



ENCOURAGING GREEN INFRASTRUCTURE TO MITIGATE TRANSPORTATION IMPACTS

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IN PARTNERSHIP WITH THE NORTH CENTRAL TEXAS COUNCIL OF GOVERNMENTS



**North Central Texas
Council of Governments**



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THE SETTING: NORTH CENTRAL TEXAS

- Dallas-Fort Worth Metropolitan Area
- BIG Growth: 7.2 million people → 10.7 million by 2040
- PROBLEM: Few requirements to mitigate environmental impacts of transportation projects, and mitigation viewed primarily as a cost by local governments
- APPROACH: This project, sponsored by North Central Texas Council of Governments, which provides:
 - Regional transportation planning
 - Technical assistance for local governments



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ABOUT THE PROJECT

- Goal: Demonstrate benefits of mitigation (and costs of not mitigating)
- Audience: local transportation planners and policy makers
- 2 Steps: Data Collection & Web-Interface Decision Tool



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Example Mitigation Measures

- Bioswales/Detention Basins/Wetlands
- Pervious Pavement
- Trees
- Riparian Planting
- Wildlife Corridors
- Streamflow regulation
- Noise/Light Mitigation



Photo Source: EPA Green infrastructure website

CHALLENGES & APPROACHES



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- **How to focus the analysis?** (Started with 20+ services and 20+ mitigation measures)

Approach: Interviews with local stakeholders to identify key services/mitigation measures, identify final ecosystem services people value and general 'types' of mitigation.



- **How to quantify values given relative limited data on urban ecosystem services and transportation mitigation measures?**

Approach: Focus on the financial values that mattered to local officials, heavily rely on local information, qualitative assessment of some measures/services, and work with ranges to reflect uncertainty

- **How to make model values applicable to all of the diverse environments in region?**

Approach: Identify key, easy to answer project and site biophysical variables for user entry (e.g., acreage of impervious area, type of habitat converted, whether recreation is affected, etc.)





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3 TYPES OF MODEL DATA DEVELOPED

- Environmental Costs Per Acre of Impervious Area/Habitat Conversion with No Mitigation
- Environmental Benefit per Acre of Mitigation (e.g., reduced pounds of nitrogen in runoff, reduced pounds of NO_x in air, etc.)
- Annual Economic Benefits per Acre of Mitigation (\$/lb of nitrogen, \$/lb of NO_x, etc.)

FINDING HIGHLIGHTS



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- We know a lot about trees, and they have high economic and social returns.
- We know some about stormwater management benefits for other mitigation measures, but not much else.
- $BC > 1$ clearly for street trees/preservation of tree canopy, pervious pavement, and likely for detention ponds, riparian planting, and wetlands.
- Raingardens/bioretention ponds may have low quantified benefits relative to costs.
- Limited data, so qualitative assessment of noise mitigation, light mitigation, wildlife mitigation, and streamflow regulation.



Photo Source: EPA Green infrastructure website

DRAFT TOOL – INPUT PROJECT DATA



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1. Draw Your Project Boundaries

Project Details

Project type:
New Roadway

Number of Lanes:
2 Lane Road

Zoom to

TX Orthoimagery Program, USDA FSA, DigitalGlobe, GeoEye, CNES/Airbus DS | User should include a credit reference to NCTCOG in any publications or products that make use of the data similar to the following: "Data from the North Centr... Powered by Esri

COMMUNICATE RESULTS – ENVIRONMENTAL COSTS IF NO MITIGATION



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3. Environmental Cost +

These numbers represent the environmental cost of one acre of transportation project if no stewardship efforts are implemented. The transportation project may be larger or smaller than one acre, affecting this cost. All environmental costs are not represented here, only those that could be quantified for the North Central Texas region. Therefore, the transportation project may have additional environmental costs.

 **HEAT ISLAND EFFECT**

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 **WATER QUALITY IMPACT**

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 **AQUATIC HABITAT**

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 **TERRESTRIAL HABITAT**

[Click to Learn More](#) 

 **VEGETATION REMOVAL**

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 **VEHICLE COLLISIONS**

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DRAFT TOOL – SELECT MITIGATION MEASURE



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4. Stewardship Options +

Stewardship options that match your project's size and location. Select an option to view details below.

 <p>Bioswales Bioretention</p> <p>★★★★★</p> <p>WATER QUALITY, WATER QUANTITY, AESTHETIC VALUE</p> <p>View Details</p>	 <p>Detention Ponds Stormwater Storage</p> <p>★★★★★</p> <p>WATER QUALITY, WATER QUANTITY, AESTHETIC VALUE</p> <p>View Details</p>	 <p>Riparian Plantings Wetland Restoration</p> <p>★★★★★</p> <p>WATER QUALITY, WATER QUANTITY, VALUE OF SPECIES, WILDLIFE</p> <p>View Details</p>
 <p>Wildlife Corridor Preservation Measures</p> <p>★★★★★</p> <p>WATER QUALITY, WATER QUANTITY, VALUE OF SPECIES, WILDLIFE</p> <p>View Details</p>	 <p>Preservation of Open Space Green Space</p> <p>★★★★★</p> <p>AESTHETIC VALUE, RECREATION VALUE, HEALTH BENEFITS, TOURISM</p> <p>View Details</p>	 <p>Pervious Pavement Traditional Pavement Replacement</p> <p>★★★★★</p> <p>AESTHETIC VALUE, RECREATION VALUE, HEALTH BENEFITS, TOURISM</p> <p>View Details</p>
 <p>Dark Skies Reduction of Artificial Light</p> <p>★★★★★</p> <p>AESTHETIC VALUE, RECREATION VALUE,</p> <p>View Details</p>	 <p>Stream Function Restoration Restoring Streams</p> <p>★★★★★</p> <p>AESTHETIC VALUE, RECREATION VALUE,</p> <p>View Details</p>	 <p>Native Tree Plantings A Tree for a Tree</p> <p>★★★★★</p> <p>AESTHETIC VALUE, RECREATION VALUE,</p> <p>View Details</p>

COMMUNICATE RESULTS – BENEFITS OF MITIGATION



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The screenshot displays the EEBS Tool interface. At the top, a blue header contains the text "EEBS Tool" and a menu icon. Below the header, a navigation sidebar on the left lists "Stewardship Evaluation Tool", "Documentation", "Stewardship Options", "Graphics", and "Maps". The main content area is titled "Economic & Environmental Benefits of Stewardship Evaluation Tool" and shows a map with a green polygon representing project boundaries. A white text box on the map provides instructions: "1. Draw Your Project Boundaries" and "Instructions: Click the polygon icon in the top right and then click on the map to draw your project area. Double click or click the first point to complete the polygon. You can update your project area by clicking it again. The first click will give you a bounding box for scale, rotation, and movement of the entire shape. Clicking it a second time will allow you to edit each point of the polygon. When finished editing, click somewhere off of the polygon to submit your changes." The map includes labels for "St. Flago Murriano Harbor", "St. Flago Overpass", "AT&T Stadium", "Globe Life Park in Arlington", "Dr. Robert C. Luck Linear Park", and "Richard Gassano". At the bottom, a dashboard shows six metrics, all with a value of 0.0: Total Acres, Acres Tree Canopy, Acres Impervious, Feet of Streams, Acres Flood Zone, and Acres Wetlands.

Metric	Value
Total Acres	0.0
Acres Tree Canopy	0.0
Acres Impervious	0.0
Feet of Streams	0.0
Acres Flood Zone	0.0
Acres Wetlands	0.0



THANK YOU!

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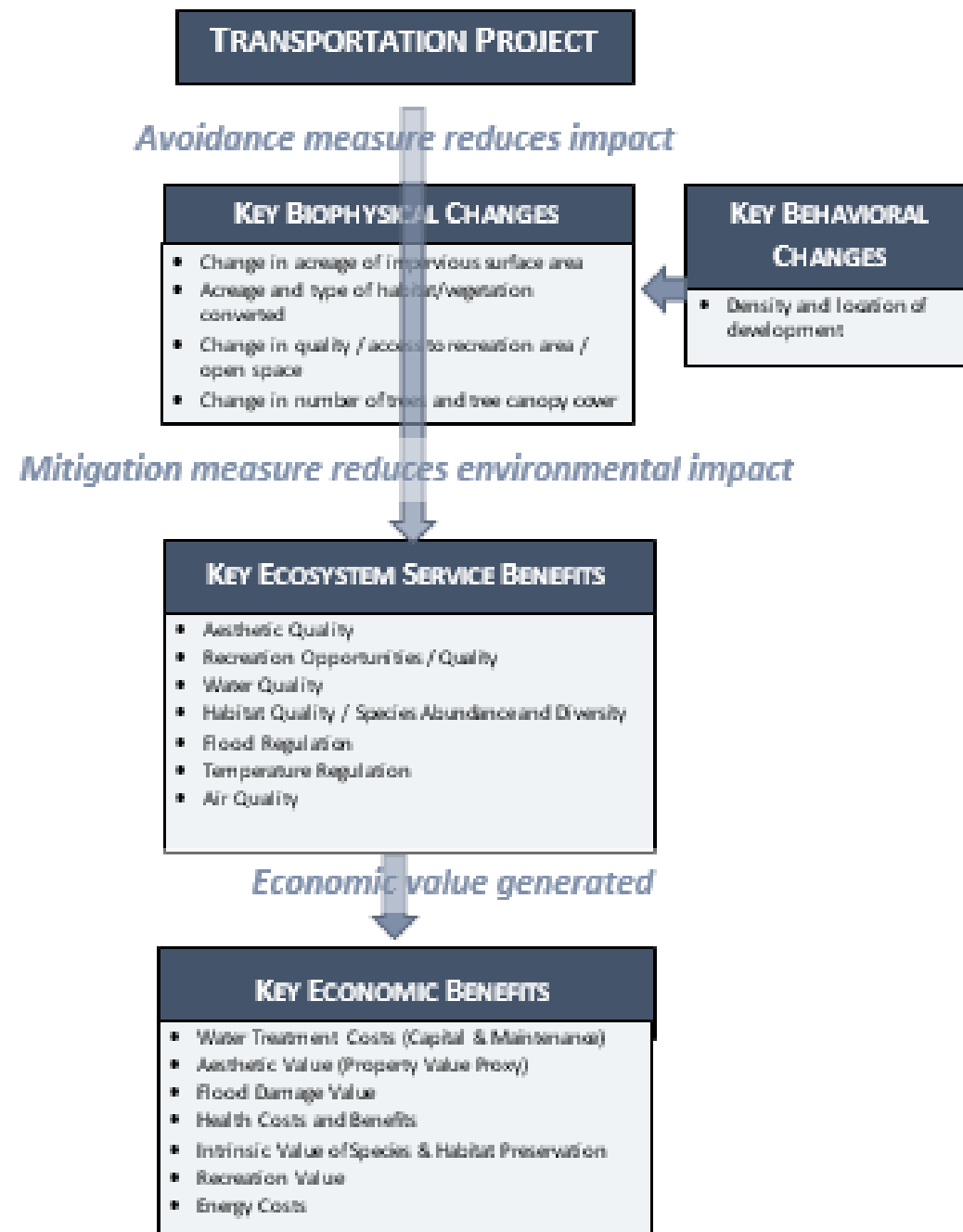




Table 1-1: Quantified Costs: Tool Inputs on Environmental Costs of Transportation

Type of Environmental Impact	Quantity	Unit
Stormwater Runoff ¹	929,381	Annual Gallons of Runoff / Acre of Impervious Area / Year
Water Quality ²		
<i>Sediment</i>	900 - 1,342	Annual Pounds in Runoff / Acre of Impervious Area / Year
<i>Nitrogen</i>	8.8 - 16.5	Annual Pounds in Runoff / Acre of Impervious Area / Year
<i>Phosphorus</i>	1.0 - 2.2	Annual Pounds in Runoff / Acre of Impervious Area / Year
Recreation ³	696 - 3,000	Visits Per Recreation Area Acre Converted / Year
Urban Heat Island ⁴	4,987	Energy Use / Acre of Tree Canopy Removed / Year
Habitat		
<i>Wetland/Riparian</i>	1	Acres Reduced Habitat / Acres Habitat Converted
<i>Terrestrial Habitat</i>	1	Acres Reduced Habitat / Acres Habitat Converted
Air Quality ⁵		
Particulate Matter	12.5 - 50.9	Annual Pounds / Acre of Tree Canopy Removed / Year
Nitrogen Dioxide	4.5 - 12.5	Annual Pounds / Acre of Tree Canopy Removed / Year
Sulfur Dioxide	1.8 - 6.2	Annual Pounds / Acre of Tree Canopy Removed / Year

Table 1-2: Quantified Benefits: Tool Inputs on Environmental Benefit

Environmental Benefit	Mitigation Measure	Benefit	Unit
Water Quantity ¹ (Stormwater Capture)	Bioretention	6.6 - 18.6	Annual Million Gallons Retained / Acre / Year
	Detention Ponds	7.2 - 38.4	Annual Million Gallons Retained / Acre / Year
	Wetlands	10.0 - 50.2	Annual Million Gallons Retained / Acre / Year
	Natural Areas	6.6 - 50.2	Annual Million Gallons Retained / Acre / Year
	Pervious Pavement	0.66 - 0.93	Annual Million Gallons Retained / Acre / Year
Water Quality ² (Sediment Capture)	Bioretention	2 - 13	Annual Tons Retained / Acre / Year
	Detention Ponds	1 - 35	Annual Tons Retained / Acre / Year
	Wetlands	7 - 54	Annual Tons Retained / Acre / Year
	Natural Areas	2 - 54	Annual Tons Retained / Acre / Year
	Pervious Pavement	0.58 - 0.64	Annual Tons Retained / Acre / Year
Water Quality ² (Nitrogen Capture)	Bioretention	31 - 314	Annual Pounds Retained / Acre / Year
	Detention Ponds	27 - 1,003	Annual Pounds Retained / Acre / Year
	Wetlands	16 - 760	Annual Pounds Retained / Acre / Year
	Natural Areas	16 - 760	Annual Pounds Retained / Acre / Year
	Pervious Pavement	4 - 11	Annual Pounds Retained / Acre / Year
Water Quality ² (Phosphorus Capture)	Bioretention	4 - 41	Annual Pounds Retained / Acre / Year
	Detention Ponds	0 - 72	Annual Pounds Retained / Acre / Year
	Wetlands	87 - 139	Annual Pounds Retained / Acre / Year
	Natural Areas	4 - 139	Annual Pounds Retained / Acre / Year
	Pervious Pavement	0.5 - 1.0	Annual Pounds Retained / Acre / Year
Recreation ³	Context Sensitive Detention Ponds	696 - 3,000	Annual Visits Per Recreation Area Acre / Year
	Wetlands	696 - 3,000	Annual Visits Per Recreation Area Acre / Year
	Parks	696 - 3,000	Annual Visits Per Recreation Area Acre / Year
Energy Use ⁴	Tree	60.8	Annual KWh savings / Tree / Year
Air Quality (Particulate Matter) ⁵	Trees	0.15 - 0.62	Annual Pounds Retained / Tree / Year
Air Quality (Sulfur Dioxide) ⁵	Trees	0.05 - 0.15	Annual Pounds Retained / Tree / Year
Air Quality (Nitrogen Dioxide) ⁵	Trees	0.02 - 0.08	Annual Pounds Retained / Tree / Year



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Table 1-3: Quantified Benefits: Tool Inputs on Economic Benefit

Environmental Benefit	Economic Value	Unit
Stormwater Management ¹	\$1,000 - \$1,100	\$ / Acre impervious / Year
Water Quality (Nitrogen) ²	\$1 - \$10	\$ / Pound
Water Quality (Phosphorus) ²	\$1 - \$10	\$ / Pound
Water Quality (TSS) ²	\$6	\$ / Ton
Recreation ³	\$3 - \$25	Per Visit Benefit to Recreator
Energy Savings ⁴	\$0.1165	\$ / kWh
Aesthetics	\$300 - \$900	\$ / Street Tree / Year
Air Quality (PM ₁₀) ⁵	\$7.36 - \$19.85	\$ / Pound
Air Quality (NO ₂) ⁵	\$4.59 - \$11.54	\$ / Pound
Air Quality (SO ₂) ⁵	\$3.67 - \$18.40	\$ / Pound
Habitat, Terrestrial	\$100 - \$750	\$ / Acre / Year
Habitat, Wetland/Riparian	\$500 - \$11,400	\$ / Acre / Year
Pavement Maintenance Costs	\$3.50 - \$17	\$ / Tree / Year

¹ Based on the cost of a stormwater management practice (SMP) multiplied by the number of SMPs required to manage the runoff from an acre of impervious surface. The cost of an SMP varies from \$1,000 to \$1,100 per acre.

Table ES-1: Annual Economic and Social Benefits Per Acre of Mitigation Type

§ = Small Benefit, §§=Moderate Benefit, §§§High Benefit



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Mitigation Measure	Total Annualized Costs	Benefits									
		Habitat Value	Avoided Flooding	Stormwater Benefit	Air Quality Health Benefit	Recreation Benefit	Energy Savings (Urban Heat Island)	Aesthetic Benefits	Other Health and Social Benefits	Reduced Road Maintenance Cost	Total Annual Quantified Benefits ²
Tree Planting (per tree, not per acre)	\$36 - \$57	§§	§§	§§	\$1.50 - \$15.50	\$	\$7	\$300 - \$900	§§	\$3.50 - \$17	\$300 - \$950+
Tree Canopy	Not Available	§§	§§§	\$1,020 - \$12,840	\$120 - \$1,270	\$2,100 - \$75,000	§§§	§§§	§§§	§§	\$3,240 - \$89,010+
Detention Ponds	\$15,600 - \$48,400	\$500 - \$11,400	§§§	\$1,030 - \$12,060	§§	\$2,100 - \$75,000	§§	§§	§§	Not Applicable	\$3,600 - \$98,500+
Wetlands / Riparian Planting	\$2,500 - \$46,800	\$500 - \$11,400	§§§	\$1,150 - \$10,410	§§	\$2,100 - \$75,000	§§	§§	§§	Not Applicable	\$3,700 - \$96,800+
Natural Areas / Open Space Preservation	Not Available	\$100 - \$750	§§§	\$1,020 - \$12,840	§§	\$2,100 - \$75,000	§§§	§§§	§§§	\$	\$3,200 - \$88,600 +
Pervious Pavement	\$0 (likely no additional cost over traditional)	Not Applicable	\$	\$1,010 - \$1,220	Not Applicable	N/A	\$	Not Applicable	Not Applicable	§§	\$1,000 - \$1,200+
Bioretention - Raingardens and Bioswales	\$88,500 - \$132,500	\$	\$	\$1,050 - \$4,730	\$	\$	\$	\$	\$	\$	\$1,000 - \$4,700 +
Noise Mitigation	Not Available	\$	N/A	N/A	Not Applicable	\$	§§ (if trees used)	§§	\$	Not Applicable	§§
Light Mitigation	Not Available	\$	N/A	N/A	Not Applicable	\$	Not Applicable	§§	\$	Not Applicable	§§
Wildlife Mitigation	Not Available	§§	N/A	\$	\$	\$	\$	\$	\$	\$	§§
Non-Vegetative Stream Flow Regulation	Not Available	§§	\$	\$	Not Applicable	\$	Not Applicable	\$	N/A	Not Applicable	§§