AN ANALYTICAL FRAMEWORK FOR SUSTAINABILITY ANALYSIS OF TRANSPORTATION INVESTMENTS ACROSS THE TRIPLE BOTTOM LINE USING A COMMON METRIC

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ABSTRACT

Investments in a more sustainable future require consideration of a comprehensive range of inter-related objectives. Transportation investment decisions affect the entire Triple Bottom Line (TBL) of economy, environment and society. Lacking some common metric, choices among competing objectives remain subject to vagaries of opinion between stakeholders. Establishment of a unifying approach to sustainability assessment is of particular importance to those seeking systematic methods for the restoration of ecological services as they relate to the existing transportation system.

Benefit- cost analysis (BCA) has proven to be an effective tool for arriving at clear, transparent analytically based decisions for the optimization of investments in mobility and safety (*Gunasekera and Hirschman 2012*). Using monetary terms, investment benefits can be adjusted for the time value of money. In this manner, user benefits and project costs over time can be expressed in terms of "present value" to facilitate decisions and discussion. A vast body of research is available on the optimization of monetary benefits. However, environmental and social effects as addressed in environmental assessments have typically not been monetized, and are typically *not* included in BCA fashion.

Multi-criteria analysis (MCA) approaches have been used for some time to evaluate projects. In an MCA framework, the actual measurement of indicators need not be in monetary terms, but can be based on the quantitative analysis (through scoring, ranking and weighting) of a wide range of qualitative impact categories and criteria. This approach is currently being applied in a number of emerging sustainability metrics and rating systems, and has done much to encourage and highlight the use of "best practices."

This presentation will review MCA transportation sustainability rating tools and describe an extension of BCA for the quantification and optimization of transportation program and project benefits within a TBL construct and describe a current application of the approach as applied in Minnesota.

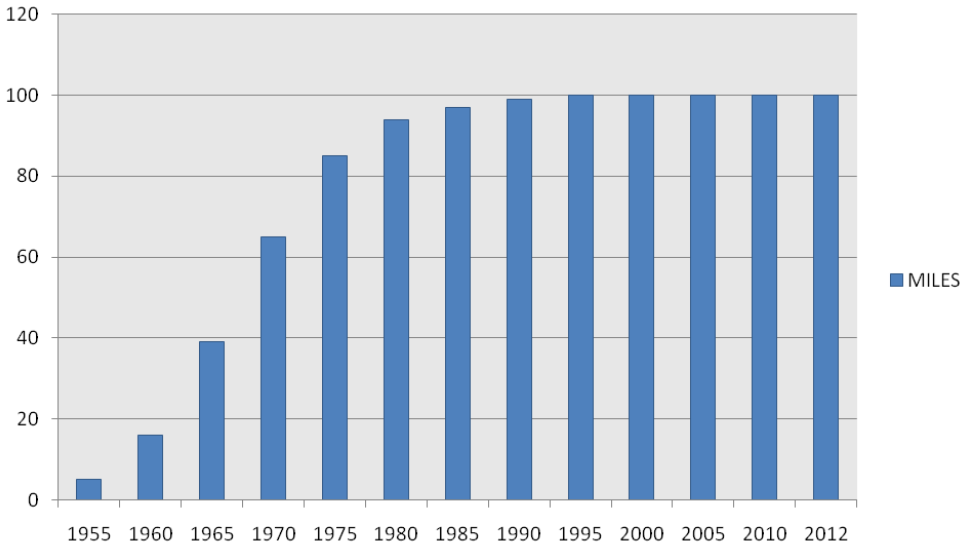
INTRODUCTION

Investments in a more sustainable future require consideration of a comprehensive range of inter-related objectives. Ecological concerns should be among them. This paper reviews some of the tools and processes used in the tradeoff analyses needed by transportation agencies in support of a more sustainable society.

"First do no harm" - Statutory protections

As appropriate for the time, the 1970's saw the development of statutes and regulations designed to protect the environment in general and preserve ecological functions in particular through such programs as the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), and Section 404 of the Clean Water Act. These protections remain important, but as shown in Table 1 from *NCHRP 25-25/Task 73 Improved Environmental Performance of Highway Maintenance (McVoy, 2012)*, the US Interstate Highway System is essentially complete for at least the time being and has been for some 30 years. Similarly, the National Highway System is growing at a rate of only about one quarter of one percent per year, according to USDOT statistics (*http://www.fhwa.dot.gov/policyinformation/statistics/2010/vmt422.cfm*).

TABLE 1 Interstate Miles Per Year



Source**:** *http://www.publicpurpose.com/hwy-intmiles.htm*

Thus, much if not most, of the ecological damage that could impact ecological systems from construction of the national highway system has already been done (though local developments continue, albeit at a slower pace). So, after some 40 years of protecting ecological systems from highway encroachment, it is becoming at least as important to seek systematic methods for the restoration of ecological services as they relate to the existing highway system as it is to study impacts from additions to the national system.

Beyond NEPA

While NEPA documents contain a wealth of data on environmental impacts, the information is typically reported in disparate units and not all sustainability concerns are well addressed. Over the past decade, several approaches to the larger questions of ecological restoration and balancing of system benefits and impact from a larger perspective have been developed. While all of these tools accommodate project specific environmental impacts to at least some degree, they also address larger sustainability issues implicit in the Brundtland Definition and the "Triple Bottom Line" questions. As such they tend to "go beyond" the inherently reactive and limited analysis of environmental impacts to include economic and social concerns and lend a useful perspective on the values implicit in adjustments to the existing transportation system.

One example of moving beyond a focus on project-specific impacts is an approach detailed in *Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects* (*FHWA 2006*). This report was developed over a three year period by eight federal agencies and four state DOTs. The intent was to develop a framework to address the greatest conservation needs associated with infrastructure projects. The premise is that agencies need to partner and cooperate to identify those improvements and enhancements that will best restore fragmented habitats, reduce wildlife mortality and achieve a number of environmental goals.

According to the report, the approach to "avoid, minimize, mitigate" infrastructure impacts is often limited to the specified boundaries of a project area. However, sensitive resources may be located outside of this boundary, but still within the influence of the agencies involved. Efforts to mitigate impacts may not always provide the greatest environmental benefit, or may do little promote overall ecosystem sustainability. The goal outlined in the *Eco-Logical* approach is to take a broader view of environmental impacts by analyzing the needs of the ecosystem as a whole, and target priority environmental resources whether inside or outside of the immediate project boundaries. This approach helps focus an agency's (or multiple agencies') finite set of financial resources on significant environmental issues system wide. *Eco-Logical* puts forth the conceptual groundwork for integrating plans across agency boundaries, and endorses ecosystem-based mitigation - an innovative method of mitigating infrastructure impacts that cannot be avoided.

Multi-criteria analysis / Green Infrastructure Rating Systems - Strengths and Limitations

Multi-criteria analysis (MCA) approaches have been used for some time to evaluate projects. In an MCA framework, the actual measurement of indicators need not be in monetary terms, but can be based on the quantitative analysis (through scoring, ranking and weighting) of a wide range of qualitative impact categories and criteria. This approach is currently being applied in a number of emerging sustainability metrics and rating systems, and has done much to encourage and highlight the use of "best practices."

One of the manifestations of growing sustainability awareness within state DOTs (and more generally in infrastructure-related organizations) has been the recent development and use of MCA green infrastructure rating systems (such as Greenroads™, GreenLITES, INVEST, Envision™, STARS, and ILAST, among others-See Table 2). These systems generally examine a range of factors associated with highway, transportation or infrastructure plans, programs or projects, and typically assign points reflective of the degree to which sustainability criteria are being achieved. Such rating systems, similar in concept to the U.S. Green Building Council's LEED certification process, generally assign scores to projects and agency actions that reflect a commitment to sustainability principles. Whereas LEED focuses on vertical construction, these rating systems focus on horizontal infrastructure where the sustainability implications can be even more complex as varying geographic, topographic, geological, environmental and community contexts are traversed.

Though similar in their use of criteria to measure sustainability practices, the systems and their applications are very diverse. Mode, project phase, and method of measurement are just a few of the differences among these systems. When evaluated together, continuums of form and complexity are evident. Some systems are open, online self-assessment tools that may be completed within a few hours. At the other end of the continuum are proprietary systems that require detailed documentation, calculations and deliverables, and are submitted to and reviewed by a third party entity for a fee. All of the systems are relatively new and evolving, and none have emerged as the predominant system. Since no one system has become the "national standard," a strong understanding of each is important before deciding which is the most appropriate to an agency's expectations and requirements.

Envision™ was developed by the Institute for Sustainable Infrastructure (ISI) in cooperation with the Zofnass Program for Sustainable Infrastructure at the Harvard Graduate School of Design. ISI is a not-for-profit education and research organization founded by three professional and industry organizations (ASCE, APWA and ACEC). According to the ISI website, each of the founding organizations were developing sustainable infrastructure programs and saw the need to work together to produce a standardized framework for documenting sustainability practices. The most recent version of Envision™ was released in February 2012. Unlike the other rating systems discussed here, the Envision™ Version 2.0 system covers infrastructure in general – dams, water supply and treatment systems, energy transmission and distribution – and all modes of transportation. It covers planning, design, construction and maintenance. Key attributes of EnvisionTM include:

- Founded by three professional/industry organizations and a university who brought their collective expertise to the table
- Broader than other systems in covering civil infrastructure
- Addresses planning, design, construction and maintenance
- 4-Stage set of tools at varying levels of complexity (self-assessment checklist, third-party rating, multi-stage project tool and optimization support tool – checklist is fully operational)
- Requires a Sustainability Professional trained in the system to guide the team; and requires a Verifier to review and confirm points

Green Leadership in Transportation Environmental Sustainability, known as GreenLITES, is a self-certification program originally issued in 2008 by the New York State Department of Transportation (NYSDOT). It is intended to serve as an internal management program for NYSDOT to measure sustainability performance, recognize good practices, and identify opportunities for improvement across planning, design, construction, maintenance and operations programs as needed. In addition, NYSDOT has encouraged others to use, improve and modify the system to fit their own unique needs. This has been and is being done in several other states such as Illinois and Colorado who have initiated their own systems modeled after GreenLITES. GreenLITES has several certification programs for planning, design and operations. GreenLITES key attributes:

- Internal program led by a State DOT (NYSDOT); certification process is embedded within the NYSDOT Plans, Specifications & Estimates (PS&E) process. Generally, all regional programs and individually advertised and awarded projects are evaluated under GreenLITES.
- Hundreds of projects and dozens of programs have been through the process, making GreenLITES the rating system applied to the most projects, albeit within the geographic confines of one state.
- Open approach encourages other states to utilize and improve upon the system for their own needs, and some have done so.
- Assessment of operations and maintenance is keyed to routine activities and is keyed to their planning cycle.

Greenroads™ is a rating system focused on roadway design and construction. Initiated as a Master's thesis published in 2007, Greenroads™ is now managed by the Greenroads Foundation, a non-profit third party corporation established to manage certification reviews. Version 1.5 of the Greenroads™ Manual was published in February 2011. Greenroads™ has 11 project requirements and 37 voluntary credits that total 108 possible points. The project requirements represent a minimum set of credits that must be met and are considered characteristics common to all Greenroads™. Project applicants submit materials to the Foundation for review with a fee calculated as a percentage of the overall project capital cost. Greenroads™ is intended to assist owners and consultants in designing and constructing more sustainable roadways. Greenroads™ also has a marketing component to give recognition to agencies and help raise awareness of sustainability efforts. Greenroads™ key attributes:

- Fee-based third-party certification system.
- Detailed implementation framework and system of credits.
- The system focuses primarily on the design and construction phases of a project, and less on the early planning stages.

FHWA's INVEST is a voluntary rating tool that can be used by states or other project sponsors to measure sustainability on roadway projects. Initially published online (*www.sustainablehighways.org*) as a Beta version in 2010, Version 1 was released in October 2012. INVEST has separate scorecards for system planning, project development and operations and maintenance. The system is structured to give points for Environmental Management System (EMS) type elements including planning, goal-setting, metric development, implementation tracking, and auditing. Per the FHWA website, the tool is intended to provide a method for practitioners to evaluate their transportation projects and to encourage progress in the sustainability arena. It is not intended to encourage comparisons across transportation agencies and projects. INVEST key attributes:

- Led by a federal agency (FHWA).
- Online, voluntary self-assessment tool.
- Extends across all major phases of a project's lifecycle.
- Captures social, economic and environmental credit categories and indicates which of the triple bottom line components each credit addresses.

STARS is an integrated planning framework for transportation plans and projects developed by the North American Sustainable Transportation Council (STC). The STC, rooted in Portland, Oregon with a municipal agency, was founded in 2009 with the intent to develop a system to promote sustainability in the transportation sector. The STC has developed a family of tools to assist transportation agencies and professionals seeking sustainable solutions for their plans and projects. To date, the STC has developed two manuals, including STARS-Project and STARS-Plan, as well as the STARS Safety, Health, and Equity Credits to supplement STARS-Project. The STARS family of tools is intended to help identify the most sustainable solution to transportation projects and plans. STARS key attributes:

- Focus on lifecycle costs and benefits (20 to 50 years)
- Most useful as a comparison of alternatives in the planning phase; less emphasis on construction, operations and maintenance.
- Intended to be utilized alongside the FTA Alternatives Analysis and NEPA processes.
- The STARS manuals provide guidance for establishing goals around each credit topic area. The process of identifying the goals prior to technical analysis allows decision makers and stakeholders to set goals without the influence of existing data.

TABLE 2 Green Infrastructure Rating System Characteristics

System	Sponsor	Scope	Organization	Review/ Certification	Construction-Related Factors
Envision™ Version 2.0	Institute for Sustainable Infrastructure	Infrastructure	60 credits in five categories (Quality of Life, Leadership, Resource Allocation, Natural World and Climate and Risk); bonus point opportunity	Stage 1: Self-assessment and Stage 2: Fee-based review	13 credits focused on materials, energy and water under Resource & Allocation Category
GreenLITES	New York State DOT	Highways	Design / Construction checklist includes 180 criteria; and other modules cover planning through operations and maintenance	Self-Assessment	Credits interspersed throughout the checklist; focused within Water Quality, Materials and Resources, and Energy and Atmosphere
Greenroads™	Greenroads Foundation	Highways	11 Project Requirements; 37 Voluntary Credits; focused on design and construction	Fee-based review	8 credits in Construction Activities; 6 credits in Materials and Resources; 5 credits in Pavement Technologies
INVEST 1.0	FHWA	Highways	3 Checklists: System Planning (16 criteria), Project Development (29 criteria, and Operations and Maintenance (14 criteria)	Self-Assessment	Factors within Project Development scorecard include emission reduction, noise mitigation, quality control, warranties, etc.
STARS	North American Sustainable Transportation Council (STC)	Multi-Modal Transportation	STARS Project: 29 credits organized in 6 categories: Integrated Process, Access, Climate and Energy, Ecological Function, Cost Effectiveness Analysis, and Innovation. STARS Plan: 8 credits STARS Employer Programs: not yet developed	Fee-based review	2 credits in Climate and Energy and 3 credits in Ecological Function

Source: Parsons Brinckerhoff, 2012

Rating Systems Summary

While green infrastructure rating systems are useful tools in evaluating and enhancing transportation project sustainability, the level of time and resources needed to achieve certification under these different systems varies. The following are considerations for agencies in deciding between rating systems:

- Integration with existing agency sustainability policies: How will the rating system help meet broader climate change goals or other applicable policies?
- Primary users: Project managers? External to agency? What is the level of training needed?
- Required versus voluntary: How widespread will the system be applied? To what extent will agency resources be devoted at the project level?
- Project tracking: How will innovative practices be tracked over time to ensure continual improvement?

While some agencies have begun to use these systems "off the shelf," others have developed their own systems customized to their existing policies and geographical conditions. This effort is primarily happening at the state DOT level. In these and other efforts to apply multi criteria analysis to transportation sustainability, many are finding inherent limitations; namely the arbitrary nature of the rating weights and the lack of basis for a "business case" for the practices. This has led some to revisit the use of benefit cost analysis to overcome these limitations.

BENEFIT-COST ANALYSIS

Benefit-cost analysis (BCA) has proven to be an effective tool for arriving at clear, transparent analytically based decisions for the optimization of investments in mobility and safety (*Gunasekera and*

Hirschman 2012). Not only can rankings / factor importance be expressed in dollar values linked to market realities and accepted standards, but investment benefits can also be adjusted for the time value of money. In this manner, user benefits and project costs over time can be expressed in terms of "present value" thereby facilitating more sustainable choices (see *Hirschman, Gunasekera, Wood 2010*). A vast body of research is available on the optimization of monetary benefits (see *Munasinghe, Sunkel, Miguel & Gunasekera 2001*). However, environmental and social effects as addressed in environmental assessments have typically not been monetized to a large degree, and are typically *not* included in BCA. In recognition of this shortcoming, recent efforts have used various means to more comprehensively address a range of Triple Bottom Line sustainability factors.

Sustainable Return on Investment/Sustainable Lifecycle Costing

Triple Bottom Line tools that have been available for some time and have been used to varying degrees in a variety of applications including the US DOT TIGER and New Starts Programs. The concept is simple and elegant. To achieve flexibility, transparency, and objectivity on a quantitative basis, all of the relevant factors are first translated into dollar equivalents so that an initial rough tradeoff analysis can be developed using standard econometric techniques. Table 3 from the Federal Register illustrates the types of benefits that factor into TIGER considerations.

TABLE 3 U.S. DOT TIGER Considerations

Long-Term Outcome	Type of Societal Benefits
Livability	Land Use Changes that reduce VMT Accessibility Property Value Increases
Economic Competitiveness	Travel Time Savings Operating Cost Savings
Safety	Prevented Accidents (property damage), Injuries and Fatalities
State of Good Repair	Long Term Replacement Maintenance & Repair Savings Reduced VMT from not closing bridges
Environmental Sustainability	Environmental benefits from reduced emissions

Source: Federal Register Volume 77, No. 20, January 2012.

Of these, the value of travel time savings in dollars per person hour, the value of a "statistical life," the value of injuries, the costs of air pollutant emissions including Volatile Organic Compounds (VOC's), Nitrogen oxides (NOx), Particulate Matter (PM), and Sulfur Dioxide (Sox) are monetized in dollars per ton; while the social cost of carbon is calculated on the basis of tons per given year. Further, the program encourages applicants to address the valuation of a more complete range of metrics as practicable.

Similarly, the Draft New Starts DOT Transit Program includes these same metrics together with direct capital and operating costs along with station area development, parking and affordable housing (Table 4).

TABLE 4 New Starts Cost Effectiveness Breakpoints
Annualized Capital and Operating Costs Per Trip

Rating	Range
High	<$4.00
Medium-High	Between $4.00 and $5.99
Medium	Between $6.00 and $9.99
Medium-Low	Between $10.00 and $14.99
Low	>$15.00

While the TIGER and New Starts Programs are typically focused on capital projects, Table 5 from *NCHRP 25-25/Task 73 Improved Environmental Performance of Highway Maintenance (McVoy 2012),* has suggested how sustainability life cycle costing might apply to a wide range of maintenance activities with an eye toward "ecological restoration" as a normal part of highway system maintenance. Table 5 shows maintenance activities as they relate to a range of triple bottom line factors.

TABLE 5 Maintenance Activities and the Triple Bottom Line

MAINTENANCE -- TRIPLE BOTTOM LINE TABULATION

Program	Activity	Cycle (yrs)	#	#/YR TARGET	# STATE FORCES	# CONTRACT	LIFECYCLE $ CAPITAL $	STATE CASH $	MOBILITY $	JOBS $	AIR $	WATER $	HABITAT $	SAFETY $	ACCESS $	LIVABILITY $	BENEFIT / COST
Bridges	Bridge Cleaning						X	x	y								X
	Bridge Painting							X	x	y							X
	Deck Sealing							X	x	y							X
	Deck Treatment							X	x	y							X
	Joints							X	x	y							X
	Bearing Restoration							X	x	y							X
	Punch list From Inspection							X	x	y							X
	Environmental Protection									y	x	x	x				X
	Storm Water Facility									y	x	x	x				X
	Stream Channel									y	x	x	x				X
	Check for Invasive Species									y	x	x	x				X
	Regulatory Cost (Fines)						x			y	x	x	x				X
	Safety								x	y				x	x	x	X
	Public Parking / Access									y				x	x	x	X
	Historic / Cultural Signing									y				x	x	x	X
Pavement																	
Drainage																	
Signals & Lighting																	
Roadside																	
Guiderail																	
Signs																	
SNOW & ICE																	
Facilities																	
$$ TOTAL																	

Minnesota DOT Sustainability Evaluation Example

As applied recently in Minnesota, MnDOT's new Corridor Investment Management Strategy (CIMS) provided $30 million under a competitive solicitation to fund trunk highway projects that improve quality of life, environmental health, and economic competitiveness to advance the state's Minnesota GO vision for transportation. Through CIMS, MnDOT placed a strong emphasis on building and maintaining a sustainable transportation system through the use of solutions that ensure high return-on-investment and complement the unique social, natural and economic features of Minnesota. The CIMS solicitation

intentionally cast a wide net for projects that address issues for which MnDOT has traditionally no system performance targets and were therefore unlikely to address through the normal programming process.

Using the PRISM™ analysis tool created by Parsons Brinckerhoff, MnDOT developed a series of evaluation metrics based on "dollar equivalents" for each project proposal considering a range of Triple Bottom Line factors (see *McVoy and Gunasekera 2011*). In each case, the number of units expected to be affected by the proposal was specified as a range of high, likely, and low number values. This distribution was then combined with a low, likely and high range of valuations as derived from literature review and discounted back to "present value." The factors considered include:

- Safety
- Bicycle/pedestrian health effects
- Noise
- Travel time
- Travel time reliability
- Vehicle operation costs
- Lifecycle costs
- Loss of agricultural land
- Urban boulevard trees
- Wetland effects, and
- Runoff

These factors are evaluated using PRISM (See Table 6).

TABLE 6 Corridor Investment Management Strategy Pilot Solicitation

Data Requested	Safety	Bicycle/Pedestrian Health	Noise	Travel Time	Travel Time Reliability	Vehicle Operation Costs	Lifecycle Costs	Agricultural Land	Induced Economic Activity	Emissions	Wetland Effects	Runoff
Vehicle Miles Traveled	✓		✓			✓				✓		
Vehicle Hours Traveled				✓	✓							
Average Bus Headways				✓								
Average Bus Occupancy				✓								
Bicycle Miles Traveled		✓		✓								
Pedestrian Miles Traveled		✓										
Annual Number or Rate of Crashes	✓											
Average Speeds			✓							✓		
Annual Average Daily Traffic			✓									
Quantity of Wetlands Affected											✓	
Quantity of Agricultural Land Affected								✓				
Site Area Acres												✓
Site Composition by Ground Cover Type												✓
Contribution to Combined Sewer Outflow												✓
Initial Construction Costs							✓		✓			
Operating and Maintenance Costs							✓					
Rehabilitation Costs							✓					
Infrastructure Replacement Costs							✓					
Expected Lifecycle of Major Capital Items							✓					

Other impacts may be included the PRISM B/C calculation provided analysis has already been done to estimate the benefits. Examples: Brownfield site cleanup benefits, energy supply impacts, "green" technology lifecycle cost savings, impact to species habitat, etc.

In addition to the PRISM™ criteria, other more qualitative factors were evaluated by an interagency selection committee to yield a final list of priority projects to maximize public return on investment. These included the following:

- Local Economic Impacts
  - Creation/retention of non-project construction jobs relative to the size of the project
  - Improves access for designated tourist destinations or schools/universities
- Context Sensitivity
  - Consistency with surrounding land uses
  - Avoids/minimizes impacts to or enhances natural, historical, archeological and cultural resources
- System Considerations
  - Closes or addresses a system gap
  - Adds redundancy to the system necessary to improve system reliability
  - Is consistent with existing plans for the region or corridor (Scenic Byway, MPO/Local Plans, etc.)
- Community Health and Access
  - Improves access to preventative and clinical health care facilities or recreational facilities
  - Avoids/minimizes negative impacts to or positively improves access for low-income or disadvantaged populations
- Multimodal Impacts
  - Includes Complete Streets treatment
  - Improves transit service, rail service (freight or passenger), access to airport/port/intermodal facilities, or conditions for pedestrians, bicyclists or other trail users

This approach represents one of the first efforts by a DOT to use the dollar equivalent approach to transparently analyze a wide range of benefits and costs across the triple bottom line. This Triple Bottom Line Valuation builds upon the information typically contained in environmental analyses to bring economic and social factors onto a level playing field in a transparent and defensible manner across a full range of factors. By bringing analytical rigor to the principles of sustainability, the approach has helped focus dialogue and provided an enriched understanding of the potential benefits and impacts of infrastructure projects, plans, policies, and programs beyond that which would be possible using NEPA or conventional MCA tools. Further, the approach also lends itself to prioritization of retrofit activities on the same basis as capital improvement projects.

CONCLUSION

Both the nature and degree of transportation impacts and ecological opportunities have evolved since NEPA. The National Highway System is approaching build out and a broader perspective on sustainability is emerging within the transportation industry. As commonly practiced, NEPA is rightly focused on impact by impact avoidance, minimization and mitigation; but given that the preponderance of the "ecological footprint" of transportation is a result of the existing system, other tools are becoming increasingly important as maintenance of the existing system becomes more of a focus. Landscape scale approaches such as *Eco-logical*, and multi criteria green rating systems such as INVEST, Envision™, STARS, GreenLITES, and others can help identify and highlight a range of impacts and opportunities that are more in keeping with a systemwide look at sustainability. Analysis of this range of systemwide impacts and opportunities can be approached using Benefit Cost type analyses and this technique can be expanded to encompass a range of Triple Bottom Line sustainability factors using dollar equivalents as a first approximation to communicate and quantify values. Triple Bottom Line Valuation can contribute to the transparent and objective assessment of project prioritization on a programmatic basis and may be particularly useful for the ecological community as it works to ensure inclusion of ecological considerations on new projects & perhaps even more importantly, on maintenance of the existing system.

BIOGRAPHIES

Gary R. McVoy, PhD is Parsons Brinckerhoff's Transportation VP Sustainably & Climate, and conceptual lead for the PRISM tblv Model. Dr. McVoy served the New York State Department of Transportation as Director of Operations and Maintenance for some 8 years and bore that was the Agency's long standing Environmental Director where he lead the adoption of an environmental stewardship ethic that became a national model. Gary holds a Ph.D. in Environmental Science from Yale University and has been an industry leader and author of books, papers and presentations on a range of topics including Environmental Stewardship, Computer Modeling, Expert Systems, Asset Management, Maintenance Management, and Sustainability. Founding board member for the AASHTO Center for Environmental Excellence and research Coordinator for the Standing Committee on Environment, his work has been repeatedly recognized for "Exemplary Service in Furthering Transportation and the Environment". http://bulletin.pbworld.com/volumes/2013_04/perspectives.aspx

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