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CANADIAN HYDROGRAPHIC SERVICE
CANADA

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COORDINATION ISSUES FOR BOUNDARY ELECTRONIC NAVIGATIONAL CHARTS

AND

PROPOSED WORK PLAN

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1.0 INTRODUCTION

As directed by the United States–Canada Hydrographic Commission (USCHC), this paper identifies the issues surrounding the production and distribution of electronic navigational chart (ENC) data along the Canadian-U.S. border. The following sections will attempt to quantify the various constraints on the charting programs of both hydrographic offices, differences between the products and approaches, and options for ENC production and distribution in the boundary waters.

The resources needed to produce and maintain ENCs are limited in both hydrographic offices. One objective of coordinating ENC production will be to limit duplication of effort between the two offices. A coordinated approach has already been used to reduce redundant coverage in the paper and raster chart coverage of the boundary waters and this should be extended to the ENC product line. A proposed work plan is presented to scope the time and tasks required to address and resolve the issues at hand. An "up-front" investment of personnel, time, and resources will be required from both HOs to capitalize on the long term benefits of coordinated and non-duplicated efforts in the borders ENCs.

Resolution of the issues outlined in this paper must be consistent with the International Hydrographic Organization's (IHO) Worldwide Electronic Navigational Chart Database (WEND) principles and to the greatest extent possible, follow the "Guidelines for the Establishment of ENC Production Boundaries" (Appendix A, IHO Technical Resolution K2.19). Each hydrographic office (HO) must commit to these principles and guidelines, and must also commit resources to the process of resolution if these issues are to be adequately addressed.

2.0 ISSUES TO BE RESOLVED

There are many challenging and interrelated issues that must be resolved. These issues range from the data (or production) level to issues at the organizational level such as pricing and distribution. Each of these issues must be addressed to promote and, "facilitate integrated services to the mariner" (Sec 5.5 IHO Technical Resolution K2.19). As such, the issues are not presented in any particular order

2.1 Coverage

There are three approaches that could be used in coordinating ENC coverage. This section will list those that have been identified as well as the benefits and drawbacks of each approach.

2.1.1 Single Agency Charting

In this approach, a particular area would be charted by either NOAA or CHS exclusively. The areas covered would be coordinated by mutual agreement between the agencies. Essentially, an entire cell would be produced by one agency that would include data covering both Canadian and U.S. waters. The national boundary line would not be used as a cutoff.

Single agency charting has been used successfully in the paper and raster chart product lines and has the advantage of being simple to coordinate once the areas of responsibility are negotiated. It is also consistent with the IHO guidelines (Appendix A, IHO Technical Resolution K2.19). The difficulty lies in the initial negotiation of areas. Areas covered by the U.S. would result in a potential

revenue loss to CHS which would not be covering that area. Areas where U.S. data are now freely available that were taken over by CHS could result in protests from U.S. shippers who would then have to pay for CHS data in those areas. The scope of this situation needs to be evaluated.

2.1.2 Duplication of Coverage

Duplication of coverage is very simple to implement as there is no coordination involved between the agencies. It would, however, be a violation of the WEND principles that call for duplication to be avoided and for user-friendly and integrated services. In areas where both agencies produce ENCs, it is possible that customers would choose to use the free U.S. ENCs, resulting in a loss of sales to CHS. It is possible that data from overlapping cells would conflict due to any number of factors (e.g., scale differences, compilation differences, different update frequencies, etc.) Finally, since ECDIS software was written assuming that ENC data does not overlap, if cells from both countries were loaded into the same ECDIS, it is unclear whether the system would: show overlapping and potentially conflicting data; not allow one of the cells to be loaded; refuse to load either cell; experience a system failure; or handle the duplicate data gracefully and function normally.

2.1.3 Junction at Border

Cutting the cells at the border would require careful coordination between agencies to ensure that there are not gaps or overlaps along the junction. The advantage is that national waters are covered by the responsible agency and the problems of redundant data and revenue loss inherent in the two solutions described above are avoided. The big drawback to this approach is apparent when the boundary intersects the cells in areas critical to safe navigation. One example of this is in the St. Mary's River, where the boundary runs up the centerline of the maintained channel in one section of the river and near Sault Ste. Marie and Whitefish Bay it zigzags back and forth across the channel. Another problem area is in the Straits of Juan de Fuca, where the boundary runs along one edge of the separation zone of the vessel traffic separation scheme. This would result in the inbound lane being in U.S. data and the outbound lane being in CHS data.

2.2 Data (or coding)

2.2.1 Depth Curve Intervals

Issue:

Both ENC product lines follow the IHO S-57 ENC Product Specification. In most cases, this will result in the two lines being compatible. However, the NOAA ENC® product is currently created by digitizing depth curves from the existing raster chart suite, which uses feet or fathoms depth units. The depth curves in the metric version are derived by simply converting the charted English unit curves to metric resulting in depth curves with non-standard metric values. Thus, the curves and depth areas on NOAA ENC® cells will not match smoothly with the curves and depth areas on the adjacent Canadian ENCs. This is probably not a major problem on small scale ENCs, but on large scale ENCs in restricted waters, such as the Detroit River, the discrepancy will be noticeable. NOAA and CHS could provide a common README.TXT that clearly explains to the mariner the significance of these differences.

Proposed solution:

Without regenerating the depth curves on the NOAA ENC® cells from source to obtain true metric curves, there is no simple way to match along the split. For the near term, try to ensure that splits involve as few curves as possible and occur in low risk areas.

2.2.2 Sounding Datum

Issue:

Canadian charts use Lowest Normal Tide for their sounding datum while U.S. charts use Mean Lower Low Water.

Proposed solution:

The sounding datum for each ENC is already encoded in the cell header record or in metadata objects for areas within a cell that have a datum different from the rest of the cell. It will be up to the mariner and the system manufacturer to note this difference and also to ensure that any water level correctors (e.g., tides) are referenced to the correct datum. NOAA and CHS could provide a common README.TXT that clearly explains to the mariner the significance of these differences.

2.2.3 Digital Boundary

Issue:

An agreed, digital international boundary between Canadian and U.S. waters needs to be used so that the boundary is consistently shown on all ENC products, regardless of which country produces them. This is especially important for the enforcement of fishing regulations, where s fishing vessel may claim to be in a particular nation's waters, while the enforcement vessel's information shows otherwise.

It is also important to use a consistent line at the junctions of ENCs, whether it is the international boundary or some other junction between cells. Due to the rigorous topological structure required for ENC cells, any discrepancies between cell boundaries could result in gaps or overlaps that would trigger alarms on navigation systems.

Proposed solution:

A digital international boundary exists and is available fom the International Boundary Commission. It can also be downloaded from the U.S. Federal Communications Commission Web site at http://ftp.fcc.gov/oet/info/maps/uscabdry/. Both Offices should implement this digital boundary in ENC products.

2.2.4 Unsafe or Inconvenient Splits

Issue:

Splitting data along the international boundary would, in some cases, result in unsafe, or at best inconvenient, situations. Two examples will make this situation clearer: splitting the Straits of Juan de Fuca along the boundary will result in the VTS inbound half residing on the NOAA ENC® and the outbound half residing on the Canadian ENC, similarly, splitting the St Marys River would cut the navigable channel in half. In either of these situations, a mariner that only had data from one nation would be missing the other half of the navigational picture. Differences between the two nation's cells, as noted in this paper, would be more critical in these instances, particularly in the case of narrow navigable channels.

Proposed solution:

An analysis of the boundary waters should be conducted to identify all areas where this is an issue. Where possible, the Single Agency Charting concept that has been applied to paper charts may be used to decide which office will produce coverage for a given area that has this issue. In the case of ENCs produced by the U.S., since they are freely available, they could easily be incorporated into the Canadian ENC CD-ROM products or other services. This would help to address the issue of mariners not having key information if they are sailing using one country's products.

2.2.5 Different Updating Cycles

Issue:

Differences in the frequency of updates to ENCs between the U.S. and Canada could result in discrepancies between adjacent cells. An example might be a change to a VTS that crosses national boundaries that is issued as an update in one country several weeks ahead of the update in the other country, resulting in a period of weeks where the VTS does not match where it crosses.

Proposed solution:

The offices will have to coordinate closely on changes to features critical to navigation in order to avoid this situation.

2.2.6 Overlapping Cells

Issue:

Duplicate coverage of an area in the same navigational usage (e.g., coastal, approach, etc.) is not permitted. For example, the U.S. and Canada should not both produce an approach scale ENC of the same area. Since this is specified in the ENC Product Specification, the way in which any given navigation system would react to overlapping data is unpredictable. Some may reject one or both of the ENCs; others may handle the data with no problem and let the user select which data to view, and still others might lock up and crash.

Proposed solution:

Cells that have overlapping coverage in the same usage should be avoided if at all possible. NOAA and CHS should implement quality assurance processes that include checking their products with their neighbor's for overlapping coverage.

2.2.7 Coverage Gaps

Issue:

The ultimate goal is to provide seamless ENC coverage of the boundary waters so that a vessel transiting the boundary can sail entirely on ENC data without having to use raster or paper nautical charts.

Proposed solution:

Gaps in the coverage between the national suites need to be identified and completed as soon as resources allow. NOAA and CHS should implement quality assurance processes that include checking their products with their neighbor's for gaps in coverage.

2.3 Distribution

Currently, the US and Canada employ different distribution mechanisms. While this may not be the ideal situation, in terms of facilitation access to ENCs and integration of services, it does function. 'Harmonizing' distribution is not a high priority for the HOs at this time; however, it should be a long term goal [consistent with the WEND principles] of the USCHC to promote a "one-stop shopping" opportunity.

United States

NOAA ENC® cells and updates are distributed by posting them on an Internet Web site. The U.S. does not copyright the NOAA ENC® and there are no restrictions placed on the use of the data. Value added service providers may freely distribute the NOAA ENC® cells and updates as part of a portfolio management service or may include them in proprietary products. Certification of such services and products may be conducted by NOAA at a future date.

Canada

Distribution of Canadian ENCs is being handled by Nautical Data International (NDI) through an exclusive arrangement.

2.4 Pricing

ENC pricing is major issue for clients with respect to boundary ENCs. There is a significant difference between the pricing schemes of the two countries' products. Given current government policies, this situation will likely remain for some time. These are summarized as follows:

United States

NOAA ENC® cells and updates are distributed free of charge.

Canada

The price of CHS ENCs is determined by CHS and NDI.

3.0 PROPOSED WORK PLAN

3.1 Overview

The proposed work plan is consists of 4 phases (each of which will be detailed below). The number of personnel involved with each phase and task will be determined by the HO. It is assumed that at the very least, one person from each organization will be engaged. Two "mini-exchanges" are proposed which is in keeping with the sentiments expressed at the USCHC meeting May 2004 in Ottawa that the CHS-NOAA exchange program be reinstated to whatever extent is possible. This project provides an opportunity for this.

Phase 1- plan and execute an exchange of NOAA-CHS personnel to evaluate the boundary ENC issues on a chart-by-chart basis. Appendix A could be used as a point of departure for this study.

This phase would see a meeting of a bilateral team in which NOAA and CHS personnel would examine each boundary ENC in detail and evaluate the coverage, content and data issues. They would propose a solution (either one of the options offered above or something original) for each situation. The only option excluded is the one of duplicate coverage, as explained previously. This work would take place in either a NOAA or CHS office. CHS should have one representative from its Pacific, Central and Arctic, and Atlantic regional offices as part of this meeting/exchange.

This bilateral team would also estimate the resources (personnel, time, source material, etc) required to complete the project and outline the production strategies for carrying out this work. In addition, it would highlight the possible long-term impacts on each nation's production resources. Its findings (i.e. a report) from Phase 1 will be submitted to the Charting Advisory.

Phase 2- Charting Advisory selects option(s) and planning for subsequent phase.

The findings and recommendations from the bilateral team will be reviewed by the Charting Advisory who will decide which options should be undertaken. The work plan for Phase 3,including logistics will be developed.

Phase 3- Production work completed

Based on the results of Phases 1 and 2, this phase would entail the actual production work required to complete project. That is, the work required to eliminate the coverage, data, and content issues. Ideally, this work should be carried out by a bilateral team working in the same location; however, logistical issues may preclude this.

Phase 4- Coordinated implementation and hand-off of production tasks and release of new ENCs, as required.

In this phase the HOs would execute a communication plan (including Notice to Mariners) to inform clients of possible impacts. The development of the communications plan can be done concurrently with Phase 3. Implementation includes the release and withdrawal of some ENCs and the assuming of new responsibilities (i.e. production and maintenance) as agreed by the HOs. IHO/WEND should also be informed.

This implementation phase must follow quickly after Phase 3, or else the production work could rapidly become out of date.

3.2 Timelines

Phase	Task/ Milestone	Description	Time (weeks)	Total
1				
	1.1	Acceptance of this report	2.0	
	1.2	Designation of personnel	2.0	
	1.3	Logistics for bilateral team (travel, material and workspace preparation etc)	8.0	
	1.4	Meeting/Exchange; writing of report	2.0	
	1.5	Delivery of Phase 1 report to Charting Advisory/USCHC		
2		Total time for Phase 1		14.0
	2.1	Charting Advisory/USCHC review report	3.0	
	2.2	Decisions made on course of action		
	2.3	Work plan and logistics for next phase developed by bilateral team	12.0	
		Total time for Phase 2		15.0
3				
	3.1	Production work completed; writing of report	12.0	
	3.2	Delivery of Phase 3 report to Charting Advisory/USCHC		
		Total time for Phase 3		12.0
4				
	4.1	Develop communication plan, including NtMs etc (concurrent with Phase 3)		
	4.2	Charting Advisory/USCHC review report	2.0	
	4.3	Decisions made on course of action		
	4.4	Implementation of production regiments	2.0	
	4.5	Withdrawal/release of affected ENCs	1.0	
	4.6	Charting Advisory/USCHC report to WEND/IHO	2.0	
		Total time for Phase 4		7.0
		Total project time in weeks		48.0

3.3 Resources

Though the resources required will vary from phase to phase, in general, the resources required include:

-NOAA and CHS personnel;

-traveling and living expenses for personnel;

-all boundary ENCs from NOAA and CHS;

-IHO documentation including, S-57 documents (Object Catalogue, Use of the Object Catalogue, etc), WEND documents (“Guidelines for the Establishment of ENC Production Boundaries”, etc), “Improving ENC Consistency” paper from TWMAD WG, etc;

-dKart Inspector or some other ENC validation tool;

-ECS/ECDIS software;

-ENC production tools; and,

- Access to each HO’s source documents, files, and databases (e.g. SIPA, NOTMAR, ATON etc).

APPENDIX A

NOAA CHARTS* ON THE CANADIAN BORDER

EAST COAST

Chart	Rec[2]	Title
13003	JB-S	Cape Sable to Cape Hatteras
13006	JB-S	West Quoddy Head to New York
13009	JB-S	Gulf of Maine and Georges Bank
13260	JB-S	Bay of Fundy to Cape Cod
13325	JB-S	Quoddy Narrows to Petit Manan I
13392	U	Grand Manan Channel – Southern Part
13394	U	Grand Manan Channel – Northern Part
13396	U	Campobella Island
13398	U	Passamaquoddy Bay and St. Croix River

GREAT LAKES

Chart	Rec	Title
14770	SAC	Morristown, NY to Butternut, Ont.
14771	SAC	Butternut Bay, Ont. to Ironsides Island, NY
14772	SAC	Ironsides Island, NY to Bingham Island, Ont.
14773	SAC	Gananoque, Ont. to St. Lawrence Park, NY
14774	SAC	Round Island, NY to Wolfe Island, Ont.
14767	SAC	Bartlett Point to Cape Vincent
14768	SAC	Cape Vincent to Allan Otty Shoal and Kingston Ont.
14800	JB-S	Lake Ontario
14802	JB	Lake Ontario Clayton To Stony Point Ny And Kingston To False Duck Is
14803	JB	Six Miles South Of Stony Point To Port Bay
14805	JB	Long Pond To Thirty Mile Point New York
14806	U	Thirty Mile Pt New York To Port Dalhousie Ontario
14810	JB-S	Olcott Harbor to Toronto
14816	U	Lower Niagara River Ontario New York
14820	JB-S	Lake Erie
14822	JB	Niagara River And Welland Canal
14823	JB	Sturgeon Point To Twenty Mile Creek New York
14824	JB	Sixteen Mile Creek To Conneaut
14826	JB	Moss Point To Vermilion Ohio
14828	JB	Erie To Geneva
14829	JB	Geneva To Lorain
14830	JB	Vermilion Ohio To Detroit River Michigan
14832	U	Upper Niagara River
14833	U	Buffalo Harbor New York
14844	U	Islands In Lake Erie Including Sandusky Bay Ohio
14848	U	Detroit River Michigan
14850	U	Lake Saint Clair

14852	U	Saint Clair River Michigan
14854	U	Trenton Channel Detroit River And Rouge River
14860	JB-S	Lake Huron
14862	JB	Port Huron To Point Aux Barques Michigan
14864	JB	Lake Huron 6 Miles North Of Oscoda Michigan To Forty Mile Point Light
14865	U	South End Of Lake Huron Including Head Of St Clair River
14880	U	Straits Of Mackinac
14882	U	St Marys River Lake Huron To Lake Munscong
14883	U	St Marys River Lake Munuscong To Sault Ste Marie Including Lake George
14884 14961	U JB-S	St Mays River Head Of Lake Nicolet To Whitefish Bay Lake Superior
14962	JB	Lake Superior St Marys River To Au Sable Point
14968	JB	Lake Superior Grand Portage Bay Minn To Shesheeb Point Ontario

WEST COAST

Chart	Rec	Title
50	JB-S	North Pacific Ocean – Eastern Part
501	JB-S	North America, West Coast – Mexican Border to Dixon Entrance
18007	JB-S	San Francisco to Cape Flattery
18400	U	Strait of Georgia and Strait of Juan De Fuca
18421	U	Strait Of Juan De Fuca To Strait Of Georgia
18431	U	Boundary Pass To Cherry Point
18432	U	Boundary Pass
18433	U	South Haro Strait Middle Bank To Stuart Island
18440	JB	Puget Sound
18460	U	Strait Of Juan De Fuca
18465	U	Strait Of Juan De Fuca Eastern Part
18480	U	Approaches To Strait Of Juan De Fuca Destruction Island To Amphitrite Point
18485	JB	Cape Flattery

ALASKA

Chart	Rec	Title
531	JB-S	Gulf of Alaska – Strait of Juan De Fuca to Kodiak Island
16003	JB	Arctic Coast
16004	JB	Pt. Barrow to Herschel Island
16041	JB	Demarcation Bay and Approaches
17400	U	Dixon Entrance to Chatham Strait
17420	U	Hecate Strait to Etolin Island
17425	U	Portland Canal – North of Hattie Island
17427	U	Portland Canal – Dixon Entrance to Hattie Island
17434	U	Revillagigedo Channel
17437	U	Portland Inlet to Nakat Bay

[1]Excludes book charts
[2]Rec – Recommended action:

JB – Junction at Border
JB-S –Junction at Border - Small-scale chart
SAC – Single Agency Coverage
U – Un-assessed, no recommendation yet

CANADIAN CHARTS* ON THE UNITED STATES BORDER

EAST COAST

Chart	Title	ENC (s)
4001	Gulf of Maine to/à Strait of Belle Isle	CA176030
4003	Cape Breton to/à Cape Cod	CA176140
4011	Approaches to/à Bay of Fundy	CA276206
4012	Yarmouth to/à Halifax	CA276800; CA276801
4114	Campobello Island	CA576033
4115	Passamaquoddy Bay and St. Croix River	CA476035
4340	Grand Manan	
8005	George's Bank	
8006	Scotian Shelf	

GREAT LAKES

Chart	Title	ENC (s)
1433	Île Saint-Regis to Croil Islands	CA473232
1434	Croil Islands to Cardinal	CA473111
1435	Cardinal to/à Whaleback Shoal	CA473275
1436	Whaleback Shoal to/au Summerland Group	CA473035
1437	Summerland Group to/à Grindstone Island	CA473034
1438	Grindstone Island to/à Carleton Island	CA473025
1439	Carleton Island to/au Charity Shoal	CA473036
2000	Lake Ontario/Lac Ontario	CA273096
2043	Lower Niagara River and Approaches	CA573012
2058	Port Hope to Port Darlington	CA373064
2060	Main Duck Island to/à Scotch Bonnet Island	CA373071
2064	Kingston to/à False Ducks Islands	CA373063
2077	Lake Ontario/Lac Ontario, Western Portion	CA373091
2100	Lake Erie / Lac Erie	CA273094
2120	Niagara River to Long Point	CA373093
2121	Long Point to/à Port Glasgow	CA373088
2122	Pointe aux Pins to/à Point Pelee	CA373090
2123	Pelee Passage to/à la Detroit River	CA373089
2200	Lake Huron/Lac Huron	CA273095
2228	Lake Huron/Lac Huron, Southern Portion	CA373092
2250	Bruce Mines to/à Sugar Island	CA473018
2251	Meldrum Bay to/à St.Joseph Island	CA373060
2297	Duck Islands to DeTour Passage	

2298	Cove Island to Duck Islands	
2300	Lake Superior/Lac Superieur	CA173245
2301	Passage Island to/à Thunder Bay	CA373070
2302	St. Ignace Island to/à Passage Island	
2307	Coppermine Point to Cape Gargantua	CA373110
2310	Caribou Island to Michipicoten Island	CA373446
2311	Thunder Bay to Pigeon River	

WEST COAST

Chart	Title	ENC(s)
3000	Juan de Fuca Strait to/à Dixon Entrance	
3001	Vancouver Island, Juan de Fuca Strait to Queen Charlotte Sound	
3002	Queen Charlotte Sound to/à Dixon Entrance	
3440	Race Rocks to/à D'Arcy Island	CA470075
3441	Haro Strait, Boundary Pass and/et Satellite Channel	CA470365; CA470366
3442	North Pender Island to/à Thetis Island	CA470005
3461	Juan de Fuca Strait, Eastern Portion/Partie Est	CA370141
3462	Juan de Fuca Strait to/à Strait of Georgia	CA370367; CA370368
3463	Strait of Georgia, Southern Portion/Partie Sud	CA370145
3492	Roberts Bank	CA570297
3601	Juan de Fuca Strait to/à Vancouver Harbour	
3602	Approaches to/Approches à Juan de Fuca Strait	CA370203
3606	Juan de Fuca Strait	CA370144

ALASKA

Chart	Title	ENC(s)
3794	Stewart	
3802	Dixon Entrance	
3933	Portland Canal and Observatory Inlet	
3960	Approaches to/Approches à Portland Inlet	CA470363; CA470364
3994	Portland Inlet, Khutzeymateen Inlet and Pearse Canal	

*Excludes small craft charts and Arctic charts