

Processo de
Planejamento do
USACE –
Estudo de Caso do Rio
Madeira

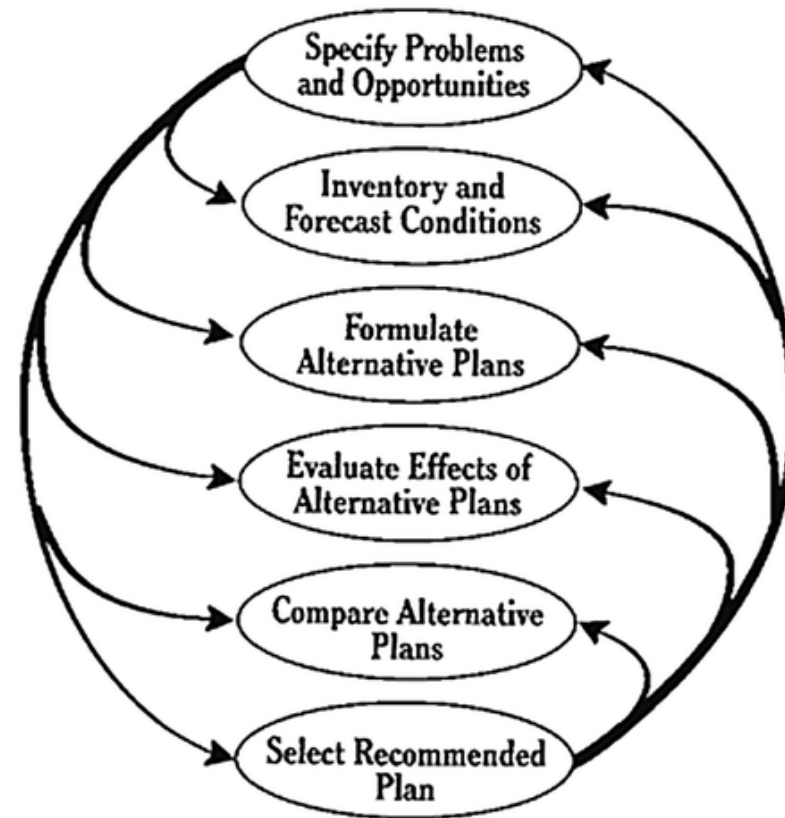
Dr. Calvin Creech, P.E.
Renato Souza Amorim

USACE Planning Process

1. Specify Problems and Opportunities
2. Inventory and Forecast Conditions
3. Formulate Alternative Plans
4. Evaluate Effects of Alternative Plans
5. Compare Alternative Plans
6. Select Recommended Plan

This is always an Iterative Process,
especially as new information becomes available

PLANNING PROCESS



STEP 1 – Specify Problems and Opportunities

- Planning Charette with Stakeholders
- Objective: Answer the Following Questions:
 - What are the Problems and Opportunities associated with this project?
 - What are the objectives of the project
 - What are the constraints?



STEP 1 – Specify Problems and Opportunities

- Identified Problems:
 - Lack of Aids to Navigation (SAFETY issues and accidents)
 - Rock Outcrops (require navigators to break up tows, leading to increase TRAVEL TIME)
 - Sand shoals in Navigation Channel (requires navigators to light-load and leading to MORE EXPENSIVE navigation)



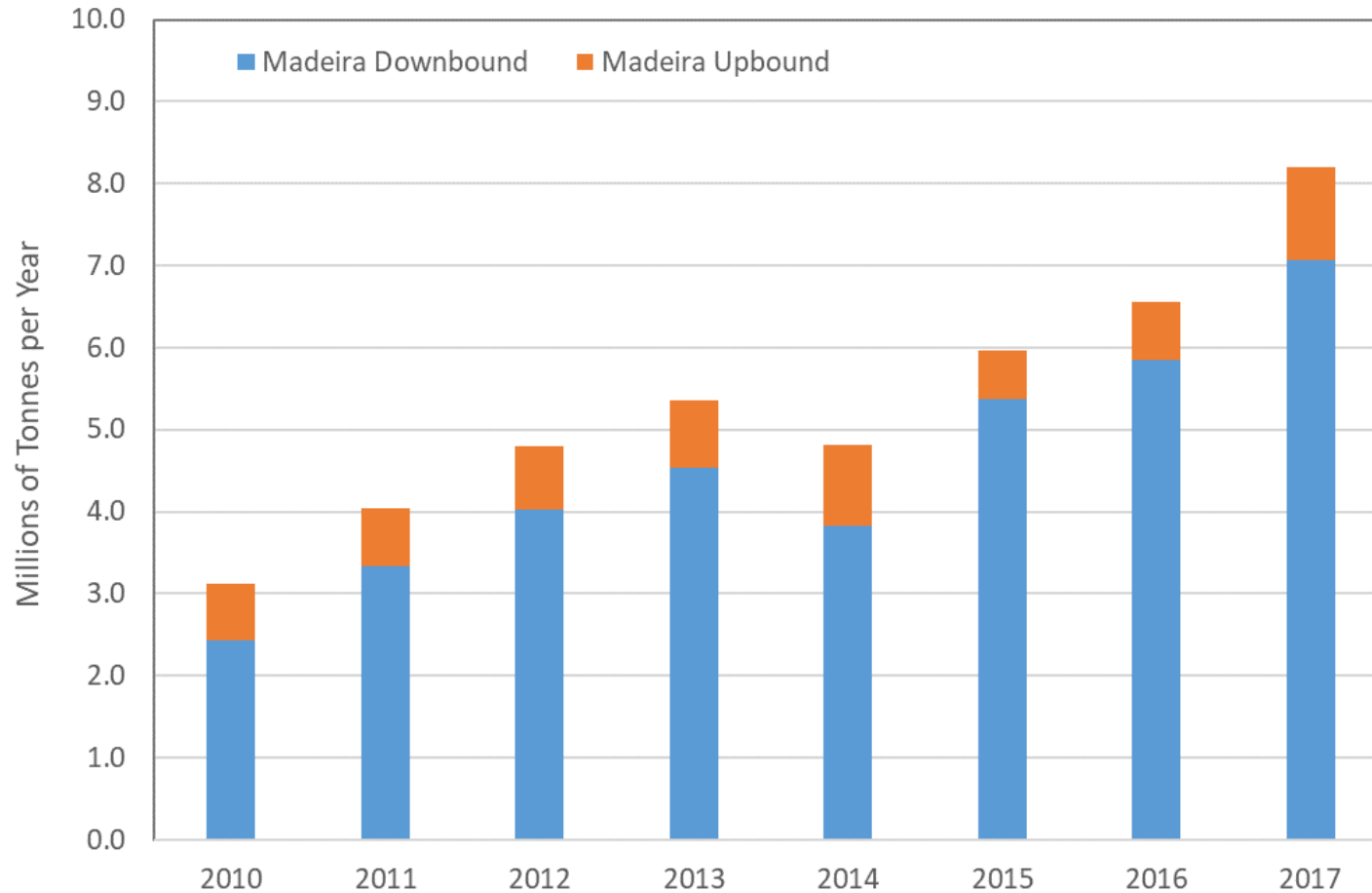
STEP 1 – Specify Problems and Opportunities

- Opportunities Consist of Defining the Following Characteristics:
 - Maintain a 3.5 m deep Channel
 - Barge Convoy that is 210m x 33 m can Safely Navigate
 - Reliability of 90%
 - Eliminate need to break up tows
 - Reduce Accidents
 - Environmentally and Socially Acceptable (EVTEA investigated this and was not repeated in the current study)

STEP 2 – Inventory and Forecast Conditions

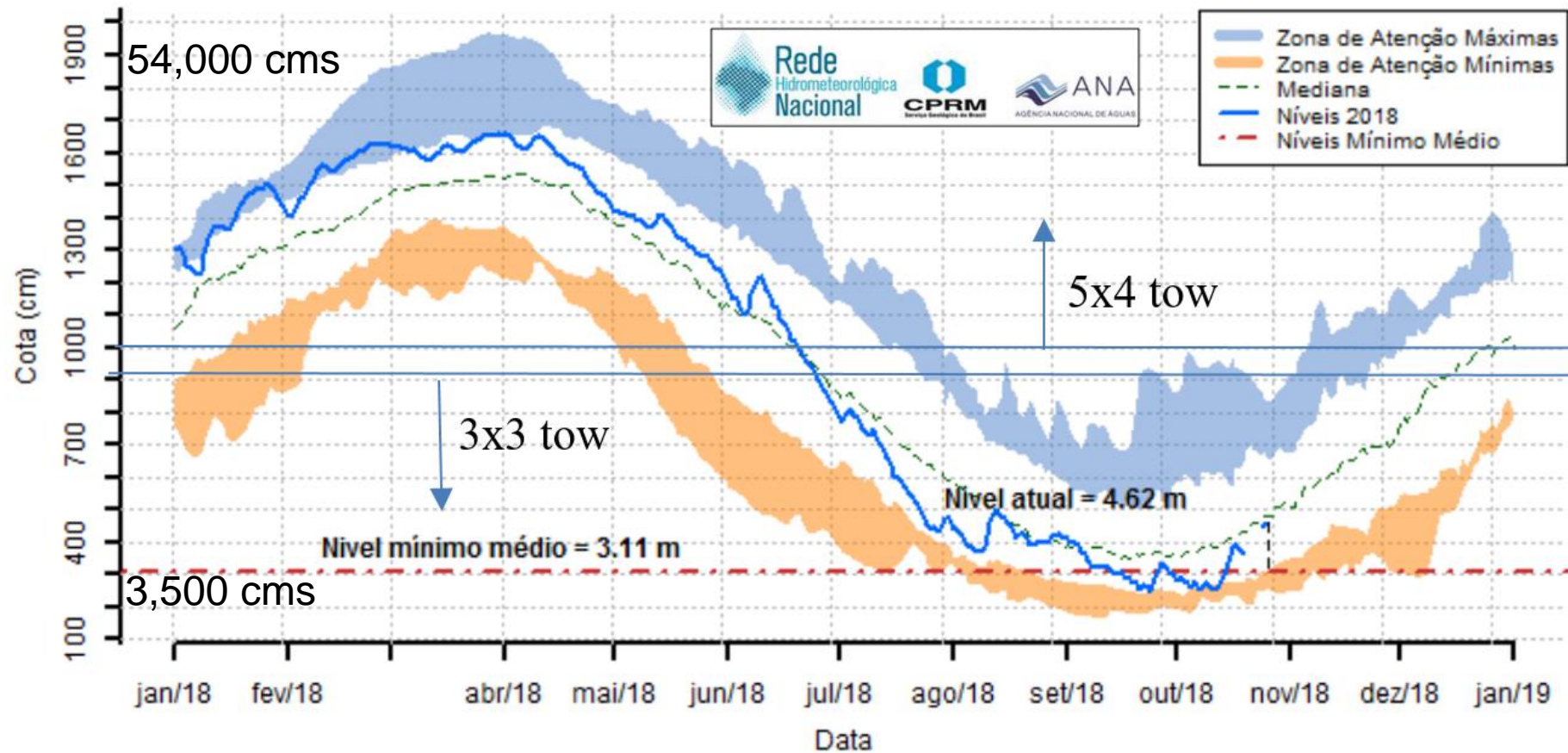
- Completed Tasks for STEP 2:
 - Navigation Statistics Analysis
 - Economic Analysis
 - Hydrologic Analysis
 - Fluvial Geomorphology and Geology Study
 - Hydraulic Modeling
 - Sediment Transport Modeling
- STEP 2 is the Most Technical Task in the USACE Planning Process

STEP 2 – Inventory and Forecast Conditions



Navigation Statistics from 2010 to 2017 on the Madeira River (Economics)

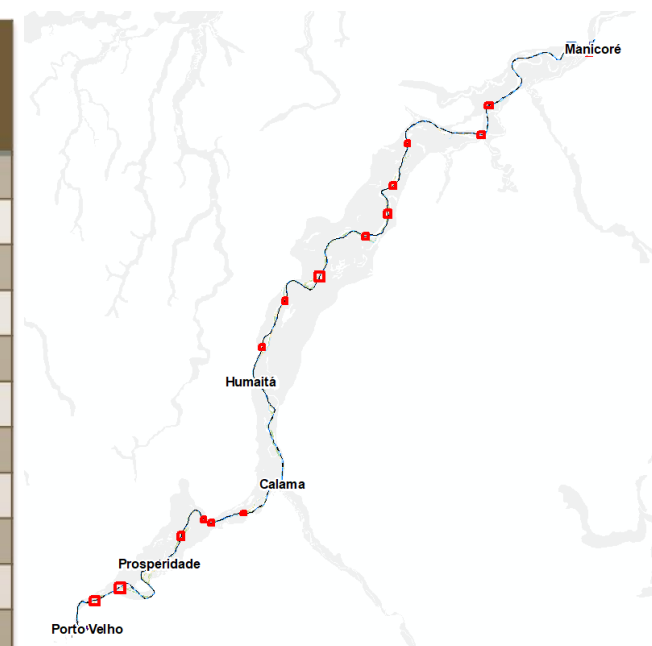
STEP 2 – Inventory and Forecast Conditions



Water Level Conditions on the Madeira River (Hydrology)

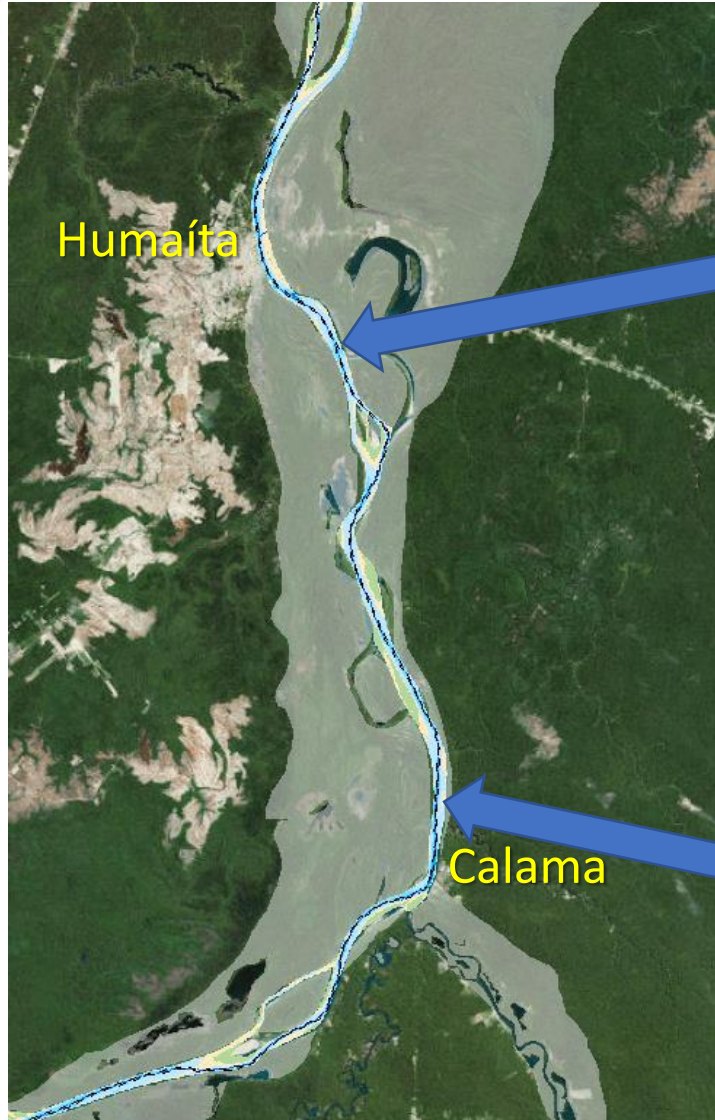
STEP 2 – Inventory and Forecast Conditions

Site	Material Type	Station, km	2014 Original EVTEA Volume, m ³	2016 (data) USACE Calculated Volume, m ³
Tamanduá	Sand	1062	231,746	228,200
Cojubim	Sand	1046	46,235	0
Mutuns	Sand	1040	64,888	1,100
Capitari	Rock	1008	331	0
Curicacas	Sand	973	110,517	211,200
Pombal	Sand	949	13,484	6,200
Abelhas	Sand	945	25,591	14,800
Papagaios	Sand	925	0	32,800
Ilha das Pupunhas	Sand	818	0	10,000
Cintra	Sand	788	7,216	62,800
Três Casas	Sand	746	350,662	55,800
Ilha Conceição	Sand	703	0	14,000
Ilha do Miriti	Sand	682	0	80,000
Ilha do Itapuru	Sand	664	0	2,400
Baianos	Rock	635	1,943	0
Ilha de Santa Cruz	Sand	589	0	185,700
Marmelos	Sand	558	235,307	0
Upstream of Manicoré	Sand	477	0	108,900
Uruá	Rock	377	0	0
TOTAL			1,087,920	1,013,900



Critical Shoals and Volumes (Sand and Rock) within the Navigaiton Channel

STEP 2 – Inventory and Forecast Conditions



Erodible Material in
Wide Holocene Valley



Competant (Hard)
Material along
Pleistocene Bluffs

STEP 2 – Inventory and Forecast Conditions

- Some Conclusions of STEP 2
 - Demand for Madeira River continues to increase
 - Dry Season (August – October) leads to shallow conditions, requiring navigators to light-load
 - Low Water Datum Reveals approximately 1,000,000 m³ of material requiring light loading
 - Stability of System provides opportunities for various measures to improve system (dredging, river training structures, rock removal)
 - Dredging quickly fills in (single year benefits)

STEP 3 – Formulate Alternative Plans

- MEASURES: Develop possible solutions at individual sites
- ALTERNATIVE PLANS: A combination of measures for the entire system

- MEASURES Considered:
 - Aids to Navigation
 - Dredging
 - Rock Excavation
 - River Training Structures



STEP 3 – Formulate Alternative Plans

Alternative Name:	3 Training Structures and Rock Removal Alternative			
Reach	1. Navigation Aids	2. Dredging	3. Rock Removal	4. Training Structures
Tamanduá	X			X
Mutuns	X			X
Capitari	X		x	
Curicacas	X			X
Pombal	X		X	
Papagaios	X	X		
Ilha Das Pupunahas	X	X		
Cintra	X	X		
Três Casas	X	X		
Ilha Conceição	X	X		
Ilha do Miriti	X	X		
Ilha do Itapuru	X	X		
Baianos	X		X	
Ilha de Santa Cruz	X	X		
Marmelos	X		X	
Manicoré	X	X		
Uruá	X		X	
Legend:	Permanent Problems		Rocky Reach	

Developed a total of 10 Alternative Plans (one example shown here)

STEP 4 – Evaluate Effects of Alternative Plans

- 10 Total Alternative Plans Developed
- Screened to 6 Plans for Evaluation
 1. Do Nothing
 2. Dredging and Rock Excavation
 3. River Training Structures at all Possible Sites
 4. River Training Structures at 3 Sites Closest to the Rock Quarry (upstream)
 5. River Training Structures at 4 sites with Highest Volume for Dredging
 6. River Training Structures at Tamanduá Only
- STEP 4 requires the second most amount of technical analysis

STEP 4 – Evaluate Effects of Alternative Plans

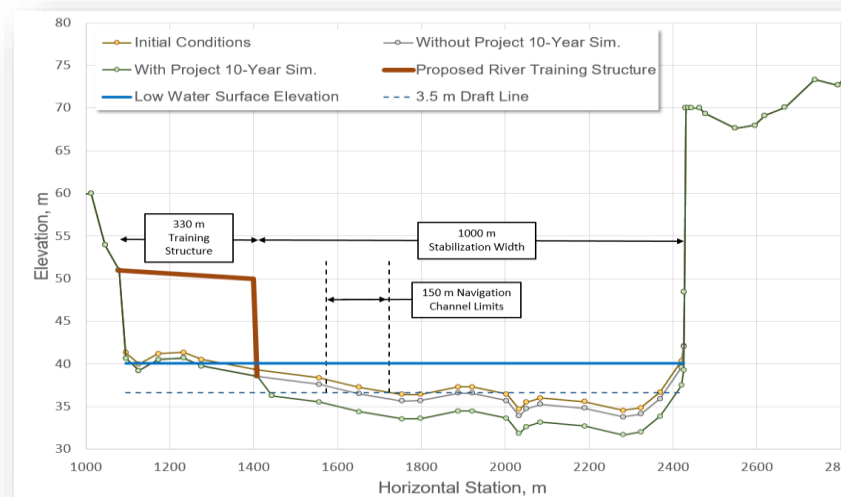
- Evaluated for:
 - Completeness
 - Cost
 - Travel Time Reduction
 - Environmental Benefits and Impacts
 - Social Benefits and Impacts
- Metrics Defined for Each Criteria

Criteria Name	Metric 1
Environmental study needed?	(Y/N)
Safety - life	Reduction in groundings, collisions, and allisions (qualitative)
Funding Source	Agency
Environmental Impacts	Licensing Process(low-High) Cost of Environmental Permit
Implementation Timeline	# of months # of environmental studies
Ease of Implementation	# of contracts Complexity of Design
Operational Impact	# of annualized closure days # Hours increased travel time
Light Loading Reduction	# days lightloading occurs # capacity used
When will benefits start?	Year
How long will benefits occur?	# of years
How much travel time will be reduced?	Total Trip Time (# of hours)
Is this plan acceptable society?	(Y/N)
Level of Outcome Risk	low-med -high ?
Does this plan compliment the country's transportation plan?	Y/N
Total Cost	Average Annual Cost(\$)
Initial Cost	Average Estimated Cost(\$)
Maintenance Cost	Average Annual Cost (\$)
Reliability	% of time the entire channel is 3.5 M
Completeness	Y/N

STEP 4 – Evaluate Effects of Alternative Plans

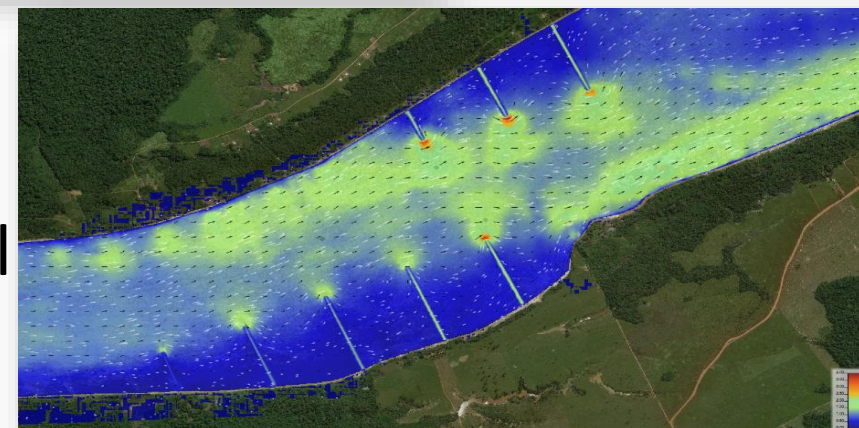
Site Name	Tamanduá
Life Cycle, years	30
Discount Rate	6.00%
River Training Structures Data	
Mobilization Cost (\$R)	R\$1,000,000.00
Structure Volume (m ³)	340,000
Transport Distance, Road, km	24
Transport Distance, Waterway, km	19
Road Transport Cost per m ³ · km	R\$1.21
Barge Transport Cost per m ³ · km	R\$0.32
Extraction and Crushing Cost per m ³	R\$75.52
Truck Load and Remove to Barge Costs per m ³	R\$12.42
Barge Release Cost per m ³	R\$7.25
Total Extraction and Handling Costs per m ³	R\$95.19
Total Capital Costs for River Training Structures	R\$45,305,400.00
Annual Maintenance (% of Capital Cost)	1.50%
Annual Maintenance Costs for RTS	R\$679,581.00
Dredging Data	
Annual Dredging Volume (m ³)	228,200
Unit Cost for Dredging (R\$)	R\$16.36
Annual Dredging Cost (R\$)	R\$3,733,352.00
River Training Structures Equivalent Annual Cost	R\$3,970,968.99
Dredging Equivalent Annual Cost	R\$4,004,575.96

Cost



Completeness
(Meets Design
Objective)

Environmental
(Velocities)



STEP 5 – Compare Alternative Plans

- Completeness: Screen to 6 alternatives (Do Nothing +5)
- Quantative Comparison - Costs

Alt.	Alternative Plan Name	Capital Costs	Annual Maintenance Costs	Annualized Costs	Life-Cycle Costs
0	Future Without Project Conditions	R\$ -	R\$ -	R\$ -	R\$ -
2	Dredging and Rock Removal	R\$ 18,300,700	R\$ 24,540,000	R\$ 27,652,330	R\$ 829,569,907
3	Training Structure Alternative	R\$ 305,714,924	R\$ 13,943,981	R\$ 36,853,648	R\$ 1,105,609,438
4	Training Structures at Upper Three Sites	R\$ 120,398,700	R\$ 17,819,486	R\$ 27,749,627	R\$ 832,488,814
4b	Training Structures at Upper Three Sites and Santa Cruz	R\$ 138,298,900	R\$ 15,061,389	R\$ 26,072,081	R\$ 782,162,429
9	Demonstration Project River Training Structure	R\$ 63,606,100	R\$ 21,486,229	R\$ 27,618,723	R\$ 828,561,698

STEP 5 – Compare Alternative Plans

- Qualitative Criteria

- - Worst Condition; - Negative; 0 Neutral; + Positive; + + Very Positive

Alt.	Alternative Plan Name	Travel Time	Environmental Considerations	Social Considerations	Total
0	Future Without Project Conditions	--	0	0	-2
2	Dredging and Rock Removal	+	+	+	+3
3	Training Structure Alternative	++	+	+	+4
4	Training Structures at Upper Three Sites	+	+	+	+3
4b	Training Structures at Upper Three Sites and Santa Cruz	+	+	+	+3
9	Demonstration Project River Training Structure	+	+	+	+3

STEP 6 – Recommend Alternative Plan

Alternative 4b – River Training Structures at 4 Sites Selected

- Constructing River Training Structures at Tamanduá, Mutuns, Curicacas, and Santa Cruz (total structure volume of approximately 756,000 cubic meters)
- Dredging all remaining sand shoal sites annually (volume of approximately 800,000 cubic meters)
- Rock Excavation at Capitarí, Pombal, Abelhas, Baianos, and Uruá (a volume of approximately 33,300 cubic meters)
- Aids to Navigation along the entire navigation channel

Obrigado!

Perguntas?

