"The obligation of any component is to contribute its best to the system, not to maximize its own production, profit, or sales ... “

- Dr. W. Edwards Deming
Getting Down to Business
Sustainability Metrics and the Quantification of Project Value for Outreach, Programming, and MAP-21 (AMPO 2014, Atlanta GA)

- Background (What to quantify)
  - Transportation in service to a sustainable society
  - NCHRP Sustainability Maturity Assessment Model
- Rating Systems and Valuation Systems (How)
- Engagement / Communication (What & Why)
NCHRP Report 750: Strategic Issues Facing Transportation, Volume 4: Sustainability as an Organizing Principle for Transportation Agencies

Mission: Contribution to a sustainable society, Per Triple Bottom Line

Measurement: ~ $ Equivalents
Sustainability as an Organizing Principle:  
**MPO / DOT Organizational Assessment Tool**

NCHRP Report 750: Strategic Issues Facing Transportation,  
Volume 4: Sustainability as an Organizing Principle for Transportation Agencies,  

Gary R. McVoy, Ph.D.  
mcvoygr@pbworld.com  
Panel Chair

Focus of Sustainability Initiatives

LEVEL 0 - SAFE MOBILITY
- Supports societal mobility & safety
- Favors government ownership & control of the transportation infrastructure
- Transportation agency: infrastructure owner-manager and regulator

LEVEL 1 - COMPLIANT TRANSPORTATION
- Supports societal mobility, safety, environmental, economic, and social needs -- *Emphasizes Environment*
- Transportation agency: infrastructure owner-manager and regulator
- Top-down planning

LEVEL 2 - GREEN TRANSPORTATION
- Supports sustainable transportation
- Risk-sharing between public and private sector
- Infrastructure integrator (some owner-operator & some private)
- Regulator

LEVEL 3 - SUSTAINABLE TRANSPORTATION
- Supports sustainable transportation
- Risk-sharing between public and private sector
- Infrastructure integrator (some owner, some owner-operator, and some private)
- Regulator

LEVEL 4 - TBL SUSTAINABILITY
- Supports societal sustainability
- Broad agency decision-making partnerships
- Risk-sharing between public and private sector
- Infrastructure Integrator (some owner, some owner-operator, and some private)
- Regulator and steward partner
## Benchmarking Tool (Conversation Starter)

<table>
<thead>
<tr>
<th>Maturity Level</th>
<th>Characteristics</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Safe Mobility</strong></td>
<td>• Support societal mobility</td>
<td>8 to 11</td>
</tr>
<tr>
<td></td>
<td>• Favors government ownership &amp; control of the transportation infrastructure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Transportation agency as infrastructure owner–manager &amp; regulator</td>
<td></td>
</tr>
<tr>
<td><strong>Compliant Transportation</strong></td>
<td>• Support societal mobility</td>
<td>12 to 19</td>
</tr>
<tr>
<td></td>
<td>• Compliance with environmental, economic, and social legislative requirements</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Transportation agency as infrastructure owner–manager &amp; regulator</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Top-down, planning</td>
<td></td>
</tr>
<tr>
<td><strong>Green Transportation</strong></td>
<td>• Support societal mobility &amp; environmental, economic, and social needs—emphasizes environment</td>
<td>20 to 27</td>
</tr>
<tr>
<td></td>
<td>• Transportation agency as infrastructure owner–manager &amp; regulator</td>
<td></td>
</tr>
<tr>
<td><strong>Sustainable Transportation</strong></td>
<td>• Support sustainable transportation</td>
<td>28 to 36</td>
</tr>
<tr>
<td></td>
<td>• Favors partnerships between public and private sector</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Transportation agency as infrastructure coordinator &amp; regulator</td>
<td></td>
</tr>
<tr>
<td><strong>Support TBL Sustainability</strong></td>
<td>• Support societal sustainability</td>
<td>37 to 40</td>
</tr>
<tr>
<td></td>
<td>• Agnostic on issues of ownership or control of transportation infrastructure—whatever is most sustainable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Transportation agency as transportation system steward</td>
<td></td>
</tr>
</tbody>
</table>

Excel tool: mcvoygr@pbworld.com
## Agency functions

<table>
<thead>
<tr>
<th>High-Level Functions</th>
<th>Governance and Policymaking</th>
<th>Decision-making</th>
<th>Enterprise Management</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Consensus on Needs and Goals</td>
<td>Planning and Programming</td>
<td>Service and Product Delivery</td>
</tr>
<tr>
<td></td>
<td>Regulation and Rulemaking</td>
<td>Budgeting and Resource Allocation</td>
<td></td>
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<tr>
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<td>Outreach and Communications</td>
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<td></td>
<td>Compliance and Dispute Resolution</td>
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<tr>
<td></td>
<td>Education, Training, and Culture Change</td>
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</tbody>
</table>

NCHRP Report 750: Strategic Issues Facing Transportation, Volume 4: Sustainability as an Organizing Principle for Transportation Agencies

Sustainability Maturity Model Survey
as adapted by Panel Chair, Gary McVoy from Appendix F. NCHRP Report 750 Vol. 4; Sustainability as an Organizing Principle for Transportation Agencies


To “score” survey results by maturity level see Appendix F page 247 or contact mcvoygr@pbworld.com for a spreadsheet tool

https://www.surveymonkey.com/s/8BKKZ3H
The following benchmarking survey walks through eight agency functions as defined by the National Academies, Transportation Research Board NCHRP 750 report; Strategic Issues Facing Transportation, Volume 4: Sustainability as an Organizing Principle for Transportation Agencies (http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_750v4.pdf).

The survey is an adaptation of Appendix F, Triple Bottom Line (TBL) Sustainability Maturity Tool which is intended to aid transportation agencies in assessing their progress toward sustainability as an organizing principle.

This survey asks for your candid views on where your transportation agency stands in terms of its regular practices across eight high level functions on a progressive “Maturity Model” spectrum. The survey questions reflect the tool language and structure, and are purposefully phrased in the survey to be consistent with the tool in the report.

The survey should take about 15-20 minutes to complete.

Thank you for supporting a more sustainable future.
This survey is an adaptation of Appendix F, TBL Maturity Assessment Tool from NCHRP Report 750: Strategic Issues Facing Transportation, Volume 4: Sustainability as an Organizing Principle for Transportation Agencies (http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_750v4.pdf) developed as part of Project No. 20-83 (07) for the National Cooperative Highway Research Program (NCHRP), Transportation Research Board of the National Academies. The Sustainability Maturity Model is intended to aid transportation agencies in assessing their progress toward sustainability as an organizing principle based on a sustainability maturity model developed as part of this project. A schematic for the model is shown below:
1. Please indicate which of the following best describes the Agency

- [ ] State DOT
- [ ] MPO
- [ ] Transit Agency / Authority (Single Mode)
- [ ] Transit Agency / Authority (Multi - Mode)
- [ ] Highway Authority
- [ ] Federal Transportation Agency
- [ ] City Transportation Agency
- [ ] County / Local Transportation Agency

Other (please specify)

2. Agency Name

[ ]
3. Please indicate which of the following best describes your role.

- Executive
- Executive Staff
- Sustainability Director
- Sustainability Staff
- Planning Director
- Planning Staff
- Environmental Director
- Environmental Staff
- Design Director
- Design Staff
- Maintenance Director
- Maintenance Staff
- Operations Director
- Operations Staff
- Budget Director
- Budget Staff
- Environmental / Sustainability Constituent
- Sustainability Team Member
- Other (please specify)

4. Name (Optional)
Maturity Model List of Functions

Appendix F, TBL Maturity Assessment Tool from NCHRP Report 750 Volume 4 assesses sustainability maturity by high level agency function to map where the agency is and where it might want to go by function on a progressive 0-4 maturity scale. The agency functions described below are the definitions used in Appendix F of the NCHRP report. They will be used in the survey questions that follow and are provided below for context.

A. Consensus on Needs and Goals
Processes by which transportation policy systems identify needs, gaps, and requirements; build consensus around a prioritized ranking of potential needs; and develop acceptable goals and priorities for transportation.

B. Planning and Programming
Processes by which transportation plans are created to carry out the goals developed in the consensus building, needs assessment, and goals setting processes. These plans are then turned into processes, which are created and authorized to carry out the goals set in the consensus building, needs assessment, project prioritization, and goals and objectives setting processes.

C. Budgeting and Resource Allocation
Processes by which transportation policy systems determine how to collect and distribute resources among different projects and programs (includes budgeting and allocation).

D. Rulemaking and Regulation
Processes by which rules, regulations, standards, and guidelines are established for compliance with legislated mandates and laws.

E. Service and Product Delivery
Processes by which transportation policy systems deliver transportation goods and services to the public and ensure that the level and quality of services meet goals and established standards.

F. Compliance and Dispute Resolution
Processes by which the transportation community sees that the intent of legislation, standards, and regulations are complied with—and processes by which disagreements over interpretations or tradeoffs can be resolved.

G. Education and Training
Processes by which the transportation community is educated to understand and embrace evolving organizing principles and to adopt (and invest in) behavioral norms associated with those principles.
A. CONSENSUS ON NEEDS AND GOALS

Processes by which transportation policy systems identify needs, gaps, and requirements; build consensus around a prioritized ranking of potential needs; and develop strategies for addressing needs.

Please check all that apply routinely

5. (A.0) Base Case
   - Needs driven by political decision makers and major stakeholders
   - Goals constrained by funding and regulations (including environmental)
   - Public participation limited to formal regulated processes

6. (A.1) Level 1
   - Significant attention to regulatory compliance (including environmental)
   - Some formal outreach and consensus-building

7. (A.2) Level 2
   - Needs shaped by political decision makers and major stakeholders, and assessment of public sentiment
   - Clear focus on environmental improvement, stewardship, and social context
   - Significant formal outreach and consensus-building

8. (A.3) Level 3
   - Needs driven by public sentiment, performance, and sustainability considerations
   - Goals focus on sustainable transportation services and programs
   - Substantial transparency and active outreach and two-way public dialogue

9. (A.4) Level 4
   - Cross-agency decisionmakers, stakeholders, and the public participate actively in needs determination and goal-setting
   - Goals and policies focused on TBL sustainability
   - Active two-way public engagement and consensus in strategic decisions

10. Above practices do not apply

   -
Planning and programming to carry out the goals developed in the consensus-building, needs assessment, and goals-setting processes.

Please check all that apply routinely.

11. (B.0) Base Case
- Emphasizes mobility, safety, and quantity (more, faster) within mode
- Expands in response to travel demand ("accept and accommodate")
- Transportation planning is siloed
- Transportation planning is not connected to land use decision-making
- Limited by political jurisdiction
- Limited data and related performance measures

12. (B.1) Level 1
- Emphasizes mobility, safety, and quantity (more, faster), alternate modes
- Plans, builds based on forecasts of likely demand ("predict and provide")
- Transportation planning more influenced by land use decision-making
- Compliance-based reporting

13. (B.2) Level 2
- Emphasizes mobility, safety, and quantity, but considers flexibility, accessibility, connectivity, system efficiency, and environmental context
- Emphasizes improved intermodal operations and the environment
- Manages transportation demand and capacity
- Formal and informal links exist between other planning entities
- Plans, builds based on forecasts of likely demand and land use plans

14. (B.3) Level 3
- Emphasizes flexibility, accessibility, connectivity, system efficiency, safety, security, and context;
- Emphasizes multimodal approach and connections between modes;
- Proactive demand and capacity management;
- Strong planning links with other planning entities;
- Contact with multiple jurisdictions
- Works from preferred vision to planning and provision;
- Reliable and up-to-date data that reflect the full range of effects of transportation investment
C. BUDGETING AND RESOURCE ALLOCATION

Budgeting and resource allocation among different projects and programs.

Please check all that apply routinely

17. (C.0) Base Case
- Limited data and related performance measures
- Budget process is competitive, siloed, and driven by previous allocation decisions (e.g., starts with last year’s budget);
- Does not consider larger social, regional, and economic costs and benefits of transportation – focuses on transportation-centric cost-benefit analysis;
- Inflexible - funds are bucketed and segregated by rules and policy;
- Driven by taxes and formulae

18. (C.1) Level 1
- Focuses primarily on immediate direct costs, but does include consideration of social, regional, and economic benefits of transportation

19. (C.2) Level 2
- Incorporate full social, environmental, fiscal, economic, and other costs into planning and provision - uses FCA (Full Cost Accounting - Economic, Environmental, Social)

20. (C.3) Level 3
- Budget approach is integrated and cooperative
- Incorporates social, environmental, fiscal, economic, and other costs into planning and provision - uses Full Cost Accounting (FCA)
- More independent funding - funds for transportation are derived more sustainably from users and other benefiting entities

21. (C.4) Level 4
- Budget process is integrated and cooperative across agency boundaries
- Flexible - funds flow to program areas, regions, and modes where they meet greatest TBL societal sustainability needs
- Independent funding - funds for transportation are derived sustainably from users and other benefiting entities

22. Above practices do not apply
- None of the above apply
D. RULEMAKING AND REGULATION

The processes by which rules, regulations, standards, and guidelines are established for compliance with legislated mandates and laws.

Please check all that apply routinely

23. (D.0) Base Case
   - Expert led
   - Heavily influenced by organized interests and economic stakeholders
   - Minimal public involvement
   - Highly politicized and conflict based

24. (D.1) Level 1
   - Significant public involvement

25. (D.2) Level 2
   - Open to a plurality of interests, stakeholders, and activists
   - Substantial public involvement during post-decision-making phase

26. (D.3) Level 3
   - Public-expert partnership in developing regulation and rules - experts invite and encourage public participation
   - Less politicized and more cooperative

27. (D.4) Level 4
   - Bias for flexible, voluntary self-regulation
   - Open to a broad TBL-related plurality of interests, stakeholders, and activists
   - Cooperative and consultative

28. Above practices do not apply
   - None of the above apply

Comments on criteria and choices (optional)
Processes by which transportation policy systems deliver transportation goods and services to the public and ensure that the level and quality of services meet goals.

Please check all that apply routinely

29. (E.0) Base Case
   - Efficient and best-value business processes
   - Transportation and mobility performance measured and reported

30. (E.1) Level 1
   - Ad hoc sustainability initiatives
   - Efficient and best-value business processes - some environmental and social issues considered
   - Some environmental performance management reports

31. (E.2) Level 2
   - General sustainability objectives established
   - Sustainability performance (centered on environment) reporting and management common among delivery functions

32. (E.3) Level 3
   - Sustainability embedded in all business processes (e.g., project delivery, procurement, operations and maintenance)

33. (E.4) Level 4
   - Sustainability performance measured and reported with TBL-related improvement targets
   - Commitment to societal sustainability in all service and project delivery functions
   - Periodic reevaluation of performance measures and regular evaluation of sustainability achievements

34. Above practices do not apply
   - None of the above apply

Comments on this criteria and choices (optional)
Processes by which transportation community sees that the intent of legislation, standards, and regulations are complied with and the processes by which disagreements are resolved.

Please check all that apply routinely

35. (F.0) Base Case
   - Highly politicized
   - Informal brokering between powerful stakeholders

36. (F.1) Level 1
   - Dependence on law and judicial system
   - Adversarial relationship between key stakeholder groups

37. (F.2) Level 2
   - Less adversarial relationship between key stakeholder groups and more constructive dialogue

38. (F.3) Level 3
   - Emphasizes “deliberate and decide” and constructive engagement
   - Avoids dependence on law and judicial system

39. (F.4) Level 4
   - Politics minimized - public involvement and transparency in compliance issues

40. Above practices do not apply
    - None of the above apply

Comments on this criteria and choices (optional)
Processes by which transportation community is educated to understand and embrace evolving organizing principles and to adopt (and invest in) behavioral norms as:

Please check all that apply routinely:

41. (G.0) Base Case
   □ Focus on technical specialties and standards
   □ Performance standards and incentives associated with traditional performance measures

42. (G.1) Level 1
   □ Informal sustainability training and recruitment and integration of environmental specialists into transportation agencies

43. (G.2) Level 2
   □ Focus on multidisciplinary workforce - development of more flexible performance standards
   □ Developing sustainability education, training, and internal incentives to support sustainable programs
   □ Culture of environmental stewardship

44. (G.3) Level 3
   □ Commitment to sustainability education, training, and internal incentives to support sustainable programs
   □ Culture of transportation sustainability and stewardship

45. (G.4) Level 4
   □ Focus on multidisciplinary workforce - established and flexible standards associated with sustainability
   □ Culture of TBL sustainability and stewardship of societal well-being

46. Above practices do not apply
   □ None of the above apply

Comments on this criteria and choices (optional)
Processes by which information on needs, strategies, expectations, and results are shared broadly by stakeholders in the public and private-sector transportation community - during decision making, planning, and policymaking.

Please check all that apply routinely:

47. (H.0) Base Case
   - One-way communication to explain transportation priorities and plans

48. (H.1) Level 1
   - One-way communication to explain transportation priorities and plans with formal requirements to present plans but limited feedback

49. (H.2) Level 2
   - One-way communication to explain transportation priorities and plans with highly structured presentation and feedback

50. (H.3) Level 3
   - Two-way active engagement and communication between transportation agencies, public, stakeholders, and decision makers

51. (H.4) Level 4
   - Regular two-way active engagement and communication between transportation agencies, public, stakeholders, and decision makers
   - Involvement of stakeholders at all stages of the decision-making and planning process
   - Active outreach to identify and include previously underrepresented groups

52. Above practices do not apply
   - None of the above apply

Comments on this criteria and choices (optional):
53. Thank you for helping support a more sustainable future.

If you have any additional comments, please include them below.
Benchmark...

<table>
<thead>
<tr>
<th>MATURITY LEVEL</th>
<th>SCORE RANGE</th>
<th>CHARACTERISTICS</th>
</tr>
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• Background (What to quantify)
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  – NCHRP Sustainability Maturity Assessment Model

• Rating Systems and Valuation Systems (How)

• Engagement / Communication (What & Why)
## Transportation Effects

<table>
<thead>
<tr>
<th>Economic</th>
<th>Environmental</th>
<th>Societal</th>
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<tbody>
<tr>
<td>Congestion</td>
<td>Air Pollution</td>
<td>Impact Inequity</td>
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<tr>
<td>Mobility</td>
<td>Carbon Emission</td>
<td>Property value</td>
</tr>
<tr>
<td>Crash Savings</td>
<td>Habitat Loss</td>
<td>Health</td>
</tr>
<tr>
<td>Facility Benefits</td>
<td>Water Quality</td>
<td>Cohesion</td>
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<tr>
<td>Consumer Benefits</td>
<td>Hydrologic</td>
<td>Livability</td>
</tr>
<tr>
<td>Improved Commerce</td>
<td>Noise</td>
<td>Aesthetics</td>
</tr>
</tbody>
</table>

Source: Adapted from “Sustainable Transportation and TDM: Planning That Balances Economic, Social and Ecological Objectives;” Victoria Transport Policy Institute (An independent Canadian research organization)
Measuring Sustainability

• Emergence of infrastructure sustainability rating systems
• Many seeking to emulate LEED
• The drivers:
  – Defining, measuring and integrating sustainability
  – Focus on performance metrics
  – Success of LEED for buildings
Metrics / Measurement : “SMART”

• **S = Specific**: clear and focused to avoid misinterpretation. Should include measure assumptions and definitions and be easily interpreted.

• **M = Measurable**: can be quantified and compared to other data. It should allow for meaningful statistical analysis. Avoid "yes/no" measures except in limited cases, such as start-up or systems-in-place situations.

• **A = Attainable**: achievable, reasonable, and credible under conditions expected.

• **R = Realistic**: fits into the organization's constraints and is cost-effective.

• **T = Timely**: doable within the time frame given.
National and State Level Systems

- Greenroads™
- GreenLITES (New York State DOT)
- INVEST (FHWA)
- Envision (Institute for Sustainable Infrastructure, a partnership between ASCE/ACEC/APWA)
GreenLITES

• Self-certification program by NYSDOT
• Internal management program to measure performance, recognize good practices, and improve where needed.
• Applied to all cap. projects
• State DOTs have replicated model nationally
GreenLITES – Annual Earth Day Awards

GreenLITES Awards

Annually on Earth Day the Department honors those projects and program areas that obtain the highest levels of sustainability. Below is a list, by year, of exemplary project designs and operations that best incorporated sustainability through the GreenLITES program.

- 2013 Engineering Evergreen Project Summaries PDF
- 2013 Operations Innovations Award Summaries PDF
- 2013 Engineering Gold Project Summaries PDF
- 2012 Engineering Evergreen Project Summaries RTF
- 2012 Operations Evergreen Program Area Summaries PDF
- 2012 Local Projects Evergreen Summaries RTF
- 2012 Engineering Gold Project Summaries RTF
- 2012 Operations Gold Summaries RTF
- 2011 Engineering Evergreen Project Summaries RTF
- 2011 Operations Evergreen Program Area Summaries RTF
- 2011 Engineering Gold Project Summaries RTF
- 2011 Operations Gold Summaries RTF
- 2010 Engineering Evergreen Project Summaries PDF
- 2010 Operations Evergreen Program Area Summaries RTF PDF
- 2010 Local Projects Gold Summaries RTF PDF
- 2009 Engineering Evergreen Project Summaries RTF
INVEST 1.0: FHWA’s Sustainability Self-Evaluation Tool

- Voluntary, web-based tool
- Integrate sustainability best practices into roadway projects and programs
- Covers system planning, project development, operations & maintenance.
Purpose, Community, Wellbeing

Collaboration, Management, Planning

Materials, Energy, Water

Siting, Land & Water, Biodiversity

Emission, Resilience
## Sustainability Rating Utility

<table>
<thead>
<tr>
<th>Feature</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broaden thinking</td>
<td>5</td>
</tr>
<tr>
<td>Demonstrate credibility</td>
<td>5</td>
</tr>
<tr>
<td>Communicate ideas</td>
<td>5</td>
</tr>
<tr>
<td>Contrast alternatives</td>
<td>3</td>
</tr>
<tr>
<td>Rate projects</td>
<td>4</td>
</tr>
<tr>
<td>Rank projects</td>
<td>2</td>
</tr>
<tr>
<td>Stimulate / Structure dialog</td>
<td>3</td>
</tr>
<tr>
<td>“SMART”</td>
<td>3</td>
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<tr>
<td>Adaptable / Expandable / Flexible</td>
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</tbody>
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• Rating Systems and Valuation Systems (How)

• Engagement / Communication (What & Why)
Optimization / Prioritization?

Social
- Safety
- Health
- Livability

Economic
- Jobs / Productivity
- Tax Base
- Mobility

Tradeoffs

Environment
- Carbon
- Air Quality
- Water
Assessment / Communication?

Social
- Safety
- Health
- Livability

Economic
- Jobs / Productivity
- Tax Base
- Mobility

Environment
- Carbon
- Air Quality
- Water

Disparate Units
Fairness / Transparency?

Social
Safety
Health
Livability

Economic
Jobs / Productivity
Tax Base
Mobility

Environment
Carbon
Air Quality
Water

Conflicting Interests
Breaking Down Issues

Disparate Units

Social
- Safety
- Health
- Livability

Conflicting Interests

Economic
- Jobs / Productivity
- Tax Base
- Mobility

Environment
- Carbon
- Air Quality
- Water

Irresolvable Tradeoffs

mcvoygr@pbworld.com
Example: USDOT - TIGER

TIGER Grants

Program Details

- Driven by Performance
- Innovation & Project Acceleration
- Safety & State of Good Repair
- Livability & Sustainability
- Planning Activities

FY 2012 TIGER Awards in 34 states, District of Columbia

On June 22, the U.S. Department of Transportation awarded nearly $500 million from the
# Tiger Criteria

## Table 3 U.S. DOT TIGER Considerations

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

Source: Federal Register Volume 77, No. 20, January 2012.
<table>
<thead>
<tr>
<th>Long-Term Outcome</th>
<th>Types of Societal Benefits</th>
</tr>
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<tbody>
<tr>
<td>Livability</td>
<td><em>Equity</em></td>
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<tr>
<td></td>
<td>Land Use Changes that reduce VMT</td>
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<td>Accessibility</td>
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<td>Property Value Increases</td>
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<td>Economic Competiveness</td>
<td><em>Economic</em></td>
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<tr>
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<td>Travel Time Savings</td>
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<td>Operating Cost Savings</td>
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<td>Safety</td>
<td><em>Equity</em></td>
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<tr>
<td></td>
<td>Prevented Accidents (property damage),</td>
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<tr>
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<td>Injuries, and Fatalities</td>
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<tr>
<td>State of Good Repair</td>
<td><em>Economic</em></td>
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<td>Long-Term Replacement</td>
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<td>Maintenance &amp; Repair Savings</td>
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<td>Reduced VMT from not closing bridges.</td>
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<tr>
<td>Environmental Sustainability</td>
<td><em>Environment</em></td>
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<td>Environmental Benefits from Reduced Emissions</td>
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</tbody>
</table>

mcvoygr@pbworld.com
"Total Value Analysis..."
TIGER Benefit-Cost Analysis (BCA) Resource Guide

How to Use This Guide

This BCA Resource Guide is a supplement to Appendix A: Additional information on Benefit-Cost Analysis, as found in the January 31, 2012, Federal Register’s Notice of Funding Availability (NOFA) for TIGER Grants (http://www.gpo.gov/fdsys/pkg/FR-2012-01-31/pdf/2012-1996.pdf). It provides technical information that Applicants will need for monetizing benefits and costs in their Benefit-Cost Analyses, as well as guidance on methodology and a selection of frequently asked questions from past TIGER grant applicants.

Table 1. Recommended Monetized Values

<table>
<thead>
<tr>
<th>Cost/Benefit Category</th>
<th>Recommended Monetized Value(s)</th>
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</thead>
<tbody>
<tr>
<td>Value of Statistical Life (VSL)</td>
<td>$6,200,000 per fatality ($2011)</td>
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<td>Value of Injuries</td>
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<td>AIS Level</td>
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<td>Unsurvivable</td>
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<td>Recommended Monetized Value(s)</td>
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<tr>
<td><strong>Value of Travel Time</strong></td>
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<td></td>
<td><strong>Recommended Hourly Values of Travel Time Savings</strong></td>
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<td><em>(2009 U.S. $ per person-hour)</em></td>
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<td><strong>Category</strong></td>
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<td><strong>Local Travel</strong></td>
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<td>Personal</td>
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<td>Business</td>
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<td>All Purposes **</td>
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<td><strong>Intercity Travel</strong></td>
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<td>Personal</td>
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<td>Business</td>
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<td>All Purposes **</td>
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<td><strong>Truck Drivers</strong></td>
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<td><strong>Bus Drivers</strong></td>
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<td><strong>Transit Rail Operators</strong></td>
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<td><strong>Locomotive Engineers</strong></td>
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<td><strong>Airline Pilots and Engineers</strong></td>
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<tr>
<td>Cost/Benefit Category</td>
<td>Recommended Monetized Value(s)</td>
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<td>-----------------------</td>
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<tr>
<td><strong>Value of Emissions</strong></td>
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<tr>
<td>Carbon dioxide (CO₂)</td>
<td>(varies)*</td>
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<tr>
<td>Volatile Organic Compounds (VOCs)</td>
<td>$1,300</td>
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<tr>
<td>Nitrogen oxides (NOx)</td>
<td>$5,300</td>
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<td>Particulate matter (PM)</td>
<td>$290,000</td>
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<tr>
<td>Sulfur dioxide (SOx)</td>
<td>$31,000</td>
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</table>

* See “Social Cost of Carbon (3%)” values below.
<table>
<thead>
<tr>
<th>Cost/Benefit Category</th>
<th>Recommended Monetized Value(s)</th>
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<tr>
<td>Social Cost of Carbon (3%)</td>
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<td>Year</td>
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</table>
PROPOSED NEW STARTS AND SMALL STARTS POLICY GUIDANCE

January 9, 2013
Transportation Benefit-Cost Analysis

Benefits

The benefits of transportation projects are commonly defined as reductions in transportation costs. However, on this website, benefits are defined as all of the effects of the project/program on its users or the society at large, even those effects that are negative (sometimes referred to as disbenefits). Benefits and disbenefits are measurable and have economic value.

These are the benefits most commonly considered in benefit-cost analysis of transportation projects:

- Travel time or delay reductions
- Vehicle cost savings
- Accident reductions
- Air Emission and greenhouse gas reductions
- Parking costs savings from projects that reduce vehicle ownership and use

Note that all of these benefits are actually reductions in the costs of transportation.
Transportation Benefit-Cost Analysis

Benefits >

Travel Time

The Value of Travel Time (VTT) refers to the cost of time spent on transport. It includes costs to businesses of the time their employees and vehicles spend on travel, and costs to consumers of personal (unpaid) time spent on travel. The Value of Travel Time Savings (VTTS) refers to the benefits from reduced travel time costs.

Travel time savings is often the principal benefit of a transportation project. Congestion relief projects are justified primarily by the reduction in travel time they will bring about. Travel time savings can also lead to reductions in vehicle operating costs. Those benefits are discussed in the Vehicle Operating Cost Reduction section.

Examples

- A new lane is added to a freeway, increasing traffic speeds and decreasing delays.
Life-Cycle Benefit-Cost Analysis
Economic Parameters 2012

The Economics Analysis Branch utilizes standard economic valuations for application in benefit-cost analysis. These values are used consistently across the Cal-B/C system, which includes the Cal-B/C V5.0 and Cal-B/C Corridor. The values are recommended for use in economic analysis on all modes, including highway, rail and transit projects. The economic values represent statewide averages.

TRAVEL TIME PARAMETERS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Discount Rate</td>
<td>Percent</td>
</tr>
<tr>
<td>Real* (Inflation Adjusted)</td>
<td>4.0</td>
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<tr>
<td>Value of Time</td>
<td>Dollars Per Person Hours</td>
</tr>
<tr>
<td>Automobile</td>
<td>$12.50</td>
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<tr>
<td>Truck</td>
<td>$28.70</td>
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<tr>
<td>Auto/Truck Composite</td>
<td>$17.35</td>
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<tr>
<td>Transit (in vehicle)</td>
<td>$12.50</td>
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<tr>
<td>Transit (out of vehicle)</td>
<td>$25.00</td>
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<tr>
<td>Average Vehicle Occupancy</td>
<td>1.15</td>
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</tbody>
</table>

VEHICLE OPERATING COST PARAMETERS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Average Fuel Price</td>
<td>Dollars Per Gallon</td>
</tr>
<tr>
<td>Regular Unleaded</td>
<td>$3.714</td>
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</tbody>
</table>

*Real value adjusted for inflation.
Common Ground Valuation

Disparate Units

Social
Safety
Health
Livability

Economic
Jobs / Productivity
Tax Base
Mobility

Environment
Carbon
Air Quality
Water

Irresolvable Tradeoffs

Conflicting Interests

$mcvoygr@pbworld.com
Purpose, Community, Wellbeing

Collaboration, Management, Planning

Materials, Energy, Water

Siting, Land & Water, Biodiversity

Emission, Resilience
Economic Companion Tools to Envision

Economic factors are an essential component of sustainable infrastructure, along with environmental and social considerations. The business case for sustainable infrastructure goes beyond a return on investment: it also includes infrastructure effectiveness, costs, reliability, and livability. These factors contribute to how communities perceive these infrastructure projects which in turn has a real dollar value associated with it.

There are several economic tools that are being developed in parallel in different agencies, companies, and research organizations that fill the unique needs of different infrastructure sectors and geographic locations. ISI encourages the development of these tools and will continue to provide an opportunity for public feedback to strengthen the metrics and tools that will be made publicly available.

Impact Infrastructure, LLC. Business Case Evaluator for Stormwater

The tool presented here, called the Business Case Evaluator, is from Impact Infrastructure, LLC, Charter Member of ISI. The first module of the Business Case Evaluator provides a value-based and risk-adjusted analysis of stormwater infrastructure projects and maps these to Envision credits. Impact Infrastructure, LLC, has made the BCE available at no-cost to Envision users.
INVEST 1.0: FHWA’s Sustainability Self-Evaluation Tool

- Voluntary, web-based tool
- Integrate sustainability best practices into roadway projects and programs
- Covers system planning, project development, operations & maintenance.
**OM-8 Bridge Management System**

*Order of magnitude dollar equivalent potential savings: $~1M, $$~10M, $$$~100M*

- DOTs can save by extending the useful service-life of bridges through more efficient maintenance.
- System users benefit from reduced traffic congestion and reliability costs due to bridge postings and closures.
- Less frequent and lengthy construction reduces emissions released from congestion/detours due to bridge closures.
- Safety/access costs avoided due to bridge closures.
OM-12 Road Weather Management Program*

- DOT’s can save 10-25 percent of their winter maintenance costs.
- Highway users can save millions of dollars in travel delay.
- Salt impacts can be reduced by 10–20 percent.
- Safety/access benefits can approach billions.

*Order of magnitude dollar equivalent potential savings: $~1M, $$~10M, $$$~100M
Paratransit and the Triple Bottom Line?

($$) - DOT’s can spend millions to provide and promote paratransit service.

$$$ - Social service agencies can save hundreds of millions in avoided institutional costs.

…..

$$ - People, communities, families enjoy the benefits of keeping seniors in their homes.
<table>
<thead>
<tr>
<th>Application Areas</th>
<th>Goal Areas</th>
<th>States &amp; Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial Management</td>
<td>Safety</td>
<td>States</td>
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<tr>
<td>Freeway Management</td>
<td>Mobility</td>
<td>Alabama</td>
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<td>Roadway O &amp; I</td>
<td>Productivity</td>
<td>Arizona</td>
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<tr>
<td>Crash Prevention &amp; Safety</td>
<td>Efficiency</td>
<td>Arkansas</td>
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<td>Road Weather Management</td>
<td>Energy &amp; Environment</td>
<td>California</td>
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<td>Transportation</td>
<td>Customer Satisfaction</td>
<td>Colorado</td>
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<td>Alternative Fu</td>
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<td>Traffic Incident Management</td>
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<td>Transit Management</td>
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## Gaps = Sub-optimization

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<tr>
<th>Economic</th>
<th>Environmental</th>
<th>Societal</th>
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<tr>
<td>Congestion</td>
<td>Air Pollution</td>
<td>Impact Inequity</td>
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<tr>
<td>Mobility</td>
<td>Carbon Emission</td>
<td>Property value</td>
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<td>Crash Savings</td>
<td>Habitat Loss</td>
<td>Health</td>
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<td>Facility Benefits</td>
<td>Water Quality</td>
<td>Cohesion</td>
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<tr>
<td>Consumer Benefits</td>
<td>Hydrologic</td>
<td>Livability</td>
</tr>
<tr>
<td>Improved Commerce</td>
<td>Noise</td>
<td>Aesthetics</td>
</tr>
</tbody>
</table>

Source: Adapted from “Sustainable Transportation and TDM: Planning That Balances Economic, Social and Ecological Objectives,” Victoria Transport Policy Institute (An independent Canadian research organization)
"The obligation of any component is to contribute its best to the system, not to maximize its own production, profit, or sales ... "

- Dr. W. Edwards Deming
Livability / Community / Aesthetics...
Valuation Methods

- **Factor of Production**: land, labor, capital, natural resources, etc
- **Consumer (Producer) Surplus**: willingness to pay vs. price
- **Defensive Expenditures**: cost to prevent adverse effects
- **Hedonic Pricing**: surrogate valuation, e.g., real estate market
- **Travel Cost**: willingness to pay to get there
- **Contingent Valuation**: surveys, questionnaires, and interviews
- **Choice Experiments**: menu of alternatives
Community input / values...

<table>
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<th></th>
<th>Low</th>
<th>Most Likely</th>
<th>High</th>
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<td>Value of Time</td>
<td>$15.20</td>
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PERT Distribution

probability

$15.20

$18.00

(most likely)

$22.80

value
Enriching the conversation...

- Surrogate Market Methods
- Non-market methods

- Workshops and Interviews
- Web surveys

- Selection of category variables.
- Cost and project information
- Discount rates

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Commonality / Communication

**Social**
- Safety
- Health
- Livability

**Economic**
- Jobs / Productivity
- Tax Base
- Mobility

**Environment**
- Carbon
- Air Quality
- Water

**Disparate Units**
- Irresolvable Tradeoffs

**Conflicting Interests**
- $ Equivalents
- Equity

mcvoygr@pbworld.com
In Service To A Sustainable Society

YOUR METRICS ACCORDING TO YOUR VALUES…

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TBL $ METRICS

- Direct Agency
- Savings - Short Term
- Maintenance Costs
- Energy
- Other
- Direct Agency Savings - Long Term
- Life-Cycle Cost Savings
- Pollution
- Safety
- Other
- Economic Benefits
- Travel Time
- Reliability
- Connectivity
- Other
- Eff. Benefits
- GHG
- Emission
- Noise
- Emissions
- Radiation
- Radiation
- Other
- Social Benefits
- Security
- Accessibility
- Safety
- Health
- Aesthetics
- Other

PROJECTS

-

mcvoygr@pbworld.com

66
## TBL Valuation Utility

<table>
<thead>
<tr>
<th>Feature</th>
<th>Score</th>
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<td>Broaden thinking</td>
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<tr>
<td>Demonstrate credibility</td>
<td>5</td>
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<td>Communicate ideas</td>
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<tr>
<td>Contrast alternatives</td>
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<td>Rate projects</td>
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<td>Rank projects</td>
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## MAP - 21  Performance Metrics / Tradeoffs

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<th>Value / Total value</th>
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Getting Down to Business
Sustainability Metrics and the Quantification of Project Value for Outreach, Programming, and MAP-21 (AMPO 2014, Atlanta GA)

- Background (What to quantify)
  - Transportation in service to a sustainable society
  - NCHRP Sustainability Maturity Assessment Model

- Rating Systems and Valuation Systems (How)

- Engagement / Communication (What & Why)

Focus of Sustainability Initiatives

**LEVEL 0 - SAFE MOBILITY**
- Supports societal mobility & safety
- Favors government ownership & control of the transportation infrastructure
- Transportation agency: infrastructure owner-manager and regulator

**LEVEL 1 - COMPLIANT TRANSPORTATION**
- Supports societal mobility & safety
- Compliance with environmental, economic, and social legislative requirements
- Transportation agency: infrastructure owner-manager & regulator
- Top-down planning

**LEVEL 2 - GREEN TRANSPORTATION**
- Supports societal mobility, safety, environmental, economic, and social needs -- Emphasizes Environment
- Transportation agency: infrastructure owner-manager and regulator

**LEVEL 3 - SUSTAINABLE TRANSPORTATION**
- Supports sustainable transportation
- Risk-sharing between public and private sector
- Infrastructure integrator (some owner-operator & some private)
- Regulator

**LEVEL 4 - TBL SUSTAINABILITY**
- Supports societal sustainability
- Broad agency decision-making partnerships
- Risk-sharing between public and private sector
- Infrastructure Integrator (some owner, some owner-operator, and some private)
- Regulator and steward partner

Ability to Support a Sustainable Society

- Focus on Highway Transportation Only
- mcvoygr@pbworld.com

Compliance/Short-term Focus

Sustainability/Long-term Focus

$
Use of $ equivalent metrics ~ USDOT TIGER + can improve virtually all functions, i.e.

- Clear
- Transparent
- Easy to share
- Quantitative ($ a “universal metric”)
- Amenable to sensitivity analysis
- Consistent with financing questions
- Helpful in a political context per above
Getting Down to Business
Sustainability Metrics and the Quantification of Project Value for Outreach, Programming, and MAP-21 (AMPO 2014, Atlanta GA)

✓ Background (What to quantify)
  ✓ Transportation in service to a sustainable society
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✓ Rating Systems and Valuation Systems (How)

✓ Engagement / Communication (What & Why)

Gary R. McVoy, Ph.D.
Parsons Brinckerhoff
VP - Sustainability
mcvoygr@pbworld.com
"The obligation of any component is to contribute its best to the *system*, not to maximize its own production, profit, or sales ... “

- Dr. W. Edwards Deming