



Smart Growth America
Improving lives by improving communities

THE FISCAL IMPLICATIONS OF DEVELOPMENT PATTERNS

County of Hawai'i



June 2019

Prepared for the County of Hawai'i

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Glossary of Terms

24-Hour Population: An aggregate of the population, jobs, and visitors in the County. It is assumed that this metric encompasses all people that will generate demand for infrastructure and services.

Infill: For the purposes of this analysis, infill is defined as development within existing built fabric that can take advantage of existing infrastructure. The cost of infill development can vary greatly, but based on discussions and work with several municipalities, SGA finds that the costs of infill development to the government can be around 35 percent of what the same development would cost in a greenfield.

Marginal Density: The density of new development that will occur as a result of the growth in population, jobs, and visitors. The marginal density does not take into account the density of existing development.

Net Fiscal Impact: The tax revenue associated with new residents and jobs less the cost of providing infrastructure and services for development to accommodate those new residents and jobs. A negative net fiscal impact indicates that the County would lose money in accommodating the new growth; a positive net fiscal impact indicates that the County would generate net revenue in accommodating the new growth.

Regression Analysis: A statistical model that estimates the relationship between variables. In this report, regression analyses are used to model the relationship between population and job density and the units of infrastructure needed per acre per capita (ex. “roads per acre per person”), and then to create estimates of the total amount of infrastructure needed in each scenario. It is this consideration of density that distinguishes this analysis from prior “average cost analyses” that simply divide infrastructure and service costs by new population.

Background and Objectives

THE COST OF SPRAWL

The Cost of Sprawl, published by the Real Estate Research Corporation in 1974, was the first study to show that providing infrastructure to low-density, sprawling development costs more than for compact, dense development. Low-density development's greater distances among homes, offices, shops, etc., requires more road and pipe infrastructure than would be required to serve the same number of homes and businesses in a more compact development pattern. Looked at another way, one mile of infrastructure costs roughly the same to build no matter where it is, but that mile can serve many times more people in a high-density place than in a low-density place.

The connection between land use development patterns and the costs of providing public infrastructure and services has long been a topic of study, particularly since *The Cost of Sprawl: A Detailed Analysis* was published in 1974. Since that time, dozens, if not hundreds of studies have been conducted related to this topic. Most of these have concluded that “smart growth” – more compact patterns of development – is associated with reduced local government spending on a per capita basis relative to sprawl (recognizing that the definition of each of those terms is not entirely consistent). Smart Growth America's *Building Better Budgets* report, published in May 2013, summarizes the results of 17 of these studies.

Yet these findings are not often included in the typical fiscal impact analysis done in connection with new development proposals. There are many reasons for this, but the inconsistent methodologies used in the above-referenced studies, as well as the time-consuming data collection efforts they involve, have likely slowed the filtering of these advanced academic findings into “practice.” Instead, most, though not all, fiscal impact analyses rely on a simple average cost approach, which implicitly assumes that each new resident or job will add the same amount of public costs, regardless of whether they live and work in a sprawling, low-density development, or a high-density, walkable urban one.

Smart Growth America (“SGA”) aims to apply a fiscal impact methodology that accounts for the increased cost efficiencies associated with denser development patterns. This report applies that fiscal impact methodology to the County of Hawai‘i.

This analysis considers how Hawai‘i might accommodate a forecasted 98,442 new residents, 12,585 new jobs and 8,180 new visitors by the year 2040. The density of this new growth matters in terms of how much infrastructure and service provision would cost the County.

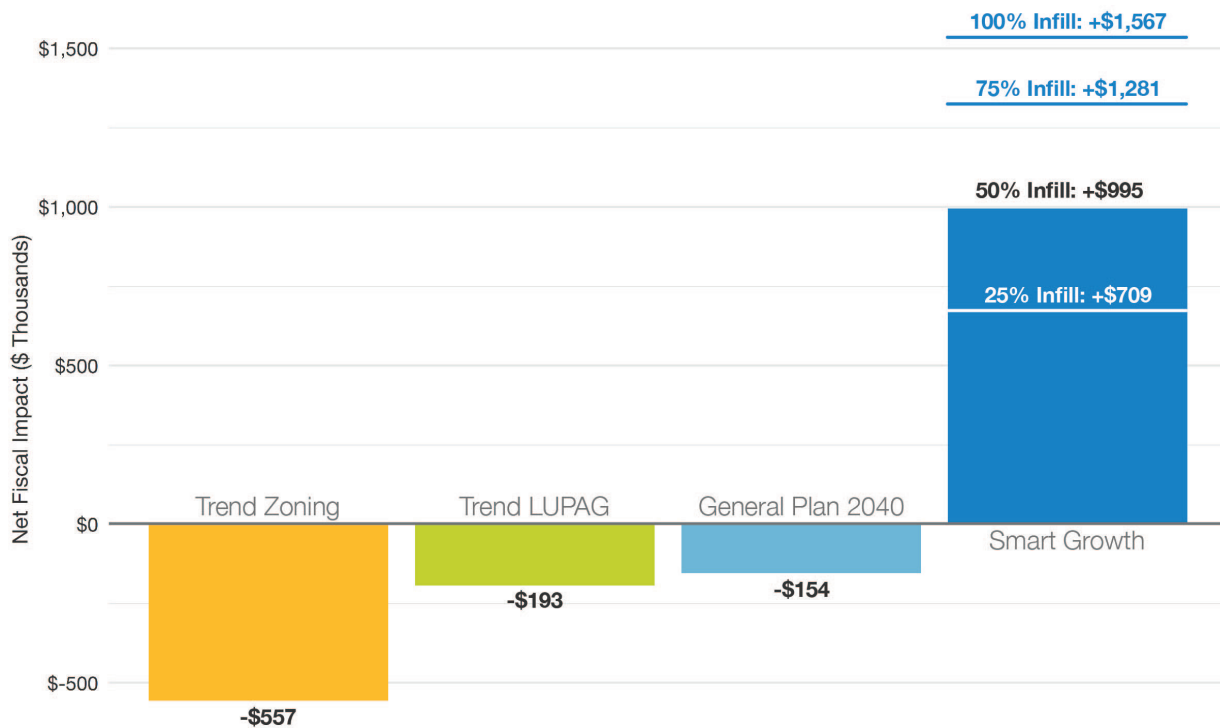
We assessed four scenarios that align with the County's recent *Trend Scenario and Land Use Allocation Technical Report* and the General Plan 2040 process. All four scenarios assume the same amount of population, job, and visitor growth, but at different densities. The details of each scenario are discussed in further depth in subsequent sections:

1. A “Trend Zoning” scenario with growth at existing allowable densities under the current zoning code.
2. A “Trend LUPAG” scenario with growth based on existing general plan policies.
3. A “General Plan 2040” scenario with growth based on proposed updates to the County's general plan.
4. A “Smart Growth” scenario, which uses a density of 10 residents per acre and 30 jobs per acre, and assumes 50% infill development.

SGA found that in the Trend Zoning, Trend LUPAG, and General Plan 2040 scenarios, new development would have a negative fiscal impact on the County, requiring more spending to provide infrastructure and services than it gains in tax revenue. Under the Trend Zoning scenario, the least dense scenario of the four, the County would face the greatest 20-year fiscal impact of \$557 million to provide additional infrastructure to accommodate growth. In contrast, under the Smart Growth scenario, the County has a positive net fiscal impact, gaining nearly \$1 billion in tax revenue over a 20-year time horizon after taking into account infrastructure spending.

The cost savings are a result of reduced roadway, water, wastewater, electricity, septic, and emergency services costs at higher densities and with infill development. When we consider the average tax revenues of the new residents, the Smart Growth scenario results in a **positive net fiscal impact** of \$50 million per year, compared to a **negative net fiscal impact** of \$28 million per year under the Trend Zoning scenario.

FIGURE 1
Comparison of 20-Year Net Fiscal Impact Across Development Scenarios



Source: Smart Growth America, 2019

County of Hawai'i Population

Hawai'i County's additional 24-hour population will consist of...

98,442 NEW RESIDENTS

12,585 NEW JOBS

8,180 NEW VISITORS

As of 2017, the County of Hawai'i has a population of 200,381 people.¹ Historically, Hawai'i's population has grown at a steady pace, having increased by 30 percent since 2000. The forecasts for this analysis are taken from the *General Plan Comprehensive Review Trends & Forecasts Final Report*, prepared by SMS for the County of Hawai'i in September 2016. Hawai'i's residential population is slated to grow to 296,322 by 2040, a 48 percent increase in 23 years. Employment within the County is projected to grow from 56,080 jobs in 2017 to 69,189 in 2040.² For number of jobs, SGA utilized 2015 LEHD LODES data to represent jobs at the block group level, and therefore estimates differ from those provided by the Hawai'i Department of Labor and Industrial Relations.

In addition to population and jobs, the average daily visitor census estimates that in 2013 there were approximately 29,000 visitors in Hawai'i per day – an amount equal to 15 percent of the County's population. That number is expected to rise to 36,320 people by 2040. This analysis combined the projected number of residents, jobs, and visitors into a 24-hour population, or simply a number of people expected to be on the Island in 2040. The aggregate 119,207 new 24-hour persons are assumed to encompass all of the unique infrastructure needs that will be provided by the County. Further discussion of the 24-hour population metric can be found in the Methodology section of this report.

A number of important trends are worth noting regarding the County of Hawai'i's current and projected 24-hour population. First, population growth estimates vary considerably across different areas of the County. *The Trends & Forecasts Report* represents this variation by examining trends at the level of "Forecast Analysis Zones" (FAZ). While the population in all of these areas is expected to grow by at least 20 percent between 2015-2040, the growth rate ranges up to over 100 percent in Hawaiian Paradise Park and Orchidland.

Several areas with higher projected growth rates are also exposed to significant environmental hazards, such as high-risk lava flow hazard zones. Defined by the USGS, "lava flow hazard zones" classify the entire County into zones between 1 and 9, with 1 being the highest-risk zone. This analysis assumes that zones 1 (summits and rift zones of Kilauea and Mauna Loa) and 2 (areas adjacent to and downslope of zone 1) can be considered the "highest risk" areas.³ Many of these areas are concentrated in Lower Puna, South Kona, and Ka'u.

1 U.S. Census Bureau, 2017 Population Estimates

2 U.S. Census Bureau, Longitudinal Employer-Household Dynamics, Origin-Destination Employment Statistics, 2015.

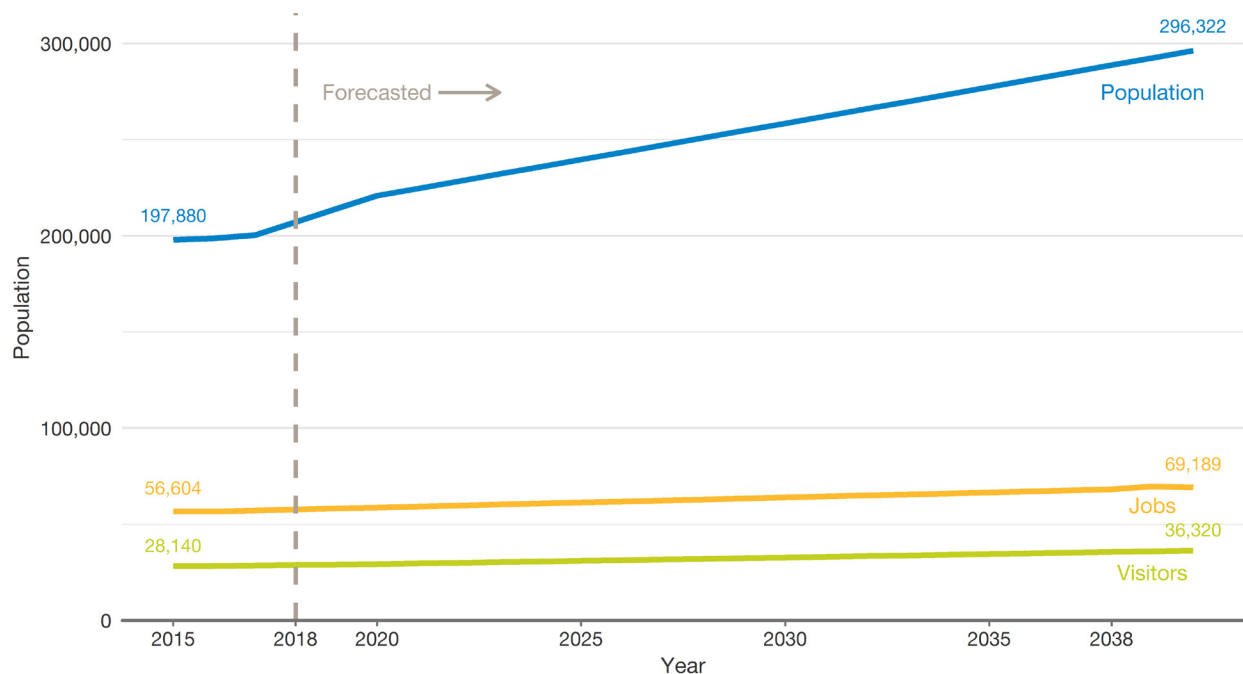
3 Volcano Lava Flow Hazard Zones, Hawai'i Statewide GIS Program, <http://geportal.hawaii.gov/datasets/volcano-lava-flow-hazard-zones>

Second, the County has a relatively low population density in both its urban clusters and rural areas, with 2 residents/acre and 0.03 residents/acre, respectively.⁴ This is important when considering potential development scenarios, particularly with regard to the County's significant amount of protected land. About half of the land area of the County is made up of National and State Parks and Forest Reserves that are protected from future development. This fact, coupled with the County's low population density and exposure to natural hazards, has significant implications for where the development to accommodate 119,207 additional residents, jobs, and visitors can be situated. This analysis considers the question of what it will cost to accommodate these additional persons. As our approach suggests, the answer depends on choices the County makes about the density of development.

4 SMS, *General Plan Comprehensive Review Trends & Forecasts Final Report*, September 2016.

FIGURE 2

Hawai'i County Population, Employment, & Visitor Forecasts



Source: SMS, *General Plan Comprehensive Review Trends & Forecasts Final Report*, September 2016; Smart Growth America, 2019

HAWAI'I KEY FACTS

0.08 people/acre

AVERAGE POPULATION DENSITY

0.02 jobs/acre

AVERAGE JOB DENSITY

0.04 visitors/acre

AVERAGE VISITOR DENSITY

0.14 people/acre

AVERAGE 24-HOUR POPULATION
DENSITY IN HAWAI'I

28,140

AVERAGE DAILY VISITORS

Development Scenarios

SGA worked with the County of Hawai'i to develop four alternative scenarios to evaluate the cost of developing at different densities. We used geographic information systems (GIS) analysis to divide the County into 40-acre grid cells, and to identify population, job, and visitor density in each cell.

Based on the GIS analysis, the existing average 24-hour population density in the County of Hawai'i is 0.14 people per acre (90 people per square mile). Uninhabited lands such as national and state parks, forest reserves, and open space were excluded from the average density calculations. Despite a generally low level of population density in the County, there are areas of the County that have a more urban density. For example, the highest population density in the County is 9.5 people/acre and the highest job density is 10.3 jobs/acre. *The Trends & Forecasts Report* identifies eight urban clusters in the County, with population densities ranging from 6 people per acre to 1 person per acre. The average density level for the entire County is much lower due to rural and agricultural development.

Summing the density of population, jobs, and visitors yields a combined 24-hour population density. For the purposes of this analysis, it is assumed that this metric encompasses all people that will generate demand for infrastructure and services. "Visitor density" is calculated with visitor accommodations including hotels, condo-hotels, timeshares, and visitor rental units (including VRBO, AirBnB, etc.)¹ As can be seen in Figures 4-7, looking at population, jobs, and visitors individually shows different areas of concentration. For example, each map demonstrates hotspots in Downtown Hilo and Kona. However, there is a higher population density in HPP, Upper & Lower Puna, and Waikoloa Village; a higher job density in Puako and Waikoloa; and a higher visitor density in Volcano. Figure 7 illustrates densities aggregated across analysis cells.

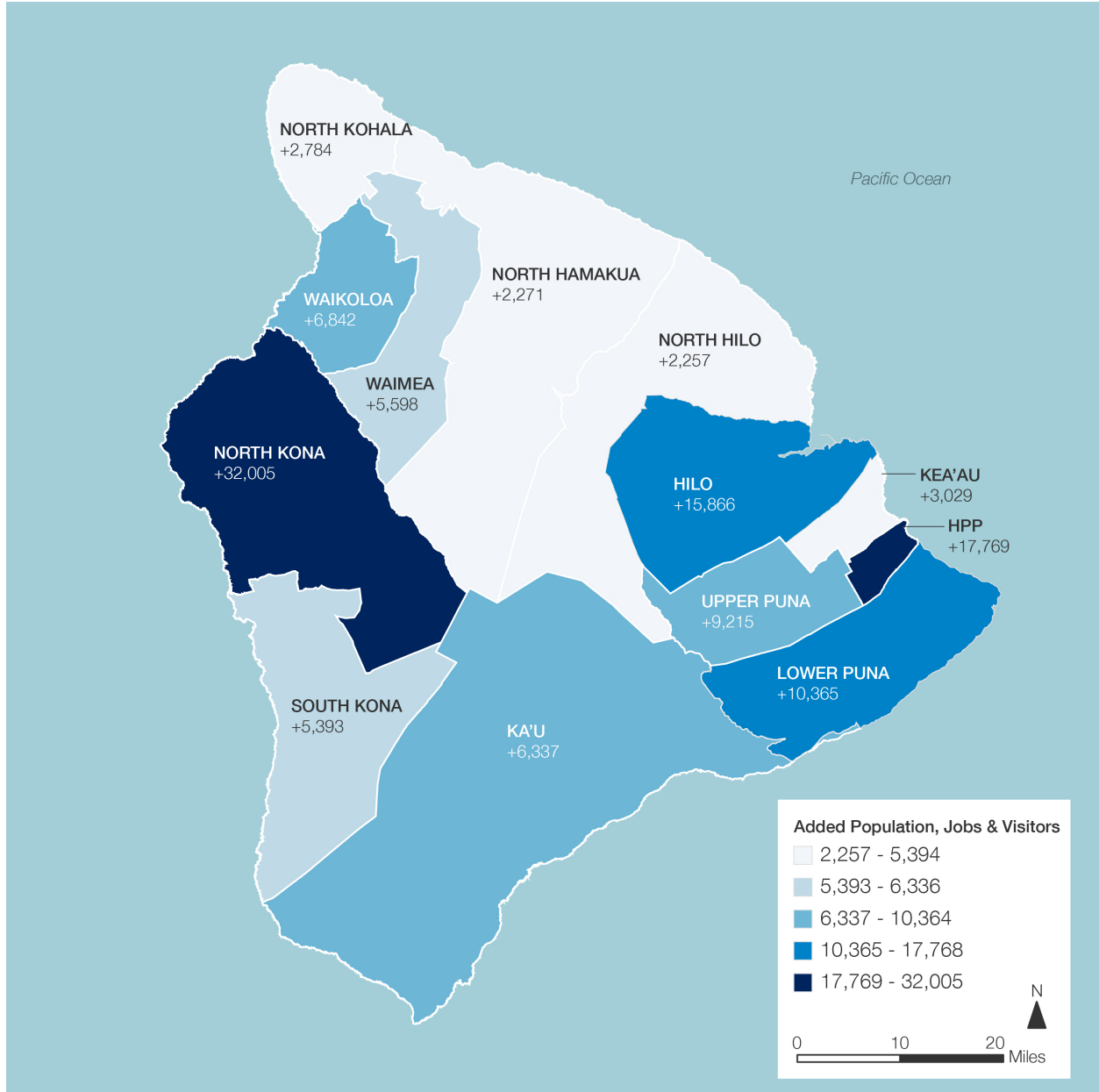
This analysis assesses four potential development scenarios, each of which accommodate the additional 119,207 combined residents, jobs, and visitors. The intent of the two baseline scenarios was to emulate allowable densities based on the County's existing regulations. The intent of the third scenario was to explore the impact of the General Plan 2040.

1. A "Trend Zoning" scenario assumes growth under existing zoning rules, which yields a marginal population density of 2.85 people/acre and a marginal job density of 21.6 jobs/acre for new development.
2. A "Trend LUPAG" scenario assumes growth under current general plan policies, which yields a marginal population density of 4.32 people/acre and a marginal job density of 21.6 jobs/acre for new development.

¹ SMS, *General Plan Comprehensive Review Trends & Forecasts Final Report*, September 2016.

FIGURE 3

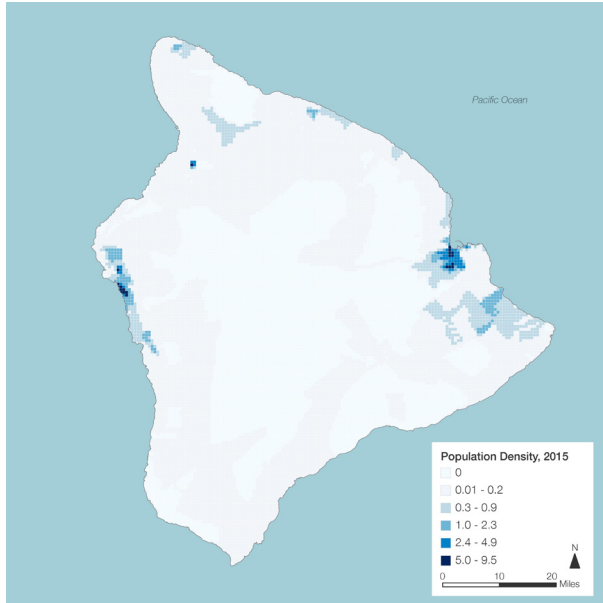
Added Population, Employment, & Visitors by Forecast Analysis Zone, 2040



Source: Smart Growth America, 2019; SMS, *General Plan Comprehensive Review Trends & Forecasts Final Report*, September 2016

FIGURE 4

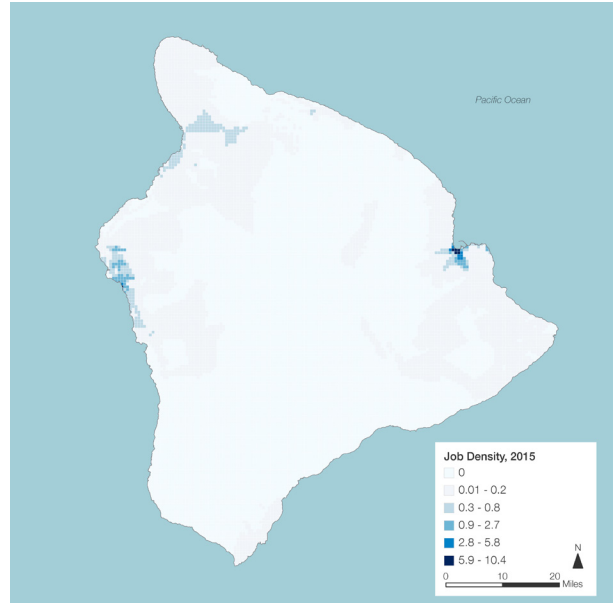
Hawai'i County Population Density, 2015



Source: Smart Growth America, 2019

FIGURE 5

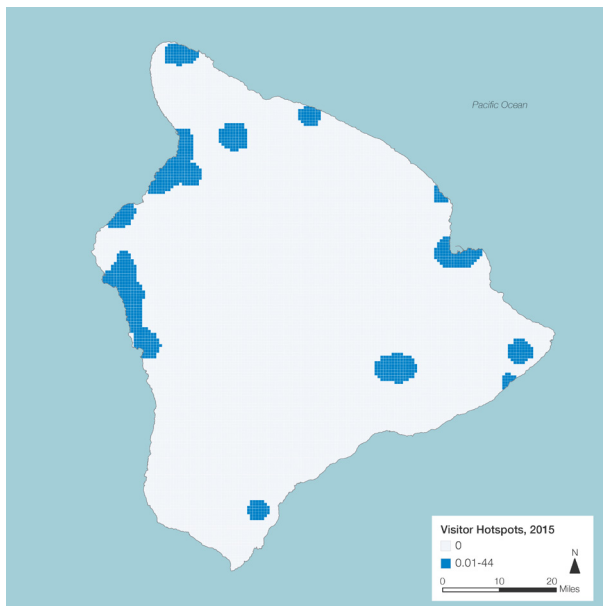
Hawai'i County Job Density, 2015



Source: Smart Growth America, 2019

FIGURE 6

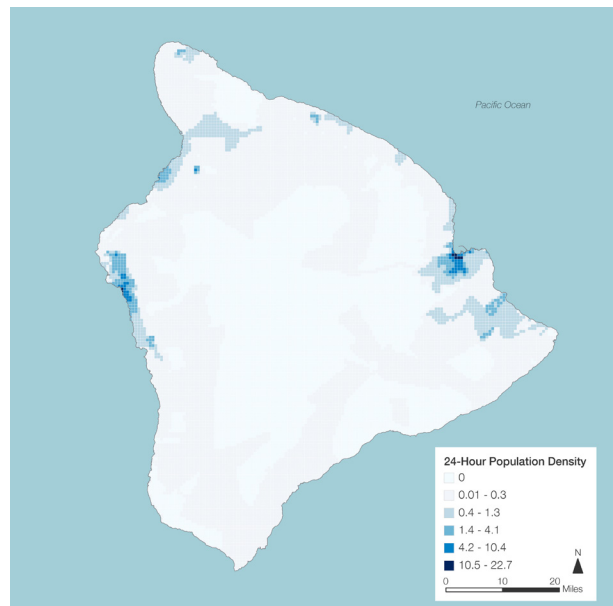
Hawai'i County Visitor Density, 2015



Source: Smart Growth America, 2019

FIGURE 7

Hawai'i County 24-Hour Density, 2015



Source: Smart Growth America, 2019

3. A “General Plan 2040” scenario assumes growth under the proposed General Plan 2040, which yields a marginal average density of 4.54 people/acre and a marginal job density of 21.6 jobs/acre.
4. A “Smart Growth” scenario assumes a marginal population density of 10 people/acre and a marginal job density of 30 jobs/acre, and 50 percent infill development.

The first two scenarios, Trend Zoning and Trend LUPAG, were created using data from the County’s recent *Trend Scenario and Land Use Allocation Technical Report*, written by Placeways LLC.² These two scenarios examine the County’s capacity under current zoning regulations and general plan land use policies and create allocation models to estimate where population growth will occur. For the purposes of this analysis, marginal density levels were calculated at the level of Forecast Analysis Zones and then averaged to the County-level.

The third scenario was created with new projected population densities as proposed by the General Plan 2040. This scenario presents a slight population density increase when compared to the Trend LUPAG scenario, and would require approximately 300 fewer acres to accommodate population growth over the next 20 years.

The fourth scenario presents a “smart growth” development alternative, with higher marginal density levels and 50 percent infill development. The Smart Growth scenario assumes that 50 percent of development will occur in existing built fabric in urban centers, while 50 percent will occur on greenfield land.

This infill assumption builds off of the recent *Development Pattern Adjustment Analysis* conducted by Placeways LLC, which assumes that 10-20 percent of development on obsolete subdivision lots can be diverted to infill properties.³ The report suggests that using an “aggressive financial incentive/disincentive program” including tools

2 DeBay, Amy, Ian Varley, and Doug Walker, Placeways LLC, *Trend Scenario and Land Use Allocation Technical Report*, April 18, 2016.

3 Placeways LLC, *Development Pattern Adjustment: Update*, January 9, 2017.

TABLE 1

Density Scenarios

	Trend Zoning	Trend LUPAG	General Plan 2040	Smart Growth
Adjusted Population Density*	2.85	4.32	4.54	10
Adjusted Job Density*	21.6	21.6	21.6	30
Total Acres	36,512	24,370	24,070	5,132

* Adjusted densities include proportional visitor population (see Methodology)

An aggregation of population, job, and visitor density comprise the County’s “24-hour population density”

such as TDR, rationing of building permits, and retiring county-owned properties could increase the diversion rate to 30-35 percent. This diversion rate was calculated solely for obsolete subdivisions, and therefore SGA increases that number to 50 percent of development diverted away from all greenfield areas and into existing urban cores to account for potential suburban development outside of these subdivisions. Furthermore, the County has initiated a “(Re)Development Feasibility Assessment” to define criteria for assessing redevelopment opportunities, and to identify and prioritize parcels. This effort will further identify community development initiatives and funding and financing mechanisms that will continue the forward momentum of infill development in the County.

SGA uses the concept of “marginal density” in each of the four development scenarios. The marginal density in each scenario is the average density of *new development*. For example, the Smart Growth scenario does not suggest that the average density of the entire County would rise to 10 people per acre by 2040, rather that development to accommodate new population would have an average density of 10 people per acre. While each of the four scenarios are defined by their marginal density, this number is aggregated to the County-level and therefore there are broad variations in density levels within each scenario. In the Trend Zoning scenario, marginal density of new development in Forecast Analysis Zones ranges from 1.1 to 6.6 people per acre. In the Trend LUPAG scenario, marginal density ranges from 2.3 to 16.4 people per acre. In the General Plan 2040 scenario, the marginal density ranges from 1.1 to 15.2 people per acre. In the Smart Growth scenario, marginal density of people in urban centers is estimated to be approximately 15 residents per acre, compared with 5 residents per acre outside urban centers.

Accommodating the 119,207 new residents, jobs, and visitors at these marginal density levels would lead to vastly different physical footprints. The Trend Zoning scenario would require 36,512 acres of development, the Trend LUPAG scenario would require 24,370 acres of development, the General Plan 2040 scenario would require 24,070 acres of development, and the Smart Growth scenario would require 5,132 acres of development.

Land Constraints

The density of new residents, jobs, and visitors in the County directly impacts the number of acres that will be developed. In addition to fiscal costs of providing infrastructure across a greater land area, developing across a larger land area has significant environmental costs. This report examines two types of land constraints that will impact future development in Hawai'i, lava flow risk hazards and loss of productive agricultural land. Neither of these costs are taken into account in the net fiscal impact assessment of the four scenarios, but they serve as a supplement to highlight the potential costs associated with land constraints in the County.

Volcano Lava Flow Hazards

There are two active volcanoes on the Big Island, Mauna Loa and Kilauea. Kilauea has been erupting nearly constantly since 1983, but on May 3, 2018 a major eruption began that destroyed upwards of 700 homes.¹ Going forward, the County plans to conduct a volcanic risk assessment that will examine hazard exposure, vulnerability, and coping capacity, and the necessary policy responses to the eruption in greater depth. However, this analysis sought to quantify the probability in each scenario that an acre developed would be in one of the County's "lava flow hazard zones," as previously defined.

To conduct this analysis, SGA used GIS to calculate the number of acres in each Forecast Analysis Zone that are protected and the number of acres within lava flow hazard zones. Protected land for these purposes included national parks, state parks, open space, and forest reserves, which were assumed to not allow development in the future. This analysis assumed that lava flow hazard zones 1 & 2 as the highest risk areas and buffered them according to USGS guidance (see Figure 8).² Then, SGA calculated the probability that an acre within the high-risk lava flow zones would be developed under each of the four scenarios. That probability metric was multiplied by the total number of acres developed for each scenario to estimate a number of acres and households at-risk of lava flow.

This estimate includes marginal households in each development scenario, not any existing households that may be damaged by a lava flow event. Therefore, the monetary impact of risk includes the possible marginal cost of a lava flow event on top of cost of damage to existing development. To quantify the monetary impact of lava-flow risk, the number of at-risk households was multiplied by the 2016 median home

LAND CONSTRAINTS CONSIDERED

Volcano Lava Flow Hazards

Loss of Productive Agricultural
Land

- 1 USGS, Volcano Hazards Program, <https://volcanoes.usgs.gov/volcanoes/kilauea/>.
- 2 Volcano Lava Flow Hazard Zones, Hawai'i Statewide GIS Program, <http://geoportal.hawaii.gov/datasets/volcano-lava-flow-hazard-zones>

value in each FAZ, which ranged from \$156,000 to \$475,000.³ This cost estimate simply represents the replacement value of new homes within the lava flow hazard zones. Additionally, the County estimated that in the recent eruption event, it has incurred approximately \$7.5 million in labor, fringe, material, and other costs for emergency response. Dividing that amount by the population impacted yields a per person emergency response cost of approximately \$600 per person, not including police and fire.⁴ Together, the property replacement costs for at-risk homes and emergency response costs for at-risk population were assumed to total the marginal cost of eruption risk.

The results of this analysis show that because the Smart Growth scenario has a lower probability of developing land in areas at high-risk of lava flow, it has a lower potential cost of property damage and emergency response. Furthermore, because the General Plan 2040 scenario redistributes population to FAZs with fewer lava flow hazard zones, that scenario saves cost of property damage and emergency response when compared to the Trend Zoning and Trend LUPAG scenarios. It is worth noting that this analysis creates a probability metric that is independent of land use regulations and assumes a level of randomness regarding the location of new development. The County's forthcoming volcanic risk assessment will conduct a more thorough examination of lava-flow risk, potential impacts, and necessary responses across the County.

3 U.S. Census, American Community Survey 5-year estimates, 2012-2016

4 County of Hawai'i estimate as of September 30, 2018.

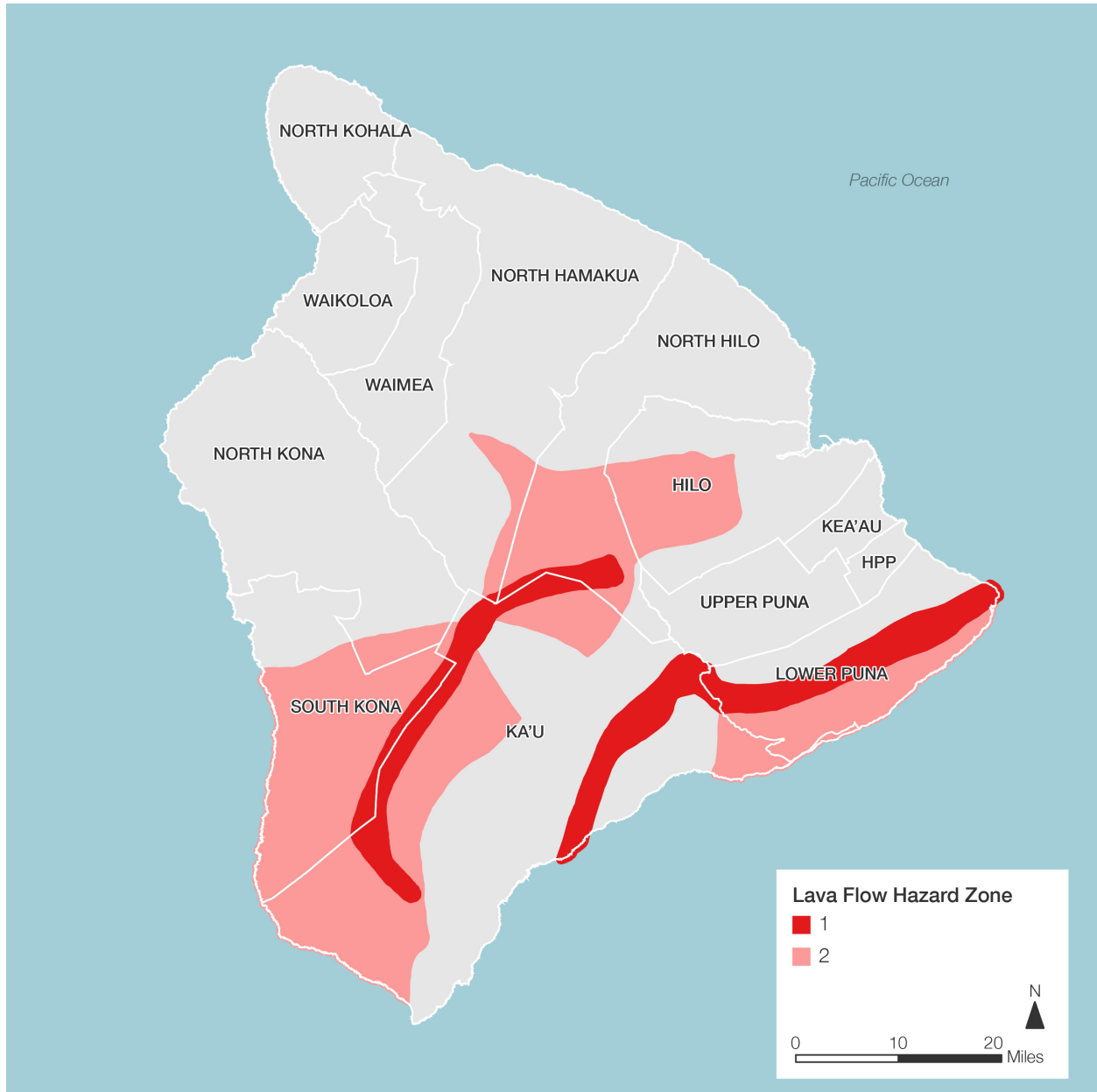
TABLE 2
Lava Flow Hazard by Scenario

	Trend Zoning	Trend LUPAG	General Plan 2040	Smart Growth
Total Acres (residential)	35,676	23,534	23,234	4,922
Probability developed acre is in lava flow hazard zone	0.5%	0.3%	0.3%	0.1%
Acres in lava flow hazard zone	76	41	28	3
At-risk homes (new development)	86	57	44	12
Value of at-risk homes	\$23,337,975	\$13,856,436	\$11,086,783	\$3,616,047
At-risk population (new development)	235	154	119	34
Emergency Response Costs (marginal)	\$141,583	\$92,591	\$71,924	\$20,593
Total Costs (marginal)	\$23,479,557	\$13,949,028	\$11,158,708	\$3,636,640

Source: Smart Growth America, 2019

FIGURE 8

Buffered Lava Flow Hazard Zones 1 & 2



Source: Hawai'i Statewide GIS Program; Smart Growth America, 2019.

Productive Agricultural Land

Agriculture is important to Hawai'i's economy, long-term sustainability, and helps the County to preserve valuable green space. In 2012, the USDA Census of Agriculture estimated that the County had approximately 687,000 acres in use for farming. *The Statewide Agricultural Land Use Baseline Report* estimated that between 1980 and 2015, the State lost 37 percent of its agricultural land. As Hawai'i County faces significant growth of residents, jobs, and visitors, looking ahead to 2040 this analysis considers the impact that this development may have on productive agricultural land.

The process used to examine impact on agricultural land is similar to that of the lava flow risk assessment. Using GIS, SGA calculated protected land and productive agricultural land, and created a metric of the probability that an acre of productive agricultural land will be developed. Productive agricultural lands were defined using two separate sources: areas defined in the LUPAG as Important Agricultural Lands and pasture lands identified in a 2015 University of Hawai'i – Hilo study that mapped areas of active agriculture and ranching (See Figure 9).

The probability that land was both developed and agricultural was multiplied by the total number of acres for each scenario to determine the number of agricultural acres at-risk for development. The monetary impact of the acres developed was created using the USDA Census of Agriculture's 2012 estimate of average land value for farms in the County per acre, \$8,892 (\$ 2018).

This analysis shows that with denser development, there is a lower probability that acres of productive agricultural land will be lost to accommodate new residents, jobs, and visitors. However, it is notable that the General Plan 2040 recommendations result in a slightly higher potential for loss of agricultural land (approximately 27 acres). This is likely due to the reapportionment of population projections to different FAZs that has increased the overall risk of loss of farmland. Just as with the lava flow risk analysis, this assessment does not take into account

TABLE 3

Loss of Productive Agricultural Land by Scenario

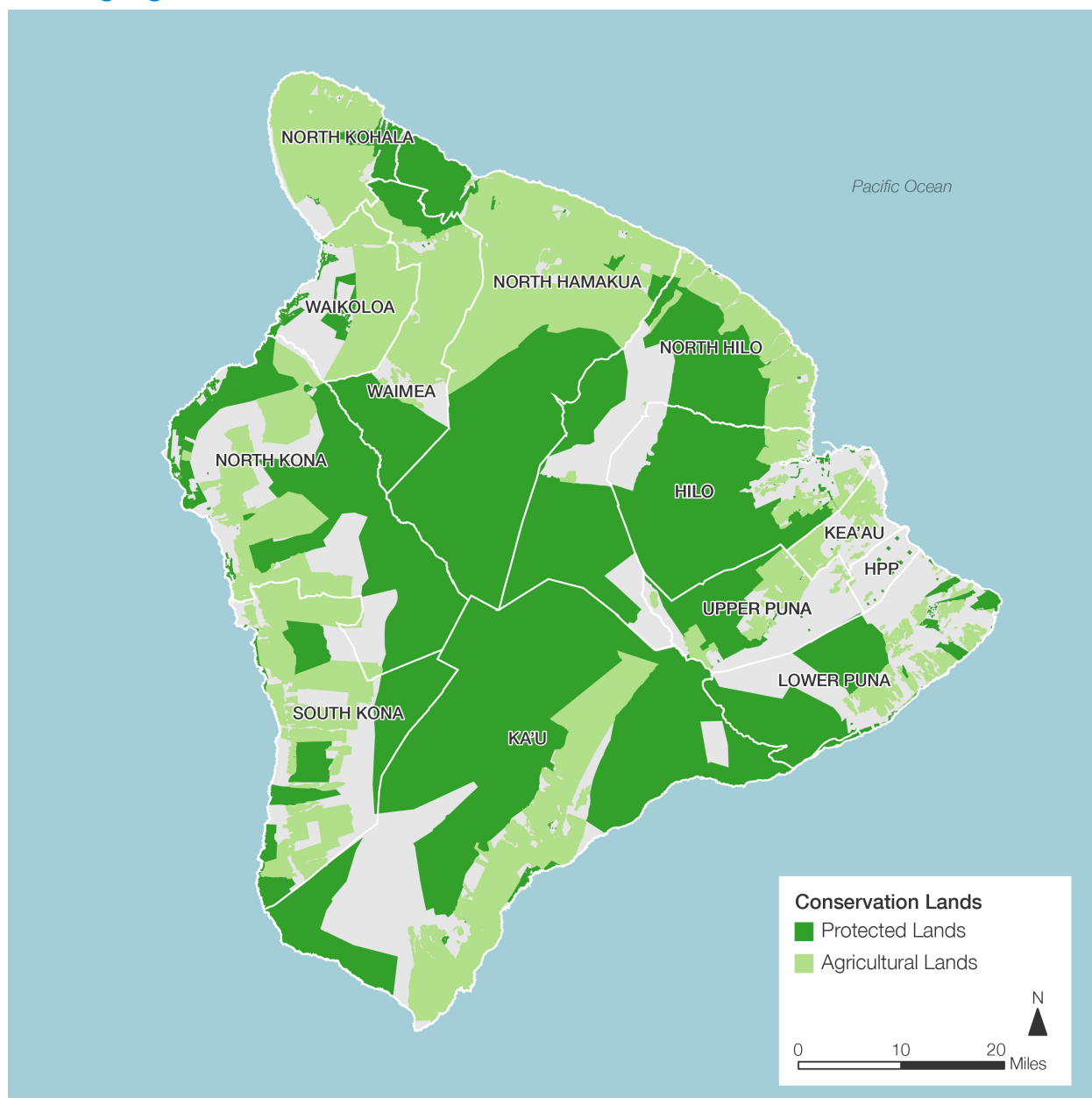
	Trend Zoning	Trend LUPAG	General Plan 2040	Smart Growth
Total Acres (residential)	35,676	23,534	23,234	4,922
Probability developed acre is on agricultural land	1.3%	0.9%	0.9%	0.2%
Acres on agricultural land	357	125	152	9
Value of land	\$3,170,461	\$1,111,883	\$1,347,981	\$80,009

Source: Smart Growth America, 2019

land use regulations or a broader consideration of economic production of each acre of agricultural land. Therefore, taking into account the land use protections and policies incorporated into the General Plan 2040, the amount of agricultural land at risk of development may decrease.

FIGURE 9

Existing Agricultural & Protected Land



Sources: County of Hawai'i LUPAG, Important Agricultural Lands; University of Hawai'i - Hilo, Pasture Lands; and County of Hawai'i, Zoning; Smart Growth America, 2019.

COUNTY-PROVIDED INFRASTRUCTURE ITEMS CONSIDERED

Roadways

Water Lines

Wastewater Lines

Emergency Response Services

DEVELOPER-PROVIDED INFRASTRUCTURE ITEMS CONSIDERED

Electricity Poles

Septic Systems

Methodology

This analysis focuses on six expenditures for development in the County of Hawai'i: roadways, water lines, wastewater lines, electricity poles, septic systems, and emergency response services. These items were selected based on the data available from the County of Hawai'i. The County has many other infrastructure and service costs that are also essential to planning for growth. These six items represent the costs that have the strongest observable relationship to 24-hour population density. Since this analysis does not examine all infrastructure, the costs we present are a conservative estimate of what future development will likely cost the County.

Two of the costs examined in this analysis—septic systems and electricity poles—are typically incurred by private developers. However, SGA included them in the fiscal impact model for two reasons. First, the spatial distribution of septic systems and electricity poles have a strong observable relationship to population density, and therefore represent a cost of sprawl. Second, while private developers typically cover the costs of installing these two infrastructure items, those costs are then passed on to the residents of new development. Therefore, just as with direct costs to the County, these development costs will ultimately be borne by the taxpayers.

For each expenditure item, the County provided GIS shapefiles. Using this data, SGA aggregated infrastructure items to the same 40-acre grid cells containing population, job, and visitor estimates. This process allowed for the calculation of unit density in each grid cell (e.g. "road area per acre" or "feet of water pipe per acre").

We then used these estimates of units per acre of each infrastructure item as the basis of an ordinary least squares (OLS) regression analysis. The unit of analysis for the data set was the 40-acre grid cell. The result is a set of models that estimate the unit density per capita (e.g. "road area per acre per person") as a function of population density ("residents per acre") and job density ("jobs per acre"). These models allow for an estimate of the amount of infrastructure units needed per capita as a function of population and job density. It is this consideration of density that distinguishes this analysis from prior "average cost analyses" that simply divide costs by new population.

When estimating the amount of infrastructure needed, population and job density were multiplied by their corresponding coefficients in each regression model. However, visitors are distributed more unevenly across the Island, with many grid cells containing no visitors. Therefore, to estimate how much infrastructure would be required per additional visitor, 60 percent of projected visitors were added to the projected jobs and 40 percent of the projected visitors were added to

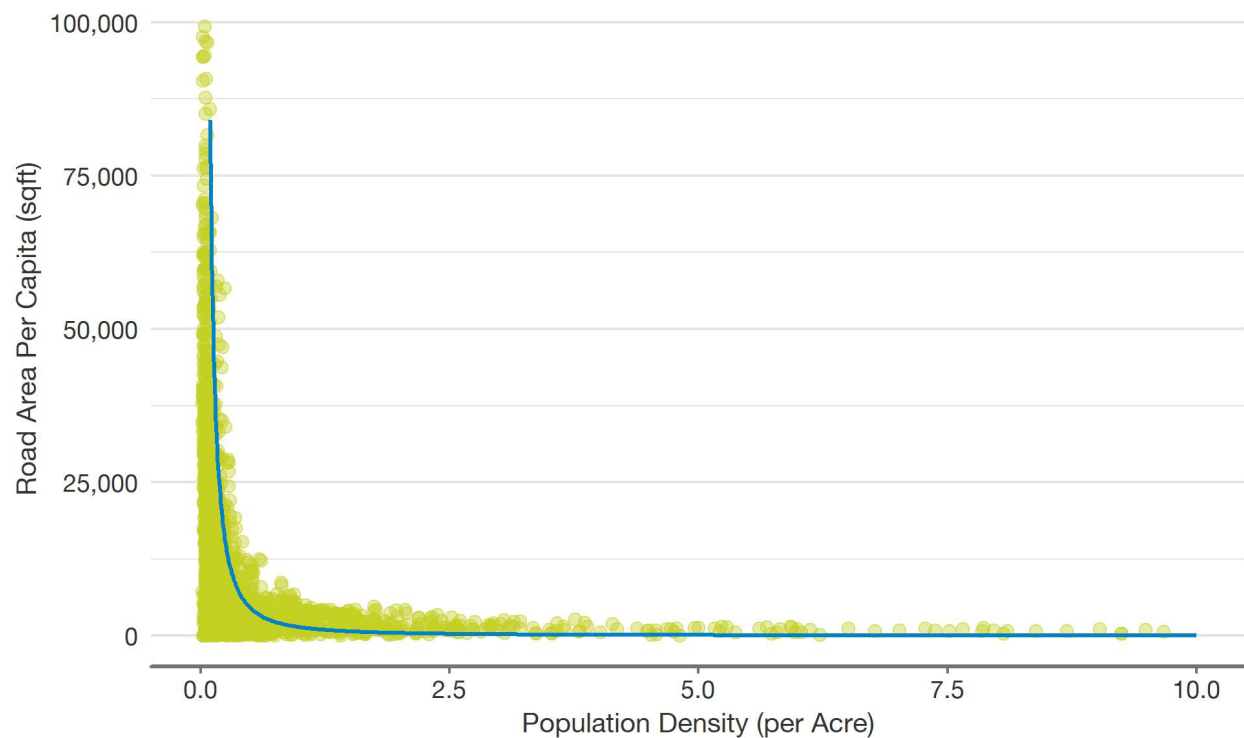
the projected residents. These percentages were taken from the visitor census, which observes that 60 percent of visitor accommodation units are hotel rooms, while the remaining 40 are timeshare and visitor rental units.¹

Figure 10 plots the relationship between 24-hour population density and road area captured by the regression analysis. SGA created a regression model for each infrastructure item and each exhibited a similar relationship. Regression outputs, plots, and cost itemization for each infrastructure item can be found in Appendix A.

1 SMS, *General Plan Comprehensive Review Trends & Forecasts Final Report*, September 2016

FIGURE 10

Road Area per Capita, by Density (Hawai'i County)



Source: Smart Growth America, 2019

TABLE 4

Results - Hawai'i Development Costs per Capita (Marginal Costs)

	Trend Zoning	Trend LUPAG	General Plan 2040	Smart Growth
Road Area Needed per Resident (sqft)	506	433	425	317
Road Area Needed per Job (sqft)	257	257	257	229
Total Road Area Needed (sqft)	55,955,081	48,577,600	47,779,527	36,274,833
Price per Square Foot of New Road	\$24	\$24	\$24	\$24
Total Cost of Road Needed (millions)	\$1,343	\$1,166	\$1,147	\$588

Source: Smart Growth America, 2019

FIGURE 11

Average Distance to Emergency Response Services

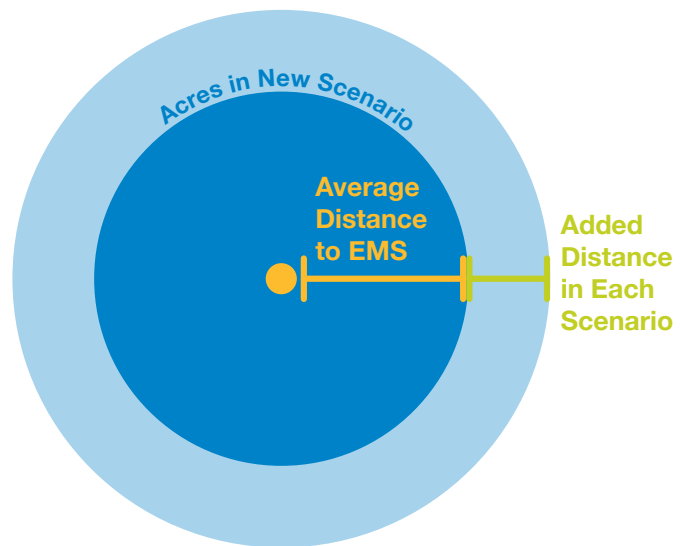


Table 4 illustrates how “road area per capita” needed decreases as a function of population and job density. This is due to the fact that at higher densities, roads can be shared and distributed among more people.

Each model estimates the total quantity of infrastructure needed, as well as the quantity of infrastructure per capita. Then, cost factors were developed for each infrastructure item based on SGA research in coordination with the County of Hawai'i. The infrastructure quantities and item-specific cost factors were then used to calculate the cost of providing infrastructure for each of the four development scenarios.

Calculating the costs of emergency response services involved a different method. First, using GIS, SGA estimated the distribution of population at the census block-group level. Then, we calculated the existing average distance to a police or fire station as a baseline, which was 2.9 miles. We created a 2.9-mile buffer zone around each of the police and fire stations, and assumed that new development in each scenario would occur in a ring surrounding that average distance. This method makes the assumption that new development would require emergency services to travel a further distance to respond to calls that is proportional with the density of that development.

SGA used the number of acres developed under each scenario and the existing 2.9-mile radius to calculate the added emergency response radius under each scenario (See Figure 12). Adding that new distance to the current average distance yielded a new average distance to police and fire stations, assuming new development outside of current service areas. SGA used the current 24-hour population and the number of 911 calls in 2016 to create a calls per capita metric, which was scaled proportionally to estimate the number of 911 calls that the new 24-hour population would generate.

This analysis assumes that many costs of providing emergency service are fixed regardless of development density. However, traveling additional miles to respond to calls would affect maintenance costs of police and fire vehicles. Using annual vehicle maintenance cost estimates from the 2018-2019 Operating Budget and the Hawai'i Police Department, SGA created a cost of emergency response per mile metric. Using the new average distance to a police and fire station in each scenario, SGA calculated the added miles required for the new 911 calls. Multiplying the new miles by the average cost per mile created an annual cost for providing emergency service to the additional 24-hour population.

The final step in this analysis was to add the financing, operations, and maintenance costs to the infrastructure and service costs. Infrastructure items are long-term capital investments, and governments typically issue bonds to pay for these investments. This analysis assumes that the financing cost to the County would be 4 percent interest over 20-years. Finally, the analysis adds operations and maintenance cost of 5 percent. Together with the estimated cost of infrastructure, the financing, operations, and maintenance costs represent the estimated total cost of providing infrastructure and services under each development scenario (See Figure 12).

FIGURE 12

Components of Total Cost



Results

The fiscal impact model for future development in Hawai'i County yielded two key results for each of the four scenarios. The total 20-year costs can be seen in Table 5, along with an annual cost as compared to the County's 2018-2019 annual budget.

The second result is the net fiscal impact of each development scenario. The net fiscal impact takes the total 20-year cost and compares it against potential revenue from new residents and jobs. Here, we use an average revenue of \$1,643 per person based on the County's 2018-2019 General Fund budget.¹ The four scenarios all plan for the same level of 24-hour population growth, therefore they each generate the same estimated tax revenues, which are \$2.4 billion over 20 years. However, due to their varying levels of density, the scenarios differ in their cost to the County. When we compare the revenue of each scenario against its costs, the difference is the net fiscal impact. A negative net fiscal impact indicates that the County would lose money in accommodating the new growth; a positive net fiscal impact indicates that the County would generate net revenue.

The results of this analysis show that the Trend Zoning, Trend LUPAG, and General Plan 2040 scenarios result in a negative net fiscal impact over 20 years, and the Smart Growth scenario results in a positive net fiscal impact (see Table 6). The Trend Zoning scenario, which allows for development consistent with current zoning regulations in Hawai'i County, would cost approximately \$2.96 billion over 20 years. This equates to \$148 million per year, which is equivalent to 27% of the County's 2018-2019 total budget. Applying the estimated potential tax revenues from the new 24-hour population yields a 20-year net fiscal impact of -\$557 million, or -\$28 million annually.

The Trend LUPAG scenario, which assumes density levels consistent with current general plan policies, would reduce the 20-year costs to \$2.60 billion, which is \$130 million per year. The 20-year net fiscal impact is -\$193 million, or -\$10 million annually.

The General Plan 2040 scenario improves upon the Trend LUPAG scenario, increasing population density and reapportioning population projections amongst FAZs. The 20-year costs of the General Plan 2040 scenario are \$2.56 billion, which amounts to \$128 million per year. Over the 20-year period, the net fiscal impact of the General Plan 2040 scenario is -\$154 million, or -\$8 million annually.

The Smart Growth scenario assumes a density slightly higher than traditional neighborhood development of 10 people per acre, along with 50 percent infill development. Both by increasing density and exploiting existing infrastructure through infill development, this scenario substantially reduces costs and results in a positive net fiscal

¹ County of Hawai'i, "Operating Budget, FY 2018-2019, Ordinance No. 18-68."

TABLE 5

Results - Hawai'i Development Costs Summary

Millions (\$)	Trend Zoning	Trend LUPAG	General Plan 2040	Smart Growth
Capital Costs - 20 years	\$1,944	\$1,706	\$1,680	\$925
Amortized Costs - 20 years (4% Rate)	\$2,862	\$2,510	\$2,472	\$1,361
Maintenance Costs - 20 years	\$97	\$85	\$84	\$46
Total Costs - 20 years	\$2,959	\$2,595	\$2,556	\$1,407
Total Costs Annually	\$148 (+27% to budget)	\$130 (+24% to budget)	\$128 (+24% to budget)	\$70 (+13% to budget)

Source: Smart Growth America, 2019

TABLE 6

Results - Hawai'i Net Fiscal Impact Summary

Millions (\$)	Trend Zoning	Trend LUPAG	General Plan 2040	Smart Growth
Total Costs - 20 years	\$2,959	\$2,595	\$2,556	\$1,407
Estimated Tax Revenue - 20 years	\$2,402	\$2,402	\$2,402	\$2,402
Net Fiscal Impact - 20 years	-\$557	-\$193	-\$154	+\$995
Total Costs Annually	\$148	\$130	\$128	\$70
Estimated Tax Revenue Annually	\$120	\$120	\$120	\$120
Net Fiscal Impact Annually	-\$28	-\$10	-\$8	+\$50

Source: Smart Growth America, 2019

impact. In this scenario, 20-year costs would be \$1.41 billion (\$70 million per year). The 20-year net fiscal impact is +\$995 billion (+\$50 million per year).

Another way of examining costs is to consider the marginal costs per new resident, job, or visitor. This measure tells us, on average, how much the County is spending to provide infrastructure and services to each new person. Under the Trend Zoning scenario, each new person would cost the County \$1,241 per year. This compares to \$1,089 annually per person under the Trend LUPAG scenario, \$1,072 annually per person under the General Plan 2040 scenario, and \$590 annually per person under the Smart Growth scenario. It is worth noting that the marginal cost per resident results differ from net fiscal impact, because it does not consider that new residents, jobs, and visitors do not arrive all at once. Net fiscal impact over a 20-year time frame accounts for that variation.

The fiscal impact model tells us that development under current zoning and regulations and guidelines in the current and proposed general plans would cost the County considerably more money than it would cost to build under a Smart Growth scenario.² The infrastructure and service items analyzed in this model consist only of items with a clearly demonstrable relationship to population density, and therefore are most likely a conservative estimate of costs to the County.

The net fiscal impact adjusts results for the County's tax revenues, and the discrepancy between costs and revenues shows that in each scenario the County will have to make up for additional costs. For example, under the Trend Zoning scenario, each person would cost the County approximately \$1,241 annually. These costs will have to be covered somewhere – be it by members of the new 24-hour population, the existing population, businesses, or external funds (See Table 7).

Finally, we convert the costs of each scenario into “cost savings” relative to the Trend Zoning scenario (See Table 8). From this standpoint, the Trend LUPAG, General Plan 2040, and Smart Growth scenarios offer significant potential savings to Hawai'i County. The Trend LUPAG scenario would save the County \$18 million per year and \$364 million over 20 years. The General Plan 2040 scenario would save the County \$20 million per year and \$403 million over 20 years—a \$39 million savings over the Trend LUPAG scenario. The Smart Growth scenario would generate net revenue for the County, with a \$78 million annual savings and a \$1.6 billion savings over 20 years when compared with the Trend Zoning scenario.

² For the infrastructure items examined in this report, including roadways, water lines, wastewater lines, electricity, septic, and emergency response.

TABLE 7

Results - Hawai'i Development Costs per Capita (Marginal Costs)

	Trend Zoning	Trend LUPAG	General Plan 2040	Smart Growth
Total Costs per Additional Resident, Job, and Visitor - 20 years	\$24,821	\$21,770	\$21,443	\$11,805
Annual Costs per Additional Resident, Job, and Visitor	\$1,241	\$1,089	\$1,072	\$590

Source: Smart Growth America, 2019

TABLE 8

Results - Hawai'i Development Cost Savings

Millions (\$)	Trend Zoning	Trend LUPAG	General Plan 2040	Smart Growth
Total Savings - 20 years	NA	\$364	\$403	\$1,552
Annual Savings	NA	\$18	\$20	\$78

Source: Smart Growth America, 2019

Conclusion

This analysis considers how Hawai'i County might accommodate 98,442 new residents, 12,585 new jobs and 8,180 new visitors by the year 2040. Density of development matters in terms of how much it will cost the County to provide infrastructure and services. This analysis examined two scenarios consistent with existing County zoning regulations and land use guidelines, one scenario consistent with the proposed General Plan 2040, and one denser scenario consistent with the principles of smart growth.

Under the Trend Zoning scenario—the least dense of the four, which allows for development consistent with Hawai'i's zoning regulations—the County would accommodate new growth at 2.85 residents per acre and 21.6 jobs per acre. To do so would cost the County \$2.96 billion over 20 years for the provision of infrastructure and services, with a net fiscal impact of -\$557 million when considering potential tax revenues from new residents and jobs.

Under the Trend LUPAG scenario, which aligns with the County's existing land use policies, the County would accommodate new growth at 4.32 residents per acre and 21.6 jobs per acre. This would cost the County \$2.60 billion over 20 years, with a net fiscal impact of -\$193 million.

The General Plan 2040 scenario is consistent with the proposed General Plan update. This plan slightly increases the density allowed in the Trend LUPAG scenario up to 4.54 people per acre and maintains the scenario's 21.6 jobs per acre. Furthermore, the population projection associated with the General Plan 2040 update reapportions population amongst FAZs in order to encourage development in areas that are at less risk of natural hazards. The General Plan scenario would cost the County \$2.56 billion over 20 years, with a net fiscal impact of -\$154 million.

While the General Plan 2040 scenario represents an improvement to the Trend LUPAG scenario, a fourth, more aggressive scenario was created based on the principles of smart growth. This scenario would allow for development at 10 residents per acre and 30 jobs per acre. Furthermore, the Smart Growth scenario assumes that 50% of development is infill and takes advantage of existing infrastructure. The Smart Growth scenario illustrates the potential savings to the County if it were to continue to encourage dense development patterns. This scenario would cost the County \$1.41 billion over 20 years, and would result in a positive net fiscal impact of \$995 million. The Smart Growth scenario would save the County \$1.6 billion over 20 years when compared with the least dense scenario. Furthermore, examining land constraints demonstrates that the County can minimize the risk of lava flow hazards and loss of agricultural land by accommodating new people, jobs, and visitors with a denser development pattern.

In short, accommodating growth at higher density levels would save the County and its taxpayers in terms of reduced costs for roadways, water lines, wastewater lines, electricity lines, septic systems, and emergency response services. This is a set of hypothetical development scenarios for Hawai'i County, using population, job, and visitor forecasts that may not come to be. However, this analysis highlights the financial consequences of land-use decisions over a 20-year time frame. The costs of low-density, sprawling development are significant and add up over time. Planners and policymakers should take note that smarter growth, with more compact development patterns, would reduce long-term costs.

There are a few caveats to note along with the results of this analysis. First, while the analysis evaluates population, job, and visitor forecasts within Forecast Analysis Zones, it does not incorporate location-specific scenarios. Therefore, the magnitude of numbers may vary and a defined geography would allow for more accurate estimates of cost for emergency response services and land constraints, along with transit, schools, and other location-sensitive factors.

Second, it is likely that in any scenario the future development in Hawai'i will comprise some infill and some greenfield development. This analysis uses infill in the Smart Growth scenario to illustrate the cost savings that can occur through prioritizing infill, as new development can often take advantage of existing infrastructure. The cost of infill development can vary greatly, but based on discussions and work with several municipalities, SGA finds that the costs of infill development to the government can be around 35 percent of what the same development would cost in a greenfield.

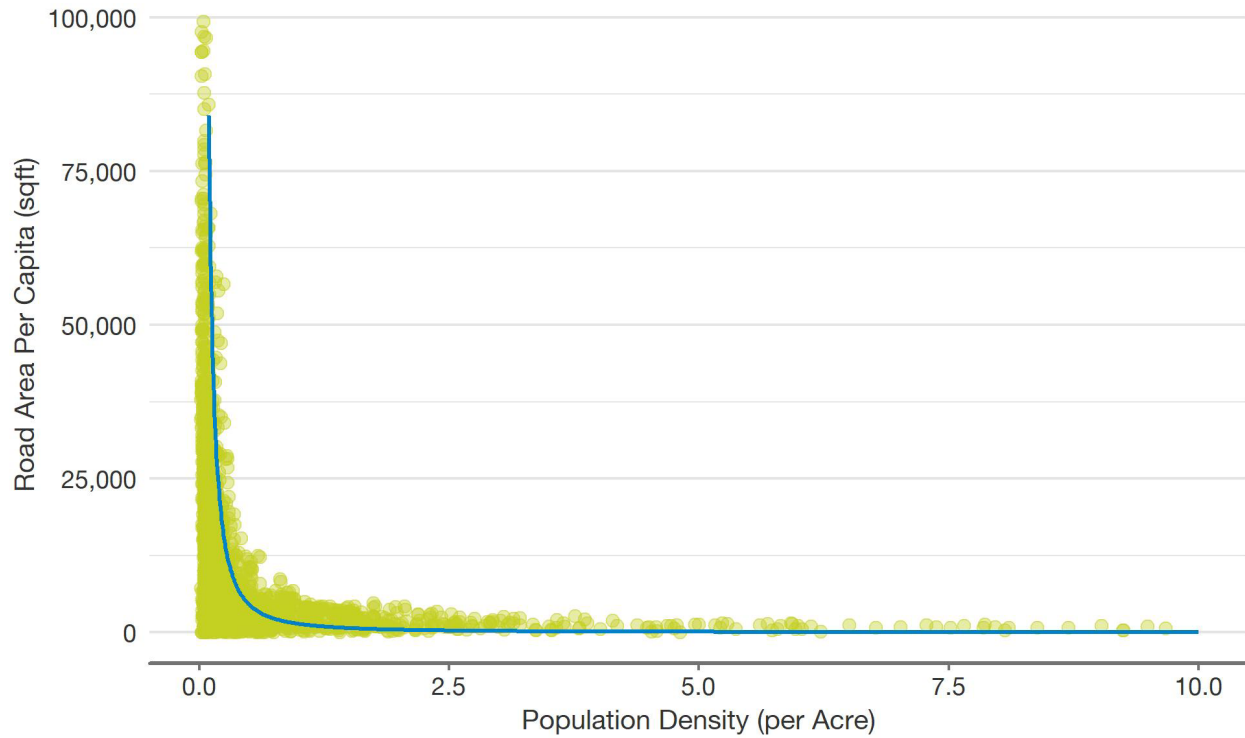
Third, it is important to note that there are many cases in which the County is not responsible for the cost of new infrastructure. Often, infrastructure provision is a condition of development, and therefore is funded by developers. However, regardless of who pays for the construction of infrastructure, the County is often responsible for the cost of maintenance. Furthermore, regardless of which entity pays for new infrastructure, denser development is more cost-efficient. Whether the cost of infrastructure is paid directly by the County or by developers, these costs are passed along to property owners and tax payers.

Finally, SGA conducted this analysis for the County of Hawai'i using data particular to that area. These factors and magnitudes differ from community to community, representing the various policy and spending decisions that differ across the country. Infrastructure provision, especially on a per-capita basis, can vary widely from one place to another, even at similar density levels. Thus, it is best to understand these cost estimating models as best suitable for Hawai'i. The parameter estimates themselves are not suitable for application to other communities, although the trends of higher density requiring fewer units of infrastructure per capita do hold.

This analysis should be used as a guideline for Hawai'i to consider the fact that context-sensitive higher density levels are not only beneficial from an economic, social equity, and environmental standpoint, they also make financial sense. The County stands to gain nearly \$1 billion in revenue over 20 years by building at higher density levels. Continuing to build at low-density levels would yield heavy capital costs for major infrastructure items, and these costs can be mitigated with a "smart growth" approach to new development.

Appendix A - Technical Output

Roadways



Roadways Regression Results

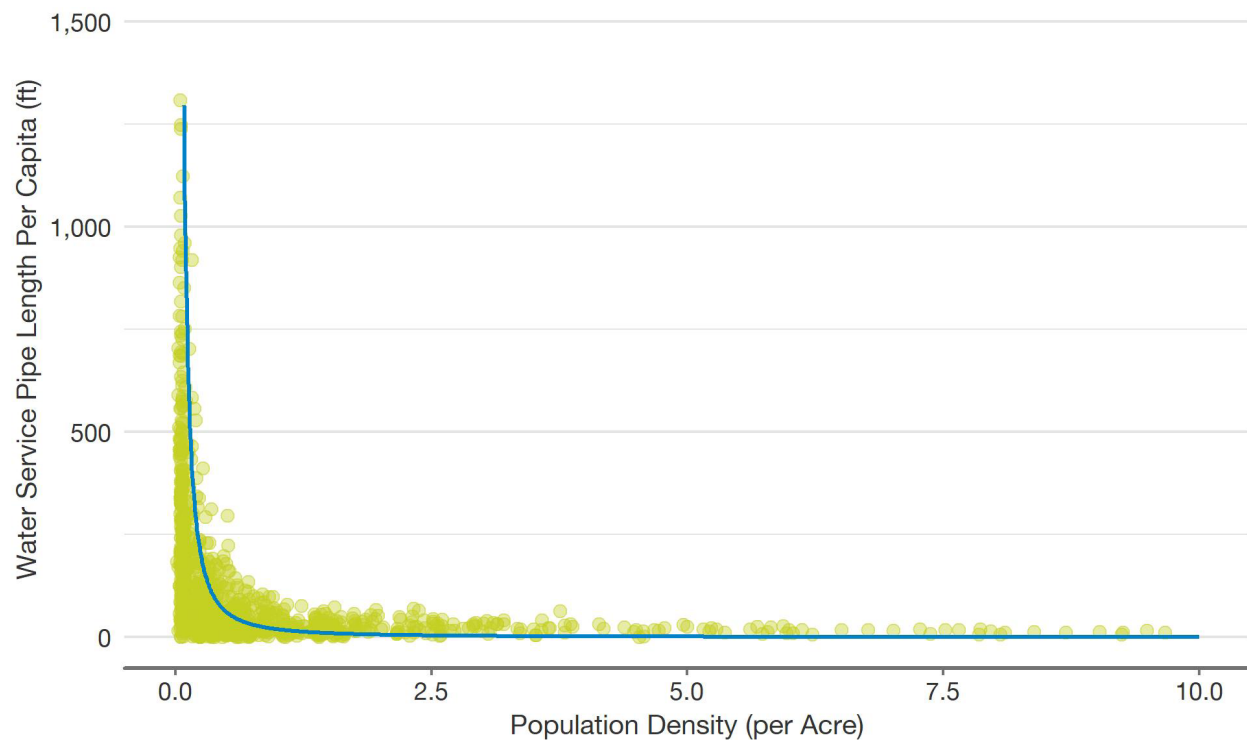
Dependent Variable	log(Road Area per Capita)		
Mean	13,780		
Standard Deviation	23,914		
OLS	$\log(\text{Road Area per Capita}) = 6.616 + -0.372 * \log(\text{Population Density}) + -0.347 * \log(\text{Job Density})$		
Variable	Coefficient	Std. Error	t-ratio
Constant	6.616***	0.07	94.06
log(Population Density)	-0.372***	0.024	-15.33
log(Job Density)	-0.347***	0.021	-16.44
Observations	2,216		
R ²	0.354		
Adjusted R ²	0.354		
Residual Standard Error	1.234		
F-Statistic	607.6***		
Log-Likelihood	-3608.586		

* p < 0.1; ** p < 0.05; *** p < 0.01

Roadway Area Needed by Scenario

	Trend Zoning	Trend LUPAG	General Plan 2040	Smart Growth
Unit Cost (\$/square foot)	\$24	\$24	\$24	\$24
Est. Road Area per Capita Population (sqft)	506	433	425	317
Est. Road Area per Capita Jobs (sqft)	257	257	257	229
Est. Road Area Needed	55,955,081	48,577,600	47,779,527	36,274,833
Est. Cost of Road Area Needed	\$1,342,921,934	\$1,165,862,408	\$1,146,708,650	\$587,652,297
Savings Compared to Baseline Scenario	NA	\$177,059,526	\$196,213,284	\$755,269,638

Water Service Lines



Water Service Line Regression Results

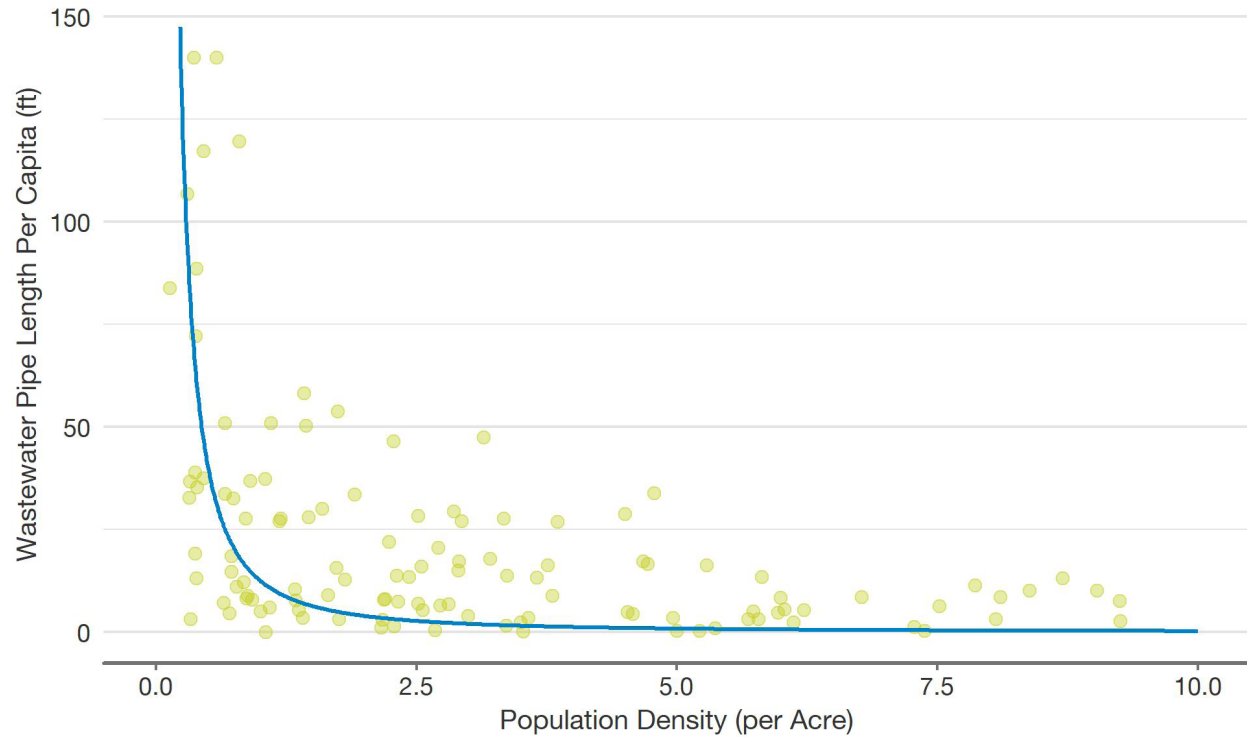
Dependent Variable	log(Water Line Linear Feet per Capita)		
Mean	140.18		
Standard Deviation	216.49		
OLS	log(Water Line per Capita) = 2.68 + -0.399 * log(Population Density) + -0.243 * log(Job Density)		
Variable	Coefficient	Std. Error	t-ratio
Constant	2.68***	0.076	35.23
log(Population Density)	-0.399***	0.035	-11.351
log(Job Density)	-0.243***	0.027	-8.830
Observations	967		
R ²	0.371		
Adjusted R ²	0.369		
Residual Standard Error	1.193		
F-Statistic	284***		
Log-Likelihood	-1540.986		

* p < 0.1; ** p < 0.05; *** p < 0.01

Water Service Line Linear Feet Needed by Scenario

	Trend Zoning	Trend LUPAG	General Plan 2040	Smart Growth
Unit Cost (\$/linear foot)	\$100	\$100	\$100	\$100
Est. Water Pipe per Capita Population (ft)	10	8	8	6
Est. Water Pipe per Capita Jobs (ft)	7	7	7	6
Est. Water Pipe Feet Needed	1,097,639	948,258	932,202	703,600
Est. Cost of Water Pipe Needed	\$109,763,879	\$94,825,767	\$93,220,161	\$47,492,981
Savings Compared to Baseline Scenario	NA	\$14,938,112	\$16,543,718	\$62,270,898

Wastewater Pipes



Wastewater Line Regression Results

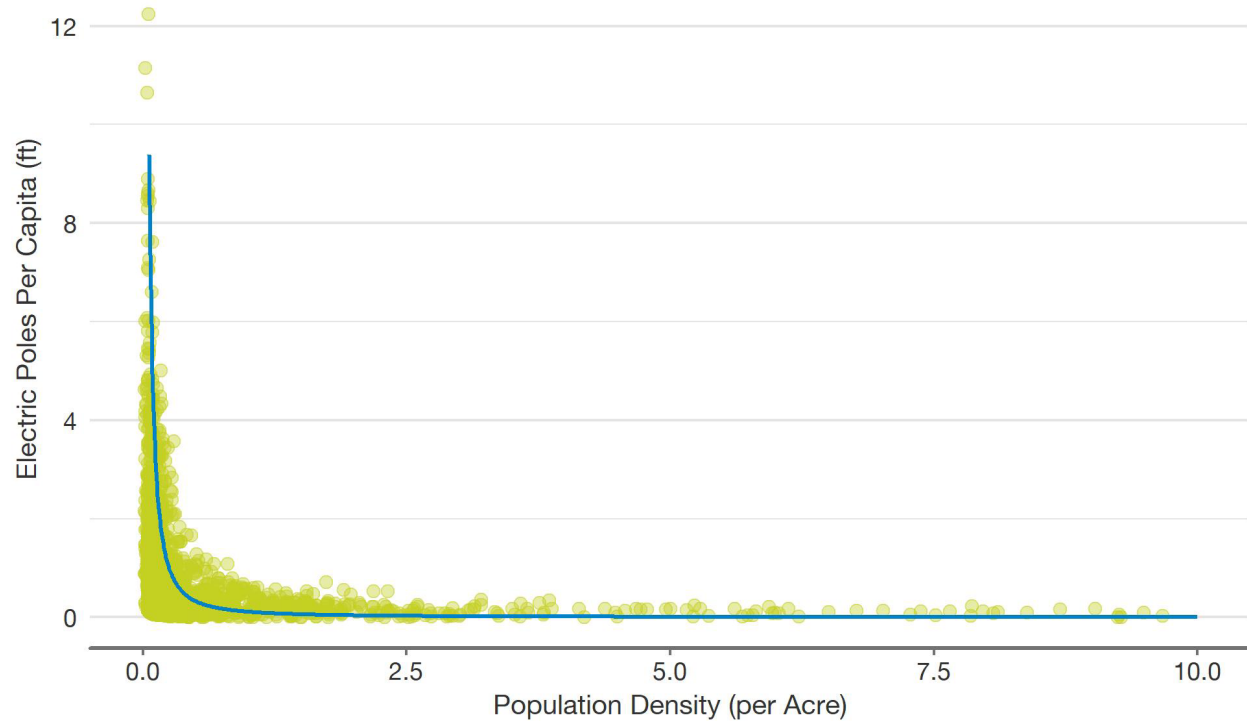
Dependent Variable	log(Wastewater Line Linear Feet per Capita)		
Mean	26.48		
Standard Deviation	50.46		
OLS	log(Wastewater Line per Capita) = 2.213 + -0.424 * log(Population Density) + -0.211 * log(Job Density)		
Variable	Coefficient	Std. Error	t-ratio
Constant	2.213***	0.126	17.560
log(Population Density)	-0.424***	0.098	-4.331
log(Job Density)	-0.211**	0.079	-2.678
Observations	133		
R ²	0.276		
Adjusted R ²	0.265		
Residual Standard Error	1.246		
F-Statistic	24.794***		
Log-Likelihood	-216.4561		

* p < 0.1; ** p < 0.05; *** p < 0.01

Waste Water Line Linear Feet Needed by Scenario

	Trend Zoning	Trend LUPAG	General Plan 2040	Smart Growth
Unit Cost (\$/linear foot)	\$350	\$350	\$350	\$350
Est. Waste water Pipe per Capita Population (ft)	5.86	4.92	4.81	3.44
Est. Waste water Pipe per Capita Jobs (ft)	4.78	4.78	4.78	4.46
Est. Water Pipe Feet Needed	680,090	583,640	573,335	428,361
Est. Cost of Water Pipe Needed	\$238,031,592	\$204,273,965	\$200,667,129	\$101,200,394
Savings Compared to Baseline Scenario	NA	\$33,757,627	\$37,364,463	\$136,831,198

Electricity Poles



Electricity Poles Regression Results

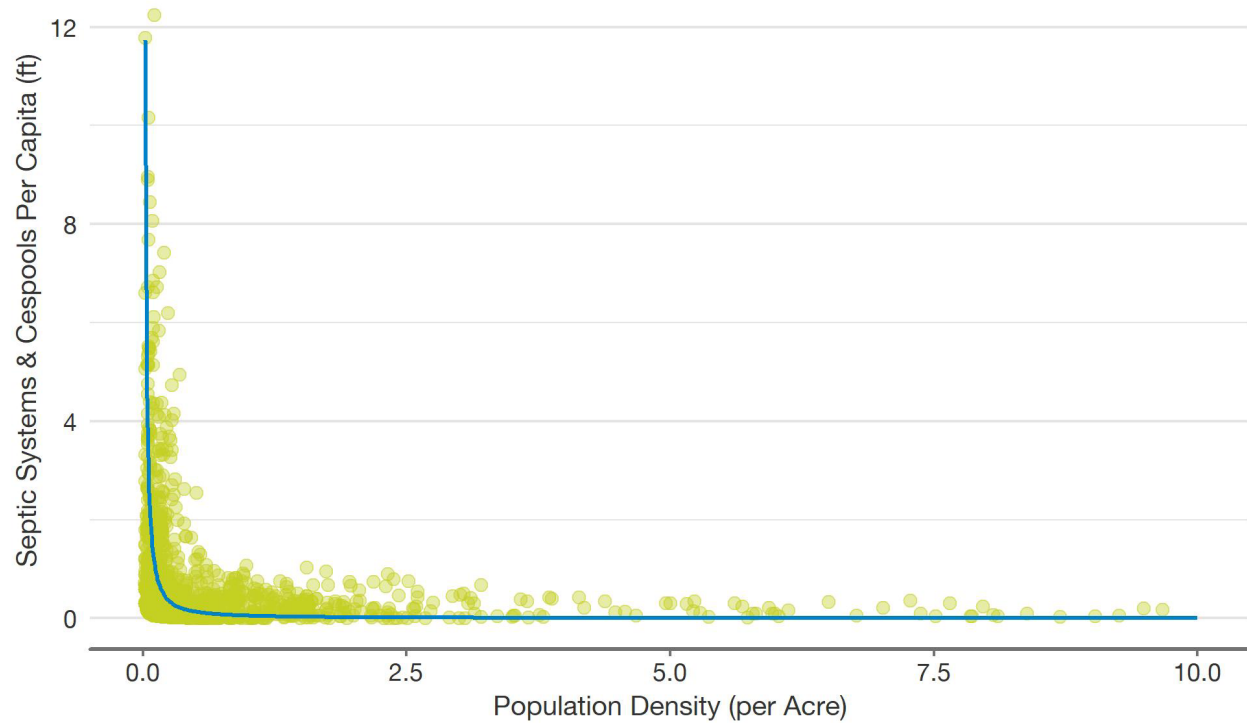
Dependent Variable	log(Electricity Poles per Capita)		
Mean	0.91		
Standard Deviation	1.42		
OLS	log(Electricity Poles per Capita) = -2.441 + -0.292 * log(Population Density) + -0.29 * log(Job Density)		
Variable	Coefficient	Std. Error	t-ratio
Constant	-2.441***	0.067	-36.337
log(Population Density)	-0.292***	0.025	-11.669
log(Job Density)	-0.29***	0.021	-114.07
Observations	1,754		
R ²	0.319		
Adjusted R ²	0.319		
Residual Standard Error	1.079		
F-Statistic	411***		
Log-Likelihood	-2620.758		

* p < 0.1; ** p < 0.05; *** p < 0.01

Electricity Poles Needed by Scenario

	Trend Zoning	Trend LUPAG	General Plan 2040	Smart Growth
Unit Cost (\$/each)	\$13,087	\$13,087	\$13,087	\$13,087
Est. Electricity Poles per Capita Population	0.06	0.06	0.06	0.04
Est. Electricity Poles per Capita Jobs	0.04	0.04	0.04	0.03
Est. Electricity Poles Needed	7,148	6,401	6,319	5,089
Est. Cost of Electricity Poles Needed	\$93,539,871	\$83,775,553	\$82,699,036	\$44,958,100
Cost Compared to Baseline Scenario	NA	\$9,764,318	\$10,840,836	\$48,581,772

Septic Systems



Septic System Regression Results

Dependent Variable	log(Septic Systems per Capita)		
Mean	0.66		
Standard Deviation	1.49		
OLS	$\log(\text{Septic System per Capita}) = -2.789 + -0.070 * \log(\text{Population Density}) + -0.031 * \log(\text{Job Density})$		
Variable	Coefficient	Std. Error	t-ratio
Constant	-2.789***	0.091	-30.529
log(Population Density)	-0.070*	0.032	-2.204
log(Job Density)	-0.031***	0.028	-11.095
Observations	1,692		
R ²	0.1279		
Adjusted R ²	0.1269		
Residual Standard Error	1.365		
F-Statistic	124.1***		
Log-Likelihood	-2,931.4		

* p < 0.1; ** p < 0.05; *** p < 0.01

Septic Systems Needed by Scenario

	Trend Zoning	Trend LUPAG	General Plan 2040	Smart Growth
Unit Cost (\$/system)	\$10,000	\$10,000	\$10,000	\$10,000
Est. Septic Systems per Capita Population	0.057	0.055	0.055	0.052
Est. Septic Systems per Capita Jobs	0.452	0.452	0.452	0.415
Est. Septic Systems Needed	13,716	13,549	13,530	12,570
Est. Cost of Septic Systems Needed	\$137,158,162	\$135,491,812	\$135,298,251	\$125,699,525
Savings Compared to Baseline Scenario	NA	\$1,666,350	\$1,859,911	\$11,458,637

Emergency Response Services

Emergency Response Services Data

	Metric	Source
Number of 911 Calls (2015)	189,973	County of Hawai'i Police Dept.
Average Distance to Police & Fire Station (2019)	2.92	GIS
911 Calls per Capita (2016)	1.5	24-hour population / 911 calls
Public Safety Vehicle Maintenance Budget (2018-2019)	\$846,281	County of Hawai'i 2018-19 Budget; County of Hawai'i Police Department
Cost per Call (2016)	\$4.45	Budget / # of Calls
Cost per Mile (2016)	\$1.53	Budget / (Calls x Miles)

Emergency Response Services by Scenario

	Trend Zoning	Trend LUPAG	General Plan 2040	Smart Growth
Additional 24-Hour Population	119,732	119,732	119,732	119,732
Additional 911 Calls	178,126	178,126	178,126	178,126
Scenario Square Miles	57.1	38.1	37.6	8.0
New Average Distance to EMS (miles)	8.1	7.5	7.5	6.3
Added Emergency Response Miles	1,440,297	1,329,512	1,326,580	1,113,016
2040 Annual Cost	\$2,197,313	\$2,028,300	\$2,023,827	\$1,698,014
Total Cost (scaled annually to 2040)	\$23,071,788	\$21,297,152	\$21,250,182	\$17,829,144

Land Constraints

Land and Value Characteristics by Forecast Area Zone

Forecast Analysis Zone	Total Acres*	Protected Acres*	All Other Acres*	Hazard Acres**	Ag Acres**	Median Home Value***	Median Farm Acre Value****
Hilo	190,179	131,575	58,604	3,696	17,020	\$299,395	\$8,893
North Hilo	265,775	159,475	106,300	8,484	44,830	\$271,249	\$8,893
Honoko-Paauilo	370,883	205,167	165,716	1	157,541	\$337,823	\$8,893
Waimea	129,425	52,263	77,162	-	62,186	\$386,900	\$8,893
North Kohala	90,285	11,440	78,845	-	67,030	\$365,800	\$8,893
Waikoloa	90,444	13,039	77,405	-	45,105	\$405,300	\$8,893
North Kona	310,935	152,520	158,415	5,170	71,034	\$475,017	\$8,893
South Kona	211,623	67,560	144,063	106,168	83,186	\$430,381	\$8,893
Ka'u	598,081	378,537	219,544	87,211	107,298	\$156,700	\$8,893
Keaau-Kurtistown	32,700	58	32,642	-	14,811	\$283,500	\$8,893
Upper Puna	97,875	35,482	62,393	74	17,654	\$185,098	\$8,893
HPP-Orchidland	97,894	302	97,592	-	351	\$220,789	\$8,893
Lower Puna	171,463	68,907	102,556	58,129	20,433	\$206,118	\$8,893
Total	2,657,562	1,276,325	1,381,237	268,932	708,479		

*Calculated in GIS using Hawai'i Zoning shapefile.

**Not including protected land

***US Census Bureau, American Community Survey 5-Year Estimates, 2012-2016

****USDA's Census of Agriculture, adjusted to 2018 dollars.

Lava Flow Hazard Zones by Scenario

	Trend Zoning	Trend LUPAG	General Plan 2040	Smart Growth
Total Acres (residential)	35,676	23,534	23,234	4,922
Probability developed acre is in lava flow hazard zone*	0.5%	0.3%	0.3%	0.1%
Acres in lava flow hazard zone**	76	41	28	3
At-risk homes (new development)	86	57	44	12
Value of at-risk homes	\$23,337,975	\$13,856,436	\$11,086,783	\$3,616,047
At-risk population (new development)	235	154	119	34
Emergency Response Costs (marginal)***	\$141,583	\$92,591	\$71,924	\$20,593
Total Costs (marginal)	\$23,479,557	\$13,949,028	\$11,158,708	\$3,636,640

*Calculated by multiplying the probability that an acre is developed by the probability that an acre is in a high-risk lava flow hazard zone and not on protected land.

**Calculated by multiplying the probability metric by the residential number of scenario acres.

***Cost estimate of emergency response costs per person (including labor, fringe, material, and other costs, excluding police and fire) provided by the County of Hawai'i.

Loss of Productive Agricultural Land by Scenario

	Trend Zoning	Trend LUPAG	General Plan 2040	Smart Growth
Total Acres (residential)	35,676	23,534	23,234	4,922
Probability developed acre is on agricultural land*	1.3%	0.9%	0.9%	0.2%
Acres on agricultural land**	357	125	152	9
Value of land	\$3,170,461	\$1,111,883	\$1,347,981	\$80,009

*Calculated by multiplying the probability that an acre is developed by the probability that an acre is productive agricultural land and not on protected land.

**Calculated by multiplying the probability metric by the number of residential scenario acres.