Horizon
WATER and ENVIRONMENT

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Technical Memorandum

To:	Geoff Brosseau, BASMAA
From:	Laura Prickett, AICP, CPESC, QSD
Date:	November 3, 2016
Re:	Urban Greening Bay Area - Design Charrette Site Identification

1. Purpose and Organization of this Memorandum

This memorandum documents the task to assist the cities of San Mateo and Sunnyvale in identifying intersections within their respective jurisdictions for green infrastructure improvements, and the process to confirm that selected intersections are as representative as possible of applicable common features of road segments that make up intersections found throughout Bay Area cities.

The memo begins with an introduction to the Design Charrette as part of the larger Urban Greening Bay Area project, followed by a description of the analytic approach used identify applicable common features of intersections in Bay Area cities, a summary of the findings of the intersection analysis, and a discussion of the candidate sites identified by the cities of San Mateo and Sunnyvale.

2. Introduction

The Design Charrette task is part of the Urban Greening Bay Area grant project, which is funded by Region IX of the US Environmental Protection Agency (USEPA) Water Quality Improvement Funds, awarded to the Association of Bay Area Governments (ABAG), a joint powers agency acting on behalf of the San Francisco Estuary Partnership (SFEP), a program of ABAG.

The Bay Area Stormwater Management Agencies Association (BASMAA) is a member of the team headed by SFEP that was awarded the grant. BASMAA is leading the development and implementation of a Design Charrette, to develop cost-effective and innovative “typical” designs for integrating green infrastructure with bicycle and pedestrian improvements at roadway intersections. The overall goal in developing standardized, transferable designs is to make progress in addressing the high cost of design, implementation, operations, and maintenance that inhibits the widespread use of green infrastructure and LID features. The Design Charrette will utilize actual intersection locations in San Mateo and Sunnyvale that are as representative as possible of the common features of road segments that make up intersections found throughout Bay Area cities. The development of the Design Charrette is guided by the Roundtable Task Team, which consists of representatives of USEPA, SFEP, the San Francisco Bay Regional Water Quality Control Board (Regional Water Board), BASMAA, the San Francisco Public Utilities Commission (SFPUC), and the cities of San Mateo, Sunnyvale, and Oakland. Horizon Water and

Environment (Horizon) is leading a team of consultants to support the development and implementation of the Design Charrette.

As part of the site identification phase of the Design Charrette, the Horizon team coordinated with the cities of San Mateo and Sunnyvale, and other members of the Charrette Advisory Committee, to identify candidate intersections. Horizon's team member Lotus Water prepared a memorandum providing site selection criteria to assist the cities in the site selection process, which is included as Attachment A. Team member Geosyntec conducted a GIS analysis to assist in verifying that selected intersections are as representative as possible of the common features of road segments that make up intersections found throughout Bay Area cities. Geosyntec's analysis is documented in a memorandum included as Attachment B.

3. Analytic Approach to Identify Common Intersection Features

The approach to identifying applicable, common roadway intersection features utilized GIS technology to identify the frequency of the occurrence of intersections, and corners within intersections, that have common roadway features that are applicable to the implementation of green infrastructure. Due to the complexity of the analysis, it was necessary to limit the GIS roadway feature analysis to four parameters, and to limit the study area to one city, as described below.

Roadway Features Analyzed

Based on the experience of the Charrette Advisory Committee and the Horizon team in designing and implementing green infrastructure projects, and the anticipated needs for the development of typical design drawings, the following intersection features were prioritized for analysis:

- Intersection corners with a 90 degree angle,
- The presence of a storm drain inlet that connects to a storm drain main,
- Configuration of on-street parking, and
- Underlying soil type.

Applicability of the GIS Study Area to Bay Area Cities

The GIS analysis was conducted within the City of San Mateo, identifying the frequency of occurrence of the four roadway features described above throughout the City of San Mateo. These results may be considered reasonably representative of common roadway intersection conditions in other Bay Area cities, based on the following considerations.

Prevalence of Intersections with 90-Degree Corners. Historic maps indicate that a dominant rectilinear street grid was established in the City of San Mateo early in its development (City of San Mateo 2012), as is typical of cities in the American West (Knight 2012). Later development in San Mateo, particularly during the extensive build-out of the city during the post-World War II era, expanded upon the street grid, and also introduced some curvilinear roadways. Patterns of development within San Mateo's downtown area can be expected to be similar to pre-World War II downtown street grids in other cities. Patterns of development in other parts of the city can be expected to be similar to areas of other cities that were developed during the major development expansion that occurred in the Bay Area in the postwar era.

Storm Drain Inlets at Intersections. Section 837.3 of the Caltrans Highway Design Manual (Caltrans 2016) identifies intersections a one of the locations at which a storm drain inlet is nearly always required. However, the Manual indicates that, under certain conditions (where the gutter flow is small and vehicular, bicycle, and pedestrian traffic are not important considerations) stormwater flows may be carried across the intersection in a valley gutter and intercepted by an inlet downstream. It is reasonable to expect that storm drain inlets will frequently be present at intersections in Bay Area cities, except for cities in which stormwater is frequently conveyed through intersections. For example, within the City of San Mateo there are some drain inlets that do not connect to the storm drain main, and, instead, allow stormwater to flow in a pipe to the other side of an intersection, where it “bubbles up” and continues to flow downstream in the gutter. The GIS analysis controlled for this occurrence, by including in the analysis only the storm drain inlets that connect to a storm main.

Configuration of On-Street Parking. A survey of Public Works and Traffic Engineering Departments of 56 California cities and 19 cities nationwide found that the average standard roadway width for residential streets was 36 to 40 feet, a width that was preferred by transportation officials because it allows for on-street parking on both sides of a street. Additionally, most cities were found to rely on standards for right-of-way width that were established by the Institute of Transportation Engineers in 1967 (Ben Josef 1995). Based on the prevalence and longevity of street design standards that allow for on-street parking, it is anticipated that on-street parking would be prevalent in most Bay Area cities.

Soil Type. The Low Impact Development Feasibility Report prepared by BASMAA (2011) included mapping of hydrologic soil groups for Alameda, Contra Costa, San Mateo, Santa Clara counties, and portions of Solano County. In general, low-lying portions of these counties have substantial areas of poorly-drained soils (hydrologic soil group D), with well-drained soils occurring primarily in hillside areas. Urbanization has occurred primarily within low-lying areas, and it is reasonable to expect that many Bay Area cities include substantial areas of poorly drained soils, similar to findings for the City of San Mateo, described in Section 4, below. It may also be reasonable to revisit soil type assumptions after analyzing the performance data of a number of green infrastructure projects across the Bay Area counties in which MRP Permittees are located.

4. Summary of Findings of the Intersection Analysis

The GIS analysis used individual street corners as the unit of analysis. As shown in Table 1, a total of 1,560 intersections were identified in the City of San Mateo, consisting of a total 4,010 corners. The GIS analysis indicated that approximately 15 percent of the corners can be expected to have all three of the following conditions: the corners are located adjacent to a drain inlet connected to a storm main, have an approximately 90-degree angle, and have on-street parallel parking on both legs of the intersection.

Of the three conditions, the chief limiting condition may be proximity to a drain inlet connected to a storm main. Only 28 percent of all corners in the city have this condition. The angle analysis was conducted only for the universe of corners that are adjacent to a drain inlet connected to a storm main. As shown in Table 2, the angle analysis found that there was an approximately 90-degree angle at 66 percent of the corners that are adjacent to a drain inlet connected to a storm main.

The parking analysis was conducted for a random sample of the intersections that met the first two conditions (corners located adjacent to a drain inlet connected to a storm main, and with an approximately 90-degree angle). The parking analysis found that 85 percent of corners that met the first two conditions had parallel parking on both legs of the corner. More detail regarding the GIS analysis is provided in Attachment B.

Table 1:
Summary of Findings from the GIS Analysis

Feature	Number of Occurrences	Percentage of Occurrences
Total intersections	1,560	100%
Total corners	4,010	100%
Corners adjacent to inlet connected to storm main	1,116	28%
Corners approximately 90 degrees, adjacent to inlet connected to storm main	737	18%
Percentage of corners approximately 90 degrees, adjacent to inlet connected to storm main, and are estimated to have parallel parking on both legs of the intersection[1]	626 (estimated)	15% (estimated)

Source: Geosyntec Consultants 2016

[1] The parking analysis was based on a random sample of the 737 corners that are approximately 90 degrees, and are adjacent to inlet connected to storm main. Eighty-five percent of the sampled intersections had parallel parking on both legs of the intersection. It may be estimated that 85 percent of the 737 corners have parallel parking on both legs, which would amount to 626 corners, or 15 percent of all corners.

Table 2:
Results of the Angle Analysis of Corners Adjacent to Inlet Connected to Storm Main

Feature	Number of Occurrences	Percentage of Occurrences
Total corners adjacent to inlet connected to storm main	1,116	100%
Corners approximately 90 degrees, adjacent to inlet connected to storm main	737	66%

Source: Geosyntec Consultants 2016

5. Selection of Sites for the Design Charrette Task

In order to maximize cost efficiencies in project implementation, the cities of San Mateo and Sunnyvale sought to incorporate green infrastructure improvements in capital projects that have been scheduled, or could potentially be scheduled, to begin construction in mid-2017. From that group of projects, the cities prioritized projects that include at least two 90-degree corners, have a storm drain line to which an underdrain may be connected, have on-street parking, and do not have any constraints that would preclude construction of bulb-outs at the intersection corners. An example of a condition that would preclude construction of bulb-outs is a dedicated right-turn lane. The cities also considered additional criteria that were identified in the Site Selection Criteria memo prepared by consultant team member Lotus Water (Attachment A).

The consultant team assisted city staff in reviewing a number of candidate intersections. The status of the site reviews is shown in Table 3. After reviewing a number of intersections, the City of San Mateo selected the 4th Avenue and Fremont Street intersection, and the City of Sunnyvale selected the Duane Avenue and San Miguel Avenue intersection. Each of the selected intersections has at least two 90-degree corners, a storm drain line to which an underdrain may be connected, and on-street parallel parking, and does not have dedicated right-turn lanes.

Table 3:
Sites Reviewed for Potential to Develop Green Infrastructure

	Intersection	City	Status/Considerations
1	9th Avenue/ Claremont Street	San Mateo	Removed from further consideration/ a corner lacks 90 degree angle
2	9th Avenue/ El Dorado Street	San Mateo	Removed from further consideration/ lacks adequate storm drain
3	10th Avenue/El Dorado Street	San Mateo	Removed from further consideration/ lacks adequate storm drain
4	4th Avenue/El Dorado Street	San Mateo	Removed from further consideration/ lacks adequate storm drain
5	4th Avenue/Fremont Street	San Mateo	Selected site
6	29th Avenue/Juniper Street	San Mateo	Removed from further consideration due to street width
7	Mathilda Avenue – pedestrian safety improvements at channeled right turn lanes	Sunnyvale	Removed from further consideration/ lacks corners with 90 degree angles
8	North Sunnyvale Ave and East Taylor Avenue	Sunnyvale	Removed from further consideration
9	Duane Avenue and San Miguel Avenue	Sunnyvale	Selected site

6. References

BASMAA. 2011. Low Impact Development Feasibility Report. Available at: http://flowstobay.org/files/newdevelopment/addresources/LIDFeasibilityReport.pdf. Accessed August 29, 2016.

Ben Josef, Eran. 1995. Residential Street Standards & Neighborhood Traffic Control: A Survey of Cities' Practices and Public Officials' Attitudes. Institute of Urban and Regional Planning, University of California-Berkeley, Available at: http://nacto.org/docs/usdg/residential_street_standards_benjoseph.pdf. Accessed August 29, 2016.

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Geosyntec Consultants. 2016. Memorandum: Urban Greening Bay Area Project – Design Charrette GIS Intersection Frequency Analysis. (August 25.)

Knight, Paul. 2012. A History of the American Grid in 4 Minutes. Available at: http://www.thegreatamericangrid.com/archives/777. Accessed August 29, 2016.

Attachment A

Site Selection Criteria Memorandum

Prepared by Lotus Water

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From: Lotus Water

For: Horizon-BASMAA staff

Date: June 29, 2016

Project: BASMAA Urban Greening Bay Area

RE: Charrette Action Items from June 21 Kickoff Meeting

This memo provides information required by the following two action items from the June 21 kickoff meeting for the Urban Greening Bay Area Project:

- Prepare site selection criteria for the Cities of San Mateo and Sunnyvale to consider with cost, performance, and transferability of designs in mind.
- Provide a list of potential Charrette participants for consideration by BASMAA

Criteria to Assist Cities with Site Selection (preliminary)

The following preliminary site selection criteria are provided for consideration. Please note that this is not a list of requirements, but recommendations. Any particular site is unlikely to meet all of these criteria. In general, sites that meet a larger number of these criteria are anticipated to be more suitable than sites that meet a lower number of criteria. However, there may be site-specific mitigating factors, and sites that meet a larger number of the criteria may not be most suitable if, for example, hazardous conditions exist at the site.

- Physical Configuration:
    - Standard Block/Intersection, street width, sidewalk width, and block length
    - Four-way intersections with the most common dimensions and parking lanes
    - Significant distance between curb radius and nearest driveway/access
    - No potential conflicts with ADA parking spaces and/or loading zones
- Drainage Infrastructure: End of block catch basins
- Utilities: No known major utility conflicts within the parking lane zones near the intersection corners
- Topography/Elevation: Suitable drainage management areas/intersections at low points, low to moderate slope and typical street crowns
- Soils: Infiltrative or sandy soils (Type A or B to eliminate the need for underdrains and additional infrastructure); no known presence of contaminated soils; groundwater below 10'; no shallow bedrock
- Land Use:
    - Lower density (with cost in-mind)
    - Lower number of parcels per block in higher density areas
    - Non-Mass Transit Streets

    - Non-major arterial streets with heavy-truck traffic
- Capital Project Coordination: Known street, pedestrian, or bicycle project scheduled in same location in an early design phase
- Miscellaneous: highly visible, adjacent, or nearby, to existing feature that requires landscape maintenance, no potential security risks (such as a known drug-use area)

Draft Charrette Participants

The number of participants should be between 18 and 27 to keep the groups manageable and costs reasonable. Ideally an even distribution of disciplines would be included in each group. For example: If we had three sites, with three different groups, then we would want to have an engineer in each one, a landscape architect in each one, and so on.

Types of Participants and suggested candidates:

- Engineer or water quality professional from San Mateo and Sunnyvale
- Capital budget-minded representative from San Mateo and Sunnyvale
- Civil Engineers with direct streetscape and green infrastructure experience (built work)
- Landscape architects with Bay Area green infrastructure experience and knowledge of native plant species (Kevin Robert Perry)
- Construction Management/Inspectors from Bay Area Municipalities (Michael Adamow, SFPUC, GI Construction Management Specialist)
- Contractors who have recently won a bid or constructed a green infrastructure project on Peninsula
- Pedestrian and/or Bicycle planner with Peninsula experience (Horizon staff has worked with and would recommend John Ciccarelli, who has done work for San Mateo County Health System)

Attachment B

GIS Intersection Frequency Analysis Memorandum

Prepared by Geosyntec Consultants

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DRAFT Memorandum

Date:	25 August 2016
To:	Matt Fabry, San Mateo County and Geoff Brosseau, BASMAA
Copies to:	Laura Prickett, Horizon Environmental
From:	Kelly Havens, Geosyntec Consultants
Subject:	Urban Greening Bay Area Project – Design Charrette GIS Intersection Frequency Analysis

INTRODUCTION AND GOAL

The Urban Greening Bay Area Project includes a Design Charrette to develop cost-effective green infrastructure designs for typical roadway intersections. The Charrette includes the development of conceptual designs for BMPs that could be implemented in these intersections, as well as an assessment of how frequently typical roadway intersections occur in the Bay Area region.

Geosyntec conducted a GIS analysis to identify the frequency that intersections characterized as typical roadway intersections occur in the Bay Area region. This memorandum serves to summarize the analysis conducted and the frequency results.

METHODOLOGY

Overview

The GIS methodology employed for this analysis entailed screening and analysis of shapefiles provided by the City of San Mateo to identify typical roadway intersections where generic BMP designs could be implemented. As BMPs would typically be implemented at one or more corners in any given intersection, corners were identified as the unit which would be analyzed for frequency of occurrence.

Based on discussions with the BASMAA team and the Project team, the characteristics associated with corners located in typical roadway intersections that would be feasible for BMP implementation include the following:

1. Corner angle is approximately 90 degrees
2. Inlet that is connected to the storm main is present at corner

Parking configuration and underlying soil type were two other factors brought up by the team that were considered relevant to suitability of implementation of a generic BMP.

Analysis Steps

Data received for the analysis included the City of San Mateo street layer (a line layer) and the City of San Mateo storm drain layer (consisting of points and storm drain lines). A summary of the analysis steps are included below:

1. Using the street layer, all intersections and corners in the City were identified. To identify the "total corners", the following steps were conducted:
   a. Corners associated with highways or bridges were removed using visual assessment.
   b. Angles of corners were calculated based on the street layer linework.
   c. Corners with angles greater than 175 degrees were removed (these were found to represent street ends through visual assessment).
2. Once the total corners were estimated, those corners adjacent to an inlet connected to a storm main were identified using the following steps:
   a. Storm main lines were extracted from the storm drain layer.
   b. Inlet points connected to the storm main lines were identified.
   c. Corners within 30 feet of an inlet connected to a storm main were identified using a buffer analysis.
3. Corners adjacent to an inlet connected to a storm main that were approximately 90 degrees were then identified.
   a. Corners with angles ranging from 87.5 degrees to 92.5 degrees were assumed to be approximately 90 degrees. This range was found to adequately represent an average of 90 degree corners based on a visual assessment of the corners in different angle ranges (85 to 95, 87.5 to 92.5, 89.5 to 90.5, and 89.95 to 90.05).
4. These corners were analyzed for underlying soil type using the NRCS SSURGO dataset available through Web Soil Survey (http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm).

To examine parking configuration for the identified corners, a visual assessment was conducted on half of the corners identified. These corners were identified using a random selection tool available in ArcGIS. The first 100 feet of curb of the corners were examined in Google Earth to characterize parking on both parking legs.

RESULTS

The analysis yielded a total of 1,560 intersections in the city, and a total of 4,010 corners with less than a 175 degree angle. Twenty-eight percent of those corners were within 30 feet of an inlet connected to a storm main. Of those, approximately 65% (18% of total corners) were found to be approximately 90 degrees (i.e. with an angle within the 87.5 to 92.5 degree range). When examining how many total intersections contained at least one of these corners, it was found that approximately one quarter of City intersections contained a corner with the identified characteristics. A summary of the corner analysis is provided in Table X below:

Table 1: Summary of Intersections and Corners

Feature	Number	Percent of Total
Total Intersections[1]	1,560	100%
Total Corners[1,2]	4,010	100%
Corners Adjacent to Inlet Connected to Storm Main[1,2]	1,116	28%
Corners Approximately 90 degrees, Adjacent to Inlet Connected to Storm Main[1,3]	737	18%
Intersections with at least one Corner Approximately 90 degrees, Adjacent to Inlet Connected to Storm Main[1,3]	399	26%

1 Does not include highway or bridge adjacent intersections or corners.
2 Includes corners with angle of 175 degrees or less.
3 Includes corners with angle between 87.5 and 92.5 degrees.

Of the 737 identified corners that are approximately 90 degrees, and are adjacent to an inlet connected to a storm main, one half of the corners (rounded to 369 corners) were randomly selected and were visually assessed for parking configuration (Angled, Parallel, or No Parking Allowed). The findings of that assessment are presented in Table 2. In addition to the three parking configurations examined, four (about 1%) of the 369 corners visually assessed consisted either of points that were not actually corners (i.e. a driveway or alleyway was represented instead of a street) or the parking configuration was not able to be determined.

The majority of corners assessed include parallel parking on both parking legs (85%). Only about 2 percent (9 total corners) included parallel parking on one leg and angled parking on the other leg.

Table 2: Summary of Visual Assessment of Parking Configuration

Parking Leg I	Parking Leg II	Number of Corners Assessed	Percent of Corners Assessed[1]
Angled	Angled	1	0.3%
Angled	Parallel	9	2%
Angled	No Parking Allowed	4	1%
Parallel	Parallel	312	85%
Parallel	No Parking Allowed	32	9%
No Parking Allowed	No Parking Allowed	7	2%
N/A or Unable to Determine	N/A or Unable to Determine	4	1%
Total		369	100%

[1] Does not sum to 100% due to rounding.

The vast majority of soil underlying the identified corners was identified by NRCS as cut and fill or urban land. No hydrologic soil group is identified by NRCS for these soil types, but they are typically assumed to be poorly drained soils. Less than one percent of these corners (5 corners) were underlain by hydrologic soil group C soils.

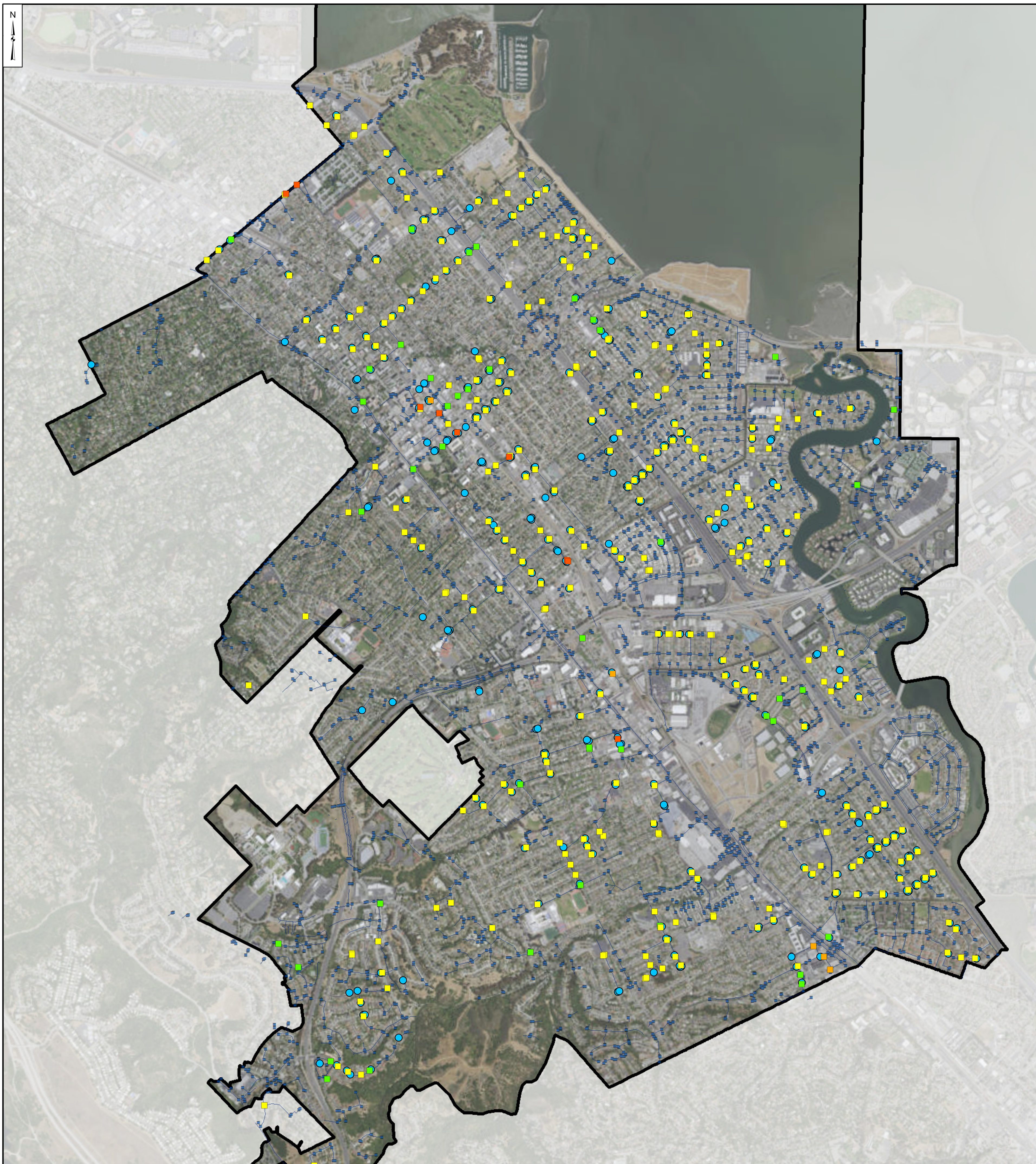
Figure 1 displays the results of this analysis graphically.

<u>Application to Greater Bay Area</u>

A detailed analysis was not conducted to examine the representativeness of San Mateo as compared to the greater Bay Area. Land use was approximately identified during the visual assessment conducted to examine parking configuration for the identified corners. Based on that assessment, approximately 85% of the corners were located in residential land use areas. The majority of the remaining corners were located in commercial land use areas, with very few located in industrial, mixed use, and open space land use areas. Whether the high proportion of residential land use is representative of City of San Mateo or if this is a function of the identified corner characteristics (or both) was not examined as part of the scope of this work.

Land use does appear to affect parking configuration based on the visual assessment conducted. Per the assessment, no angled parking was observed in residential areas, whereas at least one leg of angled parking was observed for approximately 25% of corners located in commercial land use areas.

* * * * *



Feature	Number	Percent of Total
Total Intersections[1]	1560	100.0%
Total Corners[1,2]	4010	100.0%
Corners Adjacent to Inlet Connected to Storm Main[1,2]	1116	27.8%
Corners Approximately 90 degrees, Adjacent to Inlet Connected to Storm Main[1,3]	737	18.4%
Intersections with at least one Corner Approximately 90 degrees, Adjacent to Inlet Connected to Storm Main[1,3]	399	25.6%

[1] Does not include highway or bridge adjacent intersections or corners.
[2] Includes corners with angle of 175 degrees or less.
[3] Includes corners with angle between 87.5 and 92.5 degrees.

Parking Configuration	Total Corners	Percent Corners Analyzed
One leg angled and one leg parallel	9	2.4%
At least one leg angled (not including one leg parallel)	5	1.4%
Both legs parallel	312	84.6%
Other configurations[4]	43	11.7%

Soil Type	Total Corners	Percent Underlain by
HSG C	5	0.7%
Cut and Fill and Urban Land	732	99.3%

2,500 1,250 0 2,500
Feet

Legend

Corners Assessed for Parking Configuration (369)
- One leg angled and one leg parallel
- At least one leg angled (not including one leg parallel)
- Both Legs Parallel
- Other configurations[4]

- Corners Meeting Criteria but Not Assessed for Parking Configuration (368)
- Storm Inlet connected to Storm Main
- Storm Main
- San Mateo City Limit

[4]Other configurations include combinations of parallel, no parking or unable to determine/ not available.

Urban Greening Corner Analysis

San Mateo, CA

Geosyntec consultants

Oakland | August 2016

Figure 1

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