HydrOffice QC Tools 2 Manual

Release 2.1.0

2017, CCOM/JHC,UNH

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CHAPTER

ONE

IN BRIEF

QC Tools assist in the review of various types of data occurring all throughout the ping-to-public process.

Accepted data inputs are bathymetric grids, feature files, sounding selections, and directory structures. The output is GIS-layers that alert to the user various parts of their data that might require more attention. Summary reports are also printed for the record and review.

The objectives are to improve data accuracy, while also reducing the overall time required for ping-to-chart.

CHAPTER

TWO

USER MANUAL

2.1 Survey Review

2.1.1 Overview

The **Survey Review** tab will:

- Ingests bathymetric grids and feature files (see *Data inputs*).
- Scan grids for anomalous grid data "fliers" (see *Detect fliers*).
- Scan grids for empty grid nodes that meet NOAA NOS Hydrographic Survey Specifications and Deliverables (HSSD) definitions of "holidays" (see *Detect holidays*).
- Compute basic grid statistics to ensure compliance to uncertainty and density requirements (see *Grid QA*).
- Scan grids to ensure the eligibility of soundings designated (see *Scan Designated*).
- Scan features to ensure proper attribution (see *Scan features*).
- Ensure surveyed features are properly accounted for in the gridded bathymetry (see *VALSOU checks*).
- Export bottom samples to a text file for archival (see *SBDARE export*).
- Ensures the required directory structure and completeness of survey deliverables (see *Submission checks*).

2.1.2 Data inputs

Ingest bathymetric grids and feature files.

- Select the **Survey Review** tab on the QC Tools interface.

In **Data inputs:**

- Drag-and-drop any number of grids and/or features files, anywhere onto the interface. The **"+"** browse button may also be used.
- The directory and filename of accepted grid and feature files will populate in the respective locations of Data inputs.
- With the addition of a grid and features, the **Detect fliers**, **Detect holidays**, **Grid QA**, **Scan designated**, **Scan features**, **VALSOU checks**, and **SBDARE export** tabs on the bottom of the interface are now available (Fig. 2.1).
- Note that any unaccepted file types will be rejected with a message to inform the user (Fig. 2.2).
- The **Clear data** button may be used to remove all data inputs.

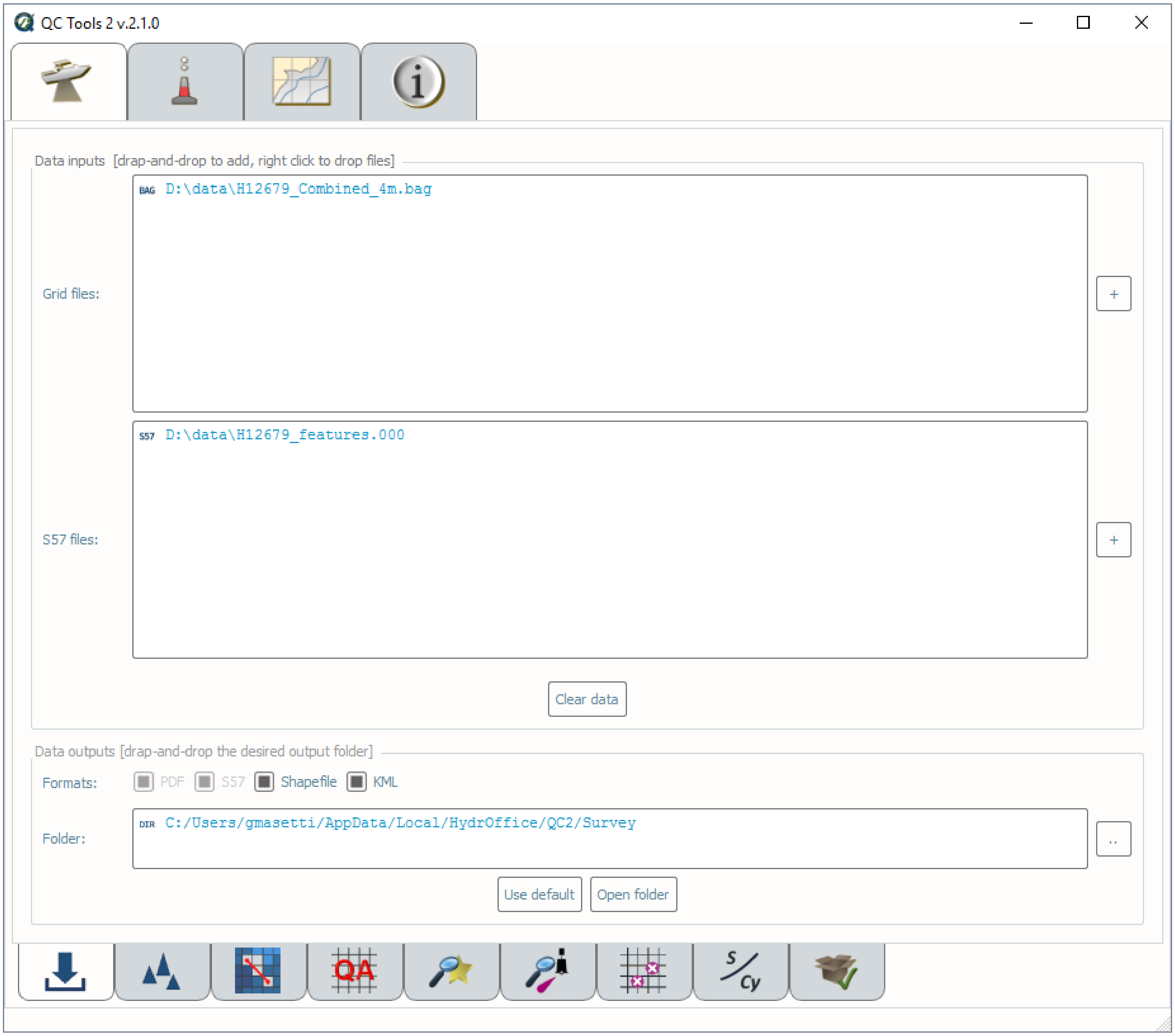


Fig. 2.1: Data inputs and outputs for the *Survey* tab.

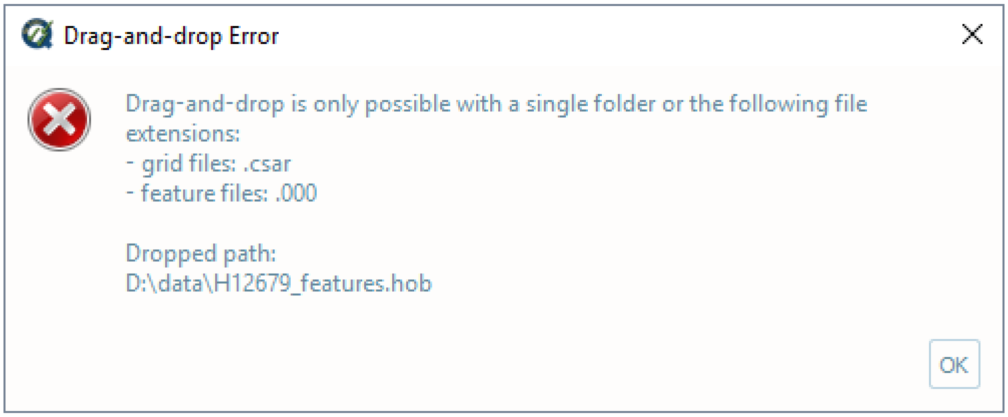


Fig. 2.2: The error message for unsupported formats.

In **Data outputs:**

- The output **Formats** may be customized. The user has the option to suppress **Shapefile** and **KML** output.
- The default output **Folder** location is listed; however, this may be modified via drag-and-drop (or browse to) a user-specified output folder. To return to the default output folder location, click **Use default**.
- The ensuing functions will open the output folder automatically upon execution; however, if needed, the specified output folder may be accessed by clicking the **Open folder** button.

2.1.3 Detect fliers

How To Use?

Scan grids for anomalous grid data "fliers".

- Select the **Detect fliers** tab (Fig. 2.3) on the bottom of the QC Tools interface.
- For **Flier finder v5**, first consider **Parameters:**
  - The **Flier height** will be determined automatically by the program and does not need to be set, but the user may choose to do so in order to run a specific **Flier height**.
  - The automatic determination of **Flier height** is performed per tile, and is based on the median depth (characteristic depth), the MAD (variability in range), and the standard deviation of the gaussian curvature (roughness).
  - Default **Checks** are enabled and are recommended for standard use, but these too may be enabled or disabled in order to run custom checks (see the "How Does It Work?" section below).
- To change the **Parameters** for **Flier finder v5**:
  - Click the **Unlock** button, and click **OK** to the dialogue.
  - If desired, enter a desired Flier search height in meters in the **Force flier heights** box.
    - A single height may be entered to apply to all loaded grids, or multiple heights may be entered (separated by comma) to apply to each grid loaded.
    - These values, if entered, will override any **Estimated heights** determined by the program.
  - Enable or Disable the specific **Checks** to run.
- In **Execution** for **Flier finder v5**:

Fig. 2.3: The **Detect fliers** tab.

- Click **Find fliers v5**. After executing, the output window opens automatically (Fig. 2.4), and the results are shown:

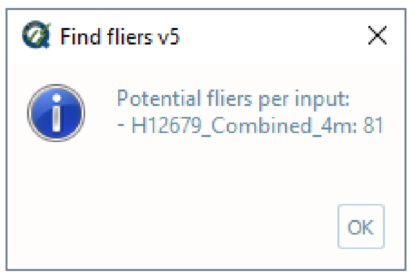


Fig. 2.4: The output message at the end of **Flier finder v5** execution.

- From the output window, drag-and-drop the output into the processing software to guide the review. Each candidate flier is labeled using the identifier of the algorithm that detected it (e.g., "2" for Gaussian Curvature).
- The output names adopt the following convention:
  - [grid filename].FFv5.chk[identifier of each selected algorithm]

How Does It Work?

Flier finder v5:

Estimate height:

First, a base height from the median depth of the grid is assigned:

Depth Interval	Base height
if < 20	1.0
if < 40	2.0
if < 80	4.0
if < 160	6.0
if >= 160	8.0

Then, the base height is incrementally increased by the level of depth variability and roughness of the grid:

- Depth variability is estimated by proxy using the Normalized Median of Absolute Deviation (NMAD) of the grid, which is derived by dividing the absolute difference of depth mean and depth median by depth standard deviation.
  - The lower the NMAD, the more depth variability we estimate.
  - An increase in the Base height of the flier search height estimation is warranted if NMAD is less than 0.20 (1 increase) or less than 0.10 (2 increases).
- Roughness is estimated by the standard deviation of the Gaussian curvature (STD_CURV).
  - The Gaussian curvature is a measure of concavity at each node, whether concave up (shoal) or concave down (deep).
  - The higher the STD_CURV, the rougher the surface.
  - An increase in the Base height of the flier search height estimation is warrented if STD_CURV is greater than 0.01 (1 increase) or greater than 0.10 (2 increases).

Increases are +2.0 meters, unless the Base height is 1.0 meter, then the increase is +1.0 meter. In this manner, Estimated flier heights are always on the interval scale of 1 (minimum), 2, 4, 6, 8, 10, 12, 14, 16 (maximum).

For example:

- if a surface has depth median = 12 m, NMAD = 0.15, and STD_CURV = 0.005, then the Estimated height = 2.0 m.
- if a surface has depth median = 75 m, NMAD = .04, and STD_CURV = 0.08, then the Estimated height = 10.0 m.

Checks:

Laplacian Operator

The Laplacian Operator is a measure of curvature at each node. It is equivalent to summing the depth gradients of the four nodes adjacent (north, south, east, and west) to each node. If the absolute value of the Laplacian Operator is greater than four times the flier search height, the node will be flagged.

In the example below, a 3 m flier search height would register 1 flag, while a 2 m flier search height would register 4 flags, and a 1m search height would register 7 flags.

Depth Layer					Laplace			
9	9	9	9		0	1	0	3
9	8	9	6		1	4	10	9
9	9	3	9		0	7	24	9
9	9	9	9		0	0	6	0

The algorithm is effective, but may be prone to excessive flags, as demonstrated in the above example. Testing showed that it generally did not reveal fliers not already revealed by the other algorithms. For these reasons, it is disabled by default, but is recommended as an additional check in those situations when the other algorithms return very few or no flags.

The example in Fig. 2.5 shows grid nodes (depths in meters) recommended for further examination by the Laplacian Operator (indicated by 1s) and a 6m estimated search height.

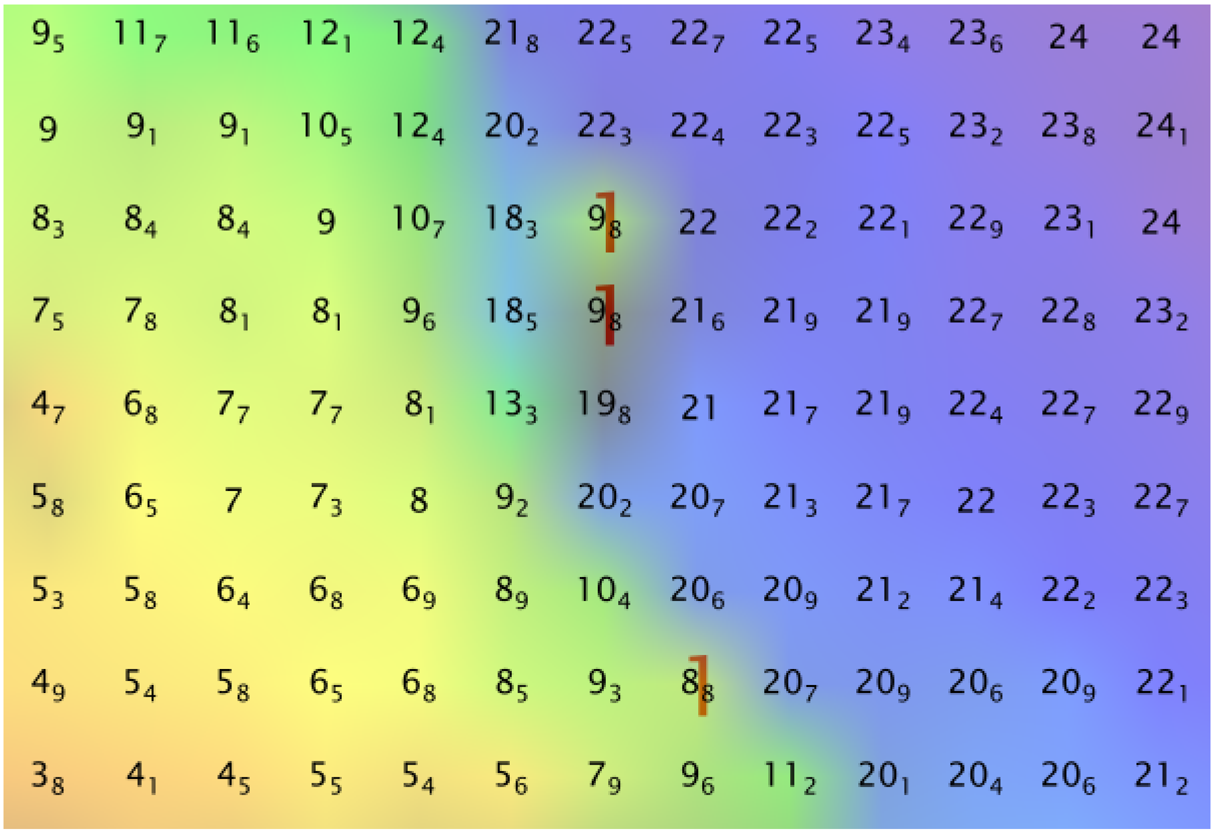


Fig. 2.5: Laplacian Operator.

Gaussian Curvature

The Gaussian Curvature is a measure of concavity at each node. The gradients are taken in the x and y directions to establish gx and gy, and repeated on each gradient again in the x and y direction to establish gxx, gxy, gyx, and gyy (note that gxy = gyx). The gaussian curvature at each node is then determined by:

(gxx * gyy - (gxy * gyx)) / (1 + (gx^2) + (gy^2))^2

If the resulting gaussian curvature at a particular node is greater than 6, it will be flagged. Note that this algorithm is independent of flier search height.

In the example below, a single flier is found (regardless of flier height).

Depth Layer					Gaussian Curvature			
9	9	9	9		-1	0	-1	-.09
9	8	9	6		0	-2.3	0	-.14
9	9	3	9		-2.5	0	20	0
9	9	9	9		0	-9	0	-36

Testing showed that the algorithm on occasion offered unique value by flagging a flier not captured by other algorithms, while also it is not prone to excessive flags. For these reasons this algorithm is enabled by default.

The example in Fig. 2.6 shows grid nodes (depths in meters) and a deep flier found by the Gaussian Curvature (indicated by the red 2).

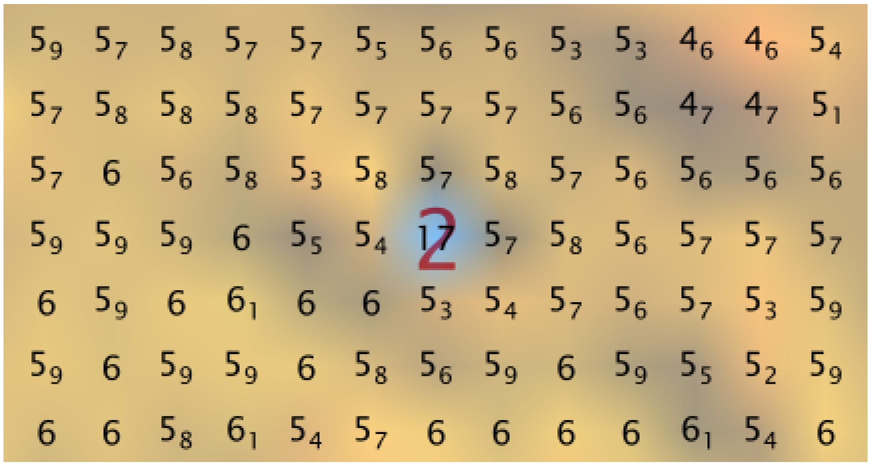


Fig. 2.6: Gaussian Curvature.

Adjacent Cells

This algorithm examines the nodes that are adjacent to a single node. There are a maximum of 8 adjacent nodes (N,NW,W,SW,S,SE,E,NE), but there could be less than 8 if the node resides on a grid edge.

Flider Finder v4 will crawl across empty cells (2 nodes diagonally, and 3 nodes in the cardinal directions) in order to establish neighbors. For example, the image below shows that 6 neighbors were found for the flagged node; previous versions of Flier Finder would only have identified 4 (Fig. 2.7).

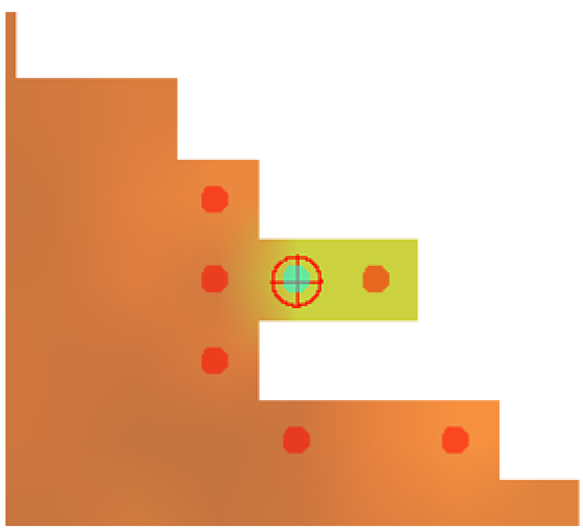


Fig. 2.7: Crawling example.

The depth is differenced with each adjacent cell identified, and the number of times the difference is greater in magnitude than the flier search height is tallied. If the ratio of this tally to the number of adjacent cells available is 0.8 or greater, then the node is flagged.[1]

In the example below, a 3 m flier search height would register 2 flags, while a 2m search height would also register 2 flags, and a 1m search height would register 3 flags.

Depth Layer					Adjacent Cells(3m)			
9	9	9	9		0	0	.2	.33
9	8	9	6		0	.13	.25	1
9	9	3	9		0	0	1	.4
9	9	9	9		0	.2	.2	.33

Testing showed that the Adjacent Cells algorithm offers unique value by flagging fliers not captured by the other algorithms (especially those residing on grid edges), and is not as prone to excessive flagging as the Laplacian Operator. For these reasons, it is enabled by default.

The example in Fig. 2.8 shows grid nodes (depths in meters) and the type of flier that Adjacent Cells (indicated by the red 3) identifies with particular effectiveness, in this case with a 4m search height.

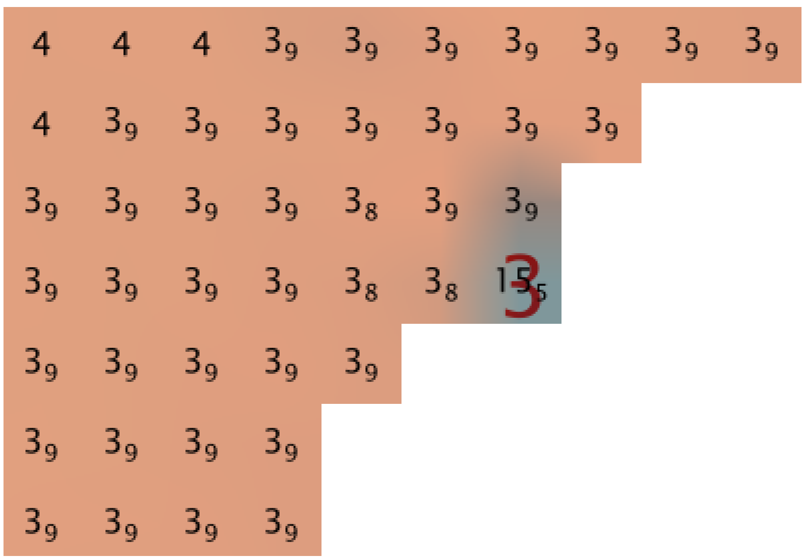


Fig. 2.8: Adjacent Cells.

Edge Slivers

The Edge Slivers algorithm identifies small groups of connected nodes (3 nodes or less) that are detached (but within 5 nodes) from the grid. If the depth difference between the nearest detached node and the valid connection to the grid is greater than half the flier search height, a flag is registered.

Testing showed that the algorithm offers unique value by identifying the quite common fliers that result in areas of sparse data density. For this reason, it is enabled by default.

The example in Fig. 2.9 shows grid nodes (depths in meters) and the type of detached nodes that Edge Slivers flags, in this case with a 4m search height.

Isolated Nodes

[1] In the case that node has only 4 neighbors, and 3 of these have a difference greater than the search height, the ratio of 0.75 will trigger a flag on the node. This exception has been made because it has been observed so frequently during testing.

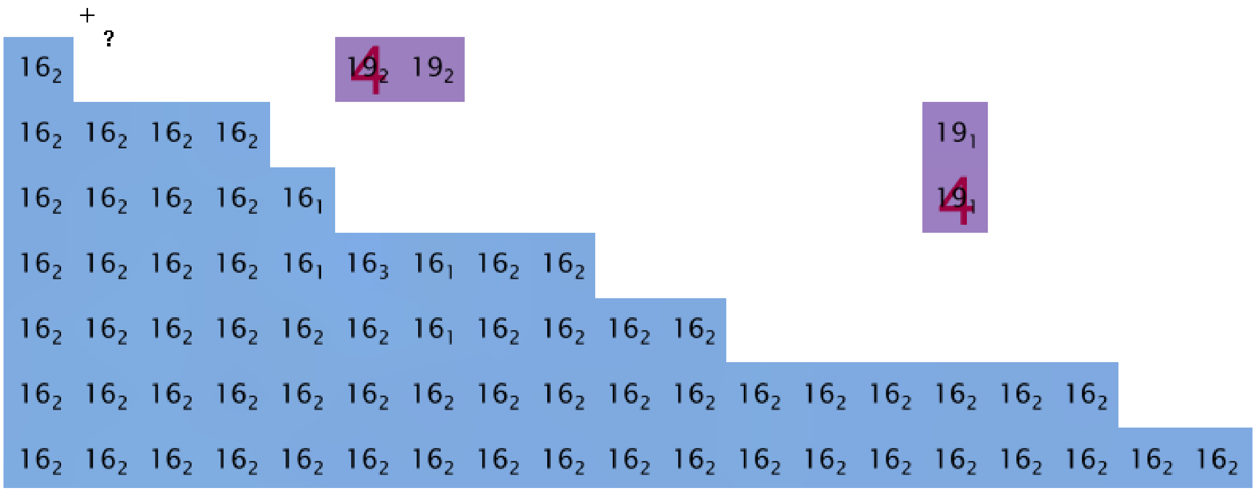


Fig. 2.9: Edge Slivers.

The Isolated Nodes algorithm identifies small groups of connected nodes (3 nodes or less) that are detached (but outside of 5 nodes) of the grid. Effectively it is identifying the remaining isolated nodes not caught by Edge Slivers, however, it is independent of flier search height, meaning that all small groups of isolated nodes will be flagged.

Testing shows that the algorithm offers unique value by identifying nodes far detached from the grid that the reviewer may wish to exclude. Because it is identifying any detached nodes and not considering their associated depth, it is largely considered a separate tool to be used on an "as-needed" basis. Therefore, it is not enabled by default.

The example in Fig. 2.10 shows a grid node far detached from the main grid, found by Isolated Nodes (indicated by a red 5).

Fig. 2.10: Isolated Nodes.

Which Flier Finder Algorithm Should I Use?

For basic use:

- The automatic estimated search height and checks are recommended for standardized operation of this tool.

For advanced use:

- If the default options generate too few flags, and/or it is desired to perform a custom search, you may force a smaller flier height, and/or utilize the "Laplace Operator" algorithm.
- The "Isolated Nodes" algorithm is used to find nodes detached from the grid and is an independent check to be used on an as-needed basis.

A summary of the checks is shown in the table below, and also see the "How Does It Work?" section to understand how each check works.

	Lap #1	Gau #2	Adj #3	Edg #4	Iso #5
Flier height required	x		x	x	
Prone to excessive flags	x				x
Enabled by default		x	x	x	
Use on as-needed basis	x				x

2.1.4 Detect holidays

How To Use?

Scan grids for unpopulated nodes ("holidays").

- Select the **Detect holidays** tab (Fig. 2.11) on the bottom of the QC Tools interface.
- In **Parameters**, turn the knob to select **All holes**, **Object detection**, or **Full coverage**.
- Set the **Upper holiday area limit (as multiple of minimum holiday size)**. Unpopulated parts of the grid larger than this setting will not be flagged as holidays.
- In **Execution**, click **Find holiday v4**.

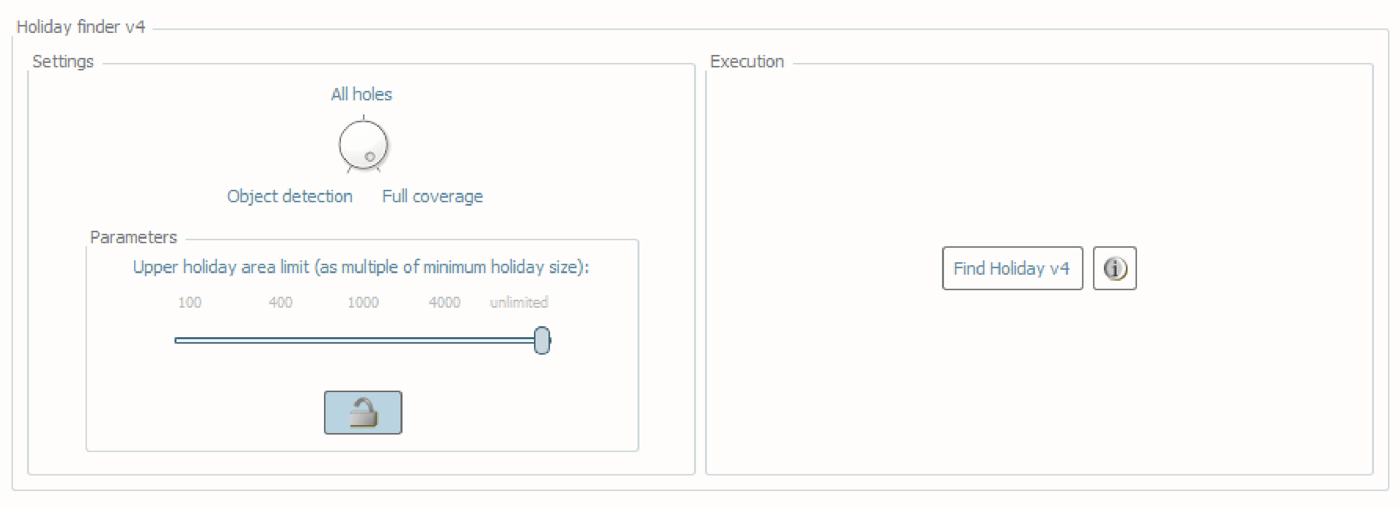


Fig. 2.11: The **Detect holidays** tab.

- After computing, the output window opens automatically, and the results are shown (Fig. 2.12).
- From the output window, drag-and-drop the output into the processing software to guide the review.
- The output names adopt the following convention:

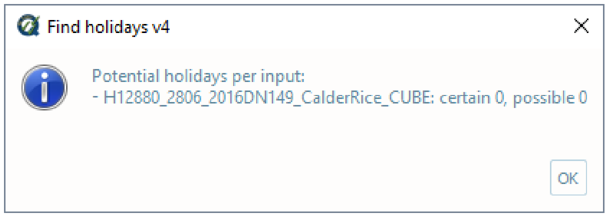


Fig. 2.12: The output message at the end of **Find holiday v4** execution.

  - [grid filename].HFv4.["all" for *All holes* | "obj" for *Object detection* | "cov" for *Full coverage*].[min size]

Note: For proper visualization, the software adopted to analyze the S57 output of VALSOU Checks has to represent the sounding values in meters.

How Does It Work?

The grid is scanned, and any empty grid nodes ("holes") surrounded by populated nodes are identified. These are flagged as holidays per specification:

- For single resolution grids, the 2017 NOAA NOS Hydrographic Survey Specifications and Deliverables.
- For variable resolution grids, the NOAA HTD 2017-2 "Caris Variable Resolution Grids".

Only in the case of a variable resolution input:

- All the tiles are resampled to create a single resolution grid (selecting the highest resolution among all the grid tiles).
- The minimum allowable resolution (and thus the holiday size) is calculated based on the median value of all the node depths belonging to the holiday perimiter.

For both single and variable resolution grids, the specifications have different criteria by which holidays are defined based on coverage requirements.

For single resolution grids:

- A holiday under **Object Detection** coverage requirements is defined as three or more collinear, contiguous unpopulated nodes sharing adjacent sides.
- A holiday under **Full Coverage** requirements is defined as a box of three by three unpopulated nodes.
- There is also the option to simply flag all unpopulated nodes as holidays, by selecting the **All holes** setting.

For variable resolution grids, similar criteria are described in the NOAA HTD 2017-2.

To illustrate the results of the three different Parameter settings are three different examples below.

Note that the output of Holiday Finder is a sounding, with a value of "1" for certain holidays, and "2" for possible holidays.

- In the example in (Fig. 2.13), the **All holes** setting marks three holes of 12, 7, and 2 nodes.

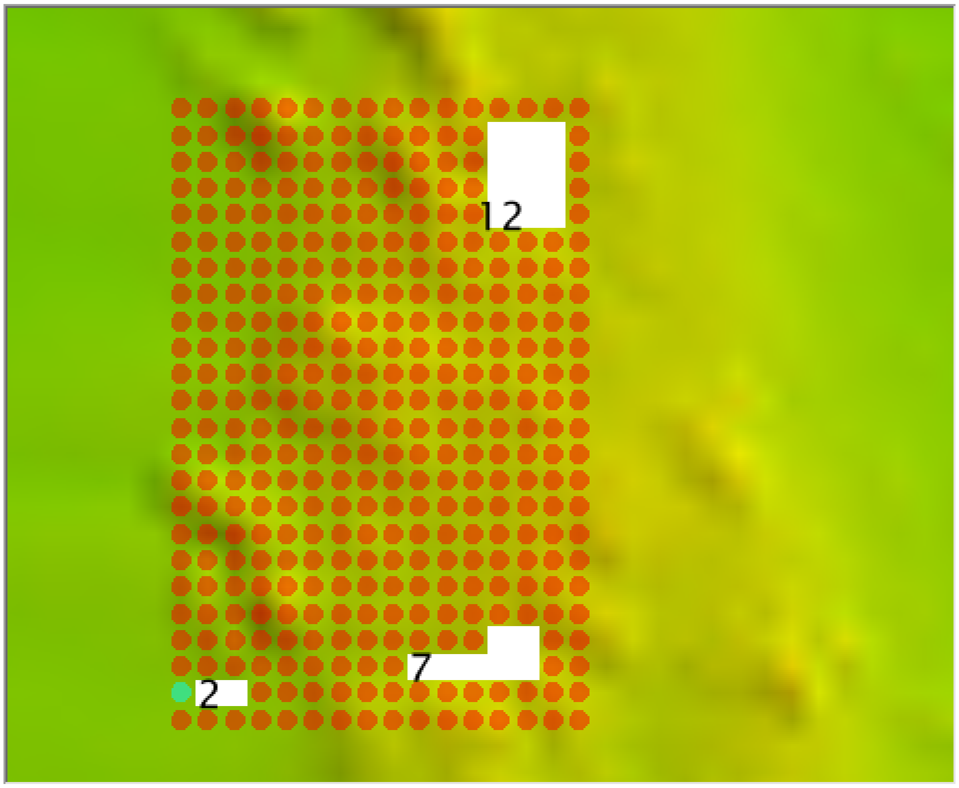


Fig. 2.13: Example for All holes.

- In the example in (Fig. 2.14), Object Detection requirements identify the holes of 12 and 7 nodes, because each has 3 collinear, contiguous unpopulated nodes. The hole with 2 grids does not.
- In the example in (Fig. 2.15), Full Coverage requirements identify the hole of 12 grid nodes, because there it contains an instance of 3x3 unpopulated grid nodes. The holes with 7 and 2 nodes do not.

A candidate hole is flagged with a "1" (if certain) or a "2" (possible holiday).

Note that the default **Upper holiday area limit (as multiple of minimum holiday size)** is set to unlimited, meaning that an unpopulated part of the grid will be flagged independently of its size. This setting exists so the search can be refined at the user's discretion.

For example:

- If desired to search for only the smallest of holidays, the **Upper holiday area limit** might be set at **100**.
- If desired to flag all unpopulated parts of the grid, regardless of their size, the **Upper limit** would be set at **unlimited**.
- Settings in between are used at the discretion of the user, to identify holidays, while also preventing undue clutter in the output.

2.1.5 Grid QA

How To Use?

Computes grid statistics to ensure compliance to uncertainty and density requirements.

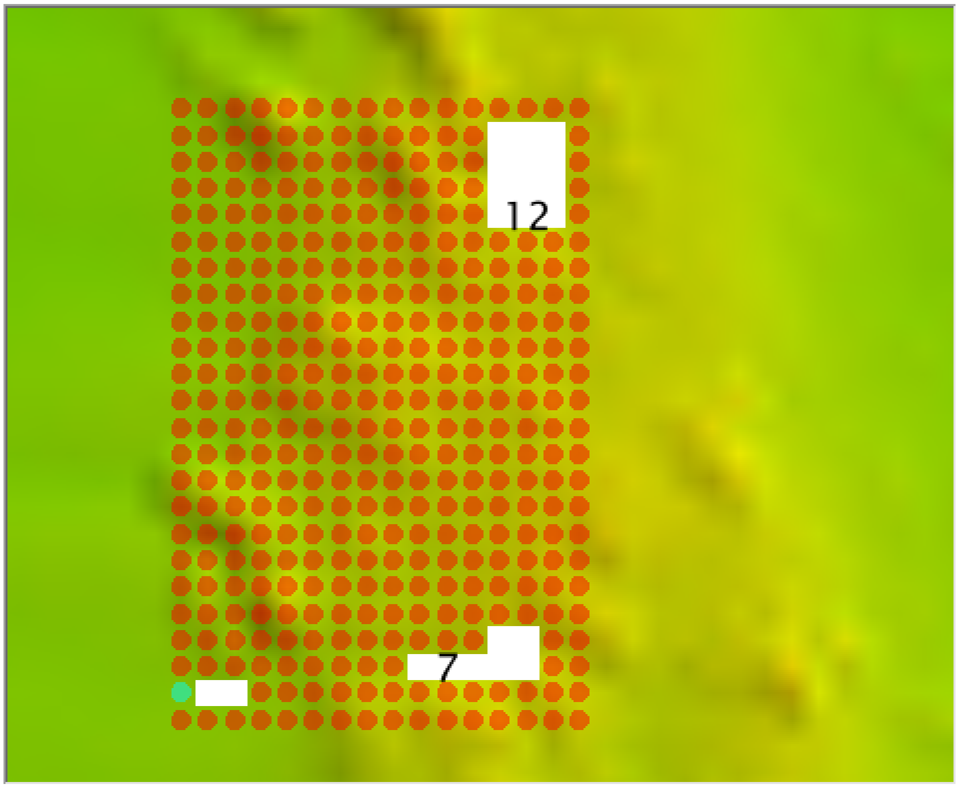


Fig. 2.14: Example for Object detection.

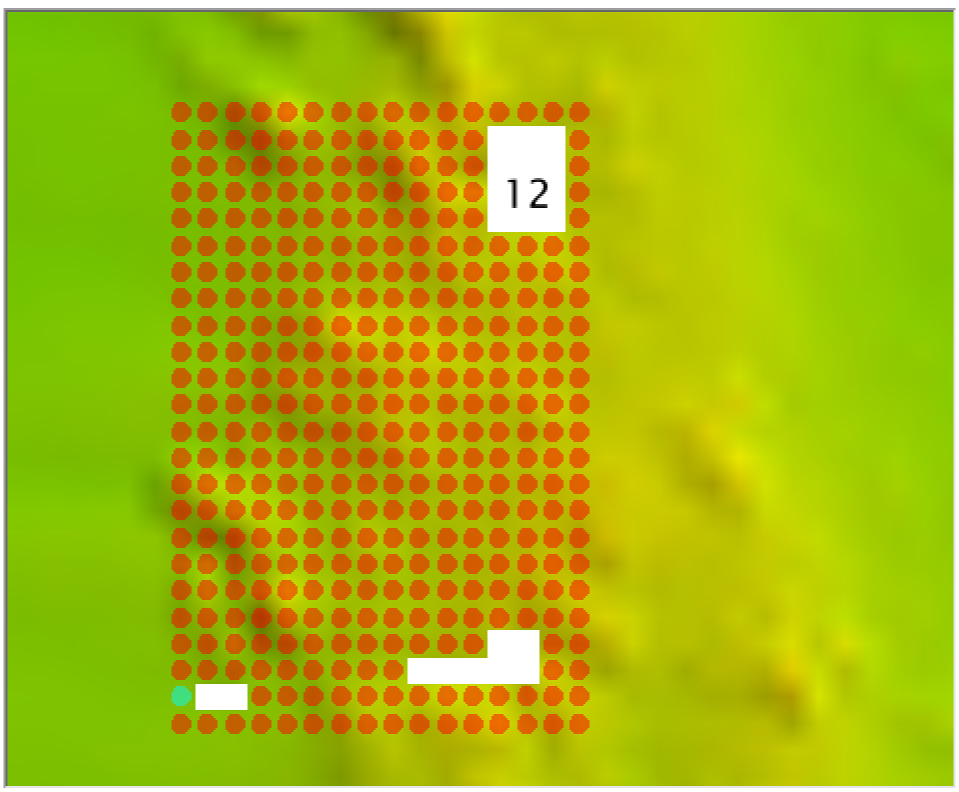


Fig. 2.15: Example for Full coverage.

- Select the **Grid QA** tab (Fig. 2.16) on the bottom of the QC Tools interface.
- In **Parameters**, check the box to calculate the TVU QC layer regardless of whether or not the grid contains the layer already.
- For **Grid QA v5**, it is also possible to select the plots to create.
- In **Execution**, click **Grid QA v4** or **Grid QA v5**.

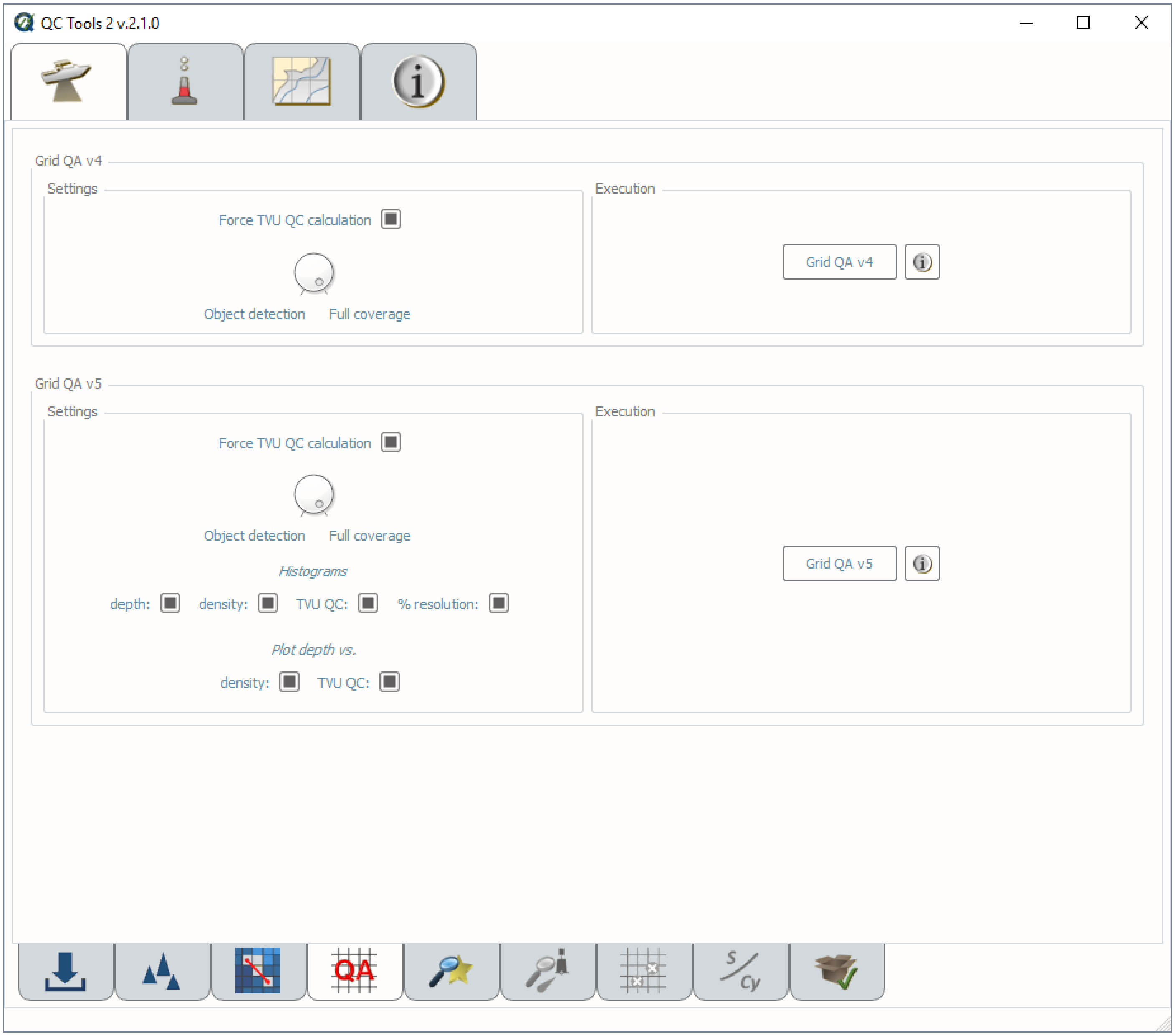


Fig. 2.16: The **Grid QA** tab.

- After computing, the output window opens automatically, and the results are shown (Fig. 2.17).
- From the output window, view each plot to assess the grid compliance to uncertainty and density specifications.

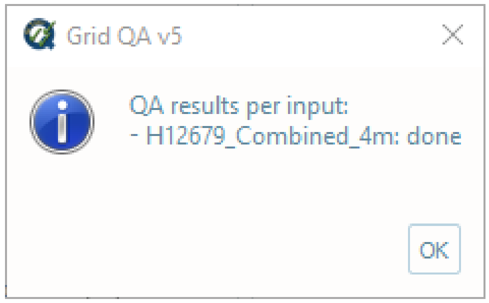


Fig. 2.17: The output message at the end of **Grid QA v5** execution.

How Does It Work?

The Depth, Uncertainty, Density (if available), and a computed Total Vertical Uncertainty (TVU) QC layer (optional) are used to compute particular statistics shown as a series of plots.

The TVU QC is either given to the program in the grid input, or calculated on-the-fly. It is determined by a ratio of uncertainty to allowable error per NOAA and IHO specification:

$$TVU\,QC = Uncertainty/\sqrt{A^2 + (B * Depth)^2}$$

where $A = 0.5, B = 0.013$ for Order 1 (depths less than 100 m), and $A = 1.0, B = 0.023$ for Order 2 (depths greater than 100 m).

The following plots are the output of Grid QA:

- The Depth layer is plotted as a distribution (plot entitled **"Depth Distribution"**).
- The Density layer is plotted as a distribution (plot entitled **"Object Detection Coverage"**).
  - Percentages of nodes less than 5 soundings per node fall in the red shaded region of the plot and together must be less than 5% of all nodes in order to "pass".
- Density is plotted against the corresponding Depth of the node (plot entitled **"Node Depth vs. Sounding Density"**).
- TVU QC is plotted as a distribution (plot entitled **"Uncertainty Standards"**).
  - Percentages of nodes with TVU QC greater than 1.0 (indicating that the allowable error has been exceeded) fall in the red shaded region of the plot, and together must be less than 5% of all nodes in order to "pass".
- TVU QC is plotted against the corresponding Depth of the node (plot entitled **"Node Depth vs. TVU QC"**).
- Only for Variable Resolution grids, an histogram with the percentage of nodes at the prescribed resolution is creted.

2.1.6 Scan Designated

How To Use?

Scans grids to ensure the validity of any soundings designated. Currently, only **Single-Resolution BAG** files are supported.

- Select the **Scan Designated** tab (Fig. 2.18) on the bottom of the QC Tools interface.
- In **Parameters**:
  - Turn the knob to select the applicable year as pertaining to required NOAA NOS Hydrographic Survey Specifications and Deliverables (HSSD).
  - Enter the **Survey scale**. Any designated soundings that have a more shoal designated sounding within 2mm at survey scale will be flagged as invalid.
  - Check the box **Evaluate neighborhood** as an estimate of designated sounding height 1 meter off the seafloor. Note this is a subjective check to be overrided by the hydrographer's discretion.
- In **Execution**, click **Designated Scan v2**.

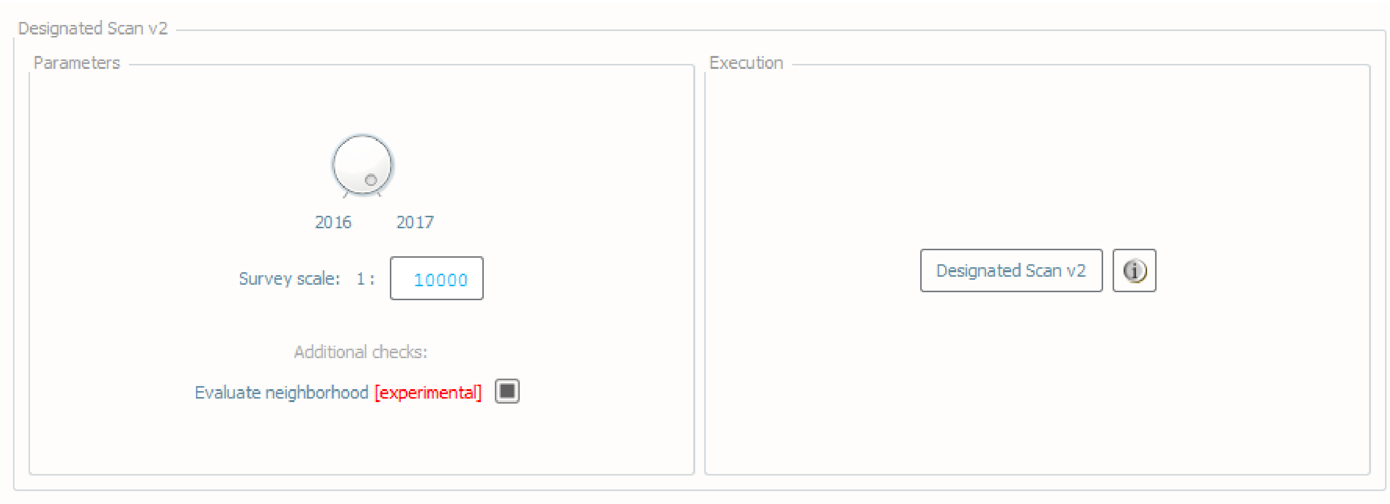


Fig. 2.18: The **Scan Designated** tab.

- After computing, the output window opens automatically.
- From the output window, drag-and-drop the output into the processing software to guide the review.
- The output names adopt the following convention:
  - [grid filename].[s57 filename].DESIGNATED_SCAN_v2.[HSSD year]

How Does It Work?

The grid is scanned to ensure the validity of designated soundings per NOAA NOS HSSD. The three requirements for validity are:

1. Height of the sounding above the grid that is more than:
    - half the allowable TVU (in depths < 20 meters) or the full allowable TVU (in depths >= 20 meters) *[2016]*.
    - the full allowable TVU *[2017]*.

The grid nodes are scanned and any node with a depth adjusted by designated sounding is checked to ensure that the difference between the original depth and the new depth (i.e. the designated depth) meet the requirement as related to TVU.

As shown in the example in Fig. 2.19, the vertical distance between the grid and the designated sounding (0.134 m) is less than half the allowable TVU for this depth (0.269 m based on HSSD 2016), thus designation of this sounding was not necessary.

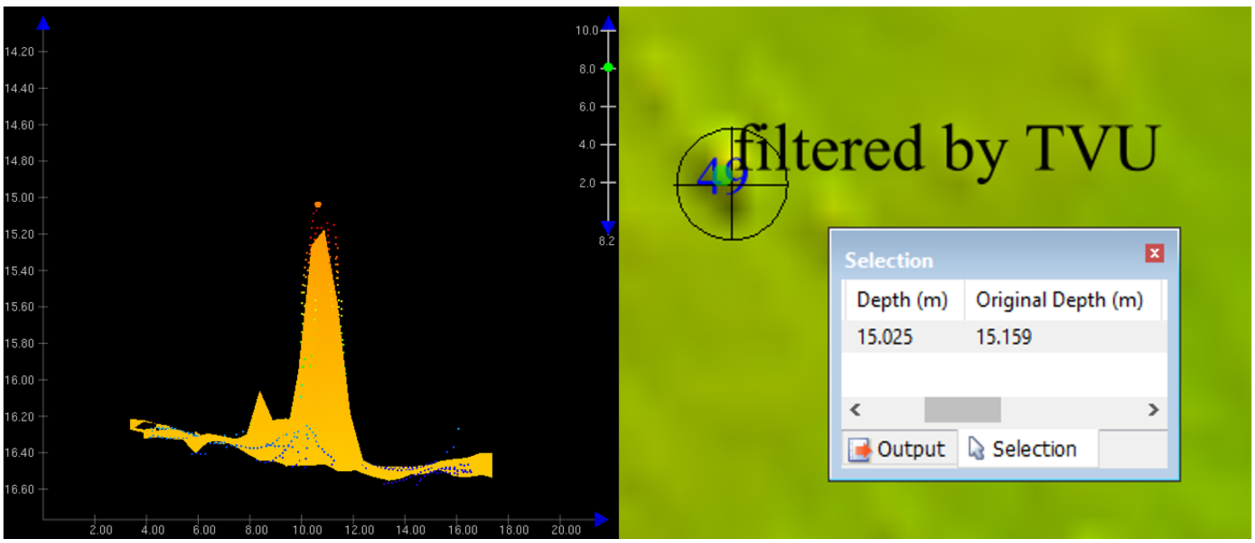


Fig. 2.19: First example of unnecessary designation.

2. No sounding designated within 2mm at survey scale that is more shoal.

As shown in the example in Fig. 2.20, at the survey scale of 1:20,000, there is a more shoal sounding designated (51 feet) approximately 31 meters away, which is within 2mm at survey scale (40 meters), thus the designated sounding of 53 feet is not necesssary.

3. A height of 1 meter or more off the seafloor.

As shown in the example in Fig. 2.21, the designated sounding appears less than 1 meter off the seafloor when viewed in both sounding and grid data. This check is not definitive, however, and should only be used if useful. The hydrographer's discretion may override the output.

Finally, a designated sounding is valid if a feature exists within 1 grid node and that feature has a VALSOU value within 1 centimeter of difference from the designated sounding depth.

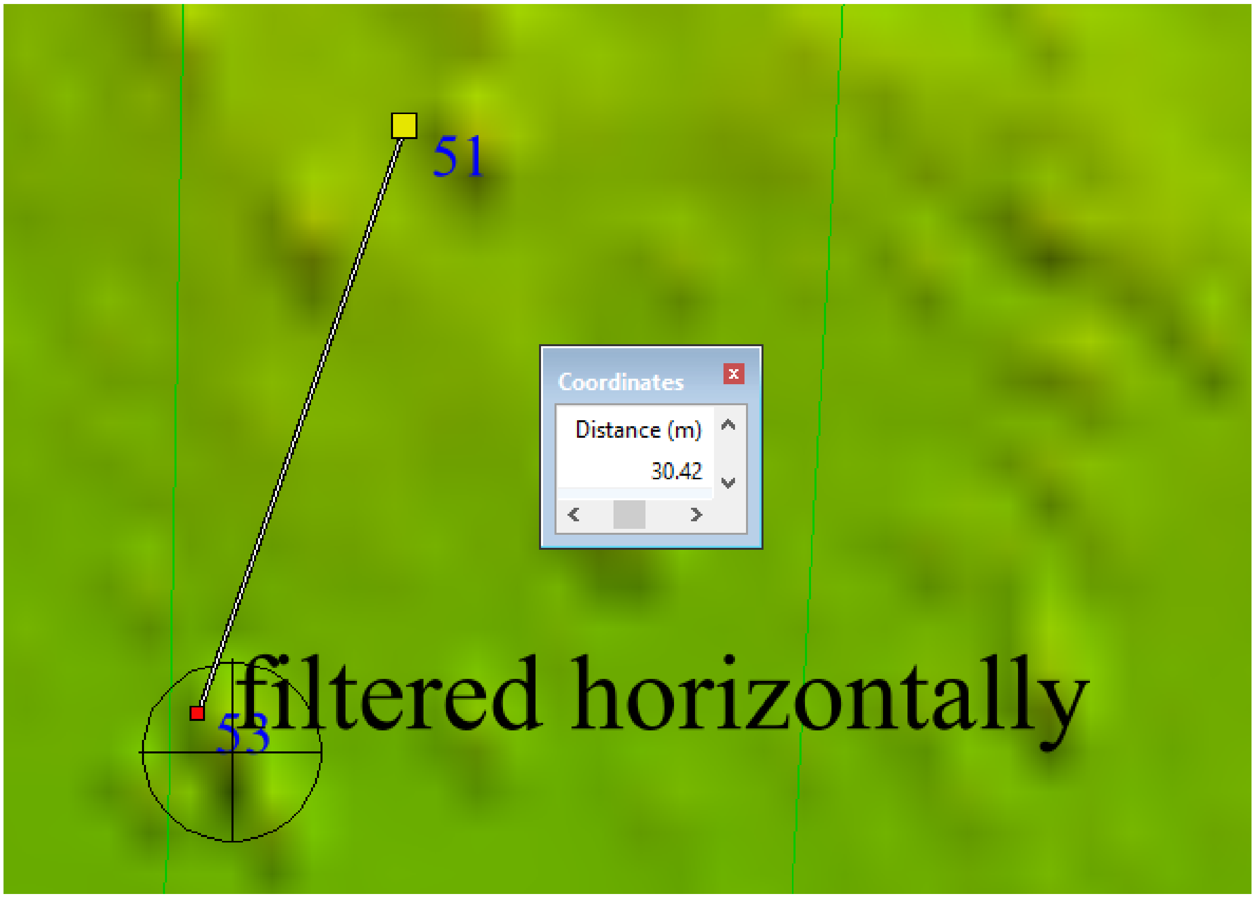


Fig. 2.20: Second example of unnecessary designation.

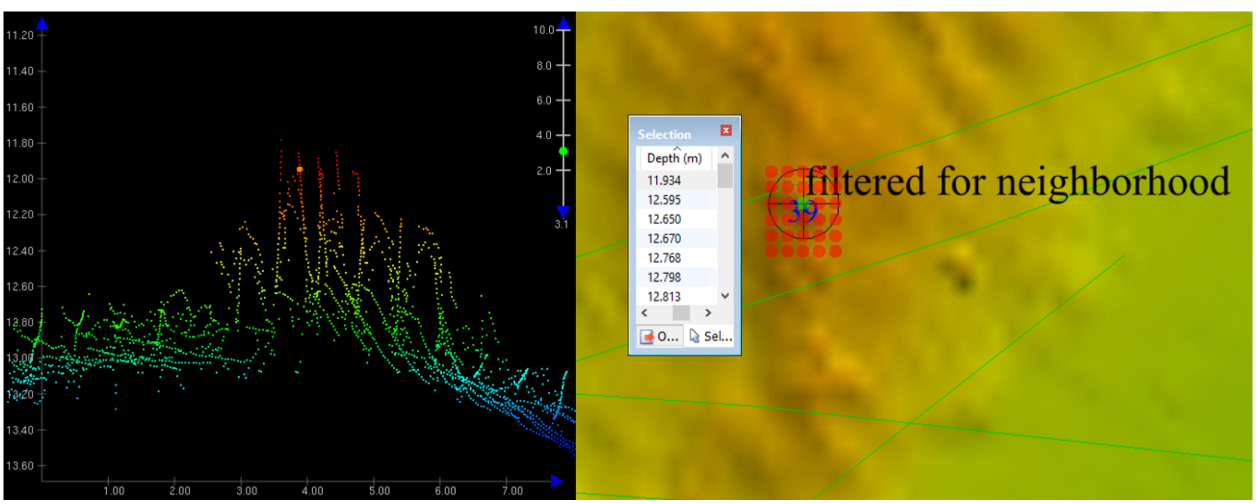


Fig. 2.21: Example of possible unnecessary designation.

2.1.7 Scan PRF

How To Use?

Scan PRF to ensure validity.

How Does It Work?

The S-57 features are scanned to ensure proper attribution.

2.1.8 Scan features

How To Use?

Scan features to ensure proper attribution.

- Select the **Scan features** tab (Fig. 2.22) on the bottom of the QC Tools interface.
- In **Parameters**:
    1. Turn the knob to select either the **Office** or **Field** profile.
    2. Turn the knob to select the applicable year as pertaining to required Hydrographic Survey Specifications.
- In **Execution**, click **Feature scan v7** (note that the '2018 test' option is used to experiment with future requirements).
- After computing, the output window opens automatically, and the results are shown (Fig. 2.23).
- From the output window, drag-and-drop the output into the processing software to guide the review.
- In addition, the results are printed to PDF for a documented summary.

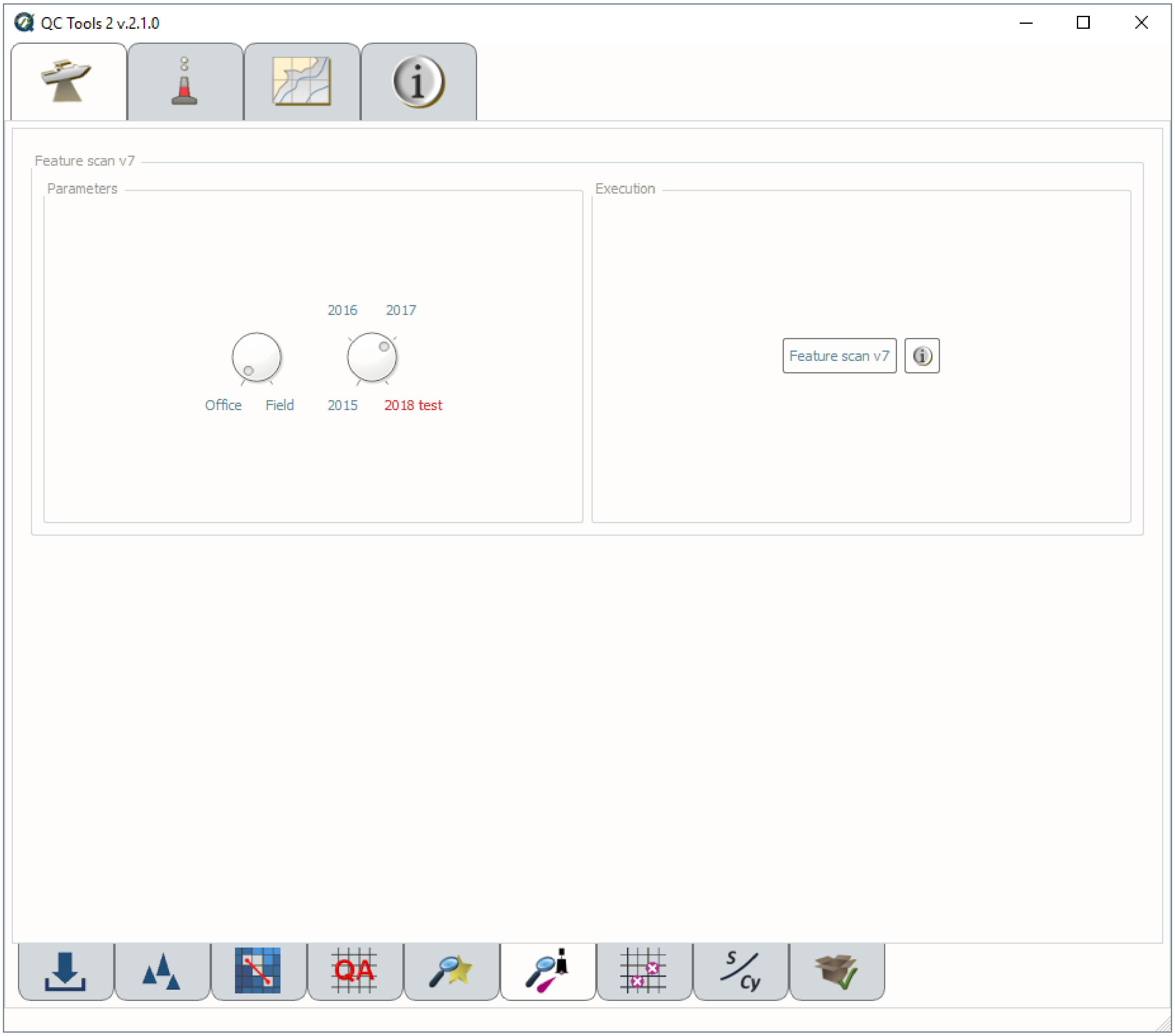


Fig. 2.22: The **Scan features** tab.

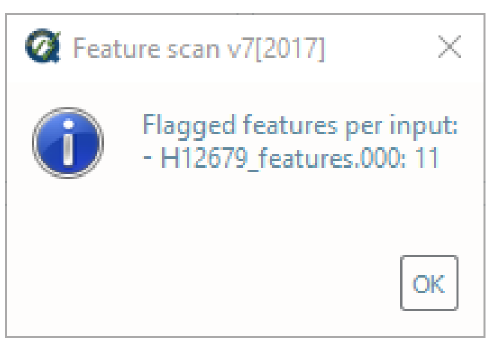


Fig. 2.23: The output message at the end of **Find holiday v4** execution.

How Does It Work?

The S-57 features are scanned to ensure proper attribution per the required year of NOAA Hydrographic Survey Specifications. Listed within the specifications are mandatory S-57 attribution.

The logic for the 2017 QC Tools feature scan is shown below. For previous years, consult the HSSD for that year.

- Check to ensure no feature redundancy.
- **Source features = all new and updated features except "$AREAS", "$LINES", "$CSYMB", "$COMPS", and "$TEXTS".**
  - All Source features must have **"SORIND"** and **"SORDAT"** in the proper formats.
- **Assigned features = all features with "asgnmt" = 2.**
  - All Assigned features must have **"descrp"** and **"remrks".**
- **New or Deleted features = all features with "descrp" = 1 or 3.**
  - All New or Deleted features must have **"remrks"** and **"recomd".**
- **Sounding features = all SOUNDG.**
  - All Sounding features must have **"TECSOU"** and **"QUASOU".**
- **DTONs = all features with "descrp" = 1 or 2, "sftype" = 3, and excludes SOUNDG.**
  - All DTONs must have **"images".**
- **Wrecks = all WRECKS with "descrp" = 1 or 2.**
  - All Wrecks must have **"images", "CATWRK", "WATLEV", "VALSOU", "TECSOU",** and **"QUASOU".**
- **Rocks = all UWTROC with "descrp" = 1 or 2.**
  - All Rocks must have **"WATLEV", "VALSOU", "QUASOU",** and **"TECSOU".**
- **Obstructions = all OBSTRN with "descrp" = 1 or 2.**
  - All Obstructions must have **"images", "WATLEV", "VALSOU", "QUASOU",** and **"TECSOU".**[1]
- **Offshore platforms = all OFSPLF with "descrp" = 1 or 2.**
  - All Offshore platforms must have **"images".**
- **Non-sounding features = all features except "SOUNDG".**
  - All Non-sounding features must have **"onotes".**[2]
- **Seabed area points = all SBDARE with point geometry.**
  - All Seabed area points must have **"NATSUR".**
  - All Seabed area points must have as many **"NATSUR"** attributes as **"NATQUA"** and/or **"COLOUR".**
  - All Seabed area points must have an allowable combination of **"NATSUR"** and **"NATQUA".**[3]
- **Seabed area lines and areas = all SBDARE with line or area geometry.**
  - All Seabed area lines and areas must have **"NATSUR"** and **"WATLEV".**
- **Additional:**

[1] Obstructions of **"CATOBS"** = 6 (foul area) do not require **"images".**
[2] Specific to the **'office'** profile
[3] Allowable combinations of **"NATSUR"** and **"NATQUA"** are shown below.

- All **MORFAC** must have **“CATMOR”.**
- All **COALNE** must have **“CATCOA”.**
- All **SLCONS** must have **“CATSLC”.**
- All **LNDELV** must have **“ELEVAT”.**
- All **M_COVR** must have **“CATCOV”, “INFORM”,** and **“NINFOM”.**

NATQUA		1	2	3	4	5	6	7	8	9	10
N	1					o	o	o	o	o	o
A	2					o	o	o			o
T	3					o	o	o			o
S	4	o	o	o			o		o	o	o
U	5								o	o	
R	6								o	o	
	7								o	o	
	8								o	o	
	9								o	o	
	11								o		
	14				o						
	17				o					o	
	18								o	o	

NATQUA: fine (1), medium (2), coarse(3), broken (4), sticky (5) soft (6), stiff (7), volcanic (8), calcareous (9), hard (10)

NATSUR: mud (1), clay (2), silt (3), sand (4), stone (5), gravel (6), pebbles (7), cobbles (8), rock (9), lava (11), coral (14), shells (17), boulder (18)

2.1.9 VALSOU checks

How To Use?

Ensure surveyed features are properly accounted for in the gridded bathymetry.

- Select the **VALSOU check** tab (Fig. 2.24) on the bottom of the QC Tools interface.
- In **Parameters**:
  - Turn the knob to select the applicable year as pertaining to required NOAA NOS Hydrographic Survey Specifications and Deliverables (HSSD).
  - Enter in the applicable survey scale (e.g. 10,000 or 20,000, etc.).
  - The **Deconflict across grids** checkbox may be enabled if the grids that are loaded have overlaps. If a feature has no grid data directly underneath, the nodes of the other grids in memory will be searched to find a valid match.
  - The **Include TECSOU=laser** checkbox may be enabled (in the event of lidar bathymetry wherein we’d expect features to be represented in the grid), or disabled (as in the case of shoreline investigations wherein we’d not have this expectation).

Note: There are currently not differences between the checks applied for NOAA NOS HSSD 2016 and 2017.

- In **Execution**, click **VALSOU check v6**

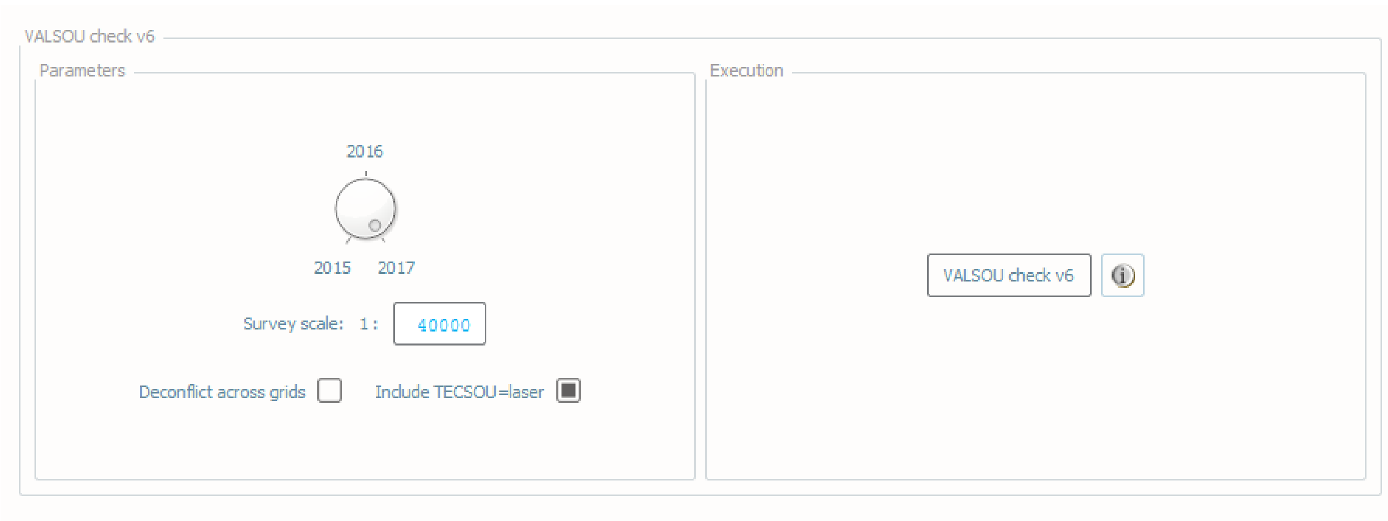


Fig. 2.24: The **VALSOU check** tab.

- After computing, the output window opens automatically, and the results are shown (Fig. 2.25). Note, the check considers all combination of grids and features files loaded. If there is no overlap found between a grid and feature file, no output is generated, and the summary will report "no overlap".

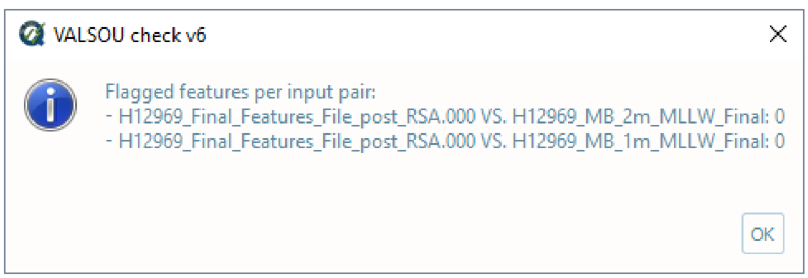


Fig. 2.25: The output message at the end of **VALSOU check v6** execution.

- From the output window, drag-and-drop the output into the processing software to guide the review.
- The output names adopt the following convention:
  - [grid filename].[s57 filename].VCv6.[version].[scale][".las" if **Include TECSOU=laser**][".dec" if **Deconflict across grids**]

How Does It Work?

The grid is scanned for features expected to be represented in the grid as per specification; in this case, the 2015, 2016 or 2017 NOAA NOS HSSDs. These features are new or updated wrecks, rocks, and obstructions, and a grid node should be found that agrees with the feature VALSOU. In most cases, this grid node should located within one grid resolution horizontally, though in some cases (such as features not submerged) this requirement is relaxed, so the grid node may be within 2mm at survey scale to the feature.

The VALSOU checks logic is shown in Fig. 2.26.

The following is an example to illustrate the search radius, and the possible results, from a feature evaluated under relaxed positioning criteria, which is 2mm at survey scale.

- First, we understand the radii involved. In the circles in Fig. 2.27, the inner radius is 2mm at survey scale, and we require the feature to reside in this radius. The outer radius is 4mm at survey scale, and this is the extent to which the grid will be searched for the feature in question.
- In Fig. 2.28, the feature is located in the center of the grid, with a VALSOU = 1.67m. We find a grid node within the inner radius with a depth of 1.67m, thus there is both a depth and location match.
- In Fig. 2.29, the feature is located in the center of the grid, with a VALSOU = 1.67m. We find a grid node within the search radius with a depth of 1.67m, however, it is outside of the inner radius. The depth match is found, however, the location is marked as a discrepancy.
- In Fig. 2.30, the feature is located in the center of the grid, with a VALSOU = 1.65m. We do not find this grid node within the search radius, so there is a depth discrepancy. However, the grid node closest in value to 1.67 is found within the inner radius, so the location check passes.
- In Fig. 2.31, the featue is located in the center of the grid, with a VALSOU = 1.67m. We do not find this grid node within the search radius, so there is a depth discrepancy. Furthermore, the grid node closest in value to the feature VALSOU resides outside of the inner search radius, so a location discrepancy is also given.

In the case of the more stringent positioning requirement, the above logic still applies, and the search radius is 4mm at survey scale; however, the inner search radius (equivalent to the grid resolution) is much smaller.

Note: If the input grid files follow the NOAA OCS naming convention (e.g., having "_1m_" in the filename), this information is retrieved and used to only evaluate the features with VALSOU value in the corresponding validity range (e.g., 0 - 20 m).

2.1.10 SBDARE export

Export bottom samples to a text file for archival.

- Select the **SBDARE export** tab on the bottom of the QC Tools interface.
- Click **SBDARE export v3** (Fig. 2.32).
- After computing, the output window opens automatically, and the results are shown (Fig. 2.33):
- The output is in the proper format for archival.

2.1.11 Submission checks

How To Use?

Ensures the required directory structure and completeness of survey deliverables.

- Select the **Submission checks** tab on the bottom of the QC Tools interface.
- Drag-and-drop (or browse **"+"** to) the directory to be examined. This can be at the survey level (**"X#####"**), or it can be at the project reports level (**"Project_Reports"**). Alternatively, the root folder may be at the project level

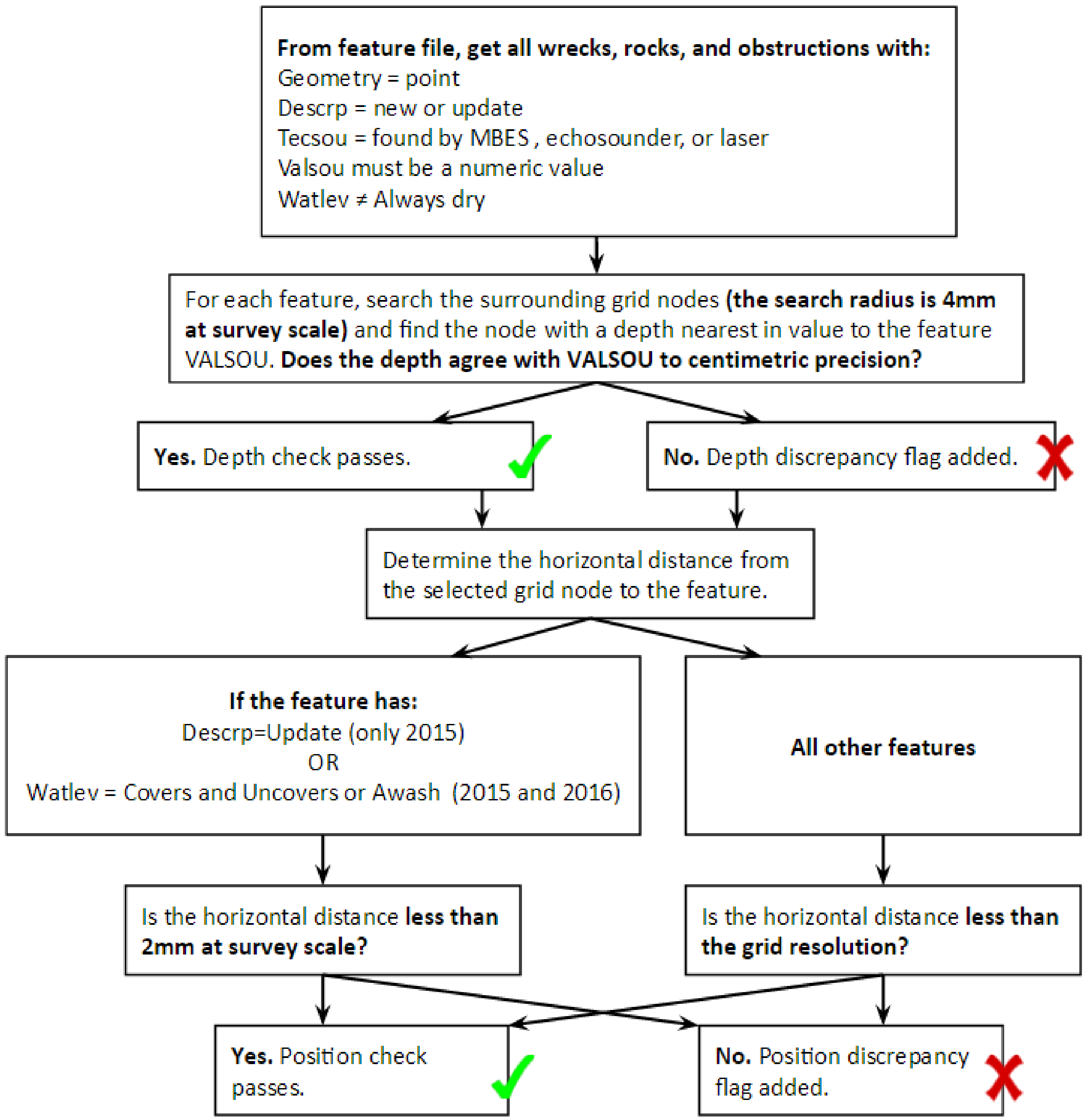


Fig. 2.26: VALSOU check logic.

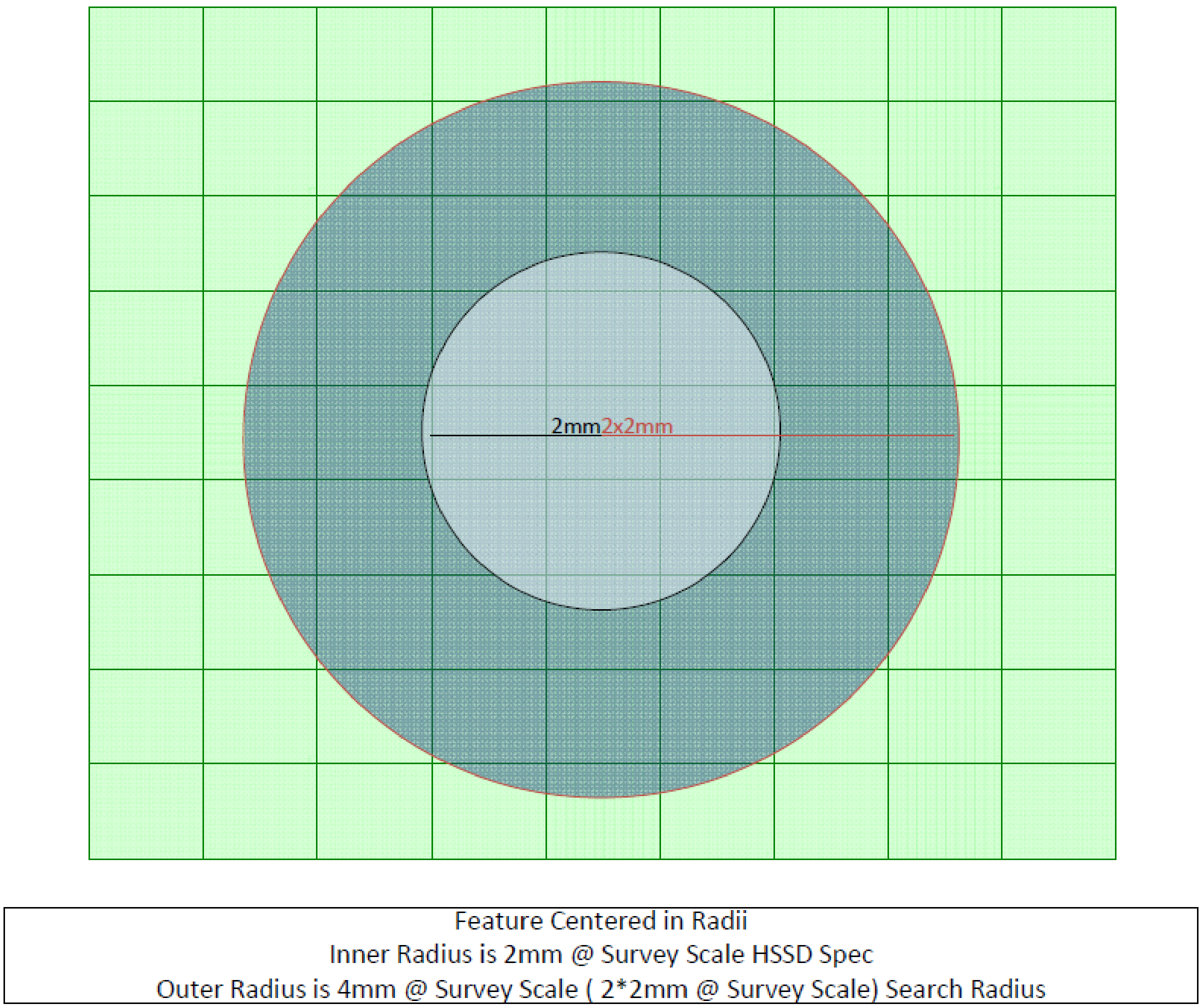


Fig. 2.27: VALSOU check's radii.

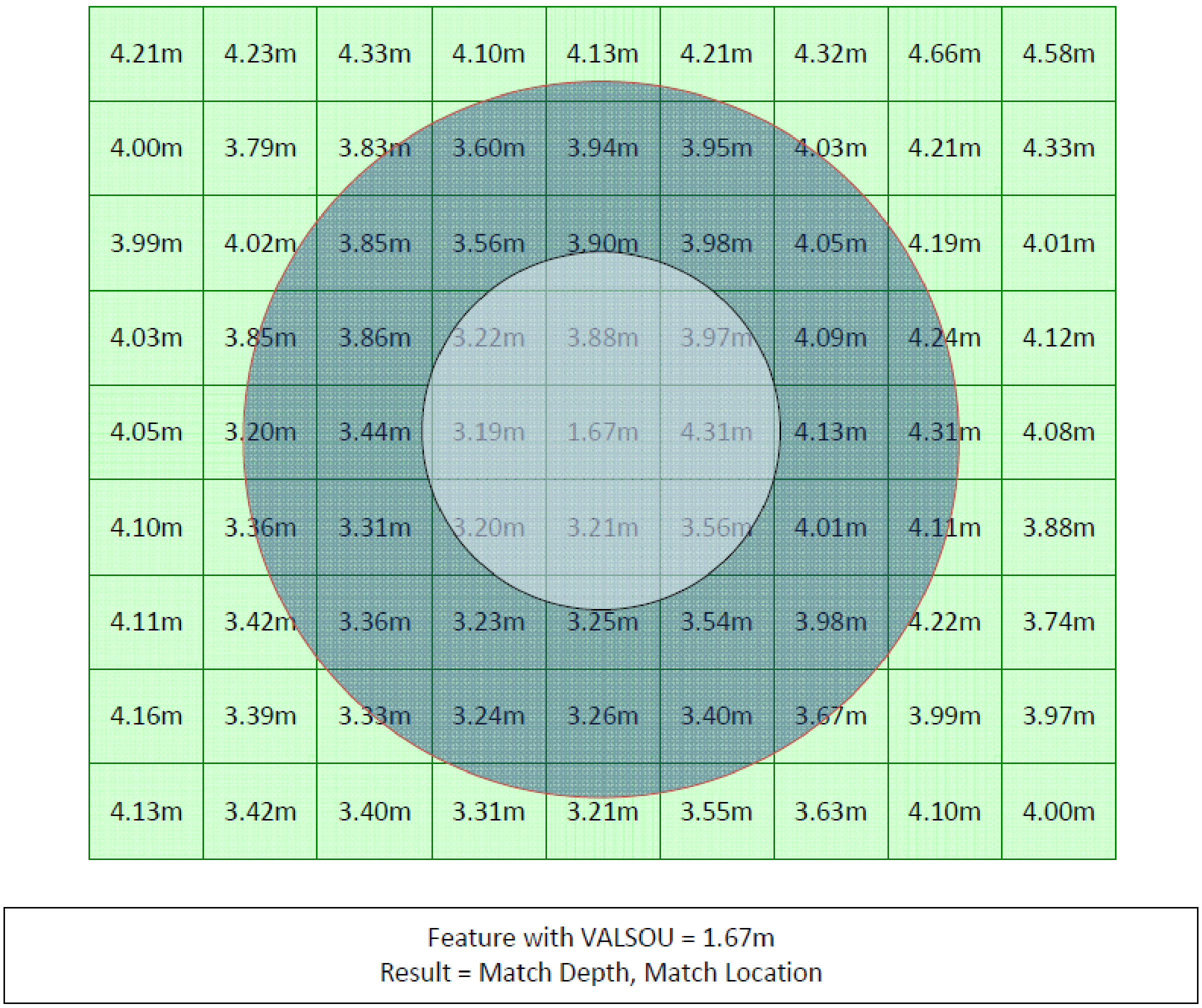


Fig. 2.28: Depth and location match.

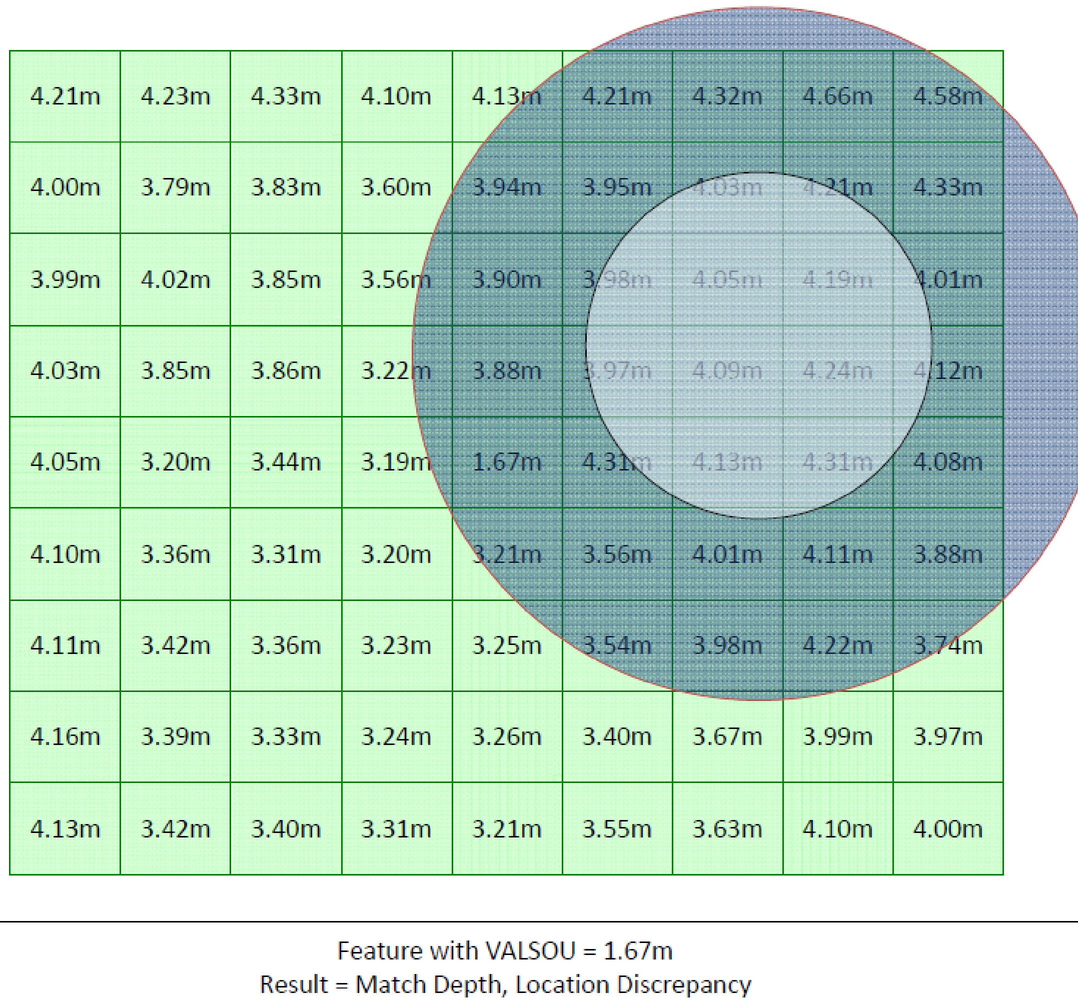


Fig. 2.29: Depth match only.

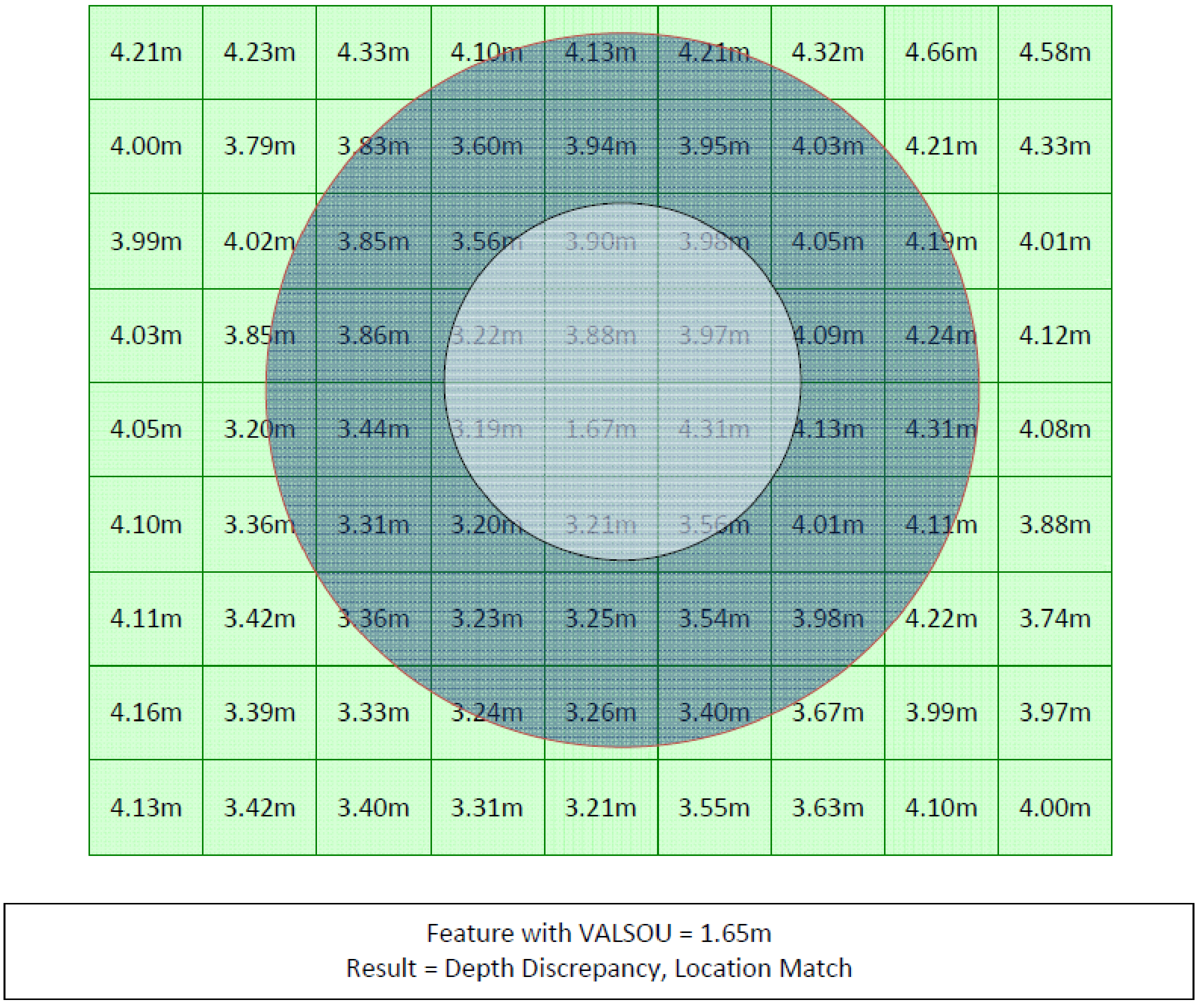


Fig. 2.30: Location match only.

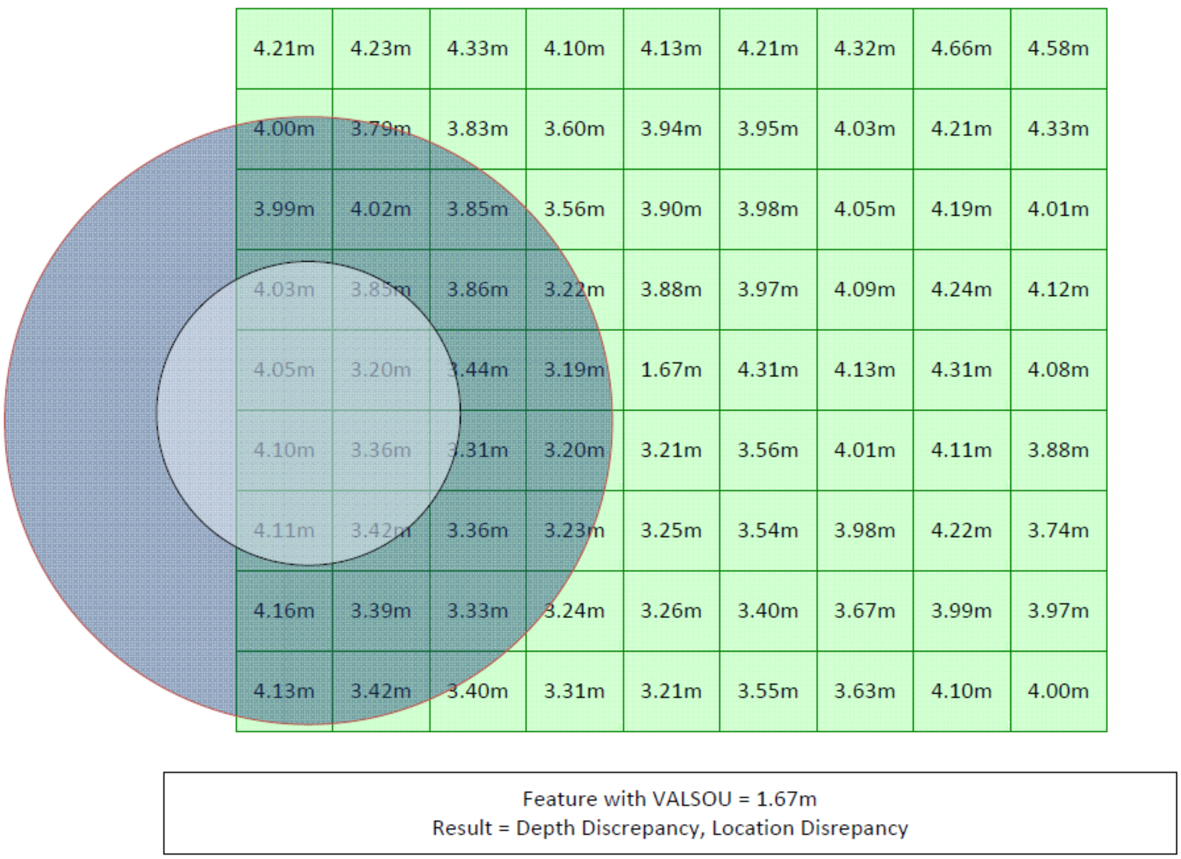


Fig. 2.31: No match.

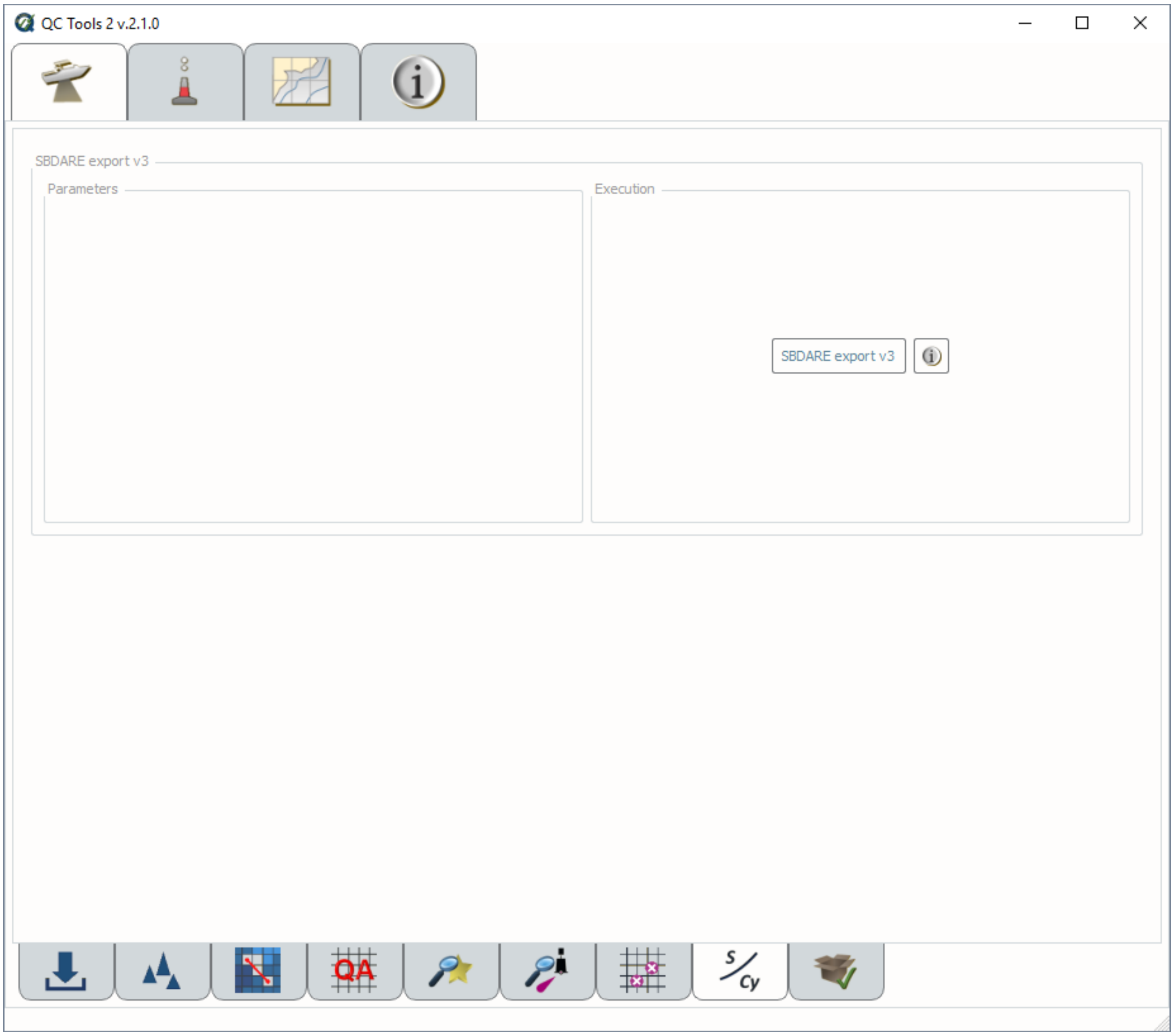


Fig. 2.32: SBDARE export's interface.

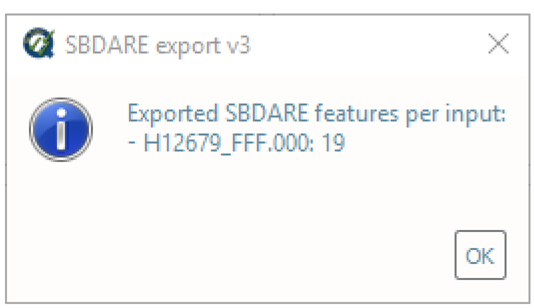


Fig. 2.33: SBDARE export's output message.

(**"OPR-X###-XX-##"** or **"S-X###-XX-##"**), which will then examine all survey folders and project reports found within.

- In **Parameters** (Fig. 2.34, left side):
  - Turn the knob to select either the **Field** or **Office** profile.
  - Turn the knob to select either **Exhaustive** or **Recursive** settings. If an error is found, **Recursive** will stop at the level of the error; conversely, **Exhaustive** will continue to check sub-folders that are likely to perpetuate the error found at the higher level.
  - Turn the knob to select the applicable year as pertaining to required Hydrographic Survey Specifications.
  - Flag the **Non-OPR project** check if the submission survey folder does not start with **OPR-**.
- In **Execution** (Fig. 2.34, rigth side), click **Submission checks v3**.

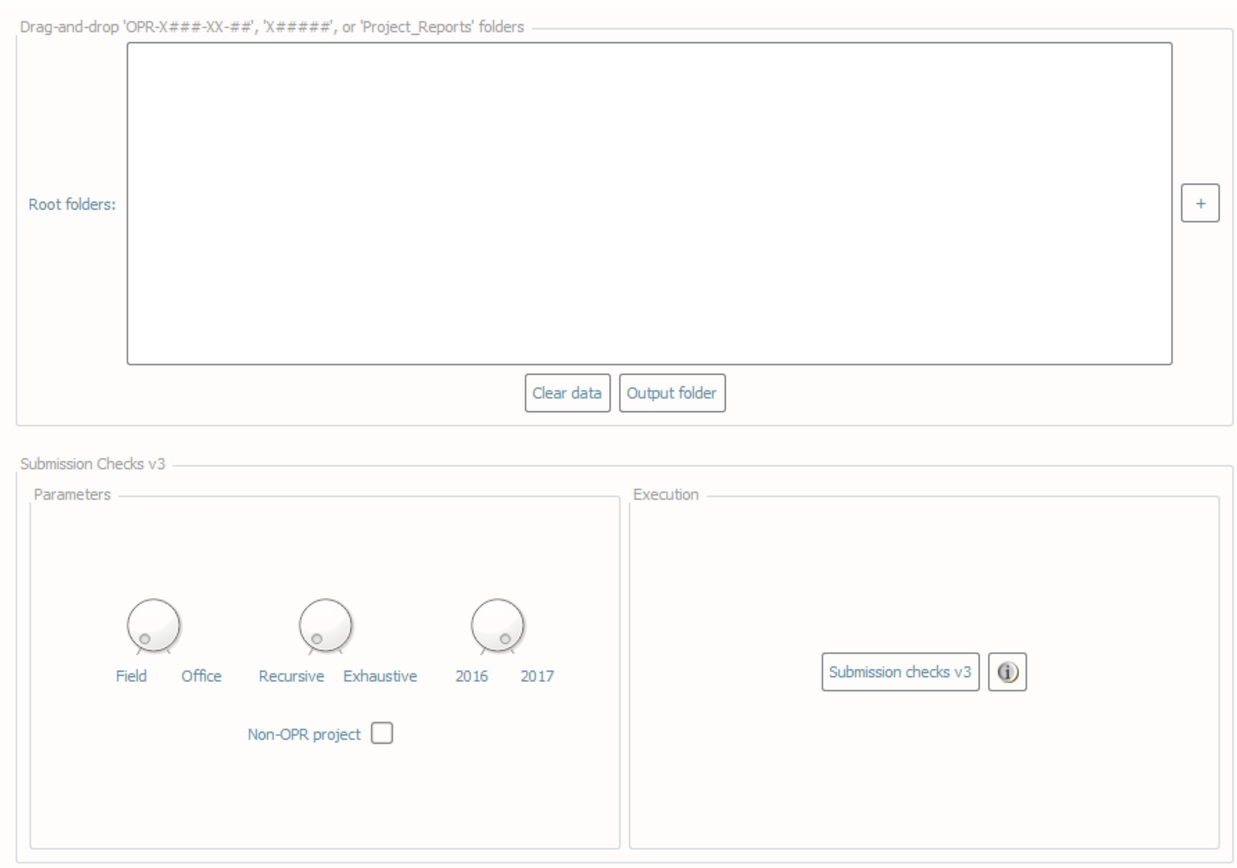


Fig. 2.34: The **Submission check** interface.

- After computing, the output window opens automatically, and the results are shown (Fig. 2.35).
- Note that the project level (**"OPR-X###-XX-##"**) contains all the results from the surveys (**"X#####"**) and project reports (**"Project_Reports"**) contained within; thus the number of errors and warnings is equivalent to the sum of the individual components.
- The results are printed to PDF, one for each root folder.
- The output names adopt the following convention:
  - [project].SCv3.["project" | "X#####" | "report"].[HSSD].[profile].["rec" for recursive | "exh" for exhaustive]

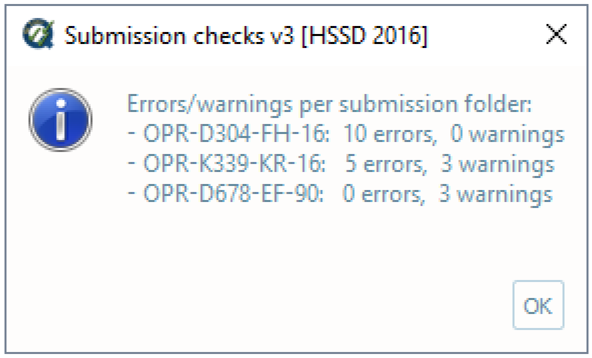


Fig. 2.35: The **Submission check** output message.

How Does It Work?

Root folders have the following requirements:

- A project root folder must be in the format of **"OPR-X###-XX-##"** or **"OPR-X###-XX-##_Locality_Name"** (unless the **Non-OPR project** check is on).
- A survey root folder must be in the format of **"X#####"** or **"X#####_Sublocality_Name"**.
- A project reports root folder must be in the format of **"Project_Reports"**.

The ensuing submission check will scan the directories of the root folders to ensure compliance with Appendix J of NOAA Hydrographic Survey Specifications.

For version 2016:

- **OPR-X###-XX-##**
  - **X#####**[1]
    - **Data**[1]
      - **Preprocess**[1]
        - Backscatter
        - **Bathymetry**
          - MBES
          - SBES
        - Features
        - Positioning
        - SSS

[1] Subfolders will not be checked if an error is found at this level (**Recursive** setting only).

            · SVP
        · **Processed**[1]
            · Bathymetry_&_SSS
            · **GNSS_Data**
                · SBET
            · Multimedia
            · **S-57 Files**[2]
                · Final_Feature_File
                · Side_Scan_Sonar_Contacts
            · SVP
            · Tide
        · **Separates**[1]
            · **I_Acquisition_&_Processing_Logs**
                · Acquisition_Logs
                · Detached_Positions
                · Processing_Logs
            · **II_Digital_Data**
                · Checkpoint_Summary_&_Crossline_Comparisons
                · Sound_Speed_Data_Summary
        · **Descriptive_Report**[1]
            · Report
            · **Appendices**
                · I_Tides_&_Water_Levels
                · II_Supplemental_Survey_Records_&_Correspondence
        · Public_Relations_&_Constituent_Products
– **Project_Reports**[1]
    ∗ **Data_Acquisition_&_Processing_Report**
        · Report
        · Appendices
    ∗ **Horizontal_&_Vertical_Control_Report**
        · Digital_A-Vertical_Control_Report
        · **Digital_B-Horizontal_Control_Report**
            · ATON_Data
            · Base_Station_Data
    ∗ Project_Correspondence

[2] If this folder is instead given as **S-57_Files** (rather than **S-57 Files**) a warning is raised.

For version 2017:

- **OPR-X###-XX-##**
  - **X#####**[1]
    - **Data**[1]
      - **Preprocess**[1]
        - Features
        - MBES
        - SBES
        - SSS
        - SVP
      - **Processed**[1]
        - **GNSS_Data**
          - SBET
        - Multimedia
        - **S-57_Files**
          - Final_Feature_File
          - Side_Scan_Sonar_Contacts
        - **Sonar_Data**
          - Surfaces_&_Mosaics
          - **HDCS_Data**[3]
            - VesselConfig[3]
            - X#####[3]
          - VesselConfig[4]
          - X#####[4]
        - SVP
        - Water_Levels
      - **Separates**[1]
        - **I_Acquisition_&_Processing_Logs**
          - Acquisition_Logs
          - Detached_Positions
          - Processing_Logs
        - **II_Digital_Data**
          - Checkpoint_Summary_&_Crossline_Comparisons
          - Sound_Speed_Data_Summary
      - **Descriptive_Report**[1]

[3] For submissions with CARIS projects.
[4] For submissions withoout CARIS projects.

            · Report
            · **Appendices**
                · I_Water_Levels
                · II_Supplemental_Survey_Records_&_Correspondence
        · Public_Relations_&_Constituent_Products
- **Project_Reports**[1]
    * **Data_Acquisition_&_Processing_Report**
        · Report
        · Appendices
    * **Horizontal_&_Vertical_Control_Report**
        · Digital_A-Vertical_Control_Report
        · **Digital_B-Horizontal_Control_Report**
            · ATON_Data
            · Base_Station_Data
    * Project_Correspondence

Additional Checks:

- An empty folder will be flagged as an error.
- No filepaths may exceed 200 (field) or 260 characters (office).

2.2 DtoN Scanner

2.2.1 Overview

The **DtoN Scanner** tab will:

- Ingest an ENC and survey soundings (see *Data inputs*).
- Identify survey soundings with a shoal discrepancy as compared to the chart, evaluated via "triangle rule" (see *Triangle rule*).

2.2.2 Data inputs

Ingest an ENC (.000), and a survey soundings selection (.000).

- Select the **DtoN Scanner** tab on top of the QC Tools interface.

In **Data inputs:**

- Drag-and-drop an ENC (.000) onto the ENC field. The **"+"** browse button may also be used.
- Drag-and-drop a survey sounding selection (.000 only) onto the SS file field. The **"+"** browse button may also be used.
- The directory and filename of loaded data will populate in the respective field of **Data inputs**.
- With the addition of a ENC and sounding selection, the **Triangle Rule** tab on the bottom of the interface will become available (Fig. 2.36).

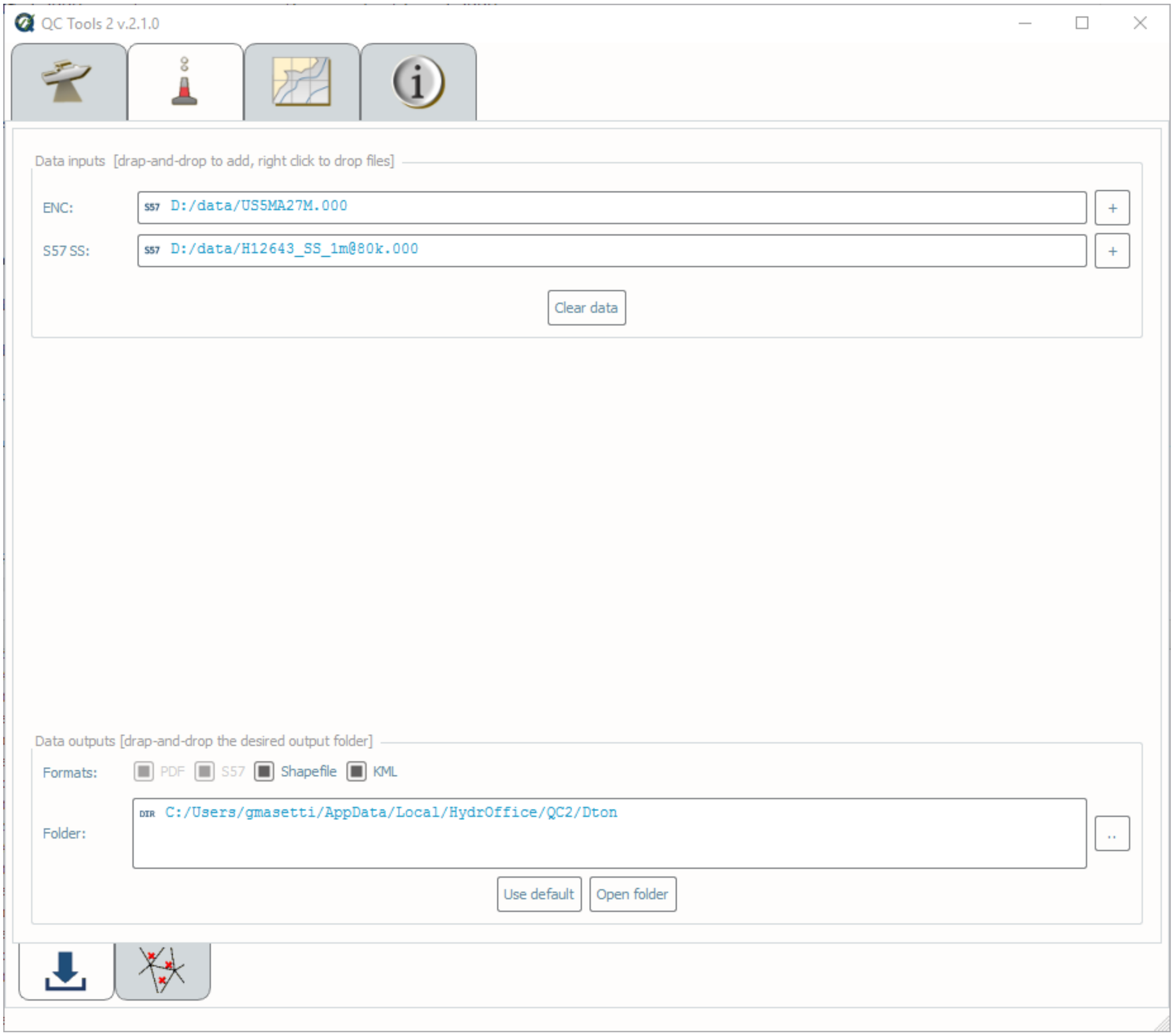


Fig. 2.36: DtoN tab.

- The **Clear data** button may be used to remove all data inputs.

In **Data outputs:**

- The output **Formats** may be customized. The user has the option to suppress **Shapefile** and **KML** output.
- The default output **Folder** location is listed; however, this may be modified via drag-and-drop (or browse to) a user-specified output folder. To return to the default output folder location, click **Use default**.
- The ensuing functions will open the output folder automatically upon execution; however, if needed, the specified output folder may be accessed by clicking the **Open folder** button.

2.2.3 Triangle rule

How To Use?

Identify survey soundings with a shoal discrepancy as compared to the chart, evaluated via "triangle rule".

- Select the **Triangle Rule** tab on the bottom of the QC Tools interface.
- In **Parameters** (Fig. 2.37, left side):
  - Check the **Use VALSOU features** checkbox if you wish for any feature VALSOUs to be included with the ENC soundings in the evaluation.
  - Check the **Use DEPCNT features** checkbox if you wish that points from the DEPCNT features are included with the ENC soundings in the evaluation.
  - Check the **Detect deeps** checkbox if you want that the deep discrepancies are also evaluated.
  - Set the **Force threshold (m)** value to set a minimum threshold in meters (only active when **Meters** units are selected).
  - Turn the knob to the applicable sounding units.
- In **Execution** (Fig. 2.37, right side), click **Triangle Rule v2**.

Fig. 2.37: DtoN's Triangle Rule interface.

- After executing, the output window opens automatically, and the results are shown by textbox (Fig. 2.38).

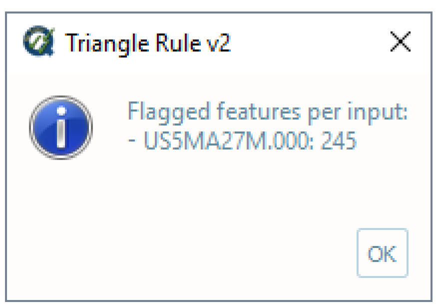


Fig. 2.38: DtoN's output message.

- After executing, the results are also shown graphically (Fig. 2.39). ENC soundings are colored by depth, and flagged survey soundings shoal of the ENC soundings are colored by their discrepancy.
- From the output window, drag-and-drop the output into the processing software to guide the review.
- Note the output consists of both a TIN (triangulated irregular network) of the ENC soundings (and feature value of soundings, if included) and flags atop the shoal survey soundings.

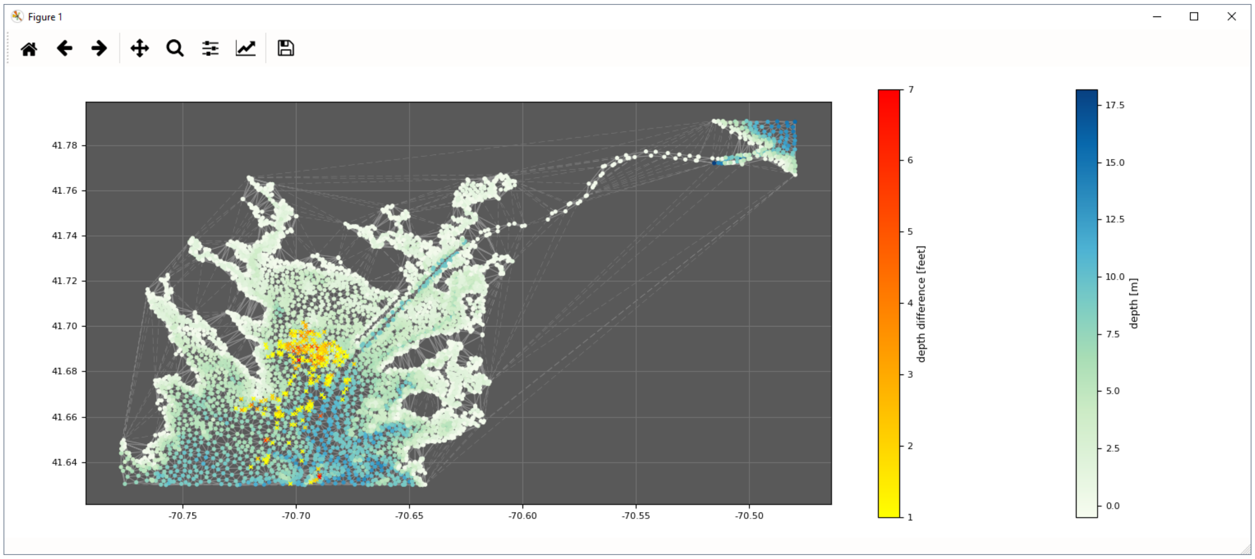


Fig. 2.39: DtoN's output display.

- The magnitude of the discrepancy against the chart is printed to the S57 attribute NINFOM, for easy sorting and identification of potential DTONs.

How Does It Work?

A TIN is created from the ENC soundings (and feature value of soundings, if included). The survey soundings are categorized within the triangles of the TIN, and if any survey sounding is shoal of the three vertices of the triangle it falls within, it is flagged. The flags might alert a surveyor to survey soundings shoal of those currently charted, which might represent dangers to navigation (DTONs).

The shoal determination factor is based on sounding rounding of the chart unit. For example, survey soundings that are shoal of the ENC soundings are only flagged if the difference is more than a chart scale unit (either in feet or fathoms, as prescribed in the parameters).

Note that, if the sounding unit is set to meters, then the difference in depth is evaluated againt the **Force threshold (m)** value.

In the example in Fig. 2.40, the survey soundings shoal of the ENC soundings are flagged (in orange). The most significant of these (circled in red) represent potential dangers to navigation.

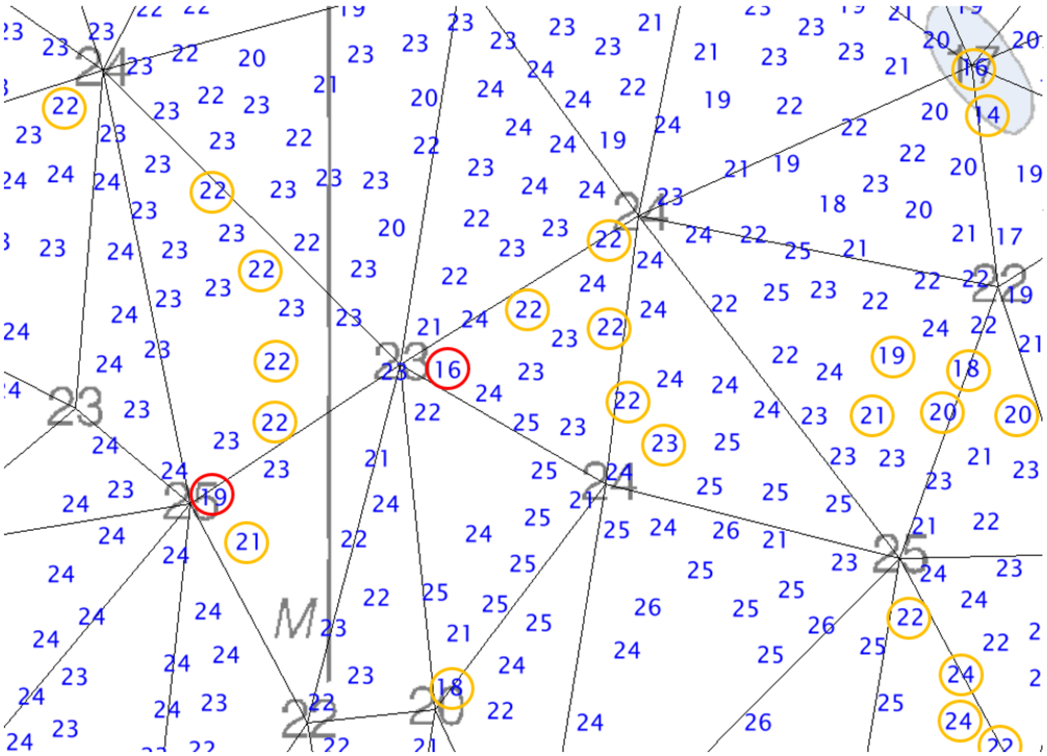


Fig. 2.40: DtoN's example.

2.3 Chart Review

2.3.1 Overview

The **Chart Review** tab will:

- Ingest a bathymetric grid, sounding selections, and feature files (see *Data inputs*).
- Truncate grid elevation to decimetric precision (see *BAG truncate*).
- Export grid elevation as ASCII XYZ file (see *Grid xyz*).
- Truncate all "z" values in an S57 file to decimetric precision (see *S57 truncate*).
- Evaluate chart-scale soundings and features versus survey-scale soundings via "triangle rule" (see *Triangle rule*).
- Scan HCell features to ensure proper attribution (see *Scan features*).

2.3.2 Data inputs

Ingest bathymetric grid(s) (.bag), a feature file (.000), and a (dense) survey soundings selection (.000).

- Select the **Chart Review** tab on top of the QC Tools interface.

In **Data inputs:**

- Drag-and-drop any number of grids (.bag only) onto the Grid files field. The **"+"** browse button may also be used.

- Drag-and-drop a feature file (.000 only) onto the S57 CS file field. The **"+"** browse button may also be used. Note that this feature file must also contain the CS soundings.
- Drag-and-drop a dense, survey sounding selection (.000 only) onto the SS file field. The **"+"** browse button may also be used.
- The directory and filename of loaded data will populate in the respective field of **Data inputs**.
- With the addition of a grid, feature file, and survey sounding selections, the **BAG truncate**, **BAG xyz**, **S57 truncate**, **Triangle Rule**, and/or **Scan Features** tabs on the bottom of the interface will become available (Fig. 2.41).

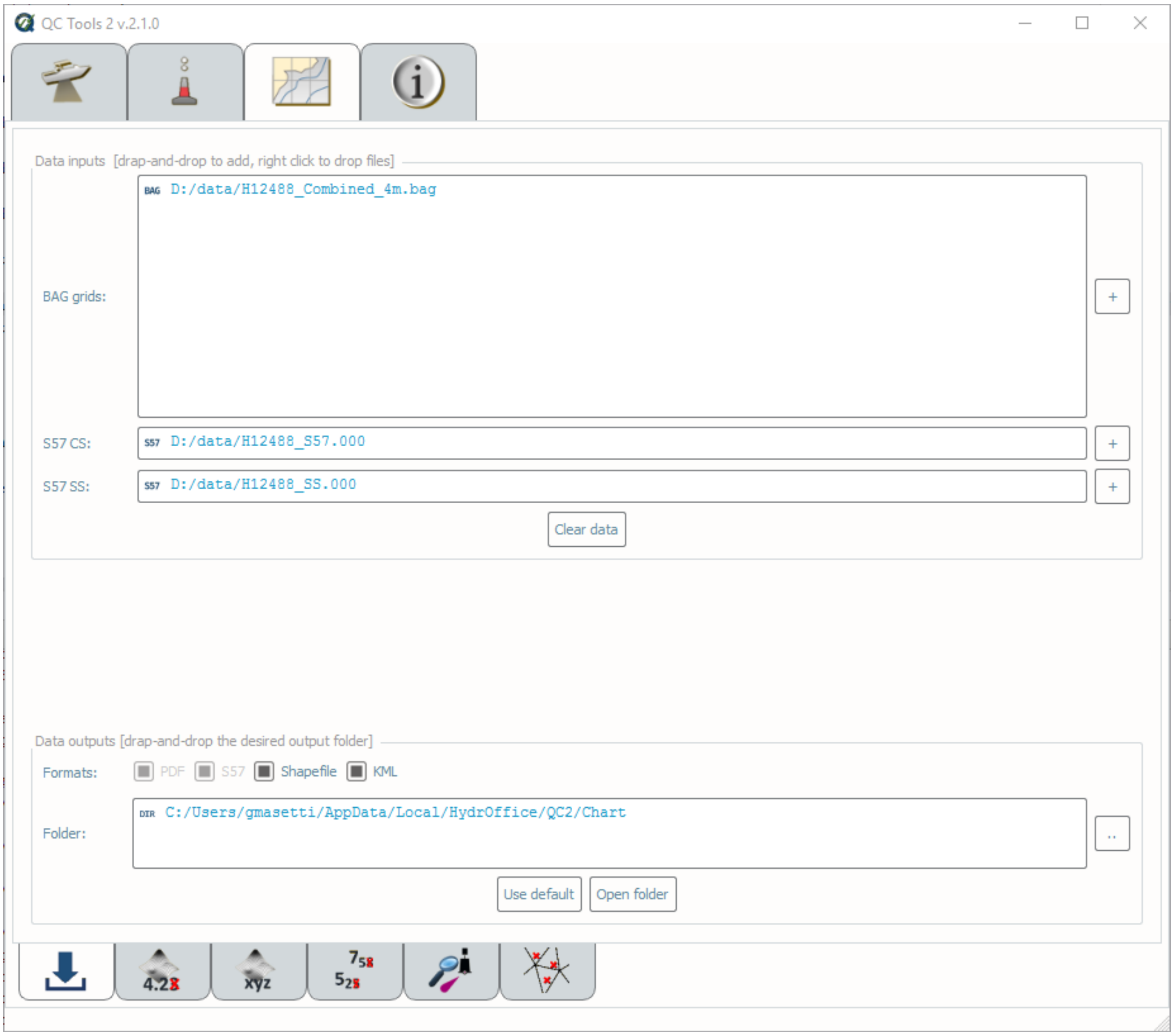


Fig. 2.41: Chart review tab.

- The **Clear data** button may be used to remove all data inputs.

In **Data outputs:**

- The output **Formats** may be customized. The user has the option to suppress **Shapefile** and **KML** output.
- The default output **Folder** location is listed; however, this may be modified via drag-and-drop (or browse to) a user-specified output folder. To return to the default output folder location, click **Use default**.

- The ensuing functions will open the output folder automatically upon execution; however, if needed, the specified output folder may be accessed by clicking the **Open folder** button.

2.3.3 BAG truncate

How To Use?

Truncate grid elevation to decimetric precision.

- Select the **Grid truncate** tab on the bottom of the QC Tools interface.
- Define the decimal place of the truncation (default is 1, thus decimetric truncation).
- In **Execution** (Fig. 2.42), click **Grid Truncate v2**.

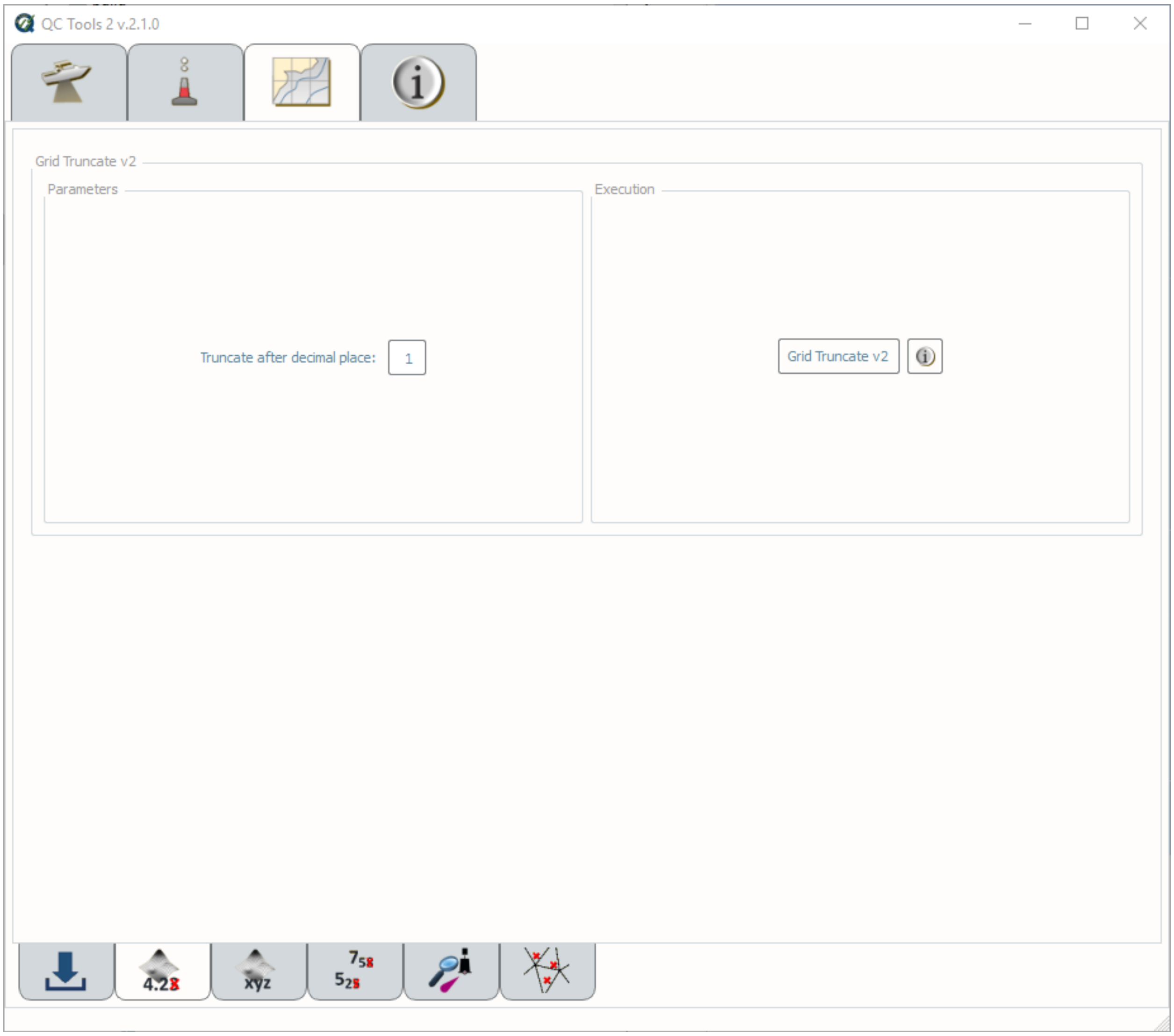
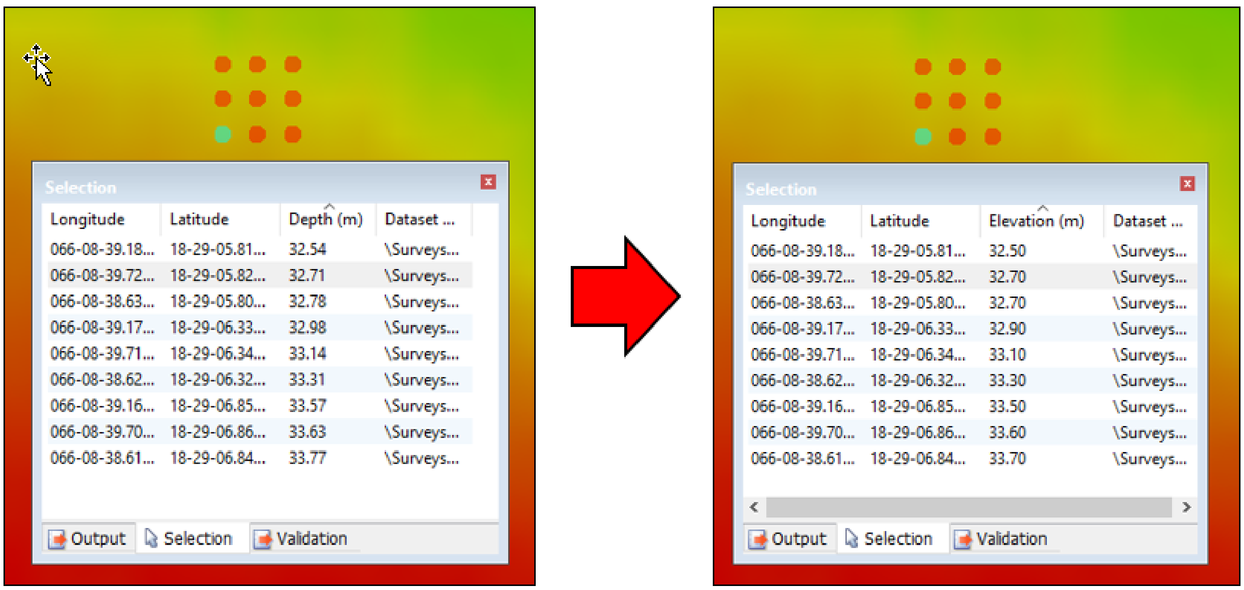


Fig. 2.42: Grid truncate's interface.

- After computing, the output window opens automatically, and the truncated BAGs are ready to use for chart compilation.

How Does It Work?

All elevation values in the grid are truncated to decimetric precision, as shown in the example below. The truncation to decimeter precision facilitates creation of the HCell (per 2016 HCell Specification units and precision).



2.3.4 Grid xyz

How To Use?

Export elevation values as a point cloud.

- Select the **Grid xyz** tab on the bottom of the QC Tools interface.
- Check the **Force conversion to geographic WGS84** checkbox if you want that the output coordinates are converted to geographic.
- In **Execution** (Fig. 2.43), click **Grid XYZ v1**.
- After computing, the output window opens automatically.

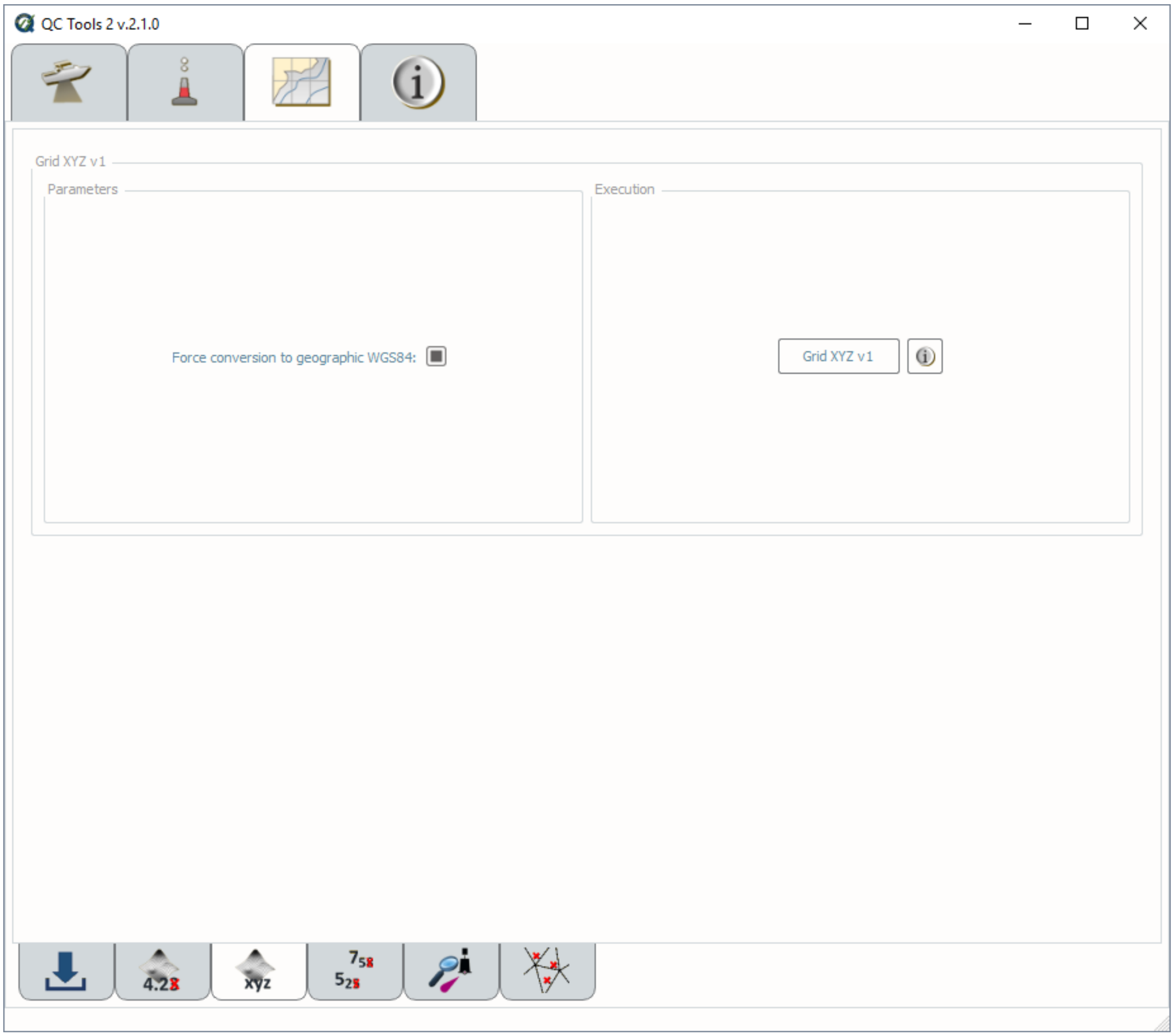


Fig. 2.43: Grid XYZ's interface.

How Does It Work?

A text file with three columns is created.

2.3.5 S57 truncate

How To Use?

Truncate all "z" values in a feature file (.000) to decimetric precision.

- Select the **S57 truncate v1** tab on the bottom of the QC Tools interface.
- Define the decimal place of the truncation (default is 1, thus decimetric truncation).
- In **Execution** (Fig. 2.44), click **S57 Truncate v2**.

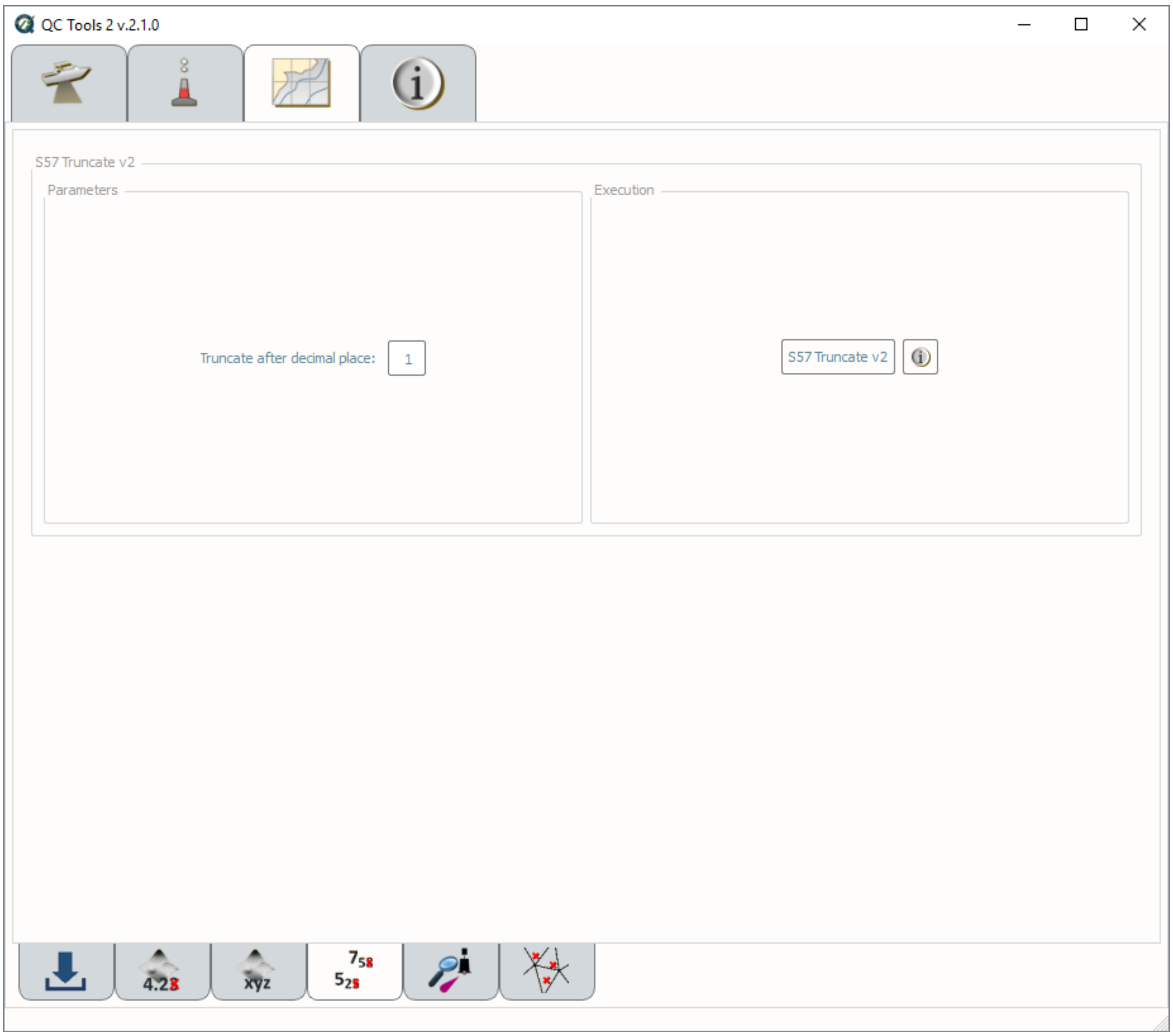


Fig. 2.44: S57 Truncate.

- After computing, the output window opens automatically, and the truncated feature file is ready to use for chart compilation.

How Does It Work?

All "z" values in the feature file are truncated to decimetric precision, as shown in the example in (Fig. 2.45). The truncation to decimeter precision facilitates creation of the HCell (per 2016 HCell Specification units and precision).

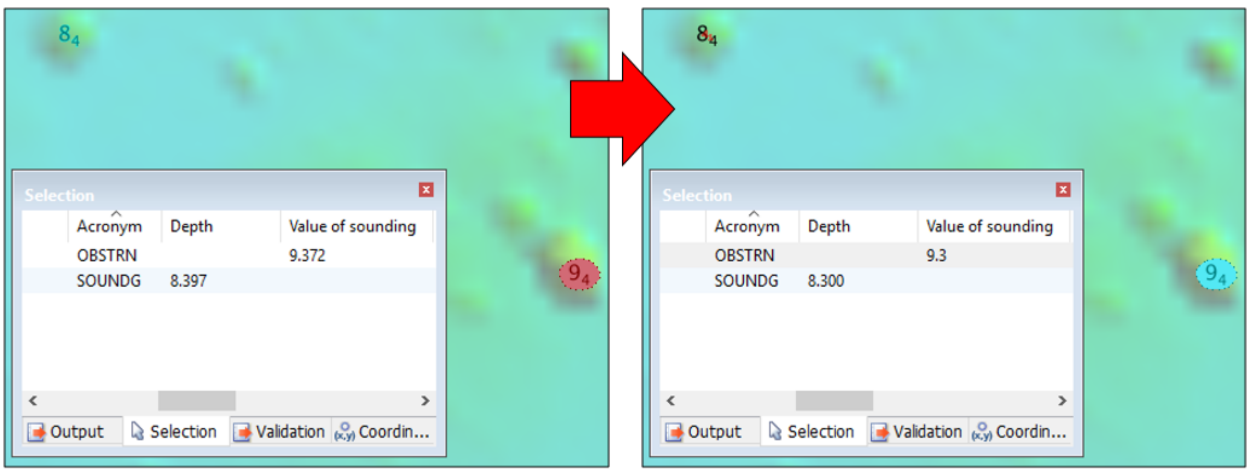


Fig. 2.45: S57 Truncate's example.

The S57 attributes that will be truncated are listed below.

For **SOUNDG** objects:

- **Depths**

For **all** objects:

- Value of Sounding (**VALSOU**)
- Height (**HEIGHT**)
- Value of depth contour (**VALDCO**)
- Depth range value 1 (**DRVAL1**)
- Depth range value 2 (**DRVAL2**)

2.3.6 Scan features

How To Use?

Scan features to ensure proper attribution and cartographic disposition.

- Select the **Scan Features** tab on the bottom of the QC Tools interface.
- In **Parameters** (Fig. 2.46, left side), turn the knob to select the required year of HCell Specification. Currently, the '2018 test' is duplicative to 2016.
- In **Execution** (Fig. 2.46, right side), click **Feature scan v2**.

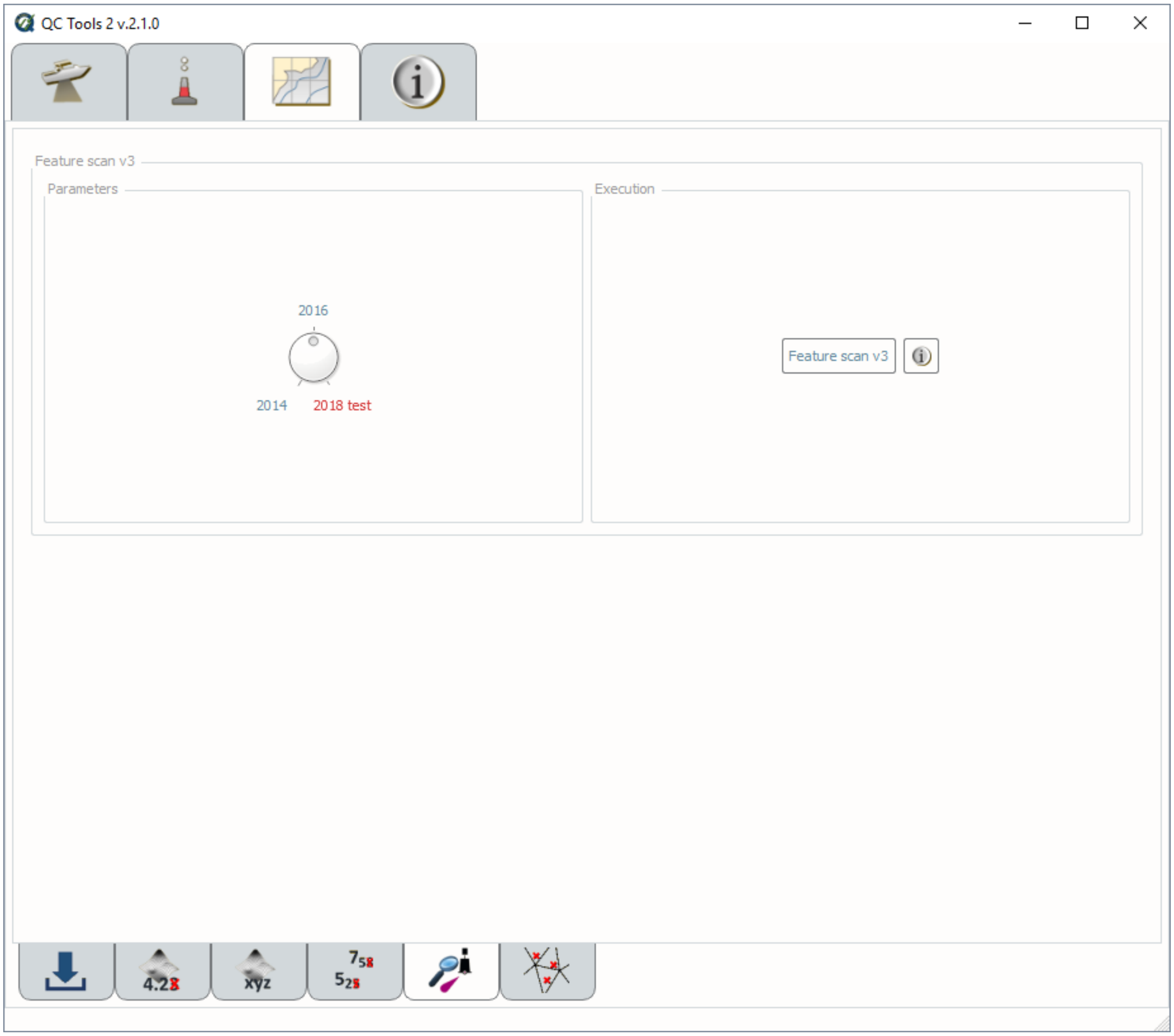


Fig. 2.46: Feature scan's interface.

- After computing, the output window opens automatically, and the results are shown (Fig. 2.47).
- From the output window, drag-and-drop the output into the processing software to guide the review.
- In addition, the results are printed to PDF for a documented summary.

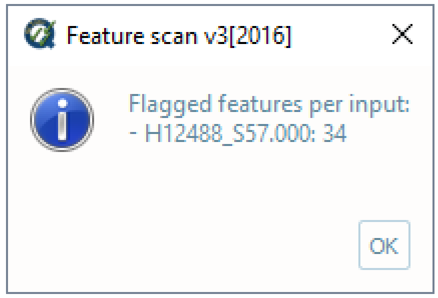


Fig. 2.47: Feature scan's output message.

How Does It Work?

The S-57 features are scanned to ensure proper attribution and chart disposition per the required year of HCell Specification. Listed within the specification are mandatory requirements and S-57 attribution.

The QC Tools Chart feature scan will ensure the following:

- No **redundant features**.
- **CS Soundings** have an accompanying **SS Sounding**.
- All feature **VALSOU** have an accompanying **SS Sounding**.
- No feature **VALSOU** coincide with a **CS Sounding**.
- No **objects** have prohibited attribute **SCAMIN**.
- No **objects** have prohibited attribute **RECDAT**.
- No **objects** have prohibited attribute **VERDAT**.
- All **objects** have mandatory attribute **NINFOM**.[1][2014]
- All **objects** have **SORIND**.[2]
- All **objects** have **SORDAT**.[2]
- No **SOUNDG** have prohibited attribute **STATUS**.
- All **Wrecks** must have mandatory attributes **CATWRK, WATLEV, VALSOU,** and **QUASOU**.
- All **Wrecks** with **WATLEV** = 5 (**awash**) must have mandatory attribute **EXPSOU**.[2016]
- All **UWTROC** must have mandatory attributes **VALSOU, WATLEV,** and **QUASOU**.
- All **OBSTRN** must have mandatory attributes **VALSOU, WATLEV,** and **QUASOU**.
- No **OBSTRN** with **CATOBS** =6 (**foul area**).[2014]
- All **MORFAC** must have mandatory attribute **CATMOR**.
- No **MORFAC** have prohibited attributes **BOYSHP, COLOUR,** or **COLPAT**.[2016]
- All **SBDARE** points must have mandatory attribute **NATSUR**.

[1] Excludes **SOUNDG, M_COVR, M_QUAL, M_CSCL,** and **DEPARE**.
[2014] Only for 2014 HCell Specification
[2] **2016** excludes **LNDARE, DEPARE, and DEPCNT** from the check for **SORIND** and **SORDAT**.
[2016] Only for 2016 HCell Specification

- No **SBDARE** points have prohibited attributes **COLOUR** or **WATLEV**.
- All **SBDARE** points have an allowable combination of **NATSUR** and **NATQUA** noted by ‘x’ in the table below.

NATQUA		1	2	3	4	5	6	7	8	9	10
N	1					o	o	o	o	o	o
A	2					o	o	o			o
T	3					o	o	o			o
S	4	o	o	o			o		o	o	o
U	5								o	o	
R	6								o	o	
	7								o	o	
	8								o	o	
	9								o	o	
	11								o		
	14				o						
	17				o					o	
	18								o	o	

NATQUA: fine (1), medium (2), coarse(3), broken (4), sticky (5) soft (6), stiff (7), volcanic (8), calcareous (9), hard (10)

NATSUR: mud (1), clay (2), silt (3), sand (4), stone (5), gravel (6), pebbles (7), cobbles (8), rock (9), lava (11), coral (14), shells (17), boulder (18)

- All **SBDARE** lines and areas must have mandatory attribute **NATSUR** and **WATLEV**.
- All **COALNE** must have mandatory attribute **CATCOA**.
- No **COALNE** have prohibited attribute **ELEVAT**.
- All **CTNARE** must have mandatory attribute **INFORM**.[2016]
- All **SLCONS** must have mandatory attribute **CATSLC**.
- All **M_QUAL** must have mandatory attributes **CATZOC, TECSOU, SURSTA,** and **SUREND**.
- All **M_CSCL** must have mandatory attribute **CSCALE**.
- All **M_COVR** must have mandatory attribute **CATCOV**.
- All **cartographic objects** must have mandatory attributes **NINFOM** and **NTXTDS**.[3][2014]
- All **cartographic objects** must have mandatory attribute **INFORM**.[3][2016]
- All objects with **NOAA extended attributes** still populated are tallied and presented (display only) as a reminder to clear before final submission.

2.3.7 Triangle rule

How To Use?

Evaluate chart-scale soundings and feature versus survey-scale soundings via “triangle rule”.

- Select the **Triangle Rule** tab on the bottom of the QC Tools interface.
- In **Parameters** (Fig. 2.48, left side):

[3] Cartographic objects include **$CSYMB, $LINES,** and **$AREAS**.

  - Check the **Use VALSOU features** checkbox if you wish for any feature VALSOUs to be included with the chart-scale soundings in the evaluation.
  - Check the **Use DEPCNT features** checkbox if you wish that points from the DEPCNT features are included with the ENC soundings in the evaluation.
  - Set the **Force threshold (m)** value to set a minimum threshold in meters (only active when **Meters** units are selected)
  - Check the **Detect deeps** checkbox if you want that the deep discrepancies are also evaluated.
  - Turn the knob to the applicable chart units.
- In **Execution** (Fig. 2.48, right side), click **Triangle Rule v2**.

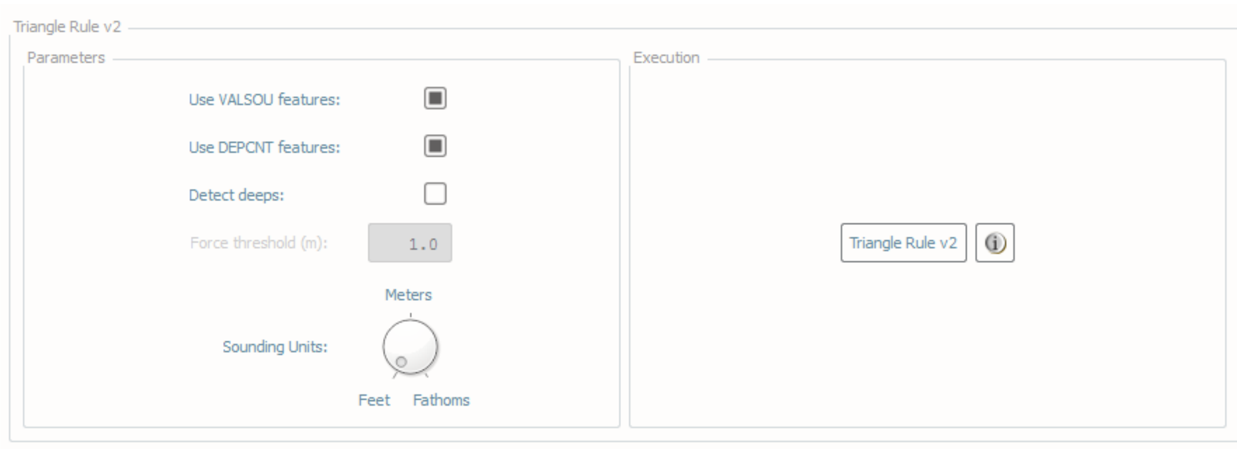


Fig. 2.48: Triangle rule's interface.

- After executing, the output window opens automatically, and the results are shown by textbox (Fig. 2.49).

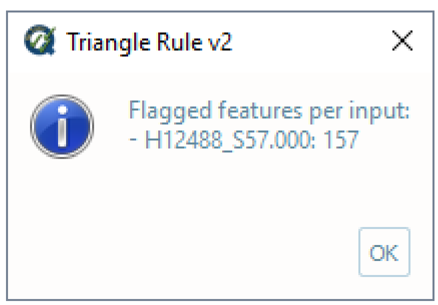


Fig. 2.49: Triangle rule's output message.

- After executing, the results are also shown graphically (Fig. 2.50). Chart-scale soundings are colored by depth, and flagged survey-scale soundings that may not be adequately represented are colored by their discrepancy.
- From the output window, drag-and-drop the output into the processing software to guide the review.
- Note the output consists of both a TIN (triangulated irregular network) of the chart-soundings (and feature value of soundings, if included) and flags atop survey-scale soundings that may not be appropriately accounted for by the prospective chart-soundings.
- The magnitude of the discrepancy against the chart-scale soundings is printed to the S57 attribute NINFOM, for easy sorting and identification of the most significant discrepancies.

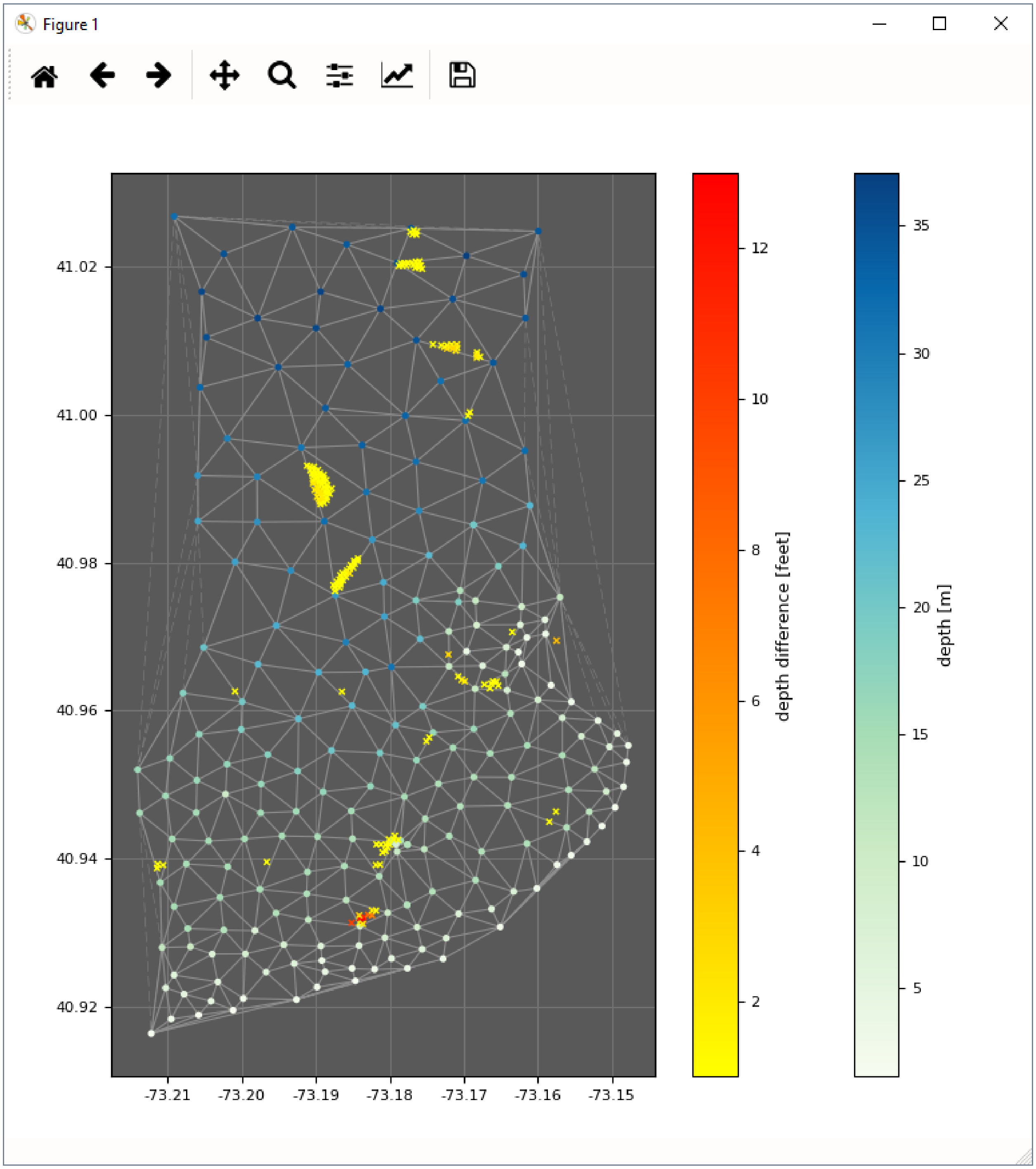


Fig. 2.50: Triangle rule's output display.

How Does It Work?

A TIN is created from the chart-scale soundings (and feature value of soundings, if included). The survey-scale soundings are categorized within the triangles of the TIN, and if any survey-scale sounding is shoal of the three vertices of the triangle it falls within, it is flagged. The flags might alert a cartographer to survey-scale soundings that may not be adequately represented by the chart-scale soundings.

The shoal determination factor is based on sounding rounding of the chart unit. For example, survey-scale soundings that are shoal of the chart-scale soundings are only flagged if the difference is more than a chart scale unit (either in feet or fathoms, as prescribed in the parameters).

Note that, if the sounding unit is set to meters, then the difference in depth is evaluated againt the **Force threshold (m)** value.

In the example in Fig. 2.51, the shoal soundings flagged by the red circles may need additional consideration by the cartographer; in particular, the 13 foot sounding in the southwest (near the 17 foot chart sounding) could be dangerous to navigation if not better represented.

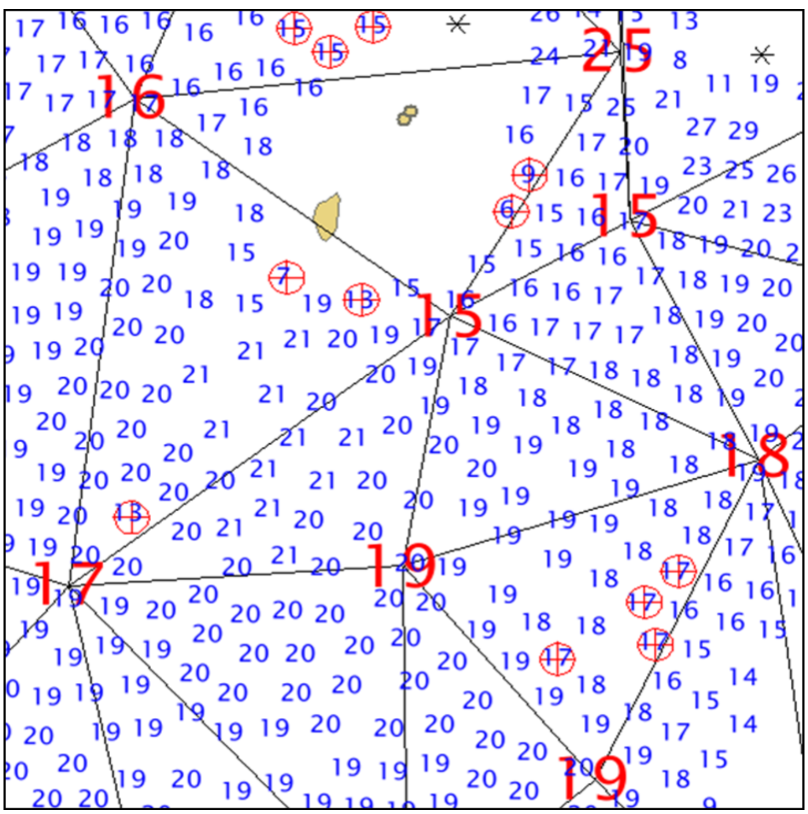
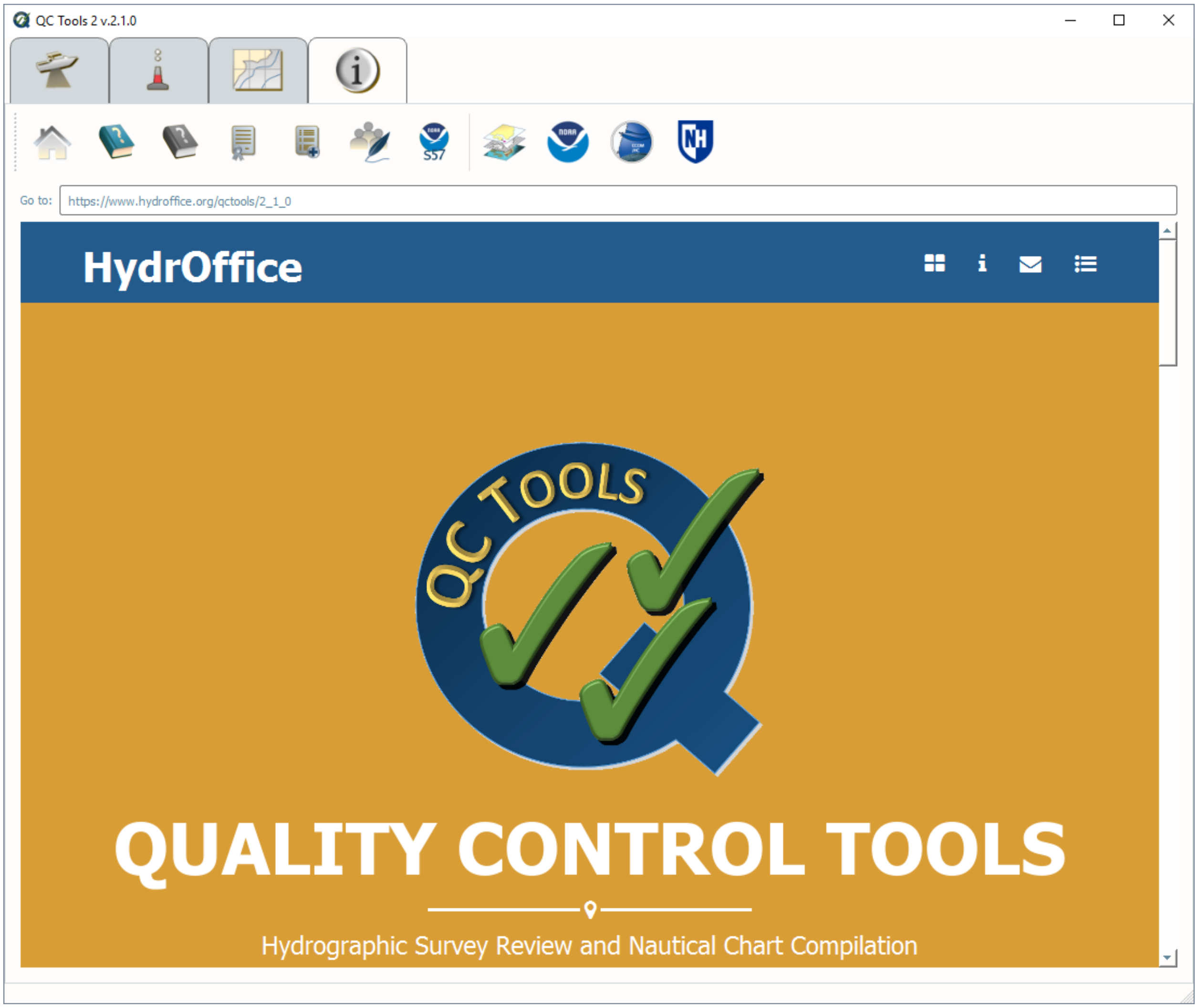


Fig. 2.51: Triangle rule's example.

2.4 Info Tab

The Info Tab contains numerous helpful links and utilities:

- The HydrOffice QC Tools website
- The Online User Manual
- The Offline User Manual (PDF)
- License Information
- QC Tools Change List
- Authors List
- NOAA S-57 Support Files for CARIS
- The HydrOffice Main Page
- The Center for Coastal and Ocean Mapping Main Page
- The University of New Hampshire Main Page

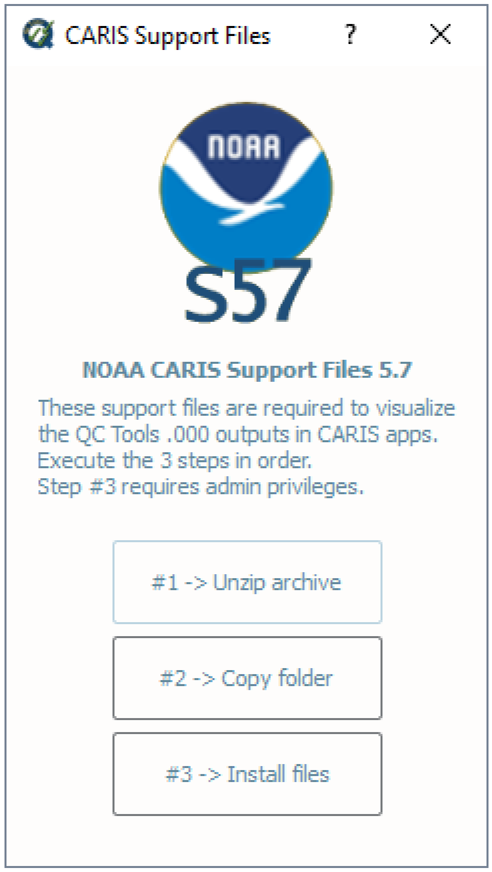


2.4.1 NOAA S-57 Support Files for CARIS

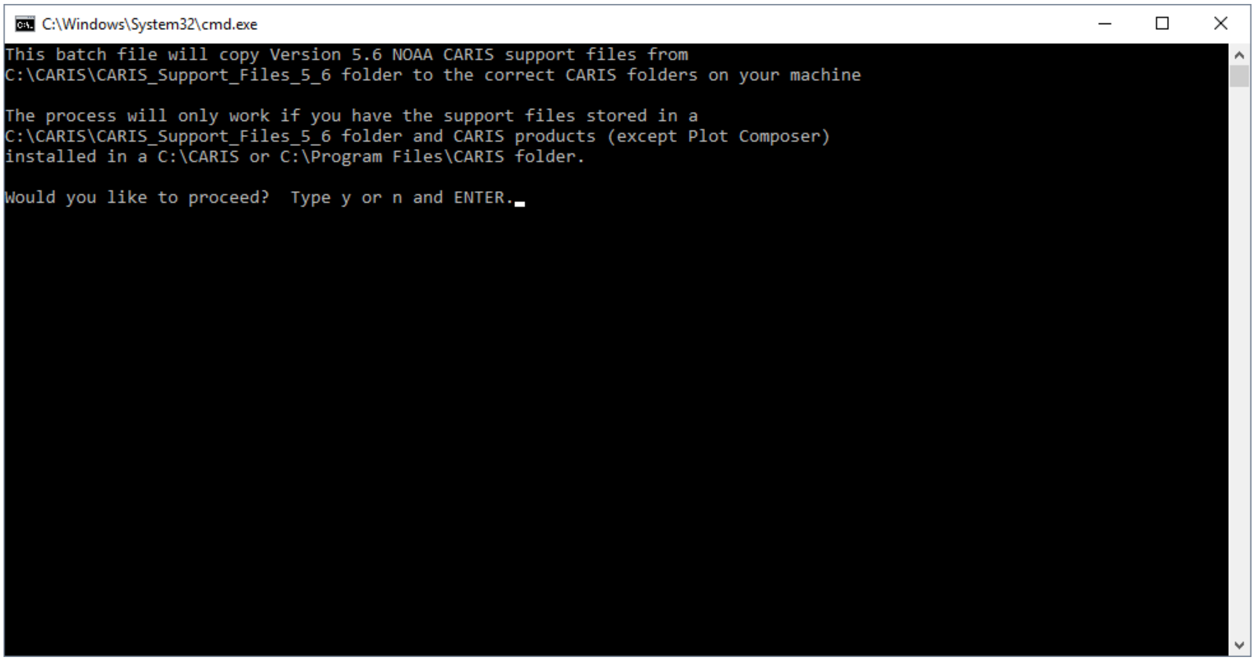
These allow for use of customized S-57 attributes in CARIS software and are required in order to visualize many of the QC Tools S-57 (.000) output.

To install them, follow these instructions:

- Click the button on the Info Tab for the NOAA CARIS Support Files.



- Click the button to unzip the archive.
- Click the button to copy the folder. If the folder is already found, you will be prompted whether or not you wish to force a re-copy.
- Click the button to install the files. Note this step requires Administrator privileges.
- Follow the prompts in the Windows command to complete the installation.



2.5 Supported Formats

Format	Read	Write
Bathymetric Attributed Grid (.bag)	X	
Caris CSAR (.csar)	X	
S-57 (.000)	X	X
Shapefile (.shp)		X
KML (.kml)		X

CHAPTER

THREE

DEVELOPER'S GUIDE

3.1 How to contribute

Every open source project lives from the generous help by contributors that sacrifice their time and this is no different.

To make participation as pleasant as possible, this project adheres to the Code of Conduct by the Python Software Foundation.

Here are a few hints and rules to get you started:

- Add yourself to the AUTHORS.txt file in an alphabetical fashion. Every contribution is valuable and shall be credited.
- If your change is noteworthy, add an entry to the changelog.
- No contribution is too small; please submit as many fixes for typos and grammar bloopers as you can!
- Don't *ever* break backward compatibility.
- *Always* add tests and docs for your code. This is a hard rule; patches with missing tests or documentation won't be merged. If a feature is not tested or documented, it does not exist.
- Obey PEP 8 and PEP 257.
- Write good commit messages.
- Ideally, collapse your commits, i.e. make your pull requests just one commit.

Note: If you have something great but aren't sure whether it adheres – or even can adhere – to the rules above: **please submit a pull request anyway**! In the best case, we can mold it into something, in the worst case the pull request gets politely closed. There's absolutely nothing to fear.

Thank you for considering to contribute! If you have any question or concerns, feel free to reach out to us (see *Credits*).

3.2 How to build the documentation

3.2.1 Requirements

The documentation is built using `sphinx`, so you neeed to have it:

- `pip install sphinx sphinx-autobuild`

3.2.2 First-time creation of documentation template

Just once for each project, you can create the documentation template as follows:

- `mkdir docs`
- `cd docs`
- `sphinx-quickstart`

3.2.3 Generate the documentation

To create the html:

- `make html`

To create the pdf, you first need to install a latex distribution, then:

- `make latexpdf`

CHAPTER FOUR

LICENSE

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Version 3, 29 June 2007

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CHAPTER FIVE

CREDITS

QC Tools 2 is based on an ongoing joint development between the NOAA's Ocean of Coastal Survey and UNH's Center for Coastal and Ocean Mapping.

Feel free to contact us for comments and suggestions:

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- Clinton R. Marcus
- Brian R. Calder
- Jack Riley
- Chen Zhang
- John Doroba

For bugs and feature requests: hydroffice.qctools@ccom.unh.edu

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