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A Greenway Network Vision for Metro Boston

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Abstract

Urban greenways are attractive for walking and especially for bicycling because they offer a pleasant and near-traffic-free environment in an area with high population density and rich with destinations. Unfortunately, urban greenways are often not connected to one another, requiring cyclists to negotiate heavy traffic getting from one greenway to another and thus diminishing their utility. In the Boston region, a planning and visioning effort is underway to promote the vision of a *network* of connected greenways offering continuous pleasant, low-stress routes by bicycle or by foot between origins and destinations across the urban area. The network plan emphasizes both connecting existing greenways and creating new greenways. Opportunities for new greenway corridors are described, including radical road diets that remove two lanes from overly-wide roads in order to create parkland strips that can host a shared use path.

Greenway network planning involves balancing the desire to increase the network's reach and connectivity by adding segments against the need to preserve the integrity of the "greenway" brand. We show that using strict criteria that emphasize low traffic stress, an extensive and dense greenway network is feasible using creative engineering solutions such as road diets and cycle tracks. Evaluation measures examine the quality, reach, geographic distribution, and connectivity of the network.

Introduction

Greenways offer an attractive environment for active recreation such as walking, jogging, and cycling. In urban areas, they are especially attractive for cycling because they can offer near-traffic-free cycling routes in areas rich with destinations. Traffic danger is a major deterrent to cycling (Winter et al. 2011), and is undoubtedly a major reason that cycling rates in most American cities are more than ten times below those of European cities such as Copenhagen, Amsterdam, and Munich that routinely provide traffic-protected bike routes (Pucher and Buehler 2008). However, the potential of greenways to meet the need for safe and attractive cycling routes depends on their being connected to form a network. Without connections, only cyclists whose origin and destination both lie along the same greenway can make a trip without having to negotiate through stressful traffic to get from one greenway to another, limiting the network's ability to serve the mainstream population that has been described as "traffic-intolerant" or "interested but concerned" cyclists (Furth 2012; City of Portland 2010). In contrast, a network of greenways in an urban area offers a radically different and attractive option for transportation and recreation with substantial attendant societal benefits in the areas of public health, energy consumption, air quality, traffic congestion, economy, and mobility.

This paper describes the plan for a greenway network for the Boston's inner metropolitan area encompassing 21 cities and towns bounded roughly by the Middlesex Fells Reservation, the Blue Hills Reservation, and Route 128. Emphasis is given to opportunities for creating connections, extensions, and new corridors, to criteria that help ensure the quality and integrity of the greenway vision, and to network evaluation measures.

Connections to Form a Network

Parks movements prior to 1960 gave the Boston area a legacy of four greenway corridors extending at least three miles – one along the seashore and paths along the Charles, Mystic, and Muddy Rivers. The Muddy River greenway forms the bulk of the Emerald Necklace, a string of parks that originally had continuous walking, bridle, and carriage paths developed by Olmsted in the 1880s that claims the title of America's first greenway. However, the priority given to highway development in the period 1930-1970 created major gaps in the Muddy River and Mystic River greenways. Modern times saw two movements that added additional greenways: the highway revolt of 1967-1972 resulted in the Southwest Corridor greenway, and the rail-trail movement gave the region the Minuteman / Community Path corridor, with four additional corridors partly built out (Neponset, East Boston, Watertown Branch, and Northern Strand).

A map of the area's existing greenway paths (Figure 1) reveals not only frequent interruptions on particular corridors, but also an obvious lack of connectivity between greenways. None of the region's long greenway corridors meet. For example, at Charlesgate, where the Muddy River meets the Charles River, the Muddy River path ends 0.3 miles from the Charles River path, separated by a gap traversed by two highways and a railroad.

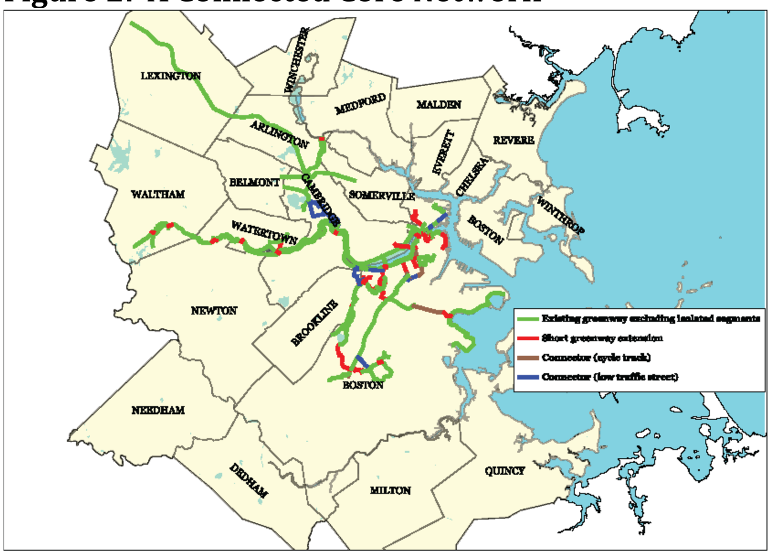
Figure 1: Existing Greenway Path Segments

Since Olmsted's time, people have dreamed of parks being connected. The recent surge of interest in bicycling gives new impetus to the need to connect greenways, because serving the mainstream population requires providing an uninterrupted network of bike routes involving low traffic stress (Mekuria,Furth, and Nixon 2012). Since 2004, civil engineering students at Northeastern University have based several senior design projects on this challenge, and have found solutions to the many of the most vexing gaps in the greenway network including

Charlesgate (Northeastern University College of Engineering, 2012). It is now evident that a *network of connected greenways* in metro Boston is feasible.

Figure 2 shows the core of this connected network. It consists of five existing corridors – the Emerald Necklace and the four existing corridors that permit uninterrupted travel for at least 3 miles – and short projects that tie them together. Some of the connection projects are themselves short greenways; others are connectors that will meet the low level of traffic stress people expect on a greenway path, either by following low traffic streets or by means of a cycle track along a busy road (NACTO 2012). This core network consists of 69 miles of existing greenway, 12 miles of new greenway paths, and 8 miles of connectors.

Figure 2: A Connected Core Network



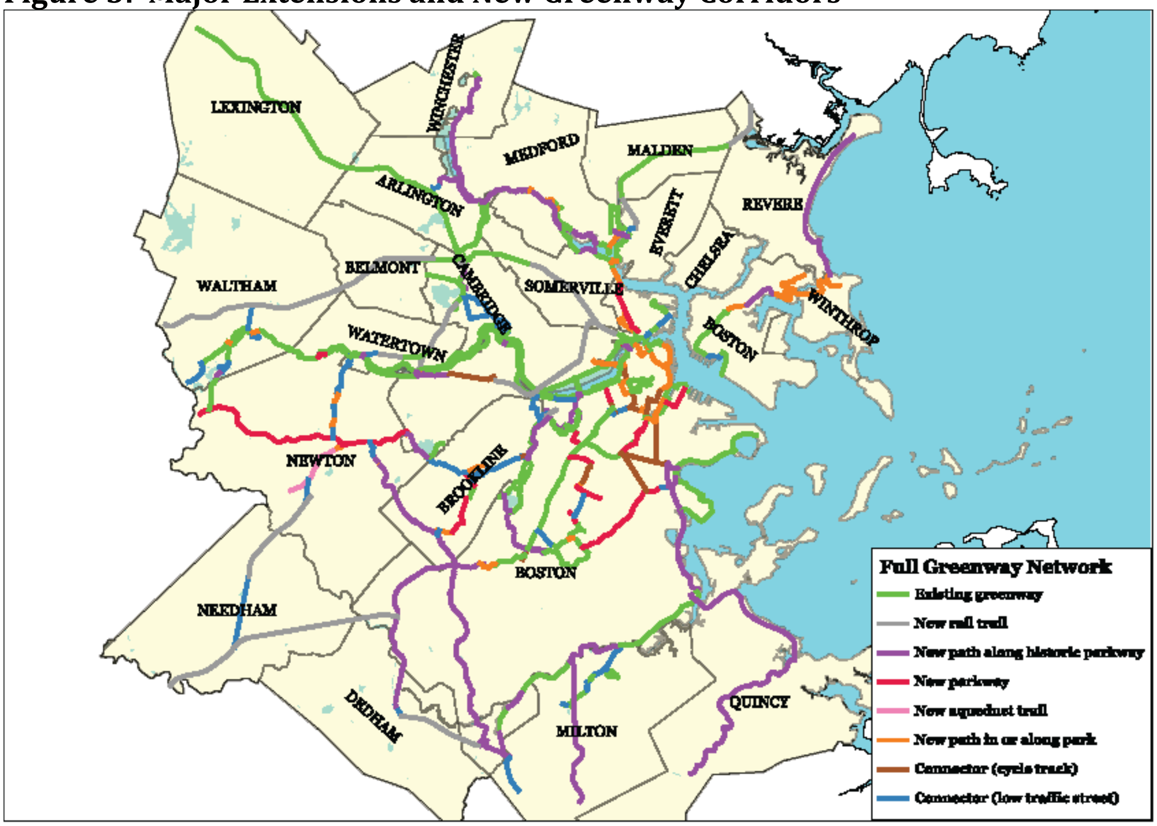
Compiling plans for other new greenways and extensions in the region – including projects currently being advanced by state and local government as well as projects being advanced by advocates, a regional greenway network can be proposed, shown in Figure 3, reaching all of the region's 21 communities except one (Chelsea). It contains 203 miles of greenway and 26 miles of connector. Of course, the network plan is open to revision as new opportunities are discovered and conceptual plans develop.

The network vision exploits five kinds of opportunities for greenway extension and new greenway corridors, highlighted in Figure 3:

- *Rail Trails.* Six new rail trail corridors and four corridors with major extensions are proposed, totaling 27 miles. Four projects involve trails along active rights of way.
- *Paths along Historic Parkways.* The Boston region has a large number of historic parkways, many of them planned in the 1910-1950 period with a focus on "pleasure driving" and often with no provision for non-motorized travel other than a narrow sidewalk. Many of them lie within reserved strips of parkland wide enough that they could host a shared use path as well as the parkway road. In some cases, space for a greenway path can be obtained by means of a "radical road diet" – eliminating two travel lanes where they are not needed to fulfill the road to fulfill its traffic function. The proposed network adds 55 miles of paths along historic parkway corridors.

- *Road Diets to Create New Parkways.* Besides historical parkways, the region has other wide roads that could fulfill their traffic function with a much smaller footprint, allowing the redeemed space to become a parkway strip with a shared use path. Such conversions offer the prospect of expanding the region's parkland resources as well as its path network. Traffic capacity analysis supports the feasibility of 11 such new parkways with a combined length of 14 miles. An example is Rutherford Avenue in Charlestown, which can be reduced to 4 lanes from an existing 6-8 lane cross section, allowing construction of a new parkland strip 0.9 miles long on the edge of one of the region's densest neighborhoods. In some cases, the greenway path can double as an access drive to abutting homes – a compatible use in conjunction with access and speed control measures that assure motor traffic speeds below 10 mph.

Figure 3: Major Extensions and New Greenway Corridors



- *New Paths Through or Along Existing Parks.* Several new paths totaling 15 miles are proposed through or alongside parks. Many of them are links between other greenway segments. An example is downtown Boston's Rose Kennedy Greenway, which currently does not allow bicycling, but has space to create paths that would form a critical link between greenways north and south downtown Boston.
- *Aqueducts.* A series of publicly owned aqueduct rights of way in the western suburbs of Boston has recently been released for trail development (Loutzenheiser et al. 2013). While most are beyond the geographical boundaries of this planning effort, a 1.5 miles section of aqueduct trail in Newton is part of the proposed greenway network.

Criteria for Greenways and Greenway Connectors

Creating a network plan involves a tension between forces of inclusion and exclusion. To expand the network reach and connectivity, there is strong force favoring adding more links; at the same time there is a need for criteria that ensure the quality and integrity of the "greenway" brand. For the public to comprehend and embrace the vision, *greenways* should be in parks or parkway strips and offer paths that are nearly free of traffic stress, and *connectors* should be short so that they don't dilute the park-like character of the network, and should involve the same low traffic stress that people expect on greenways.

Criteria for Greenway Segments

Greenway segments should meet five general criteria:

- They should be in a green or blue setting: in a park or parkway strip, or bordering a park or body of water.
- They should be physically segregated from motor traffic. Bike lanes do not qualify except on two-lane park roads with no curbside parking. Traffic limited to 10 mph can be permitted for local access.
- They should be open to both walking and bicycling, and traversable with a common road bicycle (thus excluding mountain bike trails).
- They should be suitable for travel for at least three miles along a desire line, thus excluding short, isolated segments as well as paths meant only for circulation within a large park.

Most greenway segments will be shared use paths, though some corridors may provide separate walking and cycling paths. They may be soft surface paths provided they are designed to resist rutting and are suitable most of the year for common road bikes.

Criteria for Greenway Connectors

Criteria for connectors apply to connector routes as a whole as well as to the links that make up a connector route. For the greenway network to be cohesive, connectors have to offer the same low-stress environment for bicycling and walking that people expect on a greenway. Mekuria and Furth (2012) give criteria for links to meet different levels of traffic stress (LTS) for bicycling. Using criteria for Level of Traffic Stress 2, the level that applies for the mainstream, traffic-intolerant adult population, options for connector links are as follow:

- If a road has more than two lanes, a speed limit 35 mph or more, or high parking turnover, a cycle track required. Cycle tracks (NACTO, 2012) are a zone for riding a bike that is physically segregated from moving traffic by barriers such as curbs, flexpost bollards, or a parking lane and distinct from the walking path. Where there are no abutting land uses such as homes or businesses, a shared use path can be used instead. Cycle tracks can be one-way (on either side of a road) or two-way. Two-way cycle tracks will often be preferred because they require less space than a pair of one-way cycle tracks while offering users more space. They also connect better to greenway paths which are virtually always two-way, and offer a more trail-like environment.

- On two-lane roads with speed limit 30 mph or less and either no parallel parking or parking lanes with low turnover and little or no double parking, bike lanes can achieve a sufficiently low level of traffic stress.
- On streets without any marked lanes (and therefore no centerline marking) where the prevailing motor vehicle speed is 25 mph or less and traffic volume is less than 3,000 vehicles per day, bikes can share the road with motor traffic..
- The walking path should be physically protected from motor traffic except where traffic calming limits speeds to under 10 mph.
- Unsignalized crossings should not require crossing more than two through lanes of traffic at a time.

Criteria for connector routes as a whole are:

- Connector routes should be direct. Human nature is such that people want to use the shortest path and will not go far out of their way to use a low-stress alternative route. The emphasis in network development should be on making the direct route low-stress rather than try to make people follow a circuitous route.
- Connector routes should be short – preferably one mile or less, with a suggested maximum length of two miles.
- Connector routes should aim to pass through pleasant and safe environments, avoiding, for example, ugly industrial areas and back alleys.
- Where possible, connectors should be routed so that they pass through or alongside parks that may be too small to qualify in themselves as greenways.

Many of the region's low-traffic routes that are otherwise ideal as connectors are one-way streets. Making them greenway connectors involves permitting contraflow bicycling (NACTO 2012). The network plan proposes contraflow for 13 one-way local streets, in addition to several cases in which two-way cycle tracks are proposed for busier one-way streets.

Finding space for a cycle track on a major road in a crowded urban area may seem like a daunting task, but it is surprising how often it is possible while still preserving the road's other functions. In some cases, it is possible to eliminate a travel lane; in others, space can be found by eliminating parking on one side of the street, or by making travel lanes and medians narrower. On bridges and on streets without any abutting homes or businesses, space efficiency can be found by having bicycles and pedestrians share a common path.

Relationship of the Greenway Network to the Bicycling Network

A region's greenway network will overlap its bicycling network, but they are not synonymous. A regional bike network will include many important routes that are not "green" and that may not be low-stress; including them all in the greenway network would severely dilute its park-like character. The greenway network is also more than just a bicycling network; it's also a resource for walking, jogging, and other forms of outdoor recreation, and offers substantial environmental and ecological benefits.

Within the bicycling network, some greenways may play the role of "bicycle superhighways" by offering long routes with few traffic crossing along important commuting corridors. Other greenways may play a minor role in the cycing network, serving as scenic byways.

In urban areas, greenways will inevitably serve both recreational and transportation (utilitarian) trips, and usage will often be dominated by the transportation function. However, there will usually be many more *individuals* who use the greenways for recreation than for transportation. Therefore, for developing public support for the greenway network vision, it is important to emphasize the recreational function. While relatively few citizens can see themselves riding a bike to work or to run errands, nearly all can see themselves cycling, walking, or jogging along greenway.

Evaluating a Greenway Network

Evaluating the network is important for network design as well as for making the case for public support. This section describes metrics that can be used to describe the quality, reach, and connectivity of a network plan.

Quantity and Quality of the Facilities

Table 1 shows a distribution of greenway segments by facility type. Compared to what exists today, the proposed network offers more than double the milage of greenway paths. The quality of the proposed network can be seen in the small fraction of network mileage in connectors as opposed to greenway paths, and the small fraction consisting of bike lanes as opposed to traffic-protected paths and bike routes along low-volume, low-speed roads. Nearly all of the connector routes are in pleasant surroundings; the only exceptions are a few miles of cycle track that have to pass through industial areas in order to connect parks.

Table 1: Distribution of Greenway Network by Facility Type (miles)

Existing greenway	91	
New paths along historic parkway	55	
New rail trails	27	
New paths in parks	15	
New parkway paths	14	
Aqueduct paths	2	
Subtotal, greenway paths		*203*
Connector, low traffic	19	
Connector, cycle track	7	
Subtotal, connector		*26*
Network total		***229***
Fraction connector		11%
Fraction bike lanes		4%

Geographic Distribution and Network Reach

Table 2 shows the distribution of the proposed network over the 21 municipalities in the target area. Most communities have a supply close to the regional average of 1.3 miles of greenway per 10,000 population. A supply of 2.0 or more only occurs when towns have paths running along rivers at the town edge. Chelsea, Everett, and Malden, a cluster of older industrial towns north of Boston, have the least supply. Contributing factors include wide rivers acting as barriers, a historical lack of regional parks, few unused railroads; also commercial strip development was allowed along their main historic parkway in place of parkland.

Table 2 also shows that 72% of the regional population lives within 1 km (0.62 mi) of the proposed greenway network, indicating reasonable good coverage. A buffer width of 1 km was chosen rather than 1 mile because it was believed that having to walk or cycle 1 mile to get to a greenway would be considered a deterrent to many people (especially where there is no safe access route for bicycling), while a distance of 1 km would not. A more detailed analysis would account for the existence of low-stress bike routes that can be used to access the network.

Coverage by community is more than 80% for Boston and for communities closest to downtown Boston, a natural hub considering the regional layout of railroads and rivers, which greenway paths often follow. Except for Chelsea, coverage tends to be lowest in the most distant suburbs, where the population is more spread out. Malden has a low supply of greenways, but 74% coverage because of its dense population and because its main greenway is centrally located; conversely, Milton, with the greatest supply of greenways, has only 53% coverage because its greenways are concentrated along a river that forms the edge of town.

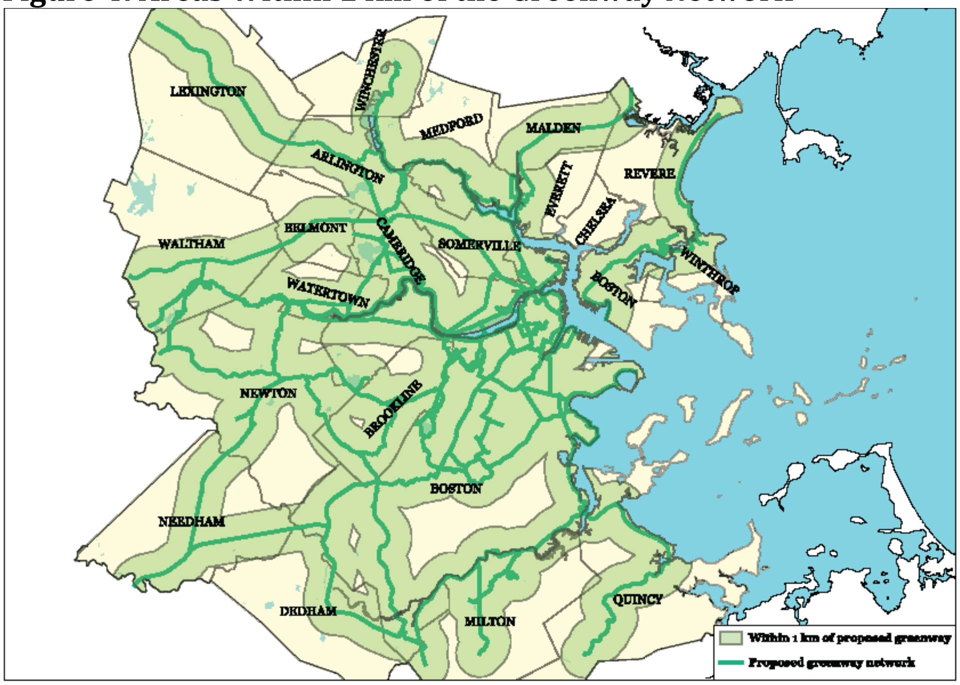
Table 2: Geographic Distribution of the Proposed Network

	Greenway miles (excluding connectors)	population	Greenway miles per 10,000 people	population within 1 km of network	% within 1 km of network
Cambridge	17.8	109,000	1.6	104,000	96%
Somerville	6	79,000	0.8	75,000	95%
Brookline	7	59,000	1.2	54,000	92%
Arlington	7.3	43,000	1.7	36,000	84%
Boston	81.7	608,000	1.3	506,000	83%
Malden	3.2	59,000	0.5	43,000	74%
Newton	12.8	84,000	1.5	59,000	69%
Needham	5.8	30,000	1.9	19,000	63%
Belmont	3.3	25,000	1.3	15,000	60%
Medford	11.4	57,000	2.0	33,000	58%
Watertown	7.3	33,000	2.2	18 ,000	56%
Revere	4.7	49,000	1.0	27,000	56%
Milton	7.6	27,000	2.8	14,000	53%
Waltham	8.1	62,000	1.3	31,000	50%
Everett	2.1	39,000	0.5	18,000	47%
Quincy	7.6	90,000	0.8	40,000	44%
Winchester	1.9	21,000	0.9	9,000	42%
Lexington	5	32,000	1.6	12,000	39%
Dedham	2.5	26,000	1.0	10,000	38%
Chelsea	0	37,000	0.0	2,000	7%
TOTAL	**203.1**	**1,567,000**	**1.3**	**1,126,000**	**72%**

Figure 4 shows the proposed network with 1 km buffers indicated. It clearly reveals several "greenway deserts" in the region. Greenway deserts in densely settled, park-poor communities such as the Mattapan- Dorchester area of Boston and Chelsea generate an impetus to find new opportunities create greenways. Bertulis and Furth (2013) describe an effort to create a new kind of greenway in Dorchester by converting local streets to linear parks. Greenway deserts in leafy suburbs are less of a concern because many of their streets offer a pleasant environment for wal king and cycling.

The network provides close access to all of the region's main recreational areas and activity centers other than suburban office parks. However, the network's break in connectivity (discussed later) makes destinations on the north shore such as Logan Airport and Revere Beach inaccessible by greenway from most of the metro area.

Figure 4: Areas Within 1 km of the Greenway Network



Connectivity and Mesh Density

From inspection, the proposed network is clearly better connected than the existing one. At the same time, one obvious shortcoming remains in the proposed network – the complete separation of the East Boston / Revere Beach corridor from the rest of the network. They are coastal communities bordered on three sides by wide bodies of water, making connections difficult.

The Dutch guide for bicycle network planning uses an indirect way of getting at the objective of connecting people's homes with destinations. It stresses that the biycling network should form a relatively dense mesh (CROW 2007). A dense mesh will enable people to travel between any pair of points with little off-network travel to access the network and with little detour. Inspection of the network reveals that much the proposed greenway network offers a mesh density that meets those objectives, especially considering local and non-greenway bike routes that may be available. The exceptions are the greenway deserts pointed out earlier and the large break that cuts East Boston and Revere Beach from the rest of the city. During planning,several of the network's connectors were added precisely in order to fill what would otherwise be gaps in the mesh. The greenway deserts that persist give a clear impetus for finding additional opportuntities for new greenways and low-stress connectors.

Discussion and Conclusion

Connecting parks has long been a goal of park planning, and the recent surge of interest in bicycling for transportation gives new impetus to this goal. This study shows that by using innovative engineering solutions such as radical road diets, cycle tracks, bicycle contraflow, and rail-with-trail, far greater connectivity and reach are possible than many people had imagined, with At the same time, the failure of the network plan at present to reach and connect all communities gives impetus to find a way to create additional greenways and connectors.

Regionally, greenway development has often advanced piecemeal, as advocates have pushed for this or that trail. This effort puts forth the vision forthe radically different and larger idea of a *network of greenways*, a concept that has the potential to capture the imagination of the public like a transit network or a freeway network. This concept also has the potential to unify and strengthen advocates for parks, trails, and bicycling paths, with each one seeing how their project becomes so much more valuable when it's connected to a network.

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