conformance framework aligns with the principles championed by the Australian Government Open Access and Licencing Framework (AusGOAL) and the Australian Government Principles on Open Public Sector Information (2015). This relates specifically to the recommended use of Creative Commons licencing. The operational element is a

defining element of the NEII, and emphasises data delivery through operational infrastructure where data are managed at-source. It addresses both technical and support aspects, such as: the extent of testing and quality assurance in place to support a web data service; whether a support team is available to users; and the extent of user documentation supporting adoption.

The information element aligns with the information modelling component detailed in the NEII Reference Architecture (page 17), which provides users information about the logical structure and semantic content of data to make them more useful beyond their intended purpose. In essence the information element explains how much explicit formalism is provided around the structure of data, and is addressed in further detail in the NEII Information Modelling Discussion Paper (Bureau of Meteorology 2015).

Table 2 Conformance maturity model *

	Discovery	Access**			Re-use		
		Metadata	Geographies	Gridded Data	Licensing	Operational	Information
Entry	Data details are available online	Basic interface deployment (for example, CSW)	Basic interface deployment (for example, WMS, WFS)	Basic graphic rendering (for example, WMS)	Restricted – agency specific	Data services experimental; no data support function in place	Information is unstructured
Base	Metadata are structured according to a standard (e.g. ISO19115, Dublin Core) and are available online	Mandatory interface deployment	Partial mandatory interface deployment	*To be confirmed as the NEII Reference Architecture is iteratively implemented and tested*	Open – agency specific	Data services operational; data and data service documentation exists describing method of data creation	Information is structured
Foundation	Metadata are visible through one standards-based metadata catalogue (centralised)	Basic deployment for discovery and publication	Complete mandatory interface deployment		Open–Creative Commons	Data documentation exists describing method of data creation; services considered operational (test, scalable, redundancy in place)	Information has basic governance
Advanced	Metadata records are visible through multiple catalogues (federated)	Complete deployment for discovery, publication and harvesting	Partial optional interface deployment			Data support function in place; explicit service or operating level agreements exist	Information can be directly traced to business requirements
Mature	Domain independent discovery (e.g. Google search)	Complete deployment for discovery, publication, harvesting and remote update	Complete interface deployment			Tools in place to monitor data service reliability	Information process is thoroughly governed

* Acronyms are detailed in Appendix D
** One assessment cannot be completed for both gridded data and a geography as these are different information types as defined in the NEII Reference Architecture.

3 Worked example

The Bureau of Meteorology has released the Australian Hydrologic Geospatial Fabric as operational NEII web data services. The following provides an example of the application of the framework for the Geofabric NEII services.

3.1 Australian Hydrologic Geospatial Fabric (Geofabric)

The Geofabric is a digital database of surface and groundwater features, which registers the spatial relationship between important hydrologic features. It comprises six product datasets (Figure 2):

- hydrology reporting regions
- hydrology reporting catchments
- surface catchments
- surface blue-line network
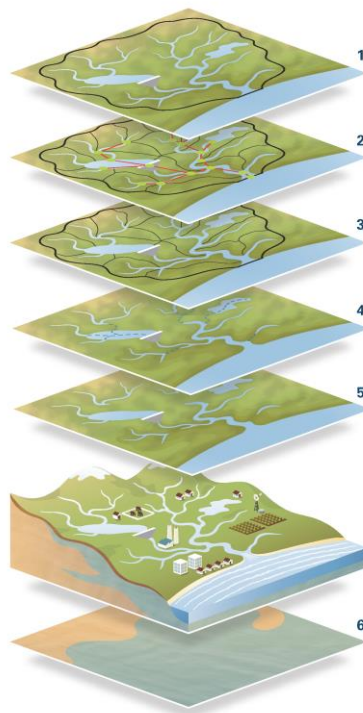- surface cartography
- groundwater cartography.

Figure 2 Australian Hydrologic Geospatial Fabric product datasets

3.2 Geofabric—enterprise viewpoint

The Geofabric (for example surface catchments, surface networks data products) are available as simple web services through a Web Map Services and Web Feature Service on operational-grade Bureau of Meteorology infrastructure. The collation of Geofabric information follows a formal and informal process from data creation, aggregation to public delivery. Figure 3 presents the current relationships in the Geofabric enterprise viewpoint to provide context for the worked example. Relationships include:

1. a collaboration between the Bureau of Meteorology, and Geoscience Australia, through a formal agreement with milestones and governance arrangements

2. an organisational relationship, whereby the NEII programme in the Bureau of Meteorology has requested that the publication of Geofabric products as NEII data services becomes an operational product and service

3. the deployment process, whereby the Bureau of Meteorology Information Systems and Services Division formally takes ownership of the system to deliver Geofabric data services as a service provider

4. a formal responsibility by the NEII Geofabric system owner delivering operational data services

5. an informal relationship with any consumer of Geofabric NEII services, as the service can be used by any capable technology, and is not restricted, apart from the scalability of the infrastructure

6. an informal relationship for specialist consumers, through the availability of data, tools and user support—use of the data and client information is captured to support continual improvement.
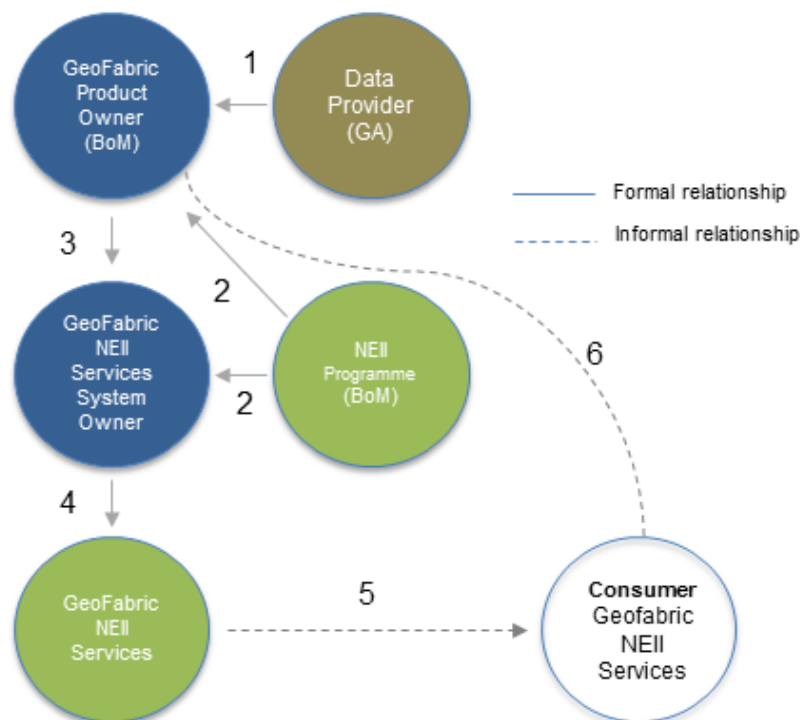

Figure 3 Enterprise viewpoint for Geofabric NEII services

3.3 Geofabric maturity assessment

Table 3 Geofabric NEII node—maturity assessment

Name	**Australian Hydrologic Geospatial Fabric**
Abstract	The Geofabric is a digital database of surface and groundwater features that registers the spatial relationship between important hydrologic features. It comprises six product datasets: hydrology reporting regions; hydrology reporting catchments; surface catchments; surface network; surface cartography; and groundwater cartography. The Geofabric has been developed by the Bureau of Meteorology and Geoscience Australia.
Custodian	Bureau of Meteorology
Resource	www.neii.gov.au\services\geofabric

	Element	Maturity	Description
Discovery	Discovery	Advanced	Geofabric structured metadata is discoverable through the Bureau of Meteorology NEII catalogue search interface at www.neii.gov.au\catalogue. Metadata records are available at a collection and data series level for both content and end point capability through NEII Reference Architecture defined standards. Data and services can also be found at data.gov.au.
Access	Metadata	Advanced	NEII Catalogue Service for the Web endpoint is publicly available, and provides additional paths for data and service discovery that includes machine-readable/programmatic access. Metadata services can be obtained through GET requests only via Catalogue Service for the Web. Automated harvest is one way *from* the NEII instance *to* external catalogues (for example find.gov.au).
	Geographies	Advanced	Geofabric feature-types are available as both Web Feature Services and Web Map Services. All mandatory Web Map Services interfaces are available for machine-to-machine operation. Partial Web Feature Services interfaces are available.
	Gridded data	NA	NA
Re-Use	Licensing	Mature	Data are available under a Creative Commons Attribution licence
	Operational	Advanced	Geofabric NEII services are available on Bureau of Meteorology operational infrastructure . This includes formal operating level-agreements. Use of the data services are logged. User support is in place to NEII data service users through system owner (ISS existing escalation processes) and Geofabric team. Formal testing and deployment have been done before data services were released.
	Information	Advanced	Geofabric product is governed through formal mechanisms between the Bureau and Geoscience Australia, and Geofabric has an explicit information model. The governance of the content and formal management of the update process, including version redundancy, strengthens this product. Vocabularies have been established.
Date	1/11/15	**Contact/assessor**	

4 Monitoring and control

This Conformance Framework will be reviewed annually, and initial reporting on conformance levels and the number of assessments will be reported through the NEII Reference Group. Updates and revisions will also occur in response to recommendations emerging from meetings of the NEII Reference Group and updates to the NEII Reference Architecture. These will include outcomes from Bureau and partner agency contributions to the NEII.

5 Acknowledgments

The NEII Conformance Framework was developed through the support of the NEII Reference Group and the efforts of the NEII Conformance Working Group. We are grateful to the members of the Working Group for their input into the design and refinement of the framework and for validation of the approach against their organisational implementations.

6 References

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Appendix A Element details

Table 4 Discovery: description of maturity levels

	Description	Detailed description
Entry	Data details are available online	Directory or web page can be used to obtain data details for NEII products available from the organisation (e.g. HTML page, PDF document etc.)
Base	Data details are structured according to a metadata standard (e.g. ISO19115, Dublin Core) and are available online	No capability to interact with the data details other than through the presented interface (e.g. HTML page, PDF document)
Foundation	Metadata are visible through one standards-based metadata catalogue (centralised)	Structured metadata are available through catalogue infrastructure
Advanced	Metadata records are visible through multiple catalogues (federated)	More than a single human interface is available for a user to discover available NEII data and services; data and services can also be discovered at data.gov.au
Mature	Domain independent discovery (e.g. Google search)	Discovery of data and services possible through multiple portals and aggregators, as the data details are consistently harvested and propagated through other systems

Table 5 Access: Metadata (services)—description of maturity levels

	Description	Detailed description
Entry	Basic interface deployment (for example CSW)	Single endpoint URL for Catalogue Service for the Web interaction deployed; some mandatory methods or optional methods; GetCapabilities response does not reflect deployed solution
Base	Mandatory interface deployment	Deployment solution only caters for discovery of data and services from NEII node; all mandatory methods are implemented
Foundation	Basic deployment for discovery and publication.	Deployment provides user with an ability to use GET requests only to search and harvest metadata records through asynchronous capability
Advanced	Complete deployment for discovery, publication and harvesting.	Partial optional interface deployment
Mature	Complete deployment for discovery, publication, harvesting and remote update.	Complete interface deployment

Table 6 Access: Geographies—description of maturity levels

	Description	Detailed description
Entry	Basic interface deployment.	Single point URL for Web Map Services/Web Feature Services interaction deployed; incomplete mandatory methods or optional methods; GetCapabilities response does not reflect deployed solution
Base	Partial mandatory interface deployment	Minimal interfaces; some mandatory methods deployed; reliance on external computational interface capability; no control of external computation implementation or standards conformance; GetCapabilites response accurately reflects deployed capability
Foundation	Complete mandatory interface deployment	Where applicable, all mandatory methods for all interfaces deployed; availability of optional methods can be determined through mandatory GetCapabilities method
Advanced	Partial optional interface deployment	All mandatory and some optional methods for each interface deployed; all mandatory and some optional parameters implemented
Mature	Complete interface deployment	All mandatory and optional methods and parameters implemented; verified using CITE tests that make use of publicly available open source solutions; components individually implemented and functioning as autonomous capability for the data/information being delivered

Table 7 Access: Gridded data —description of maturity levels

	Description	Detailed description
Entry	Basic graphic rendering of data	Basic visualisation of data; data can be displayed in Open Geospatial Consortium compliant web applications, mapping software or developed clients
Base	Basic Web Map Services deployment with client interaction	Implements basic Web Map Services to enable query/identification of pixel values; possible user defined rendering
Foundation	Basic Web Map Services deployment with access to primary data (ability to download data)	Implements a 'clip, zip, ship' model of data supply; enables user to select an area of interest to supply the raw data in a pre-determined format (such as netCDF)
Advanced	Basic deployment of Web Coverage Service*	Dynamic access to gridded data structures through standards based messaging protocols
Mature	TBC	TBC

*Web Coverage Service is still an emerging standard that tends to be implemented differently within community domains.

Table 8 Re-use: Licensing elements—description of maturity levels

	Description	Detailed description
Entry	Restricted	Data are available publically but under a restricted licence that requires negotiation with the data owner
Base	Open – Agency specific	Open licence but with specified conditions unique to the organisation/entity providing the data. Examples include TERN-BY (http://tern.org.au/datalicence), Public Access Licence (PAL); and CSIROs licence for the Data Access Portal (https://data.csiro.au/dap/legal)
Mature	Open – Creative Commons	Creative Commons By Attribution (CC-BY) licence based on AusGOAL framework. Should include clear attribution statement. Provides permission in advance to make use of data without requiring contact with the supplier of that information

Table 9 Re-use: Operational elements—description of maturity levels

	Description	Detailed description
Entry	Data services considered experimental (untested); no data support function in place	Limited or no user support tools or processes around data services; heavy reliance on subject matter expertise of individuals creating critical failure points
Base	Data/service documentation describing method of creation; services might have an operational capacity	Some user support tools available and processes repeatable for data services; some redundancy built into potential failure points
Foundation	Data documentation describing method of data creation; Services considered operational (test, scalable, redundancy in place)	User support tools such as guides, training and escalation services in place; workflows well understood and documented
Advanced	Data support function in place; explicit service or operating level agreements exist	Information about the quality and accuracy and change frequency readily available; ability to subscribe to the information and updates
Mature	Tools in place to monitor data service reliability	Service monitoring is active (not reactive); system able to dynamically scale in line with demand and community domain expectation; captured are periodically / systematically reviewed and appropriate system adjustments implemented

Table 10 Re-use: Information modelling—description of maturity levels

	Description	Detailed description
Entry	Information is unstructured	No level of implied structure, rigour or governance; generated as a simple snapshot of a business dataset; not considered a repeatable process
Base	Information is structured	Information has some level of structure, some of which has logical semantic understanding
Foundation	Information has basic governance	A formal information modelling process has been completed with some alignment with vocabularies/ontologies outside the project; implies a level of governance of the information and at least one other functions of formal data management completed
Advanced	Information can be directly traced to business requirements	Established business benefit to the producer releasing their information separately from NEII in other domains; information structured in a way that can be easily re-purposed
Mature	Information process is thoroughly governed	Available online in technology neutral format; formal governance, persistent resolvable identifiers, product approval and release, decisions traceability mappable to reference frameworks, such as Government Architecture Information Principles or DAMA-DMBOK Information Architecture functions

Appendix B Self-Assessment template

Using the tables in Appendix A to identify the relevant maturity level of each element, complete the table below against your NEII conformant service.

Name	**\<insert product name\>**
Abstract	\<a summary of the data product\>
Custodian	\<organisation with custodial responsibilities for the product\>
Resource	\<URL showing location of the NEII services, for either metadata, geographies etc.\>

	Element	Maturity	Description
Discovery	Discovery	Entry	
Access	Metadata	Base	
	Geographies	Foundation	
	Gridded data	Advanced	
Re-Use	Licensing	Mature	
	Operational	Mature	
	Information	Mature	

Date	\<d/m/y\>	**Contact/assessor**	\<insert name contact\>

Appendix C eReefs Marine Water Quality system data services

The Bureau of Meteorology has recently publicly released the gridded data supporting the eReefs Marine Water Quality system as operational NEII web data services. The following provides an example of the application of the framework for eReefs Marine Water Quality Data Services.

eReefs Marine Water Quality system

The eReefs Marine Water Quality Dashboard produces estimates of water quality indices within the optically complex and shallow waters typical of the Great Barrier Reef. The system uses space-based observations from the MODerate resolution Imaging Spectrometer (MODIS) on board the NASA Aqua satellite. These observations are processed using NASA's SeaWIFS Data Analysis System (SeaDAS) and a CSIRO-developed ocean colour data processing package to produce the Marine Water Quality Indices. Daily maps of each index are calculated, along with differences to a climatology calculated from the past 10 years of indices and each compared with annual and seasonal (wet/dry) threshold values, which are derived from the water quality guidelines for the Great Barrier Reef published by the Great Barrier Reef Marine Park Authority (GBRMPA 2010). The Marine Water Quality Dashboard is available at http://www.bom.gov.au/marinewaterquality/ and is shown in Figure 4 in concept.
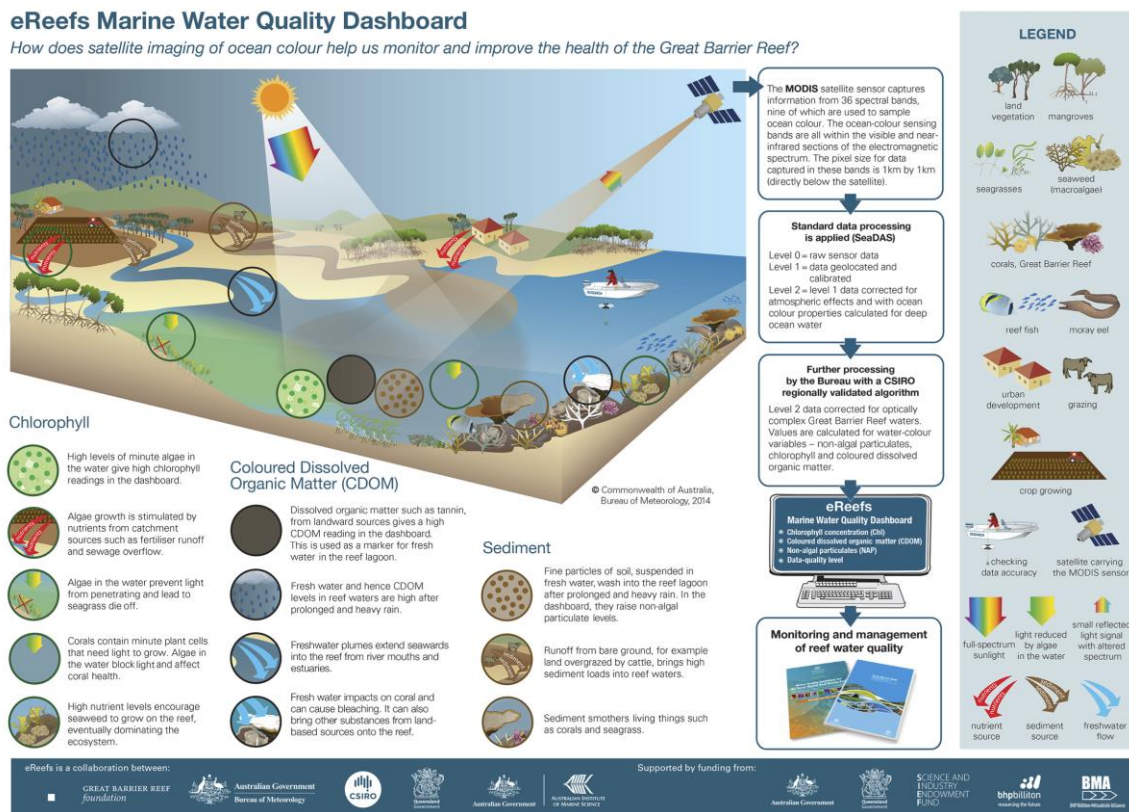

Figure 4 eReefs Marine Water Quality system

eReefs Marine Water Quality System – Enterprise Viewpoint

The eReefs Marine Water Quality system and data services are available via a Website/Dashboard and as simple web services adhering to Open Geospatial Consortium (OGC) standards using OpenDAP and THREDDS on operational-grade Bureau of Meteorology infrastructure. The collation of eReefs Marine Water Quality information follows a formal and informal process from data creation, aggregation to public delivery. Figure 5 diagrammatically presents the current relationships in the eReefs Marine Water Quality enterprise viewpoint to provide context for the worked example. Relationships include the following:

1. The Bureau of Meteorology Observations & Infrastructure Division (O&I) receives raw satellite data imagery from NASA (MODIS sensor and aqua satellite). This is calibrated and has the geolocation of each pixel calculated (Level 0 to Level 2) using SeaDAS.

2. The Bureau of Meteorology National Operations Centre (BNOC) processes the Level 2 data in the ocean colour processing package. This is used to remove the effect of the atmosphere to recover the spectrum of light leaving the water. Then an adaptive Linear Matrix Inversion (LMI) is used to calculate the concentrations of the water quality. Multiple satellite passes are combined to form a composite file relevant to the Great Barrier Reef.

3. Composite maps and regional summary files are calculated for analysis and display in the eReefs Marine Water Quality Dashboard and data services. These are provided to the Bureau of Meteorology Information Systems and Services (ISS) Division. ISS formally takes ownership of the system to deliver eReefs Marine Water Quality Dashboard and data services to then become the service provider.

4. Improvements to the eReefs Marine Water Quality algorithms involves collaboration between the Bureau of Meteorology and CSIRO. This involves a formal agreement through the eReefs project containing milestones and formal governance arrangements.

5. Organisational relationship whereby the Marine Environmental Information Services Section and the NEII programme within the Bureau has requested that the publication of eReefs Marine Water Quality products as NEII data services becomes an operational product and service.

6. An informal relationship with any consumer of eReefs NEII services, as the service can be used by any capable technology, and is not restricted, apart from the scalability of the infrastructure.

7. An informal relationship for specialist consumers, through the availability of data, tools and user support—use of the data and client information is captured to support continual improvement

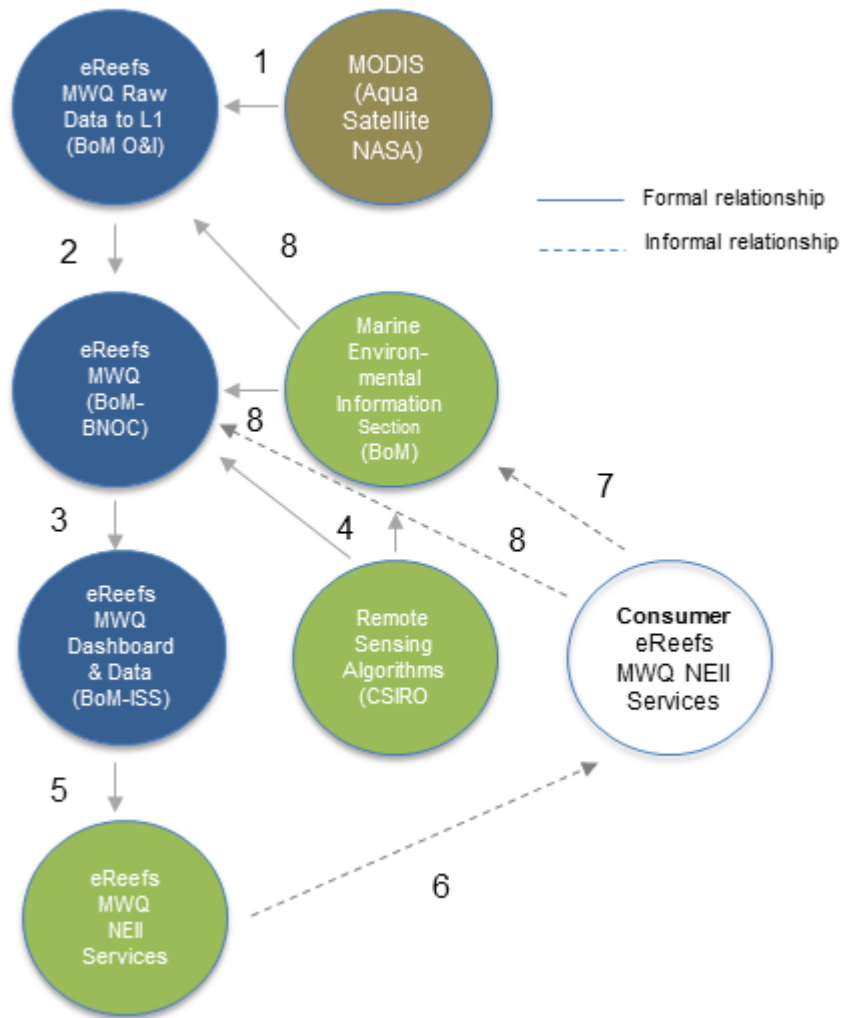8. An informal relationship between any consumer of NEII services and the team in BNOC.

Figure 5 Enterprise viewpoint for eReefs Marine Water Quality services

eReefs Marine Water Quality System Maturity Assessment

Table 11 eReefs Marine Water Quality System NEII node–maturity assessment

Name	**eReefs Marine Water Quality System**
Abstract	The eReefs Marine Water Quality Dashboard produces estimates of water quality indices within the optically complex and shallow waters typical of the Great Barrier Reef. The system uses space-based observations from the MODerate resolution Imaging Spectrometer (MODIS) on board the NASA Aqua satellite.
Custodian	Bureau of Meteorology
Resource	http://www.bom.gov.au/environment/activities/mwqd/index.shtml

	Element	Maturity	Description
Discovery	Discovery	Advanced	eReefs Marine Water Quality System structured metadata is discoverable through the Bureau of Meteorology operational THREDDS service http://ereeftds.bom.gov.au/ereefs/tds/catalog.html and through the Bureau of Meteorology NEII Catalogue search interface visible at www.neii.gov.au\catalogue. Metadata are available at data.gov.au.
Access	Metadata	Advanced	eReefs Marine Water Quality System Catalogue Service for the Web (CSW) endpoint is publically visible and provides additional paths for data and service discovery that includes programmatic access. Metadata services are harvestable through GET requests only via Catalogue Service for the Web (CSW).
	Geographies	NA	NA
	Gridded data	Advanced	The eReefs Marine Water Quality Dashboard and Data Products are available as web services using OpenDAP and THREDDS
Re-Use	Licensing	Mature	Data are available under a CC-BY licence
	Operational	Mature	eReefs Marine Water Quality services are available on Bureau Category 3 infrastructure. This includes formal operating level-agreements. User support is available through the Bureau National Operations Centre (BNOC).Information on the operational implementation can be found in the BNOC Operations Bulletin # 104. Technical references are available here.
	Information	Mature	The eReefs Marine Water Quality product is governed through formal mechanisms across the eReefs project. The eReefs project (Bureau, CSIRO, AIMS, the Queensland Government and the Great Barrier Reef Foundation) provided the formal governance to develop the eReefs Marine Water Quality Dashboard and Data Service.
	Date	1/11/15	**Contact/assessor**

Appendix D Key terms

Term	Description
architecture	a formal description of a system which may include structure and relationship of components, and principles or guidelines governing their design
AusGOAL	Australian Governments Open Access and Licensing Framework
Australian Hydrological Geospatial Fabric	a dataset published by the Bureau of Meteorology containing hydrological domain features such as rivers, water bodies, aquifers, and monitoring points
component	a discrete encapsulation of functionality within a specific deployed system or on a technology element
computational viewpoint	an architecture viewpoint describing a system based on functional interfaces
conformance	An objective to achieve likeness and interconnectedness in form, model or understanding.
Creative Commons Attribution (CC-BY)	a set of standardised copyright licences for granting permission to use and access data and other works to: share—copy and redistribute the material in any medium or format; adapt—remix, transform and build upon the material for any purpose, even commercially
CSW	catalogue service for the web
data access	the process of querying and retrieving data through machine interfaces for automated processing, visualisation, integration, etc.
data discovery	the process of identifying machine-accessible fit-for-purpose datasets through a search process
dataset	an identifiable collection of data
discovery metadata	metadata describing essential aspects of a dataset or service, to help discovery through search; usually conforming to ISO 19115
engineering viewpoint	an architecture viewpoint focusing on the system infrastructure and federated deployment architecture
enterprise viewpoint	an architecture viewpoint focusing on the purpose, scope, and policies of a system
environmental geography	a geographic domain feature providing context to environmental observations (such as catchment, bioregion, habitat)

Term	Description
feature	an abstraction of a real-world phenomenon—usually a type of domain feature, or a specific instance
federated	of an information platform, where the components are deployed at multiple geographic locations and on different computational nodes
federation	logical or physical aggregation of (meta) data harvested from multiple federated data providers
Geofabric	see Australian Hydrological Geospatial Fabric
gridded data	data discretised over a raster grid (for example, remote-sensed imagery or numerical simulation output)
harvest	retrieval and duplication of dataset metadata records from a remote metadata catalogue for the purpose of federation
information model	a formalised description of the logical structure and semantics of one or more information classes and their relationships; may be controlled by a domain authority
information viewpoint	an architecture viewpoint focusing on the semantics of information and information processing within the system
interoperability	the ability of two or more systems or components to exchange information and to use the information that has been exchanged
ISO	International Organisation for Standardisation
linear matrix inversion	Computer solution for linear algebraic systems
machine-readable	a digital format suitable for automated software interpretation and processing
metadata	contextual information about data; may refer to discovery metadata, service metadata, operation metadata, or site metadata
metadata catalogue	a component providing a searchable repository for metadata records
metadata record	a discrete metadata description, applied to a single dataset, site, service, etc.
MODIS	Moderate resolution imaging spectroradiometer - NASA's sensor on the aqua satellite
Open Geospatial Consortium	an international industry consortium of 471 companies, government agencies and universities participating in a consensus process to develop publicly available interface standards
publish	to provide access to datasets or metadata by configuring

Term	Description
	infrastructure components
reference architecture	an architecture that describes generic, rather than a specific deployed, configuration of components
reference implementation	a software implementation of a specification, providing a benchmark for other implementations
RM-ODP	Reference Model for Open Distributed Processing (ISO/IEC 10746)
service	an electronic, network-accessible system providing access to defined operations
SISSVoc	'spatial information services stack' SISS Vocabulary Service defines a standard interface through which standard vocabularies can be provided to web users
SOS	sensor observation service
standards	agreed technical specifications developed by a standards body for any aspect of an information system; key standards bodies include ISO, OGC, W3C, and OASIS
Technology viewpoint	an architecture viewpoint focusing on technology choices to realise a system
time-series	an environmental observation type consisting of a sequence of measurements of the same environmental parameter at successive points in time
user interface	a component facilitating interaction between a user and a system
vocabulary	a set of defined terms or concepts controlled by a domain authority
WFS	web feature service
WMS	web mapping service