**6th Tidal and Water Level Working Group Meeting**

25 - 28 March 2014, Australian Hydrograph Office, Wollongong, Australia

**Report to the 6th meeting of the Hydrographic Services and Standards Committee**

*(Paragraph numbering is the same as the Agenda Item numbering and does not necessarily reflect the order in which matters were discussed.)*

## 1 Opening

1.1 Captain Jenny Daetz RAN, Director Hydrographic and Metoc Policy and Coordination at the Australian Hydrographic Office (AHO) welcomed all to the meeting on behalf of the Hydrographer RAN and wished all a successful meeting. The Chair, Miss Gwenaële Jan (France-SHOM), opened the meeting at 0905. She thanked all participants for coming, she then highlighted a number of long standing members of the TWLWG who had retired since the previous meeting in Helsinki; she warmly welcome their successors, particularly Mr Jyrki Mononen from the Finnish Transport Authority and Miss Hilde Sande from the Norwegian Hydrographic Service. She also thanked Australia for hosting the meeting and providing excellent support and facilities.

The Chair highlighted the main tasks which needed to be addressed during the meeting. Particular areas identified were those which impact on other IHO bodies and organizations, which will/are using the output and products of the TWLWG. She encouraged all to participate and engage during the meeting so that maximum benefit would result.

1.2 All participants – representing Australia, Finland, France, Netherlands, New Zealand, Norway, Republic of Korea, USA and UK – introduced themselves, Annex A.

1.3 David Wyatt (IHB), on behalf of the Directing Committee thanked Australia for hosting the meeting and providing a high level of support and excellent facilities. The outcomes from the 5th meeting of the Hydrographic Services and Standards Committee (HSSC) were highlighted along with the anticipation of progress by the TWLWG on a number of Work Plan (WP) items, in particular the dynamic application of tides in ECDIS, standard for the transfer of real time tidal data and standard for digital tide tables. He noted the IMO had identified the IHO S-100 data standard as an appropriate data standard to support the e-Navigation environment. It was also noted the expectation of HSSC that final draft revised versions for definitions of Mean Sea Level (MSL) and Lowest Astronomical Tide (LAT) would be an output from this meeting. It was reported that SHOM had completed the distribution of the hard copy English version of the French Manual of Tides; the IHB expressed their thanks for the work SHOM had undertaken to complete this task.

The IHB provided a short brief on the structure of the IHO, highlighting the two main committees, HSSC and Inter-Regional Coordination and Cooperation (IRCC), and the subordinate bodies for each.

The Chair endorsed these sentiments and highlighted a need for a more active engagement by the TWLWG members during and between meetings to progress actions and WP items.

## 2 Administrative Arrangements

2.1 The Chair introduced the Agenda which was adopted, Annex B. She reported that apologies for non-attendance had been received from Brazil, Canada, Chile, Denmark, Germany, Peru, Portugal and South Africa.

2.2 The draft timetable was introduced, it was explained that this was intended for guidance only and was not intended to be a rigid structure. Where necessary time spent on individual topics would be amended to allow an appropriate discussion. The list of documents is at Annex C.

Australia provided a short brief covering the extracurricular activities and the visit to the tide gauge site and the port operations area at Port Kembla.

2.3 The Chair reported on the HSSC 5 and the TWLWG report. The work on the S-100 Product Specification and the amendments to the various IHO Resolutions were highlighted. The significant work which had been undertaken on harmonic analysis and the advised withdrawal of NOAA hard copy national Tide Tables had been particularly noted. HSSC had requested a major focus be placed on progressing the development of the S-100 Product Specification as detailed in the Work Plan.

The question of production, distribution and carriage of hard copy Tide Tables was raised. These issues generated considerable discussion with detailed explanations on the IMO regulations and Member State domestic policies; it was noted there remained a user requirement for hard copies of Tide Tables.

2.4 IHB reported on the action items from TWLWG 5. A new list of Action Items would be prepared for the meeting, Annex D.

It was noted a significant number of items were covered in the agenda for the meeting and it was agreed these should be taken under their appropriate agenda item.

4-2.5 Tide gauge sampling rates and web links – all were urged to provide up-dates whenever known, including from adjacent states and other contacts. **Action All**.

4-4.9.2 Compare tidal predictions – to be taken under Agenda Item 4.8.

4-5.2 Actual Tides On-line Link (ATOL) – to be taken under Agenda Item 4.16.

5-4.1 Standard Constituent List – to be taken under Agenda Item 4.1.

5-4.2 Standard for Digital Tide Tables – to be taken under Agenda Item 4.2.

5-4.8 Study of long term data sets – to be taken under Agenda Item 4.7.

5-4.9 Compare Tidal Predictions – France briefed on the data sets posted on the web site and encouraged all to make additional data sets available for wider analysis, it was agreed to take this item under Agenda Item 4.8.

5-4.10 It was reported an MOU was signed between IHO and the EU in 2012, since then a series of biannual meetings had taken place with DG Maritime Affairs's department to explore areas of mutual interest and to increase engagement between EU bodies and the Hydrographic Offices (HOs) of IHO member states. It was noted that significant funding had been channelled to the Maritime Affairs Department to progress marine projects, including maritime aspects of INSPIRE.

5-4.16 Actual Tides On-line Link – to be taken under Agenda Item 4.16.

5-4.17 Tides and Water Levels Workshop - – to be taken under Agenda Item 4.15.

The Chair encouraged all to provide feedback on progress of agenda item actions and to regularly check the website for new items and information.

3 **National Presentations**

National presentations were received from Finland, Australia, USA, New Zealand, Republic of Korea and France, all of which are available under the meeting document section, Annex C.

Finland provided details on activities in the Baltic area, in particular the work to establish a pan-Baltic datum and the alignment to S-100 Product Specification requirements. It was also noted the work to transfer from a sea level based Chart Datum (CD) to a geodetic based CD, it is anticipated all Finish charts would be referred to this new datum by 2020. IHB noted how these initiatives represented an excellent example of a regional solution being driven to meet a specific goal by a RHC.

Australia gave a presentation on and demonstration of the AusCoastVDT (Vertical Datum Transformation) tool, which is focused on connecting all datums in use. Highlighting, via a vertical separation grid tool, the difference between the ellipsoid and Australian height datum; it was noted the ranges of MSL to LAT were between 0.3m and 4.5m. The tool is a customer driven product which is required to connect bathymetry and land-based heights. It was noted there was no uncertainty layer or hydrodynamic modelling, although the grid file was up-dated annually. GDA94 remained the national datum and despite it being a static datum, it was now considered to be out of date. Finland highlighted the importance of 3D positioning whilst USA noted the remarkable shift over the past 10 years in the ability to improve the vertical accuracy of datums and water level measurements.

The USA gave an overview presentation on the tides and sea level variations in the Arctic. The presence of a major amphidromic system had been revealed from the analysis of data; it was noted that the complexity of the Arctic basin seabed topography clearly has an impact, and the quality of the bathymetry available would also influence the quality of the model results.

New Zealand provided an overview of the organization and structure of Land Information New Zealand (LINZ) and how the Hydrographic Authority (NZHA) sits within LINZ. Details of the organization and capabilities of the NZHA were given, as well as the assets available. The Sea Level Information Management Systems (SLIMS) was described.

Republic of Korea gave a presentation of on TideBed, a database of relations between tide datums. It was based on a 10 $m^2$ mesh with 4 harmonics per cell. It was noted that bathymetric data needs to be of a better quality for modelling than that shown on charts. Future improvements would include: uncertainty assessment, MSL to ellipsoid, more harmonics (16 to 20) and downloadable tools. The Chair suggested members should highlight the major harmonic components influencing tides for their areas and make them available to allow comparison between various locations for further analysis on a world-wide basis.

France gave a presentation on Bathyelli, GNSS reference heights used to generate vertical reference data for bathymetry reference surface creation. The work undertaken in Brittany, the Bay of Biscay and the Mediterranean Sea areas was described.

## 4 Programme matters

### 4.1 Standard Constituent List

UK provided a background brief on the history and basis of the Standard Constituent List used by various HOs around the world. It was acknowledged the work to undertake analysis to provide 7 decimal places to improve the accuracy of the data still needed to be completed. Australia noted the Nodal correction was the largest factor; it was also noted that some figures in the formulae had been amended over the past 30 years and care was needed to ensure the correct and appropriate precision was observed to ensure the final values maintained the necessary accuracy.

Considerable discussion was generated on the use of constituents and the numbers used in analysis. Australia suggested the published list needed to be revised and volunteered, on receipt of a formal request from the Chair, to undertake the initial revision. **Action Chair & Australia**. All members were encouraged to provide feedback to enable a final draft list to be presented at TWLWG 7. **Action All**

### 4.2 Standard for Digital Tide Tables

USA provided comments and details on the document TWLWG 2/4/2A as well as highlighting the availability for download of the NOAA website tidal predictions and data. It was noted that the presentation of data remained in the traditional tabulated format but for significantly more stations than previously published in the hard copy version. Australia highlighted feedback from users indicated a wish for graphical formats rather than tabulated data. New Zealand noted the receipt of a number of requests to provide predictions corrected for daylight time when it applies. Australia demonstrated the AusTide digital Tide Tables and Norway commented on their digital Tide Tables.

The Chair suggested there remained a need to document the standard display formats on what minimum information should be provided to the customer. It was considered the following may be adequate: secondary ports, warning notes, graph and tabulated values, minimum 1 hour predictions, time tag data, Latitude and Longitude, height reference, units, moon phases, pdf format, first 20 significant constituents, daylight periods (sunrise/sunset), error estimation, total propagated error value. USA volunteered to generate for comment draft standards based on TWLWG 2/4/2A and the discussions at this meeting. **Action USA**.

### 4.3 Dynamic Application of Tides in ECDIS
### 4.4 Standard for the Transmission of Real Time Tidal Data

These items were taken together.

A full day was dedicated to these topics, following S-101 2014s' objectives and HSSC request.

The Chair introduced this session presenting slides from TSMAD, a synthesis of what had been discussed during TWLWG 5 and framework of some cogitations. Points addressed in slides provided some guidelines to start discussion on dynamic

application of tides in future ECDIS (DAT), e.g. go no/go area with spatial and temporal questions on content and its portrayal. Discussion was mainly focused on:

i. ECDIS need for tidal purpose,
ii. Definitions of work packages and one leader for each one,

IHB provided a comprehensive background brief on the S-100 Product Specifications, in particular the standards for the transmission of real time tidal data and the dynamic application of tides in ECDIS. It was explained one of the major drivers was the IMO e-Navigation initiative. USA noted the need to cover tidal and non-tidal areas. France gave a presentation on potential display/visualization solutions for the dynamic application of tides in ECDIS.

During a joint afternoon session with DQWG, OMC International gave a briefing on work being undertaken to develop a dynamic visualization tool to provide near real-time data on Underkeel Clearance for harbours, channels and critical straits. There remain a number of issues to be resolved, however the concept had been proven and the tool is ready for further development work to refine the algorithms and optimal presentation of the data. OMC noted the expanded use to which the tool had already been put and the constructive feedback received. It was felt this tool might provide the basis for development of the wider dynamic application of tides in ECDIS.

Suggested metadata could include: unique ID, unique name, date and time measurement, time zone, datum, water level observation height, units, uncertainty of time and height data, position (x,y) and co-ordinate reference system, interval steps, issue date (predictions only) and source/authority.

Ship data required could be: draught, speed, squat, settlement figures.

The following questions/issues were noted:

Velocity, direction (for current) and depth of measurement?
generation of data for area between measurement points, co-tidal model?
product portrayal – simple 'No go areas', complex dynamic time variable surface with variable depths or safe water limits?
limiting conditions – file size, quality measures?

It was agreed to create two correspondence groups (CG) to progress the tasks and to generate initial drafts for presentation to HSSC 6 (* indicates task coordinator), OMC indicated their willingness to participate in the CG. **Action Australia, USA & All.**

S-100 Product Specification – provide initial draft Product Specification for comment, noting terms included in the registry need to maintain their HD definitions – Zarina Jayaswal*, Glen Rowe, Bill Mitchell and Kwang-nam Han + OMC

Portrayal model – provide initial draft ideas on portrayal and how to progress with areas between tide/water level stations – Stephen Gill*, Bill Mitchell and Zarina Jayaswal + OMC

IHB noted SNPWG could be in a position to assist with the S-100 data modelling once TWLWG identified the elements which should be in the tidal predictions exchange format.

IHB tasked to create a S-100 section on the TWLWG webpage where various S-100 guidance documents would be uploaded. **Action IHB.**

From these 4 sessions, two DAT uses were highlighted:

> Use 1, in predictions mode, preparing a marine road, a journey.
> Use 2, monitoring getting online and near real time information from satellite connexion.

Several work packages were been identified and are common to the 2 uses:

> WP1 - Product specification,
> WP2 - Real time data transfer format,
> WP3 - Gridded product,
> WP4 - Tidal current.

WP1 - Product specification (Leader: Australia, Participants: All)

This WP aims to define a tidal content in future ECDIS products and its format. Existing descriptions of tide products and XML format exchange can be used to help with this task (e.g. tidal constituents TWLWG task 4.1). Several significant variables were listed and required to be completed.

Example of start list:

> Time - time zone, datum, Chart Datum to ellipsoid, measured water levels height, units, uncertainty: (colour for uncertainty on tide/on bathymetry),
> root mean square on: height, sensor measurements, time, model, datum, precision, position (x, y, z, t) and reference systems, source of data and results, uncertainty on real total water depth, spatial variations, bathymetry useful important information, tide source of data: prediction model, analysis, tide reduction method used, output sampling, tidal data precision to be displayed (no need to provide tidal information over 2 decimals for example), information on filter applied to tidal data outputs when existing tidal streams, existing bias on data provided, (bed material and indication on seabed mobility), …/... to be continued in the frame of WP1.

WP2 - Real time data transfer format (leader: UK, Participants: All)

The session focused on transmission and display of space and time varying forecasts or tide prediction. The metadata content drove the discussion and international compliancy.

Starting point of WP2 emphasises the importance in the future products metadata of:

> the centre ID identification number to be able to recover information on where the tide is computed and the delivery centre,
> the tide prediction time flag: (a) date of the computation (if product is used in mode 1: prediction way point), (b) the delivery time and delivery centre ID,
> the products' grid information,
> the bathymetry data source,
> the uncertainty and total error budget when available,
> the distinction between the tidal data output sampling and the tidal data displayed sampling in ECDIS,
> the time period to download tidal info if telecommunications connexions are feasible onboard,

the identification of the computation output sampling and the sampling of the output display in ECDIS (e.g. 3 minutes sampling as for other international programme Tsunami care for example),
the need of an international standard for transmitting data.

With respect to the latter point, OMC noted an existing lack of standard. For real time tidal data, IHO 2.7.4.1 task could help. OMC had been invited to hear applications needs during the morning session. This was also the opportunity to discuss the present work in progress by industry, which are one of the end users of ECS and future ECDIS. OMC presented their work which is used in Australian coastal areas. One requirement is a better integration of crossing (passage) planning with ECS. See also point 4.4 in this report.

WP3 - Gridded product (Leader: USA, Participant: All)

The work package aims to raise some recommendations on the grid on which the tide values will be provided in the future products. One of the WP3 results should look to answer future products grid characteristic alternatives and to take into account time variation (when necessary). The question of a regular grid or a finite element mesh grid and interpolation functions will need to be addressed.

Optional coverage: The question of the overlaid grid was introduced by the TWLWG. This point is linked to Q-102 grid (bathymetry grid). References to IHO S-101, S-102 have been set: Navigational surface, S-Surface currents and Tidal information, S-Radio signals, S-102 bathymetric grid.

WP4 - Surface tidal current (suggested leader: SCWG chair, Participants: All)

The IHO surface current work from SCWG will be helpful for TWLWG actions on WP4. There is a synergy on which progress could be built for this action in WP4. This suggests for chair of the SCWG as the leader of WP4. For tidal current, in addition to surface current velocity and its direction, the question of adding the subsurface current (at relevant selected depth) has been suggested (e.g. 10 meters or another depth in order to take into account of the vertical current shear that could impact on the ship navigation in coastal areas).

Chair of DQWG provided a brief on the work of DQWG and the areas of focus for current work. Vertical data quality and uncertainty with temporal uncertainty for mobile seabed were particular areas of effort and work. He indicated 3 bands were being considered, noting the top and bottom quality bands were relatively easy to define, it was the middle band which has numerous variables, including user risk perception, which makes quantifying uncertainty values a challenge.

TWLWG 6 common outcomes for Dynamical Applications Tide session:

- Discussion with IHO DQWG identified the need for a more intuitive display for CATZOC information. During session, it was been suggested that the existing 3 colours system (green, amber, red) could be applied for tidal quality data. A second idea emerge, more challenging, concerns the concept of a combined risk factor for underkeel clearance, following for example a colour code: Red colour when tidal values delivered is used by a large vessel, amber colour for a small ship. This concept could also be a part of industry work starting with future ECS tidal products and adapted to navigators. Groups approached a third idea, consideration of a temporal variation of the sea floor after an extreme event. This could be displayed by a specific colour to warn of the fact that at the crossing time, there is no updated

information on the seabed changes. The link with S-57 was been identified. Some critical points were also raised. Among them, will the bathymetry suitable for future ECDIS products be available?

- The TWLWG was encouraged to discuss with other IHO groups on the level of information layer that should be recommended to be displayed. Indeed, the full metadata contained in a future ECDIS product should not be displayed, only essential tidal information should be portrayed. This requires a selection of the information on tide that suits to ECDIS S-101 reference.

- Other issues suggested:

To generate observation class and common elements for all observations: tide, current, using wordings drawing on S-100 GI registrars in dictionary terms.
* Common element/attributes: such as name, epoch,
* Specialised attributes:
* Optional attributes:

4.5 Inventory of tide gauges used by IHO Member States

IHB highlighted that few up-dates to the inventory had been received; the Chair encouraged all to check regularly their data listings and to pass any amendments or changes to IHB. As had been noted earlier, the Chair encouraged all to provide tide gauge sampling rates and web links for inclusion in the Inventory on the IHO website. **Action All**.

4.6 Development of IHO-GIS Tidal Records Metadata

IHB gave a brief on the background to the development of the IHO-GIS and queried whether there was a need for the information and how much. Subsequent discussions revolved around whether a simple link would be sufficient; however not all Member States have an online service. It was conceded the GLOSS and PSMSL sites were neither sufficiently current nor comprehensive enough to meet the stated requirements. It was suggested the IOC Sea Level Monitoring facility, which is maintained and current, would be a more suitable option.

It was agreed, if possible, a simple URL link would be more appropriate. Various web services were displayed as possible examples. It was concluded that linking to an externally maintained service would be more efficient and easier to ensure currency of the information, it was agreed that minimizing Member State interaction for currency and up-dating should be a major objective. It was considered the most appropriate site was a link to the IOC site at http://www.ioc-sealevelmonitoring.org

4.7 The study of long term data sets for the determination of global sea level rise

UK commented on their efforts to recover information from historical data and to make it available for wider public use; work was being undertaken on handwritten analogue records to make it available in digital format. It was noted that this work had attached considerable funding.

USA briefed on the work being undertaken to extract information for analysis of long term data sets in the study of global sea level rise. USA showed examples of comparison work on 1920 and 2010 Boston, Honolulu and San Diego data sets, this had highlighted the external factors which impact on the analysis work; factors such

as dredging, time zone changes and relocation of gauges were some of the many influences.

UK noted from their analysis that MSL was rising but the frequency of extreme events (levels rising above or below HAT and LAT) appeared to be reducing. USA noted that the data recovery from long term stations was almost complete.

Australia highlighted the challenges of changing the reference datum for charts, noting the political and economic implications for individual ports was often very different. It was noted that it was currently a 30 year cycle to revise/up-date the reference datum used on charts.

The Chair requested all to take long term records and conduct analysis to extract constituents and exchange the results for further comment and discussion. **Action All.**

4.8 Compare Tidal Predictions generated as a result of analysis of a common data set by different analysis software

UK gave a presentation on comparing tidal predictions generated from analysis of St Malo tides supplied by SHOM using UKHO software. Results showed good agreement with real-tides. It was noted the next step was to compare predictions generated by SHOM with those generated by UKHO, having extracted the harmonic constants using in-house software from the same supplied data set.

It was noted the St Malo data set had not been up-loaded to the same location as the previous data sets. **Action IHB.** It was suggested a section could be created for the up-load of analysis results. **Action IHB.**

4.9 Establishment and maintenance of vertical reference frameworks for the high resolution bathymetric surfaces

UK updated on the work undertaken post TWLWG 5 and at the NSHCTWG as well as interaction with the EU. It was confirmed this remained an on-going project, on which UK would report at the next meeting. **Action UK**.

4.10 Review of relevant IHO resolutions

IHB briefed on the current status of the revisions to the Resolutions submitted to HSSC 5 for endorsement and subsequent approval of IHO Member States. The need to review the current definitions for MSL and LAT as directed by HSSC as a result of the revisions to IHO Resolution 3/1919, as amended, was highlighted. The challenge of covering tidal and non-tidal areas within the definition was explained. The connections between terms in the Hydrographic Dictionary (HD) and the importance of generating a concise definition were also explained.

A revised definition for MSL was agreed, Annex G. IHB was requested to forward this revised definition to HDWG for consideration and presentation to HSSC 6. **Action IHB.** It was agreed to make an editorial amendment to the definition contained in IHO Resolution 3/1919, as amended, to ensure consistency with the HD definition and move the additional wording into a new paragraph, Annex H, with subsequent presentation to HSSC 6 for endorsement. **Action IHB**

4.11 Review of relevant IHO Charting Specifications (S-4)

After discussion it was felt Resolution 3/1947, as amended, still had relevance and a number of occurrences on charts where this Resolution applied. It was felt there remained a need to retain this Resolution.

It was considered S-4 may require further review by CSPCWG after approval of the revised wording to Resolution 3/1919 has been approved by Member States.

Both these issues would be included in the TWLWG report to HSSC 6. **Action Chair, vice-Chair & IHB.**

4.12 Exchange of harmonic constants / predictions

UK provided a background brief on past work on the exchange of harmonic constants and predictions. It was noted the Intellectual Property (IP) rights concerning the release of full data sets is an issue for some Member States. It was noted the decision to review the Standard Constituent List would also impact on this work. It was acknowledged little progress had been achieved over the past few years. Norway agreed to supply UK with a recent data set. **Action Norway.**

The Chair suggested Norway could add to the work already undertaken between UK and France. All were requested to supply UK with copies of XML data sets to allow a comparison and development of a suggested consistent format by UK. **Action All and UK.**

Australia described their 'Tidal Realm' XML structure which was aligned with the EU INSPIRE model and was compatible within the states and New Zealand. IHB highlighted the considerable work already undertaken to develop the various content models, there was a need for greater coordination and focus to define the preferred content model. France provided details on the SHOM harmonic constants XML exchange format and the work being undertaken with the UK.

4.13 Update on IOC GLOSS programme

USA provided details on the most recent GLOSS meeting held in 2013 in Liverpool, where no TWLWG representation was achieved. The Chair suggested in future, any Member State attending could circulate a brief report to TWLWG members after the meeting and it was request that IHB should ordinarily represent the IHO TWLWG at future GLOSS meetings in addition to any individual Member States attending.

4.14 Determining Ellipsoidal Height of MSL at the Coast

This item was taken with Item 5.1, Lowest Astronomical Tides in the North Sea derived from a Vertical Referenced Shallow Water Model and an assessment of its suggested sense of safety.

Netherlands provided a background brief on the work undertaken in the North Sea to derive LAT from a vertical reference shallow water model and make an assessment of uncertainty for safety.

The brief and supporting paper generated considerable discussion on the different methods used to determine LAT. USA commented that LAT was not presently used. France queried the comment 'improve LAT' and asked whether this was for definition or calculation. Australia commented there were a number of areas round the coast where meteorological affects create significant variations.

It was agreed there was a need to review the wording of the IHO Resolution 3/1919, as amended, and the associated definitions of MSL and LAT. USA identified a need to provide uncertainty information for datums used, which was more significant than defining the terms.

The Chair suggested there might be a need to form a CG to progress a review of IHO Resolution 3/1919, as amended. Netherlands suggested the author of the original paper be included in any CG. UK suggested Netherlands could study IHO Resolution 3/1919, as amended, and provide guidance on any revised wording. **Action Netherlands.**

4.15 Tides and Water Levels Workshop

Australia briefed on an AUSAID workshop to be delivered later in the year for Southwest Pacific states, it was noted the contents was mainly focused for Meteorological personnel, although the material had been developed from the tides and water level course orientated towards hydrographic aspects. A further course was being developed to cover the CAT B tidal elements in accordance with the course details in the IHO website. USA gave details of an international military course outline. Outline details of a course previously developed were displayed; IHB explained the IRCC and CBSC requirements and noted the outline provided a good basis from which to progress. IHB was requested to create a section on the TWLWG webpage to enable member states to upload and view suitable material. **Action IHB.** USA agreed to coordinate a CG (Stephen Gill*, Zarina Jayaswal and Ruth Farre) to collate available material into a suitable generic course. **Action USA, Australia & RSA.**

4.16 Actual Tides On-line Link (ATOL).

It was requested IHB to reinstate the link on the TWLWG website when received from UK. **Action UK, USA & IHB.** All were requested to check the list to ensure accuracy and currency. **Action All**

4.17 TWLWG Work Plan 2015-2016

The IHB displayed the draft work programme for 2015-2016 which had been prepared in advance of the meeting. Amendments were made to reflect discussion and progress during this meeting, Annex E. It was noted that the updated version would be included in the meeting report and that all delegates would therefore have a further opportunity to comment before it was submitted to HSSC 6 for approval.

## 5 Any other business

.1 Taken with Item 4.14.

.2 Participants were briefed on on-going discussions on the reorganization of HSSC subordinate bodies. It was highlighted the intended amalgamation of TWLWG with SCWG to form the TWSCWG. All were encouraged to engage with the process and pass comments to the Chair and Vice-chair.

## 6 Venue and dates of the 7th TWLWG Meeting

USA agreed to investigate hosting the next meeting. It was agreed the extended 4 days format was successful and in view of the challenging WP tasks it was felt

appropriate to continue with 4 day meetings. Further it was agreed to move the meeting dated back to the traditional late April/early May period. **Action USA.**

(Post meeting note: USA has confirmed hosting of TLWG 7, dates to be decided)

## 7 Review of Action Items

.1 A draft list of Action Items from the meeting were reviewed and agreed. All Action Items are marked in this report and are collected together at Annex D. It should be noted that the list of action items does **NOT** include tasks that are in the TWLWG Work Plan. An updated list of the Action Items will be maintained on the TWLWG 7 web page and all those who have actions to complete should keep the IHB informed of any progress. **Action ALL.**

## 8 Draft Report to the HSSC / Draft Agenda for TWLWG 7

.1 It was agreed that the IHB would circulate a draft meeting report to all attendees by 11 April. **Action IHB.** Participants were requested to provide any comments by 25 April. **Action ALL.** It was intended the final meeting report would be published by 9 May. **Action IHB**

.2 The IHB, Chair and vice-Chair would prepare the final report to HSSC 6 using the format required by HSSC. Representation of TWLWG at the HSSC 6 meeting would be discussed between the Chair and the vice-Chair. **Action IHB, Chair & vice-Chair**

.3 A draft Agenda was presented to the meeting and is included at Annex F to this report. The draft Agenda may require further amendment following the outcome of HSSC 6.

## 9 Closing remarks

The Chair closed the meeting by thanking all for their efforts and hard work, she noted the benefits of interaction with DQWG and members of TSMAD, and she felt significant benefit had been gained. The Chair highlighted the progress achieved on the numerous tasks, whilst identifying the focus of future work.

The Chair thanked the Australian delegate and the AHO for the venue, facilities and the support provided throughout the meeting, all of which helped to ensure the overall success and significant progress on a number of key issues. She also thanked the IHB for the support and guidance provided throughout the week.

The meeting closed at 1500.

The following Annexes are attached:

A. List of Participants.
B. TWLWG 5 – Agenda
C. TWLWG 5 – List of Documents
D. TWLWG 5 – List of Actions
E. TWLWG Draft Work Programme 2014-2015
F. TWLWG 6 – Draft Agenda
G. MSL and LAT – Final Proposed Draft Definitions
H. Revised IHO Resolution 3/1919, as amended

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| IHB | Tony Pharaoh* | | addt@iho.int |
| Australia | Bill Mitchell | National Tidal Centre (Bureau of Meteorology) | b.mitchell@bom.gov.au |
| Australia | Chris Hens* | OMC International | c.hens@omcinternational.com |
| Australia | Giles Lesser* | OMC International | g.lesser@omcinternational.com |
| | | | |
| | | | |

* Thursday 27 March only
[+] Friday 28 March only

**Tidal and Water Level Working Group**
*Wollongong, Australia, 25 – 28 March 2014*
**Agenda – (TWLWG 6)**

## 1 Opening

.1 Opening address by the Chairman
.2 Address by host nation
.3 Welcome by the IHB

## 2 Administrative Arrangements

.1 Adoption of the Agenda and Apologies
.2 Programme and timetable of the Sessions
.3 Report on Intercessional Activities including HSSC 5
.4 Matters arising from TWLWG 5/Review of Action Items

## 3 National Presentations

.1 Presentations by delegates on "National Tidal Issues"

## 4 Programme Matters

*Note:{xx} indicates TWLWG Work Plan reference*

.1 Standard Constituent List {A.1} (Chris Jones)
.2 Standard for digital Tide Tables {B.2} (Stephen Gill)
.3 Dynamic application of tides in ECDIS {C.1} (IHB, industry representative)
.4 Standard for the transmission of real time tidal data {C.2} (IHB, Stephen Gill, industry representative)
.5 Inventory of Tide gauges used by IHO Member States {F.1} (IHB)
.6 Development of IHO-GIS Tidal records metadata (IHB)
.7 The study of long term data sets for the determination of global sea level rise. {H.1}(Chris Jones, Hilde Sande, Stephen Gill & Salvador Moreno)
.8 Compare Tidal Predictions generated as a result of analysis of a common data set by different analysis software {A.2} (Stephen Gill)
.9 EU submission on Establishment and Maintenance of VRF for High Resolution Bathymetric Surfaces {E.1 – E.3} (Chris Jones and Tor Tørresen)
.10 Review of relevant IHO Technical Resolutions (IHB)
.11 Review of relevant IHO Charting Specifications (IHB)
.12 Exchange of Harmonic Constants / Predictions (Chris Jones)
.13 Update on IOC/GLOSS Programme (GLOSS/IHB)
.14 Determining ellipsoidal height of MSL at the coast (ALL)
.15 Requests for Capacity Building Tides and Water Levels Workshops (Stephen Gill/IHB)
.16 Actual Tides On-line Link status (All)
.17 TWLWG Work Plan up-dates (IHB)

## 5 Any Other Business

.1 Lowest Astronomical Tide in the North Sea derived from a Vertically Referenced Shallow Water Model and an assessment of its suggested sense of safety (NL)
.2 Reorganization of HSSC subordinate bodies.

## 6 Venue and dates of the 7th TWLWG Meeting (TWLWG 7)

## 7 Review of Action Items from TWLWG 6

**8 Draft Report to HSSC 6/Draft Agenda for TWLWG 7**

**9 Closing remarks**

**Note:**

**Items 4.3 and 4.4** (underlined above) will be covered during Thursday when there will be a number of presentations from industry. Some aspects of these items will also be discussed during the joint session with DQWG. Should time permit IHB AD Tony Pharoah will give an introductory brief on S-100 Product Specifications late on Wednesday afternoon to set the scene for the discussions and work to be undertaken on the Thursday.

# TWLWG 6 - List of Documents

| Document No | Document Title |
|---|---|
| TWLWG 6 Letter 1 | Letter of Invitation |
| TWLWG 6 Registration Form | Registration Form (Word version) |
| TWLWG 6 Map | Wollongong Area map |
| TWLWG 5 Actions | TWLWG 5-List of Actions - 29 January 2014 |
| TWLWG 6 Programme | Programme |
| TWLWG 6 Agenda | Agenda |
| TWLWG 6 Participants | Provisional List of Participants |
| TWLWG 6-2.3-1 | TWLWG Report to HSSC5 |
| TWLWG 6-2.3-2 | Extract from HSSC 5 Report |
| TWLWG 6-2.3-3 | ESA Coastal Sea Level meeting final report |
| TWLWG 6-3.1 | An Overview of Tides and Sea Level Variations-USA |
| TWLWG 6-3.1 | AusCoastVDT-Australia |
| TWLWG 6-3.1 | LINZ Overview-New Zealand |
| TWLWG 6-3.1 | FTA Overview-Finland |
| TWLWG 6-3.1 | TideBed Introduction-Republic of Korea |
| TWLWG 6-4.3 | S-100 Introduction-IHB |
| TWLWG 6-4.3 | Tides in ECDIS-France |
| TWLWG 6-4.3 | DUKC Chart Overlay-OMC |
| TWLWG 6-4.6 | Development IHO-GIS Tidal Records Metadata |
| TWLWG 6-4.8 | Compare Predictions Presentation-UK |
| TWLWG 6-4.9 | Bathyelli Jist-France |
| TWLWG 6-4.10 | IHO Resolutions |
| TWLWG 6-4.11 | Review of relevant IHO Charting Specifications |
| TWLWG 6-4.15 | CB Workshop |
| TWLWG 6-4.16 | Work Plan |
| TWLWG 6-5.1 | Lowest Astronomical Tide in the North Sea derived from a Vertically Referenced Model |
| TWLWG 6-8 | TWLWG 7 - Draft Agenda |

**LIST OF ACTIONS** – Updated 29 April 2014

| Agenda Item | Subject | Status/Date | Comments | Action |
|---|---|---|---|---|
| Continuous | | | | |
| | Compare tidal predictions | On going | Additional suitable data sets for general analysis to be provided by members to IHB | All |
| | Compare tidal predictions | On going | Report progress on results and analysis | All |
| | Study of long term data sets | On going | All to take long term records to conduct analysis of constituents and to exchange the results | All |
| | Tide gauge sampling rates and web links | On going | To provide up-dates | All |
| | Inventory of tide gauges | On going | Regularly check entries and provide up-dates and amendments to IHB as necessary | All |
| | Actual Tides On-line Link | On going | Check and provide up-dates and amendments to the information provided to ensure content is current and all links work | All |
| TWLWG 6 | | | | |
| 4.1 | Standard Constituent List | 30 Apr | Chair to make formal request to AUS to undertake review of published list | Chair |
| 4.1 | Standard Constituent List | 31 Oct | AUS to review list and provide draft for comment | AUS |
| 4.1 | Standard Constituent List | 31 Jan | Provide feedback comments to AUS | All |
| 4.1 | Standard Constituent List | TWLWG 7 | Collate final draft for presentation at next meeting | AUS |
| 4.2 | Standard for Digital Tide Tables | 30 Sep | Based on document TWLWG 2/4/2A and discussions in TWLWG 6, draft standards to be generated for comment | USA |
| 4.2 | Standard for Digital Tide Tables | 31 Dec | Provide feedback comments to USA | All |
| 4.2 | Standard for Digital Tide Tables | TWLWG 7 | Collate final draft for presentation at next meeting | USA |
| 4.3 | Dynamic Application of Tides | 31 May | Study S-100 and existing IHO product specifications to gain awareness and understanding | All |
| 4.3 | Dynamic Application of Tides | 30 Apr | Create S-100 section in TWLWG web page and upload appropriate guidance documents – section created, | IHB |

| | | | | |
|---|---|---|---|---|
| | | | documents to be up-loaded idc. | |
| 4.3 | Dynamic Application of Tides | 15 May | Obtain up-date on Product Specification from AUS for discussion at SCWG 2 | IHB |
| 4.3 | Dynamic Application of Tides | 31 Jul | Create initial draft Product Specification for comment | AUS/NZ/RoK |
| 4.3 | Dynamic Application of Tides | 12 Sep | Provide comments to AUS | All |
| 4.3 | Dynamic Application of Tides | 30 Sep | Provide up-date on progress for report to HSSC 6 | AUS |
| 4.3 | Dynamic Application of Tides | 31 Jul | Create initial ideas for portrayal, including tidal interpretation, and identify options on how to progress | USA/AUS |
| 4.3 | Dynamic Application of Tides | 12 Sep | Provide comments and feedback to USA | All |
| 4.3 | Dynamic Application of Tides | 30 Sep | Provide up-date on progress for report to HSSC 6 | USA |
| 4.4/4.12 | Exchange of Harmonic Constants/Predictions | 31 May | Provide XML datasets to UK for comparison of commonality between data sets | All |
| 4.4/4.12 | Exchange of Harmonic Constants/Predictions | TWLWG 7 | Investigate commonality between data sets and alignment with INSPIRE and Australian model, collate results and suggested way forward | UK |
| 4.4 | Exchange of Harmonic Constants/Predictions | 31 May | Provide copy of recent data set to UK | Norway |
| ~~4.8~~ | ~~Compare Tidal Predictions~~ | ~~30 Apr~~ Complete | ~~Move SHOM data set to Predictions section~~ | ~~IHB~~ |
| ~~4.8~~ | ~~Compare Tidal Predictions~~ | ~~30 Apr~~ Complete | ~~Create area for upload of analysis results~~ | ~~IHB~~ |
| 4.9 | VRF for high resolution bathymetry | TWLWG 7 | Report on discussions at NSHCTWG and liaison with EU and BSHC | UK |
| 4.10 | Review of IHO Resolutions | 9 May | Submit new and revised definitions for MSL and LAT to HDWG for comment | IHB |
| 4.10 | Review of IHO Resolutions | 9 May | Submit editorial revisions to HSSC 6 for endorsement | IHB |
| 4.11 | Review of IHO Charting Specifications | 31 Jul | Relevance of Resolution 3/1947, as amended, and impact of approved revisions of Resolution 3/1919, as amended, on S-4 to be report to HSSC 6 | Chair/vice-Char/IHB |
| 4.14 | Determining Ellipsoidal Height of MSL at the Coast | 31 Jul | Review wording of IHO Resolution 3/1919, as amended, and provide guidance on any suggested revisions | Netherlands |

| | | | | |
|---|---|---|---|---|
| ~~4.15~~ | ~~Tides and Water Levels Workshop~~ | ~~30 Apr~~ Complete | ~~Create section in TWLWG web page to upload course material for review~~ | ~~IHB~~ |
| 4.15 | Tides and Water Levels Workshop | 30 Apr | All to review commitments with the view to assessing capacity to provide training personnel to support workshops and inform UK | All |
| 4.15 | Tides and Water Levels Workshop | 31 May | USA/AUS/RSA to circulate current proposed course content for further review and comment by TWLWG | USA/AUS/RSA |
| 4.16 | Actual Tides On-line Link | 31 May | Provide link for Actual Tides On-line for inclusion on IHO-TWLWG website when received | UK/USA/IHB |
| 4.17 | Work Plan 2015-2016 | 31 Jul | Submit draft to HSSC 6 with TWLWG report | Chair/vice-Chair/IHB |
| 6 | TWLWG 7 venue and dates | 31 May | Discuss appropriate dates with USA and circulate an initial letter of invitation – venue confirmed, dates tbd | USA/IHB |
| 7 | Action List | TWLWG 7 | Keep IHB informed of progress with allocated actions | All |
| ~~8~~ | ~~TWLWG 6 Draft Report~~ | ~~11 Apr~~ Complete | ~~Draft to be circulated for comment~~ | ~~IHB~~ |
| ~~8~~ | ~~TWLWG 6 Draft Report~~ | ~~25 Apr~~ Complete | ~~All to provide comments on draft report~~ | ~~All~~ |
| ~~8~~ | ~~TWLWG 6 Final Report~~ | ~~9 May~~ Complete | ~~Publish final report~~ | ~~IHB~~ |
| 8 | Report to HSSC 6 | 31 Jul | Draft report for review and amendment. | Chair/vice-Chair/IHB |

# 1 TWLWG Work Plan

## 1.1 TWLWG Tasks

A Maintain Standard Tidal Constituent List (IHO Work Programme 3.2.4 refers)

B Prepare a Standard for Digital Tide Tables (IHOTC Report to the XVII$^{th}$ IHC as adopted)

C Liaise with TSMAD on tidal matters relevant to the Dynamic Application of Tides in ECDIS and develop a Standard of the transmission of real-time tidal data (Action HSSC1/18)

E Review the various definitions of MSL and their relevance to Hydrographic Offices and review the IHO tidal resolutions to ensure that they are compatible with the requirements of non-tidal areas such as the Baltic Sea.

F Prepare and maintain an inventory of tide gauges used by Member States and to publish it on the IHO/TWLWG web site.

H Compare the tidal predictions generated as a result of analysis of a common data set using different analysis software.

I Develop and maintain material for course on Tides

| **Task** | **Work item** | **Priority** H-high M-medium L-low | **Milestones** | **Start Date** | **End Date** | **Status** P-planned O-ongoing C-completed | **Contact Person(s) * indicates leader** | **Related Pubs/Standard** |
|---|---|---|---|---|---|---|---|---|
| A.1 | Maintain Standard Tidal Constituent List | H | Review current list of published tidal constituents | Continuous | | O | Chris Jones* | |
| A.2 | Compare the tidal predictions generated as a result of analysis of a common data set using different analysis software. | H | Select Common data set<br>Analyse using different software<br>Predict common set of tides<br>Compare results | Continuous | | O | Stephen Gill*<br>All | |
| B.2 | Prepare a Standard for Digital Tide Tables | H | Prepare draft Standard | 2009 | 2015 | O | Stephen Gill*<br>Chris Jones<br>Zarina Jayaswal | |

| Task | Work item | Priority<br>H-high<br>M-medium<br>L-low | Milestones | Start Date | End Date | Status<br>P-planned<br>O-ongoing<br>C-completed | Contact Person(s)<br>* indicates leader | Related Pubs/Standard |
|---|---|---|---|---|---|---|---|---|
| C.1 | Liaise with TSMAD and DIPWG on tidal matters relevant to the Dynamic Application of Tides in ECDIS | H | Prepare draft Product Specifications (S-1**) for tidal data in S-100. | 2010 | 2015 | O | Zarina Jayaswal*<br>Glen Rowe<br>Bill Mitchell<br>Kwang-nam Han | S-100 |
| | | H | Prepare draft Portrayal model for tidal data in S-100. | 2012 | 2015 | O | Stephen Gill*<br>Bill Mitchell<br>Zarina Jayaswal | S-100, S-102 |
| C.2 | Develop a Standard for the transmission of real-time tidal data | H | | 2009 | 2015 | O | Chris Jones*<br>All | |
| E.1 | Review the various definitions of MSL and their relevance to Hydrographic Offices and review the IHO tidal resolutions to ensure that they are compatible with the requirements of non-tidal areas such as the Baltic Sea. | H | IHO Resolution 3/1919, as amended, approved by HSSC 5. Required reviewed of definitions of MSL and LAT for submission to HDWG | 2009 | 2014 | C | | IHO Resolution 3/1919, as amended. |
| | | H | Review wording of IHO Resolution 3/1919, as amended, in light of revised definitions for MSL and LAT | 2014 | 2014 | C | | |
| F.1 | Prepare and maintain an inventory of tide gauges used by Member States and to publish it on the IHO/TWLWG web site. | H | Initial inventory from TWLWG members available on IHO web site. CL36/2010 sent to Member States seeking wider input. | Continuous | | O | David Wyatt*<br>All | |
| H1 | The study of long term data sets for the determination of global sea level rise. | H | | Continuous | | O | Stephen Gill*<br>All | |

| Task | Work item | Priority<br>H-high<br>M-medium<br>L-low | Milestones | Start Date | End Date | Status<br>P-planned<br>O-ongoing<br>C-completed | Contact Person(s)<br>* indicates leader | Related Pubs/Standard |
|---|---|---|---|---|---|---|---|---|
| I1 | Develop and maintain material for course on Tides | H | Adapt currently available course material to create a course suitable for delivery in support of CBSC requests | 2013 | 2015 | O | Stephen Gill*<br>Bill Mitchell<br>Ruth Farre | |

### 1.2 TWLWG Meetings (IHO Task 3.1.11 refers)

| Date | Location | Activity |
|---|---|---|
| 14 – 16 May 2013 | Helsinki, Finland | 5th Meeting |
| 25 – 28 March 2014 | Wollongong, Australia | 6th Meeting |
| Late April/early May | Silver Spring, Maryland, USA | 7th Meeting |

Chair: Gwenaële Jan Email: gwenaele.jan@shom.fr
Vice-Chair: Christopher Jones Email: christopher.jones@ukho.gov.uk
Secretary: David Wyatt Email: adso@iho.int

**Tidal and Water Level Working Group**
*Silver Spring, Maryland, USA – ?? ? 2015*
**Draft Agenda – (TWLWG 7)**

**1 Opening**

.1 Opening address by the Chairman
.2 Address by host nation
.3 Welcome by the IHB

**2 Administrative Arrangements**

.1 Adoption of the Agenda and Apologies
.2 Programme and timetable of the Sessions
.3 Report on Intercessional Activities including HSSC 6
.4 Matters arising from TWLWG 6/Review of Action Items

**3 National Presentations**

.1 Presentations by delegates on "National Tidal Issues"

**4 Programme Matters**
*Note:{xx} indicates TWLWG Work Plan reference*

.1 Standard Constituent List {A.1} (Chris Jones)
.2 Standard for digital Tide Tables {B.2} (Stephen Gill)
.3 Dynamic application of tides in ECDIS {C.1} (IHB, Stephen Gill, Zarina Jayaswal, industry representative)
.4 Standard for the transmission of real time tidal data {C.2} (IHB, Chris Jones, industry representative)
.5 Inventory of Tide gauges used by IHO Member States {F.1} (IHB)
.6 The study of long term data sets for the determination of global sea level rise. {H.1}(Chris Jones, TørTorresen, Stephen Gill &Salvador Moreno)
.7 Compare Tidal Predictions generated as a result of analysis of a common data set by different analysis software {A.2} (Stephen Gill)
.8 Establishment and Maintenance of VRF for High Resolution Bathymetric Surfaces {E.1 – E.3} (Chris Jones and ??)
.10 Review of relevant IHO Technical Resolutions (IHB)
.11 Review of relevant IHO Charting Specifications (IHB)
.12 Exchange of Harmonic Constants / Predictions (Chris Jones)
.13 Update on IOC/GLOSS Programme (GLOSS/IHB)
.14 Determining ellipsoidal height of MSL at the coast (ALL)
.15 Actual Tides On-line Link status (All)
.16 TWLWG Work Plan up-dates (IHB)
.17 Review TWLWG ToRs and RoPs (IHB)

**5 Any Other Business**

.1

**6 Venue and dates of the 8th TWLWG Meeting (TWLWG 8)**

**7 Review of Action Items from TWLWG 7**

**8 Draft Report to HSSC 7/Draft Agenda for TWLWG 8**

**9 Closing remarks**

# HYDROGRAPHIC DICTIONARY DEFINITIONS

1. Proposed revised definition for Mean Sea Level (MSL) in line with IHO Resolution 3/1919, as amended, was finalized at TWLWG 6:

**Current version:**

Mean Sea Level: The average height of the surface of the sea at a tide station for all stages of the tide over a 19-year period, usually determined from hourly height readings measured from a fixed predetermined reference level (chart datum).

**Proposed:**

Mean Sea Level: The average height of the surface of the sea at a water level station, determined from height readings measured over an appropriate period of time from a fixed predetermined reference level (chart datum).

2. It was agreed a new term was required to cover monitoring/measuring stations in non-tidal areas; the proposed definition for a Water Level Station was generated at TWLWG 6:

**New Term:**

Water Level Station: A place where water level observations are obtained. It is has continuous observations available for a sufficient number of years to determine the characteristic features for the locality.

IHO Resolution 3/1919, as amended – Draft Proposal

| TITLE | Reference | Last amendment (CL or IHC) | 1st Edition Reference |
|---|---|---|---|
| **DATUMS AND BENCH MARKS** | **3/1919 as amended** | ***19/2008*** | **A2.5** |

1 It is resolved that the datum of tide/water level observations and predictions for mariners shall be the same as chart datum (datum for sounding reduction).

2 It is resolved that chart datum and other tidal/water level datums used should be clearly stated on charts and all other navigational products.

3 It is resolved that chart datums (datums for sounding reduction), the datums of tide/water level prediction and other tidal/water level datums shall always be connected with the general land survey datum, and, in addition, with a prominent and permanent fixed mark in the neighbourhood of the tide gauge, station, observatory etc.

4 It is resolved that ellipsoidal height determinations of the vertical reference marks used for tidal/water level observations should be made, in order to support the production of seamless data sets; i.e. to allow the translation between data sets with differing vertical datums. It is further resolved that such observations should relate to a geocentric reference system, preferably the International Terrestrial Reference System (ITRS) or one of its realizations e.g. the World Geodetic System 1984 (WGS84).

In oceans and geographical areas connected to oceans

5 It is resolved that heights on shore, including elevations of lights, should be referred to a HW datum.

6 It is resolved that the Lowest Astronomical Tide (LAT), or as closely equivalent to this level as is practically acceptable to Hydrographic Offices, be adopted as chart datum. Alternatively the differences between LAT and national chart datums may be specified in nautical documents. If low water levels in a specific area frequently deviate from LAT, chart datum may be adapted accordingly.

7 It is resolved that Highest Astronomical Tide (HAT) be adopted as the datum for vertical clearances. Alternatively the differences between HAT and national datums for vertical clearances may be specified in nautical documents. If high water levels in a specific area frequently deviate from HAT, the datum for vertical clearances may be adapted accordingly.

*Note: LAT (HAT) is defined as the lowest (highest) tide level which can be predicted to occur under average meteorological conditions and under any combination of astronomical conditions. ~~It is recommended that LAT and HAT be calculated either over a minimum period of 19 years using harmonic constants derived from a minimum of one year's observations or by other proven methods known to give reliable results. Tide levels should, if possible, reflect the estimated uncertainty values obtained during the determination of these levels.~~*

8 It is recommended that LAT and HAT be calculated either over a minimum period of 19 years using harmonic constants derived from a minimum of one year's observations or by other proven methods known to give reliable results. Tide levels should, if possible, reflect the estimated uncertainty values obtained during the determination of these levels.

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In geographical areas with limited connection to oceans and negligible tidal range (< 30 cm)

~~8~~9 It is resolved that depths, and all other navigational information should be referred to Mean Sea Level (MSL) or other level as closely equivalent to this as is practically acceptable to Hydrographic Offices.

*Note: The adopted level may be a well-defined geodetic datum as used for heights in land survey applications or an observed local Mean Sea Level (MSL) based on long series of water level observations.*

~~9~~10 In order to support other non-navigational applications as UNCLOS and also to indicate the characteristics in the area, it is recommended to adopt the mean of yearly lowest/highest water levels observed over a long time period.

Inland Waters

~~10~~11 It is resolved that depths, and all other navigational information should be referred to an appropriate level practically acceptable to Hydrographic Offices or if needed LW as a reference level for depths and HW for vertical clearances. The selection of which one of the alternatives to be used is a difficult issue which can only be determined locally and which will be largely dependent on seasonal hydrological conditions. LW and HW are defined preferably as the mean of lowest/highest water levels, or as a suitable percentile of lowest/highest water levels, observed over a long time period.