PERFORMANCE AUDIT OF THE CITY'S QUALITY MANAGEMENT OF STREET REPAVING PROJECTS

Quality Management Should Be Improved Through Better Project Controls to Ensure Street Repaving Meets or Exceeds Expectations

Office of the City Auditor

City of San Diego

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July 2017

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THE CITY OF SAN DIEGO

July 13, 2017

Honorable Mayor, City Council, and Audit Committee Members
City of San Diego, California

Transmitted herewith is a performance audit report of the City's Quality Management of Street Repaving Projects. This report was conducted in accordance with the City Auditor's Fiscal Year 2016 Audit Work Plan, and the report is presented in accordance with City Charter Section 39.2. The Results in Brief are presented on page 1. Audit Objectives, Scope, and Methodology are presented in Appendix B. Management's responses to our audit recommendations are presented after page 39 of this report.

We would like to thank staff from the Public Works Department and Transportation and Storm Water Department. All of their valuable time and efforts spent providing us information both in the office and in the field is greatly appreciated. The audit staff members responsible for this audit report are Chris Kime, Sunny McLernon, Megan Garth, and Kyle Elser.

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Results In Brief

San Diegans need a reliable and well-maintained local street and road system. Driving on rough roads causes accelerated vehicle depreciation, vehicle repair costs, increased fuel consumption and tire wear. Years of underinvestment in the City of San Diego's (City) streets led to over half of the City's 3,000 miles of streets to be in either fair or poor condition by Fiscal Year 2012. In fact, a recent 2015 resident survey found that 59 percent of respondents were dissatisfied or very dissatisfied with the condition and maintenance of the City's streets. Additionally, the survey's analysis recommended investment in the City's streets, sidewalks, and infrastructure as a top priority over the next few years.

In Fiscal Year 2016, in a laudable effort to address the backlog of street repairs in combination with increased infrastructure funding, the Mayor pledged a goal of repairing 1,000 miles of streets by the year 2020. The goal begins by increasing the number of miles to be repaired from 199 miles in Fiscal Year 2014 to approximately 322 miles in Fiscal Year 2016. Additionally, the Fiscal Year 2017 Adopted Budget estimates an approximately $15.9 million General Fund minimum target allocation to infrastructure improvements, including street repair.

While commitment to project time and cost are important to achieve the Mayor's goal, quality provides a third critical component to ensuring the long-term durability of the City's streets. Quality is defined as conformance with requirements and the degree of excellence or customer satisfaction. A robust quality management process, embodying both quality control and assurance activities, addresses the need to verify and maintain a desired level of quality in an existing product or service by careful planning, continued inspections, and corrective action. Quality control is the planned process of testing and monitoring work performed to ensure that the work meets specifications while quality assurance is the verification of these activities.

The Public Works Department (Public Works) coordinates with the Transportation and Storm Water Department (TSW) to accomplish street repairs, known as asphalt overlay (repaving), under the City's Capital Improvement Program (CIP) whereby the City hires a private contractor to perform the work. Under the City's quality management process for street repaving, the contractor performs quality control activities while the City Laboratory and Resident Engineers verify these activities through material testing and inspections.

We conducted a performance audit focusing on the quality management of street repaving projects under CIP. Specifically, we sought to determine:

1. If Public Works employs qualified Resident Engineers to oversee CIP street repaving projects; and
2. Whether Public Works' CIP street repaving projects meet construction quality management expectations.

Based on our review we found:

1. Public Works employs qualified Resident Engineers who have met the qualifications for the Assistant Civil Engineer classification.

Public Works assigns a Resident Engineer to oversee CIP repaving contracts. The Resident Engineer is responsible for inspecting the work of the contractor. Resident Engineers must have at least two years of professional civil engineering experience and one of the following requirements: 1) a bachelor's degree in civil engineering or a related field; or 2) registration as a professional civil engineer with a state licensing board; or 3) certification as an engineer-in-training.

2. Quality management of street repaving should be improved through better planning and implementation to ensure streets perform satisfactorily. Specifically, we found:

- The design of the City's quality management of street repaving does not include requirements for the contractor to have a well-defined quality control plan to document that repaving activities meet City specifications.

- The contractor and the Resident Engineers are not required to record key activities related to the quality of repaving work. We did not find evidence that contractors perform quality control activities, and Resident Engineers' inspections are limited to observations when they are onsite.
- Without a requirement to record key paving quality activities, the City cannot ensure that street repaving meets all specifications. Additionally, the lack of recorded information precludes ongoing evaluation of the City's quality control process.

As part of its quality assurance, we also found that the City Laboratory performs material testing prior to repaving to ensure that asphalt meets City mandated specifications. Additionally, we found that the City Laboratory consistently conducts and records compaction tests after repaving. However, this testing alone does not provide sufficient quality assurance that would ensure that repaving work meets specifications.

To address the issues presented above, we recommended Public Works and TSW collaborate to strengthen their quality management process for all CIP repaving contracts. We also recommended that TSW analyze the repaved blocks identified in the report that did not perform as expected to try to determine the associated causes of deterioration. TSW should also determine if a process should be established for ongoing analysis. Management agreed to implement all recommendations.

Background

In accordance with the Office of the City Auditor's Fiscal Year 2016 Audit Work Plan, we conducted a performance audit focusing on quality management of street repaving projects under the City of San Diego's (City's) Capital Improvement Program (CIP). The overall objectives of this audit were to:

1. Determine if the Public Works Department (Public Works) employs qualified Resident Engineers to oversee CIP street repaving projects; and
2. Determine whether Public Works' CIP street repaving projects meet construction quality management expectations.

The City's current street network consists of approximately 3,000 miles of streets. This includes 2,668 miles of asphalt streets, 120 miles of concrete streets, and 204 miles of paved alleys. In the 2015 survey of resident satisfaction with City services, 59 percent of respondents indicated that they were dissatisfied or very dissatisfied with the condition and maintenance of City streets.

The City has Increased Its Efforts to Improve Streets in Recent Years

The City maintains a large network of infrastructure assets, such as streets, bridges, parks, public facilities, and airports. During the period of Fiscal Year 2000 to Fiscal Year 2012, the City experienced significant financial challenges resulting in limited resources with which to fund infrastructure repairs, including street repairs and maintenance. The City's Independent Budget Analyst released a Fiscal Year 2013 report estimating that the City had a deferred capital infrastructure backlog of $478 million for streets. From Fiscal Year 2013 to Fiscal Year 2016, the City spent approximately $84 million on street repaving.

With increased funding for infrastructure improvements and residents' desire to see improvement in their streets, in Fiscal Year 2016, the Mayor pledged to repair 1,000 miles of streets by the year 2020. The 1,000 miles of road repair will fix approximately one-third of the City's entire street network. To fund this goal, the Mayor pledged to dedicate at least 50 percent of General Fund revenue growth to investments in

infrastructure, which in Fiscal Year 2017 was projected to be $31.9 million. This results in an estimated $15.9 million minimum target allocation to infrastructure improvements.

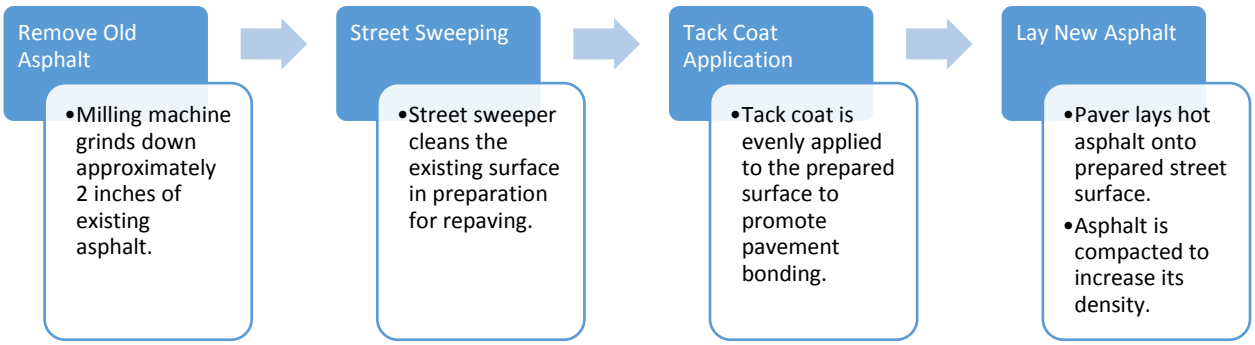
The Transportation and Storm Water Department Maintains City Streets and Identifies Repair Needs

The Transportation and Storm Water Department (TSW) is an integral part of helping the Mayor to achieve his goal. TSW's Street Division is responsible for assessing roads, identifying maintenance and infrastructure repair needs, and identifying funding for street infrastructure projects. The most cost-effective way to extend streets' service life is to perform regular minor maintenance, typically surface treatments, such as slurry seal. Slurry seal is a pavement preservation method using an asphalt emulsion to address existing surface distress. This treatment, which is considered maintenance, as opposed to capital improvement work, extends the life of streets already in good condition.

When streets require more extensive repair, asphalt overlay (also known as repaving), is used to place a new layer of asphalt over an old, worn-out street surface. For streets with deteriorated surfaces, approximately two inches of existing pavement is removed and new asphalt is then placed on top, providing a new driving surface and keeping the existing roadway profile. Streets are supposed to be ground down (milled) at the curb before repaving so that asphalt will not build up at the edge of the gutter. See **Exhibit 1** to view the repaving process. Once a street's pavement shows visible signs of several distresses, the street most likely requires reconstruction, which is more costly than repaving.

Exhibit 1:

The Repaving Process Follows Four Steps

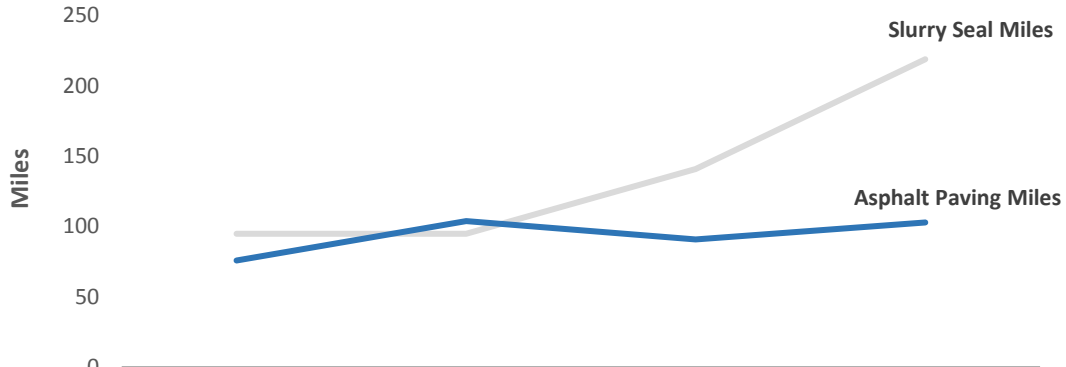


Source: Pavement Interactive

Repaving, which is considered a capital project rather than a maintenance project, is contracted out to private companies. Since Fiscal Year 2013, the number of miles of streets repaved with asphalt has increased 36 percent. **Exhibit 2** below shows the miles of streets repaired since Fiscal Year 2013.

Exhibit 2:

City Street Repairs Have Increased Since Fiscal Year 2013



	2013	2014	2015	2016
Slurry Seal Miles	95	95	141	219
Asphalt Paving Miles	76	104	91	103

Fiscal Year

Source: OCA, based on the Fiscal Year 2017 Report to the San Diego City Council Infrastructure Committee regarding the Fiscal Year 2016 pavement condition assessment, and the Independent Budget Analyst's Fiscal Year 2015 Review of the Mayor's 5-Year Repair Program.

The Transportation and Storm Water Department and the Public Works Department Work Together to Improve the City's Streets

Once TSW identifies its street repair needs, it works with Public Works to initiate a CIP repaving contract. Once a contract has been awarded, Public Works' Construction Management and Field Services Division oversees all construction management services, including performing quality control inspections. Additionally, the City Laboratory conducts testing of construction materials. Under the CIP program, TSW is the asset managing department, or the owner of the asset and Public Works is the service department responsible for ensuring that work is performed as specified in the contract. TSW assigns project managers to oversee the overall management of the contract, while Public Works assigns Resident Engineers to oversee the actual day-to-day operations of the work in the field.

Resident Engineers must have at least two years of professional civil engineering experience and one of the following requirements: 1) a bachelor's degree in civil engineering or a related field; or 2) registration as a professional civil engineer with a state licensing board; or 3) certification as an engineer-in-training. Resident Engineers are responsible for inspecting, overseeing, and documenting the work of the contractor. As on-site engineer and point of contact for the contractor during construction, Resident Engineers ensure that projects meet specification standards identified in the *Standard Specifications for Public Works Construction* (GREENBOOK) and the City's WHITEBOOK supplement. All CIP repaving contracts reference these specifications (See **Appendix C** for more details).

Quality Management

A robust quality management process includes quality control and quality assurance activities.

- Quality control is the planned process of testing and monitoring work performed to ensure that the work meets specifications.
- Quality assurance is the verification of these activities.

For the purpose of this report, the term "quality control" refers to activities performed by the contractor and the term "quality assurance" refers to activities performed by the City. "Quality management" is the process as a whole.

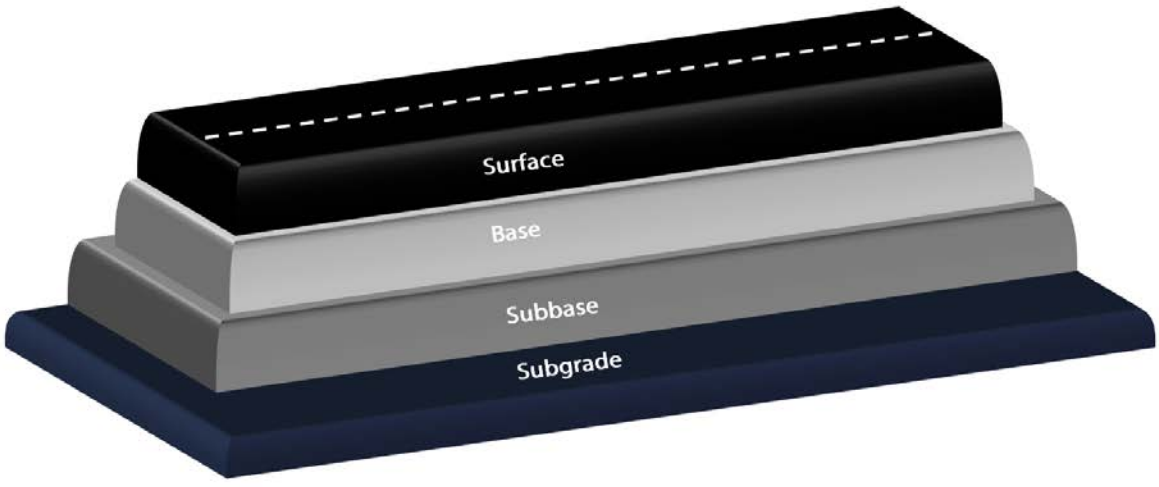
Several Material Layers Provide the Structural Support of Streets

Although we only see the surface of the street, streets are actually comprised of up to four material layers, as shown in **Exhibit 3**.

1. Surface layer comes into contact with traffic and normally contains the highest quality materials. It serves to prevent the entrance of excessive quantities of surface water into the underlying base, subbase, and subgrade.
2. Base layer is immediately beneath the surface layer. It provides additional load distribution and contributes to drainage and frost resistance.
3. Subbase layer is between the base and the subgrade. It functions primarily as structural support. The subbase is not always needed or used.
4. Subgrade layer is the foundation that underlies the road. It is the surface upon which a surface, base or subbase is to be placed.

Exhibit 3

Streets May be Composed of Several Layers



Source: OCA, based on Pavement Interactive.

Several Factors Impact the Useful Life of Streets

Each component of the City's street network is inherently subject to deterioration. Street degradation rates are dependent on several factors including the quality of materials used to construct and maintain streets, the underlying structural integrity of the street, effects of permitted and illicit damage, drainage, weathering, and traffic. As streets degrade into poorer conditions, maintenance costs become increasingly expensive. Poor street conditions lead to decreased ride quality, higher vehicle maintenance costs, as well as increased dissatisfaction by the general public in the management of the public right-of-way.

Aspects of Repaving that Affect the Long-Term Life of Streets

In addition to the factors mentioned above, other factors can affect pavement quality and longevity. These key components are described below in the order of occurrence (for more detail, see the Glossary in **Appendix E**):

Asphalt Mix: The particle size distribution, or gradation, of an aggregate is one of the most influential aggregate characteristics in determining how it will perform as a pavement material. The gradation of asphalt mix used in repaving projects helps determine almost every important property including stiffness, stability, durability, permeability, and fatigue resistance.

Base, Subbase, or Subgrade Preparation (Dig-Outs): Preparing the base, subbase, or subgrade by milling, compaction, or removing and replacing failed sections of these layers are essential to pavement longevity. Defects in these layers can cause surface level cracking, potholes, and loss of structural support.

Surface Preparation: A smooth, level, and clean surface ensures bonding between the new pavement and the existing pavement.

Tack Coat Application: Proper tack coat application is essential to promote bonding and strength between the existing road surface and the repaved asphalt layer.

Asphalt Temperature: The temperature of the asphalt at placement should be within a specified temperature range to ensure adequate compaction.

Asphalt Thickness (Depth): Proper asphalt thickness is essential to pavement longevity and is used to support traffic loads.

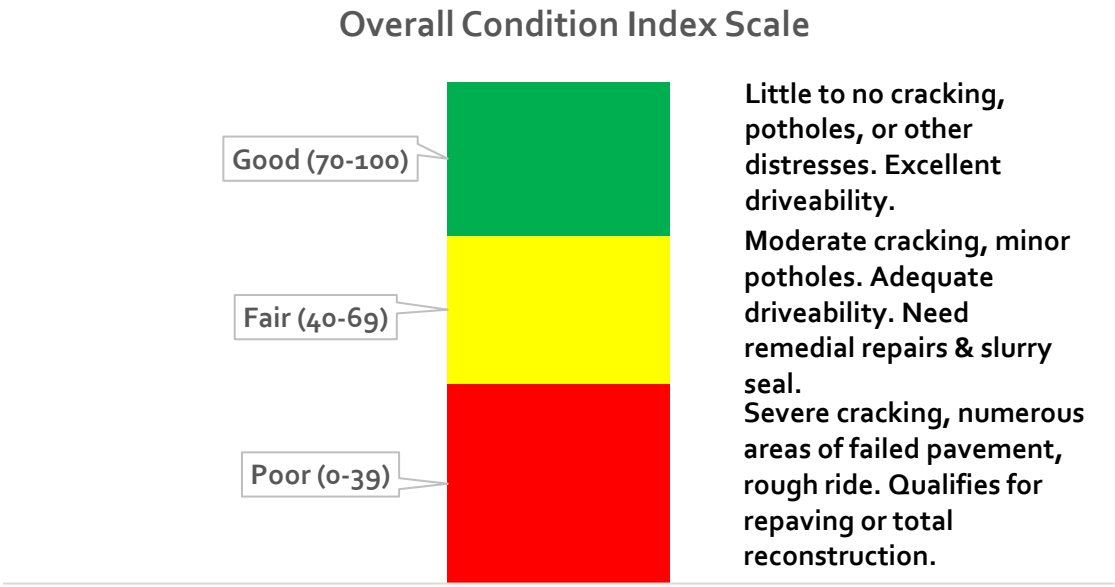
Asphalt Compaction: Compaction is the process by which the volume of air in placed asphalt is reduced by using external forces to compact aggregate particles. The volume of air in pavement is important because it has a profound effect on long-term pavement performance.

The Overall Condition Index Assessment Measures the Condition of City Streets

TSW rates and monitors the condition of streets using an Overall Condition Index (OCI) indicator. The OCI indicator was originally developed by the Army Corps of Engineers as an industry standard for measuring pavement distress and surface roughness. The OCI rating is based on many road attributes using a scale from 0–100, as shown in **Exhibit 4** below. These factors include: type of street, age, oxidation, rate of deterioration, average daily traffic, types and sizes of cracks, number of potholes, and quality of ride. Streets are placed into one of three categories based on the OCI: Good, Fair, or Poor.

Exhibit 4

The Overall Condition Index Scale Provides a Snapshot Condition of City Streets



Source: Report to City Council, Infrastructure Committee, Fiscal Year 2015.

TSW's Street Division has a goal of assessing street pavement condition once every four years. Since 2001, the Street Division has retained specialized pavement engineering consultants to perform surveys of the street network. These surveys have varied in scope on how many, and which streets were surveyed. The first full assessment of the City's street network was completed in 2011, which resulted in an average OCI of 59. The second assessment of the entire network was recently completed with a significantly improved average OCI of 72.

According to the most recent pavement condition assessment, conducted in Fiscal Year 2015, 60 percent of the City streets are in good condition, 34 percent are in fair condition, and six percent are in poor condition. The most cost-effective way to extend a street's service life is to perform maintenance, such as slurry seal, which increases the OCI by 35 and extends the life of the street by three to seven years depending on traffic load. According to TSW, repaving increases a street's OCI score to 90.

The assessment results provide key information for accomplishing the Mayor's goals of performing 1,000 miles of street repairs in five years and raising the OCI to an average of 70. The primary objectives of the pavement condition assessment were to provide the information necessary to:

- Determine pavement condition and ride quality for each street segment;
- Analyze trends in overall network conditions; and
- Correlate pavement treatments and long-term preservation results.

Audit Results

Finding 1: Quality Management of Street Repaving Should Be Improved through Better Project Controls

According to the Fiscal Year 2016 Capital Improvement Program (CIP) budget, the City of San Diego (City) estimated it would be spending a total of $448 million on street resurfacing projects.[1] In the 2015 resident survey, 59 percent of respondents reported that they were dissatisfied or very dissatisfied with the condition and maintenance of City streets. Because street infrastructure is such a large financial investment, and because the street condition impacts City residents, it is important for the City to ensure quality work is performed on repaving projects.

We reviewed the qualifications of the City's Resident Engineers and the current street repaving program to determine whether the Public Works Department's (Public Works) CIP street repaving projects meet construction quality management expectations and found:

- The Resident Engineers assigned to each project that we reviewed met all City qualifications for their position;
- The design of the City's quality management of street repaving does not include requirements for the contractor to have a well-defined quality control plan to document that repaving activities meet City specifications.
- The contractor and the Resident Engineers are not required to record key activities related to the quality of repaving work. We did not find evidence that contactors perform quality control activities and Resident Engineers' inspections are limited to observations when they are on site.

[1] This total is from the TSW Resurfacing of City Streets line item in the City CIP budget. However, repaving contracts typically also include activities such as updating or installing curb ramps and traffic loops. This total also includes projects that have received partial funding in previous years, and future fiscal year projections of expenditures to complete those projects.

- Without a quality control plan in place that requires collection of data related to key activities in the repaving process, and the retention of this data, the City is not able to perform ongoing analysis and evaluation of its quality control process.

The City Laboratory performs materials testing to ensure that asphalt material used in repaving projects meets specifications of a project. Further, we found that the City Laboratory was consistent in sampling compaction density of repaved streets. However, this testing alone does not provide robust quality assurance that would ensure that repaving work meets specifications.

To address the issues presented above, we recommended Public Works and TSW collaborate to strengthen their quality management process for all CIP repaving contracts. We also recommended that TSW analyze the repaved blocks identified in the report that did not perform as expected to determine the associated causes of deterioration. TSW should also determine if a process should be established for ongoing analysis.

What We Found

We found that the Resident Engineers that were responsible for inspecting repavement work performed during the three projects we reviewed each met City qualifications for their position. To determine this, we reviewed the classification requirements for both education and work history for the position of Assistant Civil Engineer—or Resident Engineer. We then reviewed the employment information gathered and retained by the Department of Personnel when the Resident Engineers were either promoted to their position or hired into their position.

During our review of Public Works' quality management of street repaving, we found it does not include requirements for the City or the contractor to have well-defined quality control plans in place to verify that repaving activities meet City specifications. Neither the contractors nor the Resident Engineers are required to record key activities related to quality of repaving work other than the City Laboratory's measurement of asphalt compaction. Resident Engineer inspections are limited to observation of repaving activities

when they are on site and the City places undue reliance on the final walkthrough for assurance that quality work is done.

We also found that the City Laboratory performs materials testing prior to any repaving. Asphalt mix types differ from each other mainly in maximum aggregate size and aggregate gradation. Prior to material placement, the City Laboratory provides material quality assurance for asphalt used in repaving through measurement, testing, and certification that asphalt meets City mandated specifications. In this certification process the City Laboratory tests several aspects of material quality such as stability, oil content, and gradation to ensure that the mix is in accordance with mix design and specifications.

The City Laboratory also conducts compaction tests on newly repaved streets. In our review of contract files, we found that the City Laboratory not only consistently conducts compaction tests, but it also records the results of these tests as part of their quality assurance. While this is an important aspect of the process, inspection records of additional key activities are needed to further ensure that street repaving work meets contract specifications and perform satisfactorily in the long run.

What Should Have Occurred

An effective quality management process for street repair projects should incorporate both quality control by the contractor, and quality assurance by the City. Quality management activities should ensure an acceptable level of workmanship through careful project planning, continued inspections, and corrective actions, when necessary.

To ensure quality of a project, a quality control plan should be built into the process to address monitoring including inspection, sampling, and testing. In our review of pavement literature, we identified seven key characteristics essential to pavement longevity that must be observed, measured, and documented during the repaving process (see **Appendix E** for more details):

1. Asphalt Mix;
2. Base, Subbase, or Subgrade Preparation (Dig-Outs);
3. Surface Preparation;

4. Tack Coat Application;
5. Temperature of Asphalt Mix During Application;
6. Asphalt Depth; and
7. Asphalt Compaction.

We reviewed some other government organizations repaving practices and found that they require a quality control plan for repaving jobs that includes levels of testing or sampling by the contractor. For example, the California Department of Transportation (Caltrans) implemented a quality control plan requirement for its repaving jobs in 1995. This plan has three main goals: 1) improve the quality of highway construction projects and reduce the associated lifecycle costs, 2) place some responsibility for quality on the contractor, and 3) reduce disputes between Caltrans and the contractor. Caltrans not only requires the contractor to have a quality control plan in place, but also ties payment to the contractors' fulfillment of quality control tests.

Caltrans' quality control plan places the responsibility for developing and implementing a quality control plan for inspection and testing of materials and workmanship on the contractor to ensure that pavement production and placement meet specifications. Included in this plan, which is submitted to the Resident Engineer for acceptance, are key elements such as:

1. Quality control inspection plan;
2. Sampling and testing plan;
3. Random sampling plan; and
4. A signed statement by the quality control manager.

The quality control plan must also contain a detailed testing program that outlines the quality characteristic to be tested, test method to be used, sampling location, and frequency. Additionally, Caltrans' quality control plan requires the Resident Engineer to conduct inspections before and during asphalt placement. Documentation is an important aspect of the success of a quality control program and can clearly show that a contractor is in control of the asphalt production and placement processes.

Caltrans' *Quality Control Manual for Hot Mix Asphalt* requires inspection and documentation to ensure that the work meets quality specifications. Key indicators of workmanship quality are not only verified by the contractor but also documented in a specific format for the Resident Engineer.

Entities such as Caltrans and the Federal Highway Administration (FHWA), require inspection and documentation to ensure that key preparation elements are within specifications, such as tack coat application and asphalt placement within the proper temperature ranges. Each of these key elements of quality is documented in a specific format for the Resident Engineer. The City does not require that key quality control elements be measured or recorded by the contractor or the Resident Engineer, with the exception of laboratory testing related to asphalt mix and compaction density. However, as shown in **Exhibit 5,** other governmental agencies do have plans in place to ensure this information is recorded.

Exhibit 5

Public Works' Quality Control Requirements Compared to Other Governmental Agencies

Key Elements to Pavement Longevity	Potential Resulting Failures	Public Works Checklist Requirement	Caltrans Checklist Requirements	FHWA Checklist Requirements
1. Asphalt Mix	Low durability, incorrect stiffness or stability, moisture susceptibility	Sample & Test	Sample & Test	Prior State Approval, Y/N?
2. Preparation of Base, Subbase, or Subgrade (Dig-Out)	Premature failure due to inadequate support	Check/Identify	Inspect & Check Box Indicating Inspection	Note Condition as Satisfactory Y/N?
3. Surface Preparation	Poor bonding of asphalt, premature failure	Check	Inspect	Note Condition as Satisfactory Y/N?
4. Tack Coat Application Rate	Poor bonding of pavement layers	Check	Note Application Rate, Temperature & Document	Record Application Rate
5. Asphalt Temperature at Placement	Decreased durability	Check	Measure & Document	Measure & Document
6. Asphalt Thickness/ Depth	Cracking resulting from thin surface	Check	Measure & Document	Measure & Document
7. Compaction	Reduced service life, decreased durability, moisture damage	Measure & Document	Measure & Document	Document Rollers and Compaction Test

Source: OCA, based on the Public Works' Standard Operating Procedure, Caltrans' Quality Control Manual, and the FHWA's Hot Mix Asphalt Pavement Guidelines.

We also reviewed standard construction specifications for Sacramento County municipal services. These specifications require that the contractors performing work for Sacramento County comply with Caltrans' specifications for quality control plans to ensure that work is performed to specification requirements.

If Uncorrected, What Could Occur

Without a quality control plan, and without City staff designated to specifically record, verify, or measure key activities, the City cannot ensure that all specifications are being met when streets are repaved. Without verification that the specifications were met during the project, the City does not have the assurance that the roads will maintain their integrity as planned. Early failure will result in lower rated road conditions and higher repair costs.

Why Did This Occur

Quality Management Does Not Include a Well-Defined Quality Control Plan

The City's quality management for repaving lacks a requirement for the contractor to have a defined quality control plan which would include an obligation to document key quality control activities. Instead, the City relies on the contractor to perform quality control activities without documentation and the Resident Engineer to verify these activities through observation to ensure that the work performed is in compliance with City specifications. According to the City's WHITEBOOK, the contractor is responsible for quality control testing and arranging inspections with the Resident Engineer. However, for the three contracts we reviewed, we did not find evidence of contractors' performance of quality control activities. Additionally, we found that when Resident Engineers are on-site to observe repaving operations, they are not required to document these observations.

Public Works' Repaving Inspection Process is Based on Observation

Public Works' Asphalt Overlay & Slurry Seal Inspection Process Standard Operating Procedure (SOP) for Resident Engineers' inspections of CIP repaving contracts requires Resident Engineers to observe at least 58 activities on a checklist related to the surface preparation and repaving of City streets. Of these activities, only three require the recording and collection of information:

- Resident Engineers must collect material tickets from the contractor;
- Resident Engineers must write daily reports recording onsite activities; and
- Resident Engineers must check with the materials technician on compaction results.

While the checklist used by Resident Engineers includes the seven key elements discussed in **Exhibit 5** as essential to pavement longevity, it does not emphasize the importance of these quality control activities. The SOP does not instruct the Resident Engineers to collect, measure, or document quality control information that can be used to verify that contract specifications are being met. Instead, a separate guiding document, the Construction Reports SOP requires Resident Engineers to record daily reports pertaining to on-site equipment, crew on-site, and unexpected activities. The intent of the construction reports is to provide an accounting of crew efficiency, any extra work, disputed work, and weather conditions. If the contractor claims delays at the end of the project, these records will allow the City to negotiate costs that reflect the actual conditions.

The daily reports we reviewed contained these elements and sometimes included information related to materials and workmanship. However, the daily reports did not provide verification of work meeting specifications because the checklist does not require that measurements—such as tack coat application rate or asphalt temperature—are actually performed, nor does it require that information to be documented.

Resident Engineers Have Competing Priorities that Limit Their Inspections

While we found that the Resident Engineers overseeing the three contracts we reviewed met the City's qualifications for civil engineering, we found that competing work priorities limited their ability to conduct inspections on-site.

As the single point of contact for the contractor, the Resident Engineers are responsible for keeping the project moving. This often includes dealing with unexpected issues that arise. We found that these issues might include upset residents, problems with utilities, vehicles that need to be towed, or even accidents that occur. As a result, these problems complicate Resident Engineers' ability to provide adequate time for quality inspections of key activities, thereby providing less assurance that the contractor is performing quality work. Resident Engineers are expected to visit each construction site daily to perform quality inspections. However, we found evidence that Resident Engineers are not always present to make the required observations of key activities for several reasons.

According to Public Works, TSW does not budget a full-time Resident Engineer to CIP repaving projects. Our review of labor reports found that the Resident Engineers worked between three and four hours daily on the projects. Resident Engineers stated that they often have high workloads. They can be assigned to oversee up to three CIP projects at once and to perform inspections on work completed in the public right-of-way for private contractors. While Resident Engineers sparsely document inspections in the public right-of-way due to lack of formal requirements, they must complete daily and weekly inspection reports for all CIP projects, thereby increasing their workload. Furthermore, Resident Engineers' ability to provide visual oversight to key construction activities is limited because repaving activities on multiple streets do not occur in a linear fashion; activities take place on several streets simultaneously. For instance, several blocks of Street A might be grinding, while several blocks of Street B are being swept, and several blocks of Street C are having asphalt poured. Additionally, cleanup activities might be occurring on Street D.

TSW Relies on Final Inspections for Assurance of Repaving Quality

When the contractor has completed construction, the Resident Engineer notifies the Project Manager at TSW to coordinate a final walkthrough inspection. TSW visually inspects each completed street and creates a punch list, which is a listing of work not conforming to specifications, for the contractor to complete prior to contract close-out and TSW's final acceptance of the completed work. During this inspection, TSW indicated that it primarily inspects striping; signs of asphalt failure, such as cracking; as well as signs base failure, such as partially exposed subgrade. TSW suggested that premature asphalt failures may indicate necessary base repairs did not occur. The final inspection walkthrough is a key aspect of TSW's quality assurance. According to a TSW official responsible for overseeing the walk through activities, signs of base failures are identified approximately twice per project during this final walkthrough. TSW also noted there is no testing or review of documentation that occurs during this walk through.

During our audit, we reviewed a punch list created by TSW after the walkthrough. We reviewed the repaving contract and found that the work had been performed in November 2013. The punch list was created in March 2017, about three and half years after the repaving date.[2] We viewed these streets and found that there was frequent cracking in the streets. See below **Exhibits 6–8**.

Exhibit 6:

Jewell Drive, Repaved in Fiscal Year 2013, Shows Cracking

Note: Yard stick is placed next to crack for perspective.

Source: OCA photo. Photo taken May, 2017.

[2] The walkthrough by TSW typically does not begin until all work on the project is completed, which can take years. The walkthrough inspection can then take months. Therefore, as in this instance, a walkthrough and its related punch list may not be completed for more than a year after a street was paved. In this case, the time between repaving and the punch list creation was more than three years.

Exhibit 7:

T Street, Repaved in November 2013, Shows Cracking

Source: OCA photo. Photo taken May, 2017.

Exhibit 8:

Valle Ave, Repaved in November 2013, Shows Cracking and Minor Vegetation Growth

Note: Yard stick is placed next to crack for perspective.

Source: OCA photo. Photo taken May, 2017.

How to Resolve

The design of the City's asphalt quality management can be improved with the development of a strong quality control plan similar to that of Caltrans and the County of Sacramento. Specifically, this plan can include requirements to document quality control activities. Additionally, this plan can include requirements for Resident Engineer inspection, verification, and documentation of the contractor's work prior to and during pavement placement. These efforts will provide the City with greater assurance that the contractor is performing work in accordance with specifications and that the Resident Engineer is verifying that such work is completed. Most importantly, the City will have documentation and verification of key elements essential to pavement quality.

Recommendation #1

The Public Works Department and the Transportation and Storm Water Department should collaborate to strengthen their quality management process for all Capital Improvement Program repaving contracts. The process should include a quality control plan for contractors to record pertinent information for Resident Engineer verification and documentation to ensure workmanship meets contract specifications. At a minimum, the key information that is recorded should include:

- Asphalt Mix specification (continued testing and documentation);
- Base preparation (dig-out) work performed;
- Condition of surface preparation;
- Tack coat application;
- Asphalt temperature at placement;
- Asphalt depth; and
- Compaction tests (continued testing and documentation). (Priority 2)

Departments Do Not Collect Pertinent Data Essential for a Robust Quality Assurance Program

We found that Public Works and TSW lack usable data to perform ongoing analysis and objective evaluation of their quality control processes and therefore do not have the ability to use quality control data to determine why some streets have not performed satisfactorily when placed in service.

What Should Have Occurred

A quality assurance program evaluates all projects to identify processes or quality standards that could be improved. Collection and evaluation of pertinent data that influences pavement longevity are essential for an effective quality assurance program. A strong quality assurance program requires relevant data for analysis.

Why Did This Occur

As mentioned earlier, neither the contractors nor the Resident Engineers are required to record key activities related to quality of repaving work other than the City Laboratory's measurement of asphalt compaction and materials testing. The inspections are generally limited to observations and do not always include documentation of key activities. We also found that Resident Engineers are not always present on site to observe and verify all repaving operations, therefore they are not present to record quality control information.

If Uncorrected, What Could Occur

Without data for analysis, Public Works and TSW do not have information easily accessible and useful for future evaluation as part of a robust quality assurance program. Essentially, without this critical information, the City cannot ultimately assess if the repaving process is meeting or exceeding expectations.

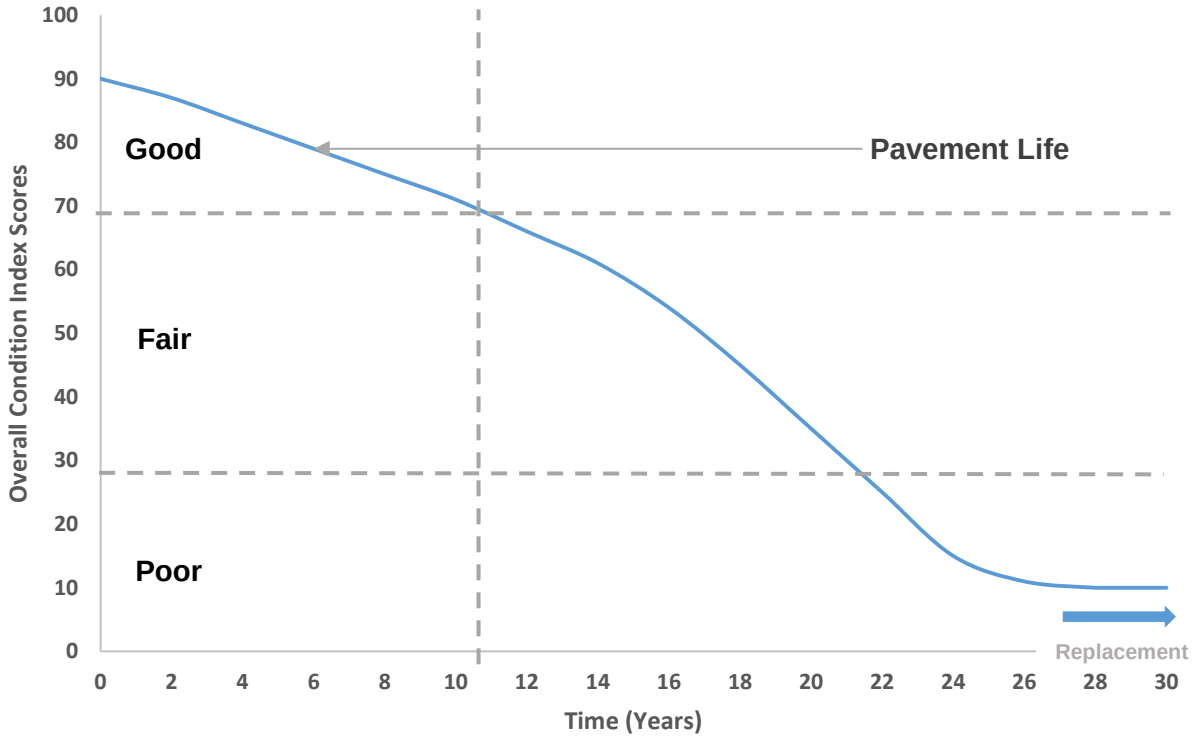
Furthermore, without data that includes quality control activities, it is difficult to analyze causes of fluctuations in Overall Condition Index (OCI) scores which indicate the present condition of City streets. As discussed in the background, the OCI is a scale of 0–100, with a score of 100 representing a surface in the best condition while a score of 0 represents pavement that is beyond repair and requires complete reconstruction. The City assigns an OCI score to each street based on ride roughness and the severity of pavement distresses and places the streets in one of three categories:

1. Poor (0–39);
2. Fair (40–69); and
3. Good (70–100).

The City conducted two assessments of City blocks in Fiscal Year 2011 and Fiscal Year 2015, with an average OCI of 59 and 72, respectively. While the OCI plays an important role in providing a snapshot of the condition of City streets, it does not control for quality and what factors influence a street's performance over time. Generally, a street's OCI score decreases each year until reaching fair condition, upon which deterioration accelerates. Moreover, according to TSW, asphalt repaving increases a street's OCI score to 90, no matter its prior score. **Exhibit 9** below illustrates the rate of deterioration once repaving is completed. Therefore, based on a beginning score of 90, a street should remain in good condition for 8-10 years after repaving, all other factors being equal.

Exhibit 9:

Pavement Life Degrades Over Time

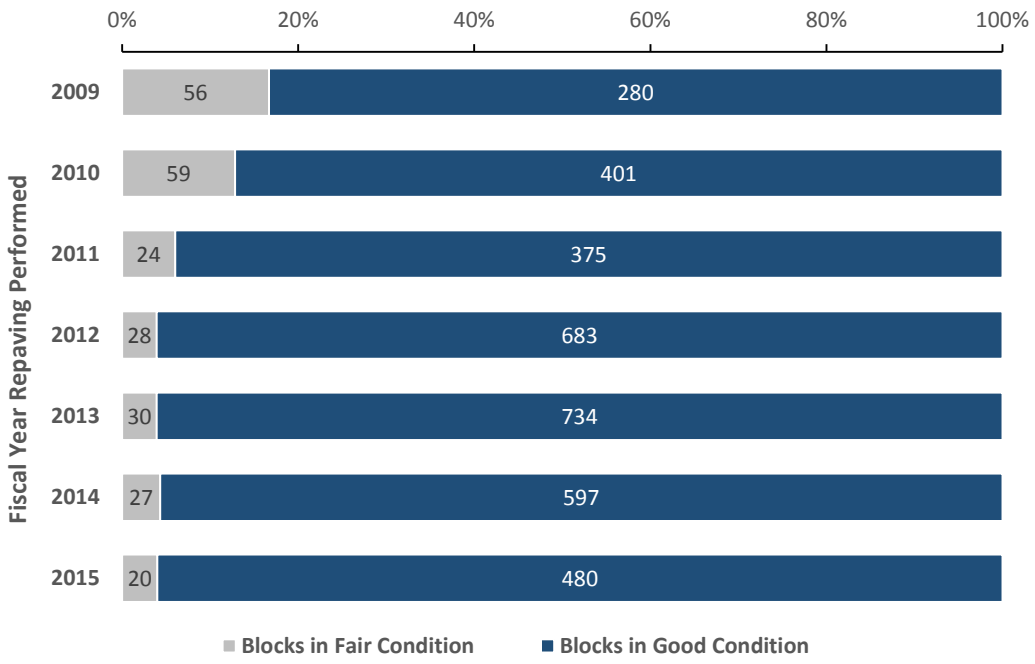


Source: OCA, based on Report to the City Council, City of San Diego, Fiscal Year 2017.

We conducted an analysis of the OCI data for 3,794 blocks that had repaving work completed between 2009 and 2015 to determine if some streets fell from good to fair condition sooner than expected. According to TSW, repaving increases a street's OCI score to absolute 90. As shown in **Exhibit 10** below, 244 blocks have declined from good to fair sooner than expected between Fiscal Year 2009 and Fiscal Year 2015. While these results are positive overall, without data analysis, TSW cannot determine what specific quality control factors account for these variations in street condition during the OCI assessment. Data analysis of street performance is important because repaving costs the City approximately $500,000 per mile. We should note that we did not perform reliability testing on the OCI data to determine if it is accurate. Data reliability was limited to obtaining TSW management's assertion that the OCI data was accurate.

Exhibit 10:

Most Blocks Have Remained in Good Condition While Some Blocks Have Declined From Good to Fair Sooner Than Expected Based on OCI Score



Note: The total sample size was approximately 3,800 blocks with 244 blocks (six percent) that declined from good to fair sooner than expected.

Source: OCA generated using deterioration curve, OCI data, and street repaving history.

How to Resolve	Documentation of testing performed during repaving is an important aspect of a quality control process. Without documented key quality characteristics, Public Works and TSW cannot analyze quality control information overall as a way to identify variables contributing to street performance and ensure that streets hold up as expected. Early failure will result in lower rated road conditions and higher maintenance costs.
Recommendation #2	Transportation and Storm Water should analyze the identified streets repaved between Fiscal Year 2011 and 2015 that have an Overall Condition Index rating of fair or poor condition to determine the likely causes of premature pavement deterioration, such as subgrade stability, material quality, workmanship, and construction impact. Based upon the review, Transportation and Storm Water staff should determine if a process should be established for ongoing analysis of Overall Condition Index, quality assurance information, and repaving history to identify what streets are underperforming and why. (Priority 3)

Conclusion

Quality control, in relation to street repaving, is a process that ensures the contractor is meeting minimum standards of material and workmanship in compliance with plans, specifications, and design intent. Quality assurance describes the City of San Diego's planned process of monitoring contractors' project results to try to eliminate any unsatisfactory results. Our review of the Public Works Department's (Public Works) quality management process, which includes both quality control and quality assurance for repaving projects, found that the process does not require contractors to have a well-defined quality control plan. We also noted that neither the contractors nor the Resident Engineers are required to record key activities related to quality of repaving work. However, we did find that the Resident Engineers assigned to the asphalt repaving projects were qualified and the City Laboratory routinely measures asphalt compaction during repaving projects. Additionally, the City Laboratory performs materials testing prior to any repaving to ensure that the mix used meets the contract specifications.

Public Works, in collaboration with the Transportation and Storm Water Department (TSW), should strengthen the quality management process for repaving projects. The lack of sufficient quality management makes it difficult to determine the causes of premature failure of repaving jobs and makes it difficult to perform long-term analysis of street performance. We recommended that Public Works and TSW collaborate to develop a quality control process for all repaving projects. This process should include measurement and recording of key repaving activities. We also recommended that TSW analyze the blocks that were repaved during the period 2011 to 2015 that have a 2015 OCI score in the fair or poor range to determine the likely cause of premature deterioration. Based upon the results of this review, TSW should determine if this type of analysis should be ongoing to identify why street repaving underperforms.

Recommendations

Recommendation #1

The Public Works Department and the Transportation and Storm Water Department should collaborate to strengthen their quality management process for all Capital Improvement Program repaving contracts. The process should include a quality control plan for contractors to record pertinent information for Resident Engineer verification and documentation to ensure workmanship meets contract specifications. At a minimum, the key information that is recorded should include:

- Asphalt Mix specification (continued testing and documentation);
- Base preparation (dig-out) work performed;
- Condition of surface preparation;
- Tack coat application;
- Asphalt temperature at placement;
- Asphalt depth; and
- Compaction tests (continued testing and documentation). (Priority 2)

Recommendation #2

Transportation and Storm Water should analyze the identified streets repaved between Fiscal Year 2011 and 2015 that have an Overall Condition Index rating of fair or poor condition to determine the likely causes of premature pavement deterioration, such as subgrade stability, material quality, workmanship, and construction impact. Based upon the review, Transportation and Storm Water staff should determine if a process should be established for ongoing analysis of Overall Condition Index, quality assurance information, and repaving history to identify what streets are underperforming and why. (Priority 3)

Appendix A: Definition of Audit Recommendation Priorities

DEFINITIONS OF PRIORITY 1, 2, AND 3

AUDIT RECOMMENDATIONS

The Office of the City Auditor maintains a priority classification scheme for audit recommendations based on the importance of each recommendation to the City, as described in the table below. While the City Auditor is responsible for providing a priority classification for recommendations, it is the City Administration's responsibility to establish a target date to implement each recommendation taking into considerations its priority. The City Auditor requests that target dates be included in the Administration's official response to the audit findings and recommendations.

Priority Class[3]	Description
1	Fraud or serious violations are being committed. Significant fiscal and/or equivalent non-fiscal losses are occurring. Costly and/or detrimental operational inefficiencies are taking place. A significant internal control weakness has been identified.
2	The potential for incurring significant fiscal and/or equivalent non-fiscal losses exists. The potential for costly and/or detrimental operational inefficiencies exists. The potential for strengthening or improving internal controls exists.
3	Operation or administrative process will be improved.

[3] The City Auditor is responsible for assigning audit recommendation priority class numbers. A recommendation which clearly fits the description for more than one priority class shall be assigned the higher number.

Appendix B: Objectives, Scope, and Methodology

Objectives

In accordance with the Office of the City Auditor's Fiscal Year 2016 Audit Work Plan, we conducted a performance audit focusing on the quality management process of street resurfacing projects under the City of San Diego's (City) Capital Improvement Program (CIP). The overall objectives of this audit were to: 1) Determine if the Public Works Department (Public Works) employs qualified Resident Engineers to oversee CIP street repaving projects; and 2) Determine whether Public Works' CIP street repaving projects meet construction quality management expectations. To achieve these objectives, we:

1. Judgmentally selected and reviewed three CIP repaving contracts from Fiscal Year 2013 to Fiscal Year 2015;
2. Evaluated and reviewed the qualifications and responsibilities of Resident Engineers assigned to the contracts we reviewed;
3. Reviewed the City's quality management process for repaving CIP projects;
4. Assessed opportunities to improve the City's quality management process for repaving CIP projects; and
5. Performed an analysis of Overall Condition Index (OCI) data for street repaving done from Fiscal Year 2009 to Fiscal Year 2015.

Scope and Methodology

We reviewed Resident Engineers' job applications, work history, education qualifications, and engineering certifications to determine if they met the City's minimum qualifications for the Assistant Civil Engineer classification. We interviewed Public Works staff to understand the training of Resident Engineers including attendance at construction academies and on-the-job training.

To assess the City's street repaving quality management process, we reviewed Public Works' Standard Operating Procedures (SOP) regarding the Quality Management Plan for Engineering and Capital Projects, Resident Engineers' responsibilities when conducting inspections on CIP repaving

contracts, instructions for writing construction reports to record daily onsite construction activities, and instructions on how to complete as-builts. Additionally, we reviewed the GREENBOOK, WHITEBOOK, and City contracts for quality control plans and requirements. Furthermore, we interviewed staff at Transportation and Storm Water Department (TSW) and Public Works' to discuss how they ensure quality paving operations at the construction level. Moreover, to assess Resident Engineers' verification of work meeting construction quality standards, we reviewed the documentation for three repaving CIP contracts including laboratory testing results, daily reports, asphalt mix tickets, project punch lists, and as-builts.

To assess opportunities to improve the City's quality management process for CIP repaving projects, we reviewed specifications, training manuals, and quality assurance processes for the California Department of Transportation (Caltrans), the Federal Highway Administration (FHWA), and Sacramento County. Additionally, we reviewed Pavement Interactive's best practices.

To assess database prospects for future data collection and analysis of street repair information, we interviewed City staff from TSW, Public Works, and the Mayor's Office regarding various potential databases presently in use or planned including: Cartegraph, IAMSANDIEGO, SAP, Interactive Mapping Coordination Action Tool (IMCAT), and Primavera.

To assess whether streets repaved in the last seven years held their expected condition, we analyzed OCI assessment data from TSW for Fiscal Year 2015. We compared the OCI scores of approximately 3,800 blocks assessed in Fiscal Year 2015 for repaving work completed from Fiscal Year 2009 to Fiscal Year 2015 to determine if any scores fell from good to fair sooner than anticipated. We did not perform reliability testing on the OCI data to determine if it is accurate. Data reliability was limited to obtaining TSW management's assertion that the OCI data was accurate.

Compliance Statement

We conducted this performance audit in accordance with Generally Accepted Government Auditing Standards. These standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that evidence obtained provides a reasonable basis for our findings and conclusions based on the audit objectives.

Appendix C: Construction Specifications

City of San Diego's repaving contracts typically require that construction work be completed in accordance with the standards listed below unless otherwise noted in the contract (see **Exhibit 11** below).

Exhibit 11:

Most City Repaving Contracts Require Adherence to Several Construction Standards

Construction Standards	Description
WHITEBOOK (City of San Diego's Supplement to the GREENBOOK)	Takes precedence over the specification language contained in the GREENBOOK.
GREENBOOK (Standard Specifications for Public Works Construction)	Designed to aid in furthering uniformity of plans and specifications accepted and used by those involved in public works construction and to take such other steps as are designed to promote more competitive bidding by private contractors. Adopted by hundreds of counties, municipalities, and public works agencies throughout the nation. Updated every three years.
City of San Diego Standard Drawings	This volume combines some of the San Diego Area Regional Standard Drawings, as developed by the San Diego Regional Standards Committee, with those additional standard drawings which are unique to public work construction in the City of San Diego. These drawings shall be used in conjunction with the latest City adopted editions of the GREENBOOK and WHITEBOOK. Updated every three years.
Caltrans Standard Specifications	Standard transportation specifications set by the Caltrans.
Caltrans Standard Plans	Standard transportation plans set by the Caltrans.

Source: City of San Diego Repaving Contracts, GREENBOOK, WHITEBOOK, Caltrans.

Appendix D: Responsibilities for the Street Repaving Process

Once TSW identifies its street repair needs, it works with Public Works to initiate a CIP repaving contract. Once a contract has been awarded, Public Works' Construction Management and Field Services Division oversees all construction management services including performing quality control inspections. Additionally, the City Laboratory conducts testing of construction materials. Under the CIP program, TSW is the asset managing department, or the owner of the asset and Public Works is the service department, responsible for ensuring that work is performed as specified in the contract. TSW assigns project managers to oversee the overall management of the contract, while Public Works assigns Resident Engineers to oversee the actual day-to-day operations of the work in the field. Exhibit 12 below shows the responsibilities of each department in the street repaving process.

Exhibit 12:

TSW and Public Works Work Together on City Repaving Contracts

DEPARTMENT	RESPONSIBILITY
Transportation & Storm Water Department – Streets Division	**Identifies streets requiring repairs/maintenance, including:** ▪ Asphalt repaving – is considered CIP; and ▪ Slurry seal – performed based on need. Considered street prolongation preservation. Should be performed regularly every 5-7 years as general street maintenance. **Assigns a Project Manager to each project, who:** ▪ Secures project funding; ▪ Coordinates projects/resolves conflicts with other departments/entities; ▪ Answers questions about project; ▪ Approves products; and ▪ Performs high-level tracking of projects, mainly time and budget. **Assigns a field inspector to perform high-level quality control at project completion, who:** ▪ Performs final walkthrough inspection.
Public Works Department – Construction Management & Field Services Division	**Resident Engineers oversee day-to-day operations of projects, including:** ▪ Managing asphalt repaving of streets. ▪ Performs daily site inspections and writes daily reports. ▪ Responsible for project scheduling, lab work, and meetings with construction workers. ▪ Provides weekly updates to PM via SharePoint.

Appendix E: Glossary

Asphalt Also known as Hot Mix Asphalt Concrete, is an engineered mix of paving grade asphalt and mineral aggregate designed to meet specific pavement application.

Asphalt Overlay Asphalt overlay is the placement of a new layer of asphalt at a thickness of 1-3 inches over an old worn out street surface, referred to in this report as repaving. Repaving also includes the repair of isolated base failures and grinding at the gutter line to retain proper drainage characteristics. Repaving is contracted out to private paving companies.

Asphalt Temperature Temperature differentials at pavement placement can cause areas of inadequate compaction resulting in decreased strength, reduced life, and accelerated aging/decreased durability, rutting, raveling, and moisture damage. These effects can cause a severe reduction in pavement life.

Asphalt Thickness (Depth) Used to support traffic loads, and essential to pavement longevity.

Asset-Owning Departments These departments identify, prioritize, and find funding for needed projects. Asset-owning departments or divisions include: Airports, Environmental Services, Fire-Rescue, Library, Park & Recreation, Petco Park, Police, Public Utilities, Public Works-General Services, QUALCOMM Stadium, and Transportation and Storm Water.

Base Base layer is immediately beneath the surface layer. It provides additional load distribution and contributes to drainage and frost resistance.

Base, Subbase or Subgrade Preparation (Dig-Outs) Preparing an existing pavement surface for repaving can involve such activities as replacing localized areas of extreme damage, applying a leveling course, milling, applying a tack coat, or cracking and seating an underlying rigid pavement, and replacing localized areas of extreme damage. Failed sections of existing pavements should be patched or replaced and existing pavement cracks should be filled. Inadequate subgrade should be removed and prepared as it would be for a

	new pavement. Unaddressed defects such as cracking will reflect through even the best-constructed repaving and cause premature pavement failure in the form of cracks and deformations.
Capital Asset	Land, structures, equipment, and intellectual property that have an estimated life of one year or more.
Capital Improvement Program (CIP)	The long-range plan for all individual capital improvement projects and funding sources. CIP projects are unique construction projects that aim to install new, replace old, or rehabilitate existing infrastructure.
Capital Improvement Program Budget	An annual allocation to CIP projects. It also identifies future funding needs.
Capital Improvement Program Project	The construction, purchase, or major renovation of buildings, utility systems, and other facilities as well as land acquisition and roadway projects.
Compaction	Compacting asphalt reduces the volume of air within the material and produces a corresponding increase in material density. The volume of air in asphalt has a profound effect on long-term pavement performance including decreased stiffness and strength, reduced fatigue life, and accelerated aging/decreased durability, raveling, rutting, and moisture damage.
GREENBOOK	Also known as the *Standard Specifications for Public Works Construction*, the GREENBOOK is designed to aid in furthering uniformity of plans and specifications accepted and used by those involved in public works construction and to take such other steps as are designed to promote more competitive bidding by private contractors.
Infrastructure	The basic structures and underlying facilities needed for the functioning of a community and its economy, such as public facilities, streets, roads, bridges, tunnels, parks, storm drains, and water and sewer systems.
Leveling, Smoothness and Sweeping	The existing pavement should be made as smooth as possible before being repaved. Milling involves grinding off the top

	layer of asphalt to provide a relatively smooth surface on which to pave. Milling machines are the primary method used for removing old pavement surface material prior to repaving. After milling, pavement surfaces should be swept or cleaned off before any new pavement is placed. Without cleaning after milling, dirt and dust decrease bonding between the new paving and the existing pavement.
Overall Condition Index (OCI)	A street condition index that was developed by the Army Corps of Engineers that is made up of two factors: Pavement Condition Index (PCI) that rates distress and the Ride Condition Index (RCI) that rates roughness. This information is then used to calculate the OCI for each segment. An OCI score of 100 represents pavement surface in the best condition while a score of zero represents pavement that is beyond repair and requires complete reconstruction.
Quality Assurance	All those planned and systematic actions necessary to provide confidence that a product or facility will perform satisfactorily in service. A process of auditing quality control requirements to obtain results from quality control measurements to ensure standards are met. Uses data from quality control activities.
Quality Control	A process that ensures the contractor is meeting minimum standards of material and workmanship in compliance with plans, specifications, and design intent. According to Pavement Interactive, a quality control program consists of: (1) the actions and considerations necessary to assess production and construction processes; and (2) setting the end product target value and controlling variability. In order for a quality control program to be effective it should (1) base actions and decisions on measurable results, and (2) be statistically valid.
Quality Control Plan	According to the California Department of Transportation (Caltrans), a quality control plan for construction must contain a detailed testing program that outlines the quality characteristic to be tested, test method to be used, frequency, and sampling location. Additionally, it must contain inspection plans, laboratories and equipment, action limits and corrective action plans, and quality control documents including plan certification by a quality control manager. Lastly, it must

include defined roles and responsibilities for the contractor and Resident Engineer.

Subbase The layer between the base layer and the subgrade. It functions primarily as structural support. The subbase generally consists of lower quality materials than the base but better than the subgrade soils. A subbase is not always needed or used.

Subgrade The subgrade is the material upon which the pavement structure is placed. Although there is a tendency to look at pavement performance in terms of pavement structure and mix design alone, the subgrade can often be the overriding factor in pavement performance.

Surface The layer in contact with traffic loads and normally contains the highest quality materials. It provides characteristics such as friction, smoothness, noise control, rut and shoving resistance and drainage. In addition, it serves to prevent the entrance of excessive quantities of surface water into the underlying base, subbase, and subgrade.

Tack Coat A tack coat is a thin liquid asphalt emulsion that is applied between pavement layers to promote bonding. Adequate bonding between the layers is critical in order for the completed pavement structure to behave as a single unit and provide adequate strength. Inadequate bonding between layers can result in delamination (de-bonding) followed by longitudinal wheel path cracking, fatigue cracking, potholes, and other distresses such as rutting that greatly reduce pavement life.

WHITEBOOK The City of San Diego's specification supplement to the GREENBOOK.

THE CITY OF SAN DIEGO

MEMORANDUM

DATE: July 12, 2017

TO: Eduardo Luna, City Auditor

FROM: Paz Gomez, Deputy Chief Operating Officer, Infrastructure/Public Works

SUBJECT: Management Response to City Audit of Street Repaving Projects

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The purpose of this memorandum is to provide Management's response to the Audit Report entitled "Quality Management for Street Repaving Projects". The Audit's primary objectives were to:

- Determine if Public Works employs qualified Resident Engineers to oversee CIP street repaving projects
- Determine whether Public Works CIP street repaving projects meet construction quality management expectations.

The Audit Report provided recommendations to strengthen the quality management of repaving projects. Below are the Departments' responses to the Audit Recommendations.

Recommendation #1: The Public Works Department and the Transportation and Storm Water Department should collaborate to strengthen their quality management process for all Capital Improvement Program repaving contracts. The process should include a quality control plan for contractors to record pertinent information for Resident Engineer verification and to ensure workmanship meets contract specifications. At a minimum, the key information that is recorded should include:

- Asphalt Mix specification (continued testing);
- Base preparation (dig-out) work performed;
- Condition of surface preparation;
- Tack coat application;
- Asphalt temperature at placement;
- Asphalt depth; and Compaction tests (continued testing and documentation). (Priority 2)

Management Response: Management agrees with this recommendation. The Public Works Department, Construction Management and Field Services Division will revise the existing Standard Operating Procedures (SOP). The SOP will also include the Quality Assurance procedures the City Testing Lab currently performs. Additionally, paving contracts will include a consolidated quality control submittal requirement from the contractor that will highlight steps to be undertaken to ensure their practices meet the minimum requirements of the terms and conditions of the contract.

Specific requirements of City Staff and Contractor remain unchanged other than improved documentation. It is important to point out that improved documentation of both SOP and contract documents will not necessarily improve the results of the paving. Most failures of the roads identified in this audit are results of poor subgrade, not the result of the quality of the installed asphalt. **Target Implementation Date: January 2018.**

Recommendation #2: Transportation and Storm Water should analyze the identified streets repaved between Fiscal Year 2011 and 2015 that have an Overall Condition Index rating of fair or poor condition to determine the likely causes of premature pavement deterioration, such as subgrade stability, material quality, workmanship, and construction impact. Based on the review, Transportation and Storm Water staff should determine if a process should be established for ongoing analysis of Overall Condition Index, quality assurance information, and repaving history to identify what streets are underperforming and why.

Management Response: Management agrees with this recommendation. Transportation and Storm Water currently maintains Overall Condition Index (OCI) information and repair history in an existing database (Cartegraph). This data will be used to identify those streets repaved between Fiscal Year 2011 and 2015 that have an OCI rating of fair or poor condition. Based on this analysis, Transportation & Storm Water will determine if a process should be established for ongoing analysis of Overall Condition Index, quality assurance information, and repaving history to identify what streets are underperforming and why. **Target Implementation Date: July 2018**

Paz Gomez, PE, CEM, GBE
Deputy Chief Operating Officer, Infrastructure/Public Works

cc: Scott Chadwick, Chief Operating Officer
Stacey LoMedico, Assistant Chief Operating Officer
Andrea Tevlin, Independent Budget Analyst, Office of the IBA
Marshall Anderson, Director of Council Affairs, Office of the Mayor
Alejandra Gavaldon, Director of Infrastructure and Water Policy, Office of the Mayor
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