



Municipal Fiber Network Plan
for
The City of Bellingham, Washington

August 5, 2024

City Council – Special Meeting

Presentation and Workshop on City Fiber Network Comprehensive Plan

Uptown Services, LLC

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Develop a comprehensive capital and operations plan for the city's municipal fiber network to achieve "carrier class" capability by increasing redundancy and reliability through incremental infrastructure improvements. The plan should improve the network's broadband capacity and services in a financially self-sustaining manner by providing leased conduit and/or dark fiber access to businesses, broadband providers, and other public organizations.

1. Update Existing Infrastructure Documentation
2. Identify Locations for New and Replacement Infrastructure
3. Identify Operational Resources
 - ◆ Services strategy
 - ◆ Staffing and Operational Resources and Procedures
4. Identify resources to Retain, Replace, and Renew Infrastructure (capex and opex)
5. Identify Opportunities to Serve Unserved and Underserved Areas
 - ◆ Opportunity to Qualify for Federal Grant Funds in Underserved Areas
 - ◆ Large Business Segment: Demand for lit and/or dark fiber transport
 - ◆ Residential Segment: Demand for fiber broadband
6. Complete Financial Analysis
 - ◆ Funding Sources
 - ◆ Pro Forma Scenario #1A: Middle Mile Dark Fiber Leasing
 - ◆ Pro Forma Scenario #1B: Middle Mile Leased Access (lit service)
 - ◆ Pro Forma Scenario #2: Last Mile Retail Broadband
7. Create Fiber Construction, Documentation, and Standards Documents

Task 1: Update Existing Infrastructure Documentation

Field Inspection and Infrastructure Audit

- ◆ Data Collection and Organization
 - ❖ Collect GIS information
 - ❖ Develop understanding of basic network components
 - ❖ Prepare walkout maps for field inspection

- ◆ Field Inspection
 - ❖ Field inspection of key splice locations and cabinets
 - ❖ Audit of key patch panel locations at City node sites

- ◆ OSP Insight Analysis
 - ❖ Update patch panel port status based on results of field survey (Gaven)
 - ❖ Use tracing tools to determine spare fiber strands throughout the network

- ◆ GIS Updates
 - ❖ Update GIS vault feature status to reflect repair / replacement needs
 - ❖ Update GIS fiber feature status to reflect total used / available fibers
 - ❖ Update conduit features to reflect “fiber ready” status

- ◆ **GIS Source Data**
 - ❖ Vaults, conduits, cabinets, fiber splice points, fiber cable and patch panels
 - ❖ Limited information available in GIS feature sets
 - ❖ Most conduit and fiber features need to be redrawn to make them useful (operationally)

- ◆ **OSP Insight**
 - ❖ OSP Insight used to model fiber connectivity for the City network
 - ❖ System needs additional updates to accurately reflect current connectivity and fiber use
 - ❖ OSP Insight is not used to maintain or edit conduit and vault infrastructure
 - ❖ Process / content improvements will be needed to make this system more functional

- ◆ **Third Party Sources**
 - ❖ Third party fiber networks have not provided detailed information to the City
 - ❖ Source data from the previous study has not been disclosed to the City
 - ❖ The lack of disclosure did not come as a surprise to Uptown
 - ❖ Future discussions with fiber network operators should be based on specific routes and requirements

- ◆ **Scope of Inspections**
 - ❖ Vault-based splice locations connected to at least one 48 fiber (or higher) cable
 - ❖ Patch panels located in facilities on the core City fiber network
 - ❖ Fiber-specific field cabinets

- ◆ **Splice / Vault Inspection Process**
 - ❖ Prepared maps for each splice / vault location to be inspected (56 locations)
 - ❖ Pulled vault lid, noted conduit condition and noted fiber placement
 - ❖ Noted overall “fiber-ready” condition relative to the ability to support more fiber cable(s)
 - ❖ Noted repair / rehab requirements to make the location fiber-ready

- ◆ **Fiber Patch Panel Audit Process**
 - ❖ Prepared inspection book for each panel to log results
 - ❖ Visited 10 node locations and identified the subject panels
 - ❖ Documented the status of each port – in use, open or not terminated
 - ❖ Flagged port status that did not match OSP Insight records
 - ❖ Provided results to John Gaven for updating in OSP Insight

◆ Goal

- ❖ Determine the likely number of fibers available on the City network
- ❖ Available fibers could be used by the City to create more resilient network for existing applications
- ❖ Available fibers could also possibly be leased to third party network operators

◆ Fiber Strand Analysis Process

- ❖ Update OSP Insight fiber assignments according to patch panel audit
- ❖ Use “Taper Report” tool for each cable segment in the City network
- ❖ Count the number of fiber strands that are coded as “Used”
- ❖ Log the actual number of available fibers based on the total number of strands in the cable segment

◆ Next Steps

- ❖ Many traces showed conflicting coding for strands patched through multiple patch panels
- ❖ Additional quality control should be performed for on each cable segment

◆ Vaults

- ❖ 40 vaults were determined to be suitable as-is to support current and future fiber infrastructure
- ❖ 15 vaults need to be replaced with a larger / deeper vault more suitable for fiber infrastructure
- ❖ 5 vaults needed significant rework due to the presence of streetlight / traffic loop wires

◆ Splice Cases

- ❖ Splice cases were predominantly PLP Coyote legacy clamshell devices
- ❖ In general, these 22-inch splice cases should be replaced over time with smaller models
- ❖ Cables exiting splice cases looked strained – resulting in out of standard cable bend radius
- ❖ In some cases, installing a suitable fiber vault may be preferable to changing the splice case

◆ Conduits

- ❖ Most conduit used for fiber cable was originally installed for streetlight cable and traffic loops
- ❖ 58 conduits entering a fiber vault were observed to be ready for more fiber with $\leq 50\%$ fill rate
- ❖ 12 conduits entering a fiber vault were observed to be suitable for fiber with 75% fill rate
- ❖ 45 conduits entering a fiber vault were completely full and not capable of supporting more fiber

◆ Fiber Cabinets

- ❖ All cabinets were well maintained and had room for additional equipment
- ❖ Fiber and conduit documentation could be improved to reflect current connectivity

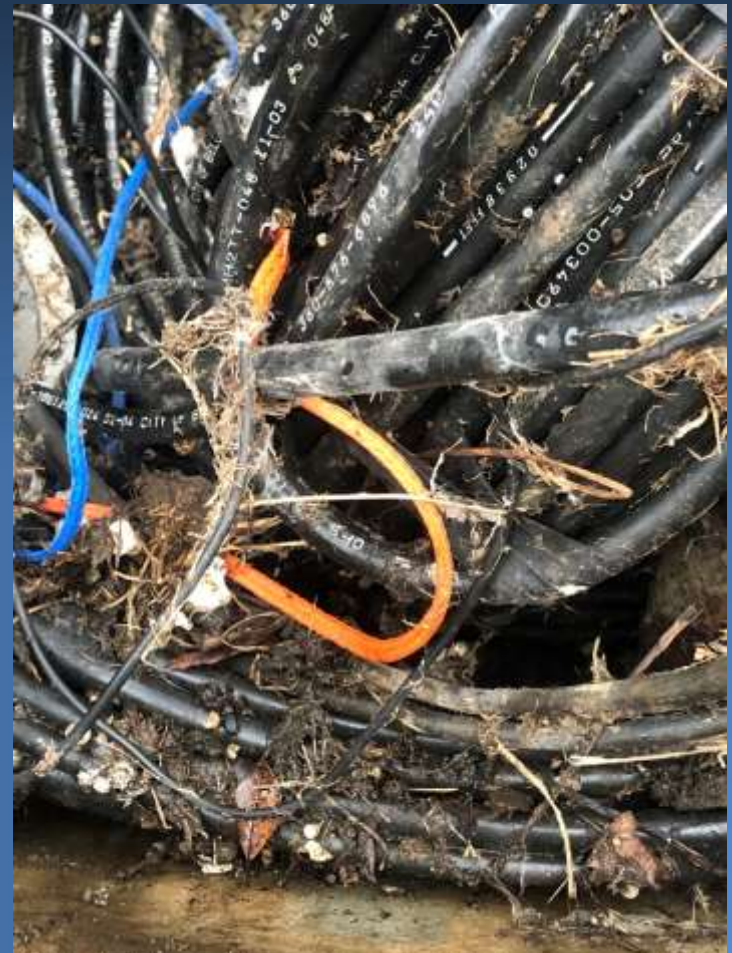
- Issue - Splice Case Too Long
- Fix - Larger Vault or Smaller Splice Case



- Issue - Too Much Wire
- Fix - Larger Vault



- Issue - Poor Cable Management
- Fix - Larger Vault



- Issue – Vault Too Shallow
- Fix - Larger Vault



- Issue – Fiber Cable Kinked
- Fix – Better Cable Management



FIELD OBSERVATIONS – FIBER CABINETS

- Issue – No Issues



- Issue – No Issues



- ❖ Outside Plant (OSP) Characteristics
 - ❖ Most fiber cable is installed underground in conduit – 57.1 miles (1,305 available strand miles)
 - ❖ The rest of the fiber system is installed on utility poles – 14.4 miles (893 available strand miles)
- ❖ Implications of OSP Type
 - ❖ Underground installation typically offers the best option for security and reliability
 - ❖ Aerial placement is typically less expensive, but also prone to weather and traffic related outages



- ◆ Conduit Leasing
 - ❖ The majority of the City's conduit infrastructure is not suitable for commercial fiber
 - ❖ The City would be taking on too much liability given the current state of the system
 - ❖ Certain opportunities may be possible on a case-by-case basis
 - ❖ Uptown would assume \$0 revenue for future conduit leasing of existing assets

- ◆ Dark Fiber Leasing – Underground Cable
 - ❖ Issues with the current conduit infrastructure would limit the capability of the fiber
 - ❖ Micro-bends have a dramatic impact on the performance of fiber transport systems
 - ❖ The City would not be able to offer service level agreements (SLAs)
 - ❖ The existing underground fiber network would likely not support > 10Gig fiber systems
 - ❖ Certain opportunities may be possible on a case-by-case basis
 - ❖ Uptown would assume \$0 revenue for underground dark fiber leasing

- ◆ Dark Fiber Leasing – Aerial Cable
 - ❖ Aerial fiber is in better shape than the underground fiber network
 - ❖ City has aerial fiber capacity on some routes connecting important hubs
 - ❖ The City should be able to offer service level agreements (SLAs) on these routes

- ◆ State of Current Fiber Network
 - ❖ System appears to be supporting the needs of the City
 - ❖ Vault, splice and cable management standards need to be implemented throughout
 - ❖ Spare fibers may be useful in creating enhanced resiliency for City applications
 - ❖ Current underground fiber network is not ready to support private network operators
 - ❖ Certain aerial routes may offer opportunity for dark fiber leasing

- ◆ Next Steps
 - ❖ Capital budget for near term fixes - vault and splice issues
 - ❖ Evaluation of existing City departmental network architectures
 - ❖ Identification of opportunities to create redundancy with available fiber strands
 - ❖ Development of construction standards for future network expansion
 - ❖ Long term strategy for ongoing upgrades of existing fiber network

Task 2: Identify Locations for New & Replacement Infrastructure

- ◆ Key Network Goals
 - ❖ Provide enhanced redundancy and resiliency for current fiber network
 - ❖ Expand Wi-Fi capabilities in the City
 - ❖ Generate revenue from leasing fiber network capacity

- ◆ Primary Issues to Overcome
 - ❖ Current network lacks the ability to support carrier class services
 - ❖ Certain network routes lack the capacity to support a ring architecture

- ◆ Overcoming Obstacles to Meeting City Goals
 - ❖ Upgrade streetlight conduits and vaults to safely house fiber cable and closures
 - ❖ Augment fiber strand capacity in routes that are current exhausted

- ◆ Define Long Term Routes Required for Redundancy and Resiliency
 - ❖ Identify main routes that will provide the foundation for implementing ring technology
 - ❖ Characterize routes according to network hierarchy and timing (priority)
 - ❖ Most routes are in place today, but gaps do exist

- ◆ Detailed Testing of Existing Fiber Network
 - ❖ Complete testing at the fiber strand level
 - ❖ OTDR testing (fiber traces) will identify trouble spots in the system
 - ❖ Trouble spots will likely be points where cable is kinked or bent beyond specifications

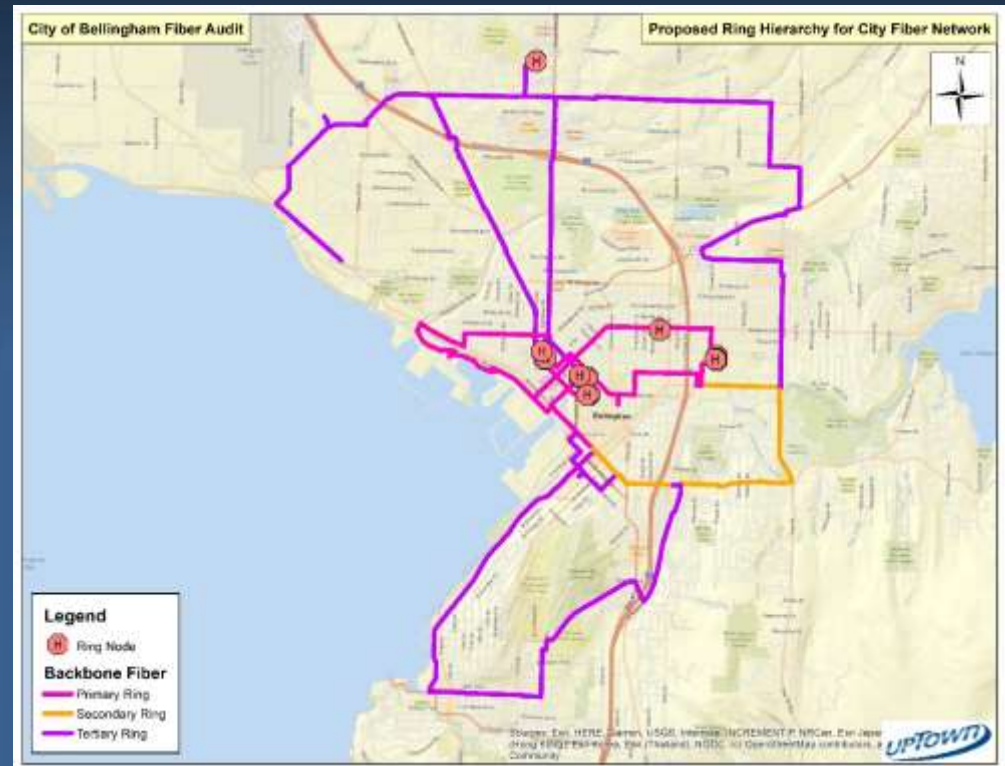
- ◆ Finalize List of Streetlight Infrastructure to be Upgraded
 - ❖ All shallow or small streetlight handholes are assumed to be upgrade candidates
 - ❖ Test results will reveal obvious issues
 - ❖ Some streetlight structures should be upgraded regardless if too congested

- ◆ Finalize List of Routes Requiring New Fiber Capacity
 - ❖ Spare fiber strands appear to be available in most proposed ring routes
 - ❖ At least one route on the southwest side of the City is out of capacity (fiber strands)
 - ❖ New fiber cable will need to be placed in this route after the vaults have been upgraded

- ◆ Primary Rings
 - ❖ Connects to critical facilities
 - ❖ City facilities
 - ❖ Data centers
 - ❖ Carrier Interconnection facilities

- ◆ Secondary Rings
 - ❖ Connects to Primary Rings
 - ❖ Connects to secondary sites
 - ❖ Connects to Tertiary Rings

- ◆ Tertiary Rings
 - ❖ Connects to Tertiary Sites
 - ❖ Connects to Primary Rings
 - ❖ Connects to Secondary Rings
 - ❖ May contain some collapsed ring sections





- ◆ Unit cost assumptions drawn from multiple sources
 - ❖ Recent bid results from Uptown clients that are deploying broadband networks
 - ❖ Other broadband operators in the region
 - ❖ Local outside plant experts
 - ❖ Local outside plant contractors

- ◆ Actual sources for this study
 - ❖ Anecdotal information from several clients in Oregon including Hillsboro and Clackamas
 - ❖ Local public works contractor – Sail Electric, Inc.
 - ❖ Local resources with construction experience in Bellingham and the region
 - ❖ John Gaven
 - ❖ Milissa Miller

- ◆ Fiber strand testing assumptions
 - ❖ Test all terminated fiber strands owned by the City
 - ❖ Complete standard OTDR testing from each patch panel port
 - ❖ Retain OTDR trace results
 - ❖ Review each trace and identify trouble spots for each strand

- ◆ Cost estimate
 - ❖ Ports to be tested – 2,400
 - ❖ Cost per trace to be paid to contractor - \$40.00
 - ❖ Cost per trace review by contractor - \$20.00
 - ❖ Total budget estimate - \$144,000

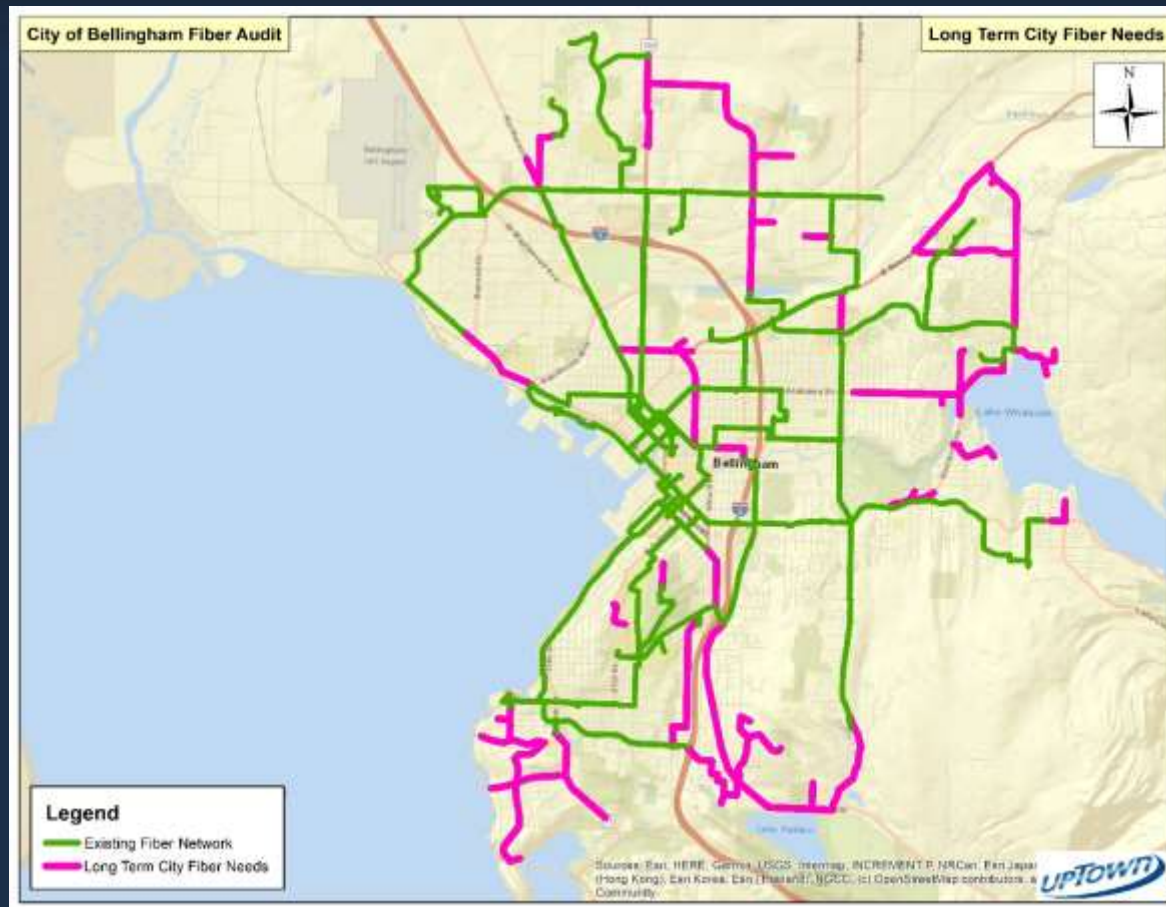
- ◆ Streetlight Handhole Upgrades
 - ❖ Upgrade existing handhole to accommodate streetlight AND fiber infrastructure
 - ❖ Will require minimum 24x36x24 vault in most cases
 - ❖ Includes replacement of conduit sweeps to reduce bending stress on fiber cable
 - ❖ Will require contractors to complete this work given the number of locations
 - ❖ Conservative estimate of \$9,500 materials and labor per location is assumed*

Route	Upgrades Required	Cost per Upgrade	Total Cost	Priority
Core	186	\$9,500	\$1,767,000	1
East	146	\$9,500	\$1,387,000	2
Southwest	16	\$9,500	\$152,000	3
South	87	\$9,500	\$826,500	4
Northeast	167	\$9,500	\$1,586,500	5
Northwest	121	\$9,500	\$1,149,500	6
Northcentral	85	\$9,500	\$807,500	7
West	37	\$9,500	\$351,500	8
Total	845		\$8.0M	

* - Estimate sourced from local contractor

- ◆ Augment Existing Fiber Route
 - ❖ 36 fiber cable in Southwest route is fully exhausted
 - ❖ Route is critical to support strong ring options for the fiber network
 - ❖ City should place new 96 fiber cable in this route after the vaults have been upgraded
 - ❖ Conservative labor and materials estimate would be \$5.00 per foot
 - ❖ 25,500 feet of new cable would be required for a total cost of \$127,500





- ❖ City has a wish list of new routes that would be beneficial for different City applications
- ❖ No current conduit is available on these routes, so new facilities would have to be installed
- ❖ City should build these routes by piggybacking on other public works projects (i.e. roads & water)

Task 3: Identify Operational Resources

Services Strategy for Last Mile and Middle Mile Scenarios

There are **three possible service strategies** for the City to further utilize the fiber asset, subject to varying degrees of operational involvement and further infrastructure investment...

1. Middle Mile Data Services
 - ◆ Scenario 1A: Lease dark fiber strands to Service Providers
 - ◆ Scenario 1B*: Lease lit fiber circuits with capacity from 1Gbps – 100Gbps to commercial entities
 - ◆ Retail Model: City owns and operates the fiber system and acts as service provider
 - ◆ Wholesale Model: City owns and maintains fiber. Existing ISP partner acts as service provider
 - ◆ Construction of fiber laterals occurs after the sale, resulting in greater certainty of financial feasibility
 - ◆ Harder to predict revenue potential (market entrants and more complex needs)
2. Scenario 2: Last Mile Broadband (includes Scenario 1B)
 - ◆ Traditional fiber broadband provided to households and commercial entities
 - ◆ Requires full fiber buildout to “pass” all premises with fiber
 - ◆ Business model can be retail or wholesale
 - ◆ Construction of last mile fiber build occurs prior to the sale, resulting in lower certainty of financial feasibility
 - ◆ Easier to predict revenue potential (homogenous market and law of large numbers)

*Scenario 1B would also include leasing of dark fiber.

- Proposed dark fiber lease fees reflect prices typical of urban areas. Differentiated fees for public sector entities are common within the municipal broadband sector and are recommended and we estimate average monthly revenue per strand mile at \$325...

	Public*	Private
Single Strand	\$300/mile**	\$350/mile**
Additional Strands	\$240/mile**	\$275/mile**
Network Maintenance	Shared maintenance costs across fiber infrastructure owners	
*Public sector discounts are applicable to non-private sector leasing entities. **Fractional miles are prorated.		

- Proposed dark fiber lease fees reflect prices typical of urban areas. Differentiated fees for public sector entities are common within the municipal broadband sector and are recommended. We estimate average monthly revenue per leased access connection of \$1,500...

Leased Capacity	MRC – 3 Year Term	MRC – 5 Year Term	Restrictions
1G	Private: \$1,200 (\$1.20/Mbps) Public: \$1,100 (\$1.10/Mbps)*	Private: \$1,000 (\$1.00/Mbps) Public: \$900 (\$.90/Mbps)*	Subject to fiber availability. A non-recurring charge may be required for new construction.
5G	Private: \$2,000 (\$.40/Mbps) Public: \$1,750 (\$.35/Mbps)*	Private: \$1,750 (\$.35/Mbps) Public: \$1,500 (\$.30/Mbps)*	
10G	Private: \$2,500 (\$.25/Mbps) Public: \$2,250 (\$.225/Mbps)*	Private: \$2,000 (\$.20/Mbps) Public: \$1,750 (\$.175/Mbps)*	Resale to end-user business and households prohibited within city limits
> 10G	Custom Quote		

*Public sector discounts are applicable to non-private sector leasing entities.

- CenturyLink presents both DSL and fiber Internet plans depending upon the service address used to check availability. The extent of fiber deployment is not known, but appears limited based upon address search results.
- Comcast appears to have fully upgraded its HFC plant to DOCSIS3.1 and can offer gig service. However, pricing is steep and a \$30 premium is required to remove the standard data cap. In December 2023, Comcast announced upcoming broadband rate increases of \$3/month to be implemented in January 2024.*

	Download	Upload	Price	Data Cap?	ACP?	Technology
CenturyLink	3M	500K	\$50.00	No Cap	Yes	DSL
	6M	500K	\$50.00			
	15M	750K	\$50.00			
	500M**	500M	\$50.00			Fiber
940M**	940M	\$75.00				
Comcast	75M	2M	<u>Promotion / Month-Month / No Data Cap</u> \$19.99 / \$61.00 / \$91.00	Yes. Unlimited data is \$30 extra	Yes	Cable Modem (DOCSIS 3.1)
	200M	5M	\$30.00 / \$73.00 / \$103.00			
	400M	25M	\$55.00 / \$83.00 / \$113.00			
	800M	25M	\$65.00 / \$93.00 / \$123.00			
	1.0G	30M	\$75.00 / \$103.00 / \$133.00			
	1.2G	35M	\$80.00 / \$113.00 / \$143.00			

CenturyLink pricing per centurylink.com as of Nov. 2023. Comcast pricing from xfinity.com as of Nov. 2023.

*Source: NextTV "Comcast Set To Up Prices on Xfinity Cable Services ... Again" dated December 8, 2023.

**Not available in all areas.

- Four alternative providers have partially deployed either fixed wireless or fiber within the community...

	Download	Upload	Price	Technology
Quantum Fiber	500M 940M*	500M 940M	\$50.00 \$75.00	Fiber
Astound Broadband	100M* 500M* 940M* 1.5G*	Not Specified	\$25.00 (24 month promotion)** \$45.00 (24 month promotion)** \$65.00 (24 month promotion)** \$80.00 (24 month promotion)**	Fiber
Ziply Fiber	45M – 115M	7M	\$50.00	DSL (resale)
	100M* 300M* 1G* 2G*	100M 300M 1G 2G	\$40.00 \$60.00 \$80.00 \$120.00	Fiber
Always ON	Not Specified		\$149.99-\$399.99 Base Fee*** + • \$60/mo. for 25GB • \$100/mo. for 100GB • \$220/mo. for 1,000GB	Fixed Wireless
PogoZone	Not Specified		\$35.00 / \$50.00 / \$65.00 / \$85.00	Fixed Wireless

Quantum Fiber pricing per quantumfiber.com as of Nov. 2023. Astound Broadband pricing from astound.com as of Nov. 2023. Always ON pricing from alwaysonwifi.com as of Nov. 2023.

*Not available in all areas. **Requires subscription to Astound TV. ***One-time fee.

- CenturyLink has DSL plans available with varying speeds (determined by distance from their Central Office). All speeds are priced at \$50/month.
- Comcast has standard business Internet plans up to 1.25Gbps, but fees are high and initial promotional discounts taper off during the contract term. They do not use data caps for their commercial service, but equipment fees are expensive.

	Download	Upload	Price	Contract	Equipment Fee	Data Cap?	Technology
Century Link	6M 10M* 15M* 40M*	500K 750K 750K 3M	\$50.00 \$50.00 \$50.00 \$50.00	No		No Cap	DSL
Comcast	50M 100M 250M 500M 750M 1.25G	15M 25M 25M 30M 35M 35M	<u>Auto Pay / Standard</u> \$49.00 / \$59.00 \$89.99 / \$104.99 \$119.99 / \$134.99 \$159.99 / \$174.99 \$234.99 / \$264.99 \$334.99 / \$364.99	Yes, 2 years	\$22.95 /month \$22.95 /month \$32.95 /month \$32.95 /month \$32.95 /month \$32.95 /month	No	Cable Modem (DOCSIS 3.1)

CenturyLink pricing per centurylink.com as of Dec. 2023. Comcast pricing from business.comcast.com as of Dec. 2023.

*Not available in all areas.

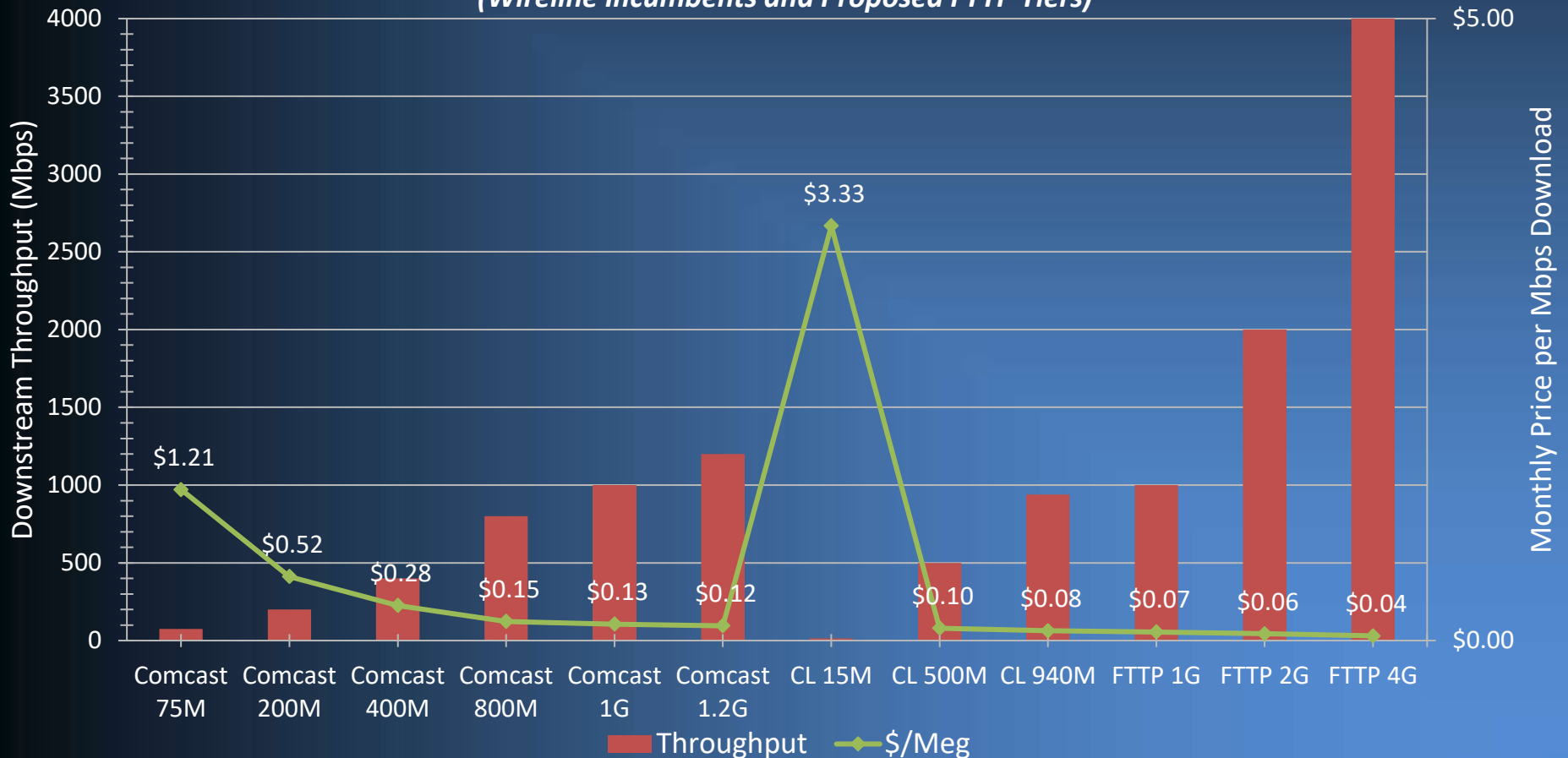
RESIDENTIAL INTERNET PRICING & TERMS

- Municipal broadband operators under the retail business model typically price their entry-level tier at ≈\$70. Service providers under the wholesale business model typically price their entry-level tier at \$80-90.
- Service pricing should provide greater value than incumbent offerings as determined in the research survey findings.
- The City’s Internet service would not have data caps, nor early termination fees and would embrace net neutrality.

Internet Tier Download / Upload	Monthly Price	Proposed Service Terms
1G / 1G	\$70	Data Cap: No Term Agreement: No Termination Fee: No
2G / 2G	\$110	
4G / 4G	\$150	
Wireless Gateway Upgrade	Add \$10	

- We measure value as the price per Mbps provided. Comcast metrics include additional fees to eliminate the data cap for comparison to CenturyLink and the proposed FTTP offerings. The CenturyLink 500M and 940M tiers are only available where FTTP has been deployed...

Internet Downstream Throughput and Price per Mbps
(Wireline Incumbents and Proposed FTTP Tiers)





COMMERCIAL INTERNET PRICING & TERMS

Commercial services reflect a pricing premium to residential services. This reflects market conditions and traffic volume/users per connection. Multiple service options are available for complex accounts.

- ◆ Shared capacity connection over GPON
- ◆ No contract requirement and no SLA guarantees
- ◆ Can upgrade to symmetrical bandwidth and add BGP Routing (some tiers)

Proposed Standard Tiers Download / Upload	Monthly Price
100M / 20M <i>Add Symmetrical</i>	\$80.00 <i>+ \$50</i>
500M / 250M <i>Add Symmetrical</i>	\$150.00 <i>+ \$50</i>
1G / 500M <i>Add Symmetrical</i>	\$200.00 <i>+ \$50</i>
Custom Quote	

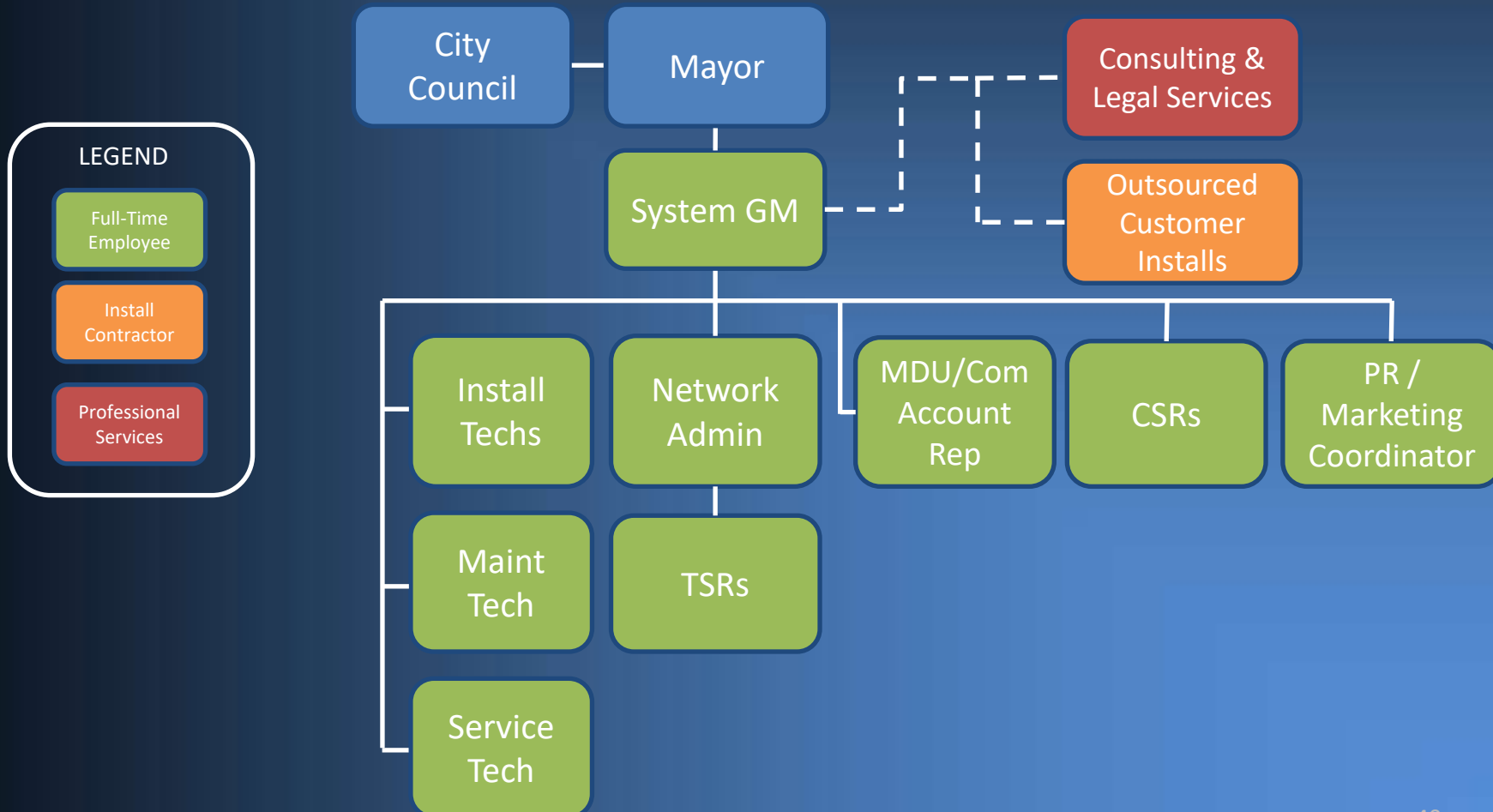
Task 3: Identify Operational Resources

Staffing and Operational Resources and Procedures

TYPICAL BROADBAND ORGANIZATION STRUCTURE

Contractor services can be utilized in the early years to complete some start-up tasks and avoid short term hiring:

- Legal: Bond counsel and legal start-up tasks
- Consulting: Implementation support during the start-up phase
- Installs: Initially outsourced and then internally staffed after install volume normalizes





INCREMENTAL HEADCOUNT BY SCENARIO

	Pay Scale*	Salary (unloaded)	Dark Fiber	Leased Access	Last Mile Retail
System GM	-	\$160,000			1
Infrastructure Manager	-	\$120,000		1	
Marketing Coordinator	Plan S Grade 3	\$86,000			1
Commercial Account Manager	Plan S Grade 4	\$91,000	1	1	1
Data Technician	-	\$120,000			1
Network Design Engineer	-	\$75,000	1	1	Contracted
Customer Service Supervisor	Plan S Grade 2	\$83,000			1
CSRs	Hourly 8	\$60,000			5
TSRs	Hourly 10	\$65,000			5
Install Techs	Hourly 8	\$60,000			5 (peak)
Maintenance Techs	Hourly 10	\$65,000	2	2	1
Service Techs	Hourly 8	\$60,000			4 (peak)
Year 5 Total FTE			4	5	21



MIDDLE MILE: STAFFING POSITION DETAILS

Position	Role	Staffing Entity	Compensation	Location
Infrastructure Manager	Lead manager responsible for all broadband operations and enterprise results. Prepares departmental budget. Negotiates contracts and manages bandwidth sourcing.	City	Exempt FTE	Onsite - desk space needed
Commercial Account Rep	Direct sales to 3 rd part resellers (ISPs) and end user business accounts, including ROI analysis of fiber lateral construction. Single point of contact for all accounts excluding outages.			
Network Design Engineer	Responsible for designing and maintaining all fiber assets within GIS, including new fiber lateral construction, meet-me locations with ISPs, etc. Generates BOM for all construction projects.			
Maintenance Techs	Oversight and inspection of fiber lateral construction. Respond to and resolve outages and maintain all outside plant assets.		Non-Exempt Hourly	City garage /operations center



LAST MILE: STAFFING POSITION DETAILS

Position	Role	Staffing Entity	Compensation	Location
System GM	Lead manager responsible for all broadband operations and enterprise results	Varies by Business Model	Exempt FTE	Onsite - desk space needed
Marketing Coordinator	Develop and implement direct marketing and fulfillment materials, and manage advertising campaigns.			
Commercial Account Rep	Direct sales to business accounts and installation coordination and MDU ROE agreements.			
Network Engineer	Secondary responsible for all broadband electronics and systems			
Customer Service Reps	Phone and email support for work order creation, trouble tickets, billing (Tier 1)		Non-Exempt Hourly	
Technical Service Reps	Help desk support (Tier 2)			
Install Techs	Complete pre and premise installs		Install Contractor	
Maintenance Techs	Resolve outage and maintain outside plant assets	Varies by Business Model	Non-Exempt Hourly	City garage /operations center
Service Techs	Complete service calls requiring a truck roll			



FTE LEVELS: DEDICATED FRONTLINE EMPLOYEES

- ◆ Customer / Technical Service Representatives (CSRs/TSRs)
 - ◆ CSRs handle inbound/office sales, order entry and first tier support
 - ◆ TSRs handle all second tier customer support, dispatch and service provisioning
 - ◆ Staffed at 1 FTE per 2k accounts growing to 4k by Year 5, but with minimum of 3 CSR and 2 TSR positions to ensure phone coverage. Supervisor position required if total CSRs and TSRs exceed 8 FTE
- ◆ Install Technicians
 - ◆ Installs are 2-phase with pre-install followed by separate premise install
 - ◆ Each Install Tech complete 2/day growing to 3/day by Year 5
- ◆ Service Technicians
 - ◆ Service techs fix subscriber problems
 - ◆ Service call volume equals 50% of all subscribers/year dropping to 25% by year 5
 - ◆ Each Service Tech can complete 4/day growing to 6/day by Year 5
- ◆ Maintenance Technicians
 - ◆ Network techs maintain the fiber system from the backbone to the network access point
 - ◆ Increases from two currently to three in Year 3

Scenario	Daypart	Position(s)	Contact Method	Sales / Support Functions
Middle Mile	M-F 8am–5pm	Account Manager Network Design Engineer Maintenance Techs	Direct customer contact	Sales meetings and proposals, including drawings of fiber routes. Communicate and conduct scheduled maintenance.
	After Hours M-F 5pm–8am / Sat / Sun	On-Call Maintenance Tech	Network alarm notification	Response to Severity I incidents and follow notification and escalation procedures
Last Mile	M-F 8am–9pm	CSRs	Inbound calls	Serviceability inquiries, connect orders, change/move orders, disconnect orders, billing
			Outbound Calls	Ready-for-service notifications
	TSRs	Inbound call or warm transfer (by CSR)	Help desk support and troubleshooting	
	Field Techs	Dispatched via OSS Trouble Ticket	Onsite service issue resolution	
	After Hours M-F 9pm–8am / Sat / Sun	3 rd Party Call Center	Inbound calls	Sales: Create account and work order for next day callback Support: Help desk support and troubleshooting
		On-Call Tech	Network alarm notification / Customer notification (via IVR)	Response to Severity I incidents



LAST MILE: CUSTOMER SUPPORT SHIFTS

Hours of Operation will need to extend beyond regular public access hours:

- Inbound calls answered by CSRs and TSRs will peak between 5-8pm weekdays
- Maintenance Tech will be on-call after hours for any network outage
- Install Techs will be scheduled into 4 hour install windows (morning and afternoon) with 1 hour arrival window commitment

Position	Shift Schedule	Skillset Requirement*
Commercial Account Rep	M-F 8am-5pm	Account sales / Prospect management / Knowledge of telecom services / Wiring design & cost estimation
Customer Service Reps	3 Shifts (M-F) Shift 1: 8am-5pm Shift 2: Noon-9pm Shift 3: Noon-9pm	Customer service experience / sales experience / computer and software proficiency /
Technical Service Reps	2 Shifts (M-F) Shift 1: 8am-5pm Shift 2: Noon-9pm	ISP help desk experience / PC, home router, and WiFi knowledge / software proficiency / basic network understanding
Install Techs	2 Install Windows Morning & Afternoon	Field Tech experience / Low-voltage wiring knowledge / basic OSP construction knowledge
Maintenance Techs	M-F 8am-5pm After Hours: On-Call	
Service Techs	M-F Noon-9pm	

* Ideal candidates for these positions will possess previous industry experience in similar roles with CenturyLink, Comcast or other service providers.



CUSTOMER SERVICE ISSUE CLASSIFICATIONS

Severity I: TSR, on-call engineer or tech will immediately initiate appropriate steps to resolve the issue as soon as possible

Severity II: Initiate within 4 hours of receiving notification from the customer

Severity III: Initiate response such that resolution activity will be underway prior to 5pm of the same day if notification from the customer was received by 11am – otherwise resolution next business day

	Residential	Commercial	Key Account / SLA
Single Premise Affecting	<p>Severity III Incident:</p> <ul style="list-style-type: none"> • ONT not powered • No Internet or Slow Internet • Email issues (if using City-provided email) 	<p>Severity II Incident:</p> <ul style="list-style-type: none"> • ONT not powered • No Internet <p>Severity III Incident:</p> <ul style="list-style-type: none"> • Slow Internet • Email issues (if using City-provided email) 	<p>Severity I Incident:</p> <ul style="list-style-type: none"> • All connectivity- related issues
Multiple Premise Affecting	<p>Severity I Incident:</p> <ul style="list-style-type: none"> • ONT not powered • No Internet <p>Severity III Incident:</p> <ul style="list-style-type: none"> • Slow Internet • Email issues (if using City-provided email) 		

- ◆ **Operations Support Software (OSS)** is the primary software tool controlling nearly all aspects of service provisioning & management (including device interdiction and control), customer account management, and billing. Examples include ETI and Great Lakes Data Systems. A key consideration is the degree of interoperability between the OSS and the FTTP electronics platform (e.g. to support auto-provisioning, etc.).
- ◆ **Fiber Management Software** is the GIS-based design tool for drafting OSP pathway, assigning fiber strands, and maintaining the fiber assets. The City is already using a GIS software platform to manage existing fiber and conduit assets. The City would need to keep the system updated as new subscribers are added and the network is expanded to new build areas.
- ◆ **Network Element Management Software (EMS)** provides an integrated system for sharing device information across management applications, automation of device management tasks, visibility into the health and capability of the network, and identification and localization of network trouble. This functionality is typically acquired as part of an FTTP Equipment RFP.

The following OSS functions are critical to having robust and reliable control over the customer fulfillment process. Furthermore, in order to minimize front-line staff efficiency and reduce human error, the OSS should fully interoperate with both the FTTP electronics vendor and the voice provider.

Functionality / Module	Required Capabilities
Platform Options	Onsite or Hosted
Supported Service Set	Required: Data services. Optional: Voice and/or Video (including hosted video apps)
House File	Import from GIS database. Serviceability status for each premises.
End User Billing	Service and package codes, discounting, bill cycles, bill statement rendering, campaign codes/rules, prorating, cash drawer, billing file export, call detail record import, payment posting, deposits, online bill payment
Service Order Management	Create and manage work order (WO) types (Connect, Disconnect, Suspension, Change, and Trouble Ticket), WO reporting, WO routing, notes filed, sales ID assignment, reason codes
Work Force & Asset Management	Scheduling and quota management, technician skill ratings, activity codes and task points assignment, inventory tracking/location of ONTs and other CPE, technician productivity reports, on-time appointments, inventory level reports
Interoperability & Integration	Interoperability and device control over all ONT models including WiFi and extenders
Trouble Ticketing	Trouble ticket creation (both manual and automated), definable problems with categories and reason codes, definable customer types and categories, notification via email based on groups, problem codes, severity

Task 4: Identify Resources to Enhance Infrastructure

- ❖ Impact of other construction projects on planned routes for broadband
 - ❖ The proposed upgrade plan calls for minimal construction of new routes
 - ❖ The primary strategy involves improving the quality and resilience of the existing network
 - ❖ City should continue to place new fiber conduit segments as part road and water work

- ❖ Level of contractor involvement throughout the upgrade process
 - ❖ Initial outside plant design and technical services (splicing) covered by staffing plan
 - ❖ Ongoing maintenance and engineering are also covered by staffing plan
 - ❖ City should contract with outside plant construction firm to complete vault upgrades
 - ❖ Fiber department staff should serve as project manager for the vault upgrades

- ❖ Material requirements and associated lead times
 - ❖ All required outside plant materials should be available within standard delivery windows
 - ❖ All vaults and handholes will be referenced to an existing Washington DOT specification
 - ❖ No specialized assemblies or devices are required for the proposed network upgrades

- ◆ Specialized permitting requirements
 - ❖ No specialized permitting will be required for the proposed upgrades
 - ❖ Some vault replacements may involve sidewalk closures
 - ❖ Most vault replacements will be complete in three days or less (including restoration)

- ◆ Project deployment strategy in terms of phasing and timeframe
 - ❖ Backbone upgrade efforts should be prioritized from the center of the network
 - ❖ Upgrades should be completed on a route-by-route basis
 - ❖ Issue an RFP for OTDR testing and analysis of the existing fiber network
 - ❖ Issue an RFP for “up to” 845 vault upgrades
 - ❖ Hold the fiber installation RFP for the Southwest Route until that route has been upgraded
 - ❖ Project should take 18 to 24 months from testing to completion of the last vault upgrade

Task 5: Opportunities to Serve Unserved and Underserved Areas

Evaluation of Federal Grant Funding Opportunity

The American Rescue Plan Act of 2021 (ARPA) is a federal grant program **available to public sector entities** that includes funds for the construction of broadband infrastructure, along with numerous other programs...

<p>Program Overview</p>	<ul style="list-style-type: none"> • Total program funds of \$350B were allocated to various governmental jurisdictions: <ul style="list-style-type: none"> • States: \$195B • Counties: \$65B • Cities: \$45B • Tribal Governments/Territories/Other Local Government: \$44B • Funds investment in broadband infrastructure (build or upgrade) • Funding starts March 3, 2021. Funds must be “obligated” by December 31, 2024 • Program rules issued by Department of the Treasury with Final Rule effective April 1, 2022
<p>Eligible Use of Funds</p>	<ul style="list-style-type: none"> • Necessary investment: Service area is eligible if there is an identified need for additional broadband infrastructure investment (e.g. lack of reliable 100M symmetrical speed) using data methods from speed tests, federal or state maps, interviews and surveys. • Minimum level of service: Minimum speed of 100Mbps symmetrical • Labor standards: Local hiring, prevailing wages, and safety and training standards • Affordability: Service provider participation in qualifying affordability plan
<p>Project Prioritization</p>	<ul style="list-style-type: none"> • Priority given to projects that provide last mile connections using wireline technology • Construction contracts should reflect prevailing wages and robust labor standards • Project ownership, operation, or affiliation with local governments or cooperatives • Avoid service areas under existing funding commitments via federal or state grants



BROADBAND EQUITY, ACCESS & DEPLOYMENT PROGRAM

The Broadband Equity, Access, and Deployment Program (BEAD) is a federal grant program that includes funds broadband deployment, mapping, and adoption projects...

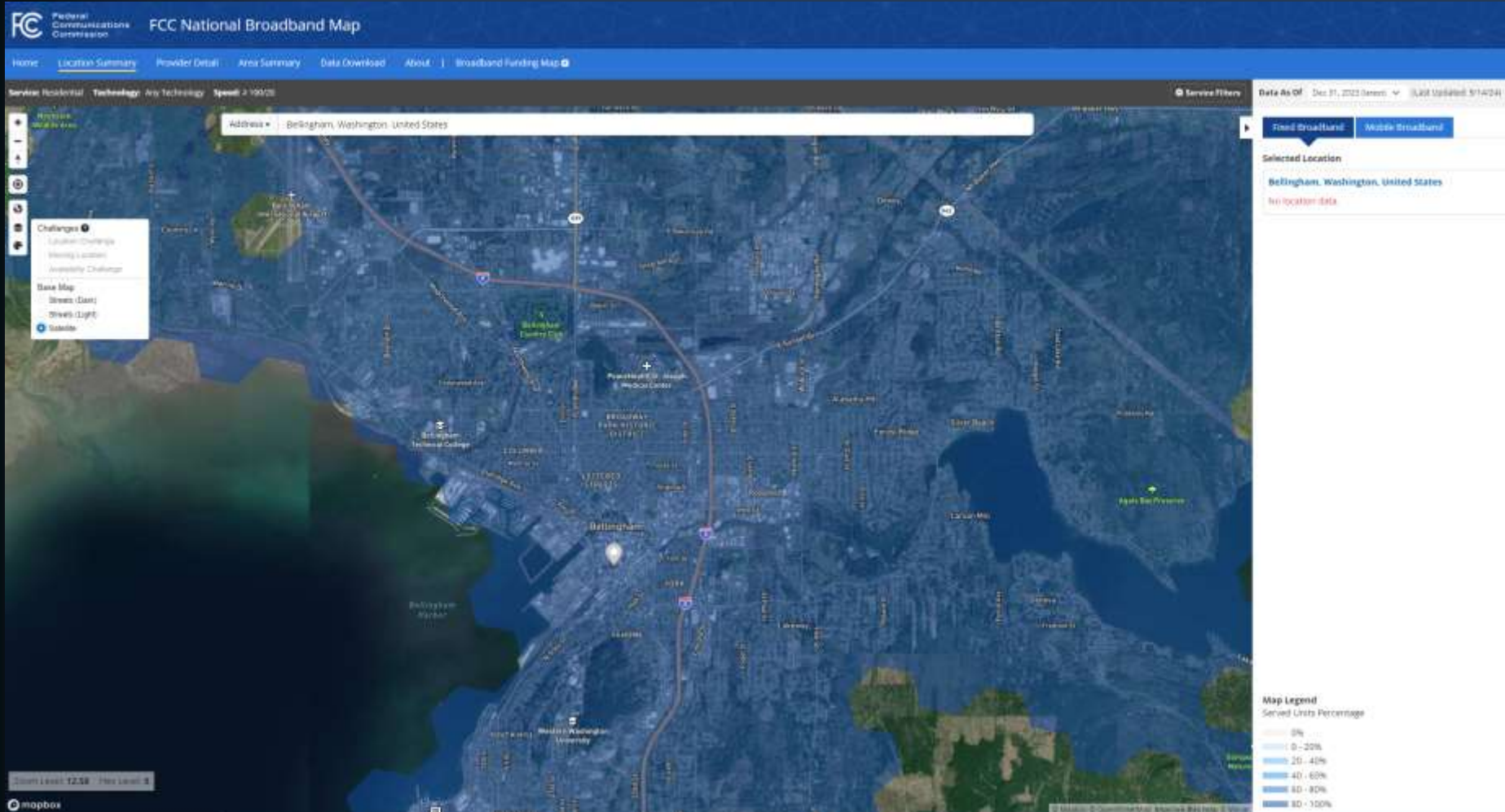
<p>Program Overview</p>	<ul style="list-style-type: none"> • \$42.5B in total funding to be allocated at the state level • Planning and project prioritization through state broadband offices which are tasked with developing 5 year action plans • Program oversight at the state level with federal implementation and support via the National Telecommunication and Information Administration (NTIA) • The 50 US states and territories are eligible grantees that can award BEAD grant funds to ‘subgrantees’ including coops, 3P partnerships, PUDs, and private firms, local governments, etc.
<p>Eligible Use of Funds</p>	<ul style="list-style-type: none"> • Last mile infrastructure projects must target un- or underserved areas where 80% or more of households do not have access to a minimum of 100Mbps/20Mbps. • State broadband offices are expected to begin accepting applications during the first half of 2023
<p>Likely Guidelines</p>	<ul style="list-style-type: none"> • While up to each state, we expect alignment with ARPA rules for determining eligible service areas • Funding recipients will be required to collect and maintain data to help the NTIA assess the programs’ impact, evaluate targets, promote accountability and coordinate with other federal and state programs • Criteria to assess grant recipients’ plans to ensure that service providers maintain or exceed thresholds for reliability, quality of service, sustainability, upgradability and other required service characteristics • Criteria to ensure that funding is deployed in a way that maximizes the creation of “good paying jobs.

The ReConnect Program provides loans, grants, and loan/grant combinations to bring high speed Internet to rural areas, including infrastructure projects...

<p>Program Overview</p>	<ul style="list-style-type: none"> • The program is funded through funding rounds with Round 4 closing on November 2, 2022 • Program oversight at the U.S. Department of Agriculture (USDA). Round 4 funds up to: <ul style="list-style-type: none"> • \$150M in loans • \$300M in loan/grant combinations • \$700M in grants • Eligible grantees include both public and private sector entities
<p>Eligible Use of Funds</p>	<ul style="list-style-type: none"> • Eligible service areas must be both a) Rural*, and b) 50% or more of households must lack sufficient access to broadband, defined as “fixed terrestrial broadband service at 100 Mbps downstream and 20 Mbps upstream • For a 100% grant (with no loan), the applicant must demonstrate that at least 90 percent of homes in the proposed service area do not have sufficient access to broadband • Program funds can be used for the construction or improvement of facilities capable of delivering 100 Mbps symmetrical service to every premises in the proposed service area at the same time
<p>Other Guidelines</p>	<ul style="list-style-type: none"> • Awardees will be required to participate in the federal ACP program • Projects funded by a 100% grant require a 25% match

*Service areas cannot be located in a city, town, or incorporated area with a population greater than 20,000, or an urbanized area adjacent to a city or town with a population greater than 50,000.

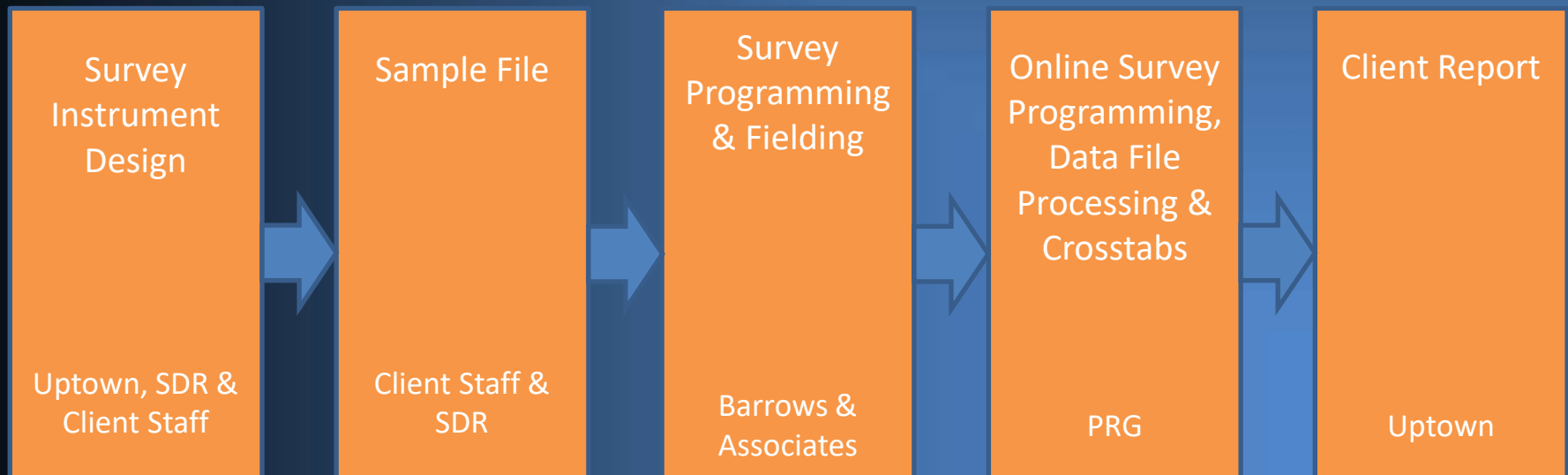
All reporting areas within Bellingham are “served” with broadband at a minimum level of 80% according to the latest FCC National Broadband Database and Mapping



Task 5: Opportunities to Serve Unserved and Underserved Areas

Residential Quantitative Market Research

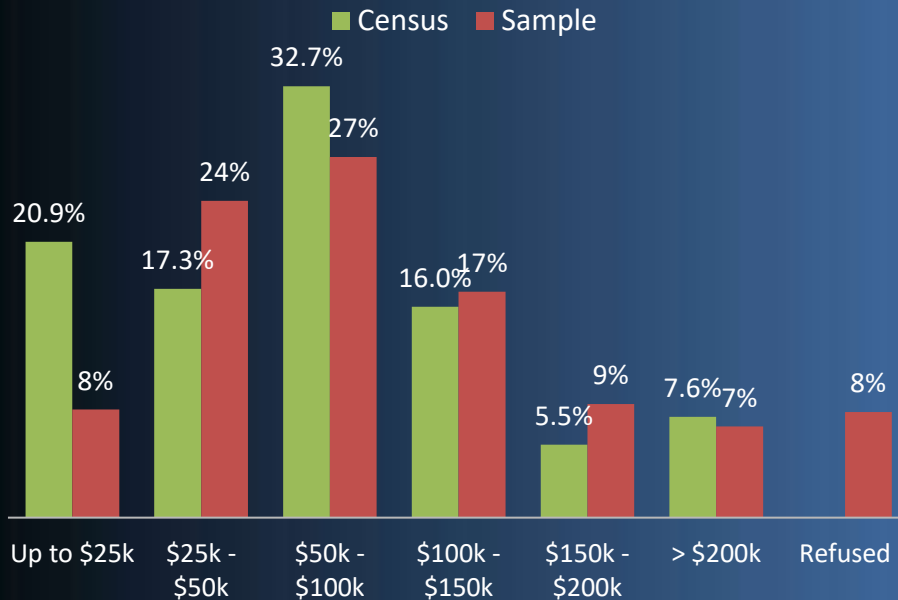
- ◆ The quantitative research process utilized both subject matter and functional expertise across multiple contractors by specialty:
 - ◆ **Uptown Services:** Subject expertise and study data needs
 - ◆ **SDR Consulting (Rick Hunter):** Research expert overseeing design and execution (23 years experience with 200k completed research projects)
 - ◆ **Barrows & Associates:** Survey fielding and data collection
 - ◆ **Prairie Research Group (James Wolken):** Online survey programming, crosstab analysis and production of output banners (25 years experience)



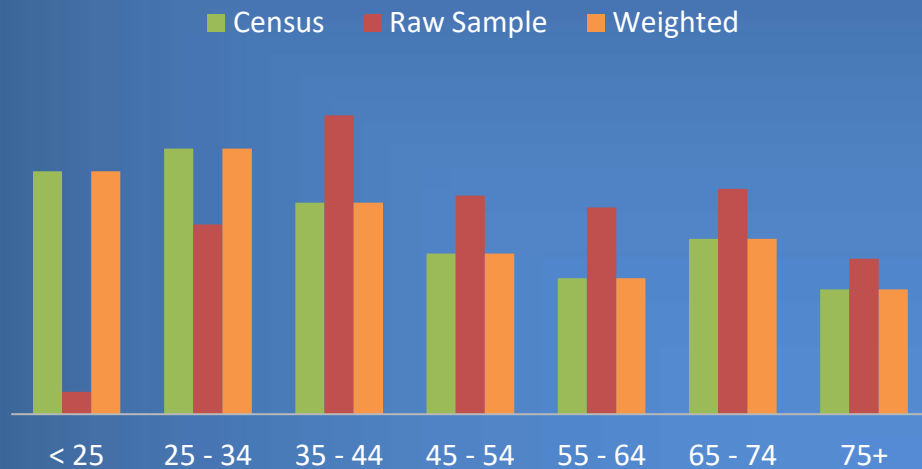
- ◆ Phone and online surveys
 - ❖ Total sample of 1,522 respondents of universe of ≈39,000 households
 - ❖ 395 via phone survey (list included wireline and wireless numbers)
 - ❖ 1,127 via online email invitation (email addresses purchased via 3rd party data source)
 - ❖ ± 2.5% sample error at 95% confidence interval
- ◆ Age quotas used to ensure robust sample across all age groups. Results weighted to reflect actual age distribution from 2022 American Community Survey (US Census Bureau) data
- ◆ Respondents screened to ensure
 - ❖ Decision-maker for telecommunications and entertainment services in the home
 - ❖ Reside within city limits
 - ❖ Respondents with immediate family members employed by any of the following were excluded:
 - The City of Bellingham
 - Comcast/Xfinity
 - CenturyLink
 - Ziplly
 - PogoZone
 - Quantum Fiber
 - Astound Broadband

- Survey results are weighted to reflect the actual age distribution (by age decile) per the 2020 census.
- The income profile of the sample is not dissimilar to the universe of residents, but skews slightly to higher income, with lower income households more likely to refuse to state income.

Household Income



Head of Household Age (Unweighted Sample)



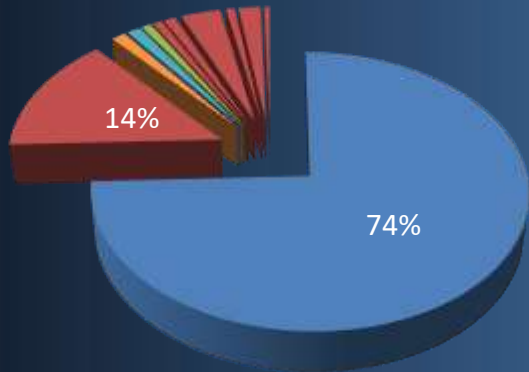
Residential Quantitative Survey

Current Broadband Services Usage

INTERNET SERVICE PURCHASING BEHAVIOR

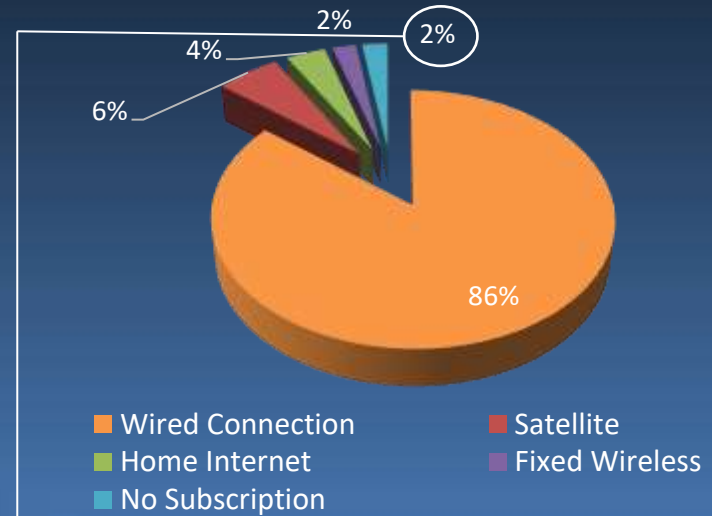
- ◆ 98% of Bellingham households subscribe to Internet service at home, with 86% via a wired connection
- ◆ Comcast has 74% market share of the residential broadband market
- ◆ Lack of need and affordability are the primary reasons for lack of an Internet subscription

Internet Market Share (Households)

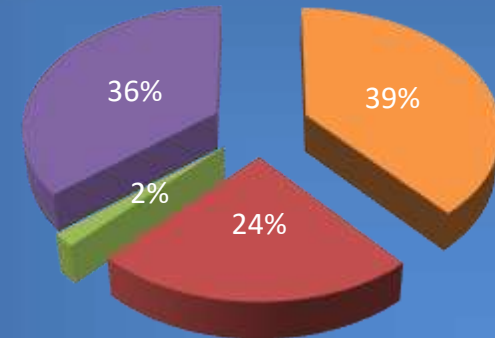


- Comcast
- CenturyLink
- Verizon
- Ziplly
- Quantum Fiber
- Astound Broadband
- PogoZone
- T-Mobile
- HughesNet
- ViaSat
- Starlink
- Other Provider

Incidence of Internet Households



Reason for No Internet at Home

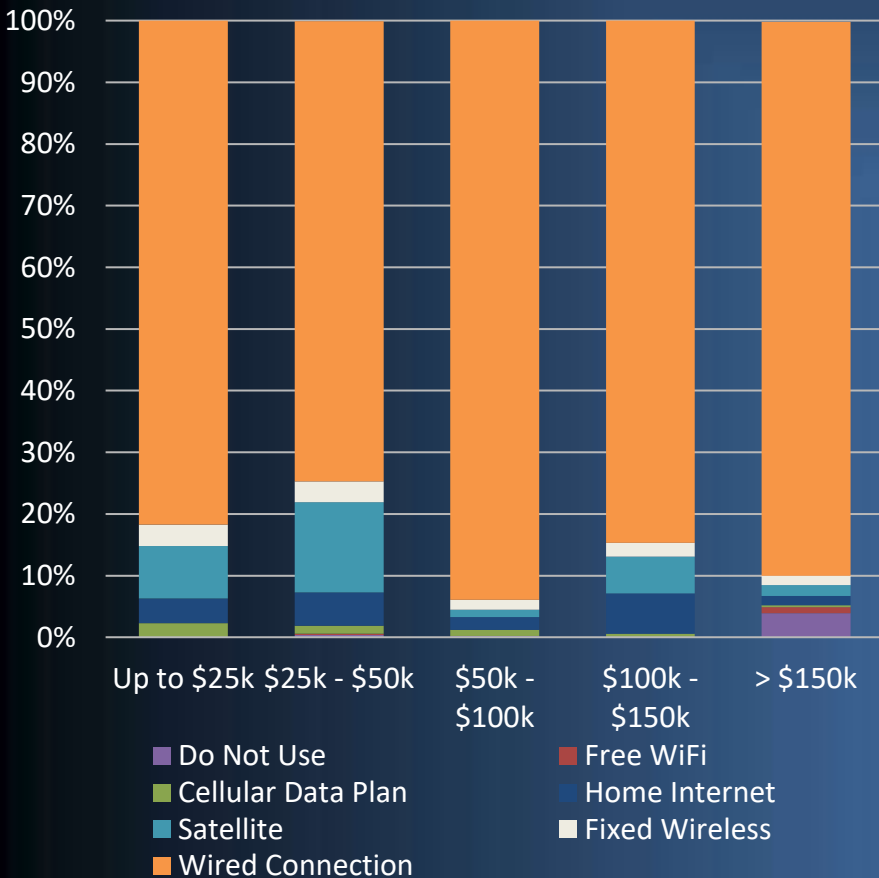


- Too Expensive
- Don't Need Internet
- No Computer
- Other Reason

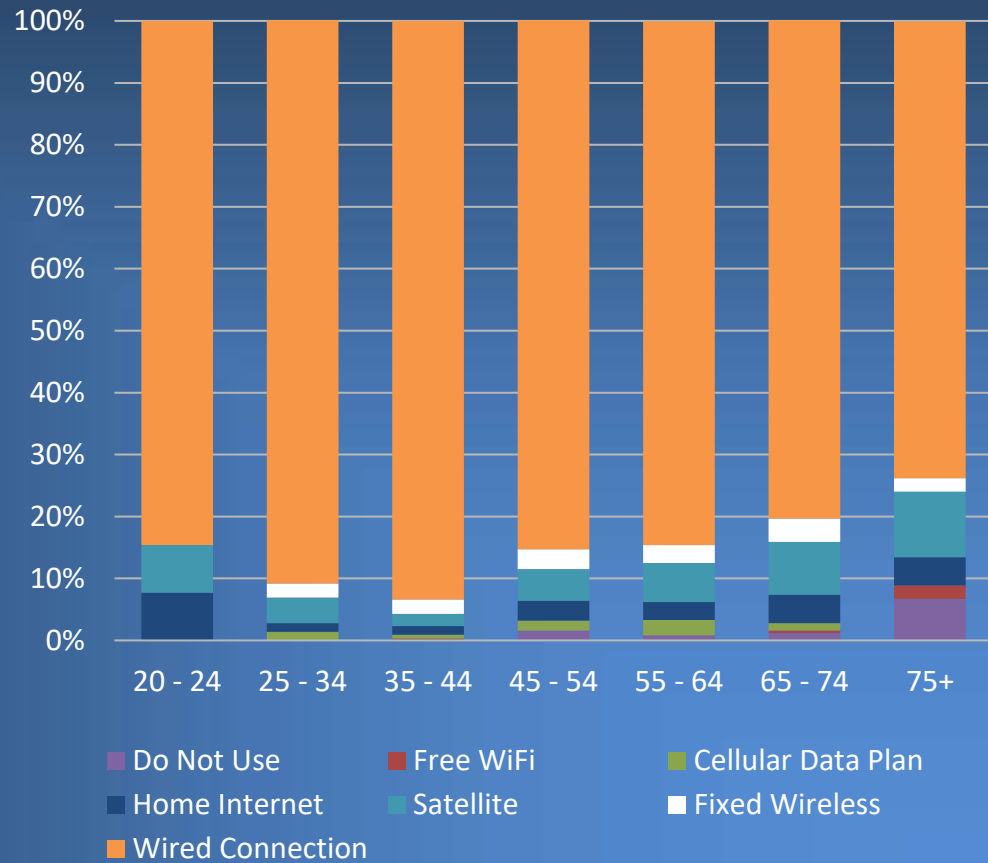
INTERNET ACCESS METHOD DEMOGRAPHICS

- ◆ Household income below \$50k slightly reduces incidence of a wired Internet connection
- ◆ Older households are slightly less likely to have a wired Internet connection

Internet Access Method by Income



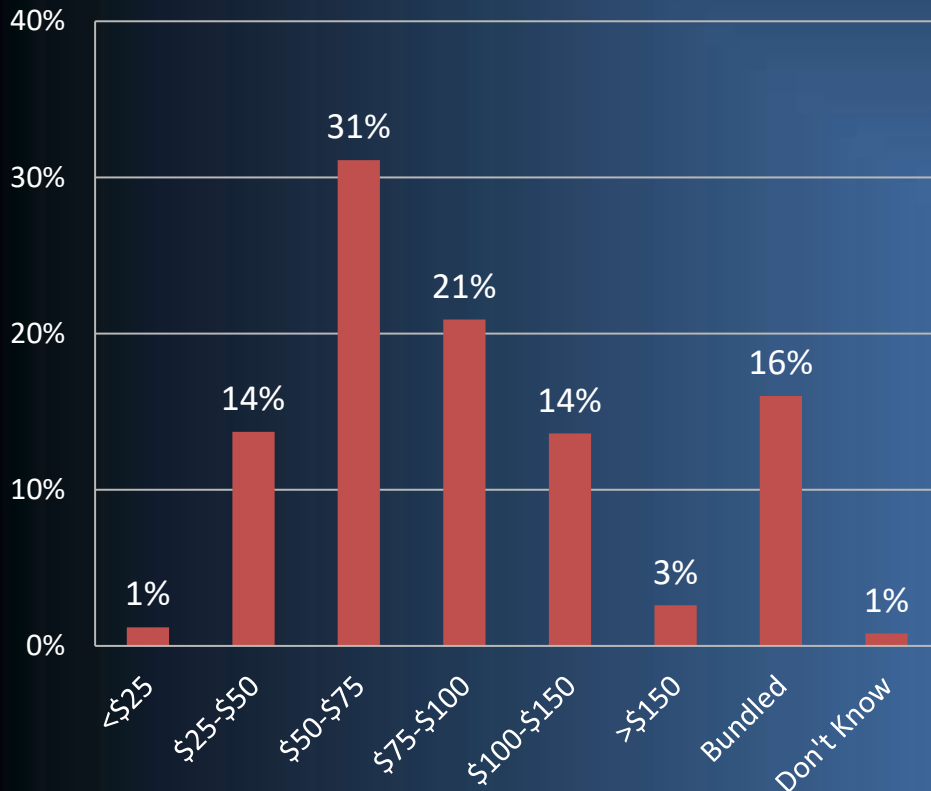
Internet Access Method by Age



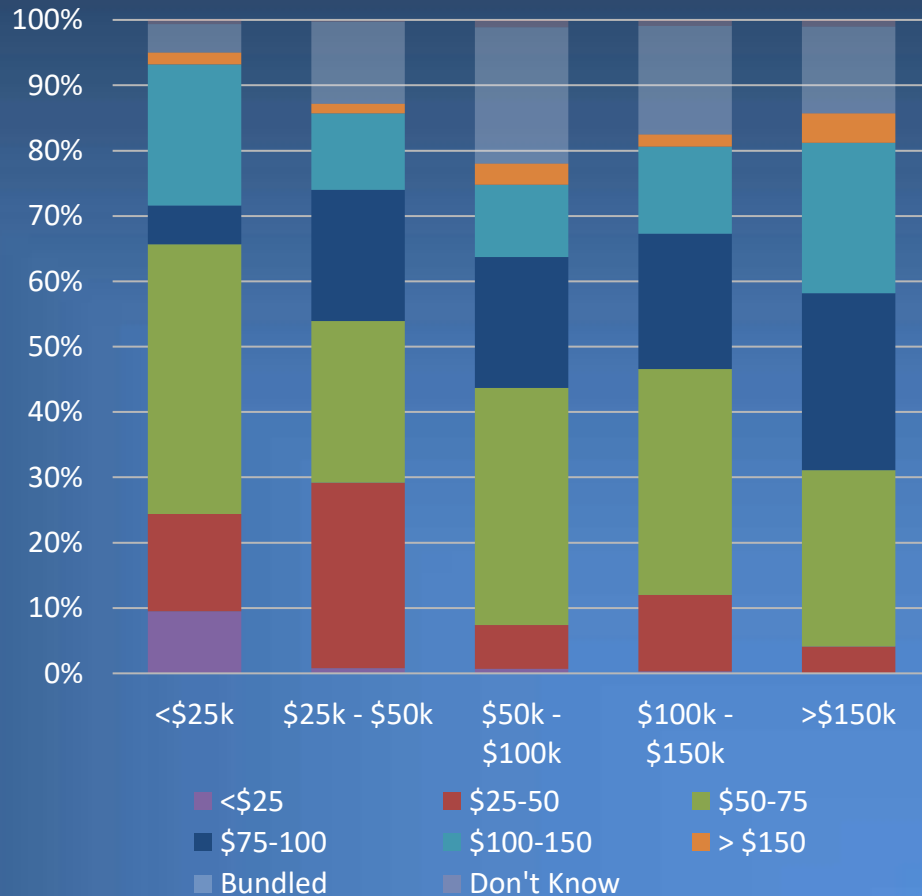
STATED INTERNET SPENDING

- ◆ Monthly spending averages \$70 across all households
- ◆ In general, average spending increases with greater household income

Monthly Internet Spending

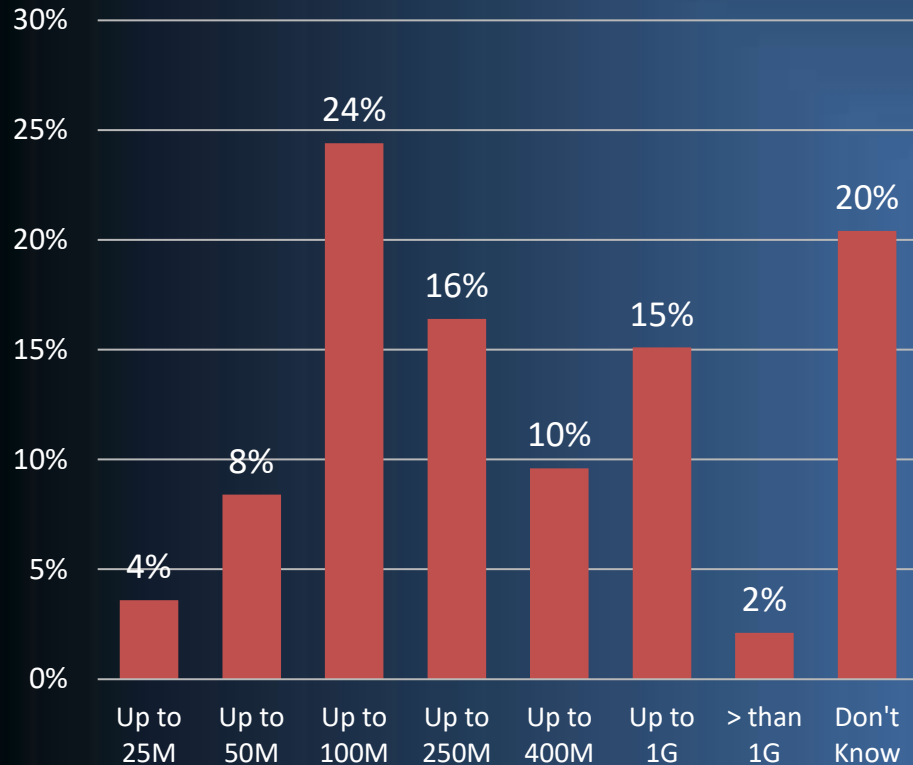


Internet Spending by Income

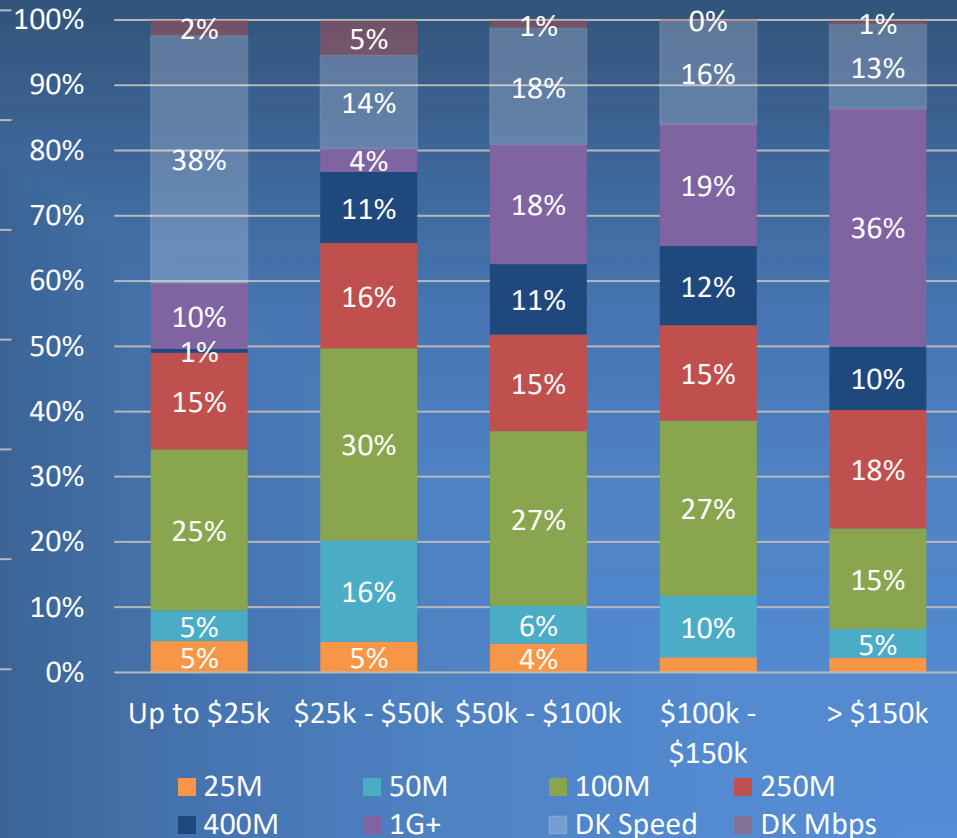


- ◆ 20% of households do not know what speed they subscribe to
- ◆ 43% of households state they subscribe to > 100M
- ◆ Lower income households are more likely to subscribe to lower capacity Internet tiers

Stated Download Speed



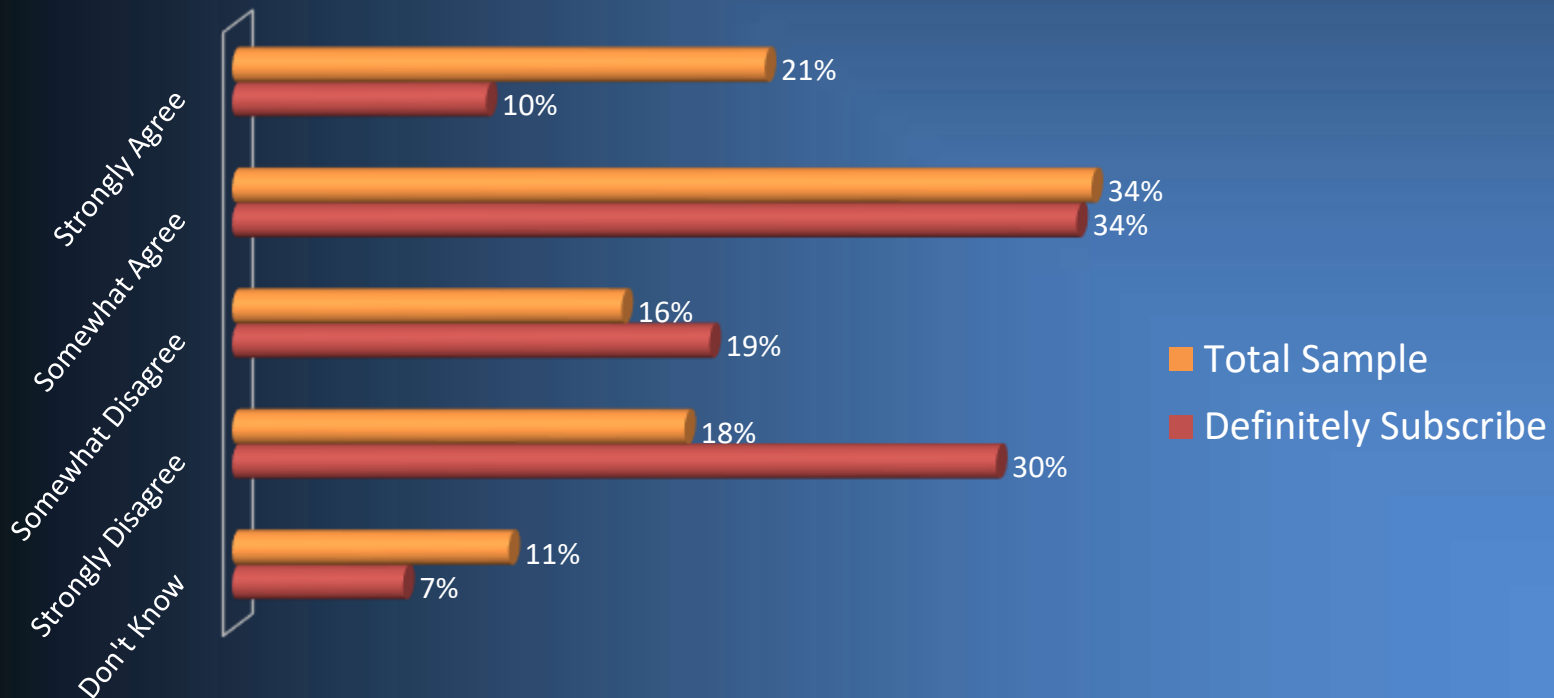
Internet Access Speed by Income



PERCEPTION OF RECEIVED VS. SUBSCRIBED SPEED

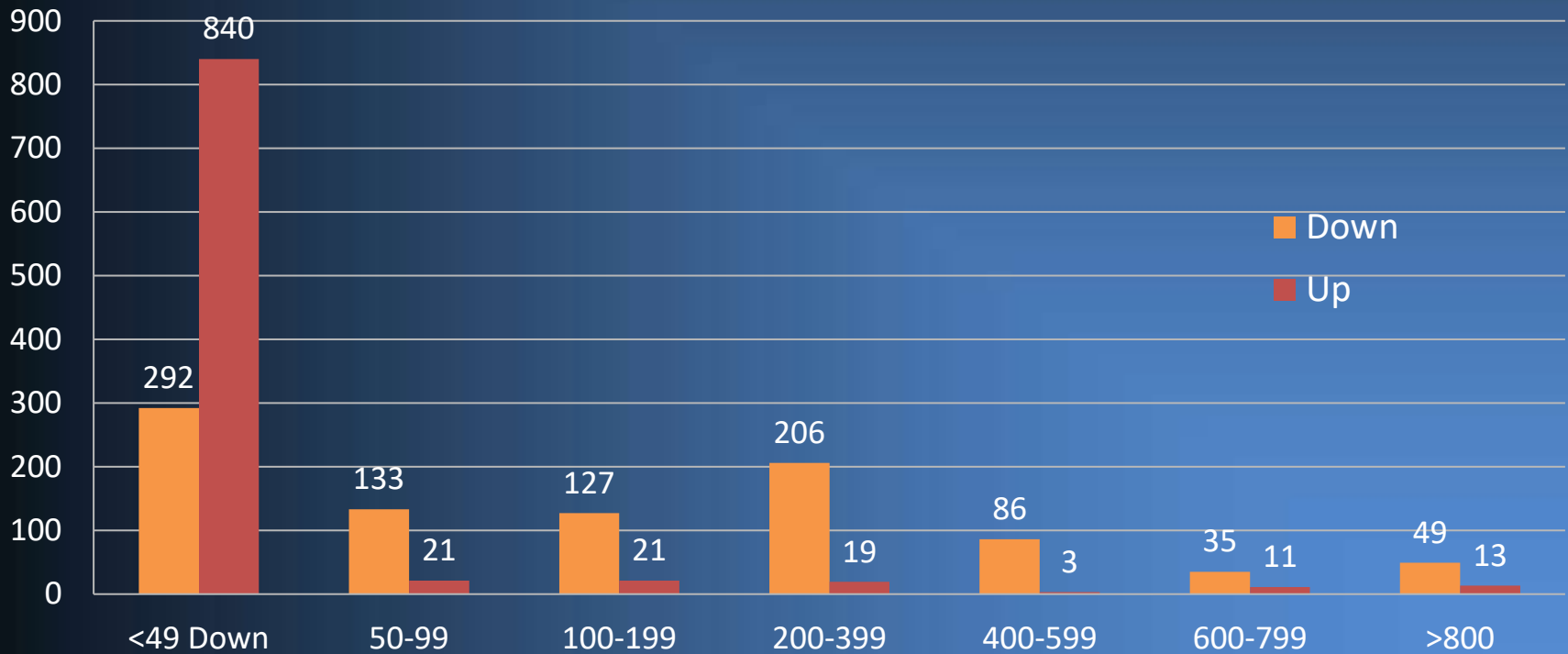
- ◆ 55% of households strongly agree or somewhat agree that they are receiving the advertised download speed they are subscribing to. This percentage drops to 44% among likely subscribers...

Q6: “To what extent do you agree or disagree with the following statement: I am receiving the advertised download speed I am paying for on my home internet connection?”



- ◆ Speed test results identify the median download speed as 122Mbps and the median upload speed as 12Mbps.

Speed Test Results – Observed Download & Upload Speeds
(n = 928)



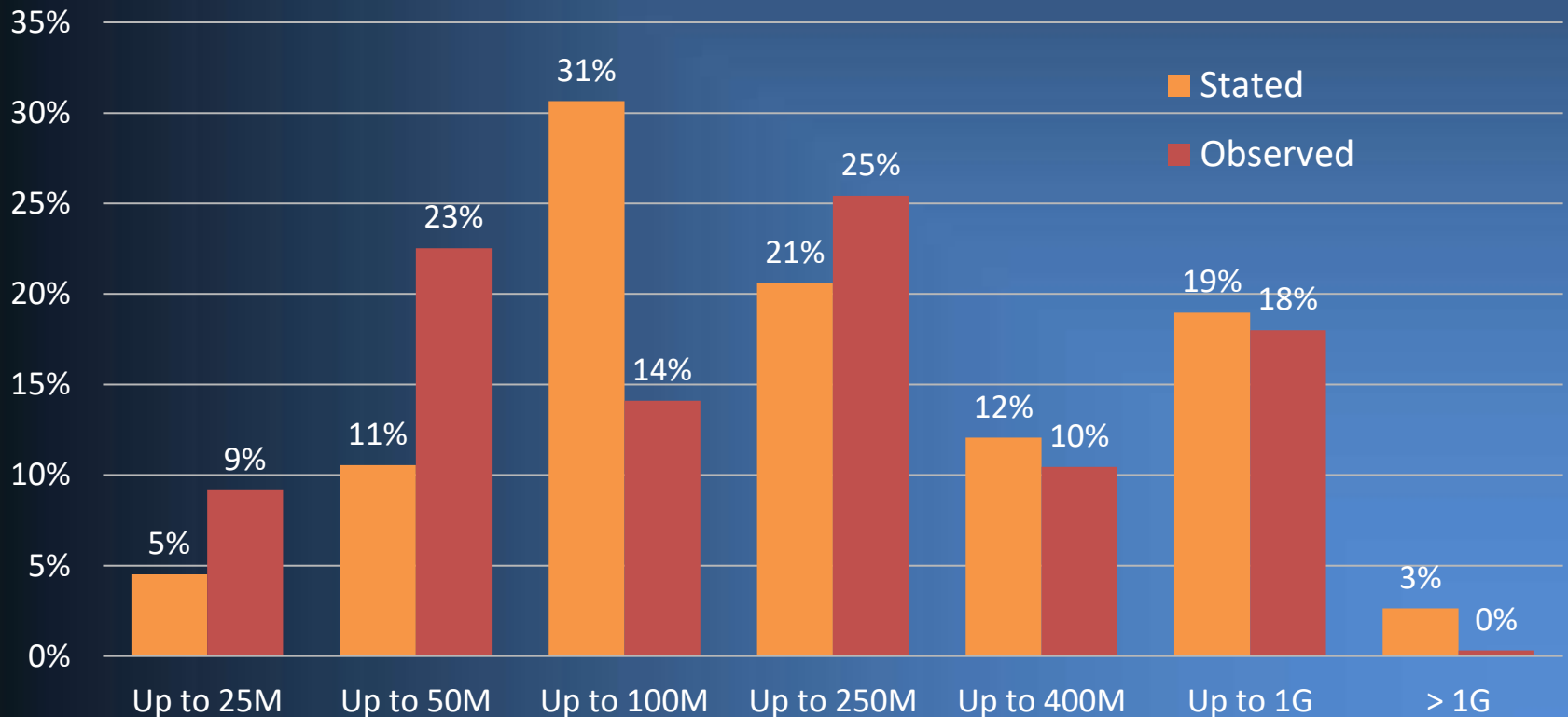
STATED VERSUS OBSERVED DOWNLOAD SPEED

- ◆ 32% of households measured at 25-50Mbps, with only 16% stating a 25-50Mbps subscription. These are likely not Comcast subscribers.
- ◆ However, at speeds of 250Mbps or greater, stated speeds closely match observed speeds...

Stated versus Observed Download Speed

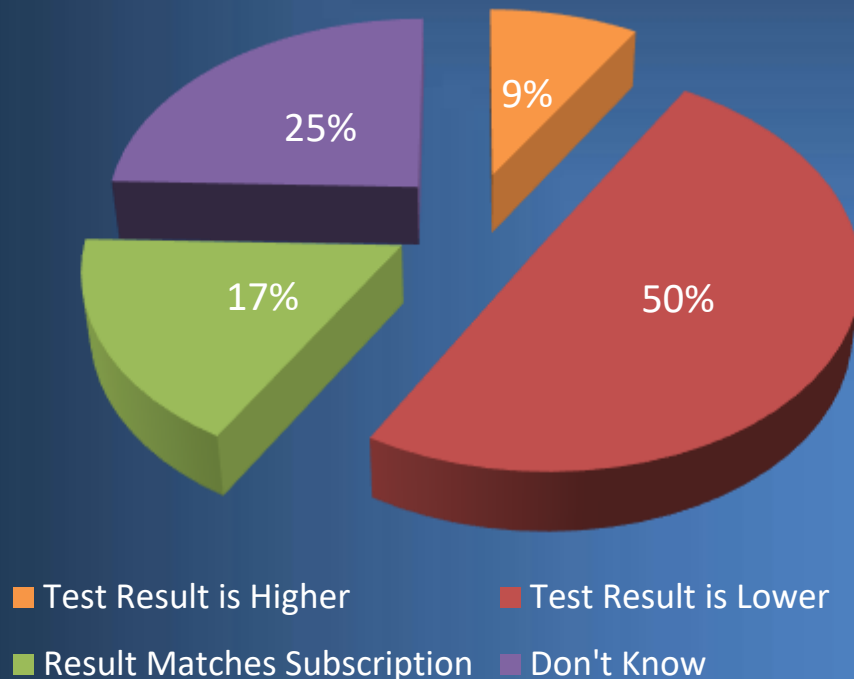
Stated: n = 1,486 / Observed: n = 928

Data excludes "Don't Know" Responses



- ◆ 50% of households that completed the speed test observed that the speed test outcome was lower than their subscribed speed...

Q30: “How does the download speed test result compare with the download speed you are subscribing to from your Internet provider?”



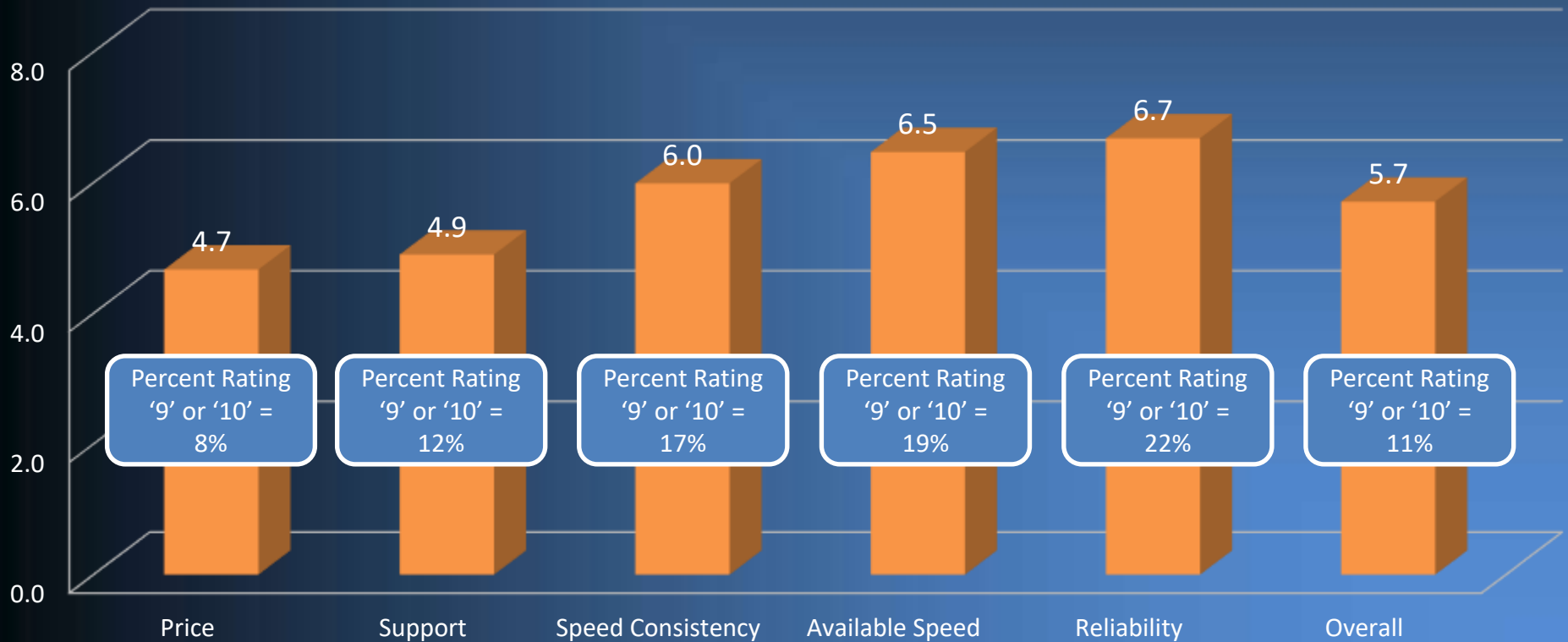
Residential Quantitative Survey

Satisfaction & Attribute Importance

SATISFACTION WITH SPECIFIC INTERNET ATTRIBUTES

- ◆ Internet satisfaction levels are low compared to other markets, with customer service and price being the service attributes with lowest satisfaction levels.
- ◆ Across all service attributes, the percentage of households that are ‘very satisfied’ and rating the service a 9 or 10 is very low.

Satisfaction Rating by Internet Attribute
(Mean Rating on a 1-10 Scale)



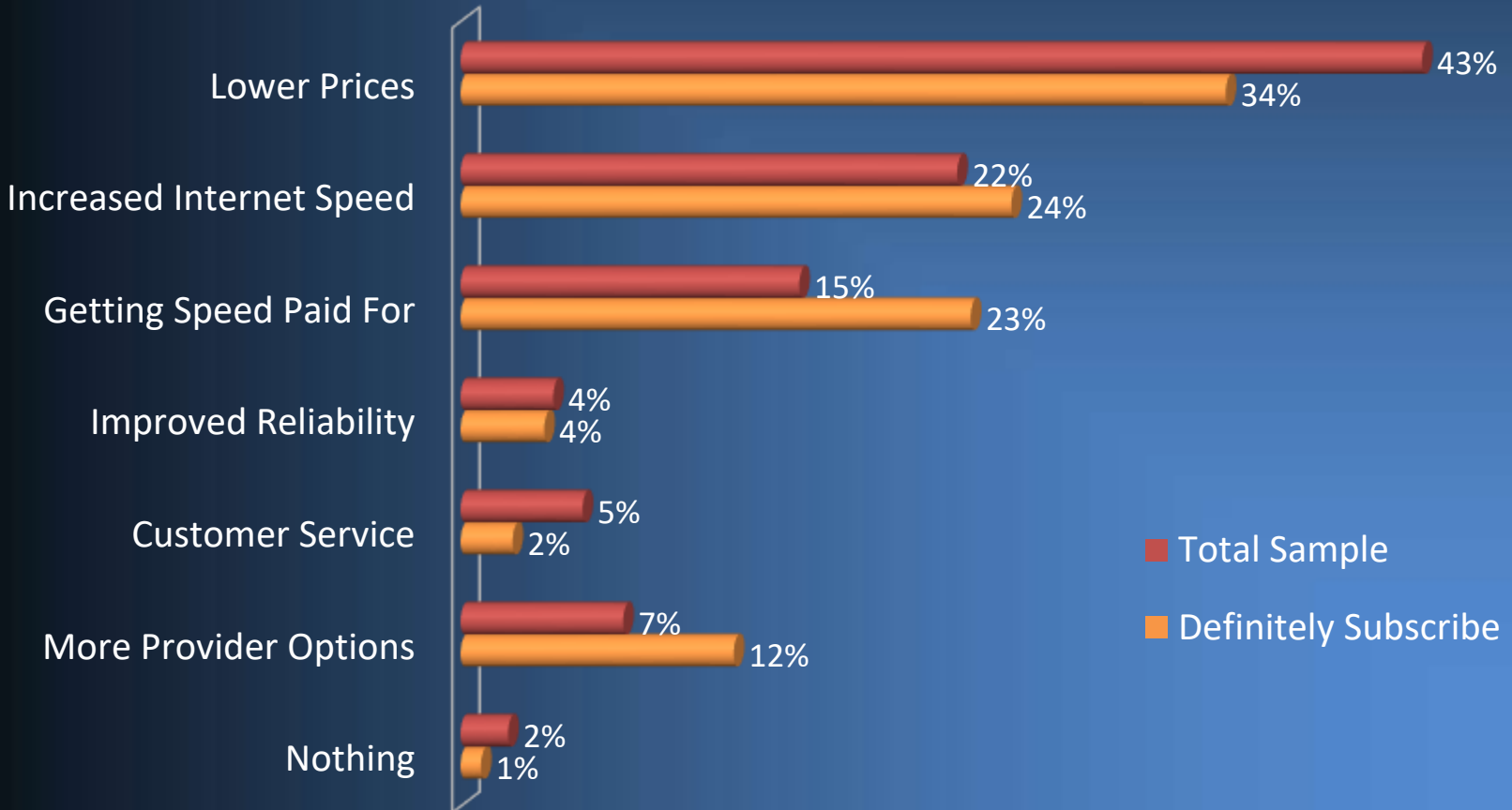
- Reliability and price are the most important attributes, with Internet speed and customer service very close in importance as well.
- Provider policies such as termination fees and data caps score high in importance as well...

Importance Rating of Select Broadband Service Attributes
(Mean Rating on a 1-5 Scale)



Bellingham residents see lower prices and increased Internet speed as the most important dimension for improving their broadband...

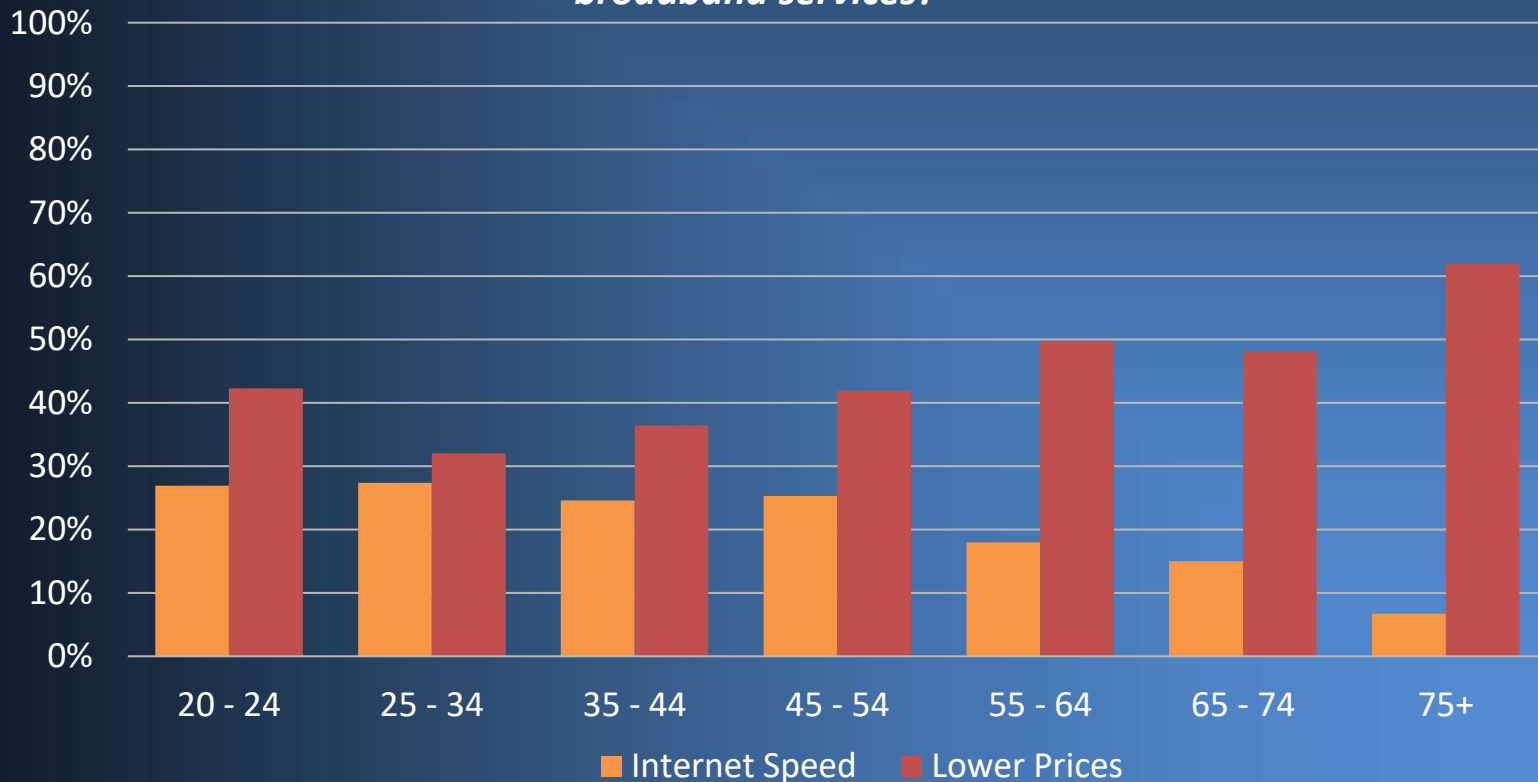
Q25: “What would you like to see most improved with your current broadband service?”



MOST DESIRED IMPROVEMENT BY AGE

- ◆ Younger households most desire lower prices, but place relatively more value on Internet speed improvements compared to older households
- ◆ Older households place relatively more value on lower price improvements than speed improvements

Q25: “What would you like to see most improved from your current broadband services?”



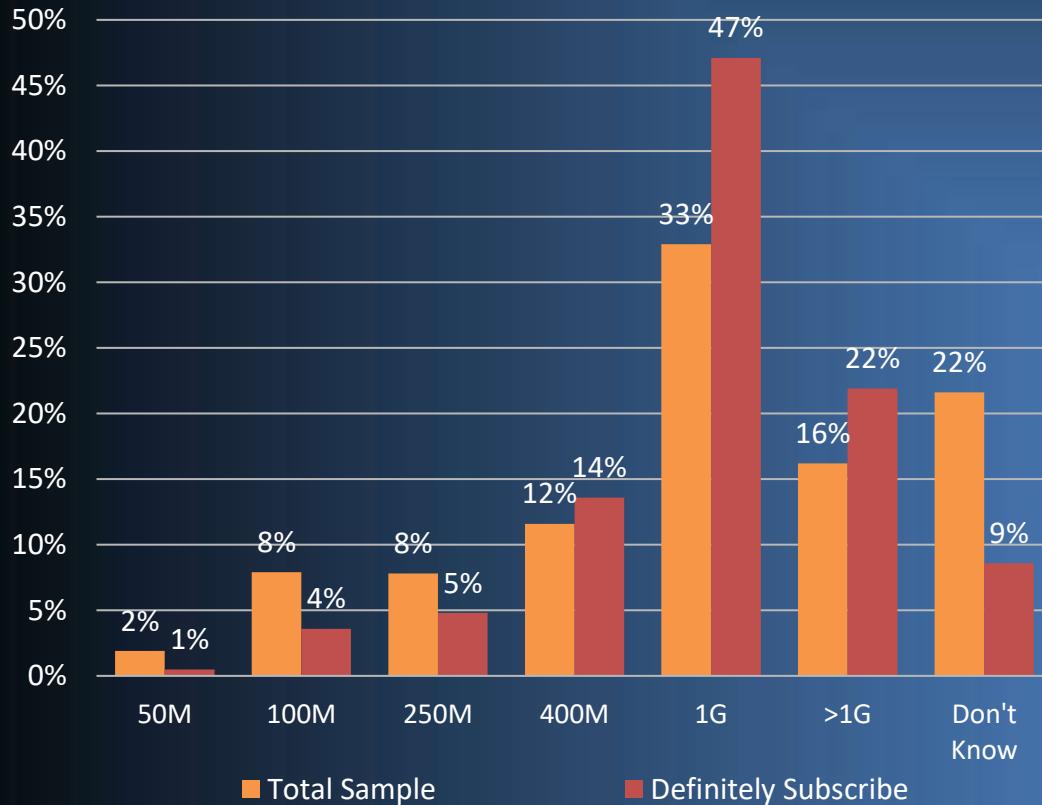
Residential Quantitative Survey

Digital Aptitude & Remote Working and Learning

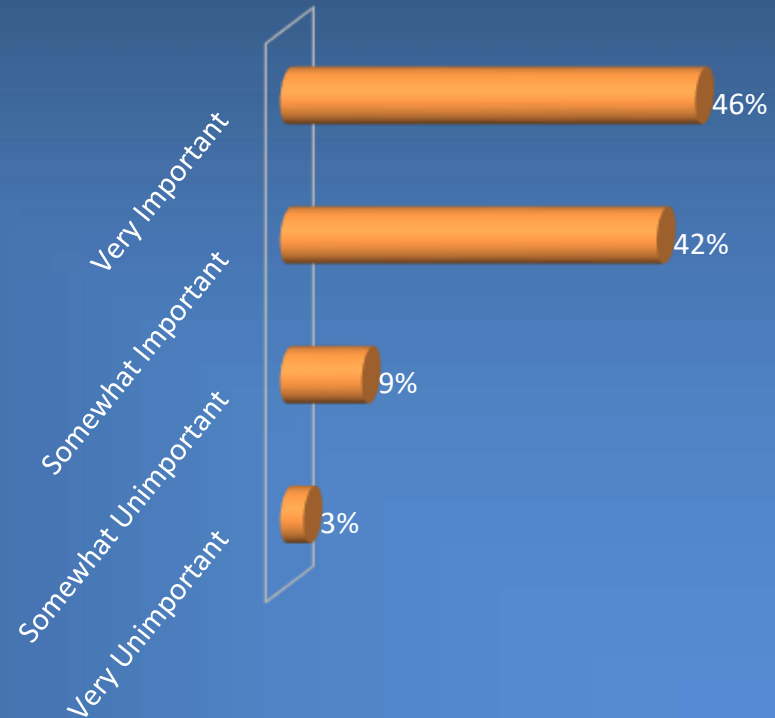
PERCEPTIONS OF INTERNET SPEED

- ◆ 49% of households state their ideal Internet speed would be 1G or higher. This increases to 69% among those who would definitely subscribe at \$70 per month for 1G.
- ◆ Nearly 90% of households perceive the upload speed as very or somewhat important.

Q12: Ideal Download Speed



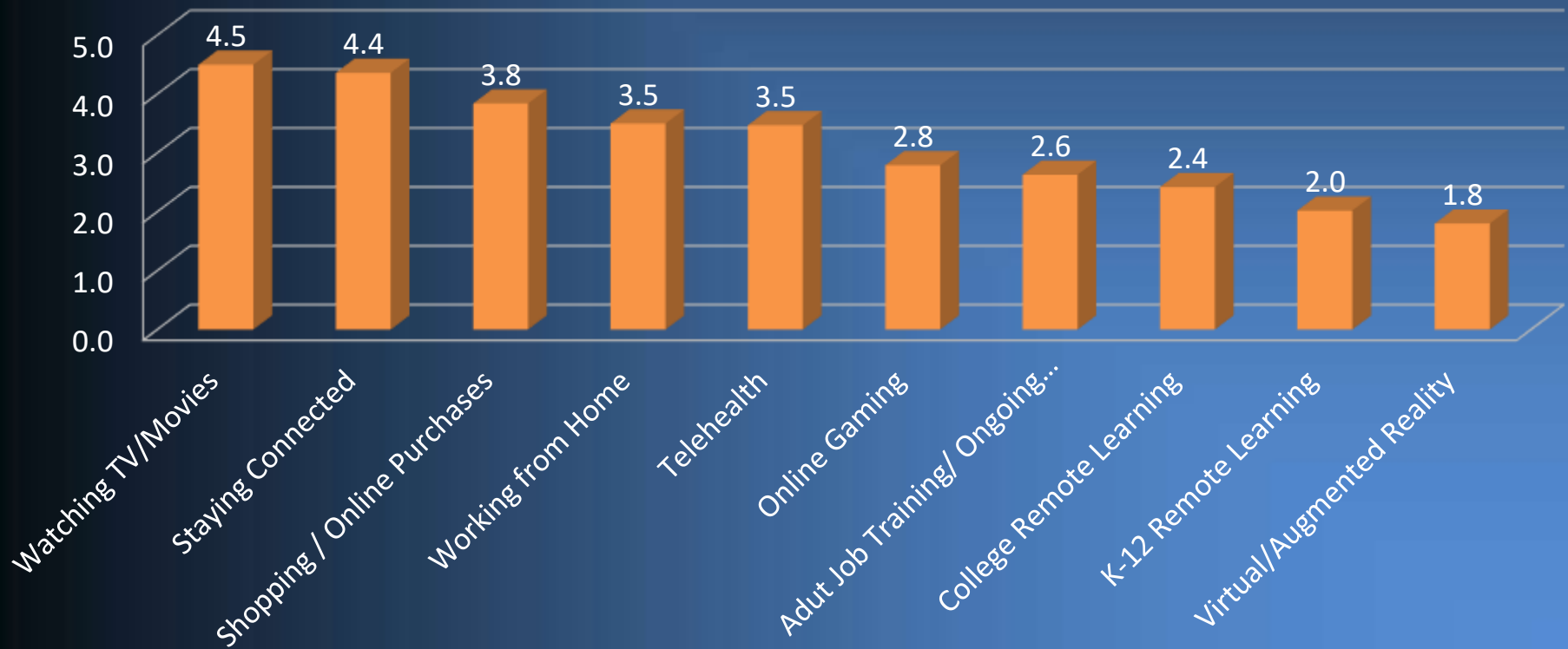
Q13: “How important is the upload speed on your home Internet connection?”



IMPORTANCE OF DIGITAL APPLICATIONS

Social connection and entertainment rate higher in importance than work-at-home and online learning applications despite the impacts of COVID-19...

Importance Rating of Select Broadband Applications/Uses in the Home
(Mean Rating on a 1-5 Scale)

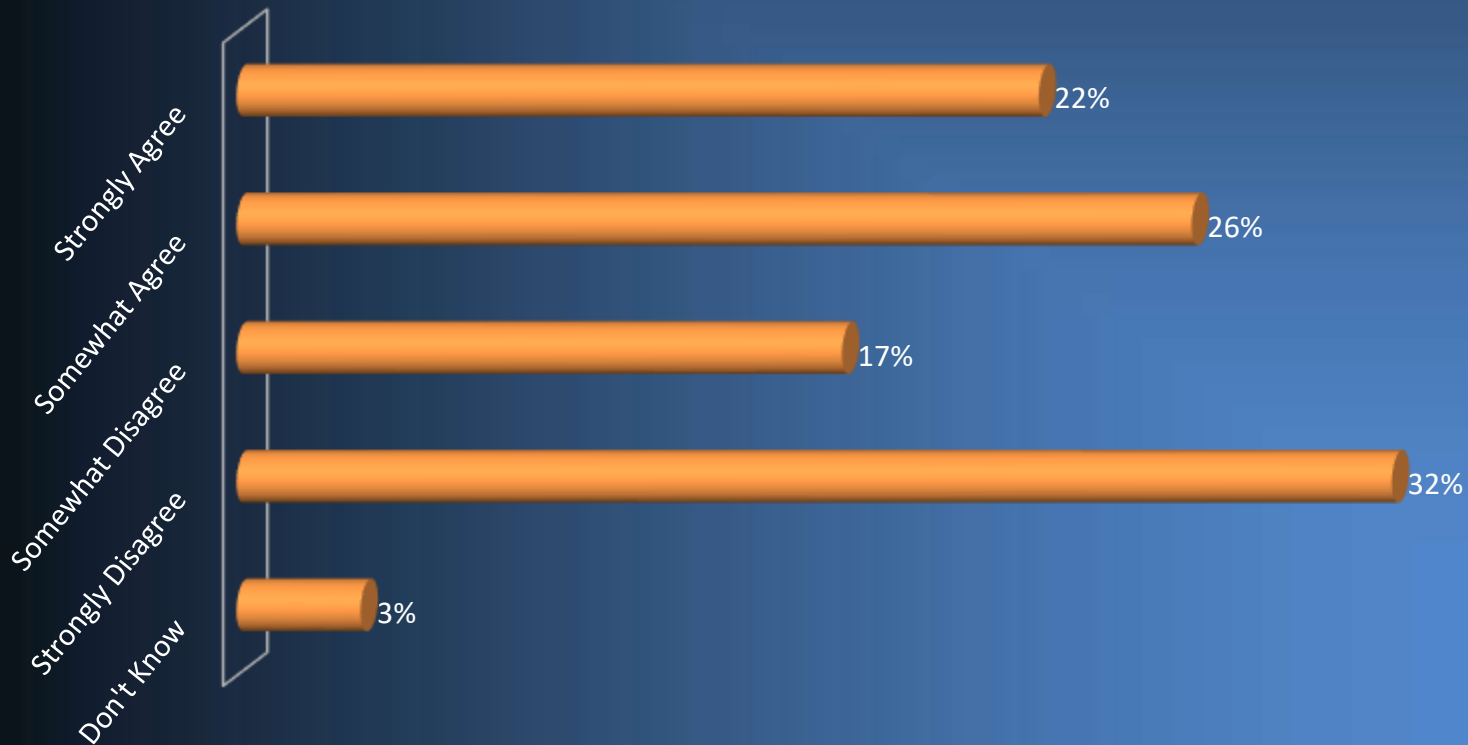


Residential Quantitative Survey

Affordable Connectivity

- ◆ 48% of households strongly agree or somewhat agree that they are subscribing to a lower Internet tier in order to save money.

Q8: “I subscribe to a lower speed Internet service than I would like to in order to save money?”

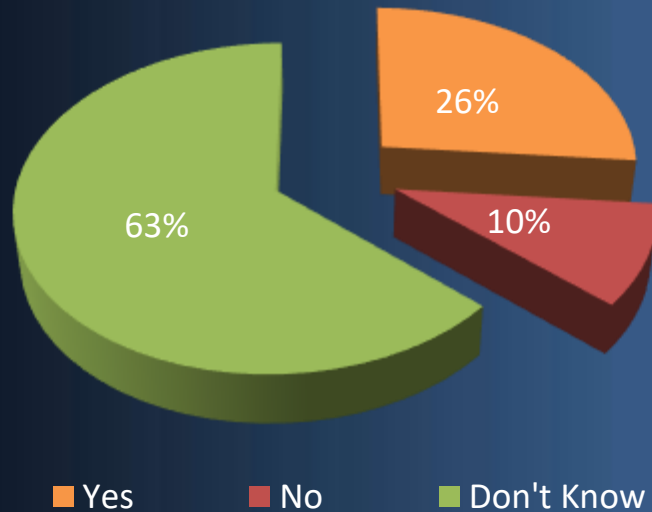


The Affordable Connectivity Program (ACP) is a newly funded federal program to subsidize Internet service among low-income households to narrow the digital divide...

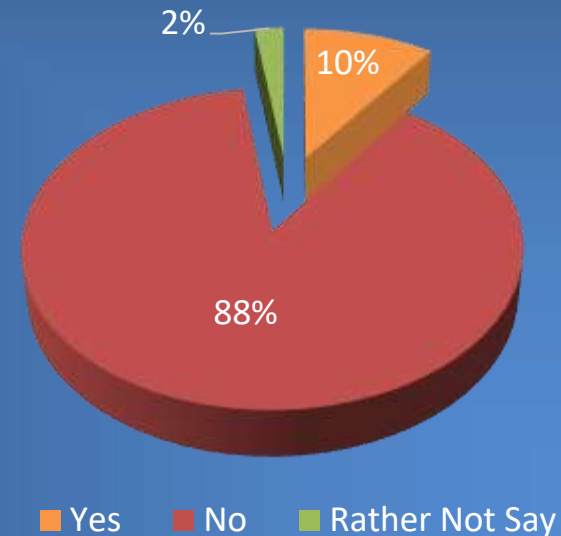
<p>Program Overview</p>	<ul style="list-style-type: none"> • \$14.2B in total funding • Qualifying households receive a \$30 monthly benefit towards Internet service • Connected device reimbursement of \$100 if provider charges between \$10-\$50 for the device • No set end date • Participation qualifies the service provider to receive BEAD grant funding
<p>Household Participation Requirements</p>	<ul style="list-style-type: none"> • Household income at or below 200% of federal poverty limit (e.g. household size of 3 earning \$44k or less) • Participation in national school lunch program • Participate in the FCC Lifeline program
<p>Service Provider Participation Requirements</p>	<ul style="list-style-type: none"> • Eligible Telecommunications Carriers (ETCs) offering residential Internet service • Requires FCC approval and USAC election notification • The \$30 discount must be available on all Internet tiers offered by the provider • No credit check and no disconnects for non-pay until 90 days past due

- ◆ Only 1 in 4 households state that their Internet provider offers an income-based subsidy, although both Comcast and CenturyLink do so.
- ◆ 10% of Bellingham households state that they are receiving a subsidized internet service based on their level of household income

Q10: “Does your Internet provider offer a discounted Internet service for households who qualify due to lower income?”



Q9: “Is your household receiving an Internet discount based on your income?”

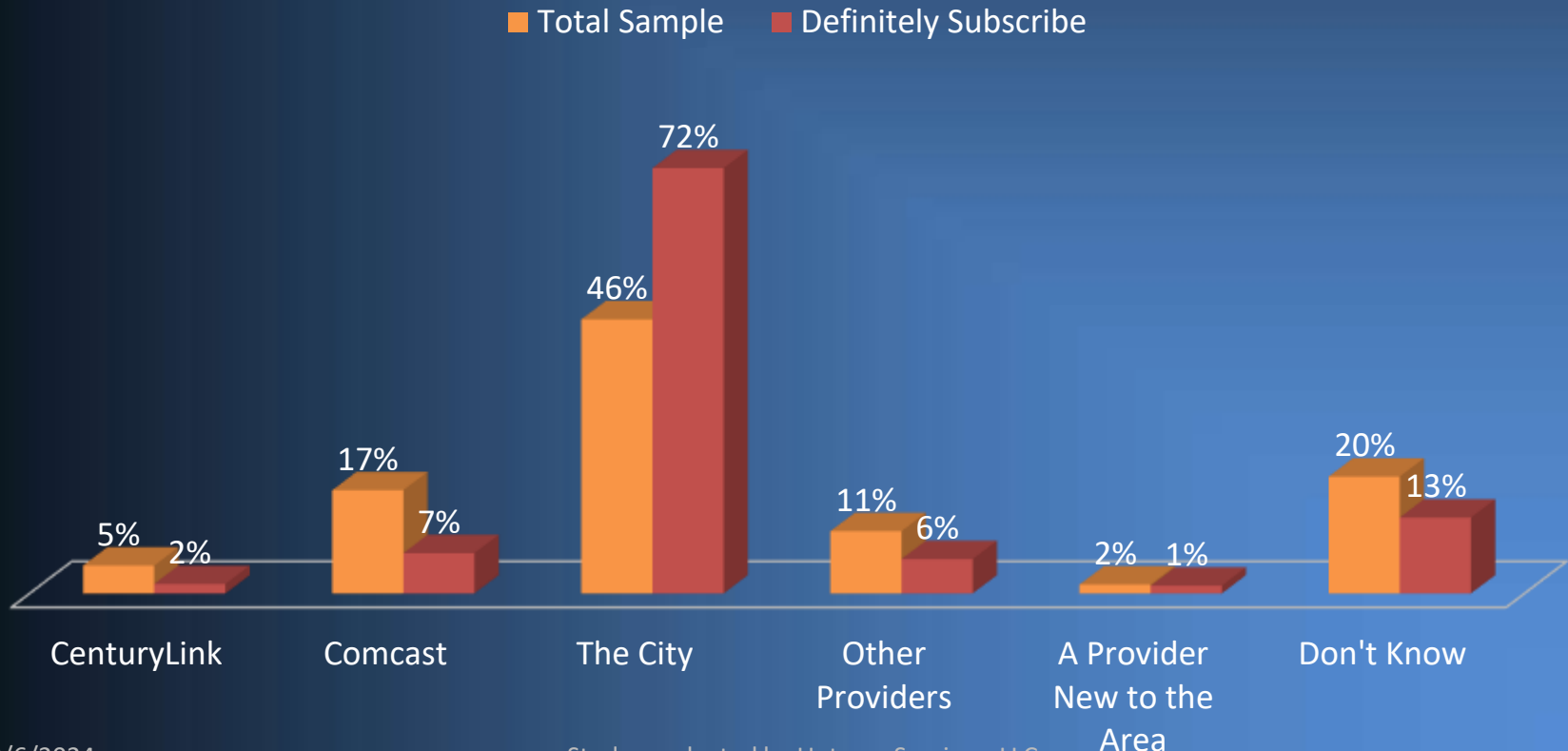


Residential Quantitative Survey

Fiber Broadband Market Potential

- ◆ 46% of respondents, when given the choice, would prefer to receive high speed Internet from the City, while 17% of respondents prefer Comcast. Preference for the City as the provider increases to 72% among households likely to subscribe.

Q26: “Among the following list of potential providers, who would you prefer to receive high-speed Internet service from?”



TESTED RESIDENTIAL INTERNET PRICE POINTS

The quantitative survey evaluated household purchase intent taking into consideration a range of download speed options:

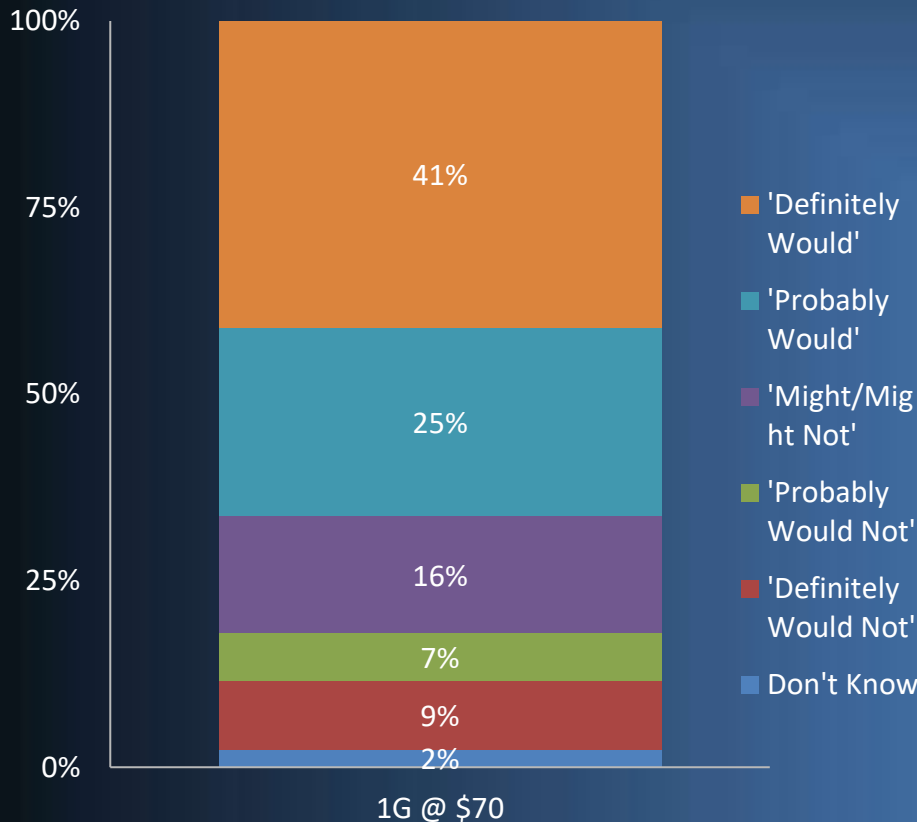
- ◆ All participants were presented with a 1Gbps Internet service priced at \$70/month
- ◆ Multi-Gig tier options were presented to participants that stated they would 'definitely' or 'probably' subscribe to the 1G tier

Internet Tier Download / Upload	Monthly Price: Standard
1G / 1G	\$70
2G / 2G	\$110
4G / 4G	\$150

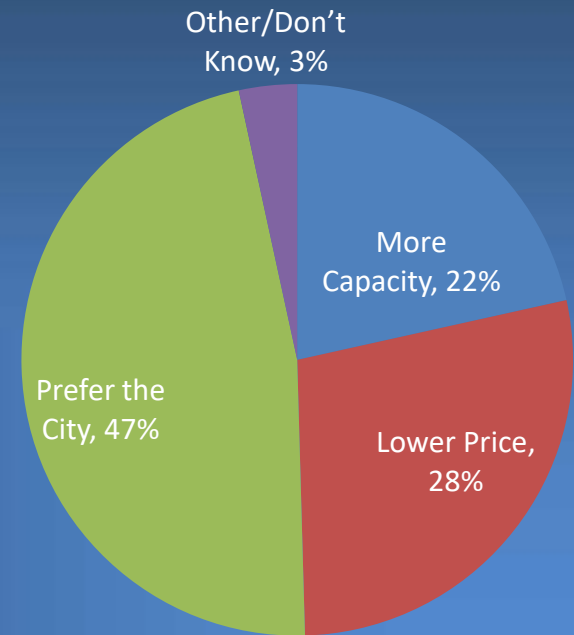
PURCHASE INTENT: ENTIRE SAMPLE

- ◆ At a \$70 price for 1G, 66% of respondents indicated they would definitely or probably switch their Internet service to a fiber system installed by the City
- ◆ Among those most likely to switch, the primary motivation is brand preference

Q22: Stated purchase intent for:
- Internet at \$70/mo. for 1Gbps



Primary Reason to Switch
(Definitely or Probably Response)



- ❖ Uptown uses a ‘Likert Scale’ with Overstatement Adjustment
 - ❖ Conservative research techniques from the Packaged Goods sector
 - ❖ Clearly specify purchase intent vs. “interest” and removes overstatement bias

❖ Example: “How likely would you be to subscribe?”

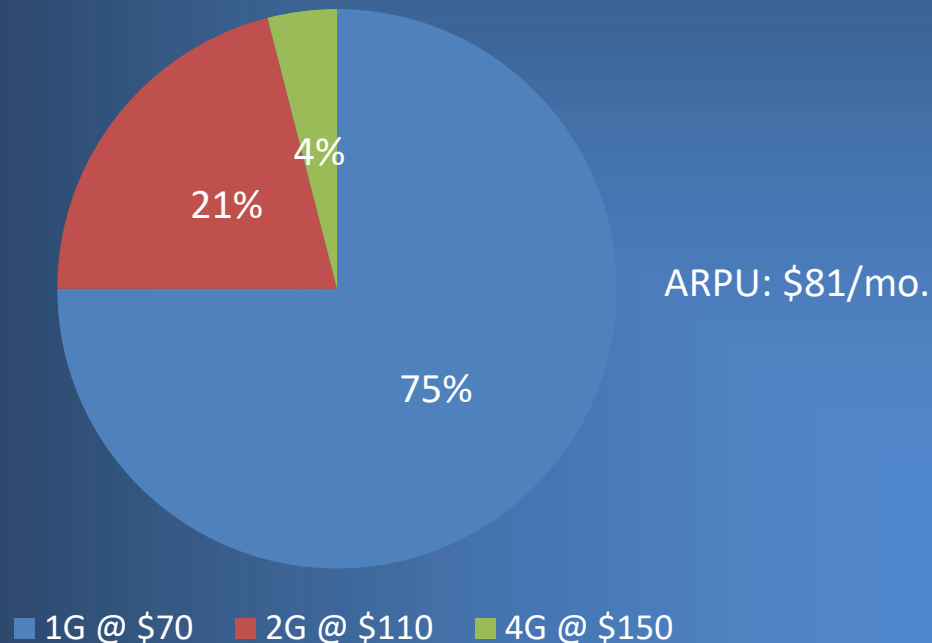
❖ Definitely Would	41.1%	x 70% =	28.8%
❖ Probably Would	25.2%	x 30% =	7.6%
❖ Might/Might Not	15.6%	x 10% =	<u>1.6%</u>

37.9% = Penetration Estimate

Survey Cell	Broadband Service	Estimated Take Rate (Year 5)
All Sample	1G Internet @ \$70	37.9%

At the tested price points, 25% of households that would definitely or probably subscribe would opt for a multi-gig tier. The resulting Average Revenue Per User (ARPU) is \$81 per month...

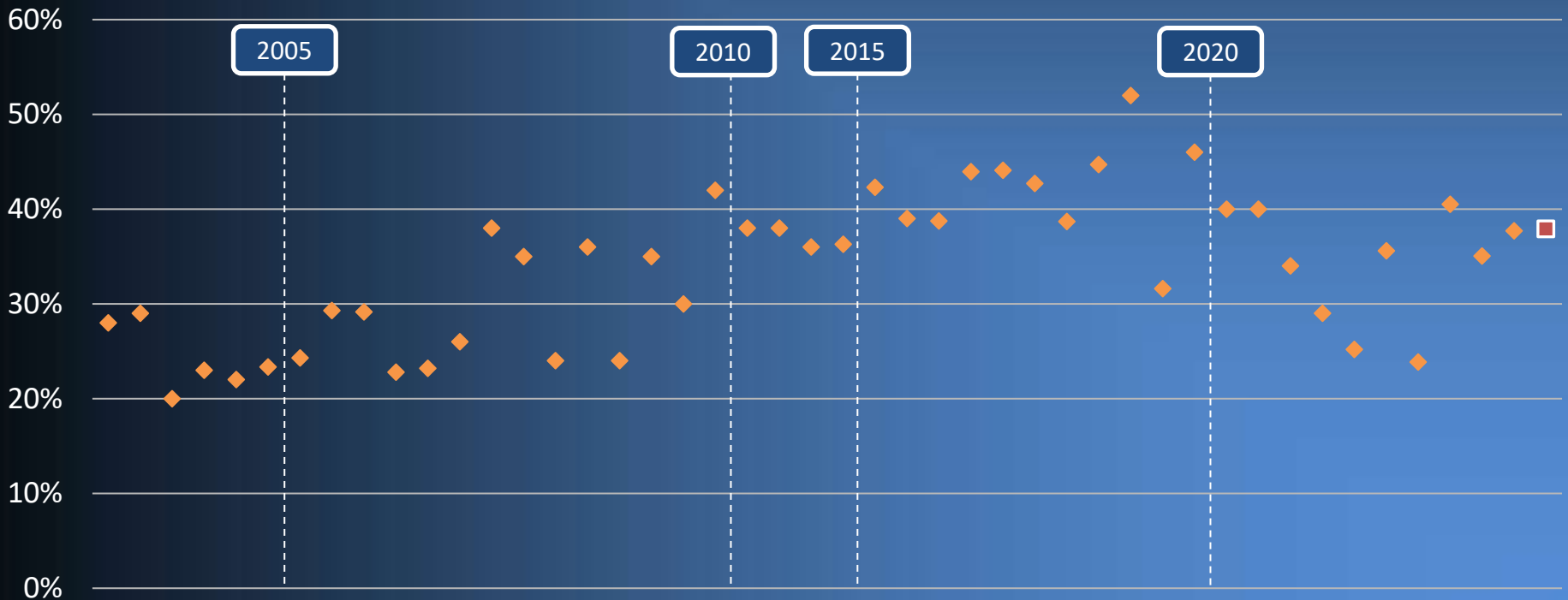
Most Likely Subscribed Tier at Stated Price Points (If 1G Tier Priced at \$70/mo.)



While markets vary across many factors, prior surveys provide anecdotal reference points:

- ◆ 47 quantitative surveys completed since 2003
- ◆ Mean forecasted penetration of 34%, with minimum of 20% and maximum of 52%
- ◆ Red square observation is Bellingham

Research Derived Penetration Estimate
(quantitative survey outcomes)



Residential Quantitative Survey

Selected Analysis by Neighborhood

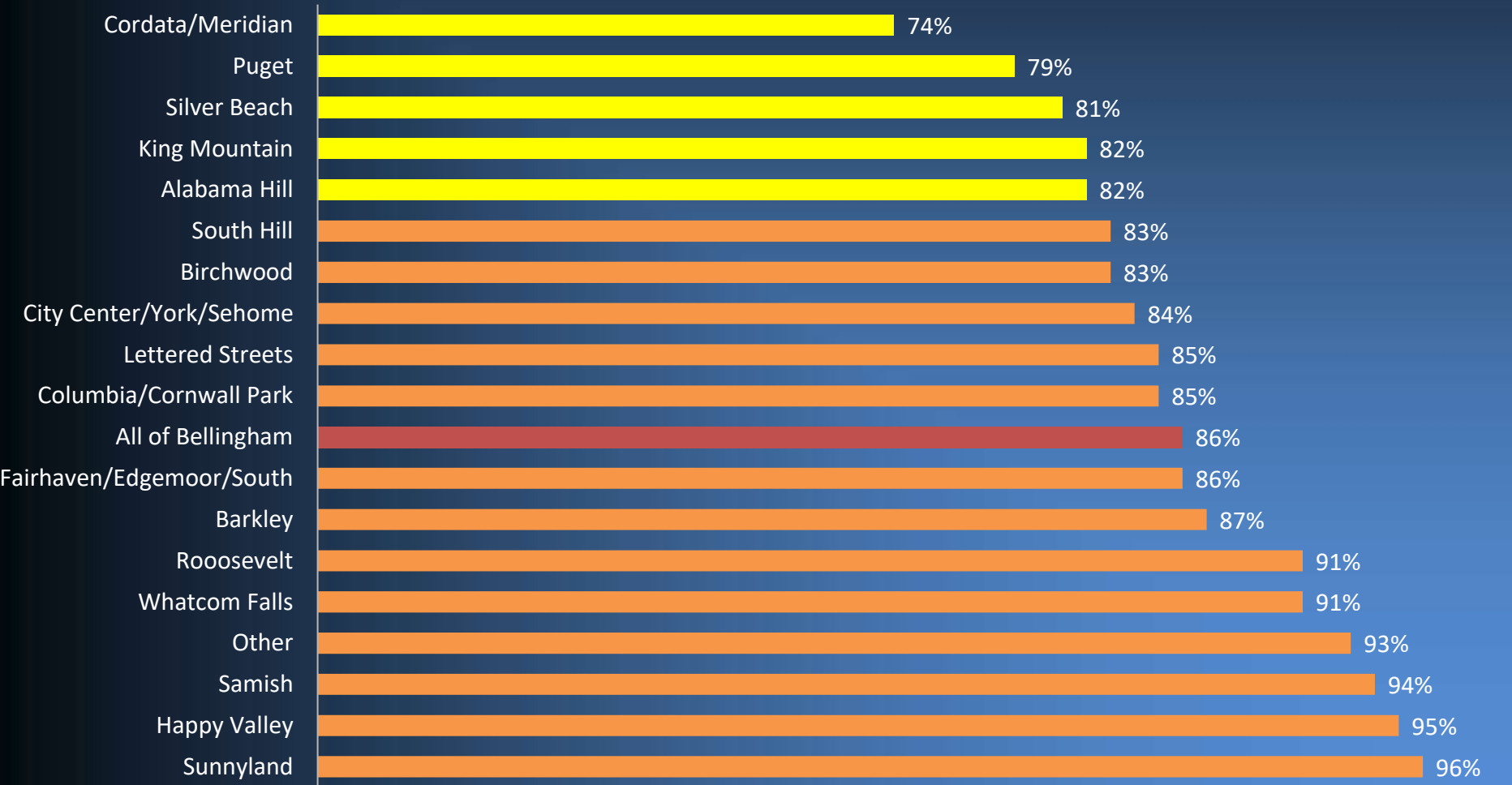
SAMPLE SIZES BY NEIGHBORHOOD

- ◆ The survey captured the residential neighborhood of each participant. Of the sampled neighborhoods, 8 had a final sample size of less than 50. Combining smaller sample areas resulted in a total of 18 neighborhoods with sample sizes of ≥ 50 ...

Neighborhood	Sample Size	Neighborhood	Combined Sample
Alabama Hill	65	City Center	155
Barkley	89	York	
Birchwood	75	Sehome	
Happy Valley	101	Columbia	123
King Mountain	53	Cornwall Park	
Lettered Streets	50	Cordata	137
Puget	75	Meridian	
Roosevelt	88	Fairhaven	91
Samish	87	Edgemoor	
Silver Beach	71	South	
South Hill	71		
Sunnyland	77		
Whatcom Falls	65		
Other	50		

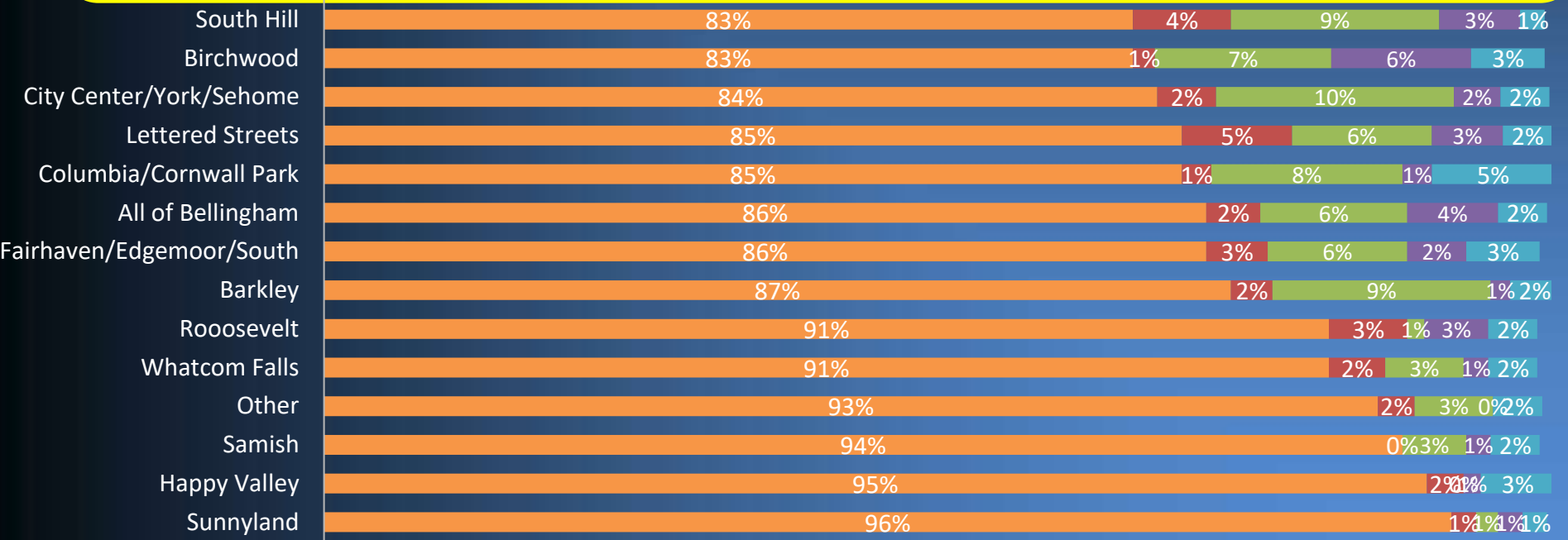
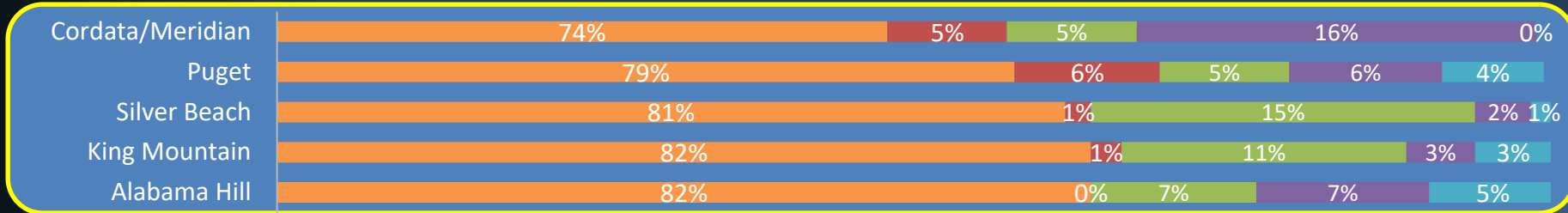
INCIDENCE OF WIRED INTERNET SUBSCRIPTION BY AREA

◆ There are 5 neighborhoods that have wired broadband subscription levels lower than 83%...



TYPE OF INTERNET SUBSCRIPTION BY AREA

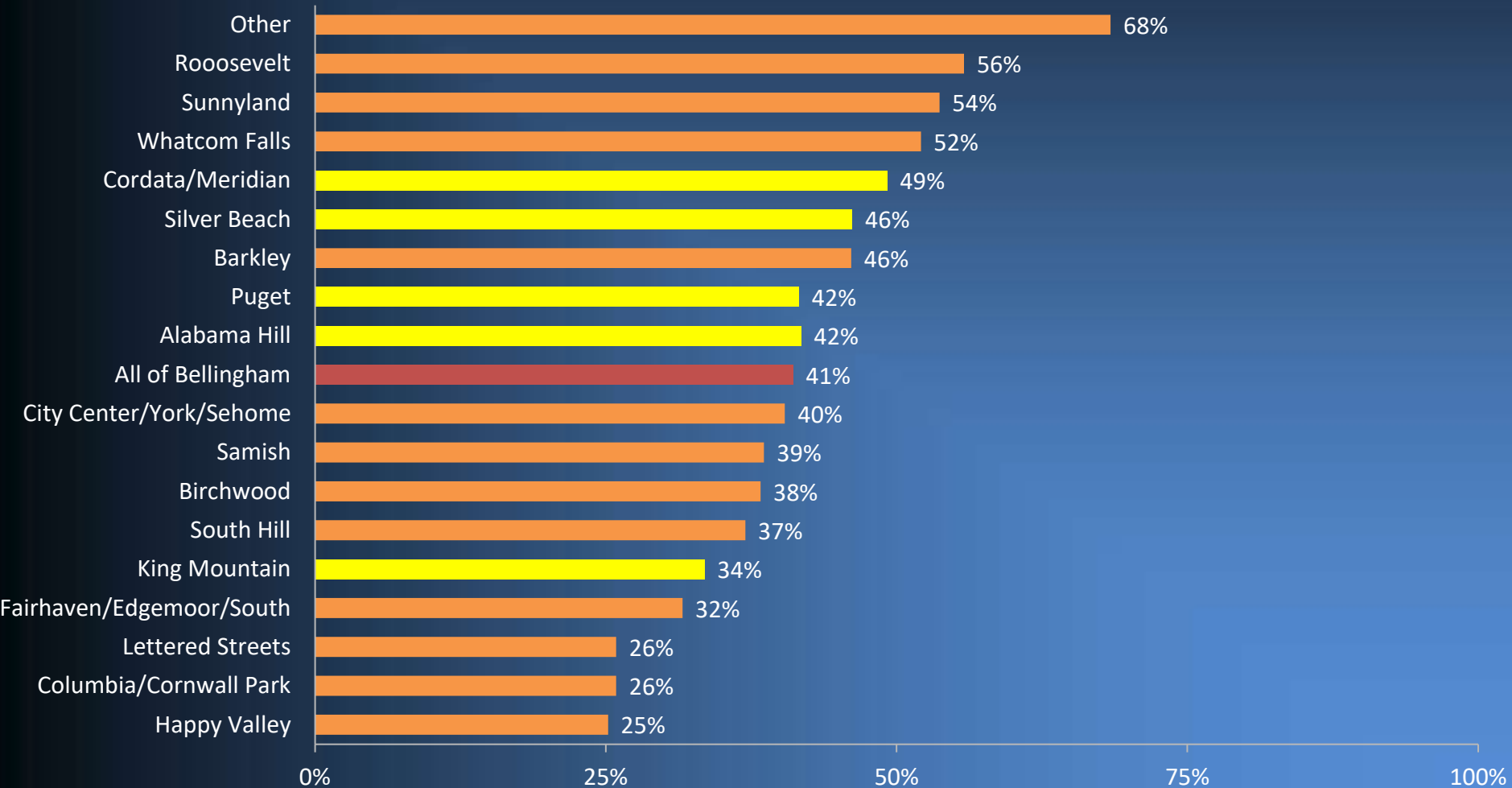
◆ These 5 neighborhoods have a higher incidence of fixed wireless, satellite and/or home Internet subscriptions...



■ Wired Subscription
 ■ Fixed Wireless
 ■ Satellite
 ■ Home Internet
 ■ Not Subscribed

'DEFINITELY SUBSCRIBE' PURCHASE INTENT BY AREA

- Of the 5 “underserved” neighborhoods, 4 have “Definitely Subscribe” purchase intent above the average of 41%...



- ◆ 98% of households use Internet at home with 86% using a wired connection. Comcast is the dominant provider.
- ◆ Household income below \$50k slightly reduces incidence of a wired Internet connection. For lower income households that do have Internet, subscribed speeds are significantly lower than higher income homes.
- ◆ Overall Internet satisfaction score is 5.7 on a 1-10 scale. The percentage of very satisfied households (rating 9 or 10) is just 11% overall due to dissatisfaction with price and customer service.
- ◆ Lower prices is the predominant need, followed by improved speed, reflecting a desire for better Internet value.
- ◆ 49% of households state their ideal Internet speed would be 1G or higher. This increases to 69% among those who would definitely subscribe.
- ◆ 10% of Bellingham households are participating in the ACP program and may be subject to losing the \$30 monthly discount within the next 1-2 years.
- ◆ About 50% of households currently are under-utilizing Internet capacity due to affordability issues.
- ◆ The forecasted take rate for 1G Internet priced at \$70/month is 38% after overstatement adjustment. This take rate benchmarks above average compared to other studies.
- ◆ The City is the preferred provider by 46% of households. This increases to 72% among those who would definitely subscribe.

Task 5: Opportunities to Serve Unserved and Underserved Areas

Large Business Qualitative Interviews

1. Data: Standard Internet Access

- ◆ Last mile connection can be copper (DSL), coax (cable modem), or fiber (FTTP)
- ◆ HFC: Capacity tiers up to 300M (up to 1.2G with DOCSIS3.1)
- ◆ FTTP: Capacity tiers up to 10G (XGS PON)
- ◆ Shared bandwidth

2. Data: High Capacity Direct Fiber Access

- ◆ Capacity tiers from 100M up to 10G
- ◆ Bandwidth is typically dedicated
- ◆ Requires contract with Service Level Agreement

3. Data: Point-to-Point Transport

- ◆ A private circuit with dedicated capacity between 2 or more client locations (e.g. branch office to server location)
- ◆ Capacity Tiers from 100M to 10G
- ◆ Customized terms dependent upon construction cost, protection required, and off-network hand-offs

Data Network Terms

DSL: Digital Subscriber Line

FTTP: Fiber-to-the-Premises

PON: Passive Optical Network

DOCSIS: Cable modem standard

SLA: Service Level Agreement

- ◆ Typical High Capacity Needs and Desired Service Attributes
 - ◆ Infrastructure Availability: Fiber is the Standard
 - ◆ Dedicated Capacity: Superior to shared bandwidth connections
 - ◆ Competitive Pricing
 - ◆ Service Experience: Reliability, Customer Service, and Responsiveness
 - ◆ Network Integration: Some entities require national/global tier 1 provider

- ◆ High Capacity Providers Bellingham
 - ◆ Lumen, Comcast, Astound, Zply, CSS Communications, and Pogozone

- ◆ Qualitative assessment of large business / anchor institution segment
 - ◆ 8 Depth Interviews of 30-40 minutes
 - ◆ 5 of 8 participants are leased transport users
 - ◆ 5 of 5 provided local market details (cost, capacity, etc.)
 - ◆ Responses aggregated for confidentiality
- ◆ Identify key market characteristics
 - ◆ Fiber availability, capacity needs, performance criteria
 - ◆ Current price levels, use of contracts, and connection requirements
- ◆ Estimate potential market share
 - ◆ Satisfaction and switching criteria
 - ◆ Openness to City-supported fiber services via an operating partnership

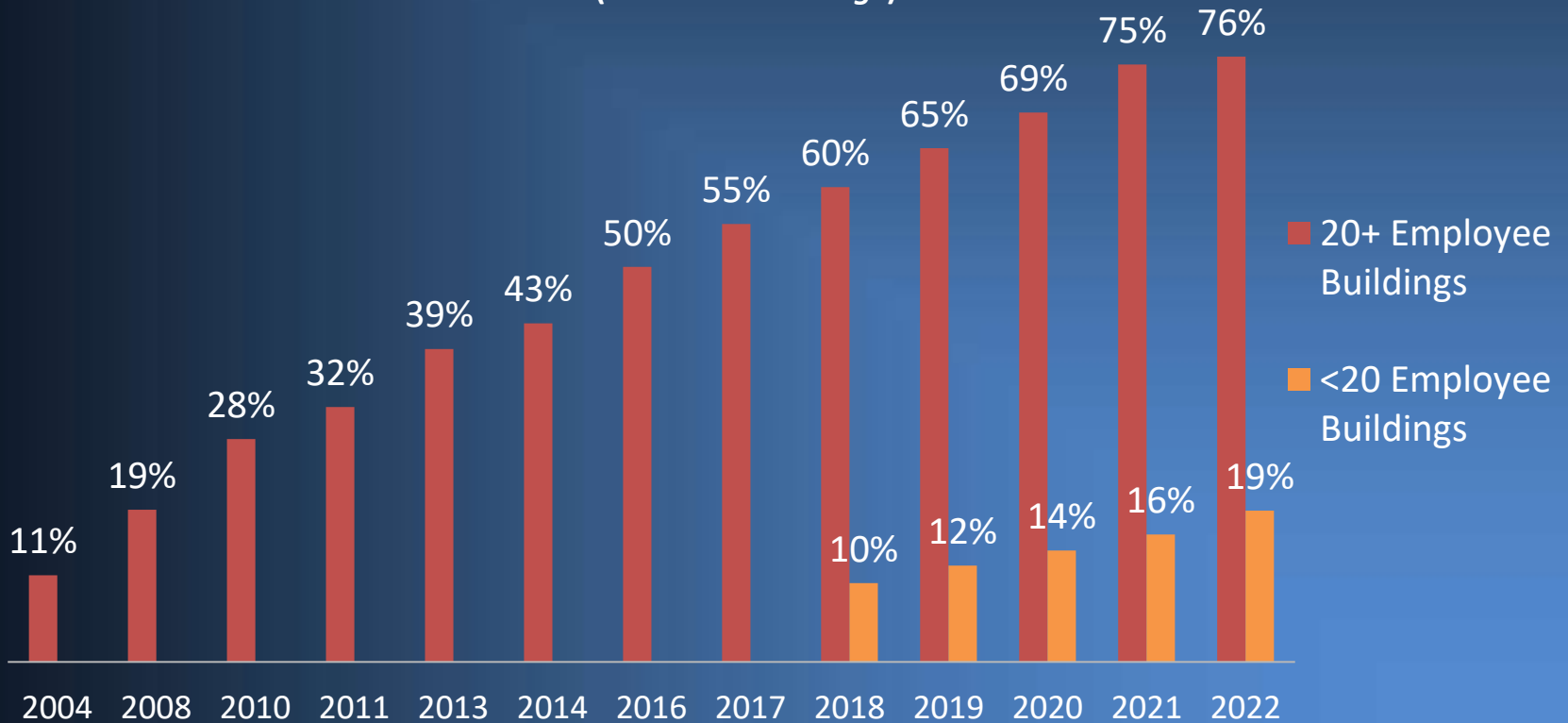
- ❖ Leased Transport End Users
 - ❖ Port of Bellingham
 - ❖ Western Washington University
 - ❖ Housing Authority of Bellingham
 - ❖ Opportunity Council
 - ❖ Dawson Construction

- ❖ Service Providers/Local Experts
 - ❖ Whatcom PUD: Point Roberts broadband infrastructure grant project
 - ❖ CSS Integration & Communications: C Street Data Center
 - ❖ Bellingham Public Schools: Fiber backbone co-owner

NATIONAL DEPLOYMENT OF COMMERCIAL FIBER

Nationally, aggressive rollouts of fiber by incumbent and alternative providers have substantially increased the availability of fiber to larger commercial buildings, but smaller locations lag significantly...

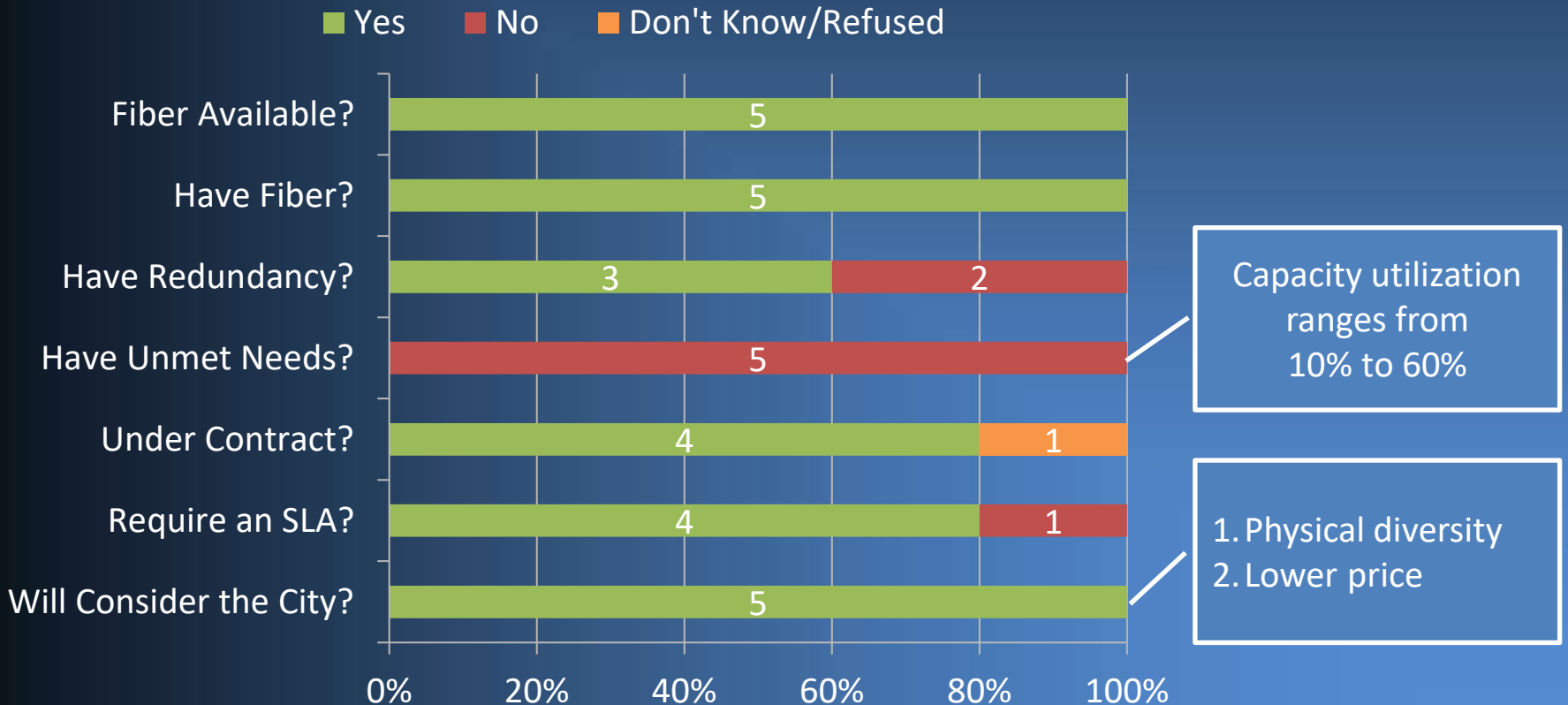
**Percentage of Commercial Buildings Served by Fiber
(Total U.S. Buildings)**



Source: Vertical Systems Group

FIBER IS AVAILABLE BUT WILLING TO SWITCH/ADD

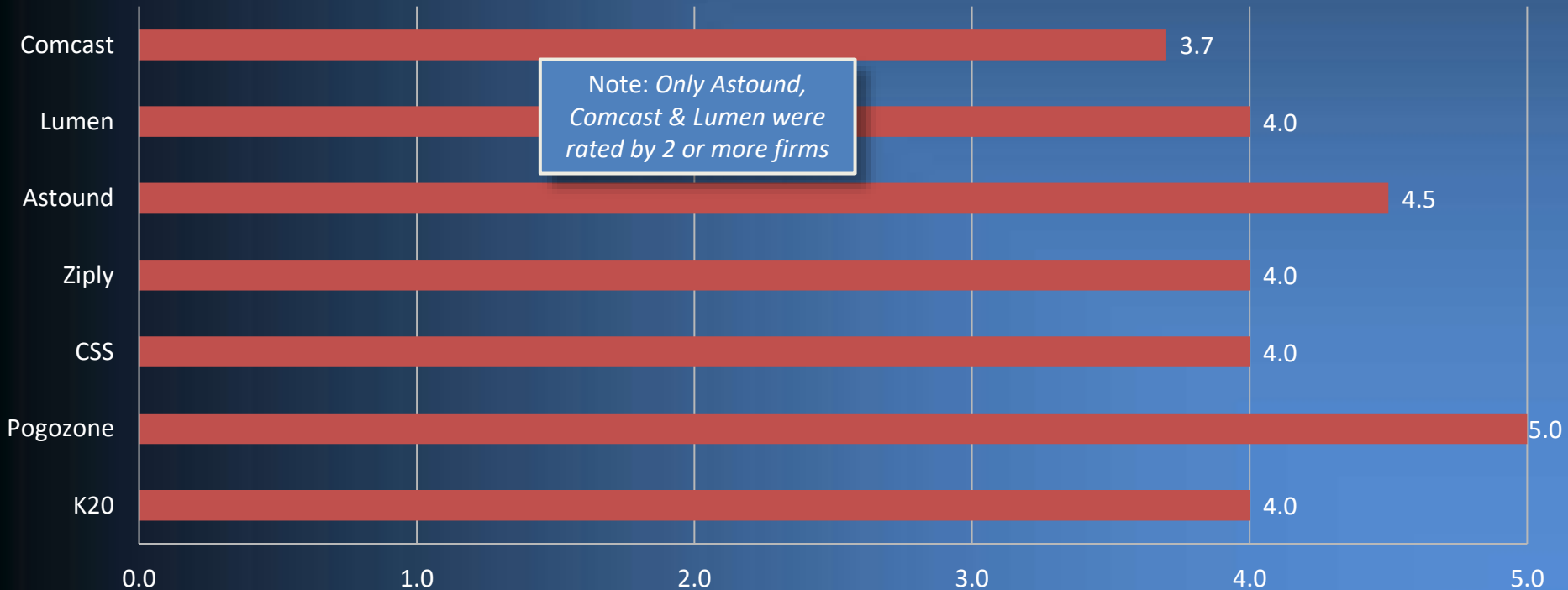
Fiber has been deployed to the participating business locations. Advanced data needs are being met for most, but businesses will “absolutely” consider city fiber infrastructure as a leased transport option, but would require an SLA...



Satisfaction levels are high when compared to ratings in other markets Uptown has studied

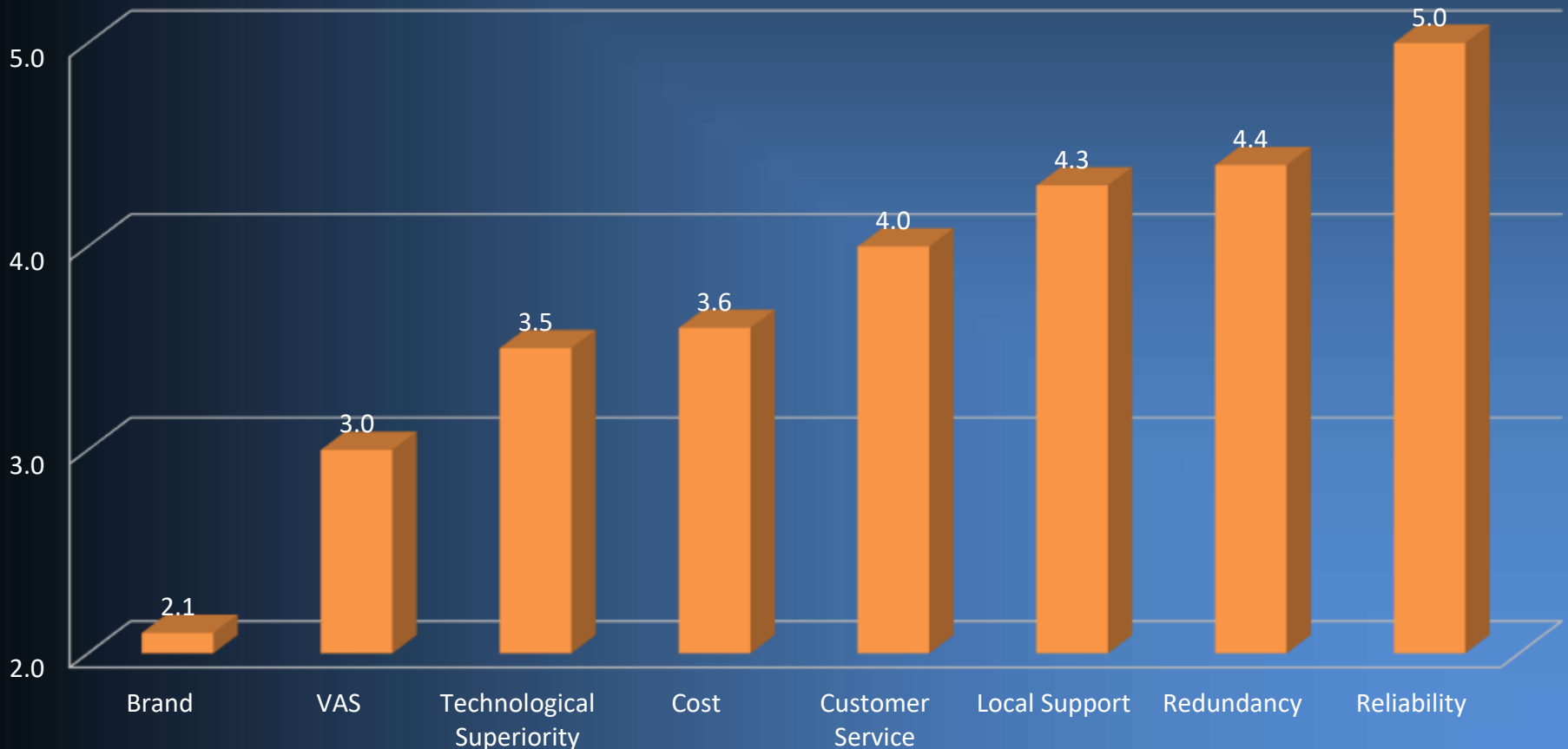
- Overall average satisfaction is 4.1 (typically 3.5 – 4.0)
- Most prevalent areas of dissatisfaction:
 - Lack of value
 - Poor customer service / responsiveness / communication

Satisfaction Rating by Service/Service Provider
(Mean Rating on a 1-5 Scale)



Among selection factors, reliability, redundancy, and local support rank highest...

Broadband Provider Selection Criteria Importance
(Mean Rating on a 1-5 Scale)



HIGH CAPACITY LOCAL MARKET PRICING

Large businesses and institutions in Bellingham are paying \$.04 - \$1.50 per Mbps for direct fiber connections. This price range is driven by the leased capacity of the circuit and scale efficiencies. Market averages by capacity for **lit, dedicated fiber** circuits are approximately:

Circuit Capacity	Monthly Recurring	\$/Mbps
1 Gbps / 1 Gbps	\$1,000	\$1.00
10 Gbps / 10 Gbps	\$2,000	\$.20
40 Gbps / 40 Gbps	\$4,000	\$.10

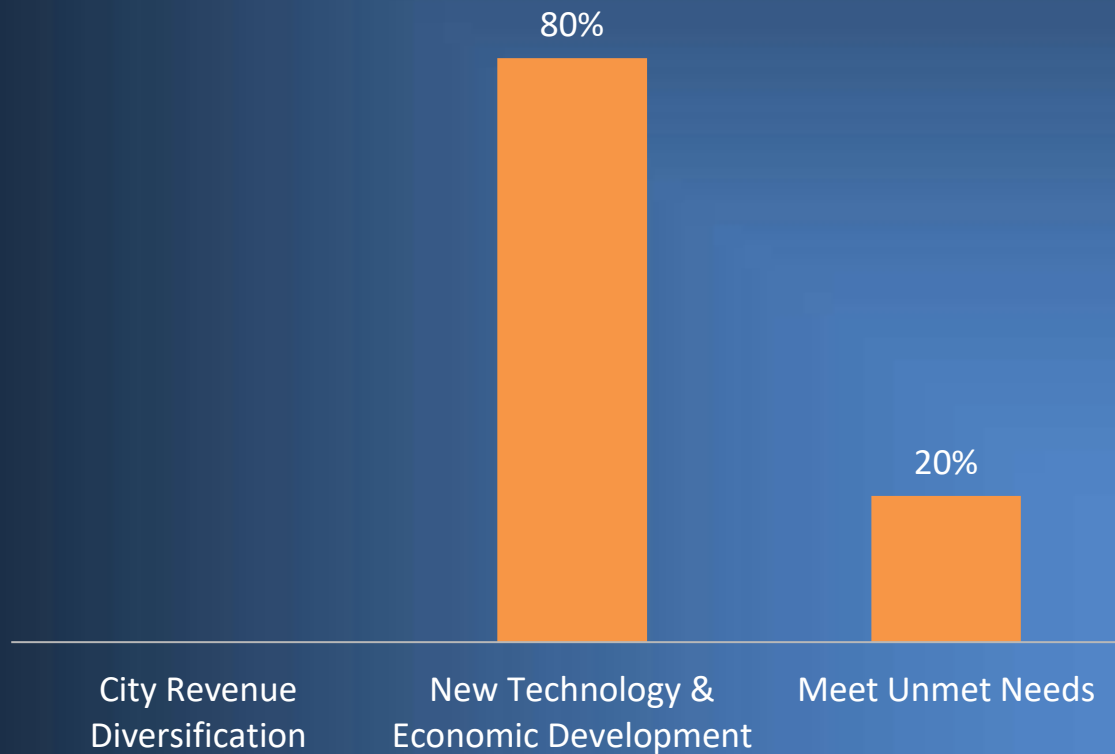
For **dark fiber** leasing, rates vary significantly by market and route length, with long distance fiber routes in rural areas commanding lower rates than urban fiber routes:

Market Type	Monthly Recurring
Urban	\$300/strand mile/month
Rural	\$15/strand mile/month

MOTIVATION FOR CITY-PROVIDED BROADBAND

Participants perceive that the most viable goal for the City in pursuing a broadband initiative would be to support the business community as a progressive, growth-oriented project...

**Percentage of Respondents by Motivation Choice
(Closed Ended with 3 Options)**



Research Findings:

- ◆ Most firms have sufficient fiber and capacity available to them, and satisfaction levels with the incumbents are above average
- ◆ Data and broadband services needs are being met, but firms will consider city fiber infrastructure for a data connection if offered.
- ◆ Some firms do not have a backup circuit or protection on their connection, creating an opportunity for the city to provide an additional circuit if physically diverse from the current circuit. Route diversity and lower price are key switching factors
- ◆ Many firms would require the city, or its operating partner, to include a Service Level Agreement providing financial recourse should network performance fail to meet typical industry standards

Pro Forma:

- ◆ Local market pricing for dark fiber leasing is in the range of \$300 per strand mile
- ◆ Identify total strand miles that would need to be leased for financial breakeven

Task 6: Financial Analysis

Potential Funding Sources

For the baseline financial analysis, both a long term bond and working capital loan were used for funding...

1. Long Term Bond
 - ◆ Single round of financing via 20-year tax exempt revenue or GO bond at 4.5% interest
 - ◆ 2 years of capitalized interest
 - ◆ 1.5% issuance cost
2. Working Capital Loan
 - ◆ 11 year term at 4.5% interest
 - ◆ Interest accumulates over first 5 years with Year 6 balloon payment
 - ◆ Level payments begin in Year 6 and complete in Year 11
3. Wholesale fees paid by the ISP under wholesale partnership models
 - ◆ Monthly fee per connected end user, or
 - ◆ Monthly fee per connection and per serviceable premises
4. Equity
 - ◆ Either upfront or ongoing annual general fund contributions
 - ◆ Equity can fund construction capex requirement and/or working capital requirement
5. Local Improvement District
 - ◆ Monthly fee assessed to all residential premises as they become serviceable
 - ◆ Assessed for full 20 years
6. Customer-funded installation (either upfront or amortized into monthly recurring fee)

Task 6: Financial Analysis

Scenario #1A: Middle Mile Dark Fiber Leasing

Scenario #1B: Middle Mile Leased Access

The Uptown pro forma model identifies key financial metrics that we rely on to evaluate financial feasibility of broadband investment projects (example project outcomes follow)...

1. Timeframe to positive operating income
 - ◆ Revenue proceeds exceed operating expenses
 - ◆ Typical goal is within 4 years

2. Net Payback Period
 - ◆ Total project revenue proceeds exceed total investment
 - ◆ Typical goal is less than 20 years

3. No Secondary financing
 - ◆ Net cash flow including debt service remains positive over the life of the investment
 - ◆ Pro forma model identifies an inability of the broadband system to self fund

4. Sensitivity Analysis
 - ◆ Reasonable ability to withstand “misses” on key operating or financial metrics
 - ◆ Typically sensitive metrics include construction cost, residential take rates, and interest rate on long term debt

The market opportunity for leasing dark fiber is primarily reliant upon the level of need for transport capacity by incumbent Internet Service providers. These service providers will lease dark fiber multiple for reasons including:

- ◆ To create route diversity and architecture redundancy
- ◆ To minimize outside plant construction requirements/costs
- ◆ To extend their service area

Total Fiber Route Miles*	219
Aerial Strand Miles	893
Underground Strand Miles	1,425
Total Strand Miles	2,318

Leased Strand Miles: Year 1	10
Leased Strand Miles: Year 5	40
Leased Strand Miles: Year 10	80
Leased Strand Miles: Year 15**	100

*Reflects strand miles available after all recommended infrastructure upgrades including vault replacements and additional fiber infrastructure construction.

** The Year 15 represents peak leased strand miles with no additional growth over years 16-20.



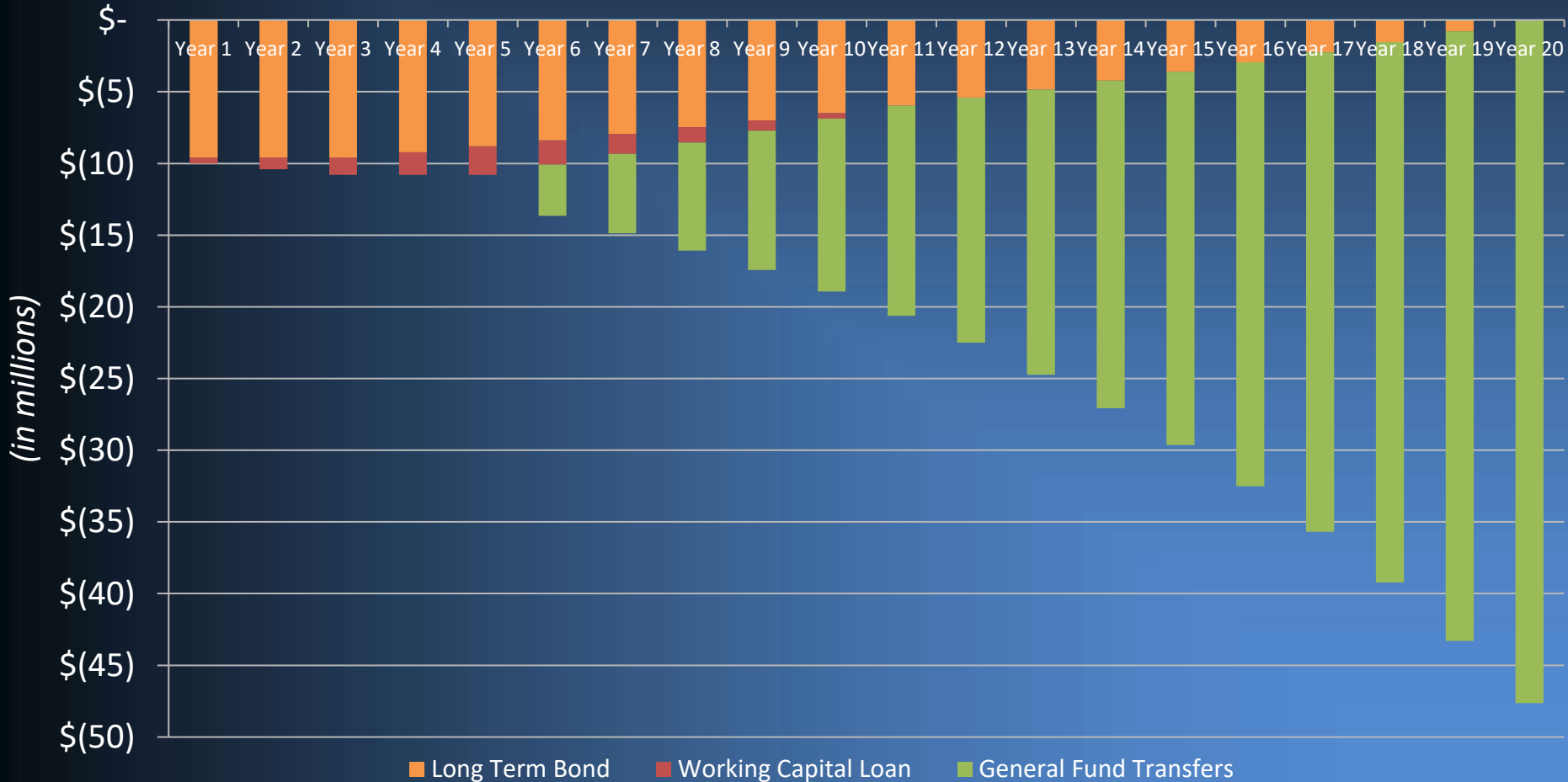
DARK FIBER LEASING: CASH FLOW BEFORE DEBT SERVICE

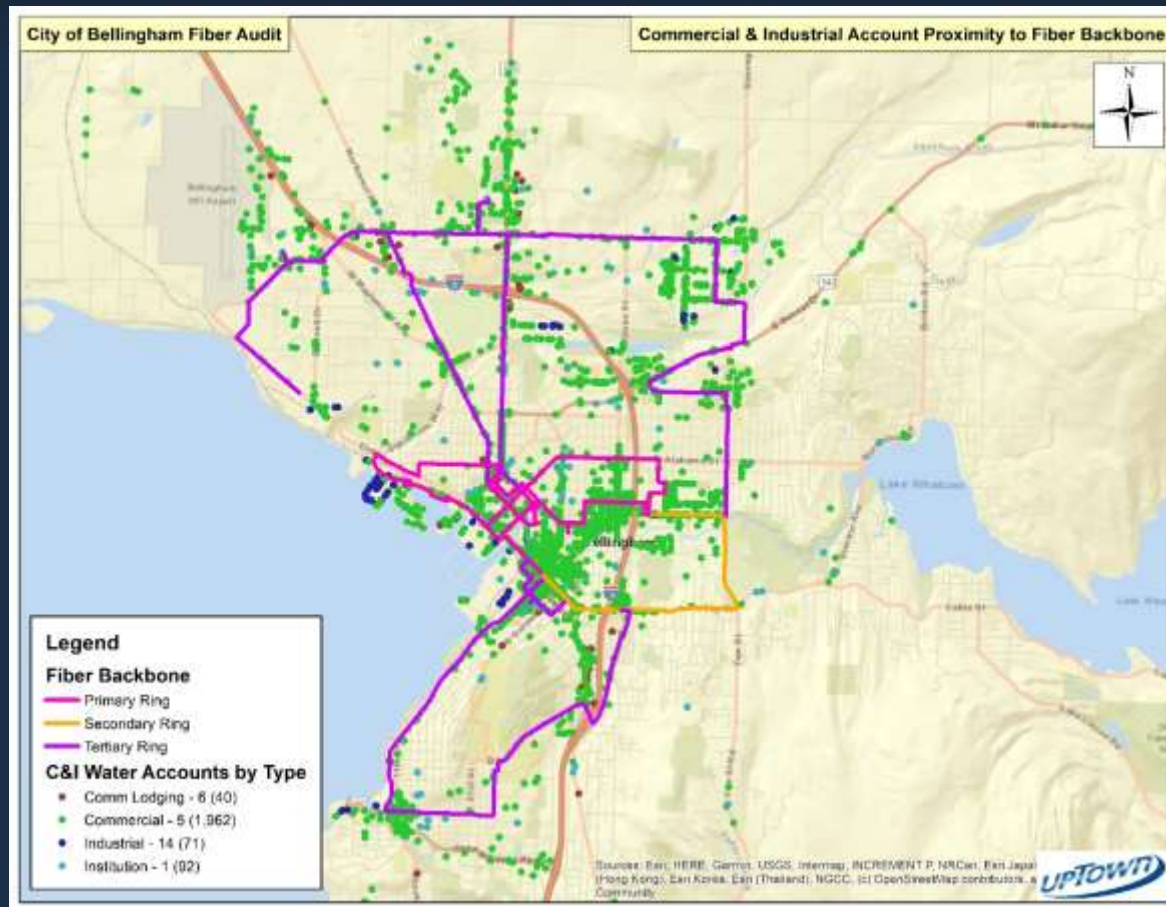
The anticipated operating income under the dark fiber leasing scenario is not sufficient to generate positive cash flow at any point over the 20 year pro forma forecast. This view excludes debt service costs...



DARK FIBER LEASING: FUNDING SOURCES

With insufficient operating cash flow, the fiber enterprise would need to continue borrowing funds since it would not be financially self sufficient...



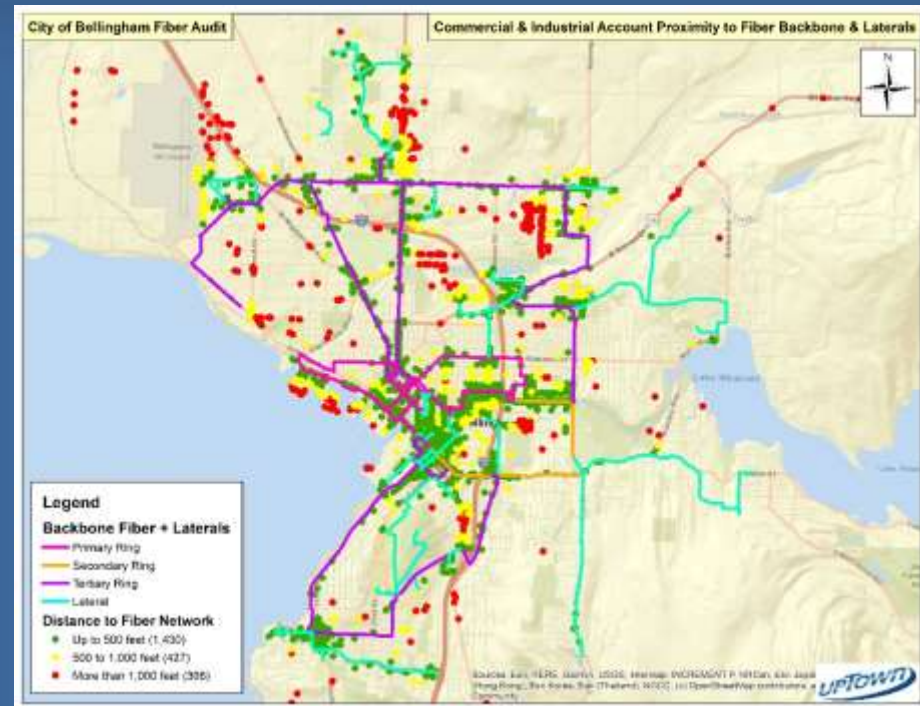
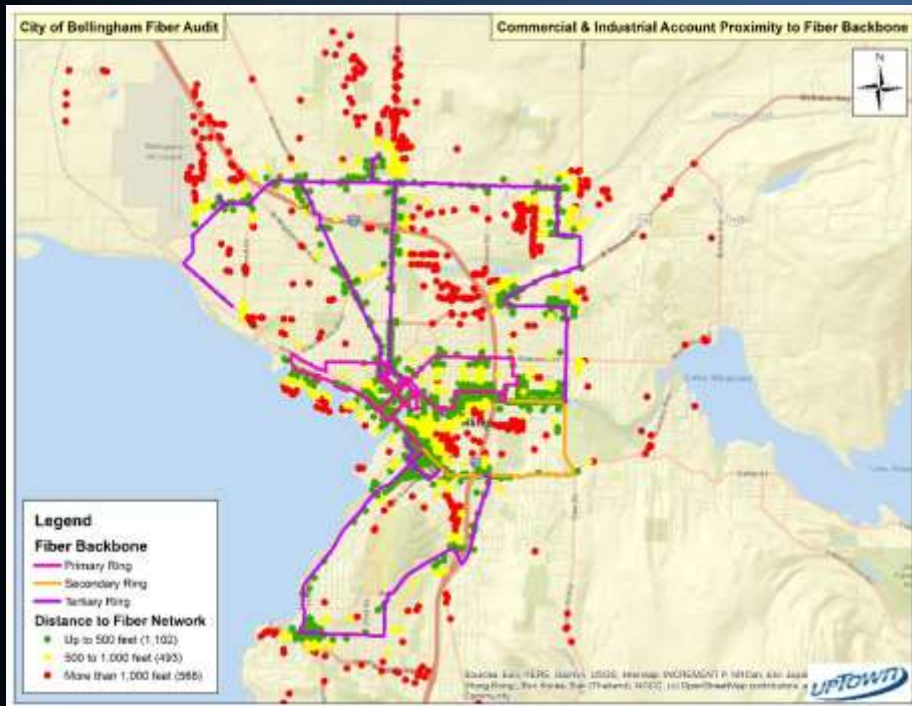


- ❖ Commercial & Industrial (C&I) water meter data used to identify potential commercial targets
- ❖ Large general commercial market throughout the City – 1,962 meters
- ❖ Smaller pockets of industrial accounts scattered around the City – 71 meters

LEASED ACCESS: PROXIMITY TO CITY FIBER

- ◆ Proximity to Upgraded Fiber Backbone Only
 - ❖ 1,102 commercial and industrial (C&I) water accounts within 500 feet of an upgraded fiber segment
 - ❖ Additional 493 C&I accounts within 1,000 feet of an upgraded fiber segment

- ◆ Proximity to Fiber Backbone Including Laterals
 - ❖ 301 commercial and industrial (C&I) water accounts within 500 feet of an existing lateral
 - ❖ Laterals would need to be evaluated as capable to support fiber leasing on a case-by-case basis



The market opportunity for leasing lit fiber access is influenced by the presence of alternative providers as well as the distance to the entity from the fiber route (i.e. higher incremental capex required to extend the fiber). While longer laterals require more construction cost, there will be less competition to build to these entities. Accordingly, Uptown is holding take rate constant across lateral lengths...

# of Entities by Distance to...	≤ 500 ft.	500-1,000 ft.	≥ 1,000 ft.	Total
Fiber Backbone	1,102	493	566	2,162
Fiber Backbone + Laterals	1,430	427	306	

Mean Lateral Construction Cost	≤ 500 ft.	500-1,000 ft.	≥ 1,000 ft.
Per Entity w/ Aerial Lateral	\$5,744	\$23,262	\$78,561
Per Entity w/ Underground Lateral	\$14,560	\$58,960	\$199,120

Mean Year 5 Take Rate	
Prospects as % of All Commercial	10% or ≈ 220
Year 1 Take Rate	2%
Year 8 Take Rate*	20%

*The Year 8 take rate reflects 'terminal penetration' with no additional take rate growth over years 9-20.

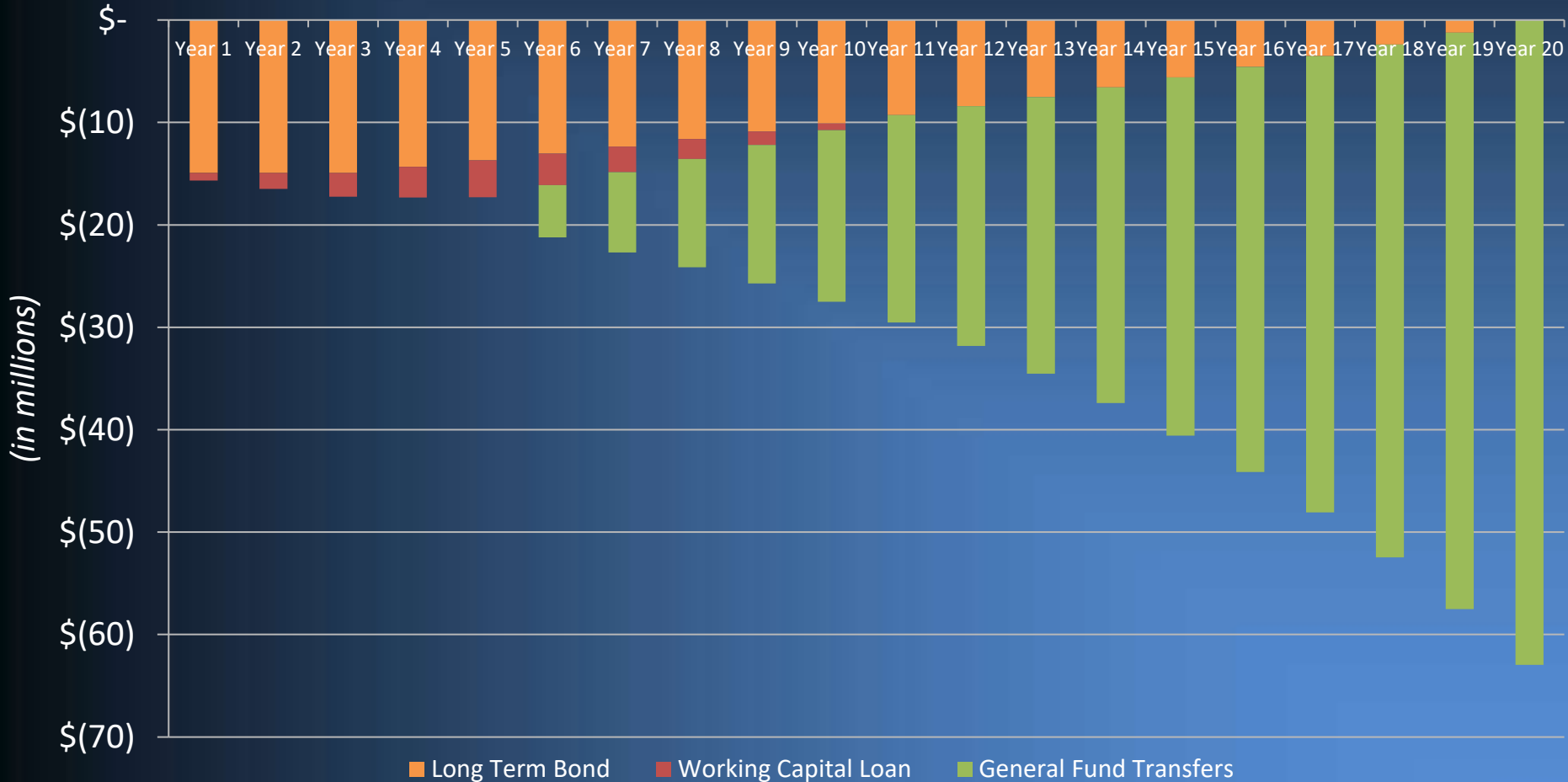


LEASED ACCESS: CASH FLOW BEFORE DEBT SERVICE

While significantly improved compared to dark fiber leasing alone, the financial opportunity of offering leased access services is similarly weak in terms of anticipated operating income. This view excludes debt service costs...



With insufficient operating cash flow, the fiber enterprise would need to continue borrowing funds since it would not be financially self sufficient...

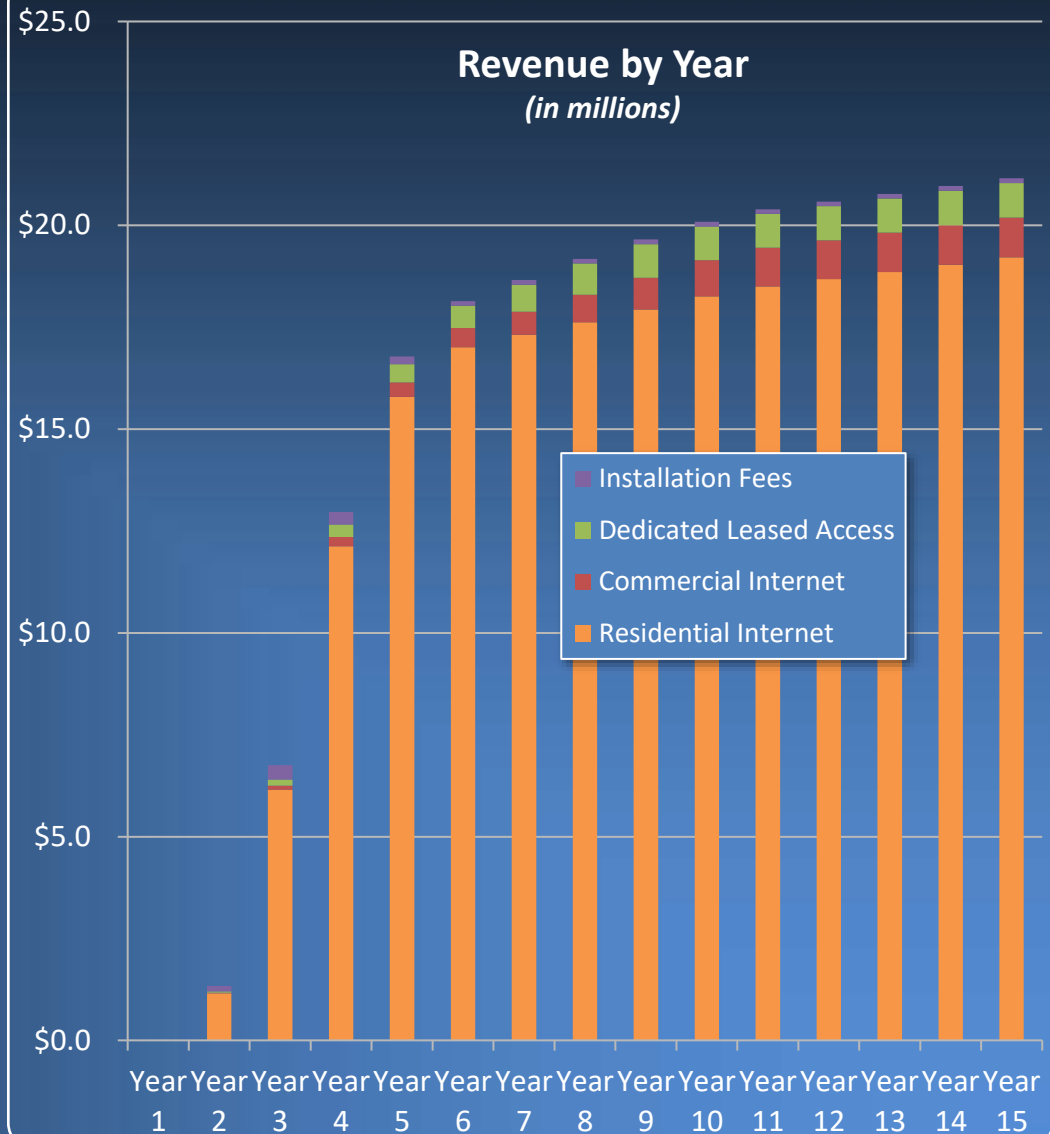


Task 6: Financial Analysis

Scenario #2: Last Mile Retail Broadband

KEY INPUTS

- Timing
 - Year 1: 0 months
 - Year 2: 10 months
- Year 1 Premises
 - Residential SFU: 39,000 (1.9% growth)
 - Commercial: 2,165 (1.0% growth)
 - % Complex: 10% of commercial
- Year 5 Penetration (Internet)
 - Residential: 38% (Year 5)
 - Commercial: 35% (Year 10)
- Residential Internet
 - 1Gbps Tier: \$70
 - 2Gbps Tier: \$110
 - 4Gbps Tier: \$150
 - WiFi Upgrade: \$10
- Commercial Internet
 - 100Mbps Tier: \$80
 - 500Mbps Tier: \$150
 - 1Gbps Tier: \$200
 - WiFi Upgrade: \$20
- Install Fees
 - Residential: \$50
 - Commercial: \$100



If the City becomes a retail ISP, much greater bandwidth capacity will be required. Leasing transport circuits to diverse data centers as a member of the National Content & Technology Cooperative (NCTC) is recommended to achieve significant volume discounts. The NCTC has secured master purchasing agreements with Zayo, Windstream and Cogent...

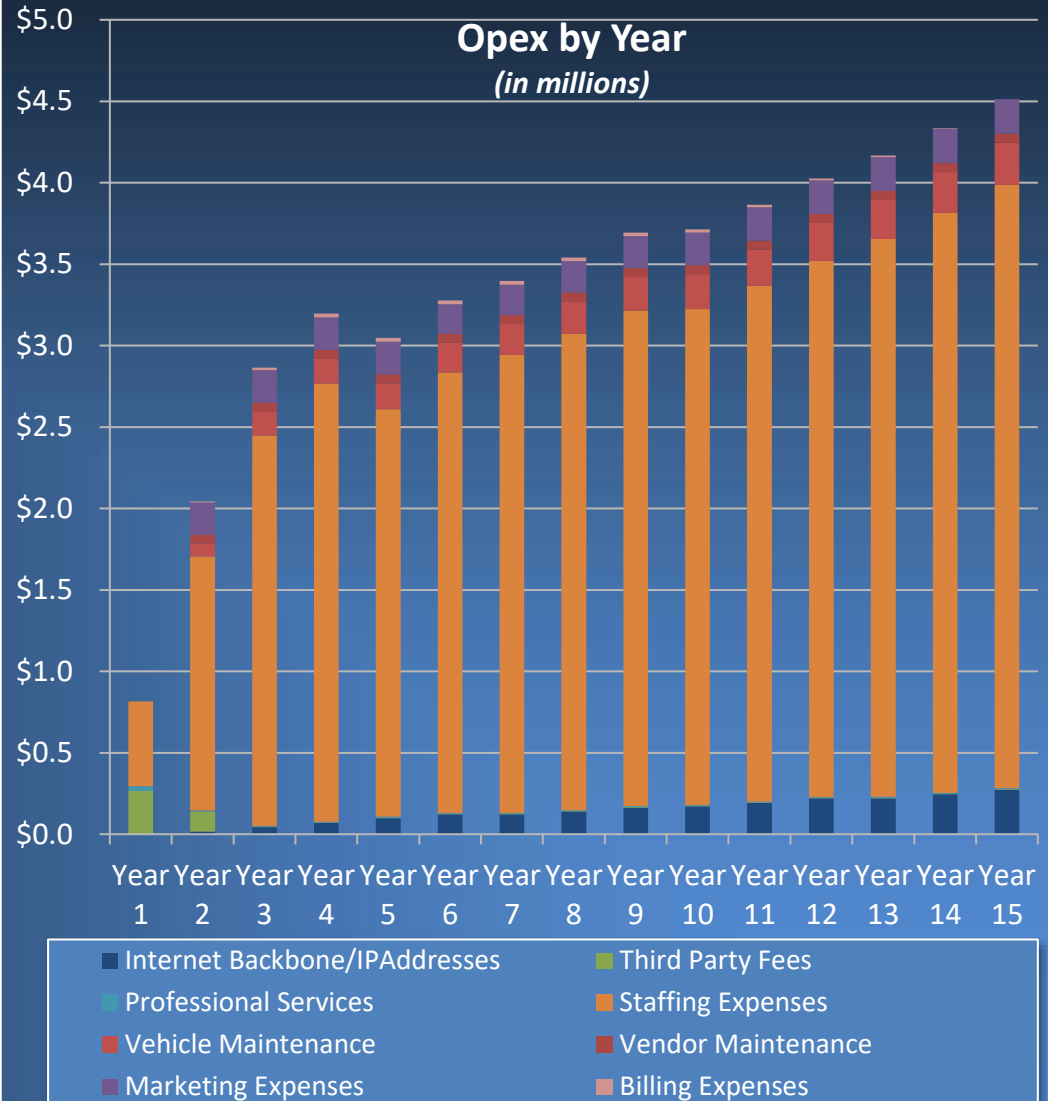
	Direct Access Configuration at Carrier-Neutral Data Centers
Transport	Use 2 existing city-owned fiber circuits terminating at: <ul style="list-style-type: none"> • Lunavi Data Center: No incremental fee • Zply Standby Circuit: No incremental fee
Access	At both locations, circuits terminate in the Lunavi Meet-Me Room for access to the greater Internet via multiple bandwidth providers. Lease capacity in 10G increments of Committed Data Rate capacity: <ul style="list-style-type: none"> • Provider “A”: 10G bandwidth for \$700 MRC/\$0 NRC and 1 year term • Provider “B”: 10G bandwidth for \$700 MRC/\$0 NRC and 1 year term • Provider “C”: Non-NCTC Comp for 10G bandwidth for \$2,590 MRC/\$2,500 NRC
Other Fees	<ul style="list-style-type: none"> • X-Connect: \$300/month per circuit • Lease IP addresses (IPv4): Budgeted at 29¢ each per month • Non-recurring NCTC membership fees: \$20,500 • Recurring NCTC membership fees: \$3,500 per year

LAST MILE: BANDWIDTH FORECAST



KEY INPUTS

- Bandwidth/IP Addresses *(see slide detail)*
- Staffing *(see slide detail)*
 - 22 Full Time Equivalent headcount
 - 4% annual wage increase
 - 40% benefits loading
- Vehicle Maintenance
 - 20k miles annually per vehicle
 - \$.75/mile growing at 4%
- Professional Services
 - Implementation: \$360k (2 years)
 - Legal/Acct: \$30k (Yr1)/\$5k (Yr2+)
- Other Opex
 - ROW Fees: \$0/pole/year
 - Vendor maintenance of \$55k/year for OSS/BSS and FTTP electronics
- Marketing
 - Years 2 & 3: \$200k annually
 - Year 4: \$150k
 - Year 5+: 1.0% of revenues
- Billing
 - 80% of residential and commercial customers on paperless billing (Yr1) growing to 100% (Yr15)
 - Paper bill cost of \$.75/each/month and growing 3% annually



- ◆ Primary cost drivers for last mile projects
 - ◆ Outside plant characteristics – overhead vs. underground
 - ◆ Cost to construct underground facilities
 - ◆ Cost to construct overhead facilities
 - ◆ “Make Ready” cost to attach to existing overhead infrastructure – Puget Sound Energy (PSE) poles

- ◆ Key outside plant assumptions
 - ◆ City would place 60% of the last network on PSE poles
 - ◆ The remaining 40% of the network would be placed in new underground conduit systems

- ◆ PSE pole make ready assumptions
 - ◆ 5% of PSE poles will need to be replaced with taller poles at the City’s expense - \$15,000 each
 - ◆ 30% of PSE poles will need to have some sort of rearrangement at the City’s expense - \$1,000 each
 - ◆ City will spend \$1,000 per pole as part of the application / permitting process

- ◆ Outside plant construction cost assumptions
 - ◆ Composite unit cost assumptions used to reflect total cost per foot (including materials and labor)
 - ◆ Aerial construction in telecom zone - \$18 per foot
 - ◆ Underground construction in City right of way - \$80 per foot

- ◆ Network Construction
 - ◆ OSP Construction: \$2,354 composite cost per passing
 - ◆ Subsequent plant extensions: \$ 3,500/passing
 - ◆ FTTP Optical Line Terminals: \$150/passing
 - ◆ Backbone/Feeder cost: \$203/passing
 - ◆ Year 10 Network electronics upgrade: \$75/premise passed
 - ◆ Make ready cost: \$2,050 per pole
- ◆ Facility Capital Costs
 - ◆ Office space remodeling: \$500k
 - ◆ Operations center building: \$1.0M
- ◆ Back Office Systems (OSS/BSS)
 - ◆ OSS/BSS: \$195k
 - ◆ Fiber Management & Network Management: Completed
- ◆ Backup Power
 - ◆ Generator w/ UPS: \$375k
- ◆ Fixed Equipment
 - ◆ Core data switch: \$500k
 - ◆ Internet systems back office: \$250k
 - ◆ Splice Trailer/Field Tech Equipment/Tools: \$270k

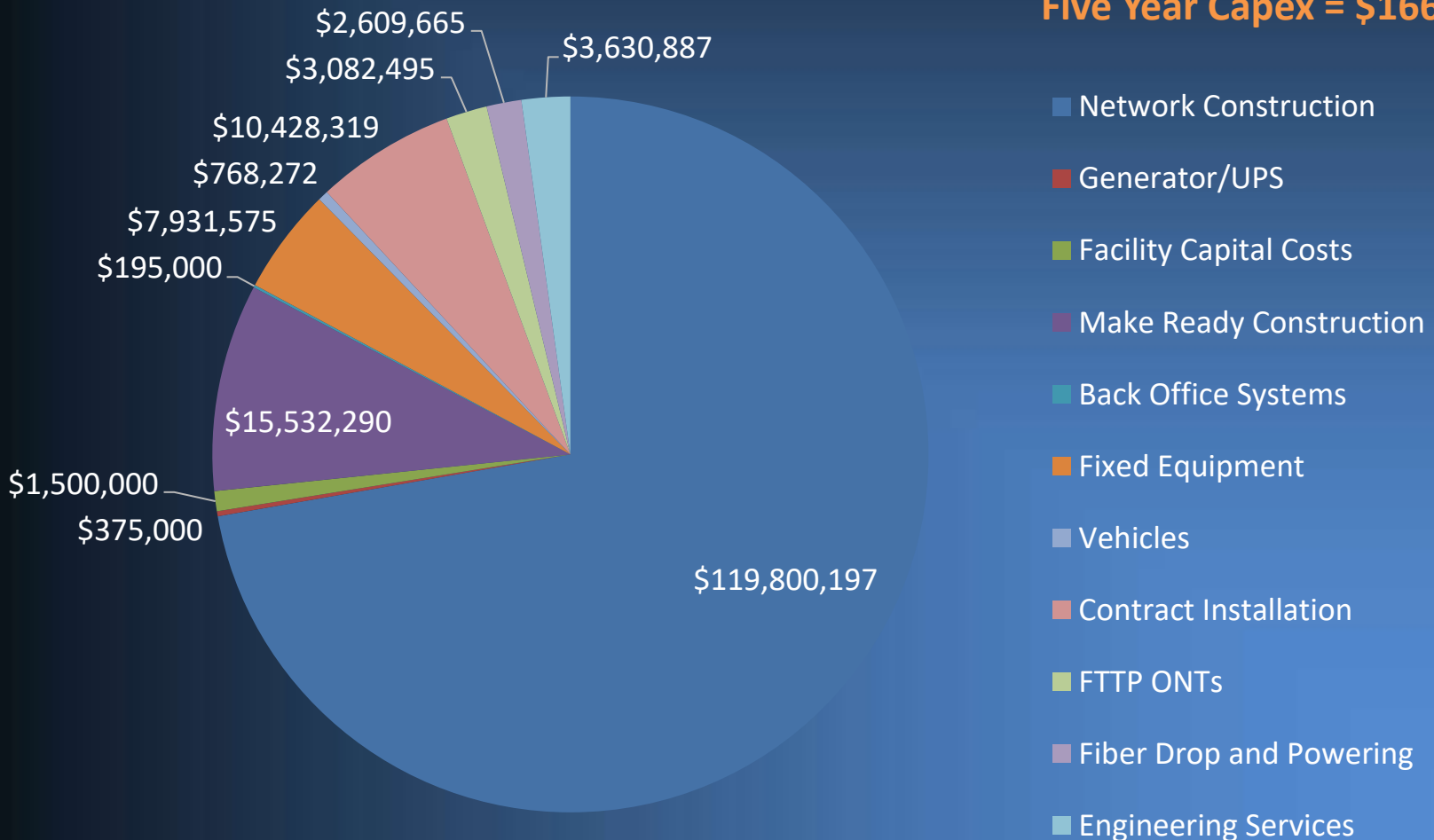
- ◆ Vehicles
 - ◆ Service Vans Per Install Technician: 1.0
 - ◆ Heavy Service Trucks Per Maintenance Technician: 0.5
 - ◆ Service vans: 8 at \$45k each
 - ◆ Heavy Service Trucks (non-insulated): 1 at \$120k each
 - ◆ Install Rigs: 1 per Install or Service Technician at \$25k each
 - ◆ Vehicles replaced at 6 year intervals
- ◆ Contract Labor
 - ◆ Pre-Installs: Insourced
 - ◆ Premise Installs: Insourced
- ◆ Optical Network Terminals (ONTs)
 - ◆ Without WiFi: \$130
 - ◆ With WiFi: \$234
 - ◆ Multi-Gig: \$310
 - ◆ Year 7 ONT upgrade: \$670k (\$40/ea.)
- ◆ Fiber Drop & Powering
 - ◆ Fiber drop and connectors: \$125 each
 - ◆ Power cord and UPS: \$50 each

- ◆ Engineering and Integration
 - ◆ Walk out & strand mapping: \$2,500 per mile
 - ◆ FTTP design: \$3,000 per mile
 - ◆ Make Ready Engineering: \$3,000 per mile
 - ◆ Construction management services: \$10,000 per mile
 - ◆ As-built drawings: \$250 per mile
 - ◆ Backbone/Feeder design: \$500,000

LAST MILE: CAPEX BY TYPE: YEARS 1-5

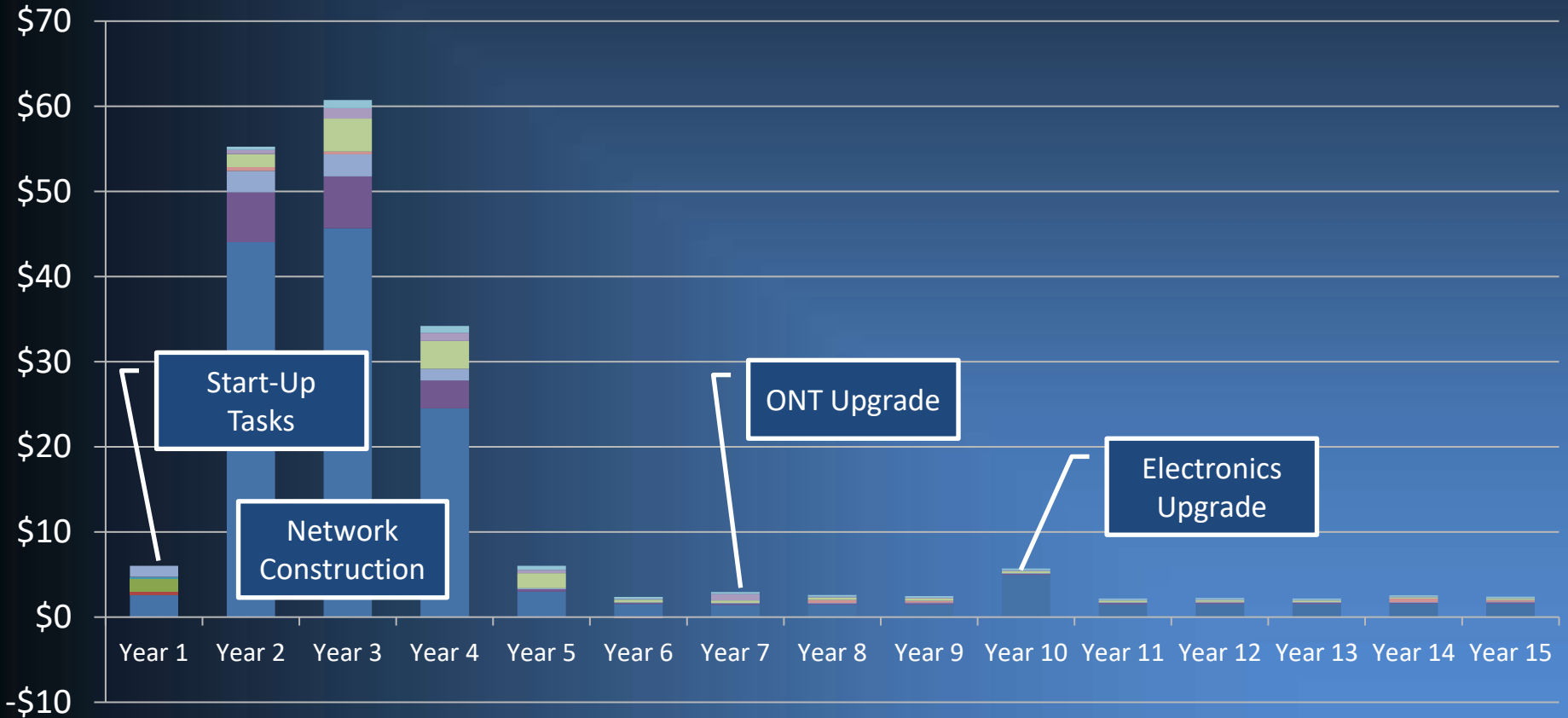
Nearly three-fourths of the 5 year capex requirement is due to outside plant construction, primarily composed of the labor cost to install aerial and underground conduit and fiber. This capex requirement is the primary driver of the long-term bond amount required to fund FTTP

Five Year Capex = \$166M



LAST MILE: CAPEX BY YEAR (\$M)

Capex spending is front-end loaded during the start-up and construction phases of the project, but the pro forma also includes incremental capex for electronics upgrades in Years 7 and 10



- Outside Plant Construction
- Generator/UPS
- Facility Capital Costs
- Make Ready Construction
- Back Office Systems
- Fixed Equipment
- Vehicles
- Contract Installation
- FTTP ONTs
- Fiber Drop and Powering
- Engineering & Inspection Services



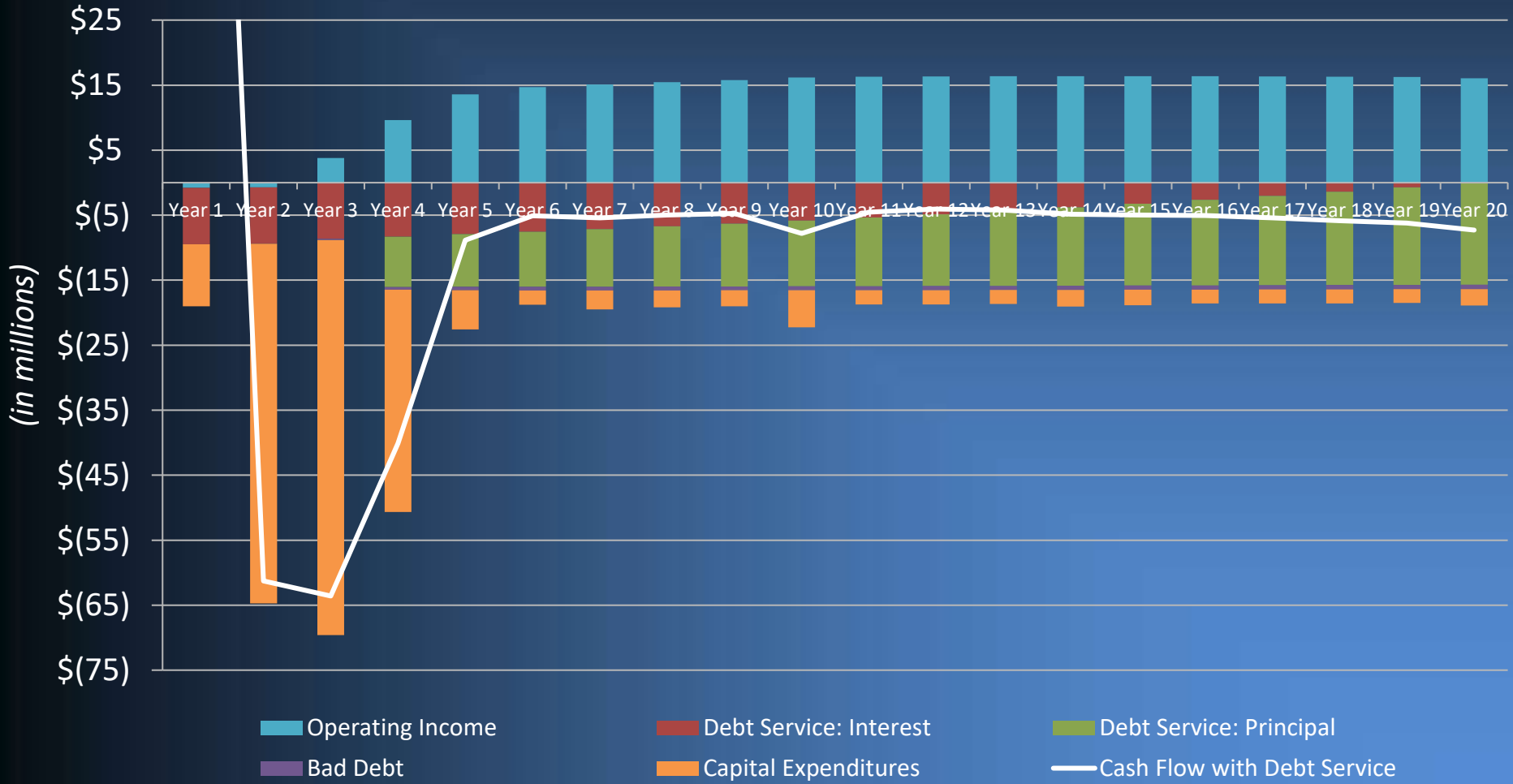
LAST MILE: CASH FLOW BEFORE DEBT SERVICE

We forecast that under the Last Mile scenario, operating cash flow would go positive in Year 3 and remain positive over the life of the project. This view excludes debt service costs...

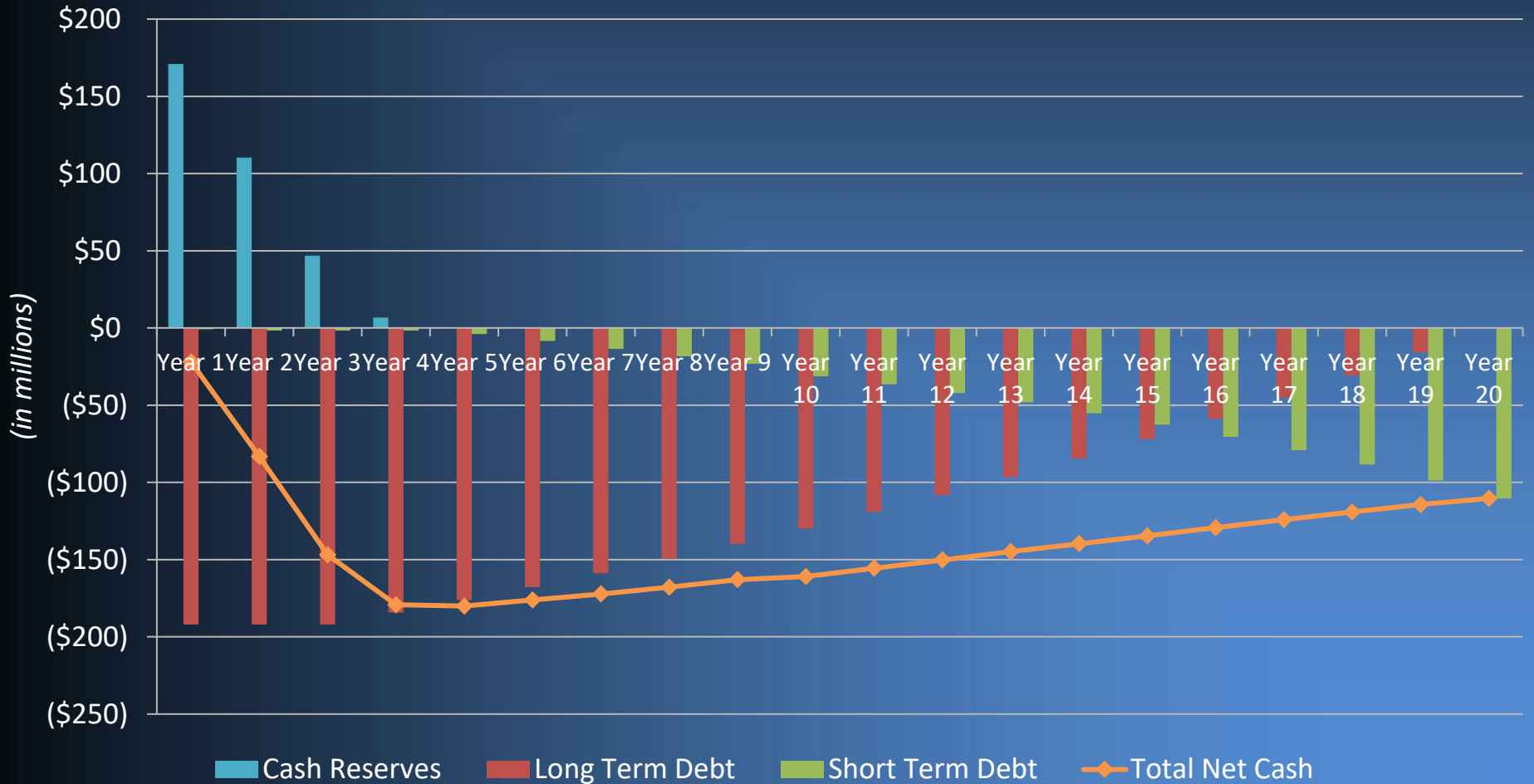


LAST MILE: CASH FLOW AFTER DEBT SERVICE

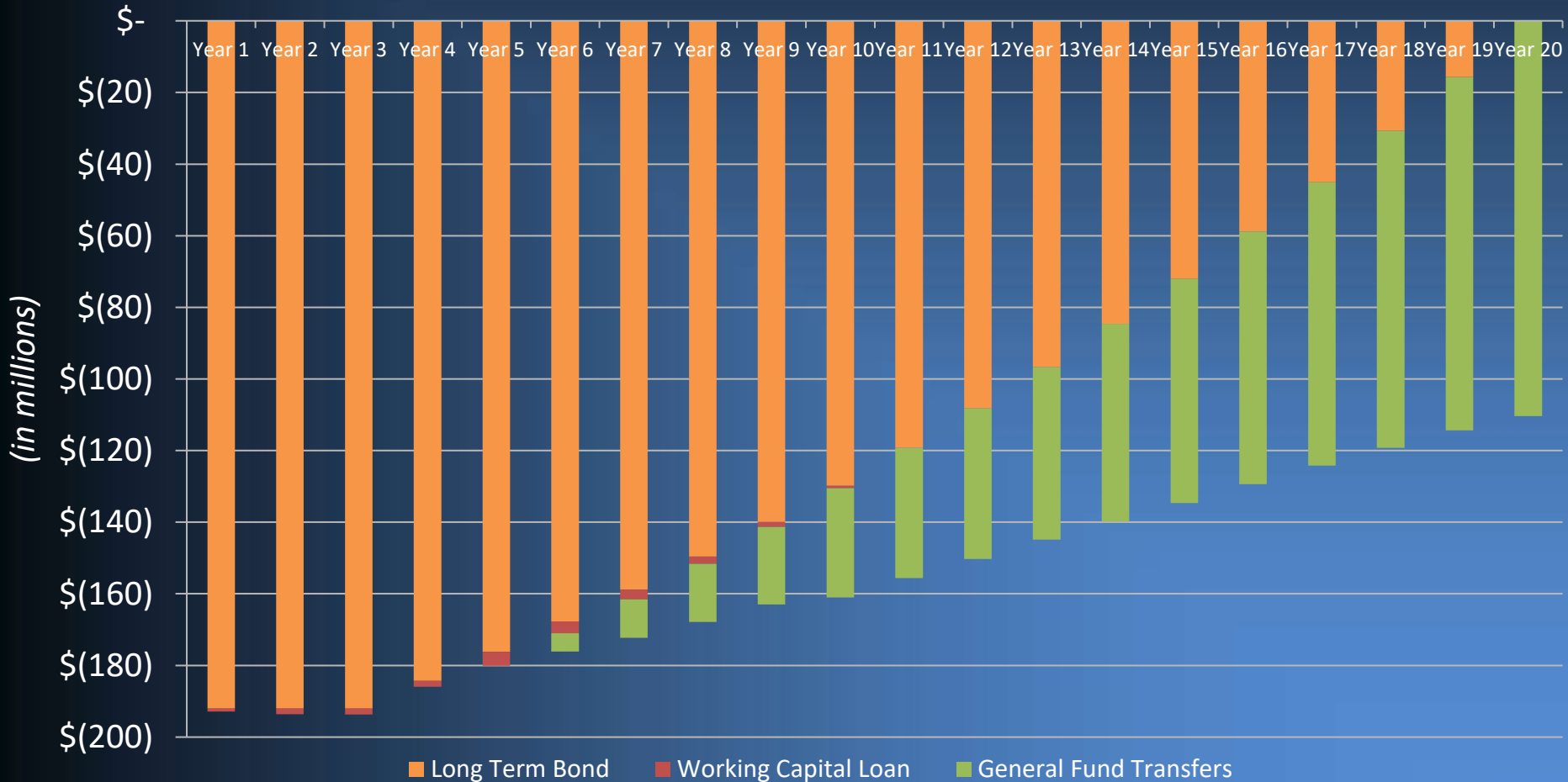
Although operating income goes positive in Year 3, cash flow including debt service never goes positive during the 20 year forecast...



The Last Mile scenario is projected to have a negative \$110M net cash position at Year 20...

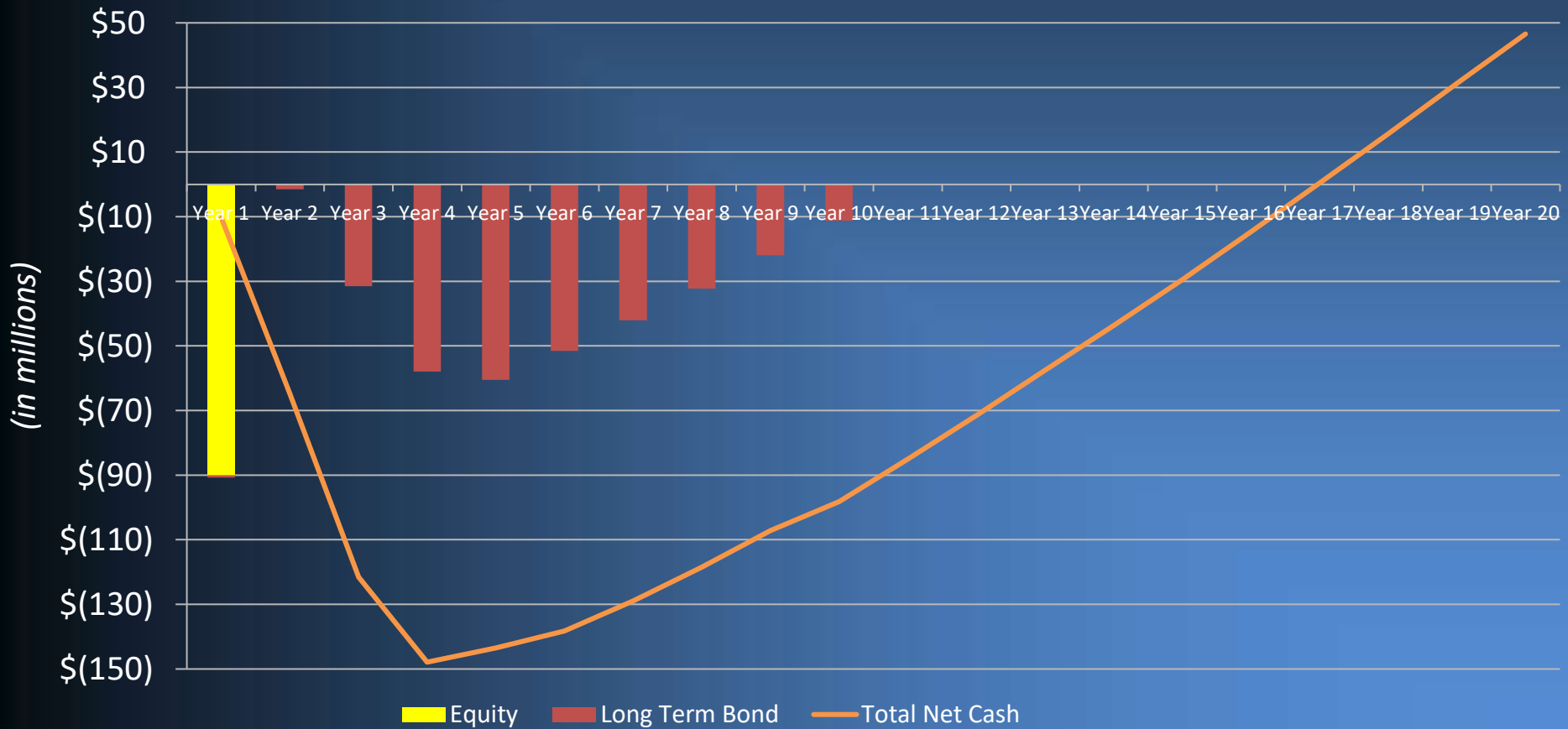


With insufficient operating cash flow, the fiber enterprise would need to continue borrowing funds since it would not be financially self sufficient...



LAST MILE: EQUITY FUNDING OUTCOME

For the Last Mile scenario to achieve financial self-sufficiency, an equity investment of \$90M would be required in addition to a \$57M 10-year bond. The equity investment would be sunk and not incur interest payments. At Year 20, the enterprise would have a \$50M net position against the \$90M equity stake...



1. Local market construction costs within the proposed service area are expensive and require significant capital investment
 - ◆ OSP Construction: \$2,354 composite cost per passing
 - ◆ Make ready cost: \$2,050 per pole
 - ◆ Walk out & strand mapping: \$2,500 per mile
 - ◆ FTTP design: \$3,000 per mile
 - ◆ Make Ready Engineering: \$3,000 per mile

2. We note that federal infrastructure grant dollars, while significant and timely, would not be available within city limits due to a lack of eligibility based on incumbent service offerings. Traditional financing using long term debt, working capital loans, and equity would be required.

3. Across the three scenarios studied, we conclude the following regarding the financial feasibility of each:
 - ◆ Dark Fiber Leasing: Not financially feasible as operating cash flow is not positive and would require ongoing budget transfers to remain in operation
 - ◆ Leased Access: Not financially feasible as operating cash flow is not positive and would require ongoing budget transfers to remain in operation
 - ◆ Last Mile: While operating income is positive, the \$200M bond debt service costs preclude financial feasibility. To sufficiently alleviate debt service costs, a \$90M upfront equity investment would be required in addition to a \$57M bond.

Task 7: Fiber Construction, Documentation, and Standards

◆ Objective

Create guidelines for new infrastructure construction, standards for as-built documentation and testing and acceptance standards for “carrier class” infrastructure

◆ Uptown deliverable

- ❖ Documentation suitable to use in the scope of future RFPs and contracting
- ❖ Drawn from multiple recent Uptown last mile and middle mile construction RFPs / Bids
- ❖ Provided under separate cover in MS Word format

- ◆ **Fiber Testing**
 - ❖ Test all terminated fiber strands owned by the City
 - ❖ \$144,000 budget estimate
 - ❖ Three to six months to complete

- ◆ **Infrastructure Upgrades – Hand Holes and Conduits**
 - ❖ Upgrade hand hole locations to fiber standards
 - ❖ Prioritize fiber routes based on test results
 - ❖ 845 potential upgrade locations
 - ❖ \$8M budget estimate
 - ❖ Two to four years to complete

- ◆ **Infrastructure Upgrades – Fiber Augmentation**
 - ❖ Place new fiber cable in Southwest Route
 - ❖ Place 96-144 fiber cable depending on capacity of the conduit
 - ❖ \$127,500 budget estimate
 - ❖ One to three months to complete