1 Traffic Sign Management System

Category	Subcategory	Grade
Overall Grade		A
Physical Health		
	Overall Condition	A
	Risk-Based Condition	N/A
Financial Health		
	Catch Up	N/A
	Keep Up	A

1.1 Background

1.1.1 What Services Do These Assets Provide?

Traffic signs play a critical role in traffic control. The main purpose of traffic signs is to regulate, warn, and guide drivers and to increase traffic safety.

The following images show some examples of the City's traffic signs.

Figure 1-1 Traffic Sign Examples

1.1.2 *Who is Responsible?*

The City is fully responsible to repair and replace approximately 12,500 traffic signs along City-managed roadways. The City has established 12 maintenance zones to organize the replacement activities for traffic signs. Since 2006, the City has been using a blanket replacement program to replace the signs in one maintenance zone per year in order to meet the Federal Highway Administration Manual on Traffic Devices retroreflectivity standards. In addition to blanket replacement, the City typically replaces about 150 damaged signs per year. The City is also responsible

for most of the poles and all the speed radar signs.

The Traffic Sign Management System focuses only on the traffic signs within the City. Other decorative signage (e.g., monuments, entry signs) are included in the Landscape Management System, and park signs are included in the Park Management System.

1.2 Asset Register

1.2.1 Asset Definition

An asset in the Traffic Sign Management System is defined as something with value that is owned and managed by the City. For City staff use, an asset is defined at the level in which a maintenance work order will be generated. In the case of the Traffic Sign Management System, each sign and each sign post are considered separate assets. In addition, radar speed signs are considered assets; these signs are interactive signs that display the speed of passing traffic and include electrical elements.

As mentioned previously, only traffic signs are included in the Traffic Sign Management System. Other signage (e.g., monuments, entry signs, parks signs) are included in other management systems.

1.2.2 Asset Class

Assets are grouped into classes for modeling and management purposes. An asset class generally refers to a group of assets that behave similarly (e.g., useful life, rehabilitation activities). Grouping the assets into these classes allows easier life-cycle behavior modeling. The asset classes for the Traffic Sign Management System are signs, posts, and traffic control devices (i.e., radar speed signs).

1.2.3 Asset Hierarchy

The asset hierarchy of the Traffic Sign Management System is organized first by maintenance area, and then by signs and posts. The radar speed signs are tracked under a separate hierarchy called traffic control devices. This hierarchy helps organize assets and supports asset management decisions at various levels (e.g., maintenance area level). The following figure illustrates the general hierarchy for the Traffic Sign Management System.

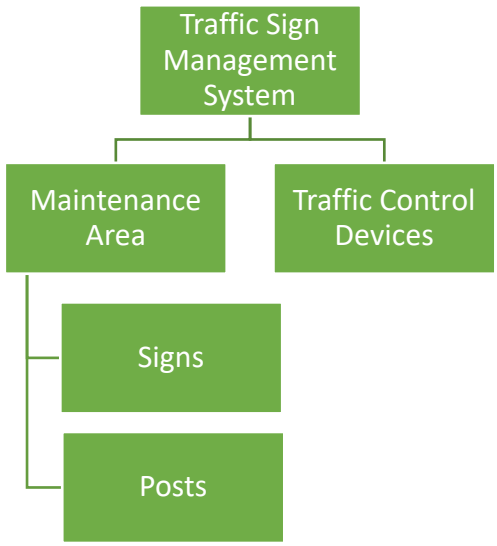

Figure 1-2 Traffic Sign Management System Hierarchy

1.2.4 Asset Inventory

For the Traffic Sign Management System, the asset inventory process involved consolidation of existing data from the City's information system (i.e., GIS). There are 23,945 assets in the Traffic Sign Management System, including traffic signs, posts, and traffic control devices.

There are 12,448 traffic signs throughout the City. Each sign was categorized by maintenance zone. These maintenance zones were established to organize inspection and replacement efforts. The 12 maintenance zones are shown on the map below, distinguished by color.

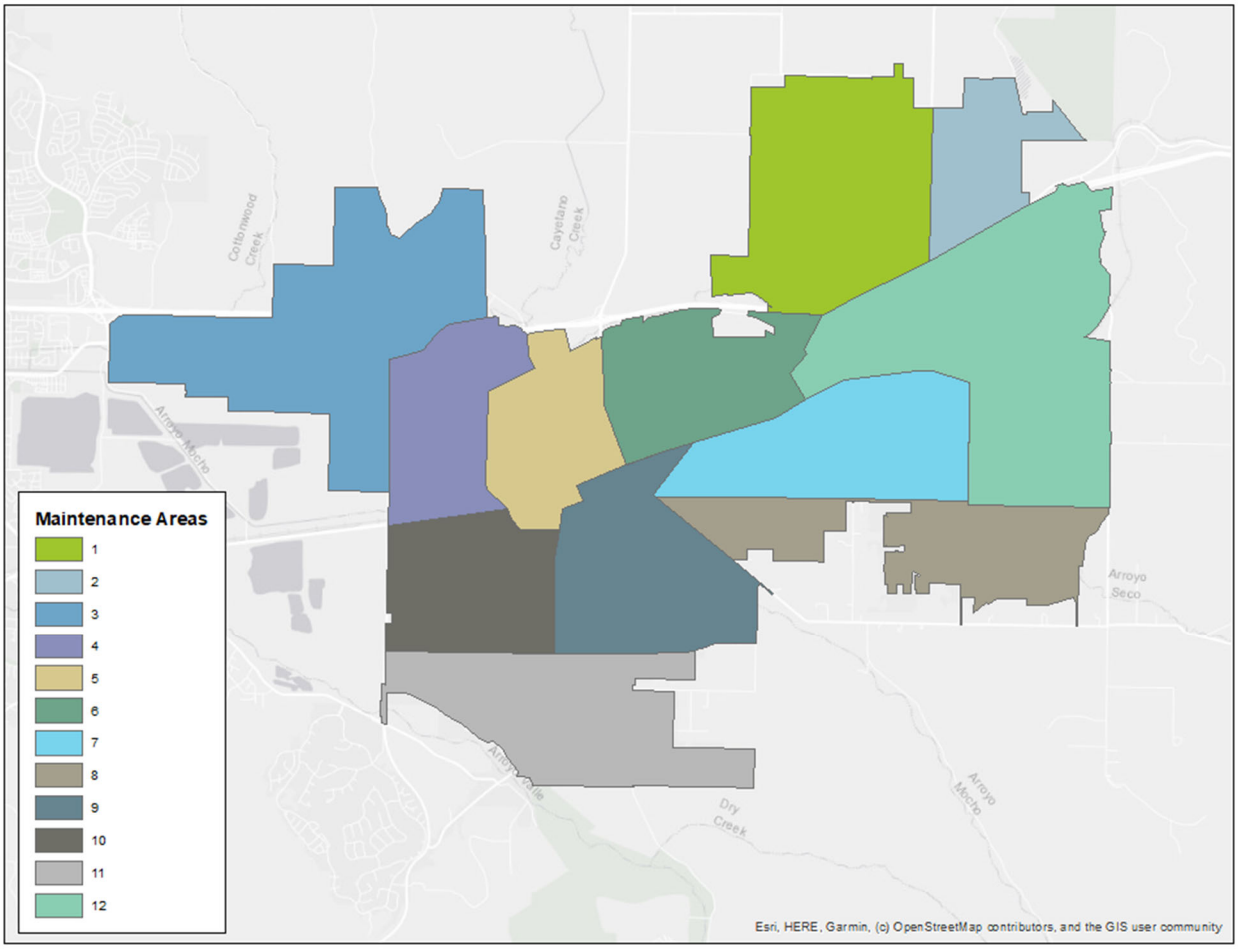

Figure 1-3 Traffic Sign Maintenance Zone Map

Some signs are attached to other roadway assets (e.g., street lights, traffic signal pole, fence) instead of posts. Because of this, there are slightly fewer posts than there are signs with a total of approximately 11,485 posts.

In addition, there are 12 radar speed signs located throughout the City.

1.2.5 Asset Replacement Cost

Each asset in the asset register was assigned an estimated replacement cost. The estimated costs for the Traffic Sign Management System were developed utilizing historical expenditure data in conjunction with current costs

associated with the manufacturing and installation of the sign assets. The following table presents the costs estimates for the signs and posts.

Table 1-1 Traffic Sign Replacement Costs

Asset Class	Replacement Cost	Replacement Cost Assumptions
Sign	$100	$35 for blank sign, remaining for labor
Post	$200	$100 for post, remaining for labor
Radar Speed Sign	$5,000	

The sum of asset replacement cost for the Traffic Sign Management System is approximately $3.6 million. This does not include any project delivery costs because the signs are built inhouse and installed by City staff. The following table presents the estimated total asset replacement cost for the Traffic Sign Management System.

Table 1-2 Traffic Sign Management System Replacement Cost by Class

Asset Class	Total Asset Replacement Cost
Signs	$1,244,800
Posts	$2,297,000
Radar Speed Signs	$60,000

The following table shows the asset replacement cost of the City's traffic signs and posts organized by maintenance area. The radar speed signs account for an additional $60,000.

Table 1-3 Traffic Sign and Post Replacement Cost by Maintenance Area

Maintenance Area	Total Sign Replacement Cost
Area 1	$283,600
Area 2	$149,800
Area 3	$284,100
Area 4	$218,700
Area 5	$292,800
Area 6	$259,500
Area 7	$368,800
Area 8	$215,900
Area 9	$560,900
Area 10	$229,200
Area 11	$319,500
Area 12	$359,000

1.2.6 Installation and Consumption Profile

The installation profile gives an indication of the age of the traffic sign assets. Installation year was determined based on historical data. The following figure shows the installation profile for the Traffic Sign Management System.

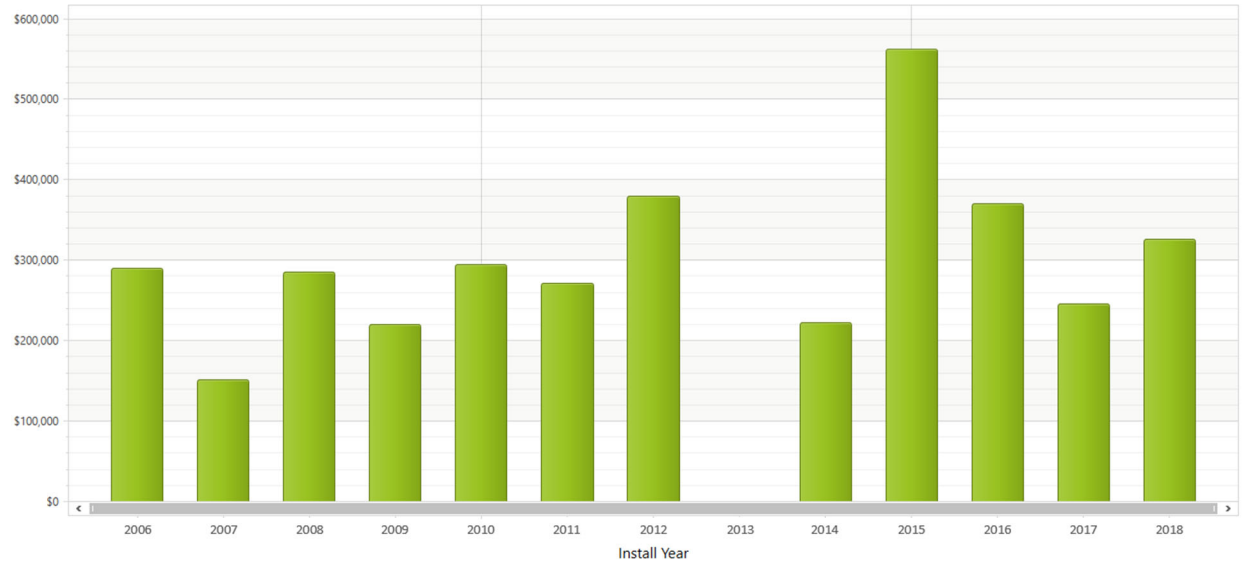

Figure 1-4 Traffic Sign Management System Installation Profile

As mentioned previously, all traffic signs have been replaced in the past 12 years as part of a blanket replacement program that started in 2006. The following figure shows the installation trends specifically for the traffic signs over the past 12 years.

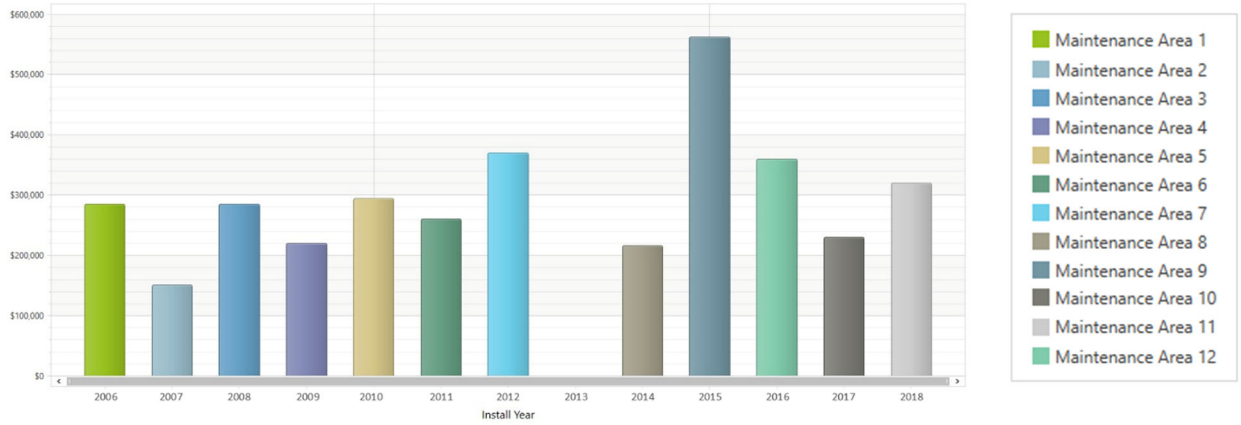

Figure 1-5 Traffic Signs Installation Profile

More important than the installation data is the estimated current state or consumption of the assets. Consumption represents the percentage of an asset's expected life that it has used up or consumed. As illustrated in the following figure, most traffic sign assets have consumed approximately 70% or less of their useful lives. Although 70% may seem high, these assets may be in relatively good condition. The assets that are approximately 90% consumed are signs in Maintenance Area 1 that are coming up as due for replacement in the next blanket replacement cycle.

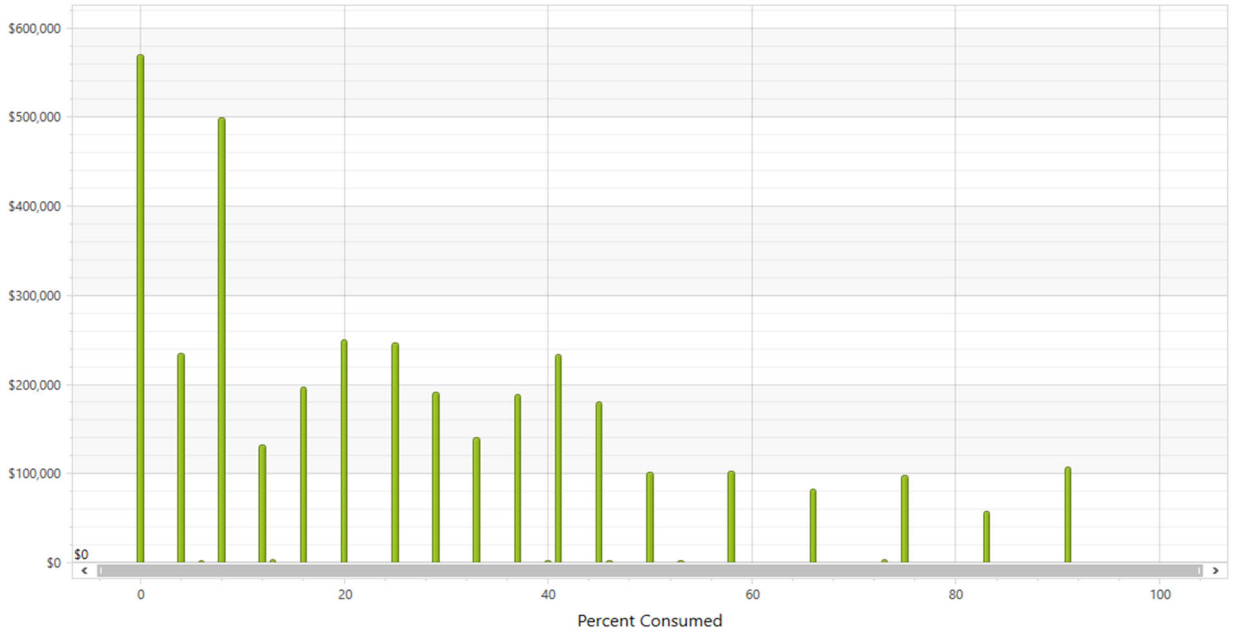

Figure 1-6 Consumption Profile

1.3 Risk Analysis

1.3.1 Probability of Failure

For the traffic signs, Probability of Failure (PoF) was calculated based on the asset's age by comparing the installation year and estimated useful life based on the City's historical usage. PoF information for each asset is available in the City's IRIS database. This information would be too lengthy to include in this report.

1.3.2 Consequence of Failure

For most management systems, Consequence of Failure (CoF) was established for the assets to prioritize the replacement and rehabilitation work. However, as the traffic sign system is managed on a set-timeframe with an adequate budget of approximately $230,000 per year, it was strategically decided that the risk assessment analysis was not currently necessary.

In the future, it may be necessary to assess the risk for the traffic signs to prioritize replacement and rehabilitation efforts. One methodology to prioritize these signs could be based on the sign type. Traffic signs are generally categorized into standard categories (e.g., regulatory, warning, informational). Each of these types could be assigned a criticality. In addition, the signs could be ranked for criticality by road class. In this methodology, the traffic signs along roads that carry more traffic would have a higher criticality that signs along lower-traffic roads. A combination of the two methodologies may also be used to rank the sign replacement.

1.3.3 Risk Analysis Results

In most management systems, the PoF and CoF would be combined into a risk analysis that resulted in high, medium, and low risk ratings for each asset. Because CoF was not assigned to the Traffic Sign Management System, the risk analysis does not apply to these assets, and high risk assets were not identified. Replacement recommendations will be entirely based on PoF as covered in the next section.

1.4 Future Needs

1.4.1 Life Cycle Cost Logic

Life cycle cost logic, also known as management strategies, were developed for the traffic sign assets. Each asset class was assigned a management strategy that includes the rehabilitation and replacement activities to best characterize the life cycle investment needs for the asset. For the traffic signs system, the management strategies were assigned based on past replacement efforts.

Currently, staff manufacture the finalized signs using recycled aluminum blanks and vinyl decals which are cut out to specification in-house. This creates a high-quality sign which lasts much longer than the previous type which used a process very similar to silk-screening to apply ink on top of the backing. These vinyl-based signs have a much longer life and a lower lifecycle cost. Staff expects a lifespan for these signs between 12 and 15 years as compared to 5 years for the ink-based signs. For the purposes of this analysis, the more conservative estimate of 12 years was used. In addition, it was estimated that the posts would need replacement every second sign replacement cycle.

The management strategies are as shown in the following table.

Table 1-4 Traffic Sign Management Strategies

Asset	Useful Life
Sign	12 years
Post	24 years
Radar Speed Sign	12 years

1.4.2 Long Range Replacement and Rehabilitation

The following figures show the replacement and rehabilitation needs for which the City is responsible over a 30-year span in 2017 dollars. This does not include any project delivery costs because the signs are built inhouse and installed by City staff. Utilizing a deterministic model (i.e., assets fail at the end of their estimated useful lives), the annual average investment needed for the traffic sign assets are approximately $205,000.

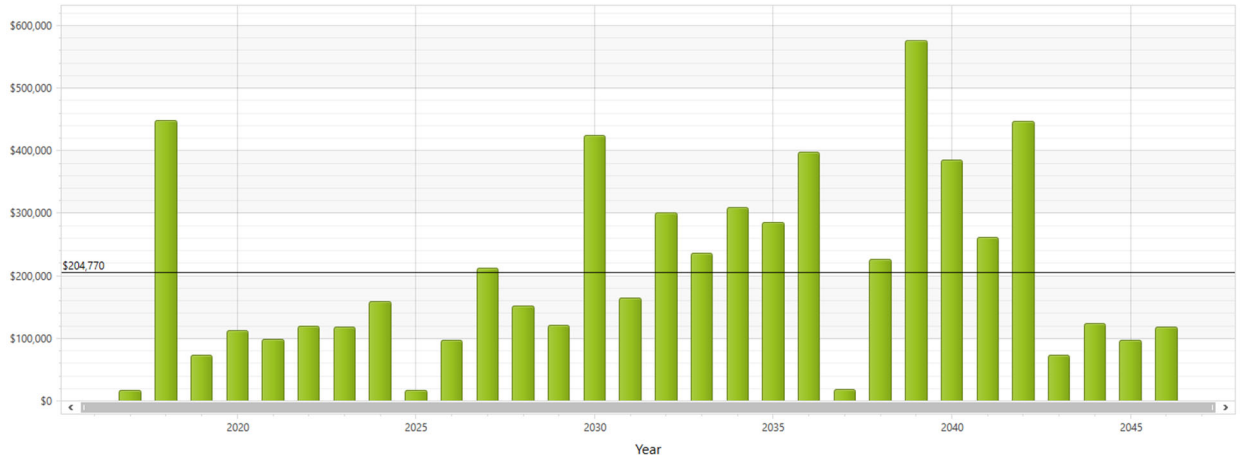

Figure 1-7 Traffic Sign 30-Year Replacement and Rehabilitation Profile (Deterministic)

A 12-year replacement and rehabilitation analysis is shown in the following figure. The annual average rehabilitation and replacement need over a 12-year horizon is approximately $134,000. This lower annual average is due to the fact that the 30-year replacement and rehabilitation profile begins to account for the replacement of the sign posts, which raises the annual average. In addition, more replacements of the radar speed signs occur in the 30-year horizon.

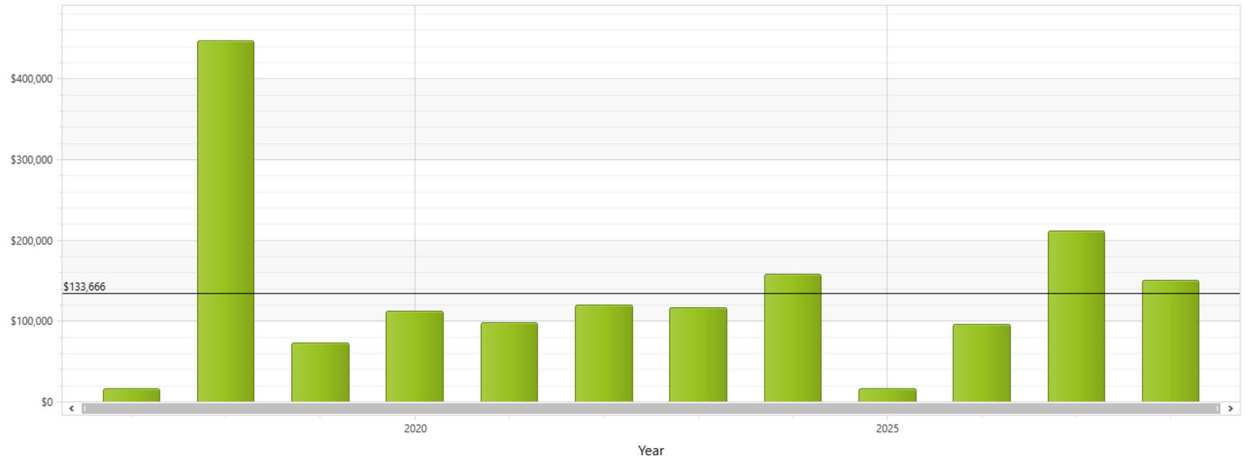

Figure 1-8 Traffic Sign 12-Year Replacement and Rehabilitation Profile

The 30-year life cycle cost analysis was repeated utilizing a probabilistic model. In this model, asset failures were smoothed to show that assets may fail sooner or later than their expected useful lives; as such, this scenario may present a more realistic estimate of the future asset failures and funding needs. The probabilistic analysis incorporates the concept of randomness in that early or late asset failures are distributed randomly using the assigned standard deviation (i.e., 20%). The probabilistic model predicts the annual replacement and rehabilitation needs to be approximately $186,000.

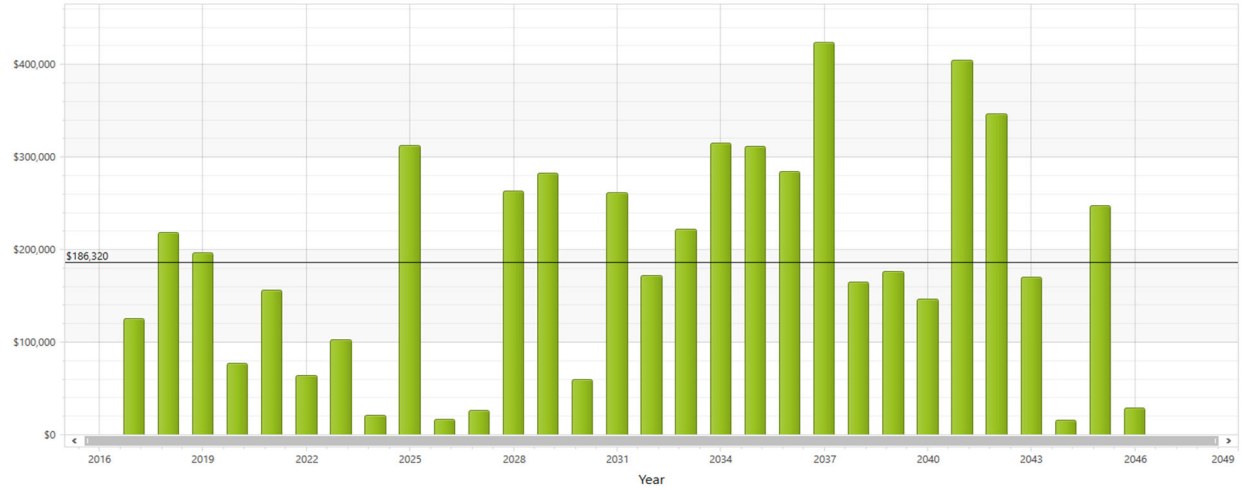

Figure 1-9 Traffic Sign Replacement and Rehabilitation Profile (Probabilistic)

Both analyses above represent results in 2017 dollars. Expecting that the cost of construction will increase with time, a second model run was performed using a 3% annual inflation factor. With 3% inflation over the 30-year planning

horizon, the projected annual investment need for the deterministic model increases from $205,000 per year to $388,000 per year. Similarly, for the probabilistic model, the annual investment need increased from $186,000 per year to $305,000 per year. The results of these analyses are presented the following figures.

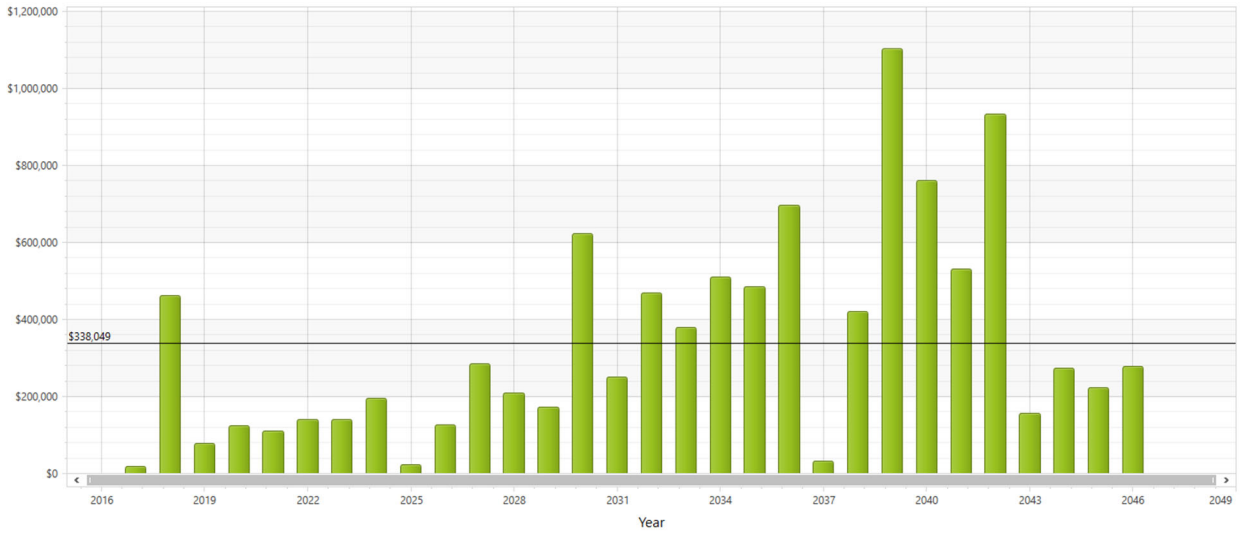

Figure 1-10 Traffic Sign Replacement and Rehabilitation Profile (Deterministic, 3% Inflation)

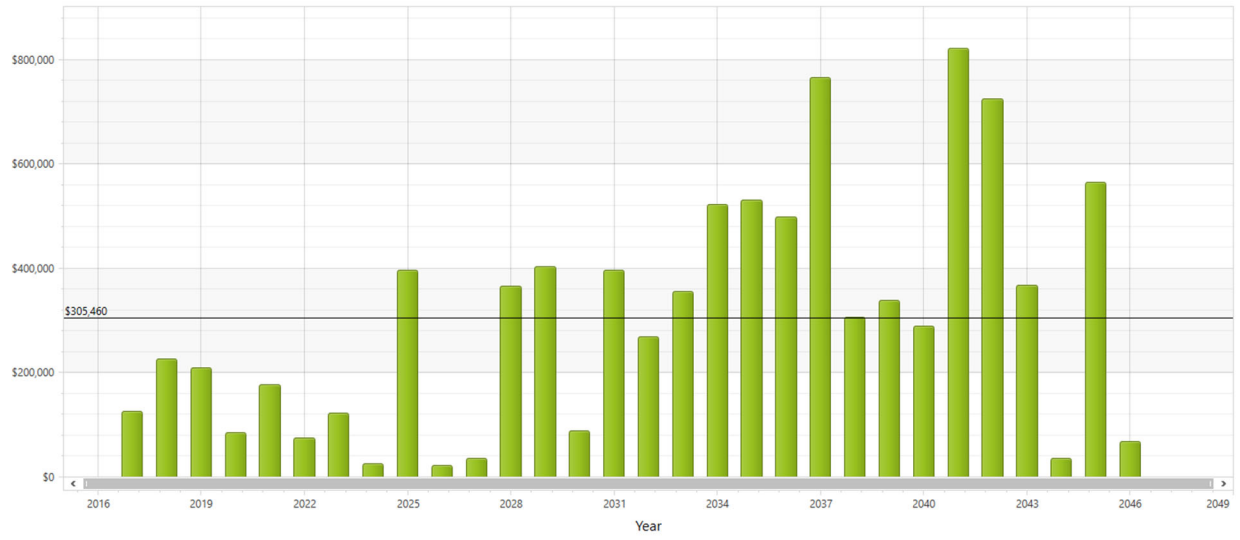

Figure 1-11 Traffic Sign Replacement and Rehabilitation Profile (Probabilistic, 3% Inflation)

The following table summarizes the 30-year replacement and rehabilitation needs for the Traffic Sign Management System.

Table 1-5 Traffic Sign Management System 30-Year Summary

Analysis Type	R&R Average
Deterministic	$205K/yr
Probabilistic	$186K/yr
Deterministic with 3% Inflation	$388K/yr
Probabilistic with 3% Inflation	$305K/yr

1.4.3 Catch Up and Keep Up

When discussing replacement and rehabilitation, Catch Up describes all replacement and rehabilitation needs (e.g., assets fully consumed with condition score of 4 or 5) in the current year. Keep Up describes all replacement and rehabilitation needs in the remainder of a given planning horizon after the City has addressed the Catch Up needs. In the Catch Up and Keep Up analysis, the deterministic 30-year replacement and rehabilitation analysis is re-examined by bringing the high-risk assets (Catch Up needs) to the beginning of the planning horizon. The remaining replacement and rehabilitation needs are represented by the Keep Up. The following table displays the total Catch Up rehabilitation and replacement costs and the Keep Up for a 30-year planning horizon in 2017 dollars, not including any project delivery costs because this work is done by City staff. While the Catch Up encompasses all incurred costs for the first year of the planning horizon, the Keep Up is presented as an average of all replacement and rehabilitation costs in the 30-year horizon.

Table 1-6 Catch Up and Keep Up Values (2017 Dollars)

	Cost
Catch Up	N/A
Keep Up	$205K average per year

Because the replacement cycles for the traffic signs have taken place on schedule, there is no Catch Up. In other systems, the Catch Up and Keep Up analysis provides a view of the future needs if the City were to focus solely on high-risk assets before addressing the other Keep Up needs. In those cases, if the City were to fund the Catch Up in the immediate future, the Keep Up represents the annual average for the remaining repair and replacement needs in the 30-year planning horizon. In this case, the Keep Up number matches the replacement and rehabilitation analyses in Section 1.4.3 and should be used as the basis for future planning. However, as the inspection program starts, it will be important to incorporate the findings of these inspections into the management strategies.

1.5 Level of Service

For most of the management systems, two levels of service were developed: the preferred level of service and the minimum level of service. The preferred level of service would be for the City to follow the rehabilitation and replacement cycles as outlined in the life cycle cost logic section of this report (i.e., full service, replace and

rehabilitate all assets on schedule regardless of priority). Under the minimum level of service, only high-risk assets (i.e., CoF 4 and above), which are generally associated with high-risk assets, would be rehabilitated and replaced.

In general, the level of service analysis was conducted in order to analyze the amount the City could feasibly fund the replacement and rehabilitation needs. In the case of the traffic signs, the current funding needs for the preferred level of service are being met. Because the traffic signs are operating at the preferred level of service, a minimum level of service analysis was not necessary.

1.6 Management System Score

1.6.1 Physical Health

The physical health of the Traffic Sign Management System was judged based on the ratio of poor condition assets to the overall replacement cost of the system assets. For most systems, physical health was also measured based on the ratio of high-risk, red zone assets to the overall replacement cost of the system assets; however, CoF and risk were not assessed for the Traffic Sign Management System, so a Risk-Based Condition score and grade were not given to the traffic signs. For these scores, the lower the percentage of poor condition (Overall Condition) and high risk (Risk-Based Condition) scores, the better.

Table 1-7 Traffic Sign Management System Physical Health Values and Scores

Category	Score	Grade
Overall Condition	4%	A
Risk-Based Condition	N/A	N/A

The Traffic Sign Management System received an Overall Condition grade of A. This indicates that the system is in good condition overall. Because the CoF was not assessed for the assets in the current iteration, no Risk-Based Condition score was assigned.

1.6.2 Financial Health

The financial health of the Traffic Sign Management System was judged based on the ratio of the catch up and keep up values to the 2017 annual rehabilitation and replacement budget of $230,000. The scores for each category are presented below. These scores were used to assess the overall grade of the management system.

Table 1-8 Traffic Sign Management System Financial Health Scores

Category	Score	Grade
Catch Up Score	N/A	N/A
Keep Up Score	100%	A

Because the CoF was not assessed for the assets in the current iteration, no Catch Up score was assigned. The Keep Up grade is an A, meaning that the annual rehabilitation and replacement budget should be sufficient to fund the traffic sign needs in the future..

1.7 Policy Options

As mentioned previously, the City has recently completed a major 12-year sign replacement program across the City. While the analysis in this report assumes that the replacement cycle will remain 12 years, the sign replacement program may move toward replacing signs based on sign inspection and condition. Under this program, signs that do not meet specifications (e.g., retroreflectivity) will be replaced as needed. Inspection and replacement procedures will be developed for the signs in the future.

1.8 Confidence Level

Confidence level factor weights are based on the City's specific goals for this phase of the asset management program development. Factors that were focused on during this phase of the asset management program development, such as asset inventory and condition assessment, were given higher weight. One of the City's particular goals was also to encourage buy-in on the part of its staff and stakeholders, so the Community Asset Management Program (CAMP) committee review was added to the general asset management program as a factor. On the other hand, factors that will be improved in future phases of the program development were given lower weight.

Table 1-9 Traffic Sign Confidence Level

Confidence Level Factor	Confidence Level Rating Score	Weighting Factor	Weighted Confidence Level Rating Score
Asset Inventory	90%	20%	18%
Data Quality	80%	15%	12%
Condition Assessment	60%	20%	12%
Asset Valuation	80%	10%	8%
Life-cycle Cost Logic	80%	10%	8%
Risk	60%	10%	6%
Staff Review	60%	5%	3%
CAMP Committee Review	100%	10%	10%
Total Score			**77%**

Asset Inventory (Unweighted Score - 90%)

The asset inventory is based on extensive data from GIS that was collected during a previous project.

Data Quality (Unweighted Score - 80%)

The asset data collected during the previous project includes extensive information on each sign. Further verification with staff will take place in the future.

Condition Assessment (Unweighted Score - 60%)

Condition was based on age for this analysis. In the future, inspections (e.g., retroreflectivity testing) will likely drive

the condition assessment process. Further verification with staff will take place in the future.

Asset Valuation (Unweighted Score - 80%)

Replacement costs were estimated for each asset. As assets are replaced in the future, the costs will be updated in the traffic sign management system.

Life-cycle Cost Logic (Unweighted Score - 80%)

Life-cycle cost logic was assigned to the assets, and a methodology based on usage was developed.

Risk (Unweighted Score - 60%)

PoF was calculated for this system. However, CoF and Risk were strategically not assigned during this project. Development of CoF and Risk scores may be necessary in the future.

Staff Review (Unweighted Score - 60%)

Staff was involved in the development of the traffic sign management system. Continued review of the inventory and condition assessment should happen regularly.

CAMP Committee Review (Unweighted Score - 100%)

The CAMP committee reviewed, analyzed, and provided input on the results throughout the asset management plan process.

1.9 Next Steps

Asset Inventory Updates

Since the initial inventory and assessment process in 2017, some assets have likely been installed or replaced. Updates should be made to the asset inventory in the future.

Condition Assessment

The City intends to begin a condition assessment process (i.e., retroreflectivity testing) on signs. The results of these tests may be translated to condition scores and included in future traffic sign analyses.

Life Cycle Cost Logic

Another future step for the Traffic Sign Management System may be to adjust the life cycle cost logic based on analysis of inspection results. At the time of this analysis, it was assumed that the signs would last 12-15 years based on the sign type. However, the City may choose to move into more of an inspection-based replacement process. Once enough data is collected through inspections, the life cycles for the signs can be updated if necessary to more accurately estimate and model the actual lifespan for the signs.

Consequence of Failure and Risk

As mentioned previously, CoF and Risk were not considered in this analysis. In the future, it may be necessary to assess the risk for the traffic signs to prioritize replacement and rehabilitation efforts. One methodology to prioritize

these signs could be based on the sign type. Traffic signs are generally categorized into standard categories (e.g., regulatory, warning, informational). Each of these types could be assigned a criticality. In addition, the signs could be ranked for criticality by road class. In this methodology, the traffic signs along roads that carry more traffic would have a higher criticality that signs along lower-traffic roads. A combination of the two methodologies may also be used to rank the sign replacement.