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MUNICIPAL BULWARKS: THE BATTLE FOR CORPORATE ACCOUNTABILITY

Local governments are a transformative force in redressing a wide range of injuries to their communities, achieving significant settlements and changing corporate behavior.

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Power Surge: The Benefits and Challenges of Data Center Development

By: LEO P. ROGERS,
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BUDDY RIZER, *Executive Director,*
Loudoun County Economic Development Authority



Data centers are the unsung heroes of the digital revolution, powering the technologies that have become integral to our lives. From facilitating global communication to driving artificial intelligence (AI) to generating cryptocurrencies and enabling cloud computing, data centers are indispensable in modern society. Their role will continue to expand as technological innovation accelerates, unlocking new frontiers and opportunities in the ever-evolving digital landscape. These facilities are the backbone of the modern digital network, enabling businesses, governments, and individuals to harness the power of data, cloud computing, and connectivity.

There are hundreds, if not thousands, of individual data centers located around the globe, but certain locales have emerged as the leaders in attracting and supporting their aggregation. These include Singapore, Hong Kong, and Silicon Valley among the world's top such locations. But one region outpaces the next six data center powerhouses combined, both international and domestic: Loudoun County, Virginia.

Focusing on Loudoun County, this article will describe why data centers are so lucrative, why they have been and will continue to be in demand, how localities need to balance the fiscal benefits of economic development with good land use planning, what issues localities should consider in reviewing administrative and legislative land use applications by data centers, how the impacts of data centers may be mitigated, and finally take you on a tour of a data center.

The Data Center "Big Bang"

The concept of data centers dates back to the emergence of mainframe computers in the mid-20th century. In the 1950s and 1960s, computers occupied entire rooms and were operated by specialized teams. These mainframes required controlled environments, including temperature and humidity regulation, to ensure optimal performance. Data was stored on magnetic tapes and punch cards, laying the foundation for the idea of centralizing computing resources. As computing technology advanced, data centers evolved with many companies building their own facilities to house the hardware necessary for their own operations.

The 1990s mark a significant turning point in the history of data centers with the proliferation of the internet and the dotcom boom. The increasing demand for online services, e-commerce, and connectivity led to the establishment of commercial data centers. Pioneering companies like Equinix and Digital Realty offered co-location services, allowing businesses to rent space for their servers within these facilities. The 2000s witnessed the rapid growth of virtualization technology and the emergence of cloud computing. Cloud providers like Amazon Web Services (AWS), Microsoft Azure, and Google Cloud introduced the concept of renting computing resources on-demand, eliminating the need for businesses to manage their own physical servers. This shift catalyzed the expansion of massive data center complexes around the world, designed to accommodate the infrastructure required for cloud services. Distinct from these cloud-based functions, but also driving the need for massive centralized computing facilities in the last decade, was the emergence of cryptocurrencies.

Data Center Logistics

This accelerating demand for computing resources drove exponential growth in dedicated physical facilities. Since 2015, data center space worldwide has grown 17-fold to approximately 3.6 billion square feet. Data center growth, as measured by power consumption, is anticipated to be 10 percent a year through 2030. The continued rise in

the use of AI will further drive the need for data center expansion.

As data centers have proliferated across the world, they have become similar in their size and design. Striking albeit vague concrete structures on the outside, on the inside data centers house a series of complex processes and mission-critical equipment that enable the reliable operation of the internet economy. Some of the critical components of the buildings include:

Servers and Hardware: The primary purpose of a data center is to house servers, which are powerful computers designed to handle data storage, processing, and networking. Servers come in various forms, from traditional rack-mounted servers to blade servers that maximize space efficiency.

Networking Infrastructure: Data centers require robust networking infrastructure to ensure seamless communication between servers, devices, and external networks. This includes routers, switches, and firewalls that manage data traffic and security.

Storage Systems: Data centers house a variety of storage systems, including hard drives, solid-state drives, and other storage arrays. These systems store vast amounts of digital information that businesses and users rely on.

Cooling Systems: The heat generated by the intense processing power of servers can be detrimental to their performance and lifespan. Data centers employ sophisticated cooling systems to maintain optimal operating temperatures.

Power Distribution: Uninterrupted power supply is critical for data centers to ensure constant operation. Data centers employ redundant power sources, backup generators, and Uninterruptible Power Supply (UPS) systems to prevent downtime.

Security Measures: Security is paramount in data centers due to the sensitive nature of the data they house. Facilities implement access controls, surveillance systems, biometric authentication, and other measures to protect against unauthorized access.

Monitoring and Management Tools: Advanced monitoring and management tools track the performance of servers, cooling systems, and other components, ensuring efficient resource allocation and timely troubleshooting of issues.

Meet Loudoun County, Virginia

In the 1990s Gatorade's slogan was "I want to be like Mike." Michael Jordan was the greatest basketball player of his time, maybe ever. When it comes to attracting data center development in the 2020s and the foreseeable future, many localities may say "I want to be like Loudoun," given that Loudoun County, Virginia is home to Data Center Alley and has the largest concentration of data centers in the world. As noted above, the next six highest data center markets combined wouldn't equal what exists in Loudoun.

This dominance can be attributed in part to a single transformative cyberspace innovator. Loudoun was the home to internet pioneer America Online. AOL chose Loudoun County as its headquarters in 1997 and became a major driver in attracting a high-level technology workforce and the construction of digital infrastructure. With its headquarters already based in the County, AOL recognized the need for robust infrastructure to support its expanding user base and the increasing demand for online content. The company established data centers in the region to house the servers and networking equipment that formed the backbone of its services. By the mid 2010s, Loudoun became the largest co-location market in the world, and led the industry into the cloud as AWS built its largest collection of data centers throughout the late teens and early 2020s.

Today, Loudoun County is home to more than 175 data center buildings comprising more than 31 million square feet, with another 4 million square feet currently under development. Data centers have greatly contributed to the quality of life and the amenities offered in Loudoun. They are a major reason why last year new commercial investment in Loudoun exceeded $10 billion, which is more than several states. Since 2010, as data centers proliferated in Loudoun, the real estate tax rate decreased by nearly one third while the County budget increased by nearly 400 percent. In addition, data centers have provided high end construction jobs, employed a high-income work force, promoted associated business growth, and attracted prestigious technology companies to locate nearby.

The rapid growth of data centers in Loudoun County, however, created negative impacts on the community, exceeded available electrical capacity, drove up the cost of land, squeezed out other types of commercial,

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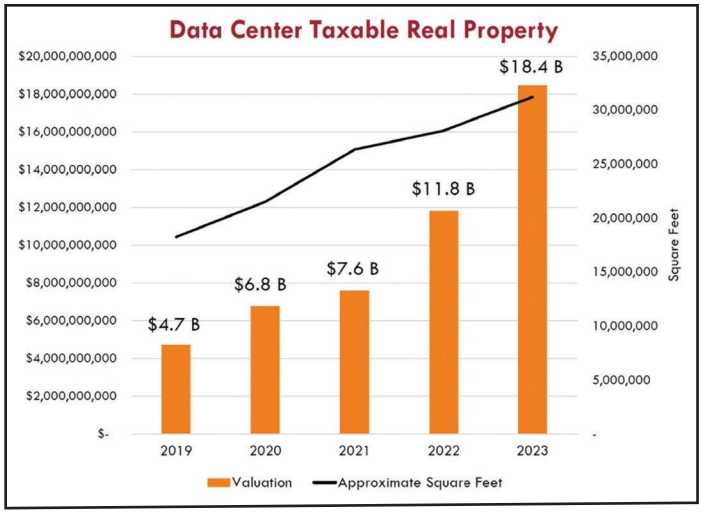
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residential and community development, and resulted in community opposition to new data center development. These concerns often echo issues raised elsewhere about the negative consequences of data centers. Some of these are discussed below.



Use of Resources and Sustainability

As concerns about energy consumption and environmental impact grew, data centers faced pressure to become more energy efficient. The latter half of the 2000s and the 2010s saw a focus on sustainability and green initiatives within the industry. Data center operators began implementing advanced cooling techniques, optimizing server configurations, and adopting renewable energy sources to reduce their carbon footprint.

Data center operators have sought to reduce their power consumption, use more green and renewable energies, and reduce water consumption. They have become outspoken advocates in the battle to fight climate change. Corporate leaders such as Microsoft, Facebook, and Salesforce, are establishing sustainability strategies to support the planet. Microsoft released an aggressive plan to halve its carbon emissions by 2030. Amazon Web Services has committed to the use of 100% renewable energy by 2025 and currently has more than 120 megawatts of renewable projects in the works. Environmentalists are noticing. Greenpeace gave Apple, Facebook and Google an "A" on their clean company scoreboard and Salesforce, Microsoft and Equinix have been given high grades in categories such as energy transparency, renewable energy commitment, energy efficiency and advocacy. Analysts have reported a significant decline in pollution over the U.S., northern China and western Europe as compared to the same time frame in 2019. Energy sustainability is a priority for the data center industry, which accounts for about 3% of global power consumption.

Here are a few of the ways that the data center industry is working toward its sustainability goals:

Investing in Green Energy: Utilizing green energy sources, such as wind and solar power, is a primary way for a data center to reduce its carbon footprint. In Virginia, the industry is working together with Dominion Energy to deliver an unprecedented amount of renewable energy, including an 830-acre solar array planned for Loudoun County.

Energy-Efficient Buildings: Given their usage of such outsized amounts of energy for computing purposes, data center buildings are understandably scrutinized for their energy efficiency. Many Loudoun data centers use energy-efficient building design standards, such as Leadership in Energy and Environmental Design (LEED).

Energy Storage: Utility-level energy storage is coming, with several operators already announcing projects to use lithium-ion batteries for their backup power. Full adoption of this technology could lead to the eventual elimination of diesel backup generators.

Minimizing Water Usage: Data centers use water to cool their computer equipment. In addition to utilizing reclaimed water lines, data centers in Loudoun are exploring new ways of cooling, including air cooling, recycled water loops and submersive cooling technology.

E-Waste Management Programs: Nearly all operators have implemented electronic and electrical equipment recycling programs.

Ongoing Investment in New Technologies: Data center operators continue to innovate and look for new ways to reduce their carbon footprint, including waste heat recycling, on-site energy generation and other initiatives that can help the industry better integrate with their communities.

Local Planning and Zoning Considerations: Loudoun's Example

As the data center industry becomes more entrenched in our communities, local governments are working to understand how to accommodate these facilities within their zoning ordinances and planning documents. Loudoun may serve as a useful exemplar. In 2000, Loudoun County first addressed data center zoning in a determination letter by the Zoning Administrator, which stated, "Uses commonly referred to as 'data centers' are most similar to 'office' and are permitted wherever offices are permitted." At the time industry representatives described the use to Loudoun staff as similar to what was commonly known as a telephone exchange building. These were generally small structures, infrequently sited by telecommunications providers to house equipment, and had little to no occupancy by employees and generated minimal amounts of traffic. Loudoun's ordinances allowed office use by-right in many zoning districts. Coupled with market conditions and a staggering magnitude of demand that was not known in 2000, this decision to consider data center and office uses as equivalent led to the proliferation of data centers where a more strategic land use and planning approach would not have otherwise permitted them. Data center development drove out other forms of commercial development and resulted in existing land uses (commercial,

residential, and civic) to be sold and redeveloped as data centers.

In 2000, the County's Comprehensive Plan, Choices and Changes, General Plan 1990 – 2000 was undergoing a major revision that dealt primarily with planned reduced residential densities in the County's rural area. The Comprehensive Plan carried over many of the non-residential land use policies of the prior plan that supported planned business and industrial land uses generally along transportation corridors and proximate to Dulles International Airport. The planning policies did not account for the advent of the data center phenomenon. For the period between 2000 and 2014, the zoning permission for data centers was based on the determination letter allowing data centers to locate where office uses were allowed. While that may appear to some observers in hindsight to be short sighted, due consideration must be given to Loudoun's rapid population growth creating a demand for residentially zoned properties to provide housing for the influx of residents. Many properties were proposed for conversion from non-residential planned land use and non-residential zoning to absorb the demand, so proposed data center development was welcomed as an alternative to diminishing acreage otherwise planned for business development. Continued data center development also began to offset the burden on residential property owners to pay the costs of increased local services escalating due to increasing population levels.

Regulating data centers in the same manner as office buildings meant applying the same setbacks, parking allocation, front entrance requirements, height, massing, and floor to area ratios. At the time, Loudoun's Zoning Ordinance did not require windows and architectural treatments for large buildings. Buildings were designed and constructed to accommodate their function, which for data centers resulted in large concrete buildings resembling warehouses more than office buildings.

As a significant number of data centers were constructed, the differences between office use and data center use became apparent. An office building primarily houses people during the day, meaning that the office building has parking, utilities, HVAC, and other facilities sized in a manner for an office use. Additionally, due to the nature of the office use, office buildings are developed in a manner that is reasonable attractive to the public with careful attention paid to screening, landscaping, and aesthetics. An office building primarily housing people also has windows and architectural treatments to enhance the buildings appeal to workers and visitors.

In contrast to office buildings, data centers primarily house computer equipment, require significant amounts of electricity, robust cooling systems, and require many huge backup generators. A single data center may use up to 32 megawatts or more of electricity. A series of high voltage powerlines are required to meet the electricity demands of data centers. The backup generators also need to be regularly operated to ensure they will function when needed. Mitigation of noise impacts is a significant difference between data centers and office buildings.

These differences in ancillary needs (i.e., high voltage transmission lines, power substations, numerous large and loud generators, and massive HVAC systems) impact surrounding properties and caused the County to define data centers as a specific use. In 2014 zoning amendments defined the data center use as:

> A facility used primarily for the storage, management, processing, and transmission of digital data, which houses computer and/or network equipment, systems, servers, appliances and other associated components related to digital data operations. Such facility may also include air handlers, power generators, water cooling and storage facilities, utility substations, and other associated utility infrastructure to support sustained operations at a data center.

The 2014 amendments also introduced performance standards for data center development that required the following measures:

- -Principal building facades need to avoid undifferentiated surfaces by including design elements such as a change in building height, building step back or recesses, fenestration or change in use of building material.
- -Screening of mechanical equipment.
- -Exterior lighting to be fully shielded and directed downward.
- -Provisions for pedestrian and bicycle facilities.
- - Additional standards for landscaping, buffering, and screening.

While the amendments added specificity to Loudoun's ordinances regarding the use, the district use permissions stayed largely similar. As a result, the amendment did not constrict data center development.

The next major update to the County land use policies occurred in 2019 with the adoption of the Loudoun County 2019 Comprehensive Plan. This effort introduced the concept known as "place type" in the County's long-term land use planning document. This step began the initial effort to strategically align a land use policy document with zoning district regulations that would serve to implement the comprehensive plan. While many articles on Loudoun's data center experience attempt to introduce the topic, the discussion herein offers a practical explanation.

The place type planning approach designates land areas appropriate for uses based on context within the County's five plan policy areas; the suburban policy area; the transition policy area; the rural policy

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area; the towns and joint land management area(s) (JLMAs); and a newly added urban policy area. The text below offers insight into this planning approach.

The Loudoun County 2019 General Plan describes the place type approach as follows:

The place type approach differs from the County's previous approach to land use planning in that it provides a way to shape the future of Loudoun by concentrating on context – the look and feel of places, their form and their character – instead of focusing only on conventional land use categories and specific uses. Place type categories define not only the basic expected land uses for Loudoun County 2019 General Plan [CHAPTER 2-8] specific areas in the County, but also preferred development patterns, streetscapes, and design features that make places and environments visually distinctive and functional for people.

The place type approach is intended to create distinct and "complete" residential neighborhoods, employment centers, open spaces, and other areas. By providing greater flexibility in development types and uses while providing additional guidance on design expectations, place types can also facilitate more dynamic, livable neighborhoods and allow for established areas to evolve and improve. In the next graphic you will find the transect of the County, which transitions from rural to increasingly urban place types. A transect defines a series of place types that transition from sparse rural farmhouses to the dense urban core. Each place type contains a similar transition from the edge to the center of the neighborhood. The transect does not show all place types found in the plan, but rather a few to show the transition at a higher level. Through the use of place types in the General Plan, the County aims to achieve Loudoun's vision for a prosperous and inclusive community consisting of great places in a variety of settings.

Further, most data center development occurs in the suburban policy area and examples of place types that either call for data center development or do not portend that type of development are the suburban employment and suburban mixed use place types, respectively.[1] The suburban mixed use place type is called for along the County's major transportation corridors of Route 7, Route 28 and Route 50, while the suburban employment place type is designated in areas north and west of Dulles Airport. The place type concept, as described above, also includes use categories expected in each area including core and complementary uses that will fulfill the intent of the place type and appropriate conditional uses. Within the suburban mixed use place type, no category of core, complementary or conditional use includes data centers. Within the suburban employment place type, data centers are listed only within the category of conditional uses.

The place type planning approach equips the Loudoun Board of Supervisors (Board) with policy guidance to consider the possibility of future amendments to the zoning ordinance to direct future data center development to districts that are located within the place type that calls for such uses, or to add new performance standards or to consider approval by special exception. As 2023 draws to a close, the only amendments now before the Board are those that add additional performance standards but largely maintain the current district use permissions.[2] Additional amendments are possible once the 2024 Board establishes its future work program.

Future regulations will also need to address technical considerations, such as power supply, connectivity, and infrastructure requirements. Additionally, the environmental impact of data centers, including energy consumption, water usage, and waste management, must be carefully weighed against local sustainability goals. However, all regulations will need to strike a balance between supporting economic growth and innovation while addressing the potential issues. Collaborative approaches that involve community engagement and public input are crucial to achieving this balance.

Recommendations: Regulating Impacts and the Siting of Data Centers

Jurisdictions should define the term "data center" as a distinct use in their zoning ordinance and comprehensive plan. The definition should be broad enough to encompass small or modular data centers, which are a few hundred or thousand square feet to large traditional data centers which sometimes exceed one million square feet. The definition and its application in the ordinance should also be flexible enough to cover data centers which are ancillary to a principal use. The impacts of each type of data center vary greatly and must be addressed differently for planning and zoning purposes.

For planning purposes, the comprehensive plan should identify planning areas where data centers may be located, where data centers are prohibited, and where the data center use can be controlled through a legislative approval such as special exceptions or use permits. Zoning ordinances should identify development criteria for by-right data centers located in close proximity to homes, schools, civic uses, and commercial development. These development criteria include size, height, buffers, setbacks, design and construction standards, landscaping, noise attenuation, backup power, and the provision of utilities.

To expand on this point further,

subject to market specific indicators, most data center developers are interested in obtaining a floor-area ratio (FAR) of 1.0 or more and a building height of 100 feet or more. Jurisdictions need to recognize and incentivize locations where local zoning can accommodate such bulk standards and when developed adjacent to residential areas, require screening, buffering, and noise attenuation that mitigates visual and aural impact. Areas subject to airport noise or ambient noise levels that are similar to data center noise impacts provide opportunities that may be suitable for future data center development. Areas that are proximate to existing utility infrastructure also may be preferred for data center development. This will be challenging for jurisdictions like Loudoun given the diminishing supply of suitable tracts of land in the suburban policy area. In the face of this challenge, a review of the land use place types and development of realistic regulations that are scalable and context appropriate are needed.

Additionally, the location of permitted data center development should be based on the ready availability of high voltage transmission lines. Electrical utilities will be required to serve the data centers. This may require new high voltage transmission lines along highways, scenic corridors, environmentally sensitive areas, or in close proximity to residential developments.

Noise is an ever-present impact of data centers. The most frequent noise complaints relate to the operation of the generators. Data centers may be required to run their generators due to power outages and the generators need to be tested regularly. Site and building design can greatly reduce this impact. More significant buffers, setbacks and landscaping may reduce this noise impact on other properties. Another less common complaint is a low frequency persistent humming noise usually generated by fans or chilling units. The hum may be troublesome even within the standards set by a local noise ordinance.

Localities should consider performing a land study to determine the best location for large data centers. An analysis of available land may help localities plan for and zone land properly for by-right data center uses. A data center park would allow buildings to be grouped in a given area where impacts may be greatly reduced or mitigated through reasonable performance standards. Design and setback regulations may also be reduced within the park. The co-location of data centers provides the opportunity for shared facilities such as backup power generation that can make data centers more eco-friendly. In addition, co-locating data centers provides the best opportunity to recapture the energy and heat expended by data centers and reuse that power to increase energy efficiency and reduce environmental impacts.

Take the Tour

To further compare Loudoun County's data center industry with Gatorade, the motto should be the internet's "Performance Starts Here." As data centers are highly secure facilities, an invitation is required to get a peek behind the curtain. Protecting the information stored in the cloud is critical to the data center market. Once an invitation is received, registration with the data center is required and strict appointment times are set to ensure smooth entry and minimize disruptions to ongoing operations.

Passersby will notice security measures such as large windowless walls, fencing, wires, bollards, surveillance cameras, gates, lighting, ditching, and security guards. Inside the facility is more of the same as visitors are restricted to an access-controlled vestibule while credentials are checked. The tour begins with a security guard leading the way, while another person follows in the rear.

Inside the bowels of the building, a cavernous steel and concrete structure that is many football fields long by several football fields wide unfolds and the cool air of the climate-controlled facility, in an effort to "Beat the Heat" (Gatorade!) is immediately felt. Given the high level of security at these facilities, a combination of digital keys and biometric data, including fingerprints and retina scans, are used to control access. The tour guide explains the intricacies of the cooling setup, including hot and cold aisle containment and airflow management techniques to keep the servers at optimal operating temperatures.

The secured rooms are owned or leased by operators and house data from companies large and small within highly advanced servers. These servers are replaced frequently to keep up with changing technologies and energy efficiency. Upon approaching one of the racks of servers you can feel the heat being generated and hear and feel the electricity pulsing throughout the units. Most impressively, you view racks filled with servers as far as your eyes can see. The tour guide explains the specific server models and functions, highlighting aspects of their CPU, memory, energy use, and storage configurations. When security escorts a visitor from the room, the doors are meticulously closed and secured.

One of the more interesting parts of a data center is the electrical power storage and generation. Data centers cannot tolerate even momentary interruption in service, therefore, an army of locomotive-sized generators, flanked by UPS systems are used in the event of a power outage to support the critical load needed within the data center. At the conclusion of a data center tour, an extensive question and answer session is offered, with information that includes an overview of the data center's commitment to environmental sustainability, such as using renewable energy and green building design. Departing the secure facility leaves you marveling at the complexity and sophistication that goes into the development and operation of data centers from a technical and practical perspective.

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ML: That's a huge responsibility! Now, as a final item, a question about Italy-besides visiting Enna and Sicily, what are some other sights and experiences you'd recommend for every visitor?

–Definitely Florence is a city most worth visiting, a true jewel. And Rome, of course, and Venice, not to mention Assisi, Matera, Bari, Naples, and you name it. Beyond that, you must not miss the opera at the historic Milan Teatro alla Scala and the concerts at Verona Arena, Bellini Theater in Catania, the Teatro Massimo or Teatro Politeama in Palermo--but above all the ancient drama performances at the Greek Theater of Syracuse located within the Neapolis.

Finally, as a Sicilian, I must recommend tasting Sicilian cassata, which should be considered a gift to humanity, and the jubilation of colors and flavors celebrated in cannoli, arancini, pasta with sardines, Trapani busiate, the Neapolitan pastiera, and the babà. For Italians, you know, food is culture!

ML: Thank you, Maria. We'll see you next October at Lake Como-

Power Surge *cont'd from page 15*

Conclusion

The data center industry is a complex and rapidly evolving sector that enables the technologies upon which we rely. Data centers offer a magnificent opportunity for localities to capitalize on a growing enterprise that provides exponential returns on investment. Business development in the community, taxes for local schools and programs, and opportunities for a well-compensated workforce point to data centers as quality community partners. With intentional planning from community leaders and open dialogue with data center partners, localities can ensure they implement best practices for smart growth of an exciting industry within their borders.

If you would like additional information to better understand the various aspects of this dynamic growing industry (or to discuss Gatorade marketing campaigns of years past), we are available to assist you in exploring the regulatory framework, environmental implications, land use considerations, and economic impact of data centers. impact of data centers.

Notes

1. Other place types included in the suburban policy area, transition policy and JLMA policy area that call for data center development include the Suburban Industrial/Mineral Extraction Place Type, the Transition Light Industrial Place Type, the Transition Industrial/Mineral Extraction Place Type, the Leesburg JLMA Employment Place Type and the Leesburg JLMA Industrial/Mineral Extraction Place Type.
2. As of late 2023, data centers remain allowed permitted by right in the PD-OP, PD-IP, PD-RDP and PD-GI zoning districts and by special exception in the CLI district. Current amendments allow the use in the MR-HI district. Draft performance standards as of late 2023 include additional façade treatment requirements and site planning standards such as loading bay location, location of mechanical equipment screening, refuse collection standards, additional parking setbacks and setbacks to residential development, and noise, light and glare standards.

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