Navigation/Coastal Structure Asset Management

Overview and Status

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US Army Corps of Engineers
BUILDING STRONG®

CORNERSTONE OF THE SOUTHWEST!

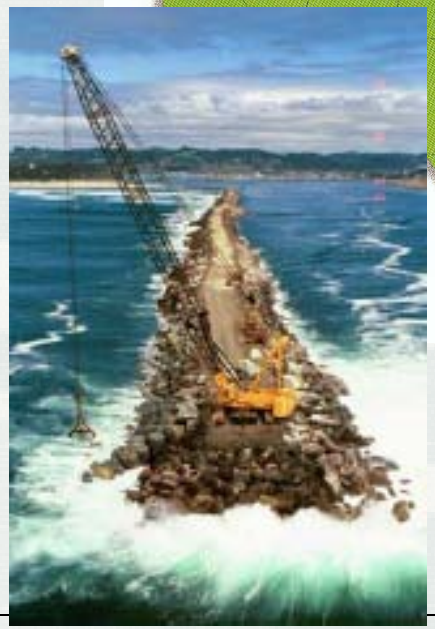
Corps Navigation Mission

Provide safe, reliable, efficient, effective and environmentally sustainable waterborne transportation systems for movement of commerce, national security needs, and recreation.

USACE Navigation Assets

INLAND NAVIGATION
- 27 Inland River Systems
- 207 lock chambers @ 171 lock sites
- 12,000 miles of inland river channels

COASTAL NAVIGATION
- 1067 Navigation Projects
- 19 lock chambers
- 13,000 miles of channels
- 929 navigation structures
- 844 bridges



FY13 O&M Budget
Coastal Navigation

Category	Inventory	Commerce	FY13 O&M Projects	FY13 O&M Funds	FY12 O&M Proj.	FY12 O&M Funds
High Use	59	90%	56	66%	54	62%
Moderate Use	100	9%	52	19%	61	25%
Low Use	908	1%	63	5%	41	6%
Other				10%		7%
Total	1067	100%	171	100%	156	100%

- Prior to FY12 we adjusted to budget decreases by minor reductions at almost all nav projects.
- The low use category was proposed as a program for 50% reduction in the FY12 budget development; This was a 50% dollar reduction, not a 50% projects reduction
- 'Other' includes Nav R&D, Project Condition Surveys, Remaining Items, etc.

Asset Management is a New Way of Doing Business

- What is AM today?
  - Discipline business approach
  - Or, a consistent way to manage our stuff
- What is new about AM?
  - “holistic integration”
  - Or, taking a corporate view and approach

What is USACE AM Vision

"A ***persistent catalyst*** for holistically integrating and enhancing the sustainment, restoration, modernization, and disposition of USACE water resources to continually serve the Nation."

USACE Asset Management

Inventory (what you own)

Indentify Condition (what kind of shape is it in, is it functioning)

Asset Management Strategy (min risk, max return)

Coastal Navigation Structures (CNS) Asset Management

The Challenge:

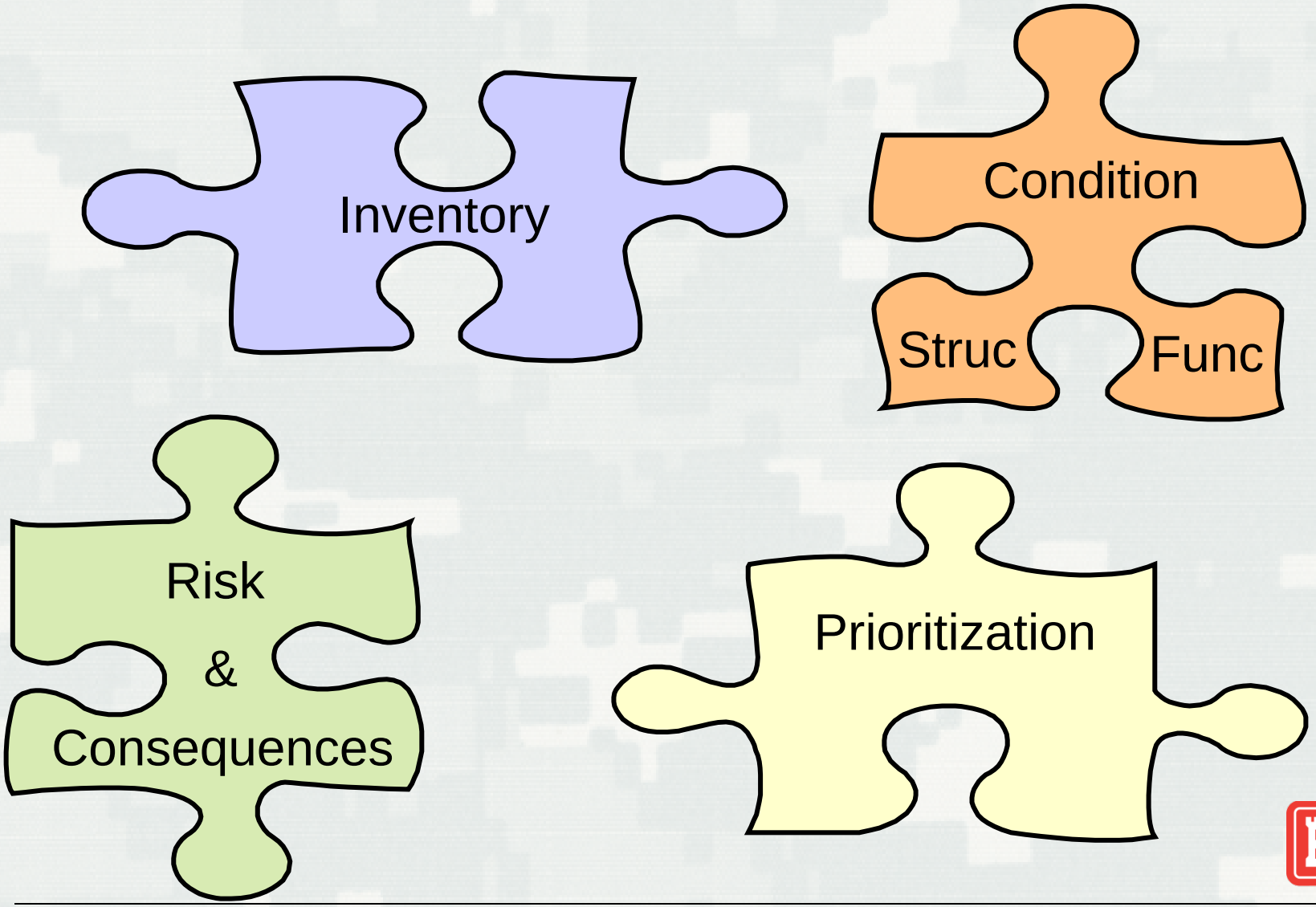
- CNS portfolio: approximately 1070 structures, such as breakwaters and jetties.
- Most structures over 50 years old (some >100 yrs)
- Districts using inconsistent methodologies to prioritize and fund repairs
- Getting the best value or reduction in risk (i.e. risk-informed) for the dollars invested

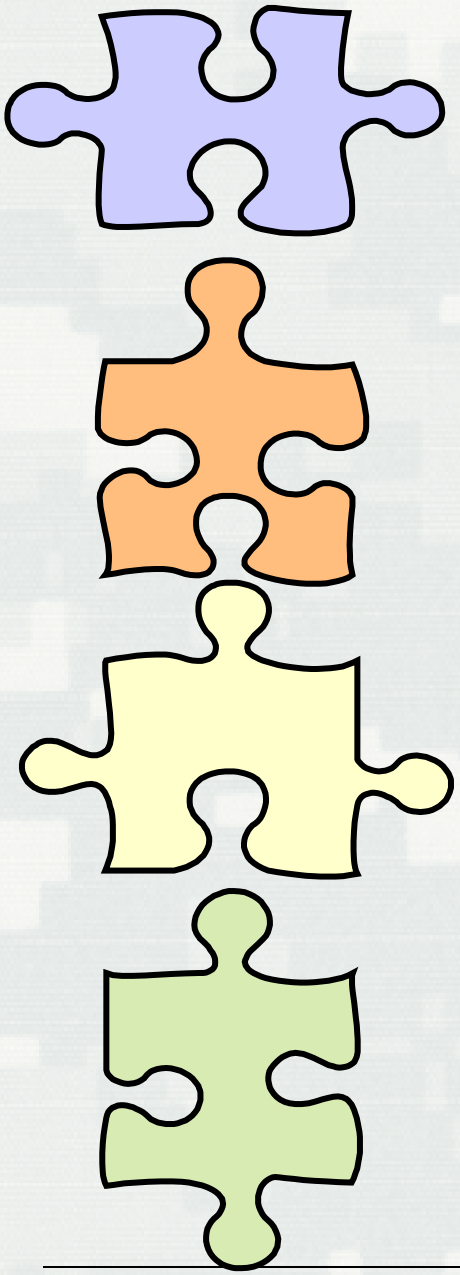
CNS Asset Management

What do we need to do -

Develop a rational, ***consistent, transparent*** *and* ***repeatable*** *method for assessing condition and risk for coastal navigation structures.*

Where are we now ???





Inventory

Condition
Structural
&
Functional

Risk
&
Consequences

Prioritization

ECID
FEMS

COSCA

CSMART

CAMS

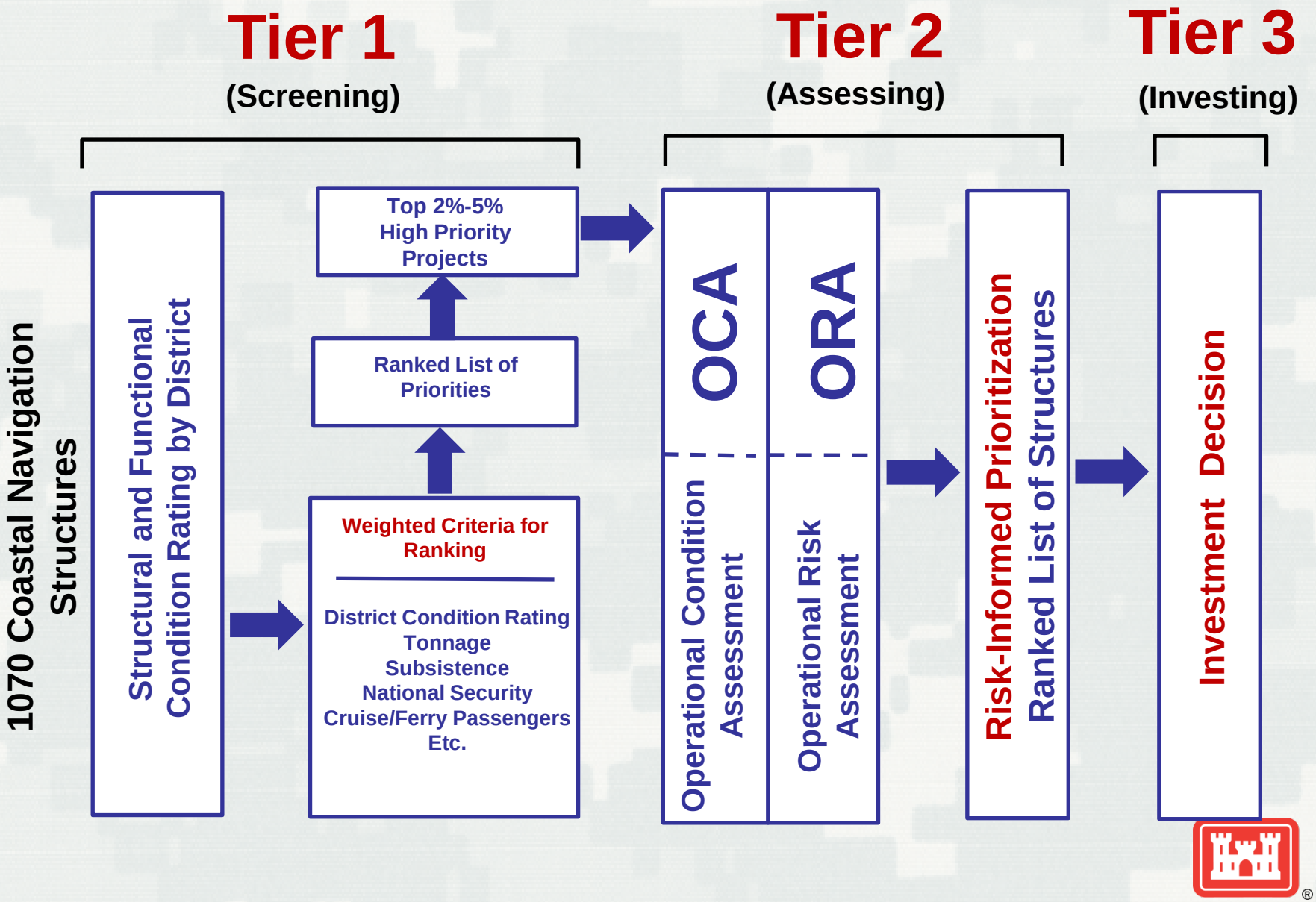
Greatest Challenge is coupling Structural Integrity with Functionality for Complete Condition Assessment

Establish Simple Relationships Between Structure Condition, Function, and Economic Consequences

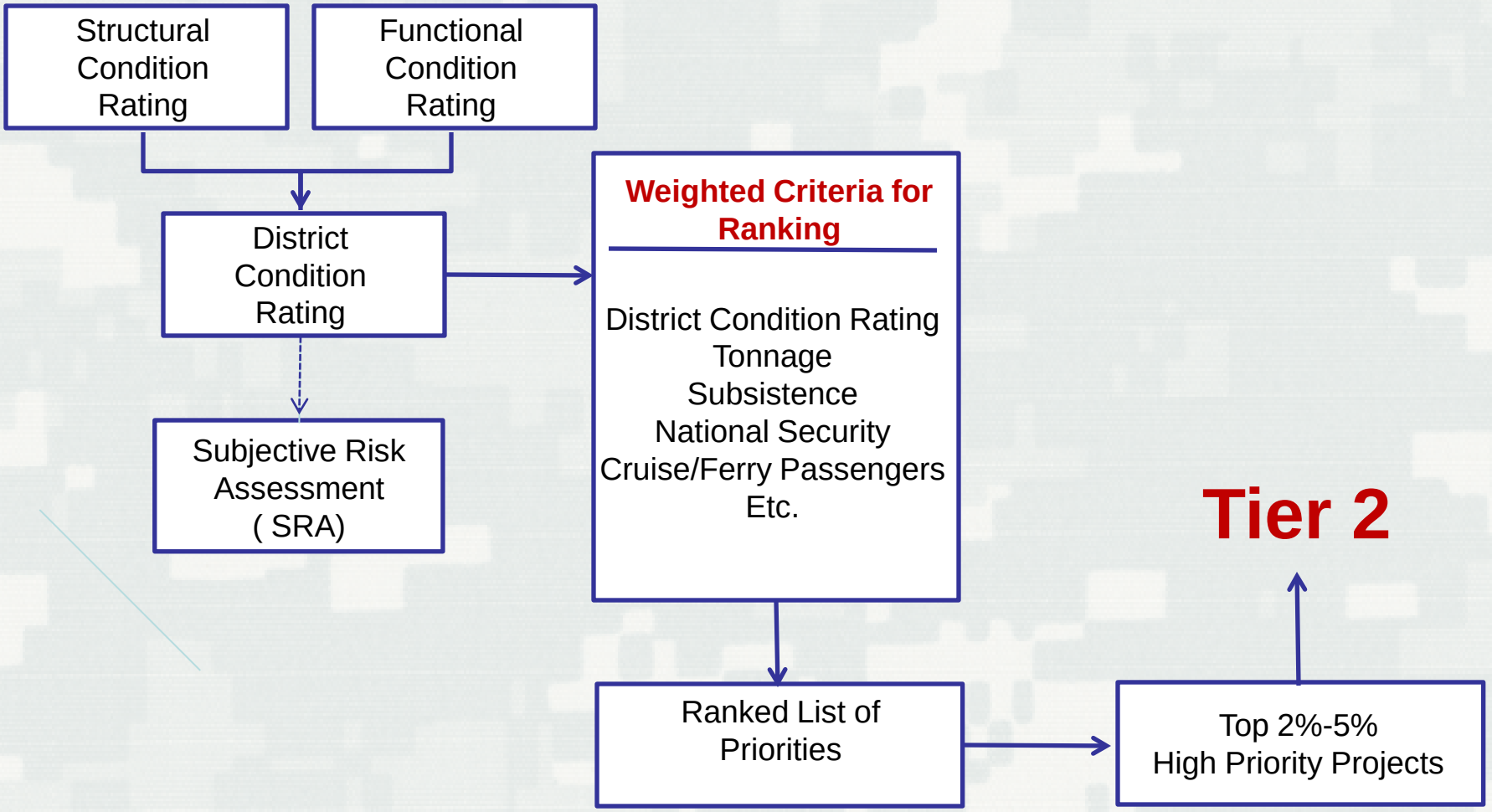
- Established transportation cost savings as a function of water depth at all GL commercial harbors/channels, also know cost to shippers associated with delays
- Relationship between crest height/structure cross section & structure function (wave attenuation)
- Relationship between wave climate and vessel loading (?), delays to vessel movements in a harbor, damages to moored vessels
- Relationship between structure condition and harbor shoaling(?)

➢ Can function and consequences be modeled, applied consistently, and generalized in meaningful ways to allow application on the scale required for asset management?

CNS Asset Management



Tier 1 – CNS AM


Structural Condition Rating
Functional Condition Rating
District Condition Rating
Subjective Risk Assessment (SRA)
Weighted Criteria for Ranking
District Condition Rating
Tonnage
Subsistence
National Security
Cruise/Ferry Passengers
Etc.
Ranked List of Priorities
Top 2%-5% High Priority Projects
Tier 2

CNS AM Tier 1

- Screening Level Process
- Full Tier 1 includes both District Condition Rating (DCR) and CSMART
- FY14 Budget Process employs 2 methodologies to prioritize CNS's for different purposes.
    1. Partial Tier 1 - District Budget Process which supports OFA submittal will combine DCR with a tabular ranking of Consequences / Impacts to determined 1-25 Navigation Relative Risk Ranking.
    2. Full Tier 1 – HQ AM will use the results DCR and CSMART to identify candidates for and fund Tier 2 OCA/ORA efforts.
- Districts are required to use Tier 1 DCA Tool to enter Ratings and supporting information (in addition to Budget EC spreadsheet)

District Budget Process

Tier 1 Structural Condition Rating (FY14 Budget EC Table F-9)

Damage Condition levels	CNS Structural Condition Rating (SCR) Table
Insignificant damage or defects – A	1. There is no evidence that the structure has a critical design flaw or has been significantly damaged. Only small areas of the structure show signs of deterioration, which is considered to be insignificant. 2. Loss or deterioration of any material composing the structure is limited to very few units. 3. There is no change in the geometry of the structure. There are no apparent areas of settlement or displacements of the structure's alignment and slopes. The head, the root, and any corner or spurs of the structure show no change. 4. There is no exposure of any other critical material or elements of the structure. 5. The foundation of the structure is sound and there is no evidence of scour or loss of supporting substrate around the base of the structure.
Minor damage or defects - B	2. Deterioration is visible but the structure appears to be sound and repairs are not indicated. Minor deterioration is noted over small areas of the structure. 2. In deteriorated areas, less than approximately 10% of the of any material composing the structure shows signs of deterioration, and less than approximately 20% of any type of the material composing the structure has been lost. 3. The geometry of the structure shows limited change. The crest elevation may have been reduced by less than 10% of the structure's above MLLW profile, and the crest width may have slightly decreased. Minor displacement of the structure's alignment and side slopes is evident. The head root, and corners or spurs of the structure show no more change than other sections of the structure. 4. The noted deterioration does not expose any other critical materials composing the structure. 5. Foundations components are sound but slight scour may exist near the toe of the structure.
Moderated damage or defects– C	3. The structure is showing deterioration that may require repair in the near future. 2. Moderate deterioration of materials is noted over many areas of the structure. A moderate amount (10-20%) of material's composing the structure shows signs of deterioration, and a moderate amount (10 - 20%) of any material composing the structure has been lost. 3. The geometry of the structure is showing significant change in some areas. The structure's cross section is losing crest elevation and/ or crest width. Some areas of the structure may have settled, collapsed, or eroded to an extent that other portions of the structure are exposed or left unsupported. In the damaged area, the above MLLW cross sectional profile may be reduced by 20 to 50%. The crest width may reduce up to 1/3 of its original width at the elevation of the original crest, but repairs would be possible by replacing a few armor units. A moderate amount of displacement in the structure's alignment and slopes is present (often as a result of lost or slumping material on one side of the structure causing the centerline of the structure to shift or due to units sliding down the side slopes). Bridging of armor stones may also be occurring. The extent of these displacements renders the structures stability to be vulnerable. The head(s) may have receded by 10-20 % of its original length. The root is still firmly attached to the shore, but scour or flanking may exist at the trailing end of the structure. Corners or spurs of the structure may have slightly greater damage than the rest of the structure. 4. In the deteriorated regions, minor amounts of other critical materials composing the structure are now exposed but there is no evidence of the exposed material being lost or damaged. 5. Foundation components of the structure may be starting to show deterioration by changing in shape or movement of the base material or by corrosion. Evidence of scour at the toe of the structure or under the structure is present.
Seriously Degraded - D	4. An extensive portion of the structure has deteriorated to a condition that repairs are indicated. 2. Deterioration of materials is noted over a significant area of the structure. A significant amount (20-40%) of materials composing the structure shows signs of deterioration, and a significant amount (20-40%) of any material composing the structure has been lost. 3. The geometry of the structure is significantly changed. The above MLLW cross-section profile may have been reduced to ~50% of its original above MLLW profile. Some area of the structure have settled, collapsed or eroded to an extent that, in the damaged area, no portion of the crest is still located at the original elevation and the resulting crest has lost 70% of the above MLLW crest elevation (crest elevation is at MLLW or a few feet above MLLW). A significant amount of displacement in the structure's alignment and slopes is present. Bridging of stones is likely. Sliding of the armor units may be present as well as displacement of the armor units. The head(s) has receded by 20-40% of its original length. The root is still attached but flanking of the tail occurs for about 1/3 the length of the trailing end. The extent of these displacements renders the structure unstable. 4. Deterioration exposes significant amount of other critical materials composing the structure and there is evidence that under layer material and substructure components are being damaged or lost. 5. The foundation could exhibit failure modes over short distances (100 ft) to include scour and erosion around the toe and under the structure, lost substrate material, major subsidence, reduced thicknesses or diameters by approximately 15% for support members, and buckling or failure of piles.
Completely Degraded – F	5. Denial or failure with extensive deterioration indicates impact is imminent for a major section of the structure. 2. More than 50% of materials composing the structure show signs of extreme deterioration, and more than 40% of any material composing the structure has been lost. 3. The geometry of the structure clearly shows that much of the structure is lost or severely damaged. Significant lengths (>300 ft) of the structure have settled, collapsed, or eroded to an extent that the expected crest elevation has been reduced to at or below the MLLW level. The structure appears to be a pile rather than an engineered structure. The structure may flex or structural material may be mobile under hydrodynamic forces. An extreme amount of displacement in the structure's alignment and slopes is present. The extent of the displacement renders the structure critically unstable. 4. The deterioration exposes significant amounts of other critical materials composing the structure, and there is evidence that under layer material and substructure components are being damaged or lost over long (>300ft) sections of the structure. 5. There is evidence that the underwater portions of the structure are severely degraded over long sections (>300 ft) of the structure. The foundation could exhibit failure modes over long distances (>300 ft) to include scour and erosion around the toe and under the structure, lost substrate material, major subsidence, reduced thicknesses or diameters by approximately 25% for support members, and buckling or failure of piles.

Tier 1 Functional Condition Rating (Table F-10)

Level of Functionality	CNS Functional Condition Rating (FCR) Table
Full – A	(1) Less than 10% of the time, design vessels cannot navigate or operate within authorized limits; (2) O&M dredging requirements in the Entrance and Bar Channel have not increased more than 10%, as compared to the long-term average annual rate.
Sufficient – B	(1) 10-20% of the time, design vessels cannot navigate or operate within authorized limits; (2) O&M dredging requirements in the Entrance and Bar Channel have increased more than 10-20%, as compared to the long-term average annual rate.
Reduced – C	(1) 20-40% of the time, design vessels cannot navigate or operate within authorized limits; (2) O&M dredging requirements in the Entrance and Bar Channel have increased more than 20-40%, as compared to the long-term average annual rate.
Severely Degraded – D	(1) 40-60% of the time, design vessels cannot navigate or operate within authorized limits; (2) O&M dredging requirements in the Entrance and Bar Channel have increased more than 40-60%, as compared to the long-term average annual rate.
Completely Degraded - F	(1)More than 60% of the time, design vessels cannot navigate or operate within authorized limits; (2) O&M dredging requirements in the Entrance and Bar Channel have increased more than 60%, as compared to the long-term average annual rate.
Notes:	1. Design vessels cannot navigate or operate for authorized reason(s) (includes but not limited to: waves, currents, shoaling, ice, safety, etc.) Local resources (Harbor master, USCG, etc.) may be contacted to support your estimates. 2. SCR attributed directly to long term structure degradation and not extremal events

Consequences / Economic Impact (Table F-12)

Coastal Navigation Structures Consequence/Economic Impact Category	
Consequence Category	Consequence Rating Criteria
I	1. Demonstrated highest economic impact[1] 2. Imminent life safety impact 3. Critical to safe navigation by commercial vessels at High Use Navigation Project (>10 million tons) 4. Critical to safe navigation at DoD Strategic Ports
II	1. Demonstrated High economic impact[1] 2. Probable life safety impact 3. Probable impacts to subsistence harbors/critical harbors of refuge. 4. High economic loss (5 - 10 million Tons) 5. Alternate modes of transportation exist for Energy Distribution Facilities, but at a higher cost than waterborne transportation
III	1. Demonstrated Moderate economic impact[1] 2. Possible life safety impact 3. Possible impacts to subsistence harbors/critical harbors of refuge. 4. Moderate economic loss (1 – 5 million Tons)
IV	1. Low economic impact[1]. 2. Little impacts to subsistence harbors/critical harbors of refuge. 3. Low economic impact (<1 million Tons) 4. No life safety impact
V	1. Negligible economic impact. No impacts to subsistence harbors/harbors of refuge. 2. Negligible economics (Recreation Harbors, No commercial Activity) 3. No life safety impact

[1] Thresholds and basis for economic impact are under development. One measure of economic impact can be demonstrated using rate savings benefit, transportation cost savings, or damages avoided. 2-17-2012

Tier 1 District Condition Rating (Table F-11)

5X5 Matrix for combining Structural Condition Rating (SCR) and Functional Condition Ratings (FCR) to select a resulting District Condition Rating (DCR) for application in the Tier 1 Approach for Asset Management Portfolio Condition Assessments

Functionality Condition Rating (FCR) \ Structural Condition Rating (SCR)	F	D	C	B	A
F	F	F	F	F	F
D	F	D	D	D	D
C	D	D	C	C	C
B	D	C	B	B	B
A	C	B	B	A	A

This table applies heavier weighting to the FCR value then to the SCR value in combining the two ratings to determine a combined value or District Combined Rating (DCR)
Thus valuing the function of navigation over the structural integrity of the structure. 2/17/2012

Navigation Relative Risk Matrix (Table F-3)

TABLE F-3 Navigation 1-25 Relative Risk Values Matrix

Consequence/Economic Impact \ Condition Classification	F Failed	D Inadequate	C Probably Inadequate	B Probably Adequate	A Adequate
I	1	2	4	7	11
II	3	5	8	12	16
III	6	9	13	17	20
IV	10	14	18	21	23
V	15	19	22	24	25

HQ AM Budget Process for CNS OCA/ORA Effort

Tier 1 Structural Condition Rating (Table F-9)

Damage Condition levels	CNS Structural Condition Rating (SCR) Table
Insignificant damage or defects - A	1. There is no evidence that the structure has a critical design flaw or has been significantly damaged. Only small areas of the structure show signs of deterioration, which is considered to be insignificant. 2. Loss or deterioration of any material composing the structure is limited to very few units. 3. There is no change in the geometry of the structure. There are no apparent areas of settlement or displacements of the structure's alignment and slopes. The head, the root, and any corner or spurs of the structure show no change. 4. There is no exposure of any other critical material or elements of the structure. 5. The foundation of the structure is sound and there is no evidence of scour or loss of supporting substrate around the base of the structure.
Minor damage or defects - B	1. Deterioration is visible but the structure appears to be sound and repairs are not indicated. Minor deterioration is noted over small areas of the structure. 2. In deteriorated areas, less than approximately 10% of the of any material composing the structure shows signs of deterioration, and less than approximately 10% of any type of the material composing the structure has been lost. 3. The geometry of the structure shows limited change. The crest elevation may have been reduced by less than 10% of the structure's above MLLW profile, and the crest width may have slightly decreased. Minor displacement of the structure's alignment and side slopes is evident. The head root, and corners or spurs of the structure show no more change than other sections of the structure. 4. The noted deterioration does not expose any other critical materials composing the structure. 5. Foundations components are sound but slight scour may exist near the toe of the structure.
Moderated damage or defects-- C	1. The structure is showing deterioration that may require repair in the near future. 2. Moderate deterioration of materials is noted over many areas of the structure. A moderate amount (10-20%) of materials composing the structure shows signs of deterioration, and a moderate amount (10 - 20%) of any material composing the structure has been lost. 3. The geometry of the structure is showing significant change in some areas. The structure's cross section is losing crest elevation and/ or crest width. Some areas of the structure may have settled, collapsed, or eroded to an extent that other portions of the structure are exposed or left unsupported. In the damaged area, the above MLLW cross sectional profile may be reduced by 20 to 50%. The crest width may reduce up to 1/3 of its original width at the elevation of the original crest, but repairs would be possible by replacing a few armor units. A moderate amount of displacement in the structure's alignment and slopes is present (often as a result of lost or slumping material on one side of the structure causing the centerline of the structure to shift or due to units sliding down the side slopes). Bridging of armor stones may also be occurring. The extent of these displacements renders the structures stability to be vulnerable. The head(s) may have receded by 10-20 % of its original length. The root is still firmly attached to the shore, but scour or flanking may exist at the trailing end of the structure. Corners or spurs of the structure may have slightly greater damage than the rest of the structure. 4. In the deteriorated regions, minor amounts of other critical materials composing the structure are now exposed but there is no evidence of the exposed material being lost or damaged. 5. Foundation components of the structure may be starting to show deterioration by changing in shape or movement of the base material or by corrosion. Evidence of scour at the toe of the structure or under the structure is present.
Seriously Degraded - - D	1. An extensive portion of the structure has deteriorated to a condition that repairs are indicated. 2. Deterioration of materials is noted over a significant area of the structure. a significant amount (20-40%) of materials composing the structure shows signs of deterioration, and a significant amount (20-40%) of any material composing the structure has been lost. 3. The geometry of the structure is significantly changed. The above MLLW cross-section profile may have been reduced to <50% of its original above MLLW profile. Some area of the structure have settled, collapsed or eroded to an extent that, in the damaged area, no portion of the crest is still located at the original elevation and the resulting crest has lost 70% of the above MLLW crest elevation (crest elevation is at MLLW or a few feet above MLLW). A significant amount of displacement in the structure's alignment and slopes is present. Bridging of stones is likely. Sliding of the armor units may be present as well as displacement of the armor units. The head(s) has receded by 20-40% of its original length. The root is still attached but flanking of the tail occurs for about 1/3 the length of the trailing end. The extent of these displacements renders the structure unstable. 4. Deterioration exposes significant amount of other critical materials composing the structure and there is evidence that under layer material and substructure components are being damaged or lost. 5. The foundation could exhibit failure modes over short distances (100 ft) to include scour and erosion around the toe and under the structure, lost substrate material, major subsidence, reduced thicknesses or diameters by approximately 15% for support members, and buckling or failure of piles.
Completely Degraded -- F	1. General failure with extensive deterioration indicates repair is needed for a major section of the structure. 2. More than 50% of materials composing the structure show signs of extreme deterioration, and more than 40% of any material composing the structure has been lost. 3. The geometry of the structure clearly shows that much of the structure is lost or severely damaged. Significant lengths (>300 ft) of the structure have settled, collapsed, or eroded to an extent that the expected crest elevation has been reduced to at or below the MLLW level. The structure appears to be a pile rather than an engineered structure. The structure may fail or structural material may be mobile under hydrodynamic forces. an extreme amount of displacement in the structure's alignment and slopes is present. The extent of the displacement renders the structure critically unstable. 4. The deterioration exposes significant amounts of other critical materials composing the structure, and there is evidence that under layer material and substructure components are being damaged or lost over long (>300ft) sections of the structure. 5. There is evidence that the underwater portions of the structure are severely degraded over long sections (>300 ft) of the structure. The foundation could exhibit failure modes over long distances (>300 ft) to include scour and erosion around the toe and under the structure, lost substrate material, major subsidence, reduced thicknesses or diameters by approximately 25% for support members, and buckling or failure of piles.

Tier 1 Functional Condition Rating (Table F-10)

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Reduced -- C	(1) 20-40% of the time, design vessels cannot navigate or operate within authorized limits; (2) O&M dredging requirements in the Entrance and Bar Channel have increased more than 20-40%, as compared to the long-term average annual rate.
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Completely Degraded - - F	(1)More than 60% of the time, design vessels cannot navigate or operate within authorized limits; (2) O&M dredging requirements in the Entrance and Bar Channel have increased more than 60%, as compared to the long-term average annual rate.
Notes:	1. Design vessels cannot navigate or operate for authorized reason(s) (includes but not limited to: waves, currents, shoaling, ice, safety, etc.) Local resources (Harbor master, USCG, etc.) may be contacted to support your estimates. 2. SCR attributed directly to long term structure degradation and not extremal events

Tier 1 District Condition Rating (This table is NOT shown in FY14 Budget EC)

5X5 Matrix for combining Structural Condition Rating (SCR) and Functional Condition Ratings (FCR) to select a resulting District Condition Rating (DCR) for application in the Tier 1 Approach for Asset Management Portfolio Condition Assessments

Functionality Condition Rating (FCR) \ Structural Condition Rating (SCR)	F	D	C	B	A
F	1	2	4	5	6
D	3	7	8	11	13
C	9	10	14	16	18
B	12	15	19	21	23
A	17	20	22	24	25

This table applies heavier weighting to the FCR value then to the SCR value in combining the two ratings to determine a combined value or District Combined Rating (DCR)
Thus valuing the function of navigation over the structural integrity of the structure. 1/30/2013

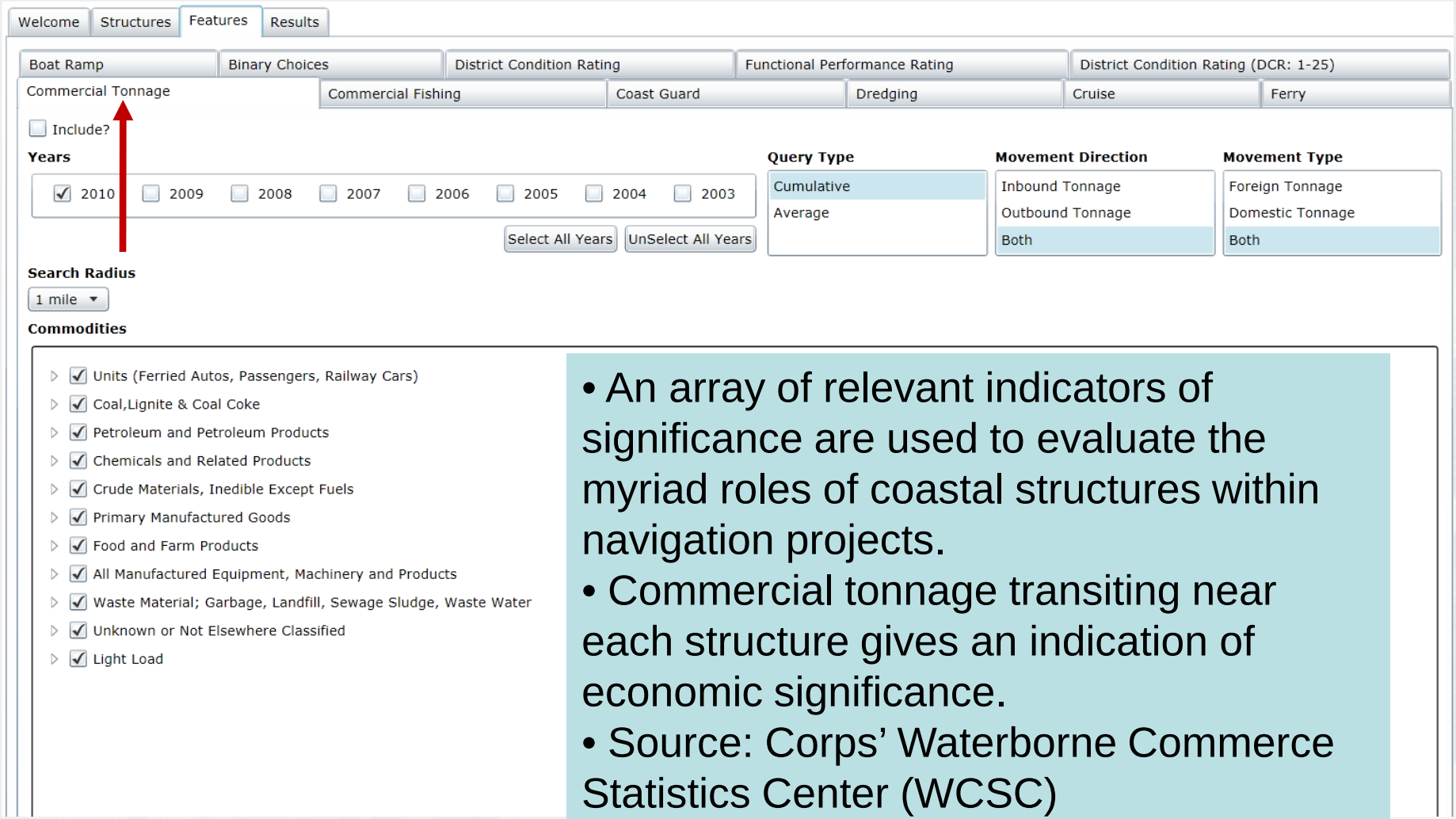
CSMART

CSMART

Coastal Structures Management, Analysis, and Ranking Tool

- Developed as part of the Coastal Inlets Research Program (CIRP)
- **Vision:** *Optimally prioritize O&M funding such* that benefits to the Nation are maximized and decisions can be defended.
  - For FY14 – Tool for HQ AM to prioritize CNS OCA's/ORA's only.
- Rank the CNS in terms of those with the greatest risk.
- Metrics in CSMART include (but are not limited to):
  - District Condition Rating (DCR)
  - Total annual commercial tonnage supported (NDC)
  - Annual commercial fish landings supported (NOAA-NMFS)
  - Cruise and ferry passengers supported (USDOT)
  - Coast Guard Incident reports
  - Project classifications such as Harbor of Refuge and Subsistence Harbor.
- ERDC Technical Note: http://chl.erdc.usace.army.mil/library/publications/chetn/pdf/chetn-iii-80.pdf.

CSMART Features



- An array of relevant indicators of significance are used to evaluate the myriad roles of coastal structures within navigation projects.
- Commercial tonnage transiting near each structure gives an indication of economic significance.
- Source: Corps' Waterborne Commerce Statistics Center (WCSC)

CSMART Rankings

Commercial Tonnage | Commercial Fishing | District Condition Rating (DCR: 1-25) | Global Rankings

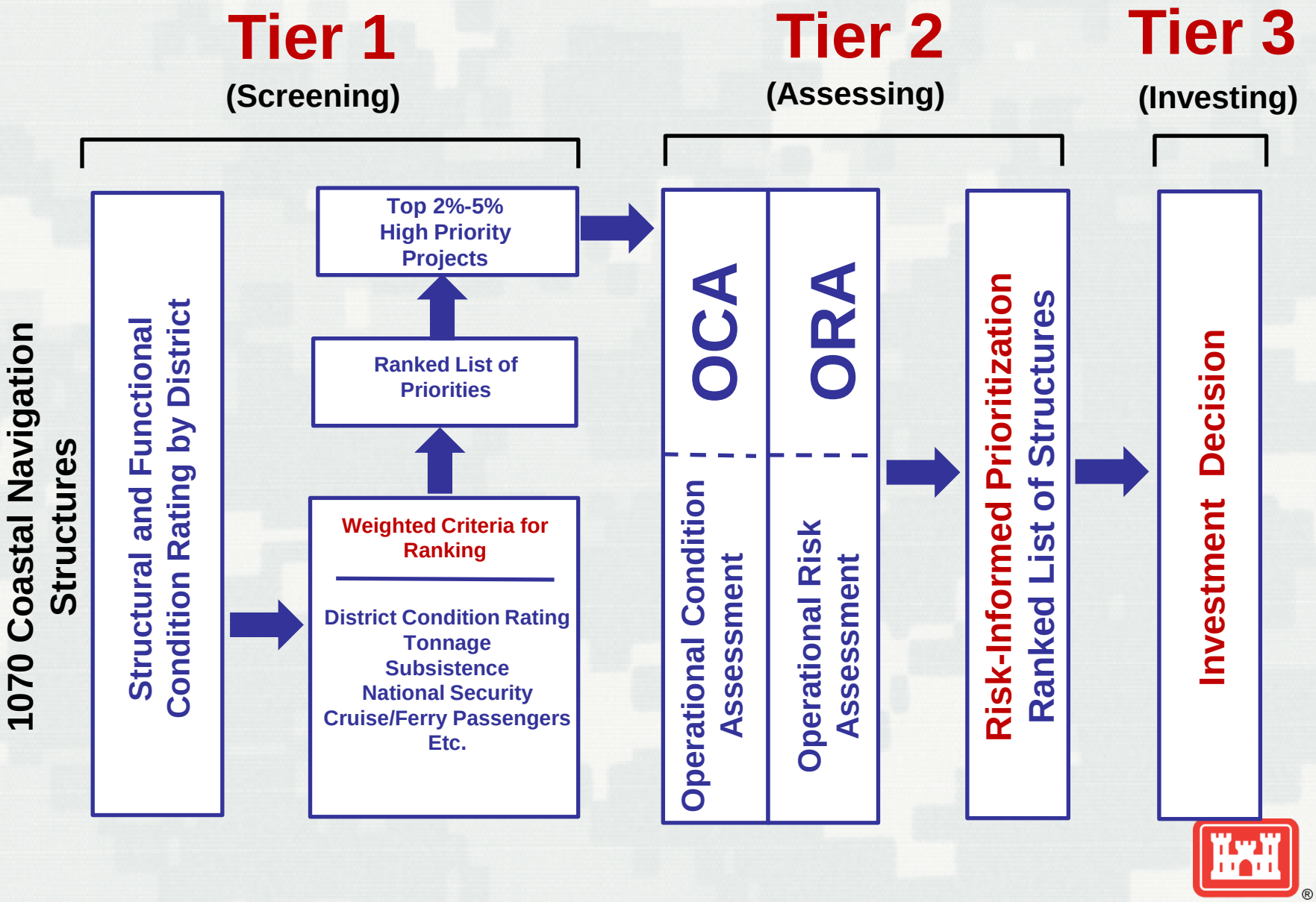
Metrics

Weightings and Ranking Methods

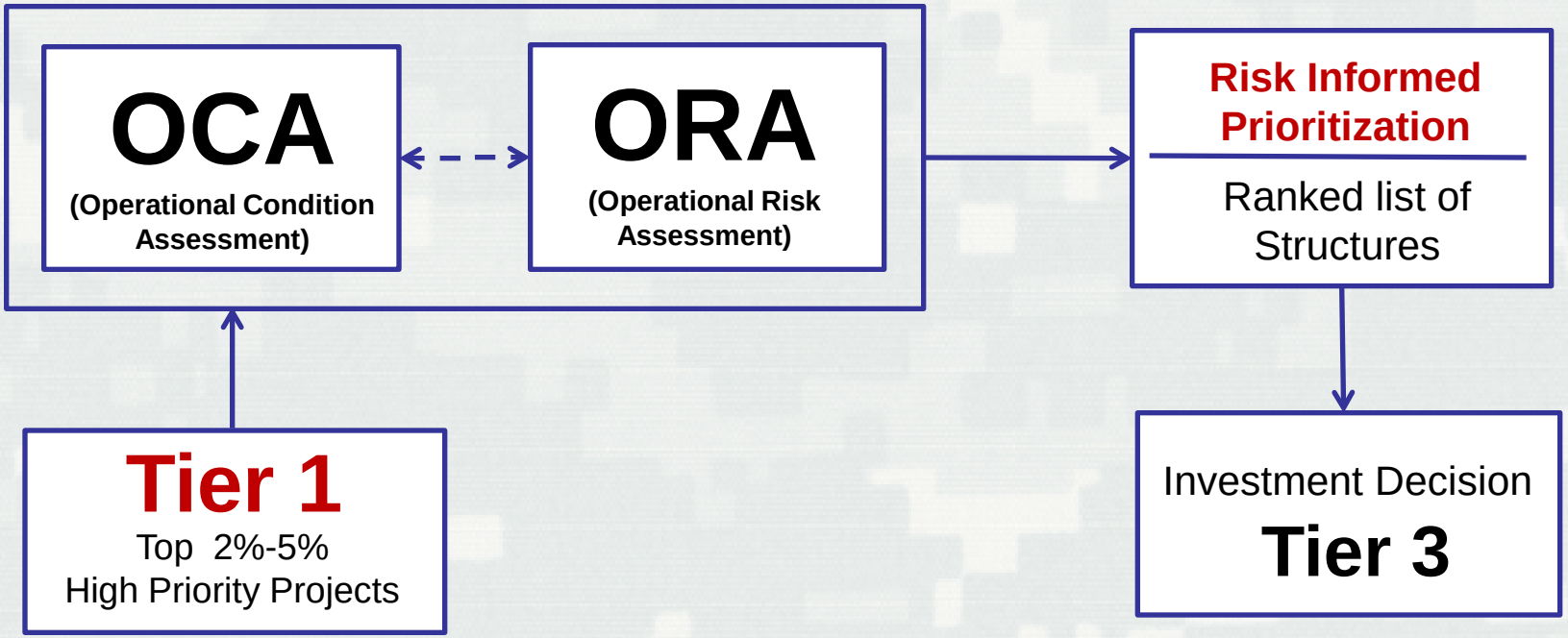
Structure Rank	Structure Score	District	Project	Structure	Commercial Tonnage (2)	Commercial Tonnage Rank	Commercial Fishing Dollars (1)	Commercial Fishing Rank	District Con
1	0.88231	Portland	Columbia River at Mouth	MCR Jetty A	44,745,096	23	$15,860,000	77	7
2	0.87498	Portland	Columbia River	West Channel Pile Dikes (4), Columbia River	44,745,096	23	$15,860,000	77	10
3	0.87498	Portland	Columbia River	Chinook and Sand Island Pile Dikes (5), Columb	44,745,096	23	$15,860,000	77	10
4	0.86749	New England	Portland Hbr, ME	Portland Hbr, ME - Inner Harbor (North) Breakw	21,677,258	40	$25,160,000	56	14
5	0.75899	Portland	Coos Bay	Coos Bay North Jetty, Oregon	1,586,404	141	$20,400,000	72	7
6	0.75804	Seattle	Grays Harbor/Markham	Gray's Harbor South Jetty, Washington	1,679,991	133	$33,820,000	27	15
7	0.74703	Jacksonville	Jacksonville Harbor	Jacksonville Harbor North Jetty, Florida	18,588,288	44	$11,040,000	86	21
8	0.74703	Jacksonville	Jacksonville Harbor	Jacksonville Harbor South Jetty, Florida	18,588,288	44	$11,040,000	86	21
9	0.74571	Seattle	Westhaven Cove	Westhaven Cove Small-Boat Basin Breakwater A	1,679,991	133	$33,820,000	27	19
10	0.74571	Seattle	Westhaven Cove	Westhaven Cove Revetment, Washington	1,679,991	133	$33,820,000	27	19
11	0.74145	Galveston	Galveston Harbor	Galveston Harbor South Jetty, Texas	218,858,528	2	$0	206	10
12	0.74111	Galveston	Sabine Pass	Sabine Pass East Jetty, Texas	78,634,070	9	$0	206	7
13	0.74111	Galveston	Sabine Pass	Sabine Pass West Jetty, Texas	78,634,070	9	$0	206	7
14	0.73759	New England	Portland Hbr, ME	Portland Hbr, ME - Spring Point (South) Breakwa	21,677,438	39	$25,160,000	56	24
15	0.72712	Galveston	Galveston Harbor	Galveston Harbor North Jetty, Texas	218,858,528	2	$0	206	14
16	0.72709	Portland	Columbia River at Mouth	MCR North Jetty, Oregon and Washington	44,745,096	23	$0	206	3
17	0.72576	Portland	Columbia River at Mouth	MCR South Jetty, Oregon and Washington	44,745,096	23	$0	206	7
18	0.71648	Detroit	Milwaukee Harbor	North Breakwater	2,495,851	110	$203,548	129	10
19	0.6982							111	24
20	0.6982							111	24
21	0.6982							111	24

- Selected metrics are then assigned linear weightings by the user to reflect decision maker priorities and rolled-up into an overall Structure Score for ranking structures for O&M outlays.

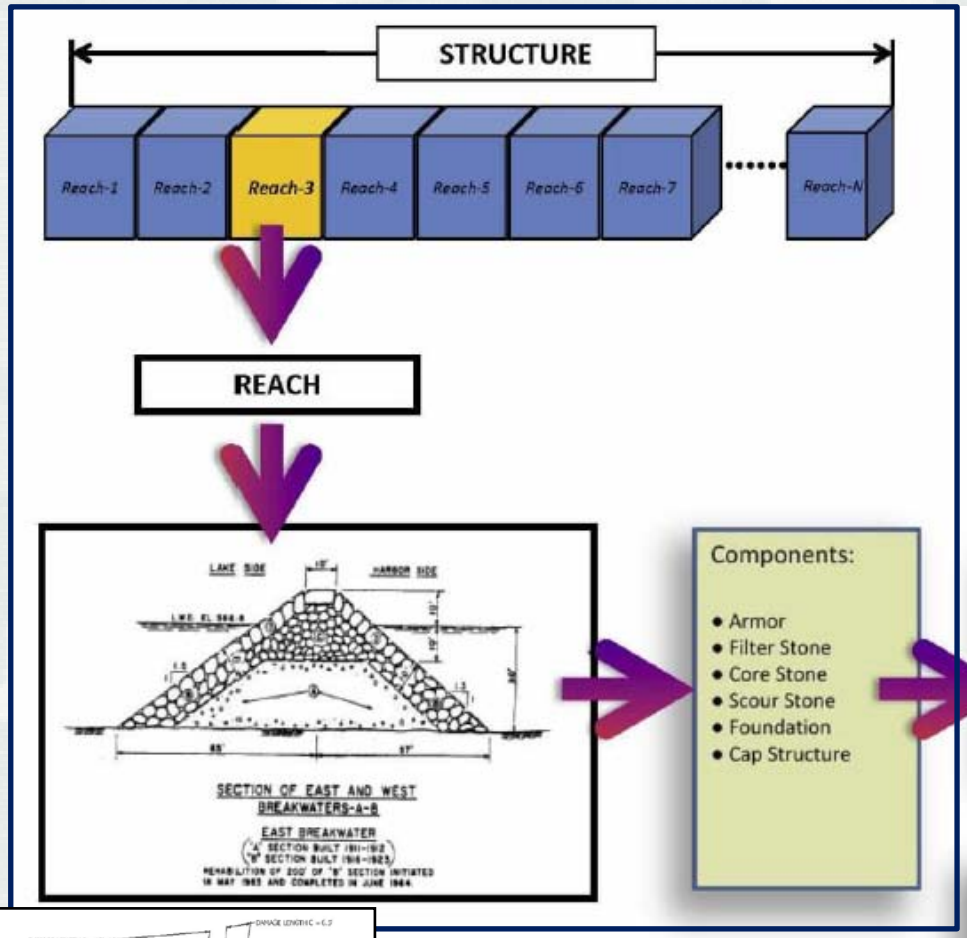
CNS Asset Management



Tier 2 – CNS AM


OCA
(Operational Condition Assessment)
ORA
(Operational Risk Assessment)
Risk Informed Prioritization
Ranked list of Structures
Tier 1
Top 2%-5%
High Priority Projects
Investment Decision
Tier 3

OCA/ORA Model Development



Components:

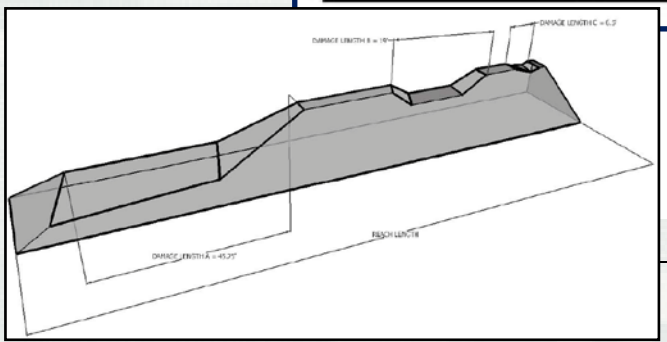
- Armor
- Filter Stone
- Core Stone
- Scour Stone
- Foundation
- Cap Structure

Component Condition Assessment:

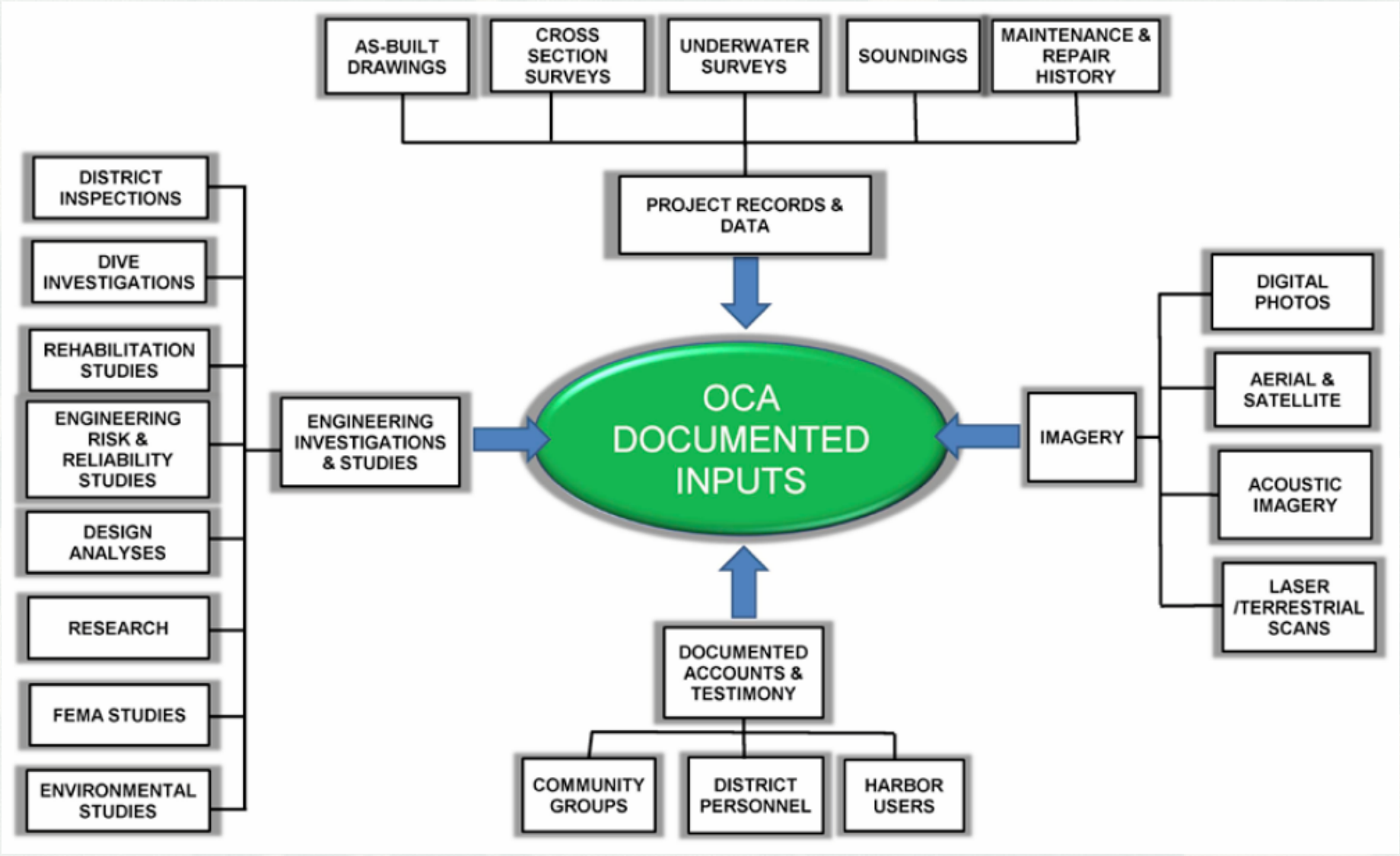
- Condition Index (1-5)
- Capacity Index (1-5)

State Condition Analysis:

- Probability of Failure, P(f)
- State Condition Rating (A-F)



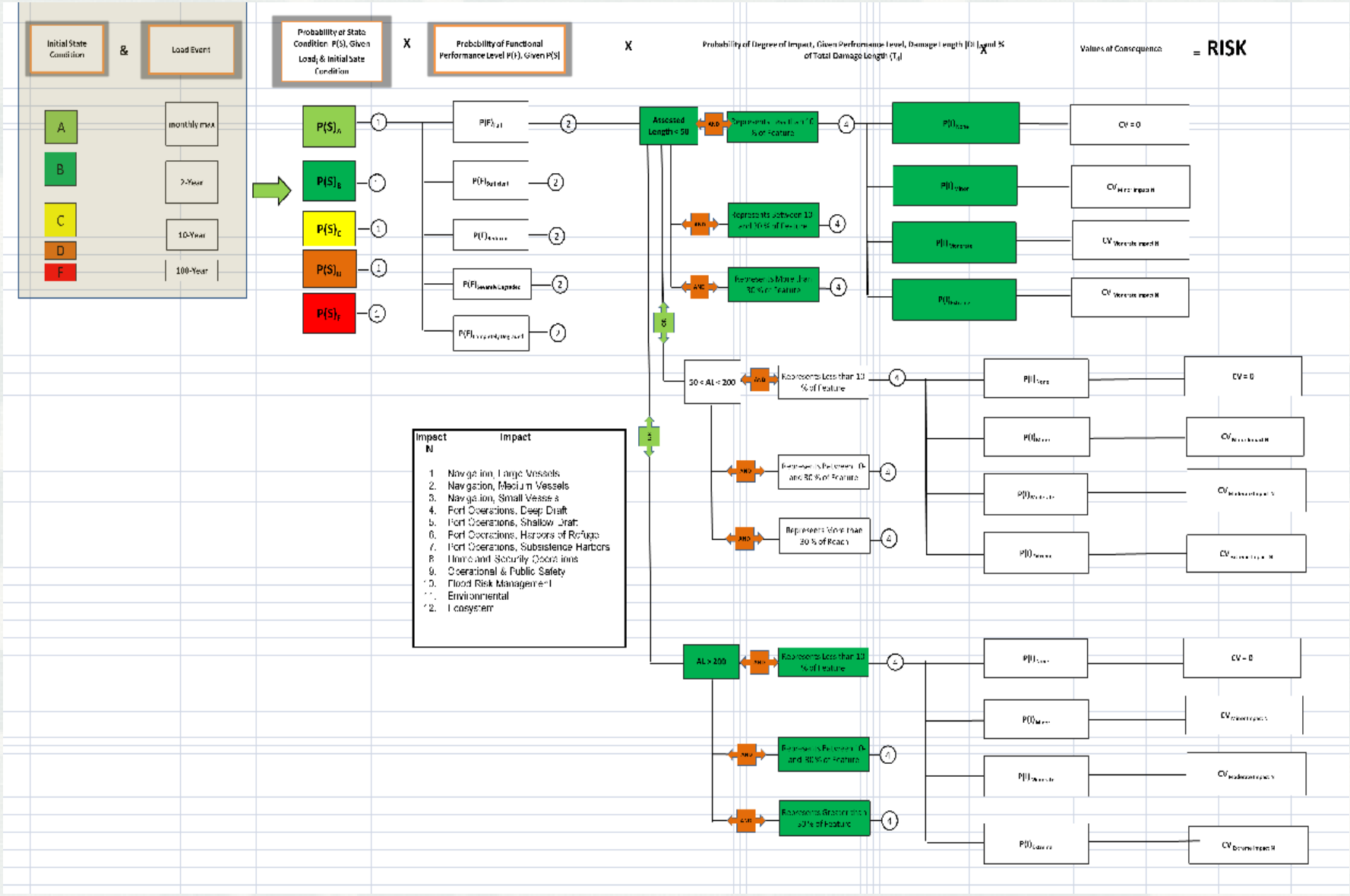
Typical Model Documentation Inputs



Condition Index Guide

CONDITION INDEX (CDI) GUIDE					
CDI Value	Condition Index Definition	CDI Indicators			
		Deterioration	Damage	Loss of Material in Damage Length	Influence on Other Components
1	**INSIGNIFICANT**: Deterioration or damage relative to the component is; □ None or insignificant.	□ None	□ None	□ 0%	□ None
2	**MINOR**: Deterioration or damage relative to the component is; □ Is in early stage of progression. □ No material has been lost. □ Does not influence other components adversely.	□ Minor Weathering □ Minor Material Distress □ No Material Breakdown	□ Minor	□ Less than 5%	□ Affords complete support of overlying components/ materials, or □ Affords complete protection to underlying vulnerable components
3	**SIGNIFICANT:** Deterioration or damage relative to the component is; □ Is in advanced stage of progression. □ Significant amounts of material lost over the Damage Length. □ Significantly influences other components.	□ Moderate Weathering □ Moderate Material Distress □ Moderate Material Breakdown	□ Significant	□ Between 5 and 25%	□ Affords sufficient support of overlying components/ materials, or □ Affords sufficient protection to underlying components
4	**CRITICAL:** Deterioration or damage relative to the component is; □ Is in late stage of progression. □ Critical amounts of material lost over the Damage Length. □ Extremely influences other components.	□ Extreme Weathering □ Extreme Material Distress □ Extreme Material Breakdown	□ Extreme	□ Between 25 and 75%	□ Affords no or inadequate support of overlying components/materials, or □ Affords no or minimal protection to underlying components
5	**EXTREME**: Deterioration or damage relative to the component is; □ Is in an extreme stage of progression. □ Extreme loss material over the Damage Length. □ Completely influences other components.	□ Complete Material Breakdown	□ Catastrophic	□ Between 75 and 100%	□ Component no longer contributes to the support or protection of any other components or the structure as a whole.

Operational Risk Assessment



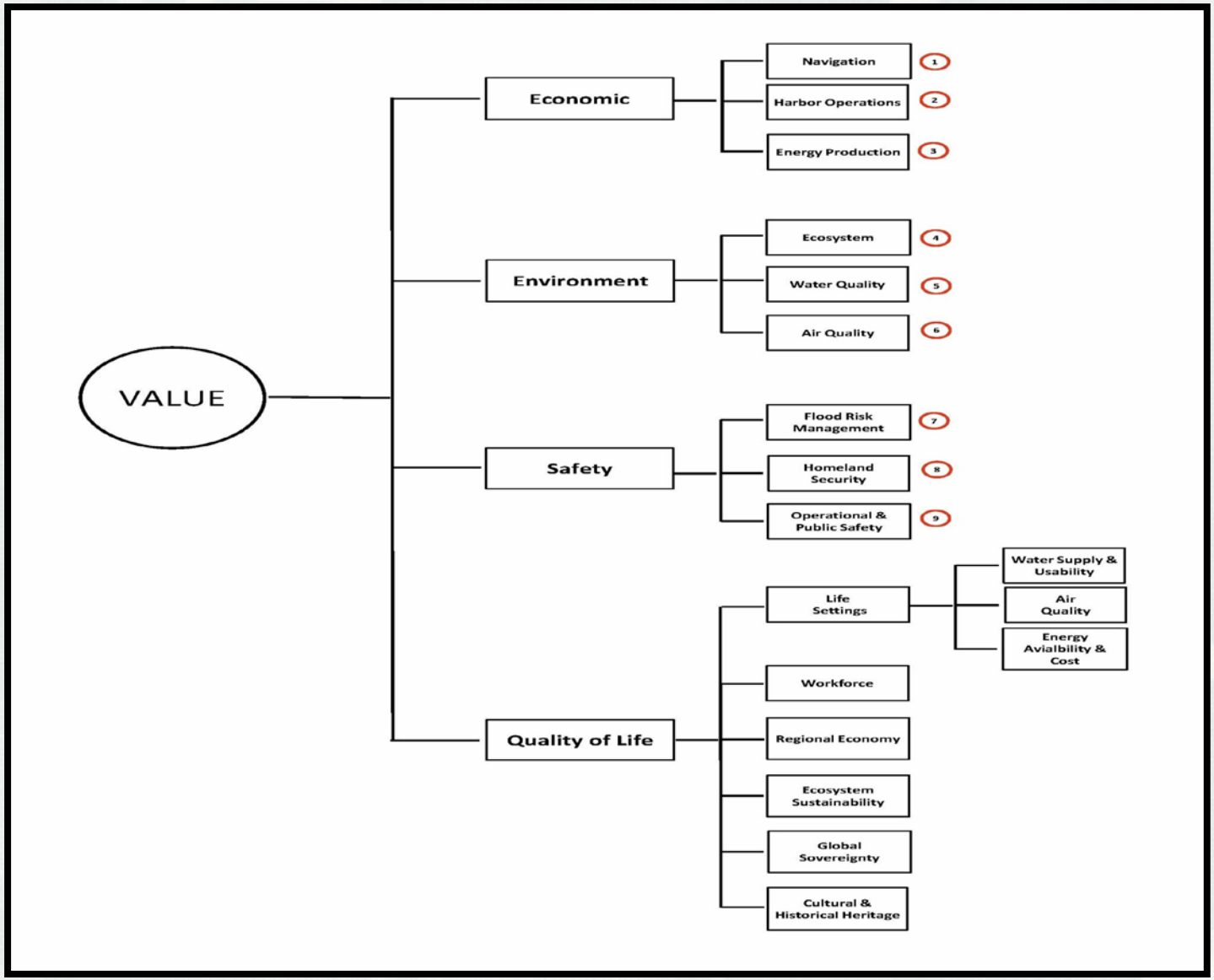
State Condition Scale

State Condition	Resistance to Load and Damage
A (EXCELLENT)	**Resistance to Load** - Will withstand loads for any common or extreme design load event. **Resistance to Damage** - Will not experience damage under any common or extreme design load events.
B (GOOD)	**Resistance to Load** - Will withstand loads for any common or extreme design load events. **Resistance to Damage** - May experience minor damage under extreme design load events, but not common events.
C (POOR)	**Resistance to Load** - Will withstand most common design load events, but not loading from extreme design load events. **Resistance to Damage** - Could sustain minor damage under common design load events; but would sustain moderate damage under extreme design load events.
D (INADEQUATE)	**Resistance to Load** - Will not withstand any common or extreme design load events. **Resistance to Damage** - Will sustain moderate damage from common design load events; but would sustain substantial damage from extreme design load events. There is a possibility for catastrophic failure of the structure under extreme load.
F (FAILING)	**Resistance to Load** - Will not withstand any design loads. **Resistance to Damage** - Will sustain extreme damage under any loads.

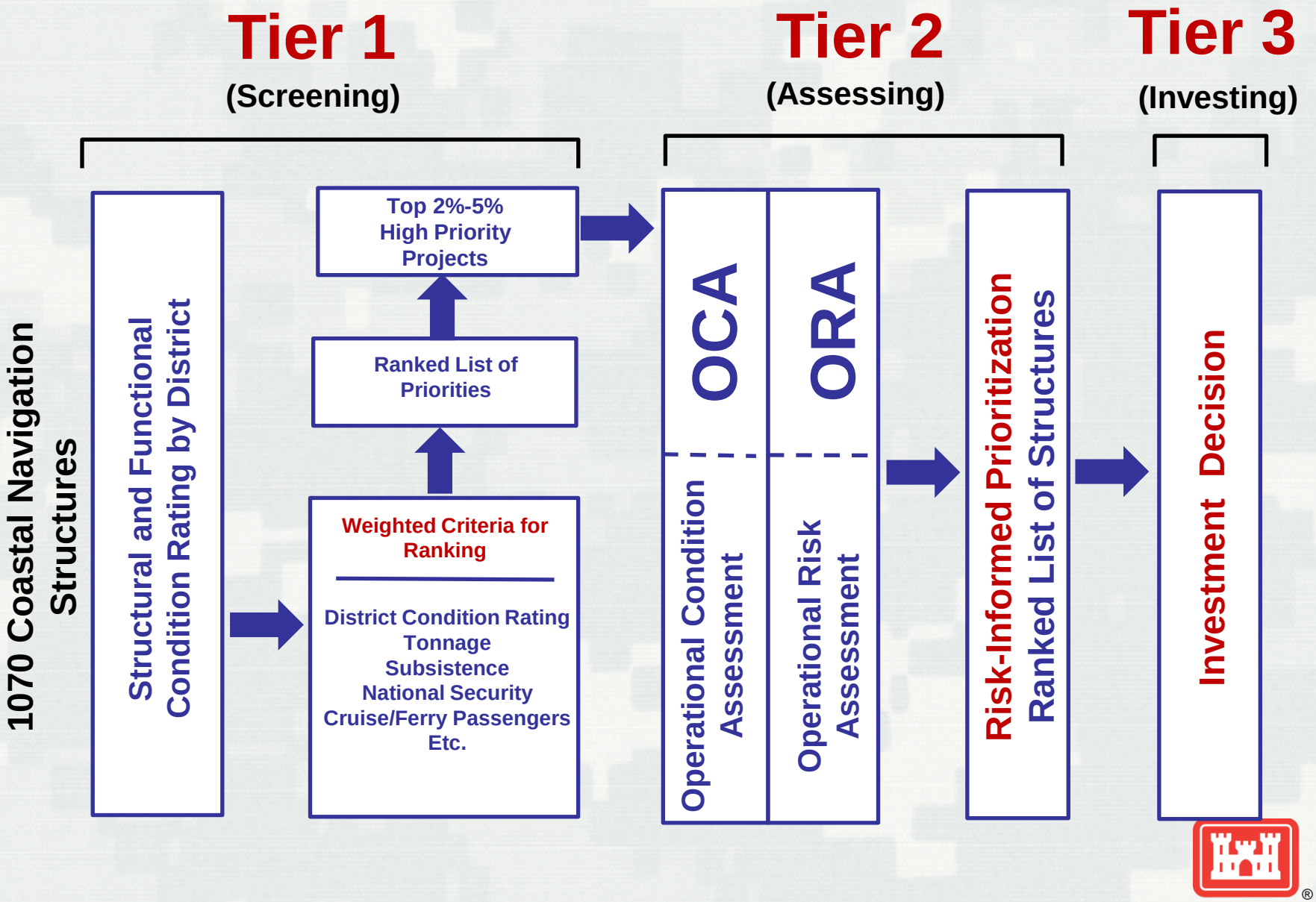
Capacity Index Guide

CAPACITY INDEX (CPI) GUIDE	
CPI Value	**Capacity Index Definition**
1	**FULL**: The structure's overall capacity to resist design loads and subsequent damage, given the component's assessed condition is expected to be; □ Unaffected by any anticipated load events.
2	**SUFFICIENT**: The structure's overall capacity to resist design loads and subsequent damage, given the component's assessed condition is expected to be; □ Unaffected within anticipated spectrum of Common Design Load Events. □ Unaffected within anticipated spectrum of Extreme Design Load Events
3	**REDUCED:** The structure's overall capacity to resist design loads and subsequent damage, given the component's assessed condition is expected to be; □ Unaffected within anticipated spectrum of Common Design Load Events. □ Affected by the most Extreme Design Load Events □ Minor to Moderate Damage from the most Extreme Design Load Events .
4	**SEVERLEY COMPROMISED:** The structure's overall capacity to resist design loads and subsequent damage, given the components assessed condition is expected to be; □ Unaffected by only the lowest Common Design Load Events. □ Affected by higher Common Design Load Events □ Affected by all Extreme Design Load Events □ Moderately Damaged by lowest Common Design Load Events. □ Extensively Damaged by higher Common Design Load Events. □ Extensively Damaged by all Extreme Design Load Events.
5	**FULLY COMPROMISED**: The structure's overall capacity to resist design loads and subsequent damage, given the component's assessed condition is expected to be; □ Fully affected by any loads. □ Progressively damaged by any loads

Consequences and Value

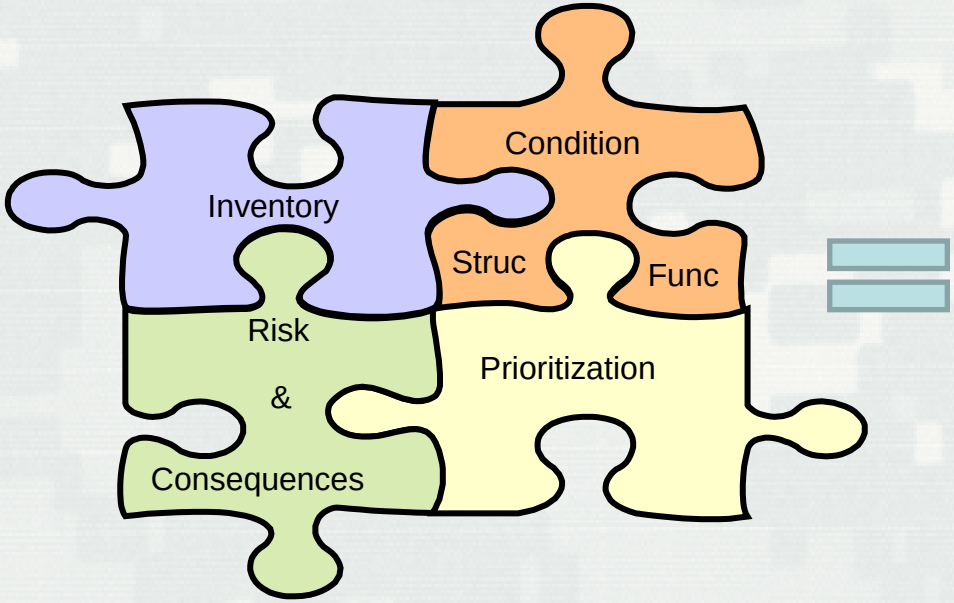


CNS Asset Management



So Where Are We ?

- Continue to work on the puzzle pieces
- Provide products to the fields as soon as developed
- Make improvements to the current process as defined in the Budget EC – Tier 1
- Beta Test – OCA and ORA Processes
- Link the puzzle pieces as soon as possible



*Rational, **consistent, transparent** and **repeatable** method for assessing condition and risk for coastal navigation structures.*

MILESTONES

- Dec 2011 – QC of Initial Screening Beta Test
- Jan 2012 – ORA process improvement meeting
- Feb 2012 – Initial Screening Beta Test completed by the field (Tier 1 process completed)
- Feb 2012 – First Beta Test - OCA
- April 2012 – Field implements Initial Screening methodology
- April 2012 – Second Beta Test – OCA with ORA Team Members and repeatability assessment
- June/July 2012 Tier 1 process completed per BY14 Budget EC and QA/QC
- Aug 2012 – Third Beta Test - Armor units, Draft ORA Process
- Aug 2012 – Final Draft OCA Process for Rubblemound Structures
- Sep 2012 – Final OCA Process
- Sep 2012 – First Full OCA, Second Beta ORA Test
- Nov 2012 – Second Full OCA with ORA
- FY 2013 – Multiple OCAs, goal to complete all required

Discussion & Questions?