National Environmental Monitoring Standards

National Quality Code Schema

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Change register

Version Number	Revision Date	Section	Topic	Revision Summary
1.0	June 2013			Initial release
2.0	July 2016			
3.0	March 2024			
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3.0.1	April 2026	Section 4	Table 1	Corrections to the QC 0 colour name, hex and CMYK
		System Integration	Para.1	The word “maximum” changed to “minimum”
		Supplementary Quality Codes (Child Coding)	Table 2.	Changes to Child Code numbers and Child Summary columns

Table of Contents

The National Environmental Monitoring Standards

The National Environmental Monitoring Standards (NEMS), and associated codes of practice, Glossary, and National Quality Code Schema can be found at www.nems.org.nz.

Development

The strategy that led to the development of these Standards and associated documents was established by Jeff Watson (Chair) and Rob Christie (Project Director) of the initial NEMS Steering Group, in 2014.

The NEMS initiative is supported by the Environmental Data Special Interest Group (ED SIG) (formerly the Local Authority Environmental Monitoring Group (LAEMG)), who contribute members to the NEMS Steering Group.

Implementation of the strategy is overseen by the NEMS Steering Group, which currently comprises Glenn Ellery (Chair), Raelene Mercer (Project Manager). Jeff Watson (Technical Advisor), Phillip Downes, Rachel Herbert, Jon Marks, Charles Pearson, Jochen Schmidt, Michael Ede, Dan Elder, Abi Loughnan and Sonja Miller.

The NEMS Steering Group directs preparation of NEMS documents on authority from the Chief Executives of the regional and unitary councils and the Ministry for the Environment (MfE).

The development of these documents involves consultation, as appropriate, with regional and unitary councils across New Zealand, major electricity generation industry representatives, research institutes, and organisations providing supporting services such as laboratory processing. These agencies together are responsible for the majority of environmental monitoring in New Zealand. In addition, the Ministry for the Environment and StatsNZ may also be consulted as primary funders and the agency's responsible for national reporting.

Implementation

Stationarity

NEMS Standards are intended for long-term monitoring programmes. Stationarity of record, whereby changes to methods and instruments do not introduce bias over the lifetime of the record, is an essential property (see also NEMS *Glossary*), without which a record cannot be confidently analysed for temporal trends.

Because the methods of collecting and processing environmental data do change over time, the Standards include provisions for identifying and mitigating potential loss of stationarity.

Data fit for purpose

To facilitate data sharing, the NEMS Steering Group recommend that NEMS Standards are adopted throughout New Zealand and all data collected be processed and quality coded in accordance with the methodologies described in the Standards.

The quality code is determined from the Standard adopted and applied at the time of data acquisition. The degree of rigour with which requirements of the Standards are applied may depend on the quality of data sought. The highest quality code (QC 600) may be assigned to data that meet the stated requirements for good data.

Data of lesser quality are accommodated but are assigned a lower quality code (i.e. less than QC 600). They may be fit for the current intended monitoring purpose but restricted in their use for a range of other current and future purposes.

Measured data coded as QC 500 (fair), or QC 400 (compromised) may be the best practicably achievable due to site limitations and/or transient lapses in data quality.

Health and safety

When implementing the Standards, current legislation relating to health and safety in New Zealand and subsequent amendments shall be complied with.

NEMS Codes of Practice (COP) provide additional guidance on health and safety issues and structural design. Use only the most recent published version of any NEMS COP.

Limitations

It is assumed that, as a minimum, the reader of these documents has an understanding of environmental monitoring and data processing techniques, and some competency in their application.

The documents do not relieve the user (or a person on whose behalf they are used) of any obligation or duty that might arise under any legislation, and any regulations and rules under those Acts, covering the activities to which these documents have been or are to be applied.

Instructions for manufacturer-specific instrumentation and methodologies are not included in NEMS documents.

The information contained in NEMS documents relies upon material and data derived from a number of third-party sources. It is provided voluntarily and for information purposes only.

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Funding

Core funding of the NEMS project at the time that this document was developed was provided by the Ministry for the Environment with in-kind contributions from New Zealand regional councils and unitary authorities.

A full list of those who have contributed funding and time to the NEMS project is available at www.nems.org.

Review

This document will be assessed for review within one year of its initial release and thereafter will be assessed for review approximately once every two years. Document status and proposed review dates can be found at www.nems.org.nz.

Feedback

If you wish to provide feedback regarding this version of the document, please provide it to www.nems.org.nz/feedback.

About this Schema

Introduction

It is critical that an understanding the data collection methodologies, data limitations and intended purpose of the original datasets is known by end users, now and in the future.

This quality coding schema provides:

the internal linkages between the organisations quality management systems (where these exist) and nationally developed monitoring standards. These linkages provide a potential reporting framework for organisational reporting.

insight and detail for the end user of the potential issues associated with provided datasets and highlights the need to review supplementary data comments and other provided metadata that is associated with a particular dataset.

The provision of a nationally consistent quality code schema will enable end users to consistently utilise and/or review environmental data sourced from multiple organisations.

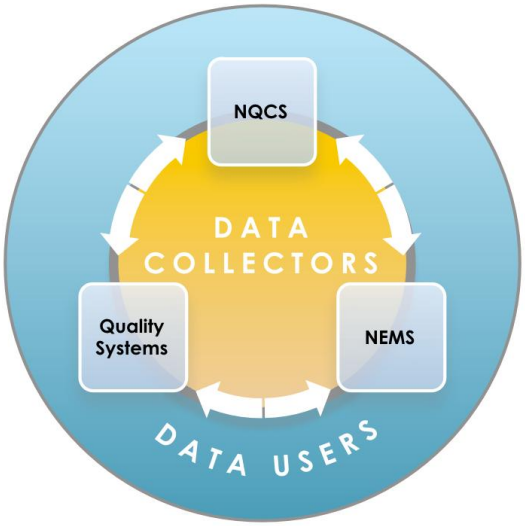

Figure 1 – Quality Interactions

This revision of the Quality Code Schema was undertaken by Jeff Watson (NEMS Technical Advisor).

Objective

This document is intended to provide data acquisition practitioners and data users with an overview and common understanding of the nationally consistent quality coding schema utilised across all NEMS.

For a complete understanding of the quality codes assigned to a particular measured environmental variable, users should consult the appropriate measurement NEMS and the NEMS: - *Processing of Time Series Data*.

Principles

This document incorporates fundamental underlying quality management principles that include being:

- understandable
- consistent in application, and
- reproducible.

The schema shall also:

- support the centralisation or federation of environmental data
- focus on environmental data quality; not instrumentation limitations
- form an integral part of the National Environmental Monitoring Standards (NEMS) suite of documents.
- provide information relating to data quality for both data collectors and the end users of the data.
- link to internal interactions with Quality Management Systems (i.e. ISO 9001:2015)

The national quality coding schema was designed to be:

- a simple & understandable map of data quality
- no more than 10 quality steps
- implementable by multiple software packages
- easy to implement by all organisations
- suitable for all measured variables, and
- numerically based.

With the above ideals, the schema shall be robust and make provision for:

- future improvements of environmental monitoring practices.
- regional sub-codes or sub-standards of data quality.
- defining historic data quality (in terms of "Quality at the Time of Collection"), and
- the development of National Environmental Monitoring Standards (NEMS) of each commonly measured variable
- the support of open data sharing models.

The following National Environmental Monitoring Standard: National Quality Code Schema (NQCS) framework is an application of the above purpose and principles.

The quality code assigned to an item of data is dependent upon the requirements specified within:

- the quality coding flowchart applicable to a specific variable,
- the applicable quality coding matrix,
- blanket provisions contained within:
- the NEMS for the measurement of each variable, and the,
- data editing actions and adjustments described within NEMS: - *Processing of Environmental Time Series Data*.

This document is intended to provide end users of environmental data, with an overview of the quality coding assigned to data that has been collected, processed and archived in accordance with National Environmental Monitoring Standards.

For the detail associated with the application of the quality coding schema to a specific variable, data acquisition practitioners and users of data should consult the measurement NEMS for that variable and also the NEMS: - *Processing of Environmental Time Series Data*.

Terms Definitions and Symbols

Relevant definitions and descriptions of symbols used in this Standard are contained within the NEMS Glossary available at www.nems.org.nz

Normative References

This Standard should be read in conjunction with the most recent version of the following references:

- *NEMS - Glossary*
- *NEMS - Processing of Environmental Time Series Data*

1 Framework

The adoption of best practices, both nationally and internationally, highlights that a NQCS must contain “Zones of Quality” with a numeric index that increases with improved quality.

Each quality zone requires a summary of the expected quality of the environmental data coded at the zone. Missing Record (QC 100) is the poorest quality data because it affects both the data collectors and end users. This fact needed to be reflected by assigning the lowest zone in the quality coding framework and the lowest quality code to the data (other than QC 0 which is assigned to raw data, or data that has been modified by documented and controlled algorithms during data recording or collection).

The quality of QC 0 data may range from compromised to good, but the quality of any data point has not been established, and these data should be used with appropriate caution.

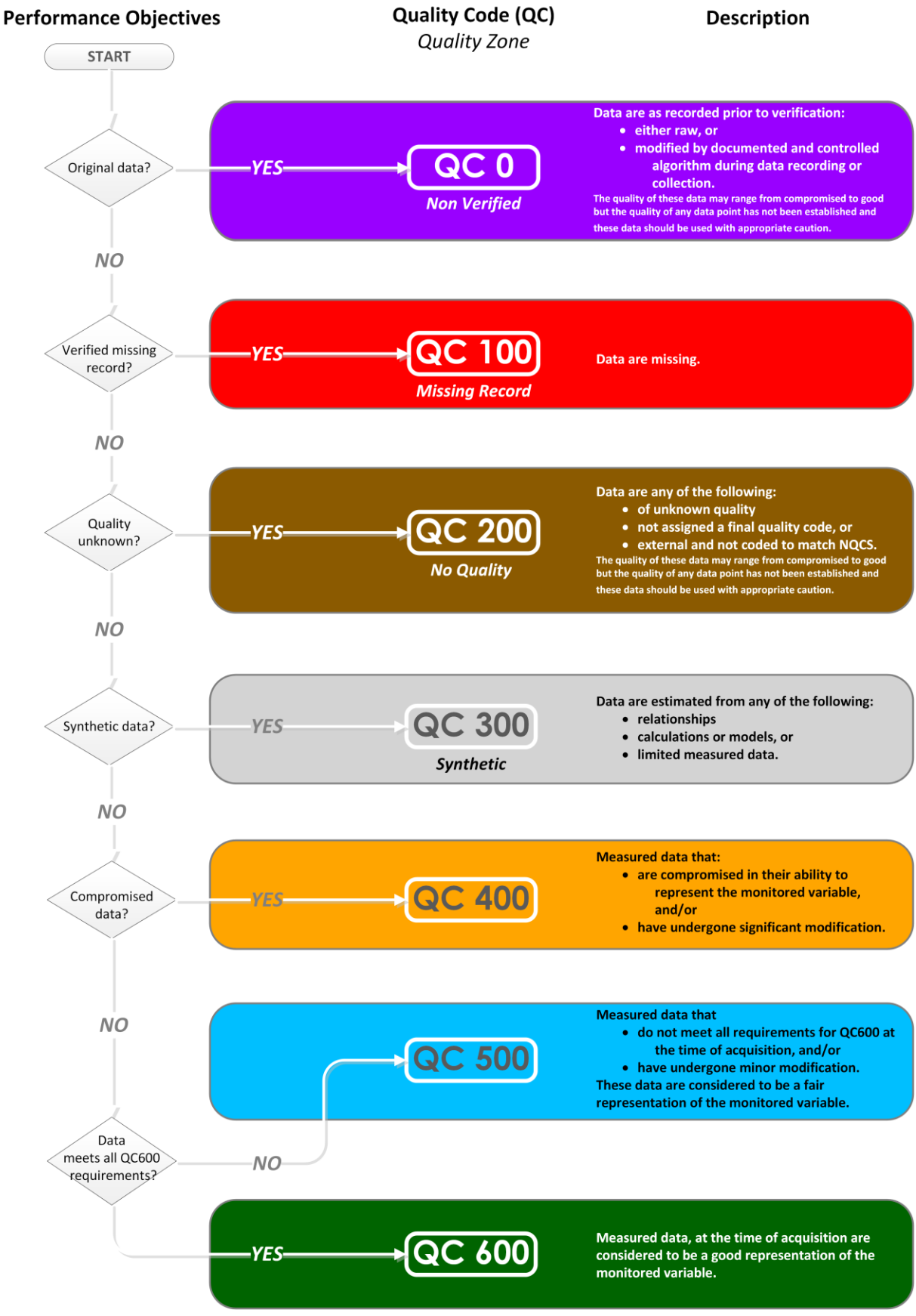

Figure 2 – Generic Quality Flowchart

2 System Integration

This NQCS provides the minimum nationally required parent coding framework for all environmental data. This schema is fixed to ensure a nationally standardised framework. The parent quality code value is the minimum value for that quality zone.

Agencies that currently operate with a prior data quality code schema may not have the resources to modify historic data or have in-house schemes that match the NQCS. To overcome this issue, each agency will need to develop a quality code map, to allow conversion of existing operational in-house codes to the NQCS.

3 Quality Map

Each agency will produce a quality map and store this quality map within their data management documentation and provide it with environmental data provided to any external agencies.

It is intended that each organisation will utilise, as closely as possible the colours assigned to the Schema. It is recognised that different printers will produce subtly different colours. However, the standardisation of colours assigned to quality codes will further assist standardisation of the Quality Coding Schema and also enable experienced data users to quickly assess data quality when looking at time series plots.

4 Quality Code Colours

The following colour codes are provided as a guide for use in software applications, web pages and print.

Table 1 – Quality Code Colours

NQCS Quality Code	Colour Name	RGB	Hex	Pantone	CMYK
QC 0	Neon violet	153,0,255	#9900FF	–	40,100,0,0
QC 100	Red	255, 0, 0	#FF0000	Pantone 186	0, 100, 81, 4
QC 200	Clay (Orange 4)	139, 90, 0	#8B5A00	Pantone 730	0 39, 76, 29
QC 300	Light Gray	211, 211, 211	#D3D3D3	–	0,0,0,40
QC 400	Orange	255, 165, 0	#FFA500	Pantone 138	0,42,100,1
QC 500	Deep Sky Blue	0, 191, 255	#00BFFF	Process Cyan	100, 0, 0, 0
QC 600	Dark Green	0, 100, 0	#006400	Pantone 3415	100, 0, 77, 22

The text shall be black or white; whichever provides maximum contrast and readability for the medium used (screen or print).

Note: The colour codes (RGB, Hex, Pantone and CMYK) are supplied to reduce the risk of colour shifts from one device or medium to another.

Note: The colours displayed or printed in this document may not be an accurate representation of the colour codes because MS Word, which was used to author this document, is not capable of colour management.

5 Supplementary Quality Codes (Child Coding)

The NQCS can be introduced in its basic parent form or it can be expanded upon to provide more data quality detail by those agencies where a greater level of detail is required; detail relating to data quality and operational requirements and standards.

This expansion to the NQCS is called child coding. These child codes are currently allocated in-house; however, a nationally agreed set of child codes may be developed in the future. When developed these child codes shall form an annex to this document.

The NQCS parent codes can be easily expanded upon with child codes.

For example, in Table 2 below, an agency may expand the QC 200 series to differentiate between data that is of unknown quality and data that is from an external agency and not quality coded to NEMS

When reporting child codes externally, the National Quality Coding Schema shall be the default quality coding series.

Table 2 – Parent Code Expanded with Child Codes

NQCS Quality Code	NQCS Quality Zone Parent	Child Code	Child Summary
QC 200	No Quality	210	Of unknown quality
		250	From an external agency and not quality coded to the NEMS schema

Example: QC 200-150

Where the NQCS is expanded upon, a clear documented structure should be produced and stored within the agencies' data management documentation. This documentation will clearly detail the linkages between the NQCS parent codes and the child codes; this linkage will also be reflected in the agencies' data quality map.

6 Child Coding – Special Case

The development of the NEMS *Indigenous Vegetation – Measurement of Indigenous Vegetation Cover (Extent)* in 2025 has necessitated the adoption of a child code of QC 310 to enable differentiation between data classified as QC 300 and QC 310, when this

data is mapped. Table 3 shows the applicable colour mapping for indigenous vegetation data that has been assigned a quality code of QC 310.

Table 3 – Quality Code Colours (QC 310)

NEMS Quality Code	Colour Name	RGB	Hex	Pantone	CMYK
QC310	Turmeric	204,204,0	#CCCC00		0,0,100,20

7 An Overview of Quality Codes for Non-Technical Users

The following guide to quality codes is provided for non-technical users and for those data users who are unfamiliar with quality coding.

QC 0, QC 100, QC 200 and QC 300 do not reflect data quality, but are a mechanism for categorising the data.

QC 400, QC 500 and QC 600 reflect data quality.

QC 0:

The data are as recorded and are either:

- raw, or;
- modified by documented and controlled algorithms during data recording or collection.

If you need to fully understand this dataset you are advised to contact the recording agency for more detail.

QC 100:

Data are missing:

We either know for sure that the data wasn't recorded due to some sort of issue (e.g. instrumentation failure, personnel or laboratory error) or;

- it was of such poor quality we deleted it, or;
- it is lost and we have looked for it, but can't find it.
- You will have to allow for the gap in the data series when undertaking analyses or synthesise some data to fill the gap if you require a continuous data series.

QC 200:

We have not defined a meaningful quality code to this data due to a number of possible reasons:

- the data has not yet passed through any quality assurance processes
- we are uncertain about the quality of the data
- it has a quality code from another organisations quality coding schema that we haven't yet migrated
- If you need to fully understand this dataset you are advised to contact the recording agency for more detail.

QC 300:

The data is estimated or modelled:

- this data has been made up by one of several possible methods

- the associated metadata will probably contain more information about how this data has been created
- it is believed that this estimated/synthetic (made up) data provides a reasonable representation of the variable over the applicable time period
- it is recommended that if data accuracy is critical to your purpose than you should remove the QC 300 data from your analyses, or make your own attempt to synthesise a better record.
- the recording agency may be able to provide you with further information about this data.

QC 400:

This measured data does not meet the expected standard and it potentially has some issues.

- There may have been issues with the sensor or datalogger
- There may have been a personnel or laboratory error
- It may have been adjusted to make the best of what was collected
- The associated metadata will probably contain more information about this data
- The recording agency may be able to provide you with further information about this data.

QC 500:

This measured data should be OK to use unless you absolutely need the best quality data for your purpose, but:

- Note that it doesn't quite meet NEMS QC600 requirements
- You should read the station and data metadata to see what happened where and why
- You may wish to allow for a bit more uncertainty when utilising this data
- The recording agency may be able to provide you with further information about this data

QC 600:

This measured data should be fine. However, you are still advised to view the station metadata.

8 Application of the Quality Code Schema to a Particular Variable

Each Environmental Monitoring Standard (NEMS) contains sections relating to the quality coding methodology applicable to the variable associated with each standard. These documents should be consulted if a detailed understanding of the quality codes associated with a specific variable is required.

Further detail relating to the quality coding of data is contained within the *NEMS: - Processing of Environmental Time Series Data,* and this document also needs to be consulted for a complete understanding of the quality coding associated with a particular variable.

National Environmental Monitoring Standards are reviewed periodically at which time document content is liable to change. It is therefore necessary to identify which version of a document was being utilised at the time of data acquisition and the quality coding applied to data, within the site metadata.

A copy of each version of a NEMS that is utilised by an organisation should also be stored within that organisations metadata to ensure that the data acquisition requirements and applicable quality coding methodology applied at any point in time, can be identified in the future.