

Fort Worth



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Brian Byrd, District 3

Cary Moon, District 4

Gyna Bivens, District 5

Jungus Jordan, District 6

Dennis Shingleton, District 7

Kelly Allen Gray, District 8

Ann Zadeh, District 9

**Street Maintenance & Repairs
Audit**

July 6, 2018



**City of Fort Worth
Department of Internal Audit**

200 Texas Street
Fort Worth, Texas 76102

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The audit of Street Maintenance and Repairs was conducted as part of the Department of Internal Audit's Fiscal Year 2018 Annual Audit Plan.

Audit Objectives

The objective of this audit was to evaluate the process by which streets are identified and selected for maintenance and repairs.

Audit Scope

Our audit covered the period from October 1, 2015 through September 30, 2017.

Opportunities for Improvement

Verify that all service requests from the Information Technology Service Management (ITSM) system are interfaced to TPW systems and completed timely

Institute a documented review process for in-house project selection

Perform additional crack and joint sealing to preserve streets and prevent deterioration

Verify the accuracy of statistics reported for in-house work performed

Executive Summary

As part of the Fiscal Year 2018 Annual Audit Plan, the Department of Internal Audit has conducted an audit of the City's Street Maintenance and Repairs identification and selection process. The Department of Internal Audit concluded that the process for selecting streets for major improvements is typically contracted, and the rationale for street selection is well supported. However, the process for selecting in-house street repairs and maintenance could be enhanced.

The selection process for major street repairs and reconstruction includes defined criteria (e.g., street condition, traffic volume, etc.), multiple sources of data, and input from stakeholders. Based on our testing, streets selected for major repairs and reconstruction resulted in repairs to streets that met defined criteria. However, we identified process errors and questionable in-house repairs selections.

The selection process for in-house street repairs and maintenance tasks (e.g., crack and chip sealing) is based on Transportation and Public Works (TPW) evaluations and public input.

- Internal Audit identified 311 open status pothole service calls (out of the 3,374 service requests during the audit period) that were not completed and closed within 30 days of the service request. Seventy-four of the 311 were open for more than one year past the service request date. Based on our audit results, delays were primarily due to a software issue.
- We identified two of 26 in-house chip seal street maintenance projects where the basis for prioritizing the repair was not provided. These two projects included chip sealing a dead-end street and a paved alleyway.
- During field observations, Internal Audit noted sealant applied in streets with cracks. However, we also identified cracks in streets and street joints that were not sealed. In some instances, vegetation was growing in cracks and joints.

TPW personnel noted that the FY2017 implementation of VUEWorks software, combined with changes that were in process during the audit, address issues identified during the audit.

These findings are discussed in further detail within the [Detailed Audit Findings](#) section of this report.



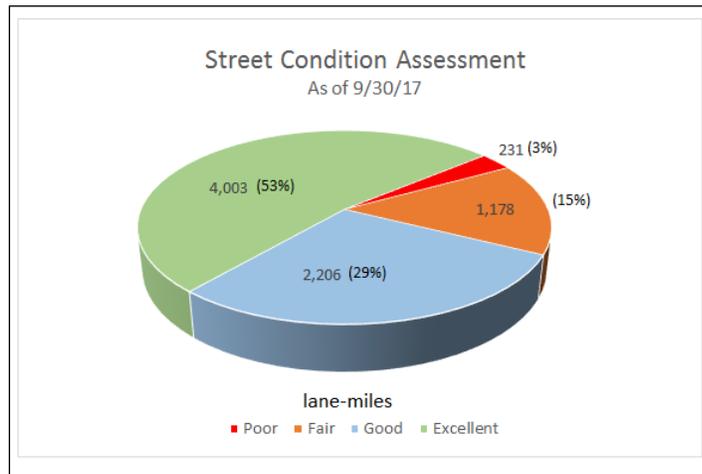
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Background

The Street Services Division of the Transportation and Public Works Department (TPW) is responsible for maintaining and assessing the condition of City of Fort Worth (CFW) streets. The Signs and Markings Division is responsible for maintaining street lane markings.

TPW maintains an inventory of streets and other infrastructure that includes a condition assessment for each street segment. Streets segments are reported in “lane-miles,” a measure that is based on the street surface area. For the CFW, the standard width of a lane is 13 feet. As noted in the following chart, TPW reported a total of 7,618 lane miles as of September 30, 2017.



Source: TPW pavement management system

Prior to FY2017, the CFW’s street condition assessment was conducted using data collected and stored in an internally developed database. Beginning in FY2017, the street condition assessment was outsourced to Data Transfer Solutions (DTS). DTS software (VUEWorks) includes street asset inventory functions, along with a work order management module for managing street service request work orders. Street condition ratings of “Very Good” and “Failed” were added concurrent with the implementation of VUEWorks software.

The selection process is not the same for major repairs as it is for minor repairs. We analyzed the CFW’s street maintenance and repair selection process by classification: 1) major repairs and reconstruction and 2) non-major repairs and street maintenance.

Major Repairs and Reconstruction

The process of identifying streets for major repairs and reconstruction requires coordination between multiple City departments, review by City leadership, and public input. Major repairs and reconstruction are typically contracted to an outside vendor.

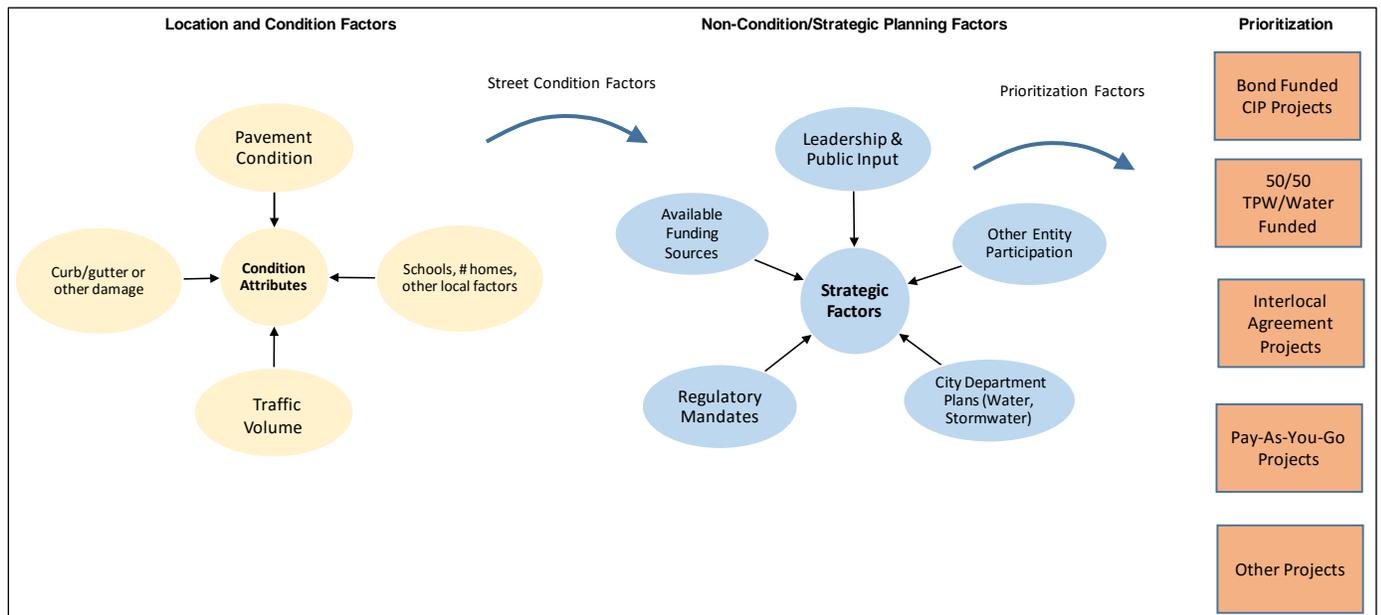
Streets are selected for major repairs based on factors that include:



- pavement condition
- traffic volume
- number of lots with homes
- curb and gutter condition
- proximity to schools
- number of failed concrete panels
- existence of sidewalks

Professional and civic judgment is required before selecting streets for major repairs/reconstruction and before including in the City’s Capital Improvement Plan. It should be noted that streets in poor condition might not be included in capital improvement plans due to limited funding availability and/or selection criteria other than pavement condition.

Street Selection Process



Source: Auditor-generated

Non-Major Repairs and Street Maintenance

The selection process for identifying projects for minor repairs and maintenance is similar to that of major repairs and reconstruction. However, minor repairs and maintenance involve a less formal public review for work performed and is more reliant on assessments made by City staff. City crews perform street maintenance and non-major repairs where deemed appropriate and as resources are available. Tasks performed by City crews include:

- crack sealing – filling cracks in streets with a hot, asphalt-based material;
- chip sealing – applying small aggregate rocks to a hot asphalt emulsion;
- milling and overlay – applying asphalt pavement to a prepared street surface after the pavement is milled by a contractor;
- pothole repairs – filling pavement defects with a hot asphalt material;
- concrete panel replacement – replacing individual concrete street panels; and,
- other tasks – examples include debris removal, striping, curb and gutter repairs, bridge, guardrail, and barricade repairs, etc.

Street cracks and joints are sealed with asphalt or silicone-based sealants to control water infiltration, and reduce pothole development. Crack sealing is reported to be a cost effective way to extend the life of



streets. Due to the amount of time required for the hot sealing material to cool and harden, sealing street cracks with hot asphalt material is typically performed during cool weather. Concrete expansion joints are typically sealed during road construction. However, the seals may deteriorate over time, allowing water infiltration or vegetation to grow in the street joints.

TPW reported that City crews performed approximately 25.2 lane-miles of chip sealing and 18.3 lane-miles of paving in FY2016, and 32.5 lane-miles of chip sealing and 19.9 lane-miles of paving in FY2017. According to TPW personnel, chip sealing is performed on non-residential streets to increase the lifespan of the street. Since the City does not have in-house milling capability, City crews perform overlay paving after streets are milled by contractors.

Citizens report potholes and other street maintenance issues through the Communications and Public Engagement Department’s call center (817-392-1234), a TPW department help line (817-392-8100, after hours), and/or the City’s internet site. Call center employees enter service requests into the Information Technology Service Management (ITSM) case management system. Based on our review of ITSM records, a majority of reported pavement-related issues referenced potholes.

Pothole cases, entered in ITSM, are assigned to field personnel for repairs using software that assigns cases to a specific geographic sector. Since pothole repair crews are directed to repair potholes identified during their workday, work performed includes significantly more potholes than the number of service requests. The table below depicts the number of pothole service request records in ITSM for the audit period.

Pothole Repair Service Request ITSM Call Records
October 2015 to September 2017

District	Council Member	FY2016	FY2017	Total
2	Carlos Flores	315	251	566
3	Brian Byrd	209	232	441
4	Cary Moon	147	172	319
5	Gyna Bivens	210	185	395
6	Jungus Jordan	134	128	262
7	Dennis Shingleton	295	218	513
8	Kelly Allen Gray	186	183	369
9	Ann Zadeh	293	266	559
-	not specified	126	85	211
Total		1,915	1,720	3,635

Note: Data within this table resulted from filtering records with a description of "Poth" or "Pot h", or with a service type code of "Pothole".

Source: ITSM

TPW’s Key Performance Indicator (KPI) of 40,000 potholes per year is based on the area repaired (in square yards) and not the count of potholes repaired. TPW personnel report that the average pothole measures 2 ft. long by 2 ft. wide (no larger than 3 ft. by 3 ft.). According to TPW personnel, the area



repaired is converted to a count of potholes for reporting. However, TPW management stated that the method used to count pothole should be based on the count of individual potholes and not the converted measure.

There are four full-time pothole repair crews, comprised of two employees each. Other crews assist when needed. The crews work in four geographic quadrants of the City, divided by Interstate 35 and Interstate 30.

TPW's four pothole-patcher trucks were acquired in 2017. Each truck includes flameless heating units to maintain the patching material at the specified temperature to provide higher quality repairs. According to TPW personnel, prior to the purchase of trucks with heating units, material from the previous day was unusable (wasted) since it was below optimum working temperature. An older pothole-patcher truck with a mechanical spray arm, reportedly prone to mechanical and electrical breakdowns, was placed in service on February 29, 2012, and taken out of service on February 22, 2018. The truck had been acquired for \$189,061.00, and had a life expectancy of 180 months/15 years, life-to-date maintenance costs of \$56,058.00, and an average cost/year of approximately \$9,343.00.

City concrete repair crews replace failed concrete panels, gutters, ramps and sidewalks. TPW reported performing 5,811 and 7,177 square yards of concrete pavement repairs in FY2016 and FY2017, respectively. City crews also repair guardrails, remove debris, repair barricades, and perform other tasks to maintain roadways.



Objectives

The objective of this audit was to evaluate the process by which streets are identified and selected for maintenance and repairs.

Scope

The scope of this audit was the period from October 1, 2015 to September 30, 2017. However, street maintenance and pothole repairs were monitored through the end of audit fieldwork to determine whether repair requests were completed.

The review of VUEWorks software was limited to service request reports, since the software was implemented near the end of the audit period.

Methodology

To achieve the audit objectives, the Department of Internal Audit performed the following:

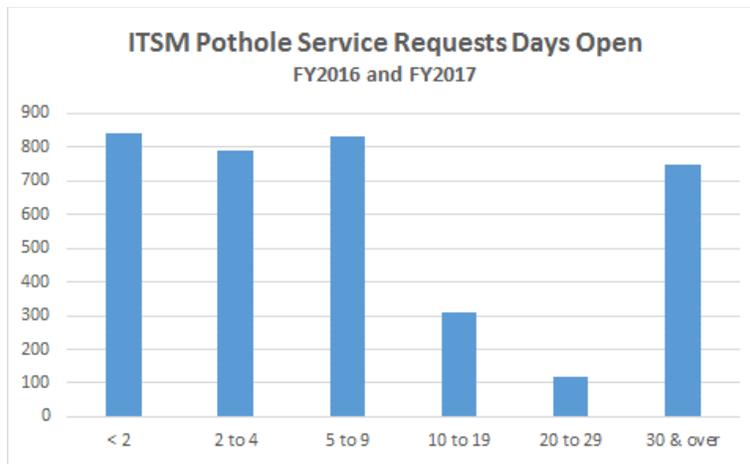
- interviewed personnel within the TPW and Information Technology Solutions (ITS) Departments;
- reviewed street condition assessment data, provided by TPW personnel, and compared the condition assessments to on-line street images and auditor observations;
- reviewed on-line images of streets prior to the repairs, to verify that repairs were justified;
- performed field observations of in-house repair projects and street conditions;
- reported potholes identified through field observation and reviewed the timing of the repairs;
- requested NetworkFleet automated vehicle location system data for street maintenance vehicles to review the routing of Street Service Division vehicles;
- reviewed ITSM call data;
- reviewed available citizen survey results;
- contacted other cities to get comparative information; and,
- evaluated internal controls related to the process by which streets are identified and selected for maintenance and repairs.

We conducted this audit in accordance with generally accepted government auditing standards. Those 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 the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Audit Results

Street condition assessments, used to select streets for repair and maintenance, were found to accurately reflect the condition of the streets tested. Major street repairs and reconstruction were supported by the condition assessment prior to the work performed. Also, based on our observations, streets selected for minor repairs and maintenance were generally supported by the street condition, with the exception of findings noted in this report.

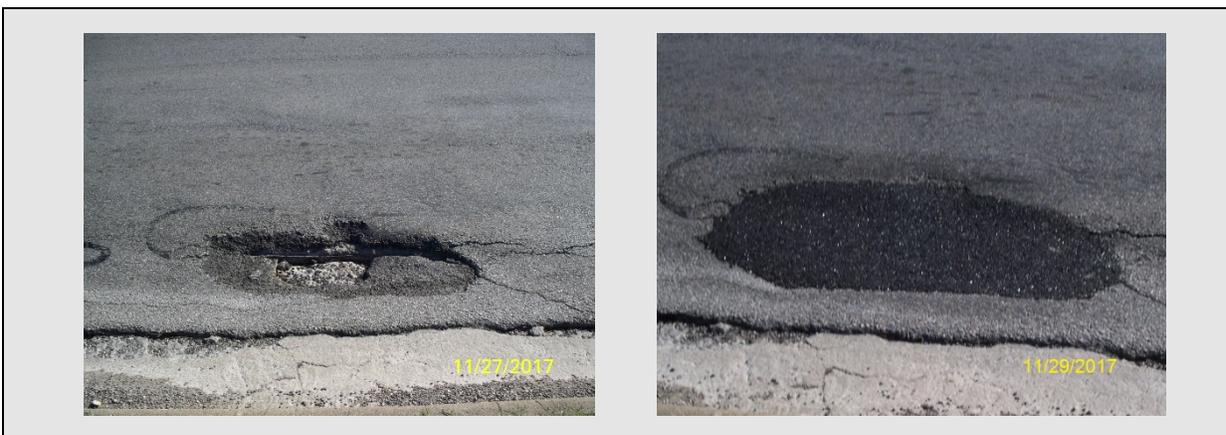
We identified 311 open and incomplete pothole service requests in the ITSM that had been open for 30 days or more as of October 21, 2017. Of the 311, there were 74 that had been open for more than one year. The open and incomplete pothole cases resulted from sector assignment changes that were not consistent with the software configuration. The graph below includes pothole service requests for the audit period, including open and closed requests. It should be noted that some service requests may have been duplicated.



Source: ITSM

The pothole in the photograph below (left), in the 3100 block of Cleburne Road, was reported on 11/27/17 and repaired on 11/29/17.

Pothole Before and After Repair



Source: Auditor-generated

To test the timeliness and assess the quality of pothole repairs, Internal Audit staff identified (through observation), reported (to the City Call Center), and tracked (through observation) the repair of six (6) potholes. Three of the six potholes were repaired between one to six working days. The other three remaining potholes were repaired beyond 14 working days.

- Two of the three potholes repaired beyond 14 working days required concrete work, and thus, required over 30 days to repair. However, interim temporary repairs were made. TPW staff noted that concrete repairs have to be scheduled in advance, since there was only one crew during the audit period. TPW staff further stated that contractors would perform this work in the future.
- The other pothole that was repaired beyond 14 working days was delayed over 20 days due to the location being recorded as North Henderson instead of South Henderson.

As stated in the Background section of this report, TPW reports the number of potholes repaired monthly as a KPI, with a target of 40,000 potholes repaired annually. Based on the four full-time crews, the number of potholes repaired per day is approximately 50 per crew, per day, without allowance for bad weather or assistance from other crews. In FY2016, TPW reported 44,317 pothole repairs compared to their KPI of 43,535 - a difference of 782.

According to TPW personnel, discrepancies result from crew leaders modifying internal reports after KPI indicators have been reported at the end of the month. In addition, some TPW work crews reported street asphalt overlay work as completed pothole repairs.

- **Chip Sealing:** We identified two streets selected for in-house chip sealing, where the prioritization of the streets for the process was not provided. One of the streets included two sections that dead-end and the other appeared to be a one-lane alleyway closed to through-traffic.

Carlock St at Washington Ave

South Henderson St

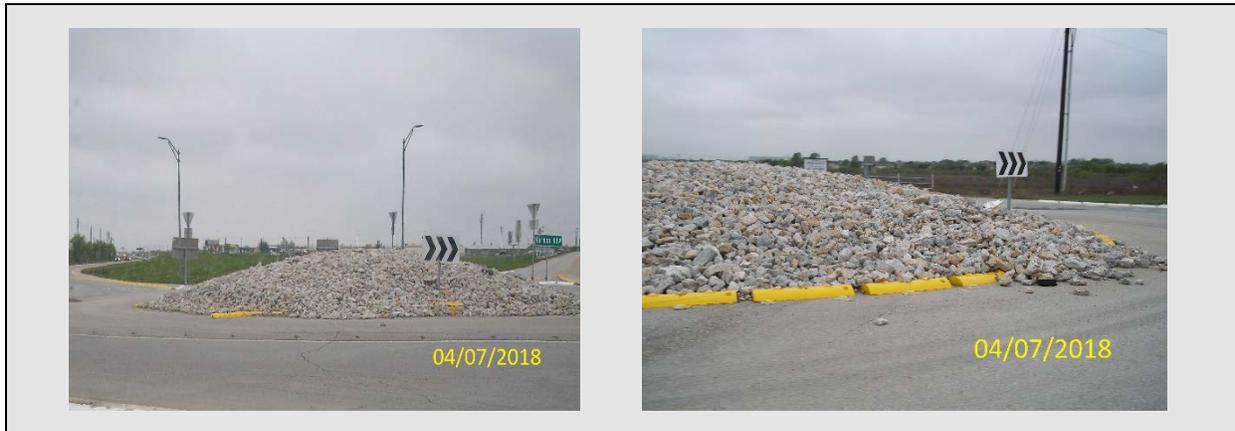


Source: Auditor-generated (Both 3/13/18)

- **Crack and Joint Sealing:** We identified streets with unsealed cracks and vegetation growing in street joints. TPW personnel indicated that street cracks are sealed after newly constructed pavement has settled. Arlington, Texas street management personnel indicated that Arlington and contractor crews crack seal approximately the same number of lane-miles as reported by Fort Worth. Published materials indicated that Arlington has approximately one-half as many lane-miles as reported by Fort Worth. Austin, Texas street management personnel reported performing approximately the same number of lane-miles of crack sealing per year, but stated that they had been requested to increase that amount.

- Roundabout Design: We found large rocks in the lanes of two roundabouts at the intersection of Harmon Road and the US-81 service road. The roundabouts include raised centers that are covered with large rocks that occasionally spill onto the roadway. Street Division personnel stated that they receive after-hours calls to remove rocks from the roadway, resulting in overtime costs. The Harmon Road intersection is the only roundabout location maintained by the City with this design, per TPW personnel, and roundabouts are scheduled to be rebuilt with a different design in two years.

Harmon Road and US-81 Service Road



Source: Auditor-generated (Both 4/7/18)

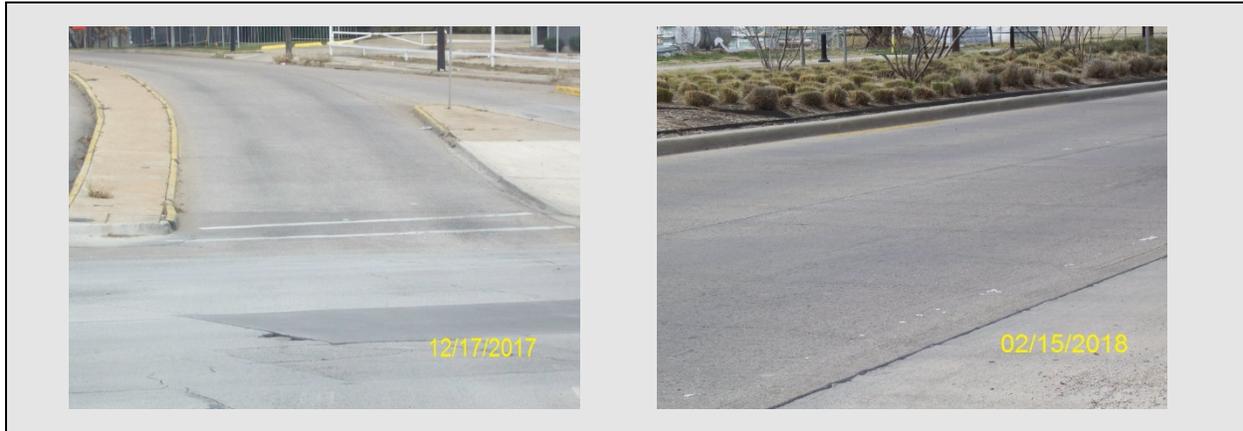
The pothole-patcher truck with a mechanical spray arm (purchased in 2012) had an expected useful life of 15 years according to the CFW's fleet services data. The truck required only one employee to operate and was expected to provide for more efficient and effective repairs. However, it was taken out of service in 2018 due to high maintenance costs and frequent breakdowns. The truck is reportedly being prepared for auction. TPW personnel stated that it will be replaced with a new pothole-patcher truck with a built in heating unit. The CFW uses four pothole repair trucks, one for each quadrant of the City. The four remaining pothole repair trucks have lower operating costs.

As a part of the audit, we attempted to utilize NetworkFleet Automatic Vehicle Location (AVL) system data to identify the location of street maintenance repair crews. However, only two of those vehicles was active in the AVL system. Based on our results, the Street Services Division was charged a total of \$285.00 each month for AVL services placed on all 17 street vehicles. Since the Street Services Division reportedly received the 17 vehicles from another division, the AVL service was terminated, but the charges were not. TPW personnel stated they have plans to add AVL monitoring to Street Services Division vehicles.

During audit fieldwork, through physical and visual observations, Internal Audit staff identified streets with either missing raised lane markers, or painted lane stripes that had deteriorated and were no longer visible. While Internal Audit acknowledges all streets will not be in excellent condition, faded or no lane markings pose a risk to Fort Worth drivers. Internal Audit also acknowledges that observed lane marking conditions could be attributed to a myriad of factors including, but not limited to, traffic volume, weather, inferior lane-marking materials, staff non-performance and/or lack of funding. TPW management indicated funding for the CFW's pavement management program (which includes re-marking of lane lines, crosswalks, etc.) is funded on a multi-year cycle and has grown in excess of two million per year. The following images are examples of streets where Internal Audit staff noted lane markings that were no longer visible.

Northside Dr at Jacksboro Hwy

Rosedale St



Source: Auditor-generated



Overall Evaluation

High	Medium	Low
<u>Potholes not repaired timely</u>		
<u>In-house repairs had questionable prioritization</u>		
<u>Insufficient crack seal and failed joint sealing</u>		



Detailed Audit Findings

1. The process for tracking pothole service requests resulted in delayed repairs.

TPW requires that potholes with the potential for vehicle damage (classified as Priority 1) be investigated within 24 hours. All other requests are to be investigated within 48 hours. While TPW standards address timeliness in which potholes should be investigated, there are no standards for the timely completion of pothole repairs.

As of October 2017, there were 311 active status pothole service requests in the ITSM system that were not completed 30 days after the service request. Seventy-four of the 311 service requests were not closed within one year of the request. After notification by Internal Audit, these service requests were assigned to TPW staff. TPW was not aware of the outstanding service requests because they did not see them when looking in TPW's assigned ITSM dashboards for the maintenance districts.

Upon inquiry with ITS personnel, ITS determined that the ITSM system had been programmed using Police Department beats as the reference points for routing calls to the correct maintenance district. However, not all beats had an assigned maintenance district in the system, and thus, these service requests were not assigned to the four TPW maintenance districts. In other words, there was a mismatch with the police beat table in ITSM and the maintenance districts.

With the number of pothole service requests not going to the respective TPW Street Division maintenance districts, the CFW was not responding to the requests and was, therefore, giving the appearance (to citizens that reported the issue) that the City was not being responsive. Moreover, potholes were not repaired, resulting in an increased workload when the TPW Superintendent ordered a Pothole Roundup starting November 15, 2017.

Recommendation 1A: *The Transportation and Public Works Director, in conjunction with the Chief Technology Officer, should develop a work plan to:*

- *periodically review operational changes in coordination with ITS programmer(s) to modify systems when required; and,*
- *implement a verification process to ensure that citizen calls captured in ITSM are correctly interfaced into VUEWorks and completed.*

Auditee Response: Concur. The first bullet has been addressed through linking with the Street Quadrant Sector maps versus the previous process, which was tied to the Police Beats. This caused requests from certain areas of the districts from being dispersed to the quadrant sector map. The integration with VUEWorks and the current ITSM Customer Service Modules has been completed. The remaining integration will take place by January 2019 to the new Customer Relationship Management System (CRM). The ITS Department will be responsible for transitioning VUEWorks from ITSM to CRM.

Target Date: February 2019

Responsibility: Transportation and Public Works, Business Process Analyst (Completed) & Information Technology Solutions, Senior IT Solutions Manager



Recommendation 1B: *The Transportation and Public Works Director should designate a person in Street Services to review open service requests on a periodic basis and ensure that all service requests for streets entered into ITSM are reflected in the new street asset management system (VUEWorks).*

Auditee Response: Concur. All Supervisors have been trained in the VUEWorks modules to review each customer service request and ensure the requests are properly dispatched to the crew leaders on a daily basis. In addition, TPW submitted a reclassification request to HR for a vacant position to a Customer Solutions Analyst, which was approved 6/5/18. Once filled, this person will coordinate all requests, responses, and reports division-wide.

Target Date: Completed

Responsibility: Transportation and Public Works, Customer Solutions Analyst

Recommendation 1C: *The Transportation and Public Works Director should develop standards for the timely completion of pothole requests. An aging report, which lists unresolved requests along with the date of the service request, should be developed for identifying problems with timely completion of requests.*

Auditee Response: Concur. The Streets & Stormwater Operations Division is currently working on a streamlined report from the newly implemented VUEWorks module to identify timelines related to SLAs [service level agreements] and number of potholes repaired in real time.

Target Date: June 2018

Responsibility: Transportation and Public Works, Chief Operating Officer

2. The prioritization of some projects selected for in-house street repairs is questionable.

We identified two street segments (out of the 26 projects selected for in-house chip sealing in FY2017) that did not appear to be selected based on a needs prioritization.

- One of the streets included two dead-end sections with no through-traffic, no curb/gutter, and no sidewalks.
- The other street was a paved alley.

In addition, the number of lane-miles reported as completed for the two streets was higher (0.5 miles) than the actual lane-miles completed (0.1 miles).

TPW personnel did not provide information about why the specific street sections were selected for chip sealing. Based on prior discussions, non-major street projects do not undergo the same level of analysis and review as major projects. Maintaining and repairing streets with little to no traffic volume results in City resources being expended in areas with lower need and higher priority repairs not being addressed. Also, the number of lane-miles of chip sealing performed by in-house work crews is overstated.

Recommendation 2A: *The Transportation and Public Works Director should develop a process that includes documenting the prioritization rationale for in-house street maintenance projects.*

Auditee Response: Concur. The implementation of VUEWorks Asset Management Module will assist in improving the selection process based on decision trees that have been developed, which utilized the



following factors: multi-modal, population density, street classifications, number of work orders, and condition assessment. The decision trees for the types of applications based on rehabilitation and pavement preservation have already been established and are non-subjective factors; however, the Pavement Management module of VUEWorks is still in the development process by the Software Developer and is pending an update in mid-July. Training and reconfigurations will continue until October 2018, which is the estimated “Go-Live” date.

Target Date: December 2018

Responsibility: Transportation and Public Works, Business Process Manager

Recommendation 2B: *The Transportation and Public Works Director should takes steps to ensure that number of lane-miles reported for street maintenance tasks is accurate.*

Auditee Response: Concur. The small percentage of the data in the system will need to be updated as we move through our maintenance program. To prevent discrepancies, we have implemented a Project Authorization Form to address the QA/QC [Quality Assurance/Quality Control] for each maintenance project and ensure the measurements and quantities are correct. Please see attached form. ([Exhibit I](#))

Target Date: Completed

Responsibility: Transportation and Public Works, Chief Operating Officer

3. The crack and joint seal process does not provide sufficient coverage for street preservation.

Crack and joint sealing are standard street maintenance practices used to prevent deterioration and extend the lifespan of streets. The City’s current process for identifying streets for sealant application focuses on recently completed streets after post construction settlement. TPW staff manually seal the cracks by applying a hot tar-based product.

Internal Audit staff drove throughout the City, to observe Fort Worth street conditions. During these observations, we identified multiple streets with unsealed cracks, and streets with vegetation growing in expansion joints. The following images show vegetation growing in an expansion joint and an example of an unsealed crack. Other cracks observed were not sealed, or the sealant did not fill the crack reservoirs completely.

Berry St East of Hemphill St

Bellaire Drive South



Source: Auditor-generated

Unsealed cracks and joints allow water to penetrate the sub-base structure and lead to further deterioration of the surface. Furthermore, the effectiveness of our pavement preservation program is diminished and may lead to higher repair costs.

Recommendation 3: *The Transportation and Public Works Director should consider the application of additional lane-miles of crack and joint sealing and consider contracting work if warranted.*

Auditee Response: Concur. On average, TPW completes 200 Lane Miles of crack sealing annually with in-house forces at an average cost of \$1,300.00/Lane Mile. In order to increase the output of lane miles, additional funding would need to be allocated beyond the current Operating and PayGo funding. For example, in order to double the lane miles for crack sealing with in-house forces, the cost would equate to an additional \$260,000.00 beyond the current budget allocation. In addition, TPW currently contracts out joint sealing for concrete streets. In FY2018, twelve lane miles will be completed at a cost of \$510,000.00. To increase contractual lane miles in FY2019, taking into account inflation, TPW would need an additional \$522,000.00.

Target Date: To be evaluated during each Budget Process

Responsibility: Transportation and Public Works, Chief Operating Officer



Acknowledgements

The Department of Internal Audit would like to thank the Transportation & Public Works and Information Technology Solutions Departments for their cooperation and assistance during this audit.



Exhibit I – Project Approval & Authorization Form

TRANSPORTATION & PUBLIC WORKS STREET OPERATIONS PROJECT APPROVAL & AUTHORIZATION

Requestor _____ Title _____
Street Name _____ Street Limits _____

Asset ID #(s) _____ Work Order # _____ Est. # of Lane Miles _____

Planned Projects 2 Years Out: Yes No

Scope of Work: Crack Seal Chip Seal Fog Seal Mill & Overlay Pulverized Overlay
 HIR Joint Seal Concrete Restoration Microsurfacing

I, _____ Agree Do Not Agree with the scope of work Verified Lane Miles
Supervisor Name/Project Manager

Comments: _____

Superintendent/Engineering Manager Authorization of Work _____ Date _____

Superintendent Inspection of Completed Work Checklist:

Speed Humps	<input type="checkbox"/> Yes	<input type="checkbox"/> No
# Removed	_____	
Pavement Markings Needed	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Concrete Collars Adj.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Existing ADA Ramps	<input type="checkbox"/> Yes	<input type="checkbox"/> No
ADA Work Required	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Flat Work Required	<input type="checkbox"/> Yes	<input type="checkbox"/> No

I have reviewed the completed scope of work and certify that it meets infrastructure standards.

Superintendent Approval of Work Completed

Project Completion Date

Upon project completion, submit form to Asset Management Business Analyst to log infrastructure improvements in system