GEOLOGICAL SURVEY OF CANADA

OPEN FILE 4459

Fourth generation seismic hazard maps of Canada: Values for over 650 Canadian localities intended for the 2005 National Building Code of Canada

J. Adams and S. Halchuk

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ABSTRACT

We summarize the methods being used for the new seismic hazard maps of Canada and estimate median ground motion on firm soil sites for a probability of exceedence of 2% in 50 years. Spectral acceleration at 0.2, 0.5, 1.0 and 2.0 second periods and peak acceleration will form the basis of the seismic provisions of the 2005 National Building Code of Canada. We tabulate values for more than 650 localities to be listed in the next Code and include maps of seismic hazard for Canada. The four spectral parameters will allow the construction of approximate uniform hazard spectra for each listed locality, and hence improve earthquake-resistant design. For comparison to NBCC 1995, selected 10% in 50 year hazard values are also given.

RÉSUMÉ

Nous résumons les méthodes utilisées pour les nouvelles cartes d'aléa séismique du Canada et nous estimons le mouvement moyen au sol sur sol ferme pour une probabilité d'excédence de 2% en 50 ans. L'accélération spectrale de 0,2, 0,5, 1,0 et 2,0 secondes et l'accélération maximale seront la base des dispositions séismiques du Code National du Bâtiment du Canada de 2005. Nous effectuons la tabulation des valeurs pour plus de 650 localités qui seront énumérées dans le prochain Code et incluons des cartes d'aléa séismique pour le Canada. Les quatre paramètres spectraux permettront de construire des spectres uniformes d'aléa approximatifs pour chaque localité énumérée et donc améliorer le design résistant aux séismes. À titre de comparaison avec le CNB de 1995, on donne aussi certaines valeurs d'aléa de 10% en 50 ans.

INTRODUCTION

The Geological Survey of Canada has produced a new seismic hazard model and thence a suite of new seismic hazard maps for Canada. The model and maps, initially released for trial use and public comment in 1995 (as GSC Open File 3029, Adams et al., 1995a) and 1996 (as GSC Open File 3283, Adams et al., 1996), were revised and reissued in 1999 as GSC Open File 3724 (henceforth "OF3724", Adams et al., 1999a). The methodology and results given in OF3724 formed the basis for CANCEE's (the Canadian National Committee on Earthquake Engineering) recommendations for the seismic design provisions in the next edition of the National Building Code of Canada (NBCC). The draft code has been released for public comment in February 2003 and the final revised code should be issued in 2005. Three generations of seismic hazard maps for Canada have been produced at roughly 15-year intervals (1953, 1970, 1985), and a fourth generation was justified because there is sufficient new information available to improve the hazard estimates (Adams et al., 1995b; Basham, 1995). Additional background information on the seismic provisions intended for NBCC2005 will appear in a special issue of the Canadian Journal of Civil Engineering in April 2003. Papers particularly relevant to users of the present document will be the introduction by R.H. DeVall, the overview by A.C. Heidebrecht, the seismic hazard paper by J. Adams and G.M. Atkinson, and the soil amplification paper by W.D.L. Finn and A. Wightman (see references).

The present open file is being issued to record seismic hazard values for numerous Canadian localities, computed using the final methods and model that will form the basis for the 2005 National Building Code of Canada. It replaces GSC Open File 3724 "Trial Seismic Hazard Maps of Canada - 1999: 2%/50 Year Values for Selected Canadian Cities ", which was computed with an almost identical seismic hazard model[1]. For convenience the old model is called 4.00 and the new one 4.01. Model changes from OF3724 are summarized in Appendix A.

While it is still intended to issue a suite of open files to document the method and computational aspects, eastern and western earthquake source zones, and the choice of strong ground motion relations, these have been delayed by the retirement of key staff. The current open file will be supplemented by these as soon as is practicable.

The new hazard model and resulting maps incorporate a significant increment of earthquake data, recent research on source zones and earthquake occurrence, together with complementary research on strong ground motion relations. In contrast to the 1985 maps, which gave national values for peak horizontal ground velocity (PGV) and peak horizontal ground acceleration (PGA), we can now provide horizontal spectral acceleration values ("Sa(T)"; 5% damped) for the range of periods important for common engineered structures. We present in Table 1 the hazard values chosen for the next NBCC, for localities (Fig. 1) intended for the NBCC "Design Data for Selected Localities in Canada" table, as well as the full Uniform Hazard Spectra (UHS) for the 22 cities given in OF3724, all computed for sites on firm soil at the 2% in 50 year probability of exceedence (0.000404 per annum). For comparison, we give values for the 10% probability of exceedence in 50 years

[1] OF3724 contains a small amount of additional background material not included in the present report.

(0.0021 per annum) using our new model; these values are those most directly comparable to the 1985 values based on Basham et al. (1982, 1985) used in the 1985, 1990 and 1995 editions of NBCC (e.g. NBCC, 1995).

METHOD

Because this Open File is being issued in advance of the Open Files containing the full documentation, an overview is given below.

The present method for calculating seismic hazard builds upon the work of Basham et al. (1982; 1985) which established the third generation of seismic hazard maps for Canada. We apply the same Cornell-McGuire methodology (e.g., McGuire, 1993) using a customized version of the FRISK88 hazard code (FRISK88 is a proprietary software product of Risk Engineering Inc.) we call GSCFRISK. This and other new-generation codes allow explicit inclusion of uncertainty (see below), so the new Canadian model will include the effects of uncertainty for the first time.

Regionalization
Of necessity, eastern and western Canada must be treated slightly differently because of the different properties of the crust. Figure 2 shows the regionalization used and identifies in a general way the low-seismicity central part of Canada we discuss later as "Stable Canada". The leftmost dashed line on Figure 2 is the most significant for the purposes of applying ground motion relations. Seismic hazard from zones to the west of this line has been calculated using western strong ground motion relations; eastern relations are used for the remaining zones and the "Stable Canada" region. This approximation underestimates the hazard from the **H** and **R** models to the non-Cordilleran parts of Alberta and the Northwest Territories, because the ground motions from Cordilleran earthquakes propagating into the shield interior of Canada will be less attenuated than indicated by the western strong ground motion relations we apply to them. Such an underestimate is mitigated however by the robust combination of **H**, **R** and **F** models used in the 4th Generation model (see later). We will seek a better way of estimating the hazard for the region immediately to the east of the Cordillera for the next hazard model.

Probability level
The probability level used in GSC Open File 3283 was 0.0021 per annum, or a 10% chance of exceedence in 50 years. This was the same as for the 1985 through 1995 National Building Code maps. Like OF3724, the current open file provides the 2% chance of exceedence in 50 years (written subsequently as 2%/50 year) equivalent to an annual probability of 0.000404, as well as certain 10%/50 year (0.0021 per annum) values for backward comparability. For reasons to be discussed later it is currently considered more reliable to base design forces on this lower-probability shaking.

Localities
The localities in the list were provided by the National Research Council in April 2002. They include most of the larger population clusters in Canada, and for large urban areas give several locations within the city. Coordinates for the localities do not necessarily coincide with those used

in OF3724 to represent the town hall, chief post office, or downtown core, so the current hazard results for the OF3724 localities have been given again in Table 3. Minor differences exist between these latter values and the ones given in OF3724. These differences are due to small corrections to the seismic hazard model, as detailed in Appendix A. Certain large urban areas, especially in regions of steep seismic hazard gradient, exhibit a range of hazard values, as can be seen in Table 1. For example values for Sa(0.2) across greater Toronto range from 0.31 g (Mississauga) to 0.24 g (Scarborough). Similar ranges were present in the 1985 seismic hazard maps, but were not evident to the engineer because zone values were used for design, and in almost every case each urban area fell into just one zone. The 2005 NBCC will use site values, not zone values, for design, so the ranges will result in slightly different designs across a city according to the estimated seismic hazard.

Uncertainty

The new seismic hazard model for Canada considers two types of uncertainty – aleatory uncertainty due to randomness in process and epistemic uncertainty due to uncertainty in knowledge; the former cannot be reduced by collecting additional information, but the latter can be (Adams and Atkinson, 2003).

Aleatory uncertainty arises from physical variability that is inherent in the unpredictable nature of future events. For example there is a random component of earthquake source and propagation processes which will cause a scatter of amplitudes about the median values, even if the median were known with perfect accuracy. The Cornell-McGuire approach, as implemented in the 1985 hazard maps included the aleatory uncertainty by incorporating the "sigma" of the ground motion relations into the computation. The sigma is the standard deviation of the scatter of the data about the median ground motion relations, and its incorporation through the GSCFRISK code increases the median hazard (the aleatory uncertainty is also included in all the percentiles of hazard).

Epistemic uncertainty arises from the differences in expert specification of modelling assumptions, unknown or only partially known parameters, and extrapolation beyond observed range of data. Examples are: specification of seismic source zones, including judgments on stochastic behaviour of historical seismicity, or belief in future activity of seismic gaps; assumptions made in calculations of recurrence curves, such as their analytical form, and extrapolation beyond the observed data range or duration of historical record; and choice of maximum magnitude. GSCFRISK uses a standard "logic tree" approach to include the epistemic uncertainty. Our 84th percentile values include the contribution of the epistemic uncertainty from all the explicitly-included parameters (strong ground motion relations, focal depth, earthquake recurrence parameters, upper bound magnitude); a further parameter — earthquake source zone configuration — is treated separately, as discussed below.

The above separation into aleatory and epistemic is over-simplified. In fact, any uncertainty that is not explicitly identified as an epistemic uncertainty will probably be lumped together with the aleatory. For example, the amplitude of ground motions from an earthquake depends on whether its mechanism is strike-slip or thrust, and on the directivity of the source. Current estimates of the uncertainty for Canada bundle this variability into the aleatory uncertainty (as the sigma); however if factored out, as additional parameters in the ground motion relations, the new sigma would be lower than before. Hence the separation of uncertainty into aleatory and epistemic is somewhat artificial.

Uncertainty is quantified in this Open File by citing both median and 84th percentiles for representative cities. A subsequent Open File will examine the origins and hazard consequences of of uncertainty in the 4th Generation model.

Computational aspects

The GSC modified a commercial software program (FRISK88, a proprietary product of Risk Engineering, Inc) into GSCFRISK to compute hazard and its uncertainty for the 4th generation maps. As discussed in Appendix C, three values were usually used to represent the epistemic uncertainty in each input parameter (alpha and beta of the magnitude recurrence parameter, upper bound magnitude, depth, strong motion relations), this being deemed sufficient to capture the range of uncertainty in each parameter. However for computational efficiency these values were set to be dependent between the sources. That is, instead of a fully-independent logic computation where each parameter choice for one source is combined with each choice for every other source, a "trimmed-tree" approach was used that included only those branches with the same (high, medium or low) value of the parameter. This still captures the range of uncertainty acceptably well, and has lower computational requirements. While the full calculation requires the integration over all magnitudes and distances, in practice sensible limits were placed on the integration range. For example, the contributions of earthquakes smaller than magnitude 4.75 are excluded because they are not of engineering concern. Also, contributions from more distant source zones (more than 600 km in the east and 400 km in the west) are excluded because their hazard contributions are negligible[2]. Sample input files for GSCFRISK are given in Appendix D.

Grids were constructed to generate the maps of seismic hazard given later. For the national maps, a 25 km grid extending from 40° to 85° North and 145° to 45° West covered the country and surrounding regions. The grid was constructed in three sections, to minimize distortions at large distances from the central latitude. Equidistant points rather than equal latitude/longitude spacing was maintained because of the large difference in distance between northern and southern latitudes (85 km between 1 degree of longitude at 40°N, 10 km at 85°N). For the southeastern and southwestern detail maps, 10 km grids were developed, spanning the regions 41° to 59° North, 89° to 48° West and 47.5° to 57.5° North, 134° to 109° West, respectively.

We have checked the hazard values from GSCFRISK against those produced by another commercial program (EZ-FRISK) from Risk Engineering Inc which runs on a PC; for the same best-estimate input parameters (EZ-FRISK lacks the treatment of epistemic uncertainty) the outputs are replicated to within 2-5%. We will be documenting these trials in a later report.

Combining results from various hazard models.

As part of the consideration of uncertainty we have used a pair of probabilistic source models to

[2]The hazard effects of the eastern cut-off are just visible on Figures 14 and 17 as a perturbation of the hazard contours at 600 km northwest of Charlevoix.

estimate the seismic hazard for Canada as a whole. For NBCC 2005 the results from these two models together with those from a "Stable Canada" and a Cascadia model are combined using the method termed "robust" by Adams et al. (1995c). The "robust" model is just choosing the highest value from the four models for each grid point across Canada, and is discussed at length later. The actual procedure is to compare the **H**, **R** and **F** models for the east and choose the higher value, compare the **H**, **R** and **F** models for the west and choose the higher value, compare the eastern and western value sets and choose the higher value (this ensures a robust join in Saskatchewan and the western Arctic), then lastly compare the Canadian **H+R+F** values for southwestern Canada with the values from the Cascadia scenario.

Accuracy of this report

The numbers in this report are as correct as humanly possible. Certain parts of the report (e.g. Appendices D1 and D2) are verbatim transcripts of the computer input files and (although subject to whims of word processor formatting) should be taken as definitive. Other tables, such as Tables 1 and 5, were formatted for ease of use and have been manipulated from the original computer-generated files. Part of the formatting was to display only the appropriate significant digits of the results. All such tables were checked by both authors. If discrepancies are noticed, please send an email to adams@seismo.nrcan.gc.ca and we will be happy to check them.

SEISMICITY PARAMETERS

Earthquake Catalogue

We have used the Canadian earthquake catalogue up to 1990 for the east and up to 1991 for the west. Relative to the catalog used for the 1985 maps, this adds a significant increment of data, particularly in the Arctic. Our knowledge of the Canada-wide earthquake activity in more recent years indicates that reprocessing the source zones and recomputing their magnitude-recurrence relations to include more recent earthquakes would not change the hazard results significantly, although it might reduce the uncertainty slightly. Of more significance, we have also revised the location and magnitude parameters of older earthquakes, and have supplemented the Canadian catalogue by recent U. S. catalogues. The eastern earthquakes chiefly have m_{bLg} magnitudes, so within the hazard program we converted them to moment magnitudes using the Atkinson (1993) relation for $m_N \leq 5.5$ and Boore and Atkinson (1987) for larger events, in order to use the Atkinson and Boore (1995) strong ground motion relations. The western earthquakes have a mix of magnitudes, depending on availability and quality, and are assigned in order of preference, moment magnitude for the largest, surface-wave magnitude for the next and so on; since the definition (or calibration) of these different scales are generally perceived to blend the scales smoothly into one another, we consider them equivalent to moment magnitudes in order to apply the Boore et al. (1993; 1994) and Youngs et al. (1997) relations. We will be publishing the earthquake catalogue ("SHEEF") used for the results in this Open File shortly.

Earthquake Source Zones

The last hazard maps were computed in 1982, using seismicity up to 1977 for most zones. They represented the distribution of seismicity by a single set of seismicity source zones. Since the 1982 maps, we have accumulated an additional decade and a half of earthquakes, and discovered clearer epicentre patterns in some places but been surprised by "unexpected" events in others. We have developed a better understanding of the seismotectonics behind the seismicity, but also an appreciation that much is unknown about how the future pattern of seismicity will resemble or differ from the historical pattern.

In some places, the Queen Charlotte Fault being an example, the level of knowledge is quite high, and one would expect a single model to suffice. In most other places, the range of opinions as to the cause and distribution of the earthquakes make a single model subject to much arbitrariness, so that the hazard results would reflect the current opinion of the compiler(s) and hence add a deterministic flavour to the maps. The resultant hazard maps might change drastically if there were a change of compiler, an "unexpected" earthquake, or a shift in the paradigm of earthquake occurrence. For these reasons we think a pair of models provides the minimal, but acceptable, representation of the diversity of opinion as to the causes and future locations of earthquakes.

To apply the Cornell-McGuire method we purchased a license for a large commercial program (FRISK88) in 1990 that allows us to use a number of source zone models and weight them by a (subjective) assessment that they are the correct model. For eastern Canada, our philosophy over the past 15 years has been shaped by the belief that while the scale of source zones could vary from the continent-scale to very small zones around single earthquakes, there are practical reasons for not choosing these extremes. Hence we have two models, a **H** model that in general uses relatively small source zones drawn around historical seismicity clusters, and a **R** model that establishes larger, regional zones (Fig. 2). The **H** and **R** models for the east were constructed by Adams and Halchuk, those for the west by Horner and Rogers. While some of the same philosophy is applicable in the eastern Rockies, the differences between the **H** and **R** models in western Canada are not generally interpretable in this manner, as neither expert in the west adopted a strongly historical model.

We have tried an approach proposed by A. Frankel as part of the USGS's estimation of eastern U.S. earthquake hazard. From our perspective, the most interesting aspect of their method is the estimation of seismic hazard based on the historical occurrence rate of $M \geq 3$ earthquakes (Frankel 1995; 1996). We applied Frankel's computer code to our earthquake file (Halchuk and Adams, unpub., 1995) and found that it replicated the hazard from our eastern **H** seismicity model very closely (our **H** model results are the appropriate ones to compare because that model in the east is designed to estimate hazard from small, historical earthquake clusters). It is reassuring that the assumptions made during the design of the **H** model, and the simplifications adopted in the Frankel code, result in similar hazard across the border (Halchuk and Adams, 1999). Despite this, we have reservations about the current USGS method, particularly with respect to the estimation of seismic hazard for regions of low or negligible contemporary seismicity, such as the regions of eastern Canada where the **R** model dominates.

In eastern Canada, the **R** model often combines a number of seismicity clusters that are inferred to have a common cause into large source zones, the larger of which are the Arctic Continental Margin (ACM), the Eastern Continental Margin (ECM), and the Iapetan Rifted Margin (IRM), shown on

Figure 3 (zone acronyms are listed in Appendix C2). For each, the **R** model zone implies that currently aseismic regions between adjacent seismicity clusters (e.g., the St. Lawrence valley near Trois-Rivières) are capable of large earthquakes, and that the rate of activity along the extensive zones (e.g., at any place along the continental margin) is constant, and is not higher in the vicinity of the historical activity. Contour maps of hazard computed using the **R** model have long 'ridges' of moderate hazard and lack the 'bulls-eyes' of high hazard produced by the **H** model (and exist in the current code maps). As a consequence, if the **R** model were implemented in a building code, it would reduce the protection significantly in regions of high historical seismicity while increasing protection only slightly in other places. This poses a dilemma to engineers concerned with safety. A probabilistic combination of the two models (as is possible with GSCFRISK) would involve their weighted-sum, but any weight given to the **R** model would reduce the protection in regions of high historical seismicity. Instead, their "robust" combination was adopted for NBCC 2005 (see below).

In western Canada, while the tectonics are better understood, and the models are not as different, there are still differences of opinion. For example, model **R** collects crustal earthquakes around Vancouver and Seattle together with the central Vancouver Island earthquakes into one zone (CASR) to represent shallow seismicity in this region of the North American Plate above the Cascadia subduction zone; model **H** uses two smaller zones (see Fig. 3). The Queen Charlotte Fault is the only earthquake source treated as a fault; all others are area sources.

Magnitude Recurrence Parameters

We use the maximum likelihood method of Weichert (1980) to compute the magnitude recurrence parameters. To provide an estimate of epistemic uncertainty we have taken the standard errors for the calculation and combined them to give an upper and a lower curve which approximate one sigma (standard deviation) error bounds. The curves are asymptotic to an assumed upper bound magnitude, and again we have used our judgment to associate the three curves with three possible upper bound values. Examples for two eastern source zones are shown in Figure 4. For some zones, the numbers of earthquakes were small and the statistics poor, so we imposed a regional value of the slope parameter. The parameters for the recurrence curves are determined from earthquakes larger than magnitude 2.5 to 4.0 (a lower limit depending on the quality of the earthquake monitoring for each zone), but for the integration to estimate seismic hazard a lower magnitude cutoff of 4.75, near the magnitude of engineering interest, is used.

For a few zones we have tempered the strict mathematical fit by our judgement. The only case where this has had a dramatic effect on major urban areas was in the Strait of Georgia region. Figure 5 shows the magnitude-recurrence curves we adopted for the CASR zone. The lower curve, representing a maximum likelihood fit to the earthquakes larger than magnitude 2.5, underestimates the rate of M>6.7 earthquakes from the past hundred years by an order of magnitude. It is not known whether the large historical earthquakes are a statistical anomaly or whether the fitted model for the rates is incorrect. Therefore, in order to better match the rate of large earthquakes we neglected all earthquakes smaller than the hazard cutoff, magnitude 4.75, and made a second maximum likelihood fit; the result is the upper curve. This curve, if extrapolated to smaller magnitudes, would badly underestimate the rates of small earthquakes. However, these earthquakes do not contribute to the hazard, while the upper curve, by matching the historical rate of larger earthquakes, better represents the historical hazard. In terms of the three-fold representation of the magnitude recurrence curve we use with GSCFRISK, we weighted the lower curve at 0.16, and took the upper curve to be both the "best" and "upper" relations, for a combined weight of 0.84. The same approach was applied to Zone JDF, as detailed in Appendix A.

Probabilistic seismicity models, H and R

Parameters used for the two probabilistic seismicity models are given in Appendices C3 and C4 as tables of the completeness years and seismicity parameters and maps of the source zones (coordinates of the zone corners are given in Appendices D1 and D2), and in Appendices D1 and D2 as a full copy of the four input files used for the GSCFRISK program.

Probabilistic Source Model for "Stable" Canada, F.

In addition to the two probabilistic source zone models, intended to span the range of likely models for the more seismically active parts of Canada, we include for the first time the following estimate for the more stable part. About half of the Canadian landmass has too few earthquakes to define reliable seismic source zones, and on prior maps the hazard computed for these regions came only from distant external sources. However, international examples suggest that large earthquakes might occur *anywhere* in Canada (albeit rarely). To improve the reliability of the estimate of seismic hazard for the stable part of Canada, the earthquake activity of those stable continental shields of the globe comparable to the Canadian shield was combined (Fenton and Adams, 1997) to reach the following conclusions:

- The maximum earthquake credible would have a magnitude of 7.0.
- Current knowledge does not permit the screening out of shield areas that could not have large earthquakes up to this size, so they should be considered as low probability events anywhere on the Canadian Shield.
- A reasonable design earthquake for the shield would be magnitude (Ms or surface wave magnitude scale) 6.0, but larger, much rarer, earthquakes can happen.
- The rate of Ms 6.0 or greater is estimated to be 0.004 p.a. per 1,000,000 square kilometres.

The global earthquake activity rate of the selected continental shields was used to estimate a magnitude recurrence curve for such stable regions (Fenton and Adams 1997; Fenton et al., 2003). Observed North American shield activity rates are lower than the global average, and rates in the part of central Canada not included in a source zone (Fig. 3) are lower still. To capture the uncertainty in seismicity rate all three rates were normalized by area and used with weights of 0.4 for the global average, 0.4 for the North American and 0.2 for the central Canada rate, the lower weight for the latter reflecting the belief that the process of defining source zones has produced a residual area ("background zone") artificially depleted in earthquakes (Appendix C5). The hazard, using eastern strong ground motion relations, was then computed at the centre of a large octagonal source zone (radius about 570 km) using these activity levels (The input file is given in Appendix D3). While the hazard values have quite a large uncertainty, the median values are expected to characterize the lowest likely hazard for any part of Canada, and so form an appropriate "floor" for Canadian seismic design. Hence we term it the **F** model. These floor values are also used for some low-hazard sites in western Canada, where the activity rates are likely to be higher, but the attenuation is stronger.

Deterministic Model for Cascadia, C.

The Cascadia subduction zone has generated prehistorical great earthquakes off Vancouver Island; from their geological record, the mean recurrence interval is about 600 years, the standard deviation of the mean is about 170 years (Adams, 1990), and the last happened 303 years ago in 1700 A.D. (Satake et al., 1996). At this point of understanding there is insufficient knowledge to estimate time-dependant seismic hazard for the next earthquake. Instead, we note that the long-term probability[3] of the next great earthquake is similar to that used for previous seismic zoning maps (10%/50 years), and so seismic hazard maps need to accommodate its expected ground motions. We have chosen to adopt a realistic scenario for the earthquake, and so provide a deterministic, rather than probabilistic, estimate of Cascadia earthquake ground motions. We term this the **C** model. Thus we tabulate the Cascadia subduction earthquake hazard separately, but intend its combination with the probabilistic results using the robust approach.

Present evidence suggests that the next great Cascadia subduction earthquake may have a moment magnitude as large as 9, with a rupture length of up to 900 km (Hyndman and Wang, 1993). For any site of interest, only part of the rupture will be close enough to contribute significant damaging ground motions. Thus the hazard approximates that of a smaller (still great) earthquake near to the site. Accordingly, for the purpose of the Cascadia subduction earthquake scenario in this report, we have adopted a magnitude of 8.2; this is also a practical choice, as there are no empirical ground motion relations that are valid for magnitudes greater than 8.5. For onshore sites we have modelled the Cascadia event as an offshore line source or locus set one third of the way into the transition zone below the locked zone (Hyndman and Wang, 1993; Dragert et al., 1994). The locus (Fig. 6) is taken to represent the closest point of energy release for onshore sites, and is used for computing distances (see code fragment in Appendix D4) to the various sites. As a refinement and to compute hazard for offshore sites (so as to complete the contour maps) a western and a northwestern boundary of the locked zone was added to produce an areal source with the distances from the boundary to offshore sites being computed as for the onshore sites. Finally, hazard for sites immediately above the locked zone was assigned equal to that above the locus (see details in Appendix C6). Like OF3724, we use a depth of 25 km, based on the position of the locus and the new contour maps on the dipping subduction interface in Dragert et al. (2001).

The occurrence of the deterministic scenario has a probability of about 10% in 50 years (~600 year recurrence interval), so its median values have a probability of being exceeded of about 5% in 50 years. The 84% ground motions (mean plus 1 sigma) for the scenario will have a probability of exceedence of 16% of 10% in 50 years, or about 2% in 50 years, which makes them appropriate for direct combination with the 2%/50 year probabilistic maps from the **H** and **R** models. In a similar manner, for the 84th percentile measures of the 2%/50 year values in Table 5 we have used the median plus two sigma ground motions for the Cascadia deterministic scenario.

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[3] The short-term probability is lower, since we seem to be only at about the mid-point of its occurrence interval, however the variability of the mean interval makes possible recurrence intervals shorter than 300 years or longer than 900 years.

STRONG GROUND MOTION RELATIONS

The different physical properties of the crust in eastern and western Canada require the use of separate strong ground motion relations. As discussed above, seismic hazard from zones to the west of the leftmost dashed line on Figure 2 has been calculated using western strong ground motion relations; for the remaining zones and the "Stable Canada" region eastern relations are used. Strong ground motion relation coefficients are detailed in Appendix E.

Eastern Canada.
For eastern Canada, a source of great uncertainty in seismic hazard estimation at the moment is the correct ground-motion relations to be used. In particular, the recordings of the 1988 Saguenay earthquake have caused the ground motion modelers to revise their prior relationships to account for its unexpectedly-large short-period motions. There appears to be a consensus of experts emerging in this field (e.g., the 1994-1995 deliberations of the Senior Seismic Hazard Analysis Committee (SSHAC) of the U. S. National Academy of Sciences, see Atkinson, 1995a). Hence, we have adopted a suite of relationships[4] with their aleatory uncertainty (the base relations of Atkinson and Boore, 1995), and their epistemic uncertainty[5] (as proposed by Atkinson, 1995a), consistent with that consensus. While these appear to be representative of most of the available published relationships, recent modelling of the Saguenay ground motions by the GSC (e.g. Haddon, 1992; 1995), modelling of the second-largest well-recorded eastern earthquake, Mont-Laurier, 1990 (Haddon and Adams 1997), and both theoretical considerations of, and empirical evidence for, the source spectrum for S-waves (Haddon, 1996; see also (i) comment by Atkinson et al. (1997) and reply by Haddon (1997) and (ii) the comment by Haddon (2000) and reply by Atkinson and Boore (2000)) gives us strong reservations that the absolute values the SSHAC consensus has produced are too low. We would emphasize that no matter how good our source models, the reliability of the final hazard values is highly dependent on the reliability of the extrapolations within the attenuation relations used, as observational data from large eastern earthquakes is sparse. We hope that these issues will be resolved soon. In the interim, we note that the suite of relations we use gives substantially similar results, for periods of 0.5 s, to the pair used by the USGS for their 1996 maps which form the basis for the 1997 and 2000 NEHRP provisions (NEHRP, 1997, 2000). One of those relationships is a single-corner-frequency model with a stress parameter of 150 bars, which gives increased ground motions at intermediate periods relative to the Atkinson-Boore two-corner-frequency model (A. Frankel, USGS, pers. comm, 1996).

The Atkinson-Boore suite of relationships was derived to fit observational data on hard-rock seismometer sites, so they need adjustment to represent the ground motions on the "very dense soil and soft rock" or "firm ground" reference ground condition chosen for Canada (see below under "Reference Ground Condition for Canada").

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[4] Note that we obtained the relationship for Sa(0.15) and Sa(0.4) by interpolation, using log(period), of coefficients in Atkinson's (1995a) Table 1. Hazard values for both periods should be used with caution because for some eastern cities and some percentiles (e.g., Figs. 26 and 35) they are less than the Sa(T) values for both shorter and longer periods (a physically unreasonable result), possibly due to one or more poorly interpolated coefficients (e.g. C4).

[5] Note that no estimate of epistemic uncertainty is available for Sa(2.0), so we do not give its 84th percentiles.

Western Canada.
For the western Canadian shallow source zones, including the subcrustal transition zones west of Vancouver Island as well as the Queen Charlotte Fault, we have adapted the ground motion relations from Boore et al. (1993, 1994 - hereafter termed 'BJF'); the same authors have published more recently (Boore et al., 1997). Our adaptation included the addition of a period-dependent anelastic attenuation term (using values from Atkinson, 1997) applied to distances larger than 100 km. Boore et al. (1993) differentiates between four soil classes, with most data in Class B, designated firm soil[6] and specified as having 360 to 750 m/s average velocity in the uppermost 30 m. We have therefore made our results consistent with their "firm soil".

For subcrustal source zones deeper under Puget Sound and for the Cascadia subduction zone we used Youngs et al. (1997) relationship adjusted to "firm soil". As representative depths we adopted 50 km for the normal-mechanism events within the subducting slab, and 25 km for the depth of energy release of the Cascadia thrust earthquake. For the Cascadia subduction zone hazard calculation we used Youngs et al. (1997) with a magnitude of 8.2 (for reasons detailed above) and with the closest approach of the rupture zone to establish distances to the various cities.

For aleatory uncertainty for BJF we have used the smoothed standard deviations ("sigmas") about the fitted relationships, as listed by the cited authors. The epistemic uncertainty (comparable to that used for the east) on each relationship we estimate by generating a pair of parallel alternative relations, factors of two higher and lower, and having weights of 0.3 each, leaving weight 0.4 for the median relation. This represents a small conservative bias in the computation of the expected ground motions. The measure of epistemic uncertainty is intended to capture firstly the range of opinion on western ground motions (for example, the upper curve envelopes the Idriss (1991, 1993) relations), and secondly the possibility that there may be systematic biases in the BJF relations. For example, the stress drops of the larger western Canadian earthquakes might be either higher or lower than those used in defining the BJF relations. We recognize that the assigned epistemic uncertainties represent an arbitrary and possibly conservative choice, but prefer to err on the conservative side.

Ground Motion Parameters
In contrast to the 1985 maps, which gave values for peak horizontal ground velocity (PGV) and peak horizontal ground acceleration (PGA), we present 5% damped horizontal spectral acceleration (Sa) values for the 0.2, 0.5, 1.0, and 2.0 second periods that will be used in NBCC 2005. The spectral acceleration values are denoted by Sa(T), where T is the period. We also present PGA values.

Units.
We express the PGA and Sa values in g for consistency with the NBCC and report them to 2 significant figures (an appropriate level of precision), except for some small 2 s values for which one significant figure is appropriate.

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[6] We prefer the term "firm ground", although in foundation engineering it is common to use the term "soil" as in "California Class B soil". In that context, the term "soil" has a very different meaning than that generally understood by, say, a gardener. The "soil" classes are defined by velocity ranges; for "Site Class C" proposed for NBCC 2005 (Finn and Wightman, 2003) the soil profile name is "very dense soil and soft rock", and is not "soil" in a gardener's terms; hence our preference for "firm ground". Assignment of a site to a particular class is based on the average shear wave velocity in the top 30 m, or an equivalent method. See Appendix B.

REFERENCE GROUND CONDITION FOR CANADA

For the preparation of national hazard maps it is essential to present seismic hazard levels on the same ground condition for all of Canada. Such a "reference" ground condition ("RGC") is needed in order to make the 2005 hazard values firstly, numerically comparable between east and west, and secondly, roughly comparable in intent to the current (1985) hazard maps.

The proposed NBCC 2005 has adopted "Site Class C" for the Canada-wide RGC. Site Class C is identical to BJF "Soil Class B", is defined by a 360 to 750 m/s average shear wave velocity in the uppermost 30 m (Finn and Wightman 2003) and has been defined formally by NEHRP (1997). Site Class C was our proposed choice in OF3724, because:

a) it appears to be the closest to the soil conditions implied in 1995 NBCC and referred as 'rock or firm soil'. Class C represents the softer part of the 'rock' classification earlier proposed by Joyner, Boore and co-workers, with the larger number of strong motion recordings.
b) Class C is the reference ground condition for the main strong motion relationship we use in western Canada.
c) a choice near the mid-range between very hard and very soft ground is preferred because it minimises the effects of uncertainty in the amplification or deamplification factors for the extreme sites.
d) the Hasegawa et al. (1981) relations used in eastern Canada for the 1985 maps were established by setting their near-source levels equal to those for western Canada (i.e. on "firm ground") and using isoseismal (felt intensity) maps to constrain the distance dependence of the relations. The isoseismal maps relied on felt-intensities reported by Canadians living on average eastern site conditions that were certainly not "hard rock". Thus the Class C "firm ground" condition is, in our view, close to the ground conditions that were implied by the 1985 eastern relationships.

The hard-rock strong ground motion equations of Atkinson and Boore (1995) for eastern Canada must be modified to Class C. The values given in Table 2 were developed in OF3724 to amplify seismic hazard *spectral* values calculated from the hard-rock Atkinson-Boore relations to those to be expected for the reference ground condition. This is mathematically identical to introducing the appropriate log factors into the Atkinson-Boore strong ground motion relations (e.g. through Atkinson's 1995 soil-response parameter, S) before the hazard calculation. For consistency, a similar factor must be applied to the PGA and PGV values, but for those parameters it is necessary to assign an average period for the motions; we have chosen 0.1 s for PGA and 0.5 s for PGV, but recognize that these periods may be a function of earthquake magnitude and distance (for the 1985 maps the choice was 0.2 and 1.0 s).

The effect of applying the RGC factors is to flatten the spectra of eastern sites, most particularly by the small amplification at periods less than 0.2 s (e.g., Fig. 7). Not too much should be read into the 3-figure precision for the RGC factors supplied in Table 2. We considered multiplying all periods by a simple factor of two, being a crude approximation with no pretensions to either accuracy or precision, however, on balance we feel that the tabulated RGC factors better represent the period dependence. If new information on the reference ground condition arises, it can be incorporated by a revision of the RGC factors. Hard-rock hazard values for eastern sites can be extracted from the published results by dividing by the RGC factors.

The above conclusions are independent of shaking intensity, at least to the degree that BJF's California-based B6 coefficients incorporate and do not separately identify shaking intensity. However, it is well known that the amplification of strong ground motions on soft soils is relatively reduced as the severity of shaking increases. This issue becomes more important as 2%/50 year values are to be used in NBCC2005 are typically twice as large as the 10%/50 year values, with more potential for non-linear effects[7]. As is discussed by Finn and Wightman (2003), the RGC factor is only one aspect of the adjustments that need to be made to soil conditions, some of which reduce the severity of very strong ground motions at high frequencies, possibly even below those on a hard rock site. Thus Finn and Wightman (2003) derived period and intensity based coefficients Fa and Fv from similar tables in NEHRP (1997, 2000) by normalizing them to Class C = 1. Tables for the site classification scheme for NBCC 2005 and the appropriate values of Fa and Fv are included in Appendix B.

The proposed scheme allows the uniform representation of seismic hazard across Canada. The choice of Site Class C as the reference is appropriate, because this is the ground condition with the best observational data set (from California) and is the basis for the BJF relations we are using for western Canada. However, we emphasize we are not making any judgment as to whether Class C is a typical or even a common condition in either western or eastern Canada.

RESULTS

Tabulated Values.
Table 1 gives the 2% /50 year robust probabilistic hazard values for the selected localities intended for the 2005 NBCC "Design Data for Selected Localities in Canada" table.

Table 3 gives the full spectral values for 22 selected cities for each of the **H** and the **R** models. These estimates include Sa for additional periods and 50th and 84th percentile values (to give a measure of uncertainty), and are given for both the 2%/50 year and 10%/50 year probabilities.

Table 4 presents the "Stable Canada" floor values for low seismicity parts of Canada for both 10%/50 year and 2%/50 year probabilities and for the median and 84th percentile results.

Table 5 presents the hazard values for cities from our Cascadia subduction earthquake scenario. Appendix C7 contains additional results for a range of distances that may be used to interpolate values for other sites in southwestern B.C.

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[7] There is an intriguing possibility that the non-linear effects observed in large California earthquakes may be more due to finite-source issues than to non-linearity in site effects (O'Connell, 1999). Such non-linear effects might be smaller for Canadian cities, since short period deaggregations for Vancouver and Montréal indicate the major contributions are from magnitude 6.4-6.5 events (Adams and Halchuk, in prep.), sources smaller than the California events.

Table 6 represents a 1-page summary of the robust hazard from Tables 3, 4 and 5 for the 2%/50 year probability level. This is also the summary table used in Adams and Atkinson (2003).

Table 7 presents a comparison of 1995 and 2005 seismic design values for the locations in Table 3. The 2005 spectral parameters can not be compared directly with the 1985 peak ground acceleration and velocity parameters, for they differ in type and probability level. Hence we compare PGA which is common to both NBCC versions. That comparison is not ideal because PGA is a short-period measure that captures the damage potential of ground motions much more poorly than spectral acceleration at short or long periods.

Maps

Figures 8 to 22 give contour maps of the design parameters Sa(0.2), Sa(0.5), Sa(1.0) and Sa(2.0) and PGA for Canada as a whole, and in more detail for southeastern Canada and southwestern Canada. The contour maps are given to indicate the extent of the seismic hazard contours and an indication of the direction and steepness of the hazard gradient, important insights that are hard to gain from Table 1. These maps represent robust hazard (i.e. they contour the maximum of **H**, **R**, **F** and **C** models) so the lowest values correspond to the Stable Canada floor values. They are also draft maps in that there are still some minor problems with the contouring, especially with the jaggedness of some of the contours. It is not intended that values be read off these maps (hence their small scale). Instead, values for localities not in the NBCC design value table will be made available from the GSC. Contours on these maps have been extended into the offshore but are limited to Canadian onshore and offshore territory. These contours are for information purposes only and are irrelevant to the application of the NBCC to onshore buildings.

Uniform Hazard Spectra

Figures 23-45 show the robust UHS corresponding to the combination of the appropriate results from Tables 3, 4 and 5. Each figure shows, for both the 2%/50 year and 10%/50 year probability levels, the median (50th percentile) and 84th percentile UHS. In addition, the Cascadia UHS are shown for western cities where the probabilistic model dominates the robust UHS.

While the larger of **H** and **R** forms the robust UHS for most cities, the Winnipeg spectra come from the **F** model from Table 4 (and so also represent the robust spectra for the large region of Canada where hazard estimated from the F model exceeds both the H and R estimates), the Tofino robust spectra come from the **C** model, and the Prince George and Inuvik robust spectra come from all three of the **H**, **R** and **F** models. As can be seen from Table 6, robust hazard values at adjacent periods may have come from different models. Note that it is inappropriate to display PGA values on the UHS plots (even though PGA is sometimes (arbitrarily) plotted at 0.03 s or 0.01 s), because its associated period differs from place to place and is generally not known.

DISCUSSION

Combining Diverse Hazard Estimates Using the 'Robust' Approach.

It is important to realize that each of the outputs from the **H** and **R** seismotectonic source models represents the result of a complete probabilistic hazard calculation. For NBCC 2005 the complete probabilistic hazard results from each of the two models (**H** and **R**), together with the probabilistic "floor" level for the "stable" part of Canada and the deterministic hazard from the Cascadia model, were combined in the fashion termed "robust" by Adams et al. (1995c). The "robust" model is just choosing the highest value from the four sources for each grid point across Canada.

The chief advantage of the "robust" approach is that it preserves protection in areas of high seismicity but also provides increased protection in low seismicity areas that are geologically likely to have future large earthquakes, such as the St. Lawrence valley near Trois-Rivières. Thus for certain low seismicity regions a conservative bias has been deliberately introduced. A further advantage is that the approach is computationally simple, and it is easy to explain what was done. Finally, the method allows a simple combination of deterministic and probabilistic hazard where this is desired.

For example, the values for the seismic hazard from the Cascadia subduction earthquake scenario in Table 5 are incorporated into the national hazard maps by the 'robust' approach; that is, where the Cascadia ground motions are larger than any probabilistic calculation, the Cascadia values are adopted. The same applies to the stable Canada "floor" values in Table 4, i.e., if the floor hazard is higher than that computed from the seismic source models **H** or **R** (i.e. probabilistic hazard from distant seismic sources) we adopt the floor value instead. We note that use of these floor values eliminates the lowest contours from many of the hazard maps we produced prior to 1999.

It is recognized that the GSC's robust combination of the deterministic Cascadia results with probabilistic crustal/sub-crustal hazard underestimates the total hazard at sites that could be strongly shaken by both sources. In effect, the design is for either the Cascadia earthquake <u>or</u> the expected crustal or subcrustal earthquake that will cause the design ground motions, whichever is larger, but not their probabilistic combination. At places where the two contributions are equal, the underestimate is the largest, and is likely of the order of 40%. On the other hand, there is the possibility that new knowledge may find that the time-varying current hazard from the subduction zone is below the Poissonian rate assumed for a probabilistic combination, or that ground motions for this particular subduction zone have been overestimated by the necessary use of data from other subduction zones. Rather than raise the designs immediately to the full probabilistic level (as should probably be the goal in the future), this either/or approach was adopted as a first step towards incorporating the hazard from mega-thrust earthquakes in Cascadia.

With the exception of places dominated by the Cascadia deterministic hazard, the mapped "robust" estimates are probabilistic at any one place, in that for each site and every ground motion parameter computed there is an identifiable probabilistic hazard calculation made using a particular source-zone model. Hence for design purposes (for a building or a city) the map provides a suitable probabilistic hazard value, though from a regional perspective the map as a whole is not probabilistic, because the model used may differ from site to site, or indeed from ground motion period to period at a particular site. Estimates for southeastern Canada suggest that adopting the robust method is equivalent to a 30% increase in seismic energy release over the historical rate, an amount equivalent to the addition of one M 6.6 earthquake in the near future or one M 7 earthquake just before the historical period began (Adams et al. 1995c).

Rationale for using the 2%/50 year probability level hazard results

Current practice, in Canada and other countries, has been to use probabilistic seismic hazard calculated at the 10%/50 year level for seismic design provisions. The performance of those design provisions, as deduced from global engineering experience with buildings in earthquakes, appears much better than the probability level used would suggest. Heidebrecht (1999) suggests the 2%/50 year probability level represents the approximate structural failure rate deemed acceptable.

A "hazard curve" can be used to display how ground shaking changes as a function of probability for a given shaking parameter. From the seismic hazard model used in this report we computed the hazard curves for Montréal and Vancouver for Sa(0.2) (Fig. 46). Although not shown on the figure, the uncertainties become larger as the probability level drops. Two special points on the curve correspond to probabilities of 10%/50 years (0.0021 p.a.) and 2%/50 years (0.0004 p.a.). In this range of probabilities the hazard curve for Montréal has a steeper gradient (increase in expected ground motions with decreasing probability) than for Vancouver, with the 2%/10% ratio being 2.39 for Montréal but 1.90 for Vancouver. The slopes of each city's hazard curve are a function of the size and distance distribution of earthquakes contributing hazard to each city. In general, where sites are dominated by distant, high-activity zones (in which earthquakes near the upper bound are relatively common), the hazard curve is less steep (= low ratio) than for sites that lie within moderate seismicity zones. While average values for the 2%/10% ratios for east and west cities are approximately 2.4 and 1.9 (Adams et al., 1999b), they vary considerably among eastern and western cities.

The variation means that applying a national, or even regional multiplicative factor to the 10%/50 year values will not reproduce lower probability hazard values reliably. The very different average slopes between east and west have important consequences for safe design (Adams et al., 2000). For example, the annotations on Fig. 46 show the effect of applying a constant factor of two (say, a "experiental factor of safety" term) to both the Vancouver and Montréal 10%/50 values. For Vancouver this would give a design appropriate to 1/2400 year shaking, but for Montréal a design appropriate to 1/1600 year shaking. Clearly the same level of safety has not been achieved. Even if different constants were used for east and west, the geographical variation shown in Fig. 47 (and present across all of Canada) would preclude achieving a constant level of safety by this means.

CANCEE concluded that the direct calculation of seismic hazard at the probability level most appropriate for design is necessary. Therefore the 2%/50 year seismic hazard values should be used to help achieve an improved, uniform level of safety.

Choice of Confidence Level

These two paragraphs are taken, slightly modified, from Adams and Atkinson (2003).

Hazard values for a specified probability are given for two confidence levels, the 50th percentile and the 84th percentile; the former is the median, and the latter includes a measure of epistemic uncertainty[8] arising from the incorporation of uncertainty into the model. For typical seismic hazard

[8] The 84th percentile is often chosen, because for a normal (or lognormal) distribution it corresponds the median plus one standard deviation. The standard deviation is less meaningful in our case, since the distributions of

computations in Canada the mean hazard value typically lies between the 65th and 75th percentile of the hazard distribution. Either the median, mean or 84th percentile might be used as the basis for engineering design, but the median was chosen. Statistically speaking the mean is the best single representatation of the hazard, as it is the expected value. However, the mean is affected by the amount of epistemic uncertainty incorporated into the analysis, and the view of the GSC, supported by CANCEE, was that the estimation of the epistemic uncertainty was still too incomplete to adopt into the code. As a certain conservative bias has been included in the hazard model, particularly through the definition of upper and lower bound values, it is anticipated that the estimated median values presented here may actually lie between the true median and true mean hazard values. Thus, as improved knowledge about epistemic uncertainty is incorporated into the analysis, a future change to using mean values may not be a large one. Current USGS practice (Frankel et al. 1999) is to compute the mean hazard value at 2% in 50 years, thus including directly a measure of the perceived uncertainty; however, for U.S. building code applications the design motions adopted are 2/3 of the mean values.

Choice of confidence level (50th, 84th, 95th percentile) and probability level (10% in 50 year, 2% in 50 year etc) of ground motions are linked. One might determine seismic loading based on the 84th percentile ground motions at the 10%/50 year probability level, because this ensures that there is little likelihood the design value will be exceeded, and so provides an appropriate degree of engineering conservatism consistent with general engineering practice (Naumoski and Heidebrecht, 1995). Or one might choose a lower probability level and base the seismic loading on the 50th percentile ground motions. While either might result in satisfactory design, the choice of median values at lower probability is preferred as providing a more consistent basis across the country, as discussed above. It should be noted that the 84th percentile of the 10%/50 year uniform hazard spectra is, coincidentally, very similar to the median (50th percentile) of the 2%/50 year results (e.g. Figures 23-45). Thus designs based on the median 2% in 50 year seismic hazard values for the new NBCC effectively accommodate Naumoski and Heidebrecht's proposal.

Changes in hazard estimates within Canada

Improved understanding of seismicity patterns, their cause and recurrence rates, and increased knowledge of strong ground motion has led to significant changes in hazard estimates relative to those of the 1985 maps. The changes are period dependent, so not all changes are apparent from the values in Table 7 which focuses on PGA changes, a short period measure. However, brief reasons for the changes in our estimate of PGA hazard are summarized in the last column of the table. The stated reasons necessarily over-simplify the sum effect of many changes, some acting to increase and some to decrease the estimated hazard.

For a particular site, the ground motion design values determined for NBCC 2005 may have changed in a very different way because:

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ground motions can be quite asymmetrical, due to the fact that the epistemic distribution is or can be quite asymmetric, and may be far from lognormal. Nevertheless, the use of the 84th percentile does include a measure of the epistemic uncertainty which we wish to include.

- a zone value applicable to a range of hazard levels in NBCC1995 has been replaced by the actual site values in NBCC 2005
- the design value at the period of interest was determined by scaling a standard spectrum in NBCC1995 but is done by interpolating the robust UHS in NBCC2005
- site classification factors have changed from soil factor F in 1995 to period- and intensity-dependent site factors in 2005.

Cross border comparisons with recent U.S. hazard maps

Comparisons with the new seismic hazard maps in the United States have been made by Halchuk and Adams (1999) and Adams et al. (2000). Although there are significant similarities (spectral parameters, probability level) there are some points of minor difference (strong ground motion relations used, reference ground condition) and some major differences (choice of mean, basis on historical activity, and treatment of the Cascadia subduction zone) in the approaches being used for Canada and the U.S. maps. Despite these differences, the overall distribution of seismic hazard is rather similar in the border regions.

CONCLUSIONS

This Open File gives the final model and results to be used in the next edition of the National Building Code of Canada. The improved seismicity model developed, the new ground motions adopted, the revised probability level chosen and the use of spectral parameters will permit site-specific uniform hazard spectra to be constructed for each listed locality, and hence allow improved earthquake-resistant design.

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TABLES

FIGURE CAPTIONS

Figure 1. Map of Canada showing the over 650 localities to be used in the NBCC "Design Data for Selected Localities in Canada" table, for which values are given in Table 1 of this report.

Figure 2. Map of Canada showing the earthquake catalog used for the 4th generation model together with dashed lines delimiting the eastern and western seismic regions and the stable Canada central region.

Figure 3. Earthquake source zone maps of Canada showing the zones that form the **H** (top) and **R** (bottom) models for earthquake distribution. Zones referred to in the text are shaded and labeled on the bottom map; corresponding **H**-model zones are shaded on the top map. Larger maps are given in Appendices C3 and C4.

Figure 4. Sample magnitude-recurrence data and curves, for Charlevoix and the Niagara-Attica (NAT) zones. The cumulative rates of earthquakes are represented by solid circles with stochastic error bounds and the best-fit curve (bold) are flanked by upper and lower "error" curves that are more widely separated for the poorly-constrained NAT dataset. All curves are asymptotic to assumed upper-bound magnitudes.

Figure 5. Magnitude-recurrence data and curves for CASR, the shallow crustal source for the Strait of Georgia - Puget Sound region. The maximum likelihood fit including the small magnitude earthquakes (lower curve) passes through the point (0.002, 7.0), considerably below the historical rate of M>6.8 earthquakes. The maximum likelihood fit to only M>4.75 earthquakes (upper curve) matches the historical rate of larger earthquakes much better. Both curves are asymptotic to an assumed upper-bound magnitude.

Figure 6. Locus used to represent the closest point of energy release for the deterministic Cascadia earthquake scenario (see text and Appendix C6 for details). The solid line represents the inboard edge most relevant to onshore sites.

Figure 7. Seismic hazard for Montréal depicted as Uniform Hazard Spectra on various ground conditions. These median 2%/50 year UHS from the **R** model are for Site Class C (values from Table 3) and for hard-rock derived using the RGC factors in Table 2; a baseline derived from the hard-rock values using a uniform amplification of a factor of two instead of the RGC factors is shown for comparison.

Figures 8-22. Seismic hazard maps depicting median, 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years. Triplets of maps show Canada, southeastern Canada, and southwestern Canada respectively. For each triplet the greyscale legend is given on the Canada map.

Figure 8. Sa(0.2) for Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

Figure 9. Sa(0.2) for southeastern Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

Figure 10. Sa(0.2) for southwestern Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

Figure 11. Sa(0.5) for Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

Figure 12. Sa(0.5) for southeastern Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

Figure 13. Sa(0.5) for southwestern Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

Figure 14. Sa(1.0) for Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

Figure 15. Sa(1.0) for southeastern Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

Figure 16. Sa(1.0) for southwestern Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

Figure 17. Sa(2.0) for Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

Figure 18. Sa(2.0) for southeastern Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

Figure 19. Sa(2.0) for southwestern Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

Figure 20. PGA for Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

Figure 21. PGA for southeastern Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

Figure 22. PGA for southwestern Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

Figures 23-45 show the 2%/50 year and 10%/50 year ground motions on Site Class C as Uniform Hazard Spectra for the named city (solid and dashed lines, respectively). For each probability, the 50th percentile (bold line) and 84th percentile (regular line) UHS are derived from the larger of the

H, **R**, **F** and **C** model values given in Tables 3, 4 and 5. For certain southwestern Canadian cities, two additional curves (dotted lines) are shown. These are the 2%/50 year and 10%/50 year spectra for the M8.2 Cascadia scenario event, as given in Table 5.

Figure 23. St. John's
Figure 24. Halifax
Figure 25. Moncton
Figure 26. Fredericton
Figure 27. La Malbaie
Figure 28. Québec
Figure 29. Trois-Rivières
Figure 30. Montréal
Figure 31. Ottawa
Figure 32. Niagara Falls
Figure 33. Toronto
Figure 34. Windsor
Figure 35. Winnipeg
Figure 36. Calgary
Figure 37. Kelowna
Figure 38. Kamloops
Figure 39. Prince George
Figure 40. Vancouver
Figure 41. Victoria
Figure 42. Tofino
Figure 43. Prince Rupert
Figure 44. Queen Charlotte City
Figure 45. Inuvik

Figure 46. Sa(0.2) hazard curves for Vancouver and Montréal, showing how increasing the 10%/50 year hazard by a factor of two produces different increases in safety (after Adams et al. 2000).

Figure 47. Ratio of 2%/50 year to 10%/50 year robust hazard for Sa(0.2) in southwestern British Columbia.

(Additional Figures are contained in the Appendices)

Table 1

Seismic hazard values intended for the 2005 NBCC "Design Data for Selected Locations in Canada" table

Notes. Peak and spectral hazard values are determined for an exceedence of 2%/50 years. Values are for "firm ground" (NBCC 2005 soil class C - average shear wave velocity 360-750 m/s). Median (50th percentile) values are given in units of g for peak horizontal and 5% damped spectral horizontal acceleration.

Locality		Lat N	Lon W	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
100 Mile House	BC	51.50	-121.28	0.28	0.17	0.11	0.063	0.14
Abbotsford	BC	49.10	-122.25	0.92	0.62	0.31	0.17	0.45
Agassiz	BC	49.23	-121.77	0.67	0.50	0.29	0.16	0.32
Alberni	BC	49.27	-124.80	0.75	0.55	0.30	0.16	0.35
Ashcroft	BC	50.72	-121.28	0.33	0.26	0.16	0.093	0.16
Beatton River	BC	57.38	-121.40	0.12	0.056	0.023	0.014	0.059
Burns Lake	BC	54.23	-125.75	0.12	0.062	0.044	0.029	0.059
Cache Creek	BC	50.80	-121.32	0.33	0.25	0.16	0.091	0.16
Campbell River	BC	50.02	-125.24	0.62	0.46	0.28	0.15	0.28
Carmi	BC	49.50	-119.12	0.28	0.17	0.09	0.053	0.14
Castlegar	BC	49.32	-117.67	0.27	0.16	0.081	0.045	0.14
Chetwynd	BC	55.70	-121.63	0.24	0.14	0.064	0.035	0.12
Chilliwack	BC	49.22	-121.94	0.73	0.51	0.29	0.16	0.35
Comox	BC	49.68	-124.93	0.66	0.49	0.28	0.16	0.30
Courtenay	BC	49.68	-124.98	0.65	0.48	0.28	0.16	0.30
Cranbrook	BC	49.50	-115.77	0.27	0.16	0.080	0.045	0.14
Crescent Valley	BC	49.45	-117.55	0.27	0.16	0.081	0.045	0.14
Crofton	BC	48.87	-123.65	1.1	0.74	0.37	0.18	0.54
Dawson Creek	BC	55.77	-120.23	0.12	0.070	0.035	0.021	0.063
Dog Creek	BC	51.58	-122.30	0.32	0.25	0.15	0.088	0.16
Duncan	BC	48.78	-123.70	1.1	0.74	0.37	0.18	0.54
Elko	BC	49.30	-115.12	0.27	0.16	0.080	0.045	0.14
Fernie	BC	49.50	-115.07	0.27	0.16	0.078	0.044	0.14
Fort Nelson	BC	58.83	-122.70	0.12	0.056	0.034	0.022	0.059
Fort St. John	BC	56.25	-120.85	0.12	0.061	0.032	0.019	0.059
Glacier	BC	51.27	-117.52	0.27	0.16	0.078	0.044	0.14
Golden	BC	51.30	-116.97	0.26	0.16	0.075	0.041	0.13
Grand Forks	BC	49.03	-118.45	0.27	0.17	0.083	0.047	0.14
Greenwood	BC	49.10	-118.68	0.27	0.17	0.085	0.049	0.14
Hope	BC	49.38	-121.44	0.63	0.47	0.28	0.15	0.29
Kamloops	BC	50.67	-120.32	0.28	0.17	0.10	0.061	0.14
Kaslo	BC	49.92	-116.92	0.27	0.16	0.080	0.045	0.14
Kelowna	BC	49.88	-119.48	0.28	0.17	0.094	0.056	0.14
Kimberley	BC	49.68	-115.98	0.27	0.16	0.079	0.044	0.14
Kitimat Plant	BC	54.05	-128.63	0.37	0.24	0.13	0.075	0.18

Locality		Lat N	Lon W	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
Kitimat Townsite	BC	54.07	-128.65	0.37	0.24	0.13	0.075	0.18
Lillooet	BC	50.68	-121.93	0.60	0.44	0.26	0.14	0.27
Lytton	BC	50.23	-121.57	0.60	0.44	0.26	0.14	0.27
Mackenzie	BC	55.30	-123.08	0.23	0.13	0.061	0.034	0.12
Masset	BC	54.02	-132.10	0.56	0.48	0.39	0.20	0.30
McBride	BC	53.30	-120.17	0.27	0.16	0.076	0.042	0.14
McLeod Lake	BC	54.98	-123.03	0.18	0.10	0.051	0.029	0.095
Merritt	BC	50.18	-120.79	0.32	0.25	0.16	0.091	0.16
Mission City	BC	49.13	-122.30	0.93	0.62	0.31	0.17	0.46
Montrose	BC	49.08	-117.58	0.27	0.16	0.081	0.045	0.14
Nakusp	BC	50.23	-117.80	0.27	0.16	0.080	0.045	0.14
Nanaimo	BC	49.17	-123.93	1.0	0.69	0.35	0.18	0.50
Nelson	BC	49.48	-117.28	0.27	0.16	0.080	0.045	0.14
Ocean Falls	BC	52.35	-127.70	0.38	0.25	0.14	0.080	0.18
Osoyoos	BC	49.03	-119.50	0.28	0.19	0.12	0.071	0.14
Penticton	BC	49.50	-119.58	0.28	0.18	0.11	0.065	0.14
Port Alberni	BC	49.28	-124.80	0.75	0.55	0.30	0.16	0.35
Port Hardy	BC	50.70	-127.42	0.43	0.30	0.17	0.10	0.20
Port McNeill	BC	50.58	-127.10	0.43	0.35	0.19	0.10	0.20
Powell River	BC	49.83	-124.52	0.67	0.49	0.29	0.16	0.31
Prince George	BC	53.92	-122.75	0.13	0.079	0.040	0.026	0.070
Prince Rupert	BC	54.32	-130.32	0.38	0.25	0.16	0.094	0.18
Princeton	BC	49.50	-120.51	0.42	0.31	0.19	0.11	0.20
Qualicum Beach	BC	49.35	-124.45	0.82	0.58	0.32	0.17	0.39
Quesnel	BC	52.98	-122.48	0.27	0.16	0.075	0.041	0.13
Revelstoke	BC	50.98	-118.20	0.27	0.16	0.080	0.045	0.14
Salmon Arm	BC	50.70	-119.28	0.27	0.16	0.082	0.046	0.14
Sandspit	BC	53.25	-131.82	0.61	0.55	0.45	0.23	0.32
Sidney	BC	48.65	-123.40	1.2	0.80	0.37	0.18	0.60
Smith River	BC	59.88	-126.43	0.52	0.31	0.15	0.086	0.24
Smithers	BC	54.85	-127.17	0.12	0.078	0.055	0.035	0.059
Squamish	BC	49.70	-123.15	0.72	0.52	0.30	0.16	0.33
Stewart	BC	55.93	-129.98	0.30	0.19	0.12	0.068	0.14
Taylor	BC	56.20	-120.69	0.12	0.060	0.031	0.018	0.059
Terrace	BC	54.52	-128.60	0.34	0.21	0.12	0.068	0.16
Tofino	BC	49.12	-125.88	1.2	0.94	0.47	0.21	0.52
Trail	BC	49.10	-117.70	0.27	0.16	0.081	0.045	0.14
Ucluelet	BC	48.93	-125.55	1.2	0.94	0.48	0.21	0.52
Burnaby (Simon Fraser Univ.)	BC	49.27	-122.95	0.94	0.63	0.33	0.17	0.47
Cloverdale	BC	49.15	-122.73	1.0	0.70	0.33	0.17	0.52
Haney	BC	49.22	-122.60	0.97	0.65	0.32	0.17	0.48

Locality		Lat N	Lon W	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
Ladner	BC	49.08	-123.08	1.1	0.73	0.35	0.18	0.54
Langley	BC	49.10	-122.65	1.1	0.71	0.33	0.17	0.53
New Westminster	BC	49.22	-122.92	0.99	0.66	0.33	0.17	0.49
North Vancouver	BC	49.32	-123.07	0.88	0.61	0.33	0.17	0.44
Richmond	BC	49.17	-123.10	1.0	0.68	0.34	0.18	0.50
Surrey (88 Ave. & 156 St.)	BC	49.17	-122.78	1.0	0.69	0.33	0.17	0.51
Vancouver	BC	49.25	-123.12	0.94	0.64	0.33	0.17	0.46
Vancouver (Granville & 41 Ave)	BC	49.23	-123.13	0.95	0.65	0.34	0.17	0.47
West Vancouver	BC	49.33	-123.17	0.88	0.62	0.33	0.17	0.43
Vernon	BC	50.30	-119.27	0.27	0.17	0.083	0.047	0.14
Victoria	BC	48.43	-123.37	1.2	0.82	0.38	0.18	0.61
Victoria (Gonzales Hts)	BC	48.42	-123.32	1.2	0.82	0.38	0.18	0.62
Victoria (Mt Tolmie)	BC	48.47	-123.33	1.2	0.82	0.38	0.18	0.61
Williams Lake	BC	52.18	-122.14	0.28	0.16	0.093	0.055	0.14
Youbou	BC	48.88	-124.20	1.0	0.69	0.35	0.18	0.50
Athabasca	AB	54.72	-113.28	0.12	0.056	0.023	0.006	0.059
Banff	AB	51.17	-115.57	0.24	0.14	0.066	0.037	0.12
Barrhead	AB	54.13	-114.40	0.12	0.056	0.023	0.008	0.059
Beaverlodge	AB	55.22	-119.43	0.13	0.078	0.039	0.022	0.070
Brooks	AB	50.58	-111.88	0.12	0.056	0.023	0.012	0.059
Calgary	AB	51.05	-114.08	0.15	0.084	0.041	0.023	0.088
Campsie	AB	54.13	-114.65	0.12	0.056	0.023	0.009	0.059
Camrose	AB	53.02	-112.83	0.12	0.056	0.023	0.007	0.059
Cardston	AB	49.20	-113.30	0.18	0.11	0.054	0.031	0.095
Claresholm	AB	50.03	-113.58	0.15	0.092	0.046	0.027	0.092
Cold Lake	AB	54.45	-110.17	0.12	0.056	0.023	0.006	0.059
Coleman	AB	49.63	-114.50	0.24	0.13	0.066	0.037	0.12
Coronation	AB	52.08	-111.45	0.12	0.056	0.023	0.006	0.059
Cowley	AB	49.57	-114.08	0.20	0.12	0.057	0.033	0.10
Drumheller	AB	51.47	-112.70	0.12	0.056	0.023	0.012	0.059
Edmonton	AB	53.55	-113.47	0.12	0.056	0.023	0.008	0.059
Edson	AB	53.58	-116.43	0.15	0.083	0.038	0.021	0.083
Embarras Portage	AB	58.45	-111.47	0.12	0.056	0.023	0.006	0.059
Fairview	AB	56.07	-118.38	0.12	0.056	0.023	0.011	0.059
Fort MacLeod	AB	49.72	-113.42	0.16	0.097	0.050	0.028	0.094
Fort McMurray	AB	56.73	-111.38	0.12	0.056	0.023	0.006	0.059
Fort Saskatchewan	AB	53.72	-113.22	0.12	0.056	0.023	0.007	0.059
Fort Vermilion	AB	58.40	-116.00	0.12	0.056	0.023	0.006	0.059
Grande Prairie	AB	55.17	-118.80	0.12	0.061	0.031	0.018	0.059
Habay	AB	58.83	-118.73	0.12	0.056	0.023	0.010	0.059
Hardisty	AB	52.67	-111.30	0.12	0.056	0.023	0.006	0.059

Locality		Lat N	Lon W	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
High River	AB	50.58	-113.87	0.15	0.087	0.043	0.024	0.090
Hinton	AB	53.40	-117.58	0.24	0.14	0.064	0.036	0.12
Jasper	AB	52.88	-118.08	0.24	0.14	0.068	0.038	0.12
Keg River	AB	57.80	-117.87	0.12	0.056	0.023	0.008	0.059
Lac la Biche	AB	54.77	-111.97	0.12	0.056	0.023	0.006	0.059
Lacombe	AB	52.47	-113.73	0.12	0.056	0.023	0.012	0.059
Lethbridge	AB	49.70	-112.82	0.15	0.087	0.044	0.026	0.087
Manning	AB	56.92	-117.62	0.12	0.056	0.023	0.008	0.059
Medicine Hat	AB	50.05	-110.67	0.12	0.056	0.023	0.009	0.059
Peace River	AB	56.23	-117.28	0.12	0.056	0.023	0.008	0.059
Pincher Creek	AB	49.48	-113.95	0.19	0.11	0.058	0.033	0.10
Ranfurly	AB	53.42	-111.68	0.12	0.056	0.023	0.006	0.059
Red Deer	AB	52.27	-113.80	0.12	0.056	0.023	0.014	0.059
Rocky Mountain House	AB	52.37	-114.92	0.15	0.080	0.038	0.021	0.085
Slave Lake	AB	55.28	-114.77	0.12	0.056	0.023	0.006	0.059
Stettler	AB	52.32	-112.72	0.12	0.056	0.023	0.009	0.059
Stony Plain	AB	53.53	-114.00	0.12	0.056	0.023	0.009	0.059
Suffield	AB	50.20	-111.17	0.12	0.056	0.023	0.011	0.059
Taber	AB	49.78	-112.15	0.12	0.059	0.032	0.018	0.064
Turner Valley	AB	50.67	-114.28	0.15	0.091	0.045	0.025	0.092
Valleyview	AB	55.07	-117.28	0.12	0.056	0.023	0.012	0.059
Vegreville	AB	53.50	-112.05	0.12	0.056	0.023	0.006	0.059
Vermilion	AB	53.37	-110.85	0.12	0.056	0.023	0.006	0.059
Wagner	AB	55.35	-114.98	0.12	0.056	0.023	0.007	0.059
Wainwright	AB	52.82	-110.87	0.12	0.056	0.023	0.006	0.059
Wetaskiwin	AB	52.97	-113.37	0.12	0.056	0.023	0.009	0.059
Whitecourt	AB	54.15	-115.68	0.12	0.056	0.023	0.012	0.059
Wimborne	AB	51.87	-113.58	0.12	0.056	0.025	0.015	0.059
Aishihik	YT	61.68	-137.51	0.26	0.18	0.12	0.070	0.13
Dawson	YT	64.07	-139.42	0.54	0.34	0.17	0.094	0.25
Destruction Bay	YT	61.28	-138.81	0.73	0.49	0.27	0.15	0.33
Snag	YT	62.40	-140.37	0.61	0.40	0.22	0.12	0.28
Teslin	YT	60.17	-132.72	0.19	0.11	0.069	0.043	0.099
Watson Lake	YT	60.13	-128.71	0.45	0.26	0.12	0.067	0.22
Whitehorse	YT	60.72	-135.05	0.22	0.15	0.094	0.056	0.12
Fort Smith	NT	60.00	-111.88	0.12	0.056	0.023	0.006	0.059
Fort Resolution	NT	61.19	-113.67	0.12	0.056	0.023	0.006	0.059
Yellowknife	NT	62.48	-114.35	0.12	0.056	0.023	0.006	0.059
Hay River	NT	60.89	-115.80	0.12	0.056	0.023	0.007	0.059
Rae-Edzo	NT	62.83	-116.05	0.12	0.056	0.023	0.008	0.059

Locality		Lat N	Lon W	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
Fort Providence	NT	61.35	-117.65	0.12	0.056	0.023	0.011	0.059
Holman	NT	70.73	-117.75	0.12	0.056	0.023	0.006	0.059
Port Radium	NT	66.05	-117.88	0.12	0.056	0.023	0.009	0.059
Fort Simpson	NT	61.93	-121.35	0.12	0.080	0.047	0.029	0.059
Norman Wells	NT	65.36	-126.83	0.51	0.31	0.15	0.085	0.24
Tungsten	NT	61.95	-128.27	0.51	0.31	0.16	0.087	0.24
Fort Good Hope	NT	66.29	-128.63	0.15	0.10	0.059	0.036	0.080
Inuvik	NT	68.35	-133.72	0.12	0.069	0.041	0.026	0.060
Aklavik	NT	68.23	-135.01	0.18	0.12	0.060	0.035	0.10
Mould Bay	NT	76.23	-119.33	0.35	0.16	0.073	0.019	0.24
Assiniboia	SK	49.63	-105.98	0.17	0.074	0.027	0.009	0.10
Battrum	SK	50.55	-108.33	0.12	0.056	0.023	0.006	0.059
Biggar	SK	52.07	-108.00	0.12	0.056	0.023	0.006	0.059
Broadview	SK	50.37	-102.58	0.12	0.056	0.023	0.006	0.059
Dafoe	SK	51.75	-104.53	0.12	0.056	0.023	0.006	0.059
Dundurn	SK	51.82	-106.50	0.12	0.056	0.023	0.006	0.059
Estevan	SK	49.13	-102.98	0.15	0.068	0.025	0.008	0.095
Hudson Bay	SK	52.85	-102.38	0.12	0.056	0.023	0.006	0.059
Humboldt	SK	52.20	-105.12	0.12	0.056	0.023	0.006	0.059
Island Falls	SK	55.53	-102.35	0.12	0.056	0.023	0.006	0.059
Kamsack	SK	51.57	-101.90	0.12	0.056	0.023	0.006	0.059
Kindersley	SK	51.47	-109.17	0.12	0.056	0.023	0.006	0.059
Lloydminster	SK	53.28	-110.00	0.12	0.056	0.023	0.006	0.059
Maple Creek	SK	49.92	-109.48	0.12	0.056	0.023	0.006	0.059
Meadow Lake	SK	54.13	-108.43	0.12	0.056	0.023	0.006	0.059
Melfort	SK	52.87	-104.62	0.12	0.056	0.023	0.006	0.059
Melville	SK	50.92	-102.80	0.12	0.056	0.023	0.006	0.059
Moose Jaw	SK	50.40	-105.53	0.12	0.056	0.023	0.006	0.059
Nipawin	SK	53.37	-104.00	0.12	0.056	0.023	0.006	0.059
North Battleford	SK	52.78	-108.28	0.12	0.056	0.023	0.006	0.059
Prince Albert	SK	53.20	-105.77	0.12	0.056	0.023	0.006	0.059
Qu'Appelle	SK	50.55	-103.88	0.12	0.056	0.023	0.006	0.059
Regina	SK	50.45	-104.62	0.12	0.056	0.023	0.006	0.063
Rosetown	SK	51.55	-108.00	0.12	0.056	0.023	0.006	0.059
Saskatoon	SK	52.12	-106.63	0.12	0.056	0.023	0.006	0.059
Scott	SK	52.37	-108.83	0.12	0.056	0.023	0.006	0.059
Strasbourg	SK	51.07	-104.95	0.12	0.056	0.023	0.006	0.059
Swift Current	SK	50.28	-107.80	0.12	0.056	0.023	0.006	0.059
Uranium City	SK	59.57	-108.62	0.12	0.056	0.023	0.006	0.059

Locality		Lat N	Lon W	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
Weyburn	SK	49.67	-103.85	0.23	0.092	0.034	0.011	0.16
Yorkton	SK	51.22	-102.47	0.12	0.056	0.023	0.006	0.059
Beausejour	MB	50.12	-96.52	0.12	0.056	0.023	0.006	0.059
Boissevain	MB	49.30	-100.06	0.12	0.056	0.023	0.006	0.059
Brandon	MB	49.92	-99.95	0.12	0.056	0.023	0.006	0.059
Churchill	MB	58.75	-94.12	0.12	0.056	0.023	0.006	0.059
Dauphin	MB	51.23	-100.05	0.12	0.056	0.023	0.006	0.059
Flin Flon	MB	54.77	-101.88	0.12	0.056	0.023	0.006	0.059
Gimli	MB	50.64	-96.99	0.12	0.056	0.023	0.006	0.059
Island Lake	MB	53.93	-94.67	0.12	0.056	0.023	0.006	0.059
Lac du Bonnet	MB	50.27	-96.06	0.12	0.056	0.023	0.006	0.059
Lynn Lake	MB	56.85	-101.05	0.12	0.056	0.023	0.006	0.059
Morden	MB	49.24	-98.10	0.12	0.056	0.023	0.006	0.059
Neepawa	MB	50.29	-99.47	0.12	0.056	0.023	0.006	0.059
Pine Falls	MB	50.65	-96.22	0.12	0.056	0.023	0.006	0.059
Portage la Prairie	MB	50.00	-98.29	0.12	0.056	0.023	0.006	0.059
Rivers	MB	50.10	-100.24	0.12	0.056	0.023	0.006	0.059
Sandilands	MB	49.36	-96.30	0.12	0.056	0.023	0.006	0.059
Selkirk	MB	50.20	-96.88	0.12	0.056	0.023	0.006	0.059
Split Lake	MB	56.31	-96.09	0.12	0.056	0.023	0.006	0.059
Steinbach	MB	49.57	-96.68	0.12	0.056	0.023	0.006	0.059
Swan River	MB	52.14	-101.27	0.12	0.056	0.023	0.006	0.059
The Pas	MB	53.87	-101.25	0.12	0.056	0.023	0.006	0.059
Thompson	MB	55.79	-97.86	0.12	0.056	0.023	0.006	0.059
Virden	MB	49.86	-100.93	0.12	0.056	0.023	0.006	0.059
Winnipeg	MB	49.89	-97.15	0.12	0.056	0.023	0.006	0.059
Ailsa Craig	ON	43.13	-81.55	0.16	0.082	0.044	0.012	0.092
Ajax	ON	43.85	-79.03	0.22	0.11	0.058	0.015	0.12
Alexandria	ON	45.32	-74.63	0.68	0.33	0.14	0.046	0.42
Alliston	ON	44.15	-79.87	0.17	0.092	0.048	0.013	0.087
Almonte	ON	45.23	-76.20	0.58	0.28	0.12	0.039	0.37
Armstrong	ON	50.30	-89.03	0.12	0.056	0.023	0.006	0.059
Arnprior	ON	45.43	-76.35	0.64	0.31	0.13	0.043	0.40
Atikokan	ON	48.75	-91.62	0.12	0.056	0.023	0.006	0.059
Aurora	ON	44.00	-79.47	0.19	0.10	0.052	0.014	0.10
Bancroft	ON	45.03	-77.75	0.26	0.15	0.071	0.022	0.13
Barrie	ON	44.40	-79.67	0.16	0.094	0.049	0.014	0.076
Barriefield	ON	44.23	-76.47	0.29	0.16	0.083	0.023	0.16
Beaverton	ON	44.43	-79.15	0.16	0.10	0.053	0.015	0.078

Locality		Lat N	Lon W	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
Belleville	ON	44.23	-77.35	0.26	0.14	0.073	0.020	0.14
Belmont	ON	42.88	-81.08	0.20	0.098	0.048	0.013	0.13
Big Trout Lake	ON	53.83	-90.00	0.12	0.056	0.023	0.006	0.059
Bracebridge	ON	45.03	-79.30	0.18	0.11	0.053	0.016	0.078
Bradford	ON	44.12	-79.57	0.18	0.097	0.050	0.014	0.093
Brampton	ON	43.68	-79.77	0.26	0.12	0.052	0.015	0.18
Brantford	ON	43.13	-80.27	0.24	0.12	0.052	0.014	0.16
Brighton	ON	44.03	-77.73	0.25	0.13	0.068	0.018	0.14
Brockville	ON	44.58	-75.68	0.40	0.20	0.10	0.030	0.22
Burk's Falls	ON	45.62	-79.40	0.21	0.12	0.057	0.018	0.11
Burlington	ON	43.32	-79.80	0.36	0.18	0.063	0.020	0.27
Cambridge	ON	43.38	-80.32	0.22	0.11	0.050	0.013	0.14
Campbellford	ON	44.35	-77.80	0.23	0.13	0.067	0.019	0.12
Cannington	ON	44.35	-79.03	0.17	0.10	0.054	0.015	0.081
Carleton Place	ON	45.13	-76.15	0.52	0.25	0.11	0.036	0.34
Cavan	ON	44.20	-78.47	0.20	0.12	0.060	0.017	0.10
Centralia	ON	43.28	-81.47	0.14	0.080	0.043	0.011	0.081
CFB Borden	ON	44.27	-79.88	0.16	0.090	0.048	0.013	0.081
Chapleau	ON	47.83	-83.40	0.12	0.058	0.029	0.009	0.059
Chatham	ON	42.40	-82.18	0.20	0.095	0.044	0.012	0.13
Chesley	ON	44.28	-81.08	0.13	0.077	0.041	0.011	0.063
Clinton	ON	43.62	-81.53	0.13	0.075	0.041	0.011	0.065
Coboconk	ON	44.65	-78.80	0.18	0.11	0.056	0.016	0.080
Cobourg	ON	43.97	-78.17	0.24	0.12	0.065	0.017	0.13
Cochrane	ON	49.07	-81.02	0.21	0.10	0.046	0.014	0.15
Colborne	ON	44.00	-77.88	0.24	0.13	0.067	0.018	0.14
Collingwood	ON	44.48	-80.22	0.14	0.087	0.045	0.013	0.069
Cornwall	ON	45.03	-74.73	0.67	0.31	0.14	0.045	0.41
Corunna	ON	42.88	-82.43	0.14	0.076	0.040	0.011	0.084
Deep River	ON	46.10	-77.50	0.66	0.32	0.13	0.043	0.42
Deseronto	ON	44.20	-77.05	0.27	0.15	0.076	0.021	0.14
Dorchester	ON	42.98	-81.07	0.19	0.096	0.048	0.013	0.12
Dorion	ON	48.78	-88.53	0.12	0.056	0.023	0.006	0.059
Dresden	ON	42.58	-82.18	0.18	0.091	0.044	0.012	0.12
Dryden	ON	49.78	-92.75	0.12	0.056	0.023	0.006	0.059
Dunnville	ON	42.90	-79.62	0.35	0.17	0.062	0.019	0.26
Durham	ON	44.17	-80.82	0.14	0.080	0.042	0.012	0.068
Dutton	ON	42.67	-81.50	0.20	0.097	0.047	0.013	0.13
Earlton	ON	47.72	-79.82	0.26	0.13	0.063	0.018	0.16

Locality		Lat N	Lon W	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
Edison	ON	49.80	-93.55	0.12	0.056	0.023	0.006	0.059
Elmvale	ON	44.58	-79.87	0.15	0.092	0.048	0.014	0.070
Embro	ON	43.15	-80.90	0.18	0.094	0.048	0.013	0.12
Englehart	ON	47.82	-79.87	0.25	0.12	0.061	0.018	0.16
Espanola	ON	46.25	-81.77	0.12	0.075	0.038	0.011	0.059
Exeter	ON	43.35	-81.48	0.14	0.079	0.043	0.011	0.076
Fenelon Falls	ON	44.53	-78.75	0.18	0.11	0.056	0.016	0.081
Fergus	ON	43.70	-80.37	0.18	0.094	0.047	0.013	0.10
Forest	ON	43.10	-82.00	0.14	0.077	0.041	0.011	0.079
Fort Erie	ON	42.90	-78.93	0.40	0.19	0.070	0.021	0.29
Fort Erie (Ridgeway)	ON	42.88	-79.05	0.39	0.19	0.068	0.020	0.28
Fort Frances	ON	48.60	-93.40	0.12	0.056	0.023	0.006	0.059
Gananoque	ON	44.33	-76.17	0.31	0.17	0.088	0.025	0.17
Geraldton	ON	49.73	-86.95	0.12	0.056	0.023	0.006	0.059
Glencoe	ON	42.75	-81.72	0.19	0.093	0.046	0.012	0.12
Goderich	ON	43.75	-81.72	0.12	0.073	0.039	0.011	0.062
Gore Bay	ON	45.92	-82.47	0.12	0.067	0.034	0.010	0.059
Graham	ON	49.25	-90.57	0.12	0.056	0.023	0.006	0.059
Gravenhurst (Muskoka Airport)	ON	44.92	-79.37	0.17	0.10	0.052	0.015	0.073
Grimsby	ON	43.20	-79.57	0.40	0.19	0.069	0.020	0.29
Guelph	ON	43.55	-80.25	0.21	0.10	0.049	0.013	0.13
Guthrie	ON	44.47	-79.55	0.16	0.096	0.049	0.014	0.075
Haileybury	ON	47.45	-79.63	0.29	0.14	0.069	0.020	0.18
Haldimand (Caledonia)	ON	43.07	-79.93	0.34	0.17	0.060	0.019	0.25
Haldimand (Hagersville)	ON	42.97	-80.05	0.29	0.14	0.053	0.017	0.22
Haliburton	ON	45.05	-78.52	0.21	0.12	0.062	0.019	0.10
Halton Hills (Georgetown)	ON	43.65	-79.92	0.25	0.12	0.051	0.015	0.17
Hamilton	ON	43.23	-79.95	0.33	0.16	0.058	0.018	0.24
Hanover	ON	44.15	-81.03	0.13	0.077	0.041	0.011	0.065
Hastings	ON	44.30	-77.95	0.23	0.13	0.065	0.018	0.11
Hawkesbury	ON	45.60	-74.62	0.65	0.32	0.14	0.042	0.39
Hearst	ON	49.68	-83.67	0.12	0.056	0.027	0.008	0.059
Honey Harbour	ON	44.87	-79.82	0.15	0.095	0.048	0.014	0.068
Hornepayne	ON	49.22	-84.78	0.12	0.056	0.023	0.007	0.059
Huntsville	ON	45.33	-79.22	0.20	0.12	0.056	0.017	0.094
Ingersoll	ON	43.03	-80.88	0.19	0.098	0.049	0.013	0.12
Iroquois Falls	ON	48.77	-80.68	0.21	0.10	0.049	0.015	0.15
Jellicoe	ON	49.68	-87.52	0.12	0.056	0.023	0.006	0.059
Kapuskasing	ON	49.42	-82.43	0.14	0.073	0.036	0.011	0.091

Locality		Lat N	Lon W	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
Kemptville	ON	45.02	-75.64	0.60	0.28	0.12	0.040	0.37
Kenora	ON	49.82	-94.43	0.12	0.056	0.023	0.006	0.059
Killaloe	ON	45.55	-77.42	0.48	0.23	0.10	0.034	0.31
Kincardine	ON	44.18	-81.63	0.12	0.073	0.038	0.011	0.060
Kingston	ON	44.30	-76.47	0.30	0.16	0.084	0.024	0.16
Kinmount	ON	44.78	-78.65	0.19	0.12	0.058	0.017	0.087
Kirkland Lake	ON	48.15	-80.03	0.24	0.12	0.057	0.017	0.15
Kitchener	ON	43.45	-80.48	0.19	0.096	0.048	0.013	0.11
Lakefield	ON	44.43	-78.27	0.20	0.12	0.061	0.017	0.095
Lansdowne House	ON	52.23	-87.88	0.12	0.056	0.023	0.006	0.059
Leamington	ON	42.08	-82.57	0.20	0.096	0.043	0.012	0.14
Lindsay	ON	44.35	-78.73	0.18	0.11	0.057	0.016	0.084
Lion's Head	ON	44.98	-81.25	0.12	0.077	0.040	0.012	0.059
Listowel	ON	43.73	-80.95	0.15	0.081	0.043	0.012	0.075
London	ON	42.98	-81.23	0.18	0.094	0.047	0.013	0.12
Lucan	ON	43.18	-81.40	0.16	0.083	0.044	0.012	0.093
Maitland	ON	44.63	-75.62	0.41	0.21	0.11	0.031	0.23
Markdale	ON	44.32	-80.65	0.14	0.081	0.043	0.012	0.067
Markham	ON	43.87	-79.27	0.22	0.11	0.055	0.015	0.12
Martin	ON	49.25	-91.13	0.12	0.056	0.023	0.006	0.059
Matheson	ON	48.53	-80.47	0.22	0.11	0.052	0.015	0.15
Mattawa	ON	46.32	-78.70	0.51	0.24	0.099	0.033	0.34
Midland	ON	44.75	-79.88	0.15	0.093	0.048	0.014	0.068
Milton	ON	43.52	-79.88	0.30	0.15	0.054	0.017	0.22
Milverton	ON	43.57	-80.92	0.15	0.082	0.045	0.012	0.080
Minden	ON	44.92	-78.73	0.19	0.12	0.058	0.017	0.089
Mississauga	ON	43.58	-79.65	0.31	0.15	0.055	0.017	0.22
Mississauga (Port Credit)	ON	43.55	-79.58	0.32	0.16	0.058	0.018	0.24
Mitchell	ON	43.47	-81.20	0.14	0.080	0.043	0.012	0.075
Moosonee	ON	51.32	-80.72	0.15	0.073	0.035	0.010	0.10
Morrisburg	ON	44.90	-75.18	0.63	0.29	0.13	0.042	0.39
Mount Forest	ON	43.98	-80.73	0.15	0.082	0.043	0.012	0.074
Nakina	ON	50.17	-86.70	0.12	0.056	0.023	0.006	0.059
Nanticoke (Jarvis)	ON	42.88	-80.10	0.26	0.13	0.053	0.015	0.18
Nanticoke (Port Dover)	ON	42.78	-80.20	0.23	0.11	0.052	0.014	0.15
Napanee	ON	44.25	-76.95	0.28	0.15	0.078	0.022	0.15
New Liskeard	ON	47.50	-79.67	0.29	0.14	0.068	0.020	0.18
Newcastle	ON	43.92	-78.58	0.22	0.12	0.061	0.016	0.12
Newcastle (Bowmanville)	ON	43.92	-78.68	0.21	0.12	0.060	0.016	0.12

Locality		Lat N	Lon W	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
Newmarket	ON	44.05	-79.47	0.19	0.10	0.051	0.014	0.10
Niagara Falls	ON	43.10	-79.07	0.41	0.20	0.073	0.021	0.30
North Bay	ON	46.32	-79.47	0.29	0.15	0.068	0.022	0.18
Norwood	ON	44.38	-77.98	0.22	0.12	0.065	0.018	0.11
Oakville	ON	43.45	-79.68	0.35	0.17	0.062	0.020	0.26
Orangeville	ON	43,92	-80.10	0.18	0.095	0.048	0.013	0.099
Orillia	ON	44.62	-79.42	0.16	0.099	0.050	0.015	0.073
Oshawa	ON	43.90	-78.85	0.21	0.11	0.059	0.016	0.12
Ottawa	ON	45.27	-75.75	0.66	0.32	0.13	0.044	0.42
Owen Sound	ON	44.57	-80.93	0.13	0.079	0.041	0.012	0.061
Pagwa River	ON	50.02	-85.22	0.12	0.056	0.023	0.006	0.059
Paris	ON	43.20	-80.38	0.22	0.11	0.050	0.013	0.14
Parkhill	ON	43.15	-81.68	0.15	0.080	0.043	0.011	0.085
Parry Sound	ON	45.35	-80.03	0.16	0.098	0.049	0.015	0.072
Pelham (Fonthill)	ON	43.03	-79.28	0.40	0.20	0.071	0.021	0.30
Pembroke	ON	45.82	-77.12	0.66	0.32	0.13	0.044	0.42
Penetanguishene	ON	44.78	-79.92	0.15	0.093	0.047	0.014	0.067
Perth	ON	44.90	-76.25	0.39	0.20	0.098	0.030	0.23
Petawawa	ON	45.90	-77.33	0.66	0.32	0.13	0.043	0.42
Peterborough	ON	44.30	-78.32	0.20	0.12	0.061	0.017	0.099
Petrolia	ON	42.87	-82.15	0.16	0.081	0.042	0.011	0.094
Pickering (Dunbarton)	ON	43.82	-79.10	0.23	0.11	0.057	0.015	0.13
Picton	ON	44.00	-77.13	0.26	0.14	0.073	0.020	0.14
Plattsville	ON	43.30	-80.62	0.18	0.094	0.049	0.013	0.11
Point Alexander	ON	46.13	-77.57	0.66	0.32	0.13	0.043	0.42
Port Burwell	ON	42.65	-80.82	0.21	0.10	0.050	0.013	0.14
Port Colborne	ON	42.90	-79.23	0.38	0.19	0.068	0.020	0.28
Port Elgin	ON	44.43	-81.40	0.12	0.074	0.039	0.011	0.059
Port Hope	ON	43.95	-78.30	0.23	0.12	0.064	0.017	0.13
Port Perry	ON	44.10	-78.95	0.19	0.11	0.056	0.015	0.096
Port Stanley	ON	42.67	-81.22	0.20	0.10	0.048	0.013	0.14
Prescott	ON	44.72	-75.52	0.44	0.23	0.12	0.033	0.27
Princeton	ON	43.17	-80.53	0.20	0.099	0.050	0.013	0.12
Raith	ON	48.83	-89.93	0.12	0.056	0.023	0.006	0.059
Rayside-Balfour (Chelmsford)	ON	46.58	-81.20	0.14	0.087	0.043	0.013	0.070
Red Lake	ON	51.05	-93.82	0.12	0.056	0.023	0.006	0.059
Renfrew	ON	45.47	-76.68	0.63	0.30	0.12	0.041	0.39
Richmond Hill	ON	43.87	-79.45	0.22	0.11	0.053	0.014	0.13
Rockland	ON	45.55	-75.29	0.66	0.31	0.14	0.044	0.41

Locality		Lat N	Lon W	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
Sarnia	ON	42.97	-82.38	0.14	0.075	0.040	0.010	0.078
Sault Ste. Marie	ON	46.52	-84.33	0.12	0.056	0.026	0.008	0.059
Schreiber	ON	48.80	-87.25	0.12	0.056	0.023	0.006	0.059
Seaforth	ON	43.55	-81.40	0.14	0.077	0.042	0.011	0.067
Simcoe	ON	42.83	-80.30	0.22	0.11	0.052	0.014	0.14
Sioux Lookout	ON	50.07	-91.98	0.12	0.056	0.023	0.006	0.059
Smiths Falls	ON	44.90	-76.02	0.42	0.22	0.10	0.032	0.26
Smithville	ON	43.10	-79.55	0.40	0.19	0.069	0.020	0.29
Smooth Rock Falls	ON	49.28	-81.63	0.19	0.092	0.042	0.013	0.14
South River	ON	45.83	-79.38	0.23	0.13	0.060	0.019	0.13
Southampton	ON	44.48	-81.38	0.12	0.074	0.039	0.011	0.059
St. Catharines	ON	43.17	-79.25	0.41	0.20	0.072	0.021	0.30
St. Mary's	ON	43.25	-81.13	0.16	0.086	0.045	0.012	0.096
St. Thomas	ON	42.78	-81.20	0.20	0.098	0.048	0.013	0.13
Stirling	ON	44.30	-77.55	0.25	0.14	0.071	0.020	0.13
Stratford	ON	43.37	-80.95	0.16	0.085	0.046	0.012	0.091
Strathroy	ON	42.95	-81.63	0.17	0.087	0.045	0.012	0.11
Sturgeon Falls	ON	46.37	-79.92	0.23	0.12	0.059	0.018	0.14
Sudbury	ON	46.50	-81.00	0.15	0.091	0.045	0.014	0.078
Sundridge	ON	45.77	-79.40	0.22	0.12	0.059	0.019	0.12
Tavistock	ON	43.32	-80.83	0.17	0.089	0.047	0.013	0.10
Temagami	ON	47.07	-79.78	0.30	0.14	0.068	0.021	0.19
Thamesford	ON	43.07	-81.00	0.18	0.095	0.048	0.013	0.12
Thedford	ON	43.15	-81.85	0.14	0.078	0.042	0.011	0.080
Thunder Bay	ON	48.40	-89.32	0.12	0.056	0.023	0.006	0.059
Tillsonburg	ON	42.85	-80.73	0.20	0.10	0.050	0.013	0.14
Timmins	ON	48.47	-81.33	0.17	0.089	0.045	0.013	0.11
Timmins (Porcupine)	ON	48.50	-81.17	0.19	0.093	0.047	0.013	0.12
Etobicoke	ON	43.70	-79.57	0.26	0.13	0.054	0.015	0.18
North York	ON	43.77	-79.42	0.24	0.12	0.054	0.015	0.15
Scarborough	ON	43.78	-79.25	0.24	0.12	0.056	0.015	0.15
Toronto	ON	43.70	-79.42	0.26	0.13	0.055	0.015	0.17
Trenton	ON	44.10	-77.58	0.25	0.13	0.070	0.019	0.14
Trout Creek	ON	45.98	-79.37	0.25	0.14	0.064	0.020	0.15
Uxbridge	ON	44.10	-79.12	0.19	0.10	0.054	0.015	0.094
Vaughan (Woodbridge)	ON	43.78	-79.60	0.24	0.12	0.053	0.014	0.15
Vittoria	ON	42.77	-80.32	0.21	0.10	0.052	0.014	0.14
Walkerton	ON	44.12	-81.15	0.13	0.076	0.041	0.011	0.064
Wallaceburg	ON	42.60	-82.38	0.18	0.087	0.041	0.011	0.11

Locality		Lat N	Lon W	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
Waterloo	ON	43.47	-80.52	0.19	0.095	0.048	0.013	0.10
Watford	ON	42.95	-81.88	0.16	0.082	0.043	0.011	0.097
Wawa	ON	47.98	-84.78	0.12	0.056	0.023	0.008	0.059
Welland	ON	42.98	-79.25	0.40	0.20	0.070	0.021	0.29
West Lorne	ON	42.60	-81.60	0.20	0.097	0.047	0.013	0.13
Whitby	ON	43.87	-78.93	0.21	0.11	0.058	0.015	0.12
Whitby (Brooklin)	ON	43.95	-78.95	0.20	0.11	0.057	0.015	0.11
White River	ON	48.60	-85.28	0.12	0.056	0.023	0.007	0.059
Wiarton	ON	44.75	-81.15	0.12	0.077	0.040	0.012	0.059
Windsor	ON	42.30	-83.02	0.18	0.086	0.040	0.011	0.12
Wingham	ON	43.88	-81.32	0.13	0.075	0.041	0.011	0.065
Woodstock	ON	43.13	-80.75	0.19	0.097	0.049	0.013	0.12
Wyoming	ON	42.95	-82.12	0.15	0.079	0.042	0.011	0.088
Acton-Vale	QC	45.65	-72.57	0.45	0.23	0.10	0.035	0.28
Alma	QC	48.55	-71.65	0.59	0.26	0.11	0.037	0.38
Amos	QC	48.57	-78.12	0.17	0.11	0.054	0.015	0.087
Asbestos	QC	45.77	-71.93	0.37	0.20	0.090	0.031	0.20
Aylmer	QC	45.40	-75.83	0.67	0.32	0.13	0.044	0.42
Baie-Comeau	QC	49.22	-68.15	0.66	0.37	0.16	0.050	0.44
Beauport	QC	46.87	-71.18	0.60	0.32	0.15	0.052	0.38
Bedford	QC	45.12	-72.98	0.60	0.28	0.12	0.041	0.37
Beloeil	QC	45.57	-73.20	0.67	0.33	0.13	0.046	0.41
Brome	QC	45.20	-72.57	0.42	0.22	0.097	0.034	0.25
Brossard	QC	45.45	-73.47	0.68	0.34	0.14	0.047	0.43
Buckingham	QC	45.58	-75.42	0.68	0.31	0.14	0.045	0.42
Campbell's Bay	QC	45.73	-76.60	0.67	0.32	0.13	0.044	0.42
Chambly	QC	45.45	-73.28	0.67	0.33	0.14	0.046	0.42
Chicoutimi	QC	48.43	-71.07	0.62	0.30	0.14	0.047	0.39
Chicoutimi (Bagotville)	QC	48.35	-70.88	0.63	0.33	0.16	0.053	0.40
Chicoutimi (Kénogami)	QC	48.42	-71.25	0.62	0.29	0.13	0.045	0.39
Coaticook	QC	45.13	-71.80	0.41	0.23	0.095	0.031	0.26
Contrecoeur	QC	45.85	-73.23	0.66	0.33	0.13	0.045	0.42
Cowansville	QC	45.20	-72.75	0.48	0.24	0.10	0.036	0.30
Deux-Montagnes	QC	45.53	-73.88	0.68	0.34	0.14	0.048	0.43
Dolbeau	QC	48.88	-72.23	0.31	0.17	0.084	0.028	0.20
Drummondville	QC	45.88	-72.48	0.50	0.25	0.10	0.037	0.32
Farnham	QC	45.28	-72.98	0.59	0.29	0.12	0.041	0.37
Fort-Coulonge	QC	45.85	-76.73	0.67	0.32	0.13	0.044	0.42
Gagnon	QC	51.93	-68.17	0.12	0.090	0.045	0.013	0.059

Locality		Lat N	Lon W	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
Gaspé	QC	48.83	-64.48	0.22	0.14	0.064	0.022	0.093
Gatineau	QC	45.50	-75.65	0.68	0.32	0.14	0.045	0.42
Gracefield	QC	46.10	-76.05	0.62	0.29	0.14	0.040	0.40
Granby	QC	45.40	-72.73	0.48	0.24	0.10	0.036	0.29
Harrington-Harbour	QC	50.50	-59.48	0.12	0.082	0.043	0.013	0.071
Havre-St-Pierre	QC	50.23	-63.60	0.33	0.17	0.070	0.023	0.22
Hemmingford	QC	45.05	-73.58	0.68	0.34	0.14	0.047	0.43
Hull	QC	45.43	-75.73	0.68	0.33	0.14	0.045	0.42
Iberville	QC	45.35	-73.23	0.66	0.33	0.13	0.046	0.41
Inukjuak	QC	58.48	-78.10	0.12	0.056	0.023	0.006	0.059
Joliette	QC	46.02	-73.45	0.63	0.30	0.12	0.043	0.39
Jonquière	QC	48.42	-71.22	0.62	0.29	0.13	0.045	0.39
Kuujjuaq	QC	58.10	-68.40	0.12	0.065	0.033	0.010	0.059
Kuujjuarapik	QC	55.28	-77.75	0.12	0.056	0.023	0.006	0.059
Lachute	QC	45.65	-74.33	0.64	0.31	0.14	0.043	0.40
Lac-Mégantic	QC	45.58	-70.88	0.40	0.22	0.091	0.031	0.27
La-Malbaie	QC	47.65	-70.15	2.3	1.2	0.60	0.19	1.1
La-Tuque	QC	47.43	-72.78	0.29	0.18	0.091	0.030	0.16
Lennoxville	QC	45.37	-71.85	0.38	0.21	0.087	0.031	0.20
Léry	QC	45.35	-73.80	0.70	0.34	0.14	0.048	0.43
Loretteville	QC	46.85	-71.35	0.63	0.30	0.14	0.048	0.40
Louiseville	QC	46.25	-72.95	0.63	0.31	0.12	0.043	0.40
Magog	QC	45.27	-72.13	0.38	0.21	0.089	0.031	0.20
Malartic	QC	48.13	-78.13	0.21	0.12	0.059	0.017	0.11
Maniwaki	QC	46.38	-75.97	0.66	0.30	0.14	0.040	0.42
Masson	QC	45.60	-75.42	0.66	0.31	0.14	0.044	0.42
Matane	QC	48.85	-67.53	0.68	0.38	0.17	0.052	0.44
Mont-Joli	QC	48.58	-68.18	0.62	0.33	0.15	0.048	0.39
Mont-Laurier	QC	46.55	-75.50	0.66	0.30	0.14	0.039	0.43
Montmagny	QC	46.98	-70.55	0.89	0.48	0.23	0.076	0.49
Beaconsfield	QC	45.43	-73.87	0.69	0.34	0.14	0.048	0.43
Dorval	QC	45.45	-73.75	0.69	0.34	0.14	0.048	0.43
Laval	QC	45.58	-73.75	0.68	0.34	0.14	0.048	0.43
Montréal	QC	45.50	-73.60	0.69	0.34	0.14	0.048	0.43
Montréal-Est	QC	45.63	-73.52	0.68	0.34	0.14	0.047	0.42
Montréal-Nord	QC	45.60	-73.63	0.69	0.34	0.14	0.048	0.43
Outremont	QC	45.52	-73.62	0.69	0.34	0.14	0.048	0.43
Pierrefonds	QC	45.48	-73.87	0.69	0.34	0.14	0.048	0.43
St-Lambert	QC	45.50	-73.50	0.69	0.34	0.14	0.048	0.43

Locality		Lat N	Lon W	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
St-Laurent	QC	45.50	-73.67	0.69	0.34	0.14	0.048	0.43
Ste-Anne-de-Bellevue	QC	45.42	-73.93	0.69	0.34	0.14	0.048	0.43
Verdun	QC	45.45	-73.57	0.69	0.34	0.14	0.048	0.43
Nicolet (Gentilly)	QC	46.40	-72.28	0.64	0.31	0.12	0.043	0.40
Nitchequon	QC	53.21	-70.91	0.12	0.061	0.031	0.010	0.059
Noranda	QC	48.25	-79.02	0.20	0.11	0.056	0.016	0.11
Percé	QC	48.53	-64.22	0.20	0.13	0.061	0.020	0.092
Pincourt	QC	45.38	-73.98	0.69	0.34	0.14	0.048	0.43
Plessisville	QC	46.22	-71.78	0.45	0.23	0.10	0.034	0.29
Port-Cartier	QC	50.02	-66.87	0.46	0.26	0.11	0.038	0.29
Povungnituk	QC	59.78	-77.32	0.22	0.088	0.041	0.011	0.15
Ancienne-Lorette	QC	46.78	-71.38	0.60	0.30	0.14	0.045	0.38
Lévis	QC	46.80	-71.18	0.58	0.30	0.14	0.049	0.36
Québec	QC	46.80	-71.23	0.59	0.30	0.14	0.048	0.37
Sillery	QC	46.77	-71.25	0.58	0.29	0.14	0.047	0.37
Ste-Foy	QC	46.78	-71.28	0.59	0.29	0.14	0.047	0.37
Richmond	QC	45.67	-72.15	0.38	0.21	0.091	0.032	0.21
Rimouski	QC	48.43	-68.55	0.63	0.30	0.14	0.046	0.39
Rivière-du-Loup	QC	47.83	-69.53	1.1	0.63	0.29	0.098	0.67
Roberval	QC	48.52	-72.23	0.43	0.21	0.095	0.031	0.29
Rock-Island	QC	45.04	-72.10	0.42	0.23	0.097	0.032	0.26
Rosemère	QC	45.63	-73.80	0.68	0.33	0.14	0.047	0.42
Rouyn	QC	48.23	-79.02	0.20	0.11	0.056	0.016	0.11
Salaberry-de-Valleyfield	QC	45.25	-74.13	0.69	0.34	0.14	0.048	0.43
Schefferville	QC	54.80	-66.83	0.12	0.059	0.031	0.010	0.059
Senneterre	QC	48.38	-77.23	0.20	0.12	0.061	0.017	0.10
Sept-Iles	QC	50.20	-66.38	0.37	0.22	0.092	0.033	0.21
Shawinigan	QC	46.55	-72.75	0.58	0.28	0.12	0.040	0.37
Shawville	QC	45.60	-76.48	0.67	0.32	0.13	0.044	0.42
Sherbrooke	QC	45.42	-71.90	0.37	0.20	0.086	0.031	0.20
Sorel	QC	46.03	-73.12	0.65	0.32	0.13	0.044	0.41
St-Félicien	QC	48.65	-72.45	0.31	0.18	0.086	0.029	0.20
St-Georges-de-Cacouna	QC	47.92	-69.50	0.98	0.54	0.25	0.084	0.56
St-Hubert	QC	45.50	-73.42	0.68	0.34	0.14	0.047	0.43
St-Hubert-de-Témiscouata	QC	47.82	-69.05	0.64	0.36	0.18	0.060	0.34
St-Hyacinthe	QC	45.62	-72.95	0.59	0.29	0.12	0.042	0.37
St-Jean	QC	45.40	-73.93	0.69	0.34	0.14	0.048	0.43
St-Jérôme	QC	45.78	-74.00	0.64	0.30	0.13	0.044	0.40
St-Jovite	QC	46.12	-74.60	0.63	0.29	0.14	0.040	0.41

Locality		Lat N	Lon W	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
St-Nicolas	QC	46.70	-71.40	0.59	0.28	0.13	0.043	0.37
Ste-Agathe-des-Monts	QC	46.05	-74.28	0.59	0.28	0.13	0.039	0.38
Sutton	QC	45.10	-72.62	0.44	0.23	0.099	0.034	0.26
Tadoussac	QC	48.15	-69.72	0.84	0.46	0.22	0.073	0.46
Témiscaming	QC	46.72	-79.10	0.59	0.26	0.10	0.034	0.38
Thetford Mines	QC	46.08	-71.30	0.35	0.20	0.097	0.033	0.19
Thurso	QC	45.60	-75.25	0.63	0.30	0.14	0.043	0.41
Trois-Rivières	QC	46.35	-72.55	0.64	0.31	0.12	0.043	0.40
Val-d'Or	QC	48.10	-77.78	0.22	0.12	0.063	0.018	0.12
Varennes	QC	45.68	-73.43	0.68	0.33	0.14	0.047	0.42
Verchères	QC	45.78	-73.35	0.67	0.33	0.14	0.046	0.42
Victoriaville	QC	46.05	-71.97	0.43	0.22	0.097	0.033	0.27
Ville-Marie	QC	47.33	-79.43	0.33	0.16	0.075	0.022	0.21
Waterloo	QC	45.35	-72.52	0.41	0.22	0.095	0.034	0.24
Windsor	QC	45.57	-72.00	0.36	0.20	0.088	0.031	0.19
Alma	NB	45.60	-64.95	0.27	0.15	0.066	0.020	0.19
Bathurst	NB	47.60	-65.65	0.41	0.22	0.084	0.027	0.29
Campbellton	NB	48.00	-66.67	0.39	0.21	0.095	0.031	0.26
Chatham	NB	47.03	-65.47	0.41	0.22	0.083	0.027	0.29
Edmundston	NB	47.37	-68.33	0.41	0.25	0.12	0.041	0.22
Fredericton	NB	45.95	-66.65	0.39	0.20	0.086	0.027	0.27
Gagetown	NB	45.79	-66.16	0.34	0.18	0.081	0.025	0.23
Grand Falls	NB	47.05	-67.73	0.42	0.23	0.099	0.034	0.28
Moncton	NB	46.10	-64.78	0.30	0.16	0.068	0.021	0.22
Oromocto	NB	45.84	-66.48	0.36	0.19	0.085	0.026	0.24
Sackville	NB	45.88	-64.37	0.25	0.14	0.063	0.019	0.17
Saint John	NB	45.31	-66.04	0.34	0.18	0.081	0.024	0.23
Shippagan	NB	47.73	-64.70	0.34	0.18	0.071	0.022	0.24
St Stephen	NB	45.20	-67.28	0.66	0.29	0.12	0.035	0.41
Woodstock	NB	46.16	-67.60	0.41	0.22	0.093	0.030	0.28
Amherst	NS	45.83	-64.20	0.24	0.13	0.062	0.018	0.14
Antigonish	NS	45.62	-62.00	0.19	0.11	0.060	0.017	0.095
Bridgewater	NS	44.38	-64.52	0.23	0.13	0.069	0.019	0.12
Canso	NS	45.33	-61.00	0.24	0.14	0.071	0.020	0.13
Debert	NS	45.43	-63.47	0.22	0.12	0.062	0.017	0.12
Digby	NS	44.62	-65.77	0.26	0.14	0.068	0.020	0.14
Greenwood (CFB)	NS	44.98	-64.90	0.25	0.13	0.067	0.018	0.14
Dartmouth	NS	44.67	-63.57	0.23	0.13	0.069	0.019	0.12
Halifax	NS	44.65	-63.60	0.23	0.13	0.069	0.019	0.12

Locality		Lat N	Lon W	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
Kentville	NS	45.08	-64.50	0.24	0.13	0.067	0.018	0.14
Liverpool	NS	44.03	-64.72	0.24	0.14	0.072	0.020	0.13
Lockeport	NS	43.70	-65.12	0.26	0.14	0.074	0.021	0.14
Louisburg	NS	45.92	-59.98	0.22	0.12	0.066	0.018	0.12
Lunenburg	NS	44.38	-64.32	0.23	0.13	0.069	0.019	0.12
New Glasgow	NS	45.58	-62.65	0.18	0.11	0.058	0.016	0.086
North Sydney	NS	46.22	-60.25	0.19	0.11	0.061	0.016	0.098
Pictou	NS	45.68	-62.72	0.18	0.11	0.057	0.016	0.084
Port Hawkesbury	NS	45.62	-61.35	0.21	0.12	0.064	0.018	0.11
Springhill	NS	45.65	-64.05	0.24	0.13	0.063	0.018	0.14
Stewiacke	NS	45.13	-63.35	0.22	0.12	0.065	0.018	0.12
Sydney	NS	46.15	-60.18	0.20	0.12	0.062	0.017	0.10
Tatamagouche	NS	45.72	-63.30	0.19	0.11	0.057	0.016	0.097
Truro	NS	45.37	-63.27	0.21	0.12	0.062	0.017	0.12
Wolfville	NS	45.08	-64.37	0.25	0.13	0.067	0.018	0.14
Yarmouth	NS	43.83	-66.12	0.23	0.13	0.068	0.018	0.12
Charlottetown	PE	46.28	-63.13	0.16	0.10	0.054	0.016	0.081
Souris	PE	46.35	-62.25	0.15	0.099	0.051	0.015	0.078
Summerside	PE	46.46	-63.79	0.19	0.12	0.057	0.017	0.10
Tignish	PE	46.95	-64.03	0.22	0.13	0.058	0.018	0.12
Argentia	NL	47.30	-53.98	0.18	0.11	0.059	0.016	0.091
Bonavista	NL	48.65	-53.12	0.17	0.11	0.058	0.015	0.088
Buchans	NL	48.87	-56.85	0.15	0.089	0.049	0.013	0.084
Cape Harrison	NL	54.78	-57.95	0.24	0.14	0.064	0.019	0.11
Cape Race	NL	46.65	-53.07	0.20	0.12	0.066	0.018	0.10
Channel-Port aux Basques	NL	47.57	-59.15	0.15	0.094	0.052	0.014	0.084
Corner Brook	NL	48.95	-57.95	0.14	0.088	0.048	0.013	0.082
Gander	NL	48.98	-54.59	0.16	0.096	0.053	0.014	0.085
Grand Bank	NL	47.10	-55.77	0.18	0.11	0.060	0.017	0.095
Grand Falls	NL	48.93	-55.67	0.15	0.092	0.051	0.013	0.085
Happy Valley-Goose Bay	NL	53.32	-60.37	0.15	0.092	0.047	0.014	0.091
Labrador City	NL	52.95	-66.92	0.12	0.076	0.039	0.012	0.059
St Anthony	NL	51.37	-55.58	0.15	0.096	0.052	0.014	0.081
St John's	NL	47.57	-52.72	0.18	0.11	0.060	0.016	0.090
Stephenville	NL	48.55	-58.58	0.14	0.089	0.048	0.013	0.081
Twin Falls	NL	53.50	-64.53	0.12	0.068	0.034	0.011	0.059
Wabana	NL	47.63	-52.95	0.18	0.11	0.059	0.016	0.088
Wabush	NL	52.92	-66.87	0.12	0.076	0.039	0.012	0.059
Alert	NU	82.48	-62.25	0.12	0.056	0.023	0.006	0.059

Locality		Lat N	Lon W	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
Resolution Island	NU	61.58	-65.00	0.44	0.21	0.10	0.028	0.29
Iqualuit	NU	63.73	-68.50	0.13	0.086	0.049	0.013	0.059
Clyde River	NU	70.45	-68.57	0.50	0.29	0.16	0.049	0.33
Nottingham Island	NU	63.10	-78.00	0.24	0.10	0.050	0.012	0.16
Coral Harbour	NU	64.13	-83.17	0.24	0.11	0.051	0.013	0.16
Arctic Bay	NU	73.03	-85.17	0.18	0.11	0.063	0.018	0.096
Eureka	NU	80.22	-86.18	0.33	0.14	0.065	0.017	0.24
Chesterfield Inlet	NU	63.33	-90.70	0.16	0.075	0.039	0.009	0.098
Rankin Inlet	NU	62.82	-92.08	0.12	0.056	0.026	0.006	0.059
Eskimo Point	NU	61.12	-94.05	0.12	0.056	0.023	0.006	0.059
Resolute	NU	74.68	-94.90	0.35	0.16	0.081	0.020	0.22
Baker Lake	NU	64.32	-96.02	0.12	0.056	0.023	0.006	0.059
Isachsen	NU	78.78	-103.53	0.40	0.20	0.097	0.028	0.22
Cambridge Bay	NU	69.12	-105.03	0.12	0.056	0.023	0.006	0.059
Coppermine	NU	67.83	-115.08	0.12	0.056	0.023	0.006	0.059

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Table 2

Reference Ground Condition factors and their effect for a sample eastern site (Montréal)

Spectral Period (s)	RGC Factor	Montréal Hard Rock	Montréal Firm Ground
0.1	1.39	0.47	0.65
0.15	1.73	0.41	0.71
0.2	1.94	0.36	0.69
0.3	2.17	0.23	0.50
0.4	2.30	0.17	0.39
0.5	2.38	0.14	0.34
1.0	2.58	0.054	0.14
2.0	2.86	0.017	0.048
Peak Parameters			
PGA	1.39	0.31	0.43
PGV	2.38	0.076	0.18

Notes:

1. Entries in the table represent the 50th percentile values of the 2%/50 year seismic hazard (5% damped Sa values in g) for the **R** model.
2. The "Hard rock" values are those computed using the Atkinson and Boore (1995) hard-rock ground motion relations; "firm ground" is the amplification of the hard rock values by the RGC factors given in column 2 (See Adams et al. (1999) for their derivation).
3. The hazard values are rounded to two significant figures.

Table 3

Probabilistic Seismic Hazard Estimates for Selected Cities, 2%/50 year and 10%/50 year probabilities*

Eastern Cities	2%/50 year probability				10%/50 year probability			
Spectral	H model		R model		H model		R model	
Parameter	50%ile	84%ile	50%ile	84%ile	50%ile	84%ile	50%ile	84%ile
St. John's (47.55 -52.72)								
Sa (0.1)	0.12	0.17	0.13	0.20	0.045	0.061	0.061	0.087
Sa (0.15)	0.15	0.24	0.15	0.27	0.059	0.094	0.072	0.12
Sa (0.2)	0.15	0.27	0.18	0.31	0.064	0.11	0.086	0.15
Sa (0.3)	0.13	0.27	0.16	0.33	0.057	0.12	0.078	0.16
Sa (0.4)	0.10	0.25	0.13	0.31	0.045	0.11	0.063	0.15
Sa (0.5)	0.090	0.23	0.11	0.29	0.037	0.098	0.054	0.14
Sa (1.0)	0.045	0.13	0.060	0.16	0.018	0.049	0.028	0.074
Sa (2.0)	0.013	-**	0.016	-**	0.005	-**	0.008	-**
PGA	0.084	0.12	0.090	0.14	0.030	0.040	0.036	0.055
PGV	0.048	0.12	0.057	0.14	0.021	0.055	0.029	0.076
Halifax (44.60 -63.60)								
Sa (0.1)	0.13	0.18	0.19	0.28	0.047	0.065	0.093	0.13
Sa (0.15)	0.15	0.26	0.22	0.35	0.061	0.11	0.099	0.16
Sa (0.2)	0.16	0.29	0.23	0.41	0.073	0.13	0.11	0.19
Sa (0.3)	0.14	0.29	0.19	0.40	0.069	0.15	0.092	0.19
Sa (0.4)	0.12	0.28	0.16	0.38	0.057	0.14	0.073	0.18
Sa (0.5)	0.099	0.26	0.13	0.34	0.049	0.13	0.062	0.16
Sa (1.0)	0.051	0.14	0.070	0.18	0.022	0.068	0.030	0.084
Sa (2.0)	0.015	-**	0.019	-**	0.007	-**	0.009	-**
PGA	0.085	0.12	0.12	0.19	0.032	0.043	0.057	0.086
PGV	0.052	0.14	0.071	0.18	0.026	0.069	0.033	0.088
Moncton (46.08 -64.78)								
Sa (0.1)	0.31	0.43	0.23	0.35	0.10	0.15	0.097	0.14
Sa (0.15)	0.29	0.50	0.24	0.46	0.10	0.20	0.099	0.20
Sa (0.2)	0.30	0.52	0.28	0.48	0.12	0.22	0.12	0.22
Sa (0.3)	0.22	0.44	0.22	0.45	0.10	0.20	0.10	0.21
Sa (0.4)	0.19	0.46	0.17	0.41	0.083	0.19	0.080	0.20
Sa (0.5)	0.16	0.42	0.14	0.37	0.069	0.18	0.068	0.18
Sa (1.0)	0.068	0.22	0.065	0.20	0.029	0.093	0.031	0.090
Sa (2.0)	0.021	-**	0.020	-**	0.009	-**	0.009	-**
PGA	0.21	0.30	0.16	0.25	0.072	0.11	0.068	0.10
PGV	0.095	0.23	0.081	0.21	0.040	0.10	0.038	0.10
Fredericton (45.95 -66.65)								
Sa (0.1)	0.33	0.47	0.38	0.56	0.13	0.19	0.14	0.20
Sa (0.15)	0.32	0.58	0.36	0.66	0.13	0.26	0.13	0.28
Sa (0.2)	0.35	0.62	0.39	0.69	0.16	0.29	0.17	0.29
Sa (0.3)	0.27	0.52	0.29	0.56	0.13	0.27	0.13	0.26
Sa (0.4)	0.23	0.52	0.24	0.58	0.10	0.24	0.10	0.24
Sa (0.5)	0.19	0.48	0.20	0.52	0.086	0.22	0.086	0.22
Sa (1.0)	0.086	0.26	0.082	0.27	0.037	0.12	0.037	0.11
Sa (2.0)	0.027	-**	0.026	-**	0.011	-**	0.011	-**
PGA	0.23	0.31	0.27	0.38	0.089	0.13	0.094	0.14
PGV	0.11	0.27	0.12	0.29	0.048	0.13	0.050	0.13

Eastern Cities	2%/50 year probability				10%/50 year probability			
Spectral	H model		R model		H model		R model	
Parameter	50%ile	84%ile	50%ile	84%ile	50%ile	84%ile	50%ile	84%ile
La Malbaie (47.65 -70.14)								
Sa (0.1)	1.9	3.3	0.62	0.91	0.94	1.5	0.26	0.37
Sa (0.15)	2.2	3.5	0.68	1.0	1.1	1.7	0.27	0.41
Sa (0.2)	2.3	3.8	0.66	1.1	1.0	1.7	0.27	0.44
Sa (0.3)	1.7	3.6	0.48	0.99	0.72	1.5	0.19	0.38
Sa (0.4)	1.4	3.5	0.36	0.87	0.57	1.3	0.14	0.34
Sa (0.5)	1.2	3.1	0.32	0.78	0.48	1.2	0.11	0.29
Sa (1.0)	0.60	1.8	0.13	0.41	0.20	0.60	0.044	0.14
Sa (2.0)	0.19	-**	0.043	-**	0.061	-**	0.014	-**
PGA	1.1	2.0	0.41	0.62	0.59	0.97	0.19	0.25
PGV	0.62	1.5	0.17	0.45	0.28	0.68	0.071	0.18
Québec (46.80 -71.25)								
Sa (0.1)	0.46	0.62	0.56	0.82	0.22	0.31	0.23	0.32
Sa (0.15)	0.48	0.75	0.61	0.93	0.23	0.36	0.24	0.36
Sa (0.2)	0.52	0.89	0.59	1.0	0.24	0.41	0.24	0.39
Sa (0.3)	0.41	0.88	0.43	0.88	0.19	0.39	0.17	0.35
Sa (0.4)	0.34	0.81	0.33	0.79	0.15	0.37	0.13	0.32
Sa (0.5)	0.29	0.75	0.29	0.71	0.13	0.33	0.11	0.27
Sa (1.0)	0.14	0.44	0.12	0.37	0.057	0.17	0.042	0.14
Sa (2.0)	0.048	-**	0.040	-**	0.017	-**	0.014	-**
PGA	0.28	0.39	0.37	0.57	0.14	0.20	0.16	0.22
PGV	0.14	0.39	0.16	0.41	0.071	0.18	0.067	0.17
Trois-Rivières (46.30 -72.55)								
Sa (0.1)	0.31	0.47	0.61	0.90	0.13	0.19	0.25	0.36
Sa (0.15)	0.31	0.57	0.67	1.0	0.14	0.25	0.26	0.39
Sa (0.2)	0.35	0.62	0.64	1.1	0.17	0.29	0.26	0.43
Sa (0.3)	0.28	0.57	0.47	0.96	0.14	0.29	0.18	0.37
Sa (0.4)	0.23	0.56	0.35	0.86	0.11	0.26	0.14	0.33
Sa (0.5)	0.20	0.52	0.31	0.77	0.092	0.24	0.12	0.29
Sa (1.0)	0.10	0.29	0.12	0.40	0.043	0.12	0.045	0.14
Sa (2.0)	0.032	-**	0.043	-**	0.013	-**	0.015	-**
PGA	0.20	0.32	0.40	0.62	0.087	0.13	0.18	0.25
PGV	0.11	0.27	0.17	0.44	0.050	0.13	0.071	0.18
Montréal (45.50 -73.60)								
Sa (0.1)	0.57	0.89	0.65	0.95	0.22	0.35	0.29	0.41
Sa (0.15)	0.58	0.97	0.71	1.1	0.24	0.39	0.29	0.45
Sa (0.2)	0.58	1.0	0.69	1.2	0.24	0.43	0.29	0.49
Sa (0.3)	0.43	0.86	0.50	1.1	0.18	0.36	0.20	0.42
Sa (0.4)	0.35	0.86	0.39	0.95	0.14	0.33	0.15	0.37
Sa (0.5)	0.29	0.71	0.34	0.83	0.11	0.29	0.13	0.32
Sa (1.0)	0.13	0.38	0.14	0.44	0.048	0.14	0.052	0.16
Sa (2.0)	0.038	-**	0.048	-**	0.014	-**	0.016	-**
PGA	0.37	0.59	0.43	0.63	0.16	0.25	0.20	0.27
PGV	0.17	0.43	0.18	0.48	0.071	0.18	0.079	0.20

Eastern Cities	2%/50 year probability				10%/50 year probability			
Spectral	H model		R model		H model		R model	
Parameter	50%ile	84%ile	50%ile	84%ile	50%ile	84%ile	50%ile	84%ile
Ottawa (45.40 -75.70)								
Sa (0.1)	0.40	0.61	0.64	0.93	0.18	0.28	0.28	0.39
Sa (0.15)	0.43	0.78	0.69	1.1	0.18	0.35	0.28	0.43
Sa (0.2)	0.45	0.85	0.67	1.1	0.21	0.37	0.28	0.48
Sa (0.3)	0.34	0.73	0.48	1.0	0.15	0.32	0.20	0.40
Sa (0.4)	0.28	0.65	0.38	0.90	0.12	0.28	0.15	0.36
Sa (0.5)	0.23	0.58	0.32	0.80	0.096	0.24	0.12	0.31
Sa (1.0)	0.10	0.31	0.14	0.42	0.043	0.12	0.050	0.15
Sa (2.0)	0.031	-**	0.045	-**	0.012	-**	0.015	-**
PGA	0.25	0.40	0.42	0.63	0.12	0.19	0.20	0.27
PGV	0.13	0.33	0.18	0.46	0.057	0.14	0.076	0.19
Niagara Falls (43.10 -79.10)								
Sa (0.1)	0.46	0.72	0.20	0.32	0.19	0.26	0.077	0.12
Sa (0.15)	0.42	0.79	0.20	0.37	0.16	0.32	0.079	0.15
Sa (0.2)	0.41	0.93	0.22	0.39	0.16	0.32	0.092	0.16
Sa (0.3)	0.31	0.78	0.17	0.35	0.11	0.26	0.074	0.16
Sa (0.4)	0.26	0.63	0.14	0.31	0.086	0.21	0.058	0.14
Sa (0.5)	0.20	0.52	0.11	0.28	0.067	0.18	0.049	0.13
Sa (1.0)	0.073	0.25	0.057	0.15	0.028	0.082	0.022	0.064
Sa (2.0)	0.021	-**	0.015	-**	0.008	-**	0.006	-**
PGA	0.30	0.48	0.14	0.23	0.12	0.19	0.053	0.084
PGV	0.13	0.35	0.069	0.17	0.048	0.12	0.029	0.076
Toronto (43.65 -79.40)								
Sa (0.1)	0.28	0.42	0.17	0.27	0.11	0.16	0.066	0.098
Sa (0.15)	0.28	0.54	0.18	0.32	0.10	0.20	0.070	0.13
Sa (0.2)	0.28	0.56	0.20	0.35	0.11	0.21	0.086	0.15
Sa (0.3)	0.22	0.49	0.16	0.33	0.085	0.19	0.072	0.16
Sa (0.4)	0.17	0.39	0.13	0.30	0.065	0.16	0.057	0.14
Sa (0.5)	0.14	0.35	0.11	0.27	0.052	0.14	0.048	0.12
Sa (1.0)	0.050	0.17	0.055	0.15	0.019	0.066	0.022	0.063
Sa (2.0)	0.016	-**	0.015	-**	0.006	-**	0.006	-**
PGA	0.20	0.28	0.12	0.20	0.080	0.11	0.045	0.068
PGV	0.083	0.22	0.062	0.16	0.033	0.088	0.029	0.074
Windsor (42.30 -83.00)								
Sa (0.1)	0.10	0.15	0.17	0.26	0.045	0.063	0.057	0.090
Sa (0.15)	0.11	0.21	0.17	0.31	0.046	0.096	0.061	0.12
Sa (0.2)	0.14	0.24	0.18	0.32	0.061	0.11	0.068	0.12
Sa (0.3)	0.11	0.23	0.14	0.28	0.049	0.11	0.053	0.11
Sa (0.4)	0.086	0.21	0.11	0.25	0.037	0.091	0.041	0.099
Sa (0.5)	0.071	0.18	0.087	0.22	0.030	0.079	0.034	0.088
Sa (1.0)	0.029	0.092	0.040	0.11	0.011	0.037	0.014	0.043
Sa (2.0)	0.009	-**	0.011	-**	0.003	-**	0.004	-**
PGA	0.067	0.10	0.12	0.19	0.030	0.043	0.040	0.065
PGV	0.040	0.10	0.055	0.14	0.019	0.050	0.021	0.057

Western Cities	2%/50 year probability				10%/50 year probability			
Spectral	H model		R model		H model		R model	
Parameter	50%ile	84%ile	50%ile	84%ile	50%ile	84%ile	50%ile	84%ile
Winnipeg (see table 4)								
Calgary (51.00 -114.00)								
Sa (0.1)	0.10	0.18	0.061	0.12	0.042	0.083	0.029	0.057
Sa (0.15)	0.14	0.27	0.089	0.18	0.063	0.12	0.044	0.086
Sa (0.2)	0.15	0.29	0.096	0.19	0.068	0.14	0.048	0.095
Sa (0.3)	0.13	0.25	0.087	0.17	0.061	0.12	0.044	0.087
Sa (0.4)	0.10	0.20	0.073	0.14	0.050	0.099	0.036	0.072
Sa (0.5)	0.084	0.17	0.061	0.12	0.041	0.081	0.030	0.061
Sa (1.0)	0.041	0.080	0.032	0.063	0.020	0.040	0.016	0.031
Sa (2.0)	0.023	0.045	0.019	0.037	0.012	0.023	0.009	0.018
PGA	0.088	0.18	0.055	0.11	0.040	0.078	0.029	0.057
Kelowna (49.91 -119.37)								
Sa (0.1)	0.18	0.36	0.12	0.24	0.089	0.18	0.064	0.13
Sa (0.15)	0.26	0.51	0.17	0.34	0.12	0.25	0.090	0.18
Sa (0.2)	0.28	0.55	0.19	0.37	0.13	0.27	0.10	0.20
Sa (0.3)	0.24	0.48	0.18	0.35	0.12	0.24	0.096	0.19
Sa (0.4)	0.20	0.40	0.16	0.31	0.10	0.20	0.086	0.17
Sa (0.5)	0.17	0.34	0.14	0.28	0.085	0.17	0.078	0.16
Sa (1.0)	0.086	0.17	0.089	0.18	0.043	0.085	0.049	0.097
Sa (2.0)	0.048	0.096	0.053	0.11	0.024	0.047	0.029	0.058
PGA	0.14	0.27	0.098	0.20	0.071	0.14	0.053	0.11
Kamloops (50.70 -120.30)								
Sa (0.1)	0.18	0.37	0.13	0.26	0.088	0.18	0.071	0.14
Sa (0.15)	0.26	0.52	0.19	0.37	0.12	0.25	0.10	0.20
Sa (0.2)	0.28	0.55	0.20	0.40	0.13	0.27	0.11	0.22
Sa (0.3)	0.24	0.49	0.19	0.38	0.12	0.24	0.11	0.21
Sa (0.4)	0.20	0.40	0.17	0.35	0.099	0.20	0.096	0.19
Sa (0.5)	0.17	0.34	0.16	0.31	0.084	0.17	0.086	0.17
Sa (1.0)	0.086	0.17	0.10	0.20	0.042	0.084	0.054	0.11
Sa (2.0)	0.048	0.095	0.060	0.12	0.024	0.047	0.032	0.064
PGA	0.14	0.27	0.11	0.21	0.071	0.14	0.059	0.12
Prince George (53.92 -122.73)								
Sa (0.1)	0.083	0.17	0.068	0.13	0.035	0.069	0.031	0.061
Sa (0.15)	0.12	0.24	0.099	0.20	0.052	0.10	0.046	0.092
Sa (0.2)	0.13	0.26	0.11	0.21	0.057	0.11	0.051	0.10
Sa (0.3)	0.12	0.23	0.096	0.19	0.051	0.10	0.047	0.094
Sa (0.4)	0.096	0.19	0.080	0.16	0.043	0.085	0.040	0.081
Sa (0.5)	0.080	0.16	0.068	0.14	0.036	0.071	0.035	0.070
Sa (1.0)	0.040	0.080	0.041	0.080	0.019	0.037	0.022	0.044
Sa (2.0)	0.024	0.047	0.026	0.052	0.012	0.023	0.015	0.029
PGA	0.071	0.14	0.060	0.12	0.033	0.067	0.030	0.060
Vancouver (49.20 -123.20)								
Sa (0.1)	0.83	1.7	0.80	1.6	0.44	0.87	0.42	0.85
Sa (0.15)	0.97	1.9	0.95	1.9	0.51	1.0	0.50	1.0
Sa (0.2)	0.96	1.9	0.96	1.9	0.50	1.0	0.51	1.0
Sa (0.3)	0.83	1.7	0.84	1.7	0.43	0.86	0.45	0.89
Sa (0.4)	0.72	1.4	0.74	1.5	0.37	0.75	0.39	0.78
Sa (0.5)	0.65	1.3	0.66	1.3	0.33	0.67	0.35	0.69
Sa (1.0)	0.30	0.60	0.34	0.68	0.16	0.31	0.18	0.35
Sa (2.0)	0.14	0.27	0.18	0.35	0.070	0.14	0.089	0.18
PGA	0.48	0.96	0.47	0.94	0.26	0.51	0.25	0.51

Western Cities	2%/50 year probability				10%/50 year probability			
Spectral	H model		R model		H model		R model	
Parameter	50%ile	84%ile	50%ile	84%ile	50%ile	84%ile	50%ile	84%ile
Victoria (48.50 -123.30)								
Sa (0.1)	1.1	2.2	0.95	1.9	0.59	1.2	0.51	1.0
Sa (0.15)	1.2	2.5	1.1	2.2	0.69	1.4	0.60	1.2
Sa (0.2)	1.2	2.5	1.1	2.2	0.68	1.4	0.60	1.2
Sa (0.3)	1.1	2.1	0.96	1.9	0.58	1.2	0.52	1.0
Sa (0.4)	0.92	1.8	0.84	1.7	0.50	1.0	0.45	0.90
Sa (0.5)	0.83	1.7	0.75	1.5	0.45	0.90	0.40	0.80
Sa (1.0)	0.38	0.77	0.37	0.75	0.21	0.41	0.20	0.39
Sa (2.0)	0.17	0.35	0.19	0.37	0.091	0.18	0.095	0.19
PGA	0.62	1.2	0.55	1.1	0.34	0.69	0.30	0.61
Tofino (49.15 -125.90) (Note: deterministic Cascadia values exceed these values)								
Sa (0.1)	0.45	0.89	0.41	0.81	0.22	0.45	0.20	0.40
Sa (0.15)	0.61	1.2	0.54	1.1	0.31	0.62	0.27	0.54
Sa (0.2)	0.65	1.3	0.58	1.2	0.33	0.66	0.29	0.57
Sa (0.3)	0.61	1.2	0.54	1.1	0.31	0.62	0.26	0.53
Sa (0.4)	0.54	1.1	0.48	0.95	0.27	0.54	0.23	0.46
Sa (0.5)	0.47	0.94	0.42	0.84	0.24	0.46	0.20	0.40
Sa (1.0)	0.27	0.54	0.24	0.48	0.13	0.26	0.11	0.22
Sa (2.0)	0.15	0.30	0.13	0.26	0.075	0.15	0.063	0.12
PGA	0.28	0.56	0.26	0.53	0.15	0.30	0.14	0.28
Prince Rupert (54.30 -130.40)								
Sa (0.1)	0.12	0.25	0.25	0.50	0.066	0.13	0.12	0.24
Sa (0.15)	0.18	0.36	0.35	0.70	0.098	0.19	0.17	0.34
Sa (0.2)	0.19	0.38	0.38	0.75	0.11	0.22	0.18	0.37
Sa (0.3)	0.18	0.36	0.34	0.68	0.11	0.21	0.17	0.34
Sa (0.4)	0.17	0.33	0.29	0.58	0.10	0.20	0.15	0.30
Sa (0.5)	0.16	0.32	0.25	0.50	0.096	0.19	0.13	0.26
Sa (1.0)	0.14	0.28	0.17	0.33	0.074	0.15	0.091	0.18
Sa (2.0)	0.078	0.16	0.096	0.19	0.043	0.084	0.052	0.10
PGA	0.10	0.20	0.18	0.36	0.061	0.12	0.095	0.19
Queen Charlotte City (53.30 -132.00)								
Sa (0.1)	0.40	0.81	0.44	0.88	0.26	0.52	0.29	0.57
Sa (0.15)	0.55	1.1	0.61	1.2	0.36	0.72	0.40	0.79
Sa (0.2)	0.61	1.2	0.66	1.3	0.40	0.79	0.44	0.86
Sa (0.3)	0.62	1.2	0.67	1.3	0.39	0.78	0.43	0.85
Sa (0.4)	0.61	1.2	0.65	1.3	0.36	0.73	0.39	0.78
Sa (0.5)	0.60	1.2	0.63	1.2	0.34	0.67	0.36	0.72
Sa (1.0)	0.48	0.98	0.50	1.0	0.23	0.45	0.24	0.48
Sa (2.0)	0.25	0.50	0.26	0.53	0.12	0.24	0.13	0.26
PGA	0.34	0.67	0.36	0.71	0.21	0.41	0.22	0.45
Inuvik (68.40 -133.60)								
Sa (0.1)	0.061	0.12	0.051	0.10	0.031	0.062	0.031	0.062
Sa (0.15)	0.091	0.18	0.078	0.16	0.048	0.096	0.048	0.096
Sa (0.2)	0.10	0.20	0.087	0.18	0.054	0.11	0.054	0.11
Sa (0.3)	0.092	0.18	0.084	0.17	0.052	0.10	0.053	0.10
Sa (0.4)	0.078	0.16	0.074	0.15	0.045	0.089	0.046	0.092
Sa (0.5)	0.067	0.13	0.064	0.13	0.039	0.077	0.040	0.080
Sa (1.0)	0.037	0.074	0.039	0.078	0.022	0.044	0.023	0.046
Sa (2.0)	0.023	0.046	0.025	0.050	0.014	0.027	0.015	0.030
PGA	0.060	0.12	0.052	0.10	0.032	0.064	0.032	0.064

Note * All values are given for firm ground; spectral and PGA units = g, PGV units = m/s.
** Sa(2) epistemic uncertainty to provide the 84th percentile is not available

Table 4

"Stable Canada" Floor Values for low Seismicity Parts of Canada

Spectral Parameter	2%/50 year probability		10%/50 year probability	
	50%ile	84%ile	50%ile	84%ile
Sa (0.1)	**0.087**	0.20	0.031	0.072
Sa (0.15)	**0.11**	0.20	0.040	0.073
Sa (0.2)	**0.12**	0.21	0.044	0.079
Sa (0.3)	**0.082**	0.18	0.033	0.072
Sa (0.4)	**0.064**	0.16	0.024	0.060
Sa (0.5)	**0.056**	0.17	0.024	0.068
Sa (1.0)	**0.023**	0.079	0.009	0.032
Sa (2.0)	**0.006**	-	0.002	-
PGA	**0.059**	0.14	0.021	0.050
PGV	**0.040**	0.11	0.019	0.045

Notes:

Values in bold are intended for use in NBCC2005
Units for Sa and PGA = g; for PGV = m/s
These values apply to Winnipeg and many other cities in central Canada
Sa(2.0) epistemic uncertainty to provide the 84^{th} percentile is not available

Table 5

Hazard values for Cascadia subduction earthquake scenario, ordered by distance (units=g). See also Appendix C7.

Median values for a probability of 2%/50 years (Figures in bold represent values to be used in NBCC 2005)

	Dist	Lat N	Lon W	0.1	0.15	0.2	0.3	0.4	0.5	1.0	2.0	PGA
Tofino	8	49.15	-125.90	0.92	1.2	**1.2**	1.1	1.0	**0.93**	**0.47**	**0.21**	0.52
Victoria	76	48.50	-123.30	0.48	0.61	0.65	0.60	0.56	0.52	0.27	0.12	0.28
Vancouver	140	49.20	-123.20	0.26	0.34	0.37	0.35	0.33	0.31	0.17	0.077	0.16
Kelowna	399	49.91	-119.37	0.053	0.072	0.079	0.078	0.076	0.074	0.043	0.021	0.034
Kamloops	402	50.70	-120.30	0.052	0.071	0.078	0.077	0.075	0.073	0.042	0.021	0.033
Queen Charlotte City	557	53.30	-132.00	0.028	0.038	0.043	0.043	0.042	0.041	0.025	0.013	0.018
Prince George	562	53.92	-122.73	0.027	0.037	0.042	0.042	0.042	0.041	0.024	0.013	0.018
Prince Rupert	588	54.30	-130.40	0.025	0.034	0.038	0.038	0.038	0.037	0.022	0.012	0.016
Calgary	792	51.00	-114.00	0.013	0.018	0.021	0.022	0.022	0.021	0.013	0.007	0.009
Edmonton	964	53.55	-113.47	0.008	0.012	0.014	0.014	0.014	0.014	0.009	0.005	0.006

84th percentile values for a probability of 2%/50 years

	Dist	Lat N	Lon W	0.1	0.15	0.2	0.3	0.4	0.5	1.0	2.0	PGA
Tofino	8	49.15	-125.90	1.8	2.2	2.3	2.1	1.9	1.8	0.90	0.44	1.0
Victoria	76	48.50	-123.30	0.92	1.2	1.2	1.1	1.1	1.0	0.52	0.26	0.54
Vancouver	140	49.20	-123.20	0.51	0.66	0.70	0.66	0.62	0.59	0.32	0.16	0.30
Kelowna	399	49.91	-119.37	0.10	0.14	0.15	0.15	0.15	0.14	0.082	0.045	0.064
Kamloops	402	50.70	-120.30	0.10	0.14	0.15	0.15	0.14	0.14	0.081	0.045	0.063
Queen Charlotte City	557	53.30	-132.00	0.053	0.073	0.082	0.082	0.081	0.080	0.047	0.027	0.034
Prince George	562	53.92	-122.73	0.052	0.072	0.080	0.081	0.080	0.078	0.047	0.027	0.034
Prince Rupert	588	54.30	-130.40	0.047	0.065	0.073	0.073	0.072	0.071	0.043	0.024	0.031
Calgary	792	51.00	-114.00	0.025	0.035	0.040	0.041	0.041	0.041	0.025	0.015	0.017
Edmonton	964	53.55	-113.47	0.016	0.023	0.027	0.028	0.028	0.028	0.018	0.011	0.011

For backward comparison to NBCC1995: Median values for a probability of 10%/50 years

	Dist	Lat N	Lon W	0.1	0.15	0.2	0.3	0.4	0.5	1.0	2.0	PGA
Tofino	8	49.15	-125.90	0.48	0.60	0.63	0.57	0.52	0.49	0.25	0.097	0.27
Victoria	76	48.50	-123.30	0.25	0.32	0.34	0.31	0.29	0.27	0.14	0.058	0.15
Vancouver	140	49.20	-123.20	0.14	0.18	0.19	0.18	0.17	0.16	0.087	0.036	0.082
Kelowna	399	49.91	-119.37	0.028	0.037	0.041	0.041	0.040	0.039	0.022	0.010	0.018
Kamloops	402	50.70	-120.30	0.027	0.037	0.041	0.040	0.039	0.038	0.022	0.010	0.017
Queen Charlotte City	557	53.30	-132.00	0.014	0.020	0.022	0.022	0.022	0.022	0.013	0.006	0.009
Prince George	562	53.92	-122.73	0.014	0.020	0.022	0.022	0.022	0.021	0.013	0.006	0.009
Prince Rupert	588	54.30	-130.40	0.013	0.018	0.020	0.020	0.020	0.019	0.012	0.006	0.008
Calgary	792	51.00	-114.00	0.007	0.010	0.011	0.011	0.011	0.011	0.007	0.003	0.005
Edmonton	964	53.55	-113.47	0.004	0.006	0.007	0.008	0.008	0.008	0.005	0.002	0.003

Table 6. Summary of NBCC 2005 design values (median values, in bold) and uncertainty (84th percentile) for selected Canadian cities

	Median (50th percentile) Robust Values						84th percentile Robust Values					
City	$S_a(0.2)$	$S_a(0.5)$	$S_a(1.0)$	$S_a(2.0)$	PGA	PGV	$S_a(0.2)$	$S_a(0.5)$	$S_a(1.0)$	$S_a(2.0)$	PGA	PGV
St. John's	**0.18 R**	**0.11 R**	**0.060 R**	**0.016 R**	**0.090 R**	**0.057 R**	0.31 R	0.29 R	0.16 R		0.14 F	0.14 R
Halifax	**0.23 R**	**0.13 R**	**0.070 R**	**0.019 R**	**0.12 R**	**0.071 R**	0.41 R	0.34 R	0.18 R		0.19 R	0.18 R
Moncton	**0.30 H**	**0.16 H**	**0.068 H**	**0.021 H**	**0.21 H**	**0.095 H**	0.52 H	0.42 H	0.22 H		0.30 H	0.23 H
Fredericton	**0.39 R**	**0.20 R**	**0.086 H**	**0.027 H**	**0.27 R**	**0.12 R**	0.69 R	0.52 R	0.27 R		0.38 R	0.29 R
La Malbaie	**2.3 H**	**1.2 H**	**0.60 H**	**0.19 H**	**1.1 H**	**0.62 H**	3.8 H	3.1 H	1.8 H		2.0 H	1.5 H
Québec	**0.59 R**	**0.29 H**	**0.14 H**	**0.048 H**	**0.37 R**	**0.16 R**	1.0 R	0.75 H	0.44 H		0.57 R	0.41 R
Trois-Rivières	**0.64 R**	**0.31 R**	**0.12 R**	**0.043 R**	**0.40 R**	**0.17 R**	1.1 R	0.77 R	0.40 R		0.62 R	0.44 R
Montréal	**0.69 R**	**0.34 R**	**0.14 R**	**0.048 R**	**0.43 R**	**0.18 R**	1.2 R	0.83 R	0.44 R		0.63 R	0.48 R
Ottawa	**0.67 R**	**0.32 R**	**0.14 R**	**0.045 R**	**0.42 R**	**0.18 R**	1.1 R	0.80 R	0.42 R		0.63 R	0.46 R
Niagara Falls	**0.41 H**	**0.20 H**	**0.073 H**	**0.021 H**	**0.30 H**	**0.13 H**	0.93 H	0.52 H	0.25 H		0.48 H	0.35 H
Toronto	**0.28 H**	**0.14 H**	**0.055 R**	**0.016 H**	**0.20 H**	**0.083 H**	0.56 H	0.35 H	0.17 H		0.28 H	0.22 H
Windsor	**0.18 R**	**0.087 R**	**0.040 R**	**0.011 R**	**0.12 R**	**0.055 R**	0.32 R	0.22 R	0.11 R		0.19 R	0.14 R
Winnipeg	**0.12 F**	**0.056 F**	**0.023 F**	**0.006 F**	**0.059 F**	**0.040 F**	0.21 F	0.17 F	0.079 F		0.14 F	0.11 F
Calgary	**0.15 H**	**0.084 H**	**0.041 H**	**0.023 H**	**0.088 H**		0.29 H	0.17 H	0.080 H	0.045 H	0.18 H	
Kelowna	**0.28 H**	**0.17 H**	**0.089 R**	**0.053 R**	**0.14 H**		0.55 H	0.34 H	0.18 R	0.11 R	0.27 H	
Kamloops	**0.28 H**	**0.17 H**	**0.10 R**	**0.060 R**	**0.14 H**		0.55 H	0.34 H	0.20 R	0.12 R	0.27 H	
Prince George	**0.13 H**	**0.080 H**	**0.041 R**	**0.026 R**	**0.071 H**		0.26 H	0.17 F	0.080 H	0.052 R	0.14 H	
Vancouver	**0.96 H**	**0.66 R**	**0.34 R**	**0.18 R**	**0.48 H**		1.9 H	1.3 R	0.68 R	0.35 R	0.96 H	
Victoria	**1.2 H**	**0.83 H**	**0.38 H**	**0.19 R**	**0.62 H**		2.5 H	1.7 H	0.77 H	0.37 R	1.2 H	
Tofino	**1.2 C**	**0.93 C**	**0.47 C**	**0.21 C**	**0.52 C**		2.3 C	1.8 C	0.90 C	0.44 C	1.0 C	
Prince Rupert	**0.38 R**	**0.25 R**	**0.17 R**	**0.096 R**	**0.18 R**		0.75 R	0.50 R	0.33 R	0.19 R	0.36 R	
Queen Charlotte	**0.66 R**	**0.63 R**	**0.50 R**	**0.26 R**	**0.36 R**		1.3 R	1.2 R	1.0 R	0.53 R	0.71 R	
Inuvik	**0.12 F**	**0.067 H**	**0.039 R**	**0.025 R**	**0.060 H**		0.21 F	0.17 F	0.079 F	0.050 R	0.14 F	

The second column for each parameter indicates which of the four models provides the "robust" or largest values - H: H model probabilistic, R: R model probabilistic, C: deterministic Cascadia scenario, F: Floor level probabilistic. Peak and spectral acceleration values are in g, peak velocity in m/s. All values are reported to 2 significant figures Peak velocity values are not available for the west. 84th percentile values for $S_a(2)$ are not available for the east.

Table 7

Peak Ground Acceleration, 10%/50 year values from the 1985 code compared with median 10%/50 year firm-ground values from the hazard model used for the 2005 code (units=g)

City	1985*	2005	change	chief reasons
St. John's	0.054	0.036	down	1 and 2
Halifax	0.056	0.057	slight	--
Moncton	0.085	0.072	down	2
Fredericton	0.096	0.094	slight	--
La Malbaie	0.70	0.59	down	2
Québec	0.19	0.16	down	2
Trois Rivières	0.12	0.18	up	3
Montréal	0.18	0.20	slight	--
Ottawa	0.20	0.20	slight	--
Niagara Falls	0.084	0.12	up	4 and 5
Toronto	0.056	0.080	up	4and 5
Windsor	0.029	0.040	up	3 and 5
Winnipeg	0	0.021	up	6
Calgary	0.019	0.040	up	5
Kelowna	0.054	0.071	up	5
Kamloops	0.056	0.071	up	5
Prince George	0.034	0.033	slight	--
Vancouver	0.21	0.26	up	4
Victoria	0.28	0.34	up	7
Tofino	0.35	0.27	down	4 and 8
Prince Rupert	0.13	0.095	down	2
Queen Charlotte City	0.57	0.22	down	2
Inuvik	0.060	0.032	down	2

* 1985 values were taken from the 1985 NBCC Commentary where possible. Values not in the commentary were computed using the 1985 seismic hazard model.

Reasons:

1. less impact of 1929 earthquake
2. new strong ground motion relations used
3. effect of **R** model
4. change in source zone boundary position
5. larger upper bound magnitudes used
6. effect of stable Canada model
7. Coordinates corrected to downtown (in 1995)
8. Less impact of 1946-type earthquakes

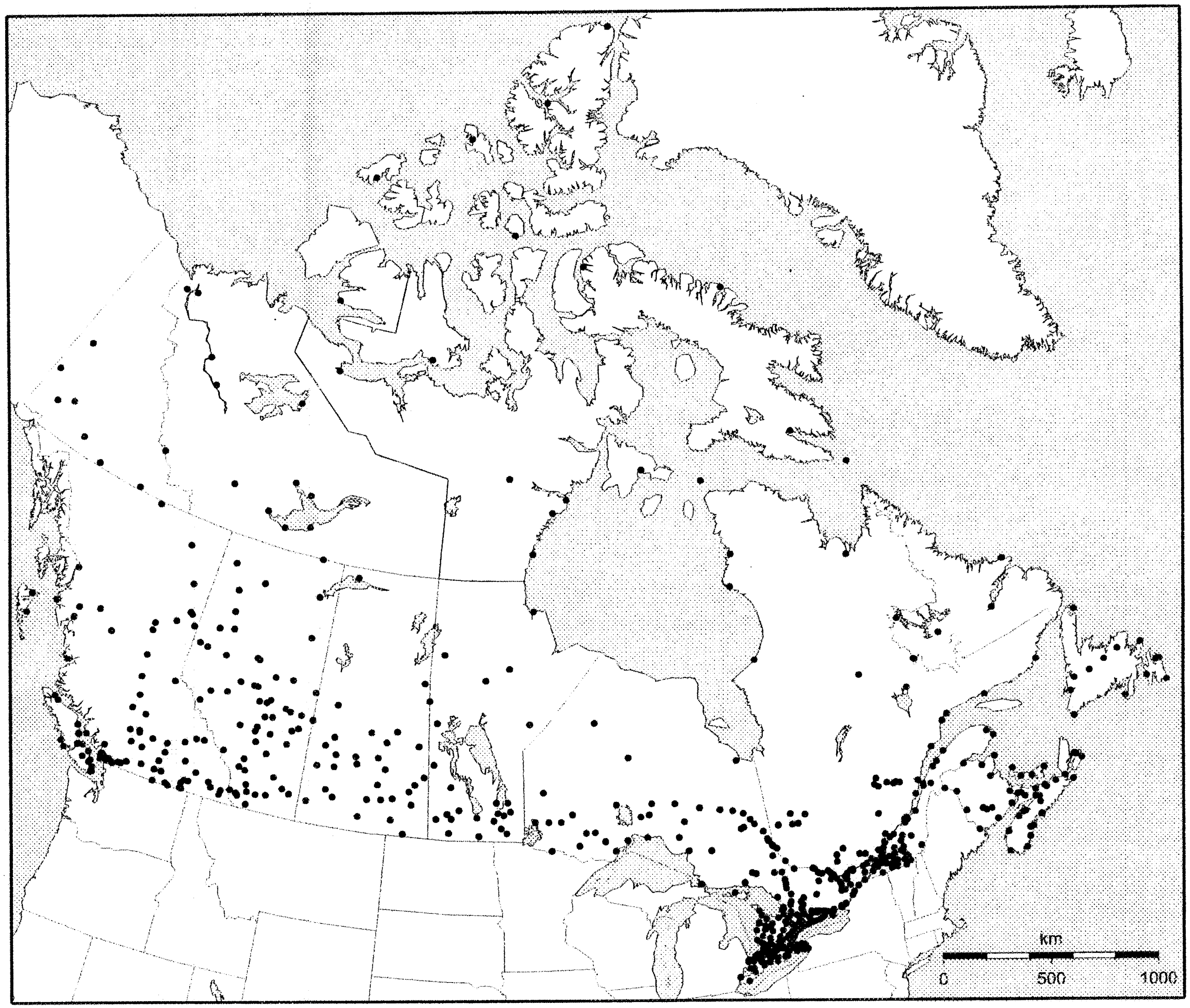


Figure 1. Map of Canada showing the over 650 localities to be used in the NBCC Design Data for Selected Localities in Canada table, for which values are given in Table 1 of this report.

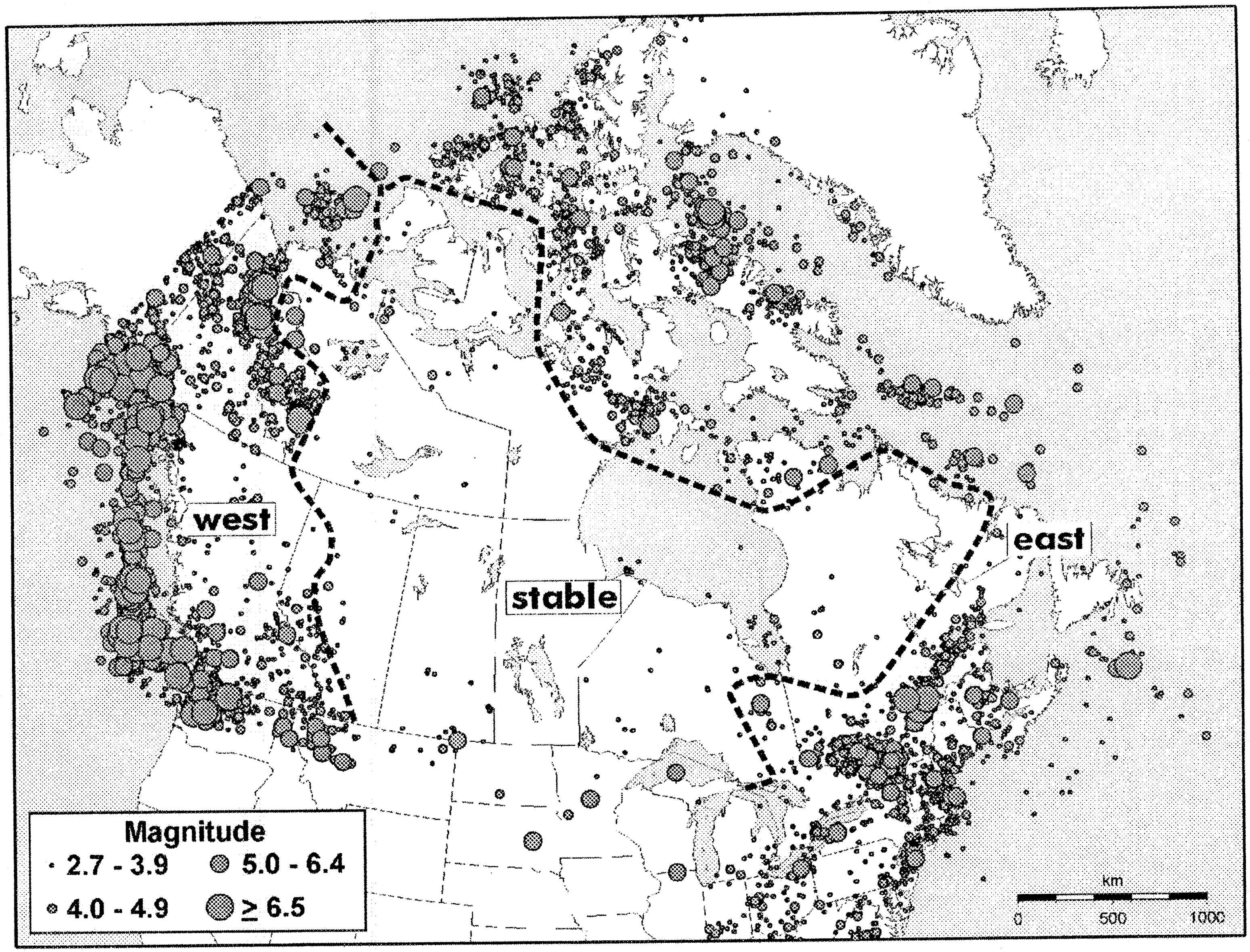


Figure 2. Map of Canada showing the earthquake catalog used for the 4th generation model together with dashed lines delimiting the eastern and western seismic regions and the stable Canada central region.

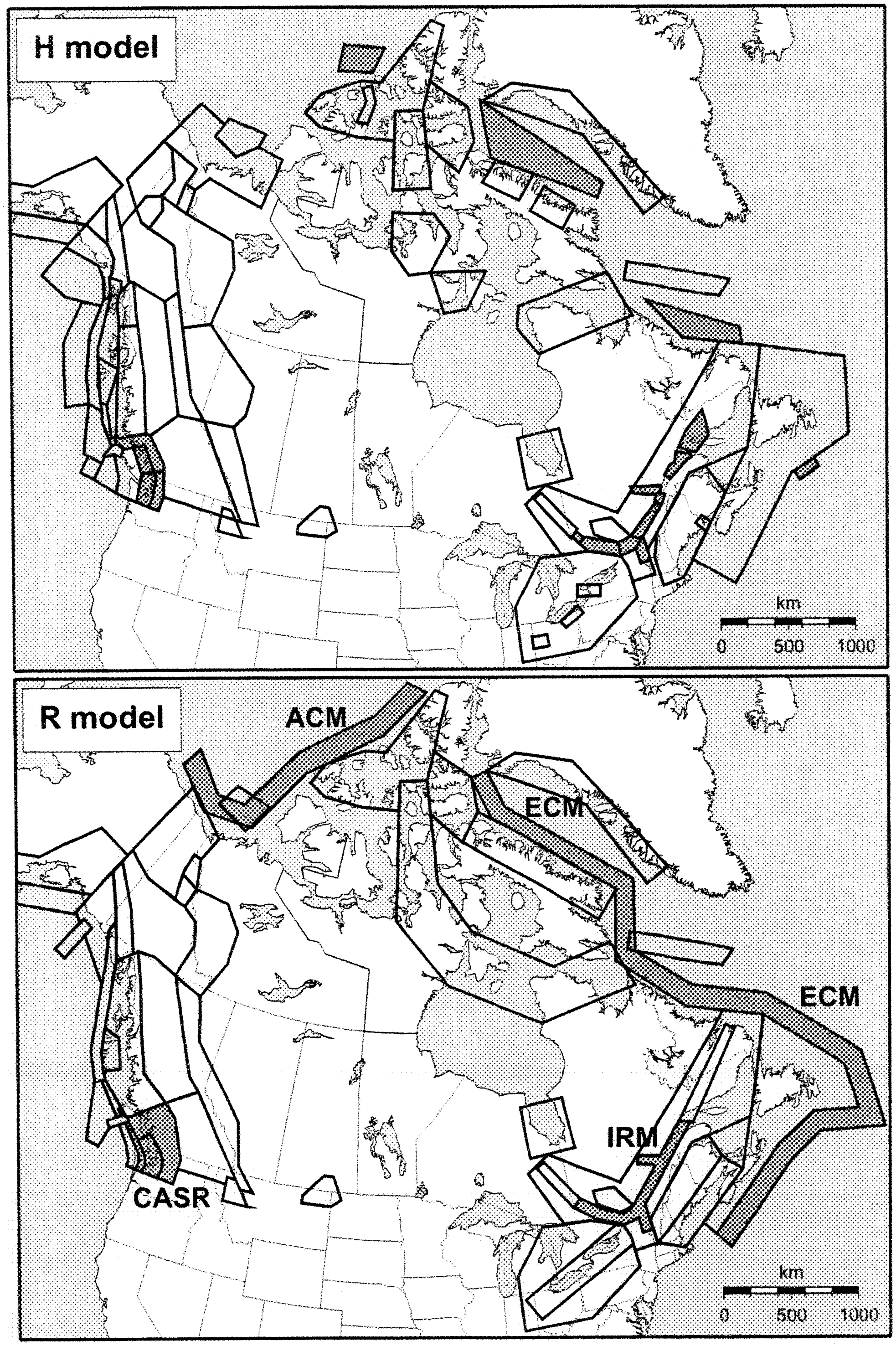


Figure 3. Earthquake source zone maps of Canada showing the zones that form the **H** (top) and **R** (bottom) models for earthquake distribution. Zones referred to in the text are shaded and labeled on the bottom map; corresponding H-model zones are shaded on the top map. Larger maps are given in Appendices C3 and C4.

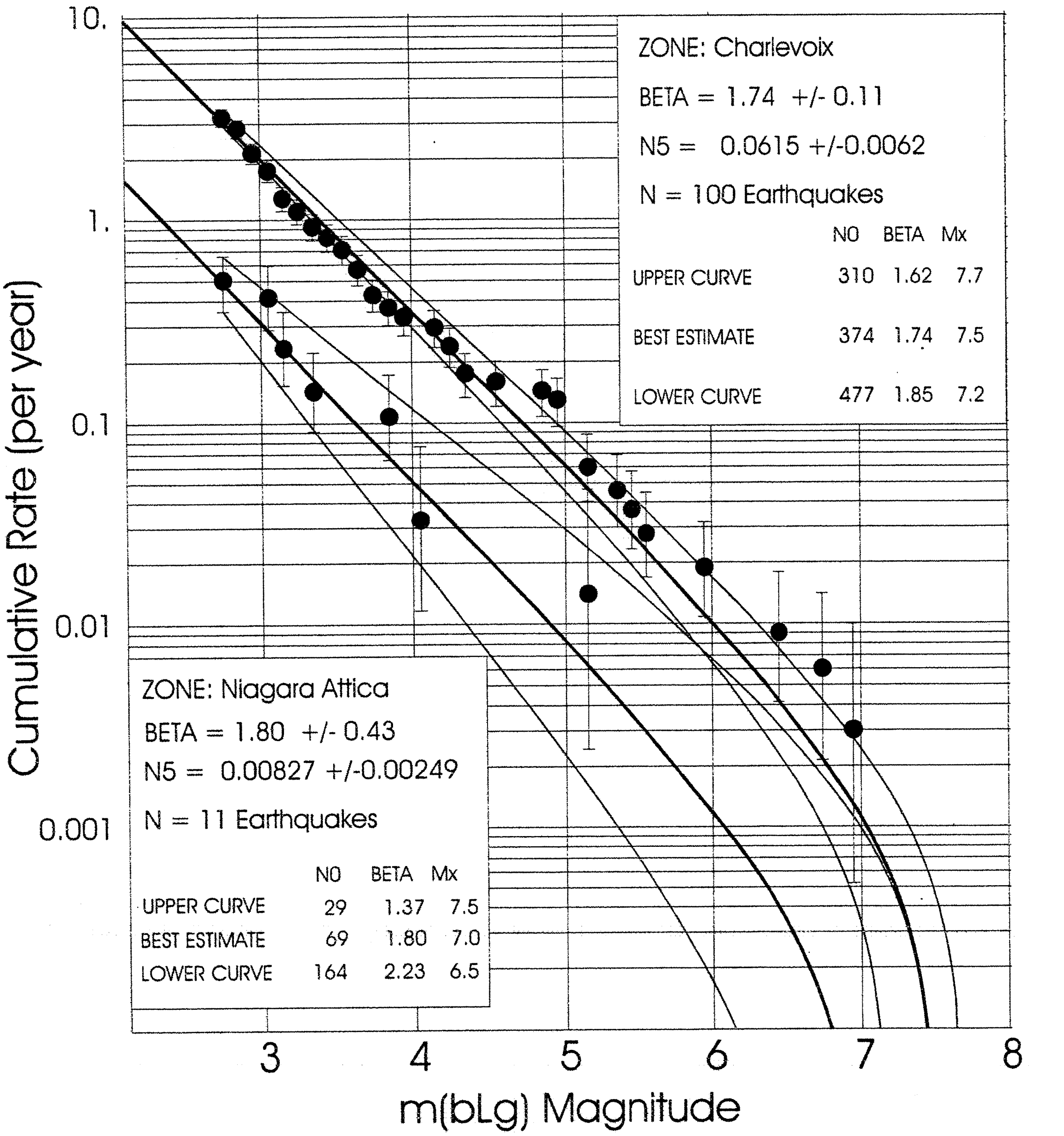


Figure 4. Sample magnitude-recurrence data and curves, for Charlevoix (CHV) and the Niagara-Attica (NAT) zones. The cumulative rates of earthquakes are represented by solid circles with stochastic error bounds and the best-fit curve (bold) are flanked by upper and lower "error" curves that are more widely separated for the poorly-constrained NAT dataset. All curves are asymptotic to assumed upper-bound magnitudes.

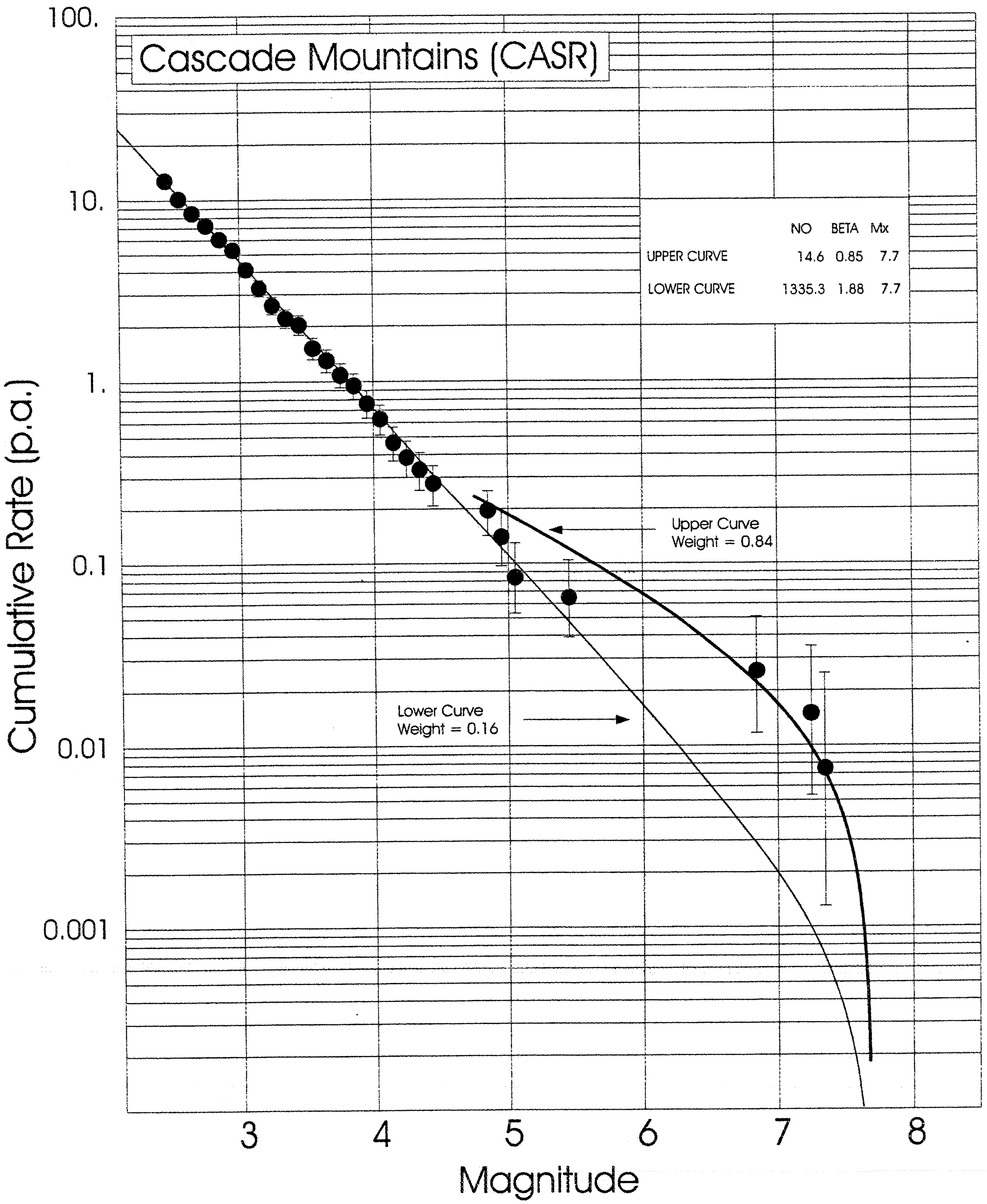


Figure 5. Magnitude-recurrence data and curves for CASR, the shallow crustal source for the Strait of Georgia - Puget Sound region. The maximum likelihood fit including the small magnitude earthquakes (lower curve) passes through the point (0.002, 7.0), considerably below the historical rate of M>6.8 earthquakes. The maximum likelihood fit to only M>4.75 earthquakes (upper curve) matches the historical rate of larger earthquakes much better. Both curves are asymptotic to an assumed upper-bound magnitude.

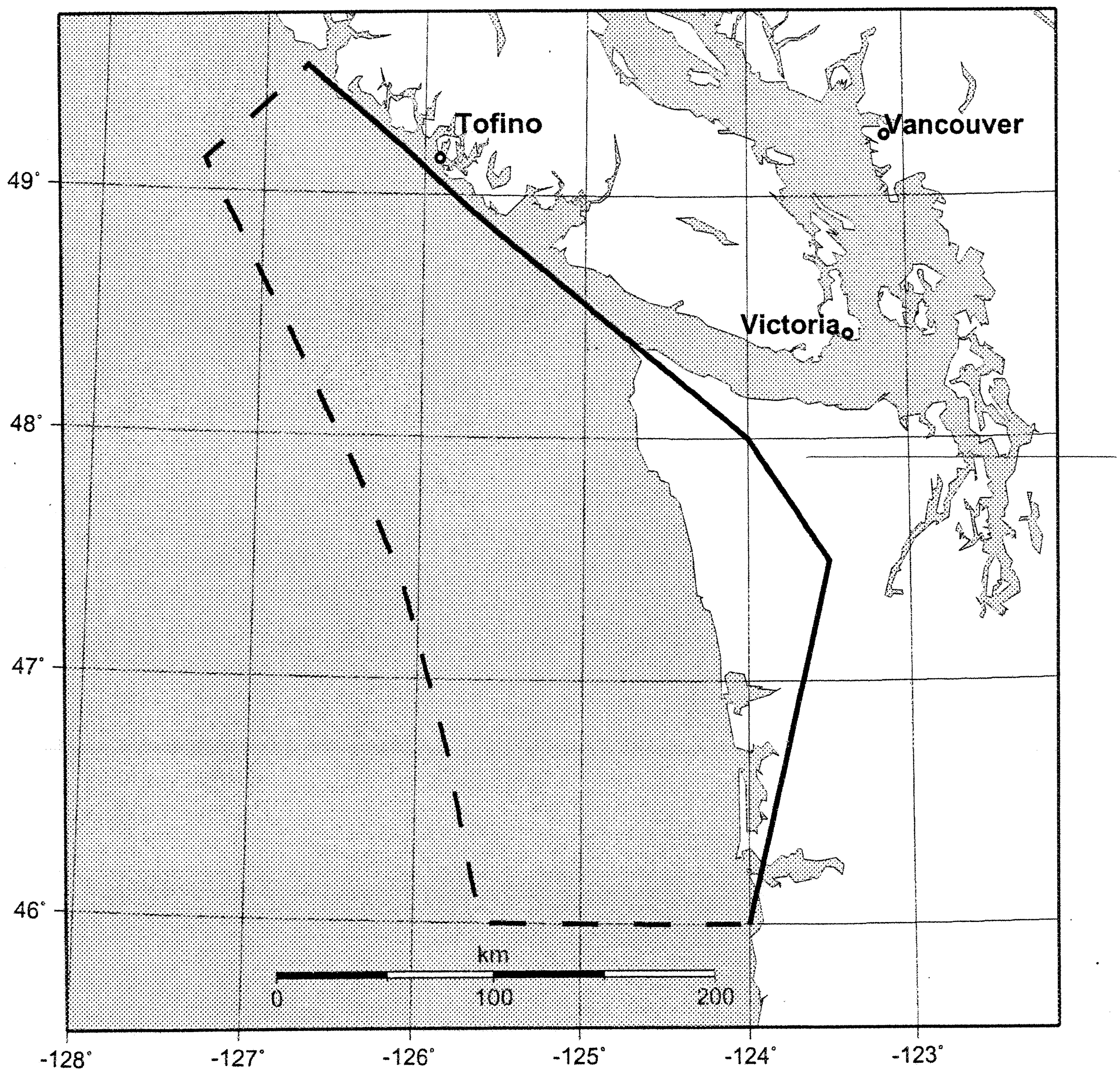


Figure 6. Locus used to represent the closest point of energy release for the deterministic Cascadia earthquake scenario (see text and Appendix C6 for details). The solid line represents the inboard edge most relevant to onshore sites.

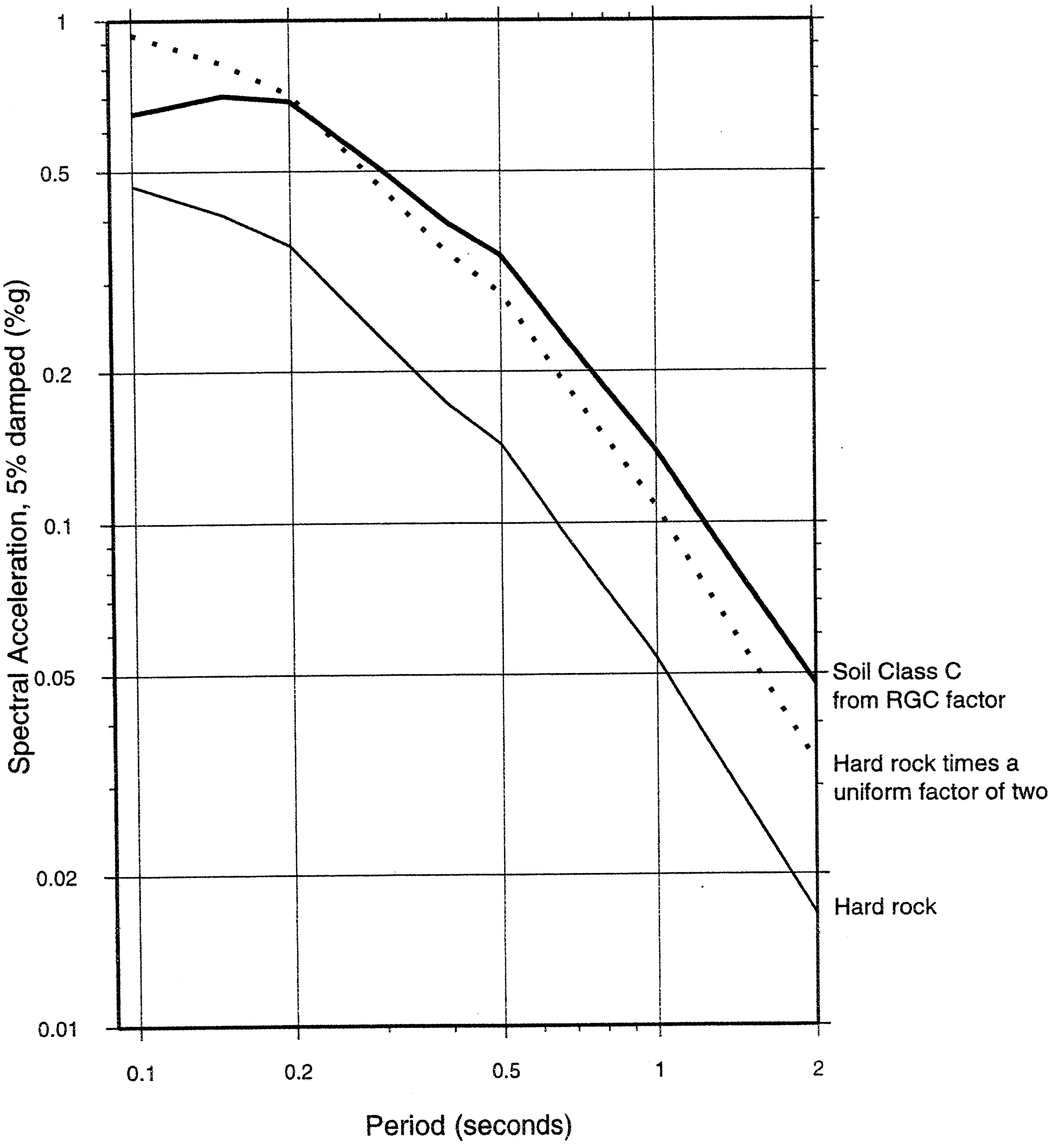


Figure 7. Seismic hazard for Montréal depicted as Uniform Hazard Spectra on various ground conditions. These median 2%/50 year UHS from the **R** model are for Site Class C (values from Table 3) and for hard-rock derived using the RGC factors in Table 2; a baseline derived from the hard-rock values using a uniform amplification of a factor of two instead of the RGC factors is shown for comparison.

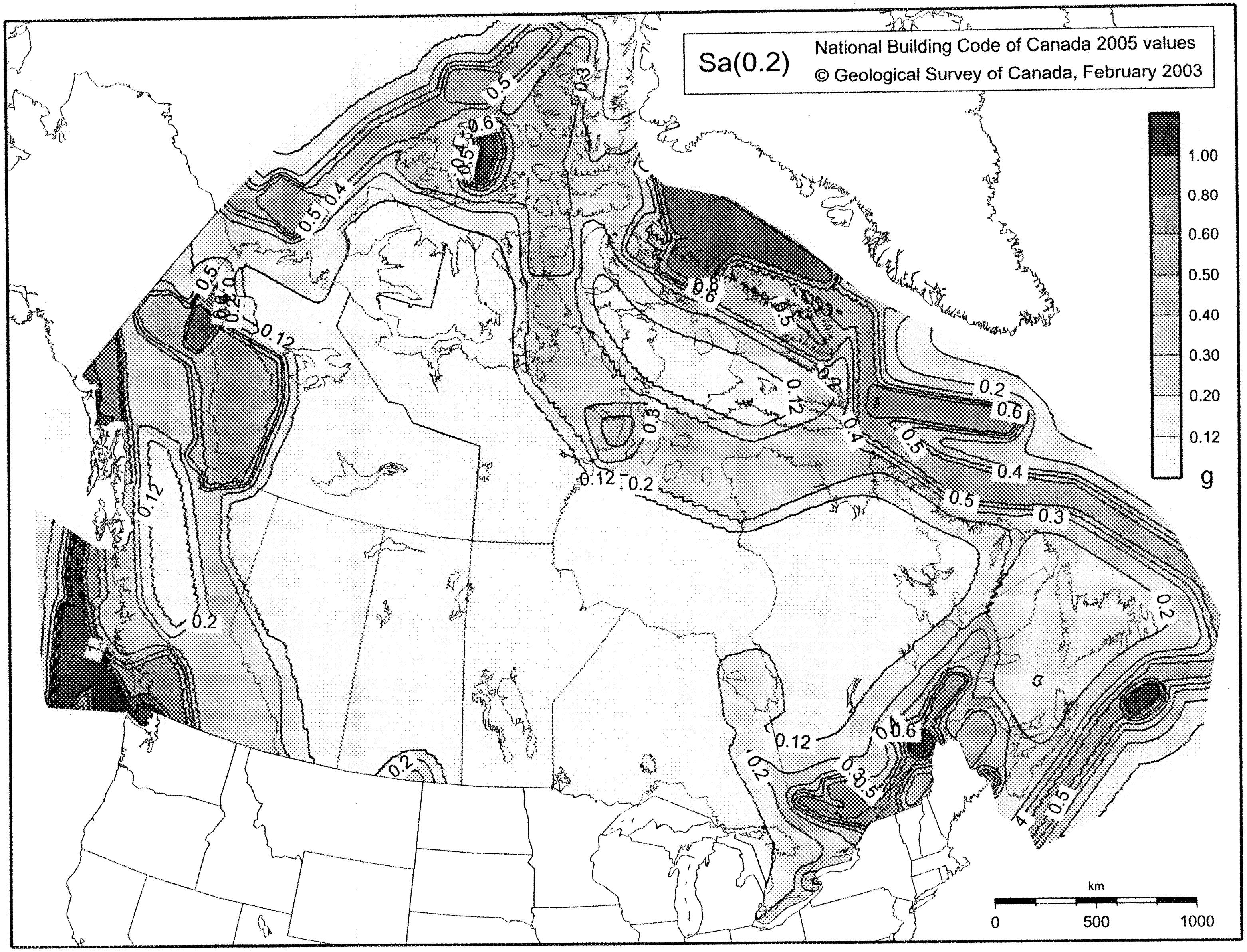


Figure 8. Sa(0.2) for Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

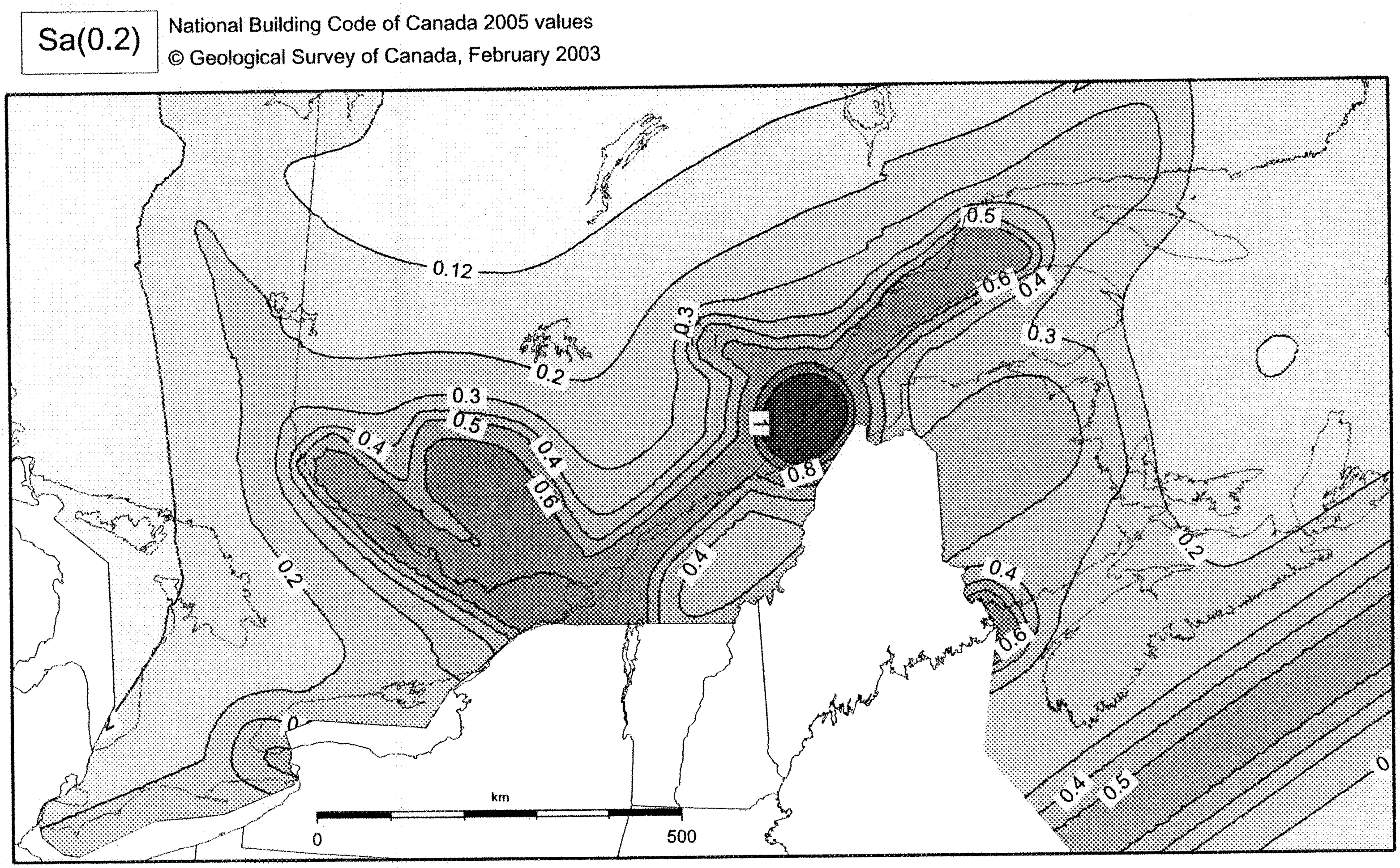


Figure 9. Sa(0.2) for southeastern Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

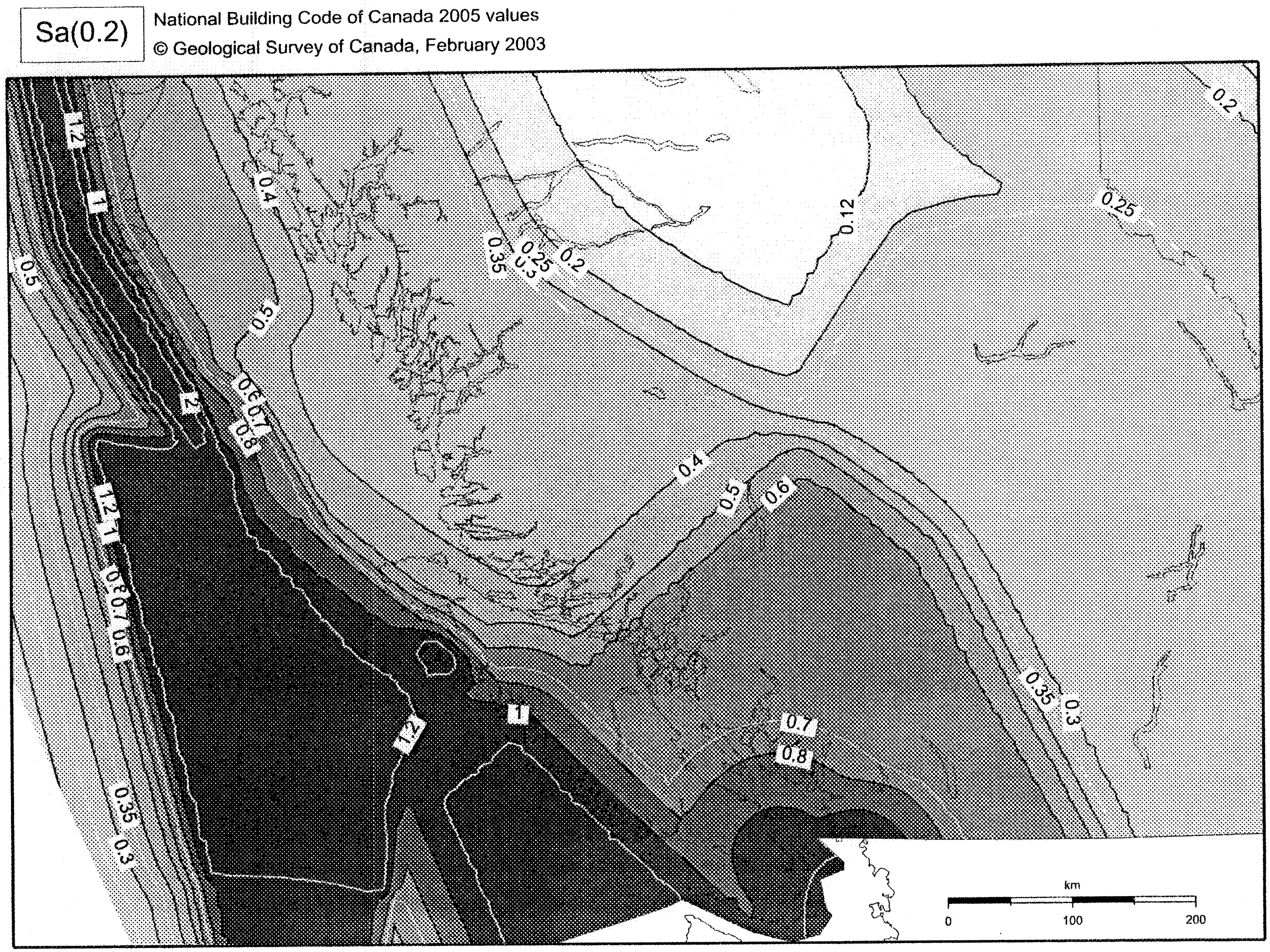


Figure 10. Sa(0.2) for southwestern Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

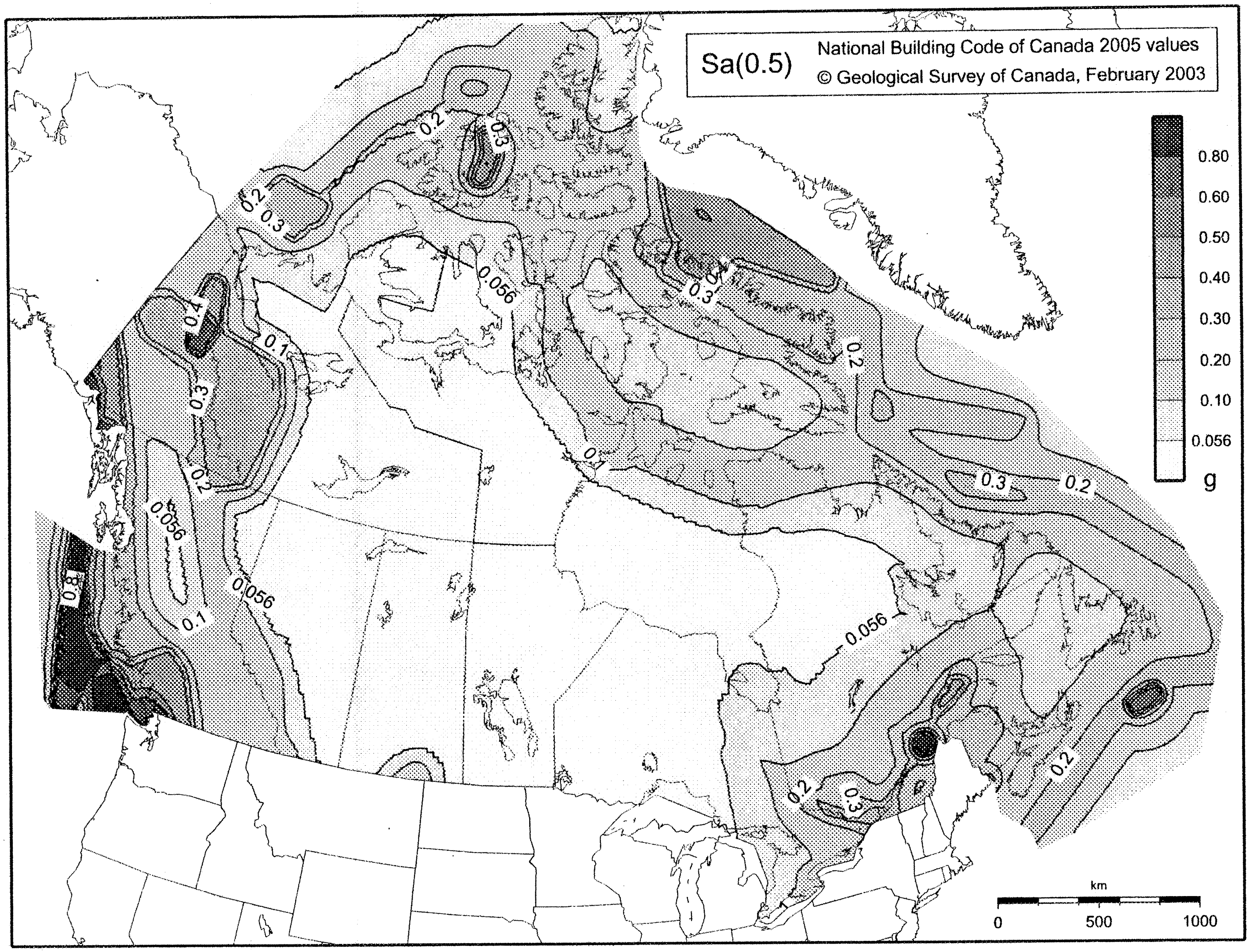


Figure 11. Sa(0.5) for Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

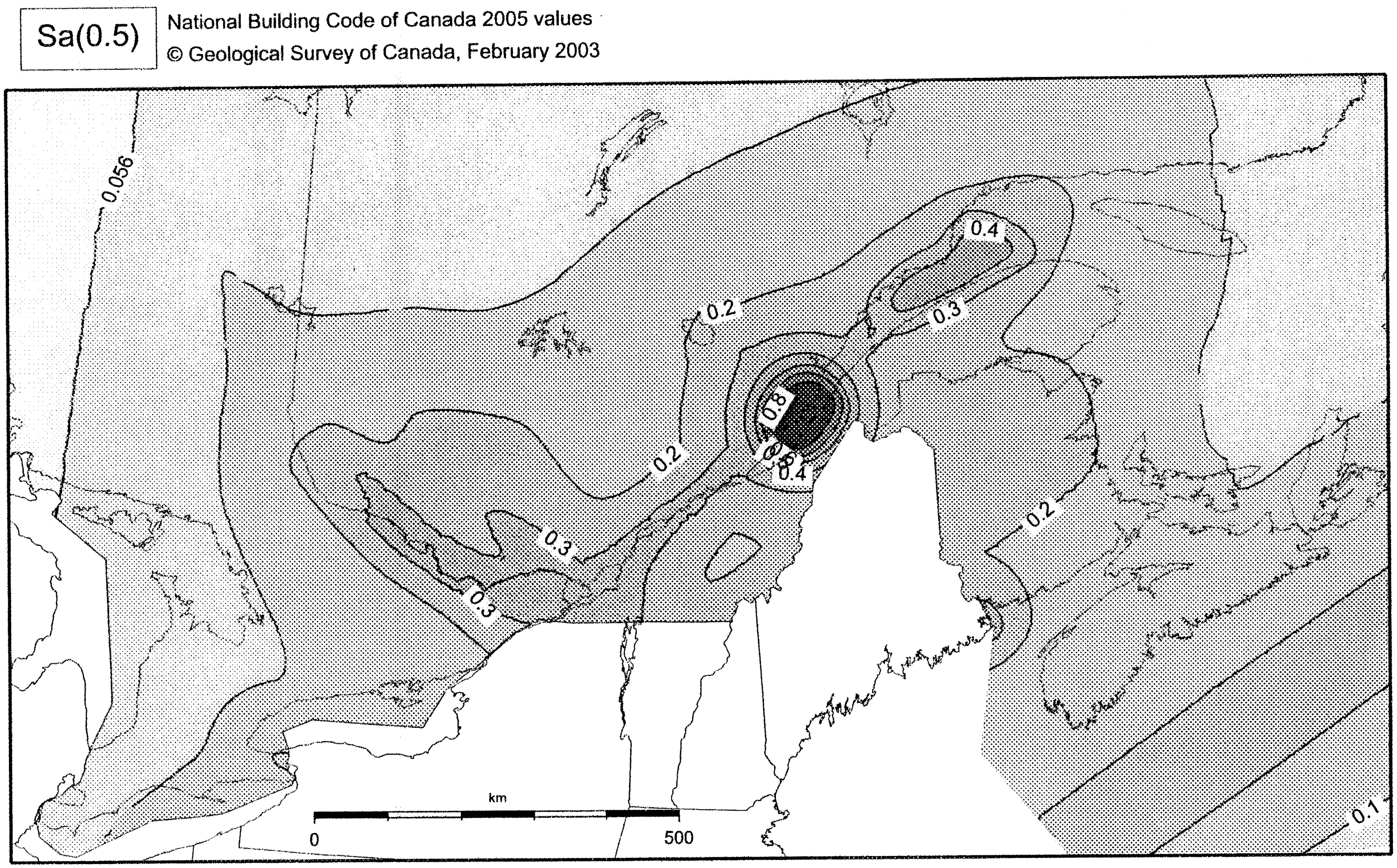


Figure 12. Sa(0.5) for southeastern Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

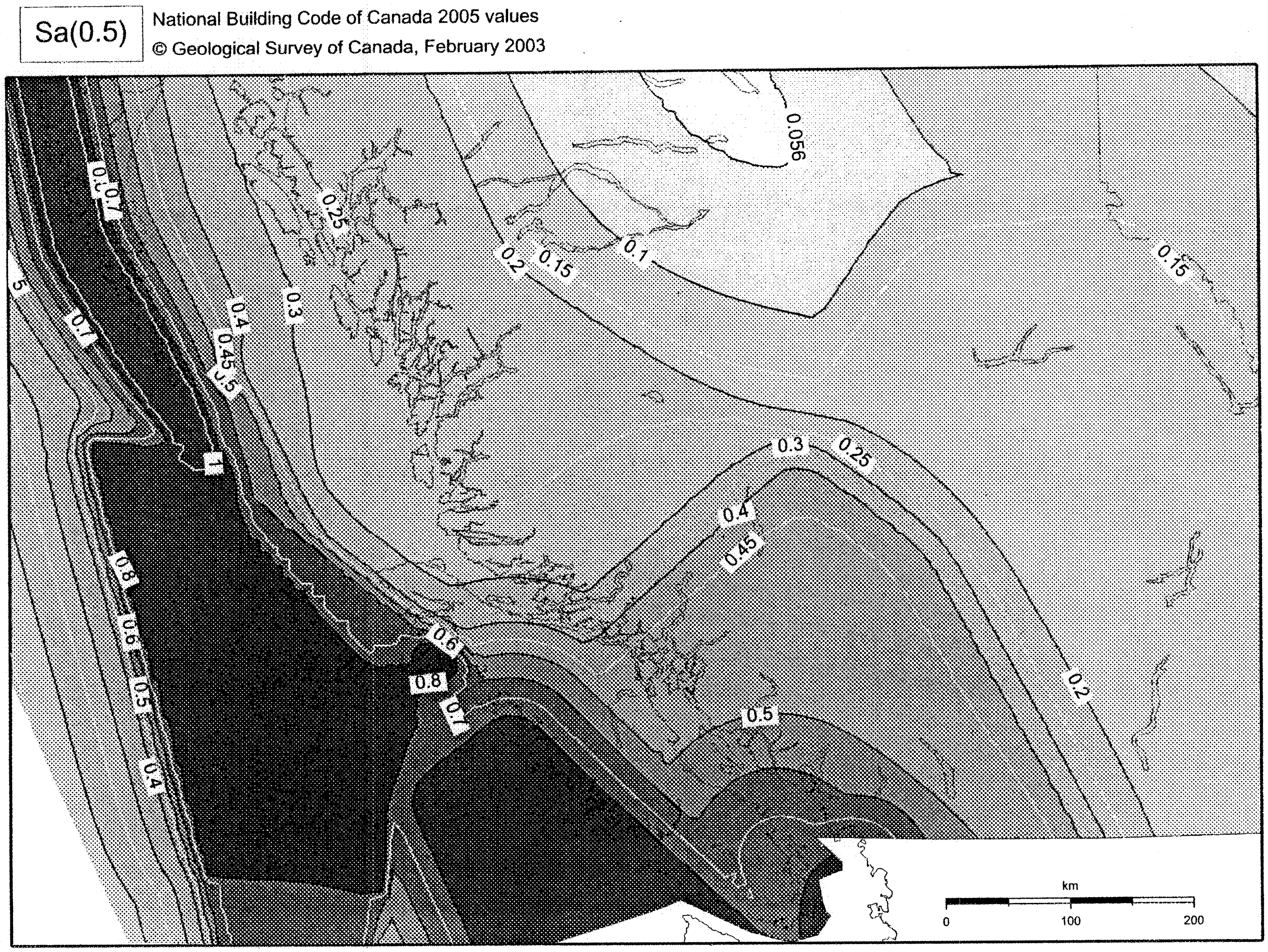


Figure 13. Sa(0.5) for southwestern Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

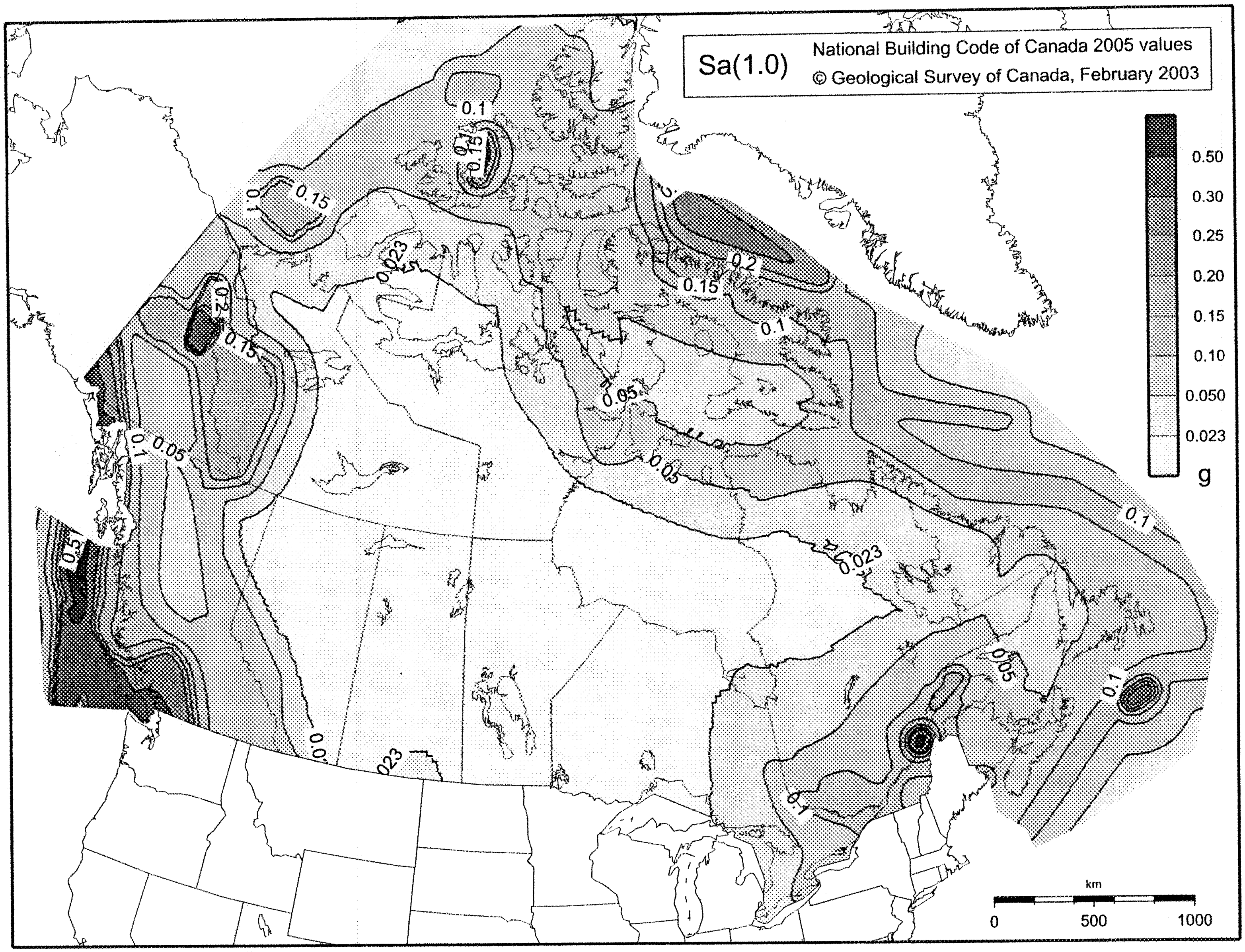


Figure 14. Sa(1.0) for Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

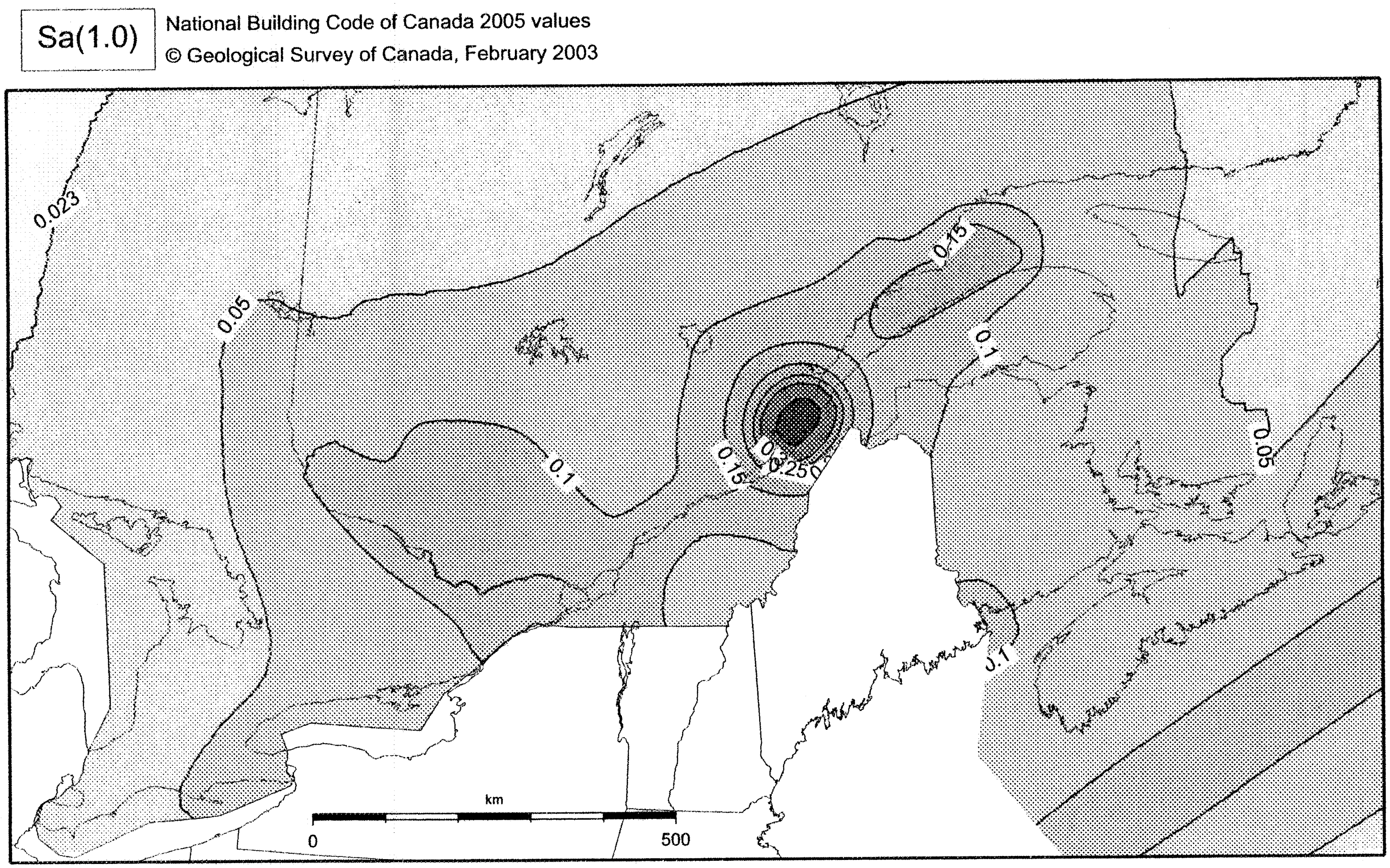


Figure 15. Sa(1.0) for southeastern Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

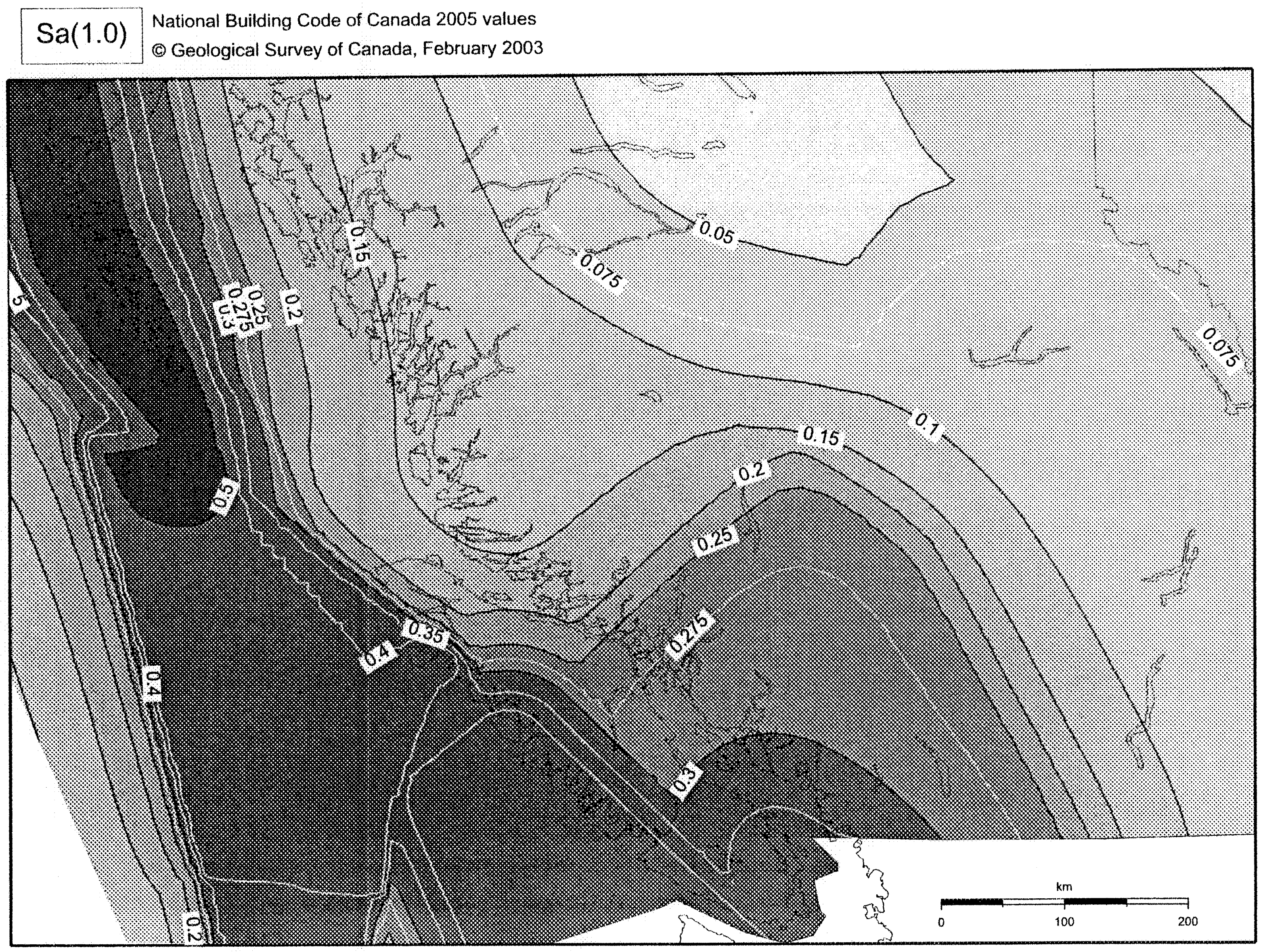


Figure 16. Sa(1.0) for southwestern Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

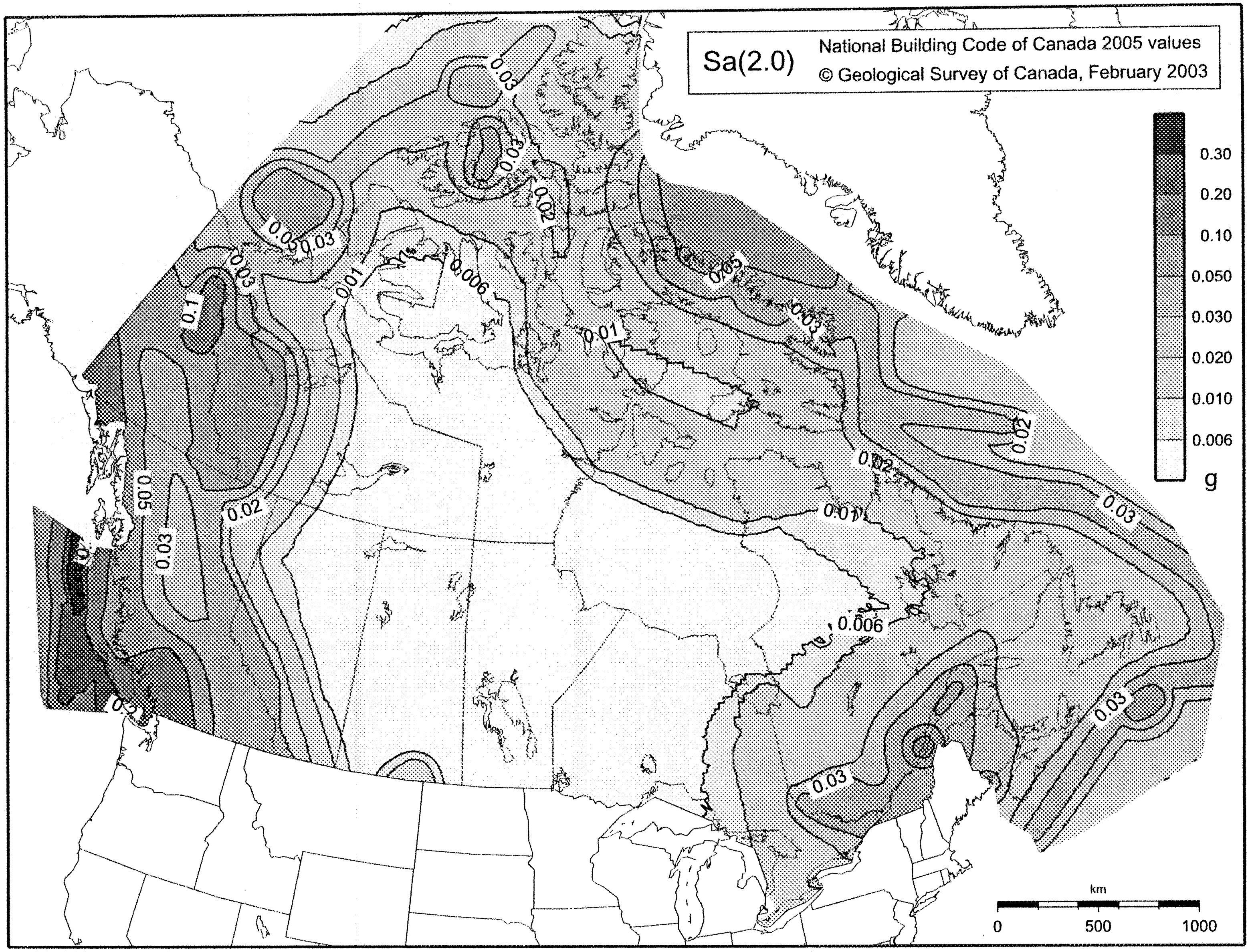


Figure 17. Sa(2.0) for Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

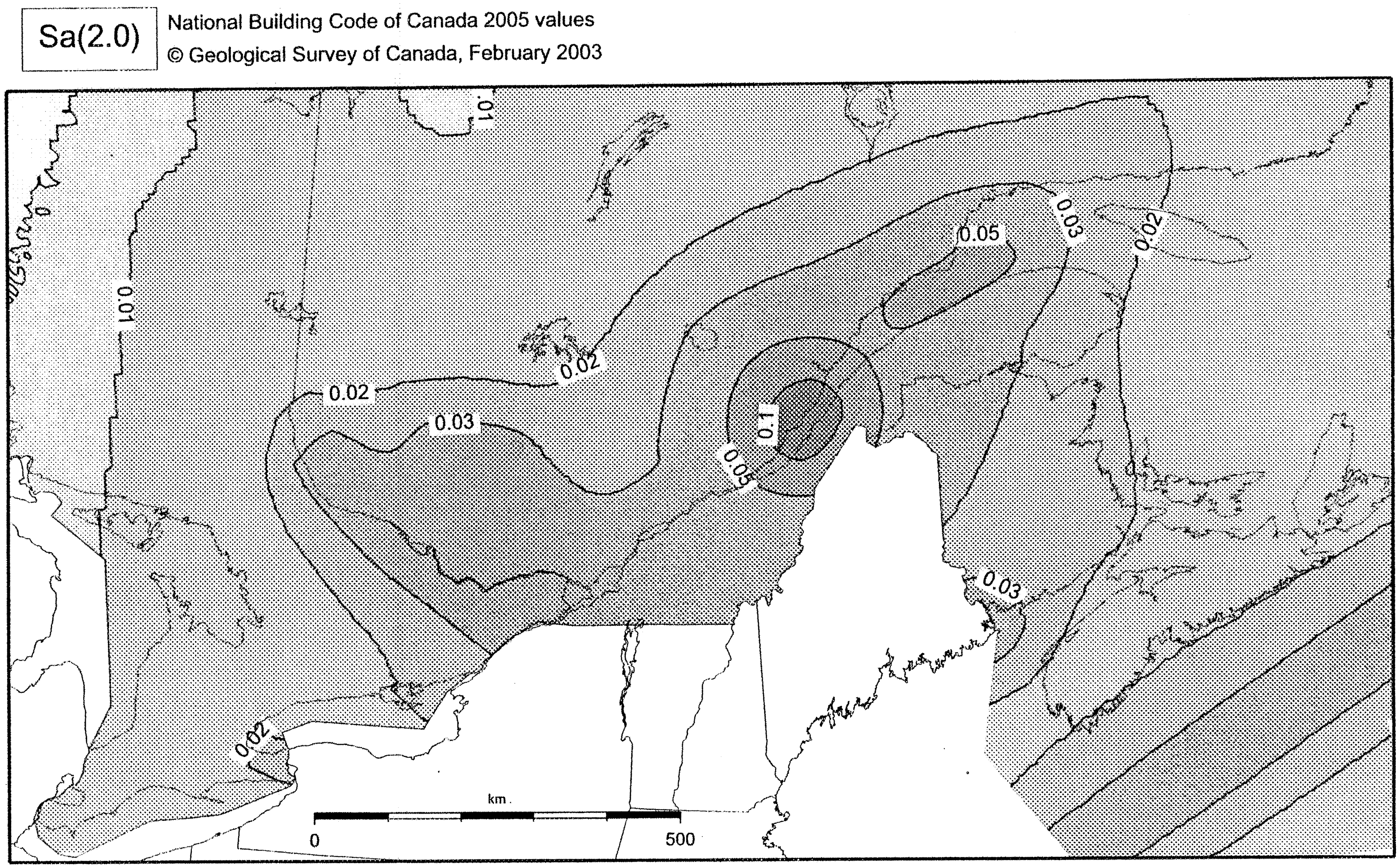


Figure 18. Sa(2.0) for southeastern Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

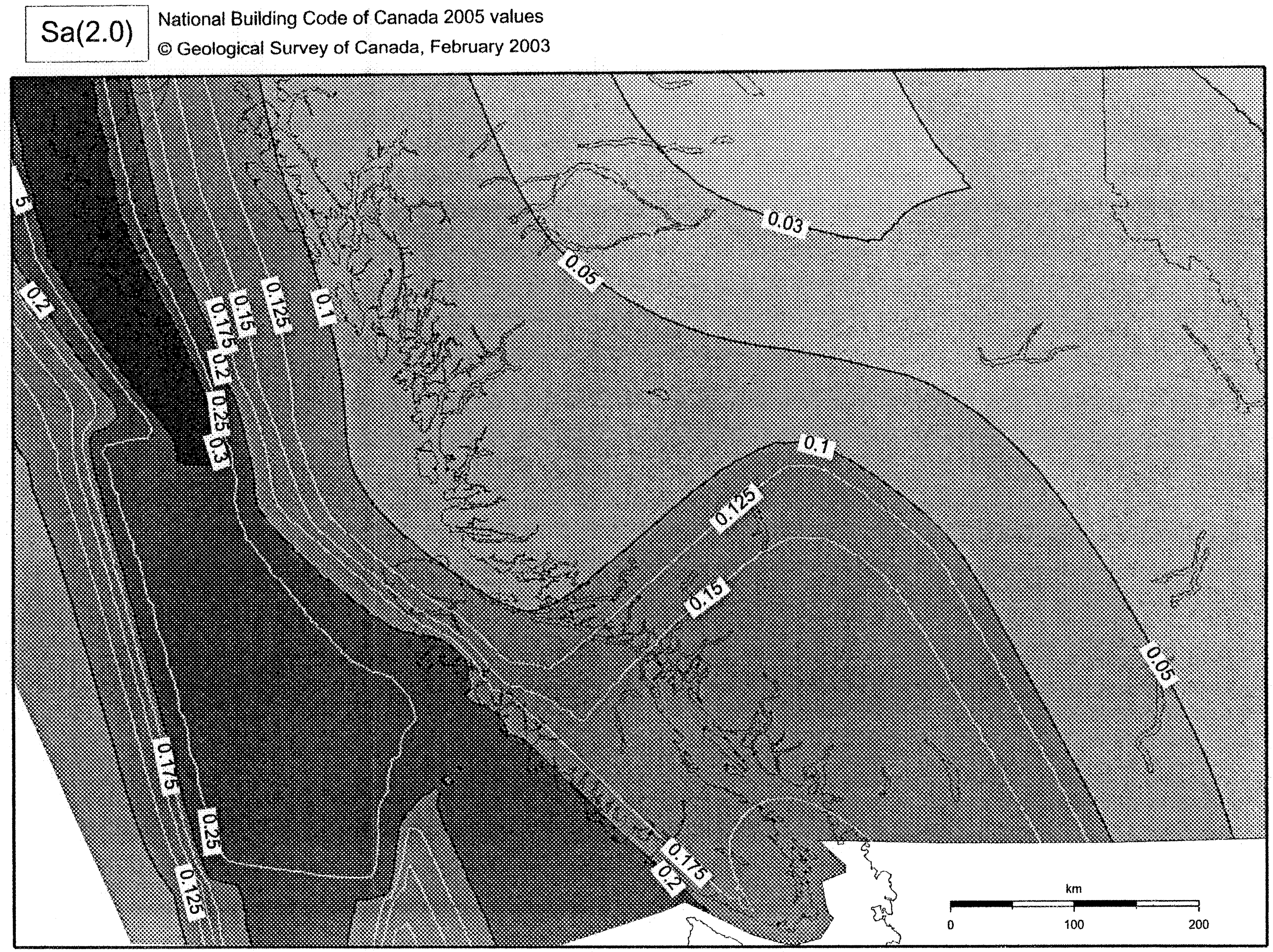


Figure 19. Sa(2.0) for southwestern Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

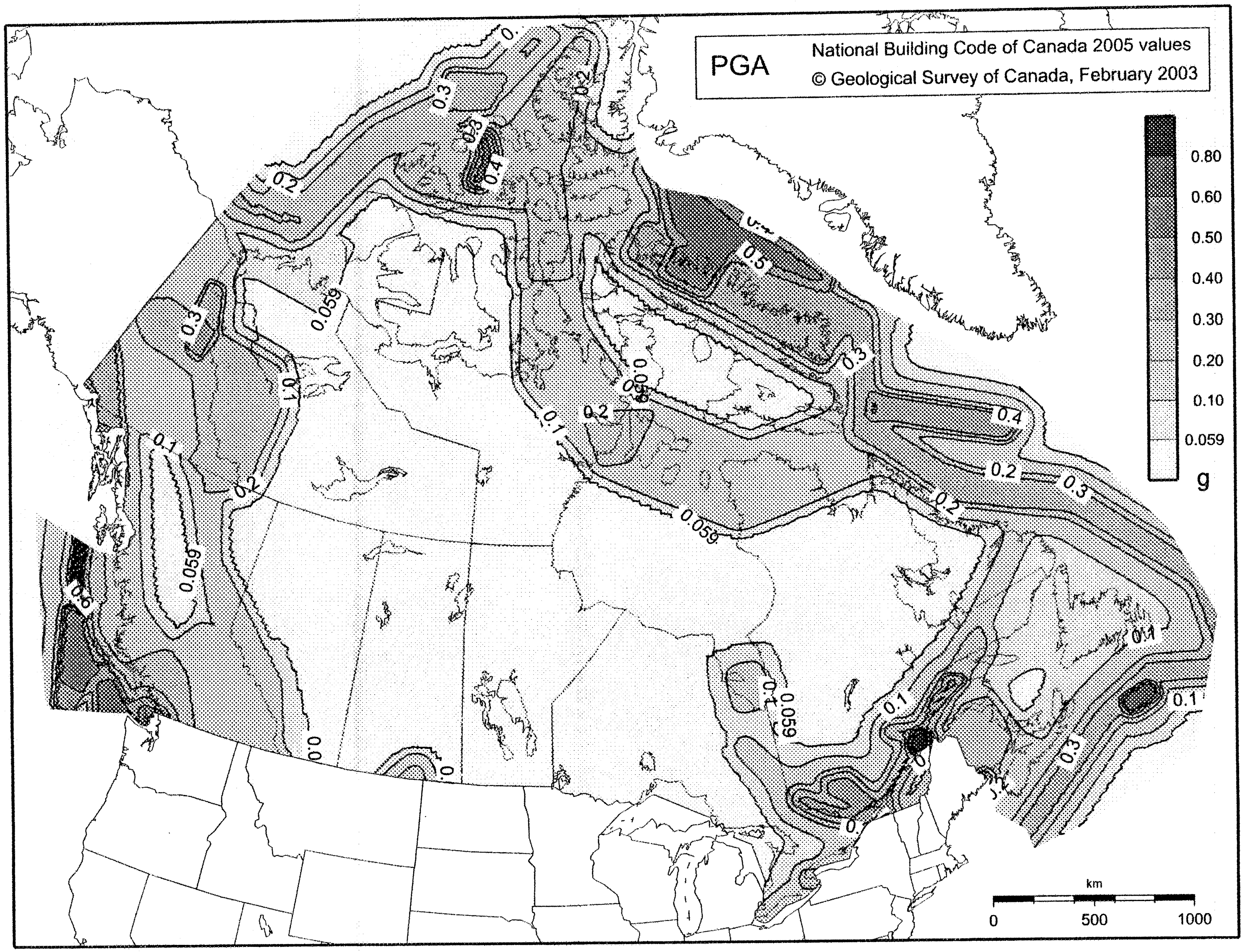


Figure 20. PGA for Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

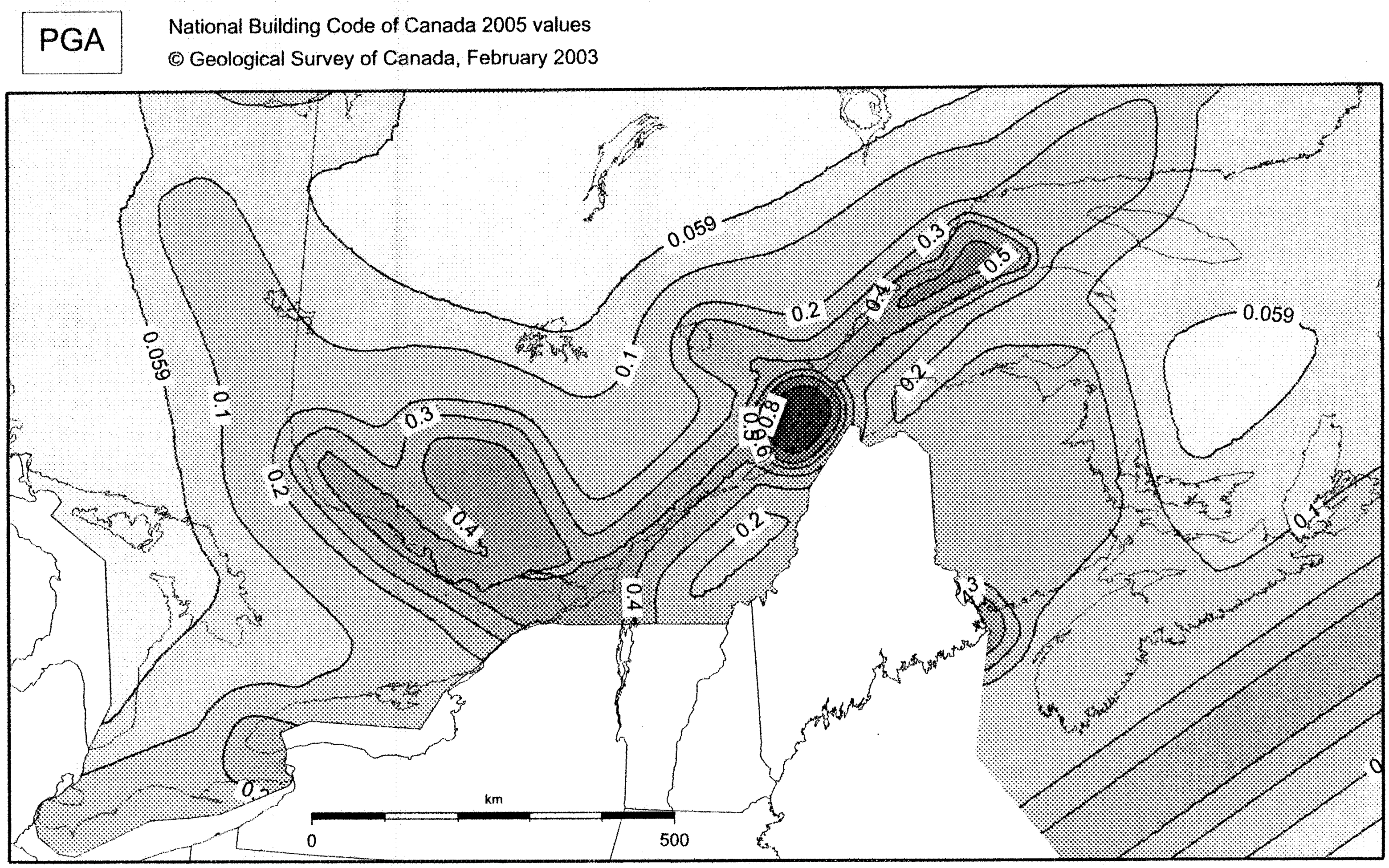


Figure 21. PGA for southeastern Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

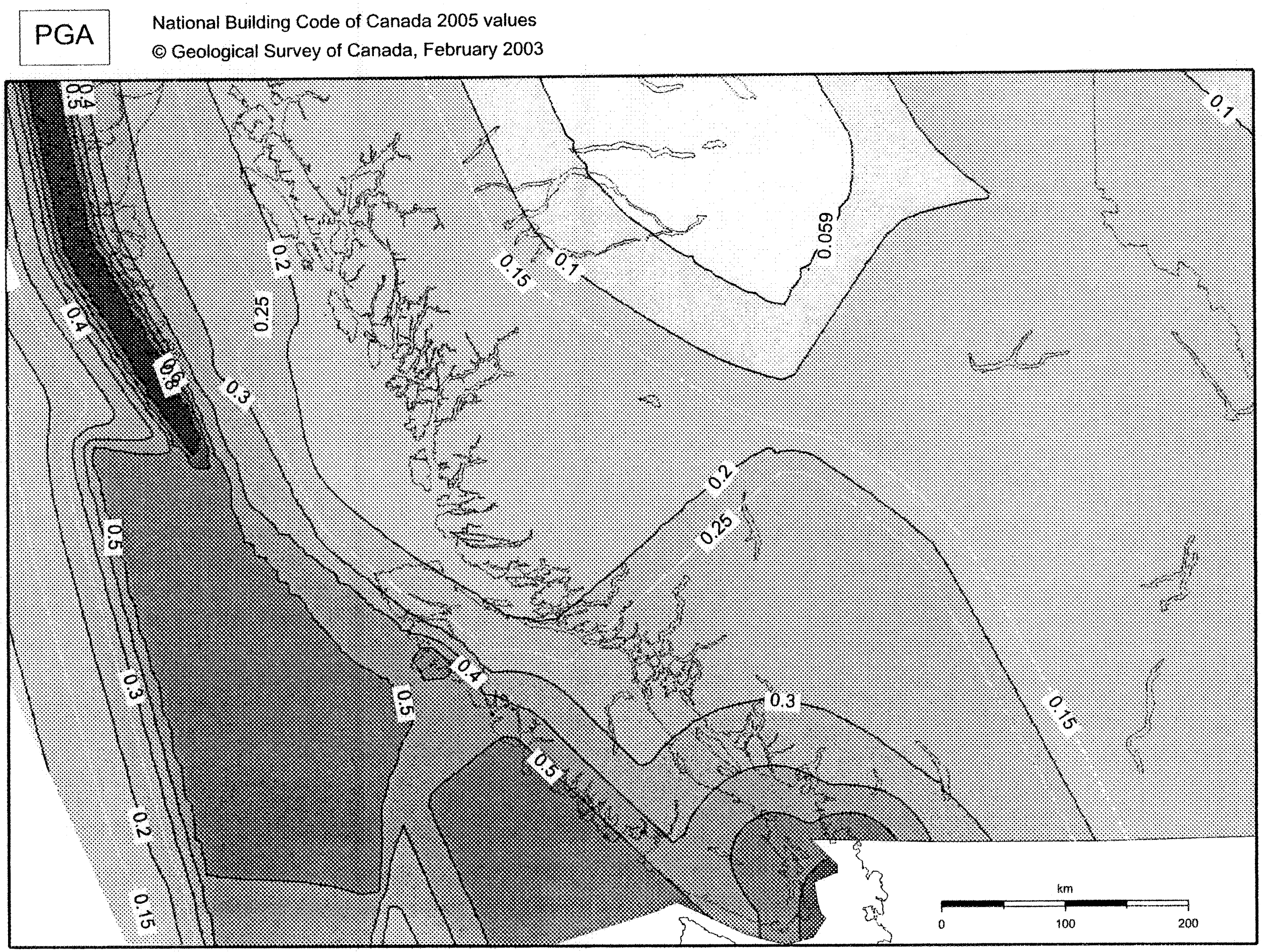


Figure 22. PGA for southwestern Canada (median values of 5% damped spectral acceleration for Site Class C and a probability of 2%/50 years).

Figures 23-45 show the 2%/50 year and 10%/50 year ground motions on Site Class C as Uniform Hazard Spectra for the named city (solid and dashed lines, respectively). For each probability, the 50th percentile (bold line) and 84th percentile (regular line) UHS are derived from the larger of the **H**, **R**, **F** and **C** model values given in Tables 3, 4 and 5. For certain southwestern Canadian cities, two additional curves (dotted lines) are shown. These are the 2%/50 year and 10%/50 year spectra for the M8.2 Cascadia scenario event, as given in Table 5.

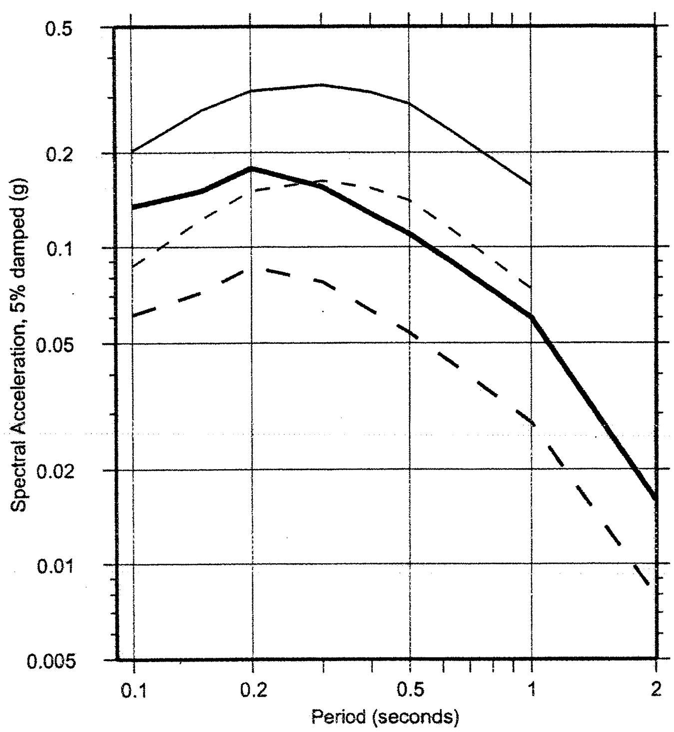


Figure 23. Robust Uniform Hazard Spectra for St. John's

2%/50 year median — 2%/50 year 84th percentile
10%/50 year median — 10%/50 year 84th percentile

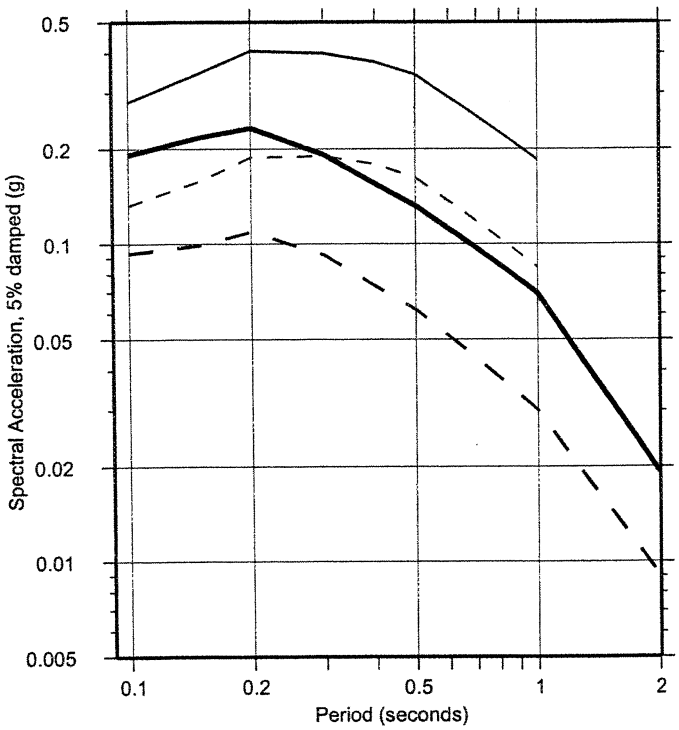


Figure 24. Robust Uniform Hazard Spectra for Halifax

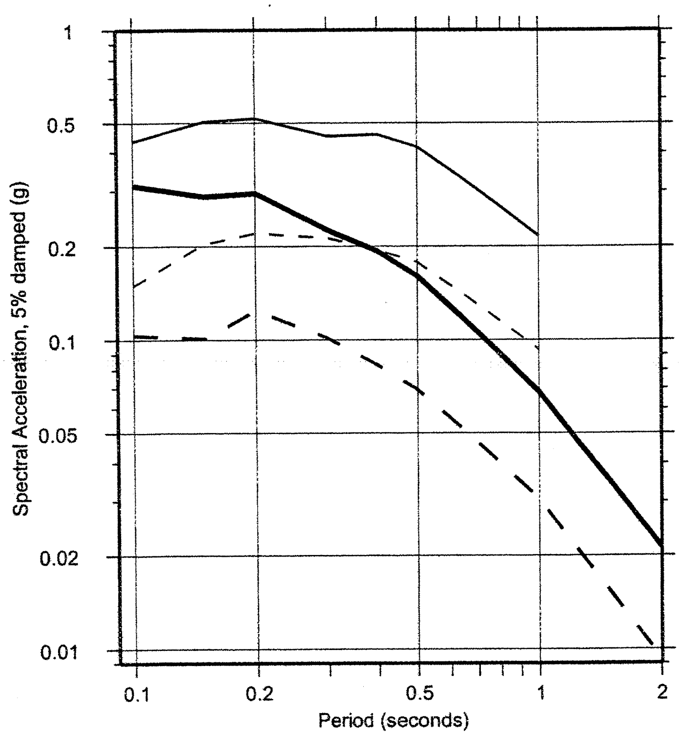


Figure 25. Robust Uniform Hazard Spectra for Moncton

2%/50 year median
10%/50 year median
2%/50 year 84th percentile
10%/50 year 84th percentile

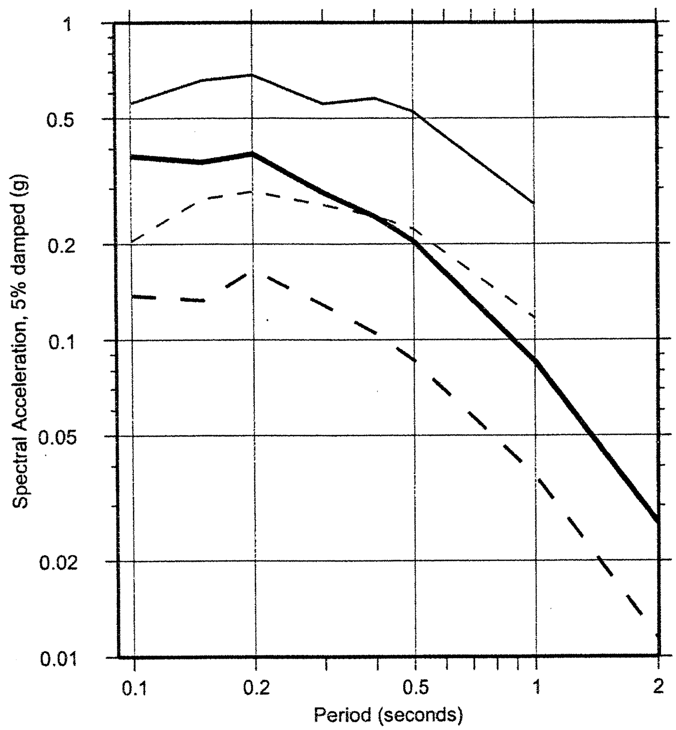


Figure 26. Robust Uniform Hazard Spectra for Fredericton

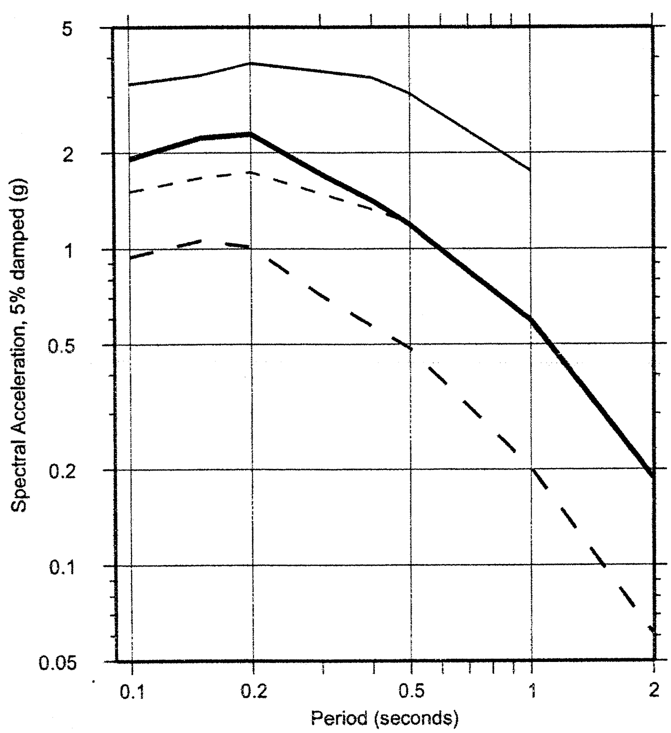


Figure 27. Robust Uniform Hazard Spectra for La Malbaie

2%/50 year median — 2%/50 year 84th percentile
10%/50 year median — 10%/50 year 84th percentile

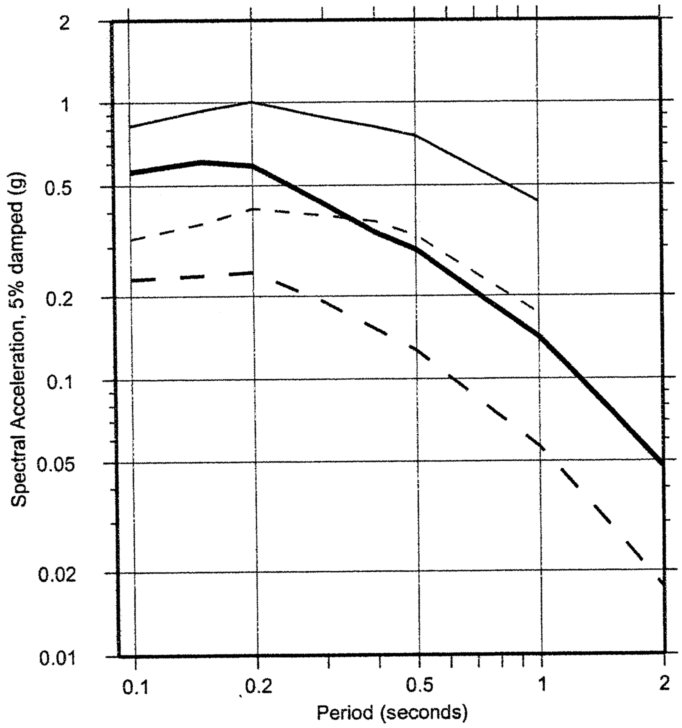


Figure 28. Robust Uniform Hazard Spectra for Québec

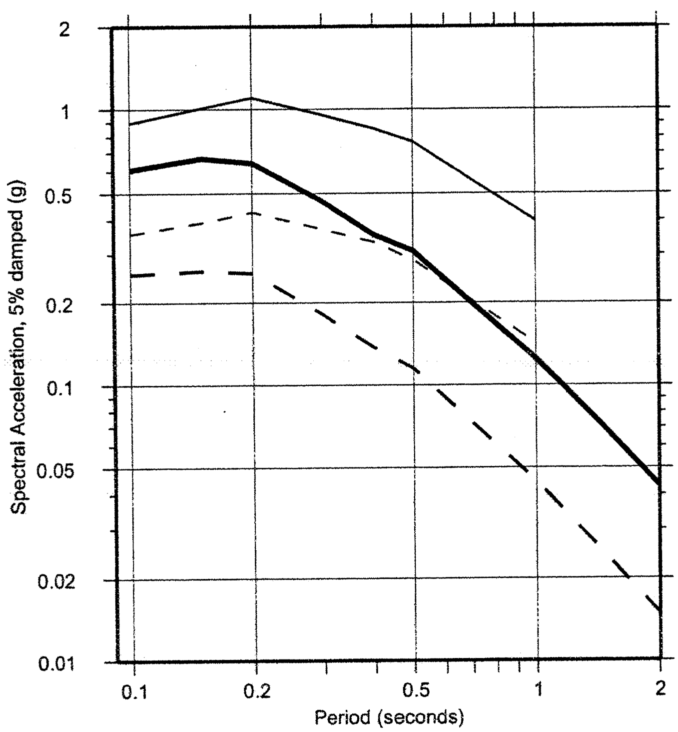


Figure 29. Robust Uniform Hazard Spectra for Trois-Rivières

2%/50 year median
10%/50 year median
2%/50 year 84th percentile
10%/50 year 84th percentile

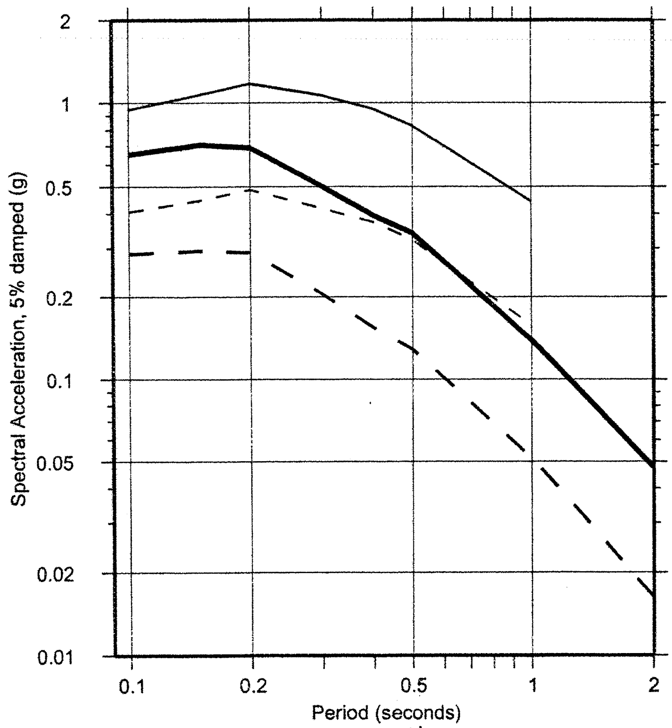


Figure 30. Robust Uniform Hazard Spectra for Montréal

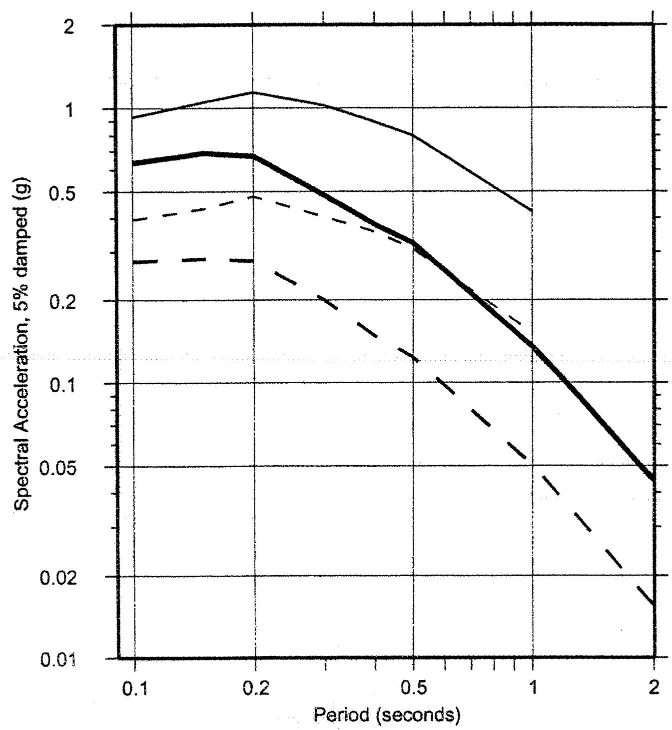


Figure 31. Robust Uniform Hazard Spectra for Ottawa

2%/50 year median
10%/50 year median
2%/50 year 84th percentile
10%/50 year 84th percentile

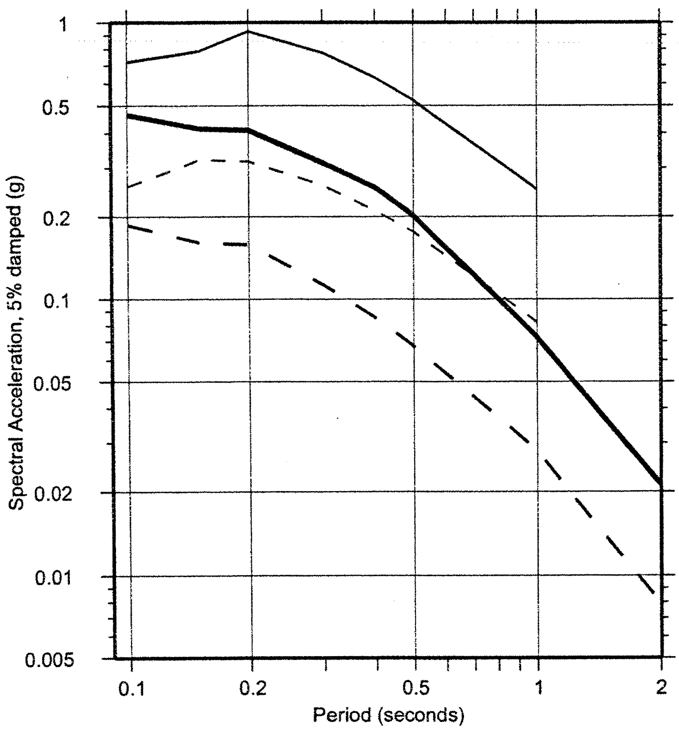


Figure 32. Robust Uniform Hazard Spectra for Niagara Falls

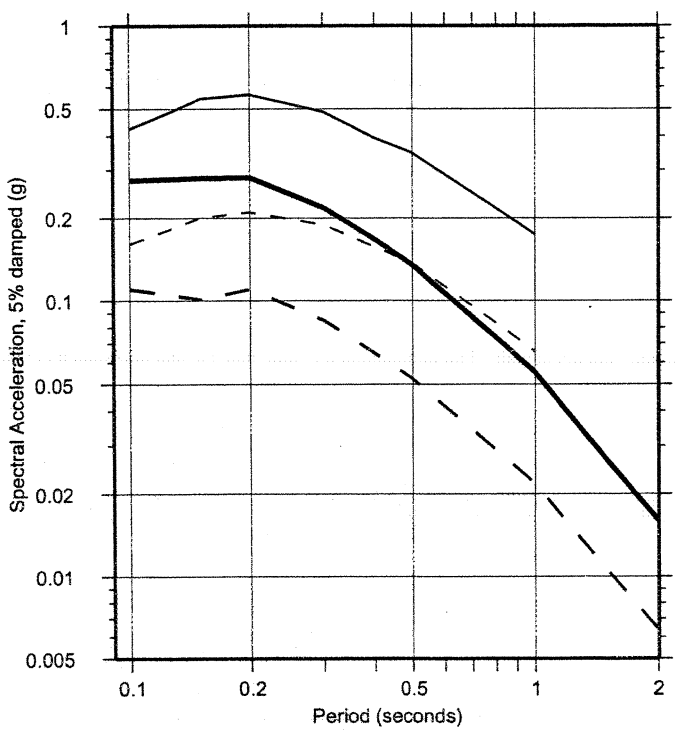


Figure 33. Robust Uniform Hazard Spectra for Toronto

2%/50 year median — 2%/50 year 84th percentile
10%/50 year median — 10%/50 year 84th percentile

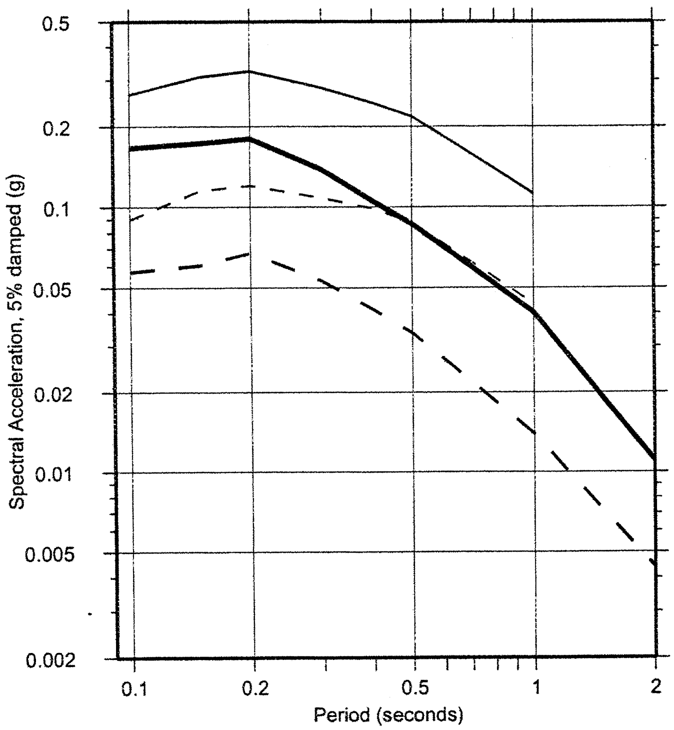


Figure 34. Robust Uniform Hazard Spectra for Windsor

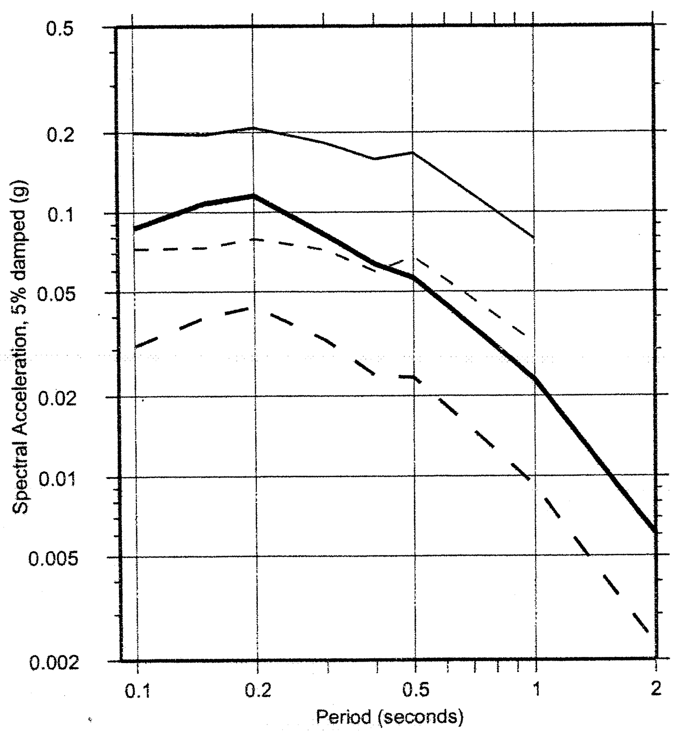


Figure 35. Robust Uniform Hazard Spectra for Winnipeg

2%/50 year median
10%/50 year median
2%/50 year 84th percentile
10%/50 year 84th percentile

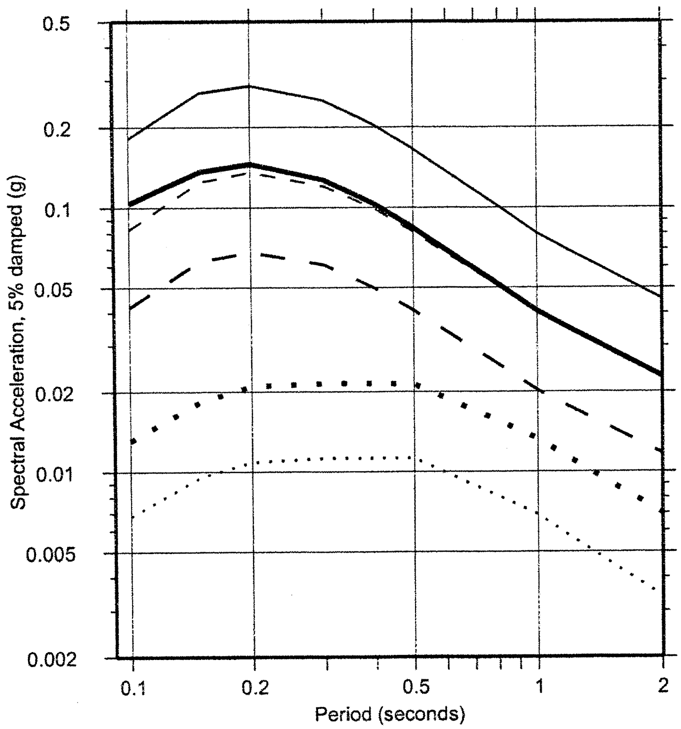


Figure 36. Robust Uniform Hazard Spectra for Calgary

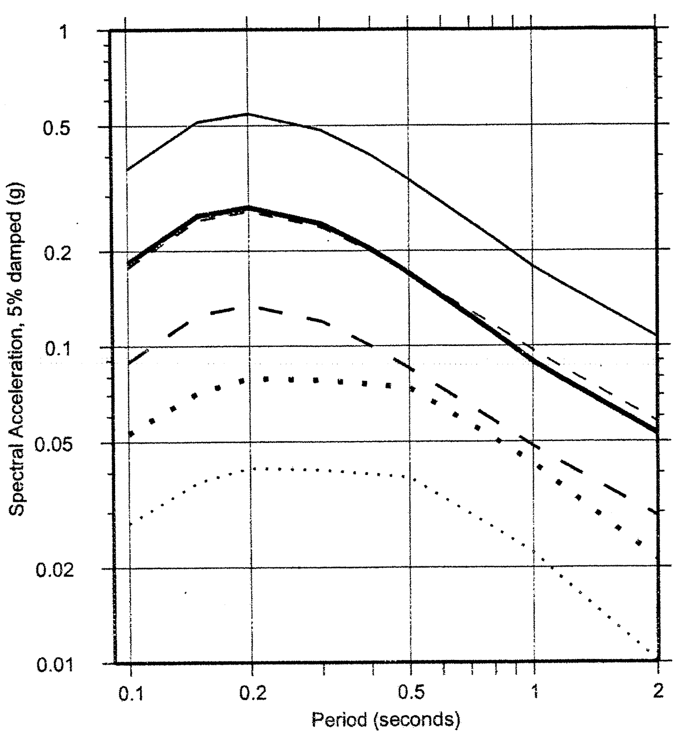


Figure 37. Robust Uniform Hazard Spectra for Kelowna

2%/50 year median
10%/50 year median
2%/50 year 84th percentile
10%/50 year 84th percentile
Cascadia 2%/50 year median
Cascadia 10%/50 year median

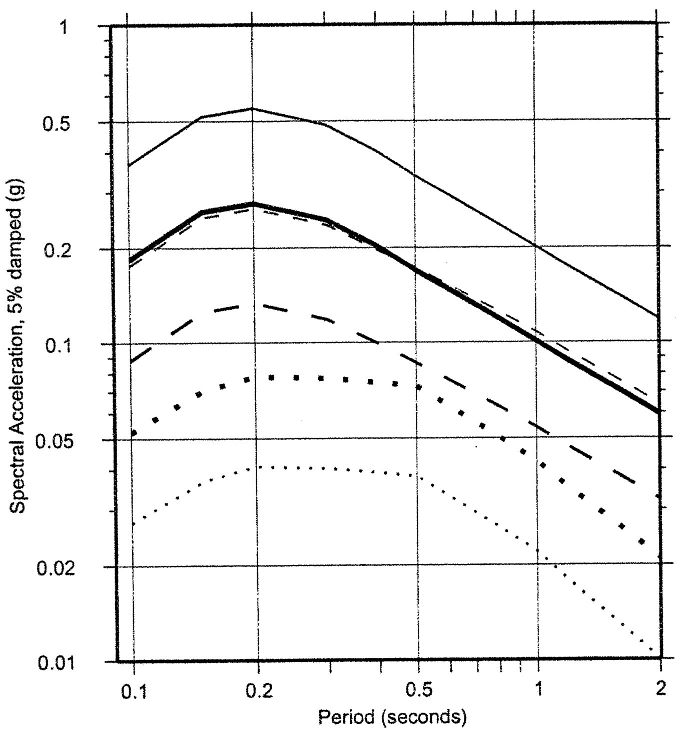


Figure 38. Robust Uniform Hazard Spectra for Kamloops

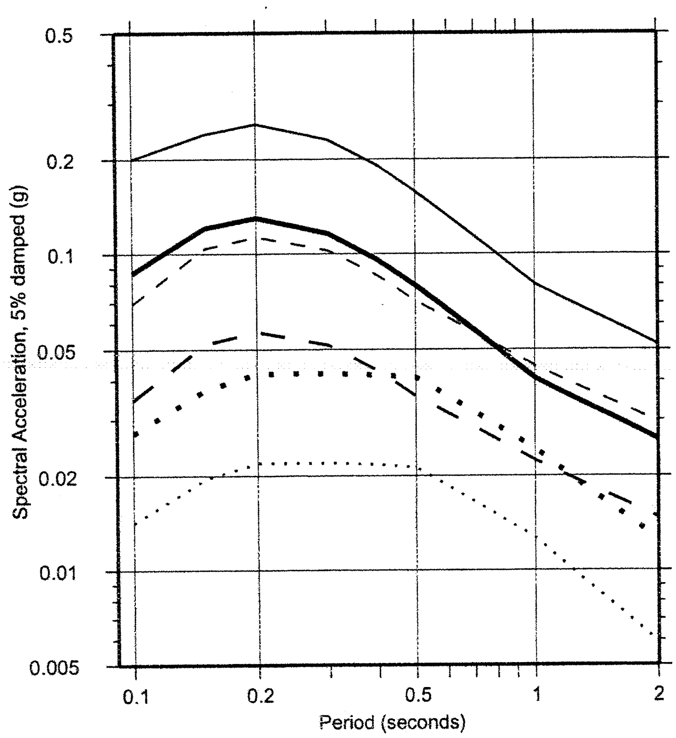


Figure 39. Robust Uniform Hazard Spectra for Prince George

2%/50 year median
10%/50 year median
2%/50 year 84th percentile
10%/50 year 84th percentile
Cascadia 2%/50 year median
Cascadia 10%/50 year median

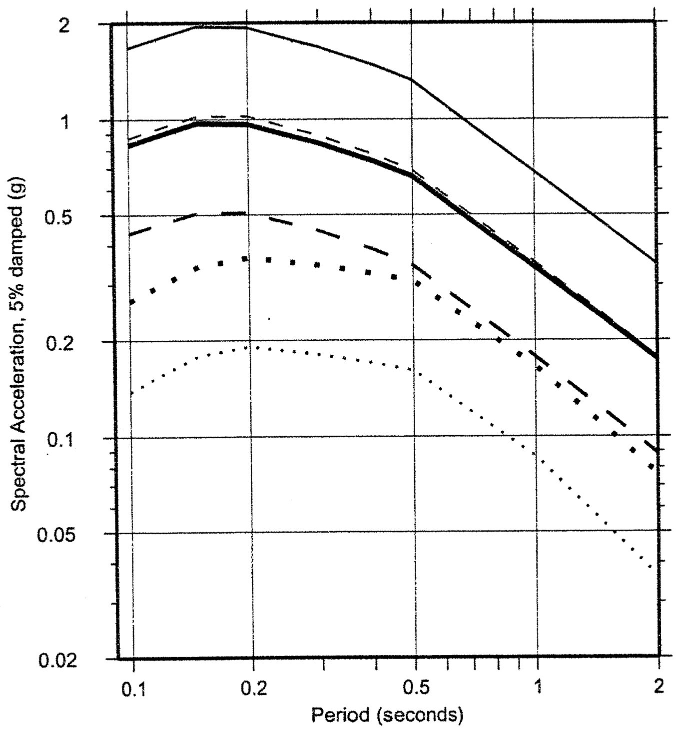


Figure 40. Robust Uniform Hazard Spectra for Vancouver

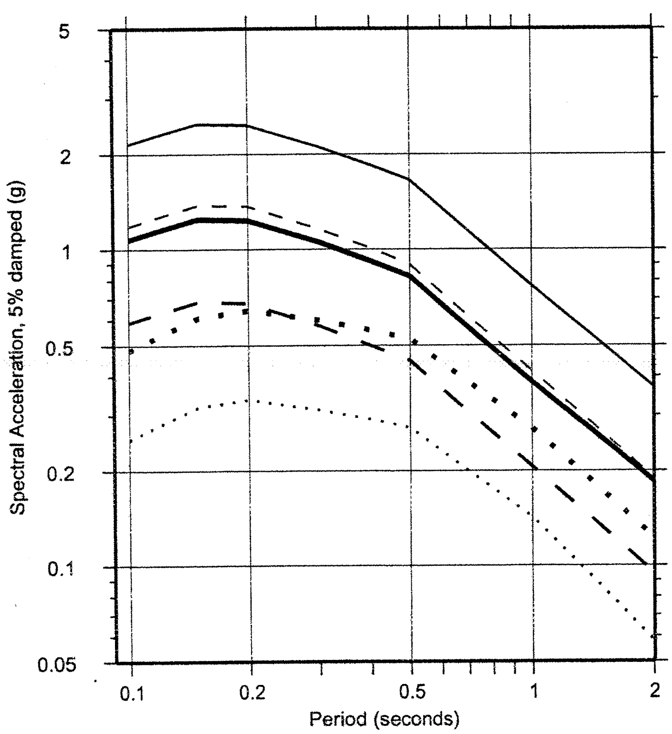
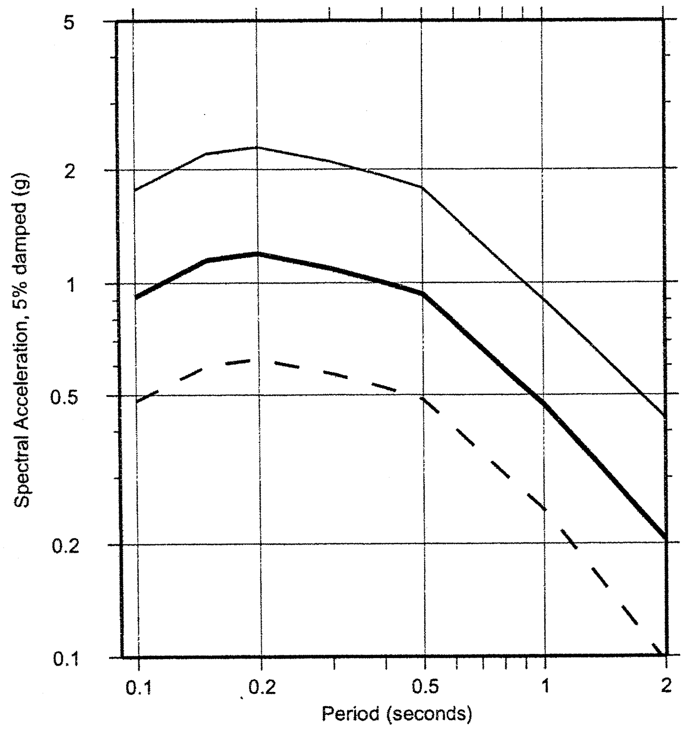


Figure 41. Robust Uniform Hazard Spectra for Victoria

2%/50 year median
10%/50 year median
2%/50 year 84th percentile
10%/50 year 84th percentile
Cascadia 2%/50 year median
Cascadia 10%/50 year median



Note: Robust values for Tofino come from the Cascadia model. The curve for the 10%/50 year 84th percentile values lies under the 2%/50 year median curve. Values for the probabilistic models are not shown, but are given in Table 3.

Figure 42. Robust Uniform Hazard Spectra for Tofino

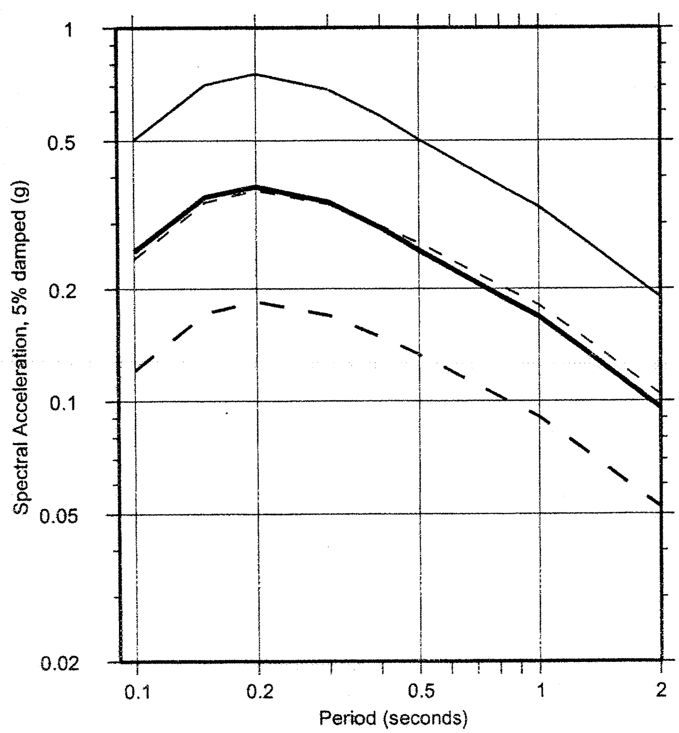


Figure 43. Robust Uniform Hazard Spectra for Prince Rupert

2%/50 year median — 2%/50 year 84th percentile

10%/50 year median — 10%/50 year 84th percentile

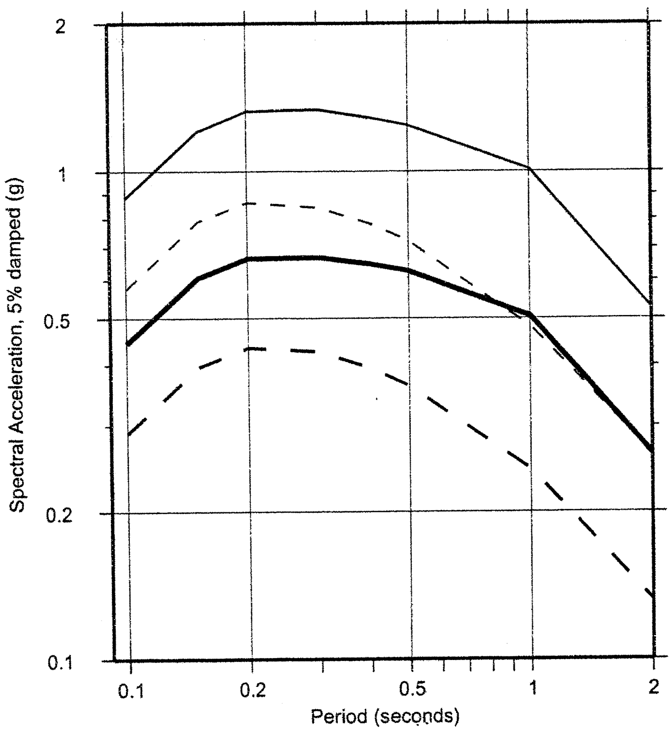


Figure 44. Robust Uniform Hazard Spectra for Queen Charlotte City

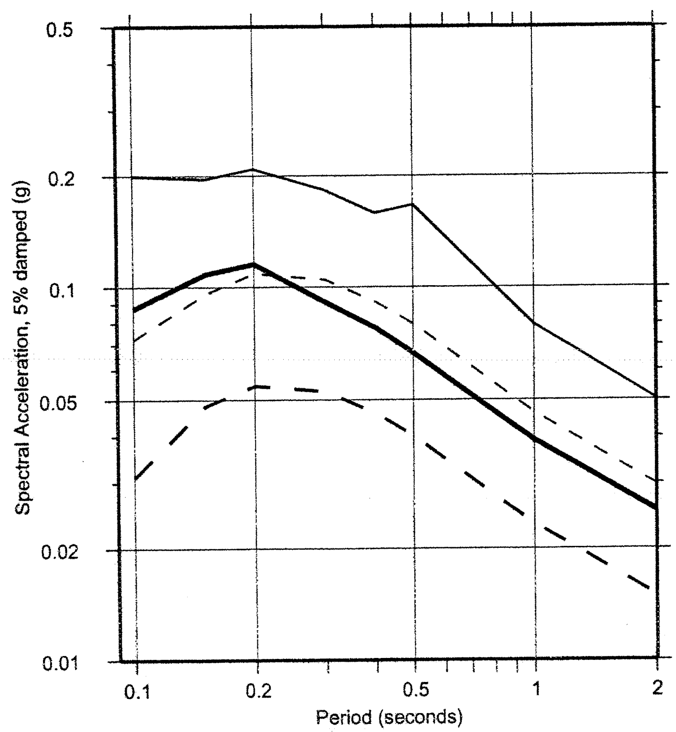


Figure 45. Robust Uniform Hazard Spectra for Inuvik

2%/50 year median — 2%/50 year 84th percentile
10%/50 year median — 10%/50 year 84th percentile

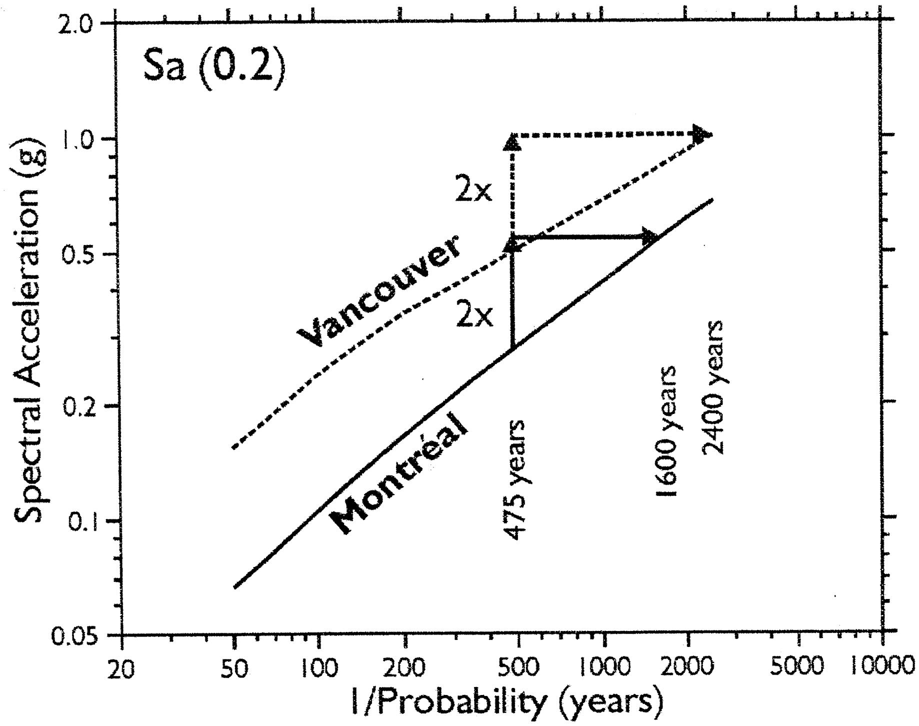


Figure 46. Sa(0.2) hazard curves for Vancouver and Montréal, showing how increasing the 10%/50 year hazard by a factor of two produces different increases in safety (after Adams et al., 2000).

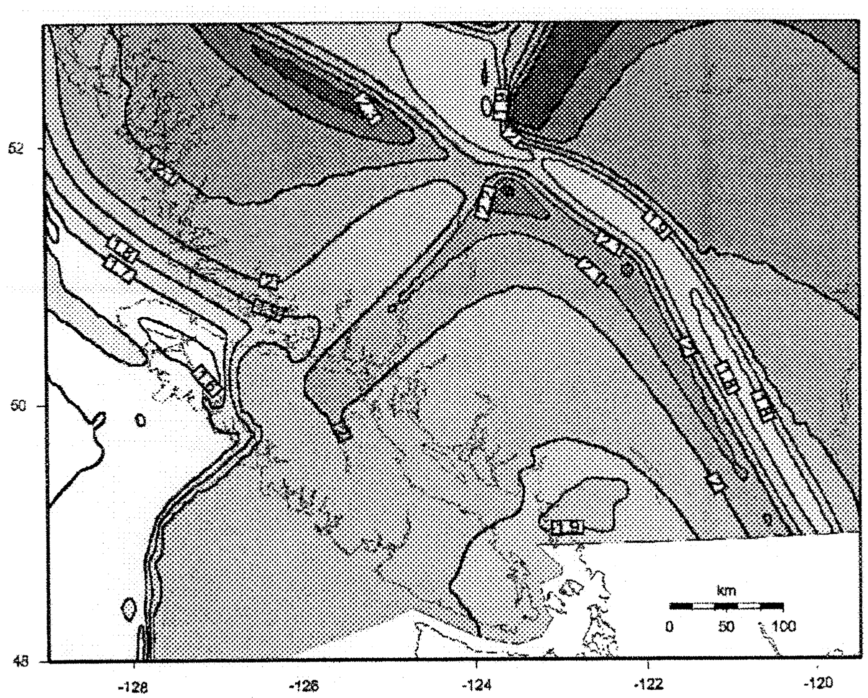


Figure 47. Ratio of 2%/50 year to 10%/50 year robust hazard for Sa(0.2) in southwestern British Columbia.

APPENDICES

A. Summary of model changes since GSC Open File 3724 and their consequences for estimated hazard.

B. Proposed site classification and site amplification factors.

C. Seismicity Parameters used for the 2005 Hazard Estimates (Version 4.01)
- C1. Background information on the zone parameters in Appendices C3-5.
- C2. Abbreviations used for source zones in the **H** and **R** models
- C3. The seismicity parameters used for the 2005 **H** probabilistic hazard estimates, comprising tables of completeness years, tables of the seismic source zone parameters, and maps of the seismic source zones for Canada, Eastern Canada, Western Canada, and for the shallow/deep zones in southwest B.C.
- C4. The seismicity parameters used for the 2005 **R** probabilistic hazard estimates.
- C5. The seismicity parameters used for the 2005 **F** probabilistic hazard estimates.
- C6. Input locus used to compute the 2005 Cascadia deterministic hazard estimates.
- C7. Cascadia deterministic hazard at 2%/50 year probability for the distance range considered.

D. Input files for GSCFRISK
- D1. The input files for GSCFRISK seismic hazard code used for the 2005 **H** probabilistic hazard estimates.
- D2. The input files for GSCFRISK seismic hazard code used for the 2005 **R** probabilistic hazard estimates.
- D3. The input file for GSCFRISK seismic hazard code used for the 2005 **F** probabilistic hazard estimates.
- D4. Fortran code fragment used to compute site-to-locus distance and thence the ground motions for the 2005 Cascadia deterministic hazard estimates.

E. Strong Ground Motion parameters
- E1. Complete set of strong ground motion parameter input data for GSCFRISK seismic hazard code.
- E2. Fortran code fragments added within GSCFRISK to use the chosen attenuation relations.

APPENDIX A

Summary of model changes since GSC Open File 3724 and their consequences for estimated hazard.

Changes from Model 4.00 (OF3724) to Model 4.01 (this Open File)

H and R MODELS

Note: abbreviations used for source zone names are listed in Appendix C2.

1. Upper bound magnitudes were increased for WLB JMS OBGH and OBGR to 7.0 6.8 and 7.2 (best, lower, upper) for consistency with the Stable Canada model values. Each of these zones lay within or adjacent to the unzoned part of Canada that we apply the "Stable Canada" model to (see Appendix C5), so it was inconsistent to have upper bound values less than the Stable Canada values.

2. The magnitude-recurrence parameters were recalculated for WLB as a consequence of the item above. Magnitude-recurrence parameters for the other zones did not change, as the slopes of their relationships had been fixed.

3. Names for some similar zones (with non-identical parameters) in the **H** and **R** models were changed by appending H and R to differentiate them:

CAS to CASR & CASH
DEN to DENR & DENH
HEC to HECR & HECH
NOF to NOFR & NOFH
QCF to QCFR & QCFH

4. JDF The magnitude-recurrence parameters were changed in a similar way to CASR (see Figure 3) to correct the poor fit of the standard magnitude-recurrence model to the larger earthquakes. As a consequence the upper bound values were changed to 7.3 7.3 7.3 from 7.3 7.2 7.4.

5. NJFR Upper bound values for NJFR were increased to 6.8 6.6 7.0 from 6.0 5.5 6.5. The magnitude-recurrence parameters were changed as a consequence.

6. DENH and DENR Upper bound values for these zones were increased to 7.5 7.0 8.0 from 7.0 6.7 7.3, based a) the occurrence of the April 2002 magnitude 7.9 earthquake which initiated on the Denali fault but then propagated from the Denali fault onto the Totschunda Fault (the rupture extended into the NW part of DENH and DENR, but did not enter Canada), and b) on the length extent of the major faults like the Denali in the zones. The magnitude-recurrence parameters changed slightly.

7. NBC Upper bound values for NBC were increased to 7.0 6.0 7.0 from 6.0 5.7 6.3 based on a modified Stable Canada approach. The magnitude-recurrence parameters were changed as a consequence of this, the next item and the decision to fix the slope of the relationship.

8. NBC CST ROC The hazard program joins points by great circle lines, the map we use draws straight lines on the map. To ensure that the two are congruent (so mapped earthquakes lie on the appropriate side of the line), we add intermediate "bracing" points to the zone coordinates. Bracing points were missing from the NBC zone, meaning that several Glacier Bay swarm events were mistakenly included in this zone. Bracing points were added (the same points were added to adjacent CST and ROC zones) and magnitude recurrence curves recalculated. Changes to ROC were minimal and to CST slight.

9. Several source zones in southwestern B.C. lie in regions that are well monitored for small earthquakes. For zones BRP, GEO, HECH, JDF, NOFH and SCM in the **H** model and zones BRO, HECR and NOFR in the **R** model the catalogue for earthquakes as small as magnitude 2.0 was considered to be complete. Such small earthquakes may well have been completely recorded (the magnitude-recurrence curves did not show any deviation to suggest otherwise) but for consistency with the rest of Canada the minimum was set to 2.5 and the magnitude-recurrence curves recalculated. Differences from Model 4.00 were not large.

10. A few moderate (magnitude 5-6) western earthquakes were missed from the catalog used in OF3724 because they were coded to obscure source-Agency names. We added these earthquakes back into the catalog and recomputed the magnitude-recurrence curves for CASR, QCFH and GSP, resulting in small increases to the slope of the curve.

11. QCFH We corrected the assignment of the the three upper bound magnitudes to the three magnitude-recurrence curves used.

STABLE CANADA

12. The Stable Canada model has evolved considerably since first introduced by Adams et al. (1999b). Model 4.00 was based on computing seismic hazard at the centre of a large zone with an activity rate equal to the full worldwide stable craton rate of earthquakes and magnitude-recurrence equation $N(\geq M) = 13800 \exp(-1.84M)(1 - \exp(-1.84(7.0-M)))$. Subsequent publications (e.g. Adams et al., 2000) adjusted this rate to use earthquake magnitudes appropriate to the rest of the eastern model. The most recent iteration for Model 4.01 recognizes that the uncertainty in the magnitude recurrence relations for the worldwide stable craton rate of earthquakes is considerably less than the range of the individual contributing continents, and that this range may represent the real variation in seismicity rate (for reasons unknown) rather than being a statistical variation on a single worldwide rate. Observed North American shield activity rates are lower than the global average, and rates in the part of central Canada not included in a source zone (Fig. 3) are lower still. To capture the uncertainty in seismicity rate all three rates were normalized by area and used with weights of 0.4 for the global average, 0.4 for the North American and 0.2 for the central Canada rate,

the lower weight for the latter reflecting the belief that the process of defining source zones has produced a residual area ("background zone") artificially depleted in earthquakes. The data and input file for the source, including the three sets of magnitude-recurrence parameters used, is given in Appendices C3 and D3.

CASCADIA

13. An incorrect algorithm was used in OF3724 to calculate the distance of sites from the locus, but the only city that correcting this had a significant hazard effect on was Tofino. The sigma in the Youngs et al. ground motion relations decreases with magnitude, but the fact that the decrease is capped for magnitude 8.0 and larger was missed in OF3724; the correct, larger sigmas have been used here, resulting in slightly higher hazard estimates. The line locus used in Model 4.00 has been retained, but augmented by a northwestern boundary near the Nootka Fault zone, a western boundary along the upper edge of the locked zone, and a southern boundary arbitrarily set at 46 S. Details of the implementation of the model are given in Appendix C6 and D4.

Consequences of above changes on estimated hazard given for cities in OF 3724

In the following list the percentage changes reflect the change in the published values (i.e. those reported to 2 significant figures). In some cases a trivial change in the exact results can result in a much larger change in the rounded values (e.g. 0.1841 changing to 0.1851 yields rounded values of 0.18 and 0.19 for an apparent change of 5%). Thus changes in the last significant digit are deemed unimportant. Furthermore, not all of these changes affect the robust hazard estimate.

1. Sa(0.1) for the **R** model for eastern sites has dropped by about 1-3% but we have been unable to ascertain why (note that Sa(0.1) values are not used for NBCC2005).

2. Estimated hazard for Niagara Falls, Toronto and Windsor has typically increased by 1-5% (exceptionally, +13% for Sa(0.1) at Windsor) as a result of increasing the upper bound magnitudes in OBGH and OBGR.

3. Hazard in Prince George from the **R** model has increased by 5-18% as a result of increasing NBC upper bound values and fixing the slope of the magnitude-recurrence relationship.

4. Short-period hazard for Vancouver and Victoria estimated from the **R** model has dropped 1-5% as a result of recomputing the magnitude-recurrence curves for CASR and GSP.

5. Short-period hazard for Tofino estimated from the **R** model has dropped 2-8% as a result of recomputing the magnitude-recurrence curves for CASR and GSP. **H** model estimate of hazard has increased greatly (up to 100%) because of the new magnitude-recurrence relationship for JDF.

Hazard from the Cascadia subduction scenario dominates the robust hazard estimate, so these changes do not affect the robust hazard. Cascadia values for Tofino have increased because an incorrect algorithm was used to calculate the distances in OF3724.

6. Estimated hazard for Prince Rupert has increased 3-5% because of the new magnitude-recurrence relationship for CST in the **R** model. The robust hazard estimates increase likewise.

7. Estimated hazard for Queen Charlotte City from the **H** model has dropped at the short periods and increased at the longer periods (-3% to +5%) because we recomputed the magnitude-recurrence curve after the addition of the missed moderate earthquakes. The **R** model still gives the robust hazard.

APPENDIX B

Proposed Site classification and Site Amplification factors from Finn and Wightman (2003)

Table 2 - Site Classification for Seismic Site Response (1994).

Site Class	Site Class Name/Generic Description	Site Class Definition
A	Hard Rock	$\bar{V}_s$ > 1500 m/sec
B	Rock	760 m/sec < $\bar{V}_s$ ≤ 1500 m/sec
C	Very dense soil and soft rock	360 m/sec < $\bar{V}_s$ ≤ 760 m/sec, or $\bar{N}$ > 50, or $\bar{S}_u$ > 100 kPa
D	Stiff soil	180 m/sec < $\bar{V}_s$ ≤ 360 m/sec, or 15 ≤ $\bar{N}$ ≤ 50, or 50 kPa ≤ $\bar{S}_u$ ≤ 100 kPa
E	Soil profile with or soft clay	$\bar{V}_s$ < 180 m/sec PI > 20, w > 40% and $\bar{S}_u$ < 25 kPa
F	Site specific geotechnical investigations and dynamic site response analyses 1. Soils Vulnerable to Potential Failure or Collapse Under Seismic Loading: (Liquefiable Soils, Quick and Highly Sensitive Clays, Collapsible Weakly-Cemented Soils, etc.). 2. Peats and/or Highly Organic Clays: (H > 3 m of peat and/or highly organic clay, where H = thickness of soil). 3. Very High Plasticity Clays: (H > 8 m with PI > 75). 4. Very Thick "Soft/Medium Stiff Clays" (H > 36 m).	

Table 6. Values of F_a as a Function of Site Class and Spectral Acceleration at T=0.2s

Site Class	Value of F_a				
	$S_{0.2} \leq 0.25$	$S_{0.2}$ 0.50	$S_{0.2} \leq 0.75$	$S_{0.2} \leq 1.00$	$S_{0.2} \leq 1.25$
A	0.7	0.7	0.8	0.8	0.8
B	0.8	0.8	0.9	1.0	1.0
C	1.0	1.0	1.0	1.0	1.0
D	1.3	1.2	1.1	1.1	1.0
E	2.1	1.4	1.1	0.9	0.9
F	a	a	a	a	a

NOTE: Use straight line interpolation for intermediate values of S_s.

[a]Site-specific geotechnical investigation and dynamic site response analyses shall be performed.

Table 7. Values of F_v as a Function of Site Class and Spectral Acceleration at T=1.0s

Site Class	Values of F_v				
	$S_{1.0} \leq 0.25$	$S_{1.0} \leq 0.50$	$S_{1.0} \leq 0.75$	$S_{1.0} \leq 1.00$	$S_{1.0} \leq 1.25$
A	0.5	0.5	0.5	0.6	0.6
B	0.6	0.7	0.7	0.8	0.8
C	1.0	1.0	1.0	1.0	1.0
D	1.4	1.3	1.2	1.1	1.1
E	2.1	2.0	1.9	1.7	1.7
F	a	a	a	a	a

NOTE: Use straight line interpolation for intermediate values of S_1.

[a]Site-specific geotechnical investigation and dynamic site response analyses shall be performed.

APPENDIX C

Seismicity Parameters used for the 2005 Hazard Estimates (Version 4.01)

Contents:

Appendix C1

Background Information on the Zone Parameters in the Parameter Tables

Source Models. For the two models **H** and **R** eastern and western zone parameters are tabulated separately (zone corner coordinates are available in Appendix D1 and D2). By using the code GSCFRISK (which is the front-end for a slightly custom-tailored version of the commercial hazard code FRISK88 of Risk Engineering Inc.) we can incorporate a range for some of the input parameters so as to include multiple hypotheses and compute a degree of uncertainty in the resultant hazard calculations. Some zones are common to more than one model (see table) and where practical the common parameters and ranges of parameters have been kept consistent. Zone TAD (Tadoussac) in the **H** model is a place holder for a future improved seismic hazard model, since at this time there is insufficient activity to define its zone activity rate. This zone is not included in Appendix D1.

Magnitude Recurrence. Three estimates, weighted 0.68, 0.16, and 0.16, are used. The heavily-weighted "best" represents the Maximum Likelihood fit using essentially the modification of the maximum likelihood method suggested by Weichert (1980), the same method as used for the last seismic hazard mapping project, as described by Basham et al. (1985).

Earthquakes with epicentres within the source zones of the two alternate models are selected from the Seismic Hazard Earthquake Epicentre File (SHEEF). Magnitude intervals of 0.1 magnitude units were used; for zones with events spanning only a short magnitude range this should result in a better definition of the recurrence slope, since grouping into half-magnitude intervals would irrevocably discard information. The magnitude uncertainty of a single event is nevertheless still on the order of 1/4. No explicit correction for this has been attempted, nor for the bias in hazard introduced by having those symmetrical error bounds on the catalog magnitudes.

Since the FRISK88 program expects the activity rate at zero-magnitude, N0, as a parameter, this is listed, but we note that it is strongly dependent on the slope, "BETA". We have also reported it to an undue level of precision. Also listed is the activity near the damage threshold, "BEST N5". This parameter is much less dependent on the BETA estimate than N0 (which is obtained by extrapolation), and is far more representative of the rate of earthquakes which contribute significant ground motions. The column "Mag5 per million sq km/yr" normalizes the activity rate to the source zone size to allow rate comparison between zones.

Error estimates for the "LOWER" and "UPPER" magnitude-recurrence curves are obtained by curves anchored to points one standard deviation above and below the cumulative rate of observed events at the magnitude threshold, and having slope parameters one standard deviation shallower and steeper than the central value. This is slightly conservative as it corresponds to a full standard deviation for each variable (instead of the more usual root-mean-square), but the conservatism is small for most data sets because at the magnitude threshold the uncertainty in the cumulative rate is generally low.

An examination of recurrence slopes in adjacent source zones showed that the recurrence slope could be averaged over several zones, and the activity then fitted under the constraint of a common slope. This procedure is useful for source zones with inadequate data for independently fitting both recurrence parameters. In the east, the recurrence slope derived from a larger source zone (say IRM) was sometimes imposed on smaller zones contained therein (e.g. TIM); it is flagged by an 'F' in the parameter table.

The three corresponding activity-recurrence slope pairs and the three maximum magnitude estimates are specified for input to FRISK88; a program switch specifies that these parameters are treated as 'perfectly dependent'. This appears reasonable since they are calculated in a dependent manner.

Maximum Magnitude. Estimates of upper-bound magnitude were made for each source zone on the basis of observed largest earthquake, tectonic judgement, or simply in a conservative fashion, remembering that the Nahanni and Saguenay earthquakes both exceeded the maximum earthquake specifications for their respective source regions within 10 years after preparation of the 1985 maps. For each zone, three estimates were used and fitted with a slope and recurrence. While the activity rate is dominated by the total number of events observed above the lower threshold, properly weighted according to their period of observation, the recurrence slope is more strongly affected by the chosen upper-bound magnitude. In anticipation of using these upper-bound magnitude estimates as input to FRISK88, two points of view were considered in choosing the three trial values. FRISK88 allows only one common set of weights to be applied to the alternate choices of parameter sets in a given model. This would imply that the three upper-bound magnitudes should be representative of the same percentile of the upper-bound magnitude distribution for each source zone. Often it *feels* best, to space the estimates evenly, suggestive of symmetric distributions, but this may lead to unreasonably high maximum upper-bound magnitudes, because that value is pushed up by an observed, but possibly incorrect magnitude. This scenario would justify unequal spacing of the upper-bound magnitude estimates. Similarly, some regions may have quite well-established upper-bound magnitudes, because of high activity with a sharp cutoff, supported by a knowledge of maximum fault areas in the source zone; in this case the upper two upper-bound magnitude estimates may also justifiably be set closer together. These considerations have led to slightly different weightings for the LOWER-BEST-UPPER upper-bound magnitude: 0.3-0.6-0.1 for the east and 0.16-0.68-0.16 for the west.

Depth. For the east, best depths and upper and lower bounds are intended to indicate the likely range of earthquake depths. However in order to assign appropriate weights to the various values, for some zones (e.g. SGL), the terms lower and upper refer merely to alternative values, not relative depths. The weights are 0.5, 0.25, and 0.25.

Depth values in the western zones where the BJF relations are used (shallow crustal zones) have no physical meaning in the hazard calculation, despite our knowledge of earthquake depths there. Instead the value is a parameter in the Boore et al. (1993, 1994) equations and its value depends on the period for which ground motions are being estimated. For the subcrustal in-plate zones, for which the Youngs et al. relation is used, we decided on a single depth of 50 km near the depths of the large earthquakes that presumably occur at or near the change of subduction angle of the Juan de Fuca plate.

Appendix C2

Abbreviations used for source zones in the H and R models

ACM	- ARCTIC CONTINENTAL MARGIN	East R
ADR	- NORTHERN ADIRONDACKS	East H East R
ALC	- ALASKA COASTAL	West H West R
ALI	- ALASKA INLAND	West H West R
AOBH	- ATLANTIC OFFSHORE BACKGROUND (H model)	East H
AOBR	- ATLANTIC OFFSHORE BACKGROUND (R model)	East R
AOH	- ANNA OHIO	East H
BFB	- BAFFIN BAY	East H
BFC	- BEAUFORT COAST	West H
BFI	- BAFFIN ISLAND	East R
BFS	- BEAUFORT SEA	West H
BFT	- BEAUFORT SEA	West R
BIN	- BAFFIN ISLAND NORTH	East H
BIS	- BAFFIN ISLAND SOUTH	East H
BOU	- BOOTHIA UNGAVA	East R
BRO	- BROOKS PENINSULA	West R
BRP	- BROOKS PENINSULA	West H
BSL	- BAS SAINT LAURENT	East H
CASH	- CASCADE MOUNTAINS (shallow)	West H
CASR	- CASCADE MOUNTAINS (shallow)	West R
CCM	- CENTRAL COAST MOUNTAINS	West H
CHA	- CHAMPLAIN	East H
CHV	- CHARLEVOIX	East H
CMF	- COASTAL MAINE FUNDY	East R
COC	- COCHRANE	East H East R
CST	- COASTAL	West R
DENH	- DENALI FAULT	West H
DENR	- DENALI	West R
DIB	- DEVON ISLAND BACKGROUND	East H East R
ECM	- EASTERN CONTINENTAL MARGIN	East R
EGA	- EASTERN GULF OF ALASKA	West H
EXP	- EXPLORER PLATE BENDING	West R
FHL	- FLATHEAD LAKE	West H West R
GAT	- GATINEAU	East H East R
GEO	- GEORGIA STRAIT (deep)	West H
GLA	- GUSTAF LOUGHEED ARCH	East H
GLB	- GLACIER BAY	West H
GLD	- GREENLAND	East H East R
GNS	- GULF OF ST. LAWRENCE - NORTH SHORE	East H
GOA	- GULF OF ALASKA	West R
GSP	- GEORGIA STRAIT/PUGET SOUND (deep)	West R
HECH	- HECATE STRAIT	West H
HECR	- HECATE STRAIT	West R
IRB	- IAPETAN RIFT BACKGROUND	East R
IRM	- IAPETAN RIFT MARGIN	East R
JDF	- JUAN DE FUCA BENDING	West H
JDFF	- JUAN DE FUCA PLATE BENDING, OFFSHORE	West R
JDFN	- JUAN DE FUCA PLATE BENDING, ONSHORE	West R
JMS	- JAMES BAY	East H East R

LAB	- SOUTHERN LABRADOR	East R
LBR	- LABRADOR RIDGE	East H East R
LBS	- LABRADOR SHELF	East H
LSP	- LAURENTIAN SLOPE	East H
MCK	- MACKENZIE MOUNTAINS	West H
MMB	- MACKENZIE MOUNTAINS	West R
MNT	- MONTREAL	East H
NAI	- NORTHERN APPALACHIANS INTERIOR	East R
NAN	- NORTHERN APPALACHIANS	East H
NAT	- NIAGARA ATTICA	East H
NBC	- NORTHERN BC	West R
NCM	- NORTHERN COAST MOUNTAINS	West H
NEA	- NORTHEASTERN ALASKA	West H
NFT	- NORTHERN FOOTHILLS	West H
NJFP	- NORTHERN JUAN DE FUCA PLATE	West H
NJFR	- NORTHERN JUAN DE FUCA RIDGE	West H
NOFH	- NOOTKA FAULT	West H
NOFR	- NOOTKA FAULT	West R
NRMT	- NORTHERN ROCKY MOUNTAIN TRENCH	West H
NYK	- NORTHERN YUKON	West R
OBGH	- ONTARIO BACKGROUND (H model)	East H
OBGR	- ONTARIO BACKGROUND (R model)	East R
OFS	- OFFSHORE	West R
OGL	- OGILVIE MOUTAINS	West H
PEM	- PEMBROKE	East H
PMQ	- PASSAMAQUODDY BAY	East H
PUG	- PUGET SOUND (deep)	West H
QCB	- QUEEN CHARLOTTE FAULT BORDER	West H
QCFH	- QUEEN CHARLOTTE FAULT	West H
QCFR	- QUEEN CHARLOTTE FAULT	West R
QCS	- QUEEN CHARLOTTE SOUND	West H
QES	- QUEEN ELIZABETH SHELF	East H
RDS	- REVERE-DELLWOOD, SOVANCO	West H
RIC	- RICHARDSON MOUNTAINS	West H
RMN	- RICHARDSON MTNS-NORTH	West R
RMS	- RICHARDSON MTNS-SOUTH	West R
ROC	- ROCKY MOUNTAIN FOLD AND THRUST BELT	West R
RST	- RESOLUTE	East H
SAG	- SAGUENAY	East H
SBC	- SOUTHERN BC	West R
SCM	- SOUTHERN COAST MOUNTAINS (shallow)	West H
SEB	- SOUTHEAST CANADA BACKGROUND	East H
SEBC	- SOUTHEASTERN BRITISH COLUMBIA	West H
SFT	- SOUTHERN FOOTHILLS	West H
SGL	- SOUTHERN GREAT LAKES	East R
SLE	- SOUTH SHORE LAKE ERIE	East H
SOY	- SOUTHERN YUKON	West R
SPB	- SPENCE BAY	East H
SVDH	- SVERDRUP BASIN (H model)	East H
SVDR	- SVERDRUP BASIN ALL EVENTS (R model)	East R
SYT	- SOUTHERN YUKON TERRITORY	West H
TIM	- TIMISKAMING	East H
TRR	- TROIS-RIVIERES	East H
UNG	- UNGAVA	East H
WGB	- WEGER BAY	East H
WLB	- WILLISTON BASIN	East H East R
YAK	- YAKUTAT COLLISION	West R
YFF	- YAKUTAT FAIRWEATHER FAULT	West H

Appendix C3

H Model Completeness table, parameter table and source zone maps

Eastern Zones, H Model Completeness Table

Zone	2.5	2.6	2.8	2.9	3.0	3.2	3.3	3.4	3.6	3.8	4.0	4.1	4.2	4.3	4.8	5.3	5.8	6.3	6.8	7.2	7.3
ADR					1968	--	1963	--	--	1938	--	--	--	--	1920	1880	--	1850	1660		
AOBH											1983	--	--	1965	--	1953	1950	1930	1920		
AOH						1976	--	--	--	1940	--	--	--	1920	1900	1850	1790	--	--		
BFB										1964	--	--	--	--	--	1950	--	1930	1920	--	1850
BIN							1975	--	--	1964	--	--	--	--	--	1950					
BIS							1975	--	--	1964	--	--	--	--	--	1950					
BSL			1975	--	--	--	1963	--	--	--	--	--	--	1938	1928	1900	--	1850			
CHA						1968	1963	--	--	1938	--	--	--	1928	1920	1880	--	1660			
CHV			1968	--	--	--	1963	--	--	1938	--	--	--	1928	1920	1880	1790	1660			
COC			1982	--	--	--	1963	--	--	--	--	--	--	--	1938	1900	--	1850			
DIB										1964	--	--	--	--	--	1950	--	1930	1920		
GAT			1975	--	--	--	1963	--	--	1938	--	--	--	1928	--	1900	--	1850			
GLA										1964	--	--	--	--	--	1950	--	1930	1920		
GLD										1964	--	--	--	--	--	1950	--	1930			
GNS			1975	--	--	--	1963	--	--	--	--	--	--	1938	1928	1900	--	1850			
JMS			1982	--	--	--	1975	--	--	1963	--	--	--	--	1953	1900	--	1850			
LBR												1964	--	--	--	1950					
LBS												1964	--	--	1950	1938					
LSP								1983	--	1965	--	--	--	--	1953	1938	1928	--	1800		
MNT	1982	--	1968	--	--	--	1963	--	--	1938	--	--	--	1928	1900	1880	1730	1660			
NAN			1972	--	--	--	1963	--	--	1953	--	--	--	1938	--	1900	--	1850			
NAT			1980	--	--	--	1963	--	--	1938	--	--	--	--	1920	1870	--	1850			
OBGH					1980	--	1963	--	--	1938	--	--	--	--	1920	1870	--	1850			
PEM			1975	--	--	--	1963	--	--	1938	--	--	--	1928	1920	1880	--	1850			
PMQ					1972	--	1963	--	--	1953	--	--	--	1938	--	1900	--	1850			
QES										1964	--	--	--	--	--	1950	--	1930	1920		
RST										1964	--	--	--	--	--	1950	--	1930	1920		
SAG			1975	--	--	--	1963	--	--	1938	--	--	--	1928	1920	1880	--	1850	--	--	1660
SEB			1982	--	--	--	1975	--	--	1963	--	--	--	--	1953	1900	--	1850			
SLE			1980	--	--	--	1963	--	--	1938	--	--	--	--	1920	1870	--	1850			
SPB										1964	--	--	--	--	--	1950	--	1930	1920		
SVDH										1964	--	--	--	--	--	1950	--	1930	1920		
TAD			1975	--	--	--	1963	--	--	1938	--	--	--	1928	1920	1880	1790	1660			
TIM		1982	1968	--	--	--	1963	--	--	--	--	--	--	1938	1928	1900	--	1850	--		1660
TRR			1975	--	--	--	1963	--	--	1938	--	--	--	1928	1920	1880	1790	1660			
UNG										1964	--	--	--	--	--	1950	--	1930	1920		
WGB										1964	--	--	--	--	--	1950	--	1930	1920		
WLB			1966	--	--	--	1965	--	--	--	--	--	--	1960	1940	1890					

see notes below

Western H Zones, H Model Completeness Table

Zone	2.5	2.6	2.8	2.9	3.0	3.2	3.3	3.4	3.6	3.8	4.0	4.1	4.2	4.3	4.8	5.3	5.8	6.3	6.8	7.2	7.3
ALC	Magnitude recurrence borrowed from United States Geological Survey; No Completeness Data																				
ALI	Magnitude recurrence borrowed from United States Geological Survey; No Completeness Data																				
BFC											1965	--	--	--	1962	1951	1935	1917	--	1899	
BFS					1982	--	1969	--	--	1965	--	--	--	--	1962	1951	1935	1917	--	1899	
BRP	1982	--	1962	--	--	--	1965	--	--	1956	--	--	--	--	1940	1917	--	--	1899		
CASH	1976	--	1970	--	--	--	--	--	--	1956	--	--	--	--	1940	1917	1899	--	1860		
CCM					1985	--	1971	--	--	1965	--	--	--	--	--	1940	1917	--	1899		
DENH			1979	--	--	--	--	--	--	1972	--	--	--	1965	1962	1951	1935	1917	--	1899	
EGA								1979	--	1972	--	--	--	1965	1962	1951	1935	1917	--	1899	
FHL											1960	--	--	--	1940	1917	1899				
GEO	1976	--	1956	--	--	--	--	--	--	--	--	--	--	--	1940	1917	1899	--	1860		
GLB			1979	--	--	--	--	--	--	1972	--	--	--	1965	1962	1951	1935	1917	--	1899	
HECH	1986	--	1985	--	--	--	1971	--	--	1965	--	--	--	--	--	1940	1917	--	1899		
JDF	1982	--	1970	--	--	--	--	--	--	1956	--	--	--	--	1940	1917	1899	--	1860		
MCK						1982	1969	--	--	1965	--	--	--	--	1962	1951	1935	1917	--	1899	
NCM									1979	1972	--	--	--	1965	1962	1951	1935	1917	--	1899	
NEA					1985	--	1972	--	--	--	--	--	--	1965	1962	1951	1935	1917	--	1899	
NFT				1982	--	--	1965	--	--	--	--	--	--	--	--	1940	1917	--	1899		
NJFP					1982	--	1965	--	--	--	--	--	--	--	--	1917	--	--	1899		
NJFR												1965	--	--	--	1917	--	--	1899		
NOFH	1982	--	1962	--	--	--	1965	--	--	1956	--	--	--	--	1940	1917	--	--	1899		
NRMT	1982	--	--	--	--	--	1965	--	--	--	--	--	--	--	--	1940	1917	--	1899		
OGL					1985	--	1972	--	--	--	--	--	--	1965	1962	1951	1935	1917	--	1899	
PUG	1976	--	1970	--	--	--	--	--	--	1956	--	--	--	--	1940	1917	1899	--	1860		
QCB					1985	--	1971	--	--	--	--	--	--	1965	--	1940	1917	--	1899		
QCS					1983	--	1965	--	--	--	--	--	--	--	--	1917	--	--	1899		
RDS							1965	--	--	--	--	--	--	--	--	1917	--	--	1899		
RIC					1982	--	1969	--	--	1965	--	--	--	--	1962	1951	1935	1917	--	1899	
SCM	1976	--	1962	--	--	--	1956	--	--	--	--	--	--	--	1940	1917	1899	--	--	1860	
SEBC					1966	--	1965	--	--	--	--	--	--	1960	1940	1917	1899				
SFT					1966	--	1965	--	--	--	--	--	--	1960	1940	1917	1899				
SYT					1979	--	--	--	--	1972	--	--	--	1965	1962	1951	1935	1917	--	1899	
YFF								1979	--	1972	--	--	--	1965	1962	1951	1935	1917	--	1899	

Notes: The entries in this table should be interpreted as follows. For columns with a year entry we consider the earthquake catalogue for that zone to be complete from the beginning of the year and for earthquakes of that tenth magnitude size class or larger. For columns with a "- -", the year immediately to the left applies. For left hand columns with a blank entry, the earthquake catalogue is incomplete and these magnitudes can not be used for hazard estimation. For right hand columns with a blank entry, no completeness year needed to be assigned.

H Model parameter table

ZONE	BEST		LOWER		UPPER		MX			DEPTH			BEST	APPROX	Mag5 per
	BETA	N0	BETA	NO	BETA	NO	BEST	LOWER	UPPER	BEST	LOWER	UPPER	N5	AREA	million
WEIGHTS	0.68		0.16		0.16		0.6	0.3	0.1	0.5	0.25	0.25	(p.a.)	(sq km)	sq km/yr
Eastern H Zones															
ADR	1.84	142	2.19	291	1.50	60	7.0	6.0	7.5	10	20	5	0.0140	30400	0.459
AOBH	2.00F	755	2.20	1530	1.80	927	7.5	6.0	7.5	10	20	5	0.0340	900000	0.038
AOH	2.05F	575	2.15	402	1.95	700	7.0	6.0	7.5	5	20	5	0.0200	10600	1.880
BFB	1.64	884	1.84	1570	1.45	485	7.5	7.3	8.0	10	20	5	0.2390	234000	1.020
BIN	1.92F	1730	2.09	2440	1.75	1000	7.0	6.5	7.5	5	20	10	0.1150	63400	1.810
BIS	1.92F	558	2.09	705	1.75	351	7.0	6.0	7.5	5	20	10	0.0370	58500	0.632
BSL	1.93	533	2.13	781	1.74	344	7.5	6.0	7.7	10	20	5	0.0341	16000	2.130
CHA	2.00F	107	2.10	92	1.90	120	7.5	6.0	7.7	10	20	5	0.0048	11500	0.418
CHV	1.74	374	1.85	477	1.62	310	7.5	7.2	7.7	10	20	5	0.0615	4740	13.000
COC	2.00F	76	2.10	74	1.90	126	7.5	6.0	7.7	10	20	5	0.0034	31000	0.110
DIB	2.25F	1200	2.55	2330	1.95	600	7.0	6.0	7.5	10	20	5	0.0154	168000	0.091
GAT	2.07	1190	2.23	1580	1.91	811	7.0	6.5	7.5	10	20	5	0.0375	32300	1.160
GLA	1.54	206	1.90	597	1.18	65	7.0	6.5	7.5	10	30	5	0.0890	21900	4.060
GLD	1.70F	500	3.11	78300	1.50	285	7.33	7.00	7.63	10	20	5	0.0998	301000	0.331
							7.5	7.0	8.0*						
GNS	2.00F	237	2.10	248	1.90	223	7.5	6.0	7.7	10	20	5	0.0107	37800	0.283
JMS	2.00F	167	2.10	190	1.90	237	7.0	6.8	7.2	10	20	5	0.0074	132000	0.056
LBR	2.00F	3970	2.46	21900	1.90	3210	6.66	6.29	7.33	10	20	5	0.1740	106000	1.630
							6.5	6.0	7.5*						
LBS	1.70F	358	2.61	11100	1.50	225	7.33	6.7	7.63	10	20	5	0.0715	100000	0.708
							7.5	6.5	8.0*						
LSP	1.70F	278	1.90	404	1.44	140	7.33	7.33	7.63	10	20	5	0.0555	13600	4.070
							7.5	7.5	8.0*						
MNT	1.96	258	2.19	405	1.74	167	7.5	6.5	7.7	10	20	5	0.0142	14100	1.000
NAN	1.75	374	1.90	508	1.60	276	7.0	6.0	7.0	5	20	5	0.0575	248000	0.232
NAT	1.80	69	2.23	164	1.37	29	7.0	6.0	7.5	5	20	5	0.0083	14600	0.566
OBGH	2.00F	273	2.20	346	1.80	176	7.0	6.8	7.2	5	20	10	0.0122	549000	0.022

ZONE	BEST		LOWER		UPPER		MX			DEPTH			BEST	APPROX	Mag5 per
	BETA	N0	BETA	NO	BETA	NO	BEST	LOWER	UPPER	BEST	LOWER	UPPER	N5	AREA	million
WEIGHTS	0.68		0.16		0.16		0.6	0.3	0.1	0.5	0.25	0.25	(p.a.)	(sq km)	sq km/yr
PEM	1.95	140	2.34	271	1.57	55	7.5	6.0	7.7	10	20	5	0.0081	27400	0.295
PMQ	1.72	49	2.17	124	1.26	18	7.0	6.5	7.5	10	20	5	0.0087	7050	1.240
QES	2.00F	1175	2.25	2310	1.75	570	7.33	6.29	7.63	10	20	5	0.0528	59100	0.893
							7.5	6.0	8.0*						
RST	2.00F	914	2.28	1920	1.72	406	7.0	6.5	7.5	10	20	5	0.0407	145000	0.279
SAG	2.00F	89	2.10	67	1.90	84	7.5	6.5	7.7	10	30	5	0.0040	12100	0.330
SEB	2.00F	649	3.33	25400	1.80	532	7.0	6.0	7.5	10	20	5	0.0289	947000	0.031
SLE	2.09	169	2.57	457	1.61	61	7.0	6.0	7.5	5	20	5	0.0048	12000	0.401
SPB	2.00F	374	2.20	478	1.34	88	7.0	6.5	7.5	10	20	5	0.0167	155000	0.107
SVDH	2.25F	6330	2.55	16300	1.95	2390	7.0	6.5	7.5	10	20	5	0.0814	399000	0.204
TAD	-	-	-	-	-	-		as TRR			as TRR		-	5780	0.000
TIM	2.00F	63	2.10	47	1.90	65	7.5	6.5	7.7	10	20	5	0.0028	3800	0.747
UNG	2.00F	849	2.28	1700	1.24	60	7.0	6.5	7.5	10	20	5	0.0378	297000	0.127
WGB	2.00F	737	2.28	1470	1.72	336	7.0	6.5	7.5	10	20	5	0.0328	86600	0.379
WLB	1.57	24	1.97	49	1.17	11	7.0	6.8	7.2	10	20	5	0.0091	45900	0.198
Western H Zones															
ALC	1.43	3848	1.51	5731	1.35	2585	8.5	8.2	8.7	2.9-7.2	0	0	3.0000	139000	21.600
ALI	1.73	57235	1.84	99129	1.62	33058	8.5	8.2	8.5	2.9-7.2	0	0	10.0000	339000	29.500
BFC	3.35	507980	3.98	4858170	2.72	50890	7.0	6.7	7.3	2.9-7.2	0	0	0.0271	301000	0.090
BFS	1.67	577	1.82	766	1.51	381	7.0	6.7	7.3	2.9-7.2	0	0	0.1330	61400	2.160
BRP	1.21	23	1.41	36	1.01	20	7.0	6.7	7.3	2.9-7.2	0	0	0.0501	2530	19.800
CASH	2.01	1402	2.12	1704	1.90	1137	7.3	7.1	7.5	2.9-7.2	0	0	0.0592	46400	1.270
CCM	1.76	81	2.41	400	1.11	18	7.0	6.5	7.3	2.9-7.2	0	0	0.0118	158000	0.074
DENH	1.85	2480	1.95	3041	1.76	2081	7.5	7.0	8.0	2.9-7.2	0	0	0.2310	61500	3.760
EGA	2.04	20316	2.12	25399	1.96	16518	7.9	7.6	8.2	2.9-7.2	0	0	0.7560	125000	6.030
FHL	2.49	14016	2.93	63129	2.06	3021	7.3	7.1	7.5	2.9-7.2	0	0	0.0546	23500	2.320
GEO	2.25	85	2.75	220	1.75	41	7.0	6.5	7.3	50	0	0	0.0011	19500	0.056
GLB	1.75	896	1.88	1153	1.62	682	7.0	6.7	7.3	5	0	0	0.1350	9760	13.800
HECH	2.07	1166	2.25	1667	1.90	897	7.0	6.7	7.3	2.9-7.2	0	0	0.0366	32000	1.140

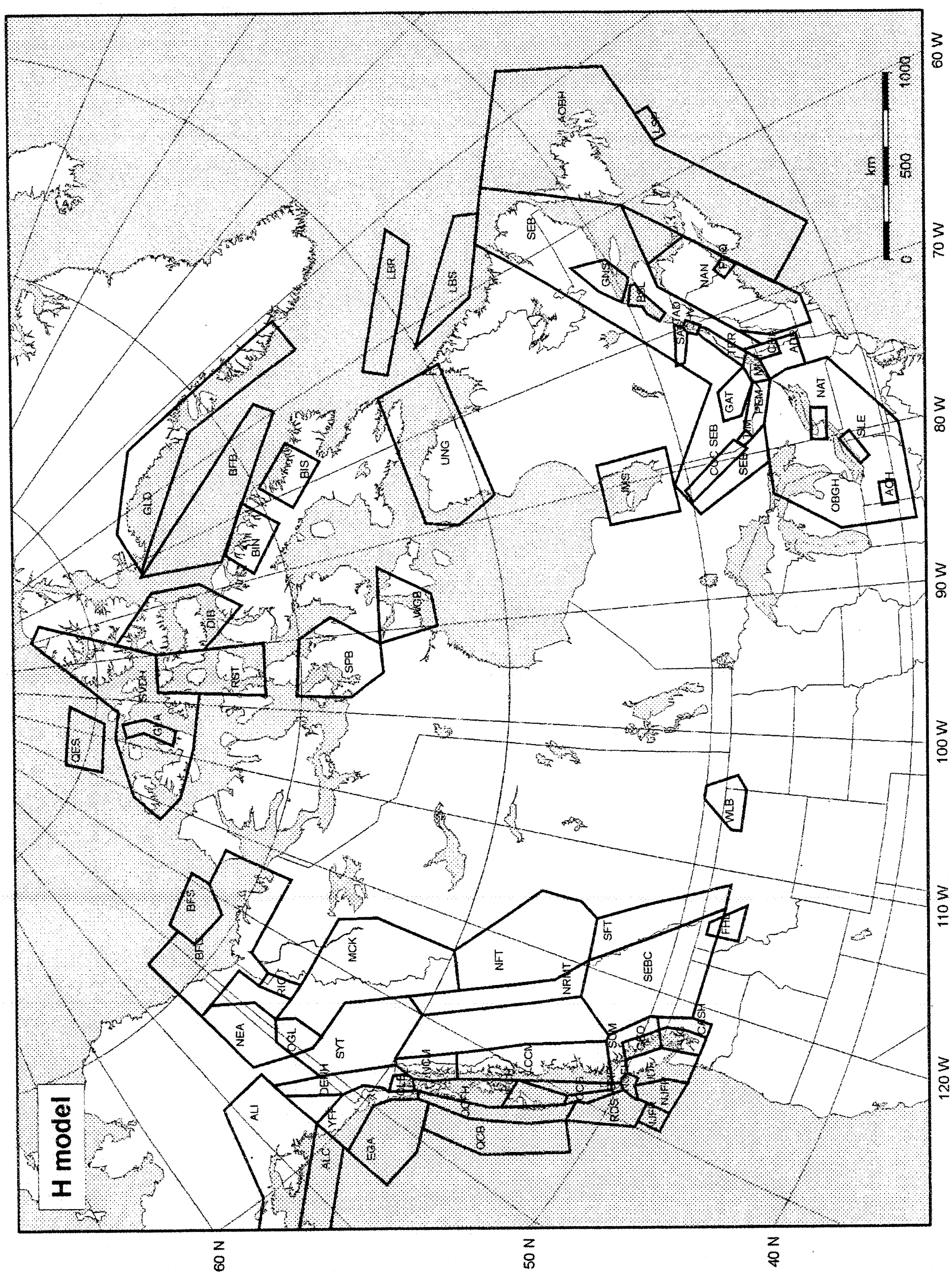
ZONE	BEST		LOWER		UPPER		MX			DEPTH			BEST	APPROX	Mag5 per
	BETA	N0	BETA	NO	BETA	NO	BEST	LOWER	UPPER	BEST	LOWER	UPPER	N5	AREA	million
WEIGHTS	0.68		0.16		0.16		0.6	0.3	0.1	0.5	0.25	0.25	(p.a.)	(sq km)	sq km/yr
JDF	0.05	0.2	1.77	223	0.05	0.2	7.3	7.3	7.3	2.9-7.2	0	0	0.0553	57000	0.970
MCK	2.21	35815	2.28	44670	2.13	30775	7.2	6.9	7.5	2.9-7.2	0	0	0.5780	326000	1.770
NCM	1.79	333	2.25	1142	1.33	78	7.0	6.7	7.3	2.9-7.2	0	0	0.0420	38900	1.080
NEA	2.20	2555	2.46	4567	1.93	1262	7.0	6.7	7.3	2.9-7.2	0	0	0.0424	96300	0.440
NFT	2.79	2757	3.43	13842	2.15	619	7.0	6.7	7.3	2.9-7.2	0	0	0.0024	274000	0.009
NJFP	1.25	22	1.56	48	0.94	13	6.8	6.6	7.0	2.9-7.2	0	0	0.0394	32500	1.210
NJFR	2.74	65516	3.37	684035	2.12	5961	6.8	6.6	7.0	2.9-7.2	0	0	0.0714	14900	4.760
NOFH	1.42	138	1.54	173	1.31	119	7.0	6.7	7.3	2.9-7.2	0	0	0.1060	8100	13.100
NRMT	2.09	278	2.44	558	1.74	156	7.0	6.7	7.3	2.9-7.2	0	0	0.0079	106000	0.074
OGL	1.69	318	1.96	646	1.43	193	7.0	6.7	7.3	2.9-7.2	0	0	0.0651	32000	2.030
PUG	1.01	18	1.12	19	0.90	16	7.3	7.1	7.6	50	0	0	0.1050	26900	3.890
QCB	1.96	363	2.39	1101	1.53	140	7.0	6.7	7.3	2.9-7.2	0	0	0.0196	130000	0.150
QCFH	1.48	905	1.56	1187	1.41	872	8.5	8.2	8.7	2.9-7.2	0	0	0.5380	63000**	8.540
QCS	1.43	72	1.67	131	1.19	47	7.0	6.7	7.3	2.9-7.2	0	0	0.0540	10400	5.190
RDS	1.46	2443	1.51	2824	1.41	2226	7.0	6.8	7.2	2.9-7.2	0	0	1.5600	55700	28.000
RIC	2.06	3519	2.21	4797	1.92	2392	7.0	6.7	7.3	2.9-7.2	0	0	0.1150	15800	7.220
SCM	1.57	85	1.77	118	1.38	61	7.0	6.5	7.3	2.9-7.2	0	0	0.0312	57800	0.540
SEBC	1.81	854	1.95	1168	1.68	634	7.0	6.7	7.3	2.9-7.2	0	0	0.0965	298000	0.323
SFT	2.48	4878	2.74	9370	2.22	2514	6.0	5.0	7.0	2.9-7.2	0	0	0.0186	127000	0.146
SYT	1.93	529	2.25	1050	1.61	239	7.0	6.7	7.3	2.9-7.2	0	0	0.0337	180000	0.187
YFF	2.13	27728	2.21	35213	2.05	22338	8.5	8.2	8.7	2.9-7.2	0	0	0.6610	73700	8.960

Notes (see also notes in Appendix C1) Table entries have not been adjusted to display only the significant figures.

* moment magnitude. Note: The Mx value represents the upper-bound magnitude and is taken to be m_{bLg} for the eastern (with exceptions below) and moment magnitude for the western zones. For eastern and arctic offshore zones, the upper-bound magnitude is defined in terms of moment magnitude and given on the second line; equivalent m_{bLg} magnitudes are given on the first line. These are the values input into the FRISK88 code, where they are reconverted to moment magnitudes (using the inverse relation) for calculation of the hazard.

F - Zones with BETA flagged with F have had a slope imposed rather than use the value derived from a maximum likelihood fit to the data.

** Note that QCFH is a fault zone and the area is NOT the area of the fault. This figure represents the area near the fault used to choose the earthquakes that are included in the magnitude recurrence calculation.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120 W
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100 W
90 W
80 W
70 W
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km
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500
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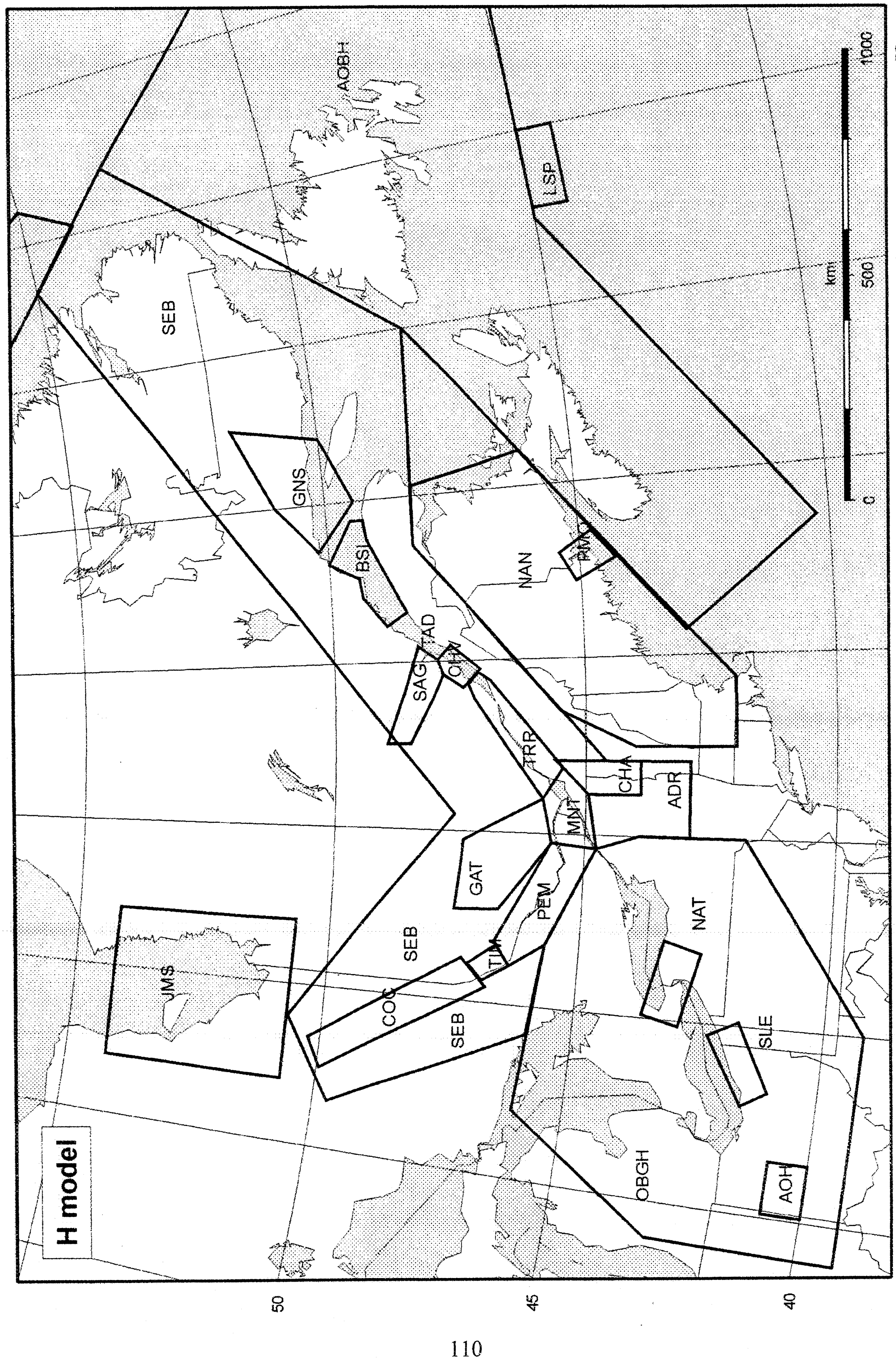
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COC
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JMS
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AOH
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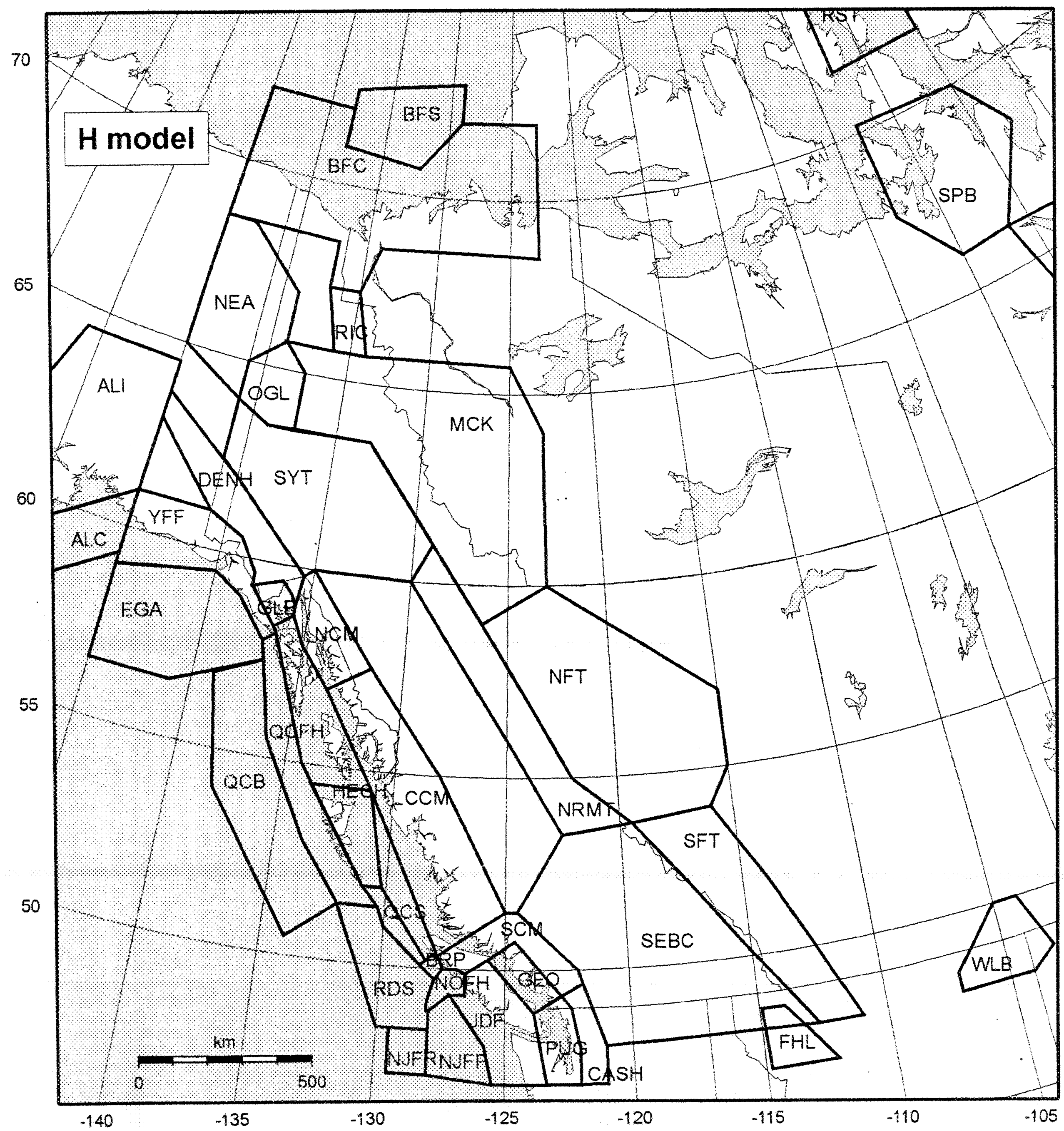
H model
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BFC
SPB
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RIC
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MCK
DENH
SYT
YFF
ALC
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GLB
NCM
NFT
QCFH
QCB
HECH
CCM
NRMT
SFT
QCS
SCM
SEBC
WLB
BRP
NOFH
GEO
RDS
JDF
FHL
NJFR
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PUG
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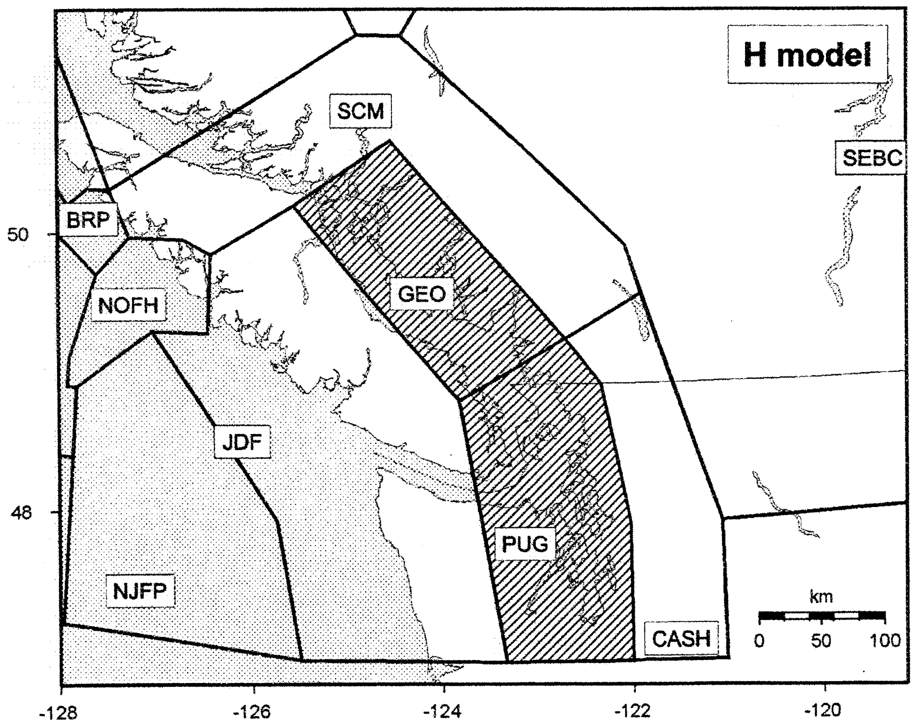
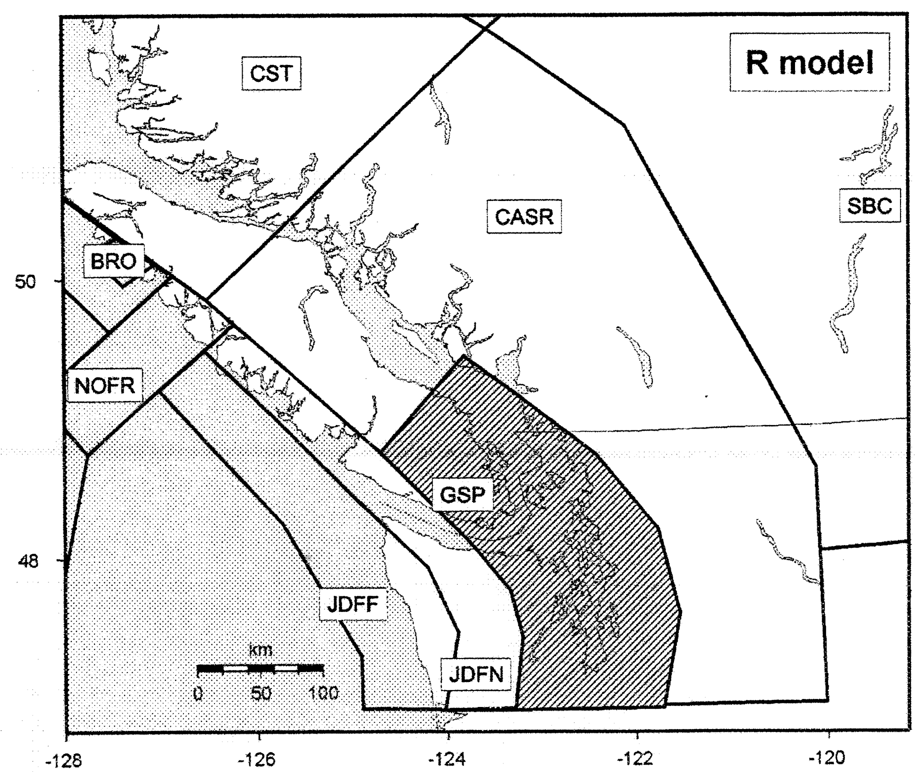


Zone GEO lies below zone SCM

Zone PUG lies below zone CASH



Zone GSP lies below zone CASR

The **R** model zones are also shown for comparison

Appendix C4 **R** Model Completeness table, parameter table and source zone maps

Eastern Zones, R Model Completeness Table

Zone	2.5	2.6	2.8	2.9	3.0	3.2	3.3	3.4	3.6	3.8	4.0	4.1	4.2	4.3	4.8	5.3	5.8	6.3	6.8	7.2	7.3
ACM										1964	--	--	--	--	--	1950	--	1930	1920		
ADR					1968	--	1963	--	--	1938	--	--	--	--	1920	1880	--	1850	1660		
AOBR							1983	--	--	1977	--	--	--	1965	1953						
BFI							1975	--	--	1964	--	--	--	--	--	1950					
BOU										1964	--	--	--	--	--	1950	--	1930	1920		
CMF			1972	--	--	--	1963	--	--	1953	--	--	--	1938	--	1900	--	1850			
COC			1982	--	--	--	1963	--	--	--	--	--	--	--	1938	1900	--	1850			
DIB										1964	--	--	--	--	--	1950	--	1930	1920		
ECM										1964	--	--	--	--	--	1950	--	1930	1920	--	1850
GAT			1975	--	--	--	1963	--	--	1938	--	--	--	1928	--	1900	--	1850			
GLD										1964	--	--	--	--	--	1950	--	1930			
IRB			1982	--	--	--	1975	--	--	1963	--	--	--	--	1953	1900	--	1850			
IRM			1975	--	--	--	1963	--	--	--	--	--	--	1938	1928	1900	--	--	1850		
JMS			1982	--	--	--	1975	--	--	1963	--	--	--	--	1953	1900	--	1850			
LAB			1982	--	--	--	1975	--	--	1963	--	--	--	--	1953	1900	--	1850			
LBR												1964	--	--	--	1950					
NAI			1972	--	--	--	1963	--	--	1953	--	--	--	1938	--	1900	--	1850			
OBGR					1980	--	1963	--	--	1938	--	--	--	--	1920	1870	--	1850			
SGL			1980	--	--	--	1963	--	--	1938	--	--	--	--	1920	1870	--	1850			
SVDR										1964	--	--	--	--	--	1950	--	1930	1920		
WLB			1966	--	--	--	1965	--	--	--	--	--	--	1960	1940	1890					

Western Zones, R Model Completeness Table

Zone	2.5	2.6	2.8	2.9	3.0	3.2	3.3	3.4	3.6	3.8	4.0	4.1	4.2	4.3	4.8	5.3	5.8	6.3	6.8	7.2	7.3
ALC	Magnitude recurrence borrowed from United States Geological Survey; No Completeness Data																				
ALI	Magnitude recurrence borrowed from United States Geological Survey; No Completeness Data																				
BFT					1982	--	1969	--	--	1965	--	--	--	--	1961	1951	1935	--	1917		
BRO	1982	--	--	--	--	--	1965	--	--	1956	--	--	--	--	1940	1917	--	--	1899		
CASR	1976	--	1970	--	--	--	--	--	--	1956	--	--	--	--	1940	1917	1899	--	--	--	1860
CST									1972	--	--	--	--	1965	--	1940	1917	--	1899		
DENR					1979	--	--	--	--	1972	--	--	--	1965	1961	1951	1935	1917			
EXP					1983	--	1965	--	--	--	--	--	--	--	--	1917	--	--	1899		
FHL											1960	--	--	--	1940	1917	1899				
GOA											1972	--	--	1965	1961	1951	1935	1917	--	--	1850
GSP	1976	--	1970	--	--	--	--	--	--	1956	--	--	--	--	1940	1917	1899	--	1860		
HECR	1986	--	1985	--	--	--	1971	--	--	1965	--	--	--	--	--	1940	1917	--	1899		
JDFF	1982	--	1970	--	--	--	--	--	--	1956	--	--	--	--	1940	1917	1899	--	1860		
JDFN	1982	--	1970	--	--	--	--	--	--	1956	--	--	--	--	1940	1917	1899	--	1860		
MMB					1982	--	1969	--	--	1965	--	--	--	--	1961	1951	1935	--	1917		
NBC					1982	--	1965	--	--	--	--	--	--	--	--	1940	1917				
NOFR	1982	--	--	--	--	--	1965	--	--	1956	--	--	--	--	1940	1917	--	--	1899		
NYK													1965	--	1961	1951	1935	--	1917		
OFS														1965	--	1917	--	--	1899		
RMN					1982	--	1969	--	--	1965	--	--	--	--	1961	1951	1935	--	1917		
RMS					1982	--	1969	--	--	1965	--	--	--	--	1961	1951	1935	--	1917		
ROC					1982	--	1965	--	--	--	--	--	--	--	--	1940	1917	--	1899		
SBC					1966	--	1965	--	--	--	--	--	--	1960	1940	1917	1899				
SOY					1979	--	--	--	--	1972	--	--	--	1965	1961	1951	1935	1917			
YAK					1979	--	--	--	--	1972	--	--	--	1965	1961	1957	1935	1917	--	--	1850

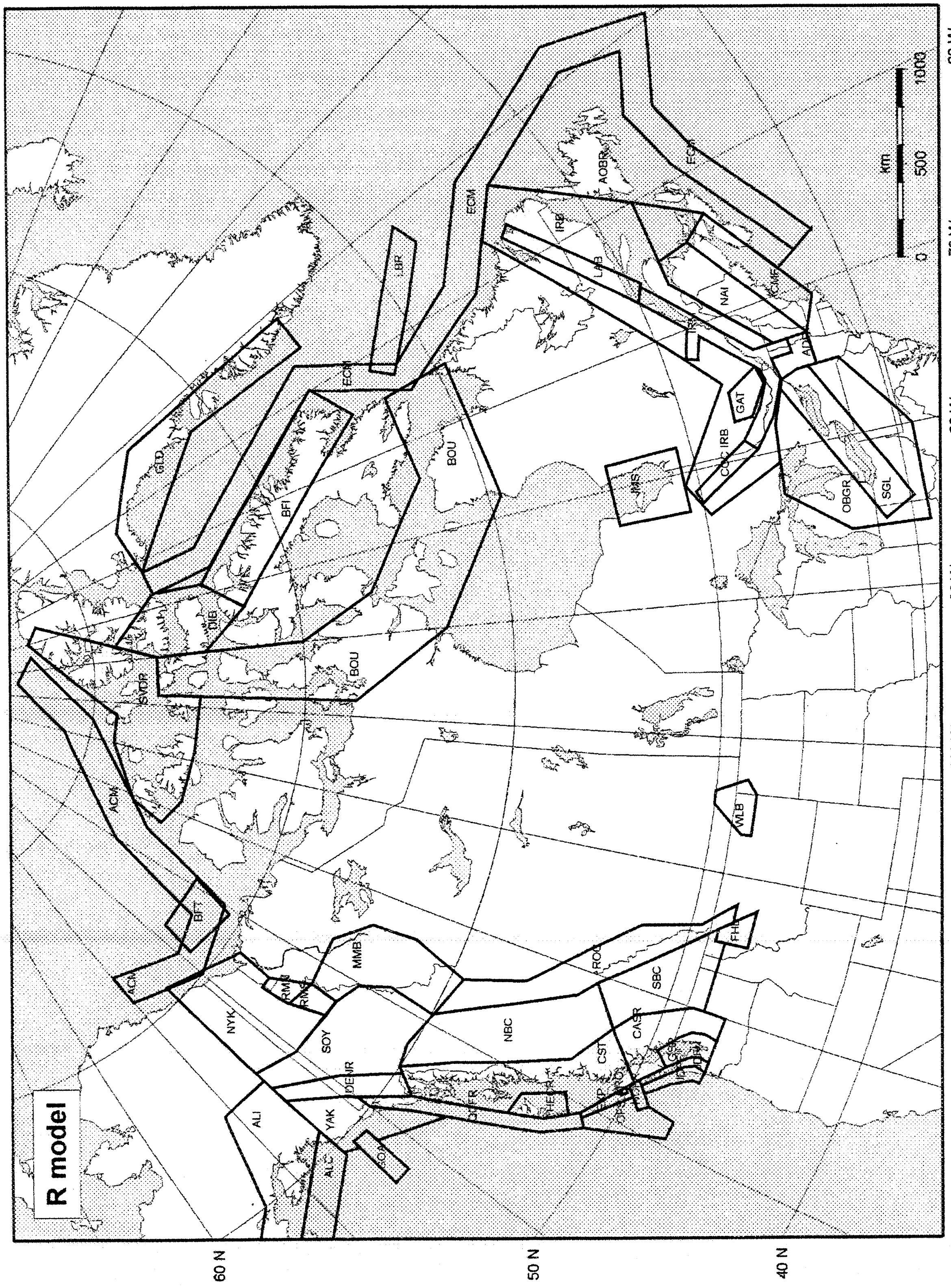
Notes: see notes to corresponding table in Appendix C3

R Model parameter table

ZONE	BEST		LOWER		UPPER		MX			DEPTH			BEST	APPROX	Mag5 per
	BETA	N0	BETA	NO	BETA	NO	BEST	LOWER	UPPER	BEST	LOWER	UPPER	N5	AREA	million
WEIGHTS	0.68		0.16		0.16		0.6	0.3	0.1	0.5	0.25	0.25	(p.a.)	(sq km)	sq km/yr
Eastern R Zones															
ACM	2.08	5100	2.34	11600	1.83	2250	7.33	7.0	7.63	10	20	5	0.1540	388000	0.397
							7.5	7.0	8.0*						
ADR	1.84	142	2.19	291	1.50	60	7.0	6.0	7.5	10	20	5	0.0140	30400	0.459
AOBR	2.00F	587	2.20	873	1.80	514	7.0	6.0	7.5	10	20	5	0.0262	562000	0.046
BFI	1.92	2390	2.09	3490	1.74	1380	7.0	6.5	7.5	5	20	10	0.1580	307000	0.516
BOU	2.02	3150	2.30	7730	1.74	1250	7.0	6.5	7.5	10	20	5	0.1270	999000	0.127
CMF	2.02	425	2.27	696	1.78	247	7.0	6.5	7.5	10	20	5	0.0172	139000	0.123
COC	2.00F	76	2.10	74	1.90	126	7.5	6.0	7.7	10	20	5	0.0034	31000	0.110
DIB	2.25F	1200	2.55	2330	1.95	600	7.0	6.0	7.5	10	20	5	0.0154	168000	0.091
ECM	1.70F	1840	1.90	3460	1.50	956	7.33	7.2	7.63	10	20	5	0.3670	858000	0.428
							7.5	7.3	8.0*						
GAT	2.07	1190	2.23	1580	1.91	811	7.0	6.5	7.5	10	20	5	0.0375	32300	1.160
GLD	1.70F	500	3.11	78300	1.50	285	7.33	7.0	7.63	10	20	5	0.0998	301000	0.331
							7.5	7.0	8.0*						
IRB	2.00F	630	2.10	844	1.90	688	7.0	6.0	7.5	10	20	5	0.0281	947000	0.030
IRM	1.98	2220	2.07	2720	1.88	1810	7.5	7.2	7.7	10	20	5	0.1110	119000	0.923
JMS	2.00F	167	2.10	190	1.90	237	7.0	6.8	7.2	10	20	5	0.0074	132000	0.056
LAB	2.00F	155	2.10	131	1.90	164	7.5	6.0	7.7	10	20	5	0.0070	69700	0.100
LBR	2.00F	3970	2.46	21900	1.90	3210	6.66	6.3	7.33	10	20	5	0.1740	106000	1.630
							6.5	6.0	7.5*						
NAI	1.51	111	1.68	152	1.33	79	7.0	6.0	7.0	5	20	5	0.0555	154000	0.359
OBGR	2.00F	144	2.20	156	1.80	100	7.0	6.8	7.2	5	20	10	0.0064	549000	0.012
SGL	1.99	454	2.23	724	1.75	262	7.0	6.0	7.5	5	20	10	0.0213	176000	0.120
SVDR	2.25	9170	2.53	23000	1.96	3590	7.0	6.5	7.5	10	20	5	0.1180	399000	0.295
WLB	1.57	24	1.97	49	1.17	11	7.0	6.8	7.2	10	20	5	0.0091	45900	0.198

ZONE	BEST		LOWER		UPPER		MX			DEPTH			BEST	APPROX	Mag5 per
	BETA	N0	BETA	NO	BETA	NO	BEST	LOWER	UPPER	BEST	LOWER	UPPER	N5	AREA	million
WEIGHTS	0.68		0.16		0.16		0.6	0.3	0.1	0.5	0.25	0.25	(p.a.)	(sq km)	sq km/yr
Western R Zones															
ALC	1.43	3848	1.51	5731	1.35	2585	8.5	8.2	8.7	2.9-7.2	0	0	3.0000	139000	21.600
ALI	1.73	57235	1.84	99129	1.62	33058	8.5	8.2	8.5	2.9-7.2	0	0	10.0000	339000	29.500
BFT	1.69	622	1.86	853	1.52	393	7.0	6.7	7.3	2.9-7.2	0	0	0.1260	65400	1.930
BRO	1.19	13	1.46	17	0.93	8	7.0	6.7	7.3	2.9-7.2	0	0	0.0302	65400	31.500
CASR	0.85	14	1.88	1335	0.85	14	7.7	7.7	7.7	2.9-7.2	0	0	0.1880	167000	1.120
CST	1.50	266	1.70	459	1.29	153	7.5	7.4	7.6	2.9-7.2	0	0	0.1450	278000	0.521
DENR	1.88	3996	1.97	4935	1.78	3264	7.5	7.0	8.0	2.9-7.2	0	0	0.3290	73600	4.480
EXP	1.30	103	1.45	160	1.15	85	7.0	6.7	7.3	2.9-7.2	0	0	0.1430	12500	11.400
FHL	2.49	14016	2.93	63129	2.06	3021	7.3	7.1	7.5	2.9-7.2	0	0	0.0546	23500	2.320
GOA	2.31	49696	2.47	86255	2.15	28865	7.8	7.6	8.0	2.9-7.2	0	0	0.4720	29800	15.800
GSP	1.13	28	1.26	35	0.99	24	7.1	6.9	7.3	50	0	0	0.0932	36100	2.570
HECR	1.90	931	2.04	1261	1.76	776	7.0	6.7	7.3	2.9-7.2	0	0	0.0692	35400	1.950
JDFF	1.87	91	2.26	175	1.48	42	7.0	6.7	7.3	2.9-7.2	0	0	0.0079	21400	0.367
JDFN	2.07	109	2.58	264	1.56	39	7.1	6.7	7.3	2.9-7.2	0	0	0.0035	15900	0.218
MMB	2.43	58008	2.50	72700	2.35	49997	7.1	6.9	7.3	2.9-7.2	0	0	0.3070	214000	1.430
NBC	2.00F	169	2.20	203	1.80	135	7.0	6.0	7.0	2.9-7.2	0	0	0.0076	310000	0.024
NOFR	1.57	270	1.69	360	1.45	247	7.0	6.7	7.3	2.9-7.2	0	0	0.1020	9120	11.200
NYK	3.75	7080982	4.35	70270912	3.15	697501	7.0	6.7	7.3	2.9-7.2	0	0	0.0508	259000	0.196
OFS	2.10	46683	2.22	73246	1.98	30343	7.1	6.9	7.3	2.9-7.2	0	0	1.2600	61800	20.400
QCFR	1.56	1703	1.62	2063	1.49	1572	8.5	8.2	8.5	2.9-7.2	0	0	0.7100	82000**	8.660
RMN	2.00	2918	2.14	3948	1.86	2016	7.0	6.7	7.3	2.9-7.2	0	0	0.1310	19200	6.800
RMS	1.67	1248	1.78	1540	1.56	945	7.0	6.7	7.3	2.9-7.2	0	0	0.2870	20800	13.800
ROC	2.04	1541	2.25	2542	1.82	870	7.0	6.7	7.3	2.9-7.2	0	0	0.0573	231000	0.247
SBC	2.21	1384	2.49	2787	1.92	673	7.0	6.7	7.3	2.9-7.2	0	0	0.0219	187000	0.117
SOY	2.15	1690	2.42	3157	1.87	853	7.0	6.7	7.3	2.9-7.2	0	0	0.0362	268000	0.135
YAK	2.01	16307	2.07	18689	1.95	14305	8.5	8.2	8.7	2.9-7.2	0	0	0.7050	117000	5.980

See notes following the corresponding table in Appendix C3.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1000
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SVDR
BOU
DIB
BFI
GLD
ECM
LBR
IRB
LAB
AOBR
NAI
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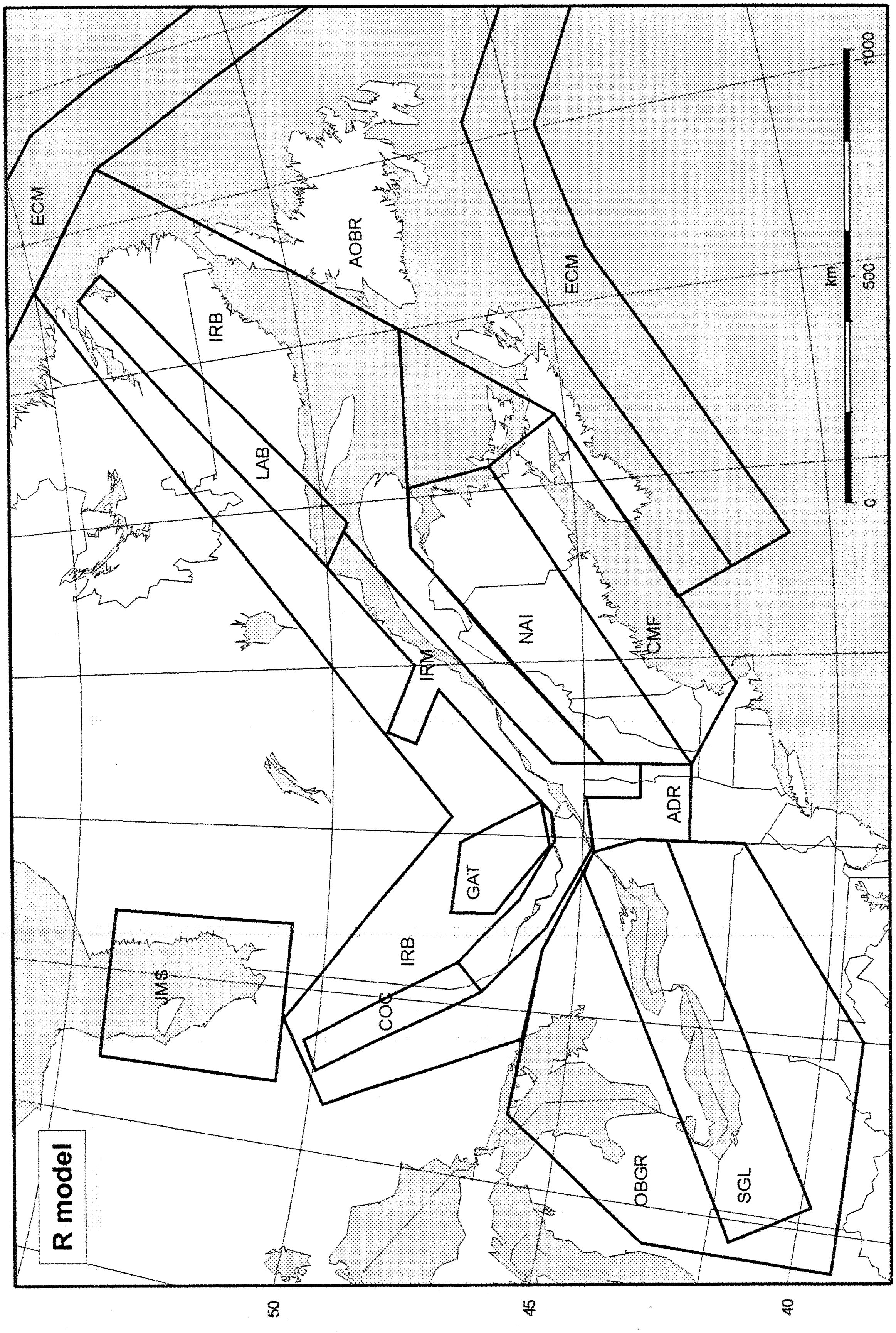
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IRM
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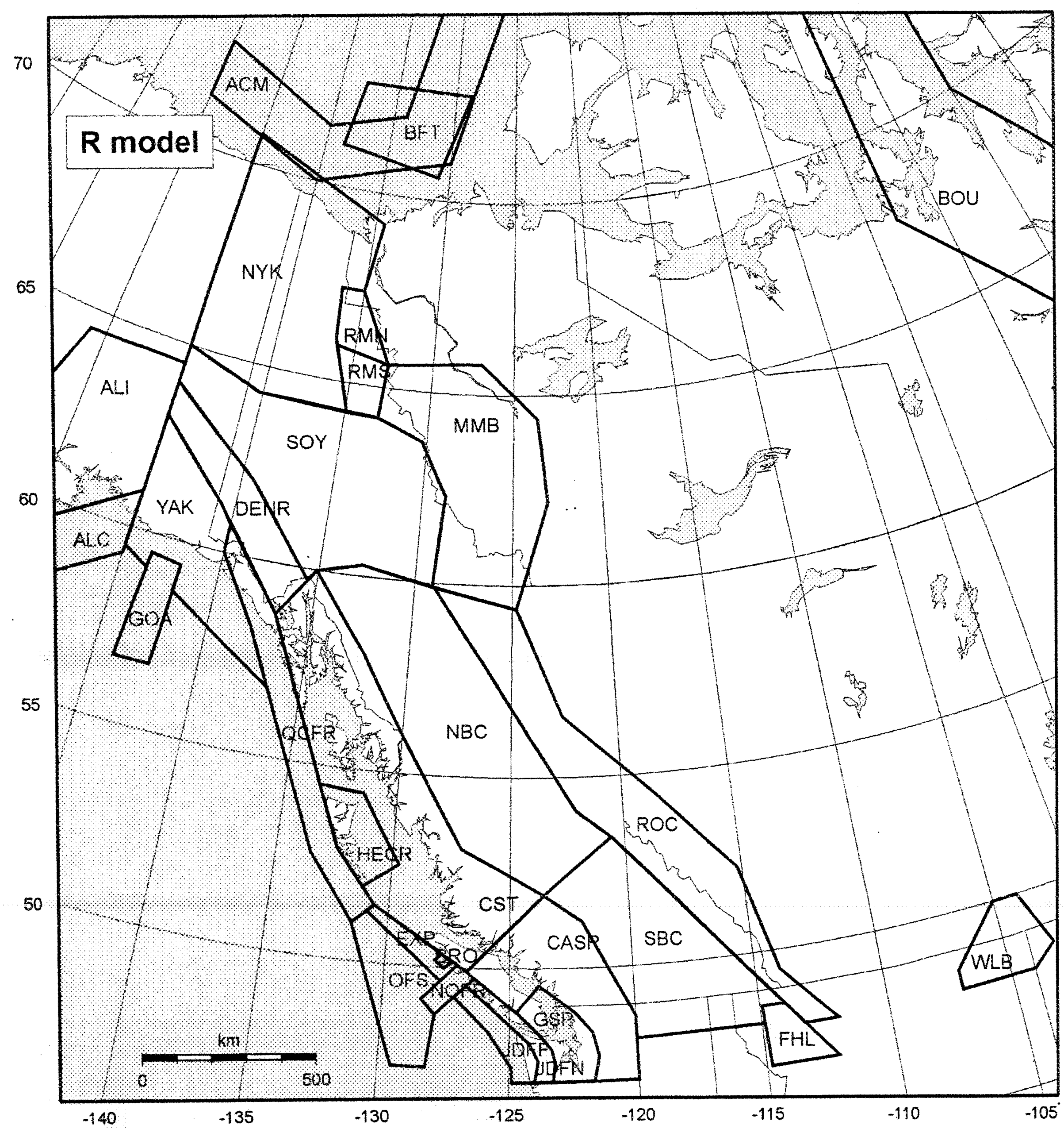
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HECR
ROC
CST
EXP
BRO
CASP
SBC
OFS
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GSP
JDFF
JDFN
FHL
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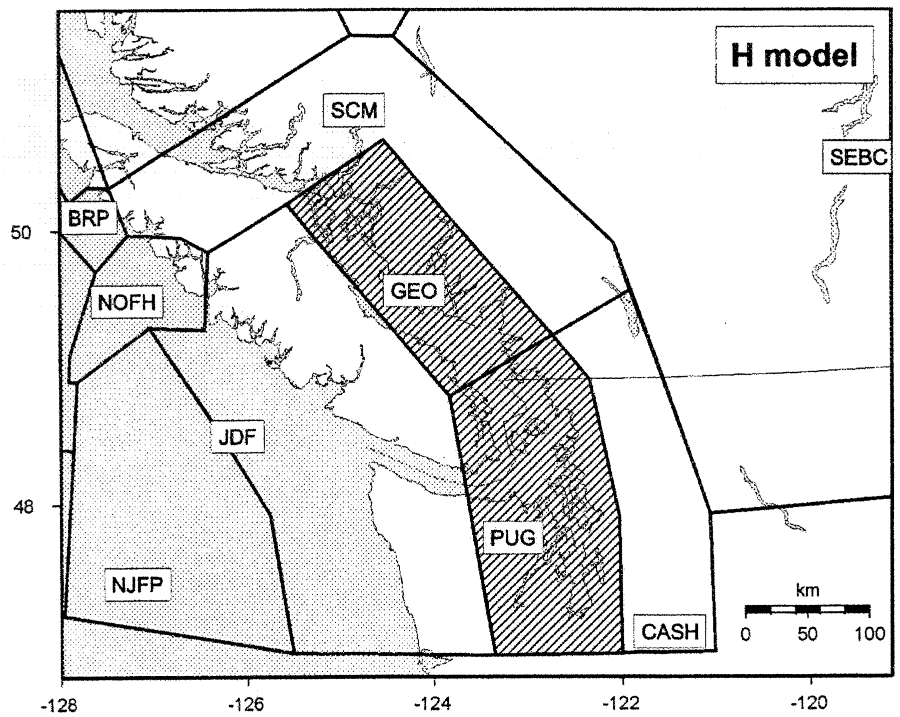
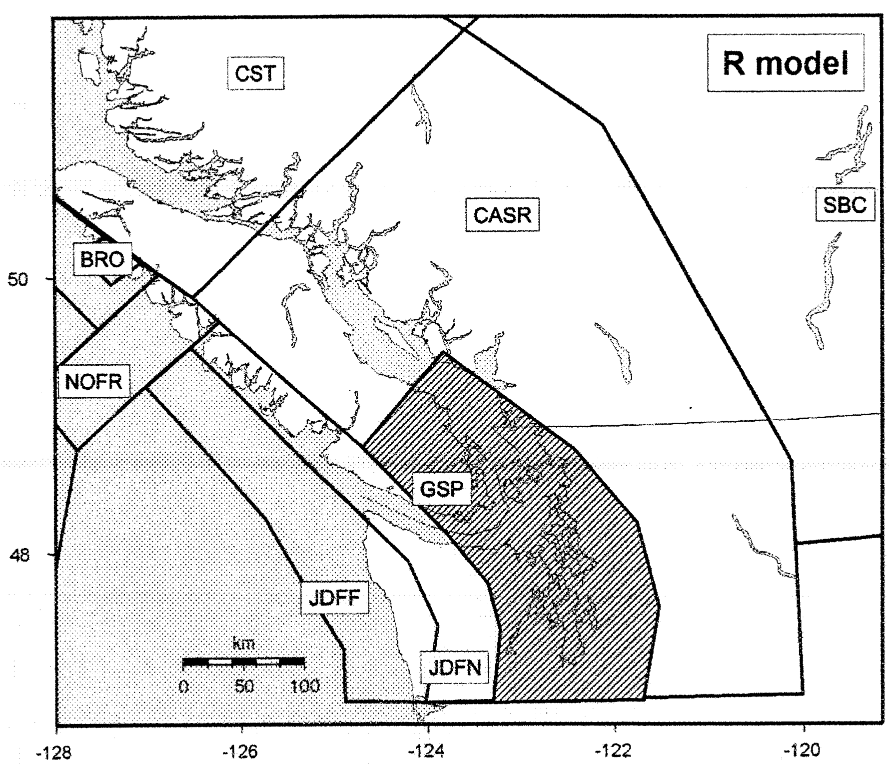


Zone GEO lies below zone SCM

Zone PUG lies below zone CASH



Zone GSP lies below zone CASR

The **H** model zones are also shown for comparison

Appendix C5

The seismicity parameters used for the 2005 F probabilistic hazard estimates

ZONE	BEST		LOWER		UPPER		MX			DEPTH			BEST	APPROX	Mag5 per
	BETA	N0	BETA	NO	BETA	NO	BEST	LOWER	UPPER	BEST	LOWER	UPPER	N5	AREA	million
WEIGHTS	0.68		0.16		0.16		0.6	0.3	0.1	0.5	0.25	0.25	(p.a.)	(sq km)	sq km/yr
World	2.18	4078	2.49	18724	1.88	926	7.0	6.8	7.2	10	20	5	0.0743	1020000	0.073
North America	2.38	6066	3.35	685190	1.41	53	7.0	6.8	7.2	10	20	5	0.0408	1020000	0.040
Canada	2.18F	202	2.48	471	1.88	81	7.0	6.8	7.2	10	20	5	0.0037	1020000	0.004

See notes following the corresponding table in Appendix C3.

Appendix C6

Input Locus used to compute the 2005 Cascadia Deterministic Hazard Estimates

Corners of the Cascadia deterministic source (see also Figure 6). In this Appendix values in bold lie on the inboard edge of the source and are the important ones for onshore hazard estimates.

46.000 -124.000	48.715 -127.042
47.500 -123.500	48.339 -126.742
48.000 -124.000	47.933 -126.442
48.750 -125.350	47.467 -126.142
49.520 -126.736	46.806 -125.842
49.128 -127.372	46.000 -125.578

The inshore boundary is set one third of the way into the transition zone below the locked zone (Hyndman and Wang, 1993; Dragert et al., 1994). The offshore boundary is set at the deformation front (Hyndman and Wang, 1993; Dragert et al., 1994). Although the extreme western part of the source may not generate significant seismic energy when it ruptures, the depth (25 km) we assign to the entire rupture region is too deep for its western edge and the two factors partially cancel out. The northern boundary is the southern boundary of R model NOFR zone. The southern boundary is arbitrary, just far enough south of Canada to avoid edge effects.

The source corners were transformed into a series of coordinates at approximately 1 km spacing along the boundary (see below) and this set or locus was used for computing distances (see code fragment in Appendix D4) to the various sites. Finally, hazard for sites immediately above the locked zone was assigned equal to that above the locus.

46.000 -124.000	**47.630 -123.630**	**47.920 -123.920**	**48.210 -124.378**	**48.500 -124.900**
46.0938 -123.969	**47.640 -123.640**	**47.930 -123.930**	**48.220 -124.396**	**48.510 -124.918**
46.1875 -123.938	**47.650 -123.650**	**47.940 -123.940**	**48.230 -124.414**	**48.520 -124.936**
46.2813 -123.906	**47.660 -123.660**	**47.950 -123.950**	**48.240 -124.432**	**48.530 -124.954**
46.375 -123.875	**47.670 -123.670**	**47.960 -123.960**	**48.250 -124.450**	**48.540 -124.972**
46.4688 -123.844	**47.680 -123.680**	**47.970 -123.970**	**48.260 -124.468**	**48.550 -124.990**
46.5625 -123.813	**47.690 -123.690**	**47.980 -123.980**	**48.270 -124.486**	**48.560 -125.008**
46.6563 -123.781	**47.700 -123.700**	**47.990 -123.990**	**48.280 -124.504**	**48.570 -125.026**
46.750 -123.750	**47.710 -123.710**	**48.000 -124.000**	**48.290 -124.522**	**48.580 -125.044**
46.8438 -123.719	**47.720 -123.720**	**48.010 -124.018**	**48.300 -124.540**	**48.590 -125.062**
46.9375 -123.688	**47.730 -123.730**	**48.020 -124.036**	**48.310 -124.558**	**48.600 -125.080**
47.0313 -123.656	**47.740 -123.740**	**48.030 -124.054**	**48.320 -124.576**	**48.610 -125.098**
47.125 -123.625	**47.750 -123.750**	**48.040 -124.072**	**48.330 -124.594**	**48.620 -125.116**
47.2188 -123.594	**47.760 -123.760**	**48.050 -124.090**	**48.340 -124.612**	**48.630 -125.134**
47.3125 -123.563	**47.770 -123.770**	**48.060 -124.108**	**48.350 -124.630**	**48.640 -125.152**
47.4063 -123.531	**47.780 -123.780**	**48.070 -124.126**	**48.360 -124.648**	**48.650 -125.170**
47.500 -123.500	**47.790 -123.790**	**48.080 -124.144**	**48.370 -124.666**	**48.660 -125.188**
47.510 -123.510	**47.800 -123.800**	**48.090 -124.162**	**48.380 -124.684**	**48.670 -125.206**
47.520 -123.520	**47.810 -123.810**	**48.100 -124.180**	**48.390 -124.702**	**48.680 -125.224**
47.530 -123.530	**47.820 -123.820**	**48.110 -124.198**	**48.400 -124.720**	**48.690 -125.242**
47.540 -123.540	**47.830 -123.830**	**48.120 -124.216**	**48.410 -124.738**	**48.700 -125.260**
47.550 -123.550	**47.840 -123.840**	**48.130 -124.234**	**48.420 -124.756**	**48.710 -125.278**
47.560 -123.560	**47.850 -123.850**	**48.140 -124.252**	**48.430 -124.774**	**48.720 -125.296**
47.570 -123.570	**47.860 -123.860**	**48.150 -124.270**	**48.440 -124.792**	**48.730 -125.314**
47.580 -123.580	**47.870 -123.870**	**48.160 -124.288**	**48.450 -124.810**	**48.740 -125.332**
47.590 -123.590	**47.880 -123.880**	**48.170 -124.306**	**48.460 -124.828**	**48.750 -125.350**
47.600 -123.600	**47.890 -123.890**	**48.180 -124.324**	**48.470 -124.846**	**48.760 -125.368**
47.610 -123.610	**47.900 -123.900**	**48.190 -124.342**	**48.480 -124.864**	**48.770 -125.386**
47.620 -123.620	**47.910 -123.910**	**48.200 -124.360**	**48.490 -124.882**	**48.780 -125.404**

48.790 -125.422
48.800 -125.440
48.810 -125.458
48.820 -125.476
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48.080 -126.552
48.067 -126.542
48.054 -126.532
48.040 -126.522
48.027 -126.512
48.014 -126.502
48.000 -126.492
47.987 -126.482
47.973 -126.472
47.960 -126.462
47.947 -126.452
47.933 -126.442
47.920 -126.432
47.907 -126.422
47.893 -126.412
47.880 -126.402
47.864 -126.392
47.848 -126.382
47.832 -126.372
47.817 -126.362
47.801 -126.352
47.785 -126.342
47.769 -126.332
47.753 -126.322
47.737 -126.312
47.721 -126.302
47.705 -126.292
47.690 -126.282
47.674 -126.272
47.658 -126.262
47.642 -126.252
47.626 -126.242
47.610 -126.232
47.594 -126.222
47.579 -126.212
47.563 -126.202
47.547 -126.192
47.531 -126.182
47.515 -126.172
47.499 -126.162
47.483 -126.152
47.467 -126.142
47.452 -126.132
47.436 -126.122
47.420 -126.112
47.404 -126.102
47.381 -126.092
47.358 -126.082
47.335 -126.072
47.312 -126.062
47.289 -126.052
47.266 -126.042
47.243 -126.032
47.220 -126.022
47.197 -126.012
47.174 -126.002
47.151 -125.992
47.128 -125.982
47.105 -125.972
47.082 -125.962
47.059 -125.952
47.036 -125.942
47.013 -125.932
46.990 -125.922
46.967 -125.912
46.944 -125.902
46.921 -125.892
46.898 -125.882
46.875 -125.872
46.852 -125.862
46.829 -125.852
46.806 -125.842
46.783 -125.832
46.760 -125.822
46.737 -125.812
46.714 -125.802
46.714 -125.802
46.682 -125.792
46.650 -125.782
46.618 -125.772
46.586 -125.762
46.554 -125.752
46.522 -125.742
46.490 -125.732
46.458 -125.722
46.426 -125.712
46.394 -125.702
46.363 -125.692
46.331 -125.682
46.299 -125.672
46.267 -125.662
46.235 -125.652
46.203 -125.642
46.171 -125.632
46.139 -125.622
46.107 -125.612
46.075 -125.602
46.043 -125.592
46.011 -125.582
46.000 -125.578
46.000 -125.435
46.000 -125.291
46.000 -125.148
46.000 -125.004
46.000 -124.861
46.000 -124.717
46.000 -124.574
46.000 -124.430
46.000 -124.287
46.000 -124.143
46.000 -124.000

Appendix C7

Cascadia deterministic values at 2%/50 year probability for the distance range considered

Epicentral Distance	Sa(0.1)	Sa(0.15)	Sa(0.2)	Sa(0.3)	Sa(0.4)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
0	0.938	1.171	1.219	1.112	1.020	0.949	0.480	0.208	0.530
10	0.913	1.141	1.189	1.085	0.996	0.927	0.469	0.204	0.517
20	0.853	1.068	1.114	1.019	0.936	0.872	0.443	0.193	0.484
30	0.778	0.976	1.020	0.936	0.861	0.804	0.410	0.180	0.443
40	0.702	0.884	0.926	0.851	0.785	0.734	0.376	0.166	0.402
50	0.631	0.797	0.837	0.772	0.714	0.668	0.344	0.152	0.363
60	0.568	0.719	0.756	0.700	0.648	0.608	0.314	0.140	0.328
70	0.512	0.649	0.685	0.635	0.590	0.554	0.288	0.129	0.296
80	0.462	0.588	0.621	0.578	0.538	0.506	0.264	0.119	0.268
90	0.418	0.534	0.565	0.527	0.492	0.463	0.243	0.110	0.244
100	0.380	0.486	0.515	0.482	0.450	0.425	0.224	0.102	0.222
120	0.316	0.406	0.432	0.406	0.381	0.360	0.192	0.088	0.186
140	0.265	0.343	0.366	0.346	0.326	0.309	0.166	0.076	0.157
160	0.225	0.292	0.313	0.297	0.281	0.267	0.144	0.067	0.135
180	0.193	0.251	0.270	0.258	0.244	0.233	0.127	0.059	0.116
200	0.166	0.218	0.235	0.225	0.214	0.204	0.112	0.053	0.101
230	0.135	0.178	0.193	0.186	0.177	0.170	0.094	0.045	0.083
260	0.112	0.148	0.161	0.156	0.149	0.143	0.080	0.039	0.069
300	0.088	0.118	0.129	0.125	0.120	0.116	0.066	0.032	0.055
350	0.067	0.091	0.100	0.098	0.094	0.092	0.052	0.026	0.042
400	0.053	0.071	0.079	0.078	0.076	0.074	0.043	0.021	0.033
450	0.042	0.057	0.064	0.063	0.062	0.060	0.035	0.018	0.027
500	0.034	0.047	0.052	0.052	0.051	0.050	0.030	0.015	0.022
550	0.028	0.039	0.044	0.044	0.043	0.042	0.025	0.013	0.018
600	0.024	0.033	0.037	0.037	0.037	0.036	0.022	0.011	0.015
700	0.017	0.024	0.027	0.028	0.027	0.027	0.017	0.009	0.011
800	0.013	0.018	0.021	0.021	0.021	0.021	0.013	0.007	0.009
900	0.010	0.014	0.016	0.017	0.017	0.017	0.010	0.006	0.007
1000	0.008	0.011	0.013	0.013	0.013	0.013	0.009	0.005	0.005

Median values on firm ground, units = g.

Source depth taken to be 25 km.

These values augment the contents of Table 5 and allow the interpolation of hazard values for other sites in southwestern Canada.

Only two significant figures should be used.

APPENDIX D

Input files for GSCFRISK seismic hazard code

The pages which follow this page contain (in 2-column format) the input files for the four models used to generate the Sa(1.0) values in this report. This page annotates the beginning of the first file.

```
1995 Eastern Canada model H Atkinson 95 attenuation PSA 1.0 s
Probabilities of Exceedence required
4  0.01      0.0021      0.001      0.000404                     ! Probability levels
Main data set for GSCFRISK program
3  50  5.0  5.0  0.10  4  1                                       ! Array sizes, integration increments
24  1. 3. 10. 13.5 17.5 23.5 30. 42. 60. 75. 100. 135. 175. 235. 300. 420. ! Ground motion interpolation points
600. 750. 1000. 1350. 1750. 2350. 3000. 4200.
0.44 0.14 0.42                                                    ! weights for attenuation relations
A
AB95R PSA 1s  Median grd motion for PSA1.0s ATKINSON BOORE 1995   ! attenuation relation #1 (best for East, upper for West)
2.77 0.620 -0.0409  0.000 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0      !       Attenuation parameters
AB95R PSA 1s  L grd motion for PSA1.0s ATKINSON BOORE 1995 L limit ! attenuation relation #2 (lower for East, best for West)
2.59 0.620 -0.0409  0.000 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0      !       Attenuation parameters
AB95R PSA 1s  U grd motion for PSA1.0s ATKINSON BOORE 1995 U limit ! attenuation relation #3 (upper for East, lower for West)
3.31 0.620 -0.0409  0.000 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0      !       Attenuation parameters
1  1.0
H - MODEL 1995  37 ZONES  HISTORICAL ZONES
37  3  3  3  37  20                                               !
0.6 0.3 0.1                                                       ! weights for Maximum magnitudes
0.68 0.16 0.16                                                    ! weights for magnitude recurrence
0.5 0.25 0.25                                                     ! weights for depths
1  1  1  1
ADR    - NORTHERN ADIRONDACKS                                     ! Zone name
1
ONLY ALTERNATIVE
1.
area                                                              ! type of zone (area/fault)
10.0  20.0  5.0                                                   ! depth to hypocentres/JB pseudo-depth
7                                                                 ! number of zone corner coordinates
-75.39  44.77                                                     ! longitude/latitude pairs
-73.85  44.95
-73.85  43.90
-72.90  43.90
-72.90  42.90
-75.00  42.90
-75.00  43.90
4.75 7.0 6.0 7.5                                                  ! minimum and maximum magnitudes
1
142. 1.84  291. 2.19  60. 1.50                                    ! No/β pairs (best, lower, upper)
```

Appendix D1

The input file for GSCFRISK seismic hazard code used for the 2005 **H** model probabilistic hazard estimates, V4.01

Eastern Canada H model V4.01

```
PSA 0.2 sec 2005 Eastern Canada H model V4.01 Atkinson95
Data for INTERP subroutine
4  0.01  0.0021  0.001 0.000404
Main data set for GSCFRISK program
3  50  5.0  5.0  0.10  4  1
24  1. 3. 10. 13.5 17.5 23.5 30. 42. 60. 75. 100. 135. 175. 235. 300. 389.5 420.
600. 750. 1000. 1350. 1750. 2350. 3000. 4200.
0.44 0.28 0.28
A
AB94R PSA 0.2s Mlg Median grd motion for Pseudo Acc 0.2s ATKINSON BOORE 1994Mlg
3.75 0.418 -0.0644 -0.000457 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
AB94R PSA 0.2s Mlg L grd motion for PSA 0.2s ATKINSON BOORE 1994 Mlg Lower limit
3.43 0.418 -0.0644 -0.000457 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
AB94R PSA 0.2s Mlg U grd motion for PSA 0.2s ATKINSON BOORE 1994 Mlg Upper limit
4.00 0.418 -0.0644 -0.000457 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
1  1.0
H - MODEL EASTERN CANADA V4.01  37 ZONES  HISTORICAL ZONES
37  3  3  3  37  20
0.6 0.3 0.1
0.68 0.16 0.16
0.5 0.25 0.25
1  1  1  1
ADR    - NORTHERN ADIRONDACKS
1
ONLY ALTERNATIVE
1.
area
10.0  20.0  5.0
7
-75.39  44.77
-73.85  44.95
-73.85  43.90
-72.90  43.90
-72.90  42.90
-75.00  42.90
-75.00  43.90
4.75 7.0 6.0 7.5
1
142. 1.84  291. 2.19  60. 1.50
AOBH   - ATLANTIC OFFSHORE BACKGROUND (H model)
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
7
-53.10  53.20
-46.70  49.00
-51.00  44.90
-57.50  45.00
-66.40  40.25
-69.30  42.95
-60.00  48.00
4.75  7.5 6.0 7.5
1
755. 2.00  1530. 2.20  927. 1.80
AOH    - ANNA OHIO
1
ONLY ALTERNATIVE
1.
area
5.0 20.0 5.0
4
-84.90  40.00
-83.50  40.00
-83.50  40.80
-84.90  40.80
4.75  7.0 6.0 7.5
1
575. 2.05  402. 2.15  700. 1.95
BFB    - BAFFIN BAY
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
6
-60.00  67.40
-57.70  68.00
-64.30  73.00
-73.10  76.80
-75.80  72.90
-71.00  71.60
4.75 7.5 7.3 8.0
1
884. 1.64  1570. 1.84  485. 1.45
BIN     - BAFFIN ISLAND NORTH
1
ONLY ALTERNATIVE
1.
area
5.0 20.0 10.0
4
-73.40  69.60
-68.50  70.90
-75.10  72.60
-79.20  71.50
4.75  7.0 6.5 7.5
1
1730. 1.92  2440. 2.09  1000. 1.75
```

```
BIS     - BAFFIN ISLAND SOUTH
1
ONLY ALTERNATIVE
1.
area
5.0 20.0 10.0
4
-67.80  69.80
-64.10  67.70
-68.10  66.70
-72.10  68.70
4.75 7.0 6.0 7.5
1
558. 1.92  705. 2.09  351. 1.75
BSL    - BAS SAINT LAURENT
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
8
-68.90  48.90
-68.00  49.35
-67.40  49.40
-66.90  50.00
-65.60  49.50
-65.60  49.25
-66.20  49.20
-68.50  48.50
4.75  7.5 6.0 7.7
1
533. 1.93  781. 2.13  344. 1.74
CHA    - CHAMPLAIN
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
4
-73.85  44.95
-72.90  45.60
-72.90  43.90
-73.85  43.90
4.75  7.5 6.0 7.7
1
107. 2.00  92. 2.10  120. 1.90
CHV    - CHARLEVOIX
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
5
-70.25  47.10
-69.53  47.69
-69.95  47.95
-70.40  47.85
-70.79  47.46
4.75  7.5 7.2 7.7
1
374. 1.74  477. 1.85  310 1.62
COC     - COCHRANE
1
ONLY ALTERNATIVE
1.
area
10.0  20.0  5.0
4
-81.60  50.25
-82.50  49.95
-79.55  46.80
-78.75  47.35
4.75 7.5 6.0 7.7
1
76. 2.00  74. 2.10  126. 1.90
DIB     -  DEVON ISLAND BACKGROUND
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
6
-83.60  72.50
-78.20  74.30
-77.10  76.60
-86.50  78.90
-90.00  77.00
-90.00  74.70
4.75  7.0 6.0 7.5
1
1200. 2.25  2330. 2.55  600. 1.95
GAT     - GATINEAU
1
ONLY ALTERNATIVE
1.
area
10.0  20.0  5.0
5
-75.26  47.43
-74.00  45.85
-75.26  45.66
-77.26  46.66
-77.32  47.55
4.75 7.0 6.5 7.5
1
1190. 2.07  1580. 2.23  811. 1.91
GLA    .- GUSTAF LOUGHEED ARCH
1
ONLY ALTERNATIVE
1.
area
10.0 30.0 5.0
6
-108.50  76.00
-105.50  76.00
-104.00  77.50
-106.00  78.60
-109.00  78.30
```

```
-107.00  77.50
4.75 7.0 6.5 7.5
1
206. 1.54  597. 1.90  65. 1.18
GLD     - GREENLAND
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
6
-55.30  64.85
-51.10  64.85
-51.10  74.15
-62.60  76.95
-72.20  76.70
-55.30  71.35
4.75  7.33 7.0 7.63
1
500. 1.70  78300. 3.11  285. 1.50
GNS     - GULF OF ST. LAWRENCE - NORTH SHORE
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
5
-65.00  49.40
-63.00  50.00
-62.40  51.70
-65.00  51.00
-66.50  50.20
4.75  7.5 6.0 7.7
1
237. 2.00  248. 2.10  223. 1.90
JMS     - JAMES BAY
1
ONLY ALTERNATIVE
1.
area
10.0  20.0  5.0
4
-83.00  50.70
-78.00  50.70
-78.00  54.20
-83.00  54.20
4.75 7.0 6.8 7.2
1
167. 2.00  190. 2.10  237. 1.90
LBR     - LABRADOR RIDGE
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
6
-61.50  62.80
-63.10  61.85
-58.00  59.60
-53.60  57.50
-51.20  57.90
-55.00  60.00
4.75  6.66 6.29 7.33
1
3970. 2.00  21900. 2.46  3210. 1.90
LBS     - LABRADOR SHELF
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
4
-54.70  54.00
-53.80  55.00
-62.00  60.00
-60.40  56.60
4.75  7.33 6.66 7.63
1
358. 1.70  11100. 2.61  225. 1.50
LSP     - LAURENTIAN SLOPE
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
4
-57.20  44.30
-55.00  44.30
-55.00  45.00
-57.20  45.00
4.75 7.33 7.33 7.63
1
278. 1.70  404. 1.90  140. 1.44
MNT     - MONTREAL
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
5
-74.00  45.85
-73.10  45.46
-73.85  44.95
-75.39  44.77
-75.26  45.66
4.75  7.5 6.5 7.7
1
258. 1.96  405. 2.19  167. 1.74
NAN   - NORTHERN APPALACHIANS
1
ONLY ALTERNATIVE
1.
area
5.0 20.0 5.0
7
-70.60  42.00
-64.00  46.05
-64.70  48.25
```

```
-66.50  48.30
-71.50  45.50
-72.50  44.00
-72.50  42.00
4.75  7.0 6.0 7.0
1
374. 1.75  508. 1.90  276. 1.60
NAT   - NIAGARA ATTICA
1
ONLY ALTERNATIVE
1.
area
5.0  20.0  5.0
4
-77.85  43.30
-79.90  43.65
-80.15  42.90
-78.15  42.55
4.75  7.0 6.0 7.5
1
69. 1.80  164. 2.23  29. 1.37
OBGH   - ONTARIO BACKGROUND (H model)
1
ONLY ALTERNATIVE
1.
area
5.0  20.0  10.0
8
-86.00  39.20
-80.00  39.20
-75.00  41.80
-75.00  43.90
-75.39  44.77
-78.21  45.68
-83.00  46.00
-86.00  43.00
4.75  7.0 6.8 7.2
1
273. 2.00  346. 2.20  176 1.80
PEM    - PEMBROKE
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
5
-78.20  46.70
-75.26  45.66
-75.39  44.77
-78.21  45.68
-78.89  46.36
4.75  7.5 6.0 7.7
1
140. 1.95  271 2.34  55. 1.57
PMQ    - PASSAMAQUODDY BAY
1
ONLY ALTERNATIVE
1.
area
```

```
10.0 20.0 5.0
4
-67.00  45.40
-66.40  44.75
-67.20  44.30
-67.80  45.10
4.75 7.0 6.5 7.5
1
49. 1.72  124. 2.17  18. 1.26
QES    - QUEEN ELIZABETH SHELF
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
4
-118.70  79.00
-106.60  79.50
-103.20  81.30
-120.70  80.80
4.75 7.33 6.29  7.63
1
1175. 2.00  2310. 2.25  570. 1.75
RST    - RESOLUTE
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
4
-90.00 77.00
-98.00 77.00
-98.00 71.70
-90.00 71.70
4.75  7.0 6.5 7.5
1
914. 2.00 1920. 2.28  406. 1.72
SAG    - SAGUENAY
1
ONLY ALTERNATIVE
1.
area
10.0 30.0 5.0
7
-71.00  48.62
-69.54  48.32
-69.95  47.95
-70.40  47.85
-71.10  48.05
-72.45  48.50
-72.45  48.95
4.75 7.5 6.5 7.7
1
89. 2.00  67. 2.10  84. 1.90
SEB    - SOUTHEAST CANADA BACKGROUND
1
ONLY ALTERNATIVE
1.
area
```

```
10.0  20.0  5.0
14
-72.90  44.60
-66.50  48.30
-60.00  48.00
-53.10  53.20
-56.70  55.00
-74.50  47.62
-81.00  50.70
-83.50  49.70
-80.80  45.90
-78.21  45.68
-75.39  44.77
-75.00  43.90
-75.00  42.90
-72.90  42.90
4.75  7.0 6.0 7.5
1
649.  2.00  25400 3.33  532  1.80
SLE    - SOUTH SHORE LAKE ERIE
1
ONLY ALTERNATIVE
1.
area
5.0 20.0 5.0
4
-81.70  41.00
-79.90  41.70
-80.30  42.30
-82.10  41.50
4.75  7.0 6.0 7.5
1
169. 2.09  457. 2.57  61. 1.61
SPB    - SPENCE BAY
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
6
-91.50 66.10
-87.50 68.40
-90.00 70.00
-98.00 70.20
-98.00 67.60
-95.00 66.00
4.75  7.0 6.5 7.5
1
374. 2.00 478. 2.20  88. 1.34
SVDH   - SVERDRUP BASIN  - No GLA events (H model)
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
11
-117.80  75.00
-108.00  75.00
 -98.00  75.00
 -98.00  77.00
 -90.00  77.00
 -75.00  82.40
 -80.00  83.00
-103.20  78.90
-110.00  78.80
-121.00  77.10
-122.90  75.50
4.75  7.0 6.5 7.5
1
6330. 2.25  16300. 2.55  2390. 1.95
TIM    - TIMISKAMING
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
4
-78.30  46.65
-78.89  46.36
-79.37  46.89
-78.90  47.20
4.75  7.5 6.5 7.7
1
63. 2.00  47. 2.10  65. 1.90
TRR    - TROIS-RIVIERES
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
6
-71.14  47.22
-70.70  47.35
-70.35  47.15
-70.60  46.90
-73.10  45.46
-74.00  45.85
4.75 7.5 6.0 7.7
1
113. 2.00  113. 2.10  122. 1.90
UNG    - UNGAVA
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
5
-78.00  59.40
-64.50  59.50
-64.80  62.80
-79.00  62.90
-80.00  61.40
4.75  7.0 6.5 7.5
1
849. 2.00 1700. 2.28  60. 1.24
WGB    - WEGER BAY
1
ONLY ALTERNATIVE
```

```
1.
area
10.0 20.0 5.0
4
-90.00  63.30
-86.50  63.40
-82.50  65.70
-91.50  66.10
4.75  7.0 6.5 7.5
1
737. 2.00 1470. 2.28  336. 1.72
WLB    - WILLISTON BASIN
1
WLB
1.0
area
10.0  20.0  5.0
6
-104.00  50.00
-103.00  48.50
-104.00  48.00
-107.00  48.00
-107.00  48.50
-105.00  50.00
4.75 7.0 6.8 7.2
1
24.4 1.570  49.1 1.972  11.7 1.168
```

Western Canada H model V4.01

```
PSA 0.2 sec 2005 Western Canada H model V4.01 Booreetal93 Youngsetal97
Probabilities of Exceedence for INTERP Subroutine in GSCFRISK.
4  0.01  0.0021  0.001 0.000404
Data Set for Integrations in GSCFRISK.
6 50 5.0 5.0 0.10 4 2
24  1. 3. 10. 13.5 17.5 23.5 30. 42. 60. 75. 100. 135. 175. 235. 300. 420.
600. 750. 1000. 1350. 1750. 2350. 3000. 4200.
3 1 0.3 2 0.4 3 0.3
B
Boore/Joyner/Fumal(1993) Attenuation; PSA (0.2s) + 0.7 log nat or 0.3 dec log
3.764 0.309 -0.090 -0.00259 -0.924 0.190 7.02 0.0 0.0 11 0.495 0 0.0
Boore/Joyner/Fumal(1993) Attenuation; PSA (0.2s)
3.464 0.309 -0.090 -0.00259 -0.924 0.190 7.02 0.0 0.0 11 0.495 0 0.0
Boore/Joyner/Fumal(1993) Attenuation; PSA (0.2s) - 0.7 log nat or 0.3 dec log
3.164 0.309 -0.090 -0.00259 -0.924 0.190 7.02 0.0 0.0 11 0.495 0 0.0
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.2s) + 0.7 nat log
1.422   -0.0027  -2.528 1.45  -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.2s)
0.722   -0.0027  -2.528 1.45  -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.2s) - 0.7 nat log
0.022   -0.0027  -2.528 1.45  -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
1 1.0
HORNER'S 1992 SOURCE ZONES (RBH92)
34  3  3  1  34  12
0.68  0.16  0.16
0.68  0.16  0.16
1.0
1  1  1  1
ALASKA COASTAL
1
ALC
1.0
area
****************************************
Borrowed from USGS; No Completeness Data.
****************************************
7.02  !JB-pseudo_depth
4
-145.000  61.000 .
-145.000  59.300
-156.000  54.700
-157.500  55.800
4.75  8.5 8.2 8.7
1
3848.1 1.43  5731.25 1.51 2585.08 1.35
ALASKA INLAND
1
ALI
1.0
```

```
area
****************************************
Borrowed from USGS; No Completeness Data.
****************************************
7.02  !JB-pseudo_depth
7
-145.000  64.500
-145.000  61.000
-157.500  55.800
-160.000  54.300
-160.000  57.000
-154.000  60.000
-151.000  64.500
4.75  8.5 8.2 8.5
1
57235.7 1.73  99129.5 1.84 33058.6 1.62
BEAUFORT COAST
1
BFC
1.0
area
6
4.0   4.8   5.3   5.8   6.3   7.2
1965  1962  1951  1935  1917  1899
7.02  !JB-pseudo_depth
   12
-123.00 72.00
-123.00 68.50
-134.00 68.50
-135.00 67.30
-137.00 67.30
-137.00 68.50
-145.00 68.50
-145.00 72.00
-138.00 72.00
-138.00 71.00
-132.00 70.70
-129.00 72.00
4.75  7.0 6.7 7.3
1
507980.34  3.3488  4858170.0  3.9772  50890.54  2.7205
BEAUFORT SEA
1
BFS
1.0
area
8
3.0   3.3   3.8   4.8   5.3   5.8   6.3   7.2
1982  1969  1965  1962  1951  1935  1917  1899
7.02  !JB-pseudo_depth
   5
-129.00 73.00
-129.00 72.00
-132.00 70.70
-138.00 71.00
-138.00 72.50
4.75  7.0 6.7 7.3
1
577.51  1.6683  766.80  1.8244  381.16  1.5123
```

```
BROOKS PENINSULA
1
BRP
1.0
area
7
2.5   2.8   3.3   3.8   4.8   5.3   6.8
1982  1962  1965  1956  1940  1917  1899
7.02  !JB-pseudo_depth
   5
-128.00 50.33
-127.75 50.33
-127.50 50.00
-127.85 49.72
-128.43 50.08
4.75  7.0 6.7 7.3
1
23.56  1.2123  36.23  1.4143  20.36  1.0102
CASCADE MOUNTAINS
1
CASH           (shallow)
1.0
area
7
2.5   2.8   3.8   4.8   5.3   5.8   6.8
1976  1970  1956  1940  1917  1899  1860
7.02  !JB-pseudo_depth
   5
-121.83 49.65
-121.00 48.00
-121.00 47.00
-123.35 47.00
-123.84 48.88
4.75  7.3 7.1 7.5
1
1402.86  2.0127  1704.07  2.1234  1137.90  1.9019
CENTRAL COAST MOUNTAINS
1
CCM
1.0
area
6
3.0   3.3   3.8   5.3   5.8   6.8
1985  1971  1965  1940  1917  1899
7.02  !JB-pseudo_depth
   6
-131.55 57.67
-128.00 55.00
-125.00 51.50
-127.75 50.33
-131.00 54.50
-133.55 57.00
4.75  7.0 6.5 7.3
1
81.39  1.7624  400.87  2.4103  18.83  1.1146
DENALI FAULT
1
DENH
1.0
```

```
area
8
2.8    3.8    4.3    4.8    5.3    5.8    6.3    7.2
1979   1972   1965   1962   1951   1935   1917   1899
7.02   !JB-pseudo_depth
   11
-145.00 63.70
-140.00 62.00
-135.50 59.80
-135.70 59.00
-136.00 59.30
-136.50 59.60
-138.00 59.33
-138.00 59.67
-139.00 60.50
-141.00 61.00
-145.00 63.00
4.75   7.5 7.0 8.0
1
2480.09   1.8540   3041.20   1.9472   2081.56   1.7607
EASTERN GULF OF ALASKA
1
EGA
1.0
area
8
3.4    3.8    4.3    4.8    5.3    5.8    6.3    7.2
1979   1972   1965   1962   1951   1935   1917   1899
7.02   !JB-pseudo_depth
   7
-145.00 59.00
-140.00 59.50
-138.50 59.00
-137.00 58.00
-136.75 57.50
-141.00 56.50
-145.00 56.50
4.75   7.9 7.6 8.2
1
20316.14   2.0392   25399.62   2.1186   16518.40   1.9599
FLATHEAD LAKE
1
FHL
1.0
area
4
4.0    4.8    5.3    5.8
1960   1940   1917   1899
7.02   !JB-pseudo_depth
   4
-114.900   48.600
-114.000   48.600
-112.200   47.000
-114.800   47.000
4.75   7.3 7.1 7.5
1
14016.46   2.4905   63129.58   2.9255   3021.49   2.0554
GEORGIA STRAIT
1
GEO            (deep)
1.0
area
6
2.5    2.8    4.8    5.3    5.8    6.8
1976   1956   1940   1917   1899   1860
50.0   !Depth
   4
-124.60 50.75
-122.70 49.33
-123.84 48.88
-125.70 50.27
4.75   7.0 6.5 7.3
1 3 4 0.3 5 0.4 6 0.3
85.17   2.2500   220.86   2.7500   41.20   1.7500
GLACIER BAY
1
GLB
1.0
area
8
2.8    3.8    4.3    4.8    5.3    5.8    6.3    7.2
1979   1972   1965   1962   1951   1935   1917   1899
7.02   !JB-pseudo_depth
   6
-136.50 59.60
-136.00 59.30
-135.70 59.00
-135.70 58.75
-136.60 58.40
-138.00 59.33
4.75   7.0 6.7 7.3
1
896.47   1.7544   1153.34   1.8849   682.50   1.6239
HECATE STRAIT
1
HECH
1.0
area
7
2.5    2.8    3.3    3.8    5.3    5.8    6.8
1986   1985   1971   1965   1940   1917   1899
7.02   !JB-pseudo_depth
   4
-131.00 54.50
-130.20 52.00
-131.00 52.00
-133.72 54.51
4.75   7.0 6.7 7.3
1
1166.99   2.0705   1667.06   2.2456   897.53   1.8955
JUAN DE FUCA BENDING
1
JDF
1.0
area
7
2.5    2.8    3.8    4.8    5.3    5.8    6.8
1982   1970   1956   1940   1917   1899   1860
```

```
7.02  !JB-pseudo_depth
   8
-127.20 49.33
-126.60 49.33
-126.60 49.90
-125.70 50.27
-123.84 48.88
-123.35 47.00
-125.50 47.00
-125.80 48.00
4.75  7.3 7.3 7.3
1
0.2 0.05  223.54 1.7658 0.2 0.05
McKENZIE MOUNTAINS
1
MCK
1.0
area
8
3.2   3.3   3.8   4.8   5.3   5.8   6.3   7.2
1982  1969  1965  1962  1951  1935  1917  1899
7.02  !JB-pseudo_depth
   11
-136.00 65.70
-134.00 65.70
-125.00 65.70
-123.00 64.00
-123.00 60.00
-126.30 59.00
-129.00 61.00
-133.00 63.50
-137.50 63.50
-137.50 65.00
-139.00 65.70
4.75  7.2 6.9 7.5
1
35815.17  2.2054  44670.69  2.2762  30775.68  2.1347
NORTHERN COAST MOUNTAINS
1
NCM
1.0
area
8
3.6   3.8   4.3   4.8   5.3   5.8   6.3   7.2
1979  1972  1965  1962  1951  1935  1917  1899
7.02  !JB-pseudo_depth
   7
-135.00 60.00
-131.55 57.67
-133.55 57.00
-135.00 58.00
-135.70 58.75
-135.70 59.00
-135.50 59.80
4.75  7.0 6.7 7.3
1
333.94  1.7908  1142.79  2.2519  78.41  1.3298
NORTHEASTERN ALASKA
1
NEA
1.0
area
8
3.0   3.3   4.3   4.8   5.3   5.8   6.3   7.2
1985  1972  1965  1962  1951  1935  1917  1899
7.02  !JB-pseudo_depth
   7
-143.00 68.50
-139.00 67.00
-139.00 65.70
-141.00 65.00
-141.00 64.00
-145.00 65.00
-145.00 68.50
4.75  7.0 6.7 7.3
1
2555.64  2.1988  4567.81  2.4627  1262.61  1.9349
NORTHERN FOOTHILLS
1
NFT
1.0
area
5
2.9   3.3   5.3   5.8   6.8
1982  1965  1940  1917  1899
7.02  !JB-pseudo_depth
   7
-123.00 60.00
-115.00 57.00
-115.00 55.00
-116.00 54.00
-119.50 53.75
-122.00 55.00
-126.30 59.00
4.75  7.0 6.7 7.3
1
2757.76  2.7926  13842.16  3.4304  619.38  2.1549
NORTHERN JUAN DE FUCA PLATE
1
NJFP
1.0
area
4
3.0   3.3   5.3   6.8
1982  1965  1917  1899
7.02  !JB-pseudo_depth
   5
-127.20 49.33
-125.80 48.00
-125.50 47.00
-128.00 47.20
-128.00 48.90
4.75  6.8 6.6 7.0
1
22.56  1.2477  48.75  1.5574  13.03  0.9380
NORTHERN JUAN DE FUCA RIDGE
1
NJFR
```

```
1.0
area
3
4.1   5.3   6.8
1965  1917  1899
7.02  !JB-pseudo_depth
   4
-128.00 48.40
-128.00 47.20
-129.50 47.20
-129.50 48.40
4.75  6.8 6.6 7.0
1
65516.41  2.7446  684035.56  3.3708  5961.35  2.1184
NOOTKA FAULT
1
NOFH
1.0
area
7
2.5   2.8   3.3   3.8   4.8   5.3   6.8
1982  1962  1965  1956  1940  1917  1899
7.02  !JB-pseudo_depth
   9
-127.85 49.72
-127.50 50.00
-126.90 50.00
-126.60 49.90
-126.60 49.33
-127.20 49.33
-128.00 48.90
-128.10 48.90
-128.10 49.10
4.75  7.0 6.7 7.3
1
138.65  1.4225  173.76  1.5392  119.39  1.3057
NORTHERN ROCKY MOUNTAIN TRENCH
1
NRMT
1.0
area
5
2.5   3.3   5.3   5.8   6.8
1982  1965  1940  1917  1899
7.02  !JB-pseudo_depth
   6
-129.00 61.00
-126.30 59.00
-122.00 55.00
-119.50 53.75
-122.50 53.50
-130.00 60.00
4.75  7.0 6.7 7.3
1
278.62  2.0912  558.80  2.4389  156.85  1.7436
OGILVIE MOUTAINS
1
OGL
1.0
area
8
3.0   3.3   4.3   4.8   5.3   5.8   6.3   7.2
1985  1972  1965  1962  1951  1935  1917  1899
7.02  !JB-pseudo_depth
   6
-139.00 65.70
-137.50 65.00
-137.50 63.50
-139.00 63.50
-141.00 64.00
-141.00 65.00
4.75  7.0 6.7 7.3
1
318.14  1.6921  646.53  1.9550  193.82  1.4292
PUGET SOUND
1
PUG        '   (deep)
1.0
area
7
2.5   2.8   3.8   4.8   5.3   5.8   6.8
1976  1970  1956  1940  1917  1899  1860
50.0  !Depth
   6
-122.70 49.33
-122.30 49.00
-122.00 48.00
-122.00 47.00
-123.35 47.00
-123.84 48.88
4.75  7.3 7.1 7.6
1 3 4 0.3 5 0.4 6 0.3
18.1  1.01 19.9 1.12  16.4 0.90
QUEEN CHARLOTTE FAULT BORDER
1
QCB
1.0
area
6
3.0   3.3   4.3   5.3   5.8   6.8
1985  1971  1965  1940  1917  1899
7.02  !JB-pseudo_depth
   7
-136.75 57.50
-136.00 55.50
-133.75 53.00
-132.00 51.50
-134.00 50.50
-138.00 54.00
-139.00 56.95
4.75  7.0 6.7 7.3
1
363.97  1.9619  1101.62  2.3947  140.58  1.5291
QUEEN CHARLOTTE FAULT
1
QCFH
1.0
fault
```

```
90.0 90.0 3 10.0 25.0
-1.085  0.389  0.01
3
-136.80  58.70
-132.40  52.90
-130.60  51.50
4.75  8.5 8.2 8.7
1
905.26  1.4845  1187.61  1.5605  872.35  1.4085
QUEEN CHARLOTTE SOUND
1
QCS
1.0
area
4
3.0   3.3   5.3   6.8
1983  1965  1917  1899
7.02  !JB-pseudo_depth
   6
-130.20 52.00
-128.21 50.21
-128.43 50.08
-130.00 51.00
-130.30 51.50
-131.00 52.00
4.75  7.0 6.7 7.3
1
72.73  1.4292  131.09  1.6718  47.41  1.1867
REVERE-DELLWOOD, SOVANCO
1
RDS
1.0
area
3
3.3   5.3   6.8
1965  1917  1899
7.02  !JB-pseudo_depth
   10
-130.30 51.50
-130.00 51.00
-128.43 50.08
-127.85 49.72
-128.10 49.10
-128.10 48.90
-128.00 48.90
-128.00 48.40
-130.00 48.40
-132.00 51.50
4.75  7.0 6.8 7.2
1
2443.76  1.4599  2824.63  1.5088  2226.72  1.4110
RICHARDSON MOUNTAINS
1
RIC
1.0
area
8
3.0   3.3   3.8   4.8   5.3   5.8   6.3   7.2
1982  1969  1965  1962  1951  1935  1917  1899
```

```
7.02  !JB-pseudo_depth
   4
-135.00 67.30
-134.00 65.70
-136.00 65.70
-137.00 67.30
4.75  7.0 6.7 7.3
1
3519.08  2.0631  4797.84  2.2094  2392.91  1.9169
SOUTHERN COAST MOUNTAINS
1
SCM             (shallow)
1.0
area
7
2.5   2.8   3.3   4.8   5.3   5.8   7.2
1976  1962  1956  1940  1917  1899  1860
7.02  !JB-pseudo_depth
   10
-126.60 49.90
-126.90 50.00
-127.50 50.00
-127.75 50.33
-125.00 51.50
-124.50 51.50
-122.00 50.00
-121.83 49.65
-123.84 48.88
-125.70 50.27
4.75  7.0 6.5 7.3
1
85.50  1.5741  118.02  1.7661  61.41 1.3821
SOUTHEASTERN BRITISH COLUMBIA
1
SEBC
1.0
area
6
3.0   3.3   4.3   4.8   5.3   5.8
1966  1965  1960  1940  1917  1899
7.02  !JB-pseudo_depth
   6
-119.50 53.75
-112.75 48.00
-121.00 48.00
-122.00 50.00
-124.50 51.50
-122.50 53.50
4.75  7.0 6.7 7.3
1
854.77  1.8125  1168.50  1.9479  634.06  1.6772
SOUTHERN FOOTHILLS
1
SFT
1.0
area
6
3.0   3.3   4.3   4.8   5.3   5.8
1966  1965  1960  1940  1917  1899
```

```
7.02  !JB-pseudo_depth
   5
-116.00 54.00
-114.00 52.00
-111.00 48.00
-112.75 48.00
-119.50 53.75
4.75  6.0 5.0 7.0
1
4878.34  2.4781  9370.34  2.7375  2514.87  2.2186
SOUTHERN YUKON TERRITORY
1
SYT
1.0
area
8
3.0   3.8   4.3   4.8   5.3   5.8   6.3   7.2
1979  1972  1965  1962  1951  1935  1917  1899
7.02  !JB-pseudo_depth
   9
-141.00 64.00
-139.00 63.50
-133.00 63.50
-129.00 61.00
-130.00 60.00
-135.00 60.00
-135.50 59.80
-140.00 62.00
-141.00 62.40
4.75  7.0 6.7 7.3
1
529.50  1.9283  1050.45  2.2452 239.13  1.6114
YAKUTAT FAIRWEATHER FAULT
1
YFF
1.0
area
8
3.4   3.8   4.3   4.8   5.3   5.8   6.3   7.2
1979  1972  1965  1962  1951  1935  1917  1899
7.02  !JB-pseudo_depth
   11
-145.00 61.00
-141.00 61.00
-139.00 60.50
-138.00 59.67
-138.00 59.33
-136.60 58.40
-136.40 58.24
-137.00 58.00
-138.50 59.00
-140.00 59.50
-145.00 59.00
4.75  8.5 8.2 8.7
1
27728.38  2.1288  35213.07  2.2119 22338.68  2.0457
```

Appendix D2

The input file for GSCFRISK seismic hazard code used for the 2005 **R** model probabilistic hazard estimates, V4.01

```
PSA 0.2 sec 2005 Eastern Canada R model V4.01 Atkinson95
Data for INTERP subroutine
4  0.01  0.0021  0.001 0.000404
Main data set for GSCFRISK program
3  50  5.0  5.0  0.10  4  1
24  1. 3. 10. 13.5 17.5 23.5 30. 42. 60. 75. 100. 135. 175. 235. 300. 389.5
420. 600. 750. 1000. 1350. 1750. 2350. 3000. 4200.
0.44 0.28 0.28
A
AB94R PSA 0.2s Mlg Median grd motion for Pseudo Acc 0.2s ATKINSON BOORE
1994Mlg
3.75 0.418 -0.0644 -0.000457 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
AB94R PSA 0.2s Mlg L grd motion for PSA 0.2s ATKINSON BOORE 1994 Mlg Lower
limit
3.43 0.418 -0.0644 -0.000457 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
AB94R PSA 0.2s Mlg U grd motion for PSA 0.2s ATKINSON BOORE 1994 Mlg Upper
limit
4.00 0.418 -0.0644 -0.000457 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
1  1.0
R - MODEL EASTERN CANADA V4.01  21 ZONES REGIONAL ZONES
21  3  3  3  21  22
0.6 0.3 0.1
0.68 0.16 0.16
0.5 0.25 0.25
1  1  1  1
ACM     - ARCTIC CONTINENTAL MARGIN
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
13
-150.00  71.30
-140.00  70.00
-130.00  71.00
-125.00  76.00
-121.00  77.10
-105.00  80.00
 -85.00  83.00
 -95.00  83.80
-110.00  81.25
-130.00  77.00
-134.00  72.10
-140.00  71.50
-150.00  72.80
4.75  7.33 7.0 7.63
1
5100.  2.08  11600. 2.34  2250. 1.83
ADR     - NORTHERN ADIRONDACKS
1
ONLY ALTERNATIVE
1.
area
10.0  20.0  5.0
7
-75.39  44.77
-73.85  44.95
-73.85  43.90
-72.90  43.90
-72.90  42.90
-75.00  42.90
-75.00  43.90
4.75 7.0 6.0 7.5
1
142. 1.84  291. 2.19  60. 1.50
AOBR    - ATLANTIC OFFSHORE BACKGROUND (R model)
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
8
-53.10  53.20
-49.40  47.20
-50.70  44.30
-54.40  46.00
-59.00  45.40
-67.60  42.00
-68.35  43.10
-63.00  45.20
4.75  7.0 6.0 7.5
1
587. 2.00  873. 2.20  514. 1.80
BFI     - BAFFIN ISLAND
1
ONLY ALTERNATIVE
1.
area
5.0 20.0 10.0
8
-59.85  65.65
-65.00  69.00
-71.25  72.00
-78.20  74.25
-83.60  72.55
-75.20  69.90
-70.05  67.70
-64.70  64.50
4.75  7.0 6.5 7.5
1
2390. 1.92  3490. 2.09  1380. 1.74
BOU     - BOOTHIA UNGAVA
1
ONLY ALTERNATIVE
```

```
1.
area
10.0 20.0 5.0
10
-64.50  59.50
-64.80  62.80
-74.00  62.80
-85.00  66.50
-90.00  70.00
-90.00  77.00
-98.00  77.00
-98.00  67.60
-90.00  63.10
-78.00  59.40
4.75 7.0 6.5 7.5
1
3150. 2.02  7730. 2.30  1250. 1.74
CMF    - COASTAL MAINE FUNDY
1
ONLY ALTERNATIVE
1.
area
10.0  20.0  5.0
5
-72.90  42.90
-70.70  42.00
-63.00  45.20
-64.30  46.60
-68.40  45.00
4.75  7.0 6.5 7.5
1
425. 2.02  696. 2.27  247. 1.78
COC    - COCHRANE
1
ONLY ALTERNATIVE
1.
area
10.0  20.0  5.0
4
-81.60  50.25
-82.50  49.95
-79.55  46.80
-78.75  47.35
4.75 7.5 6.0 7.7
1
76. 2.00  74. 2.10  126. 1.90
DIB    -  DEVON ISLAND BACKGROUND
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
6
-83.60  72.50
-78.20  74.30
-77.10  76.60
-86.50  78.90
-90.00  77.00
-90.00  74.70
4.75  7.0 6.0 7.5
1
1200. 2.25  2330. 2.55  600. 1.95
ECM    - EASTERN CONTINENTAL MARGIN
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
22
-66.80  40.80
-58.50  44.10
-54.90  44.60
-49.60  42.20
-47.20  47.10
-51.40  54.30
-58.30  57.70
-62.30  61.50
-56.60  65.60
-71.70  74.00
-72.20  76.70
-77.15  76.60
-75.70  73.60
-59.90  65.70
-65.30  61.50
-60.30  56.60
-53.10  53.20
-49.40  47.20
-50.70  44.30
-54.40  46.00
-59.00  45.40
-67.60  42.00
4.75 7.33 7.20 7.63
1
1840. 1.70  3460. 1.90  956. 1.50
GAT    - GATINEAU
1
ONLY ALTERNATIVE
1.
area
10.0  20.0  5.0
5
-75.26  47.43
-74.00  45.85
-75.26  45.66
-77.26  46.66
-77.32  47.55
4.75 7.0 6.5 7.5
1
1190. 2.07  1580. 2.23  811. 1.91
GLD    - GREENLAND
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
6
-55.30  64.85
-51.10  64.85
```

```
-51.10  74.15
-62.60  76.95
-72.20  76.70
-55.30  71.35
4.75  7.33 7.0 7.63
1
500. 1.70  78300. 3.11  285. 1.50
IRB    - Iapetan Rift Background
1
ONLY ALTERNATIVE
1.
area
10.0  20.0  5.0
14
-72.90  44.60
-66.50  48.30
-60.00  48.00
-53.10  53.20
-56.70  55.00
-74.50  47.62
-81.00  50.70
-83.50  49.70
-80.80  45.90
-78.21  45.68
-75.39  44.77
-75.00  43.90
-75.00  42.90
-72.90  42.90
4.75  7.0 6.0 7.5
1
630. 2.00  844. 2.10  688. 1.90
IRM    - Iapetan Rift Margin
1
ONLY ALTERNATIVE
1.
area
10.0  20.0  5.0
18
-72.90  43.90
-72.90  45.65
-70.00  47.40
-65.85  49.60
-66.90  50.00
-70.00  48.35
-72.00  48.90
-72.35  48.35
-70.75  47.90
-74.30  45.65
-75.10  45.55
-76.85  46.20
-78.75  47.35
-79.55  46.80
-77.60  45.65
-75.25  44.80
-73.85  44.95
-73.85  43.90
4.75  7.5 7.2 7.7
1
2220. 1.98  2720. 2.07  1810. 1.88
JMS    - JAMES BAY
1
ONLY ALTERNATIVE
1.
area
10.0  20.0  5.0
4
-83.00  50.70
-78.00  50.70
-78.00  54.20
-83.00  54.20
4.75 7.0 6.8 7.2
1
167. 2.00  190. 2.10  237. 1.90
LAB    - SOUTHERN LABRADOR
1
ONLY ALTERNATIVE
1.
area
10.0  20.0  5.0
4
-66.90  50.00
-65.60  49.50
-56.60  53.61
-57.29  54.15
4.75 7.5 6.0 7.7
1
155. 2.00  131. 2.10  164. 1.90
LBR    - LABRADOR RIDGE
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
6
-61.50  62.80
-63.10  61.85
-58.00  59.60
-53.60  57.50
-51.20  57.90
-55.00  60.00
4.75  6.66 6.29 7.33
1
3970. 2.00  21900. 2.46  3210. 1.90
NAI    - NORTHERN APPALACHIANS INTERIOR
1
ONLY ALTERNATIVE
1.
area
5.0 20.0 5.0
7
-72.90  42.90
-68.40  45.00
-64.30  46.60
-64.70  48.25
-66.50  48.30
-69.00  47.00
-72.90  44.60
4.75  7.0 6.0 7.0
```

```
1
111. 1.51  152. 1.68  79. 1.33
OBGR   - ONTARIO BACKGROUND (R MODEL)
1
ONLY ALTERNATIVE
1.
area
5.0  20.0  10.0
8
-86.00  39.20
-80.00  39.20
-75.00  41.80
-75.00  43.90
-75.39  44.77
-78.21  45.68
-83.00  46.00
-86.00  43.00
4.75  7.0 6.8 7.2
1
144. 2.00  156. 2.20  100. 1.80
SGL    - SOUTHERN GREAT LAKES
1
ONLY ALTERNATIVE
1.
area
5.0 20.0 10.0
6
-84.40  39.80
-75.00  43.35
-75.00  43.90
-75.39  44.77
-76.00  44.95
-85.60  41.30
4.75  7.0 6.0 7.5
1
454. 1.99  724. 2.23  262. 1.75
SVDR   - SVERDRUP BASIN ALL EVENTS (R model)
1
ONLY ALTERNATIVE
1.
area
10.0 20.0 5.0
11
-117.80  75.00
-108.00  75.00
 -98.00  75.00
 -98.00  77.00
 -90.00  77.00
 -75.00  82.40
 -80.00  83.00
-103.20  78.90
-110.00  78.80
-121.00  77.10
-122.90  75.50
4.75  7.0 6.5 7.5
1
9170. 2.25  23000. 2.53  3590. 1.96
WLB    - WILLISTON BASIN
1
WLB
1.0
area
10.0  20.0  5.0

6
-104.000  50.000
-103.000  48.500
-104.000  48.000
-107.000  48.000
-107.000  48.500
-105.000  50.000
4.75 7.0 6.8 7.2
1
24.4 1.570  49.1 1.972  11.7 1.168
```

Western Canada R model V4.01

```
PSA 0.2 sec 2005 Western Canada R model V4.01 Booreetal93 Youngsetal97
Probabilities of Exceedence for INTERP Subroutine in GSCFRISK.
4  0.01  0.0021  0.001 0.000404
Data Set for Integrations in GSCFRISK.
6 50 5.0 5.0 0.10 4 2
24  1. 3. 10. 13.5 17.5 23.5 30. 42. 60. 75. 100. 135. 175. 235. 300. 420.
600. 750. 1000. 1350. 1750. 2350. 3000. 4200.
3 1 0.3 2 0.4 3 0.3
B
Boore/Joyner/Fumal(1993) Attenuation; PSA (0.2s) + 0.7 log nat or 0.3 dec log
3.764 0.309 -0.090 -0.00259 -0.924 0.190 7.02 0.0 0.0 11 0.495 0 0.0
Boore/Joyner/Fumal(1993) Attenuation; PSA (0.2s)
3.464 0.309 -0.090 -0.00259 -0.924 0.190 7.02 0.0 0.0 11 0.495 0 0.0
Boore/Joyner/Fumal(1993) Attenuation; PSA (0.2s) - 0.7 log nat or 0.3 dec log
3.164 0.309 -0.090 -0.00259 -0.924 0.190 7.02 0.0 0.0 11 0.495 0 0.0
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.2s) + 0.7 nat log
1.422    -0.0027  -2.528 1.45  -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.2s)
0.722    -0.0027  -2.528 1.45  -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.2s) - 0.7 nat log
0.022    -0.0027  -2.528 1.45  -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
1 1.0
ROGERS' 1991 SOURCE ZONES - GR91
26  3  3  1  26  13
0.68  0.16  0.16
0.68  0.16  0.16
1.0
1  1  1  1
ALASKA COASTAL
1
ALC
1.0
area
*****************************************
Borrowed from USGS; No Completeness Data.
*****************************************
7.02  !JB-pseudo_depth
4
-145.000  61.000
-145.000  59.300
-156.000  54.700
-157.500  55.800
4.75  8.5 8.2 8.7
1
3848.1 1.43  5731.25 1.51 2585.08 1.35
ALASKA INLAND
1
ALI
1.0
area
*****************************************
Borrowed from USGS; No Completeness Data.
*****************************************
7.02  !JB-pseudo_depth
7
-145.000  64.500
-145.000  61.000
-157.500  55.800
-160.000  54.300
-160.000  57.000
-154.000  60.000
-151.000  64.500
4.75  8.5 8.2 8.5
1
57235.7 1.73  99129.5 1.84 33058.6 1.62
BEAUFORT SEA
1
BFT
1.0
area
7
3.0   3.3   3.8   4.8   5.3   5.8   6.8
1982  1969  1965  1961  1951  1935  1917
7.02  !JB-pseudo_depth
   4
-137.800  72.800
-128.700  72.800
-130.900  70.600
-138.600  71.100
4.75  7.0 6.7 7.3
1
622.72  1.6935  853.62  1.8624  393.90  1.5246
BROOKS PENINSULA
1
BRO
1.0
area
6
2.5   3.3   3.8   4.8   5.3   6.8
1982  1965  1956  1940  1917  1899
7.02  !JB-pseudo_depth
   4
-127.740  50.330
-127.300  50.150
-127.630  49.980
-128.000  50.180
4.75  7.0 6.7 7.3
1
13.00  1.1937  17.75  1.4563  8.48  0.9312
CASCADE MOUNTAINS
1
CASR          (shallow)
1.0
```

```
area
7
2.5    2.8    3.8    4.8    5.3    5.8    7.3
1976   1970   1956   1940   1917   1899   1860
7.02   !JB-pseudo_depth
   10
-123.600   51.900
-122.000   51.200
-120.000   48.700
-120.000   47.000
-124.030   47.000
-123.900   47.560
-124.230   48.030
-126.710   49.540
-126.400   49.740
-126.710   49.910
4.75   7.7 7.7 7.7
1
14.6 0.85 1335.28 1.8761 14.6 0.85
COASTAL
1
CST
1.0
area
5
3.6    4.3    5.3    5.8    6.8
1972   1965   1940   1917   1899
7.02   !JB-pseudo_depth
   12
-136.800   58.700
-135.100   60.000
-132.150   58.000
-130.000   56.000
-127.100   53.100
-123.600   51.900
-126.710   49.910
-130.600   51.500
-131.180   51.950
-129.700   52.600
-131.500   54.400
-133.480   54.500
4.75   7.5 7.4 7.6
1
266.56   1.4979   459.12   1.7019   153.33   1.2939
DENALI
1
DENR
1.0
area
7
3.0    3.8    4.3    4.8    5.3    5.8    6.3
1979   1972   1965   1961   1951   1935   1917
7.02   !JB-pseudo_depth
   6
-145.000   63.100
-145.000   64.000
-139.300   62.000
-135.500   59.700
-136.800   58.700
-140.700   61.200
4.75   7.5 7.0 8.0
1
3996.06   1.8759   4935.85   1.9677   3264.20   1.7841
EXPLORER PLATE BENDING
1
EXP
1.0
area
4
3.0    3.3    5.3    6.8
1983   1965   1917   1899
7.02   !JB-pseudo_depth
   8
-130.600   51.500
-127.740   50.330
-128.000   50.180
-127.630   49.980
-127.300   50.150
-127.090   50.070
-127.750   49.640
-130.900   51.330
4.75   7.0 6.7 7.3
1
103.32   1.3007   160.40   1.4544   85.62   1.1469
FLATHEAD LAKE
1
FHL
1.0
area
4
4.0    4.8    5.3    5.8
1960   1940   1917   1899
7.02   !JB-pseudo_depth
   4
-114.900   48.600
-114.000   48.600
-112.200   47.000
-114.800   47.000
4.75   7.3 7.1 7.5
1
14016.46   2.4905   63129.58   2.9255   3021.49   2.0554
GULF OF ALASKA
1
GOA
1.0
area
7
4.0    4.3    4.8    5.3    5.8    6.3    7.3
1972   1965   1961   1951   1935   1917   1850
7.02   !JB-pseudo_depth
   4
-143.600   59.500
-142.000   59.400
-142.300   56.700
-144.000   56.700
4.75   7.8 7.6 8.0
1
49696.31   2.3124   86255.05   2.4729   28865.38   2.1519
```

```
GEORGIA STRAIT/PUGET SOUND
1
GSP             (deep)
1.0
area
7
2.5   2.8   3.8   4.8   5.3   5.8   6.8
1976  1970  1956  1940  1917  1899  1860
50.0  !Depth
  10
-123.850  49.550
-122.400  48.840
-121.720  48.300
-121.500  47.680
-121.700  47.000
-123.300  47.000
-123.220  47.530
-123.350  47.870
-123.830  48.250
-124.750  48.850
4.75  7.1 6.9 7.3
1 3 4 0.3 5 0.4 6 0.3
28.56  1.1253  35.06  1.2570  24.67  0.9936
HECATE STRAIT
1
HECR
1.0
area
7
2.5   2.8   3.3   3.8   5.3   5.8   6.8
1986  1985  1971  1965  1940  1917  1899
7.02  !JB-pseudo_depth
  5
-133.480  54.500
-131.500  54.400
-129.700  52.600
-131.180  51.950
-132.400  52.900
4.75  7.0 6.7 7.3
1
931.22  1.8968  1261.21  2.0385  776.41  1.7551
JUAN DE FUCA PLATE BENDING, OFFSHORE
1
JDFF
1.0
area
7
2.5   2.8   3.8   4.8   5.3   5.8   6.8
1982  1970  1956  1940  1917  1899  1860
7.02  !JB-pseudo_depth
  8
-126.710  49.540
-124.230  48.030
-123.900  47.560
-124.030  47.000
-124.900  47.000
-124.920  47.380
-125.800  48.320
-127.180  49.240
4.75  7.0 6.7 7.3
1
91.00  1.8665  175.26  2.2560  42.63  1.4770
JUAN DE FUCA PLATE BENDING, ONSHORE
1
JDFN            (deep)
1.0
area
7
2.5   2.8   3.8   4.8   5.3   5.8   6.8
1982  1970  1956  1940  1917  1899  1860
7.02  !JB-pseudo_depth
  10
-126.400  49.740
-124.750  48.850
-123.830  48.250
-123.350  47.870
-123.220  47.530
-123.300  47.000
-124.030  47.000
-123.900  47.560
-124.230  48.030
-126.710  49.540
4.75  7.1 6.7 7.3
1
109.71  2.0692  264.78  2.5773  39.77  1.5610
MACKENZIE MOUNTAINS
1
MMB
1.0
area
7
3.0   3.3   3.8   4.8   5.3   5.8   6.8
1982  1969  1965  1961  1951  1935  1917
7.02  !JB-pseudo_depth
  9
-132.800  65.600
-127.000  65.800
-123.600  64.400
-123.100  62.200
-124.800  59.400
-129.100  59.900
-128.700  62.300
-130.300  63.700
-133.000  64.200
4.75  7.1 6.9 7.3
1
58008.89  2.4285  72700.01  2.5043  49997.28  2.3528
NORTHERN BC
1
NBC
1.0
area
4
3.0   3.3   5.3   5.8
1982  1965  1940  1917
7.02  !JB-pseudo_depth
  11
-135.100  60.000
```

```
-132.800  60.300
-129.000  59.900
-126.400  58.000
-124.100  56.000
-122.100  54.100
-120.600  53.400
-123.600  51.900
-127.100  53.100
-130.000  56.000
-132.150  58.000
4.75  7.0 6.0 7.0
1
169.98  2.0000  203.64  2.2000  135.27  1.8000
NOOTKA FAULT
1
NOFR
1.0
area
6
2.5   3.3   3.8   4.8   5.3   6.8
1982  1965  1956  1940  1917  1899
7.02  !JB-pseudo_depth
   5
-127.090  50.070
-126.710  49.910
-126.400  49.740
-127.930  48.760
-128.500  49.150
4.75  7.0 6.7 7.3
1
270.92  1.5683  360.51  1.6864  247.75  1.4501
NORTHERN YUKON
1
NYK
1.0
area
5
4.2   4.8   5.3   5.8   6.8
1965  1961  1951  1935  1917
7.02  !JB-pseudo_depth
   8
-145.000  70.800
-134.400  69.200
-135.000  67.400
-136.500  67.400
-136.300  66.100
-134.900  64.230
-140.200  64.300
-145.000  65.000
4.75  7.0 6.7 7.3
1
7080982.50 3.7503  70270912.0 4.3478  697501.56  3.1528
OFFSHORE
1
OFS
1.0
area
3
4.3   5.3   6.8
1965  1917  1899
7.02  !JB-pseudo_depth
   7
-130.900  51.330
-127.750  49.640
-128.500  49.150
-127.930  48.760
-128.200  47.350
-129.500  47.350
-131.500  51.000
4.75  7.1 6.9 7.3
1
46683.91  2.1010  73246.15  2.2212  30343.13  1.9808
QUEEN CHARLOTTE FAULT
1
QCFR
1.0
fault
90.0 90.0 3 10.0 25.0
-1.085  0.389  0.01
3
-136.80  58.70
-132.40  52.90
-130.60  51.50
4.75  8.5 8.2 8.5
1
1703.51  1.5558  2063.98  1.6216  1572.72  1.4900
RICHARDSON MTNS-NORTH
1
RMN
1.0
area
7
3.0   3.3   3.8   4.8   5.3   5.8   6.8
1982  1969  1965  1961  1951  1935  1917
7.02  !JB-pseudo_depth
   5
-136.500  67.400
-135.000  67.400
-132.800  65.600
-136.170  65.930
-136.300  66.100
4.75  7.0 6.7 7.3
1
2918.86  1.9990  3948.71  2.1410  2016.90  1.8570
RICHARDSON MTNS-SOUTH
1
RMS
1.0
area
7
3.0   3.3   3.8   4.8   5.3   5.8   6.8
1982  1969  1965  1961  1951  1935  1917
7.02  !JB-pseudo_depth
   4
-132.800  65.600
-133.000  64.200
-134.900  64.230
-136.170  65.930
```

```
4.75  7.0 6.7 7.3
1
1248.33  1.6684  1540.54  1.7767  945.32  1.5601
ROCKY MOUNTAIN F and T BELT
1
ROC
1.0
area
5
3.0   3.3   5.3   5.8   6.8
1982  1965  1940  1917  1899
7.02  !JB-pseudo_depth
   13
-129.000  59.900
-124.800  59.400
-122.600  56.600
-118.400  54.400
-115.200  52.300
-114.000  49.500
-112.000  48.000
-113.330  48.000
-114.000  48.600
-120.600  53.400
-122.100  54.100
-124.100  56.000
-126.400  58.000
4.75  7.0 6.7 7.3
1
1541.17  2.0366  2542.15  2.2525  870.70  1.8207
SOUTHERN BC
1
SBC
1.0
area
6
3.0   3.3   4.3   4.8   5.3   5.8
1966  1965  1960  1940  1917  1899
7.02  !JB-pseudo_depth
   8
-123.600  51.900
-120.600  53.400
-114.000  48.600
-114.900  48.600
-114.870  48.130
-120.000  48.100
-120.000  48.700
-122.000  51.200
4.75  7.0 6.7 7.3
1
1384.70  2.2082  2787.43  2.4950  673.48  1.9215
SOUTHERN YUKON
1
SOY
1.0
area
7
3.0   3.8   4.3   4.8   5.3   5.8   6.3
1979  1972  1965  1961  1951  1935  1917
7.02  !JB-pseudo_depth
   11
-145.000  65.000
-140.200  64.300
-133.000  64.200
-130.300  63.700
-128.700  62.300
-129.100  59.900
-132.800  60.300
-135.100  60.000
-135.500  59.700
-139.300  62.000
-145.000  64.000
4.75  7.0 6.7 7.3
1
1690.75  2.1476  3157.32  2.4208  853.36  1.8744
YAKATAT COLLISION
1
YAK
1.0
area
8
3.0   3.8   4.3   4.8   5.3   5.8   6.3   7.3
1979  1972  1965  1961  1957  1935  1917  1850
7.02 , !JB-pseudo_depth
   11
-145.000  59.500
-145.000  63.100
-140.700  61.200
-140.000  60.750
-140.000  60.000
-137.800  58.200
-136.600  56.800
-142.100  58.700
-142.000  59.400
-143.600  59.500
-143.700  59.100
4.75  8.5 8.2 8.7
1
16307.38  2.0096  18689.91  2.0681  14305.26  1.9511
```

Appendix D3

The input file for GSCFRISK seismic hazard code used for the 2005 "Stable Canada" (F) probabilistic hazard estimates.

```
PSA 0.2 sec 2002 combined floor model 0.4 world 0.4 N America 0.2 Canada
Data for INTERP subroutine
4  0.01  0.0021  0.001 0.000404
Main data set for GSCFRISK program
3  50  5.0  5.0  0.10  4  1
24  1. 3. 10. 13.5 17.5 23.5 30. 42. 60. 75. 100. 135. 175. 235. 300. 420. 600. 750. 1000. 1350. 1750.
2350. 3000. 4200.
0.44 0.28 0.28
A
AB94R PSA 0.2s Mlg Median grd motion for Pseudo Acc 0.2s ATKINSON BOORE 1994
3.75 0.418 -0.0644 -0.000457 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
AB94R PSA 0.2s Mlg L grd motion for PSA 0.2s ATKINSON BOORE 1994 Lower limit
3.43 0.418 -0.0644 -0.000457 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
AB94R PSA 0.2s Mlg U grd motion for PSA 0.2s ATKINSON BOORE 1994 Upper limit
4.00 0.418 -0.0644 -0.000457 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
1  1.0
"Octagonal" Stable Cratonic Core zone model
1  3  3  3  1  20
0.6 0.3 0.1
0.68 0.16 0.16
0.5 0.25 0.25
1 1 1  1
OCTWSCC  - Octagonal Stable Cratonic Core  Worldwide rates
3
Worldwide rates
0.4
area
10.0  20.0  5.0
8
-100.50 55.00                ***** These zone coordinates define an arbitrary octagon
-95.00 58.50                 *****   and have no other meaning
-90.00 58.50
-84.50 55.00
-84.50 51.00
-90.00 47.50
-95.00 47.50
-100.50 51.00
4.75 7.0 6.8 7.2
1
4078 2.18  18724 2.49  926 1.88  normalized world Mn
North American rates
0.4
area
10.0  20.0  5.0
8
-100.50 55.00
-95.00 58.50
-90.00 58.50
-84.50 55.00
-84.50 51.00
-90.00 47.50
-95.00 47.50
-100.50 51.00
4.75 7.0 6.8 7.2
1
6066 2.38  685190 3.35  53.7 1.41 normalized North American Mn
Canada background 2001 rates
0.2
area
10.0  20.0  5.0
8
-100.50 55.00
-95.00 58.50
-90.00 58.50
-84.50 55.00
-84.50 51.00
-90.00 47.50
-95.00 47.50
-100.50 51.00
4.75 7.0 6.8 7.2
1
202  2.18  471 2.48  81.4 1.88 normalized Canada 2001 Mn
```

Appendix D4

Distance calculation function, adapted from D. Weichert's code to determine minimum distance from a grid point to a line of points.

```
c Minimum distances from a grid to the Cascadia locus
c         written Sept.97, edited 1998 for new grid and locus.
ccc       also changed: Halchuk's grid has long first, see args in fun_call
          Dimension g(50000,2),al(5000,2) , sd(5000) , d(50000)
      character*80 gridfile,linefile,outfile,title, title2
      write(*,*) 'minimum distance calculation'
      write(*,*) 'grid of points (hazard.ll format)'
      read(*,10) gridfile
      open(unit=21, file=gridfile, status='old')
      write(*,*) 'line of comparison (hazard.ll format)'
      read(*,10) linefile
      open(unit=22, file=linefile, status='old')
      write(*,*) 'output file (lat, lon, dist)'
      read(*,10) outfile
      open(unit=23, file=outfile, status='unknown')
 10    format(a80)
         read (21,10) title
         read (21,*) ng
         read (21,*) ((g(i,j),j=1,2), i=1,ng)
         write(23,10) title
         write(23,*) ng
         read (22,10) title2
         read (22,*) nl
         read (22,*) ((al(i,j),j=1,2 ),i=1,nl)
         do 100, i=1,ng
         smalld= 10000.
         do 200, k=1,nl
         sd(k)= distance(al(k,1),al(k,2),g(i,1),g(i,2))
c                                            --------------
         if(sd(k).lt.smalld) smalld=sd(k)
 200     continue
 100     d(i)=smalld
         write(23,12) ((g(i,j),j=1,2) , d(i) , i=1,ng)
 12      format(3f10.3)
         stop
         end
c
         function distance(x1,x2,y1,y2)
         delt2 = (x1-y1)**2 + ((x2-y2)*cos(0.0174533*(x1+y1)/2))**2
         distance = sqrt(delt2)*111.2
         return
         end
```

Appendix E1

Strong Ground Motion Parameters used for each period for which hazard has been calculated

Eastern Strong Ground Motion Attenuation coefficients

Note: weights of the ground motions vary, as given by the first line for each triplet of alternative relations used

0.44 0.42 0.14
A95 PSA 0.1s Mlg Median grd motion for Pseudo Acc 0.1s ATKINSON BOORE 1994Mlg
3.99 0.360 -0.0527 -0.00121 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
A95 PSA 0.1s Mlg L grd motion for PSA 0.1s ATKINSON BOORE 1994 Mlg L limit
3.61 0.360 -0.0527 -0.00121 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
A95 PSA 0.1s Mlg U grd motion for PSA 0.1s ATKINSON BOORE 1994 Mlg U limit
4.12 0.360 -0.0527 -0.00121 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0

0.44 0.34 0.22
AB94R PSA 0.15s Mlg Median grd motion for Pseudo Acc 0.15s ATKINSON BOORE 1994Ml
3.85 0.394 -0.0595 -0.000769 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
AB94R PSA 0.15s Mlg L grd motion for PSA 0.15s ATKINSON BOORE 1994 Mlg Lower lim
3.50 0.394 -0.0595 -0.000769 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
AB94R PSA 0.15s Mlg U grd motion for PSA 0.15s ATKINSON BOORE 1994 Mlg Upper lim
4.05 0.394 -0.0595 -0.000769 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0

0.44 0.28 0.28
AB94R PSA 0.2s Mlg Median grd motion for Pseudo Acc 0.2s ATKINSON BOORE 1994Mlg
3.75 0.418 -0.0644 -0.000457 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
AB94R PSA 0.2s Mlg L grd motion for PSA 0.2s ATKINSON BOORE 1994 Mlg Lower limit
3.43 0.418 -0.0644 -0.000457 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
AB94R PSA 0.2s Mlg U grd motion for PSA 0.2s ATKINSON BOORE 1994 Mlg Upper limit
4.00 0.418 -0.0644 -0.000457 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0

0.44 0.28 0.28
AB94R PSA 0.3s Mlg Median grd motion for Pseudo Acc 0.3s ATKINSON BOORE 1994Mlg
3.54 0.475 -0.0717 -0.000106 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
AB94R PSA 0.3s Mlg L grd motion for PSA 0.3s ATKINSON BOORE 1994 Mlg Lower limit
3.26 0.475 -0.0717 -0.000106 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
AB94R PSA 0.3s Mlg U grd motion for PSA 0.3s ATKINSON BOORE 1994 Mlg Upper limit
3.88 0.475 -0.0717 -0.000106 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0

0.44 0.23 0.33
AB94R PSA 0.4s Mlg Median grd motion for Pseudo Acc 0.4s ATKINSON BOORE 1994Mlg
3.38 0.517 -0.0674 -0.000046 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
AB94R PSA 0.4s Mlg L grd motion for PSA 0.4s ATKINSON BOORE 1994 Mlg Lower limit
3.12 0.517 -0.0674 -0.000046 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
AB94R PSA 0.4s Mlg U grd motion for PSA 0.4s ATKINSON BOORE 1994 Mlg Upper limit
3.77 0.517 -0.0674 -0.000046 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0

0.44 0.19 0.37
AB94R PSA 0.5s Mlg Median grd motion for Pseudo Acc 0.5s ATKINSON BOORE 1994Mlg
3.26 0.550 -0.0640 0.000 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
AB94R PSA 0.5s Mlg L grd motion for PSA 0.5s ATKINSON BOORE 1994 Mlg Lower limit
3.02 0.550 -0.0640 0.000 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
AB94R PSA 0.5s Mlg U grd motion for PSA 0.5s ATKINSON BOORE 1994 Mlg Upper limit
3.68 0.550 -0.0640 0.000 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0

0.44 0.14 0.42
AB95R PSA 1s Mlg Median grd motion for PSA1.0s ATKINSON BOORE 1995 Mlg
2.77 0.620 -0.0409 0.000 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
AB95R PSA 1s Mlg L grd motion for PSA 1.0s ATKINSON BOORE 1995 L limit
2.59 0.620 -0.0409 0.000 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
AB95R PSA 1s Mlg U grd motion for PSA 1.0s ATKINSON BOORE 1995 U limit
3.31 0.620 -0.0409 0.000 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0

1.00
AB94R PSA 2s Mlg Median grd motion for Pseudo Acc 2 sec ATKINSON BOORE 1994 Mlg
2.27 0.634 -0.0170 0.000 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0

0.44 0.42 0.14
AB94R PGA Mlg Median grd motion for Peak ACCEL ATKINSON BOORE 1994R "MLg" mag
3.79 0.298 -0.0536 -0.00135 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
AB94R PGA Mlg L grd motion for PGA ATKINSON BOORE 1994R "MLg" mag Lower Limit
3.41 0.298 -0.0536 -0.00135 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
AB94R PGA Mlg U grd motion for PGA ATKINSON BOORE 1994R "MLg" mag Upper Limit
3.92 0.298 -0.0536 -0.00135 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0

0.44 0.19 0.37
AB94R pgv Mlg Median grd motion for Peak Velocity ATKINSON BOORE 1994 R MLg
2.04 0.422 -0.0373 0.000 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
AB94R pgv Mlg L Median grd motion for PGV ATKINSON BOORE 1994 R MLg Lower limit
1.80 0.422 -0.0373 0.000 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0
AB94R pgv Mlg U Median grd motion for PGV ATKINSON BOORE 1994 R MLg Upper limit
2.46 0.422 -0.0373 0.000 0.0 0.0 0.0 0.0 0.0 6 0.69 0.0 0.0

Western Canada crustal (Boore et al) Strong Ground Motion Attenuation Coefficients

Note: weights for all spectral and peak parameters are 0.3 0.4 0.3

Boore/Joyner/Fumal(1993) Attenuation; PSA (0.1s) + 0.7 log nat or 0.3 dec log
3.751 0.327 -0.098 -0.00395 -0.934 0.046 6.27 0.0 0.0 11 0.479 0.0 0
Boore/Joyner/Fumal(1993) Attenuation; PSA (0.1s)
3.451 0.327 -0.098 -0.00395 -0.934 0.046 6.27 0.0 0.0 11 0.479 0.0 0
Boore/Joyner/Fumal(1993) Attenuation; PSA (0.1s) - 0.7 log nat or 0.3 dec log
3.151 0.327 -0.098 -0.00395 -0.934 0.046 6.27 0.0 0.0 11 0.479 0.0 0

Boore/Joyner/Fumal(1993) Attenuation; PSA (0.15s) + 0.7 log nat or 0.3 dec log
3.814 0.305 -0.099 -0.00309 -0.937 0.140 7.23 0.0 0.0 11 0.486 0.0 0
Boore/Joyner/Fumal(1993) Attenuation; PSA (0.15s)
3.514 0.305 -0.099 -0.00309 -0.937 0.140 7.23 0.0 0.0 11 0.486 0.0 0
Boore/Joyner/Fumal(1993) Attenuation; PSA (0.15s) - 0.7 log nat or 0.3 dec log
3.214 0.305 -0.099 -0.00309 -0.937 0.140 7.23 0.0 0.0 11 0.486 0.0 0

Boore/Joyner/Fumal(1993) Attenuation; PSA (0.2s) + 0.7 log nat or 0.3 dec log
3.764 0.309 -0.090 -0.00259 -0.924 0.190 7.02 0.0 0.0 11 0.495 0 0.0
Boore/Joyner/Fumal(1993) Attenuation; PSA (0.2s)
3.464 0.309 -0.090 -0.00259 -0.924 0.190 7.02 0.0 0.0 11 0.495 0 0.0
Boore/Joyner/Fumal(1993) Attenuation; PSA (0.2s) - 0.7 log nat or 0.3 dec log
3.164 0.309 -0.090 -0.00259 -0.924 0.190 7.02 0.0 0.0 11 0.495 0 0.0

Boore/Joyner/Fumal(1993) Attenuation; PSA (0.3s) + 0.7 log nat or 0.3 dec log
3.595 0.334 -0.070 -0.00202 -0.893 0.239 5.94 0.0 0.0 11 0.520 0 0.0
Boore/Joyner/Fumal(1993) Attenuation; PSA (0.3s)
3.295 0.334 -0.070 -0.00202 -0.893 0.239 5.94 0.0 0.0 11 0.520 0 0.0
Boore/Joyner/Fumal(1993) Attenuation; PSA (0.3s) - 0.7 log nat or 0.3 dec log
2.995 0.334 -0.070 -0.00202 -0.893 0.239 5.94 0.0 0.0 11 0.520 0 0.0

Boore/Joyner/Fumal(1993) Attenuation; PSA (0.4s) + 0.7 log nat or 0.3 dec log
3.426 0.361 -0.052 -0.00170 -0.867 0.264 4.91 0.0 0.0 11 0.543 0 0.0
Boore/Joyner/Fumal(1993) Attenuation; PSA (0.4s)
3.126 0.361 -0.052 -0.00170 -0.867 0.264 4.91 0.0 0.0 11 0.543 0 0.0
Boore/Joyner/Fumal(1993) Attenuation; PSA (0.4s) - 0.7 log nat or 0.3 dec log
2.826 0.361 -0.052 -0.00170 -0.867 0.264 4.91 0.0 0.0 11 0.543 0 0.0

Boore/Joyner/Fumal(1993) Attenuation; PSA (0.5s) + 0.7 log nat or 0.3 dec log
3.280 0.384 -0.039 -0.00148 -0.846 0.279 4.13 0.0 0.0 11 0.562 0 0.0
Boore/Joyner/Fumal(1993) Attenuation; PSA (0.5s)
2.980 0.384 -0.039 -0.00148 -0.846 0.279 4.13 0.0 0.0 11 0.562 0 0.0
Boore/Joyner/Fumal(1993) Attenuation; PSA (0.5s) - 0.7 log nat or 0.3 dec log
2.680 0.384 -0.039 -0.00148 -0.846 0.279 4.13 0.0 0.0 11 0.562 0 0.0

Boore/Joyner/Fumal(1993) Attenuation; PSA1.0s + 0.7 natlog or 0.3 declog
2.822 0.450 -0.014 -0.00097 -0.798 0.314 2.90 0.0 0.0 11 0.622 0 0.0
Boore/Joyner/Fumal(1993) Attenuation; PSA1.0s
2.522 0.450 -0.014 -0.00097 -0.798 0.314 2.90 0.0 0.0 11 0.622 0 0.0
Boore/Joyner/Fumal(1993) Attenuation; PSA1.0s - 0.7 natlog or 0.3 declog
2.222 0.450 -0.014 -0.00097 -0.798 0.314 2.90 0.0 0.0 11 0.622 0 0.0

Boore/Joyner/Fumal(1993) Attenuation; PSA (2.0s) + 0.7 log nat or 0.3 dec log
2.534 0.471 -0.037 -0.00064 -0.812 0.360 5.85 0.0 0.0 11 0.675 0 0.0
Boore/Joyner/Fumal(1993) Attenuation; PSA (2.0s)
2.234 0.471 -0.037 -0.00064 -0.812 0.360 5.85 0.0 0.0 11 0.675 0 0.0
Boore/Joyner/Fumal(1993) Attenuation; PSA (2.0s) - 0.7 log nat or 0.3 dec log
1.934 0.471 -0.037 -0.00064 -0.812 0.360 5.85 0.0 0.0 11 0.675 0 0.0

Boore/Joyner/Fumal(1993) Attenuation; PGA + 0.7 nat log or 0.3 dec log.
3.187 0.229 0.0 -0.00326 -0.778 0.162 5.57 0.0 0.0 11 0.529 0 0.0
Boore/Joyner/Fumal(1993) Attenuation; PGA
2.887 0.229 0.0 -0.00326 -0.778 0.162 5.57 0.0 0.0 11 0.529 0 0.0
Boore/Joyner/Fumal(1993) Attenuation; PGA - 0.7 nat log or 0.3 dec log.
2.587 0.229 0.0 -0.00326 -0.778 0.162 5.57 0.0 0.0 11 0.529 0 0.0

Western Canada deep (Youngs et al. in-slab) Strong Ground Motion Attenuation Coefficients

Note: weights for all spectral and peak parameters are 0.3 0.4 0.3

Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.1s) + 0.7 nat log
1.818 -0.0011 -2.655 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.1s)
1.118 -0.0011 -2.655 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.1s) - 0.7 nat log
0.418 -0.0011 -2.655 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50

Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.15s) + 0.7 nat log
1.667 -0.002028 -2.583 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.15s)
0.967 -0.002028 -2.583 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.15s) - 0.7 nat log
0.267 -0.002028 -2.583 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50

Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.2s) + 0.7 nat log
1.422 -0.0027 -2.528 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.2s)
0.722 -0.0027 -2.528 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.2s) - 0.7 nat log
0.022 -0.0027 -2.528 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50

Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.3s) + 0.7 nat log
0.946 -0.0036 -2.454 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.3s)
0.246 -0.0036 -2.454 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.3s) - 0.7 nat log
-0.454 -0.0036 -2.454 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50

Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.4s) + 0.7 nat log
0.585 -0.0043 -2.401 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.4s)
-0.115 -0.0043 -2.401 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.4s) - 0.7 nat log
-0.815 -0.0043 -2.401 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50

Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.5s) + 0.7 nat log
0.300 -0.0048 -2.360 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.5s)
-0.400 -0.0048 -2.360 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.5s) - 0.7 nat log
-1.100 -0.0048 -2.360 1.45 -0.1 1.0 0.0.0.0 0.0 13 0.0 0 0.0 50

Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (1.0s) + 0.7 nat log
-1.036 -0.0064 -2.234 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (1.0s)
-1.736 -0.0064 -2.234 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (1.0s) - 0.7 nat log
-2.436 -0.0064 -2.234 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50

Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (2.0s) + 0.7 nat log
-2.628 -0.0080 -2.107 1.55 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (2.0s)
-3.328 -0.0080 -2.107 1.55 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (2.0s) - 0.7 nat log
-4.028 -0.0080 -2.107 1.55 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50

Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PGA + 0.7 nat log
0.70 0.0 -2.552 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PGA
0.0 0.0 -2.552 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50
Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PGA - 0.7 nat log
-0.70 0.0 -2.552 1.45 -0.1 1.0 0.0 0.0 0.0 13 0.0 0 0.0 50

Western Canada Cascadia scenario (Youngs et al. interface) Strong Ground Motion Attenuation Coefficients

Youngs, Chiou, Silva, Humphrey (1997) INTERFACE PSA (0.1s)
1.118 -0.0011 -2.655 1.45 -0.1 0.0 0.0 0.0 0.0 13 0.0 0 0.0 25

Youngs, Chiou, Silva, Humphrey (1997) INTRASLAB PSA (0.15s)
0.967 -0.002028 -2.583 1.45 -0.1 0.0 0.0 0.0 0.0 13 0.0 0 0.0 25

Youngs, Chiou, Silva, Humphrey (1997) INTERFACE PSA (0.2s)
0.722 -0.0027 -2.528 1.45 -0.1 0.0 0.0 0.0 0.0 13 0.0 0 0.0 25

Youngs, Chiou, Silva, Humphrey (1997) INTERFACE PSA (0.3s)
0.246 -0.0036 -2.454 1.45 -0.1 0.0 0.0 0.0 0.0 13 0.0 0 0.0 25

Youngs, Chiou, Silva, Humphrey (1997) INTERFACE PSA (0.4s)
-0.115 -0.0043 -2.401 1.45 -0.1 0.0 0.0 0.0 0.0 13 0.0 0 0.0 25

Youngs, Chiou, Silva, Humphrey (1997) INTERFACE PSA (0.5s)
-0.400 -0.0048 -2.360 1.45 -0.1 0.0 0.0 0.0 0.0 13 0.0 0 0.0 25

Youngs, Chiou, Silva, Humphrey (1997) INTERFACE PSA (1.0s)
-1.736 -0.0064 -2.234 1.45 -0.1 0.0 0.0 0.0 0.0 13 0.0 0 0.0 25

Youngs, Chiou, Silva, Humphrey (1997) INTERFACE PSA (2.0s)
-3.328 -0.0080 -2.107 1.55 -0.1 0.0 0.0 0.0 0.0 13 0.0 0 0.0 25

Youngs, Chiou, Silva, Humphrey (1997) INTERFACE PGA
0.0 0.0 -2.552 1.45 -0.1 0.0 0.0 0.0 0.0 13 0.0 0 0.0 25

Appendix E2

Fortran code fragments added within GSCFRISK to use the chosen attenuation relations

A. Sample ground motion input lines (see Appendix E1 for the complete set).

Boore/Joyner/Fumal(1993) Attenuation; PSA (2.0s)

```
2.234 0.471 -0.037 -0.00064 -0.812 0.360 5.85 0.0   0.0  11    0.675  0     0.0

Note: the parameters above are named:-
c1    c2     c3     c4       c5    c6    c7   rzero rone jcalc sigma  itrun trun
```

B. Ground motion code fragment to use Atkinson-Boore attenuation relations in subroutine atten.

```
      else if (jcalc .eq. 6) then
c code added by S. Halchuk 94/06/08 to employ Atkinson Boore's 1994
c attenuation relations and to "convert" from Moment to Mlg magnitude
c using Atkinsons 1993 relation (PhD thesis, p 102, equation 5.8)
        if(amag .le. 5.5) amag = amag * 0.98 - 0.39
        if(amag .gt. 5.5) amag = 2.715 - 0.277*amag + 0.127*amag*amag
        amt = amag - 6.0
        amean = c1 + c2*amt + c3*amt*amt - alog10(dist) + c4*dist
        amean=amean*2.302585
```

C. Ground motion code fragment in subroutine atten to adjust BJF attenuation relations to Atkinson (1997) attenuation beyond 100 km.

```
      else if (jcalc .eq. 11) then
        if (dist .le. 100.0) then
          amt = amag - 6.0
          amean = c1 + c2*amt + c3*amt*amt + c5*alog10(dist)+c6
```

```
      amean = amean * 2.302585
c add attenuation beyond 100 km
     else
      amt = amag - 6.0
      aoneh = c1 + c2*amt + c3*amt*amt + c5*alog10(100.0)+c6
      amean = aoneh - alog10(dist/100.0) + c4*(dist - 100.0)
      amean = amean * 2.302585
     end if
```

D. Ground motion code fragment in subroutine atten to use Youngs et al. attenuation relations with magnitude-variable sigma.

```
     else if (jcalc .eq. 13) then
      amean = 0.2418+ 1.414*amag+c1+c2*(10-amag)*(10-amag)*(10-amag)+
    & c3*alog(dist+1.7818*exp(0.554*amag))+0.00607*depth+0.3846*c6
c Youngs et al have a magnitude variable sigma
      amagsig=amag
      if(amag .ge. 8.0) amagsig = 8.0
      sigma = c4 + c5*amagsig
c convert from values in g to cm/s/s, apply impedance contrast
c to convert from zone A/B boundary (750 m/s) to average B (555 m/s)
      amean = amean + alog(981.0) + alog(1.162)
```