

29-H530/2:1995

STATE HIGHWAY PRESERVATION REPORT

January 1995



Operations Analysis Division



STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

STATE HIGHWAY PRESERVATION REPORT
JANUARY 1995

Report to the 1995 Legislature
As Required by NRS 408.203 (3)

NDOT Mission

To efficiently plan, design, construct and maintain a safe and effective highway system for Nevada's travelers with full regard for the environmental, social, and economic needs of the state, including seamless integration with air and rail transportation and promotion of public transportation, bicycle and pedestrian facilities.

Prepared by:
Operations Analysis

TABLE OF CONTENTS

EXECUTIVE SUMMARY	1
INTRODUCTION	3
FUNDING	4
General	4
Intermodal Surface Transportation Efficiency Act of 1991	4
NEVADA HIGHWAY NETWORK	5
National Highway System	5
Interstate Routes	5
Surface Transportation Program	5
Access-Frontage Roads	5
PAVEMENTS	7
Managing Pavements in Nevada	7
Background	7
Change in Priority	7
Pavement Condition Survey	8
Project Priorities	11
FHWA Review	11
Continuing Research	12
Pavement Management at the Local Government Level	12
Development of a Relational Database	14
Survey Results	16
Table 1: Status of the existing system	16
Table 2: Backlog of pavement resurfacing, restoration, rehabilitation and reconstruction (4R) needs	17
Figure 1: Map showing roadways in need of an overlay or pavement reconstruction in 1995	18
Figure 1A: Local maps showing roadways in need of an overlay or pavement reconstruction in 1995	19
Deterioration	20

Figure 2: Normal pavement life cycles	20
Maintenance	21
Figure 3: Cost of deferring maintenance	21
Biennial Expenditures, Fiscal Years 1993-94	24
Figure 4: Map showing overlay and pavement reconstruction projects awarded July 1, 1992 through June 30, 1994	25
Figure 4A: Local maps showing overlay and pavement reconstruction projects awarded July 1, 1992 through June 30, 1994	26
Figure 5: Roadway maintenance, overlay and reconstruction needs, 1982-95	27
Cost Estimates	28
Table 3: Costs necessary to preserve the existing system	29
Explanation of Table 3	30
Table 4: State funds necessary to preserve the existing system	31
Figure 6: Comparison of backlog 3R needs - present vs needed funding	32
 BRIDGES	 33
General	33
Sufficiency Rating	33
Bridge Inventory	34
Status of State Bridges	35
Status of County and City Bridges	37
Funding	38
Seismic Retrofit	38
 RESEARCH	 41
Strategic Highway Research Program	41
Development of Pavement Lifecycle Curves	43
Recycled Rubber	44
 CONCLUSION	 45

EXECUTIVE SUMMARY

The State of Nevada has built and now maintains about 5,400 miles of streets and highways. This State Highway Preservation Report is created biennially by the Nevada Department of Transportation to present a summary of the pavement condition on the state's highway system. As we enter fiscal year 1996, the backlog of pavement rehabilitation work consists of 3,080 lane miles in need of an overlay or reconstruction. The estimated cost to eliminate this backlog is \$348 million. NDOT will not seek additional revenues for the next biennium but mild revenue increases may be necessary to continue funding the highway preservation program in the future.

This report contains a detailed description of Nevada's Pavement Management System. This section discusses the history of the PMS, how it's used now and how it will streamline pavement preservation in the future. The PMS is the foundation on which this report is created.

A new addition to the report this year is an overview on the status of Nevada's bridges and the funding needs for their preservation. Not only is rehabilitation for normal deterioration examined, but also the need to retrofit bridges to survive earthquakes. More than 300 bridges built prior to 1975 standards may require seismic retrofitting. Nevada receives approximately \$6.3 million in federal bridge funds each year to administer the Bridge Inventory and rehabilitate and replace bridges. About \$2 million of that is designated for seismic retrofit.

This report also introduces the new Federal Highway System designation. Previously, Nevada's highways had been designated as federal-aid interstate, primary, urban and secondary routes; state-aid routes; and access-frontage roads. The new designations as set

forth by the Intermodal Surface Transportation Efficiency Act of 1991, are as follows:

National Highway System - The NHS is a system of major roads including all interstate routes, a large percentage of urban and rural principal arterials, the defense strategic highway network, and strategic connectors.

Interstate Routes - Although part of the NHS, interstate routes will retain a separate identity. The interstate is a system of national highways designed to connect principal metropolitan areas, cities and industrial centers, to serve the national defense, and to connect suitable border points.

Surface Transportation Program - The STP is a new statewide flexible program that may be used for any roads (including NHS) that are not functionally classified as local or rural minor collectors.

Access-Frontage Roads - These roads are functionally classified as local or rural minor collectors that provide access to streets and highways on the NHS or to roadways covered under the STP. These roads are not eligible for federal funds and are maintained exclusively with state funds.

INTRODUCTION

Federal-aid first became available to Nevada for highway construction in 1917, and the state has since built and now maintains 5,413 miles of streets and highways. While this represents only 12 percent of the total public road mileage in the state, this system carries 68 percent of all traffic and more than 90 percent of all heavy trucks. This network of streets and highways serves as the state's transportation lifeline, linking all communities across Nevada. Our investment in this network is substantial. Today's cost to replace the pavement surface alone is about \$3 billion.

This investment must be protected and the preservation of the existing highway system is one of the Nevada Department of Transportation's top priorities. However, even with proper maintenance these highways wear out and eventually require reconstruction and modernization.

Nevada must face the reality that the welfare, economic growth and diversification of the state's economy relies heavily on a safe, efficient network of streets and highways.

NDOT developed a pavement management system that enables NDOT managers to objectively monitor the condition of the state's highway network, and to project the resources required to maintain the network at the desired service level.

FUNDING

General

Nevada does not finance state highway programs from General Fund (general tax) revenues. These programs are financed exclusively from dedicated state highway-user revenues and federal funds. Federal funds are available only for reimbursement of expenditures on approved projects. Federal aid is not available or used for routine maintenance, administration, or other non-project related costs.

Intermodal Surface Transportation Efficiency Act of 1991

The Intermodal Surface Transportation Efficiency Act of 1991 provides federal appropriations for highways, highway safety, and mass transportation through fiscal year 1997. The purpose of ISTEA (referred to as "ice tea"), as written in its statement of policy, is "to develop a National Intermodal Transportation System that is economically efficient, environmentally sound, provides the foundation for the nation to compete in the global economy and will move people and goods in an energy-efficient manner."

NEVADA HIGHWAY NETWORK

National Highway System

One provision of ISTEA is the National Highway System. It is a system of major roads including all interstate routes, a large percentage of urban and rural principal arterials, the defense strategic highway network, and strategic connectors.

Interstate Routes

Although part of the NHS, interstate routes will retain a separate identity. The interstate is a system of national highways designed to connect principal metropolitan areas, cities and industrial centers, to serve the national defense, and to connect suitable border points.

Surface Transportation Program

The Surface Transportation Program is a new statewide flexible program that may be used for any roads (including NHS) that are not functionally classified as local or rural minor collectors.

Access-Frontage Roads

Access-frontage roads are those functionally classified as local or rural minor collectors that provide access to streets and highways on the NHS or to roadways covered under the STP. These roads are not eligible for federal funds and are maintained exclusively with state funds.

ISTEA required each state to submit a proposed highway system based on functional classification by Dec. 31, 1992. The U.S.

Secretary of Transportation must approve the new national system of public roads and streets and report to Congress by Sept. 30, 1995. Beginning with this document, NDOT will designate its highway system using functional classification.

PAVEMENTS

Managing Pavements in Nevada

NDOT's Pavement Management System was developed by an in-house advisory committee in 1979 and 1980. The impetus to develop the system came from the department's need to quantify and prioritize statewide pavement needs.

Background

From the 1920s to the 1970s NDOT focused its attention mainly on new street and highway construction. By the late 1970s, a schedule of state highway user fees that worked well for 50 years began to run into trouble. Fuel shortages created by an oil embargo prompted the development of more fuel-efficient vehicles, which leveled off fuel consumption and gas tax revenue. Double-digit inflation robbed the purchasing power of the dollar for highway construction with its high dependency on petroleum products, and a tremendous population explosion saw Nevada's population increase 50 percent in 10 years. These elements all contributed to an accelerated rate of pavement deterioration on the state's aging network of streets and highways, leaving an enormous backlog of pavement rehabilitation and reconstruction work, and inadequate funding.

Change in Priority

NDOT was forced to re-evaluate its highway program and changed its No. 1 priority from new construction to preserving the existing highway system. NDOT's Pavement Management System was developed to quantify the backlog of pavement repairs on the state highway network, to identify project priorities, and to monitor the state's

progress toward eliminating the backlog of pavement work. The PMS is also used to identify NDOT's long-range funding needs to maintain the state highway network at a serviceable level.

Pavement Condition Survey

NDOT conducts a pavement condition survey annually. During this survey a rating section from each mile in each direction of every state-maintained highway is evaluated. The severity and extent of the following pavement distresses are measured and recorded:

- Road Roughness (rideability)
- Rut Depth
- Alligator Cracking
- Linear Cracking
- Bleeding
- Ravelling

NDOT also has a pavement friction testing program. Friction testing on Nevada's Interstate Highway System is performed annually. On the remainder of the National Highway System, friction testing is conducted every two years, and roadways under the Surface Transportation Program are tested every three years. The department automatically schedules friction testing on any roadway that has received a pavement overlay or has experienced pavement related traffic accidents.

These condition data are then entered into the PMS's pavement condition file and through computer analysis each section surveyed is assigned pavement condition distress points commensurate with the severity and extent of each distress, and the magnitude of the repair strategies required to repair the pavement. Each section is also placed into one of four repair strategy categories based on an accumulation of pavement distress points.

Accumulated PMS
Distress Points

Repair Strategy

0-49	Preventive maintenance
50-399	Corrective maintenance
400-699	Overlay
700 or greater	Reconstruct

Centerline mileage for each highway system is categorized into one of these repair strategies, giving an indication of the overall health of the state highway network. Later in this report, each lane mile categorized in need of an overlay or reconstruction is evaluated to determine the estimated cost to complete all identified pavement rehabilitation work.



**Preventive
Maintenance**



**Corrective
Maintenance**



Overlay



Reconstruct

Project Priorities

A list of statewide candidate pavement preservation projects is developed, and each project is assigned a priority score up to a maximum of 10, with 10 indicating a perfect road. The lower the score, the higher the project will rank in the priority list. The priority score is calculated for each project by assigning the following weights to the following elements:

<u>Element</u>		<u>Priority Weight</u>
Road roughness (rideability)	=	15%
Pavement condition	=	65%
Maintenance cost effectiveness	=	10%
Safety (pavement- related accidents and low pavement friction numbers)	=	10%

FHWA Review

In 1989, pavement engineers from the Federal Highway Administration reviewed the PMS to determine if it contained the elements required by federal regulations under Federal Highway Program Manual 6-2-4-1. Based on this review, three areas were identified as needing improvement or expansion to comply with the FHWA's Pavement Policy Directive:

1. Expansion of the physical features inventory to include pavement structural materials, types, thicknesses and dates of major work activities (project history data).
2. An automated common database system for storage and easy retrieval of pavement condition data, physical features inventory, pavement maintenance history, etc.

3. Expansion of data analysis capabilities to include development of pavement performance curves and optimization of pavement maintenance and rehabilitation strategies.

NDOT's lack of a modern relational database management system delayed its progress to bring its PMS up to the technical level required by the FHWA's pavement policy. However, the federal directive provided the impetus that enabled NDOT to acquire the computer hardware and software necessary to bring compliance.

Continuing Research

Current research is focused on developing life-cycle cost analyses that will indicate when to apply the above maintenance and rehabilitation strategies to achieve the desired pavement serviceability at a minimum cost. Continuing PMS research will concentrate on developing a program to systematically update pavement performance models and to develop a network-optimization system. The department has recently tightened up pavement materials and construction specifications, and it is imperative that PMS performance models reflect the latest construction practices and materials to achieve accurate results. The development of a network-optimization system will indicate how to invest NDOT's limited financial resources to provide the best highway performance at the network level. The network-optimization system will also have the capability to determine the minimum investment level required to bring the overall condition of Nevada's highway system up to any desired level of serviceability.

Pavement Management at the Local Government Level

ISTEA expanded the federal-aid highway system to include all streets and highways functionally classified above the level of

local or rural minor collector. ISTEA requires that all roadways on this federal-aid system to be covered by a formal pavement management system, whether under state or local government jurisdiction. Although pavement management systems at the local government level may be less complex than those at the state level, all require certain components, including:

1. Inventory - Physical pavement features including the number of lanes, length, width, surface type, functional classification and shoulder information.
2. History - Project dates and types of construction, reconstruction, rehabilitation and maintenance.
3. Condition survey - Roughness or ride, pavement distress, rutting and surface friction.
4. Traffic - Volumes, vehicle type and load data.
5. Database - Compilation of all data files used in the PMS.

A PMS, under ISTEA, must perform the following analyses:

1. Condition analysis - Includes ride, distress, rutting and surface friction.
2. Performance analysis - Includes pavement performance analysis and an estimate of remaining service life.
3. Investment analysis - Includes an estimate of network and project-level investment strategies. Project level includes single and multi-year period analyses and should consider life-cycle cost evaluation.
4. Engineering analysis - Includes the evaluation of design, construction, rehabilitation, materials, mix designs and maintenance.
5. Feedback analysis - Includes the evaluation and updating of procedures and calibration of relationships using PMS performance data and current engineering criteria.

Development of a Relational Database

NDOT's PMS development has been hindered by the lack of access to a relational database management system. We have pavement condition history for every year back to 1982, but access to these data for analysis and comparison to more recent data is not an easy process. These data reside on the state's ES-9000 mainframe computer. The mainframe computer is shared by all other state agencies. Historically, Nevada's state agencies were not allowed to develop data processing capabilities independent from the state's Department of Information Services. All of our computer runs were executed in batch mode, and it frequently took hours to receive a hard copy.

On-line access was limited by demand and cost. Approximately four years ago, the mainframe policy was relaxed. NDOT developed a strategic plan to enhance data processing capabilities. The plan included the installation of an IBM/AS-400 mid-range computer at NDOT headquarters. IBM personal computers were connected to the AS-400, and the AS-400 became the link from PC's to the mainframe. The wheels of progress in state government move slowly, however, and modern technology has made our "strategic plan" outdated before implementation could be completed.

The PMS database will be the core of NDOT'S corporate database. We are moving files electronically from the mainframe to the AS-400. All features that can be identified at a specific location on NDOT's street and highway network will reside in the database. Several references are planned for access to these data, including: milepost, kilometerpost, engineer stationing, geodetic coordinates, Universal Transverse Mercator grid, state plane coordinate system, etc.

It will be several years before all of NDOT's files, with many not in an electronic format, are included in the database. We plan

to continue moving in that direction, however, and NDOT's corporate database will ultimately support a Geographic Information System.

NDOT has long been committed to pavement management. Its PMS has proven to be an effective tool to inform the State Legislature of the additional revenue needed to fund the state's Pavement Preservation Program, and to ensure that NDOT's limited financial resources are spent wisely.

NDOT will continue its search for new and innovative technologies to incorporate into its pavement program in the pursuit of improved pavement performance and to provide a safe, efficient and economical highway system for the movement of people and goods in Nevada.

Survey Results

Reports from the 1994 pavement condition survey indicate that of a total state highway network of 12,988 lane miles, 2,153 lane miles are presently in need of an overlay, and 927 lane miles need to be reconstructed.

Combined, the total overlay and reconstruction needs are 3,080 lane miles (24 percent of the system) and the estimated cost to accomplish this work, in 1995 dollars, is \$348.2 million. Table 1 illustrates the status of the Nevada highway system in centerline miles and Table 2 the estimated cost to eliminate the backlog of work.

1995
Status of the Existing System
(reported in centerline miles)

System	Preventive Maintenance	Corrective Maintenance	Overlay	Reconstruct	Total
Principal Arterial - Interstate	219	259	17	50	545
Principal Arterial - Non-Interstate	505	811	220	116	1,652
Minor Arterial	233	462	159	30	884
Major Collector	340	1,010	304	46	1,700
Minor Collector	18	151	123	37	329
Local	7	95	129	72	303
Total	1,322	2,788	952	351	5,413

Table 1: Status of the existing system

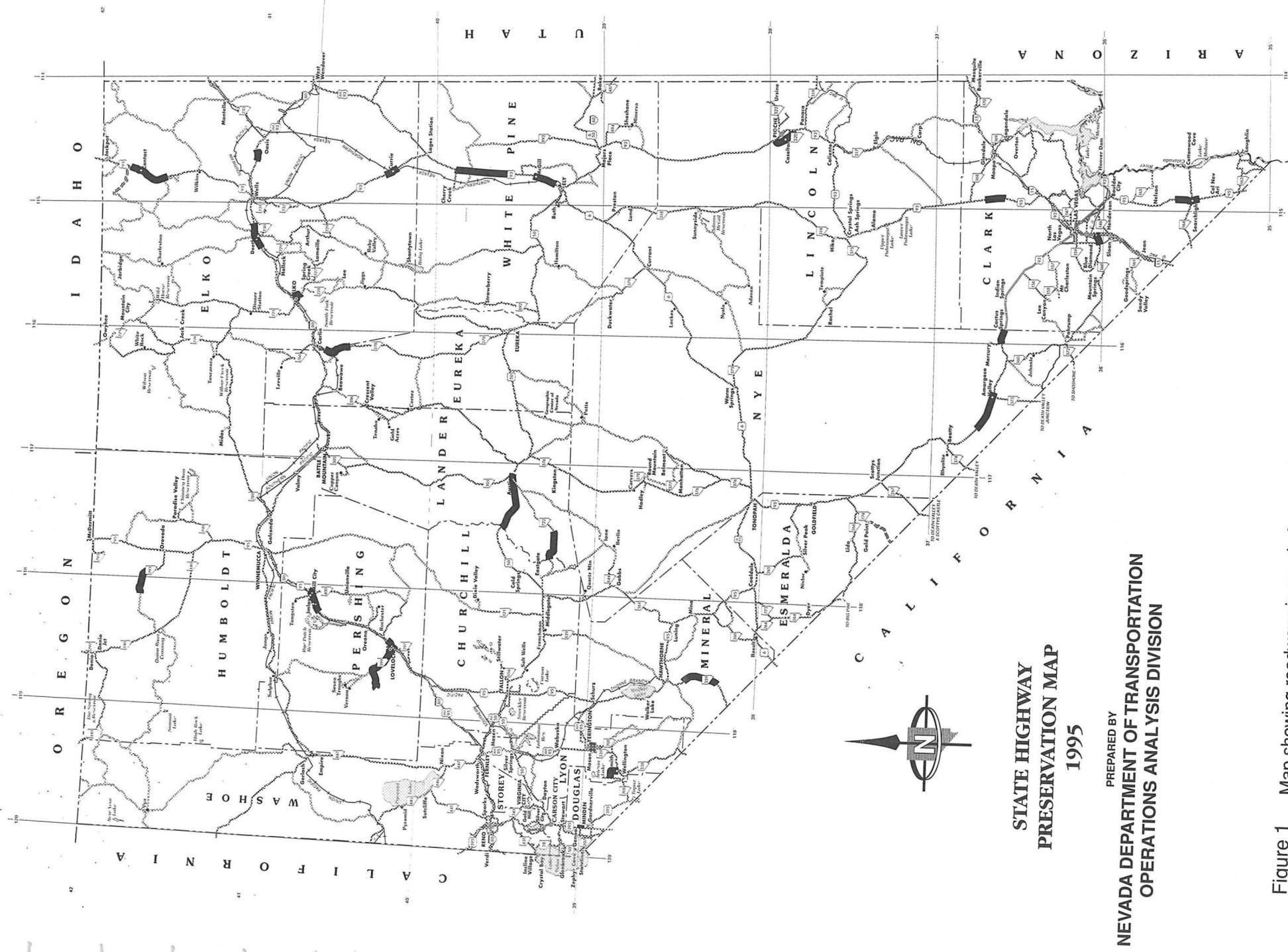
1995
 Backlog of Pavement Resurfacing, Restoration, Rehabilitation,
 and Reconstruction (4R) Needs
 (reported in lane miles)

SYSTEM	RECONSTRUCT		STRUCTURAL OVERLAYS		MINIMUM PAVEMENT OVERLAYS	
	LANE MILES	COST	LANE MILES	COST	LANE MILES	COST
Principal Arterial - Interstate	52	\$ 18,980,000	68	\$10,322,400		
Principal Arterial - Non-Interstate	221	32,002,800	368	45,694,300	107	\$ 7,126,200
Minor Arterial	73	10,898,800	192	22,078,100	191	12,563,600
Major Collector	93	11,625,000	52	5,181,400	561	36,230,200
Minor Collector	107	12,969,100	29	2,805,300	327	20,936,300
Local	144	17,409,600	3	321,000	255	16,249,600
TOTALS	690	\$103,885,300	712	\$86,402,500	1,441	\$93,105,900

SYSTEM	CONCRETE PAVEMENT REHABILITATION	
	LANE MILES	COST
Principal Arterial - Interstate	165	\$45,094,500
Principal Arterial - Non-Interstate	72	19,677,600
Minor Arterial		
Major Collector		
Minor Collector		
Local		
TOTALS	237	\$64,772,100

SYSTEM	STATEWIDE RECONSTRUCT		STATEWIDE OVERLAY		TOTAL	
	LANE MILES	COST	LANE MILES	COST	LANE MILES	COST
Principal Arterial - Interstate	217	\$ 64,074,500	68	\$ 10,322,400	285	\$ 74,396,900
Principal Arterial - Non-Interstate	293	51,680,400	475	52,820,500	768	104,500,900
Minor Arterial	73	10,898,800	383	34,641,700	456	45,540,500
Major Collector	93	11,625,000	613	41,411,600	706	53,036,600
Minor Collector	107	12,969,100	356	23,741,600	463	36,710,700
Local	144	17,409,600	258	16,570,600	402	33,980,200
TOTALS	927	\$168,657,400	2,153	\$179,508,400	3,080	\$348,165,800

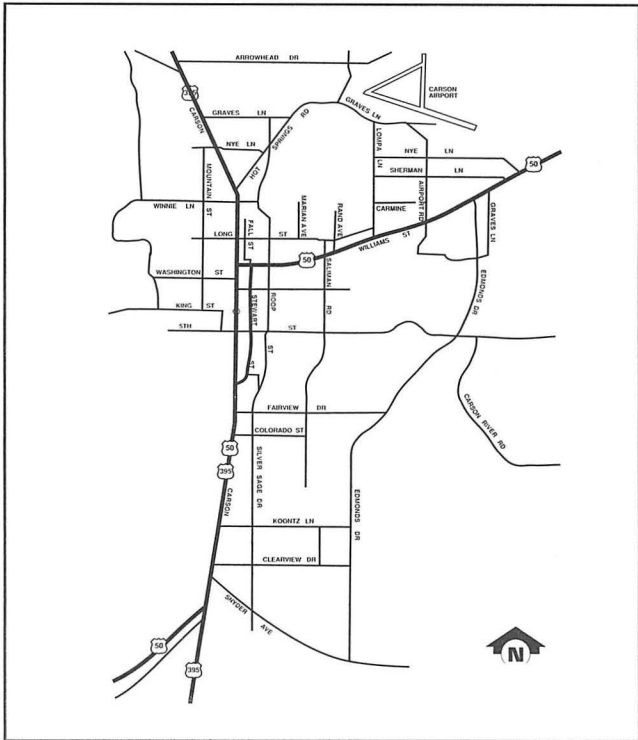
Table 2: Backlog of pavement resurfacing, restoration, rehabilitation and reconstruction (4R) needs



**STATE HIGHWAY
 PRESERVATION MAP
 1995**
 PREPARED BY
**NEVADA DEPARTMENT OF TRANSPORTATION
 OPERATIONS ANALYSIS DIVISION**

Figure 1 Map showing roadways in need of an overlay or pavement reconstruction in 1995

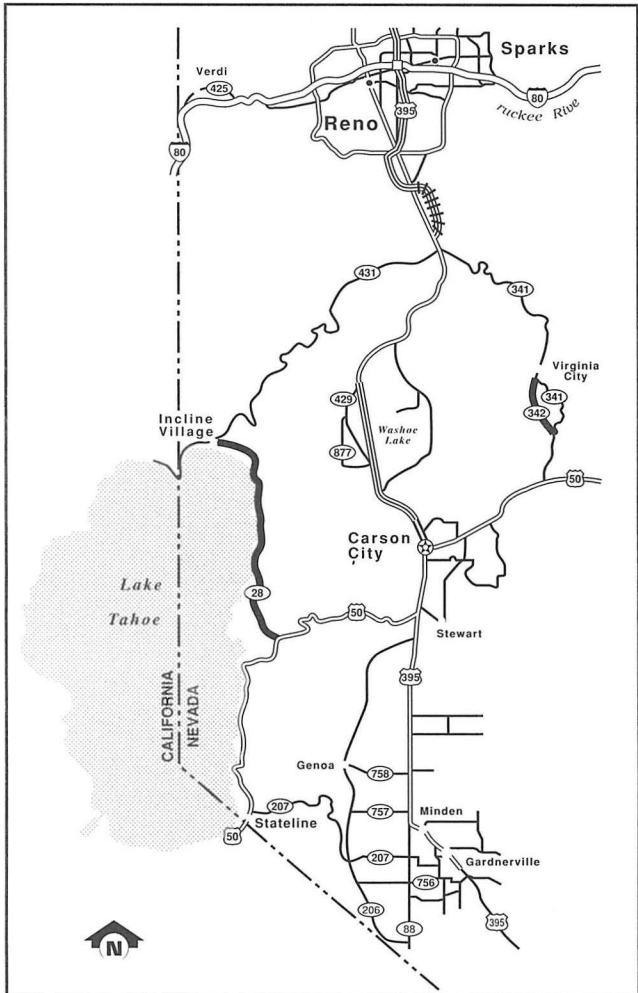
CARSON CITY AREA



RENO-SPARKS AREA



LAKE TAHOE AREA



LAS VEGAS AREA

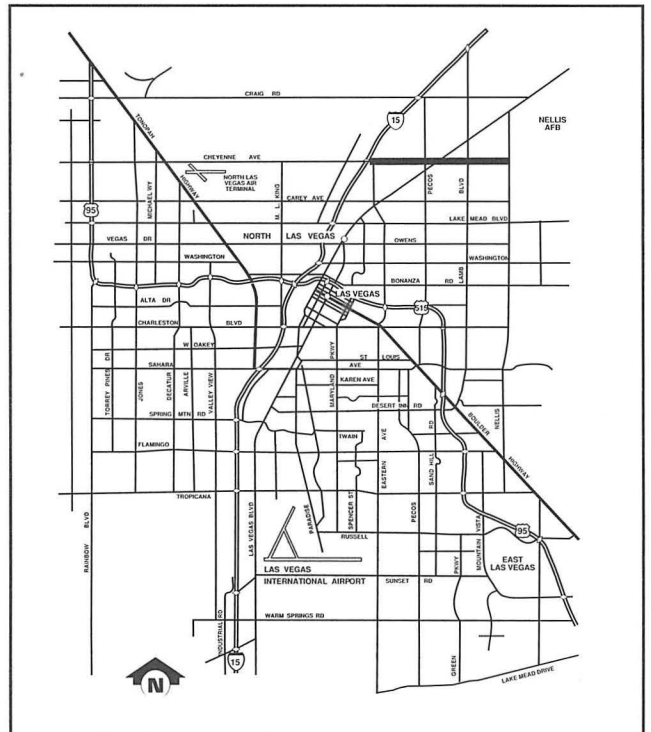


Figure 1A: Local maps showing roadways in need of an overlay or pavement reconstruction in 1995.

Deterioration

With proper maintenance, pavements will perform well, and meet the needs of the motorist for many years. Pavement behavior is similar in nature to bending a paper clip, each pass of a wheel is like a bend in the paper clip. The pavement performs well for a large number of passing wheel loads. But, like the paper clip, it suddenly begins to fail and breaks apart. A normal life cycle for asphalt pavements is shown in Figure 2.

Most all pavements are designed to withstand the wheel loadings anticipated during a 20-year life. Many of Nevada's highways were constructed during the building boom of the 50s and 60s. These roads have long exceeded their 20-year design life and are now in need of rehabilitation or reconstruction.

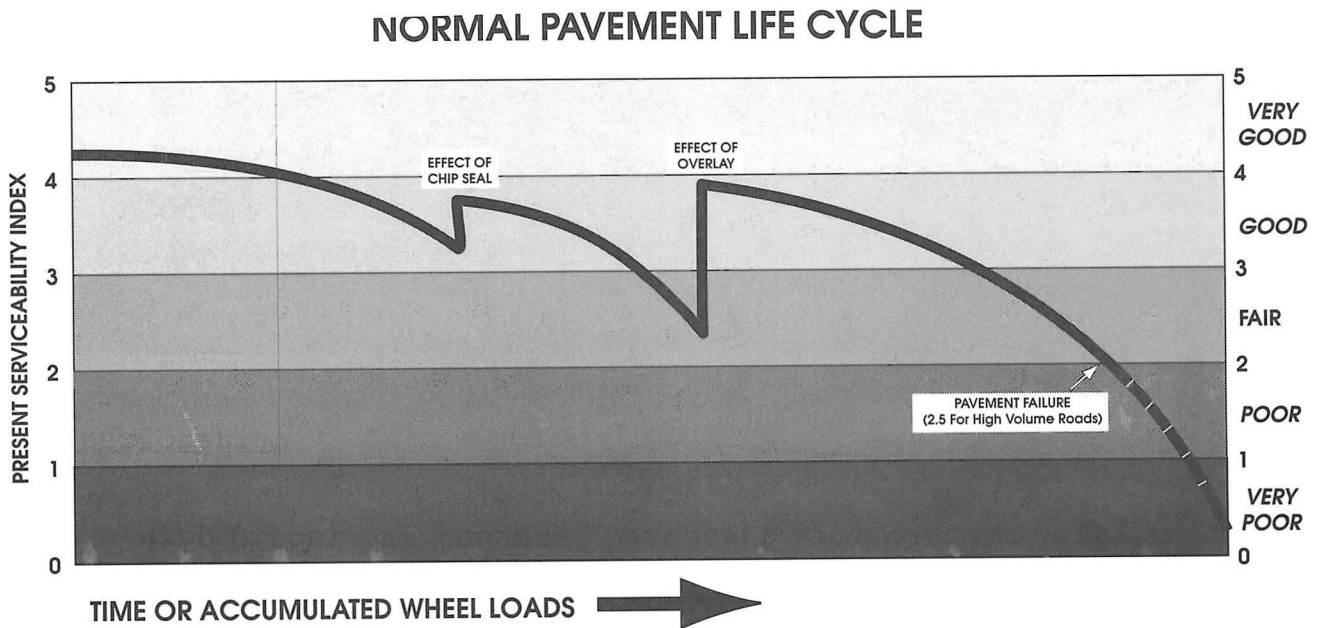


Figure 2: Normal pavement life cycles

Maintenance

Inadequate funding and manpower leads to the deferral of needed pavement maintenance, and the results of this are costly. For example, deferring the application of a seal coat allows water to seep through the pavement and get into the base and subbase materials of the road. This reduces the amount of support given to the pavement and amplifies the effects of traffic and age resulting in an accelerated deterioration rate.

The true cost of delaying maintenance can best be shown in Figure 3. One dollar of timely maintenance could easily cost four to five dollars if maintenance is delayed.

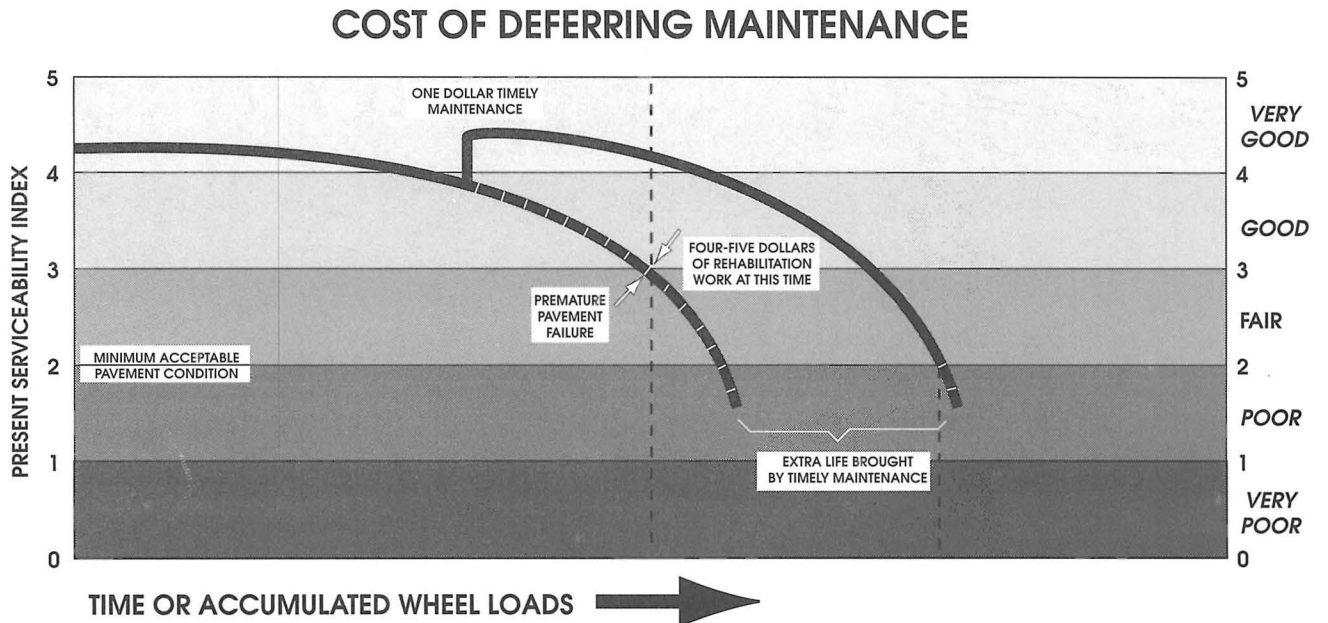


Figure 3: Cost of deferring maintenance

NDOT places a high emphasis on maintenance strategies such as crack sealing, sand seals, chip seals and minimum pavement overlays. These strategies are directed toward reducing the rate of deterioration on the state's highways.



Typical chip seal operation

Cold milling to remove distressed pavement

The department allocates approximately \$10 million per year toward the minimum pavement overlay (typically 2-inch thick) program. The philosophy behind project selection for this program is to address pavements at the point on their life performance curve where the pavement is beginning to show signs of distress, but before it has failed to where a structural overlay is required. The key is the proper repair strategy at the proper time, which extends the life of the pavement and keeps maintenance and repair costs to a minimum.



Placing a 2-inch minimum pavement overlay

The minimum pavement overlay program has been particularly beneficial to low-volume rural highways that do not compete well against high-volume roads for thicker structural overlays. It also addresses high-volume urban arterials where pavement distress causes a poor ride quality but a thicker structural overlay isn't justified.

Under no circumstances can our good roads be allowed to deteriorate to a point of premature failure. As shown in Figure 3 we can extend the service life of our good pavements for a fraction of the cost of deferring the work a few years when major rehabilitation or reconstruction is required.

Biennial Expenditures, Fiscal Years 1993-94

During fiscal years 1993 and 1994, NDOT obligated \$313.2 million for pavement resurfacing, restoration, rehabilitation and reconstruction (4R) contracts, addressing the needs of 2,185 lane miles of highway. Maintenance work, consisting of pavement surface patching and seals, was completed at a cost of \$37.5 million.

Through good pavement management practices, NDOT is doing all it can to retard pavement deterioration. However, new revenues may be required in the future to eliminate the backlog of pavement rehabilitation work and preserve Nevada's highway system at an acceptable service level.

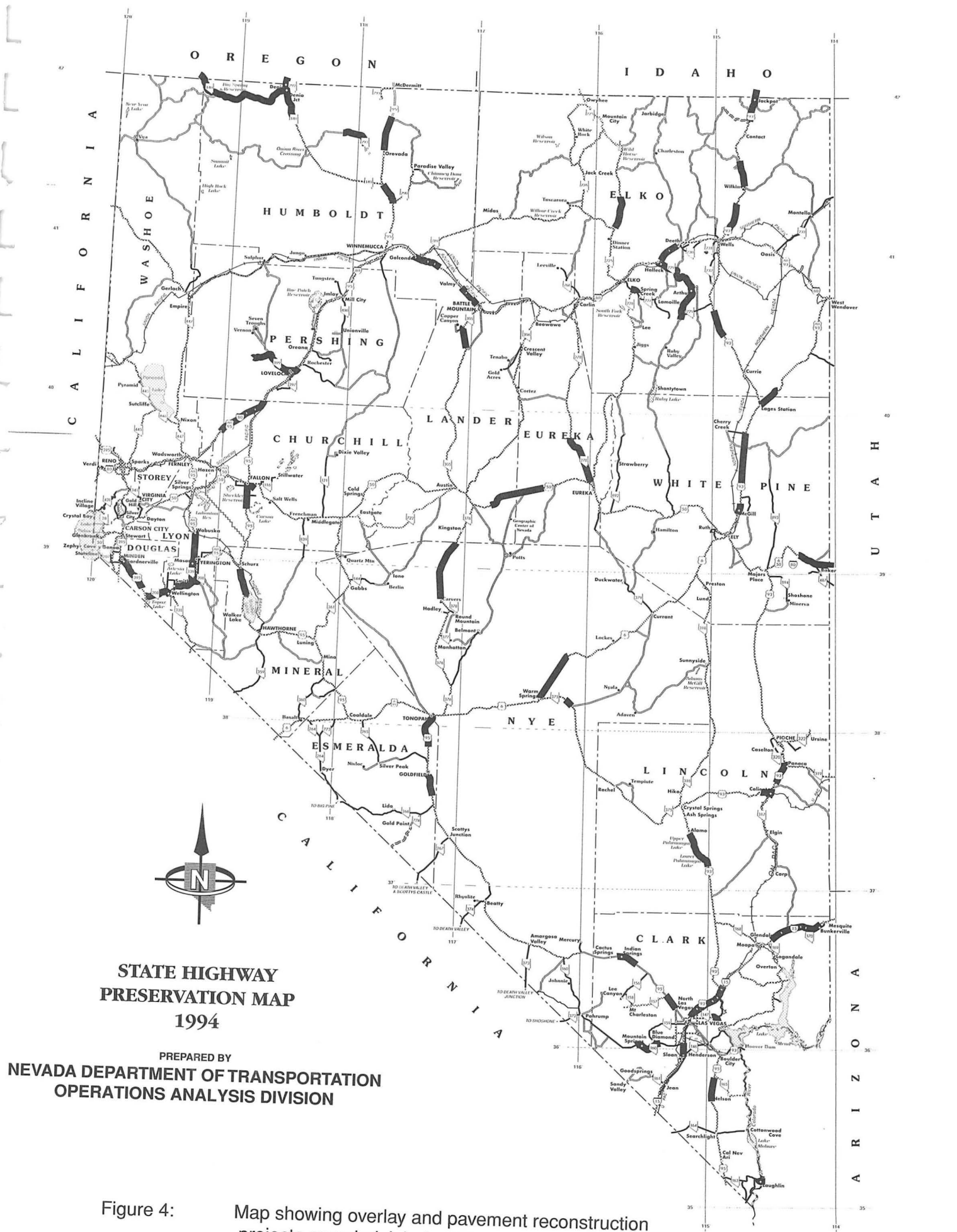
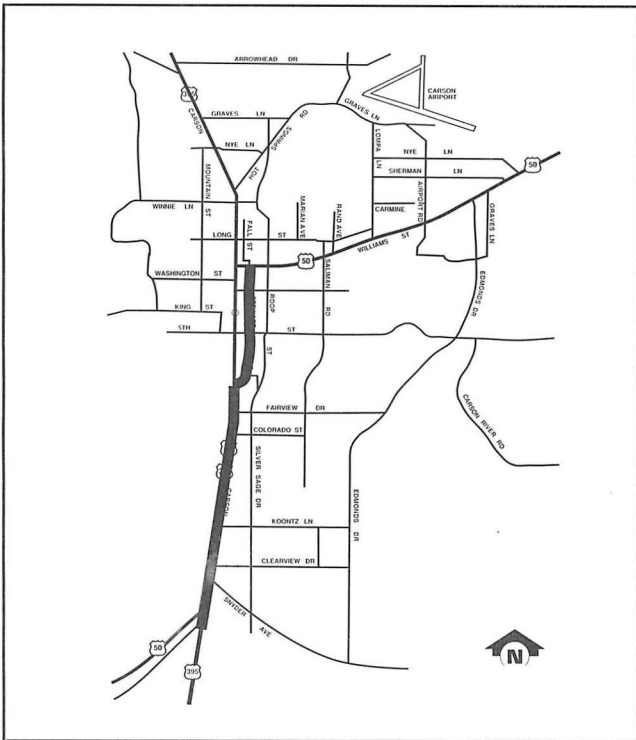
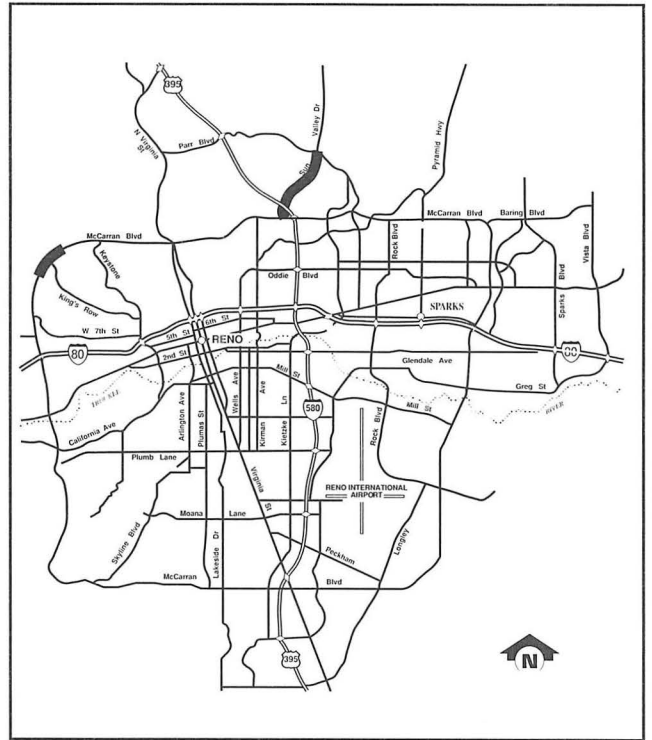


Figure 4: Map showing overlay and pavement reconstruction projects awarded July 1, 1992 through June 30, 1994

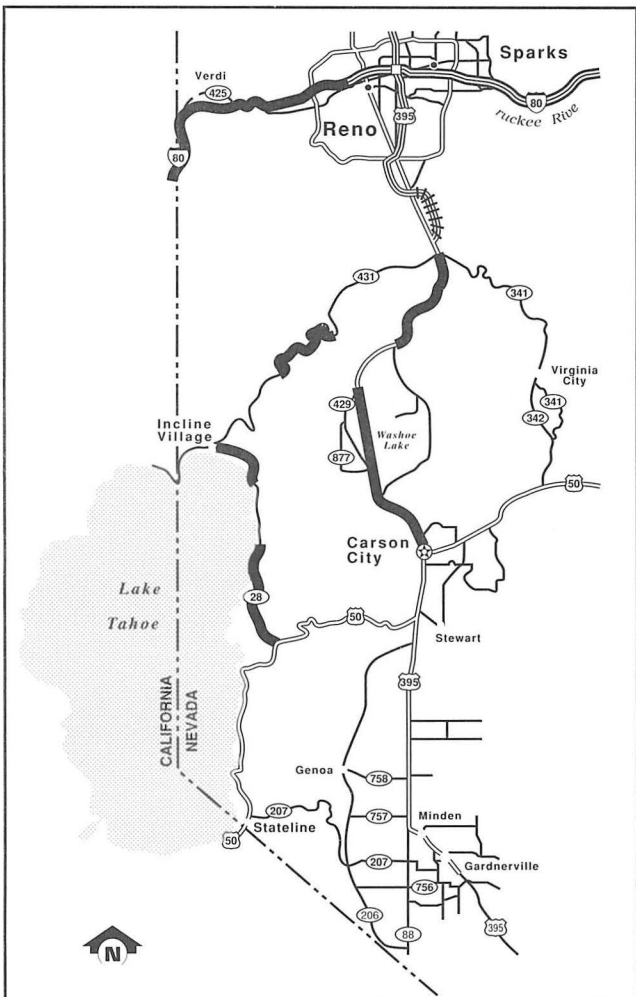
CARSON CITY AREA



RENO-SPARKS AREA



LAKE TAHOE AREA



LAS VEGAS AREA

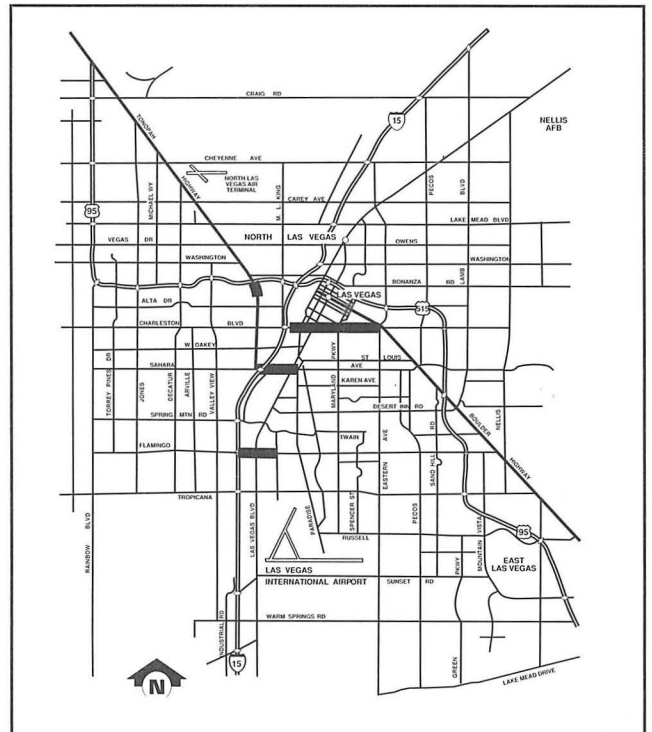


Figure 4A Local map showing overlay and pavement reconstruction projects awarded July 1, 1992 through June 30, 1994.

ROADWAY MAINTENANCE, OVERLAY AND RECONSTRUCTION NEEDS Fiscal Years 1982-1995

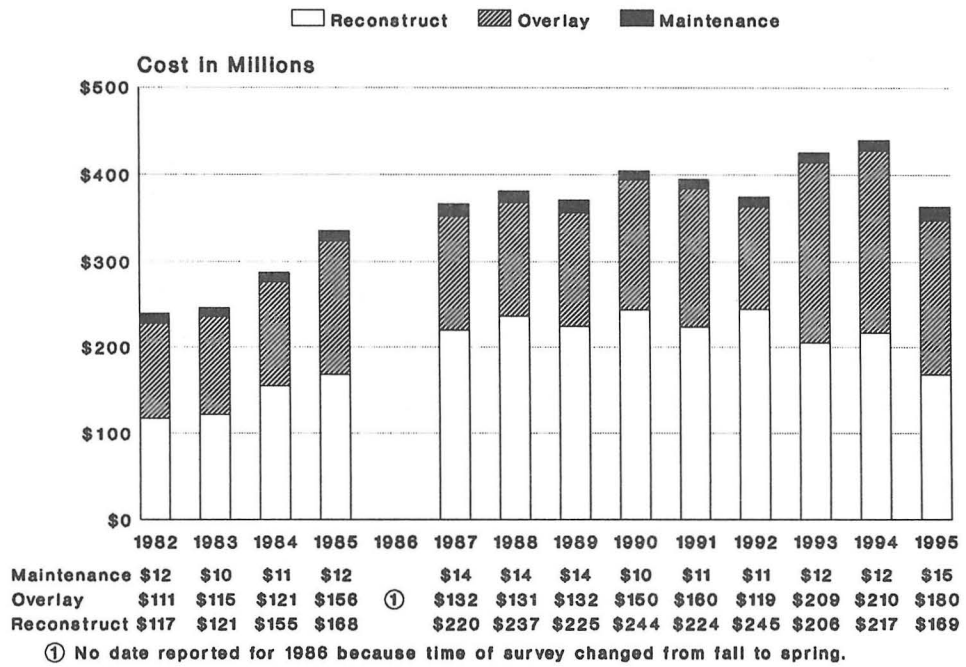


Figure 5: Roadway maintenance, overlay and reconstruction needs, 1982-95

Cost Estimates

An estimate of the cost necessary to eliminate the backlog of pavement rehabilitation work and return the network of state highways to an acceptable service level is shown in Table 3. The state funds required to finance this plan are summarized in Table 4.

Under the present user-fee structure, assuming no additional sources of revenue become available, NDOT predicts the deficit created by the backlog of Resurfacing, Restoration, and Rehabilitation (3R) pavement work will be \$162 million in the year 2005. About 1,400 lane miles will need an overlay or reconstruction. The proposed funding plan, which requires moderate revenue increases in future years, will close out the backlog in the year 2005. Figure 6 shows how these increases are needed to eliminate the backlog.

COSTS NECESSARY TO PRESERVE THE EXISTING SYSTEM
1995

(in millions of dollars)

Inflation Rate = 4.00%
Revenue Growth = 4.00%

Resurfacing, Restoration and Rehabilitation (3R) Work								Normal - Heavy Maintenance Work					
F.Y.	"A" Def + Infl	"B" System Deter Costs	"C" Total 3R Needs	"D" State Funds	"E" Fed Funds	"F" Prop 3R Expend	"G" Accum Deficit	*	"H" Norm Maint Costs	"I" Backlog 3R Maint Costs	"J" Total Maint Needs	"K" Prop Maint Expend	F.Y.
1996	362.09	96.70	458.79	95.69	25.00	120.69	348.17	*	14.96	4.31	19.27	19.27	1996
1997	351.62	100.57	452.19	105.02	25.48	130.50	338.10	*	15.56	4.18	19.74	19.74	1997
1998	334.56	104.59	439.15	115.00	26.50	141.50	321.69	*	16.18	3.98	20.16	20.16	1998
1999	309.56	108.77	418.33	119.99	27.56	147.62	297.65	*	16.83	3.68	20.51	20.51	1999
2000	281.54	113.12	394.66	130.01	28.66	158.67	270.71	*	17.50	3.35	20.85	20.85	2000
2001	245.43	117.64	363.07	135.78	29.81	165.59	235.99	*	18.20	2.92	21.12	21.12	2001
2002	205.38	122.35	327.73	141.81	31.00	172.81	197.48	*	18.93	2.44	21.37	21.37	2002
2003	161.12	127.24	288.36	148.10	32.24	180.34	154.92	*	19.69	1.92	21.61	21.61	2003
2004	112.34	132.33	244.67	154.68	33.53	188.21	108.02	*	20.48	1.34	21.82	21.82	2004
2005	58.72	137.62	196.34	161.56	34.87	196.43	56.46	*	21.30	0.70	22.00	22.00	2005
							0.00	*					

Table 3: Costs necessary to preserve the existing system

Explanation of Table 3

- A The accumulated deficit created by the backlog of resurfacing projects with an applied 4.0 percent annual inflation rate.
- B The estimated cost to address the annual deterioration of the existing network of pavements.
- C The total resurfacing needs: Column A + Column B.
- D State funds available for 3R projects.
- E Federal funds available for 3R projects.
- F Proposed 3R expenditures: Column D + Column E.
- G The accumulated deficit remaining because of the state's inability to address the backlog of resurfacing projects: Column C - Column F.
- H Normal pavement maintenance costs.
- I Additional maintenance required to hold the system 3R backlog mileage together until it can be contracted. These are short-term fixes.
- J Total maintenance needs: Column H + Column I.
- K Proposed maintenance expenditures: assumed is a 100 percent funded, routine pavement-maintenance program.

SUMMARY OF STATE FUNDS NECESSARY TO PRESERVE THE EXISTING SYSTEM
(in millions of dollars)

FISCAL YEAR	REQUIRED EXPENDITURES (NEEDS)	STATE FUNDS FROM PRESENT TAX STRUCTURE (EXISTING)	ADDITIONAL STATE FUNDS REQUIRED (NEW)
1996	95.69	95.69	0.00
1997	105.02	99.82	5.20
1998	115.00	104.12	10.88
1999	120.06	108.61	11.45
2000	130.01	113.29	16.72
2001	135.78	118.18	17.60
2002	141.81	123.27	18.54
2003	148.10	128.60	19.50
2004	154.68	134.17	20.51
2005	161.56	139.96	21.60

Table 4: State funds necessary to preserve the existing system

1995 BACKLOG 3R NEEDS Present Funding

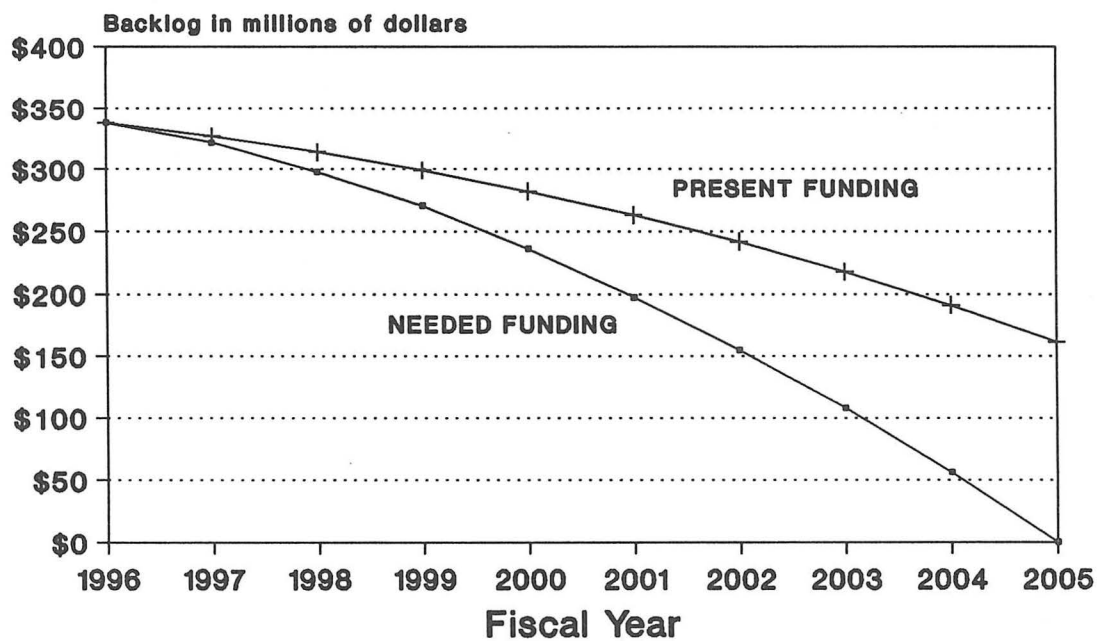


Figure 6: Comparison of backlog 3R needs - present vs needed funding

BRIDGES

General

A bridge is defined as any structure spanning a depression or obstruction having an opening measured along the center of roadway of more than 20 feet. This includes multiple box culverts and pipes.

Sufficiency Rating

The serviceability of bridges in Nevada is evaluated by use of a numerical assessment called the Sufficiency Rating. While the Sufficiency Rating is primarily used to determine eligibility for funding under the Federal Aid Bridge Program, it can also be used to assess the overall condition of a bridge. The Sufficiency Rating includes a condition assessment, an appraisal rating, and an inventory rating.

The condition assessment is the observed deterioration of selected bridge elements. These elements include the deck, bearings, girders, pier wall, etc.

The appraisal ratings assess how well the bridge serves the public, or its functionality. The appraisal ratings include the number of lanes on the bridge, under clearance, waterway adequacy, and approach geometry.

The inventory rating denotes the strength of the bridge compared to the minimum truck design loading. The condition of an element is considered as part of this rating.

Two types of projects are eligible for funding under the Federal Aid Bridge Program. A bridge rehabilitation project may be funded if the Sufficiency Rating is below 80 and the bridge is

either "functionally obsolete" or "structurally deficient." The rehabilitation must correct the functional or structural problems.

A bridge replacement project may be funded if the Sufficiency Rating is below 50 and the bridge is either functionally obsolete or structurally deficient. The replacement bridge must be built to all current standards.

To be considered functionally obsolete or structurally deficient a bridge must have low appraisal and/or condition ratings. Bridges listed as functionally obsolete or structurally deficient are considered substandard.

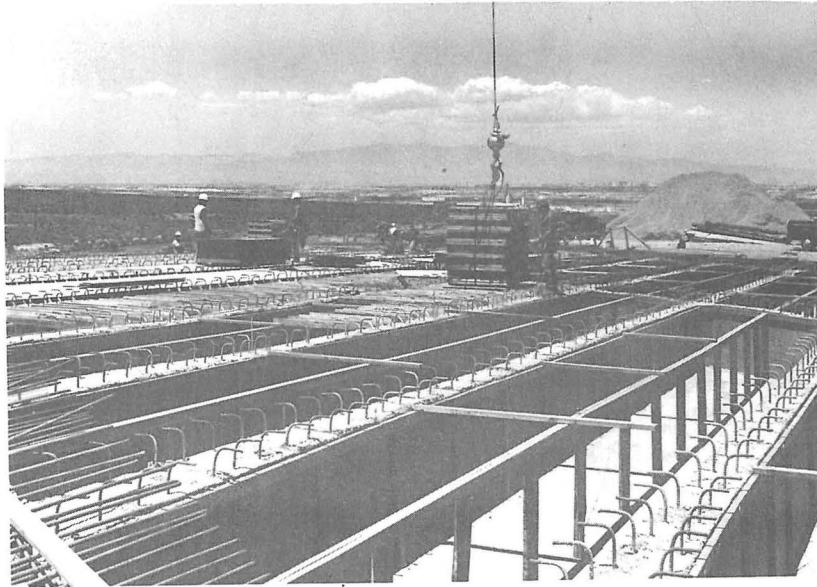
Bridge Inventory

NDOT must submit the condition of the Bridge Inventory to the Federal Highway Administration on a yearly basis. All bridges in Nevada open to the public must be included in the Bridge Inventory. In addition, all bridges must be inspected at least once every two years. Bridges in poor condition are inspected more often.



Inspecting a bridge over the Humboldt River

There are currently 1,221 bridges in Nevada. NDOT maintains 941 bridges: 216 are maintained by county or city governments; two are maintained by other state agencies; 51 are maintained by federal agencies, and 26 are privately maintained



Constructing a new bridge on the US 95 expressway in Las Vegas

Status of State Bridges

Generally, bridges with Sufficiency Ratings above 80 can be considered good, ratings of between 50 and 80 can be considered fair, and ratings below 50 are considered poor.

GENERAL CONDITION OF STATE BRIDGES

Number of state bridges.....	941
Bridges with Sufficiency Ratings above 80.....	782 (83.1%)
Number of bridges with Sufficiency Ratings between 50 and 80.....	148 (15.7%)
Number of bridges with Sufficiency Ratings below 50.....	11 (1.2%)

(Percent of total state bridges)

STATE BRIDGES CONSIDERED SUBSTANDARD

Number of substandard bridges.....	68 (7.2%)
Number of functionally obsolete state bridges.....	46 (4.9%)
Number of structurally deficient state bridges.....	22 (2.3%)

(Percent of total state bridges)

Nevada bridges overall are in good shape compared to many other states. This is mainly due to our environment and age of our bridges. Most bridges have a useful life of at least 50 years. The age distribution for state bridges on the Bridge Inventory is:

<u>Decade of Construction</u>	<u>Number of Bridges Built</u>	<u>Average Age</u>
1910 to 1920	1	76 years
1920 to 1930	7	71 years
1930 to 1940	44	61 years
1940 to 1950	41	49 years
1950 to 1960	108	39 years
1960 to 1970	378	31 years
1970 to 1980	205	21 years
1980 to 1990	116	9 years
1990 to 1994	41	3 years

The majority of state bridges were built between the mid-1950s and mid-1970s as part of the interstate freeway construction. The current funding needs for bridge repair, rehabilitation, and replacement should remain about the same for the next 10 to 15 years. After that it is anticipated higher funding levels will be required.

Status of County and City Bridges

The status of county and city bridges is provided for information. A percentage of the Federal Aid Bridge Program must be spent "off-system."

GENERAL CONDITION OF COUNTY AND CITY MAINTAINED BRIDGES

Number of county and city bridges.....	216
Bridges with Sufficiency Ratings above 80.....	152 (70.4%)
Number of bridges with Sufficiency Ratings between 50 and 80.....	46 (21.3%)
Number of bridges with Sufficiency Ratings below 50.....	18 (8.3%)

(Percent of total county and city bridges)

COUNTY AND CITY BRIDGES CONSIDERED SUBSTANDARD

Number of substandard bridges.....	34 (15.7%)
Number of functionally obsolete county and city bridges.....	12 (5.6%)
Number of structurally deficient county and city bridges.....	22 (10.2%)

(Percent of total county and city bridges)

Funding

Repair, rehabilitation, and replacement of state bridges is funded by federal and state dollars. Expenditures for calendar years 1992, 1993, and 1994 were:

(thousands of dollars)

<u>Calendar Year</u>	<u>State Funded*</u>			<u>Federally Funded</u>		
	<u>Repair</u>	<u>Rehab.</u>	<u>Replace</u>	<u>Repair</u>	<u>Rehab.</u>	<u>Replace</u>
1992	\$2,590	\$282	\$443	\$3,290	\$1,127	\$1,774
1993	\$2,290	\$322	\$400	\$1,816	\$ 364	\$1,600
1994	\$2,843	\$886	\$982	\$ 708	\$3,544	\$3,927

*Includes state participation with federal funds.

Nevada receives approximately \$6.3 million in federal bridge funds per year. These funds are used to administer the Bridge Inventory, and rehabilitate and replace bridges. "On-system" bridges must receive 65 percent of these funds and off-system bridges must receive 15 percent. The remaining 20 percent is optional. On-system and off-system status is determined by the functional classification of the roadway that the bridge carries. Of the 941 state bridges, 858 are on-system and 83 are off-system. Of the 216 county and city bridges, 89 are on-system and 127 are off-system.

Seismic Retrofit

Nevada is the third most seismically active state behind California and Alaska. There have been 11 earthquakes in Nevada of magnitude 6.0 or greater this century. The central and western parts of Nevada are the most active, hence the state transportation system is of most concern in these areas. The southern part of the state is less seismically active but does have the potential for damaging earthquakes.

Bridges designed to current seismic standards should survive a strong earthquake. Considerable damage may occur and the bridge may have to be torn down but it should not collapse. It would not be cost effective to design a bridge to withstand the strongest earthquakes without damage. Only the most critical structures, such as nuclear containment vessels, are designed to this standard.

Bridges designed to standards prior to 1975 may be susceptible to severe damage or even collapse from a moderate to strong earthquake. Eighty-two percent of the interstate bridges and 57 percent of the U.S. highway bridges were built prior to 1975. There are 543 bridges on the interstate system and 211 on the U.S. highways. Certain bridge types, such as culverts, do not need retrofit. That leaves 334 bridges on the interstate and U.S. highways that may need to be seismically upgraded. There are bridges on other routes also in need of seismic retrofit. An in-depth structural evaluation has to be performed to determine if a retrofit is really needed.



Seismic retrofitting on a bridge in Verdi

All state bridges have been prioritized for seismic retrofit. The prioritization includes the bridge's importance and

vulnerability along with the level of seismicity. It was estimated in 1989 that roughly \$150 million was needed to seismically upgrade all state bridges, excluding culverts.

Since 1989, \$8.4 million has been spent on seismically upgrading 18 bridges. Today about \$2 million a year from federal bridge funds is being spent on seismic retrofit. Bridges in need of seismic retrofit are eligible for funding under the Federal Bridge Program, however, no increase in funding has been provided. In addition, a seismic vulnerability is not considered a structural deficiency in the Sufficiency Rating of a bridge.

Not all state bridges, particularly in southern Nevada, will require a seismic upgrade, but the most important bridges exist in the Las Vegas area and many of these are vulnerable.

RESEARCH

Strategic Highway Research Program

NDOT is participating in the Strategic Highway Research Program. Originally funded by the Surface Transportation and Uniform Relocation Assistance Act of 1987, SHRP (referred to as "sharp") began as a \$150 million endeavor to find solutions to some of the most critical problems facing road transportation agencies. It was the largest highway research program in the United States. Also participating in the program are Canada, Australia and other foreign countries.

The research was aimed at four technical areas capable of yielding large cost savings: Asphalt, Concrete and Structures, Highway Operations, and Long-Term Pavement Performance. The LTPP program was created to improve, through research and experimentation, pavement design and rehabilitation techniques which would extend the life and enhance the performance of pavement. All four research projects were initially funded for five years. However, continuing LTPP research and study is now being financed by ISTEA.

In its involvement in the LTPP program, Nevada established eight experimental test sites: four in Elko, two in Clark, and one each in Washoe and Mineral counties. These sites consist of existing in-service pavement sections and specially constructed test sections on in-service highways. They include both asphalt and Portland cement concrete pavements. The experiments will provide the comparative data necessary to better understand the effects of various design methods, climate and load conditions, material properties, and surface treatments.

The LTPP program will provide improved pavement design and maintenance methods which will lead to longer pavement life, better

pavement performance, and cost savings in construction, maintenance, and rehabilitation of pavement.



Workers lay down a chip seal at an LTPP site on North McCarran Boulevard near Sullivan Lane in Sparks

Through the years Nevada and many other states have been grappling with the problem of reactive aggregates used in concrete mixtures. Specifically, a chemical reaction occurs between reactive silica in the aggregate, alkali in the cement and moisture. The alkali and silica produce a gel that expands with the presence of moisture. This alkali-silica reactivity (ASR) causes premature failure of Portland cement concrete pavement. As part of SHRP's Concrete and Structures research, NDOT is actively seeking solutions to ASR through laboratory testing for future projects and field testing of existing concrete pavement.

Since the majority of the aggregate found in Nevada is reactive, it is virtually impossible to prevent ASR from occurring. However, NDOT, in coordination with SHRP, has studied two materials

that can retard the progress of ASR: fly ash and silane. An optimum percentage (derived from lab testing) of fly ash is added to the mixture in new concrete to reduce expansion of the gel. Silane, a hydrogen-silicon compound, is used as a surface treatment to prevent any further moisture from seeping into existing pavement. Both products will help lengthen the life of concrete pavement.

Development of Pavement Lifecycle Curves

NDOT entered into a cooperative research project with the University of Nevada-Reno's College of Engineering to develop pavement performance prediction models. Three of NDOT's most commonly deployed maintenance strategies and three pavement rehabilitation techniques were selected for the development of the prediction models. The maintenance strategies were flush seal, sand seal and chip seal. The rehabilitation techniques included flexible pavement overlays, cold milling with an overlay, and roadbed modification, which consists of pulverizing and cement treating the existing base and surface and placing a dense graded asphalt surface. The research also examined Portland cement concrete pavement maintenance, repairs and rehabilitation strategies, but it was determined that the state lacked a sufficient number of sample projects to develop statistically reliable models for this work.

Using linear regression analysis, 16 flexible pavement performance models were developed: nine for maintenance and seven for rehabilitation strategies. A separate performance model for each technique, except cold milling with an overlay, was developed for each of NDOT's three engineering districts. Only one statewide model was developed for cold milling with an overlay. Each performance model relates a pavement's Present Serviceability Index

to its age, materials properties, traffic loadings and environmental conditions.

Recycled Rubber

ISTEA includes a provision for the use of recycled rubber in asphalt pavements. In fact, every state must satisfy a minimum utilization requirement for using recycled rubber as a percentage of the total tons of asphalt. This percentage was to start at five percent in 1994, and increase by five percent a year to 20 percent in 1997, and stay at 20 percent thereafter. However, a moratorium was effected for fiscal year 1994 and concerns raised by the American Association of State Highway and Transportation Officials (AASHTO) have created legislation in Congress which may lower the percentages.

NDOT has experimented with recycled rubber from scrap tires since 1975 in a crumb-rubber-modifier (CRM) process. This technique has been used in chip seals, research projects, a stress-absorbing membrane interlayer project, and most recently a full-scale rubber-modified dense-graded paving project. The latter, completed in October 1992, is located north of Hawthorne on U.S. 95. One mile was constructed with a standard design and six miles were constructed with the rubber-modified asphalt. Engineers had feared the CRM would make the plantmix difficult to lay down and leave a sticky and rough surface. However, no major problems were encountered during the construction, and the pavement had a smooth surface. The material came with a 5-year warranty in which the contractor will make repairs, if necessary, at no cost to the state. As of this printing, the pavement is still in good shape.

NDOT is prepared to meet the ISTEA recycled rubber requirements, but long-term performance and economics will require further analysis.

CONCLUSION

The network of state-maintained roadways has been designed, constructed, and maintained with user fees paid by the motoring public. This highway system is the transportation lifeline of the state, serving as a means to move people and goods between Nevada's cities and towns. In 1993, there were nearly eight billion miles of vehicle travel on the state-maintained highway system.

NDOT has established preservation of the existing highway system as one of its highest priorities. More restrictive design and construction specifications have been developed to improve the quality of pavements. An aggressive maintenance program using timely and effective repair strategies helps to arrest the deterioration rate and provide minimum life-cycle costs for pavements. Also aiding in this battle will be the much anticipated products of the Strategic Highway Research Program, and the continuing search for technological advances in pavement maintenance and rehabilitation such as the recycling of rubber from old tires.

Still, roadway maintenance and construction costs, consultant services and administrative costs will continue to rise. At the same time, more fuel-efficient passenger cars are on the road, and motor fuel taxes, the state's largest source of highway funding, don't always keep pace. Moreover, Nevada, with its phenomenal growth rate, must have good roads to attract tourists, new business and commercial development. The tremendous investment already placed in its highway infrastructure must be protected.

Although NDOT is not seeking any additional revenues over the upcoming biennium, modest revenue increases may be required to continue to fund the highway preservation program in the future.

NDOT will continue to seek more cost-effective methods of rehabilitating Nevada's pavements, ensure that timely and effective preventive maintenance is done, and use the department's Pavement Management System to monitor the progress on eliminating the 4R backlog.

Preserving Nevada's highway network is fundamental to the continued economic growth, diversification and well-being of this great state.

