



Briometrix 'City on Wheels' Mobility Pilot

July – November 2020



City on Wheels 2020

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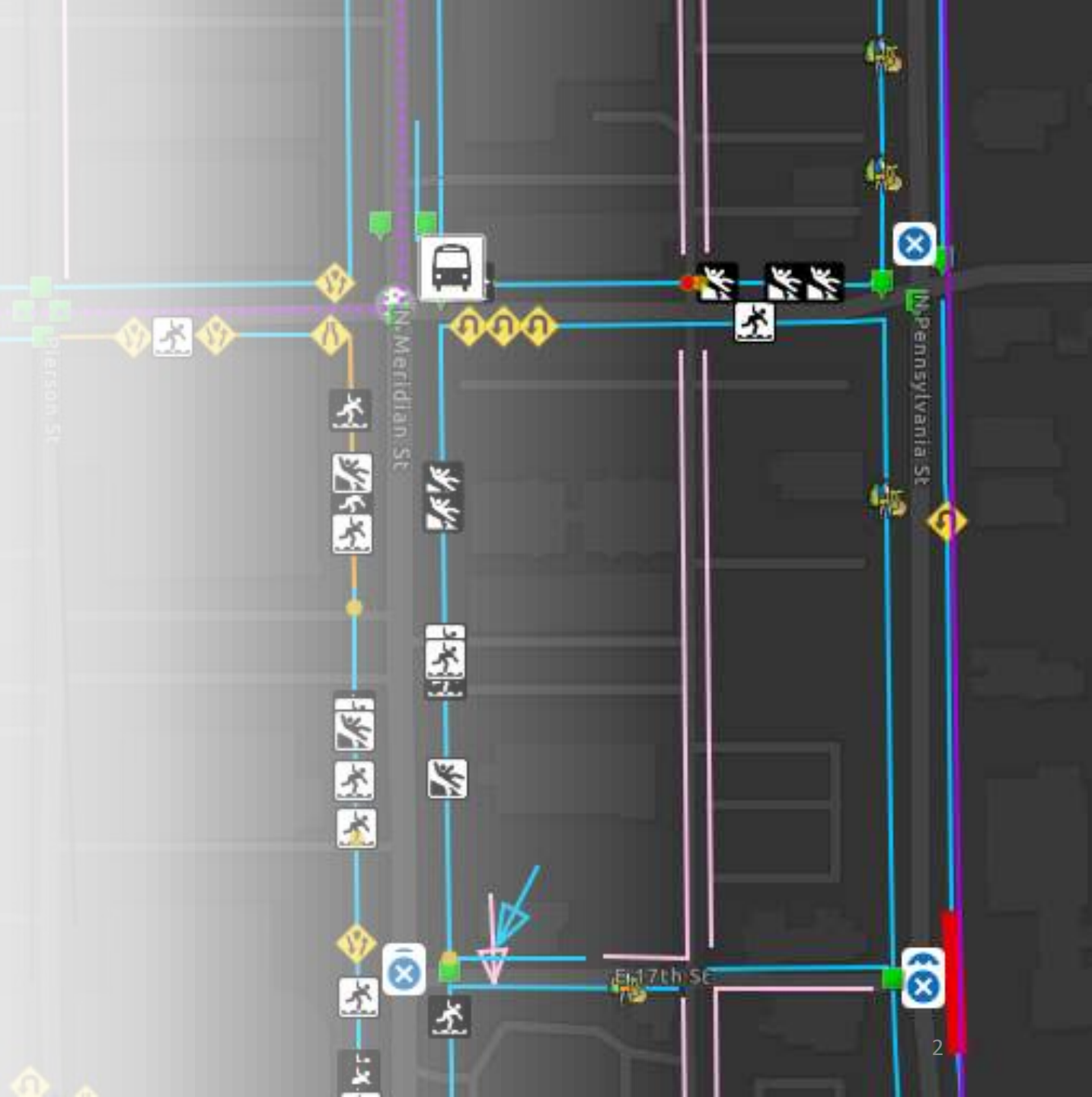
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Glossary



Indianapolis and Ford Motor Company City:One Challenge



In late 2019 IndyGo partnered with the Ford Motor Company for the Indianapolis, City:One Challenge. The program brought together Mobility focused companies to offer creative ideas to address the cities mobility issues. Over 120 detailed proposals were reviewed. Critical to each proposal were answering the following questions:

- How to increase reliable access to jobs, healthcare and education
- Support residents with disabilities and other challenges
- Create equity, inclusivity and community buy in for all community members
- Provide a case for economic value

Briometrix submitted a project that would provide sidewalk assessment for areas within a five-minute walk of selected Red Line or other stops approximate to critical areas such as medical facilities, education, retail and recreation. As a result of the assessment Briometrix would create a unique Effort Map that would assist riders with limited mobility, pushing a stroller or delivering a package in determining the most accessible route to a stop. The Effort Maps would be published on the IndyGo site and made available to the community.

Additional sidewalk assessment data would be provided to IndyGo for internal use in planning and to share with other city departments such as Engineering or Public Works. To perform the assessment Briometrix would utilize its proprietary mapping technology. Local wheelchair “Pilots” would be trained and paid by Briometrix.

Although not chosen as the winner of the competition IndyGo concluded that Briometrix functional assessment of sidewalks offered unique data sets and that the Effort Maps would be a valued support to community resource. As a result, Briometrix was offered the opportunity to provide A Pilot for the upcoming Purple Line. The Purple line would offer access to 134,000 jobs as well as to medical, educational, retail, and Recreational facilities and access to fixed route transit stops is critical.

A team consisting of representatives from IndyGo, Public Works and City Strategies (IndyGo Consultant) met in Indianapolis and reviewed the Purple Line corridor. It was determined that Briometrix assessment and mapping would focus on four areas leading to 12 stops along the Purple Line corridor with approximately 51 miles of sidewalks. The project was to begin in May of 2020 however due to COVID 19 the Project was delayed until September 2020.

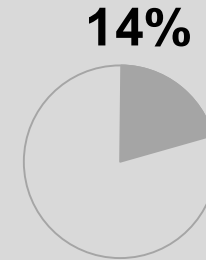
Accessible and inclusive transport is critical to allow everyone to move easily and provide the opportunity to participate

Inclusivity in every area and at all levels of government and society is critical to community. Those with impaired mobility, pushing a wheelchair or with assistive devices, as well as the aging population, are some of the most marginalized groups in our society. They deserve equal access to transportation that can deliver them to employment, health, education, recreation and culture.

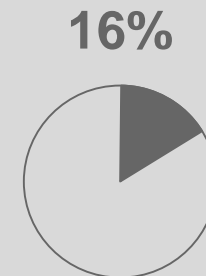
The main principle of universal design and planning is centered around designing systems or products for the 'edge' users, those that will recognize the most benefit from something that is designed specifically with them in mind. If we get it right for them, then the majority also benefit. By addressing the 'edge' user we make our society more universally accessible and usable to all including parents with strollers, tourists with luggage, people with temporary or situational impairments, as well as couriers and delivery services.

The Americans With Disabilities Act has been in existence for 30 years. Among thousands of regulations, it mandates specifications for sidewalks, ramps and bus stop. IndyGo has made significant and commendable progress in assessing ADA compliance including a plan moving forward to increase accessible stops.

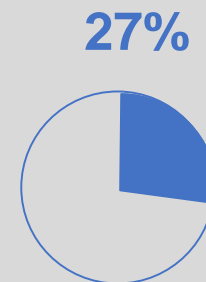
IndyGo understands that ADA compliant stops and busses are important. However, **according to the FTA the biggest challenges to using fixed route is the inaccessibility or nonexistence of sidewalks and pedestrian infrastructure.** A walking radius from a bus stop is universally considered to be ¼ mile, thus conditions for sidewalks within that distance are critical in getting people to transportation, especially for the mobility impaired. A lack of traversable sidewalks or other infrastructure problems can create "island stops" with limited access.



67,000
Approximate number of people with disabilities in Indianapolis



117,000
Approximate number of people 65 and older in Indianapolis



661 of 2,571
Number of ADA compliant bus stops after completion of Purple Line, 2023

Making the public transport system more accessible and inclusive is critical to delivering a better whole of journey experience

Permanent Temporary Situational

Touch



One arm



Arm injury



New parent

See



Blind



Cataract



Distracted driver

Hear



Deaf



Ear infection



Bartender

Speak



Non-verbal



Laryngitis



Heavy accent

Implications of not catering to the mobility requirements of people with disabilities are heightened in regional areas due to factors such as extra distance or infrastructure problems combined with a lack of alternative routes.

Addressing physical barriers to stops by creating a more accessible and inclusive environment has a number of positive implications. Importantly, **improved access makes people feel more comfortable using public transport enabling them to make new trips or making their current journeys easier and quicker.** Access for all will also increase the appeal of Indianapolis as an accessible destination.

Not addressing the needs of this community segment can:

- Have negative implications for **mental health**. Uncertain conditions can trigger stress and anxiety, especially when travelling somewhere new.
- Add **extra time** to journeys to accommodate for uncertainty and ensure there is enough time to find an alternative should it be required.
- End to end journeys are **difficult to plan**, especially where a journey requires trips on multiple modes or having to connect by walking or rolling from point to point.
- Where accessibility is not appropriately catered for potential customers, they will **look to other more expensive but convenient modes such as paratransit, rideshare, taxi.**

The diagram on the right clearly articulates the expanded population size when taking into account how a type of disability can easily be accounted for in temporary and situational circumstances.

When we take into account the implications of not designing a whole of journey approach that supports the needs of people with disabilities and factor in the expanded population base, it strengthens the business case for universal design of our networks and surrounds.

Source:

- The Persona Spectrum, Inclusive Toolkit, Microsoft.

Using Briometrix’s mapping technology and locally trained pilots, surveying was completed to determine the effort rating for sidewalks

Principles of effort

Effort refers to how much work you are putting into something.

In **mechanical terms** effort is how much force you need to apply to move something

- It takes more effort to move a wheelchair 100 metres up a hill than 100 metres on the flat.
- It takes less effort to push a wheelchair on tiles than on carpet.

In **human terms** effort is the feeling of the level of exertion

- It takes everything I’ve got to get my wheelchair up that ramp.
- It is really easy to push along the beachfront in the morning, but the wind can make it a bit of an effort in the afternoon.

Walking uses the most powerful muscles in the body, while wheeling uses the relatively small chest, shoulder, and arm muscles. A person in a wheelchair is putting in more effort than a person walking.

Wheelchair users as Lead Users for transport

People who use wheelchairs are a Lead User¹ segment for transport services. Lead Users require solutions that are far ahead of the rest of the market. Concentrating on product and service development for the needs of wheelchair users can be a catalyst for breakthrough innovations and fundamental industry advances..

1. Lead User: See https://d-labs.com/en/blog/what_are_lead_users_.html

Calculation of effort

To maintain a walking speed of 6 km/h, a Pilot weighing 78 kg in a wheelchair with luggage weighing 12 kg must be able to produce the forces and power outputs shown in the following table. The Briometrix Effort Rating system is graded for the maximum recommended repetitive push force from shoulders and arms for females.

Rating	Colour	Typical Slope %	Typical Force transitions	Surface	Cross Slope
Caution	Black	Steep descends		Rough loose surface e.g. cobblestone  Smooth hard surfaces e.g. Tiles 	>4%
Very Difficult	Red	Over 8	70		>1%
Tough	Orange	5-8	45		
Moderate	Yellow	3-5	30		
Easy	Green	0-3	0		

Comfort Rating

Vibration has a negative health impact on those in wheelchairs. The type of surface has a significant effect on Effort and Comfort. Smooth surfaces such as polished concrete and tiles offer significantly more comfortable and less rolling resistance than clay pavers and exposed aggregate.

Surface Type	Rating
Tiles	Comfortable
Asphalt	
Concrete	Functional
Paver	Usable
Cobblestones	
Sand	Unusable



Briometrix Project Brief

This section summarizes the project timelines and presents the Briometrix/IndyGo Pilots



Bus stop involved in the mapping survey



WITHIN WALKING DISTANCE

JOB: 134,603

PEOPLE: 58,470

MINORITY POPULATION: 61.6%

LOW-INCOME POPULATION: 30.3%

Timetable: City On Wheels Pilot Project

Phase 1, January – March 2020 / Research, Planning Project Management

In discussion with Lauren Day and IndyGo representative a proposal focusing on the Purple Line was developed and signed off on by IndyGo and Briometrix. In January remote research of the Purple Line was begun by both Briometrix and the IndyGo team with high value areas such as medical, educational and government facilities being considered for access. In February a Briometrix representative traveled to Indianapolis to meet with the IndyGo team consisting of representatives from IndyGo, Public Works and City Strategies Group to perform a hands on review of the Purple Line corridor and make a final determination as to priority areas.

After a thorough inspection of the route by the team and input from Inez Evans, President and CEO of IndyGo, it was determined that four areas along the route with approximately 51 miles of sidewalk and 12 stops, (Including the Julia M. Carson Transit Center) would be assessed.

Phase 2, March – May / Mapping Project Set Up

It was determined that the project would take place in May 2020. Briometrix initiated contact with IndyGo GIS mapping and infrastructure personal and began a review of relevant transport data and maps. MOU's and other agreements between Briometrix, IndyGo, Easter Seals and supporting agencies were agreed to and signed.

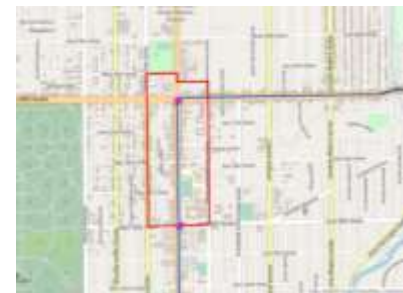
As part of the IndyGo agreement a portion of the funds paid to Briometrix were to be earmarked for technology development. Detailed information on the development can be found on slides 32 - 33.

Phase 3, August – September / Execute Pilot Mapping

Due to COVID 19 the assessment was set back until September. With significant help from Easter Seals and IndyGo/City Strategies Group Briometrix was able to recruit and employ wheelchair Pilots. On September 15th Pilot training took place at the Julia M. Carson Transit Center. Pilots were instructed on the use of the data recorder, video camera and tablet. In the upcoming weeks weather conditions were favorable and Briometrix Pilots were able to complete over 60 miles of assessment by September 27th. In addition 12 of the newly constructed stops were analyzed. See slide 25 Due to dropped satellite signals or building interference portions of the route were re-mapped in November.

Phase 4, October - December / Data Processing and Map Creation

Processing of data recorder, video camera and tablet data with feedback from the Pilots. Data and maps ready to hand over post final meeting and sign off with IndyGo project team.



Indianapolis Pilots Mapping Team

Each wheelchair is equipped with Wheelchair Motion Data recorder, video camera, and tablet, all with geocoding capabilities.

Aside from navigating routes the Pilots enter information, take photos of hazards and can add commentary on tablet.

Link to a day in the life: [WISH-TV News Story](#)

Brandon Somerville
Field Leader
Crawfordsville, IN



Cory Mick
Louisville, KY



David Daniels
Indianapolis, IN



Matthew Ware
Indianapolis, IN



Brad Magill
Crawfordsville, IN



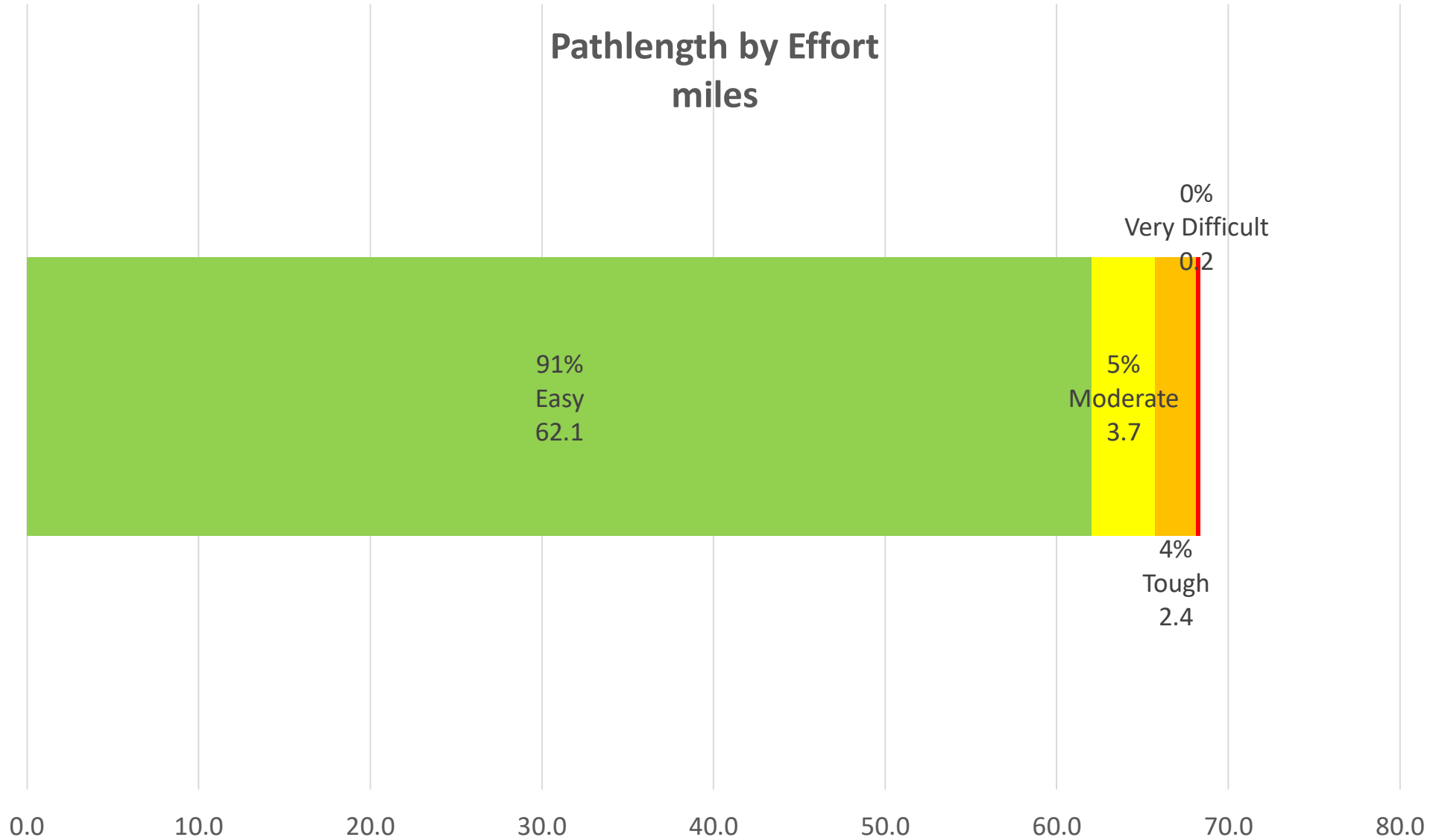
Scott Wade
Shelbyville, IN



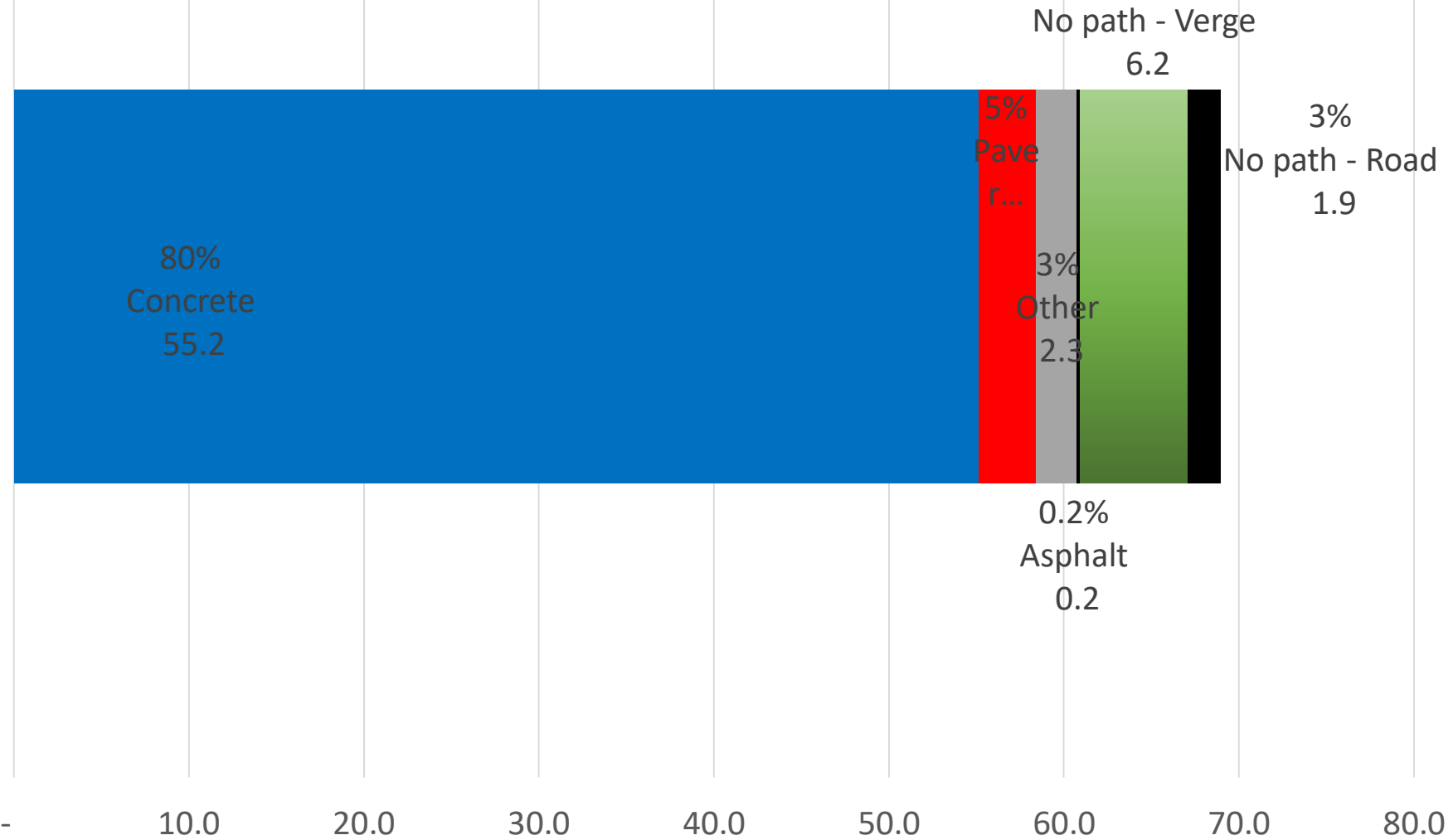
Briometrix Data Collection and Mapping Findings

This section summarizes findings from the data collection and provides examples of how data can be viewed

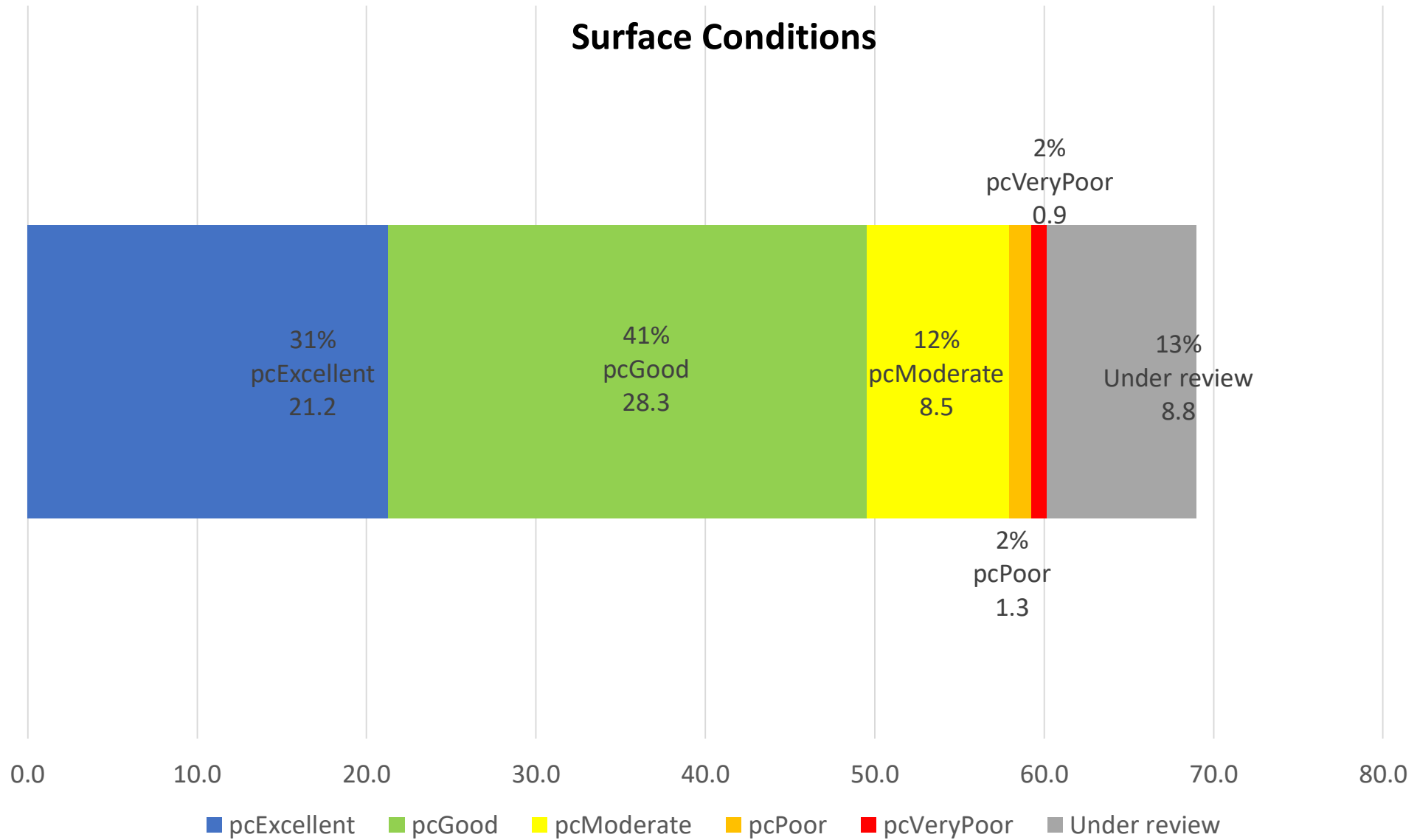
Pathlength by Effort miles



Surface Type

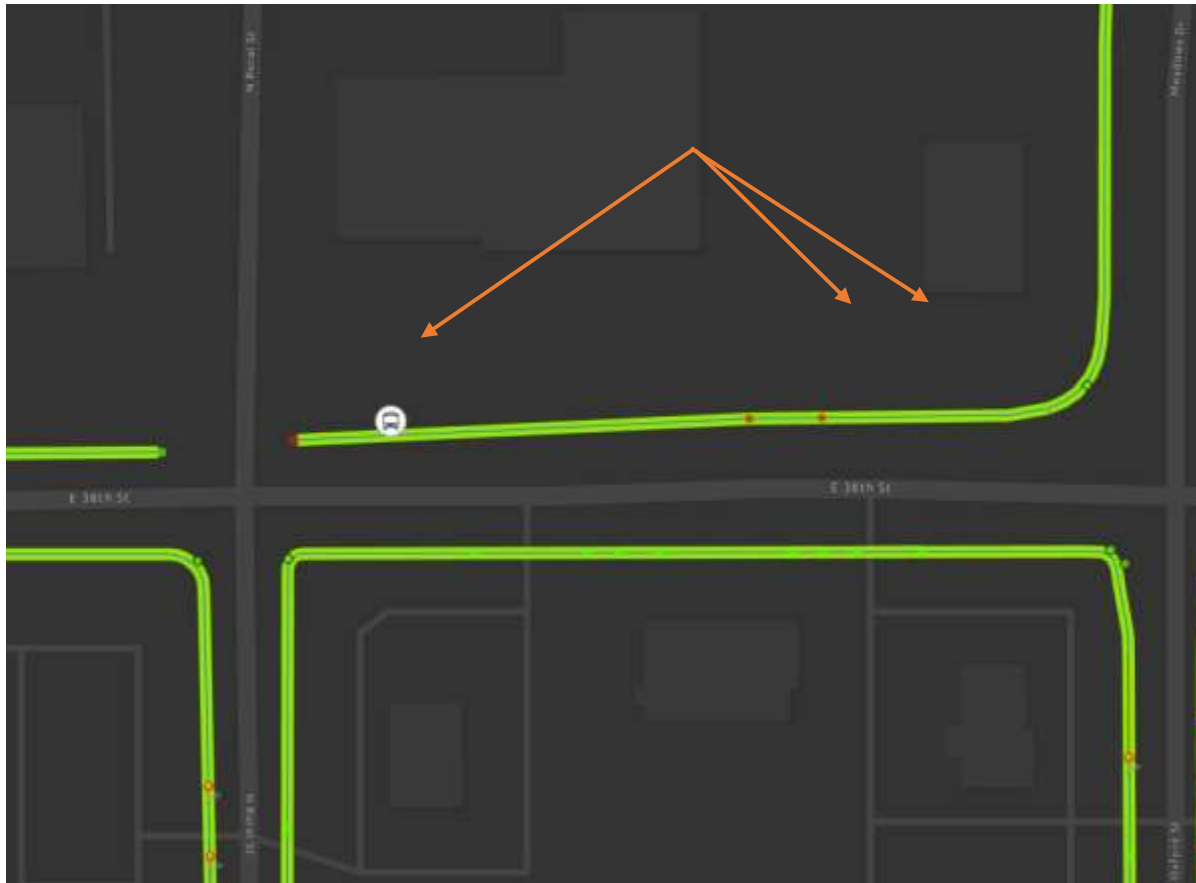


Surface Conditions



Example 1

Bus stop with **Curb Ramp Hazards** on either side



Poor alignment

- Direct wheelchair users onto main road

Bus stop with **Curb Ramp Hazards** on either side (east)



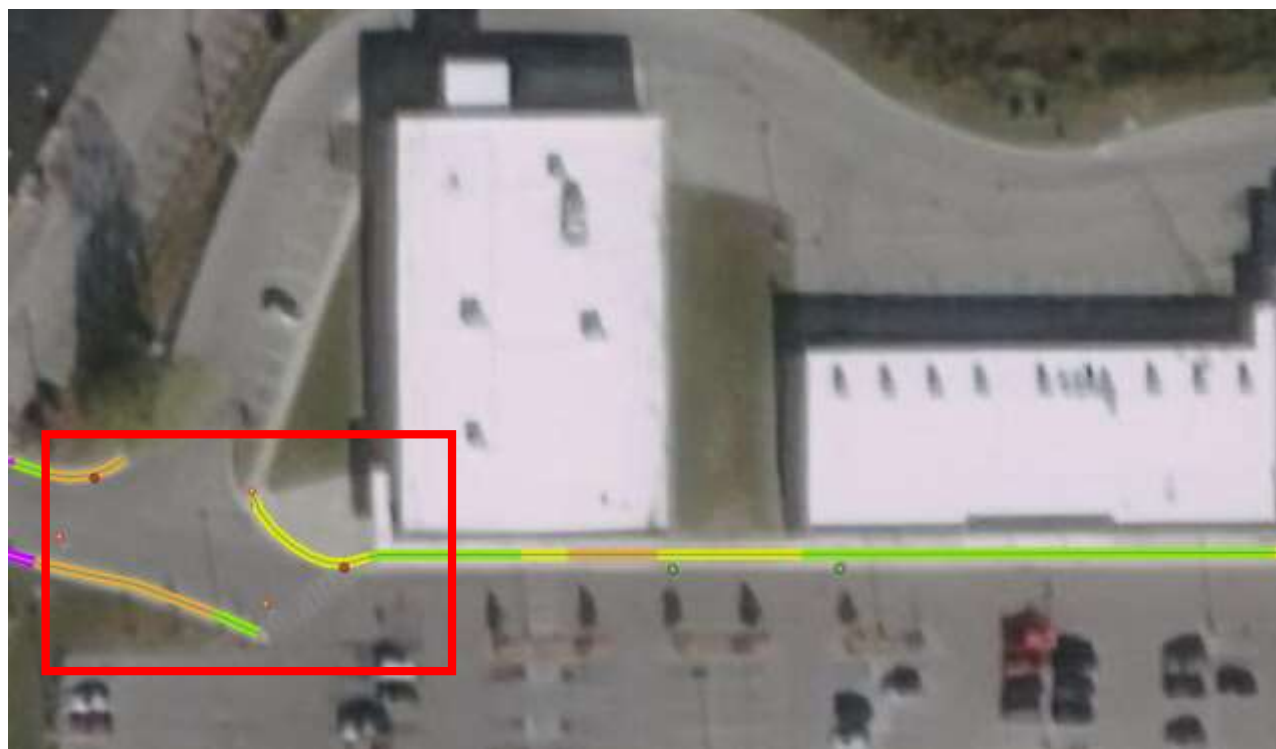
Bus stop with **Curb Ramp Hazards** on either side (west)



Example 2a.

Missing Curb Ramps on both north and south paths leading to main shopping center

- South path - inaccessible
- North path - must travel along road

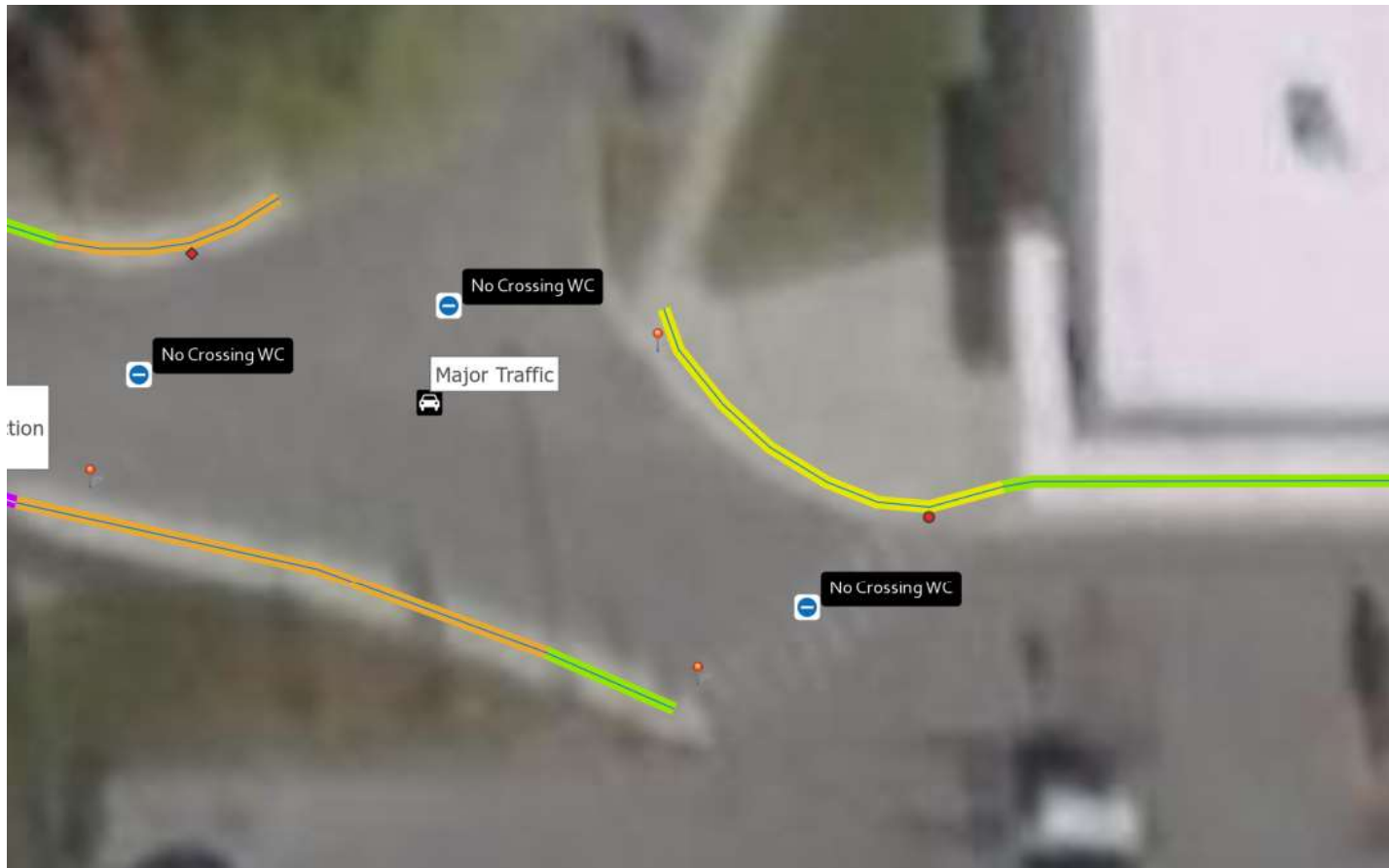


Missing Curb Ramps on both north and south paths leading to main shopping center



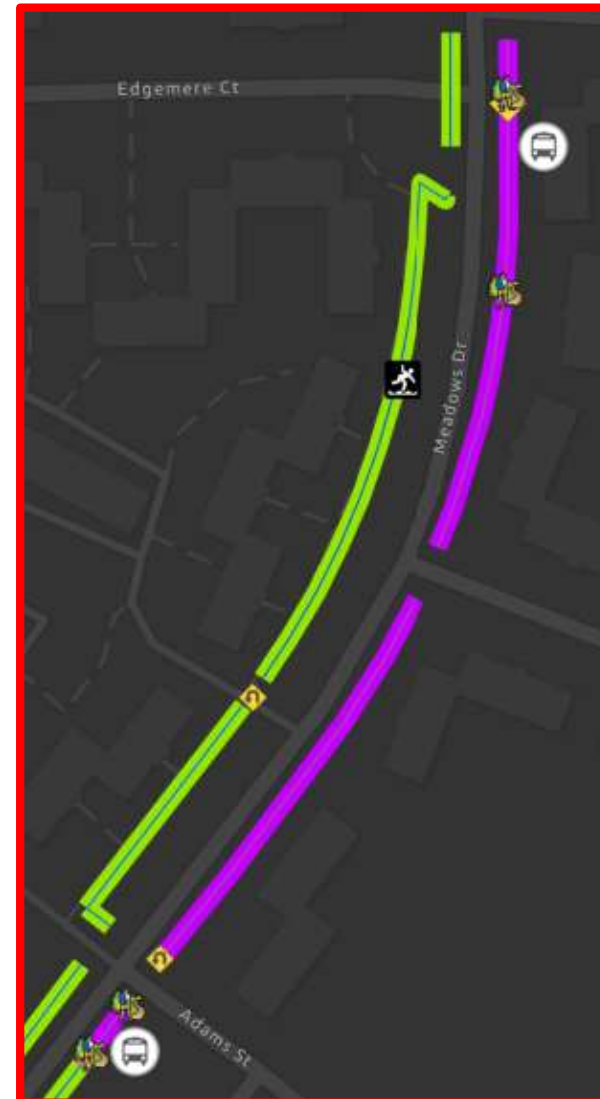
Example 2b. Missing Curb Ramps result in

- Crosswalk = No Crossing WC
- Hazard = Major Traffic



Vegetation Encroachment

- Significant **section of path** inaccessible due to tree and grass encroachment... but path does not access much
- 2 bus stops affected



Vegetation Encroachment

- Significant **section of path** inaccessible due to tree and grass encroachment... but path does not access much
- 2 bus stop affected



Obstructions

Permanent (minor)



Temporary (major)



Bus Stop Summary

Bus Stop Location	Maximum Effort	Condition	KR		Truncated Domes			Crossing	Crosswalk marking	Hazards	Shelter	Wheelchair Marker	Bicycle Marker	Comments
			Bus Stop	Footpath	Bus Stop	Road	Platform							
14th St (Capitol)	**	E	Flat	Flat	Y	Y	E	Lights	Zebra	Minor trip - small lip on bus stop KR.	Y	Y	Y	Outside designated area.
18th St (Meridan)	**	E	Flat	Flat	Y	Y	E	Lights	Zebra	N	Y	Y	Y	Bent pole. Insignificant issue.
Washington St (Capitol)	**	E	Flat	KR	Y	Y	E	Lights	Zebra	None. See comment.	Y	Y	Y	Missing bollard cover. Not sure what to call it.
Fall Creek Pkwy (Meridan)		E-	Flat	KR	Y	Y	E	Lights	Zebra	Minor trip at service ports. (x2)	Y	Y	Y	Damaged bollards.
38th St (Meridan)		E	Flat	KR	Y	Y	E	Lights	Marked, coloured concrete	N	Y	Y	Y	
Vermont St (Capitol)	**	E	Flat	KR	Y	Y	E	Lights	Zebra	N	Y	Y	Y	
34th St (Meridan)	**	E	Flat	Flat	Y	Y	E	Lights	Zebra	N	Y	Y	Y	
30th St (Meridan)	**	E	Flat	Flat*	Y	Y	E	Lights	Marked, stenciled bitumen	N	Y	Y	Y	*One unknown, outside designated area
9th St (Capitol)	**	E	Flat	Flat	Y	Y	E	Lights	Zebra	N	Y	Y	Y	
18th St (Capitol)	**	E	Flat	Flat	Y	Y	E	Lights	Zebra	N	Y	Y	Y	
22nd St (Meridan)	**	E	Flat	Flat	Y	Y	E	Lights	Zebra	N	Y	Y	Y	
38th St (Park)	**	E	Flat	Flat	Y	Y	E	Lights	Zebra	None. See comment.	Y	Y	Y	One Bus stop KR has minor damage at roadway.

9 **Reviewer Comments**

0 Overall, bus stops are done very well. Consistent design. Excellent condition.

1 Following applies to all bus stops:

2 - flat KR at BS

3 - have appropriate TGSI

4 - traffic lights

5 - sheltered

6 Pitch of ramps = good and consistent

7 Condition = excellent

8 Accessibility (from footpath to platform) = excellent

9 There are some minor hazards and other maintenance issues at a few bus stops.

0 **7 of 12 bus stops have no issues at all.**

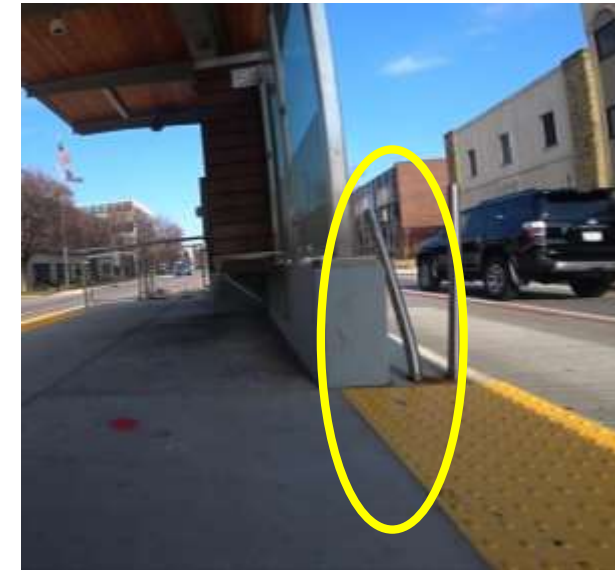
1 **3 bus stops have maintenance issues.**

2 **2 bus stops have minor hazards.**

3 **1 bus stop has minor damage that could develop into a trip hazard.**

4

Bus Stop Summary – Images account for all the issues found.



Curb ramp analysis

Curb ramps are typically the most likely cause of journey failure for wheelchair users. This work has identified that 37% of curb ramps were rated poor, hazardous, missing or none

Sidewalks remain as dead ends until they are connected across the roadways. Curb ramps and crossings are key connective elements that enable sidewalks to form a network.

The challenge is to provide accurate information that enable users the ability to continue their journey. Attention has been paid by IndyGo to the curb ramps accessing their Red and Purple line island stops thus ramps and crossings directly linking the sidewalk to the stops are in good order.

However, in many cases, if you travel just one or two blocks off the main line of the route you will find numerous problems with curb ramps.

Curb ramps are typically the most likely cause of journey failure. By denying a footpath user access both on and off the sidewalk, a poorly constructed or missing curb ramp effectively terminates a wheelchair user's journey.

	All Curb Ramps	Per Cent
Accessible	858	49%
Flat	251	14%
Poor Condition	187	11%
Hazard	163	9%
Missing Curb Ramp	66	4%
No Curb Ramp	220	13%
Total Curb Ramps	1745	100%
Number with TGIS	718	41%
Total	1745	718

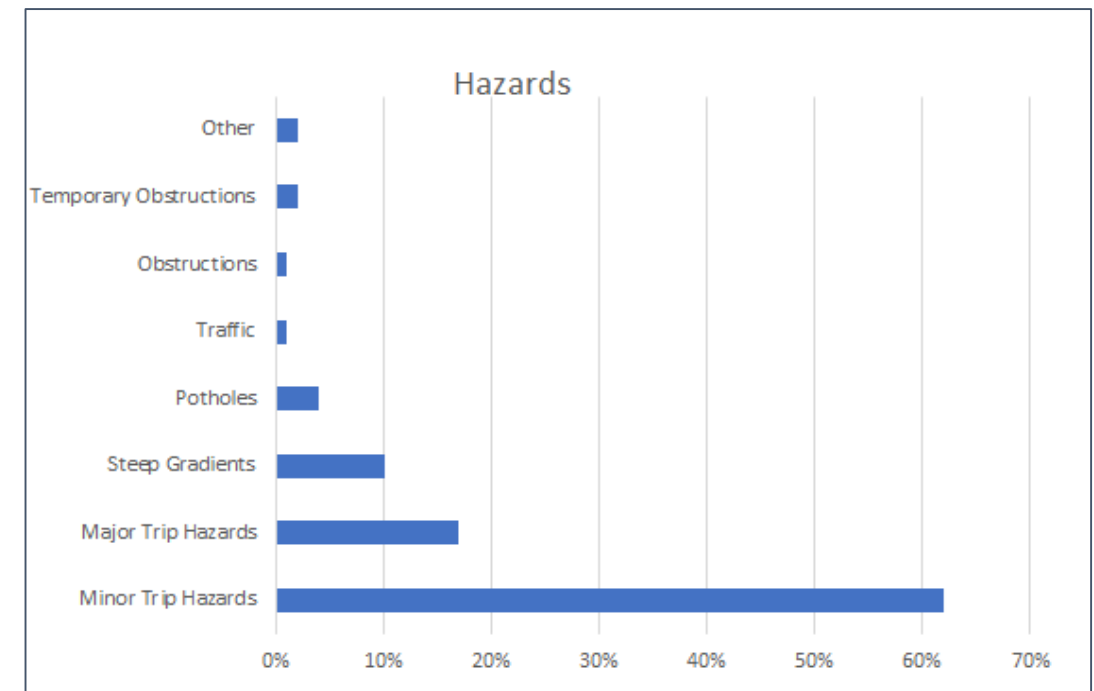
Hazards

Able body pedestrians are able to easily divert but for those using a wheelchair, who are blind or aging, trip hazards are a major issue and can lead to injury and litigation.

Interestingly minor hazards are not less a concern as they are known to impact those moving a speed.



178	Minor Trip Hazards	62%
48	Major Trip Hazards	17%
28	Steep Gradients	10%
11	Potholes	4%
4	Traffic	1%
4	Obstructions	1%
7	Temporary Obstructions	2%
5	Other	2%
285		100%



Summary of ten high level insights from the various stages of the pilot

Summarized below are ten high level project insights that have been informed from various stages of the pilot. Accessibility challenges cannot be resolved by IndyGo alone. It will require collaboration with other city, government, and private sector associations along with input from the community. Gathering and analysis of accessibility data is a good start but will not sufficiently solve all the challenges. Intergovernmental relationships and processes also need to be considered.

Insight #1: Most journey planning tools (i.e. Google Maps and others) do not take into account the factors that make the route challenging for people with mobility needs. Briometrix maps can be used to identify a more appropriate route based on factors such as effort rating and hazards allowing the customer to make a more informed decision based on time vs. effort.

Insight #2: Pedestrian hazards and the quality of the sidewalk disproportionately impacts the user experience of navigating for people with mobility needs. Analysis of the Briometrix maps have shown extended areas with major problems that are walkable however would be impossible to traverse in a wheelchair or pushing a stroller.

Insight #3: There is access needed by multiple departments and stakeholders to ensure accessibility can be considered at the front end of projects. Improvements to data sharing practices would allow information to be shared more efficiently for future projects.

Insight #4: Upon analysis the data can be used to identify key performance indicators and metrics to facilitate the assessment of performance against the strategy and to inform the future decision making processes. (i.e. If the sidewalk was repaired is the ramp being lowered more or are more people using the stop?

Insight #5: Data analysis highlights the lack of data that focuses on the patronage of people with mobility concerns and how they use the transport network. Having a better understanding of the infrastructure problems for people with disabilities, parents with strollers, older people and tourists would create another layer that could be applied to any prioritization framework for upgrades, wayfinding improvements, etc.

Insight #6: Closer analysis is needed outlining and prioritizing future areas of focus based on areas with higher needs for accessibility requirements. This should focus on urban neighbourhoods as well as destinations such as medical, health, retail, recreation and key tourist attractions.

Insight #7: Sidewalk hazards, and incomplete sidewalks were significantly higher in black neighbourhoods.

Insight #8: The Pilots provided unique perspectives. Further insights could be gained further discussions with the Pilots as well as members from the disability community.

Insight #9: It is critical that there is a deep understanding of the needs of **all** types of disabilities. This key finding is also linked to data sharing between relevant stakeholders.

Insight #10: Due to infrastructure problems and construction sidewalk hazards change regularly. This means a reliable route for a person with mobility needs can unexpectedly become impassable. Similarly, people with temporary ailments and those who walk regularly can also be challenged. Direct notification from the city permitting department to members of the community who would sign up might be considered.

Our data analysis has led to these key takeaways

Public Transport data analysis

- Recent ADA bus stop analysis provides a comprehensive “state of the bus stop “ for current and future planning. Although the data is significant it does not paint the entire picture.
- As the majority of new stops will be on main arterial routes, which are generally well cared for, infrastructure data on side streets and secondary routes needs to be gathered and assessed.

Pedestrian movement and interchange analysis

- Key interchange locations are on main arterial roads, it is important to ensure these links are accessible by sidewalks.
- Opportunity to investigate how we can understand the quantum and in turn accessibility of the first and last leg of journeys (i.e. home to bus stop/bus stop to home) - currently unknown.

Road and pedestrian safety analysis

- Statistically a high proportion of hit pedestrian and crashes are near key public transport hubs and key CBD attractors. This is an opportunity to make these key corridors safer and more accessible improving sidewalks and access to stops.

Public transport stop / station infrastructure analysis

- Sidewalks to stops and stations with higher patronage, such as areas close to Downtown, tend to have better sidewalk accessibility suggesting investment in accessibility is being made to maximise benefits (i.e. locations with the highest number of people)
- Further opportunities to invest in stop and station accessibility can be made, keeping in mind demand drivers (areas of high passengers) and area needs (e.g. health and retail precincts, neighbourhood access)
- Bus takes a higher proportion of the transport load of seniors suggesting that ensuring the accessibility of bus stops via sidewalks for this demographic is important.
- Particular zip codes have lower or higher percent of Para Transit riders generally made up of the elderly and those with disabilities thus the walkability of sidewalks should be considered in trying to redirect many of those who would rather take regular transport but are restricted by uncertainty regarding the infrastructure.

Customer experience and feedback analysis

- Customer feedback has not been assessed at this point however wheelchair Pilots were concerned by the poor conditions and hazards present in many areas, especially in poor neighbourhoods where people tend to walk the most.



Briometrix Technology Development

Review of Briometrix technology upgrades as a result of investment in technology

Investment in Technology Development

With IndyGo support we have made significant enhancements to our wheelchair mounted Sidewalk Survey Technology. \$20,000 USA of project funds was dedicated to mapping tech development.

The equipment is now much easier for the wheelchair pilot to operate, gives more accurate positions in urban areas, and maps are more accurate because of the synchronized video stream.

Adding continuously recording cameras to both the Effort Mapping and the Sidewalk Mapping process have improved play back review, allowing verification between LOGGER 2.1 data collected and actual sidewalk condition.

Wheelchair pilots now specialize in three different tasks:

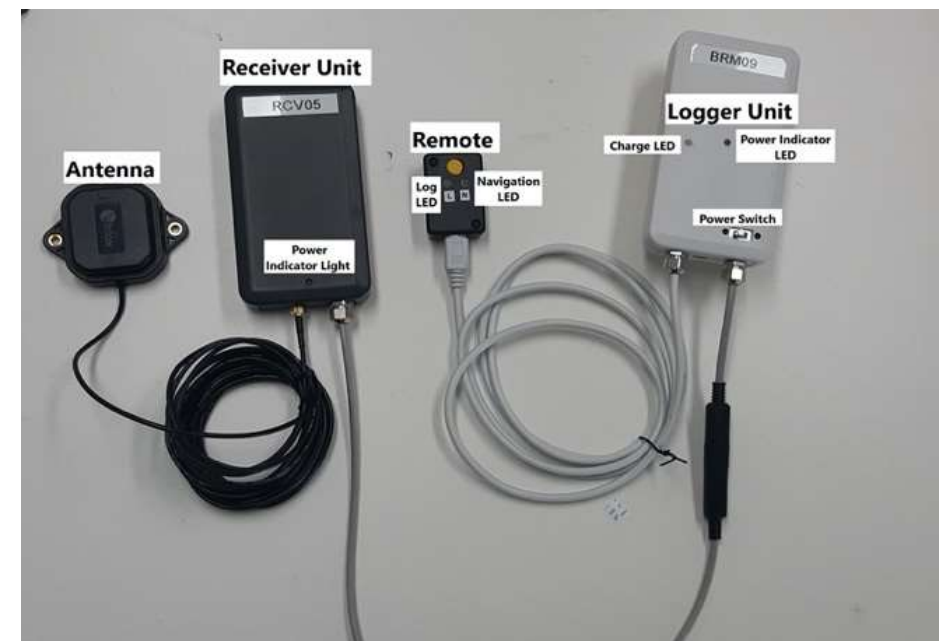
1. mapping sidewalk effort
2. mapping sidewalk infrastructure: pavement type and condition, curb ramps, crossings, lifts, ramps, underpasses etc.
3. mapping accessibility features and services: accessible doorways, toilets, parking



Wheelchair motion data recorder v2.1

The new features include:

- Improved the signal strength, stability, and accuracy of GPS in urban areas by using multi frequency GPS.
- Purchased Multi-frequency Antennae and Receivers, upgraded the firmware.
- Improved visibility of the logger status, and ease of access to the control switches.
- Built remote controls, upgraded the firmware.
- Improved the stability of the internal components to reduce vibration.
- Improved the mounting system to reduce vibration and prevent accidental movement of the motion recorder hardware.
- Improved the calibration process.
- Improvements to the Motion Recorder firmware to provide synchronization of video and images.
- Developed touch screen tablet apps for Pilot input and data capture.



Glossary

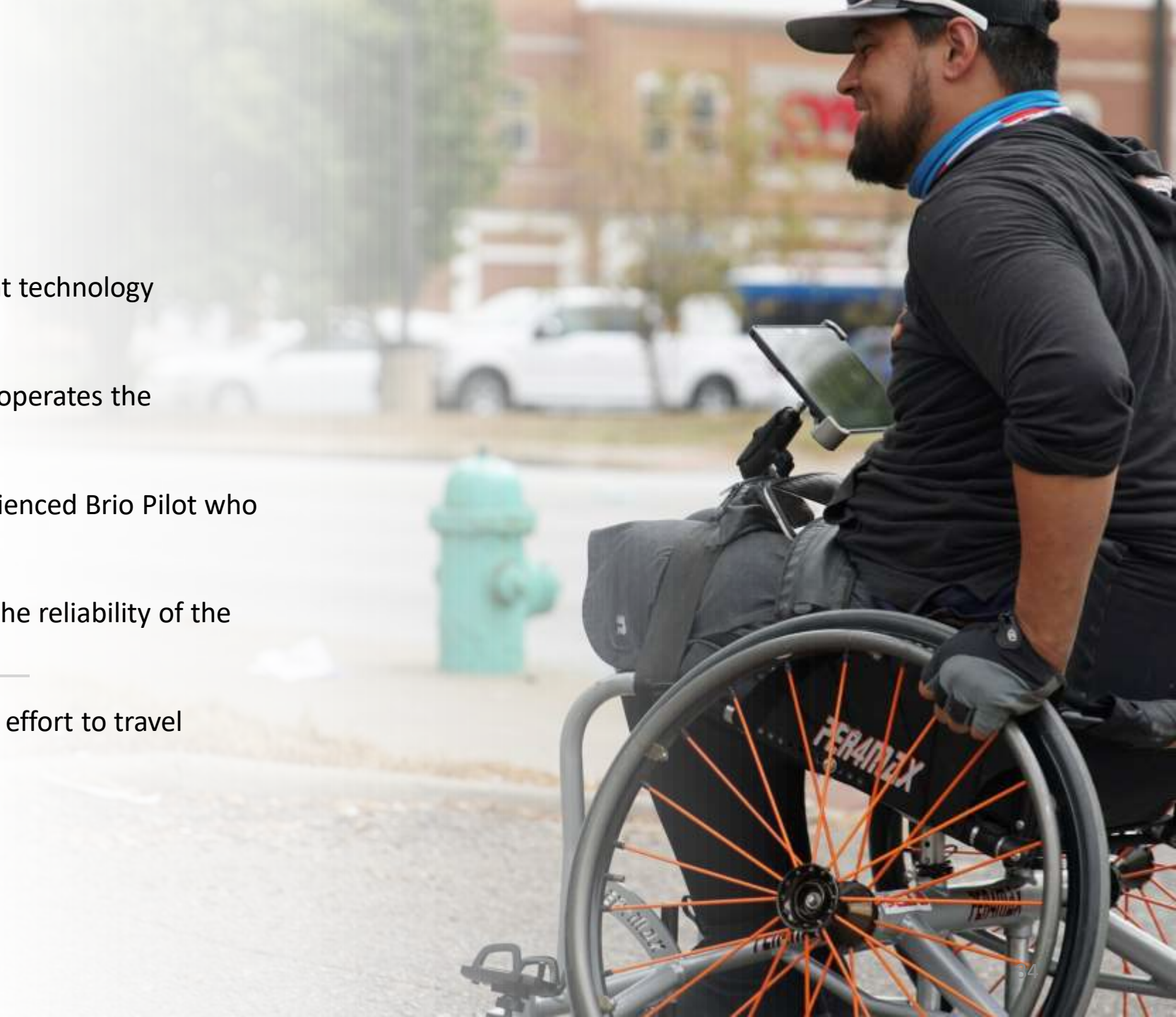
Brio Sidewalk Logger – Sidewalk assessment technology mounted on a wheelchair.

Brio Pilot – A trained wheelchair pilot who operates the sidewalk Logger.

Brio Field Leader, Field Engineer – An experienced Brio Pilot who manages a sidewalk survey project.

Brio Engineer – A technician who ensures the reliability of the survey data.

Effort Map – color coded map showing the effort to travel through an environment



Our thanks for the project support

IndyGo

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