Predicting M&R Investments and Outcomes with the BUILDER™ Sustainment Management System

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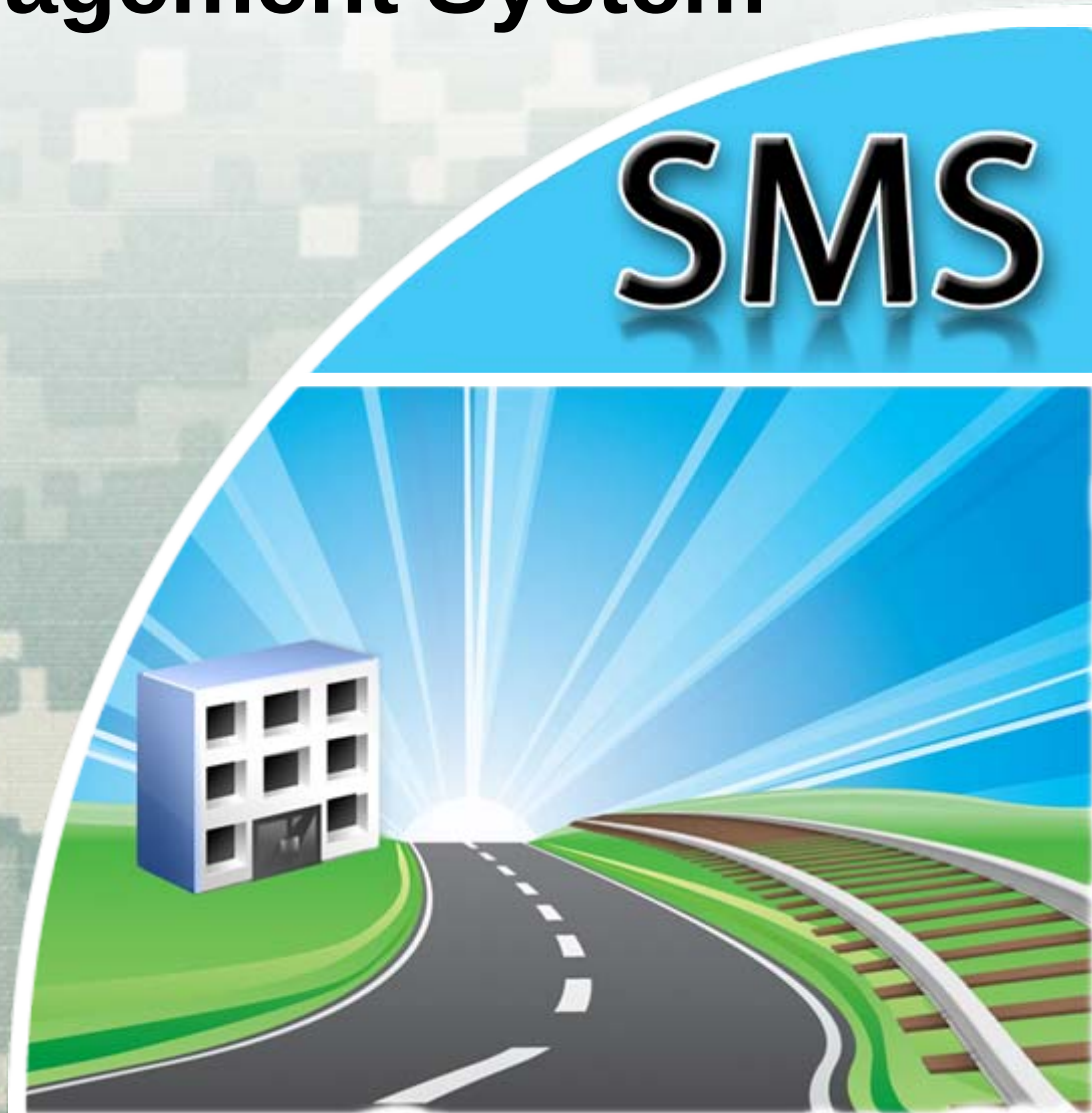
Program Manager

ERDC-CERL

20 MAR 2012



US Army Corps of Engineers

BUILDING STRONG®

Agenda/Outline

- Background
- Inventory
- Assessment
- Prediction
- Work Planning
- Forecasting
- Visualization & Integration
- Summary & Discussion

Facility Managers' Needs

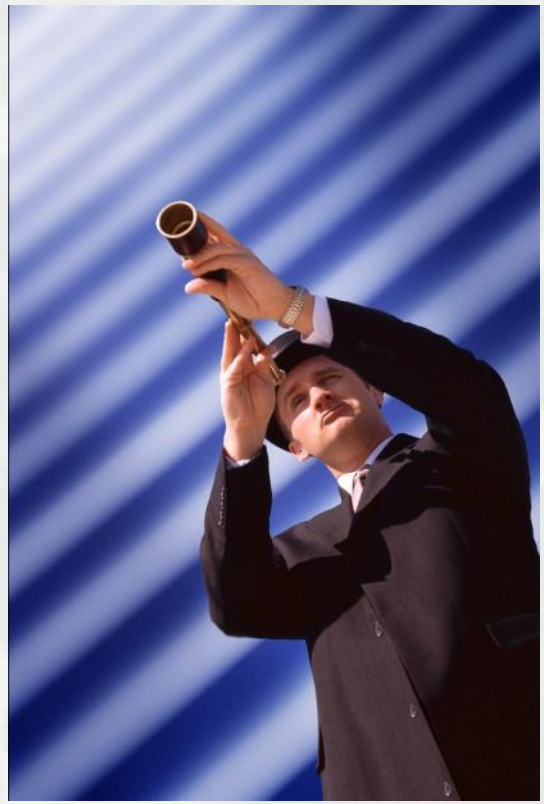
Engineered Asset Lifecycle Management Tools

Provide objective facility investment guidance for:

- **Systematic** assessment to identify maintenance requirements for increased reliability
- **Analyze** gap between current state and requirements; plan investments to close this gap and optimize return on investment
- **Prioritize** scarce resources according to economic and mission priorities
- **Predict** the effects/consequences of decisions to ensure mission readiness

The Goal

- Investment Planning driven by meaningful metrics:
  - Asset Lifecycle
  - Return on Investment (ROI)
  - Mission Assuredness
- Supports Installation, Regional, and HQ processes
  - Tactical Facility Requirements (Short Term)
  - Strategic Facility Requirements (Long Term)
  - Objective, Repeatable, & Affordable



Practice **proactive rather than reactive** maintenance planning at all levels of the organization.

Approach – A New Way of Looking At Assets

Traditional **vs.** **SMS**

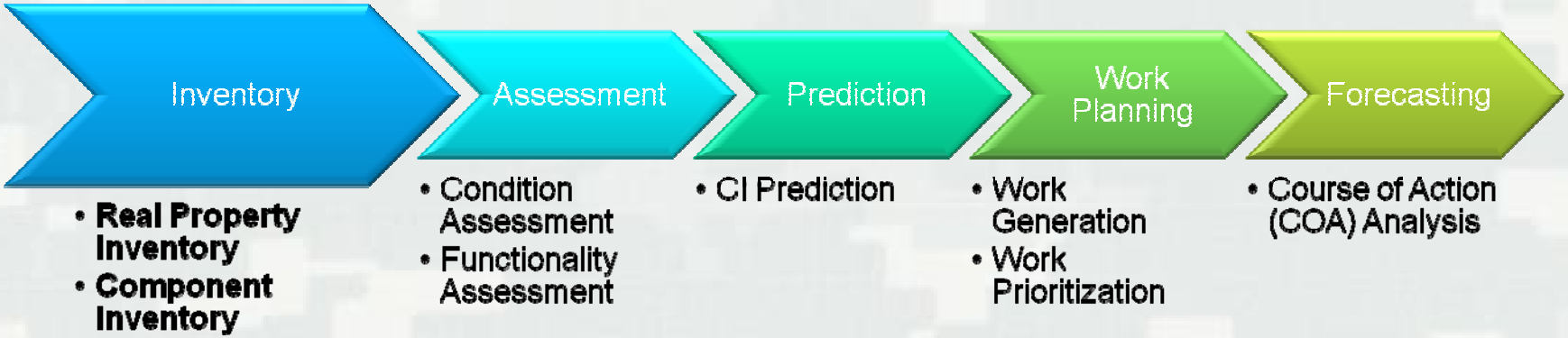
Deficiency:	Re-point brick retaining wall
Work Quantity:	200 SF
Scoping Estimate:	$1400
Urgency/Priority:	3

Work is the input

Distress Type(s):	Deteriorated and Cracked
Severity Level(s):	Low and Medium
Quantity/Density:	100 SF and 12 LF
Condition Index (calc.):	72

Work is the output

Process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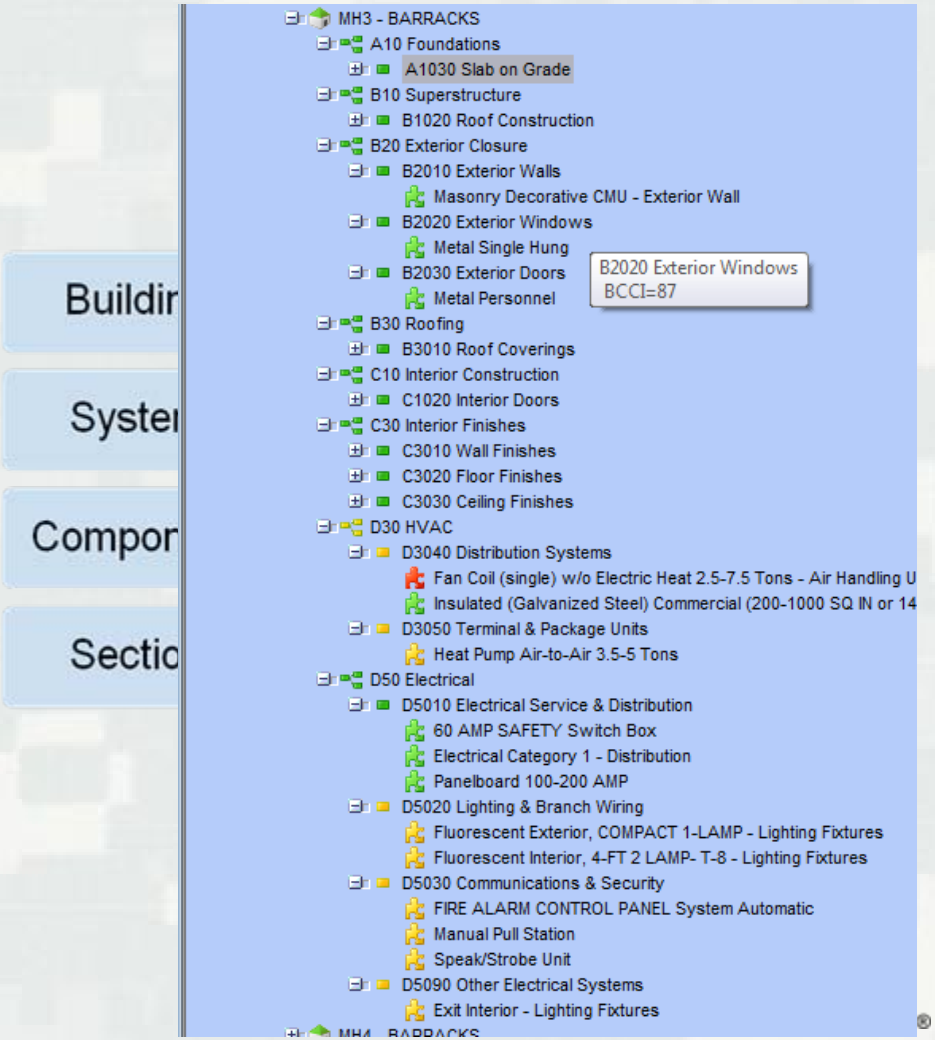
• Component Inventory
• Condition Assessment
• Functionality Assessment
• CI Prediction
• Work Generation
• Work Prioritization
• Course of Action (COA) Analysis

Inventory

- Identify “building blocks” of facilities that will be independently maintained
  - Identify components (doors, walls, windows, roof, etc.), as well as equipment.
  - Like equipment may be grouped when managed as one lifecycle group (i.e. set of exhaust fans, overhead doors)
- Capture appropriate detail to accurately reflect replacement values and service lives



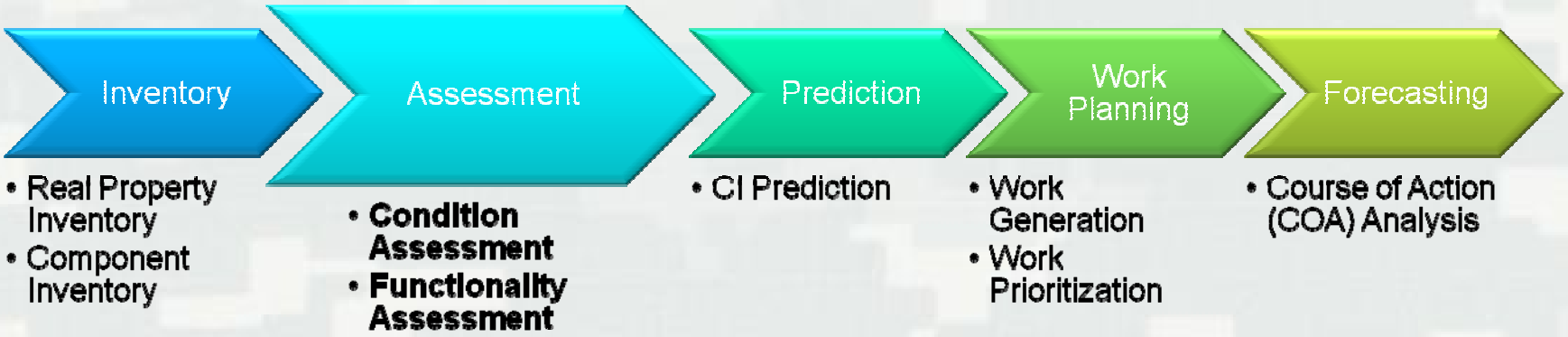
Inventory Results

- Inventory models aligned with RPI requirements
  - RP Site ID
  - RP UID
  - (Future) RP Equipment ID
- Detailed inventory can be derived from maintenance records*
  - Quantity
  - Equipment Type
  - Age
  - Etc.

* Need to also include facility assemblies, such as walls, roofs,

System	Component	Section Description	Quantity (UM)	Yr. Installed	Yr Painted
Conveying	Elevator	Electric Freight 2 Stops	1 (EA)	2007	
Electrical	Distribution	Electrical Category 1	13,000 (SF)	2007	
	Generator Set	Gasoline <35 KW	1 (EA)	2007	
	Intruder Detection/Security	Intrusion	1 (EA)	2007	
	Lighting Fixtures	Fluorescent Interior	425 (EA)	2007	
Exterior Closure	Exterior Door	Glass Personnel	6 (EA)	2007	
	Exterior Wall	Masonry Face Brick w/ CMU Backup	5,268 (SF)	2007	
	Exterior Window	Metal Casement	57 (EA)	2007	

Process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Condition Assessment

- Standardized, objective process uses technician-level experience, rather than architects/engineers
  - Inspector is “human sensor”, doesn’t insert their opinion/interpretation
  - Models the rating that would be given by a group of experts.
  - Increases consistency and quality of information across organization (apples-to-apples)

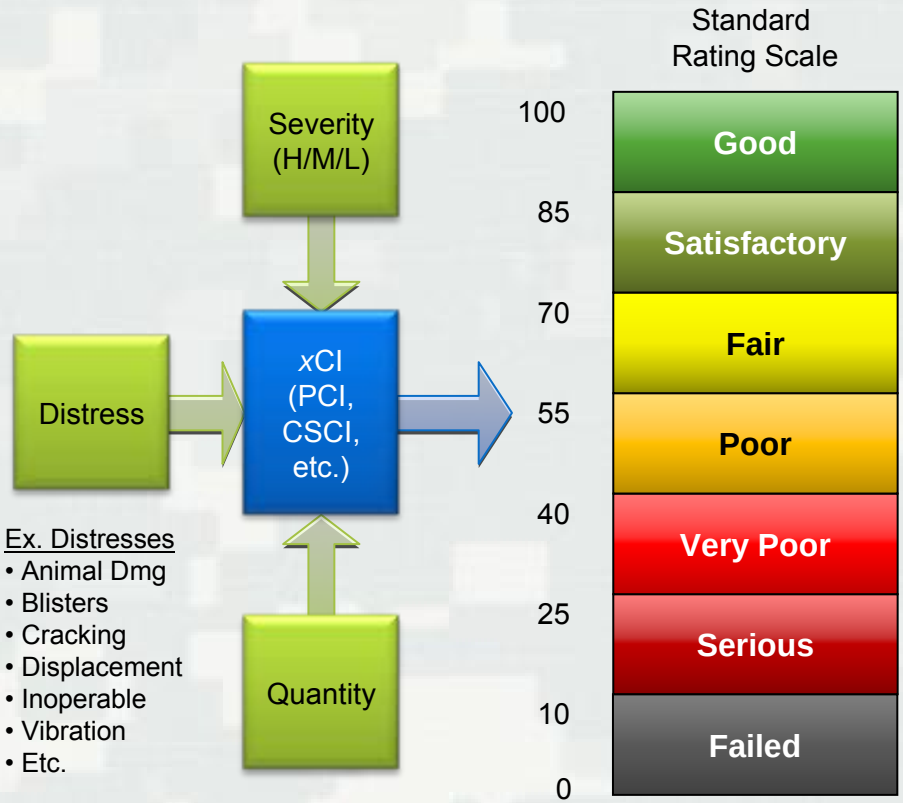
Traditional **vs.** **SMS**

Deficiency:	Re-point brick retaining wall
Work Quantity:	200 sf
Scoping Estimate:	$4400
Urgency/Priority:	3

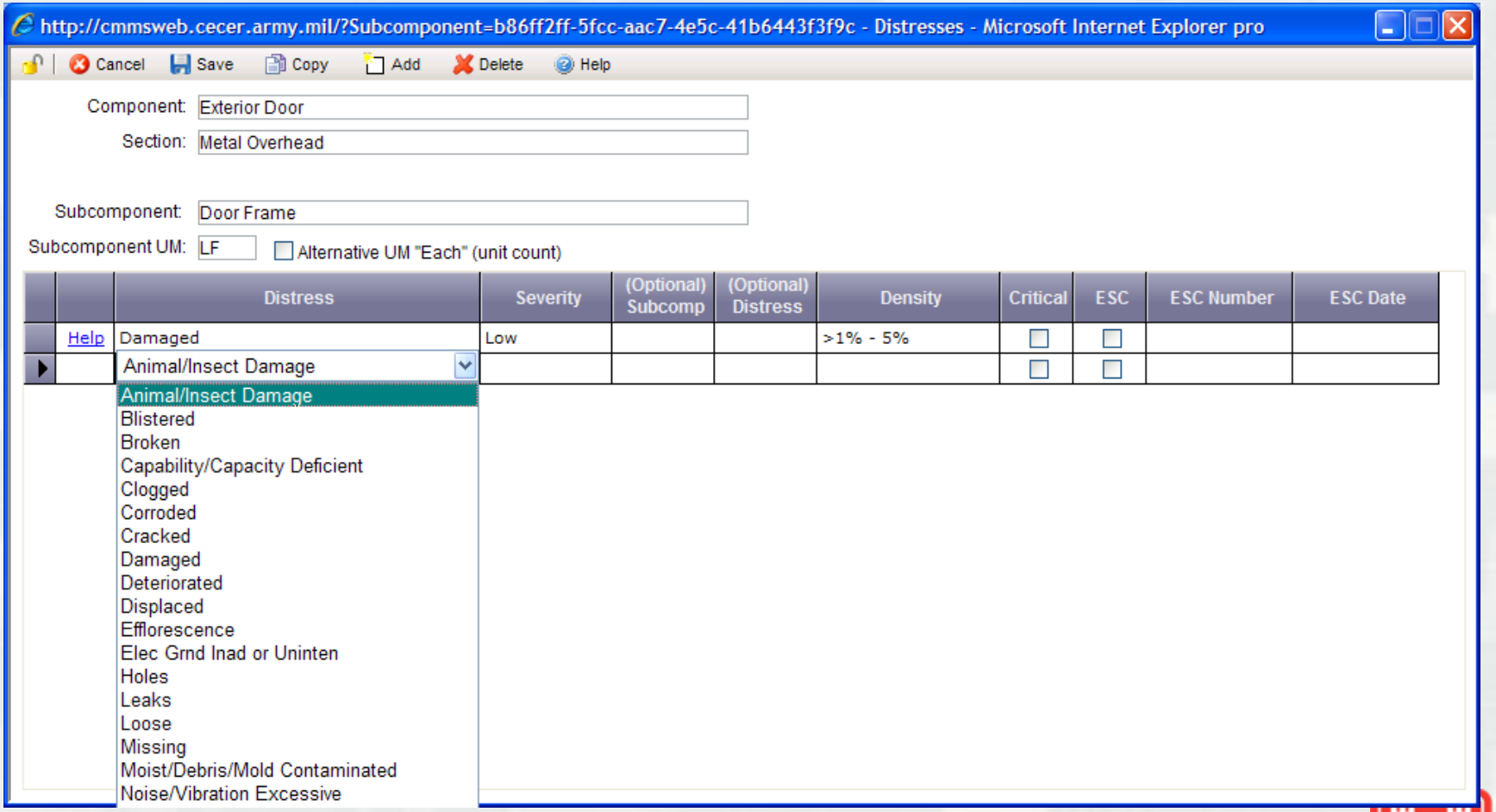
Distress Type(s):	Deteriorated and Cracked
Severity Level(s):	Low and Med
Quantity/Density:	200 SF and 12 LF
Condition Index (comp.):	72

Condition Index Metric

- Utilize objective, rules-based inspection to capture consistent information set
- Models the rating that would be given by a panel of experts
- Expresses the ability of the component to continue to reliably provide the as-designed function

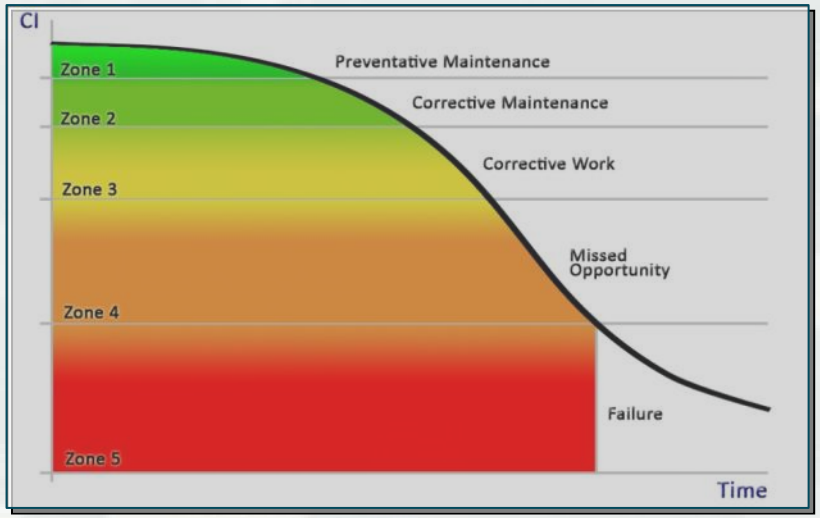


Condition Assessment



Knowledge Based Inspection

- An asset does not require the same level of scrutiny at all points in its lifecycle.
- All assets do not degrade at the same rate.
- Focus inspection attention and resources on what's important, considering risk.
- Tailor the frequency and level of detail to the purpose and lifecycle condition.



Knowledge Based Inspection

Knowledge-Based Inspection Scheduling (TM) - Windows Internet Explorer

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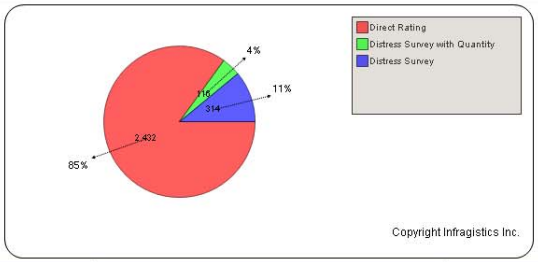


Building	System	Component	Section	Inspection Type	Inspection Reason
100 CHAPEL	C30 Interior Finishes	C3010 Wall Finishes	2FL Masonry Concrete Block	Direct Rating	Degradation Factor
100 CHAPEL	C30 Interior Finishes	C3010 Wall Finishes	2FL Drywall	Direct Rating	Degradation Factor
100 CHAPEL	C30 Interior Finishes	C3030 Ceiling Finishes	2FL Acoustical Suspended	Direct Rating	Degradation Factor
100 CHAPEL	C30 Interior Finishes	C3030 Ceiling Finishes	2FL Drywall	Direct Rating	Degradation Factor
100 CHAPEL	C30 Interior Finishes	C3030 Ceiling Finishes	1FL Acoustical Suspended	Direct Rating	Degradation Factor
100 CHAPEL	C30 Interior Finishes	C3010 Wall Finishes	1FL Vinyl/Plastic Wallpaper	Direct Rating	Degradation Factor
100 CHAPEL	C30 Interior Finishes	C3010 Wall Finishes	1FL Drywall	Direct Rating	Degradation Factor
100 CHAPEL	C30 Interior Finishes	C3030 Ceiling Finishes	1FL Drywall	Direct Rating	Degradation Factor
100 CHAPEL	C10 Interior Construction	C1030 Fittings	Wood	Direct Rating	Degradation Factor
100 CHAPEL	A20 Basement Construction	A2020 Basement Walls	Concrete	Direct Rating	Interval Exceeded
1009 WTRFR OPER BLDG	D50 Electrical	D5030 Communications & Secu	Speaker Unit	Direct Rating	Degradation Factor
1009 WTRFR OPER BLDG	D30 HVAC	D3050 Terminal & Package Unit	CU-1 Heat Pump Air-to-Air 15-20 Tons	Distress Survey with Quantity	Inspections Required
1009 WTRFR OPER BLDG	D20 Plumbing	D2030 Sanitary Waste	Cast Iron Waste Piping, 6"	Direct Rating	Interval Exceeded
1009 WTRFR OPER BLDG	A10 Foundations	A1020 Special Foundations	Concrete	Direct Rating	Degradation Factor
1010 ACFT G SPT SHOP	C30 Interior Finishes	C3010 Wall Finishes	Metal Sheet	Direct Rating	Degradation Factor
1010 ACFT G SPT SHOP	A10 Foundations	A1030 Slab on Grade	Concrete Slab On-Grade	Direct Rating	Degradation Factor
1010 ACFT G SPT SHOP	C30 Interior Finishes	C3010 Wall Finishes	UNPAINTED Metal Sheet	Direct Rating	Degradation Factor
1010 ACFT G SPT SHOP	C30 Interior Finishes	C3010 Wall Finishes	Masonry Clay Brick	Direct Rating	Degradation Factor
1011 STG AIR GRD ORG UTS	B20 Exterior Closure	B2010 Exterior Walls	Metal	Direct Rating	Degradation Factor
1011 STG AIR GRD ORG UTS	B20 Exterior Closure	B2010 Exterior Walls	Concrete CIP Concrete	Direct Rating	Degradation Factor
1011 STG AIR GRD ORG UTS	B20 Exterior Closure	B2010 Exterior Walls	Masonry CMU	Direct Rating	Degradation Factor
1011 STG AIR GRD ORG UTS	B20 Exterior Closure	B2010 Exterior Walls	Masonry Clay Brick	Distress Survey	Degradation Factor
1016 WAREHSE(STG AIR GRD ORG UTS)	C30 Interior Finishes	C3010 Wall Finishes	Ceramic	Direct Rating	Degradation Factor
1016 WAREHSE(STG AIR GRD ORG UTS)	C10 Interior Construction	C1020 Interior Doors	Wood Personnel	Direct Rating	Degradation Factor
1016 WAREHSE(STG AIR GRD ORG UTS)	C30 Interior Finishes	C3030 Ceiling Finishes	OFFICE 2 Acoustical Suspended	Direct Rating	Degradation Factor
1016 WAREHSE(STG AIR GRD ORG UTS)	D30 HVAC	D3050 Terminal & Package Unit	Unit Heater Hot Water/Steam 24-47 MBH	Direct Rating	Degradation Factor
1016 WAREHSE(STG AIR GRD ORG UTS)	D40 Fire Protection	D4020 Standpipes	Upfeed	Direct Rating	Degradation Factor
1016 WAREHSE(STG AIR GRD ORG UTS)	C10 Interior Construction	C1020 Interior Doors	OFFICE 4 HALF GLASS Wood Personnel	Direct Rating	Degradation Factor

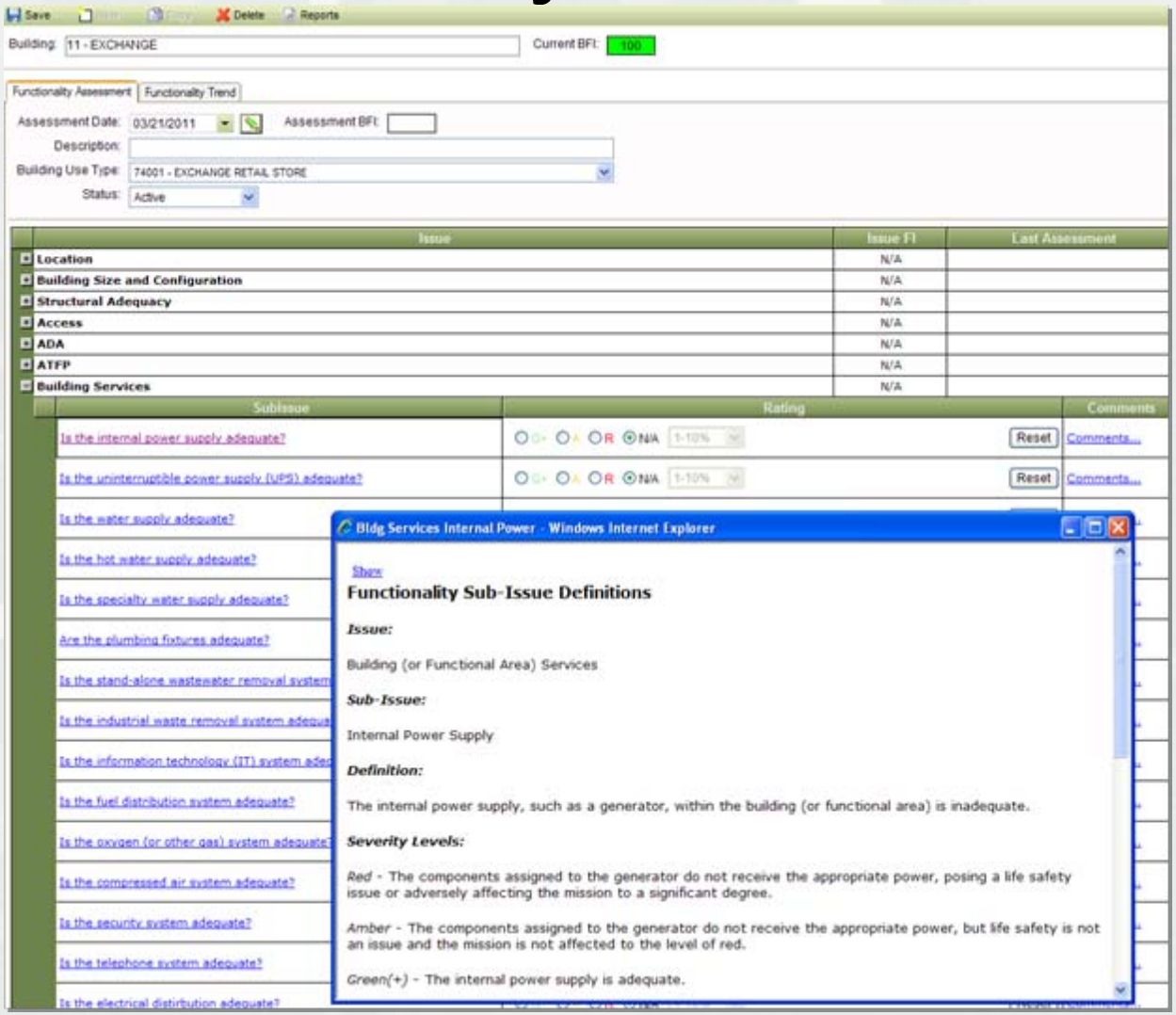
Inspection costs are ~25% of traditional, deficiency-based inspections

Functionality Assessment

- Modernization inspection addresses issues of:
  - Capacity (too little or too much)
  - Configuration
  - Change in user requirements
  - Technical obsolescence
  - Regulatory/code compliance
  - Etc.
- Available at building, space, and component levels
- Can simulate mission change to determine investment requirements for future occupants

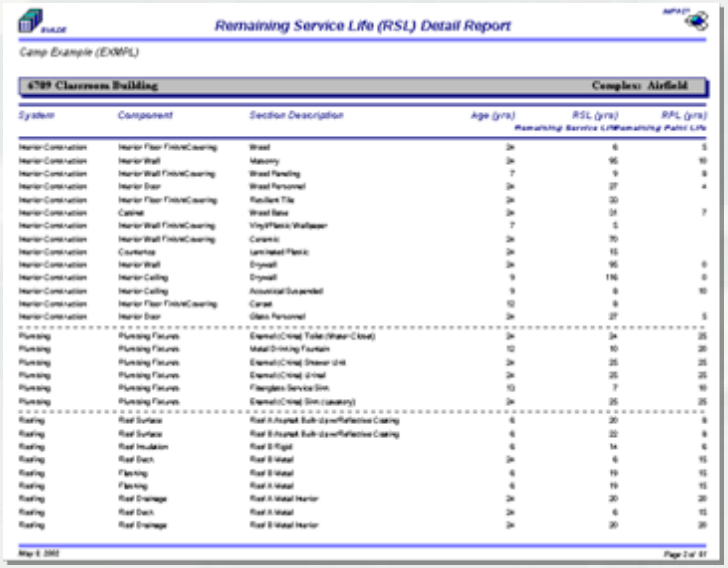
Issue	Issue FI	Last Assessment
Location	100	02/21/2007
Building Size and Configuration	100	02/21/2007
Structural Adequacy	100	02/21/2007
Access	100	02/21/2007
ADA	100	02/21/2007
ATFP	100	02/21/2007
Building Services	100	02/21/2007
Comfort	100	02/21/2007
Efficiency and Obsolescence	100	02/21/2007
Environmental/Health	100	02/21/2007
Missing or Improper Components	100	02/21/2007
Aesthetics	100	02/21/2007
Maintainability	100	02/21/2007
Cultural Resources		

Functionality Assessment



Assessment Results

- Readiness Reporting (Condition, or Quality)
- Condition for **complete** inventory, not just problems
- Up-to-date scorecard that doesn't require constant data maintenance



Remaining Service Life (RSL) Detail Report

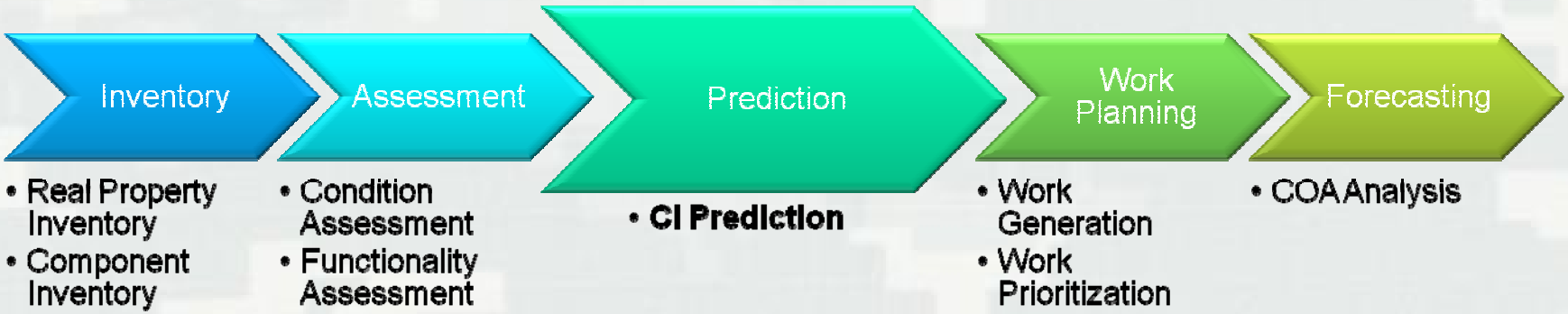
Camp Example (EXMPL)

6709 Classroom Building — Complex: Airfield

System	Component	Section Description	Age (yrs)	RSL (yrs)	RPL (yrs)
Interior Construction	Interior Floor Finish/Covering	Wood	24	6	6
Interior Construction	Interior Wall	Masonry	24	95	95
Interior Construction	Interior Wall Finish/Covering	Wood Paneling	7	9	9
Interior Construction	Interior Door	Wood Personnel	24	27	4
Interior Construction	Interior Floor Finish/Covering	Resilient Tile	24	30	
Interior Construction	Cabinet	Wood Base	24	31	7
Interior Construction	Interior Wall Finish/Covering	Vinyl/Plastic/Wallpaper	7	5	
Interior Construction	Interior Wall Finish/Covering	Ceramic	24	70	
Interior Construction	Countertop	Laminated Plastic	24	15	
Interior Construction	Interior Wall	Drywall	24	95	0
Interior Construction	Interior Ceiling	Drywall	9	176	0
Interior Construction	Interior Ceiling	Acoustical Suspended	9	9	10
Interior Construction	Interior Floor Finish/Covering	Carpet	10	9	
Interior Construction	Interior Door	Glass Personnel	24	27	3
Plumbing	Plumbing Fixtures	Enamel(C/I/Ha) Toilet (Water Closet)	24	24	25
Plumbing	Plumbing Fixtures	Metal D/I/Ha Fountain	12	10	20
Plumbing	Plumbing Fixtures	Enamel(C/I/Ha) Shower Unit	24	25	25
Plumbing	Plumbing Fixtures	Enamel(C/I/Ha) Urinal	24	25	25
Plumbing	Plumbing Fixtures	Fiberglass Service Sink	13	7	10
Plumbing	Plumbing Fixtures	Enamel(C/I/Ha) Sink (Lavatory)	24	25	25
Roofing	Roof Surface	Roof A/Asphalt Built-Up w/Reflective Coating	6	20	6
Roofing	Roof Surface	Roof B/Asphalt Built-Up w/Reflective Coating	6	22	6
Roofing	Roof Insulation	Roof B/Rigid	6	14	6
Roofing	Roof Deck	Roof B/Metal	24	6	15
Roofing	Flashing	Roof B/Metal	6	19	15
Roofing	Flashing	Roof A/Metal	6	19	15
Roofing	Roof Drainage	Roof A/Metal Horizontal	24	20	20
Roofing	Roof Deck	Roof A/Metal	24	6	15
Roofing	Roof Drainage	Roof B/Metal Horizontal	24	20	20

Bldg Num	Construction Year	B10 Supers	B20 Exteri	B30 Roofin	C30 Interio	D20 Plumb	D30 HVAC	D40 Fire	D50 Electri
5110	1998	97	98	98	85	90	94	93	100
5120	1998	100	100	98	86	80	94	92	100
5210	2000	100	100	88	87	98	94	100	100
5300	1999	100	100	100	80	95	94	100	100
5310	1998	94	87	98	84	81	94	100	100
5410	2000	94	88	99	77	82	94	100	100
5420	1998	94	89	95	83	87	93	100	99
5538	1973	94	94	87	71	88	87		100
5696	1989	93	85	67	69	85	93	99	100
5710	1998	100	100	88	76	91	94	100	100
4325	1956	94	94	89	90	88	93	77	94
4312	1954	94	93	98	91	88	94	86	92
21134A	2000	87	94	83	92	90	95		92
7224	1953	94	94	56	100	83	89	100	100
6275	1945	95	93	82	52	93	93		100
7117	1998	95	94	29	90	85	87	100	100
1686	1986	94	94	96	74		93		94
17604	1999	95	94	100	91		85		91
6655	1982	88	89	100	76	88	94		100
7136	1998	100	100	100	54		86		99
7137	1998	100	99	100	45		94		100
9118	1977	27	27	100	27				17

Process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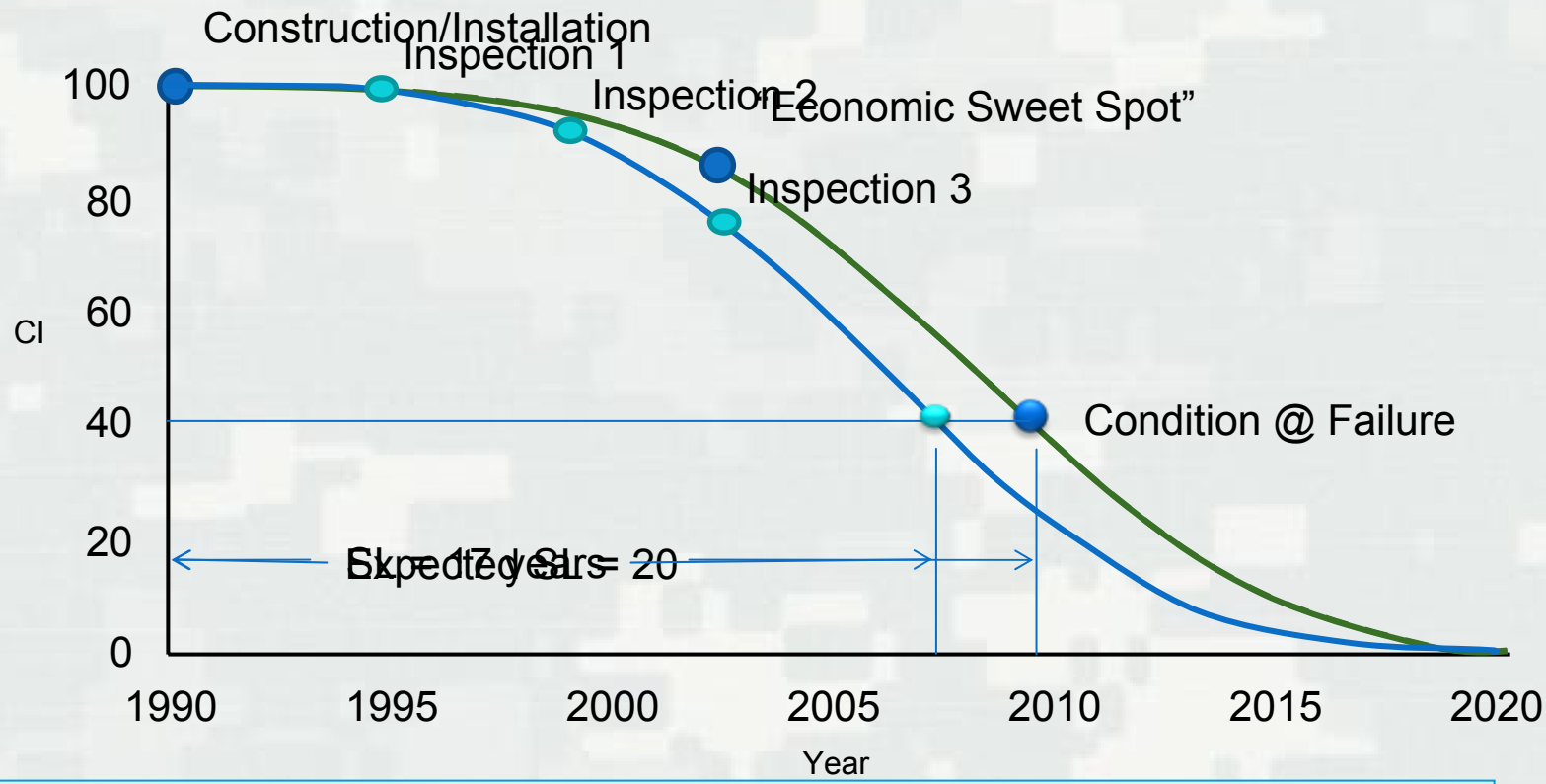
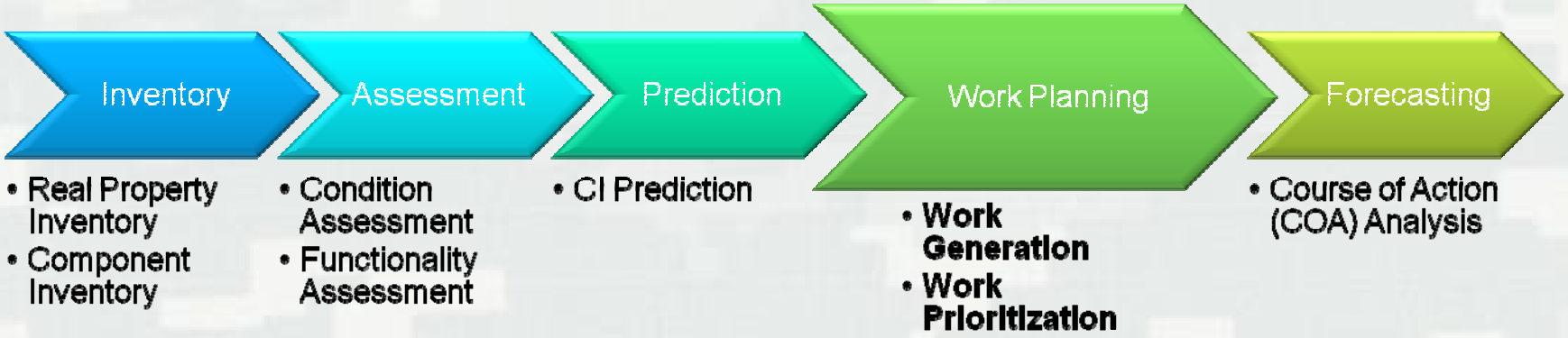
Condition Prediction



Weibull distribution used to model risk of component failure

Process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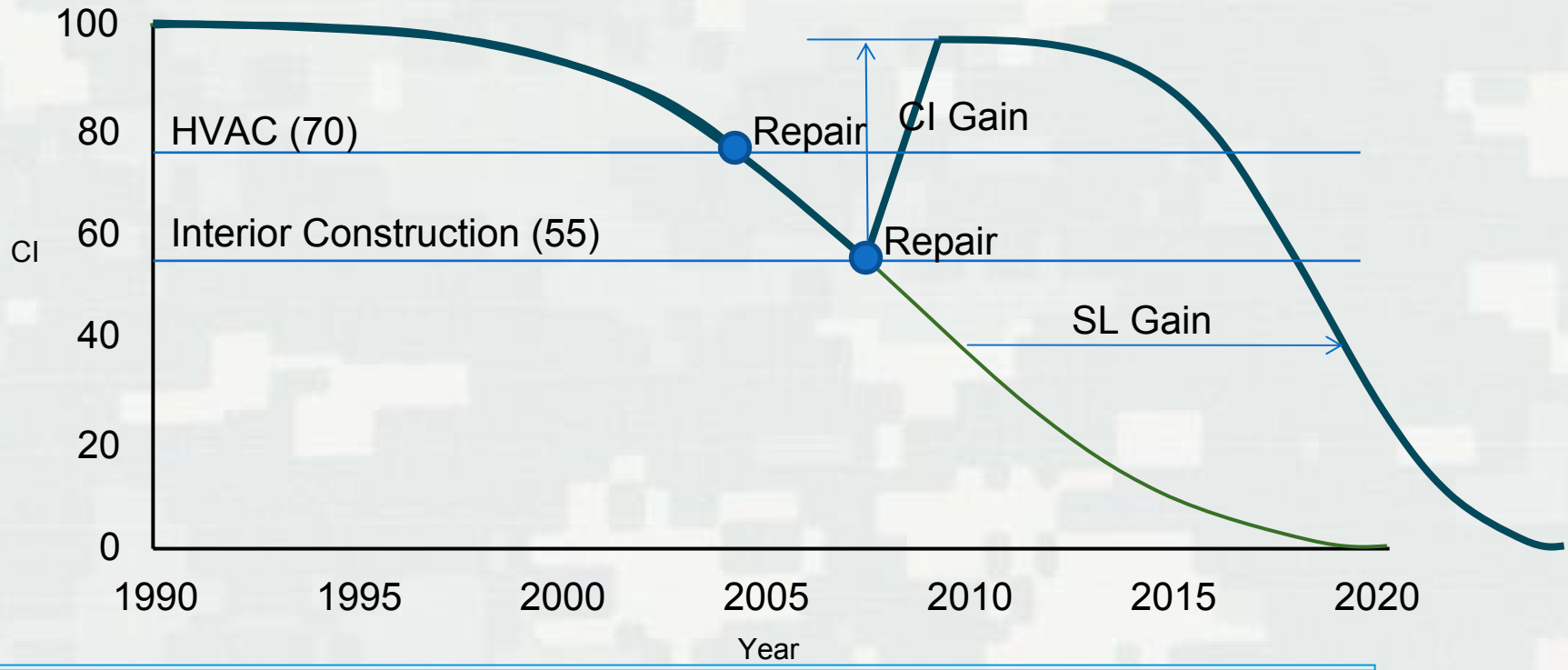
Work Generation

- Work is automatically created based upon rules
  - Standards define acceptable levels of risk as thresholds to trigger work
  - Policies apply these differing risk levels to different assets
  - Mission critical assets require higher condition levels
- Cost estimates are automatically calculated based on replacement costs
  - Repair vs. Replace calculations automatically performed to maximize ROI
- Work is tied to specific assets; establishes traceability and accountability.

Defensible rules enforce **consistent** investment policies across the enterprise.

Investment Triggers



Work requirements are **automatically generated** when condition falls below enterprise policy levels.

Work Prioritization

- Funding resources are always constrained
  - Need prioritization to rank work requirements
- Use various parameters including economic, criticality, and geographic factors
- Focus work efforts on items most critical to mission accomplishment while reducing lifecycle costs.

Enterprise-defined prioritization allows organization to **optimize** multiple **competing requirements** for scarce funding.

FCI Calculation

BUILDER-derived value is more consistent and repeatable than deficiency-based methods

- Work is now generated using objective ratings *AND* an defensible set of enterprise policies, rather than subjective judgment

FCI computation is based upon objective assessment methods and consistent work rules.

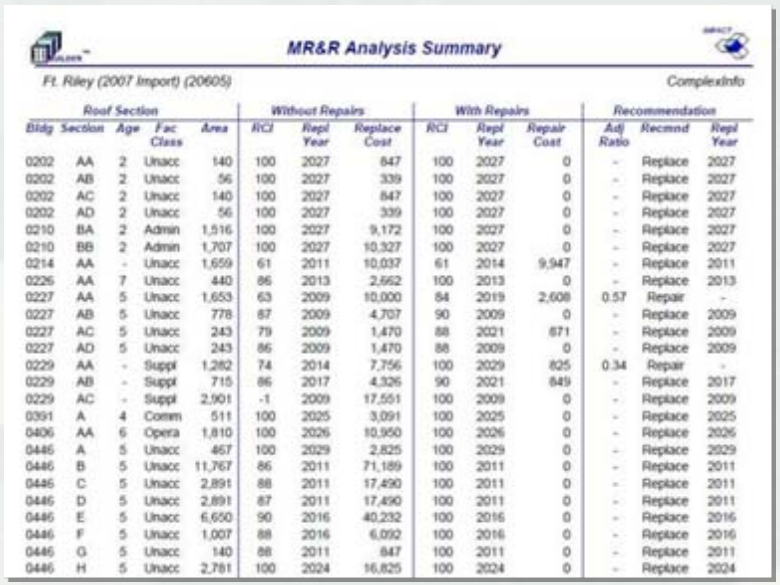
Work Planning Results

- Annual work planning attached to specific assets (accountability and traceability)
- Work planning prioritized by mission requirements to direct scarce dollars against mission-critical needs (Mission-Focused Facility Investments)

Work Items by Building Report

Twenty-nine Palms MCAGCC (MBT389)

1024 RETAIL EXCHANGE



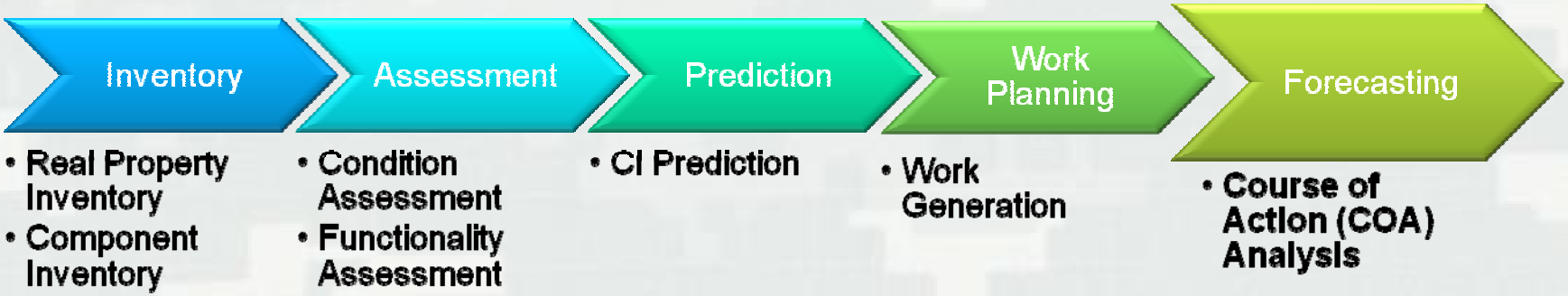
MR&R Analysis Summary

Ft. Riley (2007 Import) (20605)

ComplexInfo

Roof Section					Without Repairs			With Repairs			Recommendation		
Bldg	Section	Age	Fac Class	Area	RCI	Repl Year	Replace Cost	RCI	Repl Year	Repair Cost	Adj Ratio	Recmnd	Repl Year
0202	AA	2	Unacc	140	100	2027	847	100	2027	0	-	Replace	2027
0202	AB	2	Unacc	56	100	2027	339	100	2027	0	-	Replace	2027
0202	AC	2	Unacc	140	100	2027	847	100	2027	0	-	Replace	2027
0202	AD	2	Unacc	56	100	2027	339	100	2027	0	-	Replace	2027
0210	BA	2	Admin	1,516	100	2027	9,172	100	2027	0	-	Replace	2027
0210	BB	2	Admin	1,707	100	2027	10,327	100	2027	0	-	Replace	2027
0214	AA	-	Unacc	1,659	61	2011	10,037	61	2014	9,947	-	Replace	2011
0226	AA	7	Unacc	440	86	2013	2,662	100	2013	0	-	Replace	2013
0227	AA	5	Unacc	1,653	63	2009	10,000	84	2019	2,608	0.57	Repair	-
0227	AB	5	Unacc	778	67	2009	4,707	90	2009	0	-	Replace	2009
0227	AC	5	Unacc	243	79	2009	1,470	88	2021	671	-	Replace	2009
0227	AD	5	Unacc	243	86	2009	1,470	88	2009	0	-	Replace	2009
0229	AA	-	Suppl	1,282	74	2014	7,756	100	2029	825	0.34	Repair	-
0229	AB	-	Suppl	715	86	2017	4,326	90	2021	849	-	Replace	2017
0229	AC	-	Suppl	2,901	-1	2009	17,551	100	2009	0	-	Replace	2009
0391	A	4	Comm	511	100	2025	3,091	100	2025	0	-	Replace	2025
0406	AA	6	Opera	1,810	100	2026	10,950	100	2026	0	-	Replace	2026
0446	A	5	Unacc	467	100	2029	2,825	100	2029	0	-	Replace	2029
0446	B	5	Unacc	11,767	86	2011	71,189	100	2011	0	-	Replace	2011
0446	C	5	Unacc	2,891	88	2011	17,490	100	2011	0	-	Replace	2011
0446	D	5	Unacc	2,891	87	2011	17,490	100	2011	0	-	Replace	2011
0446	E	5	Unacc	6,650	90	2016	40,232	100	2016	0	-	Replace	2016
0446	F	5	Unacc	1,007	88	2016	6,092	100	2016	0	-	Replace	2016
0446	G	5	Unacc	140	88	2011	847	100	2011	0	-	Replace	2011
0446	H	5	Unacc	2,781	100	2024	16,825	100	2024	0	-	Replace	2024

Process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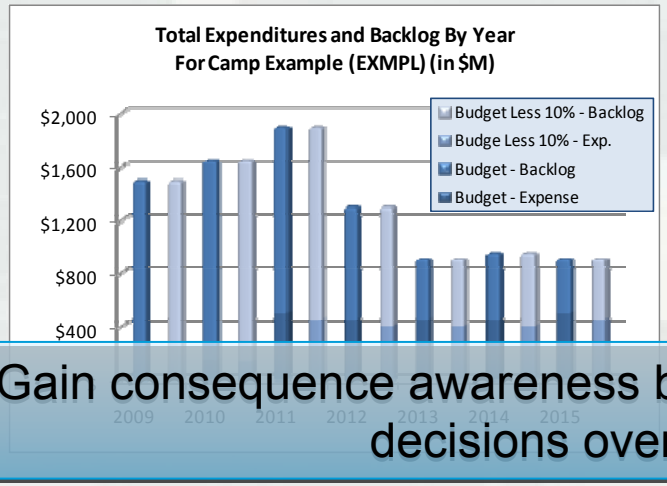
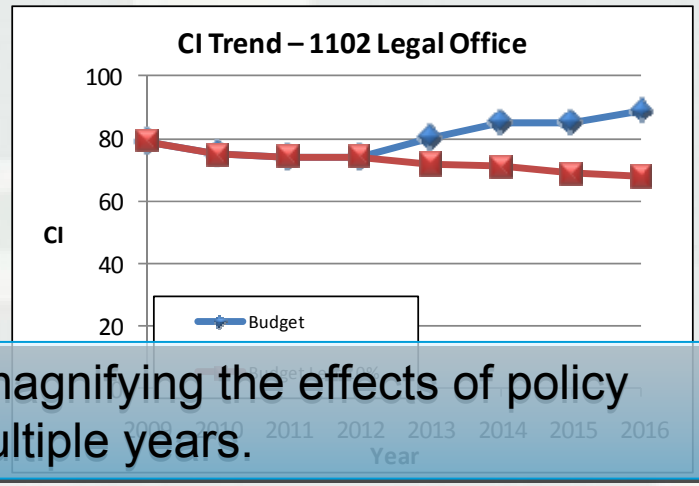
Forecasting

Same process as annual work planning, but repeated for multiple years over known inventory, behavior, policies, and funding.

- Simulate the long-term impact on condition, performance, and estimated backlog
- Evaluate different scenarios (budgets, policies, prioritization schemes, etc.)





Gain consequence awareness by magnifying the effects of policy decisions over multiple years.

Forecasting Results

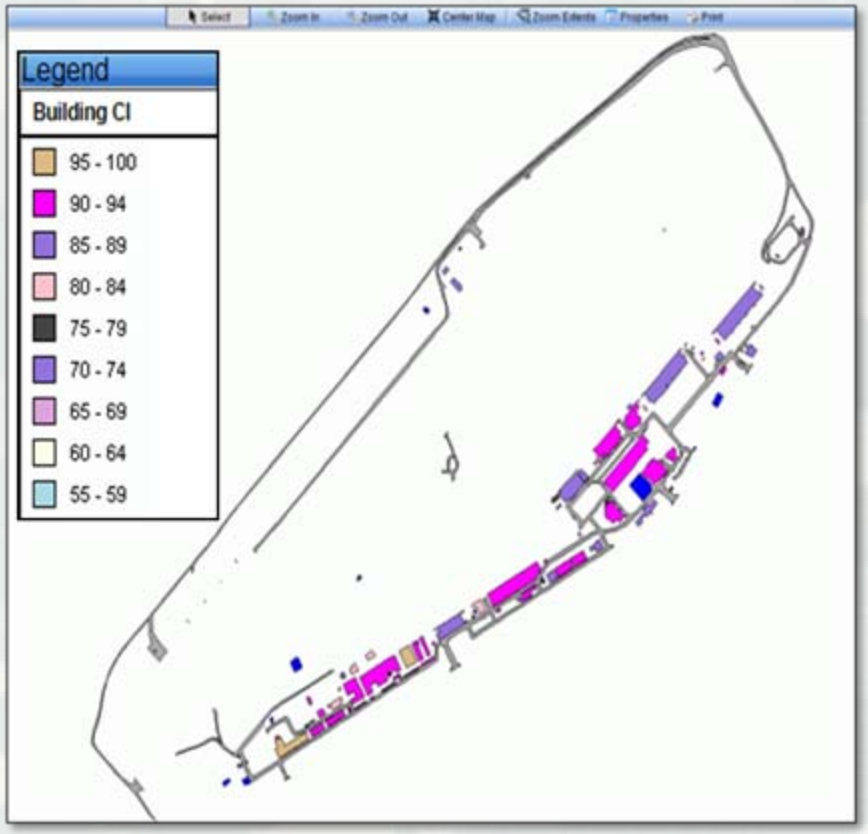
- Budget Creation
- COA Analysis
- Budget Defense
- Out-year strategic condition trends
  - Will levels meet current or future mission requirements?

Actionable intelligence built from the installation up

INTEGRATION & VISUALIZATION

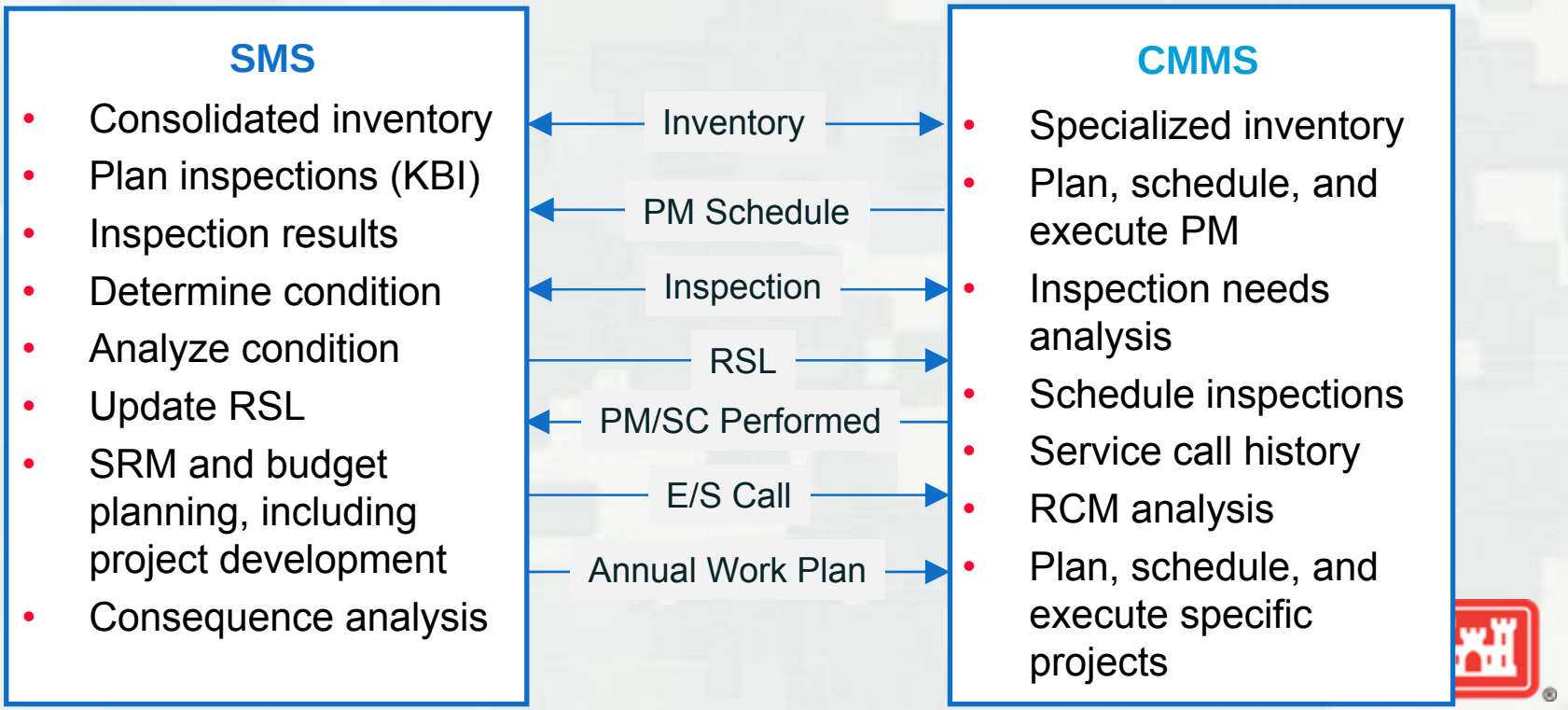
GIS

- Contains integrated or connected GIS solutions to query and display a variety of facility inventory, condition, and work planning information
  - CI,
  - RSL,
  - Work Costs,
  - and many more



CMMS Integration

- Work Planning and Work Execution have complementary roles



IMPLEMENTATION

SMS Applications

	BUILDER for all Building Components
	PAVER for Airfields and Roads
	RAILER for Track
	ROOFER for Roofing

Programs are also available to private sector users through multiple licensing partners

- Increases availability of services to Federal Users
- Lowers support costs through increased availability and broader user base

DoD Users

BUILDER
- Army*, Air Force*, Navy, USMC, DLA

PAVER
- Army, Air Force, Navy, USMC
- OSD – 2012 Implementation Deadline

RAILER
- Army, Navy, USMC
- OSD – 2012 Implementation Deadline

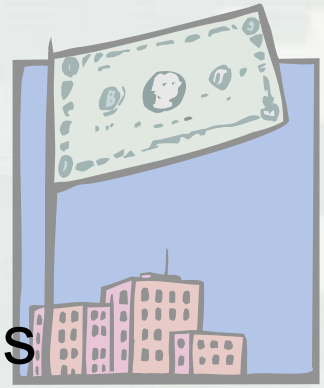
ROOFER
- Army, Air Force (Limited Deployment), Navy (Regional Deployment), USMC (Limited Deployment)

* Denotes trial or pilot use, but not yet an enterprise standard

THE RESULTS

Defensible, engineering-based investment plan

- ✓ Traceable and executable to the facility component level
  - Component-based performance models work with any size portfolio
- ✓ Aligned with mission requirements
- ✓ Balances mission and economic priorities
- ✓ Provides course of action analysis
  - Avoidance of long-term penalties
  - Awareness of the consequences of today's decisions



Manage by **leading** instead of **lagging** indicators

Summary Discussion

QUESTIONS?

More Information

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http://sms.cecer.army.mil

- SMS Resources

http://www.erdc.usace.army.mil

- Installation Operations (more products and expertise from the Engineer Research & Development Center)

BACKUP SLIDES

Condition Assessment Input