Breakdown of Datacenters and Hyperscale AI Datacenters and the Impact of their Construction near Communities

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Abstract
Currently, hyperscale AI data center projects are developed by private operators and submitted to local or county planning and permitting authorities who are responsible for overseeing all construction-related activities. These development plans are straightforward and require the operator to provide data on the proposed site location, projected electrical load, cooling capacity, construction schedule, and facility layout. These inputs are evaluated by permitting authorities, who maintain final approval based on zoning rules and building activity in the region; however, long-term environmental or community health impacts are not central factors in their decision process.

This indicates that a specific data center could be approved and constructed using parameters and criteria that do not reflect the true scale of their environmental footprint, creating situations where facility development satisfies formal compliance requirements while introducing increased emissions, noise pollution, groundwater concerns, and infrastructure strain. Local authorities generally rely on conventional building codes designed for small-scale commercial facilities, not for massive industrial operations requiring hundreds of megawatts of power and millions of gallons of cooling resources. As a result, communities may face significant impacts that are not accounted for during the initial approval nor the optimal protection of surrounding communities, creating a situation where the project is optimized for compliance, but generates avoidable emissions, health risks, and infrastructure strain.

Local authorities typically do not incorporate modern environmental performance standards, or the unique demands of AI-scale compute loads into their evaluation process, as this type of datacenter or data processing facilities are a new category of infrastructure. With the recent boom in Artificial Intelligence, and the race to generate the best LLMs (Large Language Models), CNNs (Image Models), Reinforcement learning agents, and (GANs) Generative models, companies leading the AI effort like META, GOOGLE, AMAZON, and PALANTIR, amongst others, require large infrastructure to perform the calculations that are required for these models to learn. The machines required to perform these calculations have evolved from the traditional CPU (Central Processing Unit) driven server racks to GPU (Graphics Processing Unit) centered racks which require 8-16x the traditional cooling and power required by the old datacenter CPU racks.

The cumulative effects of these developments may include deteriorating air and water quality, increased respiratory and cardiovascular risks for residents, widening disparities in environmental justice, greater grid instability and rising energy costs, and permanent alterations to local land use. As GPU-based AI facilities continue to proliferate, the lack of updated regulatory guidance threatens to amplify these impacts, especially in rural or suburban regions where zoning frameworks were never intended to govern industrial facilities of this scale.

This Whitepaper's intent is to bring awareness to this new type of construction category, and introduce relevant existing studies, journal papers, and assessments of similar type projects and their impact to the neighboring communities, the health of its residents, and the wildlife/environment that neighbors these projects.

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Project Overview

- Proposed development includes a potential **1 GW data center**, equivalent to the continuous electrical demand of a mid-sized city.
- Build-out assumed by **2035**, with long-term operational impacts extending decades beyond construction.

ULDC – Palm Beach County Law

- **Finding:**
  - The proposed hyperscale data center is inconsistent with the intent and functional distinctions of the Unified Land Development Code, which differentiates between light industrial uses and heavy, high-impact industrial operations.
  - Although classified administratively as an industrial use, the scale, intensity, and operational characteristics of a 1 GW data center align more closely with heavy industrial or utility-scale infrastructure than with light industrial development contemplated near residential and school-adjacent areas.
- **Evidence:**
  - Continuous, city-scale electrical demand (≈1 GW) and associated grid infrastructure requirements.
  - Extensive reliance on large on-site emergency generators, substations, fossil fuel, and electrical equipment typically associated with utility or heavy industrial facilities.
  - Persistent operational impacts including high-intensity lighting, industrial noise, heat rejection, heavy-truck deliveries, and long-term infrastructure footprint.
  - The ULDC's intent language emphasizes compatibility, transition, and protection of nearby residential uses. These objectives are strained when hyperscale infrastructure is permitted under classifications designed for lower-intensity industrial activity.
- **Risk:**
  - Allowing a hyperscale data center to proceed under a light-industrial or generalized industrial classification sets a precedent that **erodes the functional boundaries established by the ULDC.**
  - Creates increased risk of incompatible developments siting near homes and schools, undermines community expectations established by the zoning framework, and exposes the County to cumulative impacts and future land-use conflicts that the ULDC was expressly designed to prevent.

Energy Demand & Grid Stress

- **Finding:** A 1 GW continuous load represents a substantial and inflexible demand on Florida's electrical grid.
- **Evidence:**
  - Equivalent to hundreds of thousands of homes operating simultaneously.
  - Florida's grid relies heavily on natural gas with limited excess dispatchable margin during peak conditions.
- **Risk:**
  - Reduced grid resilience during heat waves, storms, or generation outages.

    - Increased likelihood of load shedding or service interruptions (blackouts), incentivizing on-site generator use.

Backup Generators & Air Quality

- **Finding:** Grid instability increases dependence on large-scale backup generators.
- **Evidence:**
    - N+1 / 2N redundancy models require frequent testing and emergency operation.
    - Worst-case $PM_{2.5}$(particulate) emissions preliminary analysis shows near-field concentrations that can exceed EPA health-based standards under stable atmospheric conditions.
- **Risk:**
    - Elevated particulate exposure during nighttime inversions.
    - Compounded air quality impacts when combined with regional agricultural sugar-field burning and background pollution.

Traffic & Transportation Impacts

- **Finding:** Peak-hour traffic impacts are materially increased despite LOS (level of service) compliance. Data center-specific traffic characteristics are underrepresented.
- **Evidence:**
    - PM peak-hour increases of ~31% eastbound and ~8% westbound on Southern Boulevard.
    - Roadways operate near **LOS D**, a near-unstable condition.
    - Intermittent but intensive heavy-truck deliveries (generators, fuel, equipment).
    - Collector and arterial roadways are not designed for sustained heavy industrial loads.
- **Risk:**
    - Reduced ability to absorb incidents, crashes, or evacuations.
    - Increased heavy-truck exposure on roadways not designed for sustained industrial logistics.
    - Pavement degradation, increased crash severity, and conflicts near residential areas and school zones.

Water Use & Thermal Impacts

- **Finding:** High-volume water use and heat rejection create secondary environmental stress.
- **Evidence:**
    - Cooling demand increases water withdrawals and thermal discharge.
    - Stormwater and heat island amplification exacerbate localized warming.
- **Risk:**
    - Aquatic ecosystem sensitivity to temperature increases.
    - Increased stress during drought or high-demand periods.

Noise, Light, and Community Impacts

- **Finding:** Continuous operations introduce persistent sensory impacts.
- **Evidence:**
    - Generator testing, cooling systems, and substations produce low-frequency noise.

    - Security lighting and nighttime illumination alter ambient conditions.
- **Risk:**
    - Sleep disruption, wildlife displacement, and reduced quality of life for nearby residents.

Ecological & Land-Use Impacts

- **Finding:** Large-scale industrial development contributes to habitat fragmentation.
- **Evidence:**
    - Conversion of undeveloped land and increased infrastructure footprint.
    - Barriers to wildlife movement for both migratory and non-migratory species.
- **Risk:**
    - Long-term ecological degradation and loss of habitat connectivity.

Overall Risk to Health, Safety, and Welfare

- **Conclusion:**
    - While individual impacts may meet minimum standards, the **cumulative and compounding effects** pose credible risks to community health, public safety, environmental quality, and infrastructure reliability.
    - The scale of the proposed facility justifies enhanced scrutiny, strengthened mitigation, and a cumulative impact framework rather than reliance on isolated compliance determinations.

Introduction & Scope

The scope of this paper is to provide impartial information based on published journal articles, publications, and available public data, to shed light on the key impacts and implications of Hyperscale AI Datacenters as well as the lack of applicability of today's regulations on this new category of industrial development.
To start off, it is important to understand the definition of a Datacenter, a Hyperscale Data Center.

Datacenter:

Overview

The pre-2016 definition of a datacenter is very straightforward. The scope of these projects focused on housing computer systems, servers, networking equipment, and storage, which supported the IT (information technology) needs of companies and organizations. These datacenters supported functions such as corporate applications, business data housing, and general computing tasks. Pre-2016, datacenter functionality included uses like web hosting, and traditional cloud-based systems. They were the key culprits in allowing people to stream shows into their computers and personal devices, and store files in "cloud" systems.

Scale

Traditional datacenters range widely in size, but typical mid-to-large facilities operate in the 0.5-50 megawatts (MW) of electrical load.

Year	Data center annual energy use	Percent of total annual US Consumption
2014	60 TWh	1.5%
2016	68 TWh	1.7%
2018	76 TWh	1.9%
2023	176 TWh	4.4%

Table 1- Annual Energy Consumption by Traditional Datacenters 2014-2023 (US Department of Energy)

Power Density and Cooling:

Each rack within a datacenter consumes on average 10-15 kW and traditionally utilizes air-cooling infrastructure. The cooling used in these centers focuses on reliability rather than heat rejection efficiency.

Hyperscale AI Datacenter:

Overview

An AI Hyperscale Datacenter is a completely different category and scale of datacenter. These clusters of server racks are used specifically for Artificial Intelligence (AI) training and inference. They have massive computational power used to train large language models (LLMs), convolutional neural networks (CNNs), reinforcement-learning agents, and generative models. The demand for these tasks requires exponential increases in power, computational capability, storage, and network capacity. This increased computational power demands additional power, cooling, and maintenance over the traditional datacenter.

Scale

AI Hyperscale datacenters are built in large facilities and operate in the range of 50-100MW with the newer datacenters, like **Project Tango,** estimated to require 1GW+ of power to operate (20+ times larger than the largest traditional datacenter).

Power Density and Cooling:

Each rack within a Hyperscale datacenter consumes on average 20-80 kW and are deployed in high-density rack units that require advanced cooling systems (including liquid cooling for AI workloads) to manage the higher heat rejection requirements that exceed those of standard datacenters.

Background on Hyperscale Data Centers

Hyperscale AI data centers are heavy industrial facilities engineered to support the computational demand of modern artificial intelligence. These facilities are composed of dense clusters of GPUs and AI accelerators capable of processing petabytes to exabytes of data. Their operations demand massive amounts of electricity (some mirroring the demand of small cities), specialized electrical distribution systems, and advanced cooling solutions to manage the intense heat generated by high-density server racks. The scale of energy use and thermal output produces a substantial environmental footprint, contributing to heat emissions, air and water stress, and persistent noise from cooling and mechanical systems. These centers place considerable strain on surrounding infrastructure, including electricity grids, water supplies, and transportation networks required for construction, maintenance, and logistics. The combination of high energy draw, continuous heat production, and intensive resource use can create conditions that overwhelm local systems, challenge environmental resilience, and generate long-term ecological and operational stress. While essential for training large AI models and advancing computational research, the sheer scale and intensity of hyperscale AI data centers highlight the need for careful consideration of their placement, design, and broader environmental and infrastructural impacts.

	Traditional Data Center (c. 2016)	**Hyperscale AI Data Center (~1.7 mil sqft.)**
Facility Size	10,000 – 100,000 sq ft	~1.7-3.5 million sq ft
Ceiling Height	12 – 25 ft	50 – 75 ft
Server Racks	20–40 servers per rack	4–8 GPU servers per rack; 40,000–120,000+ racks total
Rack Power Density	5–10 kW	20–80 kW
Total Facility Power	0.5 – 50 MW	1+ GW
Cooling Type	Air-cooled CRAC/CRAH units; optional water loops	Liquid cooling, high-efficiency CRAC/CRAH, chilled water, evaporative cooling
PUE (Power Usage Effectiveness)	1.5 – 2.0	1.1 – 1.25
Servers per Rack	20–40 CPU servers	4–8 GPU-heavy servers
Rack Power Consumption	10-15 kW	20-80 kW
Workload Types	Enterprise apps, web hosting, storage, virtualization	AI training (LLMs, GANs, CNNs, RL agents), cloud computing, big data processing
Networking	LAN/WAN, 1–10 Gbps typical	Ultra-low-latency, high-bandwidth fabric (100–400 Gbps per rack), multi-terabit backbone
Storage Systems	DAS, NAS, SAN; terabytes–petabytes	NVMe flash clusters, object storage, distributed file systems; exabytes
Redundancy / Backup	N+1 or 2N UPS/generator; RAID; secondary site	N+1 or 2N UPS/generator; multi-site replication; erasure coding
Security	Physical access control, surveillance, firewalls	Multi-layer access control, biometric authentication, encryption, micro-segmentation
Annual Energy Use	Small: 0.44 GWh; Medium: 44 GWh; Large: 438 GWh	~7–9 TWh/year
Key Characteristics	Moderate density; air-cooled; scalable via incremental rack addition; general-purpose IT	Ultra-high density; GPU-heavy; liquid cooling; designed for extreme AI workloads; city-scale power draw; PUE-optimized

Table 2- Comparison Table of Traditional Datacenter vs. Hyperscale AI

List of Terms

CRAC / CRAH (Computer Room Air Conditioner / Air Handler): Cooling units for maintaining data center temperature and airflow.

PUE (Power Usage Effectiveness): Metric for data center energy efficiency; PUE = total facility power ÷ IT load power. The higher the number the lower the efficiency

GPU (Graphics Processing Unit): Specialized processor optimized for parallel computation, widely used in AI workloads.

LLM (Large Language Model): AI model for natural language processing tasks.

GAN (Generative Adversarial Network): Type of AI model for generating new data (e.g., images, video).

RL (Reinforcement Learning) agent: AI system that learns optimal actions through trial-and-error in an environment.

NVMe (Non-Volatile Memory Express): High-speed storage interface for flash storage.

Erasure Coding: Method of data redundancy for distributed storage that splits data into fragments with parity for fault tolerance.

Hot/Cold Aisle Containment: Data center layout strategy that separates hot exhaust and cold intake airflow to improve cooling efficiency.

Micro-segmentation: Security approach dividing the network into isolated segments to reduce attack surface.

Cooling Systems

Due to the smaller power draw and heat rejection, traditional data centers rely primarily on air-based cooling and moderate capacity chill water systems. Hyperscale AI datacenters require more advanced cooling to maintain the equipment within its operating limits. Since Hyperscale AI datacenters are power-dense, more power (kW) per rack, air-cooling does not provide the appropriate heat transfer to cool the equipment down. Advanced water/liquid cooling or immersion cooling become key to maintaining the required operating temperatures of the facility. Below you'll find different types of cooling used on these large AI datacenters.

Direct Liquid Cooling

Direct-to-Chip Liquid Cooling delivers a coolant (water, dielectric fluid, or engineered liquid such as Glycol or PAO) directly to cold plates attached to traditional central processors and/or GPUs as well as any high-power thermal components inside the server. The coolant absorbs heat at the chip level, which is then transported to heat exchangers or central chillers, bypassing the inefficiency of traditional air cooling.

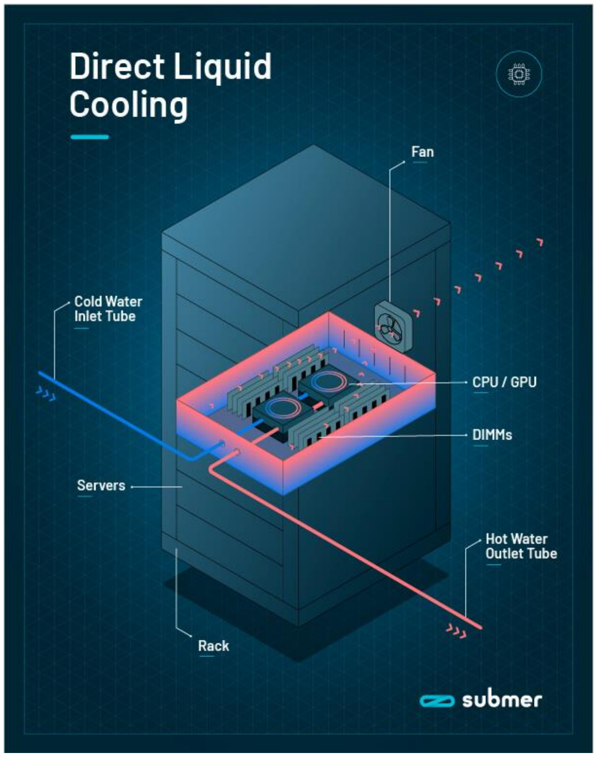

Figure 1 – Submer Company Direct Liquid Cooling System

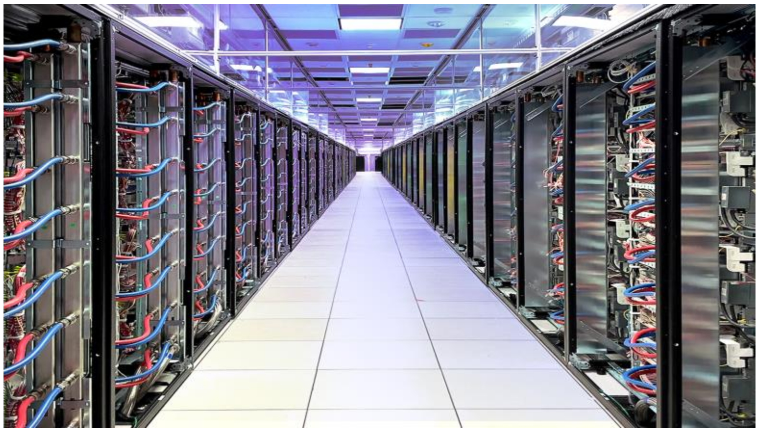

Figure 2 – Submer Company Direct Liquid Cooling System

How it works:

1. A metal plate with embedded channels is mounted directly onto the CPU/GPU.
2. Water or dielectric fluid circulates through these channels, absorbing heat from the chip.
3. Heated liquid is transported via piping to a heat exchanger or cooling plant.
4. The liquid is cooled and sent back to the cold plates in a continuous loop.

Advantages:

1. Highly efficient heat removal

2. Supports extreme rack densities like GPU-heavy AI racks
3. Reduces energy for air cooling: Less fan and CRAC load
4. Smaller footprint for cooling infrastructure
5. Reduces overall facility energy-use

Disadvantages:

1. Complex installation
2. Higher costs driven by cold plates and plumbing. More expensive set-up and parts than air-only systems
3. Requires careful monitoring of fluid chemistry and flow
4. Piping and leak management are critical, especially if water is being used

Submerged/Immersion Liquid Cooling

Immersion cooling involves placing servers or components directly into a thermally conductive, dielectric (electrically non-conductive) fluid. The fluid absorbs heat generated by CPUs, GPUs, or other components, which is then removed via external heat exchangers or cooling loops. Unlike traditional air or direct-to-chip liquid cooling, the entire server or board is submerged rather than individual components, eliminating reliance on airflow or discrete waterflow to each of the components.

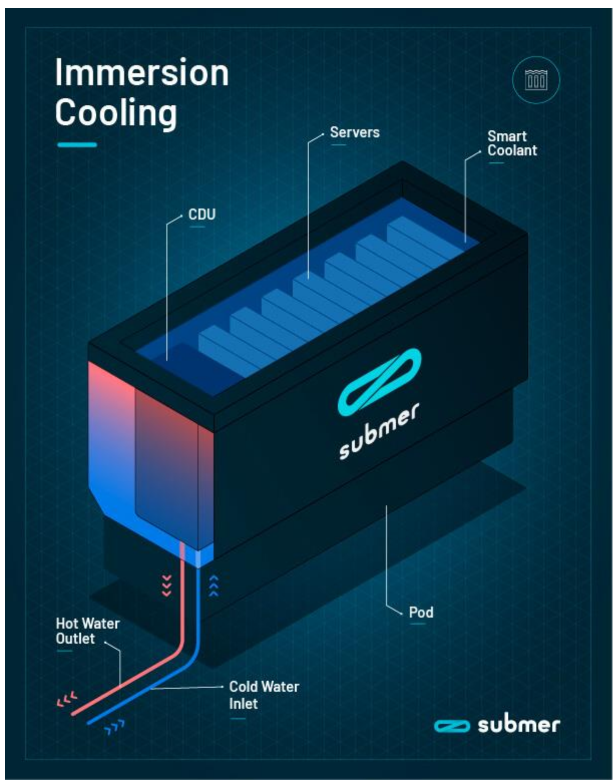

Figure 3 – Submer Company Immersion Cooling System

How it works:

1. Servers are placed in tanks filled with non-conductive fluid, such as engineered mineral oils or specialized fluorocarbon liquids
2. Components transfer heat directly to the fluid through conduction

3. Warm fluid is circulated through heat exchangers to remove the heat absorbed while exposed to the GPUs
4. Cooled fluid returns to the tank to absorb more heat

Specialized Configurations:

1. Single-phase immersion: Fluid in the pod/containment tanks remains liquid and as highlighted in the “How it Works” section, the heat is removed via circulation
2. Two-phase immersion: Fluid (usually a dielectric with very low boiling point) boils at component-level temperatures, vapor rises, condenses in a heat exchanger, and recycles back. This method has high losses

Advantages:

1. Handles extreme heat density. Ideal for AI clusters
2. No fans or air cooling needed inside the tanks
3. Quiet operation as it virtually eliminates server fan noise
4. Constant fluid immersion reduces thermal cycling stress on components, improving reliability

Disadvantages:

1. Not all servers are designed for immersion; they require specialized or modified equipment
2. Requires careful handling of dielectric fluids, monitoring, and leak prevention
3. Tanks, pumps, and fluid systems can be expensive upfront
4. Servicing submerged servers is more involved than air-cooled racks driving up maintenance cost
5. Two-phase immersion experiences significant fluid losses due to imperfect vapor recovery, permeation, leaks.

Air Cooling

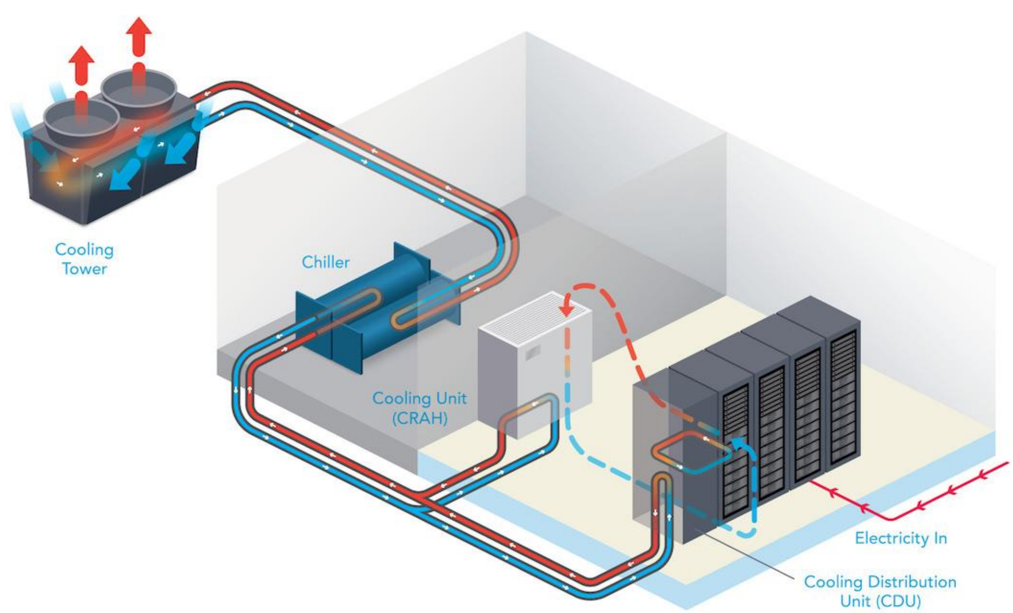

Figure 4 – Upsite Technologies Air Cooling Diagram

Types of Air Cooling:

High-Density CRAC/CRAH Units

- Computer Room Air Conditioner (CRAC) or Computer Room Air Handler (CRAH) units force chilled air through the racks
- Paired with hot/cold aisle containment to optimize airflow
- Rack density support: up to 15–20 kW/rack
- Best for smaller GPU clusters or legacy servers
- Cannot efficiently cool ultra-dense AI GPU racks (>20 kW/rack)

In-Row or In-Rack Air Coolers

- Cooling units installed directly between racks or integrated inside racks
- Pulls hot air from rear and blows cold air into the next rack
- Rack density support: 15–30 kW/rack
- Shorter air paths, more efficient airflow
- Limited for extreme GPU densities; adds equipment cost over CRAC/CRAH

Rear-Door Heat Exchangers (Air-to-Liquid Hybrid)

- Mounted on rack rear doors, air from the rack passes through a heat exchanger cooled by water (or dielectric fluid)
- Hybrid system, but air is still the cooling medium used inside the rack
- Rack density support: 30–60 kW/rack
- Reduces room airflow requirements
- Common with racks of GPUs

Hot/Cold Aisle Containment

- Segregates hot and cold air streams in the data hall to prevent mixing
- Builds off the CRAC/CRAH system with improved efficiency
- Reduces required airflow volume as you are keeping the streams of hot and cold air segregated to reduce conductive losses
- Essential for AI racks but not sufficient alone for >30 kW/rack

Overhead / Raised-Floor Air Distribution

- Traditional raised-floor plenum delivers cold air from below; overhead ducts deliver from above
- Legacy cooling method. Still used in parts of hyperscale AI centers for lower-density racks
- Rack density support: up to 10–15 kW/rack
- Not efficient for ultra-dense GPU clusters

Direct Air Economizers / Free Cooling

- Uses outside ambient air when climate allows instead of chillers (Not applicable to Florida due to the heat)
- Can be air-side economizers (outside air into room) or water-side economizers (cooling water chilled via ambient air).
- Not viable for AI racks if outside air cannot remove 20–80 kW/rack per rack

Hybrid Air + Liquid Systems

- Combines the Rear-Door system with Liquid Cooling

- This could be Direct to Component Liquid Cooling
- Supports up to 80+ kW/rack (This is probably What Project Tango will pick)
- Most modern hyperscale AI data centers use this hybrid architecture.

Chillers/Cooling Towers:

1. CRAC/CRAH can use chiller-based cooling (with cooling towers) or air-cooled systems (no cooling towers).
    a. Air cooled systems utilize the same principle as your air conditioner, which utilizes a refrigerant (freon) to extract heat.
    b. Chiller-based cooling removes heat from server racks by transferring it to chilled water circulated through a closed-loop system connecting the racks to a central chiller plant. In water-cooled systems, the chiller condenser rejects this heat to a cooling tower, where a small portion of water evaporates to dissipate heat to the atmosphere, and the cooled water is returned to the condenser to complete the cycle.
2. Closed-loop vs. Open-loop Cooling Towers
    a. Open-loop (open circuit) cooling towers: In open-loop systems, water comes into direct contact with outside air, cooling primarily through evaporation, which leads to high water loss from evaporation, drift, and blowdown; these systems have a higher risk of fouling and scaling, require regular water treatment and maintenance, and are typically used in traditional large-scale cooling applications.

    b. Closed-loop (closed circuit / fluid cooler) systems: In closed-loop systems, water remains contained within a coil while air passes over it, transferring heat with little or no evaporation, resulting in very low water loss and reduced fouling or scaling; they require lower maintenance, chemical treatment is mostly optional, and they are commonly used in closed-loop circuits, heat exchangers, or secondary cooling loops.

Summary:

Money is really the key driver in what cooling method is used. When it comes to hyperscale AI datacenters, there are very few viable methods of cooling such high-power densities (per rack). On the cheaper side, a combination of air-cooled CRAC/CRAH systems combined with water-cooled chillers and open-loop cooling towers will do the job, at the cost of high electrical use, high water use, and increased noise due to the mechanical equipment being used. This will be the lowest upfront cost between $1.7-2.7million per MW of power (assuming 1GW, this would require ~$2.7 billion in Capital) but will have the highest operating costs. This option is very appealing to developers and owners of these datacenters because most of the electric and water bills get absorbed by the consumers in the relative area.

Now on the expensive front, incorporating a hybrid cooling system with direct-to-chip liquid cooling or immersion cooling, closed-loop chillers, and dry heat rejection would be the top-of-the-line cooling equipment to minimize water use, electrical consumption and noise generation. Studies have shown that this type of set-up can reduce energy use between 15-25%, in addition to removing the risk of Legionella, and reducing maintenance cost as the cooling method is no longer the wet cooling towers, but a dry heat rejection. Unfortunately, this approach costs between $2.3 – 3.7 Million per MW of power (assuming 1GW, this can top at $3.7 Billion), which I believe makes this unattractive to developers or whomever purchases this datacenter. Things to mention about this expensive approach is it has low operating costs because of the reduced energy consumption, and it eliminates almost entirely the water consumption problem. Additionally, it helps mitigate noise as the fans used in dry heat rejection are smaller than the large CRAC fans.

Regulatory, Zoning, Policy and the ULDC

ULDC (Unified Land Development Code)

The Palm Beach County Unified Development code, or ULDC, is the governing document for land developing and zoning decisions within the county of Palm Beach. Within a lengthy 1225 pages, it covers 18 articles explaining the purpose, definition, regulation and clarification adopted to: "*...encourage the* ***most appropriate use of land, water, and natural resources****; prevent the overcrowding of land and avoid undue concentration of population; facilitate the adequate and efficient provision of transportation, water, sewage, drainage, solid waste, parks, schools, fire, and police facilities;* ***conserve, develop, utilize, and protect natural resources****;* ***protect human, environmental, social, and economic resources****; and, maintain, through orderly growth and development, the community character and stability of present and future land uses and development in PBC."*

1. Article 1 – General Provisions
   Establishes the title, authority, purpose, and intent of the ULDC; includes definitions, interpretation rules, and applicability to land development in the County.

2. Article 2 – Application Processes and Procedures
   Outlines how to apply for development approvals, describes review procedures, public hearing requirements, decision-making bodies, and processing of permits and waivers.

3. Article 3 – Overlays and Zoning Districts
   Defines zoning districts and overlay zones, including special geographic or planning areas, and sets standards for property development based on zoning.

4. Article 4 – Use Regulations
   Regulates permitted land uses by zoning district; includes the use classification system and what uses are allowed, prohibited, or conditionally permitted.

5. Article 4 – User Guide
   A companion to Article 4 that helps users navigate use classifications, approval processes, and matrices to determine applicable standards.

6. Article 5 – Supplementary Standards
   Contains additional regulations that apply to specific uses or site conditions, such as accessory structures, compatibility standards, buffering, and architectural requirements.

7. Article 6 – Parking, Loading, and Circulation
   Establishes parking and loading requirements, access standards, and circulation design requirements for developments.

8. Article 7 – Landscaping
   Sets landscape design standards, including required plantings, buffers, streetscape requirements, and treatments for screening and open space.

9. Article 8 – Signage
   Regulates sign types, placement, sizing, and design to ensure compatibility with the character of surrounding areas.

10. Article 9 – Archaeological and Historic Preservation
    Provides standards for identifying, protecting, and preserving historic and archaeological resources in development projects.

11. Article 10 – Enforcement
    Details enforcement mechanisms, violations, penalties, code compliance procedures, and appeals related to ULDC violations.

12. Article 11 – Subdivision, Platting, and Required Improvements
    Governs platting procedures, subdivision design, and required infrastructure improvements before final approval.

13. Article 12 – Traffic Performance Standards
    Establishes requirements to evaluate and mitigate traffic impacts of development, including concurrency and traffic performance criteria.

14. Article 13 – Impact Fees
    Sets impact fee requirements for various development types to fund public facilities (e.g., roads, parks, schools) needed to support growth.

15. Article 14 – Environmental Standards
    Contains standards to protect natural resources, wetlands, water quality, and environmentally sensitive lands.

16. Article 15 – Health Regulations
    Addresses health-related development requirements, such as sanitation standards, potable water, septic systems, and disease prevention.

17. Article 16 – Airport Regulations
    Regulates land use and development near airports to ensure safety and compatibility with airport operations.
18. Article 17 – Reserved for Future Use
    Currently reserved and contains no active provisions; held for potential future code expansion.

19. Article 18 – Flood Damage Prevention
    Establishes standards to regulate development in flood hazard areas, including FEMA-mapped Special Flood Hazard Areas, to minimize flood damage.

Let’s also define two key terms relevant to this development: MUPD means Multiple Use Planned Development and FLU means Future Land use.

Governing Legal Framework

The Palm Beach County Unified Land Development Code (ULDC) **regulates land development through categorical land use classifications, procedural approval requirements, and impact-based interpretive rules**. The ULDC **does not regulate** by engineering magnitude (e.g., megawatts, gallons per minute), but by functional characteristics, land use compatibility, and procedural compliance.
The key driving articles that will assist in dismantling or at the very least pushing back on the construction of AI Hyperscale Data centers in Palm Beach County are Article 1, Article 2, and Article 4. The definition listed on the first section, ULDC, highlights the key reason why this code exists. Its primary goal is to protect residents, the environment, and make appropriate use of natural resources in our area. This definition is key because as highlighted in this paper, AI hyperscale datacenters affect the residents, the environment, health and could drive the natural resources to the brink of exhaustion.

The legal defects identified within this paper's section "Regulatory, Zoning, Policy and the ULDC" arise from misapplication of these Articles, not from policy disagreement.

Revocation

Article 1, Chapter A, Section 1, Subsection D.1.B allows for the Palm Beach Zoning Board to revoke a Building Permit or Certificate of Occupancy in those cases where an administrative determination has been duly made in which **false statements or misrepresentations resulted as to material fact(s) in the application or plans upon which the permit or approval was based.**

What this means is that the fight against AI Datacenters does not stop at the initial zoning or BCC (Board of County Commissioners) approval. There are methods within the ULDC that allow for review and even revocation in the event a Building Permit is issued. As an example, a material misrepresentation could be the use of the Light Industrial (IL) designation for this type of project when it clearly falls under a different category, subject which we will explore later.

Misclassification of Use Under Article 1, 2, and Article 4

<u>Article 1:</u>

The ULDC does not regulate land use by megawatts or gallons per minute. It regulates by <u>functional characteristics</u>, land <u>use compatibility</u>, and <u>procedural compliance</u>. Where a proposed use operates as infrastructure rather than an occupant-based industrial activity, Article 4 requires classification by function, and Article 1 mandates that the more restrictive interpretation control. Approval based on misclassification, deferred concurrency, and unauthorized reliance on traffic equivalency constitutes procedural error and exposes the decision to certiorari review (this is an escalation of review from a lower court to a higher court).

This section within the ULDC is pivotal in our argument against the misrepresentation or incorrect designation of the datacenter as Light Industrial usage. These types of designations are done as a collaboration between the County Staff and the Applicant's justifications for land development. In Section 2 of the ULDC, <u>Assistance by Staff</u>, there is a very important disclaimer:

> *Except as specifically set forth in Art. 1.B.1, Interpretations, any assistance given or representation made by a PBC employee during consultation shall not constitute the approval of the Department, shall not bind the Staff, the Department, the Division, the Executive Director, or the BCC, and shall not*

> *relieve any person of any requirements of this Code or other applicable provisions of Federal, State law, or Local ordinances. If there exists a conflict between any Staff representation and the laws, rules, codes, or ordinances, such laws, rules, codes, or ordinances shall prevail to the extent allowed by law.*

"How does this help us?" this paragraph states the staff members are in fact, human, and if there is a conflict between the determination made by a staff member vs. the correct determination or interpretation set forth in the law or the ULDC, that the law and the ULDC prevail over the staff's decision or conclusion. This will become instrumental, because it supports our arguments that mistakes have been made, and it allows the county and the staff to save face because a mistake was made.

This pairs very well with Article 1, Chapter C, Section 1.A.2 which states:

> *The interpretation and application of any provision in this Code shall be the minimum required to promote the public health, safety, comfort, convenience, and general welfare. Where interpretation and application of any provision in this Code imposes greater restrictions upon the subject matter than a general provision imposed by the Plan or other provision in this Code, the provision imposing the greater restriction shall control.*

Section 1.A.2 has a similar mechanism to the US Constitution where the people who created this document didn't fully understand what could happen or come up years or decades into the future so they implemented checks and balances that would prevent people from taking advantage of the code. Their foresight was for issues just like the Hyperscale AI datacenter, where something not explicitly covered in the ULDC would emerge, and developers would try and take advantage. The quoted text above restates that the intent of this code is to protect public health, safety, comfort, convenience and general welfare of the residents, but the critical piece of this statement starts with the second sentence which clearly states that if a "use" has greater impacts than the category claimed, in this case Light Industrial, the more restrictive classification must control; it sets guardrails so staff cannot choose the least restrictive interpretation once impacts exceed it.

In the Application submitted by the developer, and commented on by staff, there is repeated statements highlighting that the project is classified as "Data Information and Processing (Light Industrial)", despite admitting it is "fundamentally different". This is a direct quote from Application DOA/ZV-2025-01602, Exhibit B.1 (page 6): "**Although the use could be considered similar to warehouse… it is very different… increased use of power, heat, excessive water usage, and noise."**

This repeated admission by the County—classifying the project as Data Information and Processing (Light Industrial) while simultaneously acknowledging that the proposed use materially differs from traditional light industrial or warehouse uses due to utility-scale electrical demand, industrial cooling requirements, excessive water usage, continuous noise generation, and 24/7 operation—destroys **the light industrial classification and is dispositive under the ULDC's use-classification rules**. Because the end use of the site would impose impacts greater than those contemplated by the Light Industrial category, the ULDC requires application of the more restrictive provisions applicable to such uses.

Article 2:

The applicant and staff try to justify the projects intensity, allowable square footage, and its light industrial classification through "equivalent traffic generating trips". Low trip generation does not reclassify infrastructure-scale operations as light industrial uses. The ULDC provides no mechanism for "intensity swaps" or land use classification whereby reduced traffic offsets increased square footage, energy consumption, or infrastructure demand. Traffic data may inform concurrency, but it cannot redefine the nature or scale of the use itself. Traffic concurrency is governed by Article 2.F; classification is governed by Article 4; combining traffic generation and use classification exceeds the authority granted by the ULDC and thus not permissible by law.

Another key item in the application is the request for a parking variance due to the minimal employee presence required at the facility. There is a legal inconsistency here because for light industrial classification, specifically that of the data processing center, ULDC defines parking ratios which are use-based proxies for operational intensity. By asserting that the parking ratios are incorrectly proportioned to their project, they are implying project does not function like traditional Data Information and Processing use classification, thus effectively concedes that the chosen classification is inaccurate. The variance request confirms that the operational characteristics of the project are incompatible with the use category under which approval is sought.

Article 2.F is also violated by their incomplete and deferred concurrency analysis. In their application, they acknowledged unknown infrastructure demand, specifically those tied to power and water usage. Article 2.F requires that adequate public facilities be demonstrated **at the time of approval**, not deferred to future phases or reviews. Approving square footage, phasing, or variances without definitive information on water demand, wastewater disposal, or cooling methodology **renders any concurrency finding premature and legally insufficient**.

Article 4:

Article 4 is critical to our argument about utilization. This section explains in detail the Use Regulations to ensure that all development in unincorporated PBC is consistent with the Comprehensive Plan. It is critical to define uses and identify where such uses are allowed. This Chapter establishes the general provisions that address regrouping of uses by classification, approval process, and any requirements specific to a use. Section A.7 within Article 4 is the exclusive authority on how to handle unlisted or atypical uses. It requires that uses not present in article 4 be further evaluated. Any use that is not consistent with the definition and functional characteristics of a listed use would require re-evaluation and formal interpretation under Article 1.

> *Uses not specifically listed in the Use Matrices of this Chapter, but consistent with the definition of a listed use, may be considered by the Executive Director of PZB pursuant to Art. 1.B, Interpretation of the Code. All uses shall comply with all requirements of the ULDC unless expressly exempted otherwise.*

Uses are grouped into classifications based on common functional characteristics or land use compatibility, not by name, branding, or applicant preference. There is no ULDC category for "technology," "data," or "digital infrastructure" as a standalone class, and justifying this development, or providing approval of it under the Light Industrial category cannot be done by simply citing "technological advances", "private power agreements", and market feasibility. These reasons do not constitute "changed land use circumstances" under the ULDC. Development Order Amendments can only be justified by changes to the physical site, regulatory conflicts, or public necessity. Accepting market evolution as a zoning justification undermines the regulatory purpose of the ULDC.

There isn't sufficient evidence to classify this project as a Light Industrial, and per Table 4.B.5.A – Industrial Use Matrix, if this project were to be re-classified as a Heavy Industrial Use (Use 6 in the table below), the current zoning classification for the Palm Beach Aggregates property which is currently classified as a Planned Development District (PDD) Multiple Use Planned Development (MUPD) Future Land Use (FLU) Economic Development Center (EDC), this type of project would not be compatible and thus unable to be approved.

Table 4.B.5.A – Industrial Use Matrix

Use Type	Supplementary Use Standards #	Planned Development Districts (PDDs)													
		PUD					MUPD								
		Pods					FLU								
		RES	COM	REC	CIV	AGR/P	CL	CH	CLO	CHO	CR	IND	EDC	CMR	INST
Light Industrial Uses (2)															
Contractor Storage Yard	1	-	-	-	-	-	-	-	-	-	-	P	D	D	-
Data and Information Processing	2	-	-	-	-	-	A	P	A	P	-	P	P	D	-
Manufacturing and Processing	8	-	-	-	-	-	-	D	-	-	-	P	P	D	-
Medical or Dental Laboratory	9	-	P	-	-	-	P	P	P	P	-	P	P	D	-
Multi-Media Production	10	-	-	-	-	-	A	P	A	P	D	P	P	D	-
Recycling Center	11	-	-	-	-	-	-	A	-	-	-	A	D	A	-
Research and Development	13	-	-	-	-	-	A	D	A	D	-	P	P	D	-
Warehouse	17	-	-	-	-	-	-	D	-	-	-	P	P	D	-
Wholesaling	18	-	-	-	-	-	-	D	-	-	-	P	P	D	-
Heavy Industrial Uses (2)															
Distribution Facility	3	-	-	-	-	-	-	D	-	-	-	P	P	-	-
Equestrian Waste Management Facility	4	-	-	-	-	-	-	-	-	-	-	A	-	-	-
Gas and Fuel, Wholesale	5	-	-	-	-	-	-	-	-	-	-	A	-	-	-
Heavy Industry	6	-	-	-	-	-	-	-	-	-	-	A	-	-	-
Machine or Welding Shop	7	-	-	-	-	-	-	-	-	-	-	P	-	-	-
Recycling Plant	12	-	-	-	-	-	-	-	-	-	-	A	-	-	-
Salvage and Junk Yard	14	-	-	-	-	-	-	-	-	-	-	A	-	-	-
Towing Service and Storage	15	-	-	-	-	-	-	-	-	-	-	P	-	-	-
Truck Stop	16	-	-	-	-	-	-	-	-	-	-	A	-	-	-

Figure 5 – Industrial Use Matrix (Table 4.B.5.A)

Noise

Team and Credentials

This summary was compiled by the LMEIC experts in mechanical and aerospace engineers with extensive combined experience in Aerospace, HVAC, noise/acoustics, and mechanics, as well as published articles and patents within the field of engineering.

Introduction

The intent of this section is to calculate a reasonable setback for the construction of a Hyperscale AI datacenter near residential zoning or schools. The limits and formulas used are taken from published journal articles and studies, and the formulas used are based on the ***Inverse Square Law*** which states that sound intensity decreases proportional to the square of the distance from the source:

$$\boldsymbol{I \propto \frac{1}{r^2}}$$

Where:

- *I = sound intensity*
- *r = distance from the sound source*

Assumed Source Level (Conservative, Worst-Case)

Although current power agreements with FPL and comparative Hyperscale AI datacenters being built around the US exceed the >1GW size, these calculations assume a 1GW power consumption AI data center and assume further expansion of AI datacenter in the future which will drive sound/noise levels to increase. For quantitative modeling, a source sound pressure level (SPL) of:

$L_1 = 118$ *dB* was used at a reference distance of: $r_1 = 3.3$ *feet (1 meter).*

The 118 dB value reflects aggregate acoustic power, not individual component loudness, and is consistent with:

1. Large axial cooling fans and cooling towers, which commonly exceed 95–105 dB at close range [1]
2. Emergency and backup generator systems, which routinely exceed 100 dB at 1–3 feet [2]
3. Simultaneous operation of multiple mechanical systems, producing additive acoustic energy
4. Low-frequency dominance, where A-weighting underrepresents physical sound pressure

Conservatively assuming 10 simultaneous operating sources, the aggregate equivalent continuous SPL is modeled as ≈118 dB at 1 m using logarithmic addition.

Sound Propagation Model

Spherical Spreading (Geometric Attenuation)

Outdoor sound propagation in free-field conditions follows spherical spreading, based on inverse square law:

$$L_2 = L_1 - 20 \cdot \log_{10}(r_2 / r_1)$$

Where:

L_2 = sound level at distance r_2 (dB)
L_1 = sound level at reference distance r_1 (dB)
r_2 = distance from source (feet)
r_1 = reference distance (3.3 feet)

This relationship applies across all frequencies, including **low-frequency noise**, which experiences **minimal** atmospheric absorption.

Calculated Sound Levels at Increasing Distances

Using the Inverse Square Law equation above we can calculate the noise levels at various distances from the point of origin.

Distance (Miles)	Appx. Distance (feet)	L_2 (dB)
0.6	3300	$118 - 20 \cdot \log_{10}(3{,}300 / 3.3) =$ **58**
1.25	6600	$118 - 20 \cdot \log_{10}(6{,}600 / 3.3) =$ **52**
2.00	10560	$118 - 20 \cdot \log_{10}(10560 / 3.3) =$ **48**
5.00	26400	$118 - 20 \cdot \log_{10}(26400 / 3.3) =$ **40**
10.00	52800	$118 - 20 \cdot \log_{10}(52{,}800 / 3.3) =$ **34**

Table 3 – Sound levels vs. Distance

The various colors in the table indicate a PASS, MARGINAL, FAIL condition against the thresholds established in the section below.

Interpretation Relative to Health-Based Thresholds

World Health Organization guideline reference levels [3]:

- 40 dB (night-time average) → onset of sleep disturbance
- 45 dB (day-night average) → broader cardiovascular and cognitive risks
- 30-35 dB indoors → micro-arousals and autonomic stress activation

The 40 dB night-time threshold is not arbitrary. It is derived from:

1. World Health Organization environmental noise guidelines identifying 40 dB L_{night} as the level below which adverse sleep effects are minimized
2. Epidemiological evidence demonstrating sleep fragmentation, autonomic activation, and hormonal disruption at or above this level
3. Experimental data showing that low-frequency noise produces physiological responses at lower perceived loudness than mid-frequency noise
4. Indoor exposure relevance, as outdoor levels near 40 dB often translate to 30–35 dB indoors, a range associated with sleep micro-arousals

The 40 dB threshold represents a population-level health protection **goal**, not a guarantee of zero impact. Sensitive populations, including children, veterans, neurodivergent individuals, older adults, and individuals with cardiovascular disease, may experience effects at lower levels.

Residential buildings typically provide no more than 5–10 dB attenuation at low frequencies, meaning outdoor low-frequency noise transmits efficiently into sleeping spaces.

Distance Estimated Outdoor SPL Estimated Indoor SPL Health Relevance

- 0.6 miles ~58 dB ~48–53 dB Above night-time threshold
- 1.25 miles ~52 dB ~42–47 dB Above night-time threshold
- 2.00 miles ~48 dB ~38–43 dB Borderline / biologically active
- 5 miles ~40 dB ~30-35 dB Below observed effect range
- 10 miles ~34 dB ~24–29 dB Well below thresholds

Distance Required to Achieve Health-Protective Levels

To reduce sound from 118 dB to 40 dB, the required attenuation is:

$$\Delta L = 78\ dB$$

Using the propagation equation:

$$78 = 20 \cdot \log_{10}(r / 3.3)$$

$$\log_{10}(r / 3.3) = 3.9$$

$$r / 3.3 = 7{,}943$$

$$r \approx \textbf{26,200 feet (≈ 5miles)}$$

Adjustment for Low-Frequency Noise and Real-World Conditions

Low-frequency noise requires additional protection due to:

- Minimal atmospheric absorption
- High penetration into residential structures
- Aggregation of multiple coherent sources
- Nighttime atmospheric inversions
- Predictive modeling uncertainty (±5 dB)

Adding a 15–20 dB safety margin to account for scaling from 150 MW to 1 GW plus low frequency uncertainty:

- 85 dB total attenuation → ~5.9 miles
- 90 dB total attenuation → ~12.3 miles

This yields:

- 5 miles as a minimum defensible precautionary setback
- 10-12 miles as a robust health-protective distance under worst-case conditions

This represents the theoretical distance required under ideal conditions to ensure compliance with night-time health-based thresholds using distance alone. 5 miles does not account for any mechanical and design variation, providing no safety or design margin, which is why the **<u>10-mile setback is recommended</u>**.

Conclusion

Quantitative sound propagation modeling demonstrates that high-power, continuous low-frequency industrial noise sources with source levels on the order of 118 dB require separation distances of several miles to ensure that residential sound levels remain below established health-based thresholds. Modeling indicates that at approximately 5 miles, predicted outdoor sound levels fall to roughly 40 dB, which—under idealized assumptions—would generally be at or just above levels associated with sleep disturbance and stress activation. However, substantial uncertainty remains due to variability in facility design, source aggregation, operational modes, atmospheric conditions, and the known persistence of low-frequency noise. When these uncertainties are incorporated, reliance on a nominal 5-mile setback provides only a minimal margin of safety. **Accordingly, health-**

protective land-use planning warrants setbacks extending beyond 5 miles to ensure that exposure limits are not exceeded under worst-case and cumulative operating conditions.

Additional Non-Noise Risk Considerations Supporting Greater Separation

While noise is the most persistent exposure pathway, it is not the only relevant risk associated with hyperscale data centers. Greater setback distances also reduce exposure to low-probability, high-consequence events, which are standard considerations in land-use safety planning.

Mechanical Failure and Projectile Risk

High-capacity cooling fans and rotating equipment operate at substantial angular momentum. Although catastrophic failures are rare, engineering safety analysis recognizes that:

1. Blade or rotor failure can eject high-energy fragments
2. Protective housing is designed to mitigate, not eliminate, risk
3. Consequence severity decreases rapidly with distance

Setbacks provide a passive safety buffer that does not rely on perfect equipment performance or maintenance.

Fire Risk and Toxic Smoke Plumes

Hyperscale data centers contain

1. Large quantities of electrical equipment
2. High-energy power distribution systems
3. Backup generators and potential fuel storage
4. Plastics, insulation, and electronic components that emit toxic combustion products

In the event of a major fire:

1. Toxic smoke plumes can travel miles downwind into residential areas
2. Combustion products may include particulates, nitrogen oxides, carbon monoxide, and toxic organic compounds
3. Nighttime atmospheric conditions can trap smoke near ground level

Greater separation distances reduce the probability that residential populations are exposed to acute smoke or toxic byproducts, particularly during worst-case meteorological conditions.

Reference:

[1] Strom Mark, “Air-cooled chiller screening noise analysis with preliminary building project information”, Inter-noise 202, 1-5 August, Washinton DC.

[2] https://www.midamericaengine.com/what-are-noise-and-dba-in-diesel-generators/

[3] https://noiseawareness.org/info-center/common-noise-levels/

Health and Environmental Impacts

Introduction

Environmental noise is the unwanted or harmful sound arising from human activities outside of occupational settings. Environmental noise has increasingly been recognized as a determinant of public health, particularly in residential communities where exposure is chronic, involuntary, and occurs during critical periods of rest, learning, and development. Unlike occupational noise, which is regulated to prevent hearing loss, environmental noise exerts its effects through non-auditory pathways, including stress activation, sleep disturbance, and cognitive interference.

The World Health Organization (WHO) Environmental Noise Guidelines synthesized evidence from over 300 epidemiological, experimental, and mechanistic studies, concluding that adverse health effects occur at sound levels substantially below those required to cause hearing damage (WHO, 2018). An umbrella review conducted by Chen et al. (2023), which incorporated 23 systematic reviews and 64 meta-analyses covering 31 distinct health outcomes demonstrated statistically significant associations between long-term environmental noise exposure and cardiovascular disease, metabolic disorders, sleep disturbance, mental health outcomes, and adverse developmental effects. These associations were consistently observed at day–night average sound levels (L_den) beginning between 45 and 55 dB(A), a range commonly encountered in residential environments.

Noise Metrics and Exposure Thresholds

Environmental noise exposure is quantified using standardized metrics such as L_den, representing a 24-hour average sound level with penalties applied to evening and night-time noise, and L_night, the average sound level during night-time hours. These metrics reflect cumulative exposure rather than transient peaks and are widely used in epidemiological research and regulatory frameworks.

Based on systematic evaluations, the WHO (2018) recommended that night-time noise levels should not exceed 40 dB(A) L_night to prevent adverse sleep outcomes and that day–night average levels should not exceed 45 dB(A) L_den to minimize broader health effects. These thresholds are derived from observed exposure–response relationships documented across hundreds of studies. Measurable health effects have been reported at and above these levels even in populations without preexisting disease, indicating that these thresholds are relevant to the general population, including children.

Health Effects of Environmental Noise in Adults

Cardiovascular Disease and Metabolic Outcomes

The association between environmental noise and cardiovascular disease is extensively documented. Münzel et al. (2014) synthesized 24 cohort and case-control studies including over 1.2 million participants. They reported relative risk (RR) increases for hypertension ranging from 1.07 to 1.17 per 10 dB(A) increase in road traffic noise above 50 dB(A). Associations with ischemic heart disease and myocardial infarction were observed at L_den values beginning around 55 dB(A).

Chen et al. (2023) corroborated these findings through an umbrella review of 18 meta-analyses examining cardiovascular outcomes. Across analyses, pooled risk estimates consistently indicated elevated risks for hypertension, coronary heart disease, and stroke associated with long-term residential noise exposure. It's important to note these associations persisted after adjustment for air pollution and socioeconomic factors, suggesting that noise represents an independent cardiovascular risk factor.

Study	Sample Size	Exposure Range dB(A)	Outcome	Effect Size/Risk
Münzel et al., 2014	1,200,000	50–65 L_den	Hypertension	RR 1.07–1.17 per 10 dB(A)
Foraster et al., 2017	4,886	50–70 L_den	Coronary Heart Disease	HR 1.14 per 10 dB(A)
Chen et al., 2023 (umbrella review)	31 studies	45–60 L_den	Cardiovascular	Consistent increased risk

Table 4 – Adult Cardiovascular Outcomes

Sleep Disturbance, Stress, and Mental Health

Sleep disturbance is among the earliest indicators of harmful noise exposure. Passchier-Vermeer and Passchier (2000) reviewed 43 laboratory and field studies and found night-time noise levels of approximately 45 dB(A) are sufficient to cause sleep fragmentation, increased sleep latency, and altered sleep architecture.

Grocott et al. (2025) conducted a systematic review of 31 population-based studies and reported increased odds of anxiety and depressive symptoms associated with long-term environmental noise exposure, predominantly within 50–60 dB(A). Mechanistic studies demonstrate that noise annoyance and perceived lack of control mediate stress responses and adverse mental health outcomes.

Environmental Noise and Child Development (Ages 1–18)

Scope of the Evidence Base

Children are uniquely vulnerable to environmental noise due to ongoing neurological, cognitive, and physiological development. The WHO (2018) identified over 100 studies specifically addressing noise exposure and child health. Stansfeld and Clark (2015) synthesized 29 epidemiological studies examining cognitive, behavioral, and physiological outcomes in children exposed to environmental noise in residential and school settings.

Cognitive Development and Learning Outcomes

Evidence from longitudinal cohort studies, school-based investigations, and meta-analyses supports the link between environmental noise and impaired cognitive development. A meta-analysis published in 2025 synthesized data from 8 primary studies involving 3,385 children and adolescents, reporting a pooled standardized mean difference of −0.544 (95% CI: −0.616 to −0.472, $p < 0.0001$) for cognitive performance outcomes, including memory, executive function, and learning ability, in higher-noise vs. lower-noise environments.

The BREATHE cohort study (Sunyer et al., 2015) followed 2,680 children aged 7–10 years at 38 schools. School-based traffic noise ranged from 45 to 65 dB(A). Each 5 dB(A) increase was associated with slower growth in working memory and attentional capacity over one year. Children attending schools averaging 63.6 dB(A) exhibited approximately 23.5%

slower working memory development and 4–5% slower attention development compared to peers in quieter schools.

Study	Sample Size	Age (years)	Exposure dB(A)	Outcome	Effect/Finding
Sunyer et al., 2015 (BREATHE cohort)	2,680	7-10	45-65 L_den at school	Working memory	5 dB(A) increase → 23.5% slower working memory growth
2025 Cohort Study	1,221	2–7	63.5 L_den residential	Language / Vocabulary	Lower expressive vocabulary scores; delayed literacy
Noise & Health Journal, 2025	1,900	6-12	50-65 L_den	Attention / Behavior	10 dB(A) increase → 1.2-1.3% higher inattention scores
European Cohort Analysis, 2025	919	6-11	50-60 L_den	Physiological stress (allostatic load)	Higher noise → elevated cumulative stress
Population-based Sleep Study	9,354	6–12	>55 L_night	Sleep disruption	Shorter sleep, daytime fatigue, emotional dysregulation

Table 5 – Child Cognitive and Developmental Outcomes

Language Acquisition and Early Childhood Development

Noise exposure during early childhood interferes with language acquisition. A 2025 cohort study of 1,221 children aged 2–7 found that residential noise averaging 63.5 dB(A) was associated with lower expressive vocabulary scores and delayed literacy milestones. Early language skills predict later academic achievement and social functioning, highlighting the long-term consequences of environmental noise.

Behavioral Outcomes, Attention, and Stress Physiology

Behavioral outcomes have been linked to environmental noise. Norwegian cohort data (n≈1,900) showed 1.2–1.3% higher inattention per 10 dB(A) increase in residential road traffic noise. Noise & Health (2025) reported significant associations between residential noise exposure and behavioral problems, including hyperactivity and emotional symptoms.

Physiological stress markers are also affected. An analysis of 919 children (6–11 years) from six European cohorts found that road traffic noise was associated with elevated allostatic load, a cumulative measure of physiological stress (European Environment Agency, 2024). These findings provide biological plausibility for cognitive and behavioral effects

Sleep Disturbance in Children

Sleep disruption is a key pathway linking noise exposure to developmental outcomes. In a population-based study (n=9,354), night-time noise above 55 dB(A) was associated with shorter sleep duration, increased daytime fatigue, and impaired emotional regulation. Sleep is essential for memory consolidation, growth, and emotional development, emphasizing the importance of reducing chronic night-time noise exposure in children.

Hyperscale AI Data Centers as Emerging Noise Sources

Acoustic Characteristics of Hyperscale Facilities

Hyperscale AI data centers operate continuously and use extensive mechanical cooling systems, including high-capacity fans, chillers, cooling towers, and backup generators. Studies show these facilities produce continuous broadband noise, dominated by low-frequency components (31.5–125 Hz). Without mitigation, boundary noise levels often reach 45–65 dB(A), overlapping with thresholds associated with sleep disturbance and cognitive effects (Grocott et al., 2025).

Health-Relevant Evidence and Research Gaps

Theres an absence of epidemiological studies examining health outcomes from data center noise. Peer-reviewed research on large data centers identifies noise from HVAC and generators as a plausible exposure pathway for sleep disturbance and stress. Mixed-method studies of communities near 11 data centers reported statistically significant increases in self-reported sleep disturbance and perceived stress. While these studies do not establish causality, they align with published studies correlating noise & health.

Study / Source	**Location / Sample**	**Noise Range (dB(A))**	**Dominant Frequency**	**Observed Community Impact**
Field Acoustic Study, 2024	11 data centers	45–65 L_den (boundary)	31–125 Hz	Baseline noise elevated; potential sleep disturbance
Mixed-Methods Community Survey, 2023	11 data centers	47–63 L_den	Broadband	Self-reported stress and sleep disruption above community norms
Engineering Noise Modeling	NA	45–60 L_den	Low frequency	Noise mitigation required to meet WHO residential night-time limits

Table 6 – Hyperscale AI Data Center Noise Measurements

Noise Metric	**WHO Threshold**	**Observed Impact in Adults**	**Observed Impact in Children**	**Observed Impact Near AI Data Centers**
L_den (24h)	45 dB(A)	Increase in Cardiovascular risk at ≥50 dB(A)	Cognitive deficits, loss of attention	Boundary noise often 45–65 dB(A)
L_night	40 dB(A)	Sleep fragmentation at ≥45 dB(A)	Shorter sleep, emotional dysregulation	Night-time noise 47–63 dB(A)

Table 7 – Summary: WHO Guidelines vs Observed Impacts

Conclusions

Evidence from over 300 adult studies, 100 child-specific studies, and multiple meta-analyses demonstrates that chronic environmental noise exposure at or above 45 dB(A) poses measurable health risks. Children are particularly vulnerable, with documented effects on cognitive development, language acquisition, behavior, sleep, and physiological stress regulation.

Hyperscale AI data centers represent a novel source of continuous mechanical noise operating within exposure ranges associated with adverse outcomes. While direct epidemiological studies specific to these facilities are lacking, acoustic measurements, community reports, and established noise–health relationships support the application of precautionary, health-based regulations.

Economic Impact vs Community Cost

The information and historical trends related to this new type of development, Hyperscale AI datacenters, are limited. The novelty and magnitude of these heavy industrial constructions cannot be yet quantified without sufficient time passing and normalizing the data to remove any external impact outside the scope. However, assumptions can be made, and similarities to other types of developments can be leveraged to get us at least a “close enough” answer as to the economic impact neighboring communities will face with the construction of a hyperscale AI datacenter.

There are three key economic impact themes that warrant discussion: real estate price impact, tax incentives vs. long term liabilities, job creation.

Real estate pricing impact on neighboring communities

First and foremost, we will address the issue of real estate pricing impact. The calculations and values that will be presented in this section are not guaranteed or final, they are approximations based on active heavy industrial use (such as a 1GW Hyperscale Facility) which produces continuous (24/7) noise, visual blight (light pollution), traffic, emissions, and risk perception. These impacts can increase (make things worse) if there are unmitigated continuous low-frequency noise, nighttime operation, visible stacks, flares, or cooling plumes, documented incidents or violations, and prevailing wind toward neighborhoods. The impact can also be decreased with substantial heavy landscaping and buffers, no nighttime operation (highly improbable as datacenters required 24/7 operation), strong housing demand.

Studies listed below have shown these impacts are not just anecdotal, but data driven. **The Impact of Industrial Sites on Residential Property Values: A Hedonic Pricing Analysis for the Netherlands** by Friso de Vor & Henri L.F. de Groot, showed the statistically significant negative effect of large industrial facilities near neighborhoods, with the impact diminishing proportional distance. Searching closer to home, the EPA has published “**The Property Value Impacts of Industrial Chemical Accidents”** by Dennis Guignet, Robin R. Jenkins, James Belke, Henry Mason, which highlights a 5-7% price impact on real estate property near industrial facilities who carry inherent risks as well as further impact after reportable accidents occur at these facilities.

These studies are further corroborated by past events such as the 1948 Donora Smog event in Pennsylvania where industrial air pollution drove property values to decrease more than 10%, or the Exide Battery Recycling lead contamination in Vernon, CA which significantly impacted property prices as well as the environment, requiring government intervention. I want to clarify that neither of these events relate 1-to-1 with a hyperscale datacenter, but it allows for the conclusion that heavy industrial construction and activity have a property value impact greater than zero.

The previous studies and information were queried to generate approximate values for property value impact in the Loxahatchee, FL area provided Project Tango is approved and built. Utilizing the general location of the initial 6 datacenters as the point of reference ("ground zero"), the following impacts are presented across increasing distance increments until impact can no longer be reliably attributed to the industrial construction as distinct from other market or environmental factors.

Distance from site	Typical price impact	Notes
0 – 2,000 ft	**−15% to −25%**	noise, vibration, visual dominance, odor, fear perception
2,000 – 4,000 ft	**−10% to −18%**	Still within "disamenity zone" in most studies
4,000 ft – 1 mile	**−6% to −12%**	Clear discount persists; buyer pool shrinks
1.0 – 1.5 miles	**−4% to −8%**	Distance decay begins; impact varies by wind/noise direction
1.5 – 2.0 miles	**−2% to −5%**	Often measurable but modest
2.0 – 2.5 miles	−1% to −4%	Usually only detectable statistically
2.5 – 3.0 miles	-3% to 0%	Marginal impact
3.0 – 3.5 miles	-2% to 0%	Often disappears in strong markets
3.5 – 4.0 miles	-1.5% to 0%	Mostly perception-driven
4.0 – 4.5 miles	-1% to 0%	Near noise-free threshold
4.5 – 5.0 miles	~0%	Typically, no measurable effect

Table 8 – Real estate pricing impact vs. distance

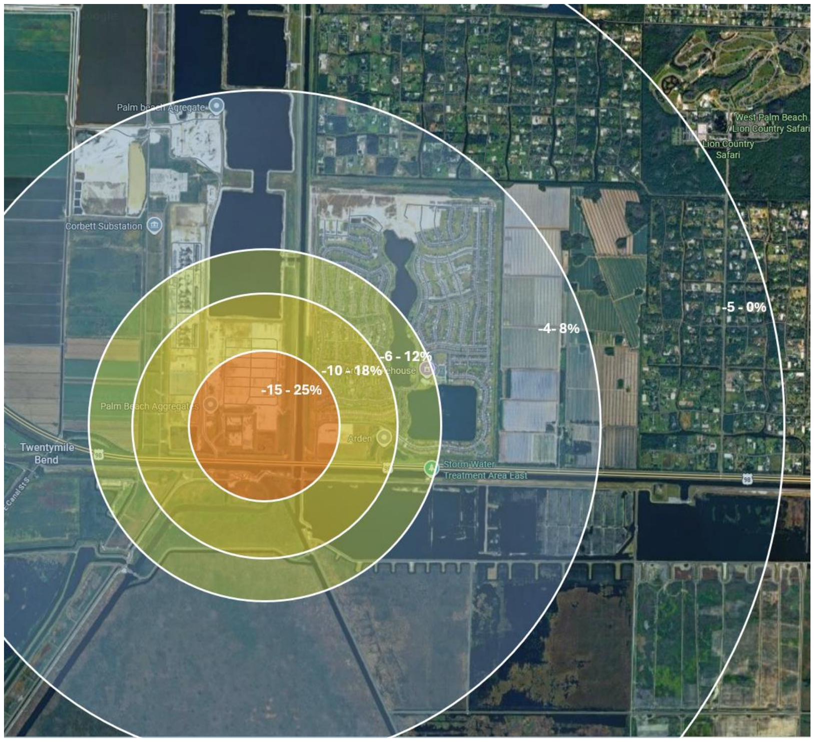

Figure 6 – Property Value vs. Distance Heatmap

Tax incentives vs long-term liabilities

While Palm Beach County and the State of Florida offer robust incentive programs — including ad valorem tax exemptions, job growth grants, and capital investment tax credits designed to attract high-impact facilities — these incentives represent a deferred or reduced revenue stream for local government. Over the incentive period, municipalities may forego millions in property tax revenue that could otherwise support public services. At the same time, if nearby residential property values experience downward pressure due to industrial externalities, the broader tax base may grow more slowly than projected, compounding long-term fiscal impacts. Additionally, with the county having to support the new facility, there will be increased public service costs for added infrastructure, especially in the utilities category, noise mitigation contingencies, traffic management during construction, and environmental monitoring, not to mention the perception effect which directly affect Palm Beach County, since the perceived nuisance or pollution sources of these facilities can dampen investment into nearby housing and commercial development.

Job creation myths for hyperscale facilities

The developer will try and sway popular opinion using "job creation" as a primary benefit to the area. Although there is some partial truth to that, specifically in the short-term, long-term job creation from hyperscale facilities is inherently low, too low to offset the other impacts listed in this paper. As an example, Elon Musks xAI data center located near Memphis carries an initial load of 150MW with expectations to grow to more than 1GW capacity over the next few years. During its construction, workforce peaks at roughly 300 workers for 1-2 years, but xAI demonstrated these centers can be built in <6 months. After the center is fully operational, permanent staff drops down to <50 FTE (Full time Equivalent). In contrast, a 2.5-3.0 million square foot warehouse would produce 500-1000 permanent jobs. Additional support to the datacenter will not add more full-time employees but rather utilize remote or temporary contracted labor.

Assumptions:

1. Facility Size: 1 GW IT load (typical hyperscale AI or cloud data center)
2. Construction Phase: 12–24 months, peak employment ~4–5 workers per MW (Maryland Dept. of Commerce, 2018)
3. Permanent Operations: Linear ~0.5–1 FTE per MW IT load (NYT, 2022, TechRadar, 2025). Log scale diminishing returns is more realistic. *See chart below*
4. Local multiplier: 1.5–2 indirect jobs per FTE (Barton, 2019, Economic Development Quarterly)

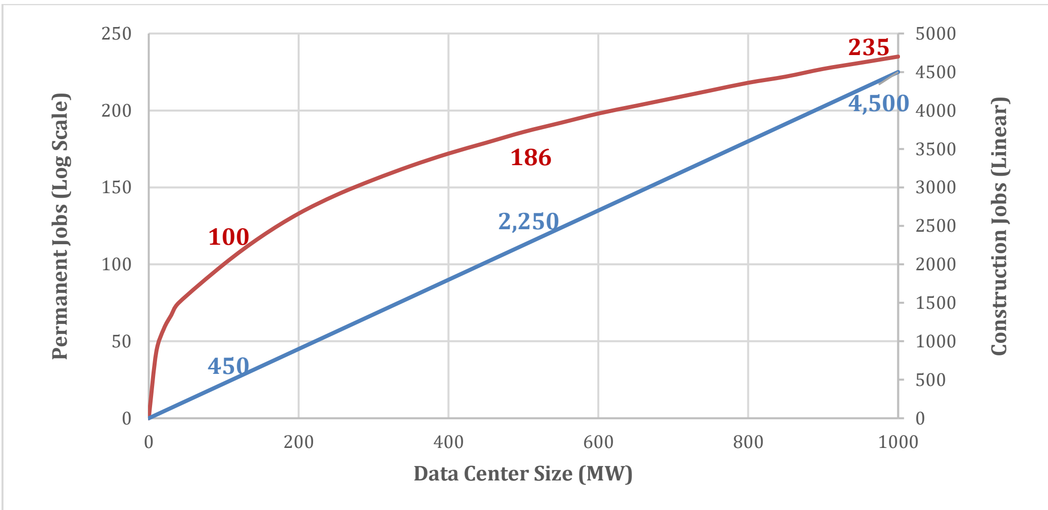

Figure 7 – Permanent & Construction Jobs vs. Data Center Size

Although there are published articles which indicate a linear projection of jobs created vs. data center size (in MW), a linear scale is not realistic. As your data center grows, there are tasks and scope that can continue to be managed by the same body of employees, making a logarithmic scale more representative of actual job projections.

Water Consumption, Pollution and Thermal Contamination

Overview of Water Consumption and its Metrics

The conventional measurement of a facility's water usage is called Water Usage Effectiveness (WUE). WUE is a rate measured in liters per kilowatt hour (kWh).

The typical WUE for datacenters are as follows:

- Average datacenter: 1.8–1.9 L/kWh.
- Datacenters with high-efficiency evaporative systems: 0.8–1.2 L/kWh.
- Datacenters with closed-loop systems: 0.2–0.5 L/kWh.
- Datacenters with air-cooled systems: 0.0–0.1 L/kWh (minimal direct water)

The differences in WUE are critical as it substantiates the earlier claim that the cooling system choice will be the primary driver in water use.

Water use of a 1GW facility

To convert WUE into *annual* water use for a 1 GW (1000 MW) facility:

1 GW = 1,000,000 kW

Assuming continuous operation at full load:

$$1{,}000{,}000\ kW \times 24\ h/day \times 365\ days = 8.76 \times 10^9\ kWh/year$$

Apply WUE ranges:

Open-Loop Evaporative Cooling (Water-Intensive)

WUE of 1.8–2.0 L/kWh

$$8.76 \times 10^9\ kWh \times \frac{1.8\ L}{kWh} = 15.8 \times 10^9\ L/yr$$

$$= \mathbf{4.2\ Billion\ gallons\ per\ year}$$

Older or less efficient systems may exceed ~2 L/kWh increasing usage above 4.2 billion gallons per year. According to the Ketos company, data centers use **millions of gallons per MW** annually with traditional cooling, especially in hotter climates.

A 1 GW facility with typical evaporative cooling could consume potable water in excess of **3.5 billion gallons of water annually** from local sources. For comparison this is 50% more than the consumption of the entire city of wellington.

Closed-Loop or Low-Loss Systems

WUE of 0.2–0.5 L/kWh

$$8.76 \times 10^9\ kWh \times \frac{0.35\ L}{kWh} = 3.1 \times 10^9\ L/yr$$

$$= \mathbf{820\ million\ gallons\ per\ year}$$

These systems reuse water internally and lose much less to evaporation; most is recirculated and not disposed of continuously.

Air-Cooled Systems (Minimal Water Use)

WUE of 0.0–0.1 L/kWh

$$8.76 \times 10^9\ kWh \times \frac{0.05\ L}{kWh} = 4.38\ \times\ 10^8\ L/yr$$

$$= \mathbf{438\ million\ gallons\ per\ year}$$

Air cooling uses fans and ambient air, drastically reducing water demand compared to evaporative systems. This, however, might not be the best approach for a Florida based datacenter as the high air temperatures during the summer months would decrease the efficiency of this system.

Aquifer drawdown concerns

Florida's drinking water system is heavily dependent on the Floridan Aquifer, which supplies drinking water to most of the state. The abuse of the aquifer has caused the water levels to lower, and the widespread groundwater pumping has reduced spring flows and increased saltwater intrusion.

This risk became evident in Manatee County very recently. They have publicly declared a water shortage and implemented consumption restrictions as their water sources are severely stressed due to drought and high demand.

Another case is in Cape Coral, Lee County, where the Mid-Hawthorn aquifer hit record low levels due to overuse and drought. The South Florida Water Management District (SFWMD) has issued Phase IV water shortage orders limiting irrigation and water withdrawals to prevent permanent damage to the aquifer. Lee county is working on drilling deeper into the aquifer to see if there is additional water that the aquifer can provide. This further proves the constraints that Florida has been under for the past few years related to potable water supply, and the message is clear: residents can no longer reliably use shallow wells, and risk of depleting the aquifer is now a concern.

Risks to ecosystems and groundwater systems

Thermal impacts

Warm water discharged from cooling systems increases local water body temperatures, altering dissolved oxygen and harming aquatic life. Existing EPA ecological assessments and guidance consider these impacts as real concerns, as this thermal pollution impacts fish, wildlife, and their ecosystems.

Under the Clean Water Act §316(a) and state water-quality standards, the maximum allowable temperature increase in receiving waters (river, lake, estuary, canal, or coastal water) is typically ≤ 2.8 °C (5 °F) above receiving water temperature.

Absolute temperature caps often range 18–32 °C (64-90 °F), depending on waterbody classification (freshwater vs estuarine). This is increasingly important as Florida waterways are already hot in the summer, so even if the water being introduced meets the < 5°F requirement, it could increase the water temperature above the 90 °F upper limit and disrupt the aquatic ecosystem.

These limits exist because small temperature increases materially alter aquatic ecosystems. In Florida,

- Phytoplankton & harmful algae show accelerated growth with +1–2 °C (+1.8 °F) warming.
- Karenia brevis (Florida red tide organism) growth rates increase under warm, stratified, nutrient-rich water conditions.
- Fish and invertebrate stress responses begin around +1–3 °C (+1-3.6 °F), with dissolved oxygen dropping ~5–10% per °C (~2.7-5.5% per °F)

Contamination and blowdown

Evaporative cooling systems need periodic discharge ("blowdown") to control mineral buildup, which can introduce minerals and treatment chemicals into wastewater. This water may require treatment to prevent ecosystem impacts.

Common additives include:
- **Biocides:** chlorine, bromine, isothiazolin
- **Corrosion inhibitors:** phosphates, molybdates
- **Antiscalants:** polymers, chelants

Blowdown typically represents 15–30% of total cooling water flow.

From the consumption calculated in section *"Water use of a 1GW facility",* 15-30% blowdown would yield volume ranges between 0.63-1.26 billion gallons per year.

The water released during the blowback is,
- Warmer than ambient
- Higher in dissolved solids
- Chemically active

Chlorinated compounds are toxic to plankton at ppb–ppm (part per billion-part per million) levels. **Phosphates & nitrogen** act as nutrient loading, worsening algal blooms, hypoxia, and red tide persistence. The EPA and academic journals confirm these impacts as can be reviewed in the CWA Thermal Issues Merrimack Station response to comments *(NH0001465).*

Even when legally permitted, high-volume cooling water withdrawals and blowdown discharges from 1 GW-scale data centers introduce measurable thermal, chemical, and hydrological stresses that are known contributors to algal blooms, long-term aquifer degradation in Florida-type environments, and significant impact to Florida native and migratory wildlife species.

Wildlife, Ecosystem, and Heat Island Effects

We covered in the previous section some of the impact of water consumption and the introduction of wastewater into the environment. Although water consumption and pollution will significantly impact the Florida aquatic wildlife, other species native to Florida will be affected by the high and low frequency noise, the added light pollution 24/7, and the heat introduced into the environment by the mechanical equipment at the site.

Heat Island

Heat islands are localized areas where temperatures are consistently higher than the surrounding areas due to dense infrastructure, heat-emitting activities, and reduced natural cooling from vegetation and water. **Large industrial facilities and data centers** contribute through continuous heat release, extensive paved surfaces, and high electricity use requiring significant heat rejection. In warm regions like Florida, heat islands can elevate nighttime temperatures, increase cooling demand, and exacerbate thermal stress on nearby ecosystems and communities.

Below, you will find an assessment of a 1GW datacenter's impact to the surrounding air temperature.

Assumptions:

1. Heat rejected: 1.08 GW thermal
2. Wind speed: 5 m/s (11 mph)
3. Neutral atmospheric conditions (Pasquill Stability Class D)
4. Distributed air heat exchangers around the datacenter campus
5. Daytime or mixed conditions
6. Values represent average temperature rise, not short plume spikes

Utilizing these assumptions, above, we can calculate the delta Temperature at various distances from the facility.

Heat rejected: $\dot{Q} = 1.08 \times 10^9$ W

Wind speed: $U = 5$ m/s

Air properties: Density - $\rho \approx 1.2\ \mathrm{kg/m^3}$
Specific heat - $c_p \approx 1005 \frac{J}{kg \cdot K}$

$$\textbf{Delta Temperature}: \Delta T(x) = \frac{\dot{Q}}{\rho c_p U A_{eff}(x)}$$

$$A_{eff}(x) = effective\ cross\ sectional\ area\ of\ the\ heat\ plume$$
$$x = distance\ downwind$$

$$\textbf{Effective Plume Area: } A_{eff}(x) = 2\pi\sigma_y\sigma_z$$

$$\textbf{Gaussian Plume: } \sigma_y = ax^{0.9}, \sigma_z = bx^{0.5}$$

Combining the three equations yields:

$$\textbf{Delta Temperature}: \Delta T(x) = \frac{\dot{Q}}{\rho c_p U\left(2\pi(ax^{0.9})(bx^{0.5})\right)}$$

For a Pasquill D neutral atmospheric conditions, typical EPA/AERMOD values for **a** and **b** for preliminary analysis (AERMOD model should be run for high-fidelity worst-case results with a Pasquill F) are as follows:

$$a = 0.08\ , b = 0.06$$

$$\Delta T(x) = \frac{1.08 \times 10^9}{1.2 \times 1005 \times 5\left(2\pi(0.08x^{0.9})(0.06x^{0.5})\right)}$$

$$\Delta T(x) = \left(\frac{1.08 \times 10^9}{181.86}\right)x^{-1.4}$$

$$\boldsymbol{\Delta T(x) = 5.9 \times 10^6 x^{-1.4}}$$

This table is **illustrative only**. For accurate results, an AERMOD or CFD analysis is required utilizing local wind rose data.

Distance from Facility	ΔT (°F)	What this feels like
50 m (165 ft)	14 – 22 °F	Obvious heat blast, uncomfortable
100 m (330 ft)	9 – 14 °F	Feels like standing near asphalt on hot day
250 m (820 ft)	4 – 7 °F	Noticeably warmer than surroundings
500 m (0.3 mi)	2 – 4 °F	Subtle but measurable
1 km (0.6 mi)	0.5 – 1.5 °F	Instrument-detectable, barely perceptible
2 km (1.2 mi)	0.2 – 0.5 °F	Background noise level
5 km (3.1 mi)	<0.2 °F	Effectively gone

Table 9 – Estimated Ambient Temperature Increase vs Distance Downwind from facility center

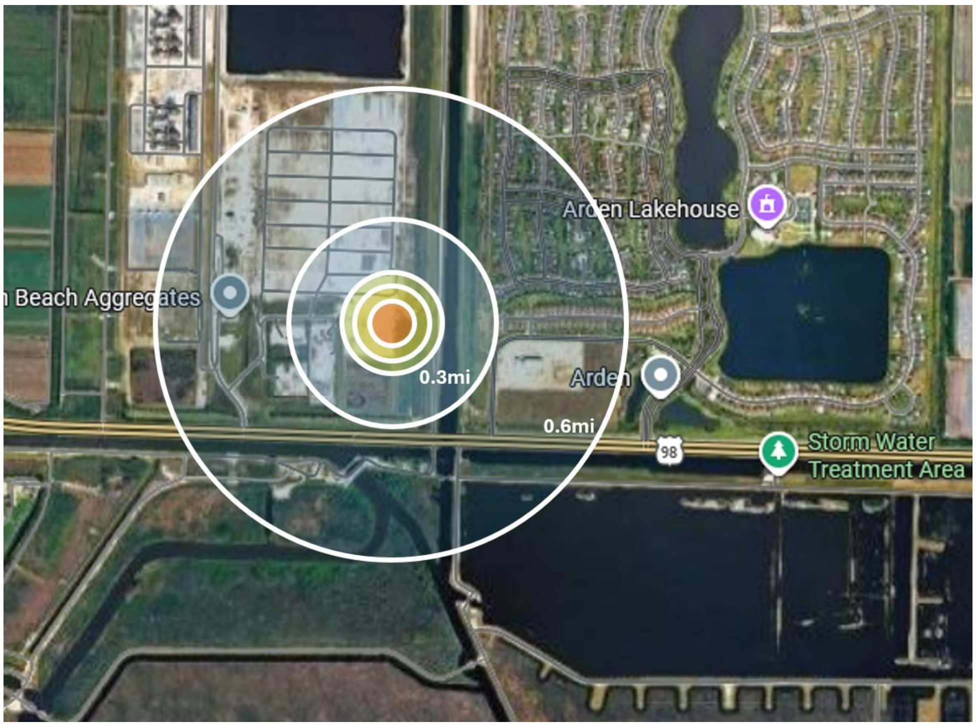

Figure 8 – Heatmap of heat island (Temperature Increase) vs. Distance

The map above follows the distance measurements in the table starting with 165ft in orange/red and moves outwards until the last circle at 0.6 miles. These calculations are to illustrate the increase in temperature to the neighboring areas, especially the everglades south of the development, the wildlife corridor east, and the impact to any animals and wildlife that inhabit the areas adjacent to the proposed site.

Impact of Datacenters on Wildlife

Heavy industrial facilities such as hyperscale datacenters can introduce negative factors into local ecosystems which disrupt wildlife and vegetation. A large facility like the one proposed as Project Tango would introduce heat, artificial light at night (ALAN), increased water use and discharge of warm water, low and high frequency noise, and habitat fragmentation. Continuous heat release as demonstrated in the last section contributes to localized warming and heat-island amplification raising both water and air temperature. Impacts of higher temperature water introduction into the neighboring canals was discussed in the previous section, nonetheless, it warrants to reiterate that increase in water temperature is a prime contributor to the altering of local food chains. Small increases in temperature also affect land-based ectotherms such as reptiles, amphibians, and insects, reducing breeding success.

Artificial light compounds these effects, especially for migratory birds as they rely on natural dark skies and celestial cues for navigation. Artificial light pollution at night can disorient them, increase collisions, and cause energy-depleting detours (Yadav, 2025) (Cabrera-Cruz, 2018). Sleep disruption and disrupted circadian rhythms are evident, and with added light, animals who utilize darkness as defense have increased risk of predation.

Added noise, especially low frequency disrupts navigation, interferes with animal communication, and hurts animals who depend on sound for predator detection and mate attraction (Environmental Evidence Journal, 2019).

The combination of these stressors can fragment habitats even without physical barriers. Wildlife may avoid areas with elevated heat, light, or noise, effectively shrinking usable habitat patches. Paved surfaces create thermal and acoustic barriers that disrupt movement. Fragmentation reduces connectivity between suitable habitats, limiting gene flow and variability, increasing local population vulnerability especially for species with limited dispersal or strict habitat requirements (ScienceDirect, 2023). Migratory corridors will be disrupted by light and noise, and neighboring species might require them to migrate or move to marginal areas to survive.

Below, you will find a table summarizing the impacts on the wildlife and environment as a function of distance from the reference location ("ground zero").

Distance	Temperature ΔT (°C)	Light at Night	Water Impact (ΔT / Flow)	Noise	Likely Ecological Effects	Species / Habitats Affected
50 m (165 ft)	8–12	Very high	Stormwater ponds & streams highly warmed; high withdrawal	Very high	Avoidance by heat/light sensitive species; high stress; aquatic oxygen depletion	Amphibians, reptiles, small mammals, macroinvertebrates, pond edges
100 m (330 ft)	5–8	High	Warmed water; moderate flow impact	High	Reduced foraging, altered behavior; possible nest avoidance	Songbirds, small terrestrial mammals, insects, riparian vegetation
250 m (820 ft)	2–4	Moderate	Minor water warming; partial dilution	Moderate	Subtle behavioral changes; minor habitat avoidance	Birds, bats, reptiles, wetland edge species
500 m (0.3 mi)	1–2	Low–moderate	Water effects minimal; normal oxygen	Moderate–low	Reduced reproductive success for sensitive species; some habitat fragmentation	Migratory birds passing through; amphibians, small mammals
1 km (0.6 mi)	0.3–0.8	Low	Water and flow largely unaffected	Low	Slight disruption; negligible mortality	Generalist species; large mammals less affected
2 km (1.2 mi)	0.1–0.3	Very low	Minimal	Low	Background conditions	Most wildlife unaffected
5 km (3.1 mi)	<0.1	Negligible	None	Negligible	No measurable ecological effects	All local species unaffected

Table 10 – Summarized Effects on Wildlife

The modeled ΔT values in Table X represent hourly averages under typical operating conditions. The qualitative discussion of ecosystem impacts reflects the cumulative effect of continuous heat release across multiple hours and facility operations, consistent with the quantitative ΔT data.

Energy Demand & Grid Stress

The energy demand and stress on the Florida Power Grid are a topic that warrants extensive discussion. Although we know there are deals already made between the developer and FPL, covered by NDAs (Non-Disclosure Agreements), we can extrapolate from the facts we have that FPL has agreed to provide the power to this site for a given cost per kW/h, and it also tells us that the size of this hyperscale datacenter is larger than we originally imagined as the information that would allow us to determine with certainty the size of this project would be the expected power consumption, which is secret because of that NDA. To continue with the theme of the 1 GW hyperscale datacenter, which, as previously stated, carries with the theme of the xAI datacenter built by Elon Musk. Although the xAI datacenter is not at the 1 GW mark to start, it is currently 150 MW with plans already in place to scale it up 8-10x its current capacity.
The implications of a single site drawing 1 GW of power from the Florida FPL power grid, without sufficient margin in the FPL capacity, would create conditions similar to those experienced in California during the rolling blackouts. For us to determine the risk, we will start with understanding the load required vs. the load available in 2025, followed by an analysis of what potential grid instability concerns that will generate.

Load Required vs. Load Available

The discussion on the load required from a data center is simple. Usually, the energy is marketed as part of the project, "150MW datacenter", "300MW datacenter", but without full transparency and disclosure from the developer or the end customer, we can only estimate the magnitude based on the size and existing power-density of the AI processing chips in the market today. for this section, we will assume a 1 GW load required, which, for comparison's sake, is the power required for ~700,000 homes. The number sounds large because it is. Modern AI and high-performance computing data centers truly operate at this scale, consuming vast, steady power rather than intermittent peaks. This constant demand stands in contrast to most residential or commercial uses, which fluctuate throughout the day.

Florida Power & Light Company (FPL) operates a **net capacity of about 37 GW** as of 2025, with a demand matching closely to the power available figure. That capacity must serve all existing loads (homes, businesses, industry, cooling demand in summer, etc.) before additional industrial loads are added.

While planners target a planning **reserve margin** (extra capacity beyond expected peak demand) of around **15%** to maintain reliability, those calculations assume existing growth patterns and distributed load growth; in other words, improvements and added capacity are planned based on prior growth patterns. A sudden large, continuous load like 1 GW changes the equation. It reduces the available margin well below the 15%, straining the ability of the power grid to manage peak demand without reserve resources being brought online.

Local grid instability concerns

Grid operators work on a balance of supply vs demand in real time. If demand outpaces supply, utilities must shed electric load, sometimes through controlled rolling outages, to prevent a total collapse. In California, during extreme heat waves, demand skyrocketed (air conditioning loads + system stress), forcing grid operators to enact rotating outages and stage emergency actions to reduce load and avoid cascading failures. These conditions occur when supply margins tighten against skyrocketing demand or unexpected power company/power grid outages.

What California experienced in 2025 shows that systems under heavy stress are vulnerable even with substantial installed capacity. Add to this uncertainty that Florida experienced one of its hottest summers, and one of its coldest winters in 2024-2026, creating an outlier scenario increasing power demand for which might not have been planned, further complicated by a 1 GW constant-demand hyperscale AI datacenter.

The significant and inflexible load of a 1 GW data center, drawing continuously rather than in cycles, can tighten operational reserves much more than typical customer growth would. Even if FPL asserts the grid can meet reserve margin rules, the practical ability to respond to unplanned generation or transmission outages during peak events could be impacted, increasing the risk of temporary grid stress events.

Backup generator dependence

If the perfect storm of events hits the FPL grid, and the grid operators have to perform corrective action to avoid total collapse, utilities may request voluntary reductions, or enforce rolling outages, at which point facilities like these datacenters, which have to meet reliability standards, cannot tolerate short interruptions and must move to backup power generation. When grid reliability becomes a concern, critical infrastructure operators gravitate toward on-site generation or other forms of local redundancy: the cost of downtime far outweighs generator investment for them. However, those known backup generators then have environmental and air quality implications, which we will explore in the following section.

Air Quality & Natural Gas Backup Generators

For backup power and reliability, a datacenter utilizes generators for backup power to maintain their N+1 or 2N redundancy (backup or spare reliability so their equipment will never go down due to single point of failure). Natural-gas-fired emergency generators are commonly rated to each produce around 20 MW of power. Continuing our assumption that Project Tango will be a 1 GW facility, the developer will need to include at least 50 generators to produce 1GW of power during emergency power-loss.

Using EPA AP-42 emission factors, lean-burn natural-gas generators emit approximately 0.004 lb. $PM_{2.5}$*(particulate matter with a diameter of 2.5 micrometers or smaller)* per 1 million Btu of fuel input. A 20 MW generator operating at ~35% efficiency requires roughly 195 million Btu/hr., producing around 0.78 lb. $PM_{2.5}$ per hour per generator. Calculating for 50 generators operating in parallel yields approximately 39 lb. $PM_{2.5}$ per hour of particulate matter released into the air.

$$39 \text{ lb./hr.} = 4.9 \text{ g/s of } PM_{2.5}$$

The EPA **24-hour $PM_{2.5}$ standard of 35 μg/m³** corresponds to $\mathbf{3.5 \times 10^{-5}\ g/m^3}$ as an ambient concentration limit.

Worst case conditions

Assumptions:

- Stack height: **10 m** (typical for small emergency generator exhaust)
- Wind speed: **1 m/s** (very low wind, stable nighttime)
- Atmospheric stability: **Pasquill Class F** (very stable, nighttime inversion)
- Plume Spread: minimal lateral and vertical mixing

$$Concentration\ at\ Ground\ Level\ (C) = \frac{\dot{Q}}{\pi \cdot U \cdot \sigma_y \cdot \sigma_z}$$

$$Concentration\ at\ Ground\ Level = \frac{4.9}{\pi \cdot 1 \cdot 8 \cdot 4}$$

$$Concentration\ at\ Ground\ Level = \ 48{,}700\ \mu g/m^3$$

The facility would exceed EPA 24-hour limits by ~1390x given the assumptions below.

Distance	σ_y (ft)	σ_z (ft)	Concentration (μg/m^3)	Exceedance Factor (C / 35 μg/m^3)
164 ft (50 m)	16.4	8.2	124,800	3,566x
328 ft (100 m)	26.2	13.1	48,700	1,391x
820 ft (250 m)	49.2	32.8	10,400	297x
0.3 mi (500 m)	98.4	49.2	3,470	99x
0.6 mi (1,000 m)	196.9	98.4	433	12x

Table 11 – Particulate Concentration in Air vs. Distance

These emissions occur within a region which conducts **seasonal sugar-cane field burning**, which elevates background $PM_{2.5}$, carbon monoxide, and other combustion byproducts, of which Arden receives the detrimental effects with multiple residents complaining about poor air quality, ash falling from the sky, and those with respiratory conditions complain of having trouble breathing during these field burning events. During burn periods, background $PM_{2.5}$ concentrations may already consume a substantial fraction of the 35 μg/m^3 daily limit, leaving limited margin for additional sources. If generator testing or emergency operation coincides with agricultural smoke, as well as other atmospheric conditions like heat-island instability, the combination of all these events could result in standards & limits being exceeded even if each source is individually permitted and annual averages remain compliant.

As an example of the air quality concern that currently exists with the sugar-cane field burning, here is a picture of late January 2026.

Figure 9 – Arden Air Quality Heatmap January 2026

AQI Range	Category	Color	PM$_{2.5}$ Concentration (µg/m^3, 24-hr avg)	Health Meaning
0–50	Good	Green	0.0 – 12.0	Air quality poses little or no risk
51–100	Moderate	Yellow	12.1 – 35.4	Acceptable; some risk for unusually sensitive people
101–150	Unhealthy for Sensitive Groups	Orange	35.5 – 55.4	Elderly, children, and those with heart/lung disease may experience effects
151–200	Unhealthy	Red	55.5 – 150.4	Everyone may begin to experience health effects
201–300	Very Unhealthy	Purple	150.5 – 250.4	Health alert; serious effects for all
301–500	Hazardous	Maroon	250.5 – 500.4	Emergency conditions; entire population at risk

Table 12 – EPA Air Quality Index Limits

Data Center Fire Risk, UPS Lithium-Ion Battery Systems, Emissions, and Human Health Impacts

Traffic & Infrastructure Strain

Applicants' Zoning Application Staff Report

The zoning application staff report provided by Palm Beach County states the will be adding 3196 trips (1 truck, 1-way trip) so in essence additional 1,598 trucks and cars westbound and 1,598 trucks and cars eastbound per day.

Another key point to note is the proportionate cost to pay for these added trips for the next 10 years is a **measly $136,881** for improvements of Southern Blvd segment between Big Blue Trace and Binks Forest Dr. This raises questions about whether the mitigation **meaningfully offsets long-term traffic impacts**, especially as build-out continues toward 2035.

> *The Department of Engineering and Public Works Traffic Division Review Staff were provided with this application for review. They provided comments throughout the review of this application and requested modifications have been incorporated by the Applicant. The proposed industrial development, including a data center, is expected to generate 3,196 net daily trips, 319 net AM peak [per hour] trips, and 337 net PM peak [per] hour trips. This is less than the already approved trips through the previously approved comprehensive plan amendment for the site. The build out of the project is assumed to be by 2035.*
>
> *Intersection of Southern Blvd and CR 880 meets adopted Level of Service (LOS). However, the intersection of Southern Blvd and Seminole Pratt Whitney Rd will have a background failure without this project. Addition of this project will add minimal delays to the intersections. TPS analysis for roadway links show background deficiencies for Test 1 for all the impacted links, regardless of addition of this project. However, in Test 2, Southern Blvd from Binks Forest Dr to Big Blue Trace in the eastbound direction in the PM peak hour fails because of the addition of this project. As allowed by the Florida Statutes 163.3180, this project will meet the transportation concurrency by paying a proportionate share of improvement cost to meet the adopted LOS.* ***The Applicant will pay $136,881 as proportionate share*** *for the improvement of this segment from the current 6 lanes to 8 lanes.*

When you look at these as simply numbers, the impact is not felt. However, if we look at current traffic volumes per hour vs. proposed traffic volumes per hour during construction, the impact is clear and concerning. Looking at the segment between Arden Lake Way and Lion Country Safari, the existing traffic count per hour is 723 eastbound, 905 westbound. They plan to add 228 eastbound, 76 westbound, per hour. That means an increase of 30% in eastbound traffic, and 8% westbound. Confirmation should be required on their projected background growth as the **assumptions materially reduce the apparent proportional impact** of the project. In other words, if growth rates are **overestimated**, then the project's impact is understated.

ADJACENT ROADWAY LEVEL OF SERVICE (PM PEAK)
Traffic volumes are in vehicles per hour Segment: Southern Blvd from Arden Lake Way to Lion Country Safari
Existing count: Eastbound=723, Westbound=905
Background growth: Eastbound=746, Westbound=929
Project Trips: Eastbound=228, Westbound=76
Total Traffic: Eastbound=1697, Westbound=1910
Present laneage: 3 in each direction
Assured laneage: 3 in each direction
LOS "D" capacity: 2940
Projected level of service: LOS D or better in both directions

Last point to make regarding the staff report statements regarding LOS “D” capacity of 2,940 vehicles/hr. per direction. To understand what an LOS “D” is, it means that capacity approaching 2,940 vehicles/hr. would cause roadway near-unstable flow, **l**imited ability to absorb incidents, crashes, weather, or special events, and though the staff is indicating the projected total traffic is below the LOS “D” Capacity, it **does not mean traffic impacts are insignificant.** It only means they remain **within minimum regulatory thresholds.**

Heavy-truck delivery patterns

Even though data centers have relatively low daily employment, they generate **non-routine heavy-truck activity** that is not well captured by standard trip-generation models:

- **Construction phase:** prolonged periods of heavy truck traffic (concrete, structural steel, generators, transformers, fuel tanks), often occurring during peak hours due to scheduling constraints.

- **Operational phase:** periodic but intensive deliveries, including:
    - Testing-related logistics
    - Large equipment replacement (servers, cooling equipment, electrical gear)
    - Waste hauling (including electronic waste and hazardous materials)

Non-routine truck trips have **disproportionate impacts** on congestion, pavement wear, noise, and safety compared to passenger vehicles. Staff report should have separated **uniform vehicle equivalents** from heavy-truck percentages so the conclusions do not underrepresent roadway stress, especially on arterial segments already operating near LOS D.

Local roadway classification issues

Compliance with LOS standards on a single roadway segment does not necessarily mean the surrounding network is functionally suited to support the scale and operational characteristics of a large data center.
Roads designed as collectors or minor arterials may not be intended to handle:

- High peak-hour directional flows
- Heavy truck turning movements
- Continuous service and maintenance access

Impact on school zones/residential roads

Traffic analyses that focus solely on arterial LOS may overlook localized safety and quality-of-life impacts on nearby residential streets and school zones, particularly during peak periods. While the staff report concludes that roadway level-of-service standards are met, it does not fully address data center-specific traffic characteristics, including intermittent heavy-truck deliveries, functional roadway suitability, and potential impacts on nearby residential streets and school zones, all of which warrant further evaluation.

Conclusion

The proposed AI Hyperscale Datacenter codename "Project Tango" represents a scale of development with impacts that extend well beyond typical light industrial use. This project will affect regional energy demand, grid stability, air quality, traffic operations, water resources, noise, light pollution, and ecological integrity. While individual analyses within the staff report often conclude that minimum regulatory thresholds are met, the cumulative evidence presented demonstrates that **compliance with baseline standards does not equate to the absence of significant impacts**.
Concentrated electrical demand reduces grid resilience and increases reliance on backup generation; traffic additions materially degrade peak-hour conditions on already constrained roadways; generator emissions and heat discharge elevate localized environmental stress; and persistent noise, lighting, water withdrawals, and land-use fragmentation pose long-term risks to public health, safety, and welfare. .

Based on the previous statements, these cumulative and compounding impacts demonstrate that hyperscale data centers of this magnitude are **fundamentally incompatible with proximity to residential neighborhoods and school zones**, and that avoidance through appropriate location and separation, not additional study or incremental mitigation, is necessary to protect public health, safety, and general welfare.

Appendix: Source Compilation & Citation Log

**Not all sources were cited in APA, some are integrated into the text*

Case Studies

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EPA Screening Coefficients

These values are engineering screening values not site-calibrated AERMOD outputs. They are used in scoping, feasibility studies, and back-of-the-envelope validation before running the full model. For actual values, an AERMOD model should be run.

Pasquill Class	Atmospheric condition	(a)
A	Very unstable (hot, sunny, calm)	0.22
B	Unstable	0.16
C	Slightly unstable	0.11
D	Neutral	0.08
E	Stable	0.06
F	Very stable (clear, calm night)	0.04

Pasquill Class	Atmospheric condition	(b)
A	Very unstable	0.20
B	Unstable	0.12
C	Slightly unstable	0.08
D	Neutral	0.06
E	Stable	0.03
F	Very stable	0.016

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