Carrying Capacity

A New Model for Mature Cities

City of Arlington, Texas

Community Development and Planning
Research & Analytics
January 2014

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1 What Is Carrying Capacity?

The concept of Carrying Capacity, on its own, is amorphous. Realms as varied as sociology, ecology, political science, engineering, and biology each prescribe specific requirements for it. This study defines the concept in broad terms associated with urban/suburban planning. Here, Carrying Capacity is at best defined as "the maximum number of people that can be supported by the environment of [an] area through optimum utilization of the available resources."[1]

As per the aforementioned definition of Carrying Capacity, most models define the sustainability of an area as purely population load (i.e. 30 people is a sustainable population for Place X, but 31 people is not). For a mature city, like Arlington, population load is not a fixed point or measure. Both in and out migration remain in flux, ebbing and flowing due to the economic health of the City and Dallas-Fort Worth (DFW) metroplex, personal preference, and a myriad of other factors beyond the scope of this project.

Therefore, the carrying capacity of this city has its own considerations. Greenfield development opportunities become less and less available, while the need for redevelopment of existing areas increases. An urban/suburban carrying capacity must not only consider variable population totals, but location of those individuals within a developed city fabric given infrastructure and policy considerations.

1 Department of civil Engineering, IIT Guwahati. "Urban Carrying Capacity…Concept and Calculation," MoUD Sponsored Centre of Excellence for Integrated land Use Planning and Water Resource Management (2011-2012): 3.

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2 Why Is It Important For Arlington?

From the City's founding through the Great Depression and World War II, population growth was slow but steady. The surging post-war economy, as well as Arlington's location between the rapidly expanding cities of Dallas and Fort Worth, contributed to a dramatic population increase.

This post-war boom resulted in a city that was six times larger in population by 1960 than it was in 1950, climbing from 7,692 to 44,775 people. During the decades that followed, several factors facilitated the continued growth of the City. The large-scale annexation of developable land (averaging nearly 15,000 acres per decade from 1950 to 1990), the opening of Interstate 20 and Dallas/Fort Worth International Airport in the mid-1970s, and a strong regional economy all contributed to a peak in population increase during the 1980s, when Arlington added 101,000 new residents. By 2010, the population was more than 47 times greater, at 365,438 people, than it was in 1950. [1]

While not continuing to grow at the rate seen in the last decades of the twentieth century, Arlington's population looks to marginally exceed 423K people at build-out (i.e. the state of maximum development as permitted by plan, regulation, or spatial constraint). While no specific year is associated with a build-out model, estimates put the date at some point past 2023. Given Arlington's existing development pattern, only 6,128 acres, or just under ten percent, of total City land area is categorized as vacant and available for development. (This number is actually smaller when future right-of-way and easements are subtracted.) Using a citywide population density (in 2010) of just under six people per acre, the remaining vacant developable land area can only sustain a population increase of around 35,000 more residents, yielding a deficit in excess of 22,000 people.

1 Community Development and Planning. "Population and Housing," in Annual Growth Report 2012. (City of Arlington, 2013), 6.

Due to the complexity of considerations required for an urban carrying capacity, the City of Arlington's model begins as a measured approach and evaluation of three tiers of information which may constrain or encourage development: the City's natural, built, and policy environments. Each environment will be analyzed both individually and as a group, thereby providing both qualitative and quantitative measures of capacity appropriate to the City. (Analysis methodology and data modeling will be detailed at length in the following sections.)

This analysis aims to provide a technical foundation to guide the City's sustainable future growth and development.

3 Why GIS? (Or, Does Location Matter?)

Development of new policies or presentation of complicated topics requires access to good data. For a Carrying Capacity Analysis, the information required is extensive and covers a range of topics. No matter the subject area utilized in the analysis, however, all of the data has one consistent factor: location. The real estate industry is correct in the old adage that "location, location, location" drives development. The location of a floodplain can affect development as much as where a new road or freeway exit will be constructed. Due to the fact that the data utilized in a Carrying Capacity Analysis is so directly tied to location, the best tool to use for the analysis is GIS (geographic information systems).

GIS is best described as a computerized data management system used to capture, store, manage, retrieve, analyze, and display spatial information.[1] GIS stores information about the world as a collection of layers that can be linked together by a common locational attributes such as latitude and longitude, a postal zip code, census tract name, or road name. These geographic references allow for location of features on the earth's surface for analysis of patterns and trends.[2] Hence, a spatial analysis of attributes with common locational features allows for comparison and analysis of items as disparate soil type and tax increment financing policies. Thus, due to the power of spatial analysis provided by use of GIS, the three environments shaping City development are quantifiable and ripe for exploration and understanding.

1 "What is GIS?," National Estuarine Research Reserve System, 2 October 2014, http://www.nerrs.noaa.gov/doc/siteprofile/acebasin/html/gis_data/gisint2.htm.
2 "Geographic Information Systems (GIS)," US Environmental Protection Agency, 2 October 2014, http://www.epa.gov/reg3esd1/data/gis.htm.

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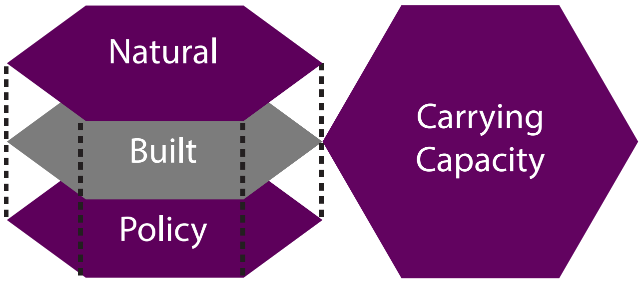
4 Methodology & Data Modeling

Effective municipal land use planning requires the analysis of incorporated areas according to an overall capacity for development. Subsequently, assessing the development suitability of a given area entails the careful examination of a broad range of contributing factors, and the distillation of that information into a single indicative score. In the absence of a definitive process detailing the steps necessary to accomplish such a task, the City of Arlington's Research and Analytics Group have created and applied a framework to accurately gauge the development potential of a given area. Additionally, the Group has detailed key specific assumptions in order to define the scope and extent of the data involved in the analysis. These assumptions include:

- City size will remain constant at just over 99 (99.3) square miles with no planned annexations;
- Acceptance of population growth projects yielding a build-out total exceeding 423K people;
- No major dynamic shifts in City land use, infrastructure, or policy are anticipated;
- While the City does not have policy or development authority over the University of Texas at Arlington (UT Arlington) property, UT Arlignton property remains a part of the model due to the activity generation potential of the University; and,
- Data sources utilized represent the best and most accurate information available at the time of model generation.



Analysis of three environments (natural, built, and policy) yeild a descriptive Carrying Capacity for the City of Arlington.

The process developed by the Group offers a methodology for the objective classification and scoring of features relative to their overall influence on an area's capacity for improvement. Moreover, the approach details the steps required to combine the quantified weight of those features into a discrete index illustrating overall development suitability.

Summary of Analytical Framework

The ultimate goal of the methodology centers on the creation of a single composite index score to indicate development suitability for a given area. To that end, the approach created and utilized by the City of Arlington's Research and Analytics Group began with the identification of features (i.e., floodplains, existing structures, zoning codes, etc.) that influence an area's capacity for future development. Once identified, features were separated into three distinct analytical categories: Natural Environmental, Built Environment, and Policy Environment. The features within each category were then reviewed, ranked, and scored according to the recommendations of Subject Matter Experts (SME). Those scores were then distilled to create a composite dataset for each category relative to a given area. Finally, the composite datasets of each category were averaged together to create a comprehensive dataset of overall development suitability scores for all areas throughout the City.

The following outlines the methodology utilized to evaluate areas throughout the City of Arlington on the basis of development suitability relative to the aforementioned influences: Natural Environmental, Built Environment, and Policy Environment.

Assessment of the Natural Environment

A measurement of development suitability for a given area requires the tandem analysis of all naturally occurring features that potentially serve to affect improvements. Examples of these types of influences on development include, but are certainly not limited to: the presence of wetlands, susceptibility to flooding, soil types, and physical topography. Although the occurrence of particular environmental constraints, such as endangered species, may preclude development in a particular area entirely, others, such as hydric soils, may simply limit development or require mitigation.

Influential Features

Data selection for this analysis centers on the Institute for Housing and Urban Studies' Outline for Urban Carrying Capacity as well as the collective experience of team members. A complete list off all datasets analyzed is found in the Appendix of this document.

- Endangered Species
- Floodplains
- Hydrography
- Slope
- Soil Types
- Streams
- Wetlands
- Water Bodies
- Vegetation

Feature Classification

In an effort to appropriately evaluate the broad range of feature data analyzed throughout the course of this process, the Research and Analytics Group consulted Subject Matter Experts (SME) regarding the inherent abilities of observed features to affect development.

First, to accurately assess a feature's influence on the improvement of a given area SMEs are asked to classify feature data according to the capacity of each to allow development. If the presence of a specific feature in any given area prevents development, the feature is classified as Prohibitive. In contrast, a feature that tolerates development in a given area is classified as Variable. The classification of influential features as either Prohibitive or Variable remains a fundamental step in the overall process developed by the City's Research and Analytics Group as the assessment of subjects determines the quantitative weight of each feature on the final valuation of an area's potential for improvement.

The Prohibitive features class includes elements that, when present in an area, mandate intensive mitigation or exclude development altogether such as sensitive wetlands, endangered species habitat, etc. For the purposes of this study, features in the Natural Environmental Constraints category classified as Prohibitive include the following: Endangered Species Habitat, Hydrography, Streams, Wetlands, and Water Bodies.

The Variable features class includes subjects that offer a range of development suitability beyond prohibiting it altogether. Constraints selected for the Natural Environmental Constraints category classified as demonstrating Variable characteristics include the following: Flood Plains, Slope, Soil Types, and Vegetation.

Feature Types

Before proceeding further it is important to understand the fundamental differences between the two data types utilized for this analysis: vector, and raster. Vector datasets are coordinate-based data models that represent geographic features as points, lines, and polygons, and each feature is associated with a set of attributes. For instance, a vector model might include a group of polygons representing water bodies. Each polygon would also include information about the pond it represents such as its name, depth, size, etc.

In contrast, a raster dataset is a spatial data model that defines space as an array of equally sized cells arranged in rows and columns. Each cell contains an attribute value and location coordinates. Groups of cells that share the same value represent the same type of geographic feature.[1]

For the purposes of this exercise, raster models representing the study area (which includes the entirety of space within the corporate boundaries of the City of Arlington) is divided into a grid of cells measuring 5ft x 5ft, or $25ft^2$.

All feature data analyzed throughout the course of this study begins as a vector model, and it is at this stage that the SME's ordinal assessments and subsequent numeric scores are applied to each feature. Once SME scores are assessed and applied, each feature is converted into a standard sized raster dataset which allows for the mathematical analysis of all features in the category relative to all areas within the City.

1 (ESRI, 2014 - http://support.esri.com/en/knowledgebase/GISDictionary/term/vector)

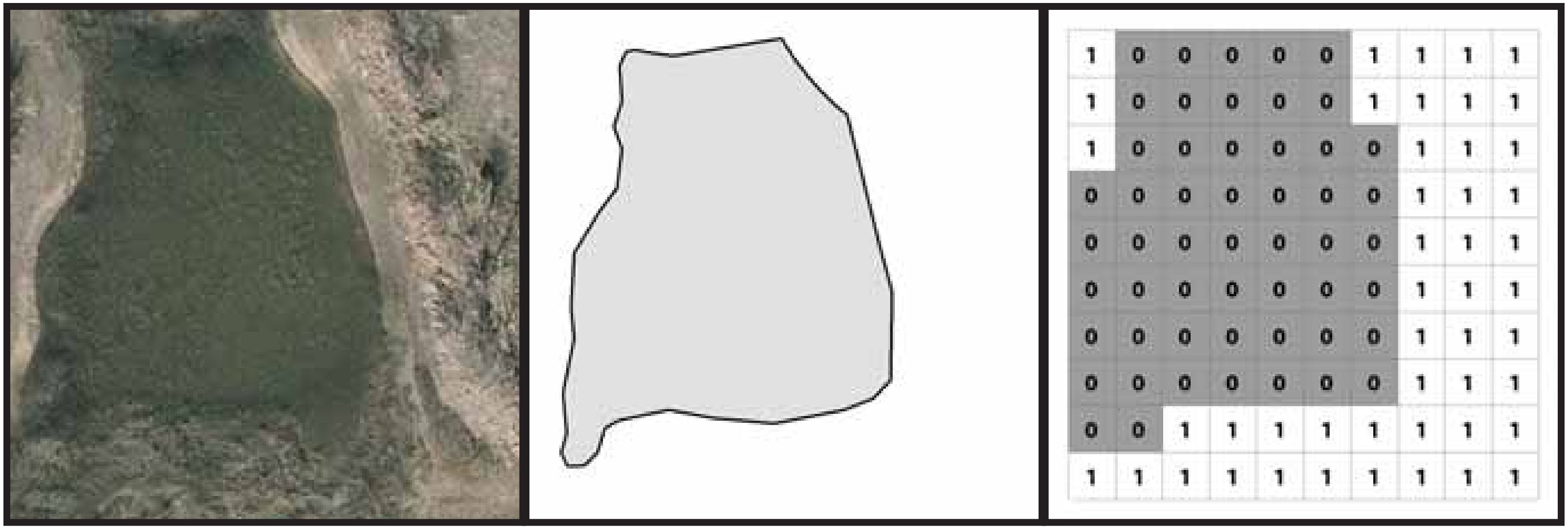


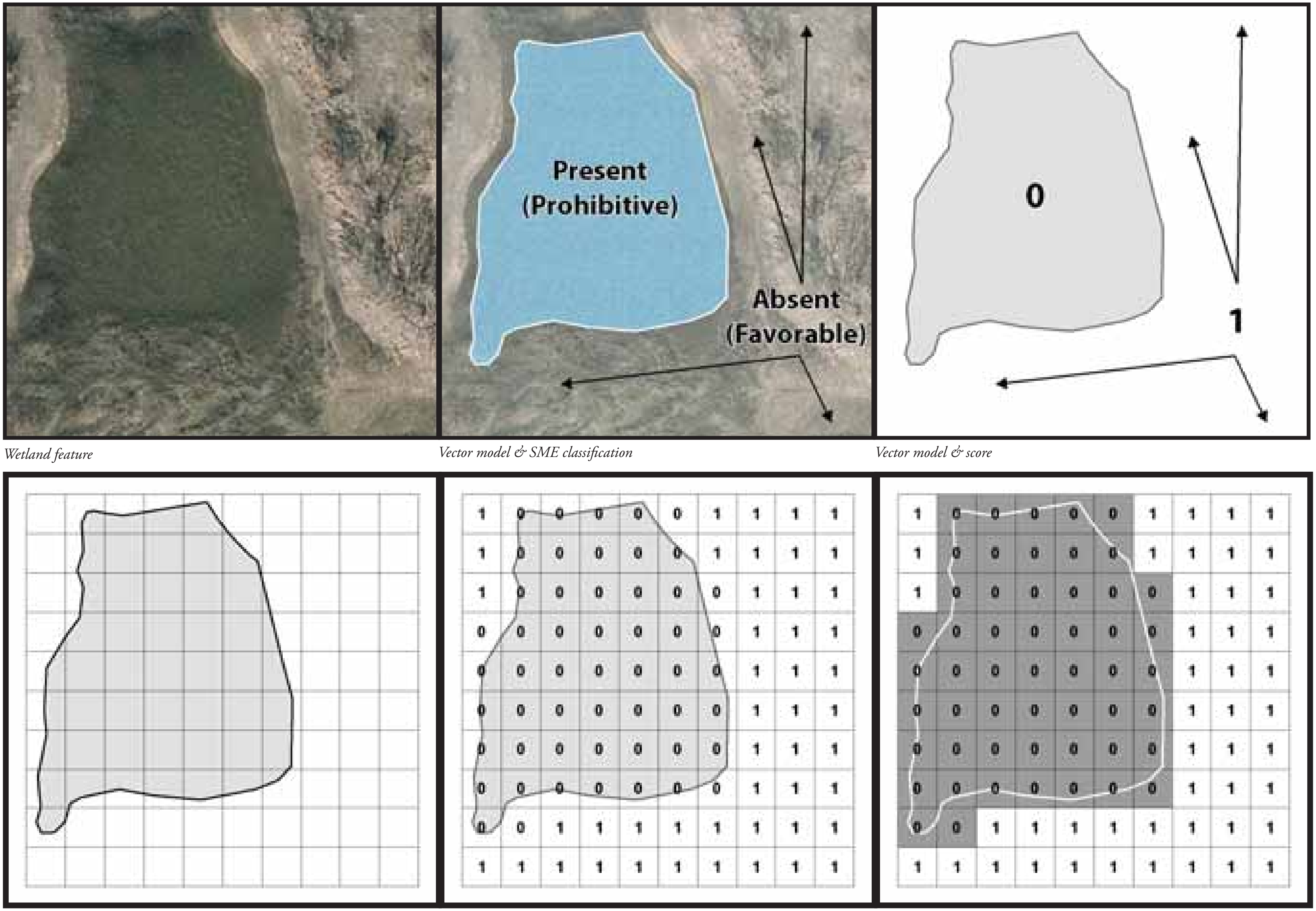
Figure 1: *Pond represented as an image, vector, and raster model.*

Scoring and Analysis

The next part of the process utilized in analyzing the development suitability of an area entails two steps. First, all data contained within the Natural Environmental Constraints category is assigned a numeric score based on ordinal assessments from the SMEs. Second, all areas of the City are analyzed relative to the features they contain to create a composite scores for all areas of the City.

Prohibitive and Variable features remain fundamentally different in terms of their respective tolerance to development. Prohibitive features define those areas where improvements cannot, and subsequently do not, occur. On the other hand, Variable features influence the overall suitability of development within permissible areas. Accordingly, both feature types are scored differently with respect to development suitability.

For example, all Prohibitive features receive a standard suitability score of 0 which indicates the feature's potential to prevent development of any kind.



Wetland feature — *Vector model & SME classification* — *Vector model & score*

Vector overlaid with raster — *Raster values relative to feature* — *Raster and vector representations*

Figure 2: *Example of the process used to identify and represent a Prohibitive feature as a vector and raster model.*

Once all Prohibitive features have been classified, scored, and converted to raster models, all rasters within the category are multiplied together to create a single raster dataset detailing the locations of Prohibitive features throughout the City of Arlington.

The following example demonstrates how the multiplication of raster datasets to one another results in a product illustrating the location of all developmentally prohibitive areas as a single composite dataset.

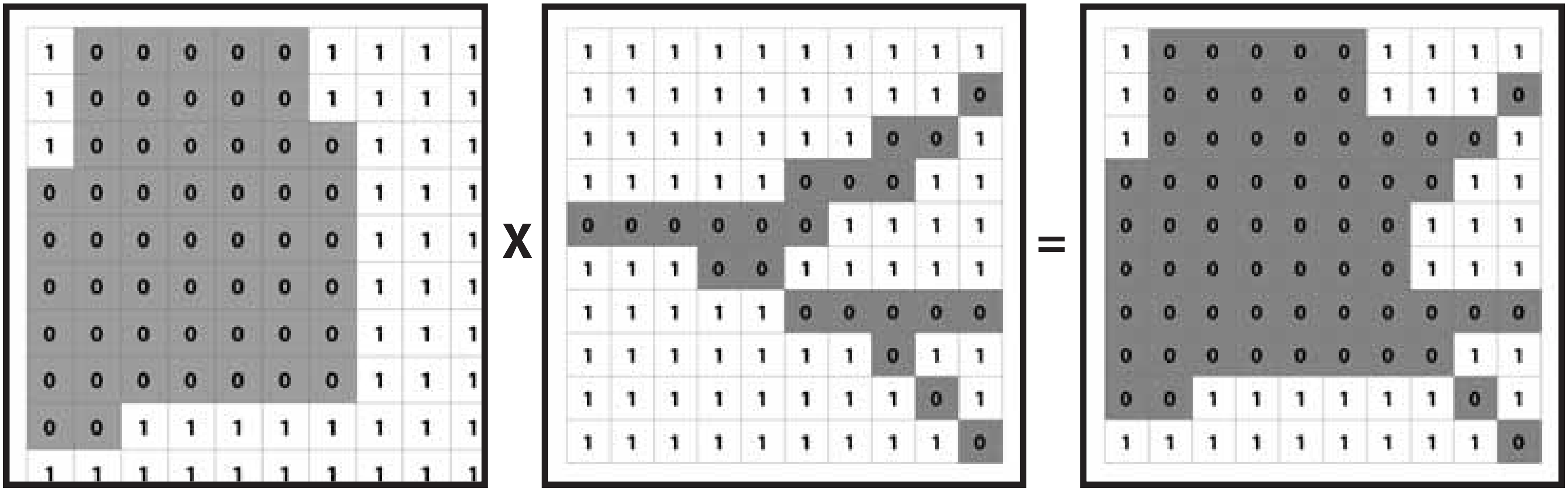
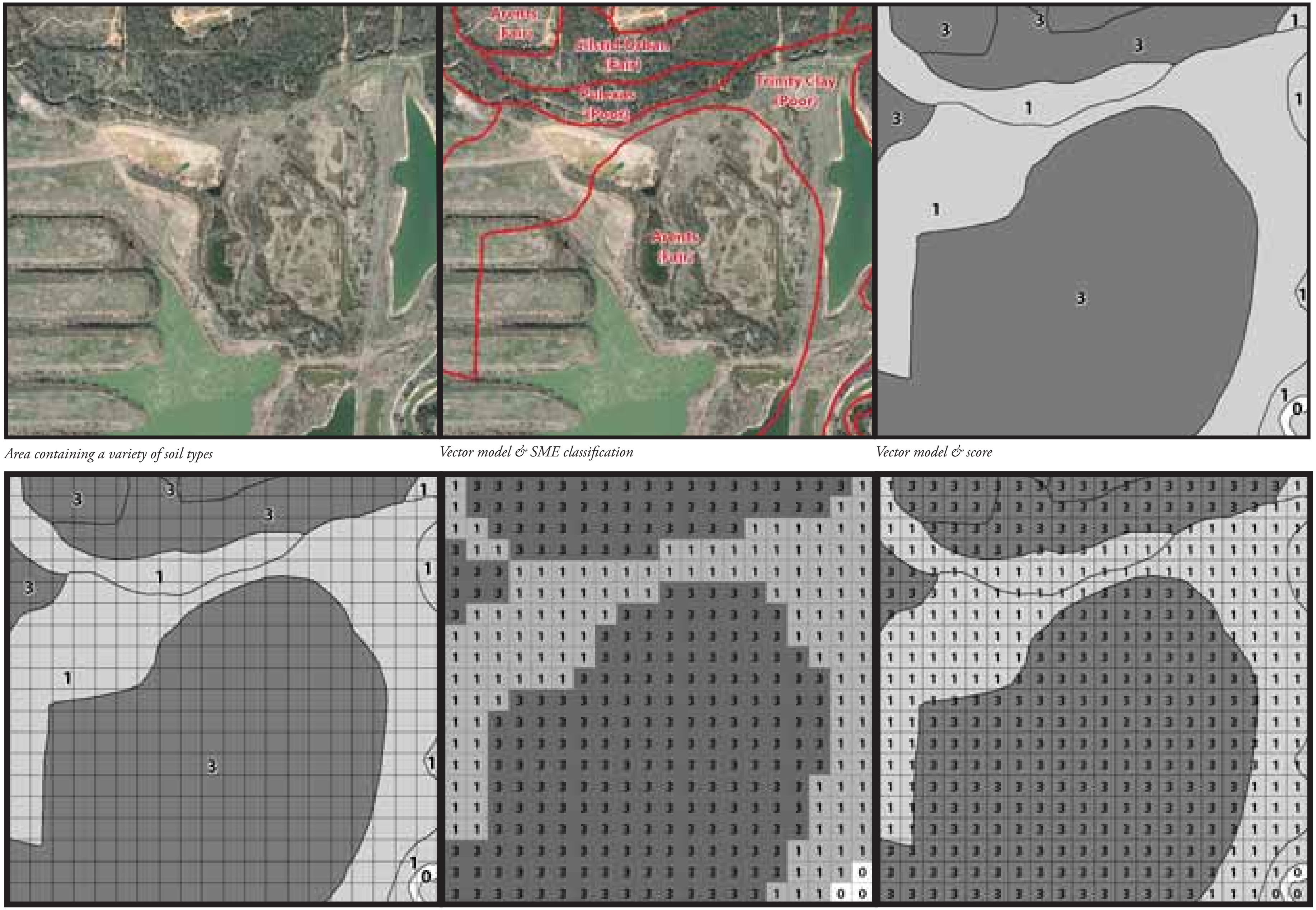


Figure 3: *Raster datasets representing different Prohibitive features, and multiplied together to create a single composite raster dataset*

Conversely, Variable features receive ordinal scores according to the SME's assessment of development suitability which is based on a standard, five-class ranking system. Ordinal scores are then multiplied by an index coefficient of to render a final suitability index score between 0 and 1. Figure 2 illustrates the standard scoring methodology used to evaluate the varying degrees of slope throughout the City of Arlington. A complete list of scoring criteria used to evaluate both Prohibitive and Variable features of all three categories can be found in the Appendix of this document.

Value	SME Determination	Ordinal Score	Index Coefficient	Index Score
>8.0%	Not Suitable	0	0.25	0
6.1%-8.0%	Poor Suitability	1	0.25	.25
3.1%-6.0%	Moderate Suitability	2	0.25	.5
0.1%-3.0%	Fair Suitability	3	0.25	.75
0%	Most Suitable	4	0.25	1

Figure 4: *Ordinal suitability assessment and scoring of different angles of slope, and corresponding index scores.*



Area containing a variety of soil types | *Vector model & SME classification* | *Vector model & score*

Vector overlaid with raster | *Raster values relative to features* | *Raster and vector representations*

Figure 5: *Example of the process used to identify and represent Variable features as a vector and raster model.*

Unlike the Prohibitive feature class, when all Variable features have been classified, scored, and converted to raster models, all rasters within the category are averaged, not multiplied, together to create a single comprehensive raster dataset for all Variable features within the category.

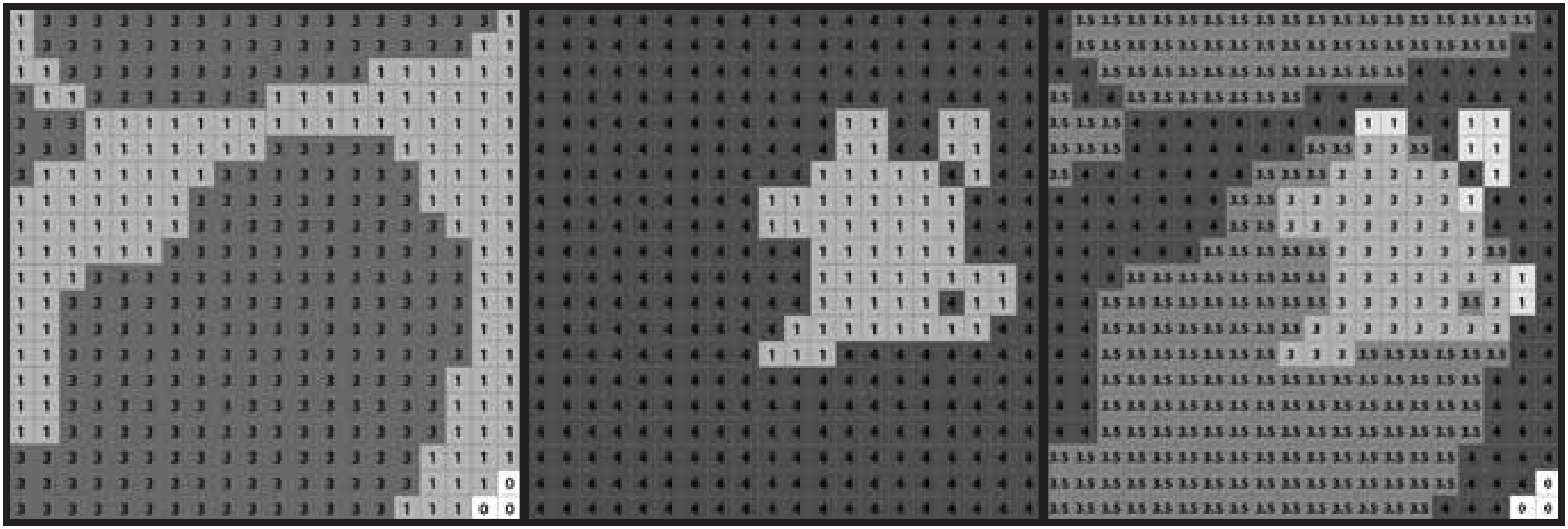


Figure 6: Raster datasets representing different Variable features, and averaged together to create a single composite raster dataset.

Final Suitability Score

Once calculated, the composite scores for both the Prohibitive and Variable feature classes are multiplied together to create a comprehensive suitability index score relative to all features characterized as Natural Environmental Constraints. Again, the composite scores of the Prohibitive feature class act as a filter to delineate areas where development remains improbable, which subsequently, outline the areas of the study area where Variable feature class scores can be applied.

Any Given Area	Prohibitive Feature Score	X	Variable Feature Score	=	Composite Score
A	1	X	0.5	=	.5
B	0	X	0.4375	=	0
C	0	X	0.4375	=	0
D	1	X	0.3125	=	.3125

Figure 7: *Example of how the Prohibitive and Variable composite datasets combine to create a comprehensive score for given areas.*

The final comprehensive raster dataset created as a result of this process represents the development suitability scores relative to the Natural Environment for the entirety of the City of Arlington as valued cells measuring 5ft x 5ft, or 25ft².

Index Class	Value Frequency	Share of Total	Area - ac	Area - mi²
0	7,411,318	7%	4,261.51	6.65
.01 - 0.1	29,082	0%	16.72	0.03
.101 - .2	945,002	1%	543.38	0.85
.201 - .3	1,107,102	1%	636.58	0.99
.301 - .4	3,969,646	4%	2,282.55	3.56
.401 - .5	9,266,359	8%	5,328.16	8.31
.501 - .6	14,964,576	14%	8,604.63	13.42
.601 - .7	35,905,517	32%	20,645.67	32.20
.701 - .8	10,457,305	9%	6,012.95	9.38
.801 - .9	24,109,594	22%	13,863.02	21.62
.901 - 1	2,656,526	2%	1,527.50	2.38
Total 25 ft² Cells	**110,822,027**	**100%**	**63,722.67**	**99.38**

Figure 8: *Quantitative analysis of development suitability index scores of the Natural Environment for all areas within the City of Arlington according to frequency, acres, and mi².*
Note: Differences in Value Frequency totals for Figures 8, 9, 12, and 13 occur due to truncation during the conversion of raster datasets from floating point rasters to integer rasters. The Value Frequency column simply lists the occurrence of value groups, and therefore has no effect on the calculation of overall area findings.

Intermediate Findings

Upon completion of the GIS analysis of individual natural features and overlay of all elements within the dataset, a composite visualization of natural environment development suitability emerged.

The natural environment provides the foundation for all development as it shapes the geography upon which cities build. Therefore, low suitability measures constrain development and require mitigation. High suitability measures, by contrast, indicate areas ripe for development with little or no natural hindrances to future growth.

Analysis of Findings

In terms of visualization of suitability measures, those areas within the City of Arlington scoring a low suitability rating tend to follow water courses and associated land areas (such as low lying floodway and floodplain areas). Additional areas scoring as low suitability also occur in areas of significant slope and elevation change, particularly in North Arlington.

Higher suitability areas are localized within areas of the City already disturbed by development, particularly the City's historic core. In these areas, continuous habitation and development have altered the natural environment to such a degree that natural elements no longer pose significant hindrances to development. Those areas south of Pioneer Parkway and Arkansas Lane were developed more recently and thus alteration to the natural environment is generally less pronounced.

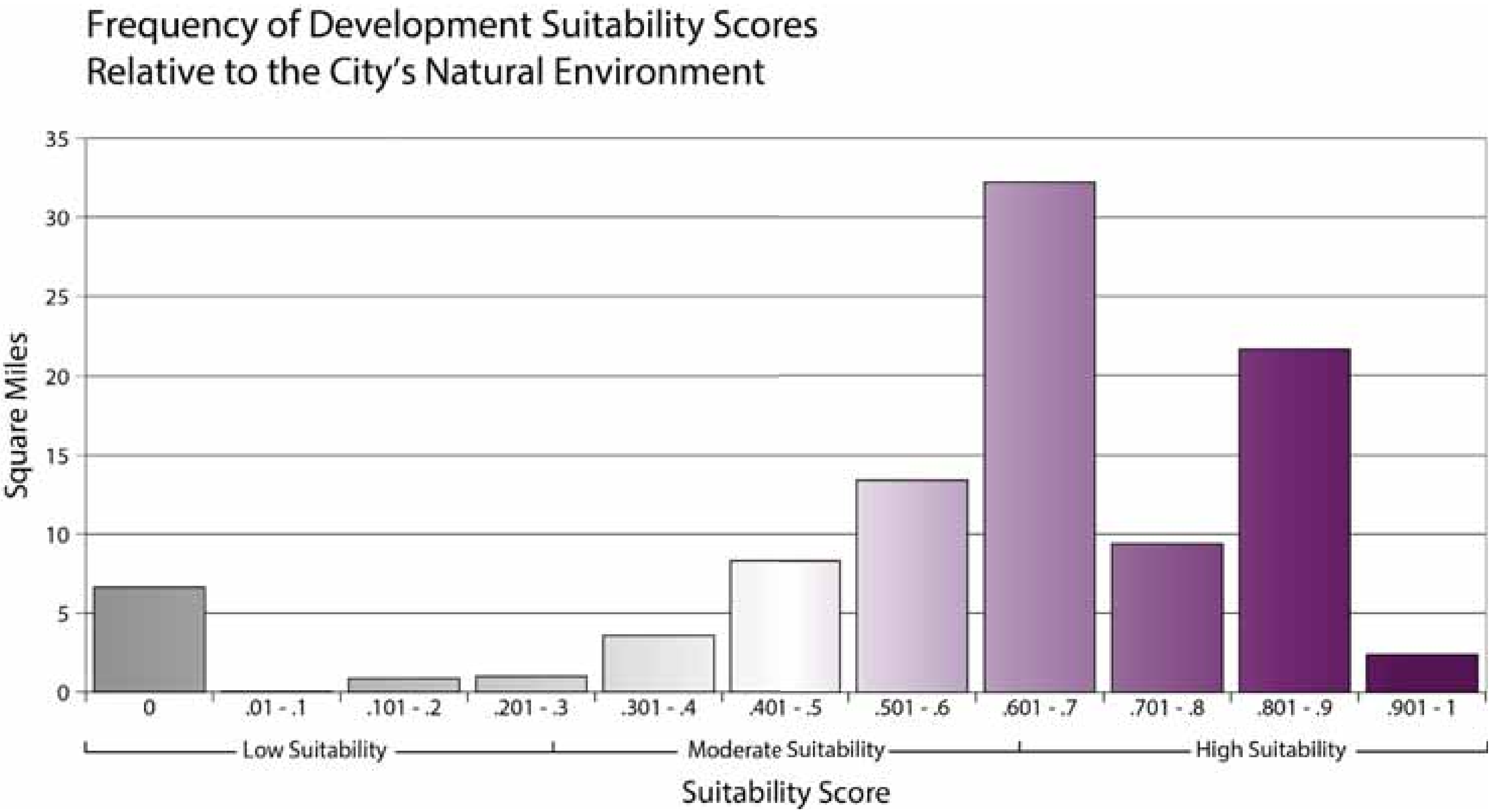
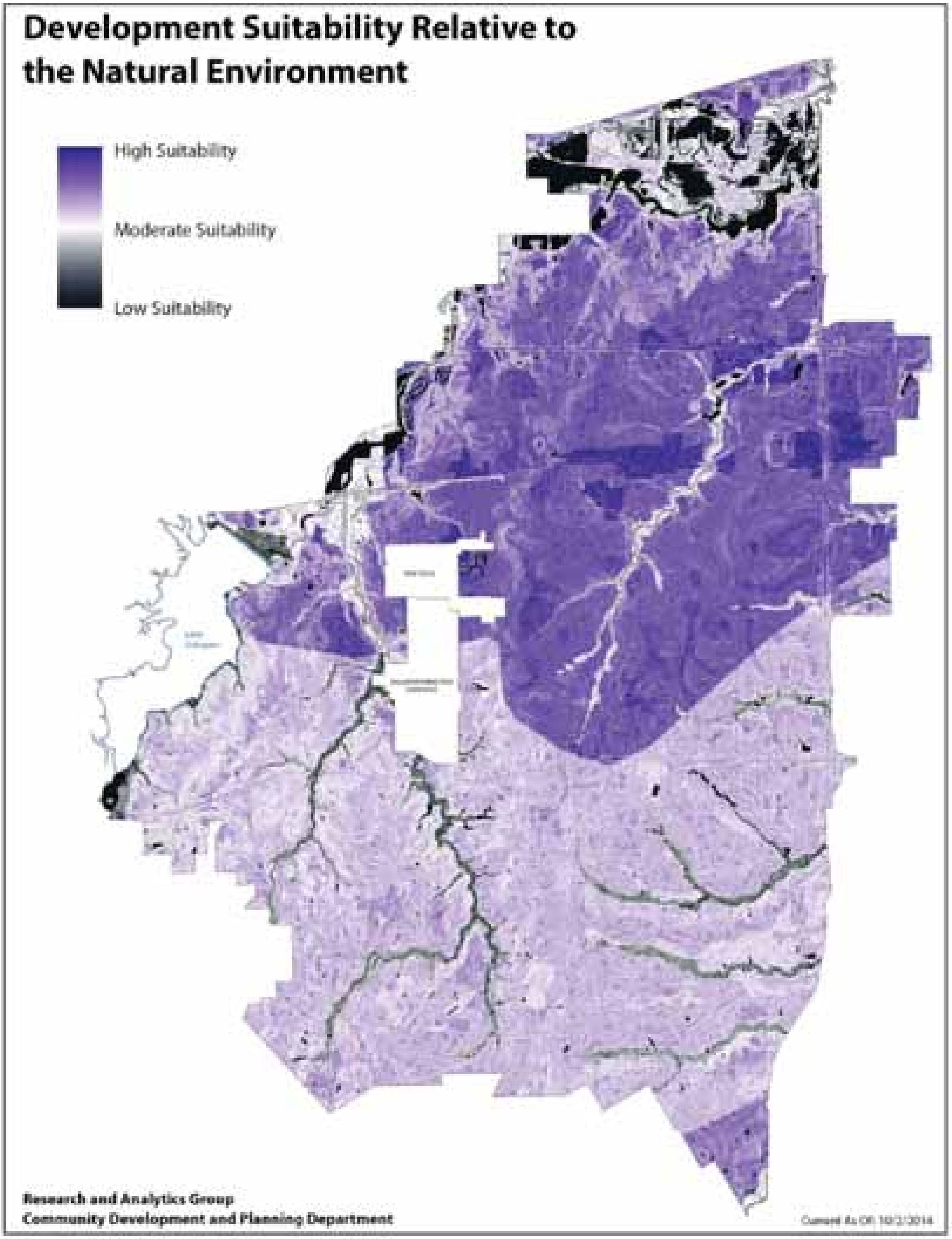


Chart 1: *Frequency of Development Suitability Scores Relative to the City's Natural Environment by mi².*



Map 1: *Final comprehensive analysis of development suitability scores relative to the City's Natural Environment.*

Assessment of the Built Environment

Aging utilities, building stock, and other physical investments in infrastructure tend to constrain development. The spatial analysis of individual built features and combined elements of all considered built features resulted in a complete visualization for suitable built environment development. The analysis indicates low suitability ratings in much of the City due to limited areas for addition to the built environment and substantial limitations for future growth. Policy incentives and significant capital infusion are options one can pursue to mitigate these constraints and facilitate development

The analysis methodology required for creating a development suitability index score relative to the Built Environment features of a region is identical to the processes and procedures developed to examine a region's Natural Environmental Constraints. Refer to the previous sections of this document for a more detailed explanation of the processes (inclusive of prohibitive and variable features) necessary to carry out this analysis.

Influential Features

- Air Quality
- Existing Land Use
- Noise Levels
- Floor \ Area Ratio
- Existing Population Density
- Water and Wastewater Service
- Building Footprints
- Broadband Service
- Brownfield Sites
- Gas Wells
- Land Fills
- Pavement
- Streets
- Electrical Easements

Intermediate Findings

Upon completion of the spatial analysis of features contained in the Built Environment category, a composite visualization of the existing built environment emerged.

Index Class	Value Frequency	Share of Total	Area - ac	Area - mi²
0	93,633,850	84%	53,839.46	83.97
.01 - 0.1	0	0%	-	-
.101 - .2	0	0%	-	-
.201 - .3	0	0%	-	-
.301 - .4	0	0%	-	-
.401 - .5	0	0%	-	-
.501 - .6	0	0%	-	-
.601 - .7	395,73	0%	22.75	0.04
.701 - .8	2,130,363	2%	1,224.96	1.91
.801 - .9	9,133,164	8%	5,251.57	8.19
.901 - 1	5,885,362	5%	3,384.08	5.28
Total 25 ft² Cells	110,822,312	100%	63,722.83	99.38

Figure 9: *Quantitative analysis of development suitability index scores of the Built Environment for all areas within the City of Arlington according to frequency, acres, and mi².*
Note: Differences in Value Frequency totals for Figures 8, 9, 12, and 13 occur due to truncation during the conversion of raster datasets from floating point rasters to integer rasters. The Value Frequency column simply lists the occurrence of value groups, and therefore has no effect on the calculation of overall area findings.

Analysis of Findings

Elements of a mature built environment tend to constrain development. These elements include, but are not limited to, utilities, building stock, and other physical investments in infrastructure. There is the option to mitigate these constraints to facilitate development potential, but such mitigation can require policy incentives, significant capital infusion, etc.

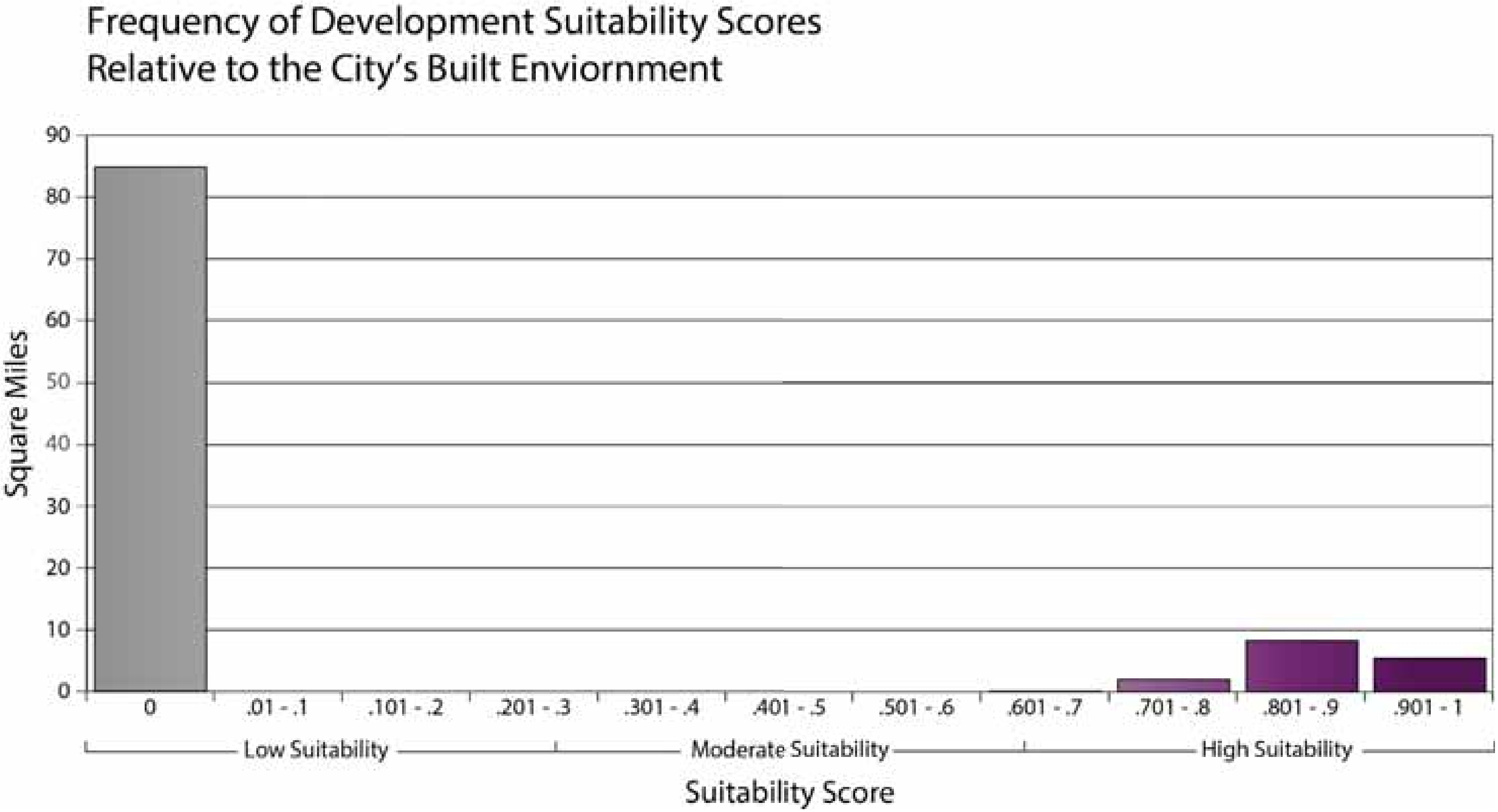
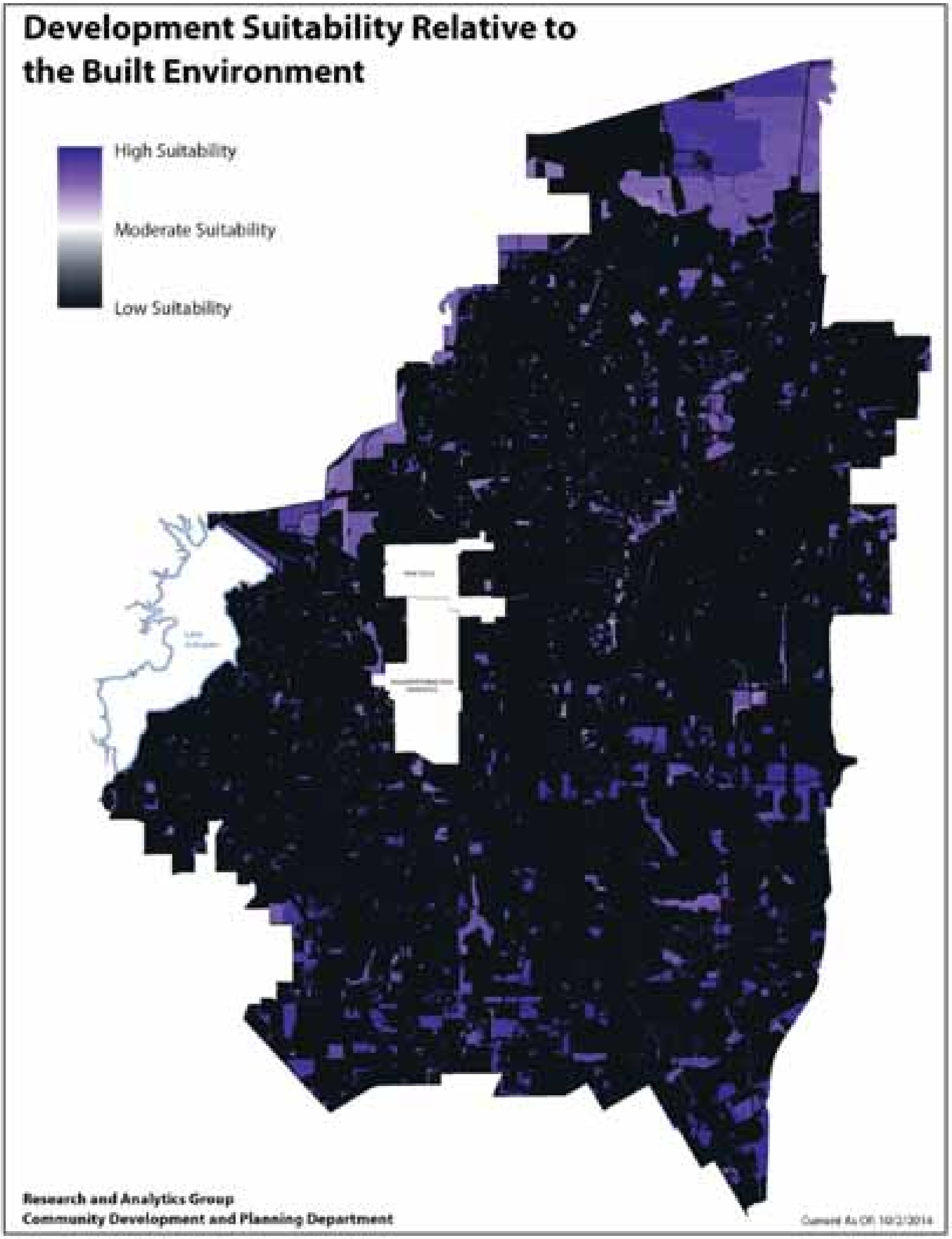


Chart 2: *Frequency of Development Suitability Scores Relative to the City's Built Environment by mi².*

Upon completion of the GIS analysis of individual built features and overlay of all elements within the dataset, a second composite visualization for built environment development suitability emerged. There are substantial limitations for future development noted, with limited areas for additions to the built environment thus yielding low suitability ratings in much of the city.



Map 2: Final comprehensive analysis of development suitability scores relative to the City's Built Environment.

Policy Groups	Associated Subject Layers
Accessibility/ Connectivity	Thoroughfare Development Plan
Development Pattern	Zoning
Health and Safety	Building Codes
Value Added	Airport Overlay Business Park Overlay Conservation District Overlay Downtown/Overlay Enterprise Zone Entertainment Overlay Hike and Bike Trails Lamar-Collins Overlay Tierra Verde Overlay TIRZ Overlay
Visioning	BBC (Housing Plan) Division ST Corridor Strategy Downtown Master Plan Future Land Use Types Neighborhood Plans New York AVE Corridor Strategy Plan Sector Plans

Figure 10: *Policy groups and associated subject layers relative to each group.*

Assessment of the Policy Environment

The policies and regulations which both guide and control development within the City of Arlington form a tertiary level of complexity for determination of appropriate future capacity. Unlike component factors of the Natural or Built Environments, the policies themselves are not concrete tangible items, yet they do yield definitive effects on the development pattern of the City. Individual policies may regulate topics as diverse as infrastructure requirements to landscape and façade aesthetics. Therefore, the impacts of such policies are directly experienced by the City's residents, business owners, and visitors of both today and tomorrow.

As development oriented policies are so varied in type, analysis requires standard categorization for direct comparison. For example, it is difficult to rank the relative merits, in terms of a sustainable development capacity, of Tax Increment Reinvestment Zones (TIRZ) as compared to a development overlay area. By imposing a generalized descriptor, disparate groups that would otherwise limit meaningful examination are combined allowing ranked analysis between groups if not amongst them. For the purposes of this analysis, five categories were utilized.

Policy Category Weighting

In order to minimize ranking bias, a sampling of individuals in City government directly linked to the development process was interviewed by the analysis team. Each person is then invited to rank the relative importance of each policy category in terms of policy value and impact. Chart 3 outlines the quantitative average of all responses obtained through the interview process, the subsequent weight afforded each category.

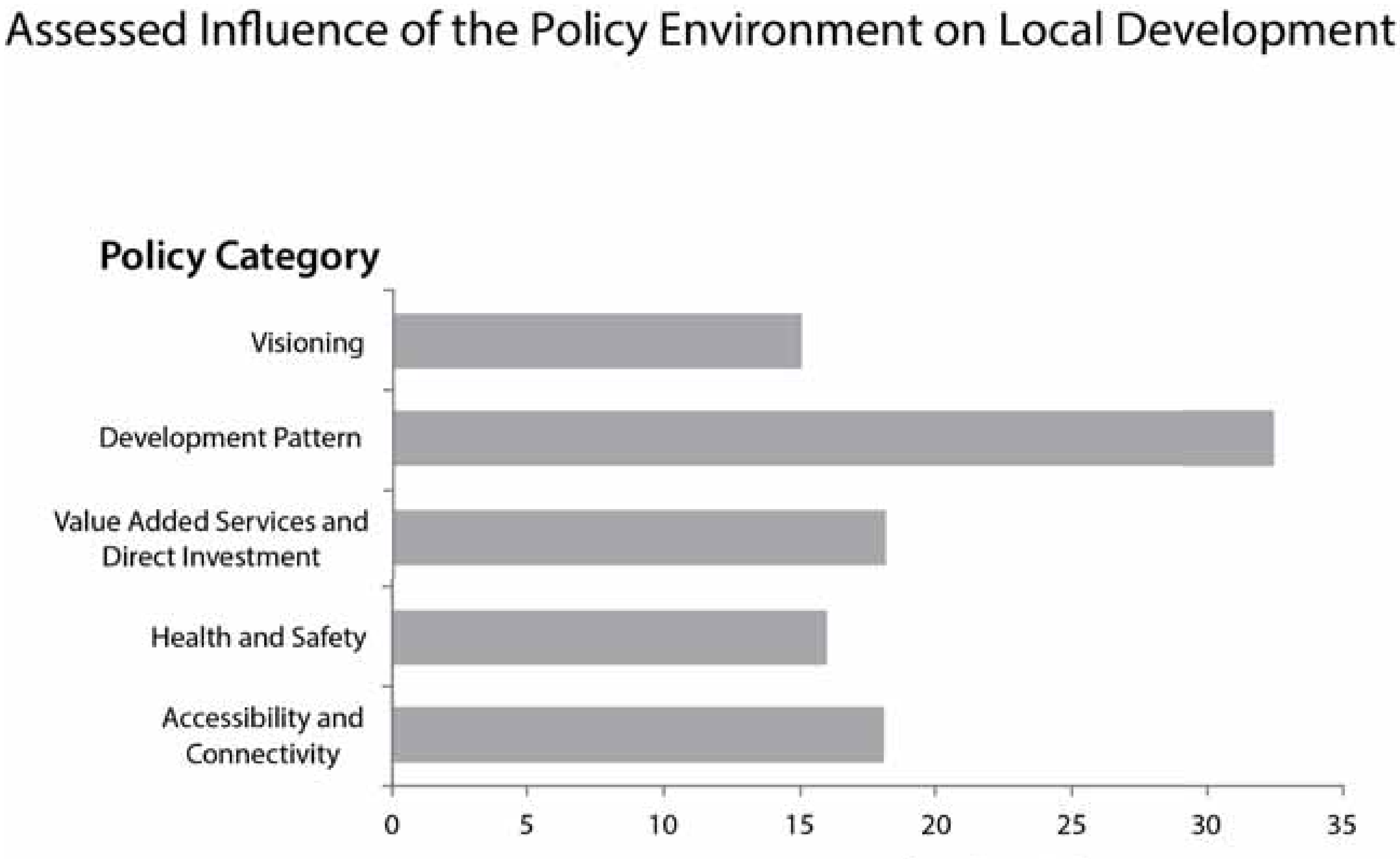


Chart 3: *Assumed influence of the Policy Environment on local development.*

Subject Layer Weighting

The subjects comprising each category were weighted equally relative to the total number of facets for their respective category. For example, the Value Added category includes ten subject layers allowing each layer a 10% share of the total weight for that category.

Policy Group	# of Subjects	Relative Share of Each Subject to Respective Group	Effective Weight of Group (Determined through Interviews)	Total Policy Weight of Each Subject
Accessibility/ Connectivity	1	1	18%	.18
Health & Safety	1	1	16%	.16
Value Added	10	0.1	18%	.018
Development	1	1	33%	.33
Visioning	6	0.166	15%	.025

Figure 11: *Prescribed weighting of policy groups and associated subjects considered within the Policy Environment categories.*

Intermediate Findings

All areas of the City have some type of development policy regulating growth in that area. However, the inclusion of additional policies on any one geography increases the policy load for that area. Those areas with the greatest load are subject therefore to both the incentives and limitations of any one policy or multiple policies concurrently. Those areas with the largest policy load are:

- Downtown/University area
- Entertainment area
- I-20 corridor between S. Cooper St. and SH-360.
- Southwest of US-287

Analysis of Findings

The policy environment provides the spatial context for City initiatives. Thus, those areas currently experiencing the greatest policy load generate the higher suitability scores. Of the three Environment analyzed in this report, the Policy Environment may prove to be the most dynamic as City amends, revises, and creates new policies to induce or hinder further development. To date, however those areas gathering the highest suitabiltiy scores are the aforementioned greatest policy load.

Index Class	Value Frequency	Share of Total	Area - ac	Area - mi²
0	0	0%	-	-
.01 - 0.1	0	0%	-	-
.101 - .2	20146713	18%	11,584.36	18.07
.201 - .3	1231771	1%	708.27	1.10
.301 - .4	950481	1%	546.53	0.85
.401 - .5	69107935	62%	39,737.06	61.97
.501 - .6	19357171	17%	11,130.37	17.36
.601 - .7	19972	0%	11.48	0.02
.701 - .8	8269	0%	4.75	0.01
.801 - .9	0	0%	-	-
.901 - 1	0	0%	-	-
Total 25 ft² Cells	**110,822,312**	**100%**	**63,722.83**	**99.38**

Figure 12: *Quantitative analysis of development suitability index scores of Policy Initiatives and Incentives for all areas within the City of Arlington according to frequency, acres, and mi².*
Note: Differences in Value Frequency totals for Figures 8, 9, 12, and 13 occur due to truncation during the conversion of raster datasets from floating point rasters to integer rasters. The Value Frequency column simply lists the occurrence of value groups, and therefore has no effect on the calculation of overall area findings.

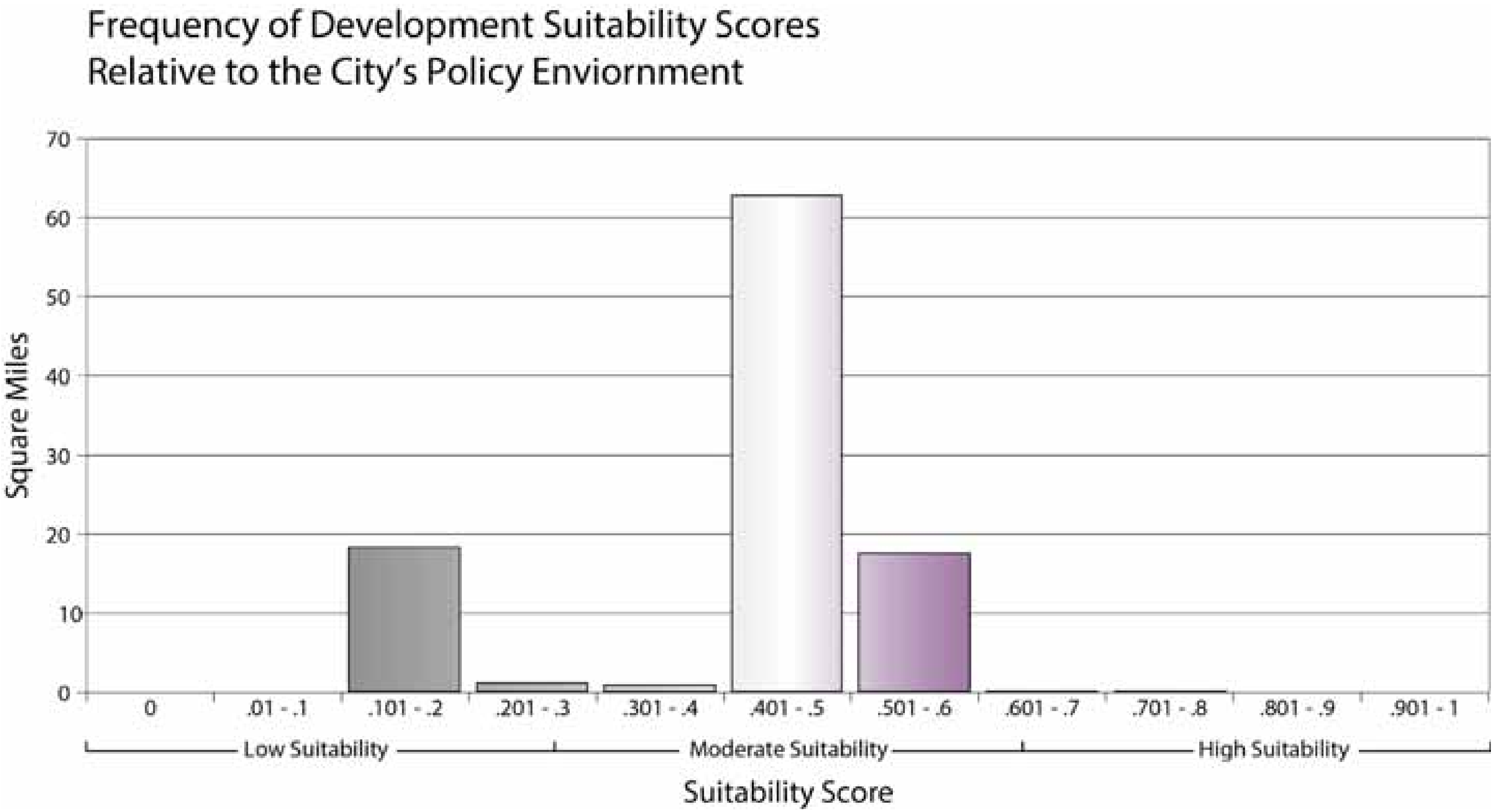
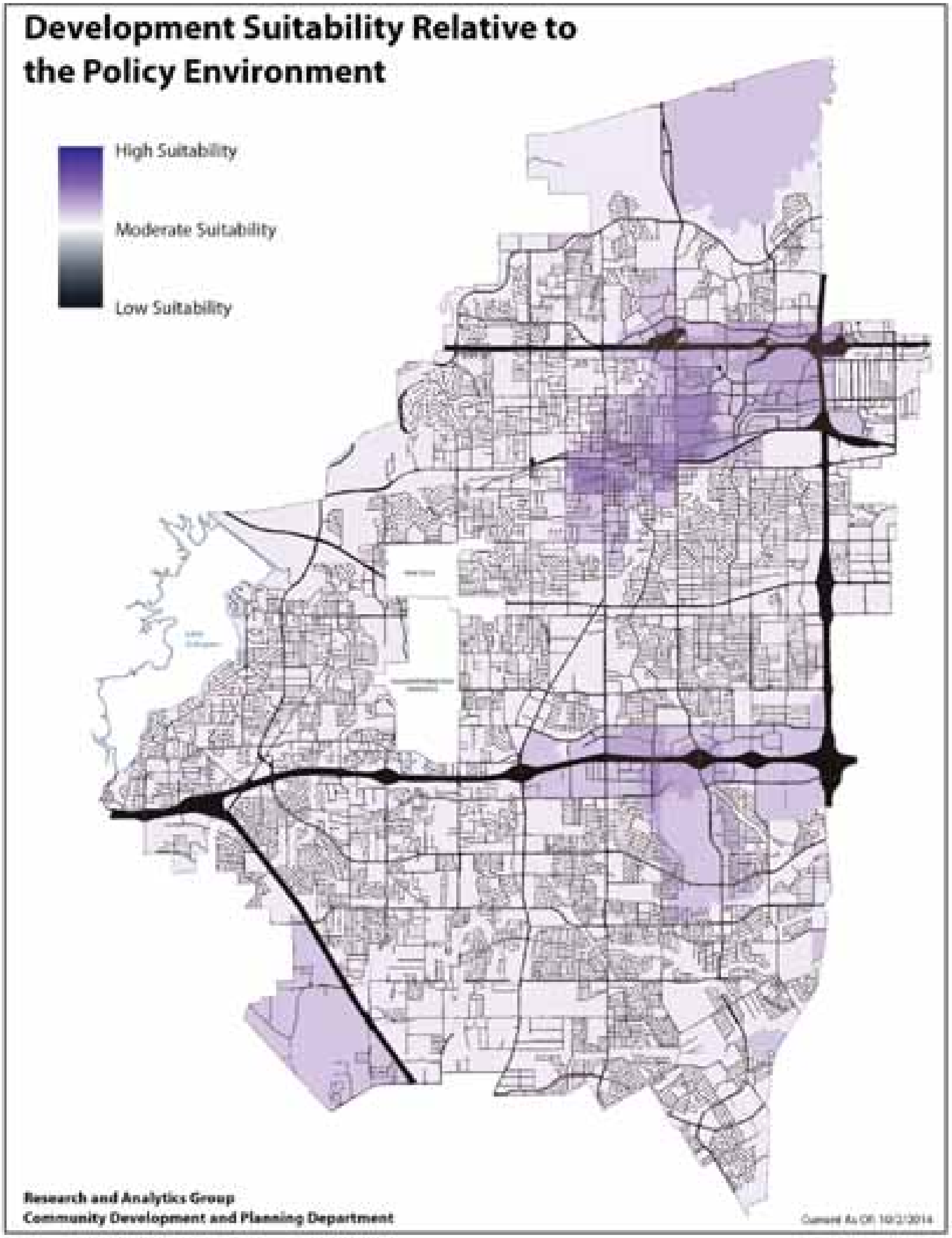


Chart 4: *Frequency of Development Suitability Scores Relative to the City's Policy Initiatives and Incentives by mi².*



Map 3: Final comprehensive analysis of development suitability scores relative to the City's Policy Initiatives and Incentives.

5 Findings & Conclusions: Comprehensive Analysis of Development Suitability

When the results of the three environment analyses are combined, the spatial analysis indicates that future city development is most appropriately located in three generalized areas.

Area north of Green Oaks Boule vard, east of Collins Street

This area provides the largest contiguous acreage suitable for future development. While this area ranked highly suitable by built and policy environment analysis, natural environmental constraints to development exist, and would require mitigation. The Viridian project provides an example of an appropriate development pattern for this area.

Area north of Park Row Road and south of Interstate30

Here, natural and policy environment suitability are high, but the current built environment constrains development. Although significant alteration of the current built environment is necessary to incentivize new growth, there is significant potential for suitable redevelopment activity. Existing utility and transportation infrastructure, and policies facilitating increased population presence and adaptive re-use means that costs associated with area redevelopment may be offset by increased economic potential.

Index Class	Value Frequency	Share of Total	Area - ac	Area - mi^2
0	0	0%	-	-
.01 - 0.1	114,909	0%	66.07	0.10
.101 - .2	2,807,265	3%	1,614.18	2.52
.201 - .3	13,100,735	12%	7,532.92	11.75
.301 - .4	51,385,800	46%	29,546.84	46.08
.401 - .5	31,633,851	29%	18,189.46	28.37
.501 - .6	2,888,851	3%	1,661.09	2.59
.601 - .7	6,480,065	6%	3,726.04	5.81
.701 - .8	2,394,835	2%	1,377.03	2.15
.801 - .9	15,716	0%	9.04	0.01
.901 - 1	0	0%	-	-
Total 25 ft^2 Cells	**110,822,027**	**100%**	**63,722.67**	**99.38**

Figure 13: *Quantitative analysis of comprehensive development suitability index scores for all areas within the City of Arlington according to frequency, acres, and* mi^2.
Note: Differences in Value Frequency totals for Figures 8, 9, 12, and 13 occur due to truncation during the conversion of raster datasets from floating point rasters to integer rasters. The Value Frequency column simply lists the occurrence of value groups, and therefore has no effect on the calculation of overall area findings.

Area south of Interstate 20

While there were limited areas of highly ranked suitable acreage for development and low policy loads, this area had the greatest potential for parcel assembly.

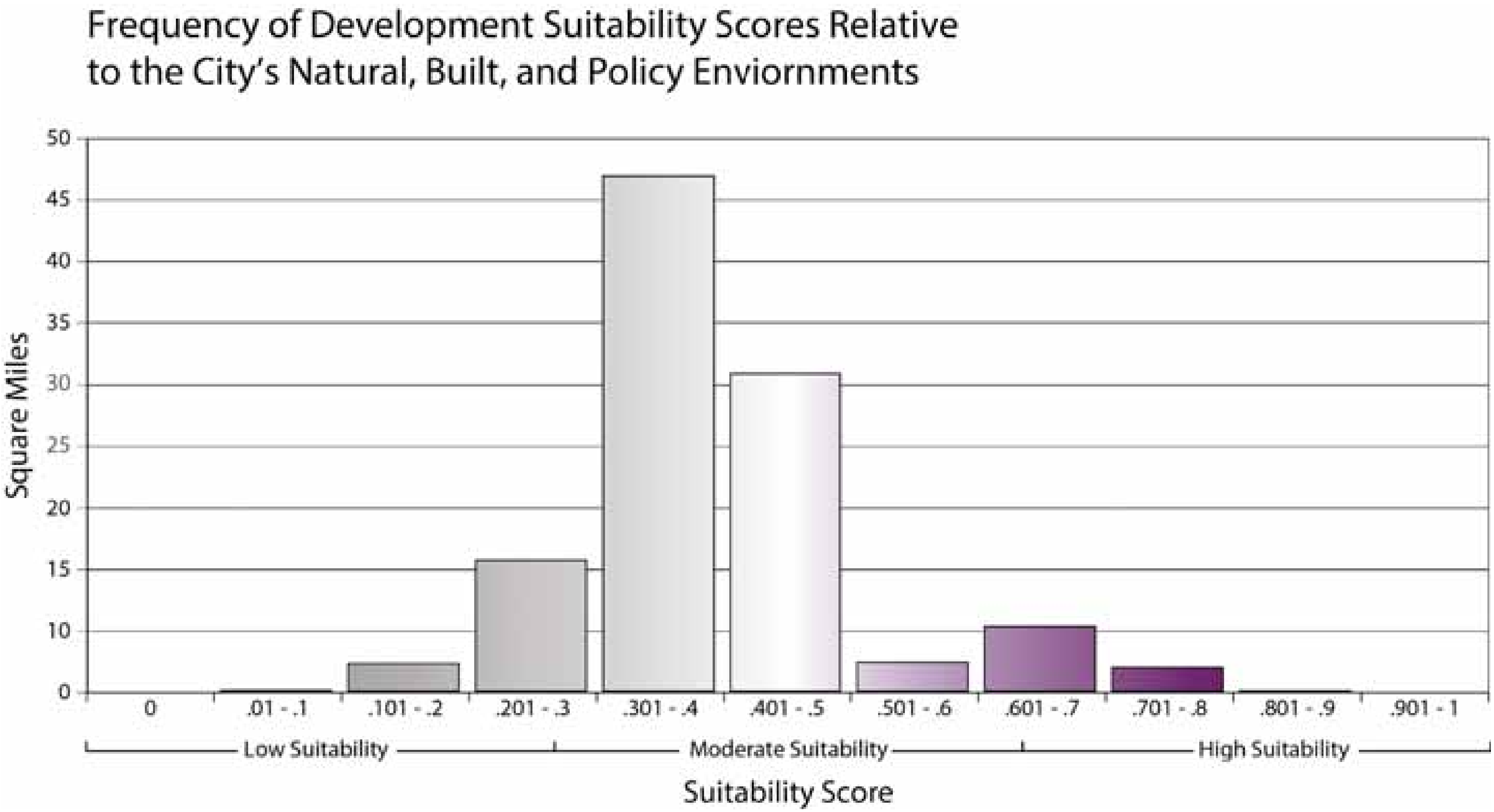
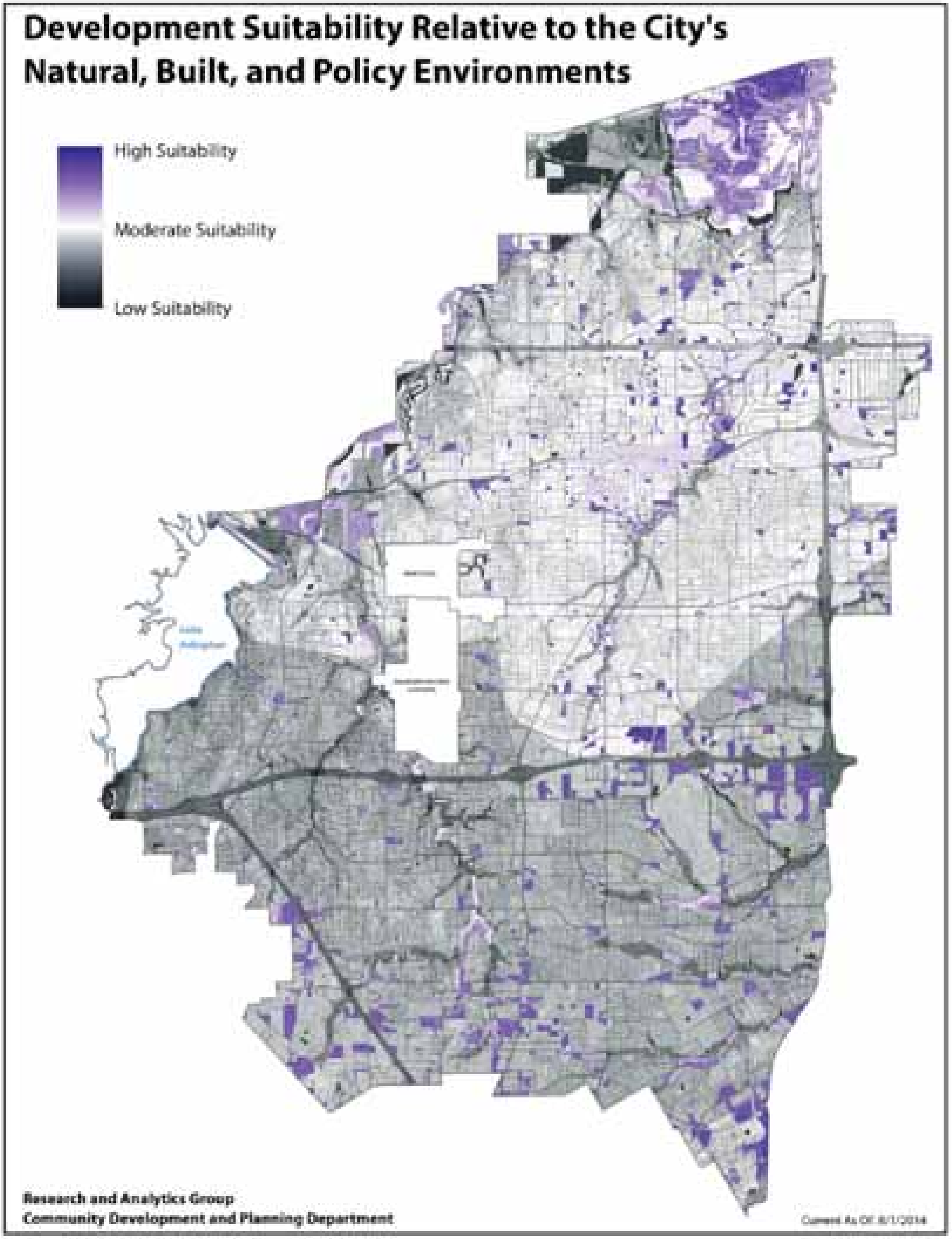


Chart 5: *Frequency of Comprehensive development suitability scores Relative to the City's Natural, Built and Policy Environments mi².*

Land areas that consistently scored as limited development suitability were not considered "lost acreage", because these areas can provide opportunities for amenities to support existing and future growth. For example, low scoring land adjacent to natural features (water courses) could be utilized as greenway connections and additional park space.



Map 4: *Final comprehensive analysis of development suitability scores relative to the City's Natural, Built, and Policy environments.*

6 | Afterword

This Carrying Capacity Analysis was utilized in its entirety as part of the City of Arlington's Comprehensive Plan update process. Those areas with the highest suitability scores became the basis for the City's Development Focus Areas. It is in these areas that the City will focus its future development and redevelopment energies.

Specifically, the identified Focus Areas envision how the city is anticipated to develop, grow, and mature. They show diversity in development patterns throughout the City, but do not dictate exact future land uses for specific parcels. By identifying these areas the City can proactively impact future change. The Development Focus Areas and associated Comprehensive Plan strategies will be used in tandem to:

- Guide zoning and land use development decisions so as to ensure the efficient and predictable use of land within the City;
- Protect private and public property investments from incompatible land uses;
- Efficiently coordinate land use and infrastructure needs; and,
- Evaluate zoning and development-related ordinances.

As the City of Arlington evolves and develops under its new Comprehensive Plan, the Carrying Capacity Analysis may be updated to assess policy changes, affected environments, and the successes of the City's development pattern.

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7 Appendices

Appendix – A

Natural Environment – Feature Types and Scoring

Feature Type	Feature Name	Feature Values	SME Determination of Development Suitability	Ordinal Score Based on SME Recommendation
Variable Suitability	Slope	0%	Most Suitable	4
		0.1%-3.0%	Fair Suitability	3
		3.1%-6.0%	Moderate Suitability	2
		6.1%-8.0%	Poor Suitability	1
		>8.0%	Not Suitable	0
	Soils	Urban land	Most Suitable	4
		Aquilla loamy fine sand Arents, frequently flooded Bastsil-Urban land complex Konsil fine sandy loam Lott-Urban land complex Silawa fine sandy loam Silstid-Urban land complex Sunev-Urban land complex	Fair Suitability	3
		Altoga silty clay loam Birome-Aubrey-Rayex complex Crosstell-Urban land complex Ferris-Heiden complex Gasil-Urban land complex Heiden clay Houston Black-Urban land complex Leson clay Navo-Urban land complex Ponder-Urban land complex Rader-Urban land complex Sanger clay	Moderate Suitability	2
		Branyon clay Burleson clay Frio-Urban land complex Mabank fine sandy loam Medlin clay Ovan clay, frequently flooded Pulexas-Urban land complex, occassionaly flooded Trinity clay, frequently flooded Whitesboro loam, frequently flooded Wilson-Urban land complex	Poor Suitability	1
		Dams Miscellaneous water Water	Not Suitable	0
	Vegetation	Urban	Most Suitable	4
		Post Oak Woods, Forest and Grassland Mosaic	Fair Suitability	3
		Crops Silver Bluestem-Texas Wintergrass Grassland	Poor Suitability	1
		Water	Not Suitable	0
Absolute Suitability	Wetlands	Not Present	Suitable	1
		Present	Not Suitable	0
	Floodplain	Not Present	Suitable	1
		Present	Not Suitable	0
	Endangered Species	Not Present	Suitable	1
		Present	Not Suitable	0
	Waterbodies	Not Present	Suitable	1
		Present	Not Suitable	0
	Floodplain	Not Present	Suitable	1
		Present	Not Suitable	0
	Streams \ Creeks	Not Present	Suitable	1
		Present	Not Suitable	0

Appendix – B

Built Environment – Feature Types and Scoring

Feature Type	Feature Name	Feature Values	SME Determination of Development Suitability	Ordinal Score Based on SME Recommendation
Variable Suitability	Air Quality Index	0 - 50	Good	5
		51 - 100	Moderate	4
		101 - 150	Unhealthy for Sensitive Groups	3
		151 - 200	Unhealthy	2
		201 - 300	Very Unhealthy	1
		301 - 500	Hazerdous	0
	Land Use	Vacant-Developable	Most Suitable	4
		-	Fair Suitability	3
		Business/Commercial	Moderate Suitability	2
		Commercial/Retail		
		Entertainment/Recreation		
		Institutional		
		Manufacturing/Warehouse/Industrial		
		Mixed Use		
		Multi Family		
		Single-Family		
		Transportation/Utilities/Communications		
		Park/Open Space	Poor Suitability	1
		Vacant-Undevelopable	Not Suitable	0
	Noise Levels	< 60db	Most Suitable	4
		60db - 65db	Fair Suitability	3
		65db - 70db	Moderate Suitability	2
		70db - 75db	Poor Suitability	1
		75db - 80db	Not Suitable	0
	Floor / Area Ratio	0	Most Suitable	4
		1 - 1.25	Fair Suitability	3
		1.2502 - 1.5	Moderate Suitability	2
		1.501 - 1.75	Poor Suitability	1
		1.751 - 2	Not Suitable	0
	Existing Population Density	0 Person per Acre	Most Suitable	4
		1 - 9 Person per Acre	Fair Suitability	3
		10 - 25 Person per Acre	Moderate Suitability	2
		26 - 41 Person per Acre	Poor Suitability	1
		> 41 Person per Acre	Not Suitable	0
	Sewer Service (Renewal, Rehabilitation and Prioritization Score)	0	System in Good Condtion	4
		.01 - 10	System in Fair Condition	3
		10.1 - 15	Requires Attention	2
		15.1 - 20	Requires Improvements	1
		> 20.1	Requires Significant Improement	0
	Water Service	0	System in Good Condtion	4
		.01 - 10	System in Fair Condition	3
		10.1 - 15	Requires Attention	2
		15.1 - 20	Requires Improvements	1
		> 20.1	Requires Significant Improement	0
Absolute Suitability	Building Footprints	Not Present	Suitable	1
		Present	Not Suitable	0
	Broadband Service	Not Present	Suitable	1
		Present	Not Suitable	0
	Brownfield Site	Not Present	Suitable	1
		Present	Not Suitable	0
	Gas Well	Not Present	Suitable	1
		Present	Not Suitable	0
	Land Fill	Not Present	Suitable	1
		Present	Not Suitable	0
	Pavement	Not Present	Suitable	1
		Present	Not Suitable	0
	Streets	Not Present	Suitable	1
		Present	Not Suitable	0
	Electrical Easments	Not Present	Suitable	1
		Present	Not Suitable	0

Appendix – C

Policy Environment – Feature Types and Scoring

Feature Type	Feature Name	Policy Applies To Area?	Feature Value	SME Prescribed Weight to Policy Types	Score Relative to Feature Weight
Accessibility	Thoroughfare Development Plan	Yes	1	18%	0.18
		No	0		0
Development Pattern	Zoning	Yes	1	33%	0.33
		No	0		0
Health & Safety	Building Codes	Yes	1	16%	0.16
		No	0		0
Value Added	Airport Overlay	Yes	1	18%	0.018
		No	0		0
	Business Park Overlay	Yes	1		0.018
		No	0		0
	Conservation District Overlay	Yes	1		0.018
		No	0		0
	Downtown Overlay	Yes	1		0.018
		No	0		0
	Enterprise Zone	Yes	1		0.018
		No	0		0
	Entertainment District Overlay	Yes	1		0.018
		No	0		0
	Hike & Bike Plan Overlay	Yes	1		0.018
		No	0		0
	Lamar-Collins Overlay	Yes	1		0.018
		No	0		0
	Tierra-Verde Overlay	Yes	1		0.018
		No	0		0
	TIRZ Overlay	Yes	1		0.018
		No	0		0
Visioning	BBC Plan	Yes	1	15%	0.025
		No	0		0
	Division Street	Yes	1		0.025
		No	0		0
	Future Land Use	Yes	1		0.025
		No	0		0
	Neighborhood Plan	Yes	1		0.025
		No	0		0
	New York Avenue	Yes	1		0.025
		No	0		0
	Planning Sectors	Yes	1		0.025
		No	0		0

Appendix – D

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