Pavement Preservation

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Background

- Preserving municipal pavement infrastructure is paramount to insuring the viable transportation of goods and services
- Preventive maintenance treatments prevents premature deterioration of the pavement and cost-effectively extends the service life
- Important to identify pavement sections that would most benefit from preventive maintenance treatments
- Timing and appropriate section selection is everything!
- Long term commitment to program is necessary for success!


What would you rather do?
Mill and Overlay


Holiday Inn
Or Full Reconstruction?


Stop the Water Infiltration?


Watch it Deteriorate the Pavement?


Until you have to Reconstruct it?


Rout and Seal this Crack at $0.50/ft?

Preventive Maintenance Program Components

- **The Right Pavement, The Right Treatment, The Right Time**
  - —Identify possible treatments and the best treatment for individual sections
  - —Trade-off based on the needs and priorities of other sections in the network
  - —Selection of appropriate materials and construction methods

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Development of an Effective Program

- Establish management aspects of the program
- Establish technical aspects of the program
- Determine maintenance needs
- Provide framework for treatment selection
- Set priorities for needs
- Provide ongoing support, monitoring and assessment

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Planning the Program

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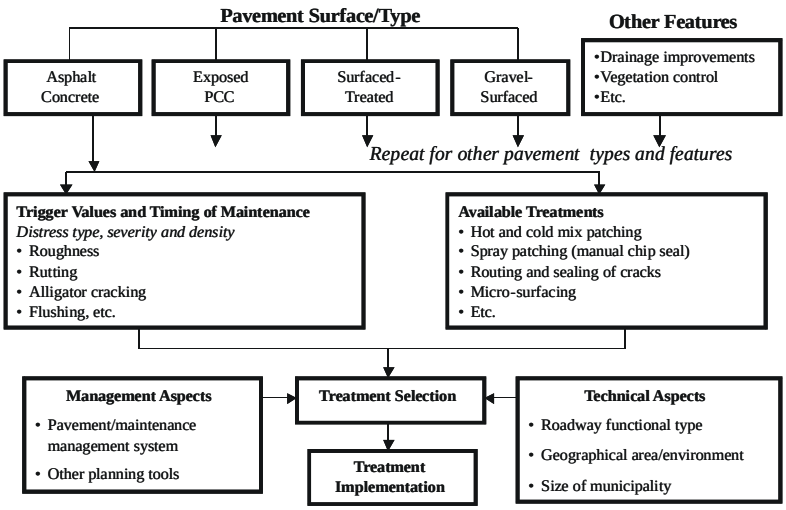
Preventive Maintenance Process



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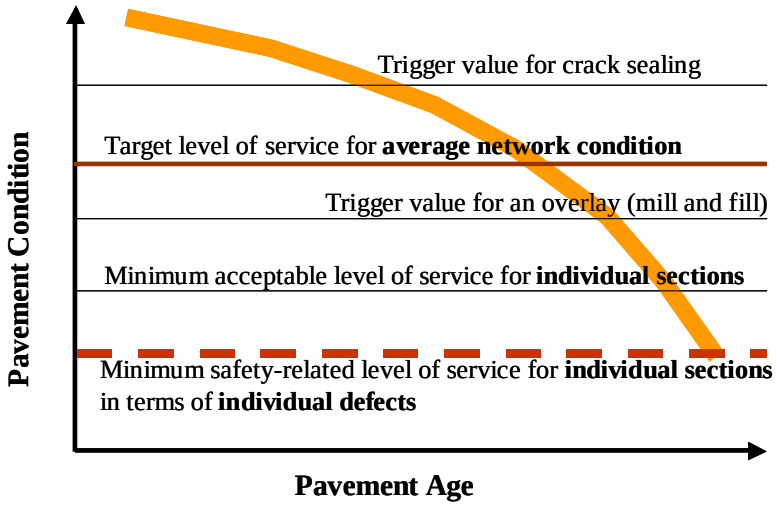
Step 1. Service Levels and Triggers



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Step 2. Inventory Data – Pavements

- **Location, roadway class, length, width and area**
- **Date of original construction and subsequent major maintenance**
- **Pavement condition (past and present)**
  - — Surface distress
  - — Ride quality
  - — Structural Capacity
  - — Frictional properties
- **Traffic information**

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Pavement Condition Data

- **Accurate and up to date pavement condition data for the roadway network is crucial**
- **An agency needs to know what the distresses are on their roadway network**
- **This data includes, raveling, construction joint, base failures, pot holes, cracked slabs & other distresses**

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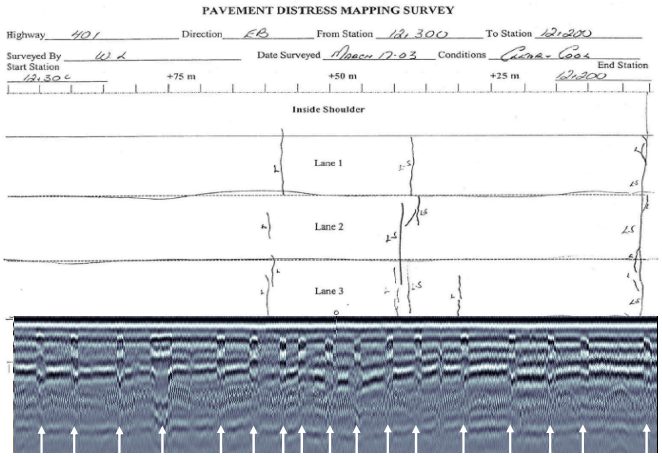
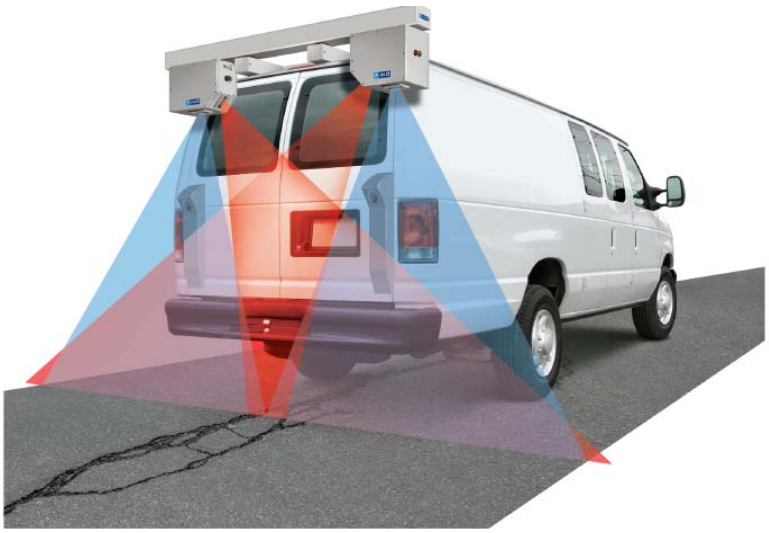
Data Collection Process

- **May be as simple as a manual pavement surface distress survey**



Laser Reflection Data Collection



Laser Reflection Data Collection

- Number of lines per second: 28,000 lines/s
- Number of pixels per line: 4,096 pixels/line
- Field of view 4 m
- Transverse resolution: 1 mm
- Longitudinal resolution (at 100 km/h) 1 mm

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Laser Reflection Data Collection

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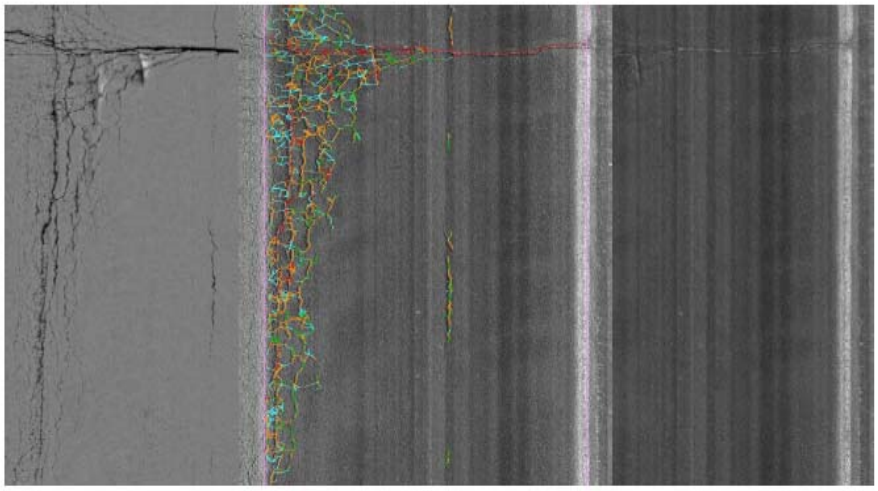
Laser Reflection Data Collection



Range 3D Intensity

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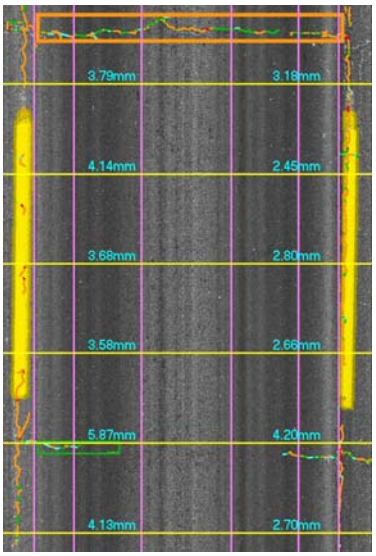
Laser Reflection Data Collection



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Lidar Measurements

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Lidar Trial Survey

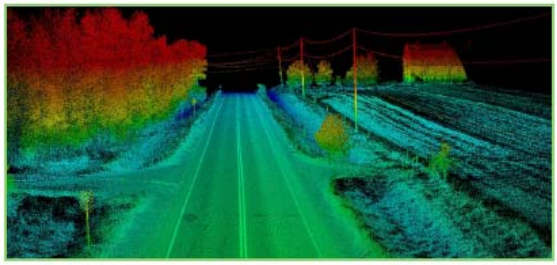

Figure 2a: LiDAR Point Cloud of Highway 594, west of Dryden

Figure 2b: Google Image of Highway 594, west of Dryden

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Advantages and Disadvantages

Advantages

- Safety in data collection
- Move towards automated data analysis
- Potential repeatability
- Ability to rapidly identify “changes”

Disadvantages

- High cost of equipment
- Immense amount of data storage (petybytes)
- Difficulty in classifying into current distress “bins”

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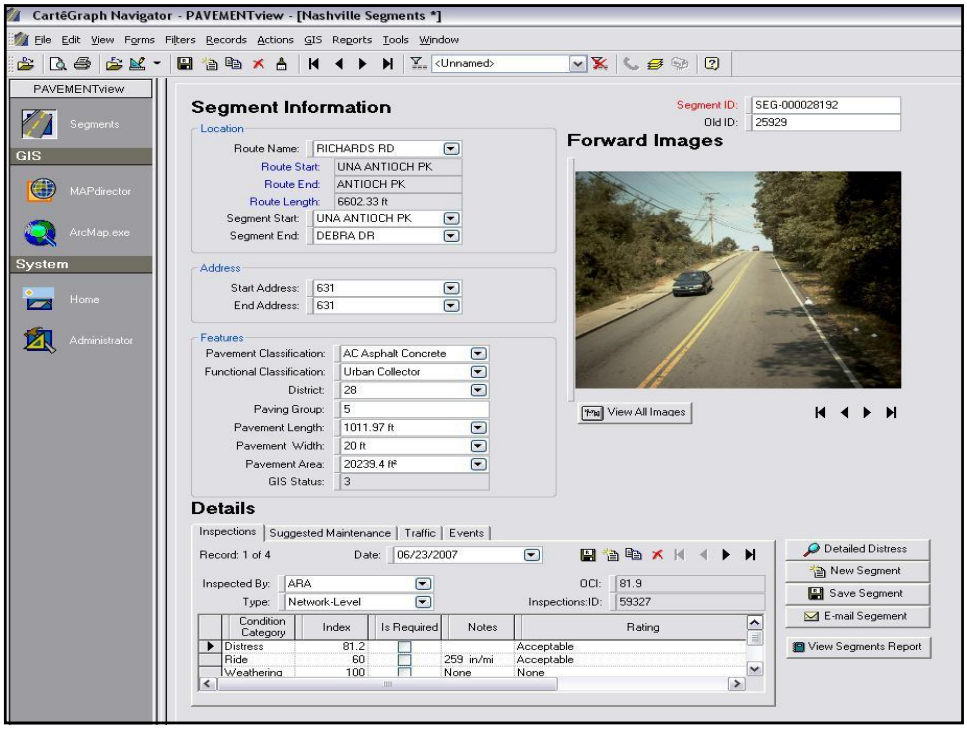
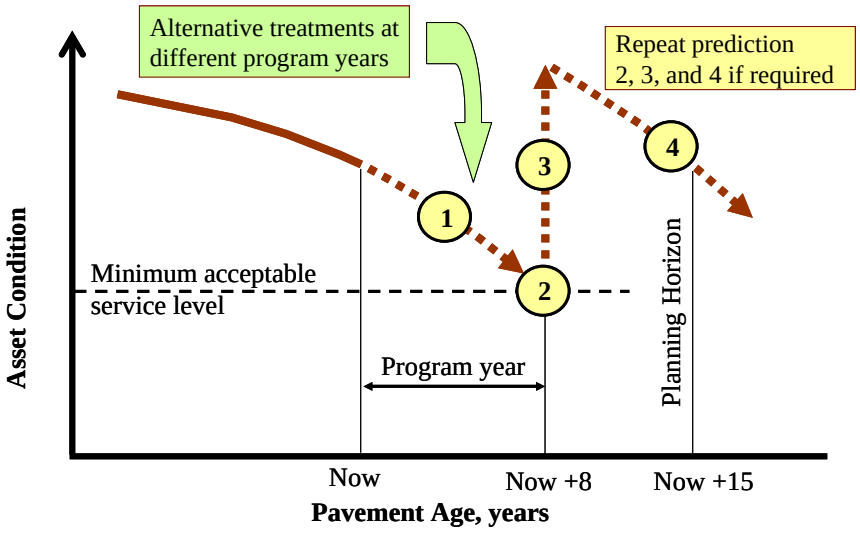


Step 3. Short Term Planning



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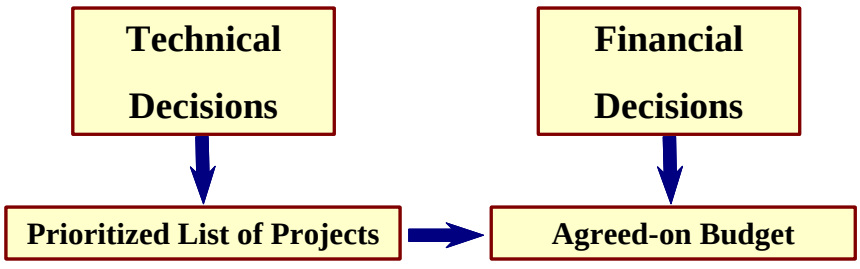
Step 4. Budgeting



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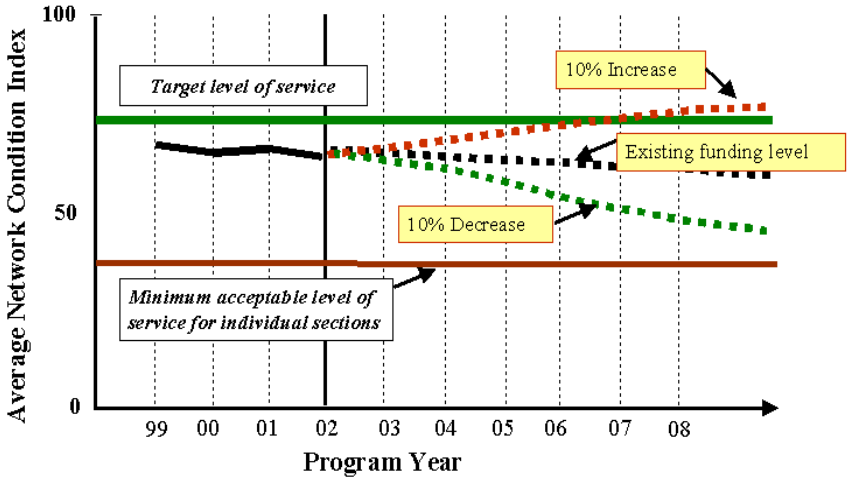
Step 5. Reporting



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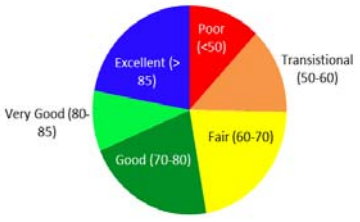
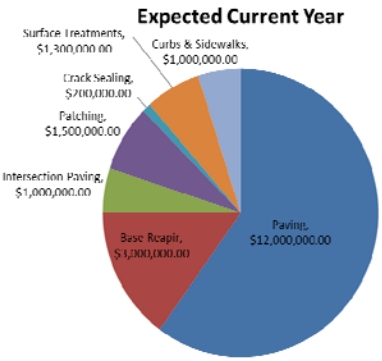
Step 5. Reporting

Current Condition Distribution





Roads Budget for 2014

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Step 5. Reporting

- **Show consequences of different budgets**
- **List specific projects that cannot be done because of funding limitations**
- **Track quantity of unfunded needs**
- **Monitor network performance trends:**
  - Long-term trends in terms of network size
  - Network condition
  - Annual spending per length of pavement

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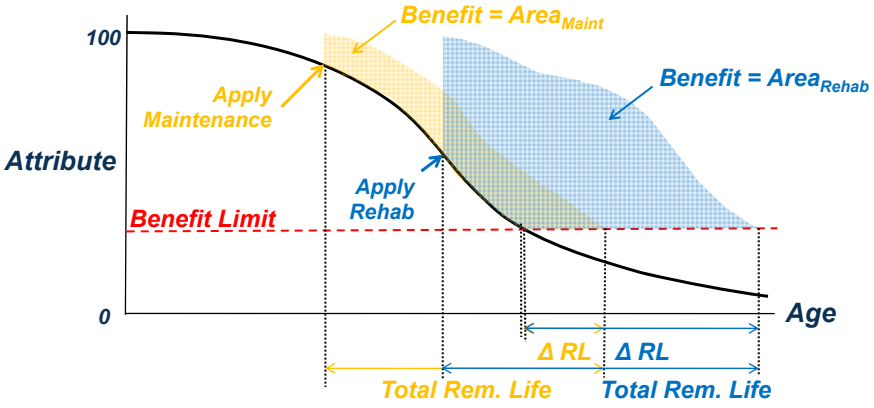
Measuring the Consequences of Decisions



- **Compare measures such as Benefit/Cost Ratio**
  - Is (Benefit$_{Rehab}$ / $$$ < Benefit$_{Maint}$ / $) ???

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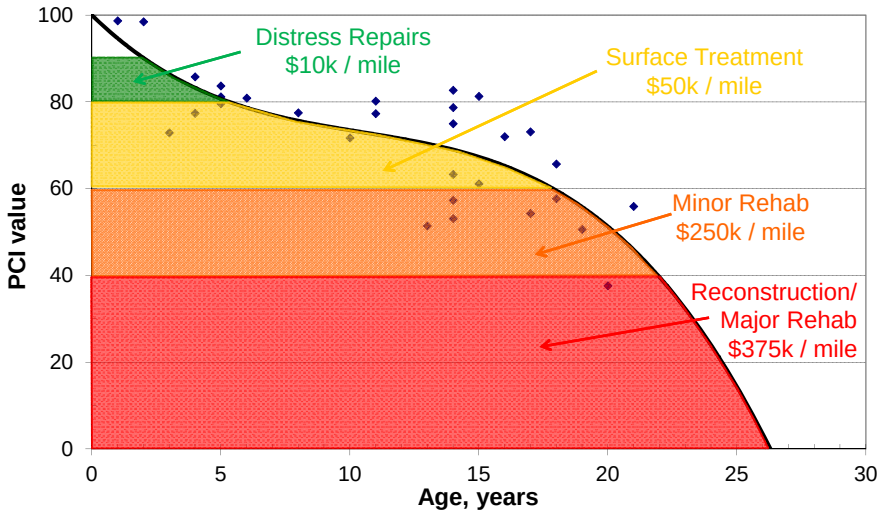
Representative Activities & Costs



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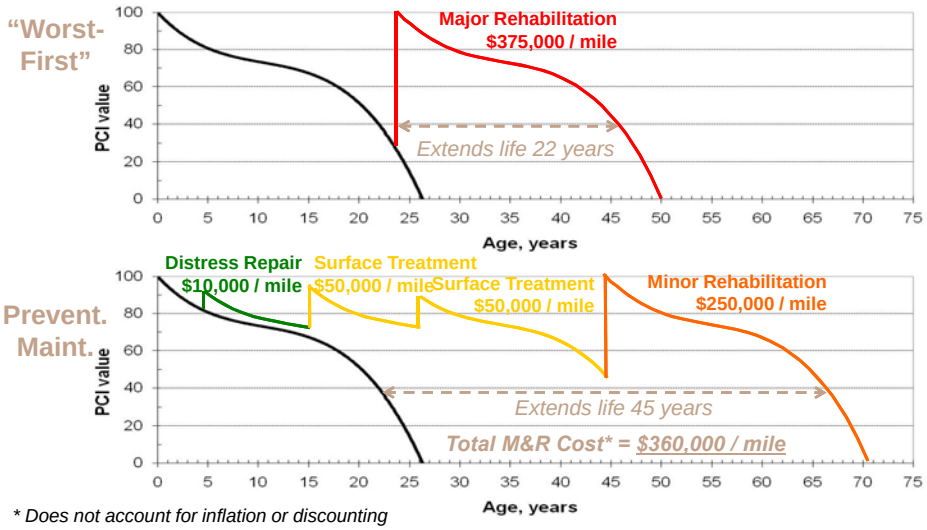
Preventive Maintenance Pays Off



* Does not account for inflation or discounting

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Benefits of a Rational Approach

- Determine, document, and justify funding needs
- Prepare prioritized, needs-based budgets
- Provides a benchmark for pavement preservation decision making
- Provide objective information to senior decision makers and the public
- Promotes the cost-effective use of pavement investments

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Other Benefits of Pavement Preservation

- Greater serviceability
- Fewer disruptions
- Reduced vehicle wear and tear, fuel consumption, etc.
- Improved user safety due to fewer safety-related defects (e.g., ruts, raveling and potholes)

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Principal Factors for Decision Making

- Pavement type
- Pavement condition
- Pavement age
- Traffic
- Geometrics
- Overhead clearances
- Local experience
- Available materials
- Experienced Contractor
- Experienced owner
- Time of construction
- Construction time

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Benefits of Decision Trees/Matrices

- Work well on the network level
- Assist sorting through the many items that should be considered in treatment selection
- Help account for the specific distress
- Provide guidance
- Makes use of existing experience

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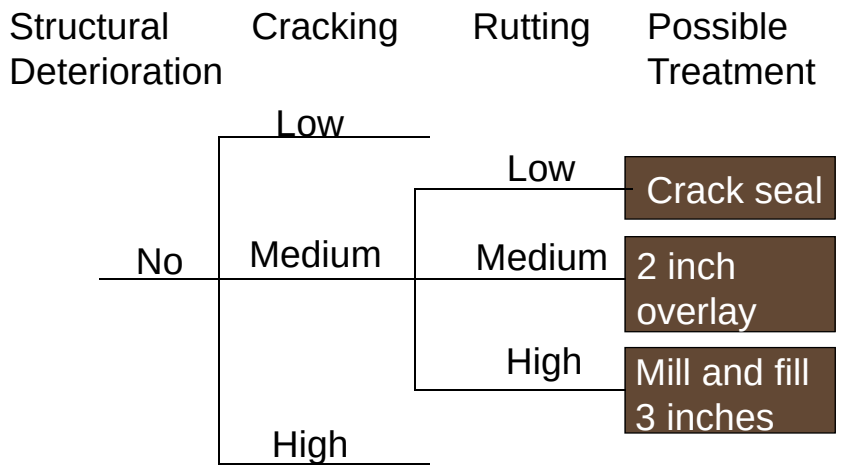
Example Decision Tree



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Simplified Decision Matrix

Preventive Maintenance Treatment	Pavement Condition for Successful Application											
	Roughness		Rutting		Longitudinal &Transverse Cracking		Ravelling		Flushing		Fatigue Cracking	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Crack Sealing												
Chip Seal												
Slurry Seal												
Micro-Surfacing												
Thin Overlay												

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Delivering the Preservation Program

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Purpose and Application of Preservation Treatments

- Provide a new wearing surface
- Seal cracks in the surface
- Waterproof the surface
- Improve pavement surface friction and surface drainage
- Slow pavement weathering and aging
- Improve the surface appearance
- Provide visual delineation between the mainline pavement and the shoulder

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Common Preservation Alternatives

Asphalt	Concrete/ Composite	Surface Treated	Gravel
Area Patching	Partial Depth/PCC	Area Patching	Grading
Spray Patching	Partial Depth/AC	Spray Patching	Dust Control
Infrared Patching	Full Depth PCC	Machine Patching	Drainage
Machine Patching	Full Depth AC	Surface Treat	
Crack Sealing	Joint/Crack Seal	Drainage	
Slurry Seal	Subsealing		
Micro-Surfacing	Diamond Grinding		
Surface Treat	Load Transfer		
Thin AC Overlay	Slab Jacking		
Thick AC Overlay	AC Overlay		
Hot In-Place	Drainage		
Cold In-Place			
UTW			
Drainage			

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Flexible Pavement Preservation

Common Flexible Pavement Treatments

1. Crack Sealing
2. Patching
3. Fog Seal
4. Sand Seal
5. Slurry Seal
6. Chip Seal
7. Micro-surfacing
8. Texturization
9. Thin Overlay
10. Hot In-Place Recycling

Crack Treatments

- Prevent water and debris from entering individual cracks in the HMA pavement surface


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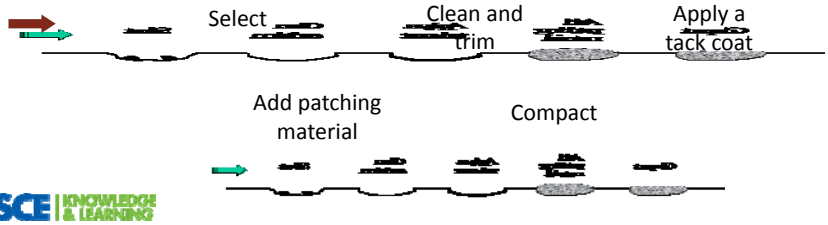
Patching

- Address localized areas of distress
- Correct surface discontinuities
- Seal the pavement from moisture infiltration



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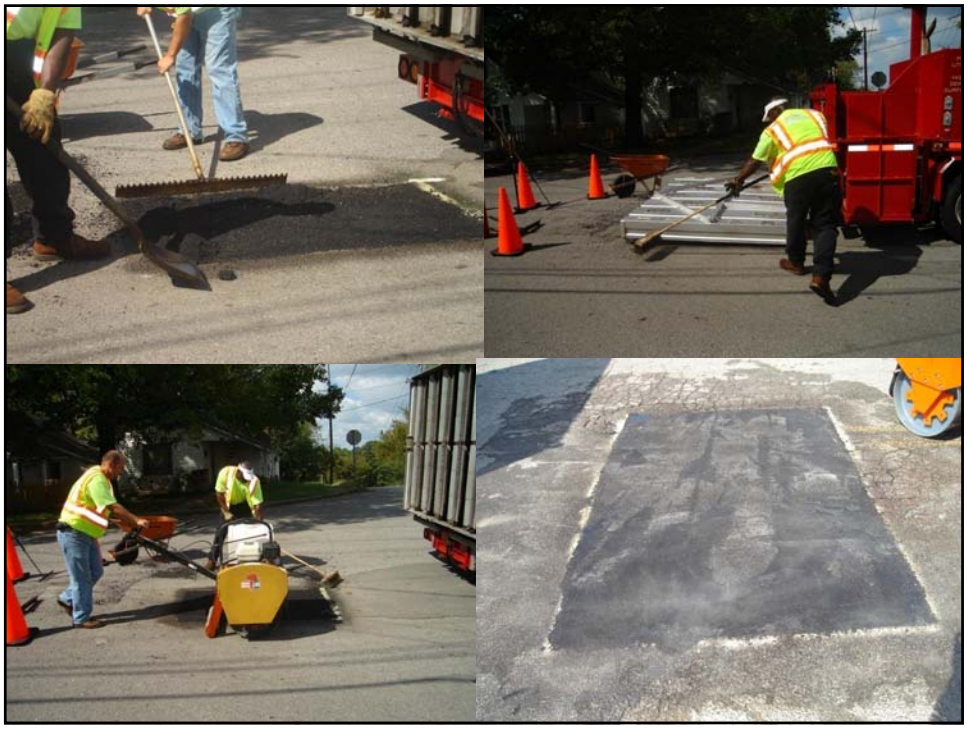

Fog Seal

- Seal pavement surface
- Rejuvenate oxidized HMA
- Provide delineation

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Sand Seal

- Seal pavement surface
- Rejuvenate oxidized HMA
- Provide delineation
- Improve friction

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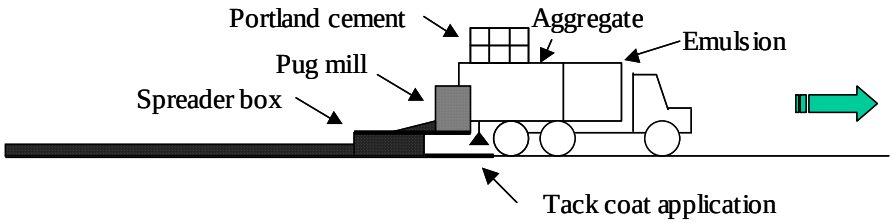
Slurry Seal

- A mixture of emulsified asphalt, graded fine aggregate, mineral filler, and water, mixed and uniformly spread over the pavement surface
- Applied cold to pavement surface



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Slurry Seal

- Seal pavement surface
- Retard surface raveling
- Improved surface friction

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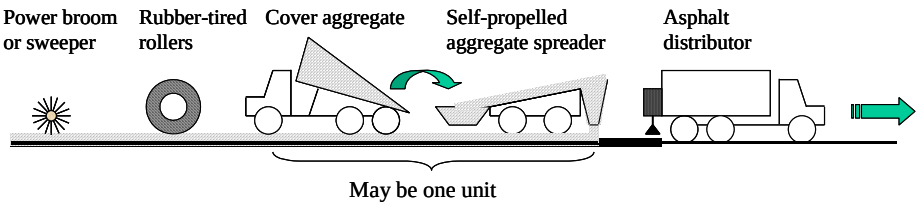
Asphalt Chip Seal

- Provide wearing course
- Improve surface friction
- Seal pavement surface from water penetration
- Lower maintenance, eliminate dust



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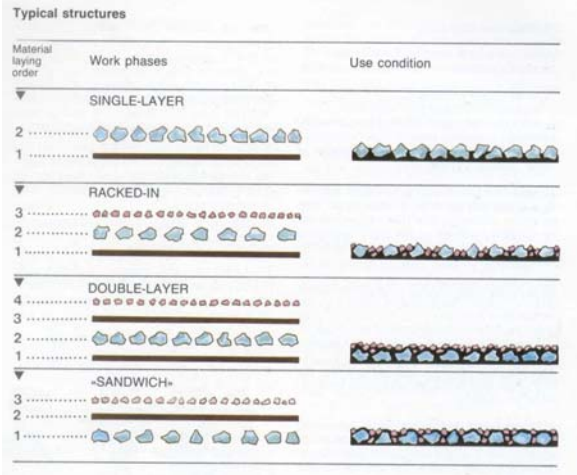
Asphalt Chip Seal

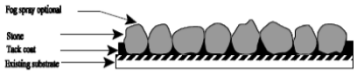
Asphalt Chip Seal (Cont'd)

- Many types of seals - France

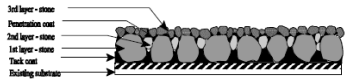


Asphalt Chip Seal (Cont'd)

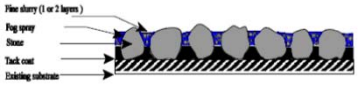
- **Many types of seals – South Africa**



Single Chip Seal

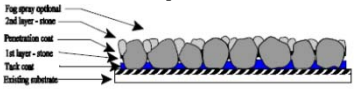


Triple Chip Seal

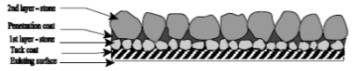


Cape Seal

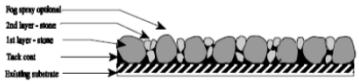
Geotextile/Fiber Chip Seal



Double Chip Seal



Inverted Chip Seal



Racked-in Chip Seal

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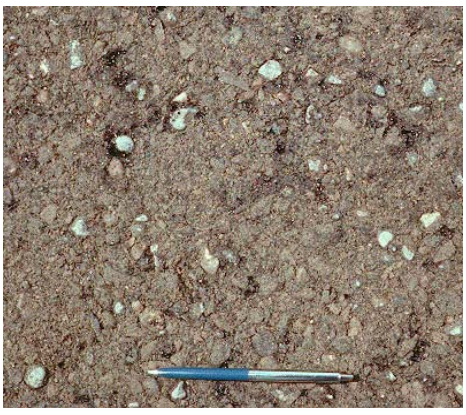
Asphalt Chip Seal



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Localized Chip Seal

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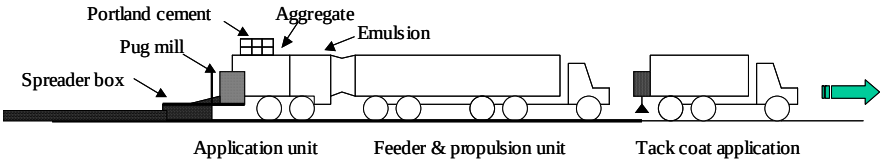
Microsurfacing

- Similar to slurry seal
  BUT…..
- Large and higher quality aggregate
- Emulsion contains latex



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Microsurfacing

- Level pavement surface
- Fill ruts
- Restore surface friction

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Microsurfacing

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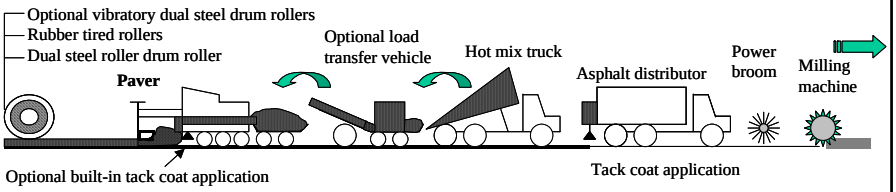
Thin Hot Mix Overlay

- Wearing course
- Level pavement
- Improve friction
- Seal pavement
- Fills ruts



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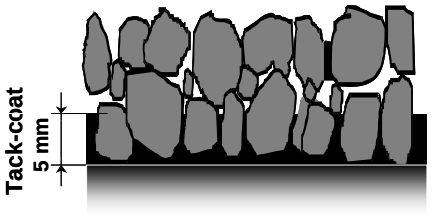
Proprietary Thin Surfacing

- Gap graded HMA
- Heavy tack coat applied first (0.7-1.0 l/m2)
- Proprietary machine and process
- Paver applies both tack coat and HMA
- Functional, not a structural overlay



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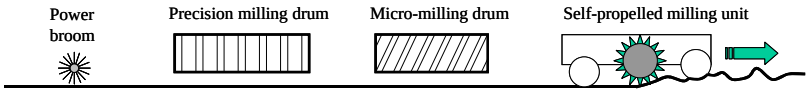
Surface Texturization

- Reduce rutting
- Reduce roughness
- Improve friction



Teeth arrangement:	square	helical
Typical milling depth:	up to 25 mm	up to 15 mm
Surface texture depth:	about 5 mm	about 1 mm
Groove-to-groove distance:	10 to 15 mm	5 mm

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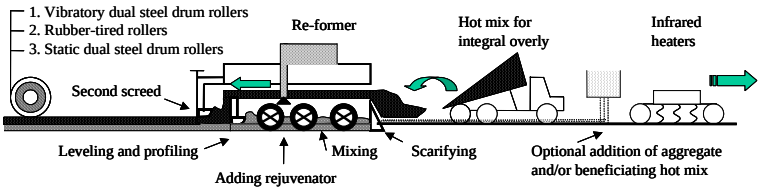
Hot In-Place Recycling

- Reduce rutting
- Reduce roughness
- Improve friction
- Reduce distress



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Hot In-Place Recycling

- **Hot In-Place Recycling**
  - — Existing pavement recycled in-place to a depth generally < 2 in (50 mm)
  - — One or more heaters used to heat pavement
  - — Scarification or pickup process used to loosen HMA
  - — Rejuvenator generally added
  - — Mix relayed using conventional paving equipment

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Hot In-Place Recycling

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Hot In-Place Recycling

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Hot In-Place Recycling

- **Advantages**
  - — Treats surface distresses, improves ride
  - — Maximum reutilization of existing HMA
  - — Aggregate conservation, no waste contract possible
  - — 100% of the existing pavement is recycled
  - — In-situ recycling in remote areas
  - — No trucking of materials required, lower transportation costs, fewer greenhouse gases and less pollution

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Rigid Pavement Preservation

Common Rigid Pavement Treatments

1. Crack/Joint Sealing
2. Surface Texturization
3. Crack Stitching
4. Load Transfer Retrofit
5. Partial Depth Repairs
6. Full Depth Slab Replacement
7. Thin Overlays

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Crack/Joint Sealing

- Prevents water from entering the pavement
- Keeps debris out of joints and cracks

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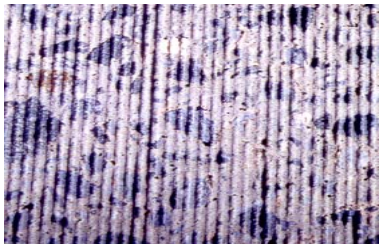
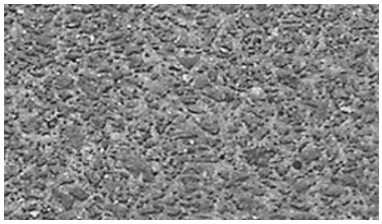
Surface Texturization

- Improves skid resistance
- Better ride quality
- Minor profiling possible





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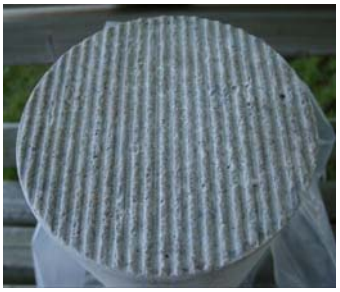
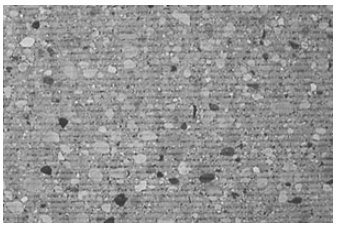
Diamond Grinding





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Blastrac Texturization

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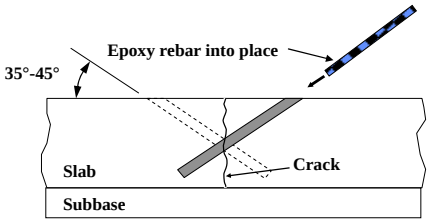
Skidabrader
Rumble Equip. Co.
AIR QUALITY CONTROL


BRADER

Crack Stitching

- Assists in maintaining load transfer across a crack



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Crack Stitching

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Crack Stitching

- Very effective if properly completed
- Much less expensive than slab replacement

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Crack Stitching

- For best performance, need to identify candidate cracks before secondary cracking occurs

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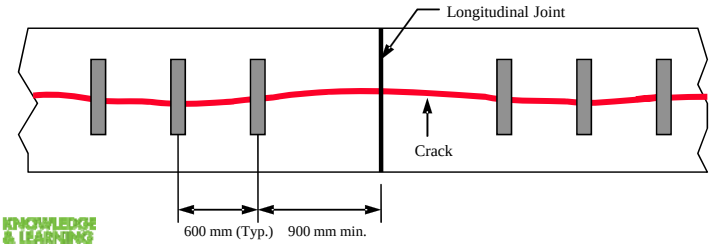
Load Transfer Retrofit

- Restores load transfer across joints or cracks
- Improves pavement performance and ride quality



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Partial Depth Repairs

- Repair to localized shallow distresses
- Require very clean and rough surface for good bonding
- Mixed success
- Best if use concrete materials

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Partial Depth Repairs

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Partial Depth Repairs

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Partial Depth Repairs

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Partial Depth Repairs

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Full Depth Repairs

- Reserved for major slab cracking or damage
- Complete removal and replacement of part or all of concrete slab

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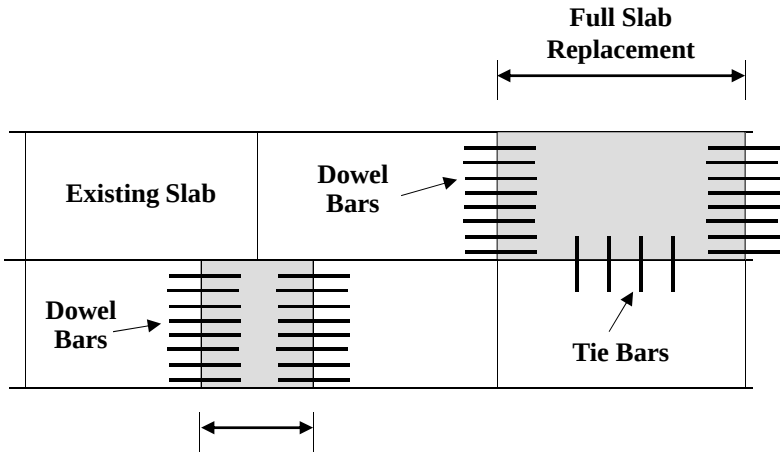
Full Depth Repairs



2.0 m (6 ft) min; 4.0 m (12 ft) max

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Pre-Cast Panel Replacement




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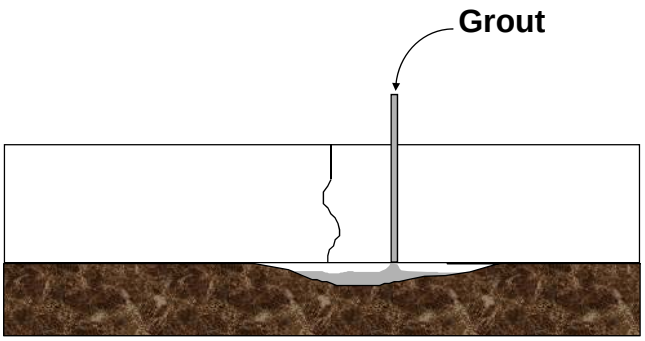
Slab jacking



Slab jacking to restore support to the slab

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Thin Overlays

- Typically used to improve concrete pavement skid resistance
- Micro-Surfacing
- Nova Chip

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Program Implementation

- System Benefits – management must be convinced that the process will provide benefits
- Decision Maker Support – acceptance and support is vital
- Management Commitment – implementation takes time and the process may change the way the pavement preservation business was done
- Establishing Technical Aspects – process must be technically sound and reflect local practices

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Program Implementation

- Support – decision support system will require ongoing software support
- Long -Term Commitment – benefits of the process increase with time and with experience
- It takes several years of data collection to obtain pavement performance trends and calibrate pavement performance models
- Ongoing Support – identifying and prioritizing needs incurs costs and requires trained personnel

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Develop Guidelines

- Procedures on how to determine, document and justify funding needs for pavement preservation
- Direction to prepare prioritized, needs-based budgets using a systematic planning and budgeting process
- Promotes best practices and benchmarks for pavement preservation decision-making

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Develop Guidelines

- Objective information on preservation needs, and long-term implication of budget decisions
- Supports funding requests for pavement preservation
- Promotes cost-effective use of pavement investments to return maximum benefits
- An up-to-date network inventory, condition and rehabilitation needs

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Develop Guidelines

- Prioritized listing of pavement maintenance and preservation needs
- Logical and defendable budget plan
- Trends in the condition of the pavement network
- Summary of unmet needs (infrastructure deficit) in terms of specific projects

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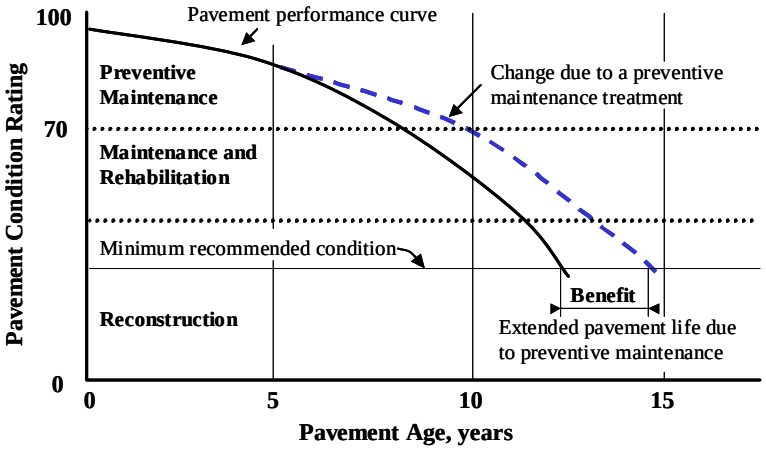
Evaluate Performance



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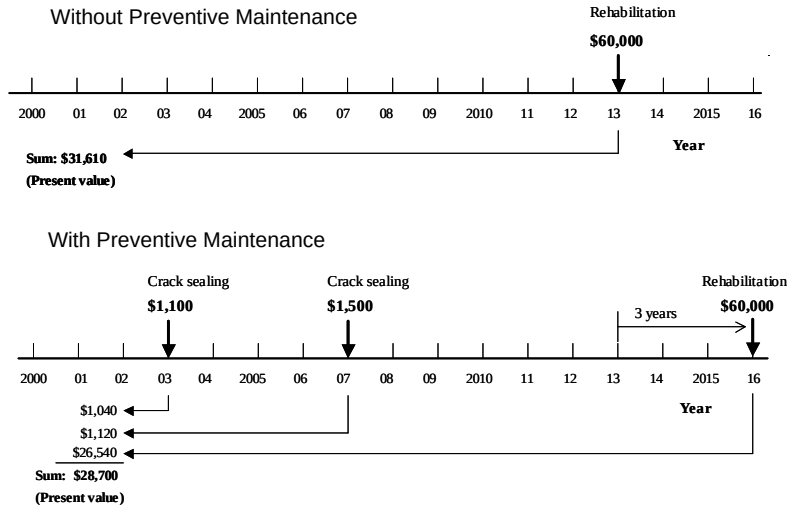
Calculate Cost-Effectiveness



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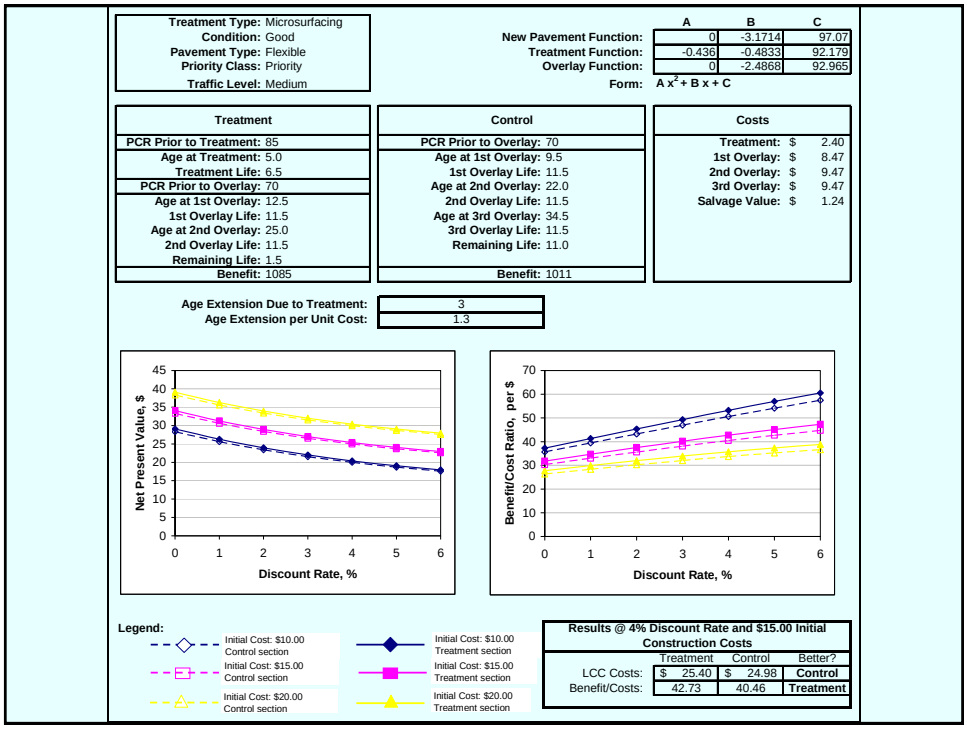

Overall Effectiveness Measures

Treatment	Condition	Pavement Type	Discount Rate, % 0	1	2	3	4	5	6	PM Treatment Effective?
Chip Seal (very low volume roadways only)	Fair	All (Mainly Flexible)	$ (3.89)	$ (3.37)	$ (2.93)	$ (2.56)	$ (2.23)	$ (1.96)	$ (1.72)	Yes
	Good	All (Mainly Flexible)	$ (1.64)	$ (1.45)	$ (1.27)	$ (1.11)	$ (0.95)	$ (0.82)	$ (0.70)	Yes
Single Microsurfacing	Fair	Flexible	$ (1.36)	$ (1.20)	$ (1.07)	$ (0.94)	$ (0.83)	$ (0.73)	$ (0.65)	Yes
	Good	Flexible	$ 0.33	$ 0.29	$ 0.28	$ 0.30	$ 0.31	$ 0.33	$ 0.34	No
	Fair	Composite	$ (2.17)	$ (2.02)	$ (1.83)	$ (1.65)	$ (1.46)	$ (1.30)	$ (1.14)	Yes
	Good	Composite	$ -	$ -	$ -	$ -	$ -	$ -	$ -	Unknown
Double Microsurfacing	Fair	Flexible	$ (0.19)	$ (0.18)	$ (0.17)	$ (0.16)	$ (0.14)	$ (0.12)	$ (0.11)	Yes
	Good	Flexible	$ -	$ -	$ -	$ -	$ -	$ -	$ -	Unknown
	Fair	Composite	$ -	$ -	$ -	$ -	$ -	$ -	$ -	Unknown
	Good	Composite	$ (0.14)	$ (0.13)	$ (0.05)	$ 0.05	$ 0.16	$ 0.26	$ 0.35	Maybe
Proprietary Hot Mix Asphalt	Fair	Flexible	$ (0.48)	$ (0.37)	$ (0.29)	$ (0.23)	$ (0.18)	$ (0.14)	$ (0.10)	Yes
	Good	Flexible	$ 1.49	$ 1.42	$ 1.37	$ 1.33	$ 1.29	$ 1.25	$ 1.20	No
	Fair	Composite	$ -	$ -	$ -	$ -	$ -	$ -	$ -	Unknown
	Good	Composite	$ -	$ -	$ -	$ -	$ -	$ -	$ -	Unknown
Thin Overlay without Repairs.	Fair	Flexible	$ (1.11)	$ (0.85)	$ (0.66)	$ (0.50)	$ (0.38)	$ (0.29)	$ (0.21)	Yes
	Good	Flexible	$ 0.58	$ 0.73	$ 0.84	$ 0.92	$ 0.97	$ 1.00	$ 1.02	No
	Fair	Composite	$ (1.69)	$ (1.43)	$ (1.20)	$ (1.01)	$ (0.84)	$ (0.70)	$ (0.58)	Yes
	Good	Composite	$ (0.21)	$ 0.02	$ 0.25	$ 0.44	$ 0.61	$ 0.75	$ 0.87	Maybe
Thin Overlay with Repairs	Fair	Flexible	$ (1.17)	$ (0.88)	$ (0.65)	$ (0.48)	$ (0.34)	$ (0.24)	$ (0.15)	Yes
	Good	Flexible								N/A
	Fair	Composite	$ (3.15)	$ (2.59)	$ (2.13)	$ (1.75)	$ (1.44)	$ (1.18)	$ (0.97)	Yes
	Good	Composite								N/A

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What is the End Result?

- Extend service life
- Cost savings
- Improved ride
- Reduce user delays

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Watch Out for Roadblocks

- Public and management perception in allocating funds for pavements in relatively good condition
- Shortage of performance and cost-effectiveness data
- Lack of data management and personnel training for selecting candidate projects and identifying appropriate PM treatments and timing

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Questions?

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