Telecommunications Feasibility Study
East Liberty Neighborhood Network
Phase One

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1. Executive Summary

East Liberty Development, Inc. (ELDI) and the Urban Redevelopment Authority (URA) of the City of Pittsburgh are working with developers to renovate three multi-tenant buildings in East Liberty -- the Highland Building, the Liberty Building and the former Bell-Atlantic Building. The projects will bring new retail and office tenants to the buildings and eventually extend the economic benefits of the new activity to the surrounding community.

ELDI has engaged Info Ren to study the feasibility of installing modern information infrastructure for the three buildings and the surrounding community and using the infrastructure and special purchasing options to obtain high-bandwidth Internet services at affordable prices. The work is divided into two phases.

Phase One examines the feasibility of bringing high-bandwidth infrastructure and services at affordable prices to the three buildings. With the growth of the Internet and its integration into business activity, the high-bandwidth building infrastructure and Internet services will soon be essential requirements for office space for high-tech and non-high-tech businesses. In the short-term, these features will provide a marketing advantage for the leasing of space in the renovated buildings.

Phase Two will explore the benefits and feasibility of extending the infrastructure and low-cost Internet services throughout the East Liberty community. The extended neighborhood infrastructure can connect neighborhood buildings using the buildings as hubs to provide Internet access and technical assistance to the neighborhood and connecting non-profits and others in a neighborhood network suitable for high-bandwidth applications, such as streaming technologies and video-conferencing. This extended network might provide the community with fast and scalable Internet access at affordable prices and enhance the ability of community organizations to provide services to the community. The infrastructure might also provide an incentive for companies and developers to locate in East Liberty.

This is a report on Phase One. Section 2 of the report provides background on the need for new high-bandwidth information infrastructure and new high-bandwidth products. It notes that traditional service providers are struggling to use their legacy voice and cable television infrastructures to provide high-bandwidth data services. The discussion concludes that the service providers' desire to preserve the value of their legacy infrastructures has constrained the offering of new high-bandwidth products. It also concludes that new for-profit and non-profit service providers are the most promising source of such new products. It suggests that new data infrastructure is necessary and that new products, such as shared services for aggregated customers, may be required to make the services affordable to small users.

Section 3 describes the buildings at issue and the developers' plans. It indicates that the Bell Atlantic and Liberty Buildings will be the first to be renovated -- both within the next twelve months -- and that they are expected to accommodate 10 to 15 small business

tenants. The schedule for the 13-story Highland Building is uncertain. This building is expected to accommodate 20 to 30 business tenants.

Section 4 identifies the physical infrastructure options for the three buildings and the organizational and purchasing options the developers can use to acquire high-bandwidth Internet services and technical assistance. Section 3 also describes the variety of service providers that building owners will work with to implement any option. Each option will entail a division of responsibility between the building owner and one or more service providers; and the division of responsibility will also allocate responsibility for initial and ongoing costs. Some physical and organizational options will be more conducive for some types of service providers (and certain allocations of costs) than others.

Section 5 evaluates the options described in section 4 for the following issues:

-- Potential services and benefits; High vs. low-bandwidth products
-- Building owner and service provider costs;
-- Prices to tenants; Potential monthly fees;
-- Potential to serve for-profits, non-profits and residential users in the surrounding neighborhood; and
-- Implementation timeline.

Traditional service providers and new commercial high-bandwidth providers deliver high-bandwidth services at high prices, affordable only by large users. The reasons are that the providers provide service with legacy infrastructure designed for voice or cable television service and they use market-based prices designed not to compete with the providers' lower-bandwidth products.

Non-profit providers can provide high-bandwidth services at affordable prices by offering service through a shared connection. They use data infrastructure that enables them to aggregate demand. They aggregate users organizationally into a common purchasing group, and they charge prices based upon costs -- not market prices. The providers use public and foundation funds to fund the infrastructure, and they organize a sufficient number of users to reduce the per-user recurring costs to affordable levels. The keys are the availability of funds and the availability of a sufficient number of users.

There are no restrictions, beyond prices, on the ability of commercial service providers to serve the desired customer base of for-profits, non-profits and residential users. In terms of non-profit service providers, section 501(c)(3) organizations face tax-exemption issues to the extent they charge fees and serve for-profit organizations. Cooperatives organized under section 501(c)(12) of the Internal Revenue Code can serve the entire desired customer class.

The study also notes the likely schedule for the renovation of the three buildings -- completion of the Bell Atlantic and Liberty Buildings in 2002 and the later renovation of the Highland Building. The study describes options for implementation on a sequential basis.

Section 6 re-focuses on the goals of the project, describes the conditions required to enable each option to attain the goals and recommends a set of options most likely to achieve the goals based upon the three potential scenarios of tenant populations -- a single large tenant, a large number of small business tenants and a small number of small business tenants.

A traditional service provider or a commercial high-bandwidth provider can probably satisfy a single, large user's needs. If the scale of operations is a single building, an exclusive purchasing arrangement might be required to achieve the necessary number of tenants. This reduces tenant choice, however, and may be unpopular. If the potential scale is larger -- covering several buildings or a neighborhood, an aggregation may be achieved that sustains itself while still preserving choice.

Section 7 makes final recommendations for the short- and longer-term based upon the most likely development scenarios. Section 7 recommends several short-term options for the period prior to the renovation of the Highland Building and a longer-term option to be implemented in conjunction with the Highland Building work.

In the short-term, the report recommends (1) the installation of a wireless hub on the roof of the Highland Building (prior to its renovation) to connect with the high-bandwidth WQED Tower project and distribute the connection to the Bell Atlantic and Liberty Buildings; or (2) the installation of a wireless connection on the roof of the Bell Atlantic Building to provide service to the Bell Atlantic Building's tenants and the further distribution of that connection to the Liberty Building with fiber optic or copper cabling. In addition, under either option, the report recommends the use of license agreements to require all service providers entering the buildings to install modern building wiring in accordance with the building owners' plans.

In the longer-term, upon the renovation of the Highland Building, the report recommends the development of a Neighborhood Area Network (NAN) comprised of the interconnection of building-wide networks installed in each of the buildings. The NAN would enable the sharing of a high-bandwidth upstream Internet connection and neighborhood-based support staff. The report recommends the creation of an Internet cooperative that would enable sales to for-profits as well as non-profit organizations. The NAN would also provide the foundation for the extension of the network into the community.

2. The Need for Modern Information Infrastructure and High-Bandwidth Services.
a. New *data* communications needs served with legacy *voice* and *cable television* infrastructure.
The public data network -- the Internet -- and private data networks are rapidly becoming integral resources for businesses and for a community's economic development. In addition to web searches, informational web sites and email, companies use the Internet to buy and sell products and services through web-based ordering systems with sophisticated databases. Companies increasingly use video-conferencing to communicate

without the costs and risks of travel. Streaming audio and video deliver educational material, employee training and music and other commercial entertainment.

Internally, companies use private data networks, such as Local Area Networks (LANs) and Virtual Local Area Networks (VLANs) to communicate and share company resources. Companies have been increasingly converting documents, records and other data from paper to digital formats, storing the data on servers and making the data accessible through private networks. The data is stored not only to preserve the data but also to enable employees to use and share it concurrently.

The infrastructure used to access the Internet and to operate the private networks, however, has not generally been designed for these purposes. The infrastructure usually consists of equipment installed many years ago by local phone companies to provide telephone service. This equipment includes switches in the central offices of Verizon and the other former Bell operating companies and copper wires that extend from the central offices to each customer's phone. It also includes copper wires that the phone companies installed in office buildings to run service from the basements to building wiring closets and from the wiring closets to individual phones. These facilities, which were designed and installed many years ago to provide voice service through analog signals, are now being used and adapted with DSL and other technologies to transport digital packets for Internet and data services.

Similarly, the infrastructure of cable television companies was designed for the one-way transmission of radio frequency (RF) signals for television services. Given the rise of the market for Internet services, the cable companies are now adapting their systems to data services with "cable modem" technologies, which transport data traffic over cable television wires by converting the data traffic into RF signals.

The voice and cable television facilities represent legacy infrastructure, which limits the kinds of services that customers can receive. The greatest limit is in performance. Performance is measured in terms of data rates, bandwidth and, more loosely, "speed." The usual measure of performance is "bandwidth", which refers to the amount of data that can travel over a telecommunications path over any given period of time. Telecommunications facilities that can carry data at high rates are referred to as "high-bandwidth" (or "broadband") facilities. Facilities that only enable lower data rates are called "low-bandwidth" (or "narrowband") facilities. The legacy voice infrastructure is low-bandwidth infrastructure.

Low-bandwidth infrastructure and services are sufficient for many of the applications that individual users have been making to date with the Internet, such as web searches and email. However, higher-bandwidth is required for LANs serving multiple users and for new data-intensive applications such as video-conferencing, streaming video and web-based business applications. Higher-bandwidth is increasingly becoming a minimum standard. Accordingly, high-bandwidth infrastructure must be installed -- with new infrastructure designed specifically for data traffic or with substantial upgrades to the legacy infrastructure.

b. Need for upgrades to "last-mile" infrastructure to and inside buildings.
The biggest need for investment is in the service provider facilities that deliver service to each customer's building or home. Modern telecommunications infrastructure has been deployed first in the competitive long distance market with fiber optic networks connecting cities. The remaining, more difficult problem consists of the millions of individual copper wires that extend from service providers' switching centers to each business and residence. This roadblock is what is known as the "last mile." These lines were installed to provide voice service. Now they need to be upgraded or replaced.

Traditional service providers are able to avoid the need to make these investments in high-bandwidth infrastructure in view of the absence of significant competition. Unlike the long distance market (where modern facilities were installed first), there is little competition among telecommunications carriers with responsibility for the "last mile" of service. Without the pressure of competition but with the clear prospect of increased capital costs to replace the last mile with modern infrastructure, service providers have been slow to deploy modern infrastructures.

Upgrades are made primarily in urban areas with dense populations of businesses, where service providers calculate that the economic returns will justify the costs. The services provided with these facilities, however, are priced beyond the reach of most businesses and individuals. As a result, customers wanting high-bandwidth data services have to pay high prices to encourage service providers to enhance the existing infrastructure to adequate levels.

In addition, a further "last mile" (or perhaps "last foot") problem consists of internal building wiring ("inside wiring"). Inside wiring in most buildings has historically been installed by the former Bell operating companies for voice service, and until recently, the wiring was owned and maintained by the Bell companies. In the early 1990s, the federal and state regulatory agencies relieved the Bell companies of their responsibilities for the inside wiring, leaving customers and building owners to inherit the responsibilities. With little experience in telecommunications and cautious about the impact on tenants, building owners have not known what to do with the wiring. As a result, there has been little investment by building owners to upgrade this internal wiring.

Also, new types of service providers -- building-based ISPs -- have been examining the opportunity to aggregate the demands of tenants in multi-tenant office buildings and achieving economies of scale, enabling them to provide new services at lower prices. These new service providers use additional building infrastructure -- configuring the internal wiring into a building-wide LAN.

c. Need for new high-bandwidth products.
Even assuming the availability of modern infrastructure, there is a need for the creation of new high-bandwidth telecommunications products. Any given infrastructure can be used as a platform for the provision of a variety of services. Copper wiring can be used for dialup connections, ISDN service, DSL service and T-1 connections, among others.

Fiber optic cables can also be used for any number of services, depending upon the electronics that are used to provide services with it (i.e., to "light" it).

Service providers make deliberate decisions about which services they will sell as products, and they do so based upon a variety of considerations. Service providers consider users' needs, but they also consider their own interests in the dollars they have already invested in facilities providing legacy services. If the service providers are insulated from competitive forces, they have no real incentive to create new products. DSL, for example, was technically feasible for years, but service providers only started offering it for sale when cable television companies decided to offer cable modem services (which were faster than the Bell companies' dialup and ISDN offerings). As a result, the offering of new high-bandwidth services as products available for purchase will likely occur only by new players, such as new special service providers and building owners, that are not encumbered with investments in legacy infrastructure and services.

d. Possible solutions.

These "last mile" and high-bandwidth product needs can be addressed with the adoption of deliberate strategies by building owners. Building owners can seek proposals or offer incentives to service providers to encourage them to install new last mile infrastructure and to provide new high-bandwidth products. They can work jointly to raise the funds to resolve the last-mile infrastructure needs. Then, unrestricted by embedded infrastructure, they can create high-bandwidth products designed for the high-bandwidth needs of the building owners' tenants. Special service providers can use innovative operational models, such as the aggregation of customer demands, bulk purchasing and shared resources, to gain low average costs for their users.

The Smart Building project in the Regional Enterprise Tower (RET) in downtown Pittsburgh is a demonstration of these principles in the context of a multi-tenant office building. The owner of the building granted 3 Rivers Connect (3RC) an exclusive franchise to provide Internet services, and 3RC partnered with Info Ren to provide the services. The parties raised funds from the state and foundations to modernize the building's infrastructure and used a special operational model to provide a new high-bandwidth product -- a burstable 10 Mbps Internet service with on-site technical support. The operational model aggregated the tenants' demands and shared the Internet and technical resources, minimizing each tenant's share of the project's recurring costs and making the service affordable.

Developers of office space and municipalities promoting economic development projects have a similar ability to address these "last mile" and high-bandwidth product needs. This feasibility study investigates the options that can be used to apply these concepts to the East Liberty projects.

3. The Three Buildings

The following section discusses the significant features of the three buildings at issue here. A summary of the features is contained in Table No. 2. Their relative locations are shown in Table No. 3.

a. Former Bell Atlantic Building

(i) Building Description. The former Bell Atlantic building is located at 134 South Highland Avenue. The building actually consists of two inter-connected buildings -- a three-story building and a one-story building. The three-story building fronts on Highland and Centre Avenues. The one-story building fronts on Centre Avenue. Both buildings are vacant. The buildings are currently owned by ELDI. The developer, Don Carlson of Carlson and McGinley, leases the building from ELDI with the right to enter into subleases with tenants. The developer also has an option to purchase the building in 2002.

(ii) Development Plans. The developer plans to develop the first floor (approximately 3,000 square feet) of the three-story building as a restaurant. The developer plans to lease the two upper floors (approximately 3,500 square feet each) of the three-story building and the single floor (approximately 2,000 square feet) of the one-story building as office space.

The developer has leased the single floor of the one-story building to an interior decorating design firm and has started construction of necessary improvements, with move-in by the tenant was originally expected in February or March 2002. The developer has identified a social services agency as a serious prospect for the two upper floors of the three-story building. Construction of that space was expected to start in January 2002 and be completed in April or May.

(iii) Access to Streets. Although the building was formerly owned by Bell Atlantic, it appears to have been used as a business office, not as a central switching office. Nevertheless, connections appear to be possible to Centre and Highland Avenues.

(iv) Wiring Pathways and Central Wiring Location. The building has a wiring pathway or "chase" running from the basement of the three-story building to the third floor of the building. A passageway also appears to have been cut through the wall separating the two buildings to provide access to the one-story building. The chase does not extend to the roof. However, the developer says that a hole could be drilled from the outside wall of the building into the internal pathway, and wire could be run from the internal pathway, along the outside of the building to the roof. He said he is not aware of any obstructions in the internal pathways.

(v) Lateral Wiring. The developer wants to run the data wiring through conduit already installed in the floors and above ceiling tiles (where drop ceilings are available). He will also run wiring through walls where necessary. Since the space has been gutted, he will include the wiring as he constructs the new walls.

(vi) Roof and Lines of Sight. The building has a flat roof. There is a clear line of sight to the Highland Building and possibly also to the WQED Tower, but not to the Liberty Building.

b. Liberty Building

(i) Building Description. The Liberty Building is a seven-story building located at 6101 Penn Avenue. The building actually consists of two inter-connected buildings -- both of which have a basement and seven floors (a ground floor, a mezzanine and five additional floors). One building fronts on Penn Avenue and an alley called Sheridan Avenue. The other building is located directly behind the first building and fronts on Sheridan Avenue and Kirkwood Street. The buildings share a common wall that starts in the basement and extends to the roof. The wall is punctured with interconnection points on each floor, starting on the second floor and extending to the top floor. The building fronting on Penn Avenue has an atrium and stairwell that begins on the second floor and extends to the sixth floor. Each floor has a walkway that opens onto the atrium. The building is vacant and is currently owned by the URA. A developer has been identified for the property.

(ii) Development Plans. The developer plans to develop the first floors of the buildings (approximately 1400 and 1100 square feet) as retail space. The rest of the building (including the basement of the rear building) will be leased for office and potentially residential space. Each floor of the combined building contains approximately 3,200 square feet of leaseable space. Tentative plans call for the creation of two leaseable spaces on each floor, but the developer is open to the opening of the space on each floor to a single tenant.

The buildings are slated for gutting and renovation, with work scheduled to start in April or May of 2002 and to be completed 8 to 12 months later. No leases have been finalized, to date.

(iii) Access to Streets. As noted above, one of the buildings fronts on Penn Avenue. However, it is unclear what kinds of connections already exist between the utility lines in the street and the building's basement and what their condition is. The architects anticipate establishing new connections in the course of the renovation of the building.

(iv) Wiring Pathways, Central Wiring Location and Wiring Closets. The architects inform us that space is available in the basement for a central wiring location. Since the buildings will be gutted prior to the renovation, the telecommunications infrastructure will not be constrained by existing conditions, except for the space available between floors (and the ramifications of that constraint upon the amount of infrastructure that can be installed in the floors and ceilings). Accordingly, the architects plan to install a utility chase that will extend from the basement to the roof in the area of the wall that connects the two buildings. The chase will be designed to be sufficient to accommodate wiring running from the basement to the roof and serving each floor. The architects are also receptive to the inclusion of space on each floor (or as appropriate) for wiring closets and/or cabinets.

(v) Lateral Wiring. The architects expect to run lateral wiring for each tenant in accordance with the tenants' preferences; but the expectations are that the lateral wiring will be run in wiring trays attached to the walls, given the limited space available between floors and ceilings.

(vi) Roof and Lines of Sight. The building will have a flat roof that will readily make possible the connection of an antenna with access to the building's utility chase and power. There is a clear line of sight to the Highland Building, but not to the WQED Tower nor to the Liberty Building.

c. Highland Building

(i) Building Description. The Highland Building is a 13-story building located at 121 South Highland Avenue. The building fronts on Highland Avenue, Antler Way, Sheridan Square and Baum Square. It has a basement and thirteen floors of space with a single stairwell and two elevators. The building is U-shaped with an inner courtyard facing the alley behind the building. The building is vacant and is currently owned by the URA. A developer has been identified for the property.

(ii) Development Plans. The design for the Highland Building has not progressed to the same degree as for the Liberty and Bell Atlantic Buildings. Tentative plans, however, call for the substantial closure of the "U" to create additional office space and the installation of a second stairwell. This will produce 7,500 square feet of rentable area per floor. The need for the second stairwell, however, has not been finalized, so that the plans for this additional construction are also not definite.

The developer plans to develop the first floor of the buildings (approximately 8,000 square feet) as retail space with three tenants. The rest of the building will be leased for office space, with one to three tenants per floor -- although the developer is open to the rental of several floors or the entire building to a single tenant.

The building requires substantial renovation work in the nature of gutting and reconstruction. Environmental hazards larger than originally anticipated have been discovered recently. Appropriate remediation may be required before starting the renovation. This recent discovery poses the potential to delay the project. Work had previously been expected to begin in June of 2002, with completion expected in 2003. With the prospect for the additional environmental remediation work, the start date of the building's renovation is unclear. No leases have been finalized, to date.

(iii) Access to Streets. As noted above, the buildings front on Highland Avenue and three alleys. However, it is unclear what kinds of connections already exist between the utility lines in the street and the building's basement and what their condition is. The architects anticipate establishing new connections in the course of the renovation of the building.

(iv) Wiring Pathways, Central Wiring Location and Wiring Closets. The basement is large and has sufficient space for a central wiring location. Since the buildings will be gutted prior to the renovation, the telecommunications infrastructure will not likely be constrained by existing conditions. The single exception is the limited space available between floors (and the ramifications of that constraint upon the amount of infrastructure that can be installed in the floors and ceilings).

The architects plan to install a utility chase that will extend from the basement to the roof. The chase will be designed to be sufficient to accommodate wiring running from the basement to the roof and serving each floor. If the second stairwell is installed, the utility chase will likely be installed to follow that path. If the second stairwell is not installed, the utility chase will likely be installed in the area of the existing elevator shafts. The architects are also receptive to the inclusion of space on each floor (or as appropriate) for wiring closets and/or cabinets.

(v) Lateral Wiring. The architects expect to run lateral wiring for each tenant in accordance with the tenants' preferences; but the expectations are that the lateral wiring will be run in wiring trays attached to the walls, given the limited space available between floors and ceilings.

(vi) Roof and Lines of Sight. The building will have a flat roof that will readily make possible the connection of an antenna with access to the building's utility chase and power. There are clear lines of sight to the WQED Tower, the Liberty Building and the Bell Atlantic Building. The developer also has preliminary plans to lease space on the roof to a mobile phone carrier.

4. Options.

This study evaluates options in the following areas: physical infrastructure, organizational structure and potential service providers.

The options are defined initially by the potential physical infrastructures. The physical infrastructures will include an upstream connection between the local network and the rest of the world and a distribution system between the upstream connection and the local end-users. Info Ren evaluates potential upstream connections (i.e., bulk or per user options from a variety of sources) and the variety of distribution systems. The physical infrastructure options are discussed in subsection a.

The options are defined finally with the selection of organizational models and service providers to use the infrastructure to deliver services. The organizational structure and the service providers that work within any such structure will be the means the developers will use to install and manage the infrastructure, to acquire the upstream and other services that can't be provided locally and to provide services, including user support, to the end users. The organizational options are discussed in subsection b. The service provider options are discussed in subsection c.

Table No. 1 outlines the options discussed below.

a. Physical Infrastructure Options.

Option 1 -- Minimal action; spaces reserved for wiring closets and pathways. The least expenditure of resources, from the perspective of the building owner, will be a building infrastructure that simply reserves space for the facilities the service providers

choose to install. Under this scenario, the building owner would take no action to encourage any kind of telecommunication service or service provider. Instead, the building owner would reserve space in the basement and on strategically located floors for entrance points from the street, wiring closets, space between floors for wiring pathways, space for lateral wiring between wiring closets and tenant offices, and, perhaps, space for rooftop antennas and internal space for related equipment. Service providers would install facilities in wiring closets, wiring into the building to and between wiring closets, and equipment for rooftop activities. Tenants would make arrangements with the service providers for lateral connections from the wiring closets to their offices.

The advantage of this approach is simply the minimal investment required of the building owner. The disadvantage of this approach is that the building owner has no control over the infrastructure that is installed and no control over the services that are made available. Every building has limited space available for utility facilities. Uncontrolled access to this space may result in quick and inefficient use of the space, potentially foreclosing more valuable uses. Left to themselves (and without coordination), competing service providers may inadvertently interfere with each others' facilities, impacting service to tenants. Disputes between service providers and unhappy tenants may draw the building owner into the conflicts. Further, unless the installations are governed by a license agreement between the building owner and the service providers, the building owner will likely be considered responsible for the maintenance of the wiring and the liability of service provider errors.[1] This option, however, is useful to establish a baseline against which to measure the costs and benefits that accrue from taking a more active role.

Option 2 -- Modern building wiring. The next level of building owner activity would include a building infrastructure deliberately designed to facilitate high-bandwidth Internet and data traffic for the building's tenants. This includes the following minimum components:

-- An entry point into the building from the street.
-- A demarcation point between service provider entrance cabling and building or customer-owned facilities.
-- A clean, ventilated, central wiring room, with electrical power, racks and panels.
-- A system of riser cables.
-- A system of wiring distribution points located strategically throughout the building.
-- Adequate wiring from each wiring closet to the termination points for each tenant.
-- All wiring conforming to standard for "Structured Wiring" as per ANSI/EIA/TIA 568-B, "Commercial Building Telecommunications Cabling Standard."
-- External space for rooftop antennas and nearby internal space for related equipment.

These facilities can be installed and maintained by the building owner in accordance with a wiring plan designed to make the most effective use of the building's space. These can be designated as the exclusive means for service providers to serve tenants. Service

[1] Although the building owner is generally responsible for the maintenance of inside wiring, it can, by agreement, make arrangements with service providers to address these responsibilities.

providers would merely plug their facilities into a wiring closet/panel in the basement, and the building owner would use pre-installed risers to take the provider's service to the desired wiring closet and, then, further, through laterals to the end users. The building owner would commit to upgrade and add wiring and other facilities as necessary. Service providers might be asked to contribute to the costs of such a system through license agreements executed as a condition of access.

An alternative approach with less extensive building owner involvement would entail the building owner's preparation of a building wiring plan, defining minimum cable and wiring standards and designating provider access through wiring closets and riser spaces installed by the building owner. The building owner and its tenants would likely be solely responsible for the lateral wiring runs, given the limited space available for such wiring. The installation and maintenance of the providers' facilities and their conformance with the building wiring plan would be enforced through license agreements with the building owner.

The advantage of these approaches is the greater control obtained by building owners with respect to the infrastructure installed, the services to be provided and the impact of the infrastructure upon the building owner's costs and other building activities.

The disadvantage is the greater expenditure of resources required to develop a wiring plan (and perhaps to install and maintain the facilities) and the greater cost to the building owner -- if the building owner assumes those responsibilities. If the building owner assigns the costs to the service providers, some service providers might determine that the costs exceed the potential returns and opt not to provide service in the building -- limiting the service options available to tenants.

Option 3 -- Modern building wiring plus building-wide network. The next level of infrastructure would add a network operations center and networking equipment to create a building-wide network. The infrastructure would add necessary electronics, such as switches, routers and hubs. This would facilitate a bulk purchase of Internet access for the building's tenants that would be resold by the building owner, a special service provider or a tenant cooperative. The building-wide network would also enable building tenants to transport data within the building at LAN speeds. LAN speeds typically range from a minimum of 100 Megabits per second (100 Mbps; 1 Mbps=1,000,000 bits per second) if provided with copper wiring or 1 Gigabit per second (1 Gbps or 1,000 Mbps) if provided with a fiber optic backbone. LAN speeds typically are 100 Mbps over copper wiring. Gigabit over copper wire interface cards have begun to enter the commodity market. Core trunks for LANs are easily 1 Gigabit over fiber optic cabling, and, in a year or so, 10 Gigabit trunks will be unsurprising.

If the building is open to a number of service providers, the building-wide network can coexist with the parallel facilities installed by other service providers to serve individual tenants. Each service provider can also install its own electronics to create its own building-wide network.

The advantages of this approach, therefore, consist of higher-bandwidth, lower-priced services. This approach would also make possible the provision of shared services, such as streaming video, caching, data warehousing and backups, special-format or volume printing, shared web servers, and tenant firewalls -- all things that tenants might want but find to difficult or expensive to set up themselves.

The disadvantage of this approach is the increased involvement by the building owner. This involvement can be direct, if the building owner is the service provider, or indirect, if the building owner contracts with a service provider to install or operate such a building LAN. Further, to the extent the building owner allows operations by multiple service providers, the increased number of service providers will reduce the revenues available to any single service provider, threatening the service providers' ability to recover their costs.

Option 4 -- Modern building wiring, building-wide networks plus Neighborhood Area Neighborhood Network (NAN) (Option 4). A fourth alternative consists of an Inter-Building Neighborhood Area Network (NAN) -- a wide area network created by connecting the three buildings into a single private network. The buildings would be connected with fiber optic cable or wireless technologies, i.e., from roof to roof. The choice of connecting technology will, of course, affect the cost of this option.

The connecting infrastructure can be installed and managed by one of the building owners taking the lead, by a cooperative of building owners, by a service provider hired by one or more of the building owners.

The advantage of a NAN is the increased scale of operations that creates the opportunity for economies of scale and efficiencies. Certain infrastructure and services are feasible if provided on a large enough basis -- with a sufficiently large number of customers to bear the costs without requiring unaffordable or unsustainable prices. By aggregating the demands of a large number of end users, the cost per user of a bulk Internet access purchase, shared physical infrastructure and shared user support can be minimized. Under this option, the economies of scale provided by each building-wide network are increased by expanding the size of the operation to include several buildings.

By connecting the buildings into a common network, for example, this option eliminates the need for the separate networking equipment that serves each building in Option 3. With the larger scale of the project, the three buildings can share a common set of networking equipment. The network's high-bandwidth and scale also facilitates the delivery of user support through software that enables a remote technician to exercise control of a PC or network element to diagnose and resolve problems.

The disadvantages are the greater involvement of the building owners and the need for cooperation and coordination. If the connections are made with fiber optic or other cabling in the street, rights-of-way and/or duct space have to be obtained; and continuing maintenance will be necessary. If the connections are made with wireless technology, lines-of-sight must be available and the wireless equipment must be maintained.

For Options 3 & 4 -- In-house technical support. Although not usually considered to be physical infrastructure, in-house technical support can be made available with the same economies of scale that make a bulk purchase of Internet access attractive. By sharing the benefits and costs of a single resource among multiple users, the users are able to get access to a resource at a lower per-unit price than any one of them could have obtained on their own.

The advantages of in-house user support lie in the needs, especially for small businesses, for affordable technical assistance. Many small businesses lack the resources to hire their own technical staff. By aggregating tenant demands, a shared building staff can make user support available at affordable prices. Having the support on-site also improves the response time and encourages a familiarity of personnel that reduces the intimidation that often interferes with communication between non-technical business people and technical consultants. For unsophisticated users, technical support is especially valuable to address issues that might otherwise fester for long periods of time. In-house user support fits particularly well with the other physical infrastructure options that involve shared resources, such as the Building and Inter-Building LAN options.

The disadvantages lie in the need for a sufficiently large tenant base over which to be able to spread the fixed costs of such staff.

b. Organizational Options

Option A -- No building owner participation -- traditional service providers contract with individual tenants. The traditional way for developers to make Internet access available for tenants is for building owners not to get involved in the process -- to allow tenants to make their own arrangements with service providers. Building owners give service providers access to their buildings (i.e., to utility areas, wiring pathways and wiring closets). Building owners install lateral connections between wiring closets and tenant termination points at tenants' expense. However, the contractual relationship for the service is solely between the building owner and each tenant, and responsibility for the adequacy of the building's infrastructure is the responsibility of the service provider.

The advantage of this option for the building owner is its minimal cost and risk. Service providers bear the responsibility for determining the infrastructure that is needed, the costs of installation and maintenance and the potential liability of service failures.

The disadvantages lie in the building owners' lack of control over the infrastructure that is installed, its adequacy for the services to which the building owner wants its tenants to have access, and the services that are ultimately provided. Infrastructure is installed without coordination and without regard to the building owner's interests in the efficient use of space. Uncontrolled access also increases the risk for service providers to damage each others' facilities, creating potential liability for building owners and dissatisfied tenants. Building owners, at a minimum, may be drawn into service provider disputes.

In addition, the infrastructure installed by these service providers is infrastructure designed to provide only the products offered by the providers. The services that providers choose to provide in any area are based upon business plans calculating customer demands and provider profit projections and making maximum use of embedded investments and facilities. As a result, some services that are sought by tenants are not offered by service providers; or, if the services are offered, they are offered at prices that are designed not to undercut the prices of the other services the providers want to promote (for reasons such as embedded investments, or the relatively lower profit margins of affordably-priced high-bandwidth services). As discussed below, it will be difficult, if not impossible, to find a provider offering high-bandwidth services in the East Liberty area at prices affordable by the potential tenants of the East Liberty projects.

Option B -- Non-exclusive franchises -- building owner enforces standards and performance through license agreements. Instead of allowing service providers unfettered access to buildings, the owners can condition their access upon the providers' conformance with a building wiring plan and, perhaps, too, their agreement to provide specific high-bandwidth services.

It is becoming standard practice for building owners to require service providers to execute right of entry or license agreements before allowing service providers to install wiring and other equipment in multi-tenant office buildings. Such agreements typically regulate the installation and maintenance of equipment and wiring and protect the building owner with insurance and liability provisions. The Building Owners and Managers Association (BOMA), for example, proposes as a standard license agreement governing such issues and suggests, too, the option of flat or percentage-of-revenue fees.

This approach would entail the building owner's preparation of a building wiring plan, defining minimum cable and wiring standards and designating provider access through wiring closets and riser spaces installed by the building owner. The building owner and its tenants would likely be solely responsible for the lateral wiring runs, given the limited space available for such wiring. The installation and maintenance of the providers' facilities and their conformance with the building wiring plan would be enforced through license agreements with the building owner.

However, building owners might take these agreements several steps further. Building owners might also require the installation of specific types of high-bandwidth infrastructure and perhaps to offer specific high-bandwidth services (other than the providers' usual offerings) at specified prices.

Indeed, the infrastructure standards may simply be prudent. The decision whether to charge a fee depends upon the size of the building and the number of potential customers (and the service providers' desire to serve the building). In smaller buildings, fees and expensive infrastructure requirements may simply discourage service providers from serving these buildings, limiting tenants' options for service.

Further, service providers would not likely agree to provide non-standard services at non-standard prices, unless the service providers could foresee the prospect of sufficient compensating revenues. The buildings would need a sufficiently large number of customers with the prospect of substantial revenues and returns to encourage a traditional service provider to change its business model for such a purpose. A service provider might ask for an exclusive franchise (discussed below) to ensure the recovery of the desired revenues.

Option C -- Non-exclusive franchises, with building owners providing exclusive infrastructure. This third option would entail the building owner's complete responsibility for the building infrastructure. The facilities would be installed and maintained by the building owner in accordance with a wiring plan designed to make the most effective use of the building's space. These can be designated as the exclusive means for service providers to serve tenants.

The advantage of this option is the greater control it affords to building owners over the standards of the infrastructure, the efficient use of limited building space and the promotion of high-bandwidth products for tenants.

The disadvantage is the greater cost to the building owner to install and maintain the facilities and the greater risk and potential liability incurred in the event of mistakes and outages.

Option D -- Non-exclusive franchises, with building owners working pro-actively with providers providing desired infrastructure and products. This fourth option is a variation of option two. The building owner allows all service providers to provide service in the building subject to the minimum standards of the building owners' wiring plan. However, the building owner works pro-actively with one or more service providers interested in installing high-bandwidth infrastructure and providing high-bandwidth service products. This option could consist of license agreements, specifying minimum standards on wiring and business conditions plus more elaborate arrangements with other service providers. These other arrangements could include measures such as coordinated fund-raising for infrastructure, cooperative marketing, forgiven fees and preferred access to utility spaces.

The advantages of this option lie in the buildings' openness to all service providers and the variety of service options this provides to tenants. The option also ensures the building owner's control over the type and location of service provider facilities inside the building. Further, it still provides the opportunity to pursue special infrastructure and services.

Further, the building owner may want to partner with the aggregator to raise funds for the necessary infrastructure. The building owner, interested development officials and community groups interested in extending the project into the neighborhood might cooperate to seek public funds through grant or loan programs to finance the capital costs of the building owner's infrastructure. Potential sources include Pennsylvania DCED

programs, such as the Pennsylvania Technology Investment Authority (PTIA) program, and funding from private foundations.

The disadvantage lies in the lower revenue potential for the provider seeking to provide the special services, in view of the competition from other service providers. The lower revenue potential will impact on the provider's ability to provide the services at affordable prices on a sustainable basis. The revenues received from the tenants must cover the costs of providing the services. Since the majority of the infrastructure costs are fixed and do not increase as the number of users increases, the task for sustainability is to establish a customer base large enough to cover the costs. Any non-exclusive arrangement shares the customer base with other providers, reducing the potential revenues.

Several measures can be tried, with the building owner's assistance, to maximize the revenue base even under a non-exclusive arrangement. The first is to maximize the absolute size of the customer base. This can be done by connecting the three buildings into a multiple-building NAN. In the case of the East Liberty projects, this could produce a customer base of 35 to 45 tenants.

An additional approach is to aggregate the demand of the East Liberty tenants with East Liberty users outside the three buildings. This could entail the community groups envisioned in Phase 2 of this study or, as discussed in section 5a, the pre-existing customer base of a non-profit service provider.

Option E -- Exclusive franchises; building owner issues franchise to provide specified services. Exclusive franchises might be appropriate for two purposes: (1) where a building owner wants its tenants to have access to a special service but the investment required to provide the service requires a return that can be realized only by serving a minimum number of customers greater than the number the service provider could enroll without the exclusive franchise; or (2) where a building owner seeks a maximum financial return to itself in exchange for granting a service provider the right to serve the building. In either case, the building owner would issue a Request for Proposals (RFP) that specifies the terms the building owner is seeking and award an exclusive franchise to the provider that submits the best proposal. The RFP and the resulting franchise agreement would include minimum performance standards to protect the tenants' interests in reliable and fairly-priced services.

Despite their apparent ability to provide the building owner with the best deal possible, exclusive franchises are relatively rare. Building owners often consider their expertise to be in property management, not in telecommunications services, and they are leery of the selecting a single service provider to serve the needs of their tenants. Building owners often want to preserve the availability of options for their tenants.

BOMA, indeed, does not recommend that its members enter into exclusive franchises. However, BOMA does recognize the value of exclusive franchises in the situation in

which traditional service providers would not otherwise make the investment in a building or the building's neighborhood required to make the desired services available.

BOMA, in fact, opposed the Federal Communications Commission's (FCC) recent attempt to prohibit exclusive building franchises. Reacting to fears raised by service providers, the FCC recently proposed a regulation to outlaw exclusive franchises issued by owners of multi-tenant office buildings to telecommunications service providers. BOMA opposed the regulation on a variety of grounds, including the FCC's lack of jurisdiction over building owners and the value, discussed above, of exclusive franchises where needed to warrant necessary investments. The FCC, as a result, modified its original proposal, to only prohibit telecommunications service providers from entering into exclusive arrangements with the owners of multiple tenant buildings. Given the limited jurisdiction of the FCC, the regulation does not govern the ability of building owners and ISPs that are not telecommunications service providers to enter into such exclusive arrangements.

The advantages and disadvantages of exclusive franchises, therefore, depend upon the circumstances of each building. Small buildings in economically depressed areas lacking necessary physical infrastructure might need an exclusive franchise to encourage the investment required for the desired services. A large building in an area with a high existing level of infrastructure might not need to offer an exclusive franchise to ensure that the desired services are provided. On the other hand, an exclusive franchise offered for the right to serve a large building in an area with a modern physical infrastructure might win a substantial financial return for the building owner.

The primary disadvantages of an exclusive franchise are the risks of poor service and tenant dissatisfaction. Competition among service providers generates pressure to provide quality service, low prices and innovation. Minimum benchmarks and incentive-based goals can be used to attempt to replicate the results of competition, but such arrangements carry the burden of enforcement and may not be as effective as genuine competition. Moreover, tenants may object to exclusivity simply because they have special confidence in a specific provider. Policies that interfere with tenant preferences may discourage prospective tenants from leasing space in the buildings.

Option F -- Building owner as ISP. The building owner gains the ultimate control over the services that are provided in its buildings (and the prices at which the services are provided) if the building owner, in fact, assumes the responsibility of providing the services. The building owner is able to accomplish this by purchasing the various pieces of infrastructure and services required to assemble and deliver the service the building owner wants to provide.

The key that makes this approach possible is the ability to aggregate demands to install infrastructure and purchase entire or elemental pieces of services that could not be purchased affordably by any individual. A building owner might be able to afford a "last mile" wireless or fiber connection that a traditional service provider might find insufficiently profitable. A building owner might also be willing to provide special high-

bandwidth services not ordinarily included within commercial service providers' standard sets of services.

In the case of the East Liberty projects, the building owners can act individually, or they can join and provide service as a unit. One owner can provide service to one, two or three of the buildings. Two or all three of the owners can join to provide services to the combined tenant base.

Building owners can provide service with their own employees, or they can subcontract with a service provider to do so. If the building owner uses its own employees, it can charge tenants fees through direct monthly charges or through charges incorporated in the tenants' rent. If the building owner elects to subcontract the service, the building owner would pay the service provider a fee to operate the network. The fee to the service provider could be structured as a specific monthly payment or as a share of the revenues. Unlike the other options discussed so far, the building owner under this scenario bears the risk of profit and loss.

The advantages of this option lie in the complete control this option affords the building owner. It enables the building owner to include the cost of the needed infrastructure in its overall fund-raising and construction plans, creating the potential for efficiencies and access to special fund-raising and tax-incentive opportunities. It also provides the building owner with a variety of ways to recover the costs of the service, i.e., through monthly service charges or by incorporating the costs into tenant rent.

The disadvantages lie in the increased risks the building owner assumes with the increased responsibilities. These risks are operational (in the ability to provide reliable service) and financial (in the ability to recover the costs of providing service).

Under Option E, a franchisee is given the opportunity to operate its business, and the franchisee takes the risks of achieving a profit or loss. The building owner receives the benefit of the infrastructure and services required in the franchise agreement, plus potentially, too, a fee or share of the franchisee's revenues. The building owner does not bear the risk of loss arising from the operations. Under Option F, however, the building owner is responsible for the entire cost of the infrastructure and the recurring costs. The building owner provides the services and bears the risks of profits and losses. The building owner may hire a contractor to actually provide the services; but the contractor is generally paid a fee for the contractor's work. Option F, accordingly, requires a willingness on the part of the building owner to accept these greater risks.

c. Service providers -- to participate in the various organizational models.
The options discussed above address the varying roles that a building owner might take with regard to the installation of infrastructure and the provision of service. Each of those options, however, also involves, in varying degrees, a service provider. This section discusses the types of service providers a building owner might want to include in its operations under any of the options above. The discussion starts with traditional

service providers and moves to various special providers that might more fully serve the needs of the building owner and its tenants.

(i) Traditional service providers. Traditional service providers are the ISP and telecommunications companies, such as America Online, Stargate, Verizon, etc. These service providers focus on low-bandwidth services as products. They have standard services, standard prices, and standard physical infrastructures. They are least likely to entertain the special requirements and needs of an individual building owner.

But there are various types of traditional service providers, and their business plans differ with respect to the infrastructure for which they and the building owner are responsible.

A company like AOL is a pure ISP. AOL provides Internet access service, which directs a data transmission received by it to its destiny on the Internet. The customer is responsible, however, for the telecommunications line (usually a telephone line) that connects the customer to AOL's routers (i.e., AOL's points of presence or POPs). If AOL is going to provide service in a building, therefore, the building will need a telecommunications service provider to install facilities in the building for the tenants to use to access AOL.

A second variety of traditional service provider is the telecommunications service companies, such as Verizon, whose primary business has been in telephone services. These companies have recently also chosen to get into the ISP business. They use the legacy physical infrastructures that have been installed previously for voice service to connect end users to their own POPs for ISP service. If a telecommunications service provider like Verizon is going to provide service in a building, the telecommunications service provider will be responsible both for the connection between the end user and the service provider's POP and for the routing and further transporting of the data to its final destination.

Traditional telecommunications service companies use the legacy voice infrastructure to provide low- and high-bandwidth services. The high-bandwidth services are priced beyond the means of most small businesses and the upgraded infrastructure required for these services may not be available outside the central business district.

A third variety is a partial reseller, such as Stargate. Stargate provides dialup service, similar to the AOL service, where the customer is responsible for the connection to Stargate's routers. However, Stargate also provides a service that includes the initial connection and the routing. In this other service, Stargate contracts with a telecommunications service provider, such as Verizon, to provide the connection between the user and Stargate, and Stargate bills the customer a single price for the package of services. If a provider, such as Stargate, is going to provide service in a building, the company will be responsible both for the connection and for the further routing and transporting.

A fourth variety consists of cable television companies providing cable modem service. Cable television companies often make arrangements with ISPs pursuant to which the cable companies use their cable television lines to transport data from an end user to the ISP's routers for further transporting to the data's destination. The cable companies call this "cable modem" service after the name of the box that is installed at the end user's premises to link the end user's computer into the cable television network. In this case, too, the cable television company is responsible both for the connection between the end user and the ISP and for the ISP service that takes the data to its final destination.

(ii) Special service providers. Beyond the traditional service providers, however, there exist some number of non-traditional service providers that serve special market niches. Instead of being responsible for the entire service (i.e., local transport and ISP service), these companies offer distinct and often smaller elements of service, and they assemble or allow others to assemble the elements into new high-bandwidth products not offered by traditional service providers.

Some of the companies install and maintain their own facilities. Others function as "resellers." Resellers purchase services from traditional service providers in large quantities for bulk discounts and resell the services to other smaller end users. Resellers make money by marketing the services more efficiently than the traditional service providers and, often, by accepting lower profit margins. Still other companies function by installing and maintaining some of the required facilities and by buying and reselling the other elements.

The advantages of these special providers lie in the possibility that they provide the kinds of services and prices desired by the building owner, such that they might fit into one of the organizational options discussed above. The disadvantages are their lesser financial strength.

Some of these companies were spawned by the Telecommunications Act of 1996. The Telecommunications Act of 1996, with its goal of encouraging competition to upgrade the nation's information infrastructure to enable high-bandwidth services, set into motion the creation of a large number of innovative telecommunications service providers, called Competitive Local Exchange Carriers (CLECs). These new companies were not encumbered with legacy infrastructure and services. Instead, their business plans focused on installing modern physical infrastructures designed specifically for high-bandwidth services and on selling new versions of high-bandwidth services as products. A growing number of these companies no longer exist, having been forced out of business by the greater financial strength of the incumbent providers. However, some CLECs do exist within various niches of the market.

Five examples -- some CLECs, some infrastructure providers and others specialized ISPs -- are discussed below.

(A) Dark fiber providers. Some companies have been formed solely to supply the higher-bandwidth physical connections between end users and ISP POPs. These

companies do not provide telecommunications or Internet services themselves. Companies, such as DQE Communications, have installed fiber optic cables in rings through Pittsburgh's Central Business District and through certain neighborhoods. DQE's business consists solely of the leasing of these fiber optic cables to telecommunications service providers that use them to provide service. CityNet is a similar company that plans to install a fiber optic network in the city using the City's sewers as conduit -- avoiding the need to trench streets.

These companies install a single element of high-bandwidth infrastructure -- fiber optic cable for the transport of data. They do not provide the electronics required provide a service over the cable (i.e., they don't "light" the cable), and they do not actually provide any services directly to end-users.

(B) Commercial high-bandwidth providers. Companies, such as Yipes Telecommunications, rent fiber optic cable from a company such as DQE and use their own ISP facilities to provide new high-bandwidth products. Unbound by the legacy infrastructures and service offerings of the traditional service providers, Yipes sought to provide the exact kind of high-bandwidth services that many larger users are seeking.

Unlike the dark fiber providers, these companies provide the most modern of high-bandwidth services as products to end-users. Unfortunately, their services are usually priced beyond the means of most small businesses making purchases solely on their own behalf.

Unfortunately, too, the downturn in the telecommunications industry has affected these providers. Yipes, for example, has recently filed for relief under Chapter 11 of the bankruptcy laws, while it continues to provide service.

(C) Non-profit aggregator/service providers. Some organizations, such as Info Ren itself, attempt to make high-bandwidth services affordable to small users by aggregating users into a purchasing group, providing shared services and charging cost-based prices. The organizations purchase a shared, bulk upstream Internet connection that all customers share, with each customer being able to burst to the full limit of the purchase. They also hire on-site technical support staff. In addition, the organizations install networking equipment, wiring and other infrastructure as needed to distribute the services to end-users. The organizations raise funds for infrastructure costs from public agencies and foundations, and they recover recurring costs through user fees.

Through the Smart Building project, Info Ren contracted with Yipes for the connection between the Regional Enterprise Tower downtown and Yipes POP for Yipes' 10 Mbps Internet service. (Yipes, in turn, contracted with DQE for the fiber to transport the Smart Building's data from the RET to Yipes's POP and contracted with other providers to take the traffic to its destination.) Additionally, Info Ren then installed wireless infrastructure to connect several community groups to the RET, at which point the data traffic of the community groups was channeled into the Yipes connection. These arrangements enabled Info Ren and the Smart Building project to craft a still different high-bandwidth

product for the end users. The Smart Building project essentially resells the entire 10 Mbps service purchased by Info Ren to each customer. However, instead of charging each customer the full price of the connection, the Smart Building project attempts to spread the costs of the fixed monthly Yipes charge over a large number of customers at lower prices to make the service affordable to smaller organizations.

These special non-profit ventures provide much of their own high-bandwidth infrastructure and provide high-bandwidth services directly to end-users. The prices are also affordable to small businesses. The prices are affordable, in part, because the providers often use foundation or public funds to cover the initial capital costs of the infrastructure. Further, recurring costs are minimized through bulk purchasing and shared infrastructure. As a result, the providers need only to recover these reduced recurring costs, and the prices are, in fact, established solely for that limited purpose.

As a downside, however, conditions attached to the funding assistance the non-profit providers receive and the providers' tax exempt status may limit the scale of their projects and might prevent them from serving for-profit and ordinary residential consumers.

(D) Commercial Aggregators. Commercial providers are also available to aggregate the demands of tenants in individual and multiple buildings. Commercial aggregators, such as Wired Environments, which operates in the U.S. Steel Building, have exclusive and non-exclusive arrangements with building owners. They purchase a bulk upstream Internet connection and re-sell discrete shares of the connection to tenants. They also charge market-based prices based upon the cost of similar services from traditional service providers. Unlike the non-profit aggregators, however, the commercial aggregators do provide discrete blocks of bandwidth, not services that can be shared by the group of users.

The advantages of commercial aggregators are their potentially greater financial resources, compared to a non-profit aggregator. The disadvantages are that the commercial aggregators prefer large buildings in central business districts with large numbers of relatively large customers. They are less likely to be interested in smaller buildings in neighborhood commercial districts. In addition, the discrete bandwidth blocks and market-based prices may result in lower levels of bandwidth available to and affordable by individual users (compared to the peak bandwidth available in a shared burstable connection).

(E) Community ISP. A Community ISP is a special case of the non-profit provider described in (C). In this scenario, a community-based organization (i.e., non-profit or for-profit organization) might install infrastructure and provide high-bandwidth Internet services for the benefit of the neighborhood or community in which the organization operates. A Community ISP can be newly-created by community leaders, or an existing organization can add the provision of ISP services to the functions it already performs. The reason for a Community ISP is to take focused action to ensure that high-

bandwidth infrastructure and products, which would otherwise not be provided in the community, are, in fact, provided.

In the case of East Liberty, for example, ELDI recognizes the absence of the necessary infrastructure and services; and it might decide to take explicit action on its own to ensure that they are provided. ELDI could provide the services through the hiring of employees or through contracts with other service providers and consultants.

The advantages of a Community ISP lie in the explicit focus such an organization can bring to the accomplishment of its goals. A Community ISP might also be eligible for the funding programs of state and local government as the ISP attempts to finance the upfront costs of the infrastructure and, perhaps, too, the recurring costs of operation and maintenance.

The disadvantages lie in the general lack of expertise within existing community-based organizations and the general lack of financial resources.

(F) Tenant cooperative ISP. A cooperative is an organization owned by its members to provide a service to or on behalf of its members. In Pennsylvania, a cooperative is a corporation that is owned and governed by its members -- instead of by shareholders. Cooperatives are generally considered tax-exempt for federal income tax purposes. They are considered tax-exempt primarily because, by law, they do not make profits. To be considered tax-exempt, they are required to distribute their excess revenues to members (except reasonable amounts retained for capital investments).

Cooperatives are corporations that are owned and operated on behalf of their members. The members form the cooperative to conduct business (i.e., producing, purchasing and selling) for the benefit of the membership. The members can be producers or manufacturers of the goods and services sold; or they can be consumers of goods and services purchased. In each case, cooperatives aggregate the supplies or demands of their members to secure better prices for their members. Purchasing cooperatives buy in bulk and obtain discounted prices. Producer cooperatives aggregate supplies and may provide common storage/warehousing and marketing functions. Both are able to spread the fixed shared costs of marketing and other technical functions among larger numbers of people, reducing the per-unit costs for their products and services.

An Internet cooperative could perform a range of functions. It could operate solely as a buyers' club, with the cooperative making a bulk purchase of upstream Internet access on behalf of its members and with the traditional service provider assuming the responsibility to deliver the service to the customers. Alternatively, the Internet cooperative could also make the bulk Internet purchase, requiring that the upstream service provider deliver the service to a point of presence, beyond which the cooperative would install and maintain facilities to distribute the service to its members. The alternative arrangement might be preferable if the upstream service provider lacks the high-bandwidth infrastructure to cost-effectively distribute the services to the cooperative's members.

The members would have two relationships with the cooperative -- as customer and owner. Users would receive service from the cooperative and pay monthly charges for the service through service agreements. In addition, the users have ownership interests in the cooperative with the power to manage the cooperative's business. This governing power is exercised through the election of a board of directors and the approval of major changes in the cooperative's organization. The terms of this second relationship are spelled out in the Articles of Incorporation and By-Laws.

The special advantages of cooperatives in this situation are their ability to act solely in the interests of their members -- unlike the differing interests that the shareholders and customers of an ordinary corporation might have. A newly-formed cooperative would not be constrained, at least initially, by legacy infrastructures and services. Unlike the standard services offered by traditional service providers, an Internet cooperative can offer Internet products tailored to match the members' needs. The cooperative can aggregate the demands of tenants to purchase upstream services at bulk discounts that get passed through in lower prices. They can also share resources, such as the Internet connection and a common technical support staff, reducing the per-user costs of each.

Traditional service providers, for example, generally sell Internet access in blocks of Kilobits per second (Kbps or 1,000 bits per second) and Megabits per second (Mbps or 1,000,000 bits per second). A cooperative, however, can allow its members to share the full amount of the cooperative's bulk purchase, recognizing that no member is likely to dominate the connection given the intermittent and burstable nature of most Internet use. This is similar to the product offering in the Smart Building project, which provides all customers with equal access to the full 10 Mbps of the project's Internet connection, instead of selling discrete Kbps segments of the connection. The result is lower prices for a higher bandwidth connection.

Further, unlike the market-based prices of commercial service providers, the prices of cooperatives will be based upon the cooperative's costs. This is due to the members' ultimate power over pricing and the IRS's requirement that the cooperative annually return to its members the revenues it receives in excess of its costs.

The disadvantages are the cooperatives' generally lesser financial resources and stability and perhaps, too, its lesser amount of technical resources. These pose a risk that the cooperative might not stay up to date with technological advances.

5. Infrastructure, Organizational and Service Provider Options Evaluated Against the Five Issues.

This section evaluates the infrastructure, organizational and service provider options against the five issues at the focus of the study:[2]

[2] The section also converts the original two categories of traditional and special service providers into three categories -- traditional service providers, commercial high-bandwidth providers and non-profit high-bandwidth providers. The separate categorization of "commercial high-bandwidth providers" is warranted

-- Potential services and benefits;
-- Initial and recurring costs;
-- Potential monthly fees;
-- Potential to serve for-profits, non-profits and neighborhoods; and
-- Implementation timelines.

Table No. 4 summarizes the results.

a. Potential Services and Benefits -- High vs. Low Bandwidth Products.
The infrastructure, organizational and service provider options at issue here will make possible a variety of services. The services examined below include Internet access, technical and user support, email and web hosting.

(i) Internet access. Telecommunications bandwidth is often analogized to water pipes and the rate at which water can flow through different sizes of pipes. Larger telecommunications pipes can carry more data per unit of time than smaller pipes. Telecommunications facilities that can carry data at high rates are referred to as or "high-bandwidth" or "broadband". Facilities that only enable lower data rates are called or "low-bandwidth" or "narrowband."

The dividing line between "high" and "low" bandwidth is not exact. The line generally refers to the point at which the data rates are sufficient for "high bandwidth" applications. These high bandwidth applications include uses such as Web hosting, streaming audio and video, and video-conferencing. All of these uses involve much higher data flows than less data-intensive applications of normal Web searches and email. High-bandwidth networks also provide the infrastructure for future growth, allowing increased numbers of users and increased sophistication of applications. The traditional embedded infrastructure can generally accommodate only low bandwidth applications -- except at high prices. See Table No. 5 (High- vs. Low-Bandwidth).

Lower quality video-conferencing, streaming audio and video (postage stamp size video with jerky video and fragmented audio) can be accomplished with data rates as low as the 56 Kbps of a dial-up connection. Service quality improves with the higher bandwidth of DSL and cable modem connections, but high quality video and audio generally requires the bandwidth of a T-1 connection (1.5 Mbps) and higher. Older video-conferencing systems were designed to run with three ISDN lines (384 Kbps); however, the more modern versions designed to run on IP-based networks generally require T-1 speeds and greater. Still higher-quality versions use MPEG technology which requires bandwidth ranging from 1 to 2 Mbps (MPEG-1) and 4 to 15 Mbps (MPEG-2).[3]

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by their differences with traditional service providers (i.e., data vs. voice & cable television infrastructure) and non-profit high-bandwidth providers (i.e., market-based pricing vs. cost-based pricing).

[3] The following illustrates the difference in data rates between high- and low-bandwidth connections. Video and audio files, such as motion pictures, can huge amounts of data. The download of the movie

Traditional service providers generally use low-bandwidth infrastructure and provide low- or mid-bandwidth services. However, they also provide high-bandwidth services on a limited scale -- usually to larger customers in areas where the providers have already deployed the required upgrades. Traditional service providers ordinarily also provide email services. They also sometimes offer limited space on Web servers for Web site hosting. These providers have user support staffs accessible by telephone to address service problems; but they do not provide technical support, on either an on-site or off-site basis.

Commercial high-bandwidth providers, such as Yipes, use high-bandwidth infrastructure to provide high-bandwidth services. They focus on Internet service and do not usually provide other services, such as email or web hosting. Like traditional service providers, Yipes and other commercial high-bandwidth providers offer telephone-based user support to address service-related problems; but they do not provide more general technical assistance.

The non-profit providers, however, generally tailor their services to the interests of the populations served -- using aggregated demands and shared resources to try to provide the services at affordable prices. Unlike traditional service providers and commercial high-bandwidth providers, which sell discrete blocks of bandwidth to individual customers, non-profit providers sell shared services to aggregations of users. The aggregation purchases a discrete block of bandwidth that is shared by all customers, with each having the ability to burst to the full amount of the block purchased. Spreading the costs of the block among the group reduces the per-user costs to make the services affordable to individual users.

Similarly, as discussed below, non-profit providers will attempt to provide the kind of email desired by the tenants; and they will purchase and maintain building-wide web servers for web hosting. Further, one of the major attractions of these providers is their recognition of the value of on-site user support and technical assistance, which they attempt to make affordable by attracting a sufficient customer base to sustain them.

(ii) Technical and User support. Technical support and user support are often valuable services, especially for small businesses and non-profit organizations too small to afford their own technical staffs. Hiring employees and contracting with consultants can be expensive. Small businesses also often are intimidated in their dealings with consultants

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"The Matrix", for example, would require the following amounts of time, depending upon the bandwidth of the connection used to do so:

Regular phone lines (dialup connections)	13 days
ISDN lines	5.7 days
T-1 phone lines	11.2 hours
Smart Building:	10 minutes

by their lack of technical sophistication and they often fail to take best advantage of the consultants.

One solution, used in the Smart Building project, entails the use of a service provider's on-site technical staff. An on-site user support staff is, in one sense, a part of the building infrastructure. Both are shared resources to be used by all tenants, and the larger the number of users, the lower the cost will be per user.

The on-site technical staff thereby provides technical support at a relatively lower price and the familiarity gained by the on-site presence encourages users to lose their technical fears.

(iii) Email. Several varieties of email service are available -- the normal kinds of email (IMAP and POP3) and email through Microsoft Exchange. Email is usually offered in packages with traditional service providers' sale of Internet services. Alternatively, the users can obtain email services through third parties.

With Internet Message Access Application Protocol (IMAP), a user copies email messages to his or her PC or device from the remote mail server, but the mail server retains the messages. This is useful if a user anticipates accessing email from more than one location. On the other hand, IMAP places a greater need for storage on the email server. With Post Office Protocol 3 (POP3), the user's download of email messages removes the messages from the mail server, such that the downloading device becomes the sole repository of the messages.

Microsoft Exchange is a special kind of email. Email through Microsoft Exchange can be structured to operate in IMAP and POP3 formats, and Exchange also provides several additional features. These features include calendaring, whereby users can see the schedules of other users and schedule meetings on others' calendars. The disadvantage of Microsoft Exchange may be its typically higher prices and its lower level of security.

(iv) Web hosting. The high-bandwidth available at the buildings will lend itself to the hosting of Web sites. Hosting might be done on individual end-user web servers or, more efficiently, as shared services on web servers serving the entire building or the set of three buildings.

The high-bandwidth enables the web sites to include interactive, data-intensive features. The shared nature of a building-owned server allows its costs to be spread over a large number of users. The server's management by on-site technical staff helps ensure that the server will be secure and well-maintained.

b. Initial and recurring costs/shares borne by building owners and service providers.

There are two issues here -- (1) the magnitude of the initial and recurring costs and (2) which costs will be borne by the building owner versus the service provider.

The physical infrastructure options entail a range of capital costs -- starting with modest expenditures for wiring and increasing to inter-connected buildings with a common network. In addition, the infrastructure options also include recurring costs to maintain the infrastructure and to provide service.

The organizational options divide the costs differently between the building owners and service providers. Under some options, the building owner installs the physical infrastructure; in others, the service provider installs it. Similarly, in some options, the building owner is responsible for the recurring costs of maintaining the infrastructure and providing the service. In other options, the service provider is responsible for those costs.

Table No. 6 outlines the initial capital and recurring costs of the physical infrastructure options. Section 6 below describes how the costs can be divided under each of the organizational options.

(i) One Time Capital Costs.

Infrastructure Option 1 entails no explicit capital costs for the building owner and unknown costs for the service providers. The selection of facilities is entirely within the control of the service providers that serve the building.

Infrastructure Option 2 entails costs for the service providers' entrance to the building, conduit and cabling from the entrance to a central wiring location, riser wiring, wiring closets and/or wiring distribution points, and lateral wiring. These facilities should meet current industry standards. The cost of the building entrance depends upon whether the entrance is by cabling through the street or through wireless facilities on the roof. The other costs per building vary based upon the size of the building. The unit costs of lateral wiring are approximately $250 per network drop. We estimated an average of one drop for 100 to 150 square feet of floor space.

Estimated costs for the riser wiring are based upon our experience with the Smart Building project. These installations include the cost of the fiber itself and termination of the fiber at a patch panel.

The number of wiring closets is determined by the distances between the central wiring location and the ultimate users. Maximum wiring runs inside buildings without the need for an intervening repeater are approximately 100 meters. The wiring runs in smaller buildings, such as the Bell Atlantic and Liberty Buildings will not exceed these maximum distances. As a result, these buildings will not need full-scale wiring closets outside the central wiring location.

The use of smaller wiring distribution points, however, would probably be advisable. The relatively small distances between the central wiring location and the end users means that a single cable could be run from the central wiring location directly to each end user's outlet. Such "home runs" may not be wise, however, if the locations of the outlets are expected to be changed with any frequency. Such changes in outlets requires the relocation of the lateral wiring, which may become unwieldy if the wiring runs the

entire distance from the outlet to the central wiring location. A better alternative, for buildings such as the Bell Atlantic and Liberty Buildings, may be the use of distribution points which provide a point on each floor where the wire run from the central wiring closet may be cross-connected to the lateral for each outlet. The distribution points enable the building owner to limit its relocation work to the span of the lateral between the distribution point and the outlet. The dimensions of the distribution points also save limited rental space on each floor.

Main wiring closets will vary in cost with the size of the building. We estimate $3,000 for the Bell Atlantic Building, $4,500 for the Liberty Building and $6,000 for the Highland Building. Each remote closet will cost approximately $2,000. Closets will include electrical supply, patch panels and racks.

Infrastructure Option 3 adds networking equipment to create building-wide networks in each building. Each of the buildings requires a router and a central switch. Given the short wiring distances in the Bell Atlantic Building, it does not require remote switches. The Liberty and Highland Buildings require remote switches. Firewalls for each tenant will protect the security of the tenant's LAN. Servers may be installed to provide email, file sharing and web hosting services.

Infrastructure Option 4 adds connections between the buildings. These connections can be accomplished with fiber optic cable or wireless technology. Since the utilities in East Liberty are underground, a fiber optic connection would also be required to be installed underground -- which is more expensive than an aerial connection. The usual cost of a traditional underground fiber optic installation is $110 per foot. The cost of a fiber optic connection through a new company that uses robots to install fiber optic cable in the City's sewers is approximately $80 per foot. Installation through spare Verizon telecommunications conduit might also be accomplished. This would include the cost of the fiber and its installation plus a monthly recurring rental to Verizon. We have not been able to obtain an assessment from Verizon of the availability of conduit for these three buildings.

Based upon the distances between the three buildings here, the total costs of fiber optic connections would be $118,250 by trench or $86,000 by sewer.

Alternatively, connections could also be accomplished with wireless technology. Assuming the delivery of an upstream connection by any means, the wireless technology would distribute the bandwidth to the other buildings. Several technologies are possible. Point to multi-point connections could be established with 20 to 60 Mbps of bandwidth using the technology employed for the WQED Tower Project. This would entail two access panels on the Highland Building and subscriber units on the Bell Atlantic and Liberty Buildings.

Somewhat lower bandwidth levels (up to 11 Mbps) could be accomplished through point to multi-point connections using 802.11b technology. We have been using this technology at three sites over the past year.

Both point to multi-point technologies have the potential to serve other users within the angle and range of coverage of the hub facilities.

Alternatively, individual point-to-point connections could be installed between the Highland Building and the Liberty and Bell Atlantic Buildings.

Further, by linking the building-wide networks of Infrastructure Option 3 into a larger Neighborhood Area Network, this inter-connected buildings option eliminates the need for redundant networking equipment in the building-wide networks. This option would eliminate the need for routers in two of the buildings, resulting in cost savings of $25,000.

(ii) Recurring Costs.
Each of the infrastructure options includes recurring costs, as do the non-infrastructure resources, such as upstream Internet/network access and on-site technical support. Further, the organizational options determine who (the building owner, service provider or tenant) will bear these costs.

The recurring costs tied directly to the infrastructure generally consist of maintenance. A rough estimate of these costs is approximately 6% of the capital cost of the electronics per year.

The more significant recurring costs are for the upstream Internet/network connection for on-site technical support. These are significant both for their size and because the scale of the project must be large enough to cover these costs on an ongoing basis. The approximate cost of a 10 Mbps Internet connection is $4,500 per month, and the cost of a user support person is approximately $4,000 per month, including benefits.

The upstream connection and the technical support staff can be obtained by each building or shared among the three buildings. Obviously, the costs per user are reduced and the sustainability of the project is enhanced if the resources and costs are shared by the three buildings.

c. Prices to Tenants; Potential monthly fees
Commercial service providers set prices based upon the market. This includes both traditional service providers and commercial high-bandwidth providers. These companies set prices based upon what others are charging for similar services. Thus, if a competitor develops a new product to compete with an existing product, the company selling the new product will likely price the product at a level only slightly below the price of the existing product -- even if the company's per-user costs are significantly below the price. As a result, prices are based upon marketing factors, such as the demand and purchasing power of the target customer class and the prices charged by competitors for services to the target class.[4]

[4] The prices of commercial high-bandwidth providers, such as Yipes, are an example. These prices are established in reference to the prices for similar products offered by traditional service providers. The

Commercial service providers establish different prices for residential and commercial customers and divide the services into three general levels -- low-bandwidth, mid-range and high-bandwidth services. The low-bandwidth services, such as dial-up connections, typically targeted to residential customers, are priced at $20 to $25 per month. Mid-range services (such as asymmetric DSL and cable modems) for residential users are priced slightly higher in the range of $40 to $60 per month. Commercial service providers do not actively market high-bandwidth services to residential customers.

Commercial service providers sell (but don't actively market) low-bandwidth services to commercial customers at the same prices as are charged for residential customers, with packages that include additional features such as email accounts and disk space for Web hosting. Businesses with LANs, however, are expected to have greater bandwidth needs and are targeted into customer classes of small, medium and large businesses. Commercial service providers promote mid-range bandwidth services, such as symmetric DSL (in bandwidth ranging from 128 Kbps to 1.54 Mbps) and cable modem service for small and medium size businesses.

The prices for these services range from $99 to $299 per month. Other medium size businesses and large users are targeted for higher- to high-bandwidth services, such as T1s, T3s and the new Ethernet-based services ranging from 5 Mbps and up. Prices for these services range from $1,000 and up.

Examples of typical pricing levels are set forth in Table No. 7.

Non-profit providers, however, set prices based upon costs. Their explicit goal is to make services affordable to small businesses and individuals. As a result, they aggregate demand, share resources and use bulk purchases to reduce the costs per user to a minimum level, and they set their prices to recover these reduced costs.

Since non-profit providers' prices are based on costs, the actual prices they charge depend upon the source (and price) of their upstream Internet access purchase, the availability of funds to cover the costs of the initial capital infrastructure and the size of the customer base over which they can spread the costs. Non-profit providers take advantage of economies of scale, whereby the incremental costs of each new user are low. Each new user enlarges the customer base over which the fixed costs can be spread, thereby reducing the average cost (and price) per user. For a non-profit provider, larger numbers of customers generally produces lower prices.

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commercial high-bandwidth providers gain customers by setting their prices below the prices of traditional service providers, and they make profits to the degree that those prices exceed their costs of providing service.

The result is that the commercial high-bandwidth provider prices are lower than the prices of traditional service providers but not low enough to be affordable by small businesses and individuals. Like the high-bandwidth prices of the traditional service providers, the prices of these special providers are affordable only by large customers and by aggregations of customers assembled by others.

Recovery of costs through rents is also an option. A building owner might consider the availability of high-bandwidth services to be a marketing advantage and incorporate the services as a standard building amenity. Under this option, the building owner would include the cost of Internet access in the rental rates charged for the office space, in the same way as the owner recovers its costs for water and electric service. This might be an attractive option to the extent that the building serves a large number of tenants and the cost impact on the rental rates is not significant.

d. Potential to Serve For-Profits, Non-Profits and End-Users in the Surrounding Neighborhood.

For-profit service providers are generally free to serve any party they choose. They are not generally prohibited from serving any one, and certain service providers (i.e., common carriers) are, in fact, generally required to offer service to all. Traditional service providers use their own funds to finance their infrastructure investments and their recurring costs, and, as a result, there are no direct restrictions stemming from their sources of financing. The only restrictions lie in traditional service provider business plans, which limit the investment to the most profitable areas and limit the products they offer to those supplying the highest financial returns. These restrictions do not discriminate between for-profits and non-profits; they discriminate between large and small users and between users located in central business districts and users located in residential neighborhoods.

For the same reasons, Yipes and similar high-bandwidth service providers have no restrictions on their ability to serve for-profits versus non-profits.

The issue of whom a service provider might properly serve arises primarily with non-profit service providers. The issue stems from restrictions related to the tax-exempt status of the service provider and the potential reluctance of foundations to subsidize the cost of Internet services for for-profits.

The Internal Revenue Service (IRS) generally considers the provision of Internet access to be a commercial activity -- not a proper activity for a tax-exempt organization. Nevertheless, the IRS recognizes that tax-exempt organizations organized under sections 501(c)(3) and 501(c)(12) of the Internal Revenue Code can provide Internet services under certain conditions. The IRS's guidance documents, however, appear to favor the provision of such services through section 501(c)(12) organizations.

Section 501(c)(3) organizations are the organizations that are typically known as non-profits. These organizations are organized and operated exclusively for religious, charitable, scientific, testing for public safety, literary, or educational purposes. The IRS states that section 501(c)(3) organizations can provide Internet service under two alternative arrangements.

First, a section 501(c)(3) organization can provide Internet service if the organization is a wholly controlled subsidiary organization of a recognized exempt entity, such as a

university, public school, library system, local government and/or an incorporated program activity of any of the above. The IRS also requires public accountability and control, dependence on government grants rather than user fees, and "free" use to students, library patrons and the general public. The guidance document uses quotation marks in its use of the word "free", but it does not describe what it means by the term. Illustrative examples in the guidance document, however, suggest that "free" includes free and substantially discounted services. See Donna Moore and Robert Harper, "Internet Service Providers Exemption Issues Under IRC 501(c)(3) and 501(c)(12)."

Second, a section 501(c)(3) organization (which is not a wholly controlled subsidiary of an exempt organization) can provide Internet service if the organization actually "lessens the burdens of government." The IRS's guidance provides few additional details. The guidance requires that a governmental unit consider the organization's activities to be the government's burden and that the activities actually lessen the burden. The first part can be proved by "the interrelationship" between the governmental unit and the organization. The second part is determined "by considering all of the relevant facts and circumstances."[5] The guidance document does not address the significance of fees charged for these services.

Section 501(c)(12) organizations are cooperatives. Section 501(c)(3) refers specifically to "local benevolent life insurance associations, mutual irrigation and telephone companies, and like organizations." The IRS has determined that "like organizations" include cooperatives that provide services such as Internet access, two-way radio and cable television service.

The primary requirements of the IRS are that the cooperative function with true democratic control by members and the cooperative must receive 85 percent or more of its income from amounts collected from members for the sole purpose of meeting losses and expenses. Cooperatives are considered tax-exempt, because they are not permitted to retain profits. The prices they charge are generally based upon the costs of providing the services. The prices are designed to recover the cooperative's expenses plus a reserve for future expenses and capital improvements. Amounts earned in excess of these costs must be returned to the members at the end of each year.

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[5] The IRS's guidance document used two examples to illustrate these standards. The first example -- an acceptable arrangement under section 501(c)(3) -- is an organization funded by a government grant to act as a clearinghouse and resource center to assist local government, public schools and the local university. The service is to be available to all members of the community, but in particular to local government departments, and students. The governing body includes officials from the town, the university and various private sector entities. The organization also receives funds from private foundations.

The second example -- an arrangement not acceptable under section 501(c)(3) -- is an organization whose main purpose is to own and maintain an Internet access for disadvantaged businesses, individuals and communities with a service primarily supported through user fees. The organization, however, is not operated exclusively for the relief of the poor, distressed, or underprivileged. The guidance said that this example is a trade or business ordinarily carried on for profit -- or the proper activity of a section 501(c)(12) cooperative.

In terms of the desired ability to serve for-profit organizations, a section 501(c)(3) organization formed as a wholly-owned subsidiary of the City, library or school district could serve for-profits, but the City, school district or library would have to be willing to undertake such a project of City- or neighborhood-wide scope, and the section 501(c)(3) organization would have to raise the funds both for any capital costs and to fully or substantially cover the recurring costs of the service. The second section 501(c)(3) option could serve for-profits, but its activities would have to be limited to disadvantaged businesses and communities; and the IRS would probably require the use of grants to provide free or discounted services. The section 501(c)(12) cooperative could serve all for-profits without restriction and charge prices based upon the cooperative's costs.

In terms of the need to raise funds for infrastructure, non-profits are more likely than commercial service providers to receive financial assistance from foundations and public agencies to fund the initial capital costs of the infrastructure (and possibly the recurring costs of operations). Among the non-profits, the section 501(c)(3) and 501(c)(12) options appear to have fairly equal eligibility for public funding. Financial assistance programs under the Pennsylvania Department of Community and Economic Development (DCED) differentiate between for-profit and non-profit organizations, but they do not appear to differentiate between various types of non-profits. The Pennsylvania Technology Investment Authority (PTIA) program (now administered by the Ben Franklin Development Authority) provides grants to for-profits, non-profits and government agencies. Section 501(c)(3) non-profits and section 501(c)(12) would both appear to be eligible for state funds.

The section 501(c)(3) options, however, have an apparent advantage in fund-raising from foundations. Both the Heinz Endowments and Pittsburgh Foundation Web sites state that section 501(c)(3) status is a condition of eligibility for grant funds. However, foundations generally are allowed, under the federal tax laws, to make contributions to non-section 501(c)(3) organizations if the funds are restricted to a specific charitable purpose.

Contracts with service providers may also restrict the parties that can be served. The initial Smart Building contract with Yipes, for example, limited the resale of the Internet access purchase from Yipes to non-profit, public and quasi-public organizations in the nine county region of Southwestern Pennsylvania. The formation of non-profits under sections 501(c)(3) or (501(c)(12), however, can satisfy the requirements of the Smart Building contrct with Yipes.

e. Implementation Timeline.

The choice of options and their rate of implementation will depend, in part, upon the developers' schedules for renovating the buildings. The developers' schedules will determine when necessary infrastructure is installed and the number of customers available at any time over which to spread the project's costs.

Ideally, the buildings would be renovated and be ready for occupancy simultaneously. Next but not as ideal would be schedule in which the largest building, such as the

Highland Building, with the most tenants and with the best access to an upstream provider (i.e., a high elevation suitable for a wireless connection or close proximity to existing dark fiber) would be renovated first.

The timeline for the East Liberty projects appears to be less ideal. The first building scheduled for renovation is the former Bell Atlantic Building, which is the smallest of the three buildings with 3-4 expected tenants and a height of three floors. Renovation work is underway and is scheduled for occupancy in December 2002.

Next in line is the Liberty Building. Construction is expected to begin in May 2002 and finish in December 2002 to March 2003. This building is a seven-story building expected to have 12 to 14 tenants.

The last building scheduled for renovation is the Highland Building. Its start date, originally scheduled for the Summer of 2002 is now uncertain. The Highland Building is the tallest of the three buildings, with 13 floors. It expects to house 13-40 tenants.

Given this expected construction schedule, there appear to be four phases of implementation for the provision of high-bandwidth Internet access.

(i) Initial service to the former Bell Atlantic Building. The Bell Atlantic Building might be the easiest building to serve. The building may have a direct line of sight to the WQED Tower, sufficient to receive high-bandwidth service directly from a project Info Ren is implementing this Spring to provide high-bandwidth Internet service to five sites in the East End. Info Ren is receiving foundation funds to install the infrastructure on the WQED Tower and to fund the costs of subscriber units for five non-profit organizations. The project's recurring costs will be covered in rates to the users. If the building does, in fact, have a sufficient line of sight to the WQED Tower, the building might qualify as a subsidized or non-subsidized user.

The number of tenants (3 to 4 tenants) in the Bell Atlantic Building does not likely have the scale to afford its own high-bandwidth connection from a traditional service provider or a special service provider such as Yipes. Given the delay in AT&T's upgrading of its cable television system, cable modem service will also not be available until later in 2002 or early 2003. However, the building's tenants would be able to purchase a DSL connection from a traditional service provider and might also be able to purchase bulk DSL connection to be shared by all of the tenants.

(ii) Service to the Bell Atlantic and Liberty Buildings. The Liberty Building does not have a clear line of sight to the WQED Tower or to the Bell Atlantic Building. This means that it cannot receive service directly from the WQED Tower.

The Liberty Building can, however, share the Bell Atlantic Building's wireless connection. The Bell Atlantic and Liberty Buildings do not have a clear line of sight between them, but the buildings can be connected with fiber optic cable or with a leased copper service (LADS service) purchased on a monthly basis from Verizon. The fiber

optic connection would provide a high-bandwidth link between the buildings that could accommodate the full 60 Mbps of the wireless link between the WQED Tower and the Bell Atlantic Building. The LADS line would provide a link up to 1.5 Mbps.

At a minimum, the Liberty Building could purchase DSL service on the same basis as noted for the Bell Atlantic Building above. By the Spring of 2003, AT&T also might be able to provide cable modem service in this area.

(iii) Advance Service from Highland Building Roof. Although the schedule for the renovation of the Highland Building is uncertain, it appears that certain preliminary work, such as the installation of a new roof, may be undertaken relatively soon. The Highland Building has a clear line of sight to the WQED Tower and to both the Bell Atlantic and Liberty Buildings. Accordingly, it might be possible to make arrangements with the owner of the Highland Building to install a wireless hub on the restored Highland Building roof in advance of the completion of the Highland Building renovations. This option would require space on the roof, an enclosed space for equipment and the running of power facilities to the roof. This option could provide service to the Bell Atlantic and Liberty Buildings prior to the completion of the Highland Building renovations.

(iv) Full implementation -- Service to the Three Buildings. The completion of renovations in all three buildings presents the greatest opportunity for affordable high-bandwidth services. The completion of the renovation work enables the broadest aggregation of demand and the greatest opportunity to share resources and achieve economies of scale -- reducing the per-user costs of any service.

The ability to aggregate the demands of the relatively large number of tenants in the Highland Building may present the opportunity to make an affordable joint purchase of bandwidth from a special service provider such as Yipes and possibly the direct leasing or installation of dark fiber optic cable. If an upstream fiber optic connection is not available, the Highland Building's roof should present the opportunity for an affordable joint purchase of Internet access through wireless technology. The installation of fiber optic cable connections between the buildings is also a possibility.

6. Which combination of infrastructure, organization and service providers is best? Section 4 shows that, under the right conditions, high-bandwidth services can be provided at affordable prices with any combination of physical infrastructure, organizational options and service providers. But what are the right conditions and which combinations of service providers, infrastructure and organization are best for each set of conditions?

The first step to answering these questions is to determine the conditions under which each type of service provider is best able to offer the desired services at affordable prices. This is important because service providers are the entities that will invariably be providing the services. The second and third steps, then, are to determine which infrastructure and organizational options are most compatible with the identified conditions and service providers.

a. Conditions compatible with each service provider option -- number & mix of tenants, availability of funds & building owner willingness to participate.
The number and size of the expected tenants are the key factors that determine whether a service provider can provide high-bandwidth services at affordable prices. The prices charged by traditional service providers and commercial high-bandwidth providers are generally affordable only by large users or by an aggregation of small users. As a result, these providers require large users or buildings in which a third party has created a large user by organizing tenants to share in the purchase of a discrete block of service. These types of providers do not generally aggregate users for joint purchases or shared connections.

If the tenants are expected to be small businesses, an aggregation will probably be required -- in a single building or among several buildings. The aggregated purchasing unit can then afford a high-bandwidth upstream connection from a traditional service provider or commercial high-bandwidth provider.

Additional factors include the availability of public and foundation funds and the willingness of the building owner to participate and accept risks. Traditional service providers generally finance their infrastructure with company funds; so if the expected tenants are large users, there will not likely be a need for outside funds. If the users are smaller and if there are only a few of them, additional sources of funds may be required to fund infrastructure costs.

Similarly, in situations with large users, commercial service providers will generally be willing to install infrastructure and provide service without the assistance of the building owner. Where the tenants are small and there are only a few of them, a building owner's participation will probably be necessary in actions such as fund-raising and perhaps the grant of exclusivity.

b. Physical Infrastructure.
The key factors influencing the choice of physical infrastructure depends upon the likely number and mix of tenants.

(i) For the single, large user -- modern building wiring (Option 2) or ad hoc infrastructure (Option No. 1). If the developers anticipate leasing to a single large business tenant (with sufficient resources to purchase an expensive high-bandwidth connection), a traditional service provider or a commercial high-bandwidth provider might install all of the physical infrastructure (entrance, riser and lateral wiring) required to serve the tenant without participation by the building owner (Option No. 1). If the tenant is sufficiently large, this infrastructure may serve the entire building. Further, if the buildings are housing a single, large tenant, the tenant will likely have its own in-house technical staff, such that the additional in-house support would not be needed.

The infrastructure installed for this single tenant would, thus, be adequate to provide the initial services desired from this provider. As time goes on, however, the infrastructure might not be adequate for future services or succeeding providers. The result might be to

lock in a service or provider that might quickly become obsolete or to be left with an infrastructure that is too inflexible to meet the tenants' needs.

The better option, however, entails the deliberate installation of building wiring satisfying desired standards (Option No. 2) and the accrual of the wiring to the building owner after the service provider (or the tenant) leaves the building.

In either case, the cost of the infrastructure can be shifted to the service provider. The ongoing costs of providing the services will also be borne by the service provider, which will attempt to recover them through fees for services.

(ii) For multiple, small users -- Neighborhood Area Network (NAN) infrastructure (Option No. 4). The most likely scenario for the East Liberty buildings, however, is that they will be leased to small business tenants -- several in the former Bell Atlantic Building and the Liberty Building and 20 to 30 tenants in the Highland Building. In this scenario, the best infrastructure option is probably the plan (Option 4) that combines the infrastructure from Options 2 & 3 -- a multi-building NAN (serving multiple tenants in the three buildings) layered upon a modern building wiring system in each building (that can be used to serve individual tenants). This option gives the building owner the maximum flexibility in organizational structure and service providers. Option 4 enables the building to aggregate demands and obtain a bulk purchase, while still allowing individual tenants to receive services through other providers. The option will also be compatible with the operations of *any* of the high-bandwidth service providers. The traditional and commercial high-bandwidth providers can use the modern building wiring to serve individual tenants; and the non-profit service providers can use the building-wide network to distribute a bulk upstream purchase and to provide high-bandwidth connections among the tenants and tenant offices. This option is also consistent with the establishment of an in-house technical support staff.

The question of how the costs (infrastructure and recurring) will be funded will depend upon the organizational and service provider options chosen. Building owners are logically responsible for certain elements of the infrastructure, and service providers are logically responsible for others. These issues are discussed in the next section.

If the amounts needed for Option 4 cannot be fully funded, the lesser options 2 & 3 might be pursued. Option 2 provides modern building wiring and facilitates competing service providers (i.e., it ensures that laterals serve each office from the local wiring closets and are available to multiple service providers), but it does not link the tenants into a building-wide network that can be used to aggregate tenants' demands for a bulk purchase. The building-wide network in Option 3 enables the aggregation of tenant demands to achieve lower prices and higher in-building data rates between tenants and/or offices of a single tenant; but it does not link the buildings into a multi-building Neighborhood Area Network (NAN)) that could provide additional economies of scale. Option 4 adds the aggregation potential of a NAN to the advantages of option three.

c. Organizational Options
The key factors for the choice of organizational structure are the likely number and mix of tenants (and the need for an aggregating body), the availability of outside funding and the building owner's preferences for involvement.

(i) For projects expecting one large tenant and for building owners disinclined to actively participate -- Options A or B. Again, as with the choice of physical infrastructure, if the developers expect to lease the space to a single large customer, the building owner might choose to take the hands-off approach of Option A. Under this option, a traditional or high-bandwidth service provider will install the necessary infrastructure at its (or the tenant's) expense and make arrangements directly with the tenant for the services the tenant wants. The traditional service providers, of course, would also bear the costs of providing the service. Further, the option involves the least planning and other expenditure of building owner resources (at least initially) of the options, since the service providers would be responsible for the entire cost of the infrastructure they will use to provide service.

Option A, however, has the same disadvantages as the hands-off approach for the physical infrastructure -- lack of control over the results. This option might result in the desired physical infrastructure and service providers, but there is no way to be certain. The building owner would have to hope that the service providers installed the desired equipment, that they installed the equipment in the proper locations, that they coordinated their activities and resolved their disputes, and that the size of the customer base was sufficiently large to support the special high-bandwidth services. If these hopes are not realized, the building owner may be subject to substantial future costs as it manages conflicts with the incumbent service providers, competing interests in limited utility space, unhappy tenants and the challenge of bringing in new providers after the building's infrastructure design (wiring closets and pathways) has been locked into place.

A better approach for this large-tenant scenario would use a license agreement to regulate the service provider's activities (Option B). The license agreement could require minimum wiring standards, regulate the location of the wiring and wiring closets and distribution points, and define the provider's responsibilities for maintenance, relocation and removal or transfer of the wiring to the building owner if the provider ceases to provide service in the building.

(ii) For projects expecting large numbers of small business tenants, public and foundation funds, and for building owners willing to actively participate -- Options B or D. To the extent that the developer anticipates a large number of smaller tenants, the preferred option is probably Option D. Like Option B, Option D ensures the installation of infrastructure meeting minimum standards. Under Option D, however, the building owner works actively with a service provider to ensure the deployment of high-bandwidth services at affordable prices through aggregation.

Under either Option B or D, the building owner should probably be responsible to install and maintain the following:

-- Conduit for wiring from the street to a central wiring closet;
-- Conduit for riser wiring;
-- Central and remote wiring closets;
-- Lateral wiring between the wiring closets and tenant offices.

By installing the infrastructure, the building owner has complete control over its design and continuing control over its use. The building owner can, therefore, ensure that service providers have reasonable access to the building and that building's limited space is used efficiently, e.g., requiring service providers to use and share existing facilities, instead of allowing the installation of duplicates. The building owner can also minimize disputes between service providers and any resulting impacts on service to tenants.

Service providers should be responsible to install and maintain the following and for the recurring costs of providing services:

-- Wiring from the street to the central closet;
-- Riser wiring from the central closet to the remote closets;
-- Any necessary networking equipment.

The traditional service providers will, therefore, likely install their usual limited facilities to serve individual customers (i.e., entry and riser wiring and wiring closet panels). The non-profit providers will install these same kinds of facilities plus networking equipment to create building LANs and the connections between the buildings to create a Neighborhood Area Network. Installation and maintenance of both infrastructures will be regulated through license agreements.

The primary disadvantage of Options B and D is the risk that the traditional and for-profit high-bandwidth providers serving individual customers will eat into the customer and revenue base available to the aggregator. This erosion of revenues threatens the sustainability of the aggregator's service.

(iii) For projects expecting small numbers of small tenants, public and foundation funds, and for building owners willing to participate actively -- Options E or F. If the buildings' customer base is too small to sustain the sale of high-bandwidth services at affordable prices under Options B or C, the next best choices would be the exclusive franchise in Option E or the building owner ISP under Option F. These options give building owners exclusive access to the tenant customer base and complete control over prices. The guaranteed, larger customer and revenue base may be needed to encourage a service provider to make the investment in the building required to provide the services desired by the building owner. These choices, however, depend upon the building owners' willingness to actively participate and assume the risks.

Under Option E, the building owner can propose a specific division of costs between building owner and service provider in its request for proposals from potential service provider franchisees. Ideally, the building owner would ask potential service providers to

bear as many of the capital and recurring costs as possible and the risk of loss in the operation of the business. The building owner may find, however, that it may need to be responsible for certain infrastructure costs itself or assist with fund-raising to cover those costs.

Under Option F, however, the building owner assumes the full cost of the infrastructure and recurring costs and the burden of fund-raising and the risk of loss in operations.

7. Final Recommendations

a. Scale and Costs. The choice of options depends most importantly on the number of expected tenants and their ability -- individually or through aggregation -- to afford prices sufficient to cover the costs of the service. As noted above, a single large tenant may have the financial resources to afford a relatively expensive high-bandwidth connection from a traditional service provider or a commercial high-bandwidth provider. However, if the goal is to make high-bandwidth services available to all tenants and the tenants are small businesses with limited resources, an aggregation effort is required. The tenants must be aggregated into a purchasing group large enough to distribute the costs of the service into an affordable price per user.

The costs to be funded include one-time infrastructure costs and recurring costs, such as the upstream network connection and, potentially, on-site technical support. The plans for the Smart Building and WQED Tower projects have relied upon public and foundation grants to fund the one-time infrastructure costs, leaving only the recurring costs to be funded through user fees. If public and foundation funds are not available for infrastructure costs, those costs, too, must be recovered from the aggregation of users.

Table 6 shows the capital costs of the various infrastructure options. Table No. 6A shows the recurring costs to sustain a high-bandwidth upstream network connection. Based upon these costs, a customer base of 30 to 40 tenants is needed to sustain a high-bandwidth connection at the monthly price of $100 to $200 per month per user. If on-site technical assistance is desired, some combination of additional charges and tenants is required.

In terms of actual expectations, a single large tenant is not anticipated for the Bell Atlantic or Liberty Buildings, although it is a possibility for the Highland Building. The 10 to 15 tenants expected for the first two buildings to be renovated -- the Bell Atlantic and Liberty Buildings -- is too small to sustain an independent purchase of upstream connectivity at an affordable price.[6] The 35 to 45 tenants expected in all three buildings, however, approaches the level of sustainability for the upstream network connection; but,

[6] Individual tenants in individual buildings may be able to obtain high-bandwidth services as part of an existing network. Tenants in the Bell Atlantic Building may be able to obtain high-bandwidth connections to the WQED Tower in the short-term. These individual solutions, however, will only sustain the Internet service itself, not a neighborhood-based support staff. It will also fail to provide the infrastructure needed to serve the other buildings and the Phase Two goal of connecting the neighborhood.

again, additional charges and/or customers are required to sustain on-site technical support.

b. Short-term recommendations. In the short-term, therefore, prior to the renovation of the Highland Building, we recommend two options (in order of preference) and an over-arching requirement for all: (1) the use of the Highland Building roof to receive service from the WQED Tower and distribute it to the Bell Atlantic and Liberty Buildings; and (2) the use of the Bell Atlantic Building roof to receive service from the WQED Tower and the further use of fiber optic cable or a LADS line to distribute service to the Liberty Building. We also recommend the over-arching requirement that the building owners use license agreements (Organizational Option No. 2) to require all service providers entering the building to install modern building wiring infrastructures. The license agreements should require the service providers to meet current industry standards (Infrastructure Option No. 2), to comply with building owner requirements for maintenance and eventual disposition, and to meet any unique requirements of the buildings at issue, such as limited space and requirements for hidden wiring.

Under the first short-term option, the building owners, ELDI and the URA could cooperate to install an interim hub system on the roof of the Highland Building. This would require the running of a power supply to the roof and the installation of antennas and radios. One antenna would connect to the WQED Tower. One or more additional antennas would distribute the WQED Tower connection to the Bell Atlantic and Liberty Buildings and, potentially, to other organizations in the community.[7] The estimated cost of this interim hub system is $30,000.

If sufficient funding can be secured, the building owners can also install the networking equipment to create the building-wide networks in Infrastructure Option 3 to distribute a single upstream connection among the building's tenants. Costs of this option are outlined in Table No. 6 as $18,280 for the Bell Atlantic Building and $43,220 for the Liberty Building.

Under the second short-term option, a wireless connection to the WQED Tower would be installed on the roof of the Bell Atlantic Building. This connection would serve the tenants in the Bell Atlantic Building, and a further wired connection could be used to serve the tenants in the Liberty Building. A high-bandwidth fiber optic link could be installed at the approximate cost of $72,000. A 1.5 Mbps link at the approximate non-recurring cost of $2,000 and the monthly charge of $60.00 could be established over a LADS line rented from Verizon.

The downside of the the short-term options is that none of them provides the scale sufficient to afford an independent upstream Internet access connection or neighborhood-based technical support. With the exception of the first short-term option, they also fail to provide the foundation required to connect the neighborhood.

[7] These building-to-building connections are the wireless form of the Neighborhood Area Network in Infrastructure Option No. 4.

c. Longer-term recommendation. In the longer term (i.e., after the renovation of the Highland Building and/or when the parties are ready to undertake the extension of the building networks into the community), we recommend the installation of the complete Neighborhood Area Network -- with building-wide networks in each building and fiber or wireless connections between the buildings (Infrastructure Option 4). We recommend that the building owners allow any interested service provider to enter the building to provide service (subject to the execution of the building owner's license agreement) and that the building owners work actively with a non-profit provider -- perhaps an Internet cooperative -- to provide service to as many tenants as possible (Organizational Option D).

The non-profit provider would purchase a bulk upstream Internet connection from the WQED Tower or from a commercial provider and share the connection among the tenants and other participants. With a sufficient customer base, the provider can also sustain an on-site technical support staff.

If the number of tenants appears to be marginal, the building owners might want to consider an exclusive franchise or a building owner ISP (Organizational Options E & F) to increase the number of participating tenants. Exclusive relationships, however, may risk tenant dissatisfaction and increase the building owners' business risks.

d. Other recommendations. Given the expected number of tenants for the three buildings is marginal in terms of sustainability, we also recommend the active extension of the network into the neighboring community. An Internet cooperative provides a mechanism to extend service to for-profits, non-profits and, potentially, individual users. The extension of service to greater numbers of users will reduce per-user costs of shared resources, such as the upstream connection and a shared technical support staff.

These extensions could be pursued by aggregating demand in other Technology Zone locations and throughout the City. The cost of user support can be further distributed through the use of software that enables technicians to resolve problems at remote PCs from a central network center.

Finally, we also recommend the exploration of several additional issues as means to increase the sustainability of the services and, more generally, to reduce the building owners' costs. We recommend that the URA and the building owners explore the use of the building networks to deliver IP telephony service. IP telephony presents the potential for reduced costs for tenants and additional revenues for the building owner or Internet cooperative. We also recommend the potential use of the building networks for security systems and to monitor building utility systems. The high-bandwidth network will support a video security system, and monitoring devices can oversee the operational status of building systems on a remote basis.

Table No. 1

Options
Physical Infrastructure, Organizational Structure & Service Providers

Physical Infrastructure Options:

1. Minimal action -- spaces reserved for wiring closets and pathways.
2. Modern building wiring.
3. Modern building wiring plus building-wide network.
4. Modern building wiring, building-wide network plus connections among buildings.

Organizational Options:

A. No building owner participation -- traditional service providers contract with individual tenants.
B. Non-exclusive franchises -- building owner enforces standards and performance through license agreements.
C. Non-exclusive franchises, with building owners providing exclusive infrastructure.
D. Non-exclusive franchises, with building owners using license agreements to enforce minimum standards and working pro-actively with providers providing desired infrastructure and products.
E. Exclusive franchises -- building owner issues franchise to provide specified services.
F. Building owner as ISP.

Service Providers:

1. Traditional service providers.
2. Special service providers.
    - (A) Dark fiber providers.
    - (B) Commercial high-bandwidth service providers.
    - (C) Non-profit service providers.
    - (D) Commercial aggregators.
    - (E) Community ISP.
    - (F) Tenant cooperative ISP.

Table No. 2
The Three Buildings -- Significant Features

	Former Bell Atlantic Building	Liberty Building	Highland Building
Address	134 South Highland Ave.	6101 Penn Avenue	121 South Highland Ave.
No. of Floors	3	7	13
Square Feet (total)	12,500 sq. ft.	21,700 sq. ft.	100,000 sq. ft.
Square Feet (per floor)	3,000 first floor 3,500 second floor 4,000 third floor 2,000 second building	2,500 first floor 3,200 other floors	8,000 first floor 7,500 other floors
No. of Tenants	4	7 to 10	20 to 30
Lines of Sight	WQED Tower, Highland	Highland	WQED Tower, Bell Atlantic Liberty
Distance to Bell Atlantic Bldg.			
by street		875 feet	450 feet
by air		607 feet	258 feet
Distance to Liberty Bldg.			
by street	875 feet		625 feet
by air	607 feet		366 feet
Distance to Highland Bldg.			
by street	450 feet	625 feet	
by air	258 feet	366 feet	
Start Date for Renovations	Jan 2002	Apr/May 2002	Unknown
Completion Date for Renovations	Dec 2002	Dec/March 2003	Unknown

Table No. 4
The Five Factors, Summary per Type of Service Provider

	Traditional Service Providers	**Yipes & Other Commercial High-Bandwidth Providers**	**Non-Profit Service Providers**
Potential services and benefits	Standard Low-, Mid- & High Bandwidth Internet Service (no aggregation) Packages with Email & Off-site Web hosting	Standard High Bandwidth Internet Service (no aggregation)	Non-Standard High Bandwidth Internet Service (aggregated, burstable service) Email & On-site Web hosting On-site technical support
Initial & recurring costs	See Tables Nos. 6 & 6A	See Tables Nos. 6 & 6A	See Tables Nos. 6 & 6A
Potential monthly fees	Market-based prices $600 per month for 1.5 Mbps	Market-based prices $4,500 per month for 10 Mbps	Cost-based prices $100 to $200 per month for 10 Mbps (based upon shared connections & sufficient aggregation)
Potential to serve for-profits, non-profits & neighborhood	No restrictions except affordability of price	No restrictions except affordability of price	Potential restrictions as to for-profits & individuals (cooperatives can serve for-profits)
Implementation timeline	Available upon completion of buildings & tenant subscription	Available upon completion of buildings & tenant subscription	Available upon completion of buildings tenant subscription & sufficient customer base

Table No. 5
High- vs. Low-Bandwidth Services
& Applications

Low Bandwidth Services:

Regular phone lines (Dialup connections)	56,000 bits per second (56 Kbps)
ISDN lines	128,000 bits per second (128 Kbps)
Cable modems	256,000 bits per second (256 Kbps) upstream 600,000 bits per second ave. (600 Kbps) downstream

Mid-Range Services:

DSL	128,000 (128 Kbps) to 1,54000 bits per second (1.5 Mbps)
T-1 phone lines:	1,544,000 bits per second (1.5 Mbps)

High Bandwidth Services:

Yipes:	5,000,000 to 10,000,000 bits per second (5 to 10 Mbps) and higher
Smart Building:	10,000,000 bits per second (10 Mbps)

Low Bandwidth Applications:

Regular phone lines (Dialup connections)	Email and web browsing
ISDN lines	Email and faster web browsing
Cable modems	Email, faster web browsing and commercially available streaming video

Mid-Range Applications:

Higher-bandwidth DSL & T-1 lines	Faster file downloads; higher quality streaming audio and video; limited videoconferencing

High Bandwidth Applications:

Yipes, WQED Tower & Smart Building	Full-screen full-motion interactive video- and audio-conferencing; motion picture quality streaming audio and video; Fast downloads of data-intensive files for GIS applications; Interactive continuous movement functions for graphic images (i.e., zooming functions) for virtual reality tours, architectural plans, building floor plans and medical imaging

Table No. 6
Capital Costs

Infrastructure Options	Bell Atlantic Building (3 flrs, 12,500 sq.ft.)	Liberty Building (7 flrs, 21,700 sq.ft.)	Highland Building (13 flrs, 100,000 sq.ft.)
Option 1			
Closets	1 central	1 central, 3 remote	1 central, 6 remote
Reserved Space	100 sq.ft.	250 sq.ft.	400 sq.ft.
Option 2			
Access point & conduit from street to central wiring room	$2,000	$2,000	$2,000
Central wiring room with racks & panels	$3,000	$4,500	$6,000
Remote wiring closets/distribution points	N/A	$6,000	$12,000
Riser wiring	N/A	$10,000	$15,000
Lateral wiring	$19,000	$43,500	$200,000
Data drops	76 drops	174 drops	800 drops
Space for rooftop facilities	50 sq.ft.	50 sq.ft.	50 sq.ft.
Total	24,000	66,000	235,000
Option 3			
Router	$12,000	$18,000	$30,000
Central switch	$4,000	$11,000	$20,000
Remote switches	N/A	$9,000	$18,000
Hubs	$2,280	$5,220	$24,000
Servers	$4,000	$4,000	$4,000
Firewalls (@ $500 per tenant)	$2,000	$5,000	$12,500
One time cost for upstream Internet access (Yipes)(see note 1)	$3,000	$3,000	$3,000
Subtotal	$27,280	$55,220	$111,500
Costs of options 1, 2	$24,000	$66,000	$235,000
Total	$51,280	$121,220	$346,500
Option 4			
Inter-building connections (from Highland Bldg)			
Wireless	$10,000	$10,000	
Fiber			
Regular (@$110 per foot)	$49,500	$68,750	
CityNet (@$80 per foot)	$36,000	$50,000	
Minus unnecessary network equipment in buildings linked to NAN	-$15,000	-$21,000	
Subtotal	-$5,000	-$11,000	
Costs of options 1, 2, 3	$51,280	$121,220	$346,500
Total (see note 2)	$46,280	$110,220	$346,500

Notes:
1. One-time cost of upstream wireless connection = $6,000 per site.
2. Total includes cost of wireless connections.

Table No. 6A
Recurring Costs

Infrastructure Related Recurring Costs:

Infrastructure Options	Bell Atlantic Building (Per Month)	Liberty Building (Per Month)	Highland Building (Per Month)
Option 1: Maintenance (6% per year of electronics costs)	0	0	0
Option 2: Maintenance (6% per year of electronics costs)	0	0	0
Option 3 Maintenance (6% per year of electronics costs)	100	230	475
Option 4 Maintenance (6% per year of electronics costs)	75	175	475

Service Related Recurring Costs:

	Per Purchasing Unit (Per Month)
Upstream Internet access	
5 Mbps	$2,900
10 Mbps	$4,500
On site technical support	
Personnel	$4,500

Table No. 7
Prices to Tenants

	Non-Recurring Charges	Recurring Charges (per month)
Low-Bandwidth Services:		
Dial-up connections (56 Kbps)	$50.00	$20-$25
Mid-Range Bandwidth Services:		
Cable modem service		
Small office (Up to 3 Mbps downstream; 700 Kbps ave.)(up to 256 Kbps upstream)	$200.00	$99.00 (See note 1)
Multi-User (Up to 3 Mbps downstream; 700 Kbps ave.)(up to 256 Kbps upstream)	$500.00	$249.00 (See note 2)
Multi-User (Up to 3 Mbps downstream; 700 Kbps ave.)(up to 512 Kbps upstream)	$500.00	$349.00 (See note 2)
DSL		
256 Symmetric DSL	$600.00	$149.00
512 Symmetric DSL	$600.00	$199.00
768 Symmetric DSL	$600.00	$199-$299
High-Bandwidth Services:		
Traditional Service Providers		
T1 (1.5 Mbps)	$600.00	$1,100.00
Yipes		
5 Mbps	$3,000.00	$2,900.00
10 Mbps	$3,000.00	$4,500.00
Smart Building		
Shared 10 Mbps	$500.00	$100 per 100 Kbps ave. unit consumed
WQED Tower		
Shared 10 Mbps	$5,000 to $6,000 per building	$100 per 100 Kbps ave. unit consumed

Notes:
1. Actual downstream availability = 768 Kbps; One IP Address; (option to 3 IP addresses); no servers; 5 email accounts.
2. 15 users permitted; additional charge for servers; 15 email accounts

Table No. 8
Recommended Options

	Scenario No. 1 Large No. Small Tenants **Infrastructure:** NAN (Option 4) **Organization:** License Agreements & Provider Partner (Option D) **Service Provider:** Non-Profit Service Provider & Others	**Scenario No. 2** Small No. Small Tenants **Infrastructure:** NAN (Option 4) **Organization:** Exclusive Franchises (Option E) or Building Owner ISP (Option F) **Service Provider:** Non-Profit Service Provider & Others	**Scenario No. 3** One Large Tenant **Infrastructure:** Modern Bldg Wiring (Option 2) **Organization:** License Agreements (Option B) **Service Provider:** Any Service Provider
Potential services and benefits	Special products Shared burstable services High Bandwidth Email, web hosting On-site technical support	Special products Shared burstable services High Bandwidth Email, web hosting On-site technical support	Standard products Discrete bandwidth blocks Low-, Mid- & High Bandwidth; Packages with email & off-site web hosting No on-site technical support
Initial & recurring costs	See Tables Nos. 6 & 6A	See Tables Nos. 6 & 6A	See Tables Nos. 6 & 6A
Potential monthly fees	Cost-based prices $100 to $200 per month for burstable 10 Mbps (based upon shared connections & sufficient aggregation)	Cost-based prices $100 to $200 per month for burstable 10 Mbps (based upon shared connections & sufficient aggregation)	Market-based prices $1,100 for 1.5 Mbps; $2,900 per 5 Mbps; $4,500 per 10 Mbps
Potential to serve for-profits	501(c)(3) service to non-profits & incidental number of for-profits 501(c)(12) unrestricted service No restrictions on competing providers	No restrictions if by traditional service provider or commercial high-bandwidth provider 501(c)(3) service to non-profits & incidental number of for-profits 501(c)(12) unrestricted service	No restrictions except affordability of price
Implementation timeline	Available upon completion of buildings, tenant subscription & sufficient customer base	Available upon completion of buildings, & tenant subscription	Available upon completion of buildings, & tenant subscription

Table No. 9
Short and Longer Term Recommendations

	Longer Term Neighborhood Area Network **Infrastructure:** NAN **Organization:** License Agmts & Provider Partner **Service Provider:** Non-Profit Service Provider for NAN Other Providers for individual connections	**Short Term No. 1** Advance Wireless Hub on Highland Building **Infrastructure:** Antennas on Highland Bldg connecting to Bell Atlantic & Liberty Buildings plus modern bldg wiring **Organization:** Info Ren, Building Owners & License Agmts **Service Provider:** Non-Profit Service Provider for NAN Other Providers for individual connections	**Short Term No. 2** Wireless for Bell Atlantic Bldg; Fiber or Copper Distribution to Liberty Bldg **Infrastructure:** Antenna on Bell Atlantic Bldg; wireline connection to Liberty Building plus modern bldg wiring **Organization:** Info Ren, Building Owners & License Agmts **Service Provider:** Non-Profit Service Provider for NAN Other Providers for individual connections
Potential services and benefits	Special products Shared burstable services High Bandwidth Email, web hosting On-site technical support	Special products Shared burstable services High Bandwidth Email, web hosting Service to neighborhood possible (Scalable to include Highland Bldg customers the neighborhood)	Special products Shared burstable services High Bandwidth Email, web hosting (equipment can be redeployed to create scalable network for the three buildings & the neighborhood)
Initial & recurring costs **One-Time** **Recurring**	See Tables Nos. 6 & 6A	$30,000 (plus networking equipment in Table No. 6)	$9,000 (plus networking equipment in Table No. 6) $60 per month
Potential monthly fees	Cost-based prices $100 to $200 per month for burstable 10 Mbps (based upon shared connections & sufficient aggregation)	Cost-based prices $100 to $200 per month for burstable 10 Mbps (based upon shared connections & sufficient aggregation)	Cost-based prices $100 to $200 per month for burstable 10 Mbps (based upon shared connections & sufficient aggregation)
Potential to serve for-profits	501(c)(3) service to non-profits & incidental number of for-profits 501(c)(12) unrestricted service No restrictions on competing providers	501(c)(3) service to non-profits & incidental number of for-profits 501(c)(12) unrestricted service No restrictions on competing providers	501(c)(3) service to non-profits & incidental number of for-profits 501(c)(12) unrestricted service No restrictions on competing providers
Implementation timeline	Available upon completion of buildings & sufficient customer base	Immediately	Immediately