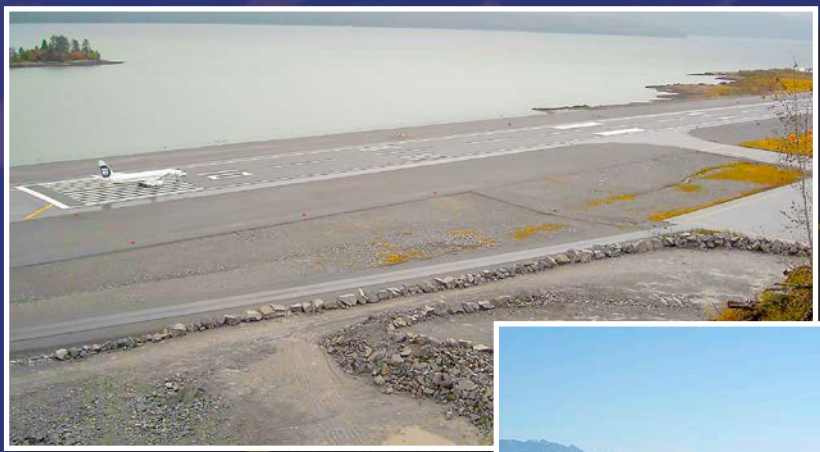
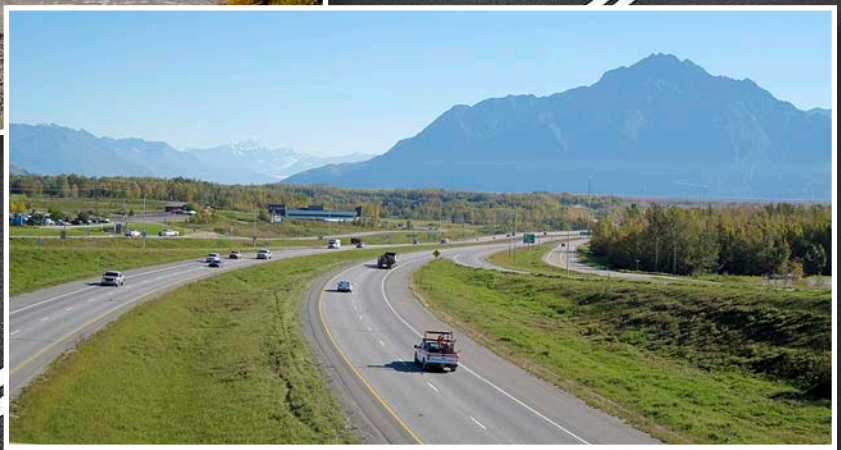
Get Alaska Moving through Service and Infrastructure

Alaska Department of Transportation
and Public Facilities

2012 Alaska Pavement Report

October 2012





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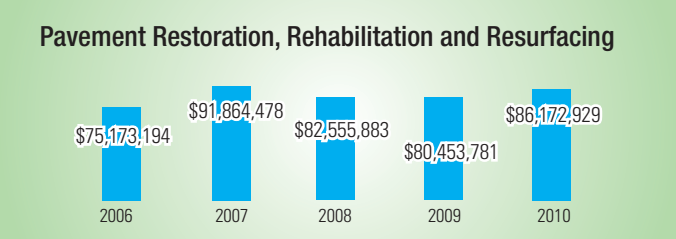
Introduction

The Department of Transportation and Public Facilities owns and maintains 5,619 centerline-miles of highway, of which 3,617 miles are paved.[1] The combined area of the state's paved airports (excluding Ted Stevens Anchorage International and Fairbanks International) equals 2,563 acres, or about four square miles. These paved surfaces represent a significant capital investment and a continuing expense for maintenance and preservation, amounting to one of the largest recurring investments made by the department.

The department spends about $83 million annually in Federal Highway Administration funds to restore, rehabilitate, and resurface roads and highways. Projected funding for airport pavement rehabilitation and preservation totals approximately $40 million annually through Federal fiscal year 2016. The department received $18 million in combined state general fund appropriations in fiscal years 2010 and 2012, specifically to begin reducing a backlog of deferred highway pavement maintenance.



ADOT&PF Division of Program Development

In this report, you will learn about the conditions that contribute to pavement wear, particularly the conditions that are unique to Alaska. You will learn about the department's program for pavement management, including the manner in which the department collects data on pavement conditions and uses the information to determine priorities. The report chronicles the challenges faced by the department's pavement and materials engineers; it contains graphic data displaying both point-in-time information and trends; it touches on materials science and pavement-related research, particularly the pavement preservation research project; and it identifies trends and innovations in materials engineering.

Pavement management practices are changing throughout the country as states and municipalities seek to optimize their investments. Pavement generally deteriorates slowly during the first few years after placement, then more quickly with aging. Traditionally, transportation departments have taken a "worst first" approach, rehabilitating or reconstructing pavements in the most deteriorated condition and paying less attention to roads in good condition. Transportation managers now understand that it is far more economical, safer, and less disruptive for the public, to preserve roads in good condition rather than to reconstruct deteriorated roads.

The department is transitioning from traditional pavement maintenance practices to a pavement asset management program that will rely on increased use of data and analysis to help support a program of pavement preservation. Other state transportation departments successfully practice pavement asset management, resulting in continuing improvements to pavement condition while avoiding costs for more expensive rehabilitation or replacement. While the Alaska environment presents unique challenges not faced elsewhere, the benefits of pavement preservation remain desirable and achievable.

While this is not a technical report, it does contain some industry terms. Please refer to the Glossary in Appendix A for definitions of unfamiliar technical terms and "terms of the trade" as you encounter them in this report.

[1] A centerline-mile does not account for multiple lane highways, highway shoulders, on-ramps and off-ramps, bike-pedestrian lanes, or other highway and road-related pavement surfaces.

Pavement Management

Department managers find cost-effective strategies for constructing, preserving, maintaining, and upgrading safe pavement surfaces on the state's highways and airports. Pavement management is a balance between public safety and comfort, continuing maintenance of good surface conditions and lowest lifecycle costs.

Cracking on the Funny River Road; photo by Jim Horn, ADOT&PF

Pavement Engineering

The state Pavement Management/Preservation Engineer, the department's technical expert, is responsible for managing Alaska's paved assets. This role includes the annual assessment and reporting of pavement conditions for the state's roads and airports and maintaining the department's pavement management system (PMS) database. The PMS helps staff and managers develop project recommendations to preserve and repair the state's paved assets.

Pavement Preservation

Pavement preservation treatments improve the overall condition of the road and retard the overall rate of deterioration. These treatments are relatively inexpensive when compared to reconstruction or rehabilitation. Common preventive maintenance treatments include crack sealing, chip sealing, micro-surfacing, and diamond grinding.

Pavement Rehabilitation

Pavement rehabilitation treatments are typically applied to roads when extensive deterioration has taken place that cannot be addressed through pavement preservation. Pavement rehabilitation treatments address the structural condition of the road and, in the worst case, require reconstruction of the roadway.

Reconstruction Backlog

The reconstruction backlog comprises all lane miles that need rehabilitation and that cannot be effectively improved through preservation type treatments. Currently, many of the department's roads fall into the reconstruction backlog category.

Support Services

Numerous other sections within the department support the work of the pavement management/preservation engineer—particularly statewide and regional materials engineers, the Statewide Maintenance Chief, regional maintenance staff, the Office of Research, Development and Technology Transfer (RD&T2), and the Office of Asset Management.

Finding cost-effective strategies for constructing, preserving, maintaining, and upgrading safe pavement surfaces on the state's highways and airports.

Trends

Trends affecting pavement management include funding levels, reducing the inventory of deferred maintenance, high costs, recruitment and retention of skilled workers, and the relentless effects of weather and climate.

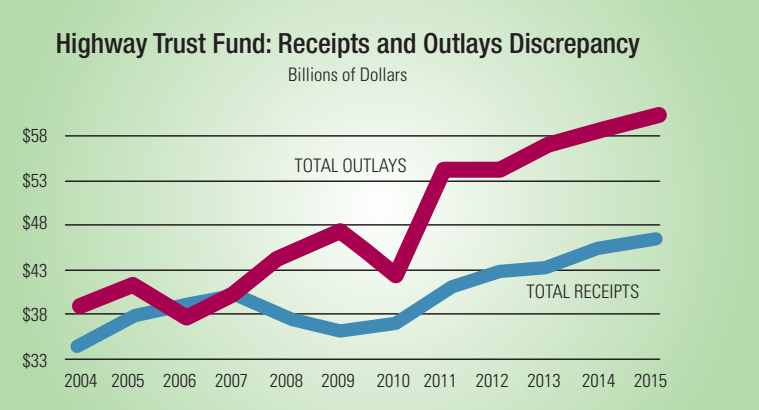
Alaskan Challenges

The Alaska climate is among the most challenging in the nation for maintaining safe, long-lasting pavement surfaces. Extreme cold, freeze-thaw cycles, frost heaves, earthquakes, thawing permafrost, and seasonally high runoff all complicate the department's work.

Climate Change

The Statewide Maintenance Chief has chronicled the existing and potential effects of climate change on a range of department operations.

Warming temperatures threaten to expand the seasonal thawing of the permafrost layer beneath paved airports and highways, a trend that will likely lead to increasingly higher maintenance costs and to higher construction costs as well. Department engineers have developed road and airport designs that incorporate mitigation elements to prevent thawing, which are expensive in the construction phase, but efficient for long-term preservation.



American Association of State Highway and Transportation Officials

Funding Issues

The Federal Highway Trust Fund, the principal source of funding for the department's pavement program, no longer earns enough revenue to fund state highway programs at the current level of need. The Trust is funded by the 18.4 cents-per-gallon federal motor fuel tax, which has remained flat for 17 years and has lost considerable purchasing power. Additionally, the total number of miles driven annually by American motorists has declined in recent years, while overall vehicle fuel efficiency has improved. Recent data indicate that fewer young people are buying cars or getting driver's licenses.

The fund has thus been depleted in each of the last three federal fiscal years, with Congress having to recapitalize it with almost $30 billion in general fund revenues.

Historically, the department has used federal funds for pavement maintenance and preservation. To the extent these funds decline, a combination of other funding sources and more efficient management and preservation practices will be needed to fill the gap.

Asset-based Preservation

Transition to an asset-based preservation program can begin on highway sections already in good condition, while older highway sections must be rehabilitated or reconstructed to achieve a condition suitable for ongoing preservation.

Pavement Wear

All pavements deteriorate with time. A well-constructed road under normal traffic conditions starts deteriorating right after construction and typically will begin to show signs of deterioration in two to five years in Alaska.

Traffic Density & Load

A high-volume route like the Glenn Highway between Anchorage and the Matanuska-Susitna Borough, or a route like the Klondike Highway into Skagway, which will carry heavy ore trucks from the Yukon, face much higher demands than low-volume routes serving residential areas. The department builds roads and highways for heavier loads in high traffic areas and on known haul routes to reduce wear and extend pavement life. For example, Glacier Highway in Juneau has been strengthened to accommodate gravel and cement trucks using the materials site at Lemon Creek. Likewise, the Klondike Highway will be strengthened to accommodate ore trucks up to 100 tons in weight.

Ore Truck on the Klondike Highway; photo by Roger Healy ADOT&PF

Environmental Conditions

In addition to traffic density and vehicle weight, environmental factors also contribute to pavement wear, particularly permafrost conditions, which are recurring and expensive to correct, mitigate, or avoid. Drainage and water infiltration are always a problem over time. Water penetrates into the road foundation from the shoulders and through patches and, to a lesser degree, through the surface. All of these sources of water wear out the base material that makes up a road's foundation. Sunlight and oxygen react with petroleum products, which ages asphalt by breaking it down.

Airports do not experience the same abuse as highways, but are subject to the relentless effects of weathering, aging, and heavy aircraft loading. It is important to apply regular surface treatments to prevent weathering and oxidation of the asphalt, which causes it to become brittle, leading to cracking, raveling, water penetration, and destabilization. Regular crack sealing, especially in the early stages, prevents water infiltration and maintains the paved surface much longer than when crack sealing is not applied.

Catastrophic Events

Other factors can affect pavements swiftly, even catastrophically. Standing water from plugged culverts can saturate and destabilize road embankments. Avalanches and falling debris can damage and break up road and high-

Flood Damage on the Richardson Highway; photo by Mike Coffey ADOT&PF

Other factors can affect pavements swiftly, even catastrophically... Damage to roads and airports are caused by storm surges and high tides in coastal communities, flooding in river communities, and throughout Alaska earthquakes are an ever-present threat.

way surfaces. Damage to roads and airports are caused by storm surges and high tides in coastal communities, flooding in river communities, and throughout Alaska earthquakes are an ever-present threat. Such acts of nature can be highly disruptive to the traveling public and expensive to fix. The department will continue to identify and adopt strategies, from slope stabilization to improved hydrology practices, that protect against sudden and damaging events.

Regional Conditions

Each of the department's three regions faces unique factors related to pavement wear and tear.

Northern Region must deal with permafrost, which annually affects between 650 and 1,000 centerline miles of highway and results in maintenance costs that have averaged $11 million annually over the past eight years. Maintenance issues related to permafrost, discussed in more detail later in this report, are anticipated to become more problematic to the extent that the rate and/or scope of thawing increases and funding remains static or declines.

Central Region, in the greater Anchorage area, is the most intensively traveled portion of the state highway system. Here, rutting is the most obvious factor in highway pavement wear. High use of studded tires, which are allowed for up to seven and a half months out of the year, contribute to rutting more than any other factor.

Southeast Region, which is unaffected by permafrost, has relatively low traffic volumes, although the use of studded tires in Juneau leads to rutting on Egan Drive. To a lesser extent, rutting can also occur on highways in Ketchikan and Sitka. Pavement wear in Southeast typically is caused by weathering and fatigue, which cracks the asphalt surface, leading to moisture infiltration, roughness, and potholing.

The Pavement Program

The goal of the state's pavement management program is to maintain highway and airport surfaces in a safe operating condition and ensure their safe use by the public.

Alaska Pavement Design

The pavement policy of the Federal Highway Administration[2] requires that pavement be designed "to accommodate current and predicted traffic needs in a safe, durable, and cost effective manner." The regulations do not specify the procedures each state must follow. Instead, each state transportation department is expected to use a design that is appropriate for its conditions.

The Alaska Flexible Pavement Design Manual, published in April 2004, establishes policies and design guidelines for the paved surfaces of Alaska's highways. The manual, along with a software program, replaces a collection of pavement design tools previously used by department engineers. The manual recognizes that poor foundation conditions and other geotechnical problems typical of Alaska can profoundly affect pavement performance regardless of other factors such as pavement layer thicknesses or materials quality. Department pavement engineers, who understand Alaska's conditions, continually seek out geographically and regionally suitable pavement treatments.

Regional Materials

Pavement engineers routinely solicit design and engineering help from technical specialists. Design measures that resolve drainage problems, foundation problems, slope stability, and erosion usually require consultation with the Regional Materials staff. Regional Materials engineers also assist with designs that address problems encountered in Alaska, such as ice-rich permafrost and muskeg, and with the associated use of specialized materials, such as polystyrene insulation and geo-synthetics. Additional information regarding the role of the department's Materials staff is addressed later in this report.

Pavement Rutting on Wendy Lane; photo from ADOT&PF archives

Lifecycle Cost Analysis

The Alaska Flexible Pavement Design Manual and associated software will soon include a lifecycle cost analysis as an element of pavement design. The analysis will help engineers choose the most cost-effective alternatives. The analysis will not necessarily recommend the least expensive design, but rather the alternative with the lowest lifecycle cost. Thus, an alternative that is more costly up-front but results in longer pavement life at a lower unit cost will be preferred.

2. Chapter 23, Section 626.3 of the Code of Federal Regulations

Highways

Pavement Management for Alaska's road system involves the automated collection of pavement conditions on approximately 4,100 lane-miles of highway per year, typically over a four-month period between June 1 and September 30

Inspection and Data Collection

Recent technological advances allow the department to collect and store a wealth of data that is used to more effectively and efficiently manage pavement assets.

Field data is collected with an inspection vehicle known as a Road Surface Profiler (RSP). Seven lasers are mounted on the front bumper of the vehicle: two in each wheel path, one in the center, and two pointing to each side. Two accelerometers assist in calculating pavement smoothness, and on-board GPS units allow for the determination of the exact position of the equipment as the data collection vehicle travels down the roadway. Rapid recording of laser reflection off the pavement surface provides data to evaluate rutting and smoothness. The GPS unit ensures that all data is location-specific, with photographs being taken continuously and tagged with GPS coordinates.

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Data quality relies on calibration of the testing equipment to the exacting standards of ASTM International, formerly known as the American Society for Testing and Materials). This organization is a globally recognized leader in the development and delivery of international standards.

Data on pavement cracking has not been collected comprehensively, but on a localized basis using visual inspection. A May 2010 assessment prepared by the Federal Highway Administration recommended collecting cracking data on a network, or system-wide, basis at the same time rutting and roughness data is collected. Collection of cracking data on a network basis is now a data requirement for the FHWA's Highway Performance Monitoring System (HPMS), a national-level highway information system that includes data on the extent, condition, performance, use and operation of the nation's highways. The inclusion of network cracking data during road inspections ensures a more accurate representation of the overall condition of the state's highways and a more comprehensive analysis using the PMS. Due to the high cost associated with this type of data collection, however, a system that uses statistical sampling, similar to that employed in airport inspections, was implemented during 2012.

Road Surface Profiler; photo by Jim Horn ADOT&PF

Future consideration should be given to collecting pavement-related data on shoulders, on-ramps and off-ramps, bike and pedestrian paths, and other road-related paved surfaces. A statewide inventory of culverts is underway, as is an inventory of unstable slopes along a portion of the Parks Highway.

Data Storage and Analysis

The department collects data under a contract with Dynatest Consulting, Inc., using Road Surface Profiling (RSP) equipment. The collected highway surface data is downloaded to the Performance and Economic Rating System (PERS) software, then uploaded to the Department's Pavement Management System database, along with up-to-date traffic information and new construction and repair information. PERS stores the data for every section of Alaska's road network. A typical section is 1-mile in length, but may be longer or shorter depending on roadway structural differences or physical boundaries such as bridges. Examples of the types of data stored in PERS are:

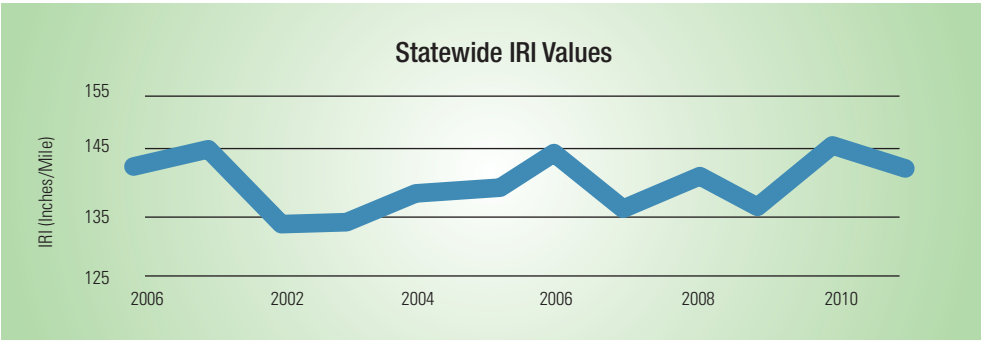
- General sectional information, such as numerical identification, number of lanes, road classification, pavement type, functional class, etc.
- Traffic data (vehicles per day) and equivalent axle loadings.
- Structural data showing materials and thicknesses forming the support system of the roadway.
- Surface data with rutting and with IRI (International Roughness Index) indicators used to calculate remaining life.
- Modeling information allowing the engineer to account for varying conditions by modifying the formulas.
- Past construction and maintenance data.

PERS performs engineering analyses, such as calculating remaining service life and a Pavement Serviceability Rating (PSR) for each section of pavement based on IRI and rutting, using its built-in software. PERS is useful in identifying projects for preventive maintenance, rehabilitation, or other action.

Using rutting and roughness data, the Pavement Management System produces a list of prioritized projects, including the appropriate remediations. The list is distributed to the regions, where actual priorities for pavement work may differ from the statewide list, according to regional priorities, with particular attention to safety.

The Pavement Management System has an important role to play in the Department's transition to asset management. It can help establish goals, illustrate the consequences of differing investments, provide "what if" scenarios, and deliver other analyses to guide both policies surrounding and the budgeting of pavement preservation. As the department shifts from a traditional maintenance approach to one that incorporates preservation, the capabilities of the PMS will become more fully realized. The PMS and the Maintenance Management Systems will ultimately become linked, allowing the integration of maintenance activities and merger of data on priorities, alternatives, and costs.

The Pavement Management System produces a statewide list of prioritized projects, including the appropriate remediations, that is distributed to the regions. Regional priorities may differ, with particular attention paid to safety.



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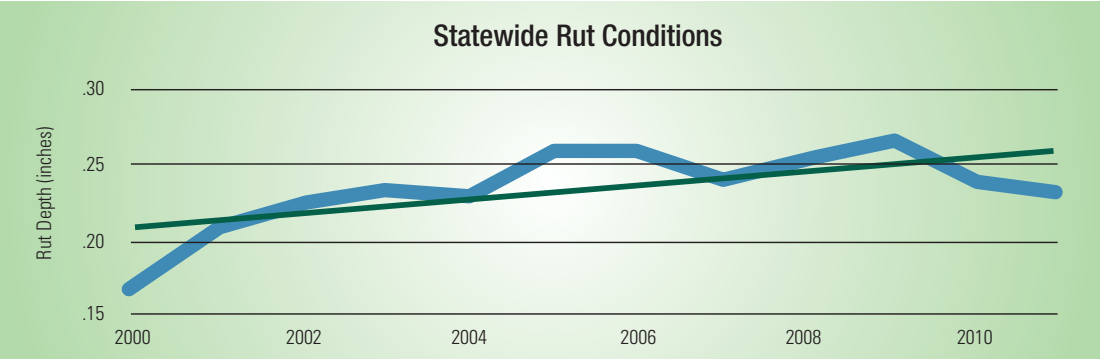

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Pavement Condition Ratings

The department currently uses three metrics to rate the condition of highway pavements:

- roughness, using the International Roughness Index (IRI);
- rutting, or the longitudinal groves worn in the pavement by tires, especially studded tires; and
- pavement serviceability rating, a rating that combines roughness and rutting into a single measure.

The International Roughness Index is an international standard for calculating pavement smoothness. The index measures pavement roughness, expressed as vertical displacement and reported in inches per mile. The FHWA has established a guideline setting the IRI at 170 inches or less per mile for an acceptable road surface and 95 inches or less per mile for surfaces in good condition. It is the department's goal for new construction to achieve an IRI of less than 60 inches per mile.

The higher the IRI number, the rougher the ride. Since its introduction in 1986, IRI has become the road roughness index most commonly used worldwide for evaluating and managing road systems. A newly constructed road should be expected to have an IRI of 60-80 inches/mile or better. Studies have proved that smoother roads with a lower initial IRI...

1. have lower roughness levels in the 10 years following construction;
2. have lower cracking levels in the 10 years following construction; and
3. have lower average maintenance costs in the 10 years following construction.

Also, smoother pavements reduce fuel consumption, vehicle operating costs, and driver fatigue by minimizing tire bounce and load impacts. Increasing smoothness by 25% results in an almost 10% increase in pavement longevity.

Rutting is a depression or groove worn into a road or path by the travel of wheels. In Alaska, paved roads are especially vulnerable to the high use of studded tires. Another method of rut formation on asphalt roads is known as

Tok Cutoff Highway by Mistee Vinzant, ADOT&PF

plastic deformation, caused by heavy loads. This usually forms a lip or ridge along the sides of a rut and can be seen sometimes at intersections where cars sit or move slowly. Pavement ruts are of concern for at least two reasons: accumulated water in the ruts can penetrate the pavement and damage structural integrity of the materials beneath the asphalt surface; and ruts can affect driver safety by influencing steering control. The department trigger for a rutting rehabilitation design is a rut depth of ½ inch; rut depths of 3/4 inch or greater require immediate rehabilitation.

Annual Performance Target

The department and the Office of Management and Budget have set an annual performance target to increase Alaska's Pavement Serviceability Rating (PSR) to 3.3 by October 2012. Established in the "1995 Status of the Nation's Surface Transportation System: Condition and Performance – Report to Congress," the Pavement Serviceability Rating (PSR) is a national standard for reporting surface transportation condition and performance. Using a 0-5 rating, where 5 is perfect and 0 is failed, the PSR is calculated mathematically using the IRI and rut depth. The average PSR for 2007 – 2011 was 3.12 (fair), compared to the 2011 rating of 3.2. The department's specific performance target, to increase the Pavement Serviceability Rating to 3.3 by October of 2012, will be re-evaluated to ensure a goal for improvement. This rating has shown slow but steady improvement since 2006, when the PSR was 3.0, to a 2011 rating of 3.2.

Improvement in Road Conditions

Overall, road conditions improved slightly for 2011. Paving projects in 2010 showed significant improvements in rut depth averages. Pavement smoothness was held at 2010 levels. Pavement preservation techniques that show promise for improving surface conditions and extending service life continue to be evaluated. Road conditions generally are improving, meaning less rutting and smoother roads that last longer than in the past.

As additional miles of highway pavement are brought up to good condition, the performance measure for PSR will be raised to reflect both improved conditions and the implementation of preservation-based standards. Raising the target over time to a PSR of 3.6 or higher, would avoid more costly treatments, consistent with pavement asset management practices.

PSR data has been digitized and is now displayed graphically using Google Earth.™ Appendix B displays a map showing the 2011 pavement serviceability ratings on the state's National and Alaska Highway systems. The PSR ratings may also be viewed at http://www.dot.state.ak.us/stwdmno/pvmtmgt/, then clicking on the "2011 PSR" link.

Studies have proved that smoother roads with a lower initial IRI, will have lower roughness levels, lower cracking levels, and lower average maintenance costs in the 10 years following construction.

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PSR Ratings

Very Good —4.0 to 5.0
Good —3.6 to 3.9
Fair— 3.1 to 3.5
Mediocre —2.7 to 3.0
Poor —2.6 & Below

Airports

For airport pavement design, department engineers rely on the Federal Aviation Administration's advisory circular, which provides guidance on soils, sub-grades, rigid and flexible surfaces, overlays, designing for frost and permafrost conditions, and other factors.[3] The department has considerable experience mitigating the effects of permafrost in airport design.

Climatic variations, funding shortfalls, and remote locations present a continuous challenge for the preservation, maintenance, and construction needs of rural airports.

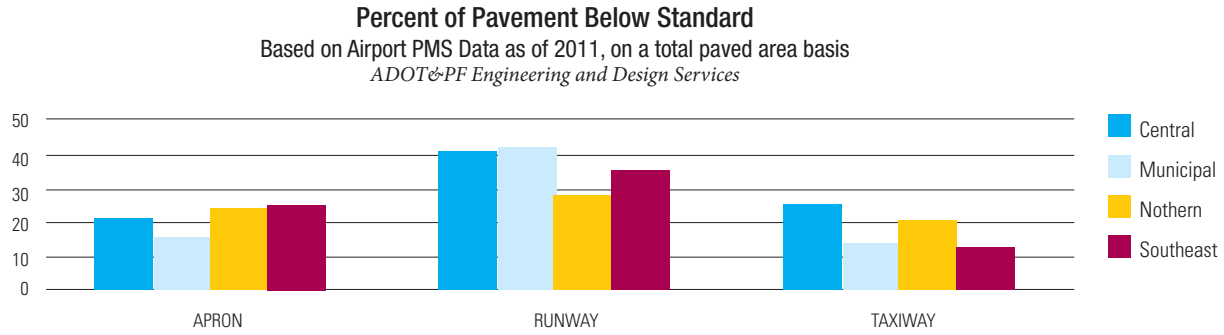
Inspection and Data Collection

Annually, the department performs visual pavement condition surveys on approximately one-third of the 55 paved airports in the statewide aviation system, not including Ted Stevens Anchorage International Airport, which is managed separately under the international airport system. Fairbanks is also in the international system but has requested to be included in the statewide pavement management system. Conditions are rated according to U.S. Army Corps of Engineers Pavement Condition Index (PCI). The department's Pavement Management Section visually inspects runway pavements using the PCI, employing a rating scale of 0 to 100, with 100 for perfect new pavement, and a PCI of 0 for a completely failed pavement.

The department follows state guidelines for PCI, which call for a minimum PCI condition rating of 70 for runways and 60 for taxiways and aprons. Climatic variations, funding shortfalls, and remote locations present a continuous challenge for the preservation, maintenance, and construction needs of rural airports.

Earthquake Damage at the Northway Airport; photo courtesy of the Federal Highway Administration

[3] FAA Advisory Circular 150/5320-6E-Airport Design and Evaluation



Data Storage and Analysis

Pavement condition data is fed into the MicroPAVER database along with pavement age and construction/maintenance histories. The system generates PCI (Pavement Condition Index) values, which are included in annual reports and maps. The MicroPAVER system can also be used to update previously entered data, predict future pavement conditions (including deterioration), and develop project budget and budgeting scenarios.

Pavement Condition Index

Recommendations based on PCI ratings fall into 3 categories:

1. **Maintenance** (surface repair) – restoring or keeping existing maintenance in serviceable condition.
2. **Rehabilitation (structural)** – restoring or improving the ability of the pavement to carry loads .
3. **Reconstruction** (removal and replacement) – design or construction of new pavement to meet requirements.

Appendix F is a map showing color-coded PCI ratings for the Bethel airport based on a 2009 inspection. To see the PCI ratings for other airports in the state, go to http://www.dot.state.ak.us/stwdmno/pvmtmgt/index.shtml and open "Airport Data Mapping." Google Earth will open showing selected Alaska airports with a two or three digit PCI rating. Zoom in on the number to see a detailed PCI rating of that airport.

Condition Rating

The airport Pavement Condition Index provides general recommendations and strategies for pavement maintenance and project work along with PCI maps for multiple years. The system recognizes that pavement maintenance is most efficient and cost effective when done at higher condition ratings. When the PCI falls below minimums, it is most cost effective to rehabilitate the pavement with construction contracts. The compelling need for safe operations, coupled with inadequate funding, sometimes requires that maintenance work be performed on pavements in lower condition categories before pavements in better condition.

Airport PCI and Recommended Action

100-85 Excellent—no action required other than routine maintenance.

84-70 Very Good—preventative maintenance (i.e., crack seal/surface seal).

69-60 Good—corrective maintenance (i.e., more aggressive crack sealing/patching)

59-40 Fair—rehabilitation (i.e. mill out and replace asphalt, overlay, reclamation)

39-0 Very Poor/serious/failed—reconstruct

Pavement Asset Management

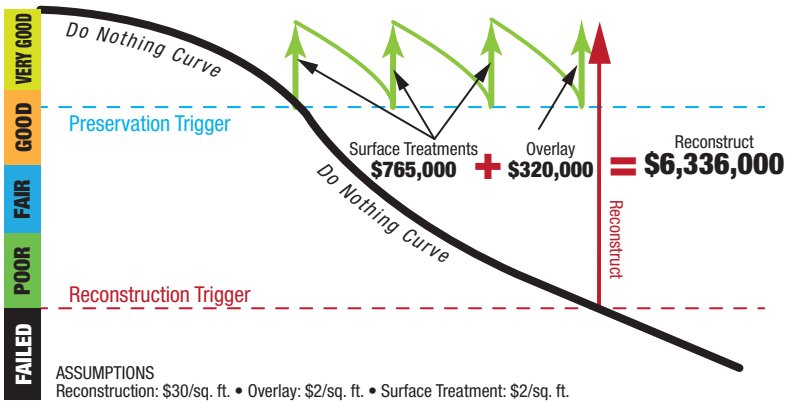
Pavement Asset Management uses data gathering and analysis to identify optimum strategies for extending the safe life of paved assets by preserving them in a good condition. Asset management is recognized by state and federal transportation officials as a sound business and investment practice. MAP-21, the recently-adopted highway reauthorization bill, now requires state departments of transportation to include asset management in long range planning.

Cost Efficiencies

State departments of transportation, including Alaska, are embracing asset management as a long-term approach to preserve assets in a cost-effective manner, using accurate and current condition data and sophisticated analysis techniques to sort through alternatives and identify the most cost-efficient preservation strategies. In an era of declining funding, and with significant "in-place" investments in roads, bridges, and airfields, the department is beginning the transition to an asset management approach over the traditional "worst first" approach.

The transition to pavement asset management is underway even as the department deals with a significant backlog of deferred maintenance, where failure to act could result in unsafe roads and driving conditions. This poses the challenge of simultaneously bringing the underperforming pavements to a good condition while spending money to preserve roads that are already in good condition before they deteriorate. As a result, the transition will be lengthy, but could be hastened with additional funds. In fiscal years 2010 and 2012, the Alaska State Legislature appropriated $18.3 million to address the deferred maintenance backlog.

M&O Preservation vs. Do Nothing



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Pavement Management System

The PMS is capable of supporting an asset-based approach to pavement management; however, the potential of the program to forecast the costs and consequences of various alternatives must become more fully realized. The recent creation in the Department of an Asset Management Office provides assurances that this is a department priority.

The advantage of implementing an asset management program for preserving highway and airfield pavements is apparent in Figure 14. As the graph shows, a preservation-based approach, where pavements are preserved through early surface treatments, provides considerable cost efficiencies compared to the more traditional "worst first" approach, where pavements deteriorate to a degree that more expensive remediation, or even reconstruction, is required.

An effective pavement preservation program will address pavements while they are still in good condition and before the onset of serious damage. By applying a cost-effective treatment at the right time, the pavement is

restored almost to its original condition. The cumulative effect of systematic, successive preservation treatments is to postpone costly rehabilitation and reconstruction. During the life of a paved surface, the cumulative cost of preservation treatments is substantially less than the cost of reconstruction, and generally more economical than the cost of major rehabilitation. Additionally, performing a series of successive pavement preservation treatments during the life of a pavement is less disruptive to uniform traffic flow than are the long closures normally associated with reconstruction projects.

Quality Assurance Report Card

Maintenance engineers have recently prepared the Quality Assurance Report Card, based on 1,000 random samples of pavement taken from highways across Alaska. Using summer highway maintenance service levels as an example, department maintenance engineers have determined per-unit costs to maintain highway pavement (as well as culverts, ditches, guardrails, traffic signs, and vegetation) to meet each of the five performance targets. Thus, the cost for maintaining identified high volume routes at performance target "A" can be quantified on a per-unit basis, establishing a clear relationship between budget amounts and maintenance outcomes.

The Report Card provides a basis for identifying priorities, assigning work, and linking budgets to measurable results. Figure 15 is a 2012 report card showing the existing service level based on samples taken statewide. The report card shows the existing service level (the letter "C") as well as the proposed service level (the letter "P"). Maintenance staff has identified unit costs for each category and service level, so, for example, the cost of improving pavement rutting from service level "F" to service level "B" can be quantified.

Maintenance staff has started to use the report card to allocate deferred maintenance funding. By knowing asset conditions and trends, the department can reallocate funding and staff time, and focus on meeting identified service levels for specific assets, such as pavement.

Quality Assurance Report Card - 2012 Data

Alaska Department of Transportation and Public Facilities

	Service Level A				Service Level B				Service Level C				Service Level D				Service Level F			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Gravel Surface Material										P							C→			
Cracks						P			←C											
Allegator Cracking						←PC														
Potholes						P		←C												
Pavement Striping										P				←C						
Pavement Marking										P								C		
Pavement Rutting						P											C			
Pavement IRI						P						C→								
Culverts						P							C							
Ditches	←C					P														
Guardrail Panels						P	C													
Guardrail Ends						P										C→				
Guardrail Height						P						C→								
Traffic Signs						P											C→			
Vegetation Management - Hydro Axe						P				C→										
Vegetation Management - Side-Arm Mowing						P								C→						
Vegetation Management - Standard Mowing						P								C→						

↔ = Trend from Previous Year (no arrow = no change)
C = Existing Service Level (2012)
P = Proposed Service Level

ADOT&PF Engineering and Design Services

Pavement Preservation Research Project

The department's Research, Development and Technology Transfer Office, together with the University of Alaska Fairbanks, the University of Alaska Anchorage, and the California Pavement Preservation Center, are researching a pavement preservation program that recognizes the importance of asset management and will recommend geographically suitable pavement preservation treatments.

By adopting effective preservation methods that proactively correct minor road deficiencies, the roadways' service lives can be extended at comparatively low cost. By studying the performance of pavement preservation in Alaska, the research project can identify where Alaska currently stands in terms of its asset management program relative to pavements and recommend specific steps for implementation of more robust pavement preservation programs.

The joint research project will include:

- information on the types of preservation treatments most suitable for Alaska;
- performance of pavement preservation treatments used in Alaska;
- a strategy selection guide for preservation treatments in Alaska;
- a prototype web-based pavement preservation application monitoring and collaboration database;
- recommendations on how to build a pavement preservation program; in Alaska and
- recommendations for implementation and integration into a comprehensive Asset Management program.

The final report will be issued in December 2012.

The Role of Materials

The department's Materials Section provides specialized technical assistance and engineering services for the design, construction, and maintenance of Alaska's highway and airfield pavements.

Department research has consistently shown that the use of harder aggregates ... can increase pavement performance by 1.4 to 1.9 times in the Anchorage and Juneau areas respectively.

The Studded Tire Problem

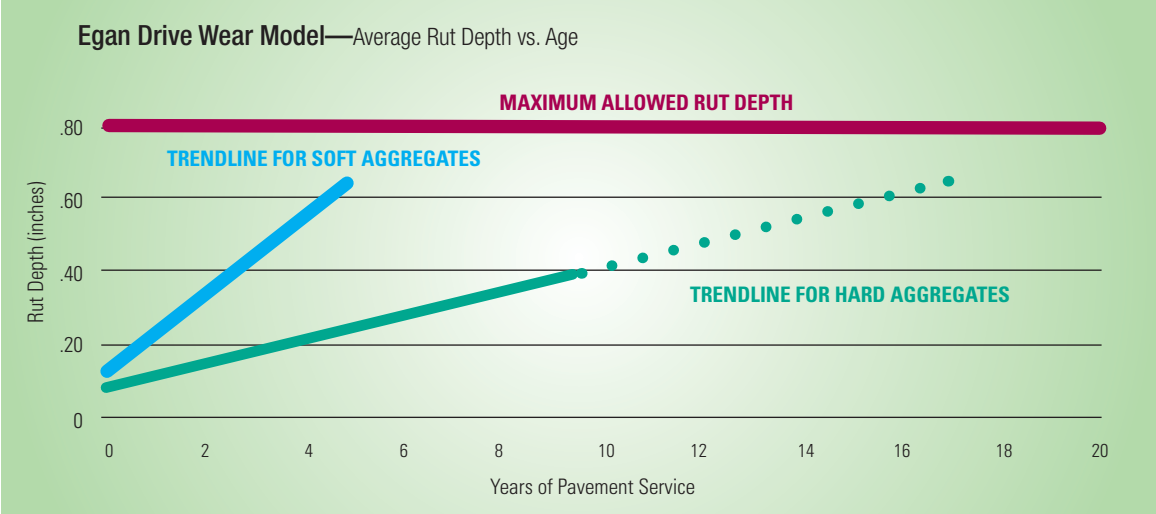
The Materials Section has been particularly interested in addressing wheel rutting, a problem endemic to Anchorage, as well as on Egan Drive in Juneau, caused primarily by studded tires. In a series of reports prepared from the early 1990s forward, and as the result of examining the practices of Scandinavian countries, the department has concluded that hard aggregates result in improved pavement performance by resisting wear from studded tires.

Hard aggregate of a type suitable for use on the road surface is not readily available in the state. Aggregate hardness is measured by using the industry-standard Nordic Abrasion Test. Local aggregates test at 12, while hard aggregates must test at 8 or below. The cost of importing hard aggregate from the large, industrial pit operation in DuPont, Washington, is more than offset by the savings that result from a longer-lasting road surface. Department research has consistently shown that the use of harder aggregates conforming to Nordic Abrasion specifications can increase pavement performance by 1.4 to 1.9 times in the Anchorage and Juneau areas respectively. On Egan Drive in Juneau, the use of hard aggregates has improved pavement performance by 2.5 times.

Rubberized Hot-Mix Asphalt

The Materials Section has also studied the use of Rubberized Hot-Mix Asphalt (RHMA) in the Anchorage area as an alternative to conventional hot-mix asphalt and as a regionally appropriate alternative to the use of hard aggregates. Department lab research demonstrated that RHMA may out-perform conventional hot mix asphalt for studded tire wear. The research concluded that, despite its higher cost, roadways paved with RHMA have a potentially lower lifecycle cost than those paved with conventional hot mix asphalt.

Rubberized hot-mix asphalts are currently being used in the Anchorage area, while asphalt mixes using hard aggregates were first developed for use in Juneau. Rutting is not an issue on roads in the Interior region where thawing permafrost, addressed in a separate section below, is a constant and growing issue.



ADOT&PF Southeast Region Materials Engineer

Materials Technology

Pavement engineers pay attention to new practices, innovations, and emerging trends and technology from around the nation and the world. The hard aggregates discussed above, for example, are rated using a procedure perfected in Sweden.

Mix Alternatives

As aggregate material sources become scarcer and more cost-prohibitive, the re-use of existing pavement material has gained significant attention. Reclaimed Asphalt Pavement (RAP) is now routinely employed in the construction of new pavements. Likewise, more sustainable asphalt mixes have come into use. For example, warm-mix asphalt (WMA), which is produced at lower temperatures than conventional hot-mix and consequently requires less fuel to bring it to a working temperature, is now being employed.WMA also takes less time and effort to compact at the job site, resulting in reduced operating hours (and fuel use) for compaction equipment.

Construction Improvements

New technologies using infrared sensors and GPS readings have been installed as after-market additions to paving equipment to improve the construction of asphalt surfaces and are likely to become standard in a new generation of pavers and compactors. The Pave-IR system, developed by the Texas Transportation Institute, uses a transverse bar with 10 infrared temperature sensors immediately behind the paver; the Pave-IR software collects and displays the asphalt mix's thermal profile in real time as the paving train progresses. This ensures uniform asphalt temperatures across the width of the paving and the correct compaction temperature during placement. Evidence has shown that uniform paving and compaction temperatures lead to a longer-lasting road surfaces.

New surfacing treatments for highways are gaining acceptance, but must be evaluated carefully for their applicability in Alaska. In ultra-wear, or dura-wear treatments, an emulsion is applied to the pavement surface, then covered immediately with an ultra-thin lift of hot-mix asphalt that seals and waterproofs the surface. Micro-surfacing, first developed in Germany in the 1960s and now widely used, utilizes a precise mixture of graded aggregate, asphalt emulsion, water, and mineral and polymer fillers that is made and applied to existing pavements by a specialized machine that carries all components, mixes them and spreads the aggregate on the road surface. Use of these surface treatments is limited in Alaska, as they do not sufficiently withstand the rigors of climate and studded tires.

A new generation of "intelligent" compactors will improve work quality and lead to longer-lasting pavements. A compactor can now be equipped with a GPS unit and with sensors that continually read the level of compaction of the asphalt mix. With this technology, the operator can view a color-coded graphic image that locates portions of the pavement where compaction meets specifications and where additional compaction is needed. This reduces both equipment and operator time while providing for optimal compaction and longer pavement life.

Implementation

The department continues to examine innovative surfacing treatments and technologies for their cost and suitability using small-scale tests to evaluate their performance under Alaska's conditions. Only when these test sections are successful, based on realistic lifecycle costing, are larger-scale projects undertaken.

Permafrost

Alaska is the only state in the U.S. that must deal with permafrost and its effects on highways and runways. Permafrost is rock or soil material that has remained below 32 degrees Fahrenheit for two or more years.

Permafrost occurs almost continuously above the Arctic Circle and discontinuously throughout northern, central, and western Alaska. Southeast Alaska is permafrost-free. Permafrost differs according to water (i.e., ice) content and the types of solid material in which the water is suspended. The stability of the permafrost is closely related. These categories represent the several types of permafrost:

1. Cold permafrost remains below 30°F or as low as 10°F / -12°C and can take considerable heat without thawing.

2. Warm permafrost remains just below 32°F; very little additional heat may cause it to thaw.

3. Thaw-stable permafrost is found in bedrock, and in well-drained, coarse-grained sediments such as sand and gravel mixtures; movement of thaw-stable permafrost is minor, so the foundation remains essentially sound.

4. Thaw-unstable permafrost is found in poorly drained, fine-grained soils, especially silts and clays; thawing can cause loss of strength, excessive settlement, and soil containing so much moisture that it flows.

5. Ice-rich permafrost contains 20% to 50% visible ice.

6. Massive ice describes structures consisting almost entirely of ice lenses and wedges.

Effects of Permafrost on the Road Surface
Photo by Mike Coffey ADOT&PF

Permafrost underlies approximately 80% of the state, and, while estimates vary, perhaps 25% of the state's highways are constructed on permafrost. The department spends roughly $11 million per year maintaining permafrost-affected roads in the Northern, Western and Arctic areas of the state. These expenditures are largely remedial, meant to keep affected roads in a safe and drivable condition, and represent only a fraction of the funds necessary to address the issue more comprehensively.

Managing Permafrost Problems

The costs associated with managing the effects of thawing permafrost will increase if average annual temperatures continue to rise and the rate and extent of permafrost thawing increases. Localized problems may expand in scope as warm permafrost, thaw-unstable permafrost, and ice-rich permafrost — those most susceptible to thawing — become subject to higher temperature regimes.

The department can deal with the effects of permafrost on paved surfaces in three ways: 1) avoid it, which is difficult in the case of existing roads and can be difficult for new alignments as well; 2) remove the permafrost and rebuild, which is typically a time-consuming and costly choice unless the permafrost is shallow and economic to remove; or 3) mitigate it through design, engineering, and construction practices that maintain the permafrost in a frozen state. This last approach represents the department's most common practice.

The department's principal techniques for maintaining permafrost in a frozen state beneath a roadway involve reducing or preventing thawing through the installation of

thicker embankments and/or insulation and supercooling, using either thermosyphons or Air Convection Embankments (see caption at right). The department performs thermal modeling using a computer program called TEMP/W to determine embankment thicknesses necessary to prevent seasonal thawing into the permafrost sub-grade.

Thermosyphons

Thermosyphons help to eliminate thaw settlement by refrigerating the permafrost during the winter. This is accomplished by using a refrigerant (carbon dioxide is used in the Thompson Drive thermosyphons in Fairbanks) that boils in the lower portion of the device. As the boiling takes place, a large amount of heat is removed from the surrounding permafrost. After boiling, the refrigerant passes to the upper portion of the thermosyphon where it is recondensed. As this happens, the heat is transported out of the upper section into the cold wintertime air. This method of super-cooling the permafrost during the winter allows it to survive the summer without melting. Thermosyphons are used on the Alaska pipeline where it runs above ground on vertical support members.

Extruded Polystyrene Insulation

The department has installed polystyrene insulation "boards" to delay or prevent thawing of permafrost, with particular application at paved airports, where polystyrene has been used for approximately 30 years, an application most recently studied by the department in the 1990s.

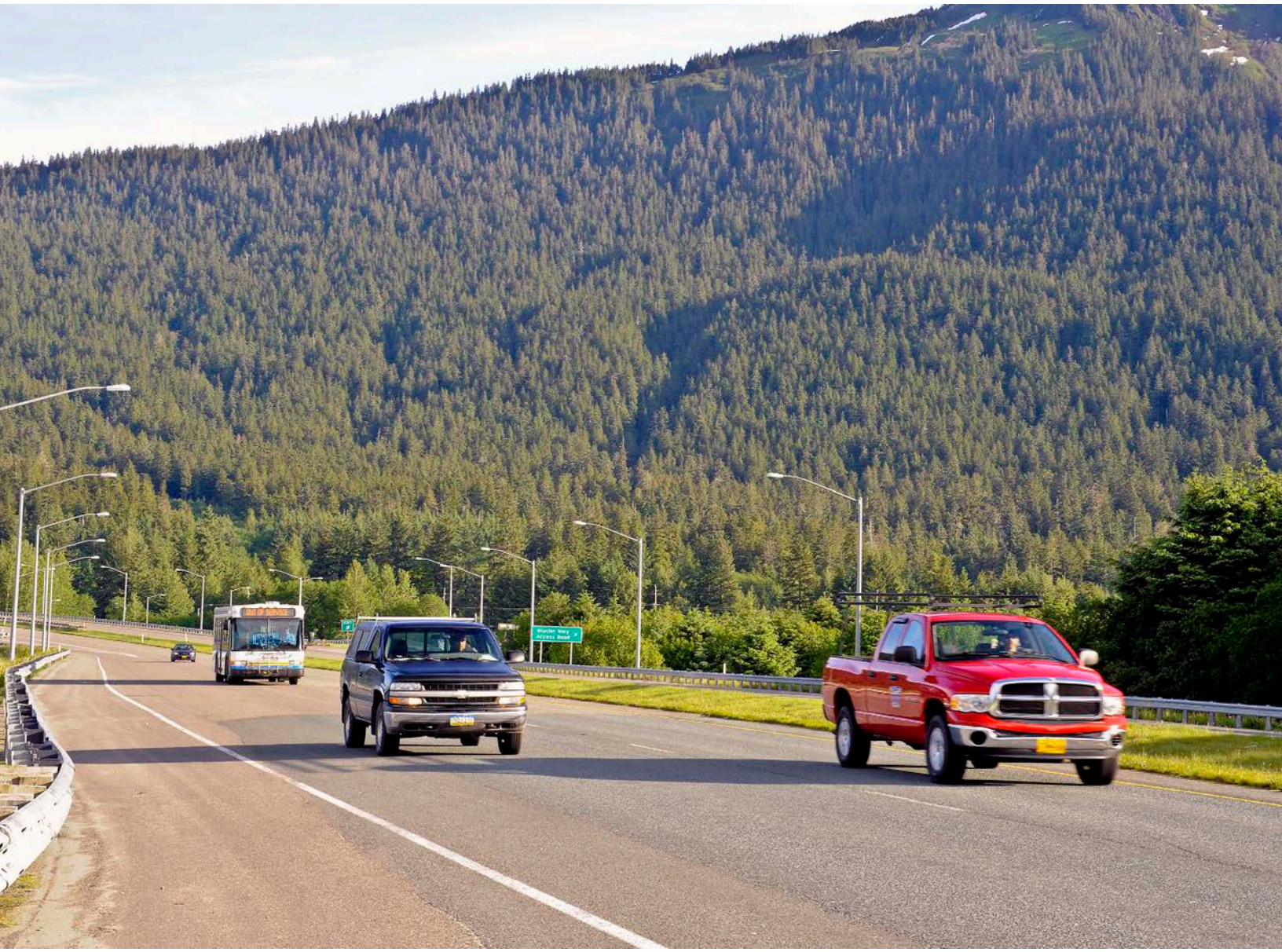
Mitigation and Prevention

No estimate is available on the cost to mitigate or prevent thawing on all permafrost-affected roads, but is assumed to be significant. For example, permanent mitigation of permafrost problems on the Dalton Highway near Deadhorse were estimated by the department to cost approximately $1 million per mile. An asset management-based approach on permafrost-affected roads is unlikely, if not impossible, given the recurring nature of the problem and the crucial importance of maintaining affected roads in a safe driving condition. More likely, given the downward pressure on funding, the department will continue its present practices and address the effects of permafrost on a "worst first" basis, with safety of the traveling public the foremost consideration.

See Appendix "G" for a map prepared at the University of Alaska Fairbanks Geophysical Institute Permafrost Laboratory showing statewide permafrost conditions.

Air Conditioned Embankment, Thompson Drive, Fairbanks, photo by Jeff Currey, ADOT&PF

An "air convection embankment," *like that of Fairbank's Thompson Drive (above), uses large sized rock to allow air to circulate. The system design promotes vigorous air ciculation during the low temperatures of winter. The net effect is an enhanced cooling of the permafrost layer below the surface. Supplying enhanced cooling during winter months enables the permafrost to survive the warm summer period without melting.*



Southbound on Egan Expressway; photo by Peter Metcalfe

Closing

Good pavement matters. Pavements that are in good condition mean safer driving, reduced fuel consumption and vehicle wear, and lower long-term preservation costs. Highway and airport surfaces in good condition are essential, both for safety and the efficient movement of goods and people. We hope this report has informed and educated you about the work we do to design, construct, manage and maintain paved surfaces throughout Alaska.

Appendix A: Glossary

Aggregate is any combination of one or more sand and rock particles, either natural or crushed, from very fine to large rocks. Aggregate is selected because of its characteristics, such as sand, gravel, crushed stone, ballast, etc., and used for specific purposes and mixing in specific proportions.

Asphalt Concrete Also referred to as asphalt concrete pavement (ACP), hot mix asphalt (HMA), flexible pavement, and hot bituminous pavement. It is the material most commonly used for surfacing roadways and airports in Alaska that are subject to high traffic of 5,000 vehicles or more per day. It is a high-quality, controlled, hot mixture of liquid asphalt cement and graded aggregate, thoroughly compacted into a uniform dense mass.

Asphalt Emulsions or Emulsified Asphalt are composed of asphalt particles suspended in water with a surface active agent (variously called surfactant, chemical, soap, or emulsifying agent) to stabilize the suspension. Emulsifying the viscous asphalt allows it to be easily pumped, transported, and applied at ambient temperatures, making emulsions ideal for use at remote locations while saving energy and providing safer worker conditions. Because emulsions are water based, they are also eco-friendly, compared to hot mix asphalt, hot asphalt cement, or asphalt cutbacks. Asphalt emulsion application techniques, including chip seals, slurry seals, and cape seals, have been used for many years.

ASTM E-950 Formerly known as the American Society for Testing and Materials (ASTM), ASTM International is a globally recognized leader in the development and delivery of international voluntary consensus standards. ASTM E-950 is the organization's test method for measuring the data collected by road profiling equipment.

Banding Using a crack-sealing material, banding completes the crack-sealing process by adhering the crack-seal material to either side of the crack.

Centerline Mile is the length of a highway regardless of the pavement width or the number of lanes.

Chip Seal A, or "single-shot" asphalt surface treatment, is the spraying of emulsified asphalt material followed immediately by a thin stone cover. This is compacted as quickly as possible to adhere the aggregate cover to the asphalt . The chips (or stones) range from 3/4-inch aggregates to sand and are predominately one size. It produces an all-weather surface, renews weathered pavements, improves skid resistance and lane demarcation, and seals the pavement.

Class I Highways are part of the National Highway System. These are designated by Congress and include the Glenn Highway, Parks Highway, Alaska Highway, Seward Highway, Dalton Highway, Richardson Highway, and Klondike, Haines, and Glacier Highways in Southeast, intermodal ferry and airport facilities, and other routes.

Cracking is the separation of the pavement surface caused by failure of the asphalt to bind properly, fatigue, temperature changes, turning movement of vehicles, and other factors. Cracks are categorized as working (move horizontally at least 0.1" or more) or non-working.

Crack-Sealing is the use of asphalt materials to fill and seal cracks to impede infiltration of moisture into the supporting layers. Modern crack-sealing compounds contain rubberized agents to help maintain flexibility even at very low temperatures.

Deferred Maintenance. The practice of postponing regular maintenance activities in order to save costs, meet budget funding levels, realign budget priorities, meet emergencies, etc. The consequence of deferred maintenance is the likelihood of higher "unit costs" in the future.

Diamond Grinding. A pavement preservation technique most often utilized on concrete pavement. Diamond grinding restores rideability by removing surface irregularities caused during construction or through repeated traffic loading over time. The immediate effect of diamond grinding is a significant improvement in the smoothness of a pavement, together with improvements in skid resistance, noise reduction and safety.

Full Depth Reclamation: An alternative to full reconstruction, it is a pavement rehabilitation method in which the asphalt pavement layer and a predetermined amount of underlying material are removed, crushed, and blended to produce a base course. A new asphalt surface course is then installed.

High Float Surfacing: High float surfacing is a special form of asphalt surface treatment that consists of a single, heavily applied layer of high-float emulsified asphalt, followed by a single layer of dense-graded, crushed cover aggregate. This is one of the department's low-cost alternatives for primary and maintenance paving.

International Roughness Indes (IRI) : The IRI is an international standard for measuring pavement smoothness. The index measures pavement roughness by the number of inches per mile that a laser, mounted in a specialized van, jumps as it is driven across the road system. The lower the IRI number the smoother the ride.

Lifecycle Cost: The total cost to construct, operate, and maintain an asset over its lifetime.

Microsurfacing: Pioneered in Germany and now widely used, microsurfacing uses a precise mixture of graded aggregates, polymer-modified emulsion and set additives to seal the pavement surface, fill wheel ruts, and correct minor surface irregularities. It is cost-efficient, provides an excellent wearing course, and requires less material and energy consumption than conventional hot mix asphalt.

Mill & Fill: Mill & fill consists of removing the existing pavement surface with a milling machine and hauling the milled material to an off-site location. New asphalt mix, often containing some recycled asphalt pavement (RAP), is installed to replace the milled-out material.

Nordic Abrasion Test: A proven method of measuring aggregate hardness and abrasion resistance.

Permafrost: Rock or soil material that has remained frozen for two or more years.

Pavement Servicability Rating (PSR): The Pavement Serviceability Rating (PSR) is a national observation-based standard for reporting highway condition and performance using a 0-5 rating, where 5 is perfect and 0 is essentially impassible. It combines data gathered for roughness and rutting into a single rating.

Pavement Structure: The combination of select material, sub-base, base, and surface course placed on a sub-grade to support the traffic load and distribute it to the roadbed (42 inches below the asphalt concrete layer).

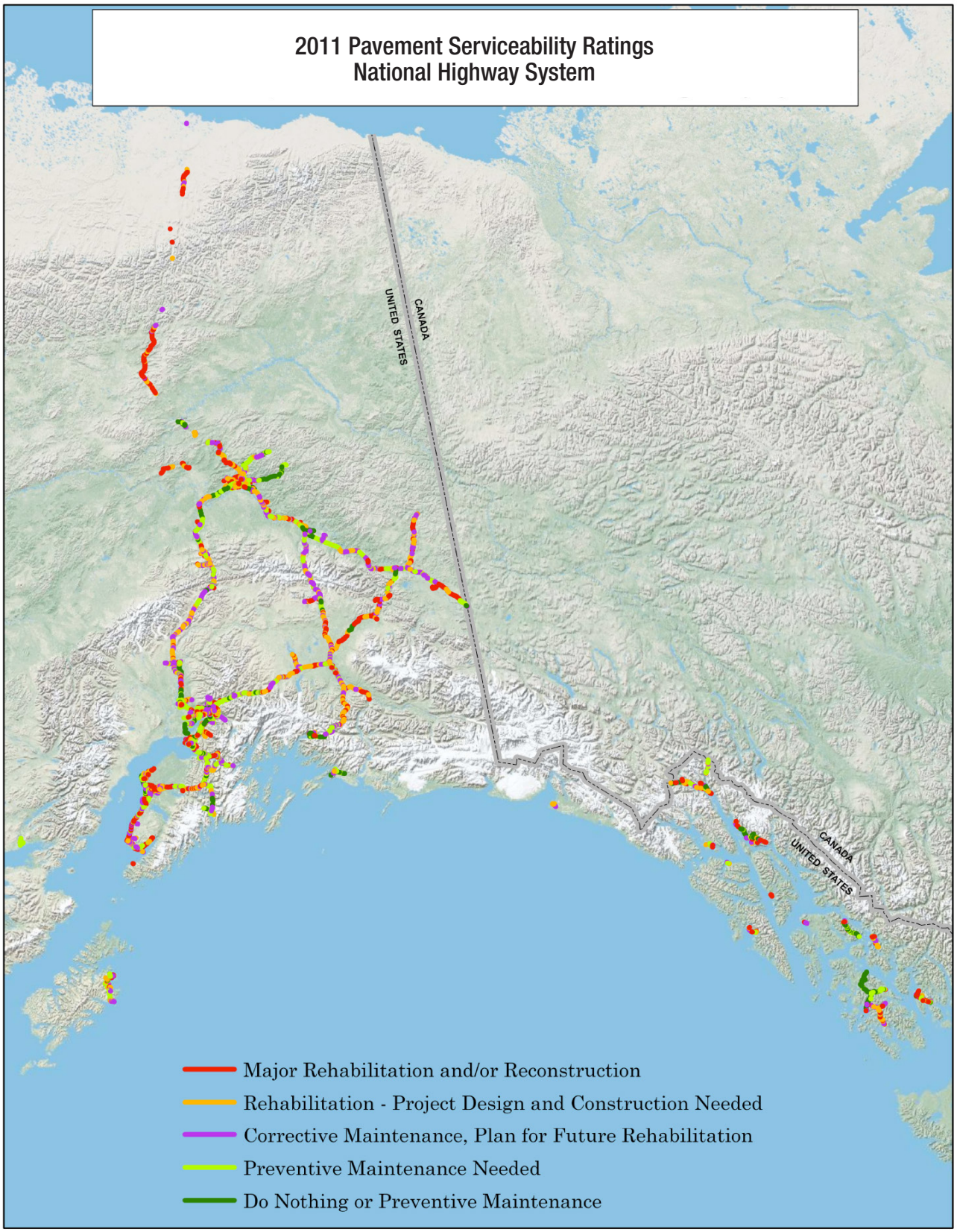
Preservation: Preservation is "a program employing a network level, long-term strategy that enhances pavement performance by using an integrated, cost-effective set of practices that extend pavement life, improve safety and meet motorist expectations." Source: FHWA Pavement Preservation Expert Task Group

Raveling: The loss or dislodgment of surface aggregate particles from the edges inward or from the surface downward. It is caused by lack of compaction, construction of a thin lift during cold weather, dirty or disintegrating aggregate, too little asphalt in the mix, or overheating of the asphalt mix. Studded tires can also contribute to raveling.

Rutting: Rutting is a longitudinal depression of the pavement structure in the wheel paths that can be caused either by pavement structural deficiency, inadequate compaction of the granular base, or by mix instability. Use of studded tires is a significant contributor to rutting in Alaska.

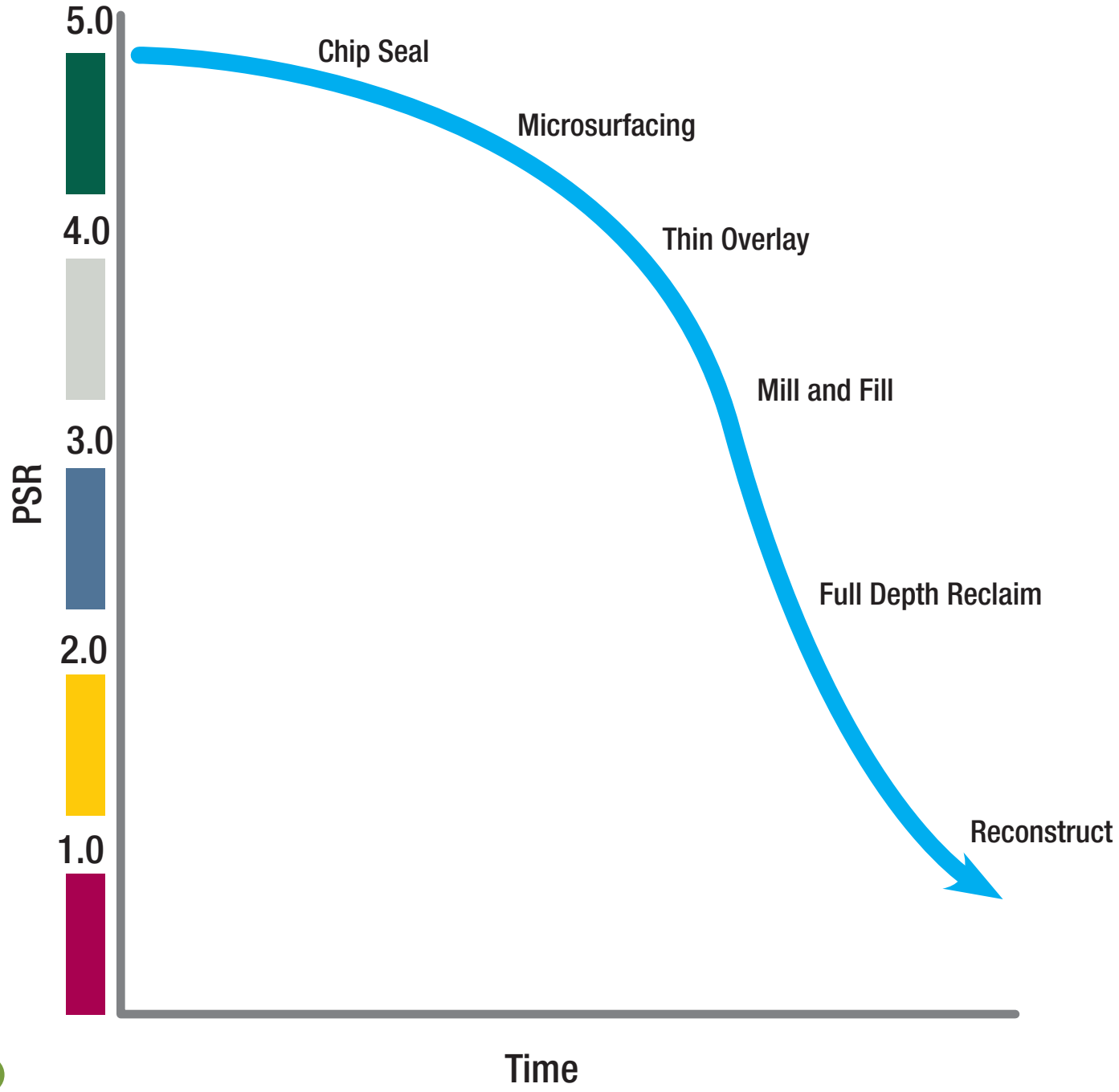
Roughness: The ride quality of the roadway, typically measured through the International Roughness Index (IRI) and expressed in vertical displacement over a distance (e.g. inches/mile).

Appendix B


2011 Pavement Serviceability Ratings
National Highway System
UNITED STATES
CANADA
UNITED STATES
CANADA
Major Rehabilitation and/or Reconstruction
Rehabilitation - Project Design and Construction Needed
Corrective Maintenance, Plan for Future Rehabilitation
Preventive Maintenance Needed
Do Nothing or Preventive Maintenance

Appendix C

Recommended Treatment per Pavement Serviceability Rating (PSR) Level



Appendix D: Regions

Regional maintenance staff has identified numerous challenges that are affecting their ability to complete assigned work and maintain safe roads. These include aging equipment, difficult recruitment of skilled workers, increasing frequency of extreme weather events, increasingly burdensome environmental permitting requirements, deferred maintenance needs, and rising commodity prices. These challenges amplify another trend—the prospect of reductions in federal highway funding.

Central Region

Overlaid or patched deteriorated sections of roads in the Anchorage, Mat-Su, and Kenai Peninsula areas with asphalt pavement based on recommendations from the department's pavement management system. Increased funding in FY10 and in deferred maintenance in FY11 (FY10 supplemental) allowed significant repairs throughout the region. Crack sealed 429 lane-miles of highways, provided surface maintenance of either gravel or paved runways for 26 airports, performed drainage improvements for 58 miles of roadway.

Northern Region

Applied chip seal, hot mix asphalt paving, or high float surfacing to 157 lane miles of paved roads and highways, returning 1,309 centerline miles of highway across the region to significantly better service condition. Applied approximately 151,000 linear feet of surface crack sealing and performed 765,000 square feet of surface crack banding, which resulted in the protection of 481 centerline miles of roadway from water intrusion and freeze/thaw damage.

Developed and implemented 11 aggregate crushing contracts, which produced over 195,000 cubic yards of stockpiled aggregate material for current and future roadway surfacing repair efforts during both federal and state projects.

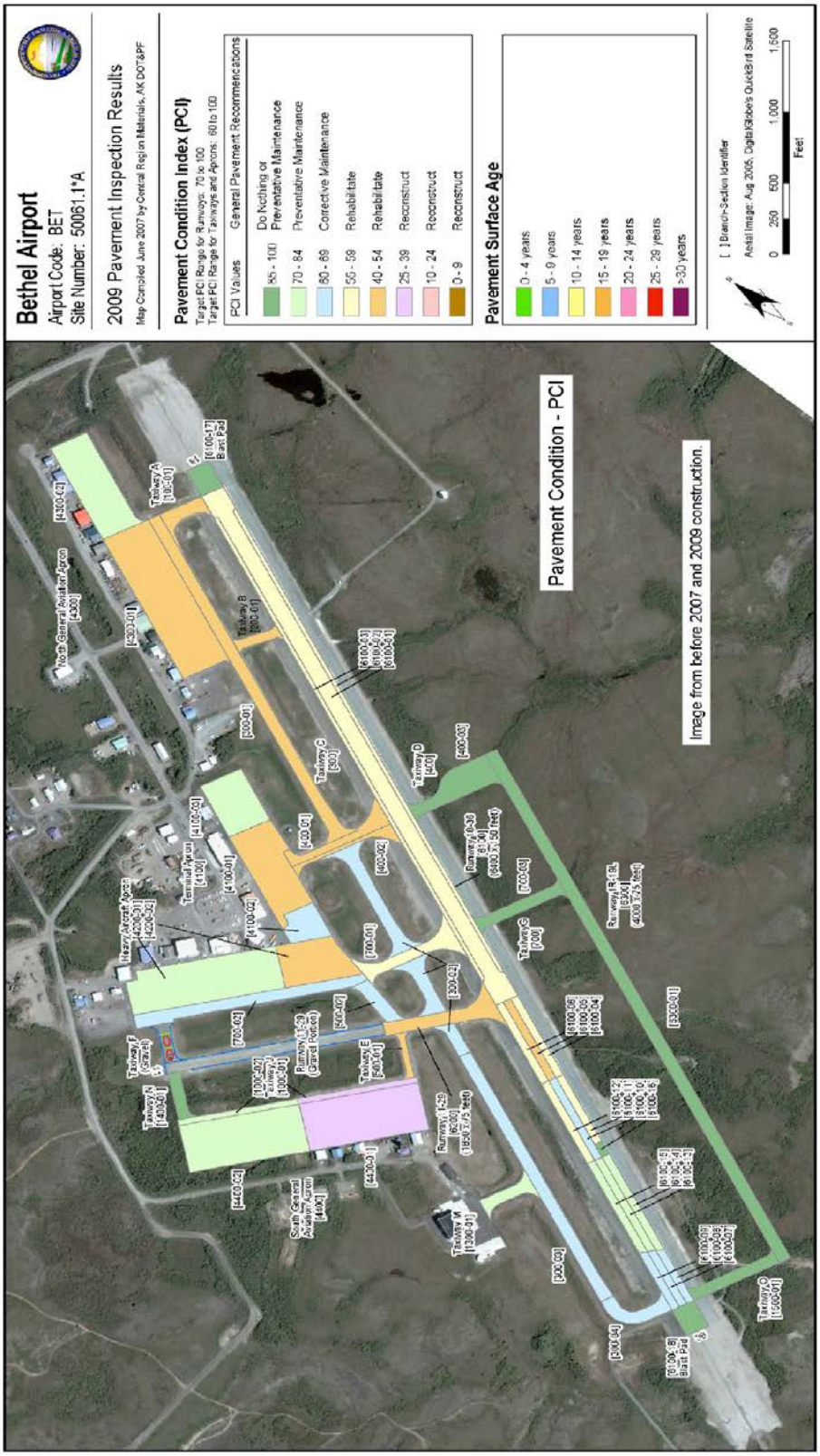
Southeast Region

Performed crack sealing on the airport runways and ramps in Gustavus; patched and crack sealed damaged roads in Haines; and in Juneau performed extensive patching of deteriorated sections of highway, including both cold patching, and mill and fill operations. Performed extensive patching of deteriorated sections of the North and South Tongass Highways in Ketchikan; chip-sealed three miles of gravel road on Mitkof Highway in Petersburg; repaired damaged pavement at the airport and on local highways in Sitka; and repaired and chip-sealed damaged sections of Zimovia Highway in Wrangell.

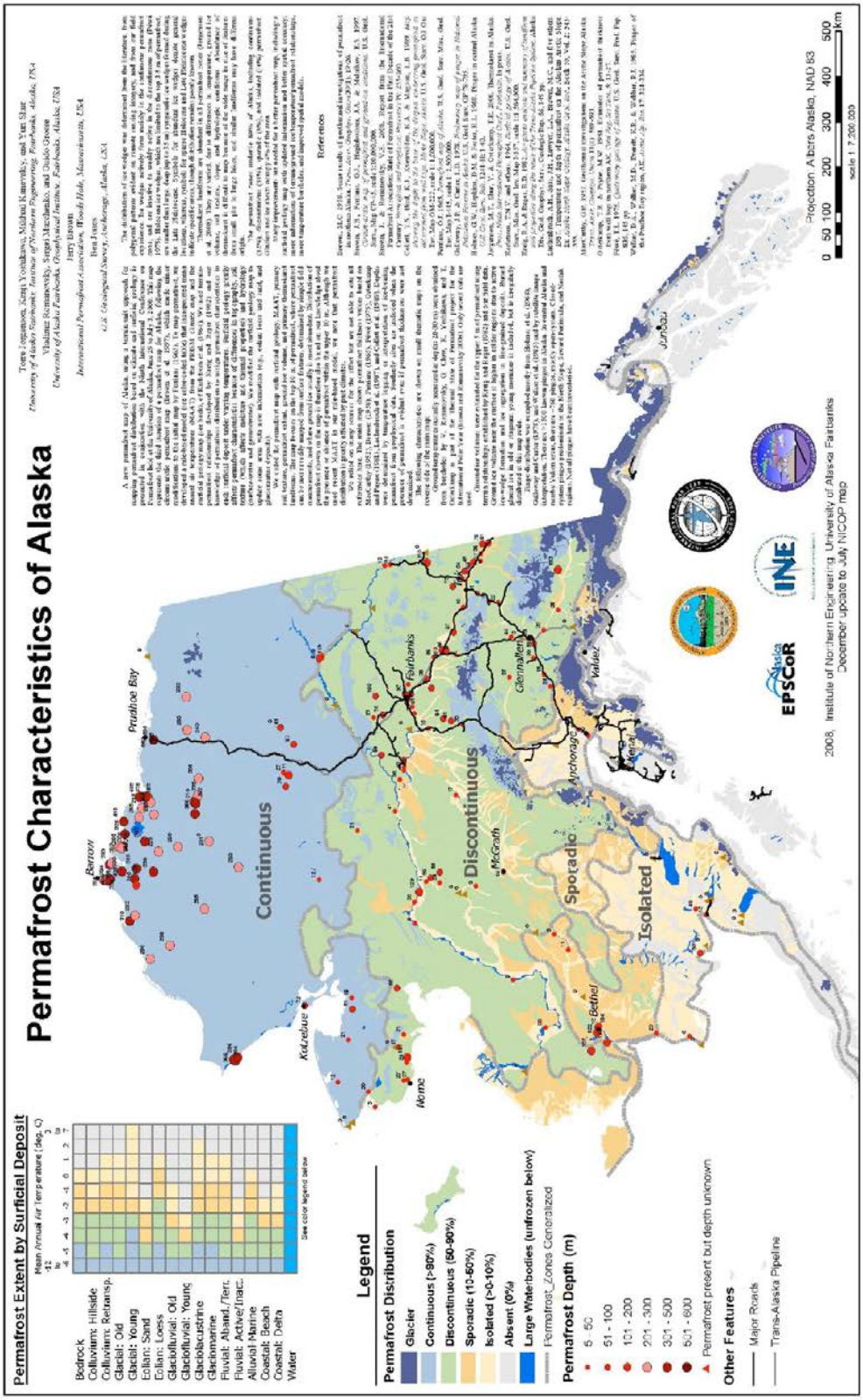
DOT Maintenance Crew Strip Paving DeBarr Road. Photo by Mark Parmelee, ADOT&PF

Appendix E

Bethel Airport Pavement Condition Index 2009



Appendix F


Permafrost Characteristics of Alaska
Permafrost Extent by Surficial Deposit
Mean Annual Air Temperature (deg. C)
Bedrock
Colluvium: Hillside
Colluvium: Retransp.
Glacial: Old
Glacial: Young
Eolian: Sand
Eolian: Loess
Glaciofluvial: Old
Glaciofluvial: Young
Glaciolacustrine
Glaciomarine
Fluvial: Aband./Terr.
Fluvial: Active/Inac.
Alluvial Marine
Coastal: Beach
Coastal: Delta
Water
See color legend below
Legend
Permafrost Distribution
Glacier
Continuous (>90%)
Discontinuous (50-90%)
Sporadic (10-50%)
Isolated (>0-10%)
Absent (0%)
Large Waterbodies (unfrozen below)
Permafrost_Zones Generalized
Permafrost Depth (m)
5 - 50
51 - 100
101 - 200
201 - 300
301 - 500
501 - 800
Permafrost present but depth unknown
Other Features
Major Roads
Trans-Alaska Pipeline
Barrow
Prudhoe Bay
Kotzebue
Nome
Bethel
McGrath
Fairbanks
Glennallen
Anchorage
Valdez
Kenai
Juneau
Continuous
Discontinuous
Sporadic
Isolated
References
Projection Albers Alaska, NAD 83
0 50 100 200 300 400 500 km
scale 1:7,200,000
2008, Institute of Northern Engineering, University of Alaska Fairbanks
December update to July NICOP map
EPSCoR
INE

Cover photos: Parks Highway from Truck Road Overpass, photo by Lisa Idell-Sassi ADOT&PF; Alaska Airlines Jet at Wrangell Airport, photo by Paul Khera, ADOT&PF

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STATE OF ALASKA