

Planning for Disruption: Connected and Autonomous Vehicles

Final Report

Tom Fisher

College of Design
University of Minnesota

CTS 19-28

Technical Report Documentation Page

1. Report No.	2.	3. Recipients Accession No.
CTS 19-28		

4. Title and Subtitle	5. Report Date
Planning for Disruption: Connected and Autonomous Vehicles	September 2019
	6.

7. Author(s)	8. Performing Organization Report No.
Fernando Burga, Tom Fisher	

9. Performing Organization Name and Address		10. Project/Task/Work Unit No.
Humphrey School of Public Affairs University of Minnesota 130 Humphrey School 301 19th Avenue South Minneapolis, MN 55455	College of Design University of Minnesota 101 Rapson Hall 89 Church Street SE Minneapolis, MN 55445	CTS Project #2018073
		11. Contract (C) or Grant (G) No. n/a

12. Sponsoring Organization Name and Address	13. Type of Report and Period Covered
Center for Transportation Studies University of Minnesota University Office Plaza, Suite 440 2221 University Avenue SE Minneapolis, MN 55414	Final Report
	14. Sponsoring Agency Code

15. Supplementary Notes

http://www.cts.umn.edu/Publications/ResearchReports/

16. Abstract (Limit: 250 words)

The future of transportation is inseparable from the future of work. Over the last century, transportation has focused on moving people and goods, but work in the 21st century has started to change dramatically due to vehicle automation, changing consumer patterns, and the rise of virtual retail. These factors will bring profound changes in transportation, infrastructure, and access to resources in the city, including housing, food, public spaces, and labor opportunities.

This research project investigated the implications of the forthcoming changes in transportation, mobility, and the nature of work. It focused on the impact of vehicle automation on jobs access and explored the tensions that arise as new vehicle automation technologies are introduced into the streets of neighborhoods with historically disadvantaged residents.

17. Document Analysis/Descriptors	18. Availability Statement
Connected vehicles, autonomous vehicles, mobility, shared mobility, labor force, work trips	No restrictions. Document available from: National Technical Information Services, Alexandria, Virginia 22312

19. Security Class (this report)	20. Security Class (this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	91	

PLANNING FOR DISRUPTION

Connected & Autonomous Vehicles



PA 5211 LAND USE PLANNING

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Teaching Assistant: Chris DesRoches

Humphrey School of Public Affairs

Fall 2018

PREPARED BY

Teaching Assistant: Lynda Chao

PROJECT COLLABERATION WITH

City of Minneapolis

Scott County

University of Minnesota - Resilient Communities Project

Minnesota Design Center

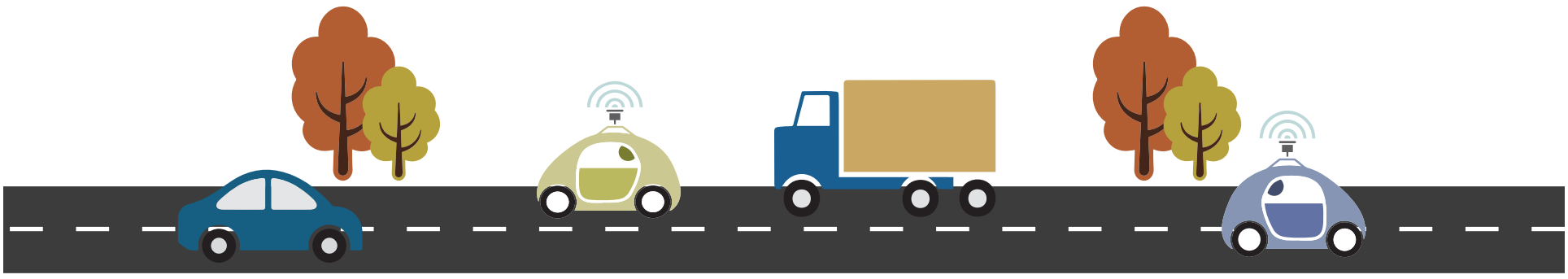
Center for Transportation Studies

Minneapolis City of Lakes

Scott

Resilient Communities Project
University of Minnesota

CENTER FOR TRANSPORTATION STUDIES
MINNESOTA DESIGN CENTER



The projects in this report was completed in collaberation with the City of Minneapolis, Scott County, the Minnesota Design Center (MDC) and Center for Transportation Studies (CTS) as a part of the Fall 2018 Resilient Communities Project (RCP) partnership. RCP is a program at the University of Minnesota's Center for Urban and Regional Affairs (CURA) that connects University faculty and students with Minnesota communities to address strategic projects that advance local resilience and sustainability.

The contents of this report represent the views of the authors and do not neccessarily reflect those of RCP, CURA, CTS, MDC the Regents of the University of Minnesota, Scott County, or the City of Minneapolis.

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- **Notes**
- **Photos**
- **Floorplan**
- **Student Posters**

Exhibit Agenda

December 6, 2018

12pm - 4pm	Open House
12:25pm	Brief General Announcement I
1:45pm	Brief General Announcement II
2:45pm	Brief General Announcement III
3:45pm	Final Announcement + People's Choice Awards

Class Description

The American auto industry is currently testing, designing and planning for connected and autonomous vehicles (CAVs). Theforthcoming deployment of CAVs will disrupt land use regulations and transform the way we live, work, and travel in our cities.

During the Fall 2018 semester, Master of Urban and Regional Planning students worked in collaboration with UMN's Center for Transportation Studies, the Metropolitan Design Center and the Resilient Communities Project to explore how CAVS will reshape our cities.

By considering the City of Minneapolis and Scott County as case studies students explored the following questions:

- How will CAVs challenge the land use regulations that shape our cities?
- How can comprehensive plans address the forthcoming CAV disruption?
- Who will be left out of the CAV disruption in terms of equity, diversity, justice and the public good?

The six projects you will see represent the result of their efforts.

The PA 5211 Land Use Planning class is comprised by:

Assistant Professor
Fernando Burga, PhD

Teaching Assistant
Chris DesRoches

Masters of Urban and Regional Planning Students:

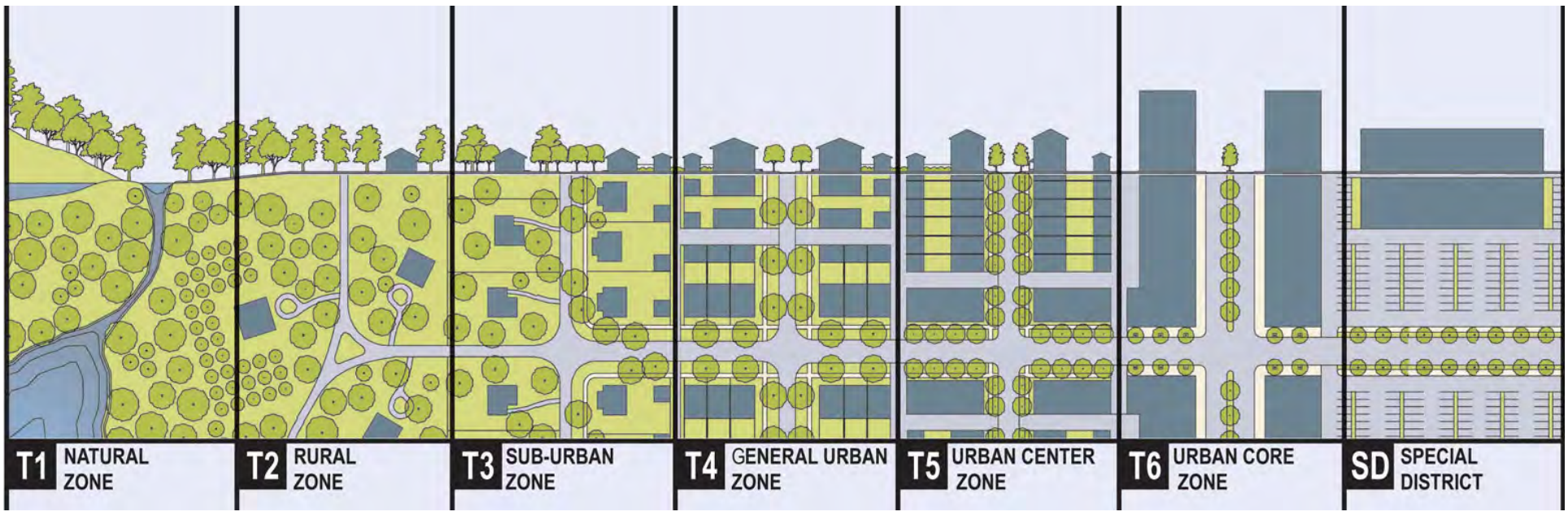
Martha Allen
Corrin Bemis
Lynda Chao
Ian Corder
Ari Del Rosario
Shannon Engstrom
John Fleming
Patrick Haney
Isaac Hase-Raney
Emily Houser
Shanda Hunt
Gwendolyn Jenkins
Emily Houser
Gwendolyn Jenkins
Lee (Ellie) Meekyung
Kathryn Leys
Daniel Mcniel
Elliot Mohler
Eric Molinari
Jacqueline Nowak
Gabriela Olvera
Megan Reineccius
Emily Reno
Galen Ryan
Benjamin Schneider
Galen Ryan
Benjamin Schneider
Koehl Simmons
Forrest Steinhoff
Yuyan Wang

The Transect

CAVs will not only drive development in densely populated areas where concentrations of people foster a sharing economy, but also potentially lead to CAV-oriented sprawl due to the increased capacity to travel long distances without making stops.

How will these developments promote land uses that support a sense of place and community? To confront this key question, MURP students were directed to apply the New Urbanist Transect as an organizational framework for their projects.

The transect represents a cut through an ideal city showing a range of different built environment according to density. Our projects range from special districts next to the urban core to rural areas beyond suburbia to establish a comprehensive framework. This framework allows us to consider CAV innovations comparatively between urban-suburban and rural areas to inform policy-making as well as place-making.



SD

Freight for the Future: The Ports of Savage as a CAV Innovation District

T5/6

Planning for Disruption: CAVs and Equity in Washington and Lake Streets

T4

The CAV Urban Village: Recalibrating the Canterbury Commons Master Plan

T3

Paving the Way: Adapting Crosswalks for CAV's in Shakopee

T3

Shared Mobility for All? CAVs and the Intellectual Disabilities in Scott County

T2

A Renaissance in Transportation: Planning the CAV Network from Urban to Rural MN

Equity Figures

MURP students were directed to include “Equity Figures” in their posters to inject a qualitative dimension that would otherwise remain hidden by the aggregate characterization of demographic analysis.

The figures represent the voices of under-represented groups and use Twitter to capture the disruptive power of social media in the public sphere. They articulate the opinions of regular residents, fierce advocates and everyday citizens who agree, disagree, and complicate the normative dimension of planning work with new questions, reflections and answers.



Freight for the Future
Hi I’m Dave. I am a local resident of Savage. I am a proud father, hunter, and American. I work at the Amazon distribution center in Shakopee and struggles to commute on Highway 13 every day.



Planning for Disruption
Hi, I’m Jerome. I work as a baggage handler at the MSP. I take the bus to downtown and transfer to the light rail to get to work. I’ve seen a lot of change around Washington Avenue since I started 15 years ago.



Planning for Disruption
Hi, I’m Linda. I migrated to the U.S. from El Salvador and now call East Lake Street my home. I came to Minneapolis to seek new opportunities as a chef. After hard work, I was able to open up my own restaurant on Lake Street.



The CAV Urban Village
Hi I’m Ed Chen! I’m an 37-year-old single Asian-American father. I work at here at Canterbury Park and my son Henry and I are excited to see the recalibration of the place I work!



Paving the Way
Hello, my name is Charlie Walker and I am a member of the National Federation of the Blind in Minnesota. I tweet about issues that impact the visually impaired community.



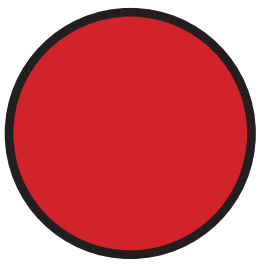
Shared Mobility for All?
Hi, I’m Linda. I migrated to the U.S. from El Salvador and now call East Lake Street my home. I came to Minneapolis to seek new opportunities as a chef. After hard work, I was able to open up my own restaurant on Lake Street.



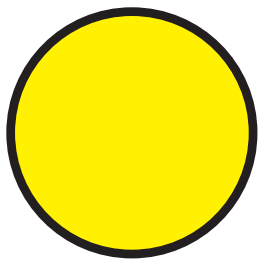
A Renaissance in Transportation
Hello! My name is Bob, and I will be live tweeting these posters periodically. As a wheelchair-bound individual, I have to rely on friends and family to drive me places but the advent of CAV’S could change all of that!

Engage + Create 6

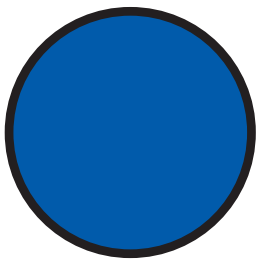
Help our teams refine their projects and participate in the exhibit through "Dot-mocracy". Use the stickers attached to this flyer to vote for the following awards:



PEOPLE'S POSTER AWARD
[Place on Poster]
Select your **overall favorite poster**



PEOPLE'S ANALYSIS AWARD
[Place on Individual Analysis]
Select your favorite **Analysis, Diagram or Graphic**



PEOPLE'S FUTURE AWARD
[Place on Individual Analysis]
Place a sticker on the topic/analysis you think is the most **thought provoking or potential for future study**

Place your stickers directly on the posters.

Freight for the Future 7

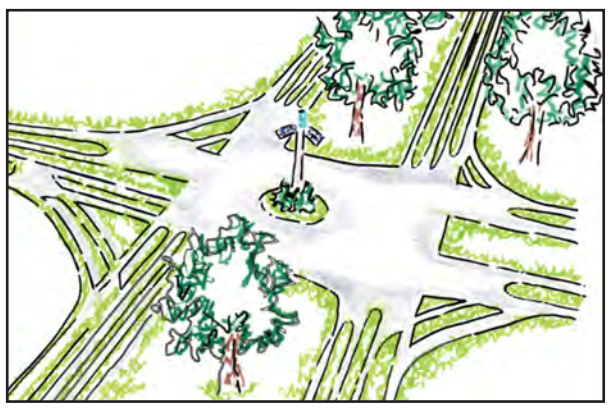
The ports of Savage, Minnesota serve an important role in the regional freight system for the Twin Cities. The ports are privately owned and operated and they, as well as the regional freight system as a whole, face challenges to their continued success. Decaying infrastructure and a declining workforce present issues to freight's future. Connected and Automated Vehicles (CAV) offer potential solutions to both.

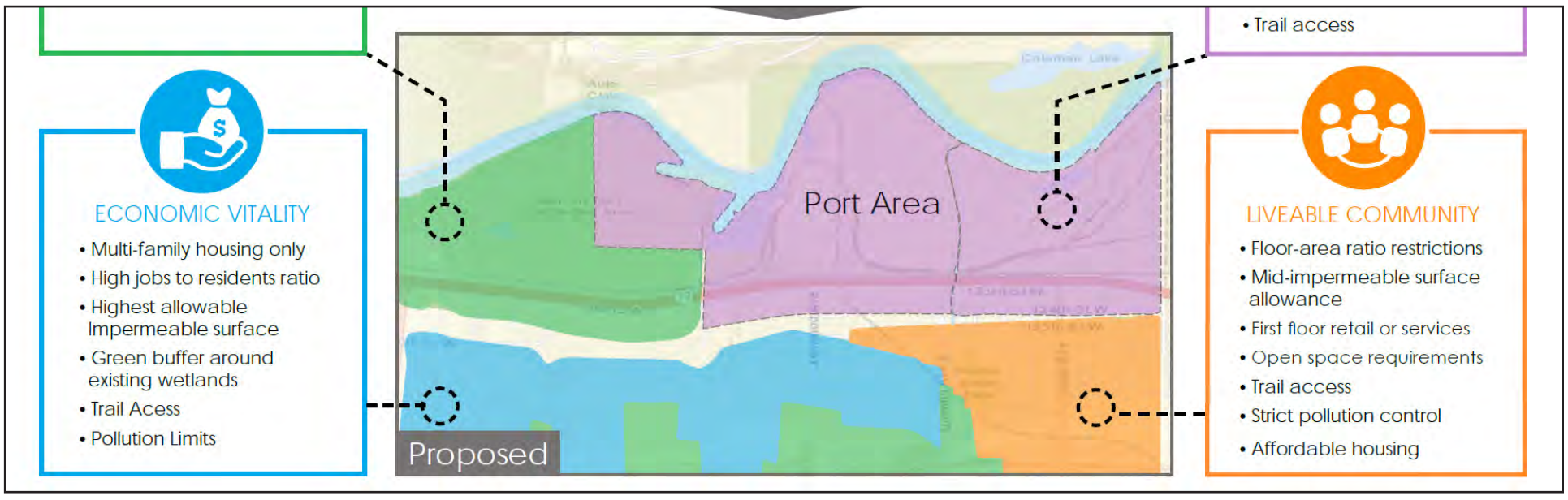
The ports of Savage will need to **adapt to accommodate the introduction of CAVs**. This new technology will transform how the land in the surrounding region is used. These changes will not be instantaneously and **adaptations can be phased** into the site and surrounding region. A decreased need for pavement allows **increased greenspace** and can help protect the Savage fen while simultaneously opening the space for recreational use. Additionally, new types of intersection controls can **relieve traffic congestion** and make moving semi-trucks out of the ports on to Highway 13 easier.

The ports of Savage can benefit from CAVs by **encouraging an educational and training museum** on land reclaimed from paved surfaces. The Minnesota Department of Transportation (MnDOT) is looking for Requests for Proposals on studying CAV innovations on the regional highway system. MnDOT and Scott County can benefit from studying CAVs in a freight intermodal environment such as that found at the ports.









SD

Freight for the Future:
The Ports of Savage as a CAV Innovation District

Patrick Haney / Shannon Engstrom / Jacqueline Nowak / Yuyan Wang

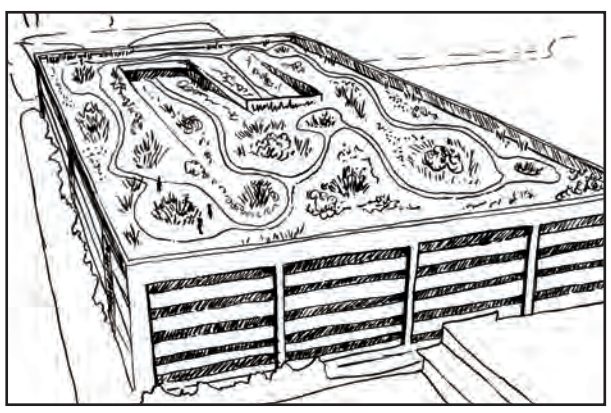
Planning for Disruption 8

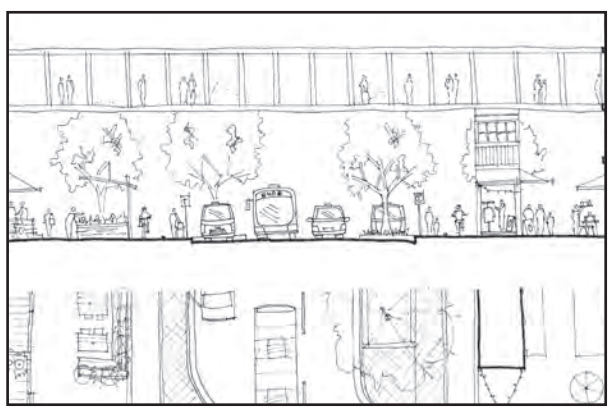
Connected and Autonomous Vehicle (CAV) technology is likely to be impactful on the transportation landscape within cities. Surprisingly few municipalities are developing strategic policies and ordinances to guide CAV disruption. CAV deployment could exacerbate social and economic disparities within cities by serving only affluent interests. **Planning for Disruption allows for policy and development suggestions that actively work toward addressing inequities.** The project offers scenarios along the Washington Avenue corridor through the Mill District, a downtown core T6 context, and the Lake Street corridor through the Powderhorn area, a main street T5 context. With a Minneapolis context, we utilize the Minneapolis 2040 Comprehensive Plan to establish goals.

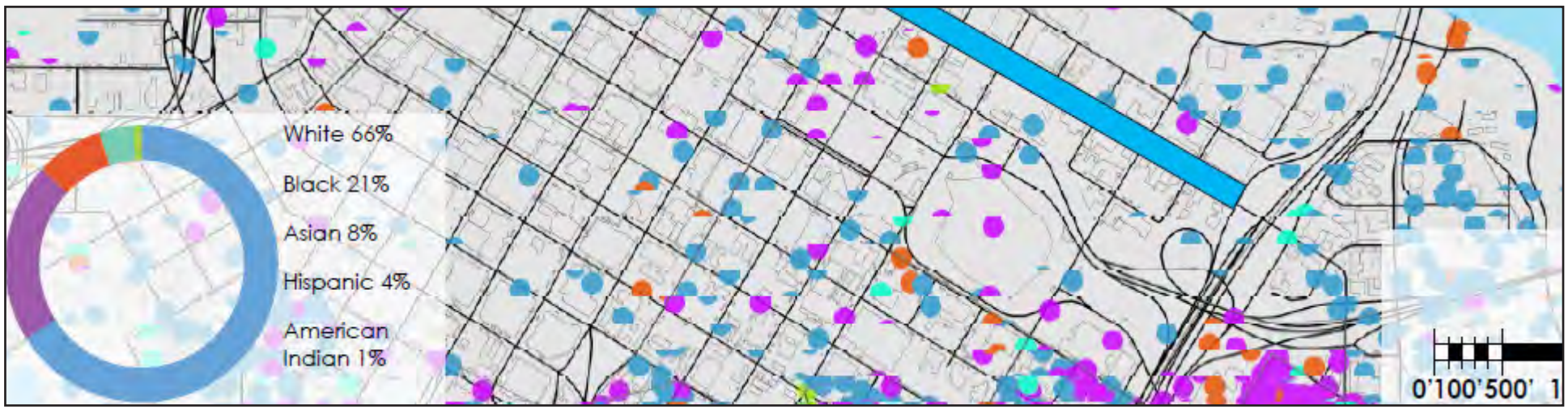
The project begins with a review of processes and planning documents guiding AV implementation to-date. Next, the project moves to an analysis of the demographic and structural frameworks of the two study areas to identify existing disparities and opportunities for equity. Next, the background information is incorporated to develop and deploy five equity opportunities within CAV implementation: **Improve the Environment, Increase Housing Access, Increase Mobility, Support Diverse Economies, and Improve Public Health**.

Finally, opportunities for equity are explored through a series of design scenarios for CAV implementation. We conclude by suggesting **phasing strategies for future development** and a summary of proposed policies. In doing so, we aim to illustrate strategies for guiding CAV deployment in order to **address disparities** within cities while **improving conditions** overall.









T5/6

Planning for Disruption:
CAVs and Equity in
Washington and Lake Streets

Ellie Lee / Gaby Olvera / Galen Ryan / Gwen Jenkins / John Fleming / Martha Allen / Megan Reineccius

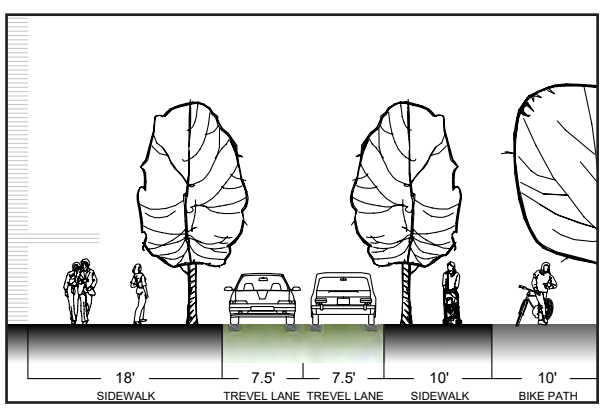
The CAV Urban Village 9

Canterbury Park is an entertainment destination offering horse racing, table games, and poker in Shakopee, MN, a suburb of the Twin Cities. Recently, plans have been enacted to build high-end housing near the site. Canterbury Park real estate developers hope to promote what they describe as the "Canterbury Experience" by attracting additional commercial and entertainment development, as well as hotels for tourists to stay nearby. The master plan for the area maintains a 45-acre parking lot, with approximately 10,000 parking spaces, near the Canterbury Park horse racing track.

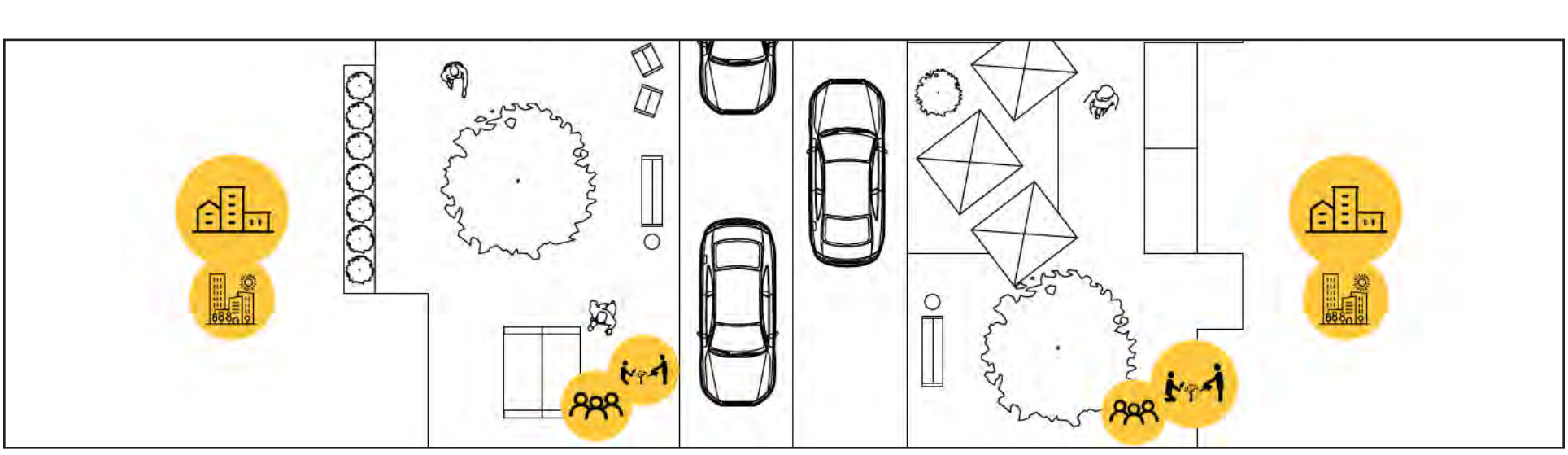
In this project, we consider the master plan for Canterbury Park in the context of a rapidly approaching future where Connected and Autonomous Vehicles (CAVs) dominate the transportation landscape. **Due to a significant decrease in the amount of parking needed by CAVs as compared to human drivers, Canterbury Park's 10,000-space parking lot will be rendered obsolete.** This presents an opportunity to rethink the possibilities for this space.

Our neighborhood plan incorporates the design principles of **people-centered** design, **green space, mixed-use development**, and diversity of **housing options**, in order to enhance the "Canterbury Experience." We evaluate the existing master plan, articulate a CAV design framework, and apply it to create a neighborhood plan for an urban village in what is currently a 45-acre parking lot. Our project provides a case study in recalibrating a master plan in the context of a CAV-oriented future.









T4

The CAV Urban Village:
Recalibrating the Canterbury Commons Master Plan

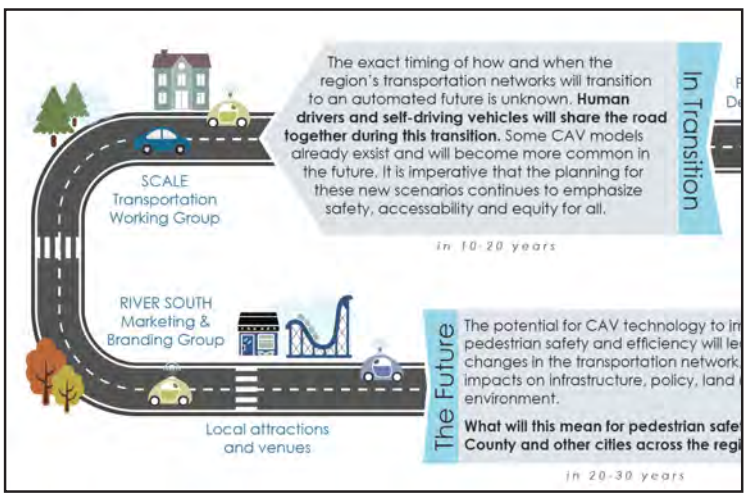
Emily Houser / Koehl Simmons / Forrest Steinhoff / Ari Del Rosario

Planning for Disruption 10

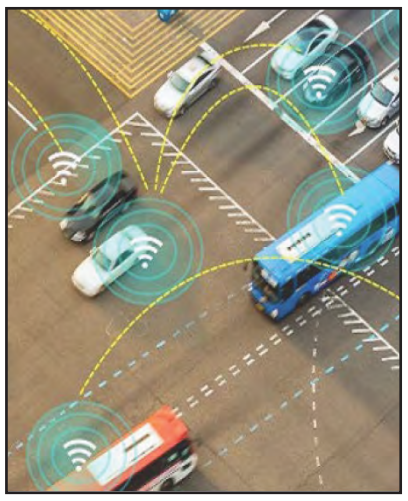
The advent of connected autonomous vehicular (CAV) technology marks the next great transition in our transportation networks. **CAVs have the potential to create more reliable transportation systems** that can dramatically improve roadway safety for everyone. The American Planning Association estimates **50% of cars will be fully automated by the year 2040**. Planning for these changes can help communities harness the many benefits of CAV technology and address the various obstacles to equitable implementation.

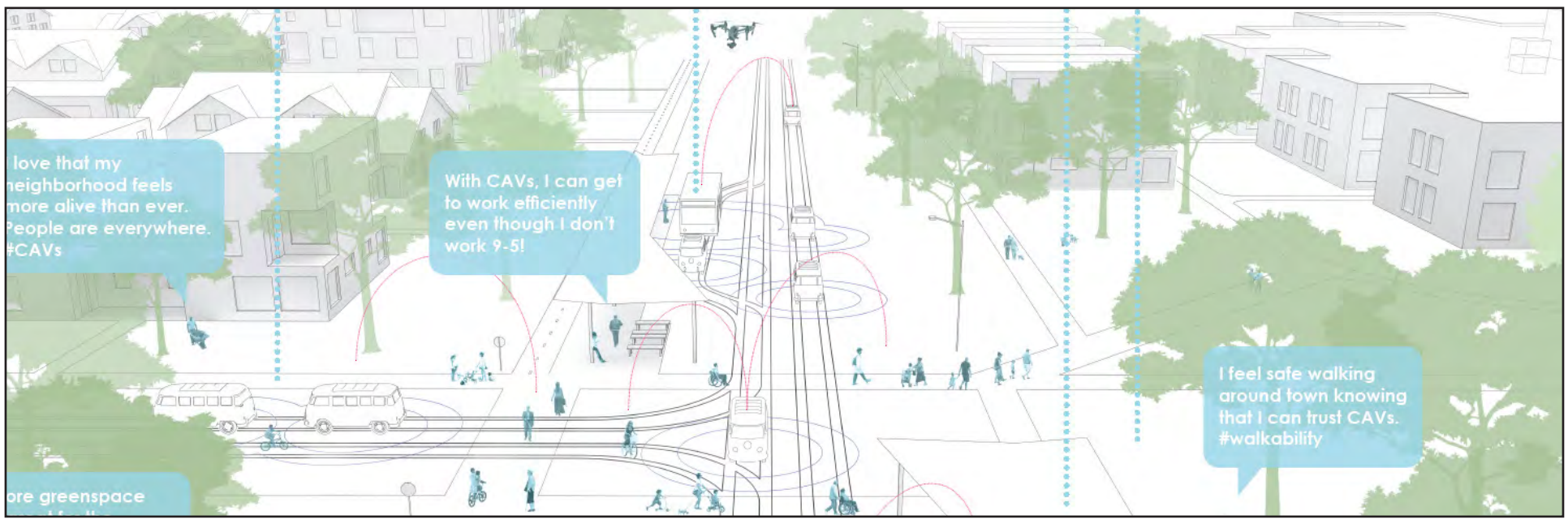
The potential for CAVs to **improve safety, efficiency and accessibility** will result in dramatic changes to our transportation networks. This project explores the impacts of CAV technology on pedestrian safety in Scott County by envisioning four phases of CAV implementation in the city of Shakopee. The four phases of CAV implementation are represented through renderings of the same intersection as it changes over time.

To identify potential changes, we analyzed the impacts of CAV technology on land use, infrastructure, policy, and the environment in order to answer the question: **how Scott County can maintain consistency in the design, engineering, and construction of its transit network to ensure pedestrian safety and promote comfortable interactions between pedestrians and CAVs?**









T3

Paving the Way:
Adapting Crosswalks for CAV's in Shakopee

Elliot Mohler / Lynda Chao / Daniel Mcniel / Isaac Hase-Raney

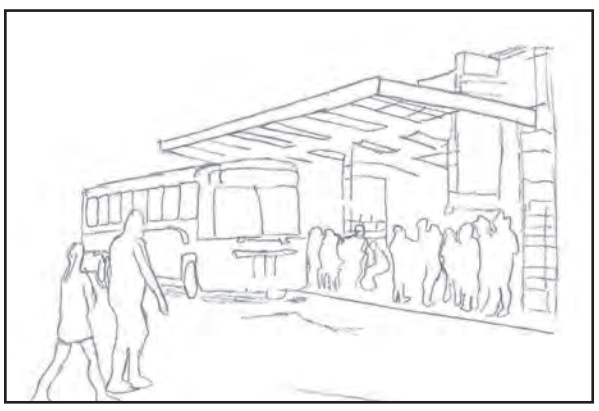
The CAV Urban Village 11

How can Scott County provide equitable, inclusive public transportation for residents needing door-to-door transit services in rural areas?

Shared Mobility for All? Is a project proposal by Scott County to address the shared mobility needs of senior residents. As Babyboomers - the most populous generation in the U.S. - matures, the **demands on shared mobility will increase**. By examining this issue in the context of connected autonomous vehicles (CAVs) we clarify the assumptions made by shared mobility literature and challenges faced by riders. The three communities in our study, Shakopee, Jordan, and Belle Plaine, are included for their representation of unique demographics along the Highway 169 corridor.

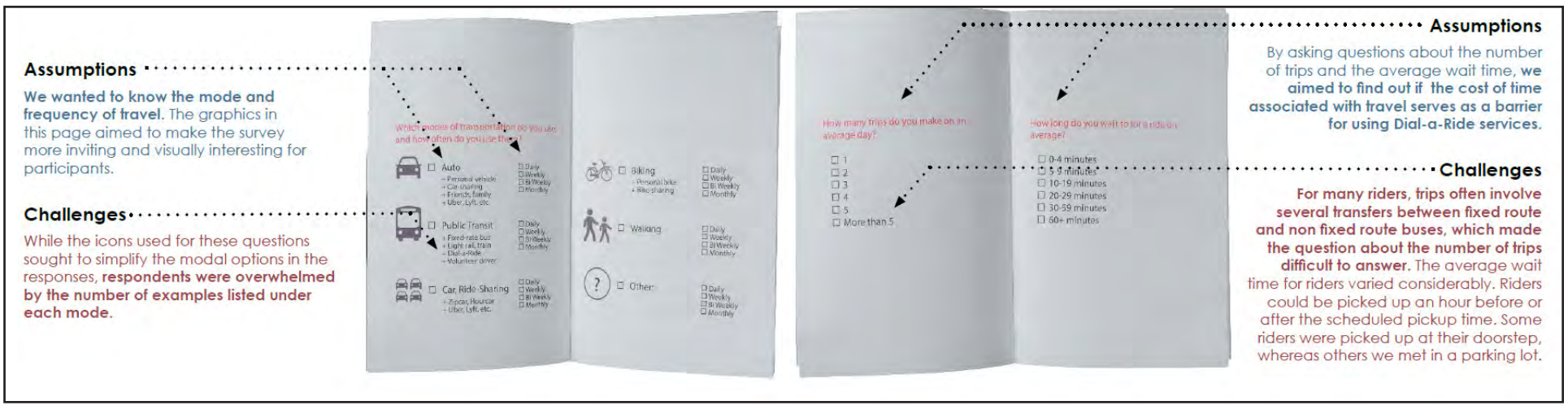
We use the following qualitative research strategies to inform land use planning recommendations: (1) a survey to be administered on bus routes in Scott County, (2) a participatory mapping exercise, and (3) stakeholder interviews.

We then analyze our data and include a document analysis with field notes and precedent cases. Our findings challenge the assumption that shared mobility efforts should focus solely on senior citizens; we instead argue they should be **tailored to the needs of low income and disabled persons**, which often include seniors. We make six distinct recommendations for shared mobility in Scott County, and recommend that qualitative data collection continues as part of a more holistic and inclusive approach to planning for a future with CAVs.









T3

Shared Mobility for All? CAVs and the Intellectual Disabilities in Scott County

Emily Reno / Corrin Bemis / Shanda Hunt / Isaac Hase-Raney

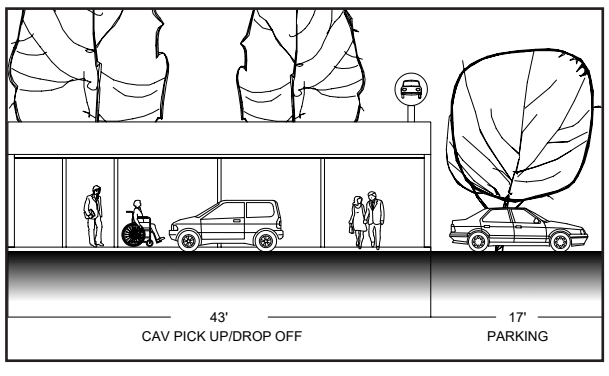
A Rennaissance in Transportation

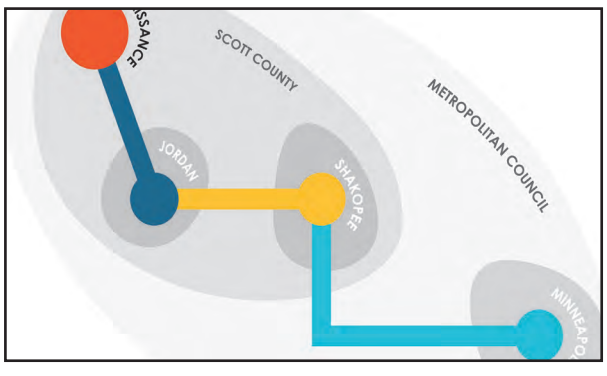
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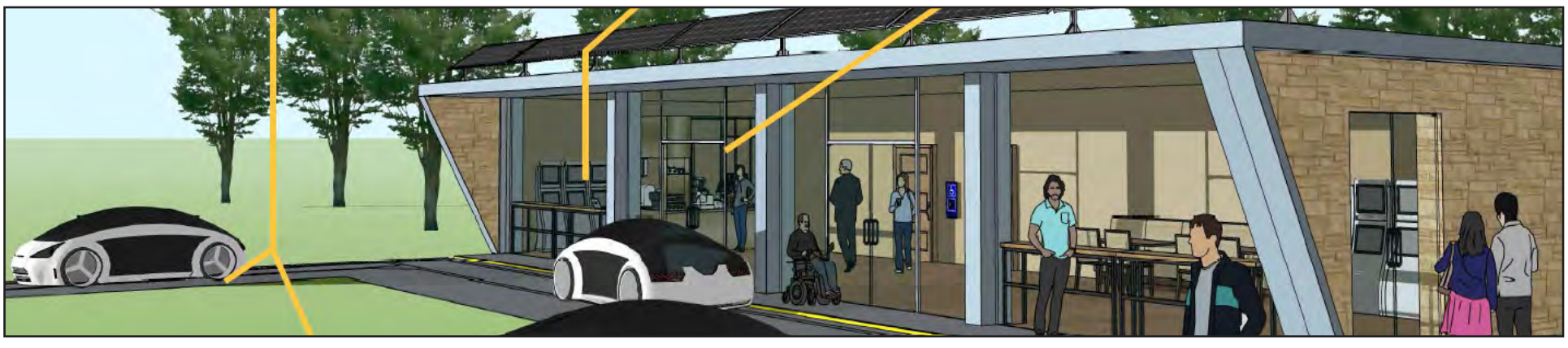
A Rennaissance in Transportation explores how connected autonomous vehicles (CAVs) could improve regional connectivity between Minneapolis and rural Minnesota. As a case study, we look at the journey on U.S. Highway 169 from Minneapolis to the new site of the Minnesota Renaissance Festival, which will be located just outside of Jordan, MN. New technology, such as CAVs, often reaches rural regions well after urban ones due to the **lack of wireless infrastructure** in the region. Rural regions also require the technology to serve needs that may not necessarily be addressed in an urban context requiring the technology to be tailored towards these specific needs. With population increases expected over the next twenty years, we are proposing **rural Minnesota update its transportation system for a CAV future** that will accommodate the future population increase of Scott County.

In our recommendations, we highlight how the **decreased need for parking** associated with CAVs will allow current parking garages to be retrofitted and transitioned into an office space, **parking hybrid structure**. Next, in order to better connect these rural areas, we propose **transitioning park and ride structures into rural public transportation networks** that can connect these previously unconnected regions to public transportation. Additionally, in order for CAVs to enter rural areas, a **network of 5G cells** will need to be installed along major travel corridors such as Highway 169. Finally, we review how parking lots that will no longer be needed could be used as a **CAV maintenance hub** in rural areas, providing storage, upgrades, and general maintenance work for CAVs.









T2

A Renaissance in Transportation:
Planning the CAV Network from Urban to Rural MN

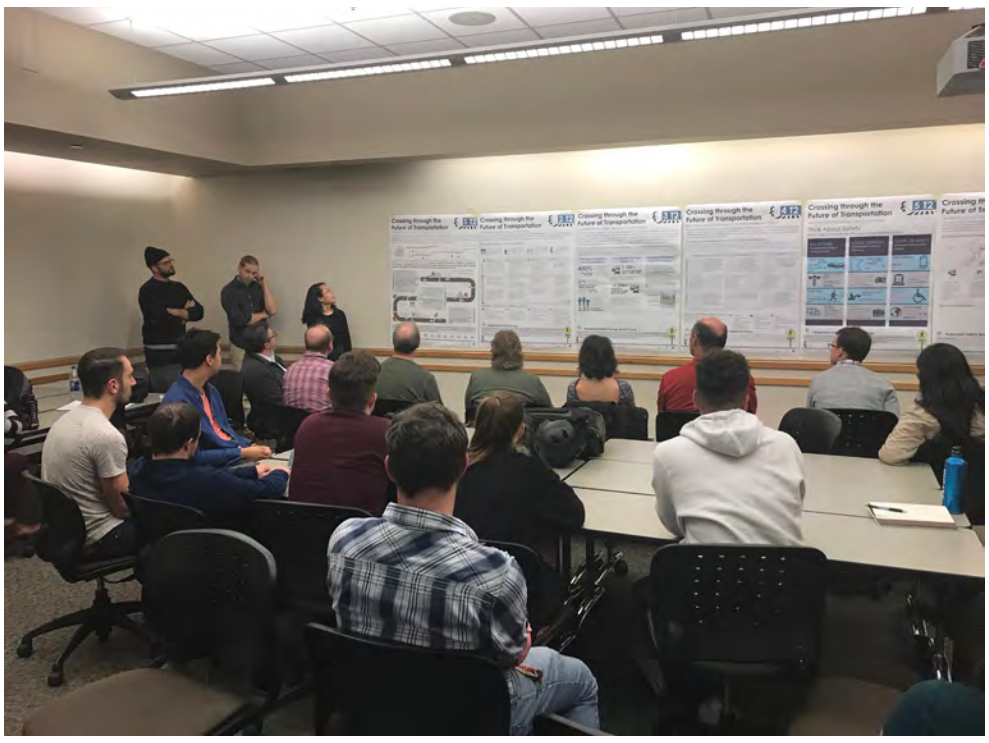
Eric Molinari / Ben Schneider / Ian Corder / Kathryn Leys / Ari Del Rosario

Appendix

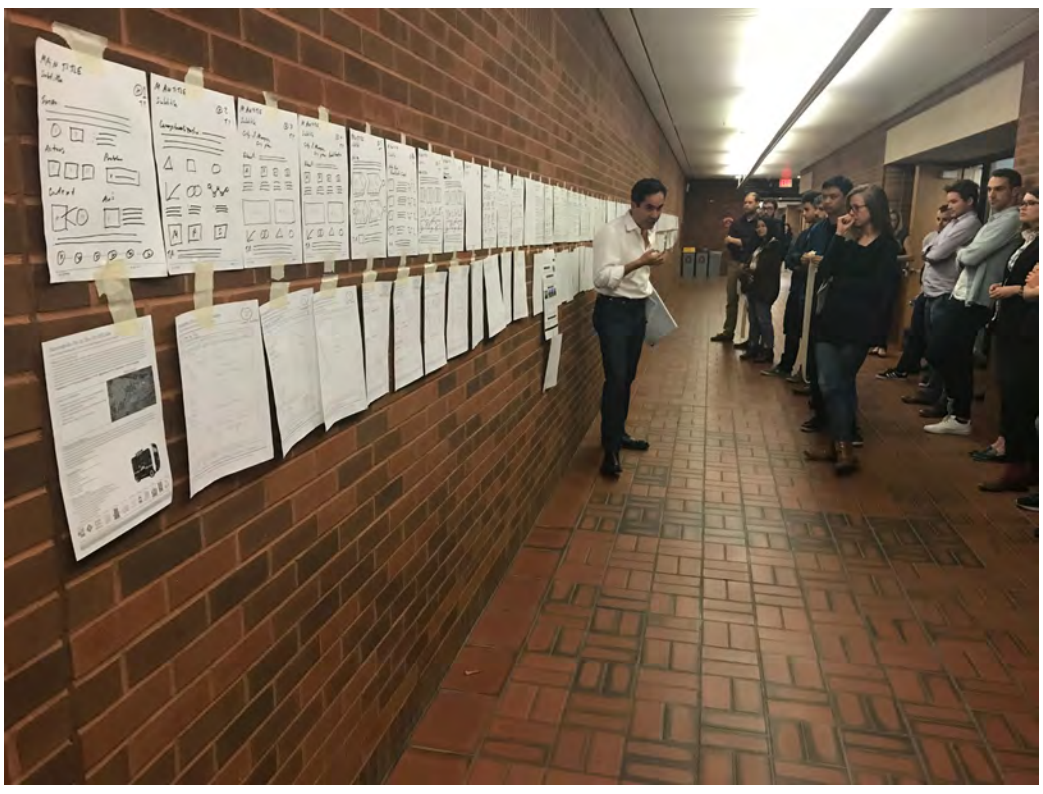
The following Appendix contains:

- Notes - Section for note taking during the Open House Exhibit
- Various photos during the Land Use Planning course (Fall 2018)
- Floorplan of the Mondale Atrium and layout of poster session
- Student Posters

Notes:




Racing into the Future
Racing into the Future
Racing into the Future




PETE 612.597.4965
DO NOT ERASE
Color Swatch Palette

A RENAISSANCE IN TRANSPORTATION

SHARED MOBILITY FOR ALL?

CROSSING THE THRESHOLD

PLANNING FOR DISTRUPTION

THE CAV URBAN VILLAGE

PLANNING FOR DISTRUPTION

FREIGHT FOR THE FUTURE

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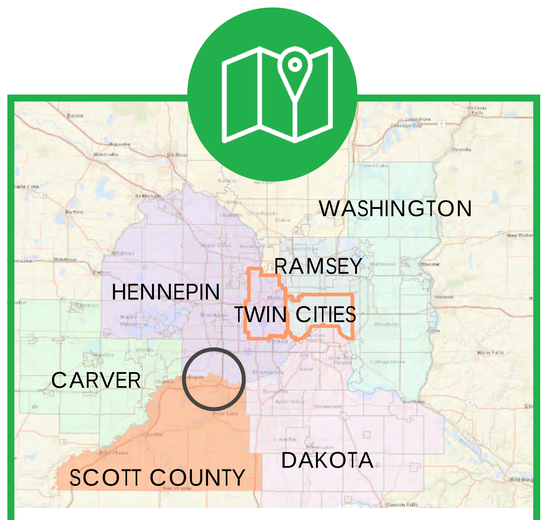
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Freight for the Future

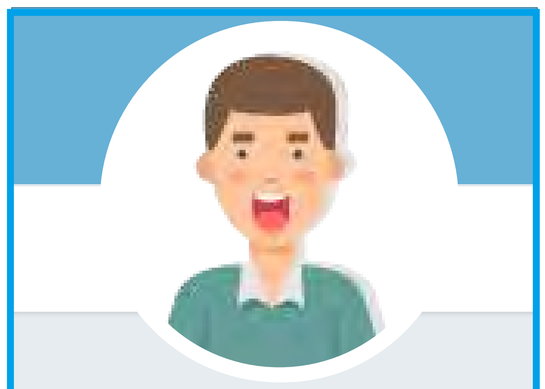
1 SD SCOTT

The Ports of Savage as a CAV Innovation District

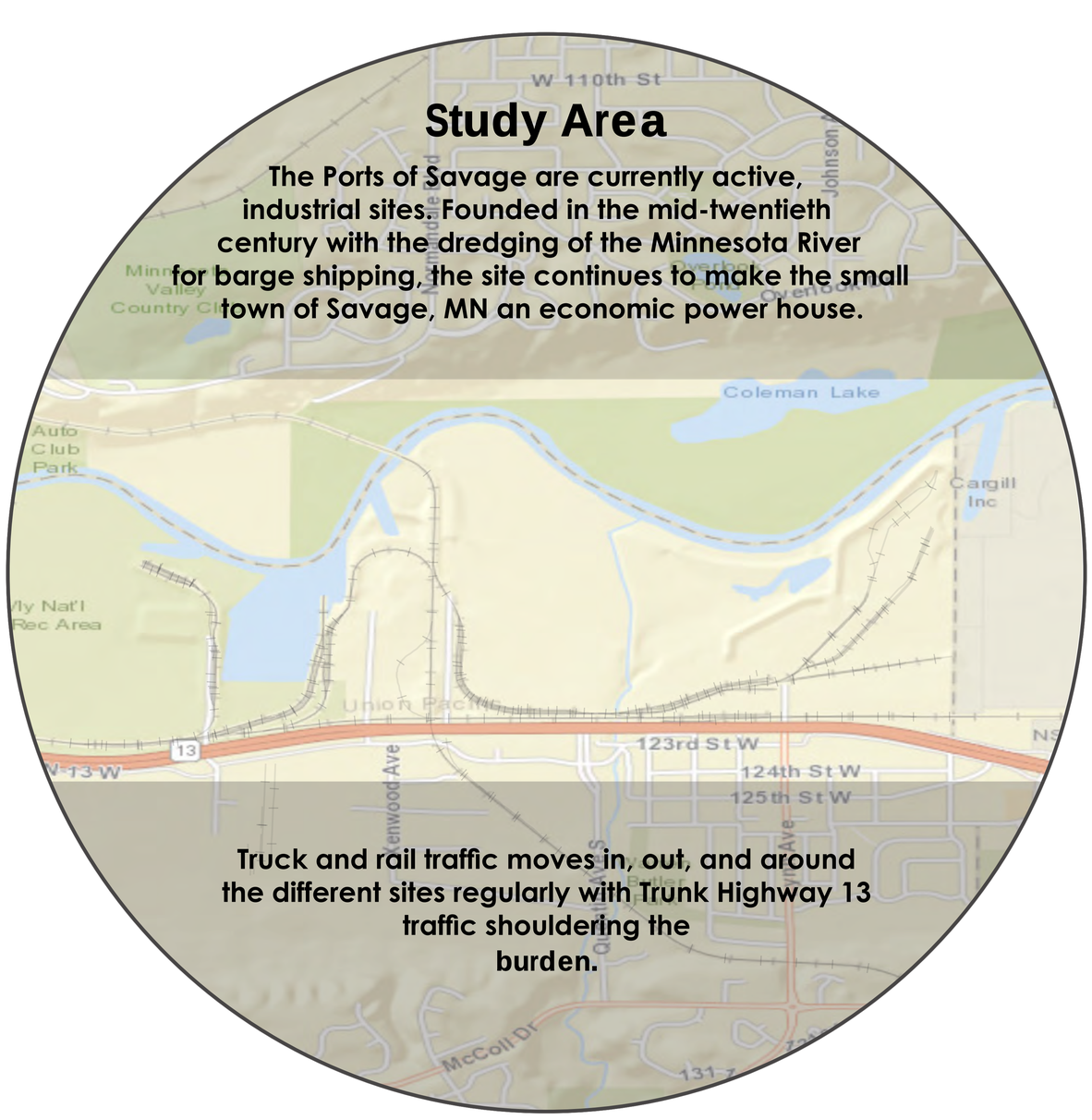
The Ports of Savage have made midwestern grain and mineral products economically competitive for decades. This project reimagines the Ports of Savage by reconsidering their current port/freight land uses through the introduction of connected and autonomous vehicles (CAVs). Our posters explore the port setting and operations, suggest new ways to implement CAVs, and apply MnDOT's CAV Challenge RFP as a visioning framework. **We beging by understanding the existing operations of the port and identifying stakeholders.**



The ports are located close to the Twin Cities to allow ease of shipping to urban jobs but far to maintain a rural character.



Dave lives in Savage and works at one of the ports. He will be tweeting commentary about the proposal as we move along.



Who owns the Ports and what do they do?

The ports are owned by private companies, creating governance challenges.

- Cargill — Shipping goods, research and development, processing goods
- CERES GLOBAL — Shipping goods
- CHS — Shipping goods
- Superior Minerals Company — Shipping and processing goods
- Mosaic — Shipping and processing goods

How will autonomous vehicles change the freight shipping process:

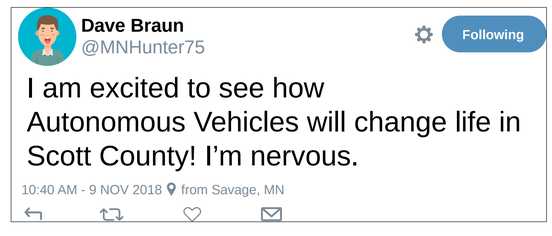
TRANSPORTATION PATTERNS
- Eliminating drivers and their errors
- Changing intersection operations
- Designed long for freight

STREAMLINE DELIVERIES
- Shift schedules to lower-traffic times
- No longer limited by driver schedules

GOVERNMENT REGULATION
- Inspection schedules
- Infrastructure to vehicle communication
- Environmental protection

SHIPPPING EFFICIENCY
- Autonomous barge towing
- Streamline barge tow scheduling

NEXT STOP What **land use changes** will be necessary for a CAV freight/port innovation district and how can we leverage these changes to benefit the community as a whole? We will explore these questions in the following posters.



1. Introduction | 2. Land Use | 3. Local Freight | 4. State Freight | 5. Nat'l Freight | 6. Process | 7. Current Site | 8. Phasing | 9. Proposed Site | 10. Conclusion

PA 5211: Land Use Planning

Shannon Engstrom, Patrick Haney, Jacqueline Nowak, Yuyan Wang | Instructors: H. Fernando Burga, Ph. D, Chris Desroches

Scott | Resilient Communities Project, University of Minnesota

References

Oberle, G (2018 October 11). Personal Interview with Shannon Engstrom, Patrick Haney, Sarah Tschida, Mark Callahan.

Local Land Use

Freight for the Future

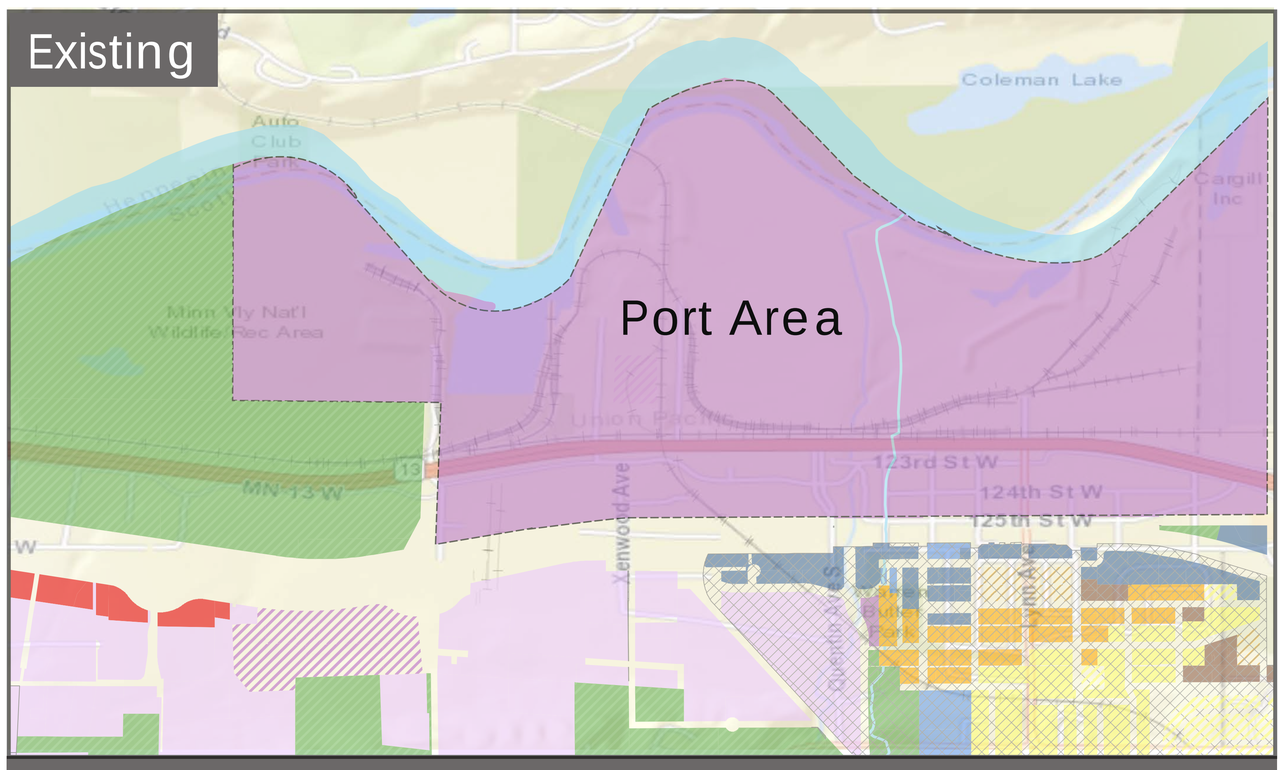
2 SD SCOTT

The land use surrounding the Ports of Savage has inefficiencies. The ports create a buffer between the Minnesota River and the City of Savage, limiting use for residents and visitors. While the size of each port site is large, significant portions of the land are located in the floodplain of the Minnesota River. **Given these constraints, what changes in land use would ensure the protection of the environment, increase access, and provide more benefits to all stakeholders?**

Zoning Near the Ports of Savage: A disconnect?

We propose turning the Ports of Savage (shown in purple as "industrial") and the area surrounding Highway 13 into an **innovation district. This area will allow for more mix of land uses and geared at the needs of both industry and residents as they transition to a CAV future.**

Currently, the corridor uses Euclidian zoning. The introduction of a performance-based code allows for mixed uses.



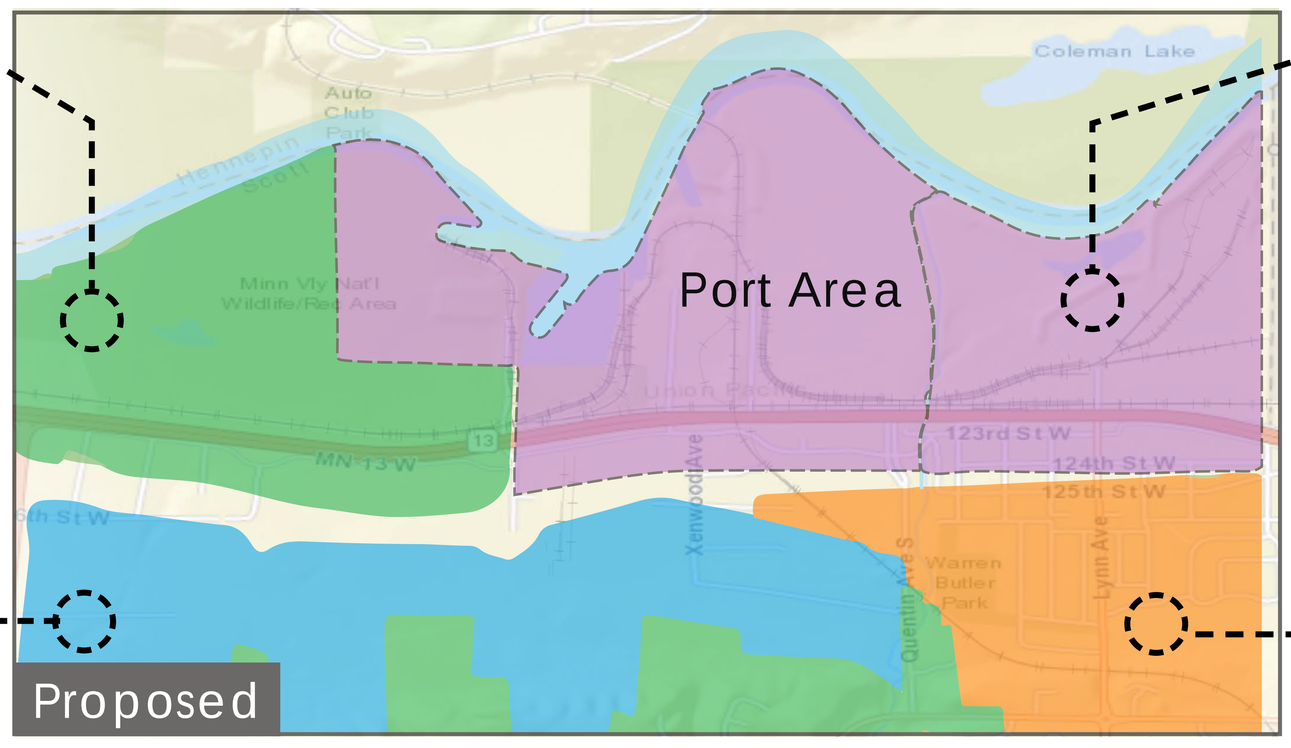
14 ZONES BEFORE — EUCLIDEAN ZONING

Current zoning in and near the Ports of Savage is complex and rigid, ill-suited for the uncertain future of autonomous vehicles.

Existing

4 ZONES AFTER — PERFORMANCE-BASED CODE

The four zones reflect the current community of Savage but push it to be ready for an autonomous vehicle future.



Proposed

- R-1 Low Density Residential District
- R-2 Medium Density Residential District
- R-3 High Density Residential District
- C-1 Neighborhood Service District
- C-2 General Commerce District
- C-3 Downtown Development District
- BP Business Park District
- I-1 Limited Industrial District
- I-2 Ports of Savage Industrial Distric
- P-1 Preservation Open Space Distric
- P-2 Public Buildings District
- PRD Planned Residential District
- PMD Planned Mixed-Use District
- PCD Planned Commercial District
- PID Planned Industrial District
- Hamilton Overlay
- CR 42 Overlay

OPEN SPACE

- Retain open space
- Environmental protection
- Community recreation

ECONOMIC VITALITY

- Multi-family housing only
- High jobs to residents ratio
- Highest allowable Impermeable surface
- Green buffer around existing wetlands
- Trail Acess
- Pollution Limits

FLOOD MITIGATION

- Minimal runoff allowed
- Low-impermeable surfaces
- Strict pollution limits
- Public river access
- Avoid residential use
- Trail access

LIVEABLE COMMUNITY

- Floor-area ratio restrictions
- Mid-impermeable surface allowance
- First floor retail or services
- Open space requirements
- Trail access
- Strict pollution control
- Affordable housing

NEXT STOP The Ports of Savage demonstrate a typical American land use pattern. Making them more flexible can make the ports more open to innovation. Understanding the **current and future needs** of freight operators is important to consider how policy changes.



2. Land Use

PA 5211: Land Use Planning

Shannon Engstrom, Patrick Haney, Jacqueline Nowak, Yuyan Wang | Instructors: H. Fernando Burga, Ph. D, Chris Desroches

Resilient Communities Project
University of Minnesota

1 Preparing Communities for Autonomous Vehicles. Jennifer Henaghan (2018) https://planning-org-uploaded-media.s3.amazonaws.com/document/Autonomous-Vehicles-Symposium-Report.pdf
2 How will autonomous vehicles transform the built environment? Annibel Rice and Adie Tomer (2017) https://www.brookings.edu/blog/the-avenue/2017/10/16/how-will-autonomous-vehicles-transform-the-built-environment/
3 As autonomous cars hit the road, real estate development may take a new direction. (2017) https://www.curbed.com/2017/5/16/15644358/parking-real-estate-driverless-cars-urban-planning-development
4 Performance Zoning: A Reassessment. Martin Jaffe (1993) https://heinonline.org/HOL/Page?collection=journals&handle=hein.journals/planevirw45&id=59&men_tab=srchresults
Asphalt Image: By SeppVei - Own work, Public Domain, https://commons.wikimedia.org/w/index.php?curid=10360400
Diversity Icon: Toilets by HeadsOfBirds from the Noun Project

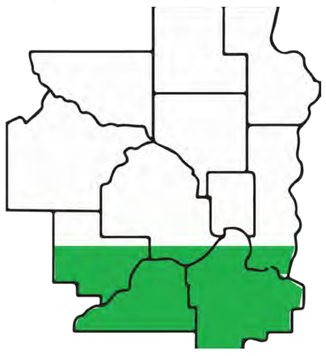
Local State of Freight

3 SD SCOTT

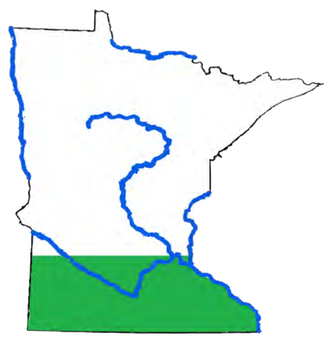
Freight for the Future

The movement of freight through the Ports of Savage is complex. Each port ships its own specific goods including grain, rock, fertilizer, and salt. Some ports ship their products downstream while others have their products delivered from downstream. Goods come in and out on land via truck and rail. Maintaining the efficiency of an integrated rail, road, and river transportation system is critical to keeping local industries competitive. **What are current operations at the Ports of Savage?**

What is the scale of goods moving through the Ports of Savage?



20% of Total Twin Cities Freight

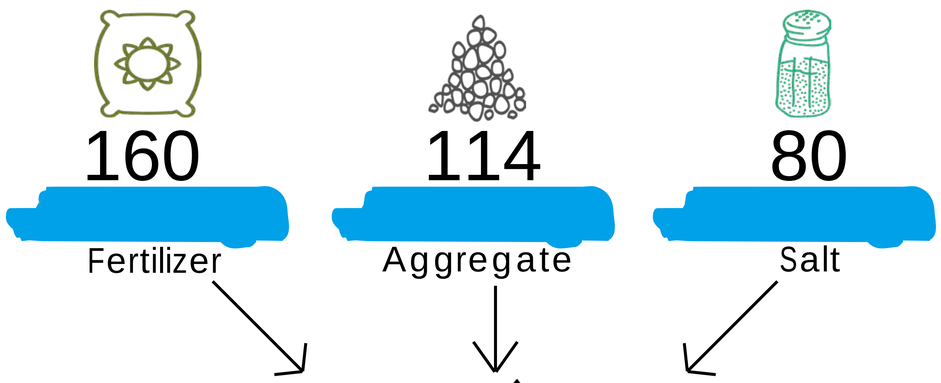


16% of River Freight in MN

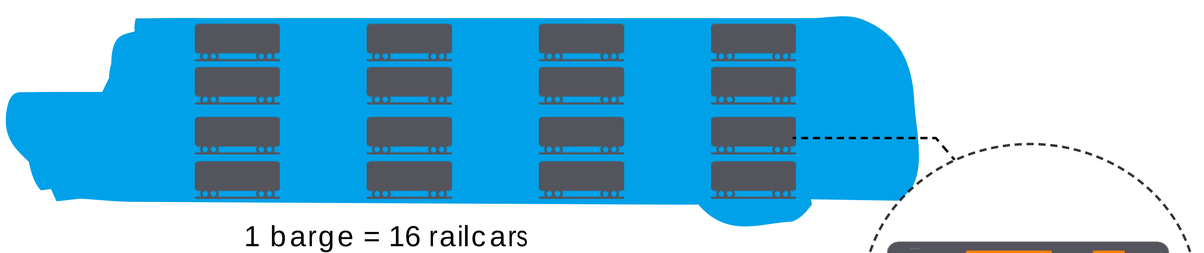


3% of River & Lake Freight in MN

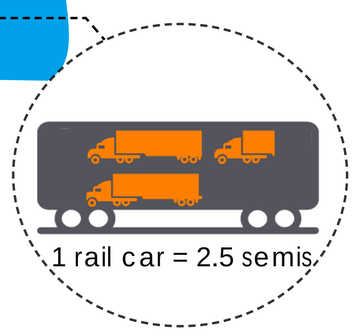
How many trucks do the Ports of Savage keep off roads annually?



How many trucks are kept off the road with one barge?



about 70!



What are operations like at different port sites; how are they similar and different?

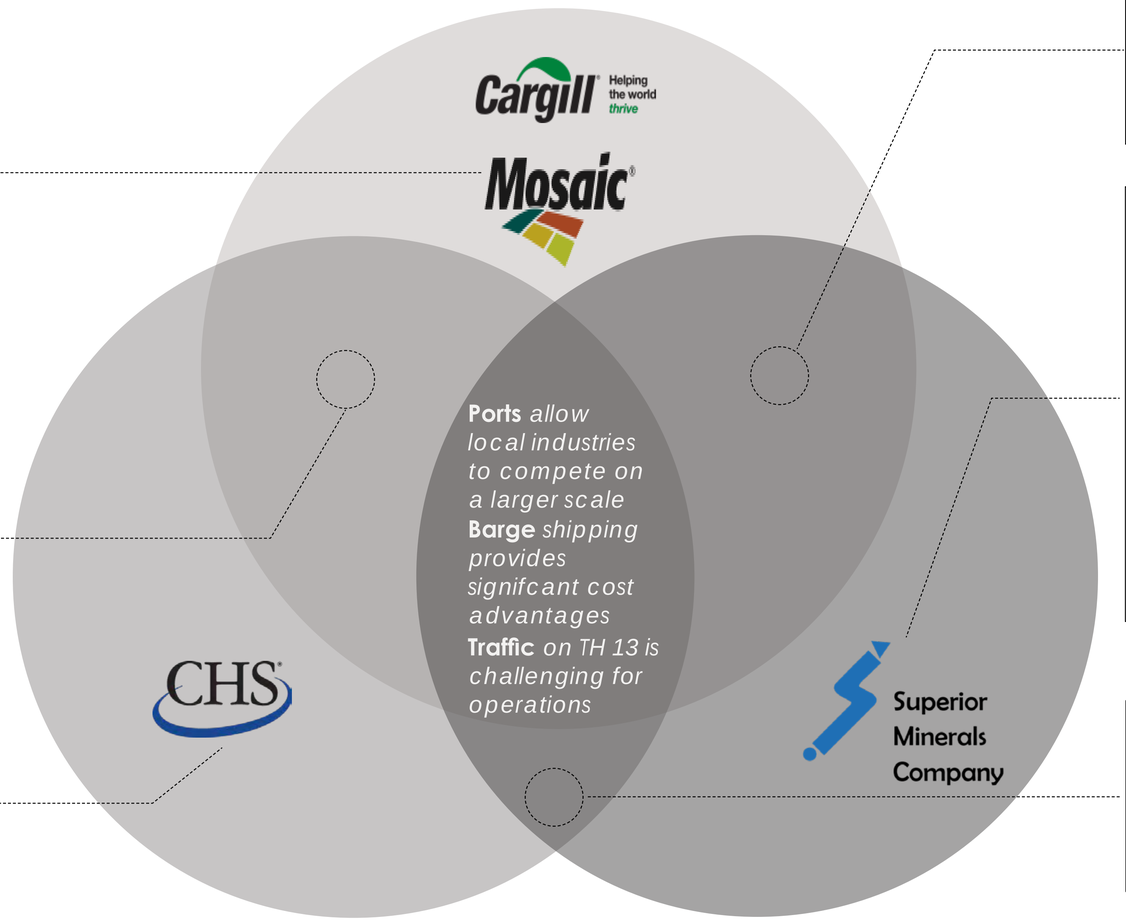
Mosaic Crop Nutrition & Cargill

- Two independent ports share a common site
- They store fertilizer and salt in covered open air structures
- Trucks transport goods from barges to storage
- Rail (including unit trains) bring large amounts of goods
- They sell salt to MnDOT and other entities for maintaining roads
- They sell fertilizer to farming co-ops

- Independent farmers bring grain in their own trucks
- Grain products require inspection
- Grain stored in enclosed structures
- Grain shipped out via barge
- Active rail lines to sites
- Grain primarily travels to New Orleans
- End buyers are global commodity traders

CHS, Inc.

- Site exclusively handles grain
- Low traffic onsite
- Opportunity for innovation district improvements



- Receive goods shipped upriver
- Significant onsite traffic
- Limited government regulation for non-food products

Superior Minerals

- Processing and distribution center for rock too small for other uses
- Empty and clean barges to be grain ready
- Store rock in open piles prior to processing
- Grind rock down onsite for resale
- Buyers of rock products contract fleet services to pick up rock via truck
- End buyers are local asphalt shingle producers and animal feed companies
- No use of rail for shipping

- Sites contain a single industry
- Material transferred onto or removed from barges via conveyor system
- All site functions significantly limited by flooding

NEXT STOP We know the scale of freight traffic in and out of the ports of Savage and how it is transported. Now we turn to freight and autonomous vehicles at the state level and how traffic congestion might change in the near future.





Shannon Engstrom, Patrick Haney, Jacqueline Nowak, Yuyan Wang | Instructors: H. Fernando Burga, Ph. D, Chris Desroches

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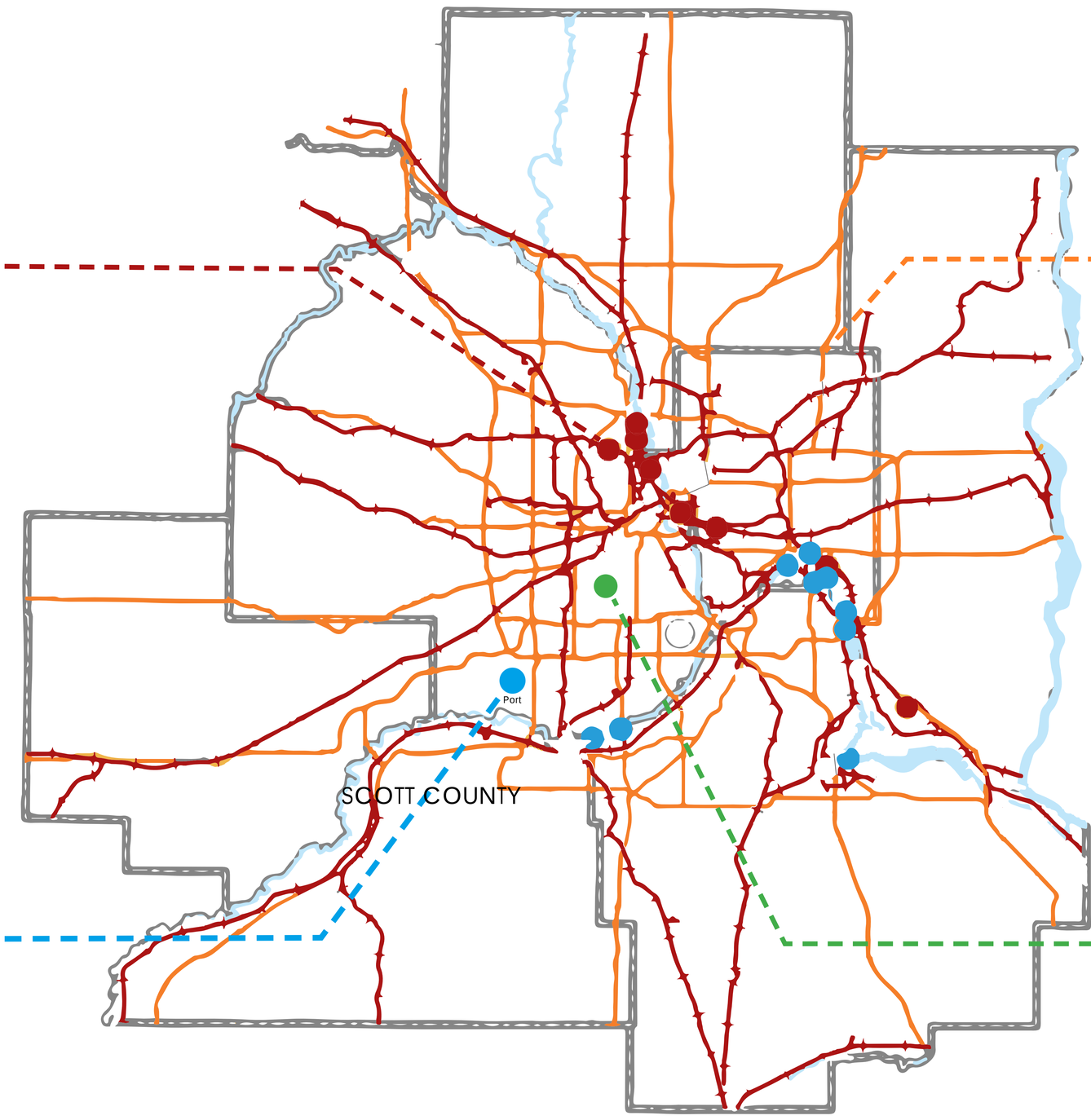
Regional State of Freight

4 SD SCOTT

Freight for the Future

The Twin Cities regional economy relies on the successful operation of its freight system. Businesses of all types send and receive freight regionally and across the country as part of their business operations. There are many components to the Twin Cities freight system, and the system faces potential challenges that might undermine its successful operation. **What are private and public sector groups doing to prepare the freight industry for CAVs?**

The Twin Cities' Metropolitan Freight System



750 MILES of RAILROAD TRACK

- Four out of the seven Class I freight railroads in the United States operate in the Twin Cities.
- Multiple providers create price competition for shipping.
- Any change to the freight system will need to coordinate with rail.

900 MILES of Highway System

- Trucks in the Twin Cities operate on almost every major road and in every industrial area.
- Will be most affected by autonomous technology implementation.
- Expensive in terms of emissions, congestion, and roadway degradation.

1,811 MILES To PORT of NEW ORLEANS

- The Twin Cities is the furthest point commercial river freight can go on the Minnesota and Mississippi Rivers.
- The Mississippi River system forms a path for more than half of U.S. grain.
- Maintenance of the Ports of Savage by the Army Corp of Engineers allows farmers in rural Minnesota and Wisconsin to ship their crops at competitive prices.

229,440 metric tons of cargo pass through MSP in 2017

- Airplanes carry freight primarily into the Minneapolis - Saint Paul International Airport, but six other reliever airports can also provide service.
- Airports provide long distance, but energy intensive shipping.
- Do not directly compete with ports for shipping.

What is the state government's role in the freight industry?

The Governor's Advisory Council on Connected and Automated Vehicles is consulting with stakeholders about the impacts and requirements of CAVS on infrastructure, data privacy and security, registration and regulations, economic development and equity.

DEPARTMENT OF TRANSPORTATION

MnDOT has released a CAV Challenge RFP which requests projects that develop and demonstrate CAV technologies.

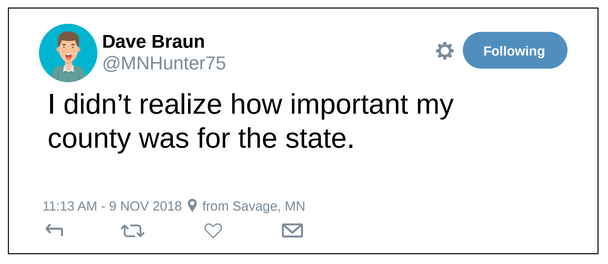
New Technology

Freight will be significantly impacted by new technologies. Testing of new technologies in freight systems is critical to their success and the continued strength of freight industries in Minnesota.

Innovation District

An Innovation District around the Ports of Savage can create opportunities to test technologies and replace lost freight training and education facilities.

NEXT STOP Now that we understand the regional freight system, let's look at the state of freight and CAV **innovation** across the country.



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National Concerns & Solutions

5 SD SCOTT

Freight for the Future

Freight is a turbulent industry without a single leader. This aspect complicates planning policy for both the private industry and public sector. Freight is not going away and has only become more necessary due to the growing demand for first and last mile delivery. The industry is also susceptible to quick changes in market forces due to changes in the political and economic landscape. **What are the key issues facing freight and how might CAVs and operation innovations resolve these issues?**

CAV Challenges & Opportunities

Driver shortage
- Driver shortage over the next 10 years concerns industry leaders
- Increases in wages and benefits have not yet made large improvements
- CAVs could alleviate crisis by changing driver's role

Congestion
- Congestion across the United States has increased
- More time stuck in traffic increases shipping costs and slows down business

Capacity crisis
- Freight that needs to be shipped exceed the number of available trucks and drivers
- Infrastructure has become overwhelmed or has deteriorated
- Some industry leaders blame it on increased regulations

Government regulation
- Labor rules and restrictions designed for safety may be putting a large burden on trucking companies
- Federal Motor Carrier Safety Administration (FMCSA) requires all carriers electronically log their hours and location

Environmental concerns
- According to the UN, freight is one of the biggest polluters of CO2. Industry leaders are likely to implement sustainable practices and electric trucks
- Freight industry may be target of increasing environmental regulations and taxes

Infrastructure Decay
- Infrastructure in the United States is aging and decaying.
- Funding challenges have slowed infrastructure repair

Education
- Flooding delays freight movement through terminals and along routes.
- Roads can close due to water and ports like those Savage may not be able to open due to high water

Current Issues

The CAV Future

Distance-base User Fees
- With more electric vehicles coming now and in the future, transportation departments are testing and considering switching from a gas tax to a distance based user fee.
- This change is likely to help rebuild U.S. aging infrastructure, a key element to a successful freight transportation network.

Urban Freight Delivery
- Many cities, including Seattle and New York, are evaluating their urban freight delivery and land use planning.
- Many cities will be monitoring this research and use their testing as best practices in the future.

Autonomous Trucks
- Likely electric and part of a fleet that is leased to the company or driver, autonomous trucks are already being tested across the country in Arizona and California.
- Freight is predicted to be a driver to autonomous vehicle technology implementation.

Labor
- CAVS will likely reduce the number of drivers needed to operate a fleet of trucks which helps solve the shortage of truck drivers.
- Fewer drivers means lower expenses for transporting freight

NEXT STOP The freight industry is facing serious challenges: CAVs will solve and exacerbate some of them. Now that we understand current freight challenges, let's review our findings, our process and then look at how we can apply some solutions to the Ports of Savage.



PA 5211: Land Use Planning

5. Nat'l Freight

Shannon Engstrom, Patrick Haney, Jacqueline Nowak, Yuyan Wang | Instructors: H. Fernando Burga, Ph. D, Chris Desroches

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Sources:
[1] http://www.logisticdynamics.com/logistics-and-transportation-industry-news-update-2018-q1-highlights/ions
[2] https://www.forbes.com/sites/theyec/2018/02/08/the-four-biggest-freight-transportation-trends-to-watch-for-in-2018/#79c39a2ff16a

Findings and Process

6

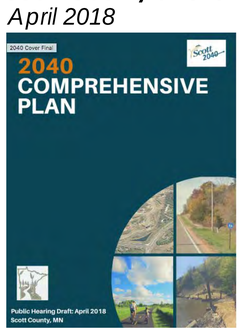
Freight for the Future

Literature reviews, in-person interviews and site visits were critical to our understanding of freight operations at the Ports of Savage. Below we review our process to propose the special innovation district. Given the lack of examples for CAV-oriented port/freight innovation districts, our observations were in the form of many questions. What is the relationship between the Ports of Savage and the surrounding community? How will freight change in rural v. urban America? How can CAVs improve rural transportation network challenges? What are the existing issues at the ports from each stakeholder's perspective (company, government, resident)?

Literature Review

We narrowed our focus for the literature review to local and state documents.

Scott County's 2040 Plan
April 2018



All three comprehensive plans for this area (Met Council, Scott County and City of Savage) mention CAVs and their future changes (pp. 64).

MnDOT Statewide Freight System Plan
May 2016



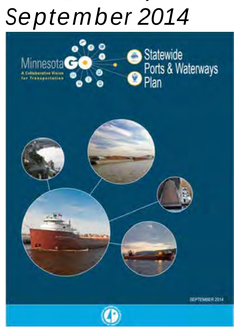
This plan highlights the potential workforce disruptions and solutions CAVs may bring (pp. 20-21).

MnDOT River Terminal Report
March 2013



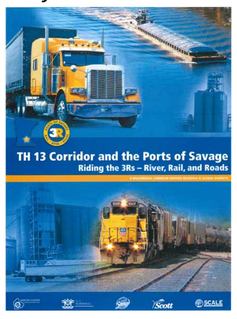
All river terminal facilities in Minnesota are profiled with basic operating facts in this directory listing (pp. 3-4).

MnDOT Ports/Waterways Plan
September 2014



The waterways plan highlights how new connections to national and international markets may open due to technology and infrastructure changes (pp. 55-56).

Trunk Highway 13 Corridor Study
May 2016



Devised to improve congestion on TH 13, the study and the plan that followed is expected to begin construction in 2020 (pp. 2-3).

Site Visits

Three Port operators gave us tours of their facilities so we could better understand their facilities and the operating challenges they face. Port staff gave us personal tours which helped give us insight into how CAVs may change their facilities. Below we highlight each of the three visits and how they are potentially impacted by CAVs.

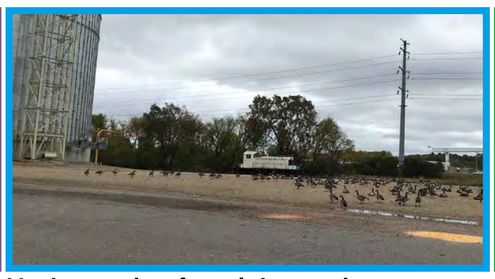
Key

Vehicle to infrastructure communication | Open lots | Automated trucks | Traffic | Safety

Site Visit #1: CHS, Inc.



Grain elevators already have some automation, but how might CAVs increase this?



Vast paved surface lots may be repurposed with the introduction of CAVs due to decreased land requirements.



Safety is a top priority for the ports and CAV technology may improve safety even further.



Currently farmers own and operate their own trucks. Will CAVs change this model?



Trucks are driven over grates to dump their grain. Will those trucks no longer need drivers in the future?

Site Visit #2: Superior Minerals



Crane removes rock from barges and places it on conveyors. This minimizes labor costs which also may happen with CAVs.



Rock is automatically dispensed into trucks based on codes entered by drivers. This process could be completely automated in the future.



Rock is loaded via human-driven loader into machines that grind and separate it by size. This task could be automated in the future.



Sensors on the conveyor automatically prompt it to move once the pile gets too high. CAVs will similarly have automatic adjustments to their environment.



Rock piles are in constantly changing locations. CAVs will be able to adapt to their location in any situation.

Site Visit #3: Mosaic



Trucks are weighed at stations in a largely automated manner. Could CAVs automate this even further?



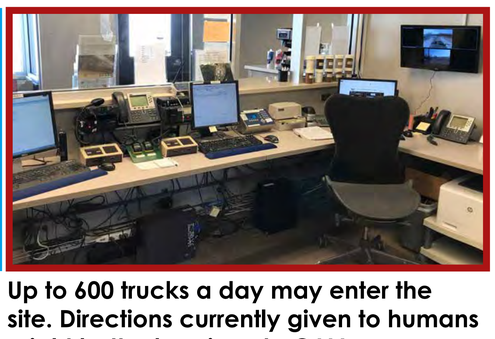
Fertilized is dispensed in an automated manner after manual loading of dispensers. CAVs could continue this automated process.



Mosaic and Cargill share a site and entry from TH 13. CAVs destined for both companies can take advantage of shared infrastructure.



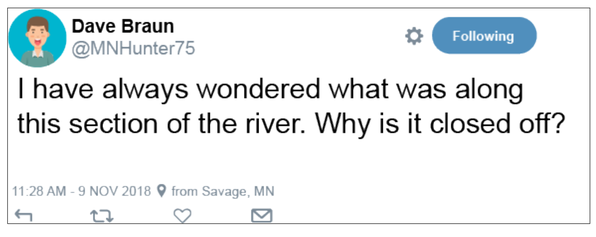
A chaotic environment could be made safer by CAVs.



Up to 600 trucks a day may enter the site. Directions currently given to humans might better be given to CAVs.

NEXT STOP

Our next posters offer a schematic proposal for MnDOT's CAV Challenge. Now that we understand our process and initial findings, let's take a look at the existing conditions.



PA 5211: Land Use Planning

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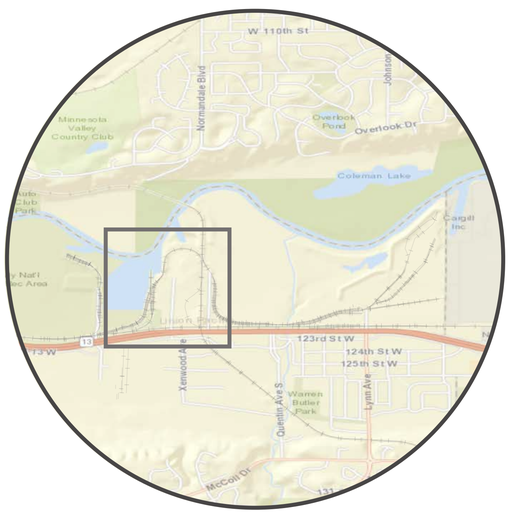
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Existing Conditions

Freight for the Future

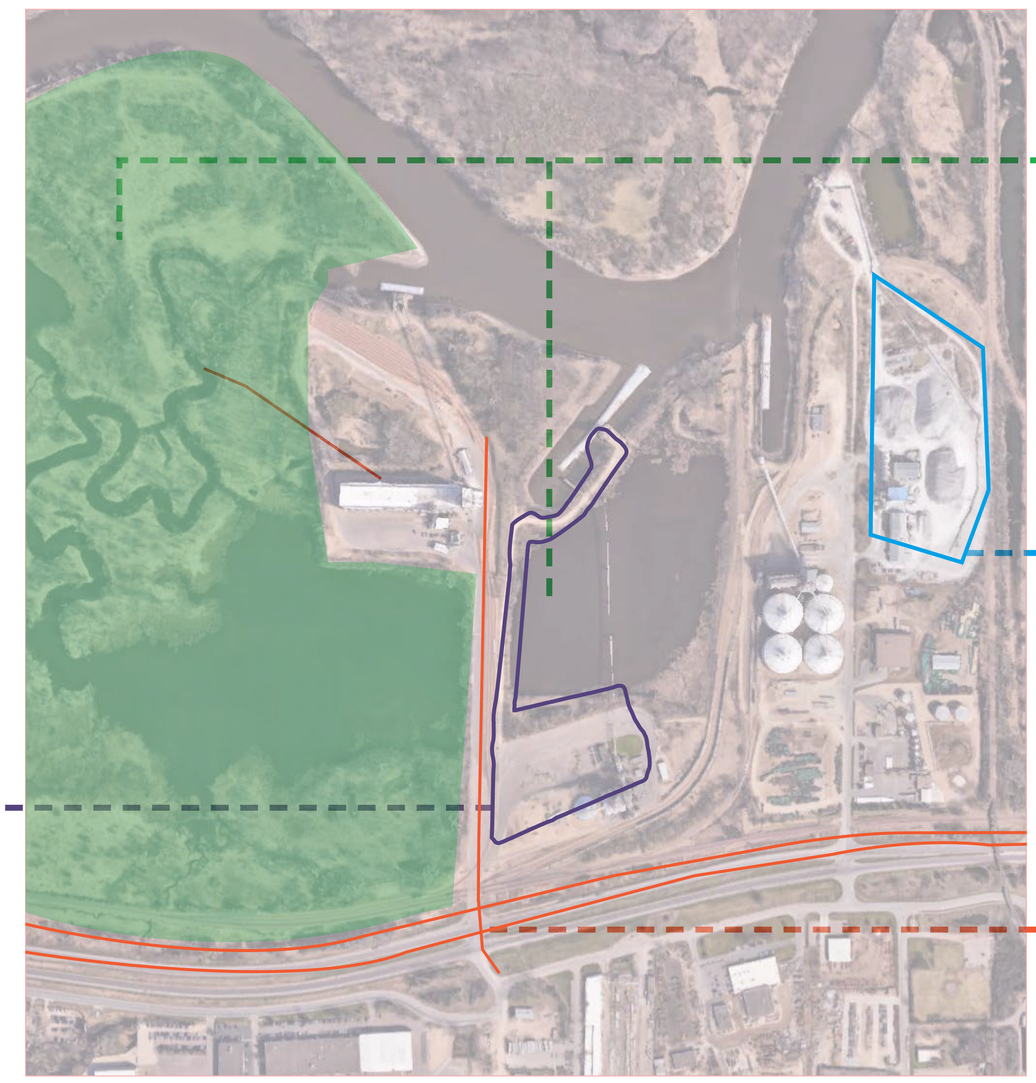
7 SD SCOTT

Each port site in Savage is unique, but they all share common challenges. By using the sub-area of the ports shown below as a case study, we can imagine how solutions can be implemented at other sites. **What are the current challenges that the CAV innovation district may address?**



Why this area?

The area surrounding the CHS site offers an ideal opportunity to connect our land use analysis with the environmental protection concerns. The CHS site itself has simpler operations than other sites as an exclusive grain port, making it a better candidate for safe pedestrian interaction. Much of the space onsite will not be needed with advanced scheduling of deliveries, creating opportunities for new features.



Wetland/Holding Pond

Most of the ports' barge loading facilities are at the end of a drive along a wetland. Significant traffic (and potential for runoff) travels along the wetland. When the river floods, port staffs are unable to access their loading facilities due to the overflowing wetland.

Industrial sites

Roads and rail tracks leading into the sites require significant maintenance, along with storage facilities and offices on the sites themselves. Lack of pedestrian infrastructure on and near the sites inhibits access.

Intersection

The intersection leading to Cargill West and CHS is currently unsignalized. Trucks struggle to make left turns against traffic while travelling in and out of the site. Adding another traditional traffic signal could cause further delay along TH 13.



Environmental Concerns

The riverfront and the adjacent fen wetland serve as important assets to Scott County. Seasonal flooding limits the ability of the ports to predictably transfer freight. Pollution and runoff from paved surfaces can threaten the environment.



Infrastructure Decay

Transportation infrastructure for the movement and storage of freight is expensive and decaying. Infrastructure deteriorates naturally through time and use which means roads and river control infrastructure will need to be replaced. Ultimately crumbling infrastructure will increase costs for freight traffic and limit the capacity of freight that can be transported.

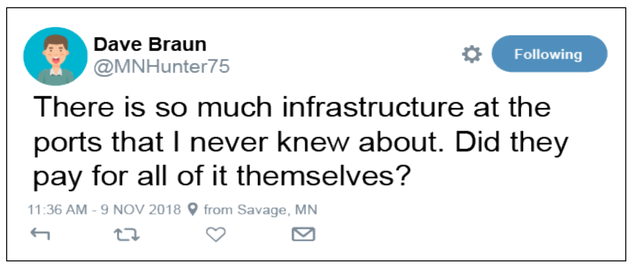


Congestion

Traffic surrounding the site is sure to grow and contribute even more to congestion issues for truck drivers. Congestion delays travel and increases expenses for everybody involved in freight. Congestion will eventually limit the capacity of freight traffic.

NEXT STOP

Numerous challenges are present at and around the CHS site. Solutions brought forth by the innovation district can help improve traffic safety, freight operations, and environmental protection in the area. Next, let's take a look at some specific design scenarios and how they can be implemented over time.



PA 5211: Land Use Planning

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Scott | Resilient Communities Project, University of Minnesota

Freight Innovation District

8 SD SCOTT

Freight for the Future

The Ports of Savage could face dramatic changes over the next several decades as CAV technology develops. There are many ways the sites may change and not every port site in Savage will undergo the same treatment. Rather, design and operational changes can be selected on a case-by-case basis. These changes will be implemented in stages as new technology is introduced.
How could these types of implementation occur in the innovation district?

Phasing

Goals/Purpose	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7
New Intersection Control **Difficult and dangerous turns can be improved to increase safety of freight and passenger traffic.**	TBD	Installation of demand-responsive signal systems at current port entrances.	Integration of vehicle to infrastructure communications at intersections.	Fully automated traffic signal control using reservation-based signaling.			
Smarter Land Use **Less pavement and paved surfaces means reduced construction and maintenance costs. Greater mix means less automobile dependence.**	Rewrite local zoning code as performance-based zoning. Remove parking requirements.	Fully implement permeable surface requirements.		Redesign streets as tracks designed for precision of autonomous vehicles.			
Recreation **Increasing access to parks for Scott County residents will improve health and wellness.**	Include open space requirements in zoning code.	Convert under-utilized parking space to recreation space.	Make riverfront near ports accessible to residents with trails.				
Dynamic Vehicle Fleets **Increasing the utilization of vehicles can be more cost effective and offer goods or services that Scott County residents currently don't receive.**					Develop tow vehicles that can pull goods to and from ports.	Develop passenger trailers to be towed by vehicles already towing goods.	Develop network of transportable services to be towed by vehicles already moving goods and people.
Autonomous Vehicle Outreach and Education **CAVs offer significant economic and quality of life improvement opportunities for all Minnesotans, but only if they know CAVs are available to them.**	Develop mobile CAV exhibit to bring to different events around Scott County.	Use space available at a port site to house exhibit while not on the road.	Continue to update exhibit as new technologies become available.				

At each phase, we might expect...

Phase 1: Pre-CAV
Preparation for CAVs can start today and there are several treatments that can start before CAV are widely adopted.

Phase 2: Intensive CAV Testing
More capital intensive projects can be done in the longer term while CAV technology is still being tested. More efficient use of land and more technologically advanced infrastructure can occur at this stage.

Phase 3: CAVs Commercially Available
When CAVs begin operating and are available to the general public, infrastructure such as intersection controls can be upgraded to integrate seamlessly with CAVs. More land use and education practices can continue.

Phase 4: > 70% Market Share
When automated vehicles have almost universal adoption, governments can change infrastructure such as road lanes due to the precision of automated vehicles. Intersection controls will be fully automated.

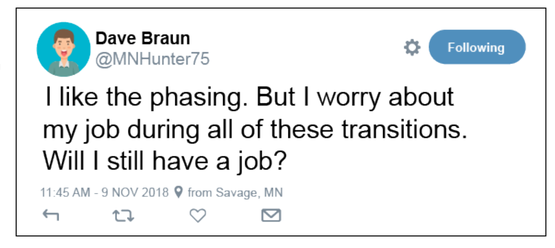
Phase 5: CAV Fleet Companies Emerge
After wide scale CAV implementation, private industry can begin to develop new uses for CAVs to improve efficiencies and reduce costs.

Phase 6: Public CAV Fleet Aquistition
Public transportation could be improved once CAV trucks are perfected and new uses for the vehicles are sought. Private industry will likely lead the way with encouragement or subsidy by the government.

Phase 7: Future CAV Innovation
At the final phase new and innovative forms of vehicle technology can be implemented that benefit private enterprise and the public.

NEXT STOP

CAV innovation will not happen overnight and affected industries and sites will have time to change as new technology is introduced. We've seen one way these changes may be implemented as technology changes but now let's return to the CHS site to see how it may be reconsidered.



8. Phasing

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The Freight Innovation District

9 SD SCOTT

Freight for the Future

With implementation of incremental change complete, the area surrounding the Ports of Savage will be transformed. What was once an overlooked yet instrumental area will be a hub for learning about connected and autonomous vehicles and the importance of freight transportation. **What might the Ports of Savage look like in the future of connected and autonomous vehicles?**



Pedestrian Infrastructure

No pedestrian infrastructure currently exists surrounding the ports. Adding an elevated pedestrian and bike trail around the ports sites, along TH 13, and adjacent to nearby wetlands will help connect pedestrians to both the ports and natural areas.

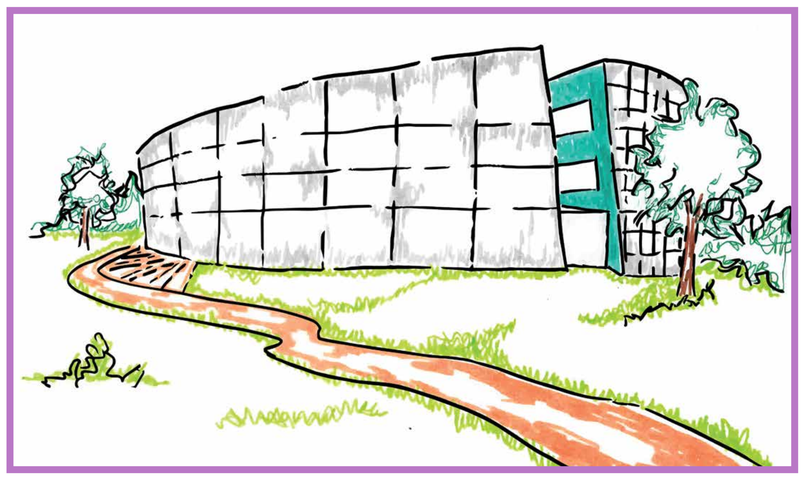




Green Open Space

Much of the land surrounding the ports is wetlands and is not needed for operation of the ports. This space can be better used by transforming unused paved surfaces to natural plantings and whenever safe, opening up the space for the public.





Education Center

As CAVs will reinvent how we look at transportation in the region, an educational component to using and understanding CAVs will serve Scott County well. A museum and educational space can help community members understand the changes and train people to use CAVs. The center can also tie in to new outdoor pedestrian spaces near the river.





New Intersection

The conversion to CAVs will change the infrastructure needs of the surrounding area. CAVs will reduce the amount of paved surface dedicated to transportation and new intersection controls will be needed to connect with vehicles.



NEXT STOP

The proposed changes to the Ports of Savage within the innovation district are exciting but by no means guaranteed. Fortunately, a request for proposal put out by MnDOT could allow for changes to be implemented. Next up, let's look at how this proposal fulfills goals put forth by MnDOT.



9. Proposed Site

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Conclusion

10 SD SCOTT

Freight for the Future

CAVs will cause significant changes in transportation in Minnesota. The Ports of Savage can be reconsidered to adopt CAVs and the changes they will cause. In this poster we connect our previous analysis and proposedal to MnDOT's CAV RFP goals.

Minnesota Department of Transportation CAV Challenge

MnDOT has a RFP for a CAV Challenge to study CAVs on state roads and facilities The Ports of Savage offer a great opportunity to study CAV and the impact freight can have on the regional transportation system. Below are the 5 principles that MnDOT proposes for their RFP and how they connect to our proposal.

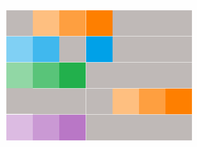
1. How can Minnesota leverage P3s to advance transportation opportunities?

The private function of the ports and the public RFP are an example of a public private partnership. We demonstrate this link throughout our posters.

2. How can Minnesota prepare its infrastructure, policy, and workforce for CAVs?



Poster 2 shows how Scott County can begin to prepare Minnesota for CAV technology.

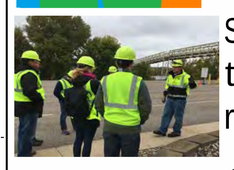


Our phasing of infrastructure improvements for the ports shown in **Poster 8** give an example of how the site can prepare the infrastructure required for CAVs.

3. How can the public better understand the benefits and limitations of CAV technology? How can the state provide opportunities for the public to give input, experience CAV technology first-hand, and provide feedback?



Scott County residents will be able to give input and feedback to CAV related changes as related in **Poster 2**.



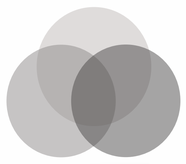
Scott County residents will be able to give input and feedback to CAV related changes as related in **Poster 2**.



Our findings shown in **Poster 6** explain how the benefits and and potential impacts of CAV technology will impact the site.

The education center shown on **Poster 9** can be a hub for teaching new information related to CAVs.

4.What ways can the state allow private industry opportunities to test and deploy advancing CAV technology?



The Ports of Savage are privately owned and **Poster 3** shows how they can benefit from opportunities to deploy CAV technology.



The national concerns of the freight industry shown in **Poster 5** demonstrate how private industry can aid from CAV technology.

5. How can the state accelerate implementation of CAV technology?



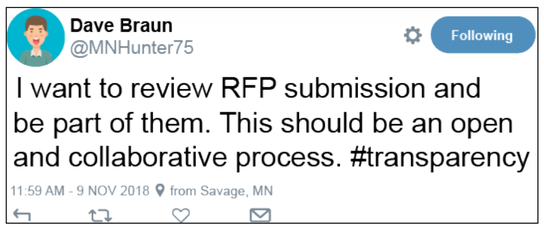
As shown in **Poster 4**, the regional freight system can benefit from an accelerated implementation of CAV technology.



The existing conditions of the ports can be challenging as displayed in **Poster 7** and the accelerated implementation of CAV technology can assist.

LAST STOP

CAVs change the freight community. Scott County along with the Ports of Savage can benefit when adapting to these changes by planning ahead and considering phasing in policy and infrastructure improvements. Preserving the surrounding natural environment and providing an educational component to the area will ensure Scott County has a successful transition as the technology is adopted.



10. Conclusion

PA 5211: Land Use Planning

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Planning for Disruption

The Journey Begins

1 T5/T6 mpls

Equitable CAVs on Washington Avenue and Lake Street

The American Planning Association predicts that highly and/or fully Connected and Autonomous Vehicles (CAVs) could represent a **quarter of our vehicle transportation systems within 15 years**[1], yet cities have been slow to plan for CAV deployment. Minneapolis is no exception. The general manager of Metropolitan Transportation Services recently stated that "**any change in investment to autonomous vehicles is a long way off and priority will remain on... preservation of our current infrastructure**."[2] With CAV implementation approaching, now is the time for Minneapolis to consider opportunities and vulnerabilities to ensure optimal outcomes.

Project Goal

CAVs are only mentioned once within one policy of the Minneapolis 2040 Plan. **This project illustrates how Minneapolis can leverage the adoption of CAV technology to further their 2040 Comprehensive Plan Goals.**

Moving Forward

We will develop design scenarios showing AV adoption along **Washington Avenue (T6)** and **Lake Street (T5)**, accompanied by policy recommendations for the Minneapolis 2040 Plan. The design scenarios will be informed by an analysis the **Minneapolis 2040 Plan** in relation to CAV adoption and the current **demographic and physical conditions** of the key corridors. This approach allows the consideration of the **equity impacts** of CAVs-driven changes in each context.

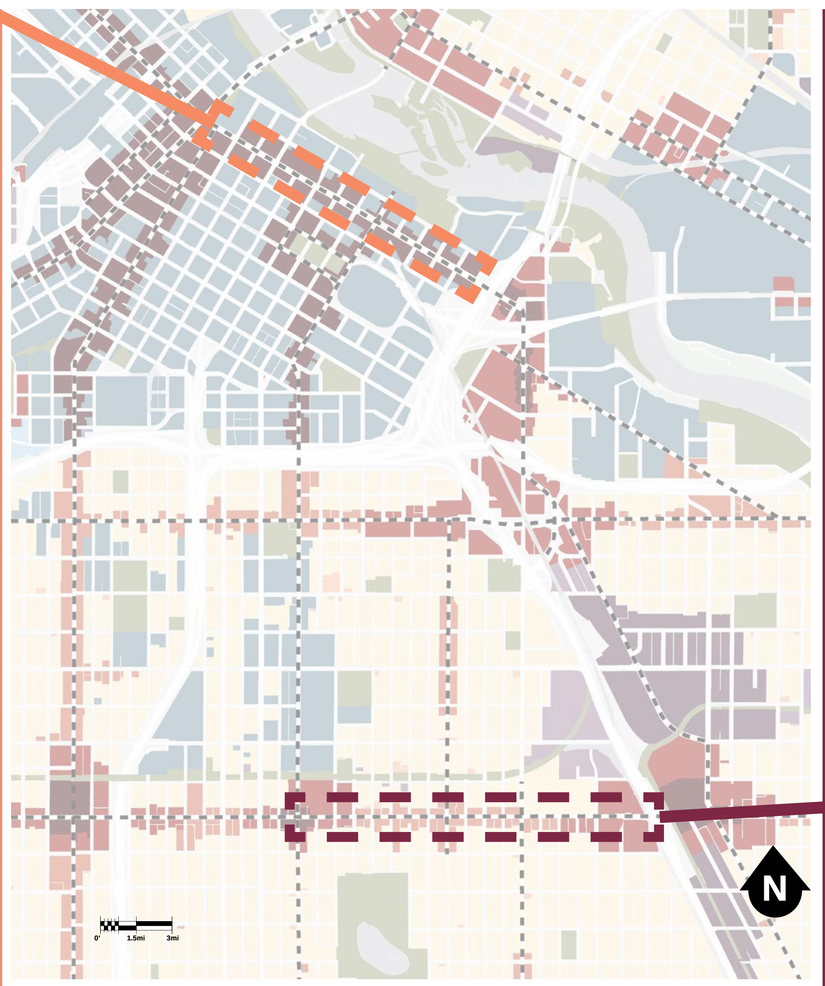
The Corridors



Typical View of Lake Street Looking East

Washington Avenue

The Transect 6 analysis is of the Washington Avenue corridor between **Hennepin Avenue and I-35**. This section of Washington runs through a dense urban core that will likely be an **early adoption site** for CAVs. The Minneapolis 2040 Plan envisions this corridor as one of the **densest parts of downtown**, a **destination area** with diverse uses. As CAVs play a larger role in access, Minneapolis must consider who will be included and who will be left out of innovation.



The Future Built Form Map from the Minneapolis 2040 Plan above shows the location of the Washington Avenue and Lake Street corridors in relation to one another. An in depth explanation of the map is on Poster 3



Typical View of Lake Street Looking East

Lake Street

The Transect 5 analysis is of the Lake Street corridor from **Chicago Avenue to Hiawatha Avenue**. This section of Lake Street is a commercial corridor running through urban neighborhoods with a high percentage of **immigrants, people of color, and low-income residents.** It is a **destination for surrounding residents** to access local businesses, services, and transit options. These characteristics create opportunities to adopt CAVs by supporting local businesses and serving people who are often left out of the planning process.

Guiding Questions

How will CAVs challenge current policy and planning strategies?

Why is it important to consider CAV adoption in comprehensive plans?

What aspects of the Minneapolis 2040 Comprehensive Plan can benefit from CAV adoption?

What opportunities does CAV adoption present for increasing equity?

How will CAVs alter current activities and land uses?

What are each area's demographics?

What commercial, cultural, and transit hubs exist long each corridor?

What are current conditions regarding transit, land use, public realm, and green space?

What future policy solutions are available?

What are examples of positive CAV-driven changes to the public and private realm along each corridor?

How can these changes be phased in the short, medium, and long-term?

What policies are needed to promote the realization of these scenarios?

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Citations: 1) Crute et al. 2018 "PAS Report 529: Planning for Autonomous Ability." American Planning Association 2) https://metrocouncil.org/News-Events/Transportation/Newsletters/Planning-for-a-future-with-autonomous-vehicles.aspx

Planning for Disruption

Comprehensive Planning

2 T5/T6 mpls

How can comprehensive planning guide the forthcoming CAV disruption?

Despite the imminent arrival of CAVs, few comprehensive plans currently contain CAV policy language. Some cities include CAV-related policies in their transportation plans; however, the potential disruption caused by CAVs extends far beyond transportation.

The American Planning Association (APA) defines a comprehensive plan as **"the foundational policy document for local governments. It establishes a framework to guide public and private decisions about future growth, preservation, and change within a municipality or county over the next 20 to 30 years... discuss[ing] a wide range of economic, environmental, and social topics that affect the sustainability of a community."**[1]

Only **5%** of the 500 largest cities in the U.S. have AV-related policies in place.[2]

Potential Outcomes of CAV Disruption

Experts predict that CAVs will operate under a **shared fleet model**; they will require fewer and narrower lanes than driven vehicles; and that they will be electric. These assumptions frame the potential for wide ranging impacts on areas traditionally included in comprehensive planning.

Potential NEGATIVES

Land Use:
Increased sprawl due to ease of travel

Environment:
Increased VMT & emissions due to ease of travel

Transportation:
Less funding for transit systems

Health:
Negative public health impacts due to decrease in active transport

Equity:
Unequal adoption locations that increase disparities in transportation access

ANALYSIS

While the nature and impacts of CAV rollout are largely unknown, planners and policymakers can guide their adoption towards positive outcomes.

Potential POSITIVES

Land Use:
Repurposing formerly car-dominated spaces

Environment:
Rideshare, electrification reduce VMT & emissions

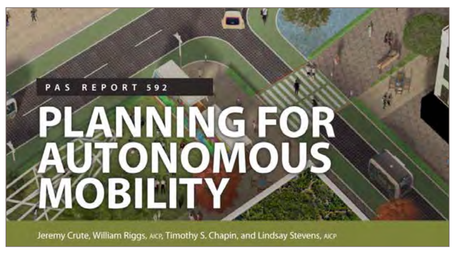
Transportation:
Reclaimed public right of way for pedestrian/bike/transit

Health:
Positive public health impacts due to Improved traffic safety, better active transport infrastructure, and increased public green space from reclaimed ROW

Equity:
Improved transit access for less mobile populations, and improved access to opportunity[2]

Precedent Policies and Standards

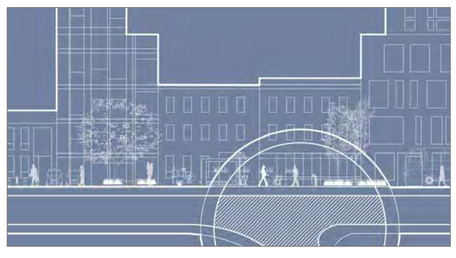
While precedents for comprehensive plan policies addressing CAVs are lacking, there is guidance from transportation experts at the national and state levels. The concepts derived from these documents guide our thinking throughout this project.



Planning for Autonomous Mobility: This APA report synthesizes current research on the benefits, challenges, and opportunities that CAV adoption will create, and suggests ways that planners can respond.[3]



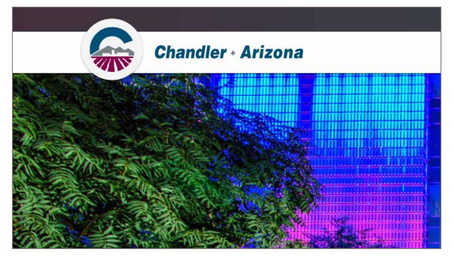
US DOT Comprehensive Guide: The Guide provides a framework and multimodal approach for the safe integration of CAVs into the Nation's broader surface transportation system.[4]



NACTO Blueprint for Autonomous Urbanism: The Blueprint illustrates policy goals for CAVs using renderings and diagrams, providing alternative visions for the future.[5]



MNDOT Advisory Council: The Governor established a task force that has completed recommendations for various policy adjustments throughout Minnesota to prepare for CAV deployment. [6]



Chandler AZ Zoning Code: Local municipalities are beginning to rethink parking requirements and to develop pick-up and drop-off zones ahead of CAV deployment. [7]

Comprehensive Planning Policy Implications

By considering CAV adoption in comprehensive planning, cities can ensure that the introduction of CAVs supports rather than hinders the achievement of comprehensive planning goals. Next we turn to the analysis of the corridors that define our transect zones. Afterwards, we investigate how CAV adoption can support the goals of the Minneapolis 2040 Plan and how we can apply an Equity Lens to planning for a CAV future.

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Citations: 1) American Planning Association 2) APA PAS Report 592 https://www.planning.org/publications/report/9157605/ 3) Planning for Autonomous Mobility: APA PAS Report 592 https://www.planning.org/publications/report/9157605/ 4) US. DOT Preparing for the Future of Transportation https://www.transportation.gov/av/3 5) NACTO Blueprint for Autonomous Urbanism https://nacto.org/publication/bau/blueprint-for-autonomous-urbanism/ 6) MN DOT Task Force http://www.dot.state.mn.us/automated/advisory.html 7) Chandler Arizona Zoning Code https://www.chandleraz.gov/government/departments/development-services/planning-and-zoning/zoning-code-and-zoning-code-amendments

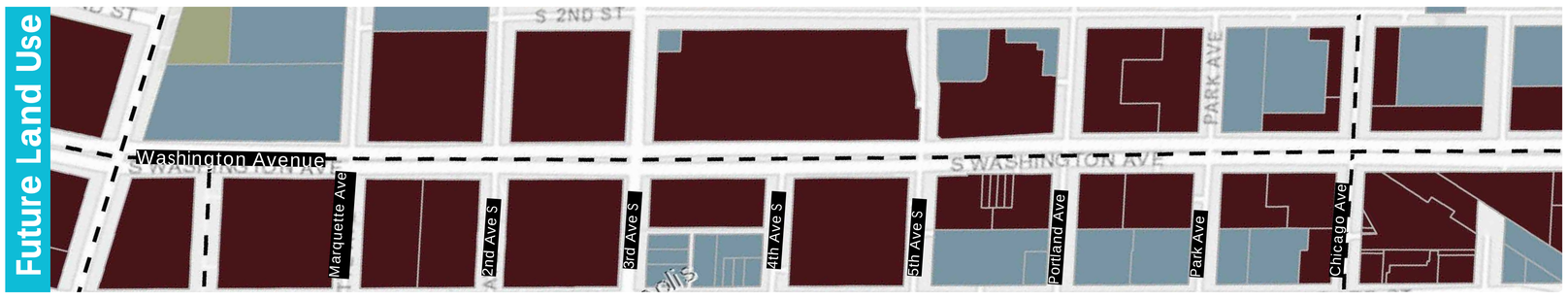
Planning for Disruption

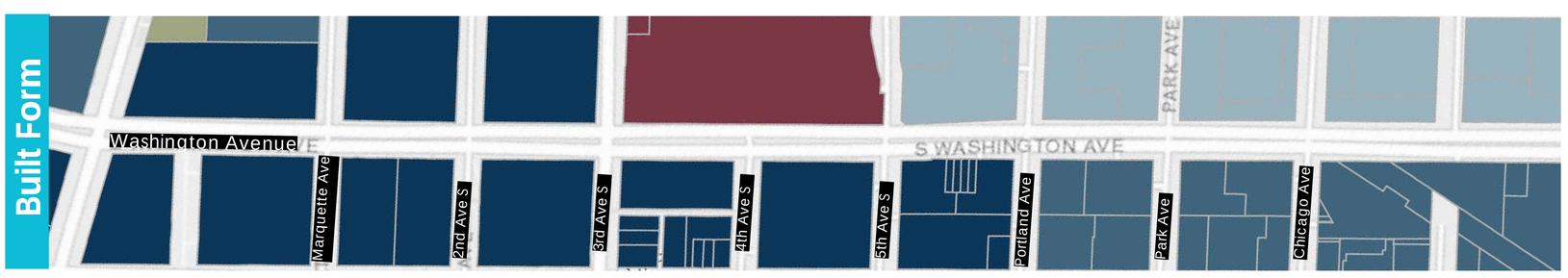
Land Use & Built Form Analysis 3

T5/T6 mpls

The Future Land Use and Built Form maps in the Minneapolis 2040 Plan illustrate the city's vision for the use and scale of future development, in pursuit of the of housing, employment, transportation, and transit access goals for all by 2040. The Future Land Use map guides types of uses allowed on a parcel, and the Built Form map guides the scale of development allowed on a parcel. CAV policy must consider the guidance of the 2040 Plan to insure that CAV-driven changes enhance the anticipated future conditions of the area.

Washington Avenue Maps (T6)





Two mixed-use categories along the corridor:

Destination Mixed Use: commercial retail at street level

Public, Office, Institutional: Offices; public/ semi-public uses (museums, hospitals, civic, etc.); multi-story residential permitted, mixed-use encouraged.

A variety of building types on moderate and large lots, with multiple buildings per block, and heights that vary as follows:

Core 50: 10 story min.

Transit 20: 2-20 stories

Transit 30: 2-30 stories

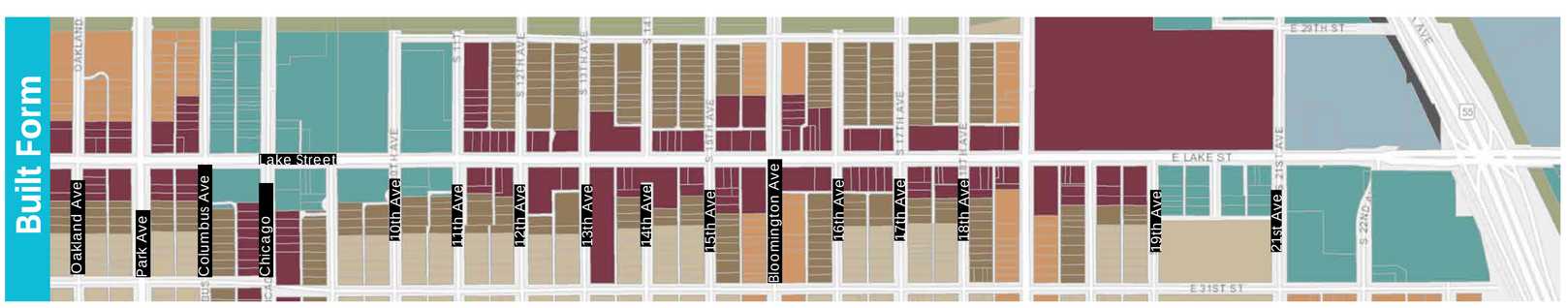
Corridor 6: 2-6 stories

CAV Implications

This stretch of Washington Avenue is mostly designated "Destination Mixed Use," surrounded by Public, Office, and Instituional uses. The requirement for street-level commercial retail, and the high-density built form types, allow continued development into a destination corrridor with high traffic from pedestrians, transit riders, and drivers throughout the day. **CAV implementation creates opportunities to further improve multi-modal transit infrastructure, enhance the pedestrian experience, increase and diversify business and housing types, expand green space, and create a more pleasant environment for those who live and spend time in the area.**

Lake Street Maps (T5)





Three mixed-use categories dominate the corridor:

Destination: Commercial retail at street level

Community: Active, public uses at street level

Corridor: Mixed use encouraged

Urban Neighborhood: Residential; scattered institutional, semi-public uses

Built form is designated through a variety of building types on moderate and large lots, with multiple buildings per block, and hights that vary as follows:

Transit 10: 2-10 stories

Corridor 6: 2-6 stories

Corridor 4: 14 stories

Interior 2: 1-2.5 stories

Interior 3: 1-3 stories

CAV Implications

This stretch of Lake Street is designated as "Mixed Use" types, surrounded by "Residential Urban Neighborhood". While considerably less dense than Washington Avenue, the 10- and 6-story height allowances of the "Transit 10" and "Corridor 6" districts will allow increased residential and business density along what is already a local destination corridor. **CAV implementation creates opportunities to reclaim auto-dominated space for bike infrastructure, improved pedestrian and business environment, recreational and social spaces, and improved transit access for surrounding residents.**

Land Use & Built Form Policy Implications

CAV policy for both corridors should support a **"Complete Street"** vision that prioritizes active transportation and transit over single-occupancy vehicles, requires safe and efficient pick-up and drop-off zones, and ensures that improvements to the public realm support local businesses and make streets more accessible and welcoming to all users. We will explain these concepts further in Posters **9-20**.

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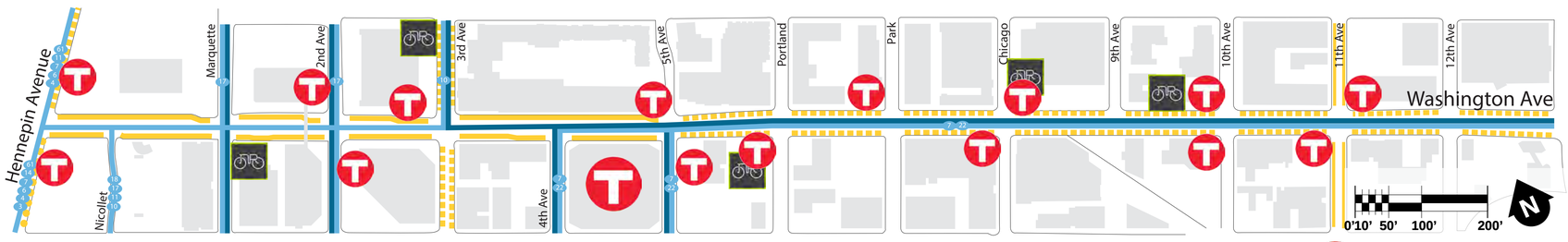
Planning for Disruption

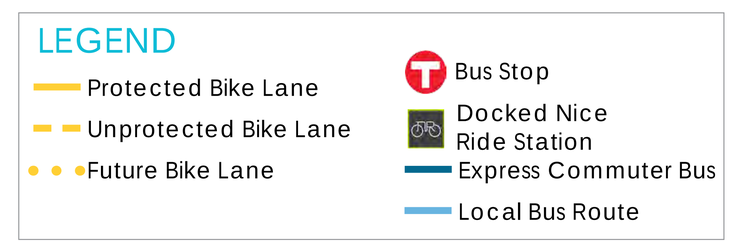
Washington Corridor Analysis

4 T6 mpls

The current conditions of Washington Ave will inform where CAV impacts will be most positive or negative in the corridor. In this poster, we analyze transportation, land use, and open space conditions in the corridor to identify locations for our design scenarios.

Transportation & Mobility





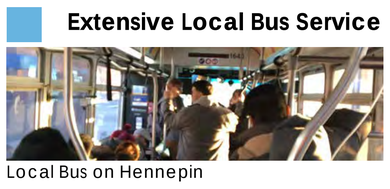
Extensive Bike Access



Off-Street Bike Lane

Bike routes and Nice Ride stations are located along, through, and surrounding the corridor.

Extensive Local Bus Service



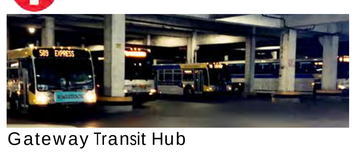
Local Bus on Hennepin

Express Commuter Routes



Marq2 Express Routes Photo Credit: Metro Transit

Transit Hub

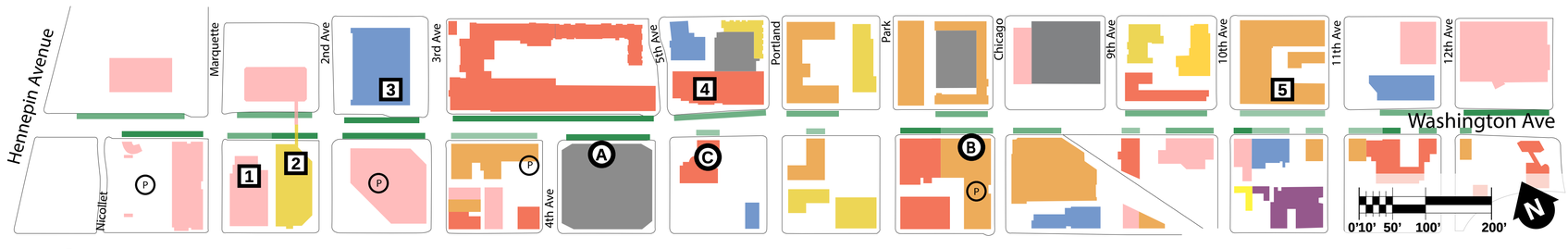


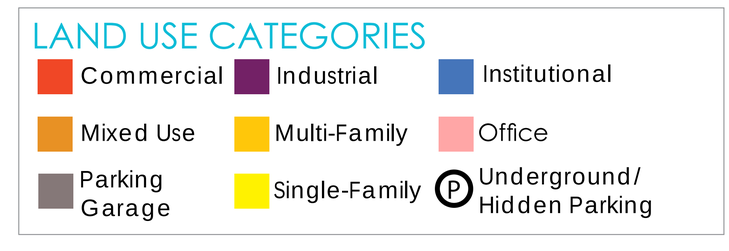
Gateway Transit Hub

Express and local bus routes dissect the corridor, connecting the surrounding city and metro area to downtown Minneapolis. A future BRT line planned for Hennepin will increase access.

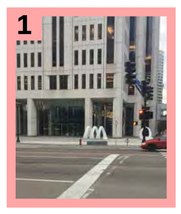
With highway access near on both ends of the corridor, Washington is a major thoroughfare for cars, express buses, and freight. CAV implementation can decrease car traffic and increase efficiency for the other transportation modes. There are various uses and destinations along and adjacent to the corridor that increase local bus, bike, and pedestrian access. There is an opportunity to establish pick-up/drop-off zones for CAVs that coincide with transit hubs.

Land Uses & Frontages



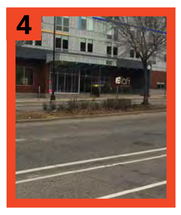


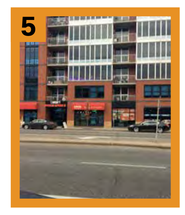
Land Uses







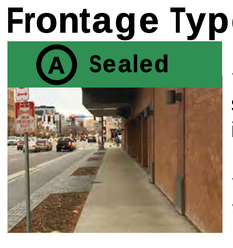




Land Use categories create different frontages types and pedestrian environments along the corridor.

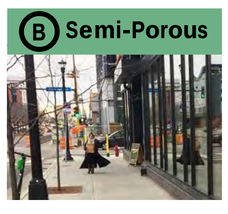
Frontage Types

A Sealed



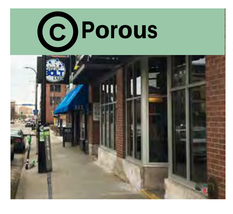
No interaction with the sidewalk. There is typically a continuous wall of brick or windows.

B Semi-Porous



Provides windows to the sidewalk, few access points and adequate sidewalk space.

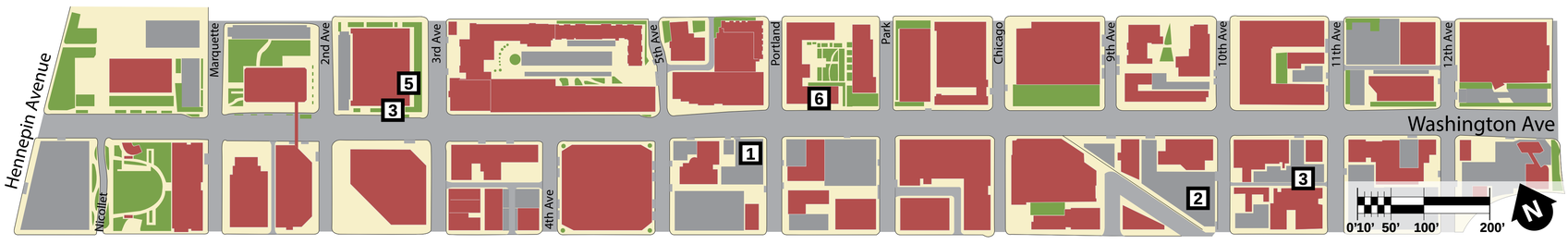
C Porous

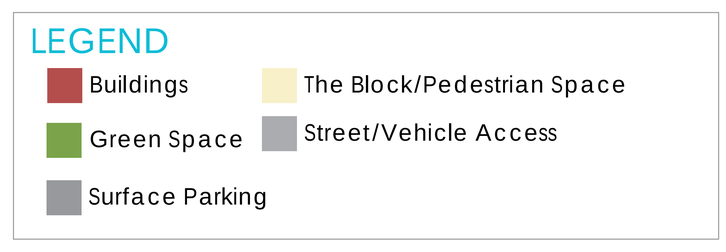


Interacts with the sidewalk, provides access points to the building.

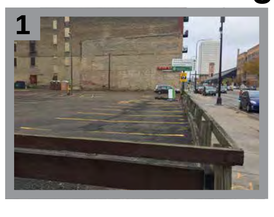
Land uses define travel behaviors and destinations along Washington. Office, institutional, and residential uses generate traffic at typical rush hour periods of the day. However, commercial and mixed uses generate traffic throughout the day into the late evenings. We can look at frontage types to inform where the pedestrian experience can be improved.

Pavement & Green Space





Surface Parking





If CAVs decrease the demand for parking, large swaths of the corridor will become ripe for development.

Internal Right-of-Way



Many alleys providing access to parking will be available for new uses and development opportunities.

Green Space







The majority of greenery along the corridor is squeezed along the Right-Of-Way or on the frontages of parcels.

If CAVs decrease pavement requirements, they could create more substantial green spaces along the corridor to improve pedestrian experience. Though Gold Medal Park is just a block away, it does not compensate for the abundance of surface concrete along Washington. As the required right-of-way shrinks, there is also potential to include natural storm water treatment systems along the corridor to protect water quality of the Mississippi River.

Washington Corridor Analysis Implications

The maps presented in this poster will inform the locations and goals of our design scenarios. There are many characteristics in the Washington corridor that could be improved by CAVs.

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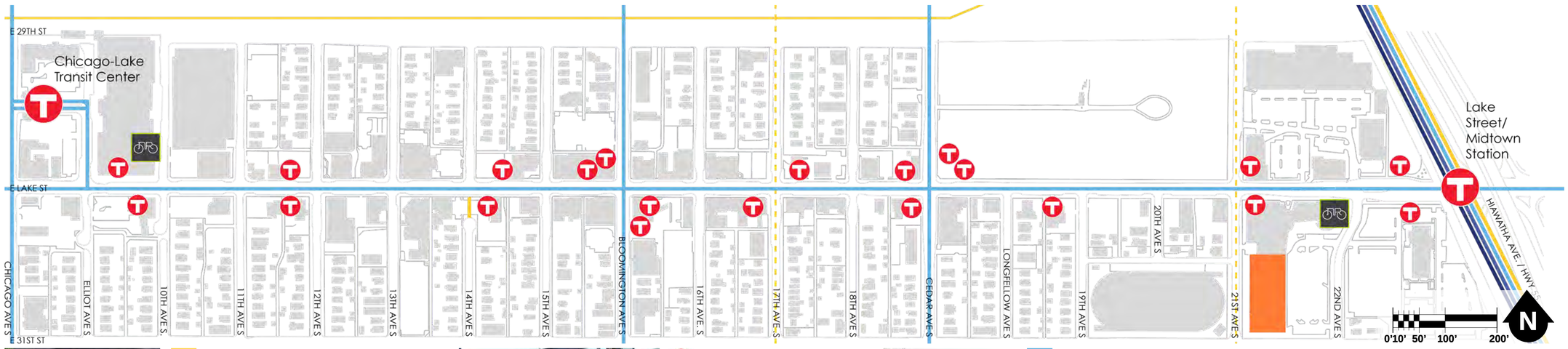
Planning for Disruption

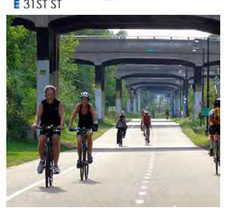
Lake Street Analysis

5 mpls

The Lake Street corridor runs from the edge of St. Louis Park in the West to the Mississippi River in the East. We have selected a small segment of the larger corridor to analyse from the perspectives of land uses, transportation infrastructure, and green space. Due to challenges described in previous posters, we will be using the following analyses to understand how this area is likely to be impacted by CAVs and inform the design scenarios in later posters.

Transportation & Mobility





Bike Access

NiceRide Stations, on-street bike lanes and the Midtown Greenway make up the bike infrastucture along Lake Street.

Midtown Greenway



Transit Access

Two tranvsit hubs for buses and lightrail bookend this segment of Lake Street.

Lake Street/Midtown Station



Local Buses

The only local, high-frequency bus that travels the length of Lake Street is Route 21.

Local Bus Traveling Route 21

With only one local bus route and no separate bike lanes, transportation along Lake Street is car-centric. Lake Street is bisected by local and express bus lines, and LRT transit. There are two Transit Centers located in this section of the corridor. The Midtown Greenway runs parallel a block north, and Nice Rides are available.

Land Use & Frontages





Frontages

Midtown Global Market is one of several mixed-use building with porous frontages. These spaces are less common along Lake Street.

Midtown Global Market

Lake Street has minimal lots with residential uses but large numbers of commercial, industrial, and institutional uses. The surrounding neighborhood is heavily residential making walkability to these locations critical to ensure the access. As evident by the frontage conditions, walkability could benefit from the activation of pedestrian space and the reduction of auto traffic. The frontage types vary from industrial and commercial developments that have sealed frontages and porous frontages that have intentional public uses (such as the Midtown Global Market).

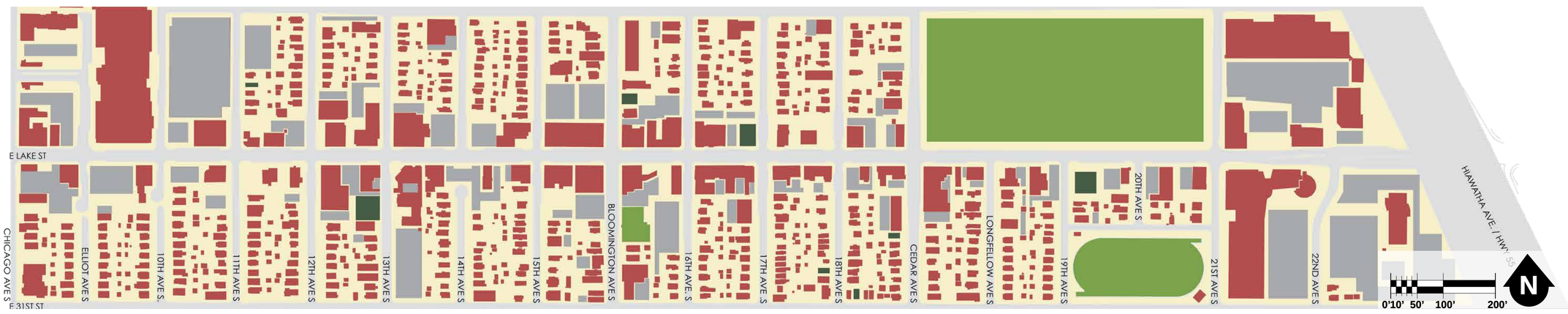
Frontage Types

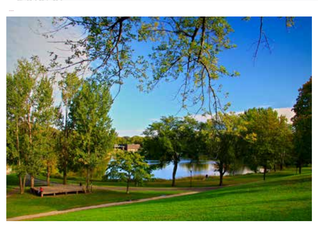
A Sealed
No sidewalk interaction and no dedicated public space.

B Semi-Porous
Interaction with sidewalk, no designated public space.

C Porous
Interaction with sidewalk, windows, and designated public space.

Pavement & Green Space





Green Space

Lake Street has minimal green space along the corridor but is served by several large parks, including Powderhorn Park, two blocks south.

Powderhorn Park



Surface Parking

Lake Street has large amounts of surface parking that could be transformed into new uses or green space if CAVs decrease the demand for parking.

Parking Lot along Lake Street Corridor

The volume of parking spaces along the corridor indicates that the area is car-centric. When compared to that of Washington Avenue, the amount of green space along Lake Street is minimal, and not necessarily accessible to the populations in the area (such as a graveyard and a high school track). The increase in permeable and geen space with the advent of CAVs could improve the green space along the Lake Street corridor, but equity concerns about gentrification and increased rents for local businesses would need to be considered.

Lake Street Corridor Analysis Implications

Due to the businesses, transportation, and central location, Lake Street is a popular destination within the midtown area. If CAVs bring increased mobility and green space, local stakeholders should be engaged to identify new policies and strategies. Policies involving CAVs would benefit from using existing infrastructure and other local resources in addition to the design of new informal spaces, and the increase of green space along the corridor.

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Planning for Disruption

Washington Demographics

6 T5/T6 mpls

Who will benefit from the CAV disruption on Washington Avenue?

Photographic Timeline



Lithograph of the Mill District ca. 1985



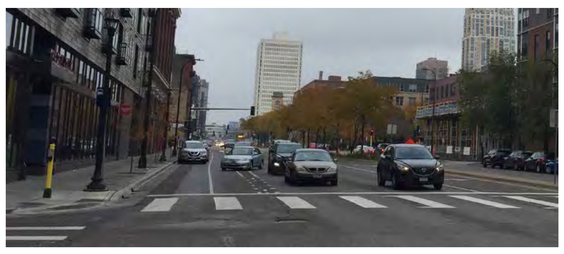
View of the west side Mill Distrcit looking northeast ca. 1904



Surface parkng along the north side of Washington Avenue looking east ca. 1997



The Mill District in mid-development in 2007

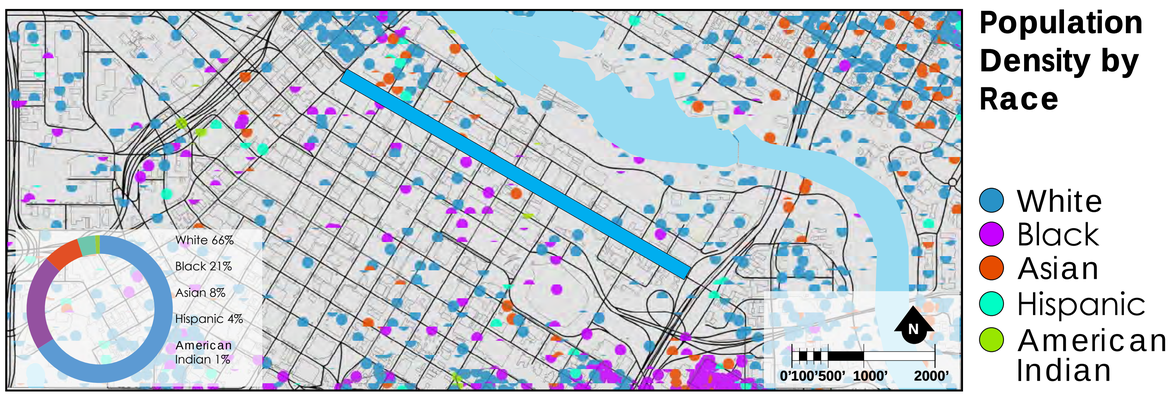


New residential units along Washington Avenue looking west

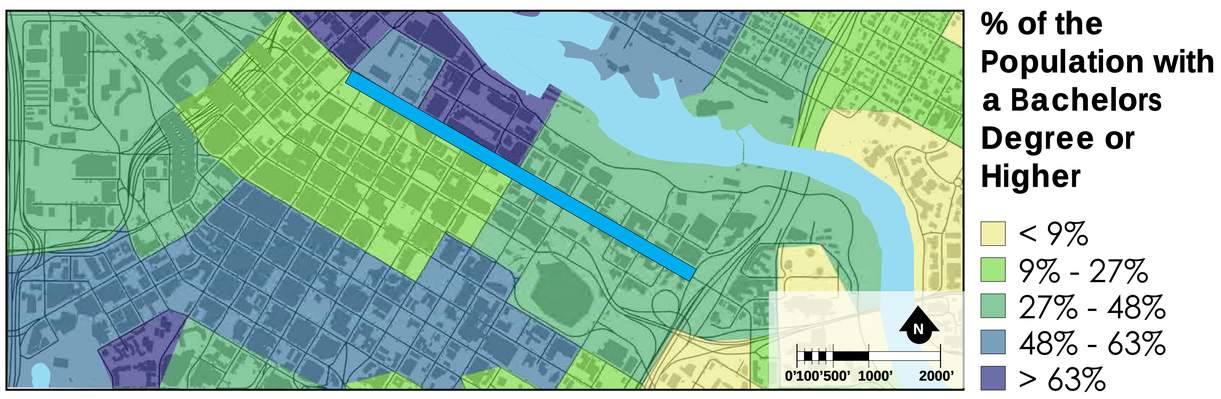
The Industrial Heart of Minneapolis

This poster examines S Washington Avenue from the end of Cedar Avenue over 35W heading northwest until Hennepin Avenue. As part of the former Mill District, the area was the center of Minneapolis' flour milling industry and the home of working class residents. Washington Avenue was demolished during the "Urban Renewal," of the 1960's. The rail lines that once served the mills were severed by the construction of the Metrodome in 1979 and by 1990, the area was lined with surface parking lots. In the late 90's the city focused on revitalizing the area, turning old factories into expensive lofts and offices.

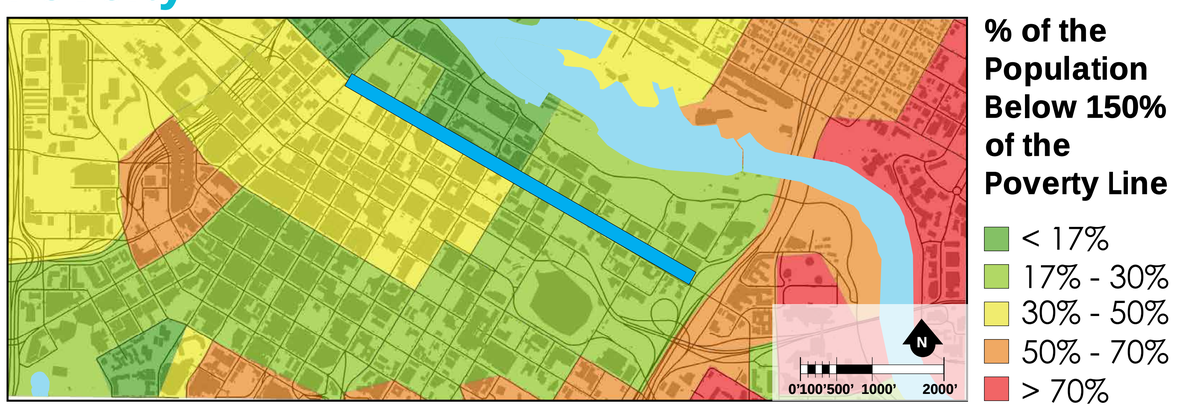
Race



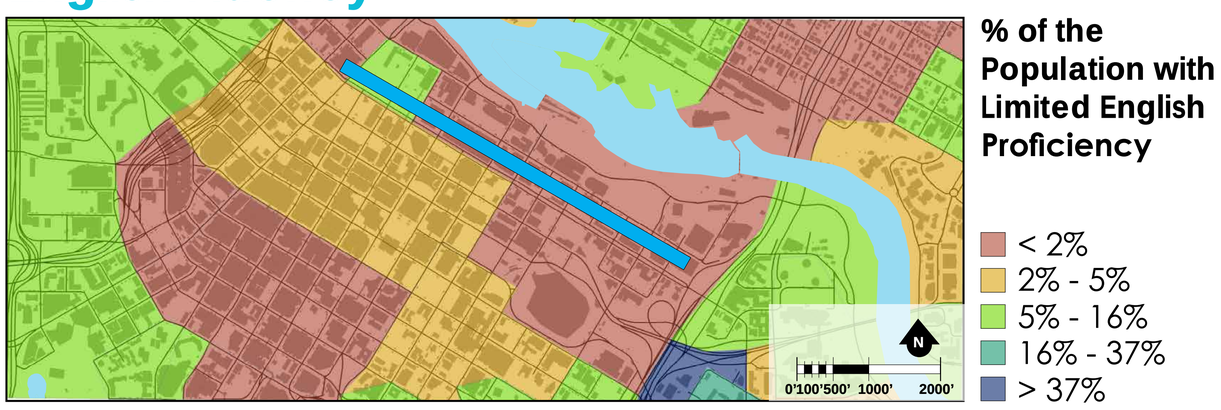
Education



Poverty



English Fluency



Demographic Findings

Washington Avenue is sparsely populated, but there are concentrations of white residents on the west end in condo developments across Hennepin Avenue. **Other populations an even mix of white and black residents** in South Downtown and the heavily Somali Cedar Riverside neighborhood.

While most of downtown is relatively affluent, the areas across I-35W and in South Downtown have high levels of residents living below 150% of the poverty line.

CAV Implications

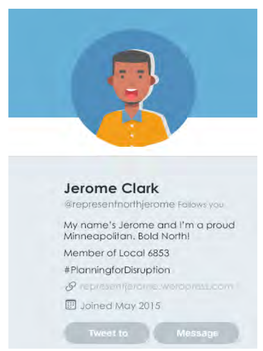
The impact that CAVs have along Washington Avenue will effect how it relates to the less prosperous communities around it. Currently **development has focused on serving the wealthy and white population of Downtown.**

If Washington Avenue is redeveloped with increasing spacial equity and affordability in mind, it can become a diverse destination for all of Minneapolis.

Washington Avenue is not primarily a residential district, and will be the destination rather than the origin of CAV trips.

Washington Avenue Demographic Analysis Implications

Recent development around Washington Avenue has created a place with income and racial disparity.
Will AV networks serve areas where low-income people of color in Minneapolis live, work, and play?
Or will their expensive prices further isolate these communities from harnessing them?
If the area is adapted for CAVs without equity goals in mind, marginalized groups will continue to closed off from downtown. In our design scenarios we will explore this question through the voice of our equity figure, Jerome Clark.



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Source: American Community Survey 2016 5-year Estimates
Photo Sources: Photo by Bobak HaZri / CC BY
West Side Milling District by U.S. National Park Service Historic American Engineering Record
Lithograph of the Mills District, 1895, Library of Congress
Photo byMinneapolis Department of Economic Development
New Residential Units by Megan Reineccius

Planning for Disruption

Lake Street Demographics

7 T5 mpls

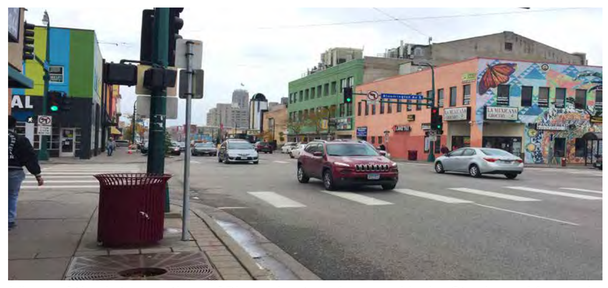
Who will benefit from the disruption of CAVs on Lake Street?



View of intersection at Lake St and 13th Ave in 1972 looking East bound.



View of intersection at Chicago and Lake St in 1953 looking South bound.



View of the intersection of Bloomington Ave and Lake St where Mercado Central and Plaza Verde are located in 2018.



Exterior view of the Midtown Global Market on Lake Street and 10th Ave in 2018.

Industrial Past

In the late 19th century, Minneapolis underwent a wave of immigrantion from Norway, Greece, Sweden and Denmark. **In 1881, the Chicago, Milwaukee, St. Paul and Pacific Railroad Corridor, a railroad system used to transport goods in the midwest, was built near Lake Street.** Manufacturing, industry, and wholesale goods turned Lake Street into an immigrant gateway. Over the 20th century, many immigrants established their own businesses--some of which still exist today.

In the late 20th century, there was an influx of Latino and East African immigrants who sought refuge or migrated to Minnesota. During this period, Lake Street was stigmatized by poverty and crime. Community and economic development strategies were deployed to deal with that stigma and uplift its people.

In 1997, Mercado Central was built establishing economic progress for Latinos residing near Lake St. Inspired by the Mercado Central

Race



Population Density by Race
- White
- Black
- Asian
- Hispanic
- American Indian

Education



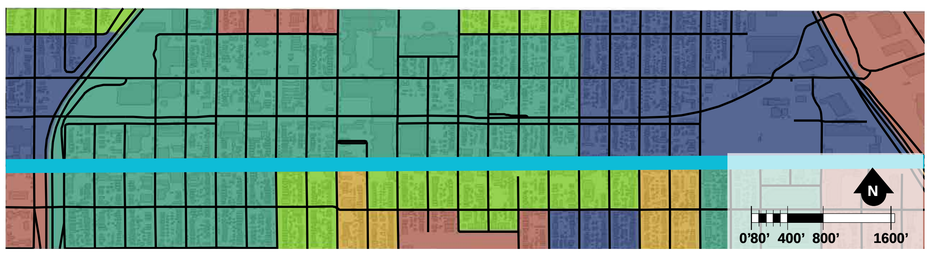
%of the Population with a Bachelors
- < 9%
- 9% - 27%
- 27% - 48%
- 48% - 63%
- > 63%

Poverty



% of the Population Below 150% of the Poverty Line
- < 17%
- 17% - 30%
- 30% - 50%
- 50% - 70%
- > 70%

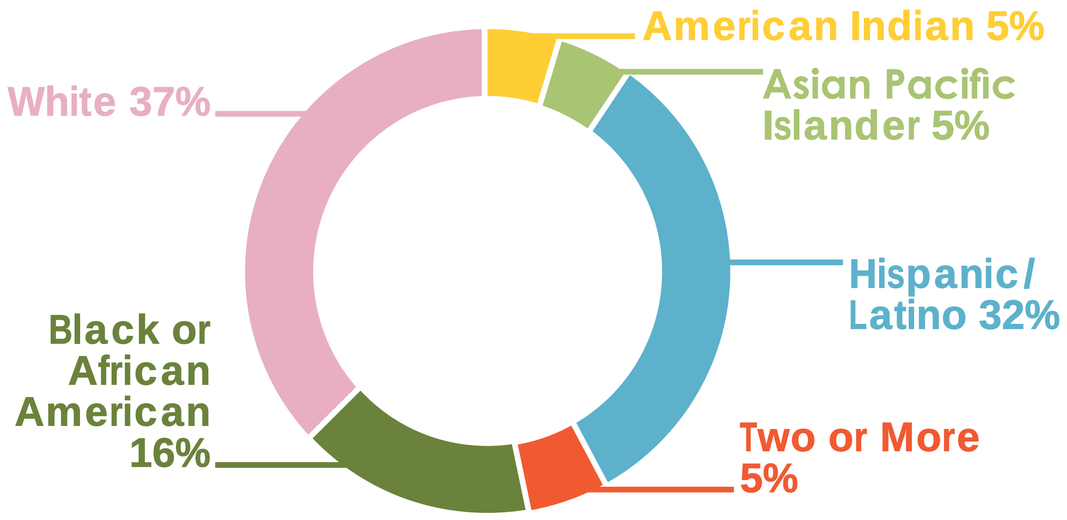
English Fluency

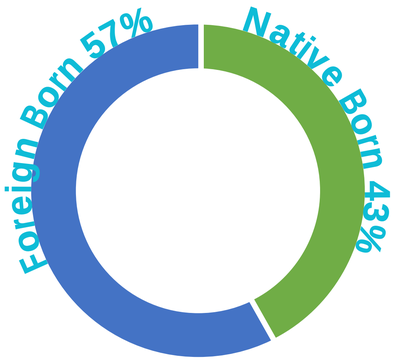


% of the Population with Limited English Proficiency
- < 2%
- 2% - 5%
- 5% - 16%
- 16% - 37%
- > 37%

Demographic Findings

The demographics around the Lake Street Corridor indicate that about 63% of the population are people of color, who are living below the poverty line. About 57% of the population is foreign born, as compared to 15% overall foreign born in Minneapolis, who are not naturalized and mostly Latino. It is reasonable to assume that a large portion of the population are undocumented and documented immigrant population living along Lake Street.



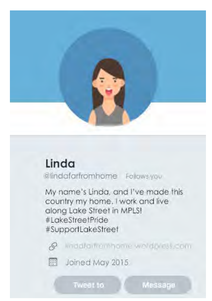


CAV Implications

CAVs will effect the lives of immigrants, documented and undocumented, who live and work along Lake Street. Immigrant businesses in particular, may be impacted by CAVs. Planning policy should ensure the sustainability of immigrant businesses, and foster economic growth. Redesigned areas along Lake Street should not be commodified in a way that makes Lake Street inaccessbile due to potential gentrification. Lake Street should preserve its cultural integrity.

Lake Street Demographic Analysis Implications:

The Lake Street corridor has been, and currently is, an immigrant destination filled with with a diverse population and immigrant owned-business. The introduction of CAVs will impact the current population and landscape of Lake Street Planning Policy must be implemented to ensure an equity. Our Equity Figure, Linda will help us understand the equity implications of CAVs and our design scenarios.



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Source: American Community Survey 2016 5-year Estimates

Planning for Disruption

CAV Equity Goals

8 T5/T6 mpls

In coordination with our corridor and demographic analyses, we developed an equity lens to inform the forth coming design scenarios and uplift the concerns of our equity figures. The equity lens is derived from the Minneapolis 2040 Comprehensive Plan, an **Equity Outcome Framework** and CAV implications.

Mpls 2040

According to the Minneapolis Director of Long Range Planning, the 2040 Plan aims to **Increase Agency** in the City.[1] This refers to dignifying marginalized communities by increasing their ability to engage with their public officials, advocate for themselves, and have access to choices. Agency is improved with access to housing, work, and transportation. In addition, the 2040 Plan aims to "[eliminate] deep rooted disparities in wealth, opportunity, housing, safety, and health" among race and ethnicity as stated in Goal 1: **Eliminate Disparities**.[2]

Equity Outcomes[3]

Equitable outcomes must be preceded by equitable processes. First, we must realize **Inequity** is the result of government policies and citizen action. The inequities need to be specifically identified and placed within society. Then, the **Communities** harmed by those inequities must be involved in creating potential solutions. Lastly, solutions must be **Reparative** actions comparable in impact to the harmful actions that created the inequity.

CAV Implications

Poster 2 described the potential positives and negatives of **CAV Impacts**. There are several pros and cons concerning land use, the environment, transportation, public health, and equity. It is important for policy makers to have these effects in mind to steer CAV deployment toward beneficial outcomes and avoid pitfalls.

Equity Goals

The design scenarios will be guided by the imperative to address socio-economic disparities in Minneapolis and achieve equitable outcomes. We have identified 5 **Equity Goals** that CAV deployment can impact on as well as their tools:

Improve the Environment

Policies that include the fair treatment and meaningful involvement of all people regardless of race, color, national origin, disabilities, or income with respect to the development, implementation, and enforcement of environmental laws, and regulations. (Environmental Protection Agency, 2015)

2040 Comp Plan Goals:

- (5) **Healthy Safe and Connected Communities**
- (10) **Climate Change Resilience**
- (11) **Clean Environment**

POTENTIAL TOOL

Impact Fees:

Fees on proposed development projects to pay for required public services or for mitigating negative externalities. Funds could be used to create green space to improve water and air quality.

Support Existing & Diverse Economies

Policies and programs that prioritize community based financial intelligence, sustainable wealth creation, and high quality job opportunities to prevent unwanted displacement of residents and small businesses from low-income communities and communities of color. (Equitable Development Principles and Score Card)

2040 Comp Plan Goals:

- (2) **More Jobs and Residents**
- (8) **Creative, Cultural, and Natural Amenities**
- (9) **Complete Neighborhoods**
- (12) **Healthy Sustainable and Diverse Economy**

POTENTIAL TOOL

Cultural Districts:

An area distinction to create and prioritize investments that benefit marginalized communities with a strong rooted culture.

Increase Housing Access

Policies that allow families of all income levels to access safe housing that costs no more than 30% of household income.

2040 Comp Plan Goals:

- (3) **Affordable and Accessible Housing**
- (5) **Healthy Safe and Connected Communities**
- (9) **Complete Neighborhoods**
- (10) **Healthy Sustainable and Diverse Economy**

POTENTIAL TOOL

Community Land Trusts:

A recognized non-profit corporate model to create affordable housing by enveloping the price of land into a financial trust to subsidize the individual. They can be used for other ends, such as land preservation and agriculture too. CLTs have been around since the 1960s.

Improve Public Health

Policies that support the distribution of money, power, and resources at local levels affect social determinants of health which are responsible for health inequities present today. (Minneapolis 2040, November, 2018)

2040 Comp Plan Goals:

- (5) **Healthy Safe and Connected Communities**
- (8) **Creative, Cultural, and Natural Amenities**
- (9) **Complete Neighborhood**

POTENTIAL TOOL

Participatory Budgeting:

Municipalities empower community members to decide how to allocate a portion of the public budget. It allows low-income communities to dictate significant investments toward their social determinants of health.

Increase Mobility

Transportation policies develop walkable, livable, and affordable land use practices that enhance healthy living within low-income communities and communities of color. (Equitable Development Principles and Score Card)

2040 Comp Plan Goals:

- (3) **Affordable and Accessible Housing**
- (5) **Healthy Safe and Connected Communities**
- (6) **Physical Environment**
- (10) **Climate Change Resilience**
- (11) **Clean Environment**

POTENTIAL TOOL

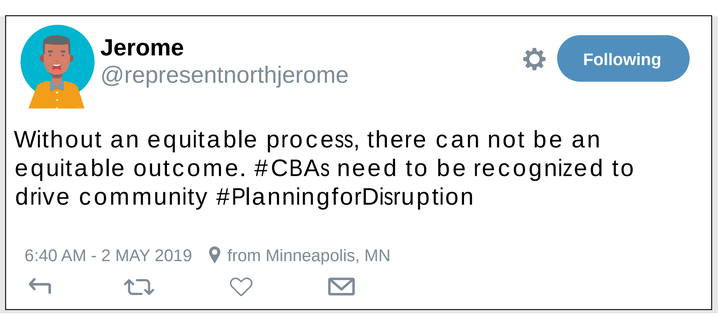
Community Benefits Agreements:

Agreements between a community and a developer that negotiates specific amenities or considerations for the local community.

Next Steps

We will place the equity goals and their tools in the design scenarios to promote ways to address equity. Now we turn to the Design Scenarios for Washington Avenue and Lake Street.





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1) Based on comments made by Heather Worthington at Racial Justice and the Comp Plan event 11/13/2018 2) Minneapolis 2040 Comprehensive Plan Final Draft (December, 2018), Goal: Eliminate Disparities 3) Equity Framework developed by C Terrance Anderson and an Associate while with The Metropolitan Council.

Planning for Disruption

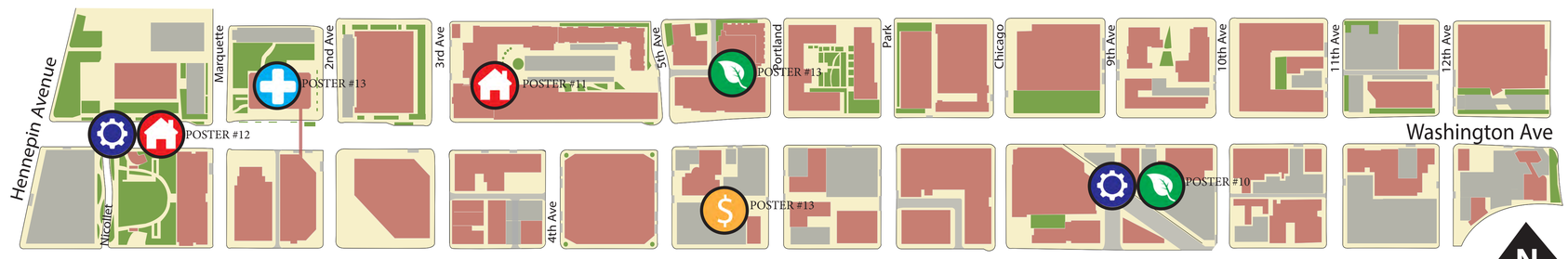
9 Washington Design Scenarios

T6 mpls

This poster introduces the design scenarios for Washington Ave and illustrates how they will uphold the Equity Goals. We aim to demonstrate a systematic approach that links land use, built form, demographic analysis and equity towards the visioning of design proposals.

Equity

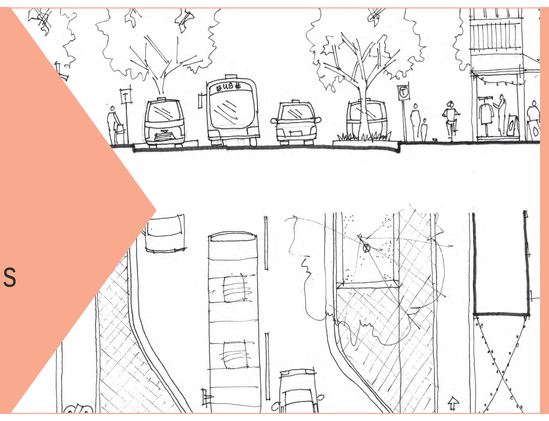
- Housing Access
- Environment
- Public Health
- Mobility
- New & Diverse Economy



This map locates the equity goals along the built environment in Washington Ave.

Walkability: Redesigning the Public ROW

Walkability refers to pedestrian mobility such as walking. We will refer to the Public Right of way (Public ROW) as sidewalks, curbs, and the roads in the street. The implementation of CAVs will reduce the width of the streets, and widen the curbs. To further strengthen walkability we propose a scenario on Washington Ave that increases mobility, incorporates housing access, and increases public health benefits.



Poster #10

Mobility: Reconfiguring the Internal ROW

Mobility focuses on the Internal Right of Way (Internal ROW), which is characterized by alleys inside blocks. On Washington Ave, we propose design scenarios that promote green spaces and more pedestrian passages to increase mobility, and public health benefits for people. We also consider the opportunity to increase housing access in light of population growth.



Poster #11

Adaptation: Rethinking the Parcel

In this scenario, we focus on the parcel. **The parcel is defined as private or public land. CAVs offer the opportunity to repurpose existing parcels by increasing their capacities and extending their use into the Public ROW.** These design adaptations will focus on increasing housing, economic, and environmental equity.



Poster #12

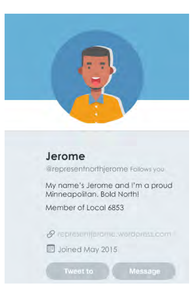
Temporality: Activating Open Space

This section focuses on surface parking lots. Open space along Washington Ave tends to be used for parking, rather than green spaces such as parks. With CAVs on the way, the need for multiple driving lanes is reduced. **These design scenarios illustrate ways in which surface parking lots can be transformed into open spaces that promote greater nvironmental, health, mobility, and economic equity.**



Poster #13

In the following posters we demonstrate the design scenarios for the Public ROW, Internal ROW, Parcel, and Open Space along Washington Ave. With the help of the Equity Figure, we will highlight opportunities as well as concerns that may arise arise due to disruption of CAVs.



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Planning for Disruption

Walkability Redesigning the Public ROW

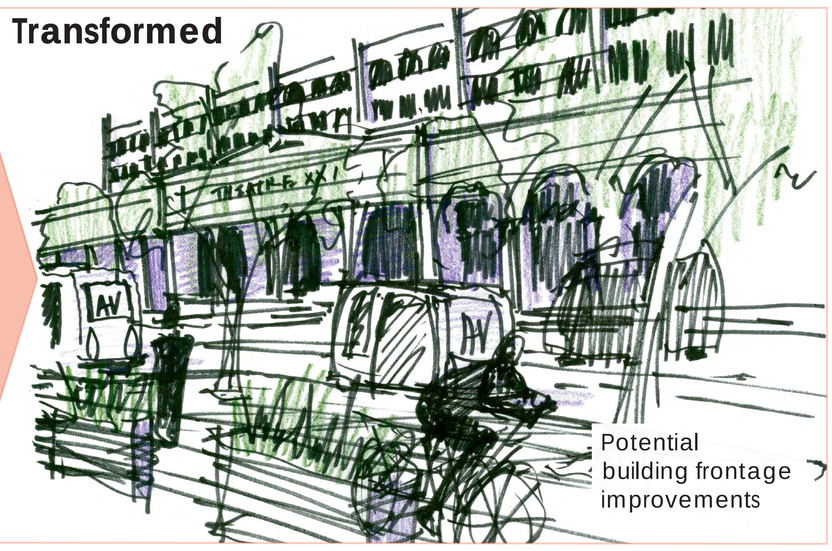
10 T6 mpls

Washington Avenue prioritizes cars. CAVs provide policymakers an opportunity to redesign the Public ROW to prioritize pedestrians. In this poster we explore how to implement these changes through phases that match the deployment of CAVs.

Existing ROW

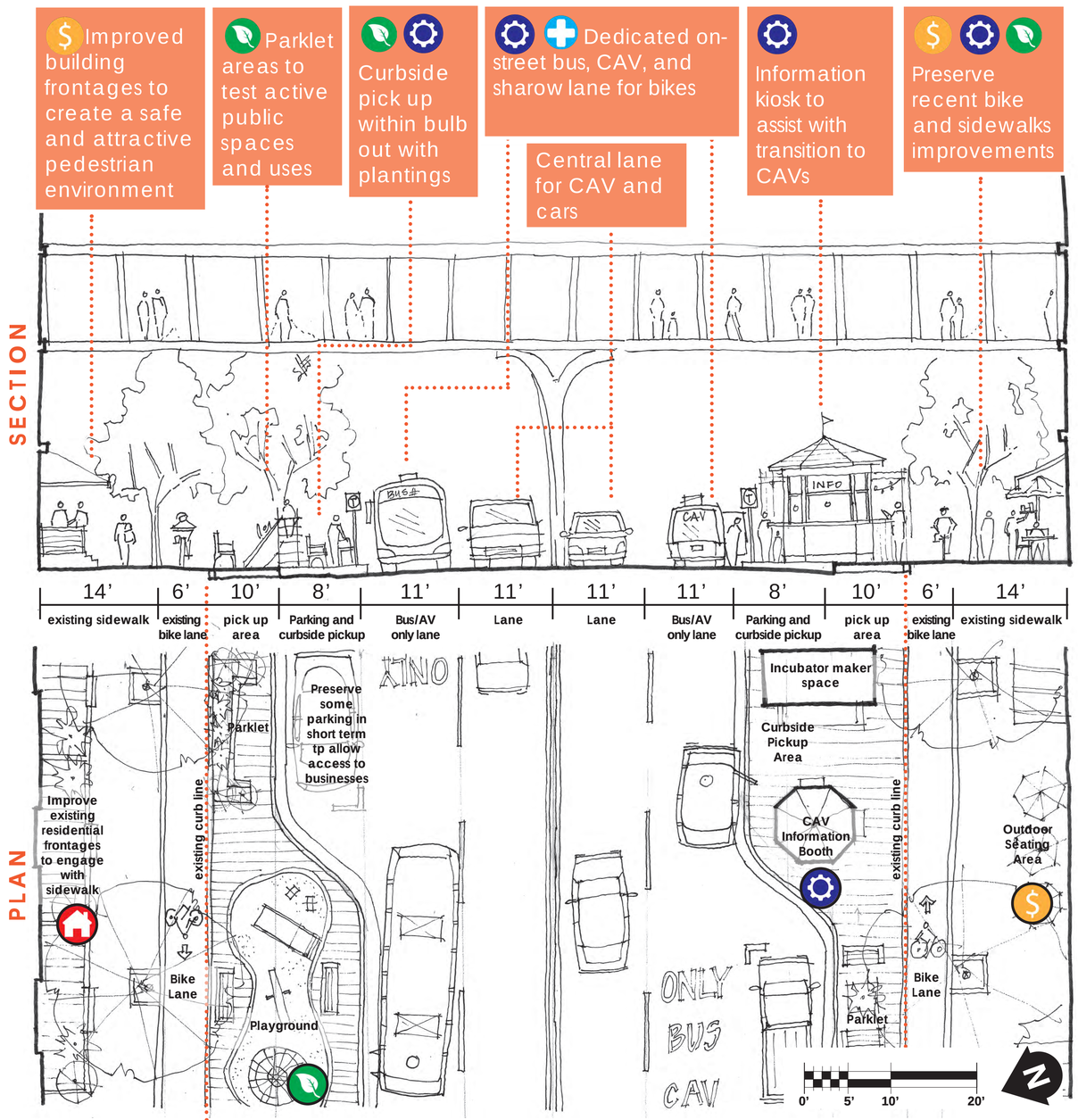
Washington Ave is a 120' wide divided corridor with multiple signaled intersections. The public ROW includes sidewalks, on-street parking, designated bike lanes, five traffic lanes, and a median. **The phyiscal environment is not pedestrian friendly because it encourages fast-moving traffic.**





Medium-term Change Scenario

While a new mobility system will be needed to accomodate CAVs, there will be a need to preserve conventional vehicular infrastructure. This proposal **reduces the number of lanes while preserving lanes for both CAVs and personal vehicles, as well as recent bike lane and sidewalk improvements.**

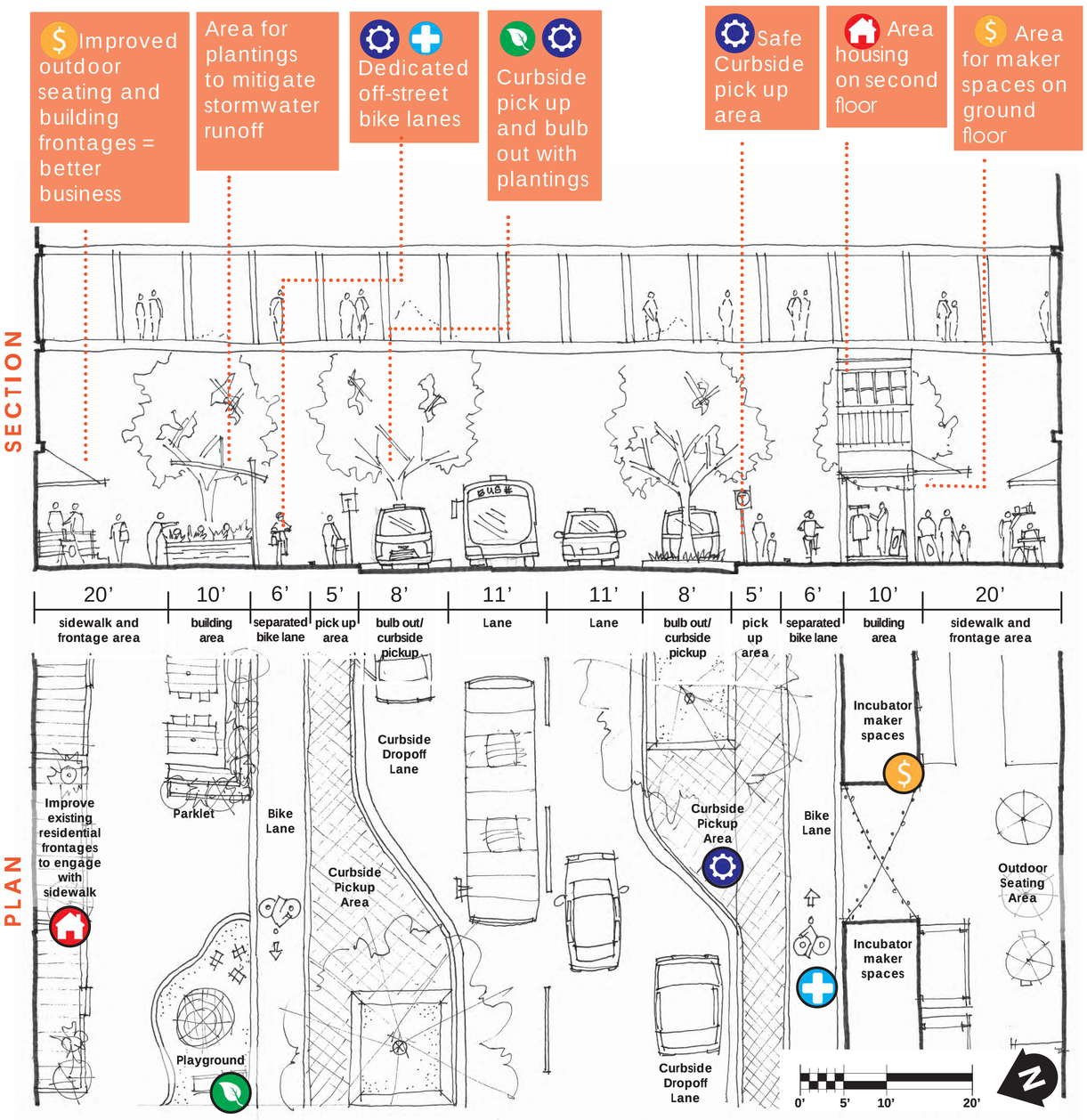


Pavement width before:	Pavement width after:	Sidewalk width before:	Sidewalk width after:	Green space before:	Green space after:
	60'		36'		12'

Measurements refer to linear feet as illustrated in the street section above

Long-term Change Scenario

Once CAVs become the dominant form of transportation, there will be **little need to design streets for personal cars.** Planners can **rethink the public ROW**, including permanent structures within the existing ROW and increasing sidewalk width.



Pavement width before:	Pavement width after:	Sidewalk width before:	Sidewalk width after:	Green space before:	Green space after:
96'	22'-40'	24'	50'-66'		24'

Measurements refer to linear feet as illustrated in the street section above

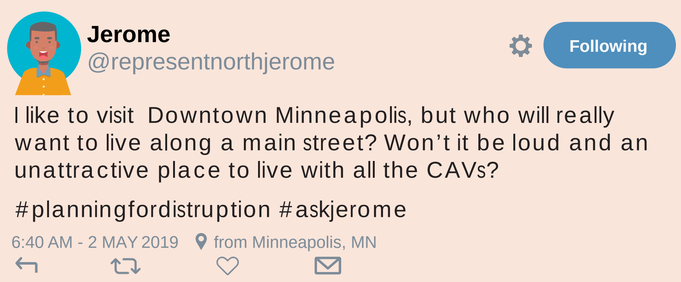
Key: Equity Goals

- New & Diverse Economies
- Mobility
- Housing
- Environment
- Public Health

Comprehensive Planning Policy Implications

Promote high quality pedestrian-oriented. business-friendly environment through updated street design guidelines **(Goal 6. High-quality physical environment)**

Apply unused spaces for uses promoting equity by applying Community Benefit Agreements and BIDs to fund public realm improvements **(Goal 9. Complete neighborhoods)**



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Planning for Disruption

11 T6 mpls

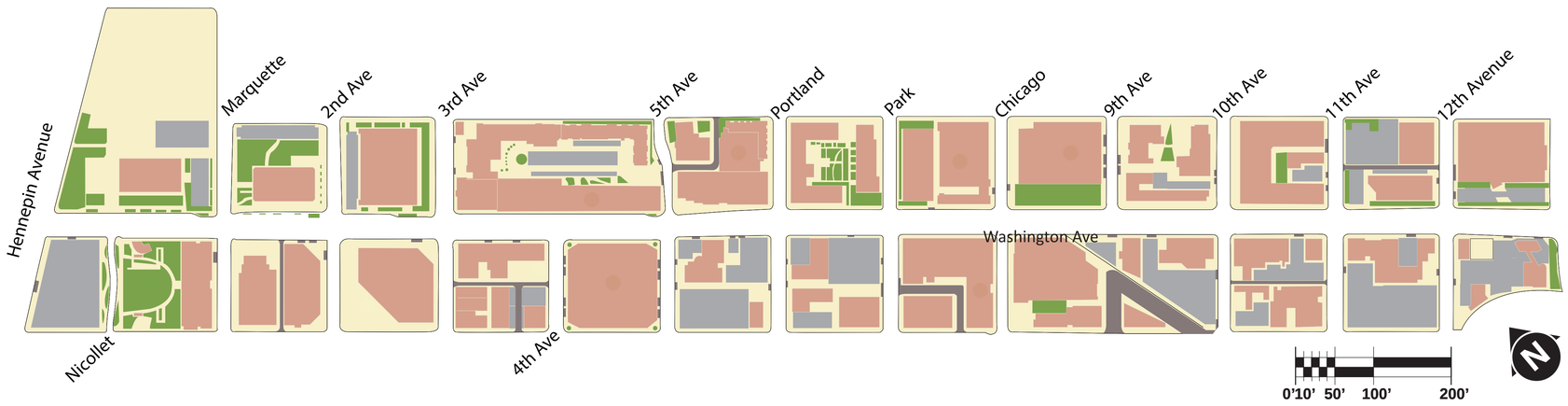
Mobility Reconfiguring the Internal ROW on Washington

The Internal ROW refers to alleys. CAVs will reconfigure land uses and movement patterns along the Internal ROWs of blocks. For alleys located inside blocks on Washington Avenue, we propose design scenarios that increase mobility options for all residents, promote green spaces, consider public health benefits, and increase alternative forms of micro-housing.

CAV Land Use Implications

Commercial Uses in the Internal ROW

With CAVs, there will be a greater **need for alternative residential and commercial spaces** that are connected pedestrian and pick-up or drop-off zones. Parking proximity will be devalued, transforming parking structures that potential commercial spaces allow businesses to capitalize on customers arriving via ride-sharing services or by foot. This development can also provide **space for informal and sharing economies**.



Residential Uses in the Internal ROW

Reconfiguring existing structures to create micro-housing along the internal right of way could **alleviate displacement or homelessness challenges by providing temporary shelters, services and programming activities**.

Other Auxiliary Uses in the Internal ROW

Alleys could continue to be used for **freight and deliveries in dense areas** like Washington Ave. They could also **provide pubic gathering spaces or recreation areas** for the entire community.

Equity Goals

We propose the following design scenarios for our Equity Goals (see poster 8). By proposing these changes, we aim for residents to have **equal access to improved neighborhood amenities and resources**.

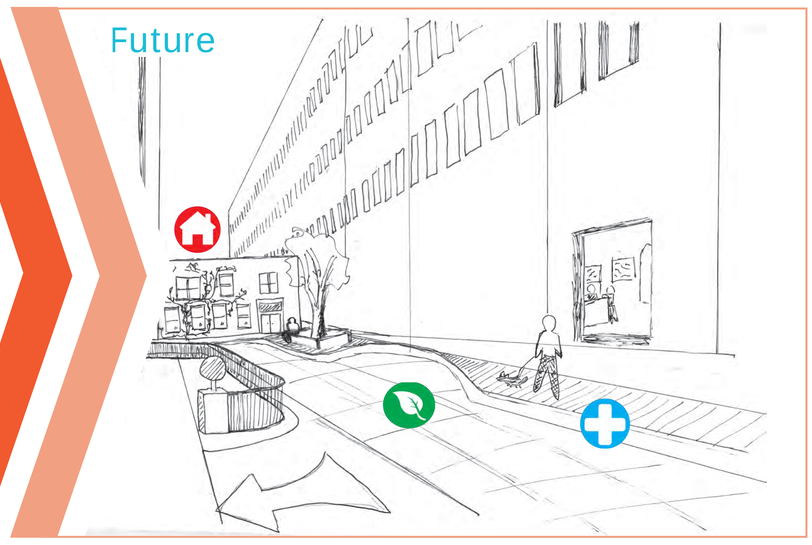
Internal R.O.W. Opportunities:

- **Provide** zones for pick-up and drop- off from CAV's, ride-sharing, and delivery services and reduce congestion on main right of ways, improve mobility between internal and main right of ways, increase walkability with a dedicated lanes for pedestrians.
- **Transform** parking structure into new types of housing to meet increasing demands for affordability.
- **Activate** current parking infrastructure as alternative commercial or office space to meet new, tactical economic demands or for storage of CAVs with minimal cost for retrofitting.
- **Reduce** stormwater run-off using permeable pavers, planter boxes, and other green infrastructure best practices. Placing electric charging stations (for CAV's and personal vehicles, when relevant)can reduce emissions in the downtown area. Reclaiming the internal right of way as green space would also improve environmental conditions.
- **Improve** the health of existing communities by increasing walkability and healthy lifestyles in urban space.

Existing



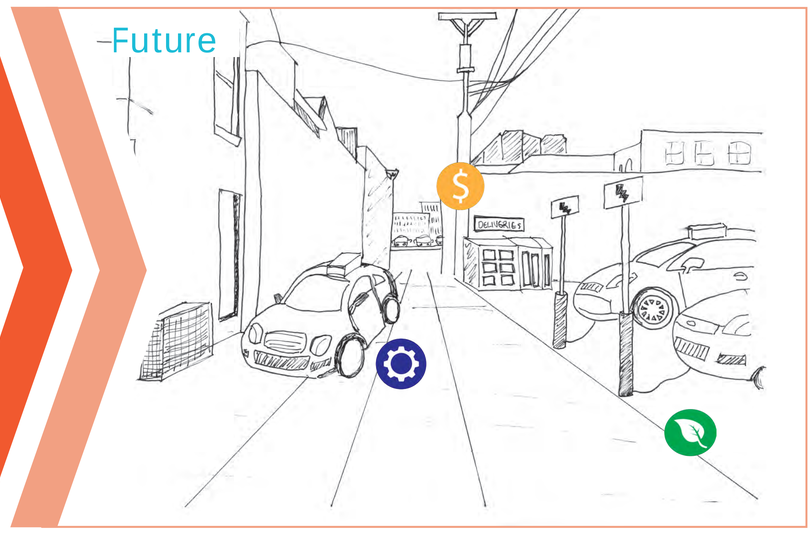
Future



Existing



Future

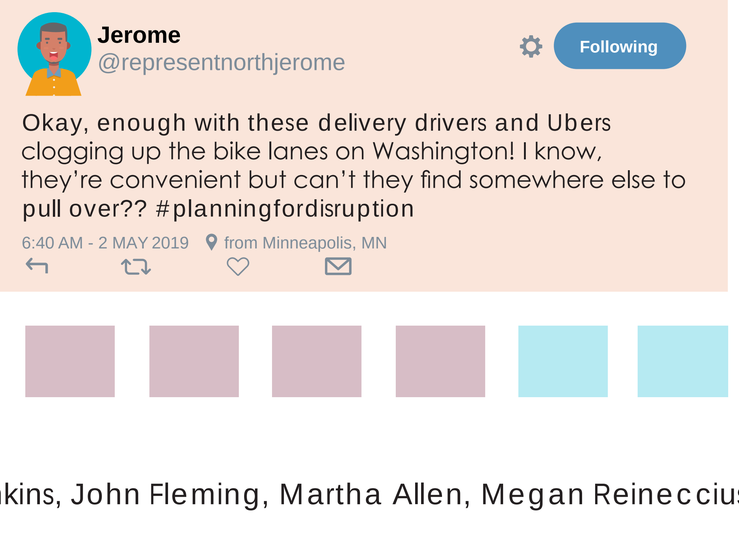


Key: Equity Goals

- New & Diverse Economies
- Mobility
- Housing
- Environment
- Public Health

Comprehensive Planning Policy Implications

Incentives should be placed to reduce the amount of parking needed for preexisting and new development. **Incentives can include activated pedestrians spaces, pick-up/drop-off lanes and use of existing parking for new types of commercial or residential uses.** These initiatives should all be community-driven and involve local organizations.



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Planning for Disruption

Adaptation

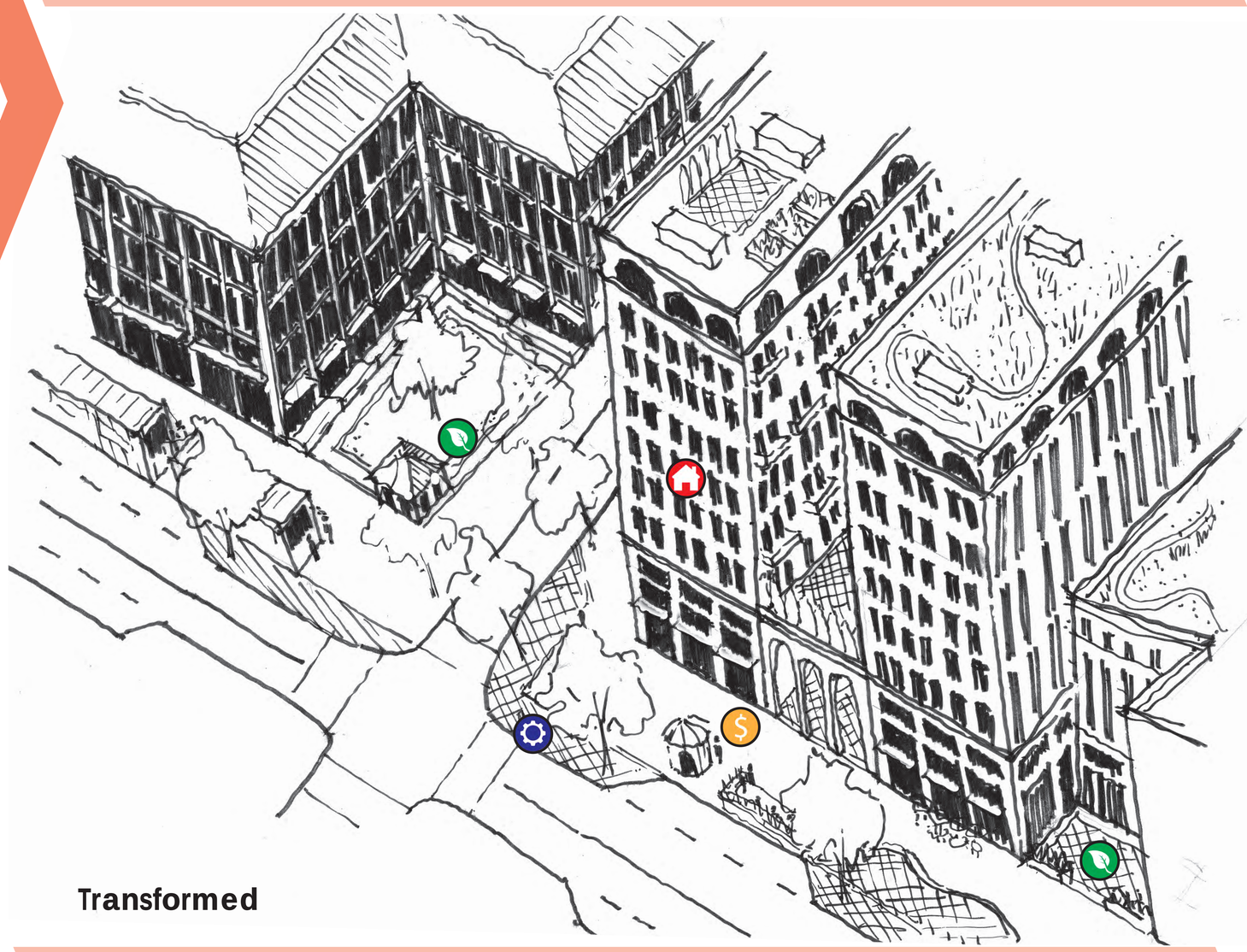
Rethinking the Parcel on Washington

12 T6 mpls

As the need for vehicles decreases, the capacity to build on surface parking lots and in the public ROW increases significantly. How can we capiltalize on this increased capacity to meet the needs of future Minneapolis residents and visitors?



Increasing the Capacity of Existing Parcels



Increased Capacity for housing and buisnesses

Without a need for parking, developers will eventually be able to completely phase parking out from existing parcels. This translates to more building capacity for much needed housing. Downtown will continue to be an attractive place to live because of proximity to services and amenities.

Leave room for small pocket parks

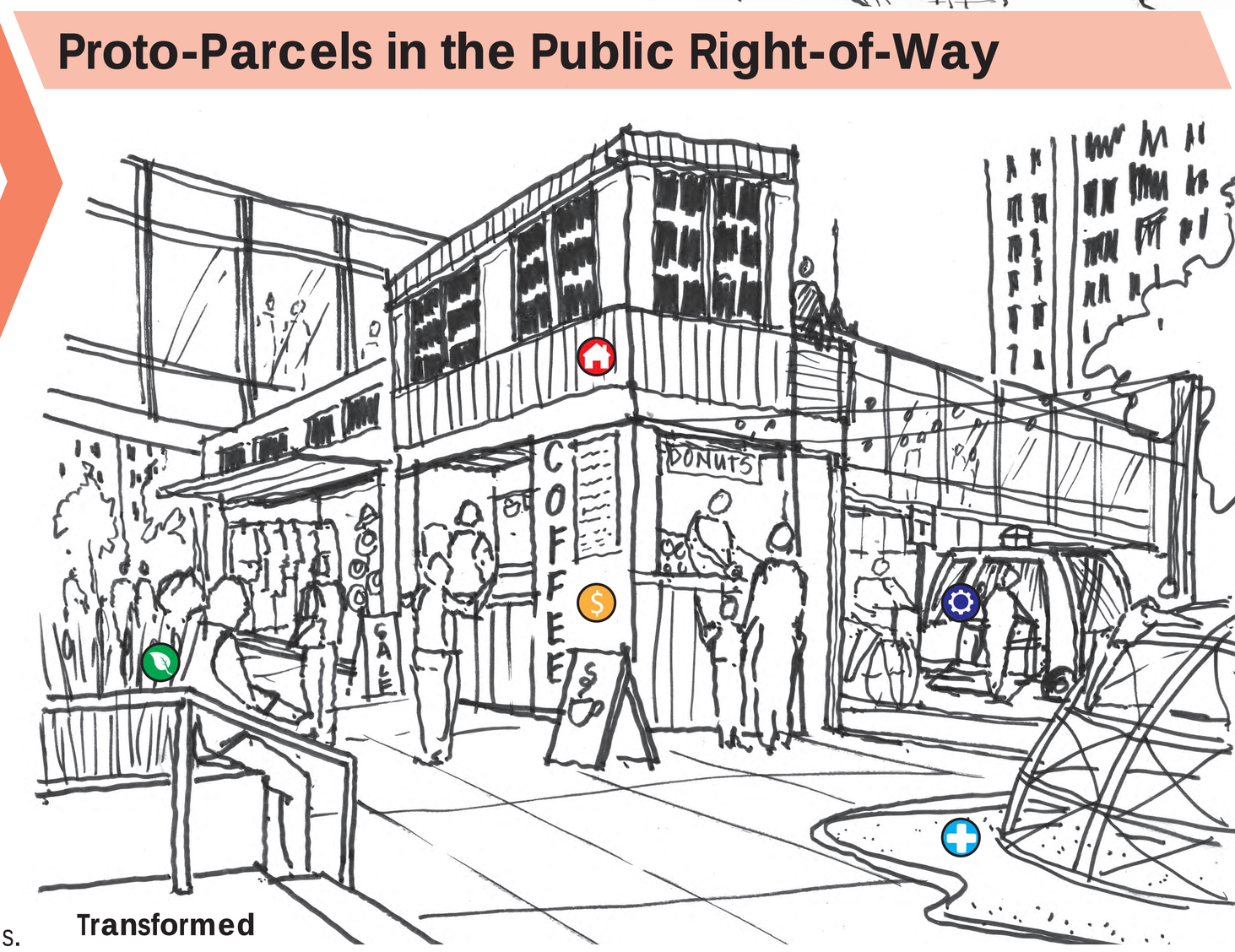
Parcels used as parking lots can be turned into privately-owned parks that serve as a semi-public amenity and function as on-site stormwater mitigation.

Focus on Frontages

Building frontages along Washington are inconsistent. Because the ROW will become more pedestrian oriented. Building frontages will become necessary to attract retail clientele and create a cohesive character.



Proto-Parcels in the Public Right-of-Way



Flexible work spaces

With increasing technology in the workplace there will be an increasing need for incubator spaces for entrepreneurs. These spaces can be small, flexibile and cheaply built. The city could lease these spaces to minority business owners and others to promote retail incentives

Flexible living spaces

Minneapolis can use the spaces left over in the public realm for much needed micro-housing. This could be transitional housing for those needing a place to stay that is cheap and short term.

Design Outdoor Rooms

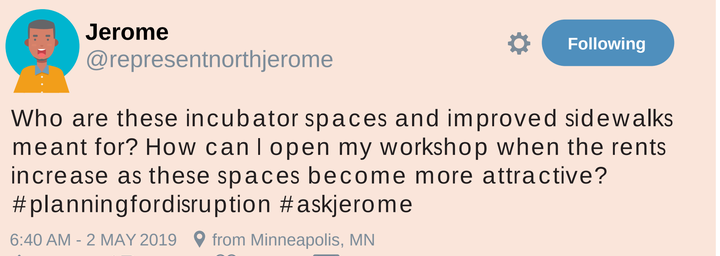
The city can use the remaining ROW to program flexible outdoor spaces for informal pop-up events and gatherings.

Key: Equity Goals

- New & Diverse Economies
- Mobility
- Housing
- Environment
- Public Health

Comprehensive Planning Policy Implications

Allow for the creation of proto-parcels in the ROW and consider the tool of a **Community Land Trust** to provide options for ownership or leasing through the city **(Goal 1. Reduced disparities)**. Allow a wider range of flexibility in land uses on the ground floor and within the new ROW proto-parcels to support uses such as craft production and processing businesses **(Goal 12. Healthy, sustainable, and diverse economy)**.



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Planning for Disruption

13 T6 mpls

Temporality: Activating Open Space on Washington

Open space along Washington Avenue is overwelmingly used for parking. CAV rollout will create opportunities to transform unused parking lots into open spaces for pedestrian vitality, to diversify the economy, and enrich the city culturally.

Open Space Design Scenarios

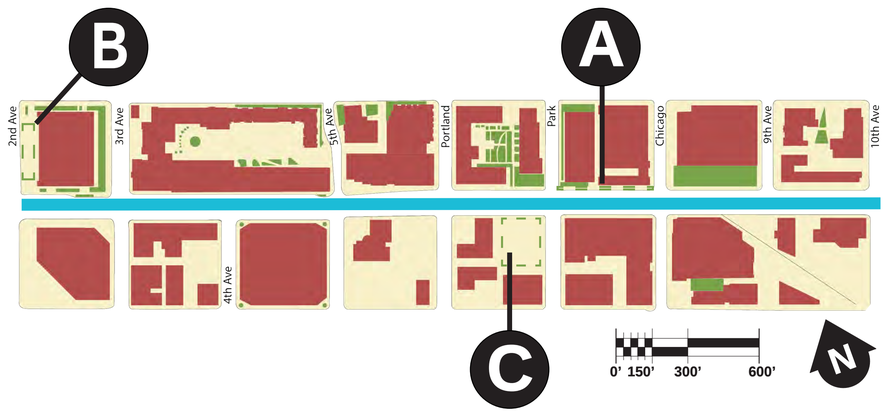
The illustration to the right shows the capacity for added green space on the central section of Washington Avenue. The following scenarios explore the transformation of three sites from parking-oriented use to public and semi-pubic open spaces.

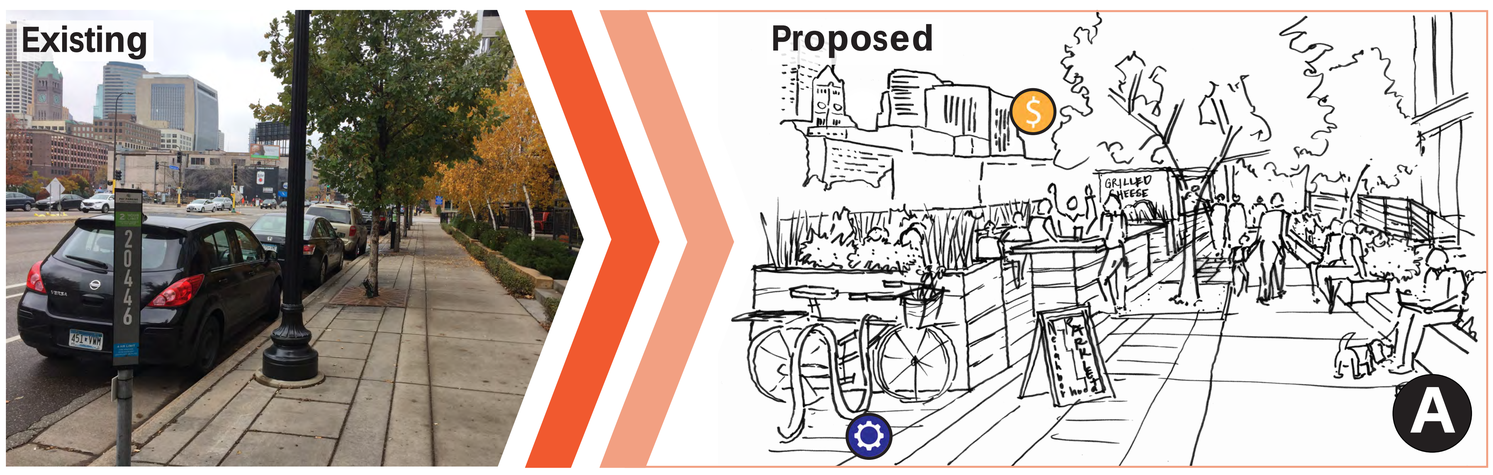
New &Diverse Economies

- **revitalize public space**
- **urban agriculture jobs**
- **small business promotion**

Environmental Resilience

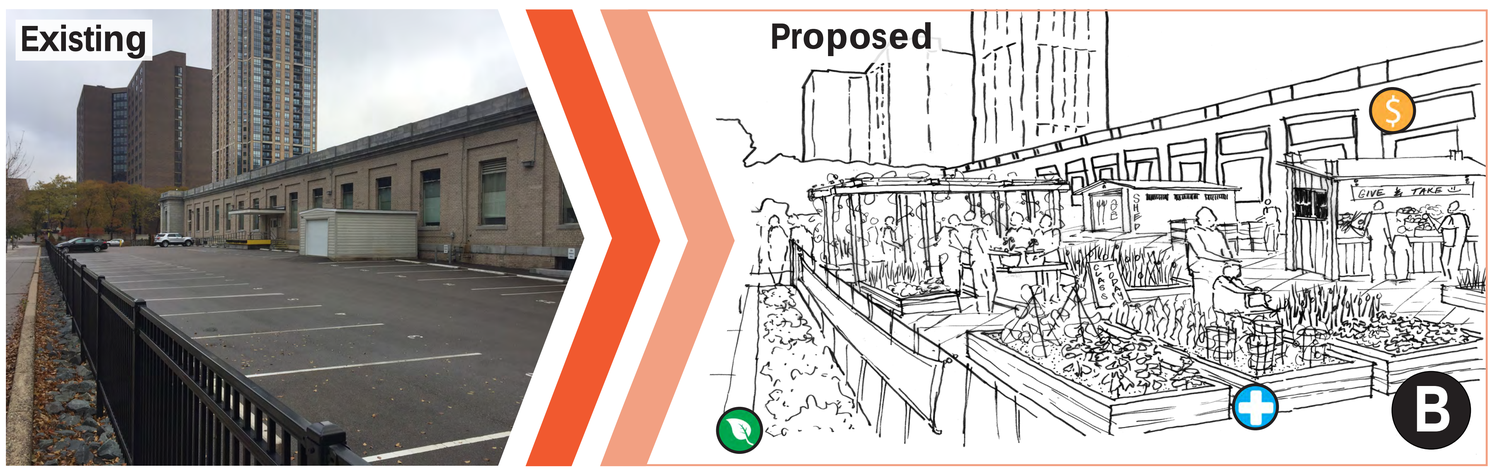
- **carbon capture**
- **access ot fresh produce**
- **encouraging pedestrian travel**





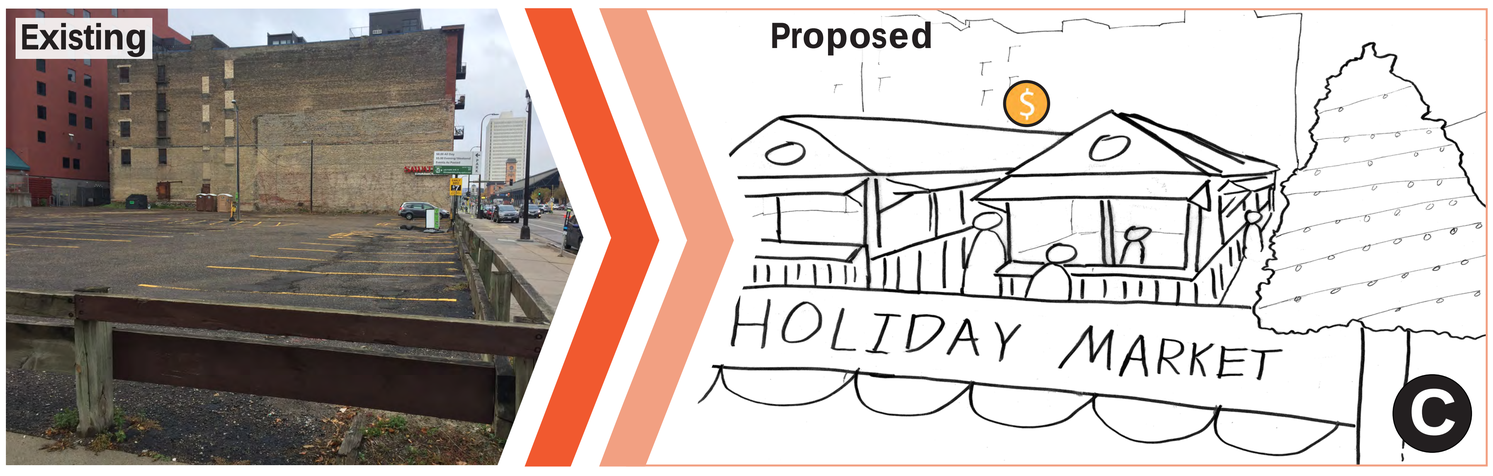
Food Truck Parklets

Food-oriented parklets equipped with **seating and table space can be deployed on street parking vacated during the adoption of CAVs.** Food trucks parked nearby can take advantage of this amenity. With the seating facing the sidewalk, the **focus is oriented towards the active streetlife of pedestrians.**



Urban Farm

Large former parking areas located behind buildings can be used for non-pedestrian oriented uses such as urban farming. **Urban agriculture contributes to our city's food security and food safety, and increases the total amount of food available to people living in cities.** It also allows fresh, high quality vegetables, fruits, and other food products to be grown and produced for urban customers.



Festival Space

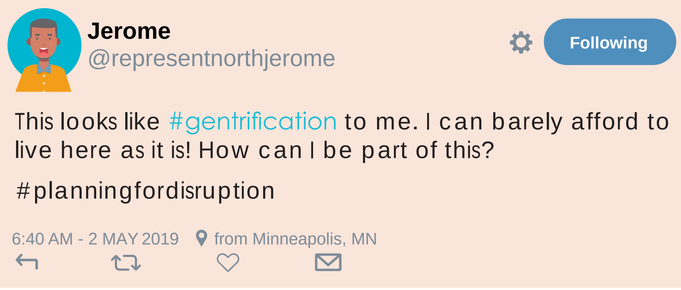
The **impervious surface of large parking lots on corner lots can be reused for temporary pop-up events.** The cultural life of the street can benefit from seasonal festivals **celebrating diversity in Minneapolis**. Leaving some of the pavement allows for interior "streets" that naturally break up the space into distinct areas.

Key: Equity Goals

- New & Diverse Economies
- Mobility
- Housing
- Environment
- Public Health

Comprehensive Planning Policy Implications

Maintain a culturally and economically diverse programs for the pop-up festival space. **A Community Land Trust ownership model is needed for the urban farm to ensure produce is available and affordable to local and low income residents.**



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Planning for Disruption

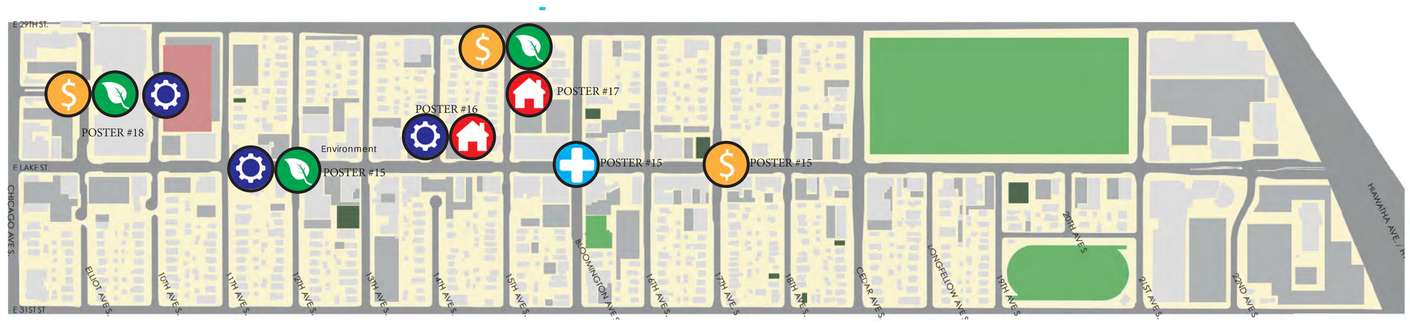
Lake Street Design Scenarios 14

T5 mpls

This poster introduces the design scenarios for the Lake Street corridor and illustrates how each scenario will uphold the Equity Goals. We aim to demonstrate a systematic approach that links land use, built form, demographic analysis and equity goals towards the visioning of design proposals.

Equity

- Housing Access
- Environment
- Public Health
- Mobility
- New & Diverse Economy



N

Scale 1:200

This map provides an overview of the equity goals along Lake Street.

Walkability: Redesigning the ROW

To improve walkabiliy on Lake Street, we will look at the Public ROW. This scenario will focus on **how the implementation of CAVs will reduce the width of the streets and widen the curbs.** To further strengthen walkability and the pedestrian experience, we have designed a scenario on Washington Ave that will increase mobility, incorporate housing access, and increase public health benefits in the public ROW.



Poster #15

New Retail: Reclaiming the Internal ROW

This design scenario will look at the Internal ROW. We will look at alleys and CAV garages. With the Implementation of CAVs these spaces will have to be repurposed. The design scenarios for the Internal ROW will demonstrate **how we can change land use, in a residential area and transform alleys to improve residential and commerical uses.**



Poster #16

Equity: Re-envisioning the Parcel

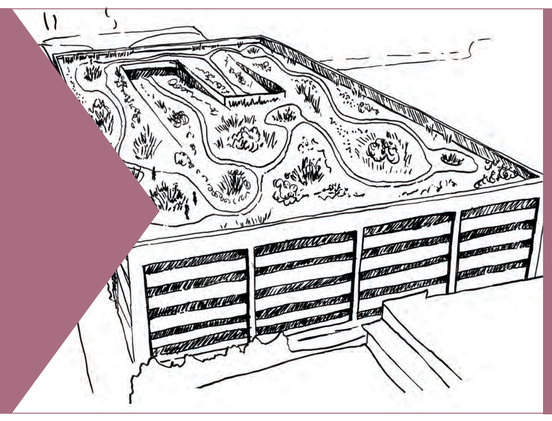
With the implementation of CAVs parking spaces along Lake Street will become obsolete. This gives planners the opportunity to rethink **how parking can be re-imagined to promote equity for those living along and around Lake Street.** The design scenarios for the parking lots will incorporate ways to promote economic, housing, health, and environmental equity.



Poster #17

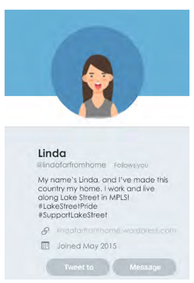
Greening: Enabling Green Space

Open spaces such as green spaces, do exist in the surrounding neighborhoods near Lake Street but seem to be absent along the corridor. The loss of interest in personal car ownership after the implementation of CAVs proposes a **reconsideration of rooftop parking lots, street-side parking, and small parking lots along Lake Street, into green spaces that promote health equity and environmental resilience.**



Poster #18

In the next posters, we demonstrate the design scenarios for the Public ROW, Internal ROW, Parcel, and Open Space along Lake Street. With the help of the Equity Figure, **we will highlight equity concerns that may arise with the disruption of CAVs.**



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Planning for Disruption

Walkability Redesigning the ROW on Lake Street

15 T5 mpls

Lake Street prioritizes cars. CAVs provide policymakers an opportunity to redesign the Public ROW to prioritize pedestrians. In this poster we explore how to implement these changes.

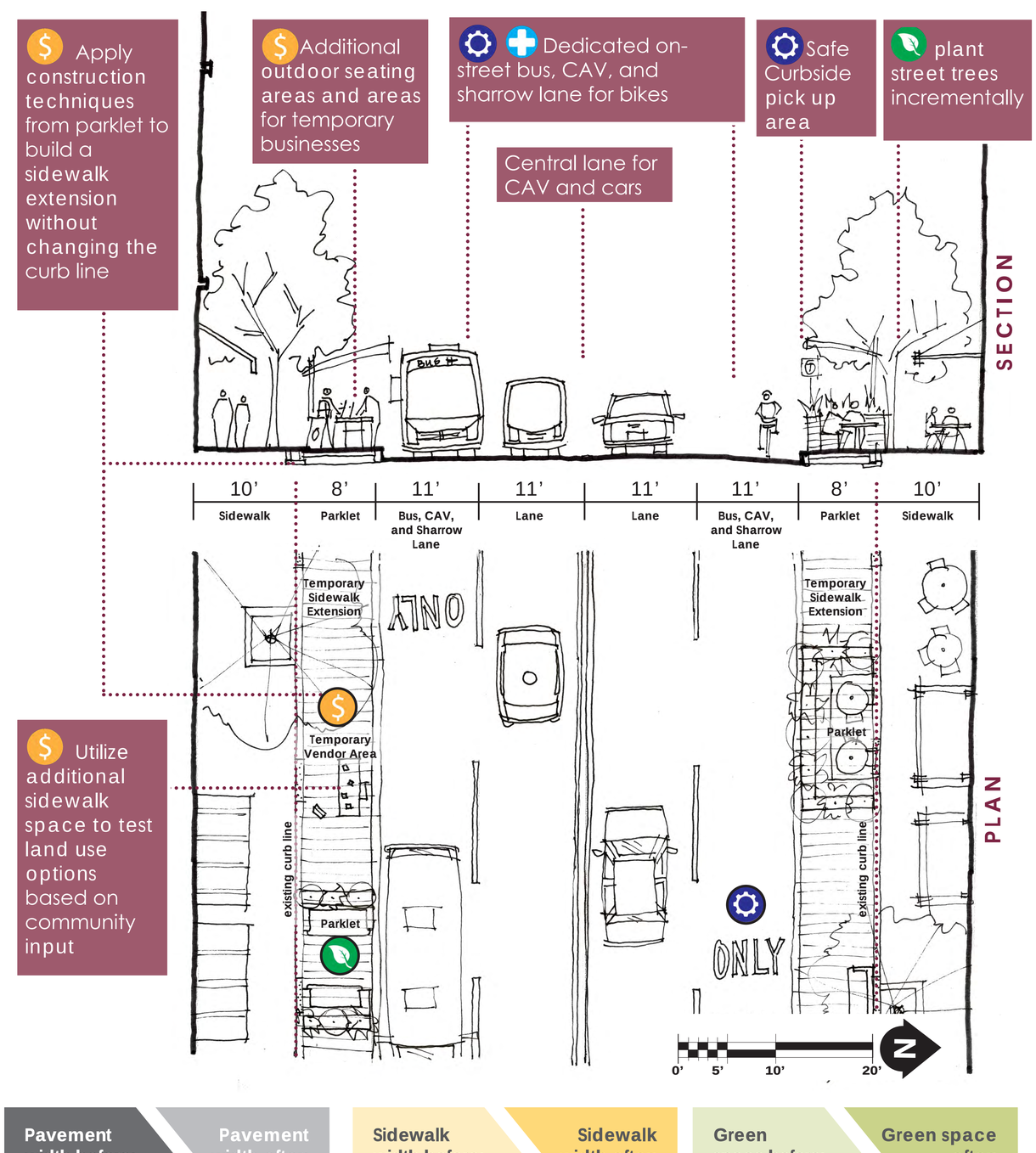
Existing ROW

Lake Street is 80’ wide street section which includes sidewalks, on-street parking, and five traffic lanes. T**he environment is pedestrian friendly but prioritizes automobiles.** There are some streetscape improvements to street furniture. There is also a lively business culture along the corridor.



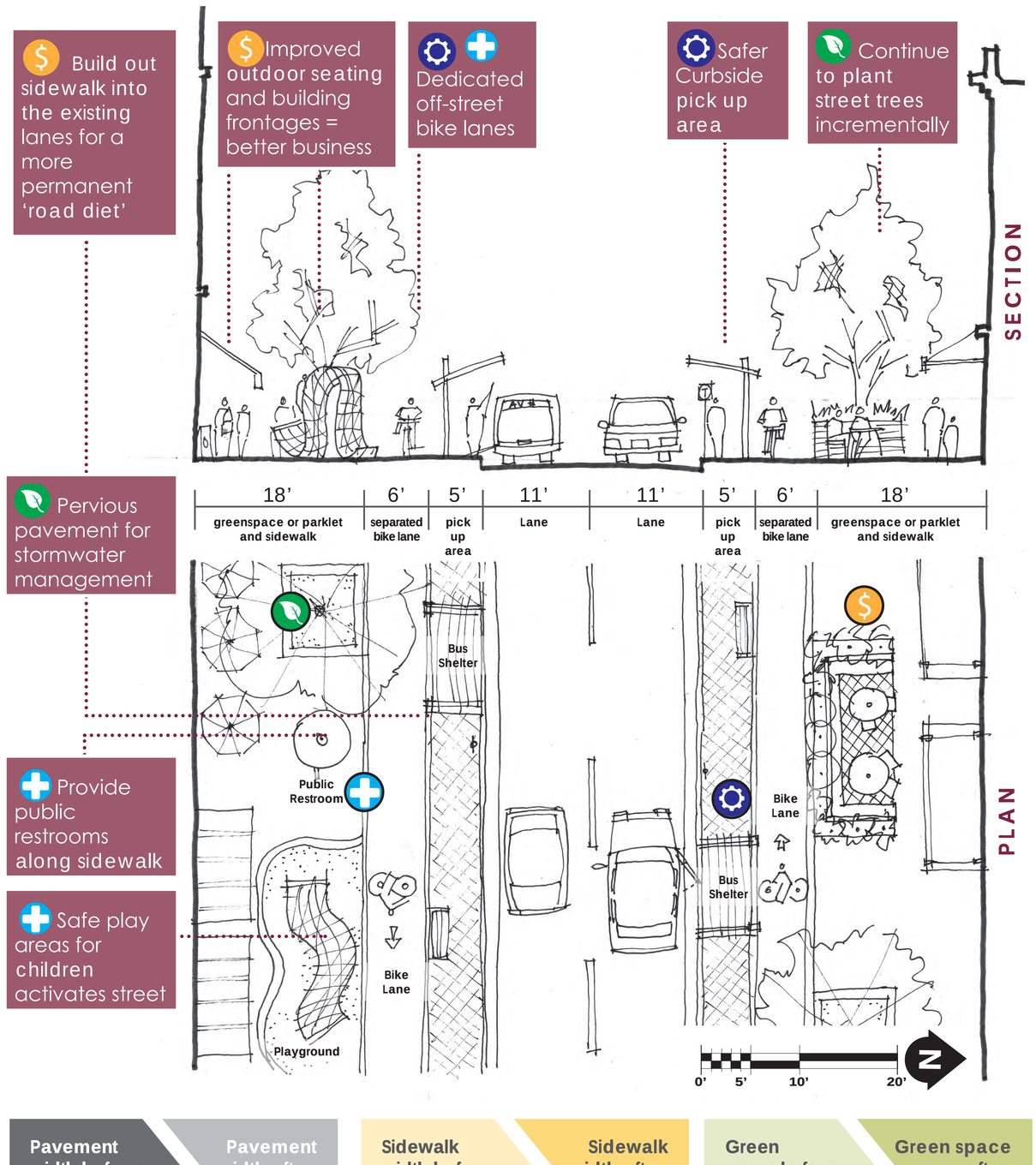
Medium-term Change Scenario

In the short to medium term, the **number of lanes can be reduced**. This implementation can happen incrementally through **tactical changes to the street section** and it can be done with relatively little expense.



Long-term Change Scenario

Once CAVs become the dominant form of transportation, there will be **little need to design streets for personal cars, allowing additional usable space.** For Lake Street this means additional space as a business corridor by increasing pedestrian space.



Pavement width before:	Pavement width after:	Sidewalk width before:	Sidewalk width after:	Green space before:	Green space after:
60’	44’	20’	36’	0’-12’	12’

Measurements refer to linear feet as illustrated in the street section above

Pavement width before:	Pavement width after:	Sidewalk width before:	Sidewalk width after:	Green space before:	Green space after:
60’	22’	20’	36’	0’-12’	12’

Measurements refer to linear feet as illustrated in the street section above

Key: Equity Goals

- New & Diverse Economies
- Mobility
- Housing
- Environment
- Public Health

Comprehensive Planning Policy Implications

Prioritize Lake Street streetscape improvements through **Community Benefits Agreement** or a **Business Improvement District** which relies on input from local businesses and also provides city assistance to small businesses. Utilize **tactical urbanism** to test future uses along Lake Street that reflect the needs and preserve the character of the neighborhood(**Goal 7. History and culture, 6. High-quality physical environment)**



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Planning for Disruption

Flexibility

Reclaiming the Internal ROW on Lake Street

16 T5 mpls

Lake Street has an extensive system of alleyways for both commercial and residential purposes. In the future these alleyways and the garages fronting the alleys will have less utility. CAVs provide an opportunity to rethink what the Internal ROW could look like and how it is used.

Potential Changes in Land Use along Internal ROW

Residential Uses:

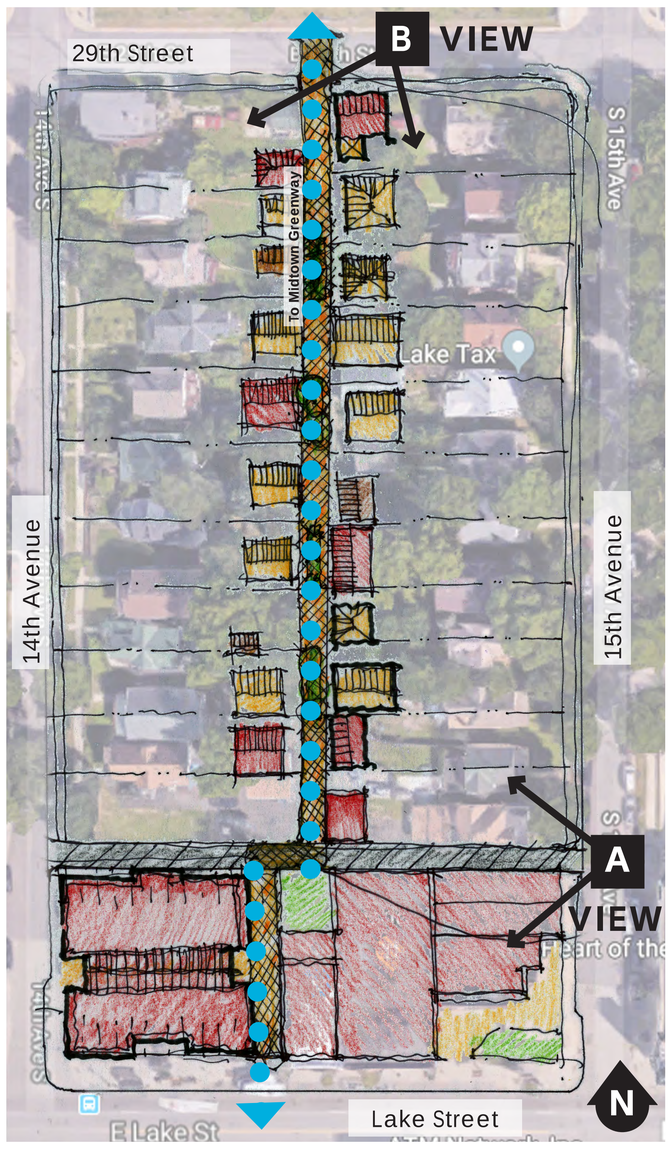
As housing demands continue to increase, **Accessory Dwelling Units (ADUs) should continue to be implemented.** With a pedestrian-oriented internal ROW this space becomes a new 'frontage' for the units facing the ROW.

Commercial Uses:

With technological advances, there will be a **greater need for home workplaces and affordable incubator spaces for start-ups.** Alleys can become home to new and diverse businesses in the form of commercial and work-live spaces. Spaces that sell craft goods could be located closer to Public ROWs to capitalize on foot traffic.

Other Auxiliary Uses:

Homeowners may choose to use their accessory buildings for other uses such as storage or workshops.



Greening of Alley:

There is potential to **convert pervious pavement to impervious pavement** because there will be less wear with fewer car use, leading to benefits such as on-site stormwater management.



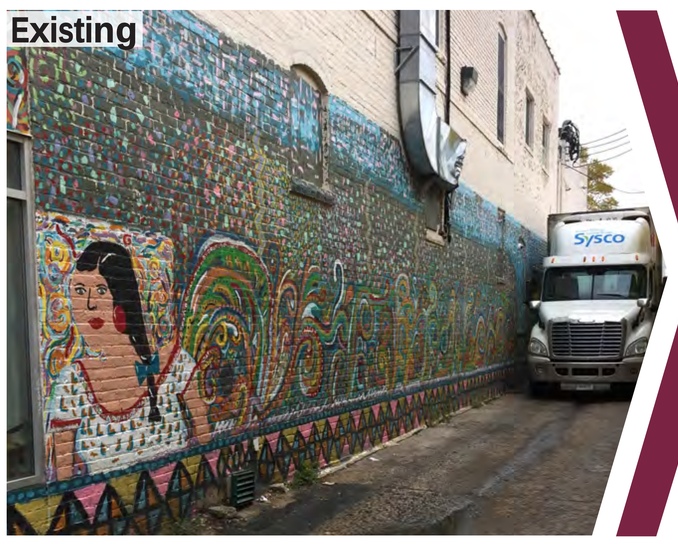
Photo credit: http://www.greengaragedetroit.com/site/building/green-alley/

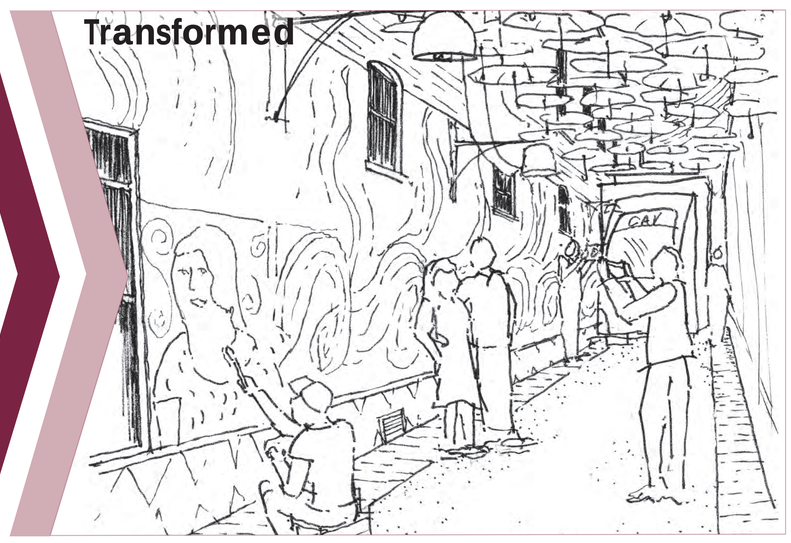
Improve Connections:

Because internal ROW will not be used for cars, there are opportunities to **improve and formalize bike and pedestrian connections through internal ROW** from the existing Midtown Greenway to Lake Street.

Dropoff of Goods:

The internal ROWs will serve as drop off zones for goods.









A Design Opportunities

Dropoff pick up area to be used by automated trucks dropping off goods at the rear of buildings

Preserve the rear access for dropoff of goods to existing commercial uses, which integral to culture of Lake Street.

Preserve the series of murals and also allow other arts and culture installations along commercial alleys to promote interest for residents and visitors

B Design Opportunities

Allow for flexible uses to allow makers to use spaces along alley especially small commercial uses which may attract customers using the access point to midtown greenway

Utilize alleys as pedestrian and bike connections to the established Midtown Greenway

Allow up to potential 1.5 story ADU units

Provide technical and possibly financial assistance for residents to green the alley with impervious pavements, plantings, etc.

Key: Equity Goals

- New & Diverse Economies
- Mobility
- Housing
- Environment
- Public Health

Comprehensive Planning Policy Implications

Transition alleys to be designated as pedestrian priority. Allow flexibility in land use for accessory units fronting alleys, so as to allow the new and diverse businesses to take advantage of underutilized space. Explore the option of a **Community Land Trust** to allow for ownership of accessory dwelling units.



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Planning for Disruption

Equity Re-envisioning the Parcel on Lake Street

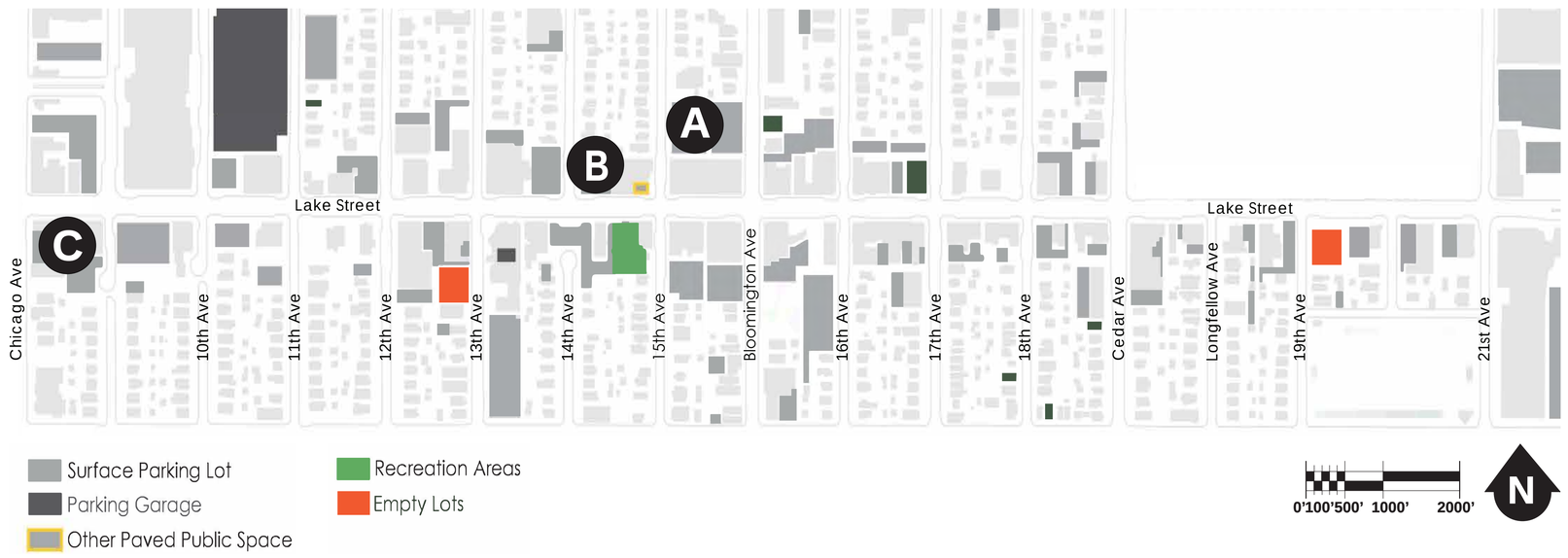
17 T5 mpls

With the arrival of CAVs, parking will become unnecessary, so we need to consider what to do with the existing parking space. In this poster, we offer three scenarios that provide alternatives for parking lots.

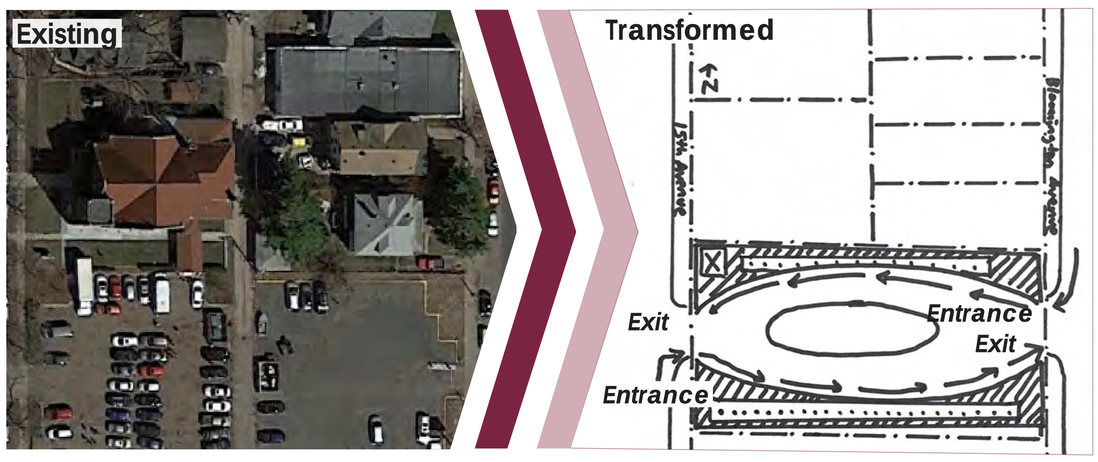
Capacity for Change

Currently, there is at least one surface parking lot on each block along Lake Street. These lots are utilized for retail purposes. Each lot can accommodate approximately up to 100 vehicles. More than 1,200 vehicles can be parked on these lots.

If a typical vehicle needs 180 square feet of space to park, 1,200 vehicles would need at least 216,000 square feet to park.[2] **Due to the CAVs, vehicles will no longer need to park and space of 216,000 square feet would be free to use.**



Re-envisioning the Parcel on Lake Street - 3 Scenarios



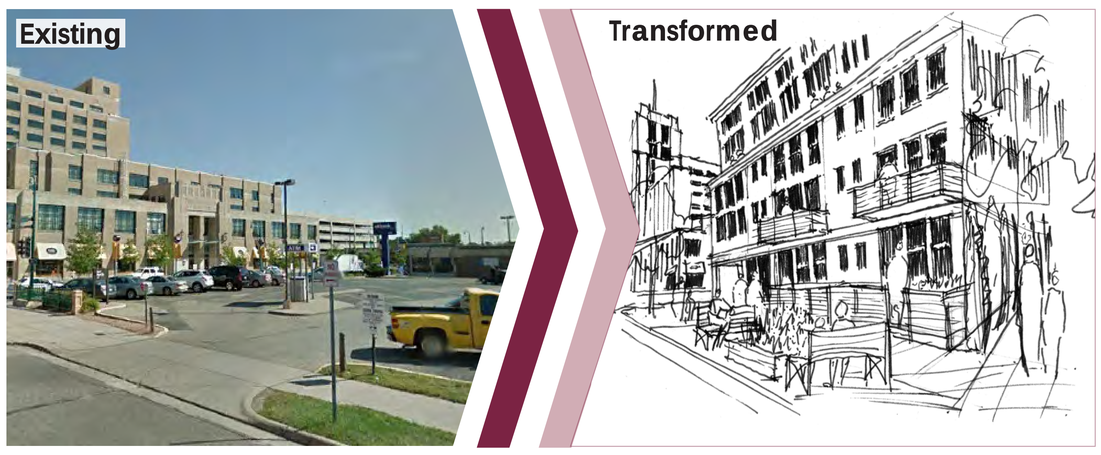
A Focus on Curbside Managment

Parking lots could be used as easily accessed CAV pickup/drop off zones. For example, Bloomington Avenue has a large parking lot, which would be a great location for the CAVs to stop. CAVs could easily enter or exit either from Bloomington Avenue or 15th Avenue.



B Envision Charging CAV Hubs

If the power source of the CAVs is electricity, CAVs would need a place to be charged. **Some lots can be utilized as CAVs charging HUBs**. There are companies designing wireless charging stations for CAVs including a **technology based on inductive charging**, which involves electricity being transferred via an air gap between two magnetic coils.[1] This process is similar to how wireless phone chargers work.



C Increase Mixed Use Residential

Freeing up parking sapce may enable businesses to develop along Lake Street. Current retail buildings may have opportunities to expand. Also, the **freed parking lots could be used to develop new buildings for affordable mixed use building types.** This rendering image from Elliot Avenue and Lake Street transforms a 16,740 sqft parking lot to approximately 40-70 unit apartment building--as four to six floor developments are reasonable in Mid-town.

Key: Equity Goals

- New & Diverse Economies
- Mobility
- Housing
- Environment
- Public Health

Comprehensive Planning Policy Implications

Transition alleys to be designated as pedestrian priority. Allow flexibility in land use for accessory units fronting alleys, so as to allow new and diverse businesses to take advantage of underutilized space. Explore the option of a **Community Land Trust** to allow for ownership of accessory dwelling units.



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1) https://www.fleetcarma.com/soon-wireless-electric-vehicle-charging-coming/

2) https://ag.tennessee.edu/cpa/information%20Sheets/CPA%20222.pdf

Planning for Disruption

Greening

Enabling Green Space on Lake Street

18 T5 mpls

CAV adoption will lead to underutilized parking, which can be converted to uses that contribute to health equity, environmental resilience, and enhancing the local economy.

Health Equity
- Improved walkability
- Space for social connection
- Increased community satisfaction

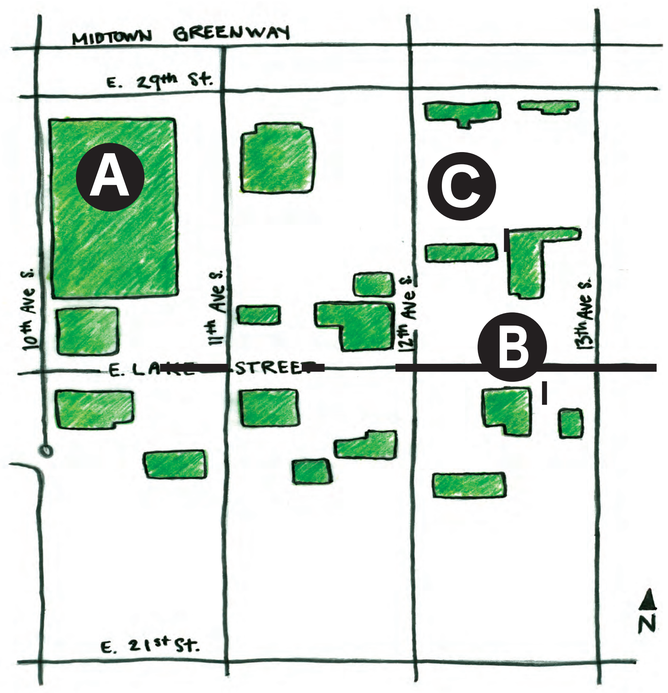
Environmental Resilience
- Protection from heat and flooding
- Wildlife and plant habitat

Local Economy
- Improved environment for local businesses along the corridor

Green Space Scenarios

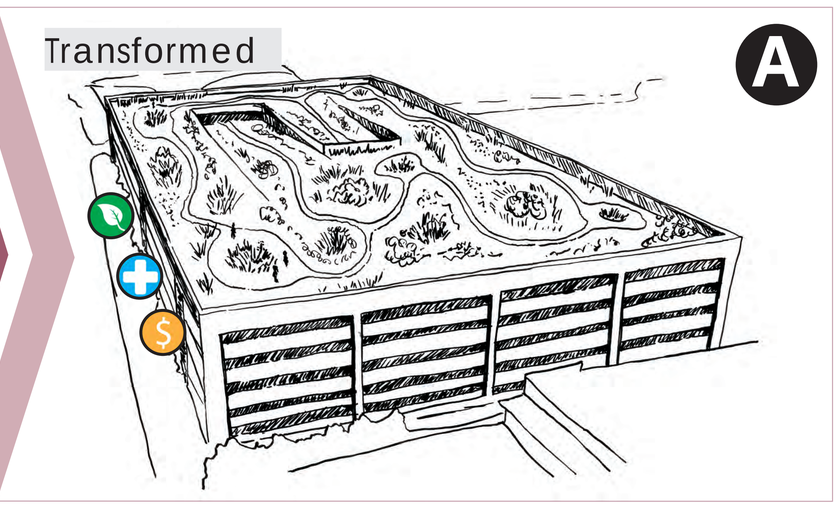
The map to the right shows the capacity to transform existing parking lots and structures into green space on a six-block section of Lake Street.

Below are examples of green space transformations that could contribute to our identified Equity Goals at right, and 2040 Plan Goals (5, 6, 8, 9, 10, **see Poster 8**).



Midtown Exchange parking structure, 10th & Lake

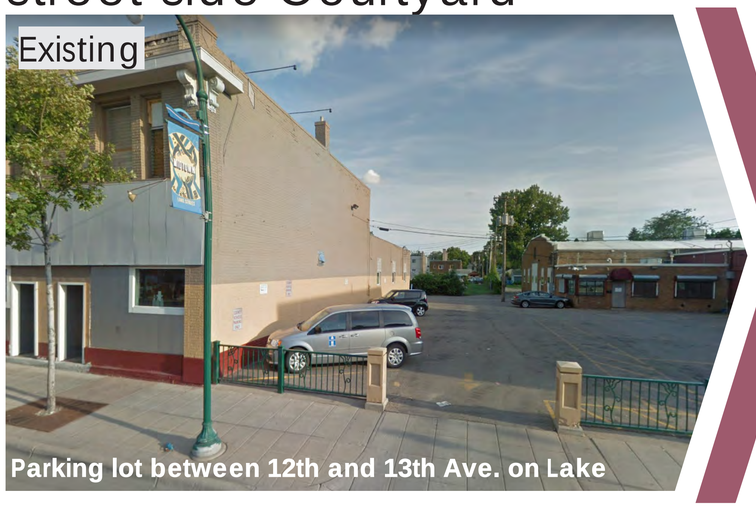


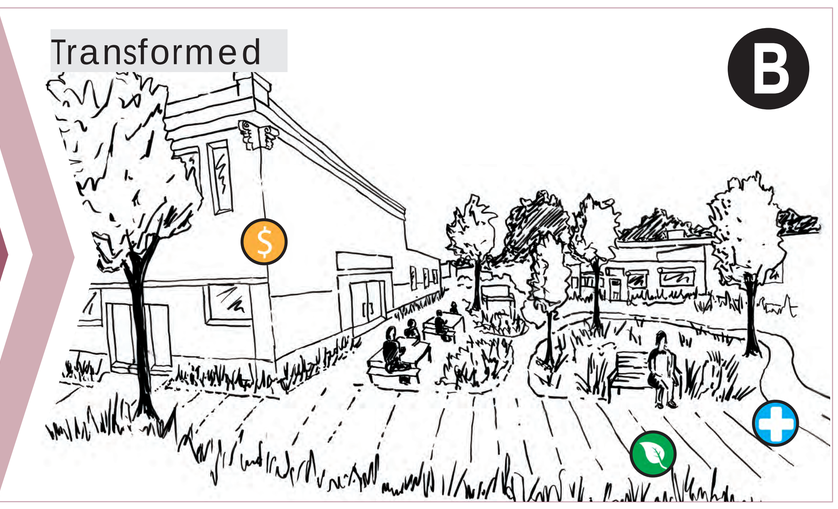


As CAVs reduce the need for parking, **rooftop parking lots can become green roof parks for people who work or live in the repurposed parking structures, as well as members of the public. Green roofs also provide environmental benefits** such as stormwater infiltration, building insulation, native plant and pollinator habitat, and space for agriculture.

Street-Side Courtyard

Parking lot between 12th and 13th Ave. on Lake



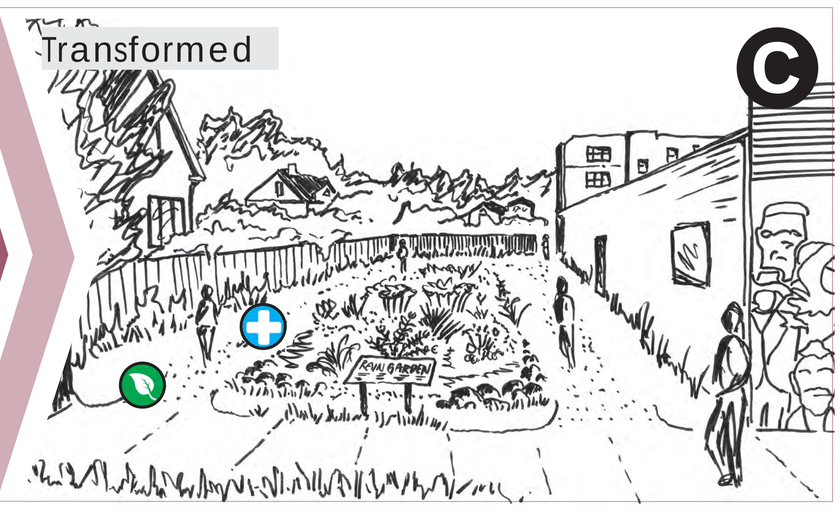


Many street-side parking lots exist along Lake Street that can be transformed into **multi-use open spaces** that include seating for restaurants, tree cover and native plants, pathways connecting to alleys, and space to relax and socialize. As CAVs allow for an *expanded pedestrian zone* **(see Poster 15)**, transforming these spaces can enhance the pedestrian and business environment.

Rain Garden

Parking lot behind St Vincent De Paul on 12th Ave.



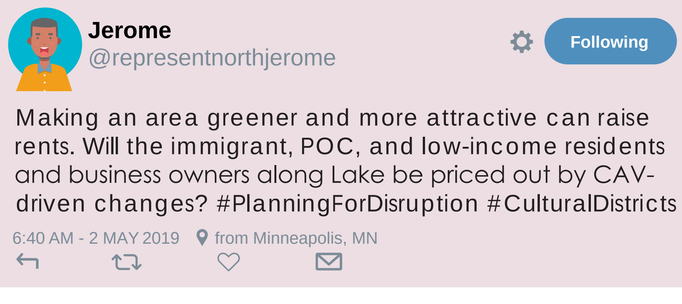


Smaller parking lots can be transformed to **rain gardens** or other **green infrastructure** that mitigates flooding, provides **native plant** and **pollinator habitat**, and adds **beauty to the streetscape**. Additionally, rain gardens can be programmed for **environmental education**. These spaces can also incorporate pedestrian connections between main and internal ROWs.

Key: Equity Goals
- New & Diverse Economies
- Mobility
- Housing
- Environment
- Public Health

Comprehensive Planning Policy Implications

The city should develop policy to guide the transformation of parking lots and structures in conjunction with public realm improvements **(see Posters 15, 16)**. Community Benefits Agreements can empower communities to negotiate these transformations as Lake Street develops, densifies and responds to CAV adoption.



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Planning for Disruption

Phasing and Outreach

The CAV disruption in Minneapolis will require phased infrastructure and policies in the short-term to simultaneously accomodate both manually driven vehicles and CAVs. How Minneapolis plans for the transitional period could determine the level of disruption, who is impacted, and the level of CAV adoption.

Short Term Options

Rethinking the Street

Keep existing curbs

- **Upgrade street infrastructure** and test out **street section innovations**
- Maintain **existing curbs** and **gutter systems** and shift to the construction of semi-permanent sidewalks
- Narrow streets at a **lower expense** until there is funding for a long term solution

Paint CAV and Bus only lanes

- **Separate CAVs and regular vehicles**
- Explore/test bus and CAV only lanes through a **lane repainting pilot program** and **user surveys**
- Repaint lanes as a **quick and inexpensive** way to test ideas and raise awareness about CAVs

Rethinking the Block

Transitioning into Green Alleys

- Introduce **permeable pavers** and other **green infrastructure**
- Encourage **community investment**
- Reduce lane sizes to incorporate more **pick-up drop off** space as a temporary solution to encourage pedestrian uses of the alleys

Allow Flexible Uses Now

- Allow commercial uses of ADUs and alley-facing buildings to **promote a pedestrian-scale sharing economy**
- Include **potential time of day priorities** for CAVs/traditional vehicles
- Consider how the city's **Cultural District policy** could support these changes

Open Space

Parklets

- Use **tacticical urbanism** approaches such as **parklets, movable planters, and street furniture** to experiment with potential uses for underutilized parking lots
- Update City's Parklet guide to meet the needs of **new parklet** types

Paint Pavement to Create Parks

- Use **temporary materials** to let communities **test ideas**, and **develop permanent designs**

Program Potential Open Spaces

- Offer **"Open Spaces Programs"** to nonprofit organizations to partner with artists to create temporary open space

Public Outreach Ideas

#PlanningForDisruption community events

- Engage the community and the **Minneapolis Tactical Urbanism Committee** in CAV disruption
- Embrace the idea that traditionally auto-centric spaces (ROW, parking lots, etc.) are transforming and will **increasingly be available for new uses**

Medium/Short Term Options

Test and Update Street Design

- As streets are upgraded, introduce CAV infrastructure needs
- Include **policy incentives** that allow **CAV-related innovations** to complement regular maintenance and new infrastructure/utility updates

Design competitions - ask the community

- Engage **expert designers and developers** through **design competitions** to develop ideas for new building types
- **Engage with trusted community groups/ leaders** throughout the process to inform and judge the final designs

Medium Term Options

Update Infrastructure Incrementally

- As streets are upgraded, introduce CAV infrastructure needs
- Include **policy incentives** that will allow for **CAV-related innovations** to complement regular maintenance or new infrastructure/utility updates that are in the area

Bike ped infrastructure

- Incorporate alleys into bicycle and pedestrian networks by creating **intentional connections** to **existing bike lanes, greenways, and walking paths**
- Install **permeable pavement** in spaces that transition between car-centric and pedestrian uses

Scenario Examples



INSURGENT BIKE LANES
When citizens in Mexico City were tired of waiting for the city of paint bike lanes, they they took matters into their own hands. While the action may not be one to be replicated, the idea behind using pint as quick and cheap way to create priority in lane type is.



ALLEY GREENING
This example of alley greening from a multifaceted alley improvement program in Detroit aims to make alleys safer and greener. This photo is from the Green Alley connecting 2nd and Cass Avenues. (Photo Credit: Model D Media)



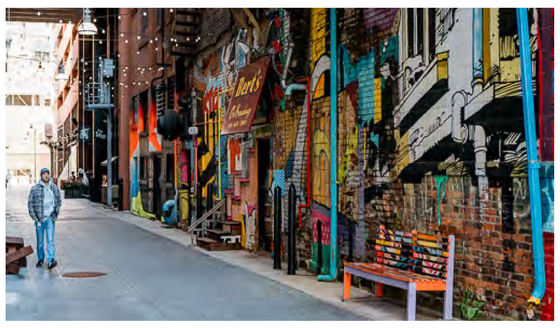
PEDESTRIAN INVESTMENT
CAVs create opportunities for investment in the pedestrian experience. Asking communities to assist in art installments creates beautiful artwork and establishes investment. (Photo credit: Portland Underground Graduate School)



COMMUNITY EVENTS
Weekly #PlanningForDisruption community events including music, food, and opportunity for interaction can establish an empty lot as a community center. Photo above is from Off the Grid event in San Francisco (Photo credit: SF Gate)



TESTING STREET SECTIONS
Testing out new street section arrangements such as temporary bike lanes can create interest and engagement in the process while testing out design ideas such as this example. (Photo credit: Build a Better Burb. Image: Kansas City)



ALLEY ART
Art installation in alleys attracts visitors and interest in a place and allows local artists show their work in a very public setting. This photo is from The Belt, an activated alley in downtown Detroit. (Photo Credit: Model D Media)



OPEN SPACE PROGRAMS
Program events in potential open spaces such as group exercise like this example from Philadelphia (Photo Credit: Carpe Diem Events Philadelphia)



DESIGN WEEK
Events like San Francisco Design Week use a design competition in urban prototyping to test new uses along a major street. Some of the designs are so successful, they become permanent. (Photo Credit: SF Exploratorium)

The ideas that are built during these **transitional periods** will determine the kinds of solutions that will dominate over the **longer term** and will also set up **goals for long-term future policy, infrastructure, and equity** decisions. These long-term solutions will be presented in the next poster. The equity goals/opportunities outlined throughout this project should be consistent throughout all stages of CAV adoption.

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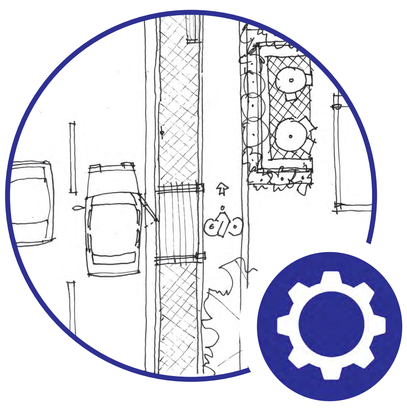
https://smartgrowthamerica.org/safe-streets-academy/

Planning for Disruption

Policy & Equity Implications

20 T5/T6 mpls

To take full advantage of the Equity Goals introduced in Poster 8, we ecommend the following:



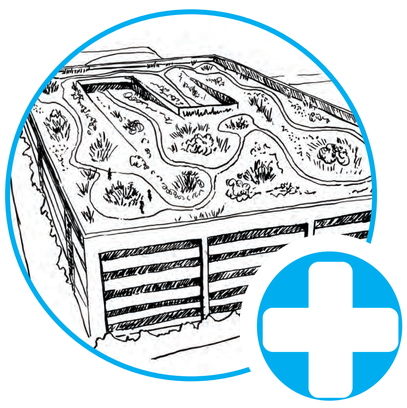
Mobility

- Prioritize **Complete Streets models** in redesigning for CAVs; clearly define where CAVs fall in the modal hierarchy.
- Develop a **phasing protocol** for the overlap between CAVs and traditional cars to **manage how modes interact** regarding curb access and pick-up/drop-off zones.
- Develop **policy guidance** to **redesign internal ROW** for pedestrians and bikes to facilitate bike/ped connections through alleys.
- Ensure that **CAV technology is deployed to all areas in the city equally** to avoid deepening disparities in transportation access and to ensure that **all residents can access** CAV tehnology.



Environment

- **Incentivize the installation of green infrastructure technology** (rain gardens, bioswales, permeable pavement, green roofs) in reclaimed main and internal ROW, parking lots, and parking structures.
- **Facilitate the transformation of unused parking lots, parking structures, and paved surfaces** into publicly accessible open space that fills a community need or desire and contribute to health equity.



Public Health

- **Prototype street configurations** that allow CAVs to improve, rather than detract from, the biking and walking environment so as to continue **encouraging active transportation**.
- **Identify areas that lack public open space, green space, tree cover, or food access** and prioritize converting paved lots into open space, green infrastructure, or agricultural space, to increase environmental resilience and health equity.



Housing

- **Adapt zoning to allow housing to be built in the right of way** as the necessary number and size of lanes diminishes.
- **Incentivize or fund the creation of small-scale affordable housing** in these spaces.
- Investigate the **conversion of parking structures into housing,** and require newly built parking structures to be easily convertible to housing or other uses once parking becomes unnecessary.
- **Expand allowable use of ADUs** (currently only allowed on lots with dwellings that contain 1 or 2 units) to incentivize the conversion of garages to housing.



Economy

- Adapt zoning to **allow flexible-use structures in the ROW** for small-business incubators, work space, pop-up events.
- Allow **flexible commercial uses** in ADUs and garages that no longer house cars.
- Investigate the **conversion of parking lots** and structures into commercial flexible space.
- Use **reclaimed space to improve building frontages** for a more pleasant and walkable commercial environment.

Conclusion

CAV introduction will have different implications for **Washington Avenue** and **Lake Street** due to the corridors' varying conditions, demographics and development goals **(see Posters 3-7)**. Given the variety of possible uses for reclaiming the space that CAV disruption will make available **(see Posters 9-18)**, **Minneapolis should develop policy mechanisms** to **enable community agency and ownership** over these transformations in order for CAV disruption to promote the Equity Goals identified in **Poster 8**. Given the imminent arrival of CAVs, now is the time to begin acting on the strategies above in order to ensure equitable outcomes from the coming CAV disruption.

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The CAV Urban Village

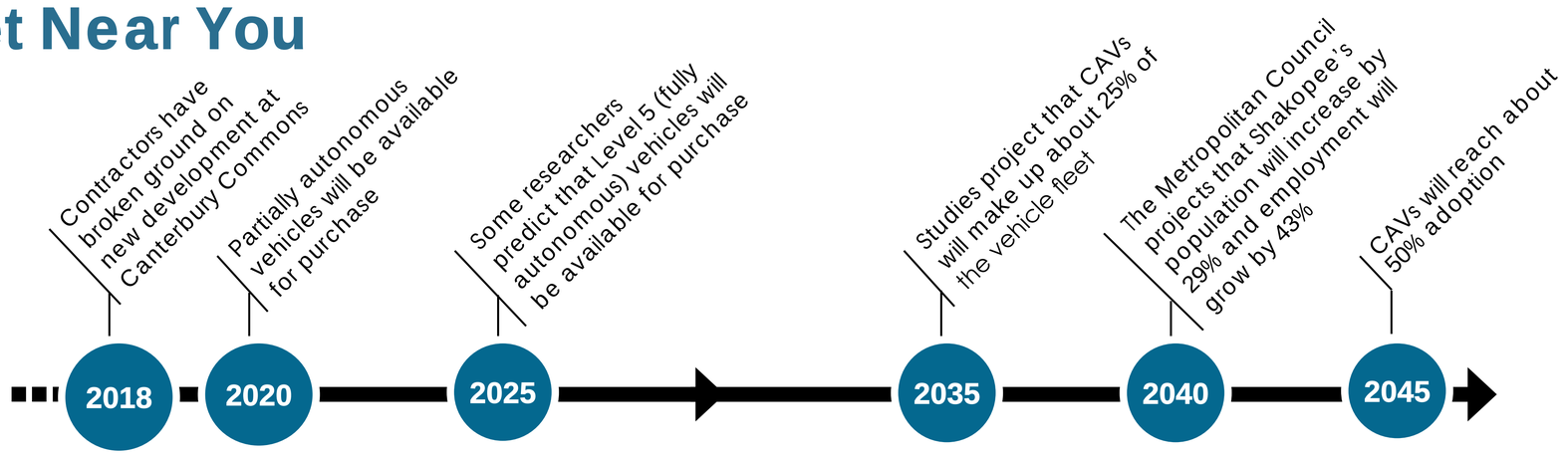
Recalibrating the Canterbury Park Master Plan

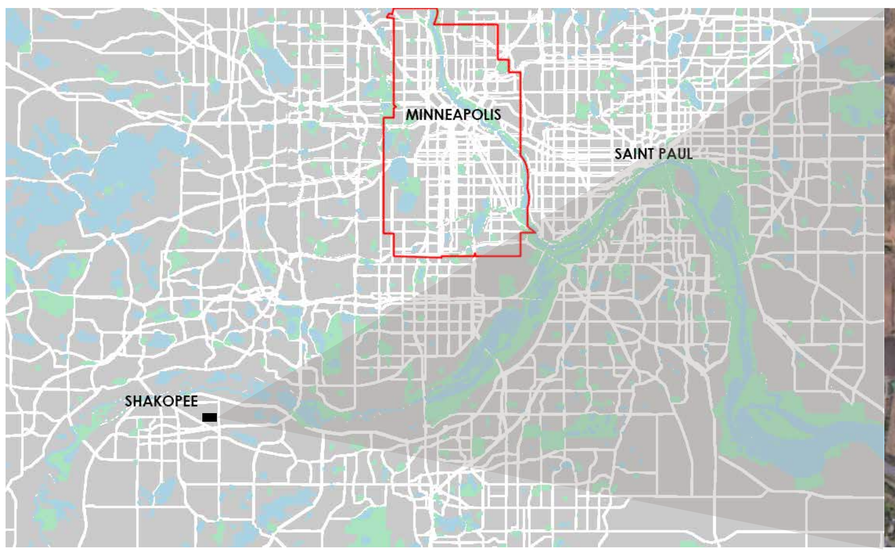
1 T4 Scott

This project considers the implementation of **Connected and Autonomous Vehicle (CAV)** technologies master planning practices. Subdivision planning could be improved by exploring best practices that recalibrate the public and private realms. We consider this challenge through the following question case study: **How can Canterbury Park recalibrate the master plan to prepare for a CAV-oriented future?**

CAVs: Coming Soon to a Street Near You

CAVs may be incorporated into our transportation systems sooner than we realize. Yet **95% of the 500 largest U.S. Cities have no AV policy or plan.** The City of Shakopee's 2040 comprehensive plan, Envision Shakopee, briefly mentions preparing for CAV technology but does not address specific policies or subdivision development guidelines.







Canterbury Park is an area in Shakopee, MN, a southwest outer-ring suburb of the Twin Cities. The area includes a new development, a casino, and a horse racetrack.

Canterbury Holdings, Inc., which owns the park, plans for the new development to draw new commercial development. Developers aspire to enhance the "**Canterbury Experience**."

As CAVs become more available, the city and developers will need to consider how to incorporate **CAV technology** into their plans and address how this technology will affect land use.

Actors

Government Agencies

These agencies control and regulate how development can occur. **How will government plan for a CAV future?**

Job Centers

Primary decision makers about how the plan is laid out. **How will the plans be affected by CAV technology?**

Development Partners

Large employment centers draw people from around the metropolitan area. **Will the new development allow people to live near their jobs? If not, how will they commute to their jobs?**

Equity in Canterbury



Will everyone benefit equally from the implementation of CAV technology in Canterbury Park? What steps can planners take to ensure **marginalized groups** are not left behind? **Ed, an Asian-American single dad who works at a restaurant at Canterbury Park as a server,** will express his opinions about the recalibration along with the posters, tweeting his commentary.

The Canterbury Experience



The "**Canterbury Experience"** is the unique feeling visitors, residents, and employees have when they are in Canterbury Park. Everyone who visits Canterbury should know that Canterbury is a special place in Shakopee and within the Twin Cities metro. The "Canterbury Experience" should **provide a unique place** for people to have **recreational**, **cultural** and **shopping experiences** in a **CAV urban village,** to create memories and encourage people to visit time and time again!

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Resilient Communities Project
University of Minnesota

Introducing the CAV Urban Village

2 T4 Scott

The CAV Urban Village

As CAV technology increases and demand for parking declines, planned subdivisions can be developed in their place. We introduce CAV Urban Village recalibration principles and suggest how they can be used to re-imagine the parking lots as CAV urban villages.

Toward a CAV Oriented Urban Village

Our **recalibration principles** suggest the new subdivision development should focus on envisioning an **urban village that upholds the "Canterbury Experience**." An urban village is a **mixed use, dense development** with a variety of business, office, and residential uses that feature public spaces and transit.[1]



Mixed-Use Development

The CAV Urban Village features a **dense, mixed-use, walkable center** with plenty of **public space**, allowing people to live, work, and play in the vicinity. Public spaces activate the village and create a **sense of place**. The Urban Village is specifically designed for people and experiences with less of a focus on CAVs.



Green Space

Public spaces provide spaces for **parks, green space, and recreational and cultural opportunities.** These parks and plazas can also provide locations for special events such as farmers markets, concerts, and pop up events. With more space made available by decreased demand for auto-oriented land uses, the extra space can be used to create a **memorable atmosphere**.

Multi-Modal Transportation

We envision a **multi-modal corridor** through the urban village. This corridor features bus lanes, bike lanes, and pedestrian plaza. A dedicated bus lane allows buses to run periodically up and down the street and provides a convenient way to transport large numbers of people to and within the urban village.

Residential Density

Multiple types of multi-family residential development will be located within the urban village. This approach will provide additional housing options to those looking for their first home or wanting to downsize.

CAV Pickup/Dropoff Stations

Dedicated CAV stations are located on the periphery of the urban village and allow people to wait for their CAV to pick them up. Stations are set back from the main road so as to not impede the flow of traffic. To **encourage people to use transit and live in more dense communities**, a **congestion/pick-up and drop-off fee** should be applied to roadways and stations.[3]

As CAV technology is adopted and parking lots become obsolete, land can be redeveloped into more productive land uses to create **new opportunities for urban form, business, leisure, and housing options**.

Urban Village

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Emily Houser, Koehl Simmons, Forrest Steinhoff, and Ari Del Rosario | Professor Fernando Burga, T.A. Christopher Desroches

1 Hamilton, Emily. "Three Policies for Making Driverless Cars Work for Cities." Market Urbanism, 6 Nov. 2018, marketurbanism.com/2018/11/06/three-policies-for-making-driverless-cars-work-for-cities/?utm_content=buffer841e1&utm_medium=social&utm_source=facebook.com&utm_campaign=buffer.
2 "Home Page." Missing Middle Housing, 2018, missingmiddlehousing.com/.
3 City of Indianapolis, "*Blueprint for an Urban Village Planning Guidebook: Great Places 2020*," City of Indianapolis, LISC. https://www.in.gov/myihcda/files/Great_Places_2020_Planning_Guidebook.pdf+

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University of Minnesota

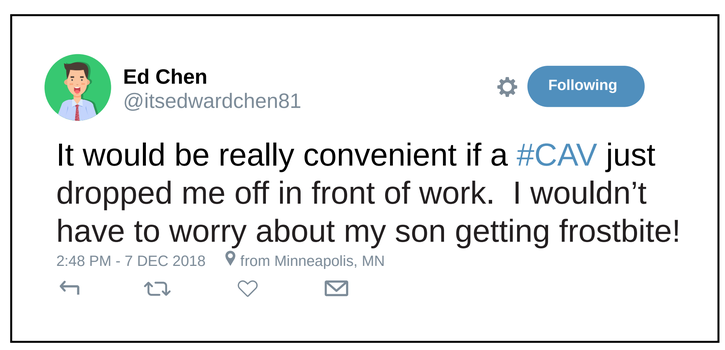
Guiding Policies and Principles

T4 3 Scott

The CAV Urban Village

What is a Master Plan Recalibration?

In this poster, we present our adjustments to the existing Canterbury Park Master Plan by adopting key design elements for the introduction of CAVs. We establish assumptions about the adoption of CAV technology, identify land use policy benefits, and put forth our CAV design framework to inform recalibration principles.

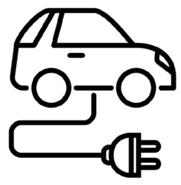


Assumptions



By 2040, most CAVs will have Level 5 Automation (**fully autonomous**).[1]

Recalibration element: CAVs will require less space on roadways due to less drift than human drivers. **Parking needs could be reduced by up to 90%.**



CAVs will be **powered electrically**.[2]

Recalibration element: Cities may consider **solar charging stations** where CAVs can be stored when they are not in use.



Due to prohibitive cost, CAVs will be largely **shared**, not privately owned.[3]

Recalibration element: Residential dwellings will not need garages, driveways, or parking spaces, but **curbside pickup and dropoff will become more important**.

Recalibration Principles	Land Use Policy Benefits	CAV Design Framework
Human-scale urban design	Human-powered and public transportation provide **environmental and public health benefits** by using less fuel and encouraging people to exercise and get outdoors.	As CAVs become more prevalent, planners should aim to **encourage and prioritize human-powered and public transportation**. Planners must also consider how CAVs and other road users, including pedestrians and cyclists, will interact, by designing **appropriate infrastructure to ensure safety**.
Green space	**Green space** in urban environments **benefits the health and well-being of residents** by providing **ecosystem services** such as filtering air, removing pollution, attenuating noise, cooling temperatures, infiltrating storm water, replenishing groundwater, and providing food.[1]	The diminished need for both surface parking lots and street parking, as well as the smaller road surface area required by CAVs vs. human drivers, will **free up space in the urban environment**, some of which can be re-designed for **public and green space**.
Mixed-use development	**Mixed-use zoning** provides a number of benefits, including **improving access to employment** opportunities, **enhancing pedestrian mobility**, attracting retail amenities, and **promoting healthy lifestyles** through functional public spaces.[2]	Traditionally, retail developments require a certain ratio of parking spaces to square footage of built floor area. The reduced need for parking following the adoption of CAV technolgy allows for the design of **greater density and diversity of building types**.
Residential density	Many cities are experiencing population growth, including the City of Shakopee,which is projected to see **29% population growth by 2040**.[3] Cities should ensure that a proportion of new development is denser, and/or affordable housing, perhaps considering **employer-sponsored affordable housing** so that employees can afford to live near their workplaces.	CAVs will allow people to travel farther to and from work with less mental strain from commuting. Given the **increase ease of commuting longer distances**, will Shakopee see even **more population growth than projected**? Will this lead to sprawl between destinations? Planners can address this challenge by promoting design guidelines that address CAVs and place-making.

The **advent of CAV technology and projected population growth** provide an exciting opportunity for the cities to reconsider subdivision planning and **recalibrate master plans**.

Policies/ Principles

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A Guide for Redevelopment 4

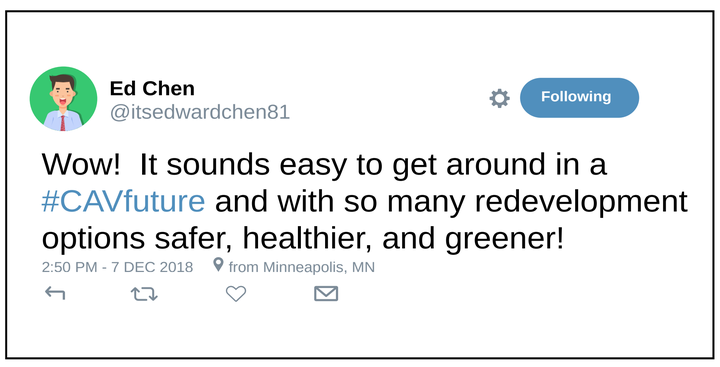
T4 Scott

The CAV Urban Village

The introduction of CAV technology will mean that existing land uses will need to evolve. In this poster, we provide a framework using the **land use policy principles** and **CAV Design Framework from Poster 3** to show how existing land use can evolve by the incorporation of CAV technology.

Street and Site Design Policies

Planners should develop policies and street design hierarchies that **prioritize pedestrian, cycling, and transit infrastructure over CAV technology**.[1][2][3] This approach will allow planners to diversify land uses and retrofit spaces which will be rendered obsolete as CAV technology becomes more prevalent.



Human-scale urban design



Photo obtained from: https://smartgrowth.org/complete-streets-model-baltimore/

Goal 1: Design complete streets to incorporate multiple modes and lanes of transportation that reflect the context and goals of the street[1][2].



Photo obtained from: https://www.citylab.com/design/2014/10/3-big-challenges-for-planning-multi-modal-cities/381254/

Goal 2: Encourage active transportation and transit ridership. Discourage single occupancy and CAV ridership.



Photo obtained from: https://nacto.org/case-study/left-side-bike-lanes-on-allen-pike-st-new-york-ny/

Goal 3: Design and incorporate varied lane textures and instruments to assist disabled users.[2]



Goal 4: Provide mid-block crossings to allow more convenient and safer crossings for pedestrians.

Green space



Photo obtained from: https://www.sciencebuddies.org/blog/from-parking-space-to-parklet-civil-engineering-and-city-planning-1

Goal 1: Incorporate green spaces and park-lets into street design



Photo obtained from: https://stradalic.com/2014/07/18/designing-stormwater-naturally/

Goal 2: Use permeable surfaces when possible to facilitate storm water infiltration.[2]



Photo obtained from: http://www.sehinc.com/portfolio/jackson-street-reconstruction-creates-backbone-st-paul-capital-city-bikeway-system

Goal 3: Encourage active lifestyles by enhancing pedestrian and bicycle paths and infrastructure.



Photo obtained from: https://www.seattle.gov/util/cs/groups/public/@spu/@conservation/documents/webcontent/01_027984.pdf

Goal 4: Establish green space minimums for all new developments.[1]

Mixed-use development & Residential density



Photo obtained from: https://www.cnu.org/sites/default/files/styles/homepage_slider/public/IMG_5584.jpg?itok=VmS5reGW

Goal 1: Improve access to employment opportunities and create additional housing options[1].



Photo obtained from: http://www.wglt.org/post/bloomington-aldermen-discuss-complete-streets#stream/0

Goal 2: Provide an attractive and dense location that encourages pedestrian, cycling, and transit use and discourage CAV use.



Photo obtained from: https://i.pinimg.com/originals/40/e0/3a/40e03a183538e939e00ab959a47e9074.jpg

Goal 3: Create Flex Zones allowing former street parking spaces to be used as CAV drop-off/pick-up locations, transit stops, parklets, and pedestrian space.



Photo obtained from: http://www.cityclock.org/top-10-cycling-communities-us/#.X8nj31xKjIU

Goal 4: Transform obsolete on-street parking spaces into new transportation uses, such as bus or bike lanes or walkng paths.

There is an exciting opportunity to incorporate new policies and design principles for streets as we transition to a CAV future.

Guide for Redevelopment

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1. Henaghan, Jennifer. "*Preparing Communities for Autonomous Vehicles.*" American Planning Association, 2018, pp. 1–44.

2. "*Blue Print for Autonomous Urbanism.*" National Associtaion of City Transportation Officials, 2017, pp 1-60

3. Roe, Matthew, and Craig Toocheck. "*Curb Appeal: Curbside Management Strategies for Improving Transit Reliability.*" National Association of City Transportation Officials, 2017, pp. 1–12.

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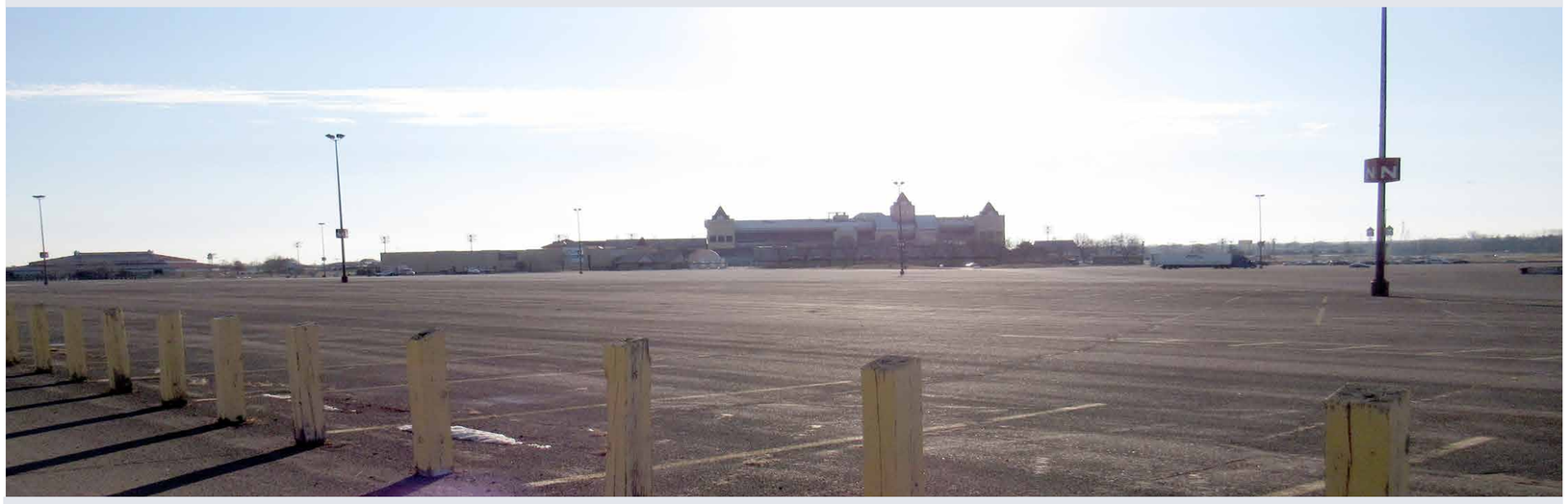
Current Conditions

5 T4 Scott

The CAV Urban Village

In this poster, we examine the current conditions of the 45-acre parking lot at Canterbury Park in relation to our **recalibration principles** and **identify opportunities** to **envision the CAV urban village**.

Welcome to the Canterbury Experience?



How can place-making improve the parking lot in the current site? View of the Canterbury Park horse racetrack from the far side of the parking lot. Most of the time, many of the 10,000 free parking spaces are empty and this land does not serve other uses. Is this the **Canterbury Experience?**

Site Planning the CAV Village



Site of existing parking lot and proposed CAV urban village

Key Observations

Opportunities



Placelessness: Aside from Canterbury Park in the distance, there are **no distinguishing features or landmarks** in the parking lot.

How can we cultivate a **sense of place**? What types of development would contribute to the "**Canterbury Experience**"?



Lack of green space: There is **no green space**, except inside the racetrack. Surface parking causes **negative environmental effects**, including the heat island effect and runoff from impervious surfaces.

The site is near the Minnesota River, which is impaired. This provides an opportunity, perhaps a responsibility, to install **water quality improvements** such as rain gardens, ponds, and other treatments to improve the water quality in the river.



Safety concerns: The empty 45-acre parking lot does not have posted speed limit signage and has limited lane markings, allowing drivers to speed through in many directions. It is **car-oriented, and not pedestrian-friendly**.

There is an opportunity to rethink a car-oriented space and make it safer for pedestrians and other road users by **envisioning a pedestrian-friendly CAV neighborhood**.



Vast open space: The amount of open (empty) space is striking. The parking at Canterbury Park is free, so **Canterbury is not earning income from the parking lot**.

A representative from Canterbury's real estate development company, Inland Development Partners, expressed **interest in developing the land into an urban village**, but cited existing zoning regulations as a barrier.[1]

Parking Facts and Figures

A typical off-street parking space requires about **250-350 square feet**, including access lanes and landscaping.[2]

A surface parking space typically costs **$5,000-10,000 per space**, depending on various factors such as topography, design, and geographic location.[3]

No-charge surface parking (as at Canterbury Park) has relatively low maintenance costs (snow removal and lighting being the biggest factors), but **surface parking lots require resurfacing every 5-10 years**.[4]

Since parking is provided free of charge, all this land is **not generating revenue for Canterbury Park**.

The **land required for just 4 parking spaces would supply enough land to build a modest (1,000 sq. foot footprint) home**, not including setbacks.[5]

The 45-acre parking lot is providing little benefit to Canterbury Park or its surroundings. A CAV-oriented future in which the demand for parking is greatly decreased creates an opportunity to address a number of issues, including those identified above.

Current Conditions

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The Canterbury Park Master Plan

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The CAV Urban Village

The current subdivision master plan shows a **separation of land uses** (i.e. residential and commercial, including specialty retail, family entertainment, and community gathering places), with new luxury housing already under construction. The new housing to be built includes market-rate apartments and senior housing. The preliminary site concept plan states that "both [high density residential structures] will have a **3-level enclosed parking garage with 315 heated parking spaces and 194 surface parking stalls.** This amount equals **1.65 stalls per unit**, well above the current market demand of 1.3-1.4 stalls per unit."

Site Concept Plan

1 Parking

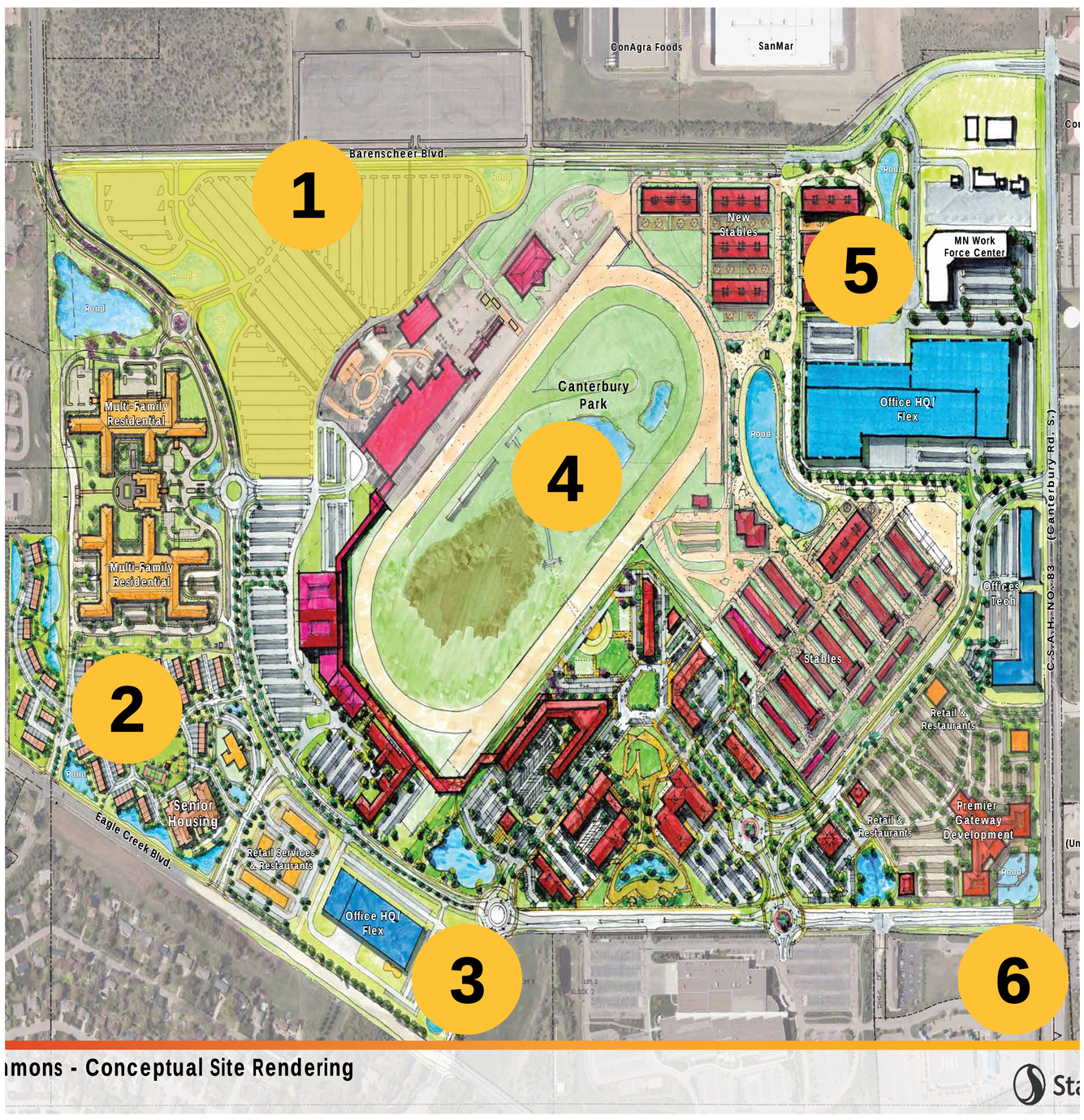
There are currently **10,000 parking** spaces in the parking lot, with plans to add an additional 509 spaces. In a CAV-oriented future in which individual parking spaces are not needed, these spaces will need to be re-purposed.

2 Housing

Housing under development includes senior housing and high-end apartments. There is demand for **affordable housing** for those who work in the community.

3 Traffic

Infrastructure improvements, such as roundabouts, will help support traffic flow and event traffic. In a CAV-oriented future, infrastructure should be redesigned to accommodate **multiple modes of travel.**



mons - Conceptual Site Rendering

Site Concept Plan from Stantec. The parking lot, highlighted in yellow, serves as the location for our neighborhood plan.

4 Zoning

The site is zoned MR - Major Recreation Zone. This allows for a high degree of land use compatibility and requires the planning of the entire parcel. **To redevelop the site, it would need to be re-zoned to allow residential uses and mixed uses.**

5 Business

Businesses in the area could make use of **CAV technology** if it is well utilized and infrastructure is updated to accommodate a CAV-oriented future.

6 Transit

Minnesota Valley Transit Authority (MVTA) operates Route 499 which directly serves Canterbury Park. In a CAV future, **improving transit access should be prioritized,** allowing people to move more efficiently.

A CAV Future?

Canterbury Park has a large area of land devoted to surface parking, and the developer plans to add more surface parking and heated parking stalls. This use will be increasingly rendered obsolete as we transition to CAVs. If CAVs are largely shared, which scholars predict they will be, there will be less demand for parking. How else could these empty parking lots be used?



The City of Shakopee and Canterbury Holdings, Inc. are working to **increase density to accommodate an influx of new residents and businesses**. While the current site concept plan begins to address these opportunities, we argue that it **does not go far enough** and that **CAVs present further opportunities in subdivision planning that are not addressed in the master plan.**

Master Plan

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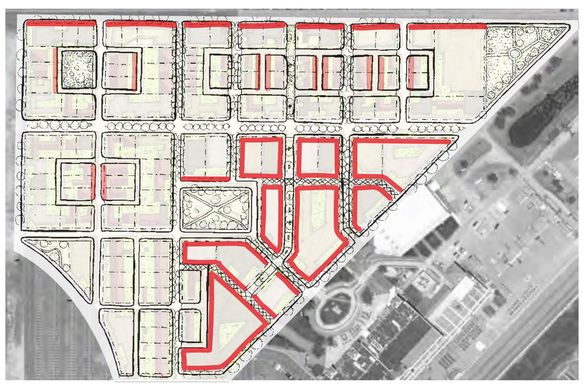
Proposed Neighborhood Plan 7

T4
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The CAV Urban Village

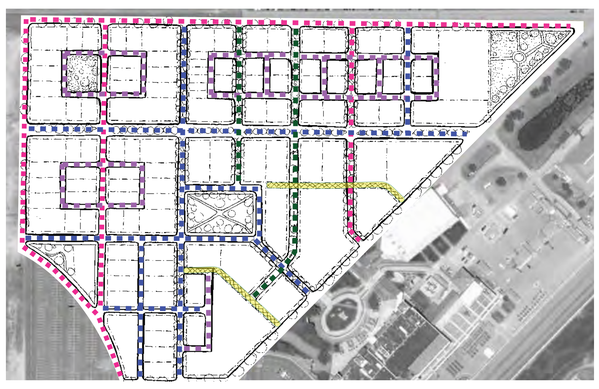
The 45 acres of parking freed up by the diminished need for parking as CAVs become prevalent mode of travel will allow for **development of new housing and job creation**. This development will enhance the tax base and provide cultural and entertainment amenities in an urban village. In this poster, we present a land use plan and map analys for the urban village.





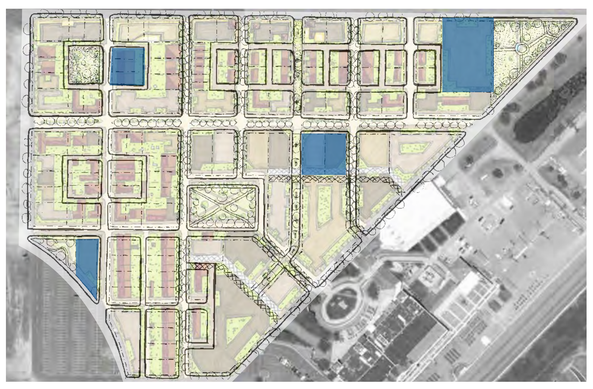
Commercial Frontage

Red lines show major commercial frontages within the CAV Urban Village. Across the street from the northern boundary of the village is industrial use, so that area is zoned for commercial use.



Roadways

- Major roadways
- Secondary roadways,
- Alleyways
- Greenways/Pedestrian walkways
- Pedestrian arcades



Civic Zones/CAV hubs

Areas shown in blue are civic zones and CAV hubs where people can congregate in public space, and where they can catch a CAV.



Green Space

Green spaces are highlighted in green, showing several parks and a green pedestrian and bicycle path.

The 45 acres of parking freed up by the diminished need for parking when CAVs are the standard mode of travel will allow for development of new housing, amenities, and cultural corridors in an urban village.

Neighborhood Plan

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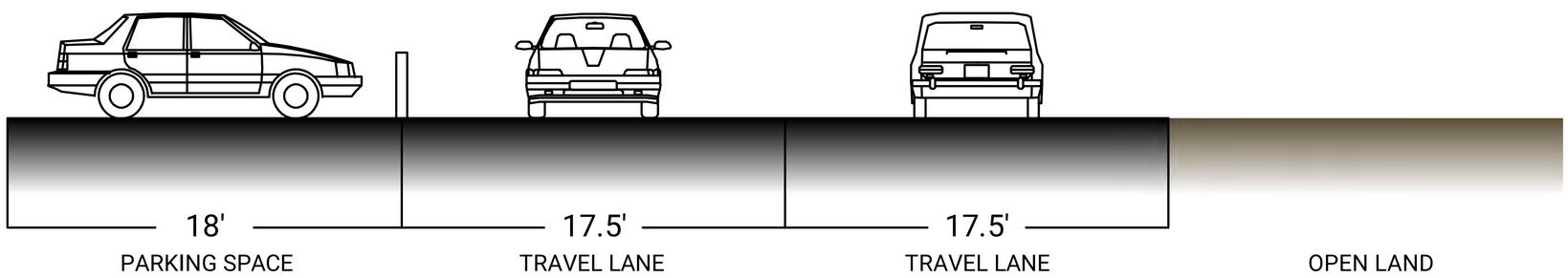
Design Scenario: External Right-of-Way

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The CAV Urban Village

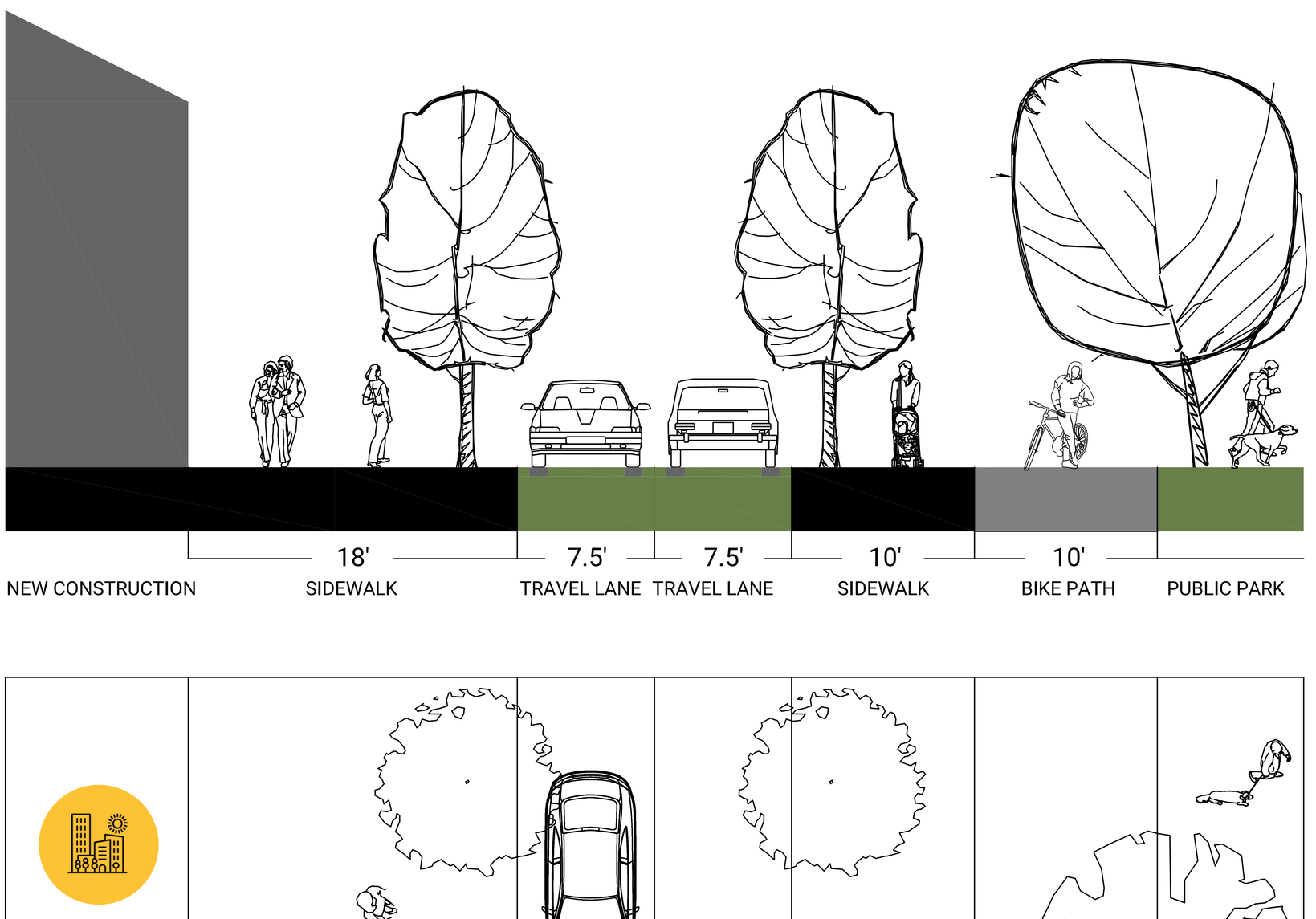
In this poster, we present a design scenario: The external arterial road of the **CAV Urban Village**. Incorporating our **recalibration principles**, our design scenario furthers the **"Canterbury Experience" by providing a unique, place-based experience in Canterbury Park.** We focus on the external right-of-way arterial in this poster because it represents a major transitway typology, which **incorporates many of the innovations brought forth by the introduction of CAV technologies**.

Current Conditions





Our Proposal



CAV Recalibration:

Human Scale Urban Design: With a reduction in auto-centric infastructure, we can incorporate **larger sidewalks** and **bike lanes**. These **human scale** amenities encourage people to get out and have a positive effect on **public health**.

Green Space: with less space devoted to cars, we can fit a **public park** in a space previously devoted to parking. In addition, because **fully-autonomous** CAVs are not subject to drift, the space between tire treads can be filled in with vegetation, **reducing runoff and pollution**.

Mixed-Use Development: Our proposal seeks to make Canterbury a place for people to live, work, and play. We do this through both mixed land uses and supporting infastructure. One of the hallmarks of our proposal is a large amount of **mixed-use buildings**.

Housing Variety: Coupled with high-end apartments and senior living currently being built in nearby Canterbury Commons, our proposal includes **multi-family housing** options in a variety of densities.

What do the streets of the CAV Urban Village look like? In the next poster, we explain how we utilize our **CAV recalibration principles** to design a Canterbury Park CAV recalibration at a street level.

External ROW

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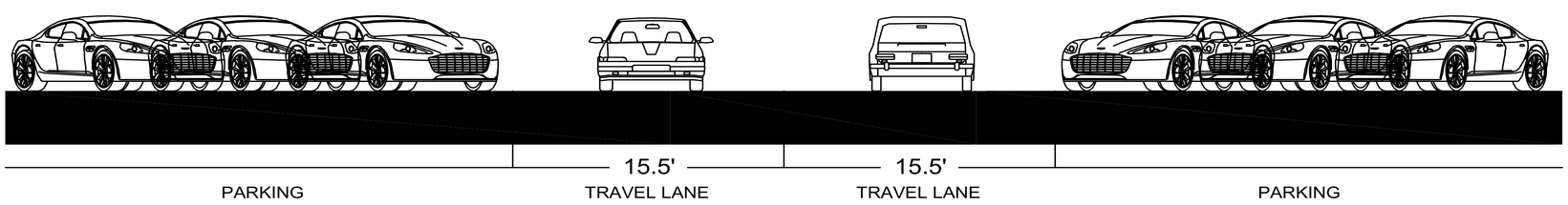
Design Scenario: Internal Right-of-Way

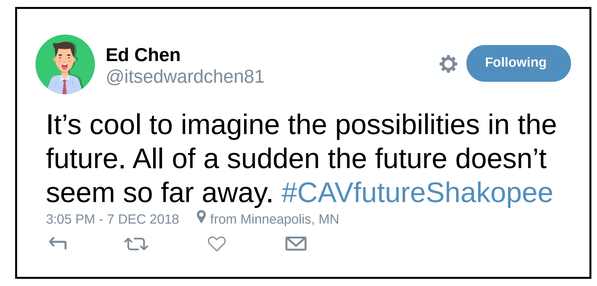
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The CAV Urban Village

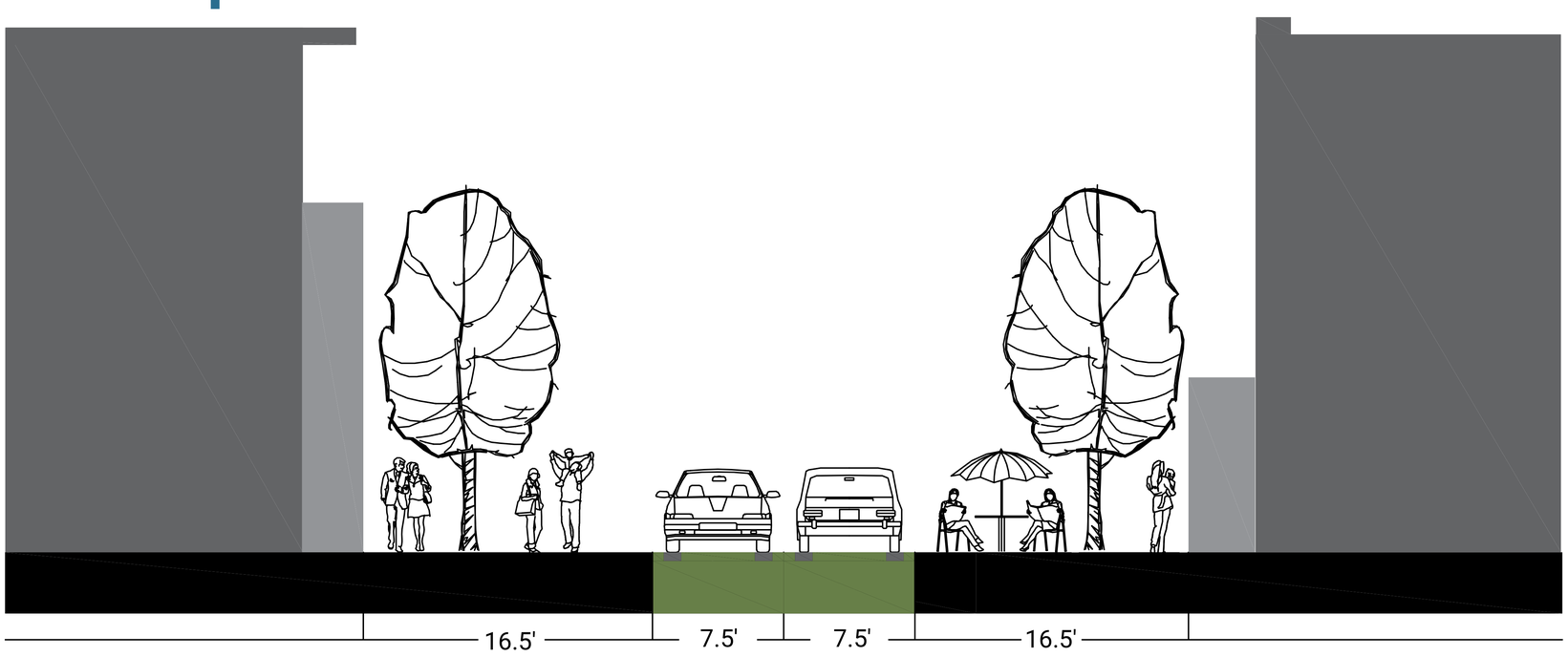
In this poster, we present a design scenario for an internal road of the **CAV Urban Village**. Incorporating our **recalibration principles**, our design scenario furthers the **"Canterbury Experience" by providing a unique, place-based experience in Canterbury Park.** We focus on the internal right-of-way in this poster to showcase some **of the diverse land use innovations brought forth by the introduction of CAV technologies**.

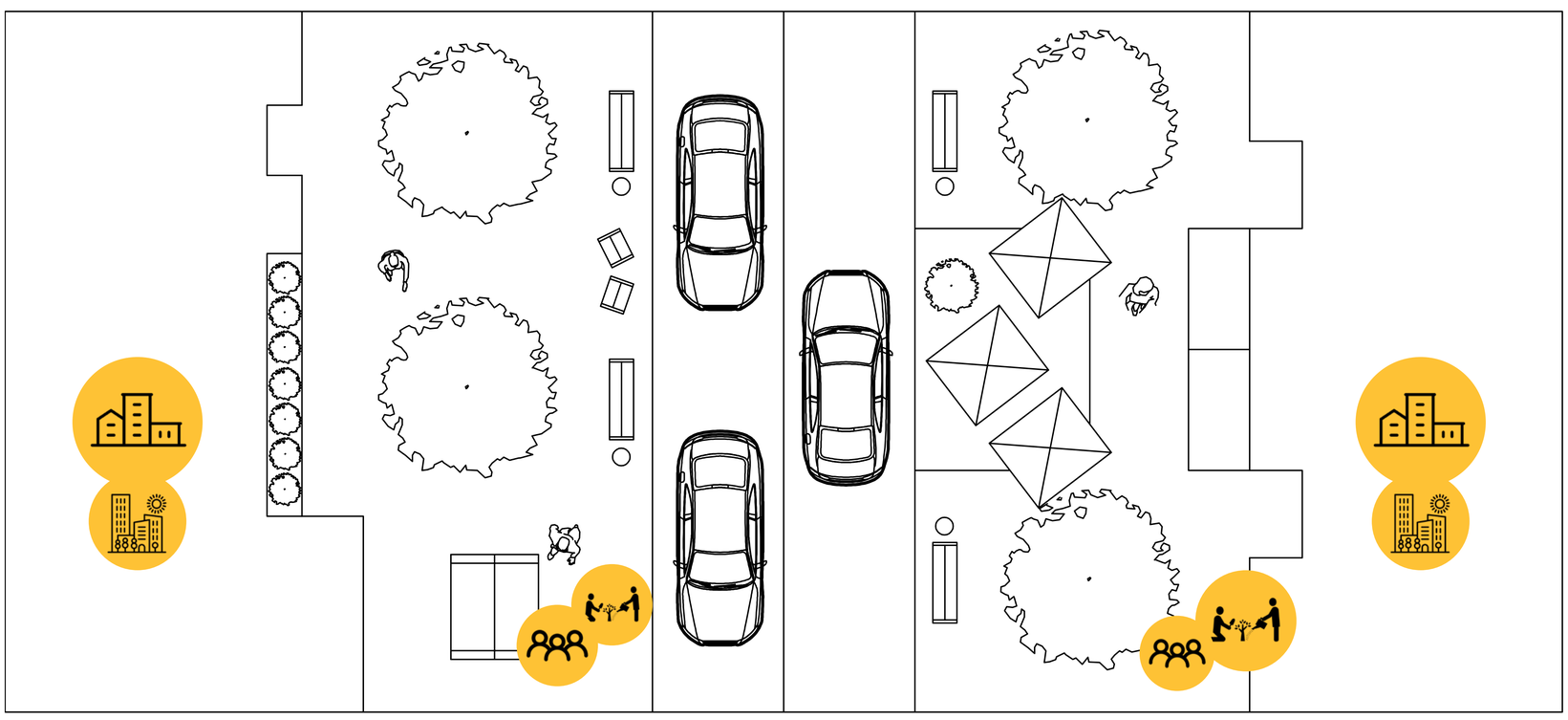
Current Conditions





Our Proposal





CAV Recalibration:

Human Scale Urban Design: In part due to **larger sidewalks** and **bike lanes**, the area is much more pedestrian friendly. This enhances the "Canterbury Experience" by providing multiple modes of transportation and encourages people to use the space more frequently.

Green Space: With the need for parking eliminated, in addition to green roads we are able to fit more trees into the parking lot; improving greenery reducing Canterbury's carbon footprint.

Mixed-Use Development: Both sides of the street now include **mixed-use developments** with residents built above street level businesses. These mixed-use buildings will bring more **jobs, residents, and business** to Canterbury, enhancing the local shared economy.

Housing Density: Coupled with high-end apartments and senior living currently being built in nearby Canterbury Commons, our proposal includes multi-family housing options **in a variety of densities.**

The 45 acres of parking freed up by the diminished need for parking when CAVs are the standard mode of travel will allow for development of new housing, amenities, and cultural corridors in a **CAV Urban Village.**

Internal ROW

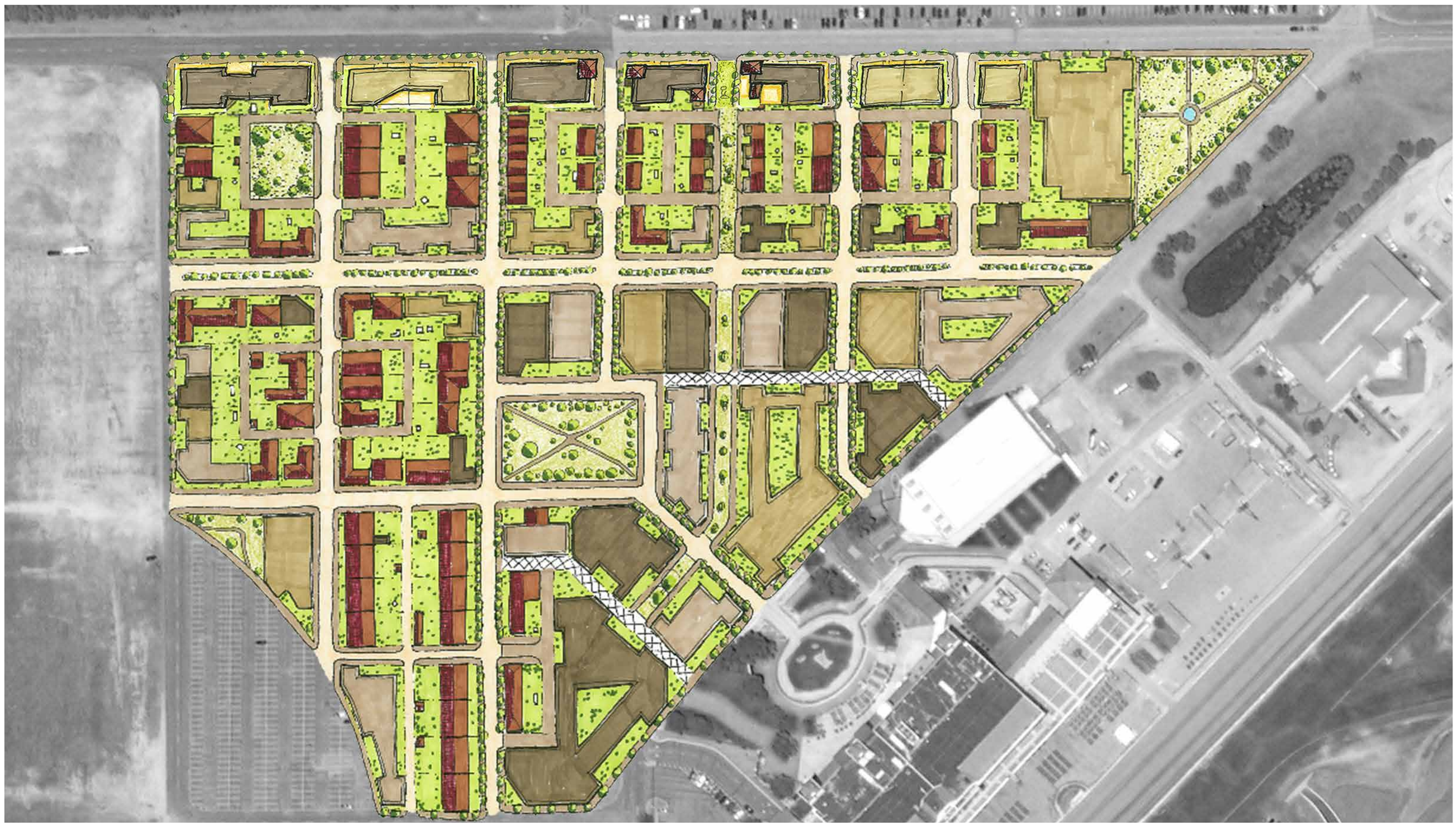
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A Bright Future for Canterbury

The CAV Urban Village

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In this project, we considered the master plan for Canterbury Park in the context of a rapidly approaching future in which **Connected and Autonomous Vehicles (CAVs)** dominate the transportation landscape.

Due to a revolutionary **decrease in the amount of parking** needed by CAVs as compared to human drivers, Canterbury Park's 10,000-space parking lot will be rendered obsolete. This presents an **opportunity to rethink the possibilities for this space**.

Our neighborhood plan incorporates the design principles of **people-centered design, green space, mixed-use development, and diversity of housing options, in order to enhance the "Canterbury Experience."** We evaluated the existing master plan, articulated a **CAV design framework**, and applied it to create a neighborhood plan for an **urban village** in what is currently the parking lot.

Canterbury Park: The Urban Village of the Future

The arrival of CAVs will give Canterbury Park an opportunity to reshape its parking lots into an urban village that will benefit the surrounding community by providing a **diversity of housing options, green space, mixed-use development, and people-centered design**. Our recalibration of the Canterbury Park master plan may serve as a case study for other metropolises facing redevelopment opportunities in the advent of a CAV-oriented future.

Conclusion

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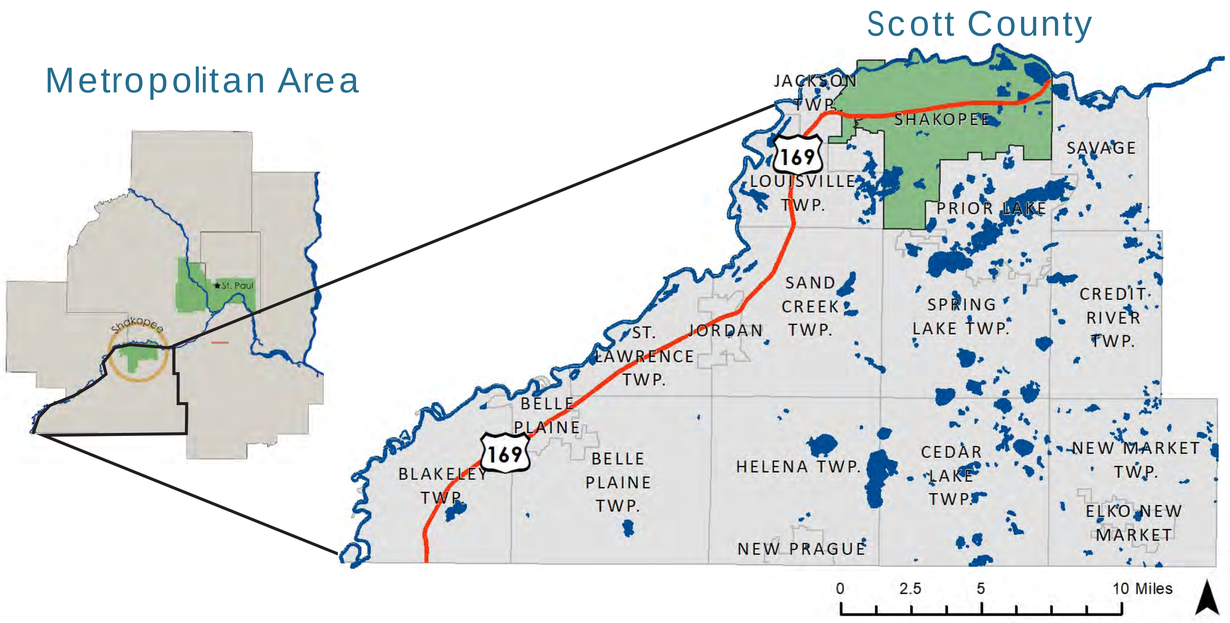
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Paving the Way

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Re-envisioning Pedestrian Safety for CAVs

The advent of connected and autonomous vehicles (CAVs) marks a great transition in transportation networks, with reports estimating 50% of cars will be fully automated by the year 2040. Planning for these new technologies can help communities realize future benefits and anticipate unintended consequences.



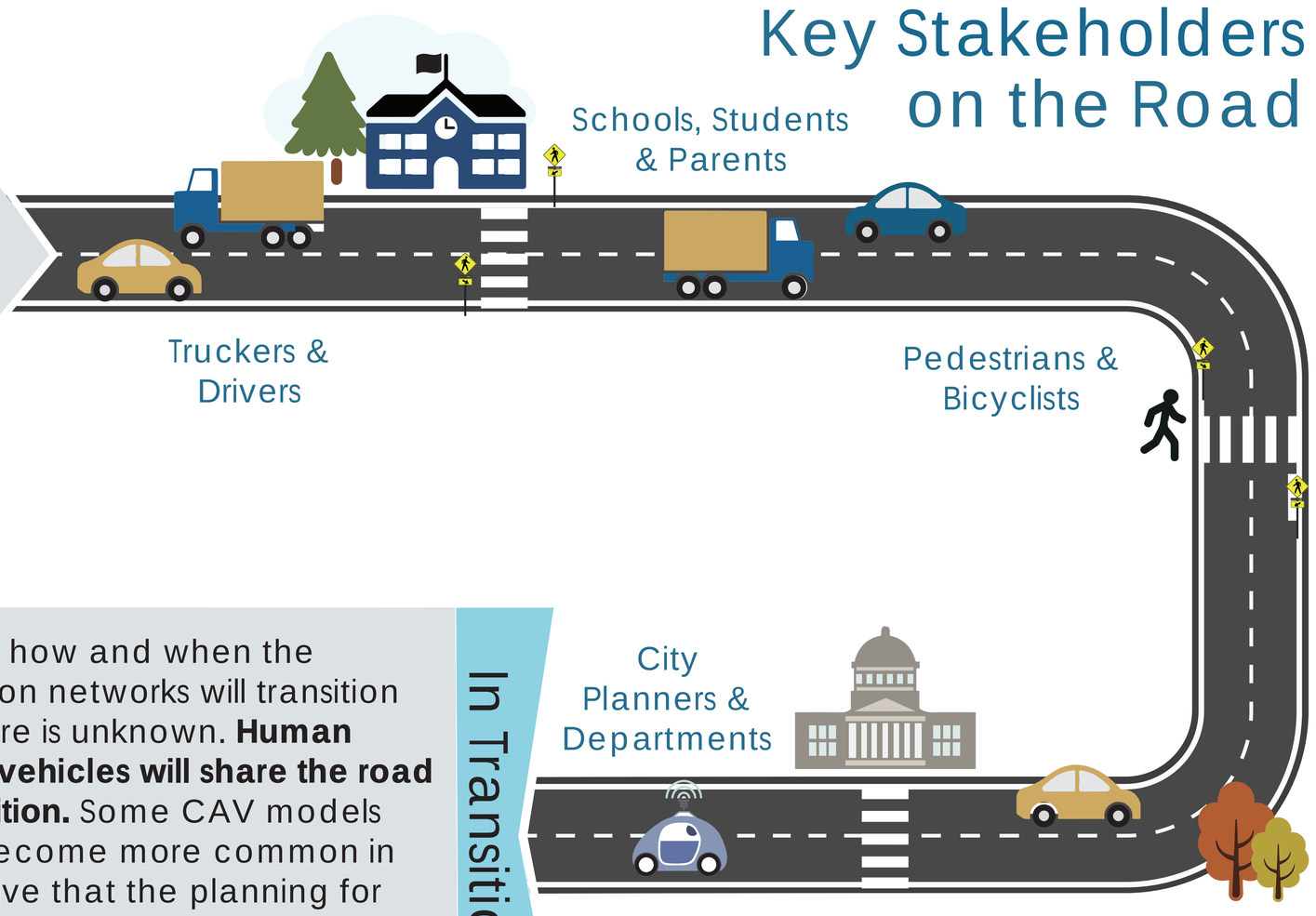
How can Scott County coordinate the design, engineering and construction of its transit network to ensure pedestrian safety, maintain mobility, and promote comfortable interactions between pedestrians and CAVs?

We explore the implications of CAV technologies on pedestrian safety in Scott County by examining crosswalk scenarios inspired by an existing school crosswalk in the city of Shakopee.

The Present

Pedestrian safety is an important concern for cities and transportation planners. **Recently, Scott County installed a series of Rectangular Rapid Flashing Beacons (RRFBs) at pedestrian crossing near four schools located along HWY 16.** RRFBS have received Federal Highway Administration approval and are a common method for emphasizing pedestrian crossings at previously non-signaled crosswalks.

Key Stakeholders on the Road



In Transition

The exact timing of how and when the region's transportation networks will transition to an automated future is unknown. **Human drivers and self-driving vehicles will share the road together during this transition.** Some CAV models already exsist and will become more common in the future. It is imperative that the planning for these new scenarios continues to emphasize safety, accessability and equity for all.

in 10-20 years

The Future

The potential for CAV technology to improve pedestrian safety and efficiency will lead to changes in the transportation network, including impacts on infrastructure, policy, land use and th environment.

What will this mean for pedestrian safety in Scott County and other cities across the region?

in 20-30 years



NEXT STOP

CAV technology will bring changes in land use, policy, infrastructure and even the environment! Poster 2 will identify the key issues, challenges and opportunities that CAVs may have on pedestrian safety.

INTRO | SAFETY | CONTEXT | STANDARDS | MATRIX | PHASING | DRIVER ONLY | DRIVER DOM | CAV DOM | CAV ONLY | CONCLUSION

Clark, J., Riggs, W., Chapin, T., & Stevens, L. (n.d.). Planning for Autonomous Mobility (Vol. 582, PAS Report). doi:https://www.planning.org/publications/report/9107405/

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Rice, E. (2009, May). Rectangular Rapid Flash Beacon (RRFB). Retrieved December 06, 2018, from https://safety.fhwa.dot.gov/intersection/conventional/unsignalized/tech_sum/fhwasa09009/

PA 5211: Land Use Planning

Lynda Chao, Dan McNiel, Elliot Mohler, Isaac Hase-Raney | Professor Fernando Burga Ph.D. | T.A. Chris DesRoches

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Re-envisioning Pedestrian Safety for CAVs

Paving the Way

2 T2 SCOTT

Pedestrian road safety ensures that residents feel safe and empowered to walk freely in their communities without fear of vehicles colliding with them. This poster explores the **key issues**, **benefits**, **challenges and opportunities of pedestrian safety** and begins to lay a framework for incorporating AV technologies into future pedestrian safety best practices.

Principles, Metrics & Characteristics for Pedetrian Safety

	Land Use	Infrastructure	Behavior	Policy
Key Issues	• Ensure there is **space for pedestrians** to walk and cross • Promote land use that fosters **connectivity** and **active streetscape** • Ensure **site plans account** for pedestrian safety	• Determine best practices for road and **intersection design** • Identify and monitor **access management** • Learn how CAVs will impact the **streetscape** • Ensure infrastructure changes are adaptable to CAV needs	• Determine how CAVs will affect **parking needs** during transition to a CAV future • Identify **metrics** for evaluating pedestrian behavior • Learn **pedestrian perceptions** of CAV technology • Consider impacts of CAVs on **streetscape**	• Identify key issues for **CAV policy at local, state and federal levels** • Determine how policy can **promote safe and equitable CAV deployment**
Challenges	• Determine measures for assessing **pedestrian behavior** in relation to CAVs and land use type • Determe impacts of **CAV technology** on **land use**	• Monitor **speeding in school zones** • Control **traffic flow** • Ensure developments account for **walkbality** and are adaptable to CAV needs	• Understand pedestrian / CAV interactions and emerging technologies such as **V2X** • Monitor evolving need for setback of cars, buildings, **curb space** and parking	• Determine how CAV policies can **promote access for all people** • Determine how CAV policies promote **multi-modal networks**
Opportunities	• Develop a **multi-modal system** where no individual mode of transportation is prioritized • Prioritize **land uses** that are **capable of adapting** to AV technologies	• **Prioritize road safety** with the implementation of CAVs • Create **reliable infrastructure systems** where safety of pedestrians and cyclists is valued CAV demployment	• Promote **multi-modal transportation networks** as AVs change travel patterns • Rethink designation of parking areas, **parking design**, and impervious surfaces	• Policies should account for pedestrain safety and **ADA compliance** • Leverage **changes in travel behavior** to promote more active streetscapes



Consideration of CAV impacts on land use will aid planning for pedestrian safety and active streetscape.



Engineering and design will determine the look and feel of streets and play an instrumental role in planning for CAVs.



Monitoring pedestrian behavior and conducting traffic studies throughout this transition will aid planning for CAVs.



Policy will determine CAV implementation and help ensure all people and communities benefit from this technology.

Benefits of Pedestrian Safety and AVs

Social

- Promotes increased pedestrian safety
- Opportunity to expand **green space**
- **Encourages ride-sharing**
- Improved mobility **connects** residents to community services

Health

- Multimodal transit promotes **active lifestyle**
- Walking or biking lowers **health risks** and helps manages chronic disease
- Expanded greenspace improves **wellbeing**

Environment

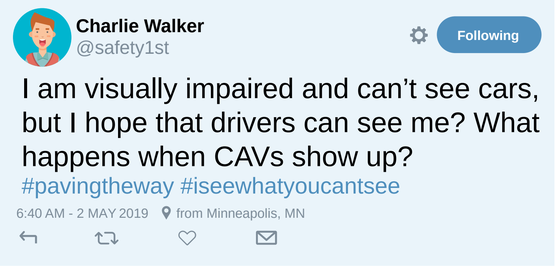
- Lessens reliability on fossil fuels
- Lowers individual **carbon footprint**
- Reduces **impervious surface**
- Improves **air quality**
- Reduces **traffic noise**

Economic

- Walking and biking are **affordable transportation** options
- Improved **real estate values** correlate with improved walkability
- **Active streetscape** bolsters local economy

NEXT STOP

It is imperative to understand current issues, challenges, benefits and principles of pedestrian road safety as we plan for CAVs. Poster 3 provides context regarding the key facts of pedestrian safety at the Federal, State and local level.



SAFETY

Bade, T., & Polley, J. (June, 2010). City of Shakopee Walkable Community Workshop Report (Rep.). doi:https://www.shakopeemn.gov/home/showdocument?id=1640

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PA 5211: Land Use Planning

Lynda Chao, Dan McNiel, Elliot Mohler, Isaac Hase-Raney | Professor Fernando Burga Ph.D. | T.A. Chris DesRoches

Resilient Communities Project — University of Minnesota

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Pedestrian Safety in Context

Paving the Way

3 T2 SCOTT

The Twin Cities region is expected to grow by more than **800,000 residents and add 500,000 new jobs by the year 2040.** Scott County has grown dramatically over the past half century and so has its transportation network. This poster contextualizes pedestrian safety at the Federal, State and local levels, illustrating how various data trends influence pedestrian safety needs. **A 2017 content analysis of 432 academic articles related to automated vehicles issues identified less than 20 that addressed pedestrian safety in any substantive way.**

USA

40,100 Motor Vehicle Fatalities (2017)

$212 B Traffic Accident Costs (2012)

5,984 Pedestrian Fatalities (2017)

90% Accidents due in part to human error

840 Bicycle Fatalities (2016)

Minnesota

392 Motor Vehicle Fatalities (2016)

35 mph Roads have the most accidents

8 Motor Vehicle Fatalities (2016)

1,355 Total Car Crashes (2016)

10 Bicycle Fatalities (2016)

3/4 Fatalities occur in rural MN areas

112 Pedestrian Fatalities (2014-2016)

75% Fatalities Occur at Night

904 Injuries on State Roads (2015)

738 Bicycle Fatalities (2017)

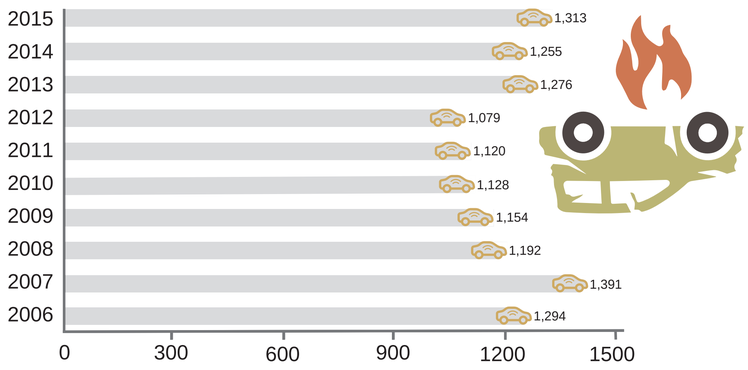
Scott County

MANY SCOTT COUNTY COMMUNITIES ARE FAMILY ORIENTED

2.89 AVERAGE HOUSEHOLD

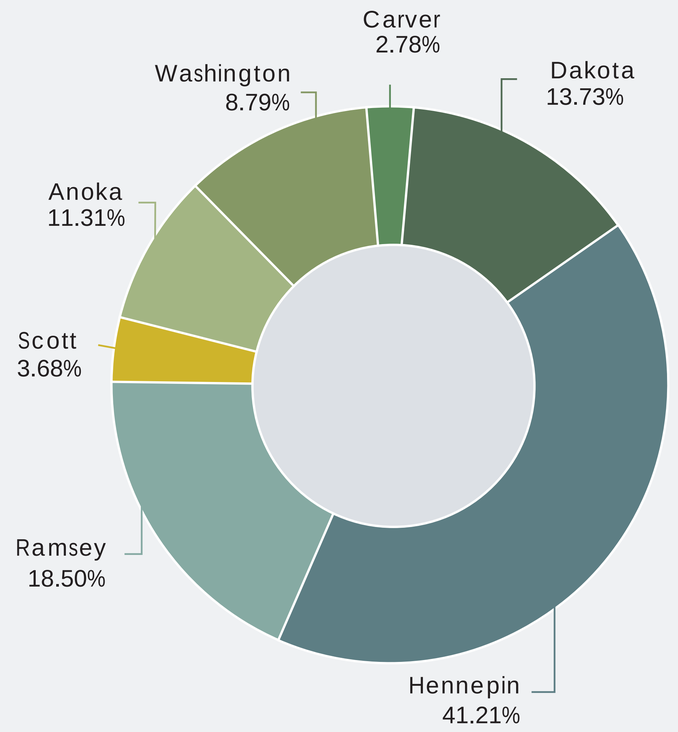
(Regional average is 2.5 persons)

Scott County Crash Incidents



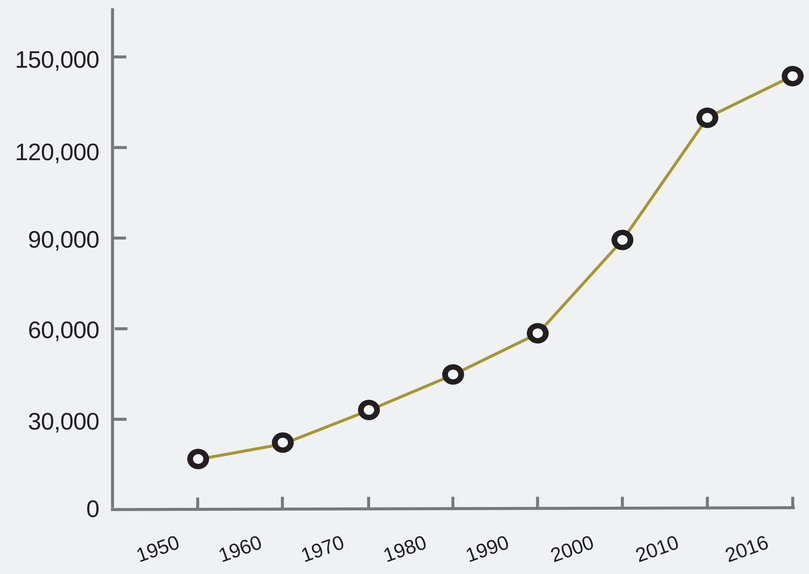
Crash incidents remain relatively constant and a fairly high in Scott County. The implementation of CAV technology is expected to help reduce the likelihood of crashes in the future.

Percent Share of Population over Age 60 in the 7-County Metro (2015)



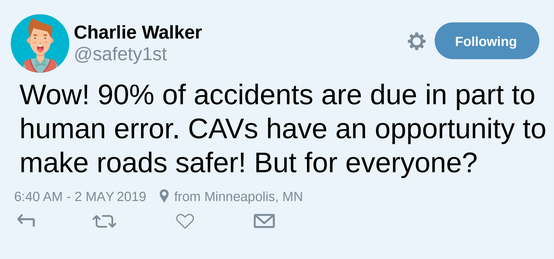
Scott County's population has increased over the years, in addition to having one of the lowest percent populations over 60 in the region. CAVs can still benefit an aging community by promoting accessible transit options. The aging population is expected to increase by 8.3% in 2020.

Scott County Population Growth



NEXT STOP

The next poster explores how to aniticipate the impacts of CAVs, and how current best practices can be leveraged to envision a CAV-oriented multi-modal transit network in urban, suburban and rural areas.



CONTEXT

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Pedestrian Traffic Fatalities by State: 2017 Preliminary Data. (2017). Retrieved December 04, 2018, from https://www.ghsa.org/resources/spotlight-pedestrians18

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Traffic Safety Facts 2016 Data(Publications). (n.d.). Washington D.C.: National Highway Traffic Safety Administration. doi:https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812507

Envision Shakopee 2040. (2018). Retrieved December 06, 2018, from https://envisionshakopee.com/

PA 5211: Land Use Planning

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Best Practices in Envisioning CAV-Oriented Pedestrian Safety

Paving the Way

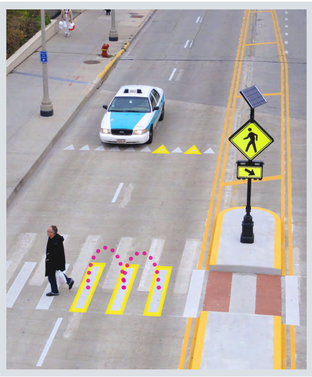
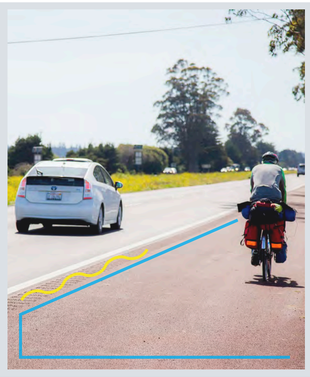
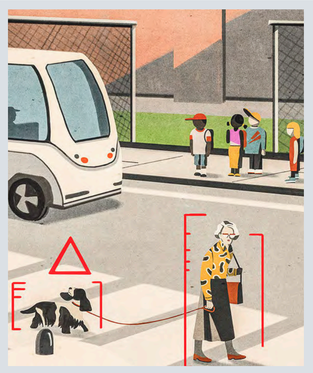
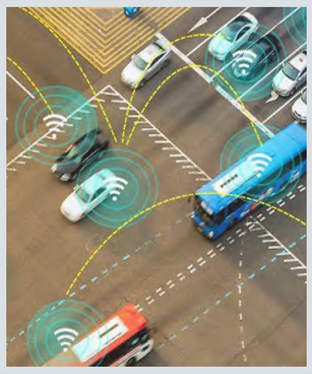
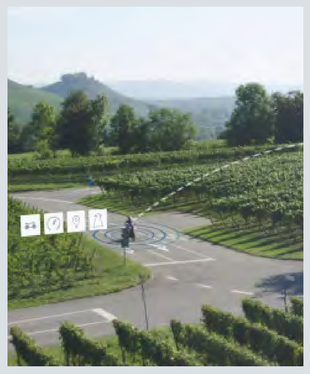
4

T2 SCOTT

Planning for pedestrian safety is never easy. This poster addresses **best practices in planning for pedestrian safety in urban, suburban and rural communities.** These best practices are analyzed through **three phases of AV implementation: the present, in transition and the future**. We also identify metrics for pedestrian safety that can be used to plan for CAV-oriented pedestrian safety.

Planning for Pedestrian Safety and CAV Environments

When it comes to planning for pedestrian safety **context matters**. Although best practices may overlap, different geographies require an analysis tailored to their unique needs and circumstances. The table below illustrates some of the **current recommendations for pedestrian road safety** (MnDOT) in rural, suburban, and urban areas. The table also considers **emergent best practices in planning for pedestrian road safety** with an eye towards an automated transporation system.

	Urban	Suburban	Rural
The Present	 Current practices in urban areas include traffic calming **refuge islands**, curb extensions, **speed bumps,** and **RRFBs**.	 Current best practices in suburban communities include RRFB systems, **curvilinear streets**, speed bumps, **curb extensions,** and **speed control** in areas such as school zones.	 Current practice in rural communities includes the installation of mini **RRFBs**, bicycle friendly edgeline rumbles, **street lights**, and **paved shoulders.**
The Transition	Urban areas can expect to have **human machine interfaces***, queue systems, **track pedestrians** behavior, and **parking modifications**. 	Suburbs can look to add human machine interfaces*, **track pedestrian - AVs interactions**, consider **curbside management**, and moderate speed and **right of way** issues. 	Rural communities can incorporate **human machine interfaces***, add **signage** or queue systems as well as **monitor public perception** regarding CAVs. 
The Future	 Urban areas can expect to install **V2X** beacons,** develop safe and reliable **detection systems** and anticipate more CAV deployment.	 Suburbs may consider employing **V2X** beacons**, investing in enhanced detection systems, or promoting **multimodal transportation** networks.	 Rural commuities may consider the installation of **V2X** beacons**, rethink roadway design and invest in enhanced **detection systems**.

What is V2X?

V2X technology is an general term for the technology that enables communication amongst traffic-related elements in an intelligent network. V2X will be a critical link in the hive of Connected and Automated vehicles and help ensure this technology is safer and more efficient that existing transportation.

Pedestrian Safety Metrics

These metrics can help planners and engineers understand the impacts of CAVs and help inform decisions related to planning for these emerging technologies.

Livability

- Promote walkability
- Consider transit dependent populations
- Parking needs
- Property values
- Residential and business feedback

Operations

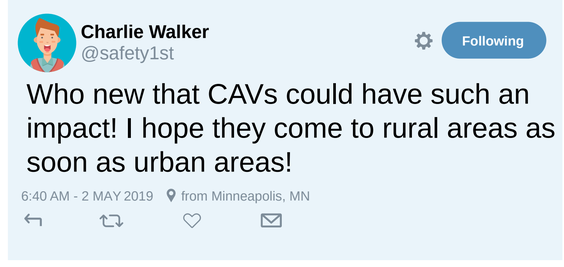
- Daily traffic counts/ speeds
- Interesection queues
- Travel time
- Impacts on VMT... Higher or lower?
- Bike/pedestrian counts

Safety

- Traffic speed
- Percent drivers Crash frequency/ type/rate
- Perceived level of pedestrian safety
- Accessibility: connecting people to services

NEXT STOP

Understanding best practices will help forecast how CAVs can be implemented in different geographic contexts. Poster 5 explores changes in policy, land use, infrastructure and the environment throughout the phasing of CAVs.



STANDARDS

Carroll, C. et al., 2017. Social and behavioural questions associated with Automated Vehicles. A Literature Review. London: Department for Transport. https://www.ucl.ac.uk/transport-institute/pdfs/social-and-behavioural-literature-review.pdf

Discussion Guide For Automated and Connected Vehicles, Pedestrians, and Bicyclists(Rep.). (n.d.). Pedestrian and Bicycle Information Center. doi:http://www.pedbikeinfo.org/pdf/PBIC_AV.pdf

Blackburn, L., Dejaer, C., & Bloodstine, K. (n.d.). Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations(Rep.). USDOT. doi:https://www.fhwa.dot.gov/innovation/everydaycounts/edc_4/guide_to_improve_uncontrolled_crossings.pdf

Bressett, J. (2018, August 20). Pedestrian Safety Concerns and New Doubts About Autonomous Vehicles. Retrieved December 06, 2018, from https://www.planetizen.com/news/2018/08/100180-pedestrian-safety-concerns-and-new-doubts-about-autonomous-vehicles

Clamann, M. (2017, August 18). Making driverless cars safe for pedestrians. Retrieved December 06, 2018, from https://phys.org/news/2017-08-driverless-cars-safe-pedestrians.html

*Human Machine Interfaces include a combination of human and machine technologies such as sensors to assist with the transition period of CAVs.

**V2X beacons wirelessly connect pedestrians, bicyclists and AVs in the future.

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Driver & CAV Transition Timeline Matrix

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The matrix below provides an idea on changes to expect in the different phases of CAVs.

Driver & CAV Transition Timeline Matrix

		1 Drivers Only	2 Driver Dominated	3 CAV Dominated	4 CAV Only
POLICY	Accessibility	Some sidewalks have truncated domes, some intersections have visual and auditory crossing cues. Opportunity to expand and make streetscapes more accessible. **Poster 7**	Installation of truncated domes and cross signals with audio and visual cues.	Greater opportunity for accomodations for residents who are in wheelchairs, are visually or auditorily impaired, are without smartphones, or that are undocumented.	CAVs will be designed to accomodate for residents with disabilities, residents without smartphones, or residents who may be undocumented. **Poster 10**
	Equity	Policy at the local, state, and federal levels play a role in determining how CAVs will align with existing transit services.	V2X technology has the potential to make pedestrians safer in a CAV future. Important to consider V2X usability for seniors, low income, and immigrant populations. **Poster 8**	Shared mobility models will provide greater accessibility. Critical to consider ADA compliance, those without smartphones, undocumented populations and accessibility to places.	CAV systems will be readily designed to accomodate residents with disabilities, those without smartphones, or those who may be undocumented. **Poster 10**
	Mobility	Minnesota Valley Transit Authority (MVTA) provides transit services to Scott County. Marschall Road transit station (near HWY 16) Routes: 490, 493, 495, 497. **Poster 7**	Bus stops improved and designed to incorporate a growing demand for CAV technology. Bike share and trail improvements for urban and suburban communities. **Poster 8**	Shared mobility is prioritized within an integrated system of bikes, public transit, CAVs, and human drivers. **Poster 9**	Transit stops also serve as drop off and pick up locations for ride sharing CAV services. Personal attendants provided for transit dependent populations.
LAND USE	ROW	Right of way (ROW) prioritizes cars at the expense of pedestrians and bicyclists. Pedestrians and bicyclists wait to cross the road at designated crossings.	Automobiles remain dominant, but there is an increase in pedestrian and bike crossings to allow for greater mobility. **Poster 8**	Pedestrians and bicyclists begin to be prioritized in the right of way as crossings are more frequent and give more time for pedestrians to cross.	The right of way is for pedestrians and bicyclists. Crossings don't need to be designated as CAVs will detect pedestrians.
	Streetscape	Cars are prioritized as streetscapes were designed around the automobile. Curbs delineate modes of transportation - notably vehicles and pedestrians. Adjacent areas are used for parking and bus stops. **Poster 7**	The implementation of CAVs will begin to give more space to pedestrians and bicyclists as streetscapes begin to be designed around the pedestrian. Introduction of curbless streets to reduce infrastructure costs and to balance right of way issues.	As CAVs become dominant, less of the streetscape is dedicated to vehicles. Lane reduction gives way to increased pedestrian space. Designated bike lanes are implemented. Curbless streets become common with safer and more efficient traffic. Curb extensions reduce lane widths and calm traffic. **Poster 9**	CAV-only streetscapes are multimodal and do not favor one mode of transportation over another. Streets and greenspace integrate. Further reduction in infrastructure costs by solely using curbless streets and removing vehicle lanes.
	Parcels	Current street layout provides a set "front" and "back" to parcels. Suburban parcels are often facing curvilinear roads away from main thoroughfares. **Poster 7**	The advent of CAVs will impact roadway design, changing the way parcels interact with adjacent roads.	Lane reduction gives way to increased greenspace, increased parcel distance from roads, and changes in the direction buildings face. **Poster 9**	Due to increased efficiency and choice, multimodal streetscapes will allow for higher density in most suburban parcels. **Poster 10**
INFRASTRUCTURE	Signage	Physical signs guide drivers between locations with information such as laws, location, and conditions: striping, lighting, and signs.	Physical signs communicate with drivers and CAVs. V2X technology digitizes physical signage, focusing on drivers, pedestrians and bicyclists. **Poster 8**	CAVs prioritized as digital signage comunicates speed limits, road conditions, and location. Physical signage will remian for drivers in rural areas.	Physical signage focuses on pedestrian wayfinding. Signage for CAVs is fully digitized, communicating speed limits, location, and traffic conditions.
	Trails	Constrained within green spaces such as parks and reserves. Seldom found in urban or suburban areas. **Poster 7**	Trails integrate with roadways, resulting in more trails in urban and suburban areas. Lighting is installed on trails and roads for safety.	Trails permeate into urban and suburban areas. CAVs alter 20th century conceptions of roads through expansion of green space near and into roadways.	Trails connect urban, suburban, and rural areas. Integration of roadways, green spaces, and trails enhances quality of life.
	Lanes	Lane size determined by turn radii of service vehicles. Number determined by traffic needs. Greater use of roadways means largers roads with more lanes.	Widths may shrink dependent on turn radii, yet lane reduction becomes more likely as traffic flow becomes more efficient.	Drastic lane reduction with streamlined traffic. CAV-exclusive zones in urban cores. Expansion of green spaces in inimaginable places. **Poster 9**	Road systems are more efficient with fewer lanes. Integration of bike lanes and shared transitways, embraces multimodal transportation. **Poster 10**
	RRFB/V2X	Rapid Rectangular Flashing Beacons (RRFBs) used to enhance pedestrian safety at crossings by notifyng drivers. Allows crossing without stoplights.	Emergence of V2X technology assist CAVs detecting their environment. RRFBs and V2X systems work together to ensure pedestrian safety at crosswalks. **Poster 8**	Potential for RRFBs to phase out as CAVs have enhanced detection capabilities. V2X technology begins to replace RRFBs. **Poster 9**	V2X technology makes RRFB systems obsolete. CAVs will use V2X technology to aid in better detection of pedestrians and bicyclists.
ENVIRONMENT	Stormwater	Municipalities use retention ponds to hold excess stormwater, relieving drainage systems. Rain gardens on private land. Near rivers, drainage systems use gravity to divert stormwater. **Poster 7**	Integration of retention ponds with wildlife habitat and native plants. Rain gardens expand into the public realm as greenspace increases. Imperveable surfaces start to disappear.	Greater integration of stormwater management. Retention ponds exist as a form of stormwater management and animal habitat. Lane reduction adds more greenspace and permeable surfaces.	Stormwater management systems are both natural and manmade systems. Stormwater diverted to rivers through gravity powered piping, stored in retention ponds, or absorbed into greenspace surrounding roadways. **Poster 10**
	Energy	The built environment is not linked to energy production. Minor energy production from regenerative braking. Opportunity to move towards renewable energy sources for the expansion of rapid charging stations.	Greater opportunity for regenerative braking. Renewable resources become inexpensive. Implementation of solar panels and electric vehicle chargin stations. **Poster 8**	Renewable energy is prioritized over fossil fuels. Solar panels and wind turbines become familiar sights. CAVs are electric and charging stations transition from private car owners to shared CAV docking hubs.	Full integration between the built environment and energy production. CAVs charge themselves at shared docking hubs, waiting to pick up potential passengers.
	Greenspace	Urban and suburban green space confined to parks and reserves. Larger tracts of greenspace found innational parks. Roadsides are maintained to prevent wildlife from nesting.	CAV implementation will bring opportunities to expand greenspace. Added greenspace can balance transportation options and improve quality of life.	Roadsides no longer passive buffers--transformed to low maintenance, natural landscaping. Adoption of forfeited road space for habitat, promoting connectivity and improving quality of life. **Poster 9**	Greenspace will provide improved habitat connectivity, reduce impervious surfaces, and increase natural landscaping. Additional greenspace will assist in stormwater management.

MATRIX

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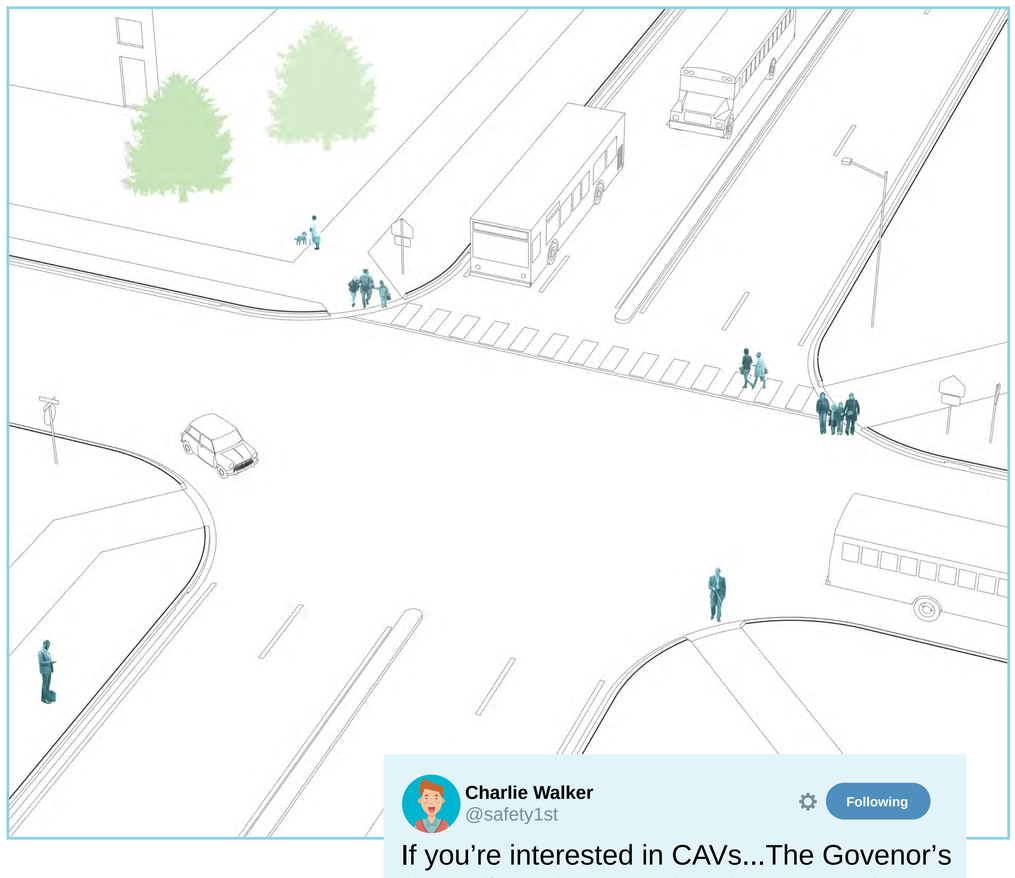
Developing a CAV-Oriented Streetscape

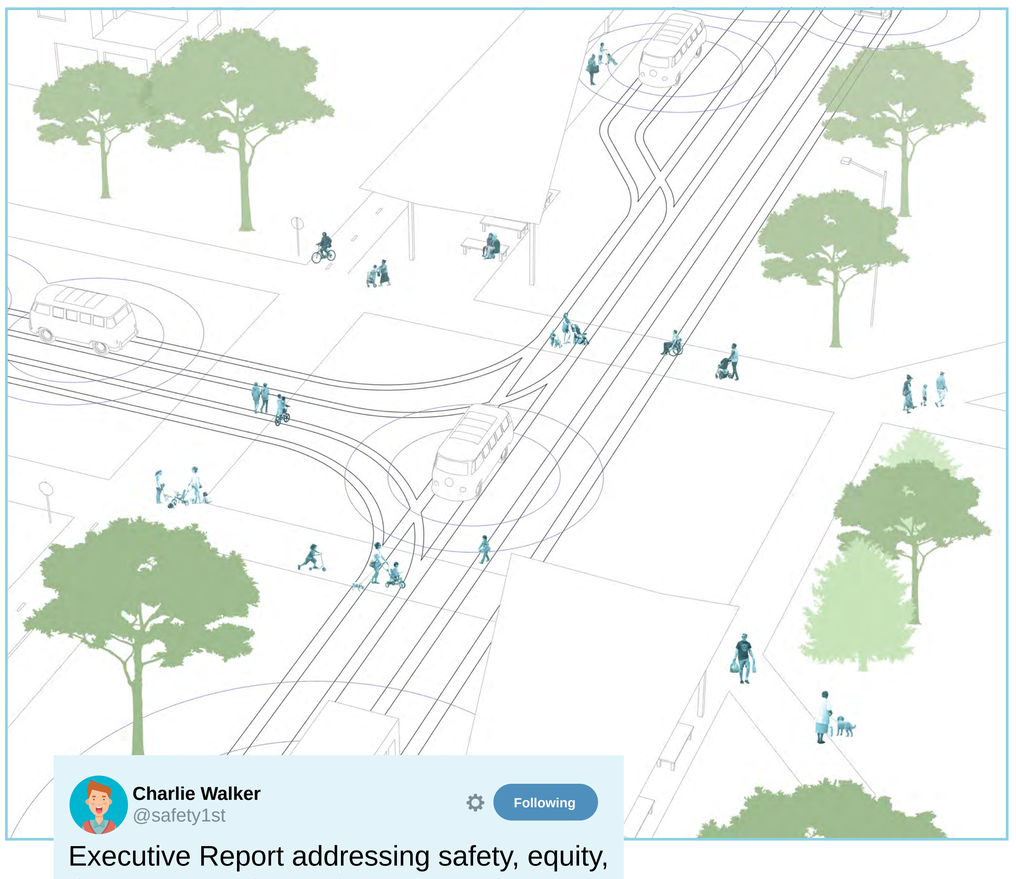
Paving the Way

6 T2 SCOTT

We will now explore the impacts of CAV technology on pedestrian safety in Scott County by envisioning four phases of CAV implementation at one intersection in Shakopee, represented through renderings that change over time. The analysis is displayed on the matrix in Poster 5 and represented graphically throughout the next several posters. We analyzed the impacts of CAV technology on land use, infrastructure, policy and the environment.

From Drivers Only.....to CAVs Only





Phasing

Drivers Only

Driver Dominated

CAV Dominated

CAV Only



Charlie Walker
@safety1st
Following

If you're interested in CAVs...The Govenor's Council on Connected and Automated Vehicles has recently released an ...
#pavingtheway #don'tlosesightofequity
6:40 AM - 2 MAY 2019 from Minneapolis, MN



Charlie Walker
@safety1st
Following

Executive Report addressing safety, equity, the economy, the environment and more! http://www.dot.state.mn.us/automated/
#pavingtheway #don'tlosesightofequity
6:40 AM - 2 MAY 2019 from Minneapolis, MN

POLICY

- Policy at the **local, state and federal levels** will play an instrumental role in determining how CAVs will be implemented.
- Policy will determine **who benefits** from these technologies, how implementation models will be **ADA complient**, what is required to ensure they are **accessible to all**, and where they will be prioritized.

LAND USE

- CAVs will present **opportunities to reorient the streetscape and transition right of way** away from automobiles.
- The advent of these emerging technologies may prompt **changes in the design of suburban subdivisions** such as reduction of curvilinear streets, expanded greenspace, a lessening need for garage space or homes built facing the street.

INFRASTRUCTURE

- Infrastructure is already being designed with an eye towards the future, but **CAVs will dramatic change the look and feel of the built environment.**
- **Parking needs will be dramatically reduced** in a shared use transportation system.
- **Trails and sidewalks will have room to expand with reduce lane sizes.**
- V2X technology and human machine interfaces **will advance safety at crosswalks.**

ENVIRONMENT

- **CAVs have the potential to be electric vehicles** and run on renewable energy sources.
- This technology provides **opportunities to reduce fossil fuel consumption,** improve **air quality**, reduce **stormwater management** costs, and improve habitat quality for wildlife.

NEXT STOP

In the next series of posters we will envision the transition to a CAV future by looking at the changes that may occur in policy, land use, infrastructure and the natural environment at one intersection in the city of Shakopee.

PHASING

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CAV-Oriented Streetscape: Drivers-Only

Paving the Way

7 T2 SCOTT

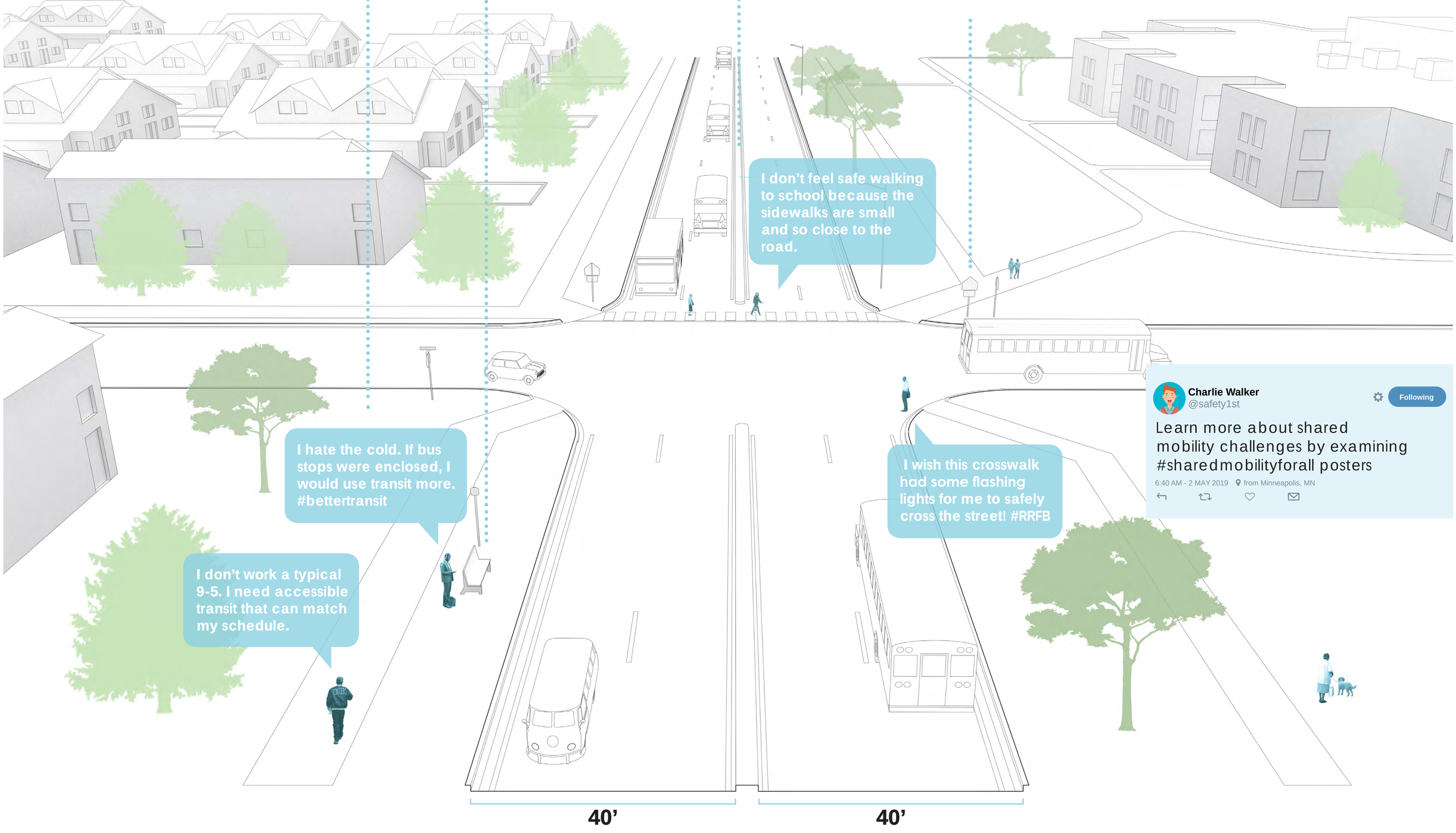
Today's streetscape was designed around the automobile use. These spaces privilege automobiles at the expense of pedestrian safety. Parking takes up valuable space and transit stops are infrequent, making contemporary streetscape inefficient for traffic flow, unsafe for the pedestrian, and an ecological problem.

Sidewalks are often incomplete, sometimes ending without warning.

This bus stop is exposed to the elements. Limited amenities discourages transit ridership.

Curbs and medians serve as a buffer between pedestrians and drivers.

RRFBs installed at school crossings in Shakopee, but many Scott County crosswalks lack other basic safety features. See Poster 4.



POLICY: mobility

- Scott County has limited amenities for those who use public transit.
- The county has an opportunity to improve ADA compliance by installing truncated domes, visual and auditory crossing cues.

LAND USE: curbs

- Curbs delineate different modes of transportation, help direct stormwater and create a barrier between vehicles and pedestrian.
- Adjacent areas are used for parking, driveways and bus stops.

INFRASTRUCTURE: trails

- Scott County has a network of trails that will continue to be connected.
- Walkways enhance pedestrian safety, but are inconsistent along roads throughout the county.
- Pedestrians are in close proximity to vehicles, right of way is given to drivers.

ENVIRONMENT: stormwater

- Impervious surfaces present stormwater challenges and significant management costs to municipalities.
- Retention ponds, rain gardens or storm water drainage systems often use gravity to flow to water bodies.

NEXT STOP

Despite the many problems of contemporary streetscape designs, the implementation of CAVs will provide opportunities to deal with their challenges. CAVs will usher in a new era focused on pedestrian safety without the compromise of efficient traffic flows.

DRIVER ONLY

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Scott

CAV-Oriented Streetscape: Driver-Dominated

Paving the Way

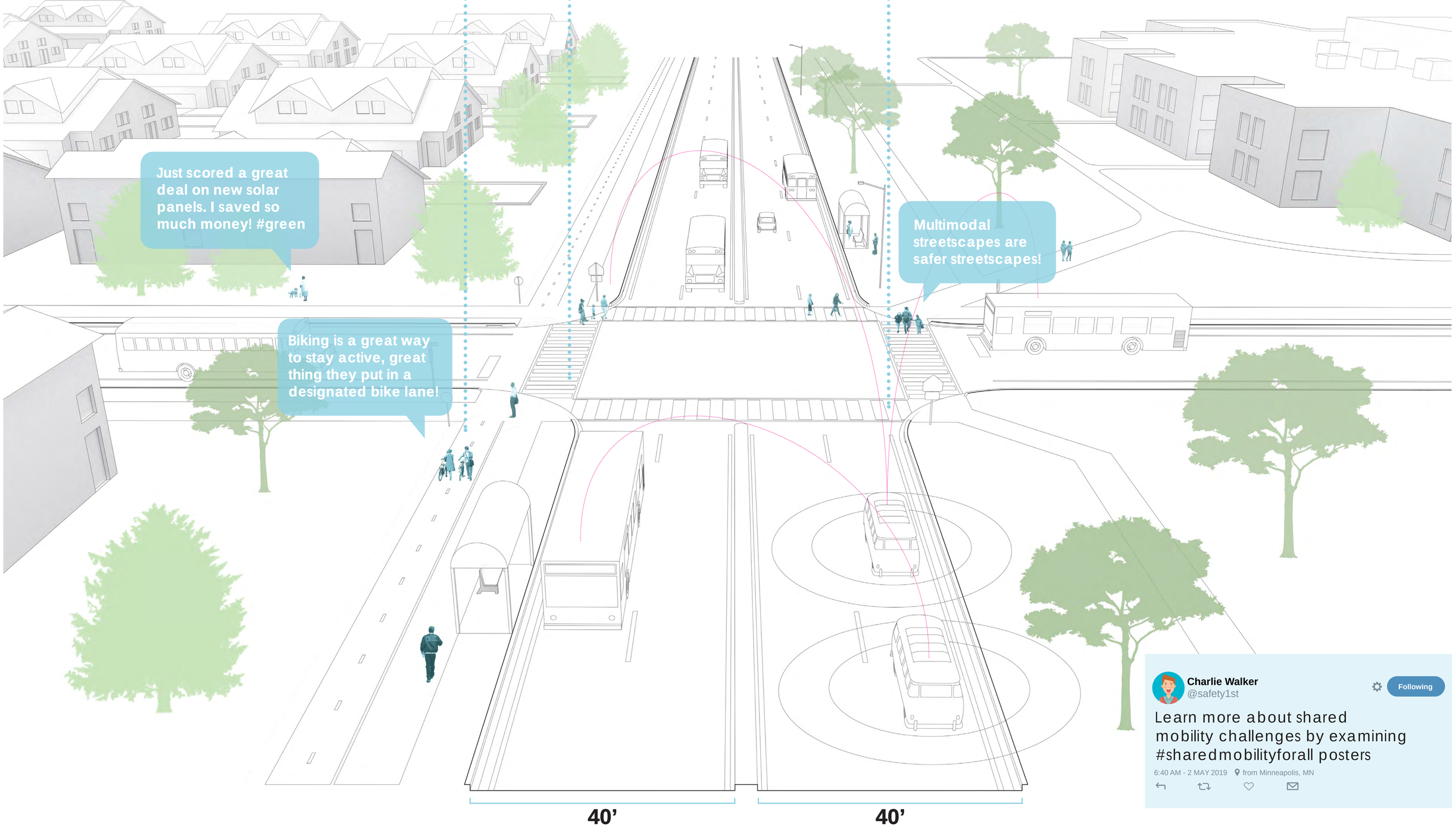
8 T2 SCOTT

The implementation of CAVs will bring changes to the built environment. Physical signage will begin to be digitized, CAVs will utilize V2X technology for communication with their surroundings, and energy production will be integrated in the built environment.

Bike sharing and trail improvements help to balance right of way issues in suburban communities that previously lacked those amenities.

Road striping is critical for the safety of pedestrians and drivers, but CAVs might not need to rely on graphic ques.

V2X tech presents important equity challenges. Important to consider V2X availability for low income, immigrant/refugee or youth populations.



POLICY: equity

- Important to consider V2X availability for low income, immigrant/refugee or youth populations.
- Signs warn pedestrians about the presence of CAVs.
- Signage will be used by human drivers and CAVs via connected technology.

LAND USE: right of way

- Right of way continues to favor cars, but suburban communities begin to transition to multi-modal transit systems.
- Opportunities for walking, biking and public transit with improved striping and trail connections.

INFRASTRUCTURE: V2X

- V2X technology could digitize signage such as speed limits, line striping or crossings and transmit information to CAVs.
- Shift towards being pedestrian and bicyclist-oriented streetscape.

ENVIRONMENT: energy

- CAVs provide opportunities for regenerative braking energy production.
- Renewable energy sources become more affordable.
- Scott County continues to implement electric vehicle charging stations.

NEXT STOP

The transition to a CAV dominated world will be slow, with minor changes occurring in high density areas. The rollout of CAVs in a driver dominant world will require forethought in how to use this technology to our advantage and how to mitigate potential problems.

DRIVER DOM

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CAV-Oriented Streetscape: CAV-Dominated

Paving the Way

9 T2 SCOTT

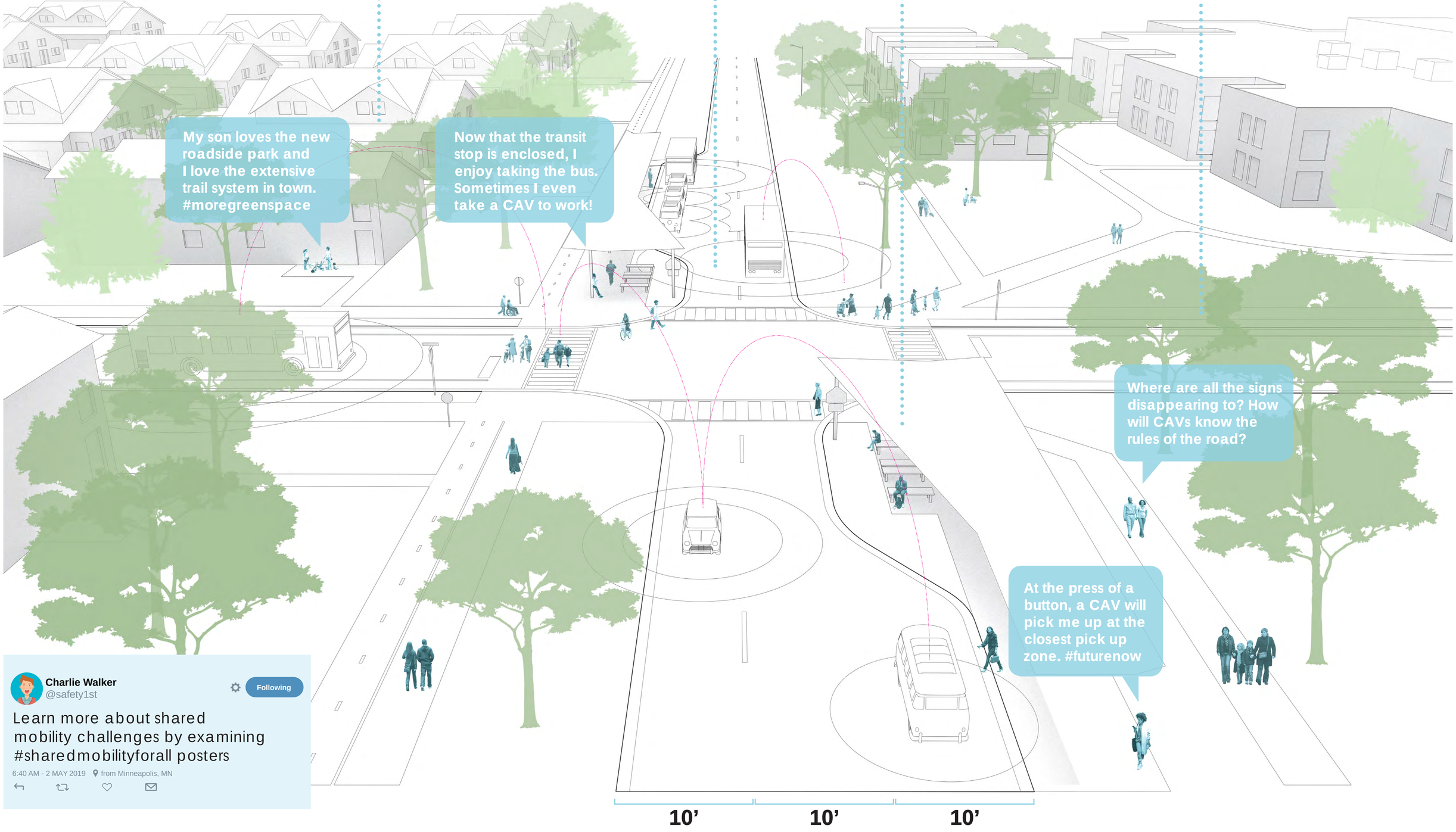
A CAV dominant transportation network will present unique opportunities and important challenges. CAV deployment will likely advance a shared mobility model similar to Uber or Lyft. This will improve accessibility, lead to changes in the urban design of suburban areas, require the development of pick up locations (CAV hubs), and significantly reduce the need for parking space.

As streets become safer and less car-centric, suburban homes begin to embrace arterial streets. Neighborhood streets may be reduced and sometimes replaced with greenways.

Lane widths may begin to shrink as autonomous drivers use less of the roadway, car designs become smaller, and turning radii is reduced.

CAV ride hailing services, similar to Uber and Lyft, are eventually supplemented with CAV commuter stations and pulloffs.

Roadsides no longer serve as passive buffers, instead become programmable with low maintenance, low cost natural landscaping.



POLICY: accessibility

- Improved bus stops are enclosed and designed with alternative use as CAV pick-up/drop off locations in mind.
- Vehicle ownership transitions towards shared use models and away from today’s private ownership models.

LAND USE: streetscape

- Curb extensions create more active streetscape with enhanced protection for pedestrians.
- As CAVs become dominant less of the streetscape is dedicated to vehicles. With less need for parking there is more space in the streetscape for pedestrians.

INFRASTRUCTURE: lane size

- Decrease in road widths as CAV models require less space within lane.
- Remaining open spaces greened, given over to pedestrian realm and reprogrammed for a community’s needs.

ENVIRONMENT: green space

- Greenspace provides opportunity for planting edible landscape and connected habitat.
- Public lawns virtually disappear in non-park settings due to maintenance and environmental costs.

NEXT STOP

Phasing out human drivers will present a wide variety of challenges, however the potential to improve safety, efficiency and accessibility will result in prompt transportation networks to fully transition to a CAV streetscape.

CAV DOM

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CAV-Oriented Streetscape: CAV-Only

Paving the Way

10 T2 SCOTT

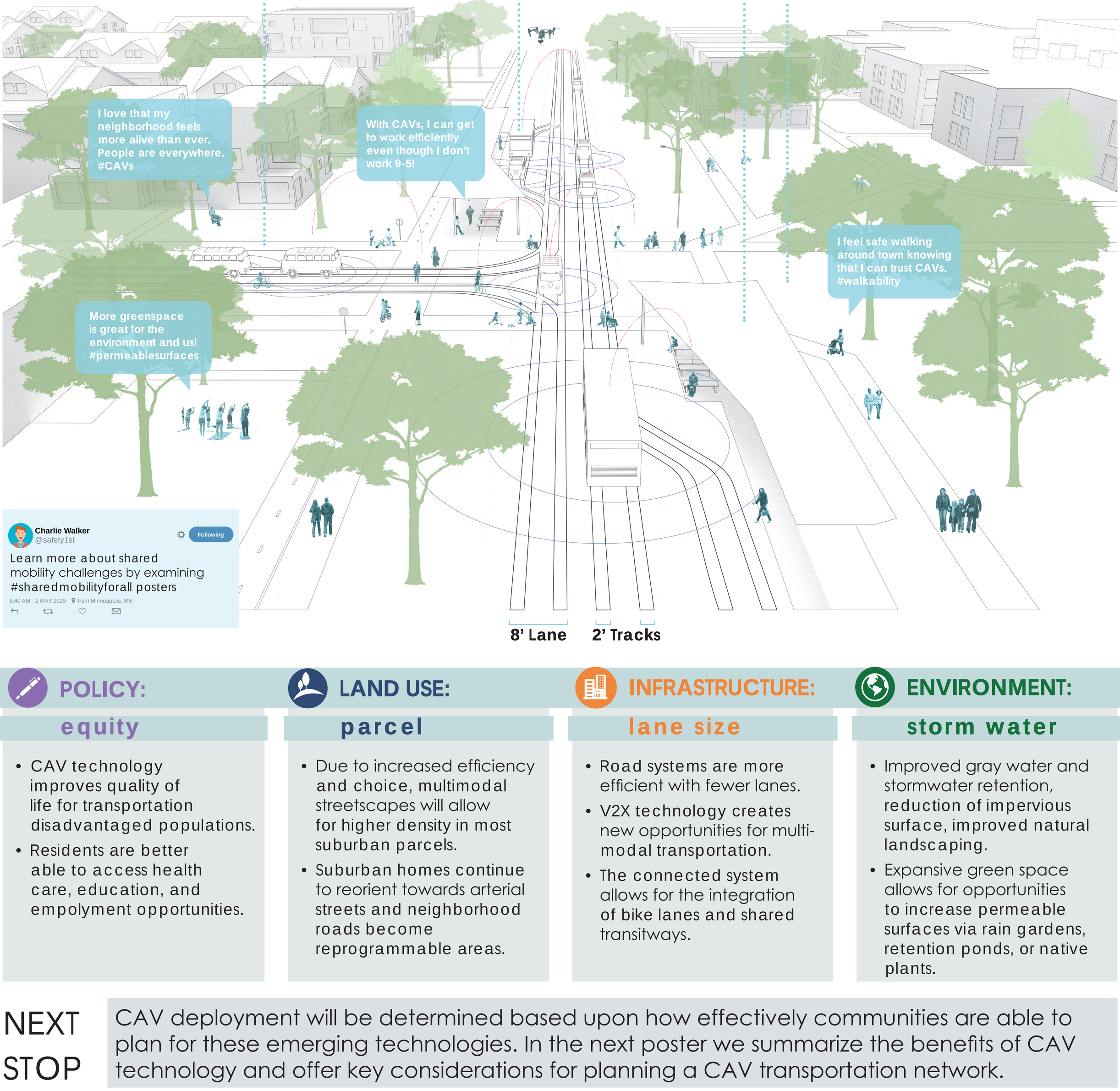
A CAV only streetscape is still a distant reality and nearly impossible to plan fully. This rendering envisions a dramatically different streetscape where pedestrians have the right of way within a multi-modal transportation network.

Transit services operate CAVs and are potentially better able to assist transit-dependent populations with disabilities affecting their mobility.

Transportation systems beome more efficient, fewer lanes will be needed. Multi-modal transportation prioritized.

Transit stops serve as drop off and pick up locations for ride sharing CAV services. Transit providers have fully transitioned to CAV technologies.

Road conversion is introduced to Scott County, in-place options continue to replace lost pavement. Pavement technologies emerge for cost-effective drainage.



POLICY: equity

- CAV technology improves quality of life for transportation disadvantaged populations.
- Residents are better able to access health care, education, and empolyment opportunities.

LAND USE: parcel

- Due to increased efficiency and choice, multimodal streetscapes will allow for higher density in most suburban parcels.
- Suburban homes continue to reorient towards arterial streets and neighborhood roads become reprogrammable areas.

INFRASTRUCTURE: lane size

- Road systems are more efficient with fewer lanes.
- V2X technology creates new opportunities for multi-modal transportation.
- The connected system allows for the integration of bike lanes and shared transitways.

ENVIRONMENT: storm water

- Improved gray water and stormwater retention, reduction of impervious surface, improved natural landscaping.
- Expansive green space allows for opportunities to increase permeable surfaces via rain gardens, retention ponds, or native plants.

NEXT STOP

CAV deployment will be determined based upon how effectively communities are able to plan for these emerging technologies. In the next poster we summarize the benefits of CAV technology and offer key considerations for planning a CAV transportation network.

CAV ONLY

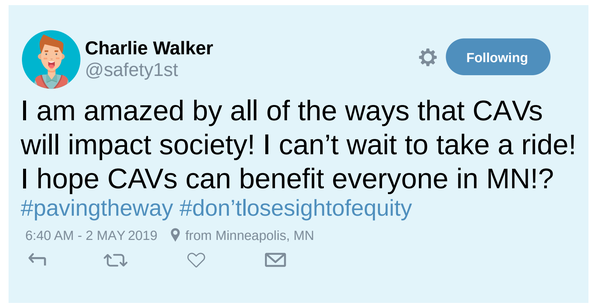
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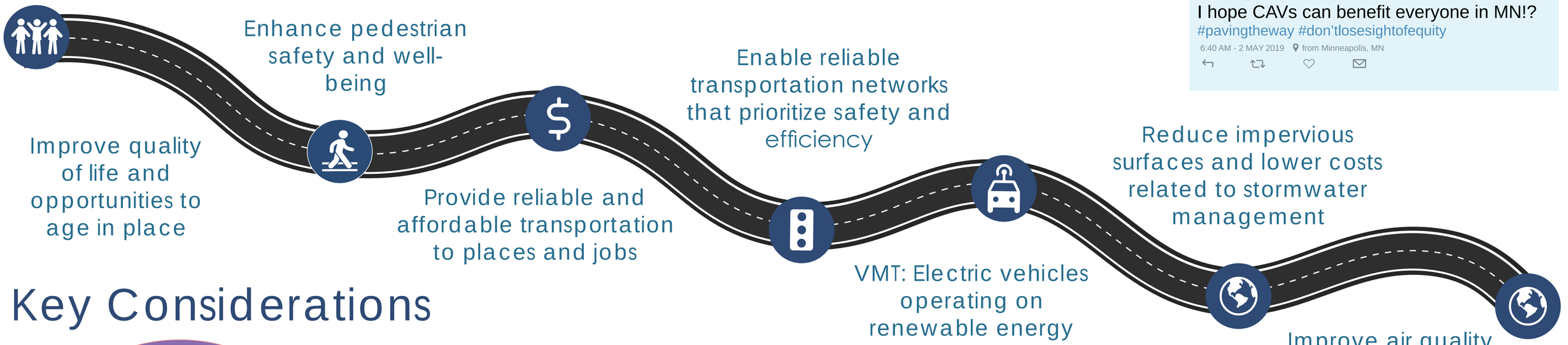
11

Conclusion and Recommendations

The deployment of CAV technology marks the next great transition in our transportation networks. These emerging technologies will dramatically change how people travel and will transform our daily lives in myriad ways. Transportation systems will have the potential to become more accessible, more equitable, more cost effective and more environmentally friendly.



Benefits of CAVs



Key Considerations



Policy

Shared mobility:

A multi-modal transportation network can provide an array of **benefits to the community**. It's critical to consider the needs of transportation disadvantaged individuals.

Accessibility:

As transit transitions to CAVs existing services are more affordable. Opportunity for CAVs to serve as first mile / last mile compliment to existing transit.

Equity:

Need to address ADA requirements prior to CAV deployment. Understand impacts on immigrant populations, youth and seniors, low income and underserved populations.



Land Use

Right of Way:

The right of way will transition from automobiles to pedestrians. Opportunity to promote shared mobility and multi-modal transportation networks.

Suburban Design:

CAVs result in reductions to curvilinear streets, allow for expanded greenspace, lessen the need for garage space and reorient homes to face street.

Streetscape:

Curb extensions, refuge islands, natural landscaping, street and trail lighting will help transition to a multi-modal transportation network that promotes pedestrian safety.



Infrastructure

V2X:

V2X will be instrumental in ensuring pedestrian safety in a CAV future. Critical to consider accessibility and equity issues prior to implementing V2X technology.

Lane Size:

CAVs will require less lane width than human drivers. Consider environmental, social and economic impacts of reducing lane size.

Signage:

CAVs won't require major infrastructure changes, but signs and stripping will be retrofitted to create a connected transportation network for pedestrians and CAVs.



Environment

Greenspace:

There are significant opportunities to reduce maintenance and operations costs by planting natural landscapes and reducing impervious surfaces.

Energy:

CAVs have the potential to use renewable energy sources. Scott County can look to implement rapid charging stations to prepare for a CAV future.

Stormwater:

A reduction in impervious surfaces has the potential to reduce stormwater management costs and improve habitat quality for wildlife.

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Shared Mobility for All?

CAVs and Intellectual Disabilities in Scott County

1 T4 Scott

To provide transportation for its residents, Scott County has traditionally relied on **shared mobility systems** such as **limited fixed-route buses** and **SmartLink Dial-a-Ride services**. However, the county has recently witnessed **increasing denial rates** for these services, resulting in decreased independence and overall mobility for senior residents and persons with disabilities. **This project considers the research tools planners can use to engage senior citizens and persons with disabilities** to envision the future of **connected automated vehicles (CAVs).** We begin our investigation by highlighting the demographics for three Scott County communities along the Highway 169 corridor that represent the key stakeholders for our analysis.

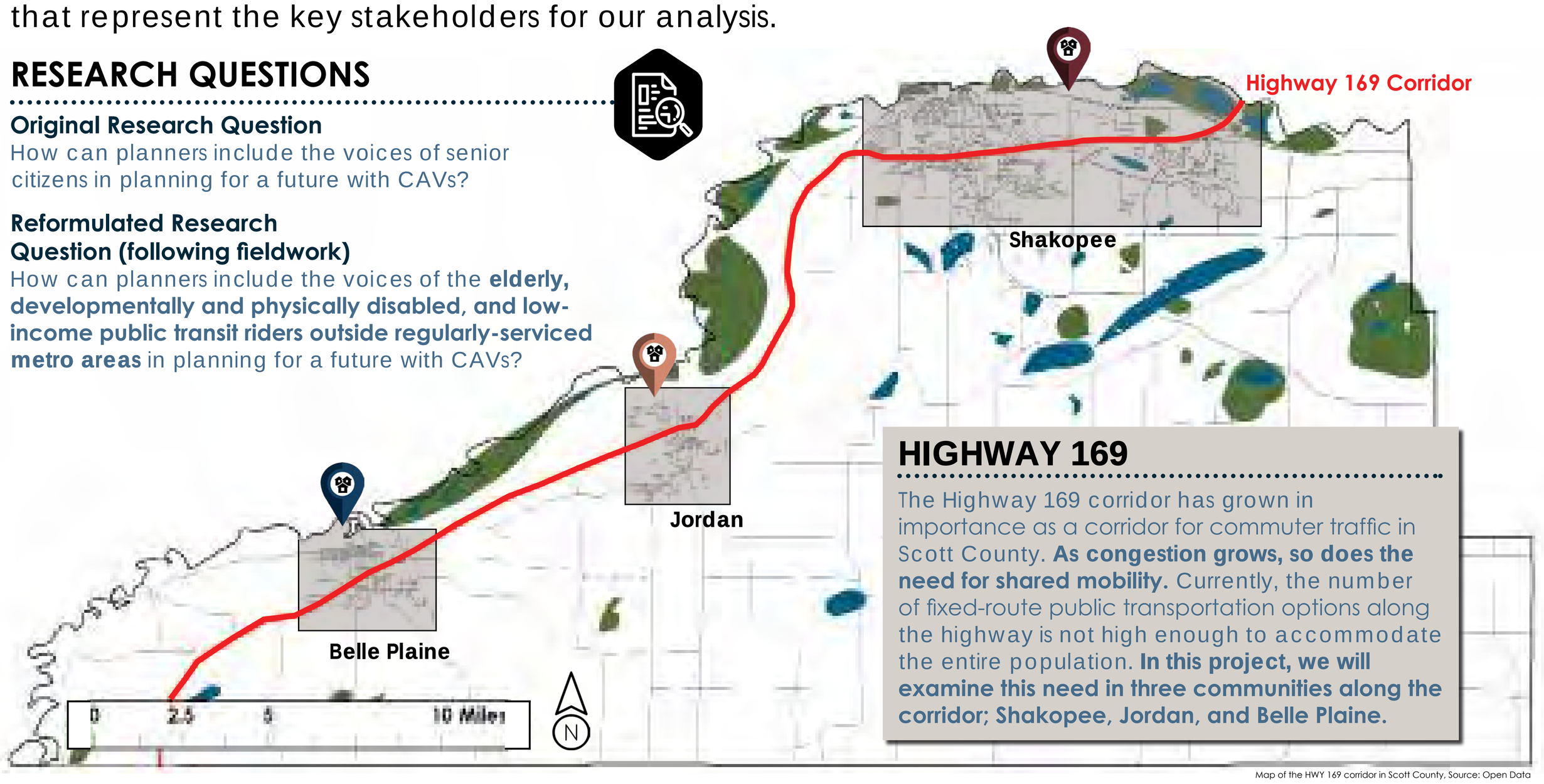
RESEARCH QUESTIONS

Original Research Question

How can planners include the voices of senior citizens in planning for a future with CAVs?

Reformulated Research Question (following fieldwork)

How can planners include the voices of the **elderly, developmentally and physically disabled, and low-income public transit riders outside regularly-serviced metro areas** in planning for a future with CAVs?



Map of the HWY 169 corridor in Scott County, Source: Open Data

HIGHWAY 169

The Highway 169 corridor has grown in importance as a corridor for commuter traffic in Scott County. **As congestion grows, so does the need for shared mobility.** Currently, the number of fixed-route public transportation options along the highway is not high enough to accommodate the entire population. **In this project, we will examine this need in three communities along the corridor; Shakopee, Jordan, and Belle Plaine.**

BELLE PLAINE

Belle Plaine has the **largest senior population** in Scott County, and offers its residents irregular access to a private automobile, a fixed bus route, and the Dial-A-Ride service.

6,700 Residents

1.1% use Public Transportation

Belle Plaine is **inadequately prepared** to offer residents public transportation. The Dial-A-Ride service is the only option for residents without automobiles.

9.3% Senior Residents

7% Persons with Disabilities

JORDAN

Jordan has the **largest population of persons with disabilities** in Scott County, but offers the **fewest public transportation options** for its residents.

6,000 Residents

0.6% Use Public Transportation

In Jordan, the only option for residents without regular access to automobiles is the Dial-A-Ride service. Steps must be taken to improve public transportation.

8.5% Senior Residents

9% Persons with Disabilities

SHAKOPEE

Shakopee is the **largest city** along Highway 169. The city is **a hub** for **commerical and industrial activity** and offers residents the most public transportation options within the county.

39,700 Residents

1.4% use Public Transportation

Even though the city offers multiple bus routes and direct routes to Minneapolis, very few residents commute by public transportation on a daily basis.

7.4% Senior Residents

7% Persons with Disabilities

Source: United States Census Bureau

Next Stop

In the following posters, we will consider the challenges and opportunities of conducting outreach through qualitative research for the implementation of CAVs. We will explore the challenges of applying survey tools to engage elderly residents, persons with disabilities, and low-income residents in transportation planning. In the right, we introduce our equity figure: Ellen Johnson, a planner from Scott County. Ellen will tweet about the challenges and opportunities in conducting outreach and qualitative research with under-represented communities. We begin in the next poster by looking at the challenges Scott County currently faces.



Introduction | Current Options | Best Practices | Municipal Precedents | Research Process | Research Implementation | Graphic Survey | Field Notes | Findings | Best Practices

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The Ride Sharing Landscape

2 T4 Scott

Understanding the Complexity of Current Mobility Options

The first step in developing an outreach/qualitative research plan is to understand Scott County's challenges in serving older and disabled populations. In this poster we explore Scott County's existing **ride sharing landscape**.

	Pickup Location	Scheduling	Accessibility	Cost of Fare
Volunteer Driver				**FREE** • Recent decline in drivers • Insurance companies treat the program like a business • IRS treats mileage reimbursement as income
Lyft, Uber, Taxi				**$6.00+** • Less available in rural areas • Generally requires access to smartphone and comfort with applications
Dial-A-Ride				**0-10 mi** $2.25 **10-20 mi** $4.50 **+20 mi** $6.75
Hwy 169 Connector				**$5.00 - $15.00**
Shakopee Local Routes				Peak / Non-Peak Adults $2.50 / $2.00 Children $2.50 / $1.00 Seniors $2.50 / $1.00
Mpls + MOA Express				Peak / Non-Peak Adults $3.25 / $2.50 Children $3.25 / $1.00 Seniors $3.25 / $1.00



Belle Plaine	Jordan	Shakopee	Scott County	Minneapolis	Metro Area
				Limited to morning and evening express routes to and from Minneapolis + MOA	
		Limited to two regular routes in Shakopee			
				Limited to service along Hwy 169	
			Limited to Scott + Carver Counties, transfers to Metro Mobility for longer trips		$$$$$
			Limited to Scott + Carver Counties, subset of SmartLink		

Next Stop

Scott County's challenge is in finding the **optimal mix of services** and **simplifying their execution**. In the next poster, we will explore existing research and case studies for examples of successful shared mobility services. This scan will also inform the creation of the qualitative research plan.

Current Options

Best Practices | Municipal Precedents | Research Process | Research Implementation | Graphic Survey | Field Notes | Findings | Best Practices

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Shared Mobility for Seniors

3 T4 Scott

Shared Mobility for All?

During the early stages of **CAV implementation**, special consideration must be paid to elderly residents, persons with physical and mental disabilities, and low-income residents. To maintain **independence** as older adults lose their ability to drive, we suggest that Scott County implement **shared mobility options**. In this poster, we develop shared mobility recommendations through a **review of best practices.**

SHARED MOBILITY DEFINED

Shared use of a vehicle, bicycle, or other low-speed travel mode as a transportation strategy enabling users to have short-term access to transportation options on an as-needed basis.



Options for shared mobility

Scott County will best serve residents by offering multiple modes of shared mobility carefully coordinated for efficiency. This will include planning for fixed-route buses, specialized shuttles, infrastructure that encourages carpooling, and partnerships with ridesource companies such as Lyft. While the various options may ideally meet the needs of a diverse population, redundancy and confusion for elderly residents must be avoided.

Recommendation

Scott County must expand their existing education around transportation options to include more residents.



Transition options for aging drivers

Scott County will best serve residents by providing a mobility transition plan for those who can no longer drive. Older adults are more likely to travel to their destinations in private motor vehicles. This dependency becomes more pronounced in rural communities due to infrequent, inaccessible, or limited-route public transit services[5]. Providing mobility transition plans would help elderly residents stay mobile and independent as they age.

Recommendation

Steps need to be taken to improve mobility for elderly, disabled, and low-income residents before CAVs are deployed.



Extending the age for active living

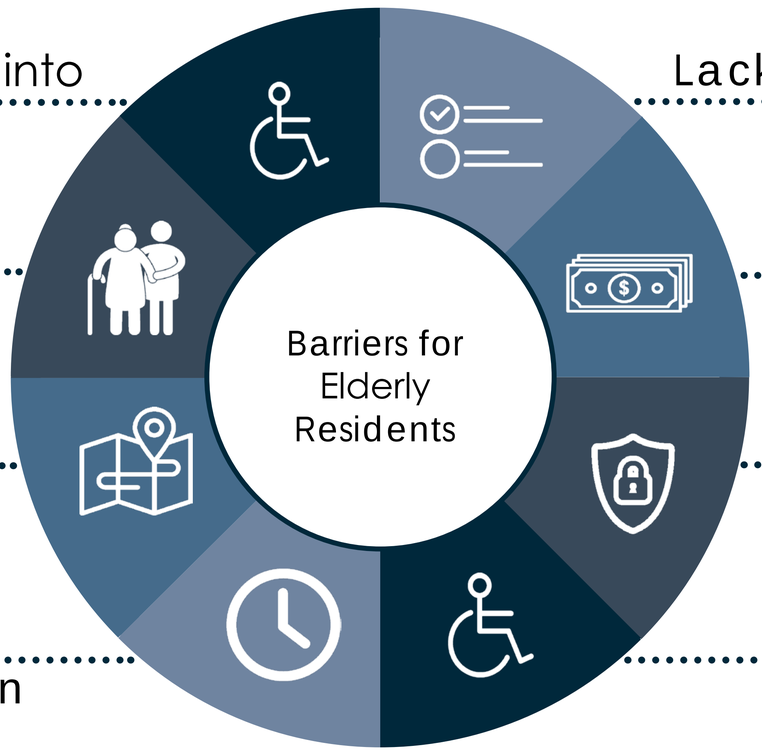
Scott County will best serve residents by planning for safe bike paths and space for specialized biking services. Bike share programs can include tricycles, e-cycles, and recumbent bikes that allow for more stability for elderly users. Non-pedal tricycles are an innovative solution in health promotion and expanding transportation options for older adults[2]. Local initiatives offer adaptive, tandem, and trishaw bike services[3,4].

Recommendation

A bicycle program is not practical for rural areas. Elderly residents need easily-accessible modes of transportation.

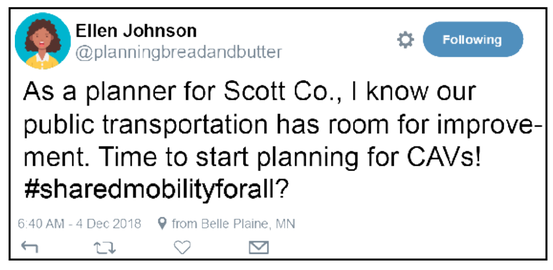
IMPLICATIONS

Shared mobility has broad implications for transportation, zoning and land use, urban and rural design, housing, economic development, and environmental policy. Shared mobility can aid planners in leveraging positive impacts and taming negative influences of access to transportation for underserved populations[1].



Next Stop

This review informs the following **questions for our outreach/qualitative research approach:** What are the current transportation modes for senior and disabled residents? Where are they travelling? What are their barriers to using shared mobility options and mobility restrictions? And how do they feel about CAVs? In the next poster, we look at municipal policy initiatives to **inform these questions.**



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1: PAS 583 Executive Summary
2: Calve, Russo, & Forti Barela, 2017
3: Twin Cities Adaptive Cycling
4: Cycling Without Age

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Municipal Policies

4 T4 Scott

Shared Mobility for All?

Planning for a shift in how the elderly and persons with disabilities access transportation requires an analysis of municipal policies. The following four cases highlight **governance practices, collaboration, transparency, and innovation**.

DAYTON, OH



Governance: Montgomery County; 3 rural towns SW of Dayton

Regional Transit Authority

Revenue: Operations, govt grants

Partnerships: Lyft, Montgomery County Board of Developmental Disabilities

Special Features

RTA runs a **free group shopping shuttle**, with **reliable fixed hours** of operation, but it is **only available** to those who are **ADA paratransit eligible** who live within **5 miles of the grocery store** they frequent.

Dayton provides reliable transport for personal errands like grocery shopping for rural residents. **Scott County should implement similar shopping programs for their residents in need.**

PORTLAND, OR



Governance: Clackamas, Multnomah, & Washington Counties

30-year non-profit

Revenue: 96% grants, contracts

Partnerships: dozens of partners support transportation, access, fare relief, and more

Special Features

Ride Connection's outreach efforts include **ride ambassadors**, **travel options counselors**, **travel trainers**, and **informational transit boards** in convenient locations. **All services are free**.

Portland shows great creativity in their outreach and education-al efforts. **Scott County should expand their travel trainer program to include options such as counselors & ride ambassadors.**

SAN DIEGO, CA



Governance: San Diego & Imperial Counties

SANDAG

Revenue: grant, sales tax

Partnerships: Caltrans Emerging Priorities Program, Imperial County Transportation Commission Services

Special Features

SANDAG has prototyped **mobility hubs for 8 locations**, the plans for which are openly available. Mobility hubs act as converging points for public transit and an integrated suite of mobility services.

San Diego provides transparent planning documentation for implementing mobility hubs. **Scott County should utilize these plans to begin planning for a mobility hub in Shakopee.**

MINNEAPOLIS, MN



Governance: Hennepin County; Downtown and west metro

30-year non-profit

Revenue: 64% grants, 21% fees

Partnerships: Jewish Family & Children's Service of Minneapolis, Jacob Garber Transportation Services

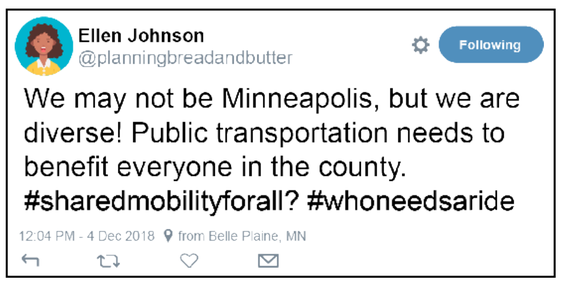
Special Features

In addition to the entire west metro and downtown, they also provide transportation to **three significant hospitals outside those areas**. They offer home visits to enroll new riders.

Minneapolis exemplifies **long-term, sliding fee scale services** that rely on volunteer drivers. Scott County could work directly with this program to learn about volunteer driver retention.

Next Stop

The previous posters inform the creation of a survey to be delivered to riders aboard the morning SmartLink commute. The outreach/qualitative research process is explained in the next several posters.



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http://www.i-riderta.org/rta-connect/paratransit-service
https://rideconnection.org/
http://www.sdforward.com/mobility-planning/regionalmobilityhub
https://www.jfcsmpls.org/our-services/senior-services/

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Outreach/Research Process

5 T4 Scott

Shared Mobility for All?

Our outreach/qualitative research approach was developed to capture the **input of a variety of stakeholders**. In this poster, we explain the value of qualitative research and various **data collection methods** as a tool for authentic outreach efforts.

THE QUALITATIVE RESEARCH PROCESSES

Qualitative research methods explore the complexity of human behavior, attitudes, and beliefs. Qualitative research participants are sometimes called stakeholders. They may be a program beneficiary, staff member, volunteer, funder, or community member. Their involvement in research ensures that the results will have value. Stakeholder input can be collected in a number of ways. The methodology we're recommending for Scott County combines interviews, focus groups, surveys, and participatory mapping. **By carrying out this approach we ensure the inclusion of rider's experience beyond this aggregation of numbers.**



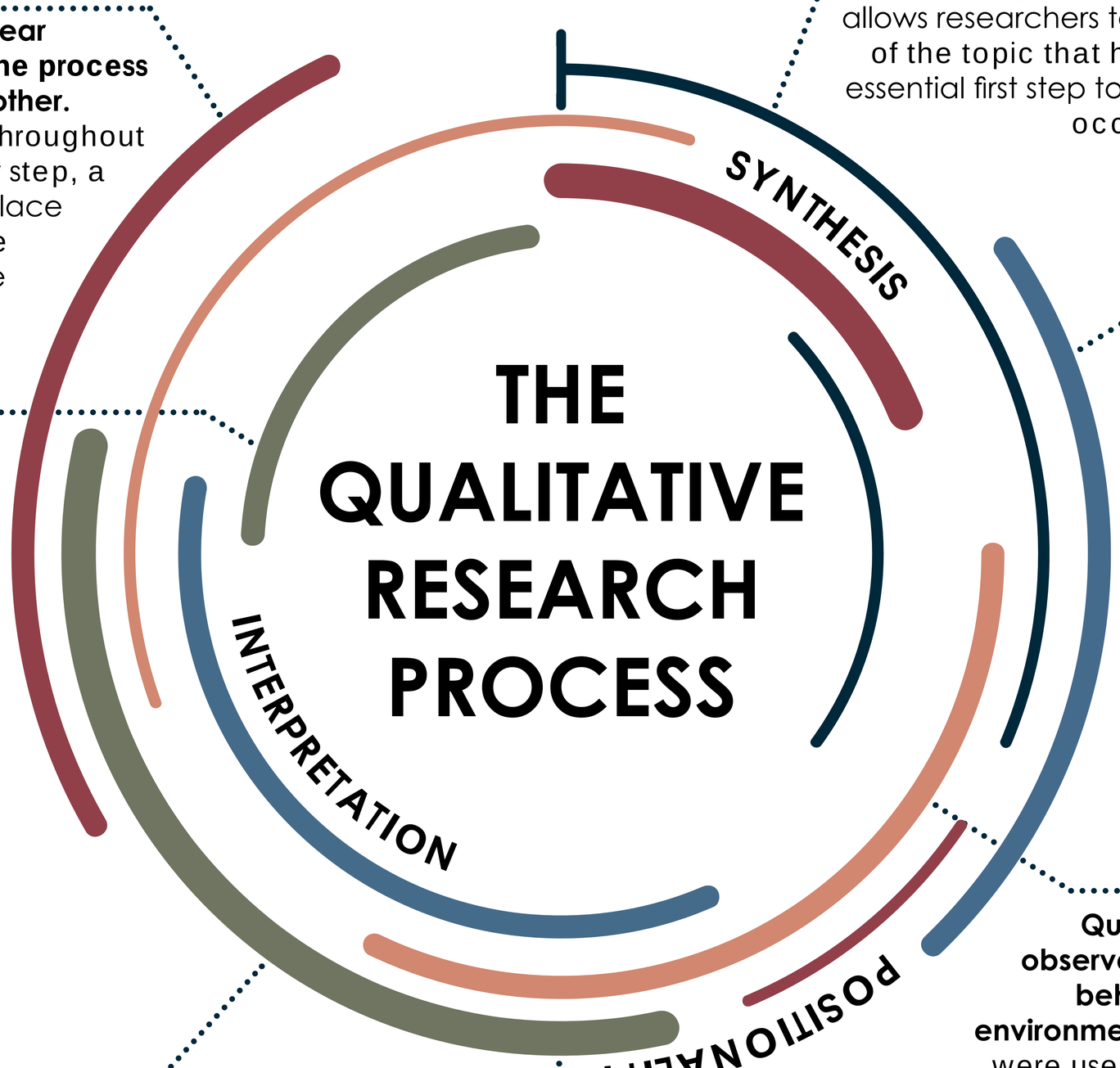


Literature Review

A literature review investigates the current knowlege and substantive findings in a field. It allows researchers to start a project with knowlege of the topic that has already been found. It is an essential first step to the research process ,but can occur throughout data collection.

Data Analysis

Qualitative research is not a linear process; instead each part of the process will overlap and influence the other. Data analysis can take place throughout the entire research. After every step, a written reflection should take place to produce texts that will shape research findings and influence the research.



Semi-Structured Interviews

A semi-structured interview is a series of open-ended questions that are asked in a predetermined order; the interviewer may **use prompts and follow up questions to clarify and probe for deeper meaning**. The open-ended questions allow participants to elaborate and provide details about their experiences.

Focus Groups

A focus group is a small group of people with common characteristics that relate to discuss a specific topic. They gather together to **suggest or react to ideas, clarify potential options, recommend a course of action, or make a decision/plan**. Focus groups are often conducted in addition to interviews, either with a subset of interviewees or a separate group with similar characteristics of interest. **Group interaction and synergy** is what makes focus groups distinctly different than interviews.

Direct Observation

Qualitative researchers use direct observation to learn about the normal behavior of people in their natural environments. In this study, our field notes were used to gather direct observations that influenced our assumptions and findings throughout the project.

Surveys

A survey consists of questions asked to help **understand thoughts, opinions, feelings, knowledge, and behaviors**. Surveys can be administered in a variety of ways (e.g., telephone, online, in person). Survey findings can be used to draw conclusions or further research questions.



PLAN VS. REALITY

Our outreach/qualitative research plan was ambitious, partially due to the time allottment for data collection. We were able to collect **7 surveys** on 2 buses during a weekday commute. The **participatory mapping exercise** was at the very beginning of the survey. We also conducted **8 semi-structured interviews with stakeholders**. We analyzed our field notes and used them as pieces of data to construct **rich descriptions of the study context.** We were not able to put together a focus group.

Participatory Mapping

Participatory mapping is a set of approaches and techniques that combines the tools of modern cartography with participatory methods to represent the spatial knowledge of local communities. Participatory maps often represent a **socially distinct understanding** of landscape and include information that is excluded from mainstream or official maps. Maps created by local communities represent the place in which they live, showing the **elements that communities themselves perceive as important**.

Next Stop

The next poster details the implementation of our outreach/qualitative research process and considers challenges and opportunities to improve community engagement and data collection in the future.



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Thompson, N., Kegler, M. C., and Holtgrave, D. R. (2006). Program Evaluation. In Research Methods in Health Promotion (Eds. Richard A. Crosby, Ralph J. DiClemente, and Laura F. Salazar). Jossey-Bass: San Francisco, CA.
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Research Implementation

6 T4 Scott

Shared Mobility for All?

In this poster we share our **initial findings** and detail the **challenges we encountered** in collecting qualitative data.

In addition to investigating **barriers that Smart Link riders face** in Scott County through online sources, we conducted **phone interviews** and **rode on a Smart Link bus** the morning of November 7th, 2018 to interview riders.

3 Phones
3 Laptops
50 Printed Surveys
2 Dial-A-Ride Buses

THE RESEARCH TOOLS

The rest of this poster highlights some of the **demographic characteristics** of our riders and interviewees. It also **details the challeges we faced** throughout the process and **gives recommendations for future use** of this qualitative research tool.

The Participatory Mapping Survey

The Task

We asked participants to draw their route for the day on a map, starting at their destination points; however, **all participants were riding the same, fixed route buses**. Thus, routes were very similar unless the participant was transferring. We also neglected to ask what the stars represented on the map and why they were traveling there. Another barrier was the unexpected population being surveyed. **Some riders could not comprehend the exercise and others left it blank**. Participants could also elect not to answer any question they wished.

The Limitations

Scott County indicated that a senior citizen population was their primary interest, but they arranged for the data collectors to ride a bus filled by persons with disabilities who were largely younger than 60 years old. **The survey was not designed with an intellectually impaired audience in mind**.

Unexpected Findings

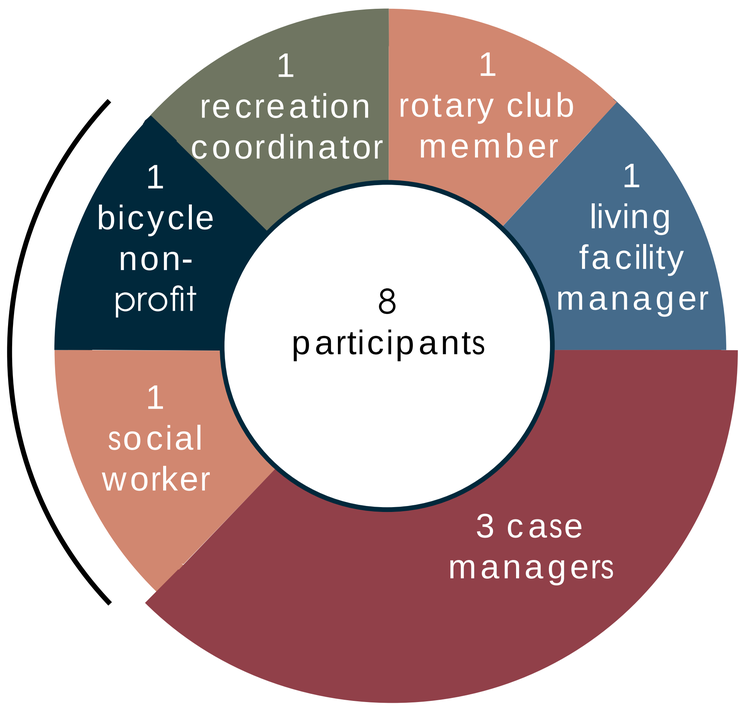
Our interactions with this population was **critical in opening up a dialogue about transportation services to low income and disabled persons**. We found surveys need to be edited and designed for persons with all types of disabilities. Recommendations for how this could be accomplished are described in Poster 10. Missing data, for instance,could be the result of varying types of data collection (verbal versus written) or a lack of understanding the questions.

Demographics at a glance



The Stakeholder Interviews

We developed a set of 14 open-ended questions. The interactions with our target populations varied between the three of us. The conversations were less formal (as in a semi-structured interview) and more conversational (as in a key informant interview). This enabled participants to offer us a more candid response. **Stakeholder input will be crucial to planning for the mobility of the target populations, especially since some of them cannot advocate or speak for themselves. Scott County should greatly expand on these initial interviews, and structure them as key informant interviews.**



Next Stop

Surveys, participatory mapping, and stakeholder interviews should continue in Scott County. Ideally, focus groups will also be conducted to confirm or deny the results found with the other methods. The next poster makes specific recommendations for improving the survey and mapping exercise.



Research Implementation | Graphic Survey | Field Notes | Findings | Best Practices

PA 5211: Land Use Planning | Corrin Bemis, Isaac Hase-Raney, Shanda Hunt, Emily Reno | Instructor: H. Fernando Burga, Ph.D. | TA: Chris Desroches

*All names used in this document are psuedo-names to protect the identity of those we interviewed and interacted with throughout the data collection process

Phone by Andrejs Kirma from the Noun Project, market challenge by Adèle Foucart from the Noun Project, task by Asif Shirazi from the Noun Project, dialogue by hans draiman from the Noun Project

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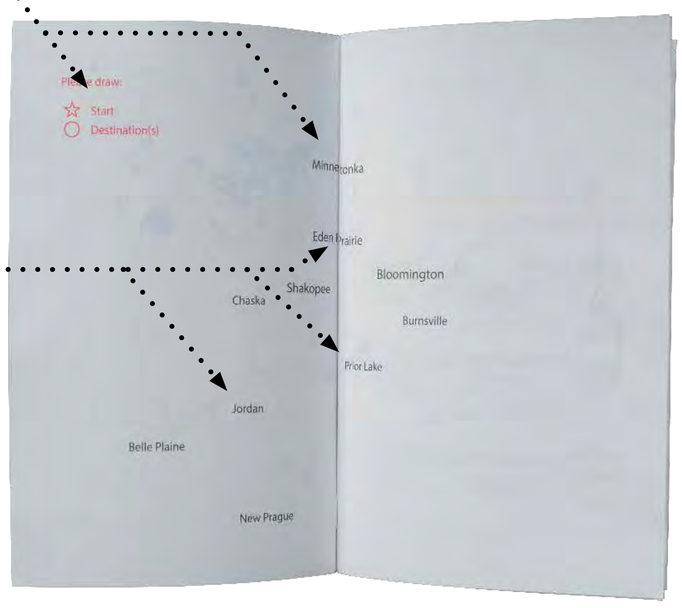
Shared Mobility for All

Survey Design & Participatory Mapping Exercise

7 T4 Scott

In this poster we dissect our survey instrument, highlighting our **assumptions** and **challenges**. While **not all pages are included**, the ones annotated below provide commentary considering **the challenges of conducting a graphic survey with a intellectually disabled population.**

ROUTE MAPPING



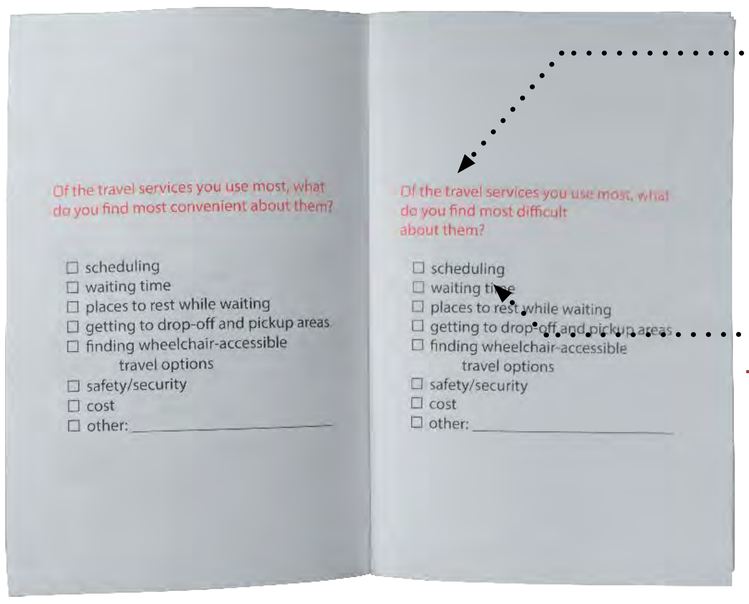
Assumptions

We asked participants to mark a star where they began their transit route and place a circle at their final destination with a line connecting the two. We hoped to see trends in the direction of travel among the riders. Urban centers were chosen based on their size and proximity to the 169 Highway Corridor.

Challenges

Most riders on the bus began and ended in the same location, capturing only a small sample and distance of ridership travel patterns. This exercise was produced under the assumption that riders would know how to map their routes. Many riders did not understand the map. We had to draw the lines for them after asking about their route. Scott County should consider the facilitation of participatory mapping and assess appropriate data collection methods for people with intellectual disabilities.

USABILITY QUESTIONS



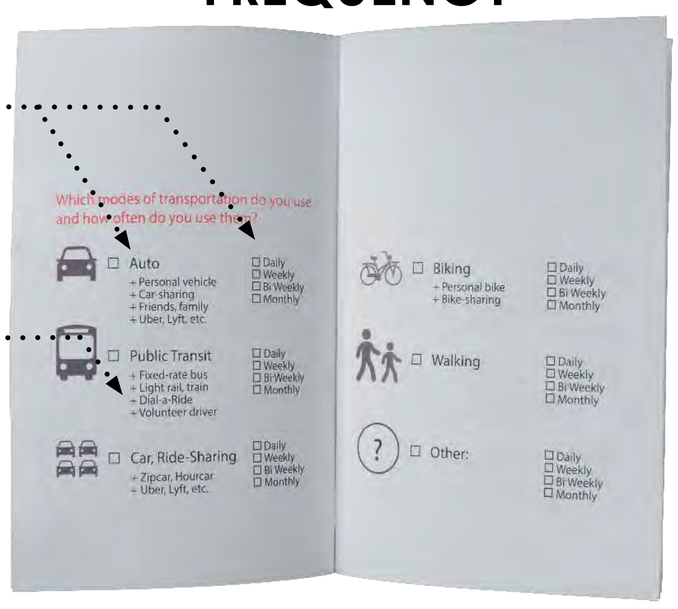
Assumptions

We intended to assist SmartLink services by gathering information about what riders find convenient and difficult about the travel services. By checking off the boxes, we aimed to capture the perspectives of riders.

Challenges

The questions assumed riders scheduled their own trips. The results were skewed because the majority of surveyed riders could not use the service without assistance. The survey failed to account for riders with disabilities.

TRAVEL MODE + FREQUENCY



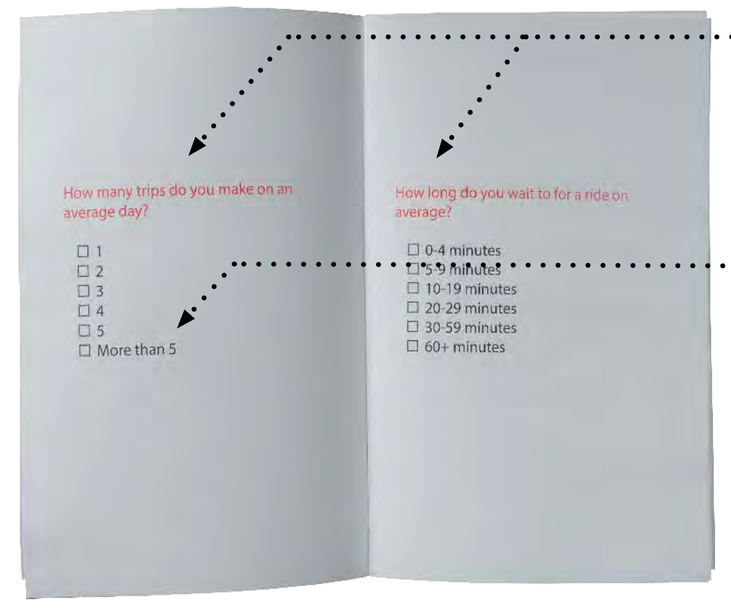
Assumptions

We wanted to know the mode and frequency of travel. The graphics in this page aimed to make the survey more inviting and visually interesting for participants.

Challenges

While the icons used for these questions sought to simplify the modal options in the responses, **respondents were overwhelmed by the number of examples listed under each mode.**

TIME + COST OF TRAVEL



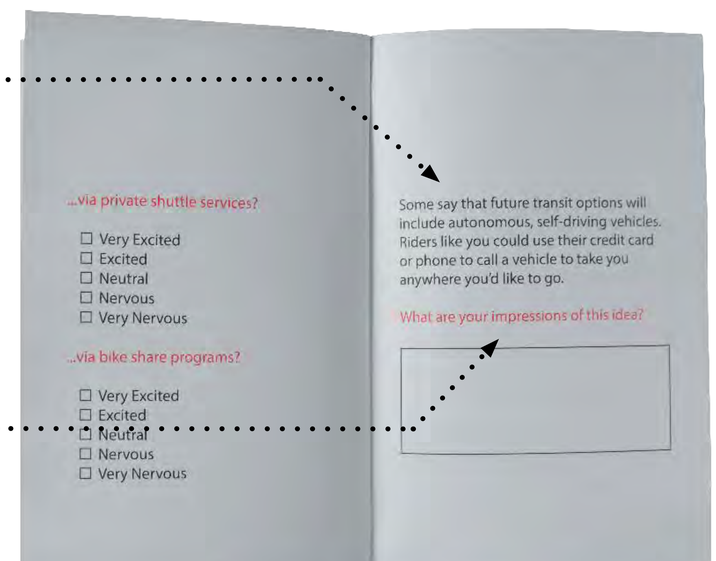
Assumptions

By asking questions about the number of trips and the average wait time, **we aimed to find out if the cost of time associated with travel serves as a barrier for using Dial-a-Ride services.**

Challenges

For many riders, trips often involve several transfers between fixed route and non fixed route buses, which made the question about the number of trips difficult to answer. The average wait time for riders varied considerably. Riders could be picked up an hour before or after the scheduled pickup time. Some riders were picked up at their doorstep, whereas others we met in a parking lot.

UNDERSTANDING OF CAVs



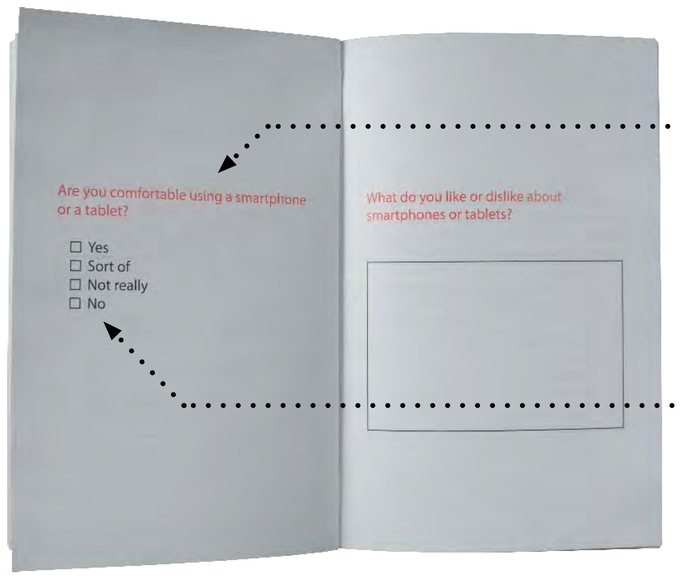
Assumptions

We assumed that riders would be familiar with the concept of automated technologies and that little explanation would be needed.

Challenges

We had to consistently educate riders about CAVs because they were not familiar with them or had not heard of them previously.

DIAL-UP SERVICES + CAVs



Assumptions

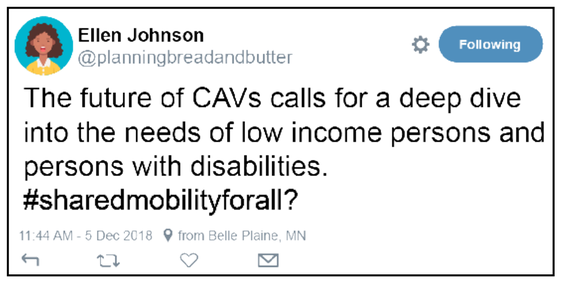
We asked participants about their comfort using a smartphone or tablet because **there is an assumption among CAV researchers and designers that rides will be hailed using an application.**

Challenges

Based on informal conversation with one of the riders, **most people using Dial-a-Ride do not own their own phone or would not know how to use a smartphone if given one.**

Next Stop

In the next poster, we consider the notes from our observations in relation to the audiences we surveyed on a morning bus trip from Belle Plaine to Shakopee.



Graphic Survey | Field Notes | Findings | Best Practices

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Field Notes

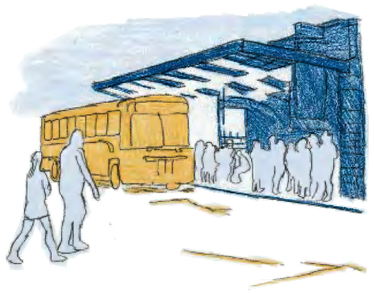
Shared Mobility for All?

8 T4 Scott

Having described the **assumptions and challenges** that we encountered with the delivery of our graphic survey, we move into the **synthesis of our fieldnotes** based on **direct observations**. Three of us split up between two buses, but ended at the same final destination. This poster describes our experience through several stops.

STOP 1:
Marschall Transit Station
7:30 a.m.
Shakopee, MN

Upon arrival at Marschall Transit Station, we sat in the lobby for about fifteen minutes before realizing that we needed to ask for the travel trainer at the window. We had the impression from conversations with Scott County employees that the bus riders would be primarily seniors. While waiting in the lobby we noticed that most of the people around us were rather young, which made us worried that our **survey might not gather meaningful data**. There was a **tangible feeling of relief** when we realized that the people in the lobby were not passengers on the the Dial-a-Ride bus that we would be taking that day. We conversed with Scott County's travel trainer on our way to Shakopee to pick up the first group of riders.



STOP 2:
Assisted living facility

We first stopped at an assisted living facility. A second bus pulled up and we decided to split up so that we could get more survey participation. All three of us were surprised to find that **most riders could not enter the bus by themselves because of physical or mental disabilities,** they needed help boarding with the lift gate for their wheelchairs, or needed the assistance of a caregiver. Some caregivers double-checked to make sure that riders were prepared with blankets **in case the bus broke down.** In this moment we all realized that **our survey might not have the impact we anticipated** because of the riders' intellectual disabilities. Nevertheless, we proceeded to attempt data collection and introduced ourselves and the project and asked if anyone was willing to participate. A few riders refused immediately, some opened up to informal conversation, others decided to take the survey when they saw others completing it, and some riders were noncommunicative. Having gone into the process expecting between 15 and 30 surveys, **we were disappointed that we only collected 7 surveys, many of which were incomplete.**



STOP 3:
Private residence in suburban neighborhood

The bus made multiple stops at private residences during our bus ride. Sometimes the rider's family members would get on the bus to ensure that they had everything they needed for the day. Others were able to board the bus themselves, and appeared to have cognitive disabilities. We learned that most riders were on their way to a **workforce development center,** and that the Dial-a-Ride bus was their primary means of transportation to work. This finding corresponded to initial commentary during our phone interviews; riders not living in assisted living facilities were much less likely to have access to Dial-a-Ride services. It also **refuted our assumption that riders would be senior citizens.**



STOP 4:
Parking lot



Next, we arrived at a parking lot where a minivan was waiting for us. The driver talked with the rider's family member like old friends. This was one of many moments when we realized that the **driver's role went well beyond simply arriving at designated locations and collecting fares.** Most riders appeared to know each other, and had **informal seating assignments.** We moved seats as riders told us that we were sitting in their spot. This made us question **how comfortable new riders might feel** if they were to secure a ride. Aside from the assisted living facility, only one individual was picked up at a time, which varies considerably from the experience of urban transit users.

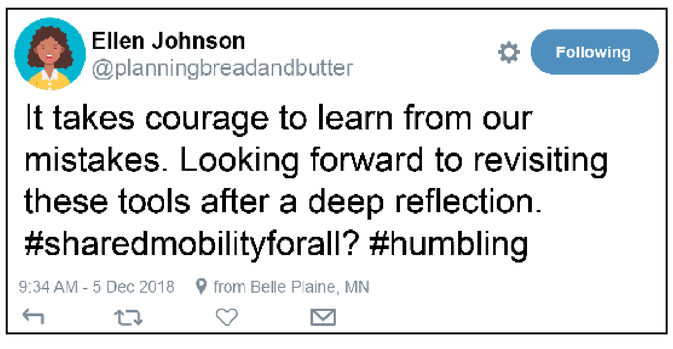
STOP 5:
Workforce development center

Our penultimate stop brought us to a **workforce development center,** which was the **primary destination for most riders.** We found that other riders who needed to get to Minneapolis using Dial-a-Ride **anticipated being late to their appointments** because of how many transfers they needed to make. These riders have continued to use the service, however, in excess of ten years because **few alternative options exist.** This reinforced the travel patterns we had discussed with Scott County employees. Many residents of Jordan and Belle Plaine commute to Shakopee.



Next Stop

Recognizing the **setbacks we experienced** through this process, we dedicate the final poster to an **interpretation of our outreach/qualitative data collection** and **provide recommendations** for how Scott County and future researchers working on this project may consider improvements.



Field Notes | Findings | Best Practices

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Synthesized Findings

9 T4 Scott

Shared Mobility for All?

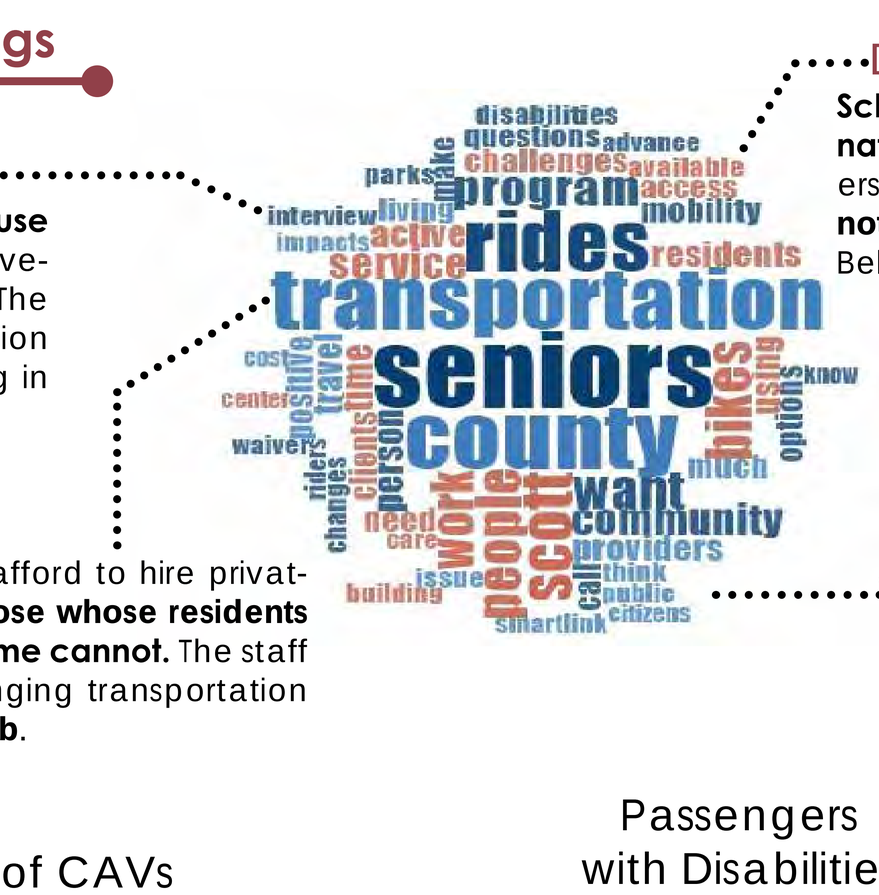
While limited, the results of the surveys, stakeholder interviews, and field notes were coded to develop emergent themes and categories. The data were analyzed by applying descriptive statistics and reviewing responses to questions according to distinctive themes. **In this poster we highlight significant findings from the surveys, stakeholder interviews, and field notes**.

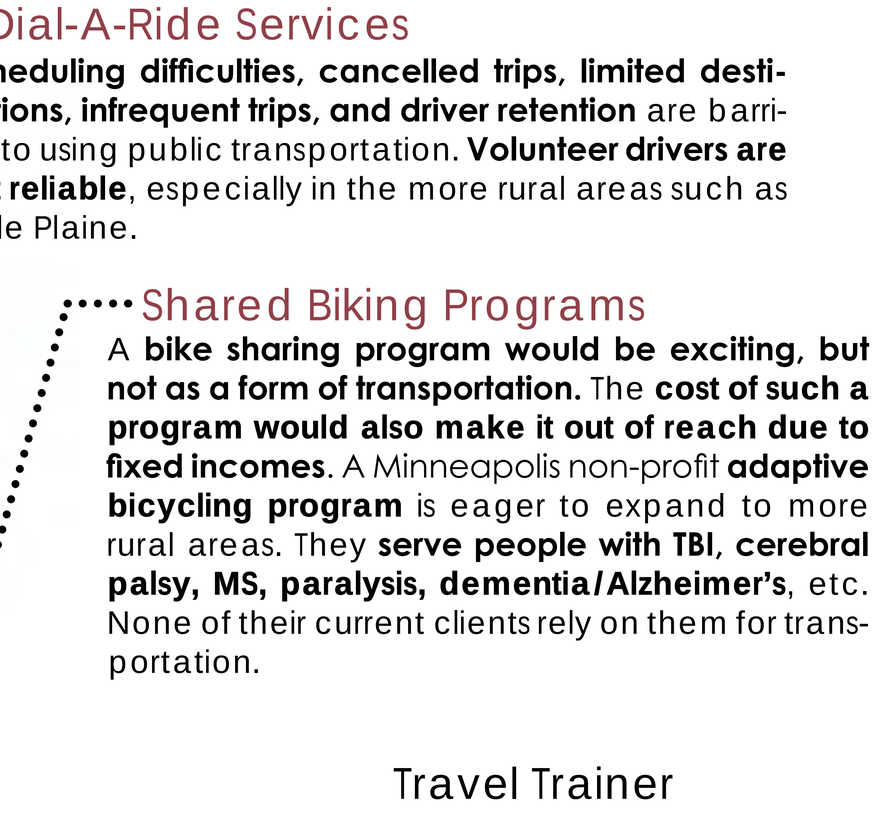
Survey Findings

Participants over 60 years old

Participants with annual income under $15,000

Participants who pay for transportation with county waivers





Stakeholder Interview Findings

Senior Transportation

Many senior citizens in Scott County do not use public transportation. Most drive their own vehicles or get rides from friends and family. The seniors who do use the public transportation system are those on **fixed incomes** residing in assisted living homes.

Assisted Living Facilities

Wealthier assisted living facilities can afford to hire privatized transportation companies, but **those whose residents are paying for services on a fixed income cannot.** The staff at one assisted living facility are arranging transportation for seniors, **when it is not part of their job**.

Dial-A-Ride Services

Scheduling difficulties, cancelled trips, limited destinations, infrequent trips, and driver retention are barriers to using public transportation. **Volunteer drivers are not reliable**, especially in the more rural areas such as Belle Plaine.

Shared Biking Programs

A **bike sharing program would be exciting, but not as a form of transportation.** The **cost of such a program would also make it out of reach due to fixed incomes**. A Minneapolis non-profit **adaptive bicycling program** is eager to expand to more rural areas. They **serve people with TBI, cerebral palsy, MS, paralysis, dementia/Alzheimer's**, etc. None of their current clients rely on them for transportation.

Field Notes Findings

Use of CAVs

Most participants did not fully comprehend the concept of CAVs. One participant had a more **positive view of CAVs** after hearing about increased mobility and safety. Most riders would not be able to use CAVs by themselves.

Passengers with Disabilities

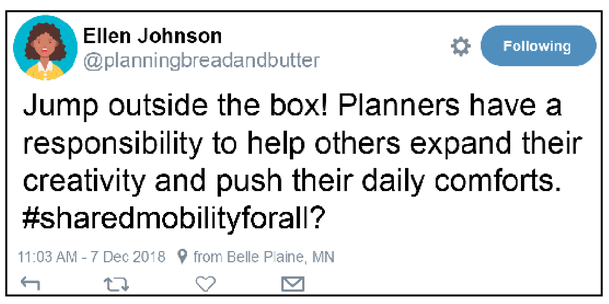
2/3 of riders were persons with cognitive and physical disabilities who needed assistance from a caregiver and/or bus driver to enter and ride the bus.

Travel Trainer Program

There is one travel trainer for all of Scott County. **The full potential of a travel trainer program is not being addressed**. Professionals who are trained in community outreach should be hired to supplement and expand the program.

Next Stop

The final poster names six distinct themes to improve shared mobility in Scott County. We also recommend a timeline of actions the county should take to better serve elderly residents, persons with physical and mental disabilities, and low-income residents.



Findings | Best Practices

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Future Recommendations

10

T4 Scott

Shared Mobility for All?

We conclude by offering recommendations to improve shared mobility through Smart Link's services. Given our outreach efforts and qualitative research, our recommendations reflect the fact that persons with intellectual disabilities are largely **nonexistent in conversations about mobility** for the elderly and CAVs.

THE INTELLECTUAL DISABILITY CHALLENGES

The most underrepresented Dial-a-ride riders are not seniors, but persons with disabilities and low-income residents.

Recommendation: Scott County would best serve its residents by shifting focus to planning for the mobility of low-income and disabled residents.

?

"Abled does not mean enabled. Disabled does not mean less abled." — Khang Kijarro Nguyen

Employee support and training

Support staff are likely in low-paying jobs, yet those jobs require a high degree of performance and emotional engagement.

Recommendation: Ensure financial compensation, proper training, emotional support, and collaborative efforts for support staff.

Focused mobility efforts

Shared bicycles are not practical as transportation options in Scott County given the long distances between destinations.

Recommendation: Incorporate bikes into recreational programming and plan for shared-road bike lanes, but do not prioritize them as primary mobility solutions.

Improving Dial-a-Ride

Unreliable transportation is severely limiting low-income and disabled residents' ability to work and run errands.

Recommendation: Scott County should expand Dial-A-Ride hours, better coordinate ride requests, and focus on driver retention.

Focus on present issues

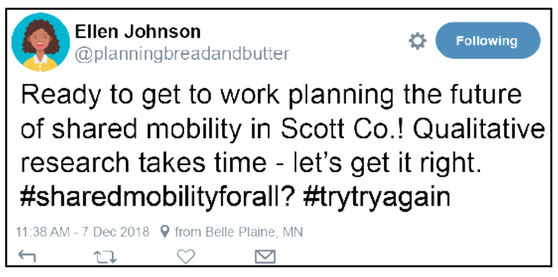
Plans for a future that incorporates CAVs into public transportation do not fully consider how low-income and persons with disabilities would utilize those services.

Recommendation: Scott County cannot begin planning for use of CAVs by this population until barriers to current transportation use are addressed.

There is currently no successful partnership between Scott County and privatized transportation services.

Recommendation: Conduct a cost/benefit analysis to partner with privatized companies to provide reliable transportation to residents.

Cost-benefit analysis



INCORPORATING CAVs ALONG HWY 169

The introduction of CAV technology will not solve the problems explored in this project. Before addressing the relationship elderly residents have with CAV technology, **Scott County must improve the relationship elderly residents, residents with disabilities, and low-income residents have with public transportation**. The timeline below offers a suggestion for Scott County to move forward.

1 — Creative Funding Initiatives

Tap into unique funds by partnering with assisted living facilities to bring in revenue for transit services and utilizing RFIs or RFPs to crowdsource ideas and solutions to complex design scenarios.

2 — Forge New Partnerships

Collaborate with surrounding counties to extend the Smartlink Boundary and simplify the routes. Collaborate with rideshare companies to remove technology barriers for users.

3 — Engage Populations with Intellectual Disabilities

Work with caregivers and particpants' families to ensure the questions are being asked in meaningful and useful ways to assess the situation. Design with disabilities in mind by using supportive conversation techniques.

4 — Informing CAV Development

For CAVs to support all public transit riders, wheelchair accessibility, seating for caregivers, space for equipment (i.e. walkers), alternative payment options, and limited internet access must be considered during the design process.

Best Practices

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[1]Clark, Lauren, Pett, Marjorie A., Cardell, Elizabeth M., Guo, Jia-Wen, & Johnson, Erin. (2017). Developing a Health-Related Quality-of-Life Measure for People with Intellectual Disability. Intellectual and Developmental Disabilities, 55(3), 140-153.
[2]Dalemans, R., Wade, D., Van Den Heuvel, W., & De Witte, L. (2009). Facilitating the participation of people with aphasia in research: A description of strategies. Clinical Rehabilitation, 23(10), 948-959.
[3]Marilyn J. Field, Alan Jette, Committee on Disability in America, Board on Health Sciences Policy, & Institute of Medicine. (2007). The Future of Disability in America. National Academies Press.

funding by Gregor Cresnar from the Noun Project, Corporation by Mahmure Alp from the Noun Project, chatting by Kathleen Black from the Noun Project, development by Gregor Cresnar from the Noun Project

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Transportation Renaissance

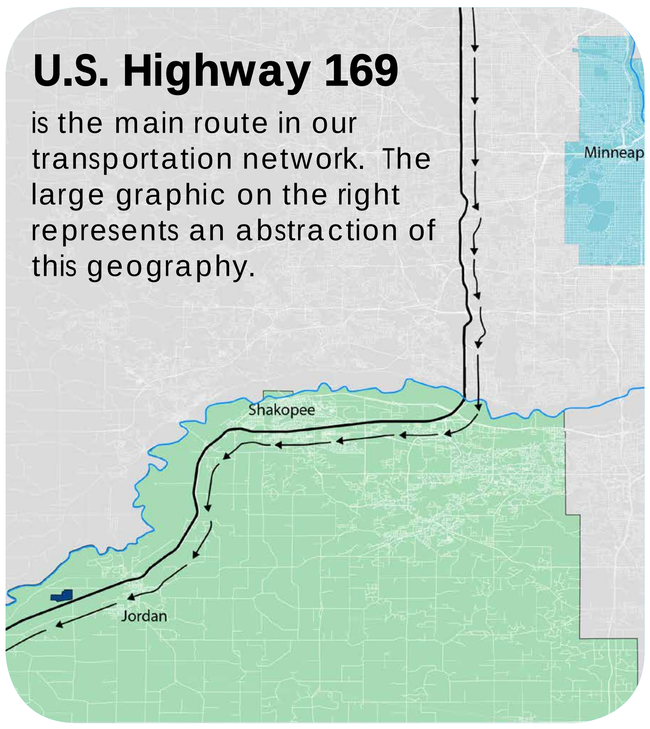
Envisioning CAV Transportation Hubs from Urban to Rural MN

1 T2 SCOTT

This project explores how connected autonomous vehicles (CAVs) may improve regional transportation **connectivity** between Minneapolis and rural Minnesota. We will look at the journey within 10 miles of U.S. Highway 169 from Minneapolis to the new site of the **Minnesota Renaissance Festival**, located outside of Jordan, MN. Our analysis begins by highlighting the different jurisdictions in this **transit network** and introducing our equity figure.

U.S. Highway 169

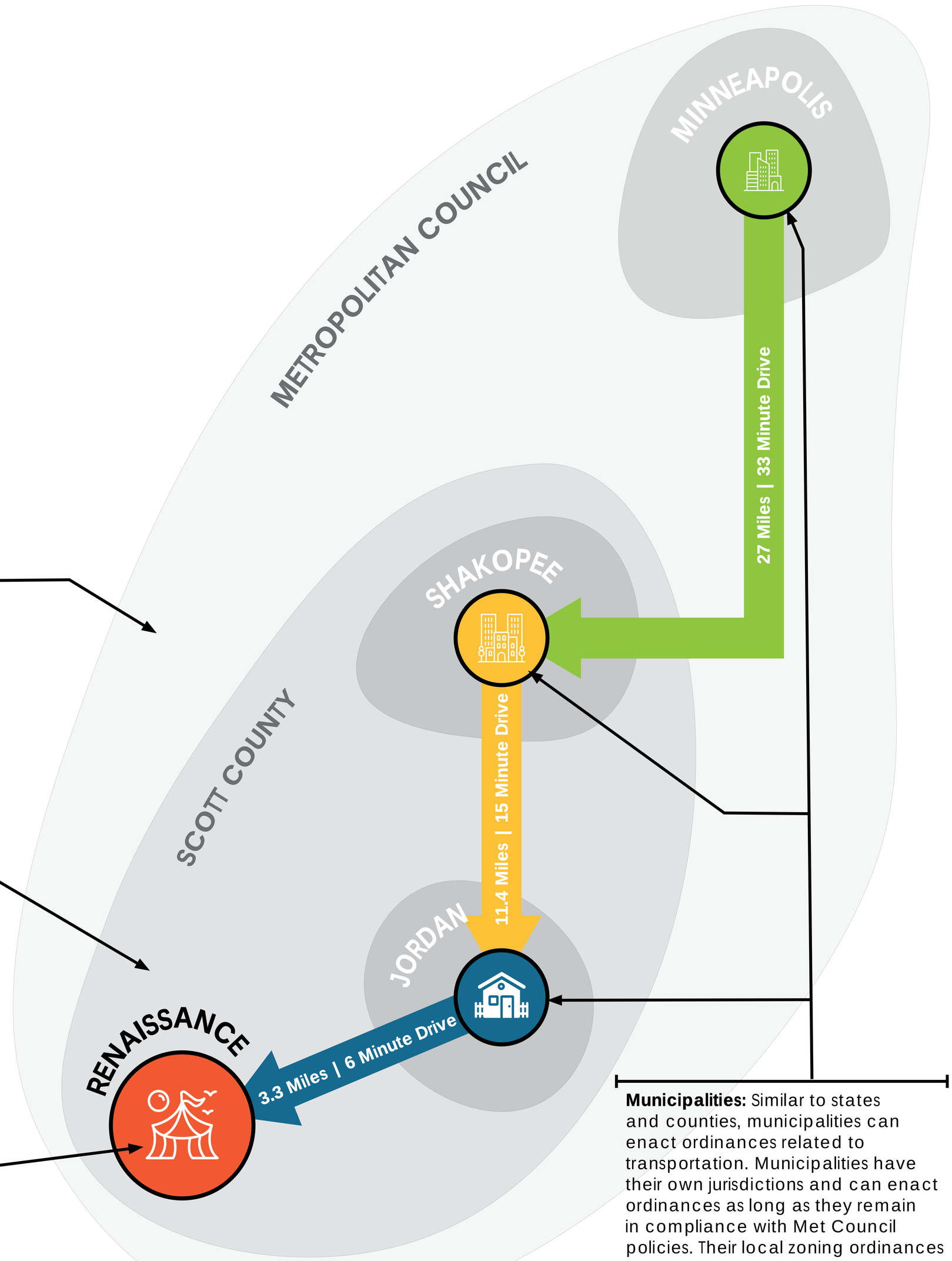
is the main route in our transportation network. The large graphic on the right represents an abstraction of this geography.



The Metropolitan (Met) Council: is a Metropolitan Planning Organization (MPO) that creates policy for transportation, wastewater, affordable housing, parks, and comprehensive plans in the 7-county region. It is the primary transportation governing authority for the region and has the statutory purview to influence overarching plans and policy for CAVs in the transit network.

Scott County: Our analysis begins in Hennepin County, but the majority of Hwy. 169 is located in Scott County. Transportation services in the county are offered via **SmartLink Transit**, a **dial-a-ride service**. Scott County has the authority to enact ordinances related to transportation as long as they remain in compliance with Met Council policy.

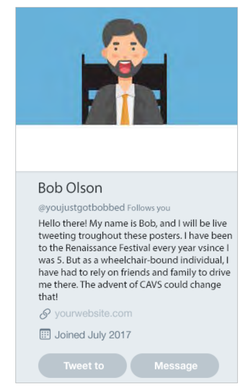
Renaissance Festival: How all of these jurisdictions work together to regulate CAV technology will be critical for the future of tourist destinations like the Renaissance Festival. Private tourist destinations may partner with local, county, and state government to fund the infrastructure needed for the introduction of CAV technology.



Municipalities: Similar to states and counties, municipalities can enact ordinances related to transportation. Municipalities have their own jurisdictions and can enact ordinances as long as they remain in compliance with Met Council policies. Their local zoning ordinances will impact the use of CAVs.

Next Stop: U.S. Highway 169 Transect Analysis

When planning for transportation it is important to ensure coherence across jurisdictions. Transportation coordination is important to provide a system that functions along an entire route without disruption when crossing borders. In the next poster we will place each of these jurisdictions into a transect and explore design scenarios from the urban core to rural areas, like the new Renaissance Festival site.



Transportation Renaissance

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Ian Corder, Kathryn Leys, Eric Molinari, Ben Schneider and Ari Del Rosario

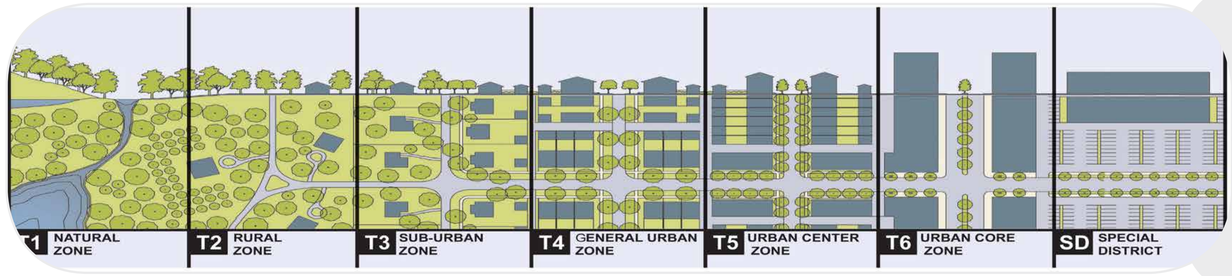
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U.S. Highway 169 Transect Analysis

2 T2 SCOTT

Transportation Renaissance

Introducing CAVs into the transportation network of the metro region is bound to affect different places in different ways. In our posters we look at these differences through the **“transects”** framework.



Pioneered New Urbanists, the transect is a framework that classifies zones according to different built densities as one moves from urban to rural areas. The zones vary according to open space, built infrastructure, and population.

T6 Urban Core Zone

Highest density and height, with the greatest variety of uses, apartments and civic buildings.

- **CAVs will be first implemented in this zone**

T5 Urban Center Zone

Higher density mixed-use buildings accommodating retail and office space.

- **CAVs will reduce the gap of transit options between the urban core and urban center**

T4 General Urban Zone

Wide use of building types, mixed-use but primarily residential.

- **Many of these residents are accustomed to driving to public transit hubs. CAVs would affect this dynamic**

T3 Sub-Urban Zone

Low-density residential adjacent to some higher density zones with limited commercial.

- **CAVs could offer public transit for residents who don’t have alternative options**

T2 Rural Zone

Sparsely settled land dotted with agricultural buildings.

- **CAVs will be implemented last in this zone**

T6

- Key Question: There is already a transportation network that operates between transects T6 and T5. Could CAVs provide a system that connects these transects to less dense transects?
- We will investigate this question in posters 4 and 5

T5

T4

- Key Question: How could CAVs improve regional connectivity in suburban and rural areas?
- We will investigate this question in posters 6 and 7

T3

T2

- Key Question: How can infrastructure be improved to provide access to rural zones for CAVs?
- We will investigate this question in posters 8 and 9

- Key Question: How will CAVs impact the site planning of destinations such as the Renaissance Festival?
- We will investigate this question in posters 10 and 11

Next Stop: Introducing our Project Proposals

Planning and development are heavily influenced by density. The transect shows that as density changes, infrastructure must change to accommodate human settlement. With each transect zone now defined, we shift our focus to the proposals of CAV transportation hub. Each CAV hub focuses on a different point or zone in the transportation network to address the key questions for each location.

Transect Analysis

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Ian Corder, Kathryn Leys, Eric Molinari, Ben Schneider and Ari Del Rosario

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CAV Hub Design Proposals

3 T2 SCOTT

Transportation Renaissance

CAVs provide an opportunity to connect more people to different areas within the Metro region. A central concept in this system is the **CAV transportation hub (CAV Hub)**. CAV hubs act as anchors for local transportation networks and connect those networks to each other as well as the region. The CAV hub is defined by the following typologies: **urban, rural, networked, and maintenance based**. We apply the concept of CAV hubs to propose designs that connect Minneapolis to Scott County and more specifically, the Renaissance Festival site.

The Suburban CAV Hub: Transforming Parking Structures



Our first hub design proposal focuses on the **Heart of the City Park and Ride in Burnsville, Minnesota.** Located just outside Scott County's borders, this structure serves as a connector between traditional cars and local buses. **In posters 4 and 5, we will:**

- Investigate how CAVs could transform this structure to improve regional connectivity
- Propose retrofitting parking structures for CAV use and the creation of office space

The Rural CAV Hub: Reclaiming the Surface Park & Ride



The next CAV hub is **a park and ride lot in Jordan**. Jordan, Minnesota is a small rural town with limited to no conventional public transportation, making it virtually impossible to travel long distances without a personal vehicle. **In posters 6 and 7, we will:**

- Discuss the need to connect this rural area to the region
- Explore how underutilized surface lot park and rides can be reclaimed for CAVs oriented uses
- Present a new scenarios to function as a connector for local vehicles and the regional CAV network

The Networked CAV Hub: Adapting Rural Intersections to 5G Connectivity



Our third CAV hub is **a 5G connectivity hub**. In rural areas of Scott County the county infrastructure accommodates low population numbers. Rural parts of Scott County are connectivity "dead zones," with no connectivity to 4G and 5G networks. **In posters 8 and 9, we will:**

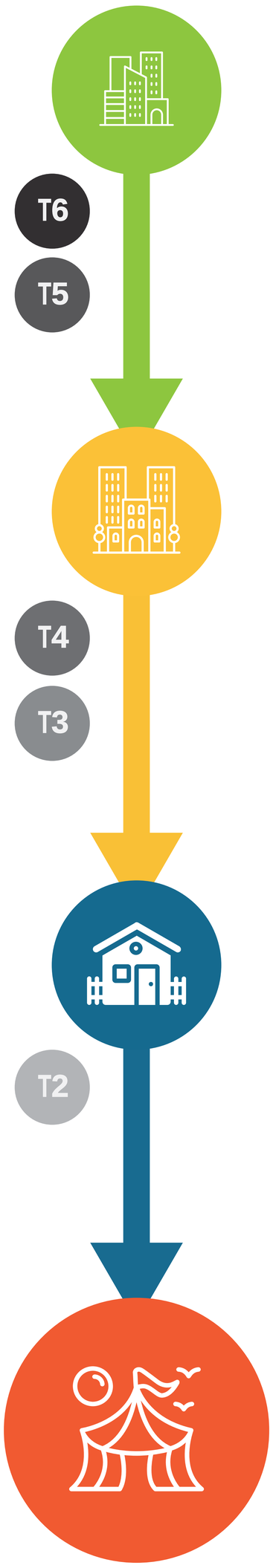
- Consider the challenge of "dead zones" that will likely result in obstacles with implementing new technology in rural areas
- Highlight infrastructure changes needed for CAVs to work
- Propose a design scenario for the intersection of **Highway 169 and Delaware Avenue with CAV infrastructure**

The Maintenance Hub: Converting Private Parking Lots



Finally, we consider how the **new Renaissance Festival site** will be the final point in the CAV transportation network. Among the site planning opportunities will be a drop-off/pick-up station for CAVs as well as creating a maintenance hub. **In posters 10 and 11, we will:**

- Illustrate how the CAVs will reduce the need for parking at the Renaissance Festival site
- Recommend converting unused parking space into a CAV maintenance hub



Next Stop: Suburban CAV Hub Analysis

In the next posters we focus on each CAV hub in our network. For each hub we provide an analytical poster and a design proposal poster.

CAV Design Proposals

PA 5211: Land Use Planning / Instructor: Fernando Burga PhD / TA: Chris DesRoches

Ian Corder, Kathryn Leys, Eric Molinari, Ben Schneider and Ari Del Rosario

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Suburban CAV Hub Analysis

Transportation Renaissance

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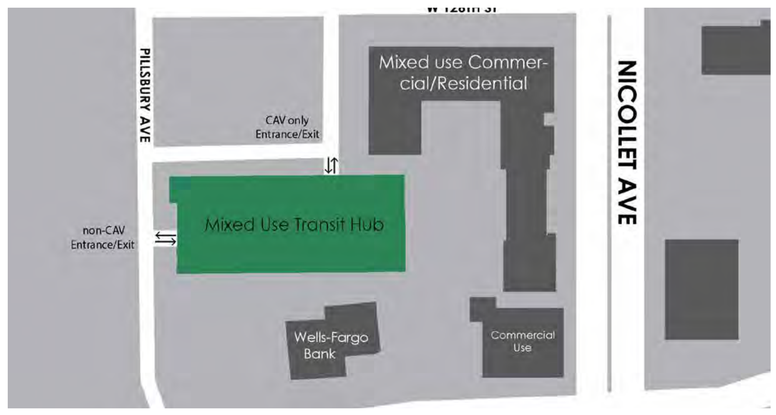
In this poster we examine how **retrofitting parking structures**, such as the Heart of the City Park and Ride in Burnsville, MN can prepare suburban zones for CAVs and provide a **connectivity node** to urban cores.

Existing Site



The Heart of the City Park & Ride is located in downtown Burnsville. The 90,000 sq ft structure is a 3 story parking garage with 370 spaces.

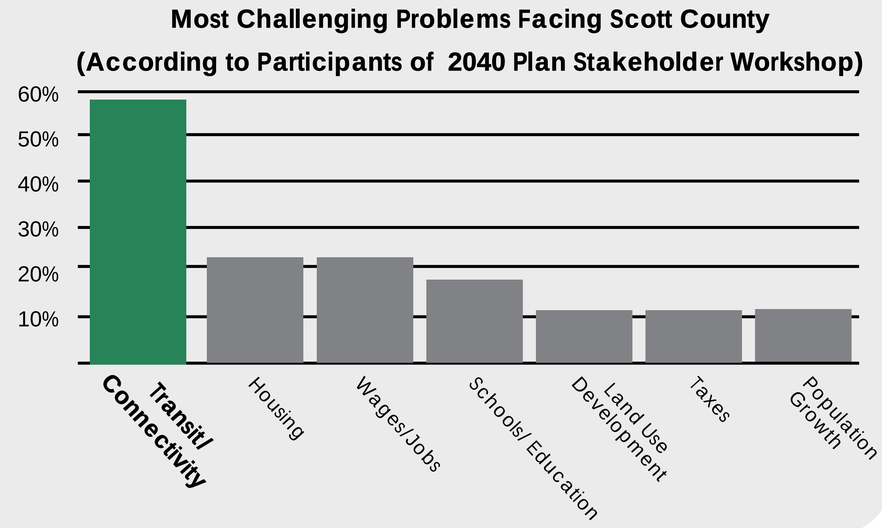
Proposed Site Plan



Our proposed site plan converts the park & ride garage into a mixed use CAV hub. The garage will be retrofitted to include a CAV pick-up zone, traditional parking, storefronts and office space.

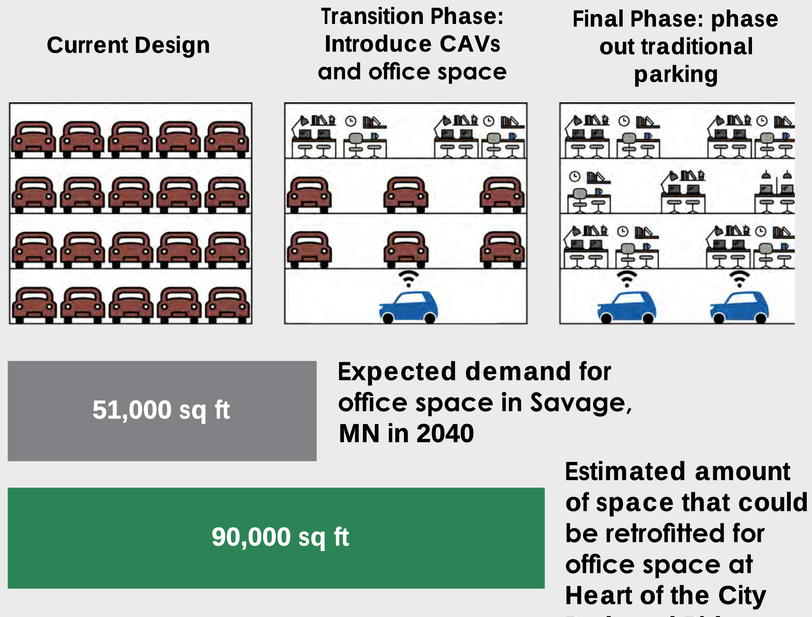
The Challenge: Retro-fitting Parking Standards

- In a survey conducted for the 2040 Comprehensible Plan, Scott County residents identified transit connectivity as the biggest challenge.[1]
- With the implementation of CAVs, parking structures will shift away from parking and adopt alternative functions.
- The Heart of the City Park & Ride, currently used solely for parking. Once CAVs are on the road, parking will become less important and this structure will become obsolete.



Retrofitting the Future

- Architectural firms are beginning to design for parking structure retrofits. Garages that can be converted into housing can be seen in Denver, Cincinnati and Atlanta, with many more in the schematic design stage.
- Scott County has a growing and changing population with a need for an increase in the amount of required workspace. It is estimated that the demand for office spaces will increase by over 700,000 sq ft by 2040.[2]
- Retrofitting unused parking garages will be a way to reuse existing infrastructure to address the new demand for office space in Scott County.



T6
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Next Stop: Design Proposal for the Urban CAV Hub

Retrofitting parking garages and using them for office space will increase connectivity to suburban areas like Burnsville and Shakopee, and to urban centers like Minneapolis. In the next poster we will discuss details of the retrofit.

Suburban Hub Analysis

PA 5211: Land Use Planning / Instructor: Fernando Burga PhD / TA: Chris DesRoches

Ian Corder, Kathryn Leys, Eric Molinari, Ben Schneider and Ari Del Rosario

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1 Scott County 2040 Comprehensive Plan

2 From "A Commercial/Industrial Demand Analysis for Scott County, Minnesota"

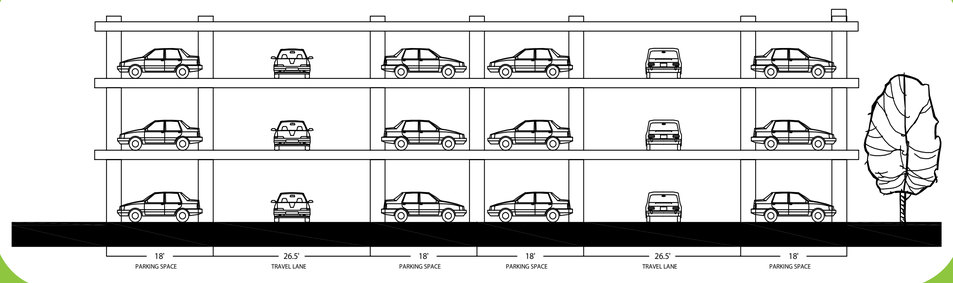
Suburban CAV Hub Scenario

5 T2 SCOTT

Transportation Renaissance

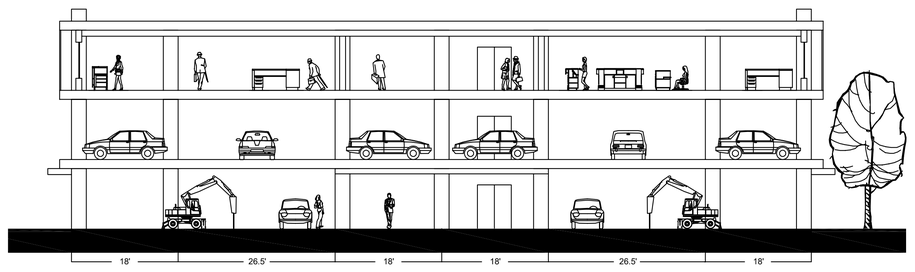
The design of **retrofitted parking structures** will differ depending on the specific cases. Our emblematic sections be;pw serve as a starting point for future discussion. As parking demand decreases, upper levels of parking garages can be **retrofitted for office space** or any other use the designer sees fit. The lowest level will almost always be used to store cars, CAVs, and also acts as a CAV/ride share pick-up and drop-off station.

Existing Section



The current parking structure is three stories tall with 370 stalls. As demand for parking rides shrink, spaces in the parking ramp will become underutilized.

Proposed Section



Our design proposes closing off the top of the ramp to create office space. As demand for parking shrinks, additional levels will be retrofitted for other commercial or residential uses.

The following pictures are examples of retrofitted parking garages in Atlanta, Denver and Cincinnati.



Denver, CO

This apartment building in Denver has first floor parking that can be retrofitted into living space



Cincinnati, OH

This building in Cincinnati has 3 stories of parking space that is in the process of being retrofitted into office space.

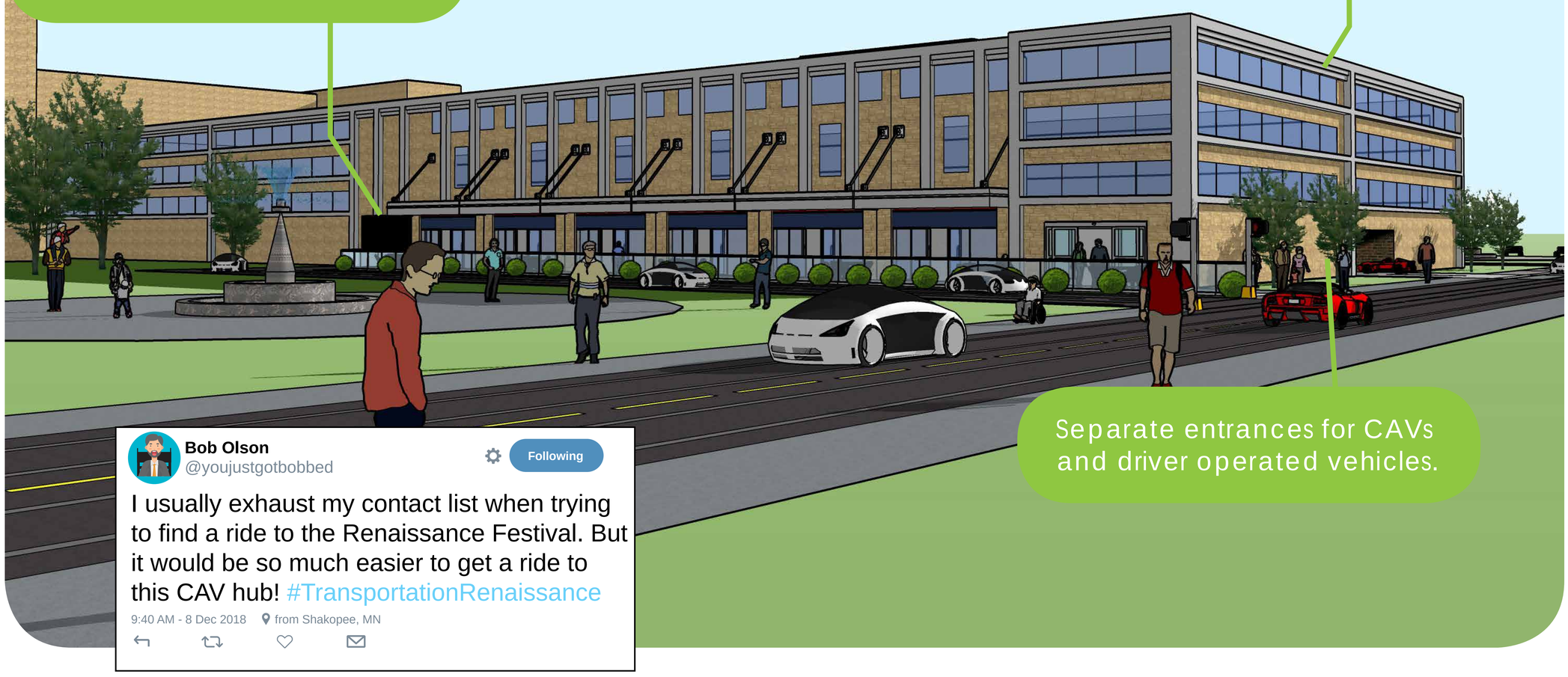


Atlanta, GA

The parking structure at this college in Atlanta has been retrofitted to create micro-living spaces for students.

The examples above are parking ramps that have been retrofitted into residential and commercial space. Our design proposes closing off the top of the ramp to create office space.

The outside area of the lower level can be used for store fronts, restaurants or other commercial uses.



Separate entrances for CAVs and driver operated vehicles.

Bob Olson
@youjustgotbobbed

Following

I usually exhaust my contact list when trying to find a ride to the Renaissance Festival. But it would be so much easier to get a ride to this CAV hub! #TransportationRenaissance

9:40 AM - 8 Dec 2018 from Shakopee, MN

T6 T5 T4 T3 T2

Next Stop: Rural CAV Hubs

While suburban areas such as Burnsville retrofit existing parking structures to transition to CAVs, rural areas such as Jordan, Minnesota can greatly improve their connectivity by reclaiming surface lot park and rides. In the next poster we discuss how the transportation network can include a surface lot park and ride in municipalities like Jordan, Minnesota.

Suburban Hub Scenario

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Ian Corder, Kathryn Leys, Eric Molinari, Ben Schneider and Ari Del Rosario

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Rural CAV Hub Analysis

Transportation Renaissance

6 T2 SCOTT

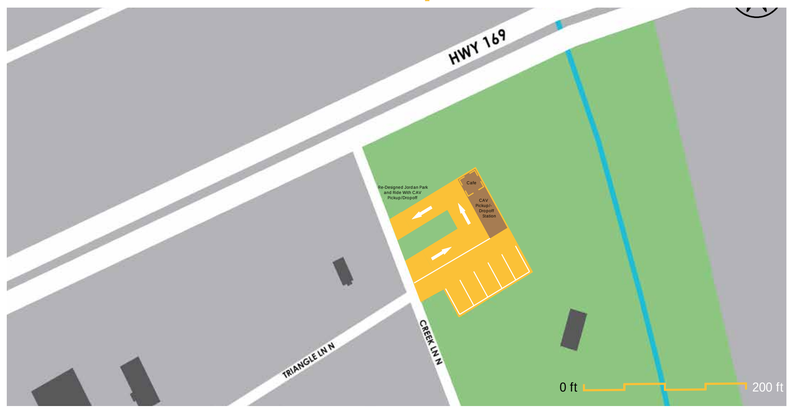
Getting around rural areas is **nearly impossible without a privately-owned vehicle**. How can CAVs transform this? By reclaiming surface lot park and rides as a rural CAV hub, a **rural public transportation station** can service residents by concentrating CAVs at their location. These stations would be equipped with **ride calling stations** for residents who may not have access to a smart phone or lack fast internet connectivity.

Existing Site



The park and ride in Jordan, MN is a small surface lot located right off of U.S. Highway 169. There are no regular bus routes that service this lot.

Proposed Site Plan



The proposed site plan will transform the current surface lot into a CAV pick-up and drop-off zone with a CAV call station, limited traditional parking and a small cafe.

The Challenge: Future Rural Growth

- While much of Scott County is rural, it has the fastest growing population among counties in Minnesota. Although the majority of this growth will be in more dense areas like Shakopee, Scott County's rural areas will also experience growth. In fact, many areas that are now considered rural are zoned as an "Urban Expansion Zone" in the 2040 comprehensive zone.[1]
- Park and rides, like the one in Jordan, already have the location and the infrastructure to support transportation connectivity between rural growing populations and the rest of the region.
- With CAVs, surface lot park and rides will no longer be needed for parking. Their use as a CAV hub offers an opportunity where local CAV fleets connect to the regional CAV networks.

Forecasted Population Growth in Scott County's 4 Smallest Cities

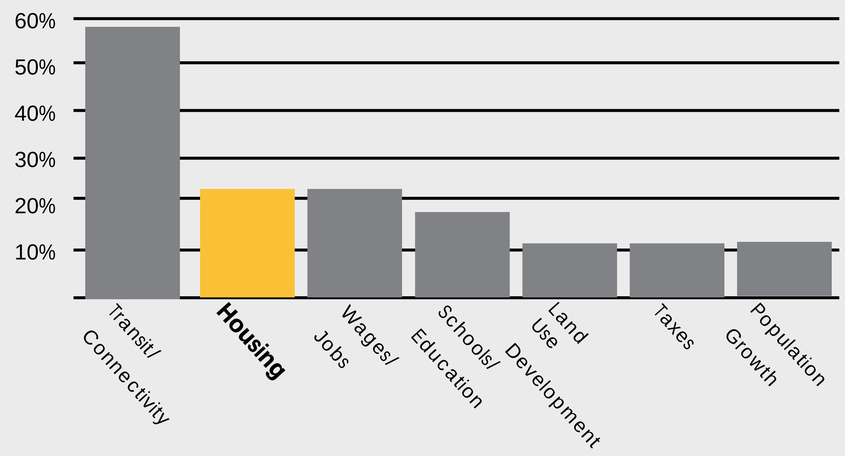
	2010 Census Population		Estimated 2040 Population
Belle Plaine	6,661	→	12,600
Elko New Market	4,110	→	11,900
Jordan	5,470	→	9,900
New Prague	4,280	→	7,200
Total	20,521	→	**41,600***

***About 100% increase**

Future Need for Rural CAV Hubs

- According to the 2040 comprehensive plan, one of the greatest challenges for Scott County community members is housing, second only to transportation.[2] These surface lots offer a solution to this challenge by providing for housing, including affordable housing.
- Transportation hubs that de-emphasize the need on CAV dependency and potentially liberate parking requirements to zoning designations. By liberating parking requirements building can add ??? to proposed developments.

Most Challenging Problems Facing Scott County
(According to Participants of 2040 Comprehensive Plan)



T6
T5
T4
T3
T2

Next Stop: Design Scenario for Rural CAV Hubs

The surface lot park and ride described above strive to connect rural areas to the regional transportation system. These lots will not be able to function if the infrastructure around them is not prepared for CAVs. In the next poster we will consider the updates for the road infrastructure in preparation for CAVs.

Rural Hub Analysis

PA 5211: Land Use Planning / Instructor: Fernando Burga PhD / TA: Chris DesRoches

Ian Corder, Kathryn Leys, Eric Molinari, Ben Schneider and Ari Del Rosario

Resilient Communities Project, University of Minnesota | Scott

1 Scott County 2040 Comprehensive Plan

2 Scott County 2040 Comprehensive Plan

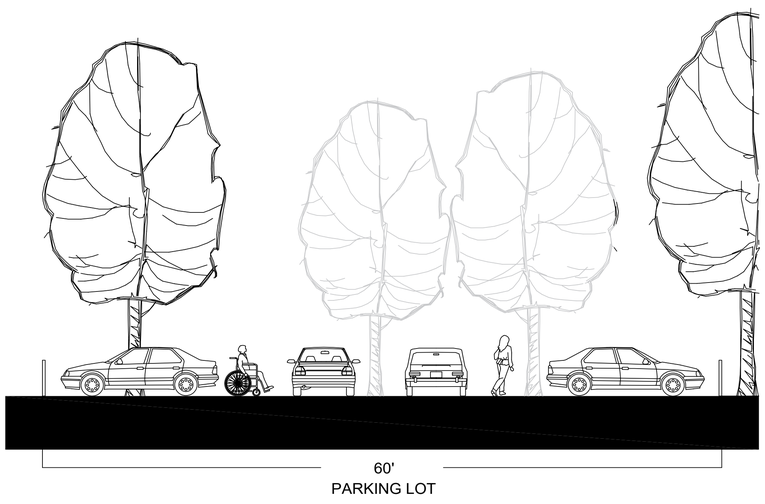
Rural CAV Hub Scenario

7 T2 SCOTT

Transportation Renaissance

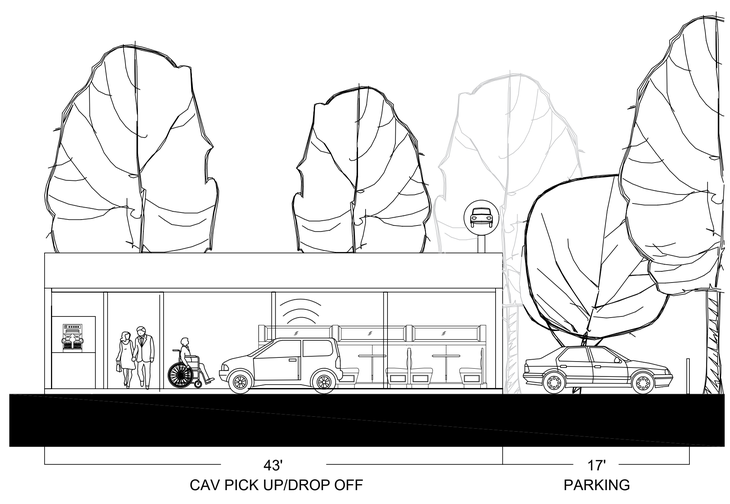
Our previous design scenario for the suburban CAV hub would be convenient for residents living in Scott County's northern suburban areas, but what about those living in the rural areas? When the regional CAV network expands to rural Minnesota, there will need to be **infrastructure to connect rural residents with regional transportation networks**. In this poster, we envision a rural CAV hub located at a surface lot park and ride in Jordan.

Existing Section

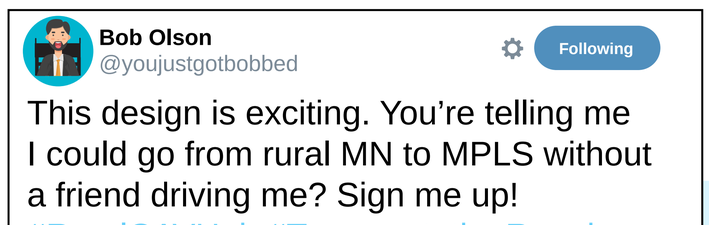


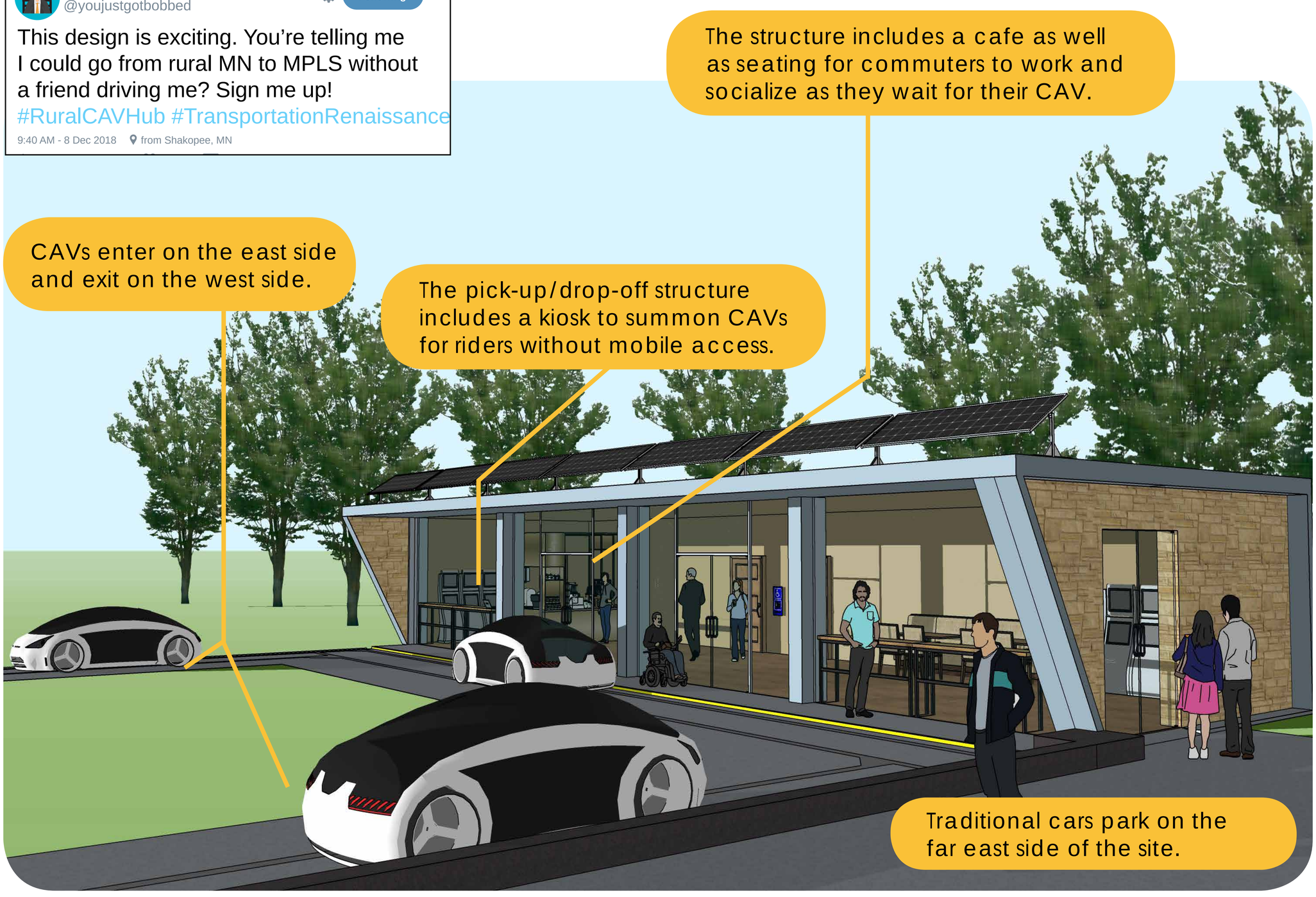
The current site only includes parking spaces that are underutilized. We propose developing a pick-up/ drop-off structure on the north end of the lot.

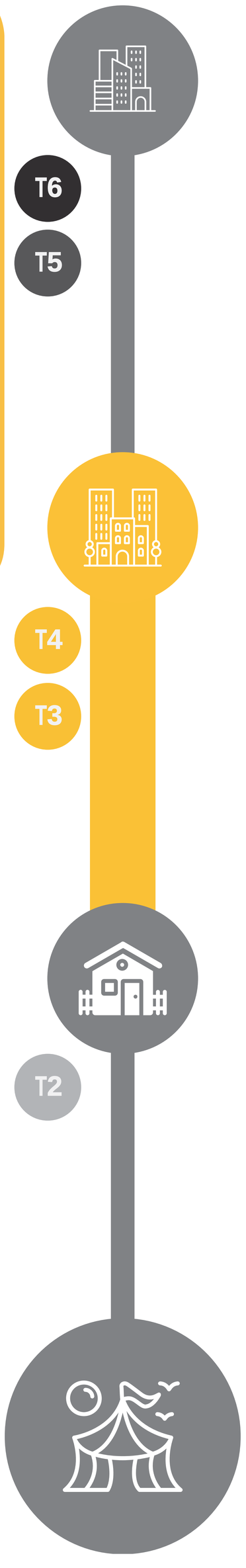
Proposed Section



The structure's width will be able to accommodate up to three CAVs at once but will also be small enough for traditional cars to park on the east side of the lot.







Next Stop: Local Roads

Rural CAV hubs will be an important step in increasing CAV accessibility in the rural parts of Scott County. The local infrastructure will need to be ready for the rural CAV hubs. In the next posters, we shift our focus to local roads and highlight the new infrastructure needed to accommodate CAVs.

Rural Hub Scenario

PA 5211: Land Use Planning / Instructor: Fernando Burga PhD / TA: Chris DesRoches

Ian Corder, Kathryn Leys, Eric Molinari, Ben Schneider and Ari Del Rosario

Resilient Communities Project
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Scott

Networked CAV Hub Analysis

Transportation Renaissance

8 T2 SCOTT

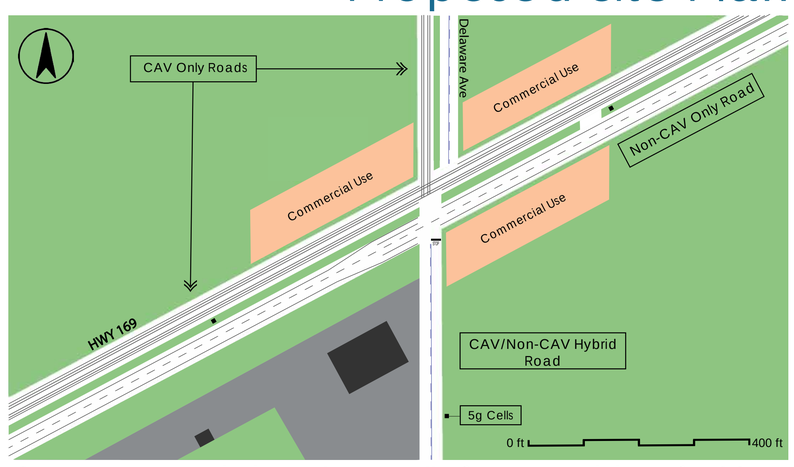
Rural areas will need to **upgrade their road infrastructure in significant ways to accommodate CAVs.** In this poster we explore the **intersection of Highway 169 and Delaware Avenue in Saint Lawrence Township, Minnesota** to consider the introduction of **5G cells** required for CAVs to operate. We also highlight the changes needed to ensure that CAVs will not **deteriorate existing concrete.**

Existing Site



U.S. Highway 169 is a four lane major arterial road. Delaware Avenue is a two lane local road. This intersection is surrounded by farm land, a restaurant, and open lots.

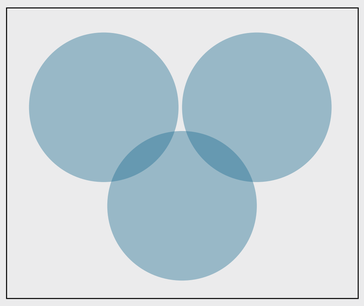
Proposed Site Plan



Our proposed site plan calls for one side of 169 to be dedicated to CAVs. We also expand the east side of Delaware Ave to give CAVs their own road towards the Renaissance Festival. The surrounding land is rezoned for commercial use.

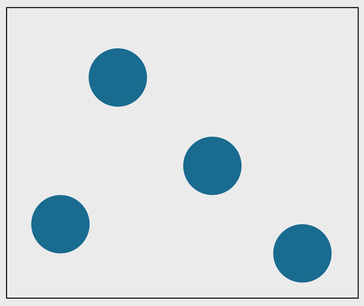
The Challenge: "Dead Zones"

- Connected autonomous vehicles will rely on **5G coverage** to operate. In isolation, these small cells behave like WiFi hotspots than large 4G cell towers. Any given area will need to install several small cells for 5G to work effectively.
- This issue poses a problem for areas like Jordan, which have smaller populations. It will take more devices to provide coverage for the same number of people.
- This technology moves to rural areas only certain areas will be connected to the network, thus **creating "dead zones."** This challenge presents a rationale for CAV park and rides in this region.



4G Coverage

This graphic depicts how current **4G coverage** operates. Large towers are installed, each with a radius of several miles. Even in some rural areas, this coverage is enough to provide connectivity.

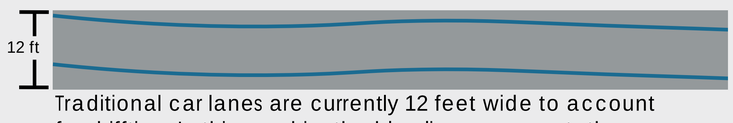


5G Coverage

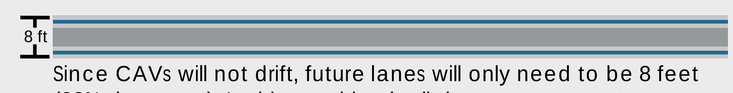
This graphic depicts **5G coverage**. While the coverage is significantly stronger, the technology uses small cells instead of towers. The radius of each device will be significantly less compared to 4G towers. Each small cell will only cover around 300-400 feet, providing much less connectivity in rural areas.[1]

Roads for CAVs

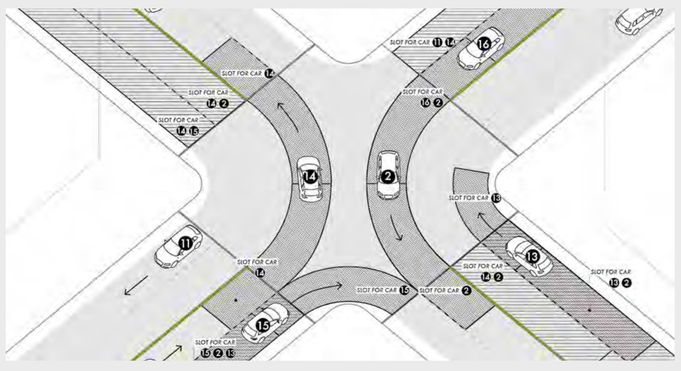
- As a result of human error, cars drift slightly. CAVs are so precise in navigation that drift is reduced to less than a half of a centimeter. This will result in ruts. To prevent this, roads will need to be constructed with reinforced concrete. Reinforced concrete, which will be able to withstand the constant use created by CAVs.
- Intersections represent another aspect of infrastructure that will change with the implementation of CAVs. Currently, most intersections have infrastructure and signage to aid and direct drivers, however, in the case of CAVs, simple is better.
- A recent study by MIT found that CAVs will use a slot-based system to pass through intersections, allowing them to travel at maximum speed without any accidents. As shown in the graphic on the right, for the slot-based system to be efficient, the intersection should be simple, with the least amount of built in infrastructure.[2]



Traditional car lanes are currently 12 feet wide to account for driffting. In this graphic, the blue lines represents the path of a traditional car.



Since CAVs will not drift, future lanes will only need to be 8 feet (33% decrease). In this graphic, the light grey represents reinforced concrete and the blue lines show the path of a CAV.



Next Stop: Designing Local Roads

5G cells will need to be added to the intersection of Highway 169 and Delaware Avenue and reinforced concrete will need to be installed to accommodate CAV travel in rural regions. With these changes we also foresee commercial use demand to rise along with the expected population growth. But what exactly will all of these ideas look like in practice? Our next poster will answer this question.



Network as Hub Analysis

PA 5211: Land Use Planning / Instructor: Fernando Burga PhD / TA: Chris DesRoches

Ian Corder, Kathryn Leys, Eric Molinari, Ben Schneider and Ari Del Rosario

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1 https://thehill.com/policy/technology/408416-rural-america-worries-it-will-miss-out-on-5g

2 http://senseable.mit.edu/light-traffic/

T6 T5 T4 T3 T2

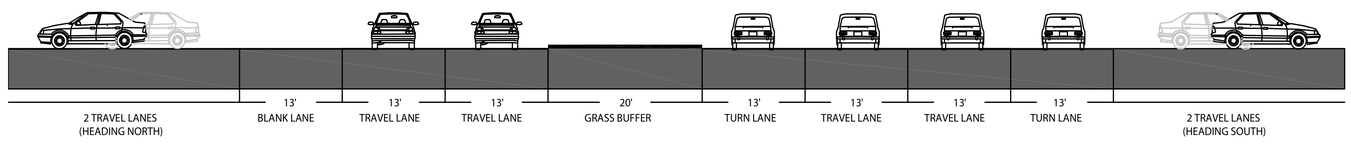
Networked CAV Hub Scenario

9 T2 SCOTT

Transportation Renaissance

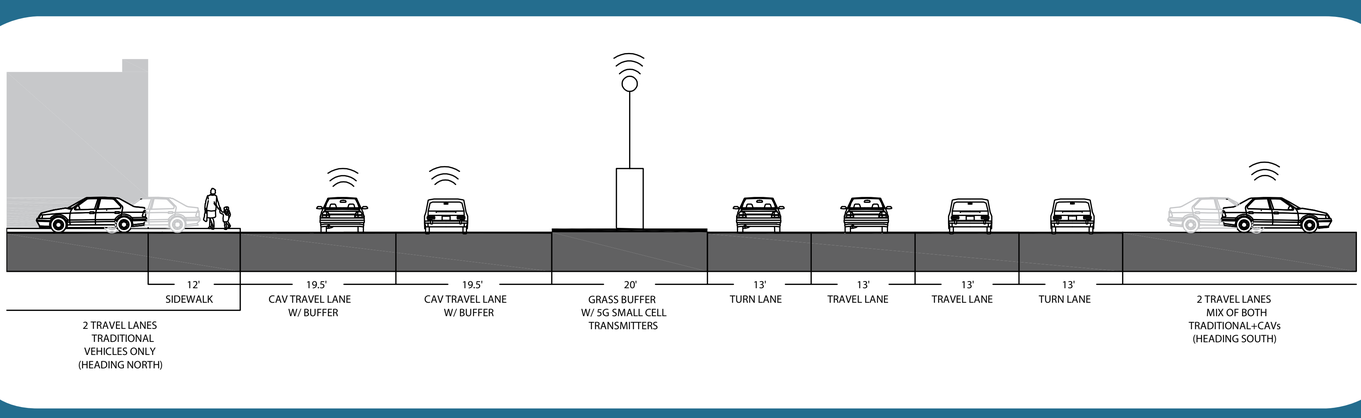
Once the **proper technology and road infrastructure is installed,** rural Minnesota will be able to join the future regional CAV network. In this design scenario, we consider the intersection of U.S. Highway 169 and Delaware Avenue as an **example of what this transition could look like**. This intersection is located just outside Jordan and is near the new Renaissance Festival site.

Before



U.S. Highway 169 currently has two lanes going both ways at this intersection. In our proposal, we use one side of the highway and convert it to a CAV-only road.

After



Along this side of the highway we also add a sidewalk to increase walkability, This is possible given the increased safety of CAVs. Sensor poles are added for the installation of 5G small cells.

T6

T5

T4

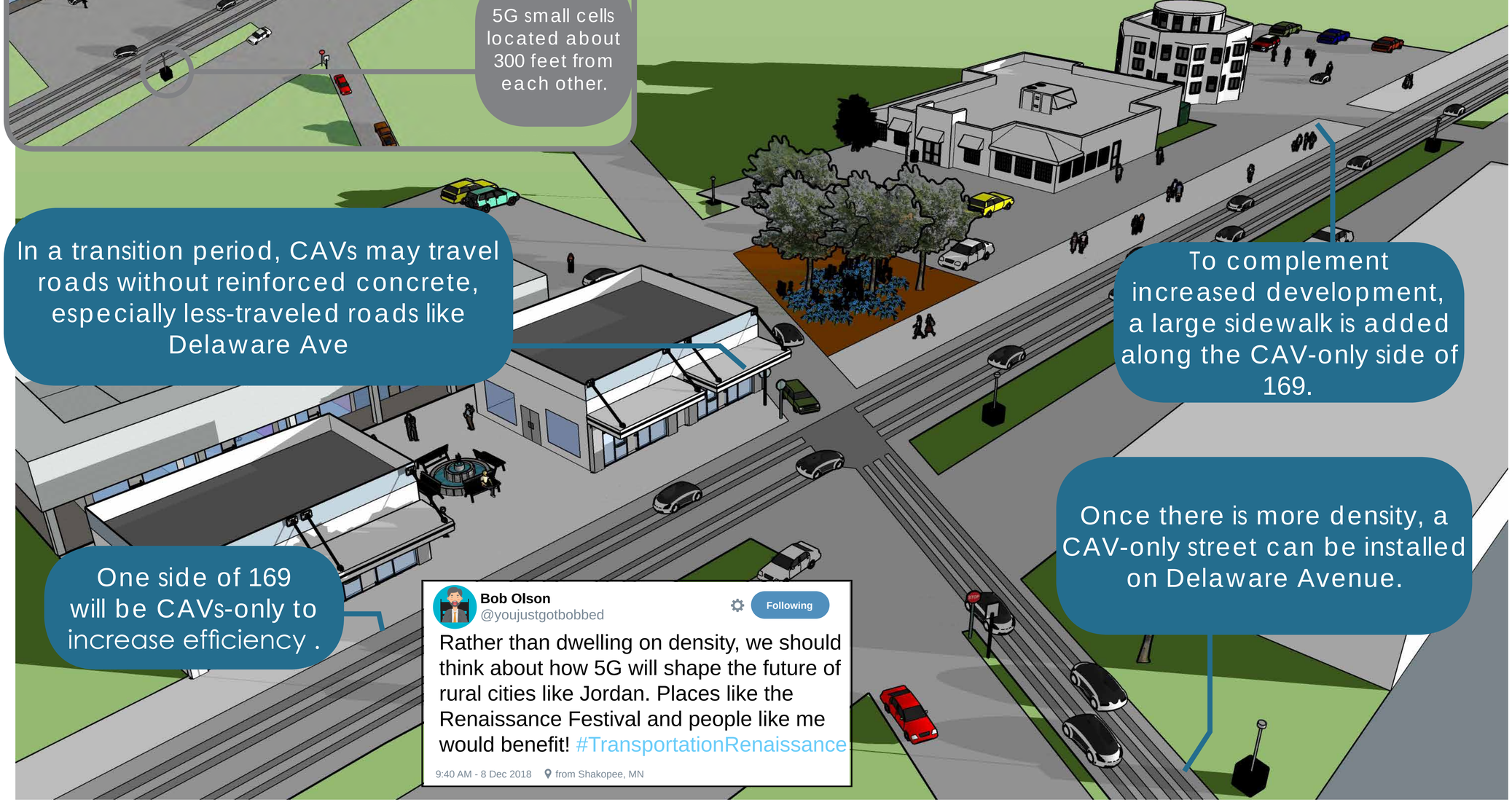
T3

T2

Left image: The initial transition: Two 5G small cells are installed allowing CAVs to access Highway 169. New commercial development begins, but Delaware Avenue does not contain CAV infrastructure.

Bottom image: Intermediate transition. More 5G small cells increase CAV traffic and spur development. CAVs now can travel on smaller roads like Delaware Avenue.





Next Stop: Maintenance Hub

This design scenario could be applied throughout all rural contexts where connectivity is needed. There is no reason rural America should be left out of the CAV revolution. We now turn our attention to the last CAV hub that will complete the regional transportation network for CAVs. The final two posters will present the CAV maintenance hub.

Network as Hub Scenario

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Ian Corder, Kathryn Leys, Eric Molinari, Ben Schneider and Ari Del Rosario

Resilient Communities Project, University of Minnesota

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Maintenance Hub Analysis

Transportation Renaissance

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T2 SCOTT

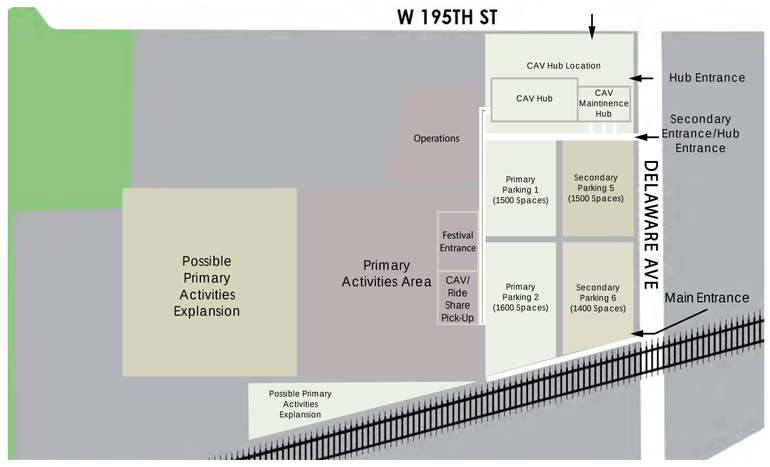
With the introduction of a regional transportation network defined by CAVs hubs, there will be a need to designate storage and maintenance space for CAV fleets. Our last CAV hub proposal focuses on the maintenance hub. We discuss why we consider the Renaissance Festival site as a desired location, why it benefits the festival, and the purpose it will serve.

Existing Site



The current proposed site plan includes approximately 15,000 parking spots, a main activities area and a vineyard.

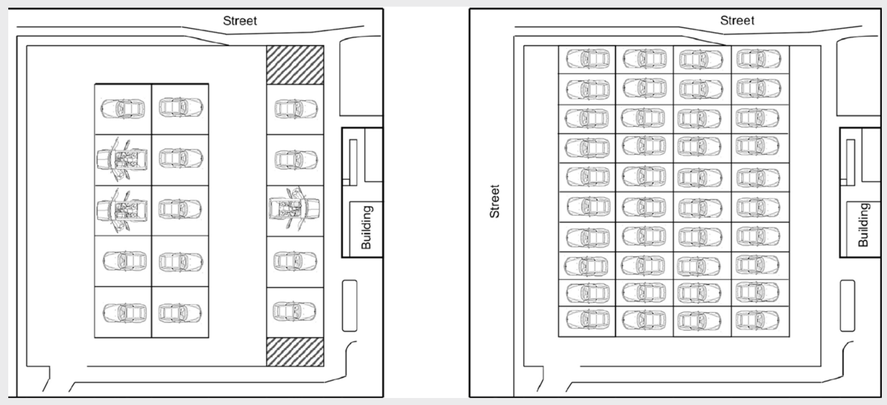
Proposed Site Plan



Our proposed site plan for the festival reduces the amount of parking space. The land that will no longer be needed for parking will be used for CAV maintenance hub.

The Challenge: Parking at the Festival

- In response to one of the biggest issues at its current site, the new Renaissance Festival site contains a large amount of space for parking. **90% of the entire site is planned for parking.**
- With the implementation of CAVs, many more people are expected to be dropped off, as an alternative to parking.
- A recent study analyzing CAV parking determined that CAVs will **reduce the size of parking spaces by 62% on average**. As a result, even if the number of parking spaces at the festival were to remain at 15,000 ft, the amount of physical space used by these parking spaces would be reduced significantly. [1]



Source: Nourinejad, Mehdi, Sina Bahrami, and Matthew J. Roorda, "Designing parking facilities for autonomous vehicles," 2018

New Uses for Old Parking

- CAVs will lead to less individual vehicle ownership and therefore decreased parking. There will be a need to store CAVs while not in use and keep up on maintenance. The space that is currently planned for parking at the new Renaissance Festival site could be used as a storage and maintenance hub for a fleet of rural CAVs.
- Rural/Suburban areas are ideal for maintenance hubs. They are close enough to larger population centers, but far enough so that they do not take up space on high valued land used for offices and housing.



Next Stop: Maintenance Hub Design Scenarios

We propose to use the excess parking space that will not be needed after the transition to CAVs as a maintenance hub for CAVs. This hub will store CAVs that are either not in use or need fixing, upgrade any CAVs that may need it and also serve as a pick-up/drop-off spot for CAVs and ride-share services.

T6 T5 T4 T3 T2

Maintenance Hub Analysis

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1 Nourinejad, Mehdi, Sina Bahrami, and Matthew J. Roorda, "Designing parking facilities for autonomous vehicles," 2018

Maintenance Hub Scenario

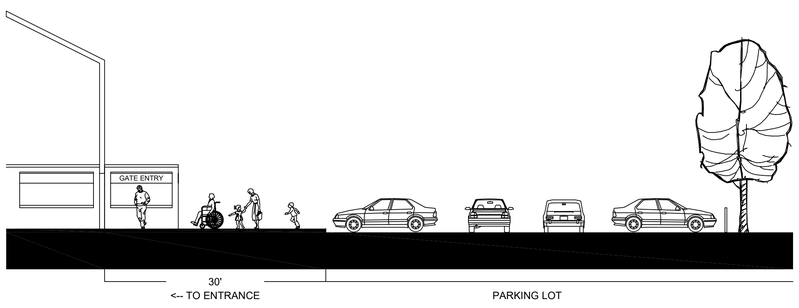
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Transportation Renaissance

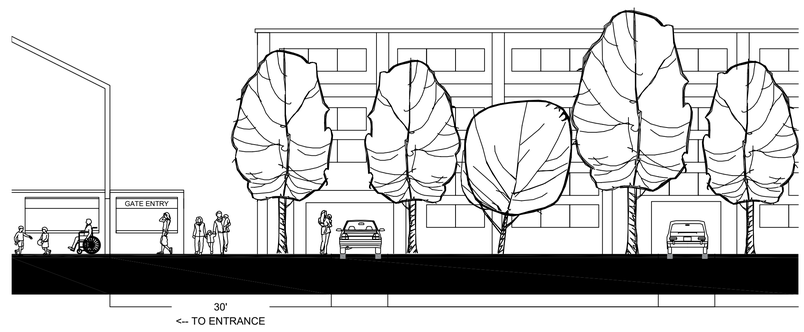
If extra parking space becomes available at the Renaissance Festival, we propose a **CAV maintenance hub**. The design scenarios we lay out in this poster could be replicated in other rural areas where excessive **parking will become obsolete**.

Existing Section



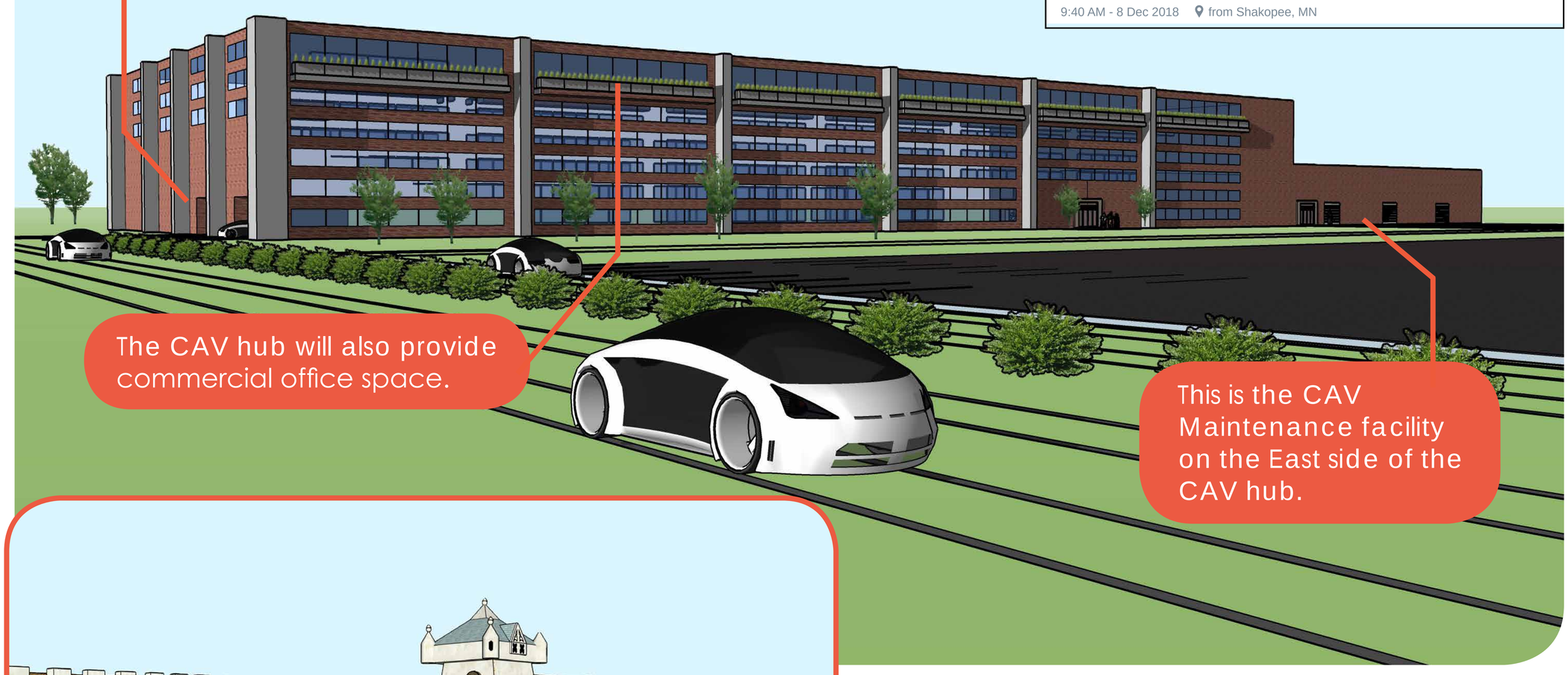
The current plan for the Renaissance Festival includes traditional parking surrounding the event location. In most cases, there will be a long distance between a parked car and the festival entrance.

Proposed Section



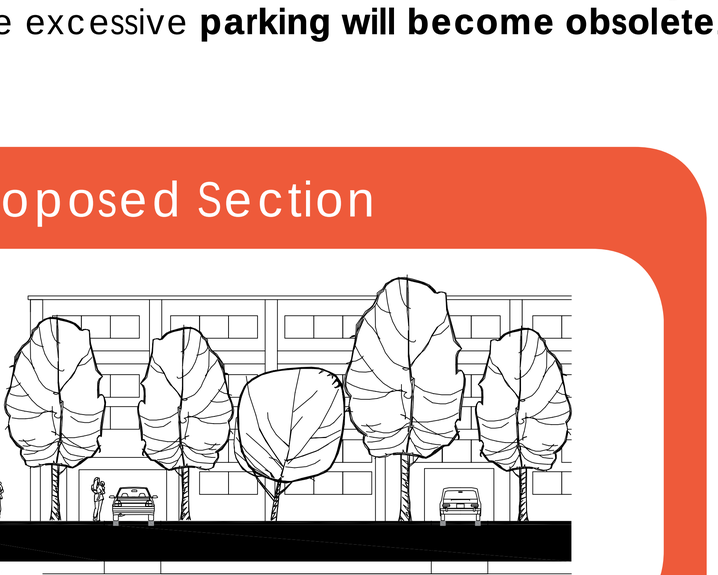
The proposed site plan for the maintenance hub focuses on a CAV pick-up/drop-off location that connects to a CAV transit hub. This design will make the entrance more accessible.

CAVs enter and exit the hub on the West end of the hub. Inside the hub, CAVs charge and receive updates in individual docks.



The CAV hub will also provide commercial office space.

This is the CAV Maintenance facility on the East side of the CAV hub.





The CAV hub connects directly to the entrance of the Renaissance Festival and a pick-up/drop-off location.

T6 T5 T4 T3 T2

Conclusion

In the last 11 posters, we have addressed how locations from urban to rural could prepare themselves for a CAV future by using the transportation hub as a model. Each transect zone faces its own set of challenges and offers a unique CAV hub vision tailored at contextualizing the problem. Much remains unknown about the changes that will come with CAVs, however we believe the research and design suggestions described above will inspire the first step towards a connected autonomous vehicle future.

Maintenance Hub Scenario

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