CENTER OF EXCELLENCE
on New Mobility and Automated Vehicles

Shifting Spaces: Understanding the Impacts of Autonomous Vehicles on Land Use

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16. Abstract This report addresses a critical knowledge deficit concerning the quantitative, long-term impacts of Autonomous Vehicles (AVs) on land use. The study employs a two-pronged approach, integrating a comprehensive literature review with a parcel-level quantitative analysis of Los Angeles County. The analysis identifies 'In-Play' Parcels—Car-Focused and Parking-Dominated land uses—and measures potential exposure using parcel area, property value, and improvement value across ten distinct geographic typologies.Findings suggest that the overall footprint of AV-impacted land is small (approximately 4% of total regional parcel area), tempering narratives of system-wide, rapid transformation. However, impacts could be highly concentrated and unevenly distributed. Commercial and Employment Centers, which contain large parcels, exhibit the highest concentrations of vulnerable land area, while Urban Centers hold disproportionately high fiscal stakes due to premium property and improvement values. Parking-Dominated parcels consistently represent the largest spatial and economic share of AV-impacted land, but their conversion will be slow and constrained by market forces and capital availability. The study concludes that policymakers must adopt a cautious, forward-looking approach, tailoring zoning reform and incentives to high-divergence commercial geographies to guide technological disruption toward equitable and sustainable outcomes.		

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About the Center of Excellence on New Mobility and Automated Vehicles

The Center of Excellence on New Mobility and Automated Vehicles focuses on the impacts of new mobility technologies and highly automated vehicles on the evolving transportation system when deployed at scale. Launched in 2023, the center studies the anticipated long-term impacts of increased new mobility technologies and services on land use, real estate and urban design; transportation system optimization; access to mobility and job participation; and municipal budgets and cost-effective allocation of public resources. Established through a cooperative agreement between the Federal Highway Administration and UCLA, the Mobility COE is made up of five core partners and a community of practice from academia and nonprofit organizations. **www.mobilitycoe.org**

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The Mobility Center of Excellence at UCLA acknowledges the Gabrielino/Tongva peoples as the traditional land caretakers of Tovaangar (the Los Angeles basin and So. Channel Islands). As a land grant institution, we pay our respects to the Honuukvetam (Ancestors), ‘Ahiihirom (Elders) and ‘Eyoohiinkem (our relatives/relations) past, present and emerging.

Disclaimer

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Table of Contents

List of Tables

List of Figures

Executive Summary

This report addresses a critical knowledge deficit concerning the quantitative, long-term impacts of Autonomous Vehicles (AVs) on urban land use. This study provides a foundational analysis aimed at helping cities better prepare for potential shifts in urban development, land valuation, and finance resulting from AV adoption. The research includes a comprehensive literature review followed by a quantitative analysis of parcel-level data within Los Angeles County, designed to quantify the potential spatial and fiscal consequences of AV adoption at scale.

Impacts on Land Use Categories (Literature Review Findings):

- **Auto-Oriented Land Use Transformation:** The switch to AVs, particularly under commercial fleet deployment models, is projected to reduce or eliminate dispersed traditional auto-oriented businesses, such as gas stations, car dealerships, and maintenance services. These functions may instead consolidate into larger-scale depots serving fleets. However, this transition is tempered by economic and physical constraints, including the costly remediation of soil contamination at former gas stations and the slow process of adapting existing zoning regulations.
- **Potential for Sprawl:** AVs have the potential to exacerbate suburban sprawl by reducing the perceived burden of long commutes, as passengers can engage in other activities during travel time. Modeling simulations suggest that futures dominated by Privately Owned AVs (PAVs) could lead to increases in urbanized land area ranging from 8% to 11.5%. In contrast, models for Shared AVs (SAVs) yield mixed results, sometimes leading to reductions in sprawl.
- **Impact on Parking:** Changes to parking are consistently identified as the most consequential potential land use impact, given that parking consumes 20% to 40% of land in city centers. Literature forecasts significant reductions in parking demand, ranging from 10% to 40% in mixed AV scenarios and up to 70% to 90% in purely SAV scenarios within Central Business Districts (CBDs). Yet, the conversion of this land is limited by physical barriers (e.g., low ceiling heights in parking garages) and the likely emergence of new Pick-Up and Drop-Off (PUDO) zones.
- **Divergent Effects on Density:** The relationship between AVs and urban density presents competing narratives. SAV deployment may support increased density in urban cores by allowing for the redevelopment of parking lots, with one scenario projecting a 104% increase in job density in city centers. Conversely, PAV adoption or shifting preferences may encourage dispersion, potentially decreasing density in both large cities and peripheral suburbs. The actual outcome is highly contingent on market forces and the flexibility of existing zoning codes to accommodate densification.
- **Uncertainty and Contingency:** The degree, speed, and location of AV-induced land use change are highly contested and complex. Key variables influencing the ultimate impact on land use include deployment models (Shared vs. Private), adoption rates, trip costs, and the geographic extent of deployment. Policymakers face both high stakes and great ambiguity when planning for the future of land use with AV integration.

Extent of AV Impacts on Land Use (Quantitative Analysis Findings)

- **Limited Overall AV-Impacts on Land Use:** The overall scale of AV-impacted land is relatively small relative to the LA County's total size, aligning with perspectives that caution against overhyped narratives of rapid, system-wide transformation. Car-Focused and Parking-Dominated land uses combined account for only approximately 4 percent of the county's total regional parcel area. The vast majority (96 percent) is classified as "Other Uses" which primarily includes housing.
- **Parking Dominates Impacts, but They May Be Slow:** Within the AV-impacted parcels, Parking-Dominated parcels are the largest component, occupying 20 times more square footage than Car-Focused parcels. This said, other research has shown that the transformation of parcels due to shifts in parking demand is slow and incremental, dispelling the narrative that AV adoption will create drastic, short-term shifts in land use.
- **Residential Contexts Show Minimal Impact:** Residential Typologies (e.g., Mid/High-Density Multi-Family and Single-Family Housing) consistently show minimal land use impacts from AVs. This is the largest land use in most cities and impacts will largely be limited to adaptive reuse of individual driveways or garages.
- **Commercial and Employment Centers Have Highest Potential Impacts:** Typologies such as Commercial/Mall, Business Park, and Auto Mall exhibit the highest overall concentrations of AV-impacted parcel area. These large-parcel contexts could see substantial changes to development *if* parking demand shifts.
- **Urban Centers Hold Highest Fiscal Stakes:** Despite having modest AV-impacted land area, Urban Centers (Downtown and Town Center) register the highest absolute property and improvement values. This high economic density means that small, incremental shifts in land use in the central core could have larger fiscal and economic impacts.
- **AV Depots May Prioritize Customer Proximity:** Current AV-fleet operators, exemplified by Waymo depots, appear to prioritize proximity to dense activity centers and customer demand rather than minimizing land costs. The Waymo Main Depot typology is located near high activity volumes and future transit corridors.

Conclusion and Policy Implications

The findings underscore that the influence of AVs on urban form is complex, uneven, and far from predetermined. While the overall regional footprint of AV-impacted land is small, the localized concentration in commercial and employment centers, coupled with the high fiscal stakes in urban cores, may require some policy intervention.

- **Don't Panic:** Land use impacts from AV's are not imminent and will likely be slow to materialize. There is no near-term need for large changes to land use policy due to AVs.
- **Tailored Responses:** Policy responses will need to be tailored to different geographies. Proactive zoning reform and incentives, where needed, should focus on the areas most impacted by AV deployment, (Commercial and Employment Centers) to manage concentrated redevelopment potential.
- **Focus on Realistic Scenarios:** Future research should focus on refining forecasts based on realistic adoption rates, the economics of PAV vs. SAV deployment, and the impacts already being seen in limited deployments, moving beyond purely speculative scenarios.

Introduction

The last decade has brought a slow but steady introduction of Autonomous Vehicles (AVs) into urban areas. Historically, shifts in transportation technologies, such as the implementation of rail and the automobile, have led to significant changes to the built environment and urban form.[1] The wide-scale adoption of the personal automobile throughout the 20th century, for instance, profoundly influenced land use, decentralizing populations and leading to more monolithic land use patterns.[2] It is expected that the introduction of AVs could similarly change the way urban space is utilized and developed. Understanding the potential shifts AVs may bring to land use is crucial to helping cities better prepare for impacts on urban development, land valuation, equity, and finances.

While the previous decade saw large claims about pending wholesale shifts to AVs, the list of cities experiencing AV deployment has only slowly expanded. This technology is still considered nascent with AVs currently being piloted and operating as commercial autonomous taxi services in limited locations.[3] Although studies on the impacts of AVs on land use have become more common, the prevalence of this topic is still far behind transportation-focused studies that look at AVs potential impact on topics such as safety, mode choice, fleet size, congestion, travel behavior, and induced travel demand.[4–13] In comparison, the literature devoted specifically to understanding potential AV impacts on land use, particularly in quantifying those impacts, is notably sparse. This study addresses this critical knowledge deficit. The research is based on the recognition that current and future policymakers face high stakes and great ambiguity when planning for AV integration.[14]

Understanding the potential transformation AVs could bring to land use is complex, in part, because AV deployment is decidedly not a monolithic phenomenon. The ultimate impact on land use and transportation systems will depend heavily on a wide array of technological, behavioral, and economic variables. Key variables influencing the effects of AV deployment could include vehicle type, adoption rates, trip costs, rider acceptance, shared versus individually owned vehicles, shared versus individual rides, and the geographic extent of the deployment (both within metropolitan areas and between different areas of the country).[15–22]

This study is organized into a two-pronged approach. The first is a literature review and summary of land use categories that might be impacted by AVs. This includes potential effects on auto-oriented land uses, sprawl, parking, and development density. These findings are then used as a basis to analyze what impacts might look like in different types of urban areas within Los Angeles County. The methodology involves identifying 'In-Play' Parcels—land uses expected to be obsolete or significantly altered by AVs—and utilizing Geographic Typologies to evaluate how these effects manifest in varied urban contexts, from dense urban cores to sprawling suburbs. This approach aims to quantify the potential spatial and fiscal consequences of AV adoption at scale, providing actionable data for city leaders tasked with managing the inevitable spatial shift.

Literature Review

Auto-Oriented Land Use

Autonomous vehicles could significantly impact auto-oriented businesses as the switch from conventional vehicles to AVs could reduce or eliminate businesses such as fuel, maintenance, and retail services. The breadth and depth of these changes will depend on the model and scale of AV deployment. While some land use changes seem likely in any AV future, an AV deployment that leans towards commercial fleets will have wider reaching impacts on auto-oriented land uses than the more conventional private ownership model.

With a higher percentage of AVs on the road, gas stations may be significantly impacted as AVs are projected to primarily be electric vehicles.[14,23] As combustion engines are phased out for all vehicles, the need for quickly accessible liquid fuel decreases whether or not the vehicle is privately or commercially owned. This is a potential change that could be realized in any AV deployment scenario, as commercially owned electric vehicles have the same power needs and charging opportunities as privately owned ones.

AV fueling needs will continue to exist but could potentially be met by charging at home, which is more likely under a deployment with heavy private ownership, or through increased development of charging stations and changes to the electric grid.[14] Because AVs will be able to navigate to nearby locations easily, fueling or charging stations will not necessarily need to be located along highly trafficked areas such as connector and arterial streets or near residential areas. Instead, charging hubs for AVs might gravitate to lower cost areas such as industrially zoned lands, and/or areas that have easy access to electrical capacity – such as land near electrical substations.

Land uses that support car sales or provide maintenance for vehicles could see more dramatic changes if the future leans towards more fleet ownership of AVs. Business types such as dealerships, car washes, repairs, and parts could become irrelevant under a commercial fleet deployment model.[24] This is not to say that these businesses would completely disappear, but their form may no longer fit the land use upon which they are based. These services particularly, under a commercial fleet model, might be consolidated into larger-scale depots.[24,25] Dealerships may give way to warehouses that deliver new cars directly to consumer locations. Leveraging economies of scale combined with autonomous capabilities could reduce the need to locate maintenance services such as car washes and oil changes close to residential areas. Untethered to a driver, these depots could service AVs in more factory-like settings that may not be welcoming to people, but which efficiently fit vehicles and the equipment necessary to maintain them.

While AVs, whether more commercially or privately deployed, have potential to alter land use through new patterns of fueling, maintenance, and retail, there are several caveats to consider that would temper the magnitude of these impacts. Although gas stations may seem like prime redevelopment opportunities with their convenient locations, there is the likelihood of soil contamination on these sites that would need to be remediated.[24] To redevelop these sites, developers will need to rectify the hazards created by fueling services – often a lengthy and costly process. If these cost are too high, the likelihood of the land use converting decreases.

Additionally, the electric vehicle market faces challengers to electrified AVs from hybrid vehicles.[26] These vehicles still require the use of liquid fuel and without the benefit of autonomous capabilities, the fuel still needs to be accessible to drivers in the form of gas stations. Until electrified vehicles command a greater share of the market, land uses that serve AV fueling needs will likely not be able to scale and gas stations will persist as a land use. This need for fueling accessibility may be cause for gas stations to maintain their land use presence in urban environments. Further, as AV markets and regulation continue to slowly develop, the timeline for fully autonomous AVs deployment is extended, requiring the continuation of existing auto-oriented land uses.[27] More than just electrified fueling stations, this applies to land uses for maintenance and car sales. The impacts to these land uses are a function of the scale of AV deployment and with market and regulatory barriers, these land uses are buffered against AVs. Based on costs, the regulatory environment, and business models, it is still unclear how large a transition to AVs will occur or if it we will ever see full adoption for all vehicular trips.

One report finds that transit network companies who operate commercial fleets are more likely to operate in dense metros, with rural areas having less overall demand.[28] Relegating AVs to a certain geography would limit the spatial scope of the impacts from commercial deployment. Although change may be likely, these caveats should give pause to embracing the idea that autonomous vehicles are guaranteed to usher in sweeping societal changes. While this literature review is exclusive to land use impacts and their issues, it cannot ignore that there may also be social and economic caveats that may interrelate and confound these impacts as well.

Potential land use changes from AVs could range from more moderate reconfigurations of existing vehicle services, such as local repair to centralized factory-like warehouses, to new services, such as the emergence of large charging centers. Depending on how autonomous vehicles are deployed, some changes may be more likely than others. Major caveats that could limit the potential for change exist, including the capacity for zoning to change to embrace autonomous vehicles and the proportion of electric cars. Changes to existing zoning for land uses is often a slow process and would require consideration, input, and approval from appointed or elected bodies and the public. Changes to zoning codes could lag changes in demand based on AV adoption. Further concerns could come from businesses and labor who may fear negative impacts of AVs to their livelihoods.[14,23,24] Together, these concerns could limit how broadly autonomous vehicles may impact auto-oriented land uses.

Sprawl

Autonomous vehicles have the potential to reshape the spatial organization of cities and their surrounding environments by altering the cost and experience of commuting. One of the most frequently cited impacts in the literature is the potential for AVs to exacerbate suburban sprawl.[23] This impact stems from a fundamental shift in how individuals perceive and value travel time. As AVs allow passengers to engage in work, leisure, or rest during commutes, they reduce the perceived burden of travel.[14] This change could make longer commutes more tolerable, thereby expanding the geographic area within which people are willing to live.

The reduction in perceived travel costs is not limited to time alone. AVs are expected to reduce the financial and psychological burdens of driving by lowering accident rates, smoothing traffic flows, and enabling more efficient vehicle use.[29] These benefits are particularly pronounced in scenarios where AVs are deployed as shared autonomous vehicles (SAVs), which further reduce costs through economies of scale and on-demand availability. As a result, the literature anticipates an increase in vehicle miles traveled (VMT) and a corresponding expansion of the urban footprint, especially in regions with permissive zoning and available land.[30] AVs, whether in a private or shared ownership model, could have substantial impacts on the level of sprawl within a region.

Although AV deployment is likely to result in increased sprawl, the relationship between AVs and sprawl is not linear. The deployment model plays a critical role in shaping outcomes. Privately owned AVs (PAVs) are more likely to encourage low-density development, as they replicate the convenience of current car ownership while reducing the burdens of driving.[25] In contrast, SAVs may limit sprawl through concentrating demand in more urbanized areas where shared services are more efficient and economically viable. Llorca et al. (2022)[31] conducted model simulations that showed PAV-dominated futures could lead to 8% increases in urbanized land area through suburbanization. Similarly, Larson and Zhao's (2020)[32] model found an approximately 11.5% increase in city size due to PAV use and a 4.2% reduction in size under a SAV fleet deployment model. In contrast, Zhang (2017)[30] found that SAVs could lead to an increase in commute distances from between 11% and 23%. These increased commute distances come in the form of residential developments farther from places that drivers commute to, creating a sprawling pattern of residences, jobs, and other amenities. Table 1 summarizes these predicted effects. These divergent outcomes underscore the importance of considering deployment models in determining the spatial consequences of AV adoption.

Table 1: Changes in Urban Area from Autonomous Vehicles by Deployment

Source	Model	Low Impact	High Impact
Llorca et al.	PAV	8%	
Zhang	SAV	11%	23%
Larson and Zhao	PAV	11.5%	
Larson and Zhao	SAV	-4.2%	

Beyond deployment models, demographic and socioeconomic factors could also influence the extent of sprawl. For example, older individuals are more likely to remain in their current locations, while younger households may relocate slightly farther from city centers—but not necessarily into rural areas—due to concerns about education quality and service wait times.[30,33–35] These patterns suggest that AV-induced sprawl will not be uniform but will vary across age groups, income levels, and household types – depending on a range of criteria that may extend beyond transportation. For instance, personal preferences and lifestyle choices often shape residential decisions. For some, the appeal of larger homes, private yards, and proximity to nature may outweigh the benefits of urban living, especially when AVs reduce the friction of distance.[32] In this way, too, AVs can exacerbate existing trends of resident relocation. This aligns with the concept of the Marchetti Constant, which posits that people have maintained a relatively fixed travel time budget over modern history.[36] If AVs allow for faster or more productive travel, individuals may simply use that time to live farther from work or amenities, rather than reducing their overall travel. As people seek to maximize their preferences, AVs might allow them to do so without sacrificing their time budget, yielding a net utility gain for current drivers, but also an increase in sprawl.

Research by Schoenmaker & Van der Vlist (2015)[37] uncovered a relationship between commercial and residential development with both seeking to locate near each other. Separate research from Zhang, (2017)[30] and Bridgelall & Stubbing (2021)[29] found that commercial development often follows residential shifts, further reinforcing sprawl. Large-format retailers and logistics hubs often relocate to suburban areas to capitalize on lower land costs and access to a broader labor pool. In a scenario where AVs shift the population out of the urban area, certain businesses are more likely to follow. This decentralization could create new economic centers outside traditional urban cores, but it may also undermine investments in urban revitalization and transit-oriented development. The spatial reorganization of commerce, like that of housing, will depend on a complex interplay of market incentives, consumer behavior, and regulatory frameworks.

As robust as these impacts on land uses may seem, the literature also cautions about factors that may complicate the narrative of AVs causing inevitable sprawl. Zoning and land use regulations may act as a brake on sprawl, particularly in regions with strong growth management policies or limited developable land. Another potential brake on sprawl is uncertainty about the economic viability of AV services in low-density areas. Longer distances, lower demand, and dispersed infrastructure may increase service costs and wait times, reducing the attractiveness of remote living.[30] Additionally, induced demand could offset some of the efficiency gains promised by AVs. As more people choose to travel farther and more frequently, congestion may return, eroding the initial benefits and potentially discouraging further dispersion.[29,32]

Environmental and infrastructural concerns may also temper the enthusiasm for AV-enabled sprawl. For instance:

- Expanding development into exurban areas often requires new roads, utilities, and public services, which can strain municipal budgets.
- Devolving land-use power throughout a region through sprawl can lead to fragmented governance[38].
- Increased land consumption often threatens farmland, open space, and ecological corridors, raising questions about the long-term sustainability and popular interest in dispersed growth[39].

While AVs may reduce per-mile emissions through electrification and efficiency, the overall environmental impact depends on whether total vehicle miles travelled increases and whether land use patterns become more or less sustainable.[28] Studies from Fagnant & Kockelman (2015)[40] and Peterson & Lewis (2017)[41] discuss how the total number of vehicles on the road could decrease but that the miles travelled per vehicle will increase due to a more sprawling land use pattern. This pattern would consume more green space as residential developments expand into the periphery.[23] PAV deployment might represent more vehicles on the road, but potentially low levels of occupation along with the continued circulation of SAVs waiting for the next fare could likely add to road congestion, increase overall vehicle miles travelled, and therefore reduce the potential environmental gains from electrification.[24]

Despite the potential of AVs to expand the spatial extent of cities by reducing the costs and inconveniences of travel, their actual impact on sprawl will depend on zoning, deployment models, demographic trends, social and economic factors, and infrastructure investments. How the combination of these factors will increase or decrease sprawl is yet still contested.

Parking

With their capacity to drive alone to the next destination and/or park themselves, AVs have the potential to significantly impact parking land uses within the central business district, the surrounding suburbs, and the overall region. The literature forecasts two key changes in parking due to AV deployment: overall space allocated for parking and the demand for parking in general. Some spaces within cities and regions currently dedicated to parking may no longer be as useful or necessary as they have previously been and undeveloped spaces on the edge of cities may now become attractive as parking.

Currently, a large portion of urban form is dedicated solely to parking cars. While estimates vary, the range typically falls between 20% to 40% in city centers[42,43] and could be significantly higher for the broader cities with the inclusion of parking in residential zones.[32] If AVs shift parking demand and use, the scale of impact is potentially large.

Central Business Districts (CBDs) are particularly susceptible to these impacts as parking can comprise nearly half of the land in these areas. Although many studies present a consistent narrative of decreasing demand for this space, the ranges vary widely. With a mix of PAV and SAV futures, parking demand could decrease from 10% to as much as 40%.[44] For purely SAV scenarios, decreases could be 20% to 65%[45], or as much as 70% to 90%[46]. This decrease in parking demand is also correlated to a reduction in space reserved for parking in CBDs. The ranges vary significantly with a low-end prediction of 4.5% decrease in demand for parking space in a SAV future[47] and a high end decrease of as much as 70%.

Studies on the impacts of AVs on parking demand and space across the city at large mirror that of the CBD. Two studies looking at SAVs predicted the decrease in parking demand city-wide to fall by 84% to 93%[48] and 90%.[49] In a mixed P/SAV future scenario, Montoya (2024)[24] predicts a 42% decrease in parking demand. A study of a nearly complete SAV future by Kondor et al. (2019)[50] predicted a 50% decrease in parking demand while Silva et al. (2021)[51] determined there could be an 83% drop in demand. The large range of predicted impacts to parking reduction seem to be based on fundamental differences in study assumptions about variables such as deployment extent, geographic coverage of AV services, service costs, transit availability in the area, and parking regulations (see Larco (2023)[52] for a more detailed discussion of these variables and their impacts).

While the literature on projected parking demand for CBDs and cities is more prolific and directionally aligned, the research on the suburbs has been less consistent. Researchers have speculated that the cost-savings through parking could translate to increased parking demand in suburbs.[24,53,54] Yet, other studies predict drops in parking demand as SAVs could reduce the need for park-and-rides, transforming them into drop-off zones,[55] and because AVs could lead to the conversion of garages into lifestyle uses or new residences.[23,24] In contrast to SAV models, PAV deployment scenarios are projected to have little material impact on the suburban residential land use.[25]

An SAV model from Japan demonstrated there could be a 94% decrease in parking space outside of cities.[46] In contrast, a model from Atlanta which mixed SAV, PAV, and human-driven vehicles revealed a 100% increase in parking space in the suburbs.[55] This increase from mixing conventional cars and AVs is echoed in the report by the International Transport Forum (ITF, 2015)[56] which indicates sharing road space between conventional cars and AV vehicles could add 2% to 7% more parking space within cities. In a PAV deployment scenario, some researchers speculated that residents could send cars to nearby suburbs to save parking costs in denser and more expensive areas.[57] Given this range and conflicting findings, it could be said that suburban parking demand faces an unknown future under AV deployment. A fully SAV future points to the complete collapse of parking demand, while a fully PAV future points to a potential increase in parking demand. A mix of both could lead to a future where parking will remain at some capacity, whether at the same level or at an increase. **Error! Reference source not found.** summarizes the findings for within the central business district and **Error! Reference source not found.** summarizes these findings for the city as a whole.

Table 2: Change in Parking Demand and Space and from Autonomous Vehicles in CBD

Source	Type	Model	Low Impact	High Impact
Walker Consultants	Demand	P/SAV	-10%	-40%
Simons et al	Demand	SAV	-20%	-65%
Kumakoshi et al.	Demand	SAV	-70%	-90%
Zhang & Guhathakurta	Space	SAV	-4.5%	
Zhang & Wang	Space	P/SAV	-75%	

Table 3: Change in Parking Demand and Space and from Autonomous Vehicles Citywide

Source	Type	Model	Low Impact	High Impact
International Transport Forum	Demand	SAV	-84%	-93%
Montoya	Demand	P/SAV	-42%	
Okeke	Demand	SAV	-90%	

Kondor et al	Space	SAV	-50%	
Silva et al	Space	SAV	-83%	

There are also interactions between different areas of the city that might affect not only parking demand, but where parking is located. Parking options outside of downtown could cost substantially lower and hence motivate AV owners in central cities to send cars outside of the CBD, ready to be called as needed.[24] Without the demand for parking, parking spaces in these areas may shift to other uses.[14,23] Regions with a mix of CBDs, cities, and suburbs, could see some degree of parking shuffle.

For all of these potential changes, just as many caveats exist to explain why they might not come to fruition or what other changes may need to accompany them. As with many of the other impacts on land use, the composition and ubiquity of the deployment model can moderate many of the predictions. Much of the existing literature focuses findings on purely SAV deployment scenarios with nearly all trips happening through these SAVs. It is uncertain how likely this future is in general, and particularly in suburban and exurban areas as SAVs face financial challenges due to geographic difficulties of operating in lower density areas. For instance, a study from Los Angeles noted that only of vehicle trips are made in a shared vehicle and only than a third of trips in the ride-sharing platform Lyft were actually shared[58]. Compared to CBDs, SAVs in suburban and exurban areas would need to cover longer distances, have longer waiting times, and potentially require larger fleets. These challenges may make SAVs generally less likely in suburban areas.[59] For people outside of the CBD, commuting in a PAV may be their most perceived efficient mode. All these factors make many of the studies focused on full SAV scenarios potentially less indicative of what the future holds.

Aside from the deployment models that may occur for AVs, the zoning that determines the supply of parking persists as a barrier to shifts in parking supply (even as demand diminishes). Parking, both commercial and residential, are codified in zoning rules which are slow to change and take significant political will and effort. Additionally, even as zoning regulations change, the physical costs of changing or redeveloping existing parking lots and garages will continue to be a significant barrier to seeing the impacts of reduced parking demand. Parking garages often have continuous ramps, low floor to ceiling heights, and deep floorplates – making conversions difficult. Additionally, reduction in demand for surface parking lots may create small, fragmented development footprints (a few spots in each larger parking lot) that are infeasible to redevelop. Even if developers were permitted to reduce their parking or eliminate them entirely, some findings reveal they may be reluctant to do so until they are certain there is sufficient market demand.[52] A report by Larco et al. (2023)[52] argues that under many scenarios, the benefits of AV may be limited by a lack of parking lot redevelopment. This lack of redevelopment may also come from market uncertainty and adaptation for different uses.

The disappearance of parking, if it happens, will hypothetically still need to be replaced by another auto-oriented land use: pick-up and drop-off (PUDO) areas. As the occupants of AVs will still need to access buildings, there will still be a need for space to accommodate their movement. To avoid congestion where curb meets road, new design patterns could be needed.[55] Some cities have already experimented with allowing for existing parking to convert to PUDO use,[28] but not all land uses have equal amounts of parking turnover during the day. Some land uses with significant amounts of turnover, such as in hospitals, or large peak PUDO moments, such as in schools, may find future PUDO areas resembling current parking lots.[14] The persistence of these PUDO needs could undermine the ability to redevelop parking lots and buildings and limit the potential for alternative uses.

Changes to parking land uses from AVs depend upon the demand for alternative uses for the land, the supply of parking to be converted, and the mechanism of the market to respond to the demand and supply. The demand will be heavily impacted by a combination of the AV deployment model composition, shared or private, and the geographic spread of AVs. Zoning will continue to control the current supply of parking, regardless of demand, and could limit parking area redevelopment. Developers and those who finance development may be slow to shift their mindsets and build without parking in mind. All of this results in substantial uncertainty as to the rate of change and total impact AVs will have on parking supply in urban areas.

Density

Autonomous vehicles may influence the density of development within metropolitan regions, but it is important to distinguish this concept from sprawl. While sprawl refers to the geographic expansion of the urban footprint, density refers to the concentration of development—whether close to or far from the city center. AVs could affect both, but the mechanisms and outcomes are distinct. This section focuses on how AVs may alter the density of land use, particularly through changes in travel behavior, accessibility, and land availability.

The literature presents competing narratives about how AVs might reshape density. On one hand, AVs may support increased density in urban cores by reducing the need for parking, enabling redevelopment of garages and surface lots, and making car ownership less essential.[23,24] SAVs, in particular, may reduce wait times and improve mobility, making dense, amenity-rich neighborhoods more attractive.[60,61] For example, Thakur et al. (2016)[61] estimate a 4% increase in population density in the inner parts of cities under a full SAV deployment scenario. Zhong et al. (2020)[62] project a 104% increase in job density in city centers when 40% of travel demand is served by SAVs. These findings suggest that SAVs could significantly intensify urban cores.

However, other studies present more modest or even negative impacts to urban environments. Gelauff et al. (2019)[63] estimate a 1% decrease in population density in large cities under a high PAV penetration scenario, even when accounting for road capacity and congestion. Under a citywide SAV scenario, Gelauff et al. (2017)[64] project a 3% increase in density due to improved travel times and reduced access and egress times for public transport. Yet, in suburban areas, the same study predicts a 3% decrease in density, suggesting that AVs may encourage dispersion in peripheral zones. Thakur et al. (2016) also estimate a 3% decrease in population density in far outer suburbs under a full SAV model. Table 4 summarizes the impacts on density that different deployment models may have. These studies point to the power of AVs to depopulate some urban areas and to grow the population in others.

Together, the findings reinforce the notion that AVs may enable both densification and dispersion, depending on deployment models and geographic context. While modeling studies suggest potential for increased density in urban cores, especially under SAV scenarios, the literature lacks conclusive, quantifiable evidence. Pimenta et al. (2023)[57] caution that while speculative studies forecast the replacement of vacant parking land by commercial uses, these impacts have not been robustly quantified. Their findings also suggest that SAV impacts on residential density in suburbs are divergent and context dependent.

The literature also anticipates a proliferation of urban amenities in response to AVs. Bridgelall and Stubbing (2021)[29] predict that demand for shopping, entertainment, and dining (SED) land uses could double, driven by increased accessibility and reduced parking constraints. Pimenta et al. (2023)[57] add that more commercial development could increase employment density and induce street network expansion. These trends may yield positive externalities such as agglomeration economies and urban consolidation benefits.[61]

Yet, the evidence remains inconclusive. Heinrichs (2016) describes a dual outcome: highly condensed city centers alongside growing low-density suburbs. Pimenta et al. (2023)[57] note that middle suburbs may lose population density as urban cores densify and outer suburbs expand. Booth et al. (2024)[65] found that younger urban residents were more likely to express intentions to move to lower-density areas, suggesting that AVs may not uniformly support densification while Zhang (2017)[30] found that older residents are more likely to move towards higher-density areas.

Caveats abound. Induced demand may lead to congestion, undermining the appeal of dense urban living. Moreover, housing density preferences are shaped by more than transportation—access to nature, privacy, and lifestyle amenities play significant roles.[66,67] For example, Yang et al. (2022)[67] found that older adults and college-educated respondents were more likely to prioritize transportation accessibility in their ideal neighborhoods, while others emphasized environmental features or space.

Further, these density patterns are highly contingent upon changes to zoning. Many zoning codes throughout the country strictly limit building dimensions and occupation which control how dense areas may become. The inability to adapt these codes to accommodate the reality of increased demand in urban areas could negate any population gains. Conversely, without limits on lot sizing, suburban spaces could exhibit densities too sparse for adequate services, such as SAVs.

In summary, AVs may enable both densification and dispersion, depending on deployment models, urban form, and individual preferences. While modeling studies suggest potential for increased density in urban cores, especially under SAV scenarios, the future of density in an AV-enabled world will likely be fragmented. Planners must consider not only transportation efficiencies but also the broader social and economic factors that shape residential and commercial land use decisions.

Table 4: Impacts on Regional Density by Deployment Model

Source	Location	Model	Impact
Gelauff et al. (2019)	CBD	PAV	−1%
Zhong et al. (2020)	CBD	SAV	104%
Thakur et al. (2016)	CBD	SAV	4%
Gelauff et al. (2017)	Citywide	PAV	3%
Gelauff et al. (2017)	Suburbs	SAV	−3%
Thakur et al. (2016)	Suburbs	SAV	−3%

AVs and Land Use – A Complex Story

The four areas examined—auto-oriented land uses, sprawl, parking, and density—highlight the complex and sometimes conflicting ways autonomous vehicles might reshape the built environment. While each domain presents distinct mechanisms of change, they are consistent in that actual AV travel cost, deployment models, and demographic preferences are still largely unknown and will collectively play a large role in determining any eventual land-use outcomes.

A key insight from the literature is that travel cost will likely be a central driver of land-use impacts. AVs could reduce the perceived and actual costs of travel by allowing passengers to focus on other activities, decreasing stress, and in some cases eliminating the need to pay for parking by sending vehicles away from high-cost areas.[14,23] If achieved, these reductions could extend the acceptable distance between origins and destinations, potentially fueling suburban expansion, increasing vehicle miles traveled, and lowered overall density of development. However, these savings are not necessarily uniform across AV deployment scenarios. It remains unclear whether either PAVs or SAVs will be affordable, which will be more affordable than the other, or whether either represents a viable business model at prices users are willing to pay—questions that ultimately point to a discrete choice modeling framework that has yet to be empirically tested. Additionally, SAV deployment scenario in suburban and exurban areas could be even more difficult to make profitable and hence may never materialize on a large scale. Demographic factors could further shape these outcomes, as some households might value space and privacy while others may prioritize access to services and amenities, shifting where people will want to live and the resultant land use impacts.

The interplay between deployment model and user preference helps explain the divergent land-use patterns across geographies that are currently seen in the literature. In many scenarios, urban cores are shown to experience densification as parking demand is reduced, auto-oriented land uses are repurposed, and SAVs improve access to services and jobs.[24,61] Conversely, outer suburbs may disperse further, fueled by PAV adoption and lower land costs. This dynamic suggests that AVs could simultaneously drive both central city intensification and peripheral sprawl, fragmenting regional growth patterns[25]. The fate of auto-oriented businesses such as gas stations, repair shops, and dealerships is similarly tied to deployment trends. These services may consolidate into large-scale SAV depots, run by large AV service provider, or – conversely – could disappear altogether as AV fleets become more prevalent, freeing up well-located parcels for redevelopment.[24,25]

Parking emerges as a critical hinge point between many of these potential future scenarios. If central business districts see dramatic reductions in parking demand it could create opportunities for redevelopment of surface lots and garages into active uses, potentially catalyzing downtown revitalization. However, in mixed or PAV-dominant futures, parking demand may simply shift to suburban or peripheral areas as AVs are dispatched to low-cost locations, complicating redevelopment efforts. Even where parking demand declines, existing zoning codes and the physical challenges of adapting parking structures may slow or prevent land-use change. Moreover, new demands such as pick-up and drop-off (PUDO) zones could replace parking as a competing use of curb and lot space, limiting the overall reduction in vehicle-oriented infrastructure. Again, these are substantially divergent potential outcomes, making concrete prediction difficult.

Despite compelling models and forecasts, significant uncertainty remains. Many projected outcomes assume high adoption rates and wide-scale AV deployment, conditions that are far from guaranteed given regulatory, economic, and geographic barriers.[28,57] Adoption is likely to vary across regions and market segments, meaning impacts could be uneven and delayed. Additionally, land-use change could be mediated by slow-to-change local governance regulations. Even if AVs alter travel behavior, their influence on urban form depends on whether zoning and planning frameworks adapt to new realities. Without proactive policy, anticipated transformations may fail to materialize.

The stakes for planners and policymakers are high. Left unmanaged, AVs could exacerbate sprawl—consuming greenfields, increasing infrastructure costs, and undermining sustainability goals—regardless of whether widespread adoption occurs over the coming decades or closer to mid-century, depending on technological, regulatory, and market conditions.[28,39] Conversely, coordinated planning could leverage AVs to support urban reinvestment and sustainable growth by reallocating land from vehicles to people-oriented uses. Because AVs transcend jurisdictional boundaries, many strategies will need to be regional in scope, addressing cross-boundary travel patterns, labor markets, and environmental systems.

Future research should refine forecasts by focusing on realistic adoption scenarios. There is currently a strong focus in the literature on SAV deployment in scenarios where most if not all travel is in AVs. While possible, it is currently unclear if this scenario will ever materialize given geographic, economic, and business-model headwinds. Having a more precise estimate of the adoption rate, geographically and by deployment model, and the sober realities of the economic challenges to profitable deployment could provide insights into the direction, scope, and scale of AVs impacts on land use. A comprehensive survey of existing efforts to prepare for potential AV-enabled impacts could reveal the current state of planning and the potential gaps and barriers to change. Further, the actual effects of AVs (where they are currently deployed) on auto-oriented business are not well quantified and more research is needed to understand how deployment models and geography will impact these land uses. Longitudinal analyses of adoption across various geographies could create more accurate forecasting models for AV impacts. Because of the presence of AVs, these research opportunities represent a timely opportunity to help shape our cities. The one thing that is certain is that we are still early in the development and deployment of this technology.

In sum, AVs present both risks and opportunities for land use and urban form. While they may disrupt existing land-use patterns, the trajectory of these changes is far from predetermined. Proactive governance, informed by research and scenario planning, will be essential to guide these technologies toward outcomes that align with community goals and sustainable development.

Methodology

This methodology provides a replicable approach to evaluating how AVs may reshape land use in cities. In this study, we use Los Angeles County as a spatial foundation to evaluate zoning reform, land use forecasting, and redevelopment strategies in an evolving mobility landscape.

Identifying ‘In-Play’ Parcels

For this project, we employed a spatial analysis of parcel-level land use patterns across Los Angeles County to identify sites with high potential for redevelopment in an autonomous vehicle (AV) future. Built upon our literature review, this analysis focuses on the hypothesis that surface parking and auto-serving land uses may become increasingly obsolete in the coming decades as cars shift from an ownership to shared use model. With this, we focused on land parcels that may be "in-play" for transition. The foundational task of this analysis was to identify parcels dominated by parking or tied to car-focused functions, using available, open-source geospatial data.

We first assembled and prepared a base layer of all parcels in Los Angeles County. This public parcel records shapefile (updated June 2025) was obtained from Los Angeles County’s GIS data portal and was reprojected into EPSG:3310 – NAD83 / California Albers, a projection suited for accurate area-based calculations across large California geographies. Within QGIS (Version 3.38), each parcel’s land area was recalculated using the field calculator to ensure internal consistency and precision, primarily since these area values serve as the denominator in downstream ratio calculations.

To assess how much of each parcel was dedicated to surface parking, we introduced a secondary shapefile of parking lots compiled by Los Angeles County in 2014. Because this dataset has not been updated since its original release, it introduces a limitation: some parcel configurations are likely to have changed in the intervening years. The layer, which represents known surface parking areas as polygon geometries, was reprojected and its areas recalculated. We then performed a spatial intersect between the parking lot layer and the parcel base, allowing calculation of the total parking area within each parcel’s boundaries. Using surface parking and total parcel area, a parking ratio was derived for each parcel, defined as the share of land occupied by surface parking (parking ratio = parking area / parcel area). This ratio served as the key indicator of parking-dominated land-use intensity.

In parallel, we compiled a detailed dataset of car-focused land uses using OpenStreetMap (OSM) and Python (Version 3.13.5). OSM maintains a database of geo-located points, each with corresponding activity categories. We selected five OSM activity categories for their relevance to existing car-focused uses likely to be impacted by the transition to autonomous vehicles:

- **Gas Stations** (amenity=fuel)
- **Car Dealerships** (shop=car)
- **Auto Repair Shops** (shop=car_repair)
- **Parking Garages** (amenity=parking with parking=multi-story)
- **EV Charging Stations** (amenity=charging_station)

After identifying all car-focused activities within OSM, we spatially joined the points to land use parcels. Parcels containing one or more car-focused uses were assigned a binary code for each use, becoming a second key input to the typology classification described later in this section. In many cases, parcels are coded for multiple uses across different fields. For example, a parcel could contain both a car dealership and an auto repair shop; thus, that parcel is coded with '1' multiple times for each use.

This overlay process, utilizing built-in spatial tools and field calculations, enabled the completion of geometry intersects, area calculations, ratio generation, and spatial joins by location. It formed the foundation for aggregating parcels into broader land use groups for further analysis. The resulting dataset was exported as a GeoPackage (.gpkg) for long-term storage and further study.

Car-Focused and Parking-Dominated Land Use Types

With each parcel assigned a parking ratio and flagged for auto-oriented uses, the next stage of analysis involved grouping parcels into types that reflect their relationship to car-dominated urban form. The purpose of this classification was to move beyond individual attributes and create broader groupings that communicate the degree to which each parcel is structurally and functionally currently tied to automobile use. These groupings also serve as the analytical lens through which AV-driven land use transformation scenarios can be considered. We established two land use types:

- **Car-Focused** parcels include at least one auto-oriented land use (i.e., gas stations, car dealerships, and auto repair shops). They reflect traditional and specific businesses or facilities that personal vehicle drivers rely on. Car-focused parcels may or may not have large amounts of parking.

- **Parking-Dominated** parcels dedicate more than 50% of total parcel area to surface parking. These sites may represent excess parking supply or underutilized land if personal vehicle storage needs decline with the adoption of AVs.

We coded parcels that met both Car-Focused and Parking-Dominated criteria as Car-Focused (e.g., a supermarket whose parcel area was 60% surface parking). Parcels with neither a high parking ratio (surface parking is <50% of total parcel area) nor an OSM-tagged auto use were left unclassified, as they did not fit the project's target categories. Unclassified parcels—though included in the dataset—were not considered part of the analysis focused on AV-related redevelopment potential.

The 50 percent threshold for classifying parcels as parking-dominated was chosen as a practical, conservative measure. While this cutoff may exclude some parcels with notable but slightly lower parking shares, it provides a reasonable signal of where parking clearly defines the site's land use pattern and limits development intensity. Parcels exceeding this ratio typically devote most of their land to surface parking, indicating potential for meaningful infill if that parking were reduced or removed. Although somewhat arbitrary, the threshold offers a transparent and replicable standard—and in practice likely overstates, rather than understates, the number of parcels that might realistically redevelop in an AV future. Future work on this topic could include a sensitivity analysis for this threshold.

Additionally, we initially categorized other activity points as car-serving uses, which AVs could potentially impact. However, these uses—if impacted at all—would be more likely to be impacted on a smaller scale; for example, a fast-food restaurant might no longer need its large parking lot, but its drive-through capacity could be expanded. Similar small-scale outcomes could be possible at convenience stores, pharmacies, and other establishments that have drive-through services.

Geographic Typologies

Because Los Angeles is polycentric and cannot be represented by a single "downtown" or "corridor" pattern alone, we incorporated a set of geographic typologies at the one–square–mile scale. These typologies were designed to reflect a cross-section of neighborhood- and district-level patterns that are both specific to Los Angeles and broadly relevant to urban contexts across the United States. Each typology captures a distinctive form of land use mix, density, and spatial orientation that shapes how car-focused and parking-dominated parcels fit into the broader urban landscape.

The use of one–square–mile typology areas reflect a balance between comparability and context. While each typology is meant to convey patterns that extend beyond its specific location, referencing local nuances helps illustrate how these forms actually appear and overlap on the ground. Edge conditions were included intentionally, as transitions between land use types are a defining feature of most urban environments rather than anomalies. In this way, the framework remains broadly transferable while still grounded in the spatial realities of Los Angeles.

More specifically, the selection of typology areas followed three guiding principles:

- **Urban Form Diversity:** Areas were chosen to reflect a spectrum of density, land use mix, and spatial orientations, from the most urbanized core to the most car-dependent suburban contexts.

- **Relevance to Other U.S. Cities:** Typologies were selected not for their Los Angeles specificity, but for their transferability to other metropolitan areas exhibiting similar development patterns. For example, the "Town Center" typology mirrors suburban centers in many U.S. regions, and "Business Park" and "Shopping Mall" typologies are nearly universal *(Note: Each typology was analyzed as a one-square-mile study area, and the results should be interpreted as representative snapshots rather than complete countywide aggregations by type)*. While no two square miles in US cities are identical, the typologies created here illustrate trends and considerations that may apply broadly.

- **AV-related Land Use Salience:** Each selected area contains a meaningful concentration of auto-oriented uses such that they provide insight into potential AV-related impacts. While these concentrations imply broad differences in vehicle presence and parking supply across typologies, the analysis does not assign fixed parking or vehicle density values to typology areas as there is likely variation in other regions where this analysis could be replicated.

Table 5 shows the ten geographic typologies selected.

Table 5: Defining Characteristics of Ten Selected Geographic Typologies

Selected Geographic Typologies				
#	**Typology Name**	**Location**	**Defining Characteristics**	**Relevance to AV-Impacted Land Uses**
1	Downtown	Downtown LA	Dense, mixed-use, employment core	Interaction between highest-value land and car-serving uses
2	Town Center	Santa Monica	Smaller-scale civic/ commercial hub	Inner-ring suburban/polycentric dynamics
3	Mid/High-Density Multi-Family Housing	Koreatown, LA	Apartment/ condo dominated	Tension between residential density and excess parking
4	High-Density Single-Family Housing	South-Central, LA	Compact single-family housing/Corner Big-Box	Car-dependency in dense but low-intensity fabric
5	Mid/Low-Density Single-Family Housing	Lancaster, CA	Suburban tracts, large lots	Archetypal car-focused suburban form
6	Business Park	Torrance, CA (Honda North American Headquarters)	Office/ employment clusters	Persistent parking dominance
7	Commercial/Mall	Arcadia, CA (The Shops at Santa Anita)	Large retail centers	Oversized parking supply
8	Auto Mall	Glendale, CA (Brand Blvd of Cars)	Aggregated dealerships	Most entrenched car-focused land concentration
9	Waymo Main Depot	Sawtelle, LA	Primary AV fleet facility	Future-facing anchor for AV logistics

10	Waymo Depot	Culver City, CA	Satellite fleet support sites	Distributed footprint of AV operations

In finalizing this step, a QA/QC process was performed within each one–square–mile typology area to validate the accuracy of the OSM-based land use classifications. Using Google Maps, every identified car-focused and car-served use was cross-checked to confirm its presence and coding. Special attention was given to uses that often span multiple parcels, such as auto dealerships or large-format grocery stores, to ensure that each parcel was correctly attributed and no sites were omitted. This process minimized classification errors and improved confidence in the typology area quantifications.

Quantifying Potential Spatial & Fiscal Impacts at Scale

To evaluate potential exposure to AV-driven land use change, this analysis relies on three indicators: *parcel area*, *property value*, and *improvement value*. The values for each indicator are obtained directly from the public parcel records shapefile (updated in June 2025), and capture a different dimension of the built environment:

1. **Parcel area** measures the spatial footprint of land uses, highlighting the extent of parking and auto-oriented parcels across the county. This is strictly the land area of a parcel and does not account for building area or differentiate between building heights differing building heights on a parcel.
2. **Property value** reflects the assessed valuation of each parcel, offering insight into the fiscal stakes in potential redevelopment.
3. **Improvement value** represents the assessed worth of existing built structures, indicating the scale of investment that may become obsolete or repurposed under future mobility systems.

Together, these three indicators provide a layered framework for identifying which parcels—and which urban contexts—are most “in play” in an AV future. They also provide a replicable framework for quantifying the spatial footprint and economic magnitude of auto-oriented land uses.

It is important to note that due to California’s Proposition 13, a substantial gap often exists between a parcel’s assessed value and its eventual sale price. Parcels that have not changed ownership for many years may be taxed based on outdated assessments, effectively receiving a long-term discount relative to market value. As a result, the assessed property values used here likely underestimate the actual market-based economic exposure of some parcels—particularly those that could turn over under AV-related redevelopment pressures.[68] Despite this limitation, these assessed property and improvement values still point to the general scale of potential fiscal and economic impact.

Two central questions form the baseline for the results presented in the following section:

1. How much land area in Los Angeles County is currently devoted to potentially AV-impacted uses?
2. What scale of redevelopment potential and impact might this represent in spatial and fiscal terms?

Finally, in addition to typology-level quantifications, a divergence analysis was designed to compare the share of each use type (by parcel area, property value, and improvement value) in each geographic typology with countywide baselines, highlighting where specific use types are over- or under-represented compared to the region. For example, if 30% of Los Angeles County parcels are car-focused, while the typology being analyzed has 25% of parcels being car-focused, then the divergence is equal to 25% - 30%, or -5%.

In this case, the examined typology has 5% fewer parcels compared to the County as a whole. This calculation provided the opportunity to understand how much each geographic typology differs—in a positive or negative direction—from the overall picture in the county. This ensured that each typology could be systematically evaluated against the countywide baseline, providing a consistent framework for comparative results and for assessing whether our chosen typologies are within a representative range of the region. We did not expect these typologies to exactly mirror the countywide averages given that we were specifically looking for unique typologies for evaluation, and more broadly, that zoning can lead to segregated land uses.

Findings

We present results first at the regional scale, which establishes the overall footprint and assessed value of car-focused and parking-dominated parcels relative to all other uses. We then present individual geographic typologies to illustrate how these uses are distributed across different urban contexts and built environments, with maps highlighting spatial concentrations. We conclude with a cross-typology comparison to quantify differences in area and value across all categories, and divergence analyses to identify which typologies deviate most from the regional baseline. Together, regional and granular results provide both a broad and fine-grained understanding of potential implications for AV-impacted land uses within Los Angeles County.

Regional Overview

Most of the land area and assessed value in Los Angeles County is tied to uses that are unlikely to be directly impacted by AV-related land use transitions. Table 6 summarizes parcel area, property value, and improvement value across three land-use categories: *Car-Focused*, *Parking-Dominated*, and *Other Uses*.

Table 6: Regional-wide Parcel Metrics

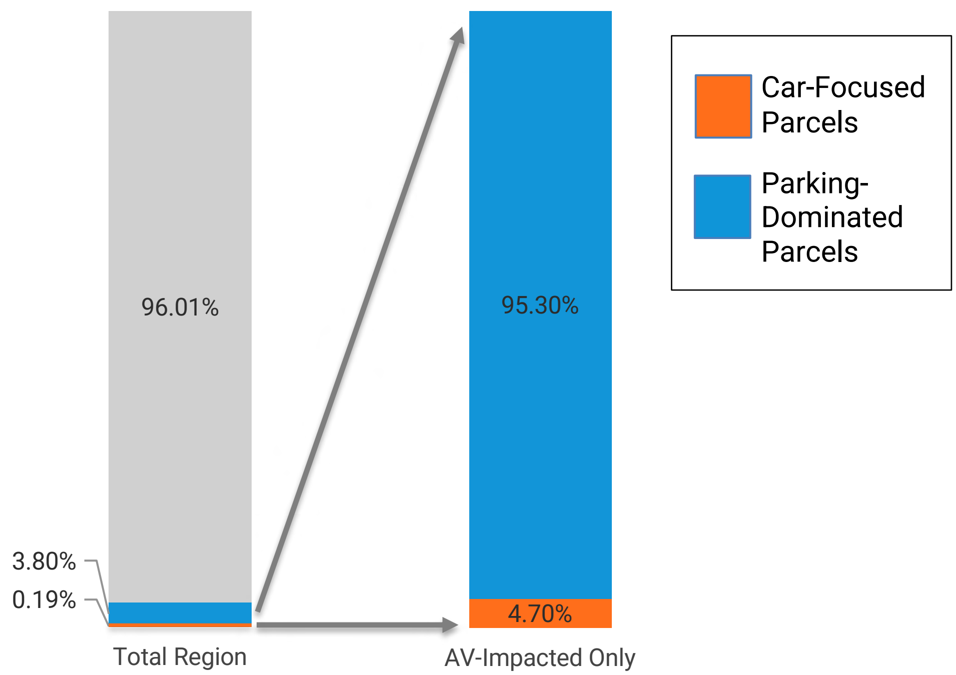
Region-wide Parcel Metrics [in millions]						
Use Type	Parcel Area (sq. ft.)	% of Total	Property Value ($)	% of Total	Improvement Value ($)	% of Total
Car-Focused	198	0.19%	4,754	0.45%	5,674	0.72%
Parking-Dominated	4,022	3.80%	120,833	11.56%	117,388	14.87%

Other Uses	101,530	96.01%	920,115	87.99%	666,493	84.41%
Total	**105,750**	**-**	**1,045,702**	**-**	**789,555**	**-**

Of the county's nearly 105.7 billion square feet of parcel area, 96.0 percent is classified as "Other Uses" outside the use types that we categorize as AV-impacted. By contrast, the two AV-impacted use types account for only 4.0 percent of the total regional parcel area. Within this share, Parking-Dominated uses are the largest contributors at 3.8 percent, followed by Car-Focused (0.19 percent). Put another way, parking-dominated parcels make up 20 times more square footage of parcel area than car-focused parcels.

Figure 1 shows the proportion of car-focused and parking-dominated land uses relative to one another, and as a small subset of all county parcels.

Figure 1: Parcel Area Distribution: Region vs. AV-Impacted Uses



From a fiscal perspective, the concentration of AV-impacted uses is somewhat greater. Parking-Dominated uses represent 11.6 percent of the total regional property value and 14.9 percent of total improvement value. While still minor compared to the dominance of Other Uses—88.0 percent of total regional property value and 84.4 percent of the total improvement value—these shares indicate that Parking-Dominated parcels hold a disproportionate economic presence relative to their land area. Car-Focused uses contribute less than 1 percent to each metric.

Figure 2, Figure 3, and Figure 4 reinforce these findings by illustrating the distribution of parcel area, property value, and improvement value across the three categories. In each case, the Other Uses account for most totals; at the same time, Parking-Dominated parcels represent the most significant portion of AV-impacted parcels from both spatial and fiscal (property and improvement values) standpoints.

Figure 2: Total Regional Area of Potential AV-Impacted Land Uses (by Typology)

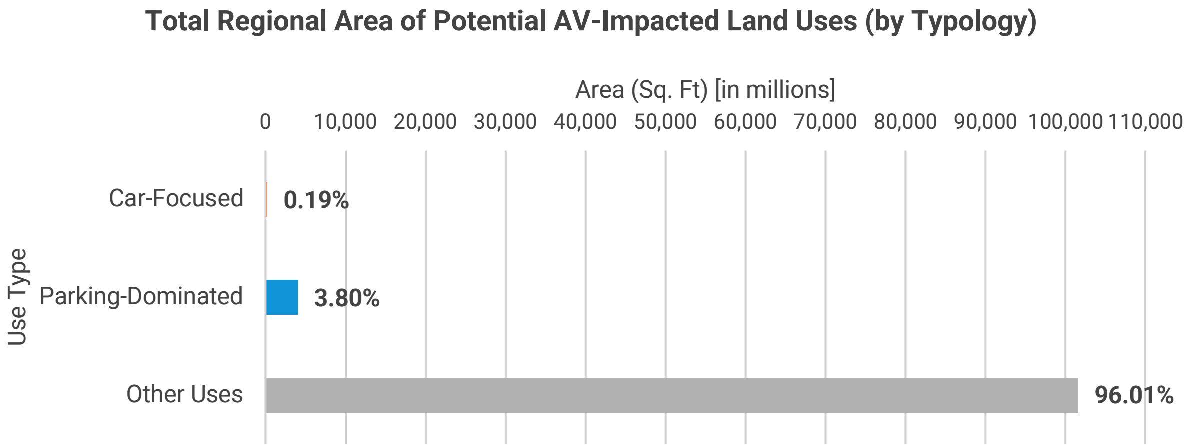


Figure 3: Total Regional Property Value of Potential AV-Impacted Land Uses (by Use Type)

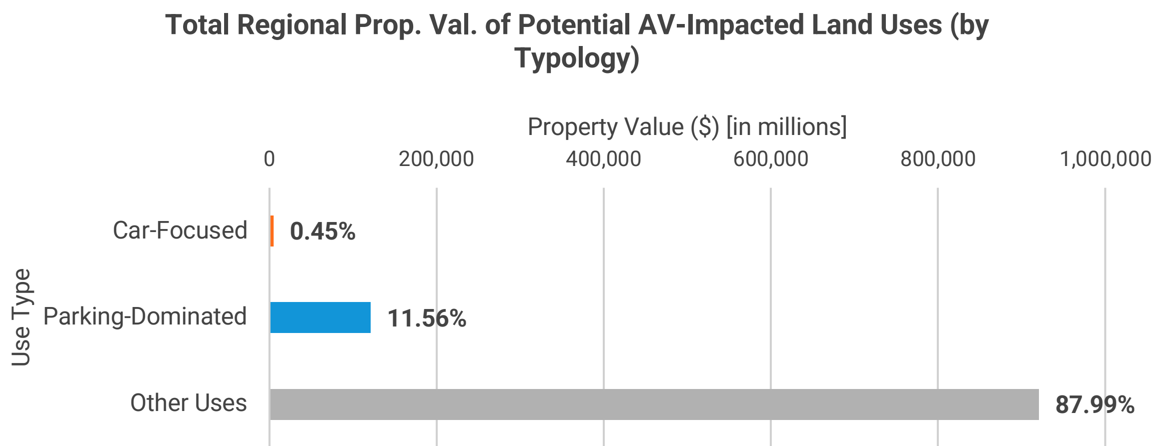
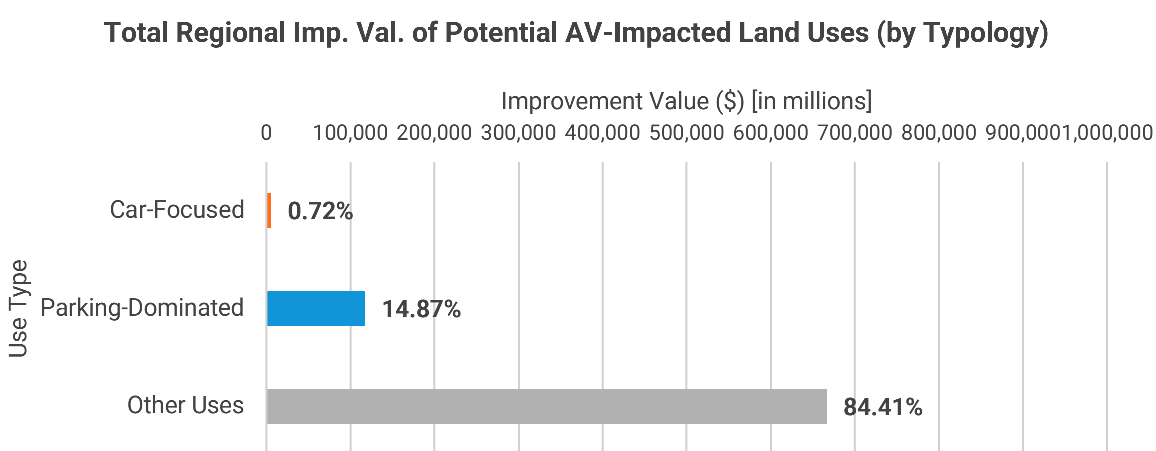


Figure 4: Total Regional Improvement Value of Potential AV-Impacted Land Uses (by Use Type)



Findings suggest two key regional takeaways. First, the overall scale of AV-impacted uses is small relative to all parcels in the county. This is not surprising given that most of the land area in American cities is housing, and housing is not a land use that we found would be significantly impacted by a shift to AVs. Second, within this small fraction, Parking-Dominated parcels stand out as both the largest area and the greatest property and improvement values. These characteristics make them central to any future scenario of AV-induced land use changes. That said, it is critical to note that our literature review found that because of nuances of developer motivations and the small footprints made available in most parcels by a reduction in parking demand, Parking-Dominated parcels are considered to be less likely impacted—especially in the short-term—and have lower property and improvement values to be impacted in a potential AV transition.

Finally, while regional summaries provide a baseline, they also mask significant variation across geographic typologies. Our study found that although small in proportion to regional land areas, AV-impacted land is disproportionately concentrated in specific urban contexts, potentially yielding focused impacts in select areas. These differences are explored in the next section, which shifts from a regional perspective to a geographic typology approach.

Geographic Typology Profiles

The distribution of AV-impacted uses takes on distinct spatial patterns within each geographic typology. While the regional analysis highlights the overall magnitude of parcel area and land value associated with car-focused and parking-dominated parcels, the typologies reveal how these uses are embedded within different geographic contexts. Some typologies are characterized by widespread but smaller parcels (e.g., residential areas), while others have large use-concentrated sites (e.g., malls, business parks, and even a horse racing track). This set of typologies is not an exhaustive list of geographic typologies in Los Angeles County. It is possible that a broader range of urban and suburban typologies could be determined; however, we do not believe these additional typologies would change the findings of this analysis. The geographic typologies are described in the Appendix, focusing on the spatial arrangements, patterns, and the clustering of AV-impacted uses.

Cross-Typology Comparisons

AV-impacted uses are embedded in land use across all ten typologies but vary widely in form and distribution. The following section compares the relative shares of parcel area, property value, and improvement value across all typologies. Comparative results highlight how AV-impacted uses differ in scale and exhibit distinct patterns depending on the context of the built environment, with implications for where the economic stakes of potential AV-related transitions could be most significant. Across typologies, car-focused uses consistently represent a small share (< 1%) relative to parking-dominated uses; unless otherwise noted, cross-typology differences are driven primarily by variation in parking-dominated parcels.

Parcel Area Comparisons

Overall, parcel comparisons—both the share of parcel area and absolute area—provide complementary insights into how AV-impacted uses are distributed across Los Angeles County. Figure 5 and Figure 6 illustrate how AV-impacted parcel area varies across typologies in both relative share and absolute magnitude.

To clearly describe the ten geographic typologies in the context of parcel areas, property values, and improvement values, we identified patterns that grouped the typologies into four functional categories: **Urban Centers**, **Residential Contexts**, **Employment and Commercial Contexts**, and **AV-fleet Contexts**. Each category displays contrasts in how car-focused and parking-dominated parcels contribute to the overall composition of use types.

Figure 5: AV-Impacted Land Uses Across Geographic Typologies

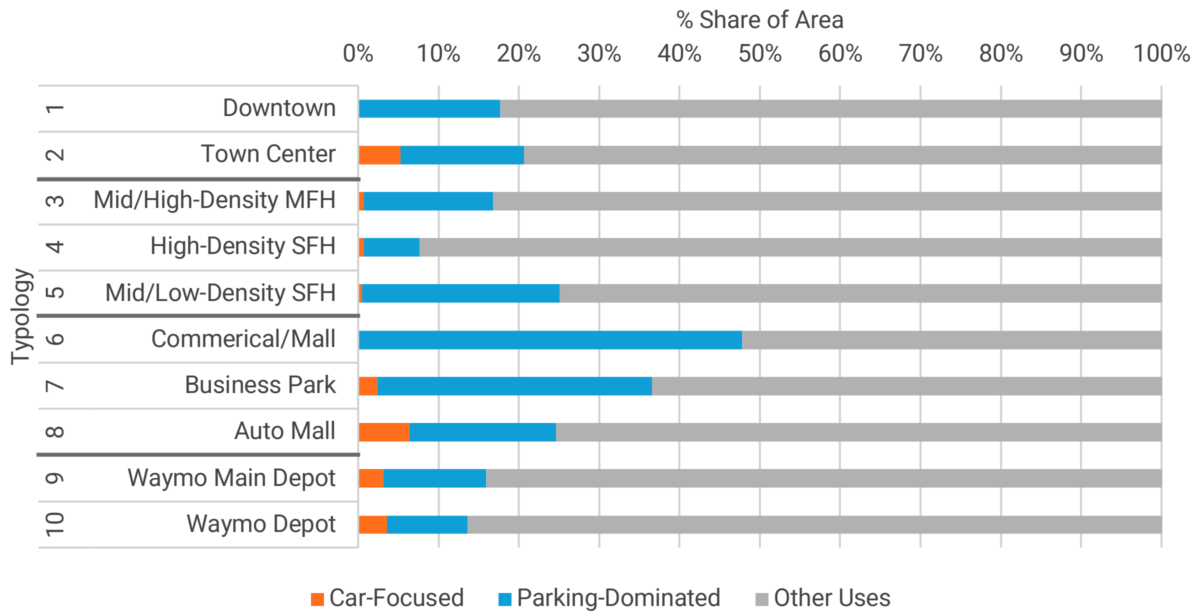
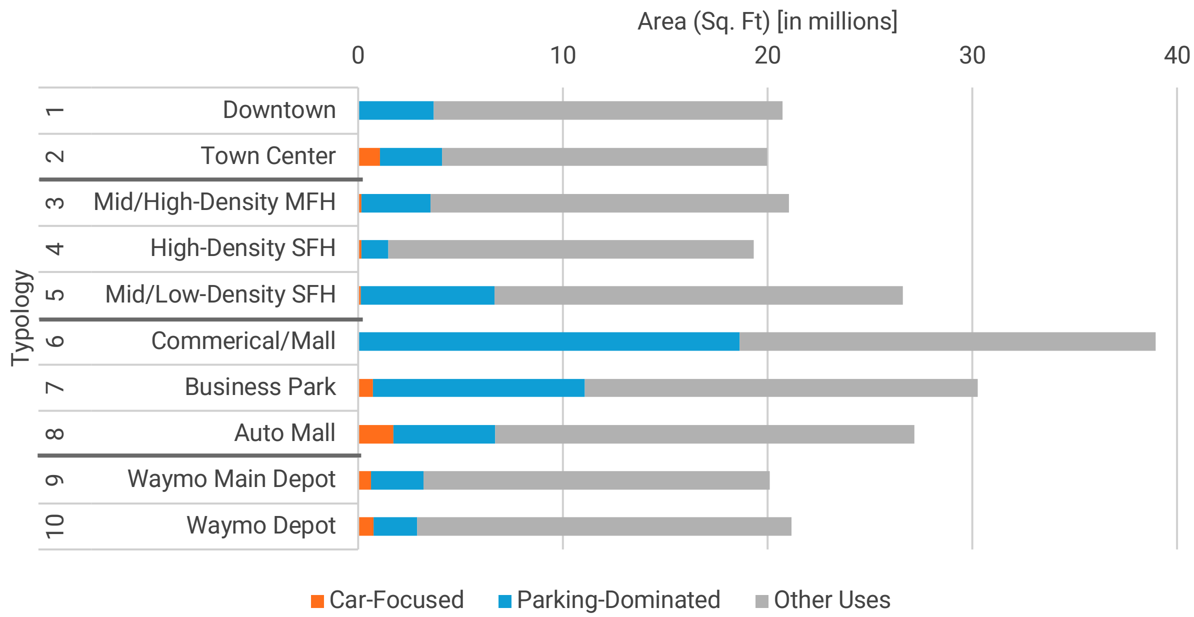


Figure 6: Parcel Area Magnitude: Total AV-Impacted Land Uses Across Typologies



Composition results show that **Residential Contexts** are characterized by limited and dispersed parcels of potential impact, as auto-oriented uses are embedded at a small scale within otherwise residential built environments. By contrast, **Commercial and Employment Contexts** exhibit much higher compositional shares of AV-impacted land, with malls and auto malls showing particularly substantial concentrations of auto-oriented uses.

When viewed in terms of absolute land area, **Urban Centers** and **Residential Contexts** contain relatively modest total AV-impacted footprints despite the local prevalence of parking-dominated uses. **Employment and Commercial Contexts**, by contrast, translate their high compositional shares into large absolute land areas, as large parcels and clustered parking amplify their regional footprint. **AV-Fleet Contexts** remain limited in overall land area but signal the emergence of AV-specific infrastructure.

Together, these findings show that composition reveals the intensity and prevalence of AV-impacted uses within each typology (i.e., how dominant auto-oriented uses are locally), while magnitudes capture their impact at the regional scale (i.e., where the largest total land areas are concentrated). Both perspectives are essential, as one explains local land use patterns and exposure, and the other highlights where land use transitions could be most consequential in absolute terms.

Property Value Comparisons

Overall, the composition and magnitude results reveal two key findings. First, certain contexts (e.g., Business Parks and Auto Malls) show high internal reliance on AV-impacted uses, reflected in their percentage shares. Second, the absolute scale of property values highlights the regional importance of urban centers and malls, where parcel size and assessment valuations amplify the overall stakes. The composition results highlight the reliance of specific contexts on AV-impacted uses, while magnitude results capture their regional economic weight.

Figure 7 and Figure 8 present the composition and absolute magnitude of AV-impacted property values across typologies, grouped into four functional categories: **Urban Centers**, **Residential Contexts**, **Employment and Commercial Contexts**, and **AV-fleet Contexts**. Each category highlights differences in how car-focused and parking-dominated parcels contribute to overall assessed property value.

Figure 7: Property Values Composition: % Share of AV-Impacted Land Uses Within Each Typology

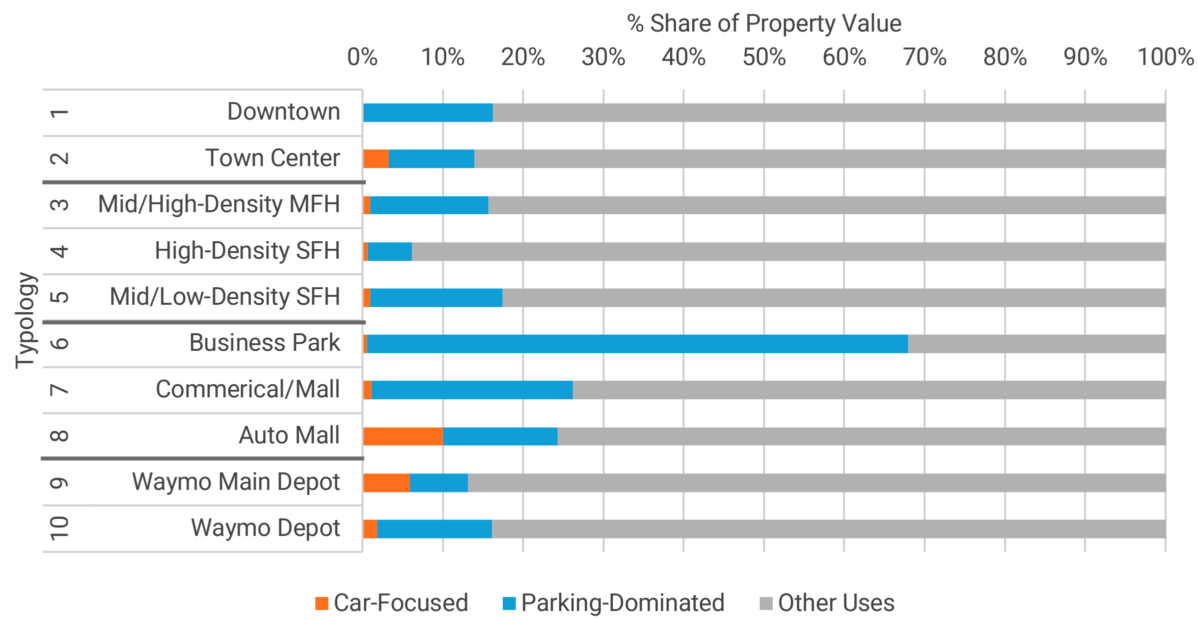
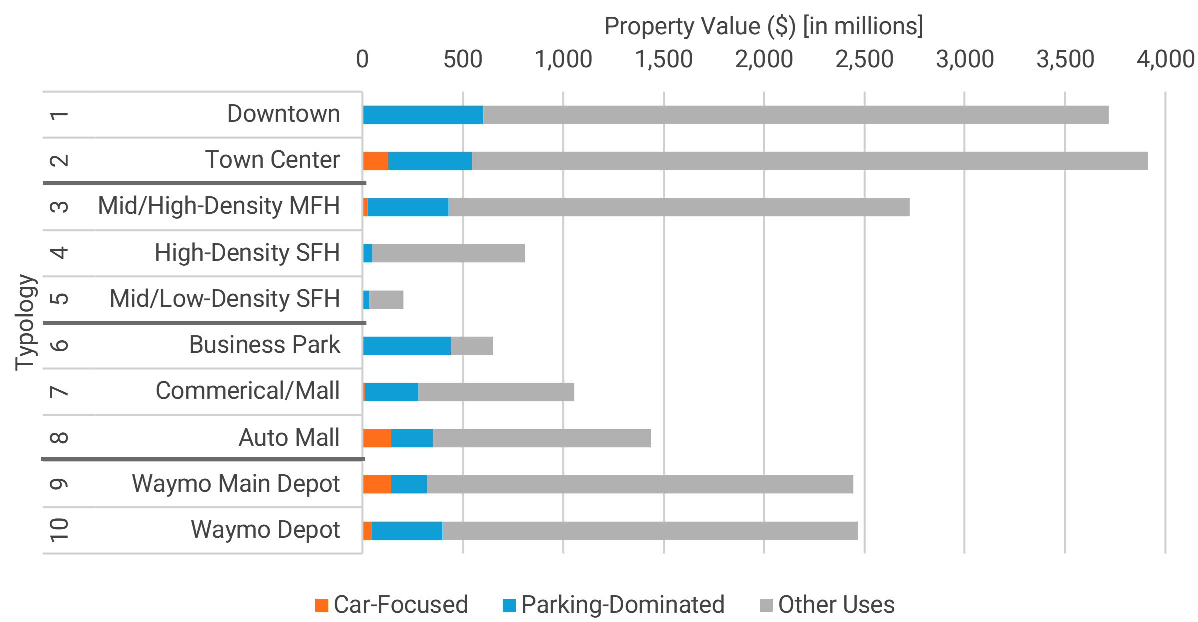


Figure 8: Property Values Magnitude: Total AV-Impacted Land Uses Across Typologies



In compositional terms, **Employment and Commercial Contexts**—particularly Business Parks, Malls, and Auto Malls—rely most on AV-impacted uses, driven primarily by parking-dominated parcels associated with large office, industrial, and retail complexes. **Urban Centers** show more balanced internal compositions, while **Residential Contexts** maintain modest shares of AV-impacted property value despite localized parking prevalence. **AV-Fleet Contexts** display elevated car-focused shares relative to most other typologies, reflecting the concentration of fleet-related facilities.

When viewed in absolute terms, the regional economic stakes shift. **Urban Centers** account for the largest total AV-impacted property values, reflecting high land values and development intensity despite lower parcel-area shares. **Commercial and Employment Contexts** also contribute substantial totals, reinforcing their importance as sites where AV-related transitions could have outsized fiscal implications. **Residential** and **AV-Fleet Contexts**, by contrast, remain limited in total AV-impacted property value, consistent with their smaller parcels and lower overall valuations.

Improvement Value Comparisons

Overall, improvement value comparisons show that the economic significance of AV-impacted uses depends less on their prevalence alone than on the intensity and valuation of the built structures they occupy. In other words, compositional reliance on AV-impacted parcels does not necessarily translate into equivalent regional economic weight. These distinctions underscore the importance of considering both relative share and absolute magnitude when evaluating where AV-related transitions may have the greatest fiscal implications.

Figure 9 and Figure 10 present the composition and absolute magnitude of AV-impacted improvement values across typologies, grouped into four functional categories: **Urban Centers**, **Residential Contexts**, **Employment and Commercial Contexts**, and **AV-fleet Contexts**. This measure highlights the relative economic weight of built structures (as opposed to land) and highlights where AV-impacted uses intersect with higher-value improvements.

Figure 9: Improvement Values Composition: % Share of AV-Impacted Land Uses Within Each Typology

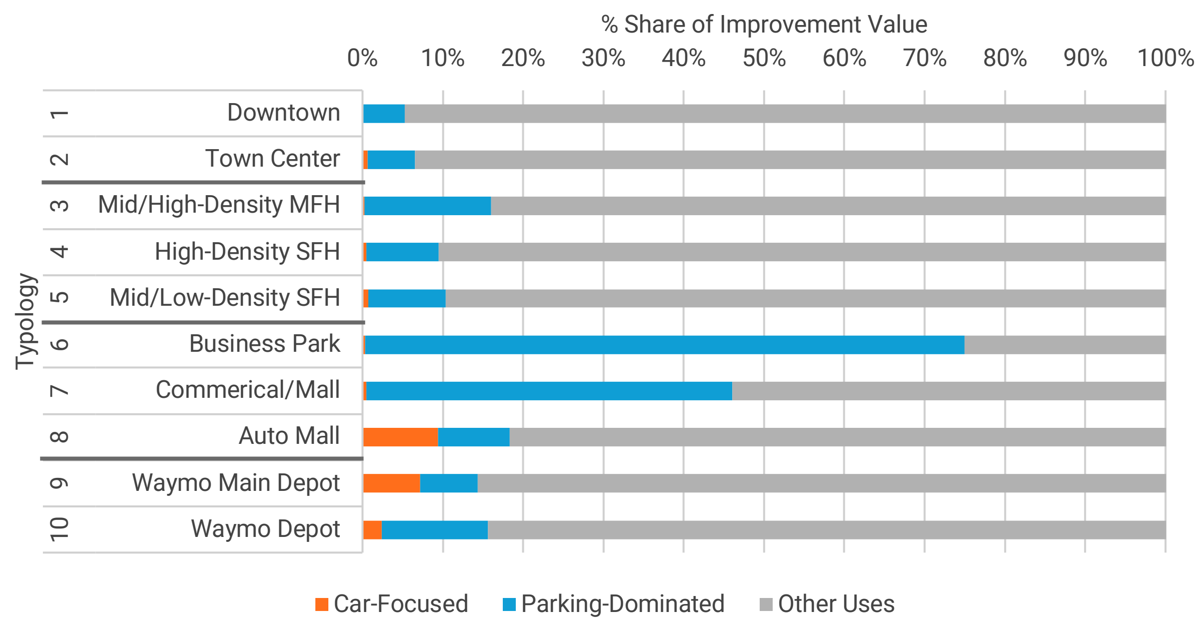
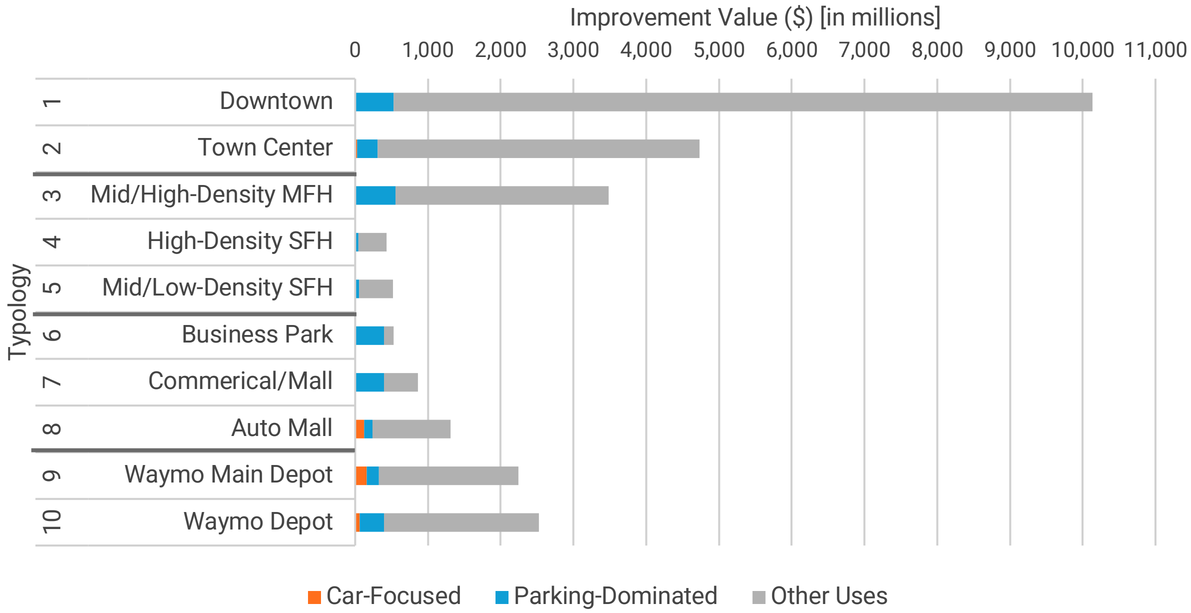


Figure 10: Improvement Values Magnitude: Total AV-Impacted Land Uses Across Typologies



In compositional terms, **Employment and Commercial Contexts** show the strongest reliance on AV-impacted improvements, driven primarily by parking-dominated parcels associated with office, industrial, and large-format retail structures. **Urban Centers** display more balanced compositions, reflecting the integration of auto-oriented uses within dense mixed-use environments. **Residential Contexts** exhibit modest compositional shares, while **AV-Fleet Contexts** show comparatively elevated car-focused improvement values tied to specialized infrastructure.

When viewed in absolute terms, **Urban Centers** emerge as the largest contributors to AV-impacted improvement value, as dense development amplifies the economic importance of even small shares of auto-oriented uses. Business Parks also register substantial totals, underscoring the high valuation of improvements on large employment parcels. Commercial/Mall contexts, despite high compositional shares, contribute more moderately in absolute terms, while **Residential** and **AV-Fleet Contexts** remain limited.

Across the three metrics reported here—parcel area, property value, and improvement value—the results show consistent contrasts between residential, urban center, commercial, and AV-fleet contexts. Residential typologies show lower-than-expected AV-impacted parcel areas and assessed values, reflecting the dispersed, small-scale nature of these parcels. By contrast, commercial and employment areas, including malls, business parks, and auto malls, stand out for their large parcels and high shares of AV-impacted land. Urban centers, while smaller in AV-impacted parcel areas, are highly significant when property and improvement values are considered, reflecting their dense, high-value built environments. AV-fleet contexts, meanwhile, introduce a distinct but more limited layer tied to AV fleet operations.

Residential contexts typically feature dispersed, small-scale parcels, with parking-dominated sites situated between residential and retail blocks, and smaller car-served parcels located at the corridor edges. By contrast, commercial and employment-oriented typologies—such as malls, business parks, and auto malls—are characterized by large, contiguous tracts of land oriented toward automobiles. The Waymo depot sites also illustrate a newer layer of AV-specific infrastructure within these patterns. Together, these typology-level results show that AV-impacted uses are embedded in all contexts across Los Angeles County. While they account for only a small share of overall regional land area and value, their scale, clustering, and spatial patterns vary widely across different built environments.

These patterns emphasize that the prevalence of AV-impacted uses within a typology (composition) does not always align with their overall scale (magnitude). This distinction provides a foundation for the next section on divergence, which examines how the composition of each typology differs from the countywide baseline and identifies where these departures are most pronounced.

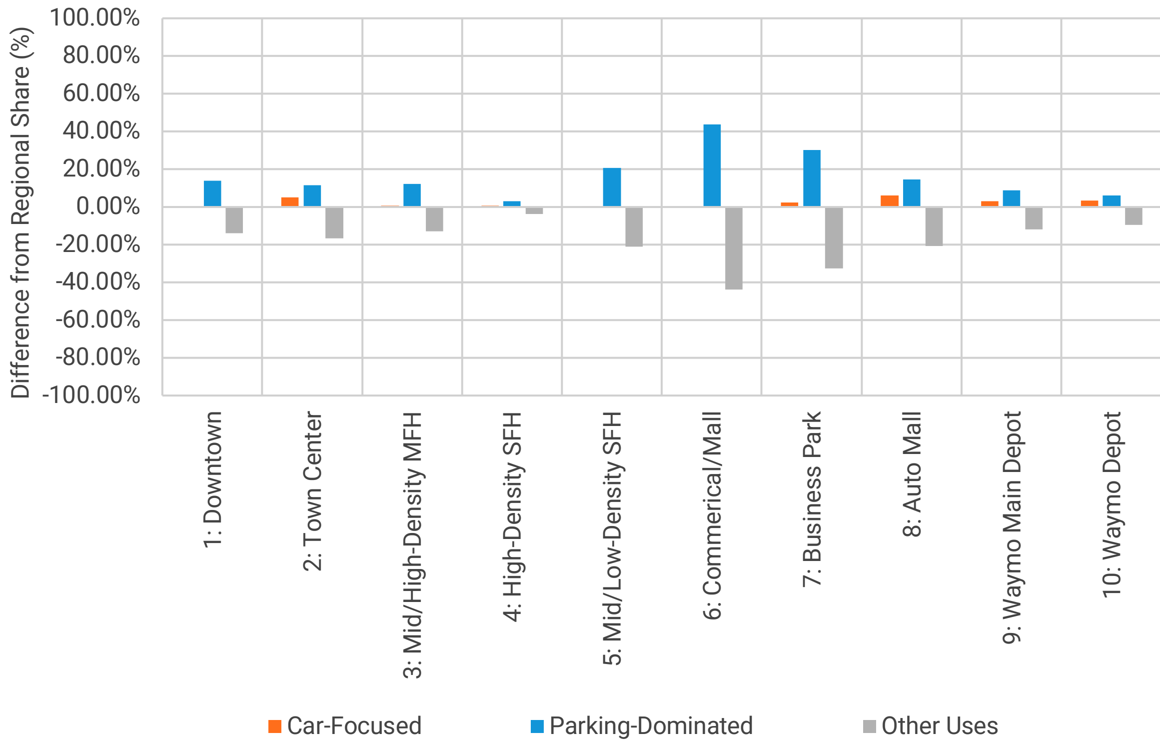
Divergence Analysis

This divergence analysis evaluates how each typology differs from Los Angeles County's overall regional profile of AV-impacted uses. Unlike the composition and magnitude results, which grouped findings into categories based on patterns, this perspective highlights deviations by use type. The focus is on whether specific parcel types—car-focused, parking-dominated, or other uses—are overrepresented or underrepresented in each typology relative to the countywide baseline. The three figures that follow (Figure 11–Figure 13) present these differences for parcel area, property values, and improvement values, respectively. Positive values indicate that a typology contains a greater share of a given use type than the regional baseline, while negative values indicate a smaller share than the baseline.

The divergence analysis is not intended to predict the magnitude or location of AV-related redevelopment, but rather to provide context for how each typology compares to the countywide baseline. This perspective helps illustrate the proportional scale of AV-impacted uses within each typology and clarifies that even the most auto-oriented typologies represent a small share of the region overall. In doing so, the analysis situates the typology results within a broader regional context, illustrating why the overall spatial and fiscal implications of AV transition appear limited.

Figure 11 illustrates typology divergence in parcel area by use type. The results show which contexts contain disproportionately high or low shares of AV-impacted uses compared to the regional baseline, revealing sharper contrasts than the composition and magnitude results alone.

Figure 11: Typology Divergence in Parcel Area Shares (Relative to Regional Baseline)

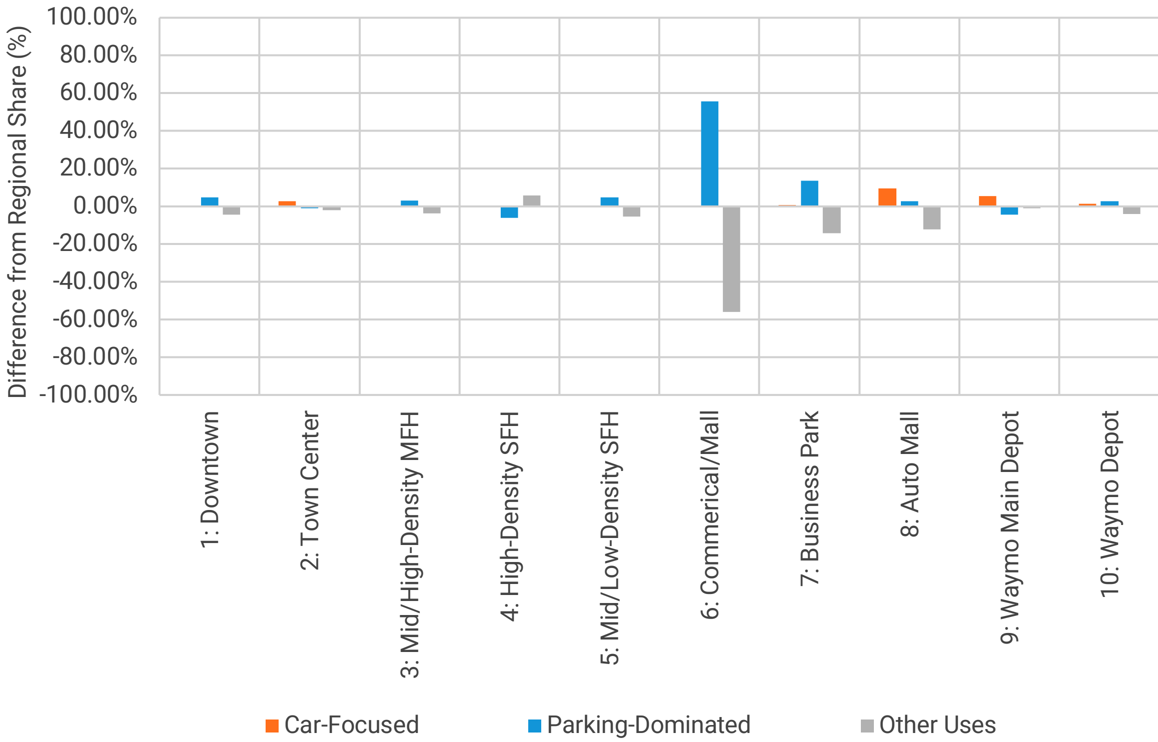


Car-focused parcels show limited divergence in most contexts, but there are key exceptions. Auto-oriented retail environments display the clearest positive divergences: Auto Malls (+6.2%) and Town Centers (+5.1%) exceed the regional baseline, with Waymo Depot (+3.4%), Waymo Main Depot (+2.9%), and Business Parks (+2.2%) also elevated. By contrast, residential settings show almost no divergence, with Mid/Low-Density Single-Family Housing (+0.3%) and High-Density Single-Family Housing (+0.6%) essentially aligned with the baseline. This seems reasonable given that these typologies are the most common throughout the county. Downtown and Commercial/Mall both post negligible deficits (–0.1%). These results confirm that truly car-focused land is concentrated in specialized or suburbanized settings, while housing and core urban districts hold little relative share.

Parking-dominated parcels are where divergence is most dramatic. Commercial/Mall registers the most substantial positive divergence (+43.9%), followed by Business Park (+30.3%), Mid/Low-Density Single-Family Housing (+20.8%), and Auto Mall (+14.4%). Downtown (+13.8%), Mid/High-Density Multi-Family Housing (+12.2%), and Town Center (+11.5%) also exceed the baseline, showing that parking dominates not just suburban or retail environments but also denser housing and employment centers. Waymo's depot areas also tilt heavily toward parking, at +9.0% (Main Depot) and +6.2% (Depot). The only context where divergence is muted is High-Density Single-Family Housing (+3.1%). These results highlight how parking-dominated parcels intersect with nearly all typologies, but are particularly significant in large-scale commercial and employment areas.

Figure 12 illustrates typology divergence in property values by use type. The results highlight where AV-impacted parcels contribute disproportionately high or low assessed values compared to the regional baseline, pointing to contexts where economic weight diverges from parcel area alone.

Figure 12: Typology Divergence in Property Value Shares (Relative to Regional Baseline)

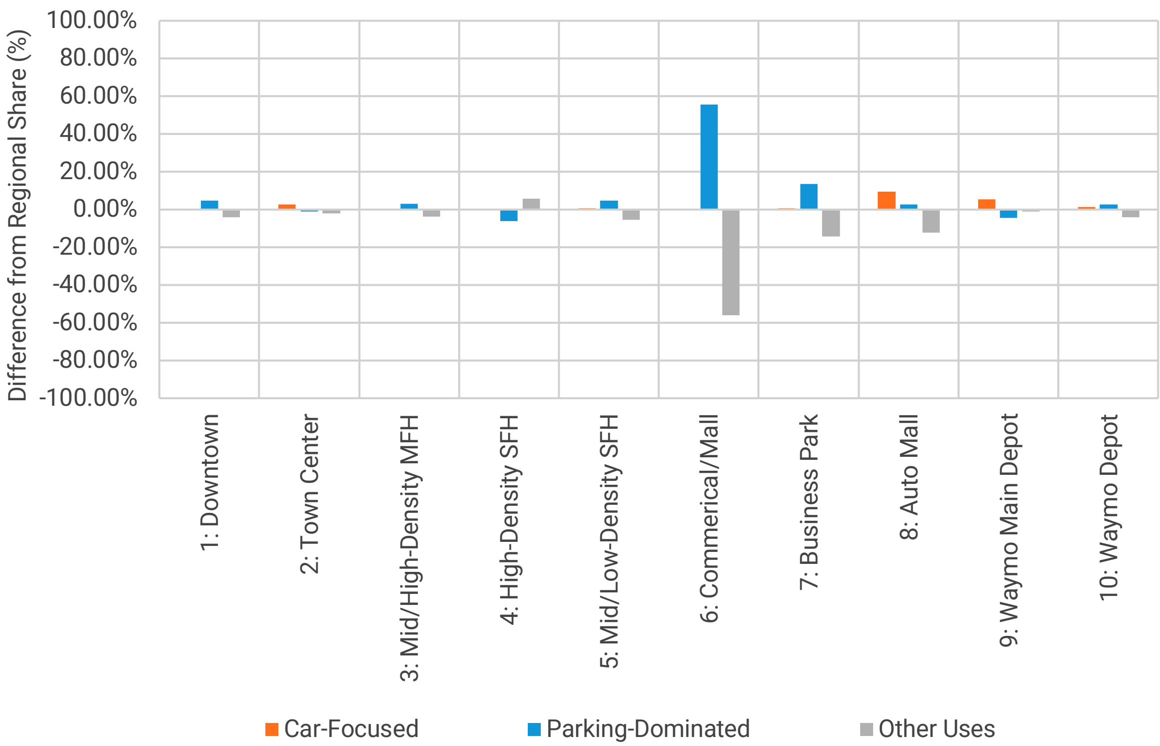


Car-focused parcels show some notable divergences across several typologies. The clearest positive divergences occur in Auto Malls (+9.6%) and Waymo Main Depot (+5.5%), followed by Town Centers (+2.8%). Smaller positive divergences are visible in Mid/Low-Density Single-Family Housing (+0.5%) and Mid/High-Density Multi-Family Housing (+0.5%). Most other contexts align closely with the baseline, including Downtown (–0.4%), Commercial/Mall (+0.1%), and Business Park (+0.7%). These results suggest that the property value footprint of car-focused parcels is concentrated in auto-oriented areas rather than spread broadly across residential or mixed-use contexts.

Parking-dominated parcels have a more uneven pattern. Commercial/Mall again dominates, with a +55.8% positive divergence in property value compared to the regional baseline, driven by the concentration of high-value retail improvements on large, parking-dominated parcels that amplify assessed values relative to their share of land area. The Business Park (+13.5%), Downtown (+4.7%), and Auto Mall (+2.7%) typologies also exceed the regional baseline. Smaller positive divergences are found in Mid/Low-Density Single-Family Housing (4.9%), Mid/High-Density Multi-Family Housing (+3.2%), and Waymo Depot (+2.7%). By contrast, several residential and the main depot typologies show negative divergences—High-Density Single-Family Housing (–6.1%) and Waymo Main Depot (–4.9%). These mixed results suggest that while parking land is widespread by the parcel area metric, its assessed property value diverges more sharply, with particularly high concentrations in malls and employment centers, and a lower divergence in value in residential environments.

Figure 13 illustrates typology divergence in improvement values by use type. The results highlight where AV-impacted parcels contribute disproportionately high or low improvements (i.e., building/structural value) compared to the regional baseline, indicating contexts where built investment increases following the assessment of the underlying property. These trends are like the results for property values presented in Figure 12; however, in some cases, the assessed improvement values are more pronounced.

Figure 13: Typology Divergence in Improvement Value Shares (Relative to Regional Baseline)



Car-focused uses generally remain close to the baseline, though specific auto-oriented typologies stand out. Auto Mall posts the most substantial positive divergence (+8.7%), followed by Waymo Main Depot (+6.4%) and Waymo Depot (+1.7%). Other contexts—including Downtown (−0.7%), Town Center (−0.1%), and Commercial/Mall (−0.4%)—align closely with or slightly below the baseline. Residential environments (Mid/High-Density Multi-Family Housing, High-Density Single-Family Housing, and Mid/Low-Density Single-Family Housing) exhibit near-zero divergence, with minimal variation. This pattern suggests that the improvement values of car-focused parcels are concentrated primarily in specialized contexts, such as auto malls, rather than being broadly distributed.

Parking-dominated parcels reveal a mixed but revealing pattern. Commercial/Mall (+59.8%) and Business Park (+30.7%) show substantial positive divergences, indicating the role of structured or surface parking as embedded improvements in these contexts. Downtown (−9.7%), High-Density Single-Family Housing (−5.9%), and Mid/Low-Density Single-Family Housing (−5.2%) all have notable negative divergences from the regional baseline, reflecting weaker building-related investment tied to parking in the urban core and in residential settings. The Auto Mall (−5.9%) and Waymo Main Depot (−7.7%) typologies also fall below the baseline, while the Waymo Depot (−1.6%) typology is near neutral. These results suggest that parking-related improvement values concentrate most strongly in employment and commercial clusters but hold diminished weight in residential areas and those where AV fleets are currently housed.

Discussion

Scale of AV-Impacted Uses

Much has been stated in transportation planning literature and popular media about the transformative potential of AVs,[23,57] often suggesting seismic shifts in urban form—the differences usually being about *how much*, *how fast*, and in what direction of growth. AV optimists, drawing on modeling assumptions, forecast dramatic land use and mobility changes, including reduced parking demand, altered density patterns, and major VMT increases or decreases depending on the deployment model.[30,40,62] Others voice caveats to stress uncertainty, pointing to zoning, market adoption, and costs as factors that will "moderate or delay" these changes; yet even here, the potential for transformation is still framed as significant. A third strand of work cautions that AV futures are speculative and often overhyped, proposing that impacts may be less than or slower than advertised.[28,52] Our findings align most closely with this last perspective.

Our divergence analysis tempers the grander narratives of both the AV industry and previous scholarship. While AV-impacted parcels—in land area and assessed value—are substantial in absolute terms in a few typologies, they remain only a small fraction of the overall regional baseline. Even within auto-dominated typologies, these uses do not approach a scale that would constitute a systemwide transformation, with car-focused uses (the most likely to be impacted by AVs) consistently the lowest in composition and magnitude across these typologies. Thus, the assumptions and popular discourse that AVs will reshape urban form everywhere—and for everyone—appear improbable at current scales when weighed against the measurable footprint of what we consider to be potential AV-impacted land.

That said, while the footprint of AV-impacted uses is small in aggregate, our typology approach highlights how AV impacts may be concentrated in specific contexts.

Benefits of a Typology Approach

The literature emphasizes uncertainty and variability in deployment models, market adoption, and zoning.[24,27] For this reason, it was important to consider a range of built environments and spatial contexts in this study. By selecting typologies that are broadly representative of the Los Angeles region—while also transferable to many other U.S. metropolitan contexts—we sought to balance these uncertainties by comparing local patterns to the larger region.

The ten typologies examined here—spanning urban centers, residential areas, commercial and employment hubs, and existing AV-fleet operation zones—consistently fall at or above the regional baseline. In other words, they capture the geographies most likely to experience AV-related transformation, without overstating prevalence across the entire region. Our results show an almost uniform pattern of positive divergence, suggesting that the regional findings are more likely overstated than understated. This reinforces that the typology lens is both representative and conservative, importantly avoiding speculative overreach while still drawing attention to the contexts most structurally vulnerable to AV-driven change.

By grounding our analysis in typologies that are both representative and conservative, we ensure that the divergences we identify are not overstated. The next step is to examine how those divergences play out unevenly across contexts.

Variation in AV-Impacts

The literature already cautions that AV impacts will vary across geographies, particularly given uncertainty around deployment models and the eventual scale of adoption.[24,25,28] If these cautions prove accurate, our findings can support an evaluation of these uneven effects. The dominant geographic typologies across Los Angeles County—the residential typologies—show only minor divergence from the regional baseline and show modest impacts from AV adoption. This suggests that AV impacts across the county will presumably be mild, diffuse, and incremental. Any changes are likely to be limited to how individual property owners repurpose underutilized garages and driveways, rather than wholesale transformation. This aligns with studies that predict modest or uncertain effects in suburban and residential settings, where PAV deployment may sustain existing patterns more than disrupt them.[32,55]

By contrast, commercial and employment centers—such as malls, auto malls, and business parks—show far larger divergences, indicating that these contexts could experience concentrated and disruptive impacts. Here, the absolute and relative scales of parcel area and assessed values tied to AV-impacted uses suggest that change could be both spatially significant and economically consequential. Additionally, the AV-affected parcels in these areas are typically larger, leading to potentially larger incentives and benefits for owners to redevelop these parcels. Given the larger parcel size, it also suggests that these areas could see large step shifts in development as single decisions to redevelop a large parcel could have larger impact to the area. This pattern reinforces arguments in the literature that parking, retail, and employment centers represent the most structurally vulnerable land uses in an AV future, where even modest shifts in demand could trigger outsized redevelopment pressures.[45,52]

Across these contexts, the critical common denominator is parking—aligning with prior research on the magnitude of potential parking reductions.[46,48,52] Parking-dominated parcels are the most consistent and often the largest positive divergence from the regional baseline, suggesting that if AV impacts fully extend to this use type, their influence would be outsized and potentially transformative.

Yet, our findings complicate this narrative. Parking change is less likely to be driven by AVs directly than by the size of parcels impacted, the availability of redevelopment capital, and the relative assessed values of surrounding parcels. Drawing on established planning and land market dynamics rather than the improvement value analysis itself, parking lots in high-value urban centers are more likely to redevelop sooner, while in lower-value suburban contexts they may persist much longer given the availability of unused, low-value parcels. In other words, AVs are unlikely to unlock a new pool of capital that accelerates redevelopment—meaning the pace of parking transition will continue to hinge on local market conditions rather than technology alone.

This tension defines the role of parking parcels in an AV future. Parking is the dominant structural presence across all typologies, and if it eventually shifts, the impacts may prove to be transformative. But the fact that parking-dominated parcels consistently show positive divergence in our typologies does not imply that such impacts will be experienced regionally. Instead, the findings highlight the opposite. At the countywide scale, residential contexts dominate, and their divergences are minimal. Thus, even if parking transformations accelerate in commercial and employment centers, they are unlikely to have a significant impact on land use, overall, across the county.

Therefore, the geography of AV impacts will remain uneven—initially concentrated on car-focused uses, and only selectively extending to parking-dominated parcels where capital and land values support redevelopment. These uneven effects underscore the central role of parking as a common denominator across typologies, suggesting that even selective shifts can be transformative. However, the scale and pace of such change will remain dependent on local market conditions—and the rise of AV operations may further complicate this.

Impacts of AV-Fleet Infrastructure

The siting strategies of current and future AV-fleet operators remain largely uncertain. Companies may pursue cost-driven approaches, locating depots in peripheral areas with lower land prices and fewer zoning restrictions—similar to warehousing and light industrial land uses.[29,37] Alternatively, they may prioritize proximity to activity centers and customer demand, locating in dense urban districts where trip volumes are high and deadheading—the distance and time between drop-off and the next pick-up—can be minimized.[30] Hybrid strategies that balance these logics are also possible, reflecting the unique cost structures and service models of AV operations.

Our findings indicate that Waymo has so far pursued the latter approach in Los Angeles. Its main depot (Typology 9) is located in the Sawtelle neighborhood, an area with an established commercial and residential base that continues to intensify with the addition of new housing and retail. This site is not only proximate to high activity volumes but will also be served by the forthcoming LA Metro Sepulveda Line, positioning it within a future high-capacity transit corridor. This reinforces the logic of aligning fleet infrastructure with areas of dense activity and future growth.[57]

Two additional depots further illustrate this strategy. The first (Typology 10) is situated on the rooftop parking deck of the Venice Crossroads shopping center in Culver City, adjacent to Venice Boulevard and within a high-traffic commercial district. The second, located outside the typologies examined in this study, occupies a surface parking lot adjacent to the former CBS Television City, near The Grove and The Original Farmers Market. Here, Waymo vehicles charge from on-site solar infrastructure and begin trips in one of the city’s most frequented retail and entertainment zones. In each case, siting decisions appear to prioritize customer proximity over minimizing land costs.

These depots signal a broader structural shift. Traditional consumer-serving auto uses such as gas stations, dealerships, and repair shops are spatially dispersed to meet individual driver demand. By contrast, AV-fleet infrastructure consolidates routine operational functions—such as vehicle storage, charging, and cleaning—into centralized hubs serving operators. More complex maintenance and repair functions may continue to occur in more specialized or distributed facilities, particularly for personally owned AVs, though this remains an open question. If fleet-based AV services expand, similar strategies are likely to emerge elsewhere.

This would not only raise the value of land near fleet depots but also create opportunities to reallocate surrounding parcels away from excess parking toward more human-centric development, particularly in dense and transit-accessible districts.[24,25]

Crucially, the presence of fleet depots also reframes our divergence analysis of car-focused uses. Across most typologies, car-focused parcels show only limited divergence from the county baseline, suggesting relatively modest exposure to AV-driven disruption. The depot typologies, however, already register above-baseline shares. If more depots are introduced in high-activity districts, they would effectively expand the car-focused category in ways not fully captured in our current results. This means that the positive divergences we report for Typology 9 and Typology 10 could be interpreted as conservative estimates, as additional fleet build-out would likely increase divergence further in these localized contexts, even if regional car-focused shares remain small.

Depots highlight how fleet operations may sharpen car-focused divergences locally. At the same time, our results point toward another issue—how economic value, rather than land area alone, determines the scale of impact.

Impacts of Economics and Zoning

Scholars have emphasized that the impacts of AVs cannot be evaluated solely on spatial distribution; the economic valuation of land and the flexibility of zoning are equally critical in shaping redevelopment trajectories.[24,57] Our divergence results reinforce this point.

While Downtown and Town Center typologies show relatively small footprints of AV-impacted parcels in terms of land area, these same parcels carry disproportionately high property and improvement values. In other words, the economic weight of AV-impacted land is concentrated in select high-value geographies rather than spread broadly across the region. This pattern contrasts with malls, business parks, and auto malls, where the land footprint is larger but assessed values are comparatively less intense.

The implication is that fiscal stakes may be outsized even where the physical scale of change is modest. This echoes longstanding planning literature that stresses the importance of location over quantity – parcels in dense, high-demand centers carry higher redevelopment leverage, meaning that even incremental shifts in use could translate into significant economic impacts. Conversely, suburban parcels with large AV-impacted footprints may contribute less to regional fiscal outcomes if surrounding land values remain low. For planners and policymakers, this underscores the need to treat AV-related change not only as a matter of spatial reallocation but also as a question of economic geography—where impacts matter most because of their fiscal and regulatory contexts, not just their scale on the map. Acknowledging that fiscal weight can outweigh physical footprint shows why zoning and policy choices matter. We explore these implications next.

Zoning, Planning, and Policy Implications

The interdependence of land use and transportation systems is well established, from early settlement patterns through the rise of 20th-century highways. The key planning tool that mediates this relationship has long been zoning—introduced as a public health and safety measure but now central to shaping growth, constraining change, and sometimes perpetuating sprawl and housing shortages.[24,57] While zoning has often been critiqued for rigidity, it also provides the mechanism to guide adaptation in moments of technological disruption.

Recent popular arguments—such as those by Klein and Thompson in *Abundance*[69]—call for sweeping deregulation and a “build everything” ethos. The appeal is clear: removing obstacles, unleashing capacity, and accelerating solutions to pressing needs. However, such visions often downplay the negative externalities of unchecked development—such as traffic, disparate land use outcomes, and environmental degradation—that zoning was originally designed to mitigate. Our findings reinforce this tension. AV-impacted parcels are widespread but uneven, and if redevelopment proceeds without context-sensitive guardrails, the outcome could echo well-documented patterns from earlier eras of auto-oriented planning, when rapid development often took precedence over long-term social and environmental considerations.

The literature is consistent that zoning, governance capacity, market adoption, and deployment models will mediate the extent of AV-driven change.[24,25,27,52,57] Our findings highlight the uneven geography of AV-impacted land, which calls for differentiated approaches. Commercial and employment centers (malls, business parks, auto malls) may require proactive zoning reform and redevelopment incentives to manage concentrated AV-impacted parcels with high assessed values. Residential contexts will likely experience incremental, diffuse changes, where zoning may need to facilitate adaptive reuse of garages, driveways, and small-scale parking conversions rather than sweeping transformation.

In this way, zoning is not simply a constraint but a steering mechanism—capable of channeling AV-related change toward more equitable and sustainable outcomes. Rather than an obstacle, it should be seen as a tool for ensuring that technological disruption serves public goals, protecting against speculative overreach while targeting the contexts most structurally vulnerable to AV-driven shifts. These implications align with our findings that AV-impacted parcels are present across all typologies but uneven in scale—meaning that zoning and policy responses must be tailored to the typologies where divergence is most pronounced.

Future Research

This research contributes to a relatively small but steadily growing body of research on the impacts of AVs on land use. As noted previously, further research is needed to bring clarity to some of the claims often made in both academic and popular publications, particularly from AV optimists. The future is far from certain – in terms of the form, extent, speed and geographies of AV deployment, and in terms of the impacts these different models might have on land use. Better understanding of the potential impacts of AVs would help the public and private sector make decisions that align with community goals.

A few areas for further research on AV’s impacts on land use include:

- Identifying the conditions under which AV-impacted parcels are likely to redevelop. An initial study of this topic (which included one of the authors of this report) found various factors that limited redevelopment in dense, urban areas, essentially slowing any impact of AVs on urban areas.[52]

- How might AV-related land use impacts vary across geographies? This is a critical question both within a single metro area and between different metro areas. Deployment models, business models, land values, and jurisdictional particularities could lead to significant variation across the country.

- How might PAV vs SAV deployment impact land use differently? At the publication of this report, it is unclear which model will dominate, if both with co-exist, or if either will thrive. Our literature review found significant differences in the land use impacts of these two deployment models, but our current analysis did not include analysis of this difference.

- What policy and regulatory levers are most effective in helping shape both AV deployment and its impacts to land use? Where land uses are impacted, planners and regulators will need tools to best address these changes.

- What impacts on land use are we already seeing in the limited AV deployments currently happening in the country? As deployments slowly grow, testing and validating the findings of this report can help planners make more informed decisions on land use changes (if needed). AV research tends to highlight extreme cases and largest possible impacts. Providing measured analysis of actual impacts will help create well-scaled responses.

- How well do existing zoning codes accommodate current AV deployments? What areas of the country/world are leading in adopting and considering these changes? And in what ways might zoning need to change for future deployments? If AVs are found to have larger impacts than this reports projects, understanding international best practices will help affected areas successfully adapt.

Conclusion

The widespread adoption of AVs has been projected to create seismic shifts in urban form and land use; however, the findings of this study, grounded in a parcel-level analysis of Los Angeles County, suggest a more nuanced and geographically uneven trajectory. Regionally, the scale of parcels classified as Car-Focused or Parking-Dominated—the uses most susceptible to AV-driven change—remains a small fraction of the county's total land area and assessed value. Additionally, 'most susceptible' to change does not guarantee change will happen. Parcels that are 'most susceptible' to change face numerous hurdles that will likely limit that change occurring and the speed of any change happening. The results of this study temper the grander narratives of pervasive, system-wide transformation, indicating that AV impacts, at current scales, may be unlikely to reshape urban form across the metropolitan area in a near-term or mid-term timeframe.

That said, localized and concentrated changes may be more likely. This underscores the necessity of moving beyond aggregated regional forecasts to context-specific evaluations. Analysis across ten distinct Geographic Typologies confirms that AV-related impacts are not monolithic but diverge significantly based on the existing built environment. Residential contexts—including Mid/High-Density Multi-Family and Single-Family Housing typologies, which represent the dominant land use in American cities—show limited impacts from AVs, suggesting that changes in these areas will likely be mild, diffuse, and incremental, limited primarily to individual property owner decisions regarding garages or driveways. Conversely, Commercial and Employment Centers, such as Commercial/Malls, Business Parks, and Auto Malls, exhibit the most substantial AV-fueled changes in parcel area, property value, and improvement value. These large-parcel contexts are structurally vulnerable, and modest shifts in parking demand could trigger substantial redevelopment due to the large scale of land area involved.

A critical factor connecting these geographies is the fate of parking. Parking-Dominated parcels consistently represent the largest spatial footprint and economic share among AV-impacted uses across the region. While a reduction in parking demand is forecasted in the literature, the ability of this land to transition to other uses will be governed not by the technology alone, but by local market conditions, land valuation, and the availability of capital for redevelopment. The study highlights that fiscal stakes are disproportionately high in dense Urban Centers (Downtown and Town Center), where even a small footprint of AV-impacted land carries premium property and improvement values. The emergence of AV-fleet infrastructure, exemplified by the Waymo Depots in Los Angeles, further complicates this pattern by centralizing car-focused functions in high-activity areas, potentially increasing the localized value and utilization of surrounding land near consumers and future transit corridors.

The uncertainty surrounding AV deployment models, adoption rates, and economic viability creates a hazy view of the future of urban development and it demands that policymakers adopt a forward-looking, yet cautious, approach. Zoning and planning frameworks must become adaptive steering mechanisms, ensuring that the inevitable disruption serves broader public goals, such as equitable and sustainable development. Responses might need to be tailored to different geographies. Proactive zoning reform and incentives might be needed in higher impacted areas such as Commercial and Employment Centers, while facilitating incremental adaptive reuse in residential areas might be a better strategy for those locations. The findings underscore that the trajectory of change is not predetermined. Informed governance, grounded in geographic and economic analysis, is essential to guide AV technology toward outcomes that align with community goals and leverage the technology's potential for urban reinvestment. In short, the future is not yet clear and further understanding of potential AV impacts on land use will be tremendously helpful to the public sector, the private sector, and to communities at large.

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Appendix

Typology 1: Downtown

Figure 14: Downtown (Typology 1)

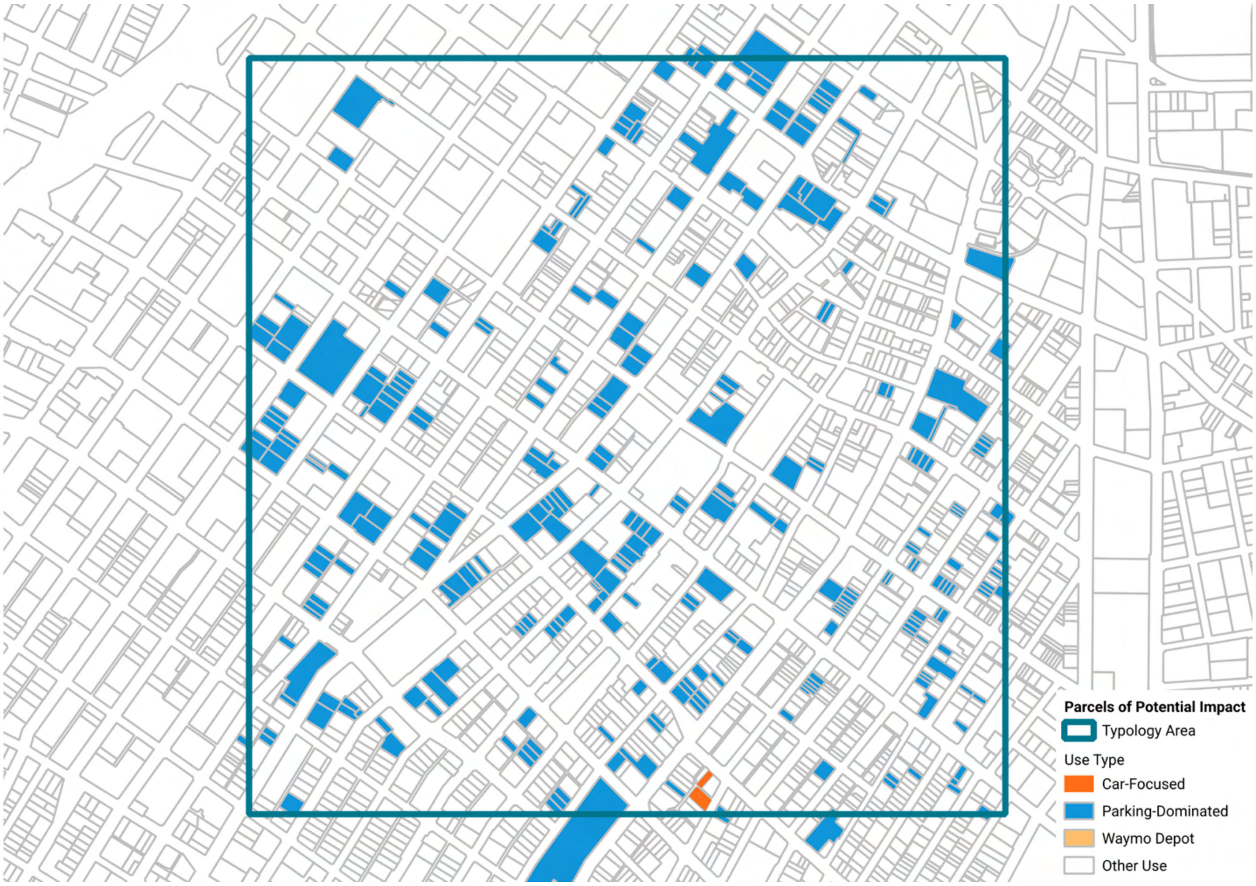

Figure 14 highlights the Downtown core, where AV-impacted uses are tightly interwoven throughout the street grid. Parking-dominated parcels (blue) appear as scattered surface lots and parking garages. The Downtown typology includes a single cluster of car-focused parcels (orange)—comprised of auto repair shops—in an area including warehousing and light industrial land uses.

Typology 2: Town Center

Figure 15: Town Center (Typology 2)

Figure 15 highlights the Town Center typology, where AV-impacted uses take on a more clustered pattern compared to the more dispersed distribution downtown. Larger car-focused parcels (orange) are positioned along arterial roadways and near commercial anchors, while smaller parking-dominated parcels (blue) fill interior blocks, are present along major arterials, and are either large parcels or span multiple parcels. The distribution indicates a hybrid urban form—denser than suburban contexts but more fragmented than the central business district. For example, auto-oriented uses are much more prevalent here than in the Downtown Typology but are still organized around retail and commercial corridors. This typology includes visible concentrations of potentially impacted parcels.

Typology 3: Mid/High-Density Multi-Family Housing

Figure 16: Mid/High-Density Multi-Family (Typology 3)

Figure 16 illustrates a mid/high-density multi-family housing typology, where AV-impacted uses are smaller in scale but widespread. Parking-dominated parcels (blue) are the most prevalent, typically adjacent to multifamily and commercial office buildings as surface lots or small ancillary parcels. Car-focused parcels (orange) are present but limited in number, reflecting the residential orientation and density of the area. Unlike the more consolidated parcels in commercial typologies described later, the pattern here is diffuse, with numerous small sites spread across the residential fabric.

The Mid/High-Density MFH typology more closely resembles the urban typologies in this analysis, with higher total absolute property improvement values and higher Parking-Dominated parcel values. This may be due to the more central location of this typology and the inclusion of large retail parcels.

Typology 4: High-Density Single-Family Housing

Figure 17: High-Density Single-Family (Typology 4)

Figure 17 showcases the high-density single-family housing typology, where AV-impacted parcels cluster along neighborhood corridors. Parking-dominated parcels (blue)—often a shopping center/plaza fronting wider roadways—are concentrated along the southern and eastern edges of the typology, as well as scattered in small pockets filling in between residential blocks. Car-focused parcels (orange) are present in limited numbers and scattered evenly across the area. Overall, the typology is characterized by dispersed, small-scale auto-oriented uses embedded within a primarily residential fabric.

Typology 5: Mid/Low-Density Single-Family Housing

Figure 18: Mid/Low-Density Single-Family (Typology 5)

Figure 18 exemplifies the mid- and low-density single-family housing typology, where AV-impacted uses are sparser and concentrated at the edges of the typology—a common feature of suburban intersections, with parking-dominated commercial/shopping center/strip mall developments at the corners. A small cluster of car-focused parcels (orange) and parking-dominated parcels (blue) appears along the northern boundary—adjoining a suburban commercial corridor. The overall pattern reveals a minimal presence of AV-impacted uses, with activity concentrated at transition zones between residential neighborhoods and larger commercial areas. This contrasts with the Mid/High-Density Multi-Family and Town Center typologies, where AV-impacted uses are more numerous and more closely integrated into the urban context.

Typology 6: Commercial/Mall

Figure 19: Commercial/Mall (Typology 6)

Figure 19 represents the Commercial/Mall typology, which contains a consolidated cluster of AV-impacted parcels. Parking-dominated parcels (blue) define this typology and form large contiguous blocks associated with a retail mall anchor and a horse racing track. While most commercial/mall typologies would not include a horse racing track, its presence draws attention to the possibility of other large single-use parcels, such as event venues, being embedded within such contexts. Smaller, car-focused parcels (orange) are scattered and limited in number, representing auto repair shops and gas stations. The overall distribution shows a highly concentrated and large-scale presence of auto-oriented land uses, distinct from the finer-grained patterns of the residential and mixed-use typologies (Typology 1-5); however, it is essential to note that these uses also have large parcels, and the existing building footprint within the parcel likely makes up a fraction of the overall parcel area.

Typology 7: Business Park

Figure 20: Business Park (Typology 7)

Figure 20 highlights the Business Park typology, where AV-impacted parcels form expansive contiguous tracts of large parking-dominated sites around office and industrial complexes. Car-focused parcels (orange) include an EV-charging lot and a gas station, clustered near major arterials and intersections. The result is a built environment characterized by extensive surface parking, with a small number of auto-oriented parcels situated at its perimeter. This level of parking concentration is greater than in residential contexts, aligning more closely with the large-parcel patterns found in Commercial/Malls (Typology 6) and Auto Malls (Typology 8); however, like with Typology 6, it is essential to note that these uses also have large parcels, and the existing building footprint within the parcel likely makes up a fraction of the overall parcel area.

Typology 8: Auto Mall

Figure 21: Auto Mall (Typology 8)

Figure 21 showcases the Auto Mall typology, where highly concentrated car-focused parcels (orange), primarily car dealerships, dominate land use patterns. Car-focused parcels form long, continuous rows along major corridors with parking-dominated parcels (blue) interspersed throughout, providing large lots associated with car dealership operations. Some parking-dominated parcels also support adjacent residential and retail parcels. Overall, this typology displays one of the most concentrated and contiguous auto-oriented land use clusters across all ten typologies.

Typology 9: Waymo Main Depot

Figure 22: Waymo Main Depot

Figure 22 highlights the Waymo Main Depot typology, where AV-impacted parcels are distributed in a mixed but clustered pattern. Car-focused parcels (orange) are scattered across the area, particularly near major arterials. Parking-dominated parcels (blue) are also prevalent, appearing in medium-sized clusters throughout the map. Distinctively, a single large Waymo parcel (gold) is located near the center of the typology. The presence of a large AV fleet parcel distinguishes this typology from others, where auto-oriented uses are conventional rather than AV-specific.

Typology 10: Waymo Depot

Figure 23: Waymo Depot (Typology 10)

Figure 23 highlights the Waymo Depot typology, where AV-impacted parcels are concentrated around the depot facility—located on the parking deck above a large shopping center/plaza. For this reason, the central Waymo parcel (gold) stands out as the largest impacted site; however, Waymo operations occupy only a portion of the parcel. Adjacent to the Waymo Depot are numerous car-focused parcels (orange). Parking-dominated parcels (blue) are scattered in smaller clusters at the edges, particularly along Venice Boulevard, the major arterial road that flows through the area. This localized concentration of auto-oriented uses, anchored by the depot, contrasts with the more diffuse distribution seen in most other contexts.

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