Houghton Road Holdings
PLANNED AREA DEVELOPMENT

August 23, 2016

A Collaborative Effort By:

Mattamy Homes
(Saguaro Trails Master
Planned Community)

City of Tucson
(Fantasy Island Trails Park)

Tucson Water
(Southeast Houghton Area
Recharge Project - SHARP)

Mattamy Property
PLANNED AREA DEVELOPMENT

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INTRODUCTION & POLICY

I.A FORWARD

This Planned Area Development (PAD) applies to approximately 319 acres of land that will be planned and developed under a comprehensive, unified vision through the joint efforts of three separate ownership interests, namely Mattamy Homes Tucson (Mattamy), the City of Tucson (the City), and Tucson Water (TW). The uses envisioned for each interest's respective holdings are: 1) Saguaro Trails, a master planned residential and recreational community; 2) a portion of Fantasy Island Trails Park; and 3) the Southeast Houghton Area Recharge Project (SHARP). While distinctly different in their basic purposes, this PAD will ensure that these uses are developed in a coordinated fashion which not only accommodates their respective and diverse needs, but which also integrates and leverages them such that they complement and enhance one another.

The Property will be developed under a comprehensive master plan that effectively weaves a variety of housing types and neighborhoods into the recreational and trail opportunities afforded by both Fantasy Island and SHARP. It will do so under a consistent aesthetic theme and project identity, thereby fostering a clear sense of place and reinforcing a focused, holistic community image.

I.A.1 Rational for Using the Planned Area Development (PAD) Zone

The Planned Area Development (PAD) is the most appropriate entitlement for the Property for the following reasons:

- It provides flexibility not found in traditional zoning constructs to cohesively integrate the holdings of three different property owners and their distinctly different land uses into a synergistic and functional whole.
- It provides the best construct for the development and regulatory enforcement of customized design and high aesthetic standards throughout the project.
- It is the most effective construct for facilitating a mix of housing styles and residential densities, and their integration into an interconnected pedestrian, recreational and multi-modal framework.
- It provides a superior construct for developing and implementing a unique project vision, identity, and image.

I.A.2 Physical, Economic & Environmental Suitability of the PAD

The PAD vehicle is wholly suitable for the regulatory administration of the Property. From a physical perspective, the Property is located on Houghton Road, one of the largest and most significant transportation corridors in the entire Tucson metropolitan region. This segment of the roadway was recently upgraded to a full six-lane cross-section with multi-use trails along both sides of the roadway. This six-lane improvement currently extends southward to Valencia Road; the ultimate plan for Houghton Road will feature this same six-lane cross-section from Interstate 10 northward to Speedway Boulevard.

From an economic standpoint, the development of the Property as a quality master planned community that offers a variety of housing types and price points will only serve to further strengthen the robustness of the housing market on Tucson's far east side. It is no secret that the Houghton Road corridor represents the most important land resource in the future growth of the City. It is therefore essential that all new development in this key region maintains the kind of high standards that will firmly establish it in the marketplace as a preferred and desirable housing sector.

From another economic perspective, the Property will be developed off of the existing, established framework of public infrastructure already in place as opposed to necessitating any significant expansion or augmentation of it. What's more, the proposed SHARP facility will provide significant benefits to the entire Tucson region through aquifer recharge and reclaimed water distribution. The PAD document is the best vehicle for defining the types of comprehensive utility and transportation master plans that will insure the project integrates seamlessly, over its entire multi-year build-out, with all existing infrastructure systems.

From the environmental perspective, the Property contains significant natural open space corridors within which a portion of the extensive network of Fantasy Island bike trails have already been developed. A PAD will best insure the preservation of these valuable corridors and the established recreational use they contain, while also providing for direct connectivity throughout the project's Saguaro Trails residential component. Such linkages represent a clear opportunity for the enhancement of both. The beneficial nature of this connectivity is further augmented when the planned public trails of the SHARP facility are considered in the mix, together with the prospect of outside linkages to nearby regional multi-use trails.

I.A.3 General Compatibility of the PAD with Adjoining Land Uses

The Proposed PAD is entirely compatible with its existing adjoining uses. To the east, across Houghton Road, lie the Civano and Sierra Morado residential communities, as well as the Pavilions planned development. Both Civano and Sierra Morado are similarly administrated by approved PAD's and each provides an example of a well planned residential community. The Proposed PAD for the subject property will fit nicely into this established residential mix.

The Pavilions site borders the east side of Houghton Road, directly across from the Property. Its approved PAD provides for neighborhood-level commercial uses, offices, healthcare, and employment. Tucson Medical Center is currently under construction with a new multi-speciality clinic (TMC Rincon Medical Campus) here to provide healthcare services to the entire region. The development of the subject PAD Property as intended will provide a significant population boost that can only benefit the full build-out of The Pavilions as planned.

To the south and west of the Property, nearly all of the adjacent vacant land is held by the Arizona State Land Trust. These holdings will eventually be planned and brought to market for auction and development by the Arizona State Land Department (ASLD). While the timing of these future planning efforts and sales cannot be predicted, it is worth noting that a comprehensive planning permit for these properties was initiated with ASLD by Macerich Companies in 2007. Significant planning work in this regard was completed before the permit was eventually withdrawn due to the national economic downturn of 2008.

I.B INTRODUCTION & GUIDING PRINCIPLES

This Section provides a general overview of the proposed PAD, its planned development program, and the goals and objectives that will guide this PAD.

I.B.1 Project Location

The PAD is comprised of approximately 319 acres located on the west side of Houghton Road, approximately one-half mile south of Irvington Road. See Exhibits I.1 & I.2 for its Regional Location and more detailed Site Location, both of which also illustrate the various nearby uses that define the surrounding context. The Property is comprised of lands owned by Mattamy Homes Tucson, the City of Tucson, and Tucson Water (see Exhibit I.3: PAD Ownership Delineation). It is presently composed of five (5) tax parcels, these being Nos. 141-01-006B, 007E, 007G, 007H & 007J.

I.B.2 Property Acquisition through City Auction Process

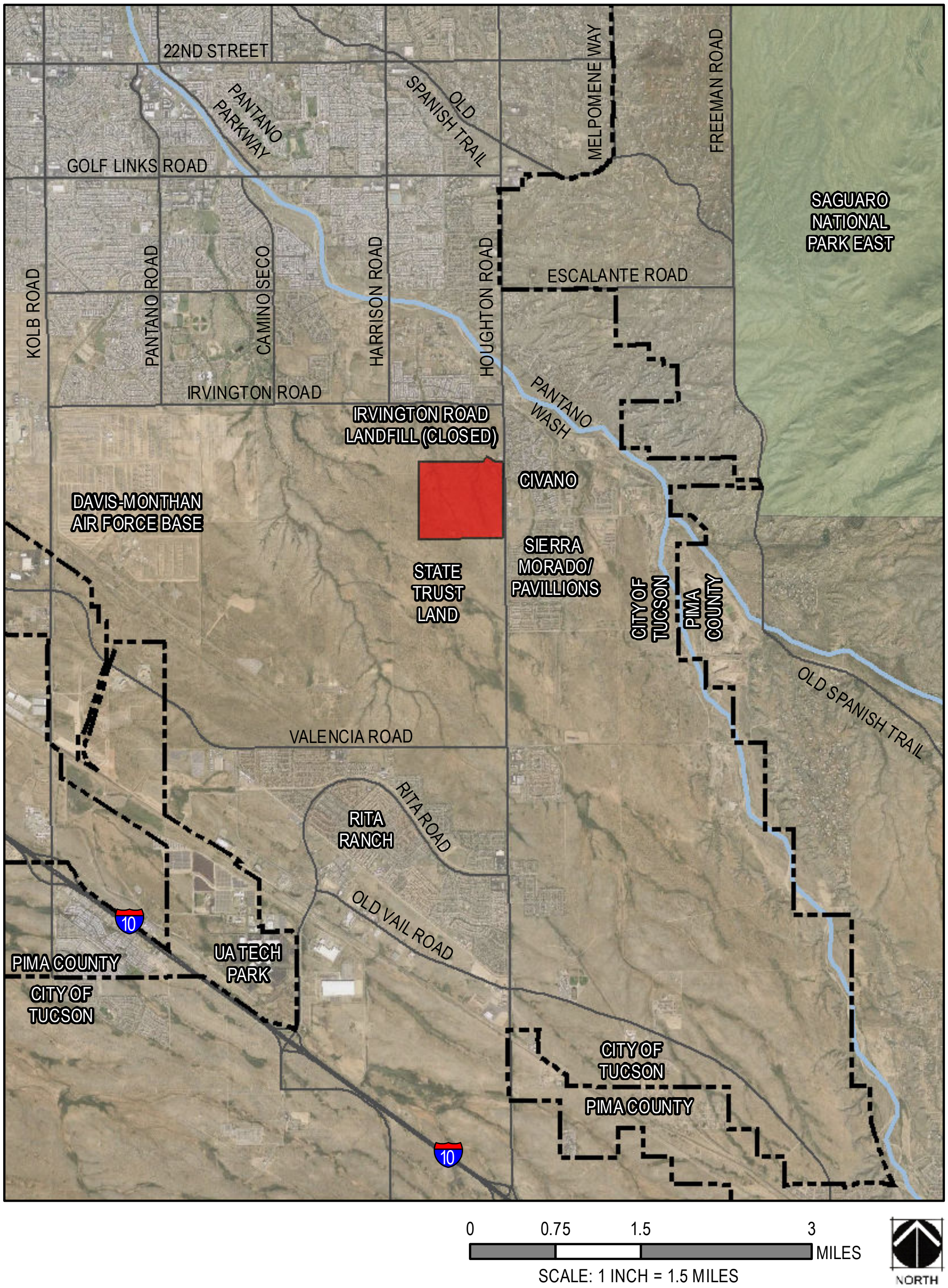
The PAD Property was originally owned, in its entirety, by the City of Tucson and was often referred to colloquially as the “Civano Parcel”. While approximately one hundred six acres (106 AC) of the Property was always envisioned as being retained by the City for a portion of Fantasy Island Trails Park, and while another forty acres (40 AC) was earmarked for Tucson Water’s planned Southeast Houghton Area Recharge Project (SHARP), the remaining one hundred seventy-three acres (173 AC) was designated, more than a decade ago, as surplus property that would ultimately be auctioned for private development.

On August 8, 2015, the aforementioned 173-acre holding was listed for sale through the local Tucson office of CBRE Group, Inc. The due date for bids was set as October 26, 2015 and the submitted bids were opened that day at the CBRE offices. Mattamy Homes Tucson was the successful bidder, earning the right to then purchase the 173 acres following a formal due-diligence period. After its investigations were completed, Mattamy subsequently waived contingencies and, on March 17, 2016, formally closed on the 173-acre property and initiated its preparations of this PAD document.

As part of the acquisition, Mattamy and the City of Tucson agreed to include all of the City’s retained acreage in the PAD, such that Fantasy Island Trails Park and the Tucson Water SHARP project will now proceed under the regulatory authority of this PAD.

View Looking North into Property

Exhibit I.1: Regional Location Map



LEGEND

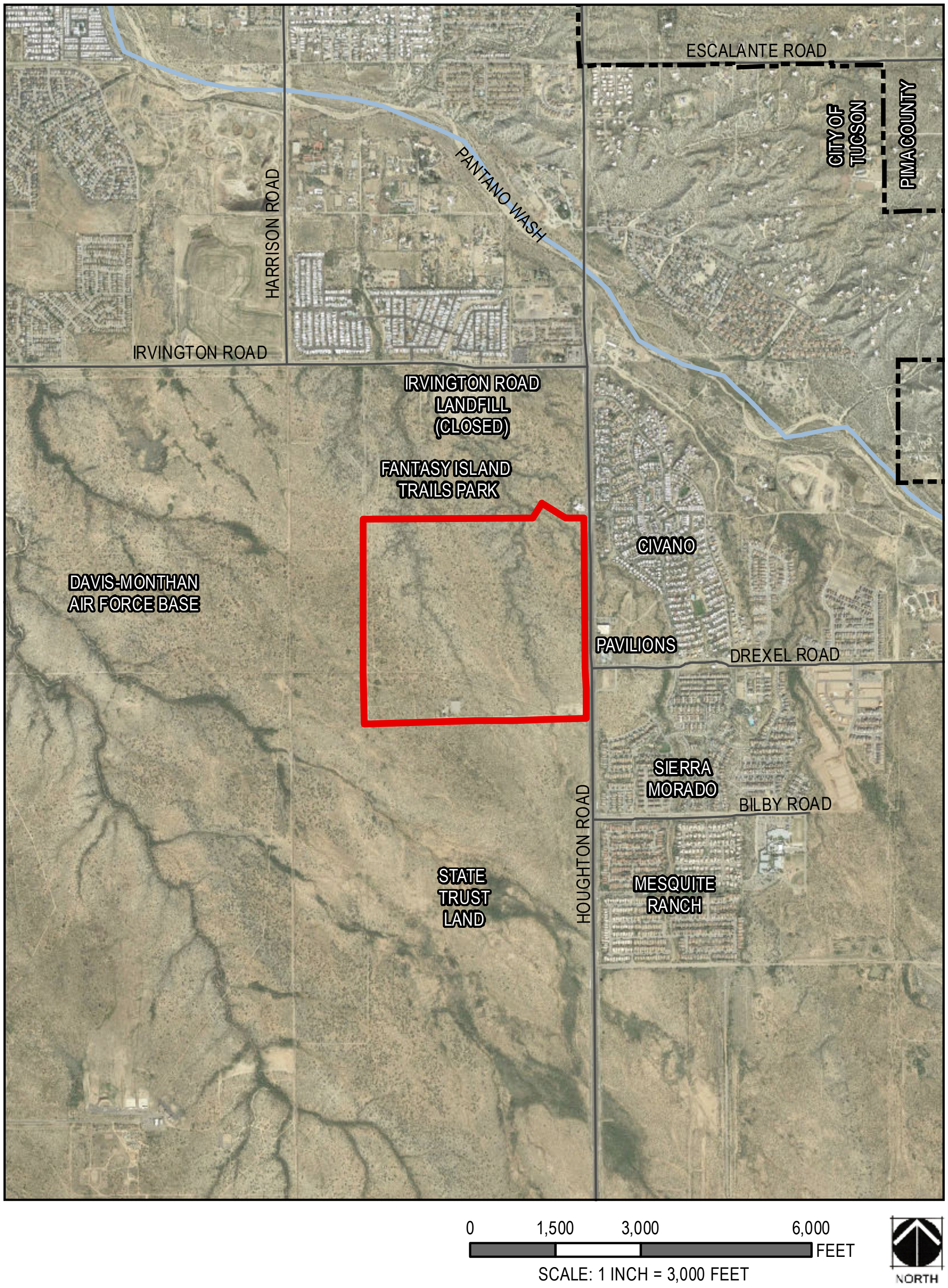
🟥 PLANNED AREA DEVELOPMENT (PAD) BOUNDARY

▭ TUCSON CITY LIMITS

— MAJOR STREET

— MAJOR WASH

Exhibit I.2: Site Location Map



LEGEND

🟥 PLANNED AREA DEVELOPMENT (PAD) BOUNDARY

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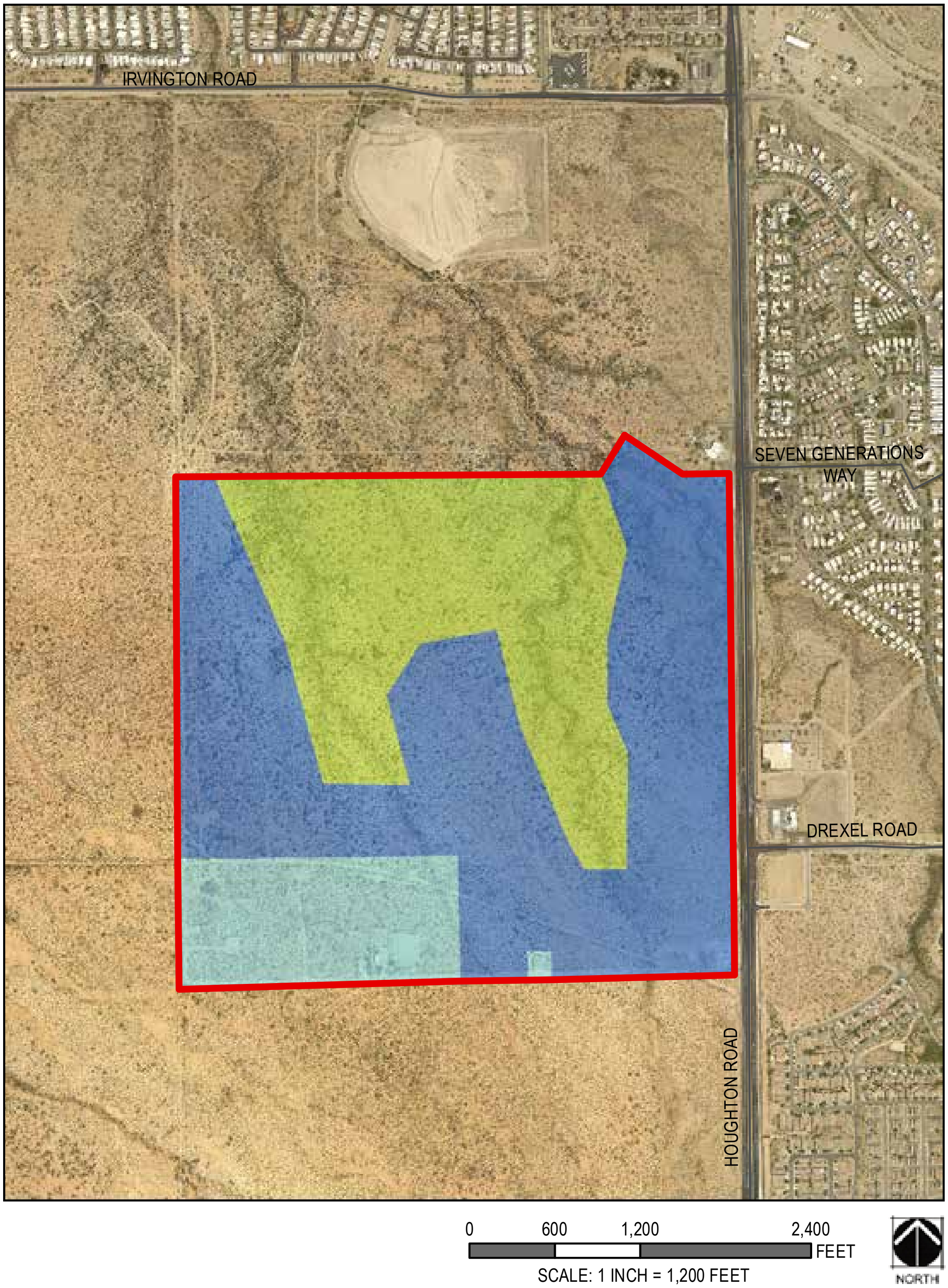
Exhibit I.3: PAD Ownership Delineation



LEGEND

▭ PLANNED AREA DEVELOPMENT (PAD) BOUNDARY

— MAJOR STREET

🟩 CITY OF TUCSON PROPERTY (PORTION OF FANTASY ISLAND TRAILS PARK)

🟦 MATTAMY HOMES PROPERTY (PROPOSED SAGUARO TRAILS RESIDENTIAL COMMUNITY)

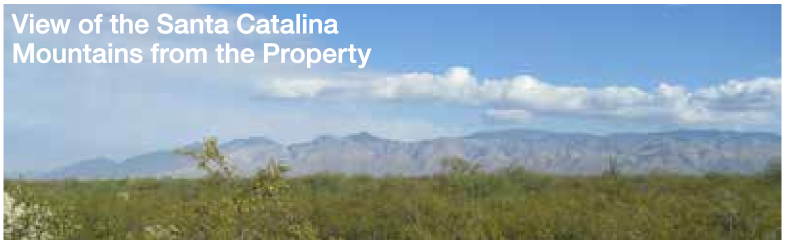
▨ TUCSON WATER PROPERTY (PROPOSED S.H.A.R.P. FACILITY AND EXISTING WELL SITE)

I.B.3 Historic and Existing Uses of the Site

The majority of the Property is currently vacant. There is, however, an extensive system of mountain-bike trails weaving throughout portions of the Property, these having been developed over time, and in a somewhat organic and informal fashion, under the name “Fantasy Island”. This collection of trails was ultimately formalized by the Mayor & Council with its adoption of the Master Plan for Fantasy Island Trails Park (FITP) in 2006. This PAD will serve as the entitlement vehicle that implements a portion of this Master Plan and establishes the final boundaries, uses and regulatory criteria for this particular portion of FITP. City representatives were instrumental in negotiating the finalized park boundaries with Fantasy Island leadership; the resultant configuration was ultimately considered and adopted by the Mayor & Council prior to the public auction process described above.

Tucson Water also currently operates an existing reservoir, within a fenced compound, on a portion of the Property that will contain the proposed SHARP facility. This existing reservoir complex has been integrated into the larger SHARP master plan and will provide the source water for SHARP’s use.


One of The Many Fantasy Island Trails


View of the Santa Catalina Mountains from the Property


Houghton Road Greenway

I.B.4 Proposed Project

The proposed project is an integrated whole comprised of a portion of Fantasy Island Trails Park, the Saguaro Trails master planned residential community by Mattamy Homes, and Tucson Water’s SHARP water recharge facility and recreational-trail complex.

The Saguaro Trails portion of the PAD Property (approximately 176 acres) will be developed as a multi-phased community that functionally complements and interconnects with both Fantasy Island and the SHARP facility. It will be anchored around a core neighborhood center in the form of a combined central park and the main public entrance to the SHARP facility, thereby providing a distinct focal point for both active and passive recreational activities, special events, and the enhancement of the community’s social fabric.

Comprehensive pedestrian and trail connectivity will be a central feature of the overall project, not only internally between Saguaro Trails and Fantasy Island/SHARP, but also externally with the remainder of the Fantasy Island trails, the Drexel Road greenway (which will extend into the Property at its main entrance), and the recently-completed multi-use trails that parallel Houghton Road. A related goal is establishing a connection to the existing regional Loop Trail (approximately one-half mile to the west), subject to successful negotiations and arrangements with the Arizona State Land Department (ASLD). This planned level of connectivity will serve to firmly knit the PAD Property into its regional surroundings and provide for public recreation in a truly functional and meaningful way.

In terms of housing particulars, Mattamy proposes approximately seven hundred (700) dwelling units in Saguaro Trails. These will be comprised of both single-family and multi-family units, be of varying development densities, and feature both attached and detached housing options. Access to these residential areas will occur via Houghton Road; two residential entry points are contemplated, together with a signalized entrance at Drexel Road and its westward extension into the Property as the project’s main boulevard. In keeping with the pedestrian/trail themes articulated above, this Drexel Road extension will feature a multi-use trail and greenway, together with landscaped roundabouts for the purpose of traffic calming and pedestrian/bicycle safety.

I.B.5 Project Goals

As already stated, the over-arching goal of this PAD is to create an integrated environment where the Saguaro Trails residential community, Tucson Water's SHARP project, and Fantasy Island Trails Park functionally complement and benefit each other in holistic fashion. The development concept and regulatory criteria presented in Section III of this document (PAD District Proposal) will provide the procedural mechanisms to ensure this goal is achieved.

A. Guiding Objectives

This PAD intends to create a dynamic residential and recreational community that integrates its residential areas with Fantasy Island Trails Park and the SHARP facility, and which will provide a variety of housing types and styles that will attract a diverse population of active residents.

With respect to the Mattamy Homes/Saguaro Trails portion of this PAD, there is the fundamental objective of creating a residential community that sets and maintains a high standard in the Tucson market, meets the full measure of resident needs and preferences, and generally elevates the local housing market by providing choices that are fresh, exciting, and innovative.

Beyond this, there is also the important sub-goal of creating and fostering a truly *Living Community*, a term which is defined on several levels. First, it means that the community's primary purpose is to *serve the lives of its residents*. This purpose cannot be achieved by simply constructing a conventional production-home community. It can only be realized by truly understanding resident needs, preferences, hopes, and expectations, and then by implementing these through the unique, buyer-inspired housing products, neighborhood amenities, and recreational opportunities that are offered. In order to facilitate this process, Mattamy conducts an extensive focus-grouping process with its potential market, the end result of which is a detailed empirical understanding of its future resident population and the community components that are essential to serving them and fulfilling their expectations.

On a second level, the term *Living Community* pertains to the fact that *the community itself is an evolving entity*. This approach demands that Mattamy listen to its residents and potential buyers on an on-going basis; the focus-grouping referenced above is not a one-time affair. Resident preferences are continually being evaluated, and each completed neighborhood will be critically examined to determine the extent to which it works as intended and/or whether modifications and refinements are needed going forward in subsequent phases. As such, a *Living Community* naturally adapts and evolves over time to improve itself … and thereby best *serve the lives of its residents*.

With all of this in mind, the appropriateness and need for this project to proceed under a Planned Area Development is clear. A dynamic, evolving community is a combination of: 1) basic principles of high quality and design and that are inviolate; and 2) flexible implementation measures that provide for responsiveness to ever-changing market demands. Only the PAD can strike this balance.

B. Mattamy Corporate History, Philosophy & Goals for the Tucson Market

Mattamy Homes is the largest privately-owned home builder in North America and now operates divisions across Canada and the United States. The company was founded by Ontario, Canada native Peter Gilgan, who believed that the production housing industry was one that had largely become stale and was almost universally characterized by sameness. After studying home-design concepts throughout North America and embracing some of the basic tenets of New Urbanism, he honed his beliefs that peoples' homes should be more individual in character, be designed into friendlier communities with integrated green spaces, and that consideration should be given more to the needs of people than those of the automobile.

Since those beginnings in 1978, Mattamy has gone on to build more than 70,000 homes in several hundred residential communities. These projects stretch across North America in major cities such as Toronto, Ottawa, Calgary, Edmonton, Minneapolis-St.Paul, Charlotte, Jacksonville, Tampa-Sarasota, Orlando, Phoenix and, most recently, Tucson, Arizona.

Mattamy's success is rooted in three core values:

- *Commitment:* we will ensure excellence is the standard for everything we do,
- *Teamwork:* we will respect and support each other in doing what is right,
- *Community:* we will have a positive impact in all of our communities

In implementing the above, local Mattamy personnel remain intimately involved~~,~~ throughout the life of each project~~,~~ in every single aspect of community planning. This involvement applies to land acquisition, the detailed designs of the homes, and to orchestrating all of the community's features, including streetscapes, parks, walking/biking trails, and amenities. The local Mattamy personnel in each office are charged with designing and building communities that distinctly and uniquely reflect the local environment and its character.

The Tucson office of Mattamy Homes was opened in August, 2014 and, since that time, it has opened two communities within existing master planned contexts. Mattamy is especially excited to be proceeding with this PAD, as it represents their first opportunity in Tucson where their corporate philosophy and approach can be applied, in ground-up fashion, from the initial master planning efforts to the final construction of finished homes and neighborhoods.

C. Specific Goals, Purpose and Intent of the PAD

The specific goals of this PAD are as follows:

- Establish a PAD that insures a thoughtfully designed and executed Saguaro Trails residential and recreational community that fits well within its surrounding context;
- Establish a PAD that executes a clear and defined project vision and image through quality design and detailing and which, by doing so, serves as a notable example of the built environment within the Houghton Road corridor and in the Tucson community at large;
- Establish a PAD that provides for development flexibility going forward and ensures the ability to respond to changing market conditions and preferences within its originally established regulatory framework;
- Establish a PAD that respects and recognizes the diverse needs and requirements of all three ownership entities (Mattamy Homes, City of Tucson, Tucson Water) and which creates an environment where all three can properly function and benefit from each other;
- Establish a PAD that not only functionally integrates its internal components, but which also effectively knits itself into the surrounding area through direct connectivity with nearby regional trail systems and open spaces; and
- Establish a PAD that provides City staff with an effective and easily interpreted regulatory tool for managing the on-going review and permitting of the project over its entire build-out.








I.C CONFORMANCE WITH GENERAL PLAN AND AREA PLANS

City of Tucson regulatory and policy guidance for the PAD Property is provided by Plan Tucson and by the Houghton Area Master Plan (HAMP). The staff of the City's Planning & Development Services Department (PDSD) has previously reviewed this conceptual PAD proposal and has determined that it is in compliance with both of these regulatory constructs. A copy of the PDSD's evaluation and plan-compliance letter is provided in Appendix B. Further detail as to Plan Tucson and HAMP policy guidelines is provided below.

I.C.1 Plan Tucson

The PAD Property is consistent with Plan Tucson (formerly known as the City of Tucson's General Plan) as adopted on November 13, 2013, see Exhibit I.4: Plan Tucson Future Land Use. The proposed PAD furthers the City of Tucson's vision for the Houghton Road Corridor area by providing master planned, phased development that incorporates residential neighborhoods with an identified neighborhood core. The PAD proposal includes the integration of community/public open space in the form of the Fantasy Island Trails Park, a new neighborhood center and park, and the desired extension of the regional multi-use trail network known as "The Loop" through the adjacent State Land Trust property. The design and development of the PAD Property reinforces and supports Plan Tucson's vision to provide an integrated and sustainable plan for the Houghton Corridor, respecting the natural desert environment, and making efficient use of existing, established infrastructure.

Goals and Policies from Plan Tucson that are supported and furthered by the proposed PAD are presented below (these items are taken verbatim from the Plan Tucson document):

Social Environment Goals:

- 1. A mix of well-maintained, energy-efficient housing options with multi-modal access to basic goods and services, recognizing the important role of home ownership to neighborhood stability.
- 5. A community that is healthy physically, mentally, economically, and environmentally.

Social Environment Policies:

- Parks and Recreation:
  - (PR4) Ensure a range of recreational opportunities from passive to active
  - (PR9) Develop an urban multipurpose path system that provides mobility options, with recreational and health benefits, to access parks, residential areas, places of employment, shopping, schools, recreational facilities, transportation hubs, natural resources, and watercourses for people of all abilities.
- Public Health Policies:
  - (PH1) Pursue land use patterns; alternate mode transportation systems, including multipurpose paths; and public open space development and programming that encourage physical activity, promote healthy living, and reduce chronic illness.
  - (PH8) Support streetscape and roadway design incorporating features that provide healthy, attractive environments to encourage more physical activity.

Economic Environment Goals:

- 13. A community whose vibrant economy and quality of life benefits residents and attracts visitors.

Economic Environment Policies:

- Business Climate
  - o (BC8) Support a safe, distinctive, well-maintained, and attractive community with neighborhoods made up of residences and businesses that contribute to Tucson's quality of life and economic success.
  - o (BC9) Encourage a mix of residential development and promote home ownership throughout the city as both an economic driver and a quality of life issue to meet the diverse needs of a growing workforce.
- Tourism and Quality of Life
  - o (TQ5) Promote Tucson as a premier healthy lifestyle, outdoor, and recreational destination for cycling, hiking, bird watching, astronomy, nature, desert ecology, golf, spas, wellness, and healthcare.

Natural Environment Goals:

- 18. A network of healthy, natural open space managed for multiple benefits.

Natural Environment Policies

- Green Infrastructure
  - o (GI3) Create and maintain a connected urban greenway system for non-motorized mobility and to provide human and environmental health benefits.
  - o (GI5) Create, preserve, and manage biologically rich, connected open space; wildlife and plant habitat; and wildlife corridors, including natural washes and pockets of native vegetation, while working to eradicate invasive species.

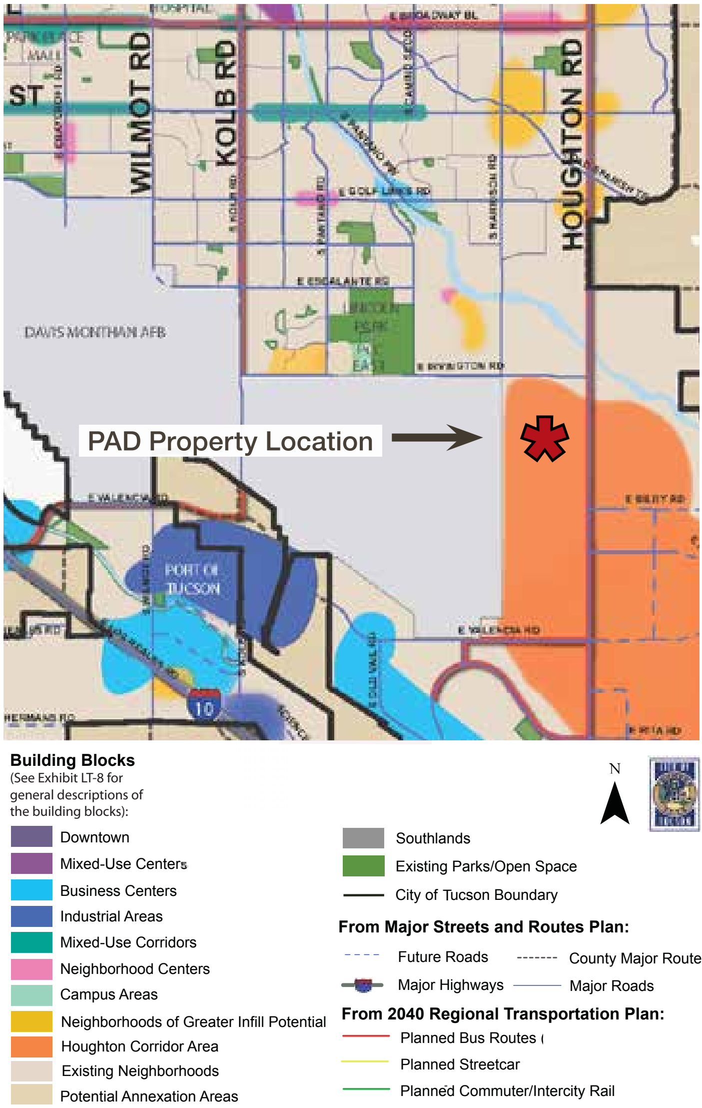
The Built Environment Goals:

- 24. Strategic public and private investments for long-term economic, social, and environmental sustainability.
- 25. An urban form that conserves natural resources, improves and builds on existing public infrastructure and facilities, and provides an interconnected multi-modal transportation system to enhance the mobility of people and goods.

Relevant Built Environment Policies

- Public Infrastructure, Facilities, & Cost of Development
  - o (P17) Coordinate with utility companies and other public service providers for the planning of infrastructure, facilities, and services, making sure infrastructure and facility construction is sensitive in design and location to environmental and historic resources.
- Land Use, Transportation, & Urban Design
  - o (LT1) Integrate land use, transportation, and urban design to achieve an urban form that supports more effective use of resources, mobility options, more aesthetically-pleasing and active public spaces, and sensitivity to historic and natural resources and neighborhood character.
  - o (LT3) Support development opportunities where: a. residential, commercial, employment, and recreational uses are located or could be located and integrated b. there is close proximity to transit c. multi-modal transportation choices exist or can be accommodated d. there is potential to develop moderate to higher density development e. existing or upgraded public facilities and infrastructure provide required levels of service f. parking management and pricing can encourage the use of transit, bicycling, and walking.

Exhibit I.4: Plan Tucson Future Land Use



- (LT4) Ensure urban design that: a. is sensitive to the surrounding scale and intensities of existing development b. integrates alternative transportation choices, creates safe gathering places, and fosters social interaction c. provides multi-modal connections between and within building blocks d. includes ample, usable public space and green infrastructure e. takes into account prominent viewsheds
- (LT9) Locate housing, employment, retail, and services in proximity to each other to allow easy access between uses and reduce dependence on the car.
- (LT14) Create pedestrian and bicycle networks that are continuous and provide safe and convenient alternatives within neighborhoods and for getting to school, work, parks, shopping, services, and other destinations on a regular basis.
- (LT28.1.10) Consider special zoning districts, such as Planned Area Developments (PAD) or overlay districts, as a way to promote the reuse of historic structures, foster mixed-use activity nodes, pedestrian and transit-oriented development areas, and pedestrian-oriented districts in areas suitable for redevelopment or enhancement.
- (LT28.1.20) Support an accessible open space system that connects open space in the urbanized area to the surrounding public natural areas.
- (LT28.1.22) Support an interconnected urban trail system throughout the city to meet the recreational needs of pedestrians, bicyclists, and equestrians.

Plan Tucson's Houghton Corridor Area:

Within Plan Tucson, future growth scenario building blocks have been identified. The PAD Property is located in the northwest quadrant of the Houghton Corridor Area (HCA). This area has been identified as an opportunity for enhanced development, thereby encouraging a master planning approach that would provide a cohesive system of neighborhoods, mixed-use centers, and regional open space designed within a relatively compact framework. Phased growth is proposed for the HCA in order to efficiently utilize existing infrastructure and provide a proper level of public services for residents.

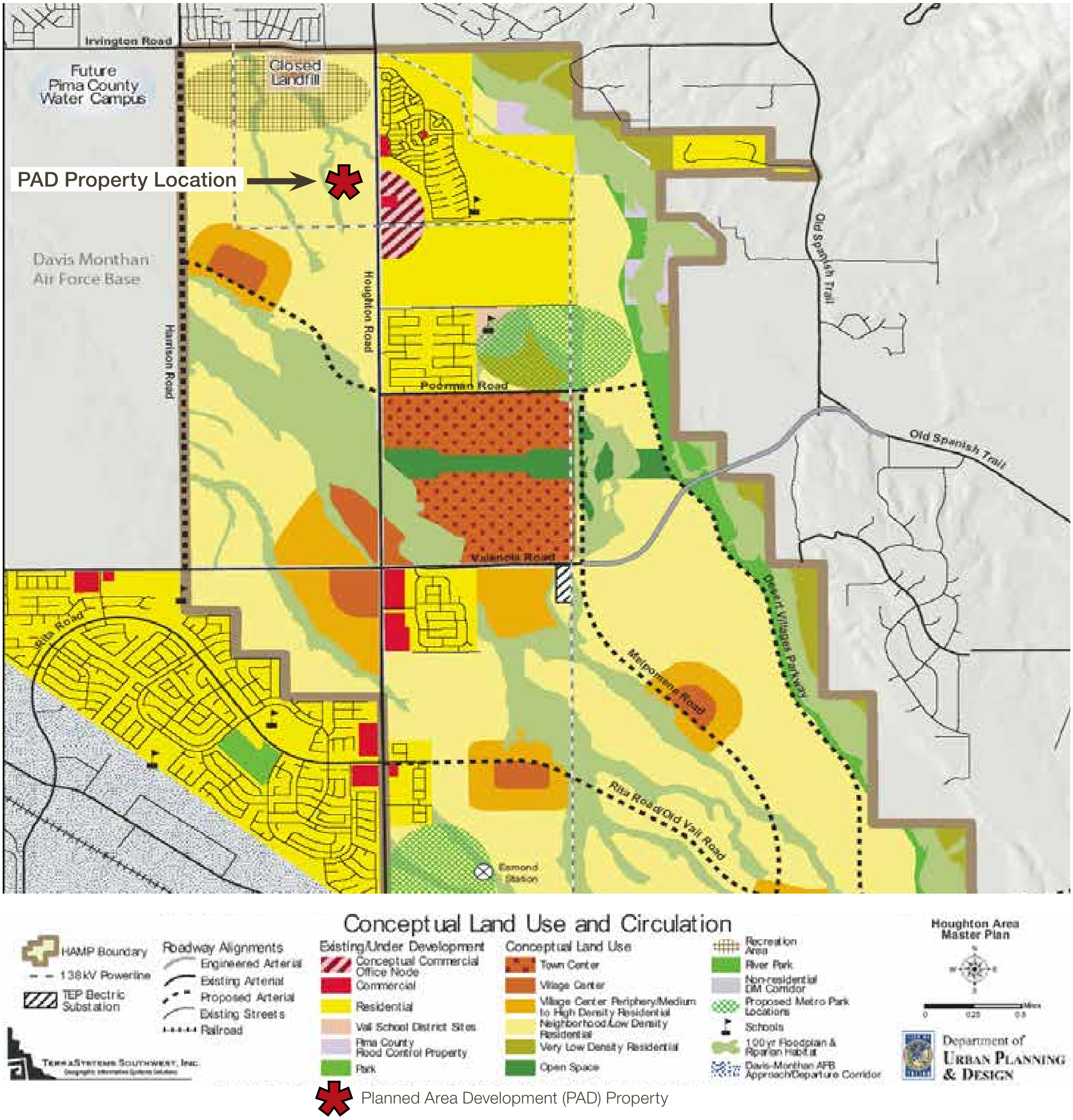
Policies Relevant to the Houghton Corridor Area:

- (LT28.8.2) In areas that are not currently developed, support master planned areas that reflect sensitivity to environmental resources and existing residential uses and that are phased or financed to meet infrastructure requirements. a. Have a minimum overall residential density that can sustain regular transit usage; b. Consist of a series of neighborhoods focused on a neighborhood center, integrated through open space and recreation areas and pedestrian, bike, transit, and the roadway system; c. Maximize connectivity of all transportation modes to enhance internal movement within and between individual neighborhoods within the master planning area, including appropriate connections to the regional circulation system; d. Provide neighborhoods with clearly defined edges and a center that provides a social focus for the residents, giving them an identity and a sense of place; f. Optimize the size of a neighborhood at a quarter mile from the center to the edge; g. Provide neighborhood entry roads that are designed and landscaped as entry statements, terminating at the neighborhood center or taking advantage of existing vistas; h. Base the neighborhood circulation system on a hierarchical network of streets, such as a spine road that provides primary access through the neighborhood, and secondary roads, decreasing in size/capacity, which provide multiple routes to diffuse traffic congestion and encourage pedestrian circulation; and i. Provide neighborhoods with a variety of housing types; and include in neighborhoods, a public space, such as a square or plaza/park area, and incorporate a transit stop as part of its design.
- (LT28.8.5) Support methods to conserve and enhance habitat when development occurs.
- (LT28.8.6) Support the development and management of healthy and attractive urban vegetation.
- (LT28.8.8) Support an accessible open space system that connects open space in the urbanized area to the surrounding public natural areas.
- (LT28.8.9) Support an interconnected open space system.
- (LT28.10) Support an interconnected urban trail system throughout the city to meet the recreational needs of pedestrians, bicyclists, and equestrians.

I.C.2 Houghton Area Master Plan (HAMP)

The Houghton Area Master Plan ("HAMP") encompasses approximately 10,800 acres of land along Houghton Road, establishing policies for growth and development within the area in accordance with Plan Tucson, see Exhibit I.5: Houghton Area Master Plan. HAMP establishes a "Desert Village" model, which promotes land use patterns that include Town Centers, Villages, Village Centers, Neighborhoods and Neighborhood Centers within the 10,800 acres. The "Desert Village" concept is based on the Town Center as a central organizing feature for a number of Villages. Village Centers support the Town Center and include clusters of many Neighborhoods. Each residential Neighborhood should include a Neighborhood Center that serves residents in their immediate areas. HAMP § III(C). Within the HAMP policies, the Property is designated as one of the residential Neighborhoods - "neighborhood/low density residential" - to support the overall Village and Town Center concept.

Exhibit I.5: Houghton Area Master Plan



As indicated in Section I.C above, PDSD staff has already completed a conceptual review of the proposed PAD development and concluded that is in compliance with HAMP, specifically noting the following (see Appendix B for the full PDSD memorandum):

1. The Project meets the density requirement of a minimum of four residential units per acre, and no more than eight units per acre.
2. The Project provides a Neighborhood Center – neighborhood park (5.85 acres).
3. The Project provides a variety of market-rate housing types, attached and detached single-family homes, potential townhomes and apartments.
4. The Project provides residential densities high enough to support mass transit usage and commercial activities, i.e. a bus stop at Drexel/Houghton, Civano commercial directly across Houghton Road.
5. The Project provides for a pedestrian and bike friendly environment, pedestrian linkages, natural open space areas that serve to define edges of neighborhoods, and trails and park, i.e. connection with Fantasy Island recreational bike paths.

Beyond the above particulars, below are the adopted HAMP values and goals that support, and which will be furthered by, the proposed PAD:

- **HAMP Fundamental Values:** 1. Providing a variety of housing types and densities, which offer both affordability and livability. 2. Promoting a mix of uses within a compact development pattern, which integrates places for people to live, work, shop, and play within a cohesive system of Neighborhoods and Village and Town Centers. 3. Supporting a transportation and circulation system that offers residents alternatives for mobility, giving high priority to pedestrian, bicycle, and transit modes. 4. Contributing to a regional open space system that preserves washes and environmentally sensitive areas as passive open space amenities, and offers active recreational opportunities such as trails and developed parks. 5. Providing a long-term, phased approach to development, in order to increase efficiency of infrastructure and services for residents.
- **Land Use Goal:** To establish a framework for development of Planned Communities in the HAMP area, while providing flexibility to accommodate demographic and economic changes that may occur over time.
- **Circulation and Mobility Goal:** To create an interconnected urban environment that avoids segregated and isolated land uses, and in doing so, provide mobility alternatives for residents in the area, including opportunities to walk, bicycle, or ride transit. Attractive design of the HAMP's travel ways and assurance of recreation and scenic linkages will be characteristic of the area's circulation and transportation system.
- **Environmental and Cultural Resources:** Establish a continuous and integrated system of open space.
- **Public Services, Facilities, and Utilities:** Ensure that adequate public facilities and services such as sewer, water, schools, roads, parks, fire and police protection are currently available or will be available concurrently in the future with any planned development. Identify opportunities for the efficient use of land through the identification of opportunities for shared-use and collocated facilities.

I.C.3 Proximity to Civano Master Planned Community

While having no regulatory authority over the Property, it makes sense to mention the proximity of the 818-acre Civano residential community. This is done not to suggest that the present PAD will attempt to emulate Civano, but to simply recognize that Civano was the first major residential development in the area that was driven by a wholly unique and innovative vision for housing in the Houghton Road corridor. This vision included various New Urbanism concepts and sustainability features, including a diverse housing mix, embedded community recreation areas and neighborhood-commercial uses, as well as an integrated open space and trails network.

In contemplating the development program for the subject Property, attention has been paid to many of the principles and elements that Civano employed. This PAD request hopes to seamlessly integrate into the overall fabric of the both the Houghton Area Master Plan (HAMP) and Civano by recognizing and building upon essential elements of these plans, such as housing product diversity, unique/flexible design standards, multi-use trails, connectivity, open space, landscape theming, multi-modal circulation, and preservation of natural wash and riparian corridors. All this being said, it is the intent of this PAD to also create a community with its own unique and distinct identity, one that will serve to maintain and heighten the high standards of innovation and quality that Civano helped establish.

I.D COMMUNITY ISSUES

This PAD will result in significant community benefits to the immediate area, the Houghton Road Corridor, and the City at large.

I.D.1 Benefits to the Community

The PAD will facilitate the following direct benefits to the community:

- It will demonstrate that the City of Tucson's auction & rezoning process constitutes a reliable and predictable path for private development;
- It will provide an important catalyst to further planning and development within the Houghton Road corridor and will set and help maintain a high standard of quality for this area;
- It will provide for the formal creation and regulatory protection of a portion of Fantasy Island Trails Park and the preservation, in perpetuity, of its associated open space corridors;
- It will provide for the permanent operation of the Southeast Houghton Area Recharge Project (SHARP) and establish the requisite entitlements for all of its potential/planned future uses;
- It will provide for recreational and trail opportunities to not only residents of the on-site Saguaro Trails community, but also to existing residents of the entire surrounding region;
- It will, together with the existing Civano, Sierra Morado, and Pavilions projects, create a critical mass of intensive development that will help energize the rest of the Houghton Road corridor and the Southeast Tucson region at large; and
- It will help further strengthen the housing and commercial markets within the larger Houghton Road corridor and, potentially, elevate the prospects of State Trust lands in the area being planned and brought to market for private development.

I.D.2 Public Participation & Outreach Program

So as to ensure substantive input and feedback as part of the rezoning process, this PAD effort has included on-going discussions and interactions with affected neighborhoods, leadership individuals and stakeholders, including the leadership that established and maintains Fantasy Island Trails Park. Prior to Mattamy purchasing its portion of the Property, the City of Tucson had already established a productive working relationship with the stakeholder groups in this area and involving the Property. This rezoning is the next logical step in the entitlement phase, and has continued the productive discussion, outreach and communication set forth by the City of Tucson. Throughout the interactions with the various groups, issues have been identified and addressed in good faith between the parties and are reflected within this PAD document. This outreach effort and the particular issues discussed are more fully described in Section III.A (Proposed PAD Overview) of this document.

II.

SITE ANALYSIS

II.A LAND USES AND EXISTING ZONING

The PAD is comprised primarily of vacant property, together with areas of established Fantasy Island bike trails and certain existing Tucson Water facilities. The site's physical and natural constraints to development are minimal. This Section provides a comprehensive analysis of the physical, cultural, and infrastructural aspects of the Property and its surroundings.

Exhibit I.2: Site Location shows the PAD Property within its surrounding context. While there is a substantial amount of vacant land throughout the area, there has also been significant nearby development within the Houghton Road corridor. This Section details both on-site and off-site land uses and characteristics, as well as applicable regulatory overlays.

II.A.1 On-Site Land Uses and Zoning

The entire PAD Property is currently zoned Suburban Ranch (SR), which requires residential development to be of the single-family variety and on large lots of minimum 3.3 acres (see Exhibit II.1: Existing Zoning). It also allows for limited institutional and non-residential uses, such as churches.

In terms of existing uses, the Property is primarily vacant. Approximately one hundred acres of it, however, contains the extensive Fantasy Island Trails Park (FITP) network of single-track mountain bike trails. While these trails wind throughout the Property, they are especially concentrated in and around the site's drainage corridors and riparian areas. In the southern portion of the PAD site, Tucson Water maintains numerous existing facilities, including a 4.5-million gallon reservoir, a series of transmission mains, a service building, and an existing well site. See Exhibit II.2: Existing Land Uses for the FITP trail locations and Tucson Water facilities.

Exhibit II.1: Existing Zoning

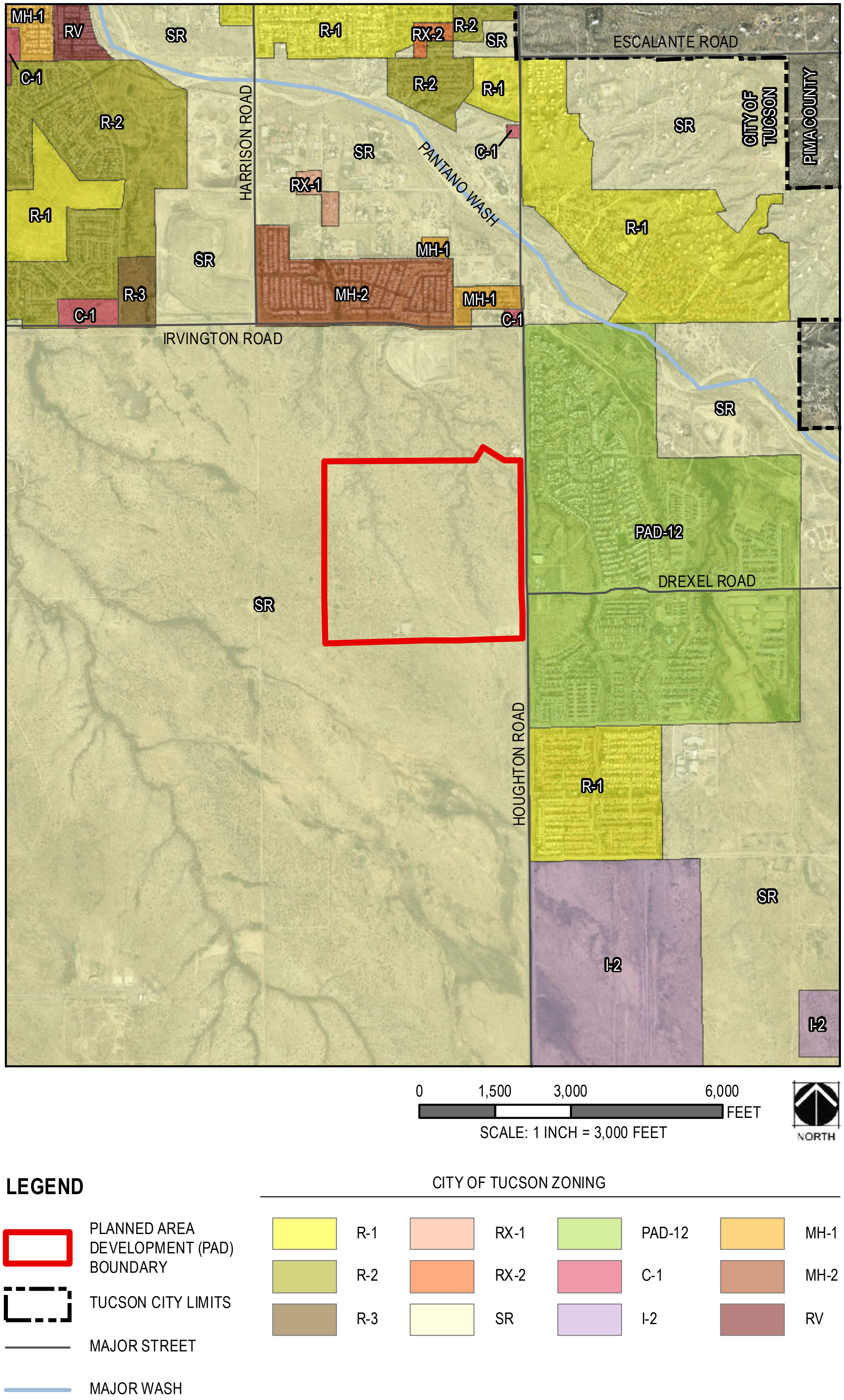
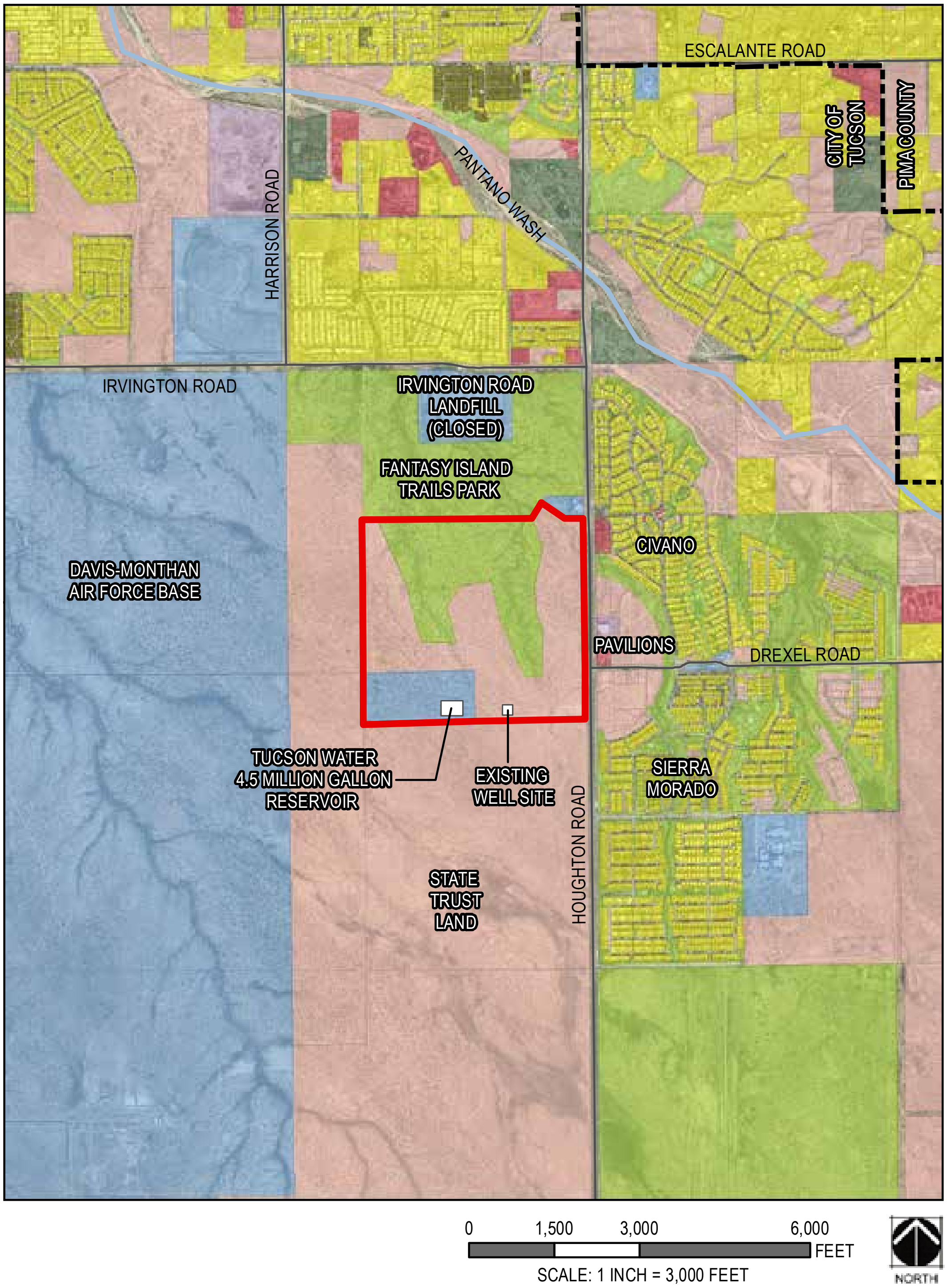


Exhibit II.2: Existing Land Uses



LEGEND

🟥 PLANNED AREA DEVELOPMENT (PAD) BOUNDARY

⬚ TUCSON CITY LIMITS

— MAJOR STREET

— MAJOR WASH

LAND USES

🟨 SINGLE FAMILY RESIDENTIAL

🟫 MULTI FAMILY RESIDENTIAL

▢ VACANT

🟩 OPEN SPACE

🟥 COMMERCIAL

🟦 INSTITUTIONAL

🟪 INDUSTRIAL

▨ AGRICULTURAL

II.A.2 Applicable Overlay Zones

The Houghton Area Master Plan (HAMP) is the City of Tucson area plan that governs the PAD site. HAMP was discussed in detail in Section I.C.2 of this PAD and that content will, as such, not be repeated here. The Planning and Development Services Department (PDSD) has already found the proposed PAD District to be in compliance with HAMP (see Appendix B for staff's plan compliance memorandum).

The only other relevant overlay zone pertains to Houghton Road's designation as a Scenic Route by the City's Major Streets and Routes Plan (MSRP). The Scenic Route designation establishes a four hundred (400) foot wide Scenic Corridor Zone (SCZ), which stipulates a variety of development restrictions affecting height, setbacks, and buffering. This PAD proposes certain modifications to the standard SCZ requirements. These are detailed in Section III (PAD District Proposal) of this document.

II.A.3 Off-Site Land Uses, Existing Zoning & Structures

The surrounding land use matrix is a combination of substantial vacant property and established residential and non-residential development. Exhibit II.1: Existing Zoning and Exhibit II.2: Existing Land Use provide an aerial photo representation of this mix; the following sections provide further narrative detail.

A. Civano, Sierra Morado, and The Pavilions

Civano, Sierra Morado and The Pavilions are all located across Houghton Road to the east and are administrated under the approved Civano Master PAD. The entire master PAD covers more than 250 acres and allows for the potential development of more than one thousand (1,000) residential units. Civano was the first major residential community in the immediate vicinity and established a benchmark for sustainable development, while also implementing creative approaches to streetscape and neighborhood design. Civano also provided for select commercial uses, including the existing Civano Nursery. Sierra Morado has followed Civano's lead and introduced its own variety of creative residential development, progressive housing options and specialized neighborhood features.

The Pavilions site provides for neighborhood-level commercial uses, offices, healthcare, and employment. Tucson Medical Center is currently under construction with a new multi-speciality clinic (TMC Rincon Medical Campus) here to furnish healthcare services to the surrounding east side region.

B. Fantasy Island Trails Park

While a portion of Fantasy Island Trails Park (FITP) exists within the proposed PAD Property, the FITP trails network extends significantly off-site (both to the north and to the south of the PAD site) onto adjacent State Trust Lands. A small paved parking lot has also been constructed on the south side of Irvington Road to provide a staging and access area for cycling enthusiasts.

C. State Trust Lands

To the immediate north, south and west of the PAD Property, nearly all of the adjacent vacant land is held by the Arizona State Land Trust. The Arizona State Land Department (ASLD) manages approximately 9.2 million acres of State Trust lands within Arizona. These lands were granted to the State under the provisions of the federal Enabling Act that provided for Arizona's statehood in 1912. These lands are held in trust, managed, and selectively brought to auction for the purpose of generating education revenues for the State.

These holdings will eventually be planned and brought to market for auction and development by ASLD. While the timing of these future planning efforts and sales cannot be predicted, it is worth noting that a comprehensive planning permit for these properties was initiated with ASLD by Macerich Companies in 2007. Significant planning work in this regard was completed before the permit was eventually withdrawn due to the national economic downturn of 2008.

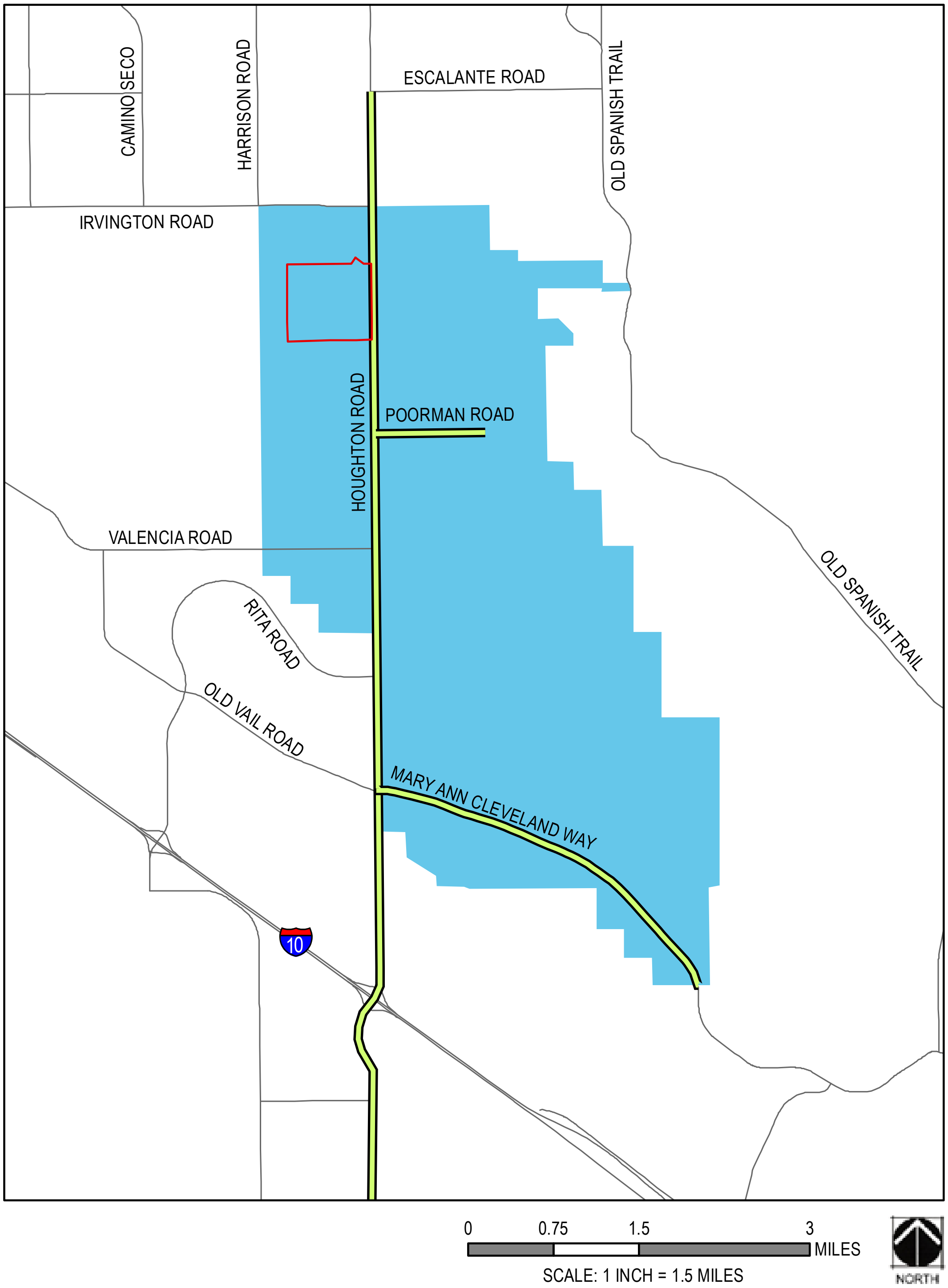
D. Davis-Monthan Air Force Base Operations

Davis–Monthan Air Force Base (DMAFB) is administered by the United States Air Force (USAF) and is approximately one-third of a mile west of the PAD Property. It is the home of the 355th Fighter Wing and its related squadrons, and is USAF's primary training base for the A-10 "Warthog" military aircraft. In addition to its active military function, the Base also conducts a variety of combat-mission and rescue training activities and is the location of the Air Force Material Command's 309th Aerospace Maintenance and Regeneration Group (AMARG), known locally and colloquially as "The Boneyard".

II.A.4 Natural and Built Constraints

The PAD Property has no significant natural or built constraints to development. Three gently sloping, wide, and generally flat-topped ridges provide excellent areas for the planned residential neighborhoods. The natural drainage/wash corridors which intervene between these ridges will generally be left in their current state, wherein they are used for the extensive network of existing Fantasy Island mountain-bike trails. The existing natural drainage conditions impacting the Property can be considered routine and manageable using conventional engineering and design solutions.

Exhibit II.3: Applicable Overlay Zones



LEGEND

☐ PLANNED AREA DEVELOPMENT (PAD) BOUNDARY

▨ HOUGHTON AREA MASTER PLAN (HAMP)

— MAJOR STREET

═ CITY OF TUCSON DESIGNATED SCENIC ROUTE

II.B Existing Educational and Community Resources & Public Services

Please see Exhibit II.4: Existing Educational, Community & Cultural Resources for a graphic depiction of the various public and community resources discussed in this Section of the PAD.

II.B.1 Vail Public School District Facilities & Capacity Consideration

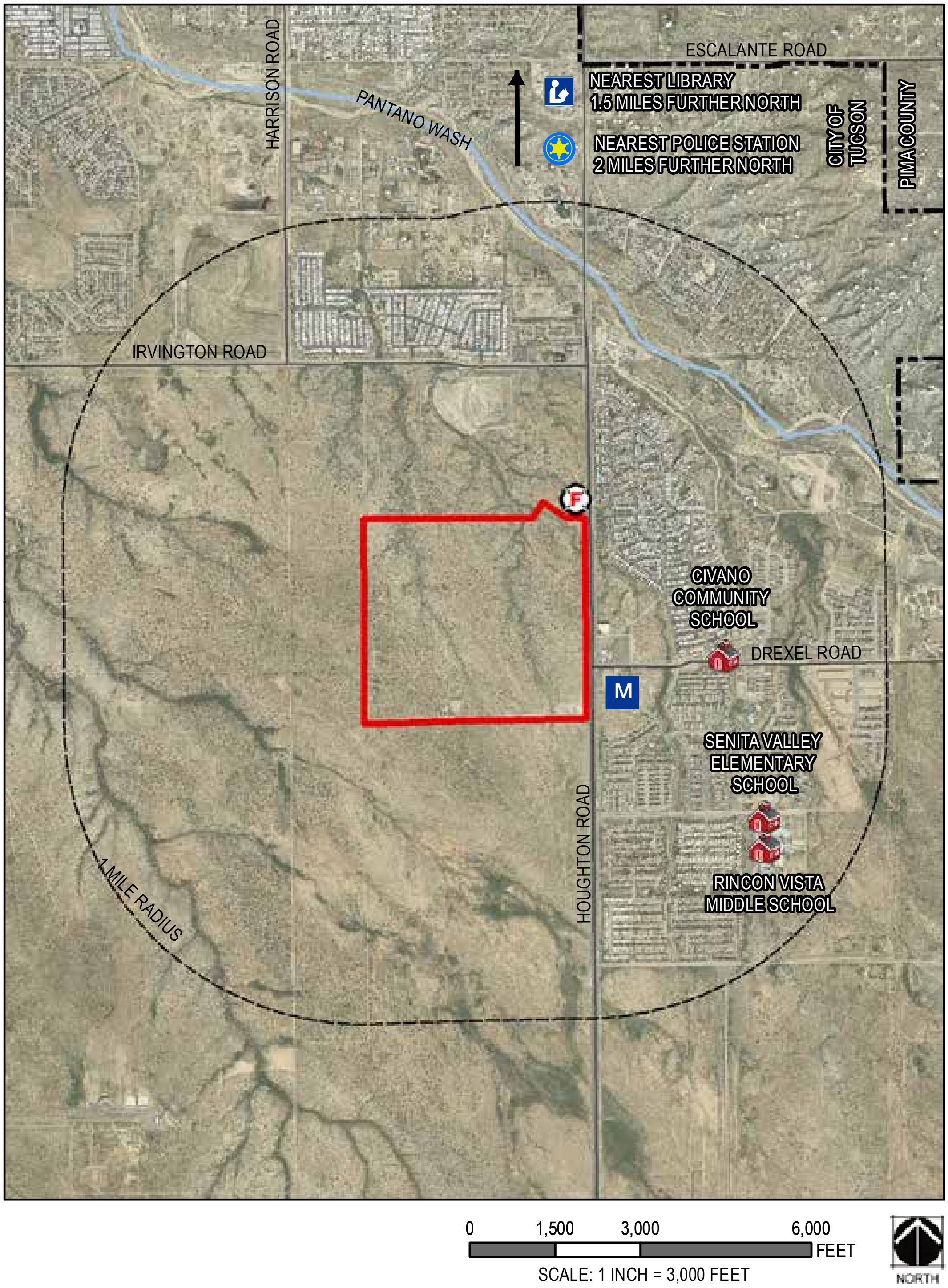
The PAD Property is located within Vail Unified School District No. 20 (VUSD). The District operates two (2) preschools, ten (10) elementary schools, seven (7) middle schools, and four (4) high schools, as well as the Vail Academy & High School (a K-12 facility) and the Vail Digital Learning Program (a Grade 6-12 online education center), see Table II.1 for enrollment data.

The closest VUSD school to the PAD site is the Civano Community K-8 School, located on Drexel Road east of Houghton Road. Two other VUSD schools are located within one (1) mile of the PAD site: Senita Valley Elementary School and Rincon Vista Middle School. There are no high schools within one (1) mile of the property. The nearest one is Empire High School, located approximately four (4) miles south of the PAD site on Mary Ann Cleveland Way, just east of Houghton Road.

Table II.1: 2016/2017 Vail School District Enrollment

SCHOOL	2016/2017 ENROLLMENT	SCHOOL CAPACITY
Civano Community K-8 School	112	125
Senita Valley Elementary	706	600
Rincon Vista Middle School	664	650
Empire High School	825	750

Exhibit II.4: Existing Educational, Community & Cultural Resources



LEGEND

- 🟥 PLANNED AREA DEVELOPMENT (PAD) BOUNDARY
- ▭ TUCSON CITY LIMITS
- ▭ 1 MILE RADIUS
- — MAJOR STREET
- — MAJOR WASH
- F FIRE STATION
- ★ POLICE STATION
- M PROPOSED TMC RINCON MEDICAL CAMPUS (UNDER CONSTRUCTION)
- SCHOOL
- LIBRARY

II.B.2 Libraries

There are no libraries with one (1) mile of the subject property. The closest facility is the Golf Links Library branch at 9640 E. Golf Links Road, approximately three (3) miles north of the Property.

II.B.3 Health Care Facilities

There are no existing health care facilities located within one (1) mile of the property. The closest health care operations are: 1) the Northwest Emergency Center at 10146 E Old Vail Road, just west of Houghton Road and approximately four (4) miles south of the PAD site; and 2) the East Side Health Center at 8181 E. Irvington Road, approximately three and one-half (3.5) miles west of the Property. Tucson Medical Center (TMC) has purchased a significant portion of The Pavilions property located immediately east of the PAD site on the east side of Houghton Road. Construction is underway on their multi-speciality clinic there (TMC Rincon Medical Campus).

II.B.4 Fire/Emergency/Law Enforcement

Fire protection and emergency-response services are provided by the City of Tucson. Fire Station No. 17 is located immediately adjacent to the northeast corner of the PAD site at 5270 S. Houghton Road. The City of Tucson will provide police and law enforcement services to the Property. There is no existing police station within a one (1) mile radius of the site. The closest police station is the Tucson Rincon Substation located at 9670 E. Golf Links Road, approximately four (4) miles northwest of the property.

II.C EXISTING OPEN SPACE, RECREATION & TRAILS

There are significant open spaces and recreational & trail facilities that exist both on-site and in the immediate vicinity of the PAD. Further detail is provided in the following sub-sections.

II.C.1 Existing On-Site Open Space & Trails

A. Fantasy Island Trails Park (FITP)

Fantasy Island Trails Park (FITP) comprises a total of over 300 acres of trails, with 106 acres occurring on-site and nearly 200 acres off-site on State Trust lands to the north and west of the PAD. The FITP mountain bike trail system exists primarily within the Mesquite Ranch and Harrison Hills Wash corridors, also wrapping around the City of Tucson's closed Irvington Road Solid Waste Landfill site, and extending northward to its existing paved parking lot and public Park entrance on Irvington Road. As mentioned earlier in this document, that portion of FITP located within the PAD was ultimately formalized by the Mayor & Council with its adoption of the Master Plan for Fantasy Island Trails Park (FITP) in 2006. This PAD will serve as the entitlement vehicle that implements a portion of this Master Plan and establishes the final boundaries, uses and regulatory criteria for this particular portion of FITP.

B. Existing FITP Encroachments into Proposed PAD Planning & Residential Areas

The great majority of the existing FITP single-track trail system will be retained in its present configuration. Because certain existing trails encroach into the proposed residential and neighborhood-center areas of the PAD, new linkages will be provided as appropriate to ensure overall FITP system connectivity. In some instances, existing trail segments traverse proposed residential areas and will be eliminated. Section III (PAD District Proposal) of this document provides further detail as to the manner in which FITP trail connectivity will be ensured; Exhibit III.7: Fantasy Island Comprehensive Trails Map therein illustrates the existing FITP trails which will be modified.

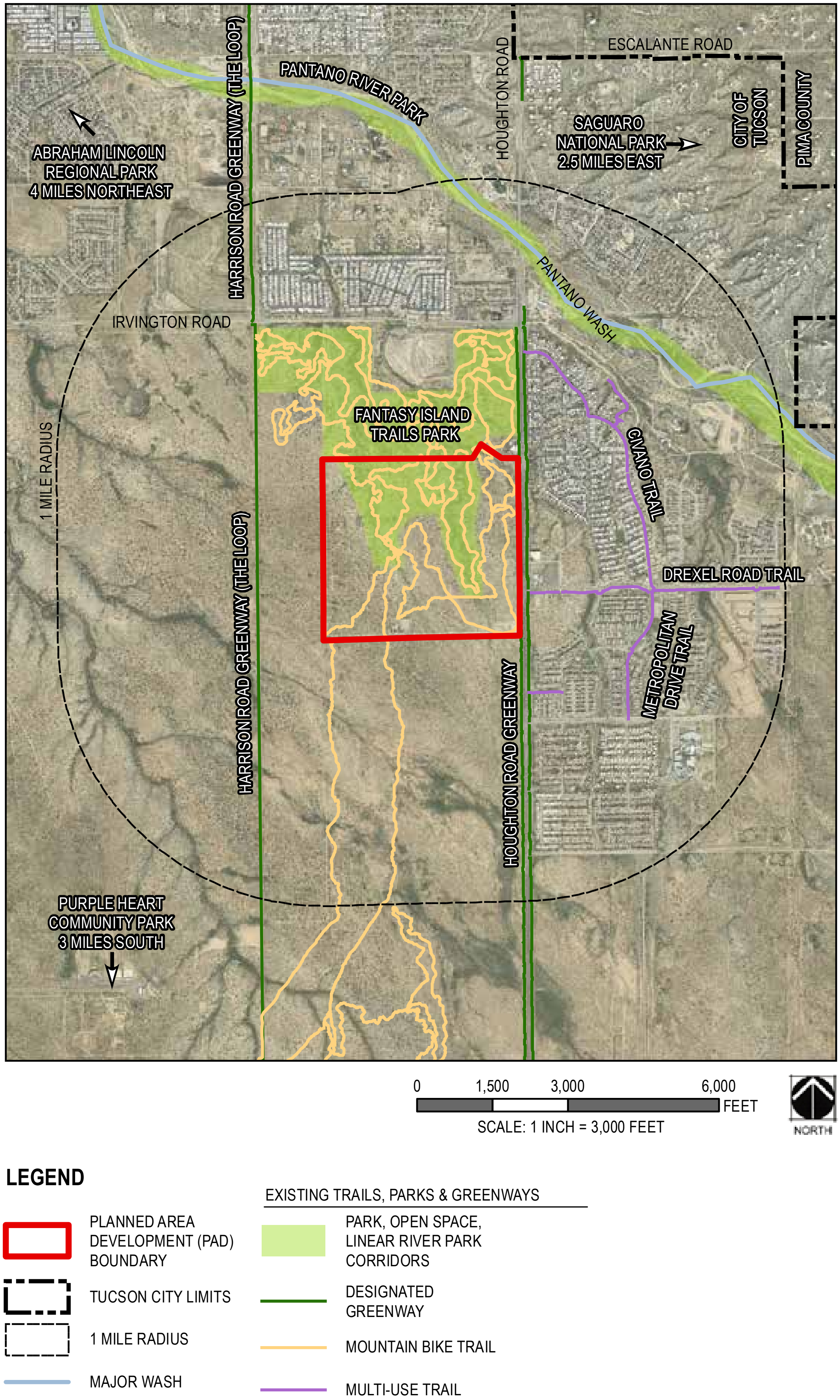
II.C.2 Off-Site Recreation & Trails

The off-site trails discussed below have been illustrated on Exhibit II.5: Off-Site Recreation and Trails.

A. Houghton Road Multi-Use Trail

The Houghton Road Greenway exists on both sides of the roadway and adjoins the PAD along its entire east boundary. This trail system is comprised of a twelve (12) foot wide, paved meandering path on the east side of Houghton Road, together with a six (6) foot sidewalk on the west side of the road. Continuous striped bike lanes also exist, in both directions, within the actual roadway prism. These multi-use trail improvements currently exist from Irvington Road southward to Valencia Road. The ultimate Houghton Road improvements include the same trail elements and pavement cross-section being constructed from Interstate 10 northward to Tanque Verde Road; this ultimate condition will be achieved in several planned phases coordinated by the Tucson Department of Transportation (TDOT) and the Regional Transportation Authority (RTA).

Exhibit II.5: Off-Site Recreation and Trails



B. The Loop Regional Trail

The Pima County Department of Natural Resources, Parks and Recreation (PCDNRPR) has been actively implementing a regional trail system, formally named "The Loop" to provide comprehensive trail connectivity throughout the entire Tucson metropolitan area. Nearly one hundred (100) miles of shared-use paths have already been completed and segments are in place within Marana, Oro Valley, the City of South Tucson, and the City of Tucson proper. When fully completed, The Loop will comprise approximately 130 miles of trails and provide comprehensive regionally connectivity with the Pima County Riverpark trail network, including the Rillito Riverpark, Santa Cruz Riverpark, Pantano Riverpark and the Julian Wash. The portion of The Loop known as the Harrison Greenway is located approximately 1/3 of mile west of the PAD, running in a north/south alignment through adjacent State Trust Lands.

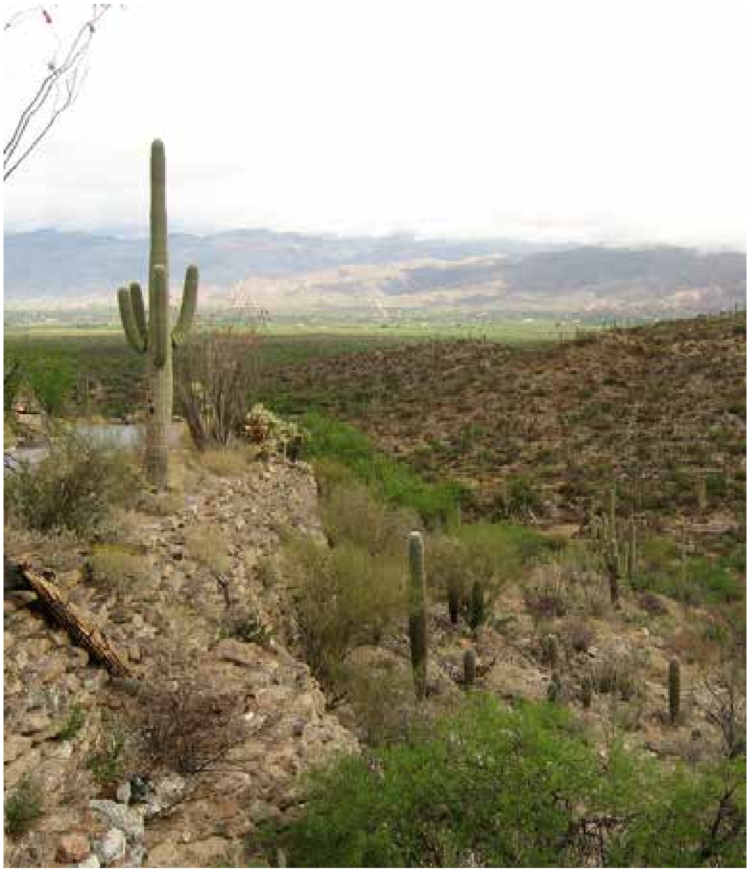
II.C.3 Off-Site Public & Neighborhood Parks

Due to the large amount of vacant and undeveloped land within the Houghton Road corridor between Irvington Road and Valencia Road, relatively few public or neighborhood parks exist in the immediate vicinity. See Exhibit II.5: Off-site Recreation and Trails for the parks discussed below.

Abraham Lincoln Regional Park is the closest public park to the site, being located at 4325 S. Pantano Road, approximately four (4) miles northwest of the PAD site. This regional park possesses a significant natural-desert component and totals approximately 190 acres in area. Developed recreational amenities include a four-field softball complex with concession stands, a swimming pool, multiple soccer fields, and a paved walking path (approximately ½-mile in length). The Park also includes ramadas, a childrens playground, four (4) sand volleyball courts, and is the home of the Atturbury Bird & Animal Sanctuary.

Approximately three (3) miles south of the PAD Property, within the Rita Ranch neighborhood, lies Purple Heart Community Park at 9800 E. Rita Road. This is a smaller, neighborhood-level park and includes a childrens playground, restroom facilities, ballfields, a dog park, and community pool.

Saguaro National Park (SNP) - East District lies approximately 2.5 miles east of the PAD site. SNP began its existence as Saguaro National Monument in 1933 and was elevated to national park status by Congress in 1994. The Park is comprised of two separate districts (East and West), each with its own visitors center and, in total, encompassing more than 90,000 acres of saguaro forest (more than 70,000 acres of which is also designated federal wilderness area) and providing more than 165 miles of hiking trails.



II.D EXISTING TRANSPORTATION & CIRCULATION

II.D.1 Relevant Public Streets

The following streets are pertinent to the PAD and have been illustrated on Exhibit II.6: Relevant Public Streets and summarized in Table II.2: Existing Roadways Adjacent to the PAD District.

A. Houghton Road

Houghton Road is the primary transportation artery for the entire eastside region and is directly adjacent to the PAD site. It provides three (3) travel lanes in each direction, curb and gutter on both sides, a raised median, and has a posted speed limit of 45 miles per hour (MPH). A sidewalk is in place along the west side of the street, while a two-way, paved multi-use path parallels the east side. Striped bike lanes are in place within the roadway prism in both the northbound and southbound directions. Houghton Road provides direct access to Interstate 10 (approximately six [6] miles south of the PAD site), as well as to all points north within the eastern metropolitan area.

B. Drexel Road

Drexel Road currently only exists east of Houghton Road, providing two (2) travel lanes in each direction, with curb and gutter on both sides, and a two-way/continuous center left turn lane. It has a posted speed limit of 25 MPH. The north side of the street is paralleled by a concrete sidewalk, while the south side is bordered by a paved multi-use/greenway path. This segment of Drexel Road extends approximately one (1) mile east of Houghton Road and primarily provides access to the existing residential communities and planned commercial node (The Pavilions) in the area.

C. Irvington Road

Irvington Road lies approximately one (1) mile north of the PAD site and is a two-lane roadway that extends west from Houghton Road; its paving terminates approximately two hundred and fifty (250) feet east of the Houghton Road intersection. West of Houghton Road, Irvington Road is a two-lane street with a posted speed limit of 45 MPH during daytime hours and 40 MPH during night time hours. Curb, gutter and sidewalk facilities are provided along the north side of this segment of the street, with only a dirt shoulder on the south side.

D. Valencia Road

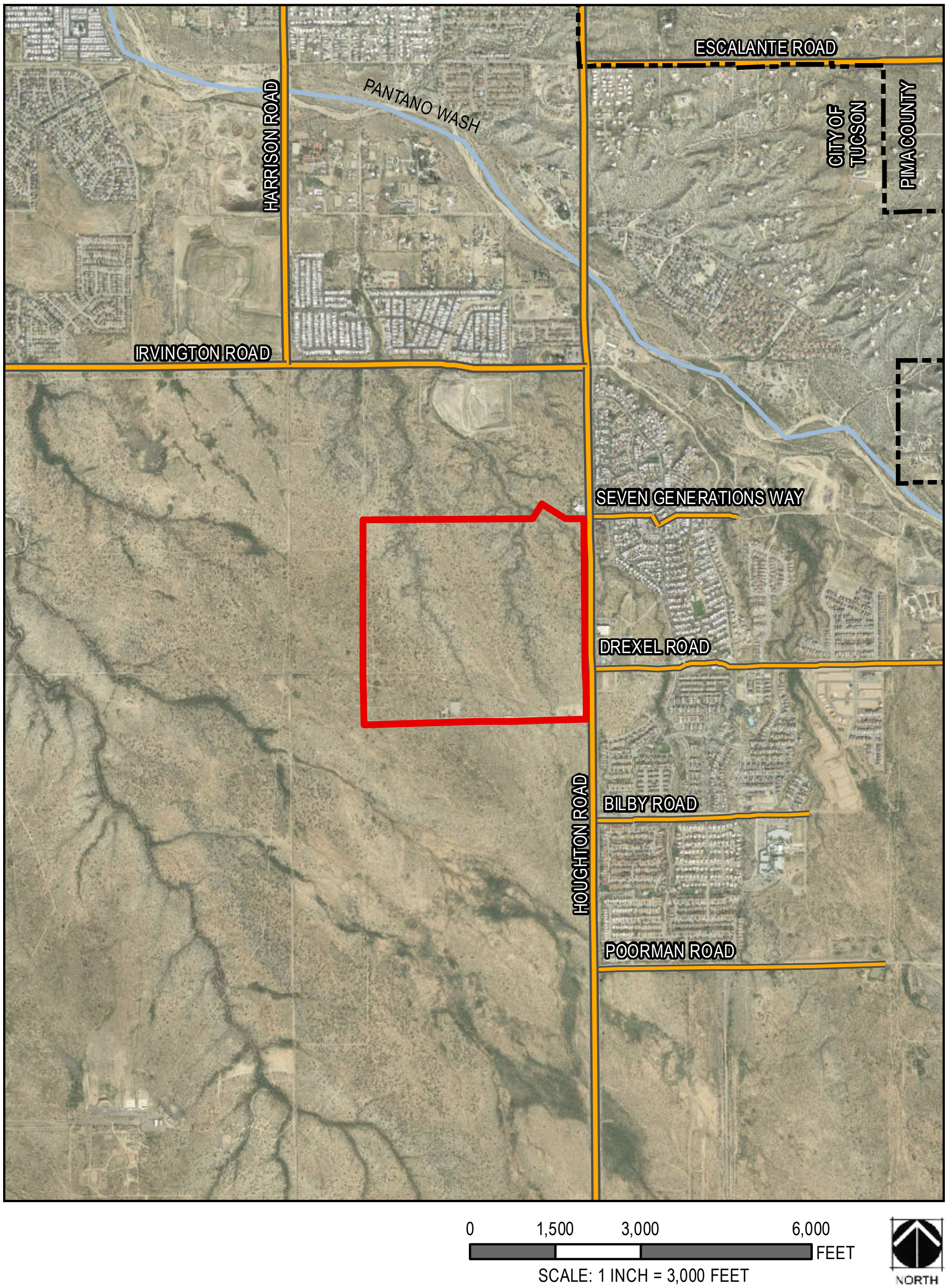
Valencia Road has an east/west alignment and is located approximately two (2) miles south of the PAD and is an undivided, two-lane roadway in that location. West of Houghton Road, Valencia Road has a posted speed limit of 45 MPH. The posted speed limit east of Houghton Road is 25 MPH, with the paved roadway terminating approximately 1.75 miles to the east.

E. Local/Neighborhood Streets

The following local streets are relevant to the PAD:

- Bilby Road: Extending approximately one (1) mile east of Houghton Road with an east-west alignment, Bilby Road provides access to several existing residential subdivisions. It is a four-lane roadway with a raised median. Striped bike lanes, sidewalks, and curb & gutter are in place in each direction.
- Seven Generations Way: Seven Generations Way has an east-west alignment and is the primary boulevard into the Civano community. The roadway has a two-lane cross-section, separated by a raised median. Curb, gutter and sidewalk facilities are in place on both sides of the street. It has a posted speed limit of 25 MPH, with on-street parking being allowed on both sides of the roadway.

Exhibit II.6: Relevant Public Streets



LEGEND

🟥 PLANNED AREA DEVELOPMENT (PAD) BOUNDARY

⬚ TUCSON CITY LIMITS

▬ MAJOR STREET

▬ MAJOR WASH

Table II.2: Existing Roadways Adjacent to the PAD District

STREET NAME	HOUGHTON ROAD	BILBY ROAD	SEVEN GENERATIONS WAY	DREXEL ROAD	IRVINGTON ROAD
Functional Classification	Principal Arterial	Future Arterial	Minor Collector	Minor Collector	Principal Arterial
Existing R.O.W.	200’	90’	50’-80’	80’	
Future R.O.W.	200’	90’	None	80’	120’
Travel Lanes	6	4-2	2	4-2	3-2
Speed Limit	45 MPH	25 MPH	25 MPH	25 MPH	45 MPH
ADT	14,300	N/A	N/A	N/A	
Bicycle Lanes	Dedicated both directions	Yes	Yes	Yes	Yes
Pedestrian Ways	6-12’ multi-use path	Yes	Yes	Yes	No
Ownership	COT	COT	COT	COT	COT
Program for Improvement	Yes (Capital Improvement Program)	No	No	No	No

II.D.2 Major Streets & Routes Considerations

Houghton Road is a dedicated Scenic Route per the City of Tucson’s adopted Major Streets and Routes Plan (MSRP); see Exhibit II.7: Major Streets and Scenic Routes. This Scenic Route designation triggers a regulatory Scenic Corridor Zone (SCZ), which places certain development restrictions along that portion of the PAD which directly fronts Houghton Road.

II.D.3 Public Transportation Components

Public transportation is somewhat limited in the general vicinity surrounding the PAD, but the elements discussed below are relevant (see Exhibit II.8: Sun Tran Bus Routes and Shuttle Service).

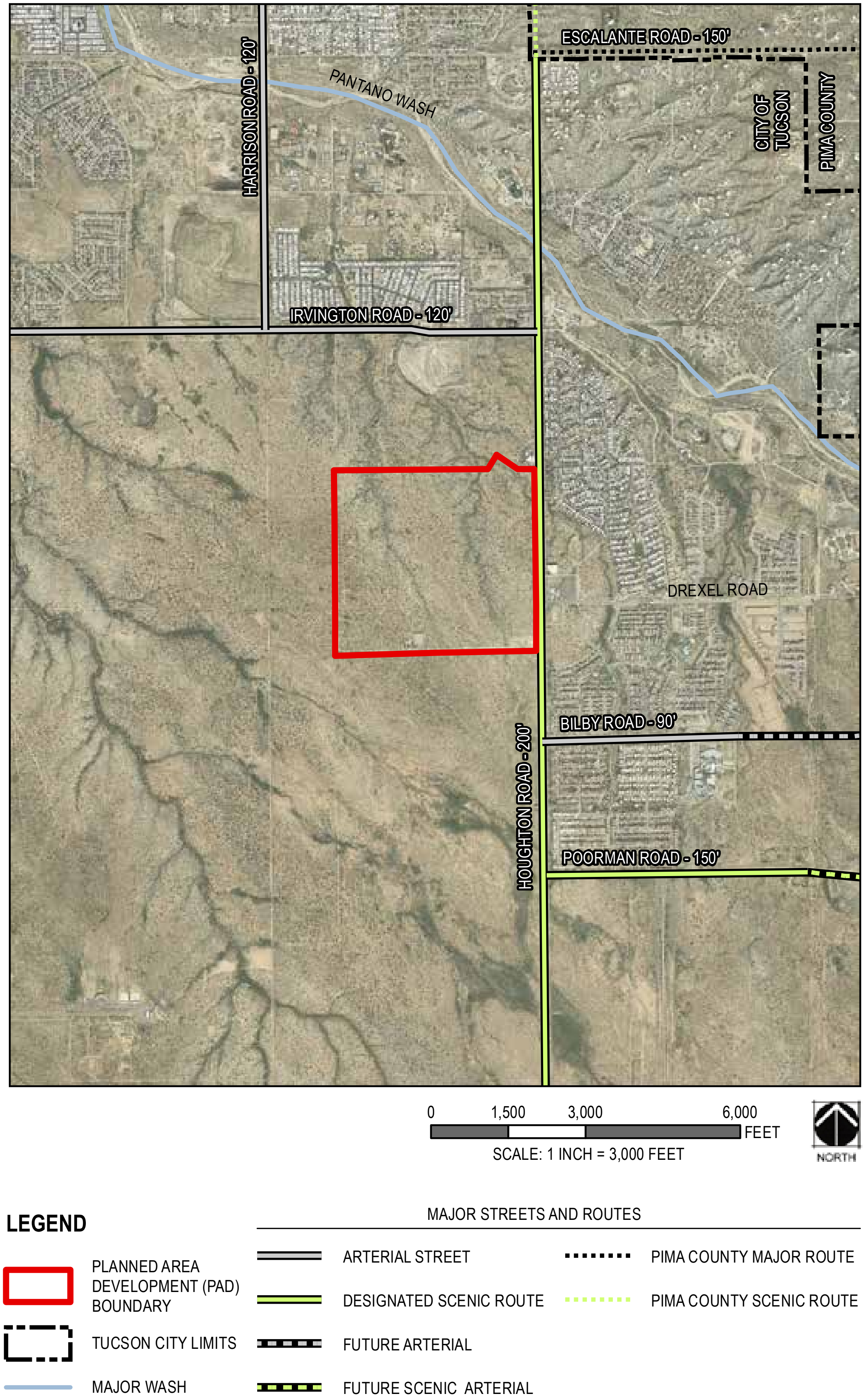
A. Sun Tran Bus Routes & Shuttle Service

The PAD site is served by Sun Shuttle Route No. 450, which runs within the Houghton Road corridor and provides transit service to Rita Ranch, the Civano/Sierra Morado community, and points further to the north and west (e.g. the Pima Community College [PCC] East Campus). Two (2) bus pullouts are located on Houghton Road to the immediate north and south of Drexel Road. There are no Park & Ride sites in the near vicinity of the PAD, with the closest ones being in Rita Ranch (approximately four [4] miles to the south) and at the PCC East campus (approximately three [3] miles to the north and west).

B. Existing & Planned Bike Routes

Houghton Road is one of the primary vehicular corridors within the overall metropolitan transportation system. However, as alluded to previously, recent roadway improvements have introduced significant bike route segments into the area (see Exhibit II.9: Existing Bike Routes and Trails). A multi-use trail system now exists on both sides of the roadway and adjoins the PAD along its entire east boundary. This trail system is comprised of a twelve (12) foot wide, paved meandering path on the east side of Houghton Road, together with a six (6) foot sidewalk on the west side of the road. Continuous striped bike lanes also exist, in both directions, within the actual roadway prism. These multi-use trail improvements currently exist from Irvington Road southward to Valencia Road. The ultimate Houghton Road improvements include the same trail elements and bike paths being constructed, in conjunction with future roadway widenings, from Interstate 10 northward to Tanque Verde Road. This ultimate condition will be achieved in several planned phases coordinated by the Tucson Department of Transportation (TDOT) and the Regional Transportation Authority (RTA).

Exhibit II.7: Major Streets and Scenic Routes



NOTE: REQUIRED M.S.R.P. ULTIMATE R.O.W. WIDTHS FOR EACH STREET ARE SHOWN IN NUMERALS (E.G. 150')

Exhibit II.8: Sun Tran Bus Routes and Shuttle Service

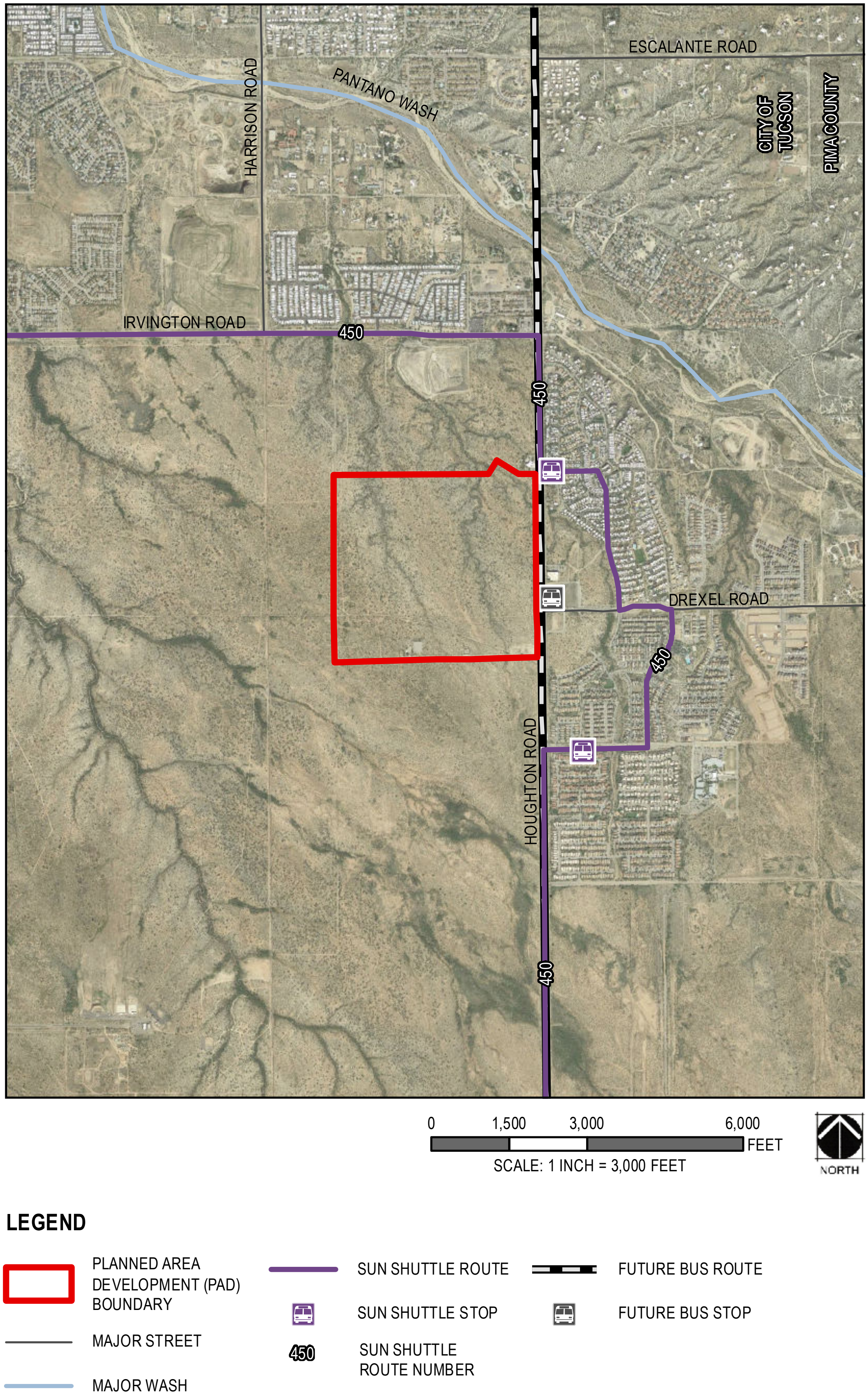
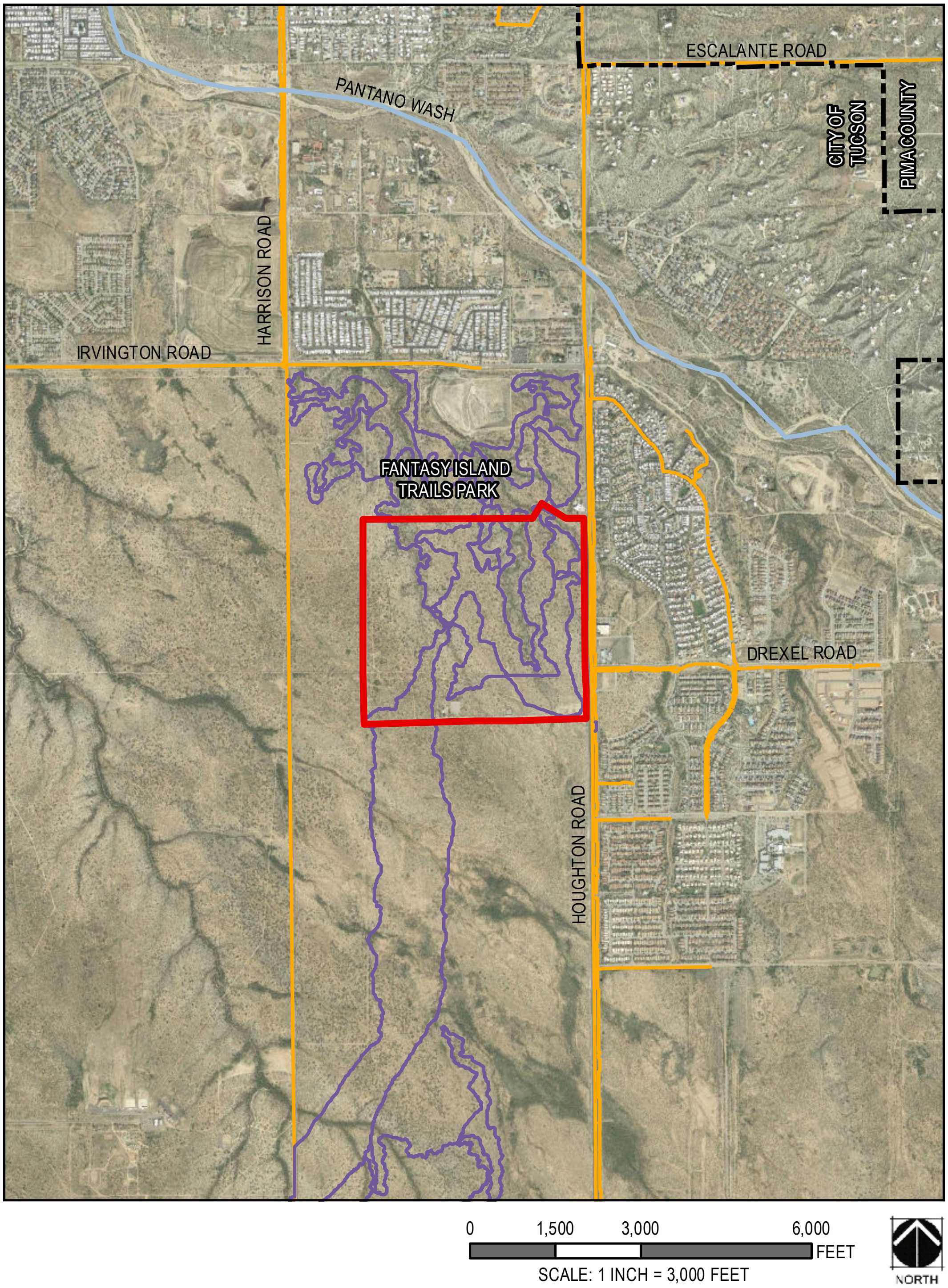


Exhibit II.9: Existing Bike Routes and Trails



LEGEND

🟥 PLANNED AREA DEVELOPMENT (PAD) BOUNDARY

▭ TUCSON CITY LIMITS

— MAJOR WASH

— EXISTING PUBLICLY DEDICATED BICYCLE ROUTE

— EXISTING MOUNTAIN BIKE TRAIL

II.E EXISTING UTILITY INFRASTRUCTURE

Significant, project-convenient infrastructure already exists within the vicinity of the PAD. The Sections below provide detail as to these infrastructural components.

II.E.1 Existing Utilities

Exhibits II.10 and II.11 show the location of the various utilities that are addressed in Sub-section II.E.1.A through II.E.1.E below.

A. Public & Private Sewer

Existing public sewer mains are located within the Civano community, east of Houghton Road, and at Irvington Road approximately one-half mile to the north. The existing 8" & 12" sewer main directly to the east within Civano does not have adequate capacity to accept flows from the PAD, but the same main does acquire sufficient capacity further to the north, where it is upsized to 21" near the intersection of Houghton and Irvington Roads. There is also an existing 15" sewer main extending northward from Irvington Road, approximately one-half mile directly north of the PAD site's northwestern most corner; this line possesses sufficient capacity to accommodate the proposed PAD development. The intervening land between the PAD Property and this 15" main is undeveloped and is part of the Arizona State Land Trust. An easement from Arizona State Land Department (ASLD) would be required to construct a public sewer connection from the PAD to the aforementioned 15" sewer main.

B. Potable Water

The project is within Tucson Water's franchise/service area and falls within its designated "F" zone; no pressure boundaries are involved. An existing Tucson Water 12" potable water main is in place on the east side of Houghton Road. Tucson Water also operates an existing well site within the PAD Property near its southern boundary, as well as maintains a 4.5-million gallon reservoir within the southwestern quadrant of the PAD property.

C. Reclaimed Water

The southwestern forty (40) acres of the PAD is the designated site of Tucson Water's Southeast Houghton Area Recharge Project (SHARP). This facility envisions multiple recharge basins and is also fed by a 30" reclaimed water pipeline which runs southward from Irvington Road along the entire west boundary of the PAD Property.

D. Solid Waste Disposal

The City of Tucson Department of Environmental Services (DES) is responsible for all solid waste collection within the City limits. DES provides single-family households with roll-off containers and refuse and recycling collection services once each week. The closest active pubic landfill to the PAD is the Los Reales landfill, located approximately seven (7) miles to the southwest.

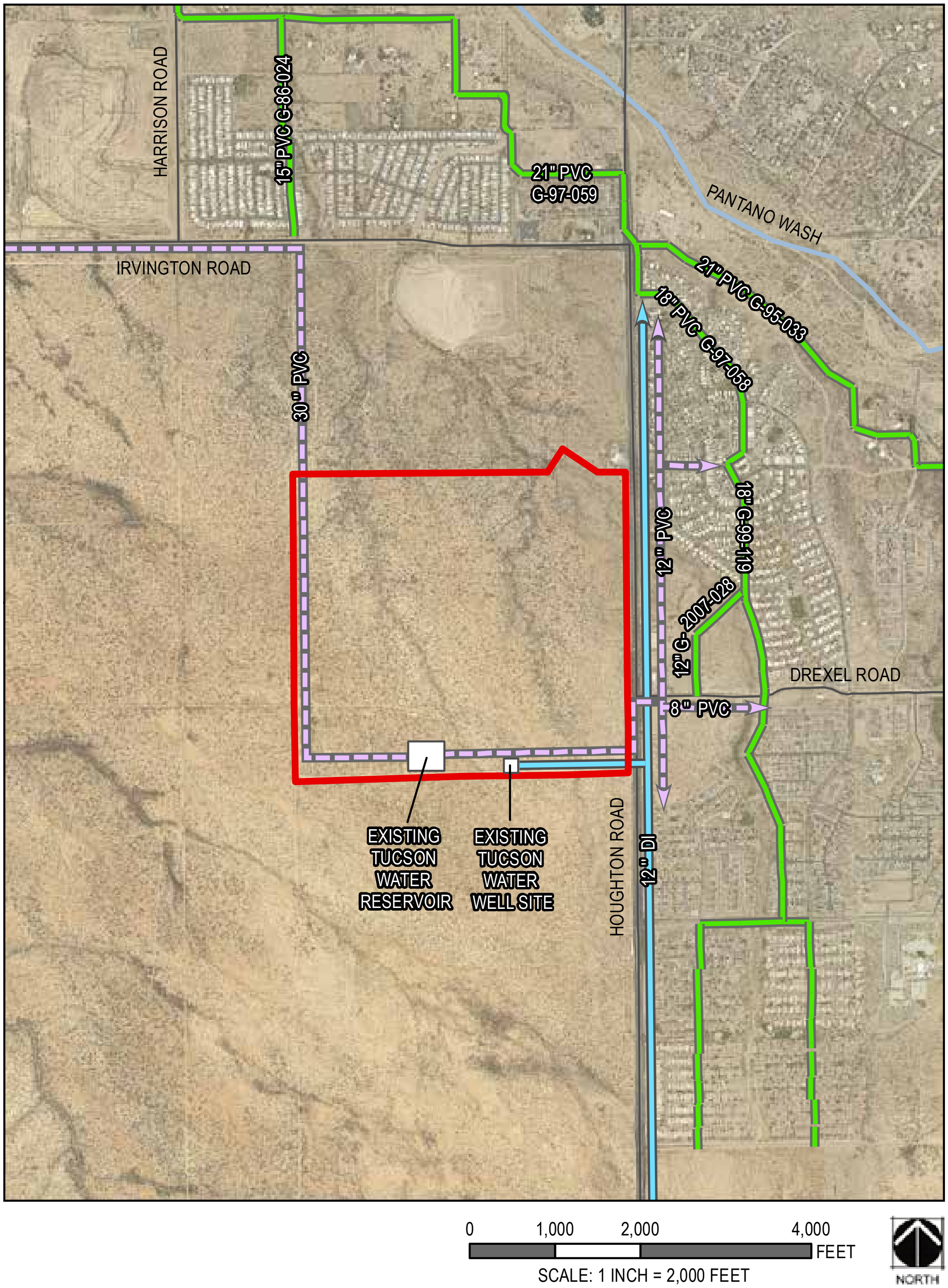
E. Gas And Electric

Southwest Gas has an existing 6" steel natural gas main on the east side of Houghton Road and a 12" high pressure line on the west side of Houghton Road. Both extend well beyond the limits of the PAD and facilitate natural gas service throughout the surrounding area. Tucson Electric Power (TEP) has an existing subsurface line on the east side of Houghton Road, as well as a secondary subsurface line along the south boundary of the PAD site. Initial discussions with TEP indicate that a new feeder line will also likely be required to service the PAD site, entering it somewhere near its northwest corner.

II.E.2 Overall Project Serviceability

Initial discussions with all servicing utility providers and public agencies have indicated that each has the ability to serve the PAD and its anticipated development density. While it is clear that various augmentations and/or off-site improvements will be necessary to do so, all of these can be considered routine from an engineering perspective (see Appendix C for will-serve letters).

Exhibit II.10: Existing Water and Sewer Utilities



LEGEND

🟥 PLANNED AREA DEVELOPMENT (PAD) BOUNDARY

— MAJOR STREET

— MAJOR WASH

— POTABLE WATER MAIN LINE

- - - RECLAIMED WATER MAIN LINE

— SEWER MAIN LINE

Exhibit II.11: Existing Electricity and Natural Gas Utilities

II.F ENVIRONMENTAL FACTORS

II.F.1 Topography

The PAD Property is primarily comprised of three, generally flat-topped ridgelines that diagonally traverse the site, sloping downward from southeast-to-northwest. The longitudinal slope along the ridges varies from less than one percent (1%) to approximately 1.6%. Natural wash corridors intervene between the ridges, and the cross-slopes from the ridgelines down to the adjacent wash flow lines are slightly steeper, falling between three percent (3%) and nine percent (9%). Given the configuration of the City-retained property for Fantasy Island Trails Park (FITP), the majority of these steeper slopes occur primarily within the City-owned FITP acreage.

There are only a small number of slopes, confined to limited areas on the site, that exceed fifteen percent (15%); all of these are in the extreme northeast corner of the PAD Property or within the FITP wash corridors. These constitute no limitation to the proposed residential development of the PAD site as intended and are shown on Exhibit II.12: Topography and Slope.

Average cross-slope calculations have been provided in Table II.3: Average Cross Slope Calculations for all sectors of the PAD District (i.e. the portions owned, respectively, by Mattamy Homes, the City, and Tucson Water) utilizing the following formula:

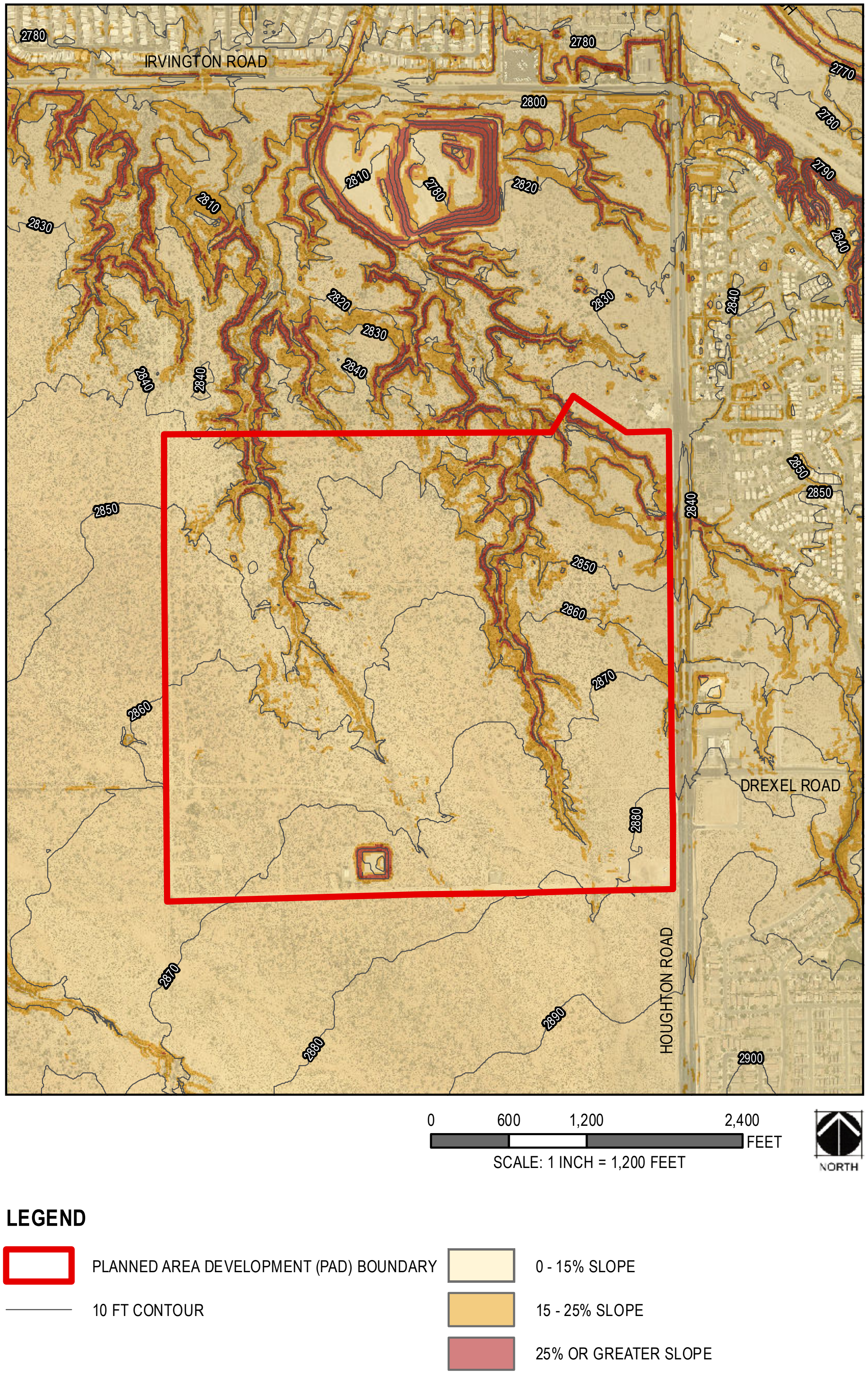
$$\text{Average Cross Slope} = \frac{I \times L \times .0023}{A}$$

Where:
I = Contour Interval in Feet
L = Total Combined Length of all Contours in Feet
0.0023 = Conversion Factor for Feet to Acres Times 100
A = Total Area of Site in Acres

Table II.3: Average Cross Slope Calculations

PROPERTY	I (CONTOUR INTERVAL IN FEET)	L (CONTOUR LENGTH IN FEET)	A (PROPERTY AREA IN ACRES)	AVERAGE CROSS SLOPE
Saguaro Trails Property	2	175,500	173.40	4.65%
FITP	2	178,846	105.62	7.79%
SHARP Property	2	37,453	39.92	4.31%
Total PAD Property	**2**	**391,799**	**318.94**	**5.65%**

Exhibit II.12: Topography and Slope



II.F.2 Existing Drainage Patterns & Site Hydrology

The off-site and on-site drainage characteristics of the PAD are discussed below.

A. On-Site Characteristics

The PAD Property is largely undeveloped in its present state, with the exception of the Fantasy Island bike-trail network, an existing Tucson Water (TW) well site, and TW's 4.5-million gallon reservoir. Outside of these established uses, the great majority of the Property is characterized by native desert vegetation typical of the region. The three (3) existing washes that traverse the site (mentioned in Section II.F.1), are largely confined to the corridors being retained by the City of Tucson for Fantasy Island Trails Park (FITP) and will, therefore, be minimally impacted by the proposed PAD development. Designated Xeroriparian Class "C" habitat zones coincide with all three of the on-site washes, as do Zone "A" FEMA flood hazard areas per FEMA FIRM Panel No. 04019C2320L, June 15, 2011 (see Exhibit II.13: Existing Drainage Patterns & Site Hydrology). Applicable erosion hazard setbacks (EHS's) for the on-site washes will be determined in conjunction with a formal drainage report submitted with the tentative plat for each phase of development. All EHS's are subject to City review and approval and shall be calculated in accordance with City of Tucson Technical Standards Manual, Section 4.04, Chapter 7.

B. Off-Site Characteristics and Downstream Issues

Three (3) off-site watersheds impact the Property (see Exhibit II.14: Pre-Development Hydrology and Off-Site Drainage); 1) the Harrison Hills Wash (Watershed A) being the westernmost; 2) the Mesquite Ranch Wash (Watershed C) traversing the Property's northeast corner; and 3) an unnamed wash, which is the central of the three (Watershed B) and which is tributary to the Mesquite Ranch Wash.

Watersheds A & B (annotated as WS-A and WS-B on the Exhibit II.14) extend southward and eastward, approximately one (1) mile beyond the southern boundary of the PAD Property, to their respective headwaters. Watershed B is the larger of the two (encompassing approximately 128 acres) and extends eastward across Houghton Road; Watershed A is approximately 70 acres in size. These two watersheds are generally undeveloped except for a residential subdivision at the headwaters of Watershed B. The remaining areas within Watersheds A&B are natural, containing desert vegetation typical of the area.

The Mesquite Ranch Wash Watershed (WS-C) extends approximately two (2) miles southeastward from the PAD's eastern boundary, beginning at a point just south of Seven Generations Way. Its headwaters are located at the northern portion of an old drag strip near the southeast corner of Houghton Road and Poorman Road. WS-C encompasses approximately 348 acres, with nearly 90% of it being existing residential development.

These three off-site watersheds, when fully developed upstream of the PAD site, will produce 100-year peak discharges as shown in Table II.4: Off-Site Watershed Discharge.

The area downstream of the PAD Property is undeveloped, natural desert and is held by the Arizona State Land Trust. There is also an area adjacent to Irvington Road that is owned by the City of Tucson and which was a former (now closed) public landfill. This landfill site lies east of the Mesquite Ranch Wash, which does not appear to be impacted by any flows emanating from the landfill property.

C. WASH Ordinance

There are no washes on the PAD Property that are designated or regulated by the City of Tucson's Watercourse Amenities, Safety and Habitat (WASH) Ordinance.

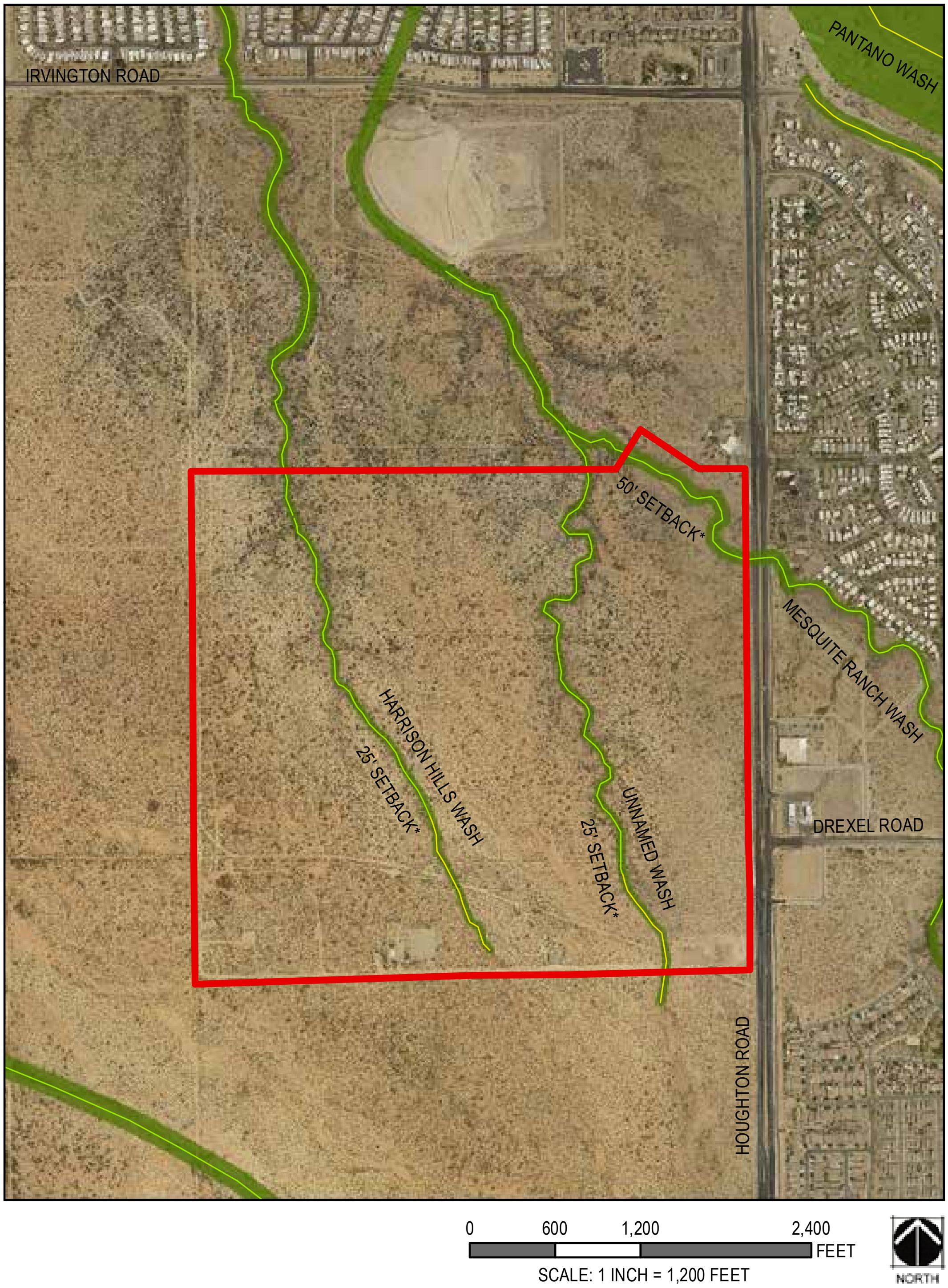
D. 404 Regulatory

An initial Federal Clean Water Act Section 404 jurisdictional determination was prepared in 2016 by SWCA Consultants (included as Appendix D). This determination concluded that all three of the on-site washes which traverse the property are considered jurisdictional.

Table II.4: Off-Site Watershed Discharge

WATERSHED	AREA (ACRES)	PROJECTED Q_{100}(c.f.s) AT PAD SOUTH PROPERTY LINE
Harrison Hills (WS-A)	70	517
Unnamed (WS-B)	128	765
Mesquite Ranch (WS-C)	348	1737

Exhibit II.13: Existing Drainage Patterns & Site Hydrology



LEGEND

□ PLANNED AREA DEVELOPMENT (PAD) BOUNDARY

RIPARIAN CLASSIFICATION

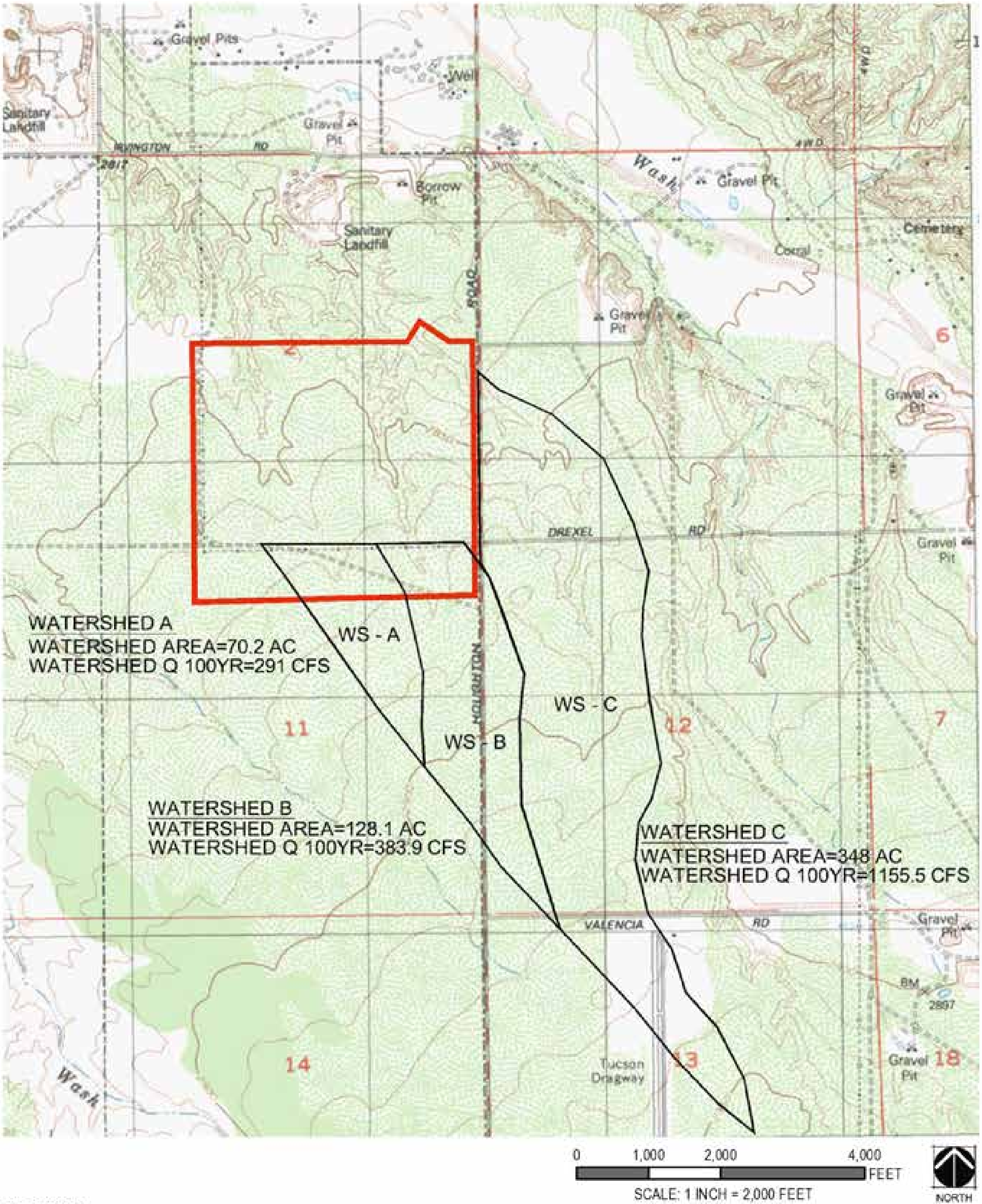
— XERORIPARIAN INTERMEDIATE DENSITY HABITAT

— XERORIPARIAN LOW DENSITY HABITAT

🟩 WASH SETBACK (DETERMINED BY WASH FLOW - CFS)

*NOTE: EROSION HAZARD SETBACK'S (EHS'S) SHOWN HEREON ARE APPROXIMATE PER PELIMINARY CALCULATIONS. FINAL EHS'S SHALL BE DETERMINED AND APPROVED BY THE CITY IN CONNECTION WITH THE SUBMISSION AND REVIEW OF A DRAINAGE REPORT.

Exhibit II.14: Pre-Development Hydrology and Off-Site Drainage



LEGEND

🟥 PLANNED AREA DEVELOPMENT (PAD) BOUNDARY

II.F.3 Plant Communities & Designated Xeroriparian Areas

The natural vegetation on the site has been relatively undisturbed, with the exception of the aforementioned FITP mountain-bike trails and the limited Tucson Water facilities. Vegetative density and composition vary across the site, dependent upon relative proximity to slopes and natural drainages. See Exhibit II.15: Vegetative Communities Map for the vegetative communities and associations discussed below.

The project area vegetation is typical of plants common to the Arizona Upland subdivision of the Sonoran Desertscrub biotic community. Most of the project area contains upland plant species typical of a creosote bush (Larrea tridentata) association within this community; however, there are two portions of the project area that mostly contain xeroriparian species. The dominant species in the upland portion of the project area are creosote bush and yellow (foothill) paloverde (Parkinsonia microphylla). Other plant species include blue paloverde (P. florida), catclaw acacia (Senegalia greggii), velvet mesquite (Prosopis velutina), saguaro, chain fruit cholla (Cylindropuntia fulgida), Engelmann prickly pear (Opuntia engelmannii), barrel cactus (Ferocactus wislizeni), ocotillo (Fouquieria splendens), soaptree yucca (Yucca baccata), joint fir (Ephedra spp.), triangle bur ragweed (Ambrosia deltoidea), desert zinnia (Zinnia acerosa), brittlebush (Encelia farinosa), burroweed (Isocoma tenuisecta), and sandmat (Chamaesyce spp.). The dominant xeroriparian species observed along the washes within the project area is yellow paloverde. Other species observed along the washes include velvet mesquite, catclaw acacia, wolfberry (Lycium sp.), creosote bush, and brickell bush (Brickellia spp.). The off-site vegetation just south of the PAD Property is classified by Brown as part of the Mixed Scrub Series of the Tropical-Subtropical Desertlands, being further sub-classified as part of the Larrea divaricata-Mixed Scrub Association. The vegetation in this classification is dominated by foothills palo verde, ironwood, saguaro, and creosote. Other, less frequently occurring species include desert hackberry, barrel cactus, white thorn acacia and triangle-leaf bursage.

Further off-site vegetation within the Pantano Wash corridor and the other washes south of the site are classified by Brown as part of the Mixed Scrub Series of the Tropical-Subtropical Swamp and Riparian Scrub, being further sub-classified as part of the Prosopis velutina (velvet mesquite) Mixed Scrub Association. The Velvet Mesquite Association includes velvet mesquite, ironwood, foothills palo verde, cat claw, whitethorn acacia, desert hackberry, and saguaro, with ironwood and cat claw acacia being the dominant species.

The Arizona Game and Fish Department's (AGFD's) Heritage Data Management System (HDMS) identifies one (1) plant species of Special Status within three (3) miles of the project vicinity, this being the Stag-horn Cholla (Opuntia versicolor). See Table II.5: Special Status Plant Species and Agency Designation below. The full Arizona Game and Fish Department HDMS Report is provided in Appendix E.

Table II.5: Special Status Plant Species and Agency Designation

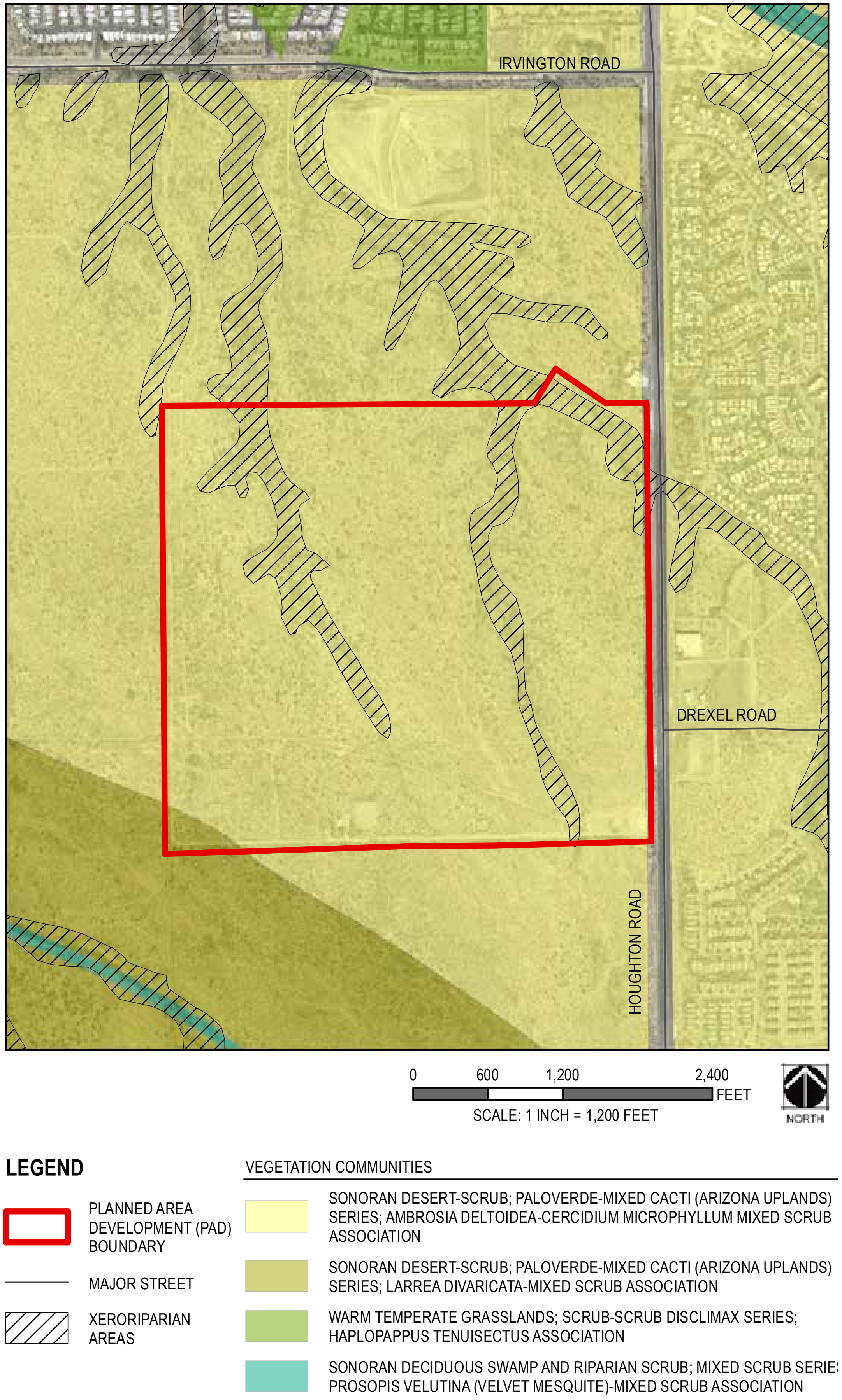
SCIENTIFIC NAME	COMMON NAME	FWS	USFS	BLM	NPL*
Opuntia versicolor	Stag-horn Cholla	N/A	N/A	N/A	SR**

*Agency Abbreviations: State - NPL Arizona Native Plant Law (2008), Arizona; Department of Agriculture

**Status: SR: Salvage Restricted

SR Definition: Collection only with permit.

Exhibit II.15: Vegetative Communities Map



II.F.4 Wildlife Characteristics & Corridors

The Arizona Game and Fish Department's (AGFD's) Heritage Data Management and Project Evaluation Program (see Appendix E for full HDMS Report) indicates that there are five (5) occurrences of Special Status Species within a three (3) mile radius of the project site: the Western Burrowing Owl (Athene cunicularia hypugaea), the Mexican Long-tongued Bat (Choeronycteris Mexicana), the Sonoran Desert Tortoise (Gopherus morafkai), the Reticulate Gila Monster (Heloderma suspectum), and the Lowland Leopard Frog (Lithobates yavapaiensis). See Table II.6: Special Status Wildlife Species and Agency Designation.

Table II.6: Special Status Wildlife Species and Agency Designation

SCIENTIFIC NAME	COMMON NAME	FWS*	USFS*	BLM*	NPL
Athene cunicularia hypugaea	Western Burrowing Owl	SC**	S***	S****	N/A
Choeronycteris mexicana	Mexican Long-tongued Bat	SC	S	S	N/A
Gopherus morafkai	Sonoran Desert Tortoise	CCA**	S	N/A	N/A
Heloderma suspectum	Reticulate Gila Monster	N/A	N/A	N/A	N/A
Lithobates yavapaiensis	Lowland Leopard Frog	SC	S	S	N/A

*Agency Abbreviations: FWS (Fish and Wildlife Service, Federal US Status; Endangered Species Act, 1973 as amended); USFS (US Forest Service, US Department of Agriculture); BLM (US Bureau of Land Management, US Department of the Interior)

**FWS Status: SC - Species of Concern; CCA -

FWS Definitions: SC - The terms "Species of Concern" or "Species at Risk" should be considered as terms-of-art that describe the entire realm of taxa whose conservation status may be of concern to the US Fish and Wildlife Service, but neither term has official status (currently all former C2 species).

CCA - Candidate Conservation Agreement: Formal, voluntary agreements between the FWS and one or more parties to address the conservation needs of one or more candidate species or species likely to become candidates in the near future. Participants voluntarily commit to implement specific actions designed to remove or reduce threats to the covered species, so that listing may not be necessary. The degree of detail in CCAs can vary widely, and there are no specific permits or assurances associated with them. CCAs are primarily entered into between FWS and other Federal agencies and States, but local governments, Tribes, private property owners, and other entities may also participate.

***USFS Status: S - Sensitive

USFS Definition: S - Those taxa occurring on National Forests in Arizona which are considered sensitive by the Regional Forester.

****BLM Status: S - Sensitive

BLM Definition: S - Those taxa occurring on BLM Field Office Lands in Arizona which are considered sensitive by the Arizona State Office.

II.F.5 Cultural Resources, Sites, etc.

A cultural resources and archaeological survey were conducted by Tierra Right-of-Way Services in August, 2011 and then updated in February, 2016 (see Appendix F for the full Reports). The original survey and its subsequent update were performed, respectively, on behalf of Tucson Water's Planning and Engineering Division (in conjunction with their proposed SHARP project) and Mattamy Homes Tucson, in conjunction with its due-diligence activities prior to formally purchasing its portion of the subject PAD Property. The purpose of these surveys was to locate and record any significant cultural resources that might impact or negatively influence development of the Property as planned.

In both Reports, the survey results indicate that one (1) previously undocumented site (AZ BB:13:818[ASM]) was found. This site is a fragment of a historic road which once linked the Rincon Valley to Tucson proper. The Report identifies that the relatively short (3,000 feet long) surviving roadway segment that exists within the PAD property lacks the integrity required for it to be considered eligible for listing on the National Register of Historic Places (NRHP). The Report therefore recommends that AZ BB:13:818(ASM) be determined ineligible for NRHP inclusion, and that no further archaeological work be required to allow the PAD Property to proceed with development.

While the Reports indicate that available records had previously identified three (3) other archaeological sites on or near the PAD Property (AZ BB:13:373[ASM], AZ BB:13:374[ASM], and AZ BB:13:372[ASM], no evidence of the three (3) sites was re-identified in the field during the more recent surveys. The Reports conclude that routine erosional activity along the on-site natural washes has obliterated any recognizable trace of the two (2) prior sites located within the PAD boundary. The third site was determined to be off-site of the PAD Property. Based upon the above, the Reports recommend that no further archaeological work be required in conjunction with the proposed PAD development.

II.F.6 Underlying Geology, Soils & Geotechnical Considerations

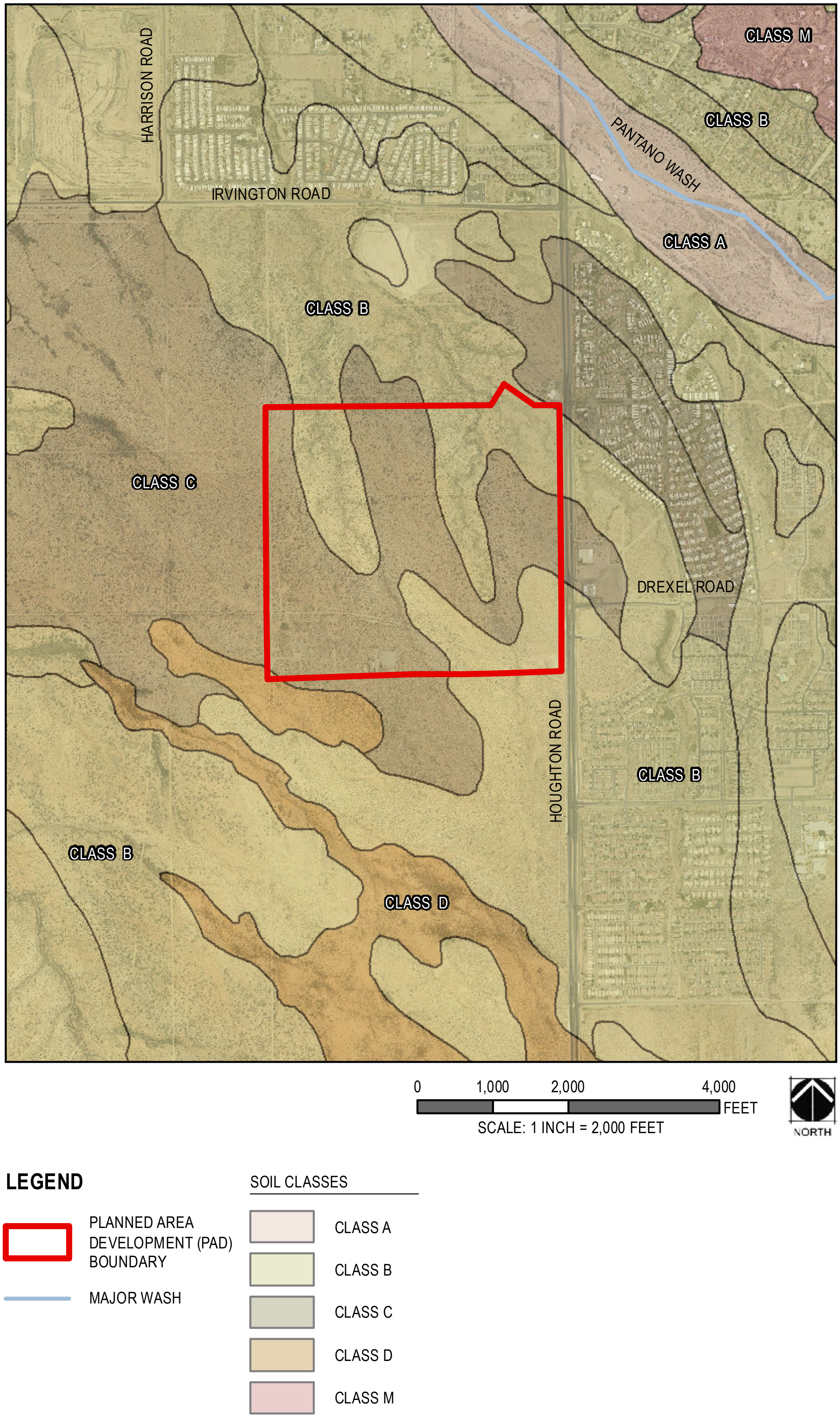
The project site is comprised of multiple soil types (see Exhibit II.16: Soils Map). The predominant soil types found within the project site are Class B and Class C. Definitions for these soil types are provided below:

Class B: Soils have moderate infiltration rates when thoroughly wetted, consisting chiefly of soils of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission and are typically located within natural drainage corridors.

Class C: Soils having slow infiltration rates when thoroughly wetted, consisting chiefly of soils with a layer that impedes the downward movement of water, or soils with moderately fine to fine texture and a slow infiltration rate. These soils have a slow rate of water transmission.

Both of these soils types are common within the Tucson metropolitan region. The geotechnical requirements to prepare them for development can be considered routine.

Exhibit II.16: Soils Map



II.G VISUAL ANALYSIS

II.G.1 Visibility from Surrounding Properties & Land Uses

The PAD site is primarily visible from the Houghton Road corridor to the immediate east, as well as from certain bike routes within Fantasy Island Trails Park (FITP). Existing vegetation within and surrounding the Property will serve to mitigate direct visibility of the PAD development from the majority of off-site locations. Exhibit II.17: Existing Viewsheds and Photo Locations provides a photographic depiction of the PAD's perimeter areas.

II.G.2 Viewsheds

The primary viewsheds relevant to the PAD Property are long range views and vistas rather than any in the immediate foreground or midground. The following sections provide further detail as to the operative views and vistas characterizing the site.

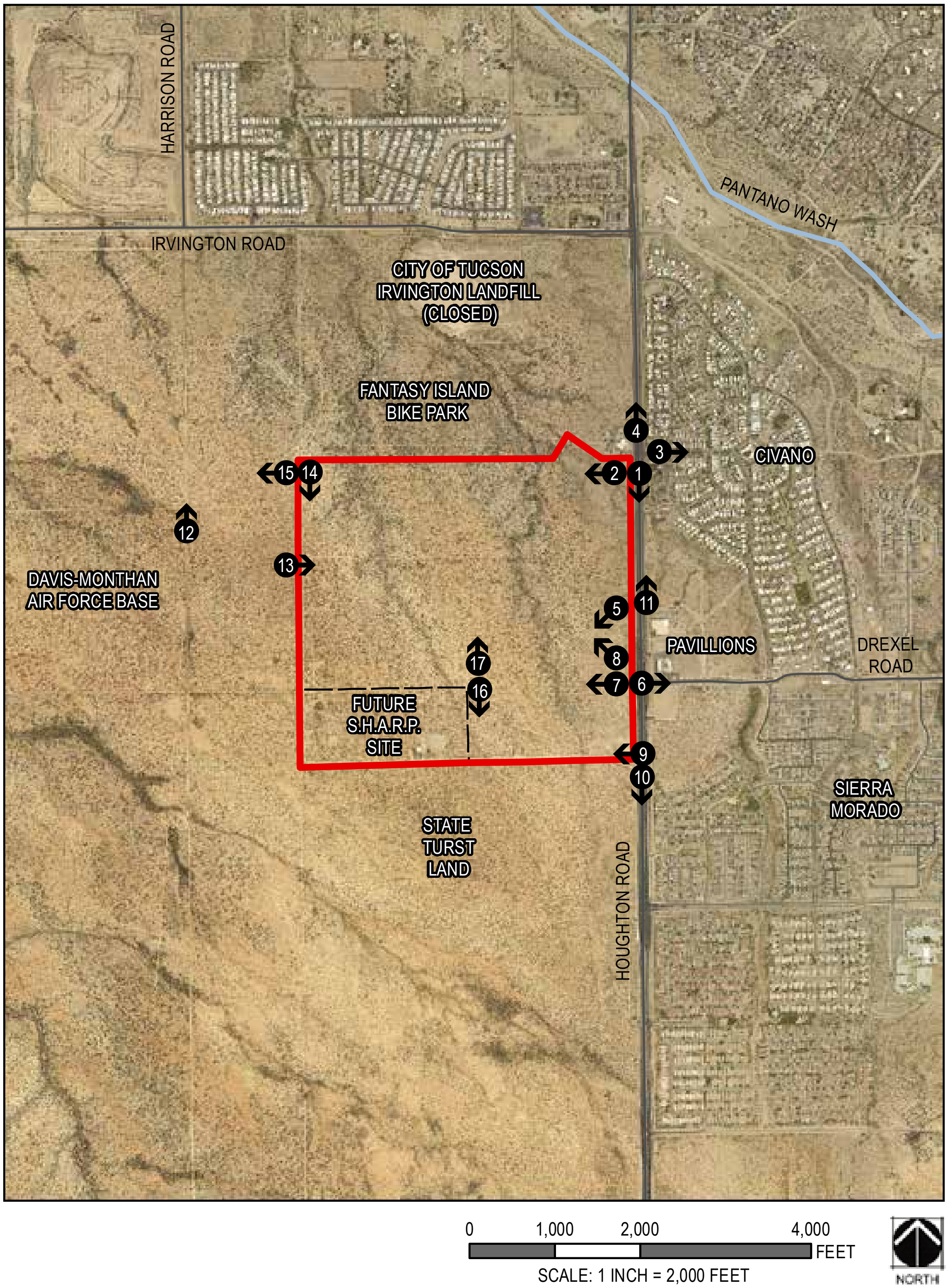
A. Onto/Across Site from Surroundings

The perimeter of the property is highly visible from the adjacent arterial roadway (Houghton Road), but the more interior portions of the property are largely obscured by topographic changes and by low to medium density natural vegetation. See Exhibit II.17: Existing Viewsheds and Photo Locations.

B. Distant Viewsheds from Site

The PAD site consists of rolling topography that slopes gently from southeast to northwest. The primary views and vistas that characterize it extend beyond the immediately adjacent properties and capture the distant Santa Catalina Mountains to the north, the Tucson Mountains to the west, the Santa Rita Mountains to the south, and the Rincon Mountains to the east. These same vistas are presently enjoyed by many residents living in the neighboring Civano and Sierra Morado communities. The proposed PAD development will sit at a naturally lower elevation than these existing residential neighborhoods and, together with the significant horizontal separation between them and the PAD site, will not see their current views significantly impacted.

Exhibit II.17: Existing Viewsheds and Photo Locations



LEGEND

🟥 PLANNED AREA DEVELOPMENT (PAD) BOUNDARY

— MAJOR STREET

— MAJOR WASH

→ VIEW LOCATION & DIRECTION

S.H.A.R.P. SOUTHEAST HOUGHTON AREA RECHARGE PROJECT
(FUTURE; SHOWN FOR PHOTO REFERENCE ONLY)

Exhibit II.17: Existing Viewsheds and Photo Locations

❶ View looking south on Houghton Road from the northeast corner of the site.

❷ View looking west into the PAD site from the northeast corner of the project.

❸ View looking east into Civano at Seven Generations Way.

❹ View looking north toward the Catalina Mountains from the northeast corner of the PAD site.

❺ View looking southwest into the PAD site from Houghton Road.

❻ View looking east at the Drexel Road and Houghton Road intersection.

Exhibit II.17: Existing Viewsheds and Photo Locations

⑦ View looking west into the PAD site from the Drexel Road and Houghton Road intersection.

⑧ View looking northwest into the PAD site from Houghton Road.

⑨ View looking west along the southern property boundary toward Tucson Water's future SHARP Facility.

⑩ View looking south from the southeast corner of the PAD site.

⑪ View looking north along the multiuse path on the east side of Houghton Road.

⑫ View looking north from the Harrison Greenway located approximately 1/3 mile west of the PAD site.

⑬ View looking east into the PAD site from the site's western boundary.

⑭ View looking south into the PAD site from the northwest property corner.

⑮ View looking west from the northwest property corner.

⑯ View looking south from the northeast corner of the future Tucson Water SHARP site.

⑰ View looking north into the PAD site from the northeast corner of the future Tucson Water SHARP property.

II.H Site Analysis Findings & Conclusion

Exhibit II.18: Comprehensive Opportunities and Constraints Map provides an illustrative depiction of the above Site Analysis primary findings, as well as the most salient factors impacting the Property. As will become clear, this is a situation where the opportunities and positives inherent in the PAD materially outweigh the constraints.

II.H.1 Site Opportunities

The proposed PAD offers the following significant opportunities:

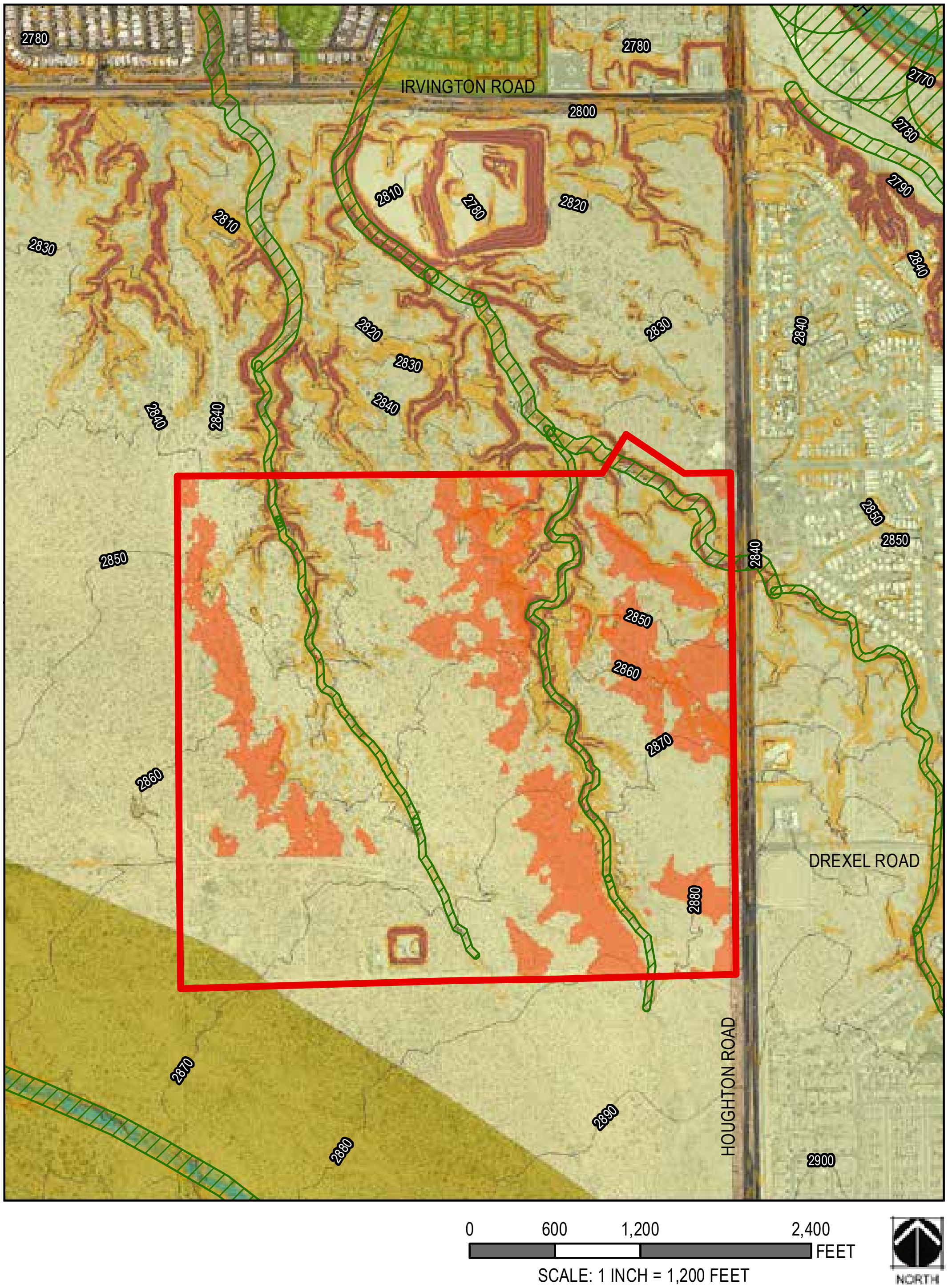
- It provides the opportunity to integrate three distinctly different land uses (Fantasy Island Trails Park, Mattamy Homes residential neighborhoods, and Tucson Water's SHARP facility) into a unique and vibrant whole that synergistically benefits and improves all three.
- It provides the mechanism for ensuring a unified aesthetic theme and project identity that further promotes a high standard of quality within the Houghton Road corridor and the City at large.
- It provides the opportunity to further promote Tucson's east side as a highly desirable residential environment and a vibrant buyer market for continued quality development.
- It provides a unique place for Mattamy Homes to introduce a variety of innovative housing products and creative neighborhood designs that are new to the Tucson market.
- The PAD will clearly complement and enhance the established residential and community models represented by Civano and Sierra Morado, and will provide a significant bolstering in population that can only energize the proposed commercial opportunities envisioned by the adjacent Pavilions project.
- It creates the opportunity to not only provide exceptional integrated recreational and trail opportunities within its own PAD boundaries, but to also provide direct connectivity to surrounding regional trail systems and public open spaces, thereby representing a recreational and trail destination for residents and recreational enthusiasts living both inside and outside of the project.
- It provides the opportunity to stimulate the Arizona State Land Department's consideration of master planning its significant holdings in the area and preparing select parcels for public auction, thereby further fostering interest in the marketing and desirability of Tucson's east side and Houghton Road corridor.
- It provides the opportunity to demonstrate a model public-private partnership between the City and the development community, thereby enhancing confidence by all concerned as to the prospects of success inherent in future City auctions and subsequent planning efforts.

II.H.2 Man-Made & Environmental Constraints; PAD Responses

The PAD site is unremarkable in terms of any major man-made, built, or natural constraints. Only the following matters are worthy of note:

- The primary constraints impacting the PAD site are the prevailing natural drainage corridors that traverse the Property. With these being set aside almost in their entirety as part of Fantasy Island Trails Park, this primary constraint is effectively eliminated.
- The proposed roadway crossing of these natural drainages represent the primary engineering challenge inherent in the project, and even the design of these crossings can be considered routine from a civil engineering and hydrologic perspective.
- The only other major constraint impacting the project is its public sewer solution, the most efficient and preferred of which entails construction of a significant portion of off-site sewer main, across Arizona State Trust Land, northward to Irvington Road. This item is discussed in detail in Section III (PAD District Proposal) of this document.
- Success in the above sewer option is dependent upon successful procurement of a new public sewer easement from the Arizona State Land Department (ASLD). Given the clear upstream benefits that would accrue to ASLD's holdings from the construction of such an off-site sewer, it is hoped that, once again, this easement matter can fall into the realm of routine.

Exhibit II.18: Comprehensive Opportunities and Constraints Map



LEGEND

▭	PLANNED AREA DEVELOPMENT (PAD) BOUNDARY
—	10 FT CONTOUR
🟨	15 - 25% SLOPE
🟥	25% OR GREATER SLOPE
🟧	AREAS VISIBLE FROM HOUGHTON ROAD
▨	WASH SETBACK (DETERMINED BY WASH FLOW - CFS)

VEGETATION COMMUNITIES

⬜	SONORAN DESERT-SCRUB; PALOVERDE-MIXED CACTI (ARIZONA UPLANDS) SERIES; AMBROSIA DELTOIDEA-CERCIDIUM MICROPHYLLUM MIXED SCRUB ASSOCIATION
🟨	SONORAN DESERT-SCRUB; PALOVERDE-MIXED CACTI (ARIZONA UPLANDS) SERIES; LARREA DIVARICATA-MIXED SCRUB ASSOCIATION
🟩	WARM TEMPERATE GRASSLANDS; SCRUB-SCRUB DISCLIMAX SERIES; HAPLOPAPPUS TENUISECTUS ASSOCIATION
🟦	SONORAN DECIDUOUS SWAMP AND RIPARIAN SCRUB; MIXED SCRUB SERIES; PROSOPIS VELUTINA (VELVET MESQUITE)-MIXED SCRUB ASSOCIATION

III.

PAD DISTRICT PROPOSAL

III.A PROPOSED PAD OVERVIEW

III.A.1 Major Land Uses and Facilities

This PAD presents a comprehensive, unified development program and vision for the Property that will be implemented through the joint efforts of Mattamy Homes, the City of Tucson, and Tucson Water. The Mattamy Homes portion of the PAD will be a distinctive active residential community known as Saguaro Trails. The City of Tucson will own and manage the Fantasy Island Trails Park (FITP) portion of the Property, while Tucson Water will be the owner/operator of the Southeast Houghton Area Recharge Project (SHARP).

Going forward, it is understood that Mattamy may place ownership of its holdings in a different entity or may engage additional builders and/or owners in the development process. Therefore, within Section III of this PAD, the more generic term “owner/developer” is used to refer to those requirements and responsibilities that pertain to the PAD’s Saguaro Trails component and the infrastructure elements necessary to serve it.

With that in mind, the PAD will ensure that the above Saguaro Trails, FITP, and SHARP uses are developed in a coordinated fashion which not only accommodates their respective and diverse needs, but which also integrates and leverages them such that they complement and enhance one another. As such, the Property will proceed under a comprehensive master plan that effectively weaves a variety of residential housing types and densities into the recreational and trail opportunities provided by both FITP and SHARP. The PAD will implement a consistent aesthetic theme and project identity to foster a clear sense of place and establish a focused, holistic community image.

The residential component of the PAD Property, Saguaro Trails, will be a multi-phased community that complements and interconnects with both Fantasy Island Trails Park and the SHARP facility. It will be anchored around a core neighborhood center that combines a central park amenity with the main public entrance to the SHARP facility. This combined feature provides a distinct node for both active and passive recreational activities, community events, and the enhancement of the community’s overall social fabric.

Comprehensive pedestrian and trail connectivity will be a central feature of this PAD, not only internally between the new residential components and FITP/SHARP, but also externally with the remainder of the Fantasy Islands trails system (on adjacent State Trust Lands), the Drexel Road Greenway (which will extend into the Property at its main entrance), and the recently-completed multi-use trail that parallels Houghton Road. The owner/developer will also work with the Arizona State Land Department (ASLD) to accommodate a direct linkage to the existing Harrison Greenway (part of The Loop, Pima County’s regional pathway system) located approximately ½ mile to the west across Arizona State Trust Lands. This planned level of connectivity will serve to firmly link the PAD Property into its regional surroundings and provide meaningful public recreation opportunities for all residents, both inside and outside of the project.

Exhibit III.1: Conceptual Master Plan illustrates the overall development concept for the project, as well as the specific Planning Areas (PA’s) that define this PAD to accommodate its planned uses. Appendix G includes a conceptual rendering of the potential development program for the PAD at ultimate build-out. This exhibit depicts only one potential scenario and is provided for illustrative and character purposes only. Changing market conditions and buyer preferences over time will surely result in changes to the final build-out scenario; this evolution is consistent with the *Living Community* principles described in Section I.B.5.A of this PAD.

A. Residential Uses

The residential uses within the PAD will afford multiple, market-rate residential options, including traditional single-family detached units, single-family attached units, and multi-family residential options. Densities will vary, as will the size and character of the residences offered. The PAD will provide built-in flexibility within each particular residential Planning Area so that the developer can adapt to evolving market conditions in a timely manner while still preserving the original intent and guiding vision of the PAD. Within all areas of residential land use, neighborhood mini-parks, recreation areas, and/or functional open spaces will be suitably integrated. The specific development standards and regulations for the various residential options are detailed in Section III.B.2.

B. Non-Residential Use Option

This PAD provides for a prescribed non-residential/ commercial option within Planning Area A (one of the residential Planning Areas) near the project's main entry at Houghton Road and Drexel Road (see Section III.B.3 for detail and location). The permitted non-residential uses have been limited to a small set that will complement the proposed residential development and provide its residents with the types of localized services that would be needed and patronized by them on a regular basis. The specific development standards and regulations for this non-residential option are detailed in Section III.B.3.

C. Neighborhood Center & Activity Corridor

The planned Neighborhood Center within the PAD aligns with the goals of Houghton Area Master Plan (HAMP) by being a highly-accessible social and recreational focal point for all of the surrounding residential neighborhoods. In this case, the planned Neighborhood Center is comprised of both an amenitized central core and central park, together with a new segment of the Drexel Road Greenway that will extend to the central park from Houghton Road. As such, the PAD's Neighborhood Center is actually a vibrant corridor that provides multi-use trails, greenway features, a landscaped main boulevard, a defined central park destination, and direct access and connectivity to each and every residential block, FITP, and the SHARP facility. The specific development standards and regulations for the neighborhood center are detailed in Section III.B.4.

D. Open Space in Residential Planning Areas

Within the residential Planning Areas of the PAD, both functional and natural open space is provided. Functional open spaces occur in the form of active and passive recreational areas, pedestrian circulation routes, and areas which have been contoured to accommodate routine project engineering and drainage needs. These areas include residential common areas, mini-parks within neighborhoods, landscape buffers, pedestrian paths, and areas which have been landscaped after necessary grading.

Natural open space areas are those which are formally delineated and set aside so as to preserve valuable resources, natural wash channels, and riparian habitat. As these areas will be preserved in place, they will be excluded from the developable acreage of the residential component and any related density calculations.

The specific development standards and regulations for the open space areas are detailed in Section III.B.5.

E. City of Tucson Fantasy Island Trails Park

Fantasy Island Trails Park (FITP) is an extensive system of mountain-bike trails that weaves throughout portions of the PAD Property, and which also stretches significantly onto the Arizona State Trust Lands that border the Property to the immediate north and south. In the post-development condition of the PAD Property, approximately ten (10) miles of trails will remain in place for both general non-motorized public recreation and dedicated mountain bike enthusiasts. In addition to its local popularity, FITP has also achieved international notoriety as a premier cycling destination.

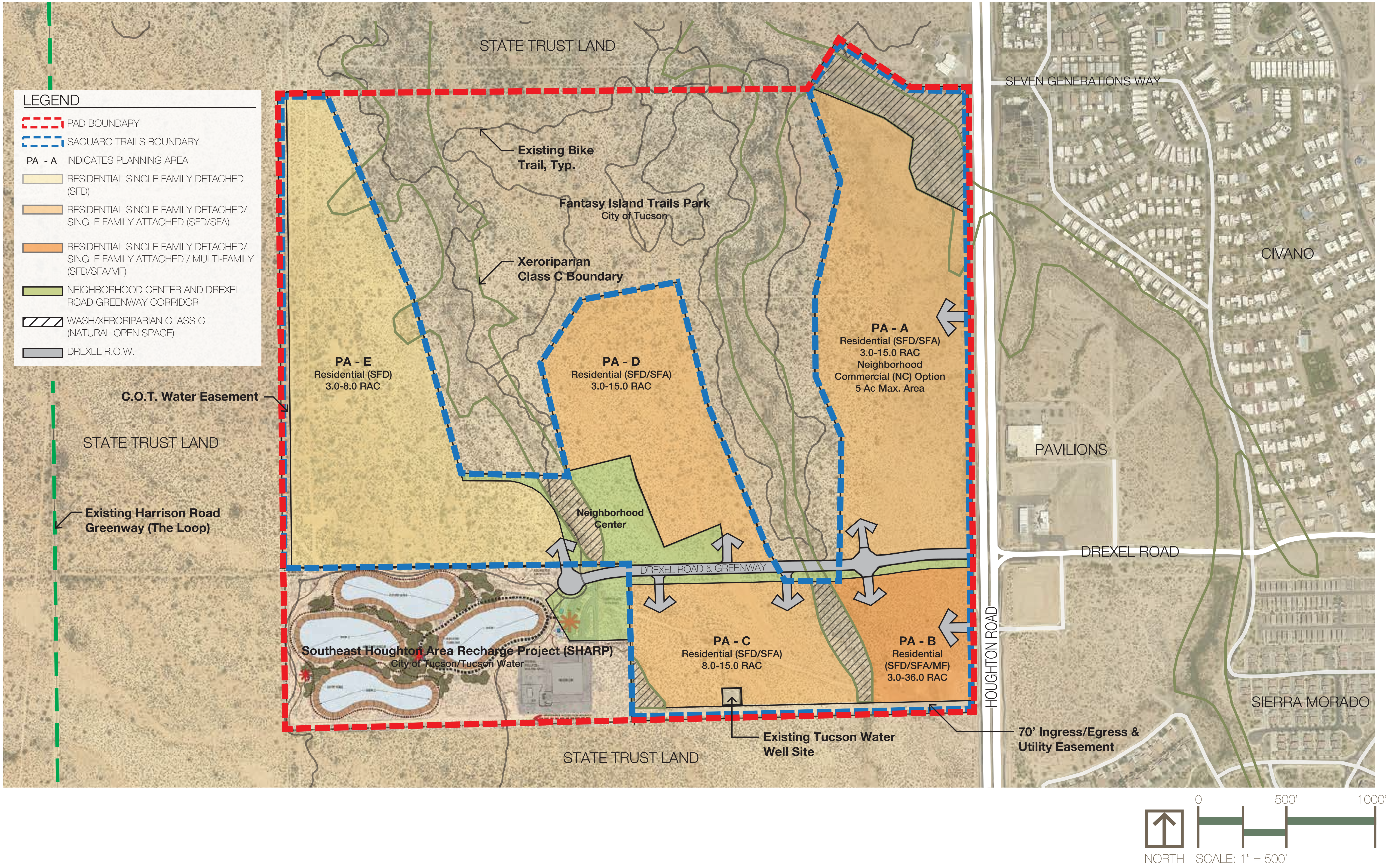
The FITP trail system was ultimately formalized by the Mayor & Council with its adoption of the Master Plan for Fantasy Island Trails Park in 2006. This PAD will implement that portion of the Master Plan which covers the City-owned lands within the subject Property; the final boundary of these lands was negotiated between representatives of the City and Fantasy Island and will be formally established with the future block plat of the PAD. Trail connectivity will be provided from the existing Fantasy Island trail system to the new pedestrian paths, trails, and sidewalks provided within the residential neighborhoods and within the proposed SHARP facility. These points of connection will be strategically located and will be appropriately signed to ensure safety and to manage cross-usage between pedestrians and cyclists. The development standards and regulations for Fantasy Island Trails Park are detailed in Section III.B.6.

F. Southeast Houghton Area Recharge Project (SHARP)

The Southeast Houghton Area Recharge Project (SHARP) is a Tucson Water facility providing aquifer recharge for the southeast region. It represents an addition to Tucson Water's strategic water resource planning efforts for the entire metropolitan area and furthers the sustainability aspect of the overall PAD project. It will contain a series of recharge basins, together with a regional reclaimed water distribution system-metering station, recover wells, monitoring wells, and maintenance yard, all of which will be integrated with the existing reservoir facility already on the site.

Beyond these primary infrastructural components, the SHARP facility will also include landscaping of nearly all of the project as a public recreational amenity, including a comprehensive system of pedestrian paths and mountain bike trails around the recharge basins, a parking lot for both private vehicles and school buses, public restrooms, and picnic ramadas. These facilities will be integrated with the PAD's Neighborhood Center (see Section III.A.1.c) and thereby provide connectivity to all of the planned residential neighborhoods and to Fantasy Island Trail Park. The specific development standards and regulations for the SHARP facility are detailed in Section III.B.7.

Exhibit III.1: Conceptual Master Plan



III.A.2 Compatibility with Adjoining Land Uses

The proposed PAD is part of an important node that is already characterized by master planned residential and multi-use development, namely the Civano and Sierra Morado communities and the Pavilions commercial project. Civano and Sierra Morado are well known for their innovative design standards, sustainability features, integrated green spaces, and diverse and unique residential offerings. The Pavilions is envisioned as an essential employment and commercial core for the region and is the site of Tucson Medical Center's eastside medical campus (currently under construction).

Exhibit III.2: Adjoining Land Use

The proposed PAD will both complement and enhance this existing residential and commercial mix (see Exhibit III.2: Adjoining Land Use). It represents a similarly innovative, creative, and integrated addition to the existing development framework that will further enhance the quality and desirability of the immediate area and of the larger Houghton Road corridor, as well as help create increased demand for the adjacent planned commercial uses at The Pavilions.

Looking more long term, it is hoped that the proposed PAD may also be a contributing catalyst to the Arizona State Land Department's (ASLD's) future master planning of its extensive holdings in the area. The ASLD planning process will benefit from a clearly established standard of quality development and innovative planning throughout the area.

III.A.3 Anticipated Phasing

Development phasing of the PAD will generally proceed as follows:

- The Drexel Road extension provides the main boulevard and greenway into the project and will be completed, in its entirety, as part of the initial site improvements with the Saguaro Trails residential community. The street will terminate at a roundabout within the designated neighborhood center, from which access will be provided into the westernmost residential block as well as the SHARP property. The Drexel Road extension will be coordinated with the SHARP project as needed.
- Construction of the outfall sewer necessary to serve the Saguaro Trails residential community.
- Construction of the Neighborhood Center and associated central park amenity will begin with the construction of the Drexel Road extension and greenway. Approximately one-half of the ultimately planned park improvements will be built by the Saguaro Trails owner/developer concurrently with the first phase of residential development, with the remainder of the Neighborhood Center central park core being completed at the time that certificate of occupancy is issued for the four hundredth (400th) residential unit.
- Residential development will begin with Planning Area "A" and generally proceed westward across the Property, subject to market demand and absorption.
- Modifications to Fantasy Island trail segments presently located within designated residential Planning Areas of Saguaro Trails will occur at the time of residential development within each Planning Area; connectivity will be insured between these trails and the new pedestrian paths, sidewalks, etc. provided within the residential neighborhood.
- The SHARP facility will proceed on its own timetable, with the expectation and intent that it be completed simultaneously with, or shortly after the completion of the above Drexel Road extension.
- The anticipated total build-out time frame for the residential Planning Areas is eight (8) to fourteen (14) years, depending upon market absorption.

III.A.4 Subdivision Block Platting & Public Right-of-Way Dedications

A block plat will be filed for the PAD as shown on Exhibit III.3: Block Plan - Conceptual Diagram and will be based on the various Planning Areas illustrated on Exhibit III.1: Illustrative Master Plan. The block plat will also dedicate the westerly extension of the Drexel Road right-of-way. This right-of-way will proceed westward from the existing Drexel Road intersection at Houghton Road, terminating near the northeast portion of Tucson Water's SHARP property. A roundabout is anticipated at this terminus, from which access will be provided to the SHARP facility and to Planning Area E. This new portion of Drexel Road is not listed as a Major Street on the City's Major Streets and Routes Plan (MSRP); the City Department of Transportation has previously stated that there is no need or requirement for it to continue westward beyond the PAD.

In conjunction with the above block plat, a detailed master drainage study will be submitted and will provide detailed hydrologic calculations for the existing condition and post-development conditions resulting from construction of the PAD and its attendant infrastructure. The study will include calculations supporting the size and configuration of new culverts beneath Drexel Road, their inlet and outlet protection, sidewalk scuppers, etc. and will set the basic design parameters for the entire Drexel Road extension.

Stormwater retention and detention for this development will be accomplished on a block by block basis as the residential properties are developed. As such, the master drainage study will not include an analysis of retention/detention provisions for the future residential lotting. At the time a tentative resubdivision plat is submitted for each of the residential Planning Areas, a detailed hydrologic and hydraulic analysis will be submitted which will address the post-development runoff volumes created by that block's development, the necessary drainage structures, basins and associated capacities required to satisfy retention/detention requirements, and the specific outlet locations and quantities for those flows exiting the resubdivision area. Concurrent with the above work, the potential for detention in-lieu fees will also be explored with City staff.

Lastly, a Native Plant Preservation Plan (NPPP) and comprehensive Environmental Resource Report (ERR) will be submitted for review and approval concurrent with the block plat.

III.A.5 Owner Maintenance Responsibilities

Maintenance responsibilities within the PAD will be apportioned as follows:

- Drexel Road, the project's main entry boulevard, will be a dedicated public street. Maintenance of its primary cross-sectional elements (pavement, curbs, etc.) shall be provided by the City of Tucson Department of Transportation (TDOT). Maintenance of specialized elements (e.g. enhanced landscaping, irrigation and associated sleeving, street furniture, greenway multi-use paths) shall be that of the owner/developer under a formal homeowners association (HOA). Administration of this specialized maintenance shall proceed under a formal license agreement with TDOT.
- Maintenance responsibilities for all public streets located within residential Planning Areas shall be that of the City of Tucson.
- Maintenance of all common areas, pedestrian paths, neighborhood mini-parks, landscape borders/buffers, etc. within residential Planning Areas shall be that of a designated private homeowners association (either a Master HOA for the entire PAD, or individual HOA's for each neighborhood).
- Maintenance responsibility for all public utilities shall be that of the servicing utility company.
- Maintenance responsibility for any private utilities and/or irrigation improvements shall be that of the appropriate private HOA.
- Maintenance responsibility for all improvements (both recreational and infrastructural) on the SHARP property shall be that of Tucson Water.
- Maintenance responsibility for all aspects of that portion of Fantasy Island Trails Park included within this PAD shall be that of the City of Tucson, in cooperation and coordination with Fantasy Island users.
- Maintenance of any new, pedestrian-only trails constructed within the FITP portion of the PAD will be the responsibility of the owner/developer or HOA.

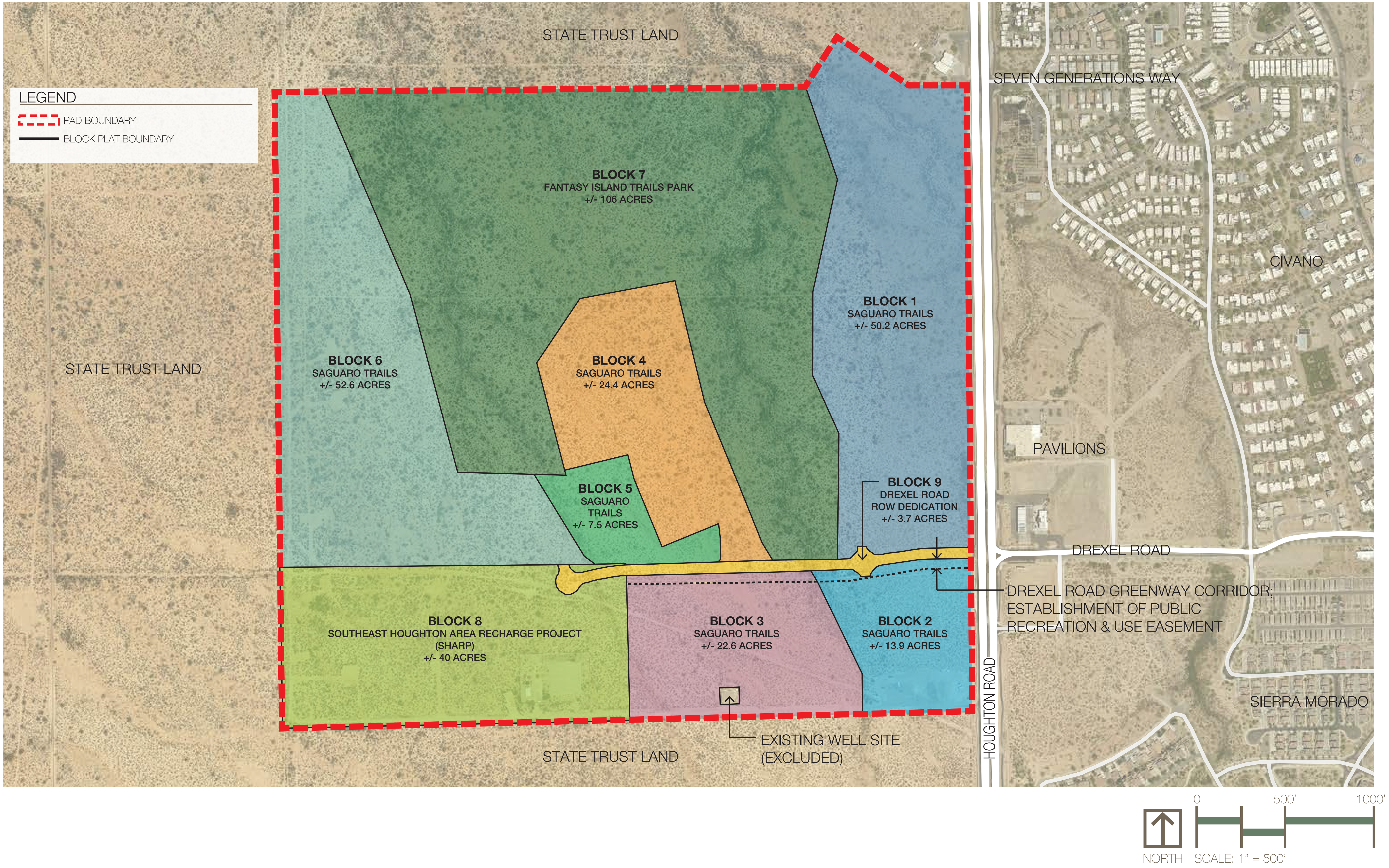
III.A.6 Financial Assurances

Following recordation of the PAD's final Block Plat, but prior to Mayor & Council scheduling of the first subsequent final Resubdivision Plat, the master residential owner/developer shall submit a form of financial assurances for review and approval by the City of Tucson. The form of assurances submitted can be a performance bond, third-party trust, development agreement, or other suitable financial instrument that covers both the on-site and off-site improvements that may be necessary to serve the PAD or to mitigate its impacts upon existing public infrastructure.

III.A.7 City of Tucson Waiver of Claims

The owner/developer shall execute and record a separate agreement, in a form acceptable to the City of Tucson, to waive any claims against the City for zoning amendments in conformance with A.R.S. Section 12-1134(I).

Exhibit III.3: Block Plat - Conceptual Diagram



III.B LAND USE REGULATIONS

III.B.1 Establishment of UDC Base Zoning Designation for the PAD District

The PAD will be developed under a series of designated Base Zonings, dependent upon each particular Planning Area and its envisioned uses. The Base Zoning designation for each Planning Area is provided in the respective discussions Sections A through I below.

Refer to Exhibit III.1: Conceptual Master Plan for the physical location and configuration of each referenced Planning Area. Table III.1: Land Use Details - Planning Areas A-E has also been provided to summarize the major features of residential Planning Areas A through E.

Refer to the glossary in Appendix A for housing related terms used in Sections A - E below.

A. Planning Area A (Single-Family Attached/Detached Residential; Non-Residential Option)

Planning Area A shall allow for single-family detached and single-family attached residential. Residential uses developed within Planning Area A shall follow the standards as outlined within Section III.B.2 (Residential Uses) of this PAD. The Base Zoning designation for residential uses within Planning Area A is R-2 (Residential).

A limited non-residential option is also allowed within Planning Area A in the form of a low intensity neighborhood commercial area; see Section III.B.3 for its specific location. This potential non-residential use is limited to a maximum area of five (5) acres. Any non-residential uses within this area shall: 1) conform to the standards outlined in Section III.B.3 (Non-Residential Uses) of this PAD; and 2) have a designated Base Zoning of NC (Neighborhood Commercial).

B. Planning Area B (Single-Family Attached/Detached & Multi-Family)

Planning Area B shall allow for either single-family detached, single-family attached, or multi-family residential units. This Planning Area was identified for potential multi-family use due to its adjacency to both Houghton Road and to the Drexel Road Greenway & Corridor extension into the PAD Property, as well as the possibility for direct vehicular access to and from Houghton Road. Residential uses developed within Planning Area B shall follow the standards as outlined within Section III.B.2 (Residential Uses) of this PAD. The designated Base Zoning for Planning Area B is R-3 (Residential).

C. Planning Area C (Single-Family Attached/Detached Residential)

Planning Area C shall allow for single-family detached and single-family attached residential units. Residential uses developed within Planning Area C shall follow the standards as outlined within Section III.B.2 (Residential Uses) of this PAD. The designated Base Zoning for Planning Area C is R-2 (Residential).

D. Planning Area D (Single-Family Attached/Detached Residential)

Planning Area D shall allow for single-family detached and single-family attached residential units. Residential uses developed within Planning Area D shall follow the standards as outlined within Section III.B.2 (Residential Uses) of this PAD. The designated Base Zoning for Planning Area D is R-2 (Residential).

E. Planning Area E (Single-Family Detached Residential)

Planning Area E shall allow for single-family detached residential. Uses developed within Planning Area E shall follow the standards as outlined within Section III.B.2 (Residential Uses) of this PAD. The designated Base Zoning for Planning Area E is R-2 (Residential).

Table III.1: Land Use Details - Planning Areas A-E

PLANNING AREA	PRIMARY LAND USES	SECONDARY LAND USES	APPROXIMATE GROSS ACRES(1)	APPROXIMATE NET DEVELOPABLE ACRES(2)	ANTICIPATED NET DENSITY RANGE (RAC)(3)
A	Single-Family Detached, Single-Family Attached	Non-Residential Neighborhood Commercial (5 Acre Max.)	41.9	33.7	3.0 - 15.0
B	Single-Family Attached, Single-Family Detached, Multi-Family		11.0	8.8	3.0 - 36.0
C	Single-Family Detached, Single-Family Attached		17.3	17.3	8.0 - 15.0
D	Single-Family Detached, Single-Family Attached		24.4	19.5	3.0 - 15.0
E	Single-Family Detached		49.5	38.8	3.0 - 8.0

Notes:

(1) Gross Acres includes lots, local roads, and functional open space. Gross Acres excludes Drexel Road and its associated greenway, dedicated easements, and natural open space.

(2) Net Developable Acres includes lots, private accessways and/or alleys, and functional open space. Net Acres excludes Drexel Road and its associated greenway, local roads, dedicated easements, and natural open space.

(3) The overall density for the PAD at residential build-out shall fall between a minimum of four (4) RAC and a maximum of eight (8) RAC. Please refer to Section III.B.2.B (Development Densities) for an explanation of how density will be tracked over the life of the project.

F. Neighborhood Center

The Neighborhood Center is a recreational focal point for the entire PAD and its surrounding neighborhoods. Its primary use will be recreational open space and a new central park located in the center of the PAD. The extension of Drexel Road and its associated greenway is also viewed as a part of the Neighborhood Center, in that this extension and greenway establishes a vibrant corridor and entry boulevard for the entire project and every adjacent Planning Area. Secondary allowed uses within the Neighborhood Center include a recreation center, day care or preschool, and neighborhood-scale religious institutions. Uses developed within the Neighborhood Center shall follow the standards as outlined within Section III.B.4 (Neighborhood Center) of this PAD. The designated Base Zoning for the Neighborhood Center is NC (Neighborhood Commercial).

G. Open Space within Planning Areas

Open space within the designated residential Planning Areas will be provided in two (2) forms: natural open space (NOS) and functional open space (FOS). NOS areas within the specific Planning Areas have been illustrated on Exhibit III.1: Conceptual Master Plan and will encompass all designated riparian habitat areas. FOS areas are those that are specifically developed for active and passive recreation and open space and may include mini-parks, neighborhood recreation centers, playgrounds, landscaped areas, drainage improvements, graded and revegetated areas, trail facilities, and private common areas. So as to insure complete clarity, the above-referenced NOS and FOS areas discussed here (and further in Section III.B.5) apply only to residential Planning Areas A through E. Open space areas within Fantasy Island Trails Park (FITP) and the SHARP component, whether natural or functional, are considered as separate and distinct from those in the residential Planning Areas.

The intent of the NOS and FOS areas within the residential Planning Areas is to provide a unifying element for the overall PAD and serve to functionally and aesthetically link the residential Planning Areas and Neighborhood Center together with Fantasy Island Trails Park (FITP) and the Southeast Houghton Area Recharge Project (SHARP). Approximately thirteen (13) acres of total NOS will be provided within the designated residential Planning Areas. The FOS component will be provided in the Neighborhood Center and within the residential Planning Areas. These NOS and FOS areas shall follow the standards outlined within Section III.B.5 (Functional and Natural Open Space).

H. Fantasy Island Trails Park (FITP)

FITP will be retained under the ownership of the City of Tucson for the purposes of preserving and protecting natural open space, washes, and wildlife habitat, and providing opportunities for non-motorized general public recreational use of the natural area. This area will protect a portion of the system of mountain bike trails described in the Master Plan for Fantasy Island Trails Park (approved by Mayor and Council May 22, 2006 Resolution No. 20333).

The permitted land uses allowed shall be the uses permitted by the OS Zone as defined in Section 4.7.1 of the UDC. The restrictions to the OS Zone shall also apply. Public recreational uses may include, but are not limited to, unpaved pedestrian and bicycle trails, select paved pedestrian and/or multi-use trails, and necessary utility easements. Certain trails may be restricted to use by mountain bicycles only and have been delineated on Exhibit III.7: FITP Comprehensive Trails Map.

I. Southeast Houghton Area Recharge Project (SHARP)

The Southeast Houghton Area Recharge Project (SHARP) is a combination of a groundwater recharge and water-distribution facility, together with a comprehensive system of pedestrian paths and mountain bike trails integrated with the recharge basins. The facility also includes a parking lot for both private vehicles and school buses, public restrooms, and picnic ramadas. These facilities will be integrated with the PAD's Neighborhood Center and thereby provide connectivity to all of the planned residential neighborhoods and to FITP. Uses developed within SHARP shall follow the standards as outlined within Section III.B.7 (Southeast Houghton Area Recharge Project) of this PAD. The designated Base Zoning for the SHARP property is SR (Suburban Ranch).

III.B.2 Development Standards: Residential Uses

The intent of the residential uses located within Saguaro Trails is to allow for a variety of densities and product types in order to create a diverse mix of housing opportunities at different price points. The PAD provides the basic framework for the residential development of each of the Planning Areas, while still providing flexibility to adapt to future market conditions. Housing types within the designated residential areas may include traditional single-family detached, single-family attached, casitas, alley loaded, row houses, auto court products, duplexes, townhomes, condominiums, lofts, apartments, assisted living centers, and group care facilities (see Glossary for definitions as appropriate). These housing options will ensure a diversity in housing products and visual aesthetics, as well as accommodate varying age groups, income levels, and lifestyles. The City of Tucson R-2 and R-3 Zones will be used as the base zoning districts for all residential uses within the PAD, except where the non-residential option is employed in Planning Area A (see Section III.B.4). With all of the above in mind, the following regulations shall apply to planning areas or portions of planning areas that are developed under the residential land use category:

A. Permitted Uses

(1) Principal Uses
    a. Single-Family Detached
    b. Single-Family Attached
    c. Multi-Family Attached (Includes Senior Independent-Living and Assisted-Living Facilities)
    d. Parks / Recreation

(2) Accessory Uses
    a. Guest House
    b. Home Occupation
    c. Farmers Market
    d. Travelers Accommodations

(3) Special Exception Uses
As permitted in the City of Tucson Unified Development Code (UDC) Section 4.8.2

(4) Prohibited Uses
The following Secondary Land Uses are not permitted:
    a. Hazardous Materials Storage
    b. Industrial Use Group
    c. Residential Care Services, Adult Care or Physical and Behavioral Health Services

B. Development Densities

The PAD residential development (Saguaro Trails) will provide a minimum overall residential density of four (4) residences per acre and a maximum density of eight (8) residences per acre. Residential density ranges for the five (5) residential Planning Areas A through E were presented in Table III.1. The densities referenced therein supersede the adopted UDC and Development Standards. The purpose of this Table is to provide a clear density expectation for each residential Planning Area, as well as for the overall PAD, so as to demonstrate compliance with the applicable City of Tucson HAMP guidelines.

So as to demonstrate and verify compliance with the required density range of the Saguaro Trails residential community (minimum 4 RAC; maximum 8 RAC), a running table shall be provided on each individual tentative resubdivision plat as residential development proceeds over the life of the project. The structure and content of this running table shall be developed in conjunction with PDSD staff prior to submittal of the first residential resubdivision plat; an updated version of the same table shall then appear on each subsequent resubdivision plat until full residential build-out is completed and the final density is determined. In all residential density calculations, the following components within Planning Areas A through E will be excluded: natural open space, easement encumbrances, and that portion of the project that is dedicated to the City of Tucson for the public right-of-way of Drexel Road.

C. Diversity in Product Type

Saguaro Trails will include a variety of housing products and architectural styles to create a dynamic and unique community within the Houghton Road Corridor. Product types will range from single-family detached to multi-family apartments, offering a spectrum of housing options for both homebuyers and renters, while satisfying their varying interests, needs and income levels. Consistent with this approach, each Planning Area is allowed to feature any or all of the permitted uses identified for each in Section III.B.2 and Table III.1.

D. Development Standards

Three (3) residential land use categories are outlined within the PAD: 1) Single-Family Detached; 2) Single-Family Attached; and 3) Multi-Family Residential. These three (3) categories will be the foundation of the regulatory development standards for the residential land uses within the PAD. Each residential land use category has its own development standards to allow for design flexibility within each category, while maintaining minimum standards that are compatible and complementary throughout the District.

(1) Single-Family Detached:

- a. Maximum Density: 10 RAC
- b. Minimum Lot Size: 2,500 sq. ft.
- c. Maximum Lot Coverage 75%
- d. Maximum Building Height: 2 stories / 36 feet
- e. Setbacks:
  - i. Front Yard:
    - (i) Main Structure: 5 feet
    - (ii) Front Entry Garage: 18 feet from back of sidewalk
    - (iii) Side Entry Garage: 10 feet
    - (iv) Off-Alley Entry/Private Accessway to Garage: 2 feet
  - ii. Side Yard:
    - (i) 0 feet
    - (ii) Minimum distance between buildings: 8 feet
    - (iii) Side Yard Adjacent to Street: 5 feet
  - iii. Rear Yards:
    - (i) Main structure: 5 feet to primary structure (including covered patio)
    - (ii) Rear Entry Garages: 3 feet
    - (iii) Accessory Structures: 0 feet

(2) Single-Family Attached:

- a. Maximum Density: 15 RAC
- b. Minimum Lot Size: 1,500 sq. ft.
- c. Maximum Lot Coverage: 85%
- d. Maximum Building Height: 3 stories / 45 feet
- e. Setbacks:
  - i. Front Yard:
    - (i) Main Structure: 5 feet
    - (ii) Front Entry Garage: 18 feet from back of sidewalk
    - (iii) Side Entry Garage: 5 feet
    - (iv) Off-Alley Entry/Private Accessway to Garage: 2 feet
  - ii. Side Yard:
    - (i) 0 feet
    - (ii) Minimum distance between buildings: 8 feet
    - (iii) Side Yard Adjacent to Street: 5 feet (adjacent to 10 foot tract)
  - iii. Rear Yards:
    - (i) Main structure: 5 feet to primary structure (including covered patio)
    - (ii) Rear Entry Garage: 3 feet
    - (iii) Accessory Structures: 0 feet

(3) Multi-Family:

- a. Minimum Site Area: 1 acre
- b. Maximum Density: 36 RAC
- c. Minimum Lot Size: None
- d. Maximum Lot Coverage: 85%
- e. Maximum Building Height: 4 stories / 52 feet
- f. Minimum Building Setback:
  - i. To Streets: 20 feet
  - ii. To Adjacent Residential Development: 20 feet
  - iii. To Adjacent Non-Residential Development: 10 feet
- g. Minimum Distance Between Buildings: 8 feet
- h. Minimum Open Space: 10% of the site excluding parking areas and driveways

E. Streetscape & Garage Treatment

The primary entrance into the PAD is from Houghton Road and is provided by an extension of Drexel Road. This new street extension will be flanked by the Drexel Road Greenway along its southern edge and will provide a clear arrival experience into the community. Drexel Road will provide direct access to the residential Planning Areas and to the project’s Neighborhood Center. Public roadways within each residential Planning Area will predominately be tree lined streets with detached sidewalks, providing a pedestrian scale and the ability to utilize street trees as a thematic element. Alleys and private access drives may not include pedestrian areas, landscape tracts or sidewalks.

To guard against garage dominance and in order to ensure visual interest of the residential streetscapes, a minimum twenty five percent (25%) of the residential lots within the PAD will feature alternative garage configurations, such as recessed entries, side-entry garages, alley-loaded, private drive entry garages, auto courts, and private courtyard projections beyond the garage face. In order to track this requirement, each residential subdivision plat shall annotate or otherwise indicate those lots that can accommodate alternative garage configurations. A note shall be placed on each tentative plat providing the percentage of alternative-configuration lots provided within that particular plat, as well as a cumulative percentage of alternative-configuration lots platted to date. An annual report shall be provided to PDSD to address garage dominance as development proceeds and to verify the minimum 25% threshold.

F. Guest House/Private Suite Provisions

One (1) primary residence, together with up to (1) guest house / private suite or secondary living quarters will be allowed on any single lot greater than 4,000 square feet. The structure may be attached or detached from the primary residence. If detached, the guest house/private suite is allowed above a garage, with a combined height not to exceed 28 feet. A guest house/private suite may provide full kitchen amenities, however, separate utility meters will not be permitted for the guest house. Rental of the guest house is allowed, with no more than two (2) residents, and shall be enforced through the private CC&Rs.

G. Lighting

All outdoor lighting shall comply with the City of Tucson Outdoor Lighting Code (OLC). Street lighting is not required for public and private streets, including the collector road and local streets. Lighting may be integrated at the discretion of the Developer. In addition, lighting is allowed within the PAD to illuminate common areas, residential lots, and multi-family sites using full cut off lights and landscape accent lighting in accordance with the OLC.

H. Parking Provisions (On-Street/Off-Street)

The residential planning areas and portions thereof within the PAD will comply with the Motor Vehicle and Bicycle Parking Requirements of Section 7.4 of the UDC with the following exceptions:

(1) Parking Spaces per Dwelling Unit.

a. Single-Family Detached and Single-Family Attached: Three (3) parking spaces per unit (inclusive of primary resident, guest and guest house parking spaces). A minimum of one (1) space on-site per unit for primary resident is required. The balance of parking spaces can be met on-lot in the driveway, on the subdivision's public streets, or within clustered parking spaces within the subdivision.

b. Multi-Family: Parking will be provided per the following criteria:

i. Units with 1 bedroom or studios. One (1) space per unit for primary resident, and one (1) space per four (4) units for guests.

ii. Units with 2 or more bedrooms. One (1) space per unit for the primary resident, and one (1) space per four (4) units for guests.

If on-site parking will not meet the required number of spaces for primary resident or guest parking, additional on or off-street parking will be provided.

(2) Guest Parking: Parking for guests is provided on site in clustered parking areas or off-site on public streets or within clustered parking. The maximum distance from a residence or multi-family building to a guest parking space is four hundred (400) feet.

(3) Bicycle Parking (Multi-Family Residential): In situations where a space in the residential unit, garage or bike storage room is not provided with a multi-family residential unit, bicycle racks will be installed, each containing spaces for four (4) bikes. A minimum of two (2) short term bicycle racks shall be located within 50 feet of the public entrance to a multi-family residence.

a. Short term bicycle parking space: Two (2) spaces per ten (10) units.

b. Long term bicycle parking space: One (1) space per two (2) units if a space is not provided within the residential unit.

(4) Vehicular Maneuvering: Private alleys and streets are also utility and ingress/egress easements and are permitted to be primary vehicular access to any residential parking areas and guest parking spaces.

I. Solid Waste and Recycle Collection

The specific method of solid waste (trash) and recycling collection will depend on the specific type of residential development and housing units built. Individual curb-side service in the public street right-of-way, private streets, alleys, or in PAAL's will be provided for those lot sizes twenty (20) feet or greater in width, unless the lot layout prevents normal pull-through service. If curb-side pick-up is not possible, a common area for collection will be provided. Further collection specifics are as follows:

(1) Residential Single-Family Detached/Attached. Standard curb-side service for Automatic Plastic Containers (APC). APC storage will be within the garage or behind a side or rear yard screen wall or fence.

(2) Residential Multi-Family. Standard curb-side service for APC. APC storage will be within garage or centralized trash containers will be in screened enclosures.

(3) Residential Alley Loaded. Standard curb-side service in the alley for APC. Residential units will include trash and recycle storage in the garage or between the units behind a screen wall or fence. For pick-up days, the APCs will be located along the alley adjacent to each unit.

(4) In the event that the spatial or pull-through or turnaround requirements for APC's cannot be met for cluster and alley loaded residential units, then a centralized trash container within screened enclosures will be provided. Where APC's cannot be accommodated, centralized trash containers may be located up to 300 feet from a residence. Centralized

trash enclosures shall be screened on three (3) sides by a solid wall and an opaque closing gate on the access side. Centralized trash enclosure walls shall have a minimum height of eight (8) feet.

(5) All trash and recycling collection methods shall include trash and recycling containers in accordance with the City's solid waste and recycling program requirements.

J. Pedestrian Circulation and Connectivity

The pedestrian circulation network for residential land uses is comprised of new public sidewalks, pedestrian trails, multi-use trails and bike routes. The core circulation network will accommodate pedestrian and bicycle routes through the interconnected system of streets, sidewalks and trails. The pedestrian trail and bike route system will connect to the public sidewalks, main entrance roadway (Drexel Road Greenway), Fantasy Island Trails Park, the SHARP project, and ultimately to the existing multi-use and bike paths along Houghton Road.

Pedestrian paths may be constructed of concrete, stabilized decomposed granite, pervious concrete, permeable pavers, concrete pavers, asphalt or other materials which meet the intent of this Section.

The pedestrian connections shall consider the following design elements to enhance connectivity:

- Pedestrian connections will be provided from proposed buildings to individual parking areas via pedestrian crosswalks.
- Connections will be made from parking lots to the closest public sidewalk adjacent to the site where possible.
- When a designated on-site pedestrian walkway crosses a parking lot, street or driveway, the walkway will be clearly visible to pedestrians and motorists through the use of: 1) a change in paving material, paving height or paving color; 2) a painted crosswalk; or 3) signage.

K. Signage and Monumentation

The applicable City Sign Code/regulations shall apply to this Property. The following community elements will be integrated into PAD to enhance its identity and guide vehicular and pedestrian circulation.

(1) Monumentation: Monumentation is an essential design element for the project. Uniform design of monuments shall provide visual continuity throughout all phases of development and establish a distinct identity and image of the community. In addition to informing and directing residents, all monuments shall be designed to be generally consistent with the materials, color, size and scale of adjacent community elements. The following principles also apply:

a. Monumentation: A series of monumentation styles are planned to establish a hierarchy of major and minor entries. The height and width of the monumentation shall vary according to the placement and use of each particular monument. Forms, colors, materials and textures used in both primary and secondary community monumentation shall complement the overall character and aesthetics of the project. Entry monuments for a designated neighborhood commercial area may be unique to accommodate retail tenants. However, even these must utilize common elements such as materials and forms to conform with to the overall community character.

b. Wayfinding: A series of wayfinding monuments shall be implemented throughout the property to assist directing automobile and pedestrian traffic.

(2) Signage: Uniform sign design shall provide visual continuity throughout all phases of development, as well as help to create the unique identity of the community. In addition to informing and directing, all signs shall be designed to remain consistent with the materials, color, size and scale of the immediately adjacent community elements. All traffic-related signs, including street-name signs, shall conform to the Manual on Uniform Traffic Devices (most recent edition) and City of Tucson standards.

(3) Materials / Color Scheme: Consistency will be maintained between building style and signage design. Color schemes and graphic schemes for signage should clearly relate to other signs in the immediate project area so as to achieve an overall consistent sense of identity.

In the event the Tucson Sign Code is amended to permit specific sign regulations to be established within a Planned Area Development, comprehensive specialized sign regulations and standards that encompass all signage in the PAD will be created and submitted for review and approval in accordance with the UDC. Any such comprehensive sign regulations and standard will address monumentation, building-mounted signage and ground (monument and pylon) signage for informational, directional, and advertising purposes. The comprehensive sign regulations and standards will complement the overall design theme of the PAD to the greatest extent possible.

L. Trails and Linkages to Fantasy Island Trails Park and the SHARP Project

Fantasy Island Trails Park (FITP) surrounds the planned residential neighborhoods of Saguaro Trails. Connections to the existing FITP system will be provided within Saguaro Trails so as to further promote an active community and healthy lifestyle. For identical reasons, Saguaro Trails will link to the proposed trail network being created by Tucson Water within its Southeast Houghton Area Recharge Project (SHARP). The means of achieving these trail and pedestrian connections will be demonstrated on each tentative subdivision plat submitted to PDSD for review. The plats will provide details and notations that identify the specific points of connection, as well as appropriate signage to insure user safety and restrict specific trails for usage by mountain bikes only.

M. Landscape Requirements

This PAD establishes base performance criteria for Saguaro Trails to address requirements prescribed by Section 7.6 (Landscape and Screening) of the UDC. The PAD is expected to meet or exceed these base performance criteria, with certain modifications of the UDC requirements applying where existing site conditions and specialized design criteria necessitate such design flexibility.

(1) Landscape Concept & Plant Palette
The PAD will implement a regionally adapted and native plant palette through the entire PAD Property that will feature varying textures and colors of plant material so as to create an inviting environment for residents and visitors (see Appendix H: Preferred Plant List). The landscape design will reinforce vehicular and pedestrian circulation routes throughout the property by highlighting primary circulation routes and key entry points to all PAD facilities and amenities.

Trees will be placed appropriately to provide shade for pedestrians, while also allowing visibility for wayfinding and signage to all facilities and amenities. For revegetated areas, a mix of desert shrubs and wildflowers will be used for disturbed areas to minimize erosion. These areas will be maintained as a naturalistic environment. Surface drainage and stormflows will be captured within landscape areas whenever practical. All run-off from pavement and from non-residential buildings and landscape will be directed into water-harvesting areas or into retention/detention basins that incorporate water harvesting.

A low water use irrigation system will be utilized for all landscape areas. The system will incorporate an automatic controller, flow sensing valves, rain shut-off capability, and will also be metered separately to monitor water usage throughout the PAD.

(2) Landscape & Screening Requirements
The PAD and all residential planning areas will comply with the following landscaping and screening requirements:

a. Street landscape borders along Houghton Road shall be a minimum of thirty (30) feet, as measured from the back of the public sidewalk within the right-of-way. A minimum of one (1) tree and ten (10) shrub and/or accents per thirty (30) linear feet of landscape area shall be required in the street landscape border.

The thirty (30) foot landscape border can be natural/undisturbed desert or can be a combination of natural and graded/relandscaped area, depending upon the quality of existing vegetation and practical project engineering considerations.

Screening may be accomplished with existing vegetation, supplemental vegetation, berms or walls. Residential lots along Houghton Road shall include a screen wall at a minimum height of five

(5) feet tall. Screening may have offsets or similar design features that encroach a maximum of three (3) feet into the landscape buffer. Final details of the above are subject to compliance with all applicable sight visibility triangle (SVT) requirements.

b. The PAD's main entry boulevard (Drexel Road) shall have a minimum of one (1) tree and ten (10) shrub and/or accents per forty (40) linear feet of landscape area along the streetscape. Within the median, a minimum of one (1) tree and ten (10) shrubs and/or accents per fifty (50) linear feet of landscape area shall be required within the median.

c. Local neighborhood streets shall integrate street trees within the curbway where feasible and outside of sight visibility triangles.

d. Street landscape borders along the main entry boulevard (Drexel Road) and local streets shall have no minimum screening requirement.

e. Residential lots shall have a minimum of one (1) tree or saguaro cactus in the front yard of each lot along the local street. For corner lots, a minimum of one (1) tree or saguaro cactus shall be located in the side yard of the lot.

f. Clustered parking areas within residential or non-residential areas shall have one (1) tree per four (4) parking spaces located along the perimeter of the parking area, within landscape islands or adjacent to the perimeter landscape. Screening in parking areas along Houghton Road and Drexel Road shall be a minimum of thirty (30) inches in height.

g. Tree and shrub substitution ratio shall be as follows: One (1) tree or saguaro cactus is equivalent to ten (10) shrubs and/or accent plants.

h. Where a planning area is adjacent to open space, park and/or local streets, a landscape border is not required.

i. To encourage visual and aesthetic connectivity between residential Planning Areas within the PAD and other land-use areas such as Fantasy Island Trails Park and SHARP, interior landscape borders between parcels within the Planning Areas that would normally be required by the Unified Development Code are not required for this PAD. Planning Areas or parcels that have the same land use, or which are developed under the same or separate subdivision plats or development packages, shall have the prerogative to individually determine the appropriate land use transitions and screening measures that are appropriate between uses. A minimum landscape border of ten (10) feet shall be applied to the transition between any neighborhood commercial/retail area and adjacent residential uses.

j. "Safe by design" principles shall be implemented in the design and construction of screen walls to prevent concealment and loitering near pedestrian and bicycle paths. Examples of the principles to be used include the articulation of walls to include jogs and offsets. Openings for pedestrian and bicycle paths should be wide and cacti and other thorny plants should be utilized to keep people out of hiding areas near pathways.

k. Private irrigation and associated sleeves, as well general utility sleeves, are allowed in public and private street rights-of-way. Those located within public rights-of-way shall be subject to a license agreement executed with the City of Tucson. Sleeves locations shall be stamped on street curbs in a visible location.

(3) Neighborhood Perimeter Border Treatments
The residential planning areas adjacent to Fantasy Island Trails Park (FITP), the SHARP property and off-site Arizona State Trust Lands will comply with the following perimeter border requirements:

- Screening of residential lots shall be accomplished with view walls, screen walls, or a combination of these treatments on the rear property line. The screening element shall be a minimum height of five (5) feet tall. The final screening treatment used for each individual residential lot shall be a function of privacy considerations and buyer/resident preference.

- Revegetation of the perimeter border shall include one (1) tree and ten (10) shrubs and/or accents per 5,000 square feet. Native seeding by the method of hydroseeding may be used in lieu of trees and shrubs.

(4) Functional Open Space Standards
Within each residential Planning Area, Functional Open Space (FOS) will be required to help promote the active and healthy lifestyle of the residents. FOS will be provided in the form of mini-parks, trails/pathways, retention/detention, common areas, and mountain bike trailheads. Each residential planning area will be required to provide a minimum of 5% FOS. For more detailed information regarding open space requirements and FOS description refer to Section III.B.5 of this PAD.

(5) Native Plant Preservation & Salvage
The PAD will comply with the City of Tucson Native Plant Preservation Standards by the Set-Aside Method; this will be accomplished by the natural open space retained in the Fantasy Island Trails Park (FITP) and associated natural-wash and riparian corridors. Final verification of compliance by this method will be demonstrated by a comprehensive Native Plant Preservation Plan (NPPP) for the entire PAD Property, which shall be submitted for review and approval in conjunction with the project's block plat as described in Section III.A.4 of this document.

(6) Water Harvesting Provisions
Residential development applications within the PAD will not require the formal submittal of a rainwater harvesting plan per the City of Tucson's Rainwater Harvesting Ordinance. New development within the PAD will integrate active and passive rainwater harvesting features when possible. See Sections II.F.2 (Conservation/Sustainability Standards) and II.F.4 (Self-Certification of Conservation & Sustainability Measures) for more detail.

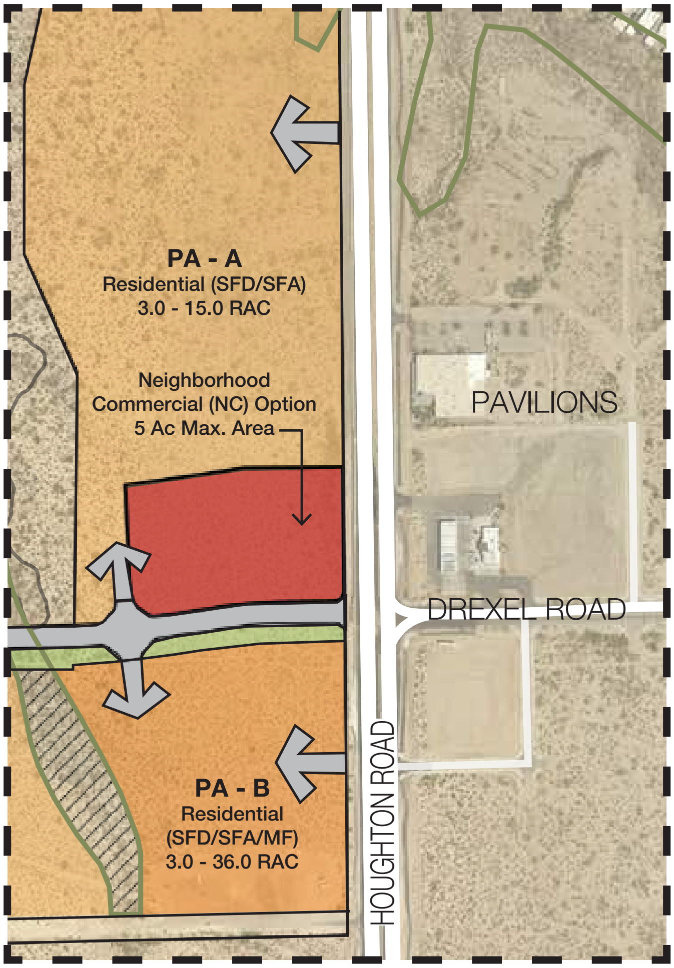
N. School Capacity Considerations & Mitigation

The Saguaro Trails owner/developer has coordinated with Vail Unified School District (VUSD) to determine the anticipated student population being generated by the PAD and its impacts upon school capacity. A formal agreement has been executed between VUSD and the owner/developer that stipulates an appropriate roof-top assessment as residential development proceeds.

III.B.3 Development Standards: Non-Residential Option

As discussed above, Planning Area A permits an option to incorporate non-residential uses by way of a small, neighborhood-scale commercial/retail area near the PAD's main entry at Houghton Road (see Exhibit III.4: Location of Non-Residential Option). The base zoning for this non-residential area is Neighborhood Commercial (NC). This non-residential option includes a prescribed set of low intensity uses that are in accordance with HAMP's definition of "convenience commercial" within, or in conjunction with, planned neighborhood centers (see HAMP, Section IV[B][6][b]). The specific uses envisioned are generally those that would be desirable to and utilized by Saguaro Trails residents. The permitted uses listed below have been reviewed by PDSD, been found to be acceptable within the PAD area, and to be in accordance with the prescriptions and intent outlined in HAMP.

Exhibit III.4: Location of Non-Residential Option



The non-residential option for Planning Area A does not require the establishment of any such uses within the Planning Area; it can still be developed, in its entirety, in residential fashion per the Development Standards prescribed above in Section III.B.2.

In the event that the non-residential option is exercised, the total area of non-residential uses within Planning Area A is limited to a maximum area of five (5) acres. Any acreage devoted to this non-residential option shall be excluded from all density calculations applicable to the residential component of this PAD. The non-residential uses must be located within the area identified on Exhibit III.4: Location of Non-Residential Option and must be oriented toward Drexel Road. The following regulations and development standards shall apply:

A. Permitted Uses

(1) Principal Uses:

- a. Farmers Market or Community Garden
- b. Postal Services (no formal US Postal Service Branch)
- c. Professional Service Offices (e.g. legal service, tax/accounting, government services)
- d. Dry Cleaners
- e. Day Care
- f. Personal Services (e.g. beauty shop, nail salon, barber shop)
- g. Coffee Shop
- h. Restaurant or Food Service (alcohol service is allowed)
- i. Drug Store or Pharmacy (no drive-thru allowed)
- j. Bank or Financial Service (located only within another primary use; no stand-alone branches allowed)

(2) Accessory Uses:
Land uses accessory to the permitted land uses are allowed, subject to compliance with Section 4.8.7 of the UDC.

(3) Special Exception Uses:
As permitted in the City of Tucson Unified Development Code (UDC) Section 4.8.7.

(4) Prohibited Uses:

- a. Civic Use Group, Section 11.3.3 Correctional Use
- b. Industrial Use Group, Section 11.3.5, Salvaging and Recycling
- c. Commercial Services Use Group, Section 11.3.4, Billboards
- d. Construction Services
- e. Non-chartered, check-cashing, or payday loan services

B. General Retail/Neighborhood Commercial Concept

The neighborhood commercial area would provide a high-intensity land use component that, in practical terms, would expand and materially enhance the PAD's Neighborhood Center and its Drexel Road Greenway corridor and main boulevard (also see Section III.B.4). The intent here is to create a gathering space for Saguaro Trails residents as well as provide the types small-scale retail/commercial that they would utilize on a regular basis. The architecture and aesthetics of the commercial area would be consistent with and complement that of the overall PAD (see Section III.G of this PAD for Architectural Standards & Guidelines).

C. Development Standards

(1) Minimum Lot Area: None

(2) Minimum Lot Width: None

(3) Separation Between Buildings: Governed by Building Code

(4) Maximum Floor Area Ratio*: 2.0

(5) Maximum Building Height: 2 stories /30 feet

(6) Minimum Building Setback:

- a. To Streets: 20 feet

(7) Minimum Landscape Border**:

- a. To Adjacent Residential Development: 10 feet
- b. To Adjacent Non-Residential Development: 10 feet

(8) Maximum Lot Coverage: None

Notes:

* Floor Area Ration (FAR) shall be defined as a ratio expressing the amount of square feet of floor area permitted for every square foot of land area within the site and the permitted maximum Floor Area (FA) shall be calculated as follows: Site Area x FAR = FA. The FAR designated above shall apply to each separate site, as that term is defined as the land area consisting of a lot or contiguous lots, not including dedicated public property, designated for development as a single entity and exclusive of any abutting public right-of-way within a Planning Area. It is conceivable that a Planning Area may also be a single site.

** Minimum Landscape Border refers to the perimeter of the zoning district only, not individual parcels or buildings.

D. Parking Requirements

Motor Vehicle and Bicycle Parking requirements of Section 7.4 of the UDC will apply with the following exceptions:

(1) To encourage alternative transportation, the motor vehicle requirements for each land use group/class categories may be reduced by 25% of the parking space required.

(2) Short term bicycle parking spaces may be substituted for long term bicycle spaces on a two for one basis up to a maximum of 50% of the required number of long term spaces. A minimum of two (2) short term bicycle racks shall be located within one hundred (100) feet of the primary public entrance.

E. Off-Street Loading Criteria

The PAD will comply with the off-street loading requirements contained in Section 7.5 of the UDC, with the following exceptions:

(1) No designated loading spaces are required for businesses with less than 2,500 square feet of GFA. Loading areas can be provided at off-street parking spaces and at designated on-street locations posted for such use, provided that the loading space is located within 250 feet of the use it serves and is not used by semi-trucks. These spaces may be reduced in size to accommodate a van or small panel truck and shall be a minimum of 8.5' x 23' in size.

(2) Two or more principal uses within the same site treated as a single project may share designated loading spaces. Users on different sites within a commercial area may share designated off-street loading spaces provided they are within 250 feet of each user. Allowing shared loading spaces could reduce the required total number of loading spaces for each principal use by up to 50%. Dimensions for

loading zones shall be 12’x35’ in size for a Type A, exclusive of access and maneuvering area and maintain a clearance of fifteen (15) feet.

(3) Off-street loading areas shall be screened per the landscape and screening standard in Section III.B.3.I.

F. Lighting

All outdoor lighting shall comply with the City of Tucson Outdoor Lighting Code (OLC). Lighting is allowed within parking areas, along pedestrian routes, and attendant to non-residential signage using full cut off lights. Landscape accent lighting is permitted.

G. Solid Waste and Recycle Collection

The PAD will comply with the solid waste and recycle collection requirements contained in Section 7.5 of the UDC, with the following exceptions:

(1) Trash collection will be allowed between 7:00 am and 7:00 pm only.

(2) Loading and delivery docks, outdoor storage areas, solid waste and recycling areas and other similar exterior improvements facing residential neighborhoods will be screened with walls that are a minimum of six (6) feet high and which are designed to prevent unreasonable light, noise and visual impact on such residential neighborhoods. No such screening element or wall will be required if the residential neighborhood is already substantially screened by intervening buildings, landscaping or natural areas.

H. Signage

The applicable City Sign Code/regulations shall apply to this Property. The following community elements will be integrated into the non-residential use area to further the identity of the PAD and to guide vehicular and pedestrian circulation.

(1) Monumentation
Uniform monumentation design will be provided to ensure visual continuity throughout the PAD and to promote the aesthetic linkage of the non-residential area to the remainder of the of the project. While informing and directing residents and retail/commercial patrons, all monuments shall be designed to remain generally consistent with the materials, color, size and scale of the larger PAD community.

a. Monumentation: a series of monumentation styles are planned to establish a hierarchy of major and minor entries. The height and width of the monumentation shall vary according to the placement and use of each particular monument. Each commercial entry may be unique, however common elements, such as materials and form, shall be used to conform to the overall character of the larger PAD community. The name of the commercial center and its tenants may be used on either, or both, primary and secondary monumentation. The height and width of monumentation shall be allowed to vary according to the placement and purpose of each monument.

b. Wayfinding: A series of wayfinding monuments shall be implemented within the property to assist directing automobile and pedestrian traffic.

(2) Signage
Uniform sign design shall provide visual continuity throughout all phases of development, as well as help to create the unique identity of the community. While informing and directing retail/commercial patrons, all signs shall also be designed to remain consistent with the materials, color, size and scale of other nearby community elements. All traffic-related signs, including street-name signs, shall conform to the Manual on Uniform Traffic Devices (most recent edition) and City of Tucson standards.

(3) Materials / Color Scheme
An effort shall be made to achieve a general consistency between building style and sign design. Color schemes for signage are allowed to vary from one another for aesthetic interest, but must still generally relate to other signs, graphics and color schemes in the same vicinity.

In the event the Tucson Sign Code is amended to permit specific sign regulations to be established within a Planned Area Development, comprehensive sign regulations and standards that encompass all signage in this PAD will be created and submitted for review and approval in accordance with the UDC. The comprehensive sign regulations and standard will include monumentation, building mounted signage and ground (monument and pylon) signage for informational, directional, and advertising purposes.

I. Landscape Requirements

(1) Landscape Concepts and Plant Palette
The landscape concept and plant palette for the non-residential use area shall be consistent with that as articulated in Section III.B.2.m(1) of this PAD.

(2) Screening Requirements & Standards
The screening requirements and standards for the non-residential use areas shall be consistent with those articulated in Section III.B.2.m(2) of this PAD.

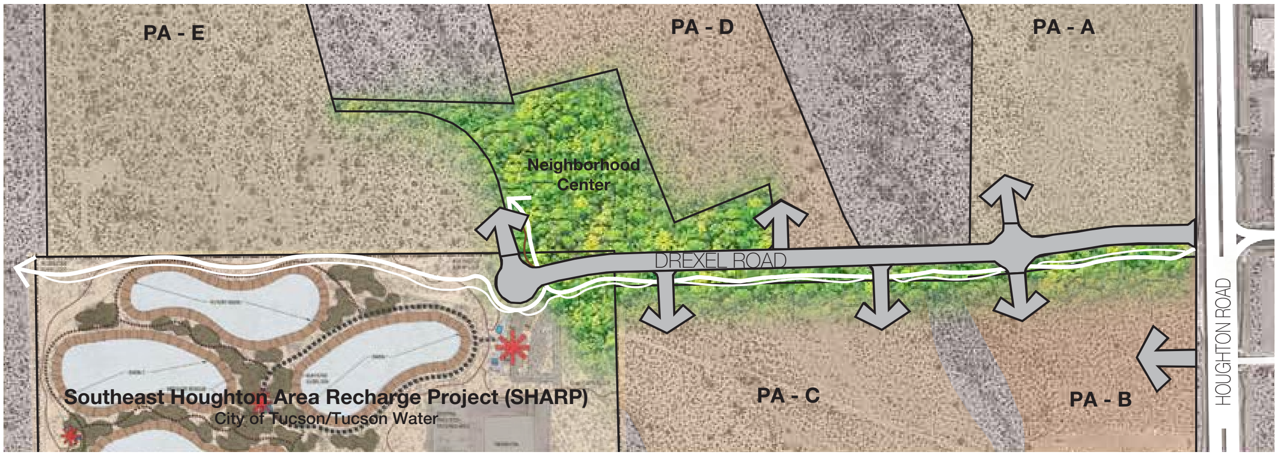
(3) Functional Open Space Standards
Functional Open Space (FOS) will be provided within all non-residential planning areas in the form of courtyards, outdoor plazas, performance areas, public art areas, patio areas, group gathering areas, and trail/pathway connections. A total of 2% of the total site area will be required to be set aside as FOS. For more detailed information regarding open space requirements refer to Section III.B.5 of this PAD.

(4) Water Harvesting Provisions
Commercial development applications within the PAD will integrate water harvesting in conformance with the City of Tucson’s Commercial Rainwater Harvesting Ordinance. A formal submittal of a rainwater harvesting plan will be required for new commercial development within the PAD integrating active and/or passive rainwater harvesting features when possible.

III.B.4 Development Standards: Neighborhood Center

A primary focal point of the PAD is the Neighborhood Center. The core element of this feature is a central park that will provide direct linkages to not only the adjacent residential neighborhoods within Saguaro Trails, but also to Fantasy Island Trails Park (FITP) and to the recreational components of the SHARP facility. The Neighborhood Center is not limited solely to this central/park node. It also includes the entire Drexel Road Greenway extension into the PAD from Houghton Road (see Exhibit III.5: Neighborhood Center and Drexel Road Greenway Corridor - Conceptual Plan View). This corridor is the central spine of the entire PAD, providing: 1) a vibrant entry sequence, created by a boulevard treatment of Drexel Road that is emphasized with enhanced landscaping and distinctive signage/wayfinding; 2) an adjoining multi-use trail (the Drexel Road Greenway extension), creating direct connectivity to the existing Houghton Road multi-use paths and outlying regional trails; and 3) direct vehicular and pedestrian access to each and every residential Planning Area within Saguaro Trails. As such, the entire Neighborhood Center and Drexel Road Greenway corridor functions as a highly accessible social and recreational artery of the entire PAD.

Exhibit III.5: Neighborhood Center and Drexel Road Greenway Corridor - Conceptual Plan View



A. Permitted Uses

(1) Principal and Secondary Uses:

- a. Neighborhood Park
- b. Recreation or Senior Center
- c. Day Care and Preschools
- d. Elementary School (parking shared with park)
- e. Model Home Complex (for later conversion to park uses and activity centers)
- f. Trails / Pathways
- g. Community Garden
- h. Farmers Market

(2) Prohibited Uses:

- a. Civic Use Group, Section 11.3.3 Correctional Use
- b. Industrial Use Group, Section 11.3.5, Salvaging and Recycling
- c. Commercial Services Use Group, Section 11.3.4, Billboards
- d. Construction Services

B. Guiding Concepts

The Neighborhood Center is the synergistic element for the entire PAD Property, functionally connecting its residential areas and non-residential areas with FITP and SHARP. This interconnection establishes a vibrant core of activity and recreational opportunity that is available and convenient to all residents, both inside and outside of the PAD.

Connectivity through the Neighborhood Center's central park will be preserved for FITP and a public parking lot and trailhead will be established for the SHARP facility. Existing FITP mountain bike trails will be rerouted, as necessary, through the new central park and SHARP property so as to ensure their continuity with the larger FITP trail network that exists to the north and south. Through the construction of comprehensive sidewalk, trail and pedestrian pathway systems within each residential Planning Area, all future neighborhoods will have direct access to the new central park, the Drexel Road Greenway, FITP and SHARP.

The Neighborhood Center central park will include, at a minimum, the following amenities:

(a) Turf (minimum 0.75 acres)

(b) Splash pad or community pool

(c) Dog park

(d) Two (2) Ramadas

(e) One (1) Playground with play elements for age 3-5 and 5-12 (ADA accessible)

(f) One (1) Swing system

(g) Six (6) Benches

(h) Four (4) Picnic benches

(i) One (1) Water fountain

(j) Community Garden

(k) Extension of two (2) one-way Fantasy Island Trails Park single-track, non-motorized mountain bike trails.

C. Landscape Requirements

(1) Landscape Concept & Plant Palette

The landscape program for the Neighborhood Center and Drexel Road Greenway corridor is intended to establish a landscape character encompassing the best regional characteristics of the Sonoran Desert and Southern Arizona. A combination of native and non-native plant materials will be utilized in the landscape design, providing year round visual interest as well as maintaining an indigenous appearance. The landscape theme is designed to blend into and enhance the existing on-site and surrounding landscape. Areas of significant vegetation within the NOS areas of the central park will be preserved in place, where possible, or transplanted. The general landscape intent is to maintain a desert theme, incorporating low water use trees, shrubs, groundcovers, and accents that will provide shade, visual interest and aesthetic value. Plant material will be consistent with the overall landscape concept for larger PAD, creating continuity throughout the project.

The landscape program shall also recognize xeriscape principles of the southwest desert environment, with the end goal being a low-water and low-maintenance environment once the plant materials have been established. The irrigation program shall be designed to optimize potable water consumption. Water harvesting techniques, such as microbasins and swales (in accordance with Ordinance Number 10210 - Water Harvesting Manual) will be utilized and illustrated on required landscape plan submittals to PDSD.

(2) Reclaimed water irrigation infrastructure shall be constructed within the neighborhood center's central park and within the Drexel Road Greenway Corridor by the owner/developer, and reclaimed water will be used therein when supply is available. These shall be the only areas in which reclaimed water is a requirement. The balance of residential Planning Areas A through E are expressly exempt from UDC Section 7.6.6.B. Any

construction of reclaimed water infrastructure and its use in these Areas shall be at the discretion of the owner/developer after practical cost-benefit considerations.

(3) Park Maintenance Responsibility & Practices
The landscape aspects of the Neighborhood Center, including both the Drexel Road Greenway and the central park, will be maintained by the Master Home Owners Association (HOA) of the PAD. The developed facilities of the central park, such as ramadas, play equipment, and any enclosed buildings, will also be the responsibility of the same Master HOA.

D. Trail and Pathway Provisions

Trail and pathway elements within the Neighborhood Center and Drexel Road Greenway corridor will be provided in accordance with the following:

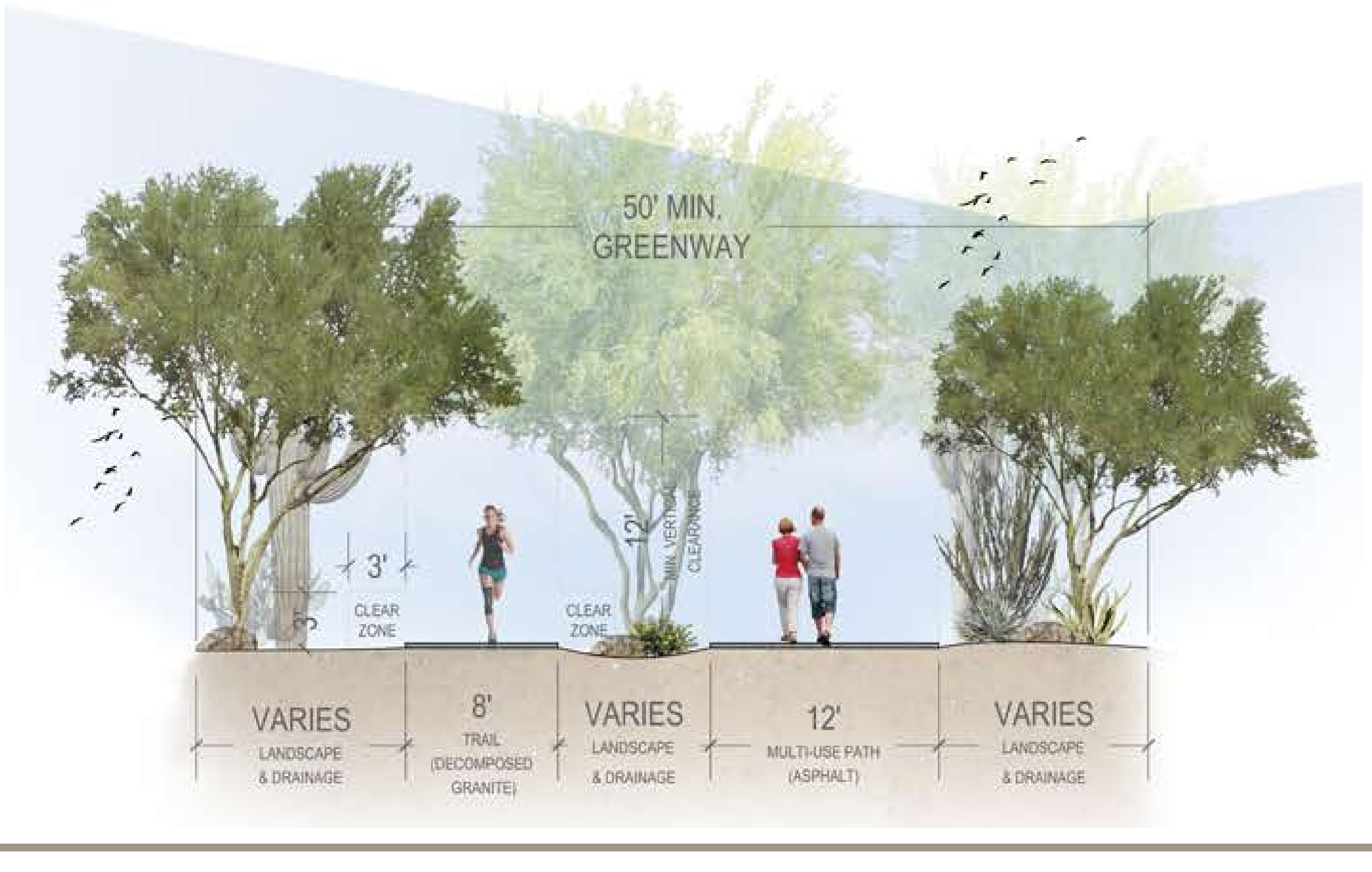
(1) Drexel Road Greenway: a twelve (12) foot wide multi-use paved path and an eight (8) foot wide decomposed granite trial will be provided. The Greenway will be consistent with the Pima County Divided Urban Pathway model and will meander within a minimum fifty (50) foot wide landscaped corridor (see Exhibit III.6: Divided Urban Greenway). The Greenway provides an east/west connection along the south side of Drexel Road from Houghton Road to the neighborhood center central park. The further extension of this greenway westward to the existing Harrison Greenway (Loop) Trail is also desired, however this is subject to the granting of an access/trail easement by the Arizona State Land Department (ASLD) through its adjacent holdings.

(2) In areas where the Drexel Road Greenway approaches/enters areas of Riparian Habitat or other environmentally sensitive site and/or physical constraint, the Greenway will be sited to minimize disturbance to the area.

(3) Designated bicycle lanes (six feet in width) will be provided within the Drexel Road pavement prism, tying in with the existing bicycle/multi-use paths in Houghton Road.

(4) Two (2) single-track, non-motorized mountain bike trails associated with the Fantasy Island Trails Park (FITP) will be realigned within/through the Neighborhood Center central park, with the intent being to provide connectivity through the central park and SHARP facility and reconnect to the existing system of FITP trails further to the south. The master residential developer is working with the mountain bike community as well as with the City of Tucson to establish the best and safest route for this realignment. At other locations within the PAD, mountain bike trailheads into FITP will be allowed from adjacent residential neighborhoods. Signage will notify residents and pedestrians that the mountain-bike trails are for bicycle use only.

Exhibit III.6: Divided Urban Greenway



III.B.5 Development Standards: Natural and Functional Open Space

Open space within the PAD's various residential Planning Areas is categorized as either Natural Open Space (NOS) or Functional Open Space (FOS). So as to ensure complete clarity, these NOS and FOS areas are only those within residential Saguaro Trails Planning Areas A through E. Open space areas within Fantasy Island Trails Park (FITP) and the SHARP component, whether natural or functional, are considered as separate and distinct from those in the residential Planning Areas.

Natural Open Space (NOS) areas within residential Planning Areas encompass all designated riparian habitat areas and wash corridors and will be delineated on the future block plat and resubdivision plats as NOS set-asides. These areas will not be considered in the overall developable acreage of the project nor in any related density calculations.

There is no minimum NOS threshold of preservation for each individual residential Planning Area. NOS preservation shall be evaluated only on a comprehensive basis over the entire PAD Property. The aforementioned block plat shall delineate all riparian and wash preservation areas within the PAD property, and shall provide verification that sufficient resource value is being protected in accordance with the findings and inventory of the PAD's site-wide Environmental Resource Report (ERR).

Some of the NOS areas on the Property have already experienced prior disturbances through past activity. Other minor, low-impact disturbances will be allowed in NOS areas in developing the PAD in the form of necessary road crossings, trails, signage, and utility easements. A careful planning approach will minimize such additional impacts on the NOS areas, facilitating better continuity of the natural open space throughout the property.

Functional Open Space (FOS) within the residential Planning Areas of Saguaro Trails provides passive and active recreation, drainage areas, trail facilities, and other common areas. Within each Planning Area, FOS areas are provided and will include components such as mini parks, trailheads, detention/retention areas, common areas, graded and revegetated areas, and perimeter landscaped buffers. A minimum threshold of five percent (5%) of FOS shall be provided within each Planning Area. This percentage calculation shall exclude any areas that are set aside as natural open space (NOS), such as designated riparian areas and wash corridors. All FOS areas and calculations will be delineated in detail at the time of final design and resubdivision platting for each Planning Area.

The following specific development standards pertain to NOS and FOS areas within the residential portions of Saguaro Trails only. They do not pertain to the designated Neighborhood Center, the central park, Fantasy Island Trails Park or the SHARP facility, each of which has their own individual development standards within this PAD document.

A. Mini Parks

Mini parks will be provided within the Planning Areas where the walking distance from the Neighborhood Center Park is greater than 1,500 feet, approximately a five (5) minute walk. It is anticipated that at a minimum total of three (3) mini parks will be provided within PAD's collective Planning Areas; these can be integrated with drainage basins in joint-use fashion, subject to insuring appropriate safety considerations for users. The mini parks will each provide approximately ¼ - ½ acres of landscaped park area and will be maintained by a private homeowners association.

Each mini-park will include the following minimum amenities:

(1) Play features such as swings and/or play elements for age 3-5 and 5-12 (ADA accessible)

(2) 2 Benches

(3) 1 Ramada

(4) An alternative set of amenities to the above agreed upon by PDSD and the owner/developer

B. Trail and Pathway Provisions

Trail and pathway elements will be provided in accordance with the following:

(1) Sidewalks will provide pedestrian connections between the residential, recreational open space, and Neighborhood Center Park uses. Sidewalks will be provided on all local roadways throughout the project and within its residential neighborhoods. These sidewalks will generally occur on both sides of the street, but may occur only one side when the other is not fronted with residential lots or when other site conditions do not warrant the continuation of the sidewalk on both sides of the street. With respect to Drexel Road, a sidewalk will only be provided along the north side of this street, since the Drexel Road Greenway paths (pedestrian and multi-use components) will be constructed along its south side. All sidewalks will be paved and be a minimum of five (5) feet in width.

(2) Pedestrian trails will have a minimum width of four (4) feet and may be paved or natural surface. Trails will provide linkages between planning areas and may integrate passive recreation amenities such as seating, landscaping, etc.

C. Open Space Relationship to Common Areas

Private common areas within the various residential neighborhoods will function as open space areas that generally provide for active or passive open space, or which incorporate basic common elements and services to all residents of the neighborhood. Common areas can include pocket parks, drainage and buffer areas, private streets, alleys, sidewalks, and landscape areas adjacent to street rights-of-way. All common areas within residential neighborhoods will be owned and maintain by the respective homeowners association for that particular subdivision.

D. Maintenance

All NOS and FOS within the PAD's designated Planning Areas will be owned and maintained by either the Master Homeowners Association for the PAD, or by individual HOA's within each residential subdivision.

III.B.6 Development Standards: Fantasy Island Trails Park

The UDC designated base zoning for the portion of Fantasy Island Trails Park (FITP) contained in this PAD shall be OS (Open Space).

FITP will be retained under ownership of the City of Tucson, for the purposes of preserving and protecting natural open space, washes, and wildlife habitat, as well as providing opportunities for general non-motorized public recreational use of the natural area. This component of the PAD will protect that portion of the mountain bike trails system described in the Master Plan for Fantasy Island Trails Park (approved by Mayor and Council May 22, 2006 Resolution No. 20333).

A. Permitted Uses

The permitted land uses within FITP shall be the uses permitted by the OS Zone as defined in Section 4.7.1 of the UDC. The restrictions to the OS Zone shall also apply. Public recreational uses may include, but are not limited to, unpaved pedestrian and bicycle trails. Certain trails, as annotated on Exhibit III.7, may be restricted to use by non-motorized mountain bicycles only. Utility easements for public sewers and other needed project utility infrastructure are also permitted, in coordination with the City of Tucson. Vehicular entry by utility company vehicles and City vehicles for maintenance purposes, public safety needs, etc. is also permitted.

B. FITP Trail Modifications

Modifications to FITP mountain-bike trails are permitted under this PAD so as to ensure connectivity between the FITP trail system and: 1) the planned pedestrian and multi-use trail system provided in residential neighborhoods; and 2) the pedestrian, multi-use, and mountain-bike trails provided within the SHARP facility. All such modifications to FITP trails shall be jointly coordinated, as appropriate, between the City of Tucson (in coordination with FITP users), the owner/ developer, and Tucson Water.

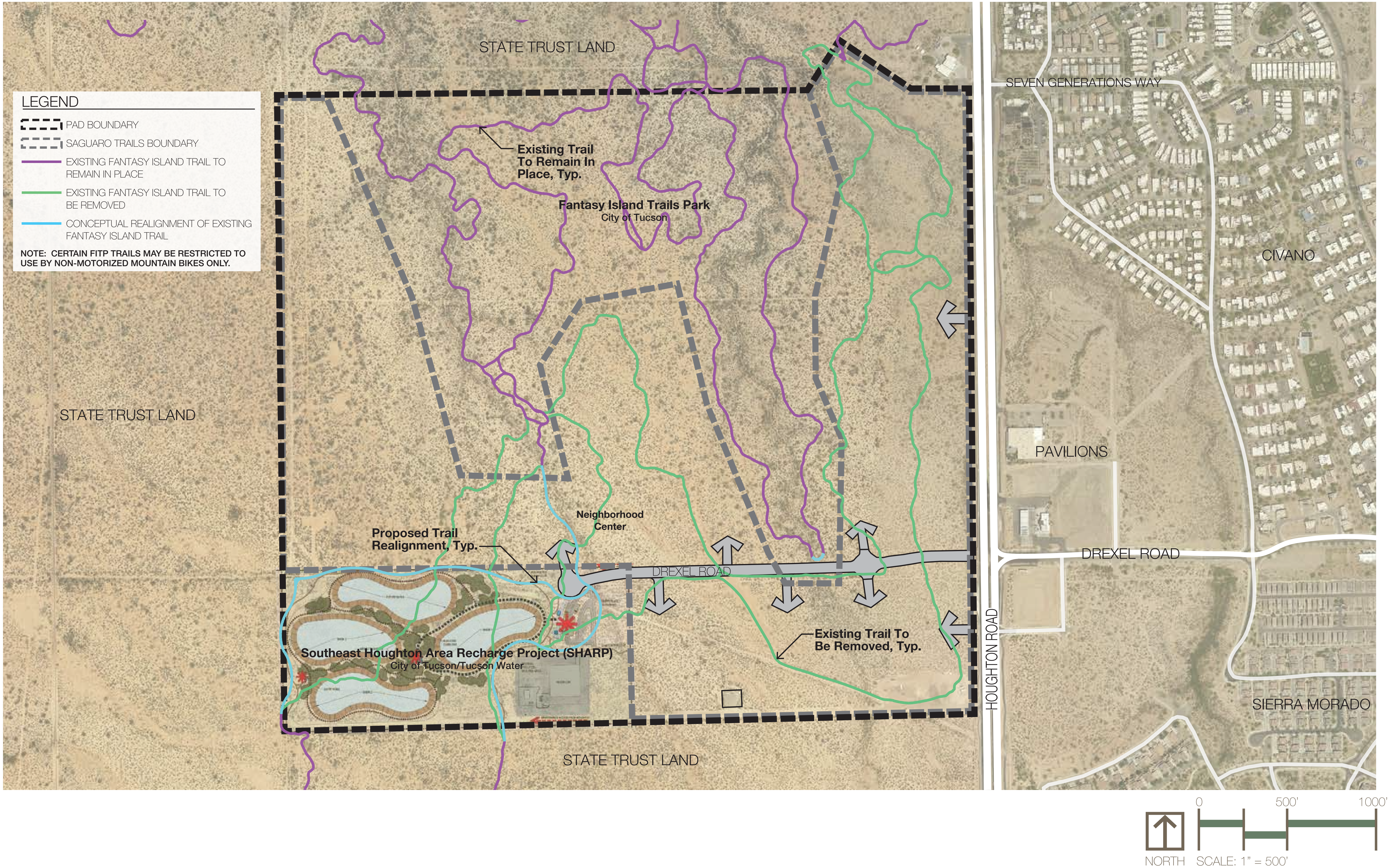
C. Regional Connectivity

It is the intent of this PAD that the existing FITP trail network effectively links to the new residential areas within the PAD, to the SHARP trail network, and to adjacent existing public trail systems (e.g. the Houghton Road multi-use paths). This connectivity shall be demonstrated on future resubdivision plats and development packages as applicable.

D. Maintenance

Maintenance responsibilities for all aspects of that portion of the FITP system located within this PAD shall be that of the City of Tucson. Maintenance of new pedestrian-only trails constructed within the FITP portion of the PAD will be the responsibility of the master HOA.

Exhibit III.7: FITP Comprehensive Trails Map



III.B.7 Development Standards: Southeast Houghton Area Recharge Project

The UDC designated base zoning for the Southeast Houghton Area Recharge Project (SHARP) facility is SR (Suburban Ranch), specifically incorporating the Parks and Recreation (PR) and Utility (U) use groups allowed therein, the latter of which allows for distribution systems, which includes groundwater recharge facilities. For illustrative purposes only, the current SHARP draft/concept master plan is provided as Exhibit III.8.

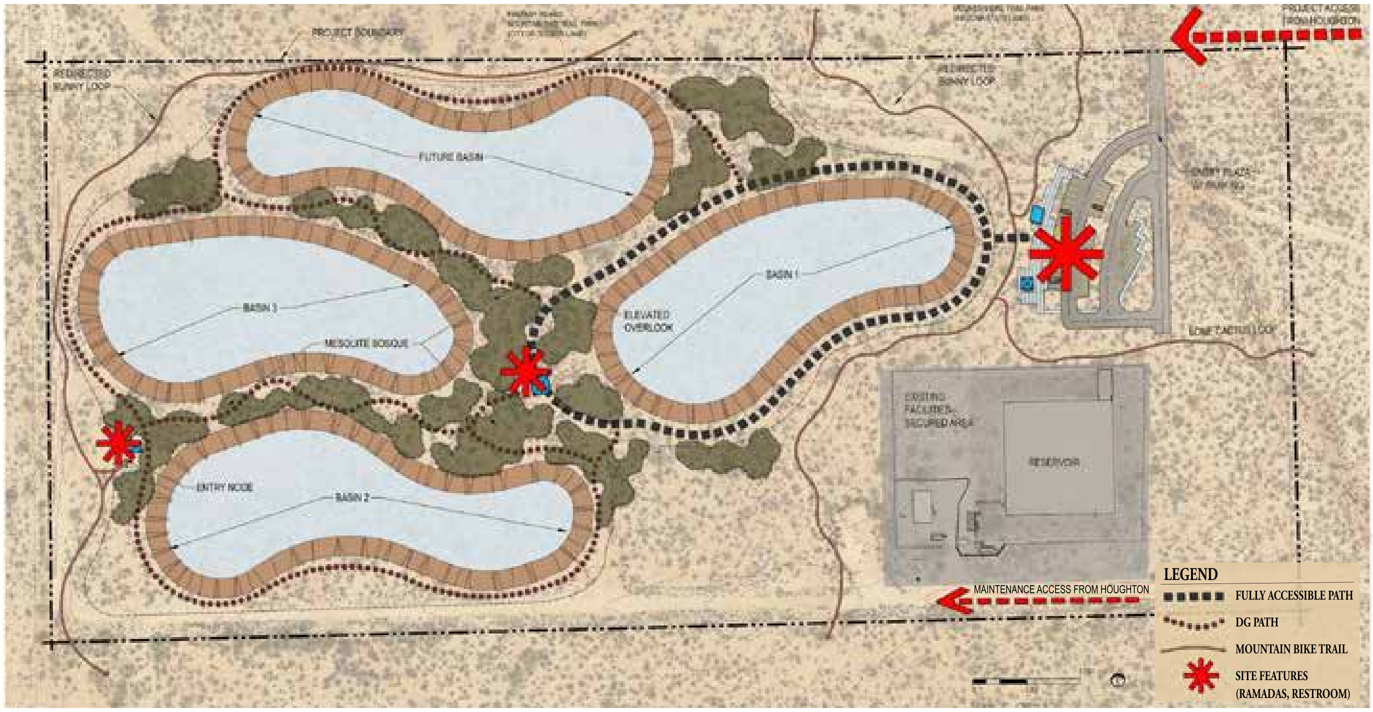
A. Maintenance

The following uses are identified to allow for the continued operation of all existing Tucson Water improvements and facilities on the property, as well as accommodate all future proposed and contemplated uses of the SHARP project.

(1) Existing Uses and Facilities
The following existing uses on the property, both above ground and subsurface, predate this PAD document and are hereby authorized and permitted uses in their present locations and in their present form under this PAD:

- The 4.5 million gallon capacity reservoir, approximately one hundred seventy (170) feet by one hundred eighty (180) feet in dimension. The reservoir exists both underground and above-ground, with the majority of the facility being buried and approximately two feet to three (2-3) feet of the structure's vertical wall being visible above ground.
- Underground 24" and 36" diameter transmission water lines which convey reclaimed water to and from the reservoir.
- A booster station, with three (3) existing pumps and reserved space for two (2) future pumps on an existing concrete pad approximately thirty (30) feet by sixteen (16) feet in size.
- A masonry building (forty-four [44] feet by twenty-two [22] feet by seven [7] feet tall) for electrical control panels and restroom for employee use, together with the existing 1,000-gallon septic facility and leach field.
- A 5,000-gallon hydro-pneumatic tank (twenty-two [22] feet by six [6] feet by seven [7] feet tall) for booster-pump operations.
- A flow-meter vault (forty-eight [48] feet by eight [8] feet).
- A Tucson Electric Power (TEP) transformer and associated twenty (20) foot tall solar-powered lamp.
- A twenty-four (24) foot tall communications antenna.
- Vehicular drives, outdoor storage, and maintenance/service yards to facilitate the interior and outdoor inspection and maintenance of all facilities and structures, and for the outdoor storage of maintenance vehicles, machinery, and supplies.
- Perimeter chain-link security fencing surrounding the reservoir structure and along the west and south property boundaries so as to secure the site against vandalism and entry by cattle.
- An existing Tucson Water system well located within the PAD Property, on Tax Code Parcel No. 141-01-006B.

Exhibit III.8: Preliminary SHARP Concept Plan



(2) Proposed Uses, New Structures and Activities
The following uses are authorized by this PAD as part of the proposed SHARP recharge facility and recreational improvements:

- Recharge basins, up to three (3) acres each in area.
- A sub-surface metering station, forty (40) feet by twenty-eight (28) feet in area.
- One (1) monitoring well and one (1) stilling well.
- Visitor restroom facilities and comfort station connected to the sewer system.
- Ramada structures up to twenty-five (25) feet square in area and up to ten (10) feet tall.
- Pre-cast concrete trash receptacles, benches, picnic tables.
- A public parking lot containing a minimum of twenty-seven (27) parking spaces (including a minimum of two [2] disabled spaces) and three (3) bus spaces.
- Mountain bike trails, a minimum of three (3) feet wide and composed raked earth.
- Multi-use asphalt paths, twelve (12) feet wide.
- Pedestrian paths, decomposed granite surfacing, eight (8) feet wide.
- Water-harvesting basins, varying depths.
- Ultimate improvements, beyond the above SHARP improvements, may include new masonry buildings, communication antennae, additional transmission mains, and an interpretive multi-use facility.
- Native plant preservation and salvage compliance, supplemented with selective additional vegetation to create native habitat and enhance the visitor experience.

B. Development Standards

The following specialized development standards shall apply to the SHARP property:

- There is no minimum lot size requirement.
- There is no maximum lot coverage limitation.
- The required setback for all structures and/or improvements (including recharge basins) is zero (0) feet.
- The maximum building height for new enclosed buildings shall be thirty (30) feet.
- The maximum height of new communications antennae shall be thirty (30) feet.
- No perimeter landscaping or screening is required; any such landscaping or screening is voluntary.
- Uses associated with the SHARP facility are not required to occur within an enclosed building.
- The public parking facility will a minimum of twenty-seven (27) parking spaces (including a minimum of two [2] disabled spaces) and three (3) bus spaces.
- There shall be no restriction on hours of operation associated with any and all Tucson Water maintenance and operations activities.
- The public parking area shall be subject to the City's Commercial Rainwater Harvesting standards and minimum shade-tree requirements. Shade structures with solar panels is an acceptable alternative to the latter.
- Temporary lighting is allowed for emergency work.
- The service road along the southern boundary of the SHARP facility (and continuing along the south boundary of the larger PAD Property) shall remain as a dirt road or, at Tucson Water's discretion, be chip sealed.
- All public use areas and park/recreational elements within the SHARP facility shall be closed at dusk for security purposes, unless posted otherwise.

C. Connectivity to Neighborhood Center and Fantasy Island

Connectivity shall be provided with the SHARP facility as follows:

- SHARP mountain-bike trails shall provide for connectivity to the Fantasy Island Trails Park (FITP) mountain-bike trail system.
- SHARP multi-use trails and pedestrian paths shall provide for connectivity to the trail system of the planned residential neighborhoods and to the Drexel Road Greenway.
- Continuous pedestrian connectivity shall be provided from Houghton Road to the public parking area associated with the SHARP facility. The multi-use path within the Drexel Road Greenway shall be considered as sufficient to satisfy this requirement.

D. Maintenance Responsibilities of SHARP Components

Maintenance responsibilities for all aspects of the SHARP project, whether recreational or infrastructural, shall be solely that of Tucson Water.

III.C Transportation Infrastructure

A comprehensive Traffic Impact Analysis (TIA) has been prepared for this PAD by Southwest Traffic Engineering, LLC (SWTE). The TIA is considered a stand-alone, companion document to this PAD. The narrative below summarizes the particulars and findings of the full TIA so as to provide a briefer version of the project's traffic-related particulars and impacts. Readers desiring more in-depth traffic and transportation detail are directed to the full SWTE document included as Appendix I.

III.C.1 Traffic Impact Analysis (TIA) Summary of Impacts

The purpose of this traffic study is to evaluate the current and future transportation system that characterizes the project study area and to do so in both the pre-development and post-development condition (i.e. the ultimate projected build-out of the PAD). The comprehensive analysis included examining the traffic operations at five (5) existing intersections, as well as seven (7) new proposed site access points. The proposed lane assignments and turning movements for these intersections and access points are illustrated in Exhibit III.9: Travel Lane and Turning Movement Recommendations.

A. Scope of Traffic Study & Methodology

The TIA's scope and methodology was structured to achieve the following objectives:

- Evaluate the current and future operational characteristics of the adjacent roadway network surrounding the PAD site.
- Estimate the traffic generation associated with the proposed PAD and assign that traffic to the existing roadway system.
- Analyze future traffic operations at the seven (7) proposed access points, as well as at the existing study intersections.
- Determine the need for auxiliary (left and right turn) lanes at the seven proposed access points that will serve the PAD site.

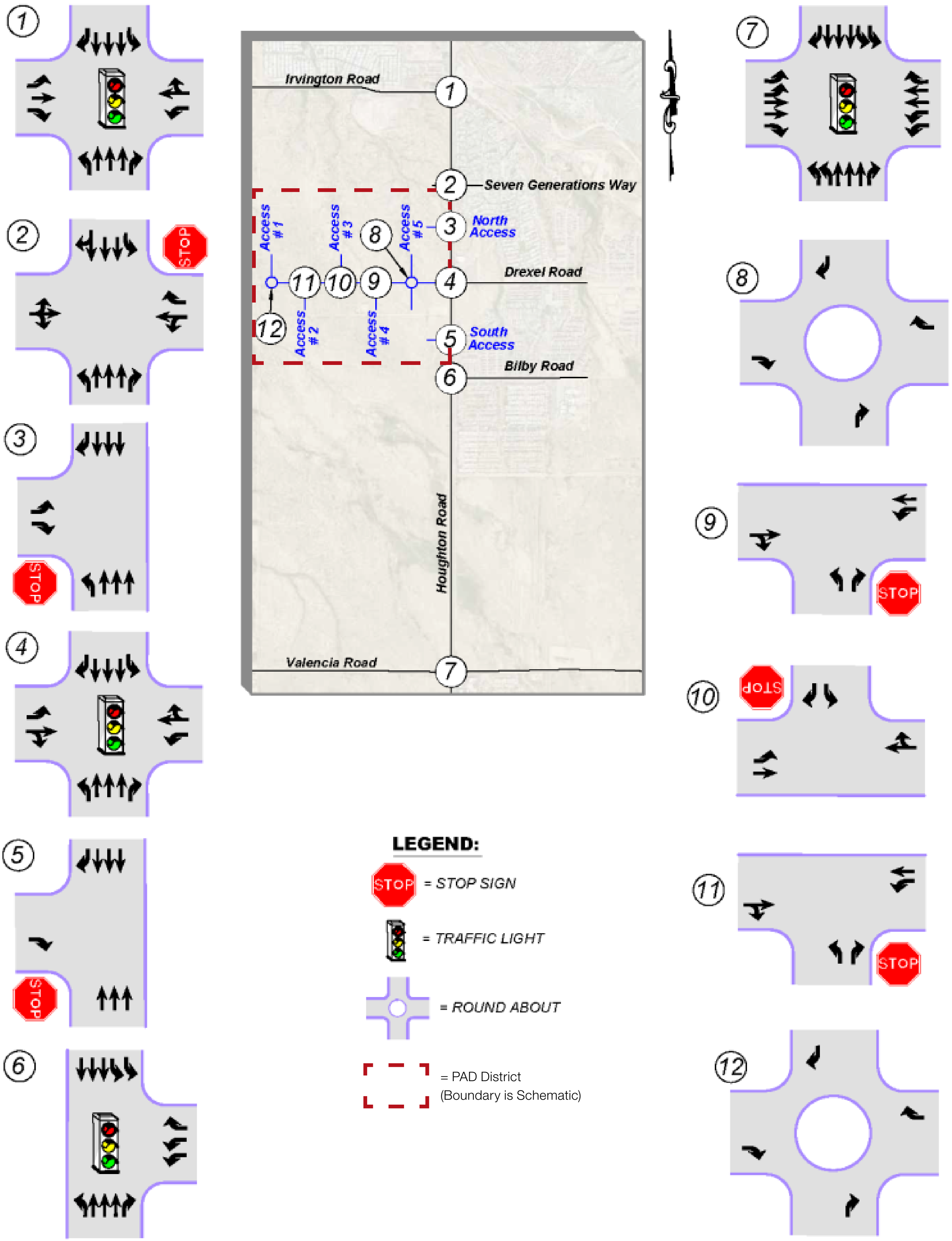
B. Traffic/Transportation Impacts of Proposed PAD Build-out

At full/maximum build-out, the proposed PAD is projected to generate an additional 11,398 weekday vehicle trips per day (VTPD) onto the adjacent street system from the new project site. Fifty percent (50%) of these new trips (6,515 vehicle trips) will be into the PAD site and the remaining 50% will be exiting the site.

All movements at the existing study intersections currently operate at an adequate level of service (LOS) and are expected to continue to do so in 2017 and 2022, without any new traffic from the project. It must be noted, however, that the southbound left turn at the intersection of Seven Generations Way/Houghton Road is on the cusp of an inadequate LOS E during the weekday AM and PM peak hour in 2022, even without any new trips from the proposed PAD.

Given the high existing southbound left turn volumes that occur at Seven Generation Way during the weekday AM/PM peak hour, together with the large northbound through volume on Houghton Road, the intersection is expected to

Exhibit III.9: Travel Lane and Turning Movement Recommendations



breakdown in future years, even without any new trips from the PAD site, based solely on continued future growth in the surrounding area.

The southbound left-turn movement at the intersection of Seven Generations Way and Houghton Road is predicted to experience an inadequate LOS E and F, during the weekday AM/PM peak hours of 2017 and 2022, when traffic from the proposed project is added to the analysis. While the installation of a traffic signal may improve LOS for this minor street, the intersection would be located less than one (1) mile between the adjacent signalized Houghton Road intersections at Drexel Road and Irvington Road and is considered an inappropriate location for an additional traffic signal. In addition, the results of a traffic signal warrant analysis shows that traffic signal warrants #1A, #1B, and #2 are not satisfied. It is expected that the adjacent signalized intersections (at Drexel & Irvington Roads) will create gaps in traffic on Houghton Road, which will allow for turning movements at the Seven Generations Way. Moreover, the aforementioned inadequate LOS occurs during the weekday peak hours only, and is expected to operate adequately during the remaining hours throughout the day.

At the proposed northern access road from Houghton Road into the PAD Property, the eastbound (exiting) left-turn movement is predicted to experience an inadequate LOS during the weekday AM/PM peak hours of 2017 and 2022 when traffic from the proposed project is factored into the analysis. Potential mitigation measures are limited at this intersection. Unsignalized minor street intersections, when onto major thoroughfares such as Houghton Road, tend to have turning movements that operate at LOS E or F during the peak hours. Once again, it is expected that the adjacent signalized intersections (at Drexel & Irvington Roads) will create gaps in traffic on Houghton Road that will allow for acceptable turning movements from the minor street.

The results of the turn lane analysis show that, based on the 2022 weekday PM peak hour traffic volumes with the new project, a new southbound right-turn lane is warranted at the project's northern access point from Houghton Road, as well as at the project's southernmost access point from Houghton Road (located south of the Drexel Road signalized intersection). A new northbound left-turn lane and median opening is also warranted at the intersection of project's northern access point from Houghton Road.

The southbound right-turn movements into the project at the northern and southern access points onto Houghton Road each require a minimum fifty (50) feet of storage, while the aforementioned northbound left-turn movement at northern access onto Houghton Road requires a minimum of twenty-five (25) feet of storage. However, based on City of Tucson Transportation Access Management Guidelines, a minimum turn lane storage length of one hundred fifty (150) feet is required for the right-turn deceleration lanes into the project from Houghton Road.

In conjunction with the PAD's proposed westward extension of Drexel Road into the Property, the existing "Florida T" traffic signal at the intersection of Drexel Road/ Houghton Road will be modified to a standard four-leg signalized intersection.

C. Public Transit Considerations

Houghton Road will continue to be the primary bus service route in the vicinity of the project. Planned improvements by the Regional Transportation Authority (RTA) envision Houghton Road as a major bus and shuttle corridor. The provision and location of new bus stops and associated shelters will be coordinated by the master developer with Sun Tran at the time of final design and subdivision platting.

D. Multi-Modal Considerations, Impacts & Benefits

New pedestrian ramps, sidewalks, and a multi-use trail/ pedestrian trail urban cross-section will be constructed along the Drexel Road & Greenway extension into the PAD. The existing multi-use path will be maintained along the east side of Houghton Road and will be connected to the new Drexel Road Greenway. These improvements are expected to increase user activity in the immediate area, as well as throughout the surrounding region, by providing an enhanced pedestrian and bicyclist experience and by providing connectivity to outlying trails and open spaces.

III.C.2 Transportation Improvements & TIA Recommended Modifications

A. Houghton Road Primary Project Entrance

In conjunction with the PAD's proposed construction of the Drexel Road & Greenway extension into the site, the existing "Florida T" traffic signal at the intersection of Drexel Road/Houghton Road should be modified to a standard four-leg signalized intersection.

B. Drexel Road Extension

As part of the roadway improvements associated with the proposed PAD, Drexel Road will be extended to the west of Houghton Road approximately one-half mile, providing the central access corridor and boulevard into the proposed development (see Exhibit III.10: Primary Project Entrance). This Drexel Road extension will serve as a collector street, offering a divided three-lane roadway section with one (1) lane in the eastbound and westbound directions separated by a two-way center left turn lane.

The eastbound and westbound approaches on Drexel Road will provide an exclusive left turn lane and a shared through/ right turn lane. The northbound approach will offer an exclusive left turn lane, three (3) through lanes, and an exclusive right turn lane. The southbound approach to the intersection will utilize an exclusive left turn lane, two (2) through lanes, and a single shared through/right turn lane.

New STOP signs and associated STOP bar pavement markings are recommended for vehicles exiting the PAD site at both proposed intersections/access points onto Houghton Road, Similar STOP signs and bar pavement markings are recommend at Access Point Nos. 2, 3 & 4 on the Drexel Road extension (refer to Exhibit III.9 for access point locations). YIELD signs are recommend to be installed on each approach to the roundabout intersections of Access Point Nos. 1 & 5 onto Drexel Road.

Exhibit III.10: Primary Project Entrance

C. Multi-Modal Components

The primary multi-modal components envisioned for the PAD is the extensive network of pedestrian and bicycle trails that will characterize the site. These include Fantasy Island Trails Park (FITP), the proposed mountain bike trails within the Tucson Water SHARP facility, pedestrian and bike paths within the residential neighborhoods, and the Drexel Road Greenway's extension into the heart of the project. This trail network, together with the existing and future transit/bus service along Houghton Road, define the multi-model framework for the project.

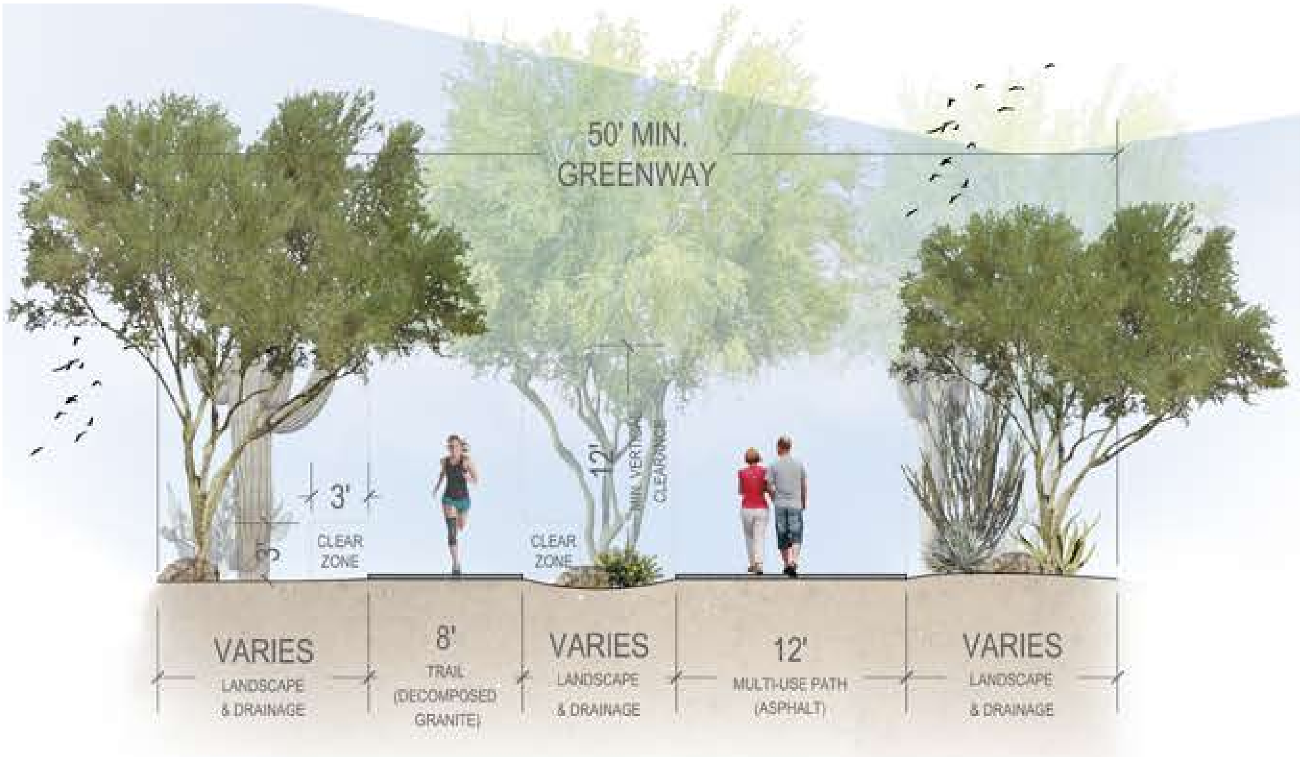
III.C.3 Typical Cross-Sections for Public Streets

All public roadways within the PAD will be designed and constructed in accordance with City of the Tucson Technical Standards Manual (TSM), Section 10-01.6.2 Geometric Design and the cross sections included in TSM Section 10-01.9.0.

The Drexel Road extension into the Property will serve as the Saguaro Trails primary entry and boulevard. It is envisioned as a two-lane divided cross-section, with a landscaped median, striped bike lanes, and multi-use pedestrian/bike path trails to effectuate the designated Drexel Road Greenway. All other local roadways within the PAD will be two-lane local or minor collector streets.

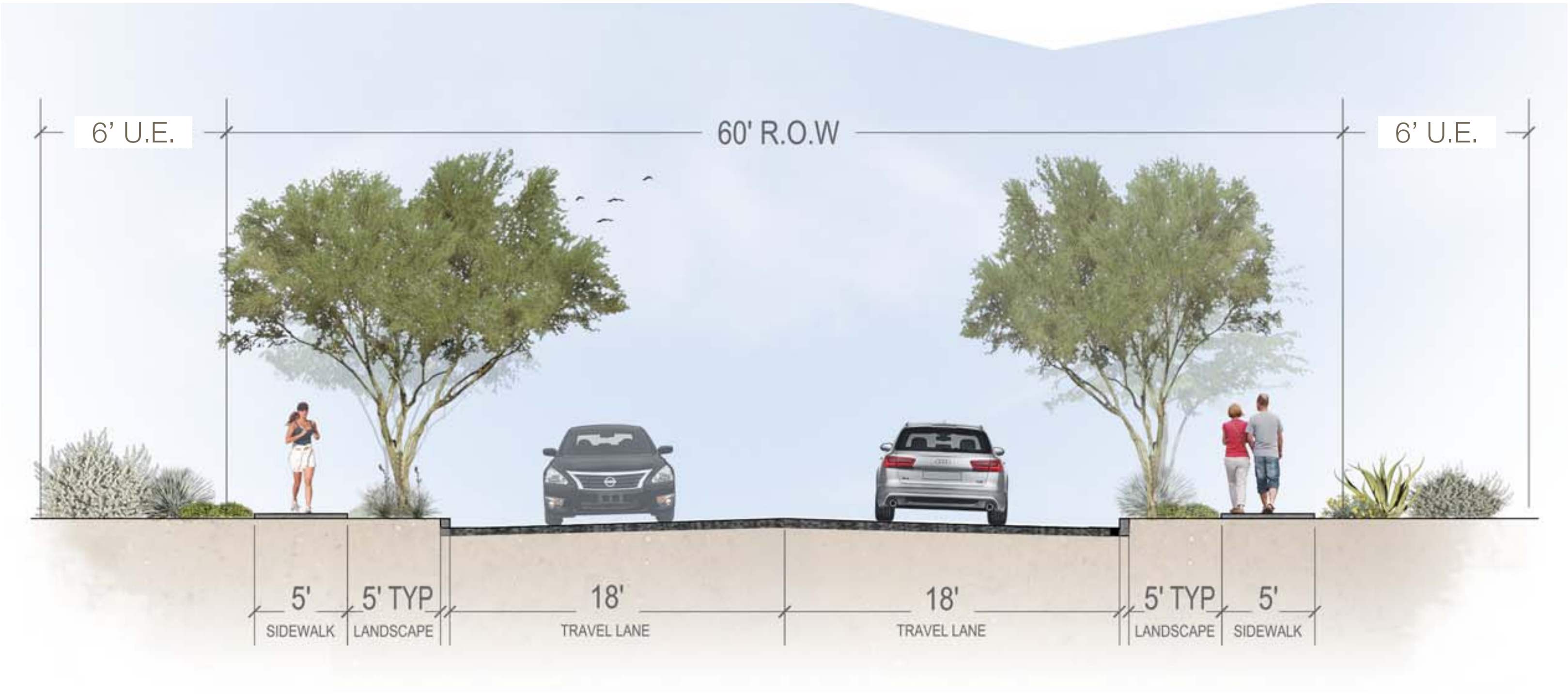
Exhibit III.11 provides conceptual cross-sections for the above streets. Final determination of specific pavement widths, cross-sectional features, and provisions for on-street parking may be refined at the time of tentative platting for each residential phase.

Exhibit III.11: Typical Cross-Sections



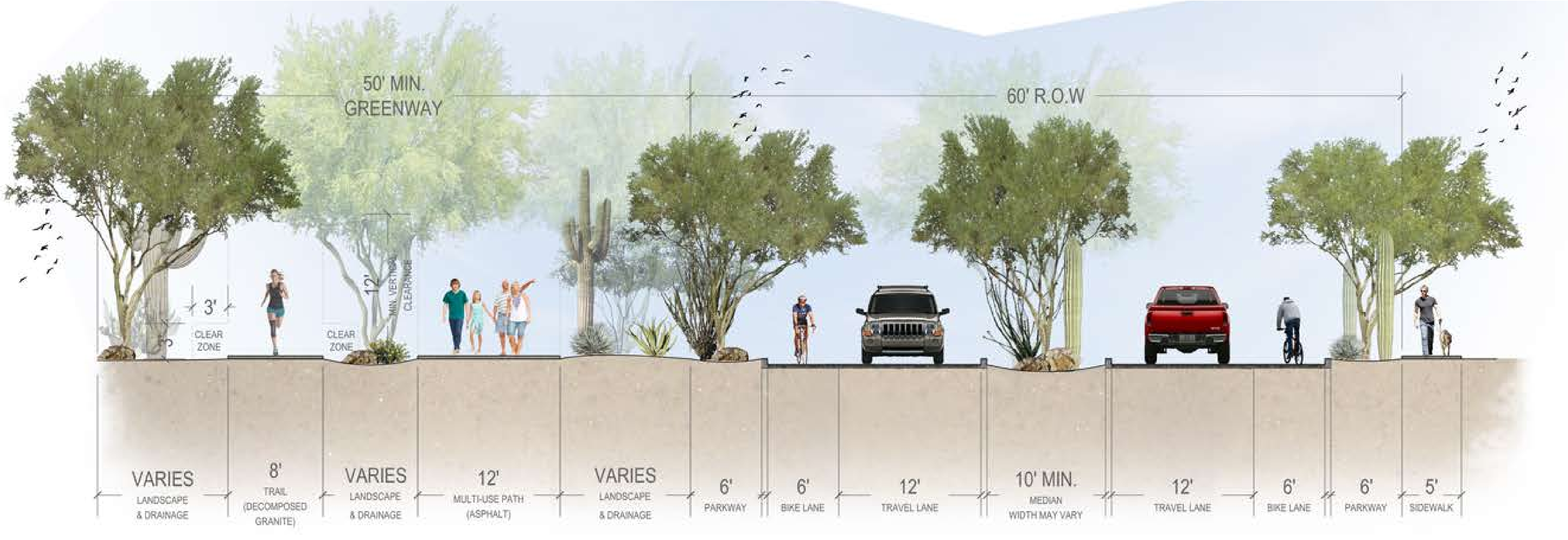
1 DIVIDED URBAN GREENWAY (DREXEL ROAD EXTENSION)

SCALE: 1"=10'



2 RESIDENTIAL COLLECTOR

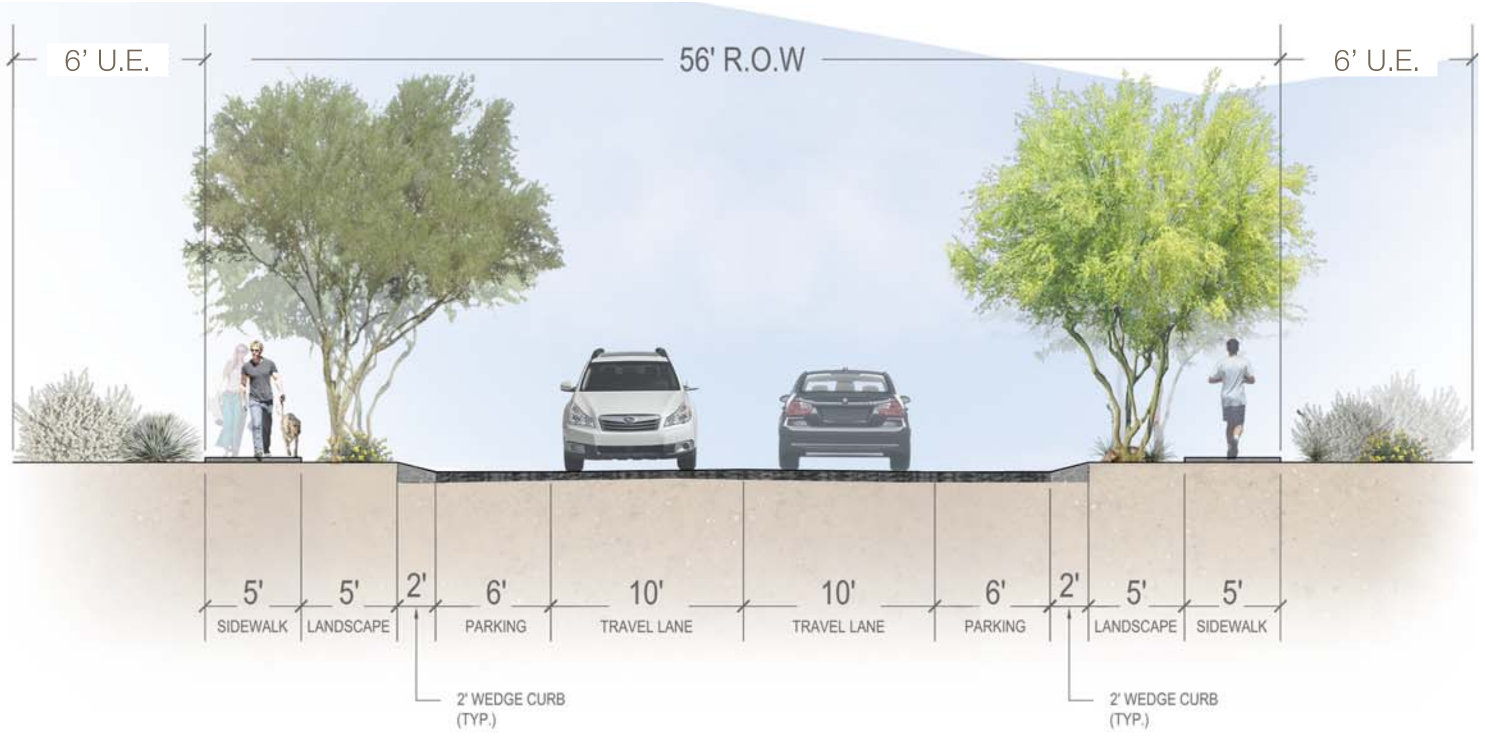
SCALE: 1"=10'



3 DREXEL ROAD PUBLIC STREET AND GREENWAY CORRIDOR

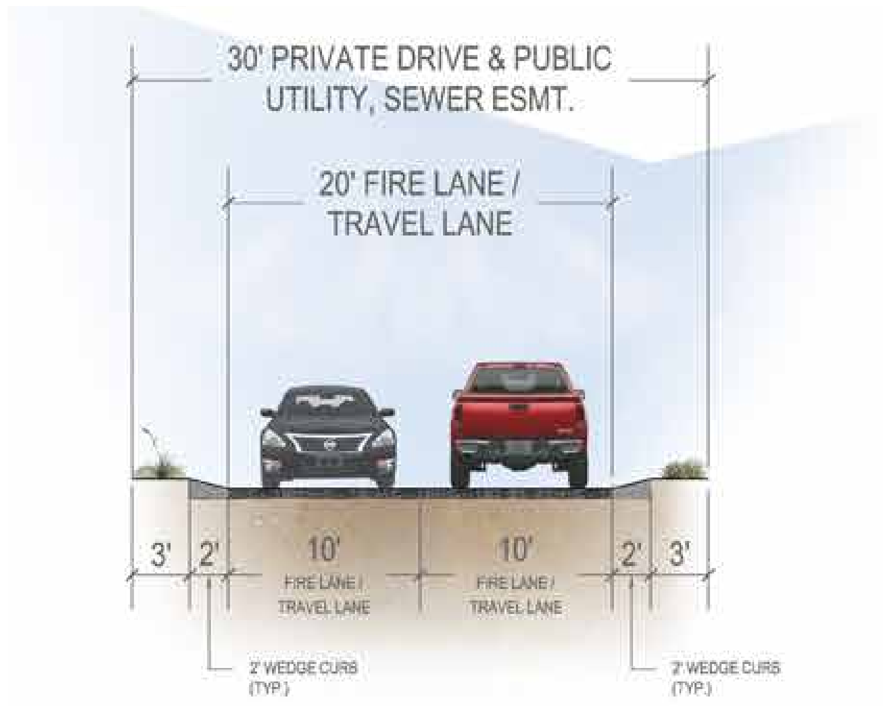
SCALE: 1"=10'

Exhibit III.11: Typical Cross-Sections - Options for Subdivision Streets



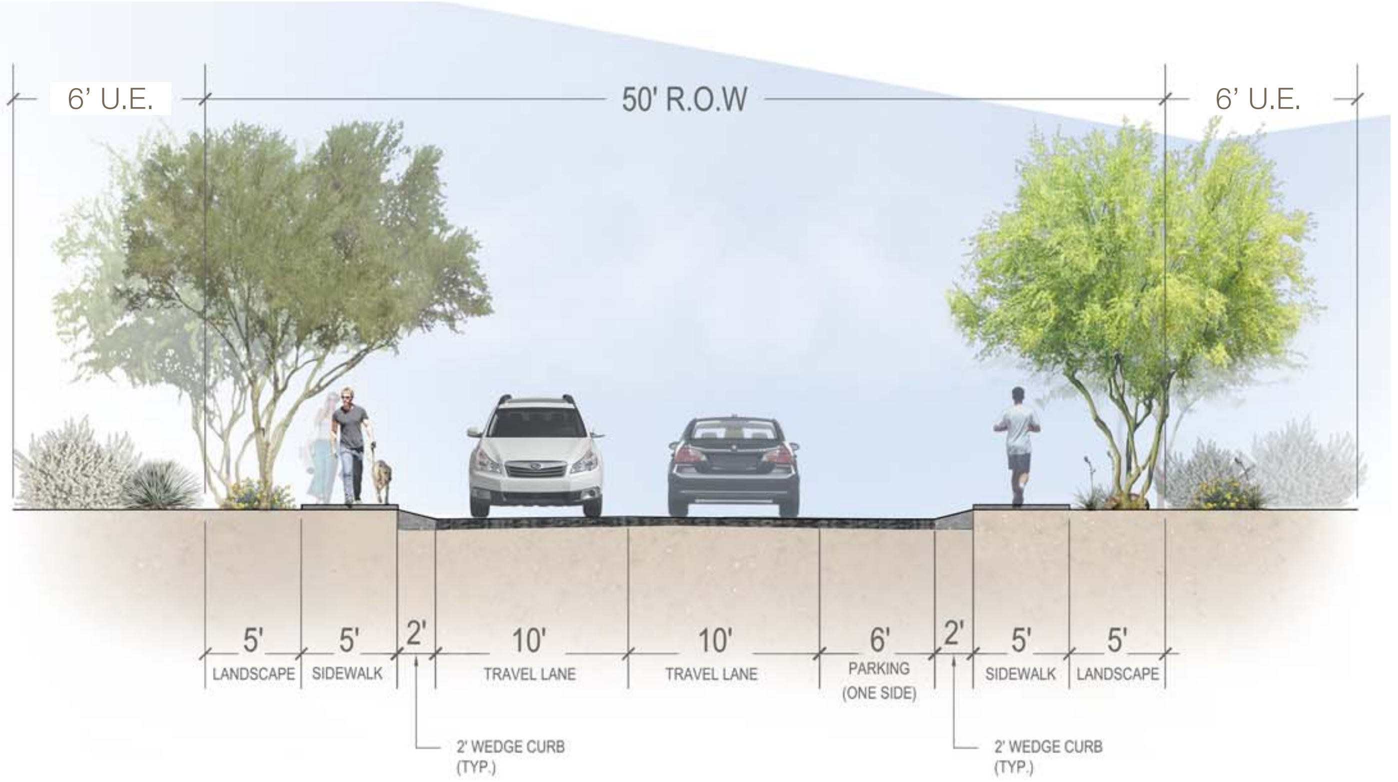
4 LOCAL SUBDIVISION/RESIDENTIAL STREET (PUBLIC)

SCALE: 1"=10'



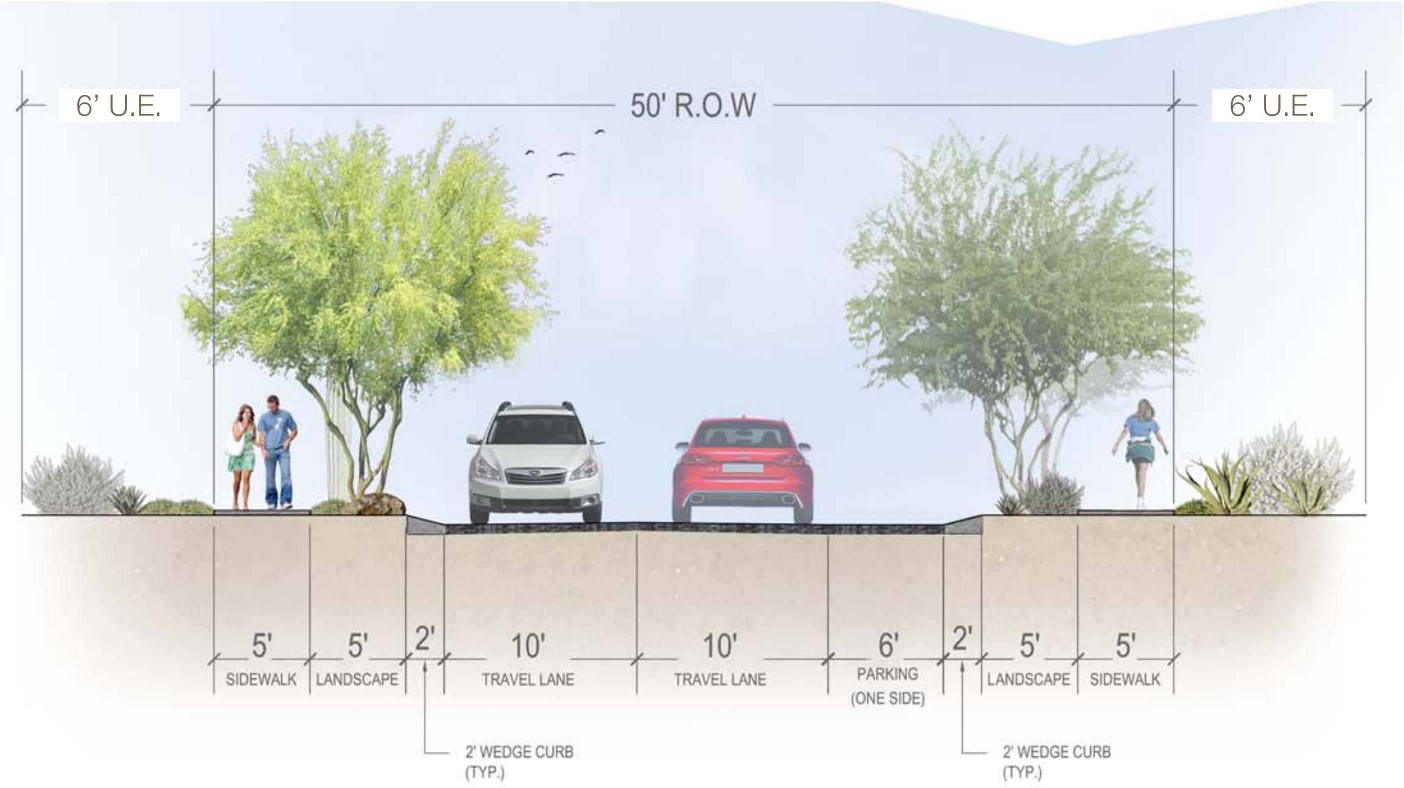
5 PRIVATE DRIVE

SCALE: 1"=10'



6 LOCAL SUBDIVISION/RESIDENTIAL STREET (PUBLIC)

SCALE: 1"=10'



7 LOCAL SUBDIVISION/RESIDENTIAL STREET (PUBLIC)

SCALE: 1"=10'

III.D CONCEPTUAL DRAINAGE SOLUTION AND ASSOCIATED IMPROVEMENTS

III.D.1 Master Drainage Plan

The PAD Property consists of separate parcels owned by Mattamy Homes, the City of Tucson, and Tucson Water. As the City-owned property will remain essentially undeveloped in its use as Fantasy Island Trails Park (FITP), and given that the primary use of the SHARP property is a series of recharge basins and recreational trails, this conceptual drainage section will primarily address the hydrologic features, impacts and provisions associated with the Mattamy Homes planned residential master plan, which will be known as Saguaro Trails.

In general, off-site drainage will have minor impacts upon the planned residential neighborhoods, in that the residential areas being developed are three (3) distinct ridgelines which are bisected by two (2) established drainage corridors. As such, these natural corridors will largely be left in their current condition and incur impacts primarily at those areas where they each cross the project's new Drexel Road extension into the PAD Property.

All new homes will be setback the appropriate erosion hazard setback (EHS) distance from the aforementioned natural washes and will not impact their hydraulic conditions. Any encroachments into the riparian and floodplain areas, such as at the two (2) Drexel Road crossings mentioned above, will be minimal and will comply with all City floodplain ordinances. In addition, any encroachments will be protected from erosion through the use of appropriate stabilization measures.

It is anticipated that the residential development within the PAD will occur in five (5) development phases, designated as Planning Areas "A" through "E". Because of the size of the project, the anticipated length of its overall build-out, and the changes in market preference that often occur over time, final lot planning is not possible at this point and will not be ultimately set until the time of subdivision platting. As such, the hydrologic analysis presented here is conceptual.

With that in mind, the residential areas of the PAD will be developed such that drainage generated within each new neighborhood will be directed from its lots to its interior subdivision streets, and from there conveyed to retention/detention basins as needed. The basins will be sized accordingly and will meter their respective volumes into the existing natural wash corridors at various outlet locations.

A complete drainage report will be provided for City review and approval for each planning area and development phase. These drainage reports will address the following:

- Retention of the difference between the existing and proposed 100-year discharges for each planning area/development phase.
- All-weather access will be provided to all proposed neighborhoods and to the Tucson Water SHARP facility.
- All 100-year discharges of 100 cubic feet per second (cfs) or greater will be identified and delineated.
- A complete Environmental Resource Report identifying all riparian areas on the rezoning parcel and how those riparian resources will be protected.

Table III.2: PAD 100 Year Peak Runoff Values

Watershed	**@ South Property Line**		**@ North Property Line**	
	Watershed Area (acres)	Pre-development Q_{100} (c.f.s)	Watershed Area (acres)	Pre-development Q_{100} (c.f.s)
Harrison Hills (WS-A)	70	291	188	651
Unnamed (WS-B)	128	383	202	524
Mesquite Ranch (WS-C)	348	1154	404	1314

The estimated 100-year peak runoff values entering and exiting the PAD in the existing/undeveloped conditions are summarized in Table III.2: PAD 100 Year Peak Runoff Values and on Exhibit III.12: Post Development Drainage Plan.

It is estimated that development of the residential component of the PAD will increase the total on-site discharge by approximately 405 cfs over and above the existing, undeveloped condition. This increase will be mitigated through the retention/detention basins described above, which will reduce the post-development discharges to the point where they are at or below existing, pre-development levels. As an alternative, in-lieu fees for detention will also be explored with staff at the time of final engineering; any such in-lieu arrangements will be subject to review and approval by the City Floodplain Section.

Tucson Water's SHARP facility will be governed by its own, separate drainage report that is subject to review and approval by PDSD.

With respect to the required Drexel Road drainage crossings of the two (2) major washes, conceptual engineering calculations indicate that the Harrison Hills (western) wash will require a two-cell, 6' x 4' box culvert, while the eastern (unnamed) wash will require a two-cell, 8' x 4' box culvert. Erosion protection will likely include grouted rip-rap and will be provided as necessary at culvert inlets and outlets (see Exhibit III.12: Post Development Drainage Plan).

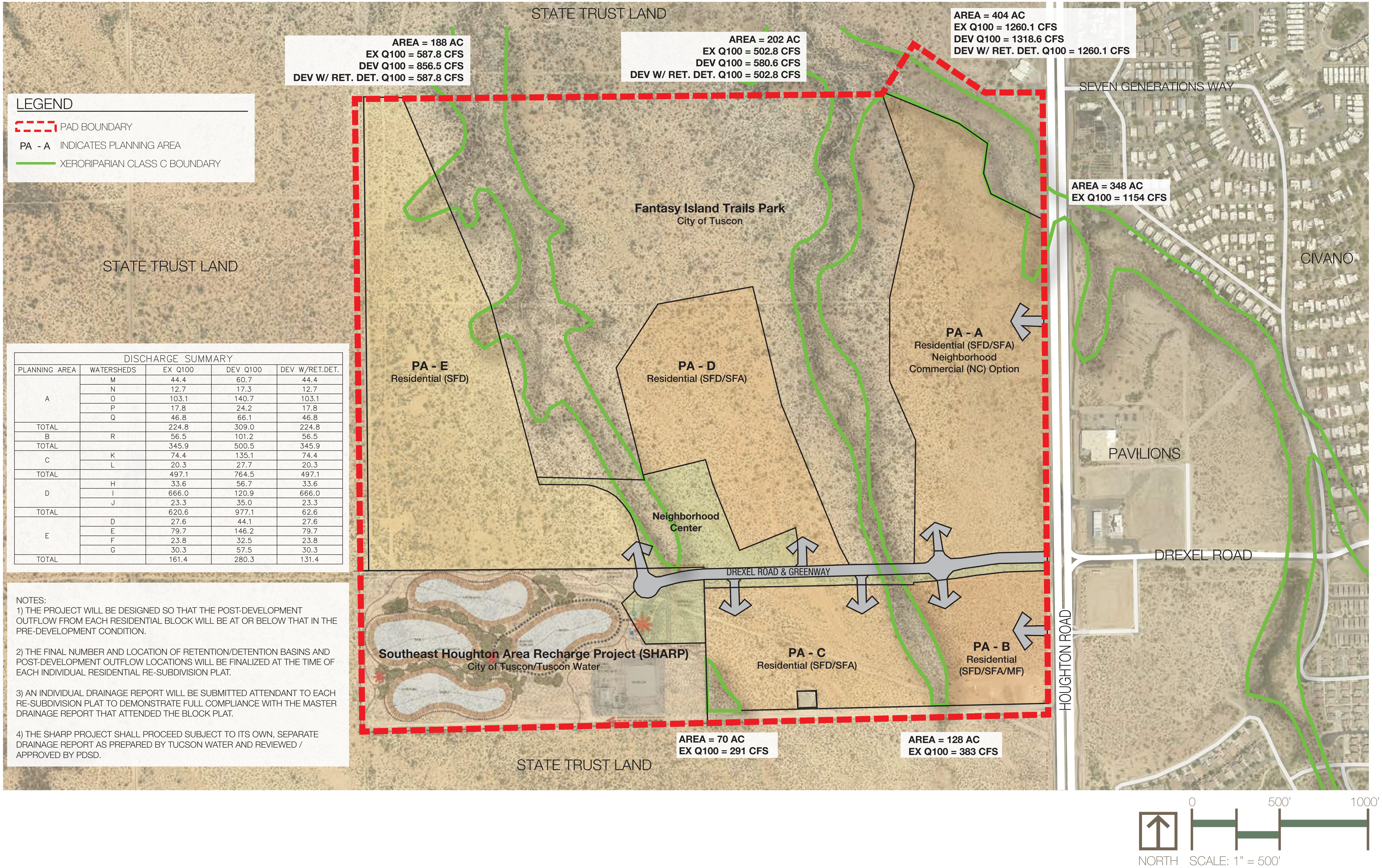
III.D.2 Post-Development Outfall Locations from the PAD Property

All residential development within the PAD will be designed to insure that all flow volumes exiting the Property are at or below exiting conditions. The locations and flow characteristics of the runoff leaving the PAD Property will be the same as that under current conditions.

III.D.3 Retention/Detention Requirements

The PAD will be developed in accordance with the City of Tucson Technical Standards Manual Section 4-03.0.0: Stormwater Detention/Retention Manual. Retention/detention basins (or potential in-lieu fees) will be provided with each residential development block. The specific locations of these basins and their exact outlet points cannot be determined until the time of resubdivision platting and engineering, wherein individual Hydrologic/Hydraulic reports will be prepared for each Tentative Plat and will document full compliance with all applicable retention/detention requirements. All basins will ensure that flows leaving the residential blocks do not exceed those in the undeveloped condition. Erosion protection will be designed at each outlet to mitigate off-site erosion.

Exhibit III.12: Post Development Drainage Plan



LEGEND

▭	PAD BOUNDARY
PA - A	INDICATES PLANNING AREA
▬	XERORIPARIAN CLASS C BOUNDARY

DISCHARGE SUMMARY

PLANNING AREA	WATERSHEDS	EX Q100	DEV Q100	DEV W/RET.DET.
A	M	44.4	60.7	44.4
	N	12.7	17.3	12.7
	O	103.1	140.7	103.1
	P	17.8	24.2	17.8
	Q	46.8	66.1	46.8
TOTAL		224.8	309.0	224.8
B	R	56.5	101.2	56.5
TOTAL		345.9	500.5	345.9
C	K	74.4	135.1	74.4
	L	20.3	27.7	20.3
TOTAL		497.1	764.5	497.1
D	H	33.6	56.7	33.6
	I	666.0	120.9	666.0
	J	23.3	35.0	23.3
TOTAL		620.6	977.1	62.6
E	D	27.6	44.1	27.6
	E	79.7	146.2	79.7
	F	23.8	32.5	23.8
	G	30.3	57.5	30.3
TOTAL		161.4	280.3	131.4

NOTES:

1) THE PROJECT WILL BE DESIGNED SO THAT THE POST-DEVELOPMENT OUTFLOW FROM EACH RESIDENTIAL BLOCK WILL BE AT OR BELOW THAT IN THE PRE-DEVELOPMENT CONDITION.

2) THE FINAL NUMBER AND LOCATION OF RETENTION/DETENTION BASINS AND POST-DEVELOPMENT OUTFLOW LOCATIONS WILL BE FINALIZED AT THE TIME OF EACH INDIVIDUAL RESIDENTIAL RE-SUBDIVISION PLAT.

3) AN INDIVIDUAL DRAINAGE REPORT WILL BE SUBMITTED ATTENDANT TO EACH RE-SUBDIVISION PLAT TO DEMONSTRATE FULL COMPLIANCE WITH THE MASTER DRAINAGE REPORT THAT ATTENDED THE BLOCK PLAT.

4) THE SHARP PROJECT SHALL PROCEED SUBJECT TO ITS OWN, SEPARATE DRAINAGE REPORT AS PREPARED BY TUCSON WATER AND REVIEWED / APPROVED BY PDSD.

III.E PROPOSED UTILITY INFRASTRUCTURE

Extensive utility infrastructure sufficient to serve the PAD exists in proximity to the Property, most of which is located within the Houghton Road right-of-way. As such, crossings beneath Houghton Road may be required in certain circumstances to serve the PAD development; these will be constructed at the same time as the PAD's new vehicular access points so as to minimize pavement cuts and inconvenience to area motorists.

III.E.1 Public & Private Sewer System Master Plan

At this time, a final decision as to the most efficient and cost-effective solution to sewer the property has not been finalized. Two (2) viable options are available: 1) a private sewer with a new lift station east to Houghton Road; or 2) a public sewer north to the existing Irvington Road public sewer. Both options require gravity sewer lines extending northward out of each of the ridge-top residential areas and into the City-retained property for Fantasy Island Trails Park (FITP). A further discussion of the particulars of each option is provided below.

Option 1: It is impossible to drain all wastewater from the new residential areas by gravity into the existing public sewer line located in Houghton Road. Therefore, Option 1 would utilize a series of new gravity sewer lines that would concentrate all of the residential flows at a central location near the northeast corner of the Planning Area "A". A new sewer lift station would be constructed there, which would pump the wastewater, via a force main, to a new public gravity sewer line in Houghton Road that would be constructed with the project. This new public sewer line would then proceed northward and tie into the existing 21-inch public sewer line near Irvington Road (refer to Exhibit III.13: Master Infrastructure Plan). At the time of design, it will be determined whether these new sewer lines (up to and including the lift station itself) will be public or private in nature, subject to applicable Pima County Regional Water Reclamation District (RWRD) policies and regulations in force at that time.

Option 2: This approach involves the construction of a new public gravity sewer line through the City-retained property (for FITP) and continuing through the adjacent Arizona State Land Trust property, ultimately connecting to the existing 15-inch sewer line in Irvington Road (refer to Exhibit III.13: Master Infrastructure Plan). Discussions have already been initiated with the Arizona State Land Department (ASLD) to further this Option, and the Department has verbally indicated their willingness to allow such an outfall. It should be noted that constructing this Option would provide sewering provisions and flow-through capacity for those State Lands to the immediate south and west of the PAD site, thereby improving their development capability and market viability at whatever time ASLD brings them to auction.

Both of these potential sewering options have been discussed with, and found acceptable by, Pima County RWRD. At this time, there is adequate capacity for this project within the public conveyance system to connect at either location, based upon the anticipated residential density of the PAD. Type I Capacity Letters have been received from RWRD and are included in Appendix C. The City of Tucson has agreed to allow the construction of a new gravity sewer within their retained property, as well as grant the corresponding public sewer easements that would be necessary.

III.E.2 Potable Water System Master Plan

The PAD site is within Tucson Water's designated service area. Potable water service will be provided through the existing 12-inch Tucson Water water main within Houghton Road. The project will tap the line in two (2) separate locations to ensure continuity of service in the event that one of the lines becomes temporarily unavailable. Within each of the residential blocks, standard "loops" will be constructed to maintain service in the event of a line break. Tucson Water has indicated that they currently have adequate capacity to serve this PAD based upon its anticipated residential density.

III.E.3 Dry Utilities Master Plan

Existing dry utility infrastructure is accessible to the PAD.

Tucson Electric Power (TEP) has an existing subsurface line on the east side of Houghton Road, as well as one along the south boundary of the PAD Property. The latter provides power to Tucson Water's existing reservoir, but does not have the capacity to serve the entire PAD (TEP has indicated that this secondary line may be used for looping purposes). In preliminary discussions, TEP has indicated that servicing the PAD will occur via a new incoming feeder line near the northwest corner of the PAD site, together with a second point of connection to their aforementioned subsurface line on the east side of Houghton Road. This latter connection would likely occur at one of the project's two (2) proposed vehicular access points onto Houghton Road (refer to Exhibit III.13: Master Infrastructure Plan).

Southwest Gas Corporation has both a 6-inch and a 12-inch high pressure natural gas line in Houghton Road. It is anticipated that the connection will be made to the 6-inch line to eliminate the need for a pressure regulating station. Two (2) connection points will be required and they will be located within the two (2) points of vehicular access as shown on Exhibit III.13: Master Infrastructure Plan).

Both TEP and Southwest Gas have indicated that their existing facilities have adequate capacity to serve this development based on the projected residential density presented in this PAD. Will-serve letters from both of these utilities have been obtained and are provided in Appendix C.

III.E.4 Phasing of Infrastructure; Upgrades/Augmentations

At this time, it is anticipated that residential development will proceed from east to west, commencing with Planning Area A. As always, changing market conditions may alter this basic approach as development proceeds.

Under any case, the initial phase of residential development will include the dual connection points for potable water and the dry utilities described above, as well as both points of vehicular access onto Houghton Road and their associated acceleration/deceleration lanes. This first phase will also include the extension of Drexel Road into the PAD Property, which will serve as Saguaro Trails' main boulevard and provide direct access to the planned neighborhood center and central park complex. Lastly, this initial residential phase will also include a connection to public sewer system utilizing either Option 1 or Option 2 as described above.

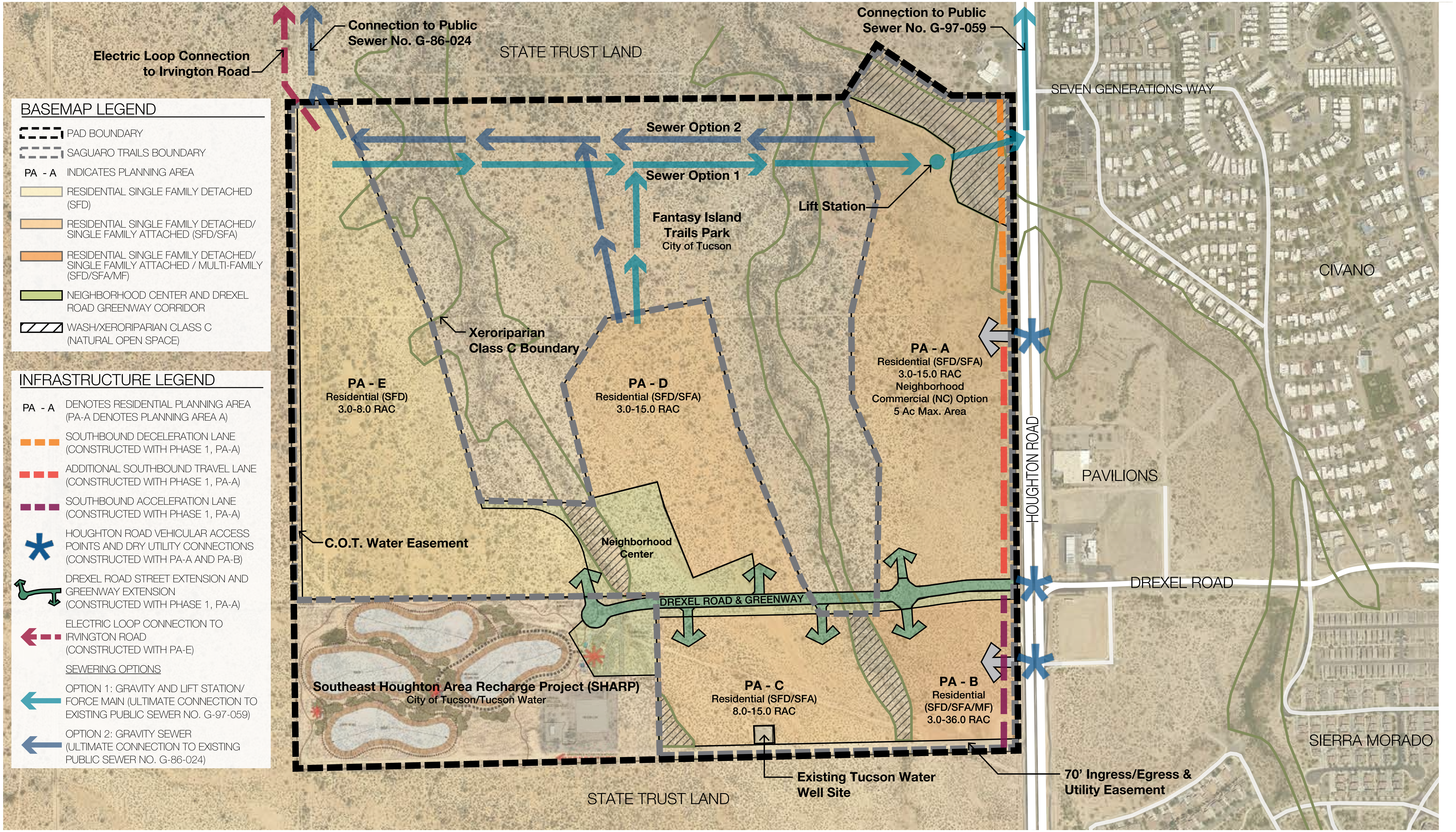
After the initial construction phase is completed, the major "spine" infrastructure needed to serve the ultimate build-out will be in place and each subsequent residential block will simply implement extensions of these initial spine improvements.

The only exception to this statement is a future electrical loop connection to Irvington Road, which will be completed in conjunction with development of Planning Area E. The conceptual locations of the various infrastructural features discussed above are shown on Exhibit III.13: Master Infrastructure Plan.

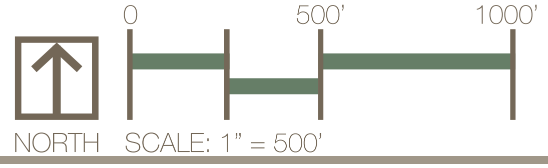
III.E.5 Maintenance Responsibilities for Utility Infrastructure

Potable water and dry utilities will be owned, operated and maintained by their respective service providers. If sewer is provided under the Option 1 scenario described above and it is ultimately determined by RWRD that the lift-station and other components will be private in nature, a private homeowners association will be required to provide maintenance of these private sewer components. If sewer Option 2 is implemented, all sewers serving the PAD (both on-site and off-site) will be operated and maintained by Pima County RWRD.

Exhibit III.13: Master Infrastructure Plan



NOTE: THE SEWER ALIGNMENTS DEDICATED ON THIS EXHIBIT ARE PURELY CONCEPTUAL. THE ULTIMATE SEWER SOLUTION AND ITS ALIGNMENT WILL BE DETERMINED AT THE TIME OF FINAL ENGINEERING IN COORDINATION WITH PCRWRD.



III.F CONSERVATION MEASURES AND ENVIRONMENTAL CONSIDERATIONS

III.F.1 View Protection and Scenic Corridor Zone Provisions

This PAD has been developed in full consideration of the applicable Scenic Corridor Zone (SCZ) provisions of the UDC (Article 5.3) that attend the Houghton Road frontage of the property. As is clear in Article 5.3.1 (Introduction and Purpose) of the SCZ requirements, the primary consideration and rationale for the ordinance is protecting the long-range views and vistas of Tucson's surrounding mountain ranges as viewable from our designated scenic routes. From this basic rationale, the ordinance proceeds to then outline the specific development standards and restrictions needed to accomplish this view protection.

With respect to the proposed PAD, three (3) of these long-range mountain vistas are wholly unaffected by the proposed development, these being the Santa Catalina Mountains (to the north), the Rincon Mountains (to the east), and the Santa Rita Mountains (to the south), all of which are in relative visual proximity and all of which possess a high degree of visual quality. The only vista that is relevant at all to the PAD is the westward one to the Tucson Mountains. The PAD's impact on this vista is minimal at best given the excessive distance between this range and the PAD Property, the fact that the entire Tucson urbanized core intervenes, and the fact that the Tucson Mountains are only intermittently visible from Houghton Road along the PAD's frontage.

With the above in mind, and in consideration of the applicable HAMP prescriptions that promote significant residential densities and a generally high intensity of development, and in further consideration of the fact that such density and intensity prescriptions can be achieved in this particular case without any undue impact on the dominant long-range mountain vistas, this PAD includes the following modifications and exceptions to UDC Article 5.3, Scenic Corridor Zone:

- Due to the marginal and often obscured nature of the long-range westward view to the Tucson Mountains as described above, the width of the corridor to which the SCZ requirements apply shall be one hundred (100) feet as measured from the existing Houghton Road west right-of-way line.
- The required scenic route buffer shall be thirty (30) feet wide, measured from the back of the existing public sidewalk on the west side of Houghton Road.
- The thirty (30) foot scenic route buffer can be comprised of natural and/or graded and revegetated/landscaped areas; any revegetated/landscaped areas shall use native desert species.
- The maximum building height within Planning Area "A" (single-family detached residential) is thirty-six (36) feet; structures of this height must honor a setback of fifty (50) feet from the west right-of-way line of Houghton Road.
- The maximum building height within Planning Area "A" for the limited commercial option (if exercised) is thirty (30) feet; structures of this height must honor a setback of thirty (30) feet, measured from the back of the existing public sidewalk on the west side of Houghton Road.

- The maximum building height within Planning Area "B" (multi-family residential) is fifty-two (52) feet; structures of this height must honor a setback of fifty (50) feet from the west right-of-way line of Houghton Road. This height is permitted in consideration of the shorter frontage of this Planning Area along Houghton Road, as well as the higher residential density objectives of this parcel.
- Structures of heights that are less than the maximums as prescribed above for Planning Areas "A" and "B" shall be limited to a figure that is one-half (1/2) of their horizontal distance from the west right-of-way line of Houghton Road.
- Given the relative lack of any high-quality long-range westward vistas of the Tucson Mountains, the view corridor prescriptions of UDC Article 5.3.6 do not apply to this PAD.

This PAD, together with the above development standards, satisfies the intent of the Scenic Corridor Zone and no future separate SCZ review will be required by PDSD.

III.F.2 Conservation/Sustainability Standards

A. Residential Structures & Neighborhoods

Innovations in energy efficiency and sustainability will be explored and incorporated. Sustainable, energy-conscious design and alternative power generation appurtenances are permitted within the PAD, including solar panels, as well as roof decks and patios (these shall be considered exclusive of building height). Neighborhood-wide conservation standards will be accomplished via low water use plants, efficient irrigation systems, and rainwater harvesting (see Exhibit III.14: Energy and Water Conservation Measures).

From the neighborhood design perspective, residential neighborhoods within Saguaro Trails will feature the following:

- A wider array of housing choices and design options for consumers, thereby fostering increased visual variety, aesthetics, and individuality, all of which contribute to enhanced social fabric.
- Diversity in both design and the spatial placement of residential units on individual lots. This creates a streetscape with greater variety and with unique and varying negative spaces in each front yard, providing the homeowner with opportunities for more individualized landscaping and front yard amenities.
- Narrowed right-of-way and pavement sections for local streets, thus decreasing paved and impervious surface and providing for neighborhood streetscapes characterized more by landscaping and homefronts than by vehicular components.
- Single-family housing options that include clusters of smaller and pocketed lots that provide for significantly increased densities and for the associated superior efficiency in the overall use of land.

From the perspective of home energy efficiency, Mattamy Homes utilizes a third-party entity (such as: Environments for Living [EFL]) to implement a comprehensive program of home energy ratings for all of its proposed home models within Saguaro Trails. This program applies the HERS (Home Energy Rating System) index to determine a specific energy score for each model. These HERS scores are then compared to the annual energy costs of more conventional or average homes in the market, thereby providing the buyer a guaranteed utility cost. Examples of the HERS ratings for several of Mattamy Home's past home models are included, for illustrative purposes, in Appendix J.

In implementing the above, the PAD will continue the tradition of the innovative residential communities already adjacent to it, and will demonstrate a strong commitment to delivering above-code energy efficiency. Mattamy Homes has already initiated discussions with Tucson Electric Power (TEP) to develop a program for integrating efficient home design and emerging technologies into the planning process, with the goal of yielding a smarter community infrastructure within the PAD. TEP has proven to be a national leader in innovative energy-efficiency programs, and it is the intent of Mattamy Homes to work closely with TEP throughout the development process to establish new, above-code energy efficient home standards, explore practical passive and active smart home technologies, evaluate demand-response potential, and explore smarter and more flexible power distribution design and management principles throughout the PAD's residential neighborhoods. Each phase of development within the PAD shall be coordinated with TEP's Smart Communities Engineering Team to maximize opportunities within Mattamy's designs & specifications and TEP's subdivision engineering standards.

B. Low Water Use Plants

The PAD will use native and regionally adapted plants, stressing low water use specimens in suitable locations to achieve significant water conservation. The overall palette will focus on zoning appropriate plants and long-term durability of the entire planting mix. A suggested plant list has been provided in Appendix H.

C. Irrigation

A low water use irrigation system will be utilized for all landscape areas. The system will incorporate an automatic controller, flow sensing valves, rain shut-off capability, and will also be metered separately to monitor water usage throughout Saguaro Trails. The irrigation system will include an enviro-transpiration module to enhance the system's ability to connect with local weather stations and thereby automatically adjust for seasonal weather changes. The use of a smart irrigation system will provide a performance system to maximize the management of water and water conservation.

D. Rainwater Harvesting

Rainwater harvesting techniques will be implemented where feasible in the residential neighborhoods to supplement the irrigated and non-irrigated landscape areas. Passive water harvesting features such as curb cuts, flush curbs, recessed planting areas, minimized compaction of planting areas and pervious/semi-pervious pavers.

E. Site Improvements and Amenities

The PAD will encourage a walkable neighborhood. The integration of pedestrian routes, bicycle connections and parks will activate the community and encourage social interaction and active pursuits. This PAD serves to maximize the active and passive spaces within each neighborhood, providing supplemental amenities to the nearby recreational opportunities found in Fantasy Island Trails Park and the SHARP facility.

III.F.3 Heat Island Considerations and Mitigation Measures

Specific heat island mitigation measures of the PAD will include a combination of strategies. Significant natural open space areas, washes, and riparian corridors will remain in place and provide significant heat island mitigation throughout the PAD. In addition, new parks, common areas and greenways will provide revegetated and landscaped areas and valuable shaded environments, constituting supplemental mitigation benefits. Walks, pathways and inorganic ground-covering landscape materials will be limited to lighter colors so as to minimize heat absorption and maintain comfortable pedestrian surfaces.

III.F.4 Self-Certification of Conservation & Sustainability Measures

Concurrent and included with the submittal of future resubdivision plats and development packages (DP's) to PDSD, or with the submittal of architectural plans to PDSD for building permits, the owner/ developer (or their appropriate design professional) shall submit a letter detailing the particular measures employed in final design to:

(1) address and promote the above Conservation Measures and Environmental Considerations; and

(2) demonstrate that the PAD is achieving progress towards the various sustainability goals outlined in this document.

The self-certification letter(s) accompanying future tentative resubdivision plat or development package submittals to PDSD shall describe the particular measures employed, and the results attained (citing approximate percentages, where applicable), toward furthering the following:

(1) the landscape-related Conservation/Sustainability Standards found in Section III.F.2; and

(2) applicable Heat Island Considerations & Mitigation Measures per Section III.F.3.

The self-certification letter(s) accompanying future architectural plan submittals to PDSD for building permits shall describe the particular measures being employed to further the following:

(1) the building-related energy efficiency provisions found in Section III.F.2.A;

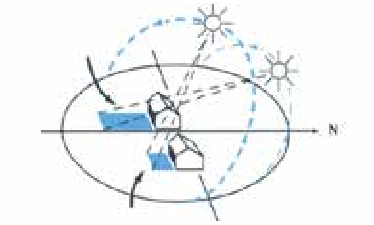
(2) the building-related water conservation provisions found in Section III.F.2.B-D.

Exhibit III.14: Energy & Water Conservation Measures

Alternative Transportation

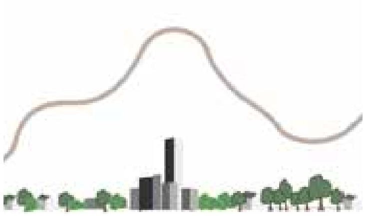
Energy Efficient

Smart Irrigation



Solar Orientation

View Preservation



Urban Heat Island

Rainwater Harvesting

Low Water Use Plants

III.G Architectural Standards and Design Guidelines

The PAD will have a unified image and identity through the use of defined theming principles and a consistent vocabulary in color, materials, and form.

III.G.1 Overall Project Theming and Identity

The PAD Property will be designed and constructed as an integrated whole, both functionally and aesthetically, so as to achieve the unique project identity alluded to above and to provide a further contribution to high-quality residential and mixed-used development within the Houghton Road corridor. The PAD will feature a simple and clean design approach, employing a palette of both modern and indigenous materials, landscaping treatments, buildings and forms, and way-finding/signage elements. Appendix K: Overall Project Theming provides illustrative examples of the PAD's major aesthetic and amenity elements, as well as the basic materials, design themes, colors and imaging that will characterize each to define the overall personality of the project. Appendix K provides supplemental material to further communicate the overall quality and flavor of the PAD.

III.G.2 Residential Architectural Design Concept & Building Elevations

Residences within Saguaro Trails will provide a distinctive architectural style and feature a variety of house elevations and color schemes. Specific aesthetic elements may include, but are not limited to, a variety of homestyles within a single streetscape, varying front yard setbacks, recessed garages, side-loaded garages, courtyards, and covered terraces. Enhanced elevations will be achieved through the use of pop-outs, cornices, window treatments, porches, varying roofing materials and landscaping. Alternative accent materials will be used for posts and columns and will include stone, brick, tile or wood depending on the particular architectural style employed.

Exhibit III.15: Architecture Design Intent illustrates a variety of the homestyles and elevations that will characterize the PAD's residential areas. While home designs naturally evolve over time and the ones shown here will be refined in accordance with market preferences, they are provided here to demonstrate a certain standard of quality and character that will typify the planned neighborhoods throughout the project.

In order to ensure a diverse streetscape, a minimum of three (3) architectural features from the Menu of Architectural Features (see Exhibit III.16: Menu of Architectural Features) will be included in each home. In addition, the following architectural guidelines and design objectives will apply:

(1) Emphasizing articulated building massing.

(2) Emphasizing front, side and rear elevations that maintain a high aesthetic quality and which relate strongly to the streetscape and any adjacent open spaces.

(3) Designing certain home models specifically for corner conditions and providing fully developed architectural elevations for all sides of the residence when directly adjacent to public streets, neighborhood parks and/or open space (whether functional or natural).

(4) Including alternative garage configurations, such as recessed, side loaded or alley loaded arrangements.

(5) Utilizing authentic materials and colors that go beyond traditional earth tones to reinforce the overall community identity, character, appeal. Colors will draw from "The Sonoran Desert Color Palette for Building Exteriors" as identified by the City of Tucson's Urban Planning and Design Department.

The above streetscape program will be implemented and documented pursuant to Section III.G.3.

III.G.3 Building Materials, Colors & Palette of Architectural Elements

The overall residential architectural and neighborhood theming of Saguaro Trails will include five-sided architecture that provides an interpretation of contemporary Southwest design. The basic objective is to achieve a timeless quality that reflects Tucson's heritage and history in contemporary fashion.

This approach responds to climatic conditions and promotes an architecture that focuses on the qualities of surface treatment, color, light and shadow, massing and building form, and negative space as it relates to the outdoor environment. Fundamental architectural elements will include the effective use of massing, intersecting wall planes, strong colors, unique building forms, shade and shadow, and the interplay of light so as to create dynamic homestyles while ensuring pedestrian-scaled spaces.

All multi-story structures will incorporate a recognizable base, middle component, and cap through the use of changes in material, architectural accents and other appropriate features. Especially with multi-storied buildings, aesthetic emphasis will be placed at the pedestrian level through the use of traditional materials, textures and increased building articulation.

Building materials used to further the above will be stucco, integrally colored CMU, light sandblasted integral color CMU, juicy-joint constructed CMU, cast-in-place concrete, metal, wood, decorative hardscape, and contemporary amenity packages. To allow for the innovative use of materials and advancements in technology, materials other than those on the above list may be used, in so far as they are consistent with the same basic architectural principles and aesthetics established here.

III.G.4 Architectural Review & Self-Certification at Time of Building Permits

Given the extent of architectural character, design, and detail presented in this PAD document for Saguaro Trails, no separate or subsequent architectural review process is required for the project. The only protocol that will apply in this regard is the substantial conformance of the ultimate residences and structures with the aesthetics, architectural concept, building elevations, colors, and materials presented herein. The builder shall, at the time of submittal for building permits to PDSD, submit an accompanying sealed letter certifying this substantial conformance and referencing applicable Section III.G of this PAD.

Exhibit III.15: Architecture Design Intent

Exhibit III.16: Menu of Architectural Features

The Menu of Architectural Features establishes a framework to develop a community theme through the use of consistent architectural elements. All of these architectural features characterize roof form, facade, architectural elements, materials and colors found in the regional architecture of the Southwest. A minimum of three (3) architectural features from the Menu of Architectural Features will be included in each home.


1. Gable End Trim Details


2. Gable End Window Detail with Corbels


3. Shuttered Window


4. Window Casing Detail


5. Window Header & Sill Detail


6. Decorative Garage Door


7. Roof Material


8. Entry Courtyard/Portches


9. Masonry Elements


10. Wrought Iron Details

III.H Interpretation and Modification of PAD District Regulations

Section III (Land Use Proposal) of this PAD has been structured to provide for clear interpretation and application by the City of Tucson in regulating a specialized land use and zoning framework for the PAD Property. In the event that supplemental PAD changes or interpretations become necessary, they shall proceed in accordance with the parameters below.

III.H.1 General Administration & Interpretation Authority

The PAD will not result in the modification or change of any existing City of Tucson adopted building codes or other ordinances, except those portions of the City Unified Development Code and Administrative Manual as specifically modified in this PAD document, together with the modification of the applicable City of Tucson Zoning Map.

The PAD shall be generally administered under the authority of the Director of the Planning and Development Services Department (PDSD). Whenever a conflict arises between this PAD and the Unified Development Code (UDC), the PAD shall control. When the PAD does not specifically address or comment upon a particular topic, the UDC and Administrative Manual shall control.

III.H.2 Amendments to the PAD

A. Criteria for Minor Amendments & Associated Process

It is understood that amendments to this PAD may become necessary for a variety of reasons, including responding to changing market or financial conditions, new residential market preferences and development realities, or to respond to requirements of homebuilders and/or non-residential users on the Property.

The Director of the Planning & Development Services Department may administratively approve minor changes to the specialized land use regulations and development standards set forth in this PAD, provided such changes are not in conflict with the overall intent, goals and objectives of the PAD as presented herein.

With this in mind, the following shall be considered minor changes that fall within the administrative purview of the Director of Planning & Development Services:

- Addition of new information to the PAD, Site Plan, maps, or text that does not change the effect of any regulation, development standard, or guideline.
- Changes to the public or private infrastructure as presented herein as necessary to properly serve the intended site plan and which do not significantly increase the development capacity of the presented Site Plan nor alter the guiding goals and objectives of same.
- The addition of permitted uses that may not be specifically listed in Sections III.B.1 and III.B.7 of this document, but which are determined to be sufficiently similar in type and nature to those explicitly listed as permitted.
- Adjustments to the Development Standards in Sections III.B.2 through III.B.7 of this document that are not harmful to the interests of the larger community or adjacent neighborhoods, or which are not explicitly stated in the PAD, but which are consistent with the guiding goals and objectives of the project and which do not create any public health or safety issues.
- Adjustments to any aspect of Section III of this PAD that is required in order to comply with changes in local, state or federal safety and/or health codes.
- The following PDSD administrative procedures may be processed through the minor amendment process of this PAD: 1) Technical Standard Modification Requests (TSMR's); and 2) Design Development Options (DDO's) for building setbacks, patio wall heights, and landscaping & screening.

B. Criteria for Major Amendments & Associated Process

Major amendments to the PAD shall be those changes or modifications that materially alter the guiding goals and objectives as presented in the PAD. The PDSD Director will determine if a proposed amendment would result in a major change per the criteria established in UDC Section 3.5.5.J.2.c. Major amendments to the PAD shall be processed in accordance with UDC Section 3.5.3, Zoning Examiner Legislative Procedure.

IV.

BIBLIOGRAPHY

BIBLIOGRAPHY

Civano Master PAD. Prepared by LVA Urban Design Studio for Pulte Homes April 7, 2005.

Houghton Area Master Plan. Adopted by Mayor and Council June 7, 2005. Prepared by the City of Tucson Department of Urban Planning and Design.

Major Streets and Routes Plan, City of Tucson Department of Transportation. Originally adopted by the Mayor & Council November 15, 1982. Last Amended July 10, 2007.

Master Plan for Fantasy Island Trails Park. Prepared for the City of Tucson by McGann & Associates April, 2006.

Pima County Regional Trail System Master Plan. Prepared by the City of Tucson Department of Parks & Recreation and the Pima County Department of Natural Resources Parks and Recreation, in collaboration with McGann & Associates. August, 2010.

Plan Tucson; City of Tucson General & Sustainability Plan 2013. Adopted by the Mayor and Council, June, 2013. Voter ratified November 5, 2013 by way of Proposition 402.

Southeast Houghton Area Recharge Project (SHARP), Final Conceptual Design Report. Prepared by CH2M Hill, Inc. for Tucson Water Department May 11, 2015.

*Stormwater Detention/Retention Manua*l, PIma County Department of Transportation & Flood Control District and the City of Tucson.

Unified Development Code, City of Tucson. Chapter 23B of the Tucson Code. Adopted October 9, 2012. Subsequently amended and current through September 23, 2014.

V.

APPENDIX

APPENDIX A: GLOSSARY

The terms and definitions used in The Saguaro Trails PAD District shall mean those defined in the City of Tucson Unified Development Code as amended, with the following exceptions, additions or clarifications:

Alley Loaded:
A residential product type that provides the primary vehicular access from public streets through a private alleyway at the rear of the residence (rear yard), while the primary pedestrian entrance is located at the front of the residence (front yard).

Auto Courts:
A residential arrangement where several houses are arranged around a shared driveway that provides access to garages and or residence entries for those dwelling units.

Casita:
A residential structure that is comprised of two or more dwelling units in cluster. It may include both ground-story and upper-story dwelling units, each of which with its own individual address.

Civano Master PAD:
The Civano PAD Districts establish comprehensive guidance and regulations for three distinct PAD districts; the approximate 456-acre Sierra Morado PAD District; the approximate 58-acre Pavilions PAD District and the approximate 304-acre Neighborhood 1 PAD District of Civano. The Civano PAD Districts establish the location, density, and community character for the individual PAD Districts.

Commercial:
Development Areas designated primarily for development of Commercial, Retail, Civic, Educational, and Industrial uses. Limited residential uses are permitted in accordance with UDC Section 4.7.26.

Common Areas:
All areas owned in common by the owners of a planned area development (PAD) or homes in a subdivision including any amenities to which the residents of Saguaro Trails have access, and all recreational and open space within the community.

Condominiums:
As defined within the UDC Section 11.4.4: “Condominium has the same meaning as “condominium” as defined in A.R.S. §33-1202(10), that is real estate, portions of which are designated for separate ownership and the remainder of which is designated for common ownership solely by the owners of the separate portions. Real estate is not a condominium unless the undivided interests in the common elements are vested in the unit owners. For the purposes of UDC application, a condominium is the same as a multiple-family structure, office structure, or commercial structure, except platting is required in accordance with the requirements of the UDC.”

Design Review Committee (DRC):
A committee whose function is to review and approve Design Guidelines submitted by each Developer for each Development Area as well as to review and approve all proposals for construction to assure that the Project is developed in accordance with the approved Design Guidelines.

Design Guidelines:
The formal guidelines developed and adopted by the Design Review Committee that will govern the development character of the individual Development Areas within the Project. The adopted guidelines for each Development Area shall become the standards by which Development Plans, Subdivision Plats, and construction plans are evaluated for compliance by the Design Review Committee.

Developer:
An individual, entity or owner who acquires or leases Development Areas in The Saguaro Trails Planned Area Development Area for the purpose of developing said Development Areas in accordance with the Plan and Design Guidelines.

Development Areas:
The area of land comprised of a subdivision plat, site plan, or development plan within a designated Planning Area.

Development Standards:
The City of Tucson Technical Standards Manual as amended from time to time.

Duplex:
As defined within the UDC Section 11.3.7: “A building containing two dwelling units on a single lot or parcel.”

Dwelling Unit (DU):
As defined within the UDC Section 11.4.5. “A building or portion of a building that is designed, occupied, or intended for occupancy as living quarters exclusively for a single household, which includes one or more rooms, with sleeping and sanitary facilities and one enclosed kitchen. One accessory cooking facility per dwelling unit is permitted.”

Fantasy Island Trails Park (FITP):
Fantasy Island Trails Park Fantasy Island Trails Park (FITP) is an extensive system of mountain-bike trails that weaves throughout portions of the Saguaro Trails Property, and which also stretches significantly onto Arizona State Trust Lands. The FITP trail system was ultimately formalized by City of Tucson Mayor & Council with its adoption of the Master Plan for Fantasy Island Trails Park in 2006.

Floor Area Ratio:
As defined within the UDC Section 11.4.7: “A ratio expressing the amount of square feet of floor area permitted for every square foot of land area within the site. The FAR is usually expressed as a single number, i.e., FAR of six means six square feet of floor area for every square foot of site area. For calculation, see Section 6.4.6.”

Front Yard:
For an interior lot, the front yard is the lot line bounding the street frontage. For a corner lot, the front yard shall be the shorter of the two lot lines adjacent to the street. For auto court cluster and/or alley loaded types where there is no direct street frontage for each lot, the front yard is the portion of a single-family residential lot where primary pedestrian access is provided.

Functional Open Space
Any public area on private or common landscape tract that is open for public use for recreation, pedestrian circulation, gathering or retention/detention areas including, but not limited to parks, trails, rights-of-way and easements with trails and walkways, drainageways with trails, plazas and courtyards. Uses may include active recreational activities, developed parks, walking, group gatherings, day picnicking.

Greenway:
A multi-use corridor that features a path and trail, preserved native vegetation and/or landscape plantings, and pedestrian amenities. Greenways typically follow washes or drainageways but can also be adjacent to roads. Depending on the greenway alignment, the path and trail can be together on one side (equivalent to the Divided Urban Pathway as designed for Drexel Road Greenway) or one on each side of the wash.

Group Care Facility:
A facility of no more than twelve (12) patients or residents, providing assisted living, congregate care, or a group residence in a supervised setting for the aged or infirmed, with the residents typically being housed in individual or shared rooms. The facility may include its own kitchen and laundry facilities, as well as outdoor activity areas.

Gross Acres:
Gross Acres includes lots, local roads, and functional open space. Gross Acres excludes Drexel Road and its associated greenway, dedicated easements, and natural open space.

Guest House:
A secondary residence or living quarters that may be an attached or detached structure from the primary residence. If detached, a guest house is allowed above a garage with a combined height not to exceed 28’. A guest house may provide full kitchen amenities, however, separate utility meters will not be permitted for the guest house and main residence. Rental of the guest house is allowed with no more than 2 residents, and shall be enforced through CC&Rs.

Home Occupation:
Same as defined within the UDC, except home occupation (i.e. Live/Work) allows for retail services, personal services or medical services to be provided from home. Gross floor area dedicated for the home occupation may take up to 50% of the structure that it occupies. One outside employee for the home occupation is allowed. Commercial site plan review and/or nonresidential development standards shall not be required.

Houghton Area Master Plan (HAMP):
The City of Tucson’s master plan for a 16.9 square mile area along Houghton Road. The vision for the plan is to provide a comfortable environment in which to live, raise children, work, retire, have social interaction with neighbors, be close to nature, and pursue a healthy lifestyle. The HAMP, which uses the Desert Village model approach, offers an opportunity to plan and develop a place where people can easily access jobs, schools, shopping, services, as well as social, cultural, recreational and leisure activities.

Local Streets:
All public streets excluding private drives, PAALs and alleys within the Saguaro Trails Planned Area Development.

Loft:
A residential dwelling unit that is located on the second-story above an existing street-level residential dwelling unit or commercial building. The loft may be comprised of one large room or be partitioned and may contain a kitchen, bathroom, sleeping area, and dining area all within the single large room or as partitioned. Lofts are allowed to have a physically separate access and address from their ground-story counterpart.

Lot Coverage:
Residential lot coverage shall be calculated on an individual per lot basis. Total coverage of buildings, storage areas and vehicular use area within a residential lot is calculated as follows: total square feet of coverage area divided by the total square feet of the lot equals the percentage of lot coverage. The lot coverage calculation shall exclude covered areas open to at least one (1) side, patios (above-grade or at-grade) and interior space used for recreational purposes.

Mini Parks:
Improved open space areas, generally less than one acre in size, which would include improvements such as tot lot, benches, turf area for passive play, as well as other passive recreation amenities.

Multi-Family:
As defined within the UDC Section11.3.7: “Any residential development consisting of three or more dwelling units on an integrated site or single lot.”

Natural Open Space:
Any public or private area that contain primarily undisturbed natural vegetation and managed as a natural appearing landscape. Uses are passive and may include trails, walkways and interpretive functions.

Net Developable Acres:
Net Developable Acres includes lots, private accessways and/or alleys, and functional open space. Net Acres excludes Drexel Road and its associated greenway, local roads, dedicated easements, and natural open space.

PAALs:
As defined within the UDC Section 11.4.17: “The area within a parking lot serving as a travel lane or lanes, other than those in a street, that provides direct ingress and egress from individual parking spaces. Typical examples include shopping center parking lots, apartment developments using common parking, and other places in which the primary or sole purpose is to provide access to a parking area, as opposed to providing access directly to property.”

Plan:
The Planned Area Development for The Saguaro Trails Project.

Product Type:
Refers to the various residential development housing options that may be provided within a residential land use. Product type may include traditional single-family homes on a single lot, auto court cluster development, alley-loaded, attached units, multi-family housing, etc.

Project:
The Saguaro Trails Planned Area Development Project.

Public Facilities:
Any facility (whether publicly or privately owned) which is to be used and/or allocated for the general good of the public. These uses would include but are, not limited to, parks, government services, utilities, streets, treatment facilities and drainage features. All facilities will be subject to applicable land use regulations.

Residential:
Development Areas designated for the establishment of dwellings.

Residential Care Services (Group Care Facility):
As defined within the UDC Section 11.3.7: Residential facilities that provide lodging, meals, and treatment to persons who are unable to be cared for as part of a single household. This use includes group homes and institutional living arrangements with 24 hour care.

Residential Single-Family Attached:
A dwelling unit attached on a horizontal plane to one or more dwelling units by structural elements common to the attached units. Each dwelling unit is located on its own individual lot or separated by a line denoting a separate ownership of each unit. The structural elements include common wall construction, roof, or other similar improvement. Product offerings for this residential category include townhomes, condominiums, row house, duplexes, lofts, and multi-story apartments.

Residential Single-Family Detached:
A building containing only one dwelling unit entirely separated from buildings on adjoining lots or building sites. Product offerings for this residential category include traditional single-family detached homes, patio homes, alley-loaded homes, and auto-court product.

Right-of-Way:
As defined within the UDC Section 11.4.19: "An area reserved for a public or private use, such as, but not limited to, street or alley rights-of-way and utility easements."

Riparian:
As defined within the UDC Section 11.4.19: "Land adjacent to or within washes and drainageways that is occupied by biotic communities differing in species composition and/or density from surrounding upland due to an increase in moisture and different soil conditions."

Row House:
A structure containing multiple residential dwelling units in cluster, all of which are physically connected but each of which is separated by a common wall. Each dwelling unit is generally similar in design and its street-level entry faces the same direction. Row houses may be single-story or multi-story in design, with all stories being separated by the same common wall that extends vertically from their ground floor.

Southeast Houghton Area Recharge Project (SHARP):
The Southeast Houghton Area Recharge Project (SHARP) is a Tucson Water facility providing aquifer recharge for the southeast region. It will contain an extensive series of recharge basins, together with a regional reclaimed water distribution system, metering station, monitoring wells, and maintenance yard, all of which will be integrated with the existing reservoir facility already on the site. The SHARP master plan also includes designing and landscaping the majority of the project as a public recreational amenity, including a comprehensive system of pedestrian paths and mountain bike trails around the recharge basins, a parking lot for both private vehicles and school buses, public restrooms, and picnic ramadas.

Unified Development Code (UDC):
Chapter 23 of the Tucson Code as adopted by the Mayor and Council establishing zoning regulations governing the use, placement, spacing, and size of land and structures within the corporate limits of the City. Such regulations are applied on individual properties through the use of zoning districts. The boundaries of these districts are depicted on the adopted City Zoning Maps. For the purposes of convenience and ease of use, the UDC is also published as a separate book from the Tucson Code.

Water Harvesting (Active and Passive)
As defined within the UDC Section 12.01.0: "The process of intercepting stormwater and putting it to beneficial use." Active: "The collection of stormwater into containment systems for storage and later diversion to beneficial uses." Passive: "The collection of stormwater directly into Water Harvesting Infiltration Areas without the temporary storage of water in a containment system."

APPENDIX B: PDSD EVALUATION AND PLAN COMPLIANCE LETTER

Appendix B

CITY OF
TUCSON

PLANNING AND
DEVELOPMENT
SERVICES
DEPARTMENT

January 27, 2016

Mr. Tim Kinney, Esq.
Lazarus, Silvyn & Bangs, P.C.
4733 East Camp Lowell Drive
Tucson, AZ 85712

Dear Mr. Kinney:

SUBJECT: Mattamy Homes – Houghton Road Property, Compliance with the Houghton Area Master Plan

I have reviewed your letter (attached) requesting confirmation that Mattamy Homes proposed residential development project (Project) located west of South Houghton Road and south of East Irvington Road is in compliance with the City of Tucson's Houghton Area Master Plan (HAMP), and therefore an amendment to the HAMP will not be required prior to pursuing a rezoning to Planned Area Development.

Mattamy Homes is proposing to develop this 173 acre site for market-rate residential uses, including single-family detached dwellings of varying lot sizes, single-family attached townhomes and potentially apartment uses. The Project site shows that only approximately 142 acres of the site is developable as the remaining 32 acres is undevelopable due to exclusive Easements, Wash/Xeroriparian Class C areas, and the portion of Drexel Road within the Project that will be dedicated to the City (Exhibit A). The Project is proposing a density range of four to eight residential units per acre, with an approximate six acre Neighborhood Center (park), and mini-parks within the Planning Areas.

Land uses in the HAMP should be organized and developed according to all policies, following the land use distribution recommended in the Conceptual Land Use and Circulation Map which identifies the Project as being within the Neighborhood Low Density Residential area. The fundamental themes of a HAMP planned community are: variety of housing types, residential densities high enough to support mass transit usage and commercial activities, pedestrian and bike friendly environment, pedestrian linkages, natural open space areas that serve to define edges of neighborhoods, trails and parks.

Therefore, it is determined that Mattamy Homes proposed residential development project (Project) located west of South Houghton Road and south of East Irvington Road is consistent with the City of Tucson's Houghton Area Master

Plan (HAMP), and an amendment to the HAMP will not be required prior to pursuing a rezoning to Planned Area Development.

Plan compliance is supported by the following:

1. Project meets density requirement of minimum four residential units per acre, and no more than eight residential units per acre.
2. Project provides Neighborhood Center - neighborhood park (5.85 acres).
3. Project provides a variety of market rate housing types attached and detached single-family homes, potential townhomes and apartments.
4. Project provides residential densities high enough to support mass transit usage and commercial activities, i.e bus stop at Drexel/Houghton, Civano commercial directly across Houghton.
5. Project provides for pedestrian and bike friendly environment, pedestrian linkages, natural open space areas that serve to define edges of neighborhoods, and trails and parks, i.e. connection with Fantasy Island recreational bike paths

Please note that a copy of this letter and attached Exhibits must be attached to any Zoning application submittal.

Sincerely,

John Beall

John Beall
Principal Planner
Planning and Development Services Department

Attachments: Applicant's Request Letter and Exhibits

LSB
LAW OFFICES OF
Lazarus, Silvyn & Bangs, P.C.
A PROFESSIONAL CORPORATION

January 25, 2016

VIA E-MAIL (JOHN.BEALL@TUCSONAZ.GOV)

John Beall
City of Tucson
Planning and Development Services Department
201 N. Stone Ave.
Tucson, Arizona 85701

RE: Mattamy Homes, Houghton Road Property; Compliance with the Houghton Area Master Plan.

Dear John:

Thank you for meeting with Mattamy Homes ("Mattamy"), Keri Silvyn, and myself on January 12, 2016 to discuss Mattamy's proposed residential development project (the "Project") located west of South Houghton Road and south of East Irvington Road (the "Property") in the City of Tucson (the "City"). The meeting was very constructive and we appreciate you working with us throughout this process. As you know, the Property is approximately 173 acres in size, is currently zoned Suburban Ranch ("SR"), and is within the Houghton Area Master Plan (the "HAMP"), which designates the Property "Neighborhood/Low Density Residential". The purpose of our meeting was to present a preliminary concept plan of the Project, summarized below, and to confirm compliance with HAMP in anticipation of a rezoning of the Property to Planned Area Development ("PAD").

Mattamy's desire is to proceed (after closing on the Property with the City) to rezone both the Property and the City-owned adjacent portion of Fantasy Island to the north of the Project (the "City-Owned Parcel") in a single PAD. The City-Owned Parcel will remain as open space and recreation use (with limited roadway/utility easements), while the Property will be developed for residential uses as discussed below.

This letter seeks to confirm that the Project is in compliance with the HAMP as required by A.R.S. § 9-462.01(F), and therefore an amendment to the HAMP will not be required in order to proceed with the PAD. Below is an overview of the Project, an overview of the HAMP policies, our analysis of the Project's conformance with HAMP and conclusions. Enclosed is the applicable fee of $236.50 for a zoning compliance letter request.

1. Overview of the Project.

Mattamy successfully participated in a City competitive bid process to purchase the Property, which was approved by the Mayor and Council on November 17, 2015. Mattamy is now within a 90-day inspection period for the Property. Mattamy is still in the early stages of planning the Project. As such, the attached Conceptual Land Use Plan ("Conceptual Plan") and Conceptual Land Use Data Chart ("Data Chart") may be modified as Mattamy prepares the actual PAD for submittal. *See* **Attachments A and B.** We believe that the Conceptual Plan and Data Chart, while subject to change, along with the Project explanation in this letter, are sufficient to permit the City to determine substantial conformance to HAMP.

1. Residential Use and Density. The Project will be developed for market-rate residential uses, including single-family detached dwellings of varying lot sizes, single-family attached townhomes and potentially apartment uses.

While the Property is approximately 173 acres, only approximately 142 acres is developable, with the developable areas organized into Planning Areas ("PA"s). The remaining approximately 32 acres is undevelopable Property. The undevelopable acreage calculation may change as planning continues, but will include exclusive Easements[1], Wash/Xeroriparian Class C areas, the portions of Drexel Road within the Project that will be dedicated to the City, any other roadways dedicated to the City within the Project, and the regional "Urban Trail" acknowledged in HAMP[2]. All undevelopable areas are noted on the Conceptual Plan with corresponding approximate acreages on the Data Chart. In calculating the density for the Project, the undevelopable areas as described above and shown on the Conceptual Plan are excluded from the calculations. Therefore density is calculated using only the developable acreage within the PAs.

There are two PAs noted as "PA D1" and "PA B" on the Conceptual Plan that both include the higher density (called "medium density" in HAMP). Those areas are purposefully located near the Neighborhood Center and Houghton Road/existing Sun Tran Bus Stops ("Transit Stop") to comply with HAMP.

While the actual acreages and densities may change within the PAs as the planning for the Project progresses toward PAD submittal, Mattamy understands the need to maintain an overall Project density (calculated exclusive of undevelopable areas) of four Residences Per Acre ("RAC"), with the higher density (described as "medium density" in HAMP) areas (PA B and PA D1 as noted on the Conceptual Plan) maintaining a minimum of eight RAC.

2. Neighborhood Center and Connectivity. There will be an approximate six-acre Neighborhood Center as required by HAMP. This area includes passive open space, active open space, and an improved park for the Project. This Neighborhood Center will be connected to the

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[1] If any of the Easements are modified or otherwise released of exclusivity and permitted for development within the Project, Mattamy understands those Easements would then be included within the developable area. The only exception would be for the Urban Trail. If the Easements permit development of the Urban Trail, those Easement areas will still be considered undevelopable areas.

[2] Mattamy is currently planning to develop the Urban Trail within the existing Easement Areas. If that is approved, those Easements and the Urban Trail will still be considered undevelopable areas. The actual location of the Urban Trail will be determined at the time of PAD submittal.

PAs by roadways and pedestrian/bicycle paths. In addition, the Neighborhood Center will provide the regional connectivity to the Fantasy Island recreation areas to the north and south of the Project. Within the larger PAs, there will be smaller parks for residences.

All washes and xeroriparian areas, as noted on the Conceptual Plan, will remain undeveloped and create the open space and environmental connectivity desired for the Project.

Although not shown in the Conceptual Plan, the PAD will provide roadway, pedestrian and bicycle connectivity throughout the PAs. These will connect to the Neighborhood Center, to the existing Transit Stop on Houghton Road and to the Fantasy Island/regional recreation paths and areas. The Project will also accommodate the Urban Trail regional connectivity contemplated in HAMP. The current desire is to include the Urban Trail within the T.G.E. Easement if Mattamy can obtain approval for such use within the Easement. If not, Mattamy will work with the City during the PAD process to accommodate that Urban Trail.

2. HAMP and Applicable Policies.

The HAMP encompasses approximately 10,800 acres of land along Houghton Road, establishing policies for growth and development within the area in accordance with Plan Tucson, the City's general plan. The HAMP establishes a "Desert Village" model, which promotes land use patterns that include Town Centers, Villages, Village Centers, Neighborhoods and Neighborhood Centers within the 10,800 acres. The "Desert Village" concept is based on the Town Center as a central organizing feature for a number of Villages. Village Centers support the Town Center and include clusters of many Neighborhoods. Each residential Neighborhood should include a Neighborhood Center that serves residents in their immediate areas. HAMP § III(C).

Within HAMP, the entire Project area is designated as one of the residential Neighborhoods – "neighborhood/low density residential" - to support the overall Village and Town Center concept as shown on the HAMP Conceptual Land Use and Circulation Map.

a. Applicable HAMP-wide Policies.

The HAMP includes broad policies that apply to all land uses, including encouraging a variety of housing types, densities, and a mix of uses. HAMP § IV(A)(1),(2). The HAMP encourages transportation and circulation systems that give high priority to pedestrian, bicycle, and transit options, as well as the creation of a regional, connected open space system that preserves washes and environmentally sensitive areas and offers amenities such as trails and parks. HAMP § IV(A)(3),(4). The HAMP also encourages a variety of housing diversity and pricing options in order to provide "residents of all ages and incomes…housing alternatives and choices." HAMP § IV(B)(1)(a).

Other policies that apply to the entire HAMP area include:

- Urban trails for pedestrians and bicycles should be planned between neighborhood centers, village centers, parks, and the open space system. HAMP § IV(C)(5).
- Trail connections to the surrounding regional trail systems around the HAMP are required to establish a continuous trail system, according to the Parks and Trails Map. HAMP § IV(E)(1). The Parks and Trails Map of the HAMP shows an "urban trail" running along the south and west boundaries of the Property.
- The washes and floodplain envelopes on the Property must be preserved as natural open space. HAMP § IV(D)(1).

b. Applicable Neighborhood and Neighborhood Center Policies.

Neighborhoods are described in the HAMP as "social/physical unit[s] based on an optimal walking radius of a quarter of a mile to half a mile. Neighborhoods include a neighborhood center, which acts as a social and recreational focal point," accessible from the surrounding residential developments. HAMP § IV(B)(5). The fundamental themes of a neighborhood include the following standards related to housing:

> Housing within neighborhoods will consist of a range of densities. The minimum average density for the entire Neighborhood, including the neighborhood center, should be four residential units per acre. Medium densities (apartments, duplexes, townhomes, condominiums, patio homes, and attached single family, with a minimum of 8 residential units per acre) may be found in and around neighborhood centers, and in areas near village centers. Very low densities (lower than 4 residences per acre) may be appropriate in areas severely constrained by drainage ways and/or environmental conditions.

HAMP § IV(B)(5)(a).

Neighborhoods are meant to be primarily residential, and the neighborhood center is meant to be a "highly accessible social and recreational focus point" for the overall neighborhood. HAMP § IV(B)(5)(b) and IV(B)(6). Neighborhood centers should include a neighborhood park, and while they may include non-residential uses, the neighborhood centers are not required to do so. Neighborhood centers should be connected by local streets and internal trail systems. HAMP § IV(B)(5)(b),(c). Neighborhood centers include the park and a range of low to medium residential densities (with a minimum average density of eight RAC as mentioned above for the medium residential densities). HAMP § IV(B)(6). Natural open space should serve to define the edges of neighborhoods, and connections to larger trail networks should be incorporated with the neighborhood's internal trail systems. HAMP § IV(B)(5)(c). Traffic calming devices should be used within neighborhoods and centers, as well as generous sidewalk widths, street trees and landscaping, and enhanced pedestrian crossings. HAMP § IV(C)(2).

3. The Project is Consistent with the HAMP's Policies.

A.R.S. § 9-462.01(F) requires all rezoning applications to be "consistent with and conform to" the City's applicable general plan document. We believe the Project is consistent with and conforms to the applicable HAMP policies.

The Project is within the Neighborhood designation, so the mix of residential uses and the almost six-acre Neighborhood Center are the policy-driven uses for the Project. As the Conceptual Plan shows, the Project includes a variety of housing types and densities in compliance with the overall goal of HAMP. The overall density of the Project is above the minimum four RAC required for neighborhoods within the HAMP, and the medium density areas around the neighborhood center are a minimum of eight RAC in compliance with the HAMP. Although the specific acreages for PAs and the actual densities may vary, the Project average of four RAC and medium density minimum of eight RAC will ultimately be achieved.

The Project has a Neighborhood Center, with a park and medium-density residential uses, that could include townhomes and/or apartments. The medium-density is located in planning areas B and D1 near the Neighborhood Center, as required by the HAMP, and near Houghton Road and the Transit Stop. The Project includes market rate housing and so will contribute to the HAMP area's broad goal of offering housing with different price options.

The Project will include local and collector roads and internal trail systems that connect to other areas within the HAMP via Houghton Road that will integrate pedestrian and bicycle-friendly designs. The Urban Trail shown on the HAMP's Parks and Trails Map will be included and integrated as part of the Project and will connect to the Fantasy Island recreation area. While this regional trail and the additional roads/pedestrian/bicycle internal connection systems are not shown on the Conceptual Plan, these elements will be included as part of the PAD.

The existing Transit Stops on Houghton Road will serve the Project, and small parks will be located throughout the Project and integrate with the Project's internal trail systems as is required by the HAMP. Washes and designated xeroriparian areas will be preserved as natural open space, which will serve to define the edges of the Project.

4. Conclusion

Based on the Conceptual Plan, Data Chart and information in this letter, we believe this Project is consistent with and conforms to the HAMP for purposes of A.R.S. § 9-462.01(F), and thus an amendment to the HAMP will not be required in order to rezone the Property for PAD. This letter is a request to confirm this conclusion with the City.

Thank you for your consideration. We look forward to the City's response on the Project's compliance with the HAMP.

Very truly yours,

Tim Kinney, Esq.

cc: Mr. Josh Robinson, Mattamy Homes
Mr. Justin Smith, Mattamy Homes
Ms. Keri Silvyn, Lazarus, Silvyn & Bangs PC

Exhibit B

Civano Property

Conceptual Land Use Data Chart

January 18, 2016

DEVELOPABLE AREA

Category	Approximate Acreage	Approximate Average Residential Density
Planning Area A	42.54	3.8 Du/Ac
Planning Area B	9.40	8.0 Du/Ac
Planning Area C	15.88	5.4 Du/Ac
Planning Area D1	5.75	8.0 Du/Ac
Planning Area D2	21.41	3.5 Du/Ac
Planning Area E	42.30	4.4 Du/Ac
Neighborhood Park (1)	4.23	
Total Developable Area	**141.51**	**4.44 Du/Ac**

NON-DEVELOPABLE AREA

Category	Approximate Acreage
Easements (2)	16.63
Wash / Xeroriparian Class C	12.68
Drexel R.O.W.	2.55
Total Non-Developable Area	**31.86**

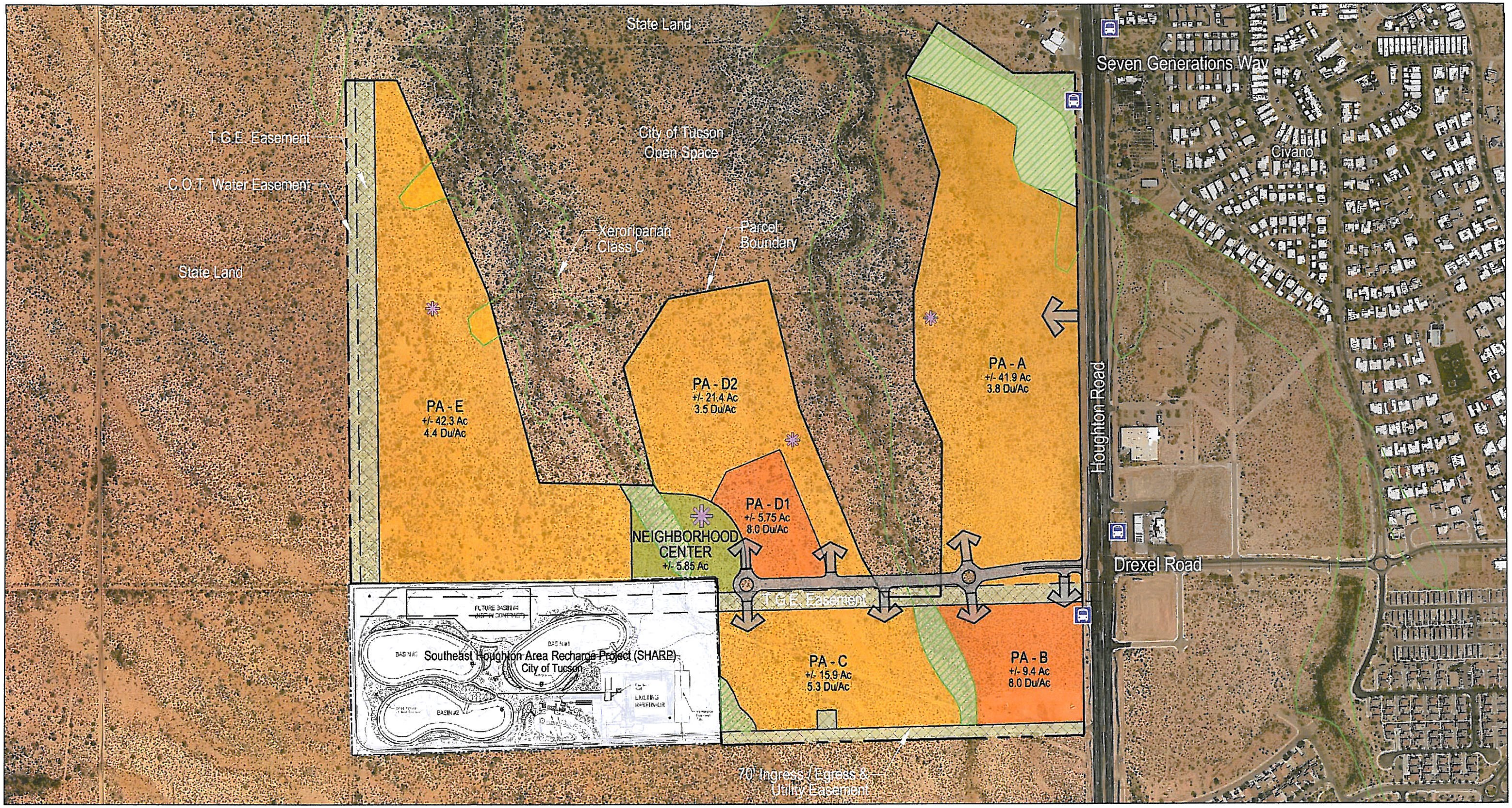
SUMMARY

Developable Area	141.51
Non-Developable Area	31.86
Total Project Area	**173.37**

Notes:

1. The Neighborhood Center is a total of 5.86 acres which includes the Neighborhood Park and a portion of Wash/Xeroriparian Class C.

2. Easements include: 1) the 100' T.G.E. easement south of the Drexel Road alignment (4.45 acres); 2) the 100' T.G.E. easement and 30' C.O.T. Water easement both located along the western Project boundary (9.21 acres); 3) the 70' ingress/egress & utility easement along the southern Project boundary (3.10 acres); and 4) the well site in PA-C (0.23 acres).



LEGEND

Developable Area

🟨 🟧 Planning Area (PA)

🟩 Neighborhood Park

Non-Developable Area

▨ Easements

▨ Wash / Xeroriparian Class C

⬜ Drexel R.O.W.

Symbols

🚌 Sun Tran Bus Stop

✳ Park / Amenity Node (Locations subject to change.)

Overall Average Residential Density: 4.44 Du/Ac

January 18, 2016

NORTH

0 250' 500' 1000'

SCALE: 1" = 500'

CIVANO PROPERTY - Conceptual Land Use Plan (Exhibit A)

mattamyHOMES

NORRIS DESIGN
Planning | Landscape Architecture

418 North Toole Avenue
Tucson, Arizona 85701
P 520.622.9565
www.norris-design.com

APPENDIX C: WILL-SERVE LETTERS

Appendix C

CITY OF TUCSON

TUCSON WATER DEPARTMENT

January 14, 2016

Mattamy Homes
6640 N. Oracle Rd.
Tucson, AZ 85704

Attn: Angela Carmitchel

SUBJECT: **Water Availability for project: Drexel Road & Houghton Road, APN: 14101006B, 14101007H, 14101007E, 14101007J, Case #: WA1877, T-15, R-15, SEC-02, Lots: 9999, Location Code: TUC, Total Area: 279.8ac Zoning: SR**

WATER SUPPLY

Tucson Water will provide water service to this project based on the subject zoning of the above parcels. Tucson Water has an assured water supply (AWS) designation from the State of Arizona Department of Water Resources (ADWR). An AWS designation means Tucson Water has met the criteria established by ADWR for demonstration of a 100-year water supply – it does not mean that water service is currently available to the subject project.

WATER SERVICE

The approval of water meter applications is subject to the current availability of water service at the time an application is received. The developer shall be required to submit a water master plan identifying, but not limited to: 1) Water Use; 2) Fire Flow Requirements; 3) Offsite/Onsite Water Facilities; 4) Loops and Proposed Connection Points to Existing Water System; and 5) Easements/Common Areas.

Any specific area plan fees, protected main/facility fees and/or other needed facilities' cost, are to be paid by the developer. *If the existing water system is not capable of meeting the requirements of the proposed development, the developer shall be financially responsible for modifying or enhancing the existing water system to meet those needs.*

This letter shall be null and void two years from the date of issuance.

Issuance of this letter is not to be construed as agency approval of a water plan or as containing construction review comments relative to conflicts with existing water lines and the proposed development.

If you have any questions, please call New Development at 791-4718.

Sincerely,

Richard A. Sarti

Richard A. Sarti, P.E.
Engineering Manager
Tucson Water Department

RS:ka
CC:File

PIMA COUNTY
REGIONAL WASTEWATER RECLAMATION DEPARTMENT
201 NORTH STONE AVENUE
TUCSON, ARIZONA 85701-1207

JACKSON JENKINS
DIRECTOR

PH: (520) 724-6500
FAX: (520) 724-9635

January 20, 2016

William Carroll
Engineering & Environmental Consultants
4625 E Fort Lowell Road
Tucson, Arizona 85712

Sewerage Capacity Investigation No. 2016-3 Type I

RE: **Civano Parcel Option A, Parcels 14101006B, 14101007H, 14101007J**
Estimated Flow 129,600 gpd (ADWF).
P16WC00003

Greetings:

The above referenced project is tributary to the Agua Nueva Wastewater Reclamation Facility via the Pantano Interceptor.

Capacity is currently available for this project in the public sewer G-86-024, downstream from manhole 4548-12.

This letter is not a reservation or commitment of treatment or conveyance capacity for this project. It is not an approval of point and method of connection. It is an analysis of the system as of this date and valid for one year. Allocation of capacity is made by the Type III Capacity Response.

If further information is needed, please feel free to contact us at (520) 724-6642.

Reviewed by: Kurt Stemm, CEA Sr.

PIMA COUNTY
REGIONAL WASTEWATER RECLAMATION DEPARTMENT
201 NORTH STONE AVENUE
TUCSON, ARIZONA 85701-1207

JACKSON JENKINS
DIRECTOR

PH: (520) 724-6500
FAX: (520) 724-9635

January 20, 2016

William Carroll
Engineering & Environmental Consultants
4625 E Fort Lowell Road
Tucson, Arizona 85712

Sewerage Capacity Investigation No. 2016-4 Type I

RE: **Civano Parcel Option B, Parcels 14101006B, 14101007H, 14101007J**
Estimated Flow 129,600 gpd (ADWF).
P16WC00004

Greetings:

The above referenced project is tributary to the Agua Nueva Wastewater Reclamation Facility via the Pantano Interceptor.

Capacity is currently available for this project in the public sewer G-97-059, downstream from manhole 6592-15.

This letter is not a reservation or commitment of treatment or conveyance capacity for this project. It is not an approval of point and method of connection. It is an analysis of the system as of this date and valid for one year. Allocation of capacity is made by the Type III Capacity Response.

If further information is needed, please feel free to contact us at (520) 724-6642.

Reviewed by: Kurt Stemm, CEA Sr.

TEP
Tucson Electric Power
Post Office Box 711 (OH-202)
Tucson, AZ 85702

November 18, 2015

Mattamy Homes
Attn: Angela Carmitchel
9200 E Pima Center Parkway, 230
Scottsdale, AZ 85258

To Whom It May Concern:

SUBJECT: **CIVANO PROJECT**

Please be advised that Tucson Electric Power Company is a public utility and the certificated provider of electricity serving the subject location. The necessary facilities for the furnishing of electric service to this area are presently available under the Company's conventional line extension policies.

This is to further advise that as a public utility, Tucson Electric Power Company is ready and willing at all times to furnish adequate electric service under its conventional rules and regulations on file with the Arizona Corporation Commission.

If your company plans on proceeding with this project please send dimension site and electrical load plans to the attention of Frank Mendez, Project Manager, to the address listed on letterhead.

Sincerely,

Natalie R. Nava

Natalie R Nava
Scheduling Coordinator

cc: Frank Mendez, Tucson Electric Power

SOUTHWEST GAS CORPORATION

January 22, 2016

Angela Carmitchel
Land Development Manager, Phoenix Division
9200 E. Pima Center Parkway, Suite 230
Scottsdale, AZ 85258

Dear Ms. Carmitchel:

Thank you for your inquiry concerning the availability of natural gas to the proposed Houghton and Drexel Project, located at Houghton and Drexel Rd.. Southwest Gas Corporation currently has a 6" Steel and 4" PE natural gas main located on the corner of Houghton and Drexel. Natural gas is available to serve your project in accordance with our Rule Six as filed with the Arizona Corporation Commission.

Southwest Gas Corporation extends facilities based on economic feasibility. Without reviewing a preliminary engineering plan on the project, we cannot, at this time, determine what fees, if any would be required from the owner/developer. We look forward to hearing from you as plans progress.

If you have any questions, please feel free to contact me. I can be reached at (520) 247-0593 or e-mail: matt.minder@swgas.com.

Sincerely,

Matt Minder /kac

Matt Minder
Energy Advisor
Southern Arizona Division

Enclosure

kac

3401 East Gas Road / Tucson, Arizona 85714-1994
P.O. Box 26500 / Tucson, Arizona 85726-6500 / (877) 860-6020
www.swgas.com

APPENDIX D: PRELIMINARY JURISDICTIONAL DETERMINATION

Appendix D

SWCA®
ENVIRONMENTAL CONSULTANTS
Sound Science. Creative Solutions.

Tucson Office
343 West Franklin Street
Tucson, AZ 85701
Tel 520.325.9194 Fax 520.325.2033
www.swca.com

Technical Memorandum

To: Justin Smith, P.E.
Mattamy Homes
6640 North Oracle Road, Suite #110
Tucson, Arizona 85704

From: Russell Waldron, SWCA Environmental Consultants

Date: January 20, 2016

Re: **Preliminary Jurisdictional Determination for 173-Acre Civano Property Project in Tucson, Arizona / SWCA Project No. 36136**

INTRODUCTION

SWCA Environmental Consultants (SWCA) conducted a preliminary[1] jurisdictional determination (PJD) to evaluate the extent of potentially jurisdictional waters of the U.S. (WUS) for an approximately 173-acre parcel (the project area) known as the Civano Property, west of South Houghton Road and south of East Irvington Road in Tucson, Arizona (Figure 1). The project area is located in Sections 2 and 11, Township 15 South, Range 15 East, Gila and Salt River Baseline and Meridian, Pima County, Arizona (Figure 2). The PJD is being conducted as part of a proposed residential development of the parcel.

METHODS

SWCA personnel reviewed aerial photography of the project area and vicinity and then conducted a field reconnaissance on December 18, 2015, and January 5, 2016, to identify and map, if present, the location of the ordinary high-water mark (OHWM) limits of potential WUS within the boundaries of the project area. During field reconnaissance, the OHWM width was measured, and channel characteristic data were recorded for drainages that crossed the project area. These data were recorded on a 2013 aerial photograph with a scale of 1 inch = 200 feet. Ground-level photographs were also taken at various locations along drainages within the project area. Field data were then superimposed onto an electronic copy of the aerial photograph using AutoCAD software. Representative photographs are provided in Appendix A, and the field data sheet is provided in Appendix B.

---

[1] This JD is considered preliminary, pending final review and approval by the U.S. Army Corps of Engineers (USACE).

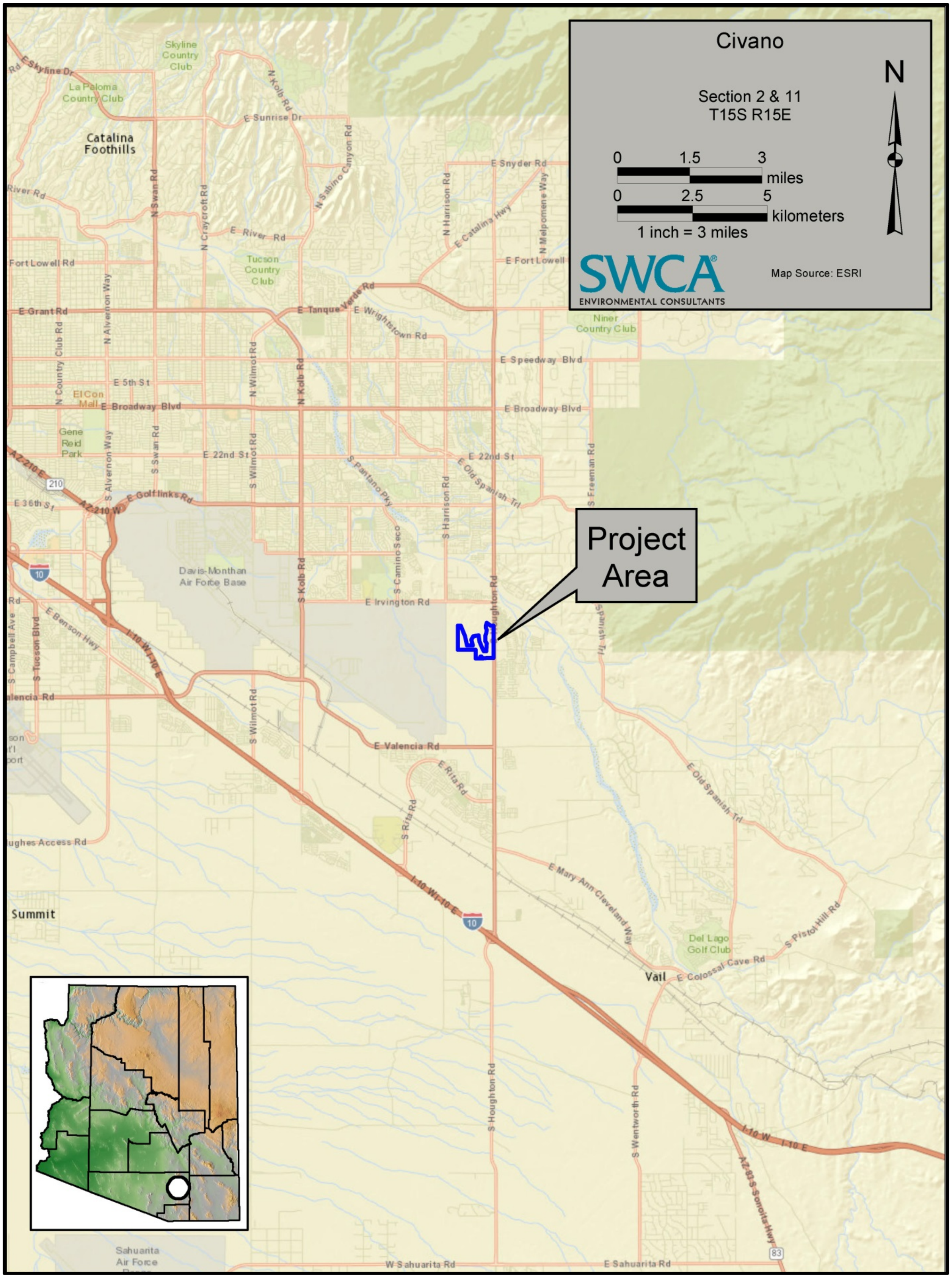
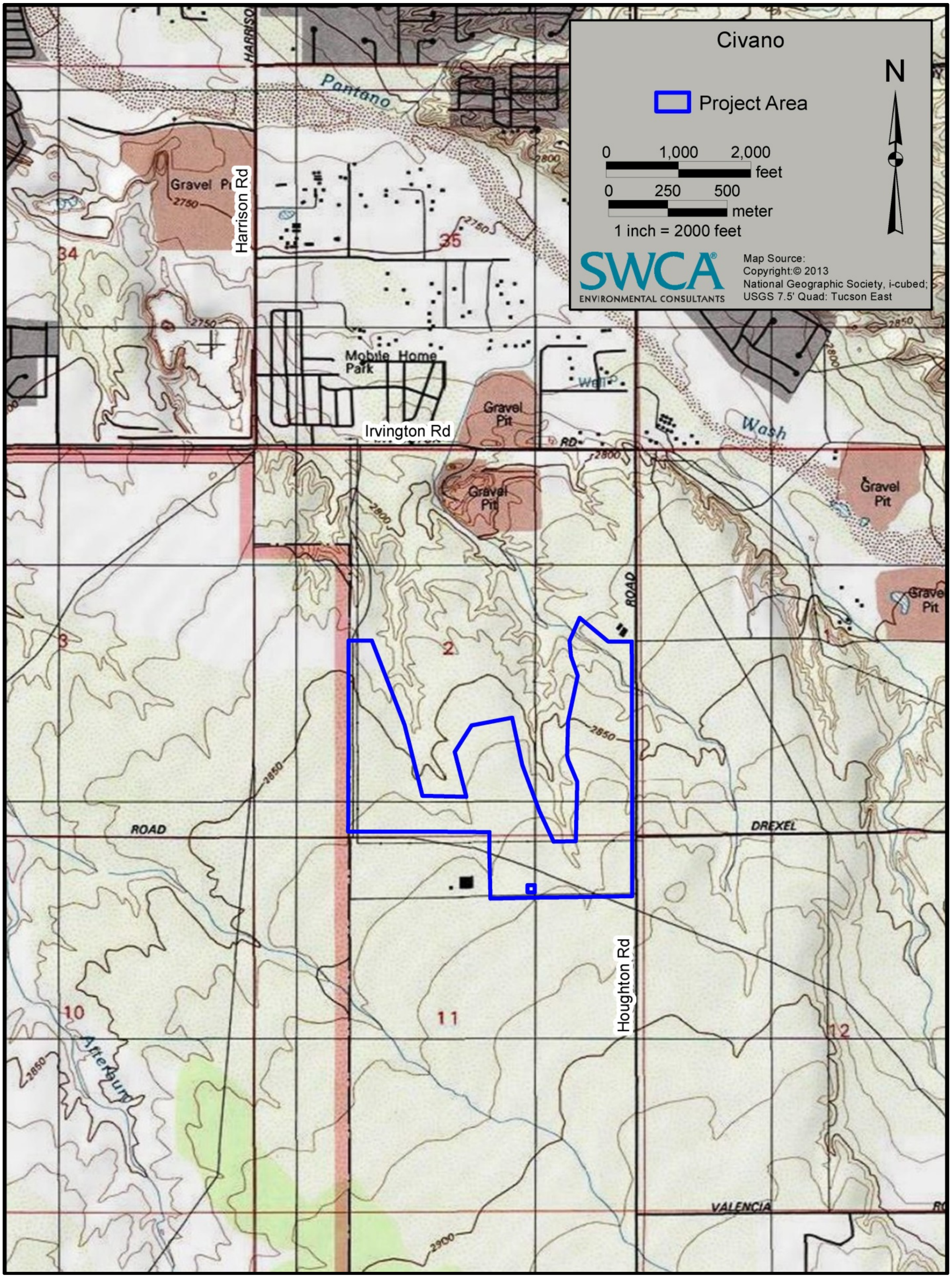


Figure 1. General location of the project area.



Map Source:
Copyright:© 2013
National Geographic Society, i-cubed;
USGS 7.5' Quad: Tucson East

Figure 2. Project area.

RESULTS

Project Area Description

The project area is located on the lower bajada of the Tortolita Mountains at elevations ranging from 2,780 to 2,880 feet above mean sea level. Topography consists of low, alternating ridges and drainages sloping downward from south to north. Drainages in the project area are ephemeral, conveying stormwater flows northward approximately 1.4 miles into Pantano Wash, which eventually flows into Rillito Creek approximately 8.6 miles northwest of the project area.

The project area is located within the Arizona Upland subdivision of the Sonoran Desertscrub biotic community.[2] The dominant species in the upland portion of the project area are creosote bush and yellow (=foothill) paloverde (*Parkinsonia microphylla*). Other plant species include blue paloverde (*P. florida*), catclaw acacia (*Senegalia greggii*), velvet mesquite (*Prosopis velutina*), saguaro (*Carnegiea gigantea*), chain-fruit cholla (*Cylindropuntia fulgida*), Engelmann prickly pear (*Opuntia engelmannii*), barrel cactus (*Ferocactus wislizeni*), ocotillo (*Fouquieria splendens*), soaptree yucca (*Yucca baccata*), joint fir (*Ephedra* spp.), triangle bur ragweed (*Ambrosia deltoidea*), desert zinnia (*Zinnia acerosa*), brittlebush (*Encelia farinosa*), burroweed (*Isocoma tenuisecta*), and sandmat (*Chamaesyce* spp.). The dominant xeroriparian species observed along the washes within the project area is yellow paloverde. Other species observed along the washes include velvet mesquite, catclaw acacia, wolfberry (*Lycium* sp.), creosote bush, and brickell bush (*Brickellia* spp.). No agaves or aquatic habitats (including stock ponds), broadleaf deciduous riparian vegetation communities (i.e., communities containing willow [*Salix* spp.], cottonwood [*Populus* spp.], or ash [Fraxinus spp.], etc.), or potential bat roost sites (e.g., natural caves or mine features) exist in the project area. There are saguaros in the project area

Waters of the U.S.

Based on the results of the fieldwork and computer analysis, three ephemeral drainages were identified as potential WUS (Figure 3) based on the presence of OHWMs. Total jurisdictional area within the project area is estimated at 0.26 acre (Table 1). Data points on the PJD figures are indicated by a blue arrows, and ground-level photographs were taken upstream and downstream at each data point. A copy of the data is provided in Appendix B.

---

[2] Brown, D.E. (ed.). 1994. *Biotic Communities: Southwestern United States and Northwestern Mexico*. Salt Lake City: University of Utah Press.

Table 1. Field Data and Estimates of WUS in the Civano Property Project Area

Drainage ID	Photo Nos.	Latitude*	Longitude*	Length (feet)	Average width (feet)	Area (acre)	Field Indicators	Jurisdictional	
								Yes	No
Wash A (Data Point PP-1)	1, 2	32.154767	-110.774217	1,620	4.0	0.15	Cut bank, shelving, sandy channel bottom, substrate change, vegetation destruction	X	
Wash B (Data Point PP-2)	3, 4	32.146583	-110.775175	858	2.0	0.04	Cut bank, shelving, sandy channel bottom, substrate change, vegetation destruction	X	
Wash C (Data Point PP-4)	7, 8	32.148717	-110.780378	980	3.0	0.07	Cut bank, shelving, sandy channel bottom, substrate change	X	
PP-3	5, 6	32.150745	-110.780332	N/A	N/A	N/A	Swale		X
PP-5	9, 10	32.150292	-110.782305	N/A	N/A	N/A	Swale		X
PP-6	11, 12	32.153445	-110.784663	N/A	N/A	N/A	Swale		X
Total				**3,458**		**0.26**			

*North American Datum (NAD) 83

* * * * *PRELIMINARY (RGL 08-02)* * * * *

SECTION 404 JURISDICTIONAL DELINEATION

U.S. Army Corps of Engineers, Los Angeles District

Application No. SPL -_______-_________-_________

🟦 ------Boundary of area surveyed for jurisdictional waters of the United States

🟥 ------ Ordinary High Water Mark

🟨 ------Potential Waters of the United States

------Potential Wetlands (If legend is blank no wetlands occur with survey area.)

1" = 200' Scale 2013 Date of Photograph

______Site Visit by Corps(Y/N) Date:____________

________________Date Delineation issued by Corps

______________________Corps Project Manager

Sheet 1 of 1

* * * * *PRELIMINARY (RGL 08-02)* * * * *

Civano

Appendix A . Aerial photograph showing jurisdictional waters.

KEY

↑	Photopoint
→	Direction of Flow
🟨	Potential Waters of the US
🟥	Approximate Ordinary High Water Mark
🟦	Project Area
=====	Unimproved Road

Section 2 & 11
T15S R15E

Background Imagery:
ESRI World Imagery June 2013
Project Midpoint:
32.1501° N, 110.7784° W, NAD 83

SWCA
ENVIRONMENTAL CONSULTANTS

36136Apdx_A.mxd - Revised: 1/7/2016

APPENDIX A

Site Photographs

Photo 1. An upstream view of PP-1 in Wash A.

Photo 2. A downstream view of PP-1 in Wash A.

Photo 3. A downstream view of PP-2 in Wash B.

Photo 4. An upstream view of PP-2 in Wash B.

Photo 5. An overview of PP-3, a swale in the project area.

Photo 6. An overview of PP-3, a swale in the project area.

Photo 7. A downstream view of PP-4 in Wash C.

Photo 8. An upstream view of PP-4 in Wash C.

Photo 9. An overview of PP-5, a swale in the project area.

Photo 10. An overview of PP-5, a swale in the project area.

Photo 11. An overview of PP-6, a swale in the project area.

Photo 12. An overview of PP-6, a swale in the project area.

APPENDIX B

Field Data Sheet

Jurisdictional Waters Delineation at: Civano

Date: 12/18/15, 1/5/16 Field Workers: Jeff Johnson, Colin Agner Page 1 of 1

Data Point ID	Width	Field Indicators of OHWM[3]				Photo Reference[4] and Notes
PP-1	4 feet	x	Cut Bank (>1 ft. high)		Swale (shallow depression)	Flows into project area under bridge across Houghton Road. Photo 1-Upstream Photo 2-Downstream
		x	Shelving		Water stains	
			Braided wash		Sheet flow area	
		x	Sandy channel bottom		Debris (piles of vegetative matter)	
		x	Substrate change	x	Other (describe) veg destruction	
PP-2	2 feet	X	Cut Bank (>1 ft. high)		Swale (shallow depression)	1 foot deep Photo 3- Downstream Photo 4- Upstream
		x	Shelving		Water stains	
			Braided wash		Sheet flow area	
		x	Sandy channel bottom		Debris (piles of vegetative matter)	
		X	Substrate change	x	Other (describe) veg destruction	
PP-3	N/A		Cut Bank (>1 ft. high)	x	Swale (shallow depression)	Photo 5 and Photo 6
			Shelving		Water stains	
			Braided wash		Sheet flow area	
			Sandy channel bottom		Debris (piles of vegetative matter)	
			Substrate change		Other (describe)	
PP-4	3 feet	x	Cut Bank (>1 ft. high)		Swale (shallow depression)	2 feet deep Photo 7- Downstream Photo 8- Upstream
		x	Shelving		Water stains	
			Braided wash		Sheet flow area	
		x	Sandy channel bottom		Debris (piles of vegetative matter)	
		x	Substrate change		Other (describe)	
PP-5	N/A		Cut Bank (>1 ft. high)	x	Swale (shallow depression)	Photo 9 and Photo 10
			Shelving		Water stains	
			Braided wash		Sheet flow area	
			Sandy channel bottom		Debris (piles of vegetative matter)	
			Substrate change		Other (describe)	
PP-6	N/A		Cut Bank (>1 ft. high)	x	Swale (shallow depression)	Photo 11 and Photo 12
			Shelving		Water stains	
			Braided wash		Sheet flow area	
			Sandy channel bottom		Debris (piles of vegetative matter)	
			Substrate change		Other (describe)	

---

[3] U.S. Army Corps of Engineers: Regulatory Guidance Letter No. 05-02. June 14, 2005

[4] Field photographs are available on file at SWCA

APPENDIX E: ARIZONA GAME AND FISH HDMS REPORT

Appendix E

Arizona Environmental Online Review Tool Report

Arizona Game and Fish Department Mission
To conserve Arizona's diverse wildlife resources and manage for safe, compatible outdoor recreation opportunities for current and future generations.

Project Name:
City Owned Civano Parcel

User Project Number:
Mattamy PAD

Project Description:
New residential community and open space planned area development.

Project Type:
Development Within Municipalities (Urban Growth), Residential subdivision and associated infrastructure, New construction

Contact Person:
Hillary Turby

Organization:
Norris Design

On Behalf Of:
CONSULTING

Project ID:
HGIS-03323

Please review the entire report for project type and/or species recommendations for the location information entered. Please retain a copy for future reference.

Disclaimer:

1. This Environmental Review is based on the project study area that was entered. The report must be updated if the project study area, location, or the type of project changes.
2. This is a preliminary environmental screening tool. It is not a substitute for the potential knowledge gained by having a biologist conduct a field survey of the project area. This review is also not intended to replace environmental consultation (including federal consultation under the Endangered Species Act), land use permitting, or the Departments review of site-specific projects.
3. The Departments Heritage Data Management System (HDMS) data is not intended to include potential distribution of special status species. Arizona is large and diverse with plants, animals, and environmental conditions that are ever changing. Consequently, many areas may contain species that biologists do not know about or species previously noted in a particular area may no longer occur there. HDMS data contains information about species occurrences that have actually been reported to the Department. Not all of Arizona has been surveyed for special status species, and surveys that have been conducted have varied greatly in scope and intensity. Such surveys may reveal previously undocumented population of species of special concern.
4. HabiMap Arizona data, specifically Species of Greatest Conservation Need (SGCN) under our State Wildlife Action Plan (SWAP) and Species of Economic and Recreational Importance (SERI), represent potential species distribution models for the State of Arizona which are subject to ongoing change, modification and refinement. The status of a wildlife resource can change quickly, and the availability of new data will necessitate a refined assessment.

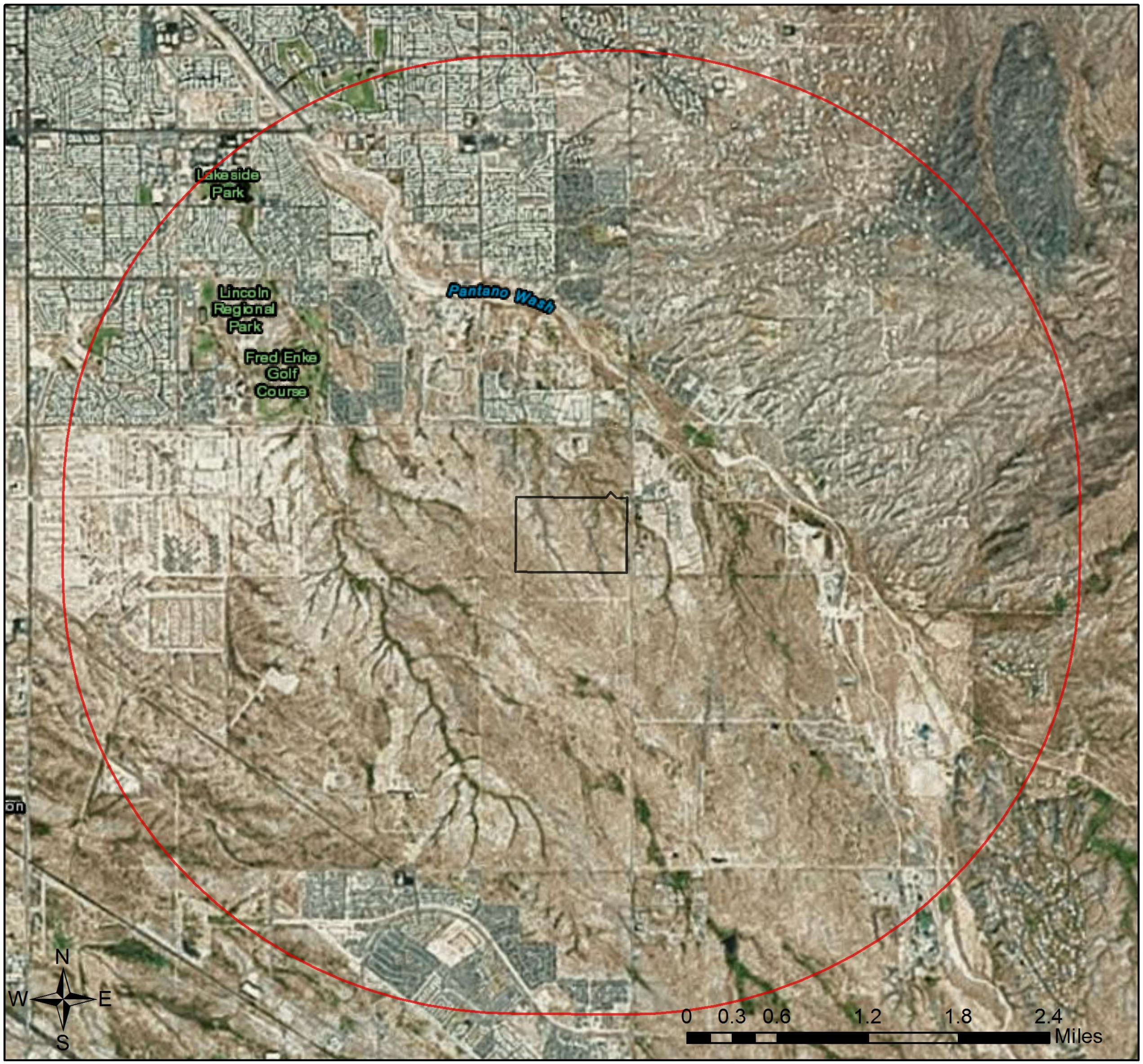
Locations Accuracy Disclaimer:
Project locations are assumed to be both precise and accurate for the purposes of environmental review. The creator/owner of the Project Review Report is solely responsible for the project location and thus the correctness of the Project Review Report content.

Recommendations Disclaimer:

1. The Department is interested in the conservation of all fish and wildlife resources, including those species listed in this report and those that may have not been documented within the project vicinity as well as other game and nongame wildlife.
2. Recommendations have been made by the Department, under authority of Arizona Revised Statutes Title 5 (Amusements and Sports), 17 (Game and Fish), and 28 (Transportation).
3. Potential impacts to fish and wildlife resources may be minimized or avoided by the recommendations generated from information submitted for your proposed project. These recommendations are preliminary in scope, designed to provide early considerations on all species of wildlife.
4. Making this information directly available does not substitute for the Department's review of project proposals, and should not decrease our opportunity to review and evaluate additional project information and/or new project proposals.
5. Further coordination with the Department requires the submittal of this Environmental Review Report with a cover letter and project plans or documentation that includes project narrative, acreage to be impacted, how construction or project activity(s) are to be accomplished, and project locality information (including site map). Once AGFD had received the information, please allow 30 days for completion of project reviews. Send requests to:
   Project Evaluation Program, Habitat Branch
   Arizona Game and Fish Department
   5000 West Carefree Highway
   Phoenix, Arizona 85086-5000
   Phone Number: (623) 236-7600
   Fax Number: (623) 236-7366
   Or
   PEP@azgfd.gov
6. Coordination may also be necessary under the National Environmental Policy Act (NEPA) and/or Endangered Species Act (ESA). Site specific recommendations may be proposed during further NEPA/ESA analysis or through coordination with affected agencies

City Owned Civano Parcel

Aerial Image Basemap With Locator Map



☐ Project Boundary

☐ Buffered Project Boundary

Project Size (acres): 240.21

Lat/Long (DD): 32.1517 / -110.7790

County(s): Pima

AGFD Region(s): Tucson

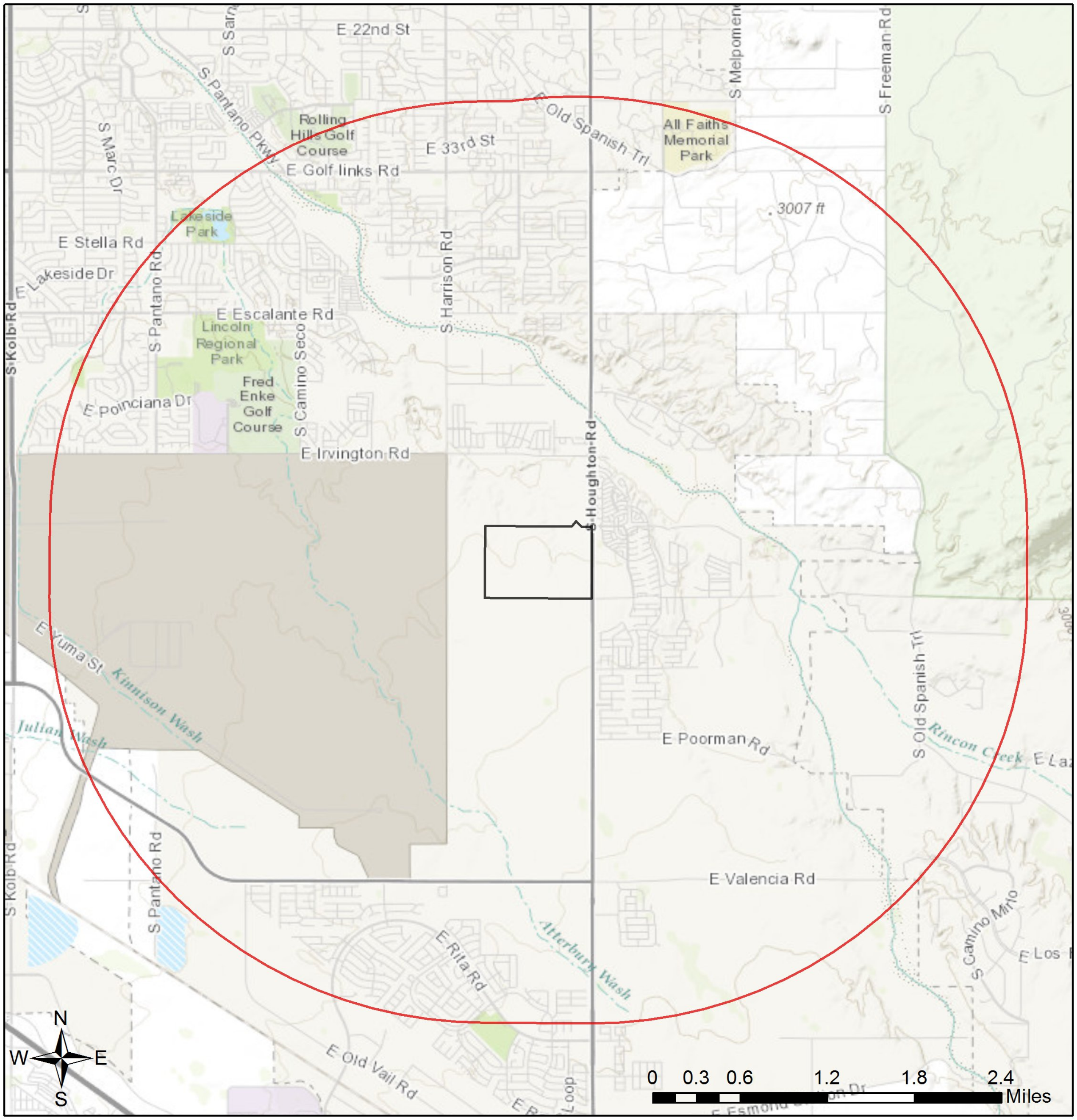
Township/Range(s): T15S, R15E

USGS Quad(s): TUCSON EAST

Service Layer Credits: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong),

City Owned Civano Parcel

Web Map As Submitted By User



☐ Project Boundary

🟥 Buffered Project Boundary

Project Size (acres): 240.21

Lat/Long (DD): 32.1517 / -110.7790

County(s): Pima

AGFD Region(s): Tucson

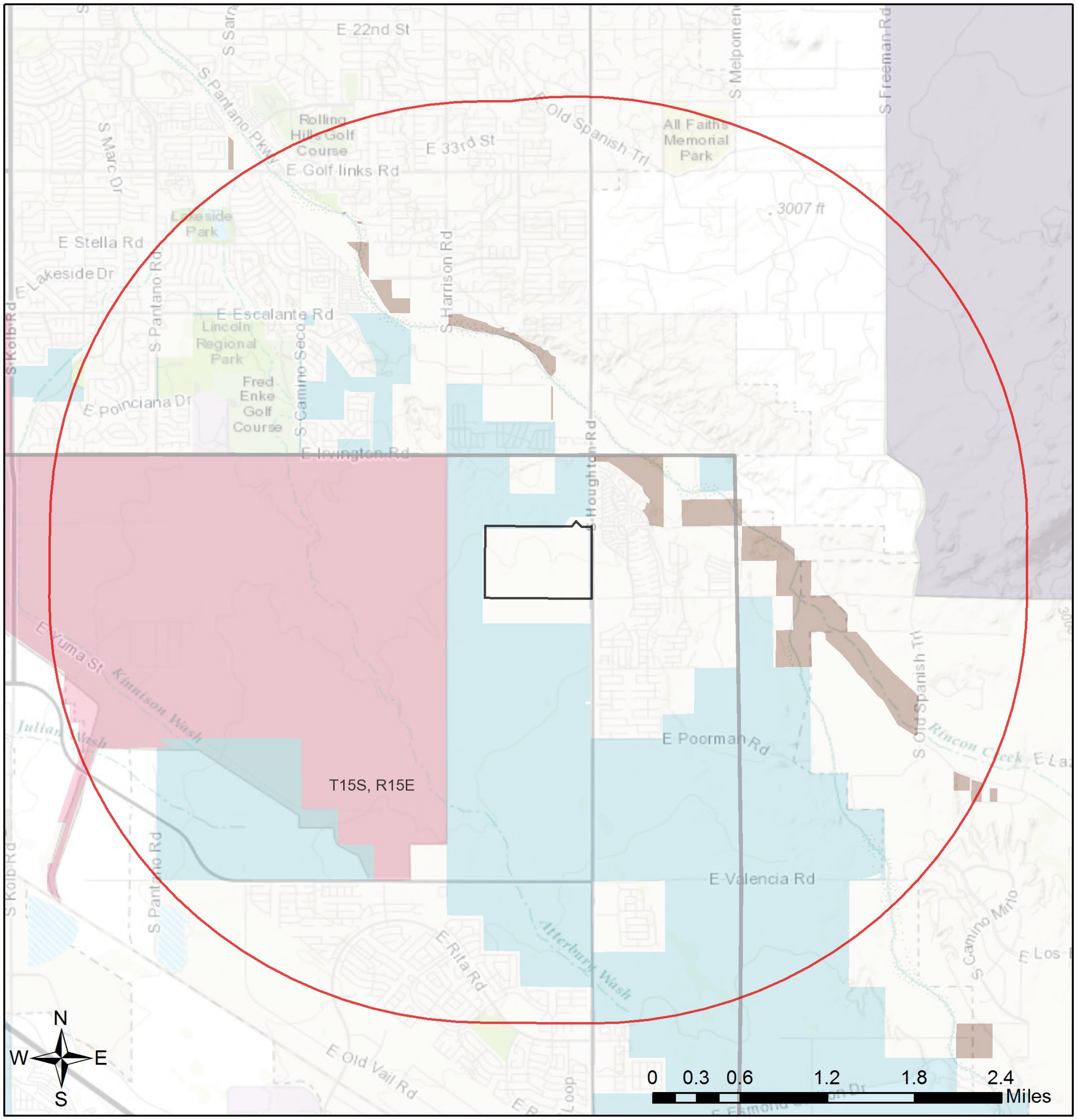
Township/Range(s): T15S, R15E

USGS Quad(s): TUCSON EAST

Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

City Owned Civano Parcel

Topo Basemap With Township/Ranges and Land Ownership



☐ Project Boundary
☐ Buffered Project Boundary
☐ Township/Ranges
🟥 AZ Game and Fish Dept.
🟨 BLM
🟫 BOR
🟧 Indian Res.
🟥 Military

🟩 Mixed/Other
🟪 National Park/Mon.
Private
🟫 State and Regional Parks
🟦 State Trust
🟩 US Forest Service
🟩 Wildlife Area/Refuge

Project Size (acres): 240.21

Lat/Long (DD): 32.1517 / -110.7790

County(s): Pima

AGFD Region(s): Tucson

Township/Range(s): T15S, R15E

USGS Quad(s): TUCSON EAST

Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Special Status Species and Special Areas Documented within 3 Miles of Project Vicinity

Scientific Name	Common Name	FWS	USFS	BLM	NPL	SGCN
Athene cunicularia hypugaea	Western Burrowing Owl	SC	S	S		1B
Choeronycteris mexicana	Mexican Long-tongued Bat	SC	S	S		1C
Gopherus morafkai	Sonoran Desert Tortoise	CCA	S			1A
Heloderma suspectum suspectum	Reticulate Gila Monster					1A
Lithobates yavapaiensis	Lowland Leopard Frog	SC	S	S		1A
Opuntia versicolor	Stag-horn Cholla				SR	

Note: Status code definitions can be found at http://www.azgfd.gov/w_c/edits/hdms_status_definitions.shtml.

Species of Greatest Conservation Need
Predicted within Project Vicinity based on Predicted Range Models

Scientific Name	Common Name	FWS	USFS	BLM	NPL	SGCN
Aix sponsa	Wood Duck					1B
Amazilia violiceps	Violet-crowned Hummingbird		S			1B
Ammodramus savannarum perpallidus	Western Grasshopper Sparrow					1B
Ammospermophilus harrisii	Harris' Antelope Squirrel					1B
Anthus spragueii	Sprague's Pipit	C*				1A
Antrostomus ridgwayi	Buff-collared Nightjar		S			1B
Aquila chrysaetos	Golden Eagle	BGA		S		1B
Aspidoscelis stictogramma	Giant Spotted Whiptail	SC	S			1B
Athene cunicularia hypugaea	Western Burrowing Owl	SC	S	S		1B
Botaurus lentiginosus	American Bittern					1B
Buteo regalis	Ferruginous Hawk	SC		S		1B
Chilomeniscus stramineus	Variable Sandsnake					1B
Coccyzus americanus	Yellow-billed Cuckoo (Western DPS)	LT	S			1A
Colaptes chrysoides	Gilded Flicker			S		1B
Coluber bilineatus	Sonoran Whipsnake					1B
Corynorhinus townsendii pallescens	Pale Townsend's Big-eared Bat	SC	S	S		1B
Crotalus tigris	Tiger Rattlesnake					1B
Cynanthus latirostris	Broad-billed Hummingbird		S			1B
Cynomys ludovicianus	Black-tailed Prairie Dog	SC		S		1A
Dipodomys spectabilis	Banner-tailed Kangaroo Rat			S		1B
Euderma maculatum	Spotted Bat	SC	S	S		1B
Eumops perotis californicus	Greater Western Bonneted Bat	SC		S		1B
Falco peregrinus anatum	American Peregrine Falcon	SC	S	S		1A
Glaucidium brasilianum cactorum	Cactus Ferruginous Pygmy-owl	SC	S	S		1B
Gopherus morafkai	Sonoran Desert Tortoise	C*	S			1A
Haliaeetus leucocephalus	Bald Eagle	SC, BGA	S	S		1A

Species of Greatest Conservation Need
Predicted within Project Vicinity based on Predicted Range Models

Scientific Name	Common Name	FWS	USFS	BLM	NPL	SGCN
Heloderma suspectum	Gila Monster					1A
Hypsiglena sp. nov.	Hooded Nightsnake					1B
Incilius alvarius	Sonoran Desert Toad					1B
Kinosternon sonoriense sonoriense	Desert Mud Turtle			S		1B
Lasiurus blossevillii	Western Red Bat		S			1B
Lasiurus xanthinus	Western Yellow Bat		S			1B
Leopardus pardalis	Ocelot	LE				1A
Leptonycteris curasoae yerbabuenae	Lesser Long-nosed Bat	LE				1A
Lepus alleni	Antelope Jackrabbit					1B
Lithobates yavapaiensis	Lowland Leopard Frog	SC	S	S		1A
Macrotus californicus	California Leaf-nosed Bat	SC		S		1B
Melanerpes uropygialis	Gila Woodpecker					1B
Meleagris gallopavo mexicana	Gould's Turkey		S			1B
Melospiza lincolnii	Lincoln's Sparrow					1B
Melozone aberti	Abert's Towhee		S			1B
Micruroides euryxanthus	Sonoran Coralsnake					1B
Myotis occultus	Arizona Myotis	SC		S		1B
Myotis velifer	Cave Myotis	SC		S		1B
Myotis yumanensis	Yuma Myotis	SC				1B
Nyctinomops femorosaccus	Pocketed Free-tailed Bat					1B
Odocoileus virginianus	White-tailed Deer					1B
Panthera onca	Jaguar	LE				1A
Passerculus sandwichensis	Savannah Sparrow					1B
Perognathus amplus	Arizona Pocket Mouse					1B
Peucaea botterii arizonae	Arizona Botteri's Sparrow			S		1B
Peucaea carpalis	Rufous-winged Sparrow					1B
Phrynosoma solare	Regal Horned Lizard					1B
Phyllorhynchus browni	Saddled Leaf-nosed Snake					1B
Progne subis hesperia	Desert Purple Martin			S		1B
Setophaga petechia	Yellow Warbler					1B
Tadarida brasiliensis	Brazilian Free-tailed Bat					1B
Terrapene ornata	Ornate Box Turtle					1A
Thomomys umbrinus intermedius	Southern Pocket Gopher					1B
Troglodytes pacificus	Pacific Wren					1B
Vireo bellii arizonae	Arizona Bell's Vireo					1B
Vulpes macrotis	Kit Fox					1B

Species of Economic and Recreation Importance Predicted within Project Vicinity

Scientific Name	Common Name	FWS	USFS	BLM	NPL	SGCN
Callipepla gambelii	Gambel's Quail					
Odocoileus hemionus	Mule Deer					
Odocoileus virginianus	White-tailed Deer					1B
Pecari tajacu	Javelina					
Puma concolor	Mountain Lion					
Zenaida asiatica	White-winged Dove					
Zenaida macroura	Mourning Dove					

Project Type: Development Within Municipalities (Urban Growth), Residential subdivision and associated infrastructure, New construction

Project Type Recommendations:

Fence recommendations will be dependant upon the goals of the fence project and the wildlife species expected to be impacted by the project. General guidelines for ensuring wildlife-friendly fences include: barbless wire on the top and bottom with the maximum fence height 42", minimum height for bottom 16". Modifications to this design may be considered for fencing anticipated to be routinely encountered by elk, bighorn sheep or pronghorn (e.g., Pronghorn fencing would require 18" minimum height on the bottom). Please refer to the Department's Fencing Guidelines located on the home page of this application at http://www.azgfd.gov/hgis/guidelines.aspx.

During the planning stages of your project, please consider the local or regional needs of wildlife in regards to movement, connectivity, and access to habitat needs. Loss of this permeability prevents wildlife from accessing resources, finding mates, reduces gene flow, prevents wildlife from re-colonizing areas where local extirpations may have occurred, and ultimately prevents wildlife from contributing to ecosystem functions, such as pollination, seed dispersal, control of prey numbers, and resistance to invasive species. In many cases, streams and washes provide natural movement corridors for wildlife and should be maintained in their natural state. Uplands also support a large diversity of species, and should be contained within important wildlife movement corridors. In addition, maintaining biodiversity and ecosystem functions can be facilitated through improving designs of structures, fences, roadways, and culverts to promote passage for a variety of wildlife.

Consider impacts of outdoor lighting on wildlife and develop measures or alternatives that can be taken to increase human safety while minimizing potential impacts to wildlife. Conduct wildlife surveys to determine species within project area, and evaluate proposed activities based on species biology and natural history to determine if artificial lighting may disrupt behavior patterns or habitat use. Use only the minimum amount of light needed for safety. Narrow spectrum bulbs should be used as often as possible to lower the range of species affected by lighting. All lighting should be shielded, cantered, or cut to ensure that light reaches only areas needing illumination.

Minimize potential introduction or spread of exotic invasive species. Invasive species can be plants, animals (exotic snails), and other organisms (e.g., microbes), which may cause alteration to ecological functions or compete with or prey upon native species and can cause social impacts (e.g., livestock forage reduction, increase wildfire risk). The terms noxious weed or invasive plants are often used interchangeably. Precautions should be taken to wash all equipment utilized in the project activities before leaving the site. Arizona has noxious weed regulations (Arizona Revised Statutes, Rules R3-4-244 and R3-4-245). See Arizona Department of Agriculture website for restricted plants, https://agriculture.az.gov/. Additionally, the U.S. Department of Agriculture has information regarding pest and invasive plant control methods including: pesticide, herbicide, biological control agents, and mechanical control, http://www.usda.gov/wps/portal/usdahome. The Department regulates the importation, purchasing, and transportation of wildlife and fish (Restricted Live Wildlife), please refer to the hunting regulations for further information http://www.azgfd.gov/h_f/hunting_rules.shtml

The construction or maintenance of water developments should include: incorporation of aspects of the natural environment and the visual resources, maintaining the water for a variety of species, water surface area (e.g., bats require a greater area due to in-flight drinking), accessibility, year-round availability, minimizing potential for water quality problems, frequency of flushing, shading of natural features, regular clean-up of debris, escape ramps, minimizing obstacles, and minimizing accumulation of silt and mud.

Minimization and mitigation of impacts to wildlife and fish species due to changes in water quality, quantity, chemistry, temperature, and alteration to flow regimes (timing, magnitude, duration, and frequency of floods) should be evaluated. Minimize impacts to springs, in-stream flow, and consider irrigation improvements to decrease water use. If dredging is a project component, consider timing of the project in order to minimize impacts to spawning fish and other aquatic species (include spawning seasons), and to reduce spread of exotic invasive species. We recommend early direct coordination with Project Evaluation Program for projects that could impact water resources, wetlands, streams, springs, and/or riparian habitats.

The Department recommends that wildlife surveys are conducted to determine if noise-sensitive species occur within the project area. Avoidance or minimization measures could include conducting project activities outside of breeding seasons.

Based on the project type entered, coordination with State Historic Preservation Office may be required (http://azstateparks.com/SHPO/index.html).

Trenches should be covered or back-filled as soon as possible. Incorporate escape ramps in ditches or fencing along the perimeter to deter small mammals and herptefauna (snakes, lizards, tortoise) from entering ditches.

Communities can actively support the sustainability and mobility of wildlife by incorporating wildlife planning into their regional/comprehensive plans, their regional transportation plans, and their open space/conservation land system programs. An effective approach to wildlife planning begins with the identification of the wildlife resources in need of protection, an assessment of important habitat blocks and connective corridors, and the incorporation of these critical wildlife components into the community plans and programs. Community planners should identify open spaces and habitat blocks that can be maintained in their area, and the necessary connections between those blocks to be preserved or protected. Community planners should also work with State and local transportation planning entities, and planners from other communities, to foster coordination and cooperation in developing compatible development plans to ensure wildlife habitat connectivity. The Department's guidelines for incorporating wildlife considerations into community planning and developments can be found on the home page of this application at http://www.azgfd.gov/hgis/guidelines.aspx.

Design culverts to minimize impacts to channel geometry, or design channel geometry (low flow, overbank, floodplains) and substrates to carry expected discharge using local drainages of appropriate size as templates. Reduce/minimize barriers to allow movement of amphibians or fish (e.g., eliminate falls). Also for terrestrial wildlife, washes and stream corridors often provide important corridors for movement. Overall culvert width, height, and length should be optimized for movement of the greatest number and diversity of species expected to utilize the passage. Culvert designs should consider moisture, light, and noise, while providing clear views at both ends to maximize utilization. For many species, fencing is an important design feature that can be utilized with culverts to funnel wildlife into these areas and minimize the potential for roadway collisions. Guidelines for culvert designs to facilitate wildlife passage can be found on the home page of this application at http://www.azgfd.gov/hgis/guidelines.aspx.

Based on the project type entered, coordination with Arizona Department of Environmental Quality may be required (http://www.azdeq.gov/).

Based on the project type entered, coordination with Arizona Department of Water Resources may be required (http://www.azwater.gov/azdwr/default.aspx).

Based on the project type entered, coordination with U.S. Army Corps of Engineers may be required (http://www.usace.army.mil/)

Based on the project type entered, coordination with County Flood Control district(s) may be required.

Development plans should provide for open natural space for wildlife movement, while also minimizing the potential for wildlife-human interactions through design features. Please contact Project Evaluation Program for more information on living with urban wildlife.

Vegetation restoration projects (including treatments of invasive or exotic species) should have a completed site-evaluation plan (identifying environmental conditions necessary to re-establish native vegetation), a revegetation plan (species, density, method of establishment), a short and long-term monitoring plan, including adaptive management guidelines to address needs for replacement vegetation.

The Department requests further coordination to provide project/species specific recommendations, please contact Project Evaluation Program directly. PEP@azgfd.gov

Project Location and/or Species Recommendations:

HDMS records indicate that one or more native plants listed on the Arizona Native Plant Law and Antiquities Act have been documented within the vicinity of your project area. Please contact:
Arizona Department of Agriculture
1688 W Adams St.
Phoenix, AZ 85007
Phone: 602.542.4373
https://agriculture.az.gov/environmental-services/np1

HDMS records indicate that Western Burrowing Owls have been documented within the vicinity of your project area. Please review the western burrowing owl resource page at: http://www.azgfd.gov/w_c/BurrowingOwlResources.shtml.

HDMS records indicate that Sonoran Desert Tortoise have been documented within the vicinity of your project area. Please review the Tortoise Handling Guidelines found at: http://www.azgfd.gov/hgis/pdfs/Tortoisehandlingguidelines.pdf

APPENDIX F: CLASS III CULTURAL AND ARCHAEOLOGICAL SURVEYS

Appendix F

Tierra Right of Way™
A LAND SERVICES COMPANY

A Class III Cultural Resource Survey of a Portion of a Proposed Housing Development Southwest of the Intersection of Drexel and Houghton Roads for Mattamy Homes in Tucson, Arizona

Prepared by:
Chance Copperstone, M.A.

Tierra Archaeological Report No. 2016-012
ASM Accession No. 2016-0041
February 10, 2016

A Class III Cultural Resource Survey of a Portion of a Proposed Housing Development Southwest of the Intersection of Drexel and Houghton Roads for Mattamy Homes in Tucson, Arizona

Prepared by:
Chance Copperstone, M.A.

Principal Investigator:
Barbara Montgomery, Ph.D.

Prepared for:
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Submitted to:
Historic Preservation Division
City of Tucson
149 North Stone, 2nd Floor
Tucson, Arizona 85701

Submitted by:
Tierra Right of Way Services, Ltd.
1575 East River Road, Suite 201
Tucson, Arizona 85718

Tierra Archaeological Report No. 2016-012
ASM Accession No. 2016-0041
February 10, 2016

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ABSTRACT

REPORT TITLE:	A Class III Cultural Resource Survey of a Portion of a Proposed Housing Development Southwest of the Intersection of Drexel and Houghton Roads for Mattamy Homes in Tucson, Arizona. February 10, 2016
PROJECT NAME:	Civano Community Development
PROJECT LOCATION:	City of Tucson Parcel 14101007E; Houghton and Drexel Roads, Tucson, Arizona
PROJECT LOCATOR UTM:	3556595N, 521190E (Zone12N)
PROJECT SPONSOR:	Mattamy Homes, Inc.
SPONSOR PROJECT NUMBER(S):	n/a
LEAD AGENCY:	City of Tucson
OTHER INVOLVED AGENCIES:	Arizona State Museum (ASM)
APPLICABLE REGULATIONS:	Tucson Unified Development Code (2-03.4.2C); A.R.S. §41-861 et seq.
FUNDING SOURCE:	Private
ASLD ROW APPLICATION NUMBER:	n/a
DESCRIPTION OF THE PROJECT/ UNDERTAKING:	Mattamy Homes initiated this project as part of an internal feasibility study with the ultimate goal of potentially rezoning the property for residential development.
PROJECT AREA/ AREA OF POTENTIAL EFFECTS (APE):	The project area, City of Tucson Parcel 14101007E, is located southwest of the intersection of Houghton and Drexel Roads. A Tucson Water access road forms the southern boundary of the project area, the western Houghton Road right-of-way forms the

eastern boundary, and the remaining boundaries are undefined by topographic features.

LEGAL DESCRIPTION: The project area is located in Section 11, Township 15 South, Range 15 East, Gila and Salt River Baseline and Meridian, as depicted on the Tucson East (1996), AZ, 7.5-minute U.S. Geological Survey quadrangle map, in Tucson, Pima County, Arizona.

LAND JURISDICTION: City of Tucson

TOTAL ACRES: 6.155 acres (2.490 ha)

ACRES SURVEYED: 6.155 acres (2.490 ha)

ACRES NOT SURVEYED: n/a

CONSULTANT FIRM/ ORGANIZATION: Tierra Right of Way Services, Ltd.

PROJECT NUMBER: 16T0-012

PERMIT NUMBER(S): 2016-002bl

DATE(S) OF FIELDWORK: February 3, 2016

NUMBER OF ISOLATED OCCURRENCES RECORDED: 0

NUMBER OF SITES RECORDED: 1

ELIGIBLE SITES: 0

INELIGIBLE SITES: 1

UNEVALUATED SITES: 0

SITES NOT RELOCATED: 0

Site Summary Table

Land Jurisdiction	Identification Status	Site Number/ Property Address	Eligibility Status/ Criterion/Criteria	Recommended Treatment
City of Tucson	previous	AZ BB:13:818(ASM)	ineligible	none

COMMENTS:

A single site, AZ BB:13:818(ASM), the Tucson to Rillito Road, was encountered during the survey. Only a small portion of the site is located within Parcel 14101007E. The site as a whole has been previously recommended as ineligible for the National Register of Historic Places (NRHP) (Doak 2011), and Tierra concurs with the previous recommendation. Therefore, Tierra recommends that the proposed Mattamy Homes project within Parcel 14101007E be allowed to proceed without any further archaeological work required.

The client and all subcontractors are reminded that, in accordance with §41-844 of the Arizona Revised Statutes, the person supervising any survey, excavation, construction, or like activity on State-administered lands is required, upon incidentally encountering cultural deposits more than 50 years old, to halt all work on the undertaking and immediately notify the Director of the ASM of the finding so that a consultation process can be initiated and an appropriate course of treatment decided upon. Work in the area is not to resume until authorization is received from the Director of the ASM. If the objects discovered are human remains, funerary objects, sacred ceremonial objects, or objects of national or Tribal patrimony, the Director shall, to the best of their ability, give notice of the discovery to all individuals that may have a direct kinship relationship to the human remains, all groups that it is reasonable to believe may have a cultural or religious affinity to the remains or objects, appropriate members of the curatorial staff of ASM, faculty members of the State universities who have a significant scholarly interest in the remains or objects, and the State Historic Preservation Office. Native American Tribal governments that wish to be notified must keep lists of the cultural groups and geographical areas with which they claim affinity on file with the Director of the ASM. If Native American human remains, funerary objects, sacred ceremonial objects, or objects of cultural patrimony are involved, the Director must give notice to the Tribes that occupy or have occupied the land on which the discovery is made, the Arizona Commission on Indian Affairs, and the Intertribal Council of Arizona.

The client and all subcontractors are also reminded that, in accordance with Section 41-865 of the Arizona Revised Statutes, if human remains are encountered anywhere in the survey area during any subsequent ground-disturbing activities, these activities shall cease in the area of the discovery and the Director of ASM shall be immediately notified. The Director will then have 10 working days to respond to the request. All ground-disturbing activities in the immediate vicinity of the discovery shall cease until a qualified archaeologist assesses the remains. Work in and around the area shall not resume until so directed by ASM personnel.

INTRODUCTION

As part of an internal feasibility study related to the potential rezoning of City of Tucson (COT) Parcel 14101007E for residential development, Ms. Angela Carmitchel of Mattamy Homes asked Tierra Right of Way Services, Ltd. (Tierra), to perform a Class III cultural resource survey of the parcel located southwest of the intersection of Houghton and Drexel Roads in Tucson, Arizona. On February 3, 2016, archaeologist Chance Copperstone, M.A., of Tierra performed the Class III survey of the 2.490-ha (6.155-acre) parcel. The purpose of the survey was to identify, record, and assess the significance of any prehistoric or historic cultural resources within the parcel that might be adversely affected by the potential development project. The Class III survey was done under authority of Arizona Antiquities Act Blanket Permit No. 2016-002bl, issued by the Arizona State Museum (ASM). Barbara Montgomery, Ph.D., acted as Tierra's principal investigator and managed the project.

The parcel under study is to be included in a larger project area that was previously surveyed by Tierra on behalf of Tucson Water's Planning and Engineering Division (Doak 2011). That project involved the survey of a 126.8-ha (313.3-acre) tract surrounding the parcel that is a focus of this current study. As part of that study, Tierra identified one site, AZ BB:13:818(ASM), a fragment of the historic Tucson to Rillito Road, that crossed into the current project area. The site was recommended not eligible for the National Register of Historic Places (NRHP) at that time (Doak 2011:24).

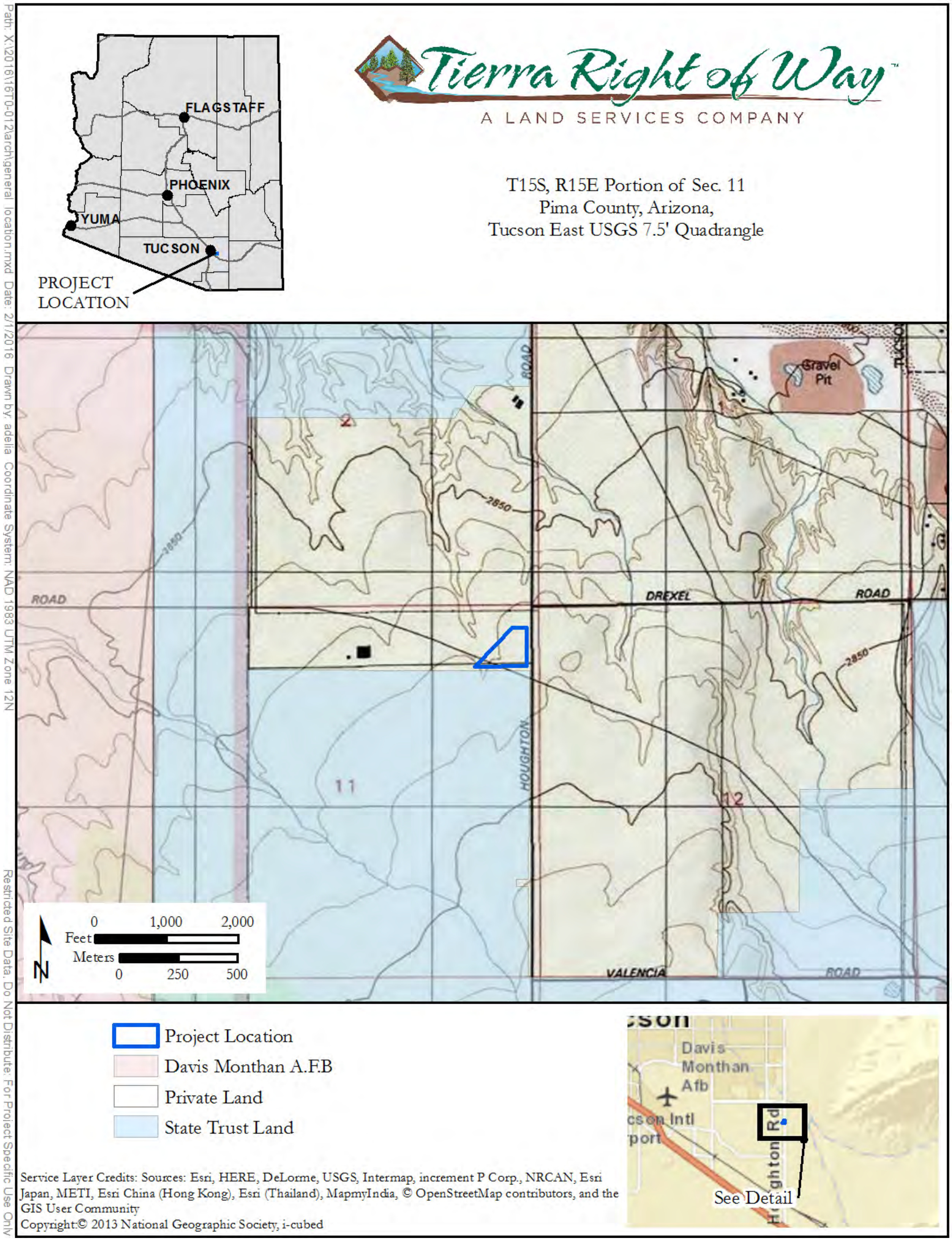
Only the previously recorded site, AZ BB:13:818(ASM), was encountered during the course of the current survey. No other archaeological sites, isolated occurrences, or nonsite historic buildings or structures were observed.

THE PROJECT AREA AND PROJECT DESCRIPTION

The project area is located in Section 11, Township 15 South, Range 15 East, Gila and Salt River Baseline and Meridian (G&SRB&M), as depicted on the Tucson East, AZ (1996), 7.5-minute U.S. Geological Survey (USGS) quadrangle map, in Tucson, Arizona (Figure 1). The proposed project area consists of the entirety of COT Parcel 14101007E, which is located in a currently undeveloped area at the southwest corner of the intersection of Houghton and Drexel Roads (Figure 2).

The project is part of an internal feasibility study related to the potential rezoning of the parcel for residential development. At this time, there is no specific plan for ground disturbance, but the project, if determined feasible, will likely result in grading and other forms of construction in the future.

The project area is located in a desert setting, but other housing developments are present nearby (see Appendix A for a selection of project photos). The southern half of the project area was cleared of vegetation at some point, and construction materials (e.g., stone and soil) have been stacked in that area (Photo A.1). Mountain bike trails, likely associated with the nearby Fantasy Island bike trail system, crisscross the project area. A dirt road at the southern end of the project area is used extensively, likely by Tucson Water to access their facility at the far end of the road. A diagonal road, also known as AZ BB:13:818(ASM), cuts across the southwest corner of the project area and has also seen heavy use. Modern trash is present throughout the project area, possibly tossed out from



T15S, R15E Portion of Sec. 11
Pima County, Arizona,
Tucson East USGS 7.5' Quadrangle

Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
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Path: X:\2016\16T0-012\arch\general_location.mxd Date: 2/1/2016 Drawn by: adelia Coordinate System: NAD 1983 UTM Zone 12N

Restricted Site Data. Do Not Distribute. For Project Specific Use Only

Figure 1. Project location.

Path: X:\2016\16T0-012\arch\fromGIS\2016-02-02\glo.mxd Date: 2/2/2016 Drawn by: adelia Coordinate System: NAD 1983 UTM Zone 12N

Restricted Site Data, Do Not Distribute. For Project Specific Use Only

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors

Figure 2. Detailed project location with streets and parcels.

vehicles along Houghton Road. Soils in the project area are described as Sahuarita soils, mohave soils, and urban land, which consist of gravelly sandy loam on 1–5 percent slopes (NRCS 2016).

The project area lies within the range of the Arizona Upland subdivision of the Sonoran Desertscrub biotic community, near its interface with the Semidesert Grassland community. The Sonoran Desertscrub community is distributed across the southwestern quarter of Arizona, the deserts of Riverside and San Diego Counties in California, and much of the Mexican states of Baja California Norte, Baja California Sur, and Sonora. The Sonoran Desert is distinguished from others in the region (the Mojave, the Great Basin, and the Chihuahuan) by a bimodal distribution of rainfall, with some precipitation in both winter and summer, which has contributed to the survival of larger plant species than in other deserts—in particular, of trees, large cacti, and massive succulents. Several discrete subdivisions of this community have been identified, of which two—the Lower Colorado River and the Arizona Upland subdivisions—cover large parts of southern Arizona.

The Arizona Upland subdivision is described by Brown (1994:200) as "the best watered and least desert-like desertscrub in North America." The range of this subdivision is characterized by the prevalence of substantial slopes; however, this does not necessarily translate to greater elevations, and elevations within the Arizona Upland Subdivision range from as low as 300 m (1,000 feet) to as high as 1,000 m (3,300 feet) above mean sea level (AMSL). Rainfall is greater than in the Lower Colorado subdivision at 20.0–42.5 cm (8.0–16.5 inches) here (Brown 1994:185).

Because this subdivision receives more rainfall than the Lower Colorado Subdivision, species that are confined to washes in the Lower Colorado are spread much more widely here. Overall, this subdivision is dominated by taller, woodier species, enough so that Brown (1994:181) speculated that many geographers would not identify this as a desertscrub community at all, but rather a "depauperate thornscrub community." Saguaro *(Carnegiea gigantea)*, organ pipe cactus *(Stenocereus thurberi)*, fishhook barrel cactus *(Ferocactus wislizenii)*, compass barrel cactus *(F. acanthodes)*, night-blooming cereus *(Peniocereus greggii)*, pencil cholla *(Cylindropuntia arbuscula)*, Christmas cactus *(C. leptocaulis)*, cane cholla *(C. spinosior)*, buckhorn cholla *(C. acanthocarpa)*, teddy bear cholla *(C. bigelovii)*, chain fruit cholla *(C. fulgida)*, and many other cacti are strongly represented within this subdivision. The most widely distributed plant community within this subdivision is a palo verde–cacti–mixed scrub series, which is best developed away from valley floors (which are dominated by the creosotebush–white bursage communities typical of the Lower Colorado Subdivision), on bajadas and mountain slopes. The dominant plants in this series are foothills palo verde *(Cercidium microphyllum)* and saguaro, with ironwood *(Olneya tesota)* being prominent in places away from valley floors and north slopes dominated by palo verde. The white bursage *(Ambrosia dumosa)* of the valley floors gives way to triangle-leaf bursage *(Ambrosia deltoidea)* on the slopes, with whitethorn acacia *(Acacia constricta)*, ocotillo *(Fouquieria splendens)*, jojoba *(Simmondsia chinensis)*, desert hackberry *(Celtis pallida)*, and numerous other species also appearing as part of the upslope community. In localized areas near the upper limit of the range, Jojoba *(Simmondsia chinensis)*, an economic plant, achieves dominance, while elsewhere at high elevations (often extending past the limit of the desertscrub community) a creosotebush–crucifixion thorn series dominates.

Mammals common within the Arizona Upland subdivision include desert mule deer *(Odocoileus hemionous crooki)*, javelina *(Dicotyles tajacu)*, California leaf-nosed bat *(Macrotus californicus)*, black-tailed jackrabbit *(Lepus californicus)*, desert cottontail *(Sylvilagus audubonii)*, Arizona pocket mouse *(Perognathus amplus)*, Bailey's pocket mouse *(P. baileyi)*, cactus mouse *(Peromyscus eremicus)*, gray fox *(Urocyon* *cinereoargenteus)*, and Harris' antelope squirrel *(Ammospermophilus harisii)*. While numerous well-known types of bird are common to this community, most, including Harris' hawk *(Parabuteo unicinctus)*, white-winged dove *(Zenaida macroura)*, Inca dove *(Scardiafella inca)*, elf owl *(Micrathene whitneyi)*, pyrrhuloxia *(Cardinalis sinuatus)*, and assorted cactus woodpeckers, are equally common to other biotic communities as well. Perhaps the animal species most characteristic of this community are the reptiles, including Regal Horned Lizard *(Phrynosoma solare)*, Western Whiptail *(Cnemidophorus tigris gracilis)*, Gila Monster *(Heloderma suspectum)*, Arizona Coral Snake *(Micruroides euryxanthus)*, and Tiger Rattlesnake *(Crotalus tigris)*.

The Semidesert Grassland biotic community is described by Brown (1994:123) as "potentially a perennial grass-scrub dominated landscape positioned between desertscrub below and evergreen woodland, chaparral, or plains grassland above." Such communities are generally found at elevations of 1,100–1,700 m (3,600–5,575 feet) AMSL, and are, for the most part, located in areas bordering the upper fringe of the Chihuahuan Desert; however, in western Arizona, similar communities are found bordering on Interior Chaparral or Sonoran Desertscrub communities instead. Over most of this range, average annual precipitation ranges between 25.0–45.0 cm (9.8–17.7 inches), with over half of this total falling during the April–September period, when rainfall typically averages 15 cm (5.9 inches) or more (Brown 1994). Even though grasses—once, perennial bunchgrasses (particularly grama grasses [*Bouteloua* sp.]), which have now largely been superseded by low-growing sod grasses and annuals—are the defining element of grassland communities, in many areas mesquites (*Prosopis* spp.), cacti (including barrel cactus *[Ferocactus wislizenii]*, hedgehog cacti [*Echinocereus* spp.], assorted prickly pear (*Opuntia* spp.), forbs, and shrubs including agaves (*Agave* spp.), sotols (*Dasylirion* spp.), and yuccas (*Yucca* sp.) have largely replaced the grasses (Brown 1994:124). Trees are uncommon, at least away from drainages. Ocotillo *(Fouquieria splendens)* and thornscrub species, including hopbush *(Dodonaea viscosa)* and kidneywood *(Eysenhardtia orthocarpa)*, are common in the southern part of the range of this community. Mammals native to the community include black-tailed jackrabbit *(Lepus californicus)*, badger *(Taxidea taxus)*, spotted ground squirrel *(Spermophilus spilosoma)*, kangaroo rats (*Dipodomys* sp.), cotton rats (*Sigmodon* sp.), assorted other rodents, and coyote *(Canis latrans)* among many others. Birds include Swainson's hawk *(Buteo swainsoni)*, prairie falcon *(Falco mexicanus)*, kestrel (*Falco* sp.), mourning dove *(Zenaida macroura)*, roadrunner *(Geococcyx californianus)*, scaled quail *(Callipepla squamata)*, ladder-backed woodpecker *(Picoides scalaris)*, and burrowing owls *(Athene cunicularia)*. Where ocotillo is present, invasive species from downslope desertscrub areas, such as javelina, are often present as well. Invasive species from grassland areas upslope from this community are much less common.

CULTURE HISTORY

Paleoindian and Early Archaic Periods (11,000–6000 B.C.)

The first known inhabitants of southern Arizona are referred to by archaeologists as Paleoindians. These groups were migratory peoples who entered North America during the Pleistocene epoch. The classic hallmark of Paleoindian material culture is fluted, lanceolate projectile point complexes. Clovis points, a type belonging to the earliest of these complexes, have been found in association with the fossil remains of now-extinct species, particularly Pleistocene megafauna such as mammoth (*Mammuthus* spp.) and ancient bison *(Bison antiquus)* (Reid and Whittlesey 1997:30–37). The Clovis complex was succeeded by the Folsom complex, which, like the Clovis, is typified by its distinctive projectile points. Folsom points, unlike Clovis points, have flutes that extend all the way from their proximal to distal ends and have pressure-flaked marginal edges. In Arizona, the only known

Folsom points have been found in surface contexts on the Colorado Plateau and the mountain transition zone to the south of the Mogollon Rim (Faught and Freeman 1998:45).

Paleoindian groups were originally conceptualized purely as big game hunters, but it is now understood that these people actually exploited a spectrum of biological resources, a subsistence strategy not unlike those practiced by later Archaic period peoples (Mabry 1998:105–107). This has become particularly evident as knowledge of the Early Archaic period (ca. 8500–6000 B.C.) has increased. The beginning of the Early Archaic period is marked by the appearance of ground stone seed-milling equipment and by the transition from the early Paleoindian fluted point complexes to later Paleoindian stemmed and lanceolate point complexes and the Early Archaic Western stemmed point complexes, although considerable geographical and temporal overlap exists between these complexes in western North America (Faught and Freeman 1998:45–52; Mabry and Faught 1998:53–59).

Middle Archaic Period (6000–2100 B.C.)

The Middle Archaic period is typified by the addition of shallow basin metates, mortars and pestles, various bifacial tools, and distinctive side-notched projectile points to the overall tool assemblage of the preceding Early Archaic period. Generally, the Middle Archaic period is viewed as a time when regional variations in material culture across the Southwest became less pronounced. In particular, notched projectile points take on a general similarity of design over large geographic regions (Slaughter 1992:70). It is thought that this uniformity of technology is related to the high degree of mobility that was presumably characteristic of populations living during this period.

Late Archaic–Early Agricultural Period (2100 B.C.–A.D. 150)

As the name implies, the Late Archaic–Early Agricultural period in the Southwest is marked by the widespread adaptation of cultivated food resources. This period is also marked by the appearance of permanent or semipermanent domestic architecture, canal irrigation, and the first Mesoamerican cultivars, which arrived as early as the beginning of the second millennium B.C. (Huckell 1996:343)—though maize may have arrived somewhat earlier. At the same time, the period is generally thought to be a time in which people continued a lifeway that remained relatively mobile with the objective of exploiting wild food resources; sites that reflect these activities continue to be categorized under the designation of Late Archaic (Huckell 1995). This period is thought to be one in which groups of people practicing a relatively mobile lifeway began to incorporate, over a long span of time, agricultural products as significant elements of their subsistence.

Work in the Southwest during the past two decades, particularly in the Santa Cruz River valley, has resulted in the discovery of numerous Late Archaic–Early Agricultural period sites and the establishment of a refined phase sequence for the period. The earliest phase (dated 2100–1500 B.C.) is presently unnamed but is defined by the first appearance of maize *(Zea mays)* and large, circular pit structures. Fired sherds, perhaps from incipient vessels, and figurine fragments that date to about 2100 B.C. have been recovered in the Tucson Basin (Mabry 2007:7).

The San Pedro phase (1500–800 B.C.) continued to include these attributes, with the addition of corner-notched San Pedro dart points—a hallmark of the phase—and, in the San Pedro core area, Empire points (Mabry 2007:Figure 1.3). Cultivars added to the crop complex included cotton (*Gossypium* sp.) and possibly the common bean *(Phaseolus vulgaris)*. Also appearing during the San Pedro phase were specialized storage structures with large, interior bell-shaped pits; oval and round house-in-pit type structures; a wider variety of functional extramural pits; flexed inhumations, often in cemeteries; stone and bone pipes; distinctive ceramic figurines; canid burials; refinements in ground stone technology; and, in the Santa Cruz River valley, canal-irrigated farming (Mabry 2007:7–9, 15–18). Large communal-ritual pit structures, perhaps descendents of even larger pre–San Pedro types, were present during the San Pedro phase.

The Cienega phase completes the Late Archaic–Early Agricultural period phase sequence. The Cienega phase was initially proposed by Huckell (1995) and is marked by the appearance of Cienega points, which are distinguished morphologically by deep, oblique corner-notching and flaring stems and were used as dart and possibly arrow points (Lorentzen 1998:150). The Cienega phase is also characterized by large, circular pit structures that often had cylindrical and, less frequently, bell-shaped subfloor pits (Huckell 1995).

Early Ceramic Period (A.D. 150–650)

In both the Tucson and Phoenix Basins, the Early Ceramic period appears to have developed out of the cultural matrix of the Late Archaic–Early Agricultural period. Two early ceramic phases have been proposed for the Tucson Basin: the Agua Caliente phase and the Tortolita phase. The Agua Caliente phase (A.D. 150–450) is marked by the appearance of plain, smudged, and incipient red ware vessels, often in the form of neckless seed jars, produced by hand-molding, scraping, and paddling. It represents the ceramic Plain Ware horizon in the Tucson Basin (Ciolek-Torrello 1998:261). This phase was also characterized by an assemblage of milling stones, an expedient flaked stone industry accompanied by a remnant Archaic period bifacial tool technology, and rectangular domestic pit houses that were more formal in design than their predecessors (Whittlesey and Heckman 2000:6). The Tortolita phase (A.D. 450–650) represents the Red Ware horizon in the Tucson Basin and corresponds approximately with the beginning of the Vahki phase (characterized by Vahki Red Ware) in the Phoenix Basin. Tortolita Red is hard-slipped and typically sand-tempered, with a greater variety in vessel forms (Bernard-Shaw 1990; Heidke 2003:148). Tortolita phase settlements are larger with more formal patterning than previous Agua Caliente phase settlements and were increasingly dependent on maize.

The Hohokam (A.D. 650–1450)

Pioneer Period (A.D. 650–750)

The Hohokam cultural sequence begins with the Pioneer period. As mentioned earlier, this is marked by the appearance of Vahki Red Ware in the Phoenix area. In Tucson and the Santa Cruz River valley, it is referred to as the Tortolita period and not yet considered “Hohokam.” There are some indications of a distinctly Pioneer-period Hohokam cultural presence in the Tucson Basin, but it never developed to the same extent that it did in Phoenix. True Snaketown phase ceramics appear in Tucson during the Snaketown phase; this is considered by some archaeologists to mark the beginning of the Hohokam sequence in Tucson.

Colonial Period (A.D. 750–950)

Some archaeologists consider the beginning of the Colonial period as the first substantially visible development of the Hohokam cultural complex (e.g., Wallace et al. 1995:576, 606). Ballcourts and cremation burials with a distinctive assemblage of mortuary offerings became hallmarks of the Hohokam culture. During this period, the Santa Cruz River was recovering from a period of entrenchment that had begun in about 50 B.C. This resulted in an environment that was increasingly conducive to floodwater farming (Waters 1992:175). Settlement expanded in the Tucson Basin, with ballcourt villages being constructed in the Santa Cruz River valley at several sites. Ballcourts likely served as focal points for regional socioeconomic interaction (Wilcox and Sternberg 1983). Larger villages were laid out in clusters of pit houses focused around courtyard areas, and cremations were frequently clustered in cemeteries that appear to have been associated with house clusters (Wilcox 1991:256). Ceramic design began incorporating zoomorphic and anthropomorphic imagery.

Sedentary Period (A.D. 950–1150)

The succeeding Sedentary period, divided into the Early, Middle, and Late Rincon subphases, was a time of expansion. Established Hohokam villages became larger, and smaller settlements were established along secondary drainages and in bajada environments (Crown 1991:149). Smaller settlements such as farmsteads and field houses also began appearing around village peripheries. The construction of ballcourts and the unique Hohokam cremation complex continued, but inhumations begin to be practiced again after virtually disappearing during the Colonial period. Copper bells, imported from western Mexico, and etched shell appear for the first time during the Sedentary period. Ceramics took on increasingly geometric, abstract designs during this time, and the distinctive Gila shoulder, which was formed by the sides of a vessel sloping downward sharply from the neck to create a low shoulder near the base, became a diagnostic marker of the Sedentary period.

Around A.D. 1000, the Santa Cruz River again became entrenched, forcing a shift away from riverine-oriented settlements and a greater emphasis on ak-chin (non-floodwater) farming. Drought-resistant plants such as agave subsequently became important (Doyel 1991:246; Whittlesey 2004: 26–27). Near the end of the Late Rincon, the ballcourt system began to wane, and formally constructed platform mounds increasingly became the primary form of public architecture (Doyel 2000:308).

Classic Period (A.D. 1150–1450)

The Classic period is divided into two broad phases: the Tanque Verde phase (A.D. 1150–1300) and the Tucson phase (A.D. 1300–1450). During the Tanque Verde phase, Tanque Verde Red-on-brown became the dominant ceramic type in the Tucson Basin and common across southern Arizona, perhaps the result of Tucson's increased prominence as a trading center during this time (Slaughter and Roberts 1996:14). Domestic architecture in the form of pit houses continued, but aboveground adobe and masonry structures, often freestanding and constructed within adobe compound walls, were developed (Rice 2003:10). In the Tucson Basin, ballcourt construction ceased. The exploitation of agave as an important food source continued and intensified.

Between A.D. 1276 and 1299, a drought affecting the entire Southwest had the effect of forcing people who lived in regions north of the Mogollon Rim to travel southward across and off the Colorado Plateau in search of food sources; local agriculture had failed and could not support the population base (Reid and Whittlesey 1999:17). This resulted in an intercultural exchange between several groups, including the Mogollon, Hohokam, Salado, and Paquimé. During the succeeding Tucson phase, this cultural interaction led to widespread social changes. Following the abandonment of many of the Tanque Verde phase sites, settlements aggregated into fewer, but larger, sites, possibly as a response to increased warfare (Doelle and Wallace 1990:331). Freestanding structures declined, and architecture became oriented toward contiguous room blocks with more substantial walls. Cemeteries, which had previously been related to discrete house clusters, now commonly were associated with multiple clusters (Crown 1991:151). Great houses, notably at Casa Grande and Pueblo Grande, appear at this time.

The Protohistoric Period (A.D. 1450–1540)

The Protohistoric period—the era between the end of the Classic period and the arrival of the Spanish—is an obscure period in the prehistory of the Southwest. Comparatively little archaeological evidence belonging to this period has come to light, and much must be inferred from the accounts recorded by Spanish explorers of the state of the Southwest toward the end of the Protohistoric period.

It remains unclear if the Piman-speaking people encountered by the Spanish in southern Arizona were direct descendants of the prehistoric peoples known by archaeologists as the Hohokam or if they were a new group of people who had moved into the region following the decline of the Hohokam. A definitive answer to this question continues to elude researchers, but oral traditions of contemporary Piman-speakers in southern Arizona contain elements of both models and suggest that the people inhabiting southern Arizona and northern Sonora at the time of European contact were the descendants of new arrivals from Mexico who had become integrated into an existing population that would have been the direct ancestors of the Hohokam (Teague 1993).

The Historic Period (A.D. 1540–1960)

Spanish exploration of the Southwest began as early as 1539 with the preliminary scouting expedition of Fray Marcos de Niza, who had been sent to the region by Mexican viceroy Antonio de Mendoza in response to the accounts of Alvar Núñez Cabeza de Vaca and an African named Esteban—the first person of Old World descent known to have passed through southeastern Arizona—who had wandered to Sonora after being shipwrecked in the Gulf of Mexico in 1528. Esteban was sent back out in 1539 as a guide on an expedition traveling from Sonora northward to the Pueblo country of northern New Mexico. When other members of his party fell ill, Esteban is believed to have traveled alone across the eastern edge of present-day Arizona to Zuni, where he was killed (Weber 1992). The nominal leader of the expedition, Fray Marcos de Níza, may or may not have eventually followed along. After de Niza's return, Viceroy Mendoza proposed a larger follow-up expedition and selected Vásquez de Coronado as its leader. Coronado's party departed in 1540 in search of the fabled Seven Cities of Cibola. The route of the expedition probably took Coronado through what is now eastern Arizona, although at one time it was speculated that one stop on the journey, Chichilticale or Red House, was in fact the Hohokam adobe house at Casa Grande (Wilson 1999:25–26).

Jesuit missionary Eusebio Francisco Kino arrived in Sonora in 1681. Kino and his fellow Jesuits established a chain of missions that began in present-day Sonora and that, by 1700, ultimately extended northward into what is now Arizona. The Pima Indians of the missions revolted against the Spanish in 1751. This rebellion was put down quickly, and in the following year a presidio was established at Tubac (Weber 1992). Apart from guarding against further internal revolt, the presidio was intended to help stem incursions by the Apache. Apaches had been raiding Piman settlements since shortly prior to the time of Kino's initial contact (Spicer 1962:234), and the escalation of raiding over time resulted in increasing resettlement of the Piman-speaking populace into defensible locations. From the late 1780s, the implementation of a policy of "carrot-and-stick" diplomacy, by which Apaches and other nomadic tribes were supplied with gifts of food and other items in exchange for halting their raids on settlements, allowed for an expansion of ranching and stock raising all along Mexico's northern frontier. This time of relative peace ended with the independence of Mexico from Spain in 1821. The Mexican government dropped the policy of purchasing a state of relative peace with stipends and raiding resumed, the result being that ranching once again ceased to be viable (Morrisey 1950:151).

Most of Arizona passed into the hands of the United States at the conclusion of the Mexican-American War of 1846–1848. The boundary between New Mexico and Texas was established in 1850, at which time the entire region south of the 37th parallel, stretching from the new Texas–New Mexico border west to the eastern boundary of California, became the Territory of New Mexico. In 1854, the Gadsden Purchase expanded the New Mexico Territory from the Gila River south to the present-day Mexican border (Walker and Bufkin 1979:22). The Territory of Arizona was split off from the Territory of New Mexico in 1863. The first railroad, the Southern Pacific, reached Arizona from the west in 1877 but it did not reach Tucson until 1880 (Myrick 1975). Conflict between the Apache and the Euroamerican settlers continued until 1886 when Geronimo surrendered and peace was negotiated (Collins et al. 1993:32). With the end of open hostilities, settlers resumed their migration to the area with the aid of the railroad. Mining and cattle ranching, which had already become fairly well-established in Arizona prior to the Civil War, became the Territory's main industries.

Arizona attained Statehood in 1912. From the end of the Civil War, ranching and homesteading, in addition to increased urban development, brought by the railroads had proliferated in the West, including Arizona. Mining also played a vital role in Arizona's economy. In the 1930s, the Great Depression limited economic growth, with the mining industry being particularly affected. However, recovery from the Great Depression was extremely rapid in the Tucson Basin, as evidenced by a large population increase. Ranching, mining, and farming continued to account for a large portion of the economic activity of the Tucson area, even into comparatively recent times.

PREVIOUS RESEARCH

Prior to fieldwork, a Class I records check was performed using the AZSITE online database, which contains records pertaining to all surveys and sites registered with the ASM. The Class I search found that 20 surveys have been previously conducted and 24 previously recorded sites are present within a 1.6-km (1.0-mile) buffer surrounding the project area (Tables 1 and 2; Figure B.1). The project area had not been previously surveyed within the last 10 years. However, it was surveyed in 1988 by the ASM (1988-120.ASM). While, according to AZSITE, no sites are present in the project area, Tierra recorded the historic Tucson to Rillito Road (AZ BB:13:818[ASM]) in the project area in 2011 (Doak 2011); the site had not been identified during the 1988 survey of the current parcel. As the project registration form for the 2011 project is present in AZSITE, it is likely that the site is waiting as part of the backlog to be added to the database.

U.S. General Land Office (GLO) maps covering the area within the 1.6-km (1.0-mile) buffer were also examined for indications of historic properties in the vicinity of the current project area (Figure 3). GLO Map No. 2119, filed on February 23, 1897, shows only the "Tucson to Rillito Road" in the current project area.

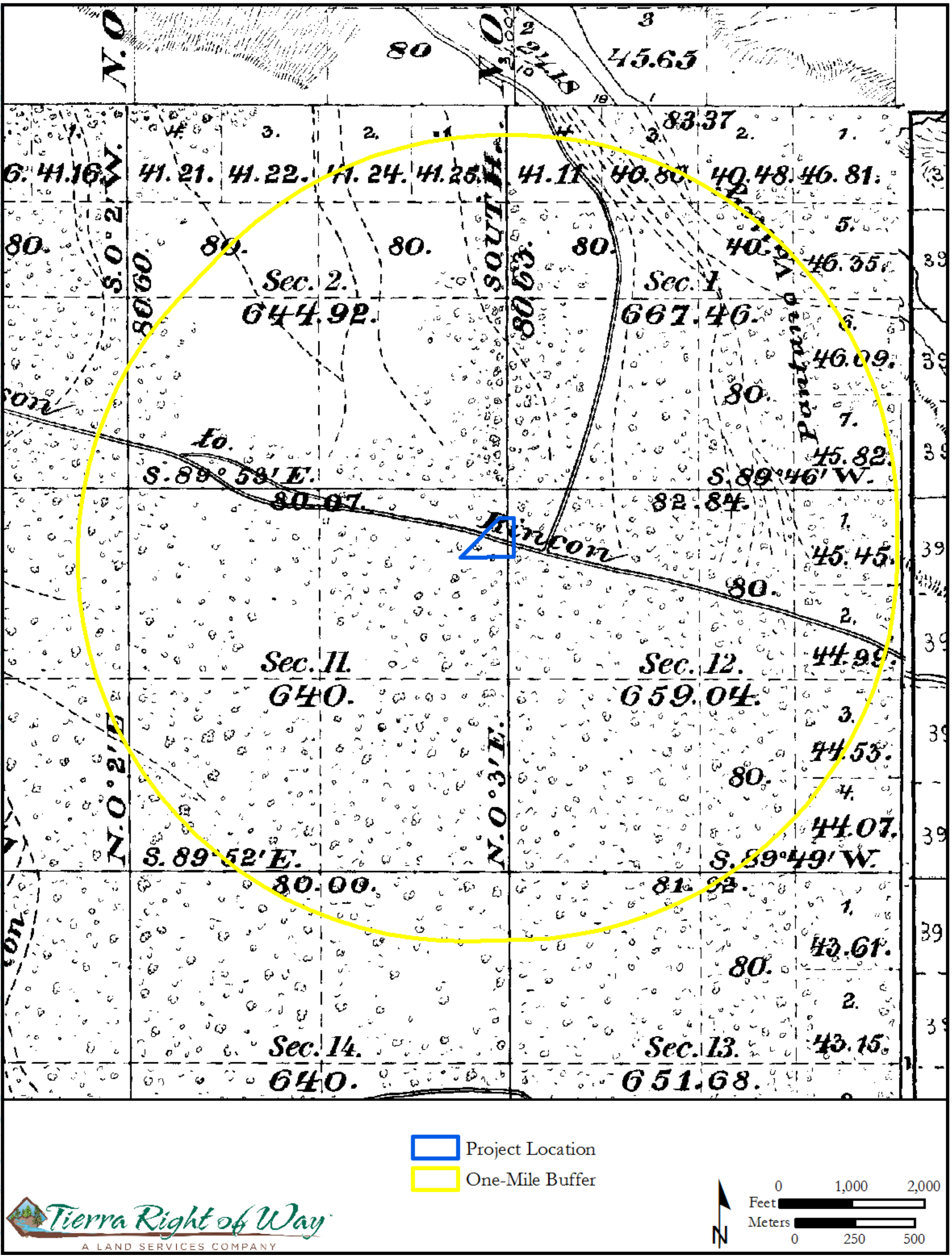
Table 1. Previous Surveys within a 1.6-km (1.0-Mile) Radius of the Project Area

Project No.	Description	Performing Agency	Report Reference
1978-2.ASM	Commercial Lease	Arizona State Museum	information not available
1980-86.ASM	Motorola Inc., Houghton Road Exchange	Arizona State Museum	information not available
1982-88.ASM	McCann Valley Rock and Sand Company Survey	Arizona State Museum	Madsen 1982
1983-91.ASM	Arizona Motor Speedway	Arizona State Museum	Lange 1983a
1983-142.ASM	Drexel Road R/W	Arizona State Museum	Lange 1983b
1984-157.ASM	Mountain Bell so521	Arizona State Museum	information not available
1985-63.ASM	Pima County Houghton Road Pit	Arizona State Museum	information not available
1985-68.ASM	State Land Survey	Arizona State Museum	information not available
1987-230.ASM	Davis-Monthan AFB Survey & Data Recovery	Statistical Research, Inc.	Altschul 1988
1987-258.ASM	Houghton Hills Project	Pima Community College	Douglas 1987
1988-120.ASM	City of Tucson Landfill and Governmental Complex	Arizona State Museum	Madsen 1988
1989-107.ASM	Rillito Creek Recharge	Bureau of Reclamation	Laush 1989
1997-106.ASM	Civano Reclaimed Main Survey	Desert Archaeology, Inc.	Eppley 1997
1999-224.ASM	Irvington Landfill Park Survey	Desert Archaeology, Inc.	Eppley 1999
2000-310.ASM	Civano-Phase 2, 310-Acre Survey	Old Pueblo Archaeology Center	Jones 2000
2006-1012.ASM	Houghton: Irvington to Valencia Survey	Desert Archaeology, Inc.	Cook 2006
2007-41.ASM	TEP 138k V Removal Survey	Tierra Right of Way Services, Ltd.	Doak 2007
2007-163.ASM	Houghton/Old Spanish Trail to Valencia Survey	Tierra Right of Way Services, Ltd.	Hushour 2007
2009-859.ASM	Houghton-Irvington to Valencia Survey	Desert Archaeology, Inc.	Diehl 2009a and 2009b
2011-399.ASM	Civano Survey	Tierra Right of Way Services, Ltd.	Doak 2011

Table 2. Previously Recorded Sites within a 1.6-km (1.0-Mile) Radius of the Project Area

ASM No.	Description	Temporal Range	NRHP Evaluation
AZ BB:13:112(ASM)	lithic scatter	Archaic (8000 B.C.–A.D. 200)	not evaluated
AZ BB:13:339(ASM)	2 roasting pits and 2 rock clusters	prehistoric (12,000 B.C.–A.D. 1500)	not evaluated
AZ BB:13:340(ASM)	roasting pit	prehistoric (12,000 B.C.–A.D. 1500)	determined Eligible by SHPO
AZ BB:13:341(ASM)	2 roasting pits with artifact scatter	Ceramic (A.D. 200–1500)	determined Eligible by SHPO

ASM No.	Description	Temporal Range	NRHP Evaluation
AZ BB:13:342(ASM)	roasting pit	prehistoric (12,000 B.C.–A.D. 1500)	determined Eligible by SHPO
AZ BB:13:343(ASM)	lithic scatter	Ceramic (A.D. 200–1500), prehistoric (12,000 B.C.–A.D.1500)	determined Eligible by SHPO
AZ BB:13:344(ASM)	roasting pit	unknown	determined Eligible by SHPO
AZ BB:13:345(ASM)	lithic scatter	Ceramic (A.D. 200–1500)	determined Eligible by SHPO
AZ BB:13:346(ASM)	lithic scatter	Ceramic (A.D. 200–1500)	determined Eligible by SHPO
AZ BB:13:348(ASM)	roasting pit	Ceramic (A.D. 200–1500)	determined Eligible by SHPO
AZ BB:13:349(ASM)	roasting pit	prehistoric (12,000 B.C.–A.D. 1500)	determined Eligible by SHPO
AZ BB:13:367(ASM)	artifact scatter	Late Archaic (1500 B.C.–A.D. 200)	not evaluated
AZ BB:13:368(ASM)	artifact scatter	Hohokam Pre-Classic period (A.D. 450–1100, Hohokam Sedentary period (A.D. 950–1100), prehistoric (12,000 B.C.–A.D. 1500)	not evaluated
AZ BB:13:369(ASM)	roasting pits and artifact scatter	prehistoric (12,000 B.C.–A.D. 1500)	not evaluated
AZ BB:13:370(ASM)	roasting pit	prehistoric (12,000 B.C.–A.D. 1500)	not evaluated
AZ BB:13:371(ASM)	roasting pit	prehistoric (12,000 B.C.–A.D. 1500)	not evaluated
AZ BB:13:372(ASM)	roasting pit	prehistoric (12,000 B.C.–A.D. 1500)	not evaluated
AZ BB:13:373(ASM)	roasting pit	prehistoric (12,000 B.C.–A.D. 1500)	not evaluated
AZ BB:13:374(ASM)	roasting pit	prehistoric (12,000 B.C.–A.D. 1500)	not evaluated
AZ BB:13:379(ASM)	roasting pit	prehistoric (12,000 B.C.–A.D. 1500)	not evaluated
AZ BB:13:380(ASM)	roasting pit	prehistoric (12,000 B.C.–A.D. 1500)	not evaluated
AZ BB:13:381(ASM)	roasting pit	prehistoric (12,000 B.C.–A.D. 1500)	determined not Eligible by SHPO
AZ BB:13:662(ASM)	lithic procurement site	Ceramic (A.D. 200–1500), prehistoric (12,000 B.C.–A.D. 1500)	determined Eligible by SHPO
AZ BB:13:818(ASM)	Tucson to Rillito Road	middle Historic (A.D. 1800–1900) late Historic (A.D. 1900–1950)	recommended Not Eligible by recorder



Path: X:\2016\16T0-012\arch\fromGIS\2016-02-02\classI.mxd Date: 2/2/2016 Drawn by: adelia Coordinate System: NAD 1983 UTM Zone 12N Restricted Site Data, Do Not Distribute. For Project Specific Use Only

Figure 3. Copy of Parts of General Land Office Map No. 2119 (Township 15 South, Range 15 East, G&SRB&M) showing the current project area and 1.6-km (1.0-mile) buffer.

Due to recent ASM and AZSITE user's agreement requirements, previous project and site locations depicted on maps are now placed as a detachable appendix at the end of this report (Appendix B). For the client copy of this report, Appendix B has been removed, but all agency copies are intact.

SURVEY METHODS

The survey was conducted in accordance with standards established by the ASM for pedestrian surveys on lands administered by the State of Arizona and its subdivisions. According to these standards, 100 percent coverage of an area can be claimed if the entire area is surveyed by crews walking transects spaced no more than 20 m (66 feet) apart across the entire project area. For the current survey, 100 percent coverage of the parcel was achieved by a single archaeologist walking multiple transects across the project area, beginning along the Houghton Road right-of-way (ROW). The survey area was photographed, and methods and any findings were noted on standardized forms where applicable. Ground visibility was good throughout the project area.

Cultural properties identified during any survey are evaluated in accordance with standards established by ASM for State-administered lands (Fish 1994). These standards require a property to be at least 50 years old. For a property of sufficient age to be recorded as an archaeological *site*, it must consist of one of the following:

> 1. At least 30 artifacts of a single type (e.g., ceramics or lithics), representing the remains of more than a single episode of activity (e.g., the dropping of a single pot or the reduction of a single core into lithic artifacts);
>
> 2. At least 20 artifacts, of two or more types of artifact;
>
> 3. A single fixed feature, with any number of artifacts in association; or
>
> 4. More than one fixed feature, with or without associated artifacts.

A property of sufficient age that does not meet any of these criteria may be recorded as an *isolated occurrence*. However, if such a property is considered to be of particular interest for some other reason, it may also be recorded as a site at the discretion of the recorder. Examples of such isolated occurrences would include rare types of projectile points or significant historic features.

Cultural properties are further evaluated with regard to significance, which is assessed largely in terms of a property's eligibility for inclusion on the NRHP. As defined by Code of Federal Regulations Title 36, Part 60.2 (36 CFR 60.2), the NRHP is "an authoritative guide to be used by Federal, State, and local governments, private groups and citizens to identify the Nation's cultural resources and to indicate what properties should be considered for protection from destruction or impairment" (36 CFR 60.2). Pursuant to 36 CFR 60.4, these are the criteria by which properties are evaluated:

> The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and

A. That are associated with events that have made a significant contribution to the broad patterns of our history; or

B. That are associated with the lives of persons significant in our past; or

C. That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

D. That have yielded or may be likely to yield, information important in prehistory or history (National Park Service 2004).

SURVEY RESULTS

The entire project area was surveyed, and no access issues were encountered. Only the previously recorded site, AZ BB:13:818(ASM), was encountered during the course of the survey. No other archaeological sites, isolated occurrences or non-site historic buildings or structures were observed.

AZ BB:13:818(ASM)

This site, the historic Tucson to Rillito Road, was previously recorded by Tierra in 2011 (Doak 2011). A that time, a 914.4-m-long (3,000.0-foot-long) segment of road was recorded within the adjacent parcels and through the current project area. However, only a small segment of the road is present within the current parcel, the visible portion of which only measures approximately 7.6 m (25.0 feet) long by 3 m (10 feet) wide (Figures 4 and 5; Photo 1). Within the parcel, the road disappears along the east-west–oriented Tucson Water access road, and no evidence of the road was found to the south of the access road, despite the fact that the road appears on recent aerial maps available through ArcGIS. The road consists entirely of dirt at this point and could only represent a single lane. Fragments of asphalt are present alongside the road segment, but it is not clear if these are related to the road or were brought in from elsewhere (Photo 2). No artifacts were observed alongside the road. The road currently sees moderate to heavy use.

As described by Doak (2011:24), the road "is apparently the last surviving stretch of a road that appears on an 1897 GLO map [see Figure 3] and a 1905 USGS map [Figure 6] as the principal artery linking Tucson with the Rincon Valley." The road does not match the exact footprint of the GLO or USGS maps, but it does run in the approximate direction and is a closer approximation to the USGS map than the GLO map.

While the exact dates of the use of the road are unknown, the road predates the 1897 GLO map and was out of use by 1948, when an east-west–running road appears to have taken its place as the primary transit route to the eastern Tucson Basin (Doak 2011:24). As part of the 2011 study, Tierra recommended the site as ineligible for the NRHP due to a lack of integrity. The current author agrees with this recommendation, as no additional information could be derived from the current study.

Path: X:\2016\16T0-012\arch\classI.mxd Date: 2/3/2016 Drawn by: adelia Coordinate System: NAD 1983 UTM Zone 12N

Restricted Site Data, Do Not Distribute. For Project Specific Use Only

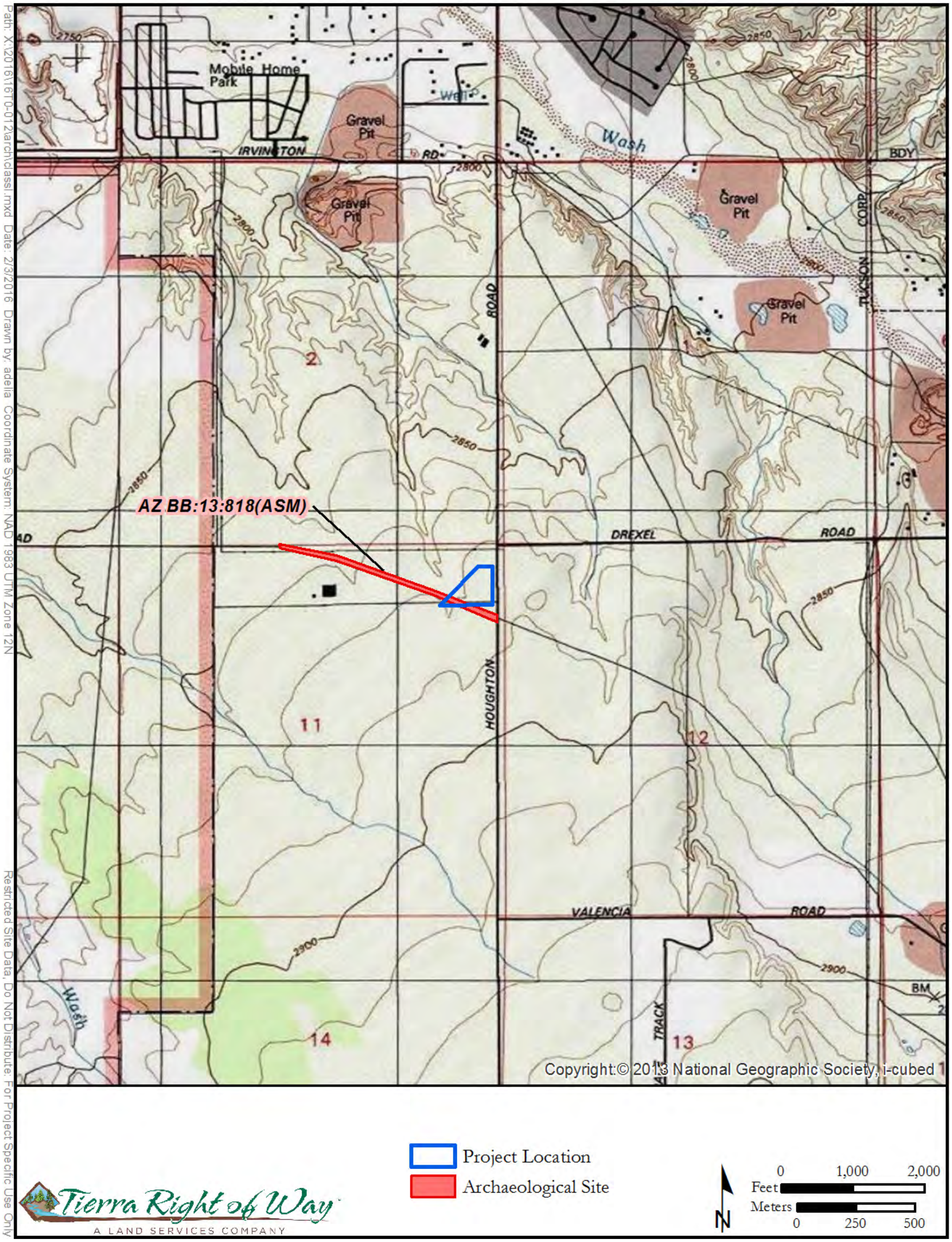


Figure 4. Location of AZ BB:13:818(ASM).

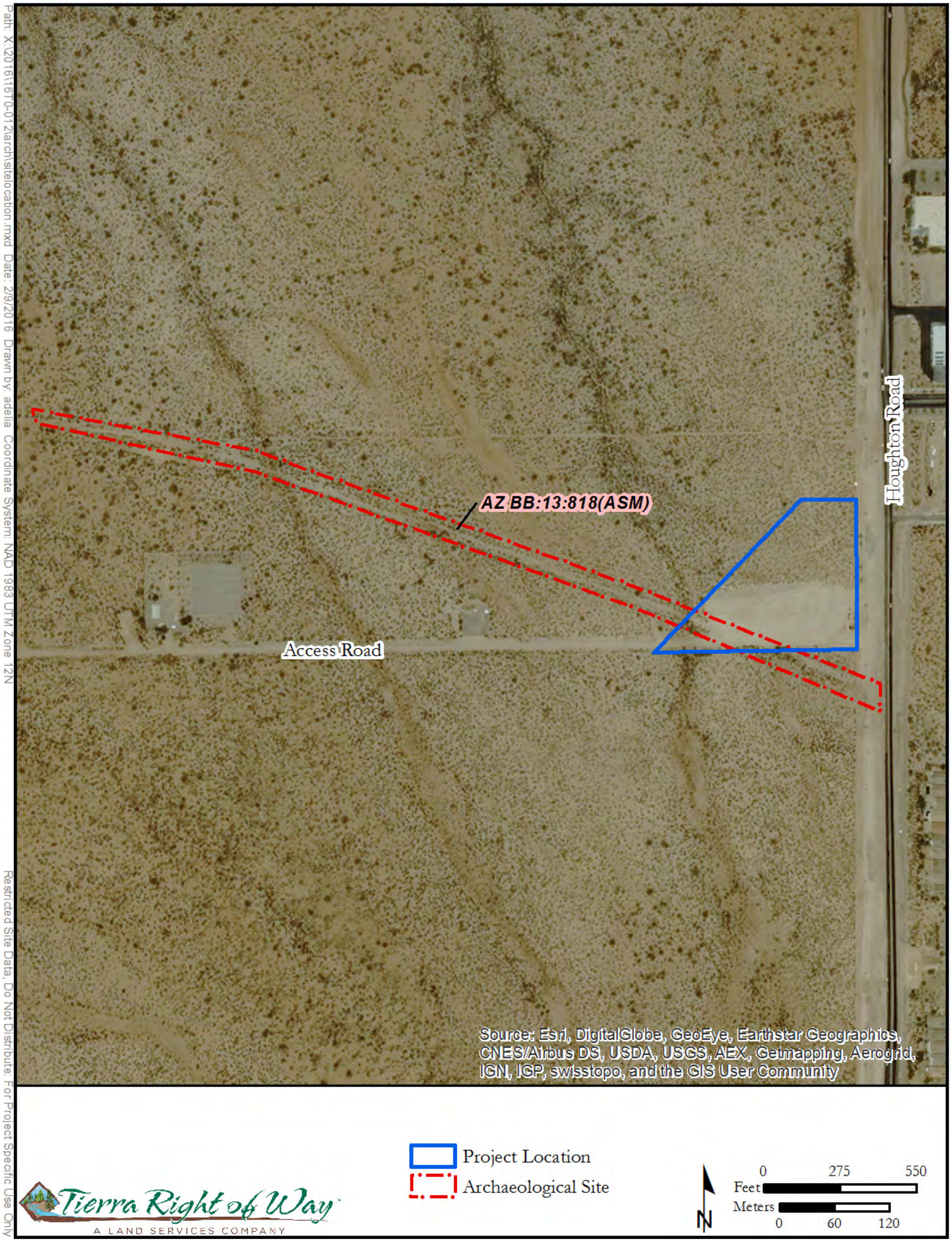


Figure 5. Detailed location of AZ BB:13:818(ASM).

Photo 1. Overview of AZ BB:13:818(ASM) through the project area, looking northwest.

Photo 2. Asphalt fragments along the road, looking west.

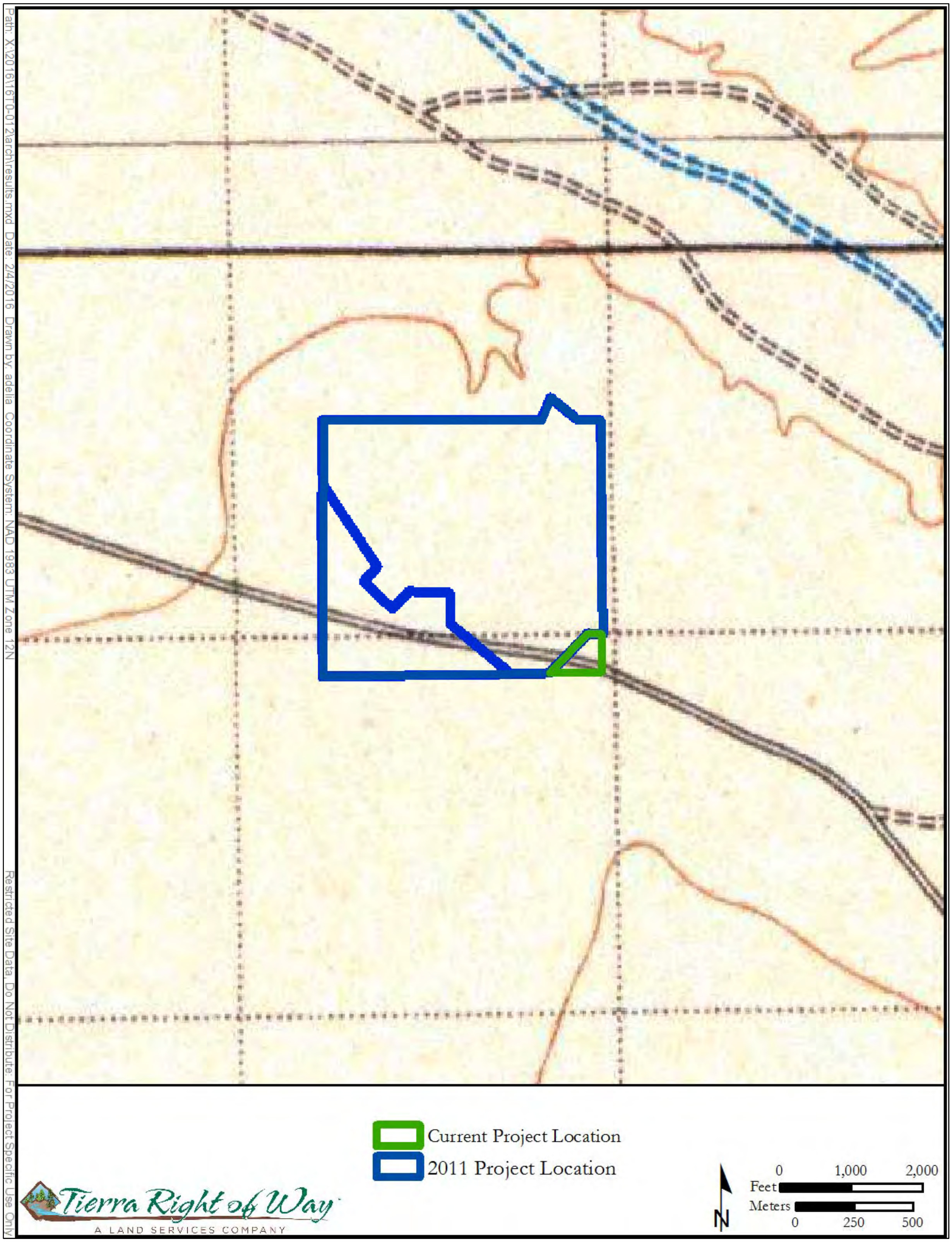


Figure 6. Tucson, Arizona (1905), 15-minute U.S. Geological Survey quadrangle map modified from Doak (2011) showing road recorded as BB:13:818(ASM), the 2011 study area, and the current project area.

ASSESSMENT OF EFFECT AND PROPERTY TREATMENT

A single site, AZ BB:13:818(ASM), the Tucson to Rillito Road, was encountered during the survey. Only a small portion of the site is located within Parcel 14101007E. The site as a whole has been previously recommended as ineligible for the NRHP (Doak 2011), and Tierra agrees with the previous recommendation. Therefore, Tierra recommends that the proposed Mattamy Homes project within Parcel 14101007E be allowed to proceed without any further archaeological work required.

The client and all subcontractors are reminded that, in accordance with §41-844 of the Arizona Revised Statutes, the person supervising any survey, excavation, construction, or like activity on State-administered lands is required, upon incidentally encountering cultural deposits more than 50 years old, to halt all work on the undertaking and immediately notify the Director of the ASM of the finding so that a consultation process can be initiated and an appropriate course of treatment decided upon. Work in the area is not to resume until authorization is received from the Director of the ASM. If the objects discovered are human remains, funerary objects, sacred ceremonial objects, or objects of national or Tribal patrimony, the Director shall, to the best of their ability, give notice of the discovery to all individuals that may have a direct kinship relationship to the human remains, all groups that it is reasonable to believe may have a cultural or religious affinity to the remains or objects, appropriate members of the curatorial staff of ASM, faculty members of the State universities who have a significant scholarly interest in the remains or objects, and the State Historic Preservation Office. Native American Tribal governments that wish to be notified must keep lists of the cultural groups and geographical area with which they claim affinity on file with the Director of the ASM. If Native American human remains, funerary objects, sacred ceremonial objects, or objects of cultural patrimony are involved, the Director must give notice to the Tribes that occupy or have occupied the land on which the discovery is made, the Arizona Commission on Indian Affairs, and the Intertribal Council of Arizona.

The client and all subcontractors are also reminded that, in accordance with Section 41-865 of the Arizona Revised Statutes, if human remains are encountered anywhere in the survey area during any subsequent ground-disturbing activities, these activities shall cease in the area of the discovery and the Director of ASM shall be immediately notified. The Director will then have 10 working days to respond to the request. All ground-disturbing activities in the immediate vicinity of the discovery shall cease until a qualified archaeologist assesses the remains. Work in and around the area shall not resume until so directed by ASM personnel.

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APPENDIX A. SELECT PROJECT PHOTOS

Photo A.1. Project area from the southeast corner showing vegetation clearing and piled materials, looking northwest.

Photo A.2. Project area, looking northeast.

Photo A.3. Project area showing mountain bike trail, looking southeast.

Photo A.4. Project area from southwest corner, looking northeast.

APPENDIX B

Class I Research

CONFIDENTIAL

This appendix contains information on the locations of cultural properties discussed in the report:

A Class III Cultural Resource Survey of a Portion of a Proposed Housing Development Southwest of the Intersection of Drexel and Houghton Roads for Mattamy Homes in Tucson, Arizona

Public disclosure is prohibited by ARS §39-125.

A Class III Archaeological Survey of a 313.3-Acre Parcel along South Houghton Road in Tucson, Pima County, Arizona

City of Tucson Project #11-07

Prepared by:
David P. Doak

Arizona State Museum Accession No. 2011-399
Tierra Archaeological Report No. 2011-175
August 23, 2011

A Class III Archaeological Survey of a 313.3-Acre Parcel along South Houghton Road in Tucson, Pima County, Arizona

City of Tucson Project #11-07

Prepared by:
David P. Doak

Submitted to:
Beatrix Gallivan
City of Tucson Housing and Community Development Department
P.O. Box 27210
Tucson, Arizona 85726-7210

Submitted by:
Tierra Right of Way Services, Ltd.
1575 E. River Road, Suite 201
Tucson, AZ 85718

Arizona State Museum Accession No. 2011-399
Tierra Archaeological Report No. 2011-175
August 23, 2011

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ABSTRACT

PROJECT TITLE: A Class III Archaeological Survey of a 313.3-Acre Tract along South Houghton Road in Tucson, Pima County, Arizona

LAND STATUS: City of Tucson

FUNDING SOURCE: City of Tucson

AGENCY: City of Tucson

PROJECT DESCRIPTION: A Class III archaeological survey of two parcels owned by the City of Tucson, as part of a feasibility investigation for the proposed Southeast Houghton Area Recharge Project (SHARP), City of Tucson Project No. 11-07

TIERRA PROJECT NO.: 11T6-008

TIERRA REPORT NO.: 2011-175

ASM ACCESSION NO.: 2011-399

PERMIT NO.: Arizona State Museum Blanket Permit No. 2011-8bl

FIELDWORK DATES: August 9-11, 2011

PROJECT LOCATION: The project area is a 313.3-acre block located in the eastern Tucson Basin, about a mile south of Pantano Wash. It consists of two parcels in the Pima County landbase system (Nos. 141-01-006A and 141-01-007B), both of which are owned by the City of Tucson. In legal terms it lies within the SE¼; the E½ of the SW¼; and part of the S½ of the SE¼ of the SE¼ of Section 2, and the N½ of the N½ of the NE¼, and the N½ of the NE¼ of the NW¼, of Section 11, Township 15 South, Range 15 East, Gila and Salt River Baseline and Meridian, in Tucson, Pima County, Arizona. The project area is currently being used as part of an offroad biking park, known as Fantasy Island, and is criss-crossed with bicycle trails.

NO. OF ACRES SURVEYED: 313.3

NO. OF SITES: 1

NUMBER OF ISOLATED OCCURRENCES: 6

MANAGEMENT RECOMMENDATIONS:

One previously undocumented site, AZ BB:13:818(ASM), was recorded during the current survey. This site is a fragment of a historic road which once linked the Rincon Valley with Tucson. We believe that the short (3,000-foot-long) fragment that survives within the current project area lacks the integrity required for a property to be considered NRHP-eligible. We therefore recommend that AZ BB:13:818(ASM) be determined ineligible for NRHP inclusion, and that no further archaeological work be required in connection with the property.

Two additional archaeological sites, AZ BB:13:373(ASM) and AZ BB:13:374(ASM), had previously been identified within the boundaries of the current project area, while a third site, AZ BB:13:372(ASM), was plotted as lying on the southern boundary line, apparently outside the project area, but not clearly so. Each of these three sites consisted of a single roasting pit on the edge of an ephemeral drainage, with small numbers of associated artifacts. None of the three sites was reidentified in the field, in spite of dedicated searches of the areas in which they had been plotted. We believe it likely that erosional activity along these washes has obliterated any recognizable trace of these roasting pits. The NRHP status of the three sites had not been assessed in the wake of the survey that originally recorded them (Douglas 1987). Based on the fact that we could not relocate the sites we are recommending that AZ BB:13:373(ASM) and AZ BB:13:374(ASM) be determined ineligible for NRHP inclusion at this time, and that no further archaeological work should be required in connection with either of these sites. As for AZ BB:13:372(ASM), while we are convinced that no part of this site lies within the current project area, because it might lie outside we cannot make a recommendation regarding the NRHP status of this site. We can, however, recommend that no further work be required at this site in connection with the current undertaking.

The client and all subcontractors are reminded that, in accordance with §41-844 of the Arizona Revised Statutes, the person supervising any survey, excavation, construction, or like activity on lands administered by the State of Arizona or any of its administrative subdivisions (i.e., counties or municipalities) is required, upon incidentally encountering cultural deposits more than 50 years old, to halt all work on the undertaking and immediately notify the Director of the Arizona State Museum of the finding, so that a consultation process can be initiated and an appropriate course of treatment decided upon. Work in the area is not to resume until authorization is received from the Director.

INTRODUCTION

On August 9-11, 2011, archaeologists from Tierra Right of Way Services, Ltd., performed a Class III archaeological survey of a 313.3-acre tract located along South Houghton Road in Tucson, Pima County, Arizona. The work was done on behalf of Tucson Water's Planning and Engineering Division. The purpose of the survey was to located and record any cultural resources within the specified tract that might be adversely affected by Tucson Water's proposed Southeast Houghton Area Recharge Project (City Project No. 11-07). The work was done at the request of Ms. Bea Gallivan of the City of Tucson's Housing and Community Development Department, and was done under authority of Arizona Antiquities Act Blanket Permit No. 2010-10bl, issued by the Arizona State Museum.

THE PROJECT AREA

The project area (Figure 1) is a 313.3-acre block located in the eastern Tucson Basin, about a mile south of Pantano Wash. It consists of two parcels in the Pima County landbase system (Nos. 141-01-006A and 141-01-007B), both of which are owned by the City of Tucson. In legal terms it lies within the SE¼; the E½ of the SW¼; and part of the S½ of the SE¼ of the SE¼ of Section 2, and the N½ of the N½ of the NE¼, and the N½ of the NE¼ of the NW¼, of Section 11, Township 15 South, Range 15 East, Gila and Salt River Baseline and Meridian, in Tucson, Pima County, Arizona. The project area is currently being used as part of an offroad biking park, known as Fantasy Island, and is criss-crossed with bicycle trails.

The project area is generally rectilinear, and is bounded on its eastern side by the western edge of the Houghton Road ROW; on its western side by a downed fence line that once marked the western edge of a power line ROW (from which the power line has recently been removed); on most of its southern side by a barbed-wire fence; and on most of its northern side by a (largely) unmarked east-west line that represents a westward extension of the alignment for East Seven Generations Way, the principal access road for the Civano development. The only place where this northern boundary line is physically marked in the field is at its eastern end, where a barbed-wire fence runs for a few hundred feet, separating the parcel from a fire station to the north.

The project area deviates from its overall rectangular shape in two places. On the south side, about 725 feet west of the western edge of the Houghton Road ROW, the southern boundary bends to the northeast at an angle of approximately 45 degrees, following this course to the northeast for ca. 760 feet, before turning again to run due east about 200 feet, finally ending at the western boundary fence for the Houghton Road ROW. On the north end, about 300 feet west of the western fenceline for the Houghton Road ROW, the northern boundary line diverts to the northwest, following a line at a bearing of approximately 310 degrees a distance of approximately 500 feet, then turns back to the southwest, following a bearing of approximately 206 degrees approximately 350 feet, back to the overall northern boundary line for the parcel.

Overall the project area is flat; however, two principle, fairly deep (ca. 3-m-deep) north-flowing washes, each having several shallower tributaries, do cut through the project area. According to the U.S. Department of Agriculture, Natural Resources Conservation Service's Web Soil Survey website, most of the upland parts of the project area are underlain by a soil unit defined as Tubac Gravelly Loam, a typical profile for which displays about 2 inches of gravelly loam at the surface, with a foot

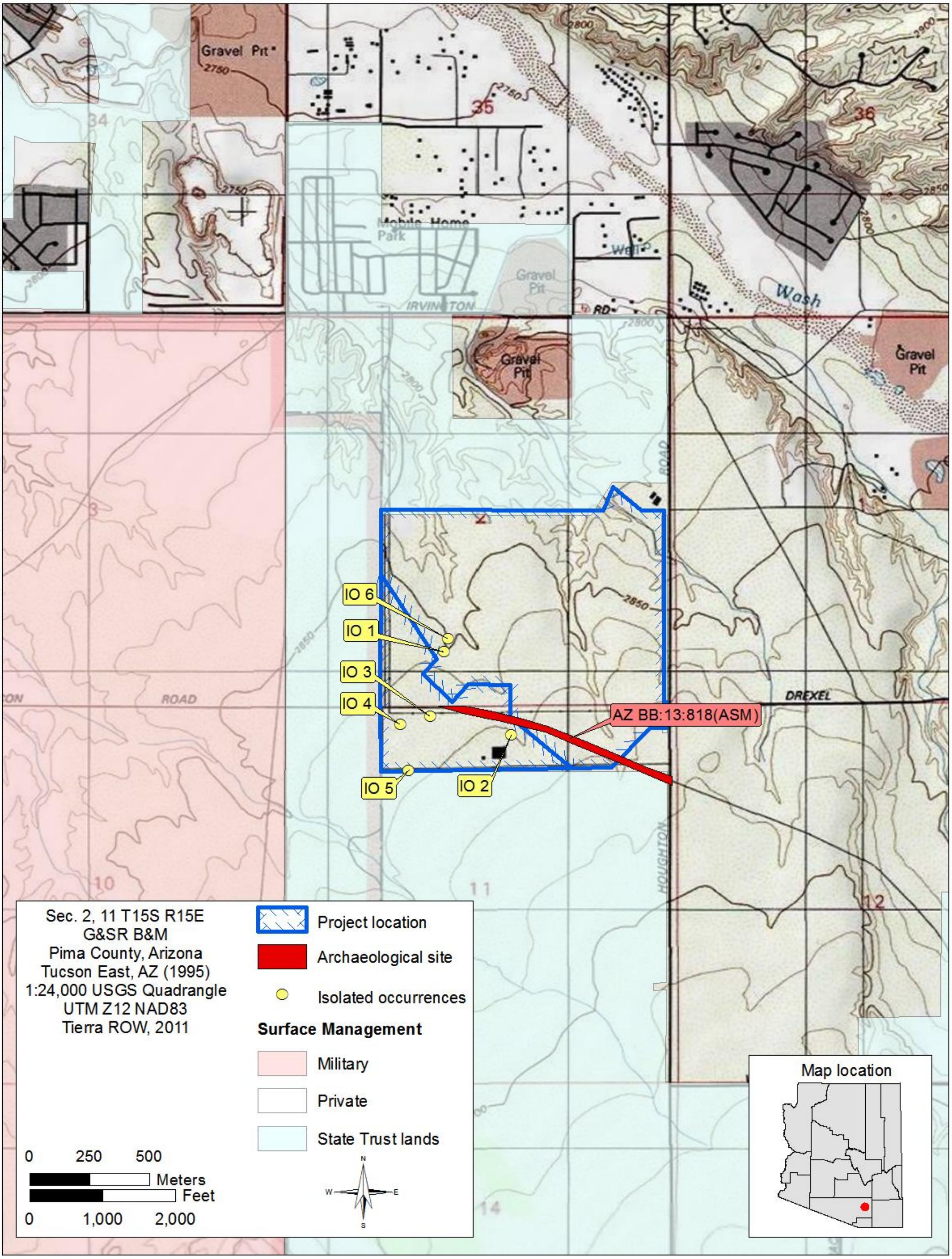

Figure 1. Project location, newly identified archaeological site, and recorded isolated occurrences.

of generic loam beneath, followed by 17 inches of clay and then 29 inches or more of gravelly sandy clay loam. Two areas at the south end of the parcel are underlain by different units. A small area in the southwest corner is underlain by Hantz Loam, a typical profile for which involves 5 inches of generic loam over 7 inches of clay loam, with two separate strata of clay beneath, continuing down to a depth of 5 feet or more. A large area in the southeast corner is underlain by a unit defined as "Sahuarita Soils, Mohave Soils, and Urban Land." Sahuarita soils display a typical profile involving ca. 3 inches of very gravelly fine sandy loam, overlying 25 inches of fine sandy loam, then 17 inches of sandy clay loam, and finally 15 inches or more of very gravelly sandy clay loam. Mohave soils display a profile with 3 inches of loam overlying 3 inches of sandy loam, with 34 inches of clay loam and then 20 inches or more of generic loam beneath. Finally, "Urban Land" is a catch-all phrase used to describe soils in developed areas, where human activity has displaced the natural soil strata; this subdivision of this soil unit applies to the Houghton Road ROW and some areas underlying housing developments east of Houghton.

The wash systems that cut through the project area are underlain by a soil unit defined as the Pinaleño-Stagecoach Complex; a typical profile for Pinaleño soils (which cover ca. 40 percent of the ground surface within the unit) displays 2 inches of very cobbly sandy loam, overlying 28 inches of extremely cobbly sandy clay loam, overlying 30 inches or more of extremely gravelly sandy clay loam, while a profile for Stagecoach soils, which cover 35 percent of the ground area within the unit, typically involves ca. 10 inches of very gravelly sandy loam, overlying 9 inches of very gravelly loam, then 21 inches of extremely gravelly loam, and finally 20 inches of very gravelly loamy sand.

The project area lies within the range of the Arizona Upland Subdivision of the Sonoran Desertscrub biotic community, near its interface with the Semidesert Grassland community. The Sonoran Desertscrub community is distributed across the southwestern quarter of Arizona, the deserts of Riverside and San Diego Counties in California, and much of the Mexican states of Baja California Norte, Baja California Sur, and Sonora. The Sonoran Desert is distinguished from others in the region (the Mohave, the Great Basin, and the Chihuahuan) by a bimodal distribution of rainfall, with some precipitation in both winter and summer, which has contributed to the survival of larger plant species than in other deserts—in particular, of trees, large cacti, and massive succulents. Several discrete subdivisions of this community have been identified, of which two—the Lower Colorado River and the Arizona Upland subdivisions—cover large parts of southern Arizona.

The Arizona Upland Subdivision is described by Brown (1994:200) as "the best watered and least desert-like desertscrub in North America." The range of this subdivision is characterized by the prevalence of substantial slopes; this does not necessarily translate to greater elevations, and elevations within the Arizona Upland Subdivision range from as low as 300 m (1,000 feet) to as high as 1,000 m (3,300 feet) AMSL. Rainfall is greater than in the Lower Colorado Subdivision—200 to 425 mm (8 to 16.5 inches) here—and mean temperatures range between 27 and 32 degrees C in summertime and between 7 and 14 degrees C in winter over the range of the subdivision (Brown 1994:185).

Because this subdivision receives more rainfall than the Lower Colorado Subdivision, species that are confined to washes in the Lower Colorado are spread much more widely here. Overall this subdivision is dominated by taller, woodier species, enough so that Brown (1994:181) speculated that many geographers would not identify this as a desertscrub community at all, but rather a "depauperate thornscrub community." Saguaro, Organ Pipe (*Stenocereus thurberi*), Fishhook (*Ferocactus* *wislizenii*) and Compass Barrel Cacti (*F. acanthodes*), Night-Blooming Cereus (*Peniocereus greggii*), Pencil Cholla (*Cylindropuntia arbuscula*), Christmas Cactus (*C. leptocaulis*), Cane Cholla (*C. spinosior*), Buckhorn Cholla (*C. acanthocarpa*), Teddy Bear Cholla (*C. bigelovii*), Chain Fruit Cholla (*C. fulgida*), and many other cacti are strongly represented within this subdivision. The most widely distributed plant community within this subdivision is a Paloverde-Cacti-Mixed Scrub series, which is best developed away from valley floors (which are dominated by the creosotebush-White Bursage communities typical of the Lower Colorado Subdivision), on bajadas and mountain slopes. The dominant plants in this series are Foothill Palo Verde (*Cercidium microphyllum*) and the Giant Saguaro (*Carnegiea gigantea*), with Ironwood (*Olneya tesota*) being prominent in places, away from valley floors and north slopes dominated by palo verde. The White Leaf Bursage of the valley floors gives way to Triangle Leaf Bursage (*Ambrosia deltoidea*) on the slopes, with Whitethorn Acacia (*Acacia constricta*), Ocotillo (*Fouquieria splendens*), Jojoba (*Simmondsia chinensis*), Desert Hackberry (*Celtis pallida*), and numerous other species also appearing as part of the upslope community. In localized areas near the upper limit of the range Jojoba, an economic plant, achieves dominance; while elsewhere, also at high elevations (often extending past the limit of the desertscrub community), a Creosotebush-Crucifixion-Thorn Series dominates.

Mammals common within the Arizona Upland Subdivision include Desert Mule Deer (*Odocoileus hemionous crooki*), Javelina (*Dicotyles tajacu*), California Leaf-Nosed Bat (*Macrotus californicus*), Black-Tailed Jackrabbit, Desert Cottontail, Arizona Pocket Mouse (*Perognathus amplus*), Bailey's Pocket Mouse (*P. baileyi*), Cactus Mouse (*Peromyscus eremicus*), Gray Fox (*Urocyon cinereoargenteus*), and Harris' Antelope Squirrel (*Ammospermophilus harisii*). While numerous well-known types of bird are common to this community, most, including Harris' Hawk (*Parabuteo unicinctus*), White-Winged Dove (*Zenaida macroura*), Inca Dove (*Scardiafella inca*), Elf Owl (*Micrathene whitneyi*), Pyrrhuloxia (*Cardinalis sinuatus*), and assorted Cactus woodpeckers, are equally common to other biotic communities as well. Perhaps the animal species most characteristic of this community are the reptiles, including Regal Horned Lizard (*Phrynosoma solare*), Western Whiptail (*Cnemidophorus tigris gracilis*), Gila Monster (*Heloderma suspectum*), Arizona Coral Snake (*Micruroides euryxanthus*), and Tiger Rattlesnake (*Crotalus tigris*).

The Semidesert Grassland community is described by Brown (1994:123) as "potentially a perennial grass-scrub dominated landscape positioned between desertscrub below and evergreen woodland, chaparral, or plains grassland above." Such communities are generally found at elevations of between 1,100 and 1,700 m (3,600–5,575 feet) AMSL, and are, for the most part, located in areas bordering the upper fringe of the Chihuahuan Desert, although in western Arizona similar communities are found bordering on Interior Chaparral or Sonoran desertscrub communities instead. Over most of this range average annual precipitation ranges between 25 and 45 cm (9.8 and 17.7 inches), with over half of this total falling during the April–September period, when rainfall typically averages 15 cm (5.9 inches) or more (Brown 1994). Even though grasses—once, perennial bunchgrasses (particularly grama grasses [*Bouteloua* sp.]), which have now largely been superseded by low-growing sod grasses and annuals—are the defining element of grassland communities, in many areas mesquites (*Prosopis* sp.), cacti (including barrels [*Ferocactus wislizenii*], hedgehogs [*Echinocereus*], and assorted *Opuntiae*), forbs, and shrubs, including agaves (*Agave* sp.), sotols (*Dasylirion* sp.), and yuccas (*Yucca* sp.), have largely replaced the grasses (Brown 1994:124). Trees are uncommon, at least away from drainages. Ocotillo (*Fouquieria splendens*) and thornscrub species, including Hopbush (*Dodonaea viscosa*) and Kidneywood (*Eysenhardtia orthocarpa*) are common in the southern part of the range of this community. Mammals native to the community include Black-tailed Jackrabbit (*Lepus californicus*), Badger (*Taxidea taxus*), Spotted Ground Squirrel (*Spermophilus spilosoma*), Kangaroo rats (*Dipodomys* sp.), cotton rats (*Sigmodon* sp.), assorted other rodents, and Coyote (*Canis latrans*), found in this community among many others. Birds include Swainson's Hawk (*Buteo swainsoni*), Prairie Falcon, Kestrel, Mourning Dove (*Zenaida macroura*), Roadrunner (*Geococcyx californianus*), Scaled quail (*Callipepla squamata*), Ladder-Backed Woodpecker (*Picoides scalaris*), and burrowing owls. Where ocotillo is present invasive species from downslope desertscrub areas, such as Javelina (*Dicotyles tajacu*), are often present as well. Invasive species from grassland areas upslope from this community are much less common.

CULTURE HISTORY

Paleoindian and Early Archaic Periods (11,000–6000 B.C.)

The first known inhabitants of southern Arizona are referred to by archaeologists as Paleoindians. These groups were migratory peoples who entered North America during the Pleistocene epoch. Two classic characteristics of Paleoindian sites are the presence of fluted, lanceolate projectile points (Clovis points; see below) and the fossil remains of now extinct species, particularly Pleistocene megafauna such as mammoth (*Mammuthus* spp.) and ancient bison (*Bison antiquus*) (Reid and Whittlesey 1997:30–37). The Paleoindians were originally conceptualized purely as big-game hunters, but it is now understood that these people actually exploited a spectrum of biological resources that were in some ways akin to later Archaic subsistence strategies (Mabry 1998:105–107).

The earliest definitively dated archaeological sites in the Southwest are Clovis occupations, typified by Clovis points. These points display concave bases, basal fluting, and lateral and marginal grinding (Slaughter 1992:72). Several important Clovis sites, including Naco, Lehner, Escapule, and Murray Springs, are located in the upper San Pedro valley of southeastern Arizona (Faught and Freeman 1998:41). At the Murray Springs site, two Clovis points were found in association with an unbutchered mammoth. Apart from these sites, much of the evidence for a Clovis presence in Arizona is reflected in isolated occurrences of Clovis points (either whole or fragments). Clovis points are known from the St. Johns and Winslow areas, for example (Neily 1985:10), and from the San Pedro valley near Kartchner Caverns (Faught and Freeman 1998:44). In Tucson, a Clovis point was discovered in a disturbed context at the Valencia site (Doelle 1985:181). The Clovis complex was succeeded by the Folsom complex, which, like the Clovis, is typified by its distinctive projectile points. Folsom points, unlike Clovis points, have flutes that extend all the way from their proximal to distal ends and have pressure-flaked marginal edges. In Arizona, the only known Folsom points have been found in surface contexts on the Colorado Plateau and the mountain transition zone to the south of the Mogollon Rim (Faught and Freeman 1998:45).

The Early Archaic period (ca. 8500–6000 B.C.) is known in southern Arizona as the Sulphur Spring phase. This phase was originally defined by Sayles and Antevs in 1941 in the Sulphur Springs Valley in southeastern Arizona (Sayles and Antevs 1941). Problems with dating (a result of the work having taken place prior to the development of carbon-dating techniques) originally led Sayles to conclude that a Paleoindian tradition (typified by the exploitation of megafauna) coexisted here with a hunting-and-gathering tradition that exploited smaller game and various plant resources, as reflected in an artifact assemblage composed of flat milling stones, unifacial scrapers, and other lithic implements. This assessment turned out to be incorrect; however, a reexamination of the material from the Sulphur Springs Valley did establish a reliable beginning date for the Sulphur Spring phase. Even though they have now been dated with certainty, the sites investigated by Sayles did not include any artifacts (e.g., projectile points) that were stylistically distinctive and, therefore, temporally diagnostic.

In southern Arizona, there has been an overall lack of diagnostic projectile points recovered from Early Archaic sites that can be directly correlated in time with the Sulphur Spring phase. It is therefore difficult to date sites to this phase when other, more-direct methods of dating, such as radiocarbon dating, cannot be used (Huckell 1996:329). One exception to this lack of diagnostic artifacts at Sulphur Spring phase sites is Ventana Cave, where 17 stemmed Ventana-Amargosa points were recovered by Haury (1950) under the Red Sand deposit. The stratigraphic location of these points suggested they were manufactured and deposited sometime after 6700 B.C. Similar points have been reported from Archaic contexts in the northern Santa Rita Mountains, but again, no associated datable material was found in the same context as the points (Huckell 1996:330–331).

Middle Archaic Period (6000–2100 B.C.)

The Middle Archaic period, also known as the Chiricahua phase of the Cochise culture in the tripartite stage designation schema of Sayles and Antevs (1941) and Sayles (1945), is part of the broader cultural entity that archaeologists have conceptualized as the Archaic period. In terms of material culture, the Middle Archaic period is typified by the addition of shallow basin metates, mortars and pestles, various bifacial tools, and distinctive side-notched projectile points to the overall tool assemblage of the preceding Early Archaic period. Generally, the Middle Archaic period is viewed as a time when regional variations in this material culture across the Southwest became less pronounced. In particular, notched projectile points take on a general similarity of design over large geographic regions. Chiricahua points, for example, are similar in style and manufacturing technique to Pinto and San Jose points, which are found in other areas of Arizona (Slaughter 1992:70); it is thought that this uniformity of technology is related to the high degree of mobility that was presumably characteristic of populations living during this period. Similarly, concave-base Cortaro points, often associated with the succeeding Late Archaic–Early Agricultural period but that are also present in Middle Archaic contexts, are widely distributed across southern Arizona and have possible equivalents in southern New Mexico and California (Justice 2002:181–182).

In the Tucson Basin, surface Middle Archaic period sites are known from montane and bajada contexts, with the typical artifacts mentioned above in addition to fire-cracked rock and occasional rock cairn burials (Huckell 1995:3). Subsurface Middle Archaic remains are known from two sites in the Santa Cruz River valley—the Los Pozos (Gregory 1999) and Rillito Fan sites (Wallace 1996).

Late Archaic–Early Agricultural Period (2100 B.C.–A.D. 150)

As the name implies, the Late Archaic–Early Agricultural period in the Southwest is marked by the widespread adaptation of cultivated food resources. In this region, this period is also marked by the appearance of permanent or semipermanent domestic architecture; canal irrigation; and the first Mesoamerican cultivars, which arrived as early as the beginning of the second millennium B.C. (Huckell 1996:343), although maize may have arrived somewhat earlier. At the same time, the period is generally thought to be a time in which people continued a lifeway that remained relatively mobile with the objective of exploiting wild food resources; sites that reflect these activities continue to be categorized under the designation of Late Archaic (Huckell 1995). This period is thought to be one in which groups of people practicing a relatively mobile lifeway began, over a long span of time, to incorporate agricultural products as significant elements of their subsistence.

Work in the Southwest during the past two decades (particularly in the Santa Cruz River valley) has resulted in the discovery of numerous Late Archaic–Early Agricultural period sites and the establishment of a phase sequence for the period. The earliest phase (dated 2100–1500 B.C.) is presently unnamed and is defined by the first appearance of maize; pepo squash (*Cucurbita pepo*); storage pits; and large, circular pit structures. Fired sherds (perhaps from incipient vessels) and figurine fragments that date to about 2100 B.C. have been recovered in the Tucson Basin (Mabry 2007:7). The San Pedro phase (1500–800 B.C.) continued to include these attributes, with the addition of a hallmark of the phase, corner-notched San Pedro dart points and, in the San Pedro core area, Empire points (Mabry 2007:Figure 1.3). Cultivars added to the crop complex included cotton (*Gossypium* sp.) and possibly the common bean (*Phaseolus vulgaris*). Also appearing during the San Pedro phase were specialized storage structures with large, interior bell-shaped pits; oval and round house-in-pit type structures; a wider variety of functional extramural pits; flexed inhumations, often in cemeteries; stone and bone pipes; distinctive ceramic figurines; canid burials; refinements in ground stone technology; and, in the Santa Cruz River valley, canal-irrigated farming (Mabry 2007:7–9, 15–18). Large, communal-ritual pit structures (perhaps descendents of even larger pre–San Pedro types) were present during the San Pedro phase. The bow and arrow may also have appeared in the Southwest during this time.

The Cienega phase completes the Late Archaic–Early Agricultural period phase sequence. The Cienega phase was initially proposed by Huckell (1995) and is marked by the appearance of Cienega points, which are distinguished morphologically by deep, oblique corner-notching and flaring stems and were used as dart and possibly arrow points (Lorentzen 1998:150). The Cienega phase was also characterized by an emphasis on large, circular pit structures that often had cylindrical and, less frequently, bell-shaped subfloor pits (Huckell 1995); a more diverse ground stone artifact assemblage that included stone disks and well-made stone trays; and large, communal houses that may have developed from San Pedro phase predecessors.

Early Ceramic Period (A.D. 150–650)

In both the Tucson and Phoenix Basins, the Early Ceramic period appears to have developed out of the cultural matrix of the Late Archaic–Early Agricultural period; work in the Tucson area in particular has, over the past several years, yielded a large amount of data supporting this idea. Sites in the Tucson region where the Early Ceramic period has been studied extensively include the Houghton Road site (Ciolek-Torrello 1998) and several sites along the Santa Cruz River.

Two Early Ceramic phases have been proposed for the Tucson Basin: the Agua Caliente and the Tortolita. The Agua Caliente phase (A.D. 150–450) is marked by the appearance of plain ware vessels produced by the coil-and-scrape technique and represents the ceramic plain ware horizon in the Tucson Basin. Vessel forms across the Southwest at this time consisted predominately of neckless seed jars, which were well suited for storage purposes, and small hemispherical bowls. This phase was also characterized by an assemblage of milling stones, an expedient flaked stone industry accompanied by a remnant Archaic period bifacial tool technology, and domestic and communal pit houses (Whittlesey and Heckman 2000a:6). Flexed inhumations and small grinding equipment typical of the Late Archaic–Early Agricultural period continued into this phase (Ciolek-Torrello 1995:542). Architecture became more formal in design, with houses incorporating formal plastered hearths and clearly defined entryways. House shapes are generally rectangular, or in some cases kidney-bean shaped, with plastered pillars or post supports on either side of the house entryways. The communal structures are larger but share morphological attributes of the smaller houses and are strikingly similar to Mogollon communal structures, which eventually evolved into Great Kivas (Reid and Whittlesey 1997:143).

The Tortolita phase (A.D. 450–650) represents the red ware horizon in the Tucson Basin and corresponds approximately with the beginning of the Vahki phase (characterized by Vahki Red Ware) in the Phoenix Basin. Tortolita Red is hard slipped (usually, but not always, on both vessel surfaces) and is typically sand tempered (Bernard-Shaw 1990; Heidke 2003:148). An additional important change in ceramic manufacture during the Tortolita phase is the expansion of vessel forms from the Agua Caliente–type seed jar to a variety of vessel forms (including flared-rim forms) intended for cooking and serving (Heidke 2003:148). Tortolita phase settlements are larger with more formal patterning than previous Agua Caliente phase settlements, were increasingly dependent on maize, and a placed greater emphasis on sedentism. In the Santa Cruz River valley, Tortolita phase sites or sites with a Tortolita component have become relatively well documented and are currently more well known than Agua Caliente sites.

Pioneer Period (A.D. 650–750)

The Pioneer period in the Tucson Basin is not currently well understood. As mentioned earlier, the first phase of the Pioneer period, the Vahki phase of the Salt-Gila Basin, is equivalent to the Tortolita phase red ware horizon in the Tucson Basin. The remaining phases of the Salt-Gila sequence—Estrella, Sweetwater, and Snaketown—are marked by the appearance of decorated pottery. The Estrella phase pottery (Estrella Red-on-gray) is distinguished by painted, broadline designs in quartered layouts (typically within bowl interiors). It has been suggested that the appearance of this pottery tradition marks a broadline ceramic horizon, similar to the earlier plain and red ware horizons (Whittlesey and Heckman 2000a:8). Incised pottery also appeared during the Estrella phase (Whittlesey and Heckman 2000b:98).

In the Tucson Basin, red ware ceramics continued to be produced into the Cañada del Oro phase (Wallace et al. 1995:596), and the beginning of the broadline horizon appears to be more reflective of an addition of broadline decorated pottery to the existing plain and red ware ceramic complex. Broadline ceramics are not common in the Tucson Basin and appear to have been restricted to a relatively short span of time. Similar remarks apply to Sweetwater Red-on-gray and Snaketown Red-on-buff ceramics, which display fine-lined and increasingly elaborate designs.

It is during the final phase of the Pioneer period, the Snaketown phase, that distinctly Hohokam traits in material culture become evident in the Tucson Basin (in ceramic design and other technologies). The Snaketown phase, when true red-on-buff ceramics began to be produced, has been viewed by some archaeologists as being the actual beginning of what can be reliably defined as Hohokam, although others believe that Hohokam culture cannot be defined until the Colonial period, when hallmark traits such as ballcourts and a distinctive mortuary complex appeared (Wallace et al. 1995:576, 606).

The Pioneer period in the Tucson Basin, if accepted as being truly present at all, lasted approximately a century. It was characterized by a temporally limited appearance of the broadline horizon in the form of Estrella and Sweetwater Red-on-gray ceramics, with a similarly brief appearance of the Snaketown phase (at least in terms of ceramic tradition) as a precursor to the Cañada del Oro phase.

Colonial Period (A.D. 750–950)

The Tucson Basin Colonial period comprises two phases, the Cañada del Oro (A.D. 750–850) and the Rillito (A.D. 850–950). Several distinguishing cultural traits mark the advent of the Colonial period; some of these will be described briefly.

Canal irrigation had been widespread in the Salt-Gila Basin during the Snaketown phase and continued to expand there during the Colonial period. Ballcourts were spaced at an average of 5.5 km (3.4 miles) along the Phoenix canals, suggesting that ballcourts served to identify their villages as the centers of "irrigation communities" (Wilcox and Sternberg 1983). During the Colonial period, the Santa Cruz River was recovering from a period of entrenchment that had begun about 50 B.C. This resulted in an environment that was increasingly conducive to floodwater farming (Waters 1992:175). Settlement expanded in the Tucson Basin, with ballcourt villages being constructed in the Santa Cruz River valley at several sites. Ballcourts, primary indicators of Mesoamerican influence in the Southwest at this time (Wilcox and Sternberg 1983), likely served as focal points for regional socioeconomic interaction. The large communal houses that had been constructed at many sites from the Late Archaic–Early Agricultural period onward disappeared during the Colonial period. Village settlement was patterned on individual houses organized into house clusters (also termed courtyard groups) that were oriented around a central plaza—a pattern that was already evident during the Pioneer period. Ceramic design began incorporating zoomorphic and anthropomorphic imagery and micaceous temper, which has been interpreted as a result of cultural influence originating in the Salt-Gila Basin (Wallace et al. 1995:601, 605–607).

Cremation burial virtually replaced inhumation burial by the middle of the Colonial period (Wilcox 1991:270). Even though this trait is a defining characteristic of the Colonial period, it, like the courtyard group settlement pattern, had precedents in the Pioneer period (Crown 1991:145–146). Hohokam cremation burials typically included palettes, worked shell, and stone censors as mortuary offerings. The cremations were placed in discrete cemeteries that became components of the typical Hohokam village and are frequently associated with plazas and house groups and their accompanying trash mounds. Such cemeteries were apparently associated with the suprahouseholds represented by the house cluster–plaza–trash mound complexes (Wilcox 1991:256).

Sedentary Period (A.D. 950–1150)

The Sedentary period in the Tucson Basin is divided into three subphases: the Early, Middle, and Late Rincon. In the Salt-Gila Basin, it is composed of a single phase, the Sacaton. During the Early Rincon subphase (A.D. 950–1000), the settlements that had been established along major drainages during the Colonial period increased in size, and new settlements expanded along secondary drainages and into bajada environments, which allowed for a diversification of agricultural strategies (Crown 1991:149; Wellman and Lascaux 1999:24). Major habitation sites were established at regular intervals along waterways. Villages continued to resemble their Colonial predecessors with their ballcourts and plaza-oriented clusters of dwellings, but smaller settlement types (such as farmsteads) started to appear around the peripheries of larger villages. The construction of ballcourts, and the intricate trade network associated with them, reached its maximum extent during the Sedentary period (Doyel 1991b:247), although their construction decreased in the Tucson Basin.

In ceramics, design motifs took on increasingly geometric forms. Sedentary motifs were less carefully executed than the fine-line work of Colonial period ceramics. The distinctive Gila shoulder, which was formed by the sides of a vessel sloping downward sharply from the neck to create a low shoulder near the base, became a diagnostic marker of the Sedentary period. Red ware also began to be produced again (after having been abandoned around the end of the Cañada del Oro phase in Tucson). Mortuary practice continued to consist of cremation as the most common form of burial, but inhumations became more frequent after having been very uncommon or nonexistent during the Colonial period (Crown 1991:149–150). Copper bells, imported from western Mexico, first appeared during the Sedentary period, and shell etching was another innovation in material culture (Haury 1976:319).

Around A.D. 1000, at the beginning of the Middle Rincon subphase (A.D. 1000–1100), the Santa Cruz River again became entrenched. One result of this was a shift in settlement to the north and to the eastern region of the valley (Waters 1992:175–177). This in turn resulted in increasingly scattered settlements as villages became less riverine oriented, at least in this area of the Tucson Basin. In the eastern Tucson region, established villages continued to expand. By the Late Rincon subphase, the continued adaptation of farming strategies (such as *ak chin* and runoff diversion) to secondary drainages and bajadas had become widespread, with some of these niches being farmed for the first time. Environmental uncertainty may have served as the stimulus for non-floodwater farming. For example, there was an increased emphasis on the cultivation of agave on bajadas (Doyel 1991b:246; Whittlesey 2004:26–27).

During the final years of the Rincon phase, the ballcourt system began to decline, although ballcourts continued to be constructed into the Soho phase in the Phoenix region (Crown 1991:151–152). Formally constructed platform mounds—in contrast to caliche-capped trash mounds, which are known from the Snaketown phase—began to be constructed and eventually eclipsed ballcourts as the primary form of public architecture by about A.D. 1200 (Doyel 2000:308). This has been interpreted as a change in overall polity as the Hohokam regional system and its accompanying trade relationships collapsed, or at least were reorganized (Crown and Judge 1991:297). This change may likewise be reflected in the construction of single-room structures (possibly associated with rituals) on the mound summits and the incorporation of surrounding palisades and, later, adobe-walled compounds (Doyel 2000:305–307).

Classic Period (A.D. 1150–1450)

Southern Arizona societies experienced drastic changes during the Classic period—settlement patterns shifted and public and domestic architecture changed. In the Tucson Basin, these changes occurred in two broad phases, the Tanque Verde (A.D. 1150–1300) and the Tucson (A.D. 1300–1450). During the Tanque Verde phase, Tanque Verde Red-on-brown became common across southern Arizona, while in Phoenix the production of red-on-buff ceramics declined (Reid and Whittlesey 1997). Some researchers have suggested that the widespread appearance of Tanque Verde Red-on-brown reflects an increasing complexity in the configuration of Hohokam economic and social relationships (Slaughter and Roberts 1996:14). While pit house architecture continued, above-ground adobe or stone masonry structures, which were constructed within surrounding compound walls, became common. These structures were frequently freestanding, unlike multiroom pueblos commonly constructed elsewhere in the Southwest (Rice 2003:10).

In the Phoenix Basin, the platform mounds that appeared during the Soho phase were generally constructed at sites with extant ballcourts and were spaced along canals at 5 km (3.1 miles). The location of the mounds in relation to the canal system could suggest that the mounds marked the centers of irrigation communities during this period, much like the ballcourts did in the Colonial period (Crown 1991). In the Tucson Basin, ballcourt construction had ceased by the Classic period, but the Marana community flourished (Fish et al. 1992). The Marana community extended across the northern circumference of the Tucson Basin and consisted of numerous types of sites centered around a platform mound (the Marana Mound site) that had replaced the regional ballcourts as the focal point of social integration. The community also had extensive agricultural fields that were irrigated by both dry-farming techniques and canals. Agave (*Agave* spp.) was the principal crop grown in these fields, presumably expanding from agave cultivation within the bajada environments that began during the Rincon phase (Fish et al. 1992:21–24). Agave is more drought resistant than many of the other Hohokam cultivars, which would have made it a reliable food source during the drier climatic conditions that prevailed during the early Classic period (Masse 1991). A serious drought, sometimes called the Great Drought, occurred between A.D. 1276 and 1299 (Reid and Whittlesey 1999:17). The Great Drought had the effect of forcing people who lived in regions north of the Mogollon Rim to travel southward across and off the Colorado Plateau in search of food sources, because local agriculture had failed and could not support the population base. This resulted in an intercultural exchange between several cultural groups, including the Mogollon, Hohokam, Salado, and Paquimé cultures. Some Anasazi migrants from the Kayenta region arrived in southeastern Arizona as well, as reflected at Reeve Ruin in the San Pedro River valley (Whittlesey and Heckman 2000a:14).

During the Tucson phase, the cultural interaction that resulted from the drought became the impetus for further widespread social changes. Following the abandonment of many of the Tanque Verde phase sites, settlements aggregated into fewer (but larger) sites. This has been interpreted as a defensive tactic in the face of an increasing threat of warfare (Doelle and Wallace 1991:331). Freestanding adobe structures declined, and contiguous (sometimes multistoried) room blocks and stronger, more substantial walls became the structure of choice (Doyel 1991a:253). Great houses, notably at Casa Grande and Pueblo Grande, appear at this time. The great houses at both sites were constructed on platform mounds. Village settlements frequently consisted of multiple compounds, occasionally concentrically arranged around a central compound-mound (such as at Casa Grande and Los Muertos), similar to the older village plan of house clusters arranged around a central plaza, such as at Snaketown (Doyel 1991a:254–256).

After the beginning of the Tucson phase, evidence for the Salado culture appears in southeastern Arizona in the form of Roosevelt Red Ware ceramics, and it has been thought that the Salado superceded the Hohokam in the lower San Pedro River valley (in the region north of Benson) at about this time (Phillips et al. 1993). The culture known by archaeologists as "Salado" was initially formulated in the 1920s to describe and explain sites in the Tonto Basin and the upper Salt River that, on one hand, had a strong resemblance to Mogollon sites but at the same time possessed Hohokam traits, such as platform mounds (but, perhaps significantly, not ballcourts). Initially, it was thought that the Salado were pueblo-dwelling people migrating from the north and expanding into the Tonto Basin whose lifeways were imposed upon or adopted by the Hohokam people already living there. Archaeologists Florence Hawley and Harold Gladwin hypothesized that this migration originated from two areas: the upper Gila region and, later, from the Little Colorado area. Finally, Emil Haury presented a somewhat modified version of the migration model, concluding that the Salado peoples did not "invade" the Hohokam so much as coexist in the same geographical region (Reid and Whittlesey 1997:238–239). Eventually, the migration hypothesis fell into disfavor, and by the 1980s, most Southwestern archaeologists had come to believe that the Salado had developed "in place" from extant Hohokam populations, the result of increased "social complexity" rather than an influx of new people. Recent speculation on the Salado has led to a reconsideration of the migration model (Elson et al. 2000:175), resulting from the intense demographic movements during the Classic period.

Protohistoric Period (A.D. 1450–1540)

The Protohistoric period, the era between the end of the Classic period and the arrival of the Spanish missionaries, is an obscure period in the prehistory of the Southwest. This period is not well represented in the archaeological record, yet early Spanish explorers did encounter people who were wellestablished in some areas of the Southwest. The fundamental question pertaining to this era is, who were these Piman-speaking peoples, such as the Sobaipuri of the San Pedro Valley?

There are two potential answers to this question. One is that the Piman-speaking people living in southern Arizona were simply direct descendants of the Hohokam populations who had faced the social and economic changes that marked the end of the Classic period. The other is that after the decline of the Hohokam and Salado cultures, the Pimans moved into the area essentially as a new cultural entity, although they may have integrated with people who were already present—a possibility suggested by oral tradition (Teague 1993:444).

The possibility that Piman speakers were direct descendants of the Hohokam is suggested by the descriptive accounts of the Spanish as they moved northwest from central Mexico into what is now Sonora and Arizona. They found that the majority of people across this region practiced agriculture as a subsistence base. This subsistence strategy differed from those of the people in the surrounding regions of California and the Great Basin and the Athabaskan speakers in the northeast where hunting and foraging prevailed. Second, little or no political unity was noted by the Spanish beyond the level of individual and autonomous *rancherías*—a system of organization unlike that encountered by the Spanish in Aztec-dominated central Mexico. Finally, trade across the region, although sporadic and not regularized, was widespread and generally did not involve food and tools but emphasized luxury and ceremonial items instead (Spicer 1962:8–15). All of these traits might be expected to have been present at the time of European contact. Agriculture and trade had long been the norm, and the *rancherías* were perhaps the result of the social reorganization that occurred at the end of the Classic period.

In contrast, Teague (1993) suggests that both linguistics and Piman oral traditions support the idea that the Piman speakers the Spanish encountered had migrated into the region from elsewhere. Linguistically, there is a continuity between west-central Mexico and southern Arizona that likely existed prehistorically and was paralleled by some aspects of material culture, notably ballcourts (Kelley 1991). This continuity exists among people speaking variants of the Tepiman language group. The languages spoken by some of the people in Sonora and southern Arizona belong to the Piman people who were one of the members of the Tepiman group.

The oral traditions of the Piman people in southern Arizona are consistent with both the archaeological record and the linguistic model described above. These traditions focus on the conflict between Elder Brother, I'itoi, the cultural hero of the Tohono O'odham (who is known as Siuuhu among the Akimel O'odham), and the Sivanyi (or Siwani), a term which the Pimans applied, in different versions of their oral traditions, to either a specific priest (Saxton and Saxton 1973:147–168), or to the priesthood in general, of a rival group. The term Sivanyi may be related linguistically to Shiwanni, the Zuni directional rain priesthoods, with whom strong functional parallels can also be drawn (Teague 1993:439). The traditions state that warfare erupted between Sivanyi and I'itoi and his followers, whom (depending on the account) he either gathered together from among the O'odham people of northern Sonora, or who emerged from beneath the earth from a point south of Baboquivari. There are rather detailed accounts of the progression of the war against the Sivanyi and the eventual victory of I'itoi's warriors. Following the conflict and the disposal of the Sivanyi priesthood, the warriors dispersed. Some returned south to the Lower Piman homeland, and some went north to the pueblos, but some remained in the Gila Valley and intermarried into the local (Hohokam?) population, eventually becoming the Pimas Gileños (Teague 1993:444). From the foregoing, it appears plausible that these traditions telling of a rebellion against a priestly hegemony at the end of the Classic period echo events that also are reflected in the archaeological record.

The Spanish, then, likely entered a world that had undergone traumatic social and environmental changes just before their arrival. It was also during this time (around A.D. 1600) that groups of Athabaskan-speaking people (Apaches) began to migrate to the area from the north and east.

Historic Period (A.D. 1540–1950)

Spanish exploration of the Southwest began as early as 1539 with the preliminary scouting expedition of Fray Marcos de Niza, who had been sent to the region by Mexican viceroy Antonio de Mendoza in response to the accounts of Alvar Núñez Cabeza de Vaca and Estevan, who had wandered to Sonora after being shipwrecked in the Gulf of Mexico in 1528. After de Niza returned, Viceroy Mendoza proposed a larger expedition and selected Francisco Vásquez de Coronado as its leader. Coronado's party departed in 1540 in search of the fabled Seven Cities of Cibola. The route of the expedition probably took Coronado through what is now eastern Arizona, although at one time it was speculated that one stop on the journey, Chichilticale or Red House, was in fact the Hohokam adobe house at Casa Grande (Wilson 1999:25–26).

Jesuit missionary Eusebio Francisco Kino arrived in Sonora in 1681. After a poorly documented visit to the Casa Grande area in 1694, Kino made a second *entrada* into the area in 1697 (Wilson 1999:24). Setting out from the Nuestra Señora de Dolores mission, Kino traveled north along the San Pedro and then followed the Gila to the west, arriving again at Casa Grande on November 18. He was accompanied, in addition to some 20 soldiers and native guides, by Captain Juan Mateo Manje. Manje, unlike Kino, kept well-written journals of his travels. The chronicle of this expedition makes note of small groups of people living along the San Pedro, who were identified as the Sobaipuri (Doelle and Wallace 1990).

Owing to the efforts of Padre Kino, the missionizing of the people of the Pimería Alta continued into the early eighteenth century, although after Kino's death in 1711 the mission system in Sonora began to deteriorate, partly as a result of neglect while Spain was distracted by the War of Spanish Succession (Walker and Bufkin 1979:14). After the Pima revolted in 1751, the presido at Tubac was established. It was later relocated to Tucson near the end of 1775. The presidio was intended not only to provide stability for the Pima mission system but also to stem incursions by the Apache. The Apache had been raiding Piman settlements since shortly prior to the time of Kino's initial contact (Spicer 1962:234), and the escalation of raiding over time resulted in increasing resettlement of the Piman-speaking populace. Beginning around 1790, as a means of bringing raiding to a halt, the Apache were provided with rations and supplies by the Spanish government, an action that allowed for the expansion of ranching and stock raising in what would eventually become southern Arizona. This time of relative peace ended with the independence of Mexico from Spain in 1821, and with

Spanish support no longer available, ranching became unviable as the Apache once again began raiding activities (Morrisey 1950:151).

The period between Mexico's independence and 1846 (the year the Mexican-American War began) is when Euroamericans first began to establish a substantial presence in the middle Gila River region. During the war, the "Army of the West," under the command of Colonel Stephen Watts Kearny, was assembled for the conquest of the Southwest, or more precisely, California (Sheridan 1995:50–51). The expedition, led by Kearny and guided by Kit Carson, passed along the Gila River and made the first accurate cartographic record of the region, which would later establish the route for Americans crossing Arizona on their way to California during the Gold Rush of 1849.

The Treaty of Guadalupe-Hidalgo, signed in 1848 following the conclusion of the Mexican-American War, ceded the portion of what is now Arizona lying north of the Gila River to the United States. The boundary between New Mexico and Texas was established in 1850, at which time the entire region south of the 37th parallel, stretching from the new Texas-New Mexico border west to the eastern boundary of California, became the Territory of New Mexico. In 1854, the Gadsden Purchase expanded New Mexico Territory from the Gila south to the present-day Mexican border (Walker and Bufkin 1979:22). The Territory of Arizona was split off from the Territory of New Mexico in 1863. The railroad, which entered Arizona at Yuma in 1877 (Walker and Bufkin 1979:46), reached Tucson in 1880. Conflict between the Apache and the Euroamerican settlers continued until 1886, when Geronimo surrendered and peace was negotiated (Collins et al. 1993:32). With the end of open hostilities, settlers resumed their migration to the area with the aid of the railroad. Mining and cattle ranching, which had already become fairly well established in Arizona prior to the Civil War, became the Territory's main industries. Arizona attained statehood in 1912.

PREVIOUS RESEARCH

Prior to fieldwork a Class I archaeological records check was performed on the AZSITE on-line database. The purpose of this inquiry was to see if all or part of the current project area, or adjoining areas, had been surveyed previously, and what sort of archaeological resources were already known to exist in the area. Records pertaining to an area extending out 1 mile in all directions from the survey area were examined. In total, 21 previous surveys and 27 previously recorded sites were identified in AZSITE records within the specified radius. Previous surveys within a mile of the project area are listed in Table 1, and previously recorded sites within the same radius are listed in Table 2. Locations of previous surveys and previously recorded sites are shown in Figure 2.

In addition to the AZSITE inquiry, U.S. General Land Office (GLO) maps and old USGS topographic maps (all viewable online) were inspected, to see if any features not documented in AZSITE, but which might potentially constitute historical resources, were documented in these sources. Once again, an area extending out a mile from the survey area was inspected for such resources. A GLO map covering Township 15 South, Range 15 East, filed on February 23, 1897 (Map No. 2119; Surveyor General's Office 1897; Figure 3) shows a "Road from Tucson to Rincon" passing through the project area. This road also appears on the 1905 USGS Tucson, Arizona 30-minute quadrangle map (U.S. Geological Survey 1905; Figure 4). Several dirt trails/paths following the same general orientation were noted in this area during the current survey. The most substantial of these—one which was used as an access road during the current survey—appears on the 1948 USGS Tucson, Arizona 15-minute topographic quadrangle map (U.S. Geological Survey 1948;

Figure 5) as an unnamed, maintained through-road, running from Wilmot Road eastward, and is labeled as Kinnison Road on later maps. Because this road appears to have once been a transportation corridor of some significance, we have recorded a half-mile stretch within the current project area as a site, AZ BB:13:818(ASM). A second road that appears on the 1948 USGS map corresponds to a dirt road that is still identifiable; however, because this appears to be a trail of much lesser significance, never having served as an arterial road of any magnitude, we have not assigned a site number to this second road.

Two other roads appear on the 1897 GLO map within a mile of the project area, and a second GLO map, covering Township 14 South, Range 15 East (Map No. 2052, filed 11-23-1899; see Figure 3), shows a "Road to Tucson" running northwest to southeast along the south bank of Pantano Wash, passing within a mile of the current project area. Because none of these roads actually encroaches on the current project area they have not been considered for recording at this time.

Table 1. Previously Conducted Surveys within a 1-mile Radius of the Project Area

Project No.	Project Name	Recording Institution	Report Reference
1973-20.ASM	TG&E 138 kV Transmission Line Survey, Vail to Houghton Loop	Arizona State Museum	Clonts 1973
1978-2.ASM	Commercial Lease	Arizona State Museum	not given
1980-151.ASM	Pima County Land Exchange	Arizona State Museum	Hartmann 1981
1980-160.ASM	Rincon Ranch	Arizona State Museum	not given
1980-86.ASM	Motorola Inc., Houghton Road Exchange	Arizona State Museum	not given
1981-18.ASM	Gilberts Rodeo Production	Arizona State Museum	not given
1982-88.ASM	McCann Valley Rock and Sand Company Survey	Arizona State Museum	not given
1983-42.ASM	Mr Campbell Access	Arizona State Museum	Madsen 1983
1983-91.ASM	Arizona Motor Speedway	Arizona State Museum	Lange 1983
1984-157.ASM	Mountain Bell so521	Arizona State Museum	not given
1984-172.ASM	Irvington Mobile Homes	Arizona State Museum	not given
1985-192.ASM	Camino Seco-Irvington Road	P.A.S.T	Stephen 1985
1985-63.ASM	Pima County Houghton Road Pit	Arizona State Museum	not given
1985-68.ASM	State Land Survey	Arizona State Museum	not given
1985-80.ASM	Harrison Hills Mobile Home Park Sewer Easements Survey	Arizona State Museum	Brew 1985
1987-230.ASM	Davis-Monthan AFB Survey and Data Recovery	Statistical Research	Altschul and Lindsay 1993
1987-258.ASM	Houghton Hills Survey	Pima Community College	Douglas 1987
1988-120.ASM	Landfill and Complex	Arizona State Museum	Madsen 1988
1989-107.ASM	Rillito Creek Recharge Project	Bureau of Reclamation-Phoenix Office	Laush 1989

Project No.	Project Name	Recording Institution	Report Reference
1996-106.ASM	Houghton/Valencia and Irvington/Alvernon Way Survey	Desert Archaeology	Eppley 1996
1997-106.ASM	Cirvano Reclaimed Main Survey	Desert Archaeology.	Eppley 1997
1999-224.ASM	Irvington Landfill Park Survey	Desert Archaeology	Eppley 1999
2000-310.ASM	Civano-Phase 2, 310-Acre Survey	Old Pueblo Archaeology Center	Jones 2000
2003-1444.ASM	Houghton-Irvington Signal Survey	Desert Archaeology	Diehl 2003
2003-1533.ASM/ 3T0-133	Houghton/Irvington	Tierra Right of Way Services	Levstik 2003
2003-910.ASM	Cultural Resources Survey of the 360Networks Fiber Optics	TRCMA	Railey et al. 2001
2005-847.ASM	Irvington Road Transmission Line Installation	Harris Environmental Group	Twilling 2005
2006-1012.ASM	Houghton: Irvington to Valencia Survey	Desert Archaeology	Cook 2006
2007-41.ASM	na	na	na
2007-163.ASM	Houghton/Old Spanish Trail to Valencia Survey	Tierra Right of Way Services	Hushour 2007

Table 2. Previously Recorded Sites within a 1-mile Radius of the Project Area

Site No.	Description	Temporal Placement	NRHP Eligibility
AZ BB:13:112(ASM)	lithic scatter	Archaic (8000 BC-AD 200)	not evaluated
AZ BB:13:326(ASM)	Diamondback Lime Kiln Site--Spanish-period lime kiln w. associated artifacts	historic (AD 1550-1950)	not evaluated
AZ BB:13:340(ASM)	roasting pit	unknown Native American	not considered eligible by recorder
AZ BB:13:341(ASM)	2 roasting pits with artifact scatter	ceramic AD200-1500	not evaluated
AZ BB:13:342(ASM)	roasting pit	prehistoric 12000BC-AD1500	not evaluated
AZ BB:13:343(ASM)	lithic scatter	ceramic AD200-1500; prehistoric 12000BC-AD1500	not evaluated
AZ BB:13:344(ASM)	roasting pit	unknown	not evaluated
AZ BB:13:345(ASM)	lithic scatter	ceramic AD200-1500	not evaluated
AZ BB:13:346(ASM)	lithic scatter	ceramic AD200-1500	not evaluated
AZ BB:13:347(ASM)	house and rock feature	historic (AD 1550-1950)	not evaluated
AZ BB:13:348(ASM)	roasting pit	ceramic AD200-1500	not evaluated
AZ BB:13:349(ASM)	roasting pit	prehistoric 12000BC-AD1500	not evaluated
AZ BB:13:367(ASM)	artifact scatter	late archaic 1500BC-AD200	determined eligible by SHPO

Site No.	Description	Temporal Placement	NRHP Eligibility
AZ BB:13:368(ASM)	artifact scatter	Hohokam Pre-Classic Period AZ 450-AD1100; Hohokam Sedentary Period AD950-AD1100; prehistoric 12000BC-AD1500	determined eligible by SHPO
AZ BB:13:369(ASM)	roasting pits and artifact scatter	prehistoric 12000BC-AD1500	determined eligible by SHPO
AZ BB:13:370(ASM)	roasting pit	prehistoric 12000BC-AD1500	determined eligible by SHPO
AZ BB:13:371(ASM)	roasting pit	prehistoric 12000BC-AD1500	not evaluated
AZ BB:13:372(ASM)	roasting pit	prehistoric 12000BC-AD1500	not considered eligible by SHPO
AZ BB:13:373(ASM)	roasting pit	prehistoric 12000BC-AD1500	not evaluated
AZ BB:13:374(ASM)	roasting pit	prehistoric 12000BC-AD1500	not evaluated
AZ BB:13:375(ASM)	roasting pit	prehistoric 12000BC-AD1500	not evaluated
AZ BB:13:378(ASM)	roasting pit	prehistoric 12000BC-AD1500	not evaluated
AZ BB:13:379(ASM)	roasting pit	prehistoric 12000BC-AD1500	not evaluated
AZ BB:13:380(ASM)	roasting pit	prehistoric 12000BC-AD1500	determined eligible by SHPO
AZ BB:13:381(ASM)	roasting pit	prehistoric 12000BC-AD1500	determined eligible by SHPO
AZ BB:13:392(ASM)	artifact scatter with rockpile	ceramic AD200-1500	not evaluated
AZ BB:13:662(ASM)	lithic procurement site	ceramic AD200-1500; prehistoric 12000BC-AD1500	determined eligible by SHPO

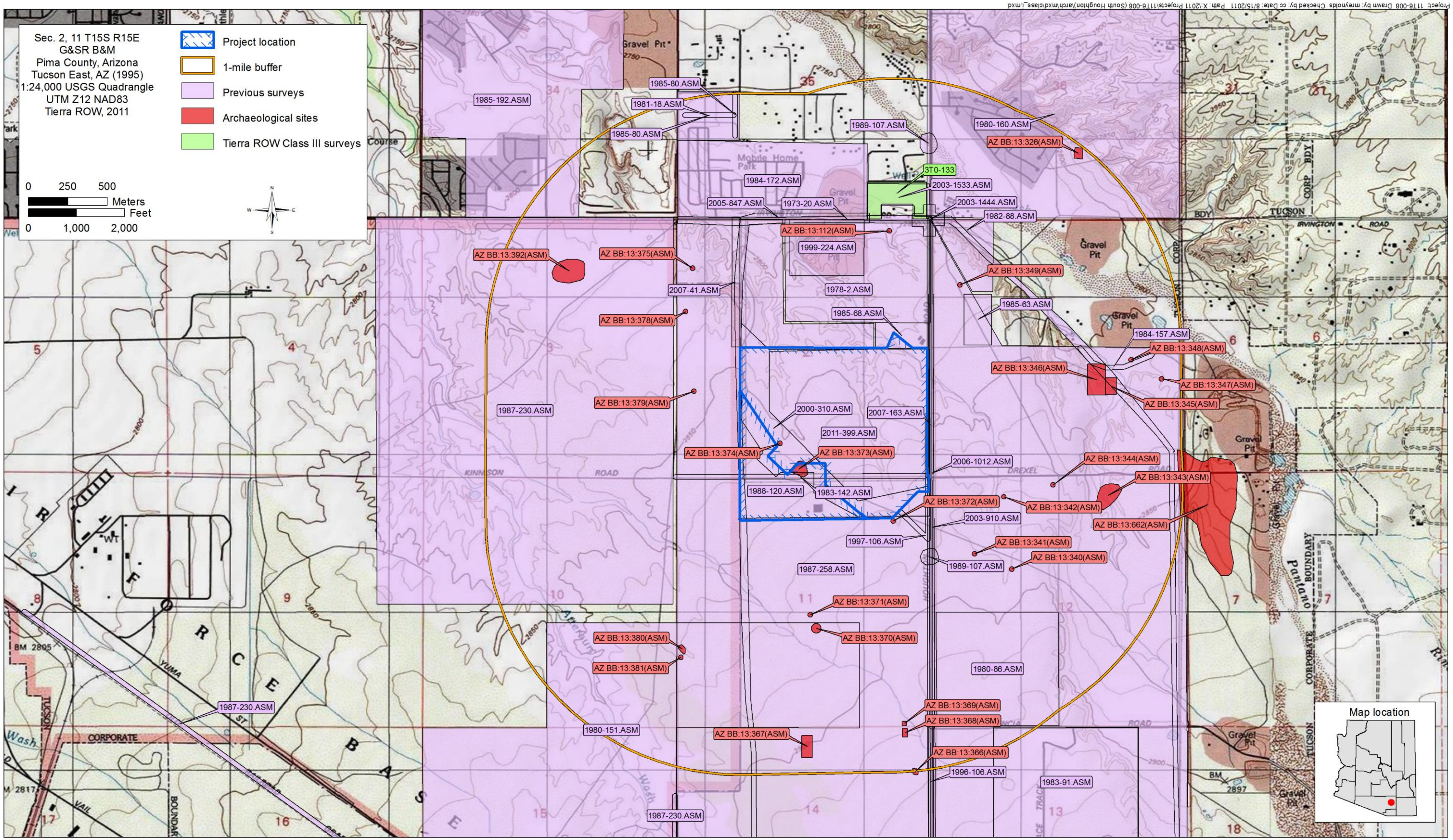

Figure 2. Previously recorded surveys and sites within a one-mile radius of the project area.

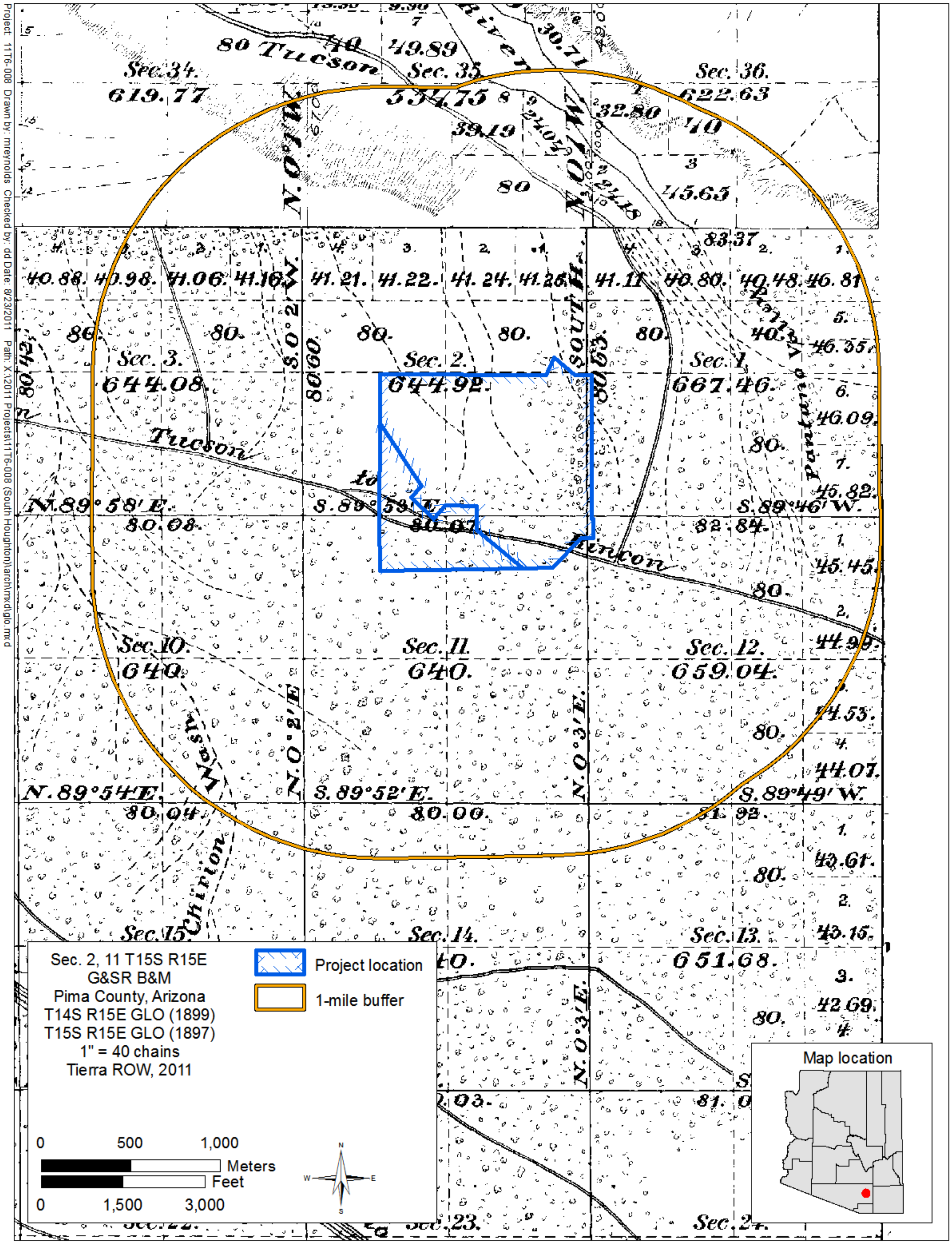

Figure 3. Map compiled from 1897 and 1899 Government Land Office (GLO) maps showing road recorded as AZ BB:13:818(ASM).

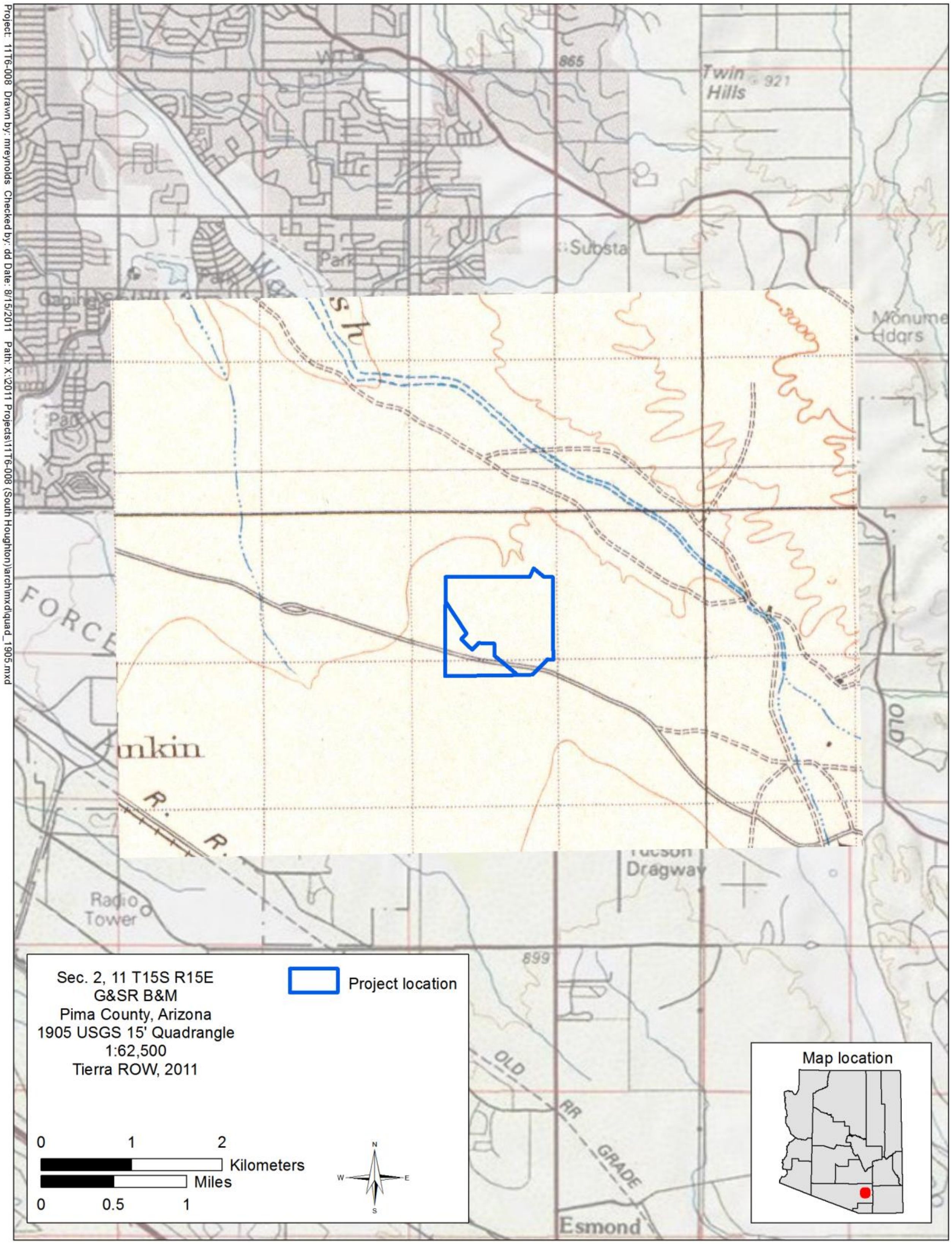

Figure 4. 1905 USGS Tucson, Arizona 30-minute quadrangle map showing road recorded as BB:13:818(ASM).

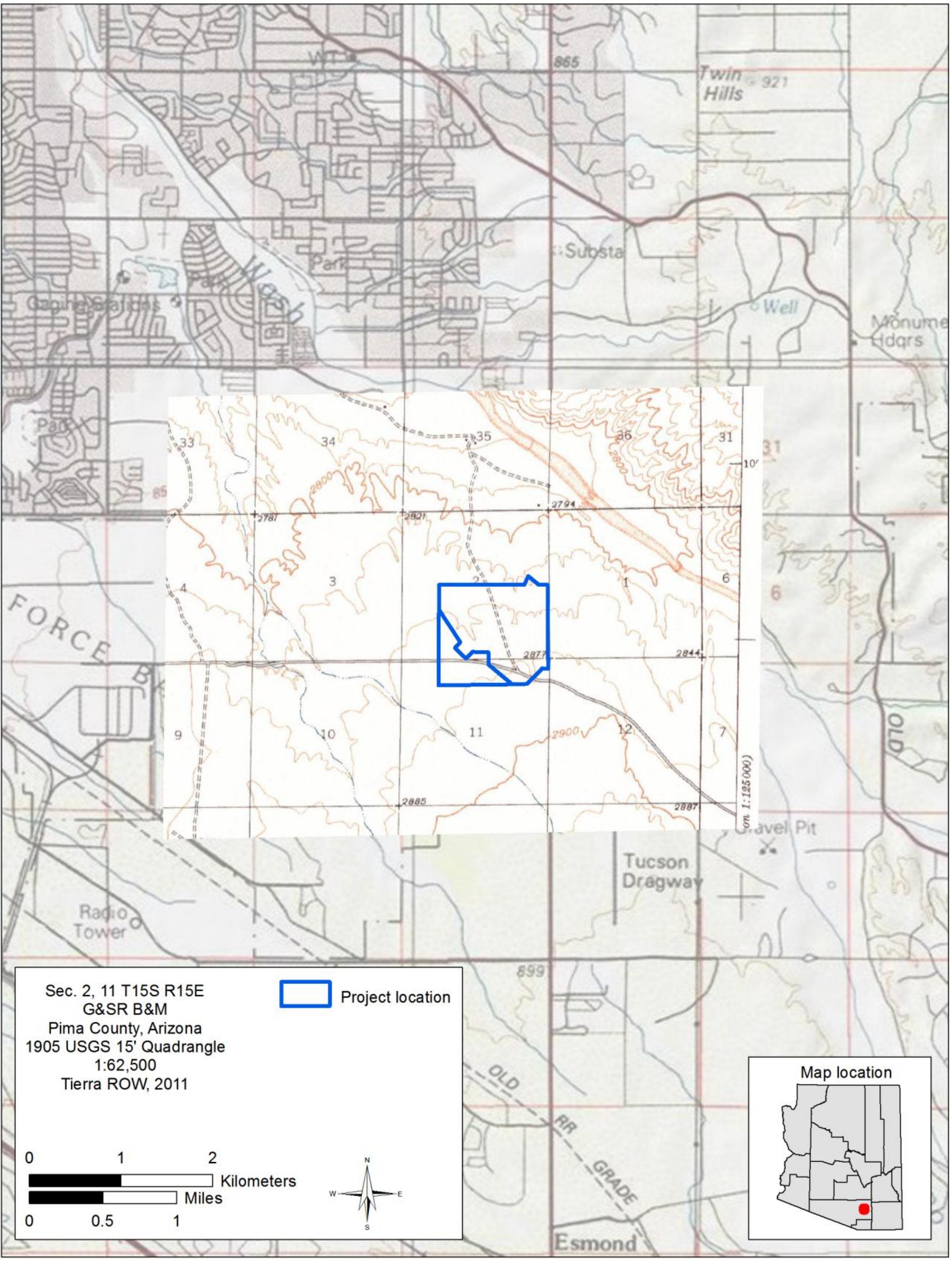

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Figure 5. 1948 USGS Tucson, Arizona 15-minute quadrangle map showing road recorded as BB:13:818(ASM).

RESEARCH FOCUS

Given that the tract under consideration was fully surveyed in the 1980s, with nothing other than a handful of isolated roasting pits being found, the current survey offered few opportunities to address, in any meaningful way, significant research questions. The only research questions we were able to address concerned the distribution of features across the landscape:

Are any of the features identified within the parcels in the 1980s—all of which were found eroding out of wash faces—still identifiable in the field? How significant an effect has two decades of erosion had on these features? And, if previously identified features have disappeared due to erosion, have previously unknown features been revealed in their place?

These questions were addressed in the field in the normal course of survey, by searching for the previously recorded sites and seeing if additional sites not visible in the 1980s were visible today.

SURVEY METHODS

The survey was conducted in accordance with standards established by ASM for pedestrian surveys of state-administered lands. According to these standards, 100 percent coverage of an area can be claimed if the entire area is surveyed by crews walking transects spaced no more than 20 meters (66 ft) apart. The current survey was done in compliance with this standard by a crew of three archaeologists walking parallel transects across the project area.

Cultural properties identified during survey were evaluated against standards established by ASM for determining the significance of properties. Briefly, under these standards a property may be of interest if it is at least 50 years of age. If, in addition, it contains either 30 or more artifacts of a single class (i.e., potsherds, or ground stone fragments, or fragments of historic glass); or 20 or more artifacts, when more than a single class of artifact is present; or a single fixed feature (i.e., a cobble foundation, or a historic road), with any number of artifacts in association; or more than one fixed feature, with or without associated artifacts, then the property must be recorded as an archaeological *site*. A property of appropriate age that does not meet with any of the above-cited additional criteria may be recorded as a lesser class of property, an *isolated occurrence* (IO), although, should the archaeologist believe that, for whatever reason, such a property is of greater significance than the IO designation would imply, he or she may, at his or her discretion, record such a property as a site anyway. A site is recorded in greater detail than an isolated occurrence; recording a site generally involves setting a permanent datum in the ground, recording the position of the datum with the help of a hand-held Global Positioning System (GPS) unit, preparing a detailed plan map, taking photographs, and making a full or partial inventory of artifacts and features, whereas recording an IO generally involves merely logging a description of the finding and its location (obtained with a GPS unit) in a table.

As part of the recording process, the significance of each cultural property encountered during the survey was evaluated. Significance is assessed in terms of a property's potential eligibility for inclusion on the National Register of Historic Places (NRHP). The criteria for determining the significance of a cultural resource are defined in Title 36, Part 60, of the Code of Federal Regulations, which explains:

> The National Register's standards for evaluating the significance of properties were developed to recognize the accomplishments of all peoples who have made a significant contribution to our country's history and heritage. The criteria are designed to guide State and local governments, Federal agencies, and others in evaluating potential entries in the National Register. . .
>
> The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and
>
> **A.** That are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> **B.** That are associated with the lives of persons significant in our past; or
>
> **C.** That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> **D.** That have yielded or may be likely to yield, information important in prehistory or history (National Park Service 1997:2).

In other words, a site's significance is dependent on its *integrity*—its retention of its essential form and construction, and its continued presence in the setting it was intended to occupy—and on its *cultural significance*, whether readily apparent or hidden in its potential to yield information. Note that a property recorded as an IO is generally considered not to have the potential to be eligible for inclusion on the National Register of Historic Places (NRHP), simply because, if such a property is considered to have great enough significance to warrant NRHP inclusion, it can be judgmentally recorded as a site rather than an IO.

SURVEY RESULTS

During our Class I research three previously recorded archaeological sites, each consisting of a single roasting pit with small numbers of associated artifacts, were identified as lying within the current survey area. None of these sites was relocated during the current survey. However, one previously unrecorded property was recorded as a site during our survey, along with six isolated occurrences. The IOs are listed in Table 3 and their locations are shown in Figure 1. A description of the newly recorded site follows Table 3.

Table 3. Isolated Occurrences Identified during Current Survey

IO No.	East	North	Description
IO-1	520549	3556883	1 sand-tempered buff ware sherd
IO-2	520831	3556531	1 basalt secondary flake, possibly utilized
IO-3	520493	3556612	historic cluster: Best Foods mayonnaise jar (ca. 32-oz), 2 hole-top cans
IO-4	520369	3556576	1 sand-tempered plain ware sherd
IO-5	520401	3556385	1 quartzite secondary flake
IO-6	520568	3556936	1 sand-tempered plain ware sherd

AZ BB:13:818(ASM)

AZ BB:13:818(ASM) is a more-or-less in-use, 3,000-foot-long segment of road . Currently the road is merely a drivable dirt trail approximately 12 feet wide that runs in a west-northwest/east-southeasterly direction, from approximately the centerpoint of the southern boundary line between Sections 2 and 11 southeast to a point at the western edge of the ROW for Houghton Road, about 150 feet south of the southern boundary of the current survey area (see Figure 1). This stretch has been singled out as a site because it is apparently the last surviving stretch of a road that appears on an 1897 GLO map and a 1905 USGS map as the principal artery linking Tucson with the Rincon Valley. While the correspondence between what is visible in the field and what appears on the GLO map is not exact, the match between the existing road alignment and what appears on the 1905 map is more precise. By the time of the 1948 USGS 15-minute quadrangle covering this area, much of this road had been superseded by a road that ran from Wilmot Road eastward, following east-west section lines (including the line between Sections 2 and 11) over most of its length. While the name does not appear on the USGS map, Pima County Road Proceedings documents indicate that this replacement road was known as Kinnison Road, and was established as a 60-foot-wide ROW sometime between 1922 and 1925. While Kinnison Road apparently, at least legally, followed the section line all the way across the Section 2/11 boundary, according to the 1948 map, over the eastern half of this interval, the diagonal stretch under consideration here was being used as part of Kinnison Road instead. Most of Kinnison Road was abandoned in the late 1940s, when areas west of the current project area along the road were incorporated into Davis-Monthan Air Force Base as part of a major expansion project. Currently the road lies almost entirely within a fenced-off area administered by Tucson Water, but it remains drivable, and is apparently used by Tucson Water personnel for access to facilities, and as part of the trail network associated with the Fantasy Island bike recreation area.

Because of the nature of this site—a dirt trail that is not visible on the location map and with no significant features—we have not prepared a separate site map for this property. A photo facing westward up the length of the road has been included as Figure 6.

SUMMARY AND RECOMMENDATIONS

One previously undocumented site, AZ BB:13:818(ASM), was recorded during the current survey. This site is a fragment of a historic road which once linked the Rincon Valley with Tucson. We believe that the short (3,000-foot-long) fragment that survives within the current project area lacks the integrity required for a property to be considered NRHP-eligible. We therefore recommend that AZ BB:13:818(ASM) be determined ineligible for NRHP inclusion, and that no further archaeological work be required in connection with the property.

Two additional archaeological sites, AZ BB:13:373(ASM) and AZ BB:13:374(ASM), had previously been identified within the boundaries of the current project area, while a third site, AZ BB:13:372(ASM), was plotted as lying on the southern boundary line, apparently outside the project area, but not clearly so. Each of these three sites consisted of a single roasting pit on the edge of an ephemeral drainage, with small numbers of associated artifacts. None of the three sites was reidentified in the field, in spite of dedicated searches of the areas in which they had been plotted. We believe it likely that erosional activity along these washes has obliterated any recognizable trace

Figure 6. Photo of AZ BB:13:818(ASM), facing west-northwest up length of right-of-way from Houghton Road.

of these roasting pits. The NRHP status of the three sites had not been assessed in the wake of the survey that originally recorded them (Douglas 1987). Based on the fact that we could not relocate the sites we are recommending that AZ BB:13:373(ASM) and AZ BB:13:374(ASM) be determined ineligible for NRHP inclusion at this time, and that no further archaeological work should be required in connection with either of these sites. As for AZ BB:13:372(ASM), while we are convinced that no part of this site lies within the current project area, because it might lie outside we cannot make a recommendation regarding the NRHP status of this site. We can, however, recommend that no further work be required at this site in connection with the current undertaking.

The client and all subcontractors are reminded that, in accordance with §41-844 of the Arizona Revised Statutes, the person supervising any survey, excavation, construction, or like activity on lands administered by the State of Arizona or any of its administrative subdivisions (i.e., counties or municipalities) is required, upon incidentally encountering cultural deposits more than 50 years old, to halt all work on the undertaking and immediately notify the Director of the Arizona State Museum of the finding, so that a consultation process can be initiated and an appropriate course of treatment decided upon. Work in the area is not to resume until authorization is received from the Director.

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APPENDIX G: CONCEPTUAL VISUALIZATION OF THE PAD DISTRICT

Appendix G

Conceptual Rendering of the PAD District

*Artist's Rendering - Birdseye View from the South Looking Northwest

APPENDIX H: PREFERRED PLANT LIST

Trees

Acacia spp	Acacia Species
Acacia farnesiana	Sweet Acacia
Celtis reticulata	Netleaf Hackberry
Cercidium hybrid “Desert Museum”	Desert Museum Palo Verde
Cercidium microphyllum	Littleleaf or Foothill Palo Verde
Cercidium praecox	Palo Brea
Chilopsis linearis	Desert Willow
Olneya tesota	Ironwood
Pithecellobium flexicaule	Texas Ebony
Prosopis (So. Am. hybrid)	Thornless Mesquite (So. Am. hybrid)
Prosopis juliflora grandulosa	Honey Mesquite
Prosopis velutina	Velvet Mesquite
Sophora secundiflora	Texas Mountain Laurel

Shrubs

Atriplex spp	Atriplex species
Buddleja marrubiifolia	Wooly Butterfly Bush
Caesalpinia gilliesii	Yellow Bird of Paradise
Calliandra spp	Fairy Duster
Dalea frutescens	Black Dalea
Dalea pulchra	Indigo Bush
Dasylirion wheeleri	Desert Spoon
Encelia farinosa	Brittle Bush
Ericameria laricifolia	Turpentine Bush
Hesperaloe parviflora	Red Yucca
Justicia sp	Justicia Species
Leucophyllum spp	Texas Ranger Species
Larrea tridentata.	Creosote
Penstemon spp	Penstemon Species
Ruellia californica	California Ruellia
Ruellia peninsularis	Desert Ruellia
Salvia spp.	Sage Species
Salvia chamaedryoides	Blue Sage
Salvia clevelandii	Chaparrel Sage
Salvia columbariae	Chia
Salvia greggii	Autumn Sage
Salvia spp.	Salvia Species
Senna covesii	Desert Senna
Senna wislizenii	Cassia
Simmondsia chinensis	Jojoba
Yucca schottii	Mountain Yucca
Zinnia acerosa	Desert Zinnia
Zinnia grandiflora	Rocky Mountain Zinnia

Accents

Agave spp.	Agave Species
Agave americana	Century Plant
Agave desmettiana	Smooth Agave
Agave filifera	Thread Leaf Agave
Agave geminiflora	Twin-flowered Agave
Agave lophantha (univittata)	Thorn-crested Agave
Agave macroacantha	Black-spined Agave
Agave ocahui	Ocahui Agave
Agave palmeri	Palmer Agave
Agave parryi v. truncate	Artichoke Agave
Agave vilmoriniana	Octopus Agave
Agave weberi	Weber's Agave
Aloe barbadensis	Aloe Vera
Aloe x 'blue elf'	Blue Elf Aloe
Asclepias subulata	Desert Milkweed
Baileya multiradiata	Desert Marigold
Carnegiea gigantea	Saguaro
Chamaerops humilis	Mediterranean Fan Palm
Cyperus alternifolius	Umbrella Plant
Dasylirion acrotriche	Green Desert Spoon
Echinocactus grusonii	Golden Barrel
Echinocereus engelmanni	Strawberry Hedgehog Cactus
Euphorbia antisyphilitica	Candellia
Euphorbia rigida	Gopher Plant
Feijoa sellowiana	Pineapple Guava
Ferocactus spp.	Barrel Cactus
Ferocactus wislizeni	Fish-hook Barrel Cactus
Fouquieria splendens	Ocotillo
Hesperaloe funifera	Giant Hesperaloe
Hibiscus coulteri	Yellow Hibiscus
Opuntia bigelovii	Teddy-bear Cholla
Opuntia santa-rita Tubac	Santa-Rita Prickly Pear
Passiflora foetida	Passion Flower
Stenocereus thurberi	Organ Pipe Cactus
Tagetes lemmoni	Mountain Marigold
Tecomaria cap	Cape Honeysuckle
Psilostrophe cooperi	Paper Flower
Yucca aloifolia	Spanish Bayonet Yucca
Yucca baccata	Banana Yucca
Yucca brevifolia	Joshua Tree
Yucca carnerosana	Giant Dagger Yucca
Yucca elata	Soaptree Yucca

Groundcover

Calylophus hartwegii	Calylophus
Chrysactinia mexicana	Damianita Daisy
Dalea greggii	Trailing Dalea
Dalea capitata	Golden Dalea
Melampodium leucanthum	Blackfoot Daisy
Malephoria lutea	Rocky Point Ice Plant
Muhlenbergia rigens	Deer Grass
Nassella tenuissima	Mexican Feather Grass

Vines

Macfadyena unguis-cati	Cat Claw Vine
Merremia aurea	Yellow Morning Glory
Antigonon leptopus	Queen's Wreath
Campsis radicans	Common Trumpet Creeper
Cissus trifoliata	Desert Grape Ivy
Mascagnia lilacina	Lavender Orchid Vine
Mascagnia macroptera	Yellow Orchid Vine

Prohibited Plants

Acacia stenophylla	Pencilleaf Acacia
Baccharis sarothroides (male plants only)	Desert Broom
Baccharis sarothroides "Centennial"	Centennial
Eucalyptus camaldulensis	Red River Gum
Eucalyptus campaspe	Silver Gimlet
Eucalyptus formanii	Eucalyptus
Eucalyptus leucoxylon (rosea)	White Iron Bark
Eucalyptus microtheca	Tiny Capsule Eucalyptus
Eucalyptus polyanthemos	Silver Dollar Gum
Eucalyptus rudis	Desert Gum
Eucalyptus spathulata	Swamp Mallee
Euphorbia antisyphilitica	Candelilla
Juniperus chinensis	Juniper (many cultivars)
Juniperus deppeana	Alligator Bark Juniper
Juniperus sabina	Sabine Juniper
Parkinsonia aculeata	Mexican Palo Verde
Phoenix canariensis	Canary Island Date Palm
Phoenix dactylifera	Date Palm
Pinus edulis	Pinon Nut Pine
Pinus eldarica	Afghan Pine
Pinus halepensis	Aleppo Pine
Pinus monophylla	Singleleaf Pinon Pine
Pinus pinea	Italian Stone Pine
Pinus roxburghii	Chir Pine
Pistacia atlantica	Mt. Atlas Pistache
Schinus molle	California Pepper Tree
Tamarix aphylla	Athel Tree, Tamarisk
Zizyphus jujuba	Chinese Date

APPENDIX I: TRAFFIC IMPACT ANALYSIS (TIA)

SOUTHWEST TRAFFIC
ENGINEERING, LLC

TRAFFIC IMPACT ANALYSIS

SAGUARO TRAILS

DREXEL ROAD/HOUGHTON ROAD

13 JUNE 2016

Registered Professional Engineer (Civil)
CERTIFICATE NO.
32339
ANDREW R.
SMIGIELSKI
Date Signed..13-5-16
ARIZONA, U.S.A.

Expires 3-31-19

PREPARED FOR
MATTAMY HOMES
6640 NORTH ORACLE ROAD, SUITE 110
TUCSON, ARIZONA 85704

SOUTHWEST TRAFFIC ENGINEERING, LLC
3838 NORTH CENTRAL AVENUE, SUITE 1810
PHOENIX, AZ 85012
T 602.266.SWTE (7983) F 602.266.1115

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Prepared By;
Andrew Smigielski, PE, PTOE, PTP
Scott Tezak, EIT
Matt Reeg, EIT

TRAFFIC IMPACT ANALYSIS
SAGUARO TRAILS
DREXEL ROAD/HOUGHTON ROAD

Executive Summary

The purpose of this traffic study is to evaluate the current and future transportation system within the project study area surrounding the site without and with the proposed Saguaro Trails development. Analysis included the traffic operations at five existing intersections as well as seven new proposed site access points.

Existing and Future Traffic Data Without Project

In order to form a basis for analysis of the project impacts, weekday AM and PM peak hour turning movement counts were conducted at five existing intersections within the study area.

All movements at the existing study intersections currently operate at an adequate LOS and are expected to continue to do so in 2017 and 2022 without traffic from the project.

However, the southbound left turn at the intersection of Seven Generations Way/Houghton Road is on the cusp of an inadequate LOS E during the weekday AM/PM peak hour in 2022, without the project. With the high existing southbound left turn volumes that occur during the weekday AM/PM peak hour, and the large northbound through volume on Houghton Road the intersection is expected to breakdown in future years, without the proposed project as growth in the area continues.

Future Traffic Data With Project

The southbound left turn movement at the intersection of Seven Generations Way/Houghton Road and the eastbound left turn movement at the intersection of North Access/Houghton Road are anticipated to operate at an inadequate LOS during the weekday AM/ PM peak hours of 2017 and 2022, with traffic from the project. These delays are due to the large amount of northbound and southbound traffic on Houghton Road, leaving an insufficient number of gaps for vehicles turning to/from the minor street approaches.

The remaining study intersections are anticipated to operate at an adequate LOS in 2017 and 2022, with traffic from the project.

Turn Lane Analysis

The results of the turn lane analysis show that based on the 2022 weekday PM peak hour traffic volumes with the project, a new southbound right turn lane is warranted at the intersections of North Access/Houghton Road and South Access/Houghton Road.

A new northbound left turn lane is also warranted at the intersection North Access/Houghton Road.

The southbound right turn movements at the intersections of North Access/Houghton Road and South Access/Houghton Road require a minimum 50 feet of storage, while the northbound left turn movement at the intersection of North Access/Houghton Road requires a minimum of 25 feet of storage.

Mitigation

The southbound left turn movement at the intersection of Seven Generations Way/Houghton Road is predicted to experience an inadequate LOS E and F during the weekday AM/PM peak hours of 2017 and 2022, with traffic from the proposed project.

It is important to note that the southbound left turn at this intersection is on the cusp of an inadequate LOS E during the weekday AM and PM peak hour in 2022, without the project. With the existing 156 southbound left turns onto Seven Generations Way during the PM peak hour, and the large northbound through volume on Houghton Road, the intersection is expected to breakdown in future years, without the proposed project as growth in the area continues.

While the installation of a traffic signal may improve LOS for the minor movements, this intersection is located less than one mile between the adjacent signalized intersections of Drexel Road/Houghton Road and Irvington Road/Houghton Road and is considered an inappropriate location for a traffic signal based on the recommendations from the *Houghton Road 22nd Street to Valencia Road Traffic Engineering Report* dated July 2008 (Houghton Road Study) and completed by Psomas. In addition the results of a traffic signal warrant analysis shows that traffic signal warrants #1A, #1B, and #2 are not satisfied. It is expected that the adjacent signalized intersections will create gaps in traffic on Houghton Road which will allow for turning movements at the minor street. Moreover, this inadequate LOS occurs during the weekday peak hours only, and is expected to operate adequately during the remaining hours throughout the day.

The eastbound left turn movement at the intersection of North Access/Houghton Road is also anticipated to operate at an inadequate LOS during the weekday AM/ PM peak hours of 2017 and 2022, with traffic from the project. This delay is due to the large amount of southbound traffic on Houghton Road, leaving an insufficient number of gaps for vehicles turning from the minor street approach. Similar to the intersection of Seven Generations Way/Houghton Road, the intersection of North Access/Houghton Road is located less than one mile between the adjacent signalized intersections, and is not considered an appropriate location for a new traffic signal.

Further mitigation measures are limited at the intersection of North Access/Houghton Road as un-signalized minor street intersections along three or more lane, major streets such as Houghton Road, tend to have their turn movements from the minor street operate at LOS E or LOS F during the peak hours. It is also expected that the adjacent signalized intersections will create gaps in traffic on Houghton Road which will allow for turning movements at the minor street.

Recommendations

New STOP signs and associated STOP bar pavement markings are recommended for vehicles exiting the project site at the intersections of North Access/Houghton Road, South Access/Houghton Road, Access 2/Drexel Road, Access 3/Drexel Road and Access 4/Drexel Road. YIELD signs are recommend to be installed on each approach to the roundabout intersections of Access 1/Drexel Road and Access 5/Drexel Road.

The existing Florida ‘T’ traffic signal at the intersection of Drexel Road/Houghton Road should be modified to a standard four-leg signalized intersection, in conjunction with construction of the proposed extension of Drexel Road west of Houghton Road.

The southbound right turn movements at the intersections of North Access/Houghton Road and South Access/Houghton Road require a minimum 50 feet of storage, while the northbound left turn movement at the intersection of North Access/Houghton Road requires a minimum of 25 feet of storage. However, based on City of Tucson Transportation Access Management Guidelines, a minimum turn lane storage length of 150 feet is required for the left and right turn lanes into the project site from Houghton Road.

TRAFFIC IMPACT ANALYSIS
SAGUARO TRAILS
DREXEL ROAD/HOUGHTON ROAD

Project Description

Mattamy Homes has proposed a new development on the vacant land located west of the intersection of Houghton Road and Drexel Road in Tucson, Arizona. The vicinity of the project is shown in **Figure 1**. The site is located as shown in **Figure 2**. The project will consist of 780 single-family homes, 220 multi-family units, 54,450 square feet of specialty retail space and a 40 acre recharge park. The Saguaro Trails project is expected to open in 2017. Full site build-out is expected to be completed in the year 2022. Access to the project site will be from seven new access points.

The purpose of this traffic impact analysis is to:

- Evaluate the current and future operational characteristics of the adjacent roadway network surrounding the project site.
- Estimate the traffic generation associated with the project and assign that traffic to the existing roadway system.
- Analyze future traffic operations at the seven proposed access points as well as the existing study intersections.
- Determine the need for auxiliary (left and right turn) lanes at the seven proposed access points that will directly serve the project site.

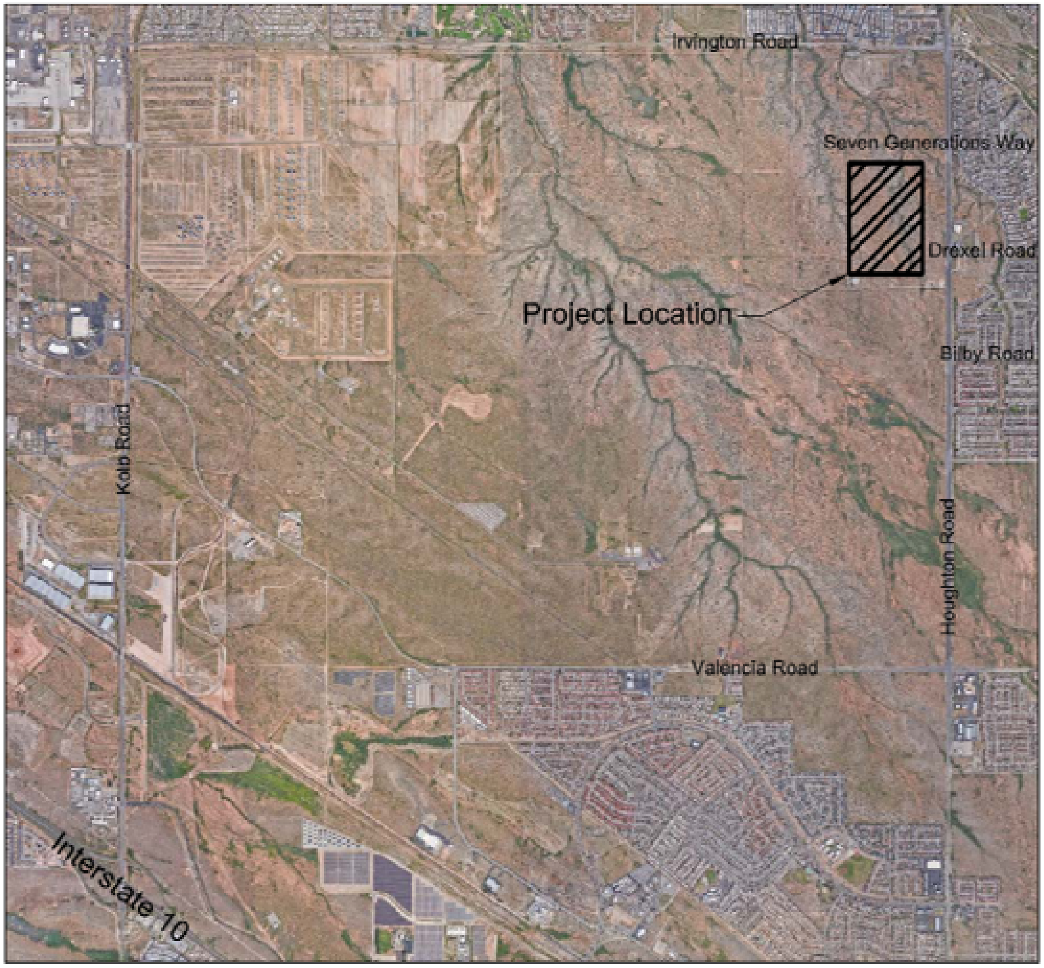
The author of this report is a registered professional engineer (civil) in the State of Arizona having specific expertise and experience in the preparation of traffic impact analyses.

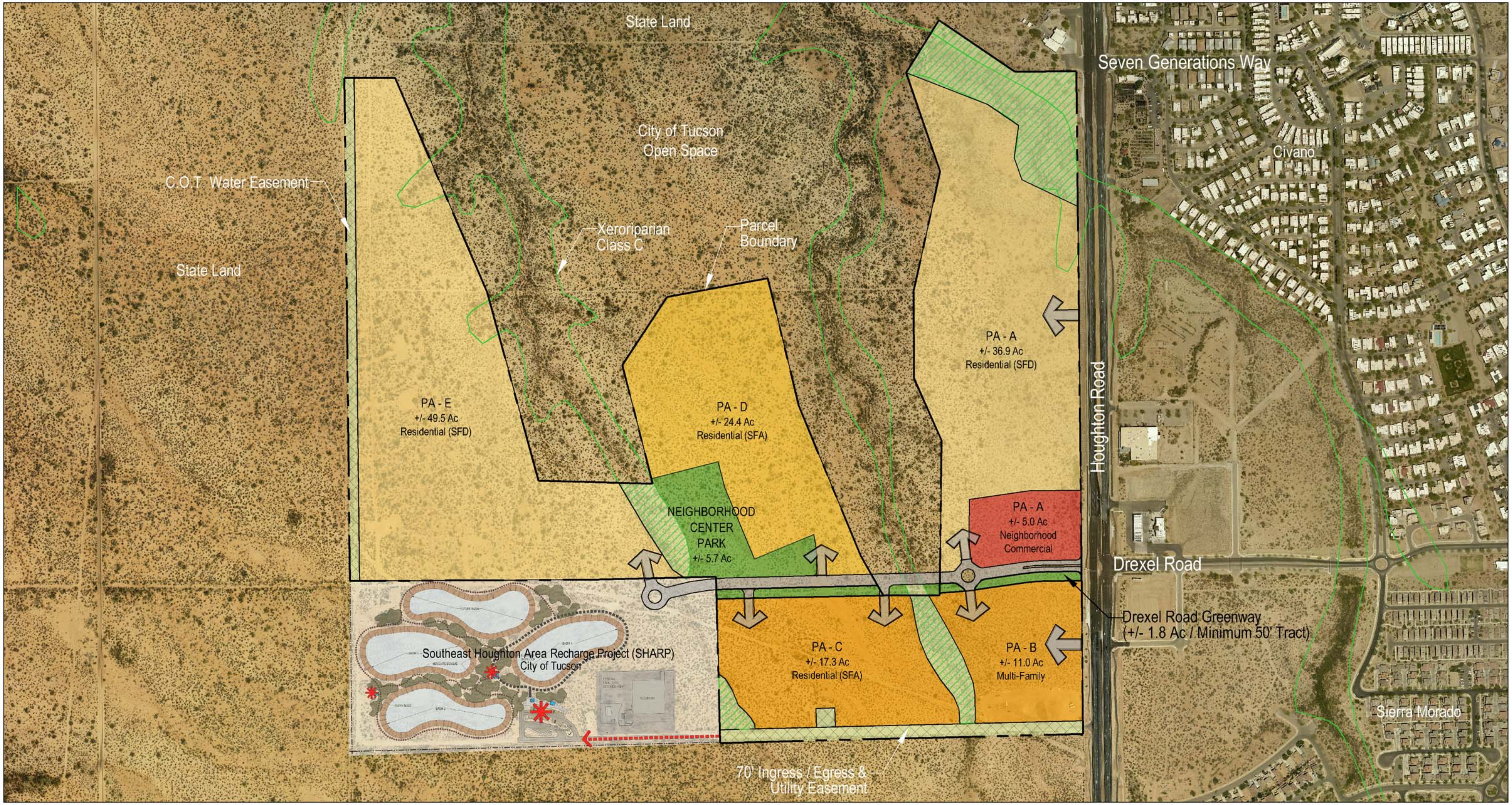
Study Methodology

In order to analyze and evaluate the potential traffic impacts of the proposed development, the following tasks were undertaken:

- Field observation of the proposed site and surrounding area was conducted to evaluate the existing physical and operational characteristics of the adjacent roadway network.
- Site traffic volumes generated by the proposed site were calculated using the *Institute of Transportation Engineers (ITE) Trip Generation Manual, 9th Edition,* 2012.
- Calculated site traffic was distributed based on existing traffic volumes and assigned to the primary roadways within the project study limits.

Figure 1 – Vicinity Map





This exhibit is intended to be used to assist with the preparation of the Saguaro Trails Traffic Study.

NORTH

0 250' 500' 1000'

SCALE: 1" = 500'

MAY 4, 2016

Saguaro Trails will have a proposed maximum overall unit cap of 1,000 units.

SAGUARO TRAILS - Conceptual Planning Areas

mattamyHOMES

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- Capacity analyses were performed for the existing conditions and future conditions without and with the project based on an opening year of 2017 and future year 2022. The intersections were analyzed using the methodology presented in the *2000* and *2010 Highway Capacity Manual (HCM).*
- The need for auxiliary turn lanes into the new site intersections were evaluated based on City of Tucson guidelines.

Existing Conditions

The study location includes the following existing intersections;

- Valencia Road/Houghton Road
- Bilby Road/Houghton Road
- Drexel Road/Houghton Road
- Seven Generations Way/Houghton Road
- Irvington Road/Houghton Road

Adjacent to the project site, Houghton Road has a north/south alignment and provides three lanes in each direction separated by a raised median. The posted speed limit is 45 miles per hour (mph). Houghton Road provides access to Interstate 10 (I-10) via a traffic interchange (TI) approximately six miles south of the project site and to various residential developments to the north. Curb and gutter is provided along both the east and west sides of the roadway. Sidewalk facilities are provided along the west side of the street while a two-way multi-use path is provided along the east side of Houghton Road. Bike lanes also exist in the northbound and southbound directions.

Valencia Road has an east/west alignment and serves as an undivided two-lane roadway near the study area. West of Houghton Road, Valencia Road has a posted speed limit of 45 MPH. The posted speed limit on Valencia Road east of Houghton Road is 25 MPH where the roadway terminates approximately 1.75 miles to the east.

Extending approximately one mile east of Houghton Road, Bilby Road provides access to various residential communities. Bilby Road serves as a four-lane roadway with a raised median. Bike lanes, sidewalk facilities, curb and gutter are provided in each direction. No roadway lighting is present on Bilby Road.

Drexel Road currently provides two lanes in each direction with a two-way center left turn lane and has a posted speed limit of 25 MPH. The north side of the road is paralleled by a sidewalk, while the south side is bordered by a multi-use path. Drexel Road begins at Houghton Road and extends approximately one mile east providing access to neighboring communities. Curb and gutter facilities exist on the both the north and south sides of the roadway.

With an east/west alignment, Seven Generations Way provides access to residential homes east of Houghton Road. The roadway serves the adjacent area as a two-lane road separated by a raised median. Curb, gutter and sidewalk facilities are present on the north and south sides of the street. Seven Generations Way allows on street parking along the north and south sides of the roadway and has a posted speed limit of 25 MPH.

Irvington Road exists as a two-lane roadway with an east/west alignment located approximately one mile north of the project site. West of Houghton Road, Irvington Road maintains a two-lane roadway and has a posted speed limit of 45 MPH during daytime hours and 40 MPH during night time hours. The paved section of Irvington Road terminates approximately 275 feet east of Houghton Road. Curb, gutter and sidewalk facilities are provided along the north side Irvington Road, while a dirt shoulder is present along the south side.

The intersection of Valencia Road/Houghton Road is a four-leg, signalized intersection with protected/permitted left turn phasing. The northbound and southbound approaches to the intersection provide dual exclusive left turn lanes, three through lanes and an exclusive right turn lane. The eastbound and westbound approaches to the intersection provide dual exclusive left turn lanes, two through lanes and an exclusive right turn lane. While eastbound and westbound traffic on Valencia Road is provided with two travel lanes approaching Houghton Road, immediately after the intersection both directions drop to one travel lane. South of the intersection, the right most southbound lane is dropped on Houghton Road. Pedestrian ramps and crosswalk are provided on each leg of the intersection. An existing drainage structure is located on the southeast and northeast corners of the intersection.

Bilby Road/Houghton Road is a three-leg, signalized “T” intersection. The northbound approach utilizes an exclusive left turn lane (for future development), three through lanes and an exclusive right turn lane, while the southbound approach to the intersection provides dual left turn lanes with protected/permitted left turn traffic signal phasing, and three through lanes. The westbound approach offers dual exclusive left turn lanes and an exclusive right turn lane. Pedestrian ramps and crosswalks are provided on each leg of the intersection. Bilby Road provides sidewalk on both sides of the roadway. A Flashing yellow arrow is provided for the westbound approach on Bilby Road during a pedestrian call within the traffic signal phasing.

The intersection of Drexel Road/Houghton Road forms a three-leg, signalized intersection. There are three through lanes and an exclusive right turn lane in the northbound direction, while southbound traffic is provided with an exclusive left turn lane and three through lanes. The southbound left turn movement at the intersection utilizes a protected only left turn phasing. The westbound approach to the intersection offers an exclusive left turn lane and an exclusive right turn lane. The intersection of Drexel Road/Houghton Road operates as a Florida ‘T’ type intersection. Westbound left turn movements from Drexel Road are provided with a dedicated acceleration lane onto southbound Houghton Road. Crosswalks and pedestrian facilities are provided on all corners of the intersection.

Seven Generations Way/Houghton Road forms a four-leg intersection, with STOP sign control on the westbound approach. Westbound vehicles on Seven Generations Way are provided with a shared left turn/though lane and exclusive right turn lanes. Existing traffic signal poles are provided on the northeast, northwest and southwest corners of the intersection, as well as within the median islands on Houghton Road. The west leg of the intersection serves a local fire station. As emergency vehicles enter the intersection from the fire station, the existing traffic signal is triggered to provide a flashing red signal and a STOP control condition for the northbound, southbound and westbound approaches to the intersection. Northbound traffic on Houghton Road utilizes an exclusive left turn lane, three through lanes and an exclusive right turn lane. The southbound approach to the intersection offers an exclusive left turn lane, two through lanes and a shared through/right turn lane. All four corners of the intersection have pedestrian ramps however, there are no crosswalks provided. Seven Generations Way has sidewalk facilities along both sides of the roadway. A second driveway is provided for the fire station is located approximately 230 feet north of the intersection, allowing right-in and right-out access to Houghton Road.

The signalized, four-leg intersection of Irvington Road/Houghton Road provides vehicles with dual exclusive left turn lanes, two through lanes and an exclusive right turn lane in the northbound direction. The southbound approach to the intersection offers an exclusive left turn lane, three through lanes and an exclusive right turn lane. Eastbound traffic on Irvington Road utilizes an exclusive left turn lane, a single through lane and an exclusive right turn lane, while westbound traffic is provided an exclusive left turn lane and a shared through/right turn lane. A protected/permitted left turn signal phasing is utilized for the northbound left turn lane, while the eastbound, westbound and southbound left turn lanes operate with permitted left turn phasing. All four legs of the intersection currently have pedestrian ramps and crosswalks. Pavement for the east leg of the intersection ends approximately 270 feet east of the intersection. The southeast corner has a large powerline structure connecting to existing power lines located on each of the other three legs of the intersection.

Existing lane configurations and traffic control are shown in **Figure 3**.

Existing Traffic Data

In order to form a basis for analysis of the project impacts, weekday AM and PM peak hour turning movement counts were conducted at the following existing intersections:

- Valencia Road/Houghton Road
- Bilby Road/Houghton Road
- Drexel Road/Houghton Road
- Seven Generations Way/Houghton Road
- Irvington Road/Houghton Road

The weekday turning movement counts were conducted from 7:00 AM to 9:00 AM and 4:00 PM to 6:00 PM in March 2016.

Figure 3 – Existing Lane Configurations and Traffic Control

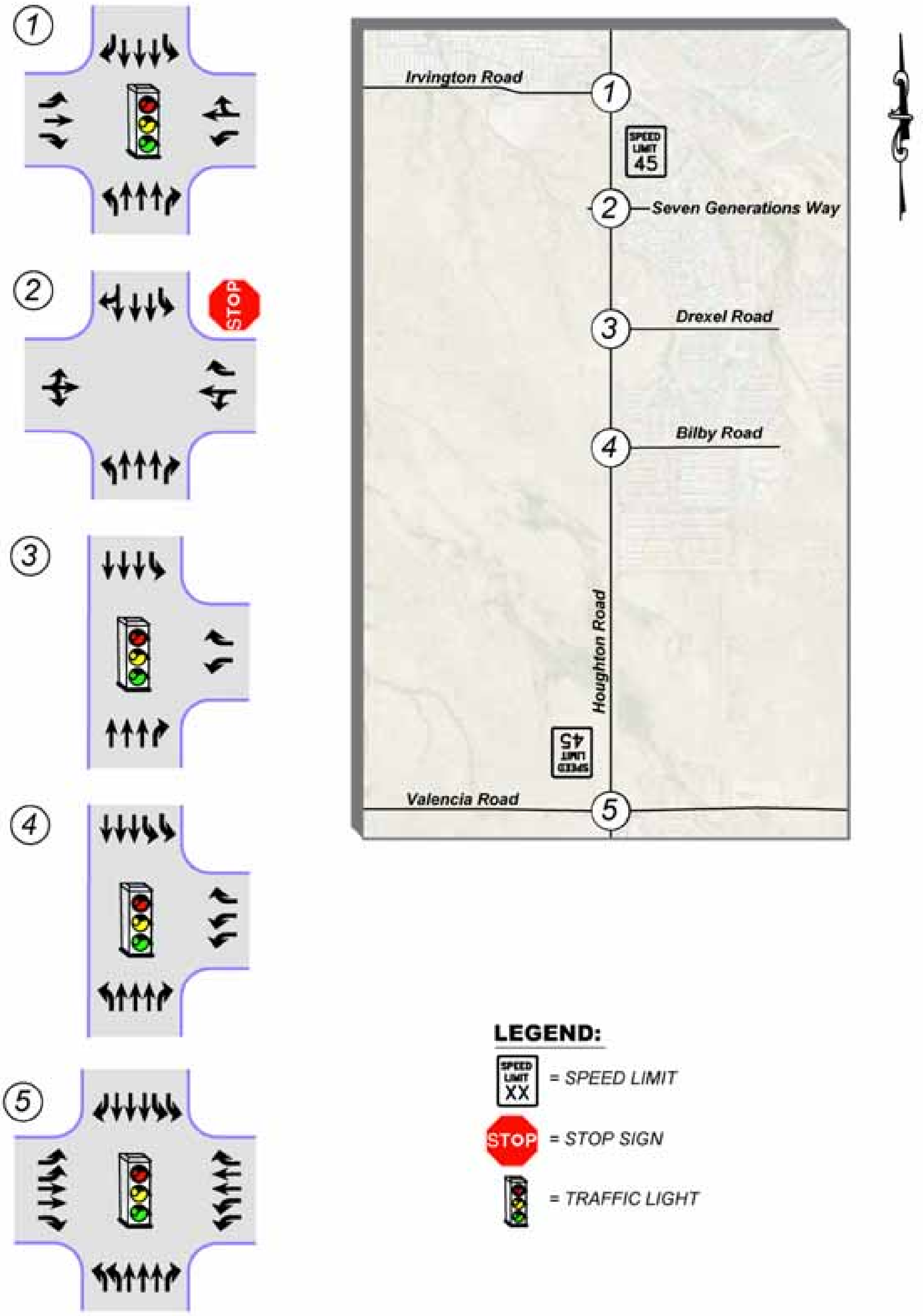
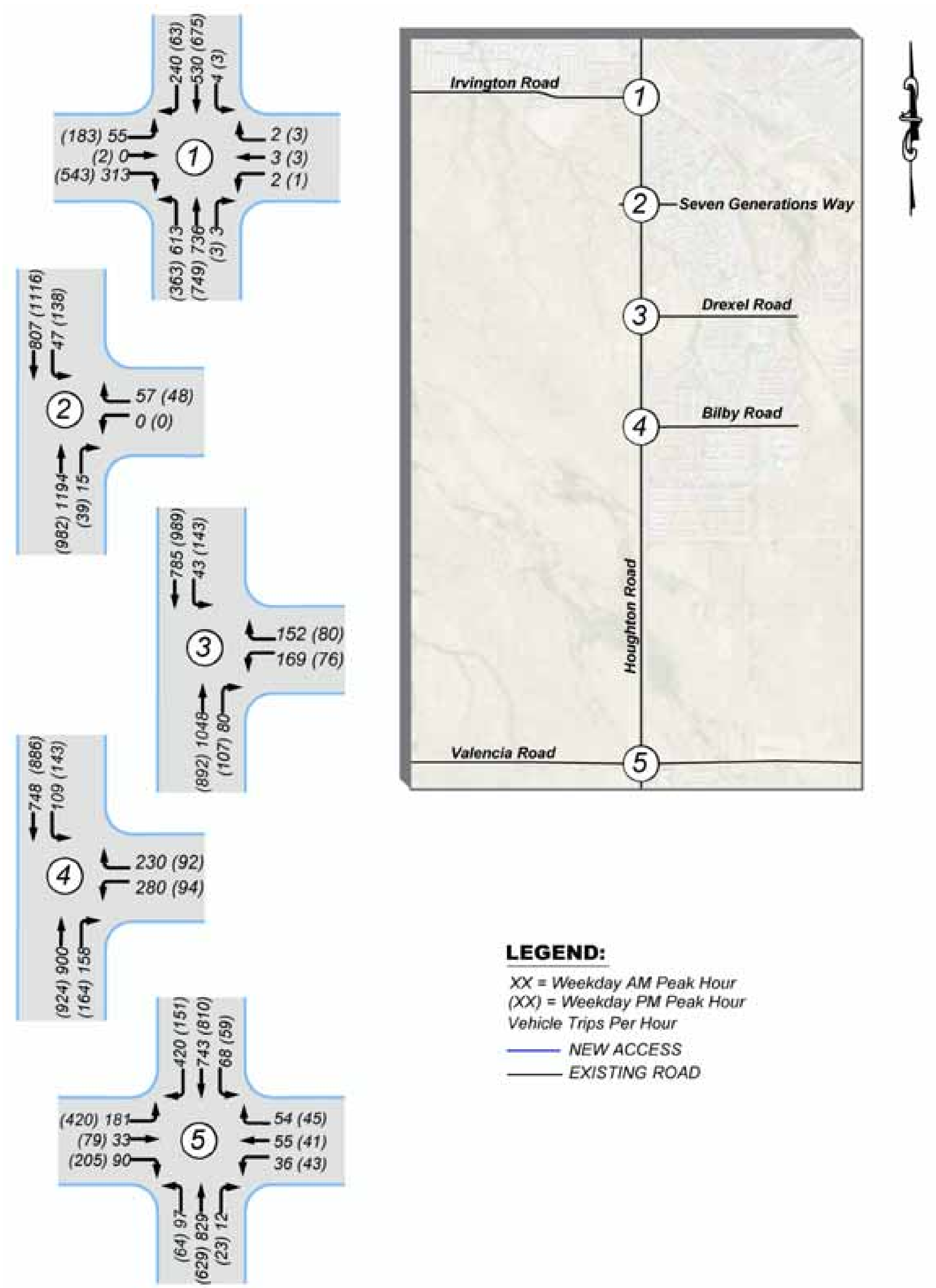


Figure 4 – Existing Weekday Peak Hour Traffic Volumes



The existing weekday AM and PM peak hour traffic volumes are shown in **Figure 4**. The complete traffic count summaries can be found in the Appendix.

Access

Access to the proposed project will be provided via seven proposed access points. Two access points will connect directly to Houghton Road, while the remaining five access points will be located along the north and south sides of Drexel Road to form the following intersections:

- North Access/Houghton Road
- South Access/Houghton Road
- Access 1/Drexel Road
- Access 2/Drexel Road
- Access 3/Drexel Road
- Access 4/Drexel Road
- Access 5/Drexel Road

The North Access extends west from Houghton Road into the proposed project approximately 1,300 feet north of Drexel Road. This “T” intersection will provide southbound traffic on Houghton Road with two through lanes and a shared through/right turn lane, while northbound traffic will utilize an exclusive left turn lane and three through lanes. The eastbound approach to the intersection will be STOP sign controlled, providing an exclusive left turn lane and an exclusive right turn lane. Northbound and southbound traffic on Houghton Road will be free-flow.

The “T” intersection of South Access/Houghton Road is located approximately 400 feet south of Drexel Road. Ingress and egress will be limited to allow right in/right out access only from Houghton Road. Southbound traffic on Houghton Road will be provided two through lanes and a shared through/right turn lane. The eastbound approach to the intersection will be STOP sign controlled, providing an exclusive right turn lane. Northbound and southbound traffic on Houghton Road will be free-flow.

As part of the roadway improvements with the proposed project, Drexel Road will be extended to the west of Houghton Road approximately one-half mile, providing access into the proposed development. The newly constructed Drexel Road will serve as a collector street, offering a three-lane roadway section with one lane in the eastbound and westbound directions separated by a two-way center left turn lane.

With the addition of a new west leg to the intersection of Drexel Road/Houghton Road, the eastbound and westbound approaches on Drexel Road will provide an exclusive left turn lane and a shared through/right turn lane. The northbound approach will offer an exclusive left turn lane, three through lanes and an exclusive right turn lane. The southbound approach to the intersection will utilize an exclusive left turn lane, two through lanes and a single shared through/right turn lane.

Access 1/Drexel Road will be constructed as a single lane roundabout type intersection, located at the west end of the proposed project and provides access to the north side of the development. The westbound and southbound approaches to the intersection will be YIELD controlled, allowing turning movements into the roundabout.

The “T” intersection of Access 2/Drexel Road will provide access to the south side of the development. The northbound approach will be STOP controlled and provide a left turn lane and a right turn lane. Eastbound traffic will have a shared through/right turn lane, while westbound traffic will utilize a left turn lane and a through lane. Eastbound and westbound Drexel Road will be free flow.

Access 3 will extend north from Drexel Road into the project site. The southbound approach to the intersection of Access 3/Drexel Road will be STOP controlled and provide exclusive left and right turn lanes. Eastbound and westbound traffic on Drexel Road will be free flow. The eastbound approach to the intersection will be offered a single shared left turn/through lane, while westbound traffic will be provide a single shared through/right turn lane.

At the intersection of Access 4/Drexel Road, northbound traffic will be STOP controlled and have exclusive left and right turn lanes. The eastbound approach will have an exclusive left turn lane and a through lane. A shared through/right turn lane will be provided for westbound traffic.

A four-leg roundabout will be constructed at the proposed intersection of Access 5/Drexel Road. Access 5 will provide a northbound and southbound leg into the development. All approaches to the intersection will operate under a YIELD control condition and provide a single entrance lane into the roundabout.

Sight distance at the proposed access points and intersections should be verified during the design process.

Trip Generation

Trip generation for the project was developed utilizing nationally agreed upon data contained in the Institute of Transportation Engineers (ITE) publication *Trip Generation, 9th Edition*, 2012.

The project trip generation was estimated for the construction of four major land use types associated with the proposed development:

- 780 Residential Homes: ITE Land Use Code 210, Single-Family Detached Housing
- 54,450 square feet of Commercial Development: ITE Land Use Code 826, Specialty Retail Center
- 220 Multi-Family Apartments: ITE Land Use Code 220, Apartment
- 40 acre Recharge Park: ITE Land Use Code 412, County Park

The result is the expected weekday trip generation for the new project and adjacent residential project as shown in **Table 1**. It was assumed that the Saguaro Trails project will be fully built-out by the opening year of 2017. The complete trip generation calculations can be found in the Appendix.

Table 1 – Weekday Project Site Generated Trips

Time Period	Single-Family Detached Housing	Specialty Retail	Apartments	Park	Total
Average Daily, Inbound (vtpd)	3,714	1,207	732	46	5,699
Average Daily, Outbound (vtpd)	3,714	1,207	732	46	5,699
Total Daily	**7,428**	**2,414**	**1,464**	**92**	**11,398**
AM Peak Hour, Inbound (vtph)	146	n/a	23	1	169
AM Peak Hour, Outbound (vtph)	439		90	0	530
Total AM Peak	**585**		**113**	**1**	**699**
PM Peak Hour, Inbound (vtph)	491	65	89	2	648
PM Peak Hour, Outbound (vtph)	289	83	48	2	421
Total PM Peak	**780**	**148**	**137**	**4**	**1,069**

vtpd - vehicle trips per day, vtph - vehicle trips per hour

Trip Distribution & Assignment

Trip distribution for the project was based on current traffic volumes and traffic patterns near the proposed site. **Figure 5** shows the weekday trip distribution for the project as a percentage of net new primary trips.

Figure 6 shows the assignment of the new site generated peak hour trips to the adjacent roadway system.

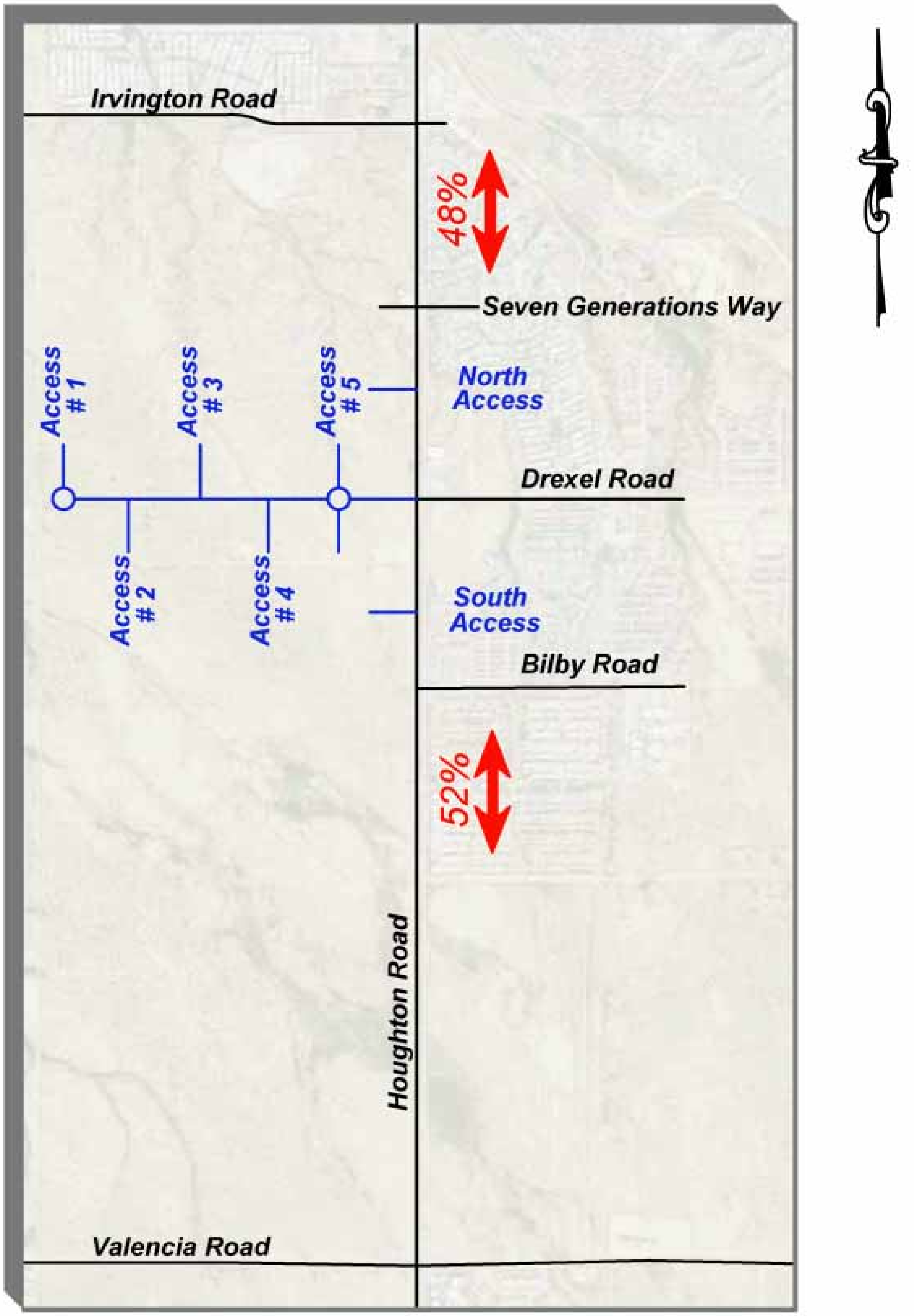
Existing Traffic Operations

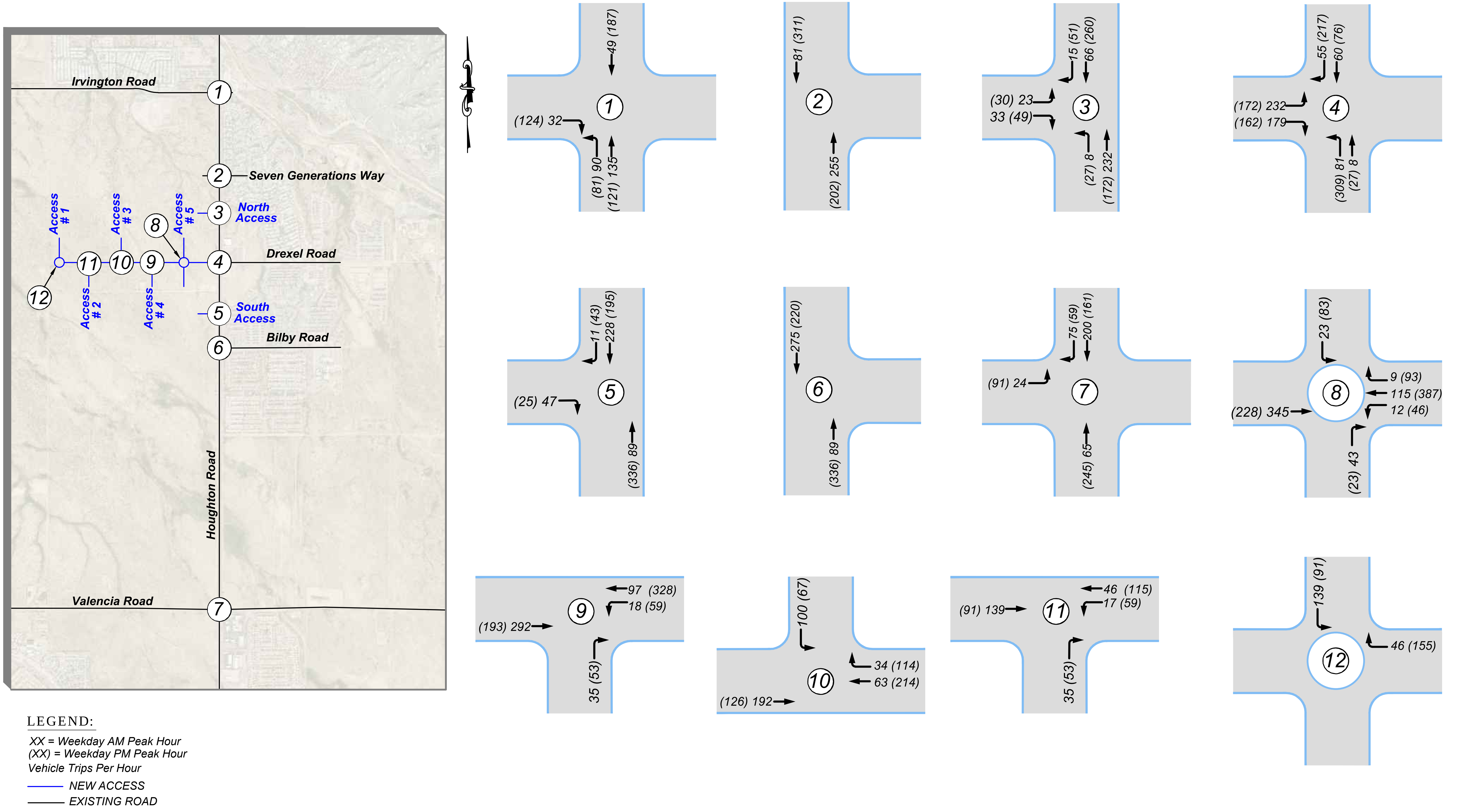
Analysis of current intersection operations was conducted for the weekday AM and PM peak hours using the nationally accepted methodology set forth in the *Highway Capacity Manual*, Transportation Research Board, 2010 (HCM 2010). The computer software Synchro 9 was utilized to calculate the levels of service for individual movements, approaches, and for the intersections as a whole.

Level of service (LOS) is a qualitative measure of the traffic operations at an intersection or on a roadway segment. Level of service is ranked from LOS A, which signifies little or no congestion and is the highest rank, to LOS F, which signifies congestion and jam conditions. LOS D is typically considered adequate operation at signalized and un-signalized intersections in developed areas.

At signalized intersections, level of service is calculated for each movement and then is summed in a weighted fashion to yield the LOS for the approach and for the intersections a whole. The criteria for level of service at signalized intersections are shown in **Table 2.**

Figure 5 – Weekday Peak Hour Trip Distribution





Assignment

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Table 2 - Level of Service Criteria – Signalized Intersections

Level-of-Service	Average Total Delay
A	≤ 10.0 seconds
B	> 10.0 and ≤ 20.0 seconds/vehicle
C	> 20.0 and ≤ 35.0 seconds/vehicle
D	> 35.0 and ≤ 55.0 seconds/vehicle
E	> 55.0 and ≤ 80.0 seconds/vehicle
F	> 80.0 seconds per vehicle

In calculating the levels of service, assumed signal phasing and timing data was used. Other assumptions included:

- Cycle length – 90 seconds
- Lane widths – 12 feet
- Approach grade – 0%
- Right turn on red allowed – 20%

At un-signalized intersections, level of service is predicted/calculated for those movements which must either stop for or yield to oncoming traffic and is based on average control delay for the particular movement. Control delay is the portion of total delay attributed to traffic control measures such as stop signs and traffic signals. The criteria for level of service at un-signalized intersections are shown in **Table 3.**

Table 3 – Level of Service Criteria – Un-signalized Intersections

Level-of-Service	Delay
A	≤ 10 seconds
B	> 10 and ≤ 15 seconds/vehicle
C	> 15 and ≤ 25 seconds/vehicle
D	> 25 and ≤ 35 seconds/vehicle
E	> 35 and ≤ 50 seconds/vehicle
F	> 50 seconds per vehicle

Existing levels of service were calculated for the study intersections. The results of this analysis are shown in **Table 4**. Complete capacity calculations are included in the Appendix.

As shown in **Table 4**, all of the existing study intersections currently operate at an adequate LOS for all movements during the existing weekday AM and PM peak hours.

Table 4 – Existing Peak Hour Levels of Service

Intersection	AM Peak		PM Peak	
	LOS	Delay	LOS	Delay
Signalized Intersections				
Valencia Road/Houghton Road				
Overall Intersection	B	14.7	B	18.7
Eastbound Left	C	31.1	C	27.4
Eastbound Through	C	30.7	C	25.3
Eastbound Right	D	37.7	C	34.1
Westbound Left	C	30.1	C	31.0
Westbound Through	C	32.9	C	32.5
Westbound Right	D	37.3	D	35.7
Northbound Left	B	10.6	B	14.8
Northbound Through	B	10.2	B	13.0
Northbound Right	A	8.2	B	11.2
Southbound Left	B	10.3	B	13.0
Southbound Through	A	9.9	B	13.8
Southbound Right	B	14.1	B	13.0
Bilby Way/Houghton Road				
Overall Intersection	B	13.3	A	8.7
Westbound Left	C	30.2	C	31.3
Westbound Right	B	16.7	B	18.4
Northbound Through	B	16.3	B	11.8
Northbound Right	A	8.6	A	8.0
Southbound Left	B	11.3	A	8.5
Southbound Through	A	3.5	A	2.2
Drexel Road/Houghton Road				
Overall Intersection	B	10.8	A	9.9
Westbound Left	B	16.2	B	16.7
Westbound Right	B	10.4	A	8.9
Northbound Through	B	17.2	B	17.7
Northbound Right	A	3.3	A	4.9
Southbound Left	C	24.5	C	22.9
Southbound Through	A	1.0	A	1.1
Irvington Road/Houghton Road				
Overall Intersection	B	11.4	B	16.5
Eastbound Left	C	29.6	C	30.5
Eastbound Through	A	0.0	C	24.9
Eastbound Right	B	17.7	C	21.2
Westbound Left	C	27.7	C	24.9
Westbound Through/Right	C	27.8	C	24.9
Northbound Left	B	12.2	B	15.9
Northbound Through	A	2.9	A	5.9
Northbound Right	A	2.0	A	4.2
Southbound Left	B	15.3	C	22.8
Southbound Through	B	14.0	C	20.8
Southbound Right	B	16.6	B	18.4
Un-signalized Intersections				
Seven Generations Way/Houghton Road				
Westbound Left	A	0.0	A	0.0
Westbound Right	C	17.7	C	15.0
Southbound Left	C	21.4	C	22.7

Delay - seconds per vehicle

Future Traffic Operations Without Project

In order to assess the impacts of the project on future traffic operations, traffic projections were made for the opening year of 2017 and study horizon year 2022.

A review of historical traffic data in the vicinity of the project showed variations in traffic volumes in the project area. Due to this, a conservative 2% annual traffic growth rate was used. Using a 2% annual traffic growth rate, 2017 and 2022 weekday peak hour traffic volumes without the project were estimated as shown in **Figures 7** and **8.**

As with the current volumes, levels of service were calculated for each of the intersections in the study area for opening year 2017 and horizon year 2022, without the project. Intersection levels of service for 2017 and 2022 without the project are shown in **Tables 5** and **6**. Complete capacity calculations are included in the Appendix.

It is predicted that all of the existing study intersections will operate at an adequate LOS D or better during the weekday AM and PM peak hours of 2017 and 2022, without traffic from the project. However, the southbound left turn at the intersection of Seven Generations Way/Houghton Road is on the cusp of an inadequate LOS E during the weekday AM and PM peak hour in 2022, without the project.

With the high existing southbound left turn volumes that occur during in the weekday AM/PM peak hour, and the large northbound through volume on Houghton Road the intersection is expected to breakdown in future years, without the proposed project as growth in the area continues.

Pima County and City of Tucson design guidelines do not have warrants for the inclusion of a traffic signal based on left turn volumes at an intersection. However, the Arizona Department of Transportation (ADOT) Engineering Guidelines and Processes include a cross-product method for determining if a left turn volume warrants a traffic signal with left turn phasing. With the cross-product of the left turn volume and the opposing through volume equaling greater than 150,000 vph on a six-lane roadway, a traffic signal at this location is warranted without the project.

Figure 7 – 2017 Weekday Peak Hour Traffic Volumes Without Project

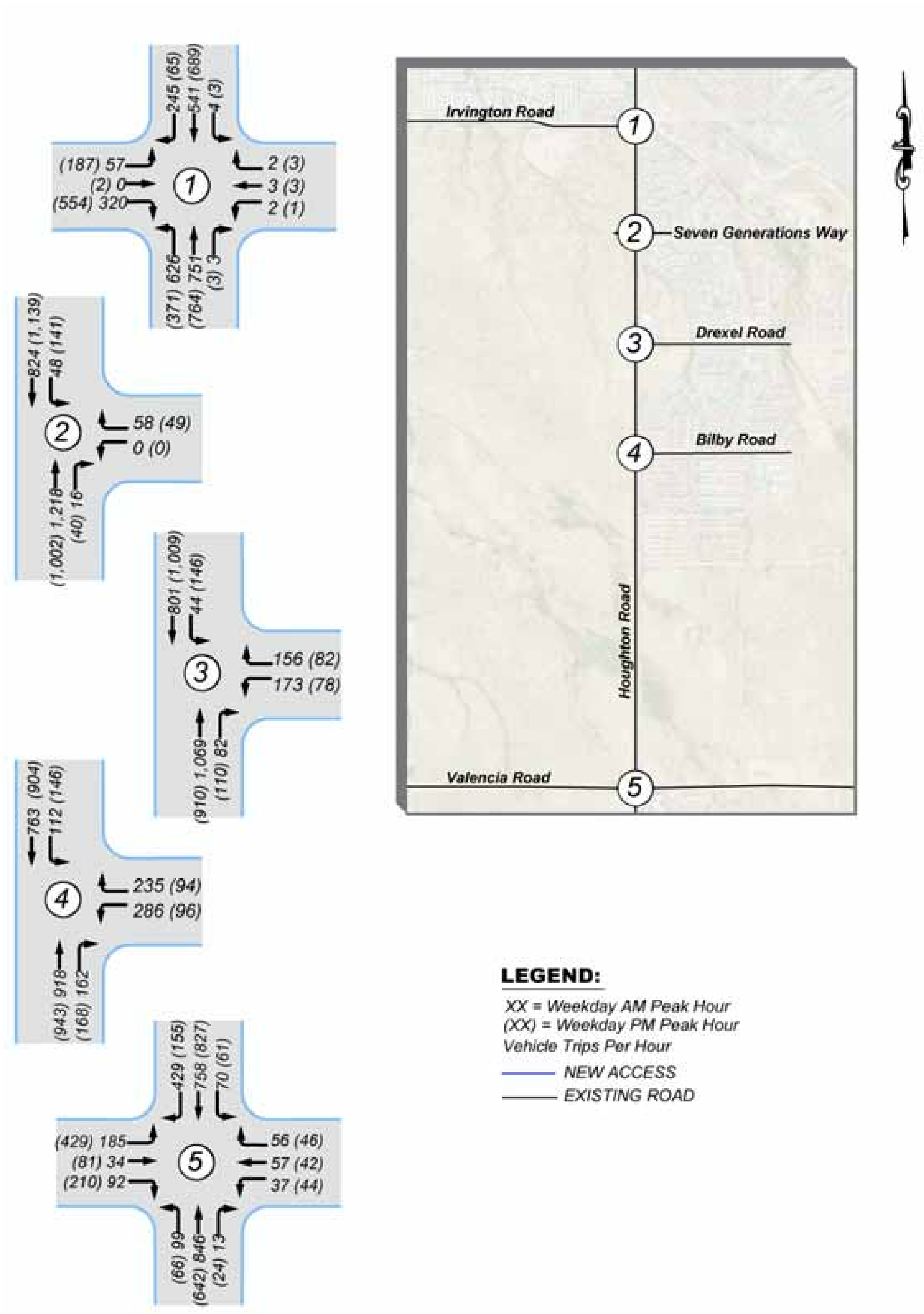


Figure 8 – 2022 Weekday Peak Hour Traffic Volumes Without Project

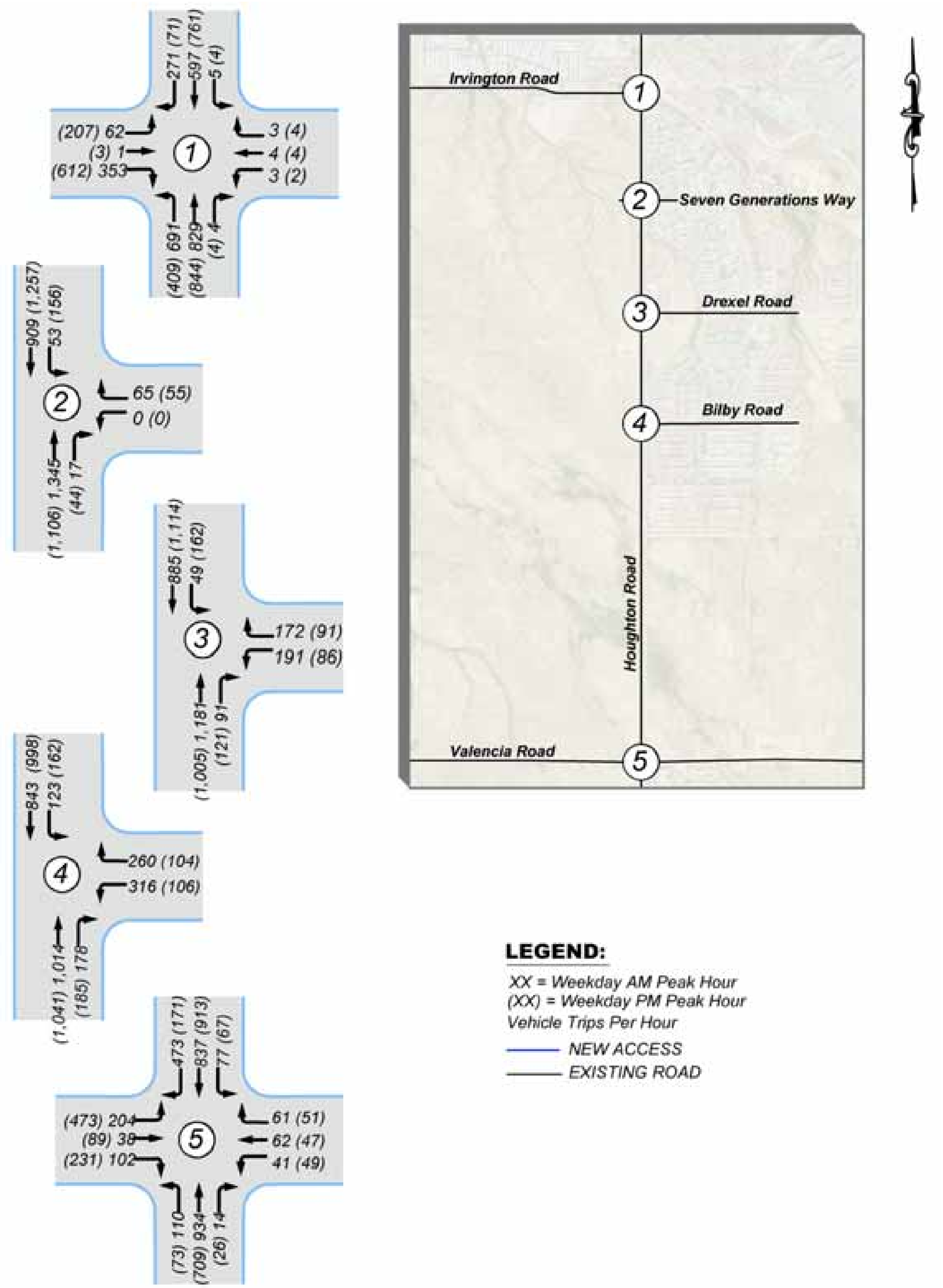


Table 5 – 2017 Peak Hour Levels of Service Without Project

Intersection	AM Peak		PM Peak	
	LOS	Delay	LOS	Delay
Signalized Intersections				
Valencia Road/Houghton Road				
Overall Intersection	B	14.9	B	18.9
Eastbound Left	C	31.2	C	27.5
Eastbound Through	C	30.7	C	25.3
Eastbound Right	D	37.7	C	34.2
Westbound Left	C	30.1	C	31.2
Westbound Through	C	32.9	C	32.7
Westbound Right	D	37.4	D	36.1
Northbound Left	B	10.8	B	15.2
Northbound Through	B	10.3	B	13.3
Northbound Right	A	8.2	B	11.4
Southbound Left	B	10.6	B	13.3
Southbound Through	B	10.0	B	14.1
Southbound Right	B	14.4	B	13.3
Bilby Way/Houghton Road				
Overall Intersection	B	13.4	A	8.7
Westbound Left	C	30.1	C	31.3
Westbound Right	B	16.7	B	18.4
Northbound Through	B	16.5	B	11.8
Northbound Right	A	8.6	A	8.1
Southbound Left	B	11.7	A	8.7
Southbound Through	A	3.6	A	2.2
Drexel Road/Houghton Road				
Overall Intersection	B	10.9	A	10.0
Westbound Left	B	16.4	B	16.8
Westbound Right	B	10.5	A	8.9
Northbound Through	B	17.4	B	17.9
Northbound Right	A	3.3	A	4.9
Southbound Left	C	24.8	C	22.9
Southbound Through	A	1.0	A	1.1
Irvington Road/Houghton Road				
Overall Intersection	B	11.5	B	16.9
Eastbound Left	C	29.6	C	30.5
Eastbound Through	A	0.0	C	24.8
Eastbound Right	B	17.8	C	21.9
Westbound Left	C	27.7	C	24.8
Westbound Through/Right	C	27.7	C	24.8
Northbound Left	B	12.6	B	16.5
Northbound Through	A	2.9	A	6.0
Northbound Right	A	2.0	A	4.3
Southbound Left	B	15.5	C	23.3
Southbound Through	B	14.1	C	21.1
Southbound Right	B	16.8	B	18.6
Un-signalized Intersections				
Seven Generations Way/Houghton Road				
Westbound Left	A	0.0	A	0.0
Westbound Right	C	18.1	C	15.2
Southbound Left	C	22.1	C	23.8

Delay - seconds per vehicle

Table 6 – 2022 Peak Hour Levels of Service Without Project

Intersection	AM Peak		PM Peak	
	LOS	Delay	LOS	Delay
Signalized Intersections				
Valencia Road/Houghton Road				
Overall Intersection	B	15.6	B	19.6
Eastbound Left	C	31.4	C	28.3
Eastbound Through	C	30.5	C	24.7
Eastbound Right	D	37.9	C	34.1
Westbound Left	C	30.4	C	32.5
Westbound Through	C	32.9	C	33.2
Westbound Right	D	37.6	D	37.6
Northbound Left	B	12.2	B	16.5
Northbound Through	B	10.9	B	14.0
Northbound Right	A	8.5	B	11.8
Southbound Left	B	11.6	B	14.3
Southbound Through	B	10.6	B	14.9
Southbound Right	B	16.1	B	14.0
Bilby Way/Houghton Road				
Overall Intersection	B	14.1	A	9.0
Westbound Left	C	30.1	C	31.6
Westbound Right	B	16.9	B	18.6
Northbound Through	B	17.7	B	12.3
Northbound Right	A	8.7	A	8.2
Southbound Left	B	13.8	B	10.0
Southbound Through	A	4.0	A	2.3
Drexel Road/Houghton Road				
Overall Intersection	B	11.3	B	10.6
Westbound Left	B	17.3	B	17.4
Westbound Right	B	11.4	A	9.1
Northbound Through	B	18.1	B	19.3
Northbound Right	A	3.1	A	5.0
Southbound Left	C	26.5	C	23.9
Southbound Through	A	1.0	A	1.1
Irvington Road/Houghton Road				
Overall Intersection	B	12.3	B	19.0
Eastbound Left	C	29.6	C	30.6
Eastbound Through	C	27.4	C	24.2
Eastbound Right	B	18.4	C	26.8
Westbound Left	C	27.5	C	24.3
Westbound Through/Right	C	27.6	C	24.3
Northbound Left	B	14.1	B	18.8
Northbound Through	A	3.2	A	7.0
Northbound Right	A	2.1	A	4.8
Southbound Left	B	16.5	C	25.6
Southbound Through	B	14.6	C	22.7
Southbound Right	B	17.9	B	19.6
Un-signalized Intersections				
Seven Generations Way/Houghton Road				
Westbound Left	A	0.0	A	0.0
Westbound Right	C	20.4	C	16.5
Southbound Left	D	26.7	D	31.6

Delay - seconds per vehicle

Future Traffic Operations With Project

In order to assess the impacts of the project on future traffic operations, levels of service were calculated for each project intersection in 2017 and 2022, with the project. Weekday peak hour traffic volumes for 2017 and 2022 without the project were combined with the estimated trips generated by the proposed Saguaro Trails development to yield weekday peak hour traffic volumes with the project as shown in **Figures 9** and **10**.

Weekday intersection levels of service for 2017 and 2022, with the project, were then calculated as shown in **Tables 7** and **8**. Complete capacity calculations are included in the Appendix.

The southbound left turn movement at the intersection of Seven Generations Way/Houghton Road is predicted to experience an inadequate LOS E and F during the weekday AM/PM peak hours of 2017 and 2022, with traffic from the proposed project. These delays are due to the large amount of northbound traffic on Houghton Road, leaving an insufficient number of gaps for vehicles turning onto the minor street approach.

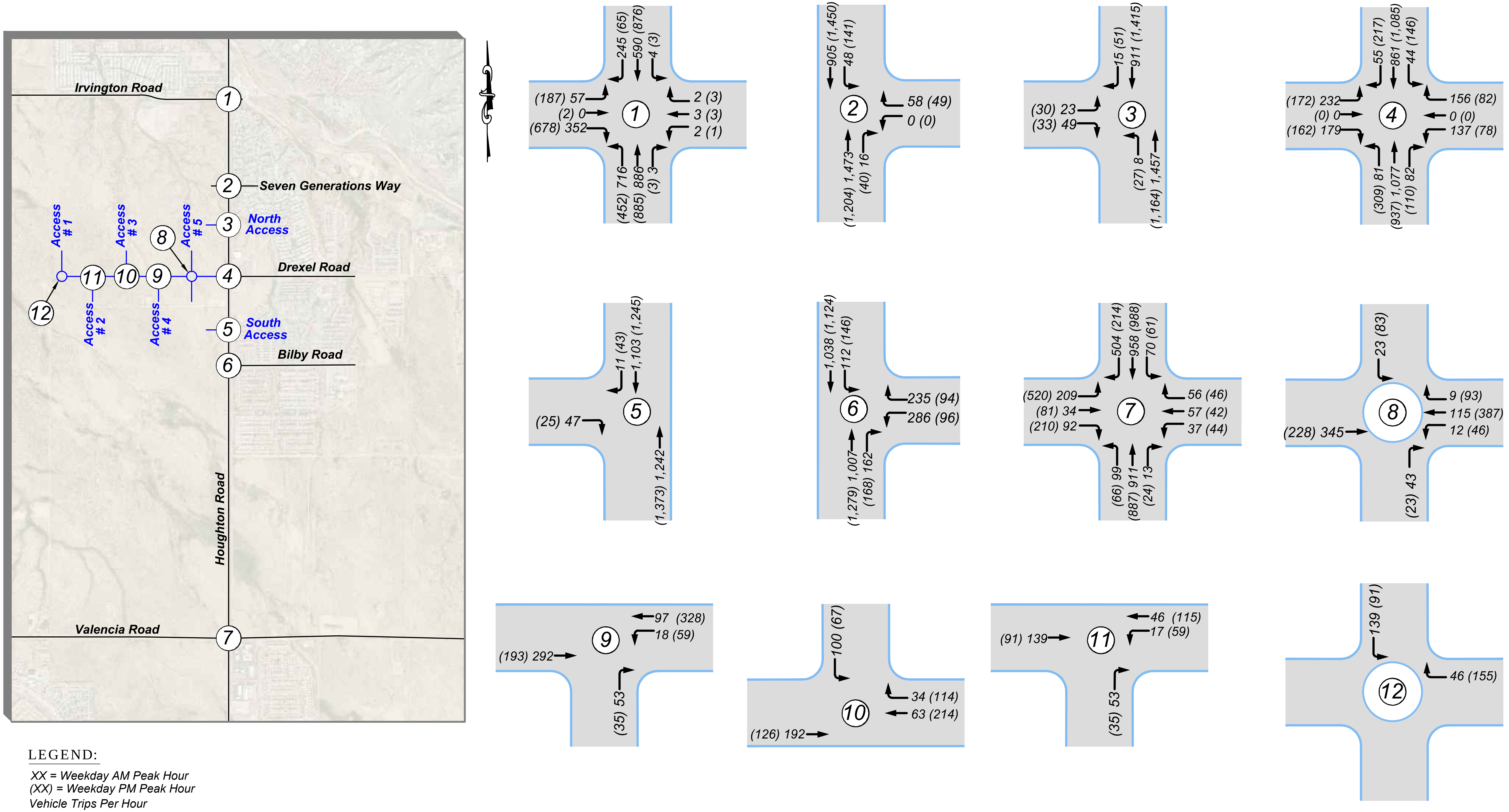
At the intersection of North Access/Houghton Road, the eastbound left turn movement is also predicted to experience an inadequate LOS E and F during the weekday AM/PM peak hours of 2017 and 2022, with traffic from the proposed project. These delays are due to the large amount of southbound traffic on Houghton Road, leaving an insufficient number of gaps for vehicles turning from the minor street approach.

The remaining study area intersections are anticipated to operate at an adequate LOS in 2017 and 2022, without and with traffic from the proposed Saguaro Trails project.

Table 7 – 2017 Peak Hour Levels of Service With Project

Intersection	2017 Without Project				2017 With Project			
	AM Peak		PM Peak		AM Peak		PM Peak	
	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Un-signalized Intersections								
Seven Generations Way/Houghton Road								
Westbound Left	A	0.0	A	0.0	A	0.0	A	0.0
Westbound Right	C	18.1	C	15.2	C	22.1	C	17.5
Southbound Left	C	22.1	C	23.8	D	31.2	E	35.7
North Access/Houghton Road								
Eastbound Left	N/A		N/A		E	37.8	F	113.8
Eastbound Right					B	14.5	C	20.0
Northbound Left					B	14.7	D	27.2
South Access/Houghton Road								
Eastbound Right	N/A		N/A		C	16.3	C	17.3
Access 1/Drexel Road								
Westbound Approach	N/A		N/A		A	3.6	A	4.6
Southbound Approach					A	4.5	A	4.0
Access 2/Drexel Road								
Westbound Left	N/A		N/A		A	7.6	A	7.5
Northbound Right					A	9.3	A	8.9
Access 3/Drexel Road								
Southbound Left	N/A		N/A		B	11.2	B	12.2
Access 4/Drexel Road								
Westbound Left	N/A		N/A		A	8.0	A	7.8
Northtbound Right					B	10.5	A	9.6
Access 5/Drexel Road								
Eastbound Approach	N/A		N/A		A	7.1	A	6.4
Westbound Approach					A	4.4	A	9.5
Northbound Approach					A	5.6	A	5.0
Southbound Approach					A	4.1	A	6.8

Delay - seconds per vehicle



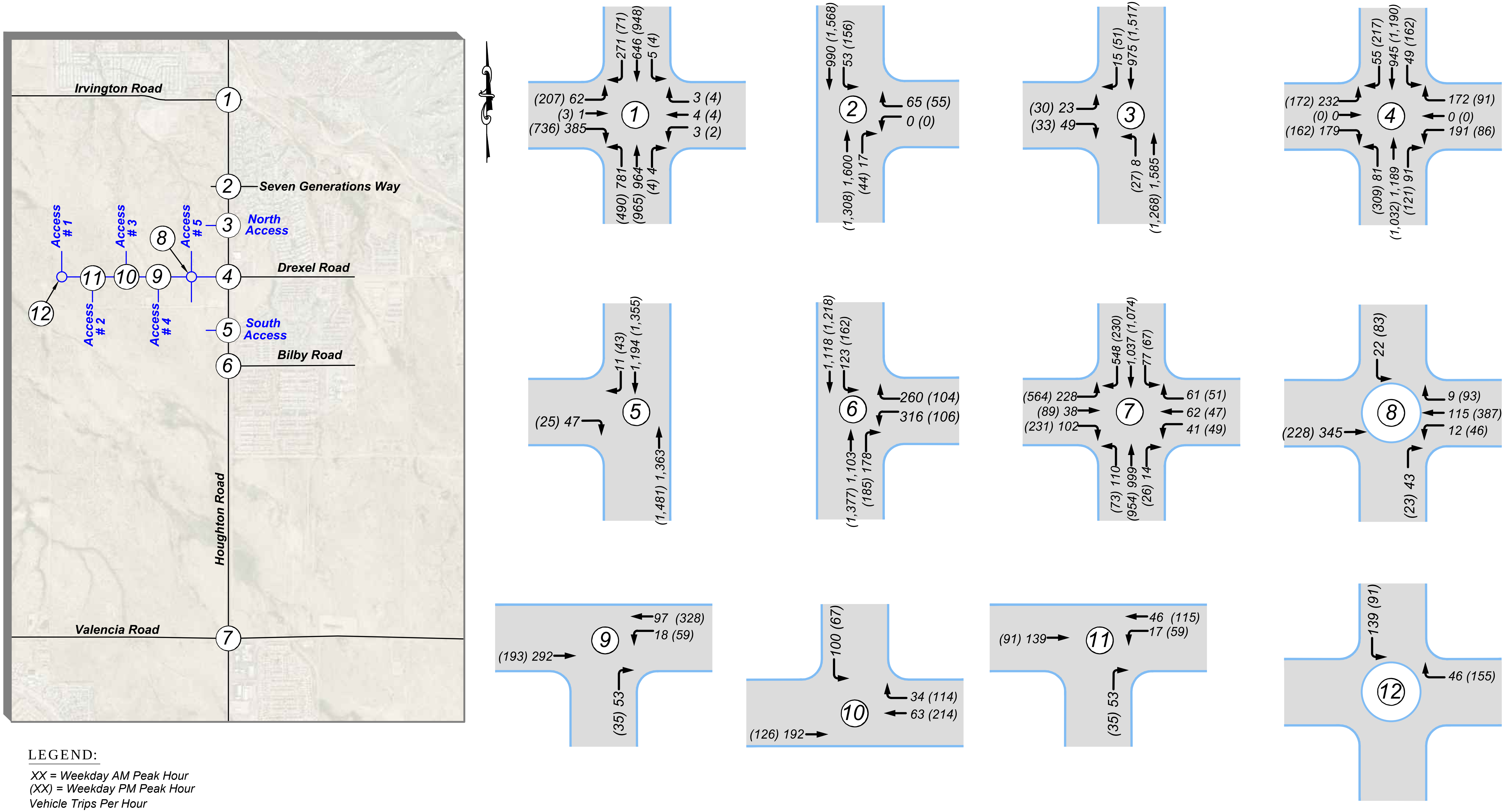
LEGEND:

XX = Weekday AM Peak Hour
(XX) = Weekday PM Peak Hour
Vehicle Trips Per Hour

NEW ACCESS
EXISTING ROAD

2017 With

SOUTHWEST TRAFFIC ENGINEERING, LLC
3838 N. Central Ave., Suite 1810
Phoenix, AZ 85012
Tel 602.266.SWTE (7983)
Fax 602.266.1115
www.swte.us



LEGEND:

XX = Weekday AM Peak Hour
(XX) = Weekday PM Peak Hour
Vehicle Trips Per Hour

——— NEW ACCESS
——— EXISTING ROAD

2022 With

SWTE
SOUTHWEST TRAFFIC ENGINEERING, LLC
3838 N. Central Ave., Suite 1810
Phoenix, AZ 85012
Tel 602.266.SWTE (7983)
Fax 602.266.1115
www.swte.us

Table 7 – 2017 Peak Hour Levels of Service With Project, Continued

Intersection	2017 Without Project				2017 With Project			
	AM Peak		PM Peak		AM Peak		PM Peak	
	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Signalized Intersections								
Valencia Road/Houghton Road								
Overall Intersection	B	14.9	B	18.9	B	15.4	B	19.5
Eastbound Left	C	31.2	C	27.5	C	31.4	C	29.9
Eastbound Through	C	30.7	C	25.3	C	30.7	C	25.3
Eastbound Right	D	37.7	C	34.2	D	37.7	C	34.2
Westbound Left	C	30.1	C	31.2	C	30.1	C	31.2
Westbound Through	C	32.9	C	32.7	C	32.9	C	32.7
Westbound Right	D	37.4	D	36.1	D	37.4	D	36.1
Northbound Left	B	10.8	B	15.2	B	13.0	B	17.1
Northbound Through	B	10.3	B	13.3	B	10.6	B	14.4
Northbound Right	A	8.2	B	11.4	A	8.2	B	11.4
Southbound Left	B	10.6	B	13.3	B	11.1	B	15.6
Southbound Through	B	10.0	B	14.1	B	10.7	B	14.9
Southbound Right	B	14.4	B	13.3	B	16.8	B	14.3
Bilby Way/Houghton Road								
Overall Intersection	B	13.4	A	8.7	B	12.9	A	9.6
Westbound Left	C	30.1	C	31.3	C	30.1	C	31.3
Westbound Right	B	16.7	B	18.4	B	16.7	B	18.4
Northbound Through	B	16.5	B	11.8	B	17.1	B	13.4
Northbound Right	A	8.6	A	8.1	A	8.6	A	8.1
Southbound Left	B	11.7	A	8.7	B	12.7	B	12.7
Southbound Through	A	3.6	A	2.2	A	4.0	A	2.4
Drexel Road/Houghton Road								
Overall Intersection	B	10.9	A	10.0	B	18.3	C	25.7
Eastbound Left	N/A		N/A		C	25.2	C	26.8
Eastbound Through/Right					C	25.3	C	31.2
Westbound Left	B	16.4	B	16.8	C	23.7	C	29.2
Westbound Through/Right	N/A		N/A		C	26.1	C	33.5
Westbound Right	B	10.5	A	8.9	N/A		N/A	
Northbound Left	N/A		N/A		C	20.6	D	36.5
Northbound Through	B	17.4	B	17.9	B	14.6	C	20.9
Northbound Right	A	3.3	A	4.9	B	11.7	B	17.9
Southbound Left	C	24.8	C	22.9	C	21.9	B	19.6
Southbound Through	A	1.0	A	1.1	B	17.3	C	24.8
Southbound Right	N/A		N/A		B	17.9	C	29.3
Irvington Road/Houghton Road								
Overall Intersection	B	11.5	B	16.9	B	11.9	C	22.5
Eastbound Left	C	29.6	C	30.5	C	29.6	C	28.2
Eastbound Through	A	0.0	C	24.8	A	0.0	C	23.2
Eastbound Right	B	17.8	C	21.9	B	18.5	C	34.8
Westbound Left	C	27.7	C	24.8	C	27.6	C	23.2
Westbound Through/Right	C	27.7	C	24.8	C	27.7	C	23.2
Northbound Left	B	12.6	B	16.5	B	13.9	C	22.2
Northbound Through	A	2.9	A	6.0	A	3.2	A	8.7
Northbound Right	A	2.0	A	4.3	A	2.0	A	5.8
Southbound Left	B	15.5	C	23.3	B	16.5	C	28.9
Southbound Through	B	14.1	C	21.1	B	14.4	C	26..0
Southbound Right	B	16.8	B	18.6	B	16.8	C	21.1

Delay - seconds per vehicle

Table 8 – 2022 Peak Hour Levels of Service With Project

Intersection	2022 Without Project				2022 With Project			
	AM Peak		PM Peak		AM Peak		PM Peak	
	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Signalized Intersections								
Valencia Road/Houghton Road								
Overall Intersection	B	15.6	B	19.6	B	16.2	C	20.4
Eastbound Left	C	31.4	C	28.3	C	31.7	C	31.6
Eastbound Through	C	30.5	C	24.7	C	30.5	C	24.7
Eastbound Right	D	37.9	C	34.1	D	37.9	C	34.0
Westbound Left	C	30.4	C	32.5	C	30.4	C	32.6
Westbound Through	C	32.9	C	33.2	C	32.9	C	33.2
Westbound Right	D	37.6	D	37.6	D	37.6	D	37.5
Northbound Left	B	12.2	B	16.5	B	14.8	B	18.9
Northbound Through	B	10.9	B	14.0	B	11.1	B	15.1
Northbound Right	A	8.5	B	11.8	A	8.5	B	11.7
Southbound Left	B	11.6	B	14.3	B	12.1	B	16.8
Southbound Through	B	10.6	B	14.9	B	11.3	B	15.8
Southbound Right	B	16.1	B	14.0	B	19.2	B	15.1
Bilby Way/Houghton Road								
Overall Intersection	B	14.1	A	9.0	B	13.7	B	10.0
Westbound Left	C	30.1	C	31.6	C	30.1	C	31.6
Westbound Right	B	16.9	B	18.6	B	16.9	B	18.6
Northbound Through	B	17.7	B	12.3	B	18.4	B	14.0
Northbound Right	A	8.7	A	8.2	A	8.7	A	8.2
Southbound Left	B	13.8	B	10.0	B	15.1	B	15.1
Southbound Through	A	4.0	A	2.3	A	4.4	A	2.5
Drexel Road/Houghton Road								
Overall Intersection	B	11.3	B	10.6	B	19.5	C	27.6
Eastbound Left	N/A		N/A		C	27.7	C	28.0
Eastbound Through/Right					C	27.6	C	32.0
Westbound Left	B	17.3	B	17.4	C	24.9	C	30.2
Westbound Through/Right	N/A		N/A		C	28.3	D	34.2
Westbound Right	B	11.4	A	9.1	N/A		N/A	
Northbound Left	N/A		N/A		C	22.5	D	38.1
Northbound Through	B	18.1	B	19.3	B	15.4	C	21.1
Northbound Right	A	3.1	A	5.0	B	12.0	B	17.5
Southbound Left	C	26.5	C	23.9	C	24.8	C	20.7
Southbound Through	A	1.0	A	1.1	B	18.4	C	28.4
Southbound Right	N/A		N/A		B	19.2	C	34.7
Irvington Road/Houghton Road								
Overall Intersection	B	12.3	B	19.0	B	12.7	C	26.5
Eastbound Left	C	29.6	C	30.6	C	29.6	C	27.0
Eastbound Through	C	27.4	C	24.2	C	27.3	C	21.8
Eastbound Right	B	18.4	C	26.8	B	19.3	D	41.5
Westbound Left	C	27.5	C	24.3	C	27.5	C	21.9
Westbound Through/Right	C	27.6	C	24.3	C	27.5	C	21.9
Northbound Left	B	14.1	B	18.8	B	15.6	C	26.2
Northbound Through	A	3.2	A	7.0	A	3.5	B	11.6
Northbound Right	A	2.1	A	4.8	A	2.2	A	7.5
Southbound Left	B	16.5	C	25.6	B	17.7	D	35.1
Southbound Through	B	14.6	C	22.7	B	14.9	C	30.5
Southbound Right	B	17.9	B	19.6	B	17.9	C	23.9

Delay - seconds per vehicle

Table 8 – 2022 Peak Hour Levels of Service With Project, Continued

Intersection	2022 Without Project				2022 With Project			
	AM Peak		PM Peak		AM Peak		PM Peak	
	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Un-signalized Intersections								
Seven Generations Way/Houghton Road								
Westbound Left	A	0.0	A	0.0	A	0.0	A	0.0
Westbound Right	C	20.4	C	16.5	D	25.6	C	19.2
Southbound Left	D	26.7	D	31.6	E	39.4	F	53.9
North Access/Houghton Road								
Eastbound Left	N/A		N/A		E	45.0	F	>120
Eastbound Right					C	15.1	C	21.6
Northbound Left					C	15.6	D	30.8
South Access/Houghton Road								
Eastbound Right	N/A		N/A		C	17.4	C	18.7
Access 1/Drexel Road								
Westbound Approach	N/A		N/A		A	3.6	A	4.6
Southbound Approach					A	4.5	A	4.0
Access 2/Drexel Road								
Westbound Left	N/A		N/A		A	7.6	A	7.5
Northbound Right					A	9.3	A	8.9
Access 3/Drexel Road								
Southbound Left	N/A		N/A		B	11.2	B	12.2
Access 4/Drexel Road								
Westbound Left	N/A		N/A		A	8.0	A	7.8
Northtbound Right					B	10.5	A	9.6
Access 5/Drexel Road								
Eastbound Approach	N/A		N/A		A	7.1	A	6.4
Westbound Approach					A	4.4	A	9.5
Northbound Approach					A	5.6	A	5.0
Southbound Approach					A	4.1	A	6.8

Delay - seconds per vehicle

Turn Lane Analysis

A key element of this traffic analysis is to determine if right or left turn lanes are required at the project driveway intersections.

The Transportation Access Management Guidelines for the City of Tucson provides warrants for the inclusion of left and right turn lane at intersections based on speed limit, through traffic volume and turning traffic volume during the peak hour.

When needed, turn lanes remove the slowing turning traffic from the through traffic stream, improving capacity and reducing rear-end accidents. **Table 9** shows the locations that were evaluated for left and right turn lanes.

Table 9 – Turn Lane Warrants

Intersection	Direction	Turn Treatment Analyzed	Turn Treatments Warranted?
North Access/Houghton Road	Northbound	Left Turn Lane	Yes
North Access/Houghton Road	Southbound	Right Turn Lane	Yes
South Access/Houghton Road	Southbound	Right Turn Lane	Yes

As shown in **Table 9**, based on the 2022 weekday AM and PM peak hour traffic volumes with the project, new exclusive right turn lanes are warranted for the southbound approaches on Houghton Road into the proposed North Access and South Access intersections. A new exclusive left turn lane is also warranted for the northbound approach on Houghton Road into the proposed North Access.

Queue storage requirements of the warranted turn lanes were calculated using the following methods as recommended in *A Policy of Geometric Design of Highways and Streets* (AASHTO, 2011).

For un-signalized intersections, storage for vehicles likely to arrive in an average two-minute period within the peak hour should be provided.

Vehicles per 2 min. period = (vehicles/hour) ÷ (30 periods/hour)
Storage length = vehicles per 2 min. period x 25 feet

Based on the 2022 weekday AM and PM peak hour traffic volumes with the project, the storage lengths were found for the warranted turn lanes serving the project site. The computed value is typically rounded up to the nearest 25 feet. **Table 10** shows the calculated queue lengths for the warranted turn lanes at the project intersections.

Table 10 – Calculated Queue Lengths

Intersection	Left Turn Storage				Right Turn Storage			
	NB	SB	EB	WB	NB	SB	EB	WB
North Access/Houghton Road								
Turning Volume (vph)	27					51		
$S_{calculated}$ =	23					43		
$S_{rounded}$ =	25					50		
South Access/Houghton Road								
Turning Volume (vph)						43		
$S_{calculated}$ =						36		
$S_{rounded}$ =						50		

S - storage in feet, vph - vehicles per hour

As shown in **Table 10**, the southbound right turn movements at the intersections of North Access/Houghton Road and South Access/Houghton Road should provide a minimum 50 feet of storage. The northbound left turn movement at the intersection of North Access/Houghton Road should provide a minimum of 25 feet of storage.

Based on City of Tucson Transportation Access Management Guidelines, a minimum turn lane storage length of 150 feet is required for the left and right turn lanes into the project site from Houghton Road.

Mitigation

The southbound left turn movement at the intersection of Seven Generations Way/Houghton Road is predicted to experience an inadequate LOS E and F during the weekday AM/PM peak hours of 2017 and 2022, with traffic from the proposed project. These delays are due to the large amount of northbound traffic on Houghton Road, leaving an insufficient number of gaps for vehicles turning onto the minor street approach.

It is important to note that the southbound left turn at the intersection of Seven Generations Way/Houghton Road is on the cusp of an inadequate LOS E during the weekday AM and PM peak hour in 2022, without the project. With the existing 156 southbound left turns onto Seven Generations Way during the PM peak hour, and the large northbound through volume on Houghton Road, the intersection is expected to breakdown in future years, without the proposed project as growth in the area continues.

In order to determine if a traffic signal is warranted at the intersection of Seven Generations Way/Houghton Road, a traffic signal warrant study was completed. Without having base approach count traffic volumes available for the analysis, several assumptions were made regarding the distribution of traffic throughout the day. A ‘K’ factor of 10% was used as the total proportion of daily traffic occurring during the peak hour. It was also assumed that 80% of the daily traffic was spread throughout the twelve busiest hours of the day from 6:00 AM to 6:00 PM.

These factors were used to determine the approach volumes for Houghton Road and Seven Generations Way in the analysis. The following formula was used in determining these average daily traffic values:

Average Daily Traffic = Peak Hour Traffic Volume/K

The *Manual on Uniform Traffic Control Devices (MUTCD)*, Federal Highway Administration, 2009, lists 9 warrants that are used to determine if a traffic signal should be considered for installation at an intersection. A traffic signal may be warranted if one or more of the warrants are satisfied. Warrants #1A and #1B (Eight Hour Volume) and #2 (Four Hour Vehicular Volume) were used to evaluate the need to signalize the intersection. Based on existing conditions, availability of information, and applicability, the remaining warrants (#3, #4, #5, #6, #7, #8, and #9) do not apply to the given conditions.

Warrant #1 (Eight Hour Volume) is satisfied when for at least eight (8) hours of an average day, specific traffic volume levels are met for both the major and minor streets (Condition A – Minimum Vehicular Volume). The MUTCD states these volumes depend on the vehicles per hour (vph) combined for both approaches of the major street, and for the highest volume approach on the minor street. The values vary depending on the number of approach lanes and the 85th percentile speed of the roadways.

Warrant #1 also applies to operating conditions where the major street traffic levels are sufficiently high that traffic entering or crossing from a minor street suffers excessive delay (Condition B – Interruption of Continuous Traffic). Once again, the warrant is satisfied when for each of any of the same eight (8) hours of an average day, specific traffic volume levels are met for both the major and minor streets.

Warrant #2 (Four Hour Volume) is met when, for any four hours of the average day on both the major and minor streets, the hourly approach volumes are above the plotted curve contained in the MUTCD.

Based on the highest hourly approach volume on Seven Generations Way calculated to be 38 vehicles, the minor street approach volume is not expected to exceed the lowest minimum volumes listed in Table 4C-1 (Columns A thru D) of the MUTCD for traffic signal warrant #1A or warrant #1B.

In order to meet Warrant #2, 80 vehicle trips are required on the minor street approach for four hours of a given day as shown in Figure 4C-1 of the MUTCD. The weekday PM peak hour approach volume on Seven Generations Way in the westbound direction is 57 vehicle trips. With a peak hour approach less that the minimum four hour vehicular volume, Warrant #2 is not met.

Table 11 shows the results of the warrant analyses for the intersection of Seven Generations Way/Houghton Road for study year 2022 with the project site traffic.

Table 11 – Traffic Signal Warrant Analysis (Seven Generations Way/Houghton Road)

Year	Warrant Number									
	1		2	3	4	5	6	7	8	9
	Condition A	Condition B								
2022 with project	No	No	No	*	*	*	*	*	*	*
Hours Met	0	0	0	*	*	*	*	*	*	*

* Warrant Does Not Apply

While the installation of a traffic signal may improve LOS for the minor movements, this intersection is located less than one mile between the adjacent signalized intersections of Drexel Road/Houghton Road and Irvington Road/Houghton Road and is considered an inappropriate location for a traffic signal based on the recommendations from the Houghton Road Study. A traffic signal spacing of one mile was recommended for the Houghton Road corridor. It is expected that the adjacent signalized intersections will create gaps in traffic on Houghton Road which will allow for turning movements at the minor street. In addition the results of the traffic signal warrant analysis shows that traffic signal warrants #1A, #1B, and #2 are not satisfied.

The eastbound left turn movement at the intersection of North Access/Houghton Road is also anticipated to operate at an inadequate LOS during the weekday AM/ PM peak hours of 2017 and 2022, with traffic from the project. This delay is due to the large amount of southbound traffic on Houghton Road, leaving an insufficient number of gaps for vehicles turning from the minor street approach. Similar to the intersection of Seven Generations Way/Houghton Road, the intersection of North Access/Houghton Road is located less than one mile between the adjacent signalized intersections, and is not considered an appropriate location for a new traffic signal.

Further mitigation measures are limited at the intersection of North Access/Houghton Road as un-signalized minor street intersections along three or more lane, major streets such as Houghton Road, tend to have their turn movements from the minor street operate at LOS E or LOS F during the peak hours. It is also expected that the adjacent signalized intersections will create gaps in traffic on Houghton Road which will allow for turning movements at the minor street.

Conclusion

When fully completed, the proposed Saguaro Trails development is predicted to generate an additional 11,398 vehicle trips per day (vtpd) on weekdays to the adjacent street system from the new project site. Fifty percent of these new trips (6,515 vehicle trips) will be into the project and fifty percent will be out of the project.

All movements at the existing study intersections currently operate at an adequate LOS and are expected to continue to do so in 2017 and 2022, without traffic from the project. However, the southbound left turn at the intersection of Seven Generations Way/Houghton Road is on the cusp of an inadequate LOS E during the weekday AM and PM peak hour in 2022, without the project.

With the high existing southbound left turn volumes that occur during in the weekday AM/PM peak hour, and the large northbound through volume on Houghton Road, the intersection is expected to breakdown in future years, without the proposed project as growth in the area continues.

While the installation of a traffic signal may improve LOS for the minor street, this intersection is located less than one mile between the adjacent signalized intersections of Drexel Road/Houghton Road and Irvington Road/Houghton Road and is considered an inappropriate location for a traffic signal based on the recommendations from the Houghton Road Study. In addition the results of a traffic signal warrant analysis shows that traffic signal warrants #1A, #1B, and #2 are not satisfied. It is expected that the adjacent signalized intersections will create gaps in traffic on Houghton Road which will allow for turning movements at the minor street. Moreover, this inadequate LOS occurs during the weekday peak hours only, and is expected to operate adequately during the remaining hours throughout the day.

At the intersection of North Access/Houghton Road, the eastbound left turn movement is predicted to experience an inadequate during the weekday AM/PM peak hours of 2017 and 2022, with traffic from the proposed project. These delays are due to the large amount of southbound traffic on Houghton Road, leaving an insufficient number of gaps for vehicles turning from the minor street approach. Mitigation measures are limited at the intersection of North Access/Houghton Road as un-signalized minor street intersections along three or more lane, major streets such as Houghton Road, tend to have their turn movements from the minor street operate at LOS E or LOS F during the peak hours. It is expected that the adjacent signalized intersections will create gaps in traffic on Houghton Road which will allow for turning movements at the minor street.

The remaining study intersections are anticipated to operate at an adequate LOS in 2017 and 2022, with traffic from the project.

The results of the turn lane analysis show that based on the 2022 weekday PM peak hour traffic volumes with the project, a new southbound right turn lane is warranted at the intersections of North Access/Houghton Road and South Access/Houghton Road. A new northbound left turn lane is also warranted at the intersection of North Access/Houghton Road.

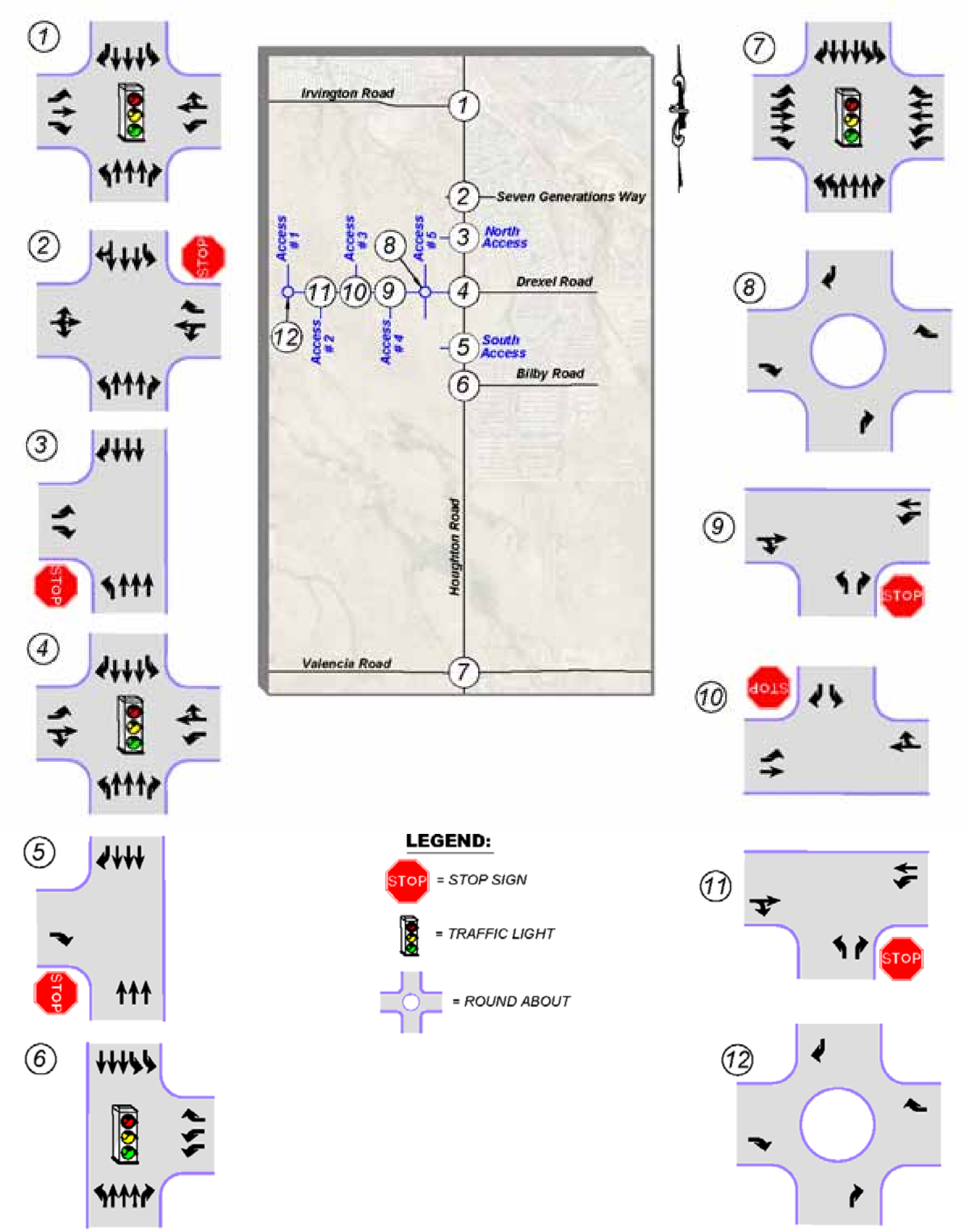
The southbound right turn movements at the intersections of North Access/Houghton Road and South Access/Houghton Road require a minimum 50 feet of storage, while the northbound left turn movement at the intersection of North Access/Houghton Road requires a minimum of 25 feet of storage. However, based on City of Tucson Transportation Access Management Guidelines, a minimum turn lane storage length of 150 feet is required for the left and right turn lanes into the project site from Houghton Road.

New STOP signs and associated STOP bar pavement markings are recommended for vehicles exiting the project site at the intersections of North Access/Houghton Road, South Access/Houghton Road, Access 2/Drexel Road, Access 3/Drexel Road and Access 4/Drexel Road. YIELD signs are recommend to be installed on each approach to the roundabout intersections of Access 1/Drexel Road and Access 5/Drexel Road.

The existing Florida ‘T’ traffic signal at the intersection of Drexel Road/Houghton Road should be modified to a standard four-leg signalized intersection, in conjunction with construction of the proposed extension of Drexel Road west of Houghton Road.

Proposed lane configurations and traffic control are shown in **Figure 11**.

Figure 11 – Proposed Lane Configurations and Traffic Control



TRAFFIC IMPACT ANALYSIS
SAGUARO TRAILS
DREXEL ROAD/HOUGHTON ROAD

APPENDIX

Traffic Counts

Trip Generation Calculations

Capacity Calculations

Turn Lane Analysis

TRAFFIC IMPACT ANALYSIS
SAGUARO TRAILS
DREXEL ROAD/HOUGHTON ROAD

APPENDIX

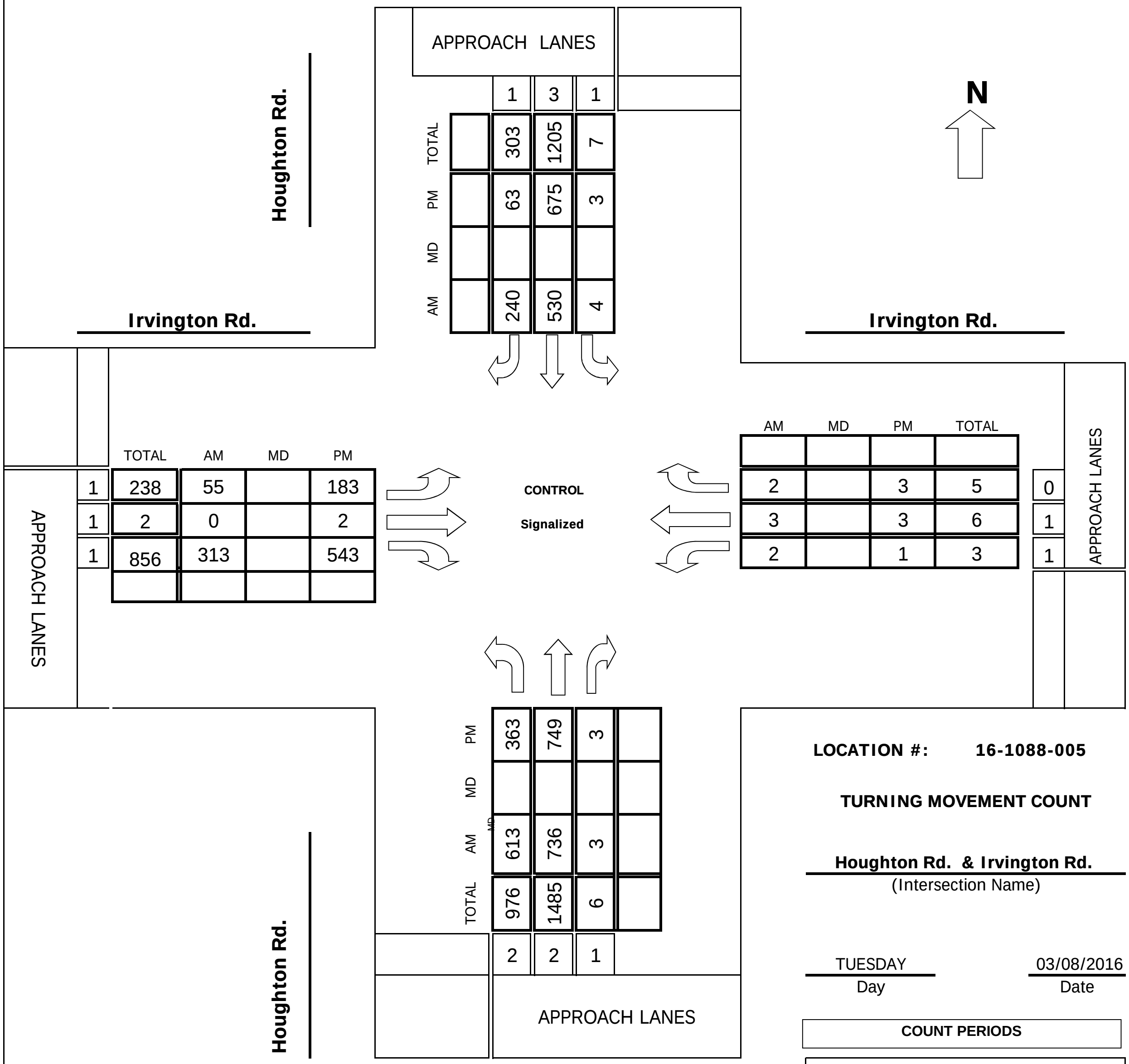
Traffic Counts

Intersection Turning Movement
Prepared by:

FIELD DATA SERVICES OF ARIZONA, INC.
520.316.6745

Project #: 16-1088-005

TMC SUMMARY OF Houghton Rd. & Irvington Rd.



APPROACH LANES		1	3	1
TOTAL		303	1205	7
PM		63	675	3
MD				
AM		240	530	4

APPROACH LANES	TOTAL	AM	MD	PM
1	238	55		183
1	2	0		2
1	856	313		543

AM	MD	PM	TOTAL	APPROACH LANES
2		3	5	0
3		3	6	1
2		1	3	1

PM	363	749	3	
MD				
AM	613	736	3	
TOTAL	976	1485	6	
APPROACH LANES	2	2	1	

LOCATION #: 16-1088-005

TURNING MOVEMENT COUNT

Houghton Rd. & Irvington Rd.
(Intersection Name)

TUESDAY
Day

03/08/2016
Date

COUNT PERIODS			
AM	700AM	-	900AM
NOON		-	
PM	400PM	-	600PM

AM PEAK HOUR 715 AM

NOON PEAK HOUR

PM PEAK HOUR 500 PM

Intersection Turning Movement
Prepared by:

FIELD DATA SERVICES OF ARIZONA, INC.
520.316.6745

veracitytrafficgroup

N-S STREET: Houghton Rd.
E-W STREET: Irvington Rd.
DATE: 03/08/2016
DAY: TUESDAY
LOCATION: Tucson
PROJECT# 16-1088-005

	NORTHBOUND			SOUTHBOUND			EASTBOUND			WESTBOUND			
	NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	TOTAL
LANES:	2	2	1	1	3	1	1	1	1	1	1	0	
6:00 AM													
6:15 AM													
6:30 AM													
6:45 AM													
7:00 AM	128	115	1	0	131	65	14	0	82	0	2	0	538
7:15 AM	158	174	0	2	142	76	14	0	86	0	1	0	653
7:30 AM	158	180	0	0	142	70	18	0	92	0	1	0	661
7:45 AM	171	179	3	0	106	48	11	0	81	2	1	0	602
8:00 AM	126	203	0	2	140	46	12	0	54	0	0	2	585
8:15 AM	120	140	0	1	106	38	10	0	56	0	2	2	475
8:30 AM	91	160	0	0	106	28	8	1	43	2	0	0	439
8:45 AM	89	119	2	3	87	22	12	1	42	3	0	3	383
9:00 AM													
9:15 AM													
9:30 AM													
9:45 AM													
10:00 AM													
10:15 AM													
10:30 AM													
10:45 AM													
11:00 AM													
11:15 AM													
11:30 AM													
11:45 AM													

TOTAL	NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	TOTAL
Volumes	1041	1270	6	8	960	393	99	2	536	7	7	7	4336
Approach %	44.93	54.81	0.26	0.59	70.54	28.88	15.54	0.31	84.14	33.33	33.33	33.33	
App/Depart	2317	/	1376	1361	/	1503	637	/	16	21	/	1441	

AM Peak Hr Begins at: 715 AM

PEAK													
Volumes	613	736	3	4	530	240	55	0	313	2	3	2	2501
Approach %	45.34	54.44	0.22	0.52	68.48	31.01	14.95	0.00	85.05	28.57	42.86	28.57	
PEAK HR. FACTOR:		0.958			0.880			0.836			0.583		0.946

CONTROL: Signalized
COMMENT 1:
GPS: 32.162369, -110.772967

Intersection Turning Movement

FIELD DATA SERVICES OF ARIZONA, INC.
520.316.6745

veracitytrafficgroup

N-S STREET: Houghton Rd.
DATE: 03/08/2016
LOCATION: Tucson

E-W STREET: Irvington Rd.
DAY: TUESDAY
PROJECT# 16-1088-005

	NORTHBOUND			SOUTHBOUND			EASTBOUND			WESTBOUND			
	NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	TOTAL
LANES:	2	2	1	1	3	1	1	1	1	1	1	0	
1:00 PM													
1:15 PM													
1:30 PM													
1:45 PM													
2:00 PM													
2:15 PM													
2:30 PM													
2:45 PM													
3:00 PM													
3:15 PM													
3:30 PM													
3:45 PM													
4:00 PM	72	165	1	0	133	16	23	1	125	0	1	2	539
4:15 PM	96	187	2	1	180	18	42	0	119	1	0	0	646
4:30 PM	80	168	1	2	151	14	29	0	128	1	1	3	578
4:45 PM	59	157	1	0	179	16	38	2	141	1	0	0	594
5:00 PM	110	212	0	0	189	11	32	0	141	0	0	2	697
5:15 PM	97	178	1	1	163	22	57	1	145	0	1	0	666
5:30 PM	84	186	0	2	166	14	41	1	136	0	1	0	631
5:45 PM	72	173	2	0	157	16	53	0	121	1	1	1	597
6:00 PM													
6:15 PM													
6:30 PM													
6:45 PM													

TOTAL	NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	TOTAL
Volumes	670	1426	8	6	1318	127	315	5	1056	4	5	8	4948
Approach %	31.84	67.78	0.38	0.41	90.83	8.75	22.89	0.36	76.74	23.53	29.41	47.06	
App/Depart	2104	/	1749	1451	/	2378	1376	/	19	17	/	802	

PM Peak Hr Begins at: 500 PM

PEAK													
Volumes	363	749	3	3	675	63	183	2	543	1	3	3	2591
Approach %	32.56	67.17	0.27	0.40	91.09	8.50	25.14	0.27	74.59	14.29	42.86	42.86	

PEAK HR. FACTOR:	0.866	0.926	0.897	0.583	0.929

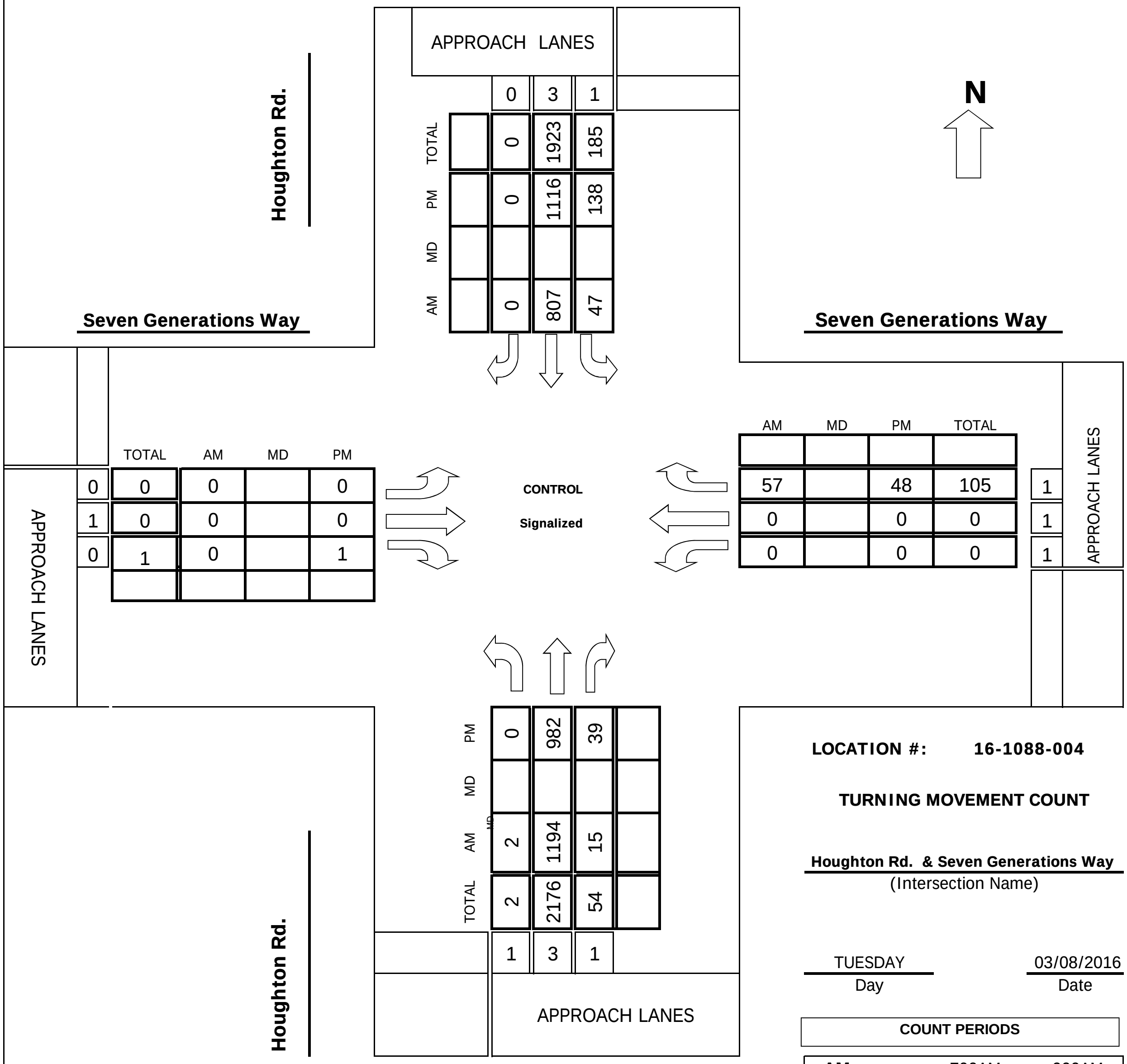
CONTROL: Signalized
COMMENT 1: 0
GPS: 32.162369, -110.772967

Intersection Turning Movement
Prepared by:

FIELD DATA SERVICES OF ARIZONA, INC.
520.316.6745

Project #: 16-1088-004

TMC SUMMARY OF Houghton Rd. & Seven Generations Way



LOCATION #: 16-1088-004

TURNING MOVEMENT COUNT

Houghton Rd. & Seven Generations Way
(Intersection Name)

TUESDAY	03/08/2016
Day	Date

COUNT PERIODS

AM	700AM	-	900AM
NOON		-	
PM	400PM	-	600PM

AM PEAK HOUR	715 AM
NOON PEAK HOUR	
PM PEAK HOUR	445 PM

Intersection Turning Movement
Prepared by:

FIELD DATA SERVICES OF ARIZONA, INC.
520.316.6745

veracitytrafficgroup

N-S STREET: Houghton Rd.

E-W STREET: Seven Generations Way

DATE: 03/08/2016

DAY: TUESDAY

LOCATION: Tucson

PROJECT# 16-1088-004

	NORTHBOUND			SOUTHBOUND			EASTBOUND			WESTBOUND			
	NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	TOTAL
LANES:	1	3	1	1	3	0	0	1	0	0.5	0.5	1	
6:00 AM													
6:15 AM													
6:30 AM													
6:45 AM													
7:00 AM	0	234	4	9	198	0	1	0	0	0	0	18	464
7:15 AM	0	285	2	9	225	0	0	0	0	0	0	16	537
7:30 AM	0	300	3	9	226	0	0	0	0	0	0	14	552
7:45 AM	0	315	4	16	173	0	0	0	0	0	0	9	517
8:00 AM	2	294	6	13	183	0	0	0	0	0	0	18	516
8:15 AM	0	232	5	17	143	0	0	0	1	0	0	19	417
8:30 AM	0	223	13	18	131	1	0	0	0	0	0	12	398
8:45 AM	0	180	9	20	113	0	0	0	0	0	0	8	330
9:00 AM													
9:15 AM													
9:30 AM													
9:45 AM													
10:00 AM													
10:15 AM													
10:30 AM													
10:45 AM													
11:00 AM													
11:15 AM													
11:30 AM													
11:45 AM													

TOTAL	NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	TOTAL
Volumes	2	2063	46	111	1392	1	1	0	1	0	0	114	3731
Approach %	0.09	97.73	2.18	7.38	92.55	0.07	50.00	0.00	50.00	0.00	0.00	100.00	
App/Depart	2111	/	2178	1504	/	1393	2	/	157	114	/	3	

AM Peak Hr Begins at: 715 AM

PEAK													
Volumes	2	1194	15	47	807	0	0	0	0	0	0	57	2122
Approach %	0.17	98.60	1.24	5.50	94.50	0.00	####	####	####	0.00	0.00	100.00	
PEAK HR. FACTOR:		0.949			0.909			0.000			0.792		0.961

CONTROL: Signalized

COMMENT 1:

GPS: 32.155273, -110.772425

Intersection Turning Movement

Field Data Services of Arizona, Inc.
520.316.6745

veracitytrafficgroup

N-S STREET: Houghton Rd.
DATE: 03/08/2016
LOCATION: Tucson

E-W STREET: Seven Generations Way
DAY: TUESDAY
PROJECT# 16-1088-004

	NORTHBOUND			SOUTHBOUND			EASTBOUND			WESTBOUND			
	NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	TOTAL
LANES:	1	3	1	1	3	0	0	1	0	0.5	0.5	1	
1:00 PM													
1:15 PM													
1:30 PM													
1:45 PM													
2:00 PM													
2:15 PM													
2:30 PM													
2:45 PM													
3:00 PM													
3:15 PM													
3:30 PM													
3:45 PM													
4:00 PM	0	240	6	22	275	0	0	0	0	0	0	12	555
4:15 PM	0	262	7	26	280	0	0	0	0	0	0	14	589
4:30 PM	0	224	10	28	250	0	0	0	0	0	0	19	531
4:45 PM	0	224	8	30	284	0	0	0	0	0	0	10	556
5:00 PM	0	280	9	40	286	0	0	0	0	0	0	15	630
5:15 PM	0	250	7	30	277	0	0	0	0	0	0	14	578
5:30 PM	0	228	15	38	269	0	0	0	1	0	0	9	560
5:45 PM	0	226	8	28	243	0	0	0	0	0	0	11	516
6:00 PM													
6:15 PM													
6:30 PM													
6:45 PM													

TOTAL	NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	TOTAL
Volumes	0	1934	70	242	2164	0	0	0	1	0	0	104	4515
Approach %	0.00	96.51	3.49	10.06	89.94	0.00	0.00	0.00	100.00	0.00	0.00	100.00	
App/Depart	2004	/	2038	2406	/	2165	1	/	312	104	/	0	

PM Peak Hr Begins at: 445 PM

PEAK													
Volumes	0	982	39	138	1116	0	0	0	1	0	0	48	2324
Approach %	0.00	96.18	3.82	11.00	89.00	0.00	0.00	0.00	100.00	0.00	0.00	100.00	
PEAK HR. FACTOR:		0.883			0.962			0.250			0.800		0.922

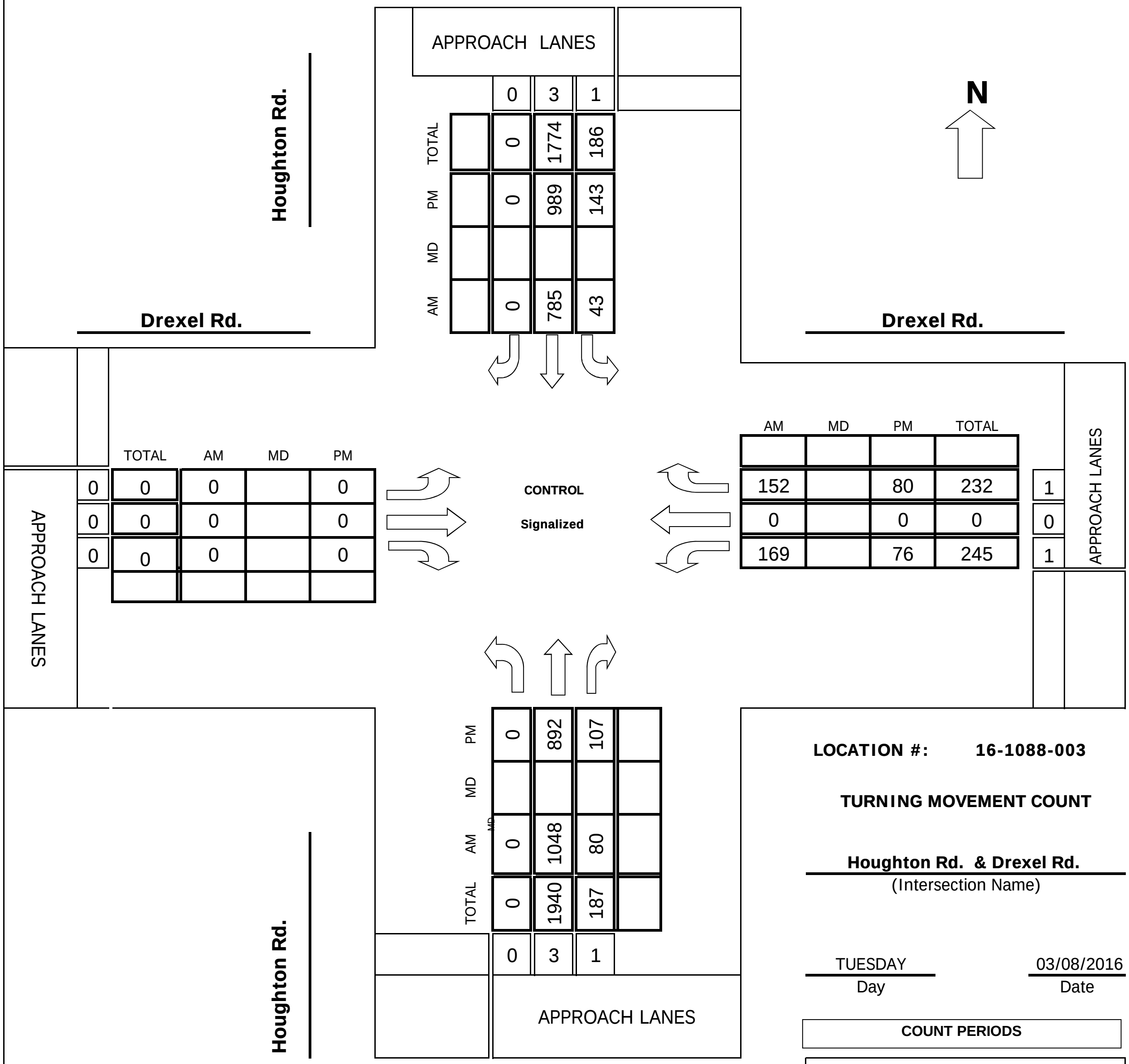
CONTROL: Signalized
COMMENT 1: 0
GPS: 32.155273, -110.772425

Intersection Turning Movement
Prepared by:

Field Data Services of Arizona, Inc.
520.316.6745

Project #: 16-1088-003

TMC SUMMARY OF Houghton Rd. & Drexel Rd.



APPROACH LANES		0	3	1
TOTAL		0	1774	186
PM		0	989	143
MD				
AM		0	785	43

APPROACH LANES	TOTAL	AM	MD	PM
0	0	0		0
0	0	0		0
0	0	0		0

AM	MD	PM	TOTAL	APPROACH LANES
152		80	232	1
0		0	0	0
169		76	245	1

PM	0	892	107	
MD				
AM	0	1048	80	
TOTAL	0	1940	187	
APPROACH LANES	0	3	1	

LOCATION #: 16-1088-003

TURNING MOVEMENT COUNT

Houghton Rd. & Drexel Rd.
(Intersection Name)

TUESDAY
Day

03/08/2016
Date

COUNT PERIODS

AM	700AM	-	900AM
NOON		-	
PM	400PM	-	600PM

AM PEAK HOUR 700 AM

NOON PEAK HOUR

PM PEAK HOUR 430 PM

Intersection Turning Movement
Prepared by:

FIELD DATA SERVICES OF ARIZONA, INC.
520.316.6745

veracitytrafficgroup

N-S STREET: Houghton Rd.
DATE: 03/08/2016
LOCATION: Tucson
E-W STREET: Drexel Rd.
DAY: TUESDAY
PROJECT# 16-1088-003

	NORTHBOUND			SOUTHBOUND			EASTBOUND			WESTBOUND			
	NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	TOTAL
LANES:	0	3	1	1	3	0	0	0	0	1	0	1	
6:00 AM													
6:15 AM													
6:30 AM													
6:45 AM													
7:00 AM	0	207	20	7	216	0	0	0	0	50	0	44	544
7:15 AM	0	262	17	8	186	0	0	0	0	31	0	41	545
7:30 AM	0	278	20	12	221	0	0	0	0	45	0	37	613
7:45 AM	0	301	23	16	162	0	0	0	0	43	0	30	575
8:00 AM	0	207	21	11	148	0	0	0	0	40	0	33	460
8:15 AM	0	227	14	12	113	0	0	0	0	18	0	18	402
8:30 AM	0	183	11	7	126	0	0	0	0	18	0	29	374
8:45 AM	0	146	10	15	102	0	0	0	0	8	0	12	293
9:00 AM													
9:15 AM													
9:30 AM													
9:45 AM													
10:00 AM													
10:15 AM													
10:30 AM													
10:45 AM													
11:00 AM													
11:15 AM													
11:30 AM													
11:45 AM													

TOTAL	NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	TOTAL
Volumes	0	1811	136	88	1274	0	0	0	0	253	0	244	3806
Approach %	0.00	93.01	6.99	6.46	93.54	0.00	####	####	####	50.91	0.00	49.09	
App/Depart	1947	/	2055	1362	/	1527	0	/	224	497	/	0	

AM Peak Hr Begins at: 700 AM

PEAK													
Volumes	0	1048	80	43	785	0	0	0	0	169	0	152	2277
Approach %	0.00	92.91	7.09	5.19	94.81	0.00	####	####	####	52.65	0.00	47.35	
PEAK HR. FACTOR:		0.870			0.888			0.000			0.854		0.929

CONTROL: Signalized
COMMENT 1:
GPS: 32.147957, -110.772340

Intersection Turning Movement

Field Data Services of Arizona, Inc.
520.316.6745

veracitytrafficgroup

N-S STREET: Houghton Rd.
E-W STREET: Drexel Rd.
DATE: 03/08/2016
DAY: TUESDAY
LOCATION: Tucson
PROJECT# 16-1088-003

	NORTHBOUND			SOUTHBOUND			EASTBOUND			WESTBOUND			
	NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	TOTAL
LANES:	0	3	1	1	3	0	0	0	0	1	0	1	
1:00 PM													
1:15 PM													
1:30 PM													
1:45 PM													
2:00 PM													
2:15 PM													
2:30 PM													
2:45 PM													
3:00 PM													
3:15 PM													
3:30 PM													
3:45 PM													
4:00 PM	0	268	24	32	240	0	0	0	0	13	0	18	595
4:15 PM	0	203	27	17	230	0	0	0	0	30	0	16	523
4:30 PM	0	217	25	29	251	0	0	0	0	13	0	11	546
4:45 PM	0	221	24	31	271	0	0	0	0	23	0	29	599
5:00 PM	0	228	29	39	236	0	0	0	0	21	0	22	575
5:15 PM	0	226	29	44	231	0	0	0	0	19	0	18	567
5:30 PM	0	222	29	33	217	0	0	0	0	20	0	15	536
5:45 PM	0	190	28	45	210	0	0	0	0	18	0	18	509
6:00 PM													
6:15 PM													
6:30 PM													
6:45 PM													

TOTAL	NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	TOTAL
Volumes	0	1775	215	270	1886	0	0	0	0	157	0	147	4450
Approach %	0.00	89.20	10.80	12.52	87.48	0.00	####	####	####	51.64	0.00	48.36	
App/Depart	1990	/	1922	2156	/	2043	0	/	485	304	/	0	

PM Peak Hr Begins at: 430 PM

	NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	TOTAL
PEAK Volumes	0	892	107	143	989	0	0	0	0	76	0	80	2287
Approach %	0.00	89.29	10.71	12.63	87.37	0.00	####	####	####	48.72	0.00	51.28	
PEAK HR. FACTOR:		0.972			0.937			0.000			0.750		0.955

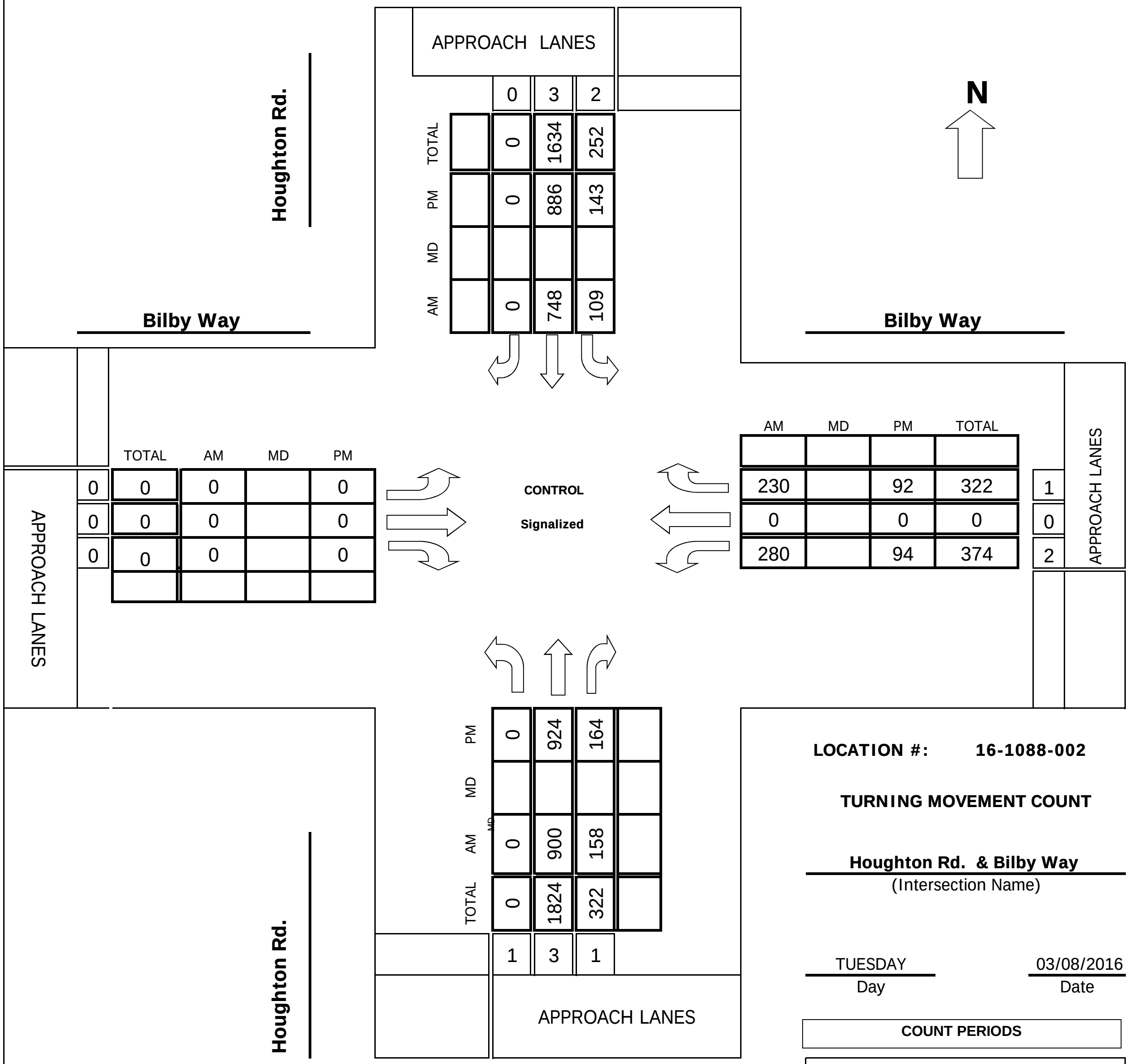
CONTROL: Signalized
COMMENT 1: 0
GPS: 32.147957, -110.772340

Intersection Turning Movement
Prepared by:

FIELD DATA SERVICES OF ARIZONA, INC.
520.316.6745

Project #: 16-1088-002

TMC SUMMARY OF Houghton Rd. & Bilby Way



Houghton Rd. (north approach)

APPROACH LANES	0	3	2
TOTAL	0	1634	252
PM	0	886	143
MD			
AM	0	748	109

Bilby Way (west approach)

APPROACH LANES	TOTAL	AM	MD	PM
0	0	0		0
0	0	0		0
0	0	0		0

Bilby Way (east approach)

AM	MD	PM	TOTAL	APPROACH LANES
230		92	322	1
0		0	0	0
280		94	374	2

Houghton Rd. (south approach)

PM	0	924	164	
MD				
AM	0	900	158	
TOTAL	0	1824	322	
APPROACH LANES	1	3	1	

LOCATION #: 16-1088-002

TURNING MOVEMENT COUNT

Houghton Rd. & Bilby Way
(Intersection Name)

TUESDAY
Day

03/08/2016
Date

COUNT PERIODS

AM	700AM	-	900AM
NOON		-	
PM	400PM	-	600PM

AM PEAK HOUR 715 AM

NOON PEAK HOUR

PM PEAK HOUR 415 PM

Intersection Turning Movement
Prepared by:

FIELD DATA SERVICES OF ARIZONA, INC.
520.316.6745

veracitytrafficgroup

N-S STREET: Houghton Rd.
E-W STREET: Bilby Way
DATE: 03/08/2016
DAY: TUESDAY
LOCATION: Tucson
PROJECT# 16-1088-002

	NORTHBOUND			SOUTHBOUND			EASTBOUND			WESTBOUND			
	NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	TOTAL
LANES:	1	3	1	2	3	0	0	0	0	2	0	1	
6:00 AM													
6:15 AM													
6:30 AM													
6:45 AM													
7:00 AM	0	157	29	23	235	0	0	0	0	56	0	47	547
7:15 AM	0	195	31	27	202	0	0	0	0	65	0	54	574
7:30 AM	0	227	50	31	199	0	0	0	0	57	0	55	619
7:45 AM	0	247	60	40	159	0	0	0	0	85	0	66	657
8:00 AM	0	231	17	11	188	0	0	0	0	73	0	55	575
8:15 AM	0	186	12	11	156	0	0	0	0	29	0	20	414
8:30 AM	0	192	15	11	120	0	0	0	0	17	0	27	382
8:45 AM	0	154	18	12	122	0	0	0	0	21	0	24	351
9:00 AM													
9:15 AM													
9:30 AM													
9:45 AM													
10:00 AM													
10:15 AM													
10:30 AM													
10:45 AM													
11:00 AM													
11:15 AM													
11:30 AM													
11:45 AM													

TOTAL	NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	TOTAL
Volumes	0	1589	232	166	1381	0	0	0	0	403	0	348	4119
Approach %	0.00	87.26	12.74	10.73	89.27	0.00	####	####	####	53.66	0.00	46.34	
App/Depart	1821	/	1937	1547	/	1784	0	/	398	751	/	0	

AM Peak Hr Begins at: 715 AM

PEAK													
Volumes	0	900	158	109	748	0	0	0	0	280	0	230	2425
Approach %	0.00	85.07	14.93	12.72	87.28	0.00	####	####	####	54.90	0.00	45.10	
PEAK HR. FACTOR:		0.862			0.932			0.000			0.844		0.923

CONTROL: Signalized
COMMENT 1:
GPS: 32.140663, -110.772387

Intersection Turning Movement

Field Data Services of Arizona, Inc.
520.316.6745

veracitytrafficgroup

N-S STREET: Houghton Rd.

E-W STREET: Bilby Way

DATE: 03/08/2016

DAY: TUESDAY

LOCATION: Tucson

PROJECT# 16-1088-002

	NORTHBOUND			SOUTHBOUND			EASTBOUND			WESTBOUND			
	NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	TOTAL
LANES:	1	3	1	2	3	0	0	0	0	2	0	1	
1:00 PM													
1:15 PM													
1:30 PM													
1:45 PM													
2:00 PM													
2:15 PM													
2:30 PM													
2:45 PM													
3:00 PM													
3:15 PM													
3:30 PM													
3:45 PM													
4:00 PM	0	228	40	30	243	0	0	0	0	28	0	25	594
4:15 PM	0	239	39	40	213	0	0	0	0	33	0	24	588
4:30 PM	0	217	46	32	200	0	0	0	0	21	0	26	542
4:45 PM	0	218	42	31	235	0	0	0	0	20	0	14	560
5:00 PM	0	250	37	40	238	0	0	0	0	20	0	28	613
5:15 PM	0	246	32	28	232	0	0	0	0	15	0	19	572
5:30 PM	0	223	41	34	202	0	0	0	0	22	0	31	553
5:45 PM	0	212	41	31	187	0	0	0	0	31	0	22	524
6:00 PM													
6:15 PM													
6:30 PM													
6:45 PM													

TOTAL	NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	TOTAL
Volumes	0	1833	318	266	1750	0	0	0	0	190	0	189	4546
Approach %	0.00	85.22	14.78	13.19	86.81	0.00	####	####	####	50.13	0.00	49.87	
App/Depart	2151	/	2022	2016	/	1940	0	/	584	379	/	0	

PM Peak Hr Begins at: 415 PM

PEAK Volumes	0	924	164	143	886	0	0	0	0	94	0	92	2303
Approach %	0.00	84.93	15.07	13.90	86.10	0.00	####	####	####	50.54	0.00	49.46	
PEAK HR. FACTOR:		0.948			0.925			0.000			0.816		0.939

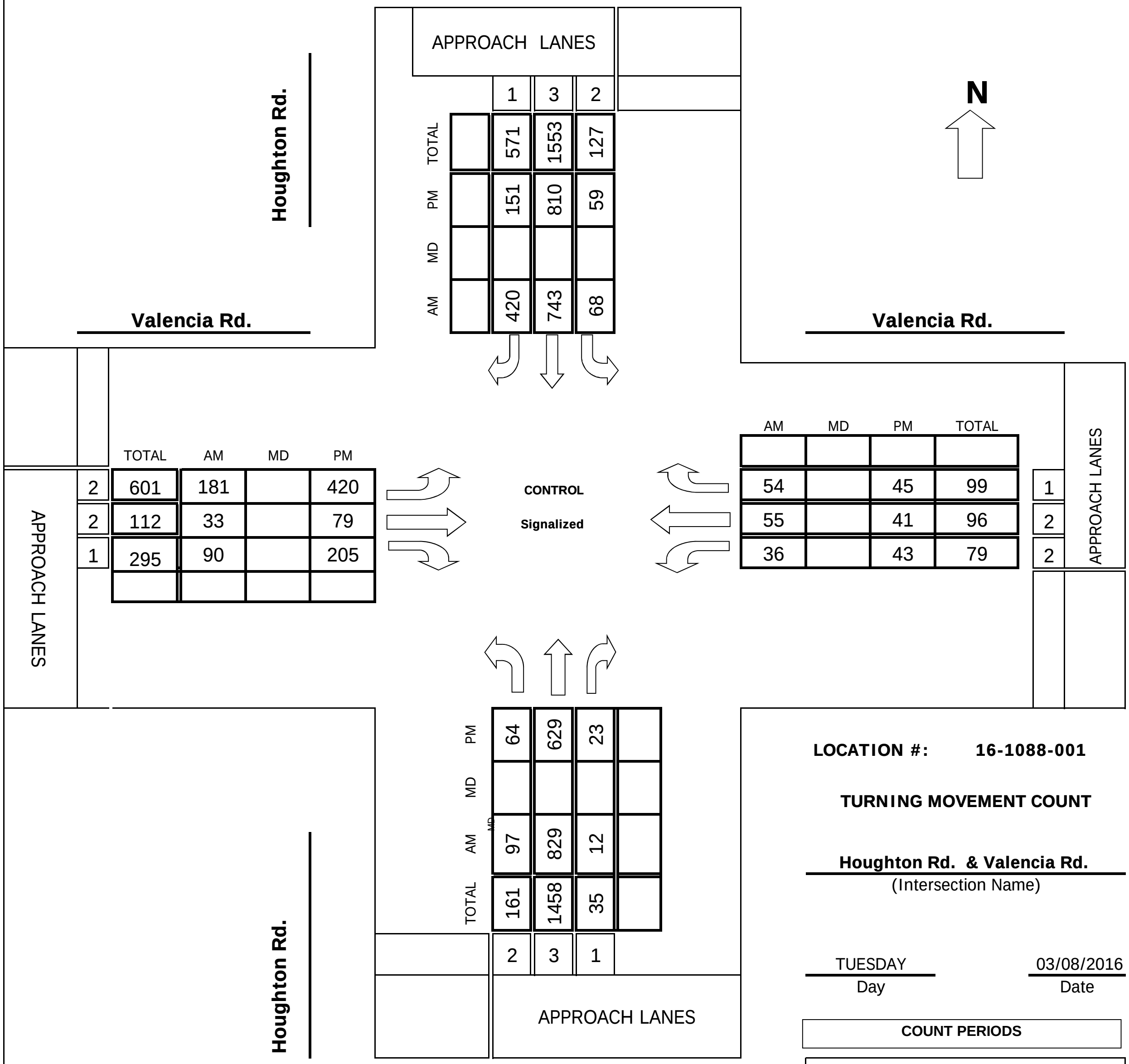
CONTROL: Signalized
COMMENT 1: 0
GPS: 32.140663, -110.772387

Intersection Turning Movement
Prepared by:

FIELD DATA SERVICES OF ARIZONA, INC.
520.316.6745

Project #: 16-1088-001

TMC SUMMARY OF Houghton Rd. & Valencia Rd.



APPROACH LANES (north approach, Houghton Rd.)

		1	3	2
TOTAL		571	1553	127
PM		151	810	59
MD				
AM		420	743	68

APPROACH LANES (west approach, Valencia Rd.)

	TOTAL	AM	MD	PM
2	601	181		420
2	112	33		79
1	295	90		205

APPROACH LANES (east approach, Valencia Rd.)

AM	MD	PM	TOTAL	
54		45	99	1
55		41	96	2
36		43	79	2

APPROACH LANES (south approach, Houghton Rd.)

PM	64	629	23	
MD				
AM	97	829	12	
TOTAL	161	1458	35	
	2	3	1	

LOCATION #: 16-1088-001

TURNING MOVEMENT COUNT

Houghton Rd. & Valencia Rd.
(Intersection Name)

TUESDAY
Day

03/08/2016
Date

COUNT PERIODS

AM	700AM	-	900AM
NOON		-	
PM	400PM	-	600PM

AM PEAK HOUR 715 AM

NOON PEAK HOUR

PM PEAK HOUR 445 PM

Intersection Turning Movement
Prepared by:

FIELD DATA SERVICES OF ARIZONA, INC.
520.316.6745

veracitytrafficgroup

N-S STREET: Houghton Rd.
E-W STREET: Valencia Rd.
DATE: 03/08/2016
DAY: TUESDAY
LOCATION: Tucson
PROJECT# 16-1088-001

	NORTHBOUND			SOUTHBOUND			EASTBOUND			WESTBOUND			
	NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	TOTAL
LANES:	2	3	1	2	3	1	2	2	1	2	2	1	
6:00 AM													
6:15 AM													
6:30 AM													
6:45 AM													
7:00 AM	36	149	0	5	190	113	35	4	20	14	17	10	593
7:15 AM	30	190	2	8	199	125	48	6	20	10	25	11	674
7:30 AM	29	218	2	16	162	94	55	12	24	6	8	24	650
7:45 AM	18	225	5	24	190	105	52	7	25	9	10	15	685
8:00 AM	20	196	3	20	192	96	26	8	21	11	12	4	609
8:15 AM	28	143	0	11	146	55	21	4	15	13	16	7	459
8:30 AM	20	157	2	9	97	49	30	6	15	6	13	5	409
8:45 AM	15	142	5	10	103	44	27	7	13	6	7	6	385
9:00 AM													
9:15 AM													
9:30 AM													
9:45 AM													
10:00 AM													
10:15 AM													
10:30 AM													
10:45 AM													
11:00 AM													
11:15 AM													
11:30 AM													
11:45 AM													

TOTAL	NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	TOTAL
Volumes	196	1420	19	103	1279	681	294	54	153	75	108	82	4464
Approach %	11.99	86.85	1.16	4.99	62.00	33.01	58.68	10.78	30.54	28.30	40.75	30.94	
App/Depart	1635	/	1796	2063	/	1507	501	/	176	265	/	985	

AM Peak Hr Begins at: 715 AM

PEAK													
Volumes	97	829	12	68	743	420	181	33	90	36	55	54	2618
Approach %	10.34	88.38	1.28	5.52	60.36	34.12	59.54	10.86	29.61	24.83	37.93	37.24	
PEAK HR. FACTOR:		0.942			0.927			0.835			0.788		0.955

CONTROL: Signalized
COMMENT 1:
GPS: 32.118798, -110.772960

Intersection Turning Movement

FIELD DATA SERVICES OF ARIZONA, INC.
520.316.6745

veracitytrafficgroup

N-S STREET: Houghton Rd.
E-W STREET: Valencia Rd.

DATE: 03/08/2016
DAY: TUESDAY

LOCATION: Tucson
PROJECT# 16-1088-001

	NORTHBOUND			SOUTHBOUND			EASTBOUND			WESTBOUND			
	NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	TOTAL
LANES:	2	3	1	2	3	1	2	2	1	2	2	1	
1:00 PM													
1:15 PM													
1:30 PM													
1:45 PM													
2:00 PM													
2:15 PM													
2:30 PM													
2:45 PM													
3:00 PM													
3:15 PM													
3:30 PM													
3:45 PM													
4:00 PM	21	175	6	16	160	46	81	21	40	8	5	14	593
4:15 PM	26	181	5	16	161	37	75	22	40	18	13	7	601
4:30 PM	15	165	6	14	178	49	82	15	36	18	6	6	590
4:45 PM	17	144	8	17	202	39	89	15	60	6	10	10	617
5:00 PM	18	166	6	18	189	41	115	27	47	16	10	15	668
5:15 PM	17	154	4	10	214	33	102	19	49	5	12	11	630
5:30 PM	12	165	5	14	205	38	114	18	49	16	9	9	654
5:45 PM	26	132	9	13	194	27	100	23	40	15	3	1	583
6:00 PM													
6:15 PM													
6:30 PM													
6:45 PM													

TOTAL	NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	TOTAL
Volumes	152	1282	49	118	1503	310	758	160	361	102	68	73	4936
Approach %	10.25	86.45	3.30	6.11	77.84	16.05	59.27	12.51	28.23	41.98	27.98	30.04	
App/Depart	1483	/	2113	1931	/	1966	1279	/	327	243	/	530	

PM Peak Hr Begins at: 445 PM

PEAK Volumes	64	629	23	59	810	151	420	79	205	43	41	45	2569
Approach %	8.94	87.85	3.21	5.78	79.41	14.80	59.66	11.22	29.12	33.33	31.78	34.88	
PEAK HR. FACTOR:		0.942			0.988			0.931			0.787		0.961

CONTROL: Signalized
COMMENT 1: 0
GPS: 32.118798, -110.772960

TRAFFIC IMPACT ANALYSIS
SAGUARO TRAILS
DREXEL ROAD/HOUGHTON ROAD

APPENDIX

Trip Generation Calculations

Single-Family Detached Housing

LAND USE: 780 Dwelling Units Single-Family Detached Housing

TRIP GENERATION CALCULATIONS ARE BASED ON THE INSTITUTE OF TRANSPORTATION
ENGINEERS' TRIP GENERATION, 9TH EDITION. THE ITE LAND USE CODE IS
Single-Family Detached Housing (210)

WEEKDAY

Rate = 9.52 Trips per Dwelling Unit (DU)
T = 9.52 Trips x 780 DU
T = 7427 VPD
ENTER: (0.5)*(7427) = **3714 VPD**
EXIT: (0.5)*(7427) = **3714 VPD**

AM PEAK HOUR (ONE HOUR BETWEEN 7 AND 9 AM)

Rate = 0.75 Trips per Dwelling Unit (DU)
T = 0.75 Trips x 780 DU
T = 585 VPH
ENTER: (0.25)*(585) = **146 VPH**
EXIT: (0.75)*(585) = **439 VPH**

PM PEAK HOUR (ONE HOUR BETWEEN 4 AND 6 PM)

Rate = 1 Trips per Dwelling Unit (DU)
T = 1 Trips x 780 DU
T = 780 VPH
ENTER: (0.63)*(780) = **491 VPH**
EXIT: (0.37)*(780) = **289 VPH**

*where, T = trip ends

TRIP GENERATION SUMMARY

WEEKDAY	**7427 VPD**
AM PEAK HOUR (ONE HOUR BETWEEN 7 AND 9 AM)	**585 VPH**
PM PEAK HOUR (ONE HOUR BETWEEN 4 AND 6 PM)	**780 VPH**

Specialty Retail Center

LAND USE: 54,450 Square Feet Specialty Retail Center

TRIP GENERATION CALCULATIONS ARE BASED ON THE INSTITUTE OF TRANSPORTATION ENGINEERS' TRIP GENERATION, 9TH EDITION. THE ITE LAND USE CODE IS
Specialty Retail Center (826)

<u>WEEKDAY</u>

Rate = 44.32 Trips per 1000 Square Feet (SF)
T = 44.32 Trips x 54450 SF / 1000
T = 2414 VPD
ENTER: (0.5)*(2414) = **1207 VPD**
EXIT: (0.5)*(2414) = **1207 VPD**

<u>PM PEAK HOUR (ONE HOUR BETWEEN 4 AND 6 PM)</u>

Rate = 2.71 Trips per 1000 Square Feet (SF)
T = 2.71 Trips x 54450 SF / 1000
T = 148 VPH
ENTER: (0.44)*(148) = **65 VPH**
EXIT: (0.56)*(148) = **83 VPH**

*where, T = trip ends

TRIP GENERATION SUMMARY

WEEKDAY	**2414**	**VPD**
AM PEAK HOUR (ONE HOUR BETWEEN 7 AND 9 AM)	**0**	**VPH**
PM PEAK HOUR (ONE HOUR BETWEEN 4 AND 6 PM)	**148**	**VPH**

Apartment

LAND USE: 220 Dwelling Units Apartment

TRIP GENERATION CALCULATIONS ARE BASED ON THE INSTITUTE OF TRANSPORTATION ENGINEERS' TRIP GENERATION, 9TH EDITION. THE ITE LAND USE CODE IS
Apartment (220)

WEEKDAY

Rate = 6.65 Trips per Dwelling Unit (DU)
T = 6.65 Trips x 220 DU
T = 1464 VPD
ENTER: (0.5)*(1464) = **732 VPD**
EXIT: (0.5)*(1464) = **732 VPD**

AM PEAK HOUR (ONE HOUR BETWEEN 7 AND 9 AM)

Rate = 0.51 Trips per Dwelling Unit (DU)
T = 0.51 Trips x 220 DU
T = 113 VPH
ENTER: (0.2)*(113) = **23 VPH**
EXIT: (0.8)*(113) = **90 VPH**

PM PEAK HOUR (ONE HOUR BETWEEN 4 AND 6 PM)

Rate = 0.62 Trips per Dwelling Unit (DU)
T = 0.62 Trips x 220 DU
T = 137 VPH
ENTER: (0.65)*(137) = **89 VPH**
EXIT: (0.35)*(137) = **48 VPH**

*where, T = trip ends

TRIP GENERATION SUMMARY

WEEKDAY	**1464 VPD**
AM PEAK HOUR (ONE HOUR BETWEEN 7 AND 9 AM)	**113 VPH**
PM PEAK HOUR (ONE HOUR BETWEEN 4 AND 6 PM)	**137 VPH**

County Park

LAND USE: 40 Acres County Park

TRIP GENERATION CALCULATIONS ARE BASED ON THE INSTITUTE OF TRANSPORTATION ENGINEERS' TRIP GENERATION, 9TH EDITION. THE ITE LAND USE CODE IS
County Park (412)

<u>WEEKDAY</u>

Rate = 2.28 Trips per Acre (AC)
T = 2.28 Trips x 40 AC
T = 92 VPD
ENTER: (0.5)*(92) = **46 VPD**
EXIT: (0.5)*(92) = **46 VPD**

<u>AM PEAK HOUR (ONE HOUR BETWEEN 7 AND 9 AM)</u>

Rate = 0.02 Trips per Acre (AC)
T = 0.02 Trips x 40 AC
T = 1 VPH
ENTER: (0.61)*(1) = **1 VPH**
EXIT: (0.39)*(1) = **0 VPH**

<u>PM PEAK HOUR (ONE HOUR BETWEEN 4 AND 6 PM)</u>

Rate = 0.09 Trips per Acre (AC)
T = 0.09 Trips x 40 AC
T = 4 VPH
ENTER: (0.61)*(4) = **2 VPH**
EXIT: (0.39)*(4) = **2 VPH**

*where, T = trip ends

TRIP GENERATION SUMMARY

WEEKDAY	**92 VPD**
AM PEAK HOUR (ONE HOUR BETWEEN 7 AND 9 AM)	**1 VPH**
PM PEAK HOUR (ONE HOUR BETWEEN 4 AND 6 PM)	**4 VPH**

TRAFFIC IMPACT ANALYSIS
SAGUARO TRAILS
DREXEL ROAD/HOUGHTON ROAD

APPENDIX

Capacity Calculations

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑	↱	↰↰	↑↑	↱	↰↰	↑↑↑	↱	↰↰	↑↑↑	↱
Traffic Volume (veh/h)	181	33	90	36	55	54	97	829	12	68	743	420
Future Volume (veh/h)	181	33	90	36	55	54	97	829	12	68	743	420
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	201	37	100	40	61	60	108	921	13	76	826	467
Adj No. of Lanes	2	2	1	2	2	1	2	3	1	2	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	556	329	147	489	244	109	767	2701	841	899	2701	841
Arrive On Green	0.07	0.09	0.09	0.04	0.07	0.07	0.06	0.53	0.53	0.06	0.53	0.53
Sat Flow, veh/h	3442	3539	1583	3442	3539	1583	3442	5085	1583	3442	5085	1583
Grp Volume(v), veh/h	201	37	100	40	61	60	108	921	13	76	826	467
Grp Sat Flow(s),veh/h/ln	1721	1770	1583	1721	1770	1583	1721	1695	1583	1721	1695	1583
Q Serve(g_s), s	0.0	0.7	4.5	0.0	1.2	2.7	0.0	7.6	0.3	0.0	6.7	14.4
Cycle Q Clear(g_c), s	0.0	0.7	4.5	0.0	1.2	2.7	0.0	7.6	0.3	0.0	6.7	14.4
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	556	329	147	489	244	109	767	2701	841	899	2701	841
V/C Ratio(X)	0.36	0.11	0.68	0.08	0.25	0.55	0.14	0.34	0.02	0.08	0.31	0.56
Avail Cap(c_a), veh/h	607	916	410	621	916	410	840	2701	841	972	2701	841
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	30.7	30.5	32.3	30.1	32.4	33.1	10.5	9.9	8.1	10.3	9.6	11.5
Incr Delay (d2), s/veh	0.4	0.2	5.4	0.1	0.5	4.2	0.1	0.3	0.0	0.0	0.3	2.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.9	0.4	2.2	0.4	0.6	1.3	0.6	3.6	0.1	0.4	3.1	6.8
LnGrp Delay(d),s/veh	31.1	30.7	37.7	30.1	32.9	37.3	10.6	10.2	8.2	10.3	9.9	14.1
LnGrp LOS	C	C	D	C	C	D	B	B	A	B	A	B
Approach Vol, veh/h		338			161			1042			1369	
Approach Delay, s/veh		33.0			33.9			10.2			11.4	
Approach LOS		C			C			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	9.4	44.0	8.2	11.8	9.4	44.0	9.9	10.1
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	6.0	39.0	6.0	19.0	6.0	39.0	6.0	19.0
Max Q Clear Time (g_c+I1), s	2.0	9.6	2.0	6.5	2.0	16.4	2.0	4.7
Green Ext Time (p_c), s	0.2	6.6	0.3	0.3	0.2	7.4	0.3	0.4

Intersection Summary	
HCM 2010 Ctrl Delay	14.7
HCM 2010 LOS	B

HCM 2010 Signalized Intersection Summary
3: Houghton Road & Valencia Road

5/17/2016

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑	↱	↰↰	↑↑	↱	↰↰	↑↑↑	↱	↰↰	↑↑↑	↱
Traffic Volume (veh/h)	420	79	205	43	41	45	64	629	23	59	810	151
Future Volume (veh/h)	420	79	205	43	41	45	64	629	23	59	810	151
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	467	88	228	48	46	50	71	699	26	66	900	168
Adj No. of Lanes	2	2	1	2	2	1	2	3	1	2	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	796	633	283	442	242	108	719	2300	716	891	2300	716
Arrive On Green	0.15	0.18	0.18	0.04	0.07	0.07	0.05	0.45	0.45	0.05	0.45	0.45
Sat Flow, veh/h	3442	3539	1583	3442	3539	1583	3442	5085	1583	3442	5085	1583
Grp Volume(v), veh/h	467	88	228	48	46	50	71	699	26	66	900	168
Grp Sat Flow(s),veh/h/ln	1721	1770	1583	1721	1770	1583	1721	1695	1583	1721	1695	1583
Q Serve(g_s), s	3.1	1.5	10.1	0.0	0.9	2.2	0.0	6.4	0.7	0.0	8.6	4.7
Cycle Q Clear(g_c), s	3.1	1.5	10.1	0.0	0.9	2.2	0.0	6.4	0.7	0.0	8.6	4.7
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	796	633	283	442	242	108	719	2300	716	891	2300	716
V/C Ratio(X)	0.59	0.14	0.81	0.11	0.19	0.46	0.10	0.30	0.04	0.07	0.39	0.23
Avail Cap(c_a), veh/h	836	1212	542	578	921	412	822	2300	716	994	2300	716
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	26.4	25.2	28.7	30.9	32.1	32.7	14.8	12.7	11.1	13.0	13.3	12.2
Incr Delay (d2), s/veh	1.0	0.1	5.4	0.1	0.4	3.0	0.1	0.3	0.1	0.0	0.5	0.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.3	0.8	4.8	0.5	0.4	1.1	0.5	3.0	0.3	0.4	4.1	2.2
LnGrp Delay(d),s/veh	27.4	25.3	34.1	31.0	32.5	35.7	14.8	13.0	11.2	13.0	13.8	13.0
LnGrp LOS	C	C	C	C	C	D	B	B	B	B	B	B
Approach Vol, veh/h		783			144			796			1134	
Approach Delay, s/veh		29.1			33.1			13.1			13.6	
Approach LOS		C			C			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	8.8	38.0	8.1	18.0	8.8	38.0	16.2	10.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	6.0	33.0	6.0	25.0	6.0	33.0	12.0	19.0
Max Q Clear Time (g_c+I1), s	2.0	8.4	2.0	12.1	2.0	10.6	5.1	4.2
Green Ext Time (p_c), s	0.1	4.6	0.8	1.0	0.1	6.6	1.1	0.3

Intersection Summary	
HCM 2010 Ctrl Delay	18.7
HCM 2010 LOS	B

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↑↑	↱	↰↰	↑↑↑
Traffic Volume (veh/h)	280	230	900	158	109	748
Future Volume (veh/h)	280	230	900	158	109	748
Number	3	18	2	12	1	6
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	311	256	1000	176	121	831
Adj No. of Lanes	2	1	3	1	2	3
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	488	603	2075	871	1242	3649
Arrive On Green	0.14	0.14	0.41	0.41	0.24	0.72
Sat Flow, veh/h	3442	1583	5253	1583	3442	5253
Grp Volume(v), veh/h	311	256	1000	176	121	831
Grp Sat Flow(s),veh/h/ln	1721	1583	1695	1583	1721	1695
Q Serve(g_s), s	6.1	0.0	10.3	4.0	0.0	3.9
Cycle Q Clear(g_c), s	6.1	0.0	10.3	4.0	0.0	3.9
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	488	603	2075	871	1242	3649
V/C Ratio(X)	0.64	0.42	0.48	0.20	0.10	0.23
Avail Cap(c_a), veh/h	1404	1025	2075	871	1242	3649
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	28.8	16.2	15.5	8.1	11.3	3.4
Incr Delay (d2), s/veh	1.4	0.5	0.8	0.5	0.0	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.9	3.7	5.0	2.4	0.7	1.8
LnGrp Delay(d),s/veh	30.2	16.7	16.3	8.6	11.3	3.5
LnGrp LOS	C	B	B	A	B	A
Approach Vol, veh/h	567		1176			952
Approach Delay, s/veh	24.1		15.2			4.5
Approach LOS	C		B			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	22.0	34.0				56.0		15.1
Change Period (Y+Rc), s	5.0	5.0				5.0		5.0
Max Green Setting (Gmax), s	17.0	29.0				51.0		29.0
Max Q Clear Time (g_c+I1), s	2.0	12.3				5.9		8.1
Green Ext Time (p_c), s	5.0	7.2				6.7		2.0

Intersection Summary	
HCM 2010 Ctrl Delay	13.3
HCM 2010 LOS	B

HCM 2010 Signalized Intersection Summary
8: Houghton Road & Bilby Road

5/17/2016

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↑↑	↱	↰↰	↑↑↑
Traffic Volume (veh/h)	94	92	924	164	143	886
Future Volume (veh/h)	94	92	924	164	143	886
Number	3	18	2	12	1	6
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	104	102	1027	182	159	984
Adj No. of Lanes	2	1	3	1	2	3
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	248	464	2472	884	1264	3970
Arrive On Green	0.07	0.07	0.49	0.49	0.22	0.78
Sat Flow, veh/h	3442	1583	5253	1583	3442	5253
Grp Volume(v), veh/h	104	102	1027	182	159	984
Grp Sat Flow(s),veh/h/ln	1721	1583	1695	1583	1721	1695
Q Serve(g_s), s	2.0	0.0	8.8	3.9	0.0	3.6
Cycle Q Clear(g_c), s	2.0	0.0	8.8	3.9	0.0	3.6
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	248	464	2472	884	1264	3970
V/C Ratio(X)	0.42	0.22	0.42	0.21	0.13	0.25
Avail Cap(c_a), veh/h	1369	979	2472	884	1264	3970
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	30.1	18.1	11.2	7.5	8.5	2.0
Incr Delay (d2), s/veh	1.1	0.2	0.5	0.5	0.0	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.0	1.5	4.2	2.1	0.8	1.7
LnGrp Delay(d),s/veh	31.3	18.4	11.8	8.0	8.5	2.2
LnGrp LOS	C	B	B	A	A	A
Approach Vol, veh/h	206		1209			1143
Approach Delay, s/veh	24.9		11.2			3.1
Approach LOS	C		B			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	20.0	38.0				58.0		9.9
Change Period (Y+Rc), s	5.0	5.0				5.0		5.0
Max Green Setting (Gmax), s	15.0	33.0				53.0		27.0
Max Q Clear Time (g_c+I1), s	2.0	10.8				5.6		4.0
Green Ext Time (p_c), s	5.6	8.5				8.5		0.7

Intersection Summary	
HCM 2010 Ctrl Delay	8.7
HCM 2010 LOS	A

HCM Signalized Intersection Capacity Analysis
14: Houghton Road & Drexel Road

5/17/2016

	↙	↖	↑	↗	↘	↓
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰	↱	↑↑↑	↱	↰	↑↑↑
Traffic Volume (vph)	169	152	1048	80	43	785
Future Volume (vph)	169	152	1048	80	43	785
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	3.0
Lane Util. Factor	1.00	1.00	0.91	1.00	1.00	0.91
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	5085	1583	1770	5085
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1583	5085	1583	1770	5085
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	188	169	1164	89	48	872
RTOR Reduction (vph)	0	8	0	29	0	0
Lane Group Flow (vph)	188	161	1164	60	48	872
Turn Type	Prot	pm+ov	NA	pm+ov	Prot	NA
Protected Phases	4!	5	6	4	5	2 8!
Permitted Phases		4		6		
Actuated Green, G (s)	18.6	25.4	20.9	39.5	6.8	50.2
Effective Green, g (s)	19.6	27.4	21.9	41.5	7.8	51.2
Actuated g/C Ratio	0.32	0.45	0.36	0.68	0.13	0.84
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	565	810	1816	1174	225	4247
v/s Ratio Prot	c0.11	0.03	c0.23	0.02	0.03	c0.17
v/s Ratio Perm		0.08		0.02		
v/c Ratio	0.33	0.20	0.64	0.05	0.21	0.21
Uniform Delay, d1	15.9	10.3	16.4	3.3	24.0	1.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.3	0.1	0.8	0.0	0.5	0.0
Delay (s)	16.2	10.4	17.2	3.3	24.5	1.0
Level of Service	B	B	B	A	C	A
Approach Delay (s)	13.5		16.2			2.3
Approach LOS	B		B			A

Intersection Summary			
HCM 2000 Control Delay	10.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	61.3	Sum of lost time (s)	16.0
Intersection Capacity Utilization	42.9%	ICU Level of Service	A
Analysis Period (min)	15		

! Phase conflict between lane groups.

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
14: Houghton Road & Drexel Road

5/17/2016

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰	↱	↑↑↑	↱	↰	↑↑↑
Traffic Volume (vph)	76	80	892	107	143	989
Future Volume (vph)	76	80	892	107	143	989
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	3.0
Lane Util. Factor	1.00	1.00	0.91	1.00	1.00	0.91
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	5085	1583	1770	5085
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1583	5085	1583	1770	5085
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	84	89	991	119	159	1099
RTOR Reduction (vph)	0	5	0	46	0	0
Lane Group Flow (vph)	84	84	991	73	159	1099
Turn Type	Prot	pm+ov	NA	pm+ov	Prot	NA
Protected Phases	4!	5	6	4	5	2 8!
Permitted Phases		4		6		
Actuated Green, G (s)	16.2	27.0	19.1	35.3	10.8	50.0
Effective Green, g (s)	17.2	29.0	20.1	37.3	11.8	51.0
Actuated g/C Ratio	0.28	0.47	0.33	0.61	0.19	0.83
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	498	854	1672	1070	341	4244
v/s Ratio Prot	c0.05	0.02	c0.19	0.02	c0.09	c0.22
v/s Ratio Perm		0.03		0.03		
v/c Ratio	0.17	0.10	0.59	0.07	0.47	0.26
Uniform Delay, d1	16.6	8.8	17.1	4.8	21.9	1.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.1	0.6	0.0	1.0	0.0
Delay (s)	16.7	8.9	17.7	4.9	22.9	1.1
Level of Service	B	A	B	A	C	A
Approach Delay (s)	12.7		16.3			3.8
Approach LOS	B		B			A

Intersection Summary			
HCM 2000 Control Delay	9.9	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	61.1	Sum of lost time (s)	16.0
Intersection Capacity Utilization	39.4%	ICU Level of Service	A
Analysis Period (min)	15		

! Phase conflict between lane groups.

c Critical Lane Group

HCM 2010 TWSC
10: Houghton Road & 7 Generation Way

5/17/2016

Intersection	
Int Delay, s/veh	1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Traffic Vol, veh/h	0	57	1194	15	47	807
Future Vol, veh/h	0	57	1194	15	47	807
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	175	0	-	200	300	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	63	1327	17	52	897

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1790	663	0	0	1327	0
Stage 1	1327	-	-	-	-	-
Stage 2	463	-	-	-	-	-
Critical Hdwy	5.74	7.14	-	-	5.34	-
Critical Hdwy Stg 1	6.64	-	-	-	-	-
Critical Hdwy Stg 2	6.04	-	-	-	-	-
Follow-up Hdwy	3.82	3.92	-	-	3.12	-
Pot Cap-1 Maneuver	121	346	-	-	271	-
Stage 1	152	-	-	-	-	-
Stage 2	549	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	98	346	-	-	271	-
Mov Cap-2 Maneuver	98	-	-	-	-	-
Stage 1	152	-	-	-	-	-
Stage 2	444	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	17.7	0	1.2
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	-	346	271	-
HCM Lane V/C Ratio	-	-	-	0.183	0.193	-
HCM Control Delay (s)	-	-	0	17.7	21.4	-
HCM Lane LOS	-	-	A	C	C	-
HCM 95th %tile Q(veh)	-	-	-	0.7	0.7	-

Intersection	
Int Delay, s/veh	1.7

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Traffic Vol, veh/h	0	48	982	39	138	1116
Future Vol, veh/h	0	48	982	39	138	1116
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	175	0	-	200	300	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	53	1091	43	153	1240

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1894	546	0	0	1091	0
Stage 1	1091	-	-	-	-	-
Stage 2	803	-	-	-	-	-
Critical Hdwy	5.74	7.14	-	-	5.34	-
Critical Hdwy Stg 1	6.64	-	-	-	-	-
Critical Hdwy Stg 2	6.04	-	-	-	-	-
Follow-up Hdwy	3.82	3.92	-	-	3.12	-
Pot Cap-1 Maneuver	107	413	-	-	354	-
Stage 1	213	-	-	-	-	-
Stage 2	364	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	61	413	-	-	354	-
Mov Cap-2 Maneuver	61	-	-	-	-	-
Stage 1	213	-	-	-	-	-
Stage 2	207	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	15	0	2.5
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	-	413	354	-
HCM Lane V/C Ratio	-	-	-	0.129	0.433	-
HCM Control Delay (s)	-	-	0	15	22.7	-
HCM Lane LOS	-	-	A	C	C	-
HCM 95th %tile Q(veh)	-	-	-	0.4	2.1	-

HCM 2010 Signalized Intersection Summary
12: Houghton Road & Irvington Road

5/17/2016

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑	↱	↰	↱		↰↰	↑↑	↱	↰	↑↑↑	↱
Traffic Volume (veh/h)	55	0	313	2	3	2	613	736	3	4	530	240
Future Volume (veh/h)	55	0	313	2	3	2	613	736	3	4	530	240
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	61	0	348	2	3	2	681	818	3	4	589	267
Adj No. of Lanes	1	1	1	1	1	0	2	2	1	1	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	235	174	595	203	98	65	1551	2682	1200	325	2040	635
Arrive On Green	0.09	0.00	0.09	0.09	0.09	0.09	0.28	0.76	0.76	0.40	0.40	0.40
Sat Flow, veh/h	1405	1863	1583	1029	1044	696	3442	3539	1583	664	5085	1583
Grp Volume(v), veh/h	61	0	348	2	0	5	681	818	3	4	589	267
Grp Sat Flow(s),veh/h/ln	1405	1863	1583	1029	0	1740	1721	1770	1583	664	1695	1583
Q Serve(g_s), s	2.8	0.0	0.0	0.1	0.0	0.2	0.0	4.9	0.0	0.3	5.3	8.2
Cycle Q Clear(g_c), s	3.0	0.0	0.0	0.1	0.0	0.2	0.0	4.9	0.0	5.2	5.3	8.2
Prop In Lane	1.00		1.00	1.00		0.40	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	235	174	595	203	0	163	1551	2682	1200	325	2040	635
V/C Ratio(X)	0.26	0.00	0.58	0.01	0.00	0.03	0.44	0.30	0.00	0.01	0.29	0.42
Avail Cap(c_a), veh/h	709	803	1129	550	0	750	1551	2682	1200	325	2040	635
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	29.1	0.0	16.8	27.7	0.0	27.7	12.0	2.6	2.0	15.3	13.6	14.5
Incr Delay (d2), s/veh	0.6	0.0	0.9	0.0	0.0	0.1	0.2	0.3	0.0	0.1	0.4	2.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.1	0.0	5.2	0.0	0.0	0.1	4.6	2.4	0.0	0.1	2.5	3.9
LnGrp Delay(d),s/veh	29.6	0.0	17.7	27.7	0.0	27.8	12.2	2.9	2.0	15.3	14.0	16.6
LnGrp LOS	C		B	C		C	B	A	A	B	B	B
Approach Vol, veh/h		409			7			1502			860	
Approach Delay, s/veh		19.5			27.8			7.1			14.8	
Approach LOS		B			C			A			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		56.0		11.3	24.0	32.0		11.3
Change Period (Y+Rc), s		5.0		5.0	5.0	5.0		5.0
Max Green Setting (Gmax), s		51.0		29.0	19.0	27.0		29.0
Max Q Clear Time (g_c+I1), s		6.9		5.0	2.0	10.2		2.2
Green Ext Time (p_c), s		9.9		1.3	7.4	4.3		1.4

Intersection Summary	
HCM 2010 Ctrl Delay	11.4
HCM 2010 LOS	B

HCM 2010 Signalized Intersection Summary
12: Houghton Road & Irvington Road

5/17/2016

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑	↱	↰	↱		↰↰	↑↑	↱	↰	↑↑↑	↱
Traffic Volume (veh/h)	183	2	543	1	3	3	363	749	3	3	675	63
Future Volume (veh/h)	183	2	543	1	3	3	363	749	3	3	675	63
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	203	2	603	1	3	3	403	832	3	3	750	70
Adj No. of Lanes	1	1	1	1	1	0	2	2	1	1	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	368	371	745	254	170	170	1372	2378	1064	247	1708	532
Arrive On Green	0.20	0.20	0.20	0.20	0.20	0.20	0.27	0.67	0.67	0.34	0.34	0.34
Sat Flow, veh/h	1404	1863	1583	812	856	856	3442	3539	1583	655	5085	1583
Grp Volume(v), veh/h	203	2	603	1	0	6	403	832	3	3	750	70
Grp Sat Flow(s),veh/h/ln	1404	1863	1583	812	0	1712	1721	1770	1583	655	1695	1583
Q Serve(g_s), s	10.5	0.1	4.2	0.1	0.0	0.2	0.0	7.8	0.0	0.3	8.9	2.4
Cycle Q Clear(g_c), s	10.7	0.1	4.2	0.1	0.0	0.2	0.0	7.8	0.0	8.1	8.9	2.4
Prop In Lane	1.00		1.00	1.00		0.50	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	368	371	745	254	0	340	1372	2378	1064	247	1708	532
V/C Ratio(X)	0.55	0.01	0.81	0.00	0.00	0.02	0.29	0.35	0.00	0.01	0.44	0.13
Avail Cap(c_a), veh/h	597	674	1002	386	0	619	1372	2378	1064	247	1708	532
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	29.2	24.9	17.5	24.9	0.0	24.9	15.8	5.4	4.2	22.7	20.0	17.9
Incr Delay (d2), s/veh	1.3	0.0	3.7	0.0	0.0	0.0	0.1	0.4	0.0	0.1	0.8	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.2	0.0	10.8	0.0	0.0	0.1	3.2	3.8	0.0	0.1	4.3	1.1
LnGrp Delay(d),s/veh	30.5	24.9	21.2	24.9	0.0	24.9	15.9	5.9	4.2	22.8	20.8	18.4
LnGrp LOS	C	C	C	C		C	B	A	A	C	C	B
Approach Vol, veh/h		808			7			1238			823	
Approach Delay, s/veh		23.6			24.9			9.1			20.6	
Approach LOS		C			C			A			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		57.0		20.4	26.0	31.0		20.4
Change Period (Y+Rc), s		5.0		5.0	5.0	5.0		5.0
Max Green Setting (Gmax), s		52.0		28.0	21.0	26.0		28.0
Max Q Clear Time (g_c+I1), s		9.8		12.7	2.0	10.9		2.2
Green Ext Time (p_c), s		8.2		2.7	6.7	4.4		3.0

Intersection Summary	
HCM 2010 Ctrl Delay	16.5
HCM 2010 LOS	B

HCM 2010 Signalized Intersection Summary
3: Houghton Road & Valencia Road

5/17/2016

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑	↱	↰↰	↑↑	↱	↰↰	↑↑↑	↱	↰↰	↑↑↑	↱
Traffic Volume (veh/h)	185	34	92	37	57	56	99	846	13	70	758	429
Future Volume (veh/h)	185	34	92	37	57	56	99	846	13	70	758	429
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	206	38	102	41	63	62	110	940	14	78	842	477
Adj No. of Lanes	2	2	1	2	2	1	2	3	1	2	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	557	333	149	491	249	112	756	2695	839	886	2695	839
Arrive On Green	0.07	0.09	0.09	0.04	0.07	0.07	0.06	0.53	0.53	0.06	0.53	0.53
Sat Flow, veh/h	3442	3539	1583	3442	3539	1583	3442	5085	1583	3442	5085	1583
Grp Volume(v), veh/h	206	38	102	41	63	62	110	940	14	78	842	477
Grp Sat Flow(s),veh/h/ln	1721	1770	1583	1721	1770	1583	1721	1695	1583	1721	1695	1583
Q Serve(g_s), s	0.0	0.7	4.6	0.0	1.2	2.8	0.0	7.8	0.3	0.0	6.9	14.9
Cycle Q Clear(g_c), s	0.0	0.7	4.6	0.0	1.2	2.8	0.0	7.8	0.3	0.0	6.9	14.9
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	557	333	149	491	249	112	756	2695	839	886	2695	839
V/C Ratio(X)	0.37	0.11	0.68	0.08	0.25	0.56	0.15	0.35	0.02	0.09	0.31	0.57
Avail Cap(c_a), veh/h	607	914	409	623	914	409	828	2695	839	958	2695	839
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	30.8	30.5	32.3	30.1	32.4	33.1	10.8	10.0	8.2	10.5	9.7	11.6
Incr Delay (d2), s/veh	0.4	0.2	5.5	0.1	0.5	4.3	0.1	0.4	0.0	0.0	0.3	2.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.0	0.4	2.2	0.4	0.6	1.3	0.7	3.7	0.1	0.4	3.3	7.1
LnGrp Delay(d),s/veh	31.2	30.7	37.7	30.1	32.9	37.4	10.8	10.3	8.2	10.6	10.0	14.4
LnGrp LOS	C	C	D	C	C	D	B	B	A	B	B	B
Approach Vol, veh/h		346			166			1064			1397	
Approach Delay, s/veh		33.1			33.9			10.4			11.6	
Approach LOS		C			C			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	9.5	44.0	8.2	11.9	9.5	44.0	9.9	10.2
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	6.0	39.0	6.0	19.0	6.0	39.0	6.0	19.0
Max Q Clear Time (g_c+I1), s	2.0	9.8	2.0	6.6	2.0	16.9	2.0	4.8
Green Ext Time (p_c), s	0.2	6.8	0.3	0.3	0.2	7.5	0.3	0.4

Intersection Summary	
HCM 2010 Ctrl Delay	14.9
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑	↱	↰↰	↑↑	↱	↰↰	↑↑↑	↱	↰↰	↑↑↑	↱
Traffic Volume (veh/h)	429	81	210	44	42	46	66	642	24	61	827	155
Future Volume (veh/h)	429	81	210	44	42	46	66	642	24	61	827	155
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	477	90	233	49	47	51	73	713	27	68	919	172
Adj No. of Lanes	2	2	1	2	2	1	2	3	1	2	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	807	644	288	440	241	108	706	2287	712	878	2287	712
Arrive On Green	0.16	0.18	0.18	0.04	0.07	0.07	0.05	0.45	0.45	0.05	0.45	0.45
Sat Flow, veh/h	3442	3539	1583	3442	3539	1583	3442	5085	1583	3442	5085	1583
Grp Volume(v), veh/h	477	90	233	49	47	51	73	713	27	68	919	172
Grp Sat Flow(s),veh/h/ln	1721	1770	1583	1721	1770	1583	1721	1695	1583	1721	1695	1583
Q Serve(g_s), s	3.3	1.6	10.4	0.0	0.9	2.3	0.0	6.6	0.7	0.0	8.9	4.9
Cycle Q Clear(g_c), s	3.3	1.6	10.4	0.0	0.9	2.3	0.0	6.6	0.7	0.0	8.9	4.9
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	807	644	288	440	241	108	706	2287	712	878	2287	712
V/C Ratio(X)	0.59	0.14	0.81	0.11	0.19	0.47	0.10	0.31	0.04	0.08	0.40	0.24
Avail Cap(c_a), veh/h	830	1206	539	573	916	410	806	2287	712	978	2287	712
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	26.4	25.2	28.8	31.1	32.3	32.9	15.2	12.9	11.3	13.3	13.6	12.5
Incr Delay (d2), s/veh	1.1	0.1	5.4	0.1	0.4	3.2	0.1	0.4	0.1	0.0	0.5	0.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.4	0.8	5.0	0.5	0.5	1.1	0.5	3.1	0.3	0.4	4.3	2.3
LnGrp Delay(d),s/veh	27.5	25.3	34.2	31.2	32.7	36.1	15.2	13.3	11.4	13.3	14.1	13.3
LnGrp LOS	C	C	C	C	C	D	B	B	B	B	B	B
Approach Vol, veh/h		800			147			813			1159	
Approach Delay, s/veh		29.2			33.4			13.4			13.9	
Approach LOS		C			C			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	8.9	38.0	8.2	18.3	8.9	38.0	16.5	10.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	6.0	33.0	6.0	25.0	6.0	33.0	12.0	19.0
Max Q Clear Time (g_c+I1), s	2.0	8.6	2.0	12.4	2.0	10.9	5.3	4.3
Green Ext Time (p_c), s	0.1	4.7	0.8	1.0	0.1	6.7	1.1	0.3

Intersection Summary	
HCM 2010 Ctrl Delay	18.9
HCM 2010 LOS	B

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↑↑	↱	↰↰	↑↑↑
Traffic Volume (veh/h)	286	235	918	162	112	763
Future Volume (veh/h)	286	235	918	162	112	763
Number	3	18	2	12	1	6
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	318	261	1020	180	124	848
Adj No. of Lanes	2	1	3	1	2	3
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	496	606	2069	872	1230	3639
Arrive On Green	0.14	0.14	0.41	0.41	0.24	0.72
Sat Flow, veh/h	3442	1583	5253	1583	3442	5253
Grp Volume(v), veh/h	318	261	1020	180	124	848
Grp Sat Flow(s),veh/h/ln	1721	1583	1695	1583	1721	1695
Q Serve(g_s), s	6.2	0.0	10.6	4.1	0.0	4.1
Cycle Q Clear(g_c), s	6.2	0.0	10.6	4.1	0.0	4.1
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	496	606	2069	872	1230	3639
V/C Ratio(X)	0.64	0.43	0.49	0.21	0.10	0.23
Avail Cap(c_a), veh/h	1400	1022	2069	872	1230	3639
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	28.8	16.3	15.7	8.1	11.7	3.5
Incr Delay (d2), s/veh	1.4	0.5	0.8	0.5	0.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.1	3.8	5.1	2.5	0.7	1.9
LnGrp Delay(d),s/veh	30.1	16.7	16.5	8.6	11.7	3.6
LnGrp LOS	C	B	B	A	B	A
Approach Vol, veh/h	579		1200			972
Approach Delay, s/veh	24.1		15.3			4.6
Approach LOS	C		B			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	22.0	34.0				56.0		15.3
Change Period (Y+Rc), s	5.0	5.0				5.0		5.0
Max Green Setting (Gmax), s	17.0	29.0				51.0		29.0
Max Q Clear Time (g_c+I1), s	2.0	12.6				6.1		8.2
Green Ext Time (p_c), s	5.1	7.2				6.9		2.1

Intersection Summary		
HCM 2010 Ctrl Delay		13.4
HCM 2010 LOS		B

HCM 2010 Signalized Intersection Summary
8: Houghton Road & Bilby Road

5/17/2016

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↑↑	↱	↰↰	↑↑↑
Traffic Volume (veh/h)	96	94	943	168	146	904
Future Volume (veh/h)	96	94	943	168	146	904
Number	3	18	2	12	1	6
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	107	104	1048	187	162	1004
Adj No. of Lanes	2	1	3	1	2	3
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	249	464	2471	884	1254	3969
Arrive On Green	0.07	0.07	0.49	0.49	0.22	0.78
Sat Flow, veh/h	3442	1583	5253	1583	3442	5253
Grp Volume(v), veh/h	107	104	1048	187	162	1004
Grp Sat Flow(s),veh/h/ln	1721	1583	1695	1583	1721	1695
Q Serve(g_s), s	2.0	0.0	9.1	4.0	0.0	3.7
Cycle Q Clear(g_c), s	2.0	0.0	9.1	4.0	0.0	3.7
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	249	464	2471	884	1254	3969
V/C Ratio(X)	0.43	0.22	0.42	0.21	0.13	0.25
Avail Cap(c_a), veh/h	1368	979	2471	884	1254	3969
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	30.2	18.2	11.3	7.5	8.7	2.0
Incr Delay (d2), s/veh	1.2	0.2	0.5	0.5	0.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.0	1.5	4.3	2.2	0.8	1.7
LnGrp Delay(d),s/veh	31.3	18.4	11.8	8.1	8.7	2.2
LnGrp LOS	C	B	B	A	A	A
Approach Vol, veh/h	211		1235			1166
Approach Delay, s/veh	25.0		11.3			3.1
Approach LOS	C		B			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	20.0	38.0				58.0		9.9
Change Period (Y+Rc), s	5.0	5.0				5.0		5.0
Max Green Setting (Gmax), s	15.0	33.0				53.0		27.0
Max Q Clear Time (g_c+I1), s	2.0	11.1				5.7		4.0
Green Ext Time (p_c), s	5.7	8.6				8.7		0.7

Intersection Summary	
HCM 2010 Ctrl Delay	8.7
HCM 2010 LOS	A

HCM Signalized Intersection Capacity Analysis
14: Houghton Road & Drexel Road

5/17/2016

	↙	↖	↑	↗	↘	↓
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰	↱	↑↑↑	↱	↰	↑↑↑
Traffic Volume (vph)	173	156	1069	82	44	801
Future Volume (vph)	173	156	1069	82	44	801
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	3.0
Lane Util. Factor	1.00	1.00	0.91	1.00	1.00	0.91
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	5085	1583	1770	5085
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1583	5085	1583	1770	5085
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	192	173	1188	91	49	890
RTOR Reduction (vph)	0	7	0	29	0	0
Lane Group Flow (vph)	192	166	1188	62	49	890
Turn Type	Prot	pm+ov	NA	pm+ov	Prot	NA
Protected Phases	4!	5	6	4	5	2 8!
Permitted Phases		4		6		
Actuated Green, G (s)	18.8	25.6	21.2	40.0	6.8	50.7
Effective Green, g (s)	19.8	27.6	22.2	42.0	7.8	51.7
Actuated g/C Ratio	0.32	0.45	0.36	0.68	0.13	0.84
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	567	809	1826	1178	223	4253
v/s Ratio Prot	c0.11	0.03	c0.23	0.02	0.03	c0.18
v/s Ratio Perm		0.08		0.02		
v/c Ratio	0.34	0.20	0.65	0.05	0.22	0.21
Uniform Delay, d1	16.0	10.4	16.6	3.3	24.3	1.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.4	0.1	0.8	0.0	0.5	0.0
Delay (s)	16.4	10.5	17.4	3.3	24.8	1.0
Level of Service	B	B	B	A	C	A
Approach Delay (s)	13.6		16.4			2.3
Approach LOS	B		B			A

Intersection Summary			
HCM 2000 Control Delay	10.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	61.8	Sum of lost time (s)	16.0
Intersection Capacity Utilization	43.6%	ICU Level of Service	A
Analysis Period (min)	15		

! Phase conflict between lane groups.

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
14: Houghton Road & Drexel Road

	↙	↖	↑	↗	↘	↓
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰	↱	↑↑↑	↱	↰	↑↑↑
Traffic Volume (vph)	78	82	910	110	146	1009
Future Volume (vph)	78	82	910	110	146	1009
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	3.0
Lane Util. Factor	1.00	1.00	0.91	1.00	1.00	0.91
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	5085	1583	1770	5085
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1583	5085	1583	1770	5085
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	87	91	1011	122	162	1121
RTOR Reduction (vph)	0	5	0	48	0	0
Lane Group Flow (vph)	87	86	1011	74	162	1121
Turn Type	Prot	pm+ov	NA	pm+ov	Prot	NA
Protected Phases	4!	5	6	4	5	2 8!
Permitted Phases		4		6		
Actuated Green, G (s)	16.2	27.1	19.1	35.3	10.9	50.1
Effective Green, g (s)	17.2	29.1	20.1	37.3	11.9	51.1
Actuated g/C Ratio	0.28	0.48	0.33	0.61	0.19	0.83
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	497	856	1670	1068	344	4245
v/s Ratio Prot	c0.05	0.02	c0.20	0.02	c0.09	c0.22
v/s Ratio Perm		0.03		0.03		
v/c Ratio	0.18	0.10	0.61	0.07	0.47	0.26
Uniform Delay, d1	16.6	8.8	17.2	4.9	21.9	1.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.1	0.6	0.0	1.0	0.0
Delay (s)	16.8	8.9	17.9	4.9	22.9	1.1
Level of Service	B	A	B	A	C	A
Approach Delay (s)	12.8		16.5			3.9
Approach LOS	B		B			A

Intersection Summary			
HCM 2000 Control Delay	10.0	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	61.2	Sum of lost time (s)	16.0
Intersection Capacity Utilization	40.0%	ICU Level of Service	A
Analysis Period (min)	15		

! Phase conflict between lane groups.

c Critical Lane Group

HCM 2010 TWSC
10: Houghton Road & 7 Generation Way

5/17/2016

Intersection	
Int Delay, s/veh	1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Traffic Vol, veh/h	0	58	1218	16	48	824
Future Vol, veh/h	0	58	1218	16	48	824
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	175	0	-	200	300	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	64	1353	18	53	916

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1826	677	0	0	1353	0
Stage 1	1353	-	-	-	-	-
Stage 2	473	-	-	-	-	-
Critical Hdwy	5.74	7.14	-	-	5.34	-
Critical Hdwy Stg 1	6.64	-	-	-	-	-
Critical Hdwy Stg 2	6.04	-	-	-	-	-
Follow-up Hdwy	3.82	3.92	-	-	3.12	-
Pot Cap-1 Maneuver	116	339	-	-	263	-
Stage 1	146	-	-	-	-	-
Stage 2	542	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	93	339	-	-	263	-
Mov Cap-2 Maneuver	93	-	-	-	-	-
Stage 1	146	-	-	-	-	-
Stage 2	433	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	18.1	0	1.2
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	-	339	263	-
HCM Lane V/C Ratio	-	-	-	0.19	0.203	-
HCM Control Delay (s)	-	-	0	18.1	22.1	-
HCM Lane LOS	-	-	A	C	C	-
HCM 95th %tile Q(veh)	-	-	-	0.7	0.7	-

HCM 2010 TWSC
10: Houghton Road & 7 Generations Way

Intersection	
Int Delay, s/veh	1.7

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Traffic Vol, veh/h	0	49	1002	40	141	1139
Future Vol, veh/h	0	49	1002	40	141	1139
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	175	0	-	200	300	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	54	1113	44	157	1266

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1933	557	0	0	1113	0
Stage 1	1113	-	-	-	-	-
Stage 2	820	-	-	-	-	-
Critical Hdwy	5.74	7.14	-	-	5.34	-
Critical Hdwy Stg 1	6.64	-	-	-	-	-
Critical Hdwy Stg 2	6.04	-	-	-	-	-
Follow-up Hdwy	3.82	3.92	-	-	3.12	-
Pot Cap-1 Maneuver	102	406	-	-	345	-
Stage 1	206	-	-	-	-	-
Stage 2	357	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	56	406	-	-	345	-
Mov Cap-2 Maneuver	56	-	-	-	-	-
Stage 1	206	-	-	-	-	-
Stage 2	195	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	15.2	0	2.6
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	-	406	345	-
HCM Lane V/C Ratio	-	-	-	0.134	0.454	-
HCM Control Delay (s)	-	-	0	15.2	23.8	-
HCM Lane LOS	-	-	A	C	C	-
HCM 95th %tile Q(veh)	-	-	-	0.5	2.3	-

HCM 2010 Signalized Intersection Summary
12: Houghton Road & Irvington Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑	↱	↰	↱		↰↰	↑↑	↱	↰	↑↑↑	↱
Traffic Volume (veh/h)	57	0	320	2	3	2	626	751	3	4	541	245
Future Volume (veh/h)	57	0	320	2	3	2	626	751	3	4	541	245
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	63	0	356	2	3	2	696	834	3	4	601	272
Adj No. of Lanes	1	1	1	1	1	0	2	2	1	1	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	237	178	597	204	100	66	1540	2677	1198	319	2036	634
Arrive On Green	0.10	0.00	0.10	0.10	0.10	0.10	0.28	0.76	0.76	0.40	0.40	0.40
Sat Flow, veh/h	1405	1863	1583	1021	1044	696	3442	3539	1583	654	5085	1583
Grp Volume(v), veh/h	63	0	356	2	0	5	696	834	3	4	601	272
Grp Sat Flow(s),veh/h/ln	1405	1863	1583	1021	0	1740	1721	1770	1583	654	1695	1583
Q Serve(g_s), s	2.9	0.0	0.0	0.1	0.0	0.2	0.0	5.1	0.0	0.3	5.4	8.4
Cycle Q Clear(g_c), s	3.0	0.0	0.0	0.1	0.0	0.2	0.0	5.1	0.0	5.3	5.4	8.4
Prop In Lane	1.00		1.00	1.00		0.40	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	237	178	597	204	0	166	1540	2677	1198	319	2036	634
V/C Ratio(X)	0.27	0.00	0.60	0.01	0.00	0.03	0.45	0.31	0.00	0.01	0.30	0.43
Avail Cap(c_a), veh/h	708	801	1127	546	0	748	1540	2677	1198	319	2036	634
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	29.1	0.0	16.9	27.6	0.0	27.7	12.4	2.6	2.0	15.4	13.7	14.6
Incr Delay (d2), s/veh	0.6	0.0	1.0	0.0	0.0	0.1	0.2	0.3	0.0	0.1	0.4	2.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.2	0.0	5.4	0.0	0.0	0.1	4.7	2.5	0.0	0.1	2.6	4.0
LnGrp Delay(d),s/veh	29.6	0.0	17.8	27.7	0.0	27.7	12.6	2.9	2.0	15.5	14.1	16.8
LnGrp LOS	C		B	C		C	B	A	A	B	B	B
Approach Vol, veh/h		419			7			1533			877	
Approach Delay, s/veh		19.6			27.7			7.3			14.9	
Approach LOS		B			C			A			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		56.0		11.4	24.0	32.0		11.4
Change Period (Y+Rc), s		5.0		5.0	5.0	5.0		5.0
Max Green Setting (Gmax), s		51.0		29.0	19.0	27.0		29.0
Max Q Clear Time (g_c+I1), s		7.1		5.0	2.0	10.4		2.2
Green Ext Time (p_c), s		10.2		1.4	7.5	4.3		1.4

Intersection Summary	
HCM 2010 Ctrl Delay	11.5
HCM 2010 LOS	B

HCM 2010 Signalized Intersection Summary
12: Houghton Road & Irvington Road

5/17/2016

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑	↱	↰	↱		↰↰	↑↑	↱	↰	↑↑↑	↱
Traffic Volume (veh/h)	187	2	554	1	3	3	371	764	3	3	689	65
Future Volume (veh/h)	187	2	554	1	3	3	371	764	3	3	689	65
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	208	2	616	1	3	3	412	849	3	3	766	72
Adj No. of Lanes	1	1	1	1	1	0	2	2	1	1	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	373	377	748	254	173	173	1356	2367	1059	241	1700	529
Arrive On Green	0.20	0.20	0.20	0.20	0.20	0.20	0.27	0.67	0.67	0.33	0.33	0.33
Sat Flow, veh/h	1404	1863	1583	802	856	856	3442	3539	1583	645	5085	1583
Grp Volume(v), veh/h	208	2	616	1	0	6	412	849	3	3	766	72
Grp Sat Flow(s),veh/h/ln	1404	1863	1583	802	0	1712	1721	1770	1583	645	1695	1583
Q Serve(g_s), s	10.8	0.1	5.1	0.1	0.0	0.2	0.0	8.1	0.0	0.3	9.2	2.5
Cycle Q Clear(g_c), s	11.0	0.1	5.1	0.1	0.0	0.2	0.0	8.1	0.0	8.4	9.2	2.5
Prop In Lane	1.00		1.00	1.00		0.50	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	373	377	748	254	0	347	1356	2367	1059	241	1700	529
V/C Ratio(X)	0.56	0.01	0.82	0.00	0.00	0.02	0.30	0.36	0.00	0.01	0.45	0.14
Avail Cap(c_a), veh/h	594	671	998	381	0	616	1356	2367	1059	241	1700	529
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	29.2	24.7	17.7	24.8	0.0	24.8	16.4	5.6	4.3	23.2	20.3	18.0
Incr Delay (d2), s/veh	1.3	0.0	4.2	0.0	0.0	0.0	0.1	0.4	0.0	0.1	0.9	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.3	0.0	11.3	0.0	0.0	0.1	3.2	4.0	0.0	0.1	4.4	1.2
LnGrp Delay(d),s/veh	30.5	24.8	21.9	24.8	0.0	24.8	16.5	6.0	4.3	23.3	21.1	18.6
LnGrp LOS	C	C	C	C		C	B	A	A	C	C	B
Approach Vol, veh/h		826			7			1264			841	
Approach Delay, s/veh		24.1			24.8			9.4			20.9	
Approach LOS		C			C			A			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		57.0		20.8	26.0	31.0		20.8
Change Period (Y+Rc), s		5.0		5.0	5.0	5.0		5.0
Max Green Setting (Gmax), s		52.0		28.0	21.0	26.0		28.0
Max Q Clear Time (g_c+I1), s		10.1		13.0	2.0	11.2		2.2
Green Ext Time (p_c), s		8.4		2.7	6.8	4.4		3.0

Intersection Summary	
HCM 2010 Ctrl Delay	16.9
HCM 2010 LOS	B

HCM 2010 Signalized Intersection Summary
3: Houghton Road & Valencia Road

5/17/2016

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑	↱	↰↰	↑↑	↱	↰↰	↑↑↑	↱	↰↰	↑↑↑	↱
Traffic Volume (veh/h)	204	38	102	41	62	61	110	934	14	77	837	473
Future Volume (veh/h)	204	38	102	41	62	61	110	934	14	77	837	473
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	227	42	113	46	69	68	122	1038	16	86	930	526
Adj No. of Lanes	2	2	1	2	2	1	2	3	1	2	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	564	358	160	488	264	118	704	2675	833	826	2675	833
Arrive On Green	0.07	0.10	0.10	0.04	0.07	0.07	0.06	0.53	0.53	0.06	0.53	0.53
Sat Flow, veh/h	3442	3539	1583	3442	3539	1583	3442	5085	1583	3442	5085	1583
Grp Volume(v), veh/h	227	42	113	46	69	68	122	1038	16	86	930	526
Grp Sat Flow(s),veh/h/ln	1721	1770	1583	1721	1770	1583	1721	1695	1583	1721	1695	1583
Q Serve(g_s), s	0.0	0.8	5.1	0.0	1.4	3.1	0.0	9.0	0.4	0.0	7.9	17.5
Cycle Q Clear(g_c), s	0.0	0.8	5.1	0.0	1.4	3.1	0.0	9.0	0.4	0.0	7.9	17.5
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	564	358	160	488	264	118	704	2675	833	826	2675	833
V/C Ratio(X)	0.40	0.12	0.71	0.09	0.26	0.58	0.17	0.39	0.02	0.10	0.35	0.63
Avail Cap(c_a), veh/h	609	907	406	624	907	406	769	2675	833	891	2675	833
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	31.0	30.3	32.3	30.3	32.4	33.2	12.0	10.5	8.4	11.5	10.2	12.5
Incr Delay (d2), s/veh	0.5	0.1	5.6	0.1	0.5	4.4	0.1	0.4	0.0	0.1	0.4	3.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.2	0.4	2.5	0.4	0.7	1.5	0.8	4.2	0.2	0.5	3.7	8.3
LnGrp Delay(d),s/veh	31.4	30.5	37.9	30.4	32.9	37.6	12.2	10.9	8.5	11.6	10.6	16.1
LnGrp LOS	C	C	D	C	C	D	B	B	A	B	B	B
Approach Vol, veh/h		382			183			1176			1542	
Approach Delay, s/veh		33.2			34.0			11.0			12.5	
Approach LOS		C			C			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	9.6	44.0	8.1	12.5	9.6	44.0	10.0	10.5
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	6.0	39.0	6.0	19.0	6.0	39.0	6.0	19.0
Max Q Clear Time (g_c+I1), s	2.0	11.0	2.0	7.1	2.0	19.5	2.0	5.1
Green Ext Time (p_c), s	0.2	7.6	0.3	0.4	0.2	8.0	0.3	0.5

Intersection Summary	
HCM 2010 Ctrl Delay	15.6
HCM 2010 LOS	B

HCM 2010 Signalized Intersection Summary
3: Houghton Road & Valencia Road

5/17/2016

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑	↱	↰↰	↑↑	↱	↰↰	↑↑↑	↱	↰↰	↑↑↑	↱
Traffic Volume (veh/h)	473	89	231	49	47	51	73	709	26	67	913	171
Future Volume (veh/h)	473	89	231	49	47	51	73	709	26	67	913	171
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	526	99	257	54	52	57	81	788	29	74	1014	190
Adj No. of Lanes	2	2	1	2	2	1	2	3	1	2	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	824	697	312	400	238	107	657	2261	704	825	2261	704
Arrive On Green	0.16	0.20	0.20	0.03	0.07	0.07	0.05	0.44	0.44	0.05	0.44	0.44
Sat Flow, veh/h	3442	3539	1583	3442	3539	1583	3442	5085	1583	3442	5085	1583
Grp Volume(v), veh/h	526	99	257	54	52	57	81	788	29	74	1014	190
Grp Sat Flow(s),veh/h/ln	1721	1770	1583	1721	1770	1583	1721	1695	1583	1721	1695	1583
Q Serve(g_s), s	4.6	1.7	11.6	0.0	1.0	2.6	0.0	7.6	0.8	0.0	10.3	5.6
Cycle Q Clear(g_c), s	4.6	1.7	11.6	0.0	1.0	2.6	0.0	7.6	0.8	0.0	10.3	5.6
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	824	697	312	400	238	107	657	2261	704	825	2261	704
V/C Ratio(X)	0.64	0.14	0.82	0.13	0.22	0.53	0.12	0.35	0.04	0.09	0.45	0.27
Avail Cap(c_a), veh/h	824	1192	533	560	906	405	747	2261	704	915	2261	704
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	26.6	24.6	28.6	32.4	32.8	33.5	16.7	13.5	11.7	14.3	14.3	13.0
Incr Delay (d2), s/veh	1.7	0.1	5.5	0.2	0.5	4.1	0.1	0.4	0.1	0.0	0.6	0.9
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	5.0	0.8	5.5	0.5	0.5	1.2	0.6	3.6	0.4	0.5	4.9	2.6
LnGrp Delay(d),s/veh	28.3	24.7	34.1	32.5	33.2	37.6	16.7	14.0	11.8	14.3	14.9	14.0
LnGrp LOS	C	C	C	C	C	D	B	B	B	B	B	B
Approach Vol, veh/h		882			163			898			1278	
Approach Delay, s/veh		29.6			34.5			14.2			14.8	
Approach LOS		C			C			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	9.1	38.0	7.6	19.6	9.1	38.0	17.2	10.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	6.0	33.0	6.0	25.0	6.0	33.0	12.0	19.0
Max Q Clear Time (g_c+I1), s	2.0	9.6	2.0	13.6	2.0	12.3	6.6	4.6
Green Ext Time (p_c), s	0.1	5.3	0.1	1.1	0.1	7.3	1.1	0.3

Intersection Summary	
HCM 2010 Ctrl Delay	19.6
HCM 2010 LOS	B

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↑↑	↱	↰↰	↑↑↑
Traffic Volume (veh/h)	316	260	1014	178	123	843
Future Volume (veh/h)	316	260	1014	178	123	843
Number	3	18	2	12	1	6
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	351	289	1127	198	137	937
Adj No. of Lanes	2	1	3	1	2	3
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	535	619	2042	882	1172	3591
Arrive On Green	0.16	0.16	0.40	0.40	0.24	0.71
Sat Flow, veh/h	3442	1583	5253	1583	3442	5253
Grp Volume(v), veh/h	351	289	1127	198	137	937
Grp Sat Flow(s),veh/h/ln	1721	1583	1695	1583	1721	1695
Q Serve(g_s), s	6.9	0.0	12.3	4.6	0.0	4.8
Cycle Q Clear(g_c), s	6.9	0.0	12.3	4.6	0.0	4.8
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	535	619	2042	882	1172	3591
V/C Ratio(X)	0.66	0.47	0.55	0.22	0.12	0.26
Avail Cap(c_a), veh/h	1382	1008	2042	882	1172	3591
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	28.7	16.4	16.6	8.1	13.7	3.8
Incr Delay (d2), s/veh	1.4	0.5	1.1	0.6	0.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.4	4.3	5.9	2.8	0.9	2.2
LnGrp Delay(d),s/veh	30.1	16.9	17.7	8.7	13.8	4.0
LnGrp LOS	C	B	B	A	B	A
Approach Vol, veh/h	640		1325			1074
Approach Delay, s/veh	24.1		16.4			5.2
Approach LOS	C		B			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	22.0	34.0				56.0		16.2
Change Period (Y+Rc), s	5.0	5.0				5.0		5.0
Max Green Setting (Gmax), s	17.0	29.0				51.0		29.0
Max Q Clear Time (g_c+I1), s	2.0	14.3				6.8		8.9
Green Ext Time (p_c), s	5.7	7.5				7.8		2.3

Intersection Summary	
HCM 2010 Ctrl Delay	14.1
HCM 2010 LOS	B

HCM 2010 Signalized Intersection Summary
8: Houghton Road & Bilby Road

5/17/2016

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↑↑	↱	↰↰	↑↑↑
Traffic Volume (veh/h)	106	104	1041	185	162	998
Future Volume (veh/h)	106	104	1041	185	162	998
Number	3	18	2	12	1	6
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	118	116	1157	206	180	1109
Adj No. of Lanes	2	1	3	1	2	3
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	250	465	2470	884	1207	3967
Arrive On Green	0.07	0.07	0.49	0.49	0.22	0.78
Sat Flow, veh/h	3442	1583	5253	1583	3442	5253
Grp Volume(v), veh/h	118	116	1157	206	180	1109
Grp Sat Flow(s),veh/h/ln	1721	1583	1695	1583	1721	1695
Q Serve(g_s), s	2.2	0.0	10.3	4.5	0.0	4.2
Cycle Q Clear(g_c), s	2.2	0.0	10.3	4.5	0.0	4.2
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	250	465	2470	884	1207	3967
V/C Ratio(X)	0.47	0.25	0.47	0.23	0.15	0.28
Avail Cap(c_a), veh/h	1368	979	2470	884	1207	3967
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	30.2	18.3	11.6	7.6	10.0	2.1
Incr Delay (d2), s/veh	1.4	0.3	0.6	0.6	0.1	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.1	1.7	5.0	2.4	1.0	1.9
LnGrp Delay(d),s/veh	31.6	18.6	12.3	8.2	10.0	2.3
LnGrp LOS	C	B	B	A	B	A
Approach Vol, veh/h	234		1363			1289
Approach Delay, s/veh	25.2		11.7			3.4
Approach LOS	C		B			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	20.0	38.0				58.0		9.9
Change Period (Y+Rc), s	5.0	5.0				5.0		5.0
Max Green Setting (Gmax), s	15.0	33.0				53.0		27.0
Max Q Clear Time (g_c+I1), s	2.0	12.3				6.2		4.2
Green Ext Time (p_c), s	6.3	9.4				10.1		0.8

Intersection Summary	
HCM 2010 Ctrl Delay	9.0
HCM 2010 LOS	A

HCM Signalized Intersection Capacity Analysis
14: Houghton Road & Drexel Road

5/17/2016

Movement	WBL	WBR	NBT	NBR	SBL	SBT
	↙	↖	↑	↗	↘	↓
Lane Configurations	↰	↱	↑↑↑	↱	↰	↑↑↑
Traffic Volume (vph)	191	172	1181	91	49	885
Future Volume (vph)	191	172	1181	91	49	885
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	3.0
Lane Util. Factor	1.00	1.00	0.91	1.00	1.00	0.91
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	5085	1583	1770	5085
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1583	5085	1583	1770	5085
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	212	191	1312	101	54	983
RTOR Reduction (vph)	0	4	0	31	0	0
Lane Group Flow (vph)	212	187	1312	70	54	983
Turn Type	Prot	pm+ov	NA	pm+ov	Prot	NA
Protected Phases	4!	5	6	4	5	2 8!
Permitted Phases		4		6		
Actuated Green, G (s)	19.7	26.3	23.1	42.8	6.6	53.2
Effective Green, g (s)	20.7	28.3	24.1	44.8	7.6	54.2
Actuated g/C Ratio	0.32	0.44	0.37	0.70	0.12	0.84
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	568	793	1902	1199	208	4279
v/s Ratio Prot	c0.12	0.03	c0.26	0.02	0.03	c0.19
v/s Ratio Perm		0.09		0.03		
v/c Ratio	0.37	0.24	0.69	0.06	0.26	0.23
Uniform Delay, d1	16.8	11.3	17.0	3.1	25.8	1.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.4	0.2	1.1	0.0	0.7	0.0
Delay (s)	17.3	11.4	18.1	3.1	26.5	1.0
Level of Service	B	B	B	A	C	A
Approach Delay (s)	14.5		17.0			2.4
Approach LOS	B		B			A

Intersection Summary			
HCM 2000 Control Delay	11.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	64.4	Sum of lost time (s)	16.0
Intersection Capacity Utilization	46.7%	ICU Level of Service	A
Analysis Period (min)	15		

! Phase conflict between lane groups.

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
14: Houghton Road & Drexel Road

5/17/2016

	↙	↖	↑	↗	↘	↓
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰	↱	↑↑↑	↱	↰	↑↑↑
Traffic Volume (vph)	86	91	1005	121	162	1114
Future Volume (vph)	86	91	1005	121	162	1114
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	3.0
Lane Util. Factor	1.00	1.00	0.91	1.00	1.00	0.91
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	5085	1583	1770	5085
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1583	5085	1583	1770	5085
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	96	101	1117	134	180	1238
RTOR Reduction (vph)	0	3	0	52	0	0
Lane Group Flow (vph)	96	98	1117	82	180	1238
Turn Type	Prot	pm+ov	NA	pm+ov	Prot	NA
Protected Phases	4!	5	6	4	5	2 8!
Permitted Phases		4		6		
Actuated Green, G (s)	16.9	28.4	19.8	36.7	11.5	52.1
Effective Green, g (s)	17.9	30.4	20.8	38.7	12.5	53.1
Actuated g/C Ratio	0.28	0.48	0.33	0.61	0.20	0.84
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	501	861	1673	1069	350	4272
v/s Ratio Prot	c0.05	0.02	c0.22	0.02	c0.10	c0.24
v/s Ratio Perm		0.04		0.03		
v/c Ratio	0.19	0.11	0.67	0.08	0.51	0.29
Uniform Delay, d1	17.2	9.0	18.2	5.0	22.6	1.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.1	1.0	0.0	1.3	0.0
Delay (s)	17.4	9.1	19.3	5.0	23.9	1.1
Level of Service	B	A	B	A	C	A
Approach Delay (s)	13.1		17.7			4.0
Approach LOS	B		B			A

Intersection Summary			
HCM 2000 Control Delay	10.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	63.2	Sum of lost time (s)	16.0
Intersection Capacity Utilization	43.2%	ICU Level of Service	A
Analysis Period (min)	15		

! Phase conflict between lane groups.

c Critical Lane Group

Intersection	
Int Delay, s/veh	1.2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Traffic Vol, veh/h	0	65	1345	17	53	909
Future Vol, veh/h	0	65	1345	17	53	909
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	175	0	-	200	300	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	72	1494	19	59	1010

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2016	747	0	0	1494	0
Stage 1	1494	-	-	-	-	-
Stage 2	522	-	-	-	-	-
Critical Hdwy	5.74	7.14	-	-	5.34	-
Critical Hdwy Stg 1	6.64	-	-	-	-	-
Critical Hdwy Stg 2	6.04	-	-	-	-	-
Follow-up Hdwy	3.82	3.92	-	-	3.12	-
Pot Cap-1 Maneuver	92	305	-	-	224	-
Stage 1	119	-	-	-	-	-
Stage 2	511	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	68	305	-	-	224	-
Mov Cap-2 Maneuver	68	-	-	-	-	-
Stage 1	119	-	-	-	-	-
Stage 2	376	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	20.4	0	1.5
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	-	305	224	-
HCM Lane V/C Ratio	-	-	-	0.237	0.263	-
HCM Control Delay (s)	-	-	0	20.4	26.7	-
HCM Lane LOS	-	-	A	C	D	-
HCM 95th %tile Q(veh)	-	-	-	0.9	1	-

Intersection	
Int Delay, s/veh	2.2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Traffic Vol, veh/h	0	55	1106	44	156	1257
Future Vol, veh/h	0	55	1106	44	156	1257
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	175	0	-	200	300	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	61	1229	49	173	1397

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2134	614	0	0	1229	0
Stage 1	1229	-	-	-	-	-
Stage 2	905	-	-	-	-	-
Critical Hdwy	5.74	7.14	-	-	5.34	-
Critical Hdwy Stg 1	6.64	-	-	-	-	-
Critical Hdwy Stg 2	6.04	-	-	-	-	-
Follow-up Hdwy	3.82	3.92	-	-	3.12	-
Pot Cap-1 Maneuver	79	373	-	-	303	-
Stage 1	175	-	-	-	-	-
Stage 2	321	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	34	373	-	-	303	-
Mov Cap-2 Maneuver	34	-	-	-	-	-
Stage 1	175	-	-	-	-	-
Stage 2	138	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	16.5	0	3.5
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	-	373	303	-
HCM Lane V/C Ratio	-	-	-	0.164	0.572	-
HCM Control Delay (s)	-	-	0	16.5	31.6	-
HCM Lane LOS	-	-	A	C	D	-
HCM 95th %tile Q(veh)	-	-	-	0.6	3.3	-

HCM 2010 Signalized Intersection Summary
12: Houghton Road & Irvington Road

5/17/2016

	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Movement	**EBL**	**EBT**	**EBR**	**WBL**	**WBT**	**WBR**	**NBL**	**NBT**	**NBR**	**SBL**	**SBT**	**SBR**
Lane Configurations	↰	↑	↱	↰	↑↱		↰↰	↑↑	↱	↰	↑↑↑	↱
Traffic Volume (veh/h)	62	1	353	3	4	3	691	829	4	5	597	271
Future Volume (veh/h)	62	1	353	3	4	3	691	829	4	5	597	271
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	69	1	392	3	4	3	768	921	4	6	663	301
Adj No. of Lanes	1	1	1	1	1	0	2	2	1	1	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	245	191	605	207	102	76	1486	2655	1188	292	2020	629
Arrive On Green	0.10	0.10	0.10	0.10	0.10	0.10	0.28	0.75	0.75	0.40	0.40	0.40
Sat Flow, veh/h	1403	1863	1583	987	990	742	3442	3539	1583	602	5085	1583
Grp Volume(v), veh/h	69	1	392	3	0	7	768	921	4	6	663	301
Grp Sat Flow(s),veh/h/ln	1403	1863	1583	987	0	1732	1721	1770	1583	602	1695	1583
Q Serve(g_s), s	3.2	0.0	0.0	0.2	0.0	0.2	0.7	6.0	0.0	0.5	6.1	9.6
Cycle Q Clear(g_c), s	3.4	0.0	0.0	0.2	0.0	0.2	0.7	6.0	0.0	6.4	6.1	9.6
Prop In Lane	1.00		1.00	1.00		0.43	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	245	191	605	207	0	178	1486	2655	1188	292	2020	629
V/C Ratio(X)	0.28	0.01	0.65	0.01	0.00	0.04	0.52	0.35	0.00	0.02	0.33	0.48
Avail Cap(c_a), veh/h	699	795	1118	526	0	739	1486	2655	1188	292	2020	629
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	29.0	27.4	17.2	27.5	0.0	27.5	13.8	2.9	2.1	16.4	14.2	15.3
Incr Delay (d2), s/veh	0.6	0.0	1.2	0.0	0.0	0.1	0.3	0.4	0.0	0.1	0.4	2.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.3	0.0	6.2	0.1	0.0	0.1	5.3	2.9	0.0	0.1	2.9	4.6
LnGrp Delay(d),s/veh	29.6	27.4	18.4	27.5	0.0	27.6	14.1	3.2	2.1	16.5	14.6	17.9
LnGrp LOS	C	C	B	C		C	B	A	A	B	B	B
Approach Vol, veh/h		462			10			1693			970	
Approach Delay, s/veh		20.1			27.6			8.2			15.6	
Approach LOS		C			C			A			B	

Timer	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		56.0		12.0	24.0	32.0		12.0
Change Period (Y+Rc), s		5.0		5.0	5.0	5.0		5.0
Max Green Setting (Gmax), s		51.0		29.0	19.0	27.0		29.0
Max Q Clear Time (g_c+I1), s		8.0		5.4	2.7	11.6		2.2
Green Ext Time (p_c), s		11.9		1.6	8.2	4.7		1.6

Intersection Summary			
HCM 2010 Ctrl Delay			12.3
HCM 2010 LOS			B

HCM 2010 Signalized Intersection Summary
12: Houghton Road & Irvington Road

5/17/2016

	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑	↱	↰	↱		↰↰	↑↑	↱	↰	↑↑↑	↱
Traffic Volume (veh/h)	207	3	612	2	4	4	409	844	4	4	761	71
Future Volume (veh/h)	207	3	612	2	4	4	409	844	4	4	761	71
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	230	3	680	2	4	4	454	938	4	4	846	79
Adj No. of Lanes	1	1	1	1	1	0	2	2	1	1	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	394	410	767	256	189	189	1286	2314	1035	210	1663	518
Arrive On Green	0.22	0.22	0.22	0.22	0.22	0.22	0.26	0.65	0.65	0.33	0.33	0.33
Sat Flow, veh/h	1402	1863	1583	755	856	856	3442	3539	1583	593	5085	1583
Grp Volume(v), veh/h	230	3	680	2	0	8	454	938	4	4	846	79
Grp Sat Flow(s),veh/h/ln	1402	1863	1583	755	0	1712	1721	1770	1583	593	1695	1583
Q Serve(g_s), s	12.2	0.1	9.9	0.2	0.0	0.3	0.0	9.9	0.1	0.4	10.7	2.8
Cycle Q Clear(g_c), s	12.5	0.1	9.9	0.3	0.0	0.3	0.0	9.9	0.1	10.4	10.7	2.8
Prop In Lane	1.00		1.00	1.00		0.50	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	394	410	767	256	0	377	1286	2314	1035	210	1663	518
V/C Ratio(X)	0.58	0.01	0.89	0.01	0.00	0.02	0.35	0.41	0.00	0.02	0.51	0.15
Avail Cap(c_a), veh/h	579	656	976	355	0	603	1286	2314	1035	210	1663	518
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	29.2	24.2	18.5	24.3	0.0	24.3	18.7	6.5	4.8	25.5	21.6	19.0
Incr Delay (d2), s/veh	1.4	0.0	8.3	0.0	0.0	0.0	0.2	0.5	0.0	0.2	1.1	0.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.9	0.1	13.3	0.0	0.0	0.1	3.7	5.0	0.0	0.1	5.2	1.3
LnGrp Delay(d),s/veh	30.6	24.2	26.8	24.3	0.0	24.3	18.8	7.0	4.8	25.6	22.7	19.6
LnGrp LOS	C	C	C	C		C	B	A	A	C	C	B
Approach Vol, veh/h		913			10			1396			929	
Approach Delay, s/veh		27.7			24.3			10.8			22.5	
Approach LOS		C			C			B			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		57.0		22.5	26.0	31.0		22.5
Change Period (Y+Rc), s		5.0		5.0	5.0	5.0		5.0
Max Green Setting (Gmax), s		52.0		28.0	21.0	26.0		28.0
Max Q Clear Time (g_c+I1), s		11.9		14.5	2.0	12.7		2.3
Green Ext Time (p_c), s		9.7		3.0	7.7	4.7		3.5

Intersection Summary	
HCM 2010 Ctrl Delay	19.0
HCM 2010 LOS	B

HCM 2010 Signalized Intersection Summary
3: Houghton Road & Valencia Road

5/17/2016

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑	↱	↰↰	↑↑	↱	↰↰	↑↑↑	↱	↰↰	↑↑↑	↱
Traffic Volume (veh/h)	209	34	92	37	57	56	99	911	13	70	958	504
Future Volume (veh/h)	209	34	92	37	57	56	99	911	13	70	958	504
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	232	38	102	41	63	62	110	1012	14	78	1064	560
Adj No. of Lanes	2	2	1	2	2	1	2	3	1	2	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	558	333	149	492	249	112	648	2694	839	843	2694	839
Arrive On Green	0.07	0.09	0.09	0.04	0.07	0.07	0.06	0.53	0.53	0.06	0.53	0.53
Sat Flow, veh/h	3442	3539	1583	3442	3539	1583	3442	5085	1583	3442	5085	1583
Grp Volume(v), veh/h	232	38	102	41	63	62	110	1012	14	78	1064	560
Grp Sat Flow(s),veh/h/ln	1721	1770	1583	1721	1770	1583	1721	1695	1583	1721	1695	1583
Q Serve(g_s), s	0.0	0.7	4.6	0.0	1.2	2.8	0.0	8.6	0.3	0.0	9.2	18.9
Cycle Q Clear(g_c), s	0.0	0.7	4.6	0.0	1.2	2.8	0.0	8.6	0.3	0.0	9.2	18.9
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	558	333	149	492	249	112	648	2694	839	843	2694	839
V/C Ratio(X)	0.42	0.11	0.68	0.08	0.25	0.56	0.17	0.38	0.02	0.09	0.39	0.67
Avail Cap(c_a), veh/h	607	913	409	622	913	409	719	2694	839	915	2694	839
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	30.9	30.5	32.3	30.0	32.4	33.1	12.8	10.2	8.2	11.0	10.3	12.6
Incr Delay (d2), s/veh	0.5	0.2	5.5	0.1	0.5	4.3	0.1	0.4	0.0	0.0	0.4	4.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.2	0.4	2.2	0.4	0.6	1.3	0.7	4.1	0.1	0.4	4.3	9.2
LnGrp Delay(d),s/veh	31.4	30.7	37.7	30.1	32.9	37.4	13.0	10.6	8.2	11.1	10.7	16.8
LnGrp LOS	C	C	D	C	C	D	B	B	A	B	B	B
Approach Vol, veh/h		372			166			1136			1702	
Approach Delay, s/veh		33.1			33.9			10.8			12.7	
Approach LOS		C			C			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	9.5	44.0	8.2	11.9	9.5	44.0	10.0	10.2
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	6.0	39.0	6.0	19.0	6.0	39.0	6.0	19.0
Max Q Clear Time (g_c+I1), s	2.0	10.6	2.0	6.6	2.0	20.9	2.0	4.8
Green Ext Time (p_c), s	0.2	7.4	0.3	0.3	0.2	8.8	0.3	0.4

Intersection Summary	
HCM 2010 Ctrl Delay	15.4
HCM 2010 LOS	B

HCM 2010 Signalized Intersection Summary
3: Houghton Road & Valencia Road

5/17/2016

	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑	↱	↰↰	↑↑	↱	↰↰	↑↑↑	↱	↰↰	↑↑↑	↱
Traffic Volume (veh/h)	520	81	210	44	42	46	66	887	24	61	988	214
Future Volume (veh/h)	520	81	210	44	42	46	66	887	24	61	988	214
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	578	90	233	49	47	51	73	986	27	68	1098	238
Adj No. of Lanes	2	2	1	2	2	1	2	3	1	2	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	807	644	288	440	241	108	614	2287	712	719	2287	712
Arrive On Green	0.16	0.18	0.18	0.04	0.07	0.07	0.05	0.45	0.45	0.05	0.45	0.45
Sat Flow, veh/h	3442	3539	1583	3442	3539	1583	3442	5085	1583	3442	5085	1583
Grp Volume(v), veh/h	578	90	233	49	47	51	73	986	27	68	1098	238
Grp Sat Flow(s),veh/h/ln	1721	1770	1583	1721	1770	1583	1721	1695	1583	1721	1695	1583
Q Serve(g_s), s	5.6	1.6	10.4	0.0	0.9	2.3	0.0	9.7	0.7	0.0	11.1	7.1
Cycle Q Clear(g_c), s	5.6	1.6	10.4	0.0	0.9	2.3	0.0	9.7	0.7	0.0	11.1	7.1
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	807	644	288	440	241	108	614	2287	712	719	2287	712
V/C Ratio(X)	0.72	0.14	0.81	0.11	0.19	0.47	0.12	0.43	0.04	0.09	0.48	0.33
Avail Cap(c_a), veh/h	830	1206	539	573	916	410	714	2287	712	819	2287	712
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	27.0	25.2	28.8	31.1	32.3	32.9	17.0	13.8	11.3	15.5	14.2	13.1
Incr Delay (d2), s/veh	2.9	0.1	5.4	0.1	0.4	3.2	0.1	0.6	0.1	0.1	0.7	1.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	5.7	0.8	5.0	0.5	0.5	1.1	0.5	4.6	0.3	0.5	5.3	3.3
LnGrp Delay(d),s/veh	29.9	25.3	34.2	31.2	32.7	36.1	17.1	14.4	11.4	15.6	14.9	14.3
LnGrp LOS	C	C	C	C	C	D	B	B	B	B	B	B
Approach Vol, veh/h		901			147			1086			1404	
Approach Delay, s/veh		30.6			33.4			14.5			14.8	
Approach LOS		C			C			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	8.9	38.0	8.2	18.3	8.9	38.0	16.5	10.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	6.0	33.0	6.0	25.0	6.0	33.0	12.0	19.0
Max Q Clear Time (g_c+I1), s	2.0	11.7	2.0	12.4	2.0	13.1	7.6	4.3
Green Ext Time (p_c), s	0.1	6.6	1.0	1.0	0.1	8.0	1.0	0.3

Intersection Summary			
HCM 2010 Ctrl Delay			19.5
HCM 2010 LOS			B

HCM 2010 Signalized Intersection Summary
8: Houghton Road & Bilby Road

5/17/2016

	↙	↖	↑	↗	↘	↓
Movement	**WBL**	**WBR**	**NBT**	**NBR**	**SBL**	**SBT**
Lane Configurations	↰↰	↱	↑↑↑	↱	↰↰	↑↑↑
Traffic Volume (veh/h)	286	235	1007	162	112	1038
Future Volume (veh/h)	286	235	1007	162	112	1038
Number	3	18	2	12	1	6
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	318	261	1119	180	124	1153
Adj No. of Lanes	2	1	3	1	2	3
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	496	606	2069	872	1196	3639
Arrive On Green	0.14	0.14	0.41	0.41	0.24	0.72
Sat Flow, veh/h	3442	1583	5253	1583	3442	5253
Grp Volume(v), veh/h	318	261	1119	180	124	1153
Grp Sat Flow(s),veh/h/ln	1721	1583	1695	1583	1721	1695
Q Serve(g_s), s	6.2	0.0	11.9	4.1	0.0	5.9
Cycle Q Clear(g_c), s	6.2	0.0	11.9	4.1	0.0	5.9
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	496	606	2069	872	1196	3639
V/C Ratio(X)	0.64	0.43	0.54	0.21	0.10	0.32
Avail Cap(c_a), veh/h	1400	1022	2069	872	1196	3639
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	28.8	16.3	16.1	8.1	12.7	3.7
Incr Delay (d2), s/veh	1.4	0.5	1.0	0.5	0.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.1	3.8	5.7	2.5	0.8	2.7
LnGrp Delay(d),s/veh	30.1	16.7	17.1	8.6	12.7	4.0
LnGrp LOS	C	B	B	A	B	A
Approach Vol, veh/h	579		1299			1277
Approach Delay, s/veh	24.1		15.9			4.8
Approach LOS	C		B			A

Timer	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	22.0	34.0				56.0		15.3
Change Period (Y+Rc), s	5.0	5.0				5.0		5.0
Max Green Setting (Gmax), s	17.0	29.0				51.0		29.0
Max Q Clear Time (g_c+I1), s	2.0	13.9				7.9		8.2
Green Ext Time (p_c), s	6.9	7.5				10.2		2.1

Intersection Summary	
HCM 2010 Ctrl Delay	12.9
HCM 2010 LOS	B

HCM 2010 Signalized Intersection Summary
8: Houghton Road & Bilby Road

5/17/2016

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↑↑	↱	↰↰	↑↑↑
Traffic Volume (veh/h)	96	94	1279	168	146	1124
Future Volume (veh/h)	96	94	1279	168	146	1124
Number	3	18	2	12	1	6
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	107	104	1421	187	162	1249
Adj No. of Lanes	2	1	3	1	2	3
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	249	464	2471	884	1129	3969
Arrive On Green	0.07	0.07	0.49	0.49	0.22	0.78
Sat Flow, veh/h	3442	1583	5253	1583	3442	5253
Grp Volume(v), veh/h	107	104	1421	187	162	1249
Grp Sat Flow(s),veh/h/ln	1721	1583	1695	1583	1721	1695
Q Serve(g_s), s	2.0	0.0	13.5	4.0	0.0	4.9
Cycle Q Clear(g_c), s	2.0	0.0	13.5	4.0	0.0	4.9
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	249	464	2471	884	1129	3969
V/C Ratio(X)	0.43	0.22	0.58	0.21	0.14	0.31
Avail Cap(c_a), veh/h	1368	979	2471	884	1129	3969
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	30.2	18.2	12.5	7.5	12.6	2.2
Incr Delay (d2), s/veh	1.2	0.2	1.0	0.5	0.1	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.0	1.5	6.5	2.2	1.1	2.3
LnGrp Delay(d),s/veh	31.3	18.4	13.4	8.1	12.7	2.4
LnGrp LOS	C	B	B	A	B	A
Approach Vol, veh/h	211		1608			1411
Approach Delay, s/veh	25.0		12.8			3.6
Approach LOS	C		B			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	20.0	38.0				58.0		9.9
Change Period (Y+Rc), s	5.0	5.0				5.0		5.0
Max Green Setting (Gmax), s	15.0	33.0				53.0		27.0
Max Q Clear Time (g_c+I1), s	2.0	15.5				6.9		4.0
Green Ext Time (p_c), s	7.0	10.3				11.7		0.7

Intersection Summary	
HCM 2010 Ctrl Delay	9.6
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↑↑	↱	↰	↑↑↱	
Traffic Volume (veh/h)	232	0	179	173	0	156	81	1077	82	44	861	55
Future Volume (veh/h)	232	0	179	173	0	156	81	1077	82	44	861	55
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1900	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	258	0	199	192	0	173	90	1197	91	49	957	61
Adj No. of Lanes	1	1	0	1	1	0	1	3	1	1	3	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	356	0	273	350	0	237	375	1889	588	278	1486	95
Arrive On Green	0.10	0.00	0.17	0.09	0.00	0.17	0.11	0.37	0.37	0.06	0.30	0.29
Sat Flow, veh/h	1774	0	1583	1774	0	1583	1774	5085	1583	1774	4887	311
Grp Volume(v), veh/h	258	0	199	192	0	173	90	1197	91	49	663	355
Grp Sat Flow(s),veh/h/ln	1774	0	1583	1774	0	1583	1774	1695	1583	1774	1695	1808
Q Serve(g_s), s	1.7	0.0	6.5	0.0	0.0	5.7	0.0	10.7	2.1	0.0	9.3	9.4
Cycle Q Clear(g_c), s	1.7	0.0	6.5	0.0	0.0	5.7	0.0	10.7	2.1	0.0	9.3	9.4
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		0.17
Lane Grp Cap(c), veh/h	356	0	273	350	0	237	375	1889	588	278	1031	550
V/C Ratio(X)	0.73	0.00	0.73	0.55	0.00	0.73	0.24	0.63	0.15	0.18	0.64	0.65
Avail Cap(c_a), veh/h	734	0	633	543	0	431	381	3141	978	371	2032	1084
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	22.4	0.0	21.6	22.3	0.0	21.8	20.2	14.2	11.5	21.6	16.6	16.7
Incr Delay (d2), s/veh	2.8	0.0	3.7	1.3	0.0	4.3	0.3	0.4	0.1	0.3	0.7	1.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.9	0.0	3.2	2.8	0.0	2.8	1.3	5.0	0.9	0.7	4.4	4.8
LnGrp Delay(d),s/veh	25.2	0.0	25.3	23.7	0.0	26.1	20.6	14.6	11.7	21.9	17.3	17.9
LnGrp LOS	C		C	C		C	C	B	B	C	B	B
Approach Vol, veh/h		457			365			1378			1067	
Approach Delay, s/veh		25.2			24.8			14.8			17.7	
Approach LOS		C			C			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	7.1	24.4	9.0	14.5	10.8	20.7	10.2	13.2
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	5.0	33.0	10.0	22.0	6.0	32.0	17.0	15.0
Max Q Clear Time (g_c+I1), s	2.0	12.7	2.0	8.5	2.0	11.4	3.7	7.7
Green Ext Time (p_c), s	0.1	6.8	1.1	0.9	0.1	4.4	1.3	0.5

Intersection Summary	
HCM 2010 Ctrl Delay	18.3
HCM 2010 LOS	B

14: Houghton Road & Drexel Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↑↑	↱	↰	↑↑↱	
Traffic Volume (veh/h)	172	0	162	78	0	82	309	937	110	146	1085	217
Future Volume (veh/h)	172	0	162	78	0	82	309	937	110	146	1085	217
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1900	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	191	0	180	87	0	91	343	1041	122	162	1206	241
Adj No. of Lanes	1	1	0	1	1	0	1	3	1	1	3	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	349	0	243	242	0	141	398	1526	475	542	1451	290
Arrive On Green	0.12	0.00	0.15	0.08	0.00	0.10	0.16	0.30	0.30	0.21	0.34	0.33
Sat Flow, veh/h	1774	0	1583	1774	0	1583	1774	5085	1583	1774	4253	850
Grp Volume(v), veh/h	191	0	180	87	0	91	343	1041	122	162	961	486
Grp Sat Flow(s),veh/h/ln	1774	0	1583	1774	0	1583	1774	1695	1583	1774	1695	1713
Q Serve(g_s), s	1.6	0.0	7.2	0.0	0.0	3.7	7.9	11.9	3.9	0.0	17.3	17.3
Cycle Q Clear(g_c), s	1.6	0.0	7.2	0.0	0.0	3.7	7.9	11.9	3.9	0.0	17.3	17.3
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		0.50
Lane Grp Cap(c), veh/h	349	0	243	242	0	141	398	1526	475	542	1156	584
V/C Ratio(X)	0.55	0.00	0.74	0.36	0.00	0.64	0.86	0.68	0.26	0.30	0.83	0.83
Avail Cap(c_a), veh/h	584	0	645	269	0	359	519	2150	669	542	1228	621
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	25.5	0.0	26.8	28.3	0.0	28.7	25.4	20.4	17.6	19.3	20.1	20.3
Incr Delay (d2), s/veh	1.3	0.0	4.4	0.9	0.0	4.8	11.1	0.5	0.3	0.3	4.8	9.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.3	0.0	3.4	1.5	0.0	1.8	7.2	5.7	1.7	2.4	8.8	9.6
LnGrp Delay(d),s/veh	26.8	0.0	31.2	29.2	0.0	33.5	36.5	20.9	17.9	19.6	24.8	29.3
LnGrp LOS	C		C	C		C	D	C	B	B	C	C
Approach Vol, veh/h		371			178			1506			1609	
Approach Delay, s/veh		29.0			31.4			24.3			25.6	
Approach LOS		C			C			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	18.2	23.9	9.0	15.2	15.5	26.6	13.2	10.9
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	11.0	27.0	5.0	27.0	15.0	23.0	17.0	15.0
Max Q Clear Time (g_c+I1), s	2.0	13.9	2.0	9.2	9.9	19.3	3.6	5.7
Green Ext Time (p_c), s	1.2	4.9	0.3	1.0	0.6	2.3	0.7	0.3

Intersection Summary	
HCM 2010 Ctrl Delay	25.7
HCM 2010 LOS	C

HCM 2010 TWSC
10: Houghton Road & 7 Generation Way

5/17/2016

Intersection	
Int Delay, s/veh	1.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Traffic Vol, veh/h	0	58	1473	16	48	905
Future Vol, veh/h	0	58	1473	16	48	905
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	175	0	-	200	300	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	64	1637	18	53	1006

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2146	818	0	0	1637	0
Stage 1	1637	-	-	-	-	-
Stage 2	509	-	-	-	-	-
Critical Hdwy	5.74	7.14	-	-	5.34	-
Critical Hdwy Stg 1	6.64	-	-	-	-	-
Critical Hdwy Stg 2	6.04	-	-	-	-	-
Follow-up Hdwy	3.82	3.92	-	-	3.12	-
Pot Cap-1 Maneuver	78	274	-	-	190	-
Stage 1	97	-	-	-	-	-
Stage 2	519	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	56	274	-	-	190	-
Mov Cap-2 Maneuver	56	-	-	-	-	-
Stage 1	97	-	-	-	-	-
Stage 2	374	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	22.1	0	1.6
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	-	274	190	-
HCM Lane V/C Ratio	-	-	-	0.235	0.281	-
HCM Control Delay (s)	-	-	0	22.1	31.2	-
HCM Lane LOS	-	-	A	C	D	-
HCM 95th %tile Q(veh)	-	-	-	0.9	1.1	-

HCM 2010 TWSC
10: Houghton Road & 7 Generation Way

5/17/2016

Intersection	
Int Delay, s/veh	2.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Traffic Vol, veh/h	0	49	1204	40	141	1450
Future Vol, veh/h	0	49	1204	40	141	1450
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	175	0	-	200	300	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	54	1338	44	157	1611

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2296	669	0	0	1338	0
Stage 1	1338	-	-	-	-	-
Stage 2	958	-	-	-	-	-
Critical Hdwy	5.74	7.14	-	-	5.34	-
Critical Hdwy Stg 1	6.64	-	-	-	-	-
Critical Hdwy Stg 2	6.04	-	-	-	-	-
Follow-up Hdwy	3.82	3.92	-	-	3.12	-
Pot Cap-1 Maneuver	65	343	-	-	268	-
Stage 1	150	-	-	-	-	-
Stage 2	301	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	27	343	-	-	268	-
Mov Cap-2 Maneuver	27	-	-	-	-	-
Stage 1	150	-	-	-	-	-
Stage 2	125	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	17.5	0	3.2
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	-	343	268	-
HCM Lane V/C Ratio	-	-	-	0.159	0.585	-
HCM Control Delay (s)	-	-	0	17.5	35.7	-
HCM Lane LOS	-	-	A	C	E	-
HCM 95th %tile Q(veh)	-	-	-	0.6	3.4	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑	↱	↰	↱		↰↰	↑↑	↱	↰	↑↑↑	↱
Traffic Volume (veh/h)	57	0	352	2	3	2	716	886	3	4	590	245
Future Volume (veh/h)	57	0	352	2	3	2	716	886	3	4	590	245
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	63	0	391	2	3	2	796	984	3	4	656	272
Adj No. of Lanes	1	1	1	1	1	0	2	2	1	1	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	240	181	599	203	102	68	1508	2671	1195	280	2032	633
Arrive On Green	0.10	0.00	0.10	0.10	0.10	0.10	0.28	0.75	0.75	0.40	0.40	0.40
Sat Flow, veh/h	1405	1863	1583	989	1044	696	3442	3539	1583	568	5085	1583
Grp Volume(v), veh/h	63	0	391	2	0	5	796	984	3	4	656	272
Grp Sat Flow(s),veh/h/ln	1405	1863	1583	989	0	1740	1721	1770	1583	568	1695	1583
Q Serve(g_s), s	2.9	0.0	0.0	0.1	0.0	0.2	0.8	6.4	0.0	0.3	6.0	8.4
Cycle Q Clear(g_c), s	3.0	0.0	0.0	0.1	0.0	0.2	0.8	6.4	0.0	6.7	6.0	8.4
Prop In Lane	1.00		1.00	1.00		0.40	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	240	181	599	203	0	169	1508	2671	1195	280	2032	633
V/C Ratio(X)	0.26	0.00	0.65	0.01	0.00	0.03	0.53	0.37	0.00	0.01	0.32	0.43
Avail Cap(c_a), veh/h	706	799	1125	531	0	747	1508	2671	1195	280	2032	633
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	29.0	0.0	17.3	27.6	0.0	27.6	13.6	2.8	2.0	16.4	14.0	14.7
Incr Delay (d2), s/veh	0.6	0.0	1.2	0.0	0.0	0.1	0.3	0.4	0.0	0.1	0.4	2.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.2	0.0	6.2	0.0	0.0	0.1	5.5	3.2	0.0	0.1	2.9	4.0
LnGrp Delay(d),s/veh	29.6	0.0	18.5	27.6	0.0	27.7	13.9	3.2	2.0	16.5	14.4	16.8
LnGrp LOS	C		B	C		C	B	A	A	B	B	B
Approach Vol, veh/h		454			7			1783			932	
Approach Delay, s/veh		20.1			27.7			8.0			15.1	
Approach LOS		C			C			A			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		56.0		11.6	24.0	32.0		11.6
Change Period (Y+Rc), s		5.0		5.0	5.0	5.0		5.0
Max Green Setting (Gmax), s		51.0		29.0	19.0	27.0		29.0
Max Q Clear Time (g_c+I1), s		8.4		5.0	2.8	10.4		2.2
Green Ext Time (p_c), s		12.9		1.5	8.7	4.7		1.5

Intersection Summary	
HCM 2010 Ctrl Delay	11.9
HCM 2010 LOS	B

HCM 2010 Signalized Intersection Summary
12: Houghton Road & Irvington Road

5/17/2016

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑	↱	↰	↑↱		↰↰	↑↑	↱	↰	↑↑↑	↱
Traffic Volume (veh/h)	187	2	678	1	3	3	452	885	3	3	876	65
Future Volume (veh/h)	187	2	678	1	3	3	452	885	3	3	876	65
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	208	2	753	1	3	3	502	983	3	3	973	72
Adj No. of Lanes	1	1	1	1	1	0	2	2	1	1	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	438	471	801	265	217	217	1176	2217	992	183	1593	496
Arrive On Green	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.63	0.63	0.31	0.31	0.31
Sat Flow, veh/h	1404	1863	1583	706	856	856	3442	3539	1583	568	5085	1583
Grp Volume(v), veh/h	208	2	753	1	0	6	502	983	3	3	973	72
Grp Sat Flow(s),veh/h/ln	1404	1863	1583	706	0	1712	1721	1770	1583	568	1695	1583
Q Serve(g_s), s	10.8	0.1	16.2	0.1	0.0	0.2	2.0	11.9	0.1	0.4	13.5	2.7
Cycle Q Clear(g_c), s	11.0	0.1	16.2	0.2	0.0	0.2	2.0	11.9	0.1	12.3	13.5	2.7
Prop In Lane	1.00		1.00	1.00		0.50	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	438	471	801	265	0	433	1176	2217	992	183	1593	496
V/C Ratio(X)	0.47	0.00	0.94	0.00	0.00	0.01	0.43	0.44	0.00	0.02	0.61	0.15
Avail Cap(c_a), veh/h	557	628	935	324	0	577	1176	2217	992	183	1593	496
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	27.4	23.2	19.3	23.2	0.0	23.2	21.9	8.0	5.8	28.8	24.2	20.5
Incr Delay (d2), s/veh	0.8	0.0	15.5	0.0	0.0	0.0	0.2	0.6	0.0	0.2	1.8	0.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.3	0.0	10.3	0.0	0.0	0.1	4.4	5.9	0.0	0.1	6.6	1.3
LnGrp Delay(d),s/veh	28.2	23.2	34.8	23.2	0.0	23.2	22.2	8.7	5.8	28.9	26.0	21.1
LnGrp LOS	C	C	C	C		C	C	A	A	C	C	C
Approach Vol, veh/h		963			7			1488			1048	
Approach Delay, s/veh		33.3			23.2			13.2			25.6	
Approach LOS		C			C			B			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		57.0		26.0	26.0	31.0		26.0
Change Period (Y+Rc), s		5.0		5.0	5.0	5.0		5.0
Max Green Setting (Gmax), s		52.0		28.0	21.0	26.0		28.0
Max Q Clear Time (g_c+I1), s		13.9		18.2	4.0	15.5		2.2
Green Ext Time (p_c), s		10.4		2.8	7.8	4.7		3.9

Intersection Summary			
HCM 2010 Ctrl Delay			22.5
HCM 2010 LOS			C

Intersection	
Int Delay, s/veh	0.7

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Traffic Vol, veh/h	23	49	8	1457	911	15
Future Vol, veh/h	23	49	8	1457	911	15
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	0	150	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	26	54	9	1619	1012	17

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1686	514	1029	0	-	0
Stage 1	1021	-	-	-	-	-
Stage 2	665	-	-	-	-	-
Critical Hdwy	5.74	7.14	5.34	-	-	-
Critical Hdwy Stg 1	6.64	-	-	-	-	-
Critical Hdwy Stg 2	6.04	-	-	-	-	-
Follow-up Hdwy	3.82	3.92	3.12	-	-	-
Pot Cap-1 Maneuver	138	433	379	-	-	-
Stage 1	235	-	-	-	-	-
Stage 2	430	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	135	433	379	-	-	-
Mov Cap-2 Maneuver	135	-	-	-	-	-
Stage 1	235	-	-	-	-	-
Stage 2	420	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	21.9	0.1	0
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	379	-	135	433	-	-
HCM Lane V/C Ratio	0.023	-	0.189	0.126	-	-
HCM Control Delay (s)	14.7	-	37.8	14.5	-	-
HCM Lane LOS	B	-	E	B	-	-
HCM 95th %tile Q(veh)	0.1	-	0.7	0.4	-	-

Intersection	
Int Delay, s/veh	1.8

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Traffic Vol, veh/h	30	33	27	1164	1415	51
Future Vol, veh/h	30	33	27	1164	1415	51
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	0	150	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	33	37	30	1293	1572	57

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2178	814	1629	0	-	0
Stage 1	1601	-	-	-	-	-
Stage 2	577	-	-	-	-	-
Critical Hdwy	5.74	7.14	5.34	-	-	-
Critical Hdwy Stg 1	6.64	-	-	-	-	-
Critical Hdwy Stg 2	6.04	-	-	-	-	-
Follow-up Hdwy	3.82	3.92	3.12	-	-	-
Pot Cap-1 Maneuver	75	276	192	-	-	-
Stage 1	102	-	-	-	-	-
Stage 2	479	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	63	276	192	-	-	-
Mov Cap-2 Maneuver	63	-	-	-	-	-
Stage 1	102	-	-	-	-	-
Stage 2	404	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	64.7	0.6	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	192	-	63	276	-	-
HCM Lane V/C Ratio	0.156	-	0.529	0.133	-	-
HCM Control Delay (s)	27.2	-	113.8	20	-	-
HCM Lane LOS	D	-	F	C	-	-
HCM 95th %tile Q(veh)	0.5	-	2.1	0.5	-	-

19: Houghton Road & South Access

Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Traffic Vol, veh/h	0	47	0	1242	1103	11
Future Vol, veh/h	0	47	0	1242	1103	11
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	52	0	1380	1226	12

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1784	619	1238	0	-	0
Stage 1	1232	-	-	-	-	-
Stage 2	552	-	-	-	-	-
Critical Hdwy	5.74	7.14	5.34	-	-	-
Critical Hdwy Stg 1	6.64	-	-	-	-	-
Critical Hdwy Stg 2	6.04	-	-	-	-	-
Follow-up Hdwy	3.82	3.92	3.12	-	-	-
Pot Cap-1 Maneuver	122	370	300	-	-	-
Stage 1	174	-	-	-	-	-
Stage 2	493	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	122	370	300	-	-	-
Mov Cap-2 Maneuver	122	-	-	-	-	-
Stage 1	174	-	-	-	-	-
Stage 2	493	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	16.3	0	0
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	300	-	370	-	-
HCM Lane V/C Ratio	-	-	0.141	-	-
HCM Control Delay (s)	0	-	16.3	-	-
HCM Lane LOS	A	-	C	-	-
HCM 95th %tile Q(veh)	0	-	0.5	-	-

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Traffic Vol, veh/h	0	25	0	1373	1245	43
Future Vol, veh/h	0	25	0	1373	1245	43
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	28	0	1526	1383	48

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2017	716	1431	0	-	0
Stage 1	1407	-	-	-	-	-
Stage 2	610	-	-	-	-	-
Critical Hdwy	5.74	7.14	5.34	-	-	-
Critical Hdwy Stg 1	6.64	-	-	-	-	-
Critical Hdwy Stg 2	6.04	-	-	-	-	-
Follow-up Hdwy	3.82	3.92	3.12	-	-	-
Pot Cap-1 Maneuver	92	320	241	-	-	-
Stage 1	135	-	-	-	-	-
Stage 2	460	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	92	320	241	-	-	-
Mov Cap-2 Maneuver	92	-	-	-	-	-
Stage 1	135	-	-	-	-	-
Stage 2	460	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	17.3	0	0
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	241	-	320	-	-
HCM Lane V/C Ratio	-	-	0.087	-	-
HCM Control Delay (s)	0	-	17.3	-	-
HCM Lane LOS	A	-	C	-	-
HCM 95th %tile Q(veh)	0	-	0.3	-	-

Intersection	
Intersection Delay, s/veh	4.3
Intersection LOS	A

Approach	WB	NB	SB
Entry Lanes	1	0	1
Conflicting Circle Lanes	1	1	1
Adj Approach Flow, veh/h	51	0	154
Demand Flow Rate, veh/h	52	0	157
Vehicles Circulating, veh/h	0	157	0
Vehicles Exiting, veh/h	157	0	52
Follow-Up Headway, s	3.186	3.186	3.186
Ped Vol Crossing Leg, #/h	0	0	0
Ped Cap Adj	1.000	1.000	1.000
Approach Delay, s/veh	3.6	0.0	4.5
Approach LOS	A	-	A

Lane	Left	Left
Designated Moves	LR	LT
Assumed Moves	LR	LT
RT Channelized		
Lane Util	1.000	1.000
Critical Headway, s	5.193	5.193
Entry Flow, veh/h	52	157
Cap Entry Lane, veh/h	1130	1130
Entry HV Adj Factor	0.981	0.981
Flow Entry, veh/h	51	154
Cap Entry, veh/h	1108	1108
V/C Ratio	0.046	0.139
Control Delay, s/veh	3.6	4.5
LOS	A	A
95th %tile Queue, veh	0	0

Intersection	
Intersection Delay, s/veh	4.4
Intersection LOS	A

Approach	WB	NB	SB
Entry Lanes	1	0	1
Conflicting Circle Lanes	1	1	1
Adj Approach Flow, veh/h	172	0	101
Demand Flow Rate, veh/h	175	0	103
Vehicles Circulating, veh/h	0	103	0
Vehicles Exiting, veh/h	103	0	175
Follow-Up Headway, s	3.186	3.186	3.186
Ped Vol Crossing Leg, #/h	0	0	0
Ped Cap Adj	1.000	1.000	1.000
Approach Delay, s/veh	4.6	0.0	4.0
Approach LOS	A	-	A

Lane	Left	Left
Designated Moves	LR	LT
Assumed Moves	LR	LT
RT Channelized		
Lane Util	1.000	1.000
Critical Headway, s	5.193	5.193
Entry Flow, veh/h	175	103
Cap Entry Lane, veh/h	1130	1130
Entry HV Adj Factor	0.983	0.981
Flow Entry, veh/h	172	101
Cap Entry, veh/h	1111	1108
V/C Ratio	0.155	0.091
Control Delay, s/veh	4.6	4.0
LOS	A	A
95th %tile Queue, veh	1	0

31: Access 2 & Drexel Road

Intersection	
Int Delay, s/veh	2.4

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Traffic Vol, veh/h	139	0	17	46	0	53
Future Vol, veh/h	139	0	17	46	0	53
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	100	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	154	0	19	51	0	59

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	154	0	243	154
Stage 1	-	-	-	-	154	-
Stage 2	-	-	-	-	89	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1426	-	745	892
Stage 1	-	-	-	-	874	-
Stage 2	-	-	-	-	934	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1426	-	735	892
Mov Cap-2 Maneuver	-	-	-	-	735	-
Stage 1	-	-	-	-	874	-
Stage 2	-	-	-	-	922	-

Approach	EB	WB	NB
HCM Control Delay, s	0	2	9.3
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	-	892	-	-	1426	-
HCM Lane V/C Ratio	-	0.066	-	-	0.013	-
HCM Control Delay (s)	0	9.3	-	-	7.6	-
HCM Lane LOS	A	A	-	-	A	-
HCM 95th %tile Q(veh)	-	0.2	-	-	0	-

Intersection	
Int Delay, s/veh	2.5

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Traffic Vol, veh/h	91	0	59	115	0	35
Future Vol, veh/h	91	0	59	115	0	35
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	100	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	101	0	66	128	0	39

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	101	0	360	101
Stage 1	-	-	-	-	101	-
Stage 2	-	-	-	-	259	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1491	-	639	954
Stage 1	-	-	-	-	923	-
Stage 2	-	-	-	-	784	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1491	-	611	954
Mov Cap-2 Maneuver	-	-	-	-	611	-
Stage 1	-	-	-	-	923	-
Stage 2	-	-	-	-	749	-

Approach	EB	WB	NB
HCM Control Delay, s	0	2.6	8.9
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	-	954	-	-	1491	-
HCM Lane V/C Ratio	-	0.041	-	-	0.044	-
HCM Control Delay (s)	0	8.9	-	-	7.5	-
HCM Lane LOS	A	A	-	-	A	-
HCM 95th %tile Q(veh)	-	0.1	-	-	0.1	-

Intersection	
Int Delay, s/veh	2.9

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Traffic Vol, veh/h	0	192	63	34	100	0
Future Vol, veh/h	0	192	63	34	100	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	100	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	213	70	38	111	0

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	108	0	-	0	302	89
Stage 1	-	-	-	-	89	-
Stage 2	-	-	-	-	213	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1483	-	-	-	690	969
Stage 1	-	-	-	-	934	-
Stage 2	-	-	-	-	823	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1483	-	-	-	690	969
Mov Cap-2 Maneuver	-	-	-	-	690	-
Stage 1	-	-	-	-	934	-
Stage 2	-	-	-	-	823	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	11.2
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	1483	-	-	-	690	-
HCM Lane V/C Ratio	-	-	-	-	0.161	-
HCM Control Delay (s)	0	-	-	-	11.2	0
HCM Lane LOS	A	-	-	-	B	A
HCM 95th %tile Q(veh)	0	-	-	-	0.6	-

HCM 2010 TWSC
28: Drexel Road & Access 3

5/18/2016

Intersection	
Int Delay, s/veh	1.6

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Traffic Vol, veh/h	0	126	214	114	67	0
Future Vol, veh/h	0	126	214	114	67	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	100	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	140	238	127	74	0

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	364	0	-	0	441	301
Stage 1	-	-	-	-	301	-
Stage 2	-	-	-	-	140	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1195	-	-	-	574	739
Stage 1	-	-	-	-	751	-
Stage 2	-	-	-	-	887	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1195	-	-	-	574	739
Mov Cap-2 Maneuver	-	-	-	-	574	-
Stage 1	-	-	-	-	751	-
Stage 2	-	-	-	-	887	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	12.2
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	1195	-	-	-	574	-
HCM Lane V/C Ratio	-	-	-	-	0.13	-
HCM Control Delay (s)	0	-	-	-	12.2	0
HCM Lane LOS	A	-	-	-	B	A
HCM 95th %tile Q(veh)	0	-	-	-	0.4	-

Intersection	
Int Delay, s/veh	1.5

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Traffic Vol, veh/h	292	0	18	97	0	53
Future Vol, veh/h	292	0	18	97	0	53
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	100	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	324	0	20	108	0	59

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	324	0	472	324
Stage 1	-	-	-	-	324	-
Stage 2	-	-	-	-	148	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1236	-	551	717
Stage 1	-	-	-	-	733	-
Stage 2	-	-	-	-	880	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1236	-	542	717
Mov Cap-2 Maneuver	-	-	-	-	542	-
Stage 1	-	-	-	-	733	-
Stage 2	-	-	-	-	866	-

Approach	EB	WB	NB
HCM Control Delay, s	0	1.2	10.5
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	-	717	-	-	1236	-
HCM Lane V/C Ratio	-	0.082	-	-	0.016	-
HCM Control Delay (s)	0	10.5	-	-	8	-
HCM Lane LOS	A	B	-	-	A	-
HCM 95th %tile Q(veh)	-	0.3	-	-	0	-

Intersection	
Int Delay, s/veh	1.3

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Traffic Vol, veh/h	193	0	59	328	0	35
Future Vol, veh/h	193	0	59	328	0	35
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	100	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	214	0	66	364	0	39

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	214	0	710	214
Stage 1	-	-	-	-	214	-
Stage 2	-	-	-	-	496	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1356	-	400	826
Stage 1	-	-	-	-	822	-
Stage 2	-	-	-	-	612	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1356	-	381	826
Mov Cap-2 Maneuver	-	-	-	-	381	-
Stage 1	-	-	-	-	822	-
Stage 2	-	-	-	-	582	-

Approach	EB	WB	NB
HCM Control Delay, s	0	1.2	9.6
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	-	826	-	-	1356	-
HCM Lane V/C Ratio	-	0.047	-	-	0.048	-
HCM Control Delay (s)	0	9.6	-	-	7.8	-
HCM Lane LOS	A	A	-	-	A	-
HCM 95th %tile Q(veh)	-	0.1	-	-	0.2	-

Intersection	
Intersection Delay, s/veh	6.2
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	383	151	48	26
Demand Flow Rate, veh/h	391	154	49	27
Vehicles Circulating, veh/h	40	0	418	144
Vehicles Exiting, veh/h	131	467	13	10
Follow-Up Headway, s	3.186	3.186	3.186	3.186
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	7.1	4.4	5.6	4.1
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Critical Headway, s	5.193	5.193	5.193	5.193
Entry Flow, veh/h	391	154	49	27
Cap Entry Lane, veh/h	1086	1130	744	978
Entry HV Adj Factor	0.980	0.983	0.980	0.963
Flow Entry, veh/h	383	151	48	26
Cap Entry, veh/h	1064	1111	729	942
V/C Ratio	0.360	0.136	0.066	0.028
Control Delay, s/veh	7.1	4.4	5.6	4.1
LOS	A	A	A	A
95th %tile Queue, veh	2	0	0	0

HCM 2010 Roundabout
24: Access 5 & Drexel Road

6/13/2016

Intersection	
Intersection Delay, s/veh	8.3
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	253	584	26	92
Demand Flow Rate, veh/h	258	596	27	94
Vehicles Circulating, veh/h	146	0	352	491
Vehicles Exiting, veh/h	439	379	52	105
Follow-Up Headway, s	3.186	3.186	3.186	3.186
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	6.4	9.5	5.0	6.8
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Critical Headway, s	5.193	5.193	5.193	5.193
Entry Flow, veh/h	258	596	27	94
Cap Entry Lane, veh/h	976	1130	795	692
Entry HV Adj Factor	0.980	0.981	0.963	0.979
Flow Entry, veh/h	253	584	26	92
Cap Entry, veh/h	957	1108	765	677
V/C Ratio	0.264	0.527	0.034	0.136
Control Delay, s/veh	6.4	9.5	5.0	6.8
LOS	A	A	A	A
95th %tile Queue, veh	1	3	0	0

HCM 2010 Signalized Intersection Summary
3: Houghton Road & Valencia Road

5/17/2016

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑	↱	↰↰	↑↑	↱	↰↰	↑↑↑	↱	↰↰	↑↑↑	↱
Traffic Volume (veh/h)	228	38	102	41	62	61	110	999	14	77	1037	548
Future Volume (veh/h)	228	38	102	41	62	61	110	999	14	77	1037	548
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	253	42	113	46	69	68	122	1110	16	86	1152	609
Adj No. of Lanes	2	2	1	2	2	1	2	3	1	2	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	564	358	160	488	264	118	611	2675	833	788	2675	833
Arrive On Green	0.07	0.10	0.10	0.04	0.07	0.07	0.06	0.53	0.53	0.06	0.53	0.53
Sat Flow, veh/h	3442	3539	1583	3442	3539	1583	3442	5085	1583	3442	5085	1583
Grp Volume(v), veh/h	253	42	113	46	69	68	122	1110	16	86	1152	609
Grp Sat Flow(s),veh/h/ln	1721	1770	1583	1721	1770	1583	1721	1695	1583	1721	1695	1583
Q Serve(g_s), s	0.0	0.8	5.1	0.0	1.4	3.1	0.0	9.8	0.4	0.0	10.3	22.0
Cycle Q Clear(g_c), s	0.0	0.8	5.1	0.0	1.4	3.1	0.0	9.8	0.4	0.0	10.3	22.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	564	358	160	488	264	118	611	2675	833	788	2675	833
V/C Ratio(X)	0.45	0.12	0.71	0.09	0.26	0.58	0.20	0.42	0.02	0.11	0.43	0.73
Avail Cap(c_a), veh/h	609	907	406	624	907	406	676	2675	833	853	2675	833
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	31.1	30.3	32.3	30.3	32.4	33.2	14.7	10.7	8.4	12.1	10.8	13.5
Incr Delay (d2), s/veh	0.6	0.1	5.6	0.1	0.5	4.4	0.2	0.5	0.0	0.1	0.5	5.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.5	0.4	2.5	0.4	0.7	1.5	0.9	4.6	0.2	0.5	4.9	10.8
LnGrp Delay(d),s/veh	31.7	30.5	37.9	30.4	32.9	37.6	14.8	11.1	8.5	12.1	11.3	19.2
LnGrp LOS	C	C	D	C	C	D	B	B	A	B	B	B
Approach Vol, veh/h		408			183			1248			1847	
Approach Delay, s/veh		33.3			34.0			11.5			13.9	
Approach LOS		C			C			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	9.6	44.0	8.1	12.5	9.6	44.0	10.0	10.5
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	6.0	39.0	6.0	19.0	6.0	39.0	6.0	19.0
Max Q Clear Time (g_c+I1), s	2.0	11.8	2.0	7.1	2.0	24.0	2.0	5.1
Green Ext Time (p_c), s	0.2	8.2	0.4	0.4	0.2	8.6	0.4	0.5

Intersection Summary	
HCM 2010 Ctrl Delay	16.2
HCM 2010 LOS	B

HCM 2010 Signalized Intersection Summary
3: Houghton Road & Valencia Road

5/17/2016

	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑	↱	↰↰	↑↑	↱	↰↰	↑↑↑	↱	↰↰	↑↑↑	↱
Traffic Volume (veh/h)	564	89	231	49	47	51	73	954	26	67	1074	230
Future Volume (veh/h)	564	89	231	49	47	51	73	954	26	67	1074	230
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	627	99	257	54	52	57	81	1060	29	74	1193	256
Adj No. of Lanes	2	2	1	2	2	1	2	3	1	2	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	821	697	312	397	239	107	578	2264	705	682	2264	705
Arrive On Green	0.16	0.20	0.20	0.03	0.07	0.07	0.05	0.45	0.45	0.05	0.45	0.45
Sat Flow, veh/h	3442	3539	1583	3442	3539	1583	3442	5085	1583	3442	5085	1583
Grp Volume(v), veh/h	627	99	257	54	52	57	81	1060	29	74	1193	256
Grp Sat Flow(s),veh/h/ln	1721	1770	1583	1721	1770	1583	1721	1695	1583	1721	1695	1583
Q Serve(g_s), s	7.0	1.7	11.5	0.0	1.0	2.6	0.0	10.8	0.8	0.0	12.6	7.9
Cycle Q Clear(g_c), s	7.0	1.7	11.5	0.0	1.0	2.6	0.0	10.8	0.8	0.0	12.6	7.9
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	821	697	312	397	239	107	578	2264	705	682	2264	705
V/C Ratio(X)	0.76	0.14	0.82	0.14	0.22	0.53	0.14	0.47	0.04	0.11	0.53	0.36
Avail Cap(c_a), veh/h	821	1194	534	561	907	406	668	2264	705	772	2264	705
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	27.3	24.6	28.5	32.4	32.7	33.4	18.8	14.4	11.6	16.7	14.9	13.6
Incr Delay (d2), s/veh	4.3	0.1	5.5	0.2	0.5	4.1	0.1	0.7	0.1	0.1	0.9	1.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	6.4	0.8	5.5	0.5	0.5	1.2	0.6	5.2	0.4	0.5	6.0	3.7
LnGrp Delay(d),s/veh	31.6	24.7	34.0	32.6	33.2	37.5	18.9	15.1	11.7	16.8	15.8	15.1
LnGrp LOS	C	C	C	C	C	D	B	B	B	B	B	B
Approach Vol, veh/h		983			163			1170			1523	
Approach Delay, s/veh		31.6			34.5			15.3			15.7	
Approach LOS		C			C			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	9.1	38.0	7.5	19.6	9.1	38.0	17.1	10.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	6.0	33.0	6.0	25.0	6.0	33.0	12.0	19.0
Max Q Clear Time (g_c+I1), s	2.0	12.8	2.0	13.5	2.0	14.6	9.0	4.6
Green Ext Time (p_c), s	0.1	7.0	0.2	1.1	0.1	8.5	0.8	0.3

Intersection Summary	
HCM 2010 Ctrl Delay	20.4
HCM 2010 LOS	C

HCM 2010 Signalized Intersection Summary
8: Houghton Road & Bilby Road

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↑↑	↱	↰↰	↑↑↑
Traffic Volume (veh/h)	316	260	1103	178	123	1118
Future Volume (veh/h)	316	260	1103	178	123	1118
Number	3	18	2	12	1	6
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	351	289	1226	198	137	1242
Adj No. of Lanes	2	1	3	1	2	3
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	535	619	2042	882	1143	3591
Arrive On Green	0.16	0.16	0.40	0.40	0.24	0.71
Sat Flow, veh/h	3442	1583	5253	1583	3442	5253
Grp Volume(v), veh/h	351	289	1226	198	137	1242
Grp Sat Flow(s),veh/h/ln	1721	1583	1695	1583	1721	1695
Q Serve(g_s), s	6.9	0.0	13.7	4.6	0.0	6.9
Cycle Q Clear(g_c), s	6.9	0.0	13.7	4.6	0.0	6.9
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	535	619	2042	882	1143	3591
V/C Ratio(X)	0.66	0.47	0.60	0.22	0.12	0.35
Avail Cap(c_a), veh/h	1382	1008	2042	882	1143	3591
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	28.7	16.4	17.0	8.1	15.0	4.1
Incr Delay (d2), s/veh	1.4	0.5	1.3	0.6	0.0	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.4	4.3	6.6	2.8	1.0	3.2
LnGrp Delay(d),s/veh	30.1	16.9	18.4	8.7	15.1	4.4
LnGrp LOS	C	B	B	A	B	A
Approach Vol, veh/h	640		1424			1379
Approach Delay, s/veh	24.1		17.0			5.5
Approach LOS	C		B			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	22.0	34.0				56.0		16.2
Change Period (Y+Rc), s	5.0	5.0				5.0		5.0
Max Green Setting (Gmax), s	17.0	29.0				51.0		29.0
Max Q Clear Time (g_c+I1), s	2.0	15.7				8.9		8.9
Green Ext Time (p_c), s	7.5	7.6				11.3		2.3

Intersection Summary	
HCM 2010 Ctrl Delay	13.7
HCM 2010 LOS	B

	↙	↖	↑	↗	↘	↓
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↑↑	↱	↰↰	↑↑↑
Traffic Volume (veh/h)	106	104	1377	185	162	1218
Future Volume (veh/h)	106	104	1377	185	162	1218
Number	3	18	2	12	1	6
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	118	116	1530	206	180	1353
Adj No. of Lanes	2	1	3	1	2	3
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	250	465	2470	884	1098	3967
Arrive On Green	0.07	0.07	0.49	0.49	0.22	0.78
Sat Flow, veh/h	3442	1583	5253	1583	3442	5253
Grp Volume(v), veh/h	118	116	1530	206	180	1353
Grp Sat Flow(s),veh/h/ln	1721	1583	1695	1583	1721	1695
Q Serve(g_s), s	2.2	0.0	15.0	4.5	0.0	5.4
Cycle Q Clear(g_c), s	2.2	0.0	15.0	4.5	0.0	5.4
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	250	465	2470	884	1098	3967
V/C Ratio(X)	0.47	0.25	0.62	0.23	0.16	0.34
Avail Cap(c_a), veh/h	1368	979	2470	884	1098	3967
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	30.2	18.3	12.9	7.6	15.0	2.2
Incr Delay (d2), s/veh	1.4	0.3	1.2	0.6	0.1	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.1	1.7	7.2	2.4	1.3	2.6
LnGrp Delay(d),s/veh	31.6	18.6	14.0	8.2	15.1	2.5
LnGrp LOS	C	B	B	A	B	A
Approach Vol, veh/h	234		1736			1533
Approach Delay, s/veh	25.2		13.3			4.0
Approach LOS	C		B			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	20.0	38.0				58.0		9.9
Change Period (Y+Rc), s	5.0	5.0				5.0		5.0
Max Green Setting (Gmax), s	15.0	33.0				53.0		27.0
Max Q Clear Time (g_c+I1), s	2.0	17.0				7.4		4.2
Green Ext Time (p_c), s	7.5	10.4				13.3		0.8

Intersection Summary	
HCM 2010 Ctrl Delay	10.0
HCM 2010 LOS	B

HCM 2010 Signalized Intersection Summary
14: Houghton Road & Drexel Road

6/13/2016

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↑↑	↱	↰	↑↑↱	
Traffic Volume (veh/h)	232	0	179	191	0	172	81	1189	91	49	945	55
Future Volume (veh/h)	232	0	179	191	0	172	81	1189	91	49	945	55
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1900	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	258	0	199	212	0	191	90	1321	101	54	1050	61
Adj No. of Lanes	1	1	0	1	1	0	1	3	1	1	3	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	342	0	267	367	0	250	363	1973	614	258	1555	90
Arrive On Green	0.10	0.00	0.17	0.10	0.00	0.17	0.11	0.39	0.39	0.06	0.32	0.30
Sat Flow, veh/h	1774	0	1583	1774	0	1583	1774	5085	1583	1774	4917	285
Grp Volume(v), veh/h	258	0	199	212	0	191	90	1321	101	54	724	387
Grp Sat Flow(s),veh/h/ln	1774	0	1583	1774	0	1583	1774	1695	1583	1774	1695	1812
Q Serve(g_s), s	2.4	0.0	7.1	0.2	0.0	6.8	0.0	12.8	2.5	0.0	11.0	11.1
Cycle Q Clear(g_c), s	2.4	0.0	7.1	0.2	0.0	6.8	0.0	12.8	2.5	0.0	11.0	11.1
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		0.16
Lane Grp Cap(c), veh/h	342	0	267	367	0	250	363	1973	614	258	1072	573
V/C Ratio(X)	0.75	0.00	0.75	0.58	0.00	0.76	0.25	0.67	0.16	0.21	0.67	0.68
Avail Cap(c_a), veh/h	679	0	586	514	0	399	363	2908	905	338	1882	1006
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	24.3	0.0	23.5	23.5	0.0	23.5	22.1	15.0	11.9	24.4	17.7	17.8
Incr Delay (d2), s/veh	3.4	0.0	4.1	1.4	0.0	4.8	0.4	0.4	0.1	0.4	0.7	1.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.3	0.0	3.4	3.3	0.0	3.3	1.3	5.9	1.1	0.9	5.2	5.7
LnGrp Delay(d),s/veh	27.7	0.0	27.6	24.9	0.0	28.3	22.5	15.4	12.0	24.8	18.4	19.2
LnGrp LOS	C		C	C		C	C	B	B	C	B	B
Approach Vol, veh/h		457			403			1512			1165	
Approach Delay, s/veh		27.7			26.5			15.6			19.0	
Approach LOS		C			C			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	7.3	27.1	10.1	15.0	11.6	22.8	10.7	14.4
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	5.0	33.0	10.0	22.0	6.0	32.0	17.0	15.0
Max Q Clear Time (g_c+I1), s	2.0	14.8	2.2	9.1	2.0	13.1	4.4	8.8
Green Ext Time (p_c), s	0.0	7.3	1.1	0.9	0.1	4.7	1.4	0.5

Intersection Summary	
HCM 2010 Ctrl Delay	19.5
HCM 2010 LOS	B

HCM 2010 Signalized Intersection Summary
14: Houghton Road & Drexel Road

6/13/2016

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↑↑	↱	↰	↑↑↱	
Traffic Volume (veh/h)	172	0	162	86	0	91	309	1032	121	162	1190	217
Future Volume (veh/h)	172	0	162	86	0	91	309	1032	121	162	1190	217
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1900	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	191	0	180	96	0	101	343	1147	134	180	1322	241
Adj No. of Lanes	1	1	0	1	1	0	1	3	1	1	3	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	339	0	241	238	0	151	396	1617	504	521	1504	274
Arrive On Green	0.12	0.00	0.15	0.07	0.00	0.11	0.16	0.32	0.32	0.21	0.35	0.33
Sat Flow, veh/h	1774	0	1583	1774	0	1583	1774	5085	1583	1774	4326	788
Grp Volume(v), veh/h	191	0	180	96	0	101	343	1147	134	180	1036	527
Grp Sat Flow(s),veh/h/ln	1774	0	1583	1774	0	1583	1774	1695	1583	1774	1695	1724
Q Serve(g_s), s	1.5	0.0	7.4	0.0	0.0	4.2	8.4	13.5	4.3	0.0	19.5	19.5
Cycle Q Clear(g_c), s	1.5	0.0	7.4	0.0	0.0	4.2	8.4	13.5	4.3	0.0	19.5	19.5
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		0.46
Lane Grp Cap(c), veh/h	339	0	241	238	0	151	396	1617	504	521	1179	599
V/C Ratio(X)	0.56	0.00	0.75	0.40	0.00	0.67	0.87	0.71	0.27	0.35	0.88	0.88
Avail Cap(c_a), veh/h	578	0	631	265	0	350	504	2100	654	521	1200	610
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	26.5	0.0	27.5	29.1	0.0	29.2	26.0	20.4	17.2	20.3	20.8	21.0
Incr Delay (d2), s/veh	1.5	0.0	4.6	1.1	0.0	5.1	12.1	0.8	0.3	0.4	7.6	13.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.4	0.0	3.5	1.7	0.0	2.0	7.5	6.4	1.9	2.7	10.3	11.5
LnGrp Delay(d),s/veh	28.0	0.0	32.0	30.2	0.0	34.2	38.1	21.1	17.5	20.7	28.4	34.7
LnGrp LOS	C		C	C		C	D	C	B	C	C	C
Approach Vol, veh/h		371			197			1624			1743	
Approach Delay, s/veh		30.0			32.3			24.4			29.5	
Approach LOS		C			C			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	17.9	25.6	9.0	15.3	15.9	27.6	12.9	11.4
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	11.0	27.0	5.0	27.0	15.0	23.0	17.0	15.0
Max Q Clear Time (g_c+I1), s	2.0	15.5	2.0	9.4	10.4	21.5	3.5	6.2
Green Ext Time (p_c), s	1.3	5.1	0.3	1.0	0.6	1.1	0.8	0.3

Intersection Summary	
HCM 2010 Ctrl Delay	27.6
HCM 2010 LOS	C

Intersection	
Int Delay, s/veh	1.4

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Traffic Vol, veh/h	0	65	1600	17	53	990
Future Vol, veh/h	0	65	1600	17	53	990
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	175	0	-	200	300	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	72	1778	19	59	1100

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2336	889	0	0	1778	0
Stage 1	1778	-	-	-	-	-
Stage 2	558	-	-	-	-	-
Critical Hdwy	5.74	7.14	-	-	5.34	-
Critical Hdwy Stg 1	6.64	-	-	-	-	-
Critical Hdwy Stg 2	6.04	-	-	-	-	-
Follow-up Hdwy	3.82	3.92	-	-	3.12	-
Pot Cap-1 Maneuver	62	246	-	-	162	-
Stage 1	79	-	-	-	-	-
Stage 2	490	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	39	246	-	-	162	-
Mov Cap-2 Maneuver	39	-	-	-	-	-
Stage 1	79	-	-	-	-	-
Stage 2	312	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	25.6	0	2
HCM LOS	D		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	-	246	162	-
HCM Lane V/C Ratio	-	-	-	0.294	0.364	-
HCM Control Delay (s)	-	-	0	25.6	39.4	-
HCM Lane LOS	-	-	A	D	E	-
HCM 95th %tile Q(veh)	-	-	-	1.2	1.5	-

Intersection	
Int Delay, s/veh	3

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Traffic Vol, veh/h	0	55	1308	44	156	1568
Future Vol, veh/h	0	55	1308	44	156	1568
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	175	0	-	200	300	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	61	1453	49	173	1742

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2497	727	0	0	1453	0
Stage 1	1453	-	-	-	-	-
Stage 2	1044	-	-	-	-	-
Critical Hdwy	5.74	7.14	-	-	5.34	-
Critical Hdwy Stg 1	6.64	-	-	-	-	-
Critical Hdwy Stg 2	6.04	-	-	-	-	-
Follow-up Hdwy	3.82	3.92	-	-	3.12	-
Pot Cap-1 Maneuver	50	314	-	-	235	-
Stage 1	127	-	-	-	-	-
Stage 2	270	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	13	314	-	-	235	-
Mov Cap-2 Maneuver	13	-	-	-	-	-
Stage 1	127	-	-	-	-	-
Stage 2	71	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	19.2	0	4.9
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	-	314	235	-
HCM Lane V/C Ratio	-	-	-	0.195	0.738	-
HCM Control Delay (s)	-	-	0	19.2	53.9	-
HCM Lane LOS	-	-	A	C	F	-
HCM 95th %tile Q(veh)	-	-	-	0.7	5.1	-

HCM 2010 Signalized Intersection Summary
12: Houghton Road & Irvington Road

5/17/2016

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑	↱	↰	↱		↰↰	↑↑	↱	↰	↑↑↑	↱
Traffic Volume (veh/h)	62	1	385	3	4	3	781	964	4	5	646	271
Future Volume (veh/h)	62	1	385	3	4	3	781	964	4	5	646	271
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	69	1	428	3	4	3	868	1071	4	6	718	301
Adj No. of Lanes	1	1	1	1	1	0	2	2	1	1	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	247	195	607	205	104	78	1457	2649	1185	256	2015	627
Arrive On Green	0.10	0.10	0.10	0.10	0.10	0.10	0.28	0.75	0.75	0.40	0.40	0.40
Sat Flow, veh/h	1403	1863	1583	955	990	742	3442	3539	1583	523	5085	1583
Grp Volume(v), veh/h	69	1	428	3	0	7	868	1071	4	6	718	301
Grp Sat Flow(s),veh/h/ln	1403	1863	1583	955	0	1732	1721	1770	1583	523	1695	1583
Q Serve(g_s), s	3.2	0.0	0.0	0.2	0.0	0.2	3.4	7.4	0.0	0.6	6.8	9.7
Cycle Q Clear(g_c), s	3.4	0.0	0.0	0.2	0.0	0.2	3.4	7.4	0.0	8.0	6.8	9.7
Prop In Lane	1.00		1.00	1.00		0.43	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	247	195	607	205	0	181	1457	2649	1185	256	2015	627
V/C Ratio(X)	0.28	0.01	0.70	0.01	0.00	0.04	0.60	0.40	0.00	0.02	0.36	0.48
Avail Cap(c_a), veh/h	698	793	1116	512	0	737	1457	2649	1185	256	2015	627
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	29.0	27.3	17.7	27.4	0.0	27.4	15.0	3.1	2.2	17.5	14.5	15.3
Incr Delay (d2), s/veh	0.6	0.0	1.5	0.0	0.0	0.1	0.7	0.5	0.0	0.2	0.5	2.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.3	0.0	6.9	0.1	0.0	0.1	6.4	3.7	0.0	0.1	3.2	4.6
LnGrp Delay(d),s/veh	29.6	27.3	19.3	27.5	0.0	27.5	15.6	3.5	2.2	17.7	14.9	17.9
LnGrp LOS	C	C	B	C		C	B	A	A	B	B	B
Approach Vol, veh/h		498			10			1943			1025	
Approach Delay, s/veh		20.7			27.5			8.9			15.8	
Approach LOS		C			C			A			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		56.0		12.1	24.0	32.0		12.1
Change Period (Y+Rc), s		5.0		5.0	5.0	5.0		5.0
Max Green Setting (Gmax), s		51.0		29.0	19.0	27.0		29.0
Max Q Clear Time (g_c+I1), s		9.4		5.4	5.4	11.7		2.2
Green Ext Time (p_c), s		14.8		1.7	8.5	5.0		1.7

Intersection Summary	
HCM 2010 Ctrl Delay	12.7
HCM 2010 LOS	B

	↰	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑	↱	↰	↱		↰↰	↑↑	↱	↰	↑↑↑	↱
Traffic Volume (veh/h)	207	3	736	2	4	4	490	965	4	4	948	71
Future Volume (veh/h)	207	3	736	2	4	4	490	965	4	4	948	71
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	230	3	818	2	4	4	544	1072	4	4	1053	79
Adj No. of Lanes	1	1	1	1	1	0	2	2	1	1	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	494	554	848	278	255	255	1066	2085	933	142	1498	466
Arrive On Green	0.30	0.30	0.30	0.30	0.30	0.30	0.24	0.59	0.59	0.29	0.29	0.29
Sat Flow, veh/h	1402	1863	1583	664	856	856	3442	3539	1583	522	5085	1583
Grp Volume(v), veh/h	230	3	818	2	0	8	544	1072	4	4	1053	79
Grp Sat Flow(s),veh/h/ln	1402	1863	1583	664	0	1712	1721	1770	1583	522	1695	1583
Q Serve(g_s), s	12.2	0.1	22.8	0.2	0.0	0.3	5.1	15.8	0.1	0.6	16.3	3.3
Cycle Q Clear(g_c), s	12.5	0.1	22.8	0.3	0.0	0.3	5.1	15.8	0.1	16.4	16.3	3.3
Prop In Lane	1.00		1.00	1.00		0.50	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	494	554	848	278	0	509	1066	2085	933	142	1498	466
V/C Ratio(X)	0.47	0.01	0.96	0.01	0.00	0.02	0.51	0.51	0.00	0.03	0.70	0.17
Avail Cap(c_a), veh/h	522	591	879	291	0	543	1066	2085	933	142	1498	466
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	26.3	21.8	19.7	21.9	0.0	21.9	25.8	10.7	7.5	34.8	27.7	23.1
Incr Delay (d2), s/veh	0.7	0.0	21.8	0.0	0.0	0.0	0.4	0.9	0.0	0.4	2.8	0.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.8	0.1	18.8	0.0	0.0	0.1	5.5	7.9	0.0	0.1	8.0	1.5
LnGrp Delay(d),s/veh	27.0	21.8	41.5	21.9	0.0	21.9	26.2	11.6	7.5	35.1	30.5	23.9
LnGrp LOS	C	C	D	C		C	C	B	A	D	C	C
Approach Vol, veh/h		1051			10			1620			1136	
Approach Delay, s/veh		38.3			21.9			16.5			30.0	
Approach LOS		D			C			B			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		57.0		31.3	26.0	31.0		31.3
Change Period (Y+Rc), s		5.0		5.0	5.0	5.0		5.0
Max Green Setting (Gmax), s		52.0		28.0	21.0	26.0		28.0
Max Q Clear Time (g_c+I1), s		17.8		24.8	7.1	18.4		2.3
Green Ext Time (p_c), s		11.5		1.4	7.6	4.0		4.4

Intersection Summary			
HCM 2010 Ctrl Delay			26.5
HCM 2010 LOS			C

21: Houghton Road & North Access

Intersection	
Int Delay, s/veh	0.7

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Traffic Vol, veh/h	23	49	8	1585	975	15
Future Vol, veh/h	23	49	8	1585	975	15
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	0	150	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	26	54	9	1761	1083	17

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1814	550	1100	0	-	0
Stage 1	1092	-	-	-	-	-
Stage 2	722	-	-	-	-	-
Critical Hdwy	5.74	7.14	5.34	-	-	-
Critical Hdwy Stg 1	6.64	-	-	-	-	-
Critical Hdwy Stg 2	6.04	-	-	-	-	-
Follow-up Hdwy	3.82	3.92	3.12	-	-	-
Pot Cap-1 Maneuver	118	410	350	-	-	-
Stage 1	212	-	-	-	-	-
Stage 2	402	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	115	410	350	-	-	-
Mov Cap-2 Maneuver	115	-	-	-	-	-
Stage 1	212	-	-	-	-	-
Stage 2	392	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	24.7	0.1	0
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	350	-	115	410	-	-
HCM Lane V/C Ratio	0.025	-	0.222	0.133	-	-
HCM Control Delay (s)	15.6	-	45	15.1	-	-
HCM Lane LOS	C	-	E	C	-	-
HCM 95th %tile Q(veh)	0.1	-	0.8	0.5	-	-

HCM 2010 TWSC
21: Houghton Road & North Access

6/13/2016

Intersection	
Int Delay, s/veh	2.2

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Traffic Vol, veh/h	30	33	27	1268	1517	51
Future Vol, veh/h	30	33	27	1268	1517	51
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	0	150	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	33	37	30	1409	1686	57

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2338	871	1742	0	-	0
Stage 1	1714	-	-	-	-	-
Stage 2	624	-	-	-	-	-
Critical Hdwy	5.74	7.14	5.34	-	-	-
Critical Hdwy Stg 1	6.64	-	-	-	-	-
Critical Hdwy Stg 2	6.04	-	-	-	-	-
Follow-up Hdwy	3.82	3.92	3.12	-	-	-
Pot Cap-1 Maneuver	61	253	169	-	-	-
Stage 1	87	-	-	-	-	-
Stage 2	452	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	50	253	169	-	-	-
Mov Cap-2 Maneuver	50	-	-	-	-	-
Stage 1	87	-	-	-	-	-
Stage 2	372	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	90.8	0.6	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	169	-	50	253	-	-
HCM Lane V/C Ratio	0.178	-	0.667	0.145	-	-
HCM Control Delay (s)	30.8	-	167	21.6	-	-
HCM Lane LOS	D	-	F	C	-	-
HCM 95th %tile Q(veh)	0.6	-	2.6	0.5	-	-

HCM 2010 TWSC
19: Houghton Road & South Access

5/17/2016

Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Traffic Vol, veh/h	0	47	0	1363	1194	11
Future Vol, veh/h	0	47	0	1363	1194	11
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	52	0	1514	1327	12

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1939	669	1339	0	-	0
Stage 1	1333	-	-	-	-	-
Stage 2	606	-	-	-	-	-
Critical Hdwy	5.74	7.14	5.34	-	-	-
Critical Hdwy Stg 1	6.64	-	-	-	-	-
Critical Hdwy Stg 2	6.04	-	-	-	-	-
Follow-up Hdwy	3.82	3.92	3.12	-	-	-
Pot Cap-1 Maneuver	101	343	268	-	-	-
Stage 1	151	-	-	-	-	-
Stage 2	462	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	101	343	268	-	-	-
Mov Cap-2 Maneuver	101	-	-	-	-	-
Stage 1	151	-	-	-	-	-
Stage 2	462	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	17.4	0	0
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	268	-	343	-	-
HCM Lane V/C Ratio	-	-	0.152	-	-
HCM Control Delay (s)	0	-	17.4	-	-
HCM Lane LOS	A	-	C	-	-
HCM 95th %tile Q(veh)	0	-	0.5	-	-

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Traffic Vol, veh/h	0	25	0	1481	1355	43
Future Vol, veh/h	0	25	0	1481	1355	43
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	28	0	1646	1506	48

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2187	777	1553	0	-	0
Stage 1	1529	-	-	-	-	-
Stage 2	658	-	-	-	-	-
Critical Hdwy	5.74	7.14	5.34	-	-	-
Critical Hdwy Stg 1	6.64	-	-	-	-	-
Critical Hdwy Stg 2	6.04	-	-	-	-	-
Follow-up Hdwy	3.82	3.92	3.12	-	-	-
Pot Cap-1 Maneuver	74	291	210	-	-	-
Stage 1	114	-	-	-	-	-
Stage 2	434	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	74	291	210	-	-	-
Mov Cap-2 Maneuver	74	-	-	-	-	-
Stage 1	114	-	-	-	-	-
Stage 2	434	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	18.7	0	0
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	210	-	291	-	-
HCM Lane V/C Ratio	-	-	0.095	-	-
HCM Control Delay (s)	0	-	18.7	-	-
HCM Lane LOS	A	-	C	-	-
HCM 95th %tile Q(veh)	0	-	0.3	-	-

Intersection	
Intersection Delay, s/veh	4.3
Intersection LOS	A

Approach	WB	NB	SB
Entry Lanes	1	0	1
Conflicting Circle Lanes	1	1	1
Adj Approach Flow, veh/h	51	0	154
Demand Flow Rate, veh/h	52	0	157
Vehicles Circulating, veh/h	0	157	0
Vehicles Exiting, veh/h	157	0	52
Follow-Up Headway, s	3.186	3.186	3.186
Ped Vol Crossing Leg, #/h	0	0	0
Ped Cap Adj	1.000	1.000	1.000
Approach Delay, s/veh	3.6	0.0	4.5
Approach LOS	A	-	A

Lane	Left	Left
Designated Moves	LR	LT
Assumed Moves	LR	LT
RT Channelized		
Lane Util	1.000	1.000
Critical Headway, s	5.193	5.193
Entry Flow, veh/h	52	157
Cap Entry Lane, veh/h	1130	1130
Entry HV Adj Factor	0.981	0.981
Flow Entry, veh/h	51	154
Cap Entry, veh/h	1108	1108
V/C Ratio	0.046	0.139
Control Delay, s/veh	3.6	4.5
LOS	A	A
95th %tile Queue, veh	0	0

Intersection	
Intersection Delay, s/veh	4.4
Intersection LOS	A

Approach	WB	NB	SB
Entry Lanes	1	0	1
Conflicting Circle Lanes	1	1	1
Adj Approach Flow, veh/h	172	0	101
Demand Flow Rate, veh/h	175	0	103
Vehicles Circulating, veh/h	0	103	0
Vehicles Exiting, veh/h	103	0	175
Follow-Up Headway, s	3.186	3.186	3.186
Ped Vol Crossing Leg, #/h	0	0	0
Ped Cap Adj	1.000	1.000	1.000
Approach Delay, s/veh	4.6	0.0	4.0
Approach LOS	A	-	A

Lane	Left	Left
Designated Moves	LR	LT
Assumed Moves	LR	LT
RT Channelized		
Lane Util	1.000	1.000
Critical Headway, s	5.193	5.193
Entry Flow, veh/h	175	103
Cap Entry Lane, veh/h	1130	1130
Entry HV Adj Factor	0.983	0.981
Flow Entry, veh/h	172	101
Cap Entry, veh/h	1111	1108
V/C Ratio	0.155	0.091
Control Delay, s/veh	4.6	4.0
LOS	A	A
95th %tile Queue, veh	1	0

Intersection	
Int Delay, s/veh	2.4

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Traffic Vol, veh/h	139	0	17	46	0	53
Future Vol, veh/h	139	0	17	46	0	53
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	100	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	154	0	19	51	0	59

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	154	0	243	154
Stage 1	-	-	-	-	154	-
Stage 2	-	-	-	-	89	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1426	-	745	892
Stage 1	-	-	-	-	874	-
Stage 2	-	-	-	-	934	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1426	-	735	892
Mov Cap-2 Maneuver	-	-	-	-	735	-
Stage 1	-	-	-	-	874	-
Stage 2	-	-	-	-	922	-

Approach	EB	WB	NB
HCM Control Delay, s	0	2	9.3
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	-	892	-	-	1426	-
HCM Lane V/C Ratio	-	0.066	-	-	0.013	-
HCM Control Delay (s)	0	9.3	-	-	7.6	-
HCM Lane LOS	A	A	-	-	A	-
HCM 95th %tile Q(veh)	-	0.2	-	-	0	-

Intersection	
Int Delay, s/veh	2.5

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Traffic Vol, veh/h	91	0	59	115	0	35
Future Vol, veh/h	91	0	59	115	0	35
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	100	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	101	0	66	128	0	39

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	101	0	360	101
Stage 1	-	-	-	-	101	-
Stage 2	-	-	-	-	259	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1491	-	639	954
Stage 1	-	-	-	-	923	-
Stage 2	-	-	-	-	784	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1491	-	611	954
Mov Cap-2 Maneuver	-	-	-	-	611	-
Stage 1	-	-	-	-	923	-
Stage 2	-	-	-	-	749	-

Approach	EB	WB	NB
HCM Control Delay, s	0	2.6	8.9
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	-	954	-	-	1491	-
HCM Lane V/C Ratio	-	0.041	-	-	0.044	-
HCM Control Delay (s)	0	8.9	-	-	7.5	-
HCM Lane LOS	A	A	-	-	A	-
HCM 95th %tile Q(veh)	-	0.1	-	-	0.1	-

Intersection	
Int Delay, s/veh	2.9

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Traffic Vol, veh/h	0	192	63	34	100	0
Future Vol, veh/h	0	192	63	34	100	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	100	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	213	70	38	111	0

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	108	0	-	0	302	89
Stage 1	-	-	-	-	89	-
Stage 2	-	-	-	-	213	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1483	-	-	-	690	969
Stage 1	-	-	-	-	934	-
Stage 2	-	-	-	-	823	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1483	-	-	-	690	969
Mov Cap-2 Maneuver	-	-	-	-	690	-
Stage 1	-	-	-	-	934	-
Stage 2	-	-	-	-	823	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	11.2
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	1483	-	-	-	690	-
HCM Lane V/C Ratio	-	-	-	-	0.161	-
HCM Control Delay (s)	0	-	-	-	11.2	0
HCM Lane LOS	A	-	-	-	B	A
HCM 95th %tile Q(veh)	0	-	-	-	0.6	-

Intersection	
Int Delay, s/veh	1.6

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Traffic Vol, veh/h	0	126	214	114	67	0
Future Vol, veh/h	0	126	214	114	67	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	100	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	140	238	127	74	0

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	364	0	-	0	441	301
Stage 1	-	-	-	-	301	-
Stage 2	-	-	-	-	140	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1195	-	-	-	574	739
Stage 1	-	-	-	-	751	-
Stage 2	-	-	-	-	887	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1195	-	-	-	574	739
Mov Cap-2 Maneuver	-	-	-	-	574	-
Stage 1	-	-	-	-	751	-
Stage 2	-	-	-	-	887	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	12.2
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	1195	-	-	-	574	-
HCM Lane V/C Ratio	-	-	-	-	0.13	-
HCM Control Delay (s)	0	-	-	-	12.2	0
HCM Lane LOS	A	-	-	-	B	A
HCM 95th %tile Q(veh)	0	-	-	-	0.4	-

HCM 2010 TWSC
27: Access 4 & Drexel Road

5/18/2016

Intersection	
Int Delay, s/veh	1.5

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Traffic Vol, veh/h	292	0	18	97	0	53
Future Vol, veh/h	292	0	18	97	0	53
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	100	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	324	0	20	108	0	59

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	324	0	472	324
Stage 1	-	-	-	-	324	-
Stage 2	-	-	-	-	148	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1236	-	551	717
Stage 1	-	-	-	-	733	-
Stage 2	-	-	-	-	880	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1236	-	542	717
Mov Cap-2 Maneuver	-	-	-	-	542	-
Stage 1	-	-	-	-	733	-
Stage 2	-	-	-	-	866	-

Approach	EB	WB	NB
HCM Control Delay, s	0	1.2	10.5
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	-	717	-	-	1236	-
HCM Lane V/C Ratio	-	0.082	-	-	0.016	-
HCM Control Delay (s)	0	10.5	-	-	8	-
HCM Lane LOS	A	B	-	-	A	-
HCM 95th %tile Q(veh)	-	0.3	-	-	0	-

HCM 2010 TWSC
27: Access 4 & Drexel Road

Intersection	
Int Delay, s/veh	1.3

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Traffic Vol, veh/h	193	0	59	328	0	35
Future Vol, veh/h	193	0	59	328	0	35
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	100	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	214	0	66	364	0	39

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	214	0	710	214
Stage 1	-	-	-	-	214	-
Stage 2	-	-	-	-	496	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1356	-	400	826
Stage 1	-	-	-	-	822	-
Stage 2	-	-	-	-	612	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1356	-	381	826
Mov Cap-2 Maneuver	-	-	-	-	381	-
Stage 1	-	-	-	-	822	-
Stage 2	-	-	-	-	582	-

Approach	EB	WB	NB
HCM Control Delay, s	0	1.2	9.6
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	-	826	-	-	1356	-
HCM Lane V/C Ratio	-	0.047	-	-	0.048	-
HCM Control Delay (s)	0	9.6	-	-	7.8	-
HCM Lane LOS	A	A	-	-	A	-
HCM 95th %tile Q(veh)	-	0.1	-	-	0.2	-

Intersection	
Intersection Delay, s/veh	6.2
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	383	151	48	26
Demand Flow Rate, veh/h	391	154	49	27
Vehicles Circulating, veh/h	40	0	418	144
Vehicles Exiting, veh/h	131	467	13	10
Follow-Up Headway, s	3.186	3.186	3.186	3.186
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	7.1	4.4	5.6	4.1
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Critical Headway, s	5.193	5.193	5.193	5.193
Entry Flow, veh/h	391	154	49	27
Cap Entry Lane, veh/h	1086	1130	744	978
Entry HV Adj Factor	0.980	0.983	0.980	0.963
Flow Entry, veh/h	383	151	48	26
Cap Entry, veh/h	1064	1111	729	942
V/C Ratio	0.360	0.136	0.066	0.028
Control Delay, s/veh	7.1	4.4	5.6	4.1
LOS	A	A	A	A
95th %tile Queue, veh	2	0	0	0

Intersection	
Intersection Delay, s/veh	8.3
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	253	584	26	92
Demand Flow Rate, veh/h	258	596	27	94
Vehicles Circulating, veh/h	146	0	352	491
Vehicles Exiting, veh/h	439	379	52	105
Follow-Up Headway, s	3.186	3.186	3.186	3.186
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	6.4	9.5	5.0	6.8
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Critical Headway, s	5.193	5.193	5.193	5.193
Entry Flow, veh/h	258	596	27	94
Cap Entry Lane, veh/h	976	1130	795	692
Entry HV Adj Factor	0.980	0.981	0.963	0.979
Flow Entry, veh/h	253	584	26	92
Cap Entry, veh/h	957	1108	765	677
V/C Ratio	0.264	0.527	0.034	0.136
Control Delay, s/veh	6.4	9.5	5.0	6.8
LOS	A	A	A	A
95th %tile Queue, veh	1	3	0	0

TRAFFIC IMPACT ANALYSIS
SAGUARO TRAILS
DREXEL ROAD/HOUGHTON ROAD

APPENDIX

Turn Lane Analysis

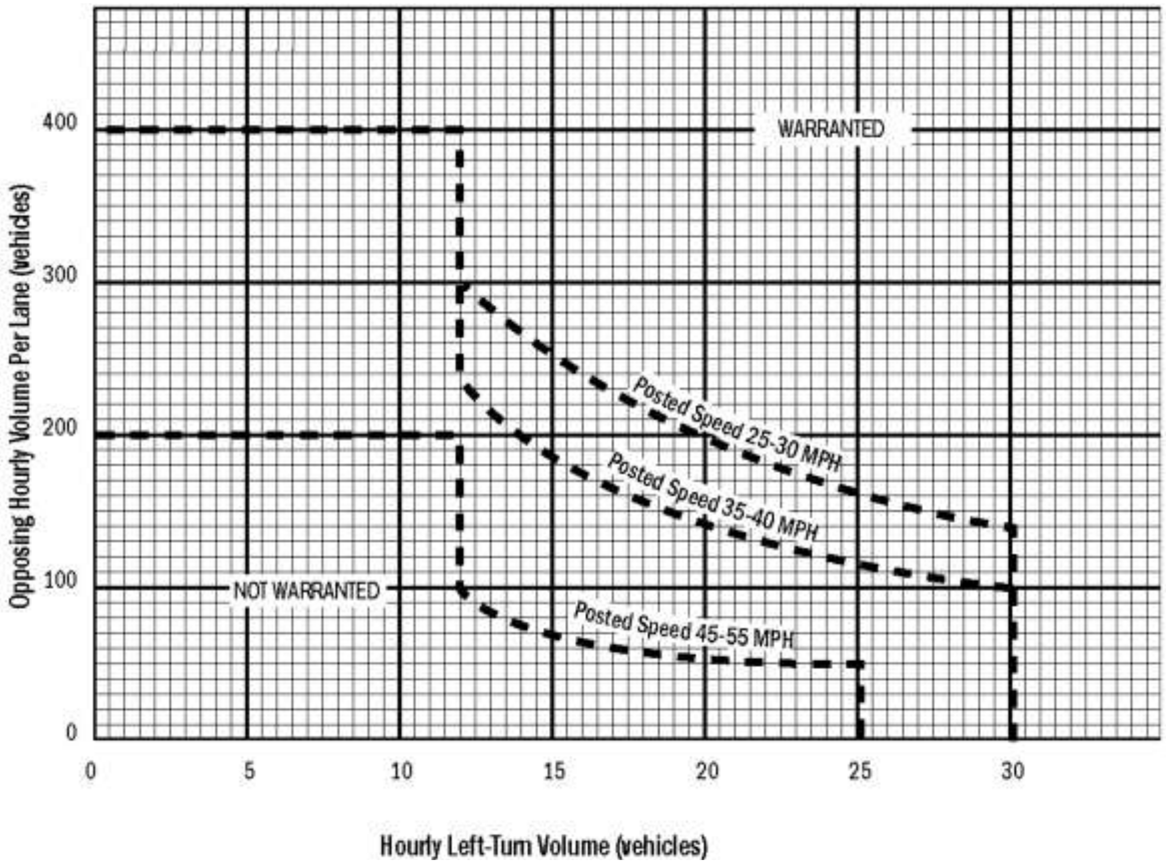


Figure 5-1 – Left Turn Lane Warrant[13]

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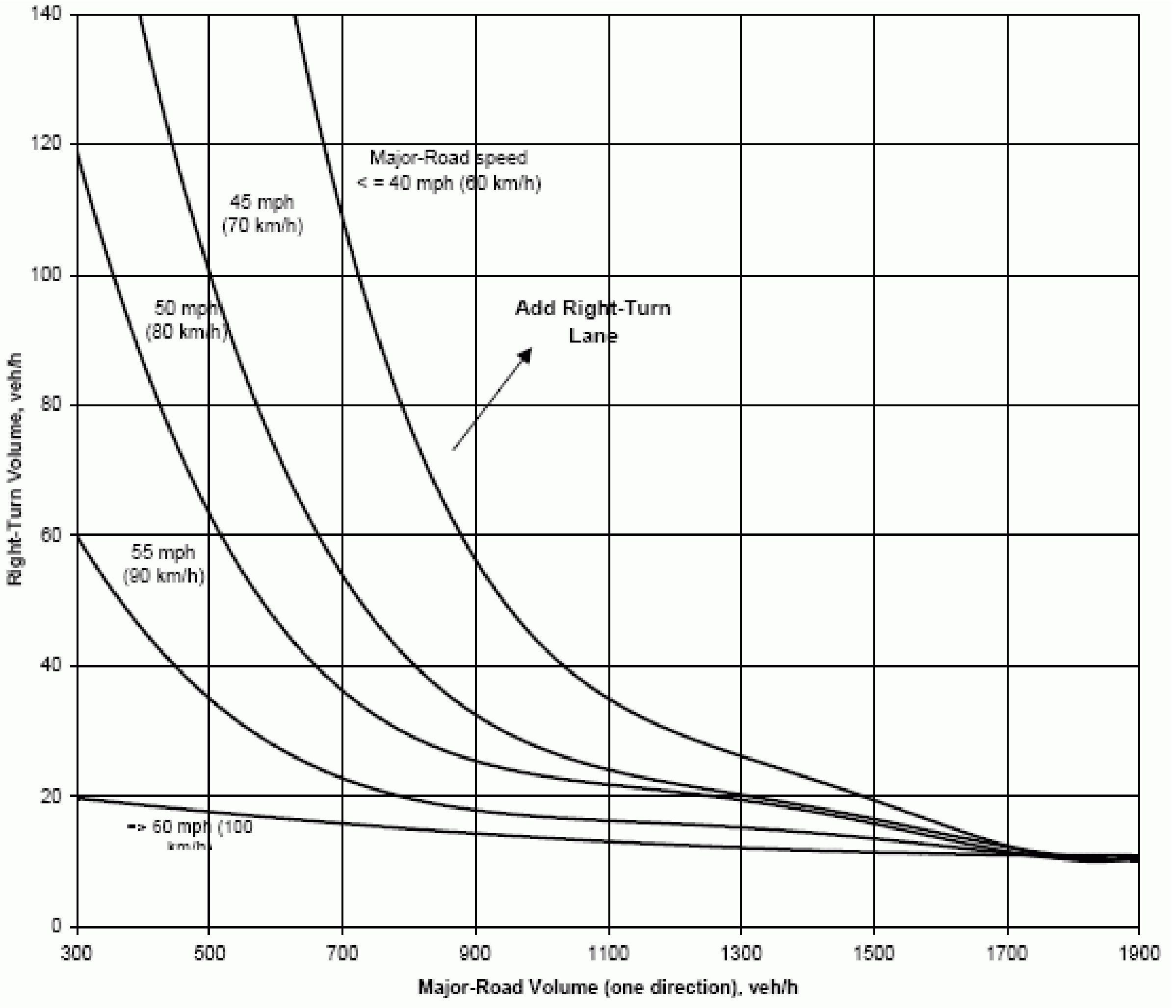
[13] Idaho Transportation Department, "Traffic Manual," 2011; and, Transportation Research Board, NCHRP Report 348, "Access Management Guidelines for Activity Centers."



Note: Existing roadway constraints may restrict the ability or need to install turning lanes. Traffic Engineering may require a traffic engineering analysis to support alternative recommendations for the installation of turning lanes.

Figure 5-3 – Right Turn Guidelines for Four-Lane Roadways[15]

5.3.1 Total Turn Lane Length

A separate turning lane consists of a taper plus a full width auxiliary lane. The design of turn lanes is primarily based on the speed at which drivers turn into the lane, the speed to which drivers must reduce in order to turn into the driveway, and the required vehicular storage length. Other special considerations include the volume of trucks that will use the turning lane and the steepness of an ascending or descending grade.

The Pima County Department of Transportation (PCDOT) and the City of Tucson Department of Transportation (TDOT) provide design guidelines for minimum

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[15] Source: MoDOT. Engineering Policy Guide. Sheet 940.9.9 “Right Turn Lane Guidelines for Four-Lane Roadways.” 2007.

Un-Signalized Intersection (Right Turn Lane)
Location: North Access/Houghton Road
Approach/Leg: Southbound **2022 With Project**

V = vehicles per hour

PM Peak Hour
V = 51 vph

S = Storage = (V *2 min* 25 ft/veh)/60 min/hr

$$S\ (ft) = \frac{51\ vph*(2\ min)*(25\ ft/veh)\ =}{(60\ min/hr)} \quad 43\ feet$$

Minimum Recommended Storage: 50 feet

Un-Signalized Intersection (Leftt Turn Lane)
Location: North Access/Houghton Road
Approach/Leg: Northbound **2022 With Project**

V = vehicles per hour

PM Peak Hour
V = 27 vph

S = Storage = (V *2 min* 25 ft/veh)/60 min/hr

$$S\ (ft) = \frac{27\ vph*(2\ min)*(25\ ft/veh)\ =}{(60\ min/hr)} \quad 23\ feet$$

Minimum Recommended Storage: 25 feet

Un-Signalized Intersection (Right Turn Lane)
Location: South Access/Houghton Road
Approach/Leg: Southbound **2022 With Project**

V = vehicles per hour

PM Peak Hour
V = 43 vph

S = Storage = (V *2 min* 25 ft/veh)/60 min/hr

$$S\ (ft) = \frac{43\ vph*(2\ min)*(25\ ft/veh)\ =}{(60\ min/hr)} \quad 36\ feet$$

Minimum Recommended Storage: 50 feet

APPENDIX J: HERS RATING EXAMPLE

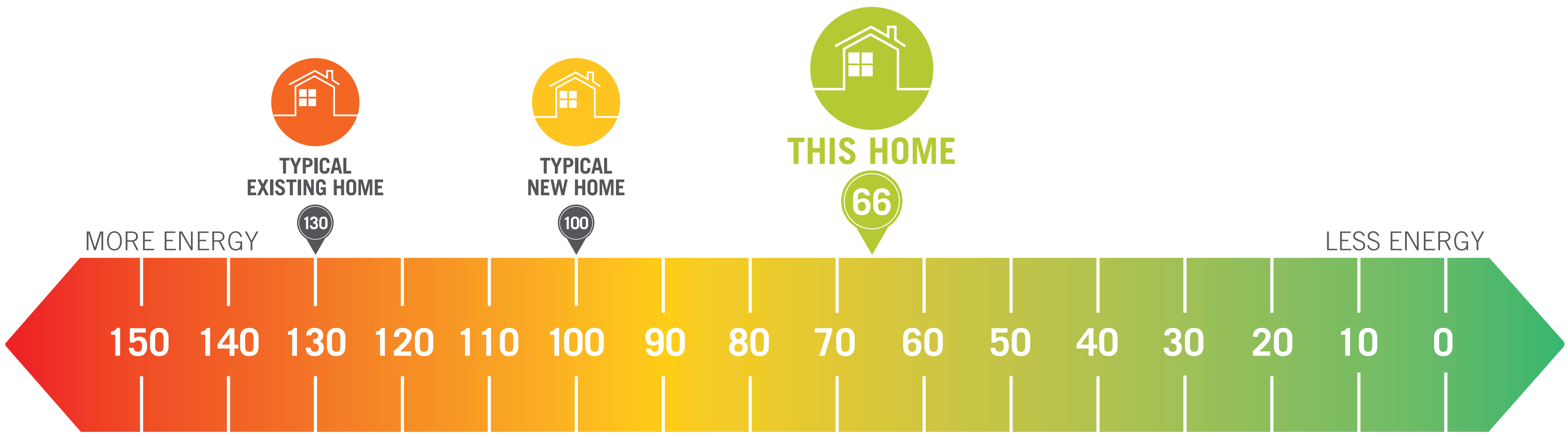
THE SCENIC SERIES

THE LOOKOUT

ENVIRONMENTS FOR Living®

GUARANTEED HEATING & COOLING

$83 MONTHLY AVERAGE



HERS® INDEX

THE LOOKOUT PLAN IS BASED ON:

COND. SPACE SQ.FT.	ANNUAL THERMS FOR HEATING USAGE	ANNUAL kWh FOR COOLING USAGE
1,893	375 THM	4,107

The estimated Monthly Costs listed above are for Heating and Cooling only and are based on the local electric and gas rates for The Lookout Plan.
This information does not constitute any warranty of energy cost or savings. Please See the Environments For Living® Limited Guarantee for Details.

Plan 4701
2 Bedroom • 2 Bath • 2-Car Garage

The HERS Index is comparable to scoring in golf. The lower the score, the better. Each of our homes is rated by a certified independent Home Energy Rater who tests many components of the home in order to provide a final rating to each home. Energy ratings are based on the testing of all exterior walls, floors in garages and basements, ceilings and roofs, attics, foundations and crawl spaces, windows, doors, vents and ductwork, HVAC systems, the water heating system and thermostats.

DOVE MOUNTAIN

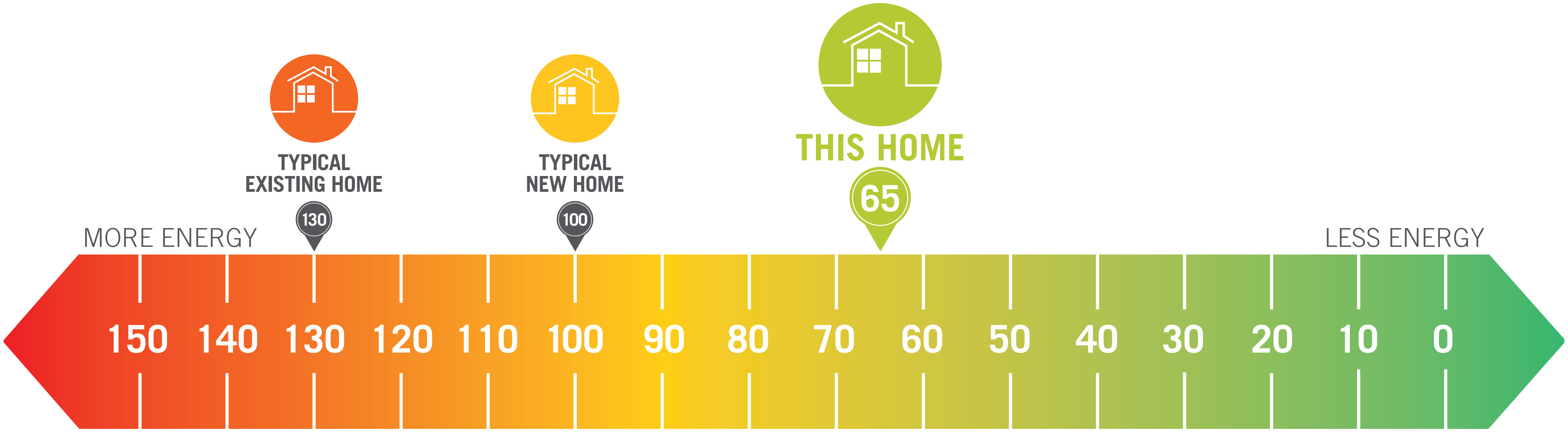
THE SCENIC SERIES

THE PANORAMA

ENVIRONMENTS FOR Living®

GUARANTEED HEATING & COOLING

$118 MONTHLY AVERAGE



HERS® INDEX

THE PANORAMA PLAN IS BASED ON:

COND. SPACE SQ.FT.	ANNUAL THERMS FOR HEATING USAGE	ANNUAL kWh FOR COOLING USAGE
2,558	561 THM	5,513

The estimated Monthly Costs listed above are for Heating and Cooling only and are based on the local electric and gas rates for The Panorama Plan. This information does not constitute any warranty of energy cost or savings. Please See the Environments For Living® Limited Guarantee for Details.

Plan 4703
3 Bedroom • 2.5 Bath • 2-Car Garage w/storage

The HERS Index is comparable to scoring in golf. The lower the score, the better. Each of our homes is rated by a certified independent Home Energy Rater who tests many components of the home in order to provide a final rating to each home. Energy ratings are based on the testing of all exterior walls, floors in garages and basements, ceilings and roofs, attics, foundations and crawl spaces, windows, doors, vents and ductwork, HVAC systems, the water heating system and thermostats.

DOVE MOUNTAIN

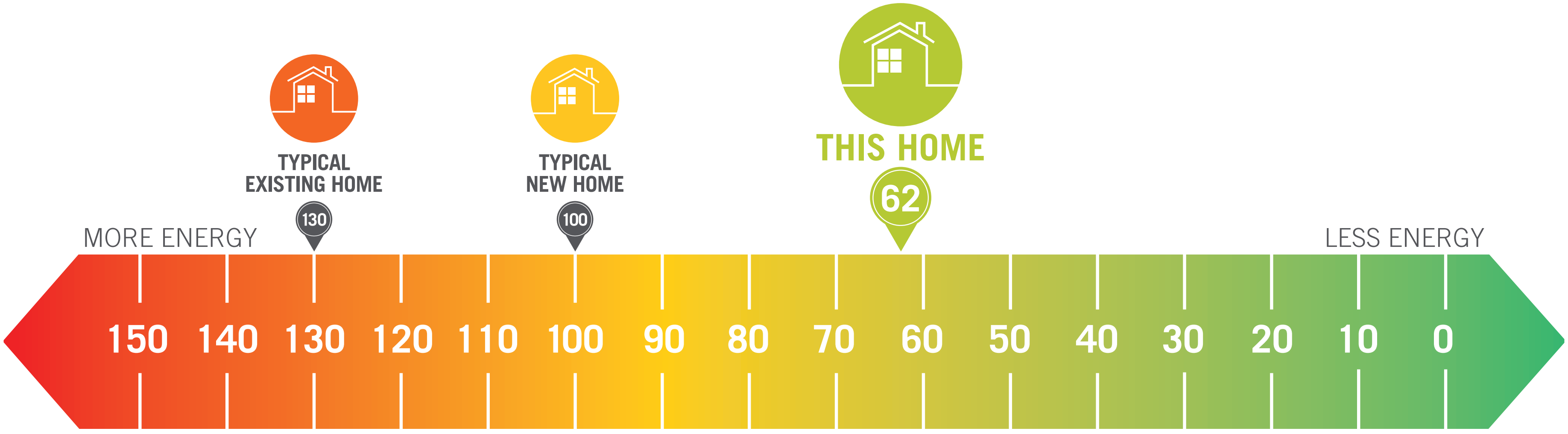
THE PEAK SERIES

THE CIMARRON

ENVIRONMENTS FOR Living®

GUARANTEED HEATING & COOLING

$124 MONTHLY AVERAGE



HERS® INDEX

THE CIMARRON PLAN IS BASED ON:

COND. SPACE SQ.FT.	ANNUAL THERMS FOR HEATING USAGE	ANNUAL kWh FOR COOLING USAGE
2,897	601 THM	5,744

The estimated Monthly Costs listed above are for Heating and Cooling only and are based on the local electric and gas rates for The Cimarron Plan. This information does not constitute any warranty of energy cost or savings. Please See the Environments For Living® Limited Guarantee for Details.

Plan 5702
4 Bedroom • 2.5 Bath • 3-Car Tandem Garage

The HERS Index is comparable to scoring in golf. The lower the score, the better. Each of our homes is rated by a certified independent Home Energy Rater who tests many components of the home in order to provide a final rating to each home. Energy ratings are based on the testing of all exterior walls, floors in garages and basements, ceilings and roofs, attics, foundations and crawl spaces, windows, doors, vents and ductwork, HVAC systems, the water heating system and thermostats.

DOVE MOUNTAIN

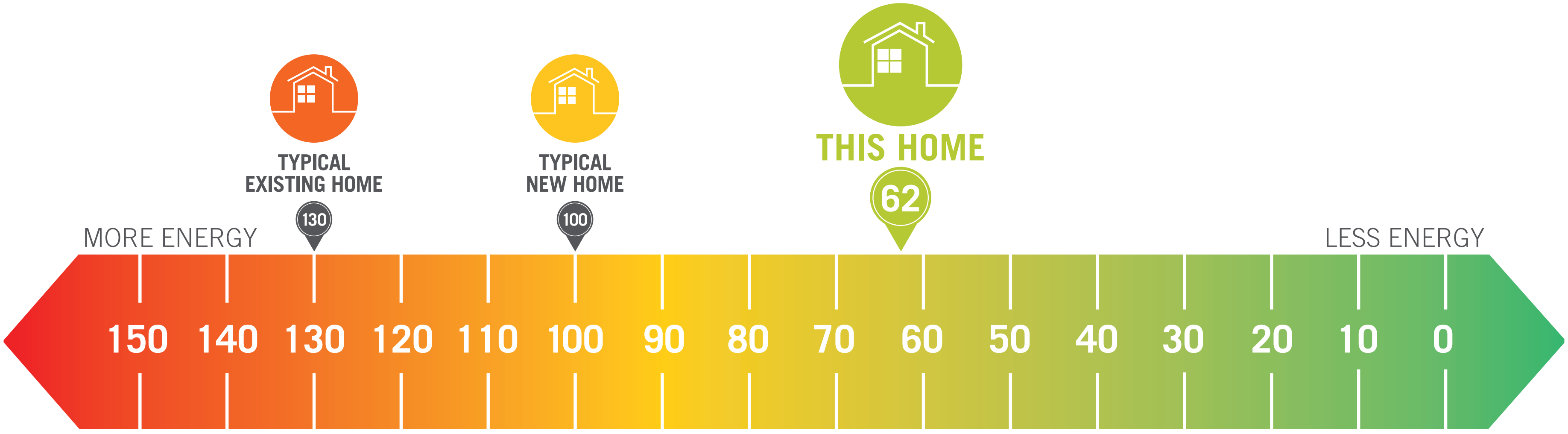
THE PEAK SERIES

THE TORTOLITA

ENVIRONMENTS FOR Living®

GUARANTEED HEATING & COOLING

$125 MONTHLY AVERAGE



HERS® INDEX

THE TORTOLITA PLAN IS BASED ON:

COND. SPACE SQ.FT.	ANNUAL THERMS FOR HEATING USAGE	ANNUAL kWh FOR COOLING USAGE
3,026	587 THM	6,009

The estimated Monthly Costs listed above are for Heating and Cooling only and are based on the local electric and gas rates for The Tortolita Plan. This information does not constitute any warranty of energy cost or savings. Please See the Environments For Living® Limited Guarantee for Details.

Plan 5703
4 Bedroom + Teen Retreat • 3.5 Bath • 3-Car Tandem Garage

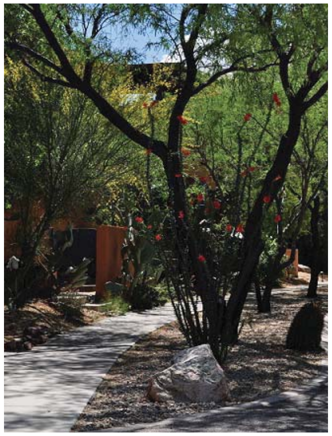
The HERS Index is comparable to scoring in golf. The lower the score, the better. Each of our homes is rated by a certified independent Home Energy Rater who tests many components of the home in order to provide a final rating to each home. Energy ratings are based on the testing of all exterior walls, floors in garages and basements, ceilings and roofs, attics, foundations and crawl spaces, windows, doors, vents and ductwork, HVAC systems, the water heating system and thermostats.

DOVE MOUNTAIN

APPENDIX K: OVERALL PROJECT THEMING

Landscape Character

Landscape Character - Greenway

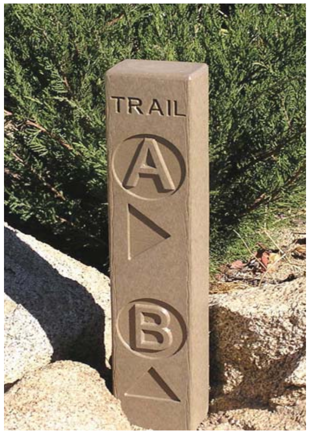


Streetscape Character

Streetscape Character

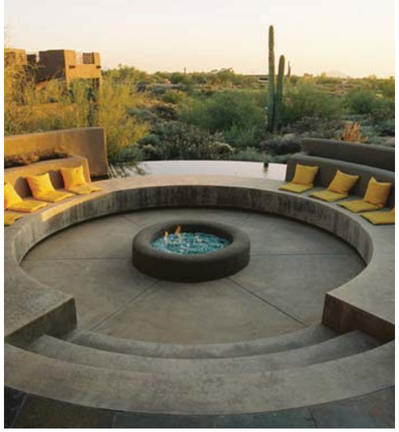
Hardscape Character

Signage Character



Signage Character

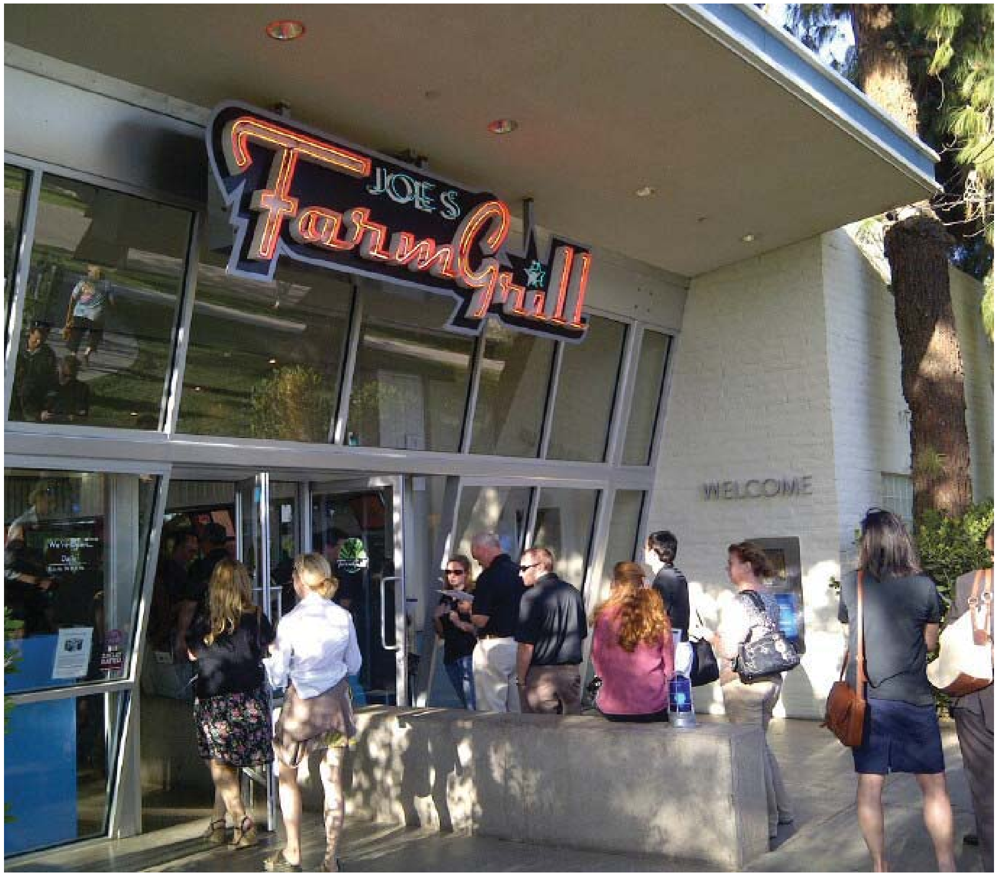




Site Character - Community Gathering Spaces

Natural Play Character



Site Character - Community Gathering Spaces

Rainwater Harvesting Character