Research Report

Assessment and Update of TIB Urban Program and Small City Preservation Program

Part 2: Small City Preservation Program (SCPP) Data Analysis

by

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SUMMARY

This document summarizes the research done by the University of Washington (UW) for the Washington State Transportation Improvement Board (TIB) on the Small Cities Preservation Program (SCPP), part 2 of a research contract between TIB and UW.

SCPP AND SCAP DATA ANALYSIS SUMMARY

Major findings:

- Small City Arterial Program (SCAP)
    1. It is not useful to compare costs between projects.
    2. Pavement constitutes 5-40% of the total construction cost with an average of 18%.
- Small City Preservation Program (SCPP)
    1. A majority of SCPP work involves either chip seals or 1.8 - 2 inch asphalt pavement overlays.
    2. Cities generally do their own contract for overlay projects, but use WSDOT or their County to execute their chip seal projects.
    3. Overlay costs are more per yd^2 than chip seal costs.
    4. TIB Southeast region chip seal projects cost significantly less than other TIB regions.
    5. WSDOT Olympic region overlay costs are probably more than other WSDOT regions.
    6. Using WSDOT as a provider does not produce significant cost savings.
    7. Smaller overlay projects (< 20,000 ft^2) tend to be expensive (> \$40/yd^2) across all TIB regions.
- Other Observations
    1. There may be an advantage to volume contracting.
    2. Condition data could provide more insight.

SCPP AND SCAP DATA ANALYSIS SUMMARY

This report summarizes a data analysis done by the University of Washington for the Transportation Improvement Board (TIB) on 2007-2015 data concerning the Small City Pavement Preservation Program (SCPP) and the Small City Arterial Program (SCAP).

MAJOR FINDINGS

Small City Arterial Program (SCAP)

1. **It is not useful to compare costs between projects**. The scope of work in the SCAP varies greatly from project to project making total project cost and per unit costs poor inappropriate comparison metrics.
2. **Pavement constitutes 5-40% of the total construction cost with an average of 18%**. Most SCAP work is outside the scope of the pavement structure and such work can vary greatly (e.g., sidewalks, landscape improvements, signals, lighting, etc.).

Small City Preservation Program (SCPP)

1. **A majority of SCPP work involves either chip seals or 1.8 - 2 inch asphalt pavement overlays**. Out of the year 2007-2015 projects reviewed there were 90 chip seals, 117 overlays, and 6 seal coats. An informal survey of projects by Christa Draggie was used to arrive at the 1.8 – 2 inch overlay thickness conclusion.
2. **Cities generally do their own contract for overlay projects, but use WSDOT or their County to execute their chip seal projects**. For overlays in 116 of 117 projects the city contracted directly with a contractor to have the work performed. For chip seals, in 85 of 90 projects the city went through an intermediary (either WSDOT or a County) to have work performed.
3. **Overlay costs are more per yd^2 than chip seal costs**. This was expected and confirmed. Overlays averaged \$29.57/yd^2, chip seals averaged \$4.41/yd^2.
4. **TIB Southeast region chip seal projects cost significantly less than other TIB regions**. A mean cost of \$2.19/yd^2 is less than the other means of \$6.69/yd^2 (NW), \$4.52/yd^2 (NE), and \$6.38/yd^2 (SW). This is a strong statistical conclusion and holds true even when design and CE costs are ignored and only contract costs are considered.
5. **WSDOT Olympic region overlay costs are probably more than other WSDOT regions**. A mean cost of \$50.75/yd^2 is more than the other means of \$21.00/yd^2 (Eastern), \$25.59/yd^2 (N. Central), \$29.26/yd^2 (NW), \$31.52/yd^2 (S. Central), and \$35.12/yd^2 (SW). This difference doesn't quite reach statistical significance.
6. **Using WSDOT as a provider does not produce significant cost savings**. Further investigation of projects in the WSDOT Eastern Region (where using WSDOT as a provider is more common practice) show no significant difference between WSDOT and the County as providers.
7. **Smaller overlay projects (< 20,000 ft^2) tend to be expensive (> \$40/yd^2) across all TIB regions**. "Expensive" overlays are ones that cost more than typical WSDOT projects (\$28-\$40/yd^2). Data show that these are usually recent projects (20 of 27 are listed as 2013, 2014 or 2015) and smaller in size (11 of 14 jobs < 20,000 ft^2 are > \$40/yd^2).

Other Observations

1. **There may be an advantage to volume contracting**. WSDOT Regions typically contract all their chip seal work to a single contractor each season believing that it saves them money. Counties generally do something similar. TIB already appears to be pursuing a similar strategy for chip seals. It may also be possible for overlays.

2. **Condition data could provide more insight**. Pre-treatment condition and post-treatment condition in subsequent years may show the effects of condition on treatment cost, and the performance of treatments. Without this data, the implicit assumption is that all treatments and projects are identical in condition, which is not likely to be the case.

DATA

The SCPP dataset included 214 projects from FY 2007 through FY 2015. Of these, there were 117 overlays, 90 chip seals, 6 seal coats, and 1 sidewalk project (Soap Lake, 2015).

METHOD

Preliminary analysis on SCAP and SCPP data revealed that cost per square yard of pavement would be a good comparison metric. It was felt that this metric would likely work for SCPP data (which are largely pavement preservation projects) and perhaps not work with SCAP data (which are roadway improvement projects consisting of many items outside the pavement envelope). This section describes the basic analysis methods used for both SCAP and SCPP data.

SCAP data

- A review of 31 SCAP bid tabulations (provided by TIB) revealed that the fraction of contract price dedicated to pavement varies greatly, and therefore a total contract price divided by pavement area (cost per square yard) would not be a good metric for comparison.
- Descriptive statistics were produced but no further analysis was done.

SCPP data

- **Convert all costs to equivalent 2013 dollars using the WSDOT Construction Cost Index (2014)**. Factors are shown below:
    - 2007: 1.057
    - 2008: 1.008
    - 2009: 1.090
    - 2012: 0.942
    - 2013-2015: 1.000
- **Determine the cost per square yard in 2013 dollars**. This was done by dividing the total project (design + CE + contract costs adjusted to 2013 dollars) by total project area.
    - A sampling of overlay projects showed that a large majority of them are 1.8 to 2.0 inches thick. This allows overlay projects to be compared on an area basis instead of resorting to a volume/weight of HMA basis (necessary if thicknesses varied greatly).
- **Analyze all SCPP data**. The following analysis were done on the total SCPP data set:
    - Descriptive statistics and histogram based on total contract cost
    - Descriptive statistics and histogram based on per square yard cost
- **Break apart SCPP data into overlay and chip seal sets**. Since there were only 6 seal coat and 1 sidewalk project, these projects were not analyzed further.
- **Analyze the overlay data set (117 projects)**.
    - Overlays were analyzed using the following categories: fiscal year (2007, 2008, 2009, 2012, 2013, 2014, 2015), provider (contractor, city, county, WSDOT), and region (TIB, WSDOT). The object was to find significant differences within these categories (e.g., WSDOT provider results in lower project cost per square yard).

- Analysis of variance was used to identify potential differences within these categories. Since the underlying chip seal data is non-normal, a non-parametric test that approximates a standard ANOVA (Kruskal-Wallis test) was used. This test attempts to determine if the data from each category come from the same population. If they do not (the null hypothesis, H0, is rejected at the $\alpha = 0.05$ level), then a second test is used to determine groupings within the category.
- The Steel-Dwass-Critchlow-Fligner procedure (two-tailed test) was used for multiple pairwise comparisons to determine groupings. For instance, it might be found that 2007 and 2008 costs belong to one group while all other costs belong to a second, distinct, group.
- Since the distribution of overlay project costs was large (See Figures 1-3), "expensive" overlays projects were defined, identified and analyzed for commonalities.

- **Analyze the chip seal data set (90 projects)**. The procedure was identical to the overlay procedure. A few additional items were analyzed for chip seals only based on preliminary results.
  - **All SCPP data using cost per square yard that only included contract cost and not design and CE costs**. It was noticed that design and CE costs were infrequent and small in the TIB Southeast region and it was thought that this may have influenced this region being significantly less costly than other regions for chip seals.
  - **WSDOT Eastern Region**. In order to better understand the influence of WSDOT as a provider, this region was examined more closely since it routinely uses WSDOT as a provider for chip seal contracts. The differences between WSDOT and County as providers was examined.

RESULTS

Entire SCPP Data Set

Descriptive Statistics

Overlays		Chip Seals		Seal Coats	
Statistic	Overlays	Statistic	Chips Seals	Statistic	Seal Coats
Observations	117	Observations	90	Observations	6
Minimum	3.916	Minimum	0.577	Minimum	3.201
Maximum	154.158	Maximum	24.746	Maximum	26.059
Range	150.242	Range	24.168	Range	22.858
1st Quartile	14.625	1st Quartile	1.982	1st Quartile	3.591
Median	23.681	Median	2.936	Median	6.135
3rd Quartile	37.602	3rd Quartile	4.999	3rd Quartile	10.098
Mean	29.569	Mean	4.412	Mean	9.282
Variance (n-1)	526.858	Variance (n-1)	18.668	Variance (n-1)	76.625
St. dev. (n-1)	22.953	St. dev. (n-1)	4.321	St. dev. (n-1)	8.754

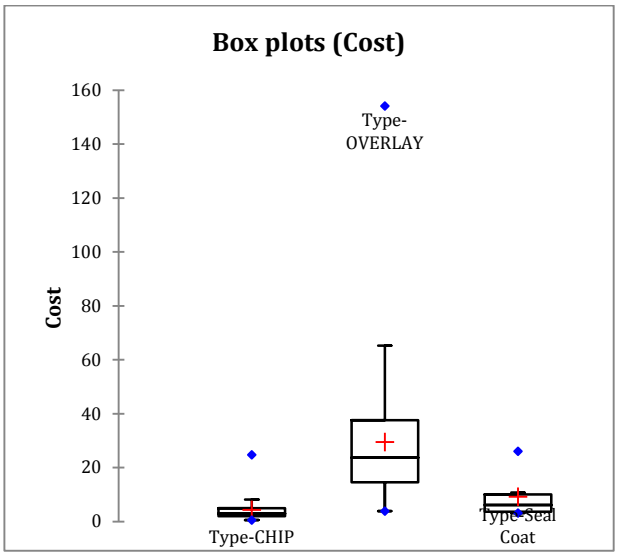

Figure 1. Box plots show quartiles of data, the median, mean, lowest and highest values.

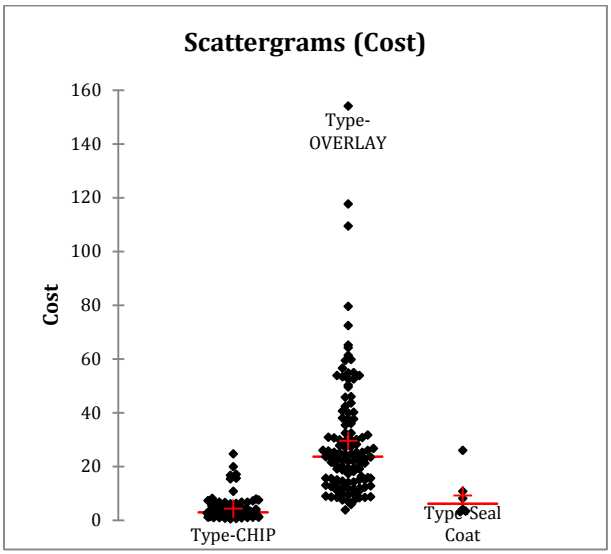

Figure 2. Scatter plots show each data point with median (red bar) and mean (red plus) values.

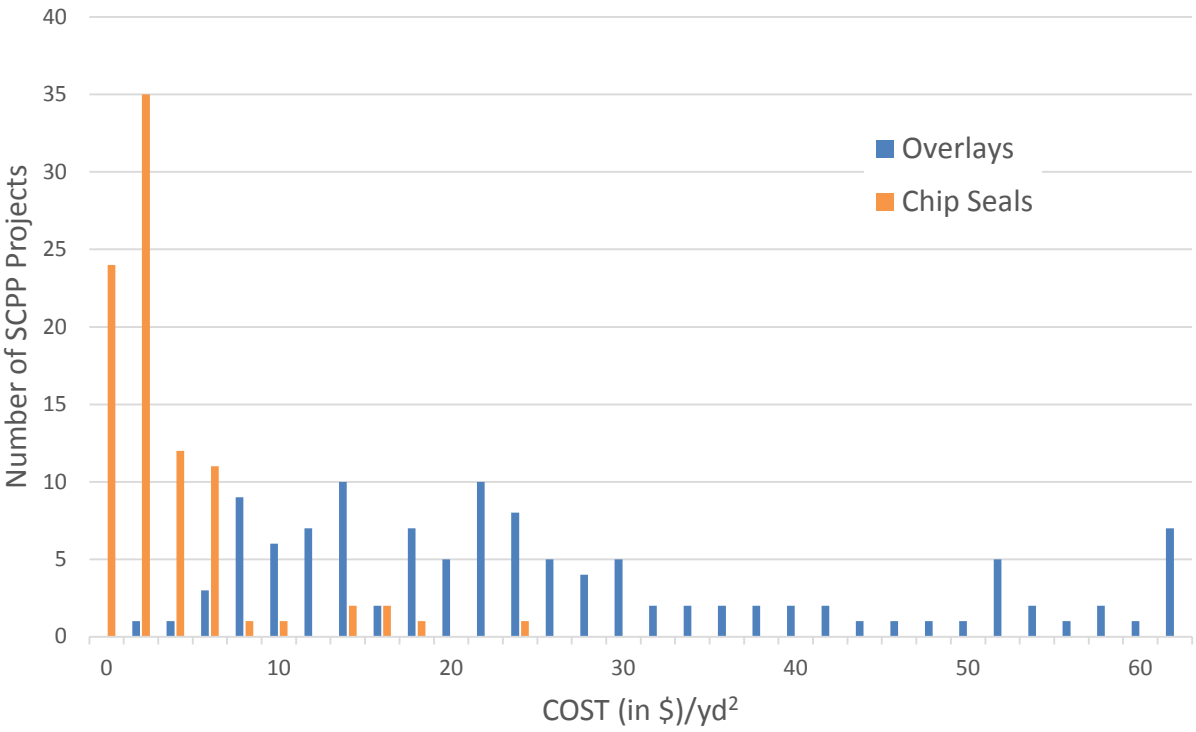

Figure 3. Frequency plot of SCPP project costs per square yard.

Overlays

These results contain just the overlay projects (117 total).

Fiscal Year

Variable	Obs.	Minimum	Maximum	Mean	Std. deviation
2007	13	5.854	40.136	16.081	10.739
2008	18	8.485	61.412	22.915	12.991
2009	19	3.916	65.232	21.154	15.871
2012	19	12.606	50.307	25.887	11.562
2013	13	6.930	117.741	39.119	30.780
2014	22	14.162	154.158	42.335	34.225
2015	13	12.216	64.284	38.792	16.616

Kruskal-Wallis Result

The samples do not come from the same population. The risk to reject the null hypothesis H0 while it is true is lower than 0.03%.

Steel-Dwass-Critchlow-Fligner procedure Results

Sample	Frequency	Sum of ranks	Mean of ranks	Groups	
2007	13	417.000	32.077	A	
2009	19	817.000	43.000	A	
2008	18	934.000	51.889	A	B
2012	19	1121.000	59.000	A	B
2013	13	890.000	68.462	A	B
2014	22	1671.000	75.955		B
2015	13	1053.000	81.000		B

Observations: The most that can be said is that more recent projects tend to be more expensive than early projects but no nice break in years can be found.

Interpretation: This may be a simple reflection that construction inflation is not entirely captured by the WSDOT Construction Cost Index. It may also reflect the typical project scope in each year (e.g., earlier projects had more limited scopes so the cost/yd^2 was lower).

Provider

Not performed. All but one contract was performed by “contractor.”

TIB Regions

Variable	Obs.	Minimum	Maximum	Mean	Std. deviation
Northwest	23	7.558	117.741	29.255	23.981
Northeast	44	3.916	79.618	22.161	17.060
Southwest	26	8.404	154.158	39.583	32.250
Southeast	24	9.909	64.284	32.600	14.299

Kruskal-Wallis Result

The samples do not come from the same population. The risk to reject the null hypothesis H0 while it is true is lower than 0.20%.

Steel-Dwass-Critchlow-Fligner procedure Results

Sample	Frequency	Sum of ranks	Mean of ranks	Groups	
Northeast	44	1980.000	45.000	A	
Northwest	23	1326.000	57.652	A	B
Southwest	26	1857.000	71.423		B
Southeast	24	1740.000	72.500		B

Observations: The NE region may be less expensive than the other regions. This is not a strong finding since NE is grouped with NW, and NW with SW and SE.

Best interpretation: This may be due to the less expensive materials in the NE, but, if so, one would expect the NW to be the most expensive, which it is not. Thus, it may reflect project scope or something else not captured in the results.

WSDOT Regions

Variable	Obs.	Minimum	Maximum	Mean	Std. deviation
Eastern	23	8.552	72.434	21.002	13.291
Northwest	23	7.558	117.741	29.255	23.981
S. Central	16	9.909	53.894	31.521	13.661
N. Central	27	3.916	79.618	25.593	19.982
Olympic	8	15.062	154.158	50.749	44.911
Southwest	20	8.404	109.474	35.115	23.946

Kruskal-Wallis Result

The samples do not come from the same population. The risk to reject the null hypothesis H0 while it is true is lower than 3.25%.

Steel-Dwass-Critchlow-Fligner procedure Results

Sample	Frequency	Sum of ranks	Mean of ranks	Groups
Eastern	23	1049.000	45.609	A
N. Central	27	1373.000	50.852	A
Northwest	23	1326.000	57.652	A
Southwest	20	1374.000	68.700	A
S. Central	16	1130.000	70.625	A
Olympic	8	651.000	81.375	A

Observations: Olympic is higher but only 8 projects prevents it from being statistically significant. The K-W result is likely driven by Olympic region costs.

Best interpretation: The Olympic region projects are higher in cost and may be driving the cost differences seen in TIB SW region.

Expensive Overlays

Overlay projects were examined to find commonalities in expensive projects.

- **For the purposes of this analysis a project is considered "expensive" if it is over $40/yd^2**. In an informal conversation with Jeff Uhlmeyer, WSDOT State Pavement Engineer, he stated that WSDOT 1.8-inch overlay projects tend to cost $200,000 - $300,000 per lane mile. Higher costs are in the Northwest region and lower costs are typical east of the Cascade Mountains. A lane-mile is about 63,360 ft^2 (one 12-ft wide lane, 1 mile long), making WSDOT costs about $28-$42/yd^2. Given this, a reasonable cutoff to be considered "expensive" would be a project that is more expensive than the WSDOT average. A round number of $40/yd^2 was selected.
- **There are 27 "expensive" (> $40/yd^2) overlay projects in the data set**. These projects are listed in Table 1.

Findings

- **The median cost for all 117 TIB overlay projects is $23.68/yd^2 (less than WSDOT's typical cost)**. The median is a better statistic than the mean since the mean can be unduly influenced by one or two high-priced outliers. Even the mean ($29.60/yd^2) is within the typical WSDOT range for overlays. Looking closer at the data, it's that last quartile that is quite high (these 27 projects).
- **Most "expensive" projects (20 of 27) are recent (2013, 2014, 2015)**. The WSDOT construction cost index used to account for inflation in this analysis may not reflect true inflation for TIB projects. It may also be that average TIB project scopes change from year to year.
- **"Expensive" projects are spread out over all regions (both TIB and WSDOT)**. There is no geographic correlation.
- **Design costs, where listed, are reasonable**. One Mattawa project has a really high design cost ($102,800) indicating something extra may have been included. The rest are remarkably consistent at 5-15% of contract cost, which is typical.
- **Smaller (< 20,000 yd^2) projects tend to be more expensive**. While there are high cost projects of every size, 11 of the 14 projects less than 20,000 ft^2 are over $40/yd^2. However, there are high cost jobs in all size ranges. 20,000 ft^2 (about 1/3 of a lane-mile) could be used as a rough rule-of-thumb cutoff, below which one might expect higher priced construction on a per unit area basis. This could be verified by checking bid tabulations to ensure these cost observations hold true on a per ton basis (our assumption was a constant 2-inch HMA thickness on all overlay projects).
- **Some "expensive" projects may be so because they include thicker overlays than assumed or extensive non-pavement work (e.g., sidewalks, subgrade work, etc.)**. Bid tabs could be checked to verify this if necessary.

Chip Seals

FY	AGENCY	County	TIB Region	WSDOT Region	LENGTH (ft)	AREA (sqft)	DESIGN COST	CE COST	CONTRACT COST	TOTAL COST	COST / SQYD	Cost Inflation Factor (adjusted to 2013)	Contract Cost (adjusted to 2013)	Total Cost (adjusted ot 2013)	COSTt / SQYD (adjusted to 2013)
2014	ROY	Pierce	Southwest	Olympic	450	10,800	21,345	21,345	142,300	184,990	154.16	1.000	142,300.00	184,990.00	154.16
2013	NOOKSACK	Whatcom	Northwest	Northwest	886	19,492	12,530	3,133	239,337	255,000	117.74	1.000	239,337.00	255,000.00	117.74
2014	MOSSYROCK	Lewis	Southwest	Southwest	285	5,130	7,200	7,200	48,000	62,400	109.47	1.000	48,000.00	62,400.00	109.47
2014	TWISP	Okanogan	Northeast	North Central	930	28,260	20,000	20,000	210,000	250,000	79.62	1.000	210,000.00	250,000.00	79.62
2013	SPRAGUE	Lincoln	Northeast	Eastern	789	19,290			155,250	155,250	72.43	1.000	155,250.00	155,250.00	72.43
2015	MATTAWA	Grant	Southeast	North Central	2,600	62,400	102,800	0	342,900	445,700	64.28	1.000	342,900.00	445,700.00	64.28
2008	BLAINE	Whatcom	Northwest	Northwest	1,600	32,000			216,557	216,557	60.91	1.008	218,354.15	218,354.15	61.41
2009	FORKS	Clallam	Southwest	Olympic	750	19,500	7,390	2,610	119,704	129,704	59.86	1.090	130,439.78	141,336.65	65.23
2014	SOUTH BEND	Pacific	Southwest	Southwest	400	19,200	14,500	14,500	98,600	127,600	59.81	1.000	98,600.00	127,600.00	59.81
2014	TWISP	Okanogan	Northeast	North Central	390	9,800	5,176	5,176	54,348	64,700	59.42	1.000	54,348.00	64,700.00	59.42
2015	TWISP	Okanogan	Northeast	North Central	700	19,600	11,834	7,890	103,551	123,275	56.61	1.000	103,551.00	123,275.00	56.61
2015	MORTON	Lewis	Southwest	Southwest	1,680	47,040	28,700	28,700	229,600	287,000	54.91	1.000	229,600.00	287,000.00	54.91
2015	PE ELL	Lewis	Southwest	Southwest	1,500	33,000	23,205	23,205	154,700	201,110	54.85	1.000	154,700.00	201,110.00	54.85
2014	WHITE SALMON	Klickitat	Southeast	Southwest	1,150	18,400	8,810	8,810	92,500	110,120	53.86	1.000	92,500.00	110,120.00	53.86
2013	WAPATO	Yakima	Southeast	South Central	2,040	70,720	30,000	43,827	346,062	419,889	53.44	1.000	346,062.00	419,889.00	53.44
2012	ELMA	Grays Harbor	Southwest	Olympic	550	26,400	9,000	12,247	135,428	156,675	53.41	0.942	127,554.28	147,565.99	50.31
2013	MORTON	Lewis	Southwest	Southwest	2,600	71,200	41,631	41,631	333,047	416,309	52.62	1.000	333,047.00	416,309.00	52.62
2014	SULTAN	Snohomish	Northwest	Northwest	1,520	60,800	40,951	40,951	273,000	354,902	52.53	1.000	273,000.00	354,902.00	52.53
2013	HAMILTON	Skagit	Northwest	Northwest	2,475	56,250	18,772	23,772	267,106	309,650	49.54	1.000	267,106.00	309,650.00	49.54
2009	ROSLYN	Kittitas	Southeast	South Central	370	11,100			60,998	60,998	49.46	1.090	66,468.67	66,468.67	53.89
2012	RIDGEFIELD	Clark	Southwest	Southwest	4,000	88,000	15,586	44,000	416,328	475,914	48.67	0.942	392,122.88	448,244.58	45.84
2015	POMEROY	Garfield	Southeast	South Central	1,050	38,980	22,000	0	177,500	199,500	46.06	1.000	177,500.00	199,500.00	46.06
2015	WESTPORT	Grays Harbor	Southwest	Olympic	1,925	42,350	24,628	8,210	172,396	205,234	43.62	1.000	172,396.00	205,234.00	43.62
2015	GRANITE FALLS	Snohomish	Northwest	Northwest	1,540	36,960	20,131	20,131	134,200	174,462	42.48	1.000	134,200.00	174,462.00	42.48
2012	MABTON	Yakima	Southeast	South Central	475	9,504	4,650	4,650	35,526	44,826	42.45	0.942	33,460.53	42,219.84	39.98
2013	WATERVILLE	Douglas	Northeast	North Central	1,150	27,600	12,465		112,184	124,649	40.65	1.000	112,184.00	124,649.00	40.65
2012	CONCONULLY	Okanogan	Northeast	North Central	1,399	26,228	11,760	5,840	100,042	117,642	40.37	0.942	94,225.60	110,802.35	38.02

Table 1. 27 “Expensive” (> $40/yd^2) overlays.

These results contain just the chip seal projects (90 total).

Fiscal Year

Variable	Obs.	Minimum	Maximum	Mean	Std. deviation
2007	25	0.577	16.740	3.738	4.194
2008	10	1.825	4.086	2.797	0.857
2009	14	0.898	7.369	3.125	1.938
2010	8	0.616	6.729	2.814	1.802
2012	14	1.787	15.720	5.853	3.988
2013	6	1.829	4.825	3.367	1.099
2014	13	2.655	24.746	8.249	7.305

Kruskal-Wallis Result

The samples do not come from the same population. The risk to reject the null hypothesis H0 while it is true is lower than 0.50%.

Steel-Dwass-Critchlow-Fligner procedure Results

Sample	Frequency	Sum of ranks	Mean of ranks	Groups	
2007	25	898.000	35.920	A	
2010	8	289.000	36.125	A	
2008	10	385.000	38.500	A	
2009	14	547.000	39.071	A	B
2013	6	282.000	47.000	A	B
2012	14	818.000	58.429	A	B
2014	13	876.000	67.385		B

Observations: The most that can be said is that 2014 projects are definitely higher cost than the others. Also, 2007, 2008, and 2010 costs are lower than the others.

Interpretation: This may be a simple reflection that construction inflation is not entirely captured by the WSDOT Construction Cost Index. It may also reflect the typical project scope in each year (e.g., earlier projects had more limited scopes so the cost/yd^2 was lower).

Provider

Variable	Obs.	Minimum	Maximum	Mean	Std. deviation
City	3	0.577	2.599	1.846	1.105
Contractor	2	3.209	6.175	4.692	2.097
County	67	0.616	24.746	4.580	4.686
WSDOT	18	1.860	15.720	4.182	3.276

Kruskal-Wallis Result

The samples come from the same population. The risk to reject the null hypothesis H0 while it is true is lower than 38.03%.

Steel-Dwass-Critchlow-Fligner procedure Results

Sample	Frequency	Sum of ranks	Mean of ranks	Groups
City	3	69.000	23.000	A
County	67	3034.000	45.284	A
WSDOT	18	872.000	48.444	A
Contractor	2	120.000	60.000	A

Observations:

- There are far more projects done by the County than any other. This limits the effectiveness of statistics in determining differences.
- Most projects (85 out of 90) are done through the “county” or “WSDOT” meaning that these entities contract with contractors (some projects listed as “county” provider may have been self-performed by county crews) while the cities do not. Chip seals are rarely contracted by the cities themselves. TIB has identified the aggregation of projects at the WSDOT our County level as advantageous and this is, essentially, already happening.
- Since there are only 5 projects listed as “city” and “contractor” provider, a statistical comparison between WSDOT/County and City/Contractor does not show a statistically significant difference in cost (differences, real or not, would have to be very large to show a significant difference because of the small city/county sample size).

Best interpretation: No significant differences.

TIB Regions

Variable	Obs.	Minimum	Maximum	Mean	Std. deviation
Northwest	6	1.054	24.746	6.688	8.938
Northeast	40	0.743	16.740	4.522	3.594
Southwest	19	1.164	19.970	6.380	5.299
Southeast	25	0.577	4.844	2.194	1.016

Kruskal-Wallis Result

The samples do not come from the same population. The risk to reject H0 while it is true is lower than 0.04%.

Steel-Dwass-Critchlow-Fligner procedure Results

Sample	Frequency	Sum of ranks	Mean of ranks	Groups	
Southeast	25	695.000	27.800	A	
Northeast	40	1953.000	48.825		B
Northwest	6	301.000	50.167		B
Southwest	19	1146.000	60.316		B

Observations: The Southeast region is significantly lower than all the other regions. This is even true when only contract costs (not design and CE also) are considered.

Best interpretation: Something is happening beyond the data. Perhaps this reflects lower materials cost in the SE region, perhaps it reflects project scopes. Further analysis is needed.

WSDOT Regions

Variable	Obs.	Minimum	Maximum	Mean	Std. deviation
Eastern	32	0.743	16.740	4.606	3.851
Northwest	6	1.054	24.746	6.688	8.938
S. Central	7	2.131	4.844	3.000	0.953
N. Central	25	0.577	7.205	2.619	1.877
Olympic	7	2.655	17.065	5.457	5.199
Southwest	13	1.164	19.970	6.527	5.459

Kruskal-Wallis Result

The samples do not come from the same population. The risk to reject the null hypothesis H0 while it is true is lower than 2.31%.

Steel-Dwass-Critchlow-Fligner procedure Results

Sample	Frequency	Sum of ranks	Mean of ranks	Groups
N. Central	25	780.000	31.200	A
S. Central	7	295.000	42.143	A
Eastern	32	1555.000	48.594	A
Northwest	6	301.000	50.167	A
Olympic	7	394.000	56.286	A
Southwest	13	770.000	59.231	A

Observations: Low populations in some regions limit the ability of statistics to differentiate.

Interpretation: No significant differences. This grouping of regions does not see the same low cost for the TIB Southeast region. It could be a combination of the WSDOT South Central and Eastern Regions.

Further Analysis of WSDOT as a Chip Seal Provider

There is a thought that using WSDOT as a provider as opposed to other providers may allow TIB to obtain lower prices for comparable contracts. The practice of using WSDOT as a provider is especially prevalent in the WSDOT Eastern Region. SCPP contracts in this region (32 total) were analyzed to determine the validity of this thought.

The Kruskal-Wallis non-parametric test showed that null hypothesis (H0) that both WSDOT and County provider contracts come from the same population cannot be rejected. The risk to reject the null hypothesis H0 while it is true is 42.12%. In other words, they are not statistically significantly different.

Conclusion: There is no difference between provider costs in the WSDOT Eastern Region. However, there may be other information confounding this result. For instance, it may be that otherwise more expensive projects are preferentially assigned to WSDOT as a provider. However, no evidence of this exists.

Statistic	CONTRACTOR	COUNTY	WSDOT
Observations	1	19	12
Range	0.000	15.996	13.859
1st Quartile	6.175	1.931	2.697
Median	6.175	2.912	3.511
3rd Quartile	6.175	6.219	4.754
Mean	6.175	4.491	4.658
Variance (n-1)		16.584	14.409
St. Dev. (n-1)		4.072	3.796

