NEW LOCAL MOBILITY

Local Mobility Improvements for Communities

Remaking Cities Institute | Carnegie Mellon University

A USDOT NATIONAL UNIVERSITY TRANSPORTATION CENTER

LOCAL MOBILITY IMPROVEMENTS FOR COMMUNITIES IN THE REGION

(LINC: LINKING OUR NETWORKED COMMUNTIES)

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LINKING OUR NETWORKED COMMUNITIES

LINC

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EXECUTIVE SUMMARY

Carnegie Mellon's Remaking Cities Institute (RCI), supported by a challenge grant from CMU's Traffic21 and the Mobility21 Urban Transportation Center, worked with communities in Allegheny County to address local mobility challenges and opportunities, specifically the role of new mobility options in addressing the challenges for residents with no or limited access to private vehicles.

The Linking Our Networked Communities (LINC) study, with community partner, the Quaker Valley Council of Governments (QVCOG), focuses on the small town/suburban communities of Bellevue, Avalon, Ben Avon, Emsworth, and Kilbuck. These compact municipalities, with a variety of mixed-use commercial centers and services on a long, contiguous street named starting at the Pittsburgh border as Lincoln Avenue, California Avenue, Church Avenue, and ending as Center Avenue in Emsworth. This close to four-mile-long roadway is effectively a shared main street and is referred to as "main street" in this report. Earlier, the communities were tied together by streetcar along this route, which helped define the streetcar suburb land use pattern. Today, most trips are by private vehicle, a transportation mode not available to some residents due to age, ability, and income. Yet the compact and linear town pattern remains, together with bus service the length of the main street, and many shops, medical and professional services, and amenities within a 5- to 10-minute walk of this shared street.

The study proposes a **New Local Mobility** approach, studying local conditions, developing prototypes, and identifying incremental approaches. LINC has focused on a specific group of communities in Allegheny County emblematic of street designs and land use patterns familiar to many parts of the Commonwealth. The study is intended to have both local and broader implications for further study, analysis, and ultimately, implementation. While the Quaker Valley COG provided critical perspective, knowledge, and review, the COG did not author the report's recommendations or conclusions, which are presented here for their further consideration and discussion.

The study foregrounds the missing middle of street design – not an urban downtown, not the typical dimensions of roadways (width for moving and parked vehicles) and rights-of-way (the full width of the street including, shoulder, sidewalks) of post-war suburbs. By doing so, the study brings attention to the remarkable resilience of regional patterns dating to the 1800s, as they continue to adapt in the twenty-first century.

The study identified key challenges.

- *Today's car-focused mobility limits opportunities for many residents who do not have access to a private vehicle*, *including those with crucial* ***first mile last mile*** *trips to transit stops and nearby services.*

- *The **connections between communities** on their shared main street as well as to the nearby residential neighborhoods, are narrow and already somewhat difficult to travel, designing for new, shared mobility is challenging.*
- *The main street is **narrow**, with a roadway of 35 feet or less, and a right-of-way of 50 feet or less, limiting options for street redesign.*

The study also identified opportunities in these communities that are prototypical for many smaller, suburban communities in the region.

- *There is a continuous main street*. Historically "streetcar suburbs," the communities in the study, from Bellevue at the Pittsburgh border through to Emsworth are joined by a main street that is continuous while having multiple names.
- *There is existing transit service (Port Authority of Allegheny County bus).*
- *There are existing slow zones (for schools).*
- *The existing street and sidewalk designs reflect attention to pedestrians and bicyclists, and potential for further change*. On much of its length, there are continuous sidewalks as well and, in a few areas, sharrows to accommodate bike use. Elsewhere, as in the three-and-a-half block mixed-use center of Bellevue, there are recent sidewalk improvements incorporating new street furniture, bump-outs, and green infrastructure. There are bus stops with shelters and sidewalk space for waiting and boarding, as well.
- *The main street has a wide range of existing uses*. Within specific mixed-use centers and cumulatively, along its full 3.7-mile length, there are municipal offices, schools, places of worship, shops, restaurants, grocery stores, medical offices, and many more uses. These reflect a robust, more than century-long legacy of use and activity.
- *There is significant pedestrian activity today*, both for daily needs and recreational walking and jogging.

The study proposes that new mobility, from ride share to e-bikes and standing scooters, defined here as "New Local Mobility," will help to meet the full range of community mobility preferences and needs in suburban locations, as well as in center cities. The proposed New Local Mobility recognizes the following:

- *The resilient, complete community, 5-minute neighborhood and 15-minute city and similar concepts should not be limited to dense center cities.* Much current work on resilient communities seeks to increase the number of short trips that can be made without a private car, both by designing for that mobility and for a dense pattern of mixed land use in which some basic services are within a 5-minute walk, and more extended services within a 15-minute walk, bike-ride, or equivalent. While there is a body of work on making a range of communities, including suburban ones, more walkable and bikeable, it does not generally recognize that relatively low-density areas, with a configuration like a long, multiple-center main street, can better recognize and enhance their role as walkable, 5- or 10-minute neighborhoods and 15- or 20-minute resilient models.

- *The policy and practice of new mobility should not be limited to dense center cities*. While there is a developed approach to creating new policy and design in response to multiple means of mobility in the region, it remains, as in many metropolitan regions, largely focused on center cities. From mobility hubs to the bike (+) lanes these policies and practices can be expanded.
- *New mobility should not be limited to communities with wide streets*. Most documented studies, prototypes, and implementation are on wider streets, where there is more opportunity for medians, protected lanes, flex zones, and related street designs. City regions like Pittsburgh often have narrower streets, within the center city and in the region, and require new and modified responses. These will be able to inform street design for both the street dimensions considered here, as well as for those with 4, 6, or 8 feet more of roadway or right-of-way.
- *A **New Local Mobility** approach puts new mobility into a broader context for application, **allows for incremental steps,** and recognizes the full range of emerging mobility.*

Research Approach

The study reviewed and analyzed information from multiple sources. In the literature review it looked at national best policies and practices in terms of urban street design in response to new mobility, both micromobility and autonomous vehicles (AV). It also reviewed more regional perspectives, both specifically urban, such as the Downtown Pittsburgh Mobility Plan (Pittsburgh Downtown Partnership 2020), and Move PGH, the 2021-initiated two-year program to bring a greater range of mobility services to Pittsburgh, and regional plans such as SmartMoves for a Changing Region, adopted in 2019 by the Southwestern Pennsylvania Council (SPC), southwestern Pennsylvania's Metropolitan Planning Organization (MPO), and the NEXTransit 25-year plan released in 2021 by the Port Authority of Allegheny County (PAAC) as well as the 2017 statewide Active Transportation Plan produced by PennDOT. The research also included interviewing regional leaders in mobility.

In the local study areas, the baseline information on the communities, mobility, residential and commercial uses was informed by the 2017 Joint Comprehensive Plan for the boroughs of Avalon, Bellevue, Ben Avon, and Ben Avon Heights. The study included a leadership survey, with both interviews and on-line completion, that underscored local perspectives on safety and local mobility, as did an ongoing dialogue with the Quaker Valley Council of Governments, including presentations and discussion. It should be noted that the study is also informed, in terms of a regional perspective on mobility, by studies of the Route 65 Corridor, focused on the Ohio River Boulevard corridor, including community workshops, as well as by the more recently initiated study of the shared mobility issues and opportunities in Shaler, where Mount Royal Boulevard serves as a long, linear main street, along a former streetcar line, similar in its mix of civic, commercial, educational, and housing resources to the LINC study communities. The development of prototypes as in this report is a step in a larger process of research and engagement with the LINC communities and similar locations in the region.

The study drew on RCI's related autonomous vehicle research on corridor and roadway design challenges along with AV's propensity for safe and cautious operation in unpredictable pedestrian environments, all beneficial for creating safer local mobility outcomes.

Networked suburban communities have often been overlooked as locations for new local mobility considering their potential for first mile last mile opportunities and limited mobility choice that favors private automobiles with limited transit.
(Ben Avon's municipal building on Church Avenue, the study area's main street. Image: Remaking Cities Institute, 2020)

Developing Prototypes

Initializing a **Local Mobility** approach, main street prototypes were developed, responsive to existing conditions in the specific communities in the study but also applicable to a range of non-center-city main street conditions in the region and beyond. Drawing on the development of bike (+) lanes in Pittsburgh and elsewhere, the prototypes use a “+” terminology to indicate increased opportunities for mobility, with two options in each category, one for neighborhood business districts and the other for the largely residential areas between those districts.

- **Existing+.** Identifies the zone for cars and similar vehicles in the center of the roadway, with zones for biking and non-sidewalk mobility, and parking.
- **Bike+**. A dedicated, two-direction bike and other non-sidewalk mobility lane at street level is generated, with or without flexible bollards. In the neighborhood business district, there is a designated pull-off zone for drop-offs and deliveries.
- **Sidewalk+**. Slower moving micromobility is located at sidewalk level, on the street side of a much wider sidewalk on one side of main street.
- **Street+**. The entire street is open to multiple forms of mobility, all at the same level, with bollards to provide a fully protected zone for pedestrians. While all the prototypes benefit from slower traffic speed, it is critical for this option.

Recommendations and Next Steps:

The recommendations include study and analysis, and steps towards implementation. Responding to LINC communities, they also designed to have implications for similar areas.

One. Building on existing “Slow Zones” such as the 15-mph zone by the Avalon Elementary School, identify new “Slow Zones” for safer walking, biking, and driving.

Two. Building on recent sidewalk improvement experience as in Bellevue, undertake further review and engagement to learn from what has worked well (or not) regarding that improvement, and review the potential of the prototypes developed in the report., from those that require relatively minor interventions such as “Existing+” to the significant infrastructure changes of “Street+.”

Three. Through further survey and review, identify opportunities for improved **first mile last mile** connectivity from neighborhoods to the main street, where there is already regularly scheduled bus service, with special attention to the needs of seniors, youth, and households without access to a private vehicle.

Four. Building on the Joint Comprehensive Plan, conduct a full community assets inventory, using or modifying frameworks such as Complete Communities to develop and promote a greater sense of the resources that already exist, as well as noting the need and potential for new services, from shopping to restaurants to cultural centers and medical offices.

Five: In this inventory, also review these assets in terms of those not using a private automobile, recognizing **equity** implications, including but not limited to income, age, and capacity.

Six. Consider interim steps, such as the “Existing+” prototype, or similar initiatives that rely on relatively modest expenditures to test the potential improvements in safety for shared mobility.

Seven: Develop a New Local Mobility plan, recognizing differences and alignments with current national and regional best practices.

Team and Resources

This study aligns with the ongoing work of the RCI and Traffic21 to address the challenges for safer, greener, and more equitable and sustainable mobility for communities connected to state highway corridors. The Carnegie Mellon University project leads were Ray Gastil, Director of the Remaking Cities Institute at CMU’s School of Architecture, and Stephen Quick, RCI Research Fellow at CMU, as well as PhD-BPD candidate Suzy Li (MUD ’13, MS of Architecture ’14) and Schuyler McAuliffe (MArch ’21, MUD ‘22). The Remaking Cities Institute is committed to addressing the challenges and opportunities in Southwestern Pennsylvania.

Traffic21, a research institute operated out of CMU’s Heinz College of Information Systems and Public Policy, and Mobility21, its affiliated USDOT National University Transportation Center in the College of Engineering, sponsored this year’s challenge grant funding with generous funding from the Hillman Foundation and the US DOT. The funding is a continuation of Traffic21’s mission to transform Southwestern Pennsylvania into a testbed for mobility innovation.

LOCAL MOBILITY AND COMPLETE COMMUNITIES

Communities are resilient when they model for social, environmental, and economic sustainability. The LINC project draws on the relatively recent concepts of complete neighborhoods, of the 5-minute neighborhood and 15-minute city/community, where daily needs can be met within a short walk, bike, or other non-automobile mode of transportation (standing e-scooters, e-bikes), supplemented by transit, both within the neighborhood and to travel beyond it. A better understanding and improvement of the relationship between the places where we live, work, learn, shop, and recreate and how we move between them--our mobility--is fundamental to this study's purpose. The study has led to prototypes intended to serve an emerging type of mobility, which recognizes the full range of what is often called New Mobility, from walking to standing scooters, to ride share services and fully autonomous passenger and freight vehicles. While this report focuses on street design issues for micromobility, the prototypes are also looking ahead to an increasing range of mobility options. It works to contribute to developing policies and practices for what is described here as **New Local Mobility.**

This has most often been promoted for larger cities, as in Paris, where building on the work of urbanist Carlos Moreno, Mayor Anne Hidalgo made it a cornerstone of the vision for the city's sustainable growth. International and national examples of developing and applying these concepts range from Melbourne's 20-minute city, Milan's drive for convenient, accessible healthcare services, and city plans for land use, mobility, and community development in the United States, including Pittsburgh.

This study, however, suggests that this is highly relevant for more suburban conditions, including the familiar "main streets" that often connect several communities along a linear spine, with mixed-use commercial centers along their length, as well as other patterns familiar to older, more compact towns and suburbs. While the precise definitions and guidelines may need to be modified (for example, 15 minutes may need to be stretched to 20 minutes, some amenities may not be available). It is likely that several aspects of 15-minute city definitions will evolve, given changing patterns of living and working Including the continuing rise of e-commerce and remote work. The important analyses and proposals for retrofitting car-centric developments (Dunham-Jones and Williamson 2021) provides a key reference for this confidence in the potential for less auto-dependent conditions in suburban settings.

Before describing the value of looking at the LINC communities and similar towns and suburbs, it is useful to review the working guidelines for 15-minute cities in more depth, both in terms of goals and practices.

In terms of goals, the connection between mobility and livability is at the heart of the concept of the 15-minute city. Municipalities, like Pittsburgh, that adopt a Complete Streets policy, are articulating a position that streets, as the most extensive and consequential public space system in a community, need to serve more functions that vehicular through-put, and need to be measured in terms other than the conventional level-of-service measurements (City of Pittsburgh 2016). A complete street can have a social function and community development function with wide sidewalks for socializing and shopping, an ecological function such as reducing heat islands through the canopy provided by trees lining the street, as well as storm water management. And most importantly, it is complete when it serves multiple modes of mobility. The complete community seeks to be more than a strictly residential zone, measured only in terms of providing housing, but rather one that has a baseline of assets, beyond dwelling units, which meet the varied needs of a mix of people who live, work, and visit in a thriving community.

The 15-minute city and related terms identify an approach to connecting mobility to a neighborhood of opportunity. Streets and mobility remain fundamental, but their purpose and value are calculated differently. One representative system of metrics for this puts out a framework of basic needs such as convenience stores in a .25-mile radius—a 5-minute walk; amenities and services such as grocery stores, schools, and parks within .75 miles—a 15-minute walk, and then moves beyond the immediate neighborhood for job opportunities to a 3-mile radius, a 15-minute bike ride (Duany and Steuteville 2021).

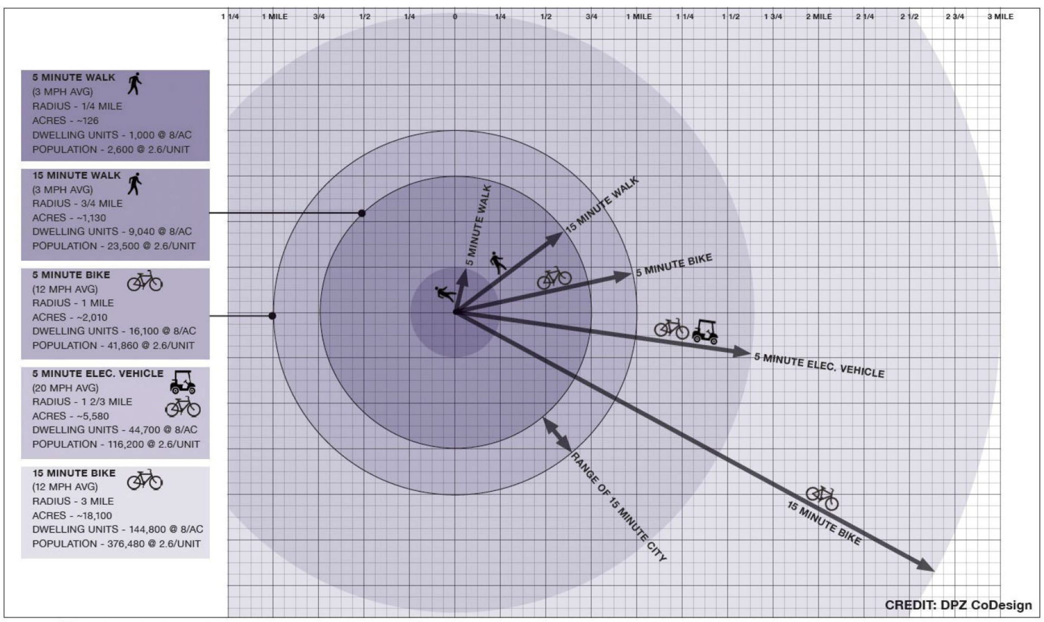


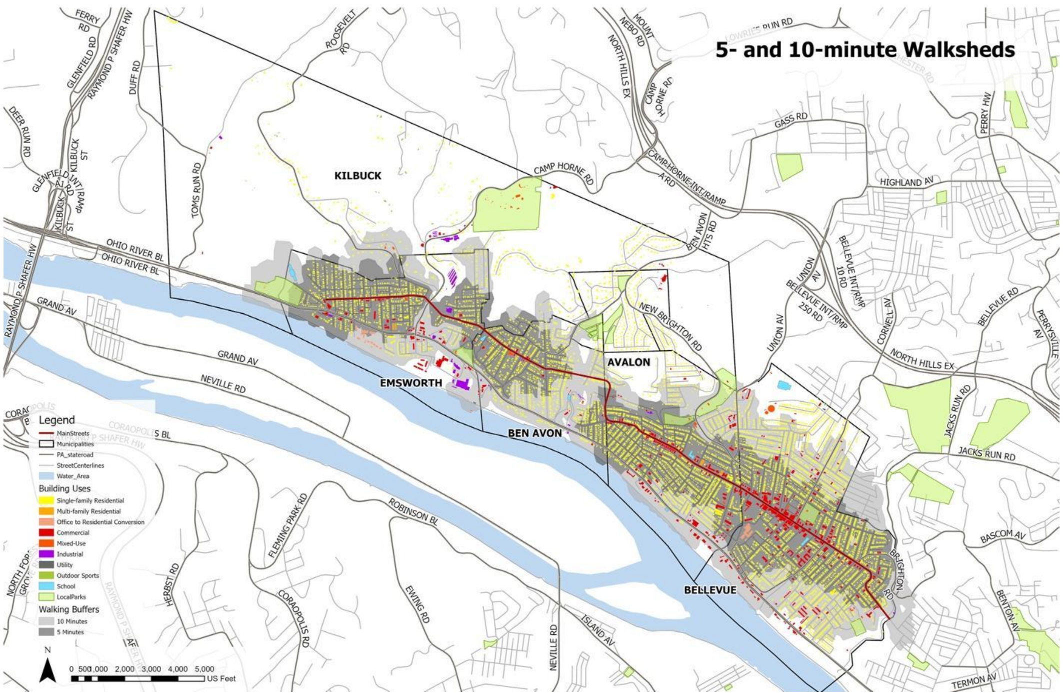
Diagram of the 15-Minute City by the Congress for the New Urbanism (CNU) illustrates the time it takes for different mobility modes to traverse a town center and beyond. Successful small-town centers can be walked in 5 minutes.
(Image: DPZ CoDesign; Duany and Steuteville 2021)

A concept of New Local Mobility encompasses a multitude of ways to walk, ride, or roll without an automobile to meet the 15-minute or similar distance standard, helps to broaden the potential applicability of the practice. The means of movement may continue to evolve, as new technologies emerge and preferences change, yet the principles can remain, from activating the ground level of main streets to the fundamentals as a prominent thought-leadership coalition describes them, including: “easy access to goods and services, particularly groceries, fresh food and healthcare,” “a variety of housing types,” “clean air,” and more capacity to “work close to home or remotely...smaller-scale offices, retail and hospitality, and co-working spaces” (C40 Cities Climate Leadership Group and C40 Knowledge Hub 2020).

The 5-minute town center model offers a desirable choice of commercial, and service uses within an accessible, walkable, and pedestrian-friendly setting. It is critical to establish how these concepts can be equitably applied across diverse types of communities.
(Habersham town center, South Carolina. Image: Weichert Coastal Properties)

As the image of a town center above indicates, concepts of walkable communities including 5-minute neighborhoods are often associated with wealthier districts, towns, and cities. As this concept needs to adjust to a more diverse vision of what a center can be spatially—such as a linear series of centers in the LINC communities—it needs to more fully adapt to diverse types of communities to inform planning and practice for equitable sustainability and resilience. Just as the 15-minute community concept is adapting in response to a fuller picture of local mobility including but going beyond walking and biking, it needs to adapt to different urban patterns, and densities, and demographics, beyond the generally prosperous, European, and North American center or near-center city neighborhoods where it has been most fully discussed and applied. It is will also need to continue to adapt, like any formula, to the full complexity of different places. Finally, the concept needs to recognize and respond to whether greater mobility in itself leads to greater fairness and equity, and how it can be improved to accomplish that goal (O'Sullivan 2021).

Being open to testing this concept in a more suburban context may help to build a stronger and more broadly applicable model. In many ways, the LINC communities, and main street-connected places like them, do fit the existing model, it is just that the pattern looks somewhat different. The area's total length from the Pittsburgh border of Bellevue the western edge of Emsworth is under four miles. In terms of biking, nothing is more than a 15-minute ride along that street. Most of the housing, which despite a preponderance of single-family homes also includes multi-story, multifamily dwellings, town houses, and duplexes, is within a mile or less of that main street. And along that main street there are clusters, from relatively dense blocks of shops, restaurants, and schools to small groupings of dental offices and town offices. In brief, while the 5-minute walk to the convenience store may not be there for some residents, almost all of them have access within a 10-minute to some service or amenity, as well as to bus service (and potential bike or micromobility connections) on their shared main street.



5- and 10-minute walksheds from the LINC communities' shared main street. The 5-minute walk distance is the darker gray; almost all residences are within the lighter gray 10-minute walk distance.
(Image: Remaking Cities Institute)

These communities, with a heritage as streetcar suburbs, and with the majority of their lay-out from an era before the dominance of the automobile, offer a linear variation on the poly-centric model assumed for most 15-minute city discussion. Looking more closely at the challenges and opportunities of Local Mobility here, this model of a complete community could become stronger: There is the potential of different types of places to adapt to meet 15-minute city model, and to adapt the model itself by learning from local communities.

ANTICIPATED IMPACT OF CHANGING MOBILITY CHOICES

The impact of localization on smaller towns and communities is closely tied to the idea of increased use of local and shared assets, where the growth and diversity of local businesses and services, a slower-paced quality of life that balances work and home, a lessening need for personal ownership, and the increasing acceptance of shopping-from-home among other characteristics, is and will change settlement patterns that offer the benefits of city living without living there. The appeal of the 5-minute walk and the 15-minute city models fit well within the localization idea and have a direct bearing on local mobility.

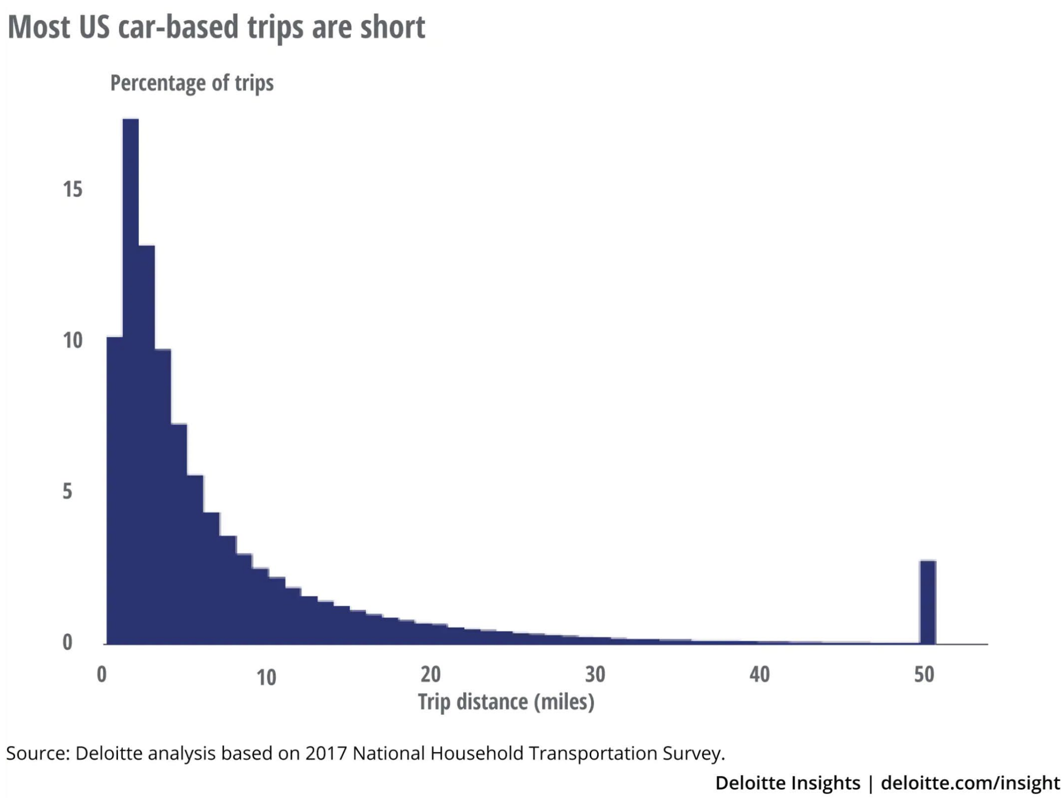
Local mobility's premise is based on the idea of right-scaled, agile, and a wider choice of modes will result in less reliance on the private automobile for all trips, and, with fewer cars on the roads and less demand for on-street parking, the greater the opportunity to repurpose the right of way for pedestrians and users of smaller vehicles.

This transition is happening now. The acceptance of environmentally friendly bicycles, e-bikes, and e-scooters has young adults questioning car ownership in favor of Uber and Lyft. The introduction of ride share has decimated the taxi industry, resulting in an explosion of new personal mobility devices, and a waning interest in owning a car. From an economics perspective, owning a car is expensive and not available for everyone. From a land use perspective, building required storage space for cars when there are other alternatives does not make sense. From the perspective of drivers, the time spent in cars is less time at home and paying for parking is getting costlier. For renters and homeowners, finding a parking space near your residence requires the equivalent of strategic planning in many neighborhoods and communities.

Cities are recognizing the costs of encouraging automobiles and eager for alternatives that can offer equivalent services. Many are piloting the shared use of personal vehicles and testing robotic delivery vehicles to relieve both auto and delivery vehicle congestion. They are also recognizing that most city trips are within 1 to 3 miles in distance and many that can be accomplished by walking or biking. Small towns and communities are also recognizing similar costs. With the explosion of home delivery of meals and goods also available in local stores, main streets are again experiencing the effects of the large supermarkets siphoning the local market. New mobility, while not currently a significant factor in smaller towns and communities, holds the promise of more active local commercial centers and safer streets if the street network and its main streets evolve to prioritize safer local trips and pedestrian-friendly experiences.

MICROMOBILITY AS A CORE ELEMENT OF NEW LOCAL MOBILITY

More than half of the annual car trips in the United States are less than 5 miles and around 46 percent are 3 miles or less, which points toward the potential for micromobility modes. In locations where short trips dominate, micromobility is well-suited. It is interesting to note that most public transit trips are short: on average, four miles for buses (Zarif et al. 2019).



Graph illustrating that most car trips are 5 miles or shorter, with 2-mile trips approaching 20% of the total.
(Image: Zarif, Pankratz and Kelman 2019)

Sizing the Vehicle to the Ride

Most of the trips taken in urban environments are mismatched in terms of duration of trip and size of vehicle. This can begin to be addressed by either “right-sizing” the trip the vehicle to the trip or disaggregating a trip from one vehicle to multiple vehicles (also known as first mile last mile).

Zarif suggests that, given the innovation within the mobility infrastructure, we should see an expansion of bike lanes to also allow for micromobility without encountering conflicts between highway-speed vehicles in the streets and pedestrians on the sidewalks (Zarif et al. 2019).

First and Last Mile Commuter Mobility

There is a large potential to use micromobility in the first mile last mile trips in suburbs where transit stops may be farther away from homes than in the heart of the city.

Micromobility is most often articulated as the most-reasonable option for short distance trips. More than half of all car trips taken in the US are 5 miles or less, lending themselves well to an alternative transportation method that rescues greenhouse gases and helps reduce congestion on the road (Zarif et al. 2019).

NEW LOCAL MOBILITY

Vehicle Types

Many cities are rethinking vehicles and the use of public streets with policies where all persons have as much right to the street's public realm as motorized vehicles. Encouragement of bicycles and ride sharing are good examples of this new thinking. Coupled with environmentally friendly and more powerful and lighter electric motors, these ideas and technologies have spurred an upsurge in research and development of smaller personal and shared vehicles. They have also encouraged city planners and engineers to reconceive the common street for safer accommodation of all users, functionality, and place-making.

Vehicles are machines that transport people and cargo. They encompass a wide variety of devices, including wagons, bicycles, motor vehicles (motorcycles, cars, trucks, buses), railed vehicles (trains, trams), watercraft (ships, boats), amphibious vehicles (screw-propelled vehicle, hovercraft), aircraft (airplanes, helicopters) and spacecraft. Land vehicles cover a wide variety of vehicle types. The lighter types of land vehicles are more compatible with newer inclusionary policies.

> Land vehicles are classified broadly by devices that apply steering and drive forces against the ground: wheeled, tracked, railed or skied. ISO 3833-1977 is the referenced standard, which is also internationally used in legislation for road vehicle types, terms, and definitions.
>
> Light vehicles, a subset of land vehicles, include automobiles, bicycles, boards, and emerging small devices that can be used to get from point A to B (Halsey 1979).

Micromobility: Lighter and Smaller Vehicles

The term "micromobility" has been coined to describe this new subset of lighter vehicles intended for short (local) trips.

Micromobility encompasses a range of small, lightweight vehicles operating at speeds typically below 16 mph (25 km) and driven personally by users (Institute for

Transportation and Development Policy 2019). However, the definition has evolved to include moderate-speed personal vehicles with top speeds of 28 mph (45 km). Some higher-speed pedal and electric standing scooter models fall into this moderate speed subcategory. Any vehicle with an internal combustion engine cannot be defined as micromobility, nor can devices with top speeds above 28 mph (45 km) (O'Hern and Estgfaeller 2020).

The electric bicycle (e-bicycle), a personal motorized micromobility vehicle, has expanded the use and popularity of bicycles for local travel.
(Image: by Gotrax on Unsplash)

While most of the literature refers to micromobility as the smallest of personal mobility devices, this study found the definition too limited based upon how the public and industry commonly use lightweight vehicles for personal, shared, and robotic use. The light passenger vehicle classification includes automobiles for both personal and shared-use and micromobility manufacturers are also making vehicles for sharing and personal use. In local neighborhoods and smaller communities, local mobility vehicles should be thought of appropriate for their size and use. For example, large city buses are out of scale in small communities, while vans, mini-buses, and smaller circulators, with capacities of 10-12 passengers, are appropriate for demand needs and the smaller streets found in local communities.

The following describes the three use types of micromobility: shared, personal, and robotic.

Shared Mobility

Shared mobility describes transportation where travelers share a vehicle either simultaneously as a group (e.g., ride sharing) or over time (e.g., car sharing or bike sharing) as personal rental, and in the process share the cost of the journey, thus creating a hybrid between private vehicle use and mass or public transport. It is a transportation strategy that allows users to access transportation services on an as-needed basis. Shared mobility is an umbrella term that encompasses a variety of transportation modes including car sharing, bike sharing systems, ride sharing companies, carpools, and microtransit.

Shared transport is not a new concept; however, today's shared transport opportunities have significantly expanded. Carpooling, using a personally owned or company-owned vehicle, has been part of the transportation system since commuters began driving to places of work. Generally, shared transport originated as an economic decision made by the commuters to lower their cost of personal transportation by sharing the task and cost of driving a small group of employees to their place of work. Eventually, companies began to share with their employees by providing a company-owned vehicle, typically a larger van that could carry 8 to 12, for several reasons: as an employee benefit, to reduce the demand for company parking facilities, and, recently, for environmental and sustainability reasons such as contributing to pollution or congestion reduction. In recent years and as more transportation options have become available for commuters, carpooling is not as popular as it was 50 years ago.

Shared transport systems include car sharing, bicycle sharing, carpools and vanpools, real-time ride sharing, "slugging" (casual carpooling), community buses and vans, demand responsive transit (DRT), paratransit, and a range of taxi-type projects. A different form of shared transport is the "shared taxi," a vehicle which follows a predetermined route and takes anybody waiting for it, more like a bus than a taxi. (Eisenberg 2008) Hitchhiking, popular in the past, is seldom used these days.

Shared transit is taking on an increasing importance as a key strategy for reducing greenhouse gas and other emissions from the transport sector in the face of the global climate emergency by finding ways of increasing the efficiency (intensive use) of vehicles on the road.

Personal Mobility

After World War II transportation systems and settlement patterns began a transformation that is still with us today. The automobile came into its own which allowed the suburbs to thrive and expand. The independence of personal transit led to the demise of the streetcar and eventually many light rail commuter trains, to be replaced by buses with the flexibility to change routes as the population grew and shifted settlement and density patterns.

The environmental movement, which began in earnest at the beginning of the 21st century, and the subsequent climate initiatives brough new thinking to transportation as a system with a serious questioning of fossil-fueled vehicles, in particular the automobile, and the damage they were creating to both the environment and climate conditions. Beginning with the renewal of interest in less-polluting natural gas, wind, and solar energy, the transportation industry began to rethink its role as an environmental leader given transportation's 25 percent consumption of all world energy on a yearly basis. In the United States, the largest consumer of transportation energy, light duty vehicles (mainly automobiles) consume 60 percent of that energy, an amount greater than all freight modes, such as heavy trucks, marine and rail. (Maritime Executive 2015) The automobile industry took great interest in electric vehicles given the global need for shifting to cleaner energy.

Robotic and Autonomous Mobility

A use type often overlooked yet expected to be using streets and sidewalks in the future, are fully autonomous micro vehicles that function without a human driver. These small, motorized devices, sometimes referred to as bots, are intended for moving goods, from groceries to delivering Amazon packages. Larger autonomous vehicles for moving people are currently regulated to closed courses on private property but may in the future supplement or replace the larger buses in smaller communities. While human-operated vehicles now move people on public streets, autonomous replacements will likely perform bus and circulator services on fixed routes in the future.

Small delivery bots are now in the testing stages and operating in several US cities and elsewhere. Intended for last-mile delivery tasks, they may be delivering pizzas, full-course meals, packaged goods, and prescriptions from the local pharmacy. Most being tested weigh less than 500 lbs., but some are larger approaching 1,100 lbs. to 1,200 lbs. Smaller delivery vehicles will likely be in the 100 lbs. to 200 lbs. range, less heavy yet still designed for stability for safe and damage-free delivery of fragile items such as a full-course meal. Use of these robotic vehicles will likely be fully operational in the near future.

In November 2020, Pennsylvania legalized delivery robots weighing up to 550 lbs. (249 kg) and traveling at up to 12 mph for operation on streets and sidewalks across the state. PA was not the first, but the 12th state, to make them legal. Washington state limited weights to 120 lbs. (54 kg) whereas Florida allows them to travel at 15 mph. Effectively, their legal use on sidewalks equates them to pedestrians.

Pilot Testing of Personal Delivery Devices (PDD) in Pittsburgh

After the Pennsylvania Legislature enacted a law in November 2020 that authorizes the use of PPDs on sidewalks, Pittsburgh was awarded a 6-month pilot program to test these devices. The Department of Mobility and Infrastructure (DOMI) is managing the program for PDD deployment in the Bloomfield neighborhood that began in June 2021. Kiwibot's PDDs, already operating in Santa Monica, CA, can travel up to 12 mph and can complete take-out deliveries in about 30 minutes, were selected for the program. They are semi-autonomous robots with many sensing capabilities and remotely supervised by humans to assist them for crossing streets or stopping if necessary. DOMI's participation with the test is focused on gaining experiential information to create local policies for future performance requirements.

The University of Pittsburgh tested a similar device in Oakland during January 2020 with a PDD manufactured by Starship Technologies. However, the testing was stopped after a wheelchair user reported that one of the robots trapped her ability to move on the sidewalk raising safety and accessibility problems. The testing resumed in March 2020 in Oakland and Bloomfield but was abandoned shortly due to the COVID-19 pandemic.

A Starship food delivery robot is seen along Liberty Avenue in Bloomfield in 2020. (Image: Jared Wickerham for Pittsburgh City Paper)

LOCAL MOBILITY VEHICLES

This vehicle type and field is evolving with new vehicle types introduced on a frequent basis. Micromobility vehicles can be human-powered or motorized and are often referred to as personal transporters. There are several ways to classify these devices based on use, speed, weight, appropriate for sidewalks, among several others which are outlined in the Appendix.

These are the vehicles typically identified as micromobility vehicles and/or devices:

Micromobility Vehicles and Devices

- Bicycles
  - Human-powered
    - Pedal bicycles
    - Unicycles
  - Motorized
    - Pedal-assisted bicycles (pedelec or EPAC)
    - Powered bicycles (e-bicycles, e-bikes)
    - Powered unicycles
    - Cargo bikes
- Scooters
  - Human-powered
    - Standing foot-operated “kick” scooters
  - Motorized
    - Powered standing scooters (e-scooters)
    - Small, seated scooters
    - Large, seated scooters

Shared low-speed electric scooters by Spin now in use in Pittsburgh.
(Image: Pittsburgh Downtown Partnership)

- Skateboards and Skates
  - Human-powered
    - Foot-operated skateboards
    - In-line roller blades
  - Motorized
    - Powered skateboards (e-skateboards)
    - Powered skates
    - Hoverboards
    - Mini Segways
    - Large Segways

- Autonomous Vehicles
  - Motorized
    - Powered delivery robots (less than 200 lbs.)
    - Large, powered delivery robots (200 - 1,100 lbs.)

This study identified other vehicles as appropriate mobility types for use in small towns and communities, with a concentration on larger capacity vehicles. The width of roadways begins to limit vehicle sizes as they eventually will scale to the local context. Locations with narrow streets that, along those above, as appropriate vehicle types for the New Local Mobility.

Local mobility vehicles and devices appropriate in smaller communities.
(Image: Remaking Cities Institute)

Vehicles also Appropriate for the New Local Mobility

- Automobiles
  - Ride share
  - Ride hail

- Transit Vehicles and Circulators
  - 10-person SUVs and Minivans
  - Transit and disability transit vans
  - Small bus circulators
  - Autonomous transit circulators
- Delivery Vehicles
  - Small delivery vans (size of a large SUV)
  - Medium delivery vans
  - Single unit trucks (30’ maximum length)

Micromobility as a Service

While micromobility vehicles have long been available for users to purchase, thinking of it as a paid service for light and personal transportation modes (enabling users to use the nearest vehicle without having to purchase or store it along with facilitating the flexibility of one-way trips) has led to growth in areas where it is available. The rise of the sharing economy resulted in a large increase in access to micromobility in many cities, first with the introduction of public bike share systems, and then with privately funded and operated dockless bike share and electric kick scooter (e-scooter) fleets. Most early bike share services specified locations, or docks, where vehicles needed to be picked up and left.

SMART TRANSPORTATION TECHNOLOGY

Micromobility will benefit by the introduction of smart transportation technology intended to increase roadway safety and visibility. Smart technology is already being adopted throughout the transportation industry as best practices. While limited to larger cities and heavily used roadways, today’s Internet-of-Things (IoT) will become ubiquitous throughout the country; semi-autonomous automobiles are already traveling this nation’s transportation system. Semi-autonomous and autonomous micromobility vehicles and devices rely heavily and/or are dependent on smart technology for their operation.

Internet of Things

As technology has advanced from the development of sensors and data analysis, cyber-physical systems (CPS: control of a mechanism by computer-based algorithms) are now in place, such as adaptive signalization and vehicle collision avoidance, and highly effective. Recent cloud and edge computing (external computing systems to store and analyze data) have greatly expanded CPS capabilities and their use in vehicles and micromobility devices will become commonplace. The IoT (sharing between computer systems without human interface) will eventually allow for fully autonomous “smart” micromobility systems where communications between them, between them and other vehicles, and various communications devices which are part of the roadway and local transportation infrastructure will be fully automatic.

With their ability to increase flow efficiency and safety, arterials and collector streets would be the likely candidates for early implementation of these more advanced systems, with local streets to follow. Micromobility’s smart technologies, including autonomous delivery robots along with more advanced AV cars, have the promise of encouraging safer and calmer use of local streets.

Adaptive Signalization

Adaptive signal control technology adjusts the timing of traffic signals to accommodate changing traffic patterns and ease traffic congestion. They can also prioritize micromobility vehicles, such as bicycles and buses. While now being installed on major corridors throughout the country, including Pittsburgh, eventually adaptive signalization will become commonplace on local main streets. Their value for micromobility is more with their ability to prioritize vehicle types than create a more efficient traffic flow, their original objective. Prioritizing personal vehicles, such as bicycles and electric wheelchairs, that travel at slower speeds than other mobility devices would assist their use for local travel. This is an equitable solution for disabled persons.

Vehicle-to-Vehicle and Vehicle-to-Other Communications

Experimentation is underway for V2X communication between autonomous vehicles (AVs) and between AVs and other IoT devices located outside the vehicle on poles, streetlights, buildings, or other infrastructure on roadway systems. Bus2bus and bus2X communication is available for vehicle synchronization and real-time schedule messaging. At multimodal intersections, pedestrian and personal micromobility vehicles are candidates for dedicated signalization sequencing and, perhaps, prioritization.

Autonomous Vehicles

Higher level autonomous vehicles, those with mostly or fully autonomous, will have a positive impact on pedestrian safety that should benefit local traffic. AVs are programmed to not exceed posted speed limits and to also proceed cautiously when within pedestrian environments, including intersections, mid-block crossings, and areas of high pedestrian traffic. The net result should be calmer local streets with AVs setting the pace on two-way streets where driver-operated vehicles cannot pass slower moving vehicles. While not conclusive and subject to testing, the programming intention of sidewalk AV robots (personal delivery devices) is to defer to pedestrians and other personal-use vehicles on sidewalks. The issue for local communities will be whether there is enough room on sidewalks for pedestrians and robots to pass one another safely or have pull-off spaces for one or the other to step aside.

APPLYING NEW LOCAL MOBILITY SERVICES

OVERVIEW OF CHALLENGES AND OPPORTUNITIES

Applying new local mobility services, whether new modes of transportation or a realignment of prioritizing biking and walking, is challenging in any community, urban or otherwise. After close to a century of prioritizing the automobile as the primary means of transportation, the car dominates many aspects of land use as well as how we use our streets for travel and parking. There were about 276 million registered vehicles in the United States in 2019 (Statista 2021). To accommodate autos, there are about five to six parking spaces for every car in Pittsburgh, estimates Karina Ricks, former Director of Pittsburgh's Department of Mobility and Infrastructure and recently appointed Associate Administrator for Research, Innovation and Demonstration with the Federal Transit Administration (Ricks: Interview 2021). Meanwhile, only one-in-ten Americans use the most common alternative to the private vehicle—transit—on a weekly basis (Anderson 2016).

Despite this striking imbalance, there is increasing interest and support from local, regional, state, and federal agencies, as well as public and professional organizations, in increasing the share of mobility other than the private automobile. These range from statewide "active transportation plans" as in Pennsylvania to street designs for micromobility by national professional organizations like NACTO. At the more local level, Move PGH, an integrated mobility platform, including ride share, has been authorized for a two-year pilot by the municipal government in Pittsburgh. These policies and practices are responding to the changing mobility preferences of residents, and to larger societal concerns regarding local impacts and systemic environmental impacts. Most compellingly, these policies and practices are responding to the long-standing equity challenge of leaving a large portion of the population that because of their youth, age, abilities, or income do not have access to owning and operating a vehicle.

This increased openness and support for local mobility will enable communities to plan for and ultimately implement new and renewed mobility choices for their residents, across different types of communities and densities.

PLANNING AND MOBILITY CHALLENGES

Access to Transportation

Not everyone has a car or good access to public transportation. Many cannot afford either. Many are older and incapable of driving or capable of accessing transit on their own as are many disabled persons of all ages.

Transit remains the core service to meet mobility needs of the population without car access. Current policy work, as the government reviews transit service through an equity lens, is increasingly prioritizing easily available and affordable transit for all persons, rather than focusing on volume of passengers. Its objective is to provide all persons with convenient access and mobility choice. It has the potential to significantly change the idea of mobility, how it is provided, and how it is funded.

The crucial complement to transit service is both how people get to the bus, light rail, or other option, often described as the first mile last mile problem. It is also how they take shorter trips, not as a first or last part of a trip, but as the entire trip itself, to reach services on foot, a bike, electric wheelchair, or other means. Today's reappraisal of what is meant by equality and equity, along with the rise of emergent artificial intelligence and autonomous devices including AVs, and the broader picture of new mobility, have begun to have a profound effect on how the government and the transportation industry approach mobility and the ideas behind future transportation.

Challenges for the Micromobility Model

The recent influx of shared vehicles, vehicles-as-a-service, and the rapid development of micromobility are tangible results of this broadened approach. They are only beginning to change the balance of mobility options for most people, however. Test cities have installed bike lanes and intersection redesigns to accommodate them, and sidewalks are now proving grounds for micro freight robots. Micromobility to date serves a relatively small portion of the public: trending, though not universally, towards young and male users (NACTO, Shared Micromobility, 2020). A more robust mobility approach will need to demonstrate its value to a larger swathe of the community. To date, while there are varying levels of support for these types of changes, many citizens have raised concerns about how the roadway and right-of-way are being shared, including concerns where street parking has been eliminated, traffic calming initiatives have been installed without complementary adjustments for optimal function (for example, road diets undertaken without adaptive signalization), and in some cases the changes have been made with limited discussion.

Regarding new micromobility services, as with most inventions or services seeking a new market, offerings are generally expensive, available to only a few, paid for by venture capital or government subsidized, and highly competitive. Forward thinking cities with large populations are now testing grounds for ensuring broader access to these new services. Adjusting the rhetoric and reality of "disruptive" technologies, communities, even in the brief history of micromobility, are adapting more incremental approaches, underscoring increased safety or convenience. They are also recognizing the paradoxical effect, at least so far, of some improvements. Ride hail services, such as Uber and Lyft, for example, have upended more locally based taxi and jitney services, increased traffic congestion, and siphoned off the wealthiest riders undercutting transit services and sustainable civic goals, and added to the total of vehicle miles traveled--data suggests that ride hail trips, in total, add 2.2 miles for every 1 mile of personal auto mile taken off the road (Schaller 2018).

In terms of the first mile last mile challenge, micromobility is an addition to other solutions. These can include programs such as the RideACTA program in the rapidly developed, car-centric shopping and employment area west of Pittsburgh, where on-demand shuttle services provide the critical short trip (around 1.5 miles) from regular route bus service to a destination that with limited sidewalks and an unlikely environment for micromobility. While ride share services may be part of the solution, given that it is not on fixed routes, and can work with a short trip model, service locations and costs imply that these are not a panacea, and that micromobility may fill some of that gap, adding to the huge potential for better, more complete transit service: “expanding a transit station’s reach from a half-mile to just 1.5 miles makes it accessible to *nine times* as many potential passengers” (Zipper 2019).

For local agencies and authorities, electric scooters, microtransit, and “future modes” are already in the toolbox along with walking and biking (Port Authority of Allegheny County 2019). As noted earlier the current Pittsburgh pilot, Move PGH, is intended to create seamless range of mobility options will generate added information about the potential for micromobility as part of a shared system. Comparative reviews of different North American city first mile last mile programs note that micromobility is an opportunity though much of its impact will be better understood following current pilot programs (Mohiuddin 2021).

Land Use Policy

Better street design and land use policy are key to achieving a safe, sustainable, equitable, and citizen-focused transportation system. Simple physical changes to street geometry can have significant impacts on safety and how people choose to travel. Successful, desirable, and competitive locations have been those that enable citizens to move safely, efficiently, affordably, and reliably. Rethinking micromobility as a safety, convenience, and equity proposition is a significantly better message than profit that often drives discussion of the topic as a “disruptive” technology.

In terms of land use, greater residential density does provide more opportunities for local-serving shops and services, accessible by multiple forms of local mobility. However, the success of walkable and affordable places is more complex than a density index, and is also related to different urban patterns, such as the suburban town main street. Even without zoning changes, many places can serve their communities with a greater range of mobility options.

Equity and Access

Surveys by e-scooter companies suggest that ridership in some cities is representative of the local population. However, city-sponsored studies show that actual users are often younger, single, and male, a profile that roughly aligns with those who commute by person-powered bicycles (Tonar and Talton 2020). This transportation equity and inclusion issue closely parallels that of current mass transit. Some cities are mandating that micromobility service providers also provide these services in underserved communities and work with persons who do not have bank accounts. Most rely on mobile phones and broadband for service access and payment, focusing on an individual's economic status and means, which can bias future investment and outreach to people who are most in need of better mobility.

The equity issue is also a challenge in terms of age and ability:

> Limited Applicability: Micromobility vehicles are designed as lightweight vehicles for individual use and not convenient for carrying more than one person, parcels, groceries, etc. Some micromobility, such as standing e-scooters, are not appropriate.
>
> Persons with Disabilities: Micromobility vehicles currently require the dexterity and strength of a younger person without physical disabilities.
>
> Older Persons: Most two-wheeled micromobility vehicles are not appropriate for seniors. They require good dexterity, balance, eyesight, and good reaction timing and coordination. Most persons 60 years and older do not have these attributes.

Equity should be practiced and in policy that covers a wide range including access, affordability, safety, mobility, and engagement. A broad definition of micromobility recognizes the importance of existing devices, such as wheelchairs, as well as emerging types of vehicles which may better serve persons with disabilities and older persons.

Motorized wheelchairs allow persons with disabilities access to local businesses and services but only if roadway conditions are conducive for safe mobility. (Image: Photo by Jon Tyson on Unsplash)

PRIORITIZATION OF THE PEDESTRIAN

Designing streets around the needs of people should be the direction going forward. Mobility, efficient use of space that prioritizes people, and operational safety are the guides for multimodal transportation design.

In designing for micromobility communities have both long-standing and innovative approaches to reference. Pedestrian safety has been and remains a priority for policy, planning, and implementation for street design. At the same time, the most future-oriented aspect of micromobility, autonomous vehicles whether microtransit, cars, or freight, are an opportunity for greater safety for all users of a shared street and right-of-way. Autonomous vehicles are designed to travel at safe speeds, and for their successful function, every vehicle in their context needs to travel at safe speeds, as well.

Pedestrian Safety and Autonomous Vehicles

“Blueprint for Autonomous Urbanism: Second Edition” (NACTO 2019) suggests setting priorities that value the pedestrian will be key to the successful adoption of autonomous vehicles. They also support the new rethinking of transportation. Priority goals, paraphrased from the cited NACTO document, include:

- Prioritize walking, biking, rolling, and pedestrian resting. Design for safety by designing streets that lower traffic speeds because traffic speed is the major factor in most traffic fatalities.

- Configure and build for on-street transit for growth without congestion. The idea is to move people, not cars. Prioritize the modes that move people efficiently, such as transit, biking, walking, and by reallocating street space and supporting people-focused street redesigns with curbside management, smarter pricing of curb space, and data policies that accurately record curb usage.
- Consolidate freight and delivery services to minimize their on-street activity and downsize delivery vehicles to increase capacity efficiency.

Autonomous Vehicles, Freight Delivery, and Micromobility

The quantity of urban and suburban freight and delivery has been growing rapidly at a pace of around 2.5B packages annually and presents specific challenges for pedestrian safety. Same-day and just-in-time delivery has been the primary driver (Laseter 2018). Use of small-scaled vehicles and electric/human-powered delivery vehicles are expected to become the favored last-mile and the last 50-feet to the customer's door. There are advantages to using these smaller vehicles including, safety, faster loading/unloading, can be loaded to 100% capacity, easier to drive, and easier to park especially when curbs are in full use.

The small semi-autonomous delivery robots being tested in Pittsburgh's Bloomfield neighborhood are monitored by humans. Similar delivery bots have been undergoing testing in California for a few years, but they also require human assistance for negotiating intersections. Fully automatic and larger delivery autonomous vehicles capable of speeds up to 35 mph are also undergoing testing in California's Silicon Valley, with restrictions to only operate on streets with posted speed limits no higher than 35 mph and in good weather conditions. These AVs are driverless and capable of grocery and other larger deliveries, meant for last-mile applications.

Amazon delivery "hub" installed near the entry of a large residential apartment building in Avalon.
(Image: Remaking Cities Institute)

Nuro delivery robot being tested in Silicon Valley.
(Image: Autoweek News. Nuro Testing Autonomous Delivery Robots in California)

Microtransit

Microtransit is a niche market service that can take several forms. One form, like carpooling or taxi-pooling, collects riders from a few dispersed places and takes them to mobility hubs, transit stations, neighborhood centers, or low-transit employment locations. Another form is a circulator vehicle that operates on a designated route picking up riders from mobility hubs and delivering them to neighborhood centers, recreational locations, or schools depending on the local need. A local government- or privately-owned circulator operating only on main street may be a consideration for the case study and similar municipalities.

Microtransit is not competitive with fixed-route bus or rail transit. Private services have found that it is difficult to aggregate more than a few riders into a single-purpose vehicle on a non-fixed route; it is cost-prohibitive without subsidization. NACTO reports that nationally it costs more than 6 times as much per passenger to run a demand response service than it costs to run fixed route bus services; and in New York the differential is 15 times. High volume, on-demand service is inherently slow and is out-performed by organized fixed-route service when it exists on a similar route (NACTO 2019). However, as a subsidized equity response, microtransit is appropriate and worthy for consideration as autonomous main street circulators.

Keolis circulator made by Navya being tested in Las Vegas as a small anonymous transit circulator. Circulators with a capacity of 8 to 12 persons are appropriately sized for local mobility in smaller communities.
(Image: Keolis)

MAIN STREET DESIGN FOR LOCAL MOBILITY

The infusion of new mobility vehicles into the roadway's right-of-way, traditionally claimed by cars, trucks, and sidewalks, that move at speeds between that of the automobile and the pedestrian requires a rethinking of this public realm for all to coexist in a safe and amenable environment. Its impact will be substantial as it will require carving out space from already tight local streets and for new rules of the road to reduce conflict. Where space is tightest, flexibility and multi-use alternatives will be required.

The next chapter will investigate design prototypes for the study area that illustrate several design possibilities for their integration. The following outlines existing policy and practices that informs those prototypes, many of which have been authored by the "National Association of City Transportation Officials (NACTO), an association of 91 major North American cities and transit agencies formed to exchange transportation ideas, insights, and practices and cooperatively approach national transportation issues" (NACTO website). Their research has taken the lead developing guidelines and best practices utilizing multimodal and complete street principles which have informed this study.

Managing the Public Right-of-Way

Many cities and communities are rethinking the use of the street's public right-of-way due to a confluence of new social and cultural understandings and a proliferation of technological advancements in the use of new energy sources, autonomous and artificial intelligence (AI), the collection and use of mass data, and new communication technologies that are structurally impacting transportation and definition of mobility. Their effect on how we use and conceive of the right-of-way is, and will have, a profound impact on future mobility, functionality, and access.

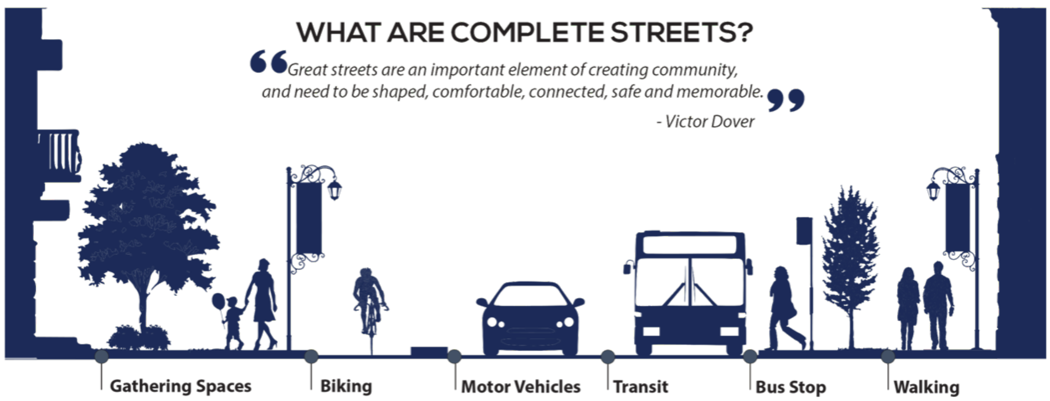
Mass introduction of motorized private automobiles and trucks in the early 20th century initiated a prolific change in the use and definition of the public right-of-way, from a multi-use public space for people, animals, and non-motorized "vehicles" to moving people and goods. Motorized vehicles soon became faster, larger, and capable of carrying heavy loads and the right-of-way changed to a paved surface and pedestrians were separated from vehicles for their safety. Over time a classification system was developed to distinguish one type of right-of-way from another based on size and speed, from narrow lanes to wide boulevards and limited access highways. Today, the term "street" distinguishes local roadways that connect local destinations whereas the term "highway" distinguishes roadways that connect distant destinations, such as another town or area of a larger city.

The space occupied by the roadway itself is a portion of the public right-of-way. The right-of-way is the space between opposite property lines, and it is divided into zones depending on function: the center zone "roadway" that includes both travel lanes and parking lanes next to the curb; the "curb" zone that separates vehicles from pedestrians and provides a transition, or furniture area, for streetlights, fire hydrants, signs, street trees, and other objects. The curb zone is also used for accessing buses and ride share vehicles; and the "sidewalk" zone that is measured from the curb's transition space to the property line and used by pedestrians, non-powered vehicles such as wheelchairs, cafe seating, and sometimes sign boards or merchandise out for sidewalk display. The sidewalk zone often contains the steps or ramps for entry past the property line and into structures or open space, both public and private.

Complete Streets Influence Design of the Right-of-Way

Complete Streets, as noted earlier, are streets designed and operated to enable safe use and support mobility for all users. Those include people of all ages and abilities, regardless of whether they are travelling as drivers, pedestrians, bicyclists, or public transportation riders. The concept of Complete Streets, now PennDOT policy, as well as national policy (US DOT 2021), encompasses many approaches to planning, designing, and operating roadways and rights-of-way with all users in mind to make the transportation network safer and more efficient. The concept is directly applicable to the new local mobility use of the right-of-way.

Complete Streets approaches vary based on community context and, depending on the width of the right-of-way, may address a wide range of elements, such as sidewalks, bicycle lanes, bus lanes, public transportation stops, crossing opportunities, median islands, accessible pedestrian signals, curb extensions, modified vehicle travel lanes, streetscape, and landscape treatments. The Complete Streets concept also articulates a vision for the street as having more than a mobility function, but also helping to build the social experiences and economic vitality of a thriving, Complete Community, and it is an appropriate model for the study area's main street and its adaptation for new local mobility.



Complete Streets equalize all forms of mobility, including pedestrians, and recommend safe separation of vehicle types whenever possible.
(Image: adapted from Philadelphia Complete Streets Design Handbook)

Integrating Local Mobility into the Right-of-Way

Recent social and cultural rethinking is now questioning the use of the street: in some respects, returning to its 19th-century mixed-use qualities while recognizing that technology has and will introduce new and specialized mobility types that will change how streets are used and managed. Embedded in sustainable practices and as an equity and inclusion policy, streets are being redefined as public space where pedestrians have a place and a right to the street equal to and just as important as vehicles for moving people and cargo.

The transportation profession's rethinking of mobility is now policy in Pennsylvania. PennDOT's policy encouraging multimodal functionality on PA roadways and the idea of complete streets, where the pedestrian is an important vehicle that must be safely accommodated, supports the profession's emphasis on equitable transportation access and creating safer and better and safer places for all people within roadways' rights-of-way. While intended for all streets, practicality would reasonably prioritize heavier-volume arterial corridors and, locally, main streets in communities. In residential neighborhoods local transit and shared micromobility options will become more abundant and offer greater options for connecting to commuter and nearby transit.

A New Role for Main Street

Neighborhood main streets are the core of community life and should be prioritized as active and lively places that attract all neighborhood residents. As found in this study, main streets are the places where residents would naturally go to access mobility services, be they micromobility or fixed-route transit, with dedicated infrastructure that prioritizes vehicle modes other than private autos. Striping can be a critical incremental step and also an option for constrained, narrow roadways, permanent infrastructure that creates safer places for pedestrians and human-powered micro vehicles. However, more permanent, more separated infrastructure remain a key goal.

Main street intersections have important roles in achieving multimodal objectives. Intersections are the homes for mobility hubs, shared micromobility vehicles, ride-hail, and other services. They take up space and will need future accommodation for good functionality, including extending them farther into parking zones. Consider medians, diverters, and roundabouts to calm all traffic. Clearly mark intersections and provide good separation between activities. Institute curb management practices that prioritize bus and higher-occupancy vehicle access above that of ride hail, shared vehicle, and freight delivery devices.

Main Street best practices include:

- Downsize **travel lanes** to create more right-of-way space for robust pedestrian and micromobility infrastructure and shorter pedestrian crossings, in addition to minimizing conflicts.
- Lower **speed limits** to increase safety, especially in commercial centers.
- Consider **flush streets**, where the sidewalk and the travel zones are at the same level, prioritize pedestrians and create accessible conditions for all users.
- Encourage the use of **multi-use vehicles**, such as shared bikes, to reduce the overall number of vehicles.

Curb Management

Except at street corners, curbs are currently considered equal, with regulations based on time limits, uses, or residency. But some are more in demand than others. Municipalities place premiums on curb space in front of stores by adjusting parking meters to charge more by the minute to encourage turn-over, more shoppers, and add to municipal income. Logic says that demand and convenience are eligible for higher charges.

Over the last several years, different demands for curb space have emerged that are also demanding curb space throughout the day. Bike share, car share, delivery trucks, food trucks, freight unloading, intersection bulb-outs, sustainable rain gardens, ride hail, and others. Competition is fierce for curb space. The trade-off could be more permanent public spaces, such as widened sidewalks and green space, to temporary use by food trucks or small vendors along the curb.

Curbs are “flex” space and could serve different users at different times. (Also see Flex Zones below.) Real-time curbside management systems using LiDAR to capture license plate information can allow curbside users to reserve time slots before arrival or on a daily reserved-time basis, as well as inform drivers where spaces are vacant or occupied. Rates could be set in real-time, changing uses with demand, and automating enforcement to ensure turnover. Cities are already experimenting with dynamic pricing of parking meters and the cost of technology, both sensors and system management, is trending downward.

Mobility Hubs

Mobility hubs are intended as safe, accessible, and convenient connections between different modes of transportation at one location. They are transfer centers that link one mobility mode with another and for those who transfer to another line of the same mode. Mobility hubs are also gateways to locations with low densities and infrequent fixed-route transit. As cities and suburban communities begin to view the transportation network as a single system serving all types of riders, mobility hubs should be viewed as critical components for effective and seamless operation.

Mobility hubs can be small or large depending on available space and number of users. Often, they have grown from bus stops into bus transfer points and later locations for multimodal and shared ride activity, while others begin as micromobility stations that grow into hubs. Other locations to consider would be park-and-ride parking lots or garages that could additionally serve as locations to meet for carpooling or transfer points for employers to run shuttle services.

On a broader basis, mobility hubs can be publicly operated by local government or privately run by a Transportation Management Association connecting transit riders to locations of employment. As densities increase, mobility hubs can become the catalysts for transit-oriented development investment as anchors for mixed-use, higher density communities. Working with local government, zoning and development incentives could be instituted to encourage this walkable form of development and help relieve the pressure for more private cars.

There are other benefits than improving mobility. Mobility hubs contribute to mental and physical health by the very act of encouraging people to actively use mobility devices that require self-propulsion, dexterity, and mental engagement, much different than a passive passenger. They also present economic opportunities that can attract new retail uses and commercial ventures or combine with public or residential amenities. They assist with balancing demand and supply across a broad range of sustainable mobility options. The more mobility hubs become successful, the more the need for personal cars should rebalance as more people find that combining personal, shared, and transit activities in convenient locations lessens the need for privately-owned cars.

CASE STUDY TESTING: NETWORKED COMMUNITIES

DESIGNING FOR NEW LOCAL MOBILITY

The report looked at communities along a shared main street in Allegheny County, reviewing existing transportation, including transit, demographics, and land use patterns. The study focused particular attention on the range of uses along the entire street, rather than just on each unique mixed-use center, to build an understanding of the existing and potential use of the street as a resource for diverse types of stores, employment, schools, and services. It looked at it as a linear type of urban development, as well as a clustered one.

This work confirmed that there is a rich range of services along the street, reachable by a short walk, a quick bike ride, a bus ride, or by car. The existing infrastructure does accommodate travel to these mixed-use centers and along the street, which have close to continuous sidewalks and as noted, a bus service. However, the challenges for increasing the number of short trips by means other than the automobile are many. The prototypes described here were developed to respond to this dilemma, describing street design changes that could both improve the opportunities for the full range of type of mobility, support thriving mixed-use districts, and be safer for pedestrians, bikers, and all users.

It became clear in developing these prototypes that rather than concentrating on each specific location, there was an opportunity to generate prototypes that would be applicable to the LINC boroughs and township more broadly, and to a wider set of communities where they may be useful. Vincent Valdes, President and CEO of the Southwestern Pennsylvania Commission (SPC) has noted the importance of both greater network connectivity and a broad definition of micromobility in the region (Valdes, Interview 2021).

Learning from the LINC community's challenges and opportunities, the designs here respond to prototypical conditions: narrow main streets in smaller towns, boroughs, and suburban communities that have retail, services, schools, single-family homes, multifamily housing, and a variety of amenities along their length.

These streets are already shared by several types of vehicles and designing to allow for more sharing among more types of mobility is challenging. Given the narrow parameters, the concepts described here refer to existing street design standards, yet at the same time endeavor to do more mobility with less roadway than those standards rely on. The study is intended to generate review, discussion, and ultimately improvements to these prototypes, from merchants to bike and pedestrian advocates to public safety offices, and regional residents interested in more mobility alternatives.

CASE STUDY COMMUNITIES

The four adjacent municipalities of Bellevue, Avalon, Ben Avon, and Emsworth are smaller inner-ring residential suburbs, like many small family- and pedestrian-friendly towns in the region, linked by a common main street within a local context. This report refers to the contiguous street, identified from Bellevue to Emsworth as Lincoln Avenue, California Avenue, Church Avenue, and Center Avenue – four different street names not fully congruous with their boundaries, as main street, except when describing the street at a specific location. This shared street includes commercial and service uses that, in aggregate, provide the variety of daily functions equivalent to an independent small city. By themselves, none are full 5- or 15-minute communities but working together they function as one.

Their connected main street, local population and market, and pedestrian-friendly environment is the reason for their case study selection. From a mobility perspective, the four represent the scale, connectivity, and accessibility consistent with micromobility's strategic positioning intended for serving a local population and market, and to be responsive to the wider goals of local mobility.

Each borough has its town center with retail and civic uses along main street. Each town center can be traversed within 5 minutes and Bellevue's within 10 minutes. They are all walkable and accessible centers. In addition, most housing is within a half-mile of the main street. This pattern is largely the result of the study area's heritage as a streetcar suburb with streetcar service from 1915 until the mid 1960s.

Kilbuck, on the other hand, was included in the study as an outer-ring and low-density suburb to understand how it differed from the networked municipalities. The township is auto-dependent and not served by transit. It does not have a town center in the classic sense but relies on Ohio River Boulevard services as well as grocery, pharmacy, and big box retail activities beyond its boundaries. Camp Horne Road is its "main street" only in the sense that it connects to outside destinations. Travel between Kilbuck and the shared main street is not a daily occurrence for Kilbuck residents and requires a planned trip to specific destinations, unlike the connected boroughs where main street is often the first leg of a commute or trip to the grocery store. However, some Kilbuck residents are within the 5- and 10-minute walksheds of main street in Emsworth and Ben Avon. Prototypes were not developed for Kilbuck-type street patterning.

Physical Context

The commercial centers of Bellevue, Avalon, Ben Avon, and Emsworth are located roughly at the midpoint between their north-south boundaries. All are located on the Pittsburgh Plateau about 100 to 300 feet above the Ohio River, which is to their west.

The plateau rises upward toward the east and becomes steeper the farther the boroughs extend to their eastern boundaries.

The tighter street grid of Pittsburgh's adjacent neighborhoods continues into Bellevue, and it follows a similar pattern through the other three, even though they are physically separated by ravines from one another. The street patterns generally orient east-west connecting to Ohio River Boulevard to the west and Kilbuck to the east. Their shared main street is located about half-way between Ohio River Boulevard and the boroughs' eastern boundaries.

The street grids are tight and typically do not have alleyways between blocks. Driveways connect most residential parcels to the street. Side streets are narrow and support street parking only on one side. These yield streets require passing cars to slow and maneuver around one another to pass. Most have sidewalks on both sides; however, where the grid begins to follow the steeper terrain to the east there are no sidewalks. Walk time between Ohio River Boulevard and their respective section of main street ranges from 5- to 10-minutes, which is about the same amount of time it takes to walk from main street to their eastern boundaries. Main street is generally within a 5-minute walk of most residents.

Kilbuck Township is significantly larger, about the same size as the four boroughs combined. It shares its western boundary with Emsworth, Ben Avon, and Avalon. Kilbuck extends west to Ohio River Boulevard for a short distance north of Emsworth. Kilbuck is a bedroom community in the truest sense of the term, with few land uses other than single-family homes. Kilbuck's suburban street pattern follows the ridges of the township's hilly terrain. The pattern does not resemble the other four municipalities, is not a network, and does not have a central commercial area. The east-west Camp Horne Road, Kilbuck's primary commercial street, traverses a valley floor below most residential properties connecting Ohio River Boulevard to I-279 to the east. Few township streets connect to Camp Horne Road and the other four boroughs.

Demographic Context

Population:		
Bellevue	8,146 (2019)	8,370 (2010)
Avalon	4,584 (2019)	4,705 (2010)
Ben Avon	1,904 (2019)	1,781 (2010)
Emsworth	2,503 (2019)	2,249 (2010)
Kilbuck	719 (2018)	697 (2010)

The predominant land use in all five municipalities is residential. Beginning in Bellevue and going north, higher-density residential transitions to smaller single-family homes. Larger apartment buildings are in Bellevue and in Avalon, where they line main street. Owner-occupied and rental structures are about equal in number in Bellevue and slowly transition to almost all owner-occupied in Emsworth. Large single-family homes distinguish main street in Ben Avon.

Governance

The four boroughs and Kilbuck Township are independent municipalities. Each control and maintain their local street system. PennDOT owns and maintains the Route 65 Ohio River Boulevard corridor.

Municipal buildings are located on the shared main street. Kilbuck's municipal building is located on Eicher Road that connects to Emsworth. Recreational areas are typically on the eastern edges of the connected boroughs and throughout Kilbuck Township where the terrain is hillier, and the street patterns begin to assume a suburban layout.

All five Municipalities are members of the Quaker Valley Council of Governments, whose purpose is to encourage intermunicipal cooperation and shared services.

Bellevue, Avalon, and Ben Avon shared long-range planning activities and prepared a combined Comprehensive Plan and Zoning Ordinance and mapping. Their 2008 zoning map, Tri Borough Zoning, emphasizes their shared main street as a commercial and higher-density residential Mixed-Use (MU) zone that transitions to Neighborhood Commercial (C-NC) in Ben Avon. Lower density residential uses expand to the east and west borders of the boroughs. Ohio River Boulevard, common to all three, is zoned as Highway Commercial (C-HC) in Bellevue and half-way north into Avalon where it transitions to Neighborhood Commercial (C-NC) and higher-density residential (R-H). The R-H zoning continues into Ben Avon where it becomes Low Density Residential (R-L) along Ben Avon's tree-lined portion of the corridor. The Bellevue to Avalon mixed-use zoning forms the commercial core of the three boroughs.

Emsworth's zoning follows a pattern similar to Avalon's along its portion of main street as Neighborhood Commercial, although at a much lower density. Zoning along Route 65 is heavily Highway Commercial and Mixed-Use Residential.

Public Transit and Paid Mobility Services

The four connected municipalities are served by the Port Authority of Allegheny County with local service on main street and commuter service on Route 65. The County does not provide bus service in Kilbuck Township.

Port Authority Buses on main street:

- 16 Brighton
  - Avalon on main street to Downtown through the North Side and return
  - 15 min frequency weekdays, 30 min weekends
- 13 Bellevue
  - West View to Downtown with four stops on Lincoln in Bellevue and return
- 19L Emsworth Limited (commuter)
  - Emsworth to Bellevue to Downtown and return

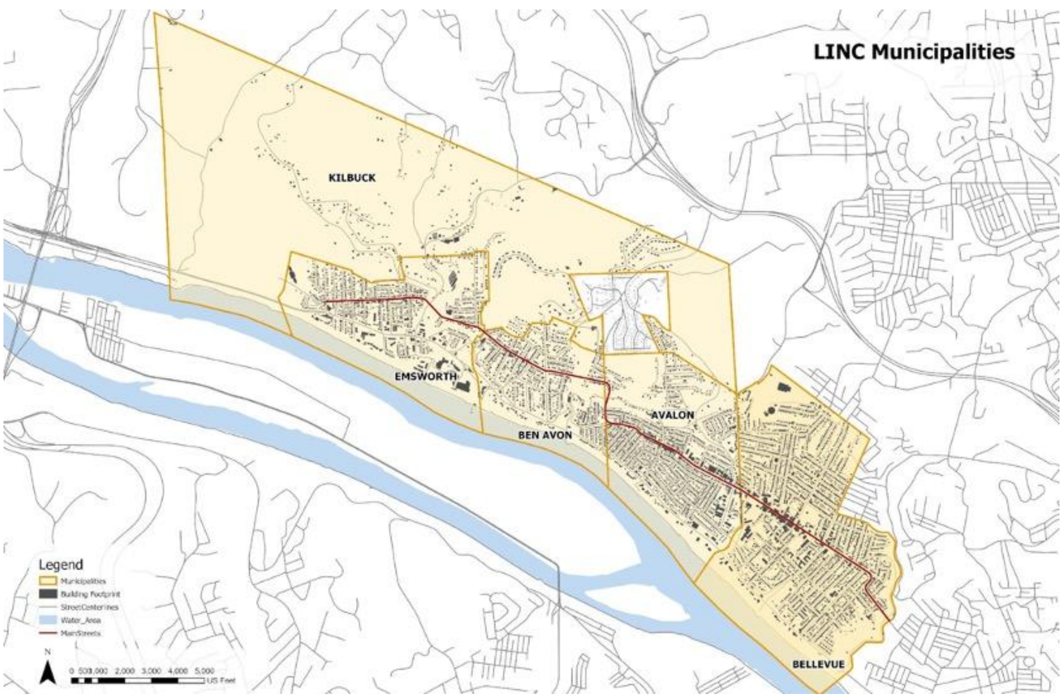
25 min frequency during rush hours

Allegheny County and Beaver County commuter buses both use the Route 65 Ohio River Boulevard corridor into Pittsburgh.

Uber and Lyft provide ride hail services in the study area. Shared car services, such as Zipcar, are not available.

“Main Street”

The communities’ shared main street is continuous from the City of Pittsburgh to the northern end of Emsworth: 3.7 miles in length. It takes 15 minutes to travel by car from one end to the other and about 75 minutes to walk. The 2.7-mile distance between the farthest commercial centers can be driven in 11 minutes and walk time takes 40 to 55 minutes depending on pace. Main street is mostly flat along its length which encourages pedestrian strolling and recreational cyclists. The route is pedestrian-friendly, physically interesting with high bridges over ravines and a treed environment that is aesthetically pleasing due to the scale and variety of buildings, architecture, and landscape.



Map of the five communities showing main street in red that connects Bellevue, Avalon, Ben Avon, and Emsworth. Kilbuck connects to main street on a local street between Emsworth and Ben Avon.
(Image: Remaking Cities Institute)

Main street names traveling northwest from Pittsburgh:

City of Pittsburgh	California Avenue
Bellevue	Lincoln Avenue then California Avenue
Avalon	California Avenue

Ben Avon	Church Avenue
Emsworth	Center Avenue
Kilbuck	Connects to Center Avenue from Locust Street in Emsworth

Main street is currently used as an informal bikeway alternative to Ohio River Boulevard. Several of the boroughs have stenciled sharrow markings on the roadway to encourage safe travel. Bikers can continue south into the City of Pittsburgh on California Avenue through Brighton Heights and into Downtown.

The largest concentration of commercial retail activity is in Bellevue, followed by Avalon, then Ben Avon. Emsworth's commercial activity is small. A wide variety of retail activities and services occupy main street overall, and it well-serves the residents' needs for daily living. Bellevue has the most active retail center with restaurants, brew houses, and small shops. Main street commercial and service uses are all within an easy 5-minute walking distance of most homes in the four connected boroughs as are local schools in Bellevue and Avalon.

ENGAGING THE STUDY COMMUNITIES

The Quaker Valley Council of Governments provided member and content assistance to the RCI team and took the communications lead with local citizens and municipal leadership. Residents participated in the LINC study through QVCOG meetings, telephone calls, and the COG-sponsored resident survey.

Related Prior and Ongoing Research

The working relationship with the QVCOG began in 2017 when the Quaker Valley and Beaver County COGs partnered with the Remaking Cities Institute to pursue funding for a study of regional highway corridors, focusing on the Route 65 Ohio River Boulevard corridor as its case study, for Pennsylvania's Department of Transportation (PennDOT). This study was intended as a further investigation of Corridor Guidelines prepared by RCI for PennDOT in 2016 that prepared design guidelines for Pennsylvania's corridor roadways, a roadway type not previously studied as a classified roadway type. The 2016 study concentrated on urban and denser suburban corridor locations, not regional-type highway corridors that connect multiple municipalities like Route 65.

Mobility21, the University Transportation Center at Carnegie Mellon, funded RCI for the first phase of the Route 65 study for foundational research and data collection as a prelude for a more in-depth design investigation of the corridor between the City of Pittsburgh and Rochester, PA in western Pennsylvania. As partners with RCI, the QVCOG received funding from Pennsylvania's Department of Community and Economic Development (DCED) for community engagement and research on how multiple municipalities can work better with PA government agencies. The Phase 1: Research and Understanding portion of the broader Regional Highway Corridor Benefit Research Study - Proof of Concept covering the 19 corridor communities that parallel the Ohio River was completed in October 2019.

Phase 2 was later funded by PennDOT Connects to complete the corridor design research. That phase began in 2020 as a partnership with the QVCOG and the design team of Michael Baker International and Civic Design and Planning LLC, who engaged RCI personnel for the project. That study involved the active participation of the Borough of Emsworth, one of the five municipalities engaged with the LINC study. While Phase 2 involved all the Route 65 corridor communities, it laid the groundwork for the more detailed local mobility LINC research and the QVCOG's continued partnering with RCI.

The following describes the civic engagement activities utilized for the LINC study:

Webpage

QVCOG incorporated a section of the COG's website, www.qvcog.org, for the LINC project. It describes the research project and provides access to the ongoing community survey for this study: https://www.qvcog.org/announcements/linc-study-underway.

Access to Local Leadership

QVCOG provided RCI their mailing list of local officials within the LINC study area. RCI sent out several emails to local leadership describing the project, asking for their assistance with publicizing the resident survey and for their assistance with individual telephone interviews on related study topics. Several local leaders participated.

RCI met by Zoom and by telephone with leaders active in Bona Fide Bellevue for briefings on the study and feedback on Bellevue's main street improvements for Lincoln Avenue. Bellevue's roadway and sidewalk improvements, the most developed of the five communities, installed intersection bulb-outs for pedestrian safety, a mid-block crosswalk, sustainable rain gardens fed by stormwater, and new street lighting as a safety and beautification project spanning several blocks in the heart of Bellevue's commercial district.

RCI made presentations to the Quaker Valley COG membership and the incoming Executive Director that provided members with a detailed description of the study's objectives and schedule and updates of findings toward the end of the study. The RCI team will be making a final presentation to the COG and interested residents later in 2021.

Community Survey

A seven-question survey was developed with the QVCOG's assistance to better understand how residents of the five municipalities use local transportation and questions about how residents without access to personal cars can, and do, access local services. The survey went public in February 2021 and will continue to gather input for the COG after completion of the LINC study.

Survey findings were consistent among residents of the four linked boroughs. Kilbuck residents, who are without public transit and rely solely on automobiles, strongly favored bicycles as alternative forms of mobility rather than bus or ride share.

- **How do residents in your community get around without using private vehicles?** (In order of preference)
  Bus, walking, bicycle, ride share (Uber), scooter.

- **How would you like to improve mobility for those that do not own private vehicles?** (In order of preference)
  Better and more frequent bus service, smoother and level sidewalks, safe bike lanes and paths, better crosswalks, shuttle or small bus for local travel, ride share hubs.

- **If you, personally, didn't have access to a private vehicle, what would work well for you?** (In order of preference)
  More consistent and frequent bus service, ride share, bicycle, taxi, pool transportation. One noted there are no options for carrying large parcels or groceries.

- **Are there any transportation or access challenges we should be aware of?** (In order of preference)
  Uneven, broken, and snow-covered sidewalks without ADA accessibility, need for more frequent and regular bus service, audible signals for safe pedestrian crosswalks, Route 65 not conducive for bicycles and pedestrians. Kilbuck responses noted widespread distances between residential clusters.

- **How concerned are you about residents who lack private vehicles to access the main street of your municipality?**

Not a Concern	(1)	13%
	(2)	27%
	(3)	36%
	(4)	7%
Highly Concerned	(5)	20%

- **How concerned are you about pedestrian safety in your municipality?**

Not a Concern	(1)	7%
	(2)	0%
	(3)	47%
	(4)	7%
Highly Concerned	(5)	40%

The survey identified community-wide concerns over poor conditions of existing infrastructure and inconsistent and infrequent public bus service. Pedestrian safety ranked high due to snow-covered, icy, and uneven sidewalks and safety concerns at intersection crossings. Few respondents noted traffic speed, lack of parking in commercial areas, or the proliferation of delivery trucks as concerns. Note that respondents were not representative of age diversity and did rely on private vehicles for access to local services and remote services. A few also noted reliance on private vehicles for access to services outside these communities due to lack of bus service other than to downtown Pittsburgh.

Access to Regional Transportation Leadership

RCI reached out to several regional and Pittsburgh leaders in transportation and planning to discuss the impacts of local mobility at the regional, city, and local scales. These discussions included issues of local mobility's inclusion onto the region's narrow street system, initiatives, and pilot testing of micromobility devices including scooters and robotic delivery vehicles, and micromobility's integration into complete street policies. The institutions represented included Pittsburgh's Department of Mobility and Infrastructure, the Port Authority of Allegheny County, and the Southwestern Pennsylvania Council (SPC), who serves as the Metropolitan Planning Organization (MPO) for the 10-county southwestern Pennsylvania region. These discussions provided valuable insights into current local mobility activities, raised safety concerns about their use on local sidewalks, concerns with pilot programs, and the importance of design guidance for safety, sustainability, and aesthetics.

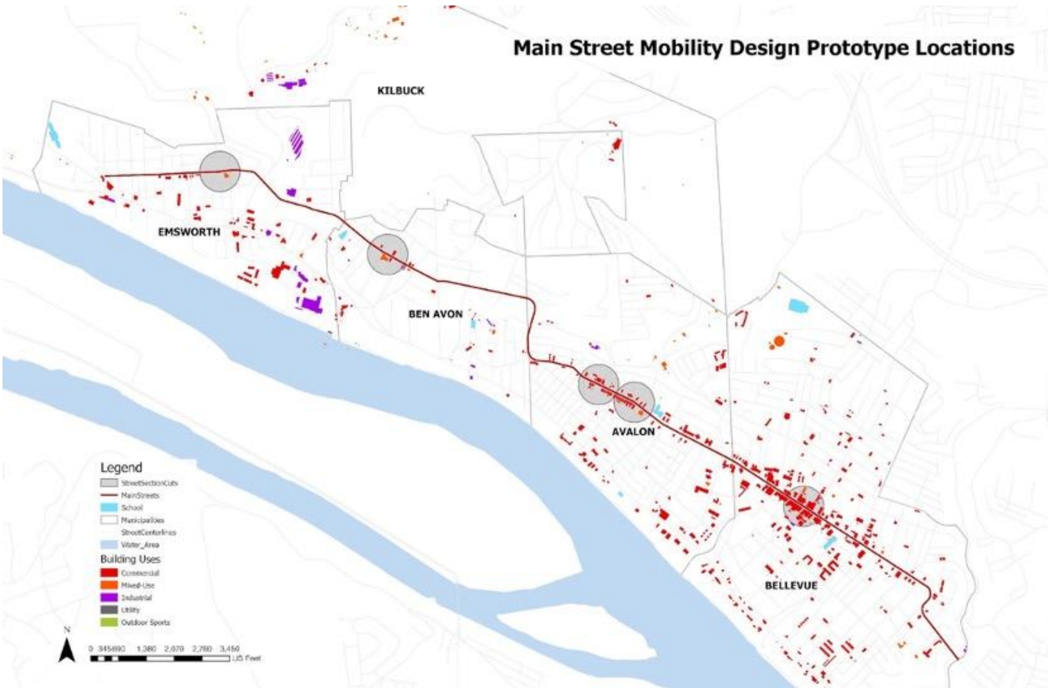
LOCAL MOBILITY DESIGN APPLIED IN CASE STUDY COMMUNITIES

Roadway and right-of-way improvements were investigated to link the shared main street, both for application in their commercial centers and the residential segments between them.

Plan and section design studies were initially developed for each municipality's commercial area of main street to understand their contexts and how various micromobility vehicles could be added within the right-of-way. These were followed by investigating common mid-segment residential portions. Because of main street's common right-of-way structure through the four boroughs, it became apparent that demonstrating various design and micromobility alternatives in a comparative manner would be more impactful than a series of specific designs for each municipality. The individual studies evolved into a set of roadway design prototypes that integrate micromobility vehicles ranging from minimal street reconfigurations to a robust prototype that changes the typical auto-oriented roadway into a pedestrian-oriented and walkable town center.

Main Street Study Locations

The main street locations investigated are located within the circled areas on the map below and descriptions of each location follow. Commercial and mixed-use land uses are in red and orange and mostly clustered along the shared main street and on the Ohio River Boulevard corridor. Schools are indicated in blue and industrial uses are purple.



Commercial center studies concentrated on the locations identified by circles along the shared main street to understand how they differed. In-between residential sections were studied for their commonalities.
(Image: Remaking Cities Institute)

The fifth community, Kilbuck, does not have a commercial area embedded in its residential fabric and its residential fabric is one of clusters without sidewalks, rather than a typical networked street grid. Other than recreational walking and biking, Kilbuck is not conducive to pedestrian traffic or bike commuting on its roadways or to its commercial area. The Existing+ option illustrated later in this section is the most likely for consideration by Emsworth and similar locations.

Bellevue

Lincoln Avenue, Bellevue’s main street, is the most varied of the four connected boroughs, with uses including restaurants, a brew pub, professional offices, auto repair, and small shops. Bellevue’s town center is about seven blocks long and book-ended by Kuhn’s Market on the north and the CVS Pharmacy to its south.

Lincoln Avenue town center in Bellevue is linked to Avalon and to the city of Pittsburgh by their shared main street.
(Image: Remaking Cities Institute)

A portion of Bellevue's town center, from close to Florence Avenue to Meade Avenue, was recently improved as a pedestrian-friendly destination. Intersection bulb-outs with rain gardens identify street crossing intersections and at midblock. Crosswalks are highlighted with red paving. Decorative pole lighting was added to the furniture/planting zone that is paved with permeable pavers that extend the sidewalk for cafe seating. A few of Bellevue's restaurants have added outdoor seating. In addition to street parking, retail and services are served by parking lots close to Lincoln Avenue.

Location:	Florence Avenue to Balph Avenue
Blocks:	7 blocks
Length:	1,175'

Avalon

Avalon's town center on California Avenue is three blocks long and active between Ohio Avenue and School Street.

Trinity Lutheran Church, located in the middle of Avalon's town center on California Avenue, illustrates the pedestrian nature of main street with an intersection bulb-out, permeable pavers in the curb zone, and a town clock.
(Image: Remaking Cities Institute)

Avalon’s town center on California Avenue connects with Bellevue’s town center and continues north into Ben Avon.
(Image: Remaking Cities Institute)

Retail stores and restaurants are interspersed with single-family residential buildings. Street parking is supplemented by parking lots at either end of Avalon’s commercial center, and accessed directly from California Avenue. Large apartment buildings line one side of main street close to Avalon’s center.

Location:	Ohio Avenue to School Street
Blocks:	3
Length:	1,275’

Ben Avon

Ben Avon's town center is small, consisting of professional offices, local services, and its Borough building, all within a two-block section.

The main street setting in Ben Avon changes to a residential scale when Avalon's California Avenue becomes Church Street and continues to Emsworth.
(Image: Remaking Cities Institute)

Ben Avon's main street, Church Avenue, is mostly residential and distinguished by large trees. The environment is tranquil and friendly, which encourages pedestrian strolling and recreational walking.

Location:	Dalzell Avenue to Forest Avenue
Blocks:	2
Length:	700'

Emsworth

Center Avenue, Emsworth's main street, is primarily a residential street with several commercial uses located between Grant and Orchard Avenues, a block north from the Borough building.

Emsworth's main street, Center Avenue, is a continuation of Ben Avon's Church Street and ends the shared main street that started in Bellevue and Pittsburgh. The municipal building and its clock are to the left. Note the intersection bulb-out and benches. (Image: Remaking Cities Institute)

Local retail and businesses in Emsworth are within a block of the Borough's municipal offices. Emsworth was the destination of the former streetcar line that connected the networked boroughs' main street to downtown Pittsburgh. (Image: Remaking Cities Institute)

Intersection bulb-outs have been added to most intersections on the west side of Center Avenue that clearly designate parking zones clear of intersections in the commercial area and at the Borough Building.

Location:	Grant Avenue to North Avenue
Blocks:	2
Length:	550’

NEW LOCAL MOBILITY PROTOTYPES

Four prototypes were developed and illustrated for alternative ways to integrate new local mobility ideas and vehicles into a main street context: Existing+, Bike+, Sidewalk+, and Street+ described below. The prototypes are sequenced beginning with minor main street improvements that can be accomplished with painted lines that then can be transformed in incremental steps to more developed right-of-way improvement configurations and more pedestrian-friendly environments.

Generalized commercial and residential right-of-way configurations form the base for the prototypes. As previously mentioned, the investigation found that main street maintained a consistent roadway configuration through the four communities. Deviations only occurred between the curb line and property lines, and they were minor. The residential areas were also consistent in configuration matching their commercial area counterparts and deviating only in the distance and composure from the curb to the property line. The roadway’s consistency encouraged a uniform approach for comparing several local mobility design alternatives for narrower yield-type rights-of-way.

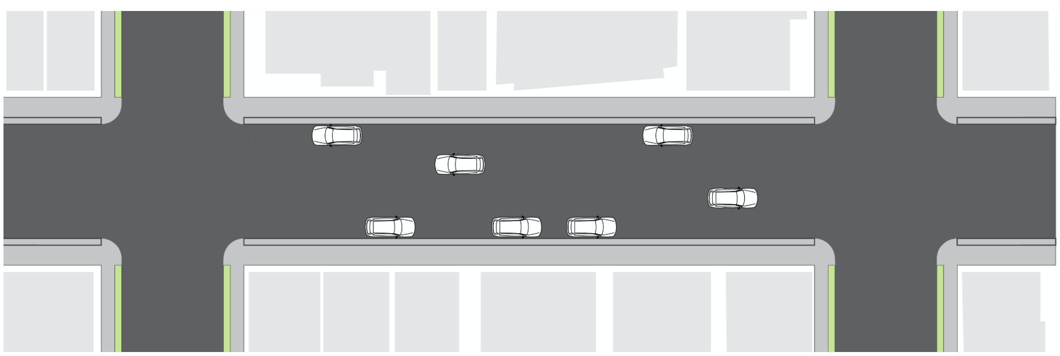
The prototypes are illustrated below beginning with a generalized existing configuration illustrating the common design features, scale, and context observed and shared among the study locations. They are generalized studies to show different, yet potential, right-of-way configurations. Detailed versions meant for implementation will require more detailed design study, particularly regarding transitions between commercial and residential settings and side street intersections perpendicular to main street.

Prototypical Existing Conditions

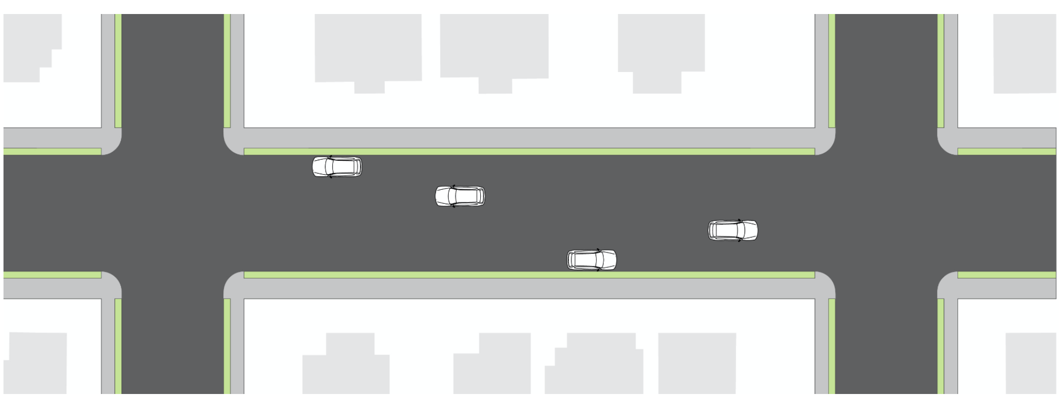
The existing conditions are represented as a common right-of-way configuration for both commercial and residential locations in the study area that serve as the base "foundation" for the proposed prototype designs and comparison.

Description
The roadway zone contains two travel lanes in its center and parking zones along the curbs. Curb to curb width varied minimally, measuring 34' to 35'. Commercial area sidewalks are composed of a 2' curb zone, which contains streetlights, fire hydrants, parking signage and often filled in with concrete or Belgian block, and a pedestrian walkway zone that varies from 4' to 6' wide from the curb zone to the property line. Sidewalks were set at 6' for all commercial prototype versions. Most commercial structures are built to the sidewalk property line with a few set back farther. Residential area sidewalks are also basically consistent: the 2' curb zone is typically grassed, and sidewalk widths range from 4' to 6'. Residential sidewalks were set at 4' for all prototype versions. Sidewalks at some intersection locations were widened by respective boroughs to decrease pedestrian travel distance between opposite curbs. These bulb-outs are either concrete or semi-filled with Belgian block, and some contain rain gardens to capture rain and stormwater. The typical existing condition used for the prototypes is illustrated without bulb-outs.

Existing **Commercial Main Street**



Existing **Residential Main Street**



Micromobility Adaptation
None, except for sharrow markings in the roadway in some areas. These illustrations show generalized existing conditions without micromobility accommodations. It is assumed that pedestrians and wheelchair users are sidewalk users and bicycles, e-bicycles, e-scooters, e-tricycles, delivery devices, and others would use the roadway.

Potential improvement/micromobility adaptation within existing conditions include:

- Location: Use both existing sidewalks and sharrow roadway.
- Speed: Maximum speed 10 mph on sidewalks with capability to automatically slow to pedestrian walking speed. **Maximum speed of 20 mph recommended for the roadway.**
- Materials: Sidewalks: Smooth concrete with saw cut expansion joints in replacement sections. Repair and patch to create a smooth and level surface. Roadway: Repair to maintain a smooth surface. Micromobility vehicles, including bicycles and scooters, require smooth surfaces to maintain stability.
- Micro Vehicles Permitted: Sidewalks: Electric wheelchairs, micro vehicles traveling at a maximum 10 mph and capable of automatically slowing to pedestrian walking speeds. Roadway: All micro vehicles capable of traveling at speeds over 10 mph.
- Not Permitted on sidewalk or in roadway: Sidewalks: All motorized micro vehicles capable of traveling faster than 15 mph. Roadway: Micro vehicles traveling faster than 20 mph should be using the automobile zone of the roadway.

Existing+ Prototype

The Existing+ prototypes begin to separate micro vehicles with relatively small investment. A flexible micro vehicle lane is added to the roadway while the sidewalks remain unchanged.

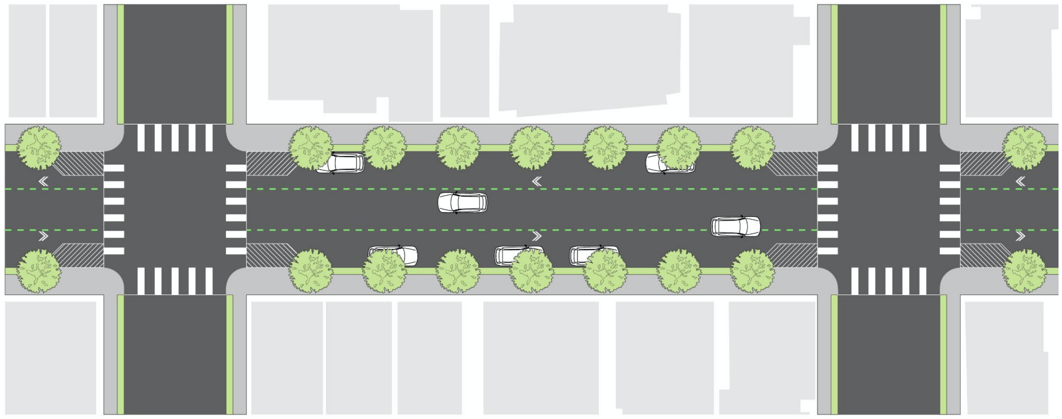
Description
The Existing+ prototype adds “micro lanes" adjacent to the parking zone for separating micromobility and other slower vehicles from using the sidewalk. The lanes are created by adding dashed lines 4’ beyond the parking zone. These are flex zones meant to be shared by micro vehicles and normal roadway traffic, with occupied micro lanes given priority by auto and truck drivers. Green paint, the color used for designating bicycle lanes, marks these lanes in the prototype illustrations. Painted white-striped zones, 20’ to 25’ long, are added at main street intersections to increase visibility for pedestrians and micromobility users of vehicles entering from side streets. These intersection zones also perform as end markers for parking zones, keep cars from parking close to or within crosswalks and provide safer bus loading areas.

Image of dashed-line flex bicycle lanes on a narrow yield-type roadway. Existing+ micro lanes create flex zones for motorized micro vehicles within roadway travel lanes.
(Image: Alta Planning + Design)

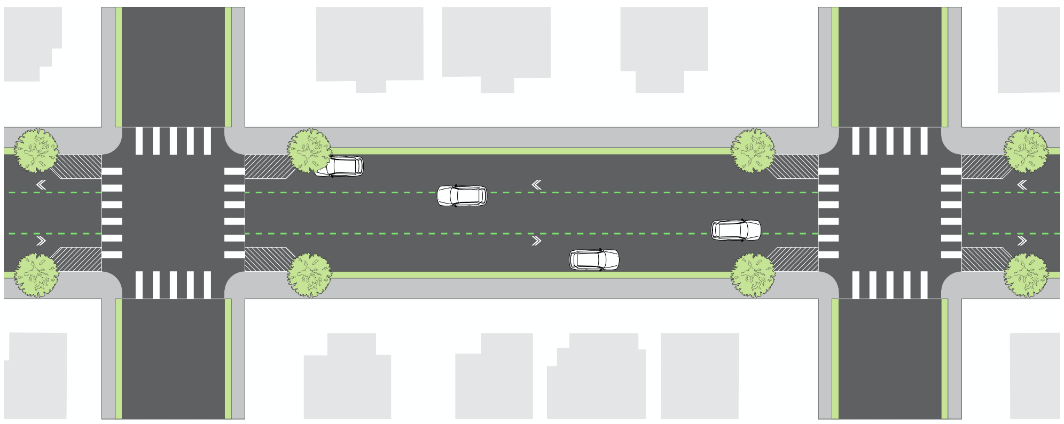
With the study area’s narrow yield-type main streets, there will be friction between vehicle types as the resultant travel lane width between the dashed lines is either 12’ or 13'. When there are no micro vehicles in the 4’ flex zone, cars will move to the side of the roadway’s center overlapping the dashed line. When the micro lanes are occupied and cars need to pass, they will move to the center of the roadway to get past one another. When micro lanes are occupied and there is opposing traffic, autos and trucks will need to slow and only pass when there is no longer opposing traffic.

As in the residential “yield street” design concept developed by NACTO, it is recognized there will be car-to-micro vehicle friction with this prototype. One would expect that common courtesy would have car and truck drivers swing out to their left to provide 4’ of space between the micro lane and the vehicle, similar to bike-auto use of sharrow-marked roadways. "For a yield street to function effectively, motorists should be able to use the street intuitively without risk of head-on collision" (NACTO 2021). Note how the car in the above photo is driving within the flex micro lane and far from the bicyclist on the opposite side of the roadway.

Existing+ Prototype **Commercial Main Street**



Existing+ Prototype **Residential Main Street**



Micromobility Adaptation
Painted green dashed lines are located 11' or 12' out from the curb edges on both sides of the roadway, creating a 7' or 8' wide parking zones and 4' micro lanes. At intersections, painted white striped zones mark the beginning of the parking zone extending 20' - 25' from the side streets and angling back to the curb. Optional: White solid line located 7' or 8' from the curb to designate the parking zone as shown in the photo above.

- Location: Both sides of main street in commercial and residential locations.
- Micros Permitted in Micro Lanes: bicycles and e-bicycles, e-scooters, electric wheelchairs, skateboards, roller and inline skates, and robot delivery vehicles. Maximum speed: 15 mph; others use auto travel lanes.
- Micro Lane Material: Existing roadway maintained for a smooth surface. Traffic-appropriate paint.
- Sidewalks: Pedestrians, wheelchairs including electric wheelchairs, baby strollers, children's bicycles, and slower moving micro devices.

Bike+ Prototype

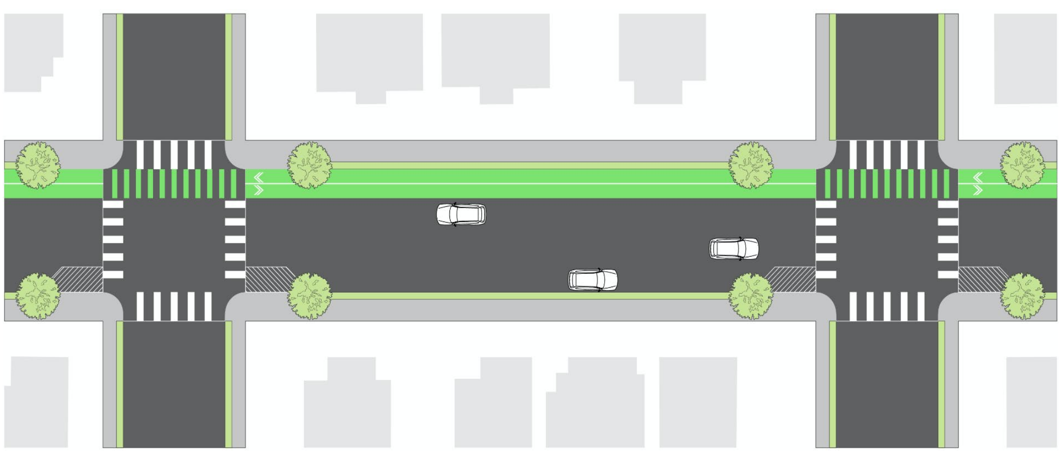
The Bike+ prototype converts one of the parking zones to a designated two-way micro lane within the roadway. This prototype provides a separate designated pathway for all micromobility vehicles that are not appropriate for sidewalks.

Description

Repurpose a single parking zone for micromobility use. Size the two-way lanes at a minimum 8' wide. Use a solid green surface to designate Bike+ lanes. Maintain the street furniture/planting strip and existing sidewalk for pedestrian and self-propelled wheelchair use, in addition to slower pedestrian-friendly devices. Continue the Bike+ lanes through the commercial areas and revise the furniture/planting strips to include tree planting beds separated from one another by permeable pavers, not Belgium block, to encourage café and bench seating between tree planting beds. Allow for designated curb-side delivery vehicle zones within the Bike+ lanes sized long enough to accommodate two large 2-axle trucks, marked by green stripes perpendicular to the roadway to designate this as flex space to be used by both micromobility and delivery/drop-off vehicles.

Bike+ Prototype Commercial Main Street

Bike+ Prototype Residential Main Street



Micromobility Adaptation

A green, two-lane wide 8'micromobility zone is created within the parking zone at the roadway level on one side of main street for its full length. Flexible bollards should be considered along the outside of the micro lanes. At intersections, painted green striped zones mark where the micro lanes extend across the intersection. On the other side of the roadway, the Existing+ painted intersection zones remain in place.

- Location: Place the Bike+ lanes on the densest side of main street commercial areas and continue this orientation for main street's full length.
- Speed: Sidewalk: Maximum 10 mph all micro vehicles but encourage motorized devices to use the designated micro lanes. Bike+ Lanes: Maximum 20 mph (15 mph recommended). Micro vehicles traveling faster should share the auto lanes in the roadway's center.
- Material: Micro Lanes: Repave with smooth asphalt. As an alternate, use smooth concrete with saw cut expansion joints. Use paint containing non-slip grit or self-adhesive material designed for bicycle use.
- Micros Permitted: All micro mobility vehicles are permitted in Bike+ lanes, such as electric wheelchairs, e-bikes, and scooters, with a maximum 20 mph speed permitted (15 mph recommended).
- Not Permitted: Motorized, self-propelled, and micro vehicles traveling at speeds above 20 mph.

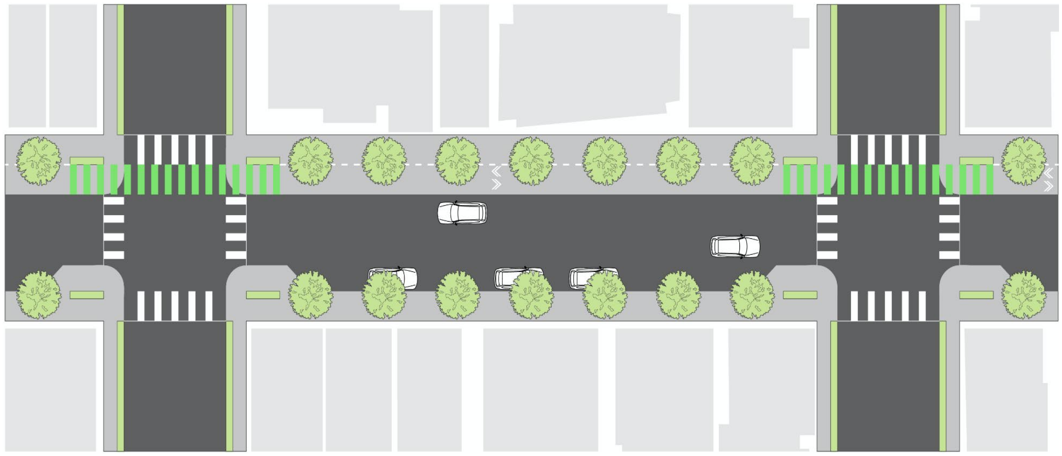
Sidewalk+ Prototype

The Sidewalk+ prototype widens the sidewalk replacing the Bike+ lane with a two-way sidewalk-level micromobility zone that maintains a curb separation between roadway travel lanes and most micro vehicles.

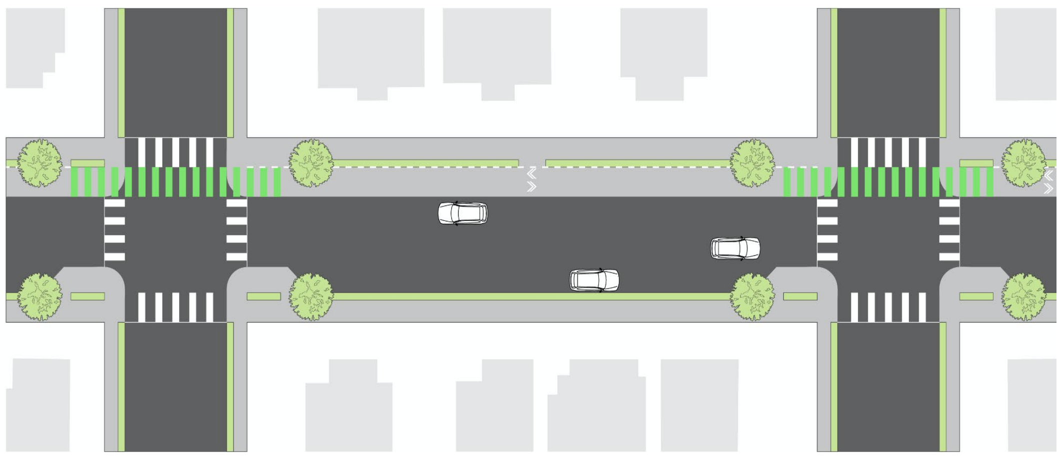
Description

The sidewalk is widened by 8' into one side of the roadway (in the Bike+ location) as a dedicated two-way micromobility zone replacing the roadway parking zone. At intersections the micro zone is ramped to transition down to the roadway level. This prototype focuses on the importance of allowing for newer mobility that is faster than walking, yet slower than what can be safely allowed in the roadway. The green striping is carried across the intersection and up onto the sidewalk extensions to visually continue the micromobility lanes as a warning to pedestrians crossing to the opposite side of main street. In commercial areas, maintain the Sidewalk+ extension along the retail frontages, continue the green striping used at intersections, revise the furniture/planting strip to include tree planting beds alternating with permeable pavers, and encourage café and bench seating between tree planting beds. In residential areas the existing sidewalks would be for the exclusive use of pedestrians, wheelchairs, children's bicycles, strollers, etc. Bulb-outs are illustrated opposite the Sidewalk+ side to shorten the distance for pedestrians crossing main street; this is optional as the Existing+ striping can remain.

Sidewalk+ Prototype   Commercial Main Street



Sidewalk+ Prototype   Residential Main Street



Micromobility Adaptation

- Location: Align the Bike+ lanes with the densest side of main street commercial areas and continue this orientation for main street's full length.
- Speed: Sidewalk: Maximum 10 mph all micro vehicles but encourage motorized devices to use the designated micro lanes. Sidewalk+ Lanes: 20 mph maximum (15 mph recommended). Those traveling faster should share the auto lanes in the roadway's center.
- Material: Micro Lane: Use smooth concrete with saw cut expansion joints. The micro lanes could be painted with non-slip grit, covered with self-adhesive material designed for bicycle use, or left as unpainted concrete. Consideration could be given to a less-expensive alternative: asphalt tinted to the concrete color, as asphalt provides a smoother surface for bicycles that is easily replaced as needed.
- Micros Permitted: All micromobility vehicles in Sidewalk+ lanes, including electric wheelchairs.

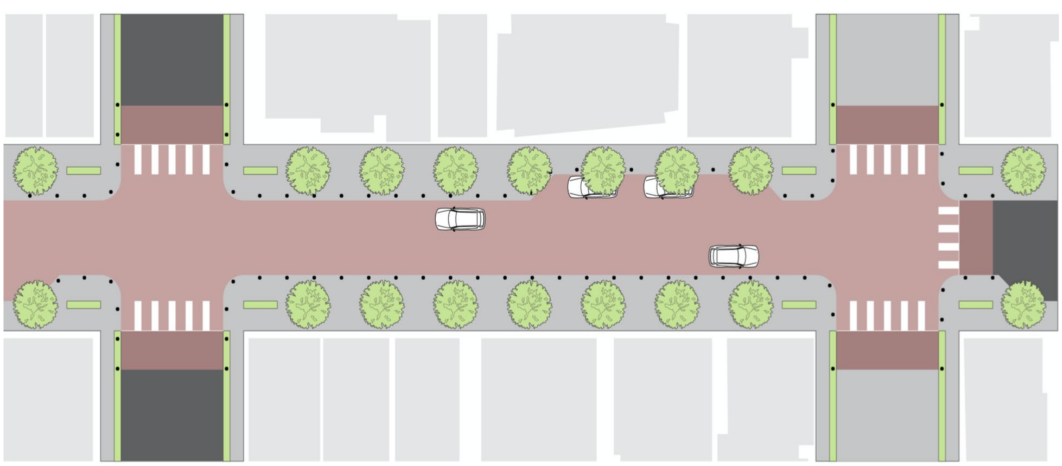
Street+ Prototype

The Street+ prototype reverses the automobile-to-pedestrian relationship by raising the roadway to the same level as the sidewalk, converting the roadway into a pedestrian zone. Automobiles and trucks are allowed, but at reduced speeds matching those of pedestrians and micro vehicles. Bollards are used to separate the former sidewalk areas from the center vehicle travel zone. In this prototype pedestrians are encouraged to cross from one side of the right of way to the other. Lower-speed micro vehicles would be allowed on the building side of the right-of-way with those traveling faster than 10 mph limited to the center zone.

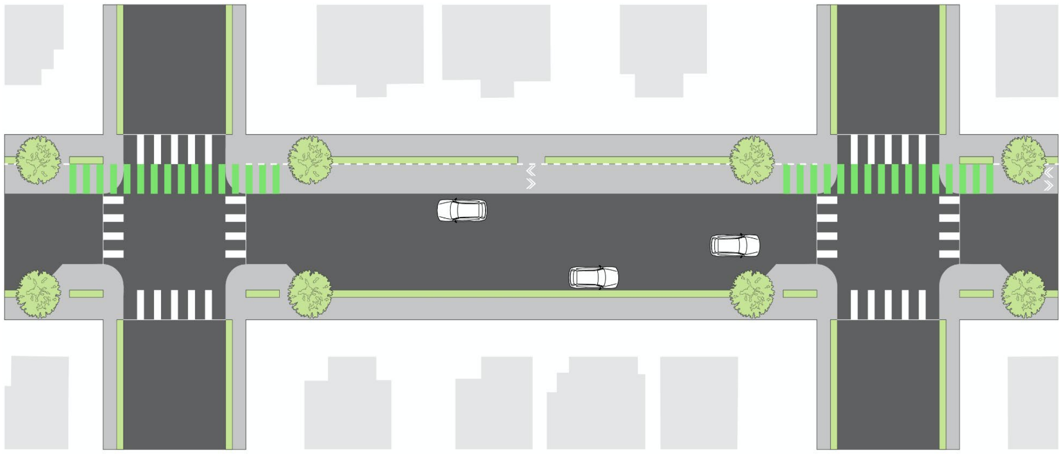
Description
In commercial centers, the full street right-of-way becomes a pedestrian zone where motorized vehicle are allowed. This concept of a shared street is sensitive to the volume of auto traffic on the roadway and anticipates a prioritization of non-auto trips (NACTO 2021). With this prototype, the roadway is raised to the height of the sidewalks for a continuous surface. Travel lanes are designated by 3' high bollards with lights and placed to allow for optional pull-out areas for freight delivery or shared-ride pick-up. Café seating, bench seating, and street trees are encouraged between bollards and buildings. Where side streets enter onto the Street+ areas, change materials to ones that will be detected by vehicle operators, such as Belgian block or durable pavers.

The Street+ prototype is not appropriate for residential areas between commercial centers or for creating multiple Street+ locations within a single commercial center. The Sidewalk+ prototype is shown for the residential main street as a potential option, although any of the previous versions are also viable.

Street+ Prototype Commercial Main Street



Street+ Prototype Residential Main Street



Micromobility Adaptation

- Location: Applicable in town centers where a pedestrian environment is preferred.
- Speed: All vehicles travel at the speed of pedestrians and pedestrians always have the right of way. Maximum speed within the bollard areas: 10 mph, with consideration for pedestrians. Maximum speed in the center zone: 15 mph, same as a Slow Zone at school locations.
- Materials: Surfaces should be smooth for all vehicle types and composed of durable material(s). Use of color is optional.
- Micros Permitted: All micros and other vehicles allowed in the travel zone between bollards. Slower micros allowed in the “sidewalk” spaces.

EVALUATING PROTOTYPES

As with proposed improvements there are opportunities and challenges to be considered and evaluated. The importance of evaluations based on intended goals, objectives and community values cannot be stressed enough, and evaluations should also weigh short-term inconvenience for longer-term gain.

For the prototype designs, these are suggested items for consideration and the beginning of an evaluation process. Every municipality should develop their own criteria in participation with residents and building owners.

OPPORTUNITY	EXISTING+	BIKE+	SIDEWALK+	STREET+
Increased mobility and safety?	Yes Improved sidewalks	Yes Safer level and lane separation for some micro vehicles	Yes Safer level and lane separation for some micro vehicles	Yes Shared street approach with all vehicles slowing for pedestrians
Improved bus stops?	Yes	Yes	Yes	Yes
Improved sidewalks?	Yes	Yes		Yes
Improved safety?		Yes Separated modes	Yes Separated modes	Yes Pedestrian environment
Increased mobility options?		Yes	Yes	Yes
CHALLENGES	**EXISTING+**	**BIKE+**	**SIDEWALK+**	**STREET+**
Loss of on-street parking and more limited curbside access?		Yes On-street parking limited to one side of the roadway	Yes On-street parking limited to one side of the roadway	Yes On-street parking limited to drop-off and delivery
Loss of travel lanes?				Loss of designated lanes, slower movement
Micro vehicles at the same level as the sidewalk?	Yes Micro vehicles share sidewalk and can move faster than pedestrians		Yes Potential for faster micro vehicles to also use the sidewalk	Yes All vehicles at the same level
Micro vehicles at the same level as the roadway?	Yes Cars and trucks sharing roadway with micro vehicles	Yes Cars and trucks sharing roadway with faster-moving micro vehicles		Yes All vehicles at the same level requiring cars and trucks to move at micro vehicle speeds

SIDE STREET LOCAL MOBILITY

Side street adaptability for local mobility vehicles was studied, but no firm recommendation is suggested for several reasons. The study area's side streets are narrow, both in their right-of-way and roadway dimensions and qualify as NACTO-defined yield streets requiring automobiles to yield to oncoming traffic. Many side streets allow parking on one side only, yet they too operate as yield streets.

One prototype may be reasonable for side street application: the flexible micro lane shown in the Existing+ prototype, where cars and micro vehicles are separated by a narrow dashed-line micro travel zone created between parked cars and the travel lane. The study area side streets are so narrow that this flex micro lane is possible on only one side of the roadway. As an additional consideration, the study area side streets are sloped upward in the west-to-east direction for their full length. In Pennsylvania autos traveling down slopes have the right of way which would place the Existing+ micro lane on the right-hand side of the upsloping street. Cars traveling up the street would be expected to yield to oncoming vehicles and pass micro devices only when there is no opposing downhill traffic.

Sidewalk use by micro vehicles should be considered an allowable alternative when communities are confronted with narrow streets. With Pennsylvania's acceptance of 550 lb. delivery robots on sidewalks so long as they yield to pedestrians, this logic could be interpreted as applying to all micro devices so long as they yield to pedestrians and never exceed 10 mph.

MOBILITY HUBS

Mobility hubs are locations where a person can change mobility modes, such as exiting from a bus and taking a shared bike or e-scooter for the last-mile trip or traveling by personal bike to a mobility hub to catch a shared ride, circulator, or bus for travel to distant destinations. Their development could fundamentally improve first mile last mile connections.

In smaller towns and communities, bus stop locations become logical places for installing mobility hubs. Typically, ride share micro vehicles are located on sidewalks or within the street adjacent to intersections and often at bus stops. Wide sidewalks, bulb-out extensions at intersections and mid-block, and painted clear zones near intersections in the roadway are all appropriate settings. In residential areas, there may not be enough existing right of way space for a mobility hub. In these situations, consider installing bulb-outs with lengths determined by demand needs. Considering the prototype designs of the case study, it may be necessary to install transition ramps at both ends of bulb-outs to maintain a continuous pathway for mobility devices. Another option might include the rental or purchase of private property beyond the right-of-way boundary to meet additional mobility hub needs, such as personal and shared vehicle storage or some of the mobility hub amenities listed below.

Spacing of mobility hubs is recommended to be within a 5-minute walk of one another. This would place them no farther than a 2-1/2-minute walk from any main street intersection. Hub locations in commercial centers could be closer together, but at minimum not farther apart than at both ends of the commercial center.

The Shared Use Mobility Center developed a list of principles for establishing and designing mobility hubs (Shared Use Mobility Center 2018). The following includes items appropriate for local mobility hubs as well as some for larger locations and higher use when space allows. Some recommendations were modified to reflect locations where space is limited, nor is this list inclusive of all the Center’s recommendations.

Basic mobility hub requirements include:

- Curbside access for buses and pick-up/drop-off services
- Storage space for personal and shared vehicles, such as bikes and/or scooters
- Sheltered waiting space, including seating, fare machines for transit services, and informational signage

In all locations consider the addition of:

- Trees and landscaping
- Sustainable stormwater mitigation
- Green roofs for shelters
- Other amenities that would enhance their appearance and functionality

When demand requires larger hubs and space is available, other amenities to consider include:

- Real-time signage for wait times and delay alerts
- Wi-Fi and mobile phone charging stations
- Covered bicycle storage and bike repair stands
- Car share space(s) such as Zipcar and parking spaces for private vehicles
- Electric vehicle charging
- Restrooms
- Storage lockers for delivery services
- Commercial services such as a café, coffee shop, or other retail activity

RECOMMENDATIONS AND NEXT STEPS

The recommendations include study, analysis, and initial steps towards implementation.

One. Building on existing "Slow Zones" such as the 15-mph zone by the Avalon Elementary School, identify new "Slow Zones" for safer shopping, driving, and biking, with the best practice standard of 20 mph recommended. Consider making the entire length, from the Pittsburgh border through Emsworth, 20 mph.

Two. Building on recent sidewalk improvement experience as in Bellevue, undertake further review and engagement to learn from what has worked well (or not) regarding that improvement, and review the potential of the prototypes developed in the report, from those that require relatively minor interventions such as "Existing+" to the significant infrastructure changes of "Street+."

- **Existing+.** Identifies the zone for cars and similar vehicles in the center of the roadway, with zones for parking, biking and non-sidewalk mobility.
- **Bike+**. A dedicated, two-direction bike and other non-sidewalk mobility lane, at street level, is generated, with or without flexible bollards. In the neighborhood business district, there is a designated pull-off zone for drop offs and deliveries.
- **Sidewalk+**. Slower-moving micro-mobility is located at sidewalk level, on the street side of a much wider sidewalk on one side of main street.
- **Street+**. The entire street is open to multiple forms of mobility, all at the same level, with bollards to provide a fully protected zone for pedestrians. While the prototypes benefit from slower speeds, it is critical for this option.

Three. Through further survey and review, identify opportunities for improved first mile last mile connectivity from neighborhoods to the main street, where there is already regularly scheduled bus service, with special attention to the needs of seniors, youth, and households without access to a private vehicle.

Four. Building on the Joint Comprehensive Plan, conduct a full community assets inventory, using or modifying frameworks such as Complete Communities to develop and promote a greater sense of the full range of resources that already exist, as well as noting the need and potential for new services, from shopping to restaurants to cultural centers and medical offices.

Five: In this inventory, also review these assets in terms of those not using a private automobile. Recognize that this review is also in terms of equity, including but not limited to income, age, and capacity.

Six. Consider interim steps, such as the "Existing+" prototype, or similar initiatives that rely on relatively modest expenditures to test the potential improvements in safety for shared mobility.

Seven: Develop a Local Mobility Plan, recognizing differences and alignments with current national best practices discussion.

Notes on developing Plans: Equity and First Mile Last Mile Considerations and the Expanding Definition of New Local Mobility.

A greater understanding and analysis of local and regional conditions is the priority for developing this type of plan. However, there are recommendations for municipalities that should accompany the development of a response to new mobility. In 2019, Transportation for America (T4America) released the Shared Mobility Playbook for local municipality implementation to assist with onboarding micromobility efficiently, effectively, and equitably. In terms of equity, they make recommendations which generally look to larger areas than the 3.7-mile study area, yet they discuss topics that smaller, suburban communities need to consider as well, from the equitable distribution of micromobility vehicles (bikes, scooters, etc.) to alternatives for fare collection that do not presuppose smartphone ownership.

Likewise, larger municipalities or municipality coalitions need to address issues of access in both neighborhood distribution and economics and gender (Tonar and Talton 2020). Reports that offer valuable insights include “New Mobility and Equity Insights from Medium-Sized Cities” which examines developing and adapting new mobility technologies and their effect on equity, including their relationship to existing transit systems (Fedorowicz et al. 2021). The integration with transit is critical to first mile last mile goals. Many cities have expressed interest in new mobility as a catalyst to promote and include equity in transportation planning and implementation. Some examples of cities partnering with ride sharing platforms, like Uber and Lyft, saw an increase in ridership for off peak transit hours to complete the first and last miles legs of a trip. This model is still discriminatory to people who do not own smartphones and or who are not tied directly to automatic payment systems (unbanked).

Tonar and Talton suggest that micromobility should “include any ‘smaller-than-car’ solution designed for first mile, last mile, and hyperlocal connectivity.” They further suggest a systems-level approach that takes a long-term perspective on civic investment and the ability to provide equitable and inclusive services before building costly infrastructure using municipal funds, noting also that service providers may need to rethink their business model to be more inclusive and seek revenue sources that do not place the full cost on users but rather on advertisers and employers (Tonar and Talton 2021).

The report largely references existing micromobility types, presuming a greater expansion of them. Ultimately, however, a New Local Mobility Plan will need to go further, reckoning with potentially ubiquitous autonomous delivery, and an emerging generation of personal and multi-passenger vehicles, autonomous and not. At the same time, to be a fully sustainable and resilient system of shared mobility will depend on shared values for humanity-first mobility, streets, and communities.

APPENDIX

RESEARCH DESCRIPTION AND APPROACH

Description and Proof of Concept

The study investigates approaches to improve access to essential services involving shorter local trips, including first- and last-mile trips related to longer commutes or trips to work or services. While this study is relevant for all residents and recognizes the role of recreational walking and other forms of mobility, as well as trips to amenities, it is focused on expanding choices for those who do not have the option to drive due to age, different abilities, or insufficient income yet require essential transportation services for daily needs and connections to jobs, services, and recreation. Its goal is to research, develop, and develop prototypes to improve local mobility with the intention of better access and connectivity, quality of life, and health for residents and assist the longer-term sustainability of these smaller communities.

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As a proof of concept, the study asks, “How Can Policy and Practice Localize Transportation for Smaller Communities, Towns, and Municipalities, Including Using the Opportunities of Micromobility?”

Recent trends in connectivity, accessibility, and equity are pointing toward prioritization of local transportation to better serve the public from their house to services for daily living and connections to public transit for commuting to jobs and, just as important, returning them home. Most of these needs are local and accomplished within a 5- to 10-minute walk zone: connections to local transit for a trip to the grocery store or a ride to the express transit stop for the commute to work and return. These first- and last-mile trips are very difficult for many residents who don’t own cars, are not capable of walking, fear being outside when it gets dark, or are uncomfortable allowing unaccompanied minors to be out and about.

Urban centers have become test beds for new forms of personal transportation devices, such as bicycles or scooters, which raises the question of their applicability, or even appropriateness, for smaller communities. This study is directed at looking at the opportunity to test these new forms outside of city centers. It works to understand these basic questions by investigating a variety of personal transportation modes, the issues they raise, and their appropriateness within a context of rethinking transportation services to make them more inclusive of all citizens and begin to address the inequities within the present transportation network of services.

Study recommendations are intended to include outcome recommendations for local mobility and related community design, preliminary deployment strategies, and equity suggestions, contributing to a New Local Mobility approach.

Methodology

Methodologically, the study involved literature research, local community interviews, regional transportation leadership interviews specifically related to new micromobility and current transportation trends, transportation equity, and autonomous technology. Five adjacent and interconnected local municipalities located just beyond the city limits of Pittsburgh provide case study testing of transportation modality and design features needed for micromobility and new vehicle technologies, including curb management. The study includes:

- Options for personal transport in non-urban core locations
- Connectivity to non-motorized vehicle routes, including bike and pedestrian trails, for alternative routes and the recreational value of micromobility.
- Consideration of local transportation as a utility and its role outside center cities

The study relates to the Regional Highway Corridor Study research, investigating the transportation and design impact of statewide regional corridor roadways on local communities. The 20-mile segment of Route 65 to Beaver is the case study for the corridor study. While these two studies were conducted within overlapping timeframes, they were independent of one another except for recognizing the importance of Route 65 for commuter connectivity to Pittsburgh, Beaver County, or job locations along its route.

Data Management Plan

Existing conditions data from publicly available sources including the U.S. Census Bureau, Pennsylvania Department of Transportation (PennDOT), the Southwestern Pennsylvania Commission (SPC), the southwestern regional Metropolitan Planning Organization (MPO), and Port Authority of Allegheny County (PAAC). Reports, plans, and interviews provided additional information regarding potential future service. Community plans provided additional information. Existing right-of-way conditions from interviews and site visits. Summary reporting from interviews and the survey are anonymized.

Metadata standards are not applicable to this research.

The report is open source. All findings, including the prototype street designs, are open source, with appropriate source credit.

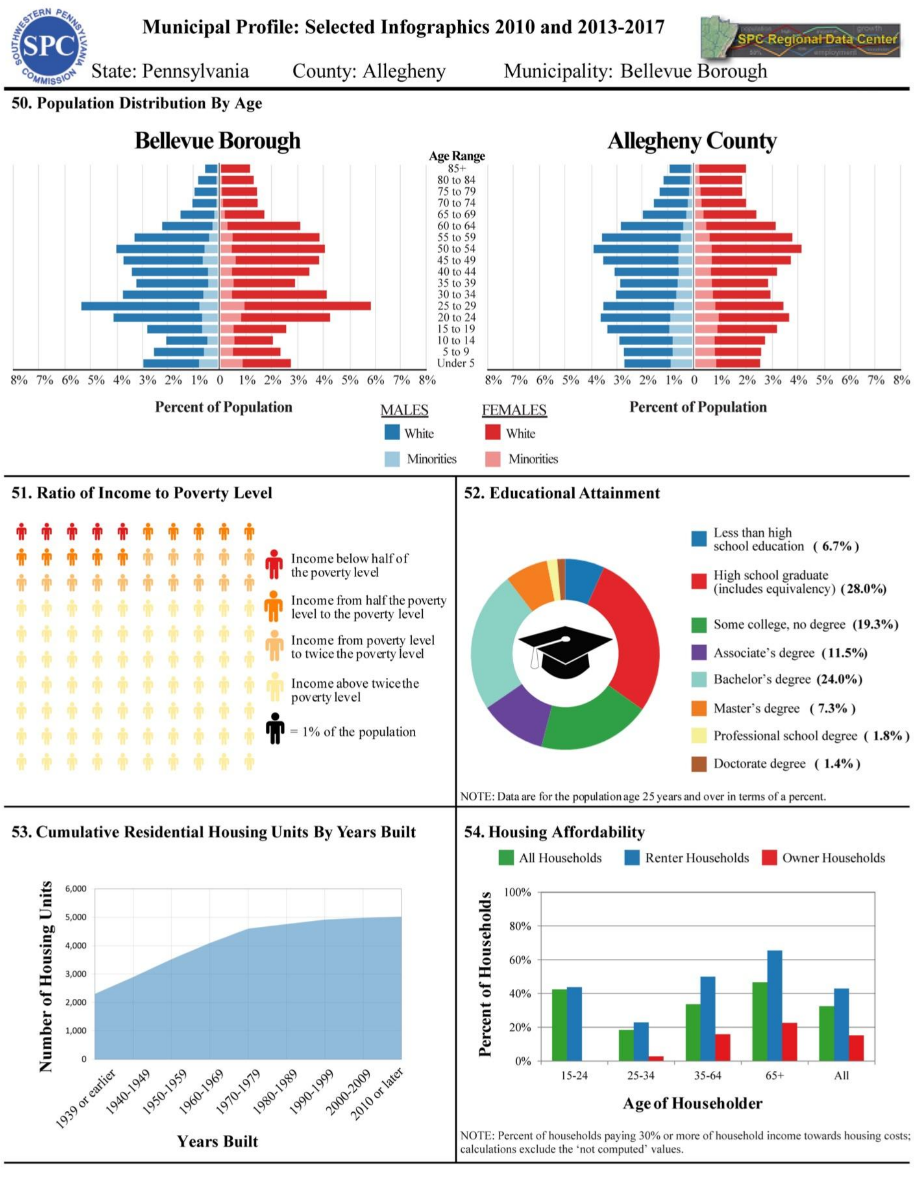
Case Study Approach

The study used design modeling to project various micromobility scenarios to understand their physical needs and impact on the local context. Issues such as sidewalk and curb management, traffic calming to create safer conditions for personal transportation devices, and how micromobility can integrate with public and other transportation vehicles to create transportation service networks appropriate for smaller communities.

Independent municipalities adjacent to one another were selected for case study modeling. Four share a single "main street" that connects them together and connects into Pittsburgh's North Side. The four are also served by the heavily trafficked Route 65 Ohio River Boulevard, a corridor arterial that parallels the main street and operates independently of immediate neighborhood life. These are older inner-ring suburbs with an urban street fabric that connect to one another by bridges across ravines. The fifth, although directly adjacent to three of the connected communities, operates independently of the other four as a very typical suburban bedroom community with larger lots and a roadway system that follows its hilly topography, yet at the same time has a street connection to the shared main street and residential areas within and near main street's walksheds. The divergent physical fabric of the fifth community, the shared main street of the other four, and the variety of street patterns and the terrain provide a valuable opportunity to test conceptual prototypes.

Bellevue Borough

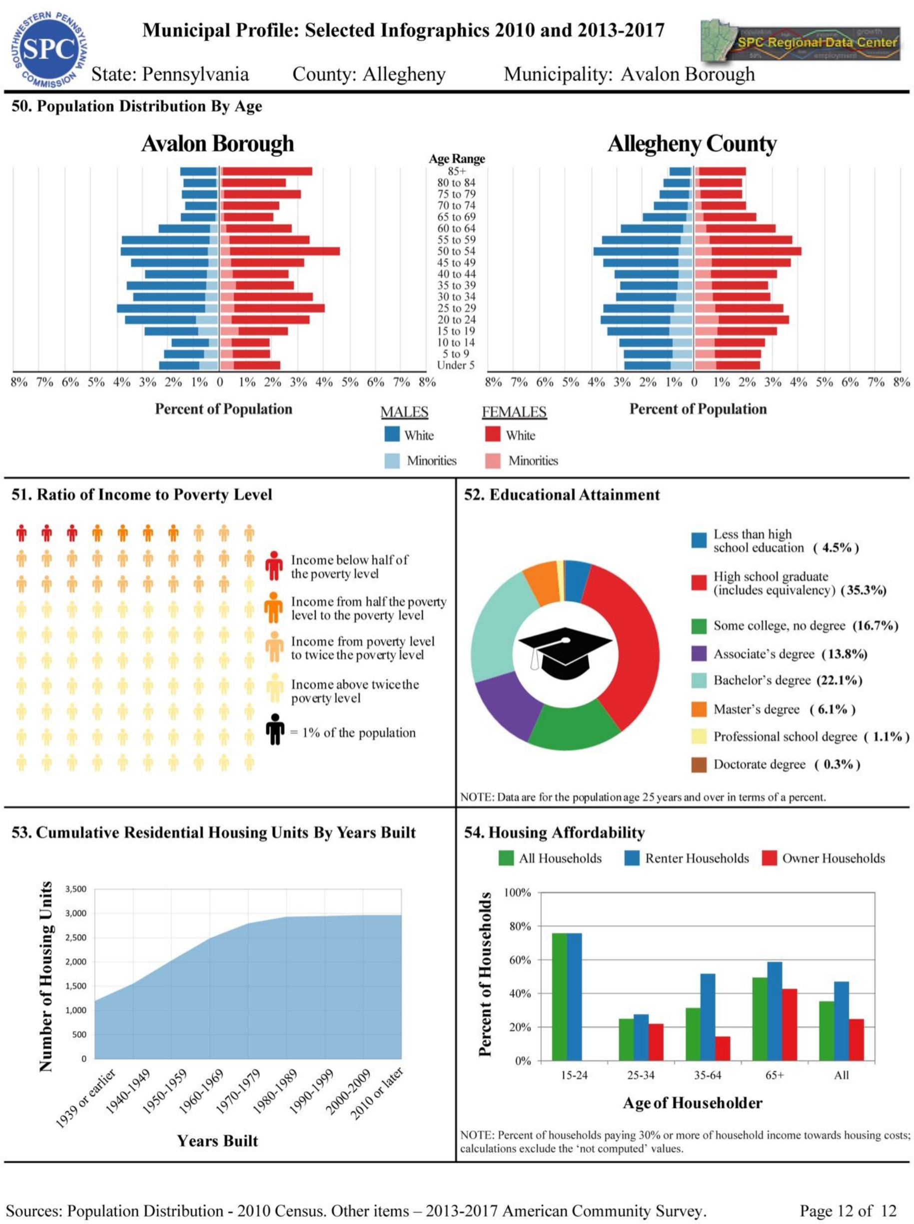
Adjacent to the City of Pittsburgh, the Borough of Bellevue, founded in 1867, is a residential community with a mixed-use on main street and highway commercial uses along Route 65. The borough was once part of the Depreciation Lands reserved for Revolutionary War veterans. Bellevue partnered with Avalon and Ben Avon, and Ben Avon Heights, for their 2017 Comprehensive Plan.



Sources: Population Distribution - 2010 Census. Other items – 2013-2017 American Community Survey. Page 12 of 12

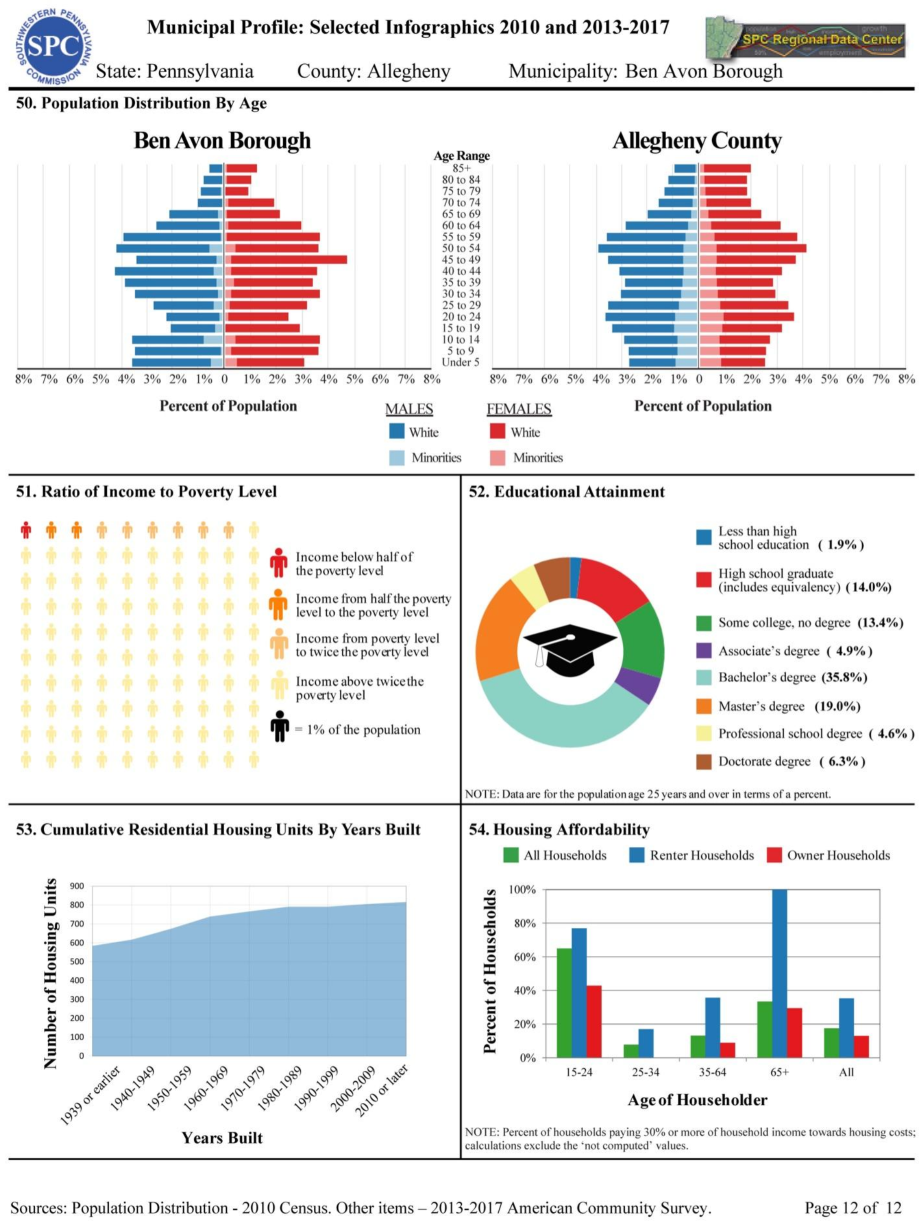
Avalon Borough

Avalon is a suburban community, founded 1892, with an active commercial main street in the center of the borough and highway-oriented commercial uses along the Route 65 highway. Avalon has a diverse mixture of single-family, moderate- and high-density residential homes as well as mixed-use residential buildings, and a significant amount of open space.



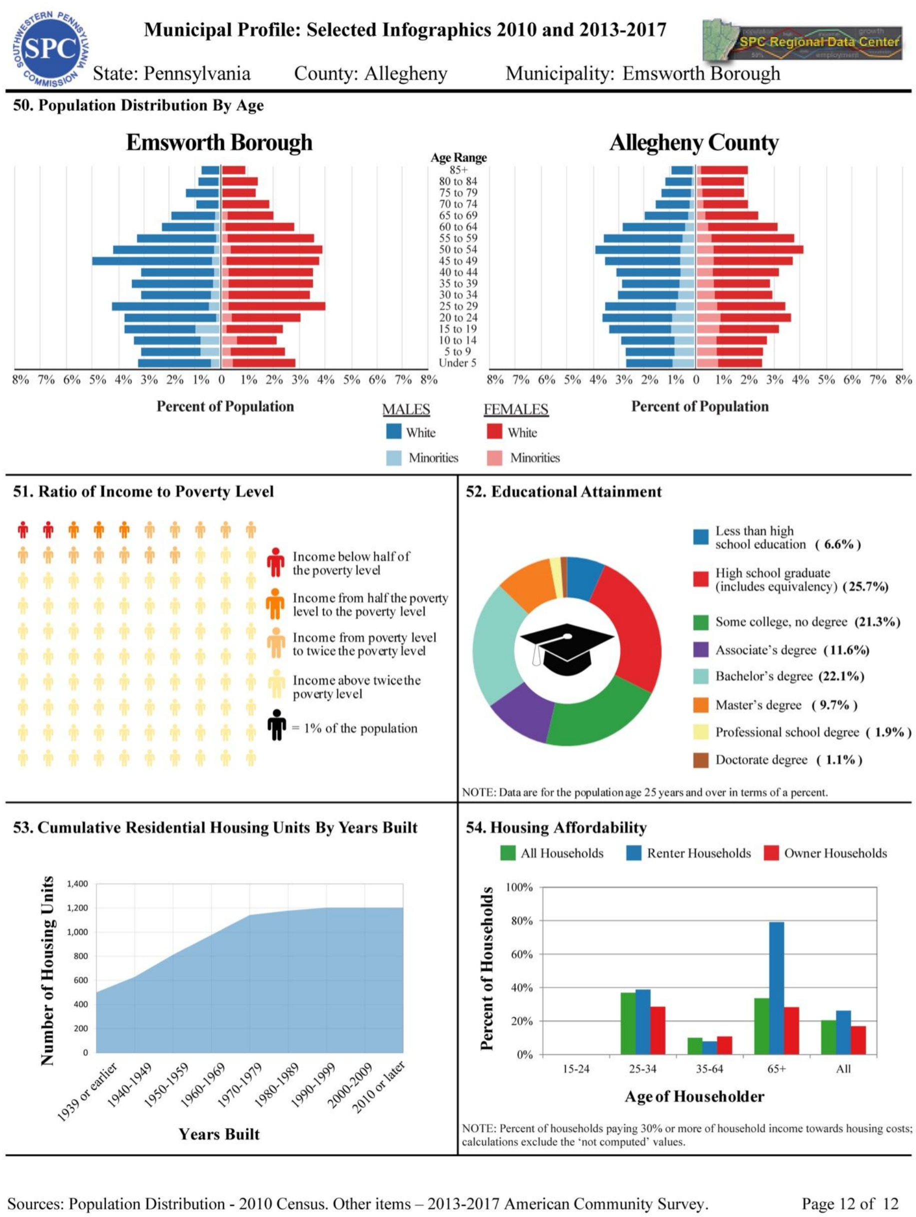
Ben Avon Borough

Ben Avon was incorporated as a Borough in 1892, splitting off from Kilbuck Township. Along with Avalon, Ben Avon was originally settled as a summer retreat for wealthy merchants and industry executives from Pittsburgh's steel industry made accessible by commuter train service from the city as well as streetcar service.



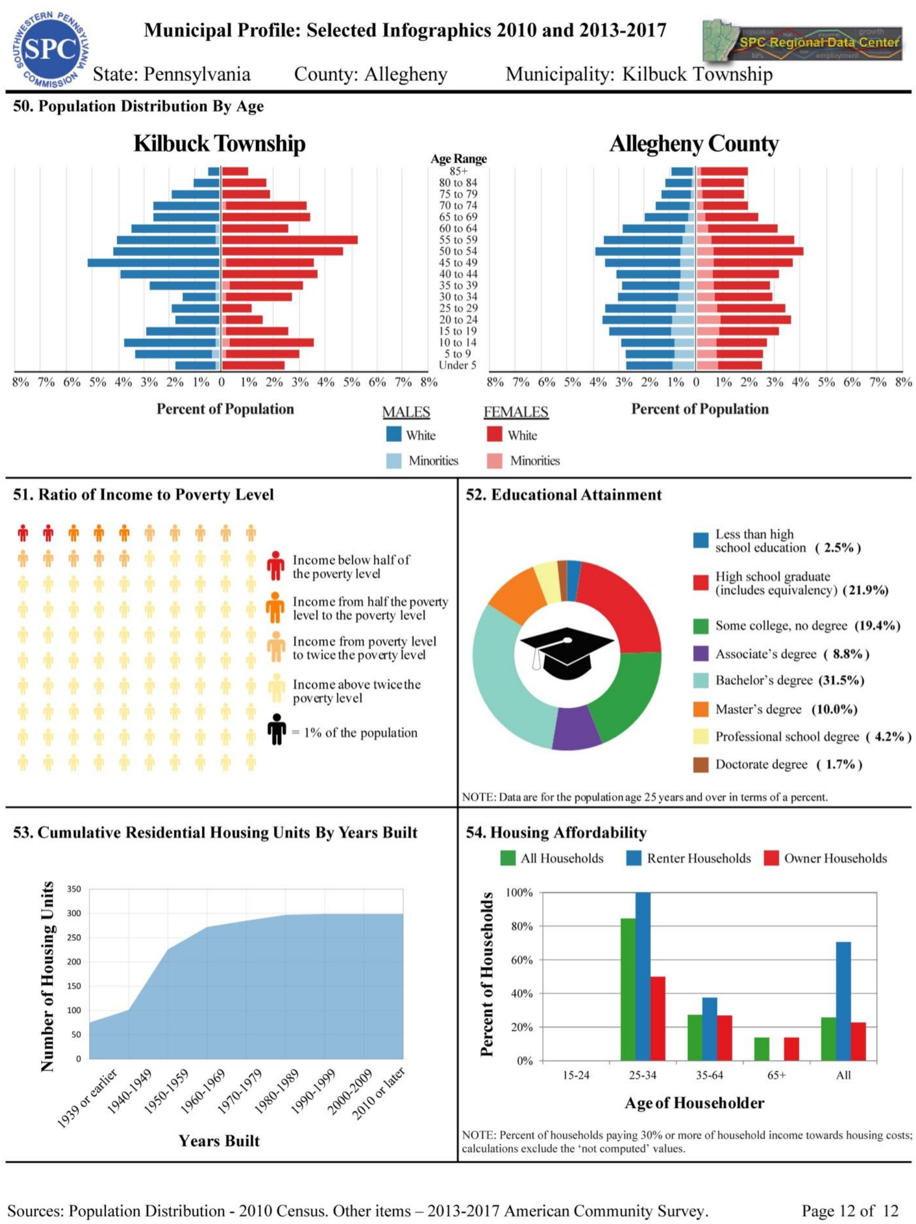
Emsworth Borough

Emsworth is a mixed-use suburb of Pittsburgh connected to Ben Avon, Avalon, and Belleview by Center Avenue, its main street. The Mackintosh Trail ran through Emsworth connecting Fort Pitt to Beaver, PA. The Borough was incorporated in 1896 shortly after Ben Avon. Camp Horne Road connects Emsworth to I-279.



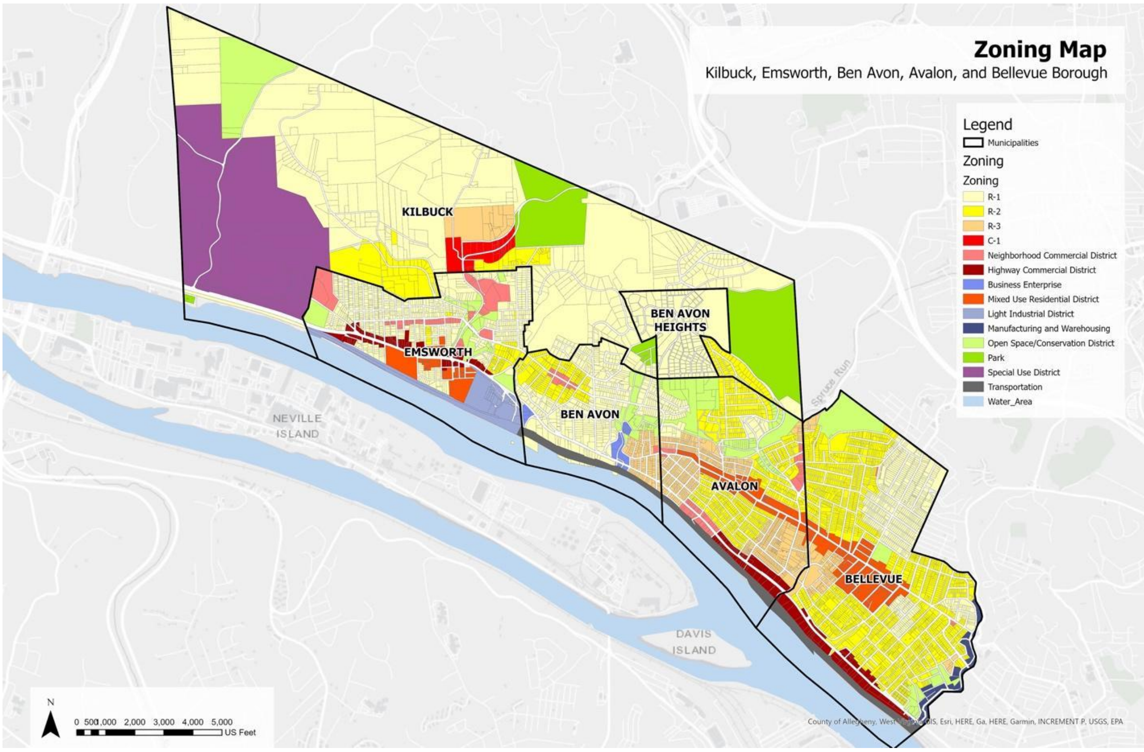
Kilbuck Township

Kilbuck Township, established in 1869, is a low-density suburb of Pittsburgh and is sparsely settled. Camp Horne Road, which follows Lowries Run from Emsworth to I-279 qualifies as the township's de facto main street due to its partial commercial zoning and adjacency to Ben Avon Heights. While large, Kilbuck's population is one of the least-dense municipalities within the Quaker Valley Council of Governments.

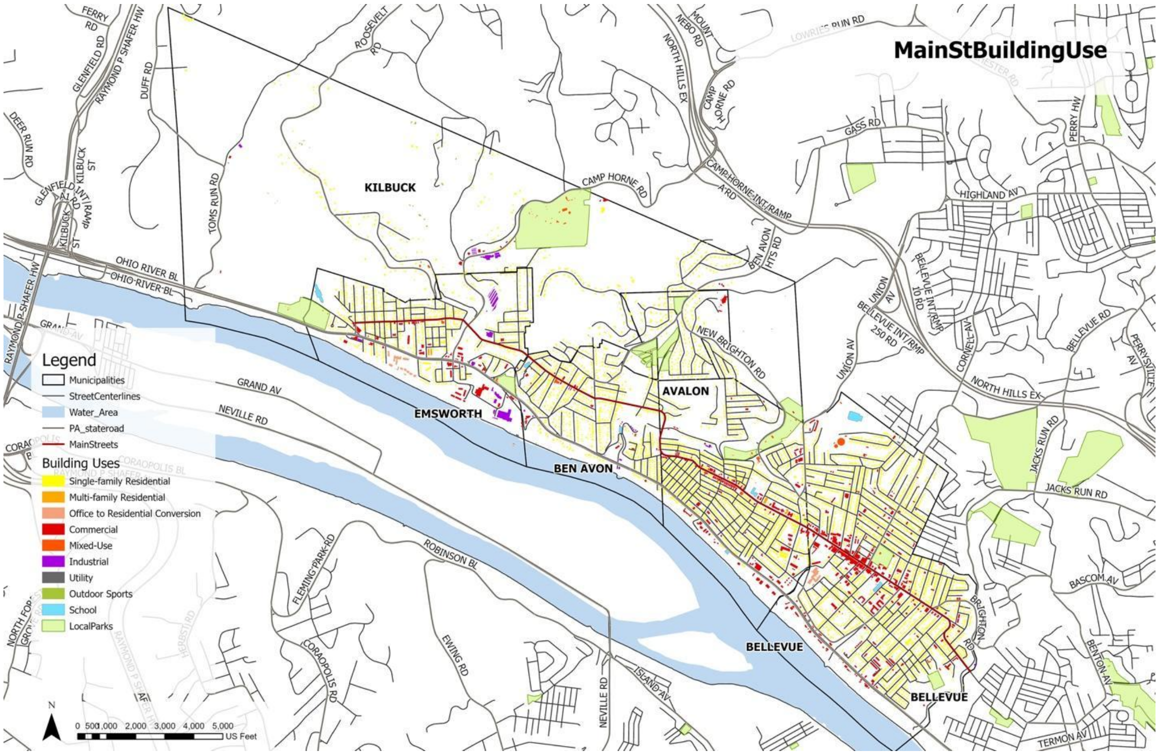


CASE STUDY AREA-WIDE DATA MAPS

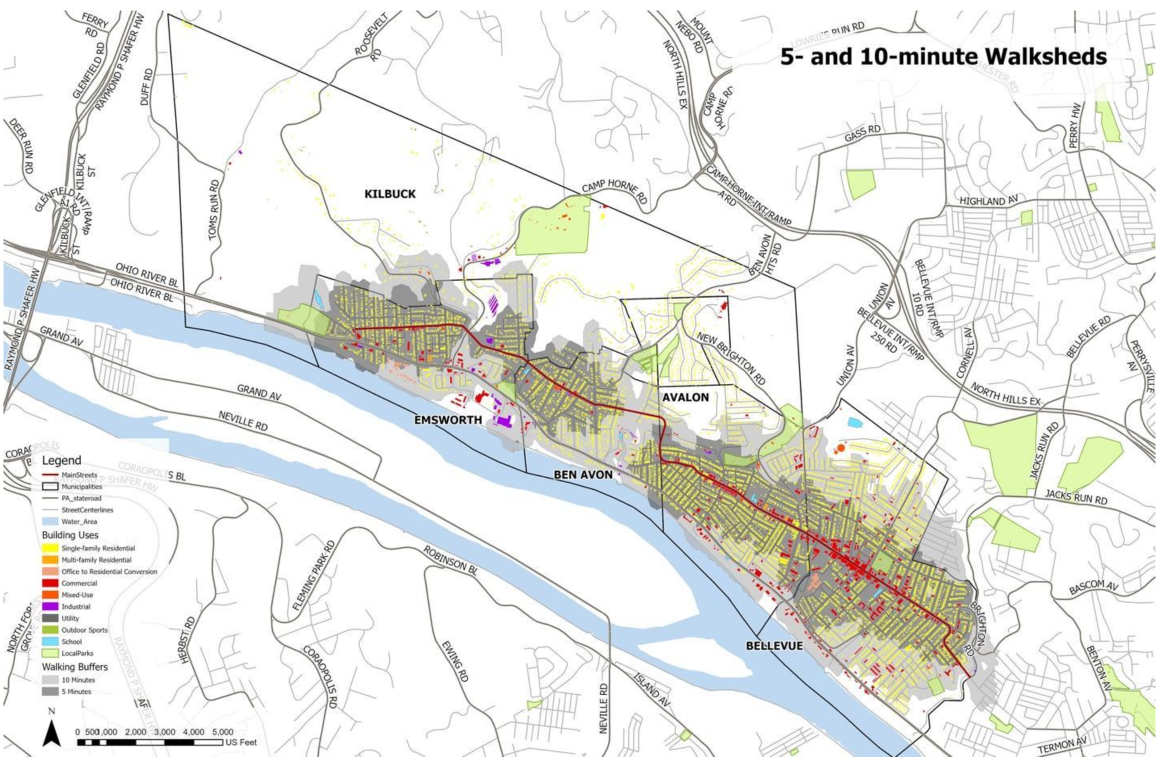
Zoning



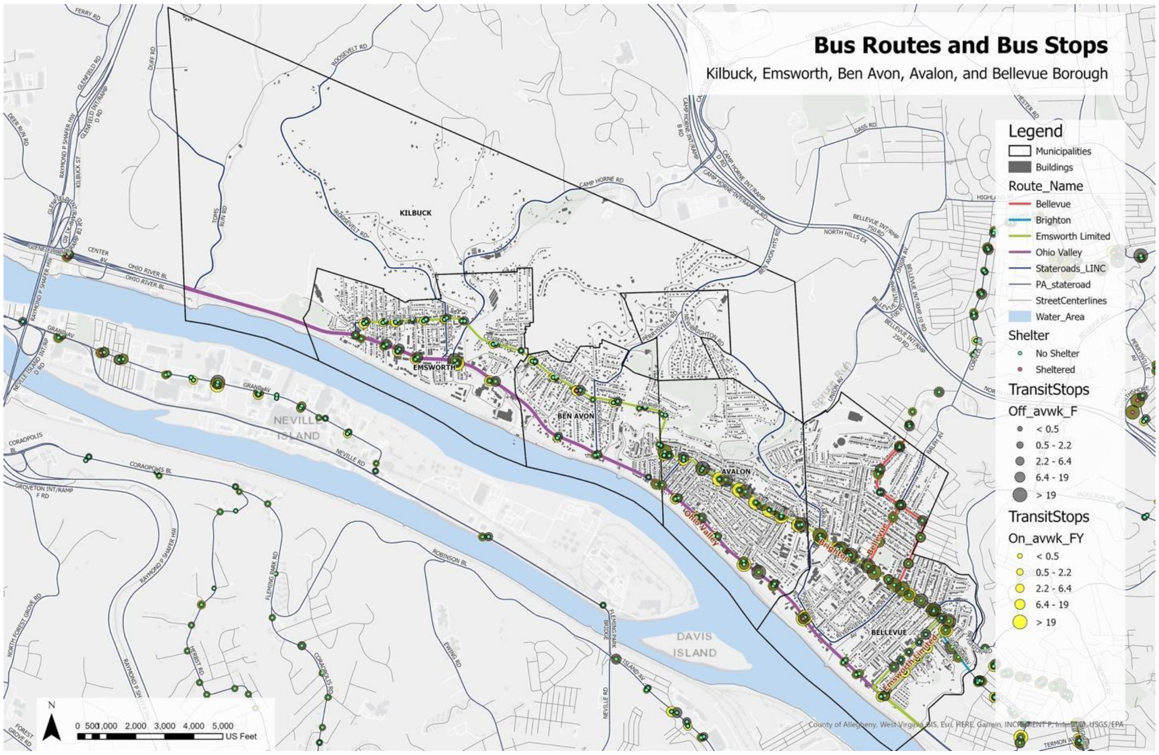
Main Street Building Use



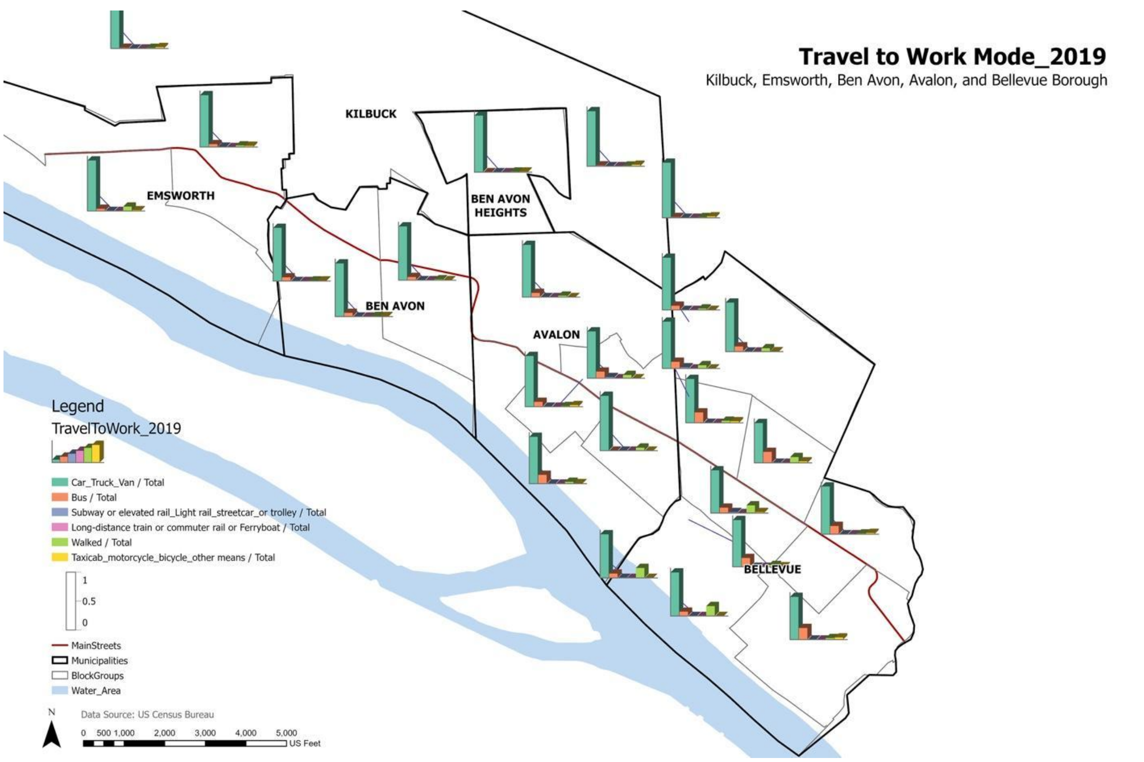
5-minute and 10-minute Walksheds from Main Street



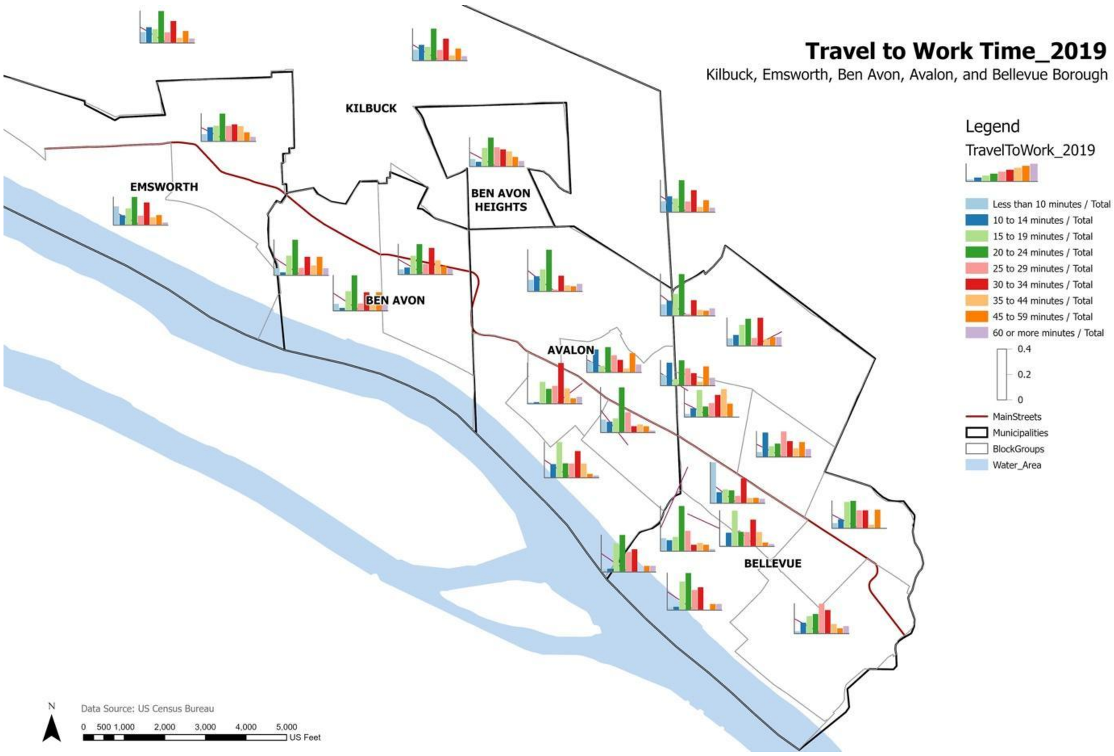
Bus Routes and Bus Stops



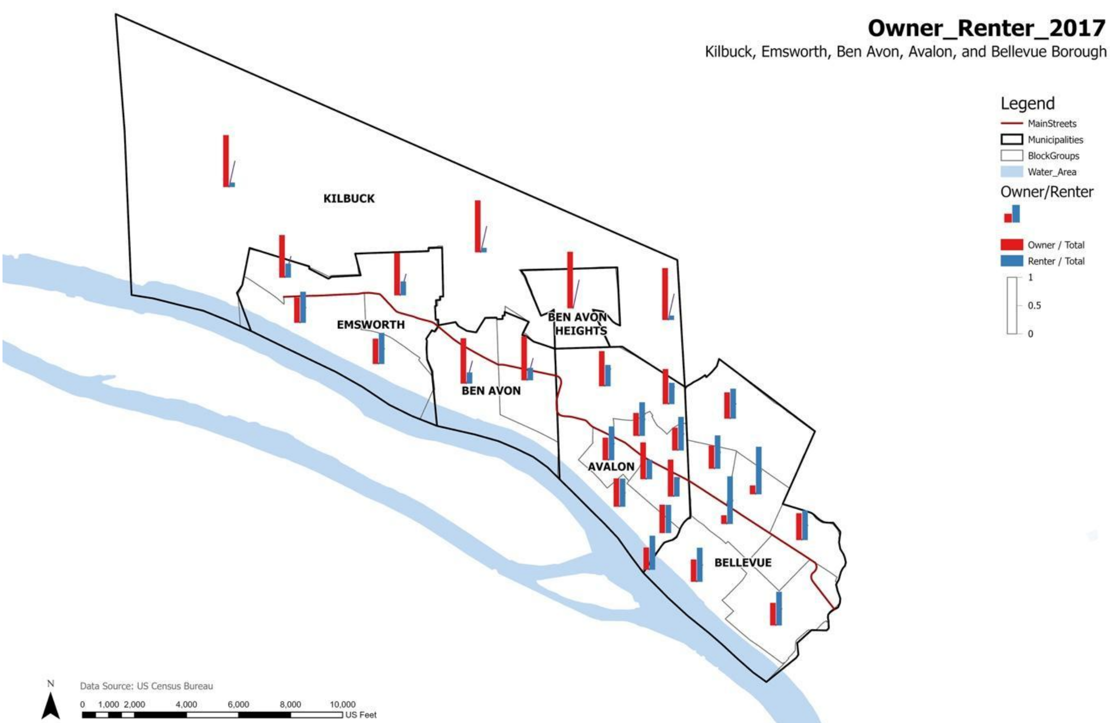
Travel to Work Mode



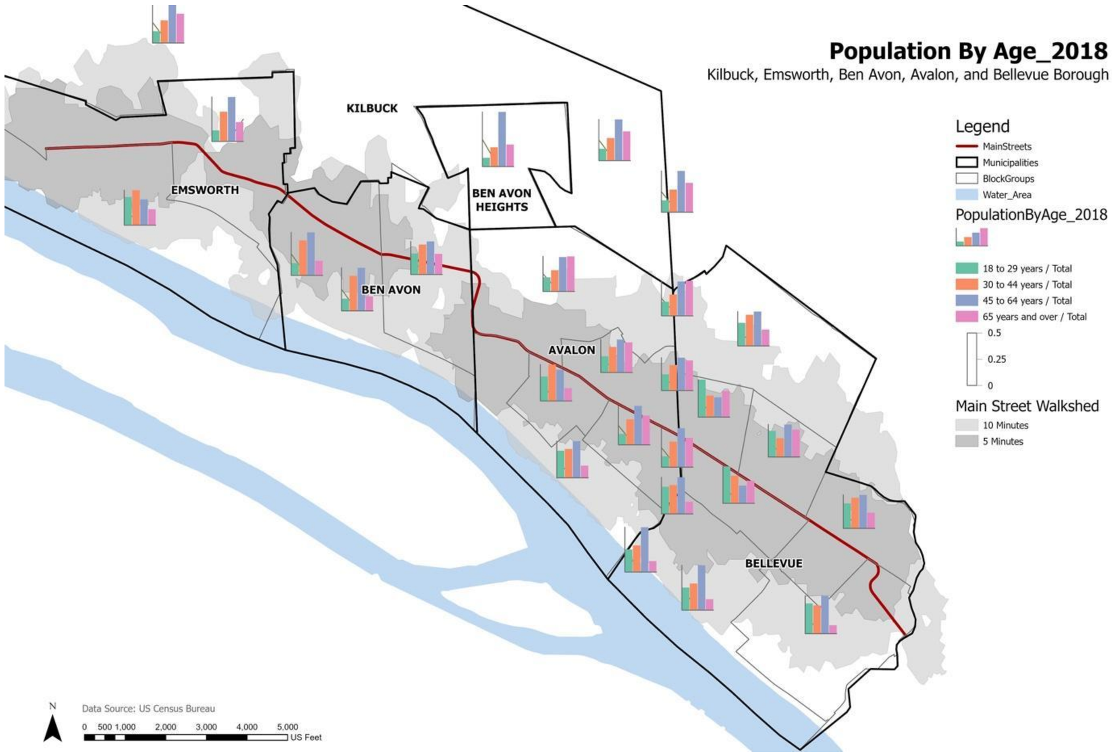
Travel to Work Time



Owner - Renter Profile

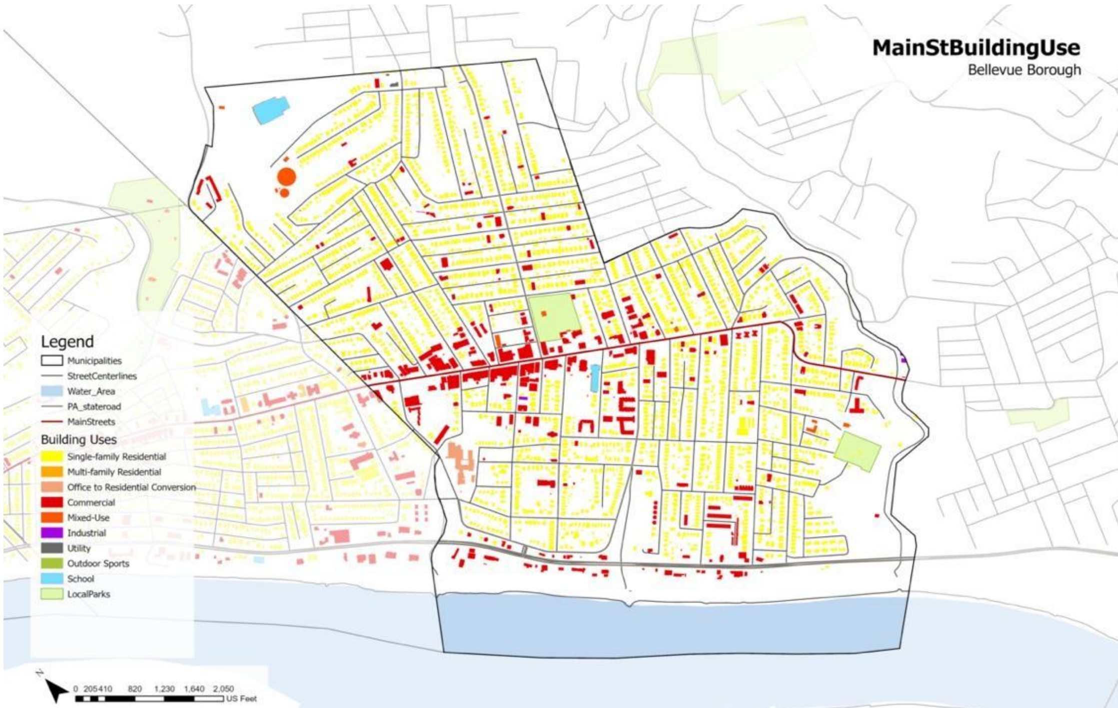


Adult Population by Age

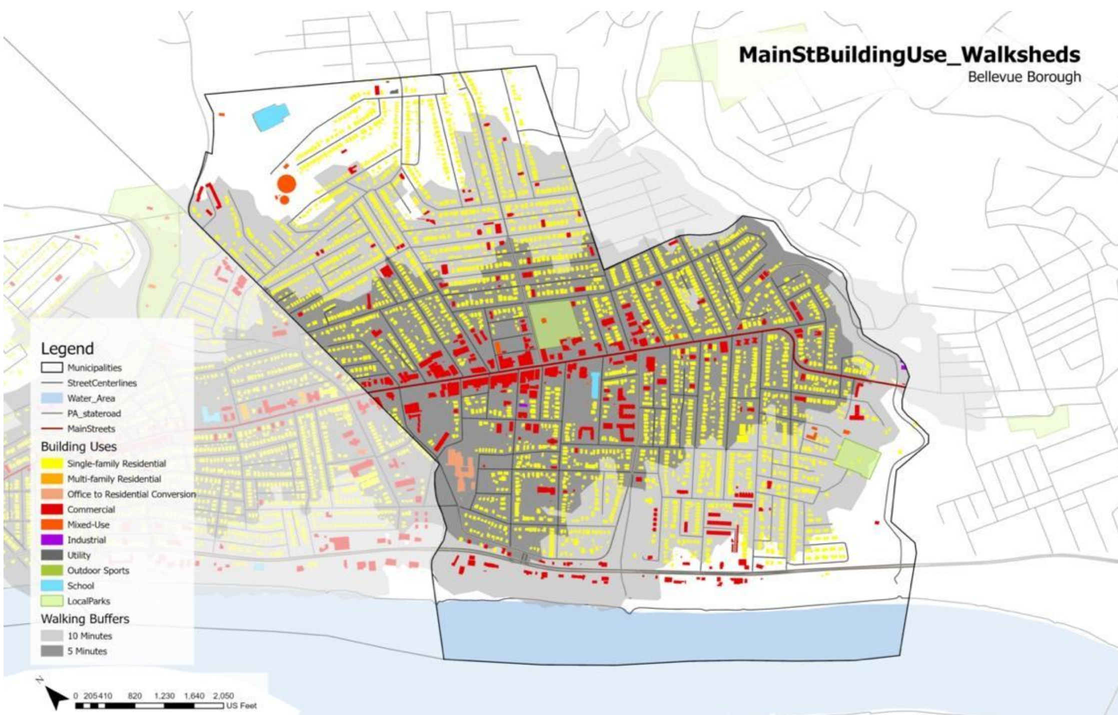


CASE STUDY MUNICIPALITY DATA MAPS

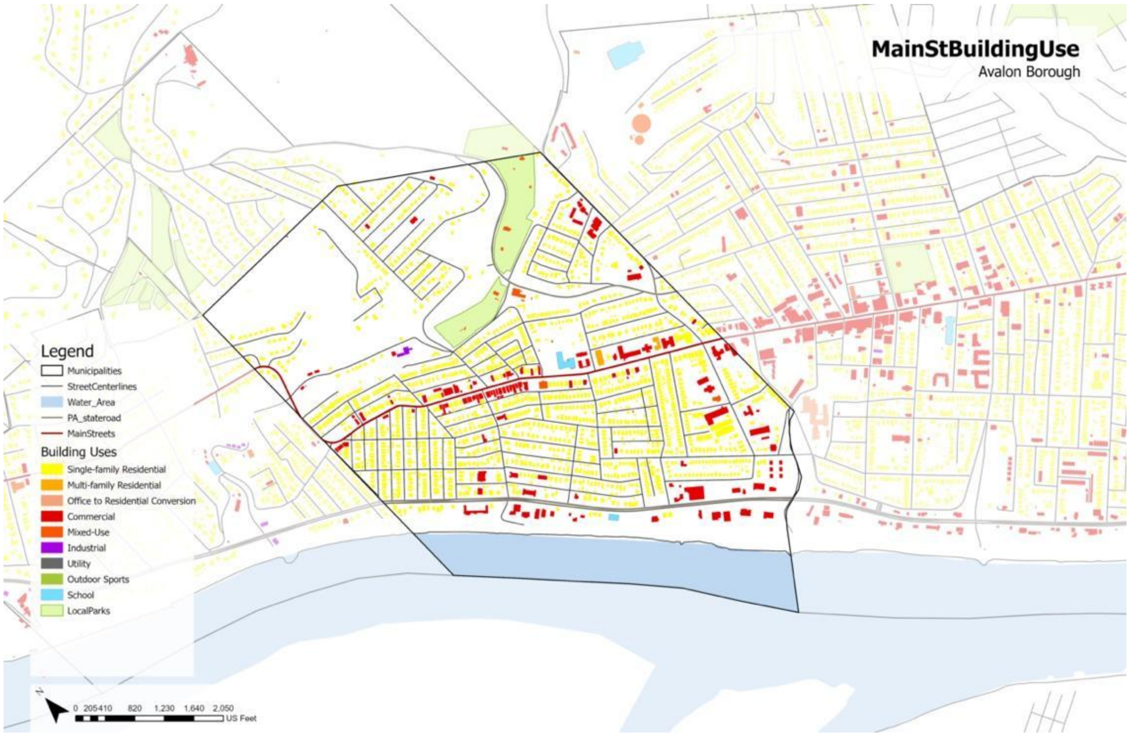
Bellevue Borough: Main Street Building Use



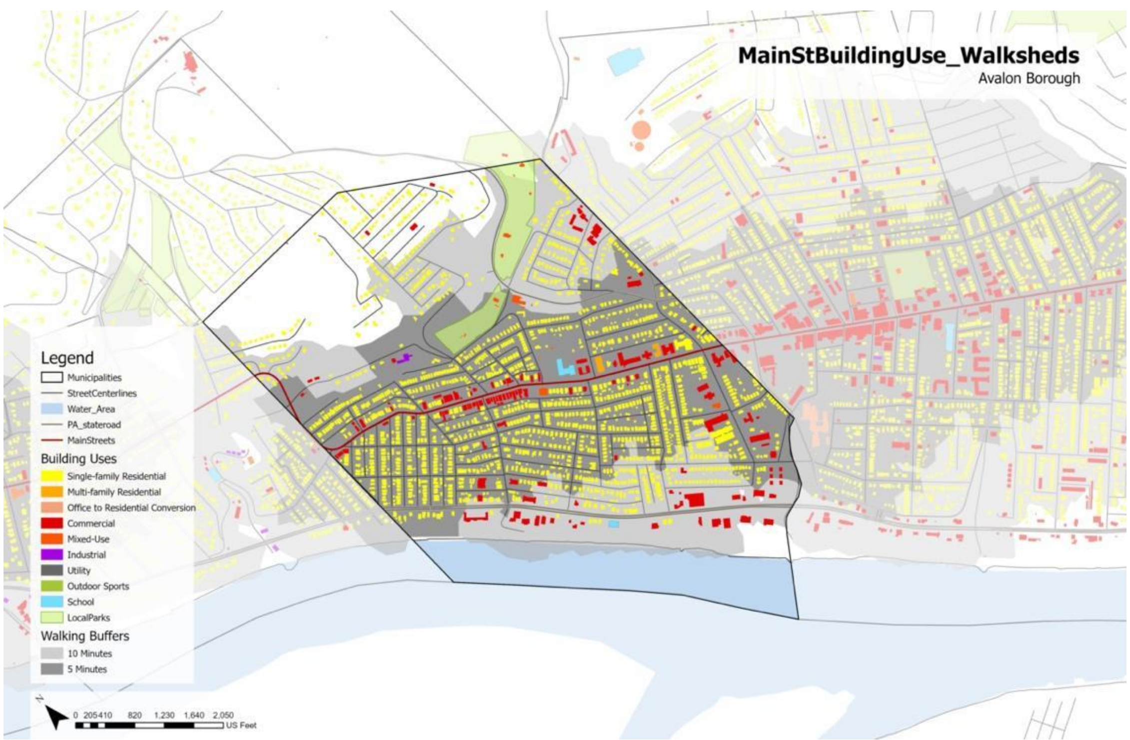
Bellevue Borough: 5-minute and 10-minute Walksheds from Main Street



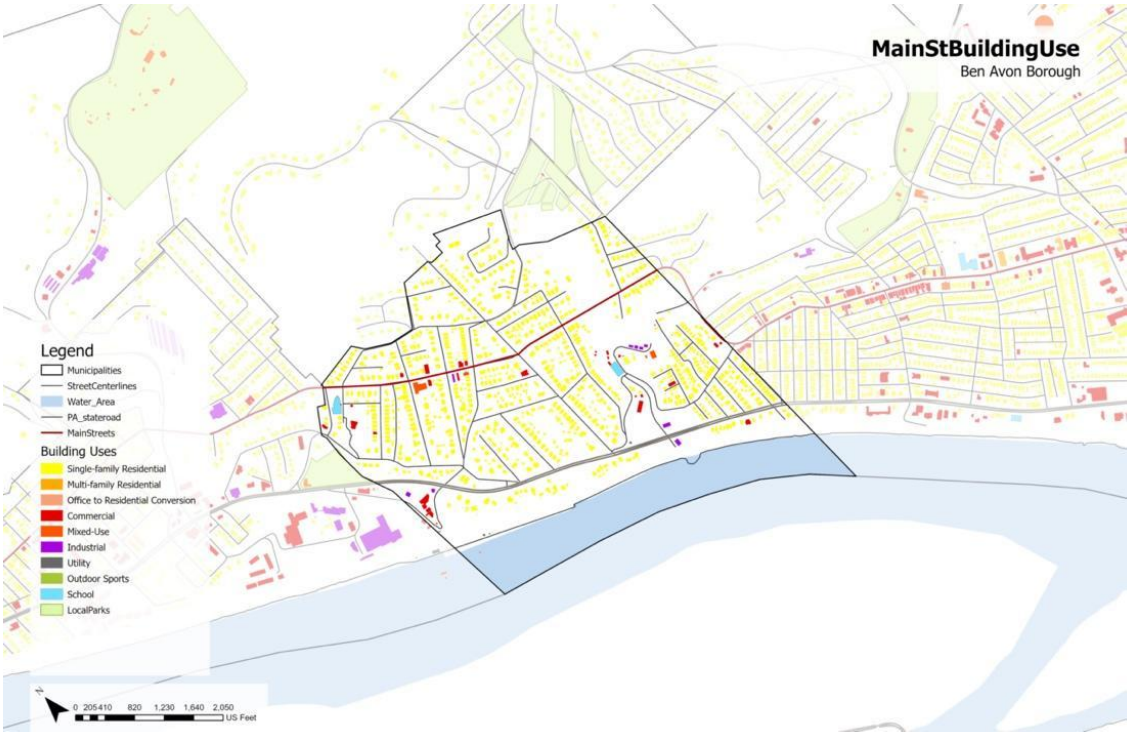
Avalon Borough: Main Street Building Use



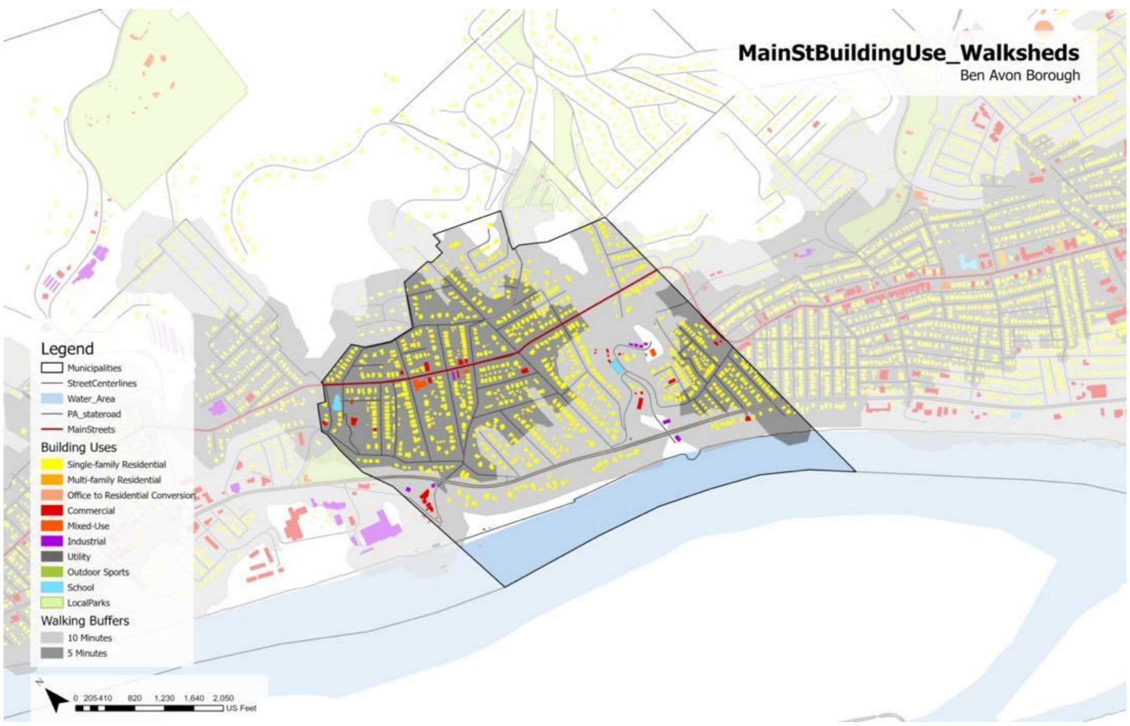
Avalon Borough: 5-minute and 10-minute Walksheds from Main Street



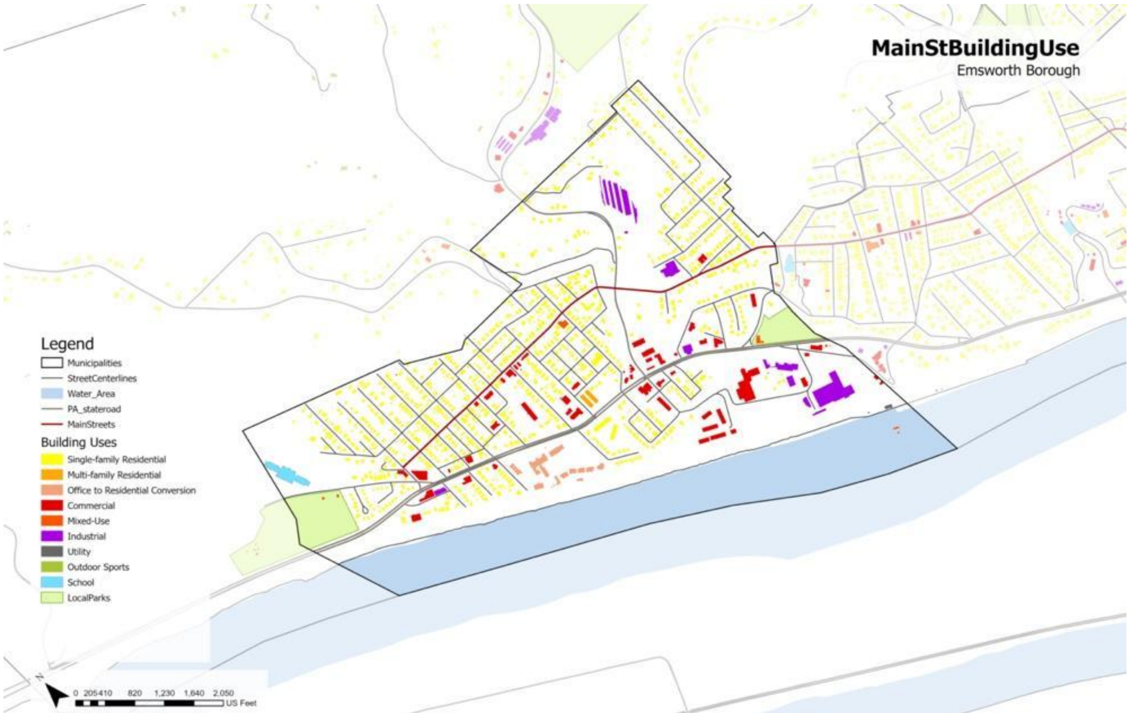
Ben Avon Borough: Main Street Building Use



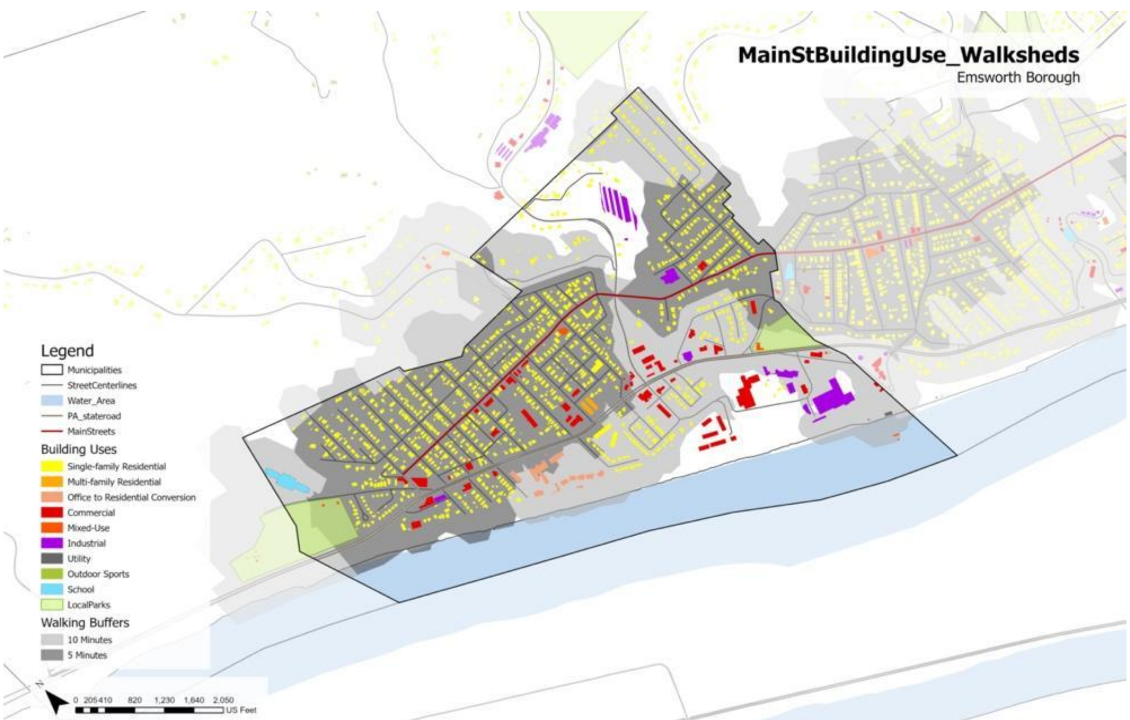
Ben Avon Borough: 5-minute and 10-minute Walksheds from Main Street



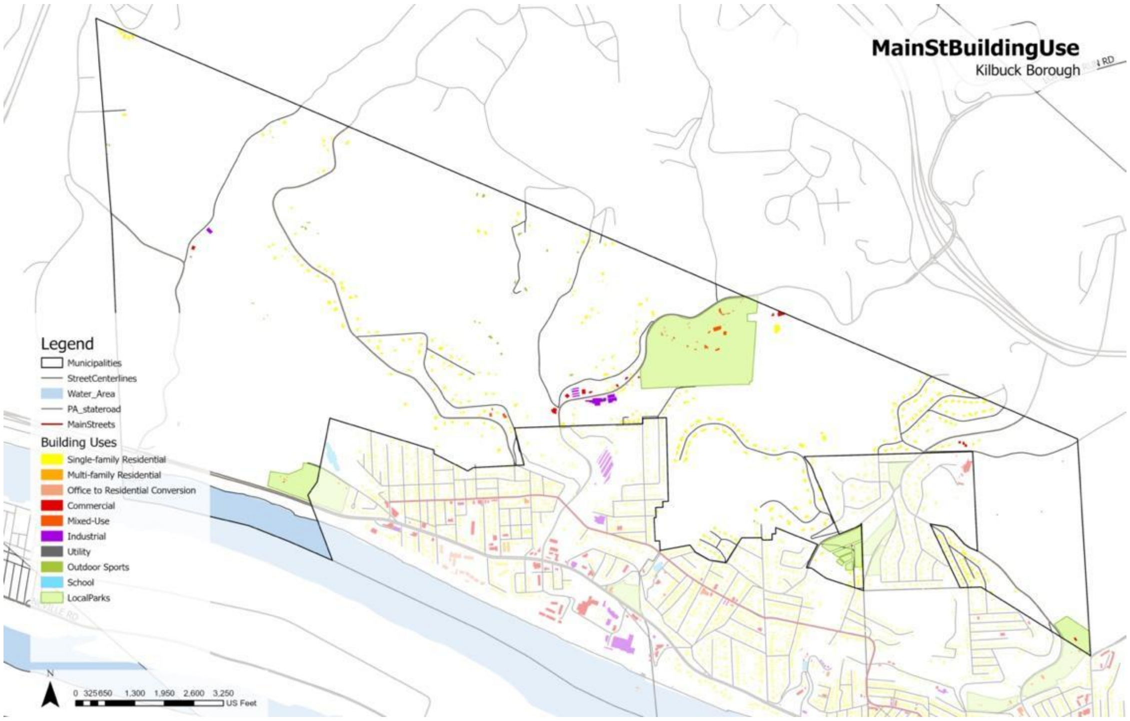
Emsworth Borough: Main Street Building Use



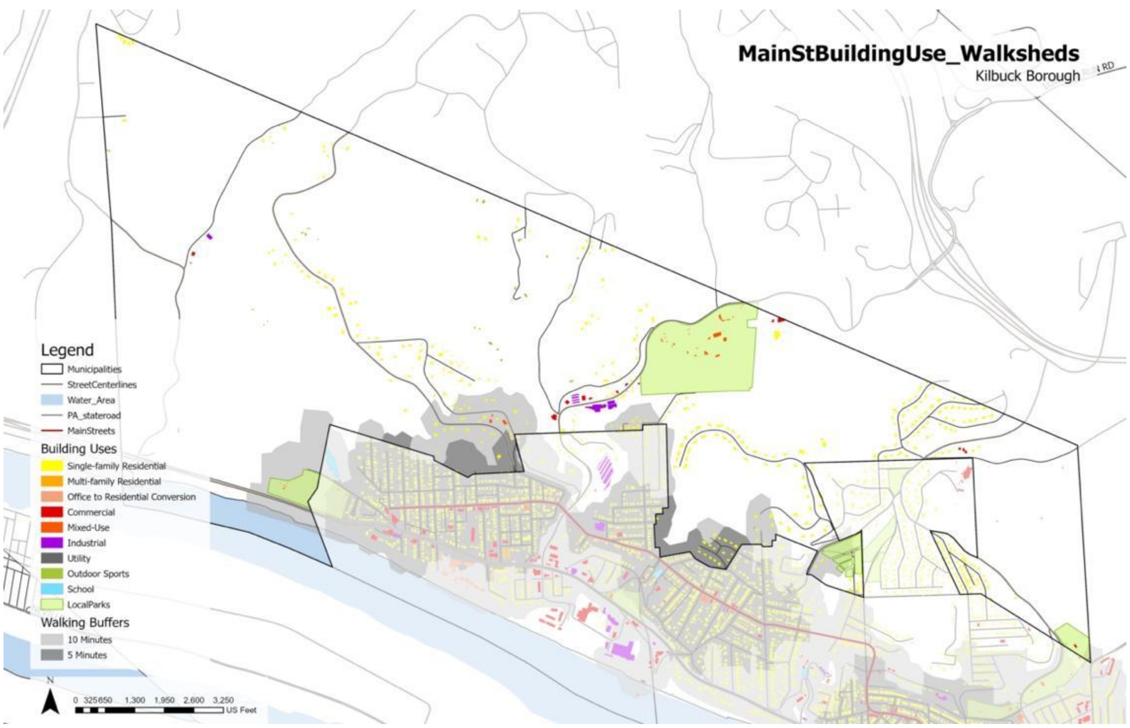
Emsworth Borough: 5-minute and 10-minute Walksheds from Main Street



Kilbuck Township: Main Street Building Use



Kilbuck Township: 5-minute and 10-minute Walksheds from Main Street



CLASSIFYING MICROMOBILITY VEHICLES

This vehicle type and field is evolving with new vehicle types introduced on a frequent basis. There are several ways to classify these devices:

Use Type

- Personal
- Shared
- Autonomous

Vehicle Type

- Bicycles
    - Human-powered
        - Pedal bicycles
        - Unicycles
    - Motorized
        - Pedal-assisted bicycles (pedelec)
        - Powered bicycles (e-bicycles, e-bikes)
        - Powered unicycles
- Scooters
    - Human-powered
        - Standing foot-operated “kick” scooters
    - Motorized
        - Powered standing scooters (e-scooters)
        - Small, seated scooters
        - Large, seated scooters
        - Mopeds
- Skateboards and Skates
    - Human-powered
        - Foot-operated skateboards
        - In-line roller blades
    - Motorized
        - Powered skateboards (e-skateboards)
        - Powered skates
        - Hoverboards
        - Mini Segways
        - Large Segways
- Autonomous Robots
    - Motorized
        - Powered personal delivery devices (PPD)
- Automobiles
    - Mini
    - Compact
    - Sedan
    - SUV
    - 9-10 passenger SUV

- Delivery Vehicles
    - Motorized
        - Small vans
        - Vans
        - 2-axle trucks
- Circulators
    - Motorized
        - Vans
        - Buses

Vehicle Characteristics

- Number of wheels
- Human- or motorized-powered
- Throttle or no throttle
- Weight limits
- Speed limits

Permitted Operating Locations

- Sidewalks
- Non-commercial sidewalks
- Bike and Bike(+) lanes
- Paved multi-use paths or trails
- Allowable roadways/streets

The City of Pittsburgh's Department of Mobility & Infrastructure issued an order under the City's Code of Ordinances titled, "Guidance for Powered Micromobility Device Use in the City of Pittsburgh," that offers some reasonable guidelines for classification based on Device Characteristics (top operating speed, weight, and throttle or no-throttle), Permitted Operating Locations, and Prohibited Operating Locations, and Age. The guidelines also include safety and courtesy rules, such as yielding to pedestrians, must give an audible signal to pedestrians when passing, maximum speeds not to exceed posted limits, etc. The Device Characteristics and Age were further categorized as follows:

(Note that a pedestrian strolls at 2-3 mph, walks at 3-4 mph, and walks fast at 5-6 mph)

Type A	Speed:	< 10 mph top operating speed (sidewalks)
	Weight:	< 45 lbs.
	Throttle:	No throttle
	Age:	< 16 yrs. old; < 12 yrs. old helmet required)
Type B	Speed:	< 20 mph (bike lanes), < 15 mph (paths and trails)
	Weight:	< 100 lbs.
	Throttle:	May have throttle
	Age:	< 16 yrs. old; < 12 yrs. old helmet required

Type C	Speed:	20-25 mph (roadways)
	Weight:	100-200 lbs.
	Throttle:	May have throttle
	Age:	> 16 yrs. old

Guidelines from sources depend more on speed than other factors:

Slow	Speed:	< 10-12 mph (16-19 kph)
Moderate	Speed:	< 16 mph (25 kph)
Fastest	Speed:	< 28 mph (45 kph)

Autonomous robotic devices depend more on weight than other factors, with maximum speeds for use on sidewalks:

Low	Weight:	100-200 lbs.
Moderate	Weight:	< 500-550 lbs.
Heavy	Weight:	1,000-1,100 lbs.
	Speed:	12-15 mph on sidewalks, up to 25 mph on roadways and shoulders

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