literature review

Assessing and Comparing Environmental Performance of Major Transit Investments

prepared for

Transit Cooperative Research Program, Project H-41

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1.0 Introduction

Transit Cooperative Research Program (TCRP) Project H-41 addresses the need for new measures of the environmental benefits of transit investments. In particular, the objective of the research is to present, evaluate, and demonstrate criteria, metrics, and methods for assessing and comparing the environmental performance of major transit investments (e.g., projects defined by FTA 5309 New Starts and Small Starts projects). The research results will offer a basis for assessing and comparing these transit projects and will offer project sponsors optional criteria, metrics, and methods for assessing transit projects with regard to environmental performance.

As part of Phase 1 of this research, a review of the literature was conducted to identify environmental performance measures and measurement systems used for transit and other transportation projects. In addition to research studies and reports, this review included systems for rating environmental performance of infrastructure projects, as well as a review of international practice in the environmental evaluation of transportation projects and programs.

The results of the literature review were included in the Phase 1 Interim Report delivered to the project panel in August 2010, and are published here as the first working product of this research effort. Other activities in Phase 1 included outreach to stakeholders (including transit agencies and others) to discuss existing and potential environmental performance metrics and how they are used; as well as the identification and prioritization of environmental performance categories and metrics for further testing. Phase 2 will acquire data from sample projects and test selected metrics against criteria including data availability, ease of computation, environmental relevance, and ability to distinguish across projects. Following completion of the testing process, a hierarchy of criteria, methods, and metrics will be developed that may be used to evaluate and compare the performance of transit projects.

The remainder of this document is organized as follows:

- Section 2.0 presents a summary of the literature review;
- Section 3.0 contains an annotated bibliography;
- Section 4.0 reviews environmental performance rating systems and tools; and
- Section 5.0 reviews international practice in transportation environmental performance measurement.

Cambridge Systematics, Inc. (Chris Porter and Jamey Dempster) was the lead author of Sections 2.0, 3.0, and 4.0. Rutgers University (Dr. Robert Noland, assisted by Nicholas Tulach and Christopher S. Hanson) developed the review of international practice (Section 5.0).

2.0 Summary of Literature Review

Published Literature

Seventeen relevant literature sources were identified. An annotated bibliography is provided in Section 3.1. Types of literature reviewed included:

- Reports enumerating and discussing how to measure benefits and impacts of transit, including environmental effects (e.g., TCRP Reports 20 and 88, Volpe Colloquium);
- Reports examining transportation performance measures and evaluation frameworks both in the United States and abroad; and
- Reports and detailed guidance on specific environmental measures, primarily greenhouse gases (e.g., GHG-reporting protocols).

Measuring emissions – in particular GHG – and the base measure of changes in VMT due to transit investments were covered the most in the literature review. This literature included studies describing and quantifying the direct and indirect effects of transportation on changes in GHG and VMT, with some reports monetizing these measures. These documents were the most specific in identifying steps and data needed to complete the measures and apply them to transit agencies.

Broad catalogues of environmental performance measures tended to offer key categories and issues to consider such as scale of analysis. The most useful of these identified specific measures, data sources and how to calculate the results. For example, the Strategic Highway Research Program 2, Project C02, produced a library of performance measures for highway capacity expansion investments, including environmental measures, many of which are applicable to transit as well as highway projects.

Environmental Performance Rating Systems and Tools

With growing interest in sustainability, a number of assessment tools have been developed to assist organizations in assessing and rating the "sustainability" or environmental performance of their operations. Most systems are not transit-specific, but many include metrics that may inform transit applications. Some of these are focused on buildings (e.g., LEED), which could be applied to transit agency facilities. Others have been developed for infrastructure projects, primarily highways (e.g., GreenROADS), but their principles could be extended to transit project construction. ISO certification is focused on environmental impacts across a full range of an agency's operations. Still others are focused at the community level (e.g., STAR) and include measures of transportation system performance and impacts (including transit). Existing rating/ assessment systems are detailed in Section 3.2.

International Practice: Strategic Environmental Assessment

Rutgers University conducted a review of the process and method by which environmental criteria are assessed in a number of countries (Appendix B). The primary focus is on Strategic Environmental Assessment (SEA) or multicriteria analysis. Directive 2001/42/EC of the European Parliament and of the Council on the assessment of the effects of certain plans and programs on the environment ("the SEA Directive") requires all Member States to assess environmental impacts of all policies, plans, and programs that are subject to being prepared or adopted by a governmental authority and by legislative procedure, and which are required by legislative, regulatory or administrative provisions. All Member States have now adopted legislation to comply with the directive (CEC, 2009). Australia and New Zealand have both adopted similar procedures, but Canada and Chile follow U.S. practice of project-based environmental impact analysis, rather than at the strategic policy level.

Strategic Environmental Assessment seeks to evaluate the environmental effect of policies and plans during early stages of the planning process. The method requires an alternatives analysis and public involvement. One of the key features is that the analysis is a multiattribute analysis that examines various environmental effects versus economic, equity, and other impacts of interest to policy-makers. We detail below the various criteria used in sampled countries.

One key issue is that no country seems to have a distinct procedure for just public transit planning. Instead, all transport modes are considered. For example, in the United Kingdom it is often a collection of various plans and projects within a Local Transport Plan that are the basis of a multiattribute analysis. Thus, in theory, all modes are evaluated equally.

The effectiveness of the SEA directive was recently reviewed by the Commission (CEC, 2009). Various difficulties have been found but most of these represent a learning process as various countries develop the capacity to engage in SEA. Difficulties include variation in defining alternatives to evaluate, lack of good quality information for analysis, and a lack of standardized indicators for comparison (CEC, 2009). Insufficient analysis of cumulative effects also has been identified as an issue (Trickler, 2007).

Climate change impacts are dealt with by most countries on a case-by-case basis, with a goal of maintaining carbon neutrality or reductions. Specific guidelines for climate analysis do not yet exist (CEC, 2009).

Several benefits of the SEA process have been mentioned. These include benefits from early consultation and increased transparency of the planning process; actual changes in policies and plans in response to environmental problems; and reduction of the need for various mitigation procedures, due to earlier consideration of environmental impacts (CEC, 2009). Therefore, as a means of improving environmental outcomes, it is widely regarded as effective.

3.0 Annotated Bibliography

[No Author] (2009) ***Performance Driven: A New Vision for U.S. Transportation Policy.*** **Bipartisan Policy Center.**

In this document, the Bipartisan Policy Center builds a case for the development of performance metrics for the U.S. transportation system, with eight suggested performance metrics, two of which are related to the environment: petroleum consumption and carbon dioxide emissions. The former is a proxy for energy security built on existing travel model outputs and average fuel economy. The latter is a proxy for climate change impacts calculated from model outputs and emissions literature. Carbon dioxide emissions would include life-cycle emissions, including upstream emissions and changes in land use. The report encompasses all modes of travel and includes project, policy, and funding recommendations most applicable to national program restructuring and evaluation. Difficulties in state and project-level analysis are noted with general methodology comments. Specific proposals for calculation are not included.

American Public Transportation Association (2009). ***Recommended Practice for Quantifying Greenhouse Gas Emissions from Transit.*** **Project CC-RP-001-09.**

This methodology for transit agencies includes approaches to estimating both emissions generated by transit and the potential reduction of emissions through efficiency and displacement. This is the most comprehensive methodology for a complex performance measure for transit. It is closely related to the methodology used by The Climate Registry and includes clarification of elements particular to transit agencies, such as avoided automobile trips, defining facility types, and operations across state lines. The document provides useful discussion of methodology, in particular descriptions of metrics (emissions per vehicle mile, emissions per revenue vehicle hour, emissions per passenger-mile), scale and sources of data.

Bailey, L., P. L. Mokhtarian, et al. (2008). ***The Broader Connection between Public Transportation, Energy Conservation and Greenhouse Gas Reduction.*** **Prepared for the American Public Transportation Association and Transportation Research Board by ICF International.**

This report describes the "second-order" effects of public transit availability. The research shows that transit systems enable more efficient land development, leading to increased transit use, shorter driving distances, and increased walking or bicycling due to short distances to destinations. The report outlines measures of land use performance and compiles evidence from existing research. The team uses a model to calculate the effect of public transportation on U.S. VMT and GHG emissions using the National Household Transportation Survey (NHTS), but does not include methodologies to apply at a smaller scale.

Cambridge Systematics, Inc. (1996). ***TCRP Report 20: Measuring and Valuing Transit Benefits and Disbenefits.*** **Prepared for Transportation Research Board.**

This report provides a useful linkage diagram for analyzing the effects of transit on regional economies. Many of the subcategories and elements include direct and proxy performance measures for transit and show where the strongest methodologies existed at the time. The performance measures (grouped by energy, emissions, noise, ecology, and land consumption) include those typically required as part of NEPA and FTA reviews and do not present new methodologies (e.g., land use, resource conservation, and construction impacts are discussed qualitatively). Metrics are not discussed as part of a framework to compare transportation investments.

Cambridge Systematics, Inc. (2009). Strategic Highway Research Program 2 (*SHRP2) Report S2-CO2-RR: Performance Measurement Framework for Highway Capacity Decision-Making.* Prepared for Transportation Research Board.

This document presents a performance measurement framework that individual transportation agencies and other public agencies can adapt to support the decision-making process for major highway capacity projects. It emphasizes performance measurement as a tool to place individual projects within a system context. Environmental categories include ecosystems, water quality, wetlands, air quality, climate change, and environmental health with 22 specific measures (e.g., loss of habitats, highway runoff, wetlands plan consistency). The community category includes land use, archeological and cultural resources, social effects and environmental justice, with 13 specific measures. This comprehensive documenting of environmental measures is a particularly useful reference in that many measures could be used to compare environmental performance of different modes. The measures are summarized, applications are described through case studies, and research needs identified.

Canadian Urban Transit Association. ***Transit Vision 2040.***

This document presents the Canadian transit industry's vision of the long-term role of public transportation in Canada. It communicates transit's contribution to quality of life, the nature of change likely to take place in communities by 2040, the implications these changes will have on transit, and strategic directions for actions that can maximize transit's contribution to our quality of life. The vision includes an emphasis on greening transit to reduce its ecological footprint. The vision also sets forth how transit contributes to quality of life, with excerpts relevant to environmental performance shown in Table 3.1.

Table 3.1 Transit's Contribution to Quality of Life

	Quality of Life Attributes	Transit's Contribution to Quality of Life
Culture/ Community Form	**Distinctive and Vibrant Places –** Supporting identity and sense of place with a varied, human-scale design that encourages activity and allows spontaneity, exploration and exchange. **Complete Communities –** Offering a variety of opportunities and choice of housing and employment. **Compact –** Bringing these opportunities closer together.	**Quality Design –** Contributing to civilized places and spaces. **Integration –** Proximity to land use and harmonious facility design. **Coverage –** Allowing choice of home, school and employment. **Competitive –** To minimize automobile use, road needs, parking requirements, etc. (cost, travel time, comfort). **Impact Reduction –** Minimizing overall noise, vibration, emissions, and visual intrusions.
Environment	**Safe, Comfortable, Clean and Conserving Communities –** Safe from environmental hazards and adverse events related to climate change; have clean air, clean water and land; and where there is conservation of resources; and reduction of waste.	**Reduced Air Emissions –** Greenhouse gases and other contaminants. **Reduced Energy Consumption –** Particularly nonrenewable petroleum fuels. **Reduced Material Consumption and Waste** **Reduced Noise Emissions** All of the above can be achieved through enabling density, modal shift and through cleaner, quieter and more efficient transit operations. Transit also provides resilience, maintaining mobility and response capacity in periods of adverse environmental events.

Source: Canadian Urban Transit Association, Transit Vision 2040.

Davis, T., M. Hale (2007) ***Public Transportation's Contribution to U.S. Greenhouse Gas Reduction.*** **Prepared for the American Public Transportation Association and Transportation Research Board by Science Applications International Corporation.**

See American Public Transportation Association (2009). *Recommended Practice for Quantifying Greenhouse Gas Emissions from Transit*. Project CC-RP-001-09.

European Commission, DG TREN (2005) ***The Strategic Environmental Assessment Manual: A Sourcebook on Strategic Environmental Assessment of Transport Infrastructure Plans and Programs.***

This manual outlines an approach to Strategic Environmental Assessment for European Commission members. See the review of international practice for a complete description.

Gallivan, F. (2010). ***TCRP Synthesis 84: Current Practices in Greenhouse Gas Emissions Savings from Transit.*** **Prepared for Transportation Research Board by ICF International.**

See also: American Public Transportation Association (2009). *Recommended Practice for Quantifying Greenhouse Gas Emissions from Transit.* Project CC-RP-001-09.

This report explains in detail the research that supports and otherwise relates to APTA's methodology to calculate GHG emissions. There is useful description of land use "leverage" rates, or multipliers, (i.e., the additional GHG benefit from transit-supportive land use, beyond the direct benefits of VMT reduced through mode-shifting to transit), including state-of-the-practice research on regional surveys and calculation methods. A chapter on GHG planning and policy development could be useful in considering ways to implement environmental performance measures for transit.

ICF Consulting (2006). ***NCHRP Project 25-25 Task 17: Assessment of Greenhouse Gas Analysis Techniques for Transportation Projects.*** **Prepared for American Association of State Highway and Transportation Officials and Transportation Research Board.**

This report identifies a total of 17 tools or methods that can be used to analyze the GHG implications of transportation projects and recommends models for transportation project or strategy analysis. Its primary value for this project is in identify GHG analysis tools that are available and could be used for transit project evaluation, including life-cycle as well as direct impacts.

John A. Volpe National Transportation Systems Center (2008). ***Comparing the Environmental Benefits of Transit Projects: Proceedings from a Colloquium.*** **Prepared for U.S. DOT Federal Transit Administration, Office of Planning and Environment.**

This document provides the topic base for the current study (TCRP H-41) and is the most directly applicable presentation of performance metrics and discussion of implementation issues. The Colloquium focused specifically on the FTA New Starts program with the intention to create a full list of possible metrics to test with projects in the program pipeline. The document provides a useful outline by organizing metrics into four broad categories (energy use, air quality, land use, and physical activity), and further designating direct versus proxy measures. Of the measures discussed, the land use metrics were not as developed in the available literature, calling attention to metrics dealing with pedestrian access to transit, development density, and parking. The report also is unique in discussing how to implement measures that would apply to projects with different operating environments, based on different regional travel models, and for sponsors with varying experience with performance measures.

Kittelson & Associates, Inc (2003). ***TCRP Report 88: A Guidebook for Developing a Transit Performance-Measurement System.*** **Prepared for Transportation Research Board.**

This Guidebook is targeted to transit system managers to assist in developing a performance-measurement system using measures that will address customer-oriented and community issues (including environmental effects). The guide presents a process for determining appropriate performance measures for a transit agency or MPO based on local conditions and concerns. The document includes a menu of performance measures and a useful summary of each suggested performance measure, including a description, major factors to consider, data requirements and references. While the Guidebook includes numerous measures on topics such as service quality and operational efficiency, only a few environmental measures are listed, including effects on energy and resource consumption, general environmental impacts (air quality, wetlands, etc. – with no details provided), and noise.

Rahman, A., R. van Grol (2005). ***Sustainable Mobility, policy Measures and Assessment (SUMMA) version 2.0.*** **Prepared for European Commission Directorate General for Energy and Transport by RAND Europe.**

This project proposes a set of system-level sustainability performance indicators for transport. Direct environmental indicators include fuel/energy usage per 100 km, emission of air pollutants by transport, and emissions from and raw materials used by industries related to transport. Other indicators are related to environmental impacts (e.g., mean distance to closest public transport stop, percent of surface covered by infrastructure by mode).

The Climate Registry (2008). General Reporting Protocol, Version 1.1. http://www.theclimateregistry.org/downloads/GRP.pdf, accessed May 2010.

The Climate Registry is partnering with APTA to develop a standard methodology for transit agencies to report GHG emissions. This methodology is based on TCR's general procedures for any organization interested in joining the registry and monitoring their carbon use and emissions. The methodology includes detailed steps in calculating direct and indirect emissions and provides detail to avoid double counting or omitting key sources of emissions. The procedures are useful in considering the level of rigorousness required to develop standard procedures for all types of environmental performance measures, in particular complex measures such as the environmental effects of changes in land use.

The Climate Registry (2010). Performance Metrics for Transit Agencies, Version 1.0. http://www.theclimateregistry.org/downloads/2010/07/Performance-Metrics-for-Transit-Agencies-v.-1.0.pdf, accessed June 2010.

See American Public Transportation Association (2009). *Recommended Practice for Quantifying Greenhouse Gas Emissions from Transit.* Project CC-RP-001-09.

U.S. Department of Transportation Federal Highway Administration (1987). "Guidance for Preparing and Processing Environmental and Section 4(F) Documents," Technical Advisory T 6640.8A, http://www.environment.fhwa.dot.gov/projdev/impta6640.asp#eis, accessed May 2010.

This document provides specific guidance for transportation agencies on preparing EIS documents required under NEPA. Topic areas addressed include land use, farmland, social impacts (community cohesion, accessibility, safety, cultural resources, equity), pedestrians and cyclists, air quality, noise, water quality, wetlands, wildlife, floodplains, wild and scenic rivers, coastal barriers and coastal zone impacts, threatened and endangered species, historic and archeological preservation, hazardous waste sites, visual impacts, energy, and construction impacts.

U.S. Department of Transportation Federal Transit Administration (2000). "Major Capital Investment Projects; Final Rule." Title 49 Code of Federal Regulations, Appendix A to Part 611.

This rule presents the methodology by which FTA evaluates projects applying for New Starts funding. The project justification categories include comparing projected and baseline environmental benefits, which includes criteria pollutant emissions, energy consumption, and NAAQS-designation status. The justification also requires "existing land use, transit supportive land use policies, and future patterns," including existing land use, change in land use, growth management policies, zoning supportive of development near transit stations, land use policy tools, land use policy performance, and pedestrian facilities.

4.0 Environmental "Best Management Practice" Assessment Tools

A number of assessment tools are available to practitioners interested in assessing environmental performance of transportation investments. Most systems are not transit-specific, but are composed of metrics that may be relevant to transit applications. Each of the systems is summarized briefly below, including how the metrics may be most applicable to environmental performance measures for transit.

■ Leadership in Energy and Environmental Design (LEED) and LEED for Neighborhood Development (LEED-ND)

Developer: United States Green Building Council

Internet: http://www.usgbc.org/DisplayPage.aspx?CMSPageID=148

The LEED certification process is means of rating a building's environmental performance. It is based on a checklist of criteria; minimum thresholds are provided for achieving different levels of ratings (silver, gold, platinum). The LEED-ND system extends certification requirements to include measures of the building's location and neighborhood context as well as the building itself, including the mix of uses, walkability, and other factors that relate to the building's likely transportation impact. LEED-ND measures may be relevant for the siting and design of transit facilities. Factors evaluated in LEED certification include:

- Purchase renewable energy attributes;
- Construction activity pollution prevention;
- Certified green building(s);
- Building energy efficiency;
- Infrastructure energy efficiency;
- Building water efficiency;
- Water-efficient landscaping;

- Wastewater management;
- Stormwater management;
- Existing building use;
- Historic resource preservation and adaptive reuse;
- Minimized site disturbance in design and construction;
- Heat island reduction;
- Solar orientation (passive solar);
- On-site renewable energy sources;
- District heating and cooling;
- Recycled content in infrastructure;
- Solid waste management infrastructure; and
- Bicycle/other nonmotorized vehicle storage.

■ GreenRoads

Developer: University of Washington

Internet: http://www.greenroads.us

The Green Roads program is a rating system designed to distinguish new or rehabilitated roads by awarding credits for design and construction choices that meet certain environmental criteria. The environmental categories are listed in the table below and include environmental, economic, and social impacts. The program offers four certification levels based on the project score that includes 11 project requirements and a total of 118 points, including all voluntary credits. Performance categories and sample metrics are shown in Table 4.1.

Table 4.1 GreenRoads Performance Categories

Category	Sample metrics
Project Requirements (11 points)	(All categories) Environmental review process, life-cycle cost analysis, life-cycle inventory, quality control plan, noise mitigation plan, waste management plan, pollution prevention plan, low-impact development, pavement management system, site maintenance plan, outreach.
Environment and Water (21 points)	Level of performance related to issues such as water runoff, site vegetation and habitat restoration.
Access and Equity (30 points)	Presence of a safety audit, use of intelligent transportation systems, use of context sensitive solutions, level of transit access.
Construction Activities (14 points)	Quality management system, environmental training, recycling plan, equipment emission reduction.
Materials and Resources (23 points)	Life-cycle assessment, pavement reuse, energy efficiency.
Pavement Technologies (20 points)	Permeable pavement, warm mix asphalt, quiet pavement.

Suggested uses of the certification include quantitatively tracking sustainability efforts, informing decision-making, increasing public understanding and participation, and rewarding targeted practices. The review can account for both environmental and social impacts of road-building and establish better uses of recycled and virgin aggregate materials, such as crushed rock, much of which must be transported.

Other states are in the process of adapting a GreenRoads-type system for their own use, such as New York State DOT's GreenLITES program.

■ Civil Engineering Environmental Quality Assessment and Award Scheme (CEEQUAL)

Developer: European Council of Civil Engineers

Internet: http://www.ceequal.co.uk/about.htm

CEEQUAL is an assessment program aiming to improve sustainability in civil engineering and public infrastructure investments. By guiding improved project specification, design and construction, it can demonstrate the commitment to improve environmental and social performance of these projects. Performance metrics cover 12 categories, rewarding teams that go beyond legal and environmental requirements to achieve distinctive environmental and social standards. The organization suggests the evaluation can build

support for the project, provide quantitative benchmarks, improve project efficiency and safety, and improve internal teamwork. The 12 categories include:

- Project Management (10.9 percent);
- Energy and Carbon (9.5 percent);
- Land Use (7.9 percent);
- Material Use (9.4 percent);
- Landscape (7.4 percent);
- Waste Management (8.4 percent);
- Ecology and Biodiversity (8.8 percent);
- Transport (8.1 percent);
- The Historic Environment (6.7 percent);
- Effects on Neighbors (7.0 percent);
- Water resources and the Water Environment (8.5 percent); and
- Relations with the Public (7.4 percent).

■ STAR Community Index

Developer: International Council for Local Environmental Initiatives (ICLEI)

Internet: http://www.starcommunityindex.org

The STAR Community Index is a national framework for gauging the sustainability and livability of U.S. communities. STAR will be launched in 2010 and is being developed through a partnership between ICLEI-Local Governments for Sustainability, the U.S. Green Building Council, and the Center for American Progress. Local governments have the opportunity to "certify" their work through independent, third-party verification. However, the metrics are intended to be used to track progress toward each locality's unique goals in environmental performance. STAR indicator categories and subcategories are shown in Table 4.2.

Table 4.2 STAR Community Index Indicators

Category	Subcategories
Natural Systems	Ecosystems and habitat, water and stormwater, air quality, waste, and resource conservation
Planning and Design	Land use, transportation and mobility, and parks, open space and recreation
Energy and Climate	Energy, emissions, renewable energy, and green building
Economic Development	Clean technologies and green jobs, local commerce, tourism, and local food system
Employment and Workforce Training	Green job training, employment and workforce wages, and youth skills
Education, Arts and Community	Education excellence, arts and culture, and civic engagement and vitality
Children, Health, and Safety	Community health and wellness, access to health care, and public safety
Affordability and Social Equity	Affordable and workforce housing, poverty, human services and race and social equity

■ ISO 14000 Environmental Management Systems Certification

Developer: International Organization for Standardization (ISO)

Internet: http://www.iso.org

The ISO certification programs for environmental management systems (14001 and 14004) provides guidance that enables an organization to develop and implement policy and objectives which take into account legal requirements and other requirements for sustainable development. An environmental management system is a management tool enabling an organization of any size or type to identify the environmental impact of its activities, improve environmental performance, and implement a systematic approach to setting environmental performance targets and showing achievement of targets. ISO does not provide specific indicators of environmental performance, but does provide a framework for an organization to systematically prepare a comprehensive management plan. ISO suggests that certification is useful in preparing plans, sharing the results with people inside and outside an organization, and setting a framework for ongoing improvement of sustainability planning by committing to compliance with the ISO standards.

■ Sustainability Reporting Framework

Developer: Global Reporting Initiative

Internet: http://www.globalreporting.org

The Global Reporting Initiative's (GRI) mission is to create conditions for the exchange of sustainability information through the GRI Sustainability Reporting Framework. The framework is focused on organizational efforts at developing and monitoring municipal programs and therefore tracks many policies and programs adopted by an organization rather than direct performance. GRI has developed sustainability reporting guidelines to provide guidance for organizations, in addition to detailed protocols to provide definitions and methodologies for quantitative indicators. Guidelines and protocols also are included for pilot "sector supplements," including logistics and transportation organizations. Reporting categories and core indicators are shown in Table 4.3.

Table 4.3 Global Reporting Initiative Categories and Indicators

Category	Core Indicators
Materials	Total materials use other than water by type.
	Percentage of materials used from wastes, sources external to the organization.
Energy	Direct energy use segmented by source: mobile, nonmobile sources; type of fuel; normalized per cubic meter km, per ton km, per delivery item or per unit km.
	Indirect energy use: used to produce and deliver energy products used.
	(Initiatives to use renewable energy sources and increase efficiency.)
Water	Total water use.
Biodiversity	Location and size of land used in biodiversity rich habitat.
	Description of the major impacts on biodiversity associated with activities and/or products and services in terrestrial, freshwater, and marine environments.
Emissions, waste	Greenhouse gas emissions: direct and indirect (WRI-WBCSD protocol)
	Use and emissions of ozone depleting substances.
	NO_x, SO_x, and other significant air emissions by type.
	Total amount of waste by type and destinations
	Significant water discharge by type.
	Significant chemical, oil, fuel spill by volume and number.
	(Initiatives to control urban area emissions by road transportation.)

Table 4.3 Global Reporting Initiative Categories and Indicators (continued)

Category	Core Indicators
Products and Services	Significant environmental impact from principal products and services.
	Share of product weight reclaimable and reclaimed at end of product lifespan.
	Incidence of noncompliance with environmental regulations.
Fleet[a]	Vehicle types, including alternative fuel vehicles.
Policy[a]	Environmental performance of operations: commitment to alternative fuel vehicles, commitment to modal shift, efficient route planning.
	Managing highway congestion (off-peak use, alternative modes, etc.).
	Guided approach to reduce noise and vibration

[a] Category/Indicators suggested specifically for transportation and logistics organizations.

■ Integrated Sustainability Assessment Toolkit/Framework

Developer: Sustainable Urban Environment, Metrics, Models and Toolkits (SUE-MoT), a consortium of British universities

Internet: http://www.sue-mot.org

The SUE-MoT consortium is developing a comprehensive framework that encourages key decision-makers to assess the sustainability of regions, taking account of scale, life-cycle, location, context and residents' values. Early research identified 670 sustainability assessment tools from a comprehensive literature review. The 30 or so most widely used performance categories have been applied to the contexts where use would be most appropriate. While the framework does not provide indicators and metrics useful to comparing transit investments, the exhaustive literature review of sustainability tools may be useful for developing some metrics.

■ Green Globes

Developer: Green Building Initiative (USA) and Building Owners and Managers Association (Canada)

Internet: http://www.greenglobes.com

Green Globes for Existing Buildings is an assessment and rating system for buildings in North America. The categories are somewhat similar to the United States Green Building Council's LEED system. The system has developed on-line tools for building managers and is planning to establish the criteria with the American National Standards Institute (ANSI). Green Globes software tools and certification system is based on a 1,000 point scale in multiple categories, with a minimum of 350 points for certification. The assessment categories include energy, indoor environment, site planning, water, resources, emissions, and project management. It differs from LEED by offering points rather than checklists, theoretically allowing for more variation within categories. However, a points-type system could be difficult to apply on a national scale to individual projects.

■ Ska Rating

Developer: Royal Institution of Charters Surveyors

Internet: http://www.ska-rating.com

Ska Rating is a system that corporations can use to inform fit-out of building projects for their offices. Ska has 99 measures across seven categories. Each category has specific targets and suggested methodologies. Because each office build out project is unique in terms of employers' requirements, the building, and scope of works, Ska Rating scores the project on only of those measures that are relevant to the project. These are called Measures In Scope. Because some measures are more important from a sustainability perspective the measures are ranked from 1 to 99 for each project. To ensure that teams do not just target the easiest measures, the project has to achieve a number of the highest ranked measures in scope – called Gateway Measures – in order to qualify. While some indicators also apply to transit facilities, the system may be most interesting due to the definition of "scopes" that affect which indicators apply to a specific project, allowing for some flexibility in evaluation. Categories and Indicators are shown in Table 4.4.

Table 4.4 Ska Rating Categories and Indicators

Category	Sample Indicators
Energy and CO_2	Reduce energy use, lighting controls, daylighting, energy efficient HVAC.
Materials	Hard flooring, timber, blockwork, partitions, kitchen fittings, insulation.
Pollution	Low-GWP insulation, refrigerant leak detection, light pollution, plant noise.
Transport	Cycle parking, showers, lockers.
Waste	Waste management plan, site waste plan, reduce material sent to landfill.
Water	Reduce water use, low-flush WC, water meter, leak detection services.
Wellbeing	Thermal comfort assessment, noise standards, low-VOC finish, ventilation.

Sustainable Infrastructure, Land-use, Environment, and Transport Model (SILENT)

Developers: Yigitcanlar, Tan and F. Dur (2010) Developing a Sustainability Assessment Model. Sustainability, 2(1) pages 321-340.

Internet: http://www.mdpi.com/2071-1050/2/1/321/

This study introduces an urban sustainability assessment model, the Sustainable Infrastructure, Land-use, Environment, and Transport Model (SILENT). The SILENT model is a geographic information system and indicator-based urban sustainability indexing model. The model aims to assist planners and policy-makers in sustainable urban planning and development by providing an integrated sustainability assessment framework. The paper gives an overview of the framework and its constructs, methodological procedures, and future development. The main characteristic of the SILENT Model is that it uses a grid-based system, dividing the study area into grid cells (100 x 100 m). The grid-based analysis is seen as useful in accessibility indexing studies due to its strengths in condensing the analysis into comparable analysis unit sizes. The study could be useful for comparing land use surrounding transit investments by creating a uniform analysis structure. The article also details methodologies for calculating indicators which, while not new, could provide some comparison for developing detailed assessment protocols. Index categories and indicators are shown in Table 4.5.

Table 4.5 SILENT Categories and Indicators

Category	Sample Indicators
Demography	Population density, car ownership, job/housing balance, employment density.
Land Use	Mix use ratio, dwelling density by type, parcel size, community facilities.
Transport	Transit access (to employment, housing), transit ridership, nonmotorized network coverage, VMT by purpose, trips by purpose, parking supply.
Environment	Wastewater, solid waste, energy use, residential water use, GHG emissions, stormwater runoff, noise pollution.

5.0 International Approaches to Transportation Environmental Assessment

Introduction

This review, conducted by Rutgers University, examines the process and method by which environmental criteria are assessed in a number of countries. Our primary focus is on Strategic Environmental Assessment or multicriteria analysis. Directive 2001/42/EC of the European Parliament and of the Council on the assessment of the effects of certain plans and programs on the environment ("the SEA Directive") requires all Member States to assess environmental impacts of all policies, plans, and programs that are subject to being prepared or adopted by a governmental authority and by legislative procedure, and which are required by legislative, regulatory, or administrative provisions. All Member States have now adopted legislation to comply with the directive (CEC, 2009). Our survey found that Australia and New Zealand have both adopted similar procedures, but Canada and Chile follow U.S. practice of project-based environmental impact analysis, rather than at the strategic policy level.

Strategic Environmental Assessment seeks to evaluate the environmental effect of policies and plans during early stages of the planning process. The method requires an alternatives analysis and public involvement. One of the key features is that the analysis is a multiattribute analysis that examines various environmental effects versus economic, equity, and other impacts of interest to policy-makers. We detail below the various criteria used in sampled countries.

One key issue is that no country seems to have a distinct procedure for just public transit planning. Instead, all transport modes are considered. For example in the United Kingdom, it is often a collection of various plans and projects within a Local Transport Plan that are the basis of a multiattribute analysis. Thus, in theory, all modes are evaluated equally.

The effectiveness of the SEA directive was recently reviewed by the Commission (CEC, 2009). Various difficulties have been found but most of these represent a learning process as various countries develop the capacity to engage in SEA. These difficulties include variation in defining alternatives to evaluate, lack of good quality information for analysis, and a lack of standardized indicators for

comparison (CEC, 2009). Insufficient analysis of cumulative effects also has been identified as an issue (Trickler, 2007).

Climate change impacts are dealt with by most countries on a case-by-case basis, with a goal of maintaining carbon neutrality or reductions. Specific guidelines for climate analysis do not yet exist (CEC, 2009).

Several benefits of the SEA process have been mentioned. These include benefits from early consultation and increased transparency of the planning process; actual changes in policies and plans in response to environmental problems; and reduction of the need for various mitigation procedures, due to earlier consideration of environmental impacts (CEC, 2009). Therefore as a means of improving environmental outcomes, it is widely regarded as effective.

References

Commission of the European Communities (CEC, 2009). On the application and effectiveness of the Directive on Strategic Environmental Assessment (Directive 2001/42/EC), COM (2009) 469 final, Brussels.

Trickleer, R. C., 2007. Assessing cumulative environmental effects from major public transport projects, Transport Policy, 14: 293-305.

Australia

Among the countries surveyed, Australia has a well-documented and clear approach toward the evaluation of environmental impacts as part of a comprehensive benefit/cost analysis framework developed for transport policy at the national level. Their guidelines consist of a general benefit/cost framework with some expanded methods developed for the specific needs of public transport. The following sections summarize their process, methods, and impacts addressed.

Assessment Process

The Australian guidelines include an eight-phase appraisal process for evaluating multimodal transportation options. Environmental evaluation of transport decisions is included as a nonmonetized assessment. Two stages of assessment are applied: a rapid assessment followed by a detailed assessment. Additional documentation on environmental impacts, such as detailed, project-specific Environmental Impact Statements, also are incorporated into the appraisal process in the early stages, though the guidelines are not clear on how the timing of such decision-making coincides with detailed project-level analyses.

The additional analyses implemented in Australia for public transport do not include major additional environmental procedures. These are instead consistent across transport modes. The results of the detailed assessment process generate an *Appraisal Summary Table* (AST), a one-page presentation of the proposal and its estimated net benefits, which is meant to be consumed by decision-makers. The AST includes both monetized and nonmonetized impacts, as well as qualitative and quantitative measures where applicable Commonwealth of Australia, 2006, Volume 3 has examples of AST forms, including a completed example on page 43 – see the source document at: http://www.atcouncil.gov.au/documents/NGTSM.aspx.

Methods Implemented

The methods include increasingly detailed analyses as the process carries forward, primarily centered around a benefit/cost analysis, strategic merit assessment, and nonmonetized assessment. Nonmonetized impacts (primarily environmental) are assessed on a seven-point qualitative rating scale from large negative to large positive. All measures in the AST – quantitative and qualitative – are assigned a confidence level on a five-point scale ranging from very low to very high.

Coverage of Impacts

Specific environmental criteria included qualitatively in the Appraisal Summary Table include:

- Greenhouse gas emissions;
- Noise;
- Local air quality;
- Landscaping;
- Biodiversity;
- Aboriginal heritage; and
- Water resources.

References

Commonwealth of Australia, 2006. National Guidelines for Transport System Management, Second edition. Volumes 1 to 4. Accessed at http://www.atcouncil.gov.au/documents/NGTSM.aspx

Austroads, 2008. Guide to Project Evaluation Part 4: Project Evaluation Data, Austroads Publication No. AGPE04/08

■ Canada

The Canadian environmental assessment process is a complex interaction of governmental entities from local agencies to provincial governments to Federal authorities, including the Minister of the Environment. The majority of this review investigates the Environmental Assessment Act as a model process initiated at many different levels of government, but directed by Federal regulations, as described in the following sections.

Assessment Process

Canada has an Environmental Assessment Act that directs agencies on the need for environmental assessment procedures. The Act itself is not specific to transport or public transit, but covers many different actions that can affect the environment. The procedures can fall into one of four types: screening, comprehensive study, mediation, and assessment by a review panel. The last two are conducted by an independent third party. The first two can be self-directed.

The Canadian act also requires the assessment of cumulative environmental effects, or those effects that for a given project may be small, but when taken in the context of other past, present or future impacts, may be significantly harmful to the environment.[1] A detailed significance test is required to determine cumulative environmental effects. This process involves three general steps:

1. Decide whether the environmental effects are adverse;

2. Decide whether the adverse environmental effects are significant; and

3. Decide whether the significant adverse environmental effects are likely.

Methods Implemented

A screening is "a systematic approach to identifying and documenting the environmental effects of a proposed project and determining the need to eliminate or minimize (mitigate) the adverse effects, to modify the project plan, or to recommend further assessment through mediation or an assessment by a review panel" (CEAA, 2003b).

Large projects with the potential to have numerous or far-reaching environmental impacts are subject to more rigorous comprehensive studies. These studies are managed at a high

[1] In the United States, the National Environmental Policy Act has a similar requirement to consider cumulative impacts.

level by the Minister of the Environment, who ultimately issues a decision statement on the significance of the environmental effects of the project and proposed mitigation efforts.

Mediation is used on a self-directed basis to resolve issues between interested parties when issues are limited in scope and number. The results of the mediation are used by the responsible authority for decision-making with regard to the project.

The Minister of the Environment also may initiate an expert review panel to discuss the impacts of a particular project. This process has the benefit of encouraging an open discussion and exchange of viewpoints and public participation.

In 2003, the Canadian government also adopted guidance on determining the needs for climate change considerations as part of the environmental assessment procedures. These methods are broken into two layers: one where a project may contribute to greenhouse gas emissions and another where climate change may impact the project (CEAA, 2003).

These methods are largely based on qualitative assessment strategies and the collection of information from a variety of Federal agencies.

Coverage of Impacts

The criteria for determining whether environmental effects are adverse include:

- Negative effects on the health of biota including plants, animals, and fish;
- Threat to rare or endangered species;
- Reductions in species diversity or disruption of food webs;
- Loss of or damage to habitats, including habitat fragmentation;
- Discharges or release of persistent and/or toxic chemicals, microbiological agents, nutrients, radiation, or thermal energy;
- Population declines, particularly in top predator, large, or long-lived species;
- Removal of resource materials from the environment;
- Transformation of natural landscapes;
- Obstruction of migration or passage of wildlife; and
- Negative effects on the quality and/or quantity of the biophysical environment.

Other criteria impacting people resulting from environmental changes include:

- Negative effects on human health, well-being, or quality of life;

- Increase in unemployment or shrinkage in the economy;
- Reduction of the quality or quantity of recreational opportunities or amenities;
- Detrimental change in the current use of lands and resources for traditional purposes by aboriginal persons;
- Negative effects on historical, archaeological, paleontological, or architectural resources;
- Decreased aesthetic appeal or changes in visual amenities;
- Loss of or damage to commercial species or resources; and
- Foreclosure of future resource use or production.

References

CEAA, 2003a. Incorporating Climate Change Considerations in Environmental Assessment, Federal Provincial-Territorial Committee on Climate Change and Environmental Assessment, November 2003. Accessed at http://www.ceaa.gc.ca/Content/D/A/C/DACB19EE-468E-422F-8EF6-29A6D84695FC/climatechange_e.pdf.

CEAA, 2003b. Canadian Environmental Assessment Act: An Overview, Canadian Environmental Assessment Agency, December 2003. Accessed at http://www.ceaa.gc.ca/Content/D/A/C/DACB19EE-468E-422F-8EF6-29A6D84695FC/CEAA-Overview_e.pdf.

CEAA, 2007. Project Description Guide: British Columbia: To Determine Federal Roles under the Canadian Environmental Assessment Act, February 2007. Accessed at http://www.ceaa.gc.ca/Content/D/A/C/DACB19EE-468E-422F-8EF6-29A6D84695FC/Project_Description_Guide_under_CEAA_BC_e.pdf.

Federal Environmental Assessment Review Office, 1994. A Reference Guide for the Canadian Environmental Assessment Act: Addressing Cumulative Environmental Effects, November 1994. Accessed at http://www.ceaa.gc.ca/Content/D/A/C/DACB19EE-468E-422F-8EF6-29A6D84695FC/Cumulative-Environmental-Effects_e.pdf.

Chile

Assessment Process

Environmental impact assessment in Chile is based on national legislation with a single structure that has regional components. Chilean law (Ley 19.300, 2007) requires review of the environmental impacts of transportation projects, in conjunction with a broad range of other types of projects, when the concern exists that these might endanger public health or air, water, or soil or cause major upheaval among populations within the country. Review also is required for projects that might harm protected populations, resources, or areas of scenic, touristic, anthropological, or historical value.

Regulation of environmental impacts (D.S. No95, 2001) is carried out by regional commissions or by a national commission in cases where impacts may occur in multiple regions. Submissions to these commissions may be one of two types: Environmental Impact Statements or Environmental Impact Studies. The former is a relatively simple document that addresses project particulars of name, purpose, place, costs, scale, roles of participants, and useful life of the project in enough detail that the commission can come to a conclusion about whether or not the latter document is needed.

Environmental Impact Studies are required when significant harm to the interests noted above must be ruled out. These documents require considerably more detail than impact statements, and clarity about potential environmental threats establishes a firm scientific rationale for the level of risk for a given project. Community participation and participation by municipal and provincial governments are provided for.

Methods

The Chilean Environmental Impact Assessment System (SEIA) (https://www.e-seia.cl/) details environmental impact statements but does not include current environmental impact studies. The SEIA web site allows users to specify project types. Bus and rail terminals and track projects are the transit-relevant options on the system. The web site did not include any rail terminal or track projects.

A large scale bus terminal construction project was evaluated based on sewer and water impacts, air pollutants and noise during the construction and operations phases of the project, and generation of liquid, solid, and domestic waste. An environmental sustainability urban transportation study for Santiago, Chile (O'Ryan, 1998) addresses public transit in a manner similar to the general Chilean approach. This study addressed pollution, noise as a public health issue, and resource use and cites reports by CONAMA (the Chilean environmental agency).

Coverage of Impacts

Impacts reported by CONAMA and cited by O'Ryan (1998) are limited to atmospheric pollutants – particulate matter, CO, ozone, NO_X, SO_2, and VOC from mobile, fixed point and other sources. These concerns also were raised by the CONAMA officials who evaluated the bus terminal environmental impact statement.

References

Ministerio Secretaría General del la Presidencia, D.S. No95 de 2001, Reglamento del Sistema de Evaluación de Impacto Ambiental. Available April 3, 2010. Accessed at http://www.sinia.cl/1292/articles-37936_pdf_reglamento_seia.pdf.

Ley 19.300 Sobre Bases Generales del Medio Ambiente, as amended 2007. Available April 3, 2010. Accessed at http://www.olade.org.ec.

O'Ryan, R. 1998. La Sustentabilidad Ambiental del Transporte Urbano: el Caso de Santiago de Chile. Serie Economía No 30. Centro de Economía Aplicada, Universidad de Chile. Available April 5, 2010. Accessed at http://www.webmanager.cl/prontus_cea/cea_1998/site/asocfile/ASOCFILE120030403115940.pdf.

■ Ireland

Ireland instituted a new transport policy emphasizing sustainability in 2009. Given how recent this is, our ability to properly assess its impact is limited; however, we review it and its history briefly in the sections below. While Ireland is covered by the SEA directive, we were unable to find details on how it has been implemented. The new transport policy does, however, lay out a framework of objectives and goals that would be consistent with implementation of SEAs in the future.

Assessment Process

The Irish government set out five main goals with its transport sustainability policy. These goals include:

1. Reduce overall travel demand;
2. Maximize the efficiency of the transport network;
3. Reduce reliance on fossil fuels;

4. Reduce transport emissions; and

5. Improve accessibility to transport.

The policy includes a list of 49 specific actions grouped into four overarching goals:

1. Actions to reduce the distance traveled by private car and encourage smarter travel, including focusing population and employment growth predominately in larger urban areas and the use of pricing mechanisms or fiscal measures to encourage behavioral change;

2. Actions aimed at ensuring that alternatives to the car are more widely available, mainly through a radically improved public transport service and through investment in cycling and walking;

3. Action aimed at improving fuel efficiency of motorized transport through improved fleet structure, energy efficient driving, and alternative technologies; and

4. Actions aimed at strengthening institutional arrangements to deliver the targets.

Methods Implemented

A number of specific methods and measures are mentioned among the 49 actions listed in the policy. Those specific to public transport include:

- Integration of spatial planning, local area planning, and transport planning with the goal of increasing density;

- Implementation of parking maximums for commercial sites with suitable public transport facilities;

- Development of travel plans for large scale developments, schools, workplaces;

- Restrictions on out-of-town retail centers;

- Implement Integrated Transport Systems and other advanced technologies to improve the efficiency of public transport;

- Creation of traffic-free urban centers and investment in cycle and pedestrian networks to facilitate transit, cycling, and walking; and

- Creation of national schemes for car sharing and car clubs.

One key issue facing Ireland is the development of policy concerning freight transport. The policy guidelines are vague surrounding the development of regulations or other restrictions on freight because it is seen as vital to the economic functioning of the country.

Coverage of Impacts

The Irish policy is a high-level guidance document that does not list many specific targets for assessing impacts. As part of the European Union, Ireland will attempt to fall within the guidelines of the EU directives discussed in the section on Europe in this report. A few general impacts are mentioned in the policy and are included below.

- Work-related car commuting will be reduced from 65 to 45 percent modal share by 2020;
- Total kilometers traveled by the car fleet in 2020 will not increase significantly; and
- Carbon-related emissions are targeted to fall by between 4Mts to 8Mts of CO_2 equivalents.

References

Department of Transport, 2008. Smarter Travel: A Sustainable Transport Future. Accessed at http://www.smartertravel.ie/.

Comhar, 2008. Sustainable Travel and Transport Action Plan: Comhar Sustainable Development Council Response to Public Consultation. May 2008. Accessed at http://www.comharsdc.ie/_files/Comhar%20STTAP%20report.pdf.

Department of Transport, 2008b. 2020 Vision – Sustainable Travel and Transport: Public Consultation Document, February 2008. Accessed at http://www.transport.ie/upload/general/10378-0.pdf.

New Zealand

The New Zealand government published the Transit New Zealand Environmental Plan in 2008.[2] This plan gives details about 12 categories of impacts and procedures for addressing each issue. The procedures include objectives, the role of transport, performance indicators, and implementation plans. Overall, New Zealand has taken a comprehensive, top-down approach toward tackling the specific impacts related to transport and 12 aspects of the environment defined in this document.

[2] The term 'transit' in New Zealand refers to transportation in general and not public transit specifically.

Assessment Process

The Environmental Plan lays out an excellent example of the assessment process for the National State Highway Strategy (NSHS). This process has six main components, and each provide a different measure of the environmental and social issues related to the NSHS. The six components are:

1. Valuation of environmental and social effects;
2. Prioritization of mitigation;
3. Financial implications;
4. Energy efficiency and conservation;
5. Urban design and community impacts; and
6. Balancing competing needs.

As is apparent from the brief descriptions of these elements, they are not necessarily mutually reinforcing, and may in some cases be directly contradictory. The sixth component specifically calls out the challenges of reconciling these contradictions through multigovernmental partnerships among local, regional, and national authorities.

Methods Implemented

Each of the 12 impacts listed in the next section of this summary contains a description of performance indicators, activities, and specific methods for those activities. In summary, the methodological approach taken in New Zealand's environmental plan is to define high-level objectives, assess the effects of those objectives on environmental conditions, determine the specific role transit may play in mitigating or worsening those effects, and give examples of common performance indicators to measure the implementation of mitigation strategies to achieve the stated objectives.

The Environmental Plan provides an extensive list of research tools to draw from for each category of impact. The list includes some of the most up-to-date procedures for assessing environmental impacts from New Zealand, Australia, Europe, and the United States. The New Zealand Environmental Plan provides a detailed set of resources for the specific tools used for each of the impacts listed below.

Coverage of Impacts

The Environmental Plan lays out details on 12 different environmental impacts that are thought to be essential to transport planning. These impacts are:

1. Noise;
2. Air quality;
3. Water resources;
4. Erosion and sediment control;
5. Social responsibility;
6. Cultural heritage;
7. Ecological resources;
8. Spill response and contamination;
9. Resource efficiency;
10. Climate change;
11. Visual quality; and
12. Vibration.

Most of these impacts have stated quantitative or qualitative performance indicators, though some are not specific measures. The notable exception is the social responsibility category, which appears to not yet have a measurement specification defined.

Of particular note is the inclusion of social and culture issues within the overall environmental assessment framework. Though not unique among the countries surveyed, New Zealand has a strong commitment toward the social impacts of transport decision-making. This also is reflected in the methodological approach reviewed above.

References

Transit New Zealand, 2008. New Zealand Environmental Plan 2008. Accessed at http://www.nzta.govt.nz/resources/environmental-policy-manual/docs/environmental-plan.pdf.

Transit New Zealand, 2007. Planning and Policy Manual SP/M/001, Version 1. Accessed at http://www.nzta.govt.nz/resources/planning-policy-manual/docs/planning-policy-manual-complete.pdf.

New Zealand Transport Agency, 2010. Stormwater Management Course. Accessed at http://integration.rwd.com/rocla/courseware/NZTA/main.html.

New Zealand Transport Agency, 2010. Transport Noise. Accessed at http://acoustics.nzta.govt.nz/.

New Zealand Transport Agency, 2010. Economic evaluation manual, Volumes 1 and 2. Accessed at http://www.nzta.govt.nz/resources/results.html?catid=401.

Ministry of Transport, 2010. Ministry of Transport, New Zealand, web site, Environmental section. Accessed at http://www.transport.govt.nz/ourwork/tmif/environmental/.

■ Spain

Spanish efforts at environmental impact assessment were motivated by the European Community Directive 85/337/EEC on environmental impact assessment (Palerm, 1999) as amended. Spanish environmental impact assessment law is based on Decree 1302/1986 (1986) and Decree 1131/1988 (1988), which respectively establish a national intention to address environmental impact assessment and establish regulations. While they also would be required to implement the SEA directive, we did not find any documents providing information on this (although a law requiring SEA was passed in 2006).

Spain is divided into 17 autonomous regions or communities and two autonomous cities, each of which is empowered to enact environmental law (Palerm, 1999). Spanish national law regarding environmental impact assessment provides minimum standards. The assessment process varies considerably among the autonomous communities, which cannot be adequately addressed in the space of this summary.

Assessment Process

Decree 1131/1988 stipulates that works, installations, and activities within a number of sectors, including transportation construction, are required to submit to environmental impact assessment, except for defense projects or when specifically mandated by Spanish law. Exceptions to the requirement for environmental impact assessment are possible but must be made public. Enforcement is under the responsibility of the General Directorate for the Environment within the Ministry of Public Works and Urban Planning. Law 27/2006 (2006) creates a right to information and public participation that was clearly meant to be interpreted broadly, which applies to those affected by an action or policy, those responsible for it, and supporters of the environment.

Under national law (Decree 1131/1988) environmental impact statements include the following:

- Description of the project and its actions;
- Examination of technically viable alternatives and justification of choice;
- Environmental inventory with a description of key ecological and environmental interactions;
- Impact appraisal for all alternatives, including the one chosen;
- Abatement and corrective measures;
- Monitoring programs; and
- Synthesis of the above elements.

Methods Implemented

Under national law, public and private entities may be required to prepare environmental impact statements for most sectors of the economy, including transportation. Spanish law allows for the application of the concept of environmental impact assessment to the breadth of planning and policy development, although the national law stops well short of mandating this. Strategic Environmental Assessment has been described as a voluntary approach at the national level, by which environmental impact assessment is addressed at all stages of planning and policy development (Arce and Gullón, 2000).

Catalonian law incorporates this approach and applies it to mobility planning, which includes bus and light rail transit (Law 27/2006). The capital of the Basque autonomous community, Vitoria-Gasteiz, conducted an environmental impact assessment of its sustainable mobility plan in 2007.

Coverage of Impacts

The Sustainable Mobility Plan of Vitoria-Gasteiz (Basque Country) includes the following:

- Air pollutants – SO_2, NO_2, PM_{10}, CO, and ozone; and
- Noise pollution.

References

Arce, R. Gullón, N. 2000. The Application of Strategic Environmental Assessment to Sustainability Assessment of Infrastructure Development. Environmental Impact Assessment Review 20 (2000) 393-402.

Ayuntamiento de Vitoria-Gasteiz. 2007. Plan de Movilidad Sostenible y Espacio Público Avance Sección 4.7 Impacto Ambiental. Accessed April 9, 2010 at http://www.vitoria-gasteiz.org/wb021/http/contenidosEstaticos/adjuntos/23980.pdf.

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Ministerio de Medio Ambiente y Medio Rural y Marino. (2009) Spain's Communication to the European Commission, Article 3.2 (a), (b), (c), and d) of Decision 280/2004/CE.

Royal Legislative Decree 1302/1986 of June 28 [1986] Regarding Environmental Impact Evaluation. BOE No. 155 June 30, 1986. Accessed April 9, 2010 at http://www.cne.es/cne/doc/legislacion/MA_RDL1302_1986_LN.pdf.

Royal Legislative Decree 1131/1988 of September 30 [1988] by which Regulations Are Approved for the Implementation of Royal Legislative Decree 1302/1986 of June 28 [1986] Regarding Environmental Impact Evaluation. BOE No. 239 Wednesday, October 5, 1988. Accessed April 9, 2010 at http://medioambiente.xunta.es/pdf/autorizacionIntegrada/p11ke02c.pdf.

Autonomous Community of Catalonia Law 6/2009, of April 28 [2009], Regarding Environmental Evaluation of Plans and Programs. BOE No. 123 Thursday, May 21, 2009. http://www.eia.es/web/04/leg_autonomica/Catalu%C3%B1a/Ley%206_2009%20de%20EA%20de%20planes%20y%20programas.pdf.

Palerm, J. R. 1999. Public Participation in Environmental Impact Assessment in Spain: Three Case Studies Evaluating National, Catalan and Balearic Legislation. Impact Assessment and Project Appraisal 17 (1999) 259-271.

Spain's Communication to the European Commission, Article 3.2 (a), (b), (c), and d) from the Decision 280/2004/CE. Accessed April 9, 2010 at http://www.mma.es/secciones/cambio_climatico/pdf/dec280_final.pdf.

■ United Kingdom

The United Kingdom has been at the forefront of the development of new procedures to incorporate an expansive approach to transport policy development. Their process largely followed the guidelines specified in European directives on Strategic Environmental Assessment as early as 1998, and they have continued to refine their process, including a major revision currently in the draft stages as this document was being prepared. The United Kingdom's approach also has been the basis for other countries' assessment processes, including Australia and New Zealand. The key component of the UK process is a simple summary of the results of a detailed analysis, easily understood by policy-makers and nontechnical interest groups alike.

Process

The overall goal of environmental assessment in the United Kingdom is to provide detailed guidance distilled into succinct information consumable by policy decision-makers, as well as the general public. The appraisal and study process should, at all levels, be consistent with the following goals:

- Be easily comprehensible, to those commissioning, steering, and undertaking the work; and where possible to a wider public;
- Avoid leading to a particular outcome simply by virtue of the method or process adopted;
- Enable a wide range of solutions and the synergy between combinations of components to be investigated in a cost-effective manner;
- Enable a preferred solution to be developed which addresses the objectives and problems at which it is aimed; and
- Provide a means by which the acceptability of the solution to the public can be tested and taken into account.

The assessment process incorporates the New Approach to Appraisal (NATA) process, with five objectives specified by government policy:

1. Environmental;
2. Safety;
3. Economy;
4. Accessibility; and
5. Integration.

The NATA process is carried out in the following steps:

- Agreeing to a set of overall objectives;
- Analyzing present and future problems of, or relating to, the transport system;
- Exploring potential solutions for solving the problems and meeting the objectives;
- Appraising options, seeking combinations which perform better as a whole than the sum of the individual components; and
- Undertaking supporting analyses of practicality and public acceptability; affordability and financial sustainability; and distribution and equity.

European guidance requires EIA for transportation projects (Planning Policy Guidance 13: Transport). Strategic environmental assessment (SEA) of Local Transport Plans and Regional Transport Strategies "is required under European Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment" (Department for Transport, 2010), and SEA is integrated into the NATA process outlined above.

As part of the multiscalar process, local governments also prepare five-year Local Transport Plans to guide the national government on funding decisions.

Methods Implemented

An *Appraisal Summary Table* (AST) is the primary product of the process described above. An AST is a one-page summary of the major economic, environmental, and social impacts of a transport solution. The target audience for this document is policy-makers and decision-makers who need concise, accurate, and reasonably objective information in order to decide on the appropriate policy or action.

The methods implemented in the development of an AST are based on established techniques from other environmental, social, and economic estimation practices. The four most common among these are transport or land-use/transport interaction models; cost/benefit analysis; environmental impact assessment; and a geographic information system. The goal of the AST is to bring these information sources together into a clear and concise document, "without giving prominence to any one type of effect or to benefits expressed in monetary terms compared with those which cannot be monetized" (Department for Transport, 2010).

In addition to the AST, local governments are required to prepare detailed cost/benefit analyses of local projects and present them as part of a five-year Local Transport Plan. Local governments also prepare Transport Assessments "where a proposed development is likely to have significant transport and related environmental impacts" (Department for Transport, 2007). The Transport Assessments take an iterative approach, addressing the following issues:

- Reducing the need for travel, especially by car;

- Sustainability and accessibility – Promote accessibility by all modes of travel;
- Dealing with residual trips – Provide accurate quantitative and qualitative analyses of the predicted impacts of residual trips and proposed management of the impacts; and
- Mitigation measures – Ensure mitigation measures promote innovative solutions and minimize physical highway improvements.

The contents of a Transport Assessment report include:

- Introductory facts;
- Scoping study;
- Assessment;
- Measures to influence travel behavior;
- Identification of impacts and mitigation measures; and
- Implementation mechanisms.

Also included are additional refinement steps for mitigation of residual trips and additional alterations to influence travel behavior.

Impacts

The AST represents a high-level policy document that provides a coherent summary of the various impacts of the plan or program that is being assessed. The impacts an AST is meant to include are shown in Table 5.1.

Table 5.1 Items in U.K. Appraisal Summary Table

Environment	**Economy**
Noise	Transport Economic Efficiency
Local Air Quality	Reliability
Greenhouse Gases	Wider Economic Impacts
Landscape	
Townscape	**Accessibility**
Heritage of Historic Resources	Option Values
Biodiversity	Severance
Water Environment	Access to the Transport System
Physical Fitness	

Table 5.1 Items in U.K. Appraisal Summary Table (continued)

Environment	Economy
Journey Ambience	**Integration**
	Transport Interchange
Safety	Land Use Policy
Accidents	Other Government Policies
Security	

These are organized according to the five overarching objectives of government policy. The table provides a simple format for assessing tradeoffs. For example, a more expensive project might have less environmental impact, allowing the decision-maker to make this explicit judgment. Detailed analysis underlies each of the specific measures, but can range from quantitative analysis to more qualitative judgments.

Specific techniques for analyzing impacts can be found in the UK Design Manual for Roads and Bridges (http://www.standardsforhighways.co.uk/dmrb/). In particular, quantitative methods are included for air quality assessment, noise calculations, and vibrations. Decibel rating scales for noise, based on a mathematical model, are provided (similar to NPL, 2005). Water environmental quality standards are assessed in four main categories: effects of routine runoff on surface waters; effects of routine runoff on groundwater; pollution impacts from accidental spillages; and assessment of flood impacts (Highways Agency, 2010).

References

Department for Transport, 2007. Guidance on Transport Assessment. Accessed at http://www.dft.gov.uk/pgr/regional/transportassessments/guidanceonta.

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Europa, 2010. Summaries of EU legislation. Accessed at http://europa.eu/legislation_summaries/environment/.

Highways Agency, 2010. Design Manual for Roads and Bridges. Accessed at http://www.standardsforhighways.co.uk/dmrb/.

■ European Examples of Strategic Environmental Assessment

The SEA of the High-Speed Rail Network (HSR) for Europe

The outline plan drawn up in 1990 envisioned 9,800 km of new lines and 14,400 km of upgraded lines by 2010. The study was multimodal in nature and compared the impact of High-Speed Rail with other modes such as roads and air transportation (ECMT, 1998).

Scope. This assessment involved a high degree of abstraction as the exact location of the proposed railway lines had not been decided. Thus, this provided a good overview of alternative modal choices from a high-level policy assessment. Lack of detailed information made it difficult to assess local impacts such as noise and visual impacts. Global warming, congestion, air pollution, traffic safety, energy consumption, and some spatial impacts were assessed.

Methods. Aggregation of impacts was limited. It was not possible to use GIS as the exact siting of the railway lines was not decided at that time. Traffic models were used, but indirect effects were not included. Alternatives were limited to infrastructure alternatives; tolls and economic policies were not included in the analysis. Scenarios were considered for uncertainty analysis.

Results. The SEA concluded that the high-speed railway will have positive impacts on greenhouse gas emissions, emissions of air pollutants, energy consumption, and traffic safety. It will consume about 80,000 hectares of land. The SEA was not able to assess noise, visual impacts and impacts on congestion because the exact routes had not yet been fixed at the time of the study.

Source: European Conference of Ministers of Transport (ECMT), 1998, Strategic Environmental Assessment in the Transport Sector, Paris.

The SEA of Proposed Route Alternatives for the Antwerp-Rotterdam HSR

This study was conducted between 1994 and 1997 to choose the route for a high-speed rail connection between Antwerp in Belgium and Rotterdam in the Netherlands. This was especially significant because of the two different planning systems involved and the inclusion of transboundary effects into consideration. The spatial and economic impacts, natural environment, traffic, and construction costs for each route were studied in this SEA. In particular, the SEA focused on protecting open spaces in Flanders, avoidance of noise is quiet zones in the Netherlands and the spatial development of the Netherlands.

Source: Strategic Environmental Assessment in the Transport Sector, European Conference of Ministers of Transport.

Helsinki Metropolitan Area Transport System Plan 1998

This was a systemwide SEA and, therefore, included all modes of transport. The scope of the environmental assessment included air quality, noise, built environment, landscape, biodiversity, and social conditions. The methods used were traffic-use forecasts, quantifying land use – transportation interactions and measurement of economic impacts of large projects. Pricing was one of the options considered in the alternatives, as were methods to increase competitiveness of nonmotorized modes and transit.

Sources: Kaljonen (1999), The role of SEA in Planning and Decision-Making: the case of the Helsinki Metropolitan Area Transport System Plan 1998, Proceedings from the third Nordic EIA/SEA Conference; Jansson (1999), Strategic Environmental Assessment for Transport in Four Nordic Countries, Proceedings from the third Nordic EIA/SEA Conference.

Gothenburg – Jonkoping Transportation Corridor

This was a Swedish multimodal study which included transit components. Bina characterizes the Swedish approach to the SEA as one based on questions.

Bina also notes the use of traffic, energy consumption, and emission models in the study, as well as the integration of the SEA with a cost/benefit analysis. In the cost/benefit analysis, the direct capital and operating costs, road safety and accessibility costs, environmental impact costs and regional distribution costs are accounted for. Similarly, benefits include income from rail services and travel-time gains. For environmental costs, willingness-to-pay is used as a measure of the cost of mitigating environmental damage from development.

Sources: Bina O., Strategic Environmental Assessment of Transport Corridors: Lessons learned comparing the methods of five member-states, Environmental Resources Management 2001; Jansson (1999), Strategic Environmental Assessment for Transport in Four Nordic Countries, Proceedings from the third Nordic EIA/SEA Conference.

SEA of the Dutch Zuider Zee Line

The Zuider Zee Line connects Amsterdam to Groningen. This study compared various types of rail links for their impacts, including their environmental impacts (which were monetized for the purpose of the cost/benefit analysis). Indicators considered were emissions of CO_2, NO_x, and SO_2, energy consumption, landscape, noise levels and area exposed to noise, and costs of mitigation of environmental impacts. These impacts then were monetized and included in a cost/benefit analysis of the Zuider Zee Line.

Source: Wee, Brink and Nijland (2003), Environmental impacts of high-speed rail links in cost/benefit analyses: a case study of the Dutch Zuider Zee line.

SEA of HSR in Portugal

The scope of the SEA was quite broad. It considered the need for high-speed rail, the networks which were proposed, and the corridors that had been proposed for each connection. A cost/benefit analysis was done and the following costs were considered: accidents, noise, air pollution, climate change, nature and landscape, urban effects and upstream process associated with transport. GIS was used in the assessment of environmental impacts. The balanced scorecard method was applied to the monitoring phase of the SEA.

Source: Coutinho et al, Strategic Environmental Assessment of the High-Speed Rail Network in Portugal (last accessed at: http://www.ua.pt/idad/ReadObject.aspx?obj=9464).

■ Specific Methodological Tools

The European Commission recently released a report that lists various methodological tools that can be applied in the environmental assessment of transport projects (EC DG-TREN, 2009). The specific categories of impact tools are as follows:

- Cause effect modeling;
- Screening – Ecological risk assessment tools;
- Transport forecast models;
- Coupled land use/transport models;
- Calculation of emissions and exposure;
- Cost/benefit analysis;
- Life-cycle assessment;
- Intelligent GIS;
- Decision support tools for multicriteria assessment (MCA); and
- Information sharing, group decision taking and public involvement tools.

Some of these are clearly specific to European practice, such as techniques for emissions modeling, on which EPA already provides guidance. Some are locally oriented, such as transport forecast and land use models, the latter including methods such as URBANSIM and MEPLAN. Cost-Effectiveness analysis is included in the New Starts process, but European practice extends cost/benefit analysis to all modes. Items listed under cause/ effect modeling include Bayesian inference (e.g., WINBugs) which are probably not realistically applicable for assessing environmental impacts. Overall, the list in their documentation may provide some useful guidance, but much of it is probably not useful.

Reference

EC DG-TREN, 2009, The SEA Manual: Fact Sheets, A Sourcebook on Strategic Environmental Assessment of Transport Infrastructure Plans and Programmes.

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