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Trails, Transportation, and Soils Resilience

TTR 688

Doctoral Assignment
PhD. in Sustainable Design and Construction

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COVER

The Trail Transect as Resilient Transportation Infrastructure (with sustainable health effects)

Introduction -

Taking care of ourselves makes for a stronger community. Being active and being outdoors creates a better life! Americans love trails, they are the number one amenity people seek when locating a home.

Trails contribute to the potential well-being and conservation synergies between walkable neighborhoods while enhancing the use of green-spaces within cities. This is important because these collaborations can help maintain the natural functioning of native ecosystems in such human-dominated urban environments.

The enhancement of green-space by urban design has the capacity to preserve the green-space and ecosystem while improving human health. The use of green-space provides contact with nature, which has been linked to an enhanced mental, emotional, spiritual, as well as physical health. Because most of the population in the world now lives in cities and this trend is projected to increase, the future conservation of these spaces is critical in order to maintain contact with nature. Good neighborhood design sets the priority to access green-space. Furthermore, neighborhoods that provide access to green-space may be activators for better health and well-being. Man and nature are integral beings with mutually nourishing existence. Medical experts such as Dr. Ben Carson have described how a patient recovering from a medical event can speed their recovery with regular contact with nature. This field of medicine is referred to as Ecotherapy. Perhaps man and nature are not radically different entities and perhaps, man needs to remain connected to nature more than he realizes. The possibility of encountering nature is increased when using trails as a form of transportation and recreation.

Description -

The influence of neighborhood design on the use of green-space and explore potential synergies with well-being and conservation support has been studied by The Congress for New Urbanism, Strong Towns, and the American Planning Association. Each of these organizations have completed extensive research on

walkability's impact on health and happiness. A chief component in these studies was the availability of trails and sidewalks which are readily available and connect across neighborhoods. I will not critique those studies here but show how to connect a system which uses various types of human powered transportation venues to offer opportunities for better health through trails systems which make sense for each setting. This is known as the Trail Transect. We integrates the findings from several research domains on neighborhood design elements that influence physical activity into the various transects.

Trail Transect: A classification system based on the correlation of the various elements by a common wilderness-to-urban Transect. Six segments calibrate the Transect to the system-wide structure. These are Game Trail, Wilderness, Recreational, Quarter, Neighborhood, and Inter-Urban.

Three categories (Natural, Developed Natural Surface, Paved Surface, or Urban) follow the system's natural development and progression. The Inter-Urban is assigned to the intensification that occurs where several neighborhoods conjoin, while the Natural is outside the urbanized area.

Each zone is an immersive environment, a place where all the component elements reinforce each other to create and intensify a specific urban character. Several such immersive environments within a single neighborhood provide variegation in contrast to the consistent tracts of wilderness found on most Public Lands.

Urban Planning designs can be improved by accompanying designs keyed to a Trail Transect, an ordering device adapted by Urban Designers from the world of science. A geographical cross-section of a selected environment helps identify the habitats in which certain environments are naturally found. The Trail Transect has been created as an analytical tool to be used by Planners, engineers, trail builders, and

governments. As human beings also thrive in different ways in different habitats (some would never choose to live in the urban core, and some would wither in a wilderness place), the Transect can be applied to recreational urban design.

The Trail Transect is intended to be a master planning tool that guides the placement and form of trails and landscape, allocates uses and volumes, and appropriately details adjoining spaces, including the selection of tree types and lighting poles where appropriate. A model Trail Transect, depicted below, was designed to be included in municipal Codes as well as given to designers and builders of trail systems. For simplicity it is divided into six zones, nicknamed “T-Zones”, which increase in intensity of development from the lessor wilderness and the untouched natural conditions (T2 and T1), towards higher T-zones (T5 and T6).

Many earlier human settlements were organized this way, in which the walkable countrysides had a center, a town, and an edge. These consisted of a natural gradient. This can be seen in historic traditional towns around the world, from those recorded in the ancient scrolls of China to medieval English villages to pre-automobile American towns. The Trail Transect is a geographic cross-section of a region used to reveal a sequence of environments. For human-occupied environments, this cross-section can be used to identify a set of habitats that vary by their level and intensity of urban character – a continuum that ranges from agrarian wilderness to urban. This range of environments is the basis for organizing the components of the built world: surface, grade, landscaping, signage, and all of the other physical elements of these built connectors. In each environmental habitat along the wilderness to urban Trail Transect, “penetrative” environments are created – places which have wholeness and a ‘connectedness’ about them because of their particular combinations of elements, even when there is a regularity to their irregularity.

The Trail Transect works by allocating elements that make up the environ habitat to appropriate geographic locations. For example, environ habitats that are wilderness might consist of narrow trails and irregular surfaces. Environ habitats that are more urban and inter-urban will likely consist of multi-lane trails and public spaces. Accordingly, narrow trails and irregular surfaces should be allocated to more wilderness zones whereas multi-lane trails and public spaces should be allocated to more urban and inter-urban zones. This proper geographic “appropriation” serves to better integrate natural and urban systems because one is defined in tandem with the other. Conventional trail zones have ignored this interrelationship.

The Trail Transect seeks to rectify the inappropriate braiding of wilderness and inter-urban elements. No desire for a particular type of development is categorically “wrong;” it is just in the wrong Trail Transect location. The Trail Transect eliminates the “urbanizing of the wilderness” – multi-lane trails and public spaces in otherwise pristine environments – or equally damaging, the “wildernessing of the urban” – undefined, braided trails within the open space of the urban core. The prescribed urban pattern is therefore based on, theoretically, finding the proper balance between natural and human-made environments along the wilderness-to-urban Trail Transect.

In nature, the sequence of habitats is continuous, but in human environments, the wilderness-to-urban continuum must initially be segmented into discrete categories. This is dictated by the requirement that human habitats fit within the language of our current approach to land regulation – zoning. In other words, codes of perfectly familiar formats can be written based on Trail Transect Zones. Surface and surrounding vegetation help define the characteristics of each T-section. Trees, shrubs and bushes may define the edges of the trail corridor. To explain this more exactly, a diagram of the nomenclature of the Trail Transect is presented in Figure 1.

The Segmentation of the Trail Transect continuum is accomplished by dividing it into six different Trail Transect Zones: Game Trail (T1), Wilderness Reserves (T2), Recreational (T3), 1/4 (T4), Neighborhood (T5), and Inter-Urban (T6). While these categories work well, it is important to note that other immersive categories have been proposed that somewhat resemble the zones discussed here. Brower's typology of neighborhoods is one example.

The Trail Transect approach is essentially a matter of finding an appropriate spatial allocation of the elements that make up the human habitat. Wilderness elements should be located in wilderness locations, while urban elements should be located in more urban locations – not unlike natural ecological systems where plant and animal species coexist within habitats that best support them. In the Trail Transect system, urban development is distributed so that it strengthens rather than stresses the integrity of each immersive environment. The Trail Transect approach also controls the geographic extent of zones, disallowing the creation of large transit monocultures of any one particular type of Trail Transect Zone.

The Trail Transect should also be viewed as a way of applying good urban principles to a range of human habitats. The idea is that human environments should be pedestrian-oriented, and diverse, and the public is intrinsic to each type of environment along the Trail Transect. The Trail Transect approach also factors in the element of time, as a Trail Transect Zone can change to another type of immersive environment (usually one of higher urban intensity – though through this current movement we are likely to be seeing mostly definition of T-zones in order to fit the character and intensification where appropriate).

Any community-based trails organization focused on helping make the world around us a better, happier place through encountering the outdoors can use the transect to develop trails of all types. Often this is accomplished with the help of tireless volunteers and trained staff. Exciting trail-building events and in-depth training sessions for volunteers is a great way to build community. Anecdotal evidence suggests those who are passionate about trails are deeply involved in their overall communities. These are often visionary people who are looking to make a better reality. Trail networks are an integral part of a strong community. Through the connection of: urban trails, dirt trails, paved trails, hiking trails, biking trails, skiing trails, transportation trails, and historic trails community sustainability and resilience are built.

Actualization -
Figure 1.



Trail Name	T1 Game Trail	T2 Wilderness	T3 Recreational	T4 1/4	T5 Neighborhood	T6 Inter - Urban
Width	 0 - 12"	 12" - 18"	 18" - 24"	 24" - 42"	 48" - 60"	 60" - 120"
Trail Usage	Local	Local → Collector	Collector & Connected	Use-Specific	Connector	Inter-Urban Connector
Trail Purpose	Local, Lacks Connectivity	Inconsistent, Non-transportational	Trail system, Seldom used for transportation, Group of trails	Created by developers, Meet ADA standards, Local connector	Primary transportation, Growing in popularity	Long distance trail, Connector
Construction Type	Nature-Made	Nature-Made, Man-Improved	Man-Designed, Hand Built	Man-Engineered (Machine)	All-Weather	Multi-User Forms
Trail Type	Livestock Trail, Game Trail	User - Improved Trail	COPMOBA Built Trail	1/4" Minus Trail	4' - 5' Asphalt Trail	10' Concrete Trail, Express
Designed Speed	3 - 4 MPH	5 - 8 MPH	8 - 10 MPH	11 - 15 MPH	16 - 20 MPH	25+ MPH
Example	Local Residential	Residential Collector	City Arterial	Boulevard / Parkway	Highway	Interstate
Gradation	25 %	15 %	10 %	6 %	4 %	2 %
Capacity	60 users per hour	120 users per hour	120 users per hour	180 users per hour	240 users per hour	300 users per hour
User	Hike, Mountain Bike, Hunt	Hike, Mountain Bike, Trail Run	Hike, Trail Run, Mountain Bike, Road Bike	Hike, Trail Run, Mountain Bike, Road Bike, Stroller, Wheelchair, Maintenance Vehicles	Hike, Trail Run, Mountain Bike, Road Bike, Stroller, Wheelchair, Maintenance Vehicles, Skate	Hike, Trail Run, Mountain Bike, Road Bike, Stroller, Wheelchair, Maintenance Vehicles, Skate
Signage	None	Informational, Low Budget	Informational, Directional	Informational, Directional	Informational, Landmarks, Ordinances	Informational, Landmarks, Ordinances
ADA Accessibility	Obstacles Present	Obstacles Present	Controlled Gradient	USDA, FS, ADA Compliant	USDA, FS, ADA Compliant	USDA, FS, ADA Compliant
Difficulty		 	  		 	

Image by Author

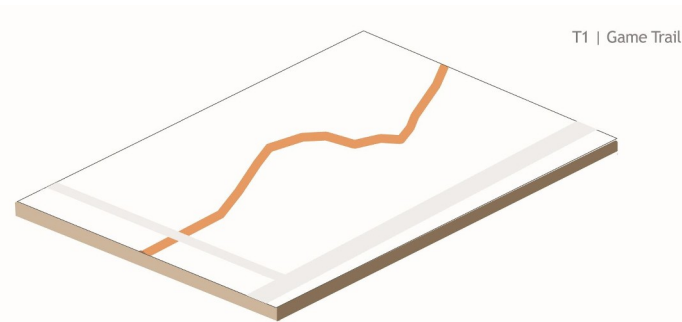
Trail 1 Transect

Game Trail



T1 | Game Trail, Livestock Trail

The Game trail is generally only up to about 12” wide and is more local to the area and lacks connectivity. This type of transect is nature-made so there won’t be signage, but there will definitely be some obstacles present. You’ll often find hikers, bikers, and hunters using this type of trail and they can typically handle up to 60 users per hour but only at walking speeds of 3-4 MPH.



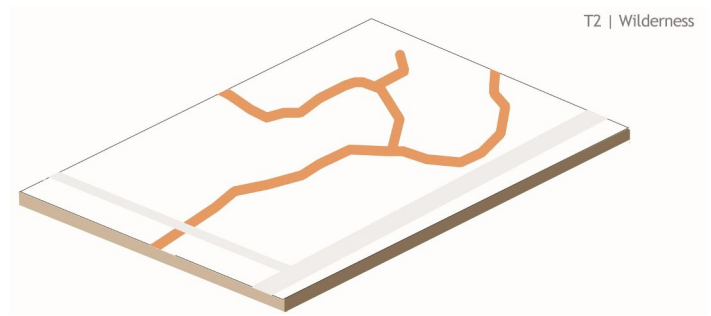
Trail Name	T1 Game Trail
Width	 0 - 12”
Trail Usage	Local
Trail Purpose	Local, Lacks Connectivity
Construction Type	Nature-Made
Trail Type	Livestock Trail, Game Trail
Designed Speed	3 - 4 MPH
Example	Local Residential
Gradation	25 %
Capacity	60 users per hour
User	Hike, Mountain Bike, Hunt
Signage	None
ADA Accessibility	Obstacles Present
Difficulty	




Trail 2 Transect

Wilderness Trail



The Wilderness trail typically ranges between 12"-18" and is an intermittent trail used to get from one local destination to another. It is often used at speeds of 5+ MPH and can handle a capacity of 120 users per hour, though very rarely would see this capacity. It can be used for hiking, running, mountain biking. These trails have traits which are unpredictable without any type of construction or consistency about them. They may be linked together by wholly natural surfaces lacking any trail traits whatsoever.



Trail Name	T2 Wilderness
Width	 12" - 18"
Trail Usage	Local → Collector
Trail Purpose	Inconsistent, Non-transportational
Construction Type	Nature-Made, Man-Improved
Trail Type	User - Improved Trail
Designed Speed	5 - 8 MPH
Example	Residential Collector
Gradation	15 %
Capacity	120 users per hour
User	Hike, Mountain Bike, Trail Run
Signage	Informational, Low Budget
ADA Accessibility	Obstacles Present
Difficulty	 

Trail 3 Transect



Recreational Trail

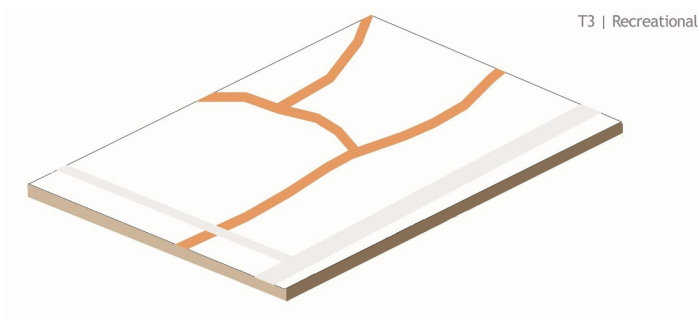


T3 | Difficulty 2

The Recreational trail typically has a constructed natural surface between 18" – 24". It is a medium-distance trail used to traverse a geographical area. It is designed for speeds of 5 -15 MPH and can handle a capacity of 300 users per hour for hiking, running, mountain biking, and dog walking. These trail surfaces are constructed using native materials found in their specific geological area. Their surfaces are irregular but often consistent in their irregularity. These trails are not USDA, FS, or ADA compliant.



Trail Name	T3 Recreational
Width	 18" - 24"
Trail Usage	Collector & Connected
Trail Purpose	Trail system, Seldom used for transportation, Group of trails
Construction Type	Man-Designed, Hand Built
Trail Type	COPMOBA Built Trail
Designed Speed	8 - 10 MPH
Example	City Arterial
Gradation	10 %
Capacity	120 users per hour
User	Hike, Trail Run, Mountain Bike, Road Bike
Signage	Informational, Directional
ADA Accessibility	Controlled Gradient
Difficulty	  



T3 | Recreational

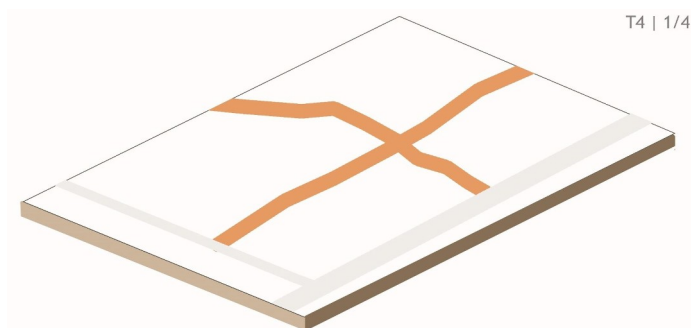
Trail 4 Transect

Quarter Trail





T4 | 1/4

The Quarter trail ranges from 24" – 42" and are use-specific trails created by developers which meet ADA standards and serves as a local connector. These transects are man-engineered (machine) and can handle 300-500 users per hour. You may find informational and directional signage on Quarter trails. These trails can be used by hikers, trail runners, mountain and road bikers, strollers, wheelchairs, and maintenance vehicles. These trails are USDA, FS, and ADA compliant.



T4 | 1/4



Trail Name	T4 1/4
Width	 24" - 42"
Trail Usage	Use-Specific
Trail Purpose	Created by developers, Meet ADA standards, Local connector
Construction Type	Man-Engineered (Machine)
Trail Type	1/4" Minus Trail
Designed Speed	11 - 15 MPH
Example	Boulevard / Parkway
Gradation	6 %
Capacity	180 users per hour
User	Hike, Trail Run, Mountain Bike, Road Bike, Stroller, Wheelchair, Maintenance Vehicles
Signage	Informational, Directional
ADA Accessibility	USDA, FS, ADA Compliant
Difficulty	

Trail 5 Transect

Neighborhood Trail






T5 | Neighborhood

The Neighborhood trail typically ranges between 48" – 60" and is the primary transportation trail used as a connector through neighborhoods. These trails are growing in popularity allowing for neighborhoods to easily support walking, running, mountain biking, road biking, strolling children, wheelchairs, maintenance vehicles, and skating. It is designed for speeds of 16-20+ MPH and can handle a capacity of 240 users per hour. These trails are USDA, FS, and ADA compliant and you may also find signage for information, landmarks, and ordinances.



Images by Author



Trail Name	T5 Neighborhood
Width	 48" - 60"
Trail Usage	Connector
Trail Purpose	Primary transportation, Growing in popularity
Construction Type	All-Weather
Trail Type	4' - 5' Asphalt Trail
Designed Speed	16 - 20 MPH
Example	Highway
Gradation	4 %
Capacity	240 users per hour
User	Hike, Trail Run, Mountain Bike, Road Bike, Stroller, Wheelchair, Maintenance Vehicles, Skate
Signage	Informational, Landmarks, Ordinances
ADA Accessibility	USDA, FS, ADA Compliant
Difficulty	 

Trail 6 Transect

Inter-Urban Trail



T6 | Inter-Urban

The Inter-Urban trail typically ranges between 60" – 120" and is a long-distance trail used as a connector. It is designed for speeds of 25+ MPH and can handle a capacity of 300+ users per hour for hiking, running, mountain and road biking, strollers, wheelchairs, maintenance vehicles, and skates. These trails are USDA, FS, and ADA compliant.



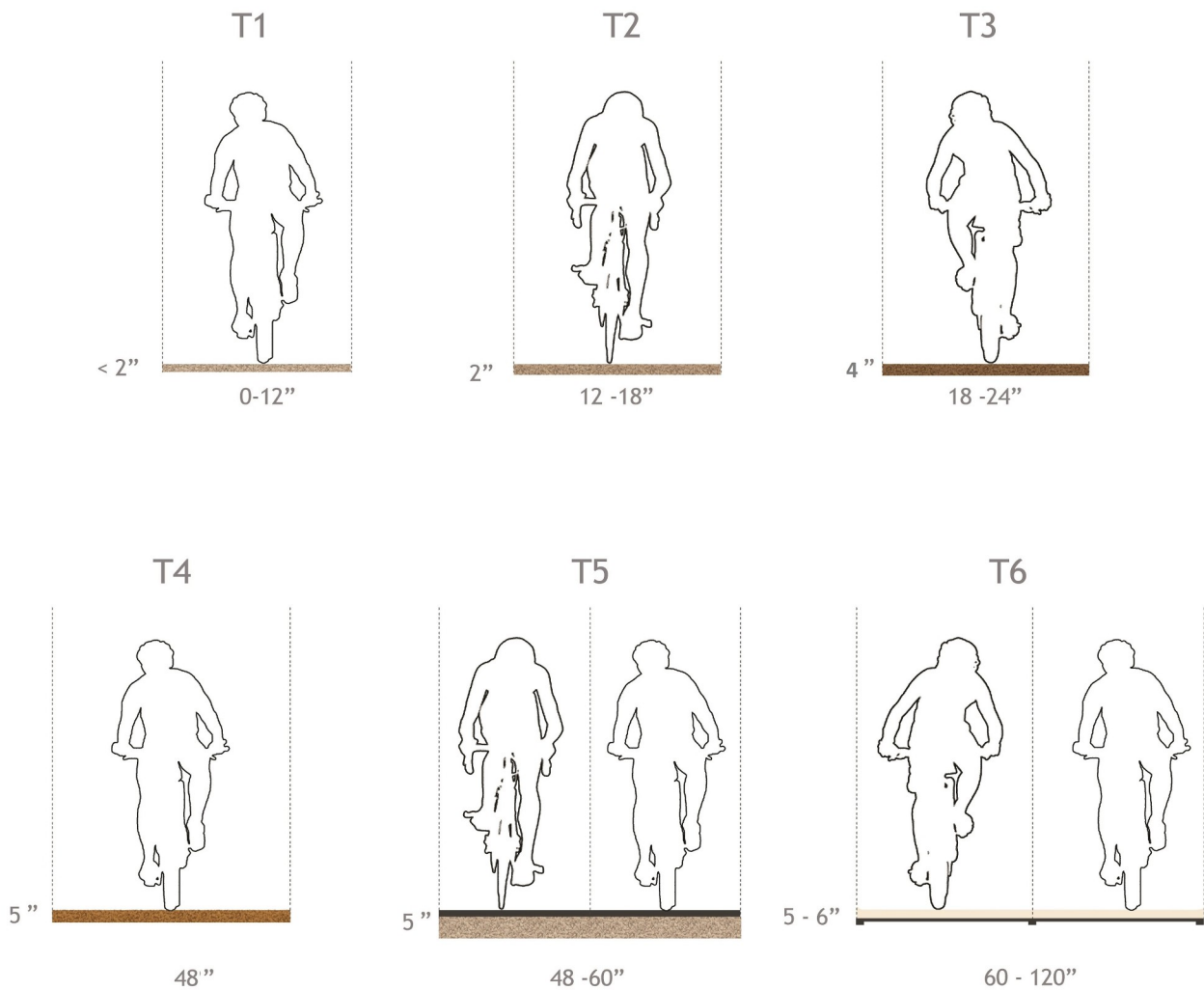
T6 | Inter-Urban



Trail Name	T6 Inter - Urban
Width	<div></div> 60" - 120"
Trail Usage	Inter-Urban Connector
Trail Purpose	Long distance trail, Connector
Construction Type	Multi-User Forms
Trail Type	10' Concrete Trail, Express
Designed Speed	25+ MPH
Example	Interstate
Gradation	2 %
Capacity	300 users per hour
User	Hike, Trail Run, Mountain Bike, Road Bike, Stroller, Wheelchair, Maintenance Vehicles, Skate
Signage	Informational, Landmarks, Ordinances
ADA Accessibility	USDA, FS, ADA Compliant
Difficulty	<div></div>

Trail tread width and the corresponding corridor width follow a logical pattern based upon surrounding ecosystem as well as purpose, gradation, transportation volumes and intended users. Higher volumes are found on more urbanized trails T4 through T6.

TRAIL WIDTH



Each T Section contains non-unique properties relating to grades. Local specifics will demand that the scales remain elastic in order to function within the system. Systems in the central United States are likely to have very little gradation while systems in the Rocky Mountain regions may be forced to create T6 trails a grades greater than 3% for sustained distances.

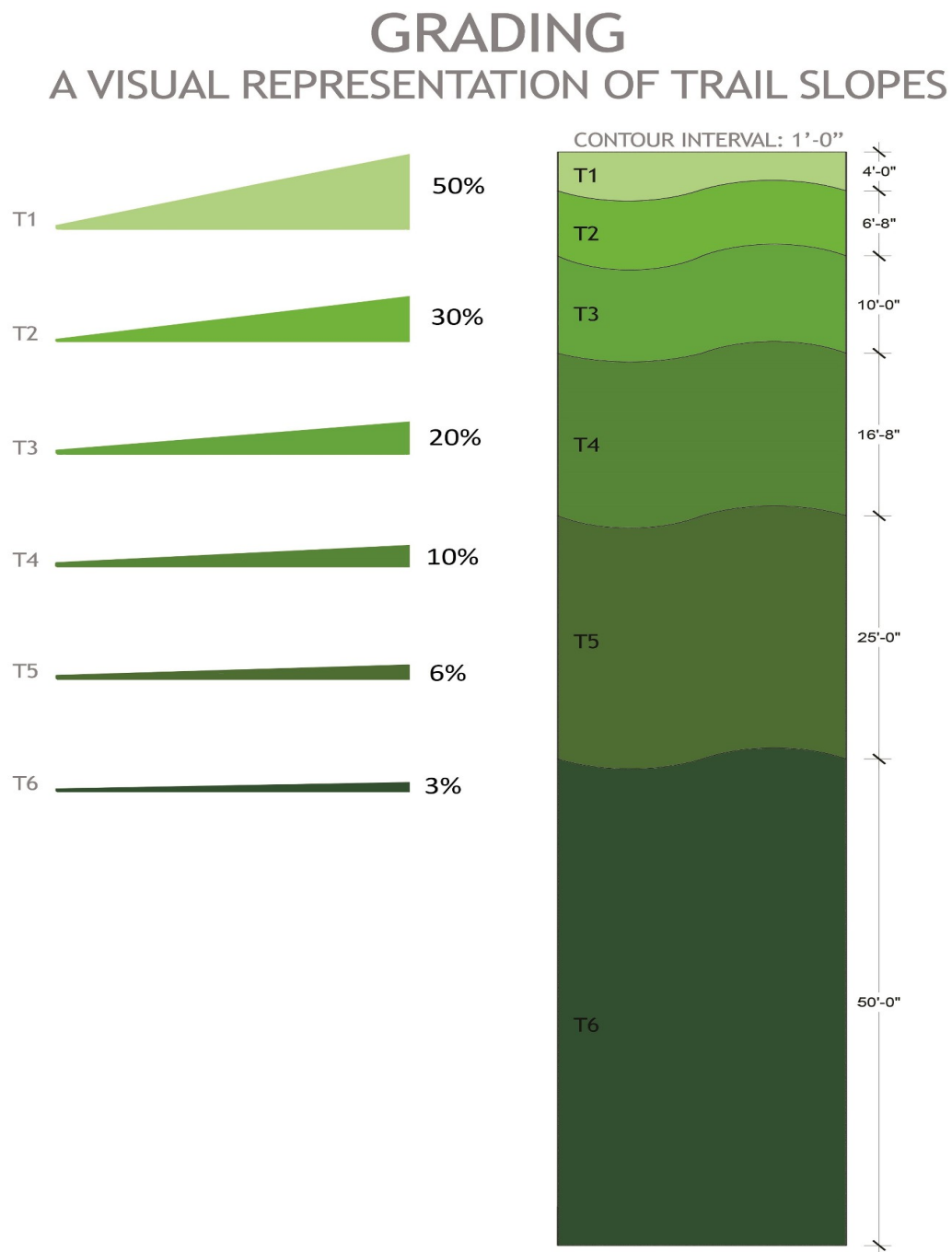


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Conclusion -

Spending active time in nature affects human health. Evidence exists between nature exposure and improved mental health, physical activity, and sleep. Implementing the Trail Transect would be a tool to increase health while building sustainability within a community. Studies provide evidence of protective effects of exposure to natural environments on mental health outcomes and cognitive function. studies provide evidence of positive associations between nature exposure and increased levels of physical activity and decreased risk of disease. Humans have evolved with nature to have an affinity for nature. Spending time in natural environments enables people to overcome mental fatigue and to restore the capacity to direct attention, it influences feelings or emotions by activating the nervous system to reduce stress. Green spaces provide children with opportunities such as discovery, creativity, risk taking, mastery, and control, which positively influence different aspects of brain development. There are a number of other pathways through which nature may affect health, including but not limited to increasing opportunities for social engagement and space for physical activity, while mitigating harmful environmental exposures. Facilitation of social contact is a promising mechanism emerging from recent literature, where natural environments and green space provide an avenue for increased contact with others and a greater sense of community. The underlying associations between nature exposure and health outcomes have been widely studied.

Opportunities presented while using trail systems are likely to have positive health outcomes while fulfilling higher goals for sustainability and resilience in each human as well as the community at large.

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