

**NATIONAL RADIO ASTRONOMY OBSERVATORY**  
Socorro, New Mexico

VLA Test Memo No. 208

**VLA Tie Deterioration Survey 1997**

L. Serna  
12/19/97

**I. Introduction**

This report summarizes the results of the Track Mainline "Tie" Survey conducted in Oct./Nov. of 1997. The survey was conducted by the Track Crew consisting of Paul Savedra, Pat Trujillo, Mike Torres and Adrain Pino. Only "mainline" track was inspected since work for the past 3 years has been concentrated on Station spur and D-Array locations. Station spur work was completed this year. This report does not address, rail, ballast, joint, sand, brush or any other problems associated with the track system. Bad ties are the dominant problem with the track system and their replacement would significantly improve the overall condition of the track.

In addition to the survey taken this year, information was gathered from the "Preliminary Review of The VLA Rail Track System" written by R. A. Sramek and G. A. Stanzione on July 3, 1986. The report indicates 190,000 ties overall with 180,000 main line ties and 10,000 antenna spur ties. The VLA Track system was installed using "used ties" and was completed in 1980.

In 1986 a detailed inspection was done on 86% of the Array which included Mainline and Station spur ties. The west arm from AW-5 To AW-9 was not inspected so the final tally of bad Ties was interpolated.

1986 Inspection:  
1986 BAD TIES (Actual = 31,980, Interpolated = 37,186)

1997 Survey:  
1997 BAD TIES (Mainline): 63,167 or 33% of total ties.  
See Appendix A.

**II. Rate of Tie Deterioration.**

Rail Tie replacement records are sketchy, but were adequate enough to make the following general approximations:

TIE REPLACEMENT:	
YEAR	TIES
1980-1986	4000
1987	5500
1988	4500
1989	2000
1990	1000
1991	1500
1992	5000
1993-1997	<u>6760</u>
TOTAL =	30260

Despite replacement of approximately 30,260 bad ties since 1980 (16% overall), we currently have 63,167 bad ties (33% overall). There are still approximately 159,740 used ties on the array. Used Ties are deteriorating at an average rate of approximately 3% per year. All used ties have exceeded their life expectancy of 1 to 15 years. New ties have a life expectancy of 20 to 40 years.

APPROX. RATE OF DETERIORATION PER YEAR:  
 1997 Bad Ties + Replaced = 63,167 + 30,260 = 93,427  
 Or-- %Bad ties since 1980= 93,427 / 190,000 = 49%  
 Avg. % Bad / Per Yr. = 49% / 17 yr. =2.9% /yr.

There are specific areas on the array where tie deterioration has increased considerably. The most probable reason for this is that the oldest ties are in these locations. There is a possibility that brush or sand has accelerated deterioration however, there is not enough survey data to conclusively support this idea.

**III. Tie Replacement:**

Track maintenance is an on going expense and effort at the VLA which will never end. Our current rate of replacement is approximately 2,000 ties / year or about 1%, (we have averaged about 1,595 in 17 years). Our current replacement effort does not adequately address the problem and we are steadily losing ground. In 15 years from now 50% of all ties on the array would be bad ties. We could never hope to keep up with maintenance and some locations of the array may become degraded to a point which will prohibit antenna moves. Figure 4 illustrates the problem. (Also see appendix B)

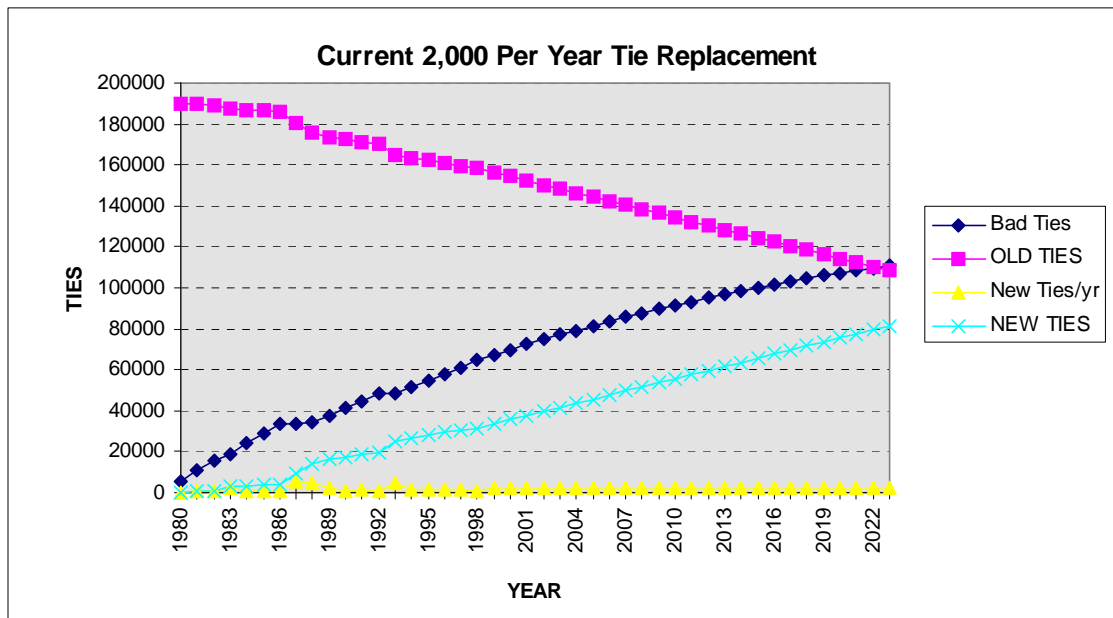


Figure-4

The following are necessary requirements to accomplish the 2,000 tie/year plan:

- |   |                                 |
|---|---------------------------------|
| Manpower: Summer 10 people:                                       | Equipment:                      |
| 5- Spikers (2 on bar, 2 on hammers, 1 gauging)                    | Backhoe - \$10,000/yr. (Rented) |
| 1- Tie Removal & Scarifying (backhoe)                             | \$45,000 (Purchased)            |
| 2- Spike pullers  |                                 |
| 1-Bobcat -(inserting ties)  |                                 |
| 1 Trailer- Tie shover (feeds ties to bobcat, Driver hauling ties) |                                 |

Winter: Alignment is also an ongoing job separate from tie replacement. Track alignment/repair consists of gauging, leveling, lifting and repairing intersections, replacing bad rail, bolts, splices etc.. Presently only 4 men have been available to do alignment. At this manpower level the work is very tedious and very little progress is made, usually only the worst areas can be attended to. Some work is saved until summer help is available. A 6 man team is more efficient for this work.

**A. 5K Ties/Yr. Plan.**

In order to reverse the “trend” it would be necessary to increase our tie replacement to around 5,000 ties a year. This plan reverses the trend, however, we will not reach 1986 levels of track condition until the year 2014. This plan would require additional manpower and equipment. Current manpower levels would need to be increased to 12 full time track crew personnel. The crew would replace Ties in the summer and do alignment, leveling and other maintenance repairs in the winter months. (Also see appendix B)

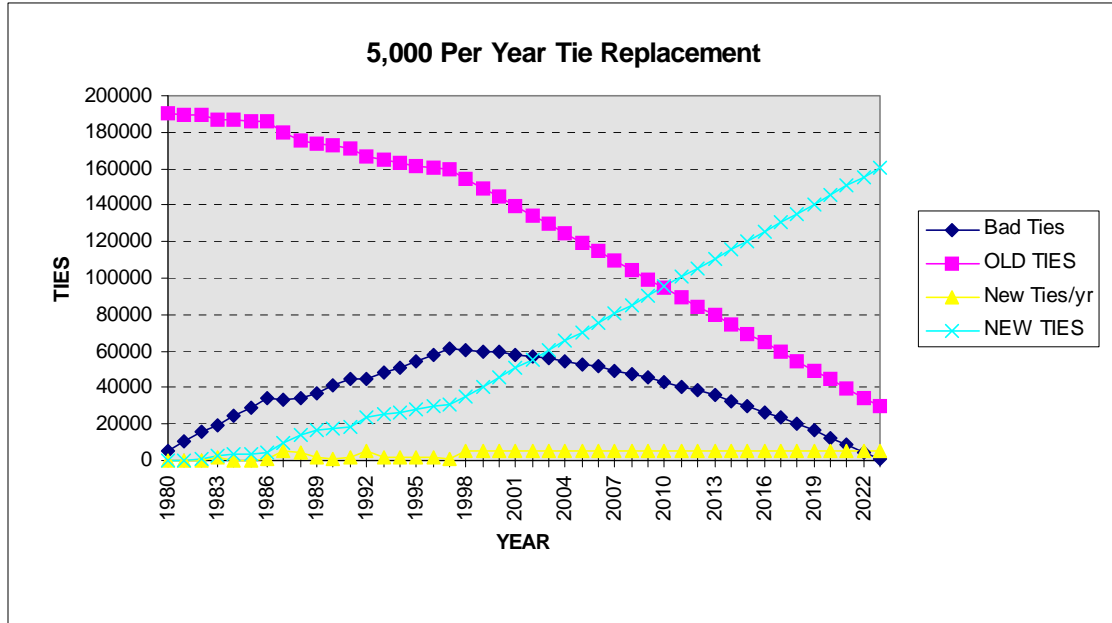


Figure 5.

The following are necessary requirements to accomplish the 5,000 tie/year plan:

Manpower: Summer 12 people required:

- 5- Spikers (2 on bar, 2 on hammers, 1 gauging)
- 1- Tie Removal & Scarifying (backhoe)
- 2- Spike pullers
- 1- Driver- (Boom truck hauling ties)
- 1-Bobcat -(inserting ties)
- 1 Trailer- Tie shover (feeds ties to bobcat)
- 1- Leadperson

Equipment:

- Backhoe - \$45,000
- Skidloader (new)- \$23,000

Also desirable but not critical:

- Scarifier tie inserter (used) \$16,000

Winter: 12 men required to do Alignment/repair and other maintenance work.

**B. 10K/5yr. , 5K/5yr, 2K Plan.**

In order to catch up, and make array track maintenance more manageable, a plan to replace 10,000 ties for five years, then 5,000 ties for another five years, then drop to 2,000 ties from then on should be considered. The following graph illustrates a 10, 5, 2 thousand plan. (Also see appendix B)

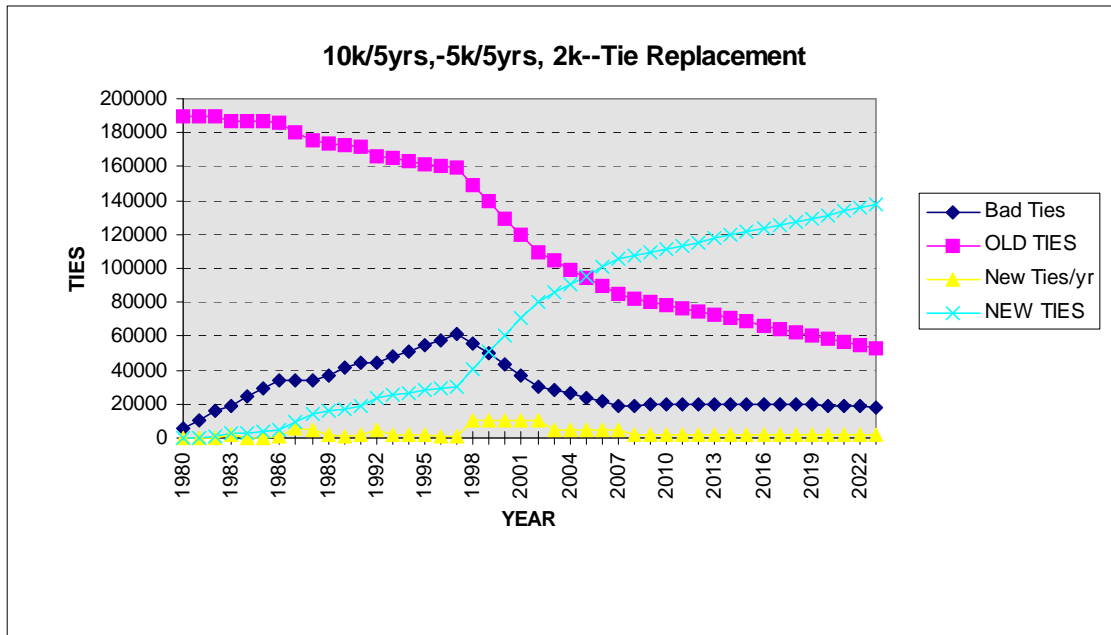


Figure 6

Summer:

Manpower: Two 12 man Teams (24 people for 5 yr.)

5- Spikers (2 on bar, 2 on hammers, 1 gauging)

1- Tie Removal & Scarifying

2- Spike pullers

1- Driver- (Boom truck hauling ties)

1-Bobcat -(inserting ties)

1-Trailer- Tie shover (feeds ties to bobcat)

1-Leadperson

Winter: 12 men required to do Alignment/repair and other maintenance work.

Equipment:

Backhoe - \$45,000

Skidloader (new)- \$23,000

2 Ballasters - \$30,000

40 track jacks - \$16,000

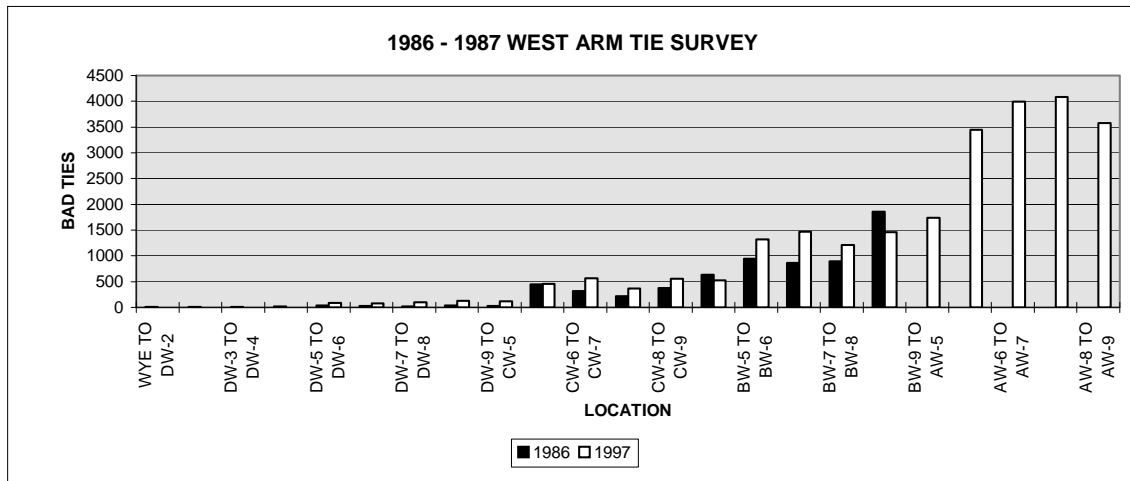
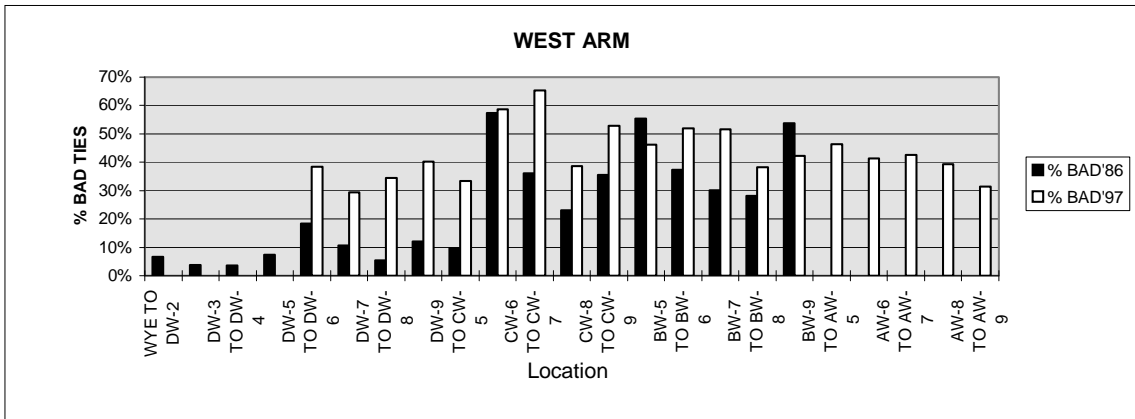
Tamper- (Surplus)

#### IV. Ballast:

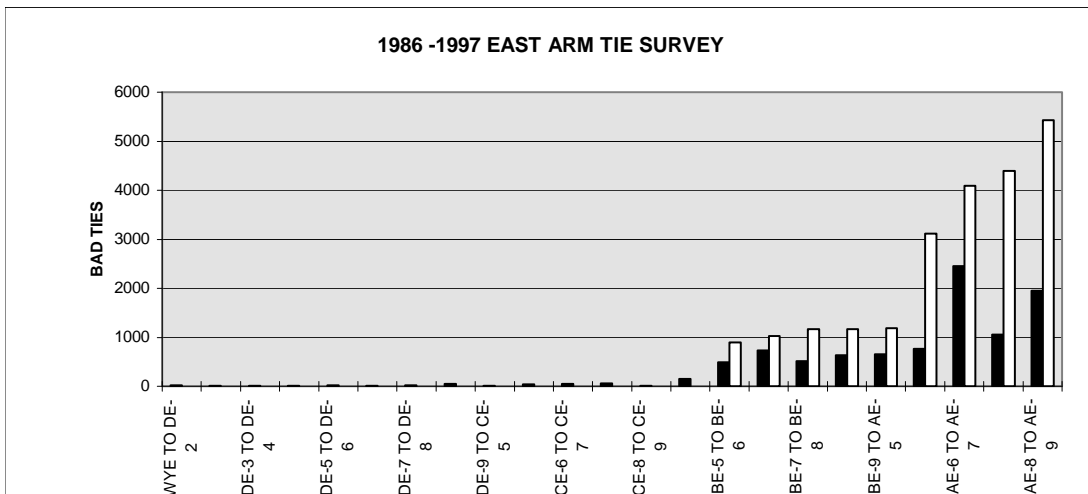
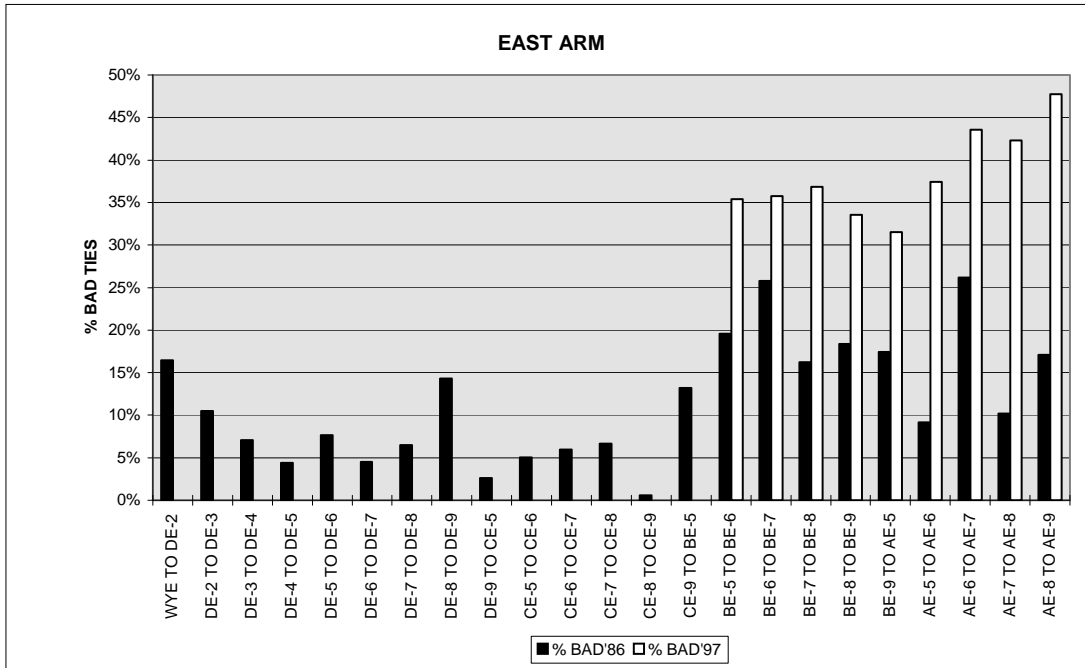
Current price for ballast is \$18/ton. Minimum recommended stockpile of ballast per year for the 5,000 Tie Replacement is 2,000 ton (\$36,000). Minimum recommended for the 10K, 5K, 2K Plan is 3,000 tons/ year (\$54,000/year).

APPENDIX A

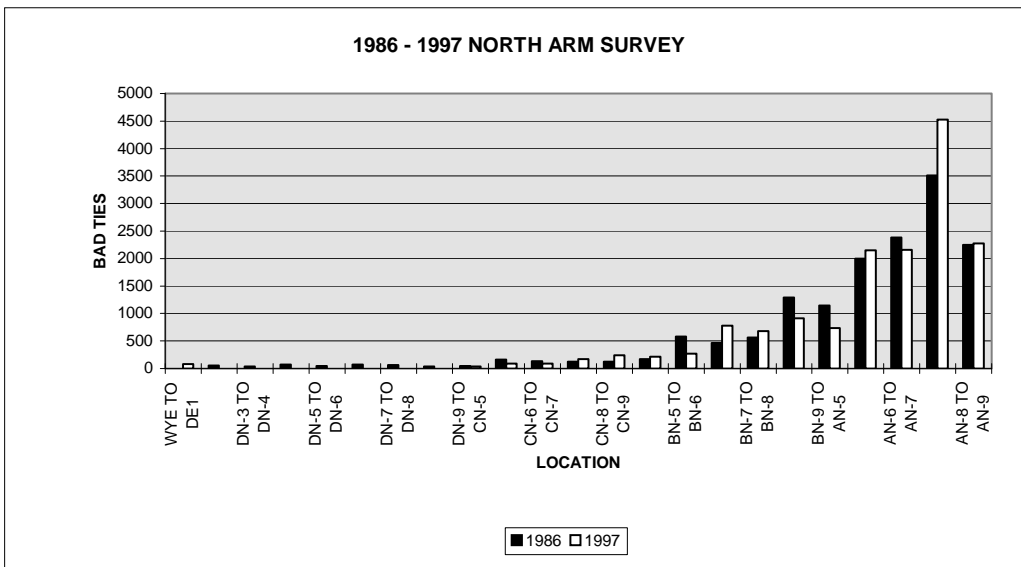
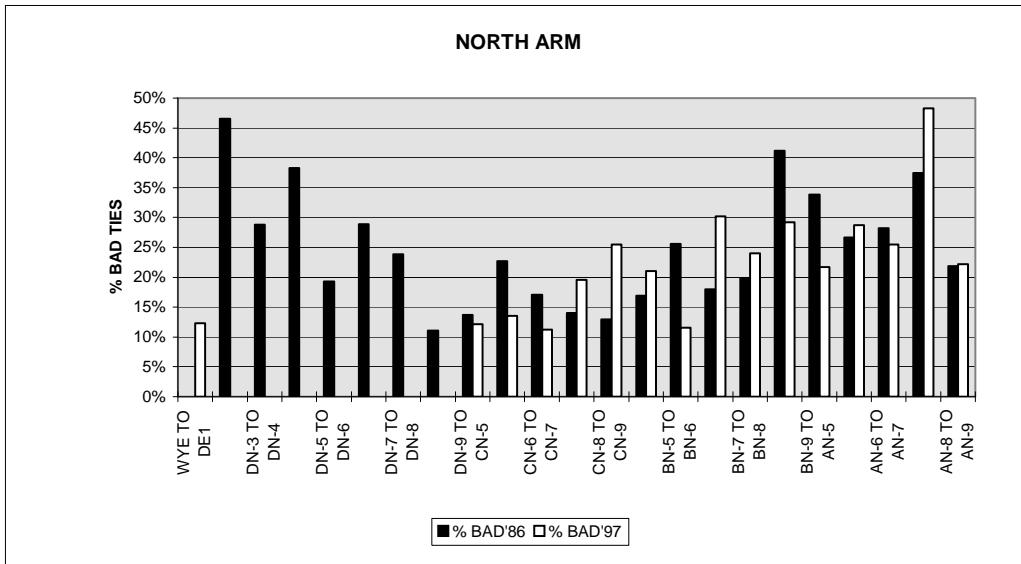
DATE				Aug-86	Aug-86	Nov-97	Nov-97			
LOCATION	% BAD'86	% BAD'97	% inc.	INSIDE	OUTSIDE	INSIDE	OUTSIDE	FT	TIES	Sand/Brush
WYE TO DW-2	7%		-100%	1	8			148	134	N
DW-2 TO DW-3	4%		-100%	2	3			148	134	N
DW-3 TO DW-4	4%		-100%	1	5			188	170	N
DW-4 TO DW-5	7%		-100%	5	10			226	204	N
DW-5 TO DW-6	18%	38%	109%	8	35	58	32	260	235	N
DW-6 TO DW-7	11%	29%	179%	7	21	42	36	294	265	N
DW-7 TO DW-8	5%	34%	531%	6	10	54	47	325	293	Y Both
DW-8 TO DW-9	12%	40%	231%	11	28	64	65	356	321	N
DW-9 TO CW-5	10%	33%	241%	5	29	61	55	385	347	Y Both
CW-5 TO CW-6	57%	59%	2%	188	255	216	237	855	771	Y Both
CW-6 TO CW-7	36%	65%	81%	111	203	296	272	964	870	Y Both
CW-7 TO CW-8	23%	39%	67%	95	128	178	194	1068	964	Y Inside
CW-8 TO CW-9	36%	53%	49%	185	190	283	274	1168	1054	Y Inside
CW-9 TO BW-5	55%	46%	-17%	432	200	222	305	1265	1141	Y Inside
BW-5 TO BW-6	37%	52%	39%	499	448	628	691	2810	2535	Y Inside
BW-6 TO BW-7	30%	52%	71%	434	426	757	715	3167	2857	Y Inside
BW-7 TO BW-8	28%	38%	36%	508	384	574	639	3509	3166	Y Inside
BW-8 TO BW-9	54%	42%	-21%	781	1081	729	734	3838	3463	Y Inside
BW-9 TO AW-5		46%				772	965	4156	3750	Y Inside
AW-5 TO AW-6		41%				1456	1989	9230	8328	Y Inside
AW-6 TO AW-7		43%				1827	2165	10404	9387	Y Inside
AW-7 TO AW-8		39%				1993	2091	11527	10400	Y Inside
AW-8 TO AW-9		31%				1951	1623	12608	11376	Y Inside
<b>TOTALS</b>				<b>3279</b>	<b>3464</b>	<b>12161</b>	<b>13129</b>	<b>68899</b>	<b>62165</b>	



DATE				Aug-86	Aug-86	Nov-97	Nov-97			
LOCATION	% BAD'86	% BAD'97	% Incr.	INSIDE	OUTSIDE	INSIDE	OUTSIDE	FT	TIES	Sand/Brush
WYE TO DE-2	16%	0%	-100%	9	13			148	134	N
DE-2 TO DE-3	10%	0%	-100%	5	9			148	134	N
DE-3 TO DE-4	7%	0%	-100%	2	10			188	170	N
DE-4 TO DE-5	4%	0%	-100%	4	5			226	204	N
DE-5 TO DE-6	8%	0%	-100%	11	7			260	235	N
DE-6 TO DE-7	5%	0%	-100%	8	4			294	265	N
DE-7 TO DE-8	6%	0%	-100%	9	10			325	293	N
DE-8 TO DE-9	14%	0%	-100%	16	30			356	321	N
DE-9 TO CE-5	3%	0%	-100%	5	4			385	347	N
CE-5 TO CE-6	5%	0%	-100%	14	25			855	771	N
CE-6 TO CE-7	6%	0%	-100%	21	31			964	870	N
CE-7 TO CE-8	7%	0%	-100%	34	30			1068	964	Y Inside
CE-8 TO CE-9	1%	0%	-100%		6			1168	1054	Y Inside
CE-9 TO BE-5	13%	0%	-100%	59	92			1265	1141	Y Inside
BE-5 TO BE-6	20%	35%	81%	232	264	435	463	2810	2535	N
BE-6 TO BE-7	26%	36%	39%	319	418	517	504	3167	2857	N
BE-7 TO BE-8	16%	37%	127%	212	302	585	582	3509	3166	N
BE-8 TO BE-9	18%	34%	83%	270	366	568	594	3838	3463	N
BE-9 TO AE-5	17%	32%	81%	284	369	562	620	4156	3750	N
AE-5 TO AE-6	9%	37%	310%	411	350	1348	1771	9230	8328	N
AE-6 TO AE-7	26%	44%	66%	1040	1417	1438	2652	10404	9387	Y Inside
AE-7 TO AE-8	10%	42%	316%	431	627	2172	2224	11527	10400	N
AE-8 TO AE-9	17%	48%	179%	827	1118	2623	2805	12608	11376	N
<b>TOTALS</b>				<b>4223</b>	<b>5494</b>	<b>10248</b>	<b>12215</b>	<b>68899</b>	<b>62165</b>	

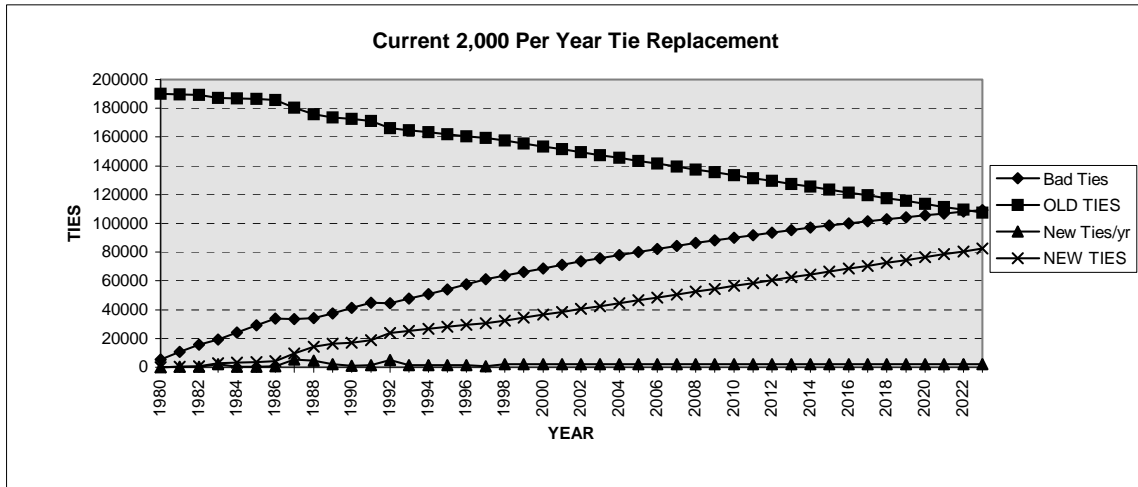


DATE				Aug-96	Aug-96	Nov-97	Nov-97			
LOCATION	% BAD'86	% BAD'97	% Incr.	INSIDE	OUTSIDE	INSIDE	OUTSIDE	FT	TIES	Sand/Brush
WYE TO DE1	0%	12%				27	50	695	627	N
DN-2 TO DN-3	47%	0%	-100%	38	17			131	118	N
DN-3 TO DN-4	29%	0%	-100%	14	20			131	118	N
DN-4 TO DN-5	38%	0%	-100%	28	40			197	178	N
DN-5 TO DN-6	19%	0%	-100%	15	26			235	212	N
DN-6 TO DN-7	29%	0%	-100%	12	57			265	239	N
DN-7 TO DN-8	24%	0%	-100%	11	52			293	264	N
DN-8 TO DN-9	11%	0%	-100%	14	18			321	290	N
DN-9 TO CN-5	14%	12%	-12%	14	29	14	24	347	313	N
CN-5 TO CN-6	23%	14%	-41%	59	99	50	44	771	696	N
CN-6 TO CN-7	17%	11%	-34%	55	79	46	42	869	784	Y Inside
CN-7 TO CN-8	14%	20%	39%	45	77	86	84	963	869	N Water
CN-8 TO CN-9	13%	25%	97%	45	78	188	54	1053	950	N Water
CN-9 TO BN-5	17%	21%	25%	76	98	127	90	1141	1029	Y Inside
BN-5 TO BN-6	26%	12%	-55%	253	332	114	151	2534	2286	Y Inside
BN-6 TO BN-7	18%	30%	68%	144	320	398	380	2856	2577	Y Inside
BN-7 TO BN-8	20%	24%	21%	263	304	360	325	3164	2855	Y Inside
BN-8 TO BN-9	41%	29%	-29%	631	655	501	410	3461	3123	N
BN-9 TO AN-5	34%	22%	-36%	622	523	389	344	3747	3381	N
AN-5 TO AN-6	27%	29%	8%	903	1097	1152	1002	8323	7509	Y Outside
AN-6 TO AN-7	28%	26%	-9%	982	1405	1094	1067	9381	8464	Y Outside
AN-7 TO AN-8	37%	48%	29%	1809	1700	2518	2010	10393	9377	N
AN-8 TO AN-9	22%	22%	1%	1020	1226	1110	1163	11368	10257	N
<b>TOTALS</b>				<b>7053</b>	<b>8252</b>	<b>8174</b>	<b>7190</b>	<b>62639</b>	<b>56516</b>	



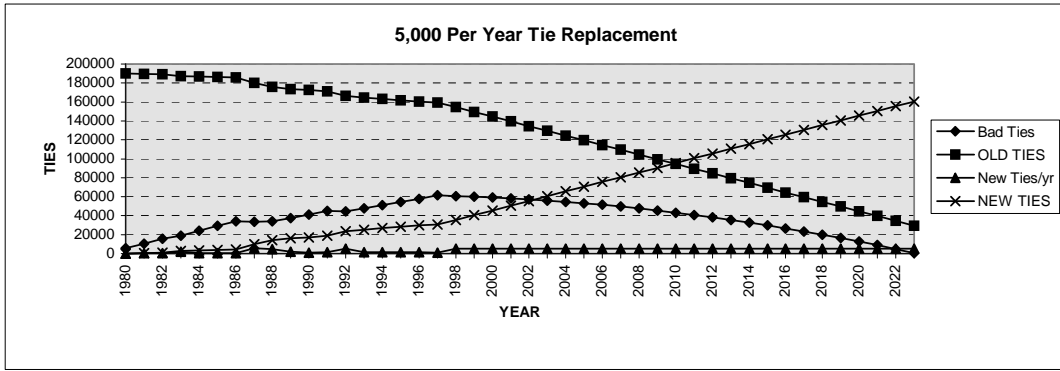


## APPENDIX B



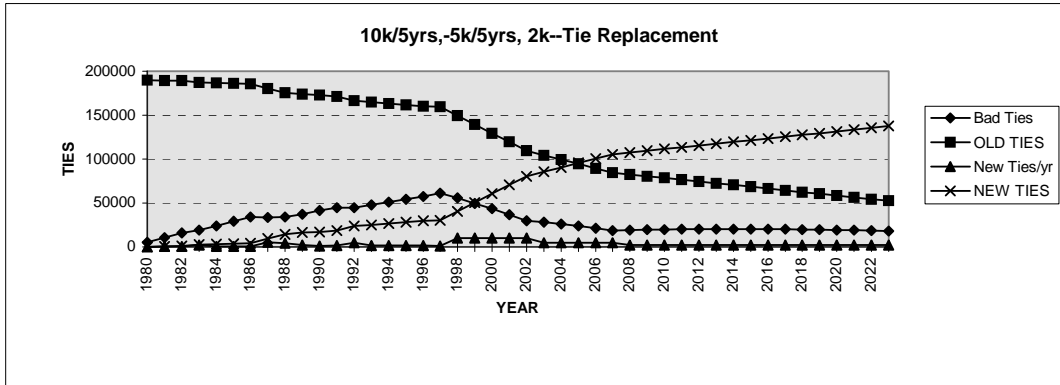
YEAR	Bad Ties	OLD TIES	New Ties/yr	NEW TIES	Ties, Spikes, Bolts Approx. Mt'l Cost	3% Inflation Cost/tie
1980	5510	190000	0	0		
1981	10608	189600	400	400		
1982	15695	189200	400	800		
1983	19124	187200	2000	2800		
1984	24141	186800	400	3200		
1985	29147	186400	400	3600		
1986	33884	185750	650	4250		
1987	33611	180250	5500	9750		
1988	34208	175750	4500	14250		
1989	37246	173750	2000	16250		
1990	41256	172750	1000	17250		
1991	44722	171250	1500	18750		
1992	44544	166250	5000	23750		
1993	47821	164750	1500	25250		
1994	51056	163250	1500	26750		
1995	54246	161750	1500	28250		
1996	57486	160340	1410	29660		
1997	61261	159490	850	30510		
1998	63829	157490	2000	32510	\$ 61,700.00	\$ 30.25
1999	66338	155490	2000	34510	\$ 63,515.00	\$ 31.16
2000	68789	153490	2000	36510	\$ 65,384.45	\$ 32.09
2001	71182	151490	2000	38510	\$ 67,309.98	\$ 33.05
2002	73517	149490	2000	40510	\$ 69,293.28	\$ 34.05
2003	75795	147490	2000	42510	\$ 71,336.08	\$ 35.07
2004	78014	145490	2000	44510	\$ 73,440.16	\$ 36.12
2005	80175	143490	2000	46510	\$ 75,607.37	\$ 37.20
2006	82278	141490	2000	48510	\$ 77,839.59	\$ 38.32
2007	84323	139490	2000	50510	\$ 80,138.78	\$ 39.47
2008	86311	137490	2000	52510	\$ 82,506.94	\$ 40.65
2009	88240	135490	2000	54510	\$ 84,946.15	\$ 41.87
2010	90111	133490	2000	56510	\$ 87,458.53	\$ 43.13
2011	91924	131490	2000	58510	\$ 90,046.29	\$ 44.42
2012	93680	129490	2000	60510	\$ 92,711.68	\$ 45.76
2013	95377	127490	2000	62510	\$ 95,457.03	\$ 47.13
2014	97016	125490	2000	64510	\$ 98,284.74	\$ 48.54
2015	98597	123490	2000	66510	\$ 101,197.28	\$ 50.00
2016	100120	121490	2000	68510	\$ 104,197.20	\$ 51.50
2017	101586	119490	2000	70510	\$ 107,287.12	\$ 53.04
2018	102993	117490	2000	72510	\$ 110,469.73	\$ 54.63
2019	104342	115490	2000	74510	\$ 113,747.82	\$ 56.27
2020	105633	113490	2000	76510	\$ 117,124.26	\$ 57.96
2021	106866	111490	2000	78510	\$ 120,601.98	\$ 59.70
2022	108042	109490	2000	80510	\$ 124,184.04	\$ 61.49
2023	109159	107490	2000	82510	\$ 127,873.56	\$ 63.34

\$ 2,363,659.06



YEAR	Bad Ties	OLD TIES	New Ties/yr	NEW TIES	Ties, Spikes, Bolts Approx. Mt'l Cost	3% Inflation Cost/tie
1980	5510	190000	0	0		
1981	10608	189600	400	400		
1982	15695	189200	400	800		
1983	19124	187200	2000	2800		
1984	24141	186800	400	3200		
1985	29147	186400	400	3600		
1986	33884	185750	650	4250		
1987	33611	180250	5500	9750		
1988	34208	175750	4500	14250		
1989	37246	173750	2000	16250		
1990	41256	172750	1000	17250		
1991	44722	171250	1500	18750		
1992	44544	166250	5000	23750		
1993	47821	164750	1500	25250		
1994	51056	163250	1500	26750		
1995	54246	161750	1500	28250		
1996	57486	160340	1410	29660		
1997	61261	159490	850	30510		
1998	60742	154490	5000	35510	\$ 154,250.00	\$ 30.25
1999	60077	149490	5000	40510	\$ 158,787.50	\$ 31.16
2000	59267	144490	5000	45510	\$ 163,461.13	\$ 32.09
2001	58312	139490	5000	50510	\$ 168,274.96	\$ 33.05
2002	57212	134490	5000	55510	\$ 173,233.21	\$ 34.05
2003	55968	129490	5000	60510	\$ 178,340.20	\$ 35.07
2004	54578	124490	5000	65510	\$ 183,600.41	\$ 36.12
2005	53043	119490	5000	70510	\$ 189,018.42	\$ 37.20
2006	51363	114490	5000	75510	\$ 194,598.97	\$ 38.32
2007	49538	109490	5000	80510	\$ 200,346.94	\$ 39.47
2008	47569	104490	5000	85510	\$ 206,267.35	\$ 40.65
2009	45454	99490	5000	90510	\$ 212,365.37	\$ 41.87
2010	43194	94490	5000	95510	\$ 218,646.33	\$ 43.13
2011	40789	89490	5000	100510	\$ 225,115.72	\$ 44.42
2012	38240	84490	5000	105510	\$ 231,779.20	\$ 45.76
2013	35545	79490	5000	110510	\$ 238,642.57	\$ 47.13
2014	32705	74490	5000	115510	\$ 245,711.85	\$ 48.54
2015	29720	69490	5000	120510	\$ 252,993.20	\$ 50.00
2016	26590	64490	5000	125510	\$ 260,493.00	\$ 51.50
2017	23316	59490	5000	130510	\$ 268,217.79	\$ 53.04
2018	19896	54490	5000	135510	\$ 276,174.32	\$ 54.63
2019	16331	49490	5000	140510	\$ 284,369.55	\$ 56.27
2020	12621	44490	5000	145510	\$ 292,810.64	\$ 57.96
2021	8766	39490	5000	150510	\$ 301,504.96	\$ 59.70
2022	4767	34490	5000	155510	\$ 310,460.11	\$ 61.49
2023	622	29490	5000	160510	\$ 319,683.91	\$ 63.34

\$ 5,909,147.64



YEAR	Bad Ties	OLD TIES	New Ties/yr	NEW TIES	Ties, Spikes, Bolts Approx. Mt'l Cost	3% Inflation Cost/tie
1980	5510	190000	0	0		
1981	10608	189600	400	400		
1982	15695	189200	400	800		
1983	19124	187200	2000	2800		
1984	24141	186800	400	3200		
1985	29147	186400	400	3600		
1986	33884	185750	650	4250		
1987	33611	180250	5500	9750		
1988	34208	175750	4500	14250		
1989	37246	173750	2000	16250		
1990	41256	172750	1000	17250		
1991	44722	171250	1500	18750		
1992	44544	166250	5000	23750		
1993	47821	164750	1500	25250		
1994	51056	163250	1500	26750		
1995	54246	161750	1500	28250		
1996	57486	160340	1410	29660		
1997	61261	159490	850	30510		
1998	55597	149490	10000	40510	\$ 308,500.00	\$ 30.25
1999	49642	139490	10000	50510	\$ 317,575.00	\$ 31.16
2000	43397	129490	10000	60510	\$ 326,922.25	\$ 32.09
2001	36862	119490	10000	70510	\$ 336,549.92	\$ 33.05
2002	30037	109490	10000	80510	\$ 346,466.42	\$ 34.05
2003	28068	104490	5000	85510	\$ 178,340.20	\$ 35.07
2004	25953	99490	5000	90510	\$ 183,600.41	\$ 36.12
2005	23693	94490	5000	95510	\$ 189,018.42	\$ 37.20
2006	21288	89490	5000	100510	\$ 194,598.97	\$ 38.32
2007	18738	84490	5000	105510	\$ 200,346.94	\$ 39.47
2008	19131	82490	2000	107510	\$ 82,506.94	\$ 40.65
2009	19465	80490	2000	109510	\$ 84,946.15	\$ 41.87
2010	19741	78490	2000	111510	\$ 87,458.53	\$ 43.13
2011	19959	76490	2000	113510	\$ 90,046.29	\$ 44.42
2012	20120	74490	2000	115510	\$ 92,711.68	\$ 45.76
2013	20222	72490	2000	117510	\$ 95,457.03	\$ 47.13
2014	20266	70490	2000	119510	\$ 98,284.74	\$ 48.54
2015	20252	68490	2000	121510	\$ 101,197.28	\$ 50.00
2016	20180	66490	2000	123510	\$ 104,197.20	\$ 51.50
2017	20051	64490	2000	125510	\$ 107,287.12	\$ 53.04
2018	19863	62490	2000	127510	\$ 110,469.73	\$ 54.63
2019	19617	60490	2000	129510	\$ 113,747.82	\$ 56.27
2020	19313	58490	2000	131510	\$ 117,124.26	\$ 57.96
2021	18951	56490	2000	133510	\$ 120,601.98	\$ 59.70
2022	18532	54490	2000	135510	\$ 124,184.04	\$ 61.49
2023	18054	52490	2000	137510	\$ 127,873.56	\$ 63.34

\$ 4,240,012.89