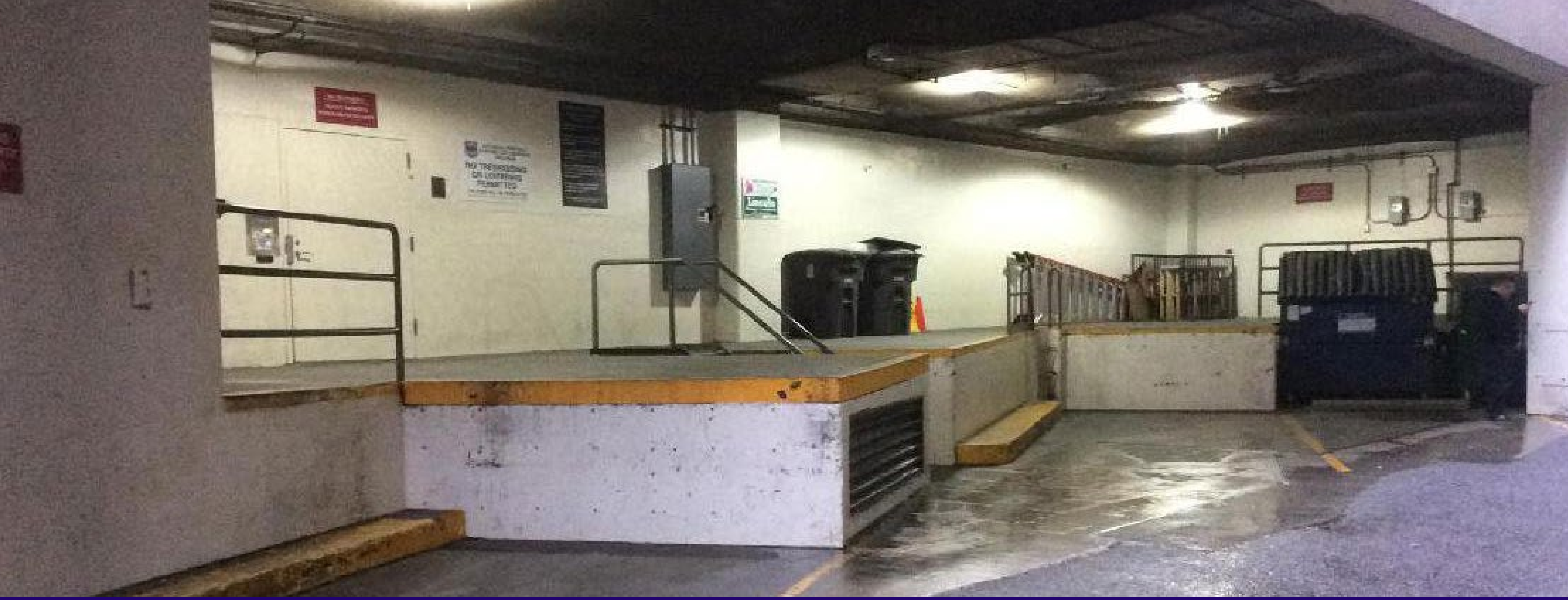

The Final 50 Feet of the Urban Goods Delivery System:

Completing Seattle's Greater Downtown Inventory of Private Loading/Unloading Infrastructure (Phase 2)

Urban Freight Lab
Supply Chain Transportation and Logistics Center
University of Washington
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SUPPLY CHAIN TRANSPORTATION & LOGISTICS CENTER
UNIVERSITY of WASHINGTON
Urban Freight Lab

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EXECUTIVE SUMMARY

This report describes the Urban Freight Lab (UFL) work to map the locations of all private loading docks, loading bays and loading areas for commercial vehicles in Seattle's First Hill and Capitol Hill neighborhoods and document their key design and capacity features. Taken together with the UFL's earlier private infrastructure inventory in Downtown Seattle, Uptown and South Lake Union *(1)*, this report finalizes the creation of a comprehensive Greater Downtown inventory of private loading/unloading infrastructure. The Seattle Department of Transportation (SDOT) commissioned this work as part of its broader effort with UFL to GIS map the entire Greater Downtown commercial load/unload network *(2,3)*, which includes alleys, curbs and private infrastructure.

The research team could find no published information on any major U.S. or European city that maintains a database with the location and features of private loading/unloading infrastructure (meaning, out of the public right of way): Seattle is the first city to do so.

By supporting and investing in this work, SDOT demonstrates that it is taking a high-level conceptual view of the entire load/unload network. The city will now have a solid baseline of information to move forward on myriad policy decisions. This commitment to creating a private load/unload infrastructure inventory is significant because infrastructure is often identified as an essential element in making urban freight delivery more efficient. But because these facilities are privately owned and managed, policymakers and stakeholders lack information about them—information critical to urban planning. By and large, this private infrastructure has been a missing piece of the urban freight management puzzle. The work represented in this section fills a critical knowledge gap that can help advance efforts to make urban freight delivery more efficient in increasingly dense, constrained cities, like Seattle.

Without having accurate, up-to-date information on the full load/unload network infrastructure—including the private infrastructure addressed here—cities face challenges in devising effective strategies to minimize issues that hamper urban freight delivery efficiency, such as illegal parking and congestion. Research has shown that these issues are directly related to infrastructure (specifically, a lack thereof). *(4)* A consultant report for the New York Department of Transportation found that the limited data on private parking facilities for freight precluded development of solutions that reduce double parking, congestion and other pertinent last-mile freight challenges. *(5)* The report also found that the city's off-street loading zone policy remained virtually unchanged for 65 years (despite major changes like the advent and boom of e-commerce.)

Local authorities often rely heavily on outside consultants to address urban freight transport issues because these authorities generally lack in-house capacity on urban freight. *(6)* Cities can use the replicable data-collection method developed here to build (and maintain) their own database of private loading/unloading infrastructure, thereby bolstering their in-house knowledge and planning capacity. Appendix C includes a Step-by-Step Toolkit for a Private Load/Unload Space Inventory that cities, researchers, and other parties can freely use.

The method in that toolkit builds—and improves—on the prior data-collection method UFL used to inventory private infrastructure in the dense urban neighborhoods of Downtown Seattle, Uptown and South Lake Union in early 2017 (Phase 1). The innovative, low-cost method ensures standardized, ground-truthed, high-quality data and is practical to carry out as it does not require prior permission and lengthy approval times to complete.

This inventory report's two key findings are:

1. Data collectors in this study identified, examined, and collected key data on **92** private loading docks, bays and areas across 421 city blocks in the neighborhoods of Capitol Hill, First Hill, and a small segment of the International District east of I-5. By contrast, the early 2017 inventory in Downtown Seattle, Uptown, and South Lake Union identified 246 private docks, bays and areas over 523 blocks—proportionally more than twice the density of private infrastructure of Capitol Hill and First Hill. This finding is not surprising. **While all the inventoried neighborhoods are in the broad Greater Downtown, they are fundamentally different neighborhoods with different built environments, land use, and density. Variable demand for private infrastructure—and the resulting supply—stems from those differences.**

2. **A trust relationship with the private sector is essential to reduce uncertainty in this type of work**. UFL members added immense value by ground-truthing this work and playing an active role in improving inventory results. When data collectors in the field found potential freight loading bays with closed doors (preventing them from assessing whether the locations were, in fact, used for freight deliveries), UPS had their local drivers review the closed-door locations as part of their work in the Urban Freight Lab. The UPS review allowed the researchers to rule out 186 of the closed-door locations across this and the earlier 2017 data collection, reducing uncertainty in the total inventory from 33% to less than 1%.

This report is part of a broader suite of UFL research to date that equips Seattle with an evidence-based foundation to actively and effectively manage Greater Downtown load/unload space as a coordinated network. <u>The UFL has mapped the location and features of the legal landing spots for trucks across the Greater Downtown, enabling the city to model myriad urban freight scenarios on a block-by-block level. To the research team's knowledge, no other city in the U.S. or the E.U. has this data trove</u>. The findings in this report, together with all the UFL research conducted and GIS maps and databases produced to date, give Seattle a technical baseline to actively manage the Greater Downtown's load/unload network to improve the goods delivery system and mitigate gridlock.

The UFL will pilot such active management on select Greater Downtown streets in Seattle and Bellevue, Washington, to help goods delivery drivers find a place to park without circling the block in crowded cities for hours, wasting time and fuel and adding to congestion. *(7)* One of the pilot's goals is to add more parking capacity by using private infrastructure more efficiently, such as by inviting building managers in the test area to offer off-peak load/unload space to outside users. The U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy under the Vehicles Technologies Office is funding the project.

The project partners will integrate sensor technologies, develop data platforms to process large data streams, and publish a prototype app to let delivery firms know when a parking space is open – and when it's predicted to be open so they can plan to arrive when another truck is leaving. This is the nation's first systematic research pilot to test proof of concept of a functioning system that offers commercial vehicle drivers and dispatchers real-time occupancy data on load/unload spaces–and test what impact that data has on commercial driver behavior. This pilot can help inform other cities interested in taking steps to actively manage their load/unload network.

Actively managing the load/unload network is more imperative as the city grows denser, the e-commerce boom continues, and drivers of all vehicle types—freight, service, passenger, ride-sharing and taxis—jockey for finite (and increasingly valuable) load/unload space. Already, Seattle ranks as the sixth most-congested city in the country.

The UFL is a living laboratory made up of retailers, truck freight carriers and parcel companies, technology companies supporting transportation and logistics, multifamily residential and retail/commercial building developers and operators, and SDOT. Current members are Boeing HorizonX, Building Owners and Managers Association (BOMA) - Seattle King County, curbFlow, Expeditors International of Washington, Ford Motor Company, General Motors, Kroger, Michelin, Nordstrom, PepsiCo, Terreno, USPack, UPS, and the United States Postal Service (USPS.)

TYPOLOGY AND KEY FEATURES OF PRIVATE LOADING/UNLOADING SPACE INFRASTRUCTURE

This inventory finalizes the collection of the locations and features of private loading/unloading infrastructure in Seattle's Greater Downtown, adding First Hill, Capitol Hill and a slice of the International District (east of I-5) to the early 2017 (Phase 1) reporting on Downtown Seattle, Uptown and South Lake Union. Researchers used the same private infrastructure typology as in that 2017 work to complete the Greater Downtown private load/unload inventory.

This inventory covers three types of private loading/unloading infrastructure:

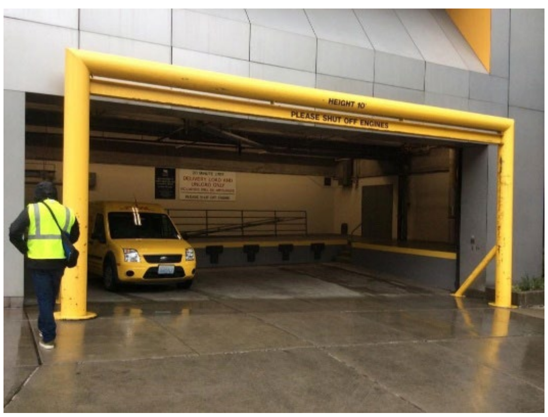
- Loading bays
- Exterior loading docks
- Exterior loading areas

Each type is defined and described below.

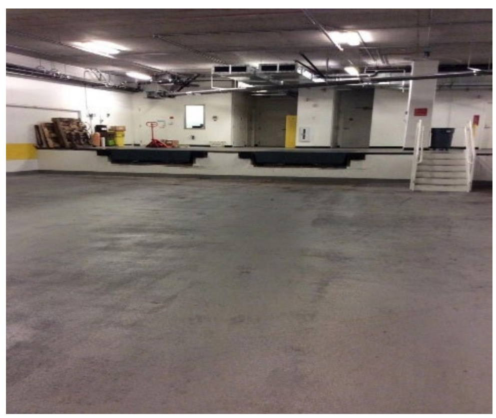
Loading bay

An enclosed space inside the building with an entrance/exit point (e.g. roll-up or garage doors). This space is at least partially dedicated to unloading and loading activities with entrances and exits greater than 8 feet x 8 feet for commercial vehicles. Loading bays often have loading docks; some truck parking spaces may be directly adjacent to the dock, others may not.

Figure 1. Greater Downtown Loading Bay Examples: (a) Loading Bay Door (b) Loading Dock Inside Loading Bay



(a)



(b)

Exterior loading dock

An elevated platform that facilitates shipping and delivery operations, located outside a building's exterior wall, either completely open to the sky or partially or completely covered by a canopy or upper-level building feature. Exterior loading docks can include interior loading platforms, where trucks dock their cargo compartment to a dock door.

Figure 2. Greater Downtown Exterior Loading Dock Examples: (a) Loading Dock with Platform Inside Building (b) Loading Dock with Platform Outside Building

(a)

(b)

Exterior loading area

Parking space for loading/unloading located outside a building's exterior wall, but without a loading dock. As with exterior loading docks, exterior loading areas can be completely open to the sky, or partially or completely covered by a canopy or upper-level building feature.

Figure 3. Greater Downtown Exterior Loading Area Examples: (a) Loading Area Accessed From Street (b) Loading Area in Alley

(a) (b)

To develop a list of features that impact operations of these three types of private infrastructure, the research team reviewed myriad design standards, city reports and research papers. *(4, 8-10)* These infrastructure features can be grouped into location, design and capacity categories. The inventory transmitted to SDOT includes data on all the following features across the three categories, except for those with an asterisk. (See Appendix A for the Private Loading/Unloading Infrastructure Survey Form.)

<u>**Location features** (apart from the geolocation) include:</u>

- The type of road used to access the private infrastructure (e.g. alley, street);
- Traffic flow direction of the road used to access the private infrastructure;
- Whether infrastructure is inside or outside the building, and;
- What clearance is needed to access the private infrastructure.

Poor layout or design of the roads or alley connecting the delivery access point to the street network may significantly affect how private freight infrastructure is used. A common example is narrow alleyways, which delivery drivers tend to avoid if they have an alternative to make sure they are not blocked in. For example, the UFL inventory of Greater Downtown alleys found that more than 90% of Greater Downtown alleys are effectively only one-lane wide *(2)*

Design features include:

- Dimensions of access points, such as vehicle doorway and dock doorway dimensions (width and height), and ground clearance restrictions (e.g. maximum vehicle height allowed.)
- The way vehicles access the loading bay, dock or area, including:
  - The access angle to the loading dock, the angle between the vehicle access and the traffic flow (the entrance angle could be contrary to traffic flow);
  - Access ramp grade;*
  - Whether the vehicle needs to back-in;
  - Presence of additional security access measures, such as physical barriers (like a gate), access code or personal interaction needed to gain entry;
- Maximum turning radius, and;*
- Maximum truck size that can use the infrastructure.*

Capacity features include:

- Number of parking spaces at the infrastructure;
- Apron space for parking and maneuverability, and;
- Presence of a dock platform and dock-levelers (an adjustable mechanized platform built into the loading dock edge that can move vertically or tilt to accommodate delivery).

Features such as turning radius, maximum truck size, and centerline distance were not possible to measure in the field due to the complexity of the geometrical features, the private infrastructure personnel's lack of knowledge or unavailability, or a lack of exterior signage.

KEY FINDINGS

1. **The total Greater Downtown inventory documented the presence of 338 private loading bays, docks and areas. But proportions of this private infrastructure vary by neighborhood, based on different land use density and demand for private infrastructure.**

Over four weeks in July and August 2017, four data collectors walked 421 city blocks to identify, examine, and collect data on **92** private loading bays, docks and areas in the neighborhoods of Capitol Hill, First Hill, and a small segment of the International District east of I-5. (See map in Figure 4.) Taken together with the early (Phase 1) 2017 data collection in Downtown Seattle, Uptown, South Lake Union and a segment of the International District west of I-5, the Greater Downtown has a total of 338 private loading bays, docks and areas over 944 city blocks. (See Table 1 and map in Figure 5.)

The 2017 inventory in Downtown Seattle, Uptown, and South Lake Union identified 246 private loading bays, docks and areas over 523 blocks--proportionally more than twice the density of private infrastructure found in Capitol Hill and First Hill. This is not surprising. While all the inventoried neighborhoods are in the broad Greater Downtown, they are fundamentally different neighborhoods with different built environments, land use, and density. Variable demand for private infrastructure (and the resulting supply) stems from those differences. For example, downtown towers are more likely to demand (and supply) underground loading bays than a two-story building in Capitol Hill. This inventory finding suggests that if, or when, plans to increase density and vertical growth are in effect for Capitol Hill and First Hill, building code requirements for private loading bays may need to be changed.

In this inventory of Capitol Hill and First Hill, the research team found four undefined locations that potentially could be a private loading bay entrance/exit, but not enough information is available to confirm this. There were 17 such undefined locations in the Downtown, Uptown and South Lake Union data collection. No information is available because: a) a barrier impeded data collection, b) there was a lack of on-site signage identifying the facility as a private freight access point, and/or c) there was a lack of carrier drivers' survey responses identifying the facility as a private freight access point.

Table 1. Total Private Loading/Unloading Infrastructure Inventory in Greater Downtown From Data-Collection Phases 1 and 2

INFRASTRUCTURE TYPE	SUMMER 2017 COLLECTION (PHASE 2): FIRST HILL, CAPITOL HILL AND INTERNATIONAL DISTRICT (EAST OF I-5) AREA=421 CITY BLOCKS	EARLY 2017 COLLECTION (PHASE 1): DOWNTOWN, UPTOWN, SOUTH LAKE UNION AND INTERNATIONAL DISTRICT (WEST OF I-5) AREA=523 CITY BLOCKS	TOTAL GREATER DOWNTOWN AREA=944 CITY BLOCKS
Exterior Loading Areas	17	9	26
Exterior Loading Docks	44	93	137
Loading Bays	31	145	176
Total	92	246	338
Undefined	4	17	21

Figure 4. Private Loading/Unloading Infrastructure in Capitol Hill, First Hill, and International District (East of I-5) Documented in This Report

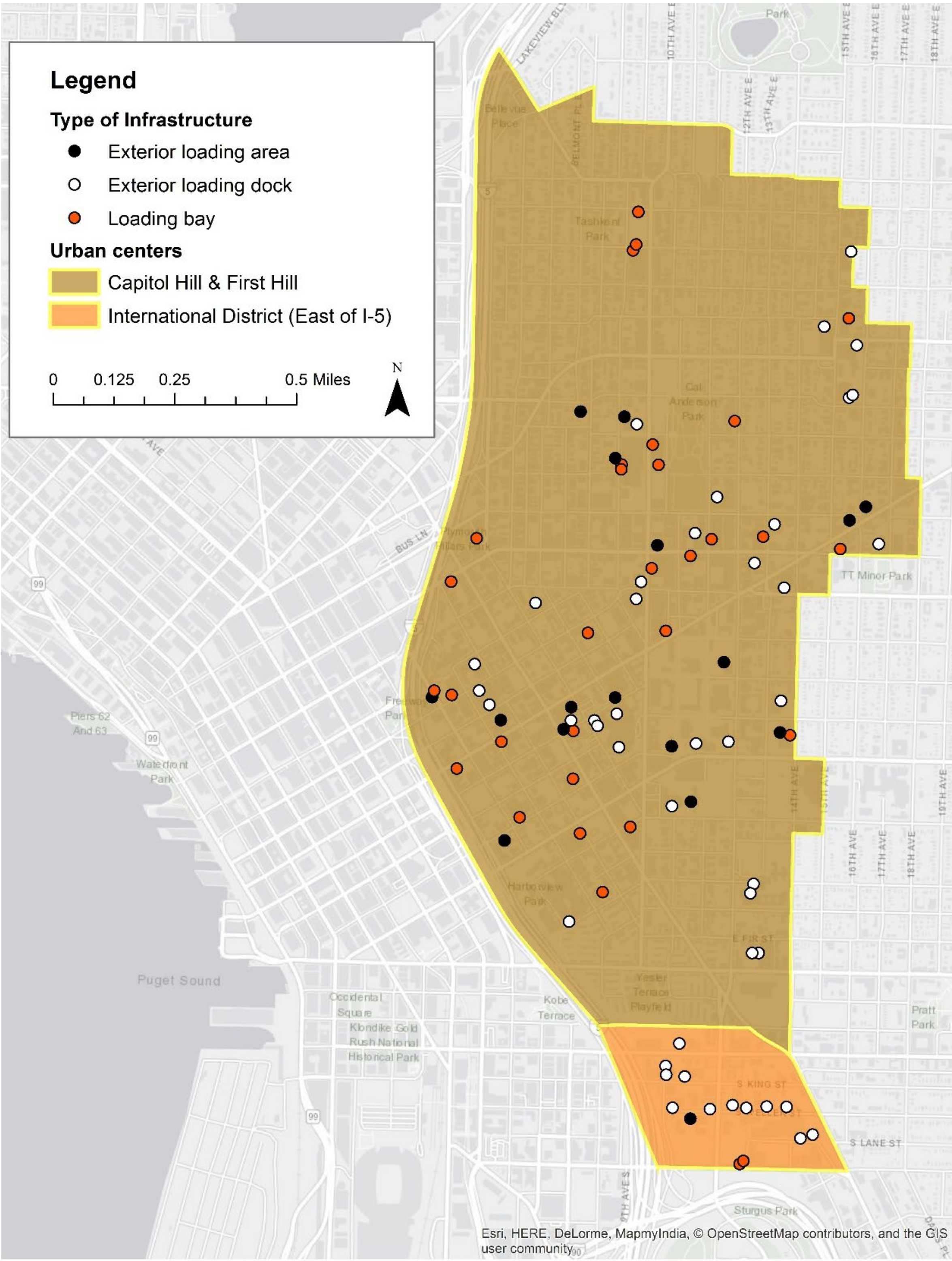
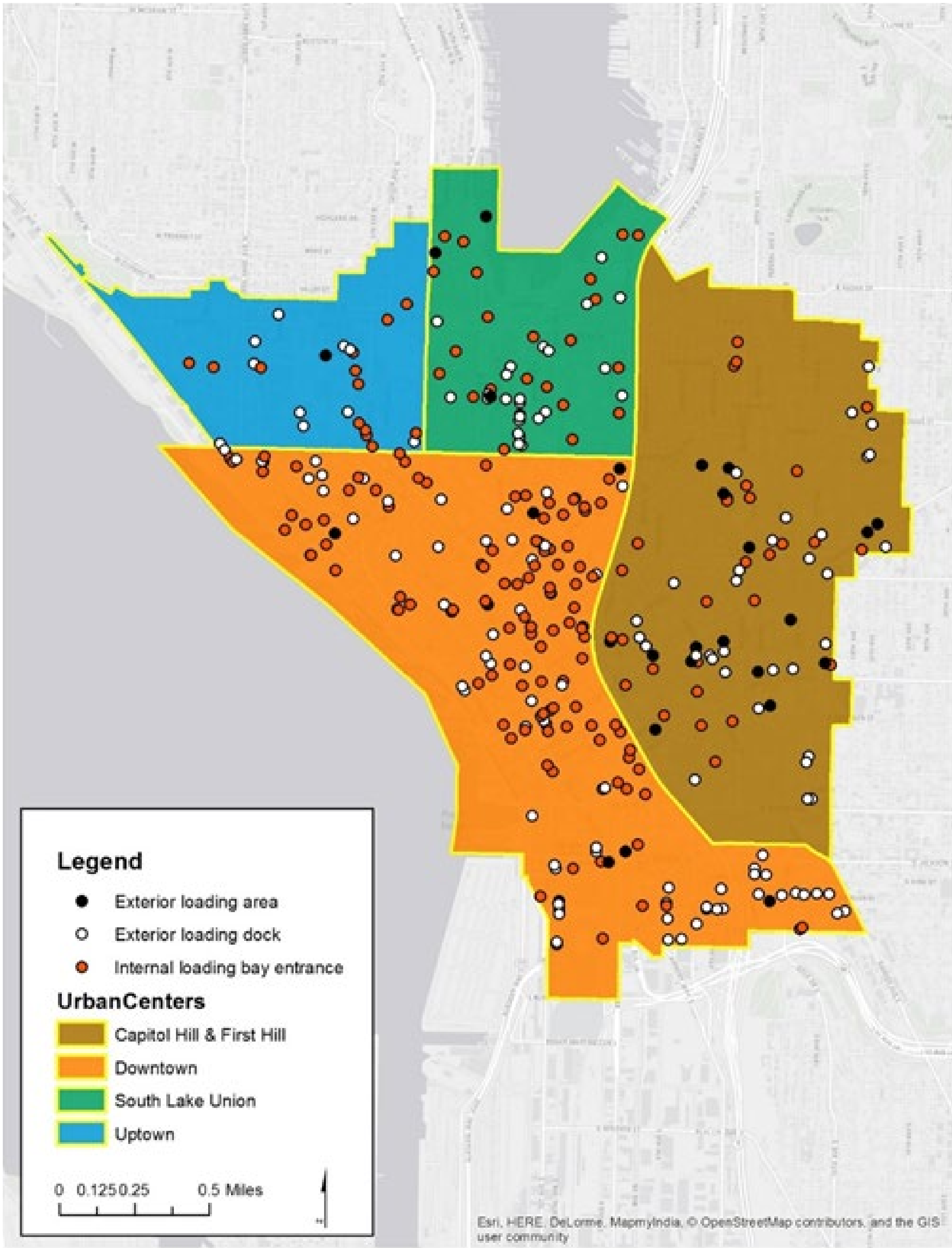


Figure 5. Total Private Loading/Unloading Infrastructure in Greater Downtown



2. **A trust relationship with the private sector is essential to reduce uncertainty in this type of work.**

UFL members added immense value by ground-truthing this work and playing an active role in improving the inventory's accuracy and comprehensiveness. Data collectors in the field found potential freight loading bays with closed doors, preventing them from assessing whether the locations were actually used for freight deliveries. To help the inventory effort, UPS had their local drivers, deeply knowledgeable about city routes, review the closed-door locations as part of their work in the Urban Freight Lab. The UPS driver review allowed the researchers to rule out 186 of the closed-door locations across this and the earlier 2017 data collection, reducing uncertainty in the total inventory from 33% to less than 1%. *(1)*

IMPROVED PHASE 2 INVENTORY METHOD DESIGN

To conduct this inventory, data collectors walked 421 city blocks over four weeks in July and August 2017 to examine and collect data on private loading/unloading infrastructure in the neighborhoods of Capitol Hill and First Hill. Four trained data collectors at a time worked in teams of two both for security reasons and for efficient operation of the various data-collection instruments, which included a Wi-Fi enabled iPad mini 2, a clipboard, and laser measuring device.

They used both hard-copy maps and a UFL-designed online app on the iPad to complete the inventory survey and measurements while standing on public sidewalks and in alleys. Each data collector received approximately five hours of training. The Step-by-Step Toolkit for a Private Loading/Unloading Infrastructure Inventory in Appendix C offers further detail for cities and other parties interested in replicating this inventory.

Based on learnings from the early 2017 inventory (Phase 1) and a pilot test for this inventory, the research team improved the method design for this inventory in these areas:

1. Data structure and survey form

The research team made the survey more efficient by only asking for information when directly relevant to a loading dock, bay or loading area. In other words, if a loading area did not have a dock platform, the survey did not ask for collection of dock details. In addition, survey questions were refined to make collection details more precise. Lastly, UPS drivers were given addresses of locations where interior infrastructure was unclear (e.g. if collectors found a closed door that prevented them from surveying what was inside). This made the UPS driver follow-up process faster and easier than the first inventory, when drivers worked with only geolocation point and photos, which often were shot too close-up for drivers to distinguish which loading bay was at issue. As key finding #2 mentions, UPS drivers were critical in reducing inventory uncertainty to less than 1% by following up on closed-door facilities to determine what was inside. The survey form is in Appendix A. The metadata associated to the database, including data structure rules, attributes and relationships, is in Appendix B.

2. Data-collection app

The research team chose a different data-collection app because it provided better quality control. The app was programmed to limit data-entry inaccuracies and enabled selection of the most appropriate base map for manual geolocation input.

3. Geolocation collection process

To increase precision and reliability, the research team chose to collect GPS coordinates (geopoints) manually by dropping a pin on the map at the infrastructure location. The team then used Survey123 to average multiple GPS readings to reduce error and uncertainty in the coordinates. This process performed better in field testing than automatic geopoint collection alone. Field testing in Capitol Hill showed six of twelve automatic GPS readings (50%) were off by 30 feet on average from the infrastructure location (dropped pin).

4. Data quality control

The research team included more data quality control in the stages before and during data collection versus after data collection. The team also optimized use of the available resources, such as the more effective app that was programmed to limit data-entry inaccuracies and allowed data collectors to both visualize and edit data in field.

CONCLUSION

Although infrastructure is identified as an essential element in making urban freight delivery more efficient, policymakers and stakeholders often lack critical information about these privately owned and managed facilities. Seattle now has this critical information. This study, taken together with the UFL's earlier private infrastructure inventory in Downtown Seattle, Uptown and South Lake Union *(1)*, finalizes the creation of a comprehensive Greater Downtown inventory of private loading/unloading infrastructure. Among major U.S. or European cities, Seattle is the first to maintain such a comprehensive inventory.

But this study can help cities beyond Seattle, as well as researchers and other parties. Other cities can use the UFL's replicable methods, as spelled out in Appendix C, to create and manage their own private infrastructure inventory.

Improving productivity in load/unload spaces of all types—including those offered by private infrastructure—can reduce failed first deliveries and dwell time and meet myriad city goals, including minimizing traffic congestion, both to sustain quality of life for urban residents and to ensure the smooth flow of goods and services to support the economy.

The suite of Final 50 Feet work to date (of which this private infrastructure inventory is one piece) drives home the interconnectedness of the elements of the load/unload network: private loading bays and docks, curbs, and alleys. *(1-3)* Increasingly dense cities like Seattle can—and should—manage the network as a comprehensive whole, operating it flexibly with the help of emerging technologies that offer real-time data to meet dynamic demand and improve the productivity of finite load/unload spaces.

Actively managing an entire load/unload network is a complex undertaking. Cities should look to test-drive on the street innovative approaches to actively managing that network. The results of those on-the-street pilot tests can then inform any future large-scale adoption of these next-generation strategies.

Just such an example is a UFL pilot on select Seattle and Bellevue, Washington, streets that will give delivery drivers access to real-time information about parking availability in congested urban areas—work supported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy under the Vehicles Technologies Office. *(7)* One of the project's goals is to add more parking capacity by using private loading bays more efficiently, inviting building managers in the test area to offer off-peak load/unload space to outside users. This pilot can help inform other cities interested in taking steps to actively manage their entire load/unload network.

ACKNOWLEDGMENTS

The Urban Freight Lab research team is grateful to SDOT for their continued support and sponsorship of advanced empirical research into supply chains, transportation and logistics topics in the UFL.

APPENDIX A:
PRIVATE LOADING/UNLOADING INFRASTRUCTURE SURVEY FORM

PART 1. Facility Access and Location

1. How is the infrastructure accessed? From a: ☐ Alleyway ☐ One-way alleyway ☐ Street

If the answer is "street":
1.1 What is the name of street? __________

If the answer is "alleyway" or "one-way alleyway":
1.2 What is the name of the street closest to where the facility access is located? ____________
1.3 Take a photo of alleyway and street intersection.

If the answer is "one-way alleyway":
1.3 Traffic flow direction?

2. Is necessary to through a gate to access the infrastructure? ☐ Yes ☐ No

If the answer is "Yes":
2.1 Take picture of gate entrance.
2.2 Horizontal clearance at the gate: ___________ **2.3 Vertical clearance at the gate: ___________**
2.3 Capture GPS coordinate of gate by dropping location pin.

3. Are there any visible security measures that limited the usage of the infrastructure by a delivery vehicle?
(Take picture if there are)

☐ Physical barrier ☐ Access Code ☐ Personal interaction ☐ None ☐ Other: ______

4. Is the infrastructure visible or partially visible? ☐ Yes ☐ No

If the answer is "No":
4.1 Is there indication of a space dedicated to loading/unloading? *(Take picture if there is)* ☐ Yes ☐ No
4.2 Proceed to "Part 2.A"

If the answer is "Yes":
4.3 Take a picture of the infrastructure.
4.4 Capture GPS coordinate of infrastructure by dropping location pin.
4.5 What is the level of infrastructure respective to street?
☐ Substructure (below street) ☐ Superstructure (above ☐ street) Level with street

4.5 Is there indication of a space dedicated to loading/unloading ? *(Take picture if there is)* ☐ Yes ☐ No

If the answer is "No":
4.5.1 Proceed to "Form 1"

If the answer is "Yes":
4.5.1 Is the infrastructure inside the building?

If the answer is "Yes":
4.51.1 Proceed to "Part 2.B"

If the answer is "No":
4.51.2 Proceed to "Part 2.C"

PART 2.A - Undefined infrastruc-

5. Is there a door for truck access? ? *(Take picture if there is)* ☐ Yes ☐ No

If the answer is "Yes":
5.1 Input door height _________ **5.2 Input door width _________**

6. *If there is a sign of maximum vertical clearance allowed to enter the infrastructure:*
6.1 Take a picture of the clearance sign. **6.2 Input clearance measure.**

7. Building address: ___________ **8. Additional Observations: _________________**

PART 2.B - Loading Bay

10. Access type of the infrastructure vehicle door(s) ☐ Exit ☐ Entrance ☐ Entrance same as exit

If the answer is "Exit":
10.1 Survey ID of the entrance corresponding to this exit door: __________

If the answer is "Entrance":
10.2 Survey ID of the exit corresponding to this entrance door: __________
10.3 Vehicle entrance maneuverability: ☐ Drive-in ☐ Back-in

11. Door angle respective to traffic flow: ☐ Perpendicular ☐ Parallel ☐ Angled contrary to traffic flow ☐ Angled to traffic flow ☐ Angled (lane with bidirectional flow)

12. How many doors 8 x 8 ft. or larger act as the same vehicle door access type surveyed?
Note: *Questions from 13 to 15 repeat as many times as the total number of door.*

13. Door height : __________ **14. Door width:** ________________

15. *If there is a sign of maximum vertical clearance allowed to enter the infrastructure:*
15.1 Take a picture of the clearance sign. **15.2 Clearance measure** ______

16. Total number of truck spaces: ______________

17. *If there is a dock:*
17.1 Number of truck spaces with direct access to loading dock platform: __________
17.2 Dock height: ________ **17.3 Take a picture of the dock.**

PART 2.C - Exterior Loading Area or Loading Dock

18. Is the infrastructure partially or completely covered? ☐ Yes ☐ No

If the answer is "Yes":
18.1 Minimum clearance between coverture & ground of parking space: __________

19. Is there a dock? *(Take a picture if there is)* ☐ Yes ☐ No

If the answer is "No":
19.1 Total number of truck spaces: ______________

If the answer is "Yes":
19.2 Dock height: __________
19.3 Dock angle respective to traffic flow: ☐ Perpendicular ☐ Parallel ☐ Angled contrary to traffic flow ☐ Angled to traffic flow ☐ Angled (lane with bidirectional flow)

19.4 Is there a dock –leveler? *(Take a picture if there is)* ☐ Yes ☐ No

19.5 Is the dock platform behind building walls? ☐ Yes ☐ No

If the answer is "No":
19.5.1 Total number of truck parking spaces : __________
19.5.2 Number of truck spaces with direct access to loading dock platform: __________

If the answer is "Yes":
19.5.3 How many dock doors are there?
Note 1: *If there are more than one dock door take a picture of group of dock doors.*
Note 2: *Questions from 19.5.4 to 19.5.7 repeat as many times as the total number of dock door(s).*

19.5.4. Take picture of dock door. 19.5.5 Door height : ________ **19.5.Door width:** ________

APPENDIX B:
SDOT-UW FINAL 50' PROJECT TO2: TASK 1 METADATA FORM

1. OBJECT INFORMATION

Layer file	Freight loading and unloading private infrastructure.
Metadata Form Date:	8/28/2017

2. DATA SET INFORMATION

Title	Freight loading and unloading private infrastructure.
Abstract:	Location, features and pictures of private freight infrastructure based on infrastructure survey.
Extent:	Capitol Hill, First Hill, Pike/Pine, 12th Ave, International District (West of I-5).
Data collection dates:	July 2017
Purpose:	Location and features of off-street urban freight infrastructure in private and public buildings.
Supplemental information:	**NA:** Information that is not applicable to that case. **Unknown:** Information that was not visible from the street or alley or was not possible to measure.
Keyword(s):	Seattle, off-street freight infrastructure.

3. ATTRIBUTE INFORMATION

ATTRIBUTE	CODE DOMAIN	DESCRIPTION
KEY_ID	None	Freight loading and unloading private infrastructure ID.
DATE	None	Date when the survey was taken.
TIME	None	Time when the survey was taken.
INF_TYPE	Internal loading bay access, Exterior loading dock, Exterior loading area, Undefined	Type of freight infrastructure See Section 5 Definitions for a further description of the categories of this variable.
ROAD_TYP	Alleyway, One way Alleyway, Street	Type of public road for vehicles from where the facility may be accessed. **Street:** infrastructure access point is accessible from a street. **Alleyway:** infrastructure access point is accessible from an alleyway. **One way alleyway:** infrastructure access point is accessible from alleyway with a sign indicating one-way vehicular flow.
ALLEY_DIR	North, South, East, West, Northeast, Northwest, Southeast, Southwest	Traffic direction of the one-way alleyway. Otherwise, "**NA**."
STREET	None	**If ROAD_TYP = "Street,"** name of the street from which the facility access is located. **If ROAD_TYP = "Alleyway" or ROAD_TYP = "One way alleyway,"** name of the street closest to where the facility access is located.
GATE	Yes, No	Indicates the need to cross a gate outside exterior building walls to access the infrastructure.
ACC_SEC	Foldable security gate, vehicle barrier, access code, personal interaction, camera, other, none	Type of security measure used to access the facility, and that was visible at the time of the survey. **Foldable security gate:** Gates that control access to hallways and receiving doors without affecting ventilation or visibility. **Vehicle barrier:** physical barrier on the drive to of the infrastructure. **Access code:** keypad in which code must be inputted to access facility. **Personal interaction:** access to facility granted via interaction with a gatekeeper such as a guard or receptionist. **Camera:** surveillance cameras. **None:** no barriers to access facility.
SEC_OTHER	None	**If ACC_SEC = "Other,"** text description of the security measure specified as other. Otherwise, "**NA.**"

ATTRIBUTE	CODE DOMAIN	DESCRIPTION
INF_VIS	Yes, No	Indicates if there is complete or partial visibility of infrastructure. Visible or partially visible infrastructure includes situations with enough visibility of the infrastructure from survey location to manually record GPS location by dropping a pin on mobile data collection app.
LOAD_USE	Yes, No	Describes if there is any indication that space is dedicated to loading or unloading goods. The Indication includes but it is not limited to pallets, signs and a parked truck.
POINT_X	In linear feet calculated with ArcGIS	X coordinate of the infrastructure access point from GIS coordinates. Projected Coordinate System: NAD_1983_HARN_StatePlane_Washington_North_FIPS_4601_Feet Otherwise, "**NA.**"
POINT_Y	In linear feet calculated with ArcGIS	Y coordinate of the infrastructure access point from GIS coordinates. Projected Coordinate System: NAD_1983_HARN_StatePlane_Washington_North_FIPS_4601_Feet Otherwise, "**NA**."
LONGITUDE	In decimal degrees calculated with ArcGIS	Longitude of the infrastructure access point from GIS coordinates. World Geodetic System: WGS 1984 Web Mercator (Auxiliary Sphere) [WGS84] coordinate system Otherwise, "**NA**."
LATITUDE	In decimal degrees calculated with ArcGIS	Latitude of the infrastructure access point from GIS coordinates. World Geodetic System: WGS 1984 Web Mercator (Auxiliary Sphere) [WGS84] coordinate system Otherwise, "**NA**."
INF_LEVEL	Substructure, Superstructure, Level	**If INF_VIS = "yes",** indicates at what level the infrastructure is placed compared to the level of the street. Substructure indicates the infrastructure is below the level of the street. Superstructure refers to infrastructure above the level of the street. Level indicates that the infrastructure is at the level of the street. Otherwise, "**NA**."
TRK_DOOR	Yes, No	**If INF_TPYE = Undefined,** indicates if there is a vehicle door greater than 8ft. x8ft. at the surveyed location in the case of limited information regarding the preferred use of the space or visibility of infrastructure. Otherwise, "**NA**."

ATTRIBUTE	CODE DOMAIN	DESCRIPTION
TRKDR_HGT	Feet	**If TRK_DOOR = "Yes,"** height of vehicle door in case of limited information. Otherwise, "**NA**."
TRKDR_WTH	Feet	**If TRK_DOOR = "Yes,"** width of vehicle door in case of limited information. Otherwise, **"NA.."**
VH_ACC_TYP	Exit, Entrance, Entrance same as exit	**If INF_TYP = "Internal loading bay access,"** the type of vehicle access to the internal loading bay. Otherwise, **"NA."**
DR_ANGLE	Perpendicular, angled to traffic flow, angled contrary to traffic flow, parallel to traffic flow, angled	**If INF_TYP = "Internal loading bay access,"** angle between a vector perpendicular to the internal loading bay door and towards the traffic flow outside the building and a vector parallel to the traffic flow. Angled refers to cases of Internal loading bays on bi-directional roads such as bi-directional alleyways, where the Internal loading bay door angle could be contrary or to traffic flow. Otherwise, **"NA."**
ENT_ID	None	**If VH_ACC_TYP = "Exit,"** KEY_ID of the corresponding Internal loading bay entrance. Otherwise, **"NA."**
EXT_ID	None	**If VH_ACC_TYP = "Entrance,"** KEY_ID of the respective internal loading bay exit. Otherwise, **"NA."**
EN_MANEUVR	Drive-in, back-in	**If VH_ACC_TYP = "Entrance" OR VH_ACC_TYP = "Entrance and exit,"** entrance maneuverability of trucks to enter Internal loading bay. Otherwise, **"NA."**
BAY_DOORS	None	**If INF_TYP = "Internal loading bay access,"** number of doors for vehicles to access the internal loading bay and with of the same type as indicated in VH_ACC_TYP. Otherwise, **"NA."**
COVER	Yes, No	**If INF_TYP is different to "Internal loading bay access,"** indicates if the infrastructure is partially or entirely covered in the case of an infrastructure not enclosed within the exterior building walls (exterior loading area or exterior loading dock). Otherwise, **"NA."**

3. ATTRIBUTE INFORMATION Continued

ATTRIBUTE	CODE DOMAIN	DESCRIPTION
COV_HIGHT	In feet	**If COVER = "Yes,"** a measure of minimum clearance between coverture and ground of parking space in the case of infrastructures different to Internal loading bays and covered. Otherwise, **"NA."**
CLEAR_SIGN	Yes, No	Indicates if there is any sign with maximum vertical clearance allowed to enter the infrastructure.
CLEARANCE	In feet	**If CLEAR_SIGN = "Yes,"** maximum vertical clearance allowed to enter infrastructure as indicated in clearance sign.
DR_HIGHT1	In feet	**If BAY_DOORS = 1,** height of door of Internal loading bay. **If BAY_DOORS > 1,** height of door 1 of Internal loading bay. Otherwise, **"NA."**
DR_WIDTH1	In feet	**If BAY_DOORS = 1,** width of door 1 of Internal loading bay. **If BAY_DOORS > 1,** width of door 1 of Internal loading bay. Otherwise, **"NA"**
CL_DIF_YN1	Yes, No	**If BAY_DOORS > 1 AND CLEAR_SIGN = "Yes,"** indicates if there is a clearance sign specific to door 1 and different to the clearance sign of the infrastructure as collected in variable CLEARANCE.
DR_CLEAR1	In feet	**If CL_DIF_YN1 = "Yes,"** maximum vertical clearance allowed at door 1 as indicated in clearance sign unique to this door.
DR_HIGHT2	In feet	**BAY_DOORS > 1,** height of door 2 of Internal loading bay. Otherwise, **"NA."**
DR_WIDTH2	In feet	**BAY_DOORS > 1,** width of door 2 of Internal loading bay. Otherwise, **"NA."**
CL_DIF_YN2	Yes, No	**if BAY_DOORS > 1 AND CLEAR_SIGN = "Yes,"** indicates if there is a clearance sign specific to door 2 and different to the clearance sign of the infrastructure as collected in variable CLEARANCE.
DR_CLEAR2	In feet	**If CL_DIF_YN2 = "Yes,"** maximum vertical clearance allowed at door 2 as indicated in clearance sign specific to this door.
DR_HIGHT3	In feet	**If BAY_DOORS > 2,** height of door 3 of Internal loading bay. Otherwise, **"NA."**

ATTRIBUTE	CODE DOMAIN	DESCRIPTION
DR_WIDTH3	In feet	**If BAY_DOORS > 2,** width of door 3 of Internal loading bay. Otherwise, **"NA."**
CL_DIF_YN3	Yes, No	**If BAY_DOORS > 2 AND CLEAR_SIGN = "Yes,"** indicates if there is a clearance sign specific to door 3 and different to the clearance sign of the infrastructure as collected in variable CLEARANCE.
DR_CLEAR3	In feet	**If CL_DIF_YN3 = "Yes,"** maximum vertical clearance allowed at door 3 as indicated in clearance sign specific to this door.
DOCK	Yes or No	**If INF_TPY is different to "Undefined,"** indicates the presence or not of a dock. Otherwise, **"NA."**
SPACES	None	**If INF_TPYE is different to "Undefined,"** total number of truck spaces including those with loading dock in the case that DOCK = "Yes", and without loading dock. Otherwise, **"NA."**
DK_ANGLE	Perpendicular, angled to traffic flow, angled contrary to traffic flow, parallel to traffic flow, angled	**If INF_TPYE = "Exterior loading dock,"** the angle between a vector perpendicular to the dock and towards the traffic flow outside the building and a vector parallel to the traffic flow. Angled refers to cases of exterior loading docks on bi-directional roads such as bi-directional alleyways, where the dock angle could be contrary or to traffic flow. Otherwise, **"NA."**
IN_PLAT	Yes or No	**If INF_TPYE = "Exterior loading dock"** indicates if the exterior loading dock has the platform inside exterior building walls. Otherwise, **"NA."**
SPACES_LD	None	**If DOCK = "Yes"** number of truck spaces with loading dock. Otherwise, **"NA."**
DOCK_HEIGHT	In feet	**If DOCK = "Yes,"** indicates the fixed height of loading dock platform. Otherwise, **"NA."**
DOCK_LEV	Yes or No	**If DOCK = "Yes,"** indicates the presence or not of a dock leveler. Otherwise, **"NA."**
DCK_DRS	None	**If IN_PLAT = "Yes,"** number of exterior loading docks with platform inside exterior building walls and next to the one surveyed. Otherwise, **"NA."**
BLDG_ADDR	None	**If INF_TYPE = "Undefined" OR "Not an internal loading bay,"** indicates the address of the building. Otherwise, **"NA."**

4. PICTURES INFORMATION

The picture database related to the infrastructure database consists of a folder with all pictures in JPG format collected in the field for each infrastructure. The pictures in the database follow a naming system that allows identifying each of the pictures corresponding to each infrastructure. The JPG files are named as follows:

"Key ID of infrastructure_Variable name of the picture.jpg."

Key ID variable is described in Section 3 above and consist of an integer that serves as a unique identifier of each infrastructure in the database. *Variable name of the picture* refers to each of the possible variable names of type picture that relate to a specific feature of the infrastructure as described below.

ATTRIBUTE NAME	DESCRIPTION
ALY_ST_PIC	Picture of alleyway at intersection with the street closest to the infrastructure.
GATE_PIC	**If GATE = "Yes,"** picture of the infrastructure gate outside building exterior walls.
SEC_PIC1	Picture of the access security measure as indicated in ACC_SEC.
SEC_PIC2	**If selected options of ACC_SEC are greater than 1,** picture of the access security measure as indicated in ACC_SEC.
LDUSE_PIC	**If LOAD_USE = "Yes,"** picture of the indication that the space is dedicated to loading or unloading goods.
INF_PIC1	Picture 1 of the infrastructure surveyed.
INF_PIC2	Picture 2 of the infrastructure surveyed.
TRKDR_PIC	**If TRK_DOOR = "Yes,"** picture of vehicle door in case of limited information.
BAYDRS_PIC	**If BAY_DOORS > 1,** picture of group of doors of the Internal loading bay.
CLEAR_PIC	**If CLEAR_SIGN = "Yes,"** picture of clearance sign of the infrastructure.
DOOR_PIC1	**If BAY_DOORS = 1,** picture of door of Internal loading bay **If BAY_DOORS > 1,** picture of door 1 of Internal loading bay
CLEAR_PIC2	**If CL_DIF_YN2 = "Yes,"** picture of clearance sign at door 2.
DOOR_PIC2	**BAY_DOORS > 1,** picture of door 2 of Internal loading bay.
DOOR_PIC3	**If BAY_DOORS > 2,** picture of door 3 of Internal loading bay.
DK_LEV_PIC	**If DOCK_LEV = "Yes,"** picture of dock leveler.
DCK_GR_PIC	**If DCK_DRS > 1,** picture of group of exterior loading docks with platform inside exterior building walls and next to the one surveyed.

ATTRIBUTE NAME	DESCRIPTION
DCK_PIC	**If IN_PLAT = "Yes,"** Picture of dock's door.
ADD_PIC1	Picture 1 to support observation.
ADD_PIC2	Picture 2 to support observation.
ADD_PIC3	Picture 3 to support observation.

5. DEFINITIONS

5.1. General definitions

Building exterior wall. The walls of a building that separate spaces, partly or entirely unobstructed to the sky, from spaces inside the building.

Internal loading bay. An enclosed space inside the building with an entrance/exit point (e.g., roll-up doors, garage doors) that act as a continuation of the upper parts of the building. This space is partially or completely dedicated to unloading and loading activities. It has entrances and exits greater than 8 feet x 8 feet for commercial vehicles. Internal loading bays can have loading docks and truck parking spaces with or without access to a loading dock.

Loading dock. An elevated platform that facilities shipping and delivery operations.

Dock leveler. An adjustable mechanized platform built into the edge of a loading dock. The platform can be moved vertically or tilted to accommodate the handling of goods or material to or from trucks.

5.2. Code definitions

FAP_TYPE code dictionary

CODE	DESCRIPTION
Internal loading bay access Point	Access point for an internal loading bay that can function as an entrance, exit or both.
Exterior loading dock	A loading dock that is located outside of building exterior wall. Exterior loading docks can be entirely open to the sky or partially or completely covered by a canopy or upper part of the building. Additionally, exterior loading docks can also include inside loading platforms, where trucks dock the cargo compartment to a dock door.
Exterior loading area	Space for loading and unloading out of the exterior building walls of a building and without a loading dock. Exterior loading zones can be unobstructed to the sky, partially or completely covered by a canopy or upper building levels
Undefined	The location that can potentially be a Internal loading bay entrance/exit. No information is available because a barrier impedes the data collection, there were not on-site signs indicating their possible use as private freight access points.

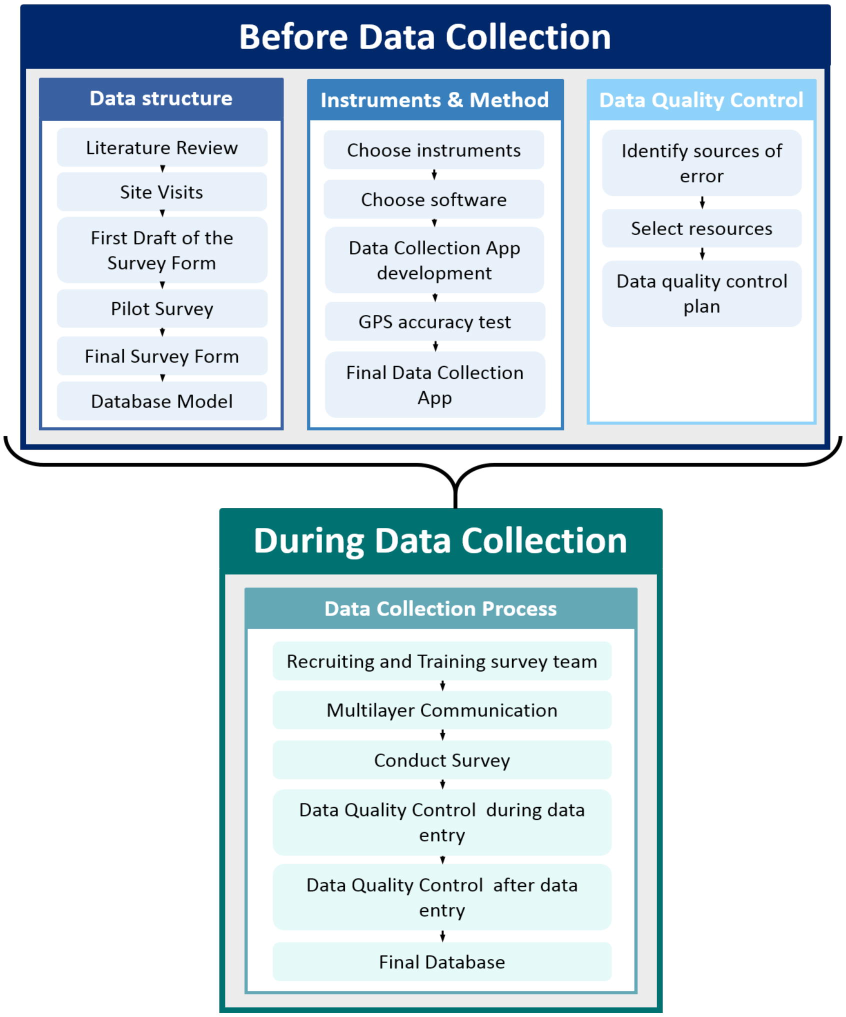
APPENDIX C:
STEP-BY-STEP TOOLKIT FOR A PRIVATE LOADING/UNLOADING INFRASTRUCTURE INVENTORY

This toolkit describes the step-by-step process that city transportation professionals can follow (or adapt as desired) to carry out a private loading/unloading inventory survey.

The data-collection and analytic methods represented here are:

- Replicable;
- Available at reasonable cost;
- Ground-truthed;
- Governed by quality-control measures in each step.

The figure below outlines the overall project data process.



STEP 1: DETERMINE STUDY PARAMETERS

The first step should define these key parameters:

- Scope/size of desired study area
- Number of city blocks in the study area: The number of city blocks could be used to assess the scope of the effort involved to complete data collection in the defined study area.
- Data-collection hours: For security reasons, it is recommended to work only during daylight hours. Because the survey includes capacity features that can only be captured when facilities are open, weekdays are recommended for data collection.

Worth noting: The research team used SDOT's publicly-available GIS layers of designated curbside parking, as well as King County's GIS layer of Seattle's alleys, to begin developing a multi-layer map of the truck load/unload locations in the city's urban centers. This UFL report adds the private infrastructure layer; an earlier UFL report updated the alley layer. Other cities also may have publicly available GIS layers that aid in any project that seeks to accurately document the load/unload network.

The research team reviewed the following Seattle GIS databases for its multi-layer map of the truck load/unload locations in the city's urban areas:

- Alleys
- Urban villages
- Arterial types
- Commercial
- Retail
- Food permit data
- Residential
- SDOT traffic lanes
- Curb space categories
- Block faces
- Year built

STEP 2: DEFINE PRIVATE LOADING/UNLOADING INFRASTRUCTURE ATTRIBUTES OF INTEREST

Section 2 in the report defines each of the three types of private infrastructure inventoried: loading bays, exterior loading docks, and exterior loading areas.

Transportation officials should also define the specific infrastructure attributes the inventory effort seeks to capture. The research team's review of design standards, city reports and research papers on recommendations regarding freight loading/unloading parking infrastructure resulted in the following extended list of infrastructure features that affect operations and that can be grouped into **location, design and capacity** features.

Important location features are the type of road at the public right of way where the access to the infrastructure is located. Poor operations of the roads connecting this infrastructure to the street network may significantly affect how private loading/unloading parking facilities are used. One example is the case of inefficient and narrow alleys, which delivery drivers tend to avoid if they have an alternative to avoid being blocked on their way out by other vehicles. The interplay between public and private freight parking infrastructure is important as well.

Design features include:

- Dimensions of access points to the infrastructure: for instance, vehicle doorway and dock doorway dimensions (width and height);
- Ground clearance: the shortest distance between vehicle tire and upper level at the infrastructure.
- The way vehicles access the infrastructure, including:
  - The access angle to the infrastructure: the angle between the vehicle access and the traffic flow
  - Access ramp's grade
  - Whether the vehicle needs to back-in
  - Maximum turning radius
  - Maximum truck size that can use the infrastructure
  - Security access measures: for instance, physical barriers, access code and any personal interaction needed to gain access.

Capacity features relate to parking spaces and mechanical devices, such as:

- Number of parking spaces;
- Apron: space for parking and maneuverability, and;
- Presence of a dock platform and dock-levelers.

Ultimately, not all features listed here were ultimately able to be captured in field, as explained in Step 3.

STEP 3: DESIGN SURVEY AND PILOT TEST

A pilot test of the initial survey gave the research team critical information about what features data collectors could capture in the field from the public right of way (e.g. sidewalks and alleys.) For this project, researchers selected a six-block area to pilot-test the draft survey. Features noted in Step 2 including turning radius, maximum truck size, and centerline distance were not possible to measure in the field due to the complexity of the geometrical features, the private infrastructure personnel's lack of knowledge or unavailability, or a lack of exterior signage. The research team used the pilot-test results to develop the final data-collection survey in Appendix A and the data structure metadata in Appendix B.

The final survey encompassed all key attributes identified in Step 2 that data collectors were able to capture from positions on sidewalks and in alleys. The specific scope of work for each project may require adaptation of the survey form used in this report. If changes are needed, the recommended process is to pilot-test the draft survey form. This pilot test enables cities to:

- Estimate the time needed to survey each infrastructure, including walking time between survey locations;
- Identify potential problems with the survey logic, and;
- Test data-collection methods and instruments.

Regarding survey logic, data collectors created a record for each loading bay entrance/exit. They recorded individual features of each loading bay.

STEP 4: SELECT DATA-COLLECTION TOOLS

It is recommended that the chosen tools of the data-collection method be:

- Able to measure metrics with sufficient accuracy
- Easy to transport
- Reasonably priced
- Available as off-the-shelf technology

Below is the list of tools used in the UFL project and their unit price:

Instrument	Unit price ($)
Laser measuring device	80
iPad mini 2 with 32 GB and Wi-Fi and cellular option*	300
Portable power bank	11
iPad Case	90
Security Vest	17.9
Clipboard	2

*This instrument may not be required if the survey instrument is paper-based.

STEP 5: CHOOSE SOFTWARE AND PROGRAM DATA-COLLECTION APP

This step requires choosing database management software that allows for:

- Controlled submission or input of data;
- Data storage in different formats, including databases with relationships;
- Geodatabases and cloud storage;
- Multiuser data editing;
- Set data rules and relationships;
- Secure data, and;
- Use of data-collection app.

These functionalities enable effective data management, data-quality control and scale-up of data collection across multiple staff members. Use of a data-collection app in field is recommended to reduce transcript time and errors. The Urban Freight Lab developed a private loading/unloading infrastructure inventory app, thought to be the first of its kind. That said, a paper-based questionnaire may be a viable alternative if a mobile data-collection app is not available or practical.

The research team conducted the data-collection process on tablets using ESRI GIS software Survey123, ArcView and ArcGIS Online. These ESRI products offer a seamless data-collection tool that allows for both visualization and editing of the collected data. Additionally, Survey123 allows selection of the most appropriate basemap to assist the geolocation input: the World Street from ArcGis.com viewer last updated in July 2017.

Additionally, the mobile data-collection app allows manual input of the infrastructure location, supported by offline basemaps. This allowed the research team to avoid the cost of having a wireless Internet plan for the tablets to support data collection. (Once collected, data could be uploaded using the Wi-Fi option.)

For precision and reliability, the research team for this inventory chose to collect GPS coordinates (geopoints) manually by dropping a pin on the map at the infrastructure location. The team then used Survey123 to average multiple GPS readings to reduce error and uncertainty in the coordinates. This process performed better in field testing than automatic geopoint collection alone.

While data quality-control checks to identify readings taken more than five-to-ten feet away from the infrastructure are effective, they are time consuming. Given the state of current technology (e.g. low accuracy of the devices), collecting the GPS coordinates of the infrastructure manually by dropping a pin at its location on the map may be the best approach. It is the approach followed in this project.

STEP 6: CREATE DATA QUALITY-CONTROL PLAN

A data quality-control plan must consider the possible sources of error in the data and the resources available to mitigate these errors at different stages of the data-collection process. This helps ensure the quality of the data before it is collected, entered or analyzed. It also helps with monitoring and maintaining the data once collected. The UFL research team identified the types and possible sources of error specific to this type of project to define the quality-control measures needed:

- **Positional error** refers to inaccuracies of GPS coordinate readings due to device issues (e.g. low satellite signal in urban canyons) and mistakes by humans manually collecting this data with tablets.
- **Attribute error** is associated with the remaining non-spatial infrastructure data collected with the survey. Some examples are incorrect data entry due to wrong measurements or mistyped data. Lack of access to the information due to obstructions or safety issues may also result in inaccurate data.
- **Conceptual error** refers to errors around identification and classification of relevant infrastructure attributes or related information. Concepts wrongly used can result in information misclassified and information not captured.

Table 1 shows the UFL project data quality-control design to address the three types of errors above. The table illustrates the measures implemented in three stages: before data collection, during data entry, and after data entry.

The Seattle project used four types of resources to carry out quality-control procedures throughout the project stages:

- **Supervisor(s):** are responsible for defining and enforcing the data collection standards and methodology; training the collectors; and monitoring and maintaining the database. The supervisor handled the data-control measures implemented before data collection and after data entry.
- **Collectors:** are responsible for data entry in field and carrying out same-day data quality-control checks after data entry.
- **Survey app:** refers to the digital and online tool that helps create entry constraints, estimates accuracy of the GPS device readings, eases the digitization of the data as it is collected and ends the need for manual information digitalization. The survey app plays an important quality-control role because it is programmed to limit inaccuracies in the data-entry stage by considering the data structure rules, attributes and relationships.
- **Carrier:** refers to the private company (UPS, a UFL member) that collaborated with the research team to review survey locations when it was unclear if the locations were used for freight operations, such as when locations had a closed door during the survey. The carrier-check happens after the collectors finish their same-day checks.

Table 1. UFL Data Quality-Control Process

	STAGE 1. BEFORE COLLECTION		STAGE 2. DURING DATA ENTRY		STAGE 3. AFTER DATA ENTRY		
	In office	In field	In field		In office		
	Supervisor(s)		Collector(s)	Survey App	Collector(s)	Carrier	Supervisor(s)
Positional	- Establish physical reference - Develop questionnaire logic to capture GPS device reading errors -Train data collectors to clean geolocation data in office following data collection	- Deliver training session to collectors about GPS location collection with survey app	- Follow instructions to always remain aware of their location - Keep track of surveyed infrastructure location with hard copies of maps	- Includes manual collection of GPS reading by dropping location pin - Includes updated base map with city blocks and building outlines	- Conduct same-day check of surveyed infrastructure location by comparing ArcGIS Online map with hard copy of map	NA = Not applicable	- Review collectors' positional check. - Identify outliers by finding geopoints out of their corresponding city block - Correctly geocode outliers based on Google Maps
Attributes *(Infrastructure features)*	- Build questionnaire's data-entry constrains in survey app - Deliver theoretical training session to data collectors - Train data collectors to clean attributes data in office following data collection.	- Deliver training on data collection with survey app and measurement devices for infrastructure features	- Take clear photos to aid data entries	- Includes visual and written aid for data fields	- Conduct same-day check of data collected in field with survey pictures using ArcGIS Online platform	NA = Not applicable	- Check numeric fields for outliers - Conduct second inspections in surveys
Conceptual *(Infrastructure concepts)*	- Establish metadata and vocabulary related to the surveyed infrastructure - Deliver theoretical training to data collectors	- Train collectors in field on how to identify infrastructure relevant to the survey	- Write open-ended comments, take additional pictures and use "Other" categories for "undefined" cases	NA = Not applicable	NA = Not applicable	- Resolve "undefined" cases due to lack of access to information	- Resolve collectors' observations and "Other" cases - Classify surveyed infrastructure - Check typology of private freight infrastructure with pictures collected

STEP 7: RECRUITING AND TRAINING OF DATA COLLECTORS

Recruiting

The workforce requirements (number of data collectors and supervisors needed) are determined by the project budget, timeline and survey length. Security concerns and survey complexity may also result in different workforce needs. For instance, data collectors may work better in teams of two to improve security conditions and enable efficient operation of the multiple data-collection instruments (e.g. laser measurement device, iPad, etc.).

In addition to data collection in field, data-collection staff may spend time commuting to and from the study area and within the study area, as well as conducting data quality-control tasks in office. These tasks will take a varying amount of time depending on the nature, size and location of the study area, and are important to consider when estimating workforce needs in relation to the desired project duration. For this project, data collectors were compensated for their time in transit to get to the study area.

Training

Three different training sessions are suggested for data collectors:

The first session instructs data collectors in concepts and attributes regarding the private loading/unloading infrastructure.

This training session can be done in a classroom-type setting, with a slide presentation introducing the audience to private loading/unloading infrastructure and the various features and concepts that surround them. The research project should be explained, providing everyone with the goal, process, timeline, and information on shifts. Security in field is also addressed.

The second session focuses on practical aspects of data collection, such as how to use the questionnaire in the tablet app and the measurement tools. This training session should be done in-field to give the collectors real-world practice with the materials and process.

This training session should lead collectors through the actual process of collecting data. Attention should be paid to teaching how to take accurate measurements with the laser, how to use the hard-copy maps, and how to effectively divide collection work between the pair. One person may become very familiar with the measurement tools and always take measurements; the other may become adept at navigating and filling in the survey tool and always take responsibility for this task. Security in field is also addressed.

The third session centers on how to implement data quality-control measures.

After every shift in-field, one of the data collectors in each pair must clean the data he or she just collected. The third training session should be dedicated to this data-cleaning process: how to access the survey data results and how to properly clean the data, noting common errors to look for and needed changes to make.

STEP 8: DATA COLLECTION

The actual data-collection step depends on the size of the study area and, subsequently, the size of the workforce required. For the First Hill/Capitol Hill inventory, a total of 230 person-hours was required to survey 96 private freight loading/unloading infrastructures across 421 city blocks. It is recommended that data collectors work in two-person teams: one member normally inputs information on the tablet and the second takes measurements, updates the hard-copy inventory sheet, and maps each location surveyed. Depending on collectors' schedules, works shifts can be formed around a geographic area, with more city blocks included if the shift is longer. A check-out and check-in process can be developed for collectors to pick up and drop off the required materials needed for each shift. Supervisors must make sure territory assignments are formed and hard-copy maps are printed for each team and shift. Data collectors use hard-copy maps to know what area they are assigned, to help with quality control for positional errors, and to update progress on data collection.

Security in field

Safety of data collectors visiting the city blocks and surveying the infrastructure is paramount. It is essential to have a multilayer communications plan in place for all parties with an interest in the study area and the survey. It is also essential to have a comprehensive security protocol to avoid unsafe situations in field.

Data collectors should carry official documents from the sponsoring agency explaining the project and granting data-collection authorization. The documents should include agency official contact information should questions arise in field. Police and other relevant agencies should be informed and recruited to help communicate with all building managers in the survey area. Relevant agencies can also disseminate information on the survey and its progress to communicate with the public and relevant stakeholders. This communication can indicate where surveyors will be working and when. In Seattle, for example, the Seattle Police Department notified all building managers in the survey area in real time through the Seattle Shield program, a pre-existing information exchange for building operators and the police. SDOT also set up a new webpage at http://www.seattle.gov/transportation/thefinal50feet.htm to communicate with the public and relevant stakeholders.

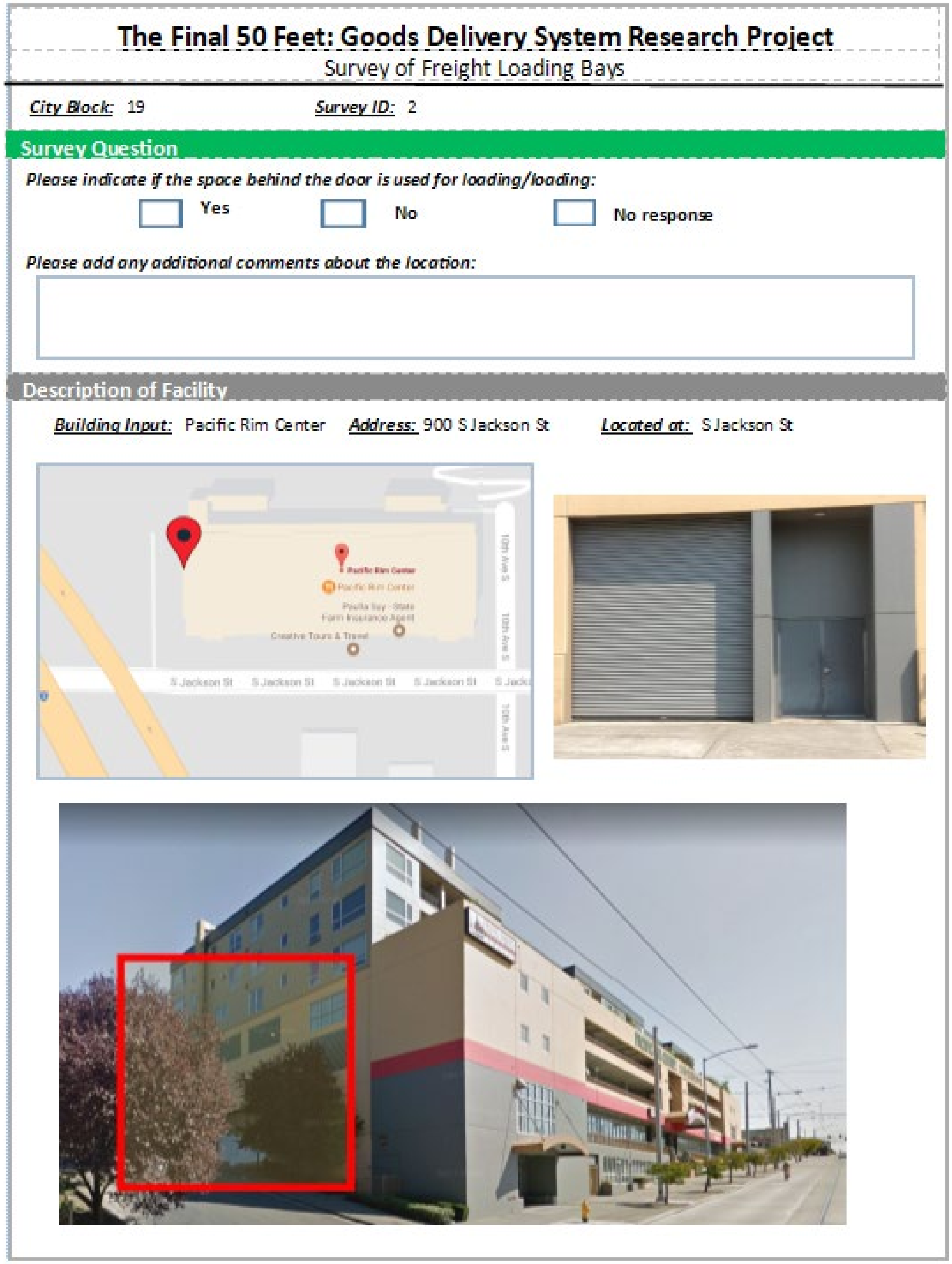
STEP 9: DATA CLEANING

After data collection, data must be cleaned. Both the data collectors and the supervisors play a role in this effort, which is detailed further in Table C-1, Stage 3. The data collector must conduct a check of the surveyed infrastructure locations after having completed in-field data collection. This step makes the final cleaning of the complete dataset easier and more efficient. The supervisor(s) can conduct their data-cleaning steps during the collection process, but must perform a comprehensive clean after all the data has been collected.

The research team collaborated with experienced UPS drivers who regularly serve the study area to identify survey locations that were closed during the survey. This step allowed the team to rule out 186 of the closed-door locations across this and the earlier 2017 data collection, reducing uncertainty in the total inventory from 33% to less than 1%. This survey of UPS drivers proved integral to accurately documenting and understanding the private inventory.

As shown in the driver survey form (Figure 1), for any facility in question, drivers were given detailed location information (including photos that gave context for the door in question) and were asked whether the space was used for loading/unloading.

Figure 1. Form UPS Drivers Used for Closed-Door Locations to Determine if Used for Freight



The Final 50 Feet: Goods Delivery System Research Project

Survey of Freight Loading Bays

City Block: 19 *Survey ID:* 2

Survey Question

Please indicate if the space behind the door is used for loading/loading:

☐ Yes ☐ No ☐ No response

Please add any additional comments about the location:

Description of Facility

Building Input: Pacific Rim Center *Address:* 900 S Jackson St *Located at:* S Jackson St

STEP 10: PUT TOGETHER AND SUMMARIZE THE DATA

Varying city needs may require different final formats. The final format can be a database made of spreadsheets with relationship between them. In the Seattle project, each private loading/unloading infrastructure was considered a point feature layer on a GIS map. Most information about this infrastructure was stored in a corresponding attribute table. Pictures of private loading/unloading infrastructure features were also collected and stored as JPEG files with a naming convention that allowed them to relate to the corresponding infrastructure.

In Seattle, the final format is an up-to-date geodatabase with detailed features of private loading/unloading infrastructure represented as a point feature on the GIS map.

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