High precision hydrography
The St. Lawrence River channel
HD Bathymetry, Production, Distribution and Updating

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High precision hydrography, HDGB, production, distribution and updating

• St. Lawrence channel
• Tools, procedures & standards
• Operations & Results
• Improved information
• New Products, S-102
• Updates
• Facts about Canada

• CHS offices in 4 regions: Pacific, Central and Arctic, Quebec, Atlantic

• Canadian Coastline 243,792Km

• Extensive system of inland waterways

• The Canadian merchant fleets operate 1,200 vessels in Canada

• 22,000 coastal and inland commercial vessels operating in Canadian waters
Facts about St. Lawrence River

- The greatest annual discharge
- Waterway of 320 km and channel restricted on 210 km
- Navigational conditions: ice, strong currents, tides, narrow channel, shallow water between Montreal and Quebec (11 m to 12.5 m)
CCGS F.C.G Smith

HYDROGRAPHIC SURVEY CATAMARAN

Length: 35 m

Sounders: Navitronics, 6 MCS, 33 Transducers

Frequency 200kHz; Depth: 2 - 100 m

Beamwidth 8 degrees

Heave/Roll/Pitch: Orion, Gyro, Speed log

St. Lawrence River channel

Québec

Grondines

Montreal
CCGS G.C. 03

HYDROGRAPHIC SURVEY CATAMARAN

Length: 18.5 m
Sounders: Navitronics, 2 MCS, 12 Transducers
Frequency 200kHz; Depth: 2 - 100 m
Beamwidth 8 degrees
Heave/Roll/Pitch: Orion, Gyro, Speed log

CCGS G.C. 03

St. Lawrence River channel  Québec
Grondines
Montreal
HYDROGRAPHIC SURVEY LAUNCH

Sounders: Navitronics 1 MCS, 6 Transducers –
Frequency 200 kHz; Depth: 2 - 100 m
Multi-beam R2Sonic, 2022
Frequency 200-400 kHz; Depth: 1 - 500 m
Heave/Roll/Pitch: POS-MV 320

St. Lawrence River channel
Québec
Grondines
Montreal
Calibration site (Groundtruth)
3 times/year each survey boat

- 48 regular targets. Average depth: 13 m
- Each target have 3 different surface sizes: (1 m X 1 m, 1.6 X 1.6, 2.5 X 2.5)
- The data is processed & cleaned
- Selection of soundings within each target
- Statistical analysis (Compare present soundings vs historical)
- Modified vessel configuration files
Positioning system Network

Montréal
Québec
Montmagny
Batiscan
Sorel / Île des B.
Ste-Marthe / PdL
Lon / Ver / Lan
Pointe du Lac
Grondines / Batis
Ste-Croix
Neu / Ste Cr
431.1MHz
430.1MHz
430.6MHz
431.1MHz
431.1MHz
431.1MHz

Montreal
Québec
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431.1MHz
430.1MHz
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431.1MHz
431.1MHz
431.1MHz

Channel
OTF station
OTF relay station
Water Level gauges Network

- Montmagny
- Ste-Croix
- Barre à Boulard
- Grondines
- Bécancoeur
- Barre à Boulard
- Saint-François (IO)
- Port de Québec
- Lauzon
- Montmagny

**Tide gauge of SINECO network**
- Channel
- Master station
- Relay station
- Future station

**Locations**
- Jetty No.1
- Frontenac
- Varenne
- Contrecoeur
- Lac Saint-Pierre
- Trois-Rivières
- Ste-Marthe
- Sorel
- Barre à Boulard
- Mont réal
- St-Bruno
An additional System for water level

**SPINE** (Système d’interpolation et Prévision des Niveaux d’Eau)

- One-dimension hydrodynamic model STLT 1081
- Water level forecast calculations at each node (transmission of a matrix)
- Water level gauges network
- Water level data transmission in real time
- Spatial-temporal interpolation
- SPINE solution compared with OTF solution
SPINE: Water Level Forecast and Interpolation Service

- Two new CHS web data services:
  1. Water level observations from permanent tide gauges (SINECO stations)
  2. Water level forecast for any time and location (SPINE)
     - Forecast for 0-30 days in the future
     - Real time request mode
     - Request in the past

- CHS provides specifications and users develop their own access interface
Dynamic Water Levels

Québec
Trois-Rivières
125 km
Variation of depths function of water level

Secteurs E16 et E17

Zéro des cartes

7 km

Chart Datum

Marée Sh00

Tide

Profondeur (m)
- 00.0 – 12.2
- 12.2 – 13.0
- 13.0 – 20.0
All the elements in place for value added products...

- Well equipped calibrated Survey boats
- Development and implementation of a hydrographic integration solution of OTF system outputs in the acquisition software (HYPACK) onboard and processing software (CARIS - HIPS)
- Precise GPS RTK network
- Precise water level gauges network
- A seamless chart datum in place and used
- A water level interpolation and forecast service (SINECO +SPINE)
- Development of an independent water level information system (SINECO +SPINE)
- All the elements are in place for a value added products like High definition Gridded Bathymetry
High Definition Gridded Bathymetry (HDGB)

- HD (much higher resolution)
- Using CUBE in CARIS HIPS
- Daily delivery of a Gridded Bathy Surface...the Navigation Surface
- Used for: chart compilation, volume calculation and visualisation but...
- Can also be a Navigation Product by itself
Before dredging
sweep single-beam system resolution

MCS Avant dragage
Résolution 1m
Densité par cellule ~10
High Definition Gridded Bathymetry from MBES

Before dredging multi-beam resolution

R2 Sonic Avant dragage
Résolution 15 cm
Densité par cellule ~10
After dredging sweep single-beam system resolution
After dredging multi-beam resolution

High Definition Gridded Bathymetry from MBES

R2 Sonic Après dragage
Résolution 15 cm
Densité par cellule ~10
High Definition Gridded Bathymetry — a navigation product by itself

- More than 500 hydrographic surveys produced annually by CHS in the St. Lawrence channel up to Montreal.
- Upstream from Montreal, hundreds more surveys produced by St. Lawrence Seaway Corp. and USACE.
- What is provided to the mariners? Notices to shipping (navigational warnings) and notices to mariners?
- So much more to offer! Data collected is reliable... All the complex work is done...
- Why don’t we provide this great useful info to the users?
Does the traditional Information Path allow it?

- **Hydrographic Surveys**
  - Notices to Shipping, local or navigational warnings (hours, days…)
  - Notices to Mariners (Months)
  - Electronic Chart Updates (Months)
  - Patches (3 to 6 Months)

- **St. Lawrence Ship Channel**
  - Shoals and NotShip in GML, available on web “Marinfo”, and automatic uploads on PPU
  - But still no HDGB provided…
Improved information path needed…

• More detailed information (HDGB) and shorter delays
• Survey to Bridge ‘s users in days instead of months or years
• Similar to Notices to Shipping (navigational warnings) but with all the details

…why don’t we provide it?

…are there some limitations?
High density contours using S-57 Standard Limitations

- Complex to generate contours (and it produces big files)
- No flexibility to integrate complex water levels
- S-57 was not designed to address the optimization of the water column, therefore not responding to present and future demand
- New S-102 standard permitting Gridded Data will not have those limitations
Approach used by CHS for the St. Lawrence

- Adoption of a collaborative approach with navigators and software manufacturers
- Prototype datasets were made available for trials
- Work of TSMAD on Geospatial Standard for Hydrographic Data (S-100) was promising, CHS embarks
- CHS and NAVO propose a product specification for GB
- Standard named Bathymetric Surface Product Specification identified as S-102
S-102 approved & adopted

- **HSSC** (Hydrographic Services & Standards Committee)
  S-102 final draft approved in November 2011
- Instructed IHB to submit it to member states for endorsement
- **IHO cl10/2012**
  Member States to review and consider S-102 draft edition available on IHO website
- April 2012, S-102 product specification was adopted.
Why don’t we provide HDGB? …Other limitations?

- A limitation, the standard charts coverage method allowing overlaps
- New coverage method without overlaps is required
- To partition HDGB
- To allow unambiguous dataset exchange
- And to facilitate updates
- CHS tiles /cells method
Tiles/cells (grid nodes) method, proposed by CHS

- **Tile** = 1000 x 1000 grid nodes
- **3 usages**
  - Harbour = 0.02 X 0.02 degrees
    - (2 kilometres)
  - Coastal = 0.1 X 0.1 degrees
    - (10 kilometres)
  - General = 1 X 1 degrees
    - (100 kilometres)
- **3 resolutions**
  - Harbour = 0.02 degrees / 1000 = 0.00002 (2 metres)
  - Coastal = 0.1 X 0.1 degrees / 1000 = 0.0001 (10 metres)
  - General = 1 X 1 degrees / 1000 = 0.001 (100 metres)
Navigation surfaces - Updates of the products

- Navigation surfaces
  - Accepted
  - Allow rapid transfer of information
- Standardised geographic cells make it easy to update
- New cell dataset with new bathymetry when provided just supersedes the previous tile
Possible Way to provide HDGB for navigation

Filtered ENC and S-102 in background
HDGB possibilities when combined to real time water level

Water column optimisation
Data used by Manufacturers

TRANSAS Draft Optimization Visualizer

INDUSOL 3D Navigator
Next steps…

- Increase awareness for potential users/clients and collect comments
- Involve ECS/ECDIS/GIS manufacturers. They are an important part of the solution ("survey to bridge")
- Trials with Navigation simulation Centers
- HDGB cells catalogue building and prioritisation of areas relies on client’s interests (86 existing tiles)
- Improving data dissemination process. Investigating, using, and adapting modern concepts already existing in other field activities.
- Incorporating other real time information layers (currents, ice coverage, …)
- Contribute to the paradigm shift (Awareness, training, etc.)
- Business models remain to be defined…
Conclusion

- High precision hydrography present in St. Lawrence, and many parts of the world
- Powerful information but not provided to its full potential to the users
- HDGB for navigation surfaces + tilling coverage scheme system (3 levels of resolution) = a solution for faster and more complete info provided and for...

TAKING CARE OF THE SEA!
Questions?

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