



**Report of the individual review of the annual submission of Canada  
submitted in 2011**

**Note by the secretariat**

The report of the individual review of the annual submission of Canada submitted in 2011 was published on 26 April 2012. For purposes of rule 10, paragraph 2, of the rules of procedure of the Compliance Committee (annex to decision 4/CMP.2, as amended by decision 4/CMP.4), the report is considered received by the secretariat on the same date. This report, FCCC/ARR/2011/CAN, contained in the annex to this note, is being forwarded to the Compliance Committee in accordance with section VI, paragraph 3, of the annex to decision 27/CMP.1.





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\* In the symbol for this document, 2011 refers to the year in which the inventory was submitted, and not to the year of publication.

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## I. Introduction and summary

### A. Overview

1. This report covers the centralized review of the 2011 annual submission of Canada, coordinated by the UNFCCC secretariat, in accordance with decision 22/CMP.1. The review took place from 29 August to 3 September 2011 in Bonn, Germany, and was conducted by the following team of nominated experts from the UNFCCC roster of experts: generalists – Mr. Bernd Gugele (European Union) and Mr. Newton Paciornik (Brazil); energy – Mr. Qiang Liu (China), Mr. Ole-Kenneth Nielsen (Denmark) and Ms. Kennie Tsui (New Zealand); industrial processes – Ms. Jolanta Merkeliene (Lithuania); agriculture – Mr. Tom Wirth (United States of America); land use, land-use change and forestry (LULUCF) – Mr. Toru Gomi (Japan) and Mr. Valentin Bellassen (France); and waste – Mr. Pavel Gavrilita (Republic of Moldova). In addition, Mr. Nielsen supported the review of the industrial processes and waste sectors. Mr. Gugele and Mr. Paciornik were the lead reviewers. The review was coordinated by Ms. Barbara Muik and Mr. Roman Payo (UNFCCC secretariat).

2. In accordance with the “Guidelines for review under Article 8 of the Kyoto Protocol” (decision 22/CMP.1), a draft version of this report was communicated to the Government of Canada, which provided comments that were considered and incorporated, as appropriate, into this final version of the report.

### B. Emission profiles and trends

3. In 2009, the main greenhouse gas (GHG) in Canada was carbon dioxide (CO<sub>2</sub>), accounting for 78.5 per cent of total GHG emissions<sup>1</sup> expressed in carbon dioxide equivalent (CO<sub>2</sub> eq), followed by methane (CH<sub>4</sub>) (13.3 per cent) and nitrous oxide (N<sub>2</sub>O) (6.8 per cent). Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF<sub>6</sub>) collectively accounted for 1.4 per cent of the overall GHG emissions in the country. The energy sector accounted for 81.9 per cent of total GHG emissions, followed by the agriculture sector (8.1 per cent), the industrial processes sector (6.7 per cent), the waste sector (3.3 per cent) and the solvent and other product use sector (0.04 per cent). Total GHG emissions amounted to 691,834.45 Gg CO<sub>2</sub> eq and increased by 17.0 per cent between the base year<sup>2</sup> and 2009. The trends for the different gases and sectors are reasonable and very well explained in the NIR.

4. Tables 1 and 2 show GHG emissions from Annex A sources, emissions and removals from the LULUCF sector under the Convention and emissions and removals from activities under Article 3, paragraph 3, and, if any, Article 3, paragraph 4, of the Kyoto Protocol (KP-LULUCF), by gas and by sector and activity, respectively. In table 1, CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O emissions included in the rows under Annex A sources do not include emissions and removals from the LULUCF sector.

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<sup>1</sup> In this report, the term “total GHG emissions” refers to the aggregated national GHG emissions expressed in terms of CO<sub>2</sub> eq excluding LULUCF, unless otherwise specified.

<sup>2</sup> “Base year” refers to the base year under the Kyoto Protocol, which is 1990 for all gases. The base year emissions include emissions from Annex A sources only.

Table 1  
**Greenhouse gas emissions from Annex A sources and emissions/removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, by gas, base year to 2009<sup>a</sup>**

		<i>Gg CO<sub>2</sub> eq</i>								<i>Change</i>	
		<i>Base year<sup>d</sup></i>	<i>1990</i>	<i>1995</i>	<i>2000</i>	<i>2005</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>	<i>Base year–2009 (%)</i>	
<i>Greenhouse gas</i>											
Annex A sources <sup>b</sup>	CO <sub>2</sub>	459 592.73	459 592.73	491 814.30	564 504.26	574 811.49	594 985.93	578 346.24	542 997.58	18.1	
	CH <sub>4</sub>	71 988.36	71 988.36	85 838.29	94 551.50	98 742.70	97 386.44	95 397.31	92 299.29	28.2	
	N <sub>2</sub> O	48 987.13	48 987.13	53 573.32	48 169.93	49 903.76	49 181.02	51 544.81	47 188.63	–3.7	
	HFCs	767.25	767.25	479.41	2 985.39	5 223.31	5 431.70	5 506.75	6 785.62	784.4	
	PFCs	6 538.83	6 538.83	5 489.59	4 311.08	3 313.31	2 188.69	2 245.69	2 171.97	–66.8	
	SF <sub>6</sub>	3 387.63	3 387.63	2 391.00	3 047.38	1 488.48	771.62	670.73	391.36	–88.4	
KP-LULUCF	Article 3.3 <sup>c</sup>	CO <sub>2</sub>						13 432.79	13 535.70		
		CH <sub>4</sub>						224.10	225.82		
		N <sub>2</sub> O						137.87	140.45		
	Article 3.4 <sup>d</sup>	CO <sub>2</sub>	3 721.13	3 721.13					–11 712.01	–12 405.89	NA
		CH <sub>4</sub>	NA	NA					NA	NA	NA
		N <sub>2</sub> O	11.10	11.10					0.70	0.37	NA

*Abbreviations:* KP-LULUCF = land use, land-use change and forestry emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, NA = not applicable.

<sup>a</sup> “Base year” for Annex A sources refers to the base year under the Kyoto Protocol, which is 1990 for all gases. The “base year” for activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol is 1990.

<sup>b</sup> The table does not reflect the adjusted estimates for N<sub>2</sub>O emissions from wastewater handling (see section II.G below) after adjustment procedures under decision 20/CMP.1 were applied for the years 2008 and 2009. It reflects the estimates contained in the submission of 17 October 2011 that were subject to these adjustments. The adjustments lead to an increase in total greenhouse gas emissions for 2008 and 2009 of 332.71 Gg CO<sub>2</sub> eq and 335.23 Gg CO<sub>2</sub> eq, respectively.

<sup>c</sup> Activities under Article 3, paragraph 3, of the Kyoto Protocol, namely afforestation and reforestation, and deforestation. Only the inventory years of the commitment period must be reported.

<sup>d</sup> Elected activities under Article 3, paragraph 4, of the Kyoto Protocol, including forest management, cropland management, grazing land management and revegetation. For cropland management, grazing land management and revegetation, the base year and the inventory years of the commitment period must be reported.

Table 2

**Greenhouse gas emissions by sector and activity, base year to 2009<sup>a</sup>**

		<i>Gg CO<sub>2</sub> eq</i>								<i>Change</i>
<i>Sector</i>		<i>Base year<sup>a</sup></i>	<i>1990</i>	<i>1995</i>	<i>2000</i>	<i>2005</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>	<i>Base year–2009</i> <i>(%)</i>
Annex A <sup>b</sup>	Energy	468 556.00	468 556.00	508 041.11	587 688.31	595 821.83	613 934.03	597 787.38	566 422.09	20.9
	Industrial processes	56 855.85	56 855.85	58 869.36	53 679.11	57 621.27	55 975.31	54 879.88	46 678.77	–17.9
	Solvent and other product use	178.71	178.71	212.58	247.15	182.89	326.32	340.94	260.49	45.8
	Agriculture	46 866.32	46 866.32	52 713.51	55 471.50	57 933.56	57 421.68	58 383.93	55 857.95	19.2
	Waste	18 805.06	18 805.06	19 749.35	20 483.48	21 923.49	22 288.08	22 319.40	22 615.14	20.3
	LULUCF	NA	–67 484.98	185 971.68	–62 106.77	53 532.78	51 429.15	–16 948.43	–12 100.16	NA
<b>Total (with LULUCF)</b>		<b>NA</b>	<b>523 776.97</b>	<b>825 557.59</b>	<b>655 462.78</b>	<b>787 015.83</b>	<b>801 374.56</b>	<b>716 763.10</b>	<b>679 734.29</b>	<b>NA</b>
<b>Total (without LULUCF)</b>		<b>591 261.94</b>	<b>591 261.94</b>	<b>639 585.91</b>	<b>717 569.55</b>	<b>733 483.05</b>	<b>749 945.41</b>	<b>733 711.52</b>	<b>691 834.45</b>	<b>17.0</b>
Other <sup>c</sup>		NA	NA	NA	NA	NA	NA	NA	NA	NA
KP-LULUCF	Article 3.3 <sup>d</sup>	Afforestation and reforestation						–737.97	–796.66	
		Deforestation						14 532.73	14 698.64	
		<b>Total (3.3)</b>						<b>13 794.76</b>	<b>13 901.98</b>	
	Article 3.4 <sup>e</sup>	Forest management	NA					NA	NA	
		Cropland management	3 732.22					–11 711.31	–12 405.51	NA
		Grazing land management	NA					NA	NA	NA
		Revegetation	NA					NA	NA	NA
	<b>Total (3.4)</b>		<b>3 732.22</b>					<b>–11 711.31</b>	<b>–12 405.51</b>	<b>NA</b>

*Abbreviations:* LULUCF = land use, land-use change and forestry, KP-LULUCF = LULUCF emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, NA = not applicable.

<sup>a</sup> “Base year” for Annex A sources refers to the base year under the Kyoto Protocol, which is 1990 for all gases. The “base year” for activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol is 1990.

<sup>b</sup> The table does not reflect the adjusted estimates for N<sub>2</sub>O emissions from wastewater handling (see section II.G below) after adjustment procedures under decision 20/CMP.1 were applied for the years 2008 and 2009. It reflects the estimates contained in the submission of 17 October 2011 that were subject to these adjustments. The adjustments lead to an increase in total greenhouse gas emissions for 2008 and 2009 of 332.71 Gg CO<sub>2</sub> eq and 335.23 Gg CO<sub>2</sub> eq, respectively.

<sup>c</sup> Emissions/removals reported in the sector other (sector 7) are not included in Annex A to the Kyoto Protocol and are therefore not included in the national totals.

<sup>d</sup> Activities under Article 3, paragraph 3, of the Kyoto Protocol, namely afforestation and reforestation, and deforestation. Only the inventory years of the commitment period must be reported.

<sup>e</sup> Elected activities under Article 3, paragraph 4, of the Kyoto Protocol, including forest management, cropland management, grazing land management and revegetation. For cropland management, grazing land management and revegetation, the base year and the inventory years of the commitment period must be reported.

5. Table 3 provides information on the most important emissions and removals and accounting parameters that will be included in the compilation and accounting database.

Table 3  
Information to be included in the compilation and accounting database in t CO<sub>2</sub> eq

	<i>As reported</i>	<i>Revised estimates</i>	<i>Adjustment<sup>a</sup></i>	<i>Final<sup>b</sup></i>	<i>Accounting quantity<sup>c</sup></i>
<b>Commitment period reserve</b>	2 512 613 494			2 512 613 494	
<b>Annex A emissions for current inventory year</b>					
CO <sub>2</sub>	542 086 243	542 997 577		542 997 577	
CH <sub>4</sub>	91 567 413	92 299 292		92 299 292	
N <sub>2</sub> O	47 050 342	47 188 634	335 226	47 523 860	
HFCs	6 785 624	6 785 624		6 785 624	
PFCs	2 171 966	2 171 966		2 171 966	
SF <sub>6</sub>	391 359	391 359		391 359	
<b>Total Annex A sources</b>	<b>690 052 946</b>	<b>691 834 450</b>	<b>692 169 676</b>	<b>692 169 676</b>	
<b>Activities under Article 3, paragraph 3, for current inventory year]</b>					
3.3 Afforestation and reforestation on non-harvested land for current year of commitment period as reported	-796 659			-796 659	
3.3 Afforestation and reforestation on harvested land for current year of commitment period as reported		NA		NA	
3.3 Deforestation for current year of commitment period as reported	14 698 636			14 698 636	
<b>Activities under Article 3, paragraph 4, for current inventory year<sup>d</sup></b>					
3.4 Forest management for current year of commitment period					
3.4 Cropland management for current year of commitment period	-12 405 512			-12 405 512	
3.4 Cropland management for base year	3 732 221			3 732 221	
3.4 Grazing land management for current year of commitment period					
3.4 Grazing land management for base year					
3.4 Revegetation for current year of commitment period					
3.4 Revegetation for base year					

Abbreviation: NA = not applicable.

<sup>a</sup> "Adjustment" is relevant only for Parties for which the expert review team has calculated one or more adjustment(s).

<sup>b</sup> "Final" includes revised estimates, if any, and/or adjustments, if any.

<sup>c</sup> "Accounting quantity" is included in this table only for Parties that chose annual accounting for activities under Article 3, paragraph 3, and elected activities under Article 3, paragraph 4, if any.

<sup>d</sup> Activities under Article 3, paragraph 4, are relevant only for Parties that elected one or more such activities.



## II. Technical assessment of the annual submission

### A. Overview

#### 1. Annual submission and other sources of information

6. The 2011 annual inventory submission was submitted on 16 May 2011; it contains a complete set of common reporting format (CRF) tables for the period 1990–2009 and a national inventory report (NIR). Canada also submitted information required under Article 7, paragraph 1, of the Kyoto Protocol, including information on: activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, accounting of Kyoto Protocol units, changes in the national system and in the national registry, and the minimization of adverse impacts under Article 3, paragraph 14, of the Kyoto Protocol. The standard electronic format (SEF) tables were submitted on 16 May 2011. The annual submission was submitted in accordance with decision 15/CMP.1. The expert review team (ERT) noted that Canada made its submission after the deadline of 15 April but within the six-week period as stated in decision 15/CMP.1. Although, under decision 15/CMP.1, there is a six-week period before any consequences resulting from a late submission come into effect, the ERT recommends that Canada submit its next inventory by 15 April 2012, including both the CRF tables and an NIR. Further, the ERT recommends that the Party review the elements of its national system that would enable the timely submission of its annual inventory.

7. Canada officially submitted revised emission estimates on 17 October 2011 in response to the list of potential problems and further questions raised by the ERT during the course of the review (see paras. 47, 53, 79, 81, 114, 123 and 124 below). The values used in this report are based on the values contained in the submission of 17 October 2011.

8. Where necessary, the ERT also used the previous years' submissions during the review. In addition, the ERT used the standard independent assessment report (SIAR), parts I and II, to review information on the accounting of Kyoto Protocol units (including the SEF tables and their comparison report) and on the national registry.<sup>3</sup>

9. During the review, Canada provided the ERT with additional information and documents which are not part of the annual submission but are in many cases referenced in the NIR. The full list of information and documents used during the review is provided in annex I to this report.

#### Completeness of inventory

10. The inventory covers almost all source and sink categories for the period 1990–2009 and is complete in terms of geographical coverage. CRF table 9(a) shows some incomplete reporting of the energy, industrial processes, agriculture, waste and LULUCF sectors. Canada has provided explanations for the emissions reported as not estimated ("NE") in CRF table 9(a). The ERT noted that, for the categories reported as "NE", methodologies and/or emission factors (EFs) to estimate emissions are not available in the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the Revised 1996 IPCC Guidelines), the Intergovernmental Panel on Climate Change (IPCC)

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<sup>3</sup> The SIAR, parts I and II, is prepared by an independent assessor in line with decision 16/CP.10 (paras. 5(a), 6(c) and 6(k)), under the auspices of the international transaction log administrator using procedures agreed in the Registry System Administrators Forum. Part I is a completeness check of the submitted information relating to the accounting of Kyoto Protocol units (including the SEF tables and their comparison report) and to national registries. Part II contains a substantive assessment of the submitted information and identifies any potential problem regarding information on the accounting of Kyoto Protocol units and the national registry.

*Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC good practice guidance) and the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry* (hereinafter referred to as the IPCC good practice guidance for LULUCF). Nevertheless, the ERT encourages the Party to carry out further work on these issues in order to further improve the completeness of its reporting.

**2. A description of the institutional arrangements for inventory preparation, including the legal and procedural arrangements for inventory planning, preparation and management**

Overview

11. The ERT concluded that the national system continues to perform its required functions.

12. Canada reported that there have been no changes to its national system since its previous annual submission.

Inventory planning

13. The NIR describes the national system for the preparation of the inventory. The national entity responsible for Canada's national inventory system is the Pollutant Inventories and Reporting Division of Environment Canada. This Division is also responsible for: inventory planning and prioritization; GHG emission estimation and analysis; inventory report preparation; quality assurance/quality control (QA/QC) and verification; and the archive system. Further, the Division collaborates with the country's provincial and territorial governments and other organizations involved in the preparation of the inventory (see para. 14 below) on the collection of data on GHG emissions.

14. Other organizations are also involved in the preparation of the inventory as data providers. Canada's national statistical agency (Statistics Canada) provides Environment Canada with underlying activity data (AD) for use in the estimation of GHG emissions from the energy, industrial processes and agriculture sectors. Natural Resources Canada (NRCan) provides expertise on the energy sector, and collects and provides AD on mineral production, ethanol consumption and wood residues. Road vehicle fuel efficiency data are provided both by Transport Canada and by NRCan. The Canadian Forest Service, NRCan and Agriculture and Agri-Food Canada are responsible for developing the key parameters required for the reporting of GHG emissions and removals from the LULUCF and agriculture sectors. Individual divisions of Environment Canada also contribute by providing data on waste and waste management. When required, consulting groups and universities conduct in-depth studies, for example on the updating of EFs. Further, a bilateral agreement between industrial associations (e.g. the aluminium and electricity associations) has been concluded for the provision of supplementary data on the industrial processes sector.

15. The ERT considers that Canada's legal, procedural and institutional arrangements for estimating and reporting GHG emissions are in line with the general and specific functions of the national system defined in the annex to decision 19/CMP.1.

Inventory preparation

*Key categories*

16. Canada has reported a key category tier 1 analysis, both level and trend assessment, as part of its 2011 submission. The key category analysis performed by Canada and that

performed by the secretariat produced similar results, with Canada's key category analysis providing a further disaggregation of subcategories in a few cases. Canada has included the LULUCF sector in its key category analysis, which was performed in accordance with the IPCC good practice guidance and the IPCC good practice guidance for LULUCF. In response to a question raised by the ERT during the review, the Party clarified that the key category analysis is one driver for the prioritization of future inventory improvements, together with recommendations of the ERT, uncertainty estimates, and the availability of improved methods, parameters or AD.

17. Canada has identified CO<sub>2</sub> emissions from deforestation and from cropland management under Article 3, paragraphs 3 and 4, of the Kyoto Protocol as key categories. The NIR and KP-LULUCF tables provide details on the criteria used to determine the key categories.

#### *Uncertainties*

18. Canada has provided a tier 1 uncertainty estimate for the inventory as a whole, although the uncertainty estimates for some categories have been calculated using a tier 2 method (i.e. the transport and LULUCF/forest land categories). The level uncertainty estimates were provided for emissions excluding and including LULUCF, whereas the trend uncertainty analysis was provided for emissions excluding LULUCF only. The overall uncertainty estimates are similar to the uncertainty estimates of the previous year, at 3.9 per cent for total emissions excluding LULUCF and 7.1 per cent for total emissions including LULUCF. The uncertainty of the emissions trend excluding LULUCF was estimated to be 0.7 per cent. The availability of new information is reflected in the uncertainty estimates (e.g. methodological improvements have reduced the uncertainty of the EFs for wood waste (CO<sub>2</sub> and CH<sub>4</sub> emissions), spent pulping liquor (CO<sub>2</sub> emissions) and civil aviation (CH<sub>4</sub> and N<sub>2</sub>O emissions)). Conversely, the uncertainty of the EFs for fuel combustion from public electricity and heat production has increased, due to the incorporation of results from a new study.

19. In response to questions raised by the ERT during the review, the Party clarified that the uncertainty estimates are a driver for the prioritization of future inventory improvements together with the elements listed in paragraph 16 above. In addition, Canada informed the ERT that: Environment Canada has abandoned the practice of reliance on external consultants and increased the in-house capacity to perform the uncertainty analysis on a regular basis; a new uncertainty analysis and parameters have been developed for stationary combustion and transport; and the Party is planning to perform a tier 2 key category analysis for future annual submissions. The ERT commends the Party for having implemented the improvements and encourages Canada to perform a tier 2 uncertainty analysis in its next annual submission. In addition, the ERT recommends that Canada include the LULUCF sector in the trend uncertainty analysis.

#### *Recalculations and time-series consistency*

20. Recalculations have been performed for all years of the time series and for several categories. The recalculations are well justified and are reported in accordance with the IPCC good practice guidance in CRF table 8(b) and in the NIR. The largest recalculations in absolute terms for 2008 are reported for carbon removals from forest land, CO<sub>2</sub> emissions from transport, CH<sub>4</sub> emissions from enteric fermentation and CH<sub>4</sub> emissions from natural gas distribution. The main reason for the recalculations of carbon removals from forest land is the modification of the algorithm used to simulate the growth of young forest stands and the recalibration of the carbon transfer parameters for fire. The main reason for the revised CO<sub>2</sub> emissions from transport was the subtraction of bioethanol from gasoline. The recalculations for enteric fermentation were conducted mainly due to the

inclusion of an EF correction factor for slaughter heifers and steers. The main reason for the revised CH<sub>4</sub> emissions from natural gas distribution was the revision of the calculated natural gas distribution EF based on the results of a new study. The magnitude of the impact of the recalculations is a decrease in estimated total GHG emissions excluding LULUCF for 2008 of 0.4 per cent and a resulting downward change in the trend from 1990 to 2008 of 0.2 per cent. Estimated total GHG emissions including LULUCF decreased by 1.0 per cent for 2008 as a result of the recalculations.

#### *Verification and quality assurance/quality control approaches*

21. Information on the Party's QA/QC procedures has been provided in the NIR in line with the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories" (hereinafter referred to as the UNFCCC reporting guidelines). Canada has a QA/QC plan in place in accordance with decision 19/CMP.1 and the IPCC good practice guidance. The plan ensures that all key categories (and categories where a significant methodological change has occurred) are subject to tier 1 QC checks every year. Over a three-year cycle, all categories undergo a tier 1 QC check. Some tier 2 QA/QC and verification activities are performed every year based on a multi-year schedule. The Pollutant Inventories and Reporting Division of Environment Canada is responsible for implementing the QA/QC plan.

#### *Transparency*

22. Canada's inventory is generally transparent and the NIR includes information on the key categories, methods, data sources, recalculations, trends, uncertainty estimates, QA/QC procedures and verification activities, which provides a good basis for the review of the inventory. A few inconsistencies have been identified between CRF table Summary 3 and the NIR regarding the methods used (e.g. transport (CO<sub>2</sub> emissions), chemical industry (CH<sub>4</sub> emissions) and metal production (PFC emissions)). The Party provided clarification on these issues during the review. In addition, the ERT noted that the provision of additional information could further improve the transparency of the reporting, in particular in the energy sector (see paras. 41–45, 48–53, 55 and 59–62 below), the industrial processes sector (see paras. 68, 72, 74, 77, 78, 80 and 82 below), the waste sector (see paras. 111, 116, 117 and 122 below) and the KP-LULUCF activities (see para. 142 below)

#### Inventory management

23. Canada has a centralized archiving system at the Pollutant Inventories and Reporting Division of Environment Canada, which includes the archiving of all information required for the inventory, including information on QA/QC procedures and their results. The ERT considers that this is in line with requirements of decision 19/CMP.1.

### **3. Follow-up to previous reviews**

24. The ERT commends Canada for the improvements made in response to previous review reports, in particular: the improved emission estimation methodologies for aviation, iron and steel production, and consumption of SF<sub>6</sub>; the inclusion of emissions from industrial wastewater; and the improved time-series consistency for emissions in the agriculture and LULUCF sectors. However, the ERT noted that some recommendations are yet to be addressed by Canada, in particular with regard to: the reporting of non-energy use of fuels; the allocation of fuels to domestic and international navigation; the development of country-specific EFs such as leakage rates and lifetimes for consumption of HFCs; the updating of waste composition data; and the improvement of the accuracy of emission estimates for landfills.

#### 4. Areas for further improvement

##### Identified by the Party

25. The 2011 NIR identifies several areas for improvement across all sectors of the inventory. They are based on the recommendations made both by national experts and in previous review reports. However, the planned improvements are not prioritized in the NIR and no timeline is provided. Therefore, the ERT encourages the Party to provide, in the NIR of its next annual submission, a list of the improvements planned together with a prioritization and a timeline for their implementation.

##### Identified by the expert review team

26. During the review, the ERT identified cross-cutting issues for improvement. These are listed in paragraph 165 below.

27. Recommended improvements relating to specific categories are presented in the relevant sector chapters of this report.

## B. Energy

### 1. Sector overview

28. The energy sector is the main sector in the GHG inventory of Canada. In 2009, emissions from the energy sector amounted to 566,422.09 Gg CO<sub>2</sub> eq, or 81.9 per cent of total GHG emissions. Since 1990, emissions have increased by 20.9 per cent. The key drivers for the rise in emissions are the increase in CO<sub>2</sub> emissions due to increased fuel use and the increase in CH<sub>4</sub> emissions due to increased activity in the oil and gas sector. Within the sector, fuel combustion was the largest contributor (89.3 per cent), with 33.6 per cent of the sectoral emissions coming from transport, followed by 28.5 per cent from energy industries, 13.9 per cent from other sectors and 13.2 per cent from manufacturing industries and construction. Fugitive emissions from oil and natural gas accounted for 10.6 per cent and the remaining 0.2 per cent were from fugitive emissions from solid fuels.

29. Canada has made recalculations for all categories in the energy sector except coal mining between the 2010 and 2011 submissions due to changes in AD and EFs, reallocations and the correction of identified errors. The impact of these recalculations on the energy sector is a decrease in emissions of less than 0.1 per cent for 2008. The main recalculations took place in the following categories:

- (a) Manufacturing industries and construction (CO<sub>2</sub> emissions);
- (b) Transport (CO<sub>2</sub> emissions);
- (c) Oil and natural gas (CH<sub>4</sub> emissions).

30. Canada's fuel categories are based on the physical state of fuel. This is not in line with the Revised 1996 IPCC Guidelines. The Party explains in the NIR that this procedure should increase comparability. However, the ERT notes that the fuels in question (e.g. coke oven gas, petroleum coke) are not specific to Canada and that all other reporting Parties apply the fuel categorization as recommended in the Revised 1996 IPCC Guidelines. The ERT therefore disagrees that this method of reporting is comparable to that of other reporting Parties and strongly recommends that Canada report the emissions from fuel categories in line with the Revised 1996 IPCC Guidelines in its next annual submission.

31. Emissions from waste incineration are not included in the inventory of the energy sector. However, according to the website of Environment Canada, several waste incineration plants operate with energy recovery. During the review, the Party explained

that all emissions from waste incineration plants, including the emissions associated with energy/heat recovery, are currently reported under the waste sector. Canada further informed the ERT that analyses are under way to assess the amount of municipal solid waste (MSW) incinerated with energy recovery for the time series in order to reallocate emissions from waste incineration with energy recovery to the energy sector in future annual submissions. The ERT appreciates this planned improvement by Canada, which is in line with the IPCC good practice guidance, and recommends that the Party implement the improvement as soon as possible in a future annual submission.

32. The ERT found that the transparency of the information provided by Canada in the NIR was not always sufficiently clear (see paras. 41–45, 48–53, 55 and 59–62 below). The ERT recommends that the Party work on improving transparency so as to resolve these issues, and report on the progress made in the next annual submission.

## **2. Reference and sectoral approaches**

### Comparison of the reference approach with the sectoral approach and international statistics

33. Canada has reported a comparison of the emission estimates calculated using the reference and the sectoral approaches for all years of the time series. In CRF table 1.A(c), the reported difference between the CO<sub>2</sub> emission estimates calculated using the two approaches is 7.6 per cent for 2009. Canada states in annex 4 to the NIR that the corresponding CRF table, 1.A(b), does not properly exclude non-energy use of fuels in its calculations and that it has conducted an additional comparison with a resulting difference of 0.9 per cent between the CO<sub>2</sub> emission estimates calculated using the two approaches.

34. During the review, the ERT identified that the method used by Canada to conduct the comparison in annex 4 to the NIR was flawed. For example, the carbon stored in bitumen was subtracted twice in the comparison. In response to the questions raised by the ERT during the review, Canada acknowledged that the method used was incorrect and provided the ERT with a corrected spreadsheet. This resulted in a difference between the two approaches of 3.4 per cent for 2009. The ERT recommends that the Party check the information provided in annex 4 to the NIR and provide explanations for any differences larger than 2 per cent.

35. Furthermore, the ERT believes that, if Canada completed the CRF tables in accordance with the Revised 1996 IPCC Guidelines, the comparison in annex 4 would not be necessary. The ERT therefore reiterates the recommendation from the previous two review reports that the Party improve the harmonization of the information provided in annex 4 to the NIR with the data reported in the CRF tables, namely that the Party follow the recommendations of the Revised 1996 IPCC Guidelines to exclude non-energy use of fuels from the reference approach.

36. The apparent consumption reported to the UNFCCC secretariat is lower than that reported to the International Energy Agency (IEA) for all years, by 7–13 per cent. The growth rate in the period 1990–2009 for the total apparent consumption is 21 per cent (CRF) versus 22 per cent (IEA). During the review Canada informed the ERT that the national inventory group at Environment Canada is engaged in discussions with agencies reporting to the IEA to try to reconcile the differences. The ERT encourages Canada to continue its efforts to reconcile the differences between the IEA and CRF reporting.

### *International bunker fuels*

37. Canada has improved the estimation methodology for aviation, including the split between civil aviation and international bunkers, by moving to a tier 3 method. Previously, the amount of fuel used in international aviation was estimated based on fuel-use data

reported as sold to foreign airlines and using a model based on the tonne-kilometre flown reported by Canadian airlines for both domestic and international flights. The Party has reported on the new methodology and the resulting recalculations in the NIR. The ERT notes that, as a result, the accuracy of the inventory has been substantially improved for domestic and international aviation. For 2008 the estimated CO<sub>2</sub> emissions from international aviation increased by 6.9 per cent as a result of the improvement. The ERT commends Canada for this improvement.

38. The amount of fuel used for international marine bunkers is based on data on fuels sold to foreign marine vessels, which may result in an underestimate of international marine bunkers, because it may not fully include foreign trips by Canadian vessels. During the review, Canada informed the ERT that it is developing a more detailed emission estimation model for navigation. The Party indicated that it would include a description of the status of this project in the 2012 submission. Canada also indicated that implementation in the 2013 submission would be dependent on data availability and other constraints. Noting that the Party's current approach does not follow the IPCC good practice guidance, the ERT reiterates the recommendation made in the three previous review reports that Canada make further efforts to allocate these fuels to domestic and international navigation separately, in accordance with the IPCC good practice guidance.

#### *Feedstocks and non-energy use of fuels*

39. In the sectoral approach, the non-energy use of fuels is accounted for under the industrial processes sector, which is in line with the Revised 1996 IPCC Guidelines. However, there is no connection between the emissions provided in CRF table 1.A(d) and the emissions reported under the industrial processes sector. The ERT recommends that Canada correctly use CRF table 1.A(d) to exclude all non-combusted fuel quantities from the comparison with the sectoral approach.

40. During the review, Canada informed the ERT that the amount of coal oil and tar reported in CRF table 1.A(d) is in fact coke. The ERT recommends that the Party report coke separately in the next annual submission.

41. Since Canada has allocated all fuel quantities for non-energy use to the industrial processes sector, the only way to obtain an accurate comparison in CRF table 1.A(d) is to report a fraction of carbon stored of 1. In this respect, the carbon stored should be interpreted as the carbon excluded from fuel combustion. If the Party were to implement this approach, documentation should be provided both in the documentation box of CRF table 1.A(d) and in the NIR. Also, Canada should improve its documentation on non-energy use of fuels in the industrial processes sector by including information on the consumption for different non-energy purposes and the assumed fraction of carbon stored for each fuel and process (see also para. 77 below).

#### Country-specific issues

42. Canada has reported emissions from unconventional oil production (tar sands). However, in the NIR, there is not much information available on the actual EFs used. The Party responded during the review that the emission estimates are based on plant-specific information that is confidential. The ERT requested a copy of the original reference for the methodology used to calculate the emissions from unconventional oil production. At the end of the review week, the ERT did receive a copy of the documentation report. While the ERT appreciates the need to protect confidential data, the ERT recommends that Canada explore the possibilities to include in the NIR AD and implied emission factors (IEFs) at an aggregated level.

43. The CRF tables only allow for an aggregated reporting of fugitive emissions from oil production, which means that emissions from conventional and unconventional oil production cannot be distinguished in the CRF tables. Since unconventional oil production is very country-specific and is increasing in significance, the ERT recommends that Canada provide, in the NIR, a table separating the AD and emissions from conventional and unconventional oil production. This would increase the transparency of the reporting and better facilitate the review process.

### 3. Key categories

#### Stationary fuel combustion: solid, liquid and gaseous fuels – CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O<sup>4</sup>

44. During the review, the ERT noted that there was some inconsistency between the energy data reported in the CRF tables and the energy statistics published by Statistics Canada. The Party provided explanations for the inconsistencies (e.g. the calorific value of natural gas had been changed in the energy statistics compared to the CRF tables; the category “refined products” in the energy statistics was non-energy use; and flaring had been subtracted from the category “producer consumption” in the energy statistics). Further, Canada informed the ERT that the emission calculations are based on physical units and that the differences in calorific values did not impact the emission estimates. The ERT recommends that the Party include the calorific values used to report the fuel consumption emission estimates in the CRF tables in its next annual submission. In addition, the ERT recommends that Canada include information in the NIR on the processes for transferring the data from the energy statistics to the CRF tables (e.g. by providing similar comparison tables in the NIR as those provided to the ERT during the review).

#### Stationary fuel combustion: gaseous fuels – CO<sub>2</sub>

45. Canada uses country-specific CO<sub>2</sub> EFs for natural gas, where the EF varies between provinces. During the review, the ERT raised a question regarding the EF used for imported natural gas. The Party responded that the CO<sub>2</sub> EF for natural gas takes into account imported natural gas at the provincial level. For example, the average CO<sub>2</sub> EF for Ontario takes into consideration the natural gas composition supplied by western regions, produced in Ontario and imported from the United States. The ERT recommends that Canada include this information in the NIR of its next annual submission.

46. The ERT further notes that imports of natural gas have been increasing significantly since 2000 and that this might affect the EFs used for provinces where natural gas import occurs. The ERT, therefore, recommends that Canada investigate the issue of gas import further and update the EFs if necessary.

#### Stationary fuel combustion: solid fuels – CO<sub>2</sub>

47. In the 2011 submission, Canada has recalculated the CO<sub>2</sub> EFs for coal including more coal samples. During the review, the ERT raised a question regarding the distribution of coal samples for different provinces and coal types and the assumptions made for the provinces not covered by coal samples. The Party provided spreadsheets with the coal samples documenting the carbon content of the coal. However, in the spreadsheets provided, the minimum/maximum values of the carbon content did not match the EFs provided in the NIR, nor was it clear how the average EFs had been derived. Further, coal

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<sup>4</sup> Not all emissions related to all gases and fuels under this category are key categories, particularly CH<sub>4</sub> and N<sub>2</sub>O emissions. However, since the calculation procedures for and issues related to this category are discussed as a whole, the individual gases are not assessed in separate sections.



samples that would appear to have an unrealistically low carbon content had apparently been included, while other samples had been excluded. The ERT concluded that this lack of transparency prevented the ERT from assessing whether the emissions had been accurately estimated. In response to the list of potential problems and further questions raised by the ERT during the review, Canada provided the ERT with more detailed documentation, including explanations that some of the anomalies identified by the ERT were typographical errors in the spreadsheet that did not impact on the calculation of the EFs. In addition, the Party informed the ERT of an error in the emission calculation database regarding the CO<sub>2</sub> EF for imported coal and provided revised emission estimates for the full time series. As a result of these revised estimates, the CO<sub>2</sub> emissions from solid fuel combustion increased by 0.3 per cent (259.0 Gg CO<sub>2</sub> eq) for 2009. The ERT accepts these revised estimates.

#### Manufacture of solid fuels and other energy industries: gaseous fuels – CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O

48. Canada states in the NIR that flaring is included under fuel consumption in the official energy statistics and that the amount is, therefore, subtracted from petroleum refining and other energy industries and allocated to flaring under fugitive emissions. In the NIR, the process for determining the amount used for flaring was not described. During the review, the Party provided the ERT with information on how the amount of gas flared was calculated. In addition, Canada provided information on the reasons for not being able to allocate N<sub>2</sub>O emissions from flaring to fugitive emissions and the reasons for reporting the same AD for both oil and gas flaring. The ERT recommends that the Party include this information in the next annual submission.

#### Road transportation: liquid fuels – CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O<sup>5</sup>

49. In the NIR, Canada states that the bottom-up estimate of fuel consumption in road transportation only differs slightly from the top-down estimate (fuel sales). The NIR also states that if the bottom-up estimate is the higher value of the two, the top-down value is used, but if the bottom-up estimate is lower, then an average of the bottom-up and top-down estimates is used. Responding to a question raised by the ERT during the review, Canada clarified that the total fuel sales are accounted for in the inventory and that the residual amount of gasoline and diesel is allocated to off-road use. Further, the Party provided the ERT with a comparison of the bottom-up and top-down estimates. The ERT recommends that Canada include the information provided to the ERT in the NIR of its next annual submission.

50. Canada has recalculated emissions from road transportation due to the fact that the energy statistics were previously thought to exclude biofuels, but bioethanol is in fact included under gasoline, while biodiesel is not included under diesel. The amount of biofuels used in Canada is based on a biofuel study conducted for Environment Canada. The ERT recommends that the Party include more detailed information in the NIR on the determination of the amount of biofuels used, especially for bioethanol, since this value is subtracted from the energy balance.

#### Coal mining and handling: CH<sub>4</sub>

51. During the review, the ERT identified that the production data for coal presented in the energy statistics and in CRF table 1.A(b) (63.32 Mt for 2009) does not match the data reported in CRF table 1.B.1 (82.77 Mt for 2009). Canada explained that the production data

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<sup>5</sup> Not all emissions related to all gases under this category are key categories, particularly CH<sub>4</sub> emissions. However, since the calculation procedures for and issues related to this category are discussed as a whole, the individual gases are not assessed in separate sections.

in CRF table 1.A(b) are “marketable coal”, while the emission estimates are based on gross production before cleaning and processing. The ERT recommends that the Party include this information in the next annual submission.

52. Canada uses a constant CH<sub>4</sub> EF for coal mining for the whole time series based on a Canadian study “Management of Methane Emissions from Coal Mines: Environmental, Engineering, Economic and Institutional Implications of Options” by B. King (1994). On the request of the ERT, the Party provided a copy of the report during the review. Based on the original reference it was not clear to the ERT how the EFs presented in the NIR had been derived. Canada responded that the original work product (with its assumptions and corresponding weighted factors based on the information presented in the King report and other reports available) was no longer available. Specifically, the ERT identified that the King report seemed to indicate an EF for underground mining in British Columbia of 15.4 t/kt, which is higher than the value of 13.79 t/kt reported in the NIR. In response, Canada referred to page 55 of the King report, and stated that the EF based on this table is 13.45 t/kt. The ERT was not able to reproduce this factor. The ERT also notes that the Canadian IEF for underground mines is far lower than the lower limit of the IPCC default EF. The ERT concluded that this lack of transparency prevented the ERT from assessing whether the emissions were accurately estimated.

53. In response to the list of potential problems and further questions raised by the ERT during the review, Canada acknowledged that the derivation of the EFs was not transparent and provided documentation on the methodology and AD used for the derivation of the EFs. The ERT recommends that the Party include this information in the next annual submission. Further, Canada provided a recalculation for the entire time series in response to the list of potential problems and further questions from the ERT. As a result of these recalculations, the CH<sub>4</sub> emissions from coal mining and handling increased by 21.4 per cent (152.0 Gg CO<sub>2</sub> eq) for 2009. The ERT accepts these revised estimates.

#### Oil and natural gas: CO<sub>2</sub> and CH<sub>4</sub>

54. During the review, the ERT noted that the AD for production of oil and transport of oil in the CRF tables are identical but the unit used is different. Canada clarified that the correct unit is 10<sup>3</sup> m<sup>3</sup>. The ERT recommends that the Party correct this error in the next annual submission.

55. During the review, the ERT noted that the oil production reported in CRF table 1.B.1 (103,953 MI) does not match the data reported in CRF table 1.A(b) and the energy statistics (139,715 MI). Canada responded that the correct amount of oil produced in Canada is the figure listed in CRF table 1.A(b) and in the national energy balance. However, the AD reported in CRF table 1.B.1 are also correct for the specific emissions that are calculated, since the AD used to estimate emissions for oil production and oil transport exclude synthetic crude oil (SCO) since SCO is manufactured from crude bitumen. Further, the Party explained that the figures for crude oil production are not taken from the energy statistics but from another publication by Statistics Canada and that the figures from these publications are not always consistent. Canada also informed the ERT that, for the province of Saskatchewan, the statistics from Statistics Canada are not used for the calculation of the split between heavy and light crude oil but instead data received from the province are used. The ERT recommends that the Party improve the transparency of the information on the derivation of the AD for oil production and transport, and include the information provided to the ERT during the review in the next annual submission.

56. The AD used for fugitive emissions from oil refining (1.B.2(a)(iv)) is the energy consumption of refineries. During the review, the ERT noted that the value reported does not match the fuel consumption reported for petroleum refining in CRF table 1.A(a). Canada responded that the value reported under fugitive emissions is correct and that, by

mistake, the fuel consumption for flaring had not been subtracted from the fuel consumption reported under petroleum refining, but that this did not affect the emission estimates. The ERT recommends that the Party correct this mistake in the next annual submission and evaluate the QC procedures performed in order to prevent this mistake from happening in the future.

57. The EFs for CH<sub>4</sub> and CO<sub>2</sub> are kept constant, and, according to the NIR and the original reference (the Canadian Petroleum Products Institute (CPPI), 2004), the EFs are 2.78 t/GJ and 11.89 t/GJ for CO<sub>2</sub> and CH<sub>4</sub>, respectively. However, in the CRF tables, the IEFs are 2.78 kg/TJ and 11.89 kg/TJ, respectively. The Party responded that the EFs are incorrect as documented in the NIR and in the data from CPPI (2004) but that this will not have an impact on the estimated emissions since the estimation model has applied correct EF values and units. The ERT recommends that Canada correct this mistake in the next annual submission.

58. During the review, the ERT questioned whether the use of refinery energy consumption was appropriate as AD for fugitive emissions. Canada responded that a review of the previous method and rationale used to develop the fugitive emissions refinery model had shown that energy consumption values are poor predictors of fugitive emissions and that, in general, production numbers are more reliable for the estimation of fugitive emissions. The ERT agrees with this assessment. The Party indicated that the reporting of AD for this category will be reassessed in the future. The ERT recommends that Canada revise, in the next annual submission, the methodology used or provide information on the progress to develop a new methodology.

#### 4. Non-key categories

##### Stationary fuel combustion: biomass – CH<sub>4</sub> and N<sub>2</sub>O

59. The Canadian energy statistics do not include alternative energy sources such as biomass; they include only information on wood waste and spent pulping liquor used for electricity production. The values presented in the energy statistics match the biomass values reported by Canada under manufacturing industries and construction. Biomass consumption is also reported for public electricity and heat production, and residential plants. The NIR mentions a survey by Environment Canada regarding the use of firewood; however, the description is not very detailed. In response to questions raised by the ERT, the Party explained that the consumption in public electricity and heat production is biogas/landfill gas, and that the biomass consumption in residential plants is firewood. Further, Canada explained that the consumption of firewood is estimated based on the 1997 Natural Resources Canada “Survey of Household Energy Use”, the New Brunswick Department of Natural Resources and Energy “Residential Fuelwood Study 1998–99”, the Quebec “L’énergie au Québec” report and a Statistics Canada publication (Catalogue number: 64-202-XPB – “Household Facilities and Equipment” from 1986 until 1997). For 1998 onwards, consumption is extrapolated based on the data for the period 1986–1997. The ERT recommends that Canada include this information in the NIR of its next annual submission and update the survey of biomass consumption to ensure the accuracy of the emission estimates. In addition, the ERT recommends that Canada provide documentation in the NIR confirming that the survey covers all biomass use, both in relation to types of biomass and biomass use in other categories, such as commercial and institutional plants or plants in agriculture.

60. There is no comprehensive information in the NIR on the use of biogas. However, substantial amounts of CH<sub>4</sub> (363.64 Gg) are reported as recovered from the waste sector (solid waste disposal on land and wastewater handling). In response to a question raised by the ERT, Canada explained that the amount of biogas used for energy production

corresponds to the amount of biomass reported under public electricity and heat production. Further, Canada provided information on the parameters used in the calculation of the amount of biogas (i.e. the calorific value, the CH<sub>4</sub> content of biogas and the CH<sub>4</sub> density). The ERT recommends that the Party provide this information, either in the energy chapter or in the waste chapter of the NIR of its next annual submission, including a table showing the recovered amount of CH<sub>4</sub>, the flared amount of biogas, the amount of biogas combusted with energy recovery and the parameters used to derive the amounts.

#### Solid fuel transformation: CO<sub>2</sub>

61. Canada has not reported emissions from solid fuel transformation, but has allocated emissions from coke production to the industrial processes sector. The Party has not provided a carbon balance for coke production in the NIR. During the review, the ERT reconstructed the balance based on information provided in the NIR, the CRF tables and the energy statistics and identified a difference in input and output of approximately 389 kt C. Canada responded that the difference is “in all likelihood due to coal tar” and indicated that coal tar production accounted for 3 per cent of the energy input. This information was provided without a reference and it was not possible to assess whether this can account for the difference between the carbon input and output. The ERT concluded that this lack of transparency prevented the ERT from assessing whether the emissions were accurately estimated. In response to the list of potential problems and further questions raised by the ERT during the review, Canada provided further information including a carbon balance that showed that the emissions were not underestimated; in fact, the information provided by Canada suggests that there might be an overestimation of emissions. The ERT recommends that the Party include this information in the next annual submission, including a carbon balance for coke production.

62. The ERT notes that the carbon content used for coke in fuel combustion is significantly lower than the carbon content assumed under the industrial processes sector. The reason for the large difference is not clearly explained in the NIR. The ERT recommends that Canada investigate the large difference in the assumed carbon content of coke between the energy and industrial processes sectors and provide an explanation for any difference in the next annual submission.

### **C. Industrial processes and solvent and other product use**

#### **1. Sector overview**

63. In 2009, emissions from the industrial processes sector amounted to 46,678.77 Gg CO<sub>2</sub> eq, or 6.7 per cent of total GHG emissions, and emissions from the solvent and other product use sector amounted to 260.49 Gg CO<sub>2</sub> eq, or 0.04 per cent of total GHG emissions. Since the base year, emissions have decreased by 17.9 per cent in the industrial processes sector, and increased by 45.8 per cent in the solvent and other product use sector. The key driver for the fall in emissions in the industrial processes sector is the decrease in N<sub>2</sub>O emissions from chemical industry. However, the trend includes an increase in other emissions (e.g. consumption of halocarbons and SF<sub>6</sub>) as well as decreasing trends for particular categories. Within the industrial processes sector, 32.2 per cent of the emissions were from metal production, followed by 20.2 per cent from the category other, 17.3 per cent from chemical industry and 15.3 per cent from mineral products. The remaining 15.0 per cent were from consumption of halocarbons and SF<sub>6</sub>. The emission trends in the solvent and other product sector use are explained by the increase in domestic demand for N<sub>2</sub>O for anaesthetic or propellant purposes.

64. Canada has made recalculations for the industrial processes sector between the 2010 and 2011 submissions, mainly due to improvements in methodologies, but also due to

updated data becoming available and the inclusion of new (sub)categories. The impact of these recalculations on the industrial processes sector is an increase of 1,920.02 Gg CO<sub>2</sub> eq (or 3.7 per cent) for 2008. The main recalculations took place in the categories iron and steel production and consumption of SF<sub>6</sub>.

65. Canada has made recalculations for the solvent and other product use sector between the 2010 and 2011 submissions due to changes in EFs. The impact of the recalculations on the solvent and other product use sector is an increase of 10.87 Gg CO<sub>2</sub> eq (or 3.3 per cent) for 2008.

66. Canada's inventory for the industrial processes sector is generally complete. The Party has not estimated CO<sub>2</sub> emissions from asphalt roofing, road paving with asphalt, and adipic acid production; CH<sub>4</sub> emissions from ammonia production and metal production; N<sub>2</sub>O emissions from ammonia production; HFC emissions from electrical equipment; and PFC emissions from aerosols/metered dose inhalers and electrical equipment. The Revised 1996 IPCC Guidelines and the IPCC good practice guidance do not provide methodologies and/or default EFs for these categories. During the review, Canada clarified that some of these categories are perhaps not occurring, such as PFC emissions from aerosols/metered dose inhalers. The ERT notes that HFC and PFC emissions from electrical equipment are greyed out in the CRF tables, indicating that these gases are considered not applicable to this category. The ERT recommends that Canada examine the use of notation keys for these categories. Further, the ERT encourages the Party to estimate emissions from all categories reported as "NE".

## 2. Key categories

### Cement production – CO<sub>2</sub>

67. Canada has estimated emissions from cement production using a tier 2 approach from the IPCC good practice guidance (using clinker production) and the default EFs for clinker from the Revised 1996 IPCC Guidelines and the cement kiln dust default EF from the IPCC good practice guidance. The Party had previously planned to develop a country-specific EF based on the calcium oxide content in the clinker. During the review, Canada explained that this is not a priority at the moment, and that the difference between a country-specific EF and the default EF was likely to be small. Nevertheless, the ERT recommends that the Party follow up on the previously planned improvement and report on the progress made in the next annual submission.

### Lime production – CO<sub>2</sub>

68. The AD reported by Canada in the CRF tables have not been corrected for the share of hydrated lime. In response to questions raised by the ERT during the review, Canada explained that the correction is taken into account when calculating the emissions but not when reporting the AD in the CRF tables. During the review, the Party also supplied the ERT with a table showing the time series for the production of high-calcium and dolomitic lime. The ERT recommends that Canada include this information in the NIR of the next annual submission. Further, the ERT recommends that the Party provide explanations for the large decline in the share of dolomitic lime during the periods 1999–2000 and 2008–2009.

### Ammonia production – CO<sub>2</sub>

69. In the last review report, the ERT recommended that Canada switch from a tier 1b approach to a tier 1a approach for the estimation of emissions from ammonia production. During the review, in response to questions raised by the ERT, the Party informed the ERT that the natural gas data obtained from Statistics Canada do not have the necessary level of

detail to enable the switch to a tier 1a approach. Only the total natural gas consumption is known, and it has not been possible to estimate the precise amount used as feedstock. Canada also informed the ERT that it was working on the development of a country-specific methodology that would enhance the accuracy of the emission estimate. The ERT recommends that the Party either acquire the necessary AD for a tier 1a approach or develop a country-specific approach and provide documentation on this method in the next annual submission.

70. During the review, the ERT identified that the IEF for 2001, 2003 and 2005 deviated from the value for the rest of the time series. In response to a question raised by the ERT, Canada explained that this was due to an AD input error in the CRF tables and the calculation of emissions had not been affected. The ERT recommends that the Party correct the error in the next annual submission and that Canada further develop its QC procedures to prevent this type of error from occurring in the future.

71. Canada uses a carbon content for natural gas for ammonia production that is different from the carbon content assumed for natural gas in the energy sector. For ammonia production, a CO<sub>2</sub> EF of 1,924 g/m<sup>3</sup> is used, whereas, in the energy sector, the EF ranges between 1,891 g/m<sup>3</sup> and 2,454 g/m<sup>3</sup> depending on the province. Unless plant-specific data are available, the ERT recommends that Canada apply the same CO<sub>2</sub> EF for natural gas irrespective of whether it is used for fuel combustion or ammonia production, taking into account information on the location of the 11 ammonia-producing plants in Canada.

#### Iron and steel production – CO<sub>2</sub>

72. In response to the previous review report, Canada has changed the methodology for iron and steel production by including the use of a country-specific carbon content for pig iron and steel. The ERT commends the Party for this improvement in the methodology used. For the year 2009, the production of pig iron and steel was reported as confidential. In response to questions raised by the ERT, Canada indicated that it would continue the dialogue with Statistics Canada and companies to try to get the confidentiality lifted. The ERT also noted that other sources (e.g. the World Steel Association) publish production statistics for Canada. The ERT recommends that Canada make every effort to ensure that AD can be reported for this key category in the future. During the review, the Party provided the ERT with information on the carbon content of pig iron and steel as well as more detailed AD for the period 1990–2008 than the AD provided in the CRF tables. The ERT greatly appreciates this information as it facilitates the review of this category. The ERT recommends that Canada include this information in the next annual submission. During the review, the Party informed the ERT that there are four major integrated iron and steel plants in the country. The ERT recommends that Canada increase the transparency of its reporting in the next annual submission by including information on the process components of these four plants.

73. The previous review report recommended that Canada report CO<sub>2</sub> emissions from reductants other than coke under the category iron and steel production instead of the category other (industrial processes). In response to questions raised by the ERT during the review, the Party explained that, while the use of other reductants is possible, there are currently no data available to determine the use of non-coke reductants in the iron and steel industry and, therefore, the emissions cannot be reallocated from other (industrial processes) to iron and steel production. The ERT recommends that Canada make efforts to improve the statistical data on the use of reductants.

Aluminium production – CO<sub>2</sub> and PFCs

74. The previous review report recommended that Canada improve the transparency of its reporting on aluminium production, especially regarding the use of methodologies throughout the time series. In response to questions raised by the ERT during the review, Canada informed the ERT that there are currently 15 aluminium plants operating in Canada, and provided information on the smelting technology for each plant. In addition, the Party clarified that, in recent years, all the plants have used a tier 3 methodology to estimate emissions. The ERT recommends that Canada include this information in the NIR of its next annual submission in order to enhance transparency.

Consumption of halocarbons and SF<sub>6</sub> – HFCs

75. A two-step approach was used for the estimation of HFC emissions. Canada reports that emissions of HFCs only started in 1995, and for that year, a simplified tier 2 approach from the Revised 1996 IPCC Guidelines was used, taking into account only the consumed amounts of HFCs and using conservative assumptions for the EFs (e.g. 100 per cent emissions for mobile air-conditioning equipment). For the period 1996–2008, a tier 2 approach was applied, which does consider the lifetime of the equipment and the emissions during use and at disposal (if applicable). Leakage rates and lifetimes stem from the Revised 1996 IPCC Guidelines. The AD (e.g. imports, exports and sales data) were collected by industry through surveys and voluntary reporting. Gaps were filled in by using assumptions such as stable growth rates. The previous review report recommended that Canada develop country-specific EFs, such as leakage rates and lifetimes, because of the increasing importance of HFC emissions over time. During the review, the Party informed the ERT that there are currently no plans to implement this recommendation. The ERT reiterates the recommendation that Canada increase the accuracy of its reporting of HFC emissions from consumption of halocarbons and SF<sub>6</sub> by developing country-specific EFs.

76. The ERT identified that a recalculation had been made in the NIR, but that, by mistake, this had not been included in the CRF tables. The ERT recommends that Canada report this recalculation in the next annual submission and that the Party enhance its QC procedures to avoid this type of error from occurring in the future.

Other (industrial processes) – CO<sub>2</sub>

77. Canada reports emissions from non-energy use of fuels under this category. During the review, the Party clarified that coke used as a reductant in the iron and steel industry, the use of natural gas as feedstock in ammonia production, and petroleum coke and coal used to make anodes in aluminium production are allocated to their respective categories under the industrial processes sector. The remaining emissions from non-energy use of fuels are included under this category. During the review, the ERT noticed that the EF used for natural gas for non-energy use is 1,522 g/m<sup>3</sup>, but that the reported EFs for natural gas in chapter A8.1.1.3 of the NIR range between 1,820 g/m<sup>3</sup> and 2,482 g/m<sup>3</sup>. Canada explained that this is because the EF for non-energy use takes into account the fraction of carbon stored (e.g. in connection with methanol production). The EFs were derived from a study carried out in 2000. However, it would seem likely that the distribution between the different non-energy uses of a fuel would vary over time, and that this approach would not capture that variation. The ERT recommends that Canada improve the transparency of the NIR by providing all underlying assumptions for the estimates in this category, including information on the different processes and on the assumed fraction of carbon stored for each fuel and process separately.

### 3. Non-key categories

#### Limestone and dolomite use – CO<sub>2</sub>

78. The use of limestone and dolomite decreases by 40 per cent from 2001 to 2002 and by 47 per cent from 2006 to 2007. These fluctuations are not explained in the NIR, and could not be clarified by Canada during the review. The amount of limestone and dolomite used is obtained from NRCan. The ERT recommends that Canada investigate these fluctuations and provide explanatory information in the next annual submission.

79. Canada uses information on the use of limestone from NRCan to estimate emissions. The Party allocates the use of limestone in cement production and lime production to the respective categories. For limestone and dolomite use, the Party includes the following items in the statistics: flux in iron and steel furnaces, and flux in non-ferrous smelters, glass factories and pulp and paper mills. Also, Canada includes a small amount of limestone from the category other chemical uses. Since the latest year's statistics are not publicly available from NRCan, the comparison between the NRCan data on limestone and dolomite consumption and the data in the CRF tables has been made for 2005. For 2005, Canada has included 591.8 kt limestone and dolomite use in the CRF tables, leading to CO<sub>2</sub> emissions. The Party explained during the review that the share of emissive chemical uses was based on the report "AMEC. 2006. Identifying and Updating Industrial Process Activity Data in the Minerals Sector for the Canadian Greenhouse Gas Inventory". However, when reading the report, it becomes clear that the report uses a share of 39 per cent for the emissive share of limestone used in other chemical uses. This percentage is based on the distribution in the United States from 1997 to 2003 of limestone used for other chemical uses. The ERT considered that there was no documentation supporting the assumption that 39 per cent of limestone use is emissive and, therefore, it concluded that the emissions were underestimated. In response to the list of potential problems and further questions raised by the ERT during the review, Canada acknowledged that the documentation on the split between emissive and non-emissive uses was not available. The Party recalculated the estimates considering all limestone use as emissive for the whole time series. As a result of the recalculation, the CO<sub>2</sub> emissions from limestone and dolomite use increased by 125.4 per cent (352.5 Gg CO<sub>2</sub> eq) for 2009. The ERT accepts these revised estimates.

80. Canada does not include a breakdown of limestone and dolomite use for other use categories in the NIR, and the data from NRCan do not distinguish between limestone and dolomite. The NIR states that, for iron and steel, a 70/30 split is assumed between limestone and dolomite. However, for other use categories, the assumed split between limestone and dolomite is not included. The ERT recommends that Canada include, in the next annual submission, a table such as the one presented to the ERT during the review, and extend it to include information on the specific use of limestone and dolomite.

#### Soda ash use – CO<sub>2</sub>

81. The ERT noted that the CO<sub>2</sub> IEF for Canada for 2009 (0.371 t/t) is lower than the IPCC default EF (0.415 t/t) and the lowest among reporting Parties (0.371–0.415 t/t). In response to questions raised by the ERT during the review, Canada explained that a part of the soda ash is used in processes that do not emit CO<sub>2</sub> (e.g. soap and detergent manufacturing). However, only the total amount of soda ash used is available in Canada. The Party has, therefore, used a split between industries in the United States, and applied that to the Canadian data. The report provided by Canada recognizes that there could be different use patterns in the United States and Canada. In addition, the Revised 1996 IPCC Guidelines do not refer to soda ash uses that do not emit CO<sub>2</sub>. The ERT noted that the current methodology could be underestimating emissions. In response to the list of potential problems and further questions raised by the ERT during the review, Canada stated that no



country-specific data were currently available regarding the specific uses of soda ash, and that the Party, therefore, would consider all soda ash use as emissive. Canada recalculated the estimates considering all soda ash use as emissive for the whole time series. As a result of these recalculations, the CO<sub>2</sub> emissions from soda ash use increased by 12.0 per cent (11.9 Gg CO<sub>2</sub> eq) for 2009. The ERT accepts these revised estimates.

#### Nitric acid production – N<sub>2</sub>O

82. In its NIR, Canada presents several methods (tier 1, tier 2 and tier 3) for estimating emissions from nitric acid production. Based on the information provided in the NIR, it is not clear to what extent the different methods are used by Canada to calculate N<sub>2</sub>O emissions. During the review, the Party informed the ERT that there are seven nitric acid plants operating in Canada, and that in 2009 only one plant used a tier 3 methodology covering 1.4 per cent of the emissions, while the rest of the plants estimated their emissions using a tier 2 methodology. The ERT recommends that the Party provide details in the next annual submission on the use of different methods to calculate N<sub>2</sub>O emissions from nitric acid production.

#### Consumption of halocarbons and SF<sub>6</sub> – SF<sub>6</sub>

83. The previous review report noted that SF<sub>6</sub> emissions were calculated based on a tier 1a methodology from the Revised 1996 IPCC Guidelines, assuming that the SF<sub>6</sub> purchased is equal to the leakage of SF<sub>6</sub> (not including the SF<sub>6</sub> purchased by equipment manufacturers, as this is assumed to be filled into new equipment). In order to increase the accuracy of the approach, the ERT recommended that Canada change the methodology. In response to the recommendation of the ERT, the Party has implemented a modified tier 3 method. The new method and the resulting recalculations have been described in detail in the NIR. The ERT commends Canada for undertaking this improvement.

## **D. Agriculture**

### **1. Sector overview**

84. In 2009, emissions from the agriculture sector amounted to 55,857.95 Gg CO<sub>2</sub> eq, or 8.1 per cent of total GHG emissions. Since the base year, emissions have increased by 19.2 per cent. The key driver for the rise in emissions is the increasing use of nitrogen (N) fertilizer and the increases in the population of non-dairy cattle and swine, with resulting increases to N<sub>2</sub>O emissions from agricultural soils, CH<sub>4</sub> emissions from enteric fermentation, and CH<sub>4</sub> and N<sub>2</sub>O emissions from manure management. Within the sector, 53.6 per cent of the emissions were from agricultural soils, followed by 34.6 per cent from enteric fermentation, 11.7 per cent from manure management and 0.1 per cent from field burning of agricultural residues.

85. The Party has made recalculations for the agriculture sector between the 2010 and 2011 submissions. The recalculations are a result of problems identified with the livestock database that were subsequently corrected, and resulted in a decrease in emission estimates. The impact of these recalculations on the agriculture sector is a 6.5 per cent reduction for 2008. The main recalculations took place in the following categories:

- (a) Enteric fermentation (CH<sub>4</sub> emissions);
- (b) Manure management (CH<sub>4</sub> and N<sub>2</sub>O emissions);
- (c) Agricultural soils (N<sub>2</sub>O emissions).

86. The agriculture sector is complete in terms of gases, categories and years. Following input from the 2010 review report, Canada now provides estimates for CH<sub>4</sub> and N<sub>2</sub>O

emissions from field burning of agricultural residues. The ERT commends the Party for the review and correction of its livestock database, which resulted in numerous recalculations across the agriculture sector.

## 2. Key categories

### Enteric fermentation – CH<sub>4</sub>

87. Canada had identified in its 2010 NIR an inconsistency in the time series with respect to the estimates of CH<sub>4</sub> emissions from enteric fermentation, in particular in relation to the implementation of equations 4.3a and 4.4b of the IPCC good practice guidance on net energy for growth and weight loss. In the previous submission, this was only corrected for the year 2008. The database used to calculate enteric emissions from animals was fully reviewed and all issues identified in the database in relation to estimates of enteric CH<sub>4</sub> emissions were corrected for the entire time series, as noted in table 6-2 of the NIR. These recalculations led to a decrease in emissions from enteric fermentation of 3.7 per cent in the base year. Corrections were applied in a consistent manner both to enteric fermentation and to manure management where the same data were utilized.

88. As noted in the 2011 submission, digestible energy by animal category is static over the time series and is based on feed rations for 2001. In its NIR, Canada has indicated that consultations are ongoing with national production experts to evaluate the possibility of developing a time series that accounts for changes in the digestibility of feed rations. The ERT recommends that the Party report its progress towards the implementation of a time series that accounts for changes in the digestibility of feed rations its next annual submission.

### Manure management – CH<sub>4</sub> and N<sub>2</sub>O

89. In the 2010 review report, the ERT requested that Canada improve the description of the animal waste management systems (AWMS) used in the country by providing a detailed description of how AWMS are broken down by region. During the 2011 review, the Party had replied that there are 10 provinces in Canada, and that it reports the emissions from nine categories of animals. To provide a table that comprehensively lists the distributions of AWMS for all animals in all provinces would require a table with 360 cells, and, according to the Party it is not practical to include such a table in the national inventory report. The ERT noted that in appendix 3.3 to the 2011 NIR, a table of the national averages of manure management systems has been provided, and in the text of section A3.3.4.4, there is a discussion on the regional variability of the most significant animal categories. The weighted national averages, as presented in NIR table A3-23, provide the values that directly relate to the national emission totals, and are therefore the values that are most directly related to the emissions reported in the NIR. However, upon request by the ERT, Canada did provide a detailed description of how the AWMS are broken down by region. The ERT considers that the information provided by the Party is sufficient, and that it is not necessary to provide a detailed breakdown in the NIR.

90. Some AWMS (e.g. anaerobic lagoons, daily spread and dry lot) have been reported as “NE”. In the previous review report, Canada stated that these AWMS were negligible sources of emissions and that information on these AWMS was not available. During the 2011 review, the Party informed the ERT that the regional distribution of manure management systems that is used for the inventory calculation model is from a 2003 survey, carried out specifically for the purposes of the development of the tier 2 methodology used by Canada for the estimates of CH<sub>4</sub> emissions from manure management. The survey was aimed at provincial experts who provided, for each province, the percentage of manure that was treated using different manure storage systems. This survey did not attribute any

manure to anaerobic lagoons or daily spread systems of manure management as defined by the IPCC good practice guidance. However, even though the survey did not attribute manure to these systems, Canada did not believe it had concrete evidence that these systems do not occur in the country, only that provincial experts consider that the amount of manure that is being treated by these systems is negligible. Therefore, the Party has continued to report these emissions as “NE”, as opposed to not occurring (“NO”), until it can accurately quantify the amount of manure being treated by these systems, or determine with certainty that these manure management systems are not used in Canada. Overall, this issue is a very minor source of uncertainty in this category. The ERT commends the Party for undertaking such a detailed survey on the use of AWMS in Canada. Given that the results of this survey indicate that the amount of manure being treated by these system types is negligible, there is unlikely to be any significant underestimation of emissions from these system types. Additionally, all manure is properly accounted for and applied to some type of AWMS; the Party is, therefore, accounting for all manure and is accounting for it by AWMS to the best of its ability. The impact (i.e. whether it lowers or raises emissions of CH<sub>4</sub> and N<sub>2</sub>O) of this uncertainty is not possible to determine, but, as mentioned above, the overall impact on the level of emissions is likely to be very low.

### 3. Non-key categories

#### Field burning of agricultural residues – CH<sub>4</sub> and N<sub>2</sub>O

91. In previous submissions, Canada did not report emissions from field burning of agricultural residues. In its 2011 submission, the Party has provided a complete time series for the estimates from this category. References to residues burned in CRF table 4.D are now provided in disaggregated detail in CRF table 4.F, which further increases the transparency of the submission. The ERT commends Canada for these improvements.

## E. Land use, land-use change and forestry

### 1. Sector overview

92. The LULUCF sector was a net sink of 12,100.16 Gg CO<sub>2</sub> eq in Canada in 2009 and net GHG removals decreased by 82.1 per cent since 1990. Natural disturbances in forest land – namely, the occurrence and severity of fires and insect epidemics – cause significant variability in the trend of emissions and removals from the LULUCF sector, which is a net sink for 11 of the 21 years in the time series, and a source in the remaining years. The ERT noted that cropland changed from being a net source of emissions (of 11,333.95 Gg CO<sub>2</sub> eq) in 1990 to a net sink (of 6,900.17 Gg CO<sub>2</sub> eq) in 2009. The key driver for this steady trend is the decrease in emissions from the conversion of forest land to cropland and in the area of summer fallow, as well as the increase in the area of no-till farming. In 2009, within the sector, 16,542.62 Gg CO<sub>2</sub> eq of net removals were from forest land, followed by 6,900.17 Gg CO<sub>2</sub> eq from cropland. Settlements accounted for net emissions of 8,865.49 Gg CO<sub>2</sub> eq and wetlands accounted for 2,477.13 Gg CO<sub>2</sub> eq. The net removals from the LULUCF sector offset 1.8 per cent of the total GHG emissions in 2009.

93. The Party has made recalculations for the LULUCF sector between the 2010 and 2011 submissions in response to the 2010 annual review report and due to changes in AD and methodological changes applied to all inventory years. The impact of these recalculations on the LULUCF sector is an increase in net removals by 32.1 per cent for 2008. The main recalculations took place in the following categories:

(a) Forest land remaining forest land: updated AD for emissions from fires, revised carbon transfer parameters following fire, and revised parameters for growth of young forest stands;

- (b) Forest land conversion: updated AD from remote-sensing images;
- (c) Land converted to cropland: revised method for soil carbon.

94. The ERT commends Canada for improving time-series consistency by applying updated AD and methodological changes to all inventory years, as recommended in the previous review report. The Party also used updated AD on forest land conversion and updated carbon transfer parameters for emissions from fires, as stated in its 2010 NIR. The ERT welcomes these implementations, yet encourages Canada to improve the transparency of the updated carbon transfer parameters for non-CO<sub>2</sub> emissions from fires by identifying an aspect of the methodologies used in the cited references that could explain why the IEFs are the highest among the reporting Parties.

95. Canada applies the IPCC tier 2 and tier 3 methods and country-specific parameters to prepare the estimates for the LULUCF sector. The methods used to represent areas of land comply with approach 2 of the IPCC good practice guidance for LULUCF. The Monitoring, Accounting and Reporting System (MARS) is used by Canada to ensure the highest consistency and spatial integrity of the GHG inventory. The Party uses a hierarchical spatial framework which, in the case of managed forest land, consists of 542 analysis units. The National Soil Database of the Canadian Soil Information System is the basis for the data used for the estimates for the cropland category. The ERT commends Canada for the transparent information provided on its tier 2 and tier 3 methods included in the NIR.

96. The ERT notes that Canada is continuing its efforts to improve the AD and estimates for the LULUCF sector. In particular, the recalculations of emissions related to land-use change to and from forest land, by updating the AD with remote-sensing data for 2008, have led to a significant improvement in the accuracy of the inventory. Detailed information on the uncertainty analysis and QA/QC procedures performed is provided in the NIR. The uncertainty analysis was implemented in 2011 for all categories in the LULUCF sector except for land converted to forest land, due to resource limitations. The uncertainty for the key categories is estimated using a tier 2 (Monte Carlo) method. Tier 1 QA/QC and tier 2 QC procedures were applied to the estimation of all emissions by sources and removals by sinks reported in the sector.

97. The Party reports GHG emissions and removals from an area of 279,804 kha, which corresponds to 28.1 per cent of the total area of Canada (996,357 kha). Emissions and removals from 5,804 kha of managed grassland are reported as “NE”, and the rest of the area is considered by Canada as unmanaged, and emissions and removals are, therefore, not reported. In the Party’s definition, land, once managed, does not become unmanaged again. Even if the management of the land has stopped, or the land is abandoned and no new management is established, Canada continues to report such land under the former land-use category. During the review, Canada informed the ERT that this choice was made because of scientific uncertainty on what determines the reversion of managed land to unmanaged status. The ERT recommends that the Party provide this explanation in the next NIR. In the NIR, the Party has provided a land-use change matrix for managed land and a table with the total area, areas of managed forests and areas of cropland for 2009.

98. Emissions from grassland remaining grassland for all gases were reported as included elsewhere (“IE”), “NO” and “NE”, and land converted to grassland was reported as “NE” and “NO”. Managed agricultural grassland is only found within the Prairie regions of Canada; their extent (5,804 kha – 2.1 per cent of all land for which an estimate of emissions or removals is reported) is estimated based on census statistics for unimproved pasture. Canada argues that no information is available on management changes, yet provided evidence to the ERT that the managed land had not changed significantly since 1990. Managed areas of grassland (i.e. cut for hay or green feed or improved pastures) are

included under cropland. The Party explained during the 2010 review that it was working on the development of an estimate for grassland remaining grassland. The ERT recommends that Canada provide an estimate for emissions and removals from grassland remaining grassland in its next annual submission.

## 2. Key categories

### Forest land remaining forest land – CO<sub>2</sub>

99. Canada reports CO<sub>2</sub> emissions and removals from this category using a tier 3 method from the IPCC good practice guidance for LULUCF. The AD used for preparing the estimates in this category are compiled by the National Forest Carbon Monitoring, Accounting and Reporting System (NFCMARS). The system integrates forest inventory data, yield curves and reference AD. The CBM-CFS3 model computes data on the growth, litter fall, tree mortality and decomposition, as well as the effects of natural disturbances and management activities, and produces estimates of emissions and removals from this category. As stated in its 2010 NIR, Canada has implemented recalculations for the entire time series in the 2011 submission. The ERT welcomes the realization of this planned improvement.

### Cropland remaining cropland – CO<sub>2</sub>

100. Canada reports CO<sub>2</sub> emissions and removals from this category using the tier 2 method from the IPCC good practice guidance for LULUCF, with a well-calibrated and validated model (CENTURY) to estimate the average changes and time frame for changes in soil organic carbon between different management practices. Under this method, the carbon stock changes in soil organic carbon that occur over a period of more than 100 years can be estimated, rather than the 20-year default time frame of the IPCC good practice guidance for LULUCF. The ERT commends the Party for using this more precise method.

101. Canada has reconstructed the AD for changes in management practices until 1970. For the years prior to 1970, the Party assumes that there were no changes in management practices. Given the tier 2 method used for soil carbon, this assumption leads to an ever increasing amount of “residual emissions”, as acknowledged by Canada in its NIR. As a result, this reconstruction method for the AD prior to 1970 is inaccurate, in the sense that emissions from earlier years are consistently underestimated. The ERT acknowledges that this source is small, and that the Party cannot be asked to devote resources to the collection of AD prior to 1970. Hence, the ERT recommends that Canada use reconstruction methods for the AD that are not more demanding than the current assumption of “no changes in management practices”, for example by assuming that changes in management practices prior to 1970 are constant and equal to the average during the period 1970–1980, or by using a suitable surrogate.

### Land converted to cropland – CO<sub>2</sub>

102. As stated in its 2010 NIR, in its 2011 submission, Canada has used new AD obtained from a remote-sensing campaign in 2008 for forest land converted to cropland, and has implemented recalculations for the entire time series in 2011. The ERT welcomes the realization of this planned improvement.

103. In its 2011 submission, Canada has changed its assumption for the estimation of emissions from soil carbon for forest land converted to cropland in western Canada, resulting in no emissions for this type of land-use change. The Party has documented this method in its NIR, showing that the soil carbon content of native forests is not different from that of cropland in this specific area of Canada. During the review, Canada clarified that the reason for this assumption was that, after conversion, the cropland was used for

perennials and pasture, and that these specific transitions have a small impact on soil carbon. The ERT encourages the Party to further clarify in the NIR how the comparable soil carbon content of forests and cropland in western Canada is compatible with an absence of change in soil carbon for the transition from forest land to the type of cropland management with a higher than average soil carbon content.

#### Land converted to wetlands – CO<sub>2</sub>

104. Under this category, Canada reports emissions from peatlands drained for peat extraction and flooded land. Peat extraction is used for horticultural application only. For the calculation of CO<sub>2</sub> emissions from flooded land, Canada uses a tier 3 approach, applying the default conversion time of 10 years, and replaces the constant EF with a time-dependent and reservoir-specific EF derived from a country-specific CO<sub>2</sub> emission curve over time, after which emissions from the decay of cleared forest biomass are considered to no longer occur. In its 2010 submission, Canada stated that it would correct the inconsistencies in the time series and reassess the aforementioned EF curve used to determine the emissions from the surface of flooded land. The ERT welcomes the realization of this planned improvement. However, the ERT noted that the method used to calculate emissions from flooded land may result in an underestimation of emissions, as the emission pattern that is reported to be specific to Canada in the NIR still shows important levels of emissions after 10 years. The ERT recommends that the Party provide evidence that the method used provides unbiased estimates regarding the decay of submerged biomass. In the case that Canada cannot provide this evidence, the ERT recommends that the Party either revert to a tier 1 approach or use a longer conversion period than 10 years.

### **3. Non-key categories**

#### Biomass burning – CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O

105. In its 2010 submission, Canada stated that it was performing investigations on the use of revised EFs for biomass burning. These revised EFs were implemented in the 2011 submission and adequately referenced in the NIR. The ERT welcomes the realization of this planned improvement.

106. Canada did not estimate emissions from biomass burning on managed grassland due to a lack of consistent AD. Due to the small area of grassland, this source is likely to be small. The ERT, nevertheless, encourages the Party to investigate the possibility of reconstructing the AD for this source of emissions.

## **F. Waste**

### **1. Sector overview**

107. In 2009, emissions from the waste sector amounted to 22,615.14 Gg CO<sub>2</sub> eq, or 3.3 per cent of total GHG emissions. Since the base year, emissions have increased by 20.3 per cent. The key drivers for the rise in emissions are the increases in emissions from solid waste disposal on land and wastewater handling. Within the sector, 92.5 per cent of the emissions were from solid waste disposal on land, followed by 4.5 per cent from wastewater handling and 3.0 per cent from waste incineration.

108. Canada has made recalculations for the waste sector between the 2010 and 2011 submissions in response to the recommendations in the 2010 review report and due to changes in AD and calculation parameters. The impact of these recalculations on the waste sector is a decrease in emissions of 1.3 per cent for 2008.

109. In the 2011 submission, Canada still reports emissions from unmanaged waste disposal sites as “NE”, with the assumptions that there are few unmanaged sites, that they are all shallow and small in size, and that there are no significant emissions from those sites. However, the Party accounts for all emissions by assuming that all waste is disposed in managed landfills, and considers that the emissions from waste disposed in unmanaged landfills are conservatively accounted for under the subcategory managed waste disposal. The previous review report recommended that Canada either reallocate the emissions or change the notation key to “IE”. During the review, the Party responded that it would change the notation key in the 2012 submission. The ERT reiterates the recommendation that Canada either reallocate the emissions to unmanaged waste disposal sites or change the notation key to “IE”, and include, in the NIR, the reason for not reporting the emissions from unmanaged waste disposal separately.

110. During the review, the ERT identified instances where the information presented in the NIR was inconsistent (e.g. the waste composition data in table A3-47 of the NIR and the description of the calculation of  $L_0$  in section 8.2.2.1 of the NIR). During the review, Canada provided the correct information to the ERT. The ERT recommends that the Party correct these errors and improve its QC procedures to prevent these types of errors from occurring in the future.

111. During the review, the ERT identified some methodological issues that potentially underestimate the emission estimates reported by Canada, one of which was concerning  $N_2O$  emissions from wastewater handling. In response to the list of potential problems and further questions raised by the ERT during the review week, Canada submitted (on 17 October 2011) more information on this issue. The ERT concluded that the emissions are underestimated and initiated an adjustment procedure (see chapter II.G of this report).

112. Canada uses information from Statistics Canada (the Waste Management Industry Survey) on the amount of waste disposed. According to the NIR, the amount of waste incinerated and the amount exported is subtracted from the amount disposed, in order to arrive at the amount of waste landfilled. According to the comparison made by the ERT between the data reported in the CRF tables and the report from Statistics Canada, substantial amounts of MSW are exported. Canada informed the ERT that data on exported waste are provided by the Ontario Ministry of Environment by personal communication. The ERT recommends that the Party present, in its next annual submission, the time series for the export of MSW, and include information on how the amount of exported waste is estimated. The ERT also identified during the review that there is import of waste to Canada. The Party responded that the imported waste would be included in the survey conducted by Statistics Canada. The ERT recommends that Canada include a description in the NIR of how the import of waste is captured in the survey.

## 2. Key categories

### Solid waste disposal on land – $CH_4$

113. Canada assumes a constant waste composition for each province for the period 1990–2009, despite the strong likelihood that waste composition has changed during the time series. The previous review report strongly recommended that Canada undertake work to update the waste composition data. However, this has not been done, nor is it mentioned under the planned improvements in the 2011 submission. During the review, the Party stated that it will be planning a strategy to collect these data in 2012 and that it expects to implement the changes in 2013 for the 2014 NIR submission. The long time frame for the implementation of this project is a concern. The ERT reiterates the recommendation that Canada update its waste composition data and improve the accuracy of its estimates as soon

as possible. In addition, the ERT recommends that Canada report, in its next annual submission, on the progress made with this issue.

114. Canada does not include emissions from landfilled waste from construction, renovation and demolition (CR&D) in the inventory. In response to questions raised by the ERT during the review, the Party stated that this waste has been excluded as it is mostly placed in CR&D waste landfills, and that this waste type is not expected to generate significant quantities of methane due to its composition. The ERT notes that, according to the reference used by the Party (*An Analysis of Resource Recovery Opportunities in Canada and the Projection of Greenhouse Gas Emission Implications*, NRCan, 2006), a significant amount of wood and a smaller amount of paper is deposited in CR&D waste landfills. Further, the ERT notes that, in appendix E to the cited reference, it is also indicated that CR&D waste contains a small amount of organics in addition to the wood waste. The ERT noted that excluding CR&D waste from the emission calculation could result in an underestimation of emissions. In response to the list of potential problems and further questions raised by the ERT, Canada provided revised estimates taking into account the CR&D waste. The Party provided the documentation for the inclusion of CR&D waste including the revised degradable organic carbon (DOC) and  $L_0$  values for different waste fractions and provinces. The ERT recommends that Canada include the revised documentation in its next annual submission. As a result of the recalculation,  $CH_4$  emissions from solid waste disposal on land increased by 2.8 per cent (579.3 Gg  $CO_2$  eq) for 2009. The ERT accepts these revised estimates.

115. During the review, the ERT requested that Canada provide documentation confirming that several of the waste fractions (renovation, multi-material and other) included in all waste categories have a DOC content of 0. The Party responded that, as a result of discussions with the author of the NRCan report, it can be assumed that these waste types contain little or no MSW organics. The ERT considers that this is not an appropriate justification for the use of a DOC content of 0. In response to the list of potential problems and further questions raised by the ERT, Canada clarified that, for the revised estimates (see para. 114 above), new DOC content values were derived, and the Party also provided further information including documentation on the derivation of the DOC values. The ERT recommends that Canada revise the description of this category in its NIR accordingly and include this information in the next annual submission.

### 3. Non-key categories

#### Wastewater handling – $CH_4$

116. In response to the previous review report, Canada has estimated emissions from industrial wastewater handling. According to the NIR, Canada has identified 19 anaerobic systems in different industrial sectors. During the review, the ERT sought clarification from the Party as to whether the identified list of plants was exhaustive. Canada provided the ERT with examples of literature, contact with the suppliers of treatment systems and previous surveys that substantiated the fact that the Party has made every effort to identify and include all anaerobic treatment facilities. The ERT commends Canada for the thorough effort made and recommends that the Party incorporate the information provided to the ERT in the NIR of the next annual submission.

117. For municipal wastewater handling, Canada has calculated the emissions as an EF times the population based on a report from AECOM. In the previous review report, the ERT recommended that Canada improve the documentation on the methodology and calculation parameters. While improvements have been made to the description in the NIR, for which the ERT commends Canada, the ERT considers that the description can be further improved by incorporating information from the AECOM report in the NIR. The



ERT recommends that the Party include more information in the NIR regarding the choice of methodology and elaborate, in particular, on the lack of applicability of the IPCC default EFs for Canada.

#### Wastewater handling – N<sub>2</sub>O

118. Canada has calculated N<sub>2</sub>O emissions from human sewage using protein consumption corrected for losses. During the review, the Party informed the ERT that the use of corrected values provides a more realistic and accurate representation of the actual quantity of protein consumed, and provided the reference to a Canadian report and a report from the United States. Canada also informed the ERT that there is very little, if any, difference in the food preparation practices and wastage habits at the plate level between Americans and Canadians. The ERT notes that the Canadian report includes the following statement: “The waste adjustment factors are provided by the United States Department of Agriculture’s Economic Research Service. Cultural or even climatic differences might affect these numbers, however, they are provided as estimates and considerable caution needs to be used when working with the waste adjusted data. Losses, particularly losses at the consumer level, are by their nature difficult to estimate. The losses are held constant over time but the loss rates may vary.” While acknowledging that Canada could use the concept of plate loss in its arriving at the food intake values, the ERT notes that in the absence of significant documentation of the appropriateness of the chosen factors, it would be impossible to ensure that the emissions are not underestimated.

119. The ERT further notes that the protein consumption per capita reported by Canada is the second lowest of all reporting Parties, and in 2009 the protein consumption reported by Canada in the CRF is 40 per cent lower than that reported by the United States to the UNFCCC, despite the little, if any, difference between practices and habits in Canada and the United States. The ERT noted that the low protein consumption used by the Party could result in an underestimation of emissions. In response to the list of potential problems and further questions raised by the ERT, Canada maintained that the methodology used was correct and that using the wastage fractions from the United States is acceptable. Further, Canada provided information comparing the consumption of different products between the United States and Canada. The ERT notes that Canada uses plate loss factors developed in the United States, but applies these factors in the context of the Revised 1996 IPCC Guidelines methodology. The ERT notes that the Revised 1996 IPCC Guidelines do not contain guidance or default methodologies for taking losses into account. However, the United States uses the methodology from the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the 2006 IPCC Guidelines), thereby including non-consumed protein added to wastewater and industrial and commercial co-discharged protein into the sewerage system to avoid an underestimation of emissions. The United States, therefore, accounts for the wastage in a different way to avoid double counting of emissions. The corrections for non-consumed protein added to wastewater and industrial and commercial co-discharged protein are not taken into account in the methodology used by Canada, and, therefore, the ERT considers that the subtraction of wastage (based on data from the United States) leads to an underestimation of emissions.

120. The ERT concluded that the information provided by Canada is not sufficient to ensure that the emissions are not underestimated. Therefore, the ERT calculated an adjustment (see paras. 130–137 below).

#### Waste incineration – CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O

121. Canada reports all waste incineration under the waste sector, despite the fact that several waste incineration plants are operating with energy recovery. This is not in line with the IPCC good practice guidance. The ERT strongly recommends that the Party reallocate,

in its next annual submission, waste incineration with energy recovery and the associated emissions to the energy sector. Further, for waste incineration without energy recovery, the ERT recommends that Canada report the fossil amount of waste incinerated under non-biogenic waste, while the biogenic waste and emissions should be reported under biogenic waste.

122. Information on the composition of incinerated waste is not presented in the NIR. In response to a question raised by the ERT during the review, Canada provided information on the composition of incinerated waste and information on the carbon content of the different waste fractions. The ERT recommends that the Party include this information in the NIR of the next annual submission.

123. According to the information received from Canada, the ERT noted that the Party uses a carbon content of plastics of 60 per cent, which is based on a book reference from 1993, that seems very general in nature. The ERT notes that the IPCC good practice guidance considers a typical carbon content of plastics to be between 75 and 85 per cent and that the 2006 IPCC Guidelines provide a range of 67–85 per cent. The use of a lower carbon content of plastics could lead to an underestimation of emissions. In response to the list of potential problems and further questions raised by the ERT, Canada changed the assumed carbon content of plastics to 80 per cent based on the average value from the IPCC good practice guidance. As a result of the recalculation, CO<sub>2</sub> emissions from waste incineration increased by 27.7 per cent (53.3 Gg CO<sub>2</sub> eq) for 2009. The ERT accepts these revised estimates.

124. Based on the 2011 submission of Canada, it was not clear whether emissions from hazardous waste incineration were included in the inventory. In response to a question raised by the ERT during the review, the Party responded that emissions from hazardous waste incineration were not included. Since emissions from incineration of hazardous waste are not included, despite the occurrence of the activity, the ERT considered this to be an underestimation of emissions. In response to the list of potential problems and further questions raised by the ERT, Canada submitted revised estimates for waste incineration including emissions from hazardous waste incineration, and documentation on the methodology and data used to estimate the emissions. The ERT recommends that Canada include the methodological description and the description of the data used in its next annual submission. As a result of the recalculation, the CO<sub>2</sub> emissions from waste incineration increased by 90.8 per cent (232.7 Gg CO<sub>2</sub> eq), CH<sub>4</sub> emissions by 28.1 per cent (0.5 Gg CO<sub>2</sub> eq) and N<sub>2</sub>O emissions by 252.4 per cent (138.3 Gg CO<sub>2</sub> eq) for 2009. The ERT accepts these revised estimates.

## **G. Adjustments**

125. The ERT identified errors in the emission estimates for wastewater handling and recommended an adjustment in the waste sector for 2008 and 2009. In accordance with the guidance for adjustments under Article 5, paragraph 2, of the Kyoto Protocol (decision 20/CMP.1), the adjustments to the waste sector were prepared by the ERT in consultation with Canada. Also, in accordance with the guidelines for review under Article 8 of the Kyoto Protocol (decision 22/CMP.1), the ERT officially notified Canada of the calculated adjustment.

126. The underestimation leading to the adjustment in the waste sector for 2008 and 2009 includes: wastewater handling – human sewage (6.B.2).

127. The adjusted estimate for GHG emissions from the waste sector for 2008 and 2009 amounts to 22,652.12 Gg CO<sub>2</sub> eq and 22,950.37 Gg CO<sub>2</sub> eq, respectively, with 22,319.40 Gg CO<sub>2</sub> eq and 22,615.14 Gg CO<sub>2</sub> eq originally reported by Canada in its 2011 annual

submission. The calculation of the adjustments leads to an increase in estimated total Annex A GHG emissions by 0.05 per cent (332.71 Gg CO<sub>2</sub> eq), from 733,711.52 Gg CO<sub>2</sub> eq as originally reported by Canada to 734,044.24 Gg CO<sub>2</sub> eq as calculated by the ERT for 2008 and an increase in estimated total Annex A GHG emissions by 0.05 per cent (335.23 Gg CO<sub>2</sub> eq), from 691,834.45 Gg CO<sub>2</sub> eq as originally reported by Canada to 692,169.68 Gg CO<sub>2</sub> eq as calculated by the ERT for 2009.

128. In its response to the draft annual review report, Canada failed to notify the secretariat of its intention to accept or reject the calculated adjustment.

129. The ERT notes that Canada may submit a revised estimate for the part of its inventory to which an adjustment was applied, in conjunction with its next inventory, or at the latest with the inventory for the year 2012. The revised estimate will be part of the review under Article 8 and if accepted by the ERT the revised estimate will replace the adjustment.

## **1. Wastewater handling, human sewage – N<sub>2</sub>O**

### The original estimate

130. Canada has reported N<sub>2</sub>O emissions of 2.15 and 2.16 Gg for 2008 and 2009. The estimate is based on a modified IPCC default approach using the total population, corrected protein consumption to take into account food waste, the N content of protein and the IPCC default N<sub>2</sub>O EF.

### The underlying problem

131. Canada calculates the N<sub>2</sub>O emissions from human sewage using protein consumption corrected for losses. In the reporting by Canada to the Food and Agriculture Organization of the United Nations (FAO), the uncorrected protein consumption is used. The Party uses correction factors derived for the United States and applies these factors to the Canadian data. The ERT notes that the protein consumption as reported by Canada in the CRF is the second lowest of all Parties reporting protein consumption in the CRF, and in 2009 the protein consumption reported by Canada is 40 per cent lower than that reported by the United States to the UNFCCC. The current approach by Canada could be underestimating the emissions as Canada states that the “food preparation practices and wastage habits at the plate level” are the same as in the United States.

### The rationale for adjustment

132. Canada uses correction factors from the United States in the estimation of emissions from human sewage to account for food wastage. Neither the Revised 1996 IPCC Guidelines nor the IPCC good practice guidance considers the concept of loss factors, nor does either guideline provide any guidance on making these corrections. In the 2006 IPCC Guidelines (used by the United States) the methodology takes losses into account but simultaneously includes non-consumed protein added to wastewater and industrial and commercial co-discharged protein into the sewerage system. Accounting for the losses (for which there is no methodology in the Revised 1996 IPCC Guidelines) without taking into account the emissions from non-consumed protein (for which there is also not a methodology in the Revised 1996 IPCC Guidelines) can lead to an underestimation of emissions.

### The recommendation to the Party

133. If country-specific loss factors are not available and the Party is not able to provide evidence that the methodology used does not underestimate emissions, the ERT

recommends that Canada use the uncorrected values for protein consumption as reported by the Party to FAO in its reporting of N<sub>2</sub>O emissions from human sewage, in order to ensure that emissions are not underestimated.

The assumptions, data and methodology used to calculate the adjustment

134. In accordance with the “Technical guidance on methodologies for adjustments under Article 5, paragraph 2, of the Kyoto Protocol” (decision 20/CMP.1) an ERT should calculate the adjustment at the level at which the problem was identified, which, in the case of Canada, is the protein consumption used in the methodology by the Party.

135. In accordance with the “Technical guidance on methodologies for adjustments under Article 5, paragraph 2, of the Kyoto Protocol” (decision 20/CMP.1), the ERT calculated the adjustment using the tier 1 method from the IPCC good practice guidance and uncorrected protein consumption data provided by the Party (37.7 and 37.5 kg/person for 2008 and 2009, respectively).

The adjusted estimate

136. Tables 4 describes the steps for the calculation of the adjustment.

Table 4

**Description of the adjustment calculation for Annex A sources**

<i>Parameter/Estimate</i>	<i>Value 2008</i>	<i>Value 2009</i>	<i>Unit</i>	<i>Source</i>
Category: wastewater handling (6.B.2)				
Party’s estimate of: protein consumption	25.60	25.50	kg/person	CRF table 6.B
Party’s N <sub>2</sub> O emission estimate for human sewage in wastewater handling	2.15	2.16	Gg N <sub>2</sub> O	CRF table 6.B
Protein consumption for calculation of adjustment	665.84	670.08	Gg CO <sub>2</sub> eq	
Calculated N <sub>2</sub> O emission estimate for human sewage in wastewater handling	37.70	37.50	kg/person	Provided by the Party
Conservativeness factor	3.16	3.18	Gg N <sub>2</sub> O	ERT calculation
Adjusted conservative estimate for N <sub>2</sub> O emission estimate for human sewage in wastewater handling	978.97	985.59	Gg CO <sub>2</sub> eq	ERT calculation
	1.02	1.02		Table 2 of the annex to decision 20/CMP.1
	3.22	3.24	Gg N <sub>2</sub> O	ERT calculation
Total aggregated GHG emissions (excluding LULUCF) as reported by the Party	998.55	1 005.30	Gg CO <sub>2</sub> eq	ERT calculation
Total aggregated GHG emissions (excluding LULUCF) after application of adjustment	733 711.52	691 834.45	Gg CO <sub>2</sub> eq	CRF table summary 2
Difference between original and adjusted total aggregated GHG emissions	734 044.24	692 169.68	Gg CO <sub>2</sub> eq	ERT calculation
	332.71	335.23	Gg CO <sub>2</sub> eq	ERT calculation
	0.05	0.05	%	ERT calculation

*Abbreviations:* CRF = common reporting format, ERT = expert review team, GHG = greenhouse gas, LULUCF = land use, land-use change and forestry

Conservativeness of the ERT's calculation of the adjustment

137. In line with paragraph 5 of decision 20/CMP.1, conservativeness was ensured by applying the conservativeness factor of 1.02 (AD for wastewater handling) from table 2 of appendix III to the "Technical guidance on methodologies for adjustments under Article 5, paragraph 2, of the Kyoto Protocol" (decision 20/CMP.1). The ERT therefore considers that the resulting adjusted values are conservative.

**H. Supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol**

**1. Information on activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol**

Overview

138. Canada has submitted estimates for afforestation, reforestation and deforestation activities under Article 3, paragraph 3, of the Kyoto Protocol and for cropland management, as Canada has elected this activity under Article 3, paragraph 4, of the Kyoto Protocol. The Party chose to account for activities under Article 3, paragraphs 3 and 4, at the end of the first commitment period. The ERT noted that Canada reported as "IE" direct N<sub>2</sub>O emissions from N fertilization, as they are reported under the agriculture sector, and emissions from limestone application, because the emissions are reported under cropland management. For the base year, estimates for cropland management were provided in tables 5(KP-I)B.2 and 5(KP-II)3, 4 and 5. Canada provided in the NIR all supplementary information required under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, although not in accordance with the annotated NIR outline developed by the secretariat. In addition, the results of the QA/QC procedures are provided for all KP-LULUCF activities. Canada reported that no factoring out of effects caused by increased CO<sub>2</sub> concentration or N deposition was applied to the estimates.

139. Canada uses the same definitions, approaches and methodologies for the KP-LULUCF reporting as for the reporting under the Convention. The land information system (MARS) is based on sampling techniques within established geo-referenced boundaries encompassing units of land subject to afforestation, reforestation, deforestation or cropland management. This is in line with method 1 of the IPCC good practice guidance for LULUCF. The data sources for afforestation and reforestation are the Feasibility Assessment of Afforestation for Carbon Sequestration, Forest 2020 records and rates of afforestation reported by industry and provincial representatives, where available. Canada describes in its NIR its decision tree for selecting the most suited source depending on the year and province, which minimizes the risk of double counting. The AD for deforestation are compiled through the interpretation of Landsat images. Linear interpolations between the years of Landsat images were applied. The data source for cropland management and land management transition is the agricultural census. Canada minimizes the risk of double counting by making documented assumptions on the type of land converted to and from forest land, which is in accordance with the IPCC good practice guidance for LULUCF.

140. The Party has made recalculations for the KP-LULUCF activities between the 2010 and 2011 submissions due to changes in AD and methodological changes to all inventory years. The recalculations have been conducted in accordance with the IPCC good practice guidance for LULUCF and lead to an improvement in the accuracy of the inventory. The impact of these recalculations on each KP-LULUCF activity for 2008 is as follows:

(a) A decrease in emissions from deforestation by 0.8 per cent. Canada stated in the 2010 NIR that it would extend the mapping with images of the time period 2000–2008.

This extension has been implemented in its 2011 submission. This, together with the methodological changes, led to the recalculation;

(b) A decrease in base year net emissions from cropland management by 12.6 per cent. This recalculation follows the revision of the method to estimate changes in soil carbon in western Canada;

(c) An increase in net removals from cropland management by 1.8 per cent.

#### Activities under Article 3, paragraph 3, of the Kyoto Protocol

##### *Afforestation and reforestation – CO<sub>2</sub>*

141. New afforestation AD sources were not identified for inclusion in the 2011 submission of Canada. The Party indicated to the ERT that renewed efforts are under way to obtain additional data on recent afforestation activities in Canada. The ERT recommends that Canada continue its data collection efforts for this activity.

##### *Deforestation – CH<sub>4</sub> and N<sub>2</sub>O*

142. The ERT noted a lack of transparency in the NIR regarding the separation of emissions from harvest residue burning and emissions from crop residue burning, both of which may occur on the same land after deforestation. During the review, Canada clarified that non-CO<sub>2</sub> emissions from harvest residue burning after deforestation, reported under this category, were clearly separated in time and data sets from crop residue burning, reported under the agriculture sector, and that there could, therefore, be no double counting of these emissions. The ERT recommends that Canada provide this explanation in the NIR of its next annual submission and include “emissions/removals from Article 3.4 activities that are not accounted for under activities under Article 3.3” in table A11-1 of the NIR, which is related to reporting requirements under decision 15/CMP.1.

#### Activities under Article 3, paragraph 4, of the Kyoto Protocol

##### *Cropland management – CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O*

143. The ERT noted that Canada’s GHG emission and removal estimates for cropland management under the Kyoto Protocol are generally consistent with those provided under the Convention. The difference is due to the fact that emissions and removals from forest land converted to cropland since 1990 are reported under deforestation activities, which is in line with the IPCC good practice guidance for LULUCF. Estimates of CH<sub>4</sub> and N<sub>2</sub>O emissions from field burning of agricultural residues are included under the agriculture sector.

144. As noted by the previous ERT, there is an apparent inconsistency between section 7.4.2 of the NIR, stating that land converted to cropland only originates from grassland and forest land, and the land-use change matrix (table 7-3 of the NIR), which reports the transitions from wetlands and settlements to cropland as “NE”. Losses of cropland to wetlands and settlements are also reported as “NE”. During the review, Canada clarified that, due to limited resources, it was currently not able to estimate these transitions, although they may occur to a small extent, and that it would in time attempt to improve completeness by estimating them. The ERT welcomes this announcement and encourages Canada in its attempt to improve the completeness of its reporting.

## 2. Information on Kyoto Protocol units

### Standard electronic format and reports from the national registry

145. Canada has reported information on its accounting of Kyoto Protocol units in the required SEF tables, as required by decisions 15/CMP.1 and 14/CMP.1. The ERT took note of the findings and recommendations included in the SIAR on the SEF tables and the SEF comparison report.<sup>6</sup> The SIAR was forwarded to the ERT prior to the review, pursuant to decision 16/CP.10. The ERT reiterated the main findings and recommendations contained in the SIAR.

146. Information on the accounting of Kyoto Protocol units has been prepared and reported in accordance with chapter I.E of the annex to decision 15/CMP.1, and reported in accordance with decision 14/CMP.1 using the SEF tables. This information is consistent with that contained in the national registry and with the records of the international transaction log (ITL) and the clean development mechanism registry and meets the requirements set out in paragraph 88(a-j) of the annex to decision 22/CMP.1.

### National registry

147. The ERT took note of the SIAR and its finding that the reported information on the national registry is complete and has been submitted in accordance with the annex to decision 15/CMP.1. The ERT further noted from the SIAR and its finding that the national registry continues to perform the functions set out in the annex to decision 13/CMP.1 and the annex to decision 5/CMP.1, and continues to adhere to the technical standards for data exchange between registry systems in accordance with decisions 16/CP.10 and 12/CMP.1. The national registry also has adequate security, data safeguard and disaster recovery measures in place and its operational performance is adequate. However, the SIAR noted that the Party did not provide readiness information, or a security plan, test plan and test report. In response to the SIAR, the Party provided these documents during the review. The ERT reviewed the documents and concluded that they were in accordance with the guidelines. However, the ERT also noted that, in the security plan, Canada states that a threat and risk assessment and a risk mitigation plan had been prepared and that the Party would implement additional authentication measures before the registry is open to entity accounts. Therefore, the ERT recommends that, if the national registry is opened to private entity accounts, Canada update the security plan by including the additional authentication measures.

### Calculation of the commitment period reserve

148. Canada has reported its commitment period reserve in its 2011 annual submission. The Party reported that its commitment period reserve has not changed since the initial report review (2,512,613,494 t CO<sub>2</sub> eq) as it is based on the assigned amount and not the most recently reviewed inventory. The ERT agrees with this figure.

## 3. Changes to the national system

149. Canada reported that there have been no changes to its national system since the previous annual submission. The ERT concluded that the Party's national system continues to be in accordance with the requirements of national systems outlined in decision 19/CMP.1.

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<sup>6</sup> The SEF comparison report is prepared by the ITL administrator and provides information on the outcome of the comparison of data contained in the Party's SEF tables with corresponding records contained in the ITL.

#### **4. Changes to the national registry**

150. The Party has reported changes to its national registry since the previous annual submission. These are reported in accordance with section I.G of the annex to decision 15/CMP.1. The NIR provides a description of the changes to the national registry, including the name and contact information of the registry administrator, a description of how the national registry conforms to the technical standards for data exchange between registry systems, the security measures employed in the national registry, publicly accessible information, and the results of test procedures. The information can be found in table A11-16 in annex 11 to the NIR. Observations on the changes to the national registry are contained in the SIAR. The ERT concluded that the Party's national registry continues to perform the functions set out in the annex to decision 13/CMP.1 and the annex to decision 5/CMP.1, and continues to adhere to the technical standards for data exchange between registry systems in accordance with relevant decisions of the Conference of the Parties serving as the meeting of the Parties to Kyoto Protocol (CMP).

#### **5. Minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol**

151. In its 2011 annual submission, Canada did not provide information on changes in its reporting of the minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol since the previous annual submission. However, the ERT identified that the information is similar to the information provided in the previous submission and concluded that the information provided continues to be complete and transparent.

152. The process to establish and implement climate change response measures in Canada includes comprehensive consultation among involved stakeholders at the international and national levels as well as an extensive public consultation with provinces on planned activities.

153. Canada has undertaken a number of fiscal and tax measures in order to phase out market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all GHG-emitting sectors. The Party reported that detailed information on its assistance to developing countries, as well as activities for the transfer of technology and finance transfer, is provided in Canada's fifth national communication.

### **III. Conclusions and recommendations**

154. Canada made its annual submission on 16 May 2011. The annual submission contains the GHG inventory (comprising CRF tables and an NIR) and supplementary information under Article 7, paragraph 1, of the Kyoto Protocol (information on: activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, Kyoto Protocol units, changes to the national system and the national registry and the minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol). This is in line with decision 15/CMP.1. However, the ERT noted that Canada made its annual submission after the deadline of 15 April but within the six-week period as stated in decision 15/CMP.1.

155. The ERT concludes that the inventory submission of Canada has been prepared and reported in accordance with the UNFCCC reporting guidelines. The inventory submission is complete and the Party has submitted a complete set of CRF tables for the years 1990–2009 and an NIR; these are complete in terms of geographical coverage, years and sectors, as well as generally complete in terms of categories and gases. CRF table 9(a) shows some incomplete reporting of the energy, industrial processes, agriculture, waste and LULUCF sectors. Canada has provided explanations for the emissions reported as "NE" in



CRF table 9(a). The ERT noted that there are no methodologies and/or EFs available to estimate these emissions in the Revised 1996 IPCC Guidelines, the IPCC good practice guidance or the IPCC good practice guidance for LULUCF.

156. The submission of information required under Article 7, paragraph 1, of the Kyoto Protocol has been prepared and reported in accordance with decision 15/CMP.1.

157. The Party's inventory is generally in line with the Revised 1996 IPCC Guidelines, the IPCC good practice guidance and the IPCC good practice guidance for LULUCF. Significant improvements have been made in all sectors since the previous annual submission. However, the ERT also identified some issues related to transparency where Canada's inventory is not in line with the guidelines (in particular in the energy sector).

158. The Party has made recalculations for the inventory between the 2010 and 2011 submissions in response to the 2010 annual review report, due to changes in AD and EFs and in order to rectify identified errors. The impact of these recalculations on the national total GHG emissions is a decrease of 0.4 per cent for 2008. The main recalculations took place in the following categories:

- (a) Carbon removals from forest land;
- (b) CO<sub>2</sub> emissions from transport;
- (c) CH<sub>4</sub> emissions from enteric fermentation;
- (d) CH<sub>4</sub> emissions from natural gas distribution.

159. Canada provided all supplementary information required under Article 3, paragraphs 3 and 4, of the Kyoto Protocol. Canada uses the same definitions, approaches and methodologies for the KP-LULUCF reporting as for the reporting under the Convention, and its approach is in line with the IPCC good practice guidance for LULUCF. However, the ERT noted a few cases where the consistency, completeness and transparency of the reporting could be improved.

160. The Party has made recalculations for the KP-LULUCF activities between the 2010 and 2011 submissions due to changes in AD and methodological changes. The recalculations have been conducted in accordance with the IPCC good practice guidance for LULUCF and have led to a decrease in emissions from deforestation of 0.8 per cent in 2008, a decrease in base year net emissions from cropland management of 12.6 per cent and an increase in 2008 net removals from cropland management of 1.8 per cent.

161. Canada has reported information on its accounting of Kyoto Protocol units in accordance with chapter I.E of the annex to decision 15/CMP.1, and used the required reporting format tables as required by decision 14/CMP.1.

162. The national system continues to perform its required functions as set out in the annex to decision 19/CMP.1.

163. The national registry continues to perform the functions set out in the annex to decision 13/CMP.1 and the annex to decision 5/CMP.1, and continues to adhere to the technical standards for data exchange between registry systems in accordance with relevant CMP decisions.

164. Canada has reported information under chapter I.H of the annex to decision 15/CMP.1, "Minimization of adverse impacts in accordance with Article 3, paragraph 14" as part of its 2011 annual submission. The reported information is considered to be complete and transparent.

165. The ERT identifies the following cross-cutting issues for improvement:

- (a) The inclusion of LULUCF in the trend uncertainty analysis;

(b) The revision of the elements of the national system that would enable the timely submission of Canada's annual inventory;

(c) The improvement of transparency in the energy sector (see paras. 41–45, 48–53, 55 and 59–62 above), the industrial processes sector (see paras. 68, 72, 74, 77, 78, 80 and 82 above), the waste sector (see paras. 111, 116, 117 and 122 above) and the KP-LULUCF activities (see para. 142 above).

166. The main recommendation related to the KP-LULUCF activities is that Canada continue its data collection efforts for afforestation AD.

167. In the course of the review, the ERT formulated a number of sector-specific recommendations. The key recommendations are that Canada:

(a) Report fuel categories under the energy sector in line with the Revised 1996 IPCC Guidelines (see para. 30 above);

(b) Report emissions from waste incineration with energy recovery under the energy sector (see paras. 31 and 121 above);

(c) Improve the transparency of the reporting of unconventional oil production by exploring the possibility of including in the NIR AD and IEFs at an aggregated level (see para. 42 above) and by providing in the NIR a table separating the AD and emissions from conventional and unconventional oil production (see para. 43 above);

(d) Update its waste composition data and improve its estimates for emissions from solid waste disposal on land (see para. 113 above).

#### **IV. Adjustments**

168. The ERT concludes, based on the review of the 2008 and 2009 inventories, that for the category wastewater handling, the AD used are not fully in line with the Revised 1996 IPCC Guidelines and the IPCC good practice guidance as required by Article 5, paragraph 2, of the Kyoto Protocol. The ERT recommended that the Party submit revised estimates or provide further justifications for its calculations for the identified category as a way of resolving the identified potential problem. The ERT, following the review of the additional information provided by Canada during and after the centralized review, concluded that it did not satisfactorily correct the problem through the submission of acceptable revised estimates and decided to calculate and recommend one adjustment in accordance with the guidance for adjustments under Article 5, paragraph 2, of the Kyoto Protocol (decision 20/CMP.1).

169. Canada, in its communications of 2 and 18 April 2012, failed to notify the secretariat of its intention to accept or reject the calculated adjustment. In accordance with the guidelines for review under Article 8 of the Kyoto Protocol, this failure was considered as acceptance by Canada of the adjustment, and the ERT applied the calculated adjustment.

170. The application of the adjustment by the ERT resulted in a change in the estimate of the 2008 emissions from the waste sector from 22,319.40 Gg CO<sub>2</sub> eq, as originally reported by Canada, to 22,652.12 Gg CO<sub>2</sub> eq, or an increase of 1.5 per cent, and in a change in the estimate of the 2009 emissions from the waste sector from 22,615.14 Gg CO<sub>2</sub> eq, as originally reported by Canada, to 22,950.37 Gg CO<sub>2</sub> eq, or an increase of 1.5 per cent. This in turn resulted in a change in the estimated total emissions of Canada for 2008 from 733,711.52 Gg CO<sub>2</sub> eq, as originally reported by Canada, to 734,044.24 Gg CO<sub>2</sub> eq, or an increase of 0.05 per cent, and for 2009 from 691,834.45 Gg CO<sub>2</sub> eq, as originally reported by Canada, to 692,169.68 Gg CO<sub>2</sub> eq, or an increase of 0.05 per cent.

**V. Questions of implementation**

171. No questions of implementation were identified by the ERT during the review.

## Annex I

### Documents and information used during the review

#### A. Reference documents

Intergovernmental Panel on Climate Change. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Available at <<http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html>>.

Intergovernmental Panel on Climate Change. *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*. Available at <<http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm>>.

Intergovernmental Panel on Climate Change. *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. Available at <<http://www.ipcc-nggip.iges.or.jp/public/gp/english/>>.

Intergovernmental Panel on Climate Change. *Good Practice Guidance for Land Use, Land-Use Change and Forestry*. Available at <<http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.htm>>.

“Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories”. FCCC/SBSTA/2006/9. Available at <<http://unfccc.int/resource/docs/2006/sbsta/eng/09.pdf>>.

“Guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention”. FCCC/CP/2002/8. Available at <<http://unfccc.int/resource/docs/cop8/08.pdf>>.

“Guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol”. Decision 19/CMP.1. Available at <<http://unfccc.int/resource/docs/2005/cmp1/eng/08a03.pdf#page=14>>.

“Guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol”. Decision 15/CMP.1. Available at <<http://unfccc.int/resource/docs/2005/cmp1/eng/08a02.pdf#page=54>>.

“Guidelines for review under Article 8 of the Kyoto Protocol”. Decision 22/CMP.1. Available at <<http://unfccc.int/resource/docs/2005/cmp1/eng/08a03.pdf#page=51>>.

Status report for Canada 2011. Available at <<http://unfccc.int/resource/docs/2011/asr/can.pdf>>.

Synthesis and assessment report on the greenhouse gas inventories submitted in 2011. Available at <<http://unfccc.int/resource/webdocs/sai/2011.pdf>>.

FCCC/ARR/2010/CAN. Report of the individual review of the annual submission of Canada submitted in 2010. Available at <<http://unfccc.int/resource/docs/2011/arr/can.pdf>>.

UNFCCC. *Standard Independent Assessment Report, Parts I and II*. Available at <[http://unfccc.int/kyoto\\_protocol/registry\\_systems/independent\\_assessment\\_reports/items/4061.php](http://unfccc.int/kyoto_protocol/registry_systems/independent_assessment_reports/items/4061.php)>.

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**B. Additional information provided by the Party**

Responses to questions during the review were received from Mr. Duane Smith (Environment Canada), including additional material on the methodologies and assumptions used. The following documents<sup>1</sup> were also provided by Canada:

AECOM. 2011. *Improved Methodology for the Estimation of Greenhouse Gases from Canadian Municipal Wastewater Treatment Facilities*.

Canadian Association of Petroleum Producers. 2005. *A National Inventory of Greenhouse Gas (GHG), Criteria Air Contaminant (CAC) and Hydrogen Sulphide (H<sub>2</sub>S) Emissions by the Upstream Oil and Gas Industry*. Volume 3. Calgary (AB): Clearstone Engineering Ltd. January.

Canadian Association of Petroleum Producers. 2006. *An Inventory of GHGs, CACs, and H<sub>2</sub>S Emissions by the Canadian Bitumen Industry: 1990 to 2003*. Calgary (AB): Clearstone Engineering Ltd.

Gas Research Institute. 2000. *Vented Emissions from Maintenance at Natural Gas Distribution Stations in Canada*. Austin (TX): Radian International LLC.

King B. 1994. *Management of Methane Emissions from Coal Mines: Environmental, Engineering, Economic and Institutional Implications of Options*. Report prepared by Neill and Gunter for Environment Canada.

McCann TJ. 2000. *1998 Fossil Fuel and Derivative Factors*. Prepared by T.J. McCann and Associates for Environment Canada.

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<sup>1</sup> Reproduced as received from the Party.

## Annex II

### Acronyms and abbreviations

AD	activity data
AWMS	animal waste management systems
CH <sub>4</sub>	methane
CO <sub>2</sub>	carbon dioxide
CO <sub>2</sub> eq	carbon dioxide equivalent
CRF	common reporting format
DOC	degradable organic carbon
EF	emission factor
ERT	expert review team
FAO	Food and Agriculture Organization of the United Nations
GHG	greenhouse gas; unless indicated otherwise, GHG emissions are the sum of CO <sub>2</sub> , CH <sub>4</sub> , N <sub>2</sub> O, HFCs, PFCs and SF <sub>6</sub> without GHG emissions and removals from LULUCF
Gg	gigagram (1 Gg = 10 <sup>3</sup> tonnes)
GJ	gigajoule (1 GJ = 10 <sup>9</sup> joule)
HFCs	hydrofluorocarbons
IE	included elsewhere
IEF	implied emission factor
IPCC	Intergovernmental Panel on Climate Change
KP-LULUCF	land use, land-use change and forestry emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol
kg	kilogram (1 kg = 1,000 grams)
LULUCF	land use, land-use change and forestry
L <sub>0</sub>	methane generation potential
m <sup>3</sup>	cubic metre
MSW	municipal solid waste
Mt	million tonnes
NA	not applicable
NE	not estimated
N <sub>2</sub> O	nitrous oxide
NO	not occurring
NIR	national inventory report
PFCs	perfluorocarbons
QA/QC	quality assurance/quality control
SEF	standard electronic format
SF <sub>6</sub>	sulphur hexafluoride
SIAR	standard independent assessment report
TJ	terajoule (1 TJ = 10 <sup>12</sup> joule)
UNFCCC	United Nations Framework Convention on Climate Change