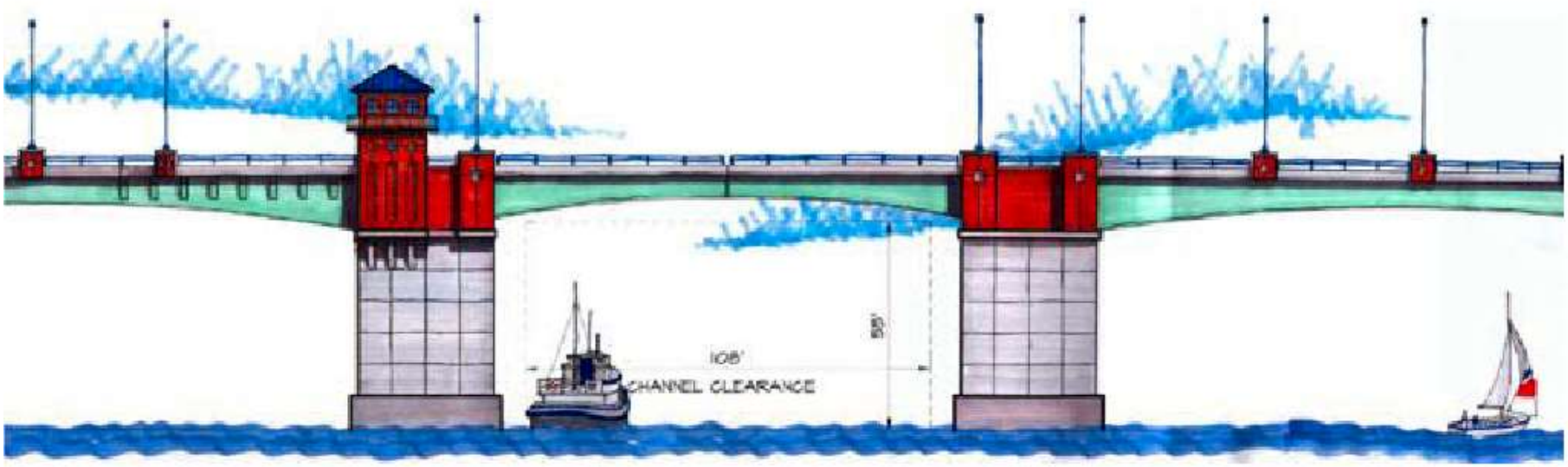
DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE



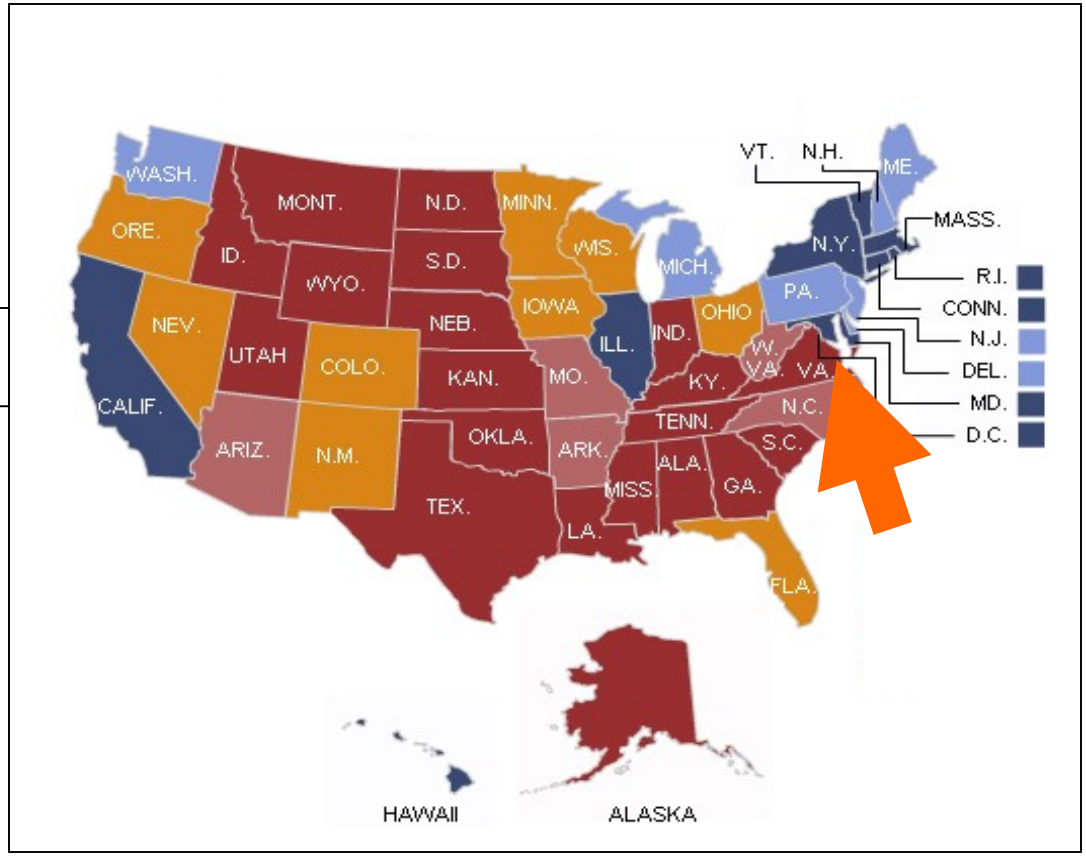
SCOTT SNELLING
PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

OUTLINE

- PROJECT OVERVIEW
- MACHINERY DESIGN
- APPENDIX

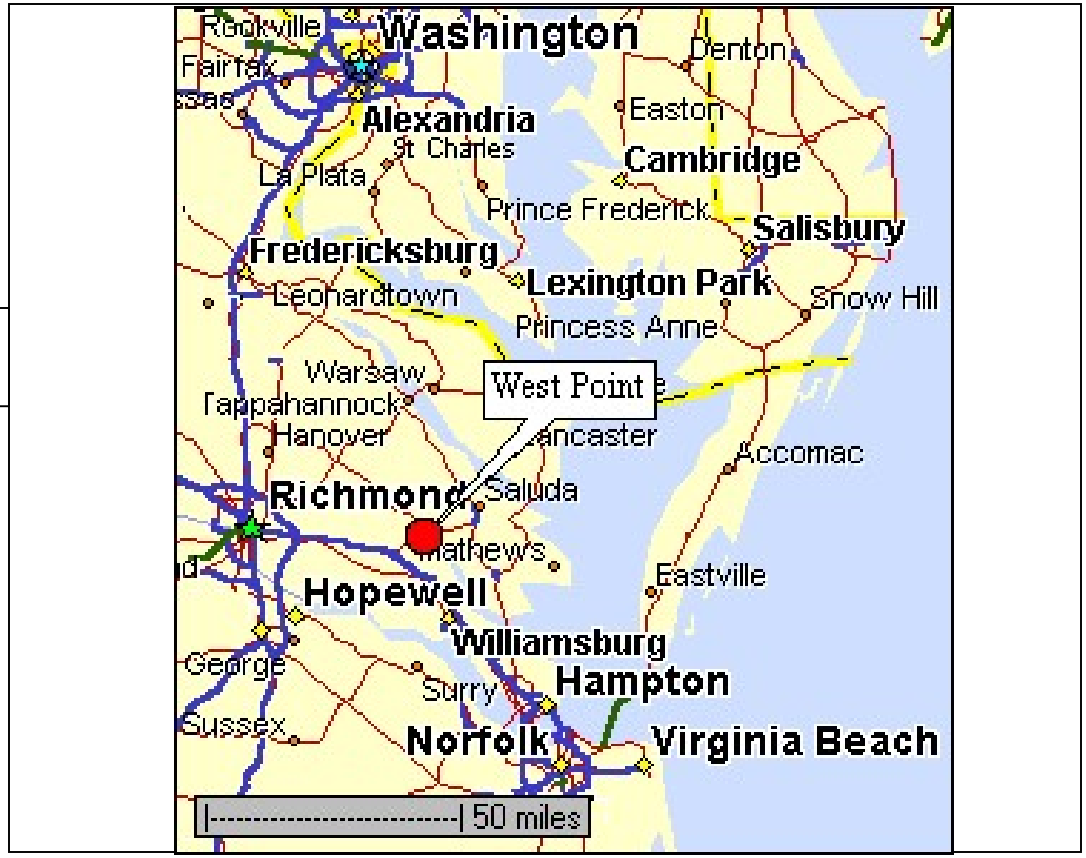
PROJECT OVERVIEW

- **LOCATION**
  - MAP
- STUDY
- DESIGN



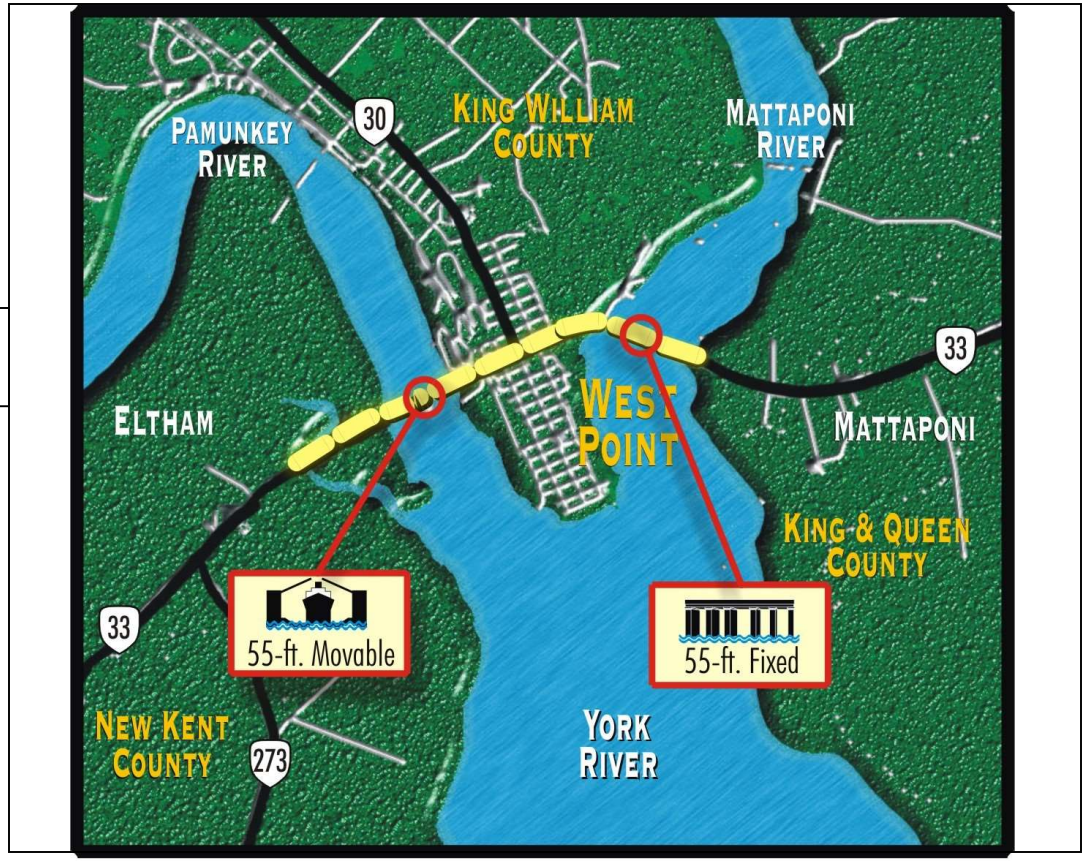
PROJECT OVERVIEW

- **LOCATION**
  - MAP
- STUDY
- DESIGN



PROJECT OVERVIEW

- **LOCATION**
  - MAP
- STUDY
- DESIGN



Alternative B-2C -- "55-Ft. Movable"

PROJECT OVERVIEW

- **LOCATION**

  ARIAL PHOTO

- STUDY

- DESIGN

PROJECT OVERVIEW

- **LOCATION**
  - ARIAL PHOTO
- STUDY
- DESIGN

PROJECT OVERVIEW

- **LOCATION**

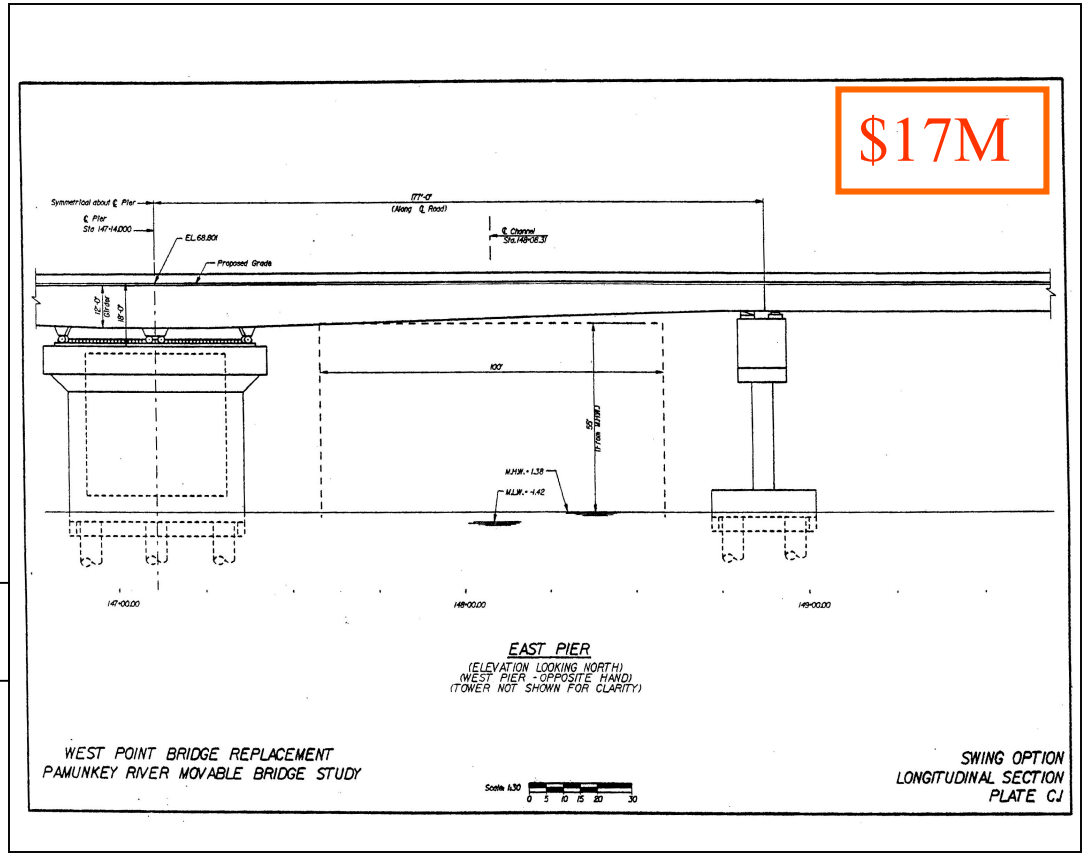
ARIAL RENDERING

- STUDY

- DESIGN

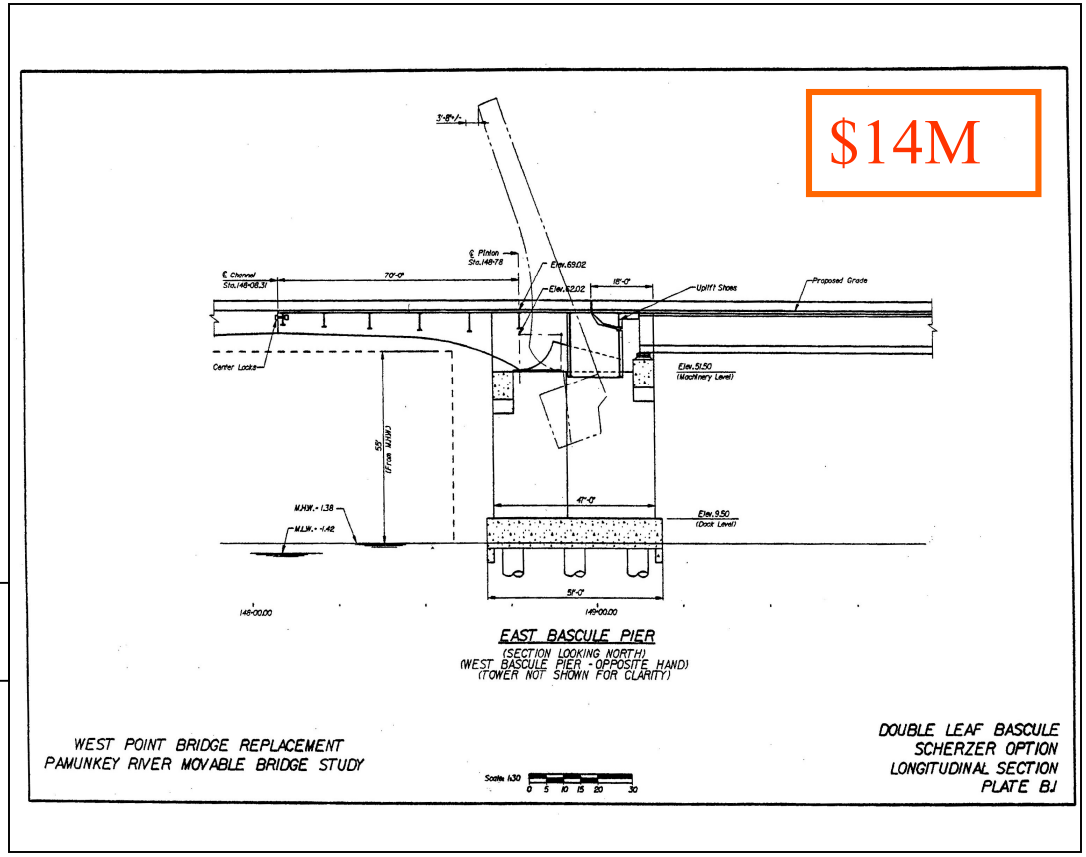
PROJECT OVERVIEW

- LOCATION
- **STUDY**
  - SWING SPAN
- DESIGN



PROJECT OVERVIEW

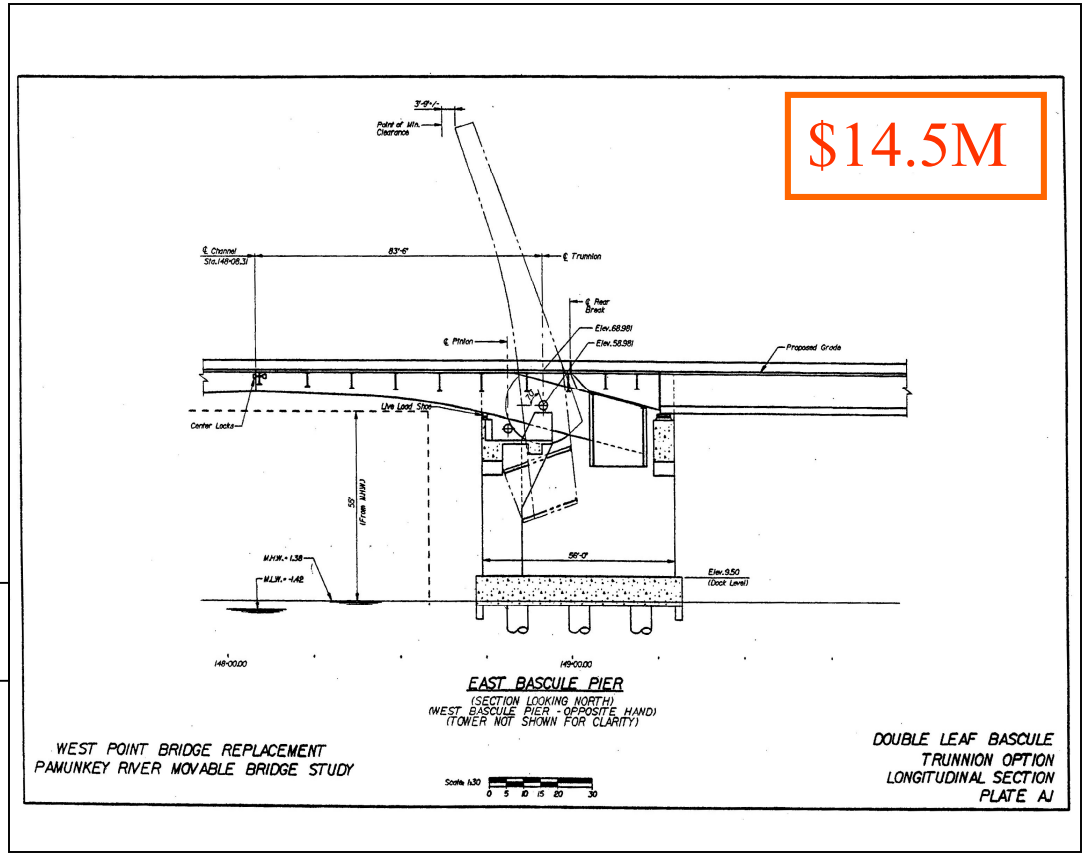
- LOCATION
- **STUDY**
  - SCHERZER
- DESIGN



DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE

PROJECT OVERVIEW

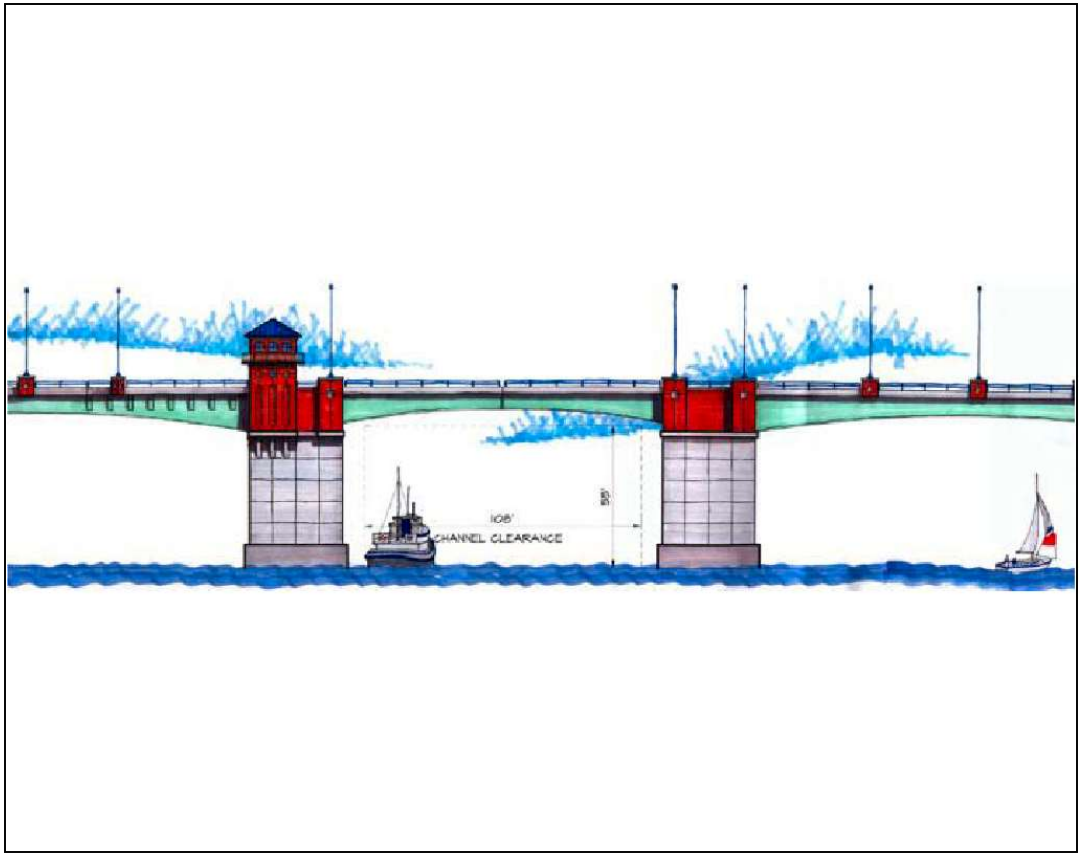
- LOCATION
- **STUDY**
  - TRUNNION
- DESIGN



DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE

PROJECT OVERVIEW

- LOCATION
- STUDY
- **DESIGN**



PROJECT OVERVIEW

- LOCATION
- STUDY
- **DESIGN**

Eltham Bridge Replacement (55-ft. Movable) project #0033-966-102 PE-101, RW-201, C-501	$91 million
Lord Delaware Bridge Replacement (55-ft. Fixed) Project #0033-966-103 PE-102, C-501	$38.5 million
Total Cost	$129.5 million

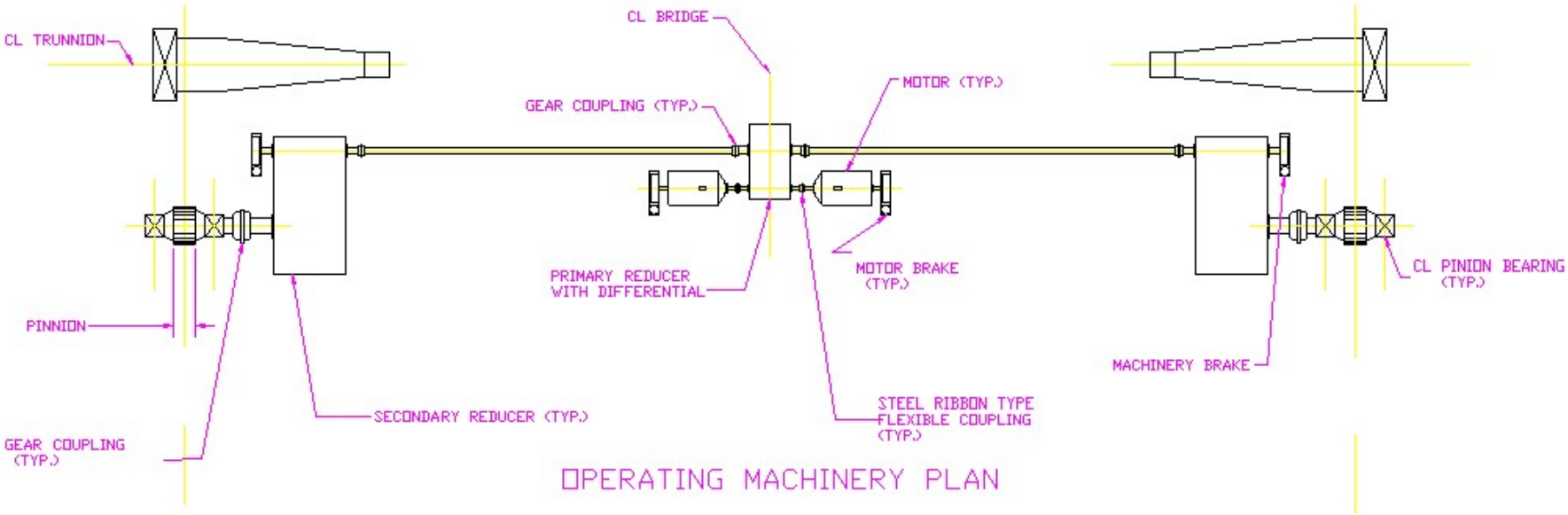
OUTLINE

- PROJECT OVERVIEW
- **MACHINERY DESIGN**
  - OPERATING MACHINERY
  - BUFFERS & CONTROL SYSTEM
  - TRUNNIONS
  - CENTER LOCKS
  - LUBRICATION SYSTEM
- APPENDIX

DESIGN MANDATE

- SIMPLE – EASY MAINTENANCE
- FULLY REDUNDANT
- FULLY IMMERSED GEARS
- EASY ACCESS FOR MAINTENANCE

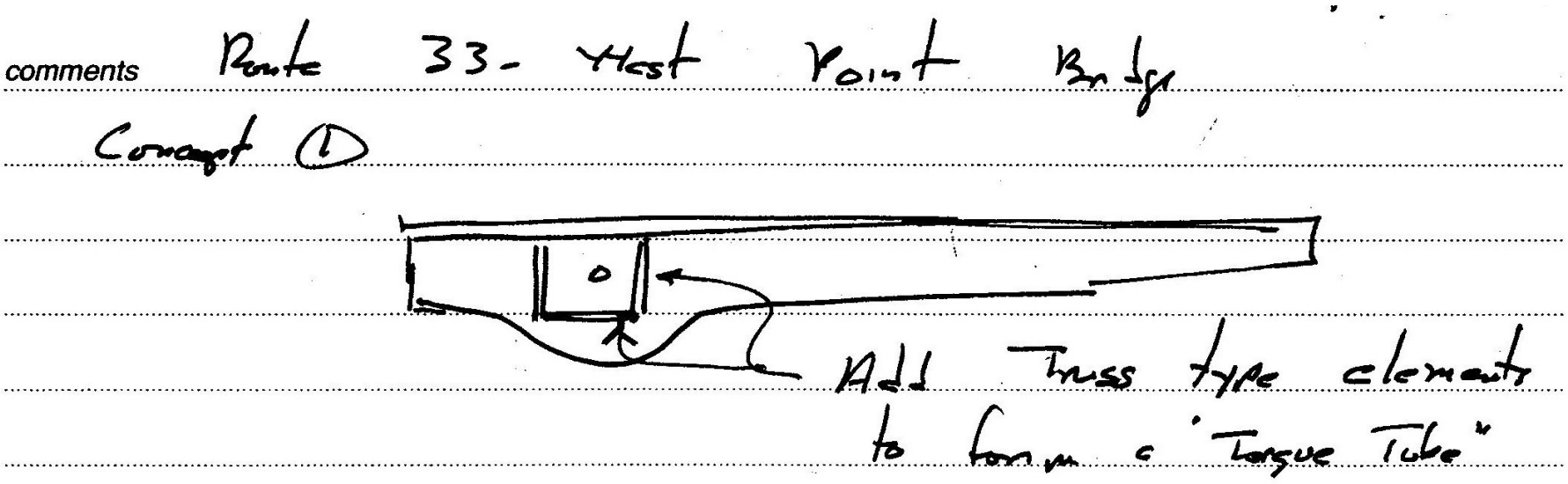
OPERATING MACHINERY



TRADITIONAL LAYOUT

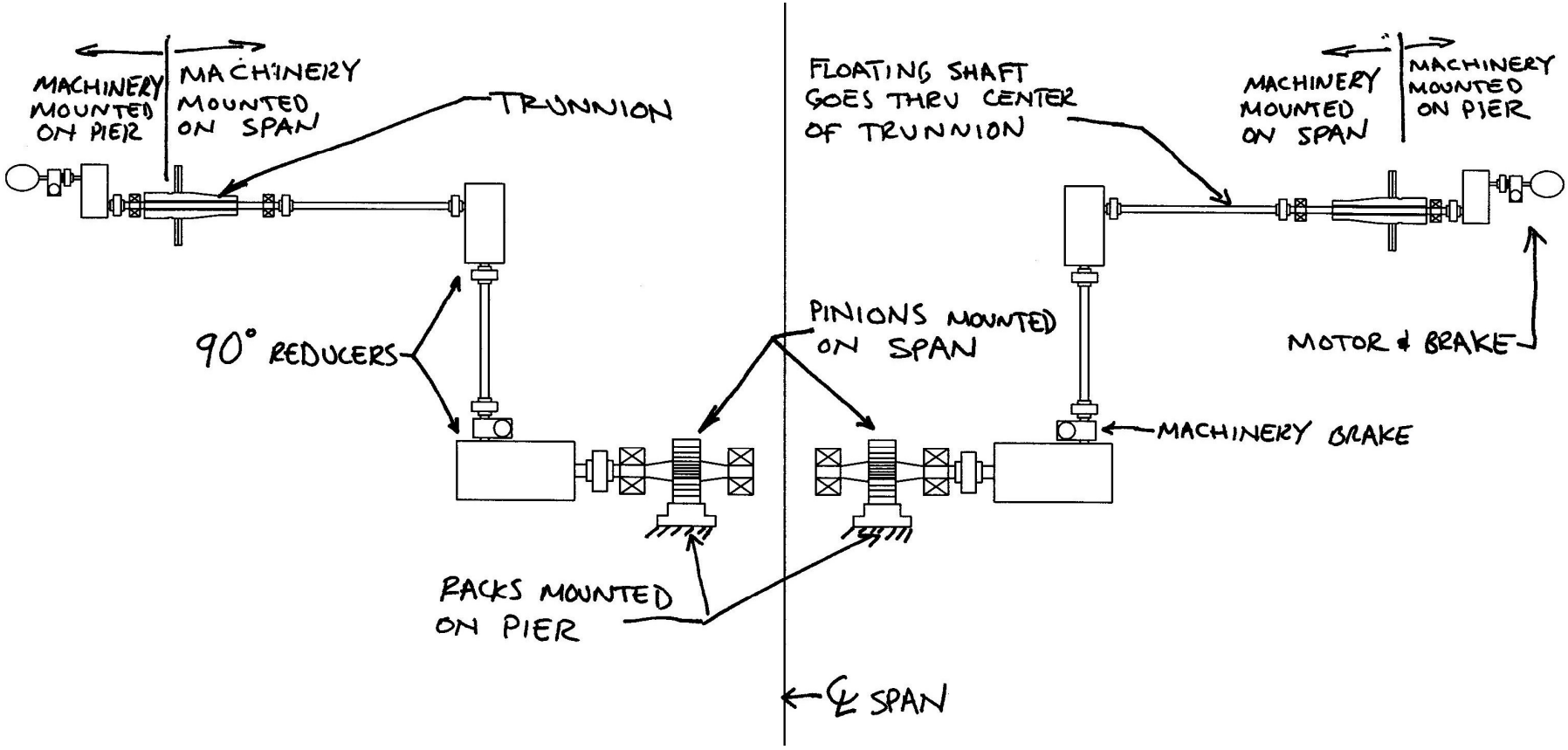
DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE

OPERATING MACHINERY



REDUNDANT CONCEPT #1

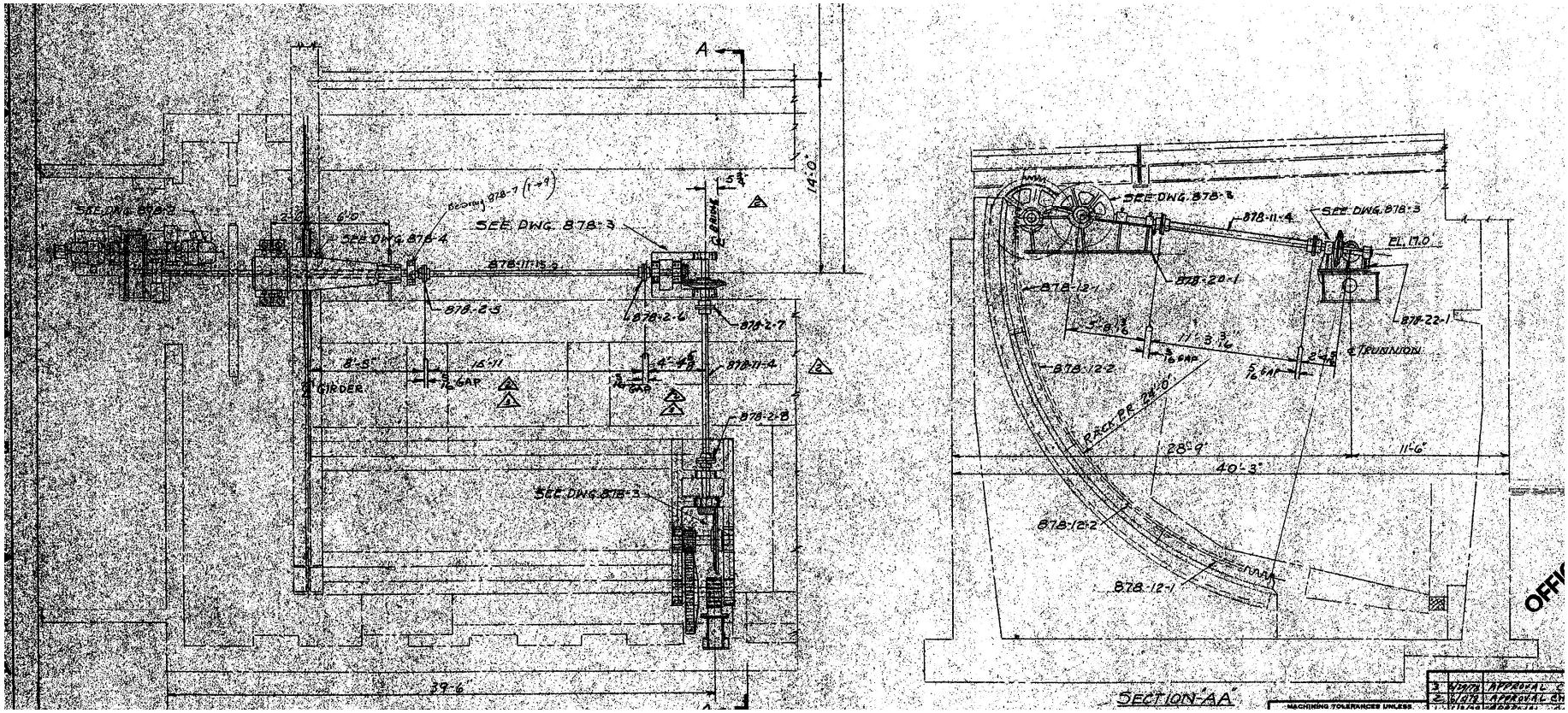
OPERATING MACHINERY



REDUNDANT CONCEPT #2

DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE

OPERATING MACHINERY

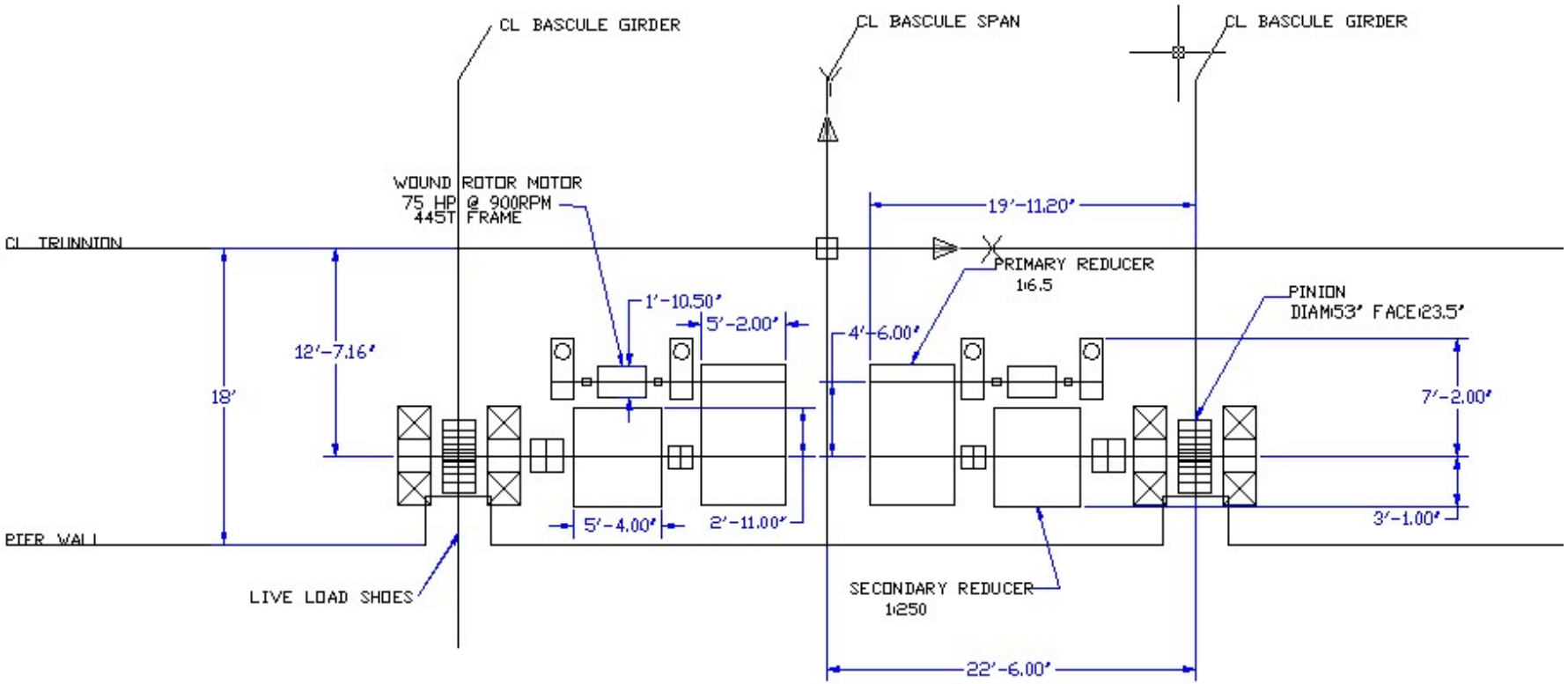


REDUNDANT CONCEPT #2

3RD STREET BRIDGE, DE

DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE

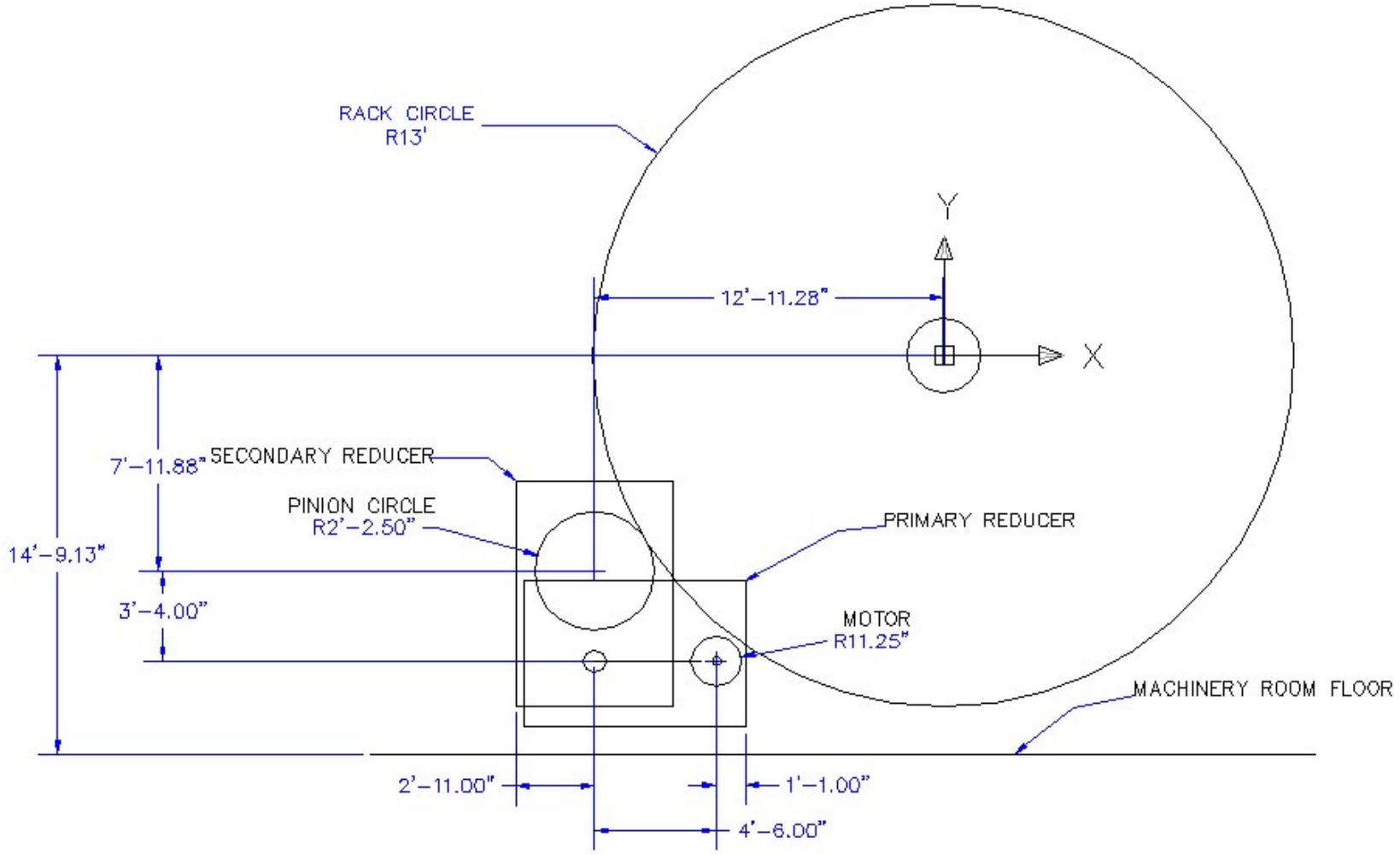
OPERATING MACHINERY



PAMUNKEY BRIDGE MACHINERY LAYOUT - PLAN
SCHEME A

DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE

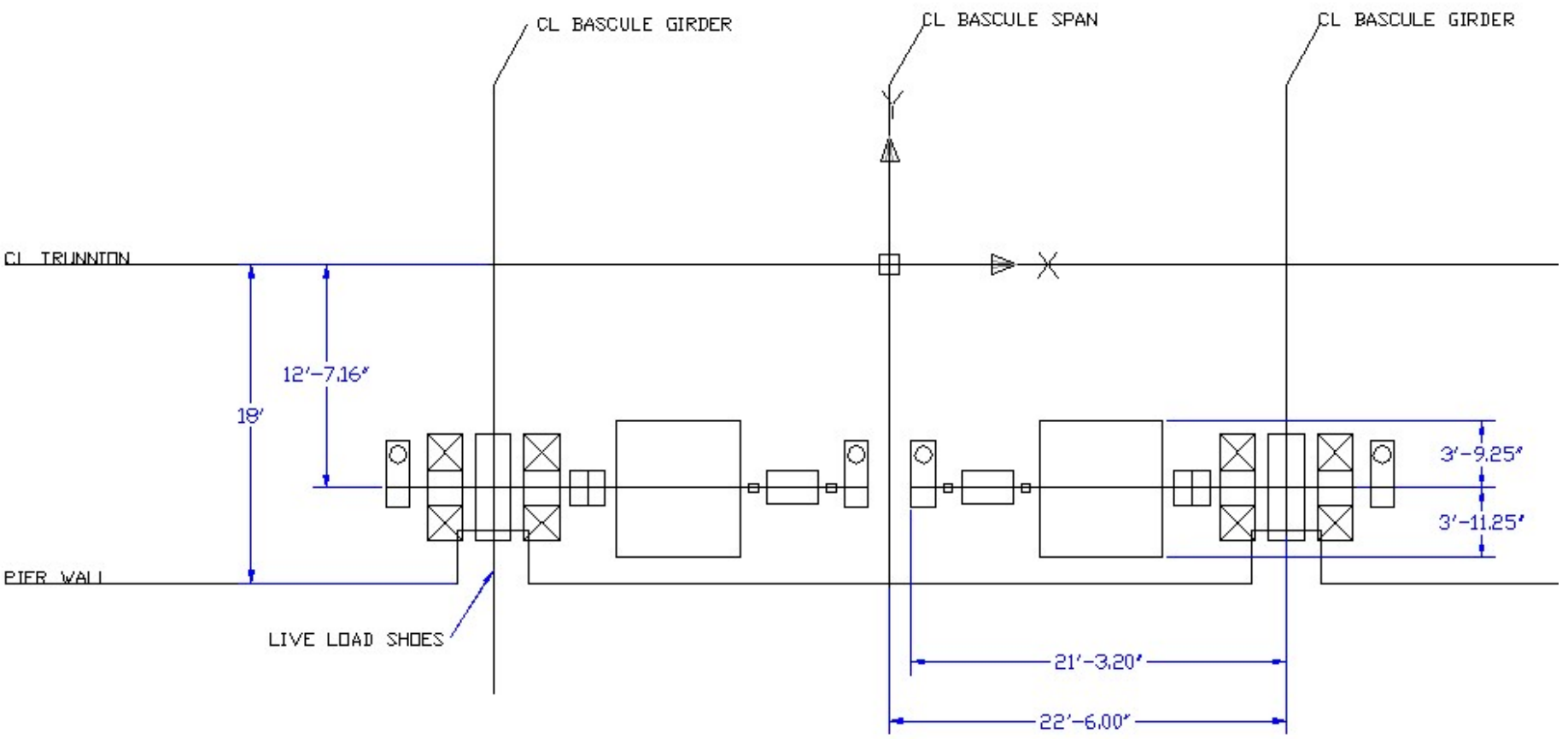
OPERATING MACHINERY



PAMUNKEY BRIDGE MACHINERY LAYOUT – ELEVATION
SCHEME A

DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE

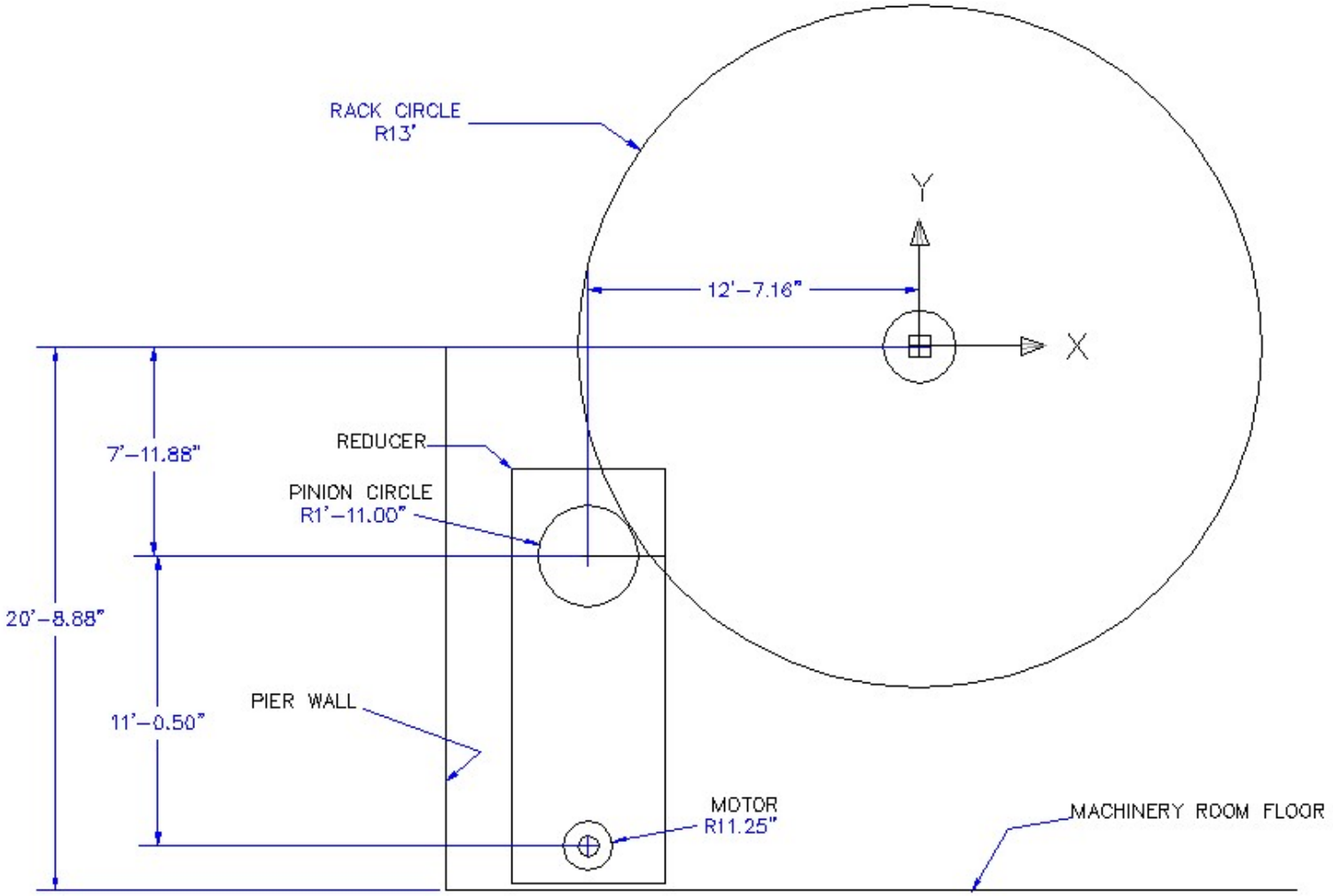
OPERATING MACHINERY



PAMUNKEY BRIDGE MACHINERY LAYOUT - PLAN
SCHEME C

DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE

OPERATING MACHINERY

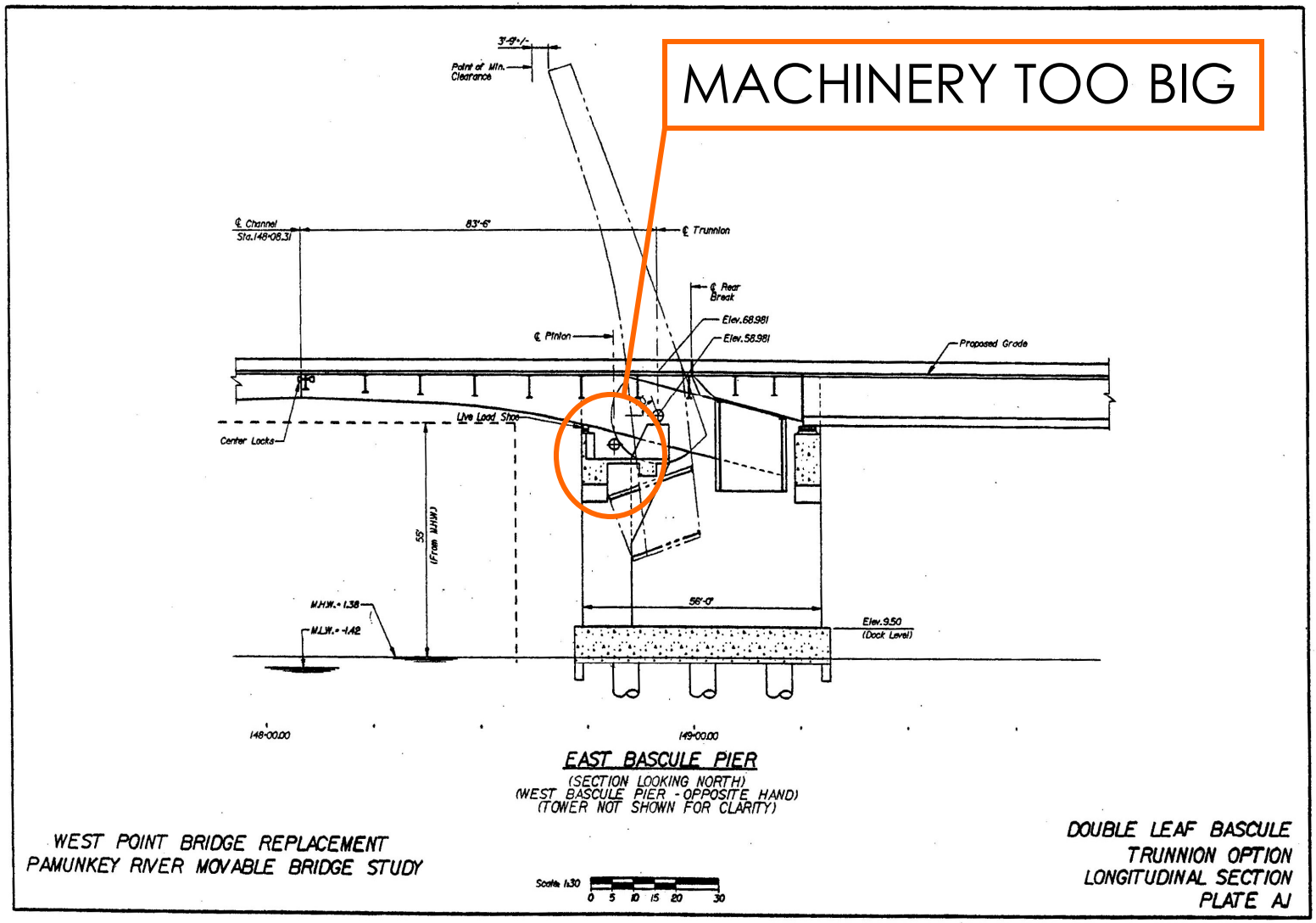


PAMUNKEY BRIDGE MACHINERY LAYOUT – ELEVATION

SCHEMES C & D

DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE

OPERATING MACHINERY



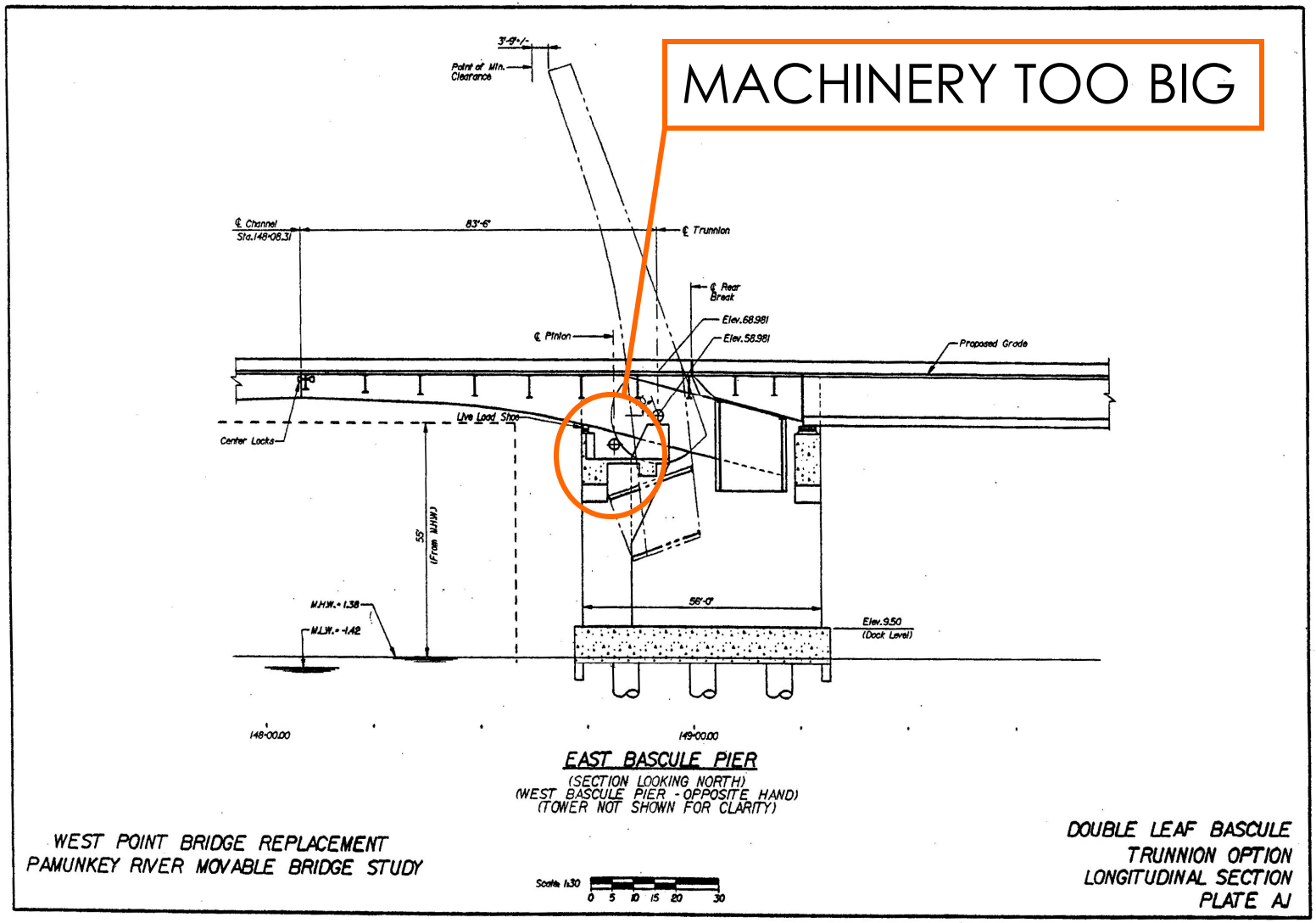
DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE

Reassess Redundancy

- TRADITIONAL - $2M
- REDUNDANT - $4M

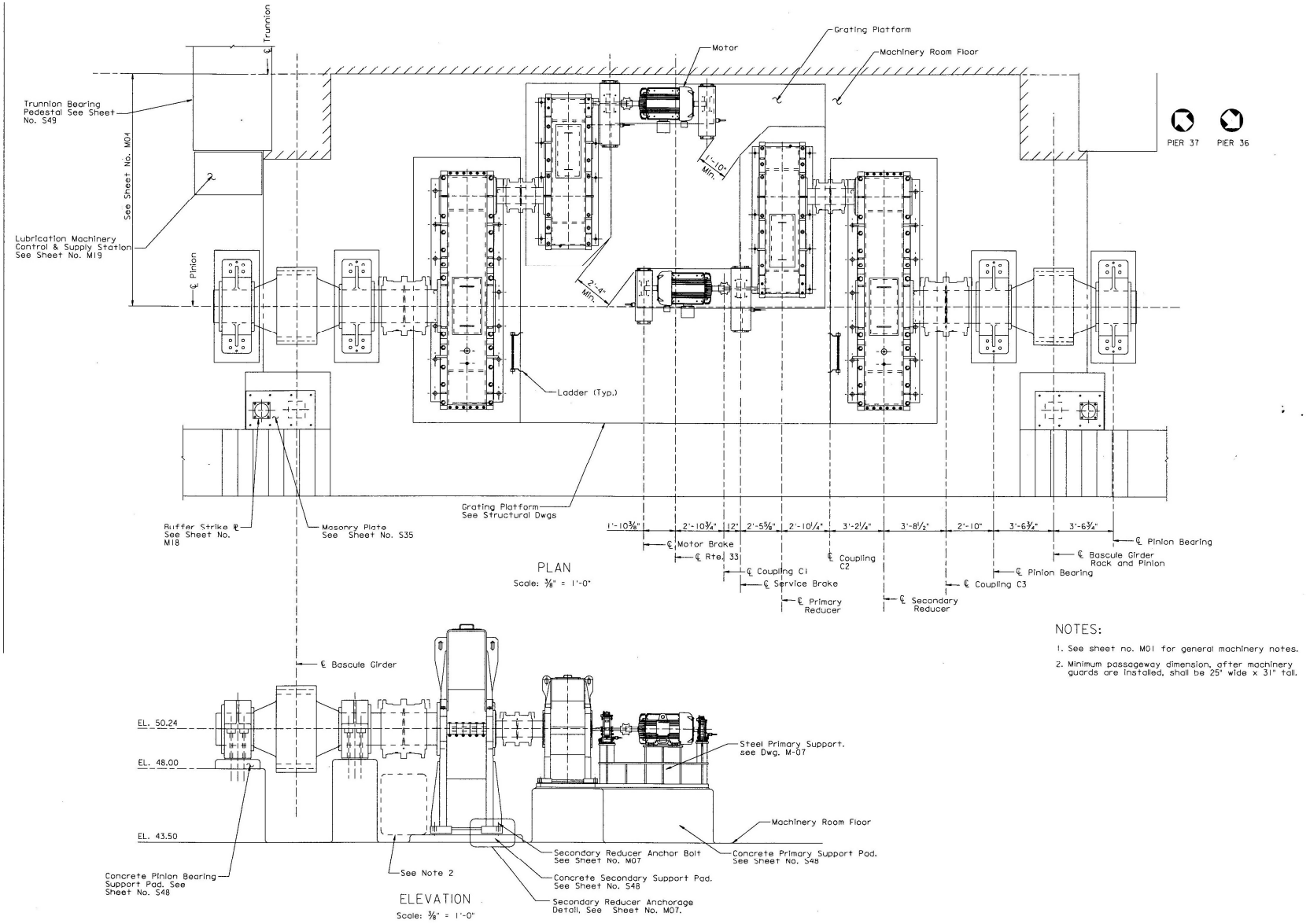
- INCRESES IN SUPERSTRUCTURE AND FOUNDATIONS ARE ADDITIONAL.

OPERATING MACHINERY



DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE

OPERATING MACHINERY

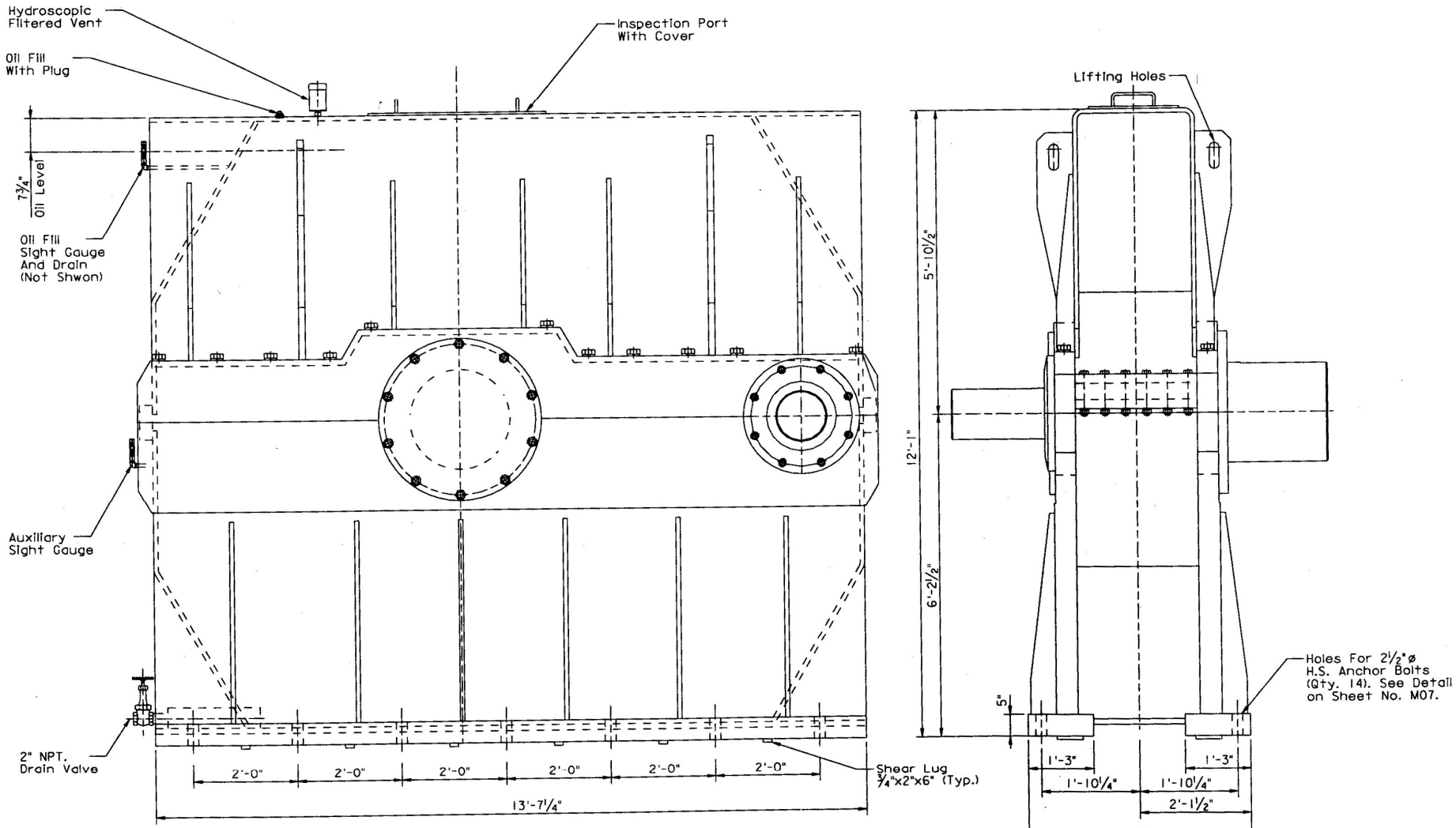


NOTES:

1. See sheet no. M01 for general machinery notes.
2. Minimum passageway dimension, after machinery guards are installed, shall be 25' wide x 31' tall.

DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE

SECONDARY REDUCERS



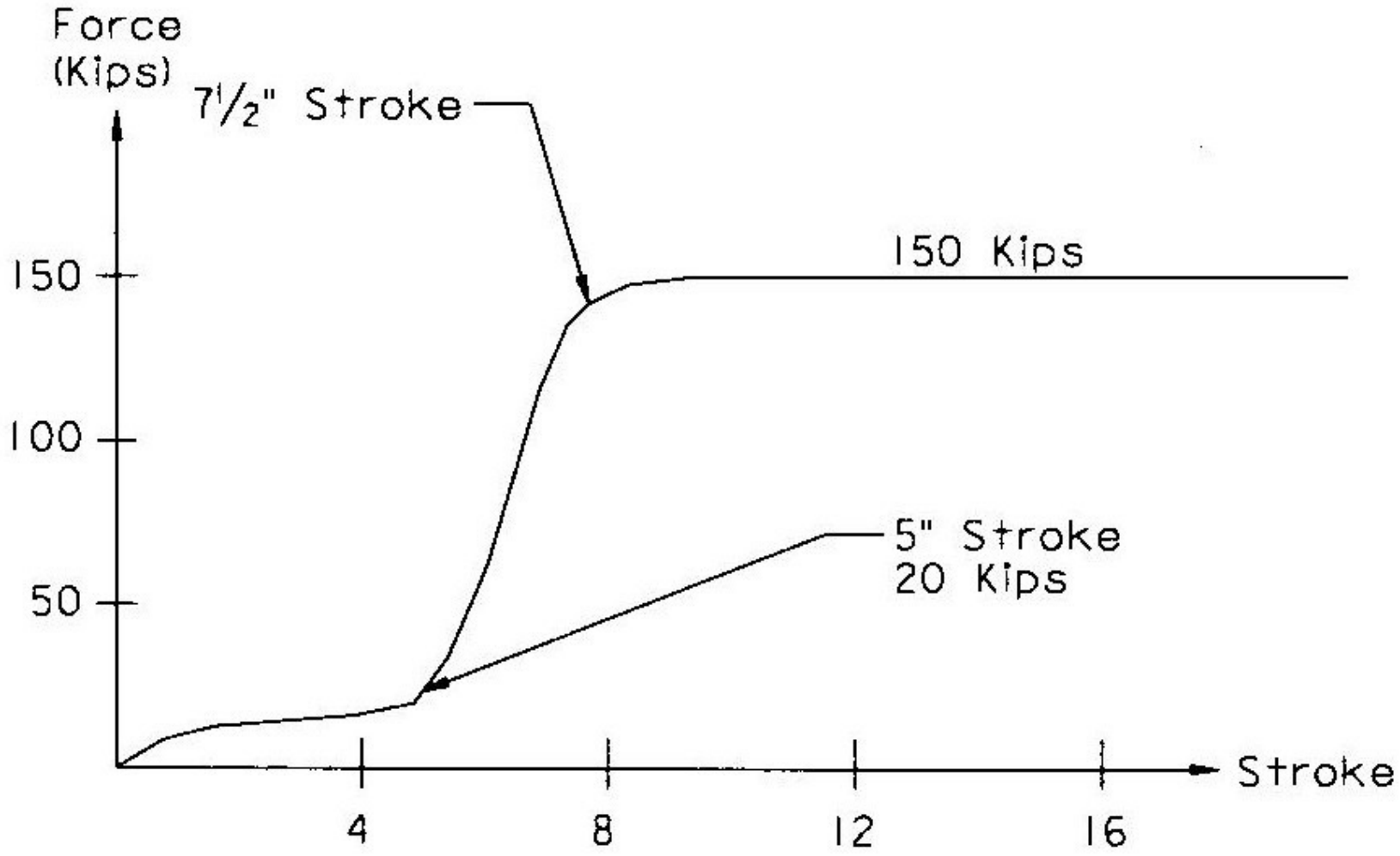
SECONDARY REDUCER - EARLE 16S
Scale: ¾" = 1'-0"
QTY: 2 AS SHOWN, 2 OPPOSITE HAND

DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE

BUFFERS & CONTROL SYSTEM

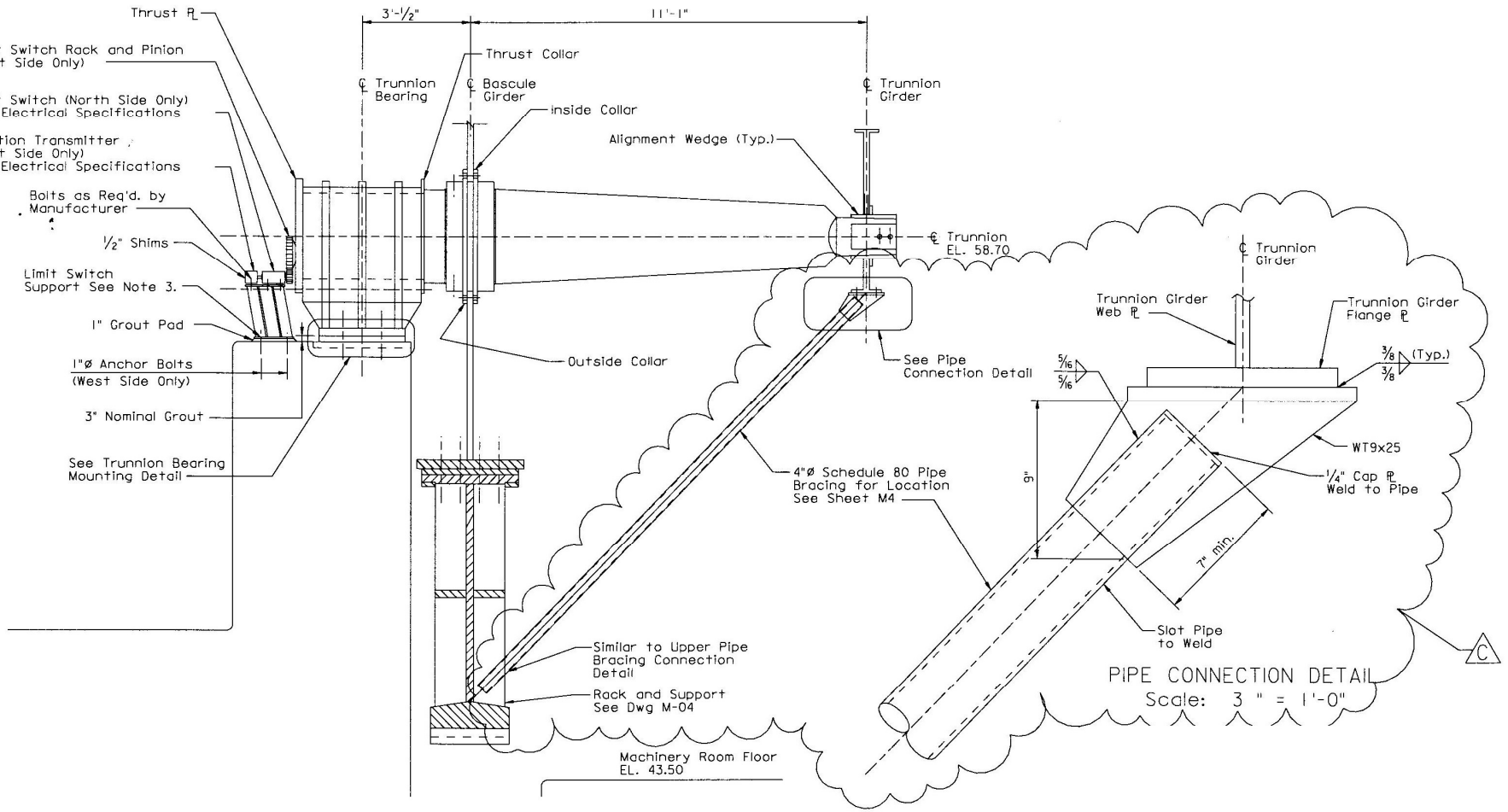
DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE

BUFFERS & CONTROL SYSTEM



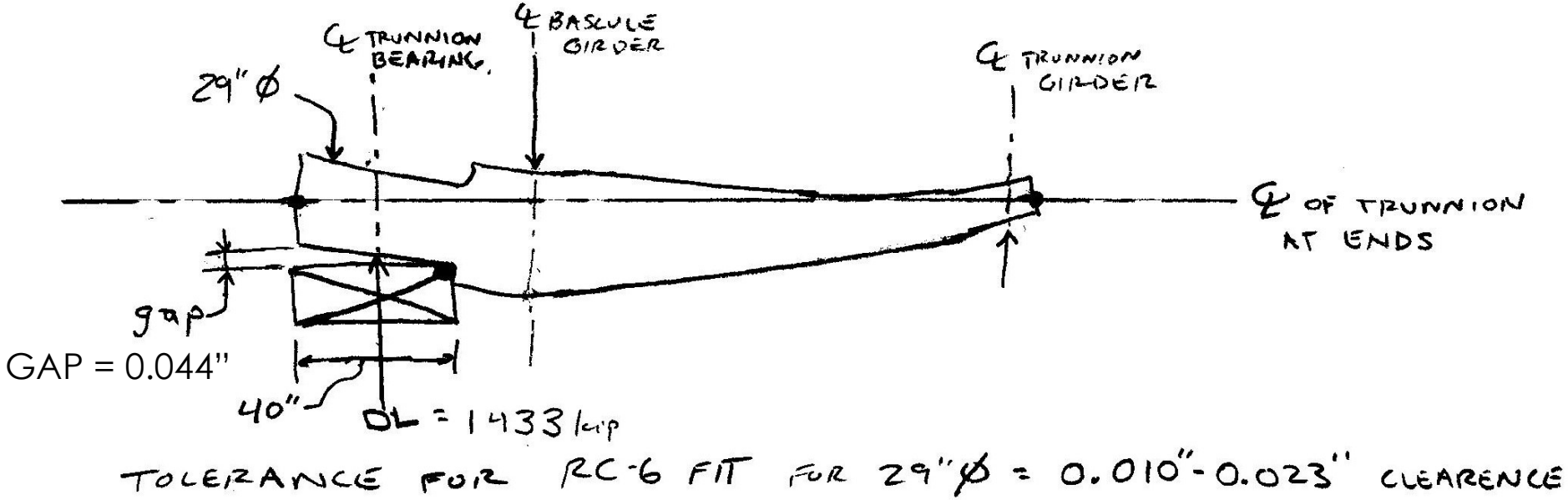
DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE

TRUNNIONS



DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE

TRUNNIONS


℄ TRUNNION BEARING
℄ BASCULE GIRDER
℄ TRUNNION GIRDER
29" ∅
℄ OF TRUNNION AT ENDS
gap
GAP = 0.044"
40"
OL = 1433 kip
TOLERANCE FOR RC-6 FIT FOR 29" ∅ = 0.010"-0.023" CLEARENCE

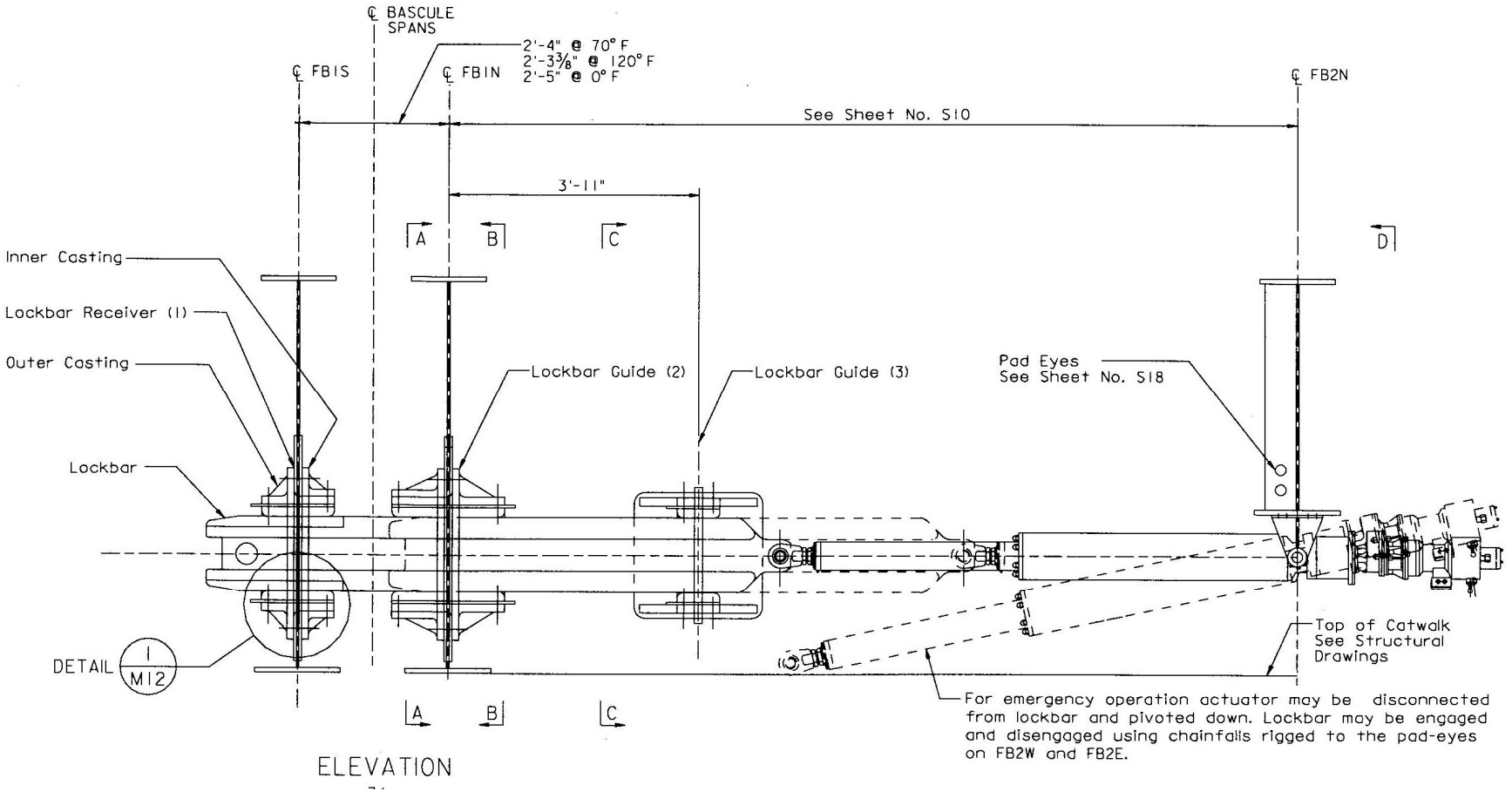
TRUNNIONS

DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE

ERASMUS BRIDGE

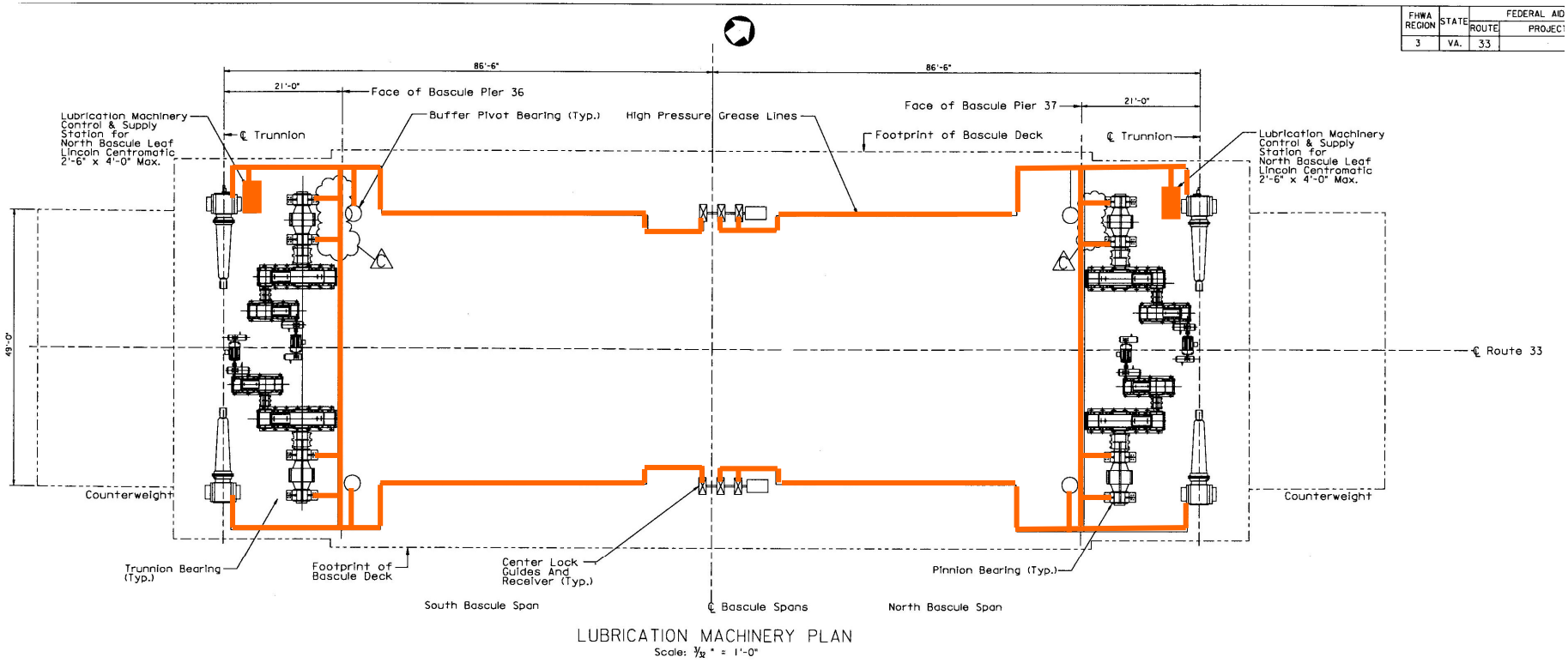
DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE

CENTER LOCKS



DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE

LUBRICATION SYSTEM



LUBRICATION MACHINERY PLAN

Scale: 1/32 " = 1'-0"

DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE

OUTLINE

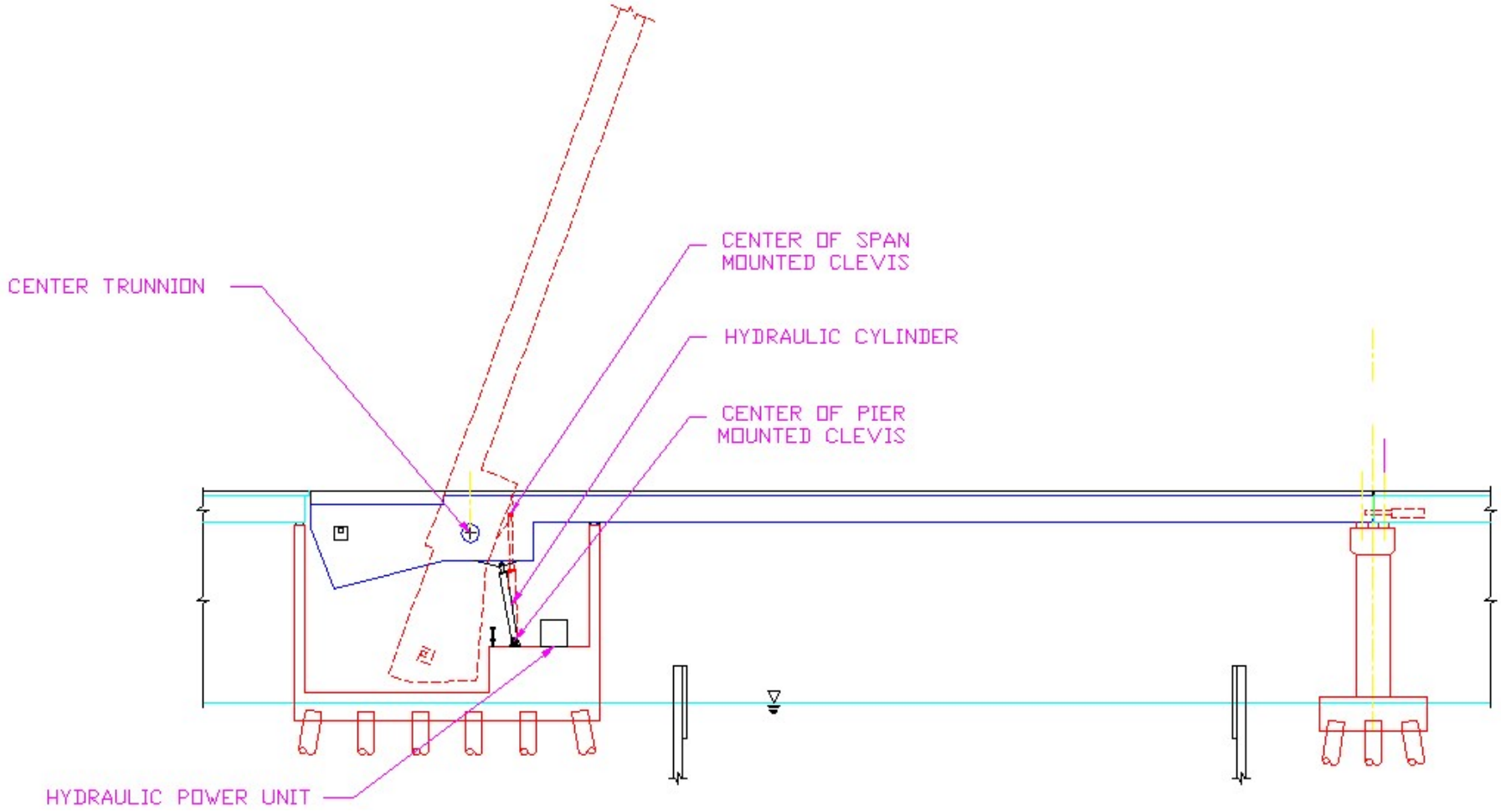
- PROJECT OVERVIEW
- MACHINERY DESIGN
- **APPENDIX**
  - A - PRIME MOVER SIZING
  - B - HYDRAULIC CYLINDER GEOMETRY

APPENDIX A - PRIME MOVER SIZING

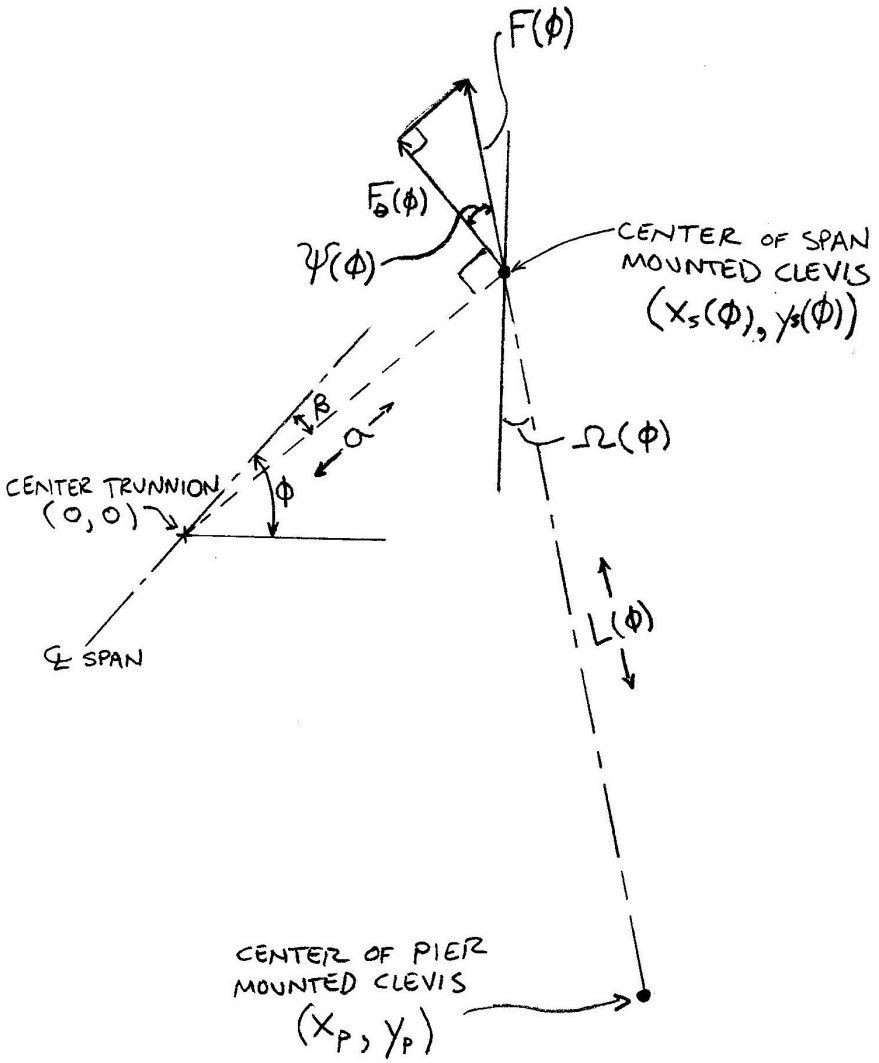
Table A.2 - Ratios of Minimum Required Power of Prime Movers, Using AASHTO 2000 Specs as the Baseline

	2000 AASHTO	1988 AASHTO Same Times for Load Cond. A, B & C	1988 AASHTO Different Times for Load Cond. A, B & C	Hydraulic Operating Machinery
Highway Bridge	100%	121%	56%	62%
Railroad Bridge	100%	119%	55%	74%
Pamunkey Redundant Layout	100%	115%	66%	84%
Pamunkey Traditional Layout	100%	95%	55%	

APPENDIX B – CYLINDER GEOMETRY



APPENDIX B – CYLINDER GEOMETRY



COORDINATES OF CYLINDER ^ CLEVISES

PIER MOUNTED (FIXED) ^ CLEVIS:

$$X_p = a\cos(\beta) + L_o\sin(\Omega_o)$$

$$Y_p = a\sin(\beta) + L_o\cos(-\Omega_o)$$

SPAN MOUNTED CLEVIS:

$$X_s(\phi) = a\cos(\phi - \beta)$$

$$Y_s(\phi) = a\sin(\phi - \beta)$$

CYLINDER LENGTH:

$$L(\phi) = \sqrt{(X_p - X_s(\phi))^2 + (Y_p - Y_s(\phi))^2}$$

THRUSTING ANGLE:

$$\psi(\phi) = \cos\left(\frac{(Y_s(\phi) - Y_p)}{L(\phi)}\right) - (\phi - \beta)$$

EFFECTIVE CYLINDER THRUST:

$$F_\theta = M(\phi)/a$$

ACTUAL CYLINDER THRUST:

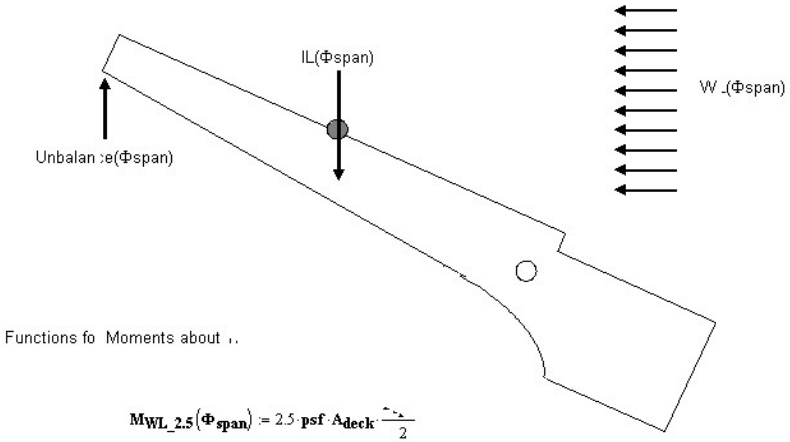
$$F = F_\theta/\cos(\psi(\phi))$$

APPENDIX B – CYLINDER GEOMETRY

PARSONS BRINCKERHOFF
COMPUTATION SHEET

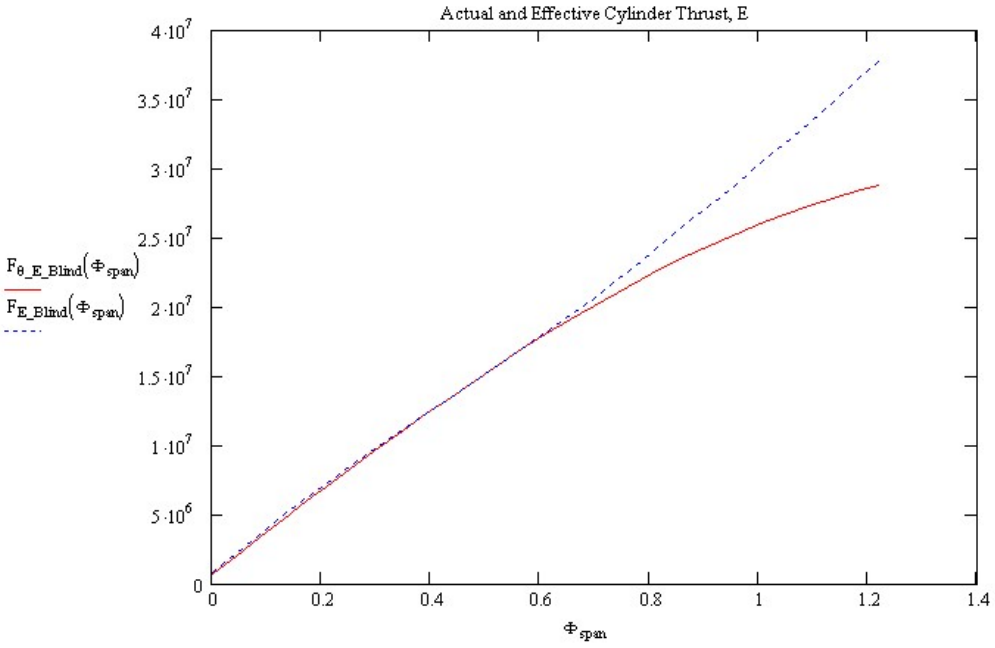
Page M10 of
Made by Scott Snelling
Date 11.06.2003
Checked by
Date

Subject Pamunkey Bridge
Wind Load, Ice Load, and Unbalance as a Function of Span Angle



Functions fo Moments about ,.

$$M_{WL\_2.5}(\Phi_{span}) := 2.5 \cdot psf \cdot A_{deck} \cdot \frac{\cdot}{2}$$



DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE

AKNOWLEDGEMENTS

- VDOT

  Milton Pritchet (PM), Bob Jacobus (Mech)

- PB

  Fred Parkinson (PM & Struc)

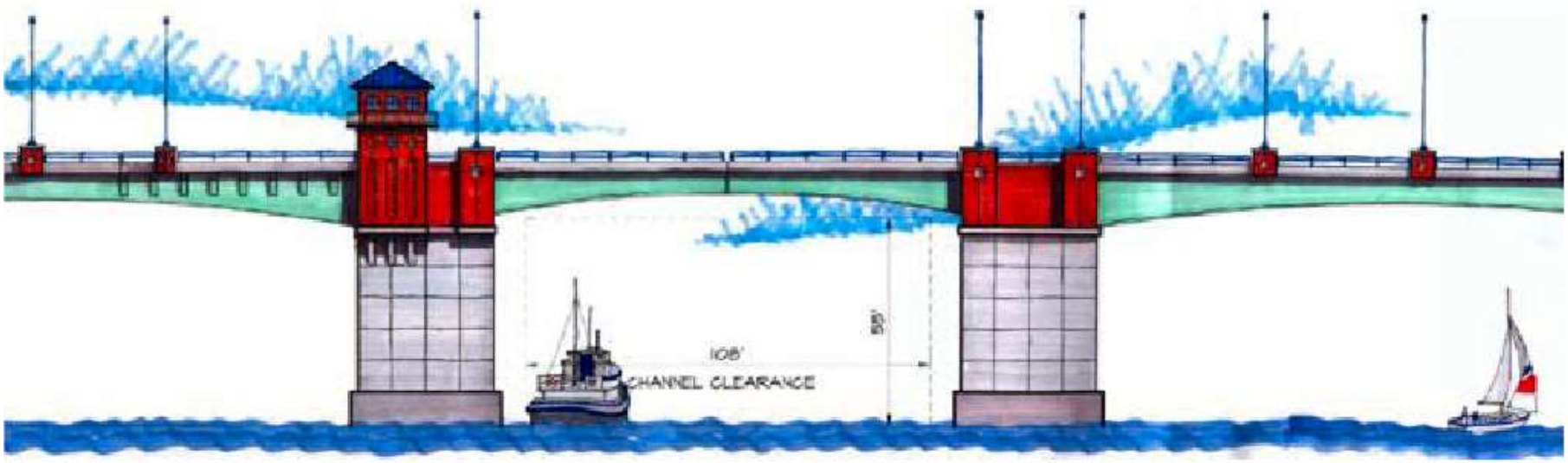
  Mike Abrahams & Bill Kam (Mech)

  Mark VanDeRee, Rick Newcomb, Akbar Siddiqui, and James Chin (Elec)

- VENDORS

  James Alison, Steward Machine; Craig Winters, Taylor Devices;
  Rich Thomas, RACO International; Bobby Harris, Lincoln Industrial;
  Gill Detweiler, SKF

QUESTIONS?



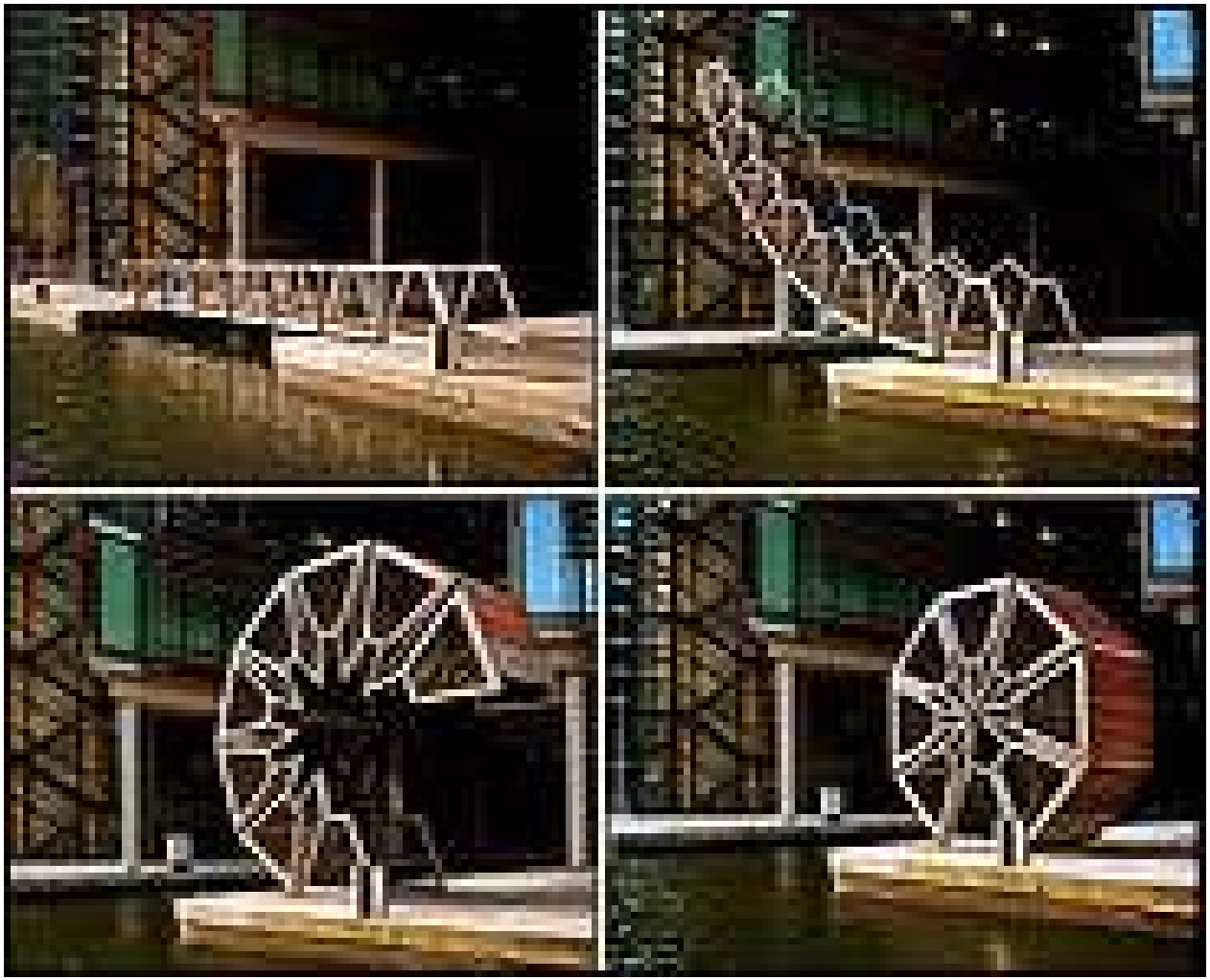
QUESTIONS?

- PROJECT OVERVIEW
  - PROJECT LOCATION
  - STUDY
- MACHINERY DESIGN
  - OPERATING MACHINERY
  - BUFFERS & CONTROL SYSTEM
  - TRUNNIONS
  - CENTER LOCKS
  - LUBRICATION SYSTEM
- APPENDIX
  - PRIME MOVER SIZING
  - HYDRAULIC CYLINDER GEOMETRY

PADDINGTON BASIN

DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE

PADDINGTON BASIN



DESIGN OF MACHINERY FOR PAMUNKEY BRIDGE