

**REVIEW OF THE TWENTY-FIRST ACTUARIAL REPORT  
ON THE CANADA PENSION PLAN**

**Conducted by the CPP Actuarial Review Panel  
March 17, 2005**

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## **ACRONYMS USED IN THIS REPORT**

AR17	Seventeenth Actuarial Report on the CPP
AR18	Eighteenth Actuarial Report on the CPP
AR21	Twenty-First Actuarial Report on the CPP
CPP	Canada Pension Plan
CPPIB	Canada Pension Plan Investment Board
CRA	Canada Revenue Agency
OAS	Old Age Security
OCA	Office of The Chief Actuary
OSFI	Office of the Superintendent of Financial Institutions
QPP	Québec Pension Plan
SDC	Social Development Canada

*This report was prepared by a review panel of three independent actuaries, Robert L. Brown of the University of Waterloo, Mark Campbell of Towers Perrin in Calgary, and James G. Paterson of Paterson Pension Management Inc. in Vancouver, all Fellows of the Canadian Institute of Actuaries.*

## **EXECUTIVE SUMMARY**

### **1. Introduction**

#### **Terms of Reference**

The panel conducted its review of AR21 in accordance with the following terms of reference:

The panel will "... review the work of the Chief Actuary in completing the Twenty-First Actuarial Report on the Canada Pension Plan as at 31 December, 2003 (21<sup>st</sup> Report) and, following the review, provide a report to the Chief Actuary and the United Kingdom Government Actuary's Department (GAD). GAD will then provide its opinion of the peer review to the Chief Actuary.

The review report should contain opinions on the following questions:

1. Is the professional experience of the Chief Actuary and his staff who worked on the report adequate for carrying out the work required?
2. Has the work been completed in compliance with the relevant professional standards of practice and statutory requirements?
3. Did the Chief Actuary have access to the information required to perform the valuation, and were relevant tests and analysis on the data completed as might be expected?
4. Were the actuarial methods and assumptions used in completing the report reasonable?

5. Does the 21<sup>st</sup> Report fairly communicate the results of the work performed by the Chief Actuary and his staff?

In providing opinions on the questions listed above, the panel will also provide such recommendations as the panel deems appropriate with respect to future actuarial reports on the Canada Pension Plan prepared by the Office of the Chief Actuary.”

### **Actuarial Report 21 (AR21)**

AR21 was prepared as at December 31, 2003. It presents a best-estimate projection of pay-as-you-go contribution rates for the Plan, rising from 8.27% of contributory earnings in 2004 to 11.52% in 2060 and then falling to 11.32% in 2075.

It also presents a steady-state contribution rate for 2007 and later of 9.8% of contributory earnings. Using this steady-state contribution rate, it projects ratios of assets-to-expenditures rising from 3.08 in 2004 to 5.45 in 2021, then hovering around 5.5 from 2021 to 2058, then dropping steadily to 5.36 in 2078. Under a continuation of the current 9.9% contribution rate from 2003 on, AR21 projects ratios rising from 3.08 in 2004 to 5.75 in 2025 and 6.88 in 2075.

AR21 also presents the results of several sensitivity tests which show how different the results would be if particular assumptions were varied up or down. The various sensitivity tests produced steady-state contribution rates varying from 9.2% to 10.3% of contributory earnings.

All of the results are estimates. All but the sensitivity tests represent the Chief Actuary’s “best” estimates, with no deliberate margins of conservatism or other deliberate bias.

It is essential to recognize that these are not predictions. They are not necessarily “accurate” to one decimal place or even to one percent of contributory earnings. They simply present what the results would be if all the assumptions were to come true in the future. The parameters involved (e.g., rates of fertility, net migration, mortality, price increases, real wage gains, real rates of return on investments – all from 2004 to 2078) are not open to accurate prediction.

## **2. Professional Experience**

**Question:** *“Is the professional experience of the Chief Actuary and his staff who worked on the report adequate for carrying out the work required?”*

**Observation:** We are satisfied that the Chief Actuary and the staff who assisted him in preparing AR21 have the relevant experience and are qualified to carry out the assignment.

**Opinion:** In our opinion, the professional experience of the Chief Actuary and the staff who worked on AR21 was adequate for carrying out the work required.

## **3. Professional Standards of Practice**

**Question:** *“Has the work been completed in compliance with the relevant professional standards of practice and statutory requirements?”*

**Observation:** We reviewed the work involved in preparing AR21 in relation to relevant Canadian and international professional actuarial standards of practice and statutory requirements.

**Opinion:** In our opinion, the work on AR21 was completed in compliance with the relevant professional standards of practice and statutory requirements.

## **4. Data**

**Question:** *“Did the Chief Actuary have access to the information required to perform the valuation, and were relevant tests and analysis on the data completed as might be expected?”*

**Observations:** The data requirements for AR21 were extensive. Several improvements in specific data inputs have occurred since AR18. Two desirable data inputs are not available. First, long-term asset mix targets are not established by the CPPIB and none are planned. The Chief Actuary therefore made assumptions as to the future asset mix in the absence of such targets. Second, there is currently no government policy in place regarding inflation-control targets after 2006 to assist the Chief Actuary in establishing future inflation rate assumptions.

Also three types of data input can be improved.

**Opinion:** In our opinion,

- the Chief Actuary had access to the data he required to perform the valuation;
- the Chief Actuary completed such relevant tests and analysis on the data as might be expected;
- the data on which this report is based are sufficient and reliable.

**Recommendation 1:** We recommend that the Chief Actuary discuss with the CRA the possibility of their speeding up the process of providing the OCA with data on contributions.

**Recommendation 2:** We recommend that the Chief Actuary explore with SDC the possibility of providing the OCA with additional data on participant utilization of the child-rearing dropout provision.

**Recommendation 3:** We recommend that the Chief Actuary

- continue his program of seminars with presentations from appropriate experts,
- strive to broaden the range of presenters,
- better focus their contributions on matters of most relevance to the preparation of actuarial reports on the CPP, and
- extend their inputs to cover the whole of the 75-year projection period covered in the Actuarial Reports

## **5. Methodology**

**Question:** “*Were the actuarial methods used in completing the report reasonable?*”

**Observations:** The Chief Actuary uses a macro-simulation mathematical model of the Plan’s past and future operations and of future economic and demographic experience to develop “best estimate” projections of income and outgo and other key outputs and to conduct sensitivity tests. The model continues to rely principally on a *deterministic* (producing a single set of results), rather than a *stochastic* (producing a probabilistic range of results), approach. However, AR21 does incorporate refinements that reflect stochastic considerations in some of the sensitivity tests. Results are produced on four actuarial cost methods, as well as estimates of internal rates of return. The model is back-tested and the results of AR21 are reconciled to those of AR18.

**Opinion:** In our opinion, the actuarial methods employed in AR21 are reasonable.



**Recommendation 4:** We recommend that the Chief Actuary maintain the tradition of continual improvements to the actuarial methods by such actions as:

Applying more extensive and sophisticated stochastic analysis, and developing more plausible and consistent sensitivity tests for key assumptions.

**Recommendation 5:** We recommend that the Chief Actuary improve the description of the “actuarial balance” figures, and explain the limitations on their use, or drop them from the report.

## **6. Assumptions**

**Question:** “*Were the assumptions used in completing the report reasonable?*”

**Observations:** The model requires the input of dozens of assumptions about future economic and demographic experience and future costs of operation of the Plan. A great deal of research and analysis goes into the selection of these assumptions. We reviewed all of these but concentrated on the nine most important ones. The assumptions are utilized on a “select and ultimate” basis, starting in 2004 with an assumption that is close to recent experience, and then modifying this assumption during the years of the “select period” to reach the level of the “ultimate” assumption which reflects the best-estimate view of the long-term future. The ultimate assumptions for these nine parameters are summarized as follows:

Table 1

<b>Parameter</b>	<b>Ultimate Assumption</b>	<b>First “Ultimate” Year</b>
Fertility rates	1.60 per woman (in her lifetime)	2016
Mortality rates	Continual but slowing improvement (using complex projections)	
Net migration rates	0.54% of population	2020
Disability incidence rates	Males 3.25, females 3.50 per 1,000 eligible	2008
Retirement rates	Rates varying by age between ages 60 and 70	2030
Unemployment rate	6.5%	2020
Participation rate	Ages 15-69: 73.4%	2030
Employment rate	Ages 15-69: 68.6%	2030

<b>Parameter</b>	<b>Ultimate Assumption</b>	<b>First “Ultimate” Year</b>
Real wage differential	1.2%	2012
Rate of price increases	2.7%	2015
Real rates of return	4.1%	2011

### **Reasonableness of the Assumptions in the Aggregate**

In our review of the major actuarial assumptions, we found that each of them was in the reasonable range. We found that five of the nine major assumptions were near the centre of the reasonable range. In our view

- the real-wage differential and the real rate of return assumptions are at the higher-cost end of the reasonable range; and
- the mortality and price increase assumptions are at the lower-cost end of the reasonable range.

The impact on the steady-state contribution rate of the high-cost differences outweighs the impact of the low-cost differences.

The total effect, in our view, is a set of assumptions well within the reasonable range, but a little on the conservative, or higher-cost, side than we would have selected.

### **Opinion:**

In our opinion, the assumptions used in completing AR21 are, in the aggregate, within the reasonable range, while a little on the conservative (i.e., high-cost) side of the best-estimate assumptions we would have selected.

## **7. Communication of Results**

**Question:** *“Does the 21st Report fairly communicate the results of the work performed by the Chief Actuary and his staff?”*

**Observations:** AR21 is a well-organized document that explains the data, methodology and assumptions and presents the results in a readable and straightforward manner. It is about the same length as AR18; the English version is 128 pages, the French version is 135 pages, each including a three page Executive Summary.

However, we think there is merit in producing a two-volume report, one with high-level results and the other with fuller details. We also think there is merit in grouping all of the

information on stochastic results and sensitivity tests, together with interpretation thereon, in a section labelled “Uncertainty of Results” or “Potential Volatility of Contribution Rates”.

**Opinion:** In our opinion, AR21 fairly communicates the results of the work performed by the Chief Actuary and his staff.

**Recommendation 6:** We recommend that future Actuarial Reports be published in two volumes.

The first volume would be intended for a broad audience and contain

- an executive summary,
- the results of the Chief Actuary’s investigations (sections IV and V and appendices C, D, E and F of AR21),
- conclusions (section VI of AR21),
- an actuarial opinion (section VII of AR21), and
- four one- or two-page appendices, summarizing the Plan provisions, data, methodology and assumptions.

The second volume would be intended for a technical audience (actuaries, demographers, economists, policy analysts and so on) and contain detailed, and separate, technical descriptions of the

- Plan provisions,
- data,
- methodology,
- assumptions,
- experience studies performed, and
- rationale and justification for the assumptions (incorporating as background data the 100-, 50-, 25- and 10-year means and standard deviations of historical rates, and selected charts illustrating trends),

and of changes in each of these elements since the previous actuarial report.

**Recommendation 7:** We recommend that the analyses now shown in section V and Appendix C of AR21, together with additional commentary on the uncertainty of the results, be combined in a single section of the first volume to be titled “Uncertainty of Results”.

**Recommendation 8:** We recommend that the Executive Summary include

- a sub-section on “Uncertainty of the Results”, including some sensitivity results and some commentary on the uncertainty of results and the potential volatility of future contribution rates,
- in the main findings, the *direction* of the projected assets/expenditures ratio in the last 20 or so years of the projection period for both the 9.9% contribution rate (e.g., rising) and the 9.8% steady-state rate (e.g., declining slightly), and
- in the assets projection, the projected assets in constant dollars for at least three representative years in the projection period (early, mid and final years).

## **8. Other Actuarial Issues**

This section addresses four other issues considered in our review:

- the relationship between the Plan’s investment returns and contribution rates,
- the possible use of an advisory panel,
- the reporting structure for the Chief Actuary, and
- the methodology to calculate the steady-state contribution rate.

### **8.1 Relationship Between the Plan’s Investment Returns and Contribution Rates**

The CPPIB does not currently establish long-term asset mix targets. Under their current procedures, the asset mix is not targeted; it results from the application of a risk-limiting process that is updated regularly. Risk is measured by comparison to a *reference portfolio* represented by the Scotia Capital Real Return Bond Index, whose value tends to move in tandem with the value of the Plan’s liabilities. The maximum risk level is an asset mix that is not expected to underperform the *reference portfolio* by more than the approved risk limit more often than one year in ten.

As secondary targets, the expected return is measured against the rate of return required for sustainability of funding of the CPP and two long-term real rate of return targets.

Current CPPIB practice does not focus on measuring and managing expected contribution rate levels and volatility (i.e., *contribution rate risk*) directly, but rather indirectly through the measurement and management of asset/liability mismatch risks. However, CPPIB management have advised us that they may consider a direct analysis of contribution rate levels and volatility in the next year or two.

We think there is much to be gained by conducting a direct analysis of the impact of investment returns on contribution rate movements, including the impacts of both shifts in the long term mean real rate of return and volatility around the mean. The insights and measurements derived from such analyses would assist the CPPIB in setting asset mix policy. Current practice does not appear to place management of contribution rate risk on a par with management of the risk of loss of the entire portfolio and management of the asset/liability mismatch. We believe that at least equal priority should be accorded to explicit management of the contribution rate risk.

Further, we believe that there is room for further refinement of the secondary targets.

## **8.2 Possible Use of an Advisory Panel**

Past review panels have recommended that the Chief Actuary establish an advisory panel, consisting of actuaries, demographers and economists, to provide input to him in selecting the actuarial assumptions. We believe there is considerable merit in establishing such a panel, as long as it is structured, and operates, properly. We believe the Chief Actuary should establish such a panel, and consider its advice. He should, however, make the final selections of the assumptions himself.

**Recommendation 9:** We recommend that the Chief Actuary develop a structured process to obtain interdisciplinary advice from a group of experts (including actuaries, demographers and economists) who interact with each other and attempt to form consensus recommendations on the whole package of key assumptions.

## **8.3 Reporting Structure for Chief Actuary**

Past actuarial review panels have also recommended that consideration be given to establishing the Office of the Chief Actuary in its own Department separate from OSFI and reporting directly to the Minister of Finance or the Minister of State for Finance. Past reviews cited the Government Actuary's Department in the UK as a model.

We note that the current structure, with the Chief Actuary located in OSFI, seems to be working well now in terms of professional independence of the Chief Actuary, adequate staffing of the OCA and the Chief Actuary's direct access to policymakers. These important elements could, however, change under the present structure.

We also note that private sector financial institutions have moved, at OSFI's urging, to a situation where financial reporting professionals are appointed and supervised by the board of directors and not by management.

**Recommendation 10:** We recommend that the reporting structure of the Chief Actuary be reviewed, with the goal of ensuring continued excellence in staffing, professional independence and direct access to policymakers.

#### **8.4 The Methodology to Calculate the Steady-State Contribution Rate**

The steady-state method follows a procedure set out in the Calculation of Default Contribution Rates Regulation. It compares assets/expenditures ratios 10 and 60 years following the review period (i.e., in 2016 and 2066 for AR21) and selects the contribution rate which results in the ratios in those two years being equal. This method was not chosen by the Chief Actuary. It is prescribed in the Regulation.

We are concerned that while this method produces reasonable results today, we believe there are possible future circumstances in which the method would lead to less reasonable indications. We see the appropriateness of the method as an issue.

We note also that the Actuarial Committee of the International Social Security Association is planning to conduct research on the issue of optimal funding of social security programs. This could shed further light on the Calculation of Default Contribution Rates Regulation.

**Recommendation 11:** We recommend that the Chief Actuary conduct an examination of the continued appropriateness of the steady-state methodology and of the selection of the pairing of years currently set out in the Calculation of Default Contribution Rates Regulation, and publish his findings.

**Recommendation 12:** We recommend that the Chief Actuary keep the Ministers of Finance of Canada and the provinces apprised of research on optimal funding of social security programs.

### **9. Summary Opinion**

Following an in-depth review of the Twenty-First Actuarial Report on the Canada Pension Plan, we have set out our opinions in the various sections of this report in

response to the questions asked in our terms of reference. These opinions are summarized below.

In our opinion, the professional experience of the Chief Actuary and the staff who worked on AR21 was adequate for carrying out the work required, the work was completed in compliance with the relevant professional standards of practice and statutory requirements, and the Chief Actuary had access to the data he required to perform the valuation. He and his staff completed such tests and analyses on the data as might be expected. The data on which this report is based are sufficient and reliable.

Also, in our opinion, the Twenty-First Actuarial Report fairly communicates the results of the work performed by the Chief Actuary and his staff.

Regarding the assumptions used, we found that all but four assumptions were near the centre of the reasonable range, while two were at the higher-cost end and two were at the lower-cost end of their reasonable ranges. The total effect, in our opinion, is a set of assumptions well within the reasonable range, but a little on the conservative, or higher cost, side than we would have selected.

We believe that the Twenty-First Actuarial Report on the CPP was competently prepared and presents a reasonable set of results.

## SECTION 1 - INTRODUCTION

This report presents the results of an in-depth review we conducted into the Twenty-First Actuarial Report on the Canada Pension Plan (AR21) and the detailed actuarial examination on which it was based. This is the third such review that has been conducted.

Rather than “re-inventing the wheel”, in this report we have borrowed extensively from the descriptive and explanatory portions of the previous review reports. The observations, conclusions and recommendations, however, are our own.

### **1.1 Terms of Reference**

In accordance with our terms of reference, our review focussed on the actuarial work done on the Plan. We were not asked to, and did not, review the merits of the current design, administration or investment arrangements of the Plan, but only how those aspects interact with, and are reflected in, the actuarial review.

The terms of reference for our review were as follows:

The panel will “... review the work of the Chief Actuary in completing the 21<sup>st</sup> Actuarial Report on the Canada Pension Plan as at 31 December 2003 (21<sup>st</sup> Report) and, following the review, provide a report to the Chief Actuary and the United Kingdom Government Actuary’s Department (GAD). GAD will then provide its opinion of the peer review to the Chief Actuary.

The review report should contain opinions on the following questions:

- Is the professional experience of the Chief Actuary and his staff who worked on the report adequate for carrying out the work required?
- Has the work been completed in compliance with the relevant professional standards of practice and statutory requirements?
- Did the Chief Actuary have access to the information required to perform the valuation, and were relevant tests and analysis on the data completed as might be expected?
- Were the actuarial methods and assumptions used in completing the report reasonable?
- Does the 21<sup>st</sup> Report fairly communicate the results of the work performed by the Chief Actuary and his staff?



In providing opinions on the questions listed above, the panel will also provide such recommendations as the panel deems appropriate with respect to future actuarial reports on the Canada Pension Plan prepared by the Office of the Chief Actuary.”

## **1.2 Procedures Followed**

Our review was conducted as a close collaboration of the three panel members. The review work took place over the months from November 2004 through March 2005. We held one one-day meeting in person and numerous meetings by teleconference. We also corresponded extensively by e-mail.

We received copies of some of the working papers in November 2004, in advance of the report. We received the report on December 8, 2004, the day it was tabled in Parliament.

We interviewed the Chief Actuary and senior members of the Social Insurance Programs Section of the Office of the Chief Actuary (OCA), a Division of the Office of the Superintendent of Financial Institutions (OSFI), for one and one-half days. We also spoke to officials of the Department of Finance (Canada), the Demography Section of Statistics Canada and the Bank of Canada. We met with two senior officers of the Canada Pension Plan Investment Board (CPPIB), the President and CEO and the Vice President, Research and Risk Management. We also reviewed the papers presented to seminars conducted in 2003 by the OCA and the Régie des rentes du Québec, and other technical materials.

All of these officials responded promptly and fully to each request we made for information.

After reviewing all of the information, and after much discussion among ourselves, we found that we were able to reach agreement on all of the opinions and recommendations presented in this report.

## **1.3 The Canada Pension Plan**

The Canada Pension Plan (CPP) is a social insurance program which provides monthly income benefits and some lump sum benefits upon retirement, death and disability of participants. Virtually all working Canadians outside Quebec contribute to the Plan.

Before 1997, contribution rates were set at a level which created relatively little advance funding of benefits and the funds not used for immediate benefit payments and expenses

were loaned to the provinces at federal government borrowing rates of interest. The Plan was amended in 1997 by Bill C-2 to

- require an increased measure of advanced funding,
- add a sunset clause regarding the investment of CPP assets in provincial revolving 20-year bonds,
- require that the funds not used for immediate benefit payments and expenses or for investment in those provincial bonds be invested in a diversified portfolio of investments, and
- establish an Investment Board to control these investments.

#### **1.4 Statutory Actuarial Requirements**

Section 115 of the Canada Pension Plan Statute now requires that an actuarial review be conducted once every three years and that it report

- projected pay-as-you-go contributions rates (i.e., each year's contribution rate is just sufficient to cover that year's benefit payments and expenses), and
- a contribution rate, calculated in a prescribed manner (the "default contribution rate").

Section 113.1 of the Canada Pension Plan Statute requires a financial review of the Canada Pension Plan by the federal Minister of Finance and ministers of the included provinces. This review is to take into account the most recent report of the Chief Actuary under section 115 and "the financing objective of having a contribution rate that is no lower than the rate that, beginning with the year 2003, is the lowest constant rate that can be maintained over the foreseeable future." Section 115 states that projections must extend for at least 75 years into the future.

The federal government adopted the Calculation of Default Contribution Rates Regulation by order-in-council on December 10, 1998. This Regulation has been confirmed by the required two-thirds of the provinces containing two-thirds of the population of Canada. This Regulation calls for a default contribution rate calculated as that constant rate for which the projected ratio of Plan assets-to-expenditures 10 years after the end of the review period matches the corresponding projected ratio 60 years after the end of the review period.

#### **1.5 Actuarial Report 18 (AR18)**

The previous full actuarial review of the Canada Pension Plan was conducted as at December 31, 2000 and is reported in AR18.

AR18 presented a best-estimate projection of pay-as-you-go contribution rates for the Plan rising from 8.14% in 2001 to 11.01% in 2030 and finally to 11.45% in 2075.

It also presented a best-estimate steady-state contribution rate to be paid in 2003 and later of 9.8% of contributory earnings. Using this steady-state contribution rate, it projected ratios of assets-to-expenditures rising from 2.20 in 2001 to 4.90 in 2018, then hovering around 5.0 from 2018 to 2030, and then dropping steadily to 4.17 in 2075. Under a continuation of the current 9.9% contribution rate from 2003 on, it projected ratios rising from 2.20 in 2001 to 5.20 in 2020 and hovering around 5.25 from 2020 to 2035, then rising steadily to 5.99 in 2075.

Several sensitivity tests were presented in AR18 which showed how different the results would be under alternative actuarial assumptions.

## **1.6 Actuarial Report 21 (AR21)**

AR21 was prepared as at December 31, 2003. It presents a best-estimate projection of pay-as-you-go contribution rates for the Plan rising from 8.27% in 2004 to 11.52% in 2060 and then declining to 11.32% in 2075.

It also presents a best-estimate steady-state contribution rate to be paid in 2007 and later of 9.8% of contributory earnings. Using this steady-state contribution rate, it projects ratios of assets-to-expenditures rising from 3.08 in 2004 to 5.45 in 2021, then hovering around 5.5 from 2022 to 2048, then dropping to 5.36 in 2078. The projected ratios in the key years 2016 and 2066 are 5.09 and 5.40. Under a continuation of the current 9.9% contribution rate from 2004 on, AR21 projects ratios rising steadily from 3.08 in 2004 to 5.50 in 2019 and then rising more slowly to 6.88 in 2075.

A reconciliation of the changes to the steady-state contribution rate, moving from AR18 to AR21, is set out in AR21. The steady-state rate was impacted, sometimes positively and sometimes negatively, by inter-valuation actuarial gains and losses due to Plan experience, changes in actuarial assumptions, two Plan amendments (Bill C-3 and Part 4 of Bill C-30, which respectively extended the entire responsibility of cash management to the CPPIB and clarified certain technicalities having to do with employer contributions), improvements in methodology and a three-year change in the steady-state pairing of years. Each such impact was relatively small. In aggregate, the positive impacts offset the negative ones, resulting in no change in the rounded steady-state contribution rate from AR18 to AR21.

AR21 presents an expanded array of sensitivity tests and four stochastic<sup>1</sup> projections.

## **1.7 Complexity**

The Canada Pension Plan is a complex Plan which provides benefits on a variety of bases (part earnings-related and part flat-rate) on the occurrence of three different events (retirement, disability and death) and with different qualification criteria for each event. It will be obvious from a reading of the body of our report that the actuarial computer model used to produce the results in AR21 is an extremely complex model. It projects the intertwining of the Plan provisions and current population statistics with projections of future demographic and economic experience.

In our work, we have tended to concentrate on what we consider to be the most important issues, in particular, the data used, the major methodology issues, and nine key actuarial assumptions.

## **1.8 Interpretation of Results**

AR21 presents

- the projected pay-as-you-go contribution rates by year to 2035 and then every fifth year through to 2075,
- the steady-state contribution rate,
- a number of sensitivity tests (which illustrate the results which would be obtained under various changes in actuarial assumptions) and four stochastic projections (which allow certain estimates of probability to be assigned to ranges of outcomes) to examine how future financial results may differ from the main projections in AR21,
- an estimate of the unfunded liability of the Canada Pension Plan obtained using the accrued benefit actuarial cost method (which is commonly used with occupational pension plans),
- estimates of “actuarial balance” for various periods which is the amount by which the 9.9% contribution rate exceeds (or falls short of) the minimum rate necessary for the Plan to exist for the defined period if the fund were allowed to become exhausted at the end of the period (a measure used in actuarial reports on the US social security system), and

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<sup>1</sup> See explanation of the term “stochastic” in Section 5.

- a calculation of the internal rate of return of each cohort of participants (the projected rate of return each cohort can expect to achieve on its combined employee and employer contributions).

The steady-state contribution rate is the only one of these results that may translate into actual contributions to the Canada Pension Plan. Under the Regulation dealing with Calculation of Default Contribution Rates, the steady-state contribution rate will become the default contribution rate if it is higher than 9.9%. The other results are also useful because they provide information as to the long-term pattern of costs under the Plan, the unpredictability and variability of the costs, how these costs compare with the costs of occupational pension plans, and the value-for-money each cohort of participants may receive, and allow comparisons to be made with other countries' public pension plans.

All of the results are estimates. All but the sensitivity tests represent the Chief Actuary's "best" estimates, with no deliberate margins of conservatism or other deliberate bias.

It is essential to recognize that these results are not predictions. They are not necessarily accurate to one decimal place or even to one percent of contributory earnings. They simply present what the outcome will be if all of the assumptions were to come true in the future. The parameters involved (e.g., fertility rates, net migration rates, mortality rates, disability incidence rates, rates of labour force participation, retirement rates, rates of price increase, real rates of wage increase, real rates of return on investments, each from 2004 through to 2078) are not open to accurate prediction.

The estimates in AR21 and in previous reports are essential outputs to provide guidance in financing the Plan and in performing other Planning and management tasks. Yet, no matter how carefully they are prepared, they are still only estimates. Thus, it is important that readers of the actuarial reports look at the sensitivity tests to get a feel for the range of possible actual outcomes.

## **1.9 Outline of this Report**

Sections 2, 3 and 4 of this report address the first three questions in our terms of reference regarding Professional Experience, Professional Standards of Practice and Data.

Section 5 (Methodology) and Section 6 (Assumptions) address question 4 in the terms of reference.

Section 7 addresses question 5 in the terms of reference.

Section 8 provides further important commentary.

The Executive Summary provides an overview of our findings.

## SECTION 2 - PROFESSIONAL EXPERIENCE

In this section we address the following question:

*“Is the professional experience of the Chief Actuary and his staff who worked on the report adequate for carrying out the work required?”*

### **2.1 Background**

The Chief Actuary submitted AR21 to the Minister of Finance on November 18, 2004; it was tabled in Parliament on December 8, 2004. The Chief Actuary is Jean-Claude Ménard, a Fellow of the Society of Actuaries (FSA, 1985) and of the Canadian Institute of Actuaries (FCIA, 1985). He accepted the position of Chief Actuary for the federal government on August 15, 1999, following 18 years (the last four as its Chief Actuary) with the Régie des rentes, the agency of the Québec government responsible for the Québec Pension Plan. Mr. Ménard was responsible for preparing the Actuarial Reports on the Québec Pension Plan from 1990 to 1999. Few actuaries working in Canada can match his 23 years of experience in social insurance actuarial work.

The professionals who worked most closely with Mr. Ménard on AR21, and co-signed the report with him, are Michel Montambeault and Michel Millette, both Senior Actuaries (Social Insurance) in the Social Insurance Programs Section of the OCA, a Division of OSFI.

Mr. Montambeault is a Fellow of the Society of Actuaries (1992) and of the Canadian Institute of Actuaries (1992). He has worked on actuarial reviews of the Canada Pension Plan and other programs in the Social Insurance Programs Section of OSFI for the last 15 years.

Mr. Millette is a Fellow of the Society of Actuaries (1986) and of the Canadian Institute of Actuaries (1986). He joined OSFI in May 2000, following 12 years of experience working on social insurance programs with Mr. Ménard at the Régie des rentes du Québec. He is also Senior Actuary (Canada Student Loans) in the Social Insurance Programs Section at OSFI. He spends 50% of his time on Canada Pension Plan affairs and is responsible for the liaison with the staff of the Canada Pension Plan Investment Board.

The other professional staff who worked on AR21 are:

Name	Actuarial Designation	Years of Experience	
		In Actuarial Work	In Social Security
Louis-Marie Pommerville	FSA, FCIA	25 years	5 years
Alain Guimond	ASA	24 years	9 years
Sari Harrel	ASA	5 years	2 years
Danita Pattemore	ASA	4 years	1 year
Patrick Dontigny	Student (5 exams)	9 years	9 years
Yu Cheng	Student (5 exams)	7 years	5 years
Annie St-Jacques	Student (5 exams)	4 years	2 years

The three senior actuaries reviewed each other's work and co-signed the report. Therefore, no separate internal peer review was conducted.

## **2.2 Observations**

There are very few actuaries working in Canada with experience in valuing and costing social insurance programs like the CPP and the QPP. The data sources, macro-economic modelling and range of assumptions involved in evaluating social programs are more complex than for employer-sponsored plans. Therefore occupational pension plan experience is useful but not as useful as previous experience with social programs like the CPP and the QPP. Messrs. Ménard, Montambeault and Millette have considerable experience and understanding of the issues involved in evaluating the Canada Pension Plan, more than most other actuaries working in Canada.

The staff of the Social Insurance Programs Section of OSFI is of sufficient size to spend adequate amounts of time on CPP matters, such as improving methodologies and data sources, inter-valuation studies, documentation and liaison with other government departments, all of which contribute to the quality of the work and of the report.

We are satisfied that Mr. Ménard and the staff who assisted him in preparing AR21 have the relevant experience and are qualified to carry out the assignment.

### **2.2.1 Continuity of Staff**

Clearly, for each actuarial review of the CPP, it is desirable to have the setting of assumptions and the review of data sources and methodologies made by a group of professionals who have had considerable previous experience with the process. We are



pleased to observe that there appears to be a program of staff recruiting and succession planning in place, and that there is a mix of more experienced and newer personnel on the staff of the OCA.

### **2.2.2 Guidance From Experts**

Because of the wide range and complexity of the assumptions and methodologies involved in actuarial reviews of the CPP, it is desirable for the Chief Actuary to seek out the advice and guidance of experts, including actuaries, demographers and economists, in order to help ensure that a wide range of analysis and opinion is considered and to improve the credibility of the actuarial reviews.

To this end, the Office of the Chief Actuary hosted an Inter-Disciplinary Seminar on May 2, 2003 and attended a seminar hosted by the Régie des rentes du Québec on September 25 and 26, 2003. The first focussed on the aging of the working labour force, and was addressed by a demographer, an economist and two investment researchers. The second focussed on the demographic, economic and financial outlook from 2003 to 2030, and was addressed by two actuaries, a demographer, a geneticist, two economists and two investment professionals. Approximately 100 invited participants from across the country and from various provincial and federal organizations attended the OCA seminar. The speakers at these seminars gave learned presentations regarding such topics as trends in mortality rates, economic projections, labour force growth and investment returns. These inputs and the discussion of them helped the OCA to crystallize best-estimate assumptions and methodologies for the development of AR21.

After the tabling of the last two triennial Actuarial Reports on the CPP (AR17 and AR18) in December of 1998 and 2001, OSFI engaged a panel of three independent actuaries to conduct a post-release review of the Actuarial Report, similar to the review described in this report. The Actuarial Review Panel Reports for AR17 and AR18 and this report have included a number of recommendations for improvements in, or revised approaches to, the processes, sources of data, methodologies and assumptions utilized in preparing Actuarial Reports on the CPP. This process provides a level of assurance to the public and also helps the Chief Actuary in gathering a range of views regarding the complex methodologies and assumptions involved.

### **2.3 Opinion on Professional Experience**

In our opinion, the professional experience of the Chief Actuary and the staff who worked on AR21 was adequate for carrying out the work required.

## SECTION 3 – PROFESSIONAL AND STATUTORY REQUIREMENTS

In this section, we address the following question:

*“Has the work been completed in compliance with the relevant professional standards of practice and statutory requirements?”*

### **3.1 Background**

To address this question, we have considered each of the following:

- *Canadian Institute of Actuaries Rules of Professional Conduct*: The Chief Actuary and his co-signatories are Fellows of the Canadian Institute of Actuaries (CIA), the professional body governing the conduct and work of actuaries in Canada. The CIA promulgates “the professional rules and ethical standards with which a member must comply and thereby serve the public interest”. The *Rules of Professional Conduct* are the Institute’s highest level of guidance to its members. Failure to adhere to the rules results in disciplinary proceedings,
- *CIA Standards of Practice*: These standards govern the work performed by actuaries in Canada. There are *general* standards governing all areas of practice and *practice-specific* standards governing work in specific areas, namely: life insurance, property and casualty insurance, occupational pensions, workers’ compensation, and actuarial evidence. There are no *practice-specific* Standards of Practice governing work on social security programs, so only the *general* Standards of Practice are relevant to this review,
- *International Actuarial Association Guidelines of Actuarial Practice for Social Security Programs*: The International Actuarial Association (IAA) is a worldwide association of professional actuarial organizations. The IAA promulgates both guidelines and standards of practice. Neither are binding on actuaries in a particular country except to the extent that their national actuarial organization makes them so. The CIA has not made the IAA *Guidelines of Actuarial Practice for Social Security Programs* binding on its

membership. However, since the IAA *Guidelines* provide guidance specific to social security programs, we have considered those guidelines in this review, and

- *Canada Pension Plan*: This statute provides the terms of reference of the Chief Actuary when preparing an actuarial report in relation to the CPP. Section 113.1 identifies the actuarial information required by the Minister of Finance and ministers of the Crown of the participating provinces when recommending changes to CPP benefits or contribution rates, or both. Section 115 stipulates the timing, contents and certain other aspects of the Chief Actuary's triennial report.

In the sub-sections below, we consider each of these in turn.

### **3.2 CIA Rules of Professional Conduct**

The following *Rules of Professional Conduct* of the CIA are relevant to this review:

- *Rule 1*: A member shall act honestly, with integrity and competence, and in a manner to fulfil the profession's responsibility to the public and to uphold the reputation of the actuarial profession.
- *Rule 2*: A member shall perform professional services only when the member is qualified to do so and meets applicable qualification standards.
- *Rule 3*: A member shall ensure that professional services performed by or under the direction of the member meet applicable standards of practice.

We are satisfied that the Chief Actuary and his staff have met the requirements of the CIA *Rules of Professional Conduct*. Further to *Rule 2*, Section 2 of this report expands on our assessment of their professional experience. Further to *Rule 3*, the next two sub-sections expand on our assessment of their compliance with the CIA *General Standards of Practice* and IAA *Guidelines of Actuarial Practice for Social Security Programs*.

### **3.3 CIA General Standards of Practice**

The *General Standards* of the CIA are extensive and detailed. The topics covered include numerous matters relevant to AR21 such as:

- materiality,

- knowledge of the circumstances of the case,
- approximations,
- subsequent events,
- data – sufficiency and reliability,
- reasonableness of results,
- documentation,
- actuary’s use of another person’s work,
- selection of assumptions,
- comparison of current and prior assumptions, and
- reporting.

The CIA standard on assumptions requires that the assumptions, in the aggregate, should be appropriate. As will be seen from our conclusions in Section 6 (Assumptions), we differ from the Chief Actuary on a few of the best-estimate assumptions. Nevertheless, we have concluded that the assumptions adopted for AR21 are, in the aggregate, within the reasonable range.

In our view the work on AR21 complies with the relevant portions of the CIA *General Standards of Practice*.

### **3.4 IAA Guidelines of Actuarial Practice for Social Security Programs**

The *Guidelines of Actuarial Practice for Social Security Programs* of the IAA are international in scope. They cover the following topics

- scientific rigour,
- objectivity,
- quality of reports – transparency, explicitness, simplicity and consistency, and
- contents of reports.

The *Guidelines* with respect to the contents of reports are particularly extensive. Nearly one hundred different disclosures are recommended, ranging over areas such as data, assumptions, methodology, results, analysis, conclusions and professional attestations. AR21 provides all of the relevant recommended disclosures, and the work of the Chief Actuary and his staff thereon complies with all of the requirements of the IAA *Guidelines*.

### **3.5 Canada Pension Plan Act**

The Canada Pension Plan stipulates the frequency, approximate timing and certain contents of the Chief Actuary's triennial reports to the Minister of Finance and ministers of the Crown of the participating provinces. In AR21, the Chief Actuary and his staff have complied with all of these statutory requirements.

### **3.6 Opinion on Professional and Statutory Requirements**

In our opinion, the work on AR21 complies with all relevant professional standards of practice and statutory requirements.

## SECTION 4 – DATA

In this section we address the following question:

*“Did the Chief Actuary have access to the information required to perform the valuation, and were relevant tests and analysis on the data completed as might be expected?”*

### **4.1 Background**

Appropriate data are required for “current status” data inputs into the computer model, for “validation” (back-testing) of the model, and to develop appropriate actuarial assumptions for future years. Examples of such data are:

Table 2

<b>Purpose</b>	<b>Examples of Data</b>	<b>Source</b>
current and past status data	<ul style="list-style-type: none"> <li>• population by age and sex</li> <li>• earnings of contributors</li> <li>• contributions</li> <li>• benefits paid</li> <li>• assets</li> <li>• labour force</li> </ul>	<ul style="list-style-type: none"> <li>• 2001 census, Statistics Canada estimates</li> <li>• SDC</li> <li>• CRA, SDC</li> <li>• SDC</li> <li>• CPPIB, Finance, SDC</li> <li>• Statistics Canada</li> </ul>
validation data	<ul style="list-style-type: none"> <li>• CPP financial transactions</li> <li>• benefit statistics</li> <li>• earnings statistics</li> </ul>	<ul style="list-style-type: none"> <li>• CPPIB, Finance, SDC, CRA</li> <li>• SDC</li> <li>• SDC, CRA</li> </ul>

<b>Purpose</b>	<b>Examples of Data</b>	<b>Source</b>
data for assumptions	<ul style="list-style-type: none"> <li>• current mortality rates</li> <li>• future mortality improvement rates</li> <li>• fertility rates</li> <li>• migration rates</li> <li>• disability statistics</li> <li>• labour force participation</li> <li>• asset mix policy</li> <li>• economic indices</li> <li>• investment policy and performance</li> <li>• several topics</li> </ul>	<ul style="list-style-type: none"> <li>• Statistics Canada Life Tables and historical deaths</li> <li>• Social Security Administration (US) Trustees Report OASDI</li> <li>• Statistics Canada</li> <li>• Statistics Canada</li> <li>• SDC</li> <li>• Finance, Statistics Canada, OCA seminars, economic forecasts</li> <li>• CPPIB, large public and private pension plans</li> <li>• Statistics Canada, Canadian Institute of Actuaries</li> <li>• CPPIB</li> <li>• OCA seminars</li> </ul>

The status and validation data are factual and up to date, except for contributions in the two years before the valuation date, which are projected by the CPP computer model. The actual contributions for each calendar year are not available from CRA until about 24 months after the year.

The data used to develop assumptions include both historical data and various projections of possible future experience.

The data on benefits and earnings received from SDC are tested in detail for internal consistency and reasonableness. The data from other sources are reviewed for internal consistency and consistency with past data. Any irregularities are checked out with the data source and any data errors are corrected.

Since AR18, there have been a number of improvements in data, most notably access to the Record of Earnings of participants maintained by SDC. This has enabled OCA to substitute actual earnings histories for estimates and thereby improve the accuracy of the computer model. Also, since AR18 the CPPIB has adopted several policies and

practices. Knowledge of these allows the Chief Actuary to make more informed estimates about long-term future asset mix and expected returns.

The Chief Actuary has advised us that he had access to sufficient data to complete his work, and in AR21 has provided his opinion that “the data on which this report is based are sufficient and reliable”.

## **4.2 Observations**

We have the following observations

- the Chief Actuary appears to have had access to the data he required,
- the data are extensive and appear to be reasonably complete and available on a timely basis,
- the data are tested for reasonableness by the Office of the Chief Actuary and any deficiencies are resolved before the data are used,
- the Canada Pension Plan Investment Board (CPPIB) has not established long-term asset mix targets for the CPP Fund. The Chief Actuary therefore made an assumption as to those targets in the absence of actual targets. We understand that the CPPIB currently has no plans to adopt long-term asset mix targets,
- since 1991, the Bank of Canada and the Minister of Finance have jointly established inflation-control targets. These targets have been agreed on for five years at a time. The current target (target range: 1% to 3%; mid-point and monetary policy target: 2%) expires on December 31, 2006. There is currently no government policy in place regarding inflation-control targets after 2006 that the Chief Actuary can take into consideration when establishing his assumption regarding future inflation rates beyond 2006,
- the seminars have provided much useful information; there is room, however, to broaden the range of presenters and for presenters to better focus their contributions on matters of most relevance to the preparation of the Actuarial Reports on the CPP, and to extend over the whole of the 75-year projection period covered in the Actuarial Reports,
- the Office of the Chief Actuary maintains contacts with other Departments and Agencies such as the CPPIB, SDC, CRA, Statistics Canada and Finance Canada, and with external agencies such as the Régie des rentes du Québec, the Conference Board, the CD Howe Institute and the Institute for Policy Analysis at the University of Toronto. All of this provides helpful input, and



- there is room to improve the data obtained in three areas: establishment of long-term asset mix targets (this is discussed in greater detail in section 7 of this report), availability of empirical data on the utilization of child rearing dropout years and timeliness of empirical data on contributions.

#### **4.3 Opinion on Data**

In our opinion,

- the Chief Actuary had access to the data he required to perform the valuation,
- the Chief Actuary completed such relevant tests and analysis on the data as might be expected, and
- the data on which this report is based are sufficient and reliable.

#### **4.4 Recommendations**

**Recommendation 1:** We recommend that the Chief Actuary discuss with the CRA the possibility of their speeding up the process of providing the OCA with data on contributions.

**Recommendation 2:** We recommend that the Chief Actuary explore with SDC the possibility of providing the OCA with additional data on participant utilization of the child rearing dropout provision.

**Recommendation 3:** We recommend that the Chief Actuary

- continue his program of seminars with presentations from appropriate experts,
- strive to broaden the range of presenters,
- better focus their contributions on matters of most relevance to the preparation of actuarial reports on the CPP, and
- extend their inputs to cover the whole of the 75 year projection period covered in the Actuarial Reports.

## SECTION 5 – METHODOLOGY

In this section, we address the following question:

*“Were the actuarial methods used in completing the report reasonable?”*

### **5.1 Background**

The results presented in AR21 are based on a macro-simulation model of the Plan’s operations, which projects the elements of income and outgo and the accumulation of the fund year by year up to the year 2078.

#### **5.1.1 Macro-simulation Model**

The macro-simulation model starts with current and past statistics on the population (numbers of people distributed by age and sex) and earnings (distributed by age, sex and broad earnings levels) of residents of Canada outside of Quebec. The model projects each of the following, in turn, for each calendar year during the projection period

- the number and characteristics (e.g., age, sex, earnings) of the entire population of Canada outside of Quebec
- the number and characteristics of eligible CPP contributors and beneficiaries
- the amount of CPP contributions made and benefits received by eligible CPP contributors and beneficiaries, and
- the assets accumulating in the CPP fund.

Thus, the model combines the contribution income and benefit outgo described above with projections of investment return and expenses to arrive at total asset amounts.

The model projects anticipated experience in future years based on demographic and economic assumptions related to the CPP as a whole. These assumptions include demographic parameters such as fertility, migration and mortality, and economic parameters such as labour force participation rates, price inflation, wage escalation and investment returns.

#### **5.1.2 Deterministic vs. Stochastic Approach**

The model continues to rely principally on a *deterministic*, rather than *stochastic*, approach. That is, each run of the model produces

- a (deterministic) single set of projected results for each year up to 2078

rather than

- a (stochastic) probability distribution of possible results derived from projections of the expected results and of the underlying volatility of one or more of the parameters of the model (this allows estimates of probability to be assigned to ranges of outcomes, thereby increasing the information available).

However, AR21 does incorporate refinements that reflect stochastic considerations. In conjunction with the sensitivity tests, AR21 reports on some stochastic analyses conducted on key assumptions. These analyses provide estimates of probability ranges of four of the key assumptions. The stochastic analysis on the assumed real rate of return reflected not only the historical volatility of each asset class separately but also the historical correlations between asset classes. The stochastic analyses are not extended to estimate the probability ranges of the steady-state contribution rates.

The Chief Actuary is still examining the greater use of stochastic methods in his work.

### **5.1.3 Sensitivity Tests**

In addition to the results based on best-estimate assumptions selected by the Chief Actuary, a number of *sensitivity tests* are produced. These show the results using alternative assumptions and thereby give information on the possible range of future actual results. Three sets of sensitivity tests are presented in AR21.

The first set consists of two “combined” sensitivity tests: the “Younger Population Scenario” and the “Older Population Scenario” (referred to as the “Low-Dependency Scenario” and the “High-Dependency Scenario” in AR18). The first is based on generally more optimistic and the second on generally more pessimistic assumptions than the best-estimate assumptions. Both of these tests were designed to test plausible *combinations* of the key assumptions (considering the interrelationship of the various parameters), in each case starting from a change in the fertility assumption.

The second set of sensitivity tests in AR21 is presented in a technical appendix rather than in the body of the report. These tests examine

- one parameter at a time – the effect of a change, both upward and downward, in each of nine parameters, and
- an economic cycle – the effect of *combined* changes (generally adverse) in several assumptions over the 10 years following the valuation date to reflect a sudden economic slowdown followed by a return to more normal times.

The third set of sensitivity tests, also presented in a technical appendix, is new in AR21. The intent is to show the impact of one possible form of stock market volatility on the burgeoning CPP asset base, and in turn upon the steady-state contribution rate. This is accomplished by showing the effect of what may be described as a “permanent market correction”, namely a two-year period of abnormally high or low stock market returns followed by a resumption of best-estimate returns.

This test is conducted for each of a pair of two-year periods: 2005/2006 and 2017/2018. These years were chosen in order to gauge the impact of a stock market correction either well before or just after 2016. The latter year is critical for determining the steady-state contribution rate. The Canada Pension Plan Act defines the steady-state rate for this valuation as the contribution rate that produces a constant ratio of projected assets to projected expenditures in 2016 and 2066 (these benchmark years are pushed outward by three years at each successive triennial valuation).

The 2017/2018 sensitivity test also analyzes the impact of having more or less of the CPP portfolio invested in equities (it was felt that the 2005/2006 asset mix was more easily projected and not likely to vary much from that projection).

#### **5.1.4 Actuarial Cost Methods**

As in AR18, the main results in AR21 are presented on two actuarial cost methods: the traditional “pay-as-you-go” method and the so-called “steady-state” method.

Additional results are presented on the accrued benefit actuarial cost method and the so-called “actuarial balance” method.

The pay-as-you-go method projects CPP income and expenditures into the future. In AR21, the projection extends to the year 2078. Section 115(1.1)(a) and (b) of the Canada Pension Plan requires the Chief Actuary to present “pay-as-you-go” projections year by year for the first 30 years and thereafter every 5 years up to at least 75 years after the valuation date.

As discussed above, the “steady-state” method is based on a comparison of assets-to-expenditures ratios 10 and 60 years following the review period (i.e., starting three years after the review date, therefore comparing ratios in the years 2016 and 2066 for AR21). This is the “default” contribution rate calculated “in prescribed manner” required by section 115(1.1) of the Canada Pension Plan.

The accrued benefit actuarial cost method is the method used by occupational defined benefit pension plans. It produces a comparison of current Plan assets to accrued liabilities for the members and beneficiaries currently covered by the Plan and a calculation of the normal actuarial cost of the Plan (the cost of benefits currently accruing). In AR21, the unfunded liability at December 31, 2003 is shown, together with a projection of funded ratios for years up to 2050. The stable pattern of future normal actuarial costs is also described.

The Actuarial Balance method calculates, for each of several periods:

- the difference between (a) the sum of the beginning assets and the discounted present value of contributions for the period and (b) the discounted present value of the expenditures for the same period,

divided by

- the discounted present value of the contributory earnings for all years in the period.

The resulting figure, referred to in each case as the “actuarial balance”, is actually the amount by which the current 9.9% contribution rate exceeds (or falls short of) the minimum rate necessary for the Plan to exist for the defined period if the fund were to become exhausted at the end of the period (a measure used in OASDI Trustees Reports on the U.S. Social Security Program).

### **5.1.5 Back-testing of Results**

Similar to AR18, the model is tested and calibrated using a back-testing procedure. Model output for years prior to the valuation date is compared against historical values. Discrepancies are investigated and resolved. Resolution may include the development of adjustment factors to better calibrate the model to historical experience.

### **5.1.6 Reconciliations**

Detailed reconciliations are conducted of the current results on the pay-as-you-go, steady-state and accrued benefit methods against the results in AR18. These identify the

principal causes of the changes in results from AR18 to AR21, and measure the impact of each on the results. The detailed reconciliations also serve as a check on the results of AR21.

### **5.1.7 Form of Output**

The model produces five principal forms of output. These are

- projected demographic and financial results, including the pay-as-you-go contribution rates, the assets/expenditures ratios based on current statutory contribution rates, and other income and expenditure details for each of the first 32 years after the review date and thereafter every 5 years up to 2075,
- the steady-state contribution rate,
- a comparison of current Plan assets to accrued liabilities based on the accrued benefit actuarial cost method, as well as normal actuarial costs,
- projected “actuarial balance” contribution rates over various periods, and
- the internal rates of return for various year-of-birth cohorts of Plan members, each of which is the rate of return the report estimates will be realized by that cohort when comparing its projected benefits to its total (employee and employer) contributions to the Plan.

## **5.2 Observations**

### **5.2.1 Stochastic Processes**

As noted in sub-section 5.1.2, considerable progress has been made since AR18 on the use of stochastic processes.

This is helpful, but could be improved by moving beyond a paradigm where the future is assumed to closely resemble the past in respect of both the mean and variability of outcomes. At a minimum, when performing the stochastic analyses, the Chief Actuary might assume that the *variability* of future outcomes will resemble the past, but will be centered on his projected values rather than around historical means that are not expected to recur.

The Chief Actuary might even go further and illustrate potential variability based on both historical and projected distributions. To illustrate, some contend that future inflation will be controlled within a narrower band than in the past since policy-makers have greater commitment to, and demonstrated expertise in, managing inflation. Although such

judgments are necessarily subjective, it may be useful to examine their possible impacts on funding of the CPP.

The ideal would be to use an integrated model where all parameters are stochastically generated in an integrated fashion (e.g., if inflation rises, other economic and even non-economic parameters are varied stochastically in a consistent and plausible fashion). Given the complexity of the CPP model, and indeed of the reality it represents, this ideal would not be easily attained. However, it may be possible to perform integrated stochastic analysis on a subset consisting of most or all of the key parameters of the model. The key assumptions discussed in Section 6 likely provide the subset that should be considered.

We think the stochastic analyses would be considerably more useful if they were extended to provide an estimate of the probability range of the steady-state contribution rates, and not just of the key assumptions.

We note that the stochastic capability of the OCA may be useful to the CPPIB if and when it conducts analyses of the impact of investment policy on contribution volatility. This topic is discussed in more detail in sub-section 8.1.

### **5.2.2 Sensitivity Testing**

All of the sensitivity tests included in AR21 are useful. However, we note that the sensitivity tests vary in their plausibility from one actuarial assumption to another, ranging from highly plausible (e.g., well within the historical observed range) to highly implausible (e.g., retirement rates that are so extreme that they are unlikely to occur without a Plan design change). We would suggest a more consistent approach, along the following lines:

- Based on historical analysis tempered by judgment, postulate distributions of results for *each* key assumption.
- Select high-cost and low-cost values for each assumption that are of *equal* plausibility. This is the key element of the suggestion. We suggest targeting high-cost and low-cost values that each represent about a 10% probability of being surpassed. That is, the actual observed values should be expected to fall within the imputed range *about 80% of the time*.
- The resultant impact on the valuation results should be reported in each case, even if it is small. This will give users of the report a clearer sense of how much a future variation from an assumption is likely to affect the Plan's funding.

The third, or “permanent market correction”, set of sensitivity tests would be even more useful if it reported the steady-state contribution for the years after the permanent market correction, rather than the steady-state contribution rate that would be required today if *one knew in advance* that a market correction was coming.

### **5.2.3 Actuarial Cost Methods**

With respect to the accrued benefit actuarial cost method, we feel the graph showing projected funded ratios up to the year 2050 is valuable information, as is the description of stable future normal actuarial costs.

Regarding the “actuarial balance” figures, we believe they are marginally useful but not well described. The comment that “A positive actuarial balance indicates that estimated income (assets and contributions) is more than sufficient to meet estimated CPP expenditures for the period as a whole” is misleading; it ignores the requirement of a fund at the end of the measurement period. We prefer: “A positive actuarial balance is the amount by which the current 9.9% contribution rate exceeds (or falls short of) the minimum rate necessary for the Plan to operate for the defined period if the fund were allowed to become exhausted at the end of the period”. We also note that the notion of exhausting the fund at the end of the measurement period is contrary to the strategy used to develop the steady-state contribution rate.

The information provided by the actuarial balance figures is most meaningful if the actuarial balance is negative (as it is in the U.S. Social Security OASDI program). However, if an inspection of projected asset balances shows them to be uniformly positive and if the asset/expenditure ratio is stable or increasing in the later years of the projection period, then we believe reporting the CPP actuarial balance may only be useful as a point of comparison with the OASDI program, and is not useful as a guide for funding of the CPP. It would be useful if the Chief Actuary explained this in his report.

### **5.2.4 Back-testing of Results**

Back-testing continues to be a powerful and useful procedure. It “validates” the model, identifies necessary adjustments to be made, and detects anomalies that may need to be resolved.

As in AR18, the resulting adjustments are generally based on the experience of the most recent 10 years or less.



### **5.3 Opinion on Methodology**

In our opinion, the actuarial methods employed in AR21 are reasonable.

### **5.4 Recommendations**

**Recommendation 4:** We recommend that the Chief Actuary maintain the tradition of continual improvements to actuarial methods by such actions as

- applying more extensive and sophisticated stochastic analysis, and
- developing more plausible and consistent sensitivity tests for key assumptions.

**Recommendation 5:** We recommend that the Chief Actuary improve the description of the “actuarial balance” figures, and explain the limitations on their use, or drop them from the report.

## SECTION 6 – ASSUMPTIONS

In this section, we address the following question:

*“Were the assumptions used in completing the report reasonable?”*

### **6.1 Background**

The actuarial review that is required to be made every three years under section 115 of the Canada Pension Plan requires that the Chief Actuary look back in time, to review the operations of the program and also look forward, to make an estimate of its future operations. For the forward-looking part of the process, the Chief Actuary builds a model that incorporates the details of the benefit, contribution and investment elements of the CPP and reflects the expected behaviour of the factors that determine the year-by-year development of the benefit costs and the contribution and investment income. The model for a plan as complex as the CPP is necessarily complex itself. The assumptions incorporated into the model for a particular actuarial review reflect the Chief Actuary’s judgment, based on his interpretation of past experience and the available evidence about the likely course of future experience.

The nature of the actuarial process is to make projections (not predictions) about the future based on the evidence available and then to revisit and review them periodically. Where appropriate, the actuary makes “mid-course corrections” in the assumptions as the emerging experience of the plan deviates from the previous assumptions and the expectations for likely future experience change. In assessing whether to change an assumption and if so, by how much, the actuary must weigh

- long-term historical data,
- shorter-term historical data,
- very recent experience data,
- recent amendments to the Canada Pension Plan,
- policy (e.g., CPPIB investment policy, SDC administration policies, government policies on inflation control and immigration levels),
- academic research, and
- other external sources of relevant information.

The assumptions are intended to apply over the long-term future, so the actuary will normally give substantial weight to long-term historical data. However, where the actuary judges that more recent data for a particular assumption indicate a shift or a trend

that is likely to continue for the long-term future, the actuary will recognize that shift or trend in the assumption.

For many of the assumptions used in the model, the Chief Actuary has adopted an approach that actuaries describe as “select and ultimate”. Under this approach, the particular assumption gradually changes over a period of years (the “select period”) from one that initially is very close to actual recent experience to one that reflects the actuary’s best estimate of the long-term future (the “ultimate” assumption). The length of the select period can be different for different assumptions. The choice is based on the actuary’s judgment and depends partly on the nature of the parameter involved and partly on how significantly the ultimate assumption differs from recent experience.

The results of the actuarial process at any given time do not yield a “right” answer but should lie somewhere within a range that can be regarded as “reasonable”. Previous actuarial reviews of the CPP have focussed on several key assumptions. All assumptions used in those reviews can be described as “best-estimate”, i.e., the assumptions were, in the judgement of the Chief Actuary, such that adverse or favourable deviations of actual future experience from each of those assumptions are about equally likely. AR21 follows this same approach.

The major actuarial assumptions in AR21 can be conveniently divided into two groups:

- “demographic” assumptions that deal with changes in the covered population (fertility, migration and mortality rates) and events (death, disability, retirement) that trigger the starting or stopping of CPP benefit payments or contributions, and
- “economic” assumptions that deal with employment, wages, prices and returns on investment.

## **6.2 Demographic Assumptions**

### **6.2.1 Fertility**

The total fertility rate summarizes a set of age-specific fertility rates and indicates the average number of children that would be born to a woman in her lifetime based on those age-specific rates. Like some other assumptions, the approach used in AR21 (and in past Actuarial Reports on the CPP) is to develop one assumption for Canada and a separate one for Quebec. The fertility trends are based on historic cohort fertility rates by age of mother, not calendar-year fertility rates. The assumption is used to develop separate

population projections for Canada and for Quebec. From these, the projected population of Canada-less-Quebec is derived.

The fertility assumption in AR21 is lower than that used in AR18 and the select period is longer. For Canada, AR21 assumes an ultimate total fertility rate of 1.60 in 2016 and later, compared to the previous assumption of 1.64 in 2007 and later.

The effect of this change on the steady-state contribution rate is an increase of 0.065% of contributory earnings. The effect on the pay-as-you-go rates, as compared to the pay-as-you-go rates that would have resulted from using the same assumption as in AR18, is to increase the pay-as-you-go rates in the later years: by 0.18% in 2050 and 0.10% in 2075.

The assumed rates reflect the significant decline in fertility rates over the last 45 years. They also anticipate a small rise in rates from recent levels because of current trends in women having a first child at a later age than previously. They are higher than the “medium” projections of Statistics Canada (which run only to 2026) and lower than the projections for Canada (to 2050) performed by the United Nations. Officials of the Demography Division of Statistics Canada feel the assumed rates in AR21 are at the high end of the expected range, but reasonable and defensible. They also noted that they (Statistics Canada) would not likely use their “25-year” assumption for a 75-year projection. Also, because future cohorts of adult females are smaller than in the recent past, the overall impact of the fertility assumption is decreasing in importance.

The sensitivity tests for the fertility assumption are a low-cost ultimate rate of 1.90 for Canada and a high-cost ultimate rate of 1.30. This spread of 0.6 is slightly broader than, but consistent with, the spread used by Statistics Canada between their “high” and “low” fertility projections to 2026. The tests show a significant variation in the long-term pay-as-you-go rates (a decrease of 1.49% or an increase of 1.96% of contributory earnings in 2075) and moderate variation in the steady-state contribution rate (a rounded low-cost decrease of 0.3% and a rounded high-cost increase of 0.3% of contributory earnings).

The long-term fertility assumption depends on social, medical and economic factors that are difficult to predict. Following a sharp decline in the 1960’s and early 1970’s resulting from social and economic changes, fertility rates in Canada have declined more slowly over the last 30 years. Nonetheless, they could in future decline to the lower levels experienced in Quebec and most European countries or could increase in the direction of a “full replacement” rate which has been the recent experience in the U.S.

## **Opinion on Fertility**

In our opinion, the AR21 fertility assumption is reasonable.

### **6.2.2 Migration**

The AR21 assumption is net annual immigration to Canada of 0.50% of population from 2004 to 2015 then increasing linearly to 0.54% in 2020 and later. The net migration assumption is higher than the assumption in AR18, which was 0.52% of population for years 2020 and later.

The change in this assumption decreases the steady-state rate by 0.055% of contributory earnings and the long-term (2075) pay-as-you-go rate by 0.25% of such earnings.

AR21 cites the expected future labour shortage as one reason for assuming the increase in net immigration rates from 2015 to 2020.

The sensitivity tests for the migration assumption are a low-cost ultimate net immigration rate of 0.64% and a high-cost rate of 0.44%. The resulting pay-as-you-go rates for 2075 deviated from the best-estimate results by a low-cost decrease of 0.40% and a high-cost increase of 0.42% of contributory earnings. The effect on the steady-state rate is a low-cost decrease of 0.2% and a high-cost increase of 0.1% of contributory earnings.

The methodology for developing the migration data has improved substantially in the last few years and the figures are more reliable than in the past. Officials of the Demography Division of Statistics Canada feel the assumed rates of net migration used in AR21 are reasonable.

The ultimate assumption of 0.54% is comparable to actual averages over the last 10 and 15 years. We note, however, that net migration rates are highly volatile. In the last 50 years, they have ranged from a low of 0.07% of population (1962) to a high of 1.2% (1952 and 1957).

## **Opinion on Migration**

In our opinion, the AR21 net migration assumption is reasonable.

### **6.2.3 Mortality**

The mortality assumption for AR21 starts from the 1995-97 Life Tables for Canada and Quebec, prepared by Statistics Canada. These mortality rates are projected to 2001 using the actual improvements in mortality experienced in the years 1996 to 2001. The rates of assumed improvement in 2002 to 2006 are extrapolated using the average annual rates experienced in Canada between 1991 and 2001. Rates of improvement for 2006 to 2026 are found by linear interpolation between the age-specific rates for 2006 and the fixed age-specific improvement rates for 2026. For 2026 and beyond, the improvement rates are lower than the Alternative II assumption used in the 2003 U.S. Social Security (OASDI) Report, so as to narrow (but not close) the gap in US and Canadian assumed mortality rates over the projection period.

The effect of the change in the mortality assumption is small: a decrease in the pay-as-you-go rate for 2075 of 0.02% of contributory earnings and an increase in the steady-state rate of 0.026% of earnings.

The sensitivity tests are a high-cost scenario of ultimate mortality reductions of 200% of the best-estimate rates of reduction by 2025 and a low-cost scenario of no mortality reductions after 2025. The high-cost pay-as-you-go rate in 2075 is higher than on the best-estimate basis by 0.60% of contributory earnings and the corresponding low-cost rate is lower than on the best-estimate basis by 0.64% of contributory earnings. The effect on the steady-state rate is an increase of 0.1% for the high-cost scenario and a decrease of 0.2% of contributory earnings for the low-cost.

We have some concern about the assumption that the gap in US and Canadian mortality rates will tend to narrow from 2026 to 2075. We believe that there will continue to exist a gap between (lower) Canadian mortality rates and (higher) US mortality rates based on three advantages in Canadian society

- access to universal health care,
- lower rates of obesity, and
- lower rates of poverty and less disparity of income.

We asked the OCA to conduct a further sensitivity test assuming the Canada/US mortality improvement gap would continue at about its current level through the entire projection period. The results were significant. Using this lower mortality rate assumption, the AR21 steady-state contribution rate increases from 9.770% to 9.843%.

## **Opinion on Mortality**

In our opinion, the AR21 mortality assumption is reasonable, but incorporates lower ultimate mortality improvement rates than we would have chosen.

### **6.2.4 Disability Incidence**

The assumption about the incidence of disability takes the form of rates that vary by age and sex. These can be summarized as an aggregate rate based on the current population distribution. The AR21 assumption for years 2008 and later can be expressed as aggregate rates of 3.25 new disabilities per thousand eligible male workers with a corresponding female rate of 3.50 per thousand. These rates are the same for males but higher for females than the rates used in AR18 which were 3.25 for males and 2.75 for females.

We note that the rates in AR21 are not directly comparable to the rates in AR18 since the data used to derive the historical population eligible for disability benefits have been changed. Historical eligible population data are now available using actual CPP records of earnings as opposed to being estimated and this reflects more precisely the labour force attachment of CPP contributors. If this change in data had been available for AR18, the ultimate disability incidence rates in that report would have been about 3.5 and 3.8 per thousand for males and females, respectively.

The rates used in AR21 are consistent with rates experienced in the period since 1994, but lower than rates experienced in the period prior to 1995. This is true because of

- the more stringent administrative rules that were adopted in 1995, and
- the significant change in the qualification requirements that were introduced as a result of the passage of Bill C-2 in 1997.

The effect of all of the changes in disability assumptions (including both disability incidence and disability termination) from the corresponding assumptions used in AR18 is identified in AR21 as a small reduction in the pay-as-you-go rates: short term (0.04% in 2025), medium term (0.02% in 2050) and long term (0.02% in 2075). The reduction in the steady-state contribution rate is 0.025% of contributory earnings.

The sensitivity tests of the disability incidence assumption are high-cost aggregate ultimate assumed rates of 4.25 per thousand for males and 4.50 for females and low-cost rates of 2.25 per thousand for males and 2.50 for females. The pay-as-you-go rate goes down by 0.28% in 2025, 0.28% in 2050 and 0.27% in 2075 under the low-cost scenario

versus an increase under the high-cost scenario of 0.28% in 2025, 0.29% in 2050 and 0.27% in 2075. For the steady-state rate, the low-cost decrease is 0.3% of contributory earnings and the high-cost increase is 0.2%.

We believe that the change in this assumption is warranted by the seven years (1997-2003) of relevant (i.e., post-Bill C-2) experience, and note that only four years of relevant experience were available for AR18.

### **Opinion on Disability Incidence**

In our opinion, the AR21 disability incidence assumption is reasonable.

### **6.2.5 Retirement Rates**

The assumption about retirement rates is considered in AR21 both as a demographic assumption (in that it affects the commencement of benefits) and as an economic assumption (in that it affects employment levels and hence contributions).

There exists a relationship between retirement rates and labour force participation rates in the age group 60 to 64 in the model. For AR21, it is assumed that the participation rate for males at ages 60 to 64 would increase from 53% in 2004 to 56% in 2030 while, for females, the increase over the same period would be from 32% to 36%. To reflect this, retirement rates at age 60 are adjusted downward by one-third of the increase in participation rates for ages 60 to 64 between 2004 and 2030 while retirement rates at age 65 were increased by the same amount.

This results in retirement rates at age 60 of 33% and 40% for males and females, respectively, in 2004 declining to 32% and 38% in 2030. At age 65 retirement rates in 2004 are 41% and 33% for males and females, respectively, rising to 42% and 34% in 2030. The retirement rates are then held constant for 2030 and beyond.

There is a sensitivity test for the retirement rate assumption. The low-cost set of retirement rates assumes that, from 2009 onward, everyone would retire at age 65 (rather than earlier). This reduces the steady-state contribution rate by 0.4% of contributory earnings, and the pay-as-you-go rates by 0.77% in 2025, 0.17% in 2050 and 0.10% in 2075. The high-cost sensitivity set of retirement rates assumes that, from 2009 onward, everyone retires at age 60. This increases the steady-state contribution rate by 0.4% of contributory earnings and the pay-as-you-go rates by 0.91% in 2025, 0.20% in 2050 and 0.08% in 2075.



The review panel feels that the retirement rate assumption in AR21 is well within the reasonable range. Our own estimate, however, of the most likely scenario in the future is a stronger shift to later retirement than that assumed in AR21. We also feel that plausible distributions of retirement rates would be better for the sensitivity analysis than “all retire at age x” scenarios.

### **Opinion on Retirement Rates**

In our opinion, the AR21 retirement rates assumption is reasonable.

## **6.3 Economic Assumptions**

### **6.3.1 Unemployment and Participation Rates**

The development of projected numbers and profiles of contributors begins with the development of calendar-year labour force participation rates by age-sex group and the application of these rates to the projections of the total population in each of those groups. The participation rates are “cohort-based” so as to reflect expected changes in participation as a result of longer periods in education and training, the trend of postponing childbearing to later ages and a move toward later retirement. The resulting labour force projections are then used in combination with projections of assumed net jobs created to give projections of employed workers. The process is repeated with alternate rates of job creation until the assumed rates of unemployment (7.5% on average from 2004 to 2008, then reducing to 6.5% by 2020 and remaining at that level thereafter) were reached. The resulting projections are taken as the best-estimate projections. The resulting aggregate labour force participation rate (ages 15-69) in 2030 is 73.4% and the corresponding employment rate is 68.6%.

The ultimate aggregate labour force participation rate and employment rate used in AR21 are a little higher than those used in AR18 (72.5%, and 66.5%, respectively) and the unemployment rates are about the same as in AR18. The effect of these changes in assumption for unemployment and labour force participation from those used in AR18 is to decrease the steady-state contribution rate by 0.078% of contributory earnings and the pay-as-you-go rates by 0.12% in 2025, 0.03% in 2050 and 0.01% in 2075.

There are two sensitivity tests for this assumption. One is the use of a low-cost ultimate assumed unemployment rate of 4.5% together with an ultimate aggregate labour force participation rate of 81% (a 7.6% upshift) and the other is a high-cost ultimate assumed

unemployment rate of 8.5% together with an ultimate aggregate labour force participation rate of 71% (a 2.4% downshift). The results, not surprisingly, show more impact on the low-cost side, with a low-cost drop in the steady-state contribution rate of 0.5% of contributory earnings and the corresponding drops in the pay-as-you-go rate diminishing from about 0.85% in 2025 to about 0.04% in 2075.

The rationale for the best-estimate assumed unemployment and participation rates seems to us both plausible and reasonable. The parameters adopted for these rates are well within the consensus range of expert opinion.

### **Opinion on Unemployment and Participation Rates**

In our opinion, the AR21 assumption as to the rates of unemployment and labour force participation are reasonable.

#### **6.3.2 Real Wage Increases**

Both contributions and initial benefits under the CPP are affected by wage increases. Benefit increases are affected by inflation. The wage increase assumption is separated into two parts: the inflation assumption (discussed in sub-section 6.3.3 below) and the real wage increase assumption (the portion above inflation, discussed here in sub-section 6.3.2).

For AR21, the real wage increase assumption in the short term takes into account the difference in recent years between the real rate of increase in average annual earnings and the real rate of increase in Average Weekly Earnings (AWE), an index that is used to adjust the Year's Maximum Pensionable Earnings in the CPP. The assumed real rate of increase in the AWE is assumed to be -0.3% in 2004 and 0.2% in 2005, gradually increasing to 1.2% in 2012 and later. The real rate of increase in average annual earnings (AAE) is assumed to be 0.1% for 2004, then slightly outpacing the AWE increases for 2005-2007 and thereafter increasing at the same rate as the AWE.

In AR18, the AAE increase assumption was 0.2% in 2002 grading up to 1.1% in 2015 and later. The AR21 assumption is, therefore, slightly higher than that used in AR18 throughout most of the projection period. The total effect of the change in the assumption is an increase in the steady-state contribution rate of 0.007% of contributory earnings and a decrease in the pay-as-you-go rates of 0.02% in 2025, 0.16% in 2050 and 0.18% in 2075.

The sensitivity tests for the real wage assumption are a low-cost scenario of an ultimate rate of 2.0% in 2012 and later and a high-cost scenario of an ultimate rate of 0.5% in 2006 and later. The results of the tests indicate a high degree of sensitivity to this assumption. The decrease in cost for the low-cost scenario is 0.6% in the steady-state contribution rate and 0.90% in the 2025 pay-as-you-go rate, 1.33% in 2050 and 1.36% in 2075. The cost increases for the high-cost scenario are 0.5% in the steady-state rate and 0.91% in the 2025 pay-as-you-go rate, 1.39% in 2050 and 1.45% in 2075.

Historical data from the *CIA Report on Economic Statistics* shows an average annual rate of real wage increase over the last 80 years (1924-2003) to be 1.39% but over the last 25 years (1979-2003) 0.0%. Economists we spoke to felt that a rate in the range of 1.5% to 2.0% would be a better long-term estimate for the future of both productivity gains and real wage gains. Such a rate reflects an expectation that labour will revert to receiving a share of productivity gains in the future, as it historically did but unlike the experience of the last couple of decades.

In our opinion, the increase in the long-term assumption from 1.1% to 1.2% is a cautious move in the right direction. We believe that the range of reasonable assumed annual rates of real wage increases is from 1.0% to about 2.0%. Our own choice would be about 1.5%.

### **Opinion on Real Wages**

In our opinion, the real wage increase assumption in AR21 is reasonable, but towards the low end of the reasonable range.

### **6.3.3 Price Increases**

The rate of price inflation is a necessary assumption for an actuarial review of the CPP. Nominal rates of increase in earnings and benefit payments are both affected by inflation but, because the impact of inflation on employment earnings occurs earlier in time than the impact on benefits, the effects on pay-as-you-go rates and on the steady-state contribution rate of a change in the inflation assumption do not cancel out. An increase in the inflation assumption results in a decrease in the pay-as-you-go rates and steady-state contribution rates, and vice versa.

The inflation assumption in AR21 is 2.0% in 2004-2008, increasing to 2.7% in 2015 and later. In AR18, the assumption was 2.8% in 2001 and 2.0% in 2002-2005, increasing to 3% in 2015 and later. The effect of the change in the assumption is to increase the

steady-state contribution rate by 0.066% of contributory earnings and to increase the pay-as-you-go rates by 0.09% in 2025, 0.10% in 2050 and 0.08% in 2075.

The sensitivity tests for this assumption are a high-cost scenario with an ultimate inflation rate of 1.7% and a low-cost scenario with an ultimate rate of 3.7%. The high-cost pay-as-you-go rates are 0.28% to 0.37% higher than the best-estimate rates and the low-cost pay-as-you-go rates are 0.24% to 0.30% lower than the best-estimate rates. The steady-state contribution rates are higher and lower by 0.2%, respectively, of contributory earnings.

Inflation in Canada has averaged 3.06% per year over the last 80 years (1924-2003), 4.06% per year over the last 50 years (1954-2003) and 4.09% over the last 25 years (1979-2003) and 1.82% over the last 10 years (1994-2003). In six of the eight decades (1924-33 to 1994-2003), the average inflation rate fell in the range from 1.45% to 4.42%. In 1924-33 it was negative 2.55% and in 1974-83 it was positive 9.21%.

The present system of Bank of Canada five-year inflation control targets has been in effect only since 1991. Since it was introduced, it has been remarkably successful at keeping the inflation rate in Canada generally within a range of +/-1% around the policy target. Our inquiries lead us to believe that this system will continue for a long time and that there is no reason to expect a change from the current target of 2%.

Our review of the opinions of some economists and financial forecasters found a concentration of views of long-term inflation rates around 2% and slightly above 2%. We think the reasonable range for this assumption is an ultimate rate from 1.5% to 3.0%. Our own choice would be about 2.25%

We believe it is appropriate for the Chief Actuary to adopt a lower short-term (2003-2014) inflation rate in AR21 than the rate used in AR18. The ultimate real price increase assumption used in AR21 remains, however, near the high end of the reasonable range.

### **Opinion on Price Increases**

In our opinion, the price increase assumption used in AR21 is within, but at the high end of the reasonable range.

### **6.3.4 Real Rate of Return on Investments**

If the CPP were totally unfunded (i.e., if the contributions each year were just enough to cover that year's benefit payments and expenses), then the costs would be equal to the

pay-as-you-go rates and no assumption for the rate of investment return would be required. However, under the steady-state contribution rate approach to financing the Plan, a sizeable fund will accumulate (equal to six to seven years' benefit payments, according to AR21) and the rate of investment return becomes a material factor in the cost of the Plan. The CPP assets totalled \$68 billion at the end of 2003 and are projected to exceed \$100 billion in 2007 and \$200 billion in 2014.

As with assumed increases in employment earnings and benefit payments, part of the assumed nominal rate of investment return is attributable to general price inflation. Here we focus on the real rate of investment return (i.e., net of the rate of inflation).

The best-estimate real rate of return assumption, net of direct investment expenses, in AR21 is 4.4% in 2004, 5.0% in 2005 and 2006, then declining gradually to 4.1% in 2025 and later. The AR18 ultimate assumption for the real rates of return was 4.15%. The changes in this assumption increase the steady-state contribution rate by 0.064% of contributory earnings.

The sensitivity tests for this assumption are to increase or decrease the rate of return on all of the CPP assets by 1%. The results of the tests are a decrease or an increase in the steady-state contribution rate of 0.5% of contributory earnings. This assumption has no effect on the pay-as-you-go rates, so there is no sensitivity effect on them of increasing or decreasing the assumed rate of return.

In arriving at the assumed long-term rate of return for the CPP assets, the Chief Actuary notes that the CPPIB anticipates an asset mix in 2006 of 65% variable income investments (he assumes a breakdown of 25% Canadian equity, 30% foreign equity, 10% real return investments such as real estate and infrastructure) and 35% fixed income investments (he assumes a breakdown of 34.5% bonds, 0.5% short-term investments).

The bond portfolio includes 20-year non-marketable revolving loans to the provinces. The provinces have the option to roll over for one further 20-year period any loans that were outstanding on January 1, 1998. The last of these loans will mature in 2033. Based on experience to date, it was assumed that the rate of future rollovers will vary by province at rates varying from 0% (Manitoba, Yukon and the Northwest Territories) to 100% (New Brunswick, Newfoundland, PEI and Quebec). These revolving loans are projected to represent 38.6% of the CPP fund in 2004, declining to 0.0% by 2033.

The CPPIB does not adopt long-term asset mix targets. In the absence of such long-term targets, the Chief Actuary derived his long-term real rate of return assumption on the

basis of an assumed ultimate asset mix of 55% variable income investments (15% Canadian equity, 30% foreign equity, 10% real return investments such as real estate and infrastructure) and 45% fixed income investments (44.5% bonds, 0.5% short-term investments).

To derive the real rate of return assumption for each year, the assumed asset mix percentages for each class of asset is multiplied by an assumed rate of return for that asset class. For years after 2008, the assumed rates of return are:

Table 3

<b>Assumed Real Returns by Asset Class</b>	
<b>Asset Class</b>	<b>Assumed Ultimate Annual Real Rate of Return</b>
Canadian equity	4.6%
Foreign equity	5.0%
Marketable bonds	3.4%
Non-marketable bonds	Varies by year
Real estate and infrastructure	4.0%
Short term investments	1.5%

The projected real return on the non-marketable bonds declines from 6.4% in 2004 to 2.9% in 2025.

The real rates of return on Canadian stocks have been approximately 6.7% over the last 80 years (to December 2003) and 6.4% over the 101 years to December 2000. After adjustment for tougher rules (labour, employment and environmental laws, for example), the particularly favourable results of the 20<sup>th</sup> century and the maturation of some capital markets (with attendant expectation of lower risk and volatility), we would select a best estimate ultimate rate of about 6.0%, a rate considerably higher than that selected by the Chief Actuary. We would have selected a lower real rate of return than this for the first 20 years, however, to reflect expected economic adjustments as the baby boomers retire and start to disinvest, labour shortages drive up labour costs, and both of these factors lower returns to capital.

The long-term real rate of return assumption adopted by the Chief Actuary is within the reasonable range but below what we would select as a “best-estimate” assumption. We would have selected a slightly lower ultimate real rate of return on bonds and, as noted, a considerably higher real rate of return on stocks than the Chief Actuary, with a higher (about 0.5% higher) resulting ultimate real rate of return for the total fund.

The assumed ultimate asset mix is a little more heavily weighted to fixed income investments than the current expectation of CPPIB management. The CPPIB intends, however, to conduct further investment risk analyses, including some which will measure investment risk in terms of the possible impact of investment results on contribution rate changes. Such further analyses may have an impact on investment policy in the future. In our view the assumed ultimate asset mix is reasonable at this stage in the evolution of the investment analyses and policies.

We believe that a reasonable range for the real rate of return assumption for a CPPIB portfolio with the assumed ultimate asset mix is in the neighbourhood of 4.6%, and would allow for a long select period of perhaps 20 years.

### **Opinion on Real Rate of Return**

In our opinion, the 4.1% assumption for the ultimate annual real rate of investment return on assets is within, but near the bottom of, the reasonable range. We would, however, select a best-estimate assumption in the neighbourhood of 4.6%.

### **6.4 Reasonableness of the Assumptions in the Aggregate**

In our review of the major actuarial assumptions, we found that each of them is in the reasonable range. We find that five of the nine major assumptions are near the centre of the reasonable range. In our view,

- the real-wage differential and the real rate of return assumptions are at the higher-cost end of the reasonable range, and
- the mortality and price increase assumptions are at the lower-cost end of the reasonable range.

The impact on the steady-state contribution rate of the high-cost differences outweighs the impact of the low-cost differences. Consequently, the steady-state rate in AR21 is a little higher than the rate we would have derived.

The total effect, in our view, is a set of assumptions well within the reasonable range, but a little on the conservative, or higher-cost, side than we would have selected.

## **Opinion on the Assumptions in the Aggregate**

In our opinion, the assumptions used in completing AR21 are, in the aggregate, within the reasonable range, while a little on the conservative (i.e., high-cost) side of the best-estimate assumptions we would have selected.



## SECTION 7 - COMMUNICATION OF RESULTS

In this section, we address the following question:

*“Does the 21st Report fairly communicate the results of the work performed by the Chief Actuary and his staff?”*

### **7.1 Background**

AR21, as tabled in the House of Commons on December 8, 2004, is a bound soft-cover book, separately published in English (128 pages) and French (135 pages). It consists of the following sections:

	Number of Pages In English
Complete index, listing all the sections, tables and charts	4
I. Executive Summary	3
II. Methodology	1
III. Best-Estimate Assumptions	11
IV. Results	15
V. Sensitivity Analysis	7
VI. Conclusion	1
VII. Actuarial Opinion	1
Appendix A – Summary of Plan Provisions	6
Appendix B – Assumptions and Methods, subdivided into	
I. Introduction	1
II. Demographic Projections	10
III. Economic Projections	14
IV. Investment Assumptions	6
V. Benefit Expenditures	17
VI. Assets	1
Appendix C – Sensitivity Tests	13
Appendix D – Financing the Canada Pension Plan	7
Appendix E – Reconciliation with Previous Report	5
Appendix F – Financial Projections with 9.8% Steady-State Contribution Rate	1
Appendix G – Acknowledgements	1

AR21 is also available from the OSFI website [www.osfi-bsif.gc.ca](http://www.osfi-bsif.gc.ca).

## **7.2 Observations**

AR21 is a very informative document. It includes a great deal of detail, a comprehensive Executive Summary and many useful tables and charts. The overall conclusions are clearly set out.

The report provides information of interest to both a broad audience and a narrower, more technical audience of actuaries, economists, demographers, policy analysts, etc. It is therefore a compromise, and will contain more detail than the former, and less than the latter, will want. Moreover the technical detail on data, methods and assumptions is intertwined and not set out separately for ease of review or analysis.

We think there would be merit in producing a two-volume report. One volume would contain the high-level results of the actuarial review, including the sensitivity tests, reconciliations and a summary of the Plan provisions, data, methodology and assumptions. The other volume would provide fuller details of the Plan provisions, data, methodology and assumptions, each in a separate section. For example:

- full and consistent historical data would be provided for each data series, even if the entire data series was not used as the basis of projection,
- all methods would be disclosed, including the statistical methods used to extrapolate past trends,
- all assumptions would be disclosed in their entirety, not just described, and
- all changes in data sources (or the construction thereof), methods and assumptions would be highlighted, and their impact on the valuation results disclosed.

We also think there would be merit in grouping all of the information on stochastic results and sensitivity tests, together with some interpretation of those results and tests, in a section labelled “Uncertainty of Results”. This would draw as much attention to this aspect of the estimates as to the *best-estimate* steady-state contribution rate. We believe this theme should be carried into the executive summary also.

We think it is important that Canadians not only understand the Chief Actuary’s best estimate of the future contribution rates, but also appreciate the uncertainty necessarily involved in such estimates.

Our recommendations are aimed at further improvement and should not be considered to detract from the opinion below.

### **7.3 Opinion on Communication of Results**

In our opinion, AR21 fairly communicates the results of the work performed by the Chief Actuary and his staff.

### **7.4 Recommendations**

**Recommendation 6:** We recommend that future Actuarial Reports be published in two volumes.

The first volume would be intended for a broad audience and contain

- an executive summary,
- the results of the Chief Actuary's investigations (sections IV and V and Appendices C, D, E and F of AR21),
- conclusions (section VI of AR21),
- an actuarial opinion (section VII of AR21), and
- four one- or two-page appendices, summarizing the Plan provisions, data, methodology and assumptions.

The second volume would be intended for a technical audience (actuaries, demographers, economists, policy analysts and so on) and contain detailed, and separate, technical descriptions of the

- Plan provisions,
- data,
- methodology,
- assumptions,
- experience studies performed, and
- rationale and justification for the assumptions (incorporating as background data the 100-, 50-, 25- and 10-year means and standard deviations of historical rates, and selected charts illustrating trends),

and of changes in each of these elements since the previous actuarial report.

**Recommendation 7:** We recommend that the analyses now shown in section V and Appendix C of AR21, together with additional commentary on the uncertainty of the

results, be combined in a single section of the first volume to be titled “Uncertainty of Results”.

**Recommendation 8:** We recommend that the Executive Summary include

- a sub-section on “Uncertainty of the Results”, including some sensitivity results and some commentary on the uncertainty of results and the potential volatility of future contribution rates,
- in the main findings, the *direction* of the projected assets/expenditures ratio in the last 20 or so years of the projection period for both the 9.9% contribution rate (e.g., rising) and the 9.8% steady-state rate (e.g., declining slightly), and
- in the assets projection, the projected assets in constant dollars for at least three representative years in the projection period (early, mid and final years).

## SECTION 8 – OTHER ACTUARIAL ISSUES

In this section, we address four other issues that we considered in our review. These are

- the relationship between the Plan’s investment returns and contribution rates,
- the possible use of an advisory panel,
- the reporting structure for the Chief Actuary, and
- the methodology to calculate the steady-state contribution rate.

### **8.1 Relationship Between the Plan’s Investment Returns and Contribution Rates**

As noted in subsection 6.3.3, the CPPIB does not currently establish long-term asset mix targets. Under their current procedures, the asset mix is not targeted; it results from the application of a risk-limiting process that is updated regularly. Under this process, the CPPIB Board of Directors has adopted general policy parameters and annually approves an upper limit on investment risk for the year. CPPIB management invests in accordance with these policy parameters and within the risk limits established by the Board of Directors.

Under this process, risk is measured by comparison to a *reference portfolio*, also called a minimum-risk portfolio. The reference portfolio is designed so that its value will tend to move in tandem with the value of the Plan liabilities (i.e., with the least amount of asset/liability mismatch). The reference portfolio thus entails minimum risk when risk is measured by *the degree to which asset values change in response to a change in liability values*.

The CPPIB has established its reference portfolio returns to be those achieved by the Scotia Capital Real Return Bond Index. Since CPP liabilities are inflation-indexed, the CPPIB has chosen an inflation-indexed reference portfolio.

The focus of the CPPIB’s risk measurement is long-term (10 years or more). The maximum risk level is an asset mix that is not expected to underperform the reference portfolio by more than the approved risk limit more often than one year in ten.

As secondary perspectives, the expected return from the CPP portfolio is measured against the rate of return required for the sustainability of funding of the CPP, and also against two long-term real rate of return targets. The rate of return required for sustainability is variously described in CPPIB materials or by CPPIB management as:

- the Chief Actuary’s best estimate of ultimate future real rate of return (currently 4.1%) (CPPIB, *Measuring Total Portfolio Performance (2002)*, page 1), and

- 4% (the actuary’s assumed rate minus an adjustment to reflect the margin between the 9.9% current contribution rate and the 9.8% steady-state rate) (CPPIB, *Annual Report 2004*, page 7).

The two long-term real rate of return targets are described as:

- the real rate of return bond yield plus 1.6% (CPPIB, *Measuring Total Portfolio Performance (2002)*, page 1), and
- 4.5% (CPPIB, *Annual Report 2004*, page 25).

Current CPPIB practice appears to place primary emphasis on “achieving a maximum rate of return, without undue risk of loss” and on limiting to some degree the asset/liability mismatch risks of the Plan, as indicated in subsection 5(c) of the Act and in sections 7 and 8(3) of the Regulations. For this purpose, the asset/liability mismatch risks are defined by comparison to the return that could have been achieved on the reference portfolio.

Current CPPIB practice does not focus on measuring and managing expected contribution rate levels and volatility (*contribution rate risk*) directly, but rather indirectly through the measurement and management of asset/liability mismatch. However, CPPIB management have advised us that they may consider a direct analysis of contribution rate volatility in the next year or two.

### **8.1.1 Contribution Rate Risks and Volatility**

We think there is much to be gained by conducting a direct analysis of the impact of investment returns on contribution rate movements, including the impacts of both shifts in the long term mean real rate of return and volatility around the mean. This would provide useful insights and measurements that are not available from a measure of asset/liability mismatch alone, and would provide an additional and valuable discipline on the investment process. It would also follow changes in occupational pension plan governance which have evolved along the following continuum:

- focus on managing asset-related risks
- manage assets and liabilities in an integrated fashion
- manage assets, liabilities and contributions in a holistic fashion.

We believe such an analysis should be conducted from both a medium-term (10- to 20-year) perspective and a long-term (75- to 100-year) perspective, using stochastic analysis. It would be useful to employ *high*, *low* and *best* estimates of the expected rates of return

in each case, together with credible estimates of volatility and correlations of returns between asset classes.

Such an analysis need not be conducted as frequently as the current risk-limiting process. It will, however, allow the CPPIB to adjust the risk limits used in the current process so that they relate to contribution rate risk in a meaningful way. In addition to their insight to investment operations, these analyses, and any CPPIB strategic actions that follow from them, would provide useful input to the Chief Actuary in the selection of his assumptions as to the future asset mix of the CPP fund.

There is a theoretical and historical correlation between the investment risks and investment returns of different asset classes, and thus between those investment risks and future CPP contribution rates. Asset classes with greater investment risk are expected to produce higher returns and therefore lower contributions, on average over the long term, but they will also produce greater volatility of returns and contribution rates. This raises the need for a *reasonable balance* between the conflicting desires for

- lower, but more volatile contribution rates, and
- higher, but more stable contribution rates.

We agree that it is necessary for the CPPIB to

- have regard to both the overall rate of return and the risk of loss of the entire portfolio of investments, and
- impose limits on the asset/liability mismatch,

as it does now. We believe it is at least equally important to achieve a reasonable balance between minimizing the long-term average contribution rate and minimizing the volatility of the contribution rates around that average rate. We hope the CPPIB will accord a high priority to implementing policies and procedures that will give at least equal priority to explicitly managing the contribution rate risk.

We believe that Federal and provincial Ministers of Finance will have a strong interest in seeing the progress of the CPPIB on this important matter that will affect all contributors.

### **8.1.2 Rate of Return Required for Sustainability**

We feel the Chief Actuary's best-estimate real rate of return should be driven by his expectation or estimate of the CPPIB's investment policies and practices over the long term and by his expectations of future real rates of return on the various classes of investments. The reverse should not be true; his best estimate is driven *by* investment policy and should *not* then be used to drive investment policy or strategy.

Moreover, to the extent that his best estimate real rate of return is used as a secondary benchmark for expected returns on the portfolio or for other purposes, that best estimate should not be reduced by any funding margins found elsewhere, such as in the contribution rate. Such a margin is a general margin and should be available to offset adverse experience in any and all of the variables that affect the contribution rate (including all nine of the demographic and economic variables described in section 6 of this report). It is not intended as a margin solely against lower than best-estimate real rates of return.

We also note our view, expressed in section 6.3.4, that we would select a best-estimate ultimate real rate of return assumption higher than that selected by the Chief Actuary, in the neighbourhood of 4.6%.

## **8.2 Possible Use of an Advisory Panel**

Past actuarial review panels have recommended that the Chief Actuary establish an advisory panel, consisting of actuaries, demographers and economists, to provide input to him in selecting the actuarial assumptions for the periodic actuarial reviews.

The Chief Actuary has taken two important steps in this regard over the last few years: establishing seminars such as that described in section 2.2.2 of this report and drawing from the advice contained in the report of the actuarial review panel that reviewed the previous actuarial review. Both of these initiatives are useful. Moreover, we think that our Recommendation 3 will help improve the inputs the Chief Actuary receives from the seminars.

We feel, however, that even more improvements can be obtained from the kind of in-depth and highly relevant input that can be provided by a multi-disciplinary group of experts,

- focusing specifically on the key assumptions,
- well prepared for discussion on those assumptions,
- interacting with each other (and debating issues among themselves) face-to-face and by teleconference and e-mail for a suitable period of time, and
- attempting to form a consensus on the whole package of key assumptions.

Such a group can be called an advisory panel or by some less formal title. Whatever they are called, we believe their contribution would be of value to the Chief Actuary. We



believe the Chief Actuary should consider the advice provided by this panel, but should make the final selections of the assumptions himself.

The Chief Actuary already has some interchanges with demographers and economists from inside and outside of government. Perhaps he can build on this base by broadening the participants and adding more structure and inter-disciplinary interaction and debate to the input process. We think there is considerable merit to this idea. We recognize, of course, that it would entail some cost.

**Recommendation 9:** We recommend that the Chief Actuary develop a structured process to obtain inter-disciplinary advice from a group of experts (including actuaries, demographers and economists) who interact with each other and attempt to form consensus recommendations on the whole package of key assumptions.

### **8.3 Reporting Structure for the Chief Actuary**

Past actuarial review panels have recommended that consideration be given to establishing the Office of the Chief Actuary in its own Department separate from OSFI and reporting directly to the Minister of Finance or the Minister of State for Finance.

The AR17 review panel cited the example of the Government Actuary's Department in the UK and noted the financial importance of the Chief Actuary's work (i.e., that the benefit payments under the CPP and OAS programs were projected to exceed 5.6% of gross national product in 2030).

The AR18 review panel noted some of the improvements in organization and management of the OCA (financially self-supporting through fees for services, larger staff, substantial professional independence). It also noted the additional costs associated with the creation and operation of a separate Department. It, nonetheless, held the opinion that a separate Department would be the best solution.

We note the current public interest in the independence and professional integrity of financial professionals, due to the Enron and other highly publicized financial collapses, and the emphasis placed on this topic by the Superintendent of Financial Institutions. The present structure in which the Chief Actuary reports to the Superintendent of Financial Institutions currently achieves very high standards, but it may not always do so, and it does not have the appearance of ensuring the highest degree of professional independence.

The present structure seems to be working well now in terms of professional independence of the Chief Actuary, adequate staffing of the OCA, and the Chief Actuary's direct access to policymakers. That situation, however, could change as a result of organizational change within OSFI or even the appointment of a new Superintendent. We also note that private sector financial institutions have moved, at OSFI's urging, to a situation where financial reporting professionals are appointed and supervised by the board of directors and not by management.

We believe the best assurance of adequate staffing, professional independence, and direct access to policymakers, not just now but also for the long term, lies in a different reporting structure. The reporting structure should both ensure, and appear to ensure, the highest degree of professional independence.

**Recommendation 10:** We recommend that the reporting structure of the Chief Actuary be reviewed, with the goal of ensuring continued excellence in staffing, professional independence and direct access to policymakers.

We have not considered what might be the optimal reporting structure. A parallel to private sector developments would see the Chief Actuary reporting to a board-like entity, such as to Parliament or to a council comprised of the federal Minister of Finance and his provincial counterparts. However, there will be governance aspects and federal-provincial considerations to these and other alternatives that we do not have the expertise to comment on. We are therefore unable to recommend a specific proposal, but believe that an improvement over the present structure is desirable.

We also note that this review could include the reporting structure for other actuarial work now performed by the Office of the Chief Actuary or all actuarial work within the federal government. We have not considered this possible extension to our recommendation, and do not express an opinion on it.

#### **8.4 The Methodology to Calculate the Steady-State Contribution Rate**

The steady-state method used in AR17, AR18 and AR21 follows a procedure set out in the Calculation of Default Contribution Rates Regulation. It compares assets/expenditures ratios 10 and 60 years following the review period (i.e., starting three years after the valuation date, therefore comparing ratios in the years 2016 and 2066 for AR21) and selects the contribution rate which results in the assets/expenditures ratios in those two years being equal.

The choice of the steady-state methodology and the pairing of years used are not items selected by the Chief Actuary. They are prescribed in the Regulation.

Both the steady-state methodology and the particular pairing of years have an element of arbitrariness to them. They produce reasonable results (but not the most stable results possible) at the present time. They will not, however, always do so. It would be useful to examine this issue in the near future, and periodically thereafter.


We note also that the Actuarial Committee of the International Social Security Association is planning to conduct research on the issue of optimal funding of social security programs. The results of that research should provide useful information to policymakers and may give grounds for a review of the Calculation of Default Contribution Rates Regulation.

**Recommendation 11:** We recommend that the Chief Actuary conduct an examination of the continued appropriateness of the steady-state methodology and of the selection of the pairing of years currently set out in the Calculation of Default Contribution Rates Regulation, and publish his findings.

**Recommendation 12:** We recommend that the Chief Actuary keep the Ministers of Finance of Canada and the provinces apprised of research on optimal funding of social security programs.


SIGNATURES

This report is respectfully submitted by,




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