East Bay Broadband Report Card

Final Report

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1. Summary

An analysis of broadband availability data for Alameda, Contra Costa and Solano Counties shows that the East Bay has wide service variations within the region. Overall, the region is close to the statewide "C" average, with Solano County getting a "C-", Alameda County a "C" and Contra Costa County a "C+". The statewide average, on the other hand, falls below performance levels achieved in other West Coast states and, particularly, states on the northern half of the East Coast. Unlike the top performing U.S. states, California does not match the broadband speed levels and adoption rates achieved in other countries.

Figure 1.1 – Regional broadband availability and infrastructure grades.

The best consumer-grade broadband service is in central Contra Costa County, in the City of Concord (A-). It was the only one of the forty cities studied that rated an "A" level grade. Walnut Creek and Pleasant Hill received "B" grades, with a high "C" given to Berkeley and Alameda. The common characteristic amongst all five is competition. All five either have or recently had three competing companies building and operating core broadband infrastructure and providing consumer-grade service.

The bottom five cities – Rio Vista (D-), Moraga (D) , Orinda (D), Clayton (D) and Dixon (D) – share one or more of three key characteristics: population densities and income levels typical of rural areas, local resistance to construction and challenging terrain. These factors play a significant role in shaping residential broadband availability.

In between, a general pattern emerges. As a rule, the further a community is from central Contra Costa County and Berkeley, the lower the quality of its broadband infrastructure and service availability. On the whole, incorporated cities tend to receive better grades than nearby unincorporated communities, indicating that municipal governments can play a role in improving broadband access.

Broadband resources also vary by land use. Residential infrastructure and service, which is more lucrative for providers, tends to be better than the services and underlying infrastructure in commercial and industrial areas. There are steps that local agencies can take to help close this gap, such as adopting broadband-friendly policies and encouraging competitive service providers to build infrastructure specifically designed for commercial and industrial users.

In general, mobile coverage in the region is good but not as good as the data submitted by carriers to the California Public Utilities Commission indicates. When advertised 4G speeds are compared to mobile field tests conducted by the CPUC, reality matches companies' claims only in small areas, mostly along the Nimitz freeway. Speeds tend to drop off as distance increases from the Bay Bridge toll plaza, with some spikes in the Livermore and San Ramon Valleys. 4G facilities have apparently been installed throughout the region, but the CPUC's tests indicate that capacity and coverage issues result in mobile data connections at speed levels more consistent with 3G service.

More people use broadband – of all kinds – in the East Bay than in California as a whole, but gaps remain. The reported regional adoption gap is 19%, versus 25% statewide. Within the region, however, there are stark differences, with adoption patterns showing a great similarity to income distribution. The adoption gap in Alameda and Solano counties is 22%; in Contra Costa it is 13%.

2. Broadband Service and Technology

2.1. Broadband technology

There are two basic methods of delivering broadband services: wireline and wireless. Wireline infrastructure is made up of copper and fiber optic cables, while wireless infrastructure can include mobile phone and Internet service, WiFi, satellites and "fixed wireless" systems, where antennas are mounted on homes and businesses and aimed at central access points, usually on towers.

This report focuses on wireline infrastructure and, to a lesser extent, mobile services, although other technologies are discussed where appropriate. Wireless technologies provide valuable tools and can solve many problems, for example delivering high capacity Internet access to a commercial building in an area with poor wireline service. Or reaching homes in rural areas, where wireline companies have decided not to invest in upgrading their facilities.

But it is wireline infrastructure that does the heavy lifting in the broadband world. Fiber optic cables, in particular, have practically unlimited capacity, high reliability and service quality, and are long lived. Wireline infrastructure is the base upon which all service is built – even wireless systems must connect to wireline networks at some point, usually directly after the first "hop" from a subscriber. Consequently, the level of broadband connectivity in a region is primarily determined by the quality and extent of wireline facilities.

2.2. Broadband service and infrastructure types

Similar to other utilities, such as water and electricity, broadband services and infrastructure vary according to the needs of the user. A commercial laundry needs heftier water and waste water hook ups than a typical single family home, for example. An oil refinery has different power needs than an office building. Generally speaking, broadband infrastructure can be grouped into three categories: consumer, commercial and industrial grade.

"Consumer grade" Internet access – from AT&T and Comcast, for example – is typically a shared resource, with many subscribers contending for the same bandwidth. In other words, 10 homes in a neighborhood may subscribe to service promising download speeds of, say, 10 megabits per second (Mbps), but if all of those subscribers tried to use their full 10 Mbps at once, each might only be able to achieve 1 or 2 Mbps actual download performance. The provider's assumption is that spikes in download demand from many homes will average out, so the actual capacity provided can be

much less – typically 20 to 100-times less – than the total capacity sold. This assumption does not always hold true, however, which is the primary reason consumer broadband speeds are advertised as being "up to" a certain number rather than guaranteed to be a specific rate.

This type of service is also subject to speed restrictions and/or data caps as determined by the provider, although these limits are not always enforced.

At one level or another though, consumer grade Internet access is available to nearly all homes in the region. It also often meets the needs of small and medium businesses, but not always. And it is inadequate for larger companies, which need commercial and industrial grade broadband facilities.

"Commercial grade" service is defined as being similar to residential service in that the provider takes effectively all responsibility for installing, maintaining and supporting the service. Speeds are similar (6 to 100 Mbps), but service levels, reliability, consistency and pricing are higher. A commercial grade broadband user will usually share bandwidth with others, but usually not to the same extent as consumer grade subscribers, and consequently will pay a higher price. Comcast's Business Class service or AT&T's business DSL service are examples of commercial grade service.

"Industrial grade" service refers to service where the customer plays a much greater role in building and supporting it, including buying different elements from different vendors and managing installation and support. Speeds would be higher – as high as a Gigabit per second and more – and quality of service levels could be as high as found in top tier Internet exchanges. DS-3 circuits or dark fiber strands are examples of industrial grade service. Industrial grade broadband users are relatively few in number, but tend to be the major institutions and employers in a region, including local governments, schools and large and/or high technology companies, as well as Internet service providers who deliver consumer and commercial grade service.

For practical purposes, the terms "broadband" and "Internet" can be used interchangeably when discussing consumer and commercial grade services, as this report does. In either case, it refers to a connection to the Internet that is installed and maintained by a service provider. The distinction is more important when considering industrial grade service, because broadband systems aren't only used for Internet access – a company might use a broadband connection to link two locations privately without touching the public Internet. The companies that need this level of service tend to be deeply involved in the nuts and bolts of delivering it. Where a distinction is appropriate in this context, this report will make it.

3. Infrastructure

3.1. Consumer wireline service

The majority of the core wireline broadband infrastructure in the East Bay region is owned by AT&T and Comcast, which are the major consumer and commercial grade Internet service providers. These two companies install and control the cables – copper and fiber – that are hung on utility poles and buried in conduits along roads and local streets in the region. The two significant exceptions are in Solano County: Dixon, where Wave Broadband is the incumbent cable company, and the Rio Vista area, where Frontier Communications is the incumbent telephone company.

With few exceptions, residents and many businesses in incorporated cities and most unincorporated communities in the region can order some level of Internet service from either AT&T or Comcast and have it installed within a few days. Two other companies – Astound in central Contra Costa County and, to a lesser extent, Sonic in western Alameda County – also install cables along residential and commercial streets, providing a third alternative in limited areas.

Consumer broadband infrastructure is a generally reliable indicator of all types of service and core infrastructure availability. Except for central business districts in major cities, most AT&T and Comcast construction to date is based on expected revenue from consumers, who will purchase television, telephone (wired and cellular) and other services in addition to Internet access. Commercial and industrial districts are less densely packed with potential customers and there are fewer opportunities to sell lucrative television service, so AT&T and Comcast tend not to invest as heavily in upgrading wireline facilities in those areas, as described below.

Although there are many exceptions, as a general rule the only way to get wireline service into businesses and institutions is to use the cables installed along local streets by AT&T, Comcast and the smaller consumer-focused companies. As discussed below, there are many other companies that provide wireline commercial and industrial grade service, but the typical way they do it is by leasing lines from consumer-focused companies, and then adding their own equipment and other resources. Absent expensive upgrade work, the quality of service provided by these commercial and industrial-focused companies is limited by the quality of the existing consumer-focused infrastructure.

Consequently, the general quality of broadband service in any area – residential, commercial, industrial – can be gauged by evaluating this core, consumer-focused infrastructure. Doing so gives a clear picture of what consumers can expect to get in

their homes and a generally accurate indication of the resources available to businesses, industrial scale users and institutions.

3.2. Grading broadband infrastructure

Internet service providers regularly submit reports regarding advertised download and upload speeds to the California Public Utilities Commission. This data is either reported on a census block basis, or by address or simple maps, which can be re-mapped to census blocks. The information submitted as of 30 June 2012 and published by the CPUC in January 2013 was used for this report.

Concord	A-	3.8
Walnut Creek	B+	3.4
Pleasant Hill	B-	2.9
Berkeley	C+	2.4
Alameda	C	2.2
Dixon	D	1.1
Clayton	D	1.0
Orinda	D	1.0
Moraga	D	1.0
Rio Vista	D-	0.9

Figure 3.1 – Highest and lowest scoring incorporated cities.

To develop a broadband report card for the region, this data was sorted by the type of service provider – core infrastructure/consumer grade, commercial/industrial grade, mobile – and letter grades were assigned to each census block in the region. A "C" grade means a census block has the most common service choices found in California, typical of the standard packages offered by AT&T and Comcast.

"A" and "B" grades were given where superior service is offered. However, as discussed below, what is superior in this context is merely average when compared to international benchmarks, and the Californian average falls far short of what is considered acceptable in developed economies.

A "D" grade indicates that service is worse than the California average, but meets the minimum standard of 6 Mbps download and 1.5 Mbps upload speed set by the California Public Utilities Commission. A census block fails – rates an "F" – if the service available doesn't even meet the CPUC's minimum standard. This methodology is more completely explained in Appendix B.

These letter grades were then assigned a numeric value on a four-point scale (A=4, B=3, etc.). Average scores – similar to grade point averages – were calculated for cities, unincorporated communities, counties and the region as a whole for comparison purposes.

In general, core broadband infrastructure is best in Contra Costa County (C+), average in Alameda County (C) and less than average in Solano County (C-). Other conclusions reached are:

- Although the region generally meets or beats statewide averages for residential broadband availability (and, consequently, core network infrastructure) only a few, limited areas come close to equaling international standards.
- Competition amongst providers results in better broadband infrastructure and service. The four highest ranking cities – Concord, Walnut Creek, Pleasant Hill and Berkeley – are where Astound and Sonic have built competing infrastructure, and the fifth ranking city – Alameda – previously had a municipally owned broadband system. Even though that system did not succeed financially, the infrastructure resulting from the three-way competition remains.
- Even in cities that, on the whole, have above average infrastructure and service, areas with "D" grades can frequently be found and those areas tend to correspond to commercial and industrial zones, confirming the lack of attention paid to such service by the major incumbents.
- Rural areas lag behind urban areas in broadband availability and infrastructure, with the lowest ranking cities tending to have a rural character and challenging terrain, as well as occasionally having a reputation for being difficult places to obtain city approval for construction projects.

3.3. U.S. and international benchmark comparison

The level of residential Internet service actually available, on average, in California is low when compared to other U.S. states or to other countries with developed economies. Akamai, a company that delivers digital media content worldwide, periodically publishes measurements of actual download performance in all 50 U.S. states and 55 countries. Since it is a consumer-oriented enterprise that uses consistent methods to deliver content and to measure results, Akamai's reports provide the best apples-to-apples benchmarks available to compare global residential Internet service. Please see Appendix F for more information.

California only ranks 19th among U.S. states in Akamai's latest measurement of connection speed to its servers[1], averaging 8.85 Mbps. That compares to 11.2 Mbps in top ranked Massachusetts, 10.1 Mbps in Washington state (8th) and 9.00 Mbps in Oregon (15th). California faces an even greater divide between high and low performing households, ranking 20th in terms of the percentage of consumers who connect to Akamai's servers at speeds of 10 Mbps or greater. Only 23% of Californian

[1] *The State of the Internet*, volume 6, number 2, 2nd quarter 2013 report by Akamai Technologies, Inc.

connections reach that level, versus nearly twice that – 42% – in Massachusetts. Similarly, our West Coast neighbors, Washington and Oregon, do significantly better with an 11th ranked 31% and a 12th ranked 28% respectively. On a national basis, California is slightly better than the U.S. average of 8.7 Mbps and slightly worse than the high-performances average of 24%.

Rated against its international competition, California's average speed would rank seventh, behind South Korea (13.3 Mbps average speed, 45% high performance adoption), Japan (12.0 Mbps/43%), Switzerland (11.0 Mbps/37%), Hong Kong (10.8 Mbps/32%), the Netherlands (10.1 Mbps/31%), and the Czech Republic (9.8 Mbps/27%), in that order. It slips even further on the high performance league table, falling behind those six as well as Belgium (8.4 Mbps/25%) and the United States (8.7 Mbps/24%), landing in a tie with Finland (8.1 Mbps/23%) and the United Kingdom (8.4 Mbps/23%). On the other hand, Massachusetts would comfortably make it into the top three on both measures, ranking behind only South Korea and Japan.

3.4. Commercial and industrial grade broadband service

As described in Appendix B, data provided by companies that specialise in commercial and industrial grade broadband service was analysed separately. The service claims from those companies were then mapped (Appendix E). It quickly became clear that these companies report service availability data differently than the companies that build and own the core infrastructure. When AT&T or Comcast report that a particular download speed is available in a census block, it means that facilities are already installed and operating, even if advertised performance claims don't necessarily match up with ground truth. The entire census block might not be wired – as frequently happens in commercial areas – but at least some facilities are already in place.

On the other hand, commercially-focused service providers tend not to install equipment or lease lines until a customer actually places an order. Instead of claiming they offer a particular level of service, commercial and industrial grade providers are, in effect, saying "we believe we can deliver a certain speed in a general area, but we'll have to do a technical evaluation before we'll know for sure, and then we can figure out how much it will cost and how long it will take to do it". There are exceptions, particularly in major business districts, but otherwise the service claims made by these companies represent assumed and not actual capabilities.

Even so, some general observations can be made:

- Commercial and industrial providers generally advertise 25 to 50 Mbps in western Alameda County and 10 to 25 Mbps in the east.

- Central business districts in Contra Costa County have advertised speeds in the 25 to 50 Mbps range, otherwise it's mostly 10 to 25 Mbps elsewhere in the county.
- These providers advertise 25 to 50 Mbps in the Fairfield/ Cordelia area, but generally lower speeds elsewhere in Solano County.

However, these general observations are of little use for economic development or commercial real estate purposes, where block by block and parcel by parcel granularity

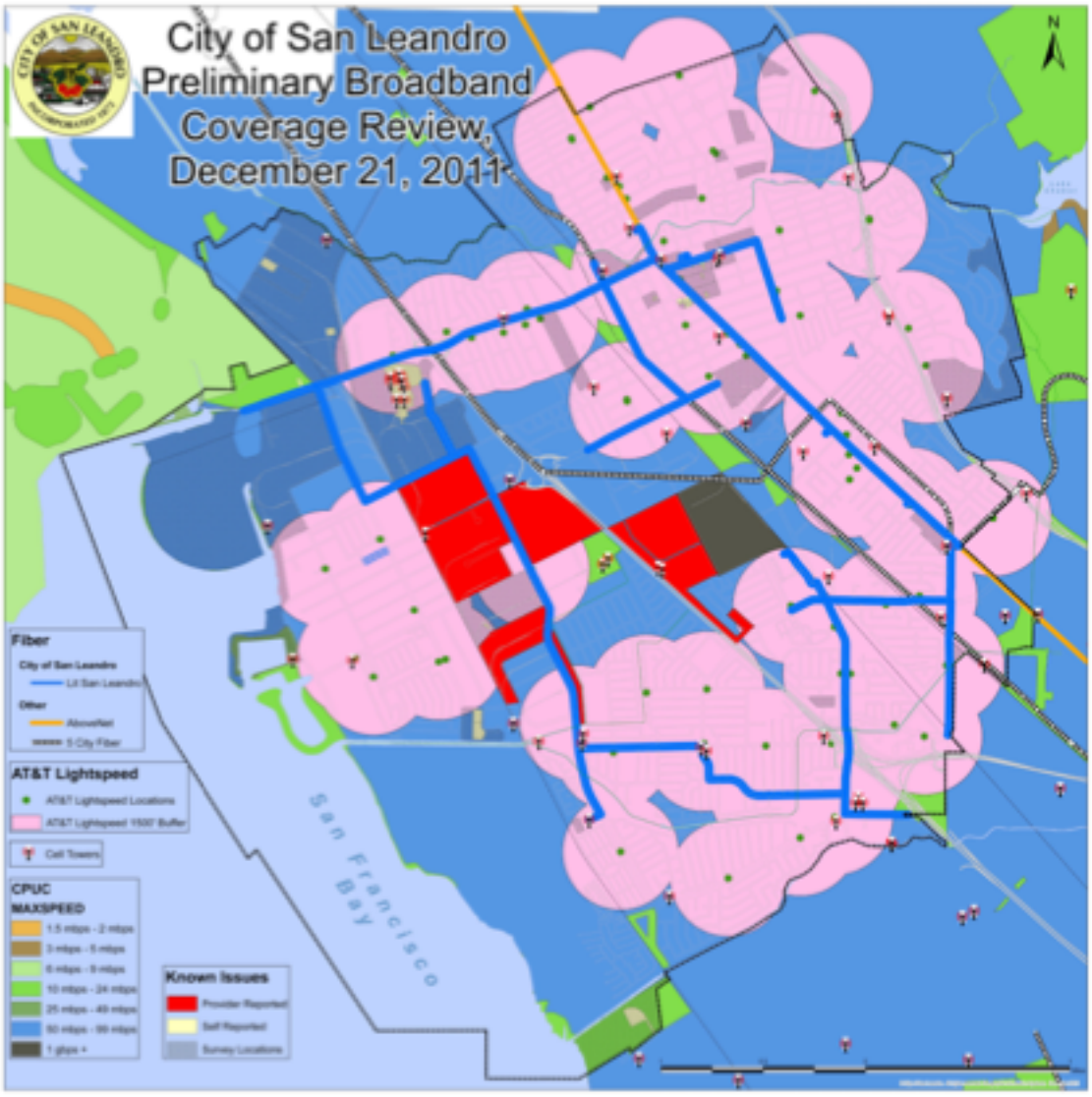


Figure 3.2 – Analysis of CPUC, City, AT&T and Comcast data highlights lack of broadband infrastructure and service in commercial and industrial areas of San Leandro.

is necessary. The grading analysis based on the core, consumer grade infrastructure is moreover useful in this regard. An earlier version of this type of analysis was performed

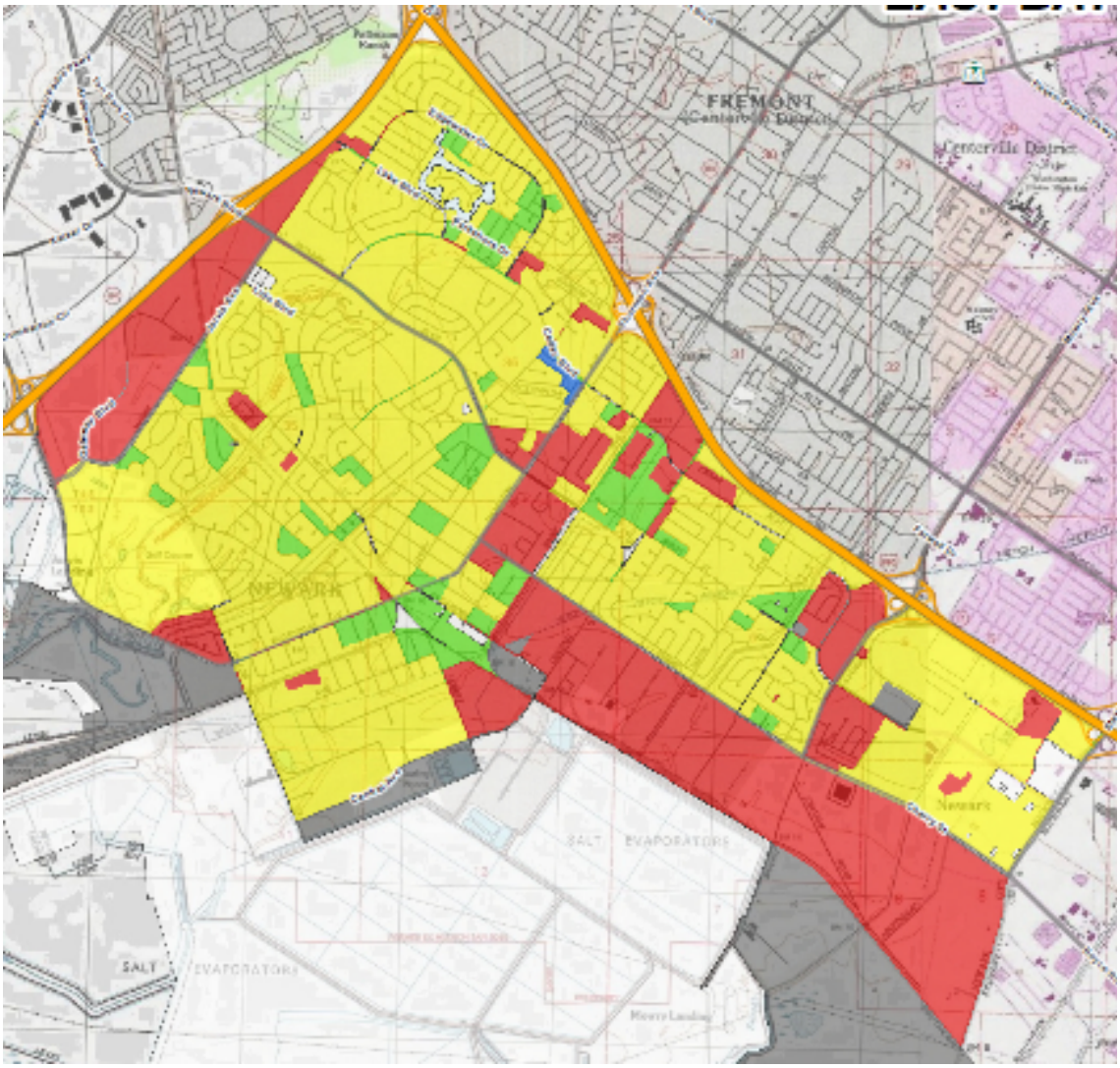


Figure 3.3 – City of Newark broadband infrastructure and service grading map. Red areas indicate below average service and infrastructure, white and grey areas indicate a failing grade.

by Tellus Venture Associates for the City of San Leandro. Five sources of information were used to try to build a picture of the broadband infrastructure and service that was available in the commercial and industrial zones of the city:

- CPUC data, as above.
- Encroachment permits given to AT&T in the course of a major upgrade project.
- Service available at specific business addresses as reported by Comcast.
- Two workshops that included major local businesses.
- An online survey of local businesses.

All five sets of data provided results consistent with each other. When the CPUC and AT&T permit data sets were mapped, both sets showed good service in a horseshoe-shaped swath that corresponded to the city's residential areas, but poor service in the commercial center and in the outlying industrial areas. The specific address data provided by Comcast and local businesses matched up with and, consequently, verified this overall picture.

Examination of the maps in Appendix D shows a similar pattern elsewhere in the region. For example, the City of Newark rates a solid "C" on the overall grading scale, but the grades for individual census blocks varies widely. Industrial areas rate a "D", as do many commercial areas. Census blocks that are primarily residential score better, some even getting "A" and "B" grades.

3.5. Filling commercial and industrial broadband gaps

As with other utilities, local governments can have a substantial impact on the development of commercial and industrial broadband infrastructure. Some already have done so, including several in the East Bay region. Initiatives include:

- Benchmarking local permit, zoning, building and other development-related policies to determine whether a local jurisdiction is creating barriers to broadband deployment or actively assisting it.
- Leveraging existing street work to develop broadband infrastructure. Examples including requiring notification of interested companies any time a trench is dug in a street or other public right of way, installing empty conduit whenever a trench is dug and providing incentives for companies to participate in open trench opportunities.
- Establish clear and consistent standards for broadband infrastructure, such as conduit or wireless towers, and make such work subject only to the standard encroachment permit processes required of other utilities.
- Enter all broadband-related data, with particular attention to conduit routes, into publicly available GIS systems.
- Require conduit be installed as a routine part of any public works project, and set standards for broadband facilities in new construction or major remodelling jobs.
- Partner with private companies to build broadband infrastructure and offer service, or do it as a purely municipal utility.

Examples of these initiatives can be found in Appendix A.

3.6. Mobile broadband availability

The four major mobile broadband carriers operating in the East Bay region – Verizon, AT&T, Sprint, T-Mobile – all provide coverage maps with service level information. Unlike wireline service, however, the CPUC then goes one step further and does standardised testing of these claims at 1,200 locations around the state.

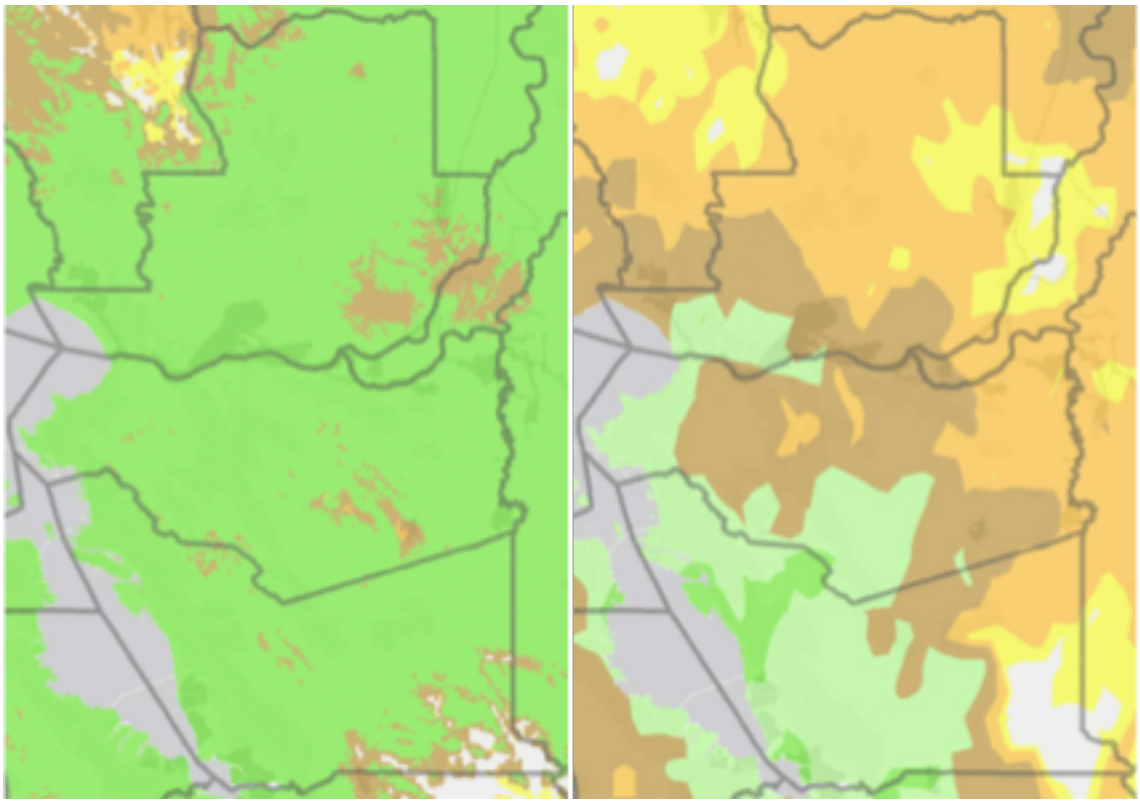


Figure 3.4 – Left: mobile carrier reported speeds, right: CPUC mobile field test results. Darker green is better; light green, brown, orange and yellow indicate progressively worse service.

Examining and then comparing these two data sets provides a basis for assessing the quality and speed of mobile broadband service in the region. When left to their own devices, mobile carriers report excellent broadband service, mostly 10 Mbps or better for consumer download speeds. Verizon and T-Mobile generally make blanket claims of of 10 Mbps or better everywhere, while AT&T is more granular, showing lower speeds in outlying areas, as might be expected. Sprint's self-reported speeds are lower, in the 3 to 6 Mbps download range.

The CPUC's standard test data, though, shows a much different picture. In the Nimitz freeway corridor, test results more or less match up with carriers' advertised claims, hitting 10 Mbps or better. Elsewhere, speeds are lower. Along the Eastshore corridor and in the San Ramon and Livermore valleys, actual speeds hit the 6 Mbps range, but in most of the rest of the three county region, measured performance is in the 1.5 to 3 Mbps range.

Based on provider claims, one might conclude that fourth generation (4G) mobile service – the technology with the fastest speeds and highest capacity currently available – is ubiquitous in inhabited areas of the region, at least from AT&T, T-Mobile and Verizon. Again, though, the CPUC's field tests tell a different story (Appendix E). It is possible – likely, even – that 4G equipment has been installed throughout the region, but the capacity of those facilities appears limited. When a consumer's 4G smart phone or tablet cannot connect to a 4G cell site, it will usually fall back to 3G or even 2G connections.

The latest test data show that Sprint's network performs at a level consistent with 3G technology, where service is available at all. The performance of T-Mobile's network is considerably less than what would be expected from full 4G technology, indicating either that its facilities are based on sub-4G technology or the capacity of such 4G facilities is so limited that a consumer should expect to receive 3G-level service. Neither provider registered a significant number of tests with speeds greater than 6 Mbps, with results in the 1.5 to 3 Mbps range more typical.

AT&T's and Verizon's mobile networks, on the other hand, do perform at 6 Mbps or better throughout the region, except for parts of eastern Solano County. This level of service indicates that 4G networks are likely in operation and available to one degree or another.

The intra-regional disparities are not necessarily as stark as these numbers would indicate. Network capacity as well as speed capability has to be factored into any evaluation. Because population density and usage patterns vary, an area, such as along a major freeway, that has high-speed service available will also tend to have many people competing to use it, which brings down performance, particularly at peak hours. In eastern Solano County, for example, mobile broadband infrastructure is not as robust but there are fewer people accessing it. The real-world mobile broadband experience in those two kinds of locations is likely to be more similar than not.

Unlike consumer or most commercial wireline providers, the major mobile carriers are still investing heavily in network upgrades, and over time coverage, capability and capacity should continue to improve. A key element in that work is building fiber optic

lines to support cell sites, which should improve overall broadband infrastructure and availability in the region.

Another barrier to full 4G availability is opposition to installation of new cellular towers and expansion and/or upgrading of existing ones. Although mobile carriers are investing in upgrading their technology, those investments are prioritised largely on the basis of expected financial return. Lengthy or cumbersome permit processes will increase the cost of any given upgrade, thus lowering the expected return on investment and pushing that project lower on a carrier's priority list.

4. Alameda County

Overall, Alameda County's broadband grade is a "C" at 2.0, putting it in the regional middle, ahead of Solano County (C-) and behind Contra Costa County (C+). Two cities – Berkeley (C+) and Alameda (C) – fall in the regional top five. Both have a history of wireline competition. Sonic has built and/or upgraded its own infrastructure in key areas of Berkeley, generally around the University of California, which has also invested in its own broadband infrastructure, to the benefit of the city, which ranks fourth in the region.

Figure 4.1 – Green area indicates Sonic's infrastructure.

The City of Alameda built and, for many years, operated a municipal cable television and broadband system until financial problems, brought on by stiff competition from incumbents, forced it to sell its network in 2008. Comcast bought it and used those facilities to improve its infrastructure in the City of Alameda. AT&T did not acquire any assets in that transaction, but still continues to benefit from the investment it made when it faced two peer broadband competitors, rather than just one. As a result, the City of Alameda's residential broadband service ranks fifth in the region.

With one exception, the cities closest to Berkeley and the City of Alameda – Albany (C), Oakland (C), Emeryville (C) and San Leandro (C) – are the next highest rated cities in Alameda County.

The exception is Piedmont (D+), which ranks last among cities in Alameda County: worse than the overall rating for the unincorporated areas (C-), worse than all but one of the county's unincorporated communities and the sixth worse incorporated city in the region. The primary reason for this low grade is the poor quality of AT&T's infrastructure and service in Piedmont.

Although there is no documented data to explain Piedmont's low grade, anecdotal evidence from residents and an AT&T representative indicates that the city has a history of opposing the construction of broadband facilities, particularly upgrades and expansion of cellular telephone towers. As noted above, it is mobile telecommunications facilities and not legacy wireline networks that are attracting private investment, particularly by AT&T. The same core infrastructure – primarily fiber optic cables – that

support mobile broadband upgrades also contribute generally to better wireline service for both residences and businesses.

Newark (C) and Fremont (C) rate as average when compared to typical service in California. Hayward (C-), Union City (C-), Livermore (C-), Dublin (C-) and Pleasanton (C-) are slightly below even that benchmark.

Alameda County also has six unincorporated communities that the U.S. Census Bureau recognises as "census designated places" (CDPs). Five – Ashland, Castro Valley, Cherryland, Fairview and San Lorenzo – are generally in the area between San Leandro and Hayward and split the difference between those two locations: all five come in with a "C" grade. The sixth, Sunol, is more rural and isolated, and rates a "D-". As noted above, all the unincorporated areas of Alameda County – including CDPs – taken together rate a "C-". Subtracting out the CDPs, though, results in a "D+" for the remainder of unincorporated Alameda County.

5. Contra Costa County

Contra Costa County (C+) has the best grades in the three county region, rating just above the statewide average. However, the quality of broadband infrastructure is not evenly distributed throughout the county. Three cities in the center of the county – Concord (A-), Walnut Creek (B+) and Pleasant Hill (B-) – are outliers in the region.

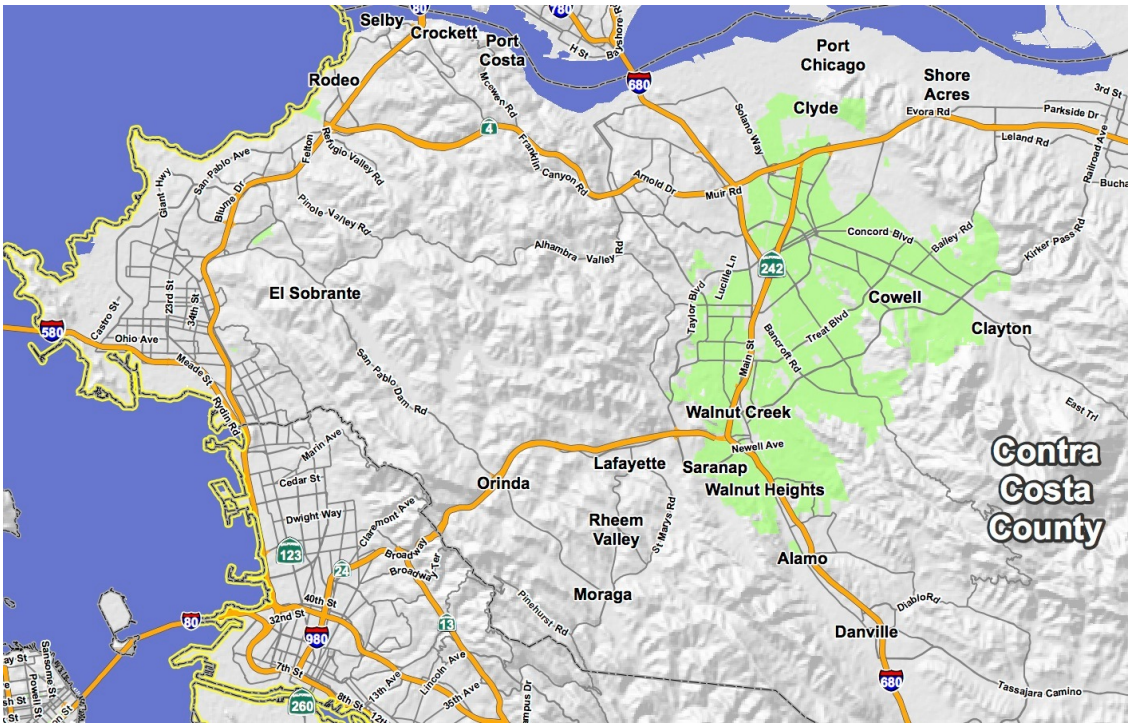


Figure 5.1 – Green area indicates where Astound has built out competing infrastructure.

Astound has built a third wireline network in the area. The competitive dynamic between Astound, AT&T and Comcast has resulted in the construction of superior broadband infrastructure directly to homes and businesses, resulting in "A" grades in or near areas where all three compete.

Outside of these broadband-rich neighborhoods, however, infrastructure grades in these three cities resemble the mix of "C" and "D" (with an occasional "B") ratings that are typical for both Contra Costa and Alameda counties. Neighboring cities – Martinez (C), Lafayette (C), Danville (C-) and Pittsburg (C-) follow this pattern as well. Grades drop slightly a step further out in Antioch (C-) and San Ramon (C-). In eastern Contra Costa County, Brentwood (C) and Oakley (C) do a little bit better, perhaps reflecting the relatively newer residential development there.

Grades for cities in western Contra Costa County follow a pattern similar to that found just to the south in Alameda County: as the distance from Berkeley increases, grades have a tendency to drop. El Cerrito (C), San Pablo (C), Richmond (C), Pinole (C) and Hercules (C-) generally follow this trend.

Three Contra Costa County cities – Clayton (D), Orinda (D) and Moraga (D) – rank among the five worst in the region. The three are generally hillier, which can create challenges for broadband infrastructure deployment. They also have a more quasi-rural character than most other central county cities, and factors such as those identified in Piedmont (see above) may also play a significant role in these low grades: similarly, AT&T's infrastructure is deficient.

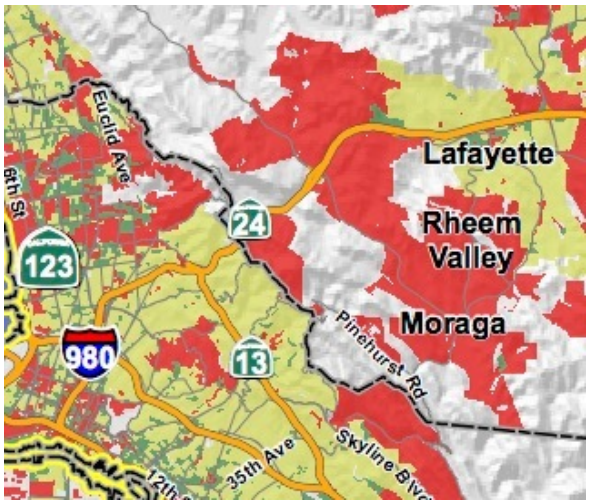


Figure 5.2 – Red area indicates where AT&T's infrastructure and service is substandard.

As Appendix C shows, the quality of broadband infrastructure and service in Contra Costa County's census designated places (CDPs) varies widely. Six – San Miguel (A), Saranap (A), North Gate (A), Castle Hill (A), Acalanes Ridge (A-) and Shell Ridge (A-) – are within or adjacent to Astound's service area and have perfect or near-perfect grades. Contra Costa Centre (B) and Clyde (C+) likewise benefit from the competitive environment created by three competing wireline service providers.

In the middle of the rankings, Mountain View (C), El Sobrante (C), Alamo (C), Rodeo (C-) and Vine Hill (C-) have grades generally equal to or slightly below nearby incorporated cities.

The remaining CDPs have significantly lower grades than their neighbors. East Richmond Heights (C-), North Richmond (C-), Pacheco (D+), Rollingwood (D), Bayview (D), Bay Point (D), Crockett (D), Montalvin Manor (D-) and Port Costa (F+) are similar in that household income levels are lower than average in Contra Costa County overall but consistent with neighboring incorporated cities. The implication is that the lack of a municipal government is an additional negative factor for economically disadvantaged areas, in regards to attracting investment by broadband service providers. For those communities located along the Eastshore corridor, these results are also generally consistent with the trend of declining infrastructure and service levels as the distance from Berkeley increases.

Kensington (C-), Reliez Valley (C-), Blackhawk (C-), Alhambra Valley (D+), Camino Tassajara (D+), Tara Hills (D), Norris Canyon (D-) and Diablo (F+) have relatively higher household income levels than nearby cities or, in most cases, than Contra Costa County as a whole. In many respects, these low rated unincorporated communities resemble the lowest rated incorporated cities in the county, as discussed above.

The remaining four CDPs evaluated – Discovery Bay (D+), Byron (D+), Knightsen (D) and Bethel Island (D-) – are located in rural eastern Contra Costa County. On the whole, rural areas tend to have poorer broadband infrastructure and service due to lower population densities and household income levels.

Altogether, the unincorporated areas of Contra Costa County score a "C-". Factoring out the CDPs, the grade falls to a "D+", identical to Alameda County.

6. Solano County

Broadband service and infrastructure in Solano County (C-) is measurably worse than in the balance of the East Bay region or even than the California average. More of the county is rural and it follows the trend of declining grades as the distance from better performing Berkeley and central Contra Costa County increases.

Service providers have a more rural character as well: Frontier Communications is the incumbent telephone company in and around Rio Vista, Wave Broadband provides cable service in Dixon, and Winters Broadband, a wireless company, serves northeastern Solano County. Wave's infrastructure and service is somewhat below the level set by Comcast elsewhere in the region, and Frontier's is considerably worse than AT&T's. Winters Broadband's service area is centered in Yolo County, and its performance drops in Solano County as the distance from that center increases.

Figure 6.1 – Left: Wave Broadband's service area in Dixon. Right: Frontier Communications' service area around Rio Vista.

Consequently, Rio Vista (D-) and Dixon (D) rank worst and fifth worst respectively amongst incorporated cities in the region.

The cities with the best grades – Vallejo (C) and Benicia (C) – are the ones nearest the region's (and the Bay Area's) urban and core suburban communities. Following the Interstate 80 corridor to the east and away from the Bay Area, grades drop in the cluster of Suisun City (C-), Vacaville (C-) and Fairfield (C-) and slide even further in Dixon.

Census designated places (CDPs) in Solano County also follow a familiar pattern: the further east, the lower the grade, which is lower than nearby incorporated cities. Green Valley (D) is north of Fairfield; Hartley (D-) and Allendale (F+) are north of Vacaville.

Elmira (F), south of Vacaville, has the worst grade of any city or CDP in the East Bay region.

The remainder of Solano County – census blocks not in a CDP or an incorporated city – gets a “D”. Add in the CDPs and the overall grade for all unincorporated areas in Solano County falls to a “D-”.

7. Broadband Adoption

The CPUC also publishes limited data regarding the rate at which people in different communities sign up for broadband service. Overall, Contra Costa County has the smallest broadband adoption gap, with 13% of homes not subscribing to some kind of broadband service, either wireline or mobile. In both Alameda and Solano Counties, 22% of homes lack Internet access. The average three county gap is 19%, at least according to the numbers the CPUC is making available.

When drilling down further, however, a different picture emerges. The CPUC data shows that affluent suburbs east of the Oakland-Berkeley hills have much lower adoption gaps, often 10% or less, than inner city neighborhoods, where between 71% and 100% of homes lack Internet access. The differential between high and low broadband adoption gaps appears to generally correspond to the equivalent gap in household income levels.

Larger maps can be found in Appendix E.

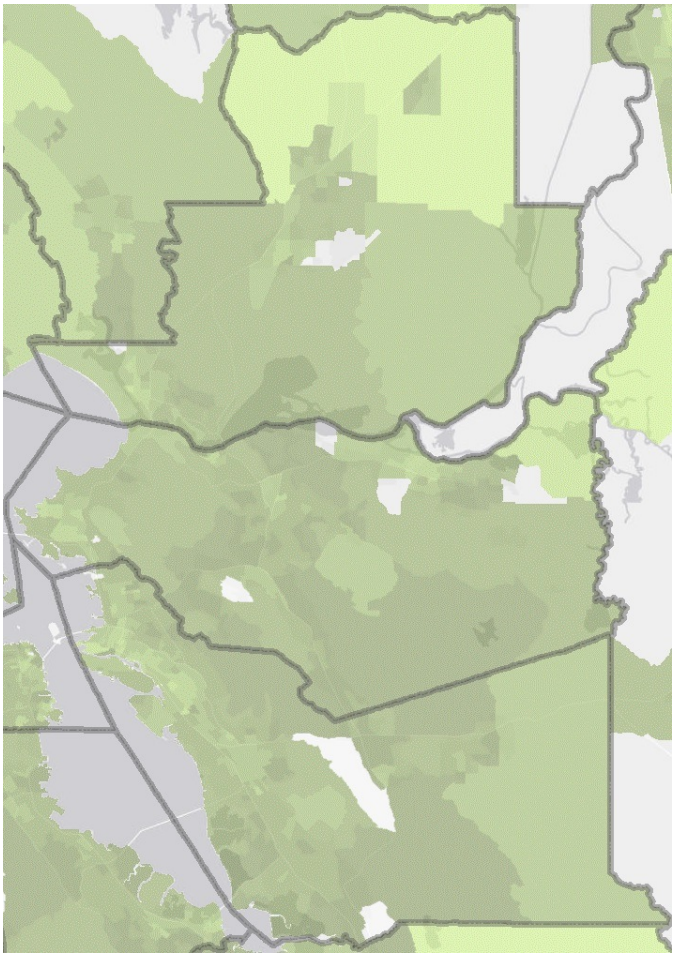


Figure 7.1 – Lighter green areas indicate areas where the broadband adoption gap is the greatest.

	HHs subscribing	HHs with availability	Adoption gap
Alameda	430,724	551,959	22%
Contra Costa	332,991	381,061	13%
Solano	110,402	141,910	22%
EBBC	874,117	1,074,930	19%

Table 7.1 – Broadband adoption rates

8. Appendix A – Policy and Public-Private Partnership Examples

California cities have a wide range of choices when considering how to pursue broadband projects. They can work with, or even own, for profit corporations, participate in cooperatives and non profit corporations or they can own and operate a broadband network, either fully or in partnership with a private sector company.

Generally, California cities (and special districts) can provide telecommunications services within their boundaries with few restrictions. Even if a city provides a service that falls under the CPUC's jurisdiction, it is exempt from CPUC oversight. On the other hand, it is subject to all the controls, restrictions and obligations that pertain to any other municipal function, such as public oversight, open access and Brown Act requirements.

8.1. Full city ownership

A common way of organising a municipal telecommunications utility is to run it via a separate enterprise fund. For example, several U.S. cities, such as Chattanooga, Tennessee, received stimulus grants for the purpose of building publicly available telecommunications networks.

Other examples:

Cities of Palo Alto and Santa Clara. Both cities operate their own electric utility and have installed fiber optic cables along key utility routes. They lease dark fiber to businesses on a first come, first served basis.

City of Santa Monica. The city does not operate an electric utility, but does provide water, waste water and refuse services. It used the fiber optic network installed to support its traffic signal system as the basis for a fiber optic service. It provide dark fiber and “lit” Ethernet connectivity to businesses.

City of Lompoc. Evaluated both a fiber-to-the-home and a wireless Internet system. Lompoc moved ahead with a WiFi-based Internet utility, and continues to provide basic Internet service to residents on a subscription basis.

City of Alameda. Also an electric utility provider. Alameda built and operated a cable television system that provided TV and Internet service in competition with Comcast. It was financed through bonds, but the system could not support the debt service

requirements. Eventually, it was sold to Comcast for about half the value of the bonds. The bondholders unsuccessfully sued for the balance.

City of Watsonville. As the municipal cable franchise agreement with Charter Communications was coming to an end, the city was presented with a $150,000 annual bill to maintain an institutional network previously provided at no charge under that agreement. Using data previously collected and mapped in its GIS system, the city designed and is currently building a fiber optic network that connects key locations in the city, and can be leased to private businesses and Internet service providers.

8.2. Partial city ownership

When a city contributes resources to a broadband network project, it can take ownership of specific parts of that network, rather than owning and operating the entire system.

Examples:

City of San Leandro. The city signed an agreement that allows a local company to install fiber optic cables in city-owned conduit on a non-exclusive basis. The agreement eventually provides for lease payments, but the primary initial benefit (in addition to the economic development advantages) is that the city receives ownership of a certain number of fiber optic strands, systemwide. The city has complete discretion over the use of these strands, and may use them for internal networking purposes, or even sell access to private companies. The city has no interest in going into competition against its private sector partner, however it retains that option as a guarantee that the system will always be available to meet economic development goals.

City of Monterey. When Comcast installed an institutional network as part of its former franchise agreement, the city paid for extra fiber strands to be installed. Those strands are the property of the city, and are now being used to provide effectively free connectivity between city locations even though local franchise agreements have been preempted at the state level.

City of Benicia. The Benicia Industrial Park is the driver of the city's economy, but it lacks modern, industrial grade broadband facilities. The city allocated $750,000 to upgrading broadband infrastructure in the park and the surrounding area, issued a request for proposal, and is now negotiating with prospective partners.

8.3. Non-profit

In California, CENIC (Corporation for Education Network Initiatives in California) is a non-profit that runs a statewide broadband network supporting K-12 and higher educational institutions. It is a membership based non-profit, controlled primarily by major public and private universities, which in turn are its major customers. Because it is a non-profit serving primarily government entities (as well as a few private non-profit schools) it can more directly serve the needs of its members than it could if its members were for-profit companies.

The Nevada Hospital Association (technically a not-for-profit professional association) received a $20 million stimulus grant to build a public access fiber network throughout Nevada. OneCommunity received a stimulus grant to build a fiber network in Ohio, as did the University Corporation for Advanced Internet Development, which is working on a national network primarily for higher education use.

8.4. Cooperative

Cooperatives are not-for-profit corporations that are usually set up to provide some kind of benefit to members. Commonly, cooperatives are set up to pool buying power.

Examples:

California Broadband Cooperative. A stimulus grant recipient that recently completed a 500+ mile fiber optic network from Reno, down the eastern side of the Sierra generally along U.S. 395 in California, to Barstow. Local governments are active participants in the cooperative.

Plumas-Sierra Rural Electrical Co-op. A rare California example of a traditional rural utilities cooperative. This sort of organisation is common in the midwest and south, and can provide telecommunications services as well as electricity.

Mid-Atlantic Broadband Cooperative. Located in rural Virginia, operates a fiber optic network of several hundred miles. Built with tobacco settlement money and stimulus funds.

9. Appendix B – Grading Methodology

The primary data for assessing the quantity and quality of broadband service that is available in the East Bay region comes from the California Public Utilities Commission, which collects service level reports from providers throughout California. This data can be broken down to the census block level, and shows what Internet companies claim to provide, but not necessarily what they deliver. The accuracy of this data and the definition of service levels varies from company to company, although it is generally consistent within any given company. In other words, if Company Z exaggerates the speeds and availability of home Internet service, it tends to do so to more or less the same extent everywhere. By using a comparative system for ranking, rather than using the absolute values provided, the variation in the accuracy of the data can be smoothed out and an apples-to-apples comparison can be achieved.

The data collected by CPUC was divided into three categories: core wireline service, commercial broadband service providers and mobile carriers. One fixed wireless company, Winters Broadband, was included in the core wireline service category because it provides primary consumer grade service to rural areas of eastern Solano County, and can be compared on a fair, apples-to-apples basis with other consumer grade providers. As a practical matter, the level of service delivered by Winters Broadband is not so high that including it would distort an assessment of core infrastructure for commercial and industrial purposes.

Four fixed wireless providers – CalDSL, California Broadband Services, Internet Free Planet, Unwired Broadband, Inc. – were excluded from the analysis because they either were located in adjacent counties and do not operate on a regular basis in the East Bay Region or the data provided was too low in quality.

In addition, consumer-grade service throughout California was assessed, and used as one of the two primary grading benchmarks, the other being the CPUC's standard for minimum acceptable service of 6 Mbps download/1.5 Mbps upload speed. Upload speed was given equal weight to download speed, even though it's generally less critical for consumers, because upload speed gives a good indication of the capacity of the underlying infrastructure. When a service provider skimps on upload speeds, as frequently happens, it is usually because its cables and other core equipment have a limited capacity.

Grades were then assigned as follows:

A - Two competing providers, both advertising maximum download speeds of at least 25 Mbps and maximum uploads speeds of 6 Mbps, or 3 or more competing providers offering that standard of service in combination.

B - Competing providers, both advertising maximum download speeds of at least 10 Mbps and maximum uploads speeds of 6 Mbps.

C - Competing providers, one advertising max down/up speeds of at least 10/6 Mbps and the remainder meeting CPUC's minimum 6 down/1.5 up standard.

D - At least one provider advertising speeds that meet the CPUC's minimum standards of 6 Mbps down and 1.5 Mbps up.

F - At least one provider offers service, but no service is available that meets the CPUC's minimum standard of 6 Mbps down and 1.5 Mbps up (meets CPUC's definition of underserved).

F- - No broadband service available (meets CPUC's definition of unserved).

A "C" grade indicates that the consumer grade broadband services, and consequently the underlying core infrastructure, in a given area meets the statewide average. A "D" grade means it meets the minimum passing service standard set by the CPUC. "F" grades indicate full or partial failure, which also means the area is eligible for infrastructure construction subsidies from the Commission. "A" and "B" grades show that service in an area is superior to the California average.

The first step in grading was to give a letter grade to each census block in the three counties. Then, the grade points were tallied and averaged for the census blocks within cities, counties and unincorporated areas, to produce a numerical grade on a four point scale. The results of this scoring can be found in Appendix C and maps illustrating the grading results in Appendix D.

10. Appendix C – East Bay Broadband Report Card

East Bay Broadband Report Card

	Grade	GPA
Overall		
Alameda County	C	2.0
Contra Costa County	C+	2.3
Solano County	C-	1.8
EBBC	C	2.1
Alameda County - Cities		
Berkeley	C+	2.4
Alameda	C	2.2
Albany	C	2.2
Oakland	C	2.1
Emeryville	C	2.1
San Leandro	C	2.1
Newark	C	2.0
Fremont	C	2.0
Hayward	C-	1.9
Union City	C-	1.9
Livermore	C-	1.9
Dublin	C-	1.8
Pleasanton	C-	1.8
Piedmont	D+	1.5

East Bay Broadband Report Card

	Grade	GPA
Alameda County - Census Designated Places		
Cherryland CDP	C	2.0
San Lorenzo CDP	C	2.0
Castro Valley CDP	C	2.0
Fairview CDP	C	2.0
Ashland CDP	C	2.0
Sunol CDP	D-	0.7
Rest of Alameda County	D+	1.4
Unincorporated Alameda County (includes CDPs)	C-	1.9

East Bay Broadband Report Card

	Grade	GPA
Contra Costa County - Cities		
Concord	A-	3.8
Walnut Creek	B+	3.4
Pleasant Hill	B-	2.9
San Pablo	C	2.2
El Cerrito	C	2.2
Richmond	C	2.1
Pinole	C	2.0
Martinez	C	2.0
Lafayette	C	2.0
Brentwood	C	2.0
Oakley	C	2.0
Danville	C-	1.9
Hercules	C-	1.9
Pittsburg	C-	1.9
Antioch	C-	1.9
San Ramon	C-	1.8
Clayton	D	1.0
Orinda	D	1.0
Moraga	D	1.0

East Bay Broadband Report Card

	Grade	GPA
Contra Costa County - Census Designated Places		
San Miguel CDP	A	4.0
Saranap CDP	A	4.0
North Gate CDP	A	4.0
Castle Hill CDP	A	4.0
Acalanes Ridge CDP	A-	3.9
Shell Ridge CDP	A-	3.9
Contra Costa Centre CDP	B	3.2
Clyde CDP	C+	2.5
Mountain View CDP	C	2.2
El Sobrante CDP	C	2.1
Alamo CDP	C	2.0
Rodeo CDP	C-	1.9
Vine Hill CDP	C-	1.9
Kensington CDP	C-	1.8
East Richmond Heights CDP	C-	1.8
North Richmond CDP	C-	1.8
Reliez Valley CDP	C-	1.7
Blackhawk CDP	C-	1.7
Pacheco CDP	D+	1.6
Alhambra Valley CDP	D+	1.4
Discovery Bay CDP	D+	1.3
Camino Tassajara CDP	D+	1.3
Tara Hills CDP	D	1.1
Knightsen CDP	D	1.1
Rollingwood CDP	D	1.1

East Bay Broadband Report Card

	Grade	GPA
Bayview CDP	D	1.1
Crockett CDP	D	1.0
Bay Point CDP	D+	1.0
Montalvin Manor CDP	D-	0.9
Norris Canyon CDP	D-	0.9
Bethel Island CDP	C-	0.8
Byron CDP	D-	0.7
Port Costa CDP	F+	0.5
Diablo CDP	F+	0.5
Rest of Contra Costa County	D+	1.4
Unincorporated Contra Costa County (inc. CDPs)	C-	1.8

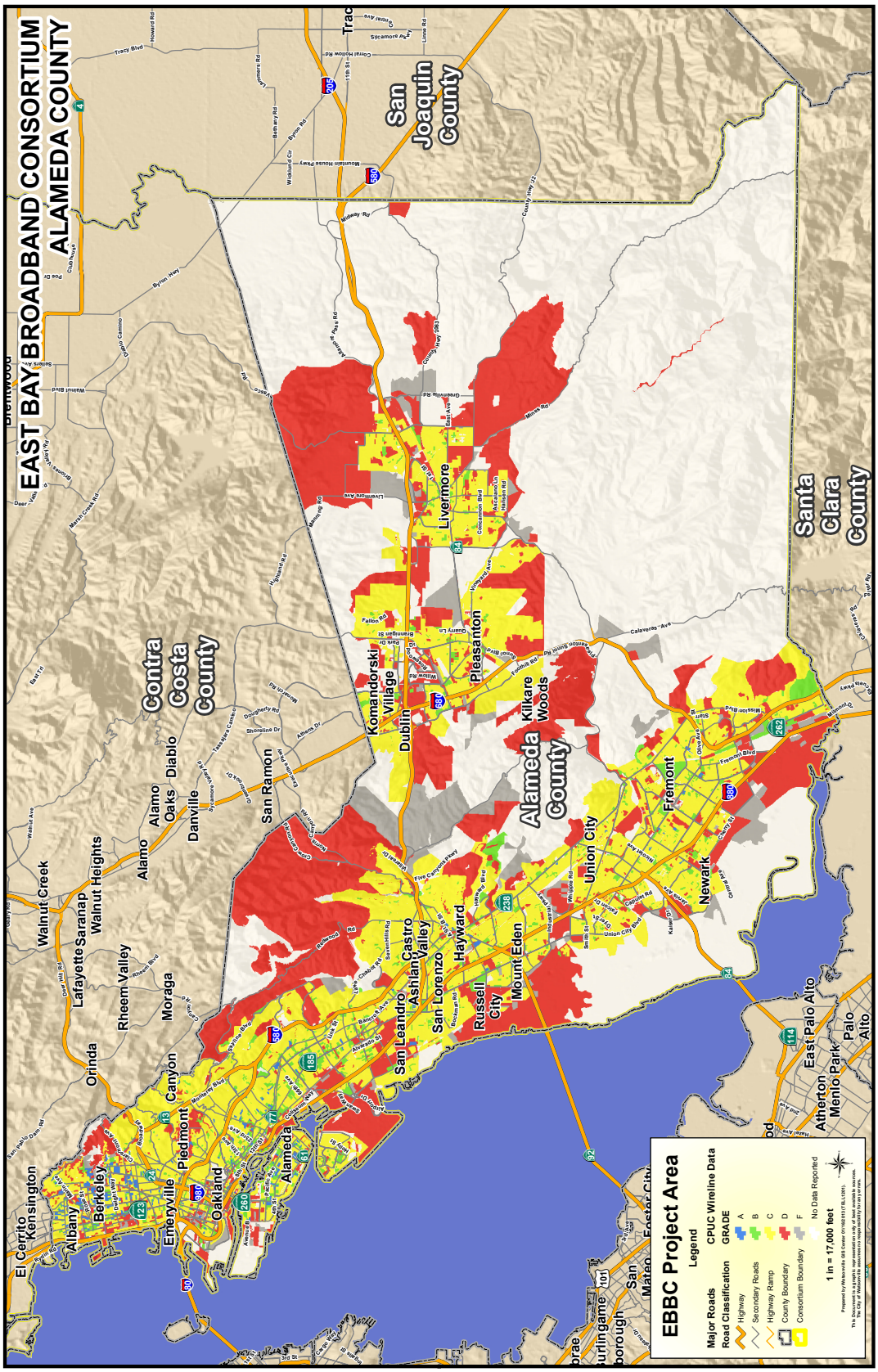
East Bay Broadband Report Card

	Grade	GPA
Solano County - Cities		
Vallejo	C	2.0
Benicia	C	2.0
Suisun City	C-	1.9
Vacaville	C-	1.9
Fairfield	C-	1.8
Dixon	D	1.1
Rio Vista	D-	0.9
Solano County - Census Designated Places		
Green Valley CDP	D	1.0
Hartley CDP	D-	0.7
Allendale CDP	F+	0.6
Elmira CDP	F	0.0
Rest of Solano County	D	1.0
Unincorporated Solano County (includes CDPs)	D-	0.9

11. Appendix D – East Bay Regional Broadband Grading Maps

Detailed maps for individual cities are available from the East Bay Broadband Consortium's website:

http://www.ebbroadband.org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San Ramon
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Oaks
Diabio
Walnut Creek
Walnut Heights
Lafayette
Saranap
Rheem Valley
Moraga
Orinda
Canyon
Piedmont
Emeryville
Berkeley
Albany
El Cerrito
Kensington
Oakland
Alameda
San Leandro
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Castro Valley
Hayward
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Russell City
Mount Eden
Union City
Fremont
Newark
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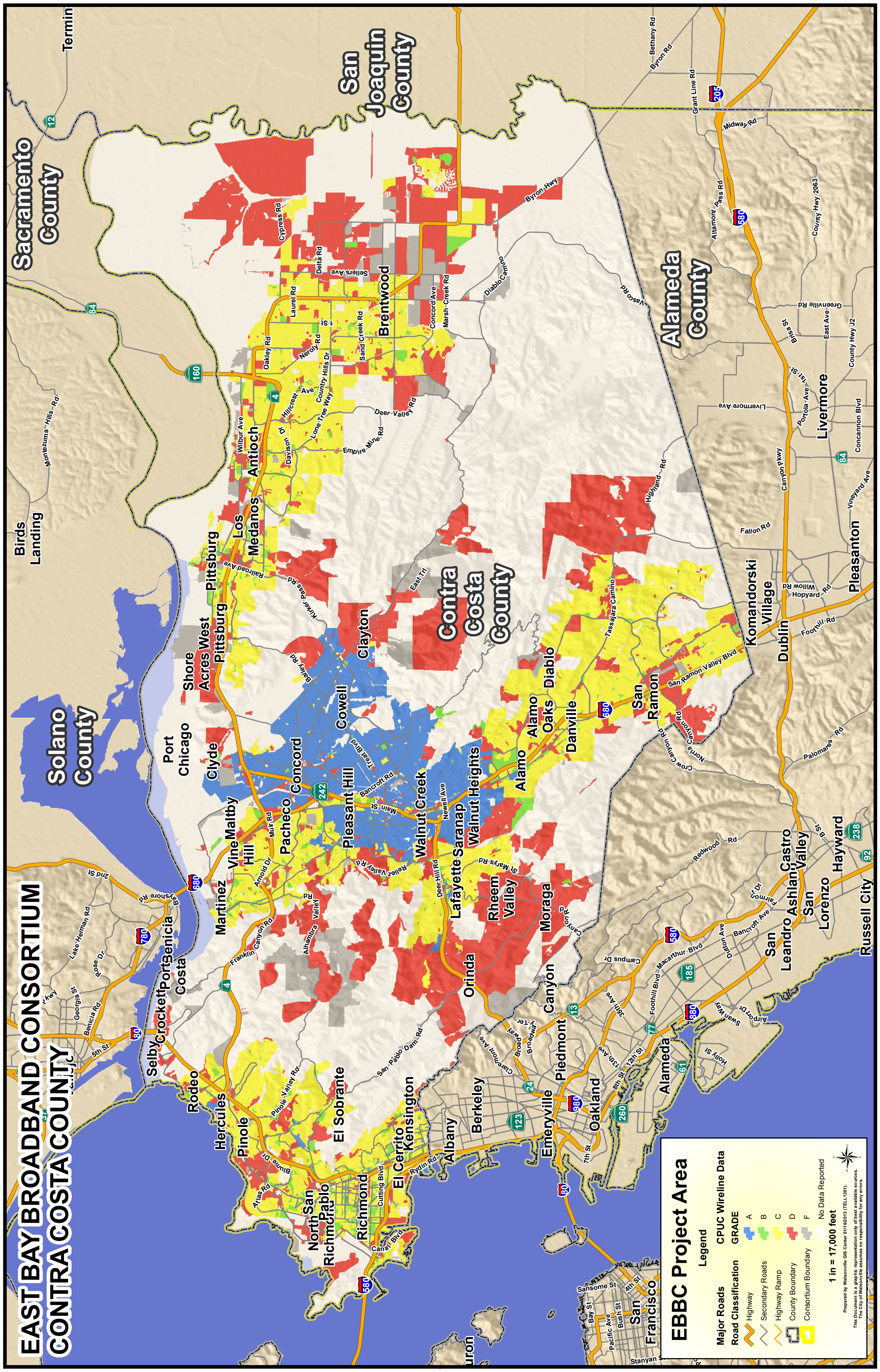
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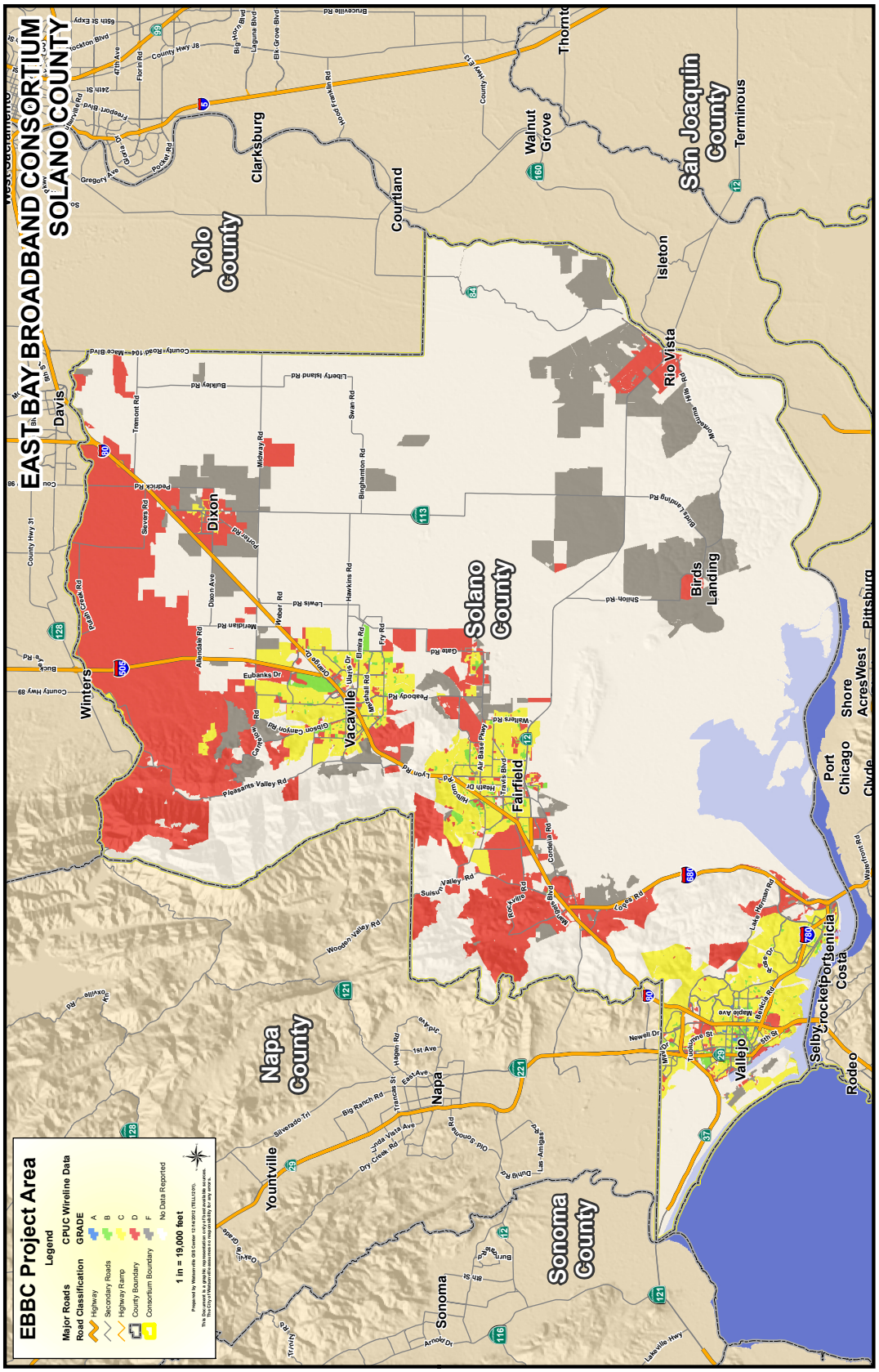
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Birds Landing
Pittsburg
Port Chicago
Shore Acres
West Clyde
Crockett
Port Costa
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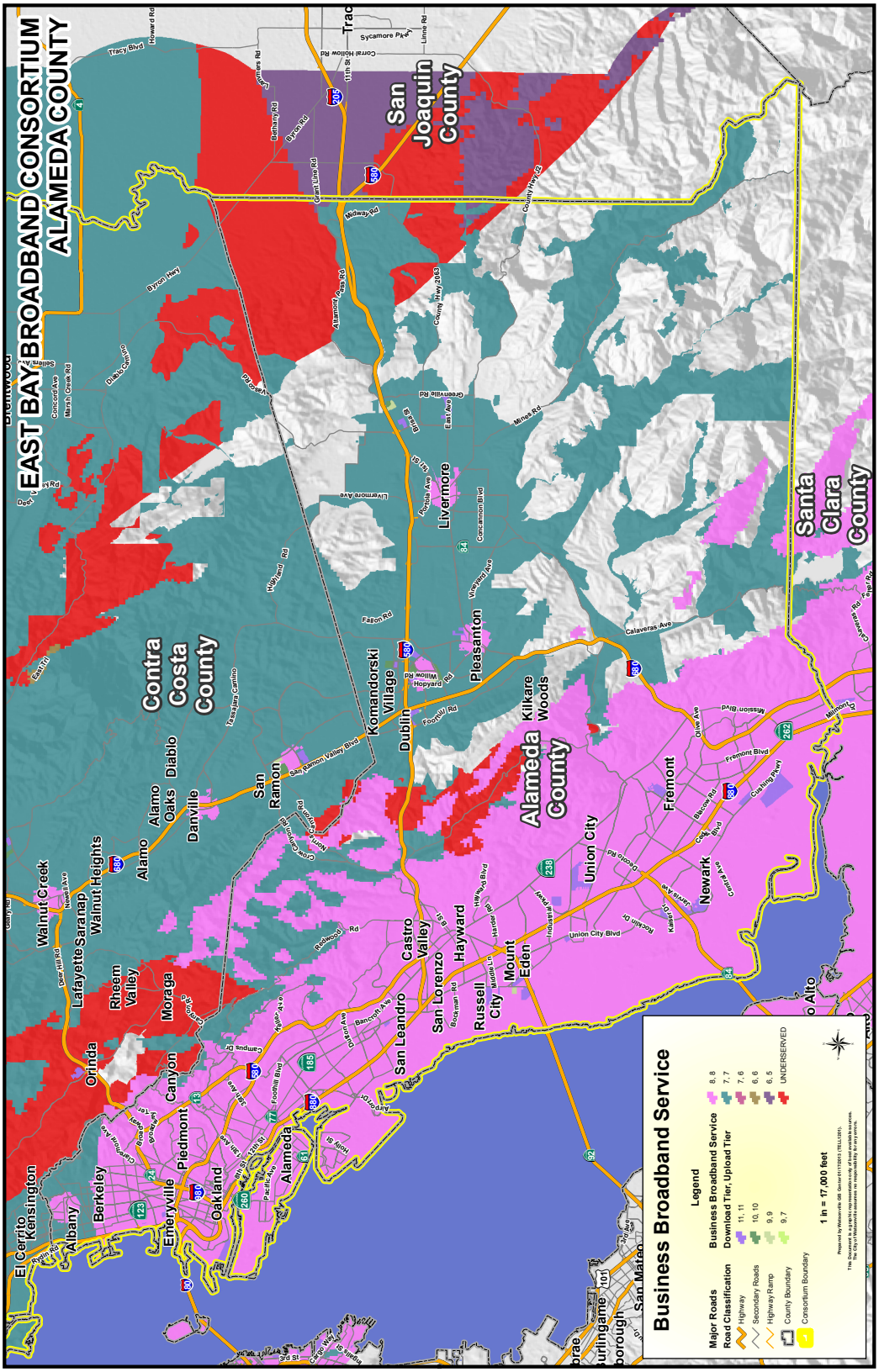
Napa
Yountville
Sonoma

12. Appendix E – Commercial, Wireline, Mobile and Adoption Maps

12.1. Commercial broadband availability maps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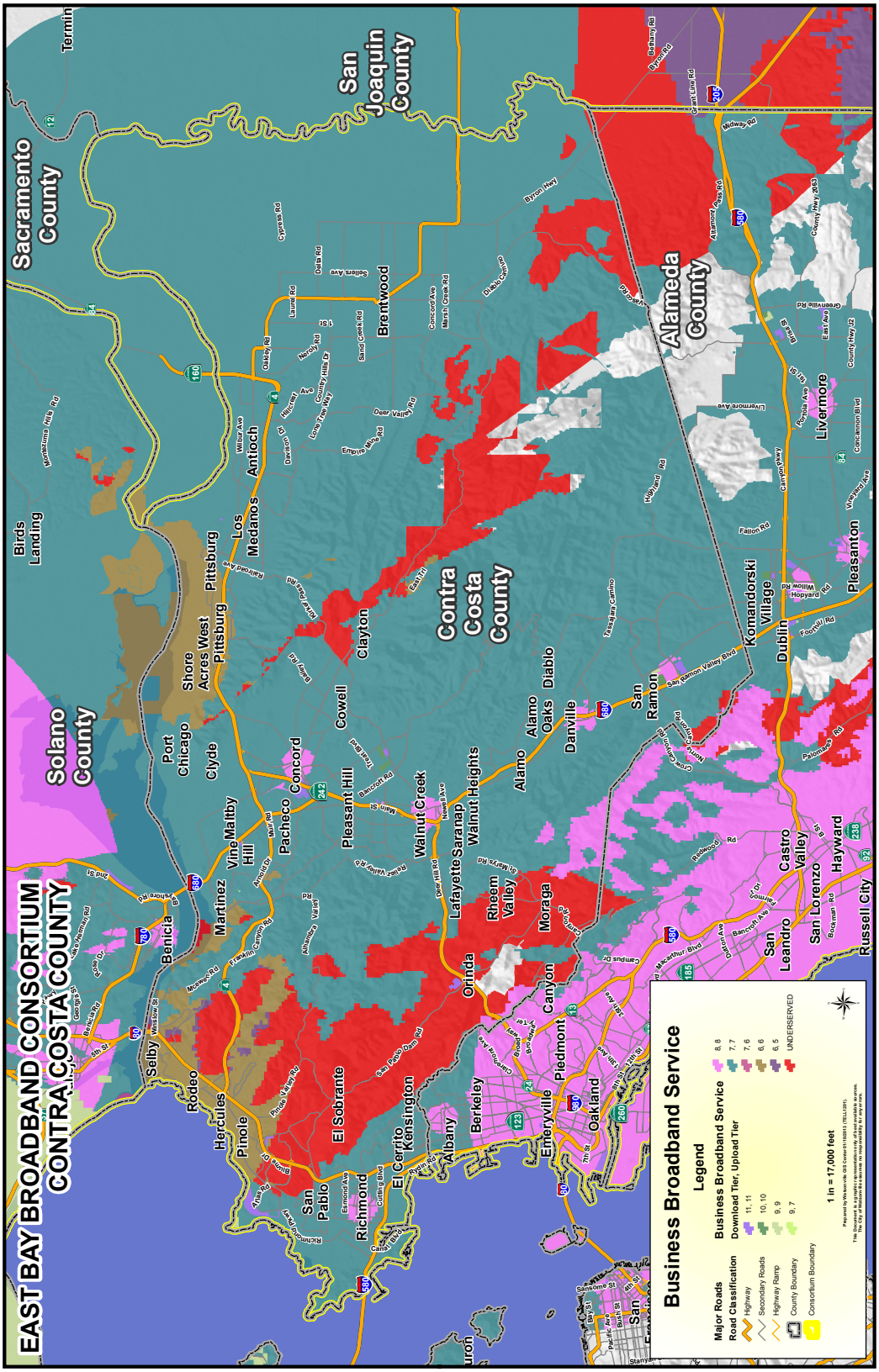
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Saranap
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El Sobrante
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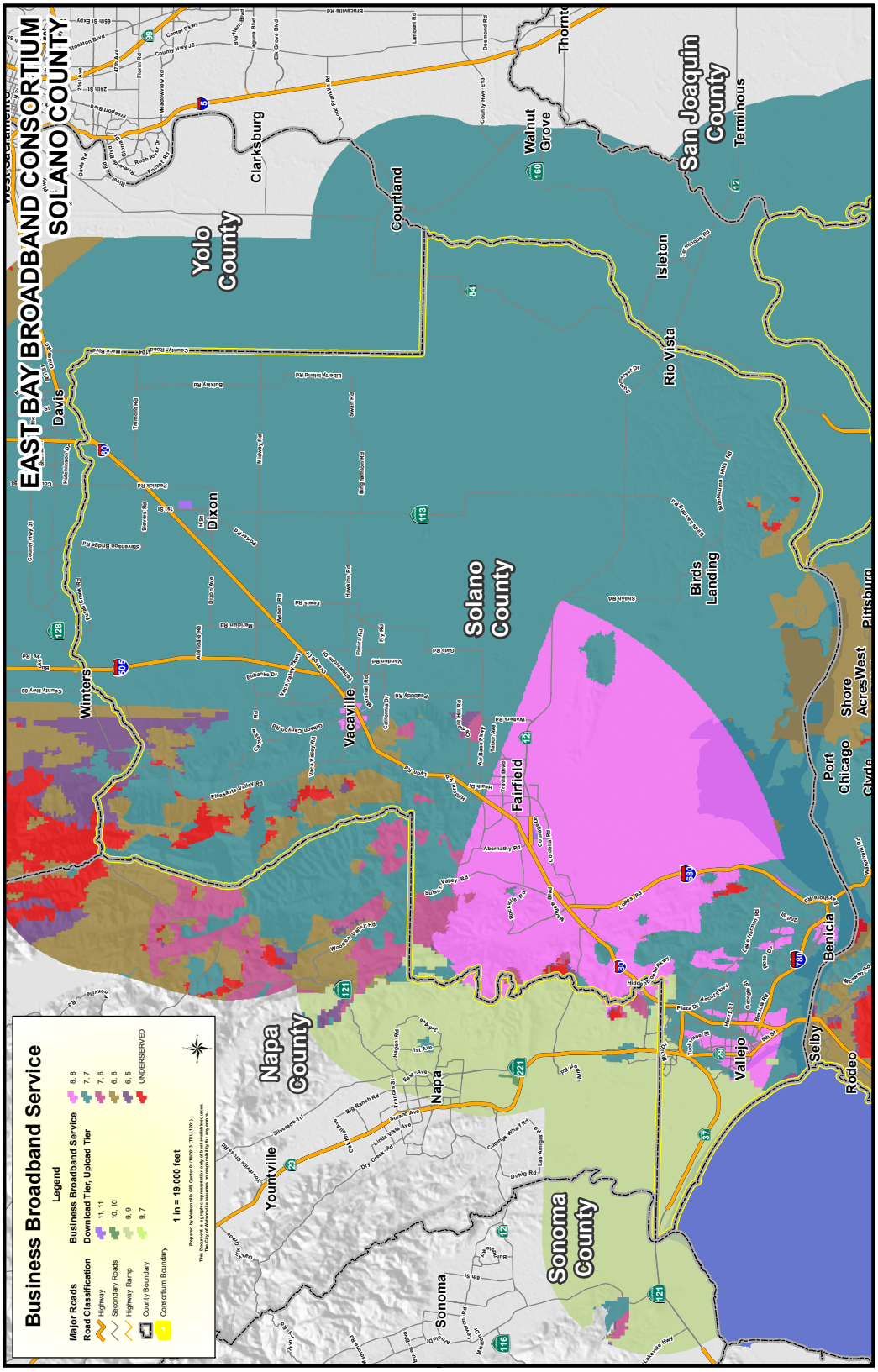
Russell City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Shore Acres
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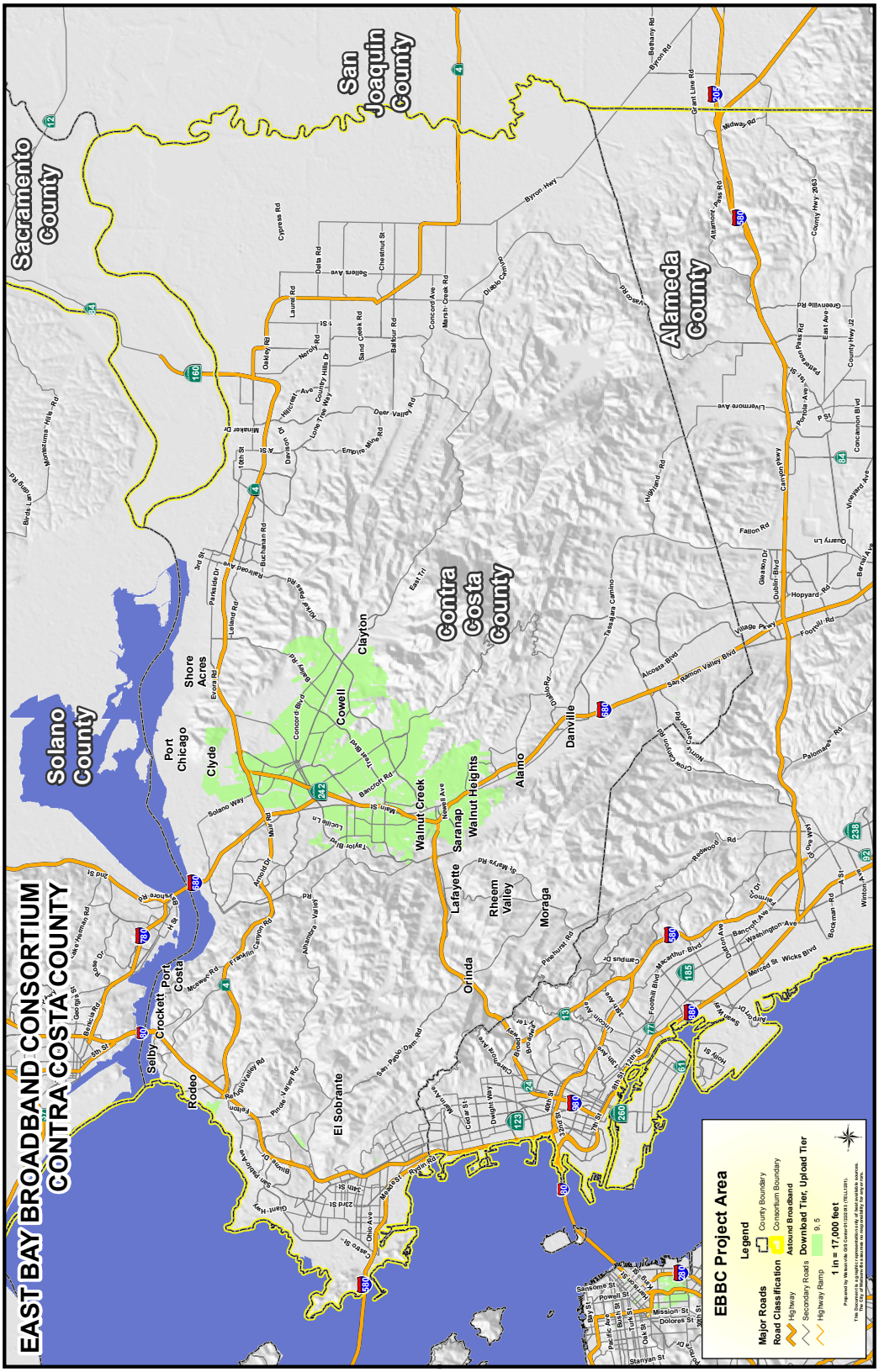
12.2. Wireline and fixed wireless broadband infrastructure maps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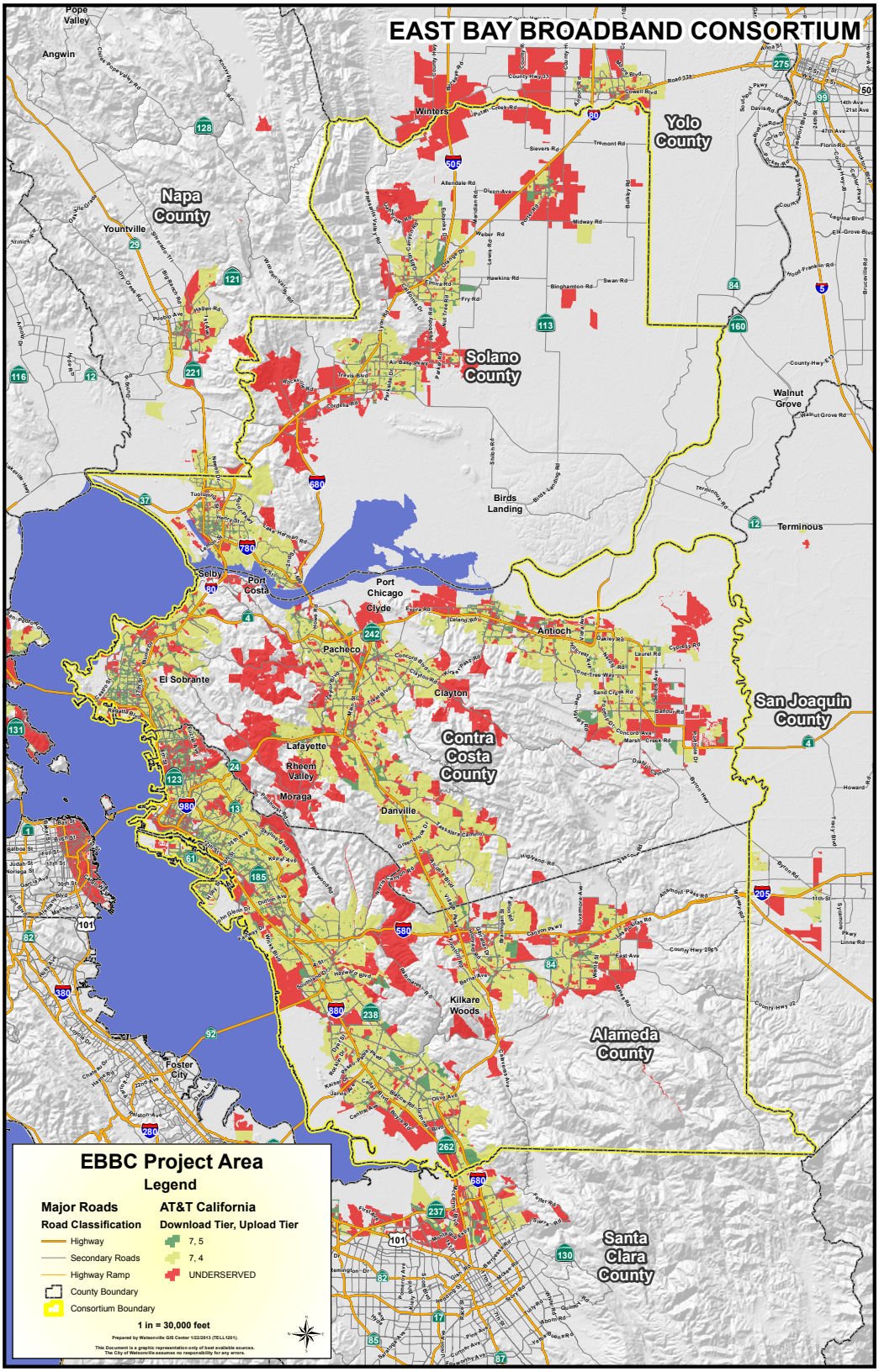
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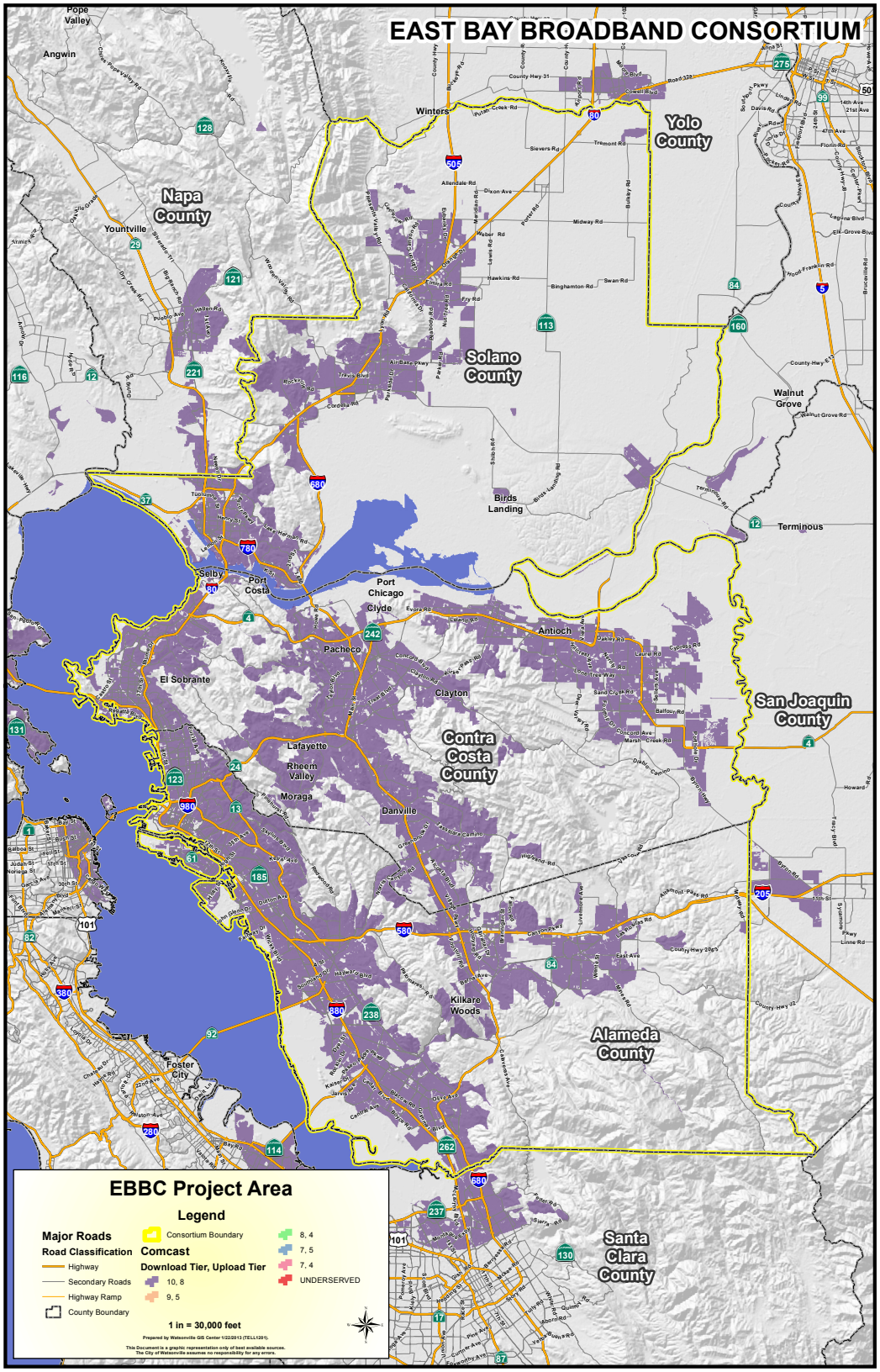
This Document is a graphic representation only of best available sources.
The City of Watsonville assumes no responsibility for any errors.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Port Chicago
Clyde
Antioch
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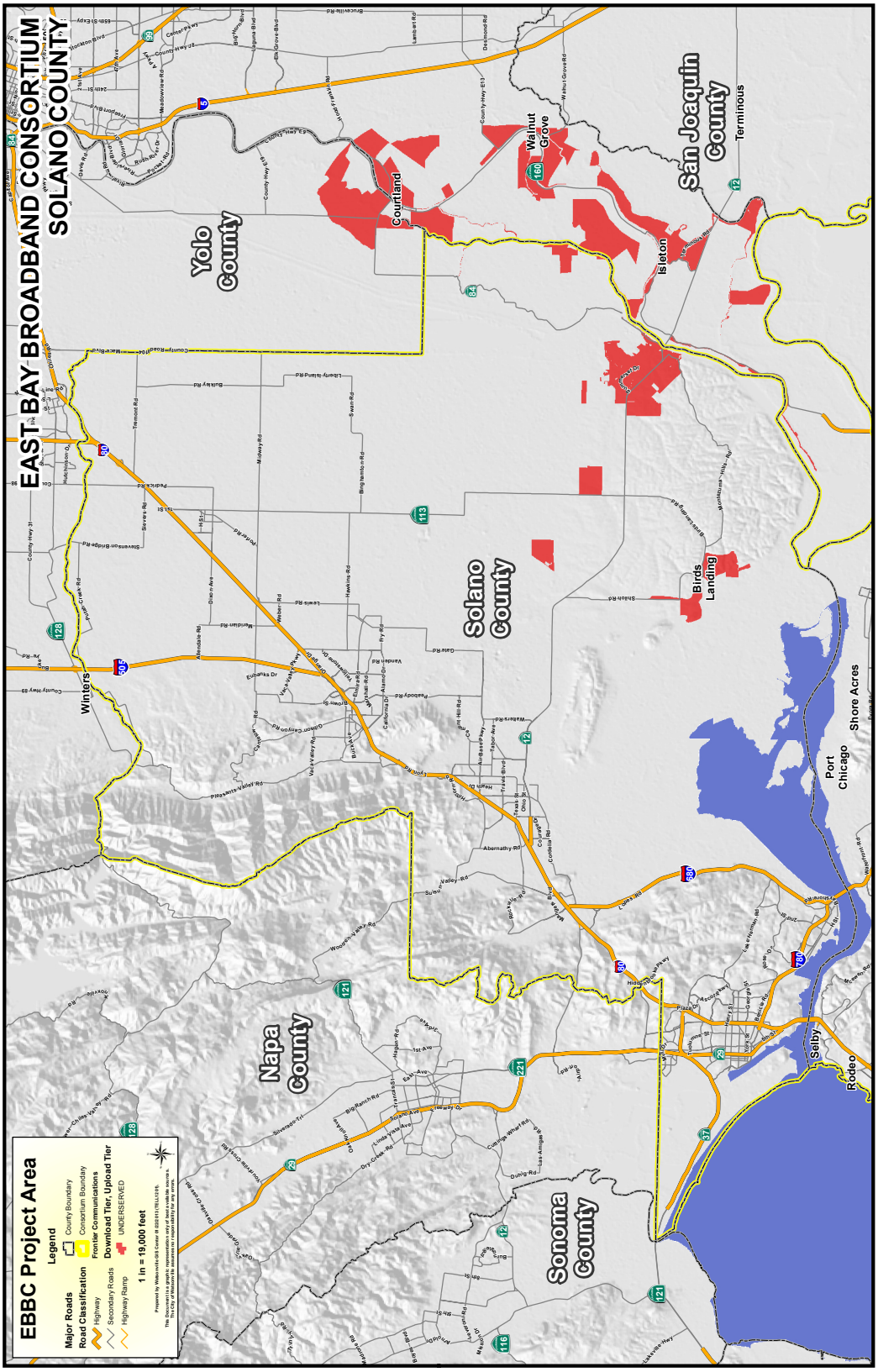
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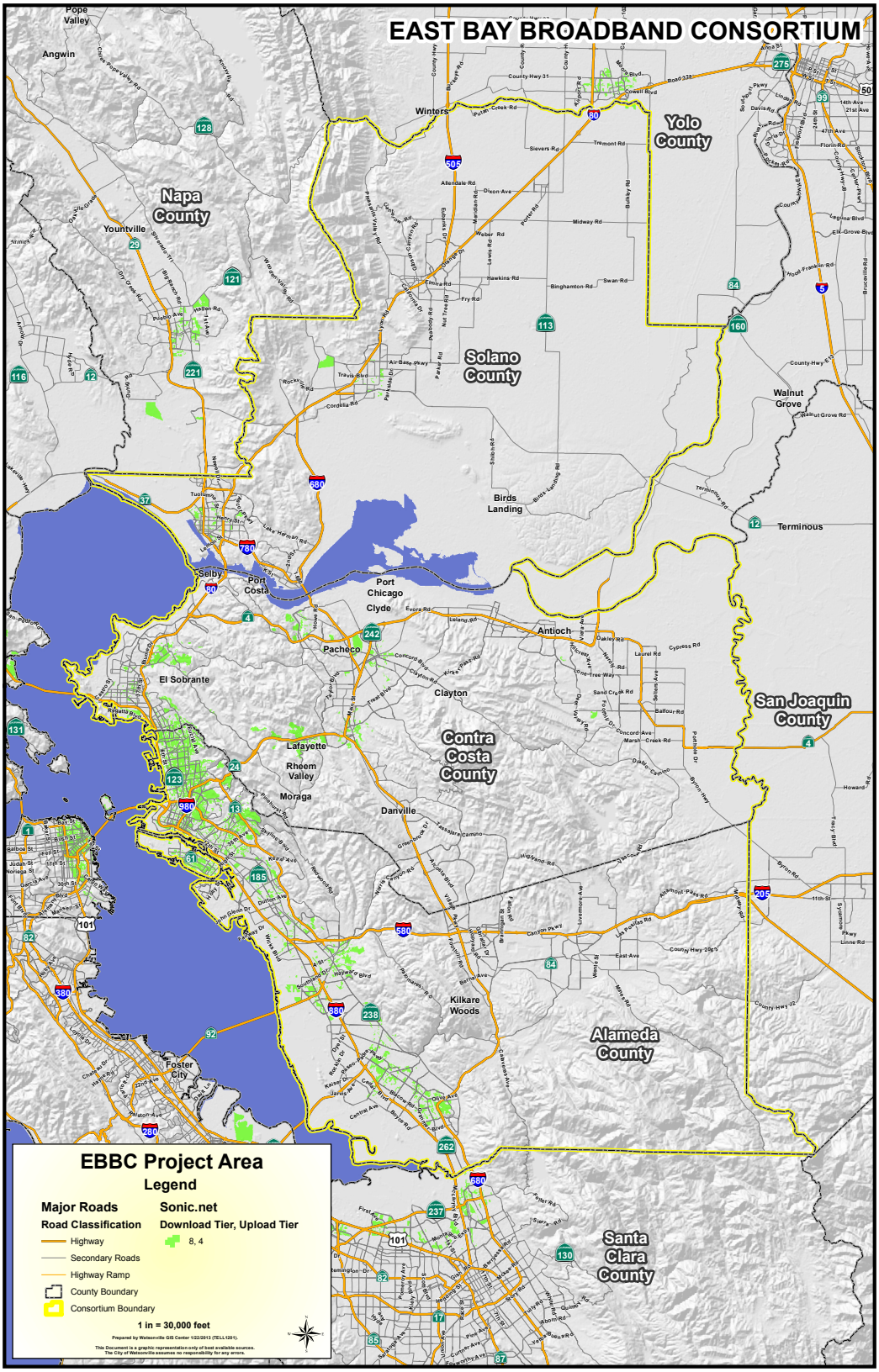
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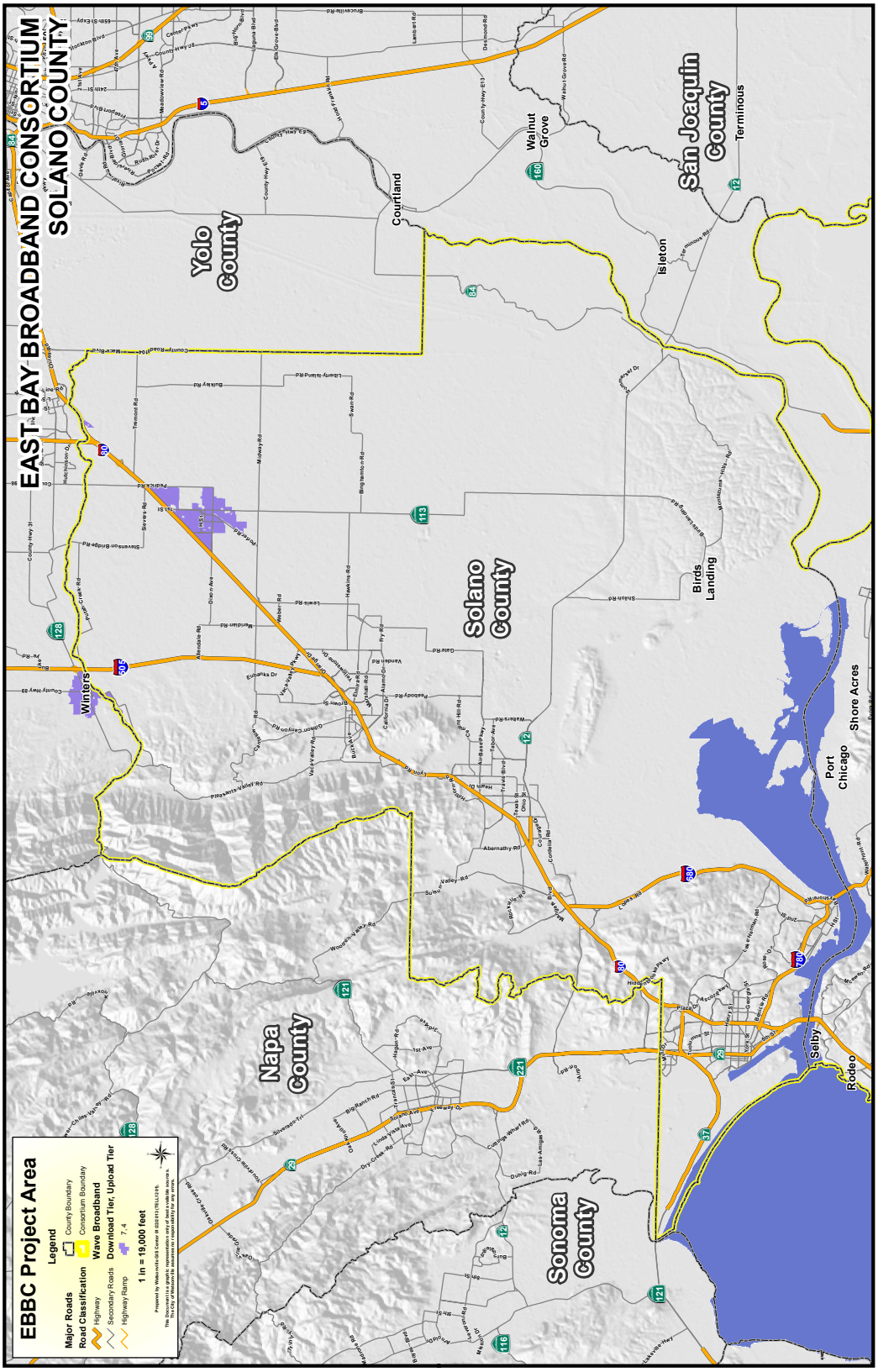
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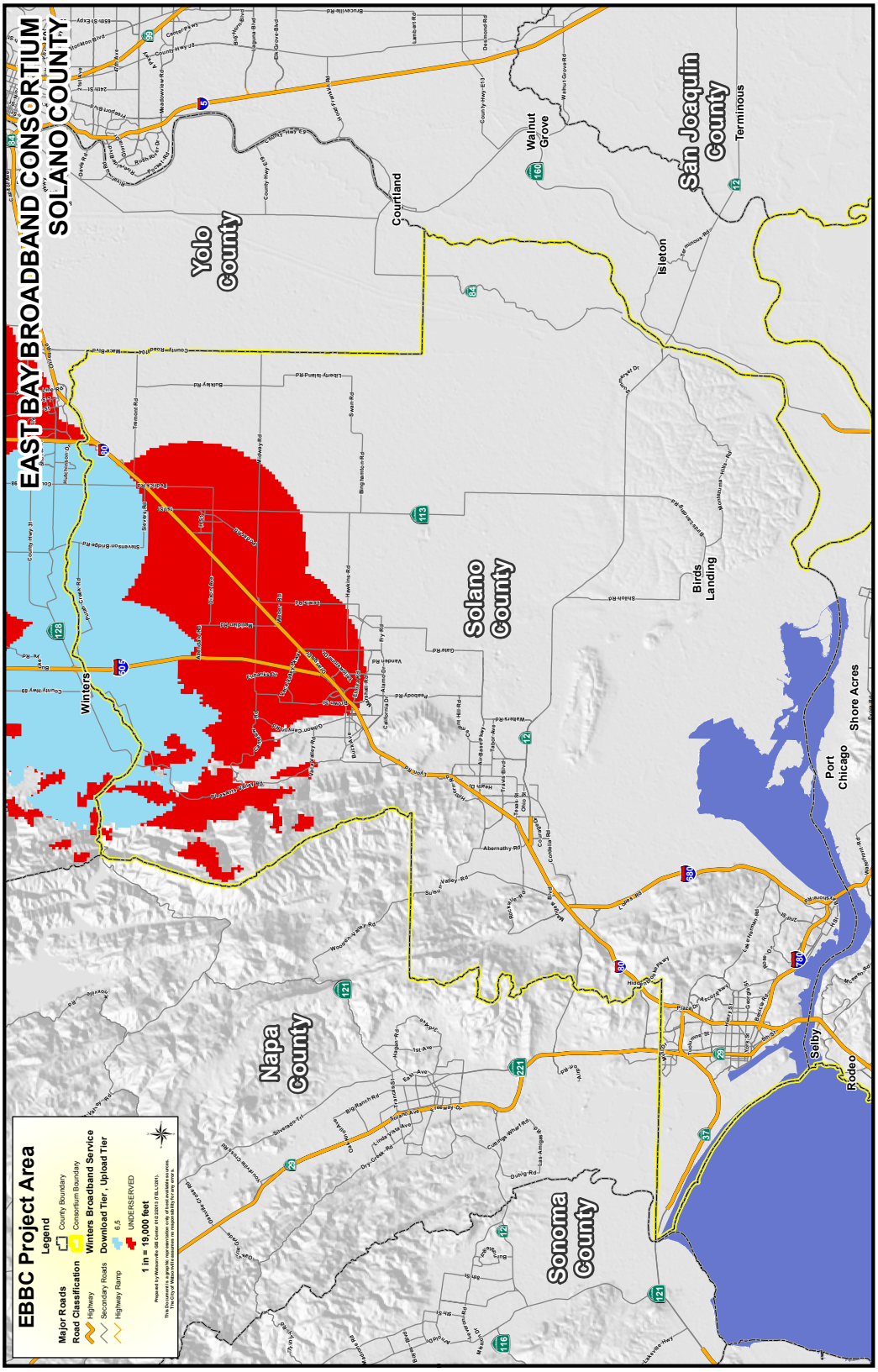
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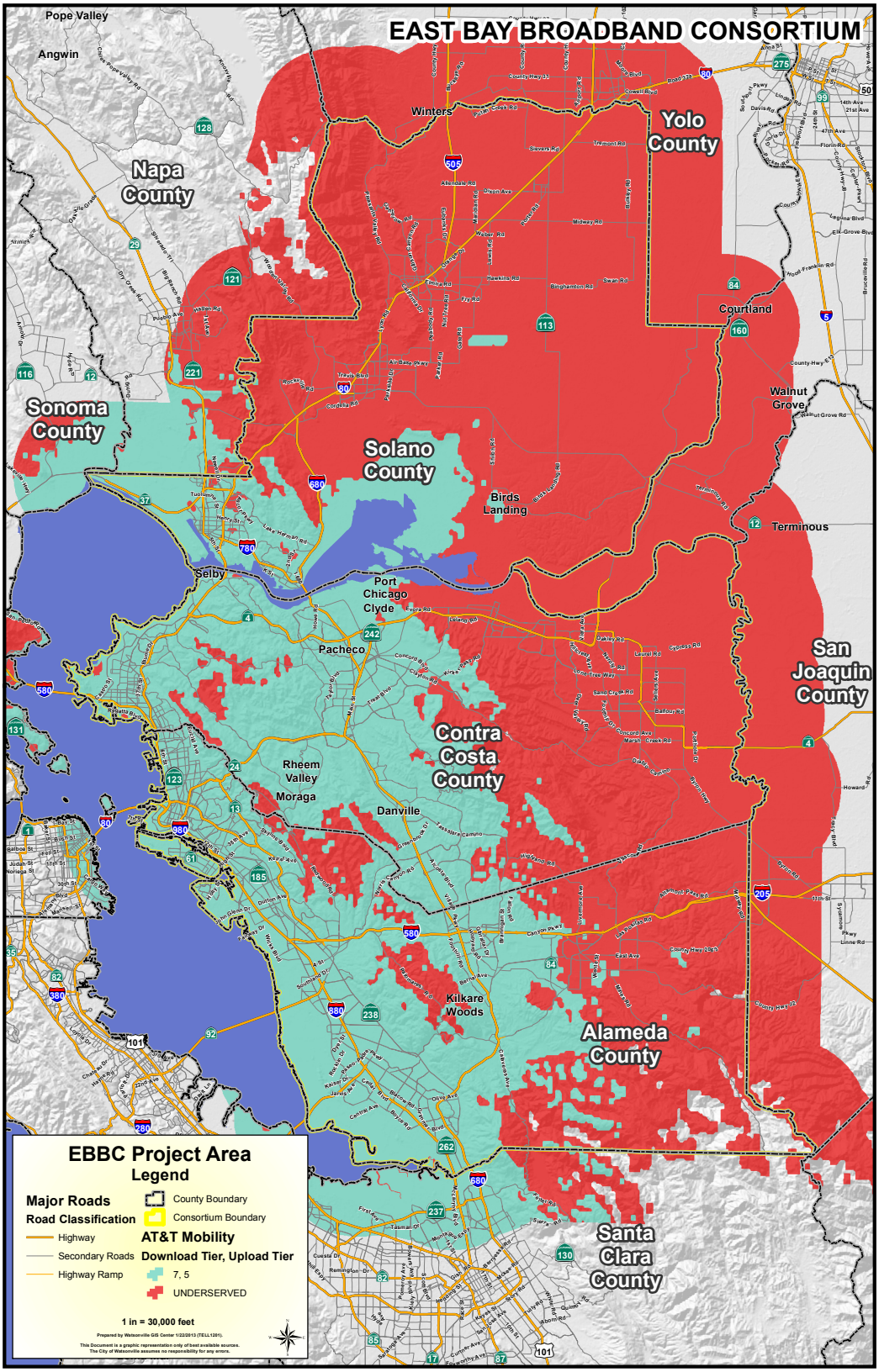
12.3. Mobile broadband advertised coverage maps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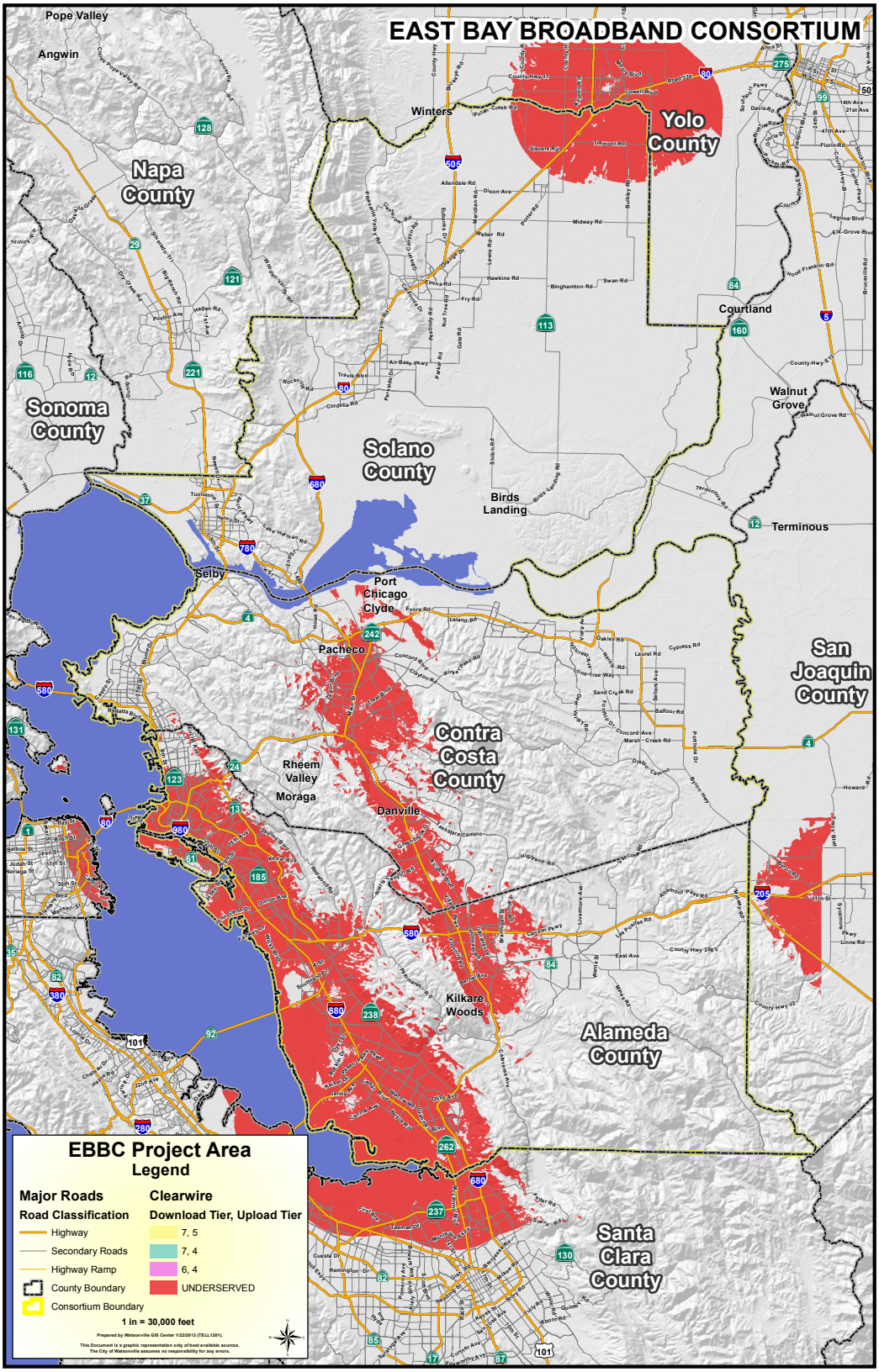
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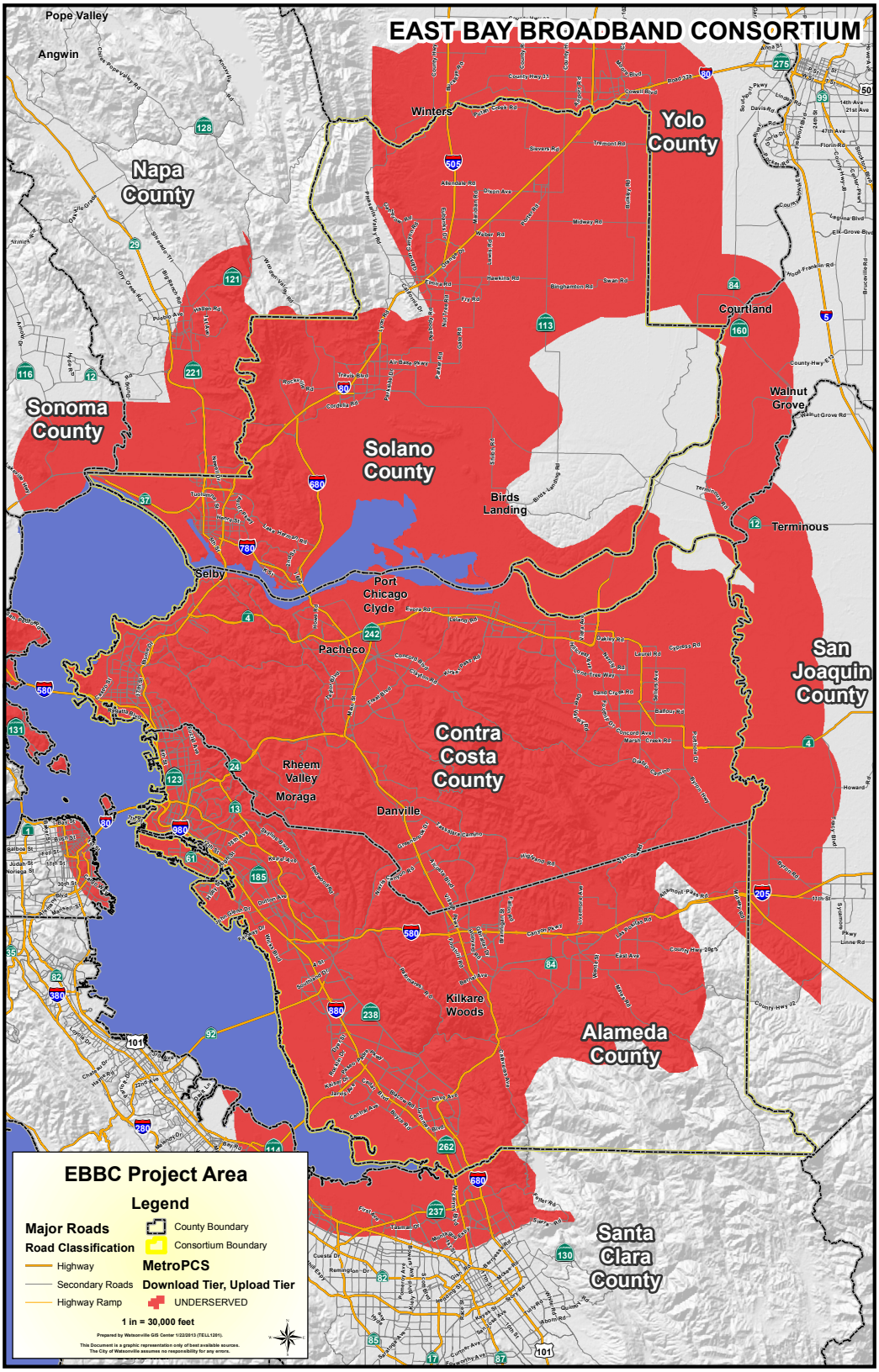
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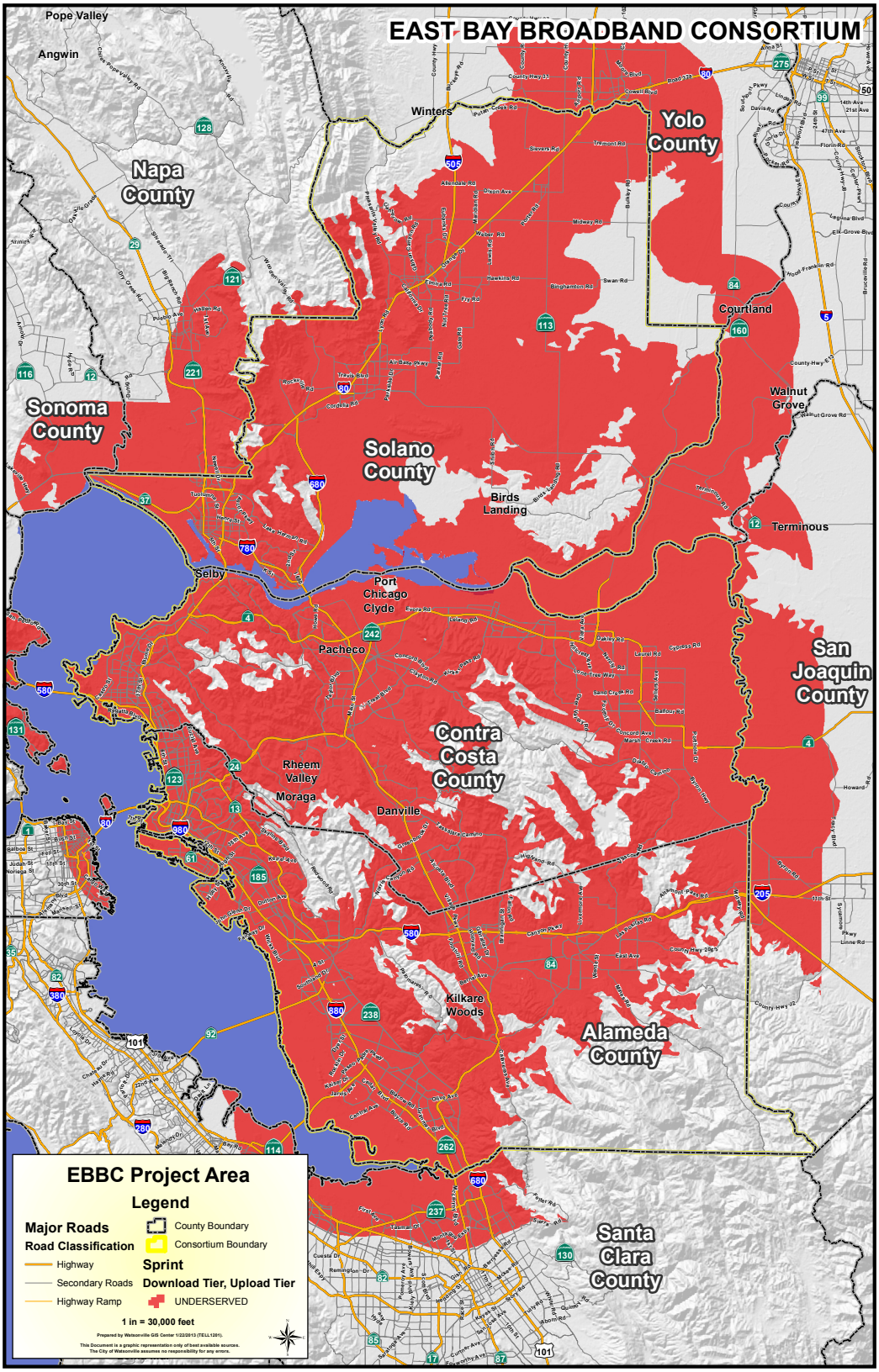
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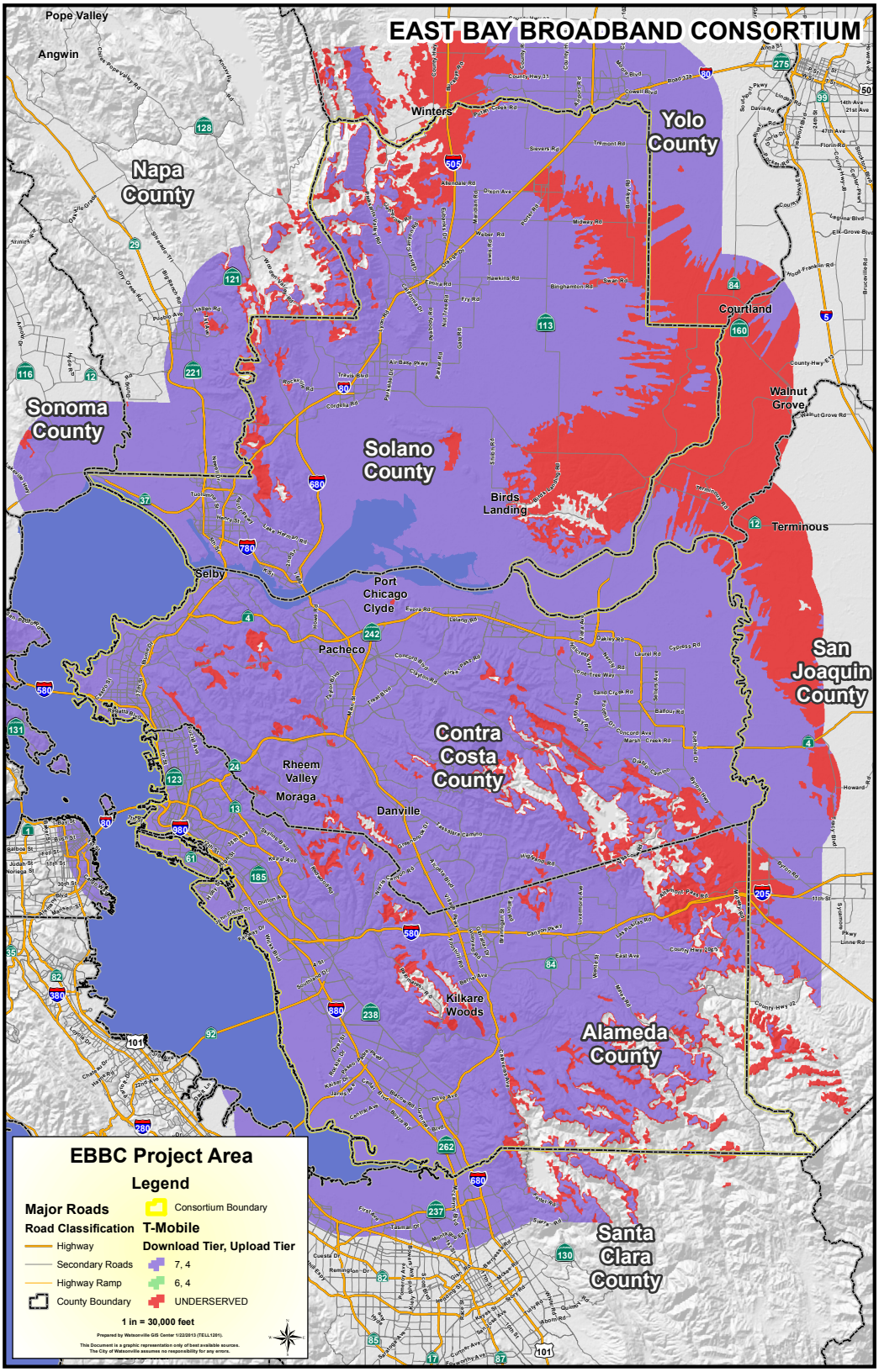
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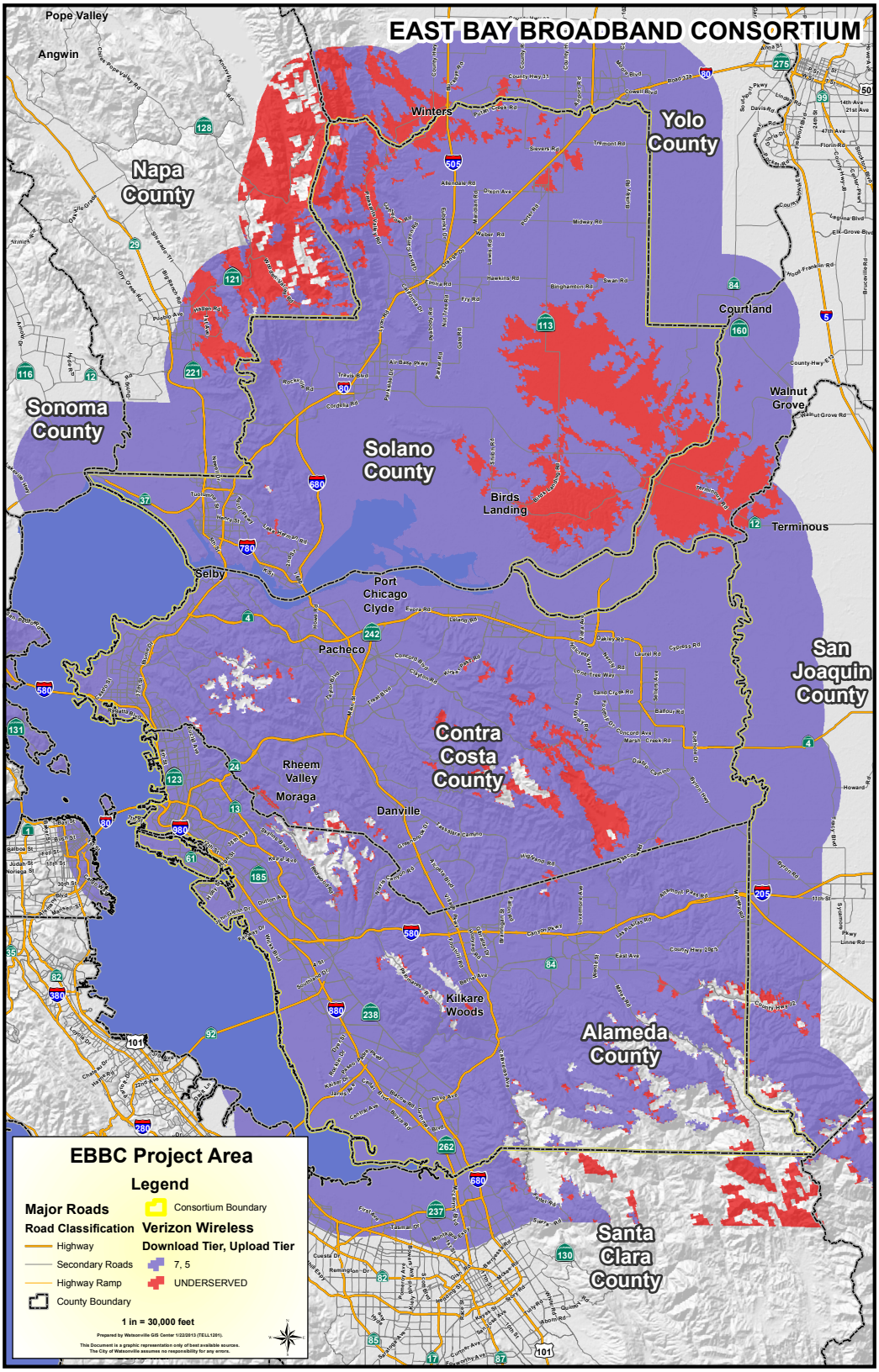
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12.4. Broadband adoption

The maps on the following two pages show broadband adoption rate data as collected by the California Public Utilities Commission. The key to the maps is below.

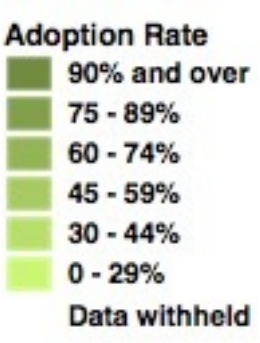

Figure 12.1 – CPUC broadband adoption map key.

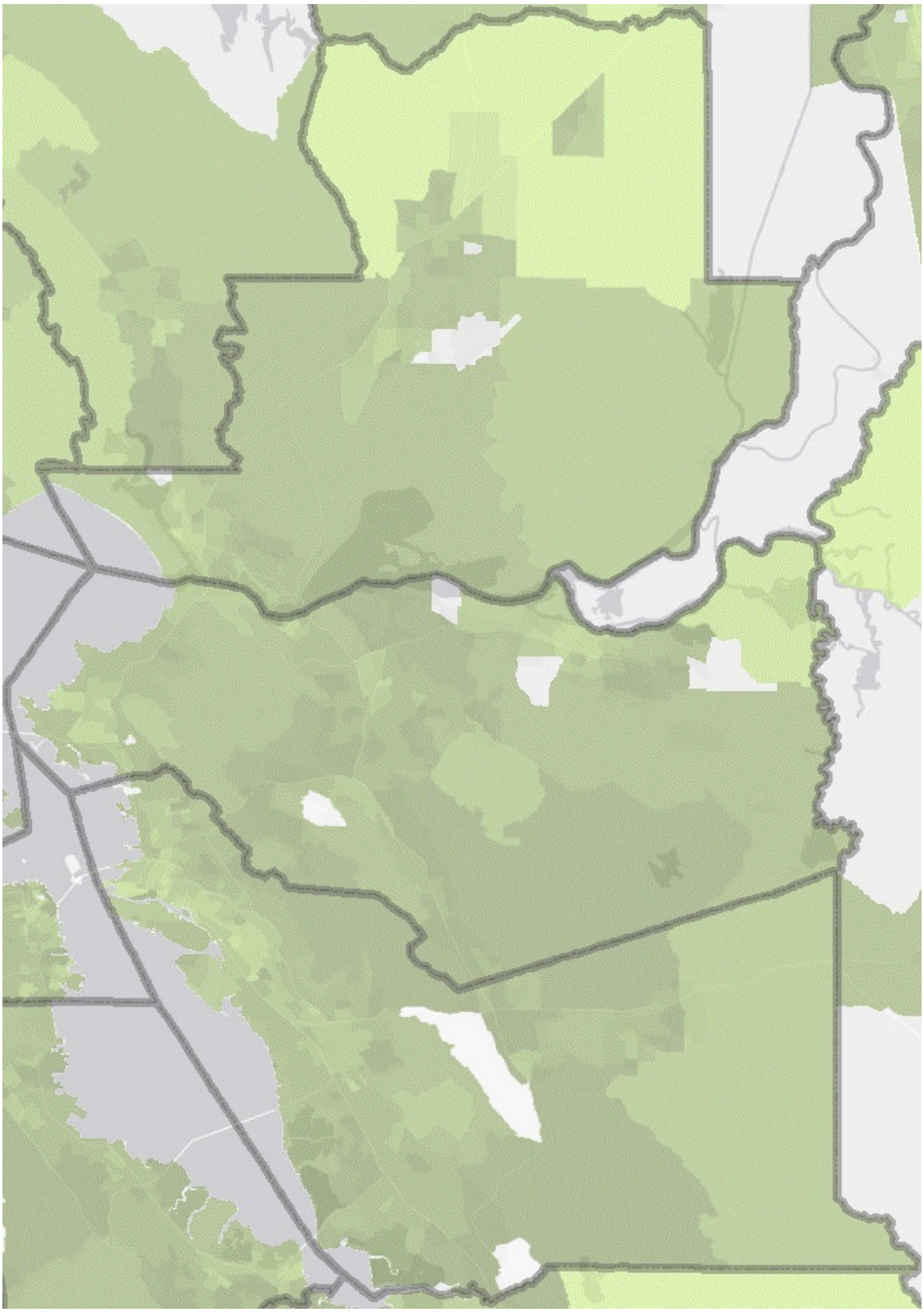

Figure 12.2 – CPUC broadband adoption map for East Bay region. Lighter colors indicate greater broadband adoption gaps.

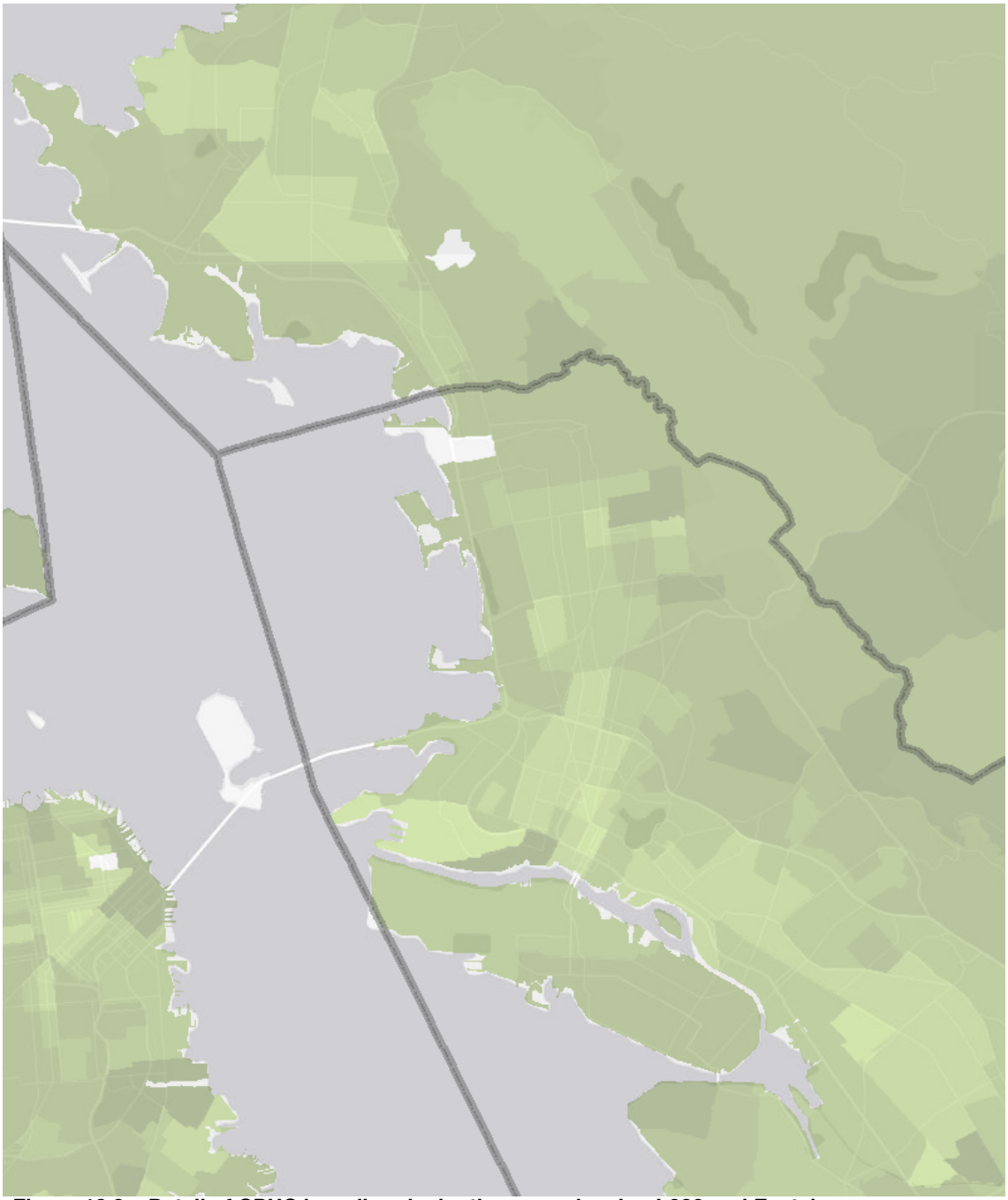

Figure 12.3 – Detail of CPUC broadband adoption map showing I-880 and Eastshore corridors. Lighter colors indicate greater broadband adoption gaps.

13. Appendix F – Akamai Broadband Speed Results

The State of the Internet, 2nd quarter 2013, Akamai Technologies, Inc.

Country	Avg. Connection Speed (Mbps)	Country	% Above 10 Mbps*
Massachusetts[D]	11.2	Massachusetts	41.9%
Virginia[G]	11.1	New Jersey	40.7%
Delaware	10.8	New Hampshire	39.8%
New Hampshire	10.7	Maryland	39.1%
Maryland	10.6	Rhode Island	36.7%
Utah	10.3	Delaware	35.7%
New Jersey	10.2	Pennsylvania	32.5%
Washington	10.1	Connecticut	32.3%
Connecticut	10.0	New York	32.1%
Rhode Island[F]	9.9	Virginia	31.0%
North Dakota	9.8	Washington	31.0%
New York	9.8	Oregon	28.1%
Pennsylvania[E]	9.5	Vermont	26.5%
Ohio	9.3	South Dakota	26.4%
Oregon	9.0	Michigan	25.1%
Vermont	9.0	North Carolina	24.8%
North Carolina	8.9	Utah	24.8%
Michigan	8.9	Indiana	23.8%
California	8.9	Ohio	23.3%
Indiana	8.7	**California**	23.2%
South Dakota	8.5	Tennessee	22.5%
Minnesota	8.4	Illinois	22.4%
Wisconsin	8.3	Florida	21.9%
Illinois	8.2	Georgia	21.4%
South Carolina	8.1	Nevada	21.4%
Tennessee	8.0	South Carolina	21.4%
Georgia	8.0	Minnesota	20.0%
Florida	8.0	North Dakota	19.8%

The State of the Internet, 2nd quarter 2013, Akamai Technologies, Inc.

Country	Avg. Connection Speed (Mbps)	Country	% Above 10 Mbps*
Texas	7.8	Wisconsin	19.4%
Colorado	7.8	Colorado	18.9%
Nevada	7.6	Texas	18.7%
Arizona	7.6	Missouri	17.4%
Missouri	7.4	Arizona	17.2%
Nebraska	7.3	Alabama	16.9%
Alabama	7.1	Wyoming	16.6%
Maine	7.1	West Virginia	16.2%
Wyoming	7.1	Montana	14.1%
Iowa	7.0	Nebraska	13.9%
Oklahoma	6.9	Oklahoma	13.9%
Kentucky[C]	6.5	Maine	12.7%
Hawaii	6.4	Alaska	11.8%
New Mexico	6.2	Kentucky	11.1%
Kansas	6.2	Louisiana	11.1%
Montana	6.2	New Mexico	11.1%
West Virginia	6.1	Mississippi	11.0%
Mississippi	5.9	Iowa	10.3%
Louisiana	5.9	Kansas	8.4%
Alaska	5.7	Hawaii	7.0%
Idaho	5.7	Idaho	6.6%
Arkansas	4.5	Arkansas	4.1%

The State of the Internet, 2nd quarter 2013, Akamai Technologies, Inc.

Country	Avg. Connection Speed (Mbps)	Country	% Above 10 Mbps*
South Korea	13.3	South Korea	45%
Japan	12.0	Japan	43%
Switzerland	11.0	Switzerland	37%
Hong Kong	10.8	Hong Kong	32%
Netherlands	10.1	Netherlands	31%
Czech Republic	9.8	Czech Republic	27%
California	8.9	Belgium	25%
United States	8.7	United States	24%
Belgium	8.4	Finland	23%
Sweden	8.4	United Kingdom	23%
United Kingdom	8.4	**California**	23%
Canada	8.2	Sweden	22%
Austria	8.1	Denmark	21%
Denmark	8.1	Canada	20%
Finland	8.1	Russia	19%
Ireland	8.0	Norway	18%
Romania	7.5	Austria	17%
Norway	7.4	Romania	17%
Israel	7.4	Israel	17%
Germany	7.3	Ireland	16%
Iceland	7.2	Germany	15%
Russia	7.0	Poland	13%
Hungary	6.5	Singapore	13%
Singapore	6.5	Hungary	12%
Slovakia	6.4	Iceland	12%
Poland	6.3	Slovakia	10%
Luxembourg	6.1	Spain	8%
Spain	5.9	Taiwan	8%
France	5.7	Portugal	7%
Taiwan	5.5	France	7%

The State of the Internet, 2nd quarter 2013, Akamai Technologies, Inc.

Country	Avg. Connection Speed (Mbps)	Country	% Above 10 Mbps*
Portugal	5.4	Luxembourg	6%
Italy	4.9	United Arab Emirates (UAE)	6%
Greece	4.8	Australia	5%
Australia	4.8	New Zealand	4%
New Zealand	4.6	Greece	4%
United Arab Emirates (UAE)	4.6	Italy	4%
Turkey	3.7	Malaysia	2%
Mexico	3.6	South Africa	2%
Malaysia	3.1	Turkey	1%
Chile	2.9	China	1%
Colombia	2.9	Mexico	1%
China	2.8	Brazil	1%
Saudi Arabia	2.5	Kuwait	1%
Kuwait	2.4	Chile	1%
Brazil	2.4	Egypt	<0.1%
South Africa	2.3	Sudan	<0.1%
Sudan	2.1	Syria	<0.1%
Peru	2.1	Peru	<0.1%
Costa Rica	2.1	Argentina	0%
Argentina	2.0	Costa Rica	0%
Indonesia	1.7	India	0%
Vietnam	1.7	Colombia	0%
India	1.3	Indonesia	0%
Syria	1.3	Vietnam	0%
Venezuela	1.3	Saudi Arabia	0%
Egypt	1.1	Venezuela	0%

14. Appendix G – Glossary

ADSL	Asymmetric Digital Subscriber Line: DSL service with a larger portion of the capacity devoted to downstream communications, less to upstream. Typically thought of as a residential service.
ATM	Asynchronous Transfer Mode: A data service offering by ASI, that can be used for interconnection of customer's LAN. ATM provides service from 1 Mbps to 145 Mbps utilizing Cell Relay Packets.
Backhaul	Connecting Internet access to a location over long or short distances. Traditionally, wired networks have been necessary for backhaul, but with 802.16, also known as WiMAX, backhaul via wireless will become even more common than it is with WiFi.
Bandwidth	The amount of data transmitted in a given amount of time; usually measured in bits per second, kilobits per second, and megabits per second.
Bit	A single unit of data, either a one or a zero. In the world of broadband, bits are used to refer to the amount of transmitted data. A kilobit (Kb) is approximately 1,000 bits. A megabit (Mb) is approximately 1,000,000 bits.
Broadband	"Broadband" refers generally to any telecommunications service capable of supporting digital data transmission at high speeds. These services can include and/or support Internet, television, telephone, private data networks and various specialized uses. Broadband service can be delivered in a variety of ways, including telephone lines (e.g. DSL), coaxial cable (e.g. cable modem), fiber optic cable (e.g. Lit San Leandro), wireless cellular/mobile service (e.g. cell phones, tablets, wireless modems), WiFi, point-to-point and point-to-multipoint wireless service (e.g. TelePacific, Etheric) and hybrid networks (XO Communications). Although different organizations use different criteria, the California Public Utilities Commission considers 6 Mbps download and 1.5 Mbps upload speed to be a standard for adequate broadband service availability. Unless otherwise stated, this report uses the CPUC definition.
Byte	The amount of memory space needed to store one character, which is normally 8 bits.

Cable modem	A device that hooks to your cable TV line to allow your computer to receive data at about 1.5 Mbps. The theoretical maximum for downstream transactions is 27 Mbps and 2.5 Mbps upstream, but the connection is usually much slower because the provider may be hooked to the Internet via a T-1 line.
CDMA	The type of digital cellular phone network used throughout most of the United States, but rare elsewhere in the world. CDMA stands for Code Division Multiple Access, and CDMA2000 1x is the third-generation, or 3G, extension to which CDMA cellular operators are upgrading their networks. It is a digital cellular technology that uses spread-spectrum techniques. Unlike competing systems, such as GSM, that use TDMA, CDMA does not assign a specific frequency to each user. Instead, every channel uses the full available spectrum. Individual conversations are encoded with a pseudo-random digital sequence. CDMA consistently provides better capacity for voice and data communications than other commercial mobile technologies, allowing more subscribers to connect at any given time, and it is the common platform on which 3G technologies are built.
Cell	The geographic area covered by a cellular telephone transmitter. A connected group of cells form a cell system, which is what you gain access to when you sign up for cellular telephone service.
Cellular	A mobile communications system that uses a combination of radio transmission and conventional telephone switching to permit telephone communications to and from mobile users within a specified area.
CLEC	Competitive Local Exchange Carrier: Wireline service provider that is authorized under state and Federal rules to compete with ILECs to provide local telephone service. CLECs provide telephone services in one of three ways or a combination thereof: a) by building or rebuilding telecommunications facilities of their own, b) by leasing capacity from another local telephone company (typically an ILEC) and reselling it, and c) by leasing discreet parts of the ILEC network referred to as UNEs.

Coaxial cable	A type of cable that can carry large amounts of bandwidth over long distances. Cable TV and cable modem service both utilize this technology.
Commercial grade	Broadband service similar to residential service in that the provider takes effectively all responsibility for installing, maintaining and supporting the service. Speeds are similar (6 to 100 Mbps), but service levels, reliability, consistency and pricing are higher.
CPCN	Certificate of Public Convenience and Necessity: Authorization given by the CPUC to telecommunications carriers in order to provide service in the state of California.
Dial-Up	A technology that provides customers with access to the Internet over an existing telephone line.
DS3	A dedicated phone connection supporting data rates of about 43Mbps (megabits per second). Also called a T-3, the line actually consists of 672 individual channels, each of which supports 64Kbps. DS3 lines are used mainly by Internet Service Providers (ISPs) connecting to the Internet backbone. Large businesses also use DS3 lines when they have large sites to interconnect.
DSL	A common form of broadband Internet connection. DSL stands for Digital Subscriber Line.
E-Rate	A Federal program that provides subsidy for voice and data lines to qualified schools, hospitals, CBOs, and other qualified institutions. The subsidy is based on a percentage designated by the FCC. CTF benefits are calculated net of the E-rate subsidy.
E911	Enhanced 911, an emergency service that automatically sends phone number and location information to the operator. E911 comes in handy, say, when you need to get emergency help and are unable to speak or don't know your location.
Ethernet	The most common networking standard in the world, formally known as IEEE 802.3.
Fixed wireless	The operation of wireless devices in a specific location, such as an office. This term is usually reserved for devices that need to be plugged in to operate, such as a desktop computer. If it runs off a battery, it's not fixed wireless. The point-to-point signal transmissions occur through the air over a terrestrial microwave

	platform rather than through copper or fiber cables; therefore, fixed wireless does not require satellite feeds or local phone service. The advantages of fixed wireless include the ability to connect with users in remote areas without the need for laying new cables and the capacity for broad bandwidth that is not impeded by fiber or cable capacities.
FTTN	Fiber To The Neighborhood: A hybrid network architecture involving optical fiber from the carrier network, terminating in a neighborhood cabinet with converts the signal from optical to electrical.
FTTP	Fiber To The Premise (Or FTTB
Gigahertz	A measure of electromagnetic wave frequency equal to one thousand million (1,000,000,000) hertz, often abbreviated as GHz and used to specify the radio frequency used by wireless devices. 802.11a networks operate at 5 GHz. 802.11b and g networks use 2.4 GHz, which is susceptible to interference from nearby cordless phones and microwave ovens that use the same frequency.
GPON	Gigabyte-Capable Passive Optical Network: GPON uses a different, faster approach (up to 2.5 Gbit/s in current products) than BPON.
GSM	Global System for Mobile Communications: This is the current radio/telephone standard in Europe and many other countries except Japan and the United States.
Hub	A common connection point for devices, such as computers and printers, in a network.
ILEC	Incumbent Local Exchange Carrier. An ILEC is a telephone company that was providing local service when the Telecommunications Act of 1996 was enacted. Compare with CLEC, a company that competes with the already established local telephone business.
Industrial grade	Broadband service where the customer plays a much greater role in provisioning and supporting the service, including buying different elements from different vendors and managing installation and support. Speeds would be higher – perhaps as high as a Gigabit per second or more – and quality of service levels could be as high as Tier 1. Comcast's Business Class service or AT&T's business DSL service are examples of

	commercial grade service. A DS-3 or dark fiber strands are examples of industrial grade service.
Inet	Institutional Network. Provides a high-speed connection between government, educational and community entities. It is often negotiated with a cable franchise, in exchange for using right- of-way in a jurisdiction.
ISP	Internet Service Provider: A company providing Internet access to consumers and businesses, acting as a bridge between customer (end-user) and infrastructure owners for dial-up, cable modem and DSL services.
LAN	Local Area Network: A geographically localized network consisting of both hardware and software. The network can link workstations within a building or multiple computers with a single wireless Internet connection.
Last mile	Infrastructure (e.g. fiber optic lines, distribution boxes, equipment vaults, poles, conduit) that provides broadband service to end users or end- user devices (including households, and businesses).
Local Loop	A generic term for the connection between the customer's premises (home, office, etc.) and the provider's serving central office. Historically, this has been a wire connection; however, wireless options are increasingly available for local loop capacity.
MAN	Metropolitan Area Network: A high-speed date intra-city network that links multiple locations with a campus, city or LATA. A MAN typically extends as far as 50 kilometers.
Mbps	Megabits per second: 1,000,000 bits per second. A measure of how fast data can be transmitted.
Middle mile	Broadband infrastructure that does not predominantly provide broadband service to end users or to end-user devices, and may include interoffice transport, backhaul, Internet connectivity, or special access. Middle mile facilities are the link between last mile facilities and major interconnection points, such as those that form the core of the Internet.
Modem	Short for modulator/demodulator. A modem modulates outgoing digital data into analog signals so they can be sent over copper

	phone lines, and demodulates incoming analog signals into digital.
Overbuilders	Building excess capacity. In this context, it involves investment in additional infrastructure project to provide competition.
PON	Passive Optical Network: A Passive Optical Network consists of an optical line terminator located at the Central Office and a set of associated optical network terminals located at the customer's premise. Between them lies the optical distribution network comprised of fibers and passive splitters or couplers. In a PON network, a single piece of fiber can be run from the serving exchange out to a subdivision or office park, and then individual fiber strands to each building or serving equipment can be split from the main fiber using passive splitters / couplers. This allows for an expensive piece of fiber cable from the exchange to the customer to be shared amongst many customers thereby dramatically lowering the overall costs of deployment for fiber to the business (FTTB) or fiber to the home (FTTH) applications.
Rights-of-Way	Legal rights of passage over land owned by another. Carriers and service providers must obtain rights-of-way to dig trenches or plant poles for cable systems, and to place wireless antennae.
Router	An intelligent network device that goes one step beyond bridging by converting address-based protocols that describe how packets move from one place to another. In practice, this generally comes down to translating between IP addresses and MAC addresses for data flowing between your local network and the Internet. Many people use the term interchangeably with "gateway." You must enter the IP address of your router when configuring network settings manually.
Subscribership	Subscribership is how many customers have subscribed for a particular telecommunications service.
Switched Network	A domestic telecommunications network usually accessed by telephones, key telephone systems, private branch exchange trunks, and data arrangements.
T-1	The T-1 standard was introduced in 1961 in order to support a bi-directional speed of 1.5 Mbps at a high quality-of-service level, using the copper wires of the time. Because it is a dedicated and managed circuit, its performance is usually

	substantially better than shared services such as DSL or cable modem, even in cases where the claimed top speed of those shared services is many times higher. A T-1 circuit is generally considered to be the lowest level of service that can be described as industrial or carrier grade.
Telco	An abbreviation for Telephone Company.
Telecommunications	Refers to all types of data transmission, from voice to video.
Throughput	The amount of data that can be transmitted in a given amount of time. Throughput is commonly measured in bits per second. (Although throughput is not really a measurement of speed, most people, including us, use the word "speed" when talking about a high-throughput network.)
Universal Service	The idea of providing every home in the United States with basic telephone service.
Videoconferencing	Conducting a conference between two or more participants at different sites by using computer networks to transmit audio and video data.
VLAN	Virtual Local Area Network. A network of computers that behave as if they are connected to the same wire even though they may actually be physically located on different segments of a LAN.
VoIP	Voice Over Internet Protocol: A new technology that employs a data network (such as a broadband connection) to transmit voice conversations.
VPN	A method of creating an encrypted tunnel through which all traffic passes, preventing anyone from snooping through transmitted and received data. VPN stands for virtual private network.
WAN	Wide Area Network, A collection of local area networks connected by a variety of physical means. The Internet is the largest and most well-known wide area network. Wide area network is generally abbreviated to WAN.
WiFi	Short for wireless fidelity and is meant to be used generically when referring of any type of 802.11 network, whether 802.11b, 802.11a, dual-band, etc. The term is promulgated by the WiFi Alliance. Any products tested and approved as "WiFi Certified" (a registered trademark) by the WiFi Alliance are certified as

	interoperable with each other, even if they are from different manufacturers. A user with a "WiFi Certified" product can use any brand of access point with any other brand of client hardware that also is certified. Typically, however, any WiFi product using the same radio frequency (for example, 2.4 GHz for 802.11b or 11g, 5 GHz for 802.11a) will work with any other, even if not "WiFi Certified." Formerly, the term "WiFi" was used only in place of the 2.4 GHz 802.11b standard, in the same way that "Ethernet" is used in place of IEEE 802.3. The Alliance expanded the generic use of the term in an attempt to stop confusion about wireless LAN interoperability.
WiMAX	Another name for the 802.16 wireless networking specification used for long-haul and backhaul connections.
Wireless ISP	A company that provides wireless Internet access. The term is often abbreviated to WISP.
WLAN	Wireless Local Access Network, a LAN that can be connected to via a wireless connection.

Sources: Tellus Venture Associates, California Public Utilities Commission, Neratech, Wikipedia.