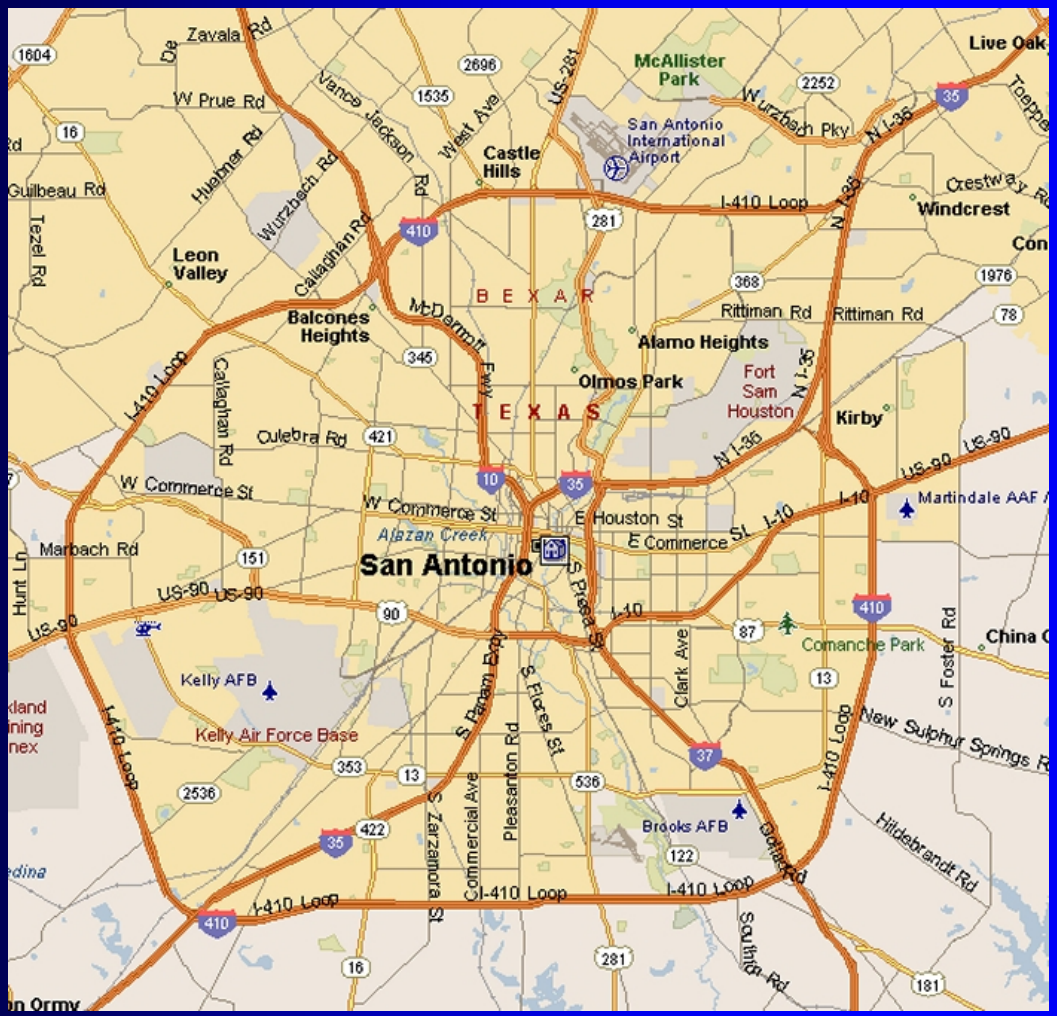
Program Compliance Division

“Asphalt Modifiers Selection ”

Presented by :

Dean Bayer, Public Works Project Manager

Mileage of San Antonio Roadways



TXDOT

1,050 Lane Miles of Freeways

City of San Antonio

1,603 Lane Miles Arterials

744 Lane Miles of Collector Streets

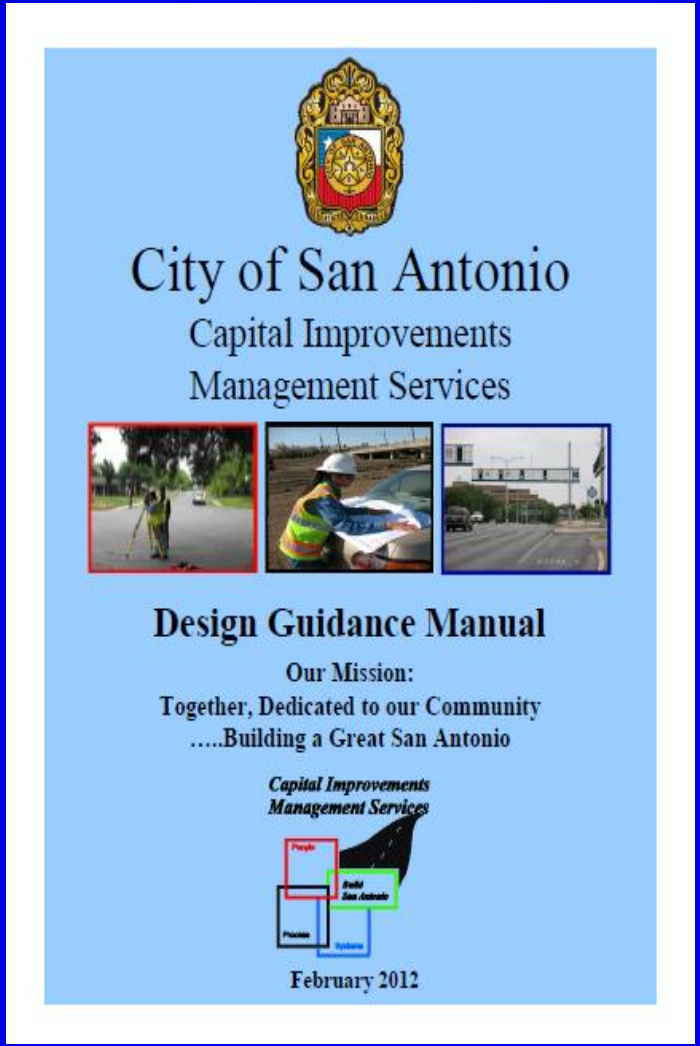
9,369 Lane Miles of Local Streets

Total Lane Miles – 12,015

Street Maintenance Budget

- Average Annual – $60,000,000

COSA Design Guidance Manual



Appendix 10-A ~ City of San Antonio Pavement Design Standards

Introduction

Article 5 Section 35-506 Subsection (p) of the Unified Development Code (UDC) (dated January 1, 2006) titled "Pavement Standards" provides guidance on the design of pavements and also includes recommended curb and gutter as well as median and divider details. The pavement design standards included herein are to be used to supplement the pavement design standards found in the UDC and are based upon newer technologies and design methods currently being utilized in the industry.

Pavement Type

Allowable pavement structures for City maintained roadways include both flexible and rigid structures, as defined by the *American Association of State Highway and Transportation Officials (AASHTO)*. Perpetual pavements (see Figure 1), which are considered to be long-life structures using premium hot-mixed asphalt (HMA) mixtures which require periodic maintenance to renew the surface, are also acceptable pavement structures. Pavement type selection shall be based upon the project conditions, economics, and long-term performance or as directed by the City. If necessary, life-cycle

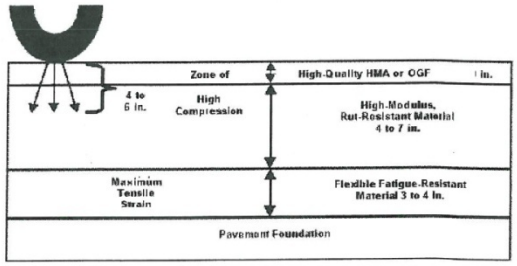


Figure A-1 Perpetual Pavement Design – Typical Cross Section.

cost analysis (LCCA) shall be conducted for pavement type selection.

Pavement Design Methodologies

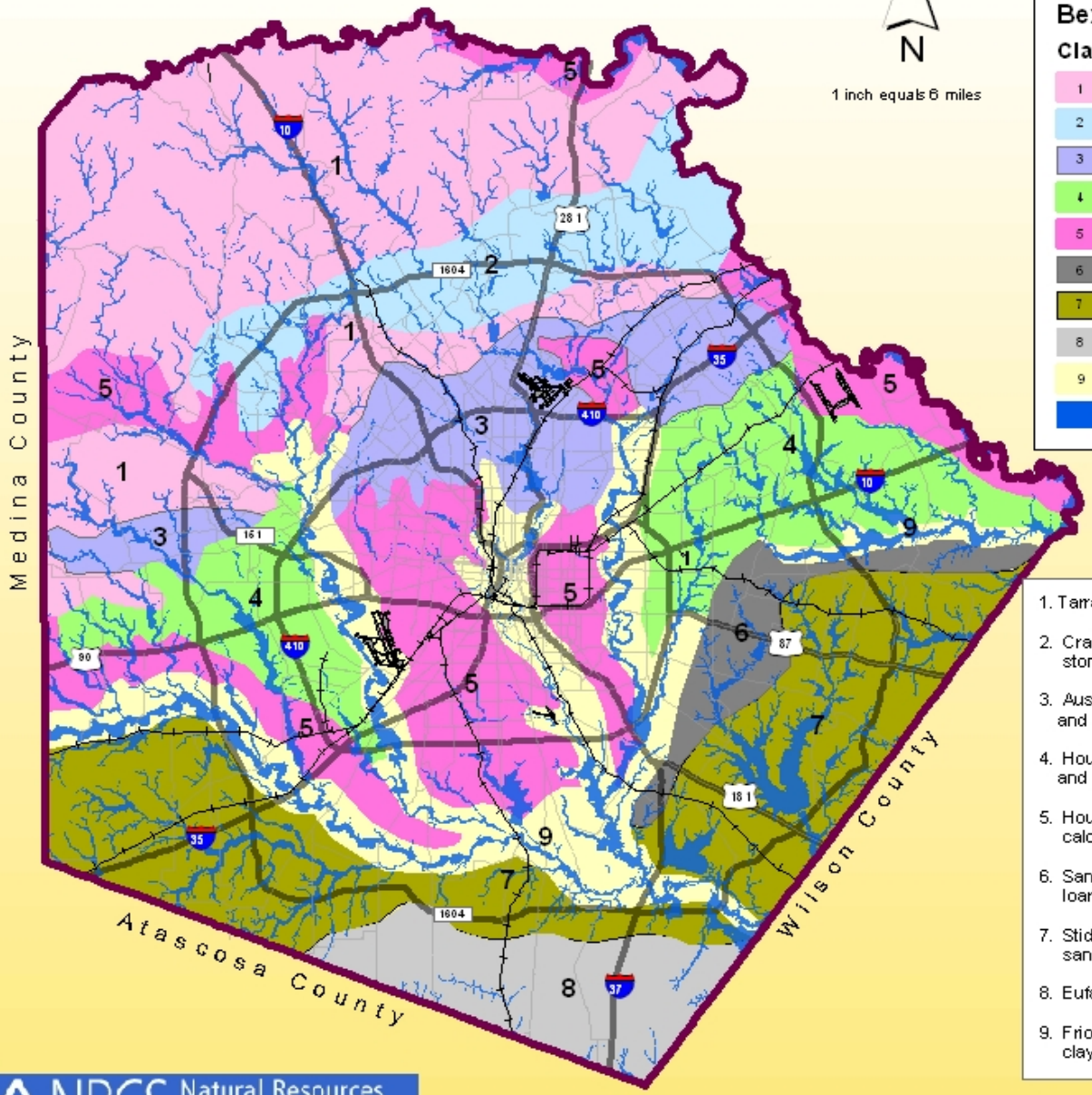
The design of both flexible and rigid pavement structures shall be in accordance with the *AASHTO Guide for Design of Pavement Structures*, 1993 or latest approved edition. Flexible pavement design may also be conducted using the Texas Department of Transportation (TxDOT) program entitled *Flexible Pavement System 19 for Windows (FPS19w)*.

Perpetual pavement design may be conducted as described in the *TxDOT Pavement Design Manual* (October 2006 edition, Chapter 5 Section 5 or latest edition). Other

Why Flexible in San Antonio?

- Local Availability of Material
- Utilities under the streets
  - Normal Maintenance
  - Emergency Repairs

Bexar County Soil Association Map



Legend

Bexar Soils Association

Class

1. Tarrant-Brackett Assoc. 374.3 Sq. Mi.
2. Crawford-Bexar Assoc. 74.8 Sq. Mi.
3. Austin-Eddy Assoc. 99.6 Sq. Mi.
4. Houston Black-Houston Assoc. 125.7 Sq. Mi.
5. Houston Black, Terrace-Knippa-Lewisville Assoc. 134.0 Sq. Mi.
6. San Antonio -Miguel Assoc. 29.6 Sq. Mi.
7. Stidham-Webb-Miguel Assoc. 249.4 Sq. Mi.
8. Eufaula Assoc. 99.8 Sq. Mi.
9. Frio-Trinity Assoc. 59.9 Sq. Mi.

F.E.M.A. 100-year Floodplain

1. Tarrant-Brackett Association: Very shallowsoils over limestone.
2. Crawford-Bexar Association: Moderately deep to shallow stony clays and cherty clay loams over limestone.
3. Austin-Eddy Association: Moderately deep crumbly silty clays and very shallow clay loams over limestone.
4. Houston Black-Houston Association: Deep calcareous clays and gravelly clays.
5. Houston Black, Terrace-Knippa-Lewisville Association: Deep calcareous clays and clay loams over old alluvium.
6. San Antonio-Miguel Association: Clay loams and fine sandy loams with dense clay subsoils.
7. Stidham-Webb-Miguel Association: Loamy fine sand and fine sandy loams with clayey sbusoils.
8. Eufaula Association: Deep fine sands with loamy subsoils.
9. Frio-Trinity Association: Deep calcareous silty clay loams, silty clays, clay loams, and clays over alluvial sediments.

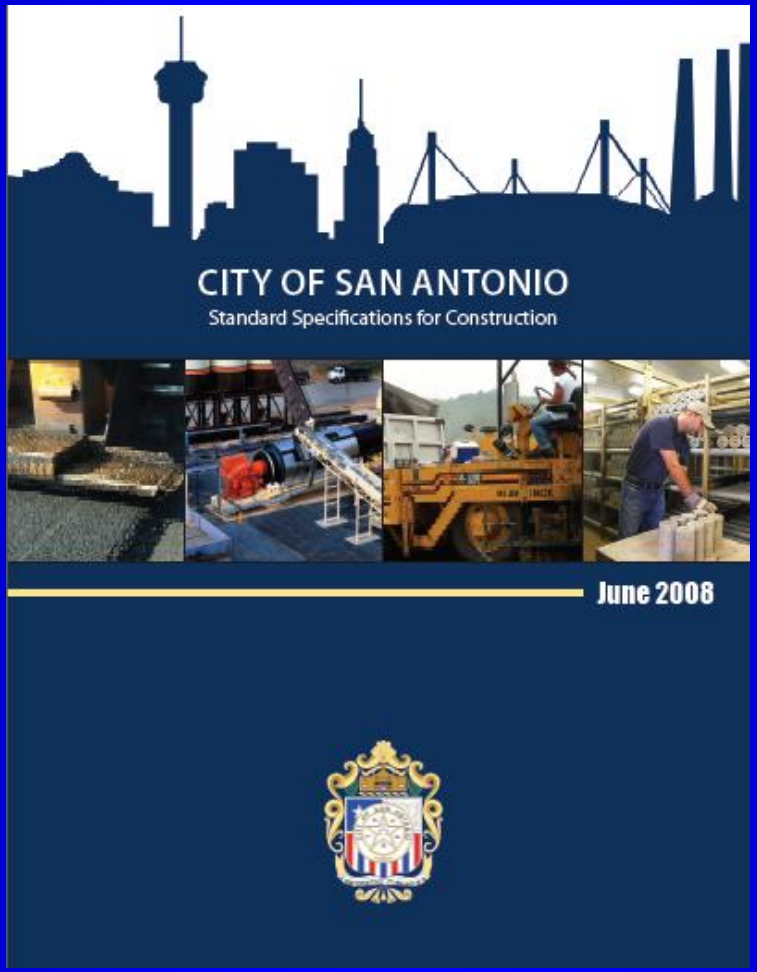
Bexar County total area: approx. 1257 Square Miles

NRCS Natural Resources Conservation Service

Soil Characteristics

- Large Variation
- Many Soils are highly Expansive
- High Potential Vertical Rise
- I-37 just South of Downtown TxDOT recently raised 3 bridges.

COSA Standard Specifications for Construction



ITEM

205

HOT MIX ASPHALTIC CONCRETE PAVEMENT

205.1. DESCRIPTION: *Construct a leveling-up course, a surface course or any combination of these courses as shown on the plans, each to be composed of a compacted mixture of mineral aggregate and asphaltic material. The pavement shall be constructed on the existing pavement, bituminous surface or in the case of bridges, on the prepared floor slab, as herein specified and in accordance with the details shown on the plans.*

205.2. MATERIALS: Materials used in Hot Mix Asphaltic Concrete Pavement shall meet the requirements as set forth herein. If shown on the plans, materials may also meet the requirements as described in Item 340, "Dense-Graded Hot-Mix Asphalt (Method)" or Item 341, "Dense-Graded Hot-Mix Asphalt (QC/QA)" of the 2004 Texas Department of Transportation Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges.

Unless otherwise shown on the plans, provide aggregates that meet the aggregate quality requirements of TxDOT's Bituminous Rated Source Quality Catalog (BRSQC). Unapproved sources may be used if accepted by the Engineer and approved prior to use.

Furnish aggregates from sources that conform to the requirements shown in Table 1 herein, and as specified in this Section, unless otherwise shown on the plans. Provide aggregate stockpiles that meet the definition in this Section for either a coarse aggregate or fine aggregate. When reclaimed asphalt pavement (RAP) is used, provide RAP stockpiles in accordance with this Section. Aggregate from RAP is not required to meet Table 1 requirements unless otherwise shown on the plans.

Document all test results on a mixture design report and submit to the Engineer for approval. The Engineer may perform tests on independent or split samples to verify Contractor mix design results. Stockpile aggregates for each source and type separately. Determine aggregate gradations for mixture design and production testing based on the washed sieve analysis given in TxDOT standard laboratory test procedure Tex-200-F, Part II. Do not add material to an approved stockpile from other sources, unless otherwise approved by the Engineer.

Unless otherwise shown on the plans, reclaimed asphalt pavement (RAP) may be used in asphalt pavement maintenance or rehabilitation applications and shall be limited to a maximum of 20% RAP for surface or wearing courses and 30% RAP for courses below the surface or wearing course. Higher percentages of RAP may be used if requested in writing and approved by the Engineer prior to use.

A. Coarse Aggregate. Coarse aggregate stockpiles must have no more than 20% passing the #8 sieve. Provide aggregates with a surface aggregate classification (SAC) as shown below:

Street Classification	Minimum Surface Aggregate Classification
Primary and Secondary Arterials	A
Collector and Local Type B Streets	B
Local Type A Street With Bus Traffic	B
Local Type A Street Without Bus Traffic	C

SAC requirements apply only to aggregates used on the surface of travel lanes, unless otherwise shown on the plans. Blending aggregates to meet SAC criteria is allowable. Class B aggregate meeting all other requirements in Table 1 may be blended with a Class A aggregate in order to meet requirements for Class A materials. When blending Class A and B aggregates to meet a Class A requirement, ensure that at least 50% by weight of the material retained on the No. 4 sieve comes from the Class A aggregate source. Blend by volume if the bulk specific gravities of the Class A and B aggregates differ by more than 0.300. When blending, do not use Class C or D aggregates. For blending purposes, coarse aggregate from RAP will be considered as Class B aggregate.

B. **Reclaimed Asphalt Pavement (RAP).** RAP is defined as a salvaged, pulverized, broken or crushed asphalt pavement. The RAP to be used in the mix shall be crushed or broken to the extent that 100% will pass the two inch sieve.

The stockpiled RAP shall not be contaminated by dirt or other objectionable materials. Unless otherwise shown on the plans, stockpiled, crushed RAP shall have a decantation of 5% or less and a plasticity index of eight (8) or less, when tested in accordance with TxDOT standard laboratory test procedures Tex-406-A, Part I, and Tex-106-E, respectively. This requirement applies to stockpiles from which the asphalt has not been removed by extraction. When RAP is used, determine asphalt content and gradation for mixture design purposes.

C. **Fine Aggregate.** Fine aggregates may consist of manufactured sands, screenings and field sands. Supply fine aggregates that are free from organic impurities. Field sands and other uncrushed aggregates shall be limited to 15% of the total aggregate.

If 10% or more of the fine aggregate stockpile is retained on the No. 4 [4.75 mm] sieve, test the stockpile and verify that it meets the requirements in Table 1 for coarse aggregate angularity (TxDOT standard laboratory test procedure Tex-460-A) and flat and elongated particles (TxDOT standard laboratory test procedure Tex-280-F).

D. **Asphalt Binder.** Unless shown on the plans, provide the type and grade of performance-graded asphalt binder in accordance with TxDOT Item 300.2.J. "Performance-Graded Binders" and as specified below:

Street Classification	Minimum PG Asphalt Cement Grade		
	Surface Courses	Binder & Level Up Courses	Base Courses
Primary and Secondary Arterials	PG 76-22	PG 70-22	PG 64-22
Collector and Local Type B Streets	PG 70-22		
Local Type A Street With Bus Traffic		PG 64-22	
Local Type A Street Without Bus Traffic	PG 64-22		

E. **Mineral Filler.** Mineral filler consists of finely divided mineral matter such as agricultural lime, crusher fines, hydrated lime, cement, or fly ash. Mineral filler is allowed unless otherwise shown on the plans. Do not use more than 2% hydrated lime or cement, unless otherwise shown on the plans. The plans may require or disallow specific mineral fillers. When used, provide mineral filler that:

- is sufficiently dry, free-flowing, and free from clumps and foreign matter;

- does not exceed 3% linear shrinkage when tested in accordance with Tex-107-E; and
- meets the gradation requirements of Table 3 herein.

F. Baghouse Fines. Fines collected by the baghouse or other dust collecting equipment may be reintroduced into the mixing drum.

G. Tack Coat. Unless otherwise shown on the plans or approved, furnish CSS-1H, SS-1H, or a PG binder with a minimum high-temperature grade of PG 58 for tack coat binder in accordance with Item 203, "Tack Coat." Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.

H. Additives. When shown on the plans, use the type and rate of additive specified. Other additives that facilitate mixing or improve the quality of the mixture may be allowed when approved. If lime or a liquid antistripping agent is used, add in accordance with TxDOT Item 301, "Asphalt Antistripping Agents." Do not add lime directly into the mixing drum of any plant where lime is removed through the exhaust stream, unless the plant has a baghouse or dust collection system that reintroduces the lime back into the drum.

Table 1
Aggregate Quality Requirements

Property	TxDOT Standard Laboratory Test Procedure	Surface Courses	Binder, Level Up, & Base Courses
Coarse Aggregate			
Deleterious Material, %, max	Tex-217-F, Part I	1.0	1.5
Decantation, %, max	Tex-217-F, Part II	1.5	1.5
Micro-Deval Abrasion, %, max	Tex-461-A	Screening Only	Screening Only
Los Angeles Abrasion, %, max	Tex-410-A	35	40
Magnesium Sulfate Soundness, 5 cycles, %, max	Tex-411-A	25	30
Coarse Aggregate Angularity, 2 crushed faces, %, min	Tex-460-A, Part I	95[1]	85[1]
Flat and Elongated Particles @ 5:1, %, max	Tex-280-F	10	10
Fine Aggregate			
Linear Shrinkage, %, max	Tex-107-E	3	3
Combined Aggregate[2]			
Sand Equivalent, %, min	Tex-203-F	45	45

Note 1: Applies to Gravel Only
Note 2: Aggregate without mineral filler, RAP, or additives combined as used in the job-mixed formula (JMF)

Table 2
Gradation Requirements for Fine Aggregates

Sieve Size, in [mm]	% Passing by Weight or Volume
3/8 [9.5 mm]	100
#8 [2.36 mm]	70 – 100
#200 [75 µm]	0 – 30

Table 3
Gradation Requirements for Mineral Filler

Sieve Size, in [mm]	% Passing by Weight or Volume
#8 [2.36 mm]	100
#200 [75 µm]	55 – 100

Asphalt Modifiers

- Asphalt Modifiers that assist in Flexibility are beneficial and desirable.
  - Polymer Modifiers
  - Rubber Modifiers

Rubber-Modified Asphalt Pilot Program

Pavement Preservation within the Street Maintenance Program

Public Works Department, Streets Division
City of San Antonio

The City of San Antonio Streets Division in the Public Works Department is developing and implementing a rubber-modified asphalt pilot program. Rubber-modified asphalt has proven to provide a variety of benefits when incorporated into street maintenance. However, there are many variables that can determine the success of a rubber-modified asphalt program. Results of rubber-modified pavement applications may vary depending on the type of application used (sealant, overlay or reconstruction), the various available mixes, the current condition of the road receiving the application as well as the region of the country (various soils and weather patterns). Determining the best application suited to the current conditions and good construction practices may improve results significantly.

The most appropriate manner in which to currently test the success of rubber-modified asphalt applications in San Antonio, is to implement pilot program as part of an increased pavement preservation approach with the City's current street maintenance plan.

Street Maintenance Program

The Streets Division maintains approximately 4,018 Centerline Miles (CLM) of streets classified as principal, minor, collector or local across ten Council Districts. The maintenance of these streets is identified, scheduled and delivered as part of the City's Five (5) Year Infrastructure Management Program (IMP). The vast majority of the City's streets consist of an asphalt (flexible) pavement material with the remainder consisting primarily of the brick paver streets in the downtown area.

Currently, the Streets Division performs two primary types of maintenance applications: non-structural pavement preservation (sealants such as slurry seal, crack seal, fog seal, and scrub seal) and structural rehabilitation (such as asphalt overlay, hot paver-laid microsurface, reconstruction, asphalt recycling and overlay and full depth reclamation).

The Street Maintenance Program is managed through a Pavement Management System (PMS). The current PMS is a database of all streets that have been surveyed through visual inspection. The street condition is assessed based on the presence or absence of pavement distresses, ride quality and assigned a score between 0 (failed) to 100 (excellent). The condition assessment data is then manually entered into a Pavement Information Management System (PIMS) to generate a Pavement Condition Rating (PCR) of excellent, very good, good, fair, poor, very poor or failed. Currently, 89% of the San Antonio street network is rated as good, very good, or excellent and the average PCR is 81.33. The appropriate maintenance application is then determined according to the PCR. However, it has been found that variations in the assessments can be reached by multiple raters and raters

1

are unable to identify or interpret certain underlying pavement conditions that are not readily visible.

To achieve a more comprehensive and consistent evaluation process, staff has initiated the implementation of an improved PMS that is driven by data collected through an automated pavement condition survey. An automated pavement condition survey captures street distresses and the ride quality through laser scanning. It also enables staff to capture video for review and inclusion in a video pavement condition library. These evaluations will help ensure that proper applications are consistently applied for the appropriate pavement conditions. The primary benefit of the improved survey system is the refined manner in which maintenance applications are selected and applied across the network, thereby optimizing pavement expenditures.

Pavement Preservation

Currently, the City's pavement management program is designed to address the streets with major structural defects. The current program consists of a combination of 90% pavement rehabilitation (e.g., overlay or reconstruction) and 10% pavement preservation (e.g., sealants). This is not considered to be an optimal combination to sustain the good to excellent pavement conditions within the City's street network.

In order to increase the pavement life of streets currently in good to excellent condition, the pavement management program is shifting resources and expanding the application of sealants as a means of pavement preservation. This new pavement preservation approach will consist of a combination of 50% rehabilitation and 50% preservation. In order to expand the program's pavement preservation capabilities, existing City crews will be redirected from the overlay program to a sealant program adding approximately 156 CLMs of streets to the overall Street Maintenance Program. Preventative maintenance applied to an increased number of the City's streets will serve to enhance existing pavement and increase the ability of the City to apply structural applications to the other 9% of streets currently rated below good (fair, poor, very poor or failed) and which require more in-depth rehabilitation work.

A significant piece of the new pavement preservation program is the introduction of rubber-modified asphalt in the pavement preservation applications such as sealants and structural applications such as overlays and rehabilitations.

Rubber-Modified Asphalt

Rubber-modified asphalt has been used nationwide since the early 1970s. Generally, rubber-modified asphalt is pavement material that consists of regular asphalt concrete/cement mixed with crumb rubber material (ground, used tires that would otherwise be placed in landfills) and other additives. The rubber component is a percentage by weight of the asphalt binder and generally reacts in the hot asphalt cement to cause swelling of the rubber particles. The swelling in the particles provides for additional elasticity.

According to research results provided by various institutions, industry expert organizations and public entities, rubber-modified asphalt has generally proven to increase pavement life,

reduce maintenance costs, improve skid resistance, decrease noise levels and contribute to the reuse of tires.

- A rubber-modified asphalt application generally resists the formation of cracks better than conventional asphalt applications. Not only does rubber-modified asphalt exhibit more elasticity than unmodified asphalt, but it also shows a greater resistance to aging. This anti-aging effect is the result of anti-oxidants contained in the scrap tires, which are processed into the crumb rubber modifier used in rubber-modified asphalt.

- Because of the resistance to cracking and aging exhibited by the rubber-modified asphalt, roads paved with rubber-modified asphalt applications generally experience longer service lives before maintenance is required.

- Rubber-modified asphalt has the possibility to improve the safety of roads. Applications made from rubberized asphalt exhibit greater skid resistance than those made from conventional asphalt.

- Rubber-modified asphalt has the benefit of being smoother, quieter and generally reduces tire noise by an average of four decibels.

- Depending on the specific application, between 500 and 2,000 scrap tires may be used in each lane mile of pavement. This means that for a one-mile section of a four-lane highway, anywhere between 2,000 and 8,000 tires can be used in creating a safer, quieter, longer-lasting road.

Some of the more common potential drawbacks are the higher initial cost, availability of supply contractors and a contractor's comfort level delivering the final pavement application. Higher initial costs should be expected to implement a rubber-modified asphalt program in San Antonio. However, pavement life is anticipated to be longer, thus decreasing the future maintenance cost. Another concern and difficulty may be the contractor ability and comfort factor within our region.

2010-2011 Rubber-modified Asphalt Pilot Program

A rubber-modified asphalt pilot program will be implemented over a two year period (2010 & 2011) through the Street Maintenance Plan (SMP) as part of the City's 5 Year IMP. The rubber-modified asphalt applications will be concentrated on streets classified as principals (arterials) and delivered in the form of three applications: sealant, asphalt overlay and hot paver laid micro surface. During this 2 year period, staff will work toward scheduling a total of 53.48 center line miles of arterials or 1.3% of the City's street network to receive one of the three rubber-modified asphalt pavement applications.

SPECIAL PROVISION TO ITEM 205
GROUND RECYCLED TIRE RUBBER MODIFIED ASPHALT BINDER

Revised: September 24, 2010

Description. This work shall consist of constructing Hot Mix Asphalt (HMAC) mixtures containing Ground Recycled Tire Rubber (GTR) modified asphalt binder. Work shall be according to City of San Antonio (COSA) Standard Specifications, except as modified herein.

Materials. Binder materials shall be according to COSA Standard Specifications, except as modified herein.

(A) Bituminous Material. The base asphalt binder shall be performance-graded (PG) binder meeting or exceeding PG 64-22.

(B) Ground Recycled Tire Rubber. The GTR shall be produced from processing automobile and/or light truck tires by the ambient grinding method. Heavy equipment tires, uncured or de-vulcanized rubber will not be permitted. The GTR shall not exceed 2 mm (1/16 in.) in any dimension and shall contain no free metal particles or other foreign contaminating materials. Detection of free metal particles shall be determined by thoroughly passing a magnet through a 50 gram sample. Metal embedded in rubber particles will be permitted.

The GTR shall be stored in a dry location protected from the rain. The GTR shall have a maximum of 0.75% moisture by weight and shall be free flowing. When the GTR is combined with the asphalt cement, the moisture content of the GTR shall not cause foaming of the blend.

When tested in accordance to AASHTO T-27, *Sieve Analysis of Fine and Coarse Aggregates a* 50 gram sample of the GTR shall conform to the following gradation requirements:

Sieve Size	Percent Passing
2.36 mm (No. 8)	100
1.18 mm (No. 16)	98 ± 2
600 µm (No. 30)	95 ± 5
300 µm (No. 50)	> 20

A mineral powder (such as talc) meeting AASHTO M17, *Mineral Filler for Bituminous Paving Mixtures*, requirements may be added, up to a maximum of 4% by weight of GTR particles, to reduce sticking and caking of the GTR particles.

GTR shall have a specific gravity of 1.150 ± 0.050 when tested in accordance with ASTM D-1817, *Standard Test Method for Rubber Chemicals-Density.*

The GTR may be provided in bulk or in whole plastic containers. Plastic containers shall be made from low density polyethylene having a melting point less than 240° F. The

manufacturer shall ship along with the GTR, certificates of compliance which certify that all requirements of this specification are complied with for each production lot number or shipment.

(C) Polymer Additions. With approval of the Engineer, compatible polymers may be added to the GTR or to the asphalt-rubber blend during the process of blending and reaction of the asphalt binder with the GTR. The additional costs for the polymer additions shall be borne by the asphalt binder Supplier or the Contractor. The asphalt binder Supplier or the Contractor shall provide material product information along with usage rates for approval.

Preparation of GTR Modified Asphalt Binder. The GTR shall be blended with the PG-graded base asphalt binder, forming a consistent, homogeneous blend, using the Terminal Blend method, where the GTR is blended and reacted with the asphalt binder at the asphalt production facility. The asphalt-rubber blend shall consist of a minimum of 10% GTR (by dry unit weight of asphalt binder).

(A) Blending Requirements

(1) A separate agitated shipping / storage tank, with continuous mixing and recirculation of the asphalt-rubber blend, shall be required to react the GTR with the asphalt binder and to maintain the homogeneous blend of asphalt binder and GTR. This tank shall be heated and capable of maintaining the temperature of the homogeneous blend of asphalt binder and GTR at 325°F to 375°F (163°C to 191°C). The GTR shall be reacted with the asphalt binder for a minimum of 6 hours at a temperature of 325°F to 375°F.

(2) Terminal blended GTR asphalt binder may be stored at 300°F to 350°F with continuous mixing and/or recirculation, to maintain the homogeneous blend. Full Specification Compliance testing shall be repeated every 30 days on previously certified material held in storage.

(3) A dedicated storage tank for "terminal blended GTR asphalt binder" shall be provided at the HMAC plant. This tank must be capable of providing continuous mixing and/or recirculation of the GTR asphalt binder. This tank shall be heated and capable of maintaining the temperature of the homogeneous blend of asphalt binder and GTR at 300°F to 350°F. The maximum storage time of the GTR asphalt binder at the HMAC plant shall be 3 days maximum, unless approved by the Engineer.

(B) Asphalt-rubber Blend Characteristics. Asphalt-rubber blend must be homogeneous, but may contain visible particles of tire rubber.

GTR Modified Binder Compliance Testing. When the asphalt binder and GTR have reacted and form a homogeneous blend, test samples shall be obtained and submitted for testing. COSA personnel may also collect samples at any time. The GTR asphalt binder shall meet the requirements shown in Table 1.

Table 1. Requirements for GTR Asphalt Binder		
Test	**Value**	**Test Method**
Flash Point, Min, °C	230	T 48
Viscosity, Max, 3.0 Pa· s, temperature, °C	135	T 316
Softening Point, ° F, min.	135	T 53
Elastic Recovery @77°F, (25°C), 100mm elongation, 5cm/min., cut immediately, % min.	65	ASTM D6084 Procedure A

(A) The supplier of the GTR asphalt binder shall certify and provide the following documentation:

(1) Certificate of Analysis with the accompanying Producer's Sequence Number of the base asphalt binder.

(2) The composition of the GTR.

(3) The material product information and usage rates for any polymer additions, and

(4) The characteristics and test results of the final GTR asphalt binder.

(B) The final GTR asphalt binder shall be referred to using the PG grade of the base asphalt binder, GTR, and the minimum percent of GTR required (example: 64-22 GTR 10).

HMAC Mixture Design. The mixture design shall be according to COSA Standard Specifications.

Ground Tire Rubber

- Testing conducted at National Center for Asphalt Technology-Auburn Alabama.

Other Technologies Used

- Warm Mix
- Chemical
- Water Foam

Performance Evaluation of the Rubber-Modified Asphalt Program

City of San Antonio
Department of Public Works
March 2013

Introduction

- Rubber Modified Asphalt is a blend of plain bitumen and ground rubber produced from reclaimed tires.

- Research studies have demonstrated that the Rubber Modified Asphalt is able to enhance the mechanical performances of the bituminous mixes while simultaneously creating the environmental benefit by re-using a waste material.

- City of San Antonio has started a pilot program in 2009 and used Rubber Modified Asphalt to rehabilitate the city street. Till today Rubber Modified Asphalt is applied to approximately 400 lane miles of city street.

Objective

- The objective of this study is to evaluate the performance of the Rubber Modified Asphalt Application and compare it with conventional asphalt overlay application.

Pavement Distress to Evaluate

Fatigue (Alligator) Cracking

Longitudinal Cracking

Rutting

Pavement Distress to Evaluate (Cont..)

Potholes

Transverse (Temperature) Cracking

Methodology

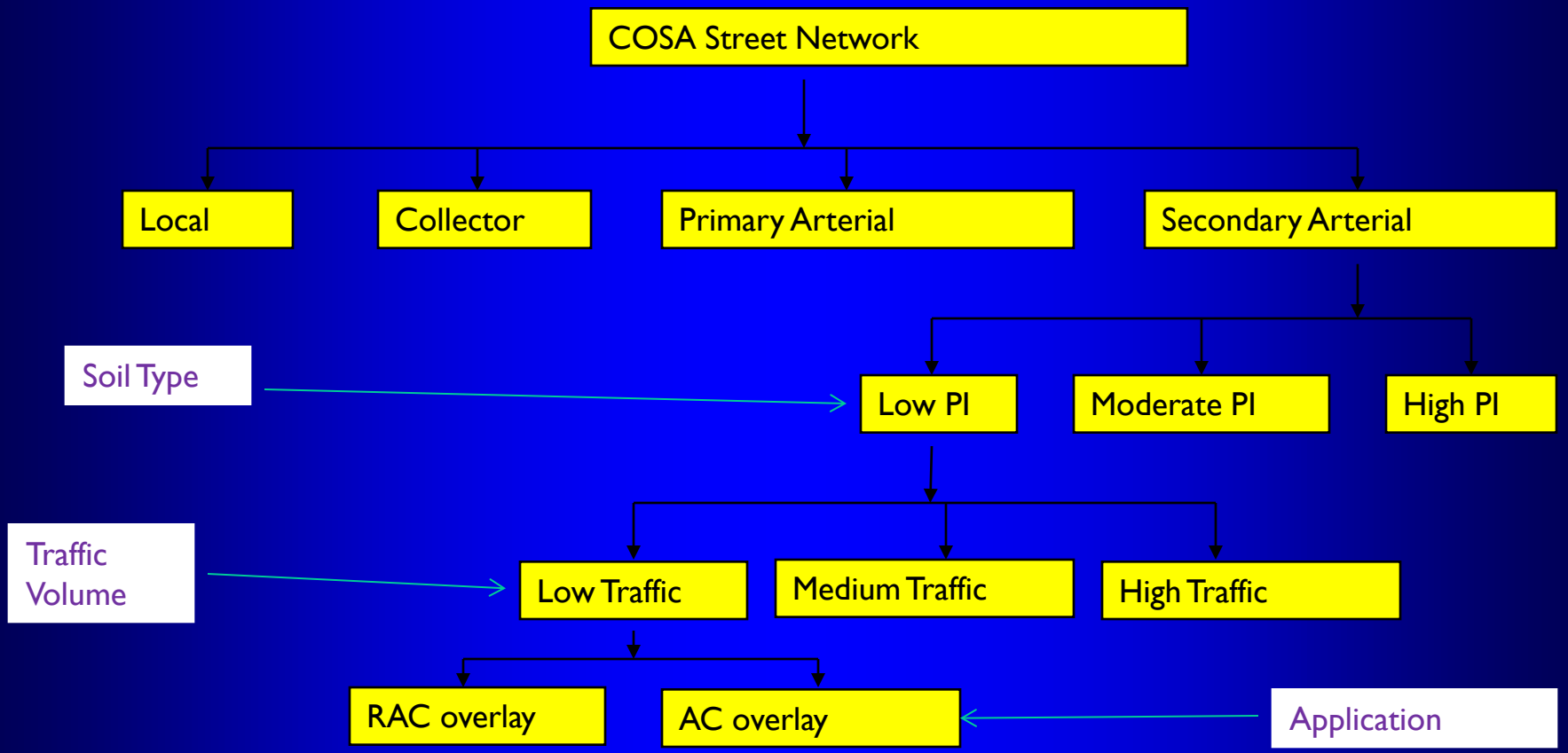
- Task 1: Selecting Uniform Pavement Sections and Grouping Similar Sections
- Task II: Data Collection
- Task III: Statistical Analysis and Performance Comparison

Task I: Selecting Pavement Sections and Grouping Similar Sections

- Pavement sections of comparable type with similar class of street (i.e. local, arterial, collector), similar level of traffic and soil type will be selected for data collection and comparison analysis.

Type of Pavement Sections

Total of 36 types of street section will be selected for comparison a minimum of there (3) section of each type with RAC and AC overlay will be selected for data collection. Which means 216 street sections data will be collected.



Task II: Data Collection

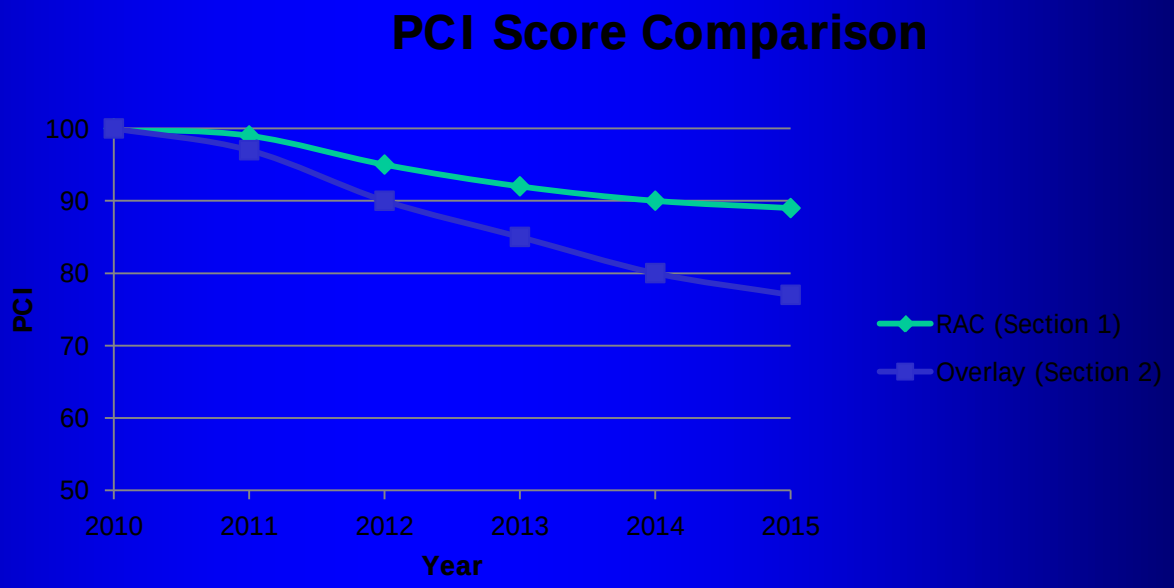
- PCI scores and distress data such as Rutting, Fatigue Cracking, Longitudinal Cracking, Transverse cracking and # of potholes will be collected every year for each of the selected sections

Sample Section Data

Section	Section Length (Mile)	Street Type	Soil Type (PI)	Fiscal Year	PCI	Rutting (in)	Fatigue Cracking (%)	Longitudinal Cracking (%)	Transverse Cracking (#)	Potholes(#)
1 (Commerce ST- St Mary's to Navarro)	0.5	Primary Arterial	22	2010	100	0	0	0	0	0
				2011	97	0	0	0	0	1
				2012	90	0	2	1	0	3
				2013	88	1	3	10	1	5
				2014	85	2	5	20	2	6
2 (W Market St- Alamo to Bowie)	0.7	Primary Arterial	25	2010	100	0	0	0	0	0
				2011	95	0	2	0	1	0
				2012	85	0	3	10	1	0
				2013	77	1	5	115	1	2
				2014	75	2	6	16	4	2

Expected Results:

- It is expected based on the literature research that pavement section with Rubber Modified Asphalt overlay will perform better than the asphalt overly for a comparable section.
- PCI score of a comparable section may be presented as follows.



Pavement Management System

- 1996 the first test of implementation of a computerized Pavement Management System was piloted

- PMS program created a framework for
  - Proactive approach to maintenance (know extent & condition of Street Network)
  - Basis for requesting additional budget for maintenance

Pavement Management System Cont.

- Pavement Management Information System (PMIS) software.
  - Displays pavement inventory
  - As of 2006:
    - 33%/year
    - Tied to GIS
    - Currently in progress of updating system (additional 2/3 completed FY 2007
    - Acquire the condition (PCI) of street network)
- GASB 34 Compliance (Data on Infrastructure Assets)

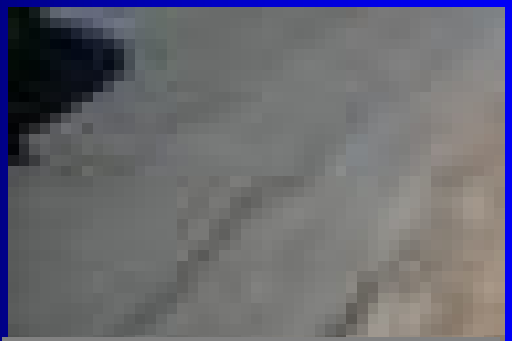
PMS CONTINUED

Distresses that are considered include:

Rutting

Raveling

Alligator cracking



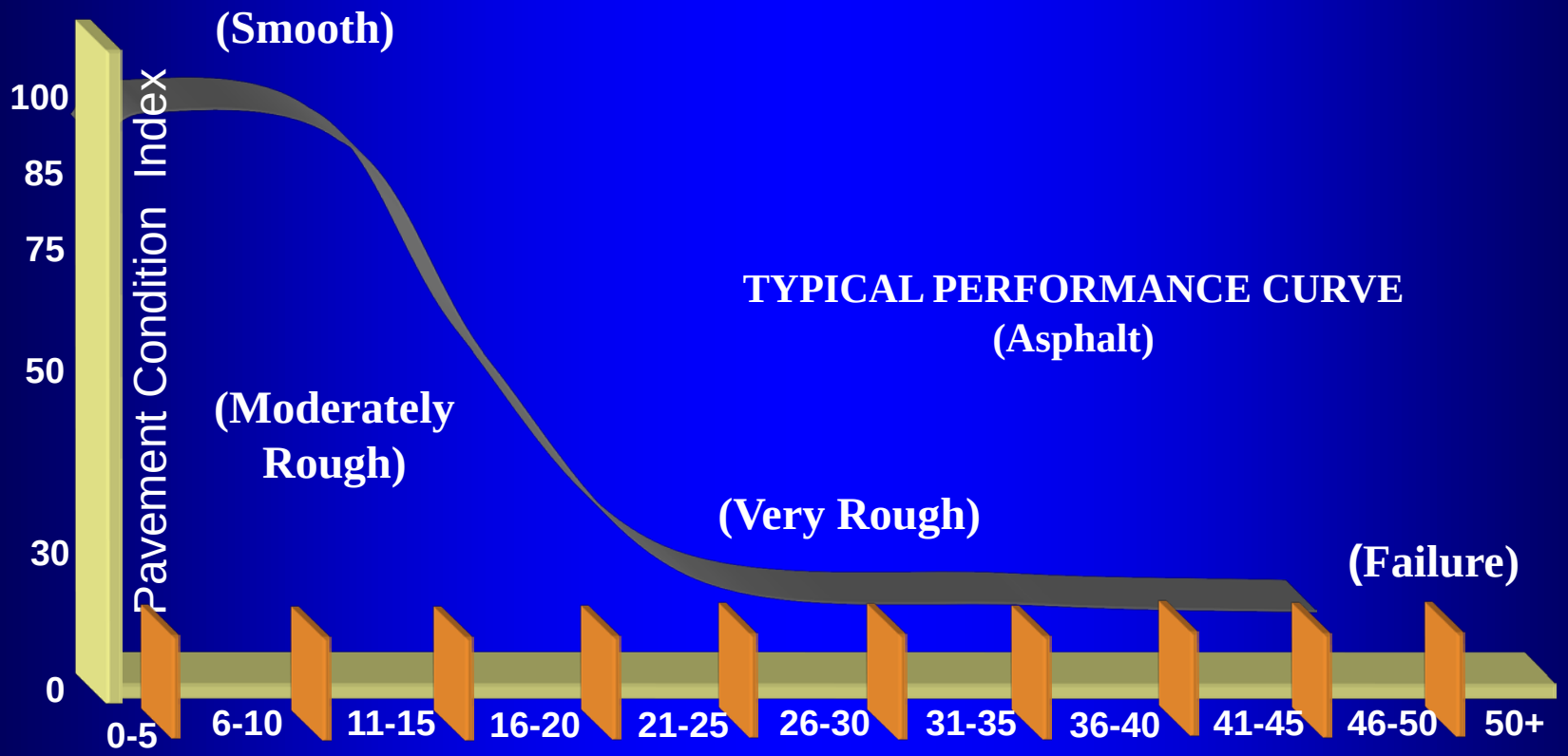
Transverse cracking

Longitudinal cracking

Street Network by CD & Average PCI

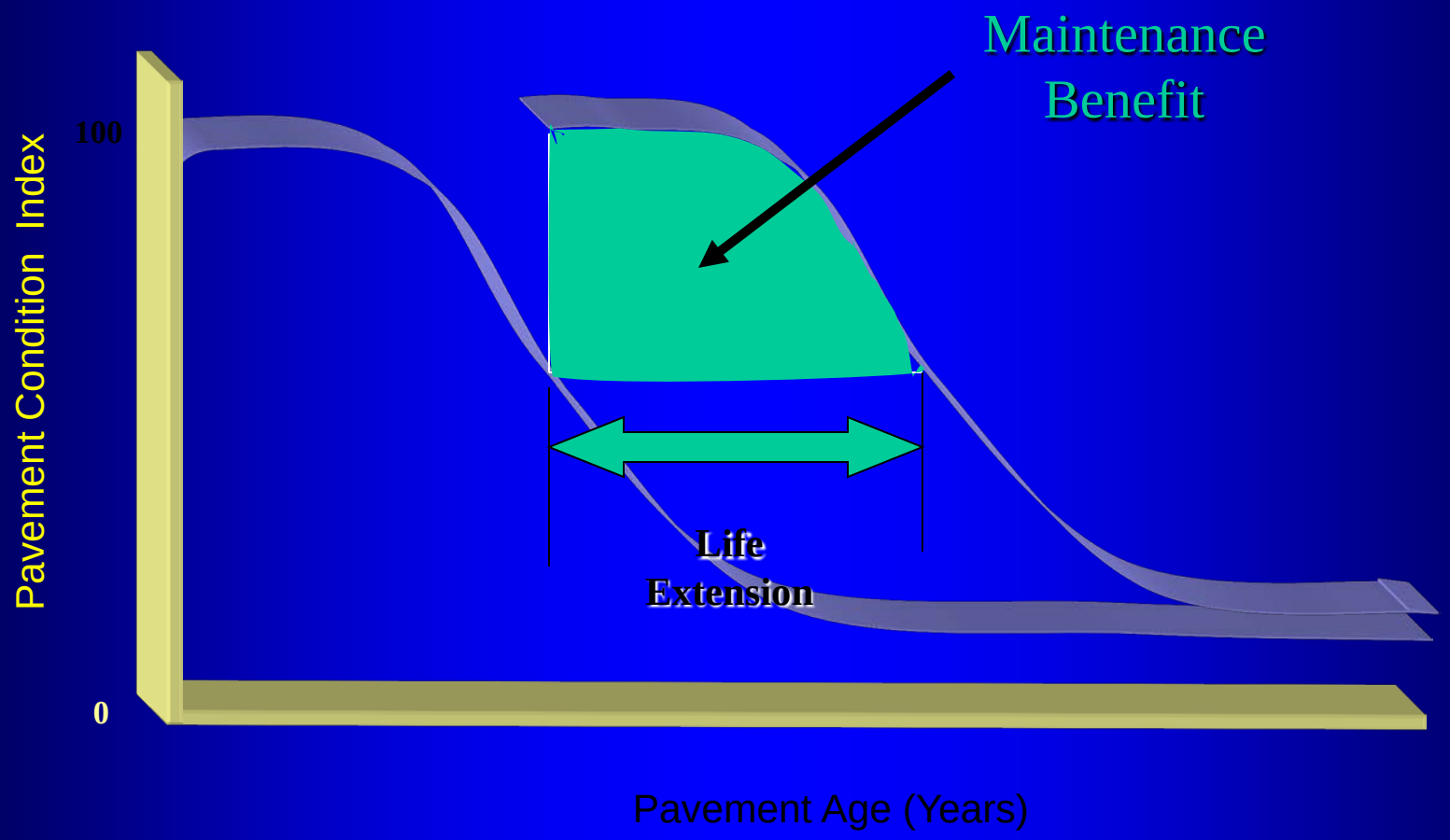
Council District	1	2	3	4	5	6	7	8	9	10
PCI Arterial	70.88	71.13	70.25	63.55	73.51	62.70	67.60	66.01	84.47	77.97
PCI Collector	68.41	64.45	65.58	69.34	65.59	73.66	65.87	49.33	81.58	79.16
PCI Local	67.38	65.69	72.14	65.99	71.34	67.78	68.66	58.19	75.14	84.61

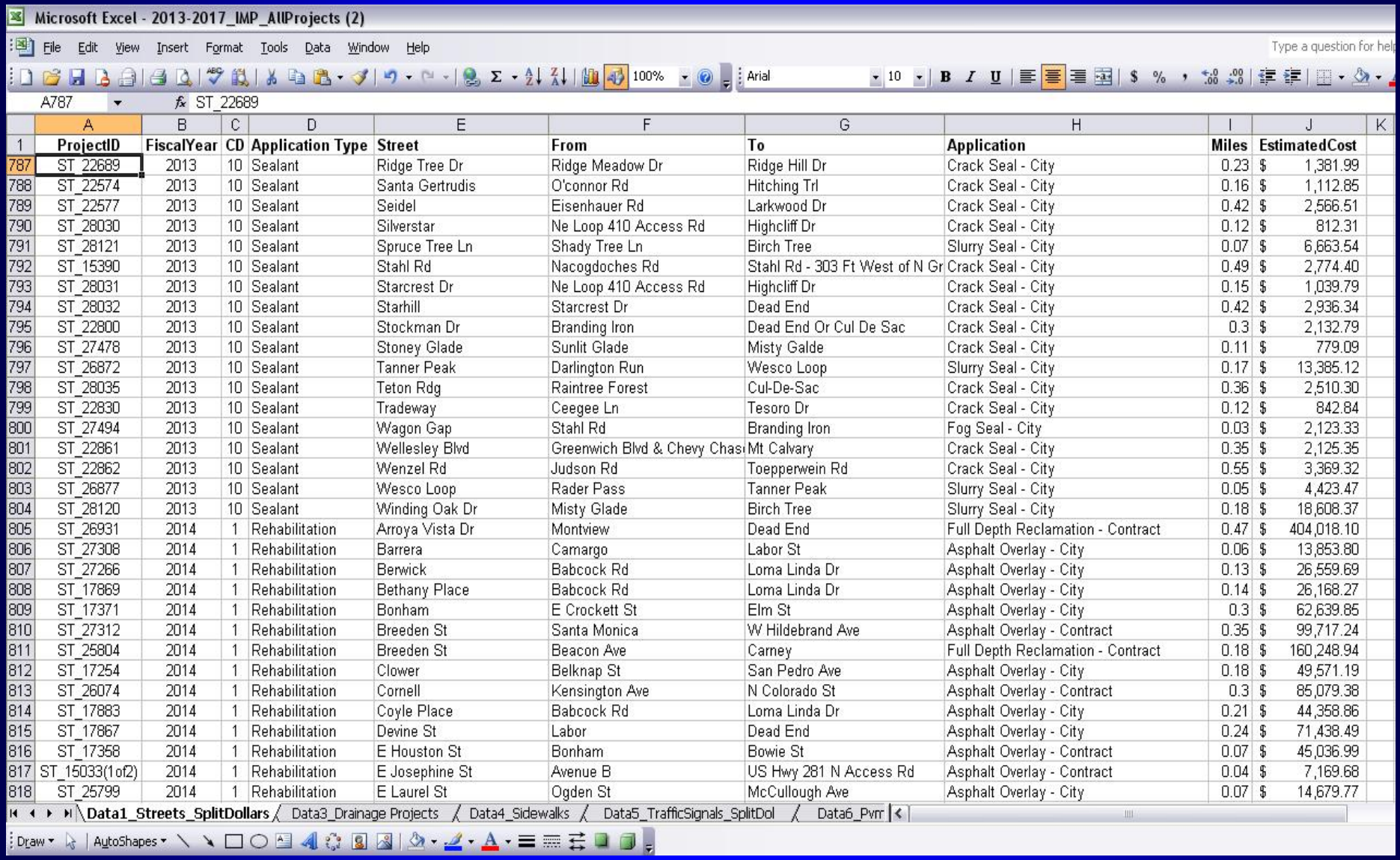
Infrastructure Management Performance Curve



Depends on Traffic Volume and Loading

Pavement Life Extension and Maintenance Benefit





Microsoft Excel - 2013-2017_IMP_AllProjects (2)

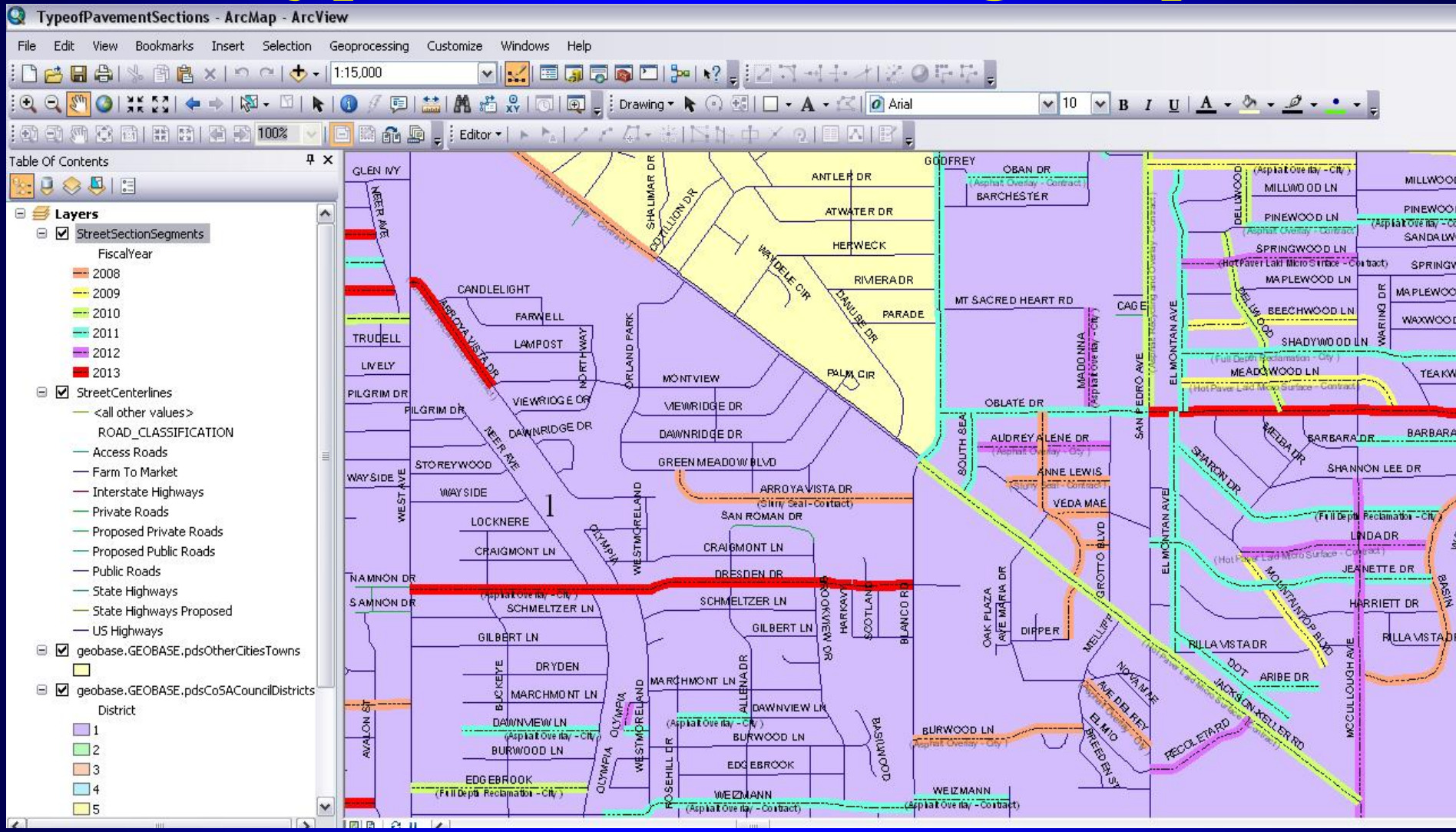
File Edit View Insert Format Tools Data Window Help

A787 ST_22689

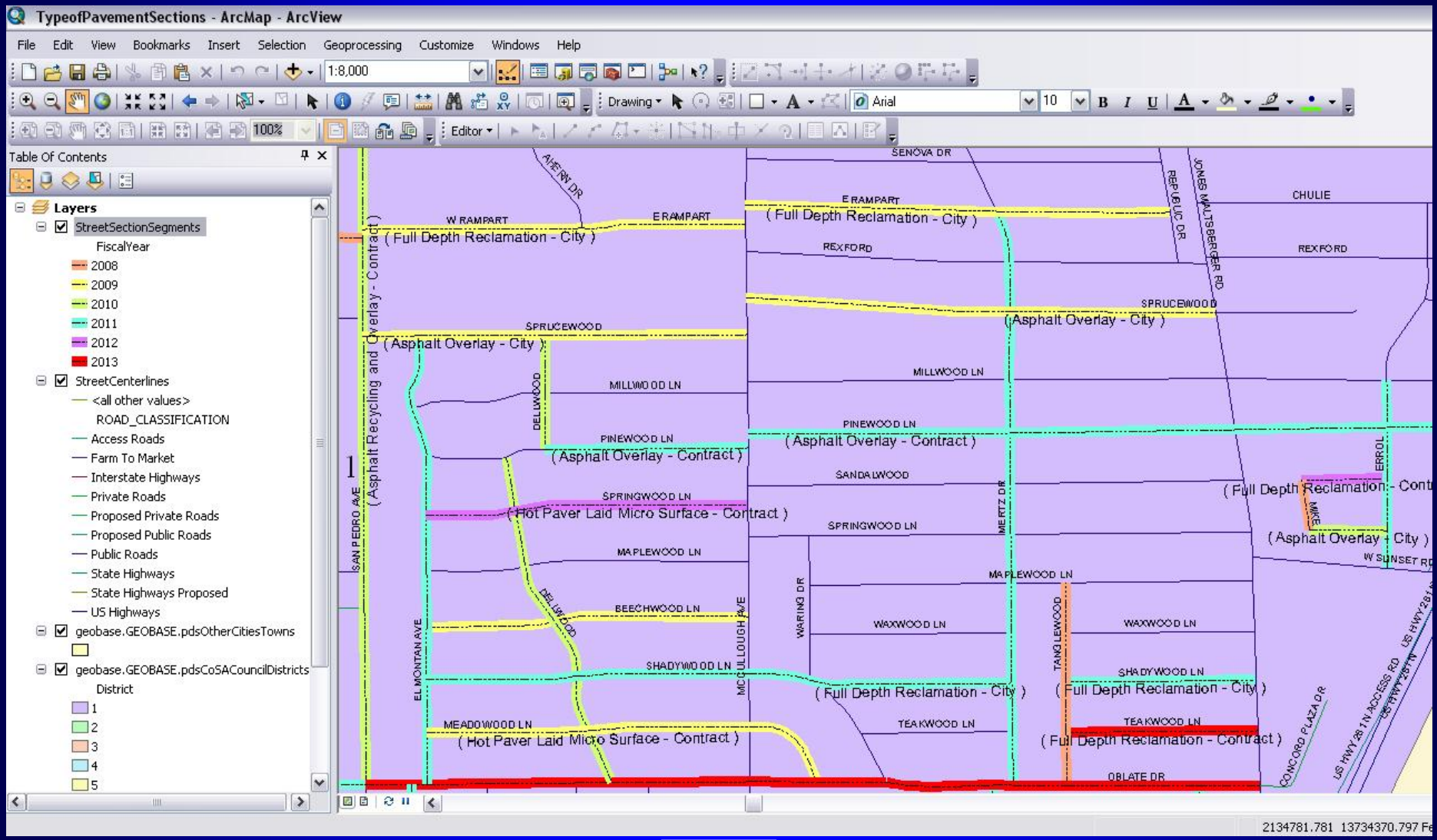
	ProjectID	FiscalYear	CD	Application Type	Street	From	To	Application	Miles	EstimatedCost
787	ST_22689	2013	10	Sealant	Ridge Tree Dr	Ridge Meadow Dr	Ridge Hill Dr	Crack Seal - City	0.23	$ 1,381.99
788	ST_22574	2013	10	Sealant	Santa Gertrudis	O'connor Rd	Hitching Trl	Crack Seal - City	0.16	$ 1,112.85
789	ST_22577	2013	10	Sealant	Seidel	Eisenhauer Rd	Larkwood Dr	Crack Seal - City	0.42	$ 2,566.51
790	ST_28030	2013	10	Sealant	Silverstar	Ne Loop 410 Access Rd	Highcliff Dr	Crack Seal - City	0.12	$ 812.31
791	ST_28121	2013	10	Sealant	Spruce Tree Ln	Shady Tree Ln	Birch Tree	Slurry Seal - City	0.07	$ 6,663.54
792	ST_15390	2013	10	Sealant	Stahl Rd	Nacogdoches Rd	Stahl Rd - 303 Ft West of N Gr	Crack Seal - City	0.49	$ 2,774.40
793	ST_28031	2013	10	Sealant	Starcrest Dr	Ne Loop 410 Access Rd	Highcliff Dr	Crack Seal - City	0.15	$ 1,039.79
794	ST_28032	2013	10	Sealant	Starhill	Starcrest Dr	Dead End	Crack Seal - City	0.42	$ 2,936.34
795	ST_22800	2013	10	Sealant	Stockman Dr	Branding Iron	Dead End Or Cul De Sac	Crack Seal - City	0.3	$ 2,132.79
796	ST_27478	2013	10	Sealant	Stoney Glade	Sunlit Glade	Misty Galde	Crack Seal - City	0.11	$ 779.09
797	ST_26872	2013	10	Sealant	Tanner Peak	Darlington Run	Wesco Loop	Slurry Seal - City	0.17	$ 13,385.12
798	ST_28035	2013	10	Sealant	Teton Rdg	Raintree Forest	Cul-De-Sac	Crack Seal - City	0.36	$ 2,510.30
799	ST_22830	2013	10	Sealant	Tradeway	Ceegee Ln	Tesoro Dr	Crack Seal - City	0.12	$ 842.84
800	ST_27494	2013	10	Sealant	Wagon Gap	Stahl Rd	Branding Iron	Fog Seal - City	0.03	$ 2,123.33
801	ST_22861	2013	10	Sealant	Wellesley Blvd	Greenwich Blvd & Chevy Chas	Mt Calvary	Crack Seal - City	0.35	$ 2,125.35
802	ST_22862	2013	10	Sealant	Wenzel Rd	Judson Rd	Toepperwein Rd	Crack Seal - City	0.55	$ 3,369.32
803	ST_26877	2013	10	Sealant	Wesco Loop	Rader Pass	Tanner Peak	Slurry Seal - City	0.05	$ 4,423.47
804	ST_28120	2013	10	Sealant	Winding Oak Dr	Misty Glade	Birch Tree	Slurry Seal - City	0.18	$ 18,608.37
805	ST_26931	2014	1	Rehabilitation	Arroya Vista Dr	Montview	Dead End	Full Depth Reclamation - Contract	0.47	$ 404,018.10
806	ST_27308	2014	1	Rehabilitation	Barrera	Camargo	Labor St	Asphalt Overlay - City	0.06	$ 13,853.80
807	ST_27266	2014	1	Rehabilitation	Berwick	Babcock Rd	Loma Linda Dr	Asphalt Overlay - City	0.13	$ 26,559.69
808	ST_17869	2014	1	Rehabilitation	Bethany Place	Babcock Rd	Loma Linda Dr	Asphalt Overlay - City	0.14	$ 26,168.27
809	ST_17371	2014	1	Rehabilitation	Bonham	E Crockett St	Elm St	Asphalt Overlay - City	0.3	$ 62,639.85
810	ST_27312	2014	1	Rehabilitation	Breeden St	Santa Monica	W Hildebrand Ave	Asphalt Overlay - Contract	0.35	$ 99,717.24
811	ST_25804	2014	1	Rehabilitation	Breeden St	Beacon Ave	Carney	Full Depth Reclamation - Contract	0.18	$ 160,248.94
812	ST_17254	2014	1	Rehabilitation	Clower	Belknap St	San Pedro Ave	Asphalt Overlay - City	0.18	$ 49,571.19
813	ST_26074	2014	1	Rehabilitation	Cornell	Kensington Ave	N Colorado St	Asphalt Overlay - Contract	0.3	$ 85,079.38
814	ST_17883	2014	1	Rehabilitation	Coyle Place	Babcock Rd	Loma Linda Dr	Asphalt Overlay - City	0.21	$ 44,358.86
815	ST_17867	2014	1	Rehabilitation	Devine St	Labor	Dead End	Asphalt Overlay - City	0.24	$ 71,438.49
816	ST_17358	2014	1	Rehabilitation	E Houston St	Bonham	Bowie St	Asphalt Overlay - Contract	0.07	$ 45,036.99
817	ST_15033(1of2)	2014	1	Rehabilitation	E Josephine St	Avenue B	US Hwy 281 N Access Rd	Asphalt Overlay - Contract	0.04	$ 7,169.68
818	ST_25799	2014	1	Rehabilitation	E Laurel St	Ogden St	McCullough Ave	Asphalt Overlay - City	0.07	$ 14,679.77

Data1_Streets_SplitDollars | Data3_Drainage Projects | Data4_Sidewalks | Data5_TrafficSignals_SplitDol | Data6_Pvmr

Typical GIS Planning Map



Typical GIS Planning Map



Street Maintenance Applications

Crack Seal Application

Slurry Seal Application

Chip Seal Coat Application

Micro-Surface Application

Maintenance Applications Cont.

Base & Pavement Repair

Asphalt Overlay

Asphalt Recycling

Street Reconstruction

Reconstruction Applications Candidate Example

Reclamation Application Candidate Example

Slurry Seal Application Candidate Example

ITEM

EMULSION AGGREGATE SLURRY SEAL MIX

1.1 DESCRIPTION: This item shall govern for the asphalt emulsion aggregate slurry seal mix that will be used for pavement preservation. This item shall consist of a mixture of modified emulsified asphalt, ground tire rubber, mineral aggregate, and water. The slurry seal mix shall be produced in an approved centrally located facility and the mix shall be tested and certified by the producer to meet specifications prior to shipment to distribution location(s). The Slurry Seal mix shall be uniform and stable for placement the day of loading when proper agitation is maintained. The aggregates, emulsion, and water should form a creamy-textured slurry that, when spread, will flow ahead of the strike-off squeegee. When cured, the surface shall have a uniform appearance, fill cracks, and adhere to the existing pavement surface. Proportions shall be based on the mix design specifications herein.

MATERIALS

2.1 AGGREGATE: The aggregate shall consist of sound and durable Trap Rock 100% crushed in accordance with these specifications. The aggregate shall be clean and free from vegetable matter, dirt, and other deleterious substances. The aggregate shall have a sand equivalent of not less than 45 percent when tested in accordance with ASTM D 2419. The aggregate shall show a loss of not more than 35 percent when tested in accordance with ASTM C 131. The sodium sulfate soundness loss shall not exceed 12 percent, or the magnesium soundness loss shall not exceed 20 percent after 5 cycles when tested in accordance with ASTM C 88.

The combined aggregate shall conform to the gradation shown in Table 1 when tested in accordance with ASTM C 136 and ASTM C 117.

TABLE 1

GRADATION OF AGGREGATES

Sieve Size	Precent by Weight Passing Sieve
No.4 (4.75 mm)	100
No.8 (2.36 mm)	75 – 85
No.16 (1.18 mm)	30 – 40
No.30 (600 micro m)	10 – 20
No.50 (300 micro m)	3 – 8
No.100 (150 micro m)	0 – 2
No.200 (75 micro m)	0 – 1
Emulsion content by dry weight of aggregate	14% - 17%

The mix formula (mix design) shall be run using aggregate within the gradation band shown in Table 1. Once the mix design has been submitted and approved, the aggregate used on the project shall be within the gradation bands in Table 1.

2.2 MINERAL FILLER: If mineral filler, in addition to that naturally present in the aggregate, is necessary, it shall meet the requirements of ASTM D 242 and shall be used in the amounts required by the mix design. The mineral filler shall be considered as part of the aggregate.

2.3 GROUND TIRE RUBBER: The material shall be granulated tire rubber specifically designed for use with the Slurry Seal mixes. The rubber shall have a specific gravity between 1.15 and 1.20. One hundred percent of the granulated tire rubber shall pass a No. 16 sieve, 95% shall pass a No. 20 sieve, and a maximum of 2 percent shall pass a No. 200 sieve. The ground tire rubber (GTR) content shall not exceed 10% based on the weight of the asphalt in the emulsion.

2.4 POLYMER MODIFIER: Polymer modifier shall be latex and shall be added at a minimum of 2 percent polymer solids by weight of the emulsion.

2.5 WATER: All water used in making the slurry shall be potable and free from harmful soluble salts and chemicals.

2.6 EMULSION: The emulsion shall be a slow-set or a quick-set type of emulsion as approved by the Engineer. The emulsion shall contain ground tire rubber and polymer modifiers and shall conform to the following quality requirements as shown in Table 2:

TABLE 2

TESTS ON EMULSION

Emulsion Property	Test Procedure	Min	Max
Rotational viscosity at 77°F, cP	ASTM D 7226	200	2000
Uniformity	ASTM D 2939	Pass[1]	
Resistance to heat	ASTM D 2939	Pass[2]	
Resistance to water	ASTM D 2939	Pass[3]	
Wet flow, mm	ASTM D 2939	--	0
Residue by evaporation, % by weight	ASTM D 2939	33	--
Tests on residue from evaporation:			
Penetration, 77°F, 100 g, 5 sec.	ASTM D5	15	30
Flash point, Cleveland open cup, °F	ASTM D92	500	
Softening Point, °F [4]	ASTM D36	230	--

1. Product shall be homogenous and show no separation or coagulation that cannot be overcome by moderate stirring.
2. No sagging or slippage of film beyond the initial reference line.
3. No blistering or re-emulsification.
4. Cure the emulsion in the softening point ring in a 200°F ± 5°F oven for 2 hr.

COMPOSITION AND APPLICATION

3.1 COMPOSITION: The slurry shall consist of a mixture of polymer emulsified asphalt, mineral aggregate, ground tire rubber, and water.

3.2 JOB MIX FORMULA: The Vendor shall submit to the Engineer for approval a complete mix design on the materials proposed for use, prepared and certified by an approved laboratory. Compatibility of the aggregate, emulsion, mineral filler, and other additives shall be verified by the mix design. The mix design shall be made with the same aggregate and emulsion that the Vendor will supply. The

slurry seal mix shall be produced in an approved centrally located facility and the mix shall be pretested and certified to meet specifications by the producer prior to shipment to distribution location.

3.3 APPLICATION RATE: Unless otherwise specified, the slurry seal shall be applied to at the application rates of 10-15 pounds of mixture per square yard. The rate of application shall not vary more than +/- 2 pounds per square yard.

4.1 CERTIFICATE OF ANALYSIS: The producer of the Slurry Seal Mix shall make available a certificate of analysis (C of A) for the slurry seal mix supplied under the contract. The C of A shall indicate the proportions of aggregates, mineral filler, ground tire rubber, water and emulsion based on the dry aggregate weight. The main items of design in the Emulsion Slurry Seal are aggregate gradation, emulsion content and consistency of the mixture.

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