Paper for Consideration by S-101PT

Encoding Guidance for QualityofBathymetricData Features

Submitted by:	AU
Executive Summary:	Changes in guidance are proposed for the **Quality of Bathymetric Data** meta feature to facilitate the downgrading of these areas due to Temporal Variation.
Related Documents:	S-101 DCEG S-101PT11-08.9
Related Projects:	S-101.

Introduction / Background

1. In S-101, the ability to encode an area of **QualityOfBathymetricData** exists. The AHO would like to see an adjustment to the encoding guidance to allow a smooth and simple transition from one category of Zone of Confidence value to another in the event of Temporal Variation changes to the area.
2. This Paper proposes to update the guidance in the DCEG for this capability in regards to the area feature itself and the corresponding point features within the area.

Analysis/Discussion

3. The AHO believes that there is a potential to enhance the guidance provided in the DCEG.
4. The AHO has enhanced the encoding guidance below, seen in Red Text.
5. AHO has identified a possible confusing issue with the grouping of Soundings and a possible need for Software Producers to create **QualityOfBathymetricData** Composition associations automatically on export of products. The way that sounding grouping is handled by software may need to change.

   AHO believes that the grouping of soundings should be related to the creation of **QualityOfBathymetricData** Composition association grouping. These groups would be based on the features that have identical Spatial Quality values rather than feature attribution. This could then be possibly automated as grouping is now in S-57. This would then ensure that the associations are correctly made and the indication of accuracy of data within the area is defined.

   The grouping of soundings based on feature attributes such as SCAMIN after associations have been made will create a confusing output in a pick report of an ECDIS for a mariner. An example of this will be the grouping of soundings with differing feature attributes for SCAMIN. Within an association area there may exist 4-5 individual groups based on the feature attributes.

If grouping was managed by the composition associations, then these different feature attributes won't then be visible to a mariner, as the group has Spatial Quality alone as the defining attribution. AHO would like to discuss the best approach to this encoding.

AHO wishes to discuss the purpose of the Composition Association for an ECDIS and the impact it would have if we were to remove this requirement. This would allow sounding grouping to remain unchanged to today.

6. As an area of **QualityOfBathymetricData** may be defined by multiple surveys, AHO believes the use of fixed date range is a better indication of the quality of data in that area. Using survey date range (in areas of Temporal variation) implies that only one survey has been used to define the Quality of Bathymetric Data area.

3.8 Quality of bathymetric data

IHO Definition: **QUALITY OF BATHYMETRIC DATA**. An area within which a uniform assessment of the quality of the bathymetric data exists. (S-57 Edition 3.1, Appendix A – Chapter 1, Page 1.216, November 2000).

S-101 Metadata Feature: Quality of Bathymetric Data (M_QUAL)

Primitives: Surface

Real World	*Paper Chart Symbol*	*ECDIS Symbol*

S-101 Attribute	S-57 Acronym	Allowable Encoding Value	Type	Multiplicity
category of temporal variation		1 : extreme event 2 : likely to change and significant shoaling expected 3 : likely to change but significant shoaling not expected 5 : unlikely to change 6 : unassessed	EN	1,1
data assessment		1 : assessed 2 : assessed (oceanic) 3 : unassessed	EN	1,1
depth range maximum value	(DRVAL2)		RE	0,1
depth range minimum value	(DRVAL1)		RE	0,1
features detected			C	1,1
least depth of detected features measured			(S) BO	1,1
significant features detected			(S) BO	1,1

size of features detected			(S) RE	0,1
full seafloor coverage achieved			BO	1,1
survey date range		See clause 2.4.8	C	1,1
date end	*(SUREND)*		(S) TD	1,1
date start	*(SURSTA)*		(S) TD	0,1
zone of confidence			C	1,*
category of zone of confidence in data	CATZOC	1 : zone of confidence A1 2 : zone of confidence A2 3 : zone of confidence B 4 : zone of confidence C 5 : zone of confidence D 6 : zone of confidence U	EN	1,1
fixed date range		See clause 2.4.8	(S) C	0,1
date end	(DATEND)		(S) TD	0,1 †
date start	(DATSTA)		(S) TD	0,1 †
information		See clause 2.4.6	C	0,*
file locator			(S) TE	0,1
file reference	*(TXTDSC)* *(NTXTDS)*		(S) TE	0,1 †
headline			(S) TE	0,1
language		ISO 639-2/T	(S) TE	1,1
text	*(INFORM)* *(NINFOM)*		(S) TE	0,1 †

Feature Associations

S-101 Role	Association Type	Associated to	Type	Multiplicity
Defines	**Quality of Bathymetric Data Composition** (see clause 25.12)	**Spatial Quality**	Composition	1,1

† For each instance of fixed date range, at least one of the sub-attributes **date end** or **date start** must be populated.

  For each instance of **information**, at least one of the sub-attributes **file reference** or **text** must be populated.

<u>INT 1 Reference</u>:

1.1.1   Quality, reliability and uncertainty of bathymetric data (see S-4 – B-297)

Information about quality, reliability and uncertainty of bathymetric data is given using:
- the meta feature **Quality of Bathymetric Data** and the Information type **Spatial Quality** (see clause 24.5) for an overall assessment of the quality of bathymetric data;
- the meta feature **Quality of Survey** for additional information about individual surveys (see clause 3.11);
- the attributes **quality of vertical measurement** and **technique of vertical measurement** on groups of soundings or individual features;
- the attributes **horizontal position uncertainty**, **quality of horizontal measurement** and **vertical uncertainty** on the spatial types (see clauses 2.4.7 and 24.5).

Bathymetric data quality comprises the following:

- o completeness of data (for example, seafloor coverage);
- o currency of data (for example, temporal degradation);
- o uncertainty of data;
- o source of data.

For the Mariner, **Quality of Bathymetric Data** provides the most useful information. Therefore, the use of **Quality of Bathymetric Data** is mandatory for areas containing depth data or bathymetry on ENC datasets at optimum display scale 1:700000 and larger.

In order to provide an indication of the horizontal position and vertical accuracies of the features to which it applies, each instance of **Quality of Bathymetric Data** must be associated to an instance of the information type **Spatial Quality** (see clause 24.5), using the association **Quality of Bathymetric Data Composition** (see clause 25.12).

More detailed information about a survey may be given using **Quality of Survey** (see clause 3.11). For example, in incompletely surveyed areas, lines of passage soundings may be indicated as such using a curve **Quality of Survey** feature. This information is more difficult for the Mariner to interpret, therefore the use of **Quality of Survey** is optional.

For individual features (wrecks, obstructions etc), or individual/small groups of soundings, **quality of vertical measurement**, **technique of vertical measurement**, **horizontal position uncertainty** and **vertical uncertainty** may be used to provide additional information about quality and uncertainty.

The meta feature **Quality of Bathymetric Data** defines areas within which uniform assessment exists for the quality of bathymetric data, and must be used to provide an assessment of the overall quality of bathymetric data to the Mariner. Areas of a dataset containing depth data or bathymetry must be covered by one or more **Quality of Bathymetric Data**, which may overlap vertically in order to define the quality of bathymetric data at varying depths in the water column.
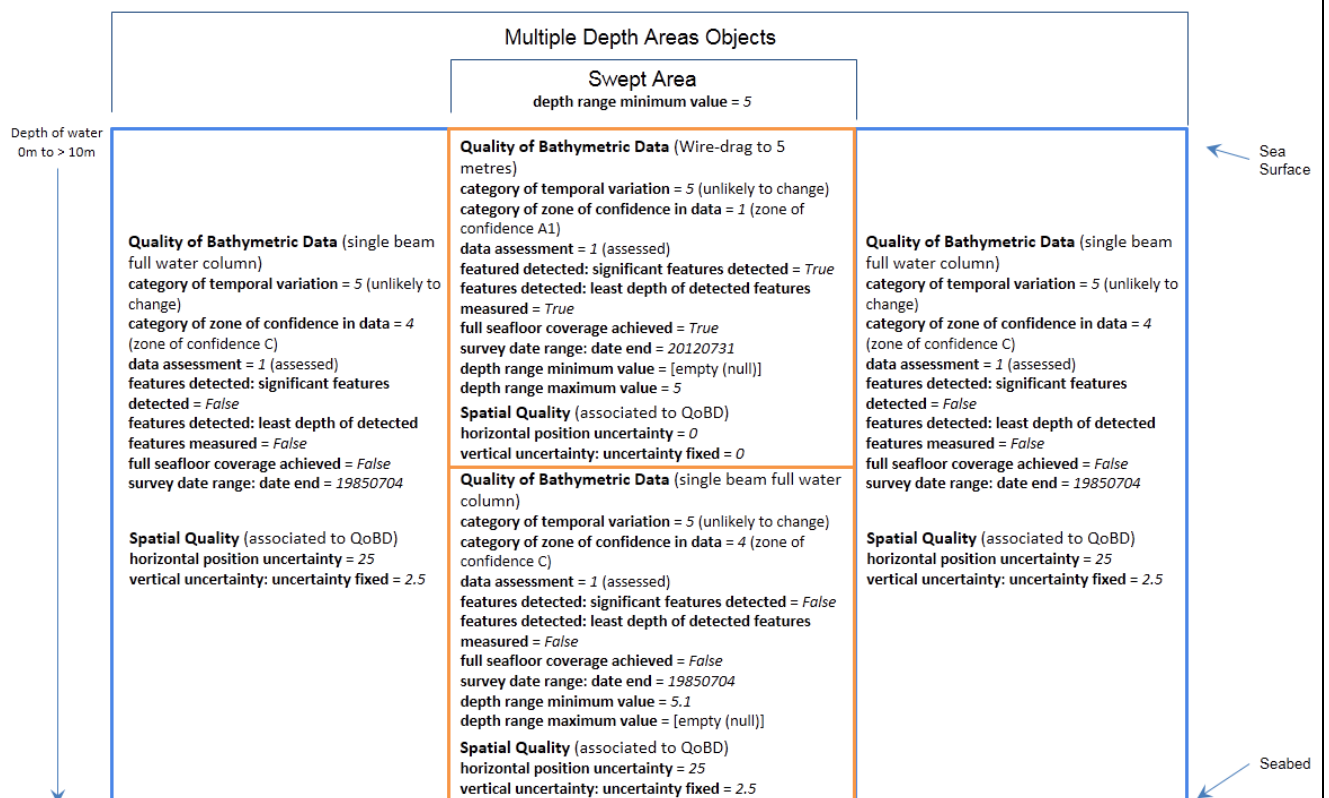
Figure 3-2 – Adjoining and overlapping Quality of Bathymetric Data features

The Figure above demonstrates the encoding for varying quality of bathymetric data in the water column, in this example a mechanically swept area to a depth of 5 metres that has also been previously surveyed using single beam echo sounder to the seabed. For the **Quality of Bathymetric Data** feature that defines the data quality for the swept area, it is important to note that the recommended attribution shown above is intended to provide the highest (best) quality indicator for vessels navigating at a safety depth of less than 5 metres in the area. For

vessels navigating at a safety depth of greater than 5 metres in the area, or at any depth outside the area, the lower quality indicator will be provided.

Remarks:

- The mandatory attribute **data assessment** provides an overall indicative level of assessment of bathymetric data from which further attribution is derived, and assists with portrayal of bathymetric data quality information in ECDIS:
  - Where the value for **data assessment** is set to *1* (assessed), all additional attribution for the **Quality of Bathymetric Data** feature must be indicative of the quality of bathymetric data for the area.
  - Where the value for **data assessment** is set to *2* (assessed (oceanic)), all additional attribution for the **Quality of Bathymetric Data** feature should be indicative of the quality of bathymetric data for the area for a Mariner's ECDIS pick report, however no portrayal of the quality information will display on the ECDIS. This value should only be used to cover open ocean (oceanic) depths in waters deeper than 200 metres.
  - Where the value for **data assessment** is set to *3* (unassessed), the mandatory attributes **category of temporal variation** = *6* (unassessed); **features detected** (**least depth of detected features measured** and **significant features detected**) = *False*; **full seafloor coverage achieved** = *False*; and **category of zone of confidence in data** = *6* (zone of confidence U) must be populated.
- Wherever possible, meaningful and useful values for the attributes **category of temporal variation**, **full seafloor coverage achieved**, and the complex attribute **features detected** must be used for areas of bathymetry. For areas of unstable seafloors, the complex attribute **survey date range** (**date end**) must be used to indicate the date of the survey of the underlying bathymetric data.
- As a result of some disasters, for example earthquakes, tsunamis, hurricanes, it is possible that large areas of seafloor have moved and/or become cluttered with dangerous obstructions. Emergency surveys may subsequently be conducted over essential shipping routes and inside harbours. Outside these surveys, all existing detail is now suspect, whatever the quality of the previous surveys. In such cases, the attribute **category of temporal variation** should be reclassified to value *1* (extreme event), the Boolean attribute **full seafloor coverage achieved** set to *False*; complex attribute **features detected**, Boolean sub-attributes **least depth of detected features measured** and **significant features detected** set to *False*; the **zone of confidence** sub-attribute **category of zone of confidence in data** reclassified to *5* (zone of confidence D); and the sub-attributes **horizontal position accuracy** (**uncertainty fixed**) and **vertical uncertainty** (**uncertainty fixed**) on the associated **Spatial Quality** populated with an empty (null) value in the affected areas outside the area covered by emergency surveys.
- To express completeness of bathymetric data, the complex attribute **features detected** must be encoded. **features detected** indicates that a systematic method of exploring the seafloor, or the water column to the depth indicated by population of the attribute **depth range maximum value**, was undertaken to detect significant features. The sub-attributes **size of features detected** and **least depth of detected features measured** must not be encoded unless the sub-attribute **significant features detected** is set to *True*.
- The mandatory complex attribute **zone of confidence** is used on a **Quality of Bathymetric Data** feature to provide an overall indication of the accuracy of the bathymetric data in the area. Where **category of temporal variation** is set to values *2* (likely to change and significant shoaling expected) or *3* (likely to change but significant shoaling not expected), multiple instances of **zone of confidence** should be encoded (encoding of multiple instances is achieved by utilising the complex attribute functionality within the Quality of Bathymetric Data feature.) to provide an indication of the degradation of the overall accuracy of the charted bathymetric information over time.
  - Wherever possible, meaningful and useful values of the mandatory sub-attribute **category of zone of confidence in data** should be used (that is, values other than **category of zone of confidence in data** = *6* (zone of confidence U)) for areas of bathymetry. These values must be determined from the **category of zone of confidence in data** definition table (see clause 27.73) in accordance with the values populated for the attribute **full seafloor coverage achieved**, the complex attribute **features detected** and the sub-complex attributes **horizontal position uncertainty** and **vertical uncertainty** on the associated **Spatial Quality**.
  - The sub-complex attribute **fixed date range** is used to define the date range(s) where the quality is degraded over time. Where multiple date ranges are specified, the **date start** of an instance must be equal to the **date end** of the previous instance. Within the sequence, the **date start** of the first instance and the **date end** of the last instance should not be populated; the values populated for **fixed date range** must not result in the removal of the indication of bathymetric data quality for an area from the Mariner.
- The sub-complex attribute **vertical uncertainty** on the associated **Spatial Quality** is used to specify the vertical uncertainty of the depths covered by the surface within a specified date range (where encoded).

When **depth range minimum value** is specified on **Quality of Bathymetric Data**, **vertical uncertainty** refers only to the uncertainty of the swept depth defined by **depth range minimum value**.

- The sub-complex attribute **horizontal position uncertainty** on the associated **Spatial Quality** is used to specify the positional uncertainty of the depths covered by the surface within a specified date range (where encoded).
- **depth range minimum value** must only be used on a **Quality of Bathymetric Data** feature where a swept area occupies the entire **Quality of Bathymetric Data** surface, or **Quality of Bathymetric Data** features overlap. Where these features overlap such that varying bathymetric data qualities exist at different depths in the water column, the **depth range minimum value** for a **Quality of Bathymetric Data** must be set to a value 0.1 metres deeper than the **depth range maximum value** for the **Quality of Bathymetric Data** feature defining the quality for the level above; and the topmost **Quality of Bathymetric Data** must have **depth range minimum value** set to an empty (null) value (see Figure 3-2 above).
- **depth range maximum value** must only be used on a **Quality of Bathymetric Data** feature to specify the maximum depth to which all other attributes for the **Quality of Bathymetric Data** feature applies. When **depth range maximum value** is specified, values populated for all other attributes apply only to depths equal to or shoaler than **depth range maximum value**. No quality information is provided for depths deeper than **depth range maximum value**. Where **Quality of Bathymetric Data** features overlap such that varying bathymetric data qualities exist at different depths in the water column, the **depth range maximum value** for a **Quality of Bathymetric Data** must be set to a value 0.1 metres shoaler than the **depth range minimum value** for the **Quality of Bathymetric Data** feature defining the quality for the level below; and the bottommost **Quality of Bathymetric Data** must have **depth range maximum value** set to an empty (null) value (see Figure 3-2 above).
- **Quality of Bathymetric Data** must be encoded over **Unsurveyed Area** features that contain any depth data or bathymetry (depth contours, obstructions, soundings, underwater rocks, wrecks); and must have mandatory attributes **data assessment** = *1* (assessed) **category of temporal variation** = *6* (unassessed); **features detected** (**least depth of detected features measured** and **significant features detected**) = *False*; **full seafloor coverage achieved** = *False*; and **zone of confidence** (**category of zone of confidence in data**) = *5* (zone of confidence D). The **vertical uncertainty** (**uncertainty fixed**) and **horizontal position uncertainty** (**uncertainty fixed**) for the associated **Spatial Quality** should be populated with an empty (null) value.
- For **Unsurveyed Area** features that do not contain any depth data or bathymetry, it is not required to encode a **Quality of Bathymetric Data** feature that covers the area.
- If the attribute **technique of vertical measurement** is required, it must be encoded on either the meta feature **Quality of Survey** (see clause 3.11) or on individual geo features (for example **Sounding**).
- When the **Quality of Bathymetric Data** surface contains data from only one survey, the date of survey must be specified using the complex attribute **survey date range**, sub-attribute **date end**. When the **Quality of Bathymetric Data** surface contains data from two or more surveys, the date of the most recent and the oldest survey must be specified using the complex attribute **survey date range**.
- **Quality of Bathymetric Data** areas must not be encoded over land.
- **Spatial Quality** (**quality of horizontal measurement**) or (**horizontal position uncertainty**) on the associated spatial types (boundary) using the association **Spatial Association** (see clause 24.5) qualifies the location of the **Quality of Bathymetric Data** feature itself. **Spatial Quality** (**horizontal position uncertainty**) associated to the **Quality of Bathymetric Data** using the association **Quality of Bathymetric Data Composition** (see clause 25.12) applies to bathymetric data situated within the surface.
- Meta features **Quality of Bathymetric Data** and **Quality of Non-Bathymetric Data** may overlap.
- Additional quality information may be given using the meta feature **Quality of Survey**.

1.1.1.1   Temporal variation

The changeability of the bathymetry must be encoded using **category of temporal variation**. In order for a time reference to be given for the expression of temporal variation, the relevant dates of the bathymetric data must be encoded using the Spatial Quality complex attribute ~~survey~~ **fixed date range** if **category of temporal variation** is set to *1* (extreme event), *2* (likely to change and significant shoaling expected) or *3* (likely to change but significant shoaling not expected).

1.1.1.2   Temporal variation and downgrading

Where temporal variation has been set to *1* (extreme event), *2* (likely to change and significant shoaling expected) or *3* (likely to change but significant shoaling not expected) and Data Producers would like to downgrade the values for this area based on information they hold the following must occur:

At least 2 instances of **zoneOfConfidence** are to be encoded. Consecutive instances of **zoneOfConfidence** must have sequential values (no temporal gap) of **dateEnd** and **dateStart** to ensure a smooth transition between zone of confidence categories.

Furthermore, **SpatialQuality** information features associated to the relevant hydrographic features within the **QualityOfBathymetricData** feature, must have the same number of **spatialAccuracy** instances encoded. Their **dateEnd** and **dateStart** are to match the **fixedDateRange** values of their corresponding **zoneOfConfidence** instances to ensure **horizontalPositionAccuracy** and **verticalAccuracy** values are within the boundaries of the **zoneOfConfidence** category in force at that point in time.

1.1.1.3 Feature detection

In the context of bathymetry, a feature is any object, whether manmade or not, projecting above the seafloor, which may be considered a danger to surface navigation. Refer to IHO Publication S-44.

The ability to detect bathymetric features must be encoded using the complex attribute **features detected**. The sub-attribute **significant features detected** indicates whether the survey was capable of detecting features of a size indicated by the sub-attribute **size of features detected**. The sub-attribute **least depth of detected features measured** indicates whether the least depth of detected features was found. For instance, if a wreck was found, but it is not certain that the least depth of that wreck was measured, **least depth of detected features measured** must be set to *False*.

1.1.1.4 Sounding uncertainty

Sounding uncertainty is encoded using an associated instance of the information type **Spatial Quality**, complex attribute **spatial accuracy** (see clause 24.5) and using the association **Quality of Bathymetric Data Composition** (see clause 25.12). If it is required to encode additional sounding uncertainty information, it must be done using the attributes **quality of vertical measurement** and **technique of vertical measurement** on groups of soundings or individual features; or by associating another instance of the information type **Spatial Quality** to the spatial type associated with the individual geo features. Note that this is a mandatory requirement for the features **Sounding** and **Underwater/Awash Rock**; and **Foul Ground**, **Marine Farm/Culture**, **Obstruction** and **Wreck** of type point, of depth 30 metres or less.

The vertical and horizontal position uncertainty values populated on the instance of **Spatial Quality** associated to the **Quality of Bathymetric Data** must reflect the most commonly associated values for the **Foul Ground**, **Marine Farm/Culture**, **Obstruction**, **Sounding**, **Underwater/Awash Rock** and **Wreck** features within the area.

Distinction: Quality of Non-Bathymetric Data; Quality of Survey; Spatial Quality.

Conclusions and recommendations

7. The proposed amendments to the guidance for the S-101 **QualityOfBathymetricData** meta feature is intended by the AHO to simplify the use of Temporal Variation instances within an S-101 ENC. AHO believes it will provide the end-user an enhanced interaction/experience and provides a minimal impact on resources for Data Producers.
8. It is recommended that S-101PT:
   - Approve the revised guidance for the **QualityOfBathymetricData** meta Features and discuss any improvements that could be made;
9. That the S-101 Validation Sub WG ensure that Validation checks are in place to check that values for Spatial Quality are within tolerance for the area they fall within and that the number of instances of Spatial Quality matches the instances of category of **zoneOfConfidence**.

Justification and Impacts

10. Inclusion of the guidance for this **QualityOfBathymetricData** meta feature will simplify the workload for Data Producers in areas of temporal change. The requirement to update and publish new updates to ENC's will be reduced as this can be populated by the Data Producer upon compilation of datasets when survey information is received.

11. Sounding grouping is to be reviewed and a best practice approach adopted by the Project team in the guidance based on the existence of Composition Associations and current sounding grouping functionality.

12. AHO recognises that the use of this functionality in an S-101 ENC during the Dual Fuel period will be limited due to the inability to replicate this in S-57. This is intended to be used by the AHO at a time where S-101 is the only data available to the ECDIS.

Action Required of S-101PT

13. The S-101PT is invited to:
    - **Discuss** this proposal
    - **Approve** the inclusion of guidance as written for **QualityOfBathymetricData** meta features into 2.0.0 Operational release
    - **S-164** Test Dataset Sub Working Group to update ENC Test Datasets for the proposed changes.
    - **Initiate** any further action as required.