NEW ENGLAND TRANSPORTATION CONSORTIUM

2019 RESEARCH PROBLEM STATEMENT SOLICITATON

Submit Research Problem Statements to: MassDOT Research Section
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I. PROBLEM TITLE

Case Studies of Successful Tree Planting for Separated Bike Lanes

II. RESEARCH PROBLEM STATEMENT

If a city has separated bike lanes (barrier-protected bicycle-exclusive paths beside sidewalks), more individuals would bicycle[1-7] and, if bicycle/E-bike usage increases, mobile source air pollution could be reduced by 11%.[8] If, additionally, a separated bike lane corridor has permeable surfaces and trees planted in a manner that fosters growth, trees develop a healthier canopy, shade bicyclists and pedestrians, and lessen heat island effect.[9-14] Just as pavement and storm water systems are now viewed as important, street trees beside separated bike lanes should also be identified as an integral part of the transportation system and designed as a necessary asset with an anticipated life cycle and cost benefit. Urban transportation infrastructure and urban forest management should be intertwined to lessen air pollution[15] and respond to Climate Change.[16,17] With the creation of separated bike lanes in cities, the opportunity exists to put a new focus on street trees. This needs to be addressed now because some documents on the future of transportation show trees in the sidewalk and bicyclists on a separated bike lane with only delineator posts in the hardscape separating them from the cars.[18] Because trees increase in ecological benefits as they increase in size, it is important to plan the locations where trees will thrive now and then plant them.

Recent research in *Cities,*[10,14] found that, contrary to the common practice of planting trees in sidewalk pits, pedestrians and bicyclists preferred trees planted between the separated bike lane and the street. If trees were in this location, the pedestrians and bicyclists perceived that the trees made them feel cooler, blocked the perception of traffic, and exposed them less to mobile source air pollution. While urban areas have trees in sidewalk planting pits[19,20], trees in pits rarely develop an optimal canopy due to the limited rooting area (4' x 4' x 3') and thus fail to lessen heat island effect, provide shade, or absorb pollutants.[21] If trees are in sidewalk tree pits and not between the separated bike lane and the street, the trees are closer to buildings which can restrict crown volume and radius.[22] Even with this evidence, the new Green Streets health impact assessment from Lawrence, MA, recommends planting trees in isolated sidewalk pits[23] while the best location would be in continuous planting pits between the separated bike lane and the street with increased soil volume in that continuous pit and under adjacent permeable surfaces.[13,24,25] The expanded root space for trees between separated bike lanes and the street would then include under the continuous planting pits, under the permeable surface of the separated bike lane, and under the permeable surface of the sidewalk. With this new location for trees, the street design focus would be above and below grade to foster crown and root growth. New measures would include the effective shade provided by the tree and a degree cooling/capital investment and maintenance cost for a reasonably life-cycled planting.

Streets now need to serve regular/autonomous/electric/Lyft-Uber vehicles, Bus Rapid Transit, regular bikes, electric bikes, shared bikes, electric scooters/unicycles/skateboards, cargo bikes, and senior-friendly three-wheeled bikes. Personal-mobility users[26] will not be in air-conditioned vehicles and street trees would provide them with shade and cooling. Yet the current highway design manuals and bicycle design guidelines[5,27-29] that dictate the built environment across the U.S. do not describe how to design a separated bike lane with parallel street trees. Local builders of separated bike lanes then do not have guidelines that explain the benefits of trees or best practices for planting. No one has fully compared all of the latest planting mediums. To foster biking and have successful thriving trees (assessed through foliage, rate of growth, effective canopy size and expanse of shade area), there is a need to:

A. Assess the effectiveness of alternative planting mediums to go under pavement e.g. sand-based structural soil, CU-Structural Soil, Silva-cells, or other technological innovations that function to establish and sustain thriving urban trees.[30-32]

B. Identify the cities that have built separated bike lanes with trees between the separated bike lane and the street and, if they have successful plantings, what were the factors - e.g. engineered soils, modified drainage, city-wide tree management strategy, etc.

C. Identify if cities have an urban forest management plan and what aspects of such plans best sustain thriving trees.

These findings need to be published in a peer reviewed journal as a start to writing new design guidelines for trees, separated bike lanes, and sidewalks. Engineers in Boston, a city with a tree canopy of only 27% compared with the national average of 35% for urban areas,[33] and engineers across North American would benefit from having the information for a new design manual about best practices for planting and maintaining sustainable trees between the separated bike lanes and the streets.

III. RESEARCH OBJECTIVES

This research will consist of three components:

A. Assess the effectiveness of sand-based structural soil, CU-Structural Soil, Silva-cells, or other technological innovations that function to establish and sustain thriving urban trees to identify best practices for: 1) Soil structure; 2) Hydration system; and 3) Stormwater capture strategies such as permeable pavement, sidewalk drains, sidewalk drainage design for passive collection at tree planting areas, etc. For instance, valuable information would also come from specifically selected, existing examples of narrow "tree lawns" or "green strips with trees" that have used CU structural or Sylva soil cells next to a busy road surrounded by pavements that are not specifically separated bike lanes. This component will involve these steps:

1. Identify approximately 50 tree/soil academics and tree experts (DOT and city arborists) in North America who are familiar with these tree-planting innovations, are near the locations of the trees planted, and/or can give an unbiased appraisal of the tree growth/year and the health of the trees.

2. With a few key experts, develop a tree assessment survey for approximately 50 experts to complete about tree growth and health including details about the soil structure, hydration system, and surrounding surface.

3. Send the survey to approximately 50 tree/soil academics and tree experts who live near the trees under study.

4. Conduct the analysis of the survey results to provide a suite of recommendations based on site factors to help assist planners, engineers, and landscape architects in their choosing optimal strategies for inclusion of tree planting as part of urban infrastructure development.

B. *Identify the cities that have built separated bike lanes with trees between the separated bike lane and the road and, if they have successful plantings, what were the factors - e.g. engineered soils, modified drainage, city-wide tree management strategy, etc. This component will involve these steps:*

1. Send a query to members of the Association of Pedestrian and Bicycle Professionals (a community of practitioners with 1,200 members who work to create more walkable, bikeable places in the U.S. and Canada) to ask them to identify the location of existing or new separated bike lanes in North America that have included trees between the separated bike lane and the street. Also, send a query to staff with PeopleforBikes because they have been tracking the building of new separated bike lanes in the U.S. As a cross check, a query would also be sent to the municipal arborists across the U.S. because they would be familiar with tree planting locations.

2. Obtain details and specifications for any recently constructed tree-lined separated bike lane and the tree planting specifications from government agencies or project designers, as applicable.

3. Ask local tree experts (e.g. DOT arborists and city tree arborists) to give an unbiased appraisal of the health of the trees beside the treed separated bike lanes.

4. Summarize the findings to generate recommendations for optimal design approach(es) for establishing and sustaining trees that are between the separated bike lane and the street.

C. *Identify if cities have a maintenance plan to foster full tree maturity in urban environments.*

1. In the cities that have used CU structural soil or Silva cells or that have separated bike lanes with trees between the separated bike lane and the street, identify if they have a maintenance plan to ensure long life of the trees. Also, ask every city that has planted trees for separated bike lanes if they have an urban forestry plan/survey, and to share insights and recommendations. etc.

2. Of the communities that have produced manuals to guide long-term tree life, collect and compare these documents for best practices. In particular, determine if the plans include updated information about tree maintenance and Climate Change.

IV. COST ESTIMATE

$150,000

V. RESEARCH PERIOD

12 months

VI. URGENCY AND PAYOFF POTENTIAL

With the competing demands on the road right-of-way for car storage, AVs, EVs, Lyft/Uber, Bus Rapid Transit, and all of the micro mobility users (bikes, scooters, unicycles, seniors on bikes, etc.), this research is necessary now to quantify the benefits of having trees, separated bike lanes, and sidewalks as critically important contributors to Climate Change mitigation. Trees offer environmental benefits and help to attract new bicyclists, pedestrians, seniors on three-wheeled bikes, etc. Without this research, roads will widen or be re-paved, cars will remain parked on the side of the road, money will be budgeted for trees that will fail in small tree pits, and short demarcated sections of isolated separated bike lanes will appear periodically because the existing highway design manuals and bicycle guidelines do not specify separated bike lane networks. The guidelines also do not specify best practices for planting trees beside separated bike lanes. If the information about best practices was available to individuals across North America, they could use this infom1ation when making planning decisions about how to rebuild or build their roads, sidewalks, and bicycle provisions. Rather than individuals in all states having to conduct investigations alone about best practices for trees, they could share and discuss the ideas identified by the experts and DOT/city arborists. The individuals in the New England states could then consider testing some of the solutions and sharing results with others across the nation. Eventually, individuals in the six New England states could write new sections for highway design manuals and bicycle design guidelines about tree planting and long-term tree maintenance.

The findings about the soil structures, the separated bike lanes plantings, and the existence of any tree planting maintenance programs would be published in a peer-reviewed journal as a start to writing new highway and bicycle facility design guidelines on for best management practices for how to plant trees beside separated bike lanes to address Climate Change.

VII. PRELIMINARY LITERATURE SEARCH

This research covers four domains including: 1) Soil structure; 2) Hydration system; 3) Surrounding surface (permeable, designed stormwater capture system, etc.); and 4) Plan for long-term maintenance. The :findings would come from: A. Examples of trees planted as early as 1994 using new technologies, i.e., Sand-based structural soil, CU-Structural Soil, and Silva-cell; B. Existing or new tree plantings between the separated bike lane and the road and if that community used advanced soils; and C. Determination of whether the city has a tree maintenance plan.

1) Soil Structure: Soils in urban areas are deficient in nutrients, compacted, and polluted from exposure to runoff.[34] While many recommendations are offered for planting trees in regular soil with the addition of loam, etc. many companies have also provided systems to avoid compaction and root damage.[30,31] Some individuals, including Nina Bassuk, Ph.D. at Cornell University and Amereq http://www.amereq.com/pages/2/index.htm, hold patents on certain soil structure systems **(CU-Structural Soil®).**[35] CityGreen has a soil structure system that incorporates a plastic grid. https://citygreen.com/product-category/soil-stmcture-systems/. Tree stability comparisons have shown the benefits of engineered versus conventional soils in urban areas.[36] Individuals or companies may want to endorse their own structural system but all systems need comparing. Even though the problems of soil structure are documented,[37] no one has identified the best long-term soil structure for planting trees in a planting pit between a separated bike lane and a street that would allow trees to reach maturity and expand their tree caliper within that space.

2) Hydration system: Companies offer systems for improving hydration for tTees, including CityGrcen, but all systems deserve equal consideration. https://citygreen.com/solutions/aeration-and-deep-watering/ While cities could continue to incorporate piped water under the sidewalk to hydrate individual trees, this system often fails over time. Trees could take advantage of storm water runoff with water held in underground tanks.[38] This system involves suspended pavement with structural cells, structural soil, storm water tl·ee pits, and permeable pavement, all of which can be costly.

Comparisons are necessary amongst all of the companies for benefits and costs. With Climate Change, a system might also need to be developed that would provide additional nutrients to the trees so they reach maturity

3) Surrounding surface (permeable, designed stormwater capture system, etc.): Rather than only having the sidewalk for water infiltration, the sidewalk, separated bike lane, tree planting pit, and even the edge of the road could provide more opportunities for water infiltration to support healthy tree growth. A comparison of permeable asphalt (PA), permeable concrete (PC), and permeable interlocking pavers (PIP) showed that all needed to be maintained to assure infiltration.[39] All three were similar in pollutant treatment but the permeable pavers did not create black ice and thus did not require deicing agents. While many companies and studies recommend the inclusion of permeable pavement,[38] the permeable pavement voids fill with sediment, causing runoff and loss of infiltration. A slot drain for harvesting stormwater in the middle of the sidewalk might help overcome the issue of permeable surfaces filling with silt.[31] Bioswales can increase absorption but these take space right-of-way. Perhaps a bioswale could be part of the continuous tree planting pit as a study has shown the benefits for larger trees in a bioswale.[40,41]

4) Maintenance-Research has determined that cities lack long-term maintenance plans that guarantee the trees will live to full maturity.[42-45] It is critical that cities provide maintenance for trees in urban environments and invest in the trees as they mature to give the true benefit of "environmental services." The existence of maintenance plans and the benefits of the plans would be through a search for examples of cities that have tree maintenance plans for structural pruning, evaluation, and replacement as needed.

VIII. RESEARCH KEY WORDS

Environment, Transportation, Planning and Design, Construction and Maintenance

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TWO DOT ENDORSEMENTS ARE REQUIRED (To be signed by separate individuals.)

IX. ENDORSEMENT BY THE SPONSORING DOT (To be signed by the DOT representative to the NETC Advisory Committee through whom the Problem Statement is submitted.)

By signing the endorsement, the DOT representative is certifying that:

1. *The Problem Statement follows the required format.*
2. *The required literature search has been conducted.*
3. *The Problem Statement addresses a transportation issue of relevance to NETC and does not duplicate another Problem Statement being submitted at this time.*

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Signature — Date

X. ENDORSEMENT BY A SECOND EMPLOYEE OF THE SPONSORING DOT who agrees to chair the project's technical advisory committee (TAC) if the Problem Statement is selected for funding, (To be signed by a DOT staff person who has technical knowledge of the project topic and is committed to the research outcome.)

DOT Technical Endorsement: *I agree to chair the project's Technical Adviso,y Commillee if this Problem Slatemenl is selectedforfunding* ***by*** *NETC.*

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