RECYCLING: PERFORMANCE, ENVIRONMENTAL AND COSTING FACTORS - SOME CONTEXT ON THE WAY FORWARD

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Overview

- Larger context
- Regulatory
- Sustainability / rating systems
- Examples – old & new

RECYLING….?

The National Environmental Policy Act of 1969

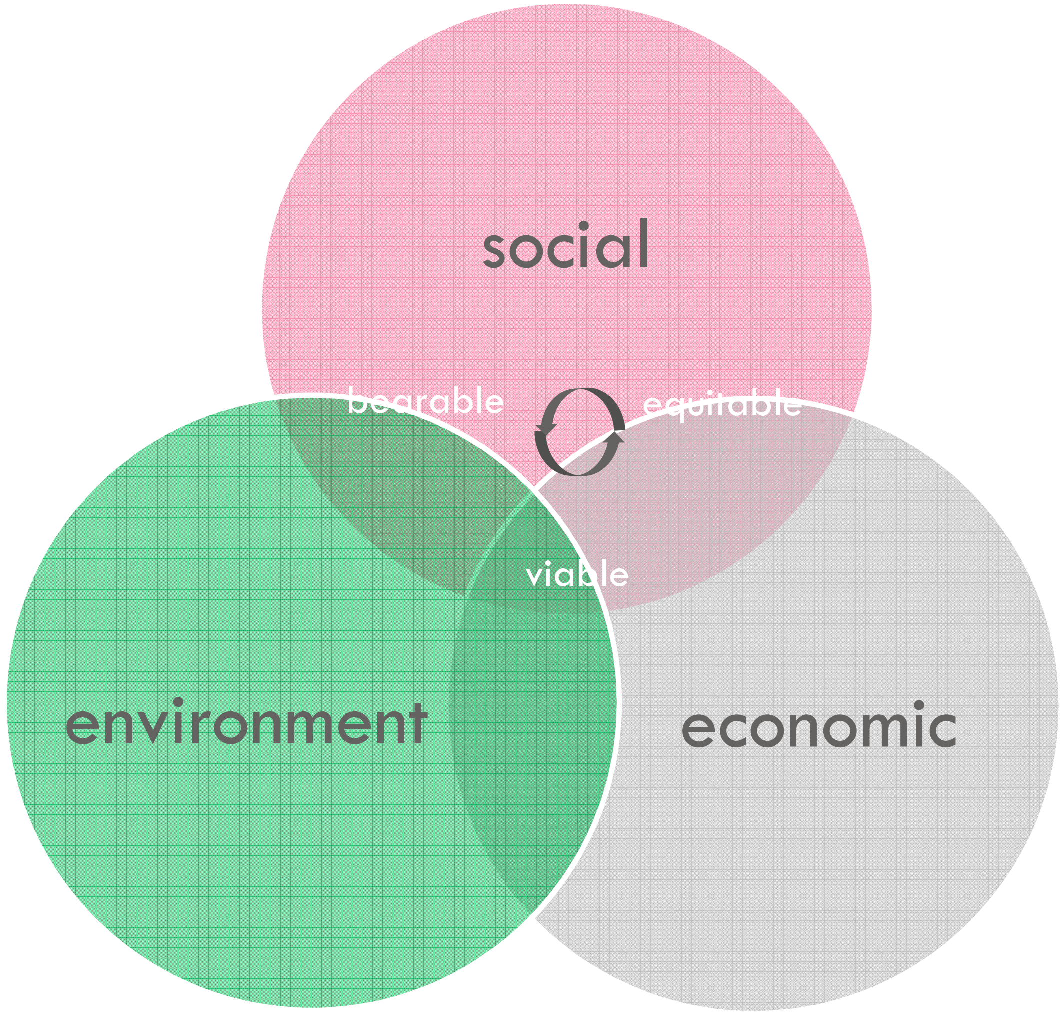
Sec. 101(a) The Congress, …. declares that it is the continuing policy of the Federal Government…. to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations…

Great Law of The Iroquois Confederacy

In our every deliberation, we must consider the impact of our decisions on the next seven generations….

Sustainability : Meeting the needs of the present without compromising the future…

Brundtland 1987



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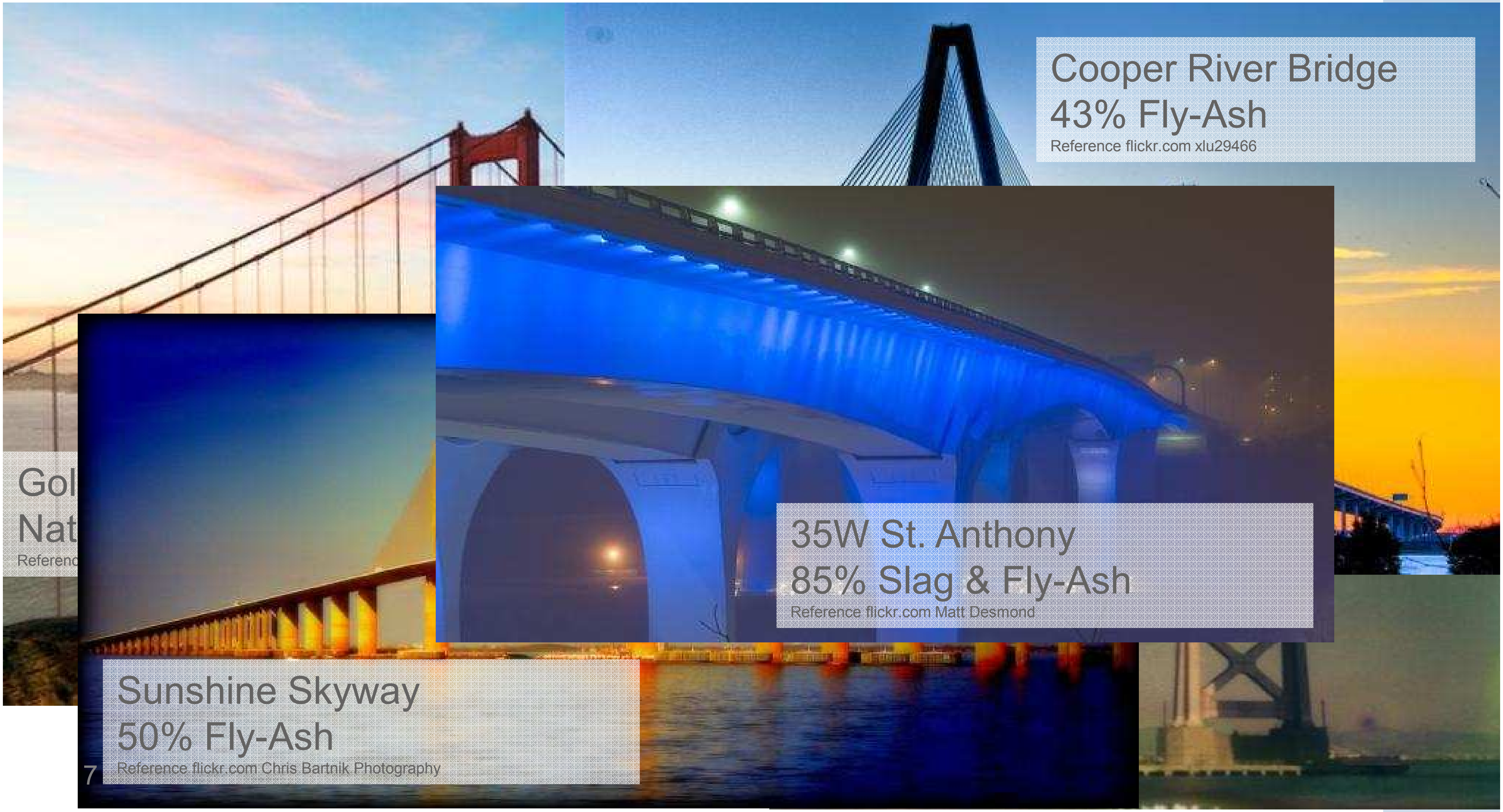
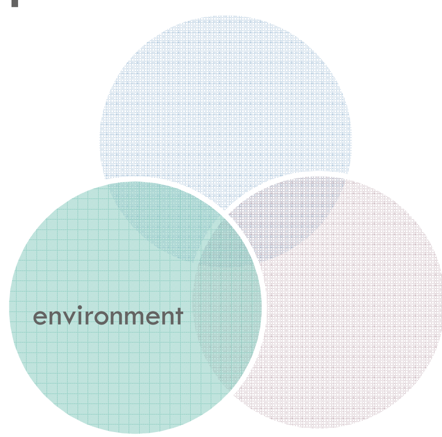
Concrete with Fly Ash…



The National Environmental Policy Act of 1969

Sec. 102(c) include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on -- (i) the environmental impact of the proposed action



Regulatory ….
http://www.fhwa.dot.gov/environment/env_sum.htm

U.S. Department of Transportation
Federal Highway Administration

Environment

Summary of Environmental Legislation Affecting Transportation

Table of Contents

Regulatory ….
http://www.fhwa.dot.gov/environment/env_sum.htm

III. Historical and Archeological Preservation

- Section 106, Historical Preservation Act
- Section 110, Historical Preservation Act
- Archeological and Historic Preservation Act(Moss-Bennett)
- Archeological Resources Protection Act
- Preservation of American Antiquities
- American Indian Religious Freedom Act
- Native American Grave Protection and Repatriation Act

Regulatory ….
http://www.fhwa.dot.gov/environment/env_sum.htm

IV. Land and Water Usage

- Wilderness Act
- Wild and Scenic Rivers
- Land and Water Conservation Fund Act (Sec 6(f))
- Executive Order 11990 Protection of Wetlands
- Wetland Mitigation Banking (ISTEA)
- Emergency Wetlands Resources Act of 1986
- National Trails Systems Act
- National Recreation Trails (ISTEA)
- Rivers and Harbors Act (Sec. 9 and Sec. 10)
- Federal Water Pollution Control Act (Sec. 404)
- Executive Order 11988 - Floodplain Management
- National Flood Insurance
- Marine Protection Research and Sanctuaries Act
- Water Bank Act

Regulatory ….
http://www.fhwa.dot.gov/environment/env_sum.htm

- Coastal Zone Management Act
- Coastal Barrier Resources Act
- Farmland Protection Policy Act
- Resource Conservation & Recovery Act (Hazardous Waste)
- Superfund(CERCLA)
- Endangered Species Act
- Fish and Wildlife Coordination Act
- Migratory Bird Treaty Act
- Transportation Enhancements Activities (ISTEA)
- Recycled Paving Material (ISTEA)
- Scenic Byways Program (ISTEA)

Regulatory ….
http://www.fhwa.dot.gov/environment/env_sum.htm

V. Noise

- Standards 23USC109

VI. Air Quality

- Clean Air Act (Conformity)
- Clean Air Act (Sanctions)
- Congestion Mitigation & Air Quality Improvement(CMAQ)

Regulatory ….
http://www.fhwa.dot.gov/environment/env_sum.htm

General Environmental Statutes

Legislative Reference	Regulations Reference	Purpose	Applicability
National Environmental Policy Act: 42 U.S.C. 4321-4335 (P.L. 91-190) (P.L. 94-83)	23 CFR 771-772 40 CFR 1500-1508 Executive Order 11514 as amended by Executive Order 11991 on NEPA	Consider environmental factors through systemic interdisciplinary approach before committing to a course of action.	All FHWA actions

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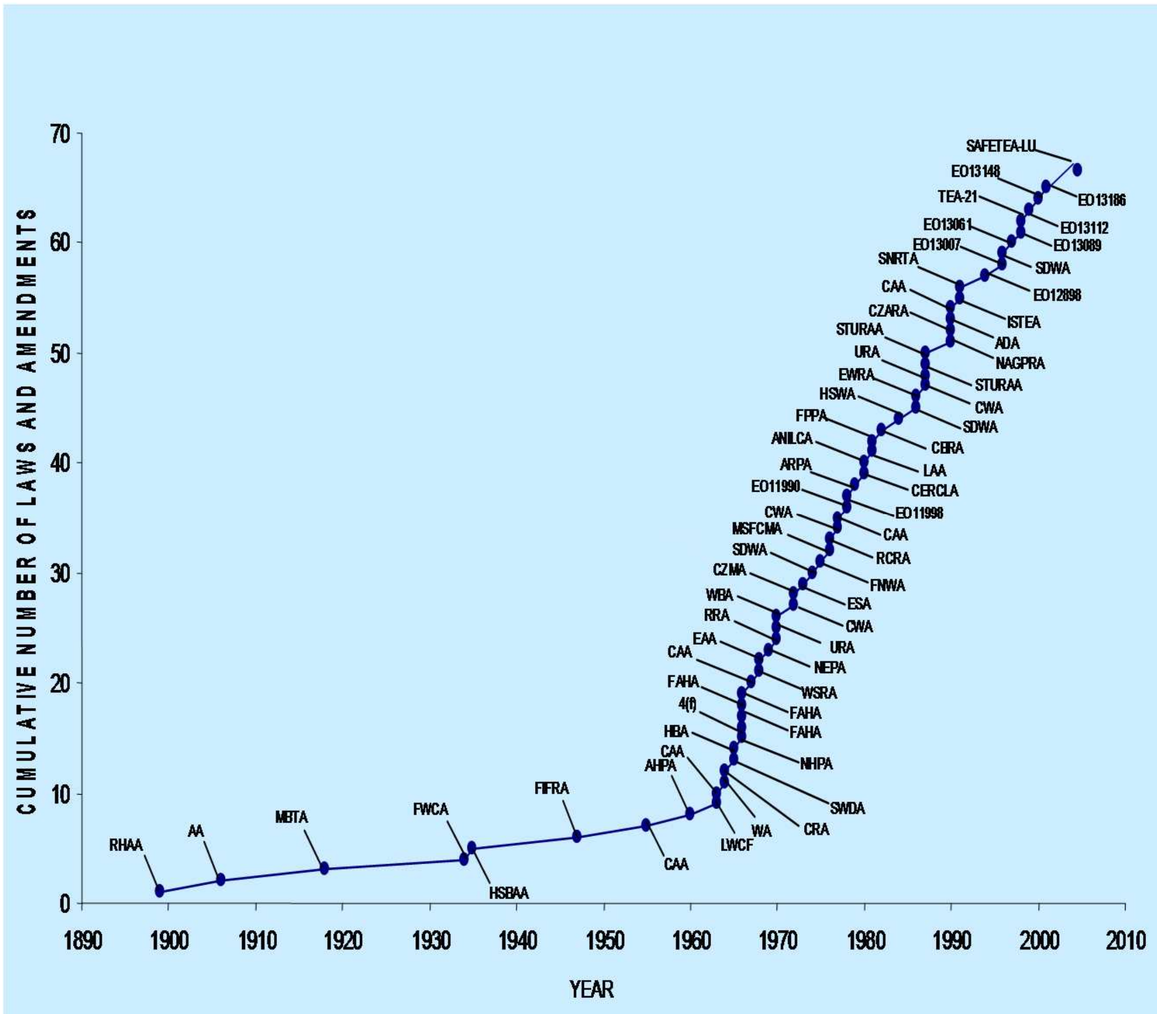
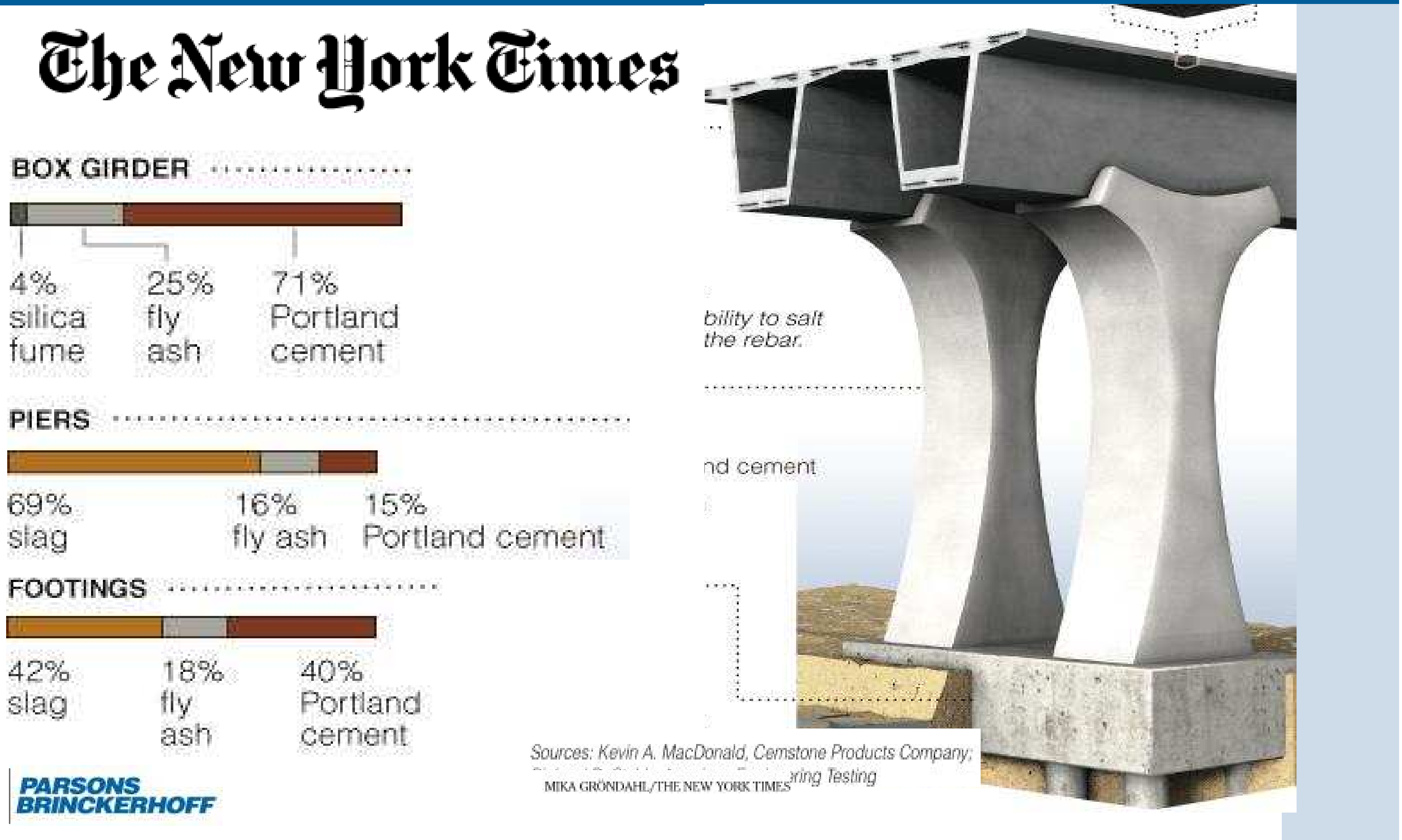
Regulatory ….
http://www.fhwa.dot.gov/environment/env_sum.htm

Section 4(f) of The Department of Transportation Act: 23 U.S.C. 138 49 U.S.C. 303 (P.L. 100-17) (P.L. 97-449) (P.L. 86-670)	23 CFR 771.135	Preserve publicly owned public parklands, waterfowl and wildlife refuges, and significant historic sites.	Significant publicly owned public parklands, recreation areas, wildlife and waterfowl refuges, and all significant historic sites "used" for a highway project.
Economic, social, and environmental effects: 23 U.S.C. 109(h) (P.L. 91-605) 23 U.S.C. 128	23 CFR 771-772	To assure that possible adverse, economic, social, and environmental effects of proposed highway projects and project locations are fully considered and that final decisions on highway projects are made in the best overall public interest.	Applicable to the planning and development of proposed projects on any Federal-Aid system for which the FHWA approves the plans, specifications, and estimates, or has the responsibility for approving a program.
Uniform Relocation Assistance and Real Property Acquisition Act of 1970 (42 U.S.C. 4601 et seq., P.L. 91-646) as amended by the Uniform Relocation Act Amendments of 1987 (P.L. 100-17)	49 CFR 24	To implement the Uniform Act as amended in an efficient manner; to ensure property owners of real property acquired for and persons displaced by Federal-Aid projects are treated fairly, consistently, and equitably; and so they will not suffer disproportionate injuries.	All projects involving Federal-aid funds.

Necessary, but not sufficient….

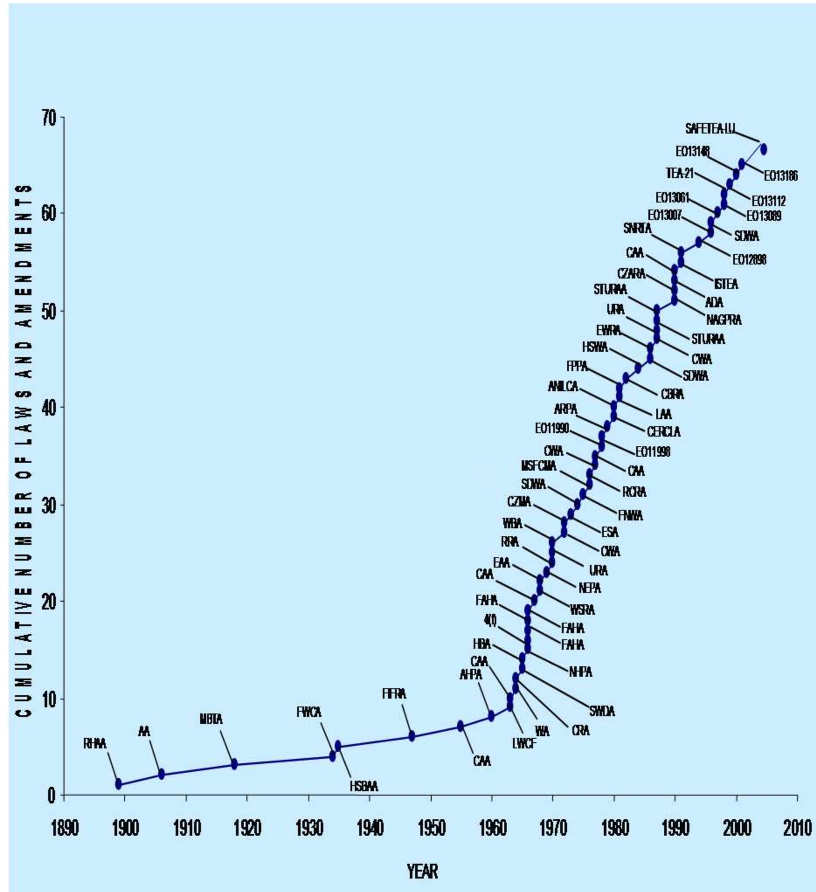


Concrete & Fly ash



Recycling / Sustainability?

Protection Statutes



Programs,
Projects,
Plans,
Practices,
Policies…..

Necessary, but not sufficient….

Date: Monday, August 2, 2010, 4:32pm PDT - Last Modified: Sunday, May 8, 2011, 4:30pm PDT

New fly ash regulations threaten sustainable concrete

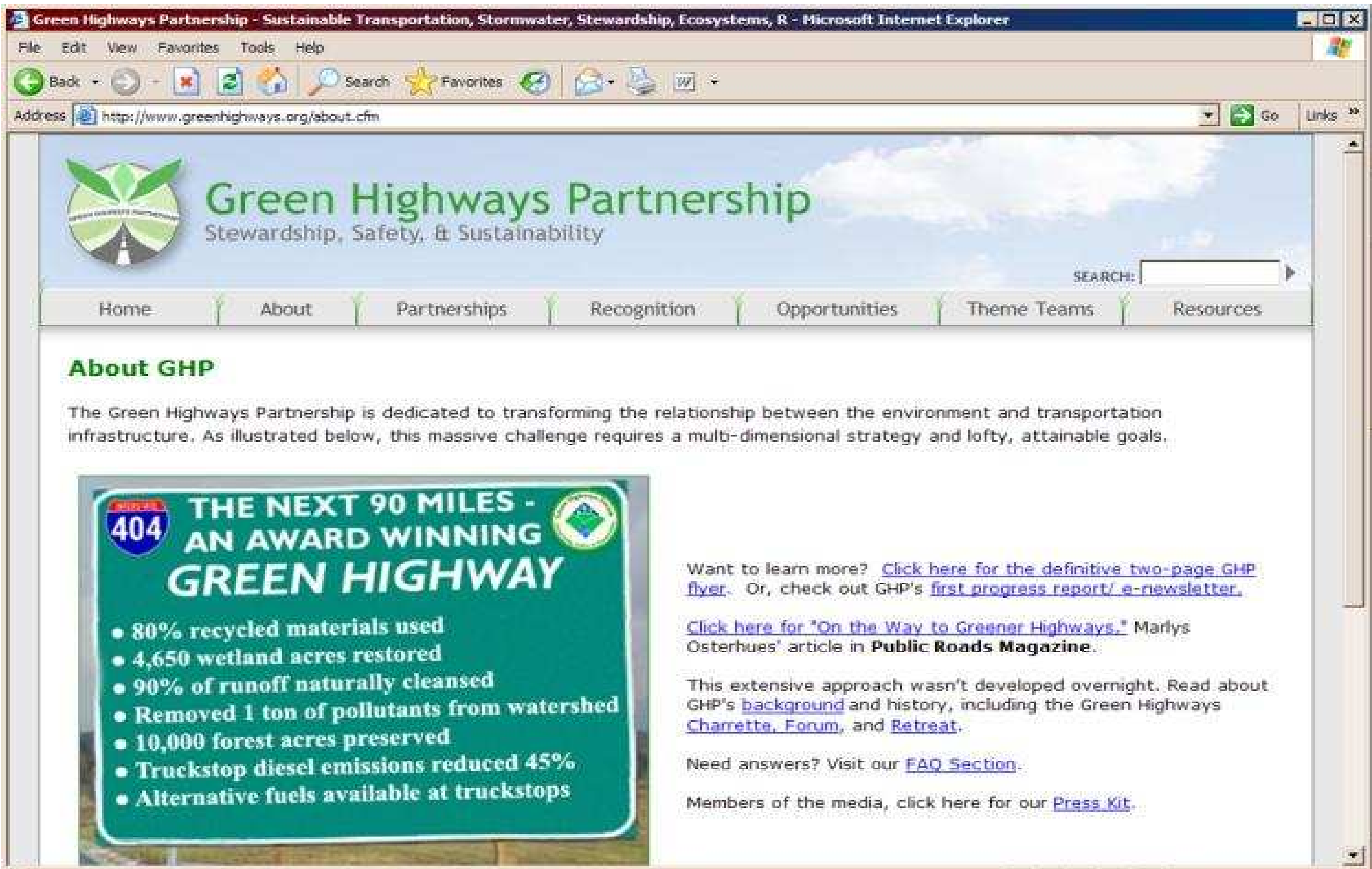
By Jason Ideker
Oregon State University

http://www.sustainablebusinessoregon.com/columns/2010/08/new_fly_ash_regulations_threaten_sustainable_concrete.html

Triple Bottom Line, now - more than ever…

- Environment: Planetary Ecosystem (Climate, Energy, Land, Air, Water…)
- Economy : Jobs (food, clothing, shelter…)
- Societal needs: Equity (security, order, stability…)

Cooperative convergence…



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All aspects…

Draft Green Highway Concept, Source: Andy Fekete, RBA Group

Federal Funding Criteria

Selection Criteria Include:

- **Sustainability**
- Livability

Popularity of Green Buildings

Federal DOT   Lakewood Colorado

Reference twgi.com

Sustainability Rating Systems (check lists)

INSTITUTE FOR SUSTAINABLE INFRASTRUCTURE

I S I

envision™

U.S. Department of Transportation

Federal Highway Administration

GreenLITES

Evergreen

Greenroads

Sustainable Transportation Access Rating System (STARS)

Pilot Project Application Manual

Version 1.0

November 23, 2010

A project of the North American Sustainable Transportation Council

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Sustainability rating system comparison10a (Autosaved) the real deal.xlsx - Microsoft Excel

Home Insert Page Layout Formulas Data Review View PDF-XChange 4

TBLCriteria	ASCE	FHWA	Greenlites	Stars 1.1 checklist
Economic				
Value of Travel Time Savings				
Commercial Travel Cost Savings				
				Sustainable Enterprise, Carpool discount
Commute Travel Cost Savings (Peak)				
				student commute modal split, employee comute mod split
Leisure Travel Time Savings (Off-Peak)				
Vehicle Costs				
Fixed (ownership) Costs				
Variable (operating) Costs				
Reductions in the Economic Costs of Oil Imports				
Travel Time Reliability			Concrete Pavement,Special use lane (HOV/Bus express), Innovative inerchange design,Projects that increase transportation efficiencies for moving freight through	
			operation, Installation of a transit express system, Limiting/consolidating access points along highway, Bus turnouts, Incoperate ITS technology to improve traffic flow,	
Parking Costs				
On Street Parking				
Off Street Parking				
Surface Parking				
Structured Parking				
Traffic Congestion Effects				
Recurrent (occurring regularly)				
Non-Recurrent (due to accidents, special events)				
Transportation Diversity (option value)				
Consumer Benefits	improvement throughout the useful life of the		Ride")., Project reports and community outreach materials	
Efficiency	2.1.3 Deliver the project using integrated project design and delivery, 10.1.1 Improve access and efficiency,			Facilities for Bicyclists, Bicycle Plan, mass transit
	2.2.2 identify stakeholders, issues,constraints and by-product synergy opportunities		Use LED lighting, Solar bus stops, Retrofit existing street/ sign lighting with high efficiency types,	
Equity		PD-2 incorporate contractor warranty and construction quality into the public low-bid process through the use of warranties		
	2.3.1 Follow sustainable procurement policies and			

Sustainability rating system comparison10a (Autosaved) the real deal.xlsx - Microsoft Excel

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Z1

TBLCriteria		ASCE	FHWA	Greenlites	Stars 1.1 checklist
Social					
housing					Themed Semester or Year*
	affordability				Local housing
safety					
	accidents	10.1.2 Create appropriate signage for accessibility, safety and way findig			
	injuries				
	fatalities				
health			PD-19 Reduce human exposure to hazardous airborne compounds from construction materials		
	cardiovascular		science- based quantative safety analysis processes within project development that will reduce serious injuries and fatalities within the project footprint.		
	obesity	9.2.2. Use reclaimed and recycled content materials			
		2.4.1 Meet all applicable health and safety requirements			
	Proximity of sensitive populations to new roadway for MSATs				
Greenways					
walkability			PD-14 Promote walkable and wheelable communities by providing pedestrian facilites within the project footprint	Inclusion of visually contrasting pedestrisan crosswalk treatments, Project applies " Walkable communities/ Complete Streets" Concepts	
			PD-15 Promote bicycling in communities by providing deddicated cycling facilities within the project footprint		
neighborhood				Use of more engaging public participation techniques (charette, task force, etc)	
	cohesion	9.1.1 Use locally sourced materials, equipment and		Use of more engaging public participation techniques	

Sustainability rating system comparison10a (Autosaved) the real deal.xlsx - Microsoft Excel

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TBLCriteria		ASCE	FHWA	Greenlites	Stars 1.1 checklist
ENVIRONMENT		6.3.1 manage effectively the ecological aspects of the project	PD- 7 Ensure the environmental commitments made by the project are completed, and documented in accordance with all applicable laws, regulations and issue permits		
			PD-26 Provide construction personnell with the knowledge to identify environmental issues and best practice methods to minimize environmental impacts		Condensed Work Week, Telecommuting
Air & Atmosphere					Carpool/Vanpool Matching, Car Sharing
Climate Change		2.1.3 Deliver the project using integrated project design and delivery methodologies			Greenhouse Gas Emissions Reduction
	GHG Emissions	8.2.1 Conduct a life-cycle carbon assessment			Greenhouse Gas Emissions Inventory
				Material selection & detailing that reduces overall urban "heat island" effect.	Air Travel Emissions
					Indoor Air Quality
Air Quality			PD-27 Reduce air emissions from nonroad construction equipmeny		
	Criteria Pollutants	3.2.2. Take appropriate measures to minimize adverse impacts on local air quality during operation.			
	Air Toxics	2.3.1 Follow sustainable procurement policies and practices		Clear zones seeded with seed mixtures that help to reduce maintenance needs and increase carbon sequestration.	
		3.4.3. Control and minimize air pollution, including dust and odors, during construction.			
Energy			PD-20 Reduce lifetime energy consumptiomn of lighting systems for roadways		Clean and Renewable Energy
	fossil fuel energy		PD-23 Reduce energy in the production of pavement materials	Use warm mix asphalt	Building Energy Consumption, , Vending Machine Sensors, Energy Management System, Energy Metering, LED lighting
	Renewable Energy	8.1.1. Conduct a life-cycle energy assessment , 8.1.2improve energy efficiency and conservation	Offset total operational energy use through autonomous renewable energy sources		
		8.1.4 use renewable energy resources			
Watershed					
	Water Quality	7.2.1 Conserve water and reduce water consumption during construction and operation 7.3.1 Design the constructed works to prevent pollution of surface water containing potentially polluting substances away from sensitive environments		Demonstrate, through the use of models, reduction of pollutant loadings to adjacent water resources by the use of best management practices, Inclusion of permeable pavement such as grid pavers	
		7.2.2 Incoporate long term water impacts monitoring			

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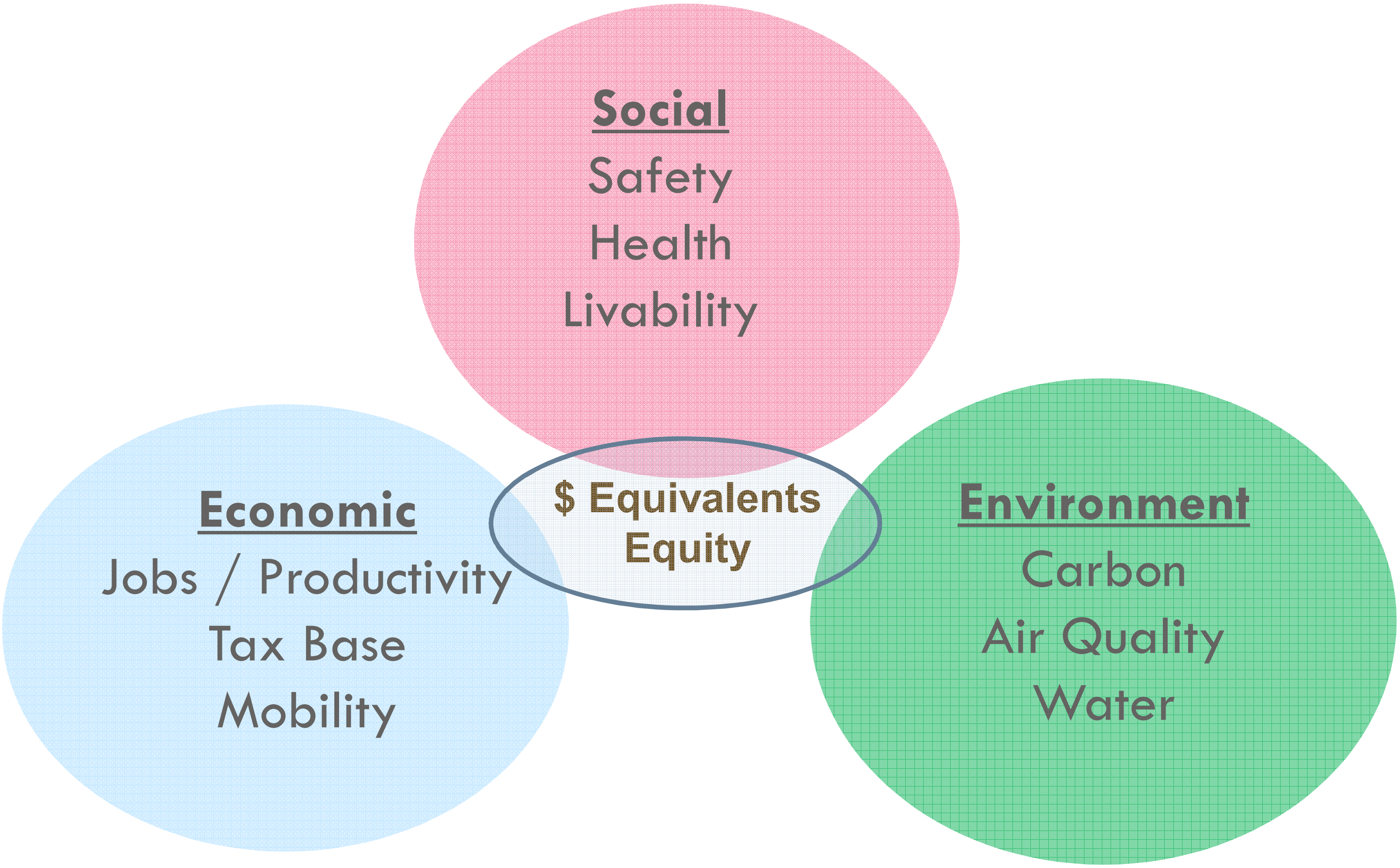
TBLCriteria	ASCE	FHWA	Greenlites	Stars 1.1 checklist
Storm water Quantity	7.4.1Protect floodplain functions, 7.4.2 Manage stormwater on site	PD-9 Improve stormwater quality from the impactd of the project and control floe to minimize their erosive effects on receiving waters using management methods and practices that reduce the impacts associates with the	stormwater retrofits, crediting strategies, stream restoration, added wetlands protection,etc,detect and eliminate any non-storm water dischargers from unpermitted sanitary or other residential, commercial or industrial sources. Detect non-stormwater discharges from unpermitted sanitary, Use of other structural Best	Stormwater Management, Water Consumption,Waterless Urinals,Building Water Metering*,Non-Potable Water Usage
Wetlands	4.1.2 preserve and restore wetlands, 7.4.3 rehabilitates lost streams, wetlands and shorelines		Wetlands restoration,enhancement or establishment above what is required to obtain a wetland-related permit, Provide additional mitigation to offset wetland impacts due to construction, Installation of mowing markers to protect wetlands and natural areas, bioengineering treatments along water bodies/wetlands, biotechnical engineering treatments along water bodies/wetlands.	
Ecosystem		PD-8 offset the loss anf alteration of natural (stream and terrestrial) habitat caused by road construction. Restore and protect natral beyond regulatory requirements.	Mitigation of habitat fragmentation through significant techniques such as creation of dedicated "eco viaducts"	
Endangered Species	6.1.1 Protect/enhance land of high ecological or species value			
animals	3.1.2. Preserve or enhance parks, recreational areas and wildlife refuges, 6.2.2 control invasive species	PD-10 Provide or improve wildlife amphibian, and aquatic species passage access and mobility across roadway facility boundaries	Provide enhancements to existing wildlife habitat, Inclusion of scheduling and logistic requirements to avoid disruptig wildlife nesting and breeding activities, use of targeted biological control methods to reduce invasive species.	Integrated Pest Management*
plants	6.2.1. Protect, enhance, restore habitat, biodiversity, 4.1.3 mmaintain/increase high conservative value forested lands 6.2.3 use appropriate non avasive plants, 3.1.2 only Use wood from non-thretened tree species or certified sources		Micro-adjustments which do not compromise safety or operation but which might make the difference in providing sufficient clear area for tree planting., Planting of native species, Avoidance/ protection of individual significant trees and localized areas of established, desirable vegetation, Designs which demonstrate, through a combination of preservation and new planting, an anticipated ultimate net increase in tree canopy, Re-establish/ expand native vegetation in reclaimed work areas or abandoned old alignments, Use of living snow fences(beach rose, huneysuckle and shrub willows), Use of natuve species for seed mixing and other plantings,Planting trees, shrubs and /or plant materials in lieu of traditional turfgrass, Removal of undesirable plant species,Specify local seed stock and plants	Native Plants*,Tree Campus USA*, Xeriscoping*, organic garden

Sustainability rating system comparison10a (Autosaved) the real deal.xlsx - Microsoft Excel

TBLCriteria	ASCE	FHWA	Greenlites	Stars 1.1 checklist
Aquatic Ecosystem			Stream restoration/enhancemetn	
Wildlife Corridors/ habitat connectivity			wildlife crossings that allow for safe passage of wildlife across highways, Minimize use of lands that are part of a significant contingouus wildlife habitat	
Edge habitat				
Wildlife refuges				
Earth			bodies/wetlands, Soil bioenginerring treatments or soil biotechnical engineering treatments in upland areas	
Soils-Prime	4.2.1 Protect from desertification, 6.2.4 Reduce the use of pesticides, fertilizer use 9.3.2 Reduce risk of future land contamination	PD-13 Promote sustainable site vegetation within the project footprint that doe not require long-term irrigation, consistent mowing or invasive/noxious weed sppecies removal	erosion and sediment control practices, Use highly permeable soils to remove surface pollutants from runoff, Specify that 75% or more of the topsoil removed for grading is reused on site, Cuts and fills balanced to within 10 percent,	Weather-Informed Irrigation*
Geological hazards (sinkh	4.4.1. Prevent soil loss, pollution infiltration from stormwater runoff during construction			
Waste	4.4.3. Restore soils disturbed during previous development	PD-30 Utilize a management plan for road construction waste materials, and minimizw the amount of of construction-related waste destined for landfill		
Construction Waste prod	9.2.3 Design for disassembly and deconstruction			
listed haz mat sites				
Recycled products	9.2.2. Use reclaimed and recycled content materials , 9.2.1 Design for waste minimization and/or reuse, Redirect construction and demolition materials away from disposal to recycling and reuse	PD-11 Reduce lifecycle impacts from extraction and production virgin materials	Examples retaining walls, selecting design option with minimal footprint, reuse of previous pavement as subbase for full-dept Reconstruction projects,Arranging for the reuse of excess excavated material, specify the processing of demolished concrete to reclaim scrap metals and to create a usable aggregate material, slvaging removed trees for lumber, Use surplus excavated material on nearby state highways for slope flattening, Reuse of granite curbing,	
Hazardous Materials / Br	9.3.3. Reduce the quantity of excavated material that is taken off site		hazardous materials to maintain the bridge or highway, or increases the interval before re-construction must be	Sustainability Events,Waste Reduction Pre/post consumer waste food waste composting, waste
	4.3.1 select brownfields/greyfields	PD-25 Reduce need for tramsport of earthen materials balancing cut and fill quntities	contaminated wastes, Removing and disposing of contaminated soild beyond that necessary for project	Discounts,Reusable To-Go Containers, Compost*, Electronic Waste Recycling Program, Electronic Wa
TOTAL Environment	33	14	7	
Social				
housing				Themed Semester or Year*
affordability				Local housing

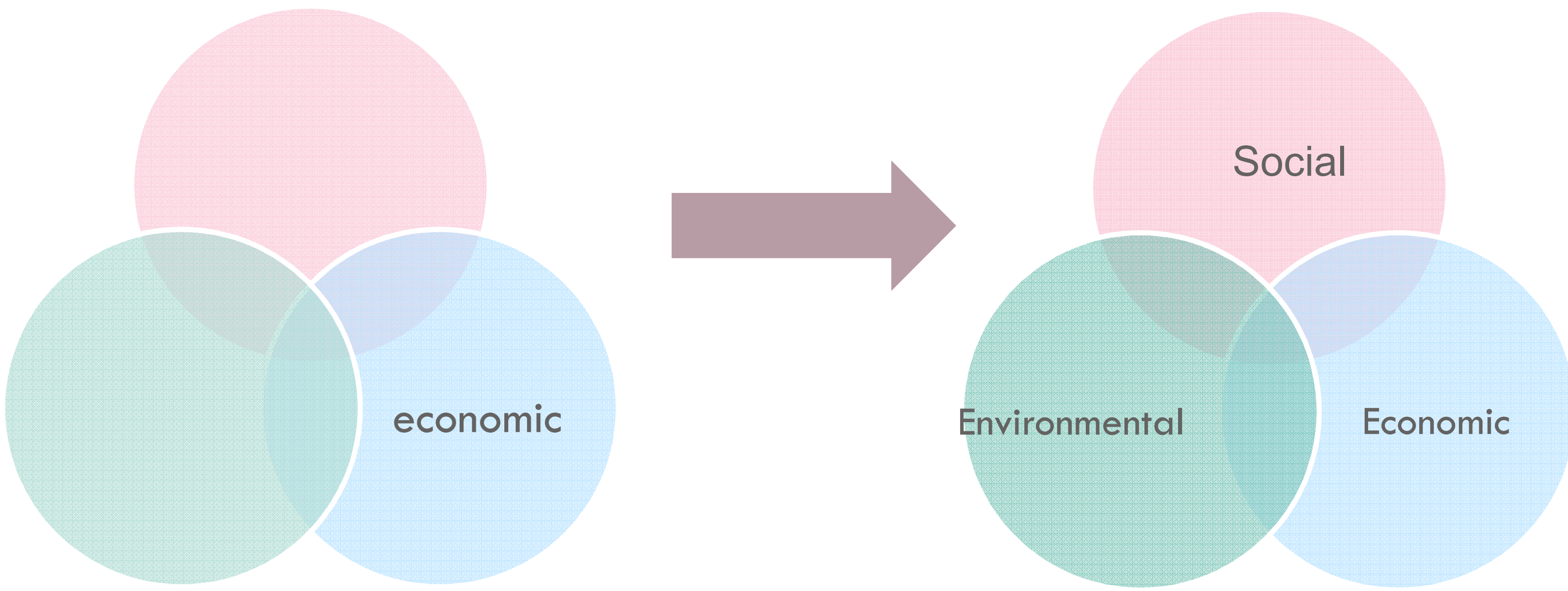
Triple Bottom Line Analysis



PRISM (Economic)   PRISM *tblv*

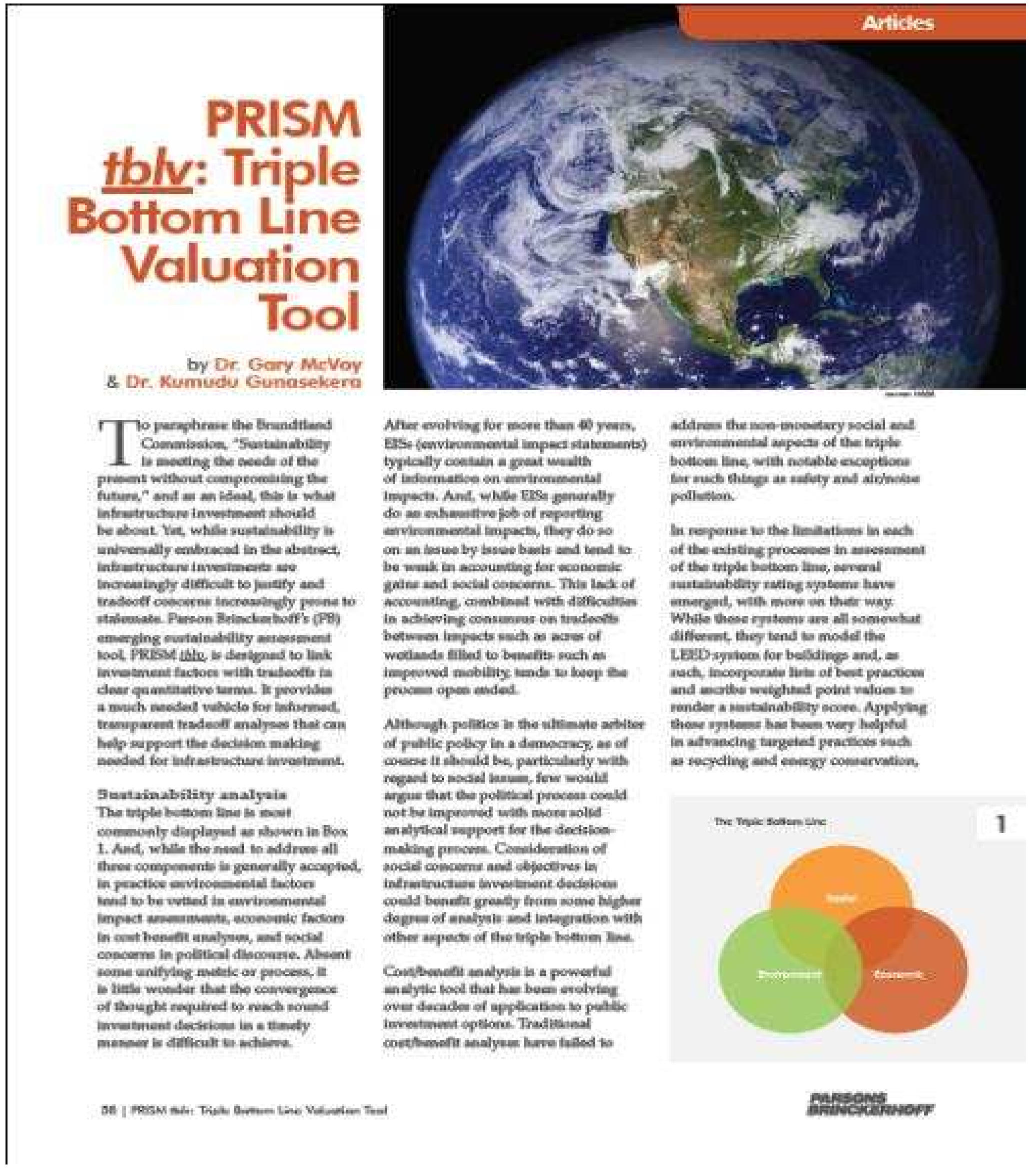
Economic Valuation Tool

Triple Bottom Line Valuation



(X env + Y soc + Z econ) = $ eq

http://www.pbworld.com/pdfs/publications/efr/volume_5_issue_1.pdf



Articles

PRISM *tblv*: Triple Bottom Line Valuation Tool

by Dr. Gary McVoy
& Dr. Kumudu Gunasekera

To paraphrase the Brundtland Commission, "Sustainability is meeting the needs of the present without compromising the future," and as an ideal, this is what infrastructure investment should be about. Yet, while sustainability is universally embraced in the abstract, infrastructure investments are increasingly difficult to justify and tradeoff concerns increasingly prone to stalemate. Parson Brinckerhoff's (PB) emerging sustainability assessment tool, PRISM *tblv*, is designed to link investment factors with tradeoffs in clear quantitative terms. It provides a much needed vehicle for informed, transparent tradeoff analyses that can help support the decision making needed for infrastructure investment.

Sustainability analysis

The triple bottom line is most commonly displayed as shown in Box 1. And, while the need to address all three components is generally accepted, in practice environmental factors tend to be vetted in environmental impact assessments, economic factors in cost benefit analyses, and social concerns in political discourse. Absent some unifying metric or process, it is little wonder that the convergence of thought required to reach sound investment decisions in a timely manner is difficult to achieve.

After evolving for more than 40 years, EISs (environmental impact statements) typically contain a great wealth of information on environmental impacts. And, while EISs generally do an exhaustive job of reporting environmental impacts, they do so on an issue by issue basis and tend to be weak in accounting for economic gains and social concerns. This lack of accounting, combined with difficulties in achieving consensus on tradeoffs between impacts such as acres of wetlands filled to benefits such as improved mobility, tends to keep the process open ended.

Although politics is the ultimate arbiter of public policy in a democracy, as of course it should be, particularly with regard to social issues, few would argue that the political process could not be improved with more solid analytical support for the decision-making process. Consideration of social concerns and objectives in infrastructure investment decisions could benefit greatly from some higher degree of analysis and integration with other aspects of the triple bottom line.

Cost/benefit analysis is a powerful analytic tool that has been evolving over decades of application to public investment options. Traditional cost/benefit analyses have failed to address the non-monetary social and environmental aspects of the triple bottom line, with notable exceptions for such things as safety and air/noise pollution.

In response to the limitations in each of the existing processes in assessment of the triple bottom line, several sustainability rating systems have emerged, with more on their way. While these systems are all somewhat different, they tend to model the LEED system for buildings and, as such, incorporate lists of best practices and ascribe weighted point values to render a sustainability score. Applying these systems has been very helpful in advancing targeted practices such as recycling and energy conservation,

The Triple Bottom Line

1

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TBLV - Summary

	Quantity	Value ($ /)	Total
Economic	+ -	x	+ -
Environment	+ -	y	+ -
Social	+ -	z	+ -

Sample Environmental Benefits
Recycling activity x

	Quantity	Value ($ /)	Total
Carbon - Short term - Long term	 tons tons	 5-120	 X to Y
Air Quality - NOx - PM10		 x x	
Water - Quantity - Quality	 -- acre ft by specie	 variable variable	

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Sample Economic Benefits – Life cycle costs Recycling activity x

	Quantity	Value ($ /)	Total
<u>Jobs</u> - Direct - Indirect / Induced	+ -	x	+ -
Energy	+ -	y	+ -
Waste Disposal	+ -	z	+ -

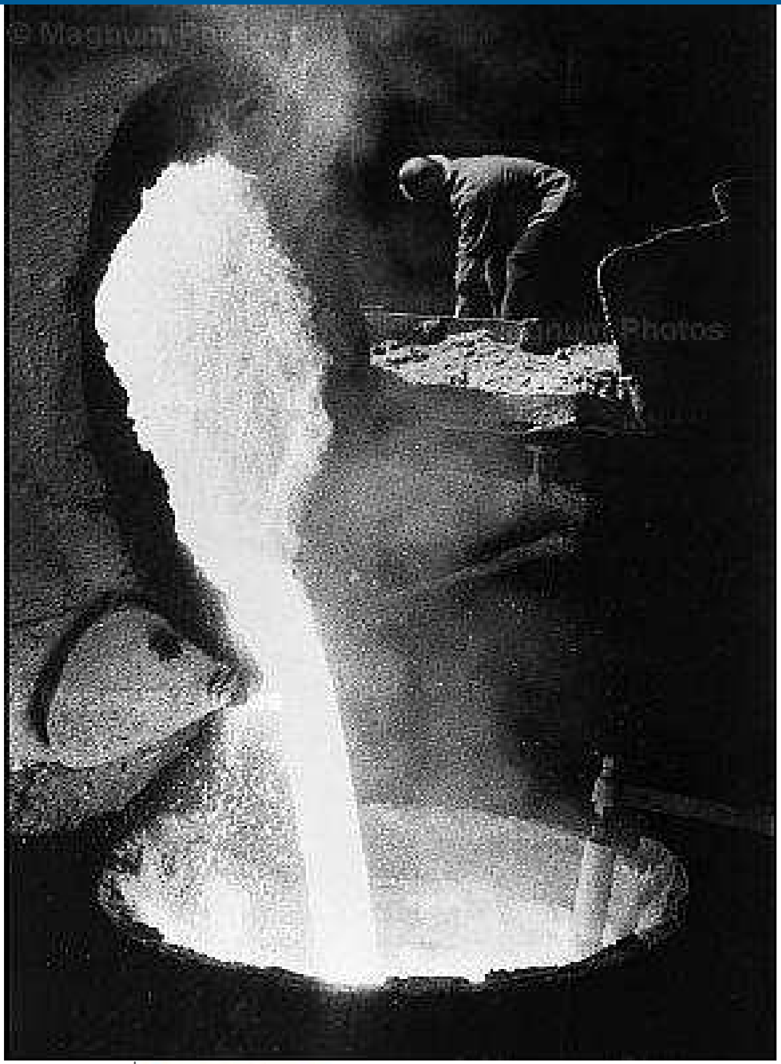
Sample Social Benefits
Recycling activity x

	Quantity	Value ($ /)	Total
Aesthetics	+ -	x	+ -
Positive education	+ -	y	+ -
Neighborhood Pride	+ -	z	+ -

Recycled Materials

- **Steel**
- Concrete
- Plastic

Steel
Economic, Environmental - -



96% Recycled Content in USA

Reference: Steel Recycling Institute, www.recycle-steel.org
Photo reference: Magnum Photos, Eugene Smith

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Steel -- TBLV

	Quantity	Value ($ /)	Total
Economic	X	Y / ton	Z
Environment (carbon,..)	X	Y / ton	Z
Social	+ -	z	+ -

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Recycled Materials

- Steel
- Concrete
- Plastic

Recycled Materials - Concrete

Recycled Aggregate:

Tailings, Synthetics, RCP

Photo: flickr.com kuinsy13


Photo: Library of Congress

Pozzolan Cements:

Fly-Ash, Slag, & Flume Ash

Social – highly visible

“Seems Right…”

Recycling Concrete -- Social Benefits…

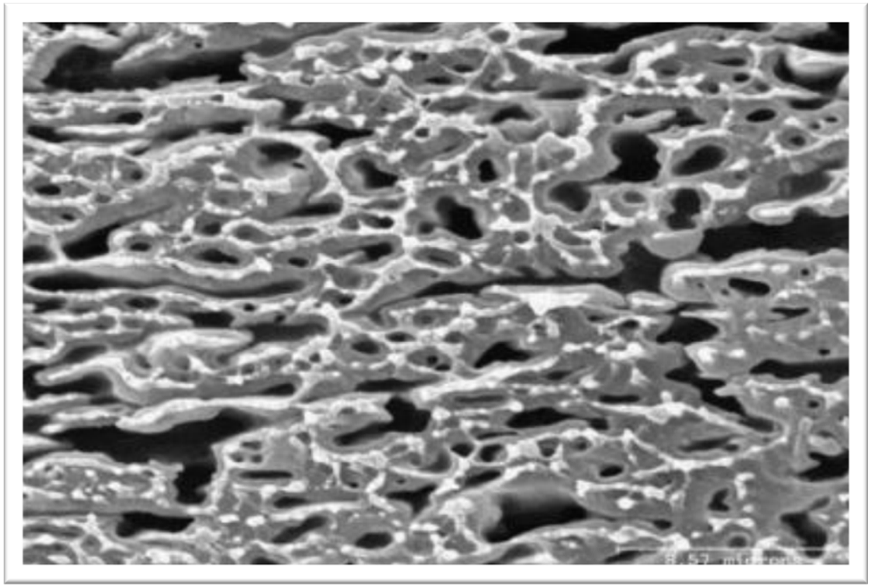
	Quantity	Value ($ /)	Total
Aesthetics	+ -	x	+ -
Positive education	+ -	y	+ -
Neighborhood Pride	+ -	z	+ -

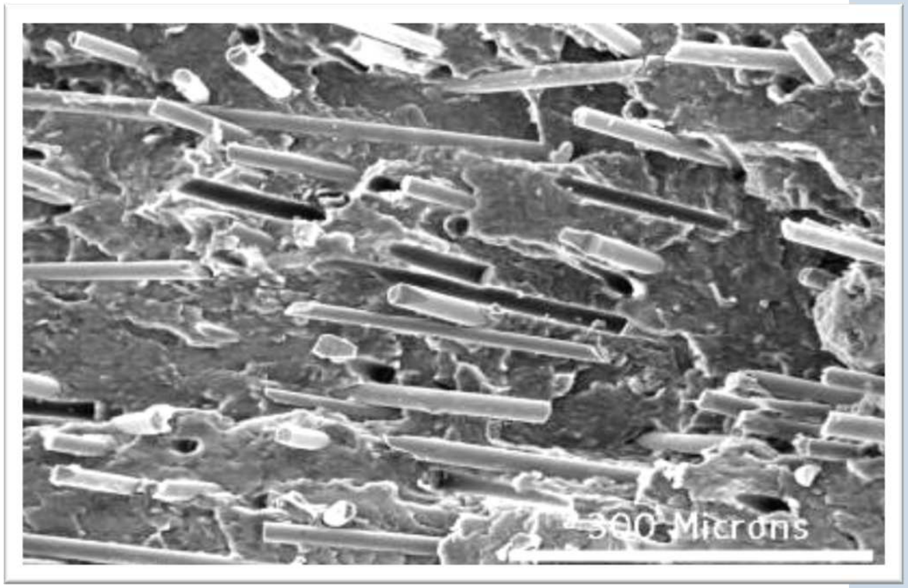
Recycled Materials

- Steel
- Concrete
- **Plastic**

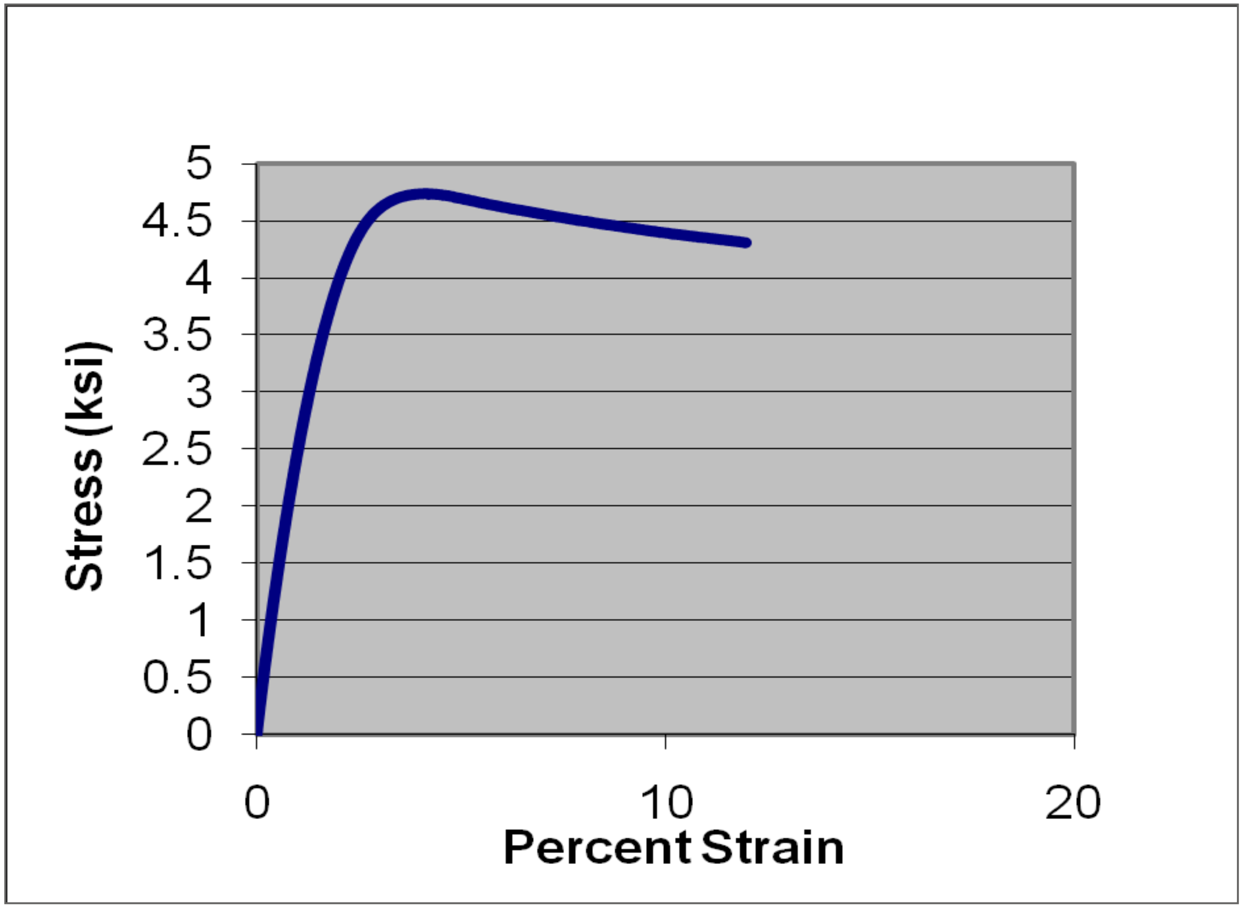
Thermoplastic

- Recycled Plastic
- Immiscible Polymer Blend
  - High Density Polyethylene with Polystyrene or Polypropylene coated glass fibers (up to 8%)





Typical Stress/Strain Curve



Properties

Properties

- Weight: 55pcf (Wood: 60pcf; Concrete: 150pcf; Steel: 490pcf)
- Specific Gravity: 0.85 – 0.90
- Elastic Modulus: 250,000 psi
- Allowable Flexural Stress: 600 psi (Ult. = 3,000 psi)
- Allowable Compressive Stress: 600 psi (Ult. = 2,500 to 4,300 psi)
- Allowable Shear Stress: 350 psi (Ult. = 1,500 psi)
- Coefficient of Thermal Expansion: 0.0000282 in/in/deg F

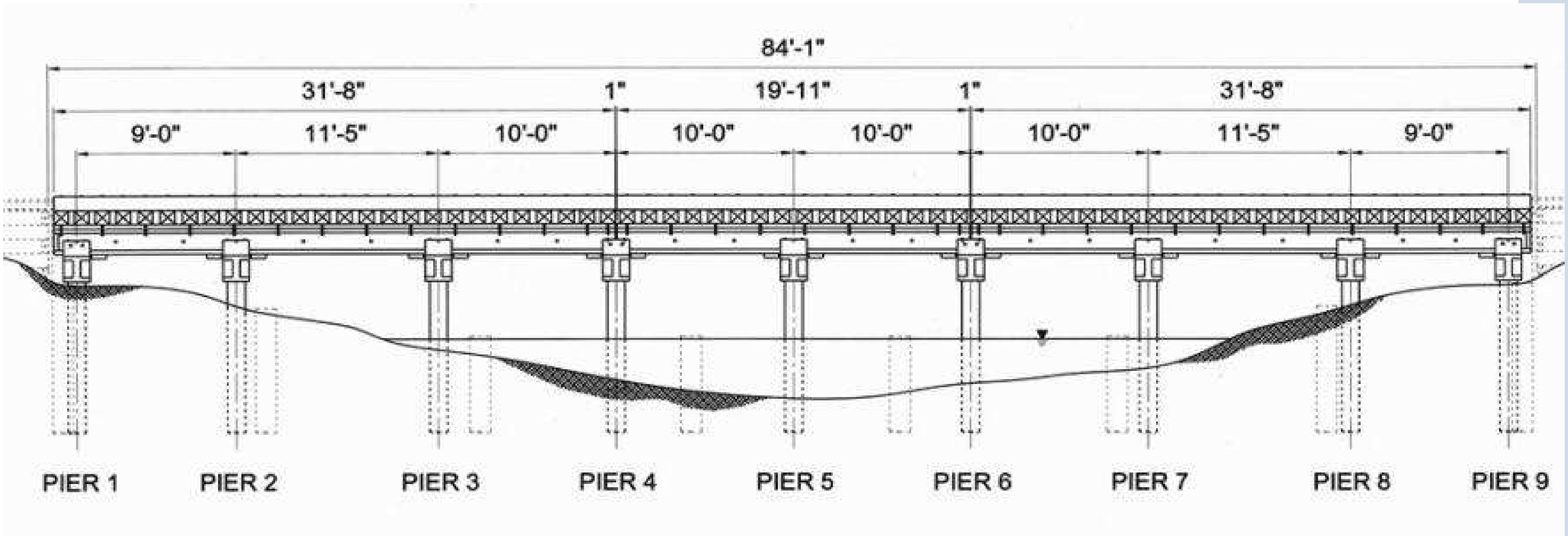
Advantages

- Green Product (Recycled Plastic)
- No Corrosion, Rotting or Insect Infestation
- Reduced Landfill Dumping
- Good toughness Characteristics
- No Chemical additives
- Green House Gas Savings
- Reduced Maintenance
- Sustainable & Durable
- Cost Competitive: Initial and Life Cycle

Design Considerations

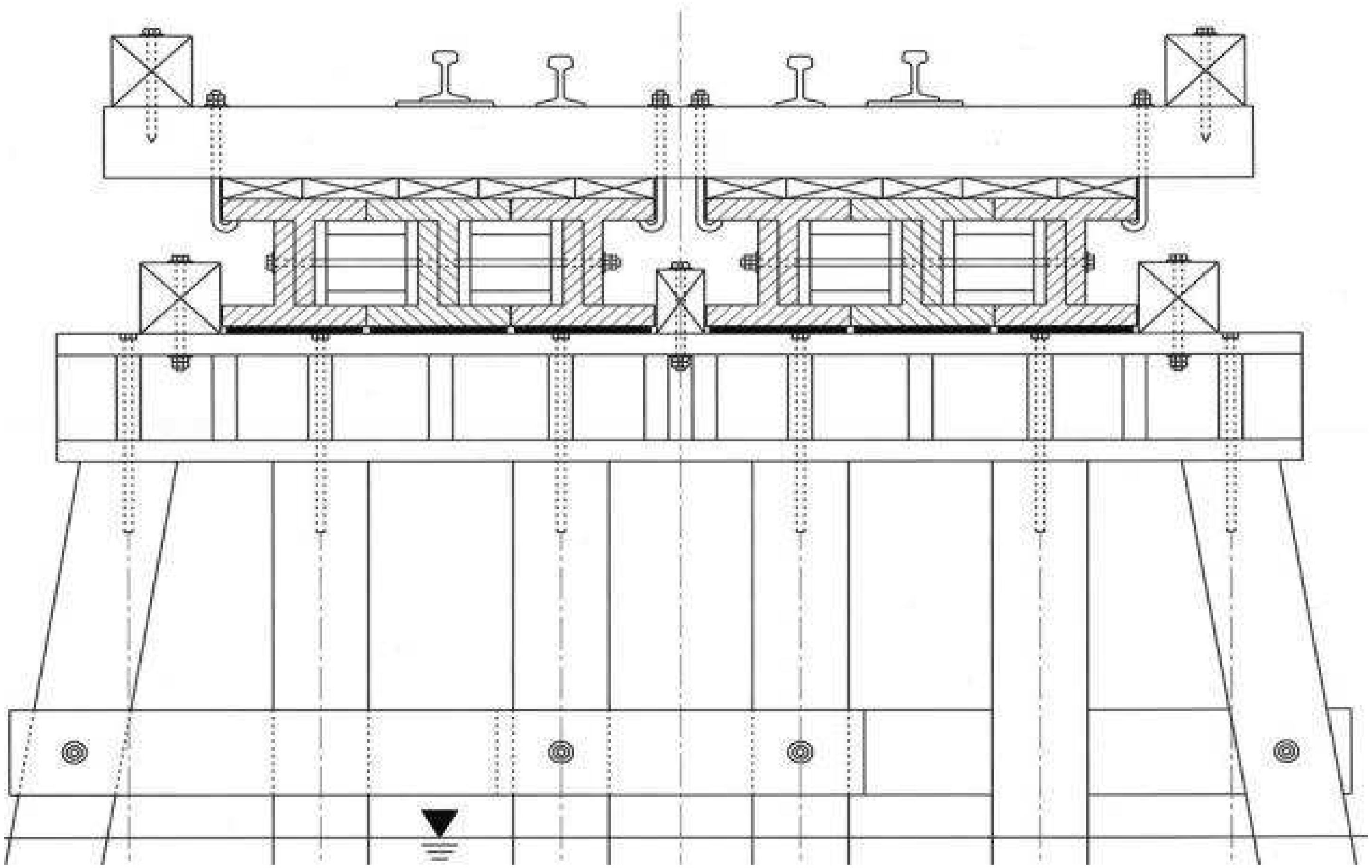
- Ultraviolet Degradation - 0.003 in/yr (full sunlight)
- Creep - Low (high Safety factor to Ultimate)
- Thermal Resistance - Heat Deflection +/- 250 deg F
- Skid Resistance - Coefficient Of Friction = 0.5 w tire
- Acid Resistance - To most acids & salts
- Moisture Absorption - Virtually impervious
- Abrasion - High resistance to sand & salts
- Color - Graphite

Fort Eustis, VA -- Bridge No. 7



ELEVATION

Fort Eustis, VA -- Typical Section



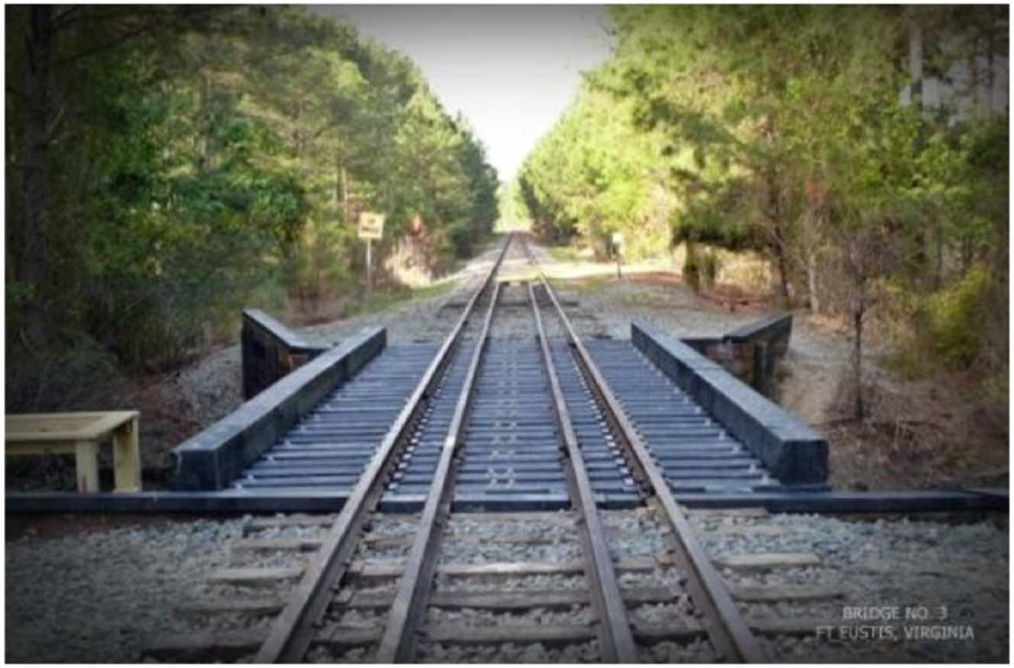
Fort Eustis Construction

- Driving

Splicing

Pile Cap Installation

Fort Eustis, VA -- Completed Bridge No. 3



PARSONS BRINCKERHOFF

Fort Eustis, VA -- Completed Bridge No. 7

Maintenance

Vs. 1% Construction Cost, Annually

- Painting
- Cleaning
- Deck Repair
- Scupper Work
- Joint/Bearing Repair

PARSONS BRINCKERHOFF

Other Applications

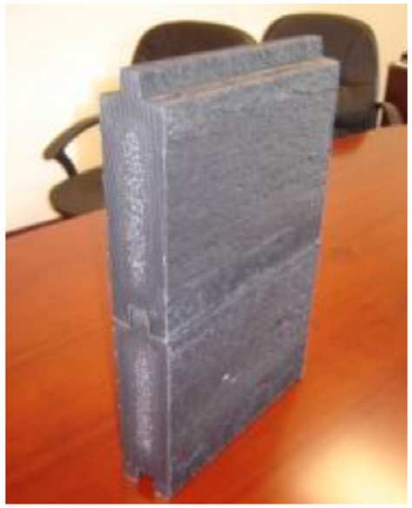
- Marinas
- Fenders
- Jetties and Piers
- Platforms and Boardwalks
- Temporary Reusable Bridges
- Sound Walls & Retaining Walls
- Railroad Ties & Switch Sets

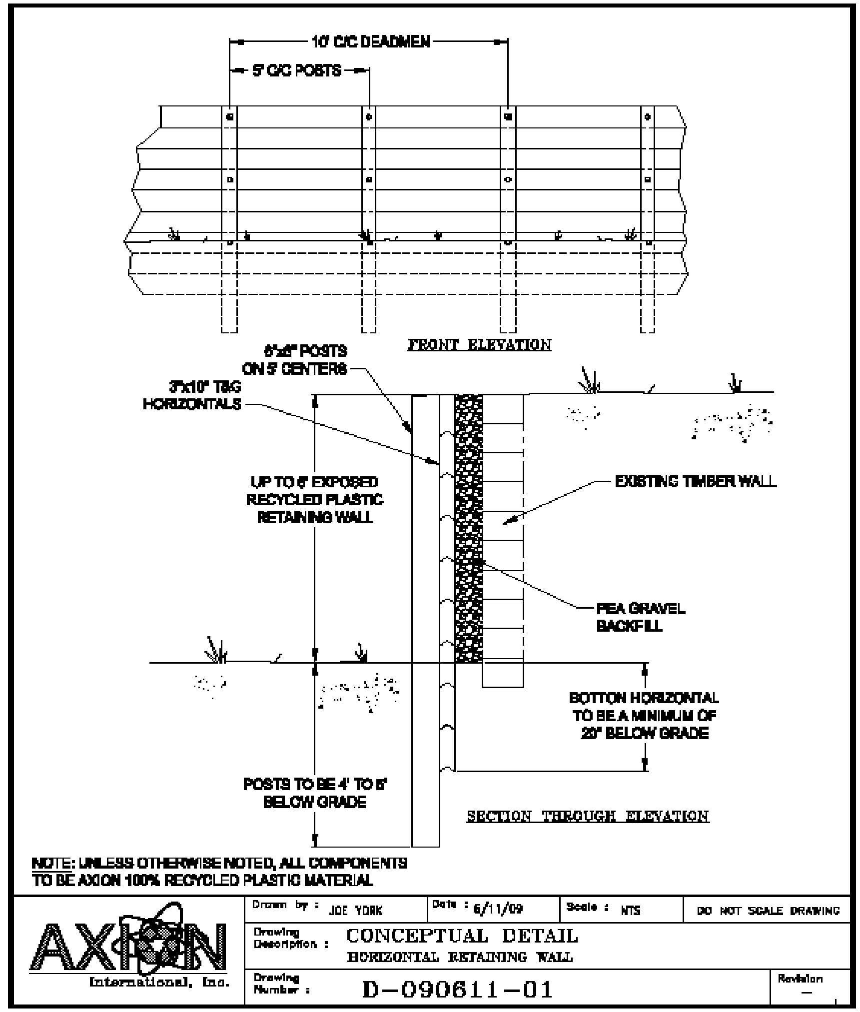
Recycled Materials – Plastic Piles

US Navy

Caltrans, Carquinez Bridge

Retaining Walls





PARSONS BRINCKERHOFF

Railroad Ties and Switch Set

PARSONS BRINCKERHOFF

Advantages…

- Green, Sustainable and Durable
- Environmentally Beneficial
- Vast Areas of Application
- Accelerated Construction
- Minimal Maintenance
- Cost Competitive

Recycling Plastics -- Economic Benefits

	Quantity	Value ($ /)	Total
<u>Jobs</u> - Direct - Indirect / Induced	+ -	x	+ -
Energy	+ -	y	+ -
Waste Disposal	+ -	z	+ -

Recycling Plastics -- Environmental Benefits

	Quantity	Value ($ /)	Total
<u>Carbon</u> - Short term - Long term	 tons tons	 5-120	 X to Y
<u>Air Quality</u> - NOx - PM10		 x x	
<u>Water</u> - Quantity - Quality	 -- acre ft by specie	 variable variable	

Recycling Plastic -- Social Benefits…

	Quantity	Value ($ /)	Total
Aesthetics	+ -	x	+ -
Positive education	+ -	y	+ -
Neighborhood Pride	+ -	z	+ -

Recycling Plastics -- TBLV

	Quantity	Value ($ /)	Total
Economic	**X**	**/ ton**	
Environment (carbon,..)	**Y**	**/ ton**	
Social	**Z**	**/ person**	
Total			***tblv***

Summary

- Larger context
- Regulatory
- Sustainability / rating systems
- Examples – old & new
- **Triple Bottom Line Valuation**


Sustainable…
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