Technical Inputs to Dredging Estimates

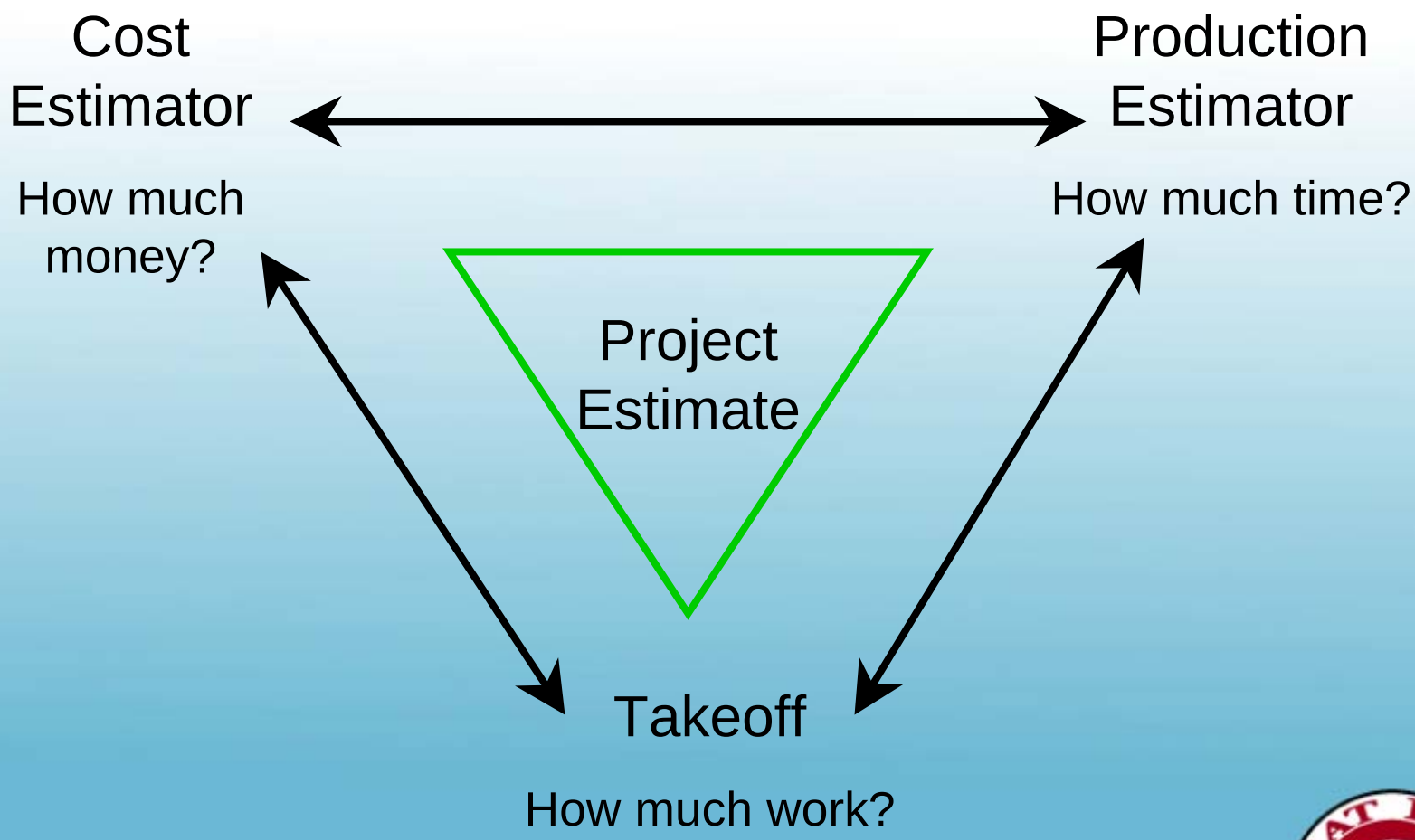
Robert Ramsdell

Manager of Production Engineering

Great Lakes Dredge & Dock

Production Engineering

- Estimate the productivity of dredging equipment
- Work to improve productivity on ongoing projects
- Evaluate the design of new and upgraded equipment


Cost Estimator
How much money?
Production Estimator
How much time?
Project Estimate
Takeoff
How much work?

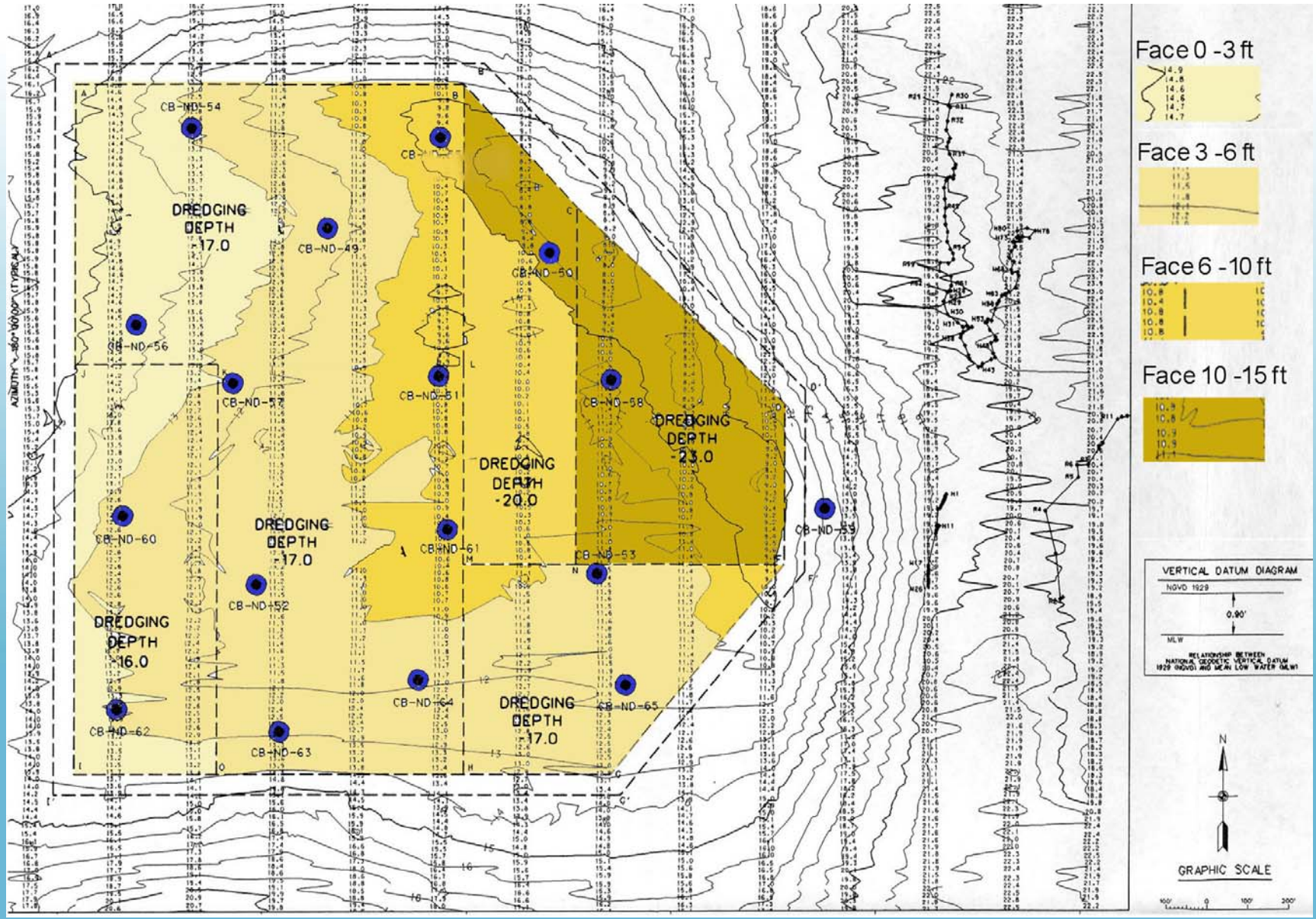
Cost Estimator

Answers the Question:
How much will the project cost?

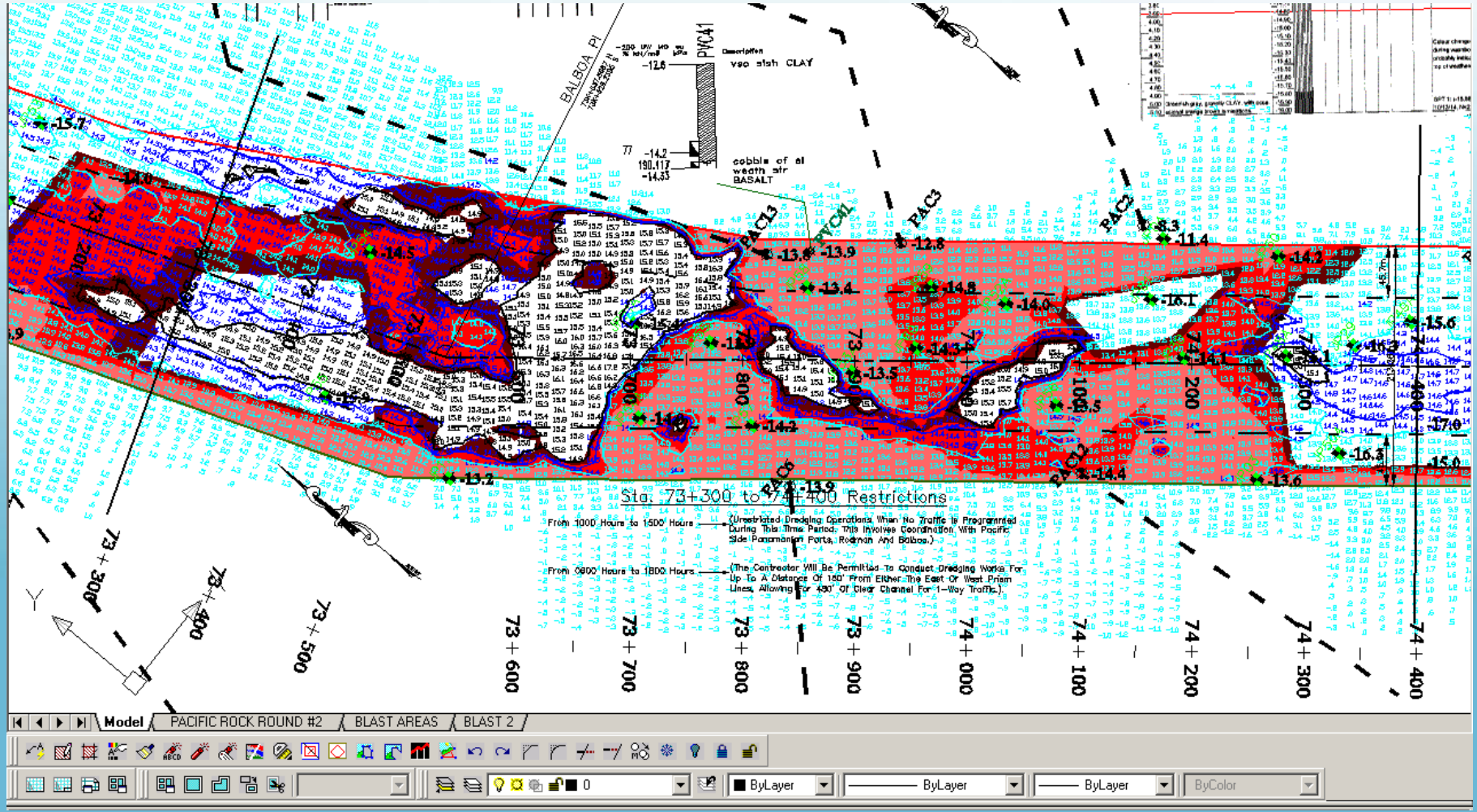
Cost Estimator

- Mobilization, subcontract & supply costs
- Daily cost for dredging plant
- Lays out estimate

Dredging Area Plan



Rock Contours



Takeoff

Answers the Question:

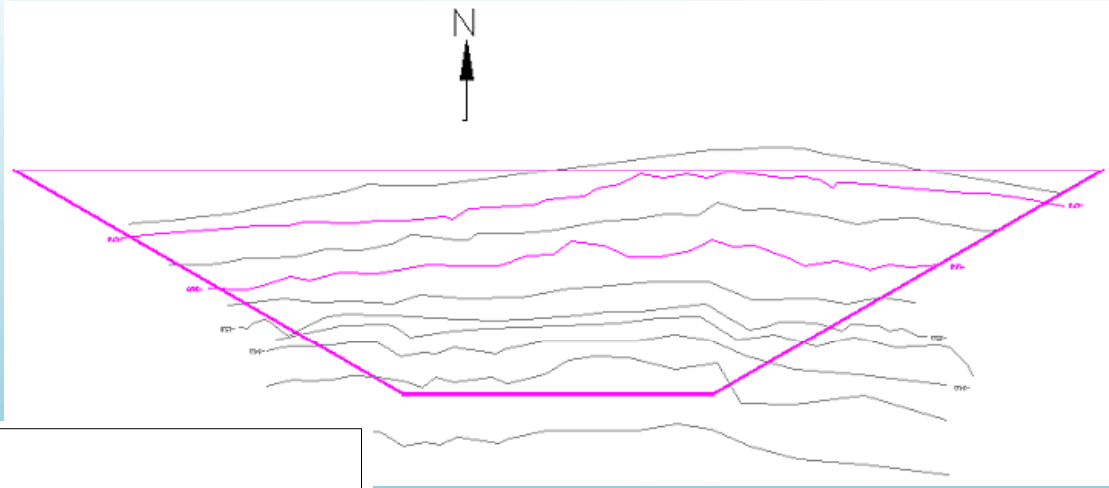
How much work is there to do?

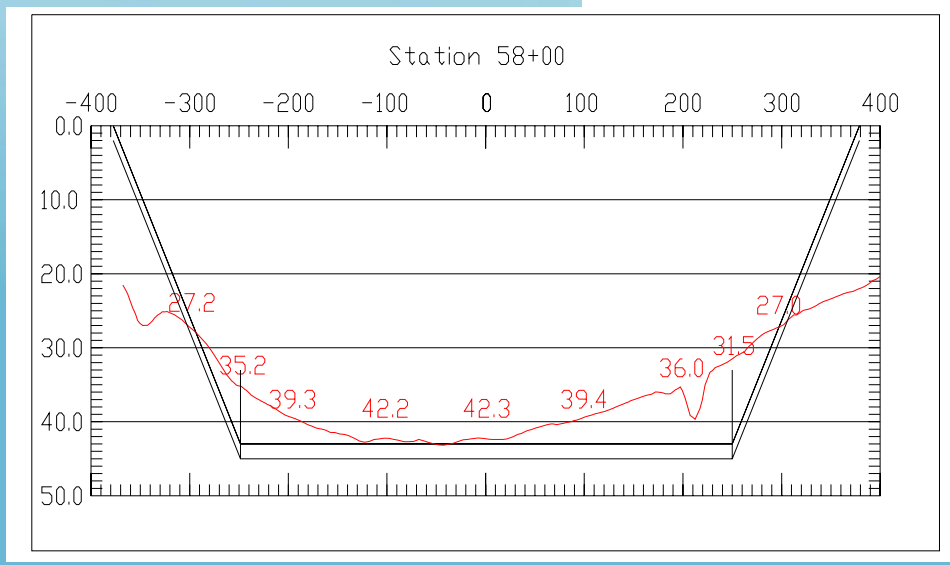
Takeoff – Dredge/Borrow Area

- Dredge & fill quantities (CY)
- Material quantities/breakout (CY)
- Area to be dredged or filled (SF)
- Pipeline/Sail/Haul Distances (LF/NM)

Takeoff: Project Layout

Maps





Cross-Sections
& Profiles

Production Estimator

Answers the Question:

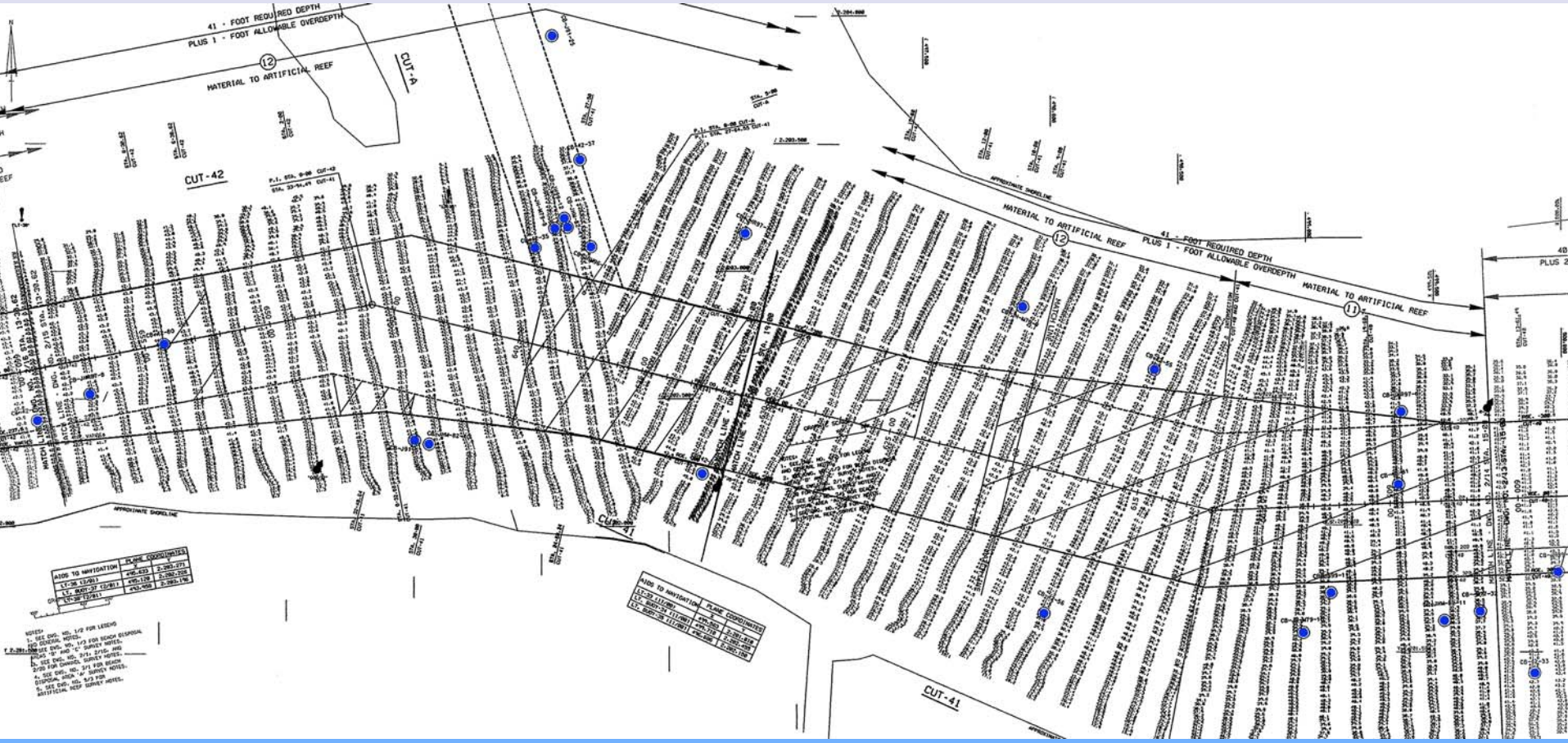
How long will the project take?

Production Estimator

Evaluate Geotechnical Information:

- Adequacy of the information
- Material Types
- Strength
- Size

Evaluating Materials



- Are there enough borings?
- Are there enough useful tests?

Production Estimator

Productivity of equipment

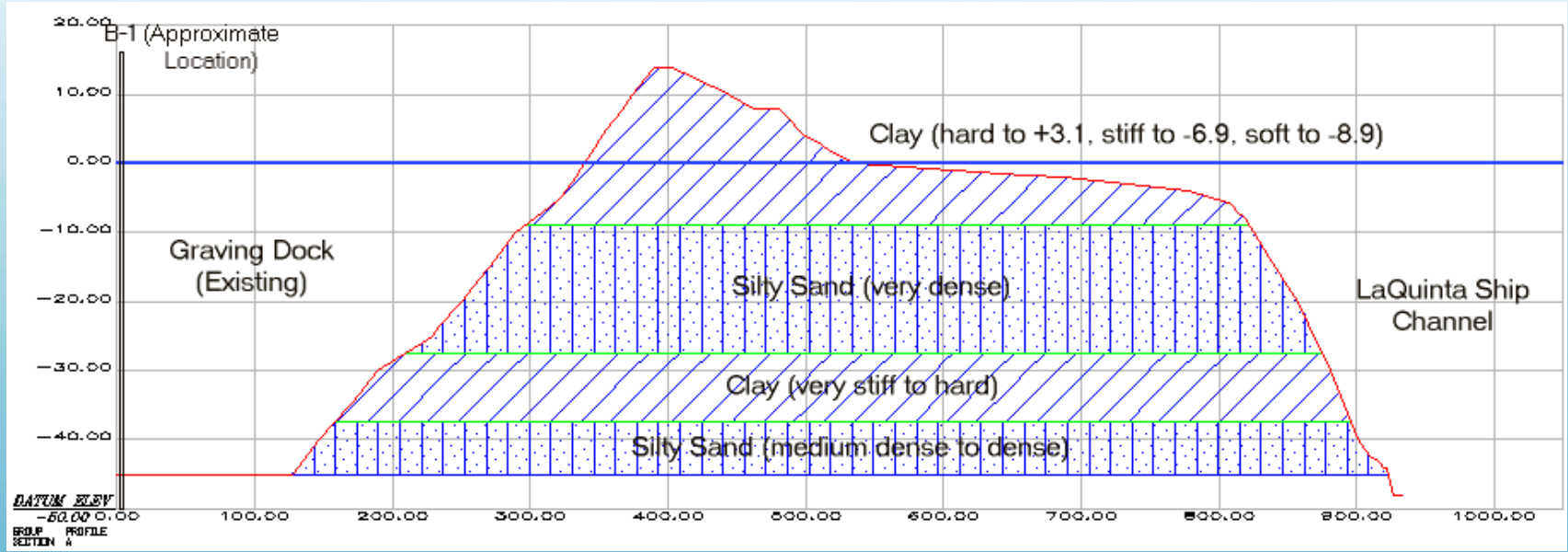
- CSD vs Hopper vs Mechanical
- Digging versus pumping for each section of the project
- References to similar past projects

Time = Qty/Production

Crucial Variables for Production

- Material Type
  - Strength
  - Grain Size
  - Extents/Distribution
- Face/Thickness
- Pipeline Length

Material Classification

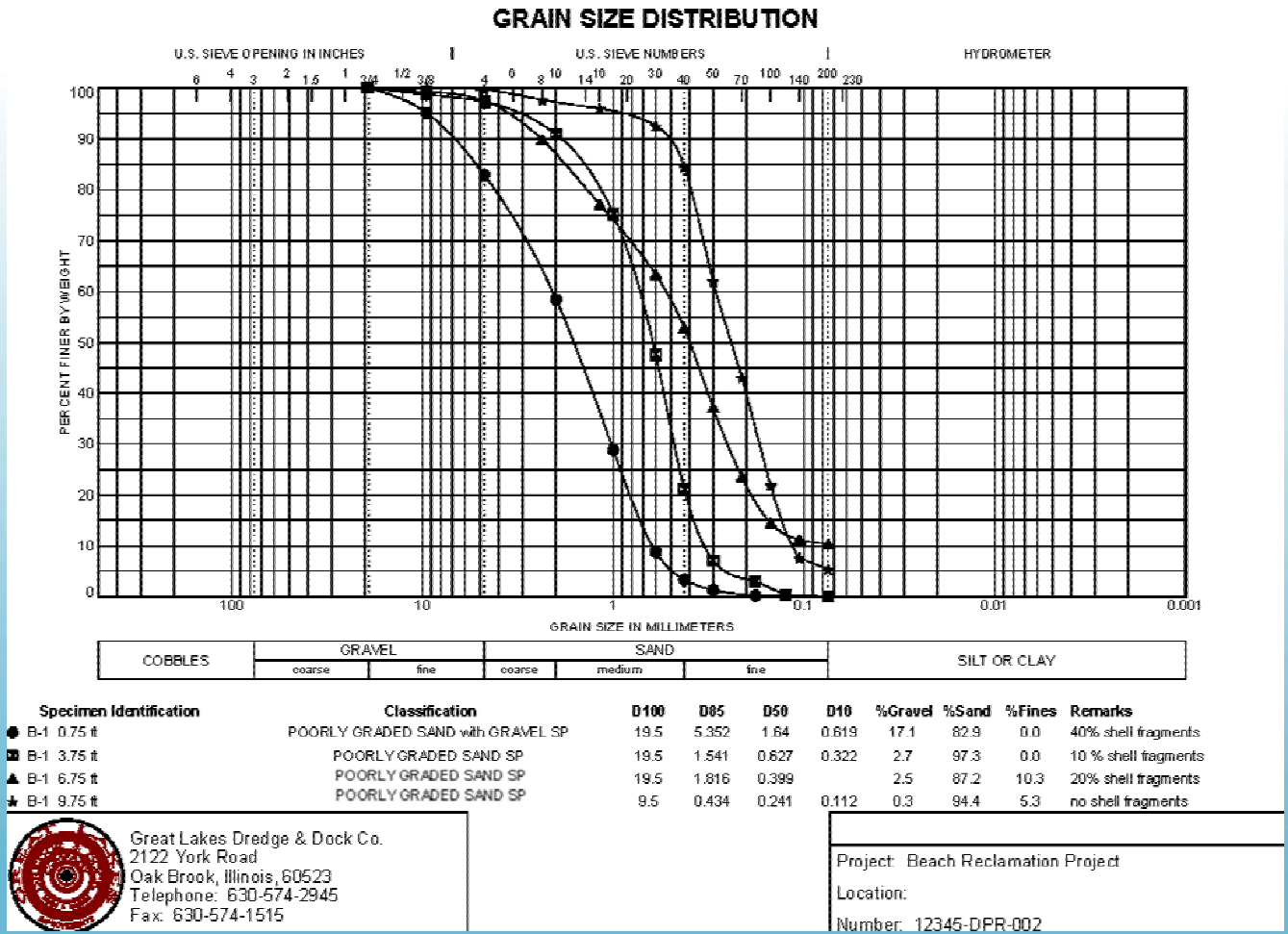


Material Strength

- Standard Penetration Test
- Compressive, tensile or shear strength

Indicative or non-standard tests are no substitute for proper tests!

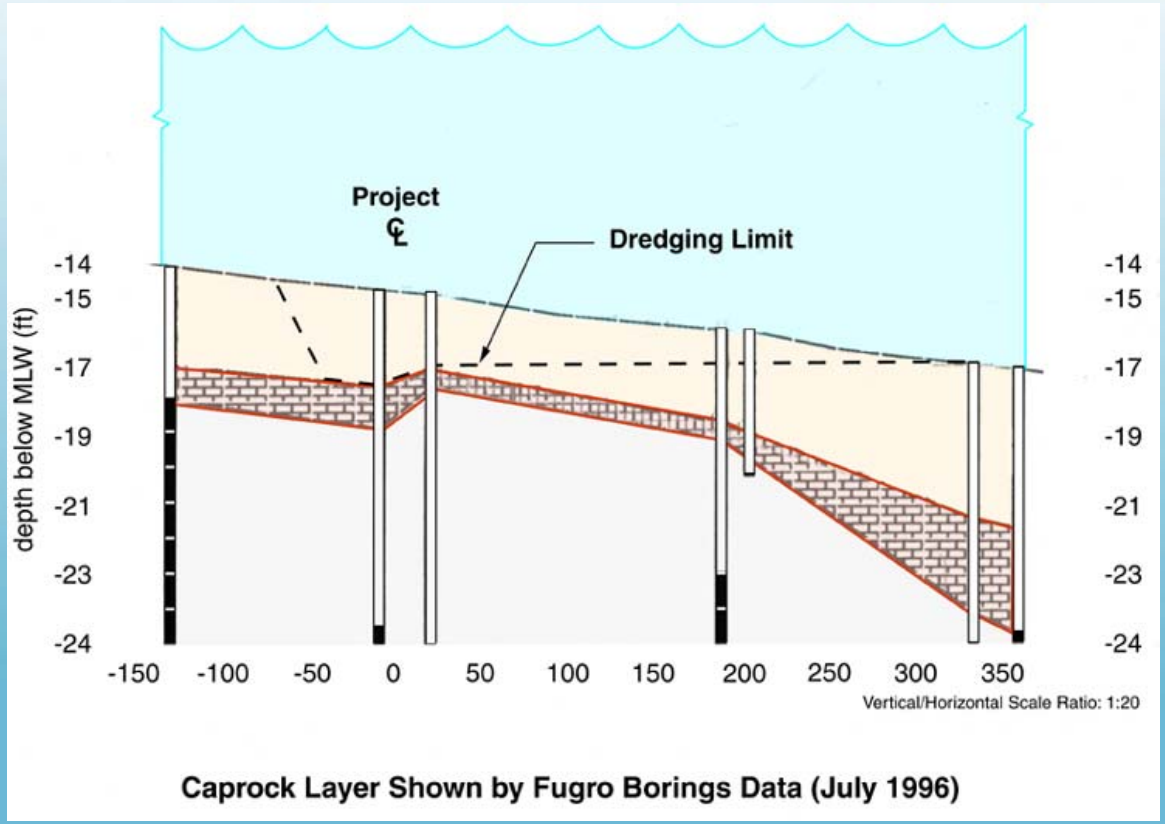
Grain Size Distribution



Important in determining how well the material can be pumped.

Material Type

The Perils of Poor Information



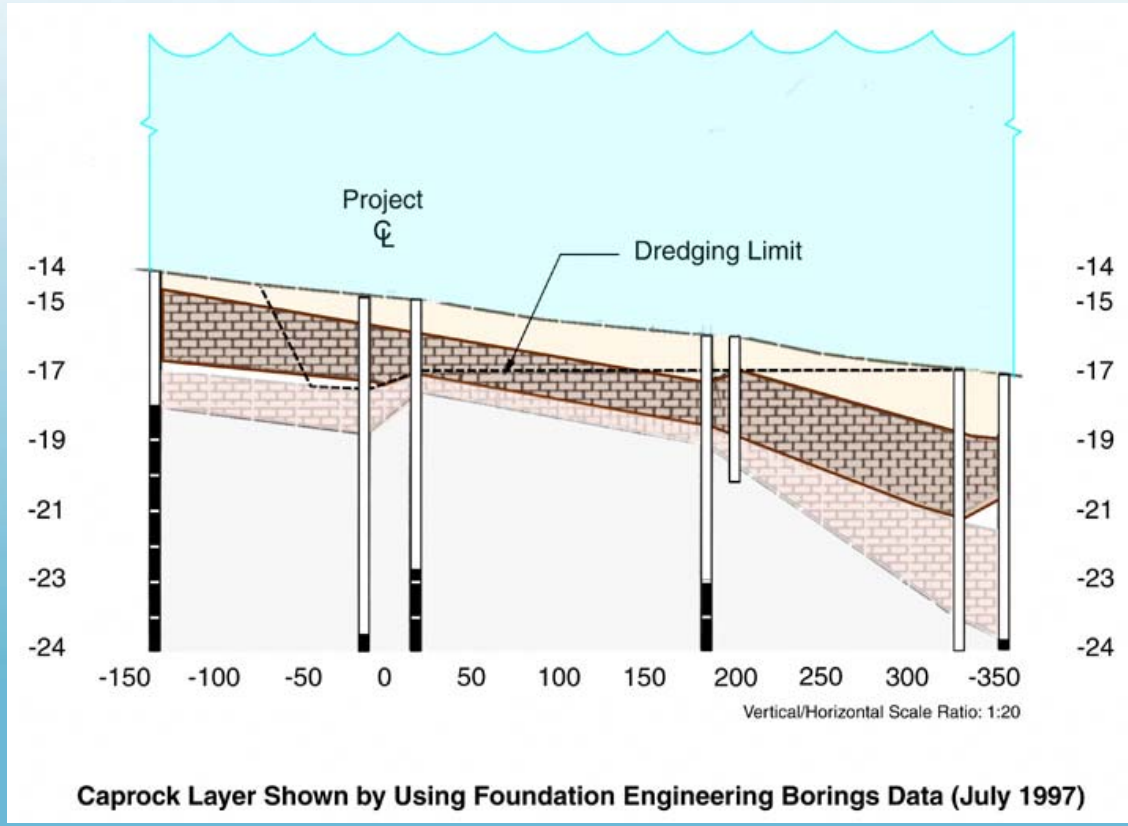
Caprock Layer Shown by Fugro Borings Data (July 1996)

Estimate: 1438 m^3/WH

Estimate: 5 Teeth/Day

Material Type

The Perils of Poor Information



Caprock Layer Shown by Using Foundation Engineering Borings Data (July 1997)

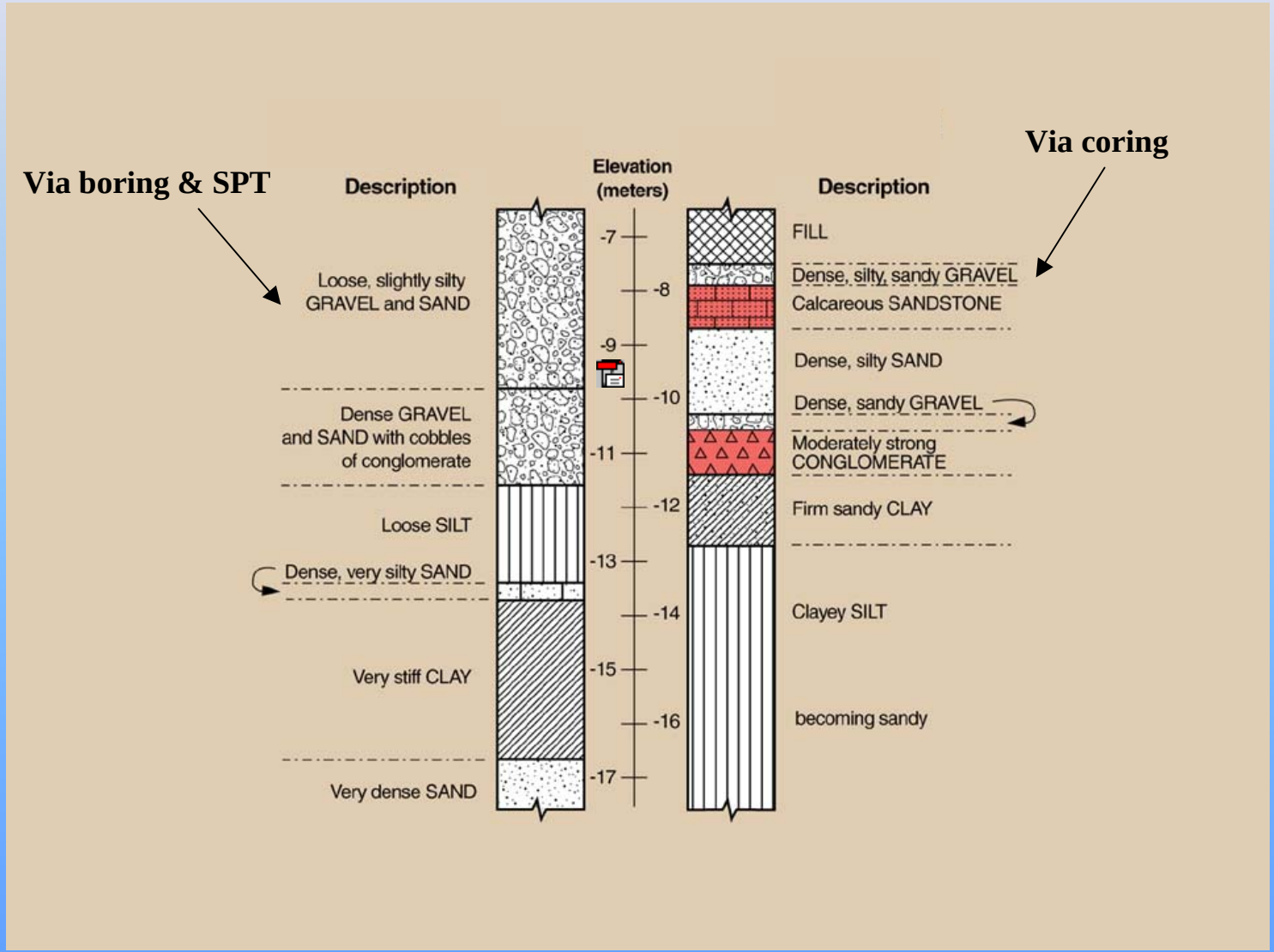
Estimate: 1440 m^3/WH

Actual: 605 m^3/WH

Estimate: 5 Teeth/Day

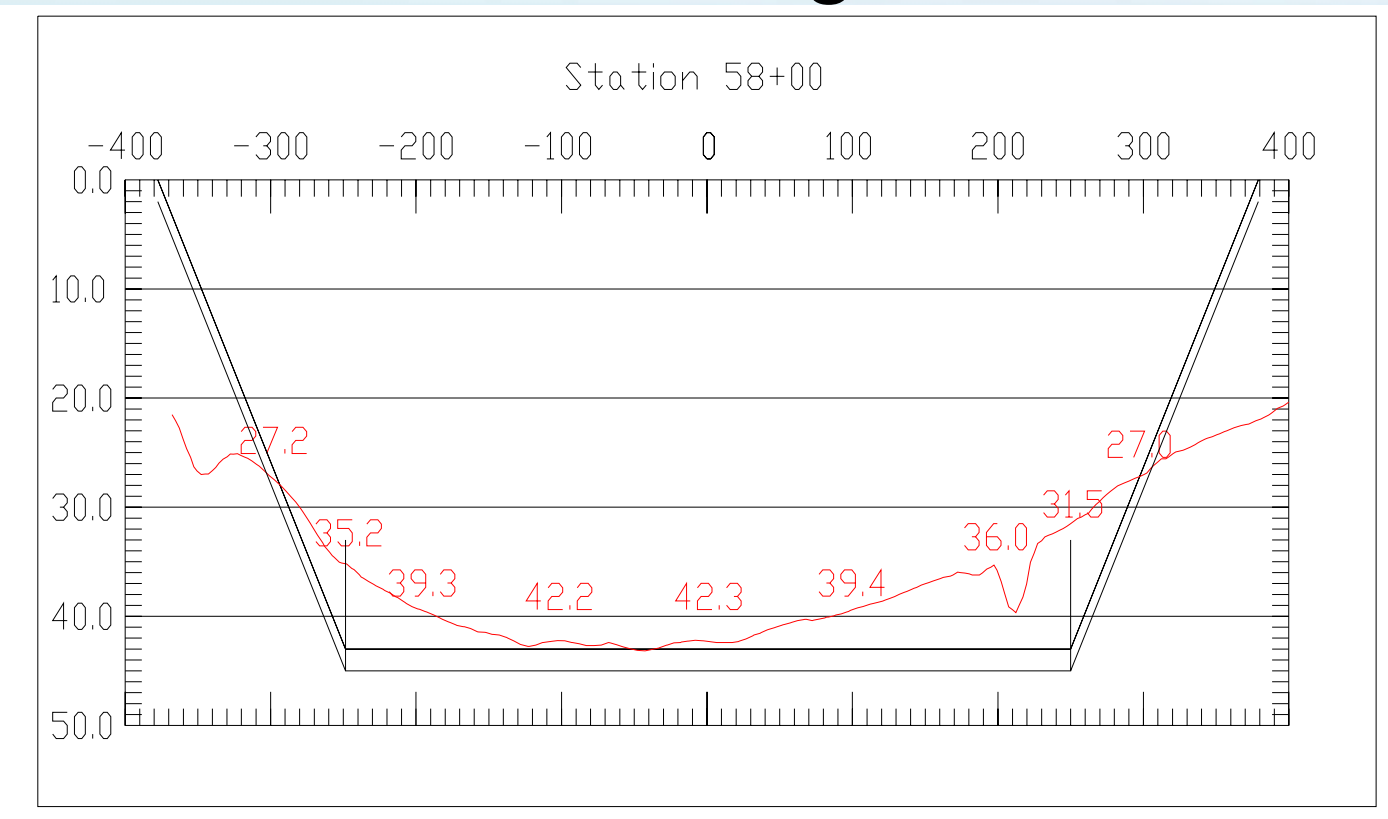
Actual: 104 Teeth/Day

SPT vs. CORING

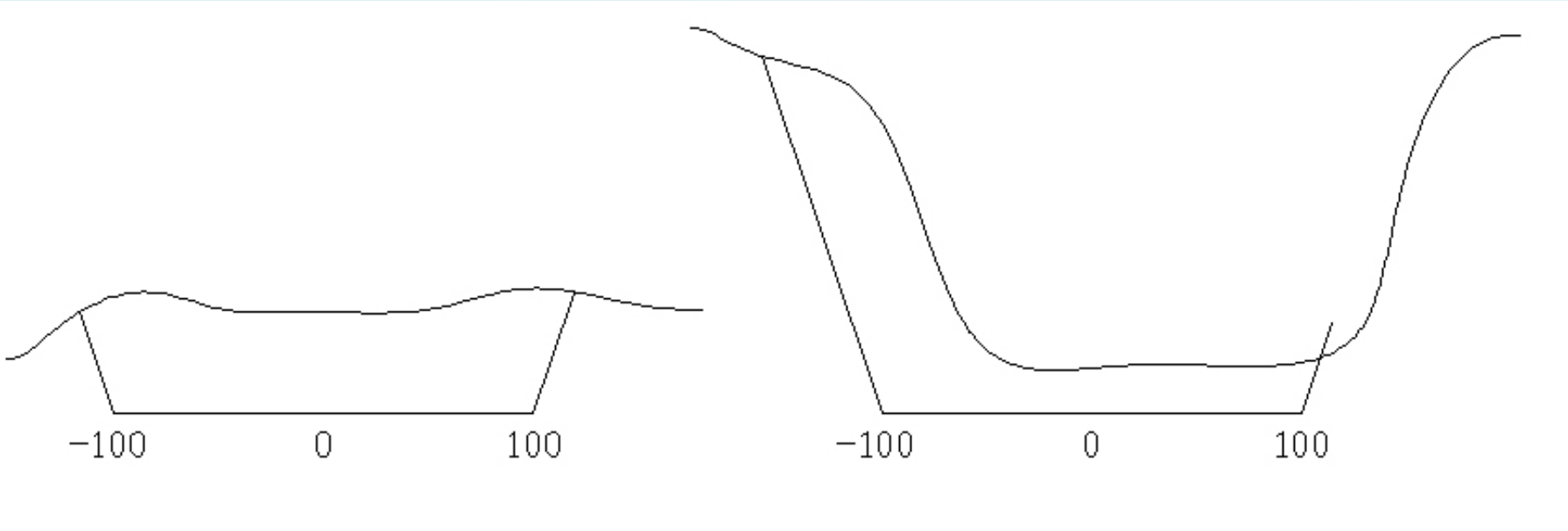


Bank Height – Face

The thickness of material to be dredged.

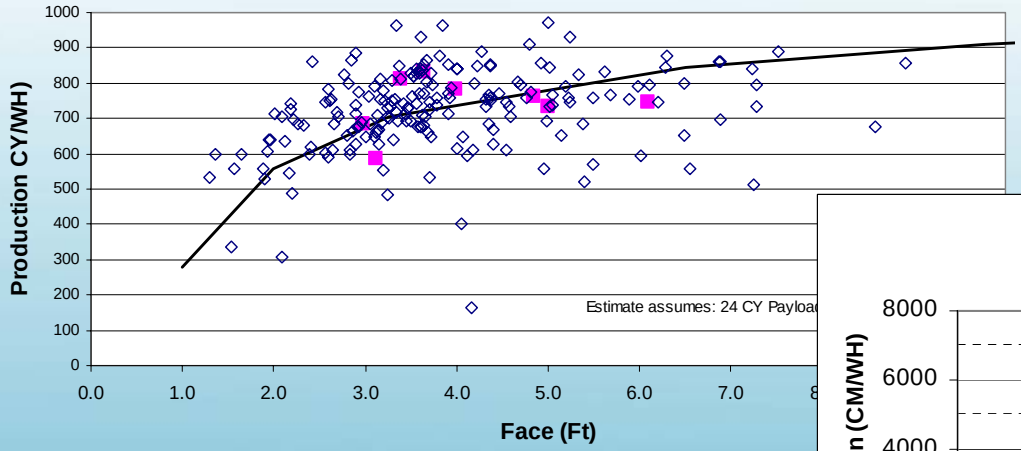


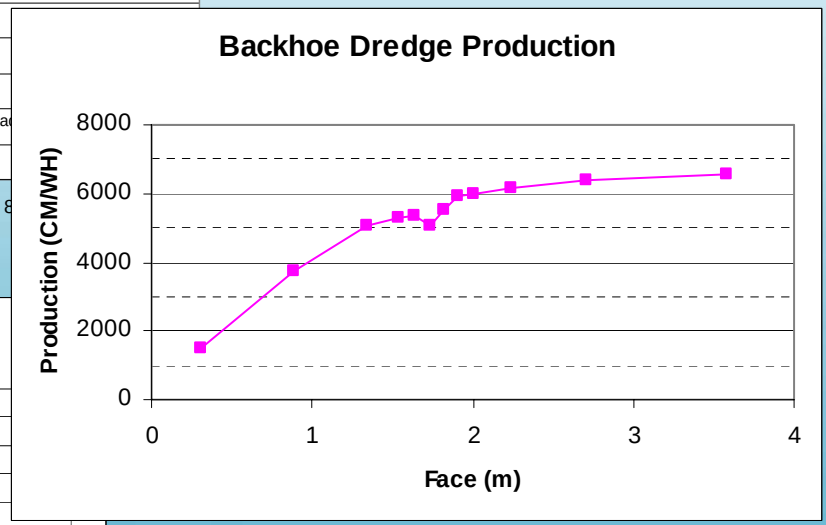
Layout of Face

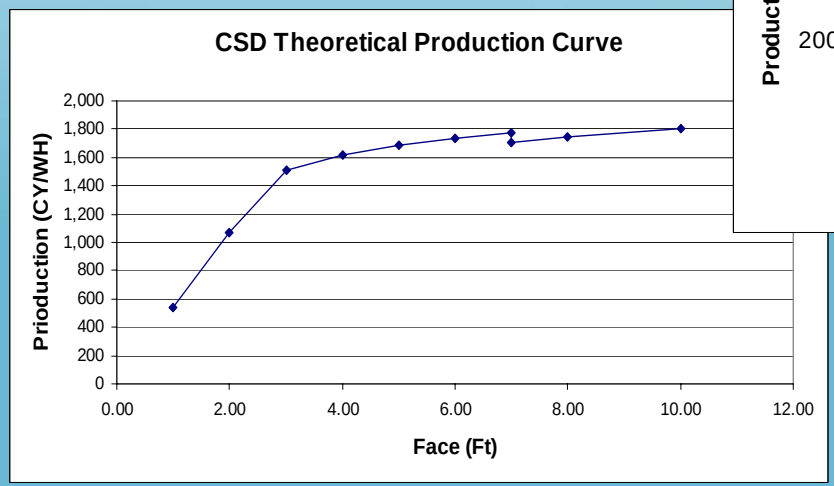


Similar cross-sectional area, but layout requires two different digging methods.

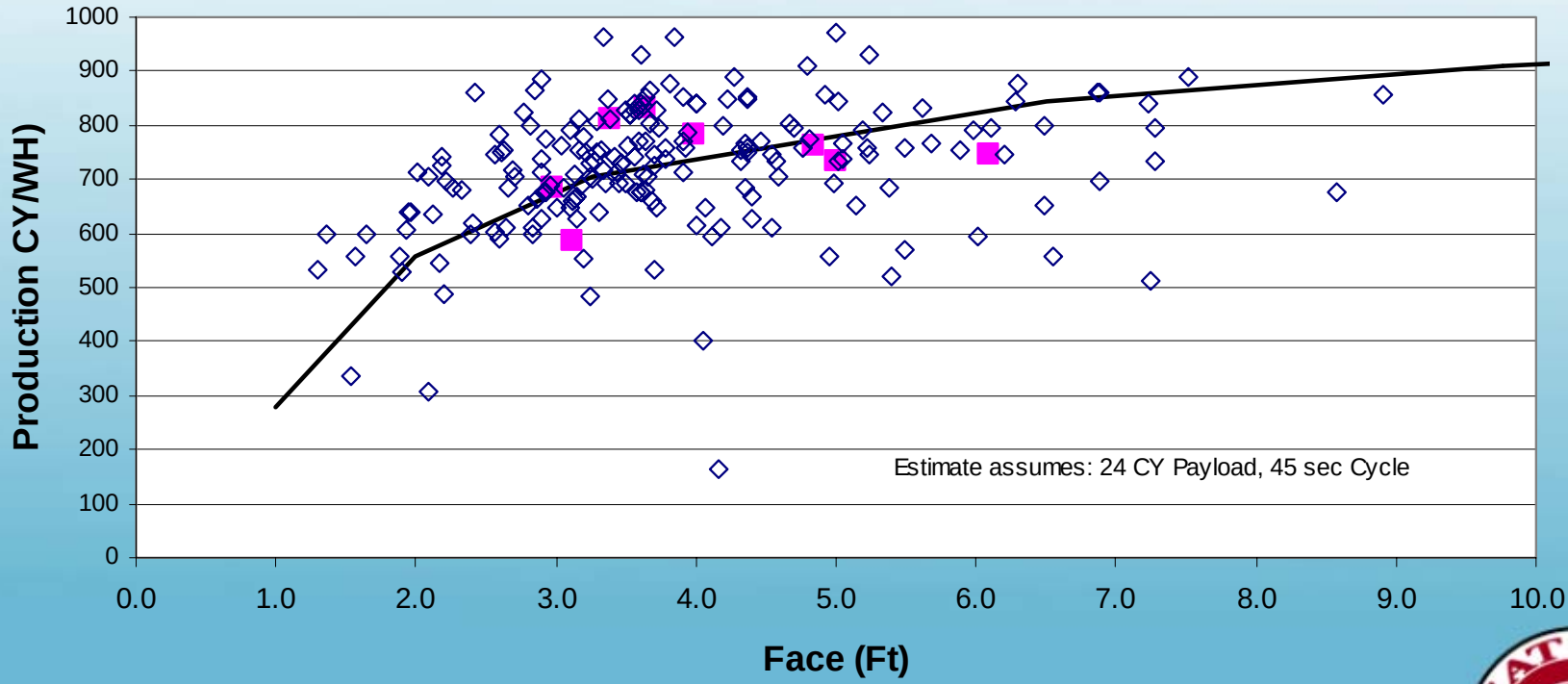
Production vs Face



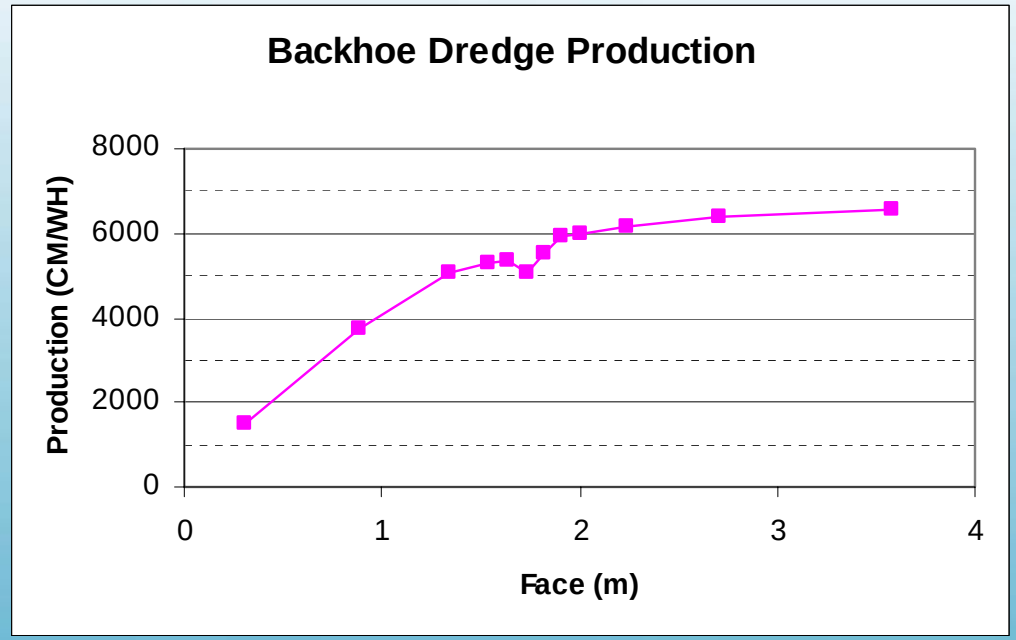




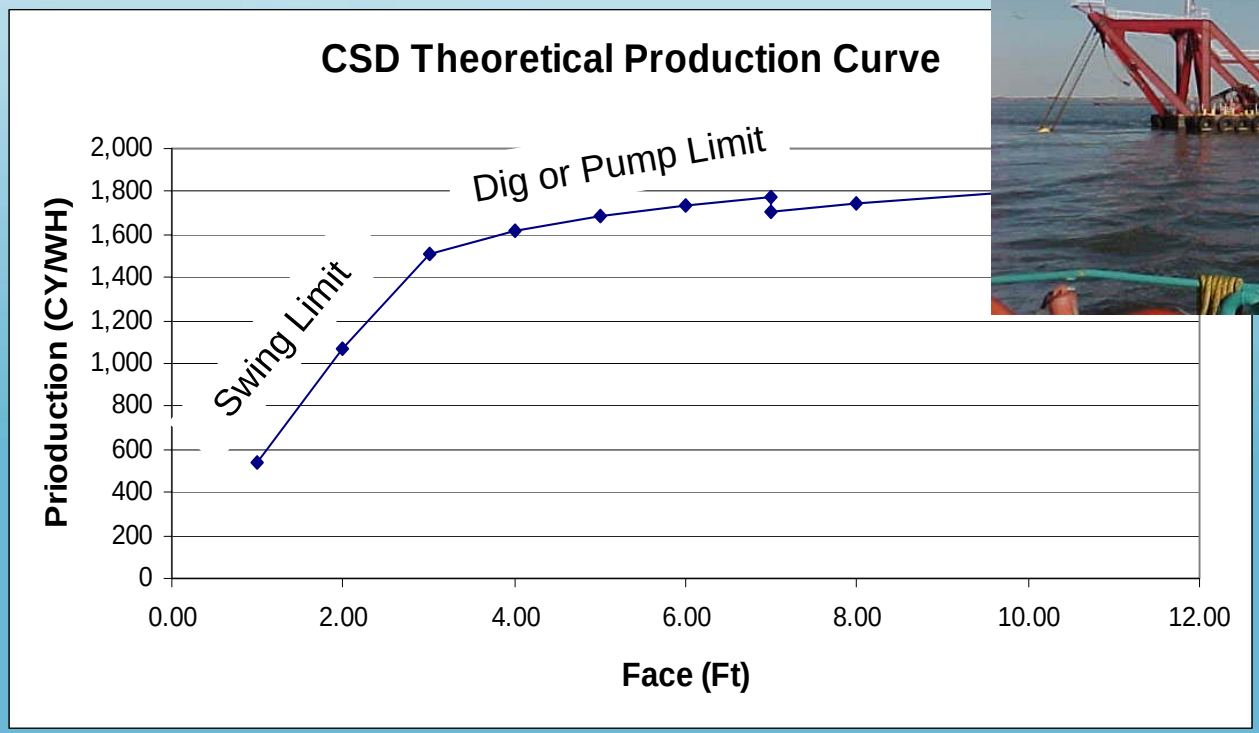
Bucket Dredge Production Curve



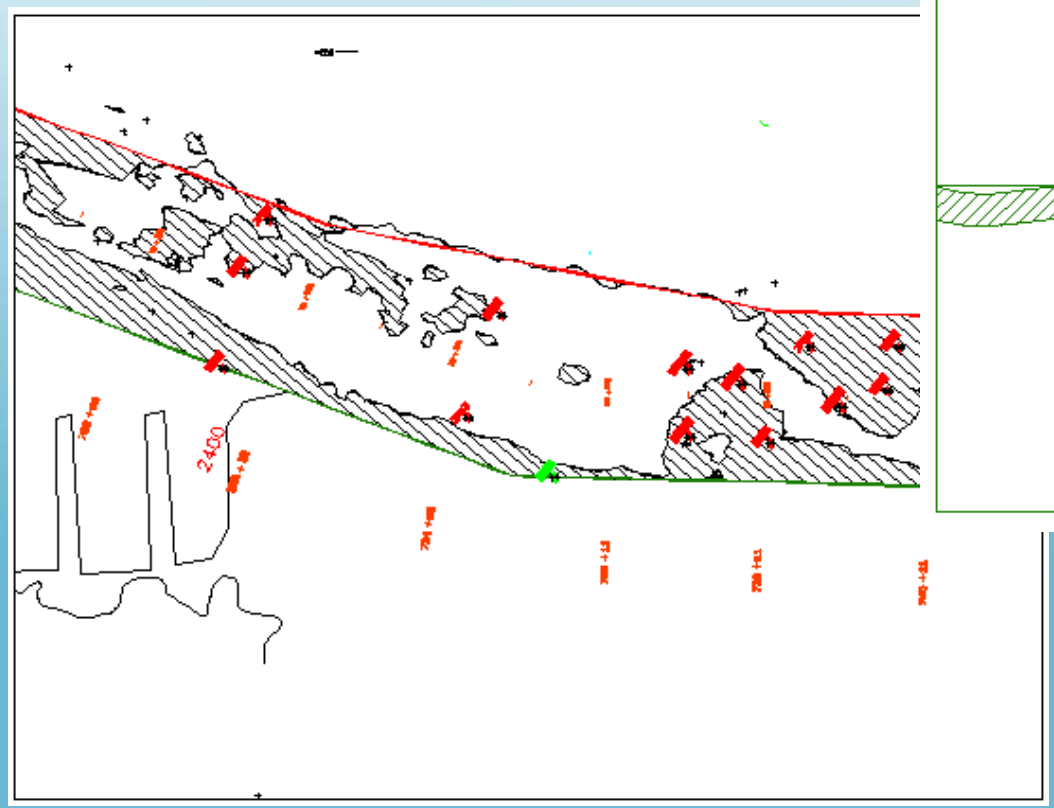
Backhoe Dredge Production Curve

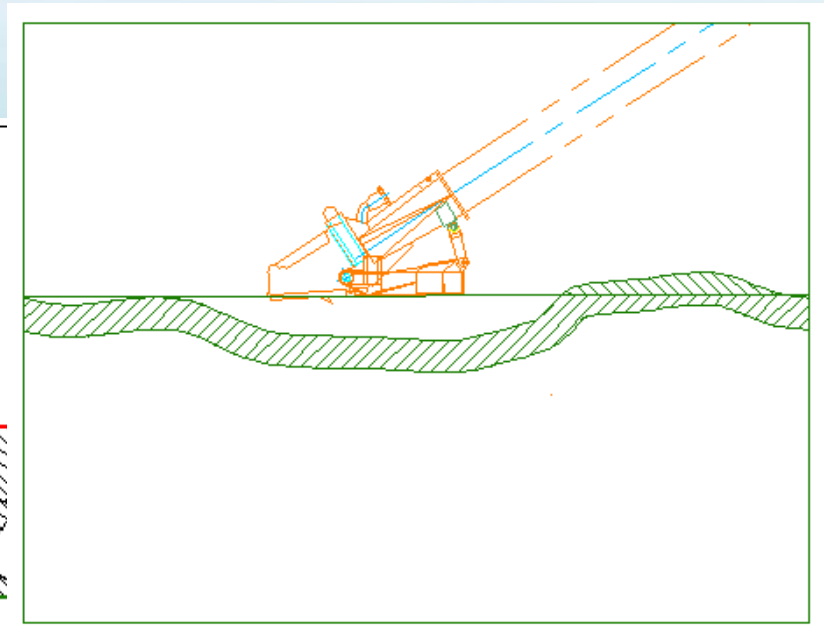


Cutter Suction Dredge Digging Curve

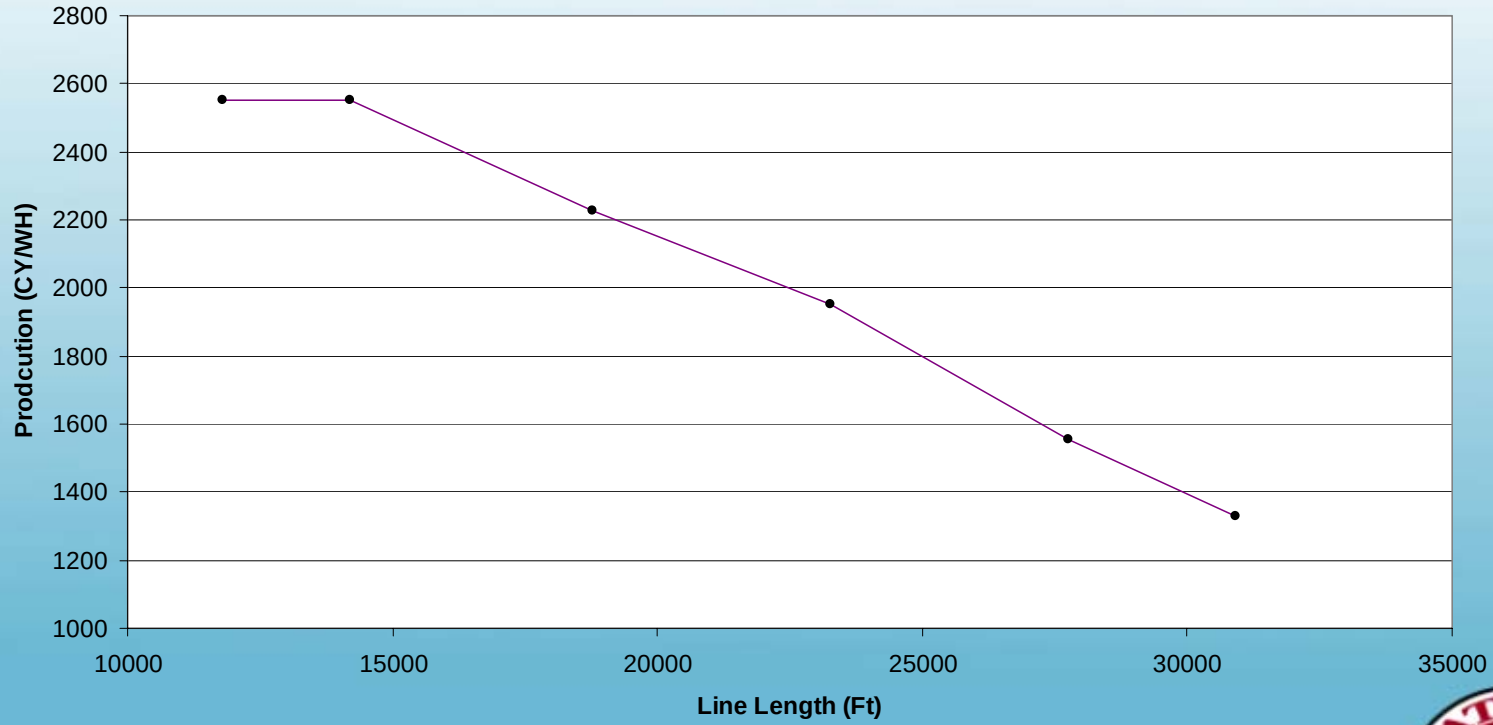


Hopper Dredge in Low Face “Hang Time”





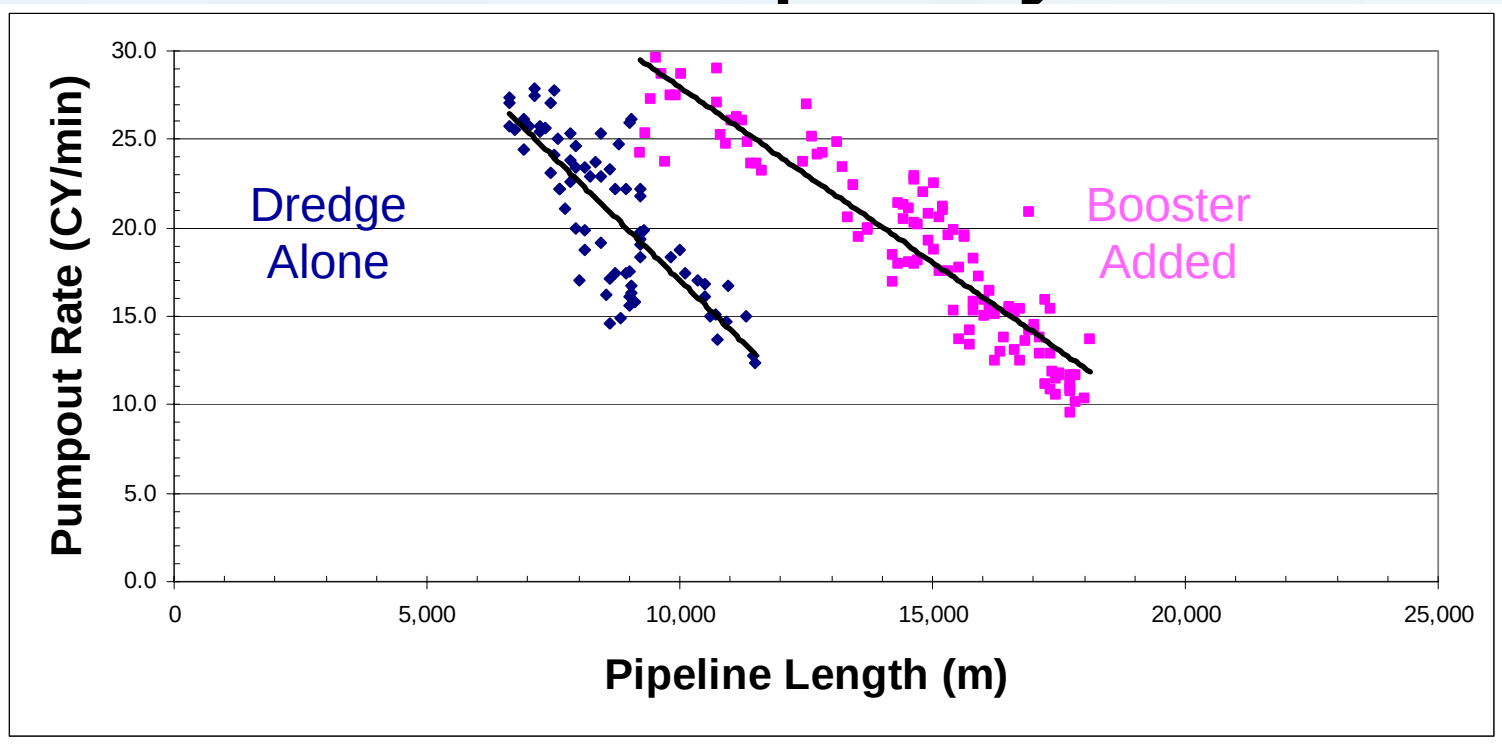
Pumping Capacity



Pumping Production

$PROD_{pump} = f\ (L/D_{pipeline},\ P_{pumps},\ Material\ )$

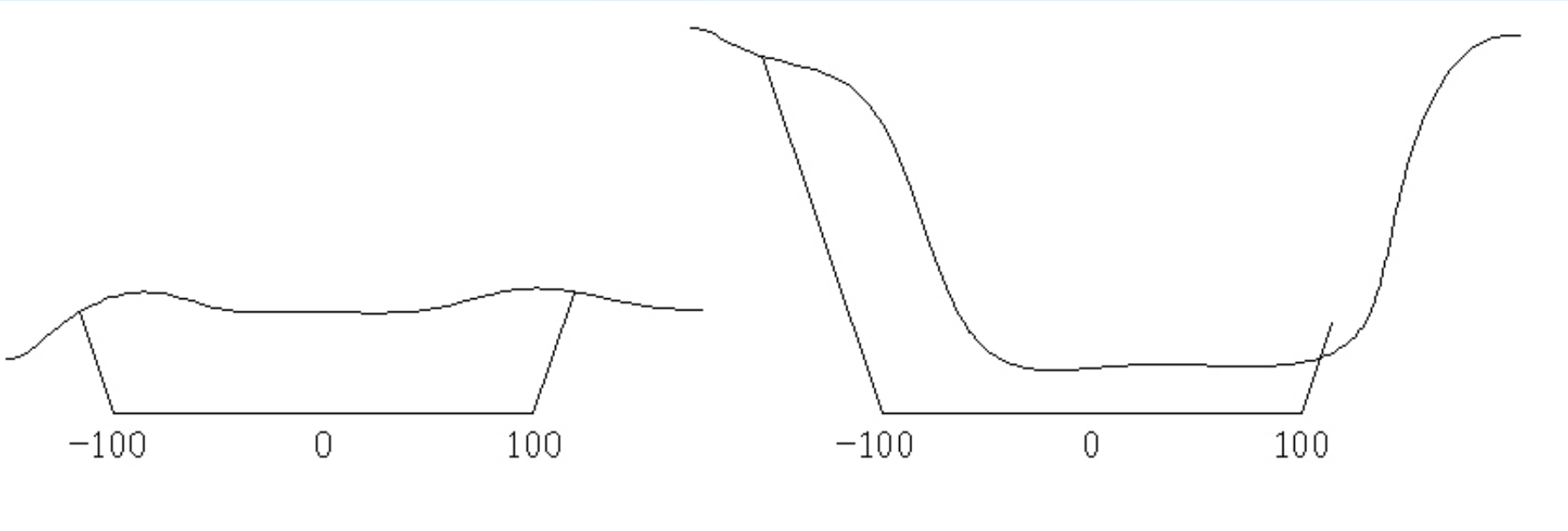
Hopper Dredge Pump Capacity



Other Important Variables

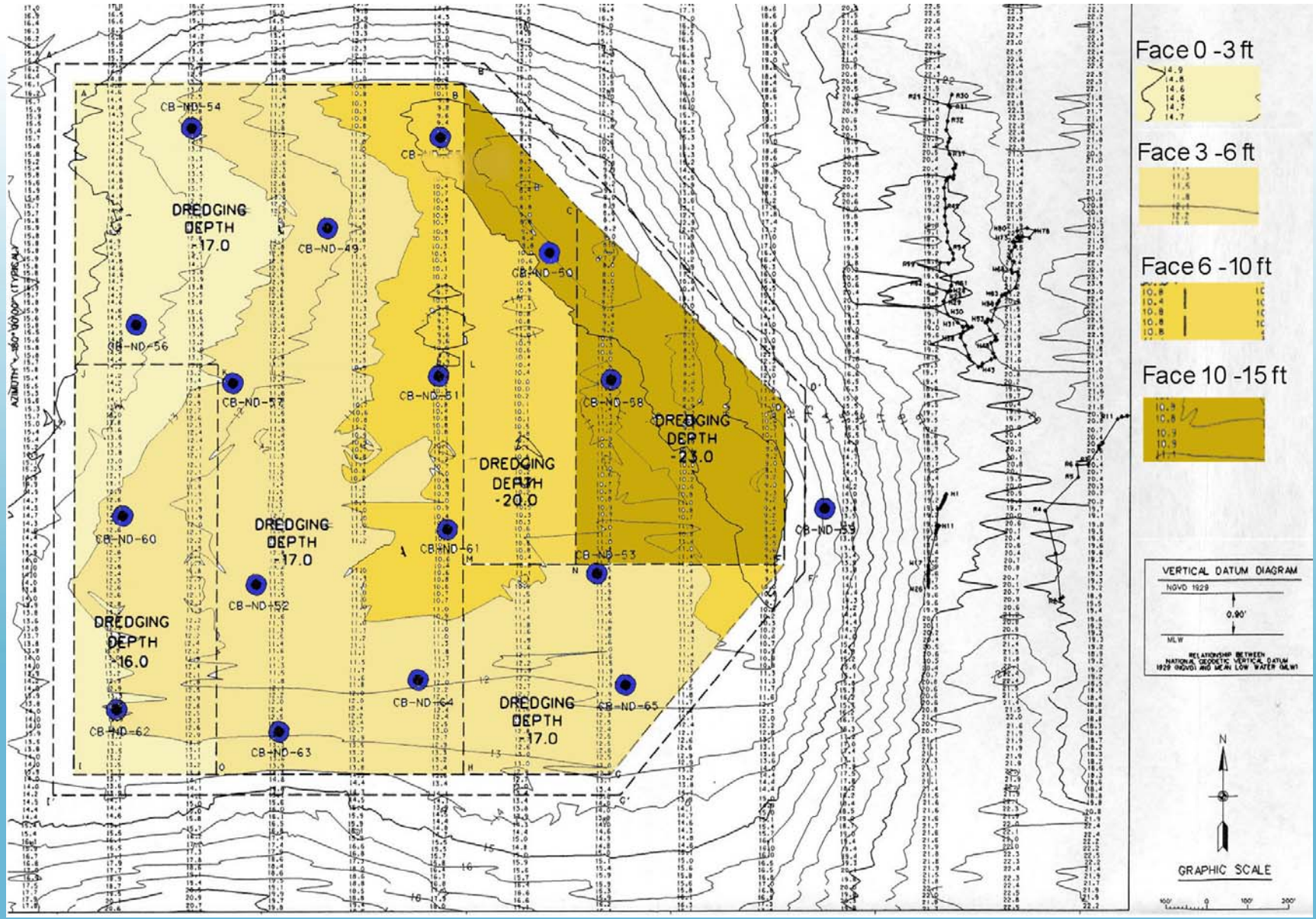
- Layout
  - Narrow or Odd Shaped Cuts
  - Slope Cuts
- Tow or Sail Distance
- Water Depth

Layout of Face



Similar cross-sectional area, but layout requires two different digging methods.

Dredging Area Plan



Tow and Sail Distance

- For Clamshell, a matter of adding barges and tugs
- For hopper, another element of the overall cycle
- In both cases, consider the route when determining distance

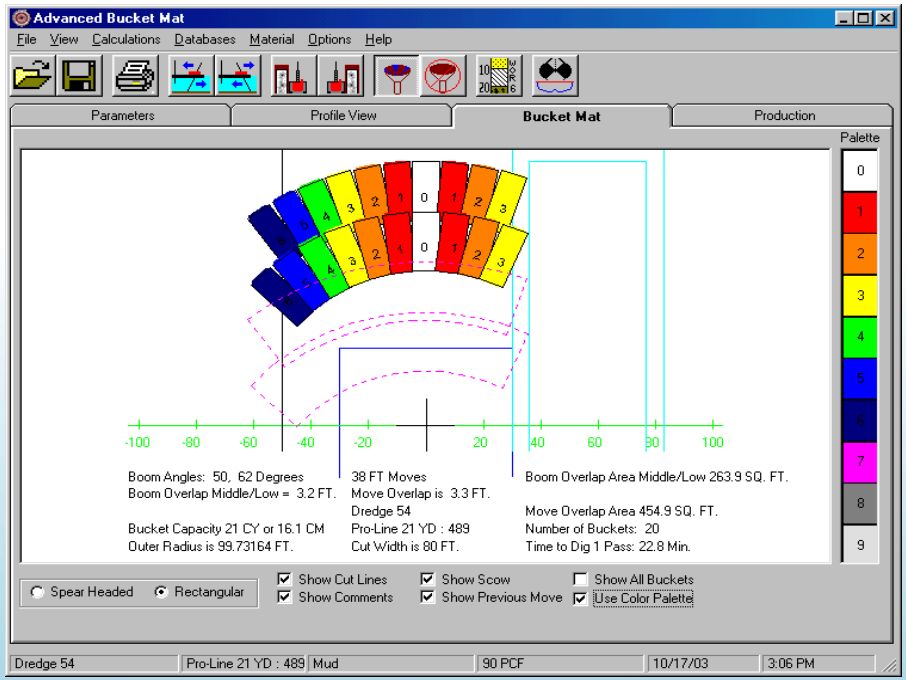
Water Depth

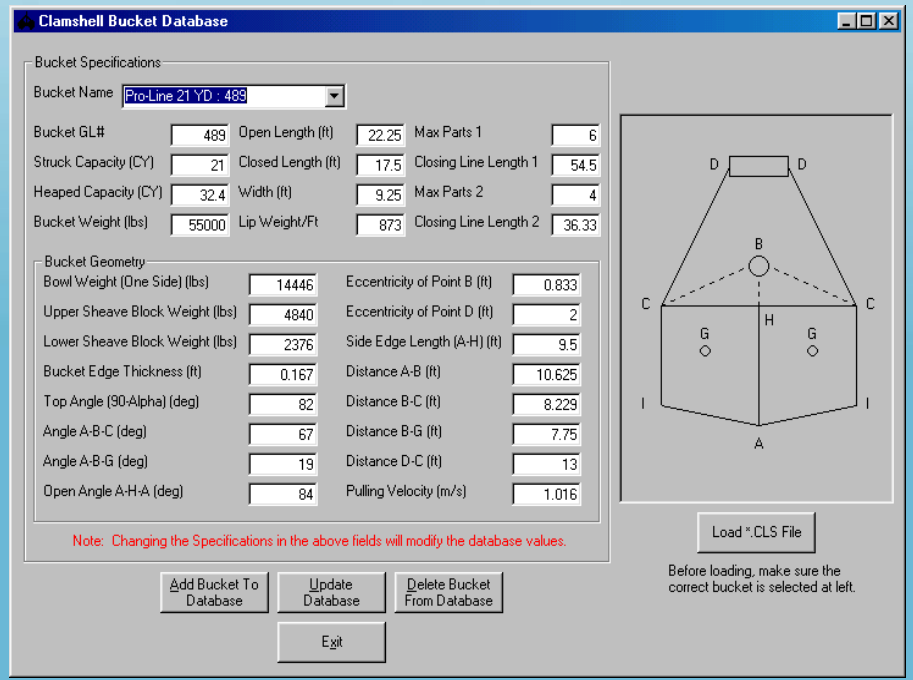
- Can the dredge physically reach the material in deep water?
- Can the dredge float and dig in shallow water?
- For clam, cycle is directly dependent on depth.
- For backhoe, bucket size is dependent on depth.

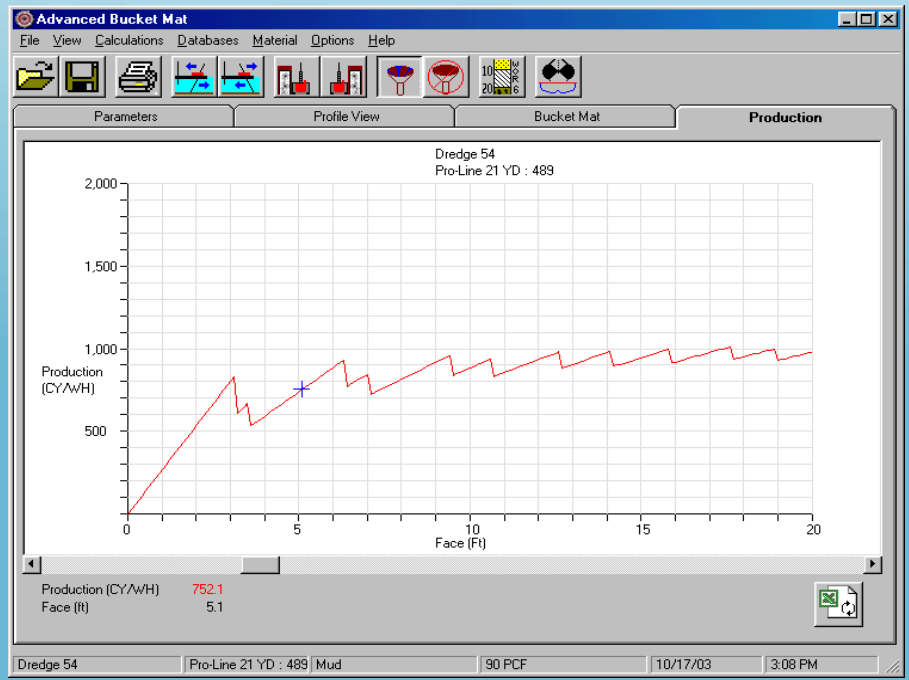
Estimating Dredge Productivity

- By analysis of the capabilities of the dredge as compared to the conditions of the project.
- By reference to similar projects in the past
- By combining the two – Using analysis to ‘extend’ references

Clamshell Fill & Cycle Analysis



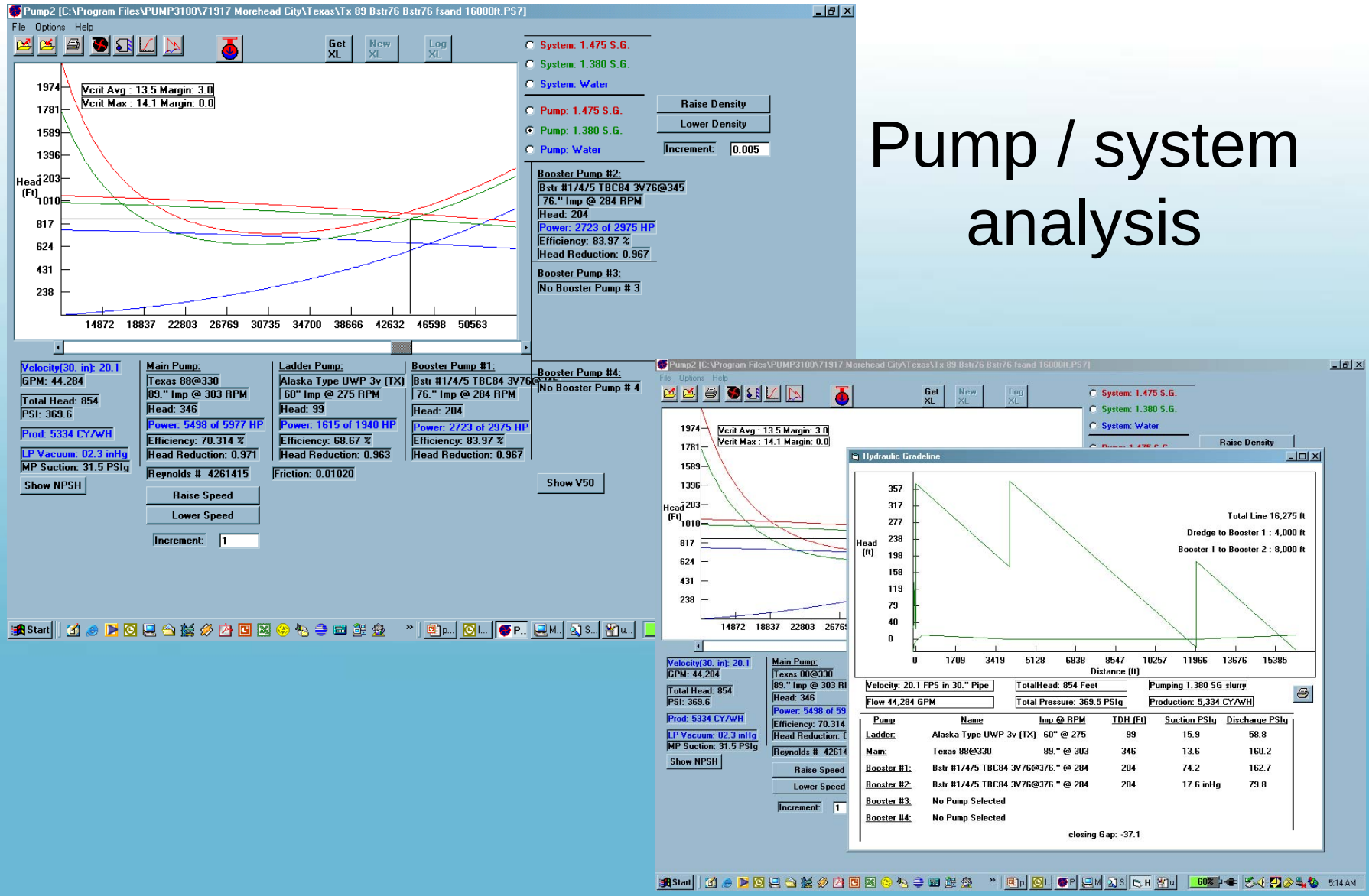




CSD Production Limits

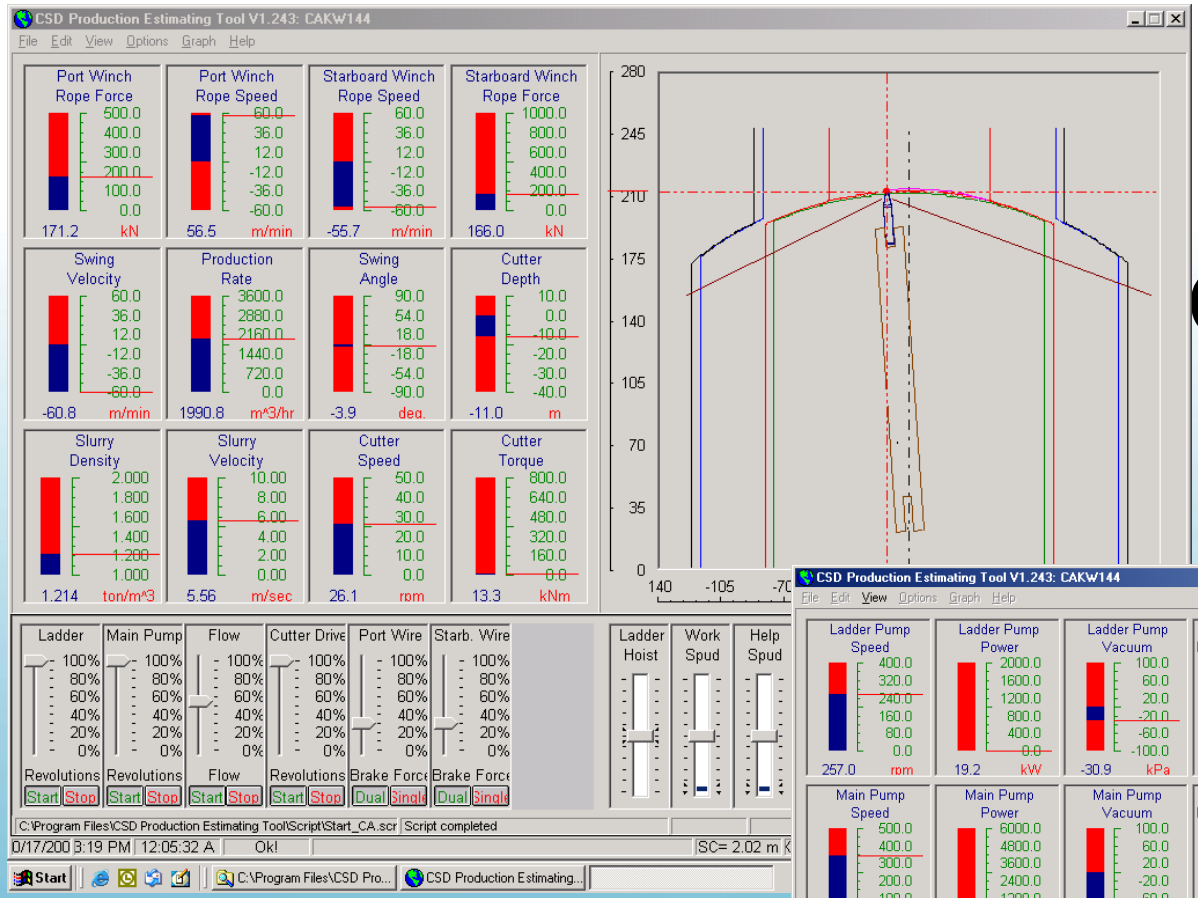
- Pumping capacity
- Dig limit – ability to excavate the material
- Swing limit – How fast can the dredge swing?

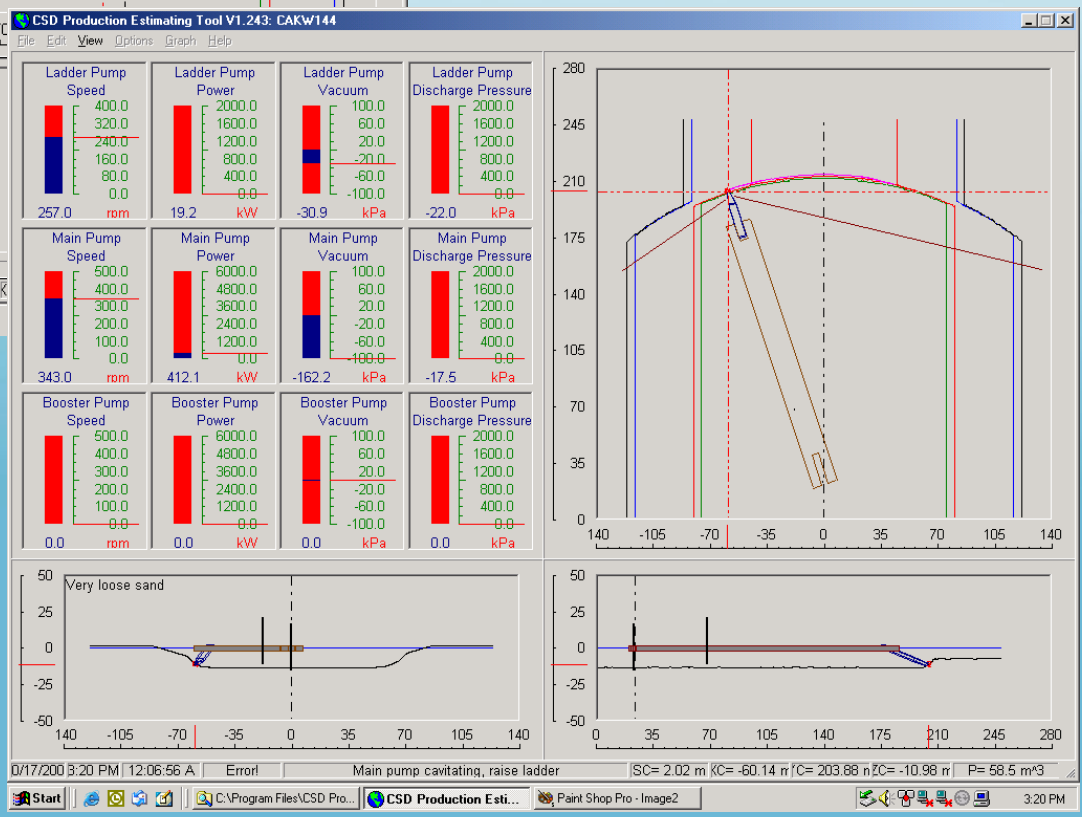
Production Engineering Tools

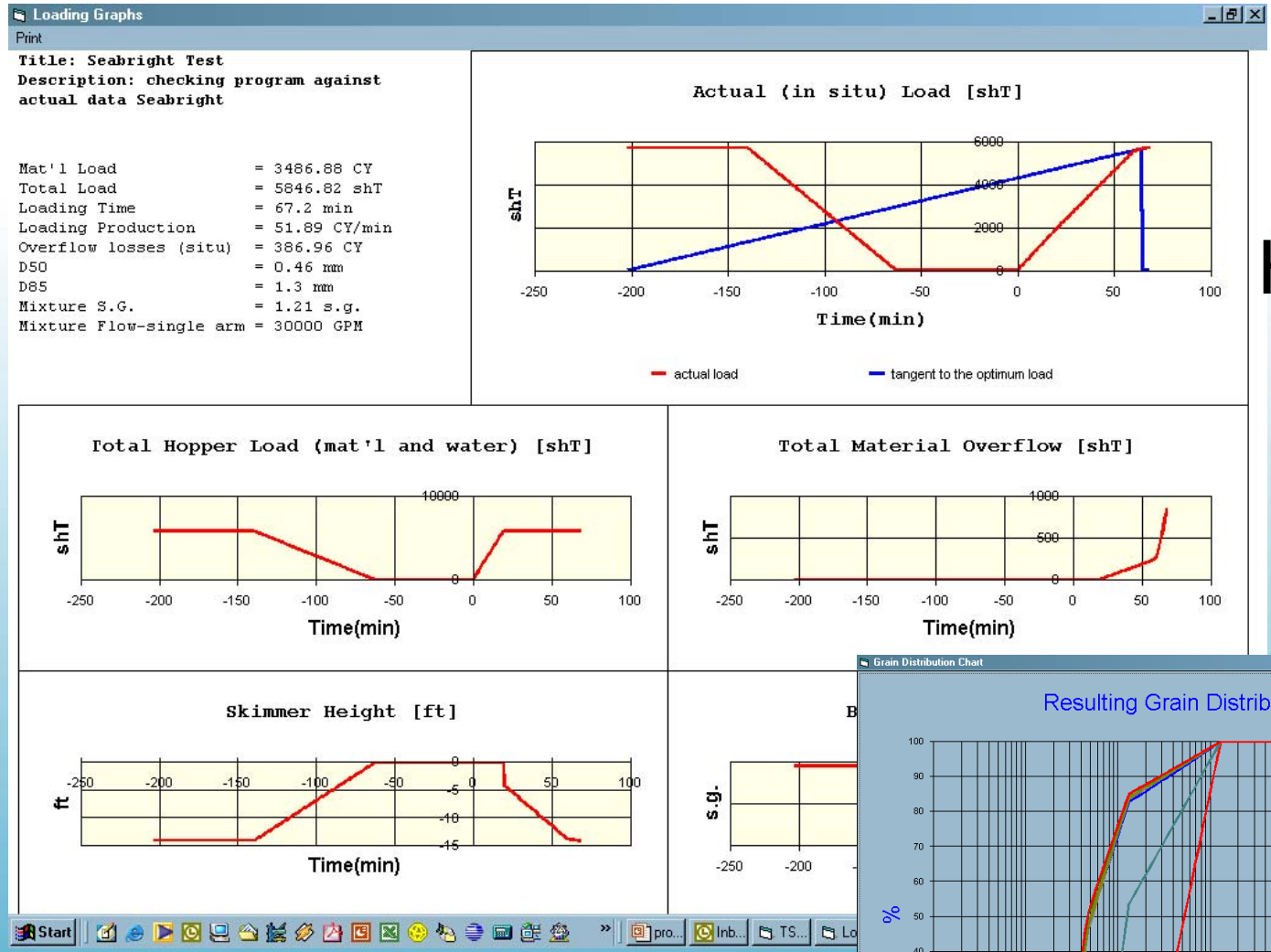


Pump / system analysis

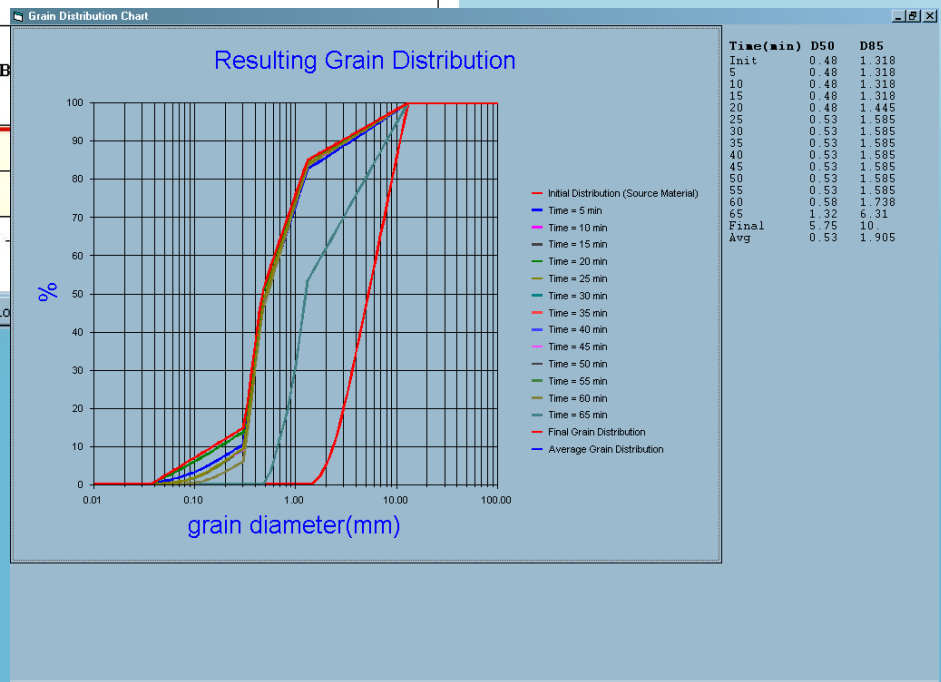
CSD Simulators







Hopper Load & Cycle Analysis



References
Florida Beach 1995

Sub Job	Booster	Face	Line Length	Qty/Day
1	No	11.6	11000	37600
2	Yes	11	18900	33300
3	No	11.6	9500	28700
4	Yes	17.3	24900	29000
Total		12.4	17900	33300

Reference Comparison
Florida Beach 2005

Sub Job	Booster	Face	Line Length	Qty/Day
1		9.6	14200	
2		8.6	18800	T
3		10.8	23300	B
4		7.0	27800	A
5		6.8	30900	
Total		8.4	22800	

References – Comparing Projects

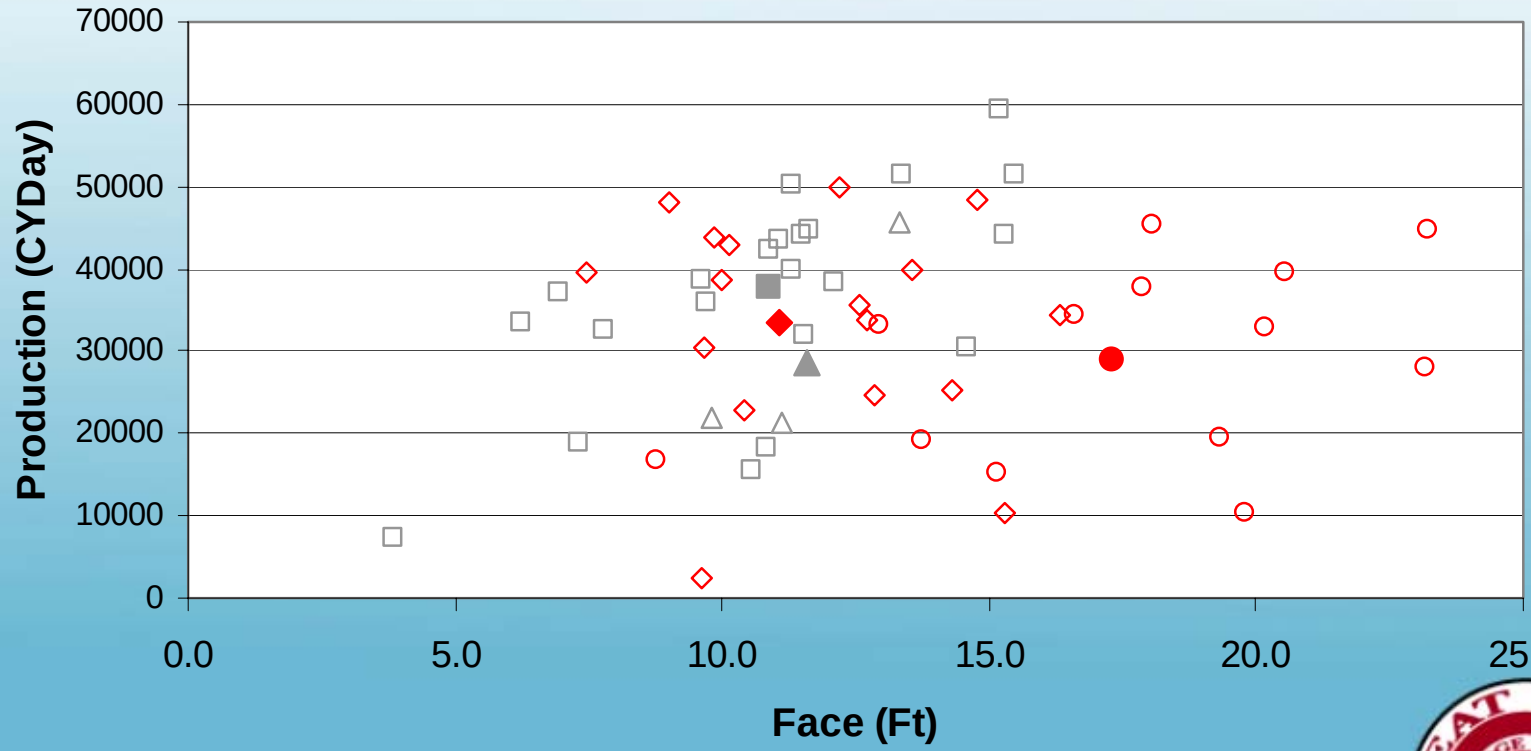
1995

- 12.4’ Face
- 17900’ Pipe
- Dredge Alaska

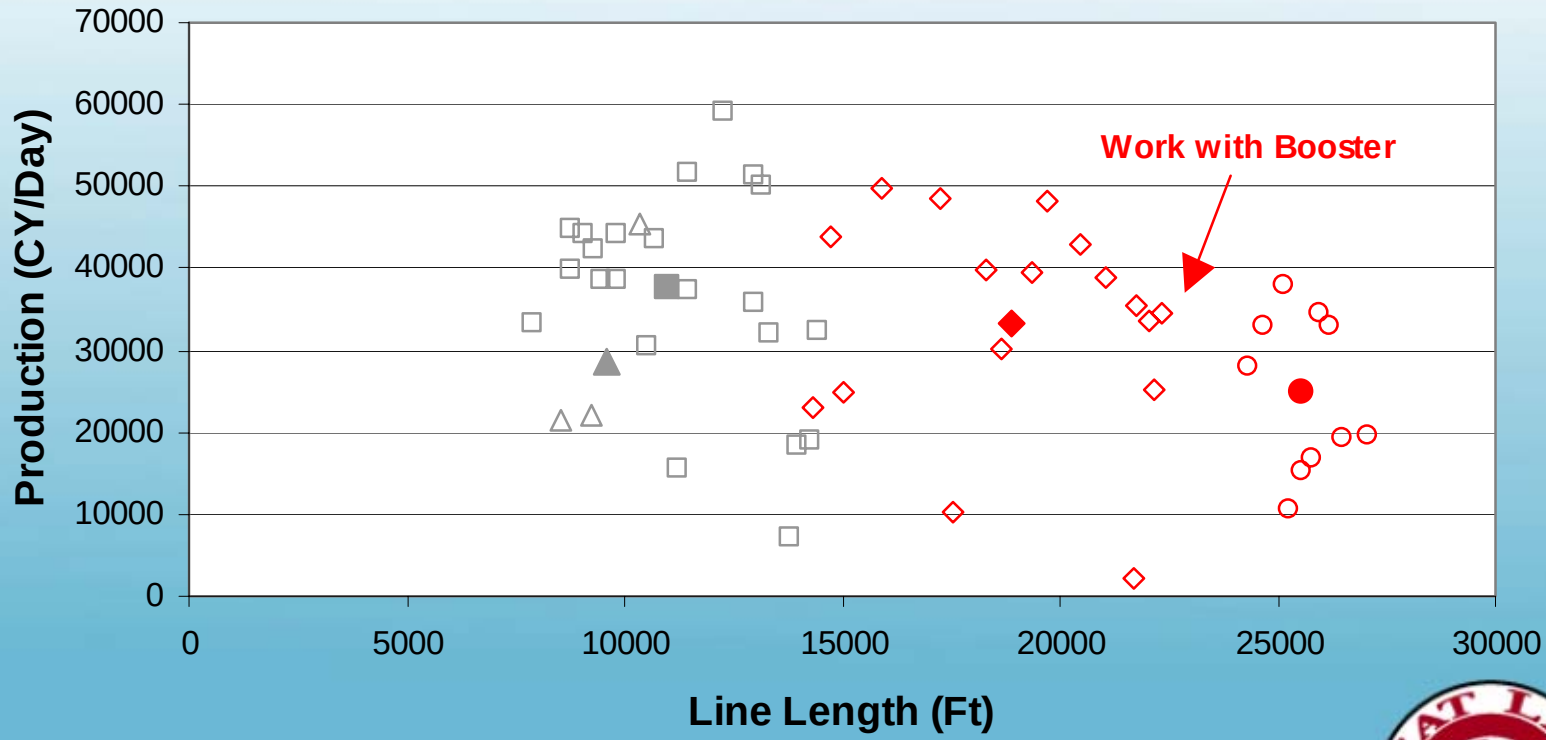
2005

- 8.4’ Face
- 22800’ Pipe
- Dredge Texas

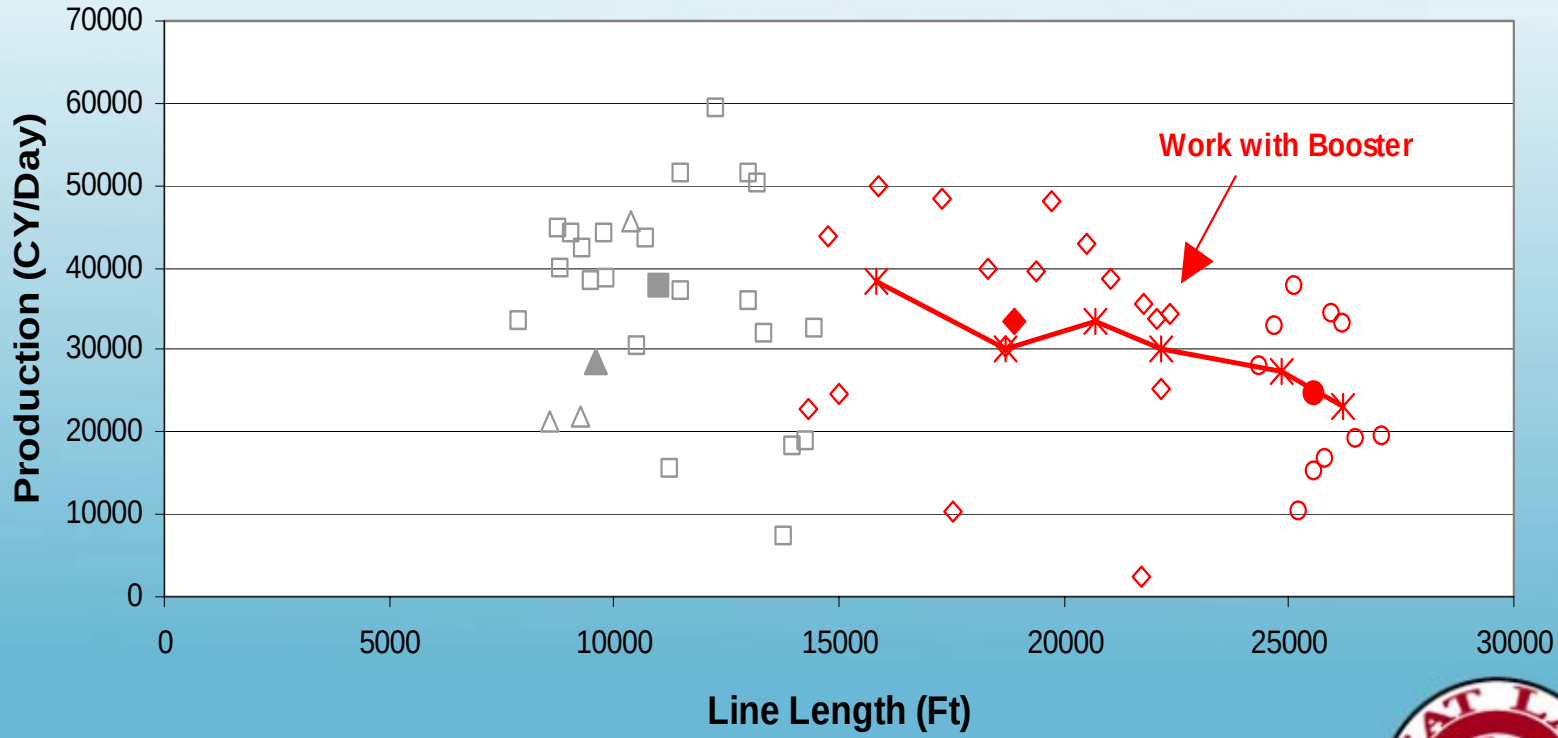
1995 Project – by Face



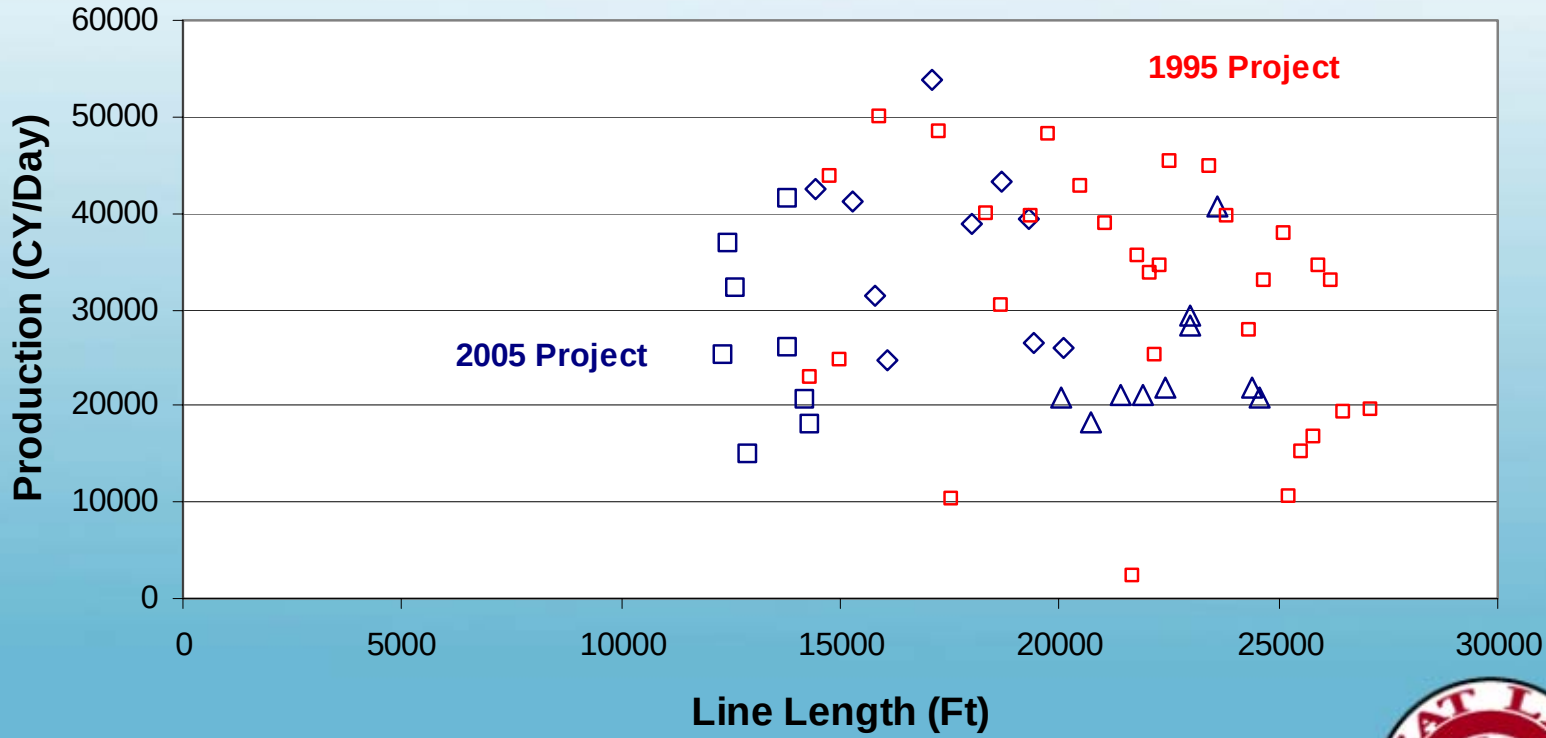
1995 Project – by Line Length

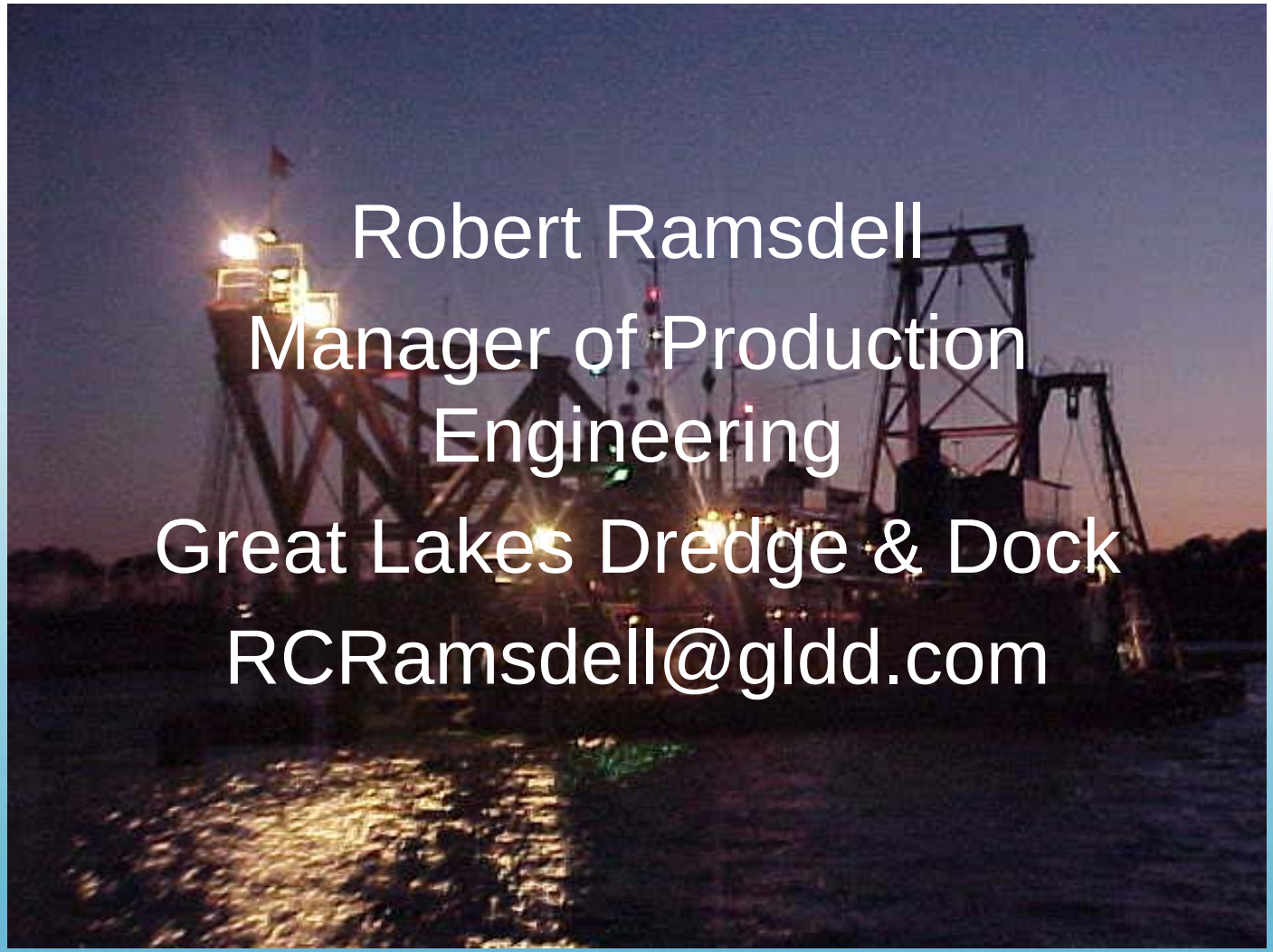


1995 Project – by Line Length



2005 Project - Results





Robert Ramsdell
Manager of Production Engineering
Great Lakes Dredge & Dock
RCRamsdell@gldd.com