Implementing Pavement Management Systems, Do's and Don’ts at the Local Agency Level

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Do

Understand Basic Pavement Management Concepts

Pavement Management Is

A Decision Making Process

Effective Pavement Management

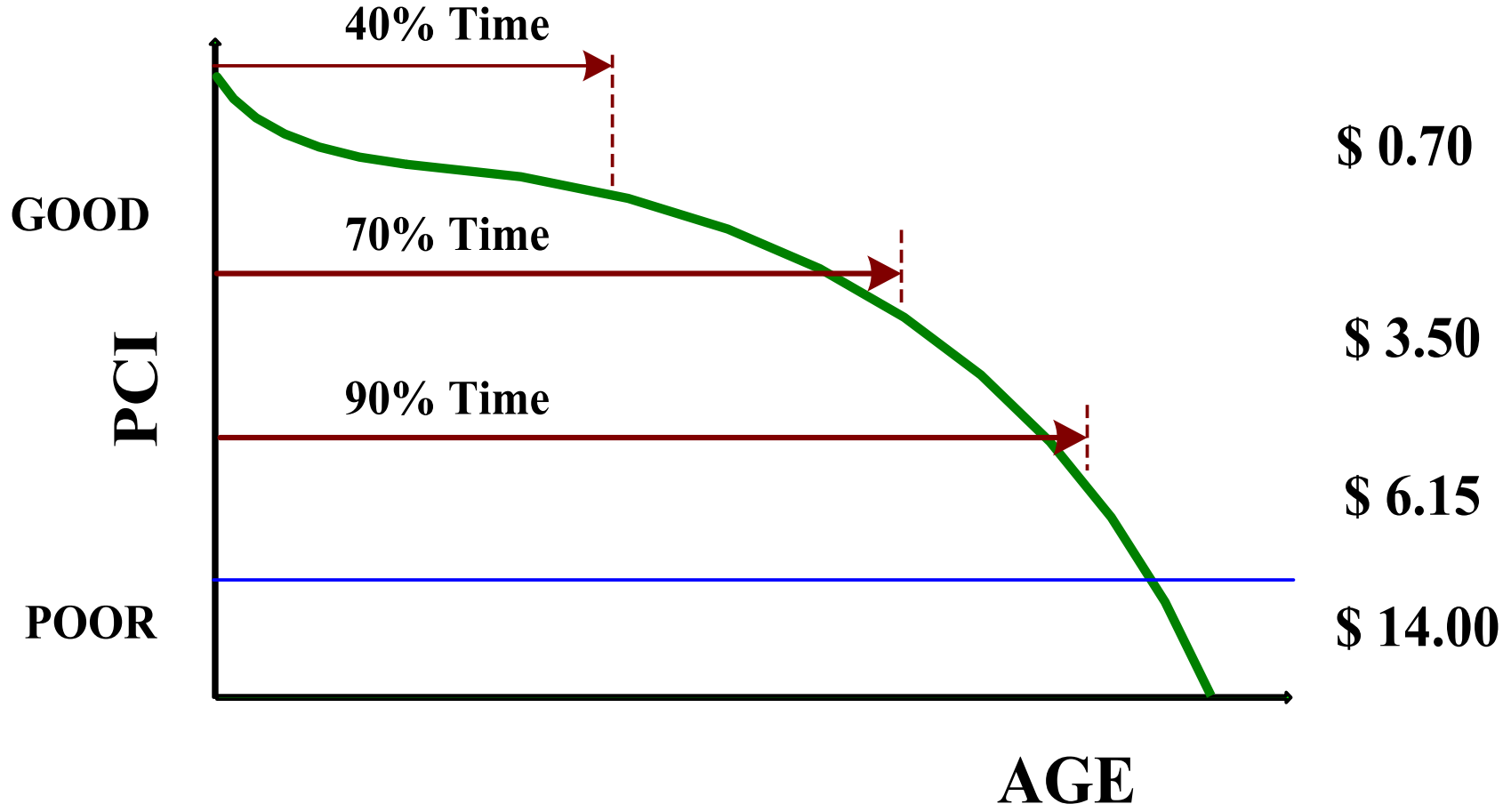
- Based on finding cost-effective treatments
- At given time
- To provide desired level of service

Pay me Now

or

Pay me Later

Pay Me Now or Pay Me Later



Pay Me Now

- 3 Seal Coats at $ 0.70 /sy - 24 yrs
- 1 Overlay at $ 3.50 /sy - 8 yrs
- 2 Seal Coats at $ 0.70 /sy - 16 yrs

- Total $7.00 /sy for 56 yrs

Pay Me Later

- 2 Remove & Replace at $ 14.00 /sy
  - 54 yrs
- Total $28.00 /sy for 54 yrs

Compare

- Pay Me Now
  - Total $7.00 /sy for 56 yrs
- Pay Me Later
  - Total $28.00 /sy for 54 yrs
- Which Gave Better Service?

Good Roads Cost Less than Bad Roads

- It costs the maintaining agencies less to have good roads than bad roads - Over the long term
- Providing:
  - Reasonable level of service provided
  - Pavements will respond to preventive maintenance, e.g. they must be structurally adequate
- Pavement preservation approach provides best roads for the least cost

Pavements Must be Designed

- Pavements not structurally adequate to support traffic loads will fail no matter the preventive maintenance applied
- Many local pavements not designed
- Many agencies have a large backlog of more extensive/expensive work

To Address Backlog

- Agencies must retain good roads
- While repairing poor roads

Pavement Management Management Software

- Decision support tool
- Used to help make cost-effective decisions

In Concept

Pavement Management Covers

- Planning
- Programming
- Analysis
- Design
- Construction
- Research

As Implemented

Pavement Management Systems Primarily Address:

- Maintenance
- Rehabilitation
- Reconstruction

of the Existing Pavement System

Maintenance Addressed by PMS

- Programmed or planned maintenance
- Preventive maintenance

Maintenance Management Systems

Normally Address

- Routine maintenance
- Work requirements
- Work standards
- Etc.

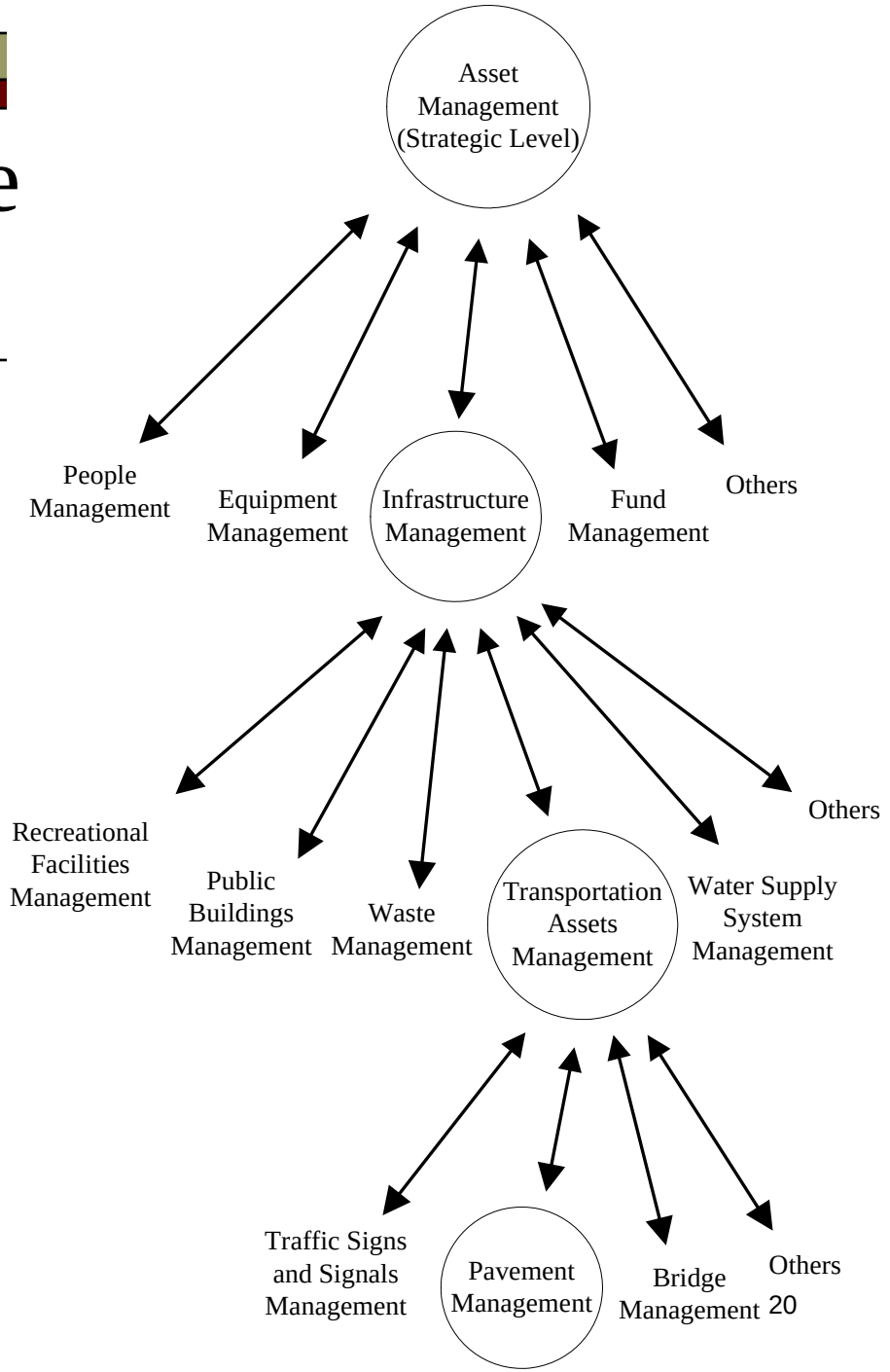
Do

Understand Infrastructure Asset Management Levels

Pavement & Infrastructure Asset Management Levels

- Strategic – the entire transportation system or infrastructure system
- Network - the entire street/road network
- Project-Selection – select those to be worked on in the current or next funding cycle
- Project – design and construction of a specific pavement section

Asset and Infrastructure Management



Differences in What is Managed at Different Levels

Strategic – Level

- Related to Investment Analysis & Fund Allocation
  - Total Funds Needed and Allocation of Funds for Each Type Facility to Meet Established Goals
  - Show Impact of Funding Options
  - Justification of Funds
- Communicate with Funding Authorities
  - Level of service desired (Goals & Policies)
  - Investment needed to provide that service
- Previously Considered Planning Activities

Network-Level

- Related to the Budget Process
  - Identify Maintenance and Rehabilitation Needs
  - Funds Needed to Complete M&R
  - Prioritized Listings of Segments Needing Work
- Allocation to
  - Sub-organizations
  - Funding Categories
- Show Impact of Funding Options
  - Preservation vs New Construction
  - Distribution Among Sub-organizations
- Communicate Within Agency

Input from Strategic-level

Project-Selection-Level

- Identify Constraints not Previously Considered
  - Physical
  - Financial
- Refine Alternative Treatments
- Improve Cost Estimates
- Select Segments for Funding & Project-Level Analysis, Design & Construction
- Show Impact of Deviation from Network-Level

Input from Network-level

Project-Level

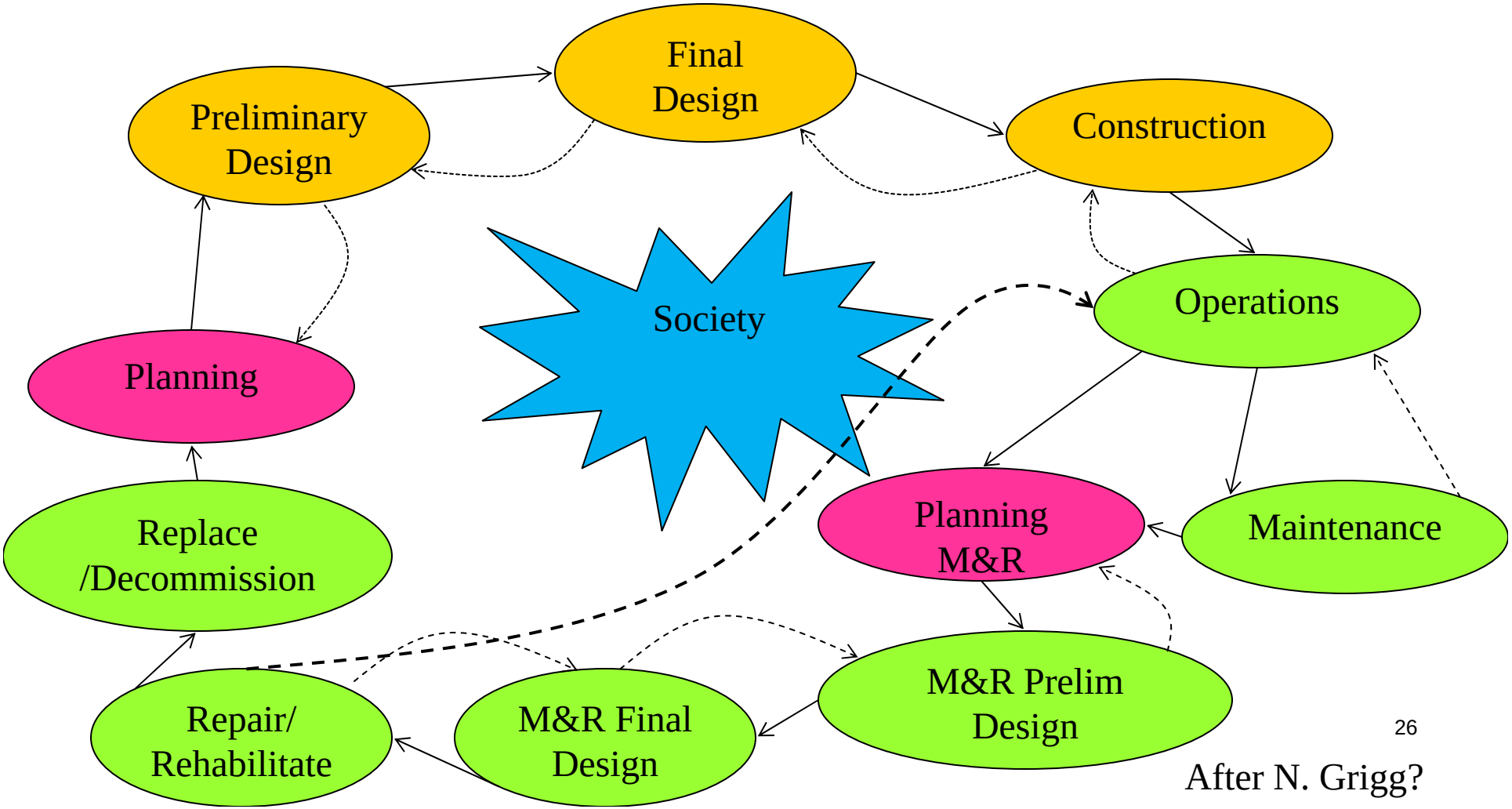
- Develop Cost-effective Strategy for:
  - Original Construction
  - Maintenance
  - Rehabilitation
  - Reconstruction
- Within Imposed Constraints
- Complete Design
- Construct Project

Input from Project Selection-level

Post Project-Level Analysis & Design

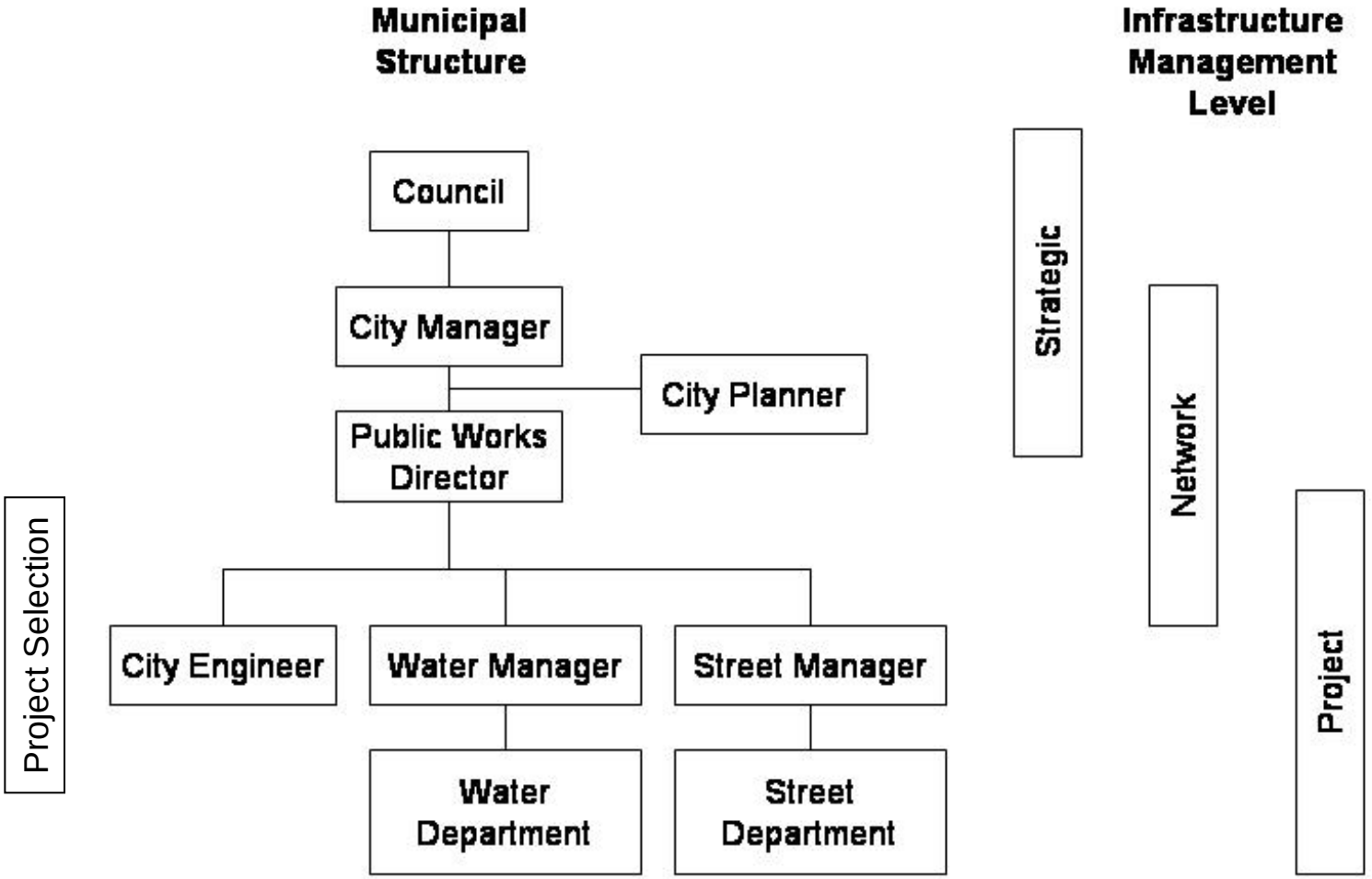
- Complete Required Work
- Monitor Construction
- Monitor Performance

Infrastructure Life Cycle



After N. Grigg?

Typical Municipal IM Organization



Differences in Those Responsible

- Project-level
  - Engineers/Technical Staff
- Project-selection Level
  - Senior Management and/or Department/District Managers
  - Department/District Staff
- Network-level
  - Senior Management
  - District/Department Managers
- Strategic-level
  - Funding authorities
  - Senior management

Those Responsible Vary

- Differences Depend on:
  - Centralized, Decentralized, Public Private Partnerships or Privatized
  - Funding Source
    - Capital vs Maintenance
    - Enterprise vs General vs Dedicated Funds
  - Importance of Facility
  - Organizational & Historical Relationships

Differences in Data Required

- Project-level - Detailed data needed to complete final design
- For those sections selected for work in funding period (very small % of network)
  - Mechanics based design models and inputs
  - Functional, structural, & safety requirements
  - Available materials, etc.
  - Material properties, construction techniques, etc.
  - Other constraints & impacts
  - Costs & available funds
  - Prior performance if M&R

Project-Selection Level

- Enough data to compare preliminary alternatives for sections considered for funding (small % of network)
  - Consider constraints not included in network-level analysis
    - Programmed work
    - Additional work
    - Funding restrictions
  - Define work limits & best time to complete work
    - More complete performance data than network-level
  - Preliminary design using limited data in full model or limited design models

Network-Level

- Data on every segment in the network
- Enough to identify:
  - Best group of candidate segments or
  - Number & type of segments that need to be addressed
  - Funding impacts of different alternatives
  - Optimization, prioritization, or simulation using empirical models that connect condition, or changes in condition, of type facility to changes to funds invested
    - Network-level condition
    - Network inventory
    - Past M&R, etc.

Strategic-Level

- Focus of Asset Management
- Combined Data from Network-level Systems
  - Data on every segment in every infrastructure network
- Funding needed to provide desired level of service in all facilities
  - Enough to identify:
    - Best allocation among systems
    - Funding impacts of different alternatives
    - Multi-objective optimization, prioritization, or tools using empirical models that connect performance, or changes in performance, of type facility to changes to funds invested

Differences in Data Summary

- Project-level
  - Detailed data needed to complete design
  - For very small % of network
- Project selection-level
  - Enough data to select projects to be funded
  - For small % of network
- Network-level
  - Enough data to identify candidates & support allocation
  - For entire network
- Strategic-level
  - Data from network-level (entire network)
  - Data that funding authorities can use
  - Indicators of work performed and results achieved

Do

Understand at which Levels Decision Support Software will Assist

Pavement Management Software

- Primarily supports network-level analysis
- Can assist with some project selection-level analysis
- Provides input for strategic level analysis
- Does not design pavements
- Does not identify segments needing emergency or routine maintenance

Do

Understand What Assistance a Pavement Management Decision Support Software will Provide

Network-Level Elements

- Inventory
- Condition assessment
- Determination of fund needs
- Identification of candidate projects for funding
- Determine impact of funding decisions on future condition and fund needs
- Feedback process

Inventory

- What the agency is responsible for
- Where it is located
- Basic information needed to support network-level decisions

Condition Assessment

- Defines the health of individual sections
- Collectively defines the health of the network

Determination of Fund and Work Needs

- Identifies sections needing work
- Determines funds needed to complete work

Prioritizing Candidate Sections

- Rank order sections needing work
- Goal - provide best possible pavement network for available funds

Determine the Impact of Funding

- Connect PMS to funding decisions
- Determine funds needed to provide desired level of service
- Justification for funding requests
- Support for allocation decisions

Feedback System

- Helps system learn from past
- Improves reliability
- Updating costs
- Updating projection procedures

Project Selection-level Analysis

- Used to develop improved cost estimates for each individual segment
- Consider constraints & cost elements not included in network-level analysis
- May require more data and more analysis
- Some help from some PM software
  - Run Analysis with Selected Projects

Project-Level Analysis

- Used to determine the best treatment and to develop final cost estimates for each individual segment
- Requires more detailed data and more extensive analysis

Project-Level Coverage

- Network - M&R of existing system
- Project-level
  - New pavements
  - Rehabilitation
  - Reconstruction
  - Preventive (programmed) maintenance

Project-Level Elements

- Design and analysis
- Developing maintenance, rehabilitation, and reconstruction treatments
- Select best strategy

Project Level Requires

- Design procedures
- Additional data collection
- Cause of deterioration
- Alternative treatment strategies to address cause
- Funding estimates for each alternative strategy
- Life estimated for each alternative strategy
- Life-cycle costing
- Consider constraints

Project Level Analysis Followed by

- Completion of Required Work
- Monitoring Construction
- Monitoring Performance

Do

Follow Established Pavement Management Implementation Steps

Implementation Concepts

- Mandated implementation

  versus

  Actual use

- IMS is implemented if it
  - Impacts decisions

Recommended Approach

- Phased process
  1. For potential champions
  2. Get decision from management
  3. Select & Test PMS
  4. Evaluate & Adjust PMS prior to full implementation
  5. Put PMS components in place
  6. Develop effective use
- May start at any point
- May redo some steps

Steps Appropriate for

- New Implementation
- Implementation of new component

Phase 1 - Potential Champions

- Deciding that PMS needed
- Directed at PMS "champion"

Components of Phase 1

- First Knowledge
  - Recognize need to change or enhance
- Attitude Formation
  - Requires knowledge of PMS Principles
  - “How-to” information

More Components of Phase 1

- Decide to implement/adopt
- Develop alliances
- Formulate initial goals
- Get PMS adoption or change on agency agenda

Don’t

Start until you know your agency and understand the probably barriers you will encounter

Institutional Analysis

- Barriers to Adoption Implementation or Effective Use
  - Adoption
  - Implementation
  - Effective use
- Most are people and institution related
- Which ones will impact your implementation efforts

Turf Protection

- Information is power
- Some within organization feel threatened when new methods are being considered

Fear of Exposure

- PMS may not agree with previous decisions

If It Wasn't Developed Here, It Can't Be Any Good

- Refusal to use PMS developed by others

Resistance to Change

- People who just do not want to change
  - I know how to do my job
  - It took me a long time to learn this
  - I don’t want to have to start over

One Person Show

- Investment in 1 or 2 people
- Lost through personnel turnover
- Cross-training is often impractical

Do Know

- Who will need to be involved
- Who will be most likely to resist adoption
- Who will be most likely to resist use
- Who can have the most negative impact

Organizational Analysis

- More Later

Phase 2 – Management Decision

- Obtaining a corporate decision by the agency
  - Management commits to implementing PMS
  - Champion must convince management to commit
- Prepare implementation plan for agency

Champion Persuades Management

- Demonstrate that PMS or new component is better than current process
  - Explain PMS concepts
  - Describe problems that PMS can address
  - Identify requirements
  - Show benefits

Agency Decides

- Management decides to adopt (or reject) PMS
- Decision can be conditional

Form Steering Committee

- Upper level management, possibly include elected officials
- Leadership of all affected groups
- Provide support needed to facilitate
- Prepare (review) goals
- Ensure adequate resources are available
- Help get "buy in"

Gain Commitment for Funding

- Real commitment occurs when funds and resources are committed

Form Implementation Group

- Should include people from all major users
- Responsible for day-to-day efforts
- Maintain close liaison with steering committee
- Core group of trained personnel
- Group of “champions”
- Convert goals into work plan

Phase 3 - Select & Test PMS

- Responsibility of Implementation (Working) Group
  - Coordination with Steering Committee
- Selecting and Testing PMS
  - PMS components
  - Data collection methods
  - Software
  - Management procedures
- More details in this step later

- Conduct More Organizational Analysis
  - Review existing organizational structure and decision making processes
- Design and/or Select System
  - Match to agency needs
  - Match to agency resources
- Or Modify Selected PMS
  - Modify to fit agency needs & resources

Prepare Implementation Plan

- As specific as possible
- Approved by the steering committee
- Staged implementation often preferred
  - Conditional acceptance
  - Find needed changes while they can still be made without large penalties
  - Financial/resource constraints
  - Possible pilot implementation
- Provide adequate time for training

Implement through Trial Operation

- Use small percentage of network
- Go through all usage steps
- Identify needed changes
- Use as training
- Document costs and results

Phase 4 - Evaluate & Adjust PMS

- Final Agency Decision
  - Continue through full implementation?
- Management commits to:
  - Full implementation
  - Desired revisions
  - Repeating some steps if needed
  - Rejection at this time

Revise the Goals

- Steering Committee
  - Looks at needed resources versus available resources
  - Looks at benefits
  - Reviews original goals
  - Reviews time tables and implementation plans
  - Revises as needed

Revise the Implementation Plan

- Implementation (Working) Group
  - Identify revisions needed for PMS
  - Consider revised goals
  - Consider revised resource plans
  - Revise work plans
  - Can still be staged
  - Training and support must be provided

Phase 5 – Complete Implementation

- Make final adjustments
  - Data collection
  - Software
- Implement for full infrastructure system

- Largest initial expenditure of resources

Implementation for Full System

- Complete:
  - Data collection
  - Data entry
  - Program revisions
  - Prepare plans to submit to funding authorities

- Use as training opportunity
  - Train appropriate agency personnel
  - Communication with senior management

Stage 6 - Effective PMS Use

- IMS must become a part of normal management process
  - Institutionalize management approach using PMS decision support system

Matching Output to Management Styles and Needs

- Modify reports to match style and needs for
  - Agency management
  - Funding authorities
- Train management in PMS

Placement in the Organization

- Formalize PMS in organizational structure
- Facilitate communication to upper, middle, and lower management
- Assign responsibility for:
  - Data collection
  - Data entry
  - Maintaining data base integrity
  - Preparing reports for selected groups
  - Updating data

Training on a Continuing Basis

- Support changes and improvements
- Refresher training needed due to:
  - Part time job
  - Staff turn-over
- Formalize training as part of agency culture

Adjust and Improve

- Respond to technology changes in:
  - Data collection
  - Analysis
  - Data storage
  - Software
  - Hardware

Assistance

- Need depends on PMS knowledge & capabilities in agency
- Select consultant to give support at selected stages
  - Data collection services
  - Training
  - Developing programs

Sources of Information and Assistance

- Look for available assistance
  - AASHTO
  - FHWA
  - NACE
  - APWA
  - ASCE
  - Universities and Research Organizations
  - Neighboring jurisdictions
  - User groups
  - Consultants

Summary

- Implementation needs to be planned
- Large implementation efforts should be staged
- Specific phases of implementation need to be considered
- All affected groups need to be involved
- Plans need to be changeable
  - Issues will develop
  - Can redo phases

Summary Continued

- More barriers require more implementation planning
- Major changes need to be planned as well as new adoption
- Need to consider both agency needs and resources
- ASTM Guide E 1889

Do

Select Pavement Management Methodologies and Software that Supports Your Agency Needs

Do

Remember that pavement management software is network-level with some possible project selection-level assistance

Organizational Analysis

- Agency structure
- Communication flow
- Data collection and flow processes
- Existing data bases
- Other affected infrastructure systems
- Decision making processes
- Available resources
- Constraints

Past Management and Decision Making Practices

- Management practices
- Types of decision making
  - Optional
  - Collective
  - Authoritative
- Combination

Planning Horizons

- Single year
- Biennial
- Longer multiple year plans

Constraints on Selection of Projects

- Other activity
- Funds allocated to single project for several years
- Funding categories
- Political commitments
- Management decisions

Fixed Facilities and Process

- Computer system
- Location referencing system
- Existing data and data formats
- Data collection process
- Existing database manager
- Existing GIS Capabilities

Resources

- Resources to implement and operate
  - Funds
  - Staff
  - Equipment
- Resources to apply needed treatments
- Personnel to operate and maintain the PMS

Competing Fund Needs

- Competition for all funds
- Dedicated funds

Size

- Staff
- Organizational structure
- Road/street network

Structure

- Communications across boundaries
- Matched to functions
- Centralized versus decentralized

Who Will Operate the Process

- In-house agency personnel
- Consultant
- In-house with consultant data collection
- Other

Who Will be Responsible

- Where will responsible person be located in organization
- Who will ensure:
  - The process is reasonably resource
  - Data is collected
  - Data is entered
  - Reports prepared
  - Presentations presented

Stability

- Of organizational structure
- Of staff
- Of management

Do

Assess Your Needs

Manual Versus Automated Software

- Network-level Pavement Management Software

Manual Systems Have Limited Capabilities

- Inventory – on cards
- Condition assessment - on cards
- Pick “worst first”; those not worked on in last X years
- OK for
  - Small towns with less than ~25 miles of streets
  - Counties and townships that primarily have unpaved surfaces

Spreadsheet Systems Also Have Limited Capabilities

- Inventory
- Condition assessment
- Needs analysis – very limited
- Prioritization limited to simple set of rules
- OK for
  - Small towns with less than ~50 miles of streets
  - Counties and townships that primarily have unpaved surfaces

Microcomputer/Server Based

- Advantages in:
  - Storing data
  - Retrieving data
  - Preparing reports
  - Needs analysis
  - Prioritization
  - Impact analysis

Internet Accessed Server Based

- More power
- Minimal IT conflict issues
- Immediate updates

Do

Select a compatible system that will provide needed support

Match to Agency Needs

- Decision support needed
- Recommendations in useable form
- Data collection within available resource

Compatibility

- More compatible to agency approach - more likely to be adopted and used
  - Helps when the situation seems dismal
  - Provides information needed by senior management and politicians
- Support designed for local agencies
  - Does not require sophisticated outside support
  - Minimizes resources required to implement and operate system

Relative Advantage

- Greater perceived advantage - more likely adoption and use
- Show benefits provided to the agency
- Show benefit to operating personnel
- Support securing funds

Complexity

- Complexity is relative – it can be reduced by training
- Easier to understand - more likely to be adopted and used
- Understandable by staff
- Explainable to management

Adaptability

- Modifiable to meet individual differences and changes
- Reports and formats
- Accommodate technological changes

Do Avoid

Black Box PMS

Inventory

- Defines What Is Being Managed
  - What Agency Is Responsible for
  - Where It Is Located
  - Basic Information
- Compatible with current data
- Compatible with GIS, etc.

Condition Assessment

- Condition data collection costly
- Must be updated periodically

Type of Condition Data

- Selected to:
  - Meet needs of agency
  - Resources available
- Distress generally considered the most important at network-level
- Roughness next most important for high speed roads
- Surface friction important for high speed roads - seldom collected at local level
- Structural primarily used in project-level

Focus of Data Collection

- Support for network-level decision support
  - Which segments need work
  - About how much $ needed
  - Over some analysis period

- Project-level data collected for those sections being designed that year

At Local Agency Network-Level

- Distress most important
- Condition indices help in decision support systems

Method of Collection

- Match to:
  - Needed:
    - Accuracy
    - Precision
    - Resolution
  - Available:
    - Funds
    - Resources

Automated Collection of Distress

- Improve safety of personnel
- Decrease traffic interruptions
- Funds to contract but limited staff
- Will not collect “same” data

Manual Collection of Distress

- Requires commitment of trained personnel
- Develops expertise within agency
- Can improve understanding of pavement performance
- Can help develop confidence in PMS
- Can help develop communication with agency

Reducing Staff Effort

- Data recording devices
- Sampling processes

Data Collection Equipment and Local Agencies

- Initial Expense
- Specially trained operators
- Trained personnel to interpret the data
- Limited use
- High maintenance costs

Contracting for Data Collection

- Define:
  - Data to be collected
  - Accuracy needed
  - Precision desired
- Let economics tell how to collect
- See my presentation from last year

Do

Develop a Data Quality Plan

Quality Control Plan for Contracted Data Collection

- Prequalification of inspection agency
- Description of the training and experience of the inspectors
- Certifications of inspectors
- Data verification processes completed by the contractor which can include:
  - Periodic re-inspection of “control” sections
  - Re-inspection of sections previously inspected
  - Re-inspection of inspected sections by a supervisor
  - Re-inspection of inspected sections by independent evaluation
- Define what will considered acceptable
- Describe what be required if the re-inspection data is not acceptable

Quality Acceptance Plan for Contracted Data Collection

- Verification that Quality Control plans are conducted
- Check Quality Control results to ensure that the required tolerances were met or appropriate corrective actions completed
- Inspection of small percent of sections inspected by contractor
  - Define acceptance criteria
  - Define requirements imposed on contractor when acceptance criteria is not met
- Data checks
  - Check against prior inspection data for same section if no treatment has been applied since last inspection
  - Check against projected PCI

Quality Control is Worth the Cost

- You wouldn’t spend money on construction without quality checks

- Don’t spend money on inspection without quality control !!

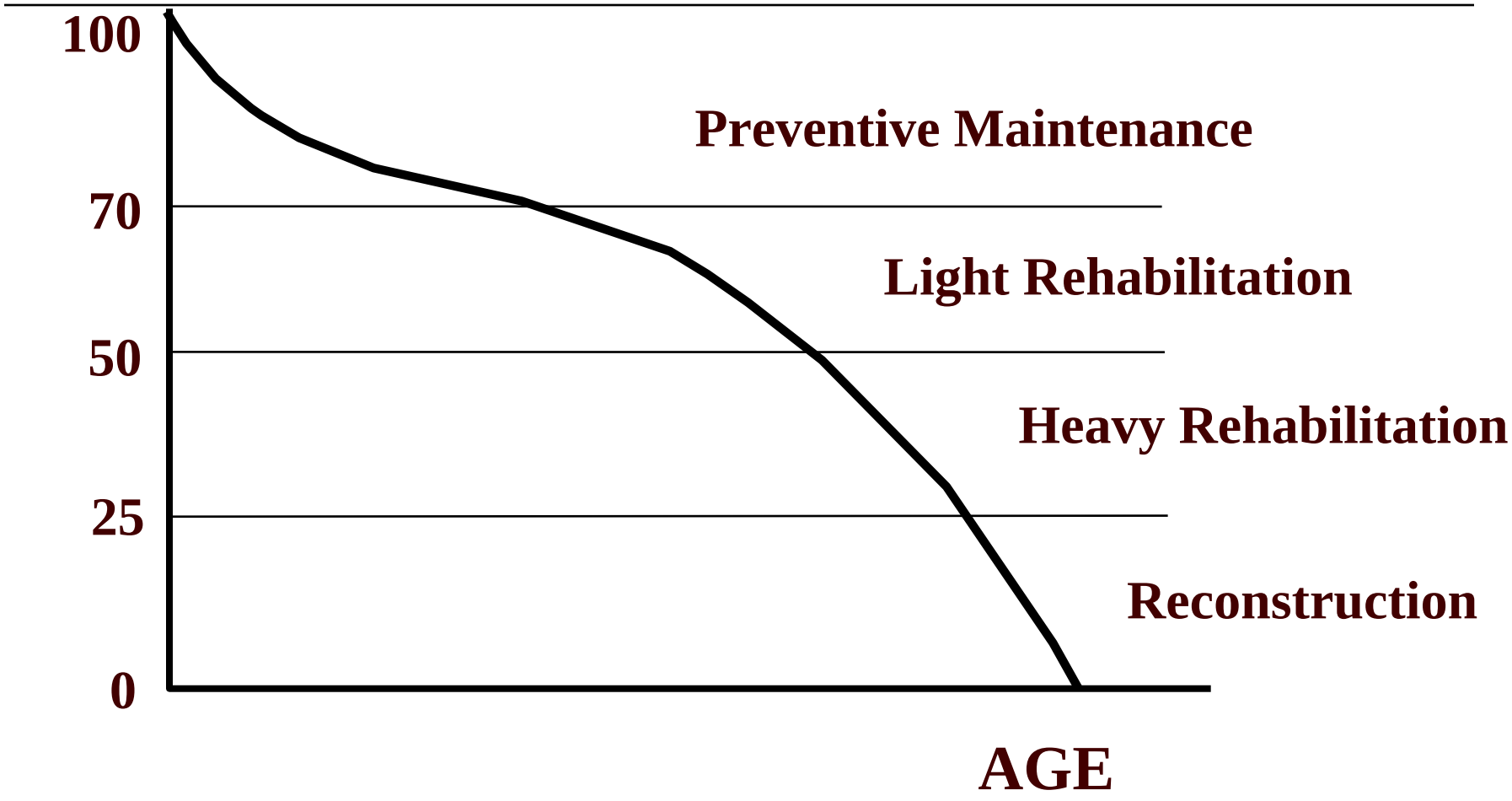
Needs Analysis

- Reflect past practices and needs of the agency

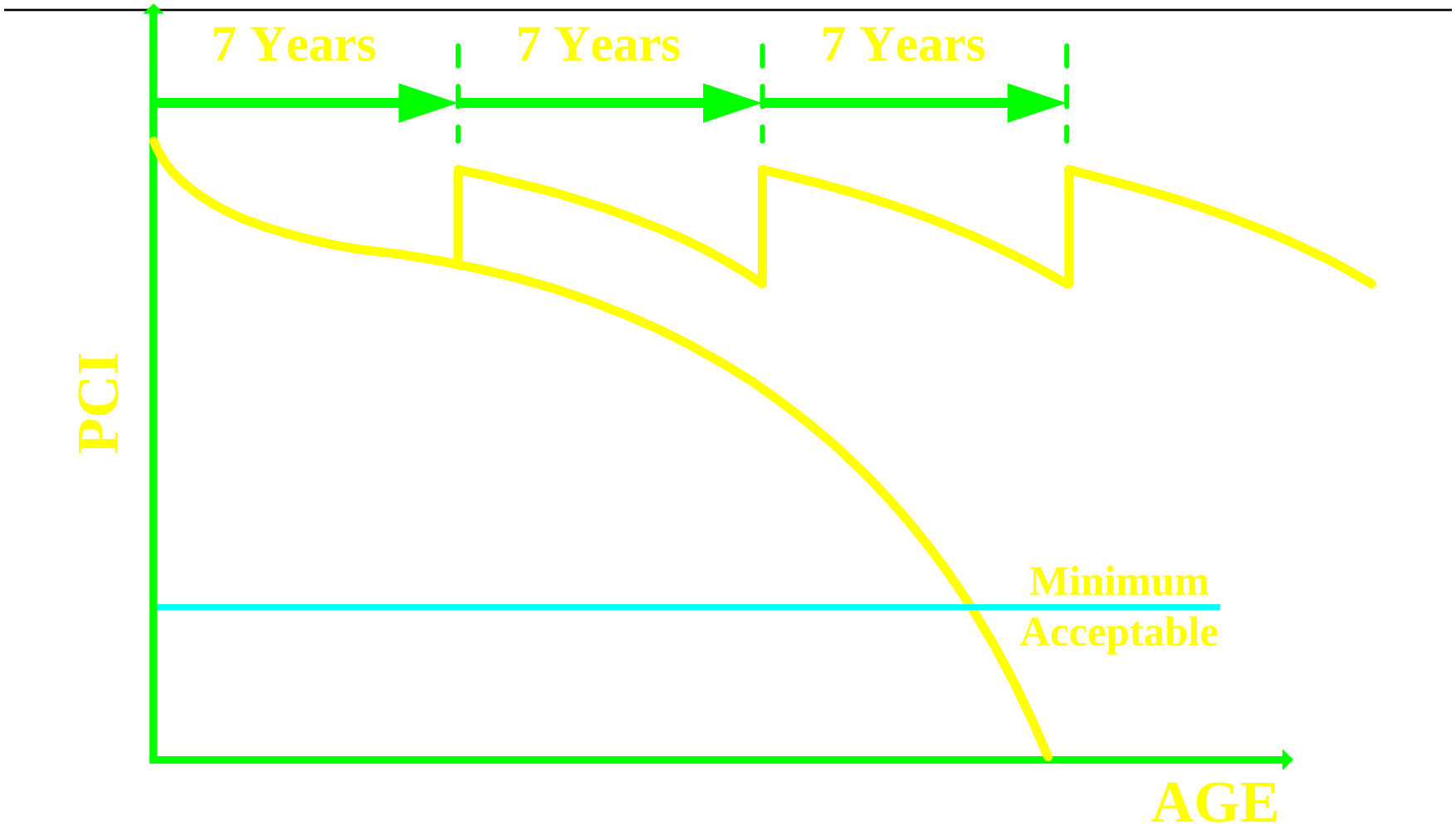
Needs Analysis

- Identify Sections Needing Work
- Estimate Funds Needed
- Rehabilitation - Condition Driven
- Preventive Maintenance
  - Minimum Condition &
  - Time Interval

Rehab – Condition Driven



PM – Time Sequenced



Decision Tree/Matrix Approach

- Network-level planning treatment
  - Assigned each section needing work
  - During analysis period (5 to 20 yrs)
- Factors to consider:
  - Condition
  - Usage & importance
  - Surface type

Decision Trees/Matrices

- This is where you put in your treatments
- Selecting the treatment for each condition category sets up your strategy
- Selecting the right treatment for the right condition sets up a pavement preservation strategy

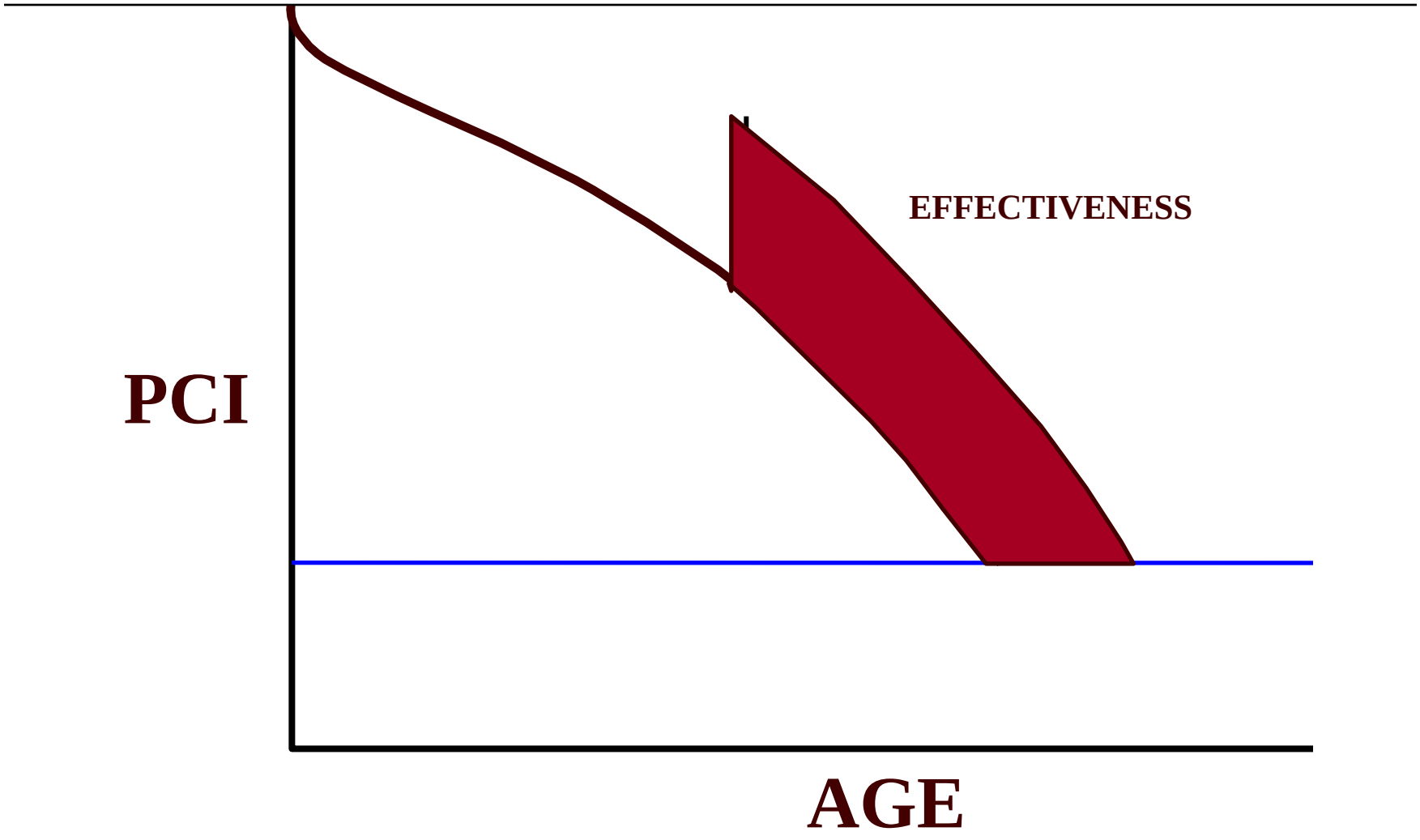
Prioritizing

- Match:
  - Accuracy of the data used
  - Requirements of the agency
  - Expertise of the personnel

Possible Prioritization Concepts

- Worst First - Weighted for Traffic
- Least Life-cycle Costs
- Best Benefit-cost Ratio
- Best Effectiveness-cost Ratio

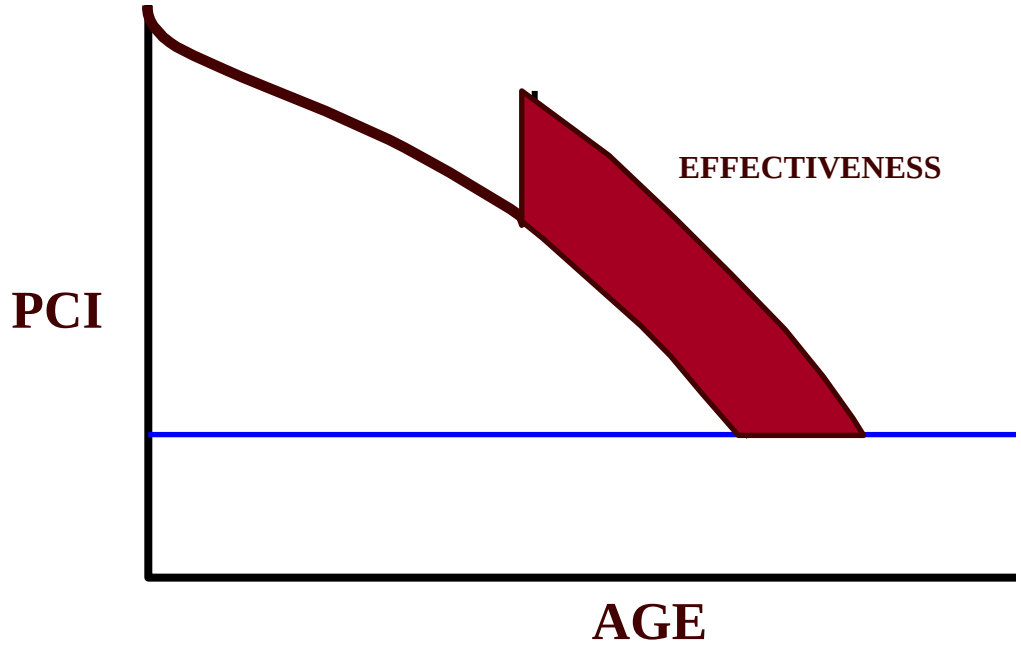
Prioritization Based on Cost-Effectiveness



Cost-Effectiveness

- Sections
  - That will be in the best condition for the longest time for least cost
  - Give best return on funds &
  - Should be repaired first

Cost-Effectiveness Ratio



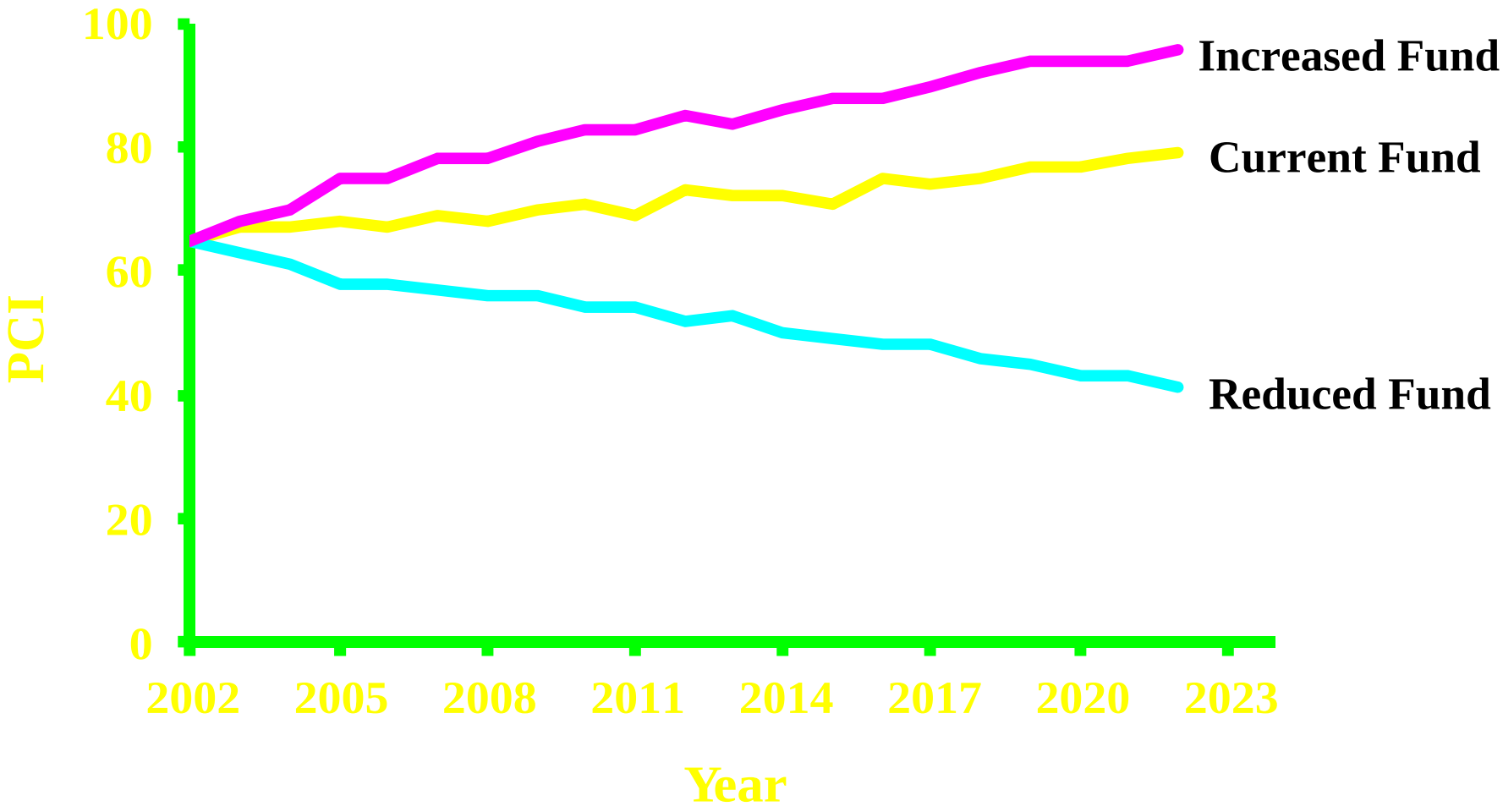
$$\text{Cost-Effectiveness Ratio} = \frac{\text{Effectiveness}}{\text{Cost}}$$

Impact of Funding Alternatives

- Connect PMS to Funding Decisions
- Justify Fund Requests
  - How much $ needed to provide selected level of service
- Support of Allocation Decisions
  - Fix Worst First
  - Apply PM

Projected Condition

- How Condition Changes With Alternatives
- Amount in poor conditions
- Don’t Rely Only on Changes in Average PCI


100
80
60
40
20
0
PCI
2002
2005
2008
2011
2014
2017
2020
2023
Year
Increased Fund
Current Fund
Reduced Fund

Deferred or Back-Logged

- Deferred Fund Needs
  - Needs Minus Spend
- Back-logged
  - Sections That Needed Work That Was Not Recommended

Others

- Average remaining life
- Network value
- Funds needed for stop-gap treatments

Results of Impact Analysis

- Ability to Look at Different Funding Scenarios
  - Different Funding Levels
  - Different Allocation Approaches
  - Different Approaches to Treatment
- Answer “What If?”

Assessing Available PMS Procedures

- Contact other users
- Implement through trial operation

Do

Consider need for support

Need for Support

- Upper level management
- Financial
- On-line for software and data operations
- User meetings

Training

- For all affected by PMS
- At several levels
- Upper management
- Areas of greatest resistance
- Must be cyclic and continue indefinitely
- Reduce resistance
- Reduce perceived complexity

Questions

Specific Issues in Your Agency