Transport Canada Transports Canada

EVALUATION OF TRANSPORTATION DEVELOPMENT CENTRE'S RAIL RESEARCH AND DEVELOPMENT

Evaluation and Advisory Services

Transport Canada

January 2017

This page intentionally left blank.

Table of Contents

Executive Summary

The evaluation of Transportation Development Centre's (TDC) rail research and development (R&D) was conducted to support decision making and planning within Transport Canada. The evaluation examined Transport Canada support for rail R&D projects, as well as the department's participation in the Rail Research Advisory Board (RRAB), a collaborative rail R&D forum of industry, government and other stakeholders. Transport Canada's rail R&D is managed and coordinated by TDC, the department's central R&D branch located within the Policy Group's Transportation and Economic Analysis directorate.

Evaluation Scope and Approach

The evaluation was conducted between March and June 2015. In accordance with the Treasury Board's Policy on Evaluation the evaluation examined the issues of program relevance and performance. The evaluation focused on rail R&D activities conducted by Transport Canada since 2009, which followed a reconstituted role and governance structure for the RRAB, the development of new RRAB R&D priorities/themes, and additional Transport Canada funding for rail safety announced in Budget 2009.

The evaluation was based on five case studies of R&D projects from different RRAB R&D themes, a review of program documentation and administrative information, and interviews with a sample of RRAB members. A total of 31 stakeholders from Transport Canada and other government organizations, industry, and academia were interviewed or consulted during the conduct of the evaluation.

Major Findings – Relevance

The evaluation found that Transport Canada support for rail R&D remains relevant. There is a continuing need for Transport Canada to support rail R&D to fulfill its regulatory and policy responsibilities. Rail R&D informs the development of regulatory tools, supports Transport Canada's participation in broader government initiatives such as the Clean Air Agenda, and addresses specific recommendations of the Transportation Safety Board, for example. The need for Transport Canada support for, and active participation in, rail sector innovation was emphasized in the 2007 *Railway Safety Act* Review and the 2008 Report of the Standing Committee on Transport, Infrastructure and Communities. The *Railway Safety Act* Review recommended that Transport Canada take a leadership role in advancing rail technology, strengthen its commitment to rail safety R&D, increase its capacity to assess new technologies, and, with industry, fund R&D to address rail safety issues specific to the Canadian operating environment.

While most rail R&D projects examined in the evaluation were aligned with industry and departmental priorities, more could be done to improve this alignment across all projects. While TDC has developed its complement of rail R&D projects through discussions of the RRAB and in consultation with other areas of Transport Canada including Rail Safety directorate, in a few cases R&D projects were not perceived to have targeted critical priorities or were not well-timed to address topics when they were considered a priority. There has been no long-term Transport

Canada rail R&D project plan setting out specific R&D objectives, with projects and timelines aligned to those objectives.

Transport Canada's role in rail R&D is aligned with federal roles and responsibilities, departmental Strategic Outcomes, and departmental and federal priorities. Transport Canada has the legislated authority under the *Railway Safety Act* to conduct R&D to further rail safety and security. Although situated within Transport Canada's Program Alignment Architecture under the Strategic Outcome of an "Efficient Transportation System", TDC's rail R&D activities support all three of the department's Strategic Outcomes, including improving the safety and security and environmental performance of rail. Rail R&D supports Transport Canada priorities, including advancing innovation and technology in the sector, and aligns with broader federal government priorities, including fostering innovation to help sustain Canada's prosperity.

Major Findings – Performance

The evaluation examined the effectiveness of RRAB as a collaborative forum, as well as the results achieved by the R&D projects examined in case studies.

Effectiveness of RRAB as a Collaborative Forum

As a collaborative forum, the RRAB is generally viewed by members as a useful forum for bringing together stakeholders across different areas of the sector, including government, industry, and academia. The RRAB has facilitated interactions that have helped to build collaboration on R&D projects and inform members of what R&D is being undertaken. Overall, composition of the RRAB was felt to generally be appropriate, although continuity of membership and organizational knowledge has been an issue due to the recent number of member retirements.

Potential areas of improvement for the RRAB were noted in the evaluation, including:

- **Ensuring that R&D projects are consistently strategic** and focused on key areas of potential greatest impact through longer-term project planning. Alignment of R&D projects with a longer-term plan for regulatory modernization, for example, would help to further innovation in the sector;
- **Improving communication and linkages with international organizations** in order to leverage international knowledge and ensure R&D projects are targeted to information gaps; and
- **Strengthening knowledge transfer** in order to build interest, awareness and usage of rail R&D projects and their results. This would include strengthening communication with senior managers in industry and government, performance measurement and reporting, and information management.

It was suggested by a few members that the RRAB may be improved through consolidating the two committees into one, which could help to improve coordination and communication.

Other identified potential improvements included strengthening the RRAB's role in informing members of emerging trends in the rail sector at committee meetings, and improving communication between meetings.

R&D Project Results

Transport Canada had led or co-led 71 RRAB projects since 2009, of which 52 had been completed at the time of the evaluation. Most of the projects examined for the evaluation did not experience significant delays or issues related to project completion. A few issues were noted that were outside the control of the department, such as unforeseen technological problems. In one notable exception, however, Transport Canada cancelled a project midway through its conduct due to a lack of available project funding resulting from communication issues within the department, which delayed the development of industry guidelines on the safe conduct of long trains. This issue speaks to the importance of a formal rail R&D plan for the department.

Evaluation case studies examined different types of results achieved through R&D projects, examples of which are provided as follows.

- **Building Knowledge** – R&D projects have generated new information on the safe operation of trains on areas of soft soil, cost-effective methods of maintaining track infrastructure, landslide movement in a critical rail corridor in British Columbia, the prevalence and characteristics of rail suicides in Canada and their impacts on rail crews who witness them, and the safe operation and marshalling of long trains, among other areas.
- **Capacity Building** – R&D projects have helped to build rail engineering and rail R&D capacity in Canada. For example, the Canadian Rail Research Laboratory has involved students in rail R&D projects with industry, established a new graduate-level course in Railway Engineering, and bolstered the University of Alberta's physical R&D infrastructure.
- **Informing Regulatory and Policy Framework** – R&D projects are supporting the development of industry guidelines for the safe conduct of long trains, and new guidelines for risk assessment of rail ground hazards, including landslides and rockslides.
- **Developing, Testing Technology** – Technologies are being developed and tested to improve the efficiency and accuracy of the assessment of track infrastructure and train equipment for maintenance and repair. British Columbia's Ripley landslide, in the Thompson River Valley, has become a major site for testing a variety of monitoring technologies to improve the management of railway ground hazards. This is expected to improve the cost-effectiveness of track maintenance, the reliability and safety of this critical rail corridor, as well as potentially reduce the impact on the environment of the rail lines.
- **Informing Practices** – Examples were identified of R&D informing industry practices. Railways are changing how they monitor railway ground hazards based on their exposure to new technologies demonstrated/tested in the CaRRL and Railway Ground Hazard Research Program projects. Use of new technology for identifying areas of weak track subgrade has begun to influence industry spending plans and to more efficiently target areas most in need of maintenance. A railway used information from the Countermeasures to Reduce Rail Suicides R&D to improve its protocols for assisting staff who witness a rail suicide incident.

Key project success factors identified in the case studies included:

- The high degree of collaboration with a wide range of stakeholders, including sharing of industry infrastructure and data. Project steering committees, for example, were identified as successful means of involving key stakeholders from government and industry in project activities, and ensuring buy-in and knowledge transfer.
- Many projects had successfully leveraged pre-existing expertise, experience, capacity and networks of universities and the National Research Council (NRC) to support the conduct of R&D. Strengthening partnerships with these organizations would appear to be an effective means to continue to build R&D capacity in Canada and to efficiently conduct high-quality R&D.

In terms of projects' weaknesses, a few cases were noted in which projects did not appear to have clearly defined end goals/outcomes, there was a lack of agreement within Transport Canada on R&D funding priorities, and project results were not produced at the optimal time to maximize their impact.

Efficiency

The efficiency of the conduct of rail R&D has been strengthened through considerable in-kind contributions from industry and other stakeholders. Focusing on a smaller number of larger projects, and strengthening partnerships with proven R&D centres of expertise like the NRC and universities, could improve the efficiency of program delivery.

Recommendations

The evaluation includes three recommendations.

Recommendation #1	Transport Canada should strengthen its participation in the RRAB through establishing formal linkages with international counterparts, in order to ensure maximum complementarity and leveraging of rail R&D.
Recommendation #2	Transport Canada, in consultation with the RRAB, should develop and implement a targeted, outcomes-based rail R&D plan, identifying specific information/technology needs, how they will be addressed, timelines, and the specific role for Transport Canada in each R&D project/program.
Recommendation #3	Transport Canada should develop and implement a knowledge management strategy for its rail R&D. This should include improved information management systems, performance reporting, and a strategy for knowledge transfer to senior decision-makers.

Program Profile

Rail Research and Development at Transport Canada

Transportation Development Centre (TDC) is Transport Canada's central research and development (R&D) Branch, located in the Transportation and Economic Analysis directorate of the department's Policy Group. TDC undertakes two primary sets of activities in support of rail R&D: planning and managing rail R&D projects, and participating in the Rail Research Advisory Board (RRAB).

TDC's staff plan rail R&D projects in consultation with the RRAB and other areas within Transport Canada including Rail Safety directorate, and manage project contracts. Rail R&D projects are carried out by other federal organizations (including National Research Council (NRC) and Natural Resources Canada (NRCan)), private consultants, and universities.

Transport Canada actively participates in the RRAB, a collaborative body of industry, government and other stakeholders. Transport Canada participates in and co-chairs the RRAB Management and Technical Committees, provides secretariat support for the RRAB through the TDC, and, with its partners, provides funding for R&D projects discussed at RRAB meetings.

In addition to its project and RRAB activities, TDC supports rail-related decision making and informs policy direction through the provision of scientific and technical evidence.

Rail Research Advisory Board

The RRAB was created by Transport Canada in 1989. According to its Terms of Reference, the purpose of the RRAB is to:

- Optimize collaboration and create synergy in the railway R&D programs of the three performing sectors of industry, government and academia;
- Help mobilize resources and programs to address problem areas and issues of particular relevance in Canada; and
- Facilitate participation by industry and academia in the formulation and implementation of railway-oriented R&D programs by the federal government.

In addition, the RRAB has monitored the implementation of 25 proposals put forward in the final report of the *Rail Safety Act* Review Working Group on Technology to address the recommendations on technology, innovation and R&D stemming from the 2007 *Railway Safety Act* Review.

The RRAB developed eight priorities (later renamed "themes") for rail R&D based on the input of sector stakeholders at a 2007 workshop. This number was reduced to six in January 2014, as two of the themes (Emerging Technologies, and Outreach and Technology Transfer) were deemed to be cross-cutting issues. Several of these R&D themes include research "programs" grouping multiple projects focused on a specific area of study. Table 1 shows the RRAB R&D themes and programs.

Table 1: RRAB R&D Themes, Programs

Theme	Program
1. Grade Crossings and Trespassing	Highway-Railway Grade Crossing Research Program
2. Harsh and Changing Environments	Railway Ground Hazards Research Program
	Winter and Cold Weather Operations
3. Infrastructure	Track Performance and Measures
	Smart Management of Bridge Structures
4. Human Resources	Improving Human Behaviour and Performance in a Culture of Safety
5. Service Efficiency and Capacity	--
6. Energy and Environment	Clean Air Initiative
Research themes discontinued in January 2014:	
7. Emerging Technologies	--
8. Outreach and Technology Transfer	--

Program Resources

Rail R&D activities have been funded through various sources. Budget 2009 allocated funding to Transport Canada for railway safety-related R&D, including for three Full Time Equivalents ($1.8 million) and Other Operating Costs (OOC) funding of $5.5 million over five years (2009-10 to 2013-14) and $750,000 annually ongoing after that period to assess new technologies and facilitate their implementation. Funding has also been provided from other departmental sources, including Transport Canada's R&D Central Fund.

Expenditures for rail R&D totaled $8.9 million for the six-year period from 2009-10 to 2014-15. This included $2.8 million in salaries and $6.1 million in OOC funding for contracts for R&D projects. These expenditures included both the costs of rail R&D projects supported by TDC, as well as Transport Canada's RRAB-related activities including secretariat and planning duties.

Table 2: Transport Canada Expenditures on Rail R&D, 2009-10 and 2014-15, $ millions

	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	Total
Salaries[1]	0.34	0.47	0.36	0.50	0.59	0.57	**2.83**
OOC[2]	1.03	1.08	1.05	0.80	1.02	1.11	**6.08**
Total	**1.37**	**1.55**	**1.41**	**1.3**	**1.60**	**1.68**	**8.91**

[1] Estimate. Includes Employee Benefit Plan.
[2] Other Operating Costs
Table does not include salary and OOC expenditures for R&D under the Clean Transportation Initiative, which included other transportation modes in addition to rail.

About the Evaluation

Evaluation Rationale and Scope

The evaluation of Transportation Development Centre's rail R&D was conducted by Transport Canada's Evaluation and Advisory Services to support decision making and planning within Transport Canada. The evaluation examined Transport Canada support for rail R&D projects, as well as the department's participation in, and contribution to, the RRAB.

The evaluation was conducted between March and June 2015. In accordance with the Treasury Board Policy on Evaluation the evaluation examined the issues of program relevance and performance. The evaluation placed particular emphasis on examining the results of a selection of R&D projects. The evaluation focused on R&D conducted since 2009, which followed a reconstituted role and governance structure for the RRAB, the development of new RRAB R&D priorities/themes, and additional Transport Canada funding for rail safety announced in Budget 2009.

Evaluation Methodology

The evaluation was conducted using primarily a case study approach. This allowed for an in-depth examination of a sample of projects' results along the R&D results chain (i.e., activities completed, outputs produced, short- and medium-term outcomes achieved, and any identified impacts on industry more broadly). Case studies were supplemented by other information on the RRAB from interviews and documents.

More detail on the evaluation methodology is provided below.

- **Case studies** were selected to examine Transport Canada-supported RRAB projects that represent a variety of R&D themes and programs. Five case studies were undertaken, which examined the following R&D:
    - Countermeasures to Reduce Suicides on Railway Rights-of-Way;
    - Ashcroft Thompson River Valley Landslides R&D;
    - The Canadian Rail Research Laboratory (CaRRL);
    - Performance-based Track Geometry R&D; and
    - Long Trains R&D.

  Case studies included a review of project documents/outputs, as well as interviews/consultations with Transport Canada project officers, funding recipients and project steering committee members. In addition, a site visit was undertaken at the University of Alberta for the CaRRL case study.
- An **analysis of administrative and financial data** was conducted to compile information on the number and types of rail R&D projects, and expenditures on rail R&D at Transport Canada.
- A **document review** examined foundational and operational documents, as well as key background/contextual documents of relevance to R&D at Transport Canada. This included RRAB annual reports, reports of the Standing Committee on Transport, Infrastructure and Communities and the *Railway Safety Act* Review, RRAB-related briefing notes and communication materials, and other documents.

- **Interviews** were conducted with Transport Canada staff, managers and with a sample of other members of RRAB outside of the department (in addition to interviews conducted as part of case studies). Interviews were used to collect information on the effectiveness of the RRAB.

Across the case studies and other interviews, a total of 31 stakeholders were consulted and interviewed for the evaluation.

Evaluation Considerations

The following should be taken into consideration in this evaluation:

- There were limited performance measurement data on rail R&D being collected by Transportation Development Centre. At the time of the evaluation, Evaluation and Advisory Services was completing, in consultation with Transportation and Economic Analysis directorate, an R&D Performance Measurement Framework that is expected to inform the development of a Performance Measurement Strategy for rail R&D. This will help to facilitate the future measurement of long-term impacts of R&D.
- Issues were identified during the course of the evaluation with financial reporting within the program, with not all expenditures being charged against the correct R&D projects. As a result, it was not possible to undertake further analysis of, for example, expenditures by RRAB R&D theme/priority.
- While case studies allow for a more in-depth view of specific R&D projects, they do not provide a comprehensive picture of the results achieved by all rail projects supported by TDC.
- R&D can take a long time to achieve its full impact, and some of the R&D projects were ongoing at the time of the evaluation. Additional results and benefits for the sector from the projects are likely to continue to materialize beyond the period examined.

Evaluation Findings: Relevance

To assess the relevance of the TDC's rail R&D activities, the evaluation examined the continuing need for Transport Canada support for rail R&D, as well as alignment of rail R&D with federal roles and responsibilities, departmental strategic outcomes, and federal and departmental priorities.

Continuing Need

Finding 1: There is a continuing need for Transport Canada to support rail R&D to fulfill its regulatory and policy responsibilities.

There is a continuing need for Transport Canada to support rail R&D to fulfill its regulatory and policy responsibilities. For example, TDC undertakes R&D on behalf of Rail Safety directorate in order to collect information needed to support new regulatory tools like guidelines. Rail R&D has also been undertaken to address specific recommendations of the Transportation Safety Board (TSB). For example, R&D conducted under the Railway Ground Hazards Research Program addressed a TSB recommendation, following investigation of a train derailment in the Lévis subdivision,that the department and industry conduct in-depth research to better understand the stability and behavior of track built on soft soils like peat.[1]

Rail R&D also supports Transport Canada participation in broader government initiatives, including, for example, the Clean Air Agenda's Clean Transportation Initiative. Furthermore, R&D activities such as the RRAB help to keep the department informed about broader issues of relevance to its mandate.

Finding 2: The need for Transport Canada support for rail sector innovation was emphasized in the 2007 *Railway Safety Act* Review and the 2008 Report of SCOTIC on Rail Safety in Canada.

The importance of Transport Canada involvement in rail R&D was emphasized in two significant studies of rail safety: the *Railway Safety Act* Review (RSAR), and the 2008 Report of the Standing Committee on Transportation, Infrastructure and Communities. Both reports highlighted the need for Transport Canada to work with industry to further rail safety innovation.

The RSAR was initiated by the Minister of Transport to identify gaps in the *Railway Safety Act*, and to strengthen rail safety following a number of serious train accidents. The report of the RSAR, completed in 2007 by an independent panel, contained four recommendations related to science and technology aimed at Transport Canada. These included that Transport Canada should: take a leadership role in technological and scientific advances that would improve public safety; strengthen its contribution to innovation and technological advancements in railway safety; increase its capacity to assess new technologies and facilitate their implementation; and jointly fund scientific and technological innovation to address rail safety issues specific to the

[1] Transportation Safety Board. Railway Investigation Report R04Q0040. Accessed at: http://www.bst-tsb.gc.ca/eng/rapports-reports/rail/2004/r04q0040/r04q0040.pdf

Canadian operating environment.[2] Transport Canada's roles in rail R&D since the report have aligned with these recommendations. The 2008 Report of the Standing Committee on Transportation, Infrastructure and Communities endorsed the findings and recommendations of the RSAR report and further emphasized the importance of Transport Canada's leadership role in supporting the development and testing of new technologies for improving safety.[3]

The continued importance of the RRAB as a forum for communication between government, industry and academia was noted in evaluation interviews. The RRAB is the major venue in Canada for sharing information on rail R&D priorities and activities in Canada. No other similar forum was noted in the evaluation.

Finding 3: At the project level, rail R&D has generally aligned with industry and departmental priorities—but alignment could be improved to ensure R&D projects are consistently targeted to key information needs.

In order to prevent duplication with other rail R&D internationally, and to ensure that the department is supporting R&D that can have a significant and timely impact, it is important that Transport Canada-funded rail R&D projects are addressing industry/departmental priorities and information gaps.

TDC has supported R&D to address needs and priorities as they are identified through the RRAB committee meetings, and in consultation with other areas of Transport Canada including Rail Safety and Transportation of Dangerous Goods directorates. However, there has been no formal longer-term plan for rail R&D. The RRAB's R&D themes/programs are broad, rather than strategic or focused, and have not been refreshed since 2007. Planning between TDC and Rail Safety has been focused on the short term horizon.

Most of the rail R&D projects examined in the evaluation were seen to be addressing identified priorities and needs. Some R&D projects/programs, including CaRRL and the Railway Ground Hazard Research Program (RGHRP), have undertaken gap analyses and/or consultations to ensure the ongoing relevance of the activities in their specific areas of research. CaRRL and RGHRP are primarily focused on rail R&D relevant to Canada's severe climatic conditions and geo-hazards, which were R&D gaps identified by RRAB that were not being addressed by other North American R&D initiatives such as the Transportation Technology Centre, Inc. and the Association of American Railroads.

Other R&D activities examined respond directly to the proposals set out to address the recommendations of the RSAR, including fostering collaborative R&D within universities through CaRRL. The significant industry engagement in projects like CaRRL speaks to their relevance to the sector.

In some cases, however, R&D projects were not perceived to be addressing critical needs/priorities. R&D on the safe operation of long trains, for example, was completed long

[2] Advisory Panel for the *Railway Safety Act* Review, Stronger Ties: A Shared Commitment to Railway Safety – Review of the *Railway Safety Act*, November 2007.
[3] House of Commons Canada, Report of the Standing Committee on Transport, Infrastructure and Communities on Rail Safety in Canada, May 2008, p. 11.

after this issue was first perceived to be a major priority of industry and the department. Performance-based track geometry (PBTG) standards do not appear to have been a major Transport Canada priority, but R&D was pursued in this area for over a decade.

PBTG projects included a project designed to support the development of an Autonomous Track Geometry Measurement System (ATGMS). It was noted by evaluators that a larger US Federal Railroad Administration ATGMS research program had been underway since 2000, but there was no evidence that the projects explored synergies or leveraged efforts.[4]

Alignment with Federal Roles and Responsibilities, Departmental Strategic Outcomes

Finding 4: Transport Canada has the legislated authority to conduct R&D to further rail safety and security, and rail R&D aligns with Transport Canada's strategic outcomes.

Investment in rail R&D aligns with the department's legislated authority. Section 3.1 of the *Railway Safety Act* indicates that Transport Canada may undertake, and cooperate with persons undertaking, technical research or study to support its rail-related responsibilities.

Rail R&D supports the department's Strategic Outcomes. TDC's activities in support of rail R&D are currently situated under Transport Canada's Strategic Outcome of an Efficient Transportation System (SO #1) in the department's Program Alignment Architecture. The R&D examined in the evaluation contributed to this Strategic Outcome, but also supported the department's Strategic Outcome of Clean Transportation System (SO #2) and a Safe and Secure Transportation System (SO#3). For example, R&D on improvements to track maintenance is intended to reduce the number of train derailments, which would improve transportation efficiency, safety, and environmental performance.

Alignment with Federal Priorities

Finding 5: Rail R&D aligns with federal and departmental priorities.

Transport Canada support for rail R&D is aligned with federal priorities. The importance of federal government support for R&D was emphasized in the 2014 federal Science and Technology Strategy.[5] The Strategy outlined the government's commitment to maintaining science, technology and innovation as key government priorities. Transport Canada support for rail R&D is aligned with the principles set out in the Strategy, including supporting research excellence and encouraging partnerships with industry and academic sectors, a key role of the RRAB.

The alignment of rail R&D with federal priorities was also evidenced in the additional Transport Canada funding for rail R&D announced as part of Budget 2009. Additional resources were provided to help Transport Canada undertake R&D activities to respond to recommendations of

[4] US Department of Transportation – Federal Railroad Administration. Current Projects 2015. Presentation for 2015 TRB Annual Conference. Slide 27. Retrieved at: https://www.fra.dot.gov/Elib/Document/14400.

[5] Government of Canada, Seizing Canada's Moment: Moving Forward in Science, Technology and Innovation 2014.

RSAR and the 2008 Report of the Standing Committee on Transportation, Infrastructure and Communities.

Lastly, the 2011 Speech from the Throne emphasized the importance of rail to Canada's economy, and highlighted federal initiatives to promote rail safety as priorities, which aligns with rail safety R&D. Recent Speeches from the Throne and Budgets have emphasized the importance of innovation, science, and R&D in positioning Canada for future prosperity.[6] Rail R&D activities at TDC align with the federal priority of innovation as a means to sustain Canada's prosperity.

TDC's rail R&D activities are also aligned with Transport Canada departmental priorities, as outlined in the department's 2014-15 Integrated Business Plan. Rail R&D supports the priorities of advancing innovation and technology deployment in the sector, and continuing to modernize and strengthen the regulatory and oversight framework.[7]

[6] See, for example, the Speech from the Throne 2013 and 2011, and Budget Plan 2012.
[7] Transport Canada, Integrated Business Plan 2014-15.

Evaluation Findings: Performance – Effectiveness

The evaluation examined the effectiveness of RRAB as a collaborative forum, as well as the results achieved by the case study R&D projects.

Effectiveness of RRAB as a Collaborative Forum

Finding 6: **The RRAB has helped to facilitate interactions and build collaboration between government, industry and other stakeholders.**

Some areas for improvement were identified, including ensuring that R&D projects were consistently strategic such as through better alignment of R&D to regulatory modernization, improving communication and linkages with international organizations, and strengthening knowledge transfer.

The RRAB is generally viewed by members as a useful forum for interaction and collaboration-building between different areas of the sector (government, industry, academia), and between different companies within industry. Those interviewed for the evaluation generally felt that the membership of the RRAB Management and Technical Committees included relevant organizations, and that the committee meetings had helped to foster relationship-building, collaboration, and coordination of R&D activities among members.

Some areas of potential improvement for the RRAB were noted in interviews. First, it was suggested that additional effort could be made in ensuring that R&D projects are consistently strategic and that the complement of projects is focused on key areas where impacts are likely to be greatest. Some RRAB members felt that projects were taking on too many topics and not focusing only on those specific areas where Canadian R&D could have a demonstrable impact.

Related to this point, it was suggested that Transport Canada could better align R&D with regulatory modernization. For example, where technology has made it feasible to make a regulatory change, Transport Canada could define the information needed to support a change, and industry could lead the collection of this information. This would require strategic communication and planning between TDC and other areas within Transport Canada, including Rail Safety and Transportation of Dangerous Goods directorates, to establish priorities and timelines for regulatory modernization and to align R&D results to this work over a long planning horizon (i.e., 10 years).[8]

Second, communication and linkages with international organizations could be improved in order to consistently leverage international knowledge and ensure that R&D projects are targeted to information gaps. There is some linkage with international groups on R&D, but this could be deepened and expanded. For example, TDC developed a Memorandum of Cooperation with the US Federal Railroad Administration (FRA)—which has funded approximately $35 million a year in rail R&D—but a specific path forward for sharing and collaborating with FRA was still a

[8] One of the activities assigned by the Technology Working Group of the *Rail Safety Act* Review to the Rail Safety directorate was to review the rail regulatory framework to identify areas that could potentially be updated to facilitate innovation. At the time of the evaluation, this had not been completed.

work in progress at the time of the evaluation.[9] There was no formal mechanism or any significant relationship with European counterparts noted. Strengthening these relationships was a recommendation following the RSAR that was not completely addressed.

Third, strengthening knowledge transfer would help to build interest, awareness and uptake of rail R&D projects and their results. One component of this would be strengthening the dissemination of information and results achieved by R&D projects with senior managers in industry and government in order to built interest, buy-in and knowledge transfer. In addition, the need for more effective management of information on projects and their results was noted.

Weaknesses in knowledge transfer were exacerbated by the lack of formal performance measurement for the RRAB. While 11 performance measures were adopted by the RRAB following its reconstitution in 2009, no data were collected for these measures. In 2012, the RRAB Management Committee did recommend use of a new approach to project management, in which expected results are defined at the front end of a project and R&D planners and performers are held responsible for achieving measurable results. This is similar to the approach being implemented in the US by the FRA, which is working to make performance measurement and evaluation integral to the R&D program lifecycle by building evaluation methods into R&D from the start.[10] This includes developing and implementing written guidelines for incorporating the collection of performance information into contracts and grants. This type of results-based approach would strengthen knowledge transfer through increasing the availability of information on results achieved. TDC would be well advised to set out performance reporting requirements in all future rail R&D funding agreements.

At the time of the evaluation, work was also being undertaken by Transport Canada's Evaluation and Advisory Services on the development of a Performance Measurement Framework for R&D. This work is expected to inform the development, with TDC, of a PM Strategy for rail R&D.

It was also suggested by a few members that combining the RRAB Management Committee and Technical Committees could potentially improve the RRAB, as a single committee would make communication and decision-making more efficient, and could improve cross-pollination of ideas across different types of members. This could also help to simplify more communication between meetings, which was suggested as a way to help sustain momentum for RRAB activities.

Other suggestions for improving the RRAB included:

- RRAB's role in identifying and informing members of emerging trends in the rail sector could be strengthened. Some members noted that more emphasis on bringing in outside speakers to present or discuss current and emerging issues would strengthen the meetings and promote strategic thinking.

[9] US Department of Transportation – Federal Railroad Administration – Office of Research and Development. Research and Development Strategic Plan, May 2013.
[10] US Department of Transportation – Federal Railroad Administration – Office of Research and Development, Research and Development Strategic Plan, May 2013.

- Bolstering the rail-related knowledge and capacity of Transport Canada RRAB members would ensure that members are able to fully and effectively contribute to the RRAB.

Finding 7: Transport Canada, and the RRAB, should conclude its monitoring of activities being undertaken to address the recommendations of the *Railway Safety Act* Review.

TDC, with the RRAB, has responsibility for monitoring progress of the proposals to address the recommendations of the *Railway Safety Act* Review set out in 2009 by the RSAR Working Group on Technology. Given that these proposals were, at the time of the evaluation, six years old, and all proposals were expected to be implemented by the end of March 2011, it may be appropriate to produce a final status report on their implementation, including reasons for any proposals not implemented as recommended, and end monitoring activities.

As of summer 2015, 14 of the 24 proposals requiring action by Transport Canada (either in conjunction with industry or alone) were deemed to have been completed, while 10 were considered ongoing or not undertaken. Actions completed included providing long-term, dedicated funding for rail safety R&D, involving universities in collaborative research and related educational initiatives, and establishing a rail research laboratory in Canada, among others. Annex A provides more information on the status of the proposals.

R&D Project Results

Effectiveness of R&D projects was assessed in case studies by examining the achievement of expected outcomes, including:

- Completed Projects;
- Building knowledge;
- Capacity building;
- Informing Transport Canada's regulatory and policy framework;
- Developing and/or testing technology; and
- Informing practices.

Results in these areas are discussed in the following sections.

Finding 8: Since 2009, RRAB had undertaken 74 R&D projects, 52 of which were completed at the time of the evaluation.

Since 2009 the RRAB has undertaken 74 rail R&D projects. Of these, Transport Canada led or co-led 71 projects, with the Railway Association of Canada leading the remaining three. Two of the 71 were terminated/cancelled, while the rest were ongoing or completed at the time of the evaluation. In addition to these projects, TDC has undertaken 57 rail-related projects under the Clean Transportation Initiative, 38 of which have been completed. Table 3 shows the number of projects and number of completed projects, by RRAB R&D theme and research program.

The Highway-Railway Grade Crossing Research Program had the largest number of projects, with 16 projects, followed by the Railway Ground Hazard Research Program (RGHRP), with 14. The Highway-Railway Grade Crossing Research Program undertook a series of projects that

examined the causes and behaviours related to road-railway grade crossings and trespassing, as well as projects examining engineering countermeasures.

The RGHRP is a collaborative initiative to develop and evaluate scientific and technical solutions to help railways manage the risks associated with ground hazards, which include rock falls, landslides, erosion, snow and ice, and other ground hazards. The initiative, which began in 2003 and is directed and coordinated by professors of engineering at the University of Alberta and Queen's University, was undertaking projects examining the causes of ground hazards, developing guidelines to help railways to assess and manage the risks, and identifying and developing technologies to mitigate the hazards.

Table 3: TDC Rail-Related Projects, 2009-10 to 2014-15

Theme	Program	# of Projects	# of Completed Projects
Crossings and Trespassing	Highway-Railway Grade Crossing Research Program	16	11
Harsh and Changing Environment	Railway Ground Hazard Research Program	14	7
	Winter and Cold Weather Operations	5	2
Infrastructure	Track Performance and Measures	12	10
Human Resources	Improving Human Behaviour and Performance in a Culture of Safety	3	1
Service Efficiency and Capacity		12	9
Energy and Environment		8	8
Outreach and Technology Transfer (former theme)		4	4
	Total RRAB-related Projects	**74**	**52**
Clean Transportation Initiative rail projects		57	38
	Grand Total	**131**	**90**

Finding 9: Issues related to project completion have, for the most part, been outside the control of TDC.

Most of the projects examined in evaluation case studies did not experience significant delays or issues related to completion. Some issues were noted that were outside of the control of TDC, including:

- As part of CaRRL projects, delays had been experienced related to the use of MRail Technology, developed at the University of Nebraska, that detects areas of large vertical track deflection that are indicative of weak substructure. This technology is designed to

help railway identify areas in need of track maintenance in an economical manner, thus improving maintenance efficiency and track safety. Delays were experienced due to equipment being damaged, as well as the technology not being readily compatible for use in Canada.

- Data issues were also experienced in a PBTG project that was undertaken In order to compare the use of Instrumented Wheel Sets Technology—which provides data on wheel-rail contact forces—with a commercial Vehicle-Track Interaction (VTI) system, for track performance monitoring. There was uncertainty over the reliability of track data obtained from outside Canada and, in the end, no conclusions could be derived from the project.

In one case study (long trains R&D), Transport Canada cancelled a project (and contract) midway through its conduct due to a lack of available funding resulting from communication issues and changing priorities within the department. This delayed the development of guidelines on long trains. This issue again speaks to the importance of a formal rail R&D plan for the department.

Building Knowledge

Finding 10: Rail R&D has helped to build a body of new information on a variety of subjects, including train operations, track maintenance, ground hazards, rail suicides and others.

The evaluation case studies provided examples of new information being generated from rail R&D projects.

Canadian Rail Research Laboratory
• CaRRL had begun to generate findings on the safe operation of trains on areas of soft soils. Research suggested that rail built on areas of peat (such as in Northern Alberta) can, when well maintained, sustain heavy trains at current axle loads, speeds and volumes. This R&D was conducted following a recommendation of the TSB to conduct this research after a Levis subdivisions derailment. As a result of the R&D, the recommendation was deemed to have been satisfactorily addressed in 2012. • CaRRL has generated information on cost-effective and safe track infrastructure, including ballasts (the trackbed on which railway track ties are laid). R&D examined the types of material to use for effective ballast, in order to reduce maintenance costs and to improve safety. The R&D showed that ballast degradation does not appear to be correlated with track performance. The R&D was also examining how degraded ballast was causing frost heaves that were creating hazardous bumps in tracks. • Other areas being examined included: hazards posed by tunnel icing, and methods to limit these safety hazards; cold weather reliability of air brakes; rail steel toughness/behavior in cold weather; rolling contact fatigue/wheel life; and system optimization studies (locomotive failure models, analysis/modeling of train blocking).
Ashcroft Thompson River Valley Landslide R&D
• The Ashcroft Thompson River Valley Landslide R&D has furthered understanding of the factors influencing landslides in a critical rail corridor linking the Prairies with Pacific ports. This information is important to Canadian National (CN) and Canadian Pacific (CP)

Railways, both of which have mainlines that are vulnerable to the valley's shifting landslides. Previous to this research, information about the landslides was piecemeal and incomplete, and there was no coordinated R&D initiative examining this ground hazard in this area. • As an initial step, the project compiled all available information on the area's landslides, and identified information gaps. An initial hypothesis on the main factors influencing landslide movement was then developed, which factored in the level of the river, the level of the groundwater, and the complex geology of the region. • At the time of the evaluation, this hypothesis was being validated through monitoring activities on the area's Ripley Slide. A correlation was identified between level of snow pack and landslide activity, which is expected to help railways with planning.
Countermeasures to Reduce Suicides on Railway Rights-of-Way
• The Countermeasures to Reduce Suicides on Railway Rights-of-Way project provided the first comprehensive body of information on the prevalence and characteristics of rail suicides in Canada, which has helped Transport Canada to better understand trespassing and rail safety. Information from this project is expected to inform the future development of new regulations on railway rights-of-way access control and trespassing. • The project did not, however, test a rail suicide countermeasure, as originally planned. Interviews indicated that this was because potential interventions identified through a review of practices in other jurisdictions did not appear to be financially feasible due to the high cost of the interventions and the lack of specific "hot spots" in Canada where rail suicides were prevalent.
Long Trains R&D
• Long trains R&D has provided information on effective and safe operation and marshalling of long trains. The long trains R&D provided industry with information on track superelevation, the adequacy of train power, and the potential benefit of using distributed power, with specific recommendations for CN and CP with respect to specific subdivisions.
Performance-based Track Geometry
• PBTG projects have confirmed that vehicle performance measures (i.e., on vehicle-track interaction) can be useful in identifying areas of track requiring maintenance and have been shown to be potentially more accurate than traditional methods based on track geometry.

Finding 11: New information from R&D projects have been disseminated through various means, including steering committees, new websites and other venues. Universities were particularly active in knowledge dissemination in the projects examined.

R&D project results have been disseminated through RRAB meetings and project-level steering committees. In addition, other activities have been undertaken aimed at wider dissemination:

- Websites –CaRRL and the RGHRP have had a website (www.carrl.ca) that Transport Canada has supported. A "Railway Suicide Prevention and Reduction of Negative Consequences" website was also developed as part of the Countermeasures to Reduce

Suicides on Railway Rights-of-Way project (www.railwaysuicideprevention.com). According to the University of Quebec at Montreal (UQAM) there were 1,802 users of the website in 2014.

- Publications, presentations – For example, at the time of the evaluation, CaRRL R&D had been shared by researchers through three journal articles, ten conference publications, 12 technical reports/theses, 22 conference posters, and nine special/invited presentations.
- Other events and forums – Examples of the use of other forums were identified. For example, the findings on rail suicide were presented by UQAM researchers at a workshop at the International Railway Safety Conference in Vancouver in 2013.

Overall, dissemination of research findings was more evident in R&D projects that were conducted by universities. These professors have access to networks (of experts in their fields, such as mechanical engineering) through academic journals and conferences, experience undertaking knowledge dissemination, and are motivated to undertake these types of activities.

Capacity Building

Case studies identified examples of capacity building resulting from R&D projects. Most significantly, this included the results of the CaRRL.

Finding 12: CaRRL has built capacity in rail-related engineering and R&D infrastructure capacity.

CaRRL was designed to help address the critical capacity gaps in the rail sector. At the time of evaluation, there were six PhDs, seven Master's students, three undergraduates, three post-doctoral students, and two visiting graduate students involved in CaRRL R&D. The program had also graduated four Master of Engineering students and one PhD. Through its relationships with industry, CaRRL had facilitated students getting training in "real-world" situations through fieldwork. While CaRRL had slower than anticipated recruitment results for graduates students, and was, instead, focusing on recruiting undergraduates who may continue on to graduate studies.

In addition, CaRRL established a new graduate course in Railway Engineering at the University of Alberta. The first offering was Winter 2013. The 2015 offering was cancelled due to low enrolment. CaRRL students have established a student chapter of AREMA (American Railway Engineering and Maintenance-of-Way Association) at the University of Alberta, which encourages students to pursue rail engineering education and careers in the railway industry through field trips, professional development seminars and other networking opportunities. At the time of the evaluation, railways had hired one CaRRL graduate, and consultants working with the railway industry have hired three.

CaRRL has also built rail R&D infrastructure capacity. CaRRL has a dedicated laboratory space inside the Natural Resources Engineering Facility at the University of Alberta, which includes cold room facilities, and has expanded the equipment available for rail R&D, including new abrasion testing equipment and shear boxes for studying ballast, and ShapeAccelArray/measurand monitoring equipment.

Informing Regulatory and Policy Framework

Finding 13: Rail R&D has informed Transport Canada's regulatory framework.

A key objective of the R&D conducted within Transport Canada, across all modes, is to gather information to support Transport Canada's regulatory framework, including regulations, rules, codes, standards, and guidelines. The projects examined in the evaluation demonstrated examples of R&D being used to develop new guidelines to provide industry with guidance on specific safety topics.

R&D on long trains is informing the development of new guidelines for the safe conduct of long trains, the first such guidelines in North America. A draft of the guidelines was being finalized by the project steering committee at the time of the evaluation. The guidelines are based on research undertaken for TDC by NRC. The development of the guidelines followed a series of derailments in the early 2000s, and the TSB Watchlist that called on railways to take further steps to ensure appropriate handling and marshalling of longer, heavier trains. The guidelines outline Transport Canada's expectation with respect to long trains, and are designed to help railways with marshalling and handling of long trains.

In addition, the Ashcroft Thompson River Valley Landslide R&D, with other RGHRP R&D, will inform the development of new Guidelines for Geohazard Risk Assessment along Canadian Railways, expected to be completed in 2016. These guidelines will provide frontline rail staff information and tools to understand ground hazard risks, monitor risks, and make operational decisions based on these risks.

In some cases, R&D projects did not appear to be well aligned with regulatory priorities within Transport Canada—such as the case with the PBTG-related R&D—or projects were not well timed to facilitate the development of new regulatory tools when they would be most useful, such as in the case of the long trains R&D. RRAB members also noted that Transport Canada could have better aligned R&D projects and regulatory modernization in areas such as Automated Train Brake Effectiveness (ATBE) testing, which could have significant efficiency benefits if applied across the industry.

Developing, Testing Technology

Finding 14: Technologies are being developed or tested to improve the efficiency and accuracy of assessing track infrastructure and train equipment.

Case studies demonstrated several examples of R&D projects developing/testing technologies. These included technologies for improving railways' assessment of track and train equipment, and other new technologies.

Track Assessment Technology
• Testing new technology (MRail) to determine the location and extent of soft soils below tracks—which have an increased risk of shifting, particularly as trains get heavier (CaRRL/RGHRP)—as well as evaluating the effectiveness of different remedial methods to upgrade tracks on sections of soft subgrade (CaRRL) • New method for testing the toughness of rail steels in an economical/efficient manner to improve winter operability and reduce costs of maintenance (CaRRL) • New railway track reliability index being developed, which is expected to help minimize failures and service disruptions (CaRRL) • Development of a platform for analysing track condition (geometry) with minimal human effort (autonomous track geometry measurement systems (ATGMS)) (PBTG R&D)
Train Assessment Technology
• Adapting and testing the use of ultrasonic detectors for detecting leaks in locomotive air brakes, currently used for detecting leaks in pipelines. This was being tested with industry, and was felt to have significant potential to increase maintenance efficiencies for industry. (CaRRL) • Testing the reliability of technology to detect wheel temperature (CaRRL) • Developing predictive models of locomotive and car failure to help railways make more efficient maintenance decisions (CaRRL)
Other Technology
• New modeling and research to better understand and predict rock falls, which is expected to reduce the frequency of railway operational delays for railways (CaRRL) • Advanced techniques for network routing, railway blocking and train scheduling (CaRRL) • New risk tolerance strategy for railway operations being developed – including ground hazards, ballast, subgrade, rail, tiles, etc. (CaRRL) • Several people indicated that the brake testing tools being tested are promising – testing of CP's Automated Train Brake Effectiveness, as well as CaRRL's air brake problem detection project were ongoing at the time of the evaluation.

Finding 15: Ashcroft Thompson River Valley's Ripley Slide has become a major site testing/demonstrating a variety of monitoring technologies to better manage ground hazards.

Through the RRAB R&D projects, Ashcroft Thompson River Valley's Ripley Slide has developed into a major rail ground hazards test site. Through the participation of the project partners, a variety of monitoring technologies are being tested and demonstrated to better manage ground hazards, at this site and others.

Technologies have included Radar satellite imagery (using corner reflectors and RADARSAT II), global positioning (GPS), ShapeAccelArray / measurand monitoring (i.e., the use of boreholes), fibre optical measurement, geological mapping, geophysical surveys and field observations.

At the time of the evaluation, the project had provided its members new insights into the effectiveness of different types of monitoring for landslides. For example, it was noted that the use of fibre optics had not been as effective for monitoring landslides as it had been for pipelines. The project also demonstrated the benefits of using radar satellite imagery to measure movement of landslide, and of ShapeAccelArray / measurand to monitor movements below the ground.

Informing Practices

Finding 16: Case studies demonstrated examples of ways that R&D has informed industry practices.

Some examples of R&D case study projects having an impact on industry practices were noted in case studies, including:

- A railway used information from the Countermeasures to Reduce Rail Suicides R&D project to improve its protocols for staff who witness a rail suicide incident. In addition, a subsequent R&D project was undertaken by UQAM, industry and a labour organization, following this project, to evaluate the effectiveness of interventions to assist rail crews who witness suicide incidents.
- Railway companies were changing how they monitor railway ground hazards based on exposure to new technologies demonstrated/tested through RGHRP and CaRRL projects. For example, railways planned to make more use of GPS and satellite imagery for monitoring landslides beyond the Ripley Slide. Railways have begun using different change detection technologies (photogrammetry, Lidar) that were tested as part of the RGHRP to monitor rockslides.
- Use of new technology (MRail) for identifying areas of weak track subgrade had begun to influence industry capital spending plans and to more efficiently target areas most in need of maintenance. Weak subgrade is a major cause of slow orders, which impede the efficiency of railways.

Interviewees from industry also identified examples of technologies and practices developed through the Rail Ground Hazard Research Program that had been put into practice, including a precipitation index to gauge the potential for landslides based on precipitation, and a seismic rockfall detection system.

Performance – R&D Project Success Factors and Barriers/Weaknesses

The evaluation identified project success factors, as well as barriers to project success.

Finding 17: Identified factors in the success of R&D projects included strong collaboration across sectors, and leveraging of pre-existing expertise, experience and capacity of universities and the National Research Council.

Two major success factors were evident across the R&D projects examined in case studies. First,

R&D projects benefited from strong collaboration and the participation of a wide range of stakeholders. All projects examined included strong cross-sectoral input and communication on projects, sharing of information and, in many cases, sharing of infrastructure and data. Stakeholders are involved in project conceptualization through the RRAB, and in project implementation through project-level steering committees, which has also facilitated knowledge transfer, as expected users of project results are involved throughout the project's lifecycle.

Secondly, many projects have benefited from the leveraging of the pre-existing expertise, experience, capacity and networks of universities and NRC's Centre for Surface Transportation. NRC was also perceived as having effectively managed the conduct of potentially sensitive R&D projects in a way that showed an understanding of the needs of Transport Canada as regulator, while having the methodological rigour and objectivity required and trusted by industry. In the case of the University of Alberta and UQAM, both universities had demonstrated their ability to undertake rail research that is well received by industry, partly due to the capacity and experience that already existed in those places.

Finding 18: The evaluation identified barriers/weaknesses to RRAB R&D project success.

Some barriers to project success, or project weaknesses, were also noted in the case studies. These included:

- *Some R&D was not clearly linked to defined end goals/outcomes.* For example, it was not clear what the outcome of R&D research on PBTG technologies and standards was, and there appeared to be no shared understanding between industry and Transport Canada on the final goal for this R&D.
- *Some R&D results materialized after they could have maximum impact.* As noted, stakeholders indicated that some products developed, including the long trains guidelines were being produced long after they could have a maximum impact.
- *Shifting priorities or lack of agreement on R&D funding priorities within Transport Canada.* As noted, some projects lacked shared understanding and buy-in across different areas of the department, which, as previously noted, resulted in one project being cancelled mid-way through its conduct.

Evaluation Findings: Performance – Efficiency/Economy

The following section presents findings related to efficiency/economy of the rail R&D.

Finding 19: The efficiency of the conduct of rail R&D has been strengthened through considerable in-kind contributions from industry and other stakeholders.

As shown in Table 4, RRAB projects have included significant contribution from industry, other government organizations, academia and international partners. Based on information provided by industry for RRAB annual reporting, industry provided $1.8 million in in-kind resources for RRAB projects, as well as $1.9 million in cash contribution, from 2009-10 to 2013-14.

Table 4: RRAB Expenditures, 2009-10 to 2013-14, $ millions

Organization	Cash	In-Kind
Transport Canada	4.97	0.25
Industry	1.93	1.83
Other Government	2.71	0.62
Academia	0.05	0.31
International	0.82	0.75
Total	**10.48**	**3.76**

Source: Cash expenditures for Transport Canada from Transport Canada financial information. All other expenditures from RRAB annual reports.

Projects have benefited from industry expertise, time, funding, infrastructure, and the provision of data and information. For CaRRL, for example, in-kind industry contributions estimated at $400,000 from 2012-15 have included:

- Railway staff time for meetings, workshops;
- Staff time for data collection, site visits, training of HQP, technical advice, and consultations;
- Provision of steel samples;
- Data collection on track deflection measurement, ground penetrating radar;
- Access to rail lines for ballast samples; and
- Students situated at CN and CP offices.

Finding 20: TDC has managed a large number of projects and funding agreements relative to its rail R&D budget. Focusing on a smaller number of larger projects, and strengthening partnerships with proven R&D centres of expertise like the NRC and universities, could improve the efficiency of program delivery.

TDC has managed a large complement of rail projects, each with contract administration responsibilities. As previously noted, TDC has led or co-led 71 projects since 2009 related to rail, not including those undertaken for the Clean Transportation Initiative.

Focusing on a smaller number of larger projects, and fewer funding agreements, could increase program delivery efficiency, and allow TDC members to focus more effort on more value-added roles—such as knowledge transfer, and identifying and informing stakeholders of emerging themes and opportunities—rather than administering contracts. This would be more aligned with the role of a policy branch.

The case studies demonstrated the significant, and growing, rail-related R&D capacity and expertise available at NRC and select universities. Deepening partnerships with the NRC and universities in the conduct of R&D could help to improve program delivery efficiency going forward.

Conclusions and Recommendations

Transport Canada support for rail R&D remains relevant. There is a continuing need for Transport Canada to support rail R&D to fulfill its regulatory and policy responsibilities. The need for Transport Canada support for, and active participation in, rail sector innovation was emphasized in the *Railway Safety Act* Review and the 2008 Report of the Standing Committee on Transport, Infrastructure and Communities. Transport Canada could improve the relevance of its rail R&D program by ensuring it is consistently targeted to key information gaps and priorities, including regulatory modernization.

Transport Canada support for rail R&D is aligned with federal roles and responsibilities, and federal and departmental priorities. Although situated within Transport Canada's Program Alignment Architecture under the Strategic Outcome (SO) of an "Efficient Transportation System" (SO #1), TDC's rail R&D activities support all three of the department's Strategic Outcomes.

The RRAB is a useful forum for bringing together stakeholders across different areas of the sector, including government, industry, and academia, and between different companies within industry. Some areas of potential improvement of the RRAB were noted, including bringing more strategic focus to the R&D program, improving linkages with international organizations, and strengthening knowledge transfer. It was also suggested that reducing the number of committees from two to one could strengthen communication and coordination.

Since 2009, Transport Canada led or co-led 71 projects as part of the RRAB, 52 of which were completed at the time of the evaluation. Most of the projects examined did not experience significant delays or issues related to project completion. The case studies identified a range of different types of results achieved, including new knowledge and R&D capacity, new regulatory guidelines, new technologies tested or developed, and changes to industry practices.

Key R&D project success factors included the high degree of stakeholder collaboration, as well as the leveraging of the pre-existing expertise, experience, capacity and networks of universities and the NRC to support the conduct and knowledge transfer of R&D. In terms of project weaknesses, some cases were noted in which R&D did not appear to have clearly defined end goals/outcomes, there was a lack of agreement within Transport Canada on R&D funding priorities, and project results were not produced at the optimal time to maximize their impact.

The efficiency of the conduct of rail R&D has been strengthened through considerable in-kind contributions from industry and other stakeholder. Focusing on a smaller number of larger projects, and strengthening partnerships with proven R&D centres of expertise like the NRC and universities, could improve the efficiency of program delivery.

The evaluation includes the following three recommendations:

Recommendation #1 Transport Canada should strengthen its participation in the RRAB through establishing formal linkages with international counterparts, in order to ensure maximum complementarity and leveraging of rail R&D.

Recommendation #2	Transport Canada, in consultation with the RRAB, should develop and implement a targeted, outcomes-based rail R&D plan, identifying specific information/technology needs, how they will be addressed, timelines, and the specific role for Transport Canada in each R&D project/program.
Recommendation #3	Transport Canada should develop and implement a knowledge management strategy for its rail R&D. This should include improved information management systems, performance reporting, and a strategy for knowledge transfer to senior decision-makers.

Management Action Plan

#	Recommendations	Proposed Actions	Forecast Completion Date	OPI
1	Transport Canada should strengthen its participation in the RRAB through establishing formal linkages with international counterparts, in order to ensure maximum complementarity and leveraging of rail R&D	A. **<u>Collaboration Agreement with US-DOT</u>**: ACAF will explore opportunities for a formal collaboration agreement for rail R&D initiatives between Transport Canada (TC) (primarily Transportation and Economic Analysis (TEA) and the Transportation of Dangerous Goods (TDG) directorate) and the United States Department of Transportation (US-DOT) (primarily the Federal Railroad Administration (FRA), Pipeline and Hazardous Material Safety Administration (PHMSA), and VOLPE) - the agreement would likely form part of a larger Canada-US dialogue and joint partnership on RAIL (planned for FY 2016-17), and would build on the existing Memorandum of Cooperation (MOC) between TC and the FRA. The sub-actions below will be completed:	*Completed*	Policy
		A.1. Create **<u>an inventory of existing collaborative rail R&D initiatives</u>** between TC (TEA/TDG) and the US-DOT (FRA/PHMSA/VOLPE): Primary outcome - a list of *working-level* collaborations - projects, committees, working groups, etc. (limited *institutional-level* initiatives currently in place)	Completed	Policy
		A.2. Investigate **<u>areas of mutual interest in rail R&D</u>** between TC (TEA/TDG) and US-DOT (FRA/PHMSA/VOLPE): Phase 1 - identify priority areas of rail R&D for TC and the US-DOT; Phase 2 - establish common priority areas/themes of rail R&D between TC and the US-DOT; Phase 3 - outline a plan to ensure maximum rail R&D synergy (e.g., minimizing duplicative efforts; implementing collaborative projects; increasing resource sharing, etc.)	November 2017	Policy

#	Recommendations	Proposed Actions	Forecast Completion Date	OPI
		A.3. Develop a **<u>communication plan</u>** to support the realization of a formal collaboration agreement for rail R&D between TC (TEA/TDG) and US-DOT (FRA/PHMSA/VOLPE): Establish regular management- and working-level meetings between TC and US-DOT, and encourage the use of the RRAB as a forum for discussion, prioritization, synergy, and engagement	Completed	Policy
2	Transport Canada, in consultation with the RRAB, should develop and implement a targeted, outcomes-based rail R&D plan, identifying specific information/technology needs, how they will be addressed, timelines, and the specific role for Transport Canada in each R&D project/program	B. **<u>Revitalize the RRAB</u>**: TC, in consultation with the RRAB, is leading an effort to re-focus the RRAB in order to address new challenges facing the rail sector, such as financing, lifecycle of infrastructure, institutional changes, energy consumption, changing climate, and safety and security. The following RRAB activities will be completed: • The RRAB will build on its existing research and industry expertise and to address these challenges and move towards providing opportunities for innovation in the sector. • Project development and partnerships for the future will focus on concrete, actionable objectives, and a medium- to long-term outlook, as opposed to supporting short- to medium-term operational needs. • The key objectives of the re-focused RRAB will be to improve the forward-looking capacity of the rail sector; enhance technology uptake and dissemination; and target specific partnerships and collaboration. • TC will continue to engage with government, the research community, and industry to broaden the participation of the RRAB and to foster better engagement with key strategic partners.	*Completed*	Policy

#	Recommendations	Proposed Actions	Forecast Completion Date	OPI
		B.1 **Strategic Plan:** TC is leading the development of a 3 to 5 year research, development and deployment (RD&D) strategy focused on improving efficiency, safety, security, and sustainability for the rail sector. The strategic plan will be completed, and will include the following: • An annual implementation plan that highlights priority research areas. Through consultations with RRAB members, specific information and technology R&D needs have been identified for: human factors and operations, inspection and detection enhancements and new and emerging technologies that could reduce the risk of derailments, improve winter operations and enhance network capacity and resiliency. TC will contribute funding, play a key role in coordinating research activities, and ensure timely dissemination of results. • A robust project evaluation process with criteria to ensure clearly defined goals and outcomes, strategic alignment with priorities and likelihood of success.	Completed	Policy
3	Transport Canada should develop and implement a knowledge management strategy for its rail R&D. This should include improved information management systems, performance reporting, and a strategy for knowledge transfer to senior decision-makers	C.1 **Information Repository:** ACAF (in consultation with IM/IT) will develop a repository to capture information on all rail R&D projects, including performance measurement data. • The data collected will be chosen based on the results of the R&D Performance Measurement Framework. This will help facilitate the measurement of long-term impacts of R&D. Incorporate the collection of performance measurement data into research (or R&D) contracts so the information can be collected for a period of time after the transportation-related technology has been developed. • Provide annual updates on the performance of transportation-related technologies developed with TC funding. • Create a working group to define business requirements for the information repository.	June 2018	Policy and Corporate Services

#	Recommendations	Proposed Actions	Forecast Completion Date	OPI
		C.2 **"<u>Open" On-line Collaboration Tool</u>**: ACAF (in consultation with IM/IT) will leverage existing resources to create an on-line collaboration platform regarding rail R&D. • The platform will allow public and private sector members to share ideas, documents, and promote dialogue to focus the R&D program to meet the needs of its community. Furthermore, on-line project summary bulletins will be produced for each project to disseminate project information and results to decision makers. • The goal is to raise awareness on work that is done within TC to provide research and analysis for a stronger transportation sector. The increased awareness will increase partnering opportunities and decrease barriers to exchange information. • Create a working group to define business requirements for on-line collaboration. Once requirements are identified, GC IM/IT solutions will be leveraged to ensure alignment with GC Direction Open Government, Collaboration and Service Delivery.	Completed	Policy and Corporate Services
		C.3 **<u>Virtual Library:</u>** ACAF will publish an on-line library of studies, conducted by TC, that are relevant to the rail R&D program. • Essential in order to develop a strong R&D program, as knowledge of past work is crucial in pinpointing areas for investment • Primary Action: The migration of 500 publications to the virtual library	Completed	Policy and Corporate Services

ANNEX A – Progress of Implementation of Proposals of the Technology Working Group of the *Railway Safety Act* Review

The following table outlines the status of progress (at the time of the evaluation), according to RRAB monitoring, of the 24 proposals of the Technology Working Group of the *Railway Safety Act* Review directed at Transport Canada or Transport Canada with industry.

Status	# of Proposals	Comments
For Transport Canada		
For implementation by March 31, 2010		
Completed	2	Transport Canada did provide additional R&D funding for rail safety, and did make Rail Safety R&D a pillar of activities to be undertaken by TDC.
Ongoing	5	
For implementation by March 31, 2011		
Completed	3	One of the proposals categorised as completed was the development of an Integrated Railway Research Strategy for the department, which was deemed to "no longer be necessary" because all RRAB activities ensure an integrated approach.
Ongoing	2	One of the "ongoing" proposals was that Transport Canada's Rail Safety directorate should undertake an internal review of regulations vis-à-vis their impacts on implementation of new technologies. It does not appear that this has been undertaken.
For Transport Canada and Industry		
For implementation by March 31, 2010		
Completed	6	
Ongoing	2	Ongoing proposals related to performance measurement for R&D, as well as undertaken periodic environmental scans and gap analyses.
For implementation by March 31, 2011		
Completed	3	
For Potential Future Action	1	