

Technical Inputs to Dredging Estimates

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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

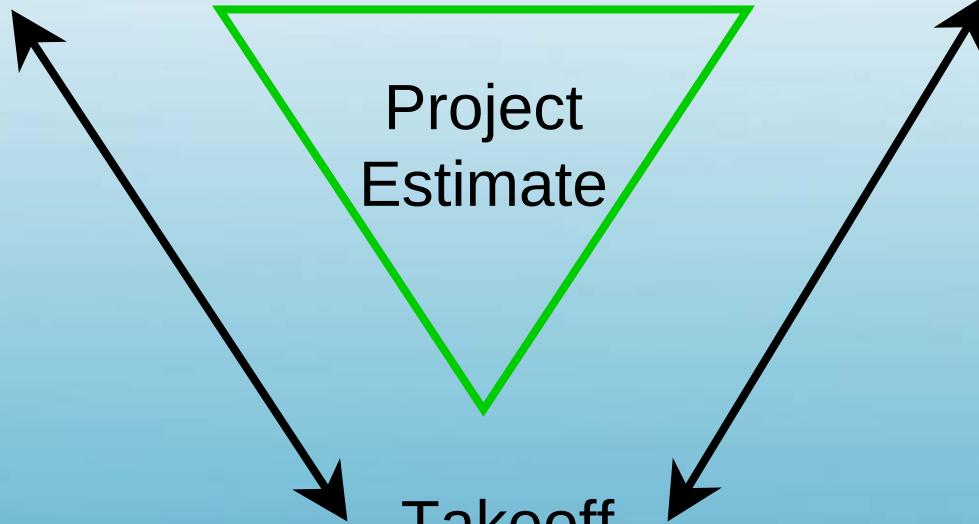
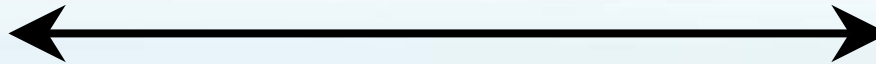


Cost
Estimator

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?



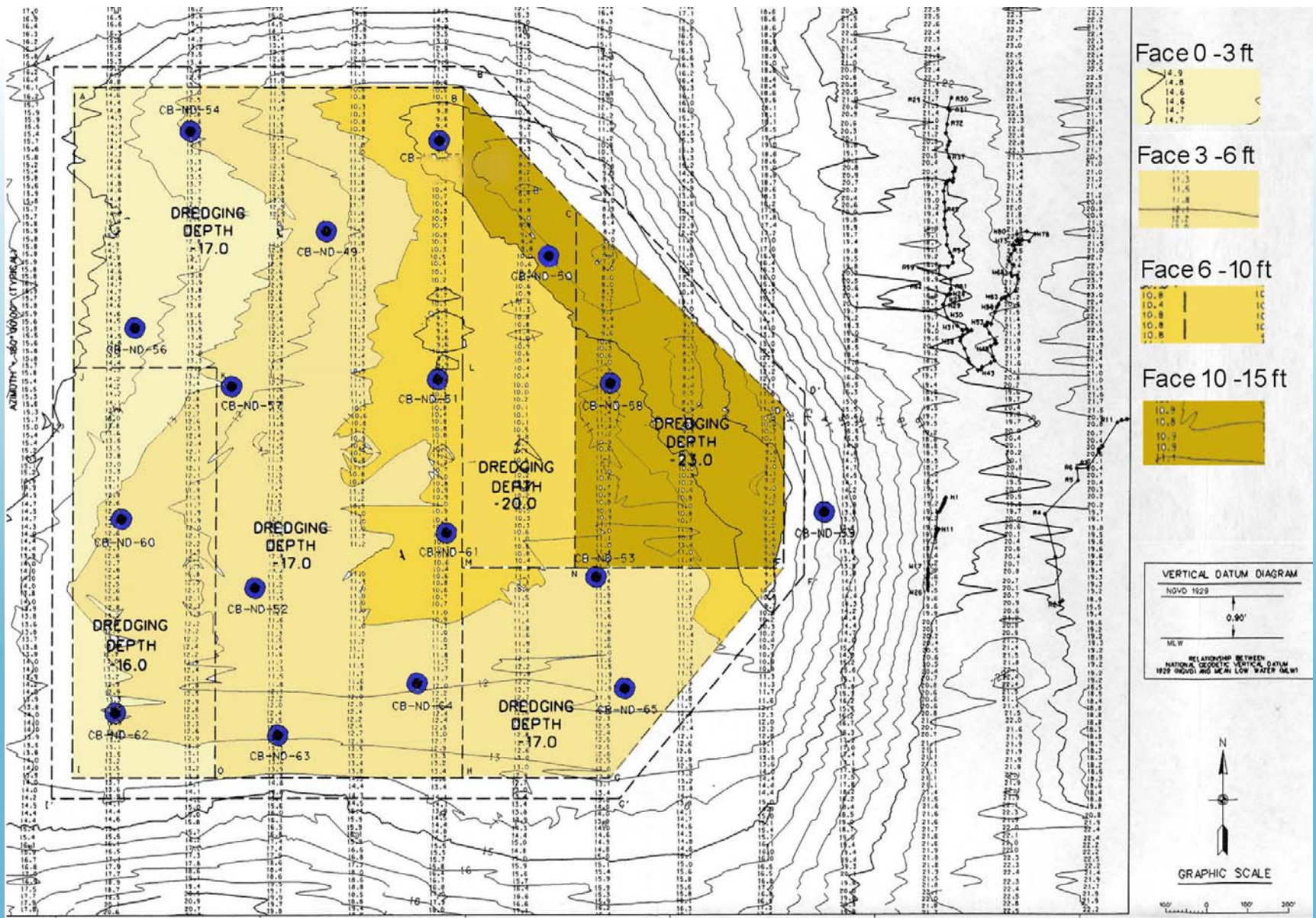
Cost Estimator



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



Dredging Area Plan



Takeoff

Answers the Question:
How much work is there to do?



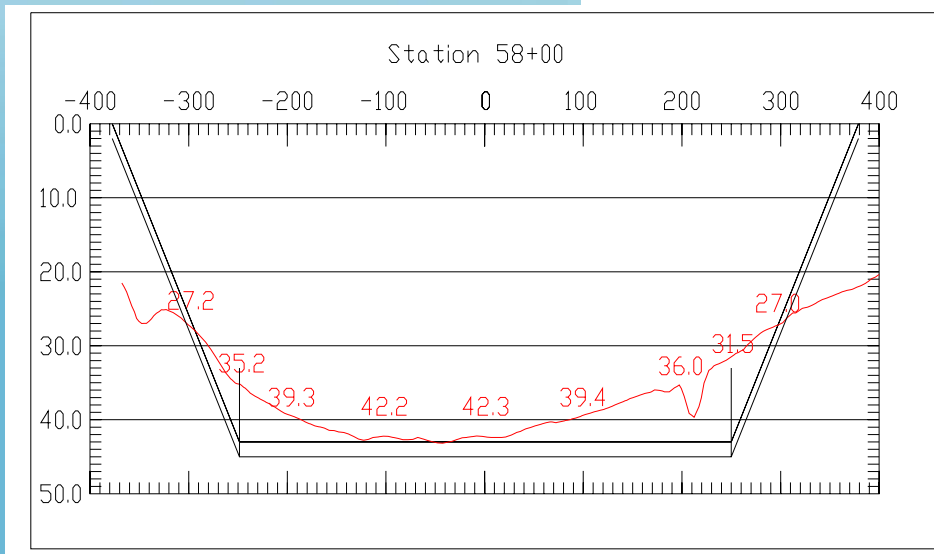
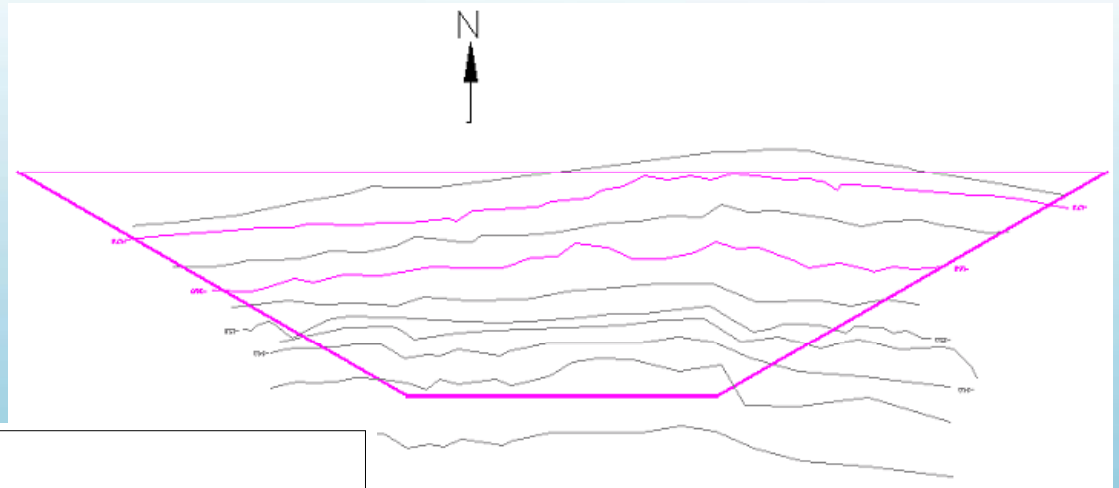
Takeoff – Dredge/Borrow Area

- 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

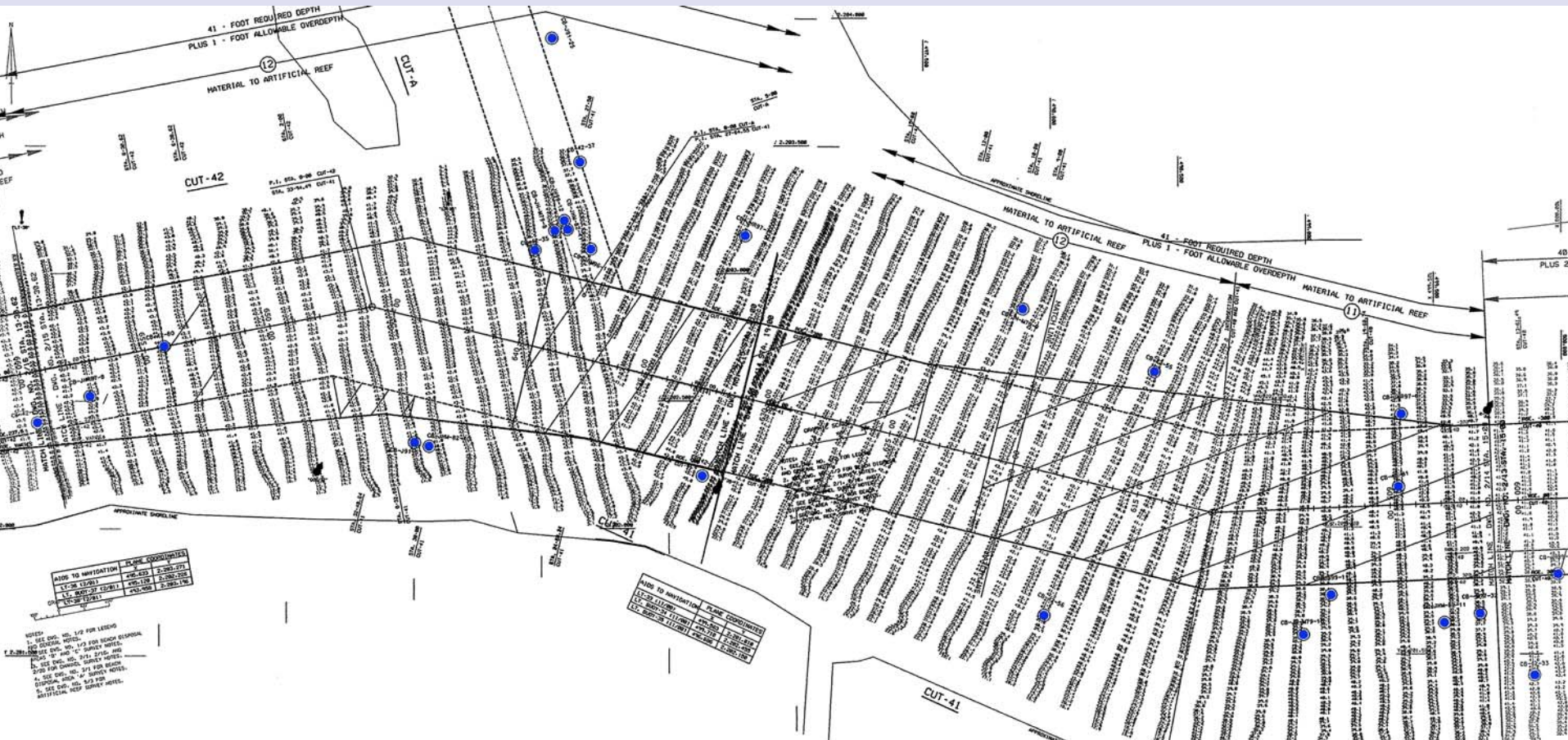
Evaluate Geotechnical Information:



- 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

$$\text{Time} = \text{Qty} / \text{Production}$$

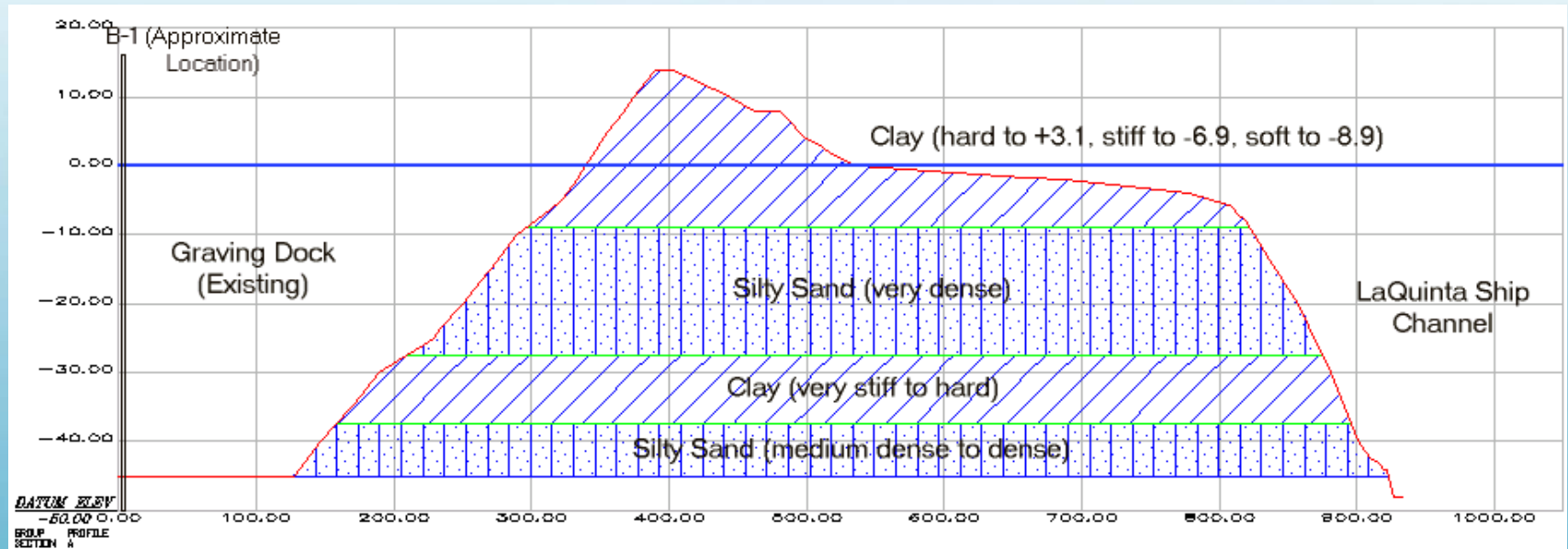


Crucial Variables for Production

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



Material Classification



Material Strength

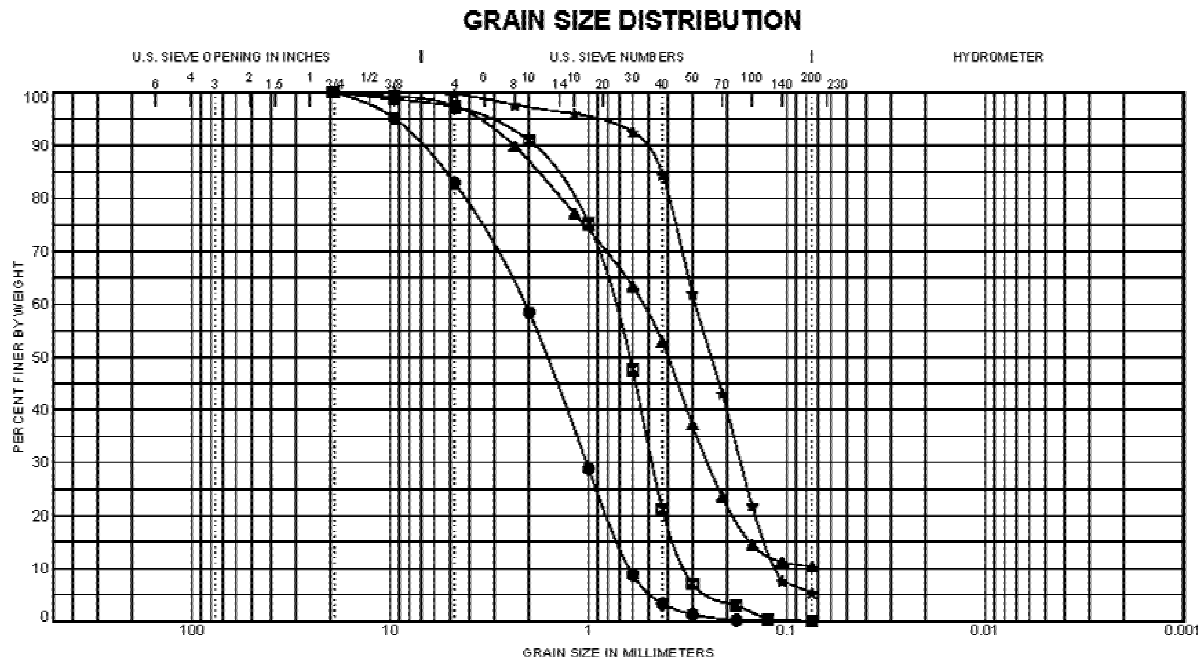


- Standard Penetration Test
- Compressive, tensile or shear strength

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



Grain Size Distribution



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	D100	D85	D50	D10	%Gravel	%Sand	%Fines	Remarks
● B-1 0.75 ft	POORLY GRADED SAND with GRAVEL SP	19.5	5.352	1.64	0.619	17.1	82.9	0.0	40% shell fragments
■ B-1 3.75 ft	POORLY GRADED SAND SP	19.5	1.541	0.627	0.322	2.7	97.3	0.0	10 % shell fragments
▲ B-1 6.75 ft	POORLY GRADED SAND SP	19.5	1.816	0.399		2.5	87.2	10.3	20% shell fragments
★ B-1 9.75 ft	POORLY GRADED SAND SP	9.5	0.434	0.241	0.112	0.3	94.4	5.3	no shell fragments



Great Lakes Dredge & Dock Co.
2122 York Road
Oak Brook, Illinois 60523
Telephone: 630-574-2945
Fax: 630-574-1515

Project: Beach Reclamation Project

Location:

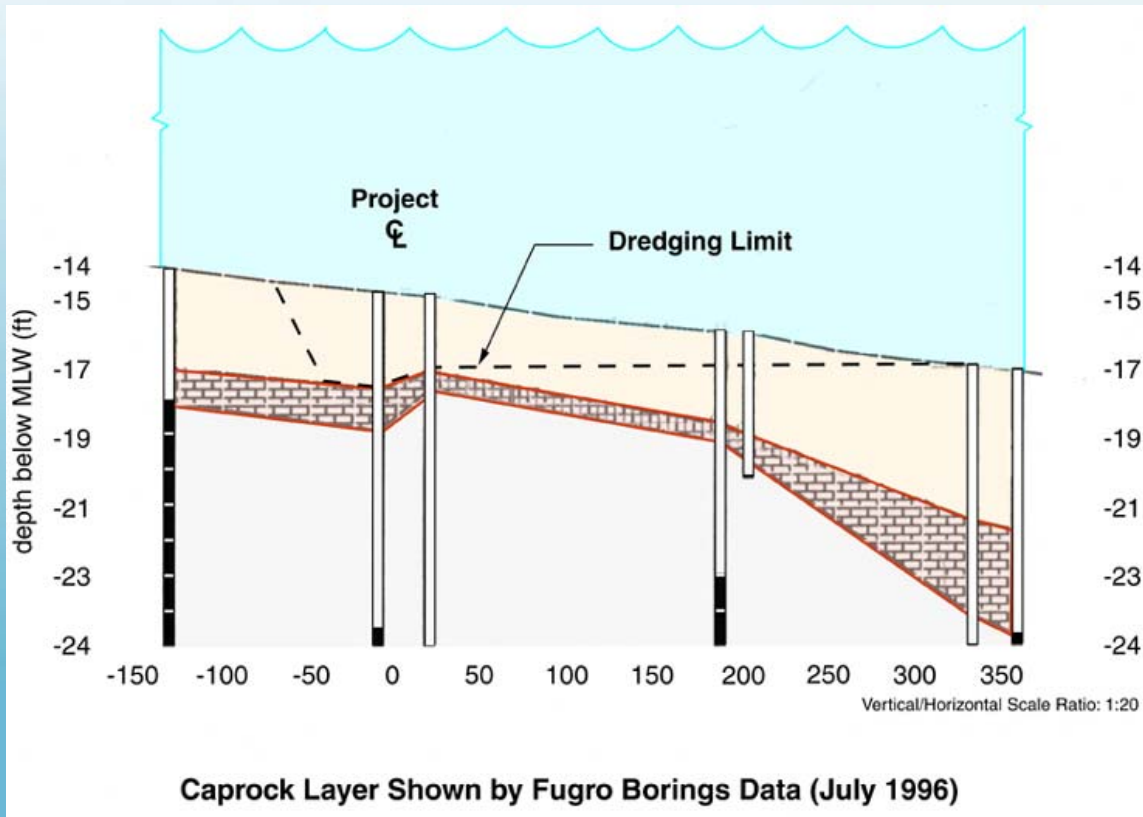
Number: 12345-DPR-002



Important in determining how well the material can be pumped.

Material Type

The Perils of Poor Information



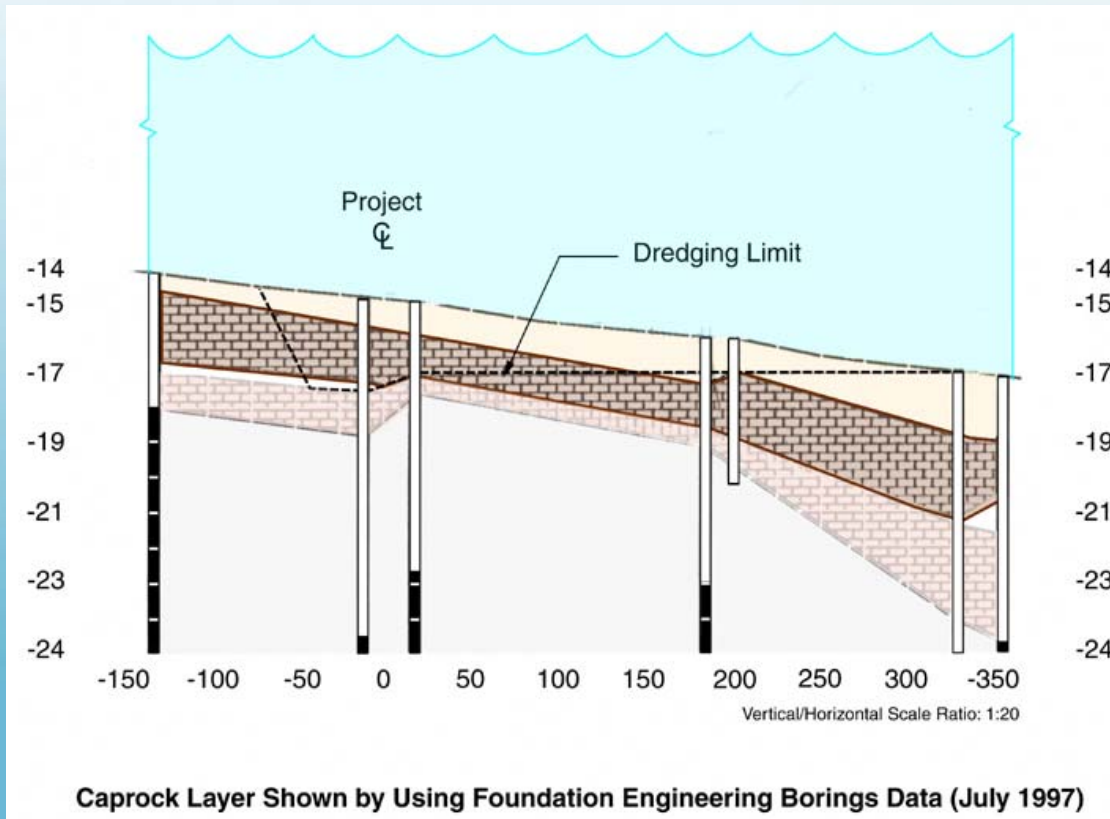
Estimate: 1438
 m^3/WH

Estimate: 5
Teeth/Day



Material Type

The Perils of Poor Information



Estimate: 1440 m³/WH

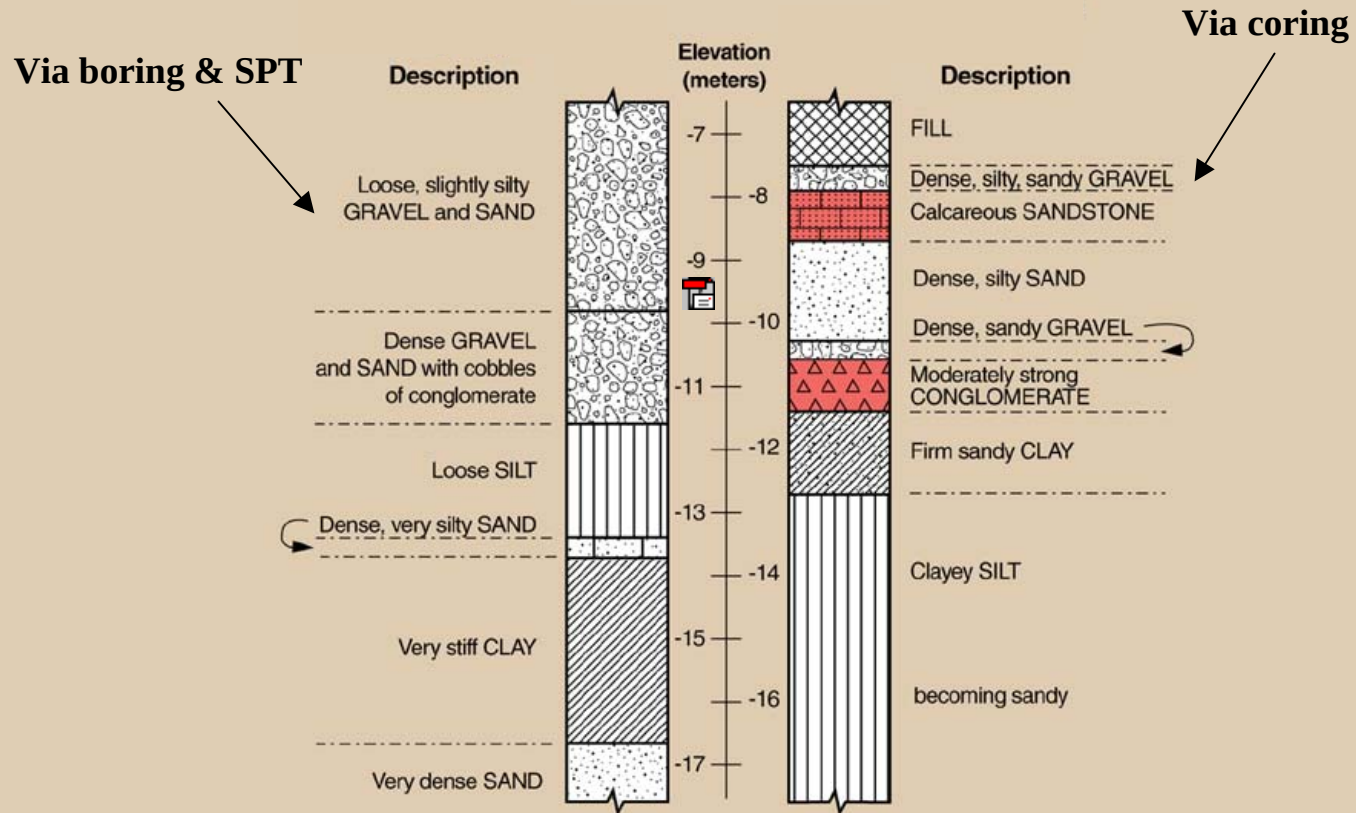
Actual: 605 m³/WH

Estimate: 5 Teeth/Day

Actual: 104 Teeth/Day

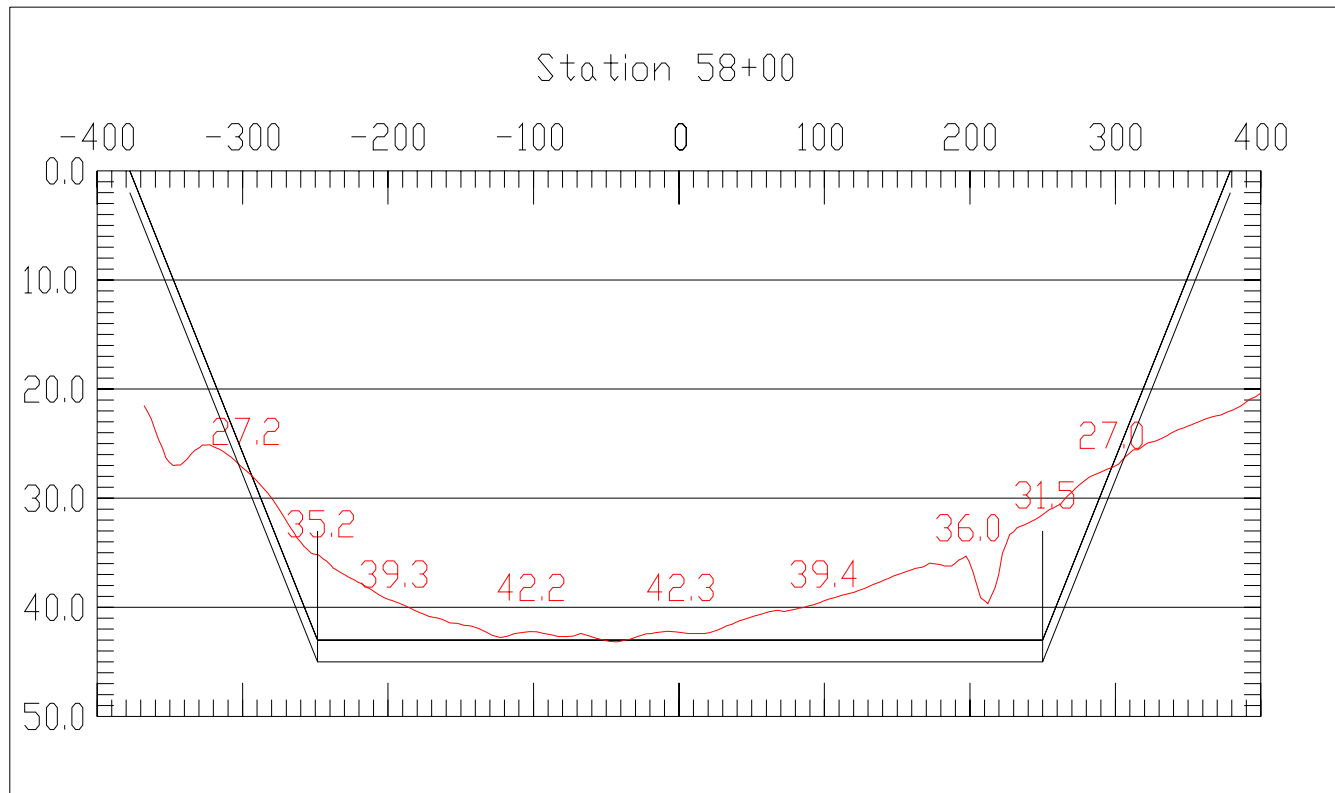


SPT vs. CORING

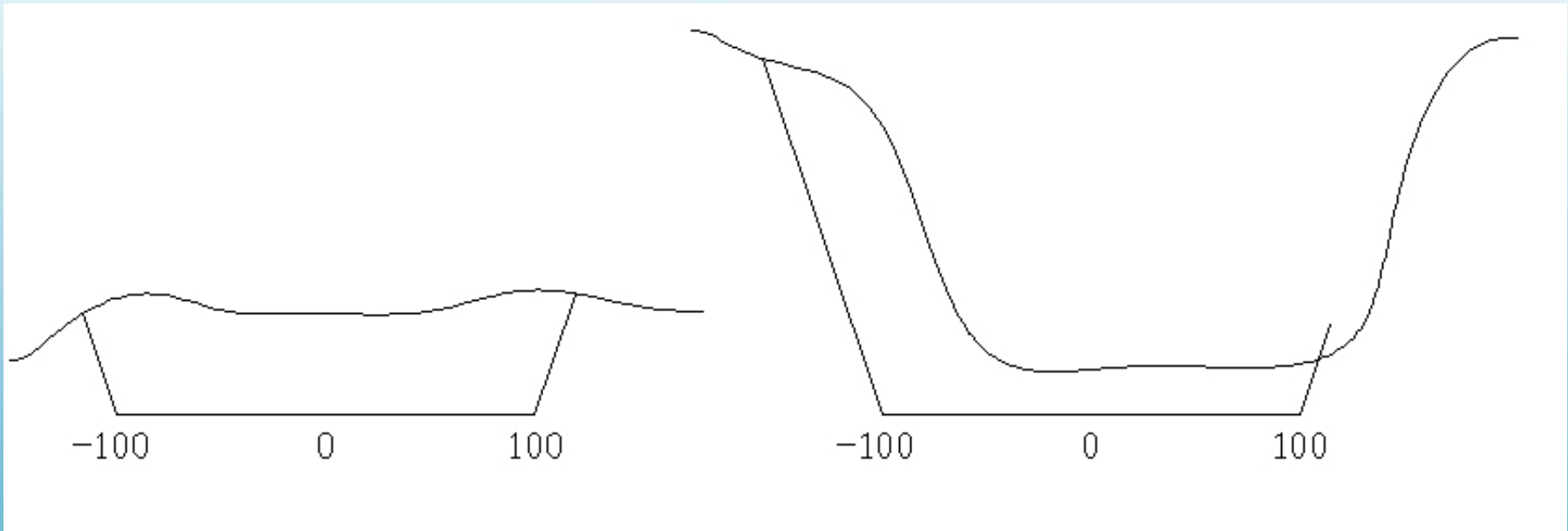


Bank Height – Face

The thickness of material to be dredged.



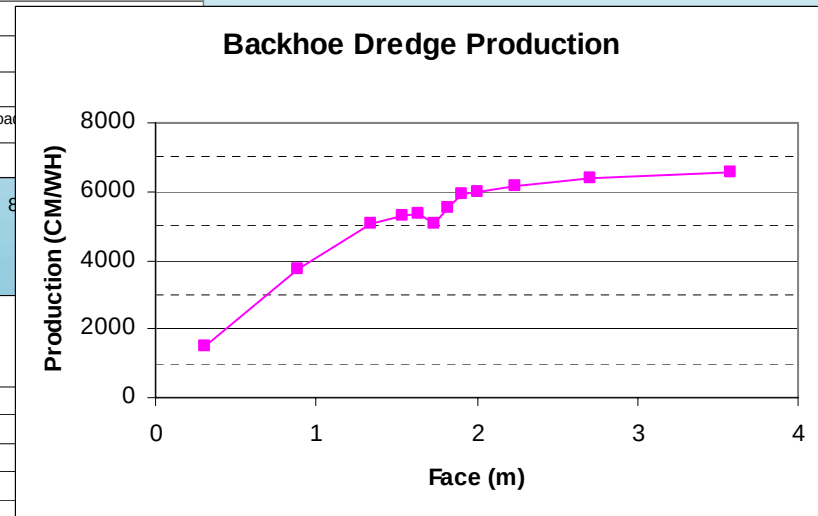
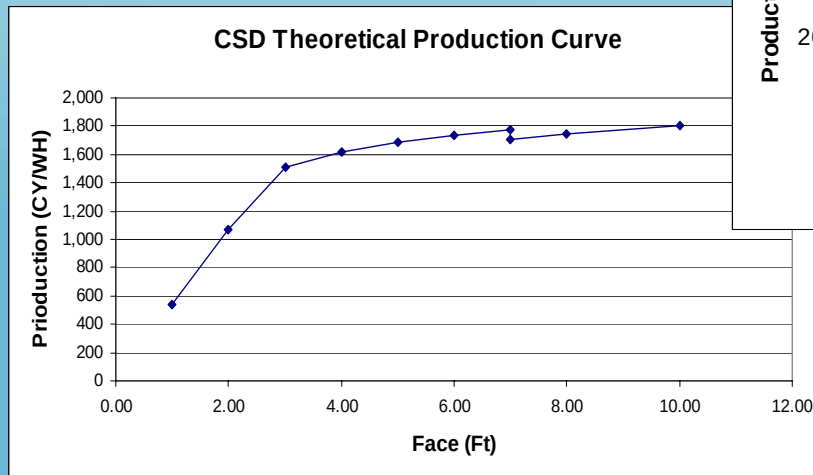
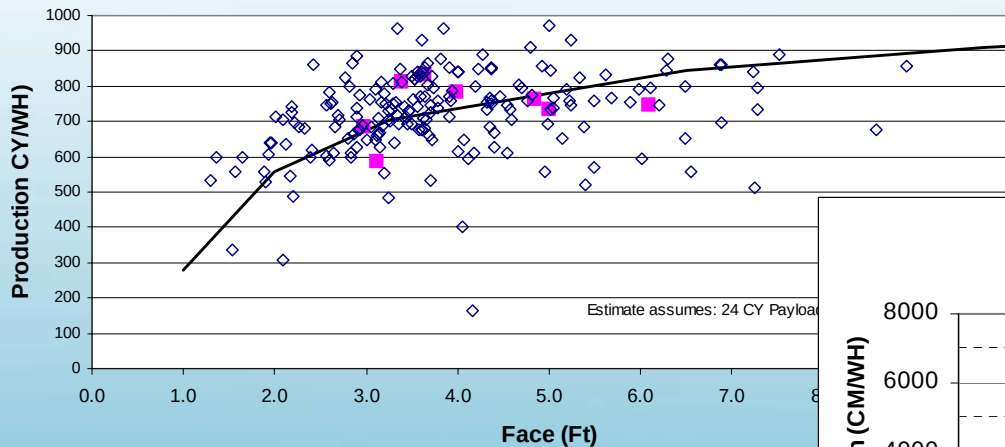
Layout of Face



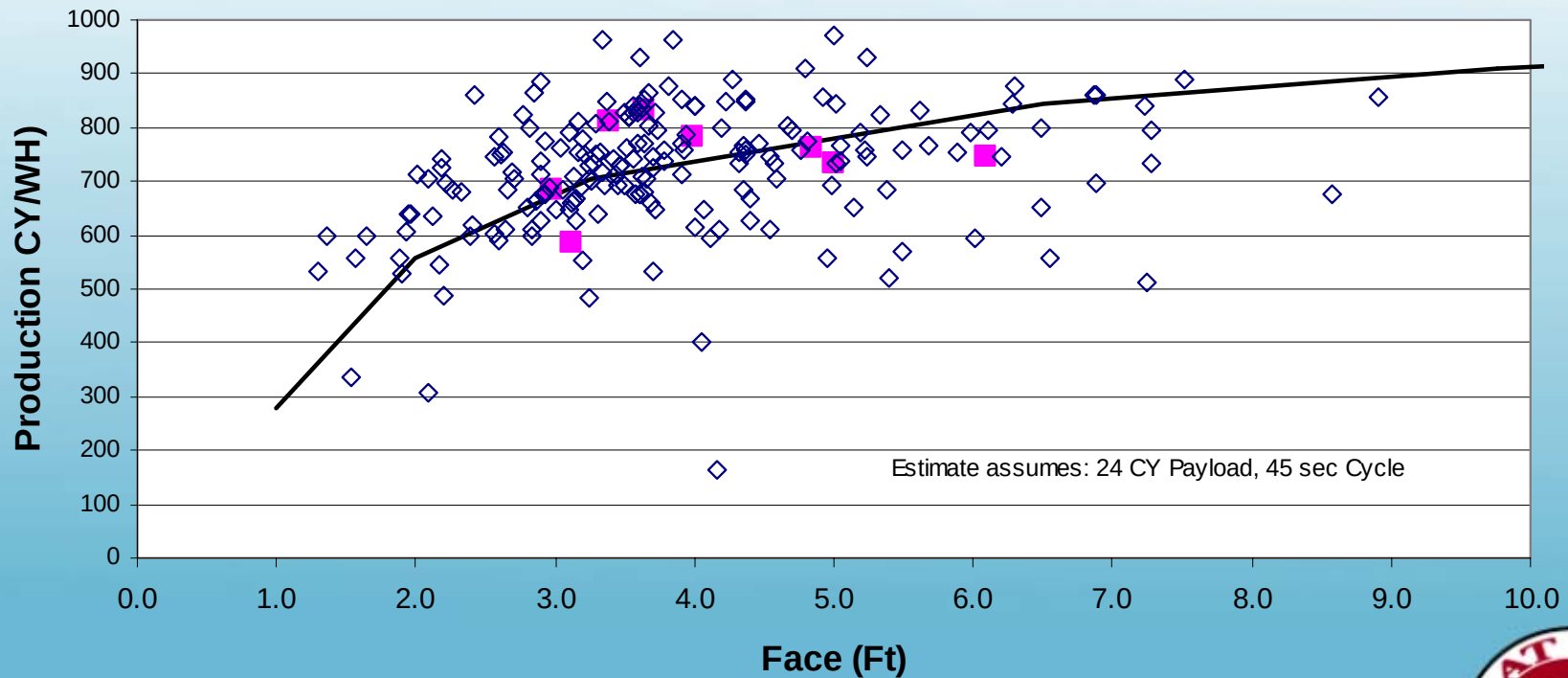
Similar cross-sectional area, but layout requires two different digging methods.



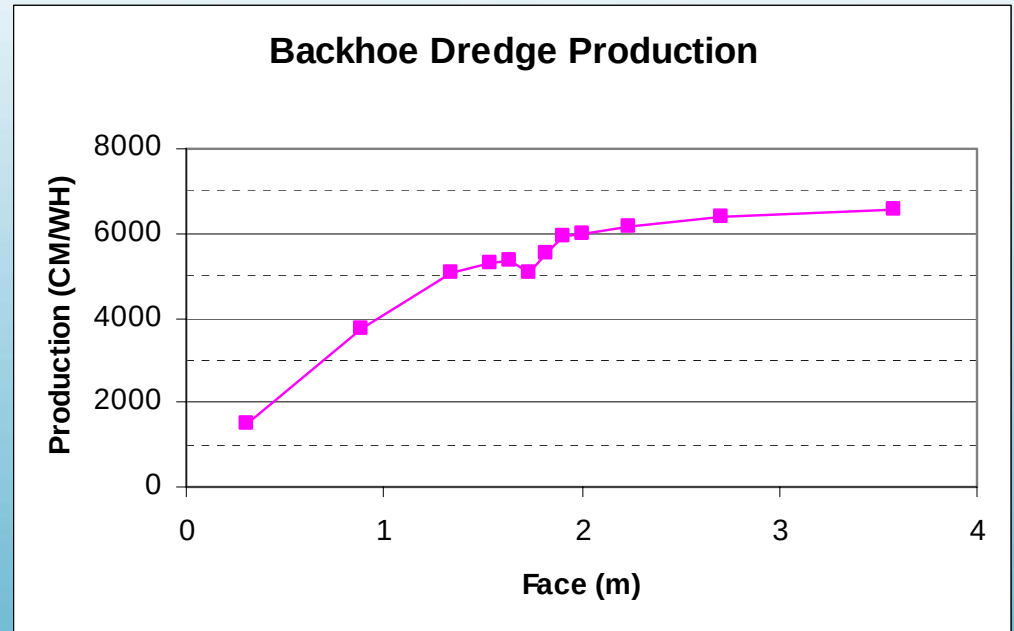
Production vs Face



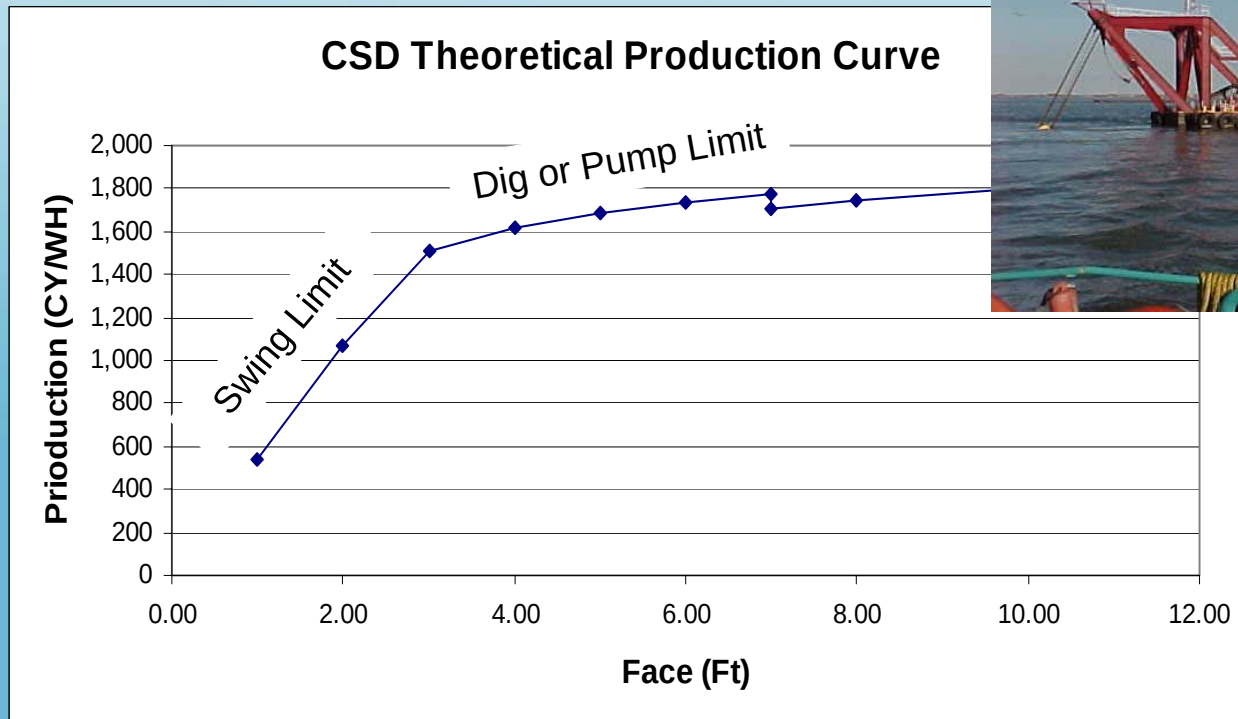
Bucket Dredge Production Curve



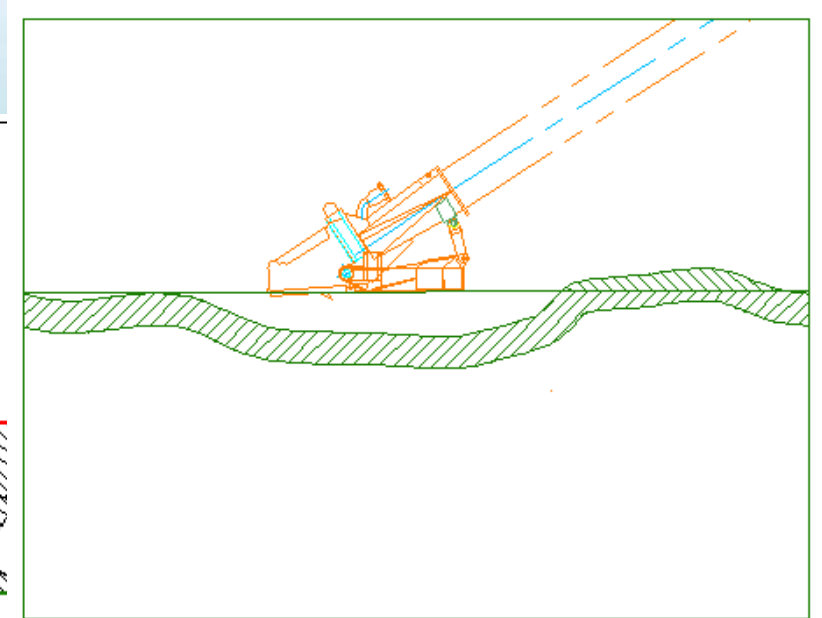
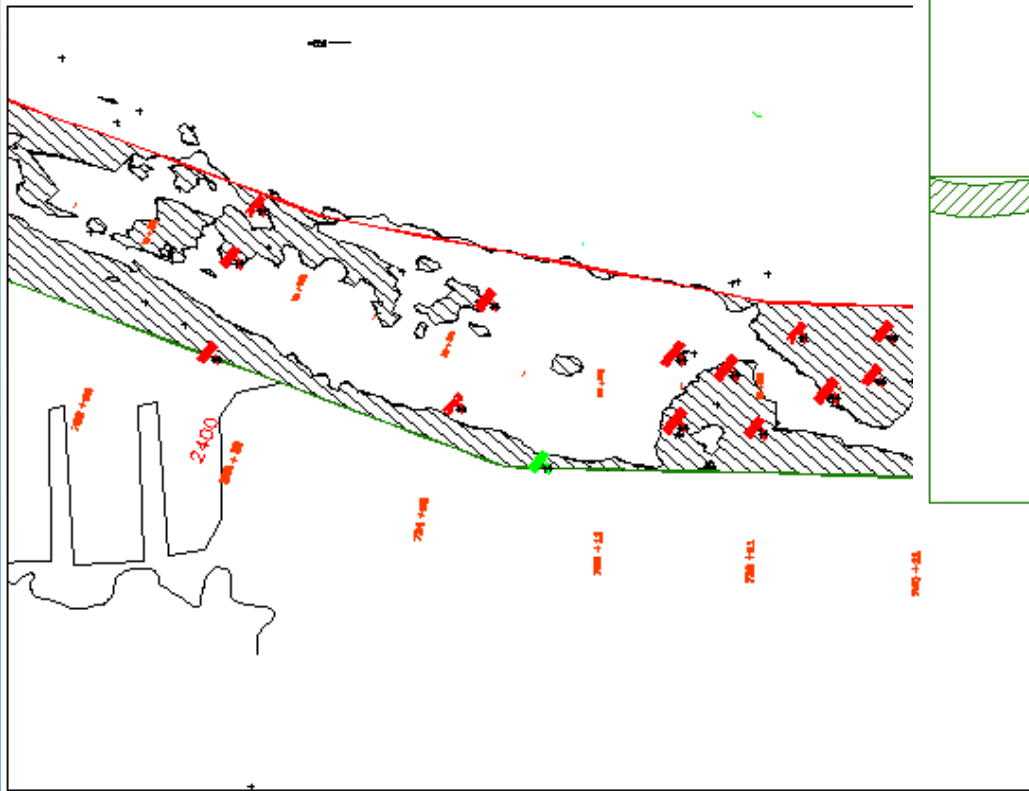
Backhoe Dredge Production Curve



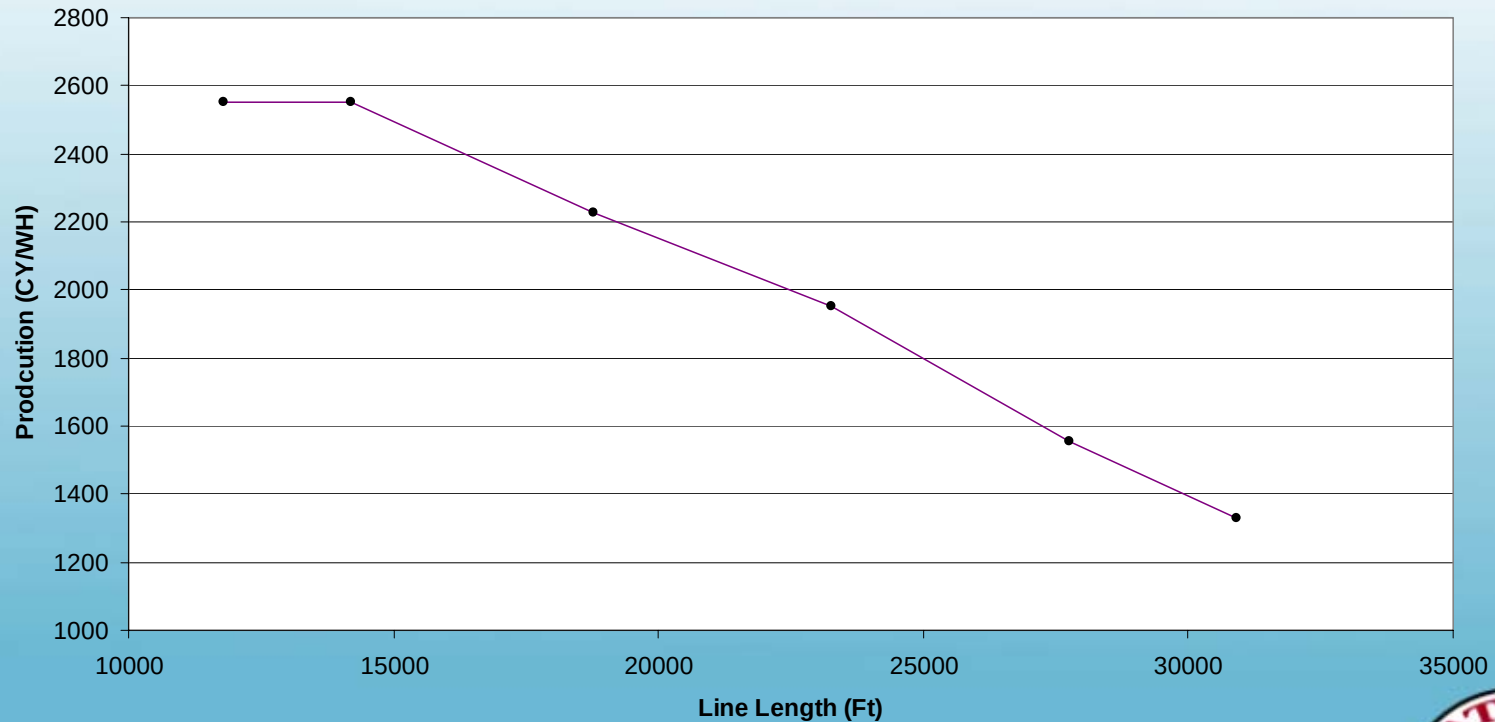
Cutter Suction Dredge Digging Curve



Hopper Dredge in Low Face “Hang Time”



Pumping Capacity

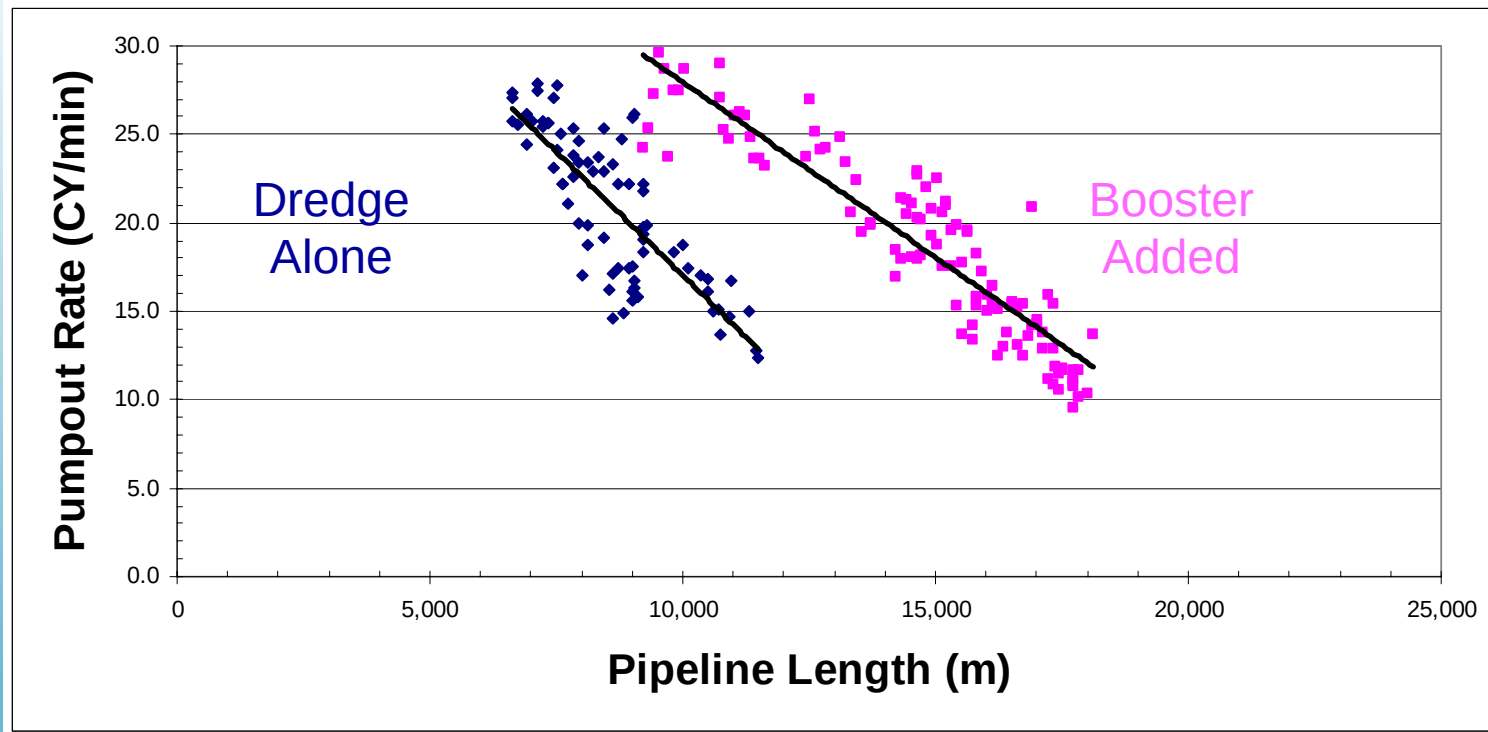


Pumping Production

$$\text{PROD}_{\text{pump}} = f(\text{L/D}_{\text{pipeline}}, P_{\text{pumps}}, \text{Material})$$



Hopper Dredge Pump Capacity

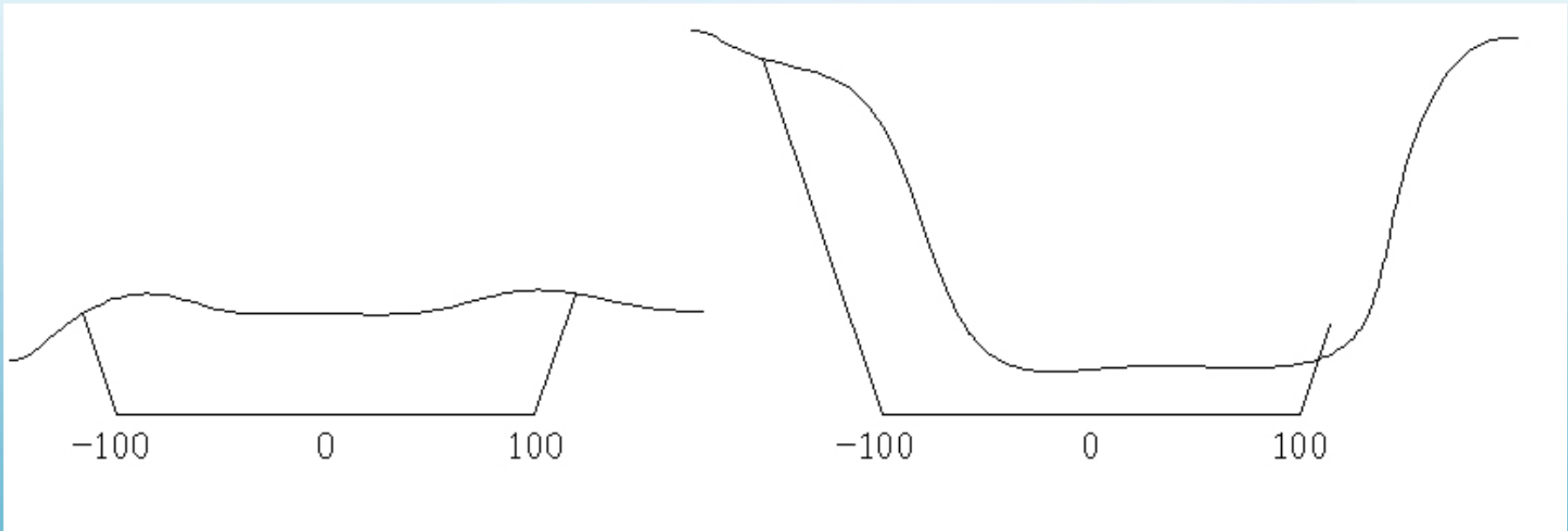


Other Important Variables

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



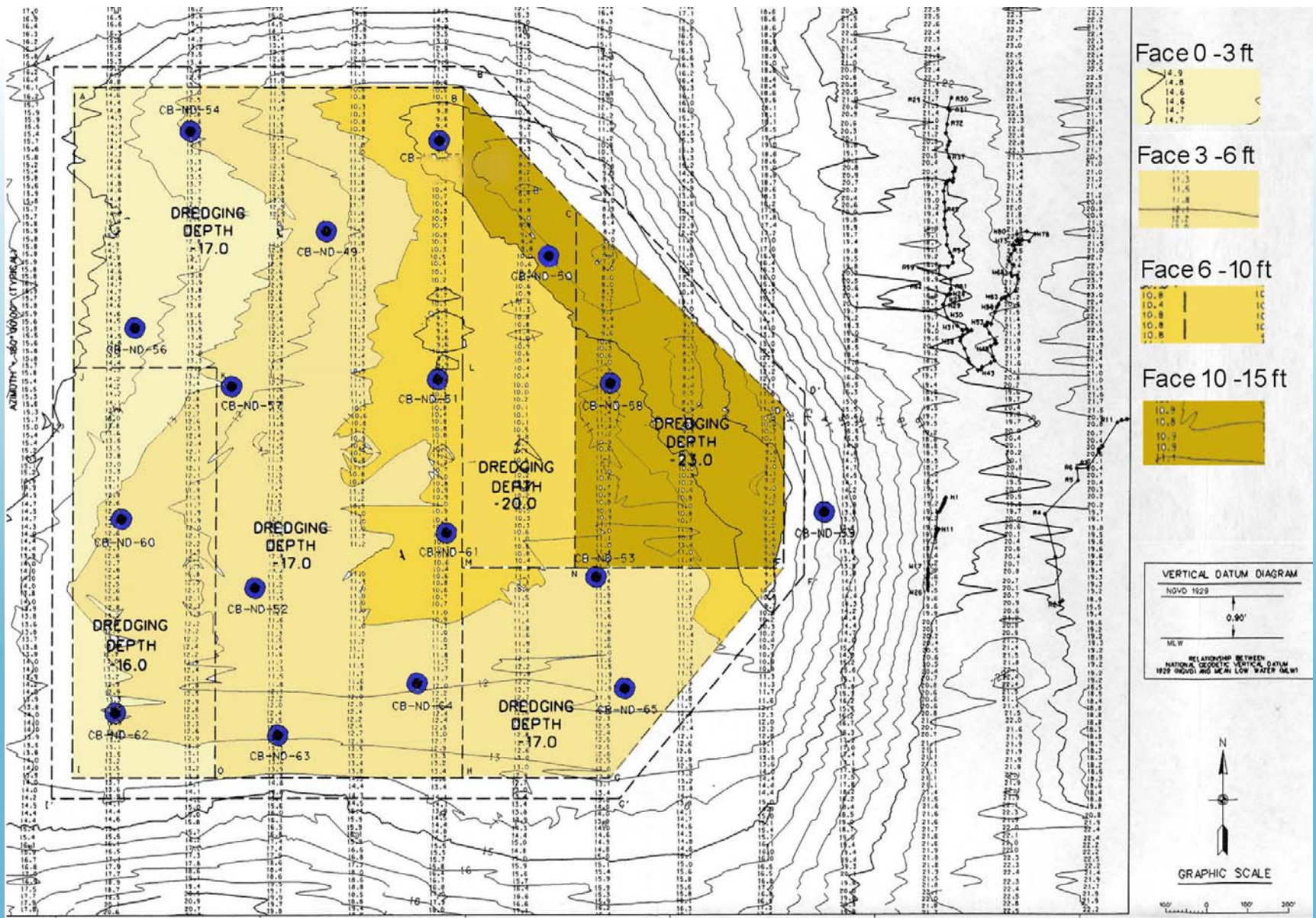
Layout of Face



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

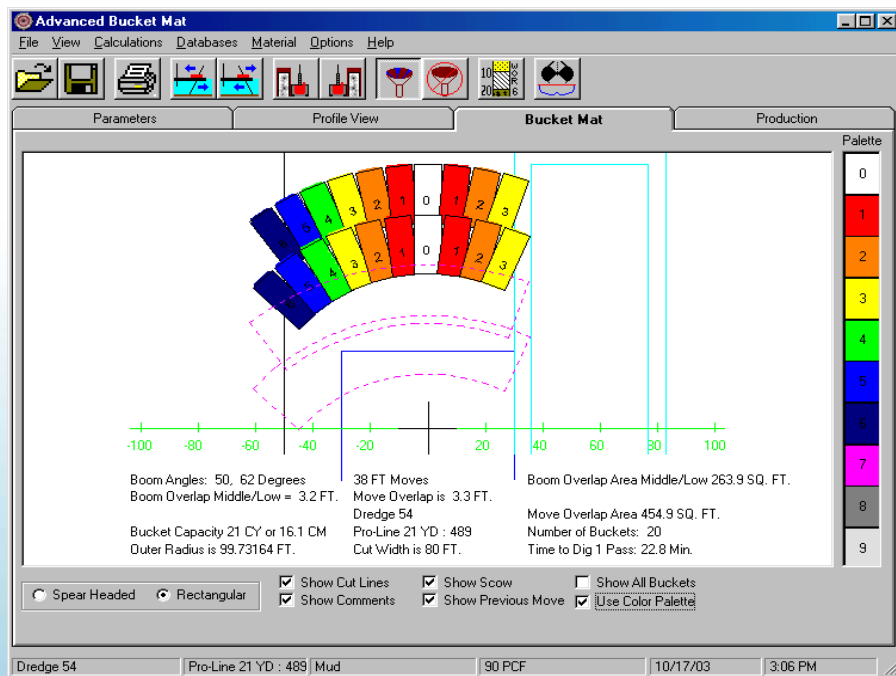
- Can the dredge physically reach the material in deep water?
- Can the dredge float and dig in shallow water?
- For clam, cycle is directly dependent on depth.
- For backhoe, bucket size is dependent on depth.



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

Clamshell Bucket Database

Bucket Specifications:

Bucket Name: **Pro-Line 21 YD : 489**

Bucket GL# **489** Open Length (ft) **22.25** Max Parts 1 **6**
 Struck Capacity (CY) **21** Closed Length (ft) **17.5** Closing Line Length 1 **54.5**
 Heaped Capacity (CY) **32.4** Width (ft) **9.25** Max Parts 2 **4**
 Bucket Weight (lbs) **55000** Lip Weight/Ft **873** Closing Line Length 2 **36.33**

Bucket Geometry:

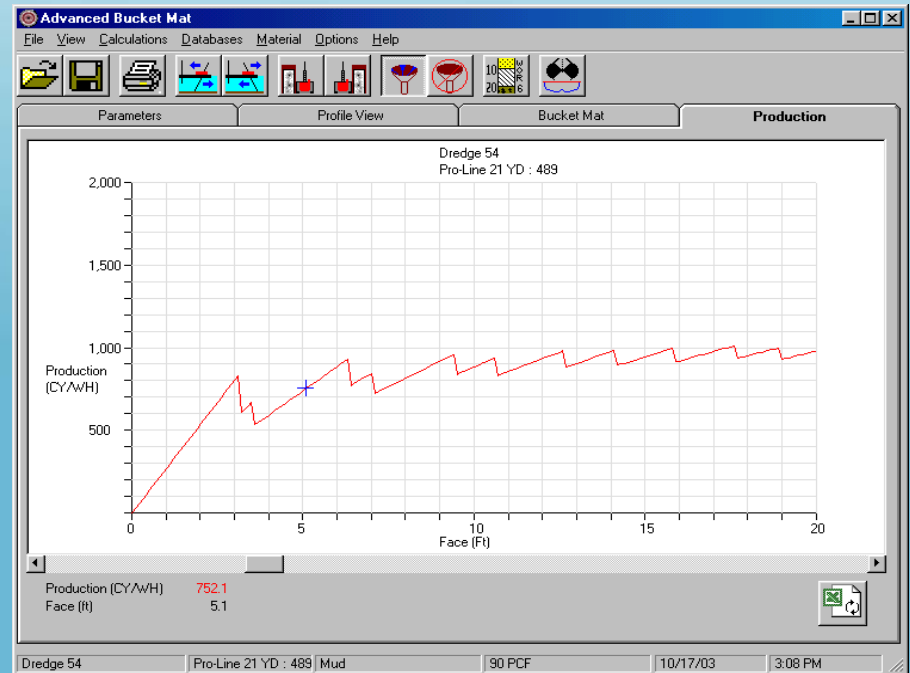
Bowl Weight (One Side) (lbs) **14446** Eccentricity of Point B (ft) **0.833**
 Upper Sheave Block Weight (lbs) **4840** Eccentricity of Point D (ft) **2**
 Lower Sheave Block Weight (lbs) **2376** Side Edge Length (A-H) (ft) **9.5**
 Bucket Edge Thickness (ft) **0.167** Distance A-B (ft) **10.625**
 Top Angle (90-Alpha) (deg) **82** Distance B-C (ft) **8.229**
 Angle A-B-C (deg) **67** Distance B-G (ft) **7.75**
 Angle A-B-G (deg) **19** Distance D-C (ft) **13**
 Open Angle A-H-A (deg) **84** Pulling Velocity (m/s) **1.016**

Note: Changing the Specifications in the above fields will modify the database values.

Add Bucket To Database Update Database Delete Bucket From Database Exit

Load *.CLS File

Before loading, make sure the correct bucket is selected at left.



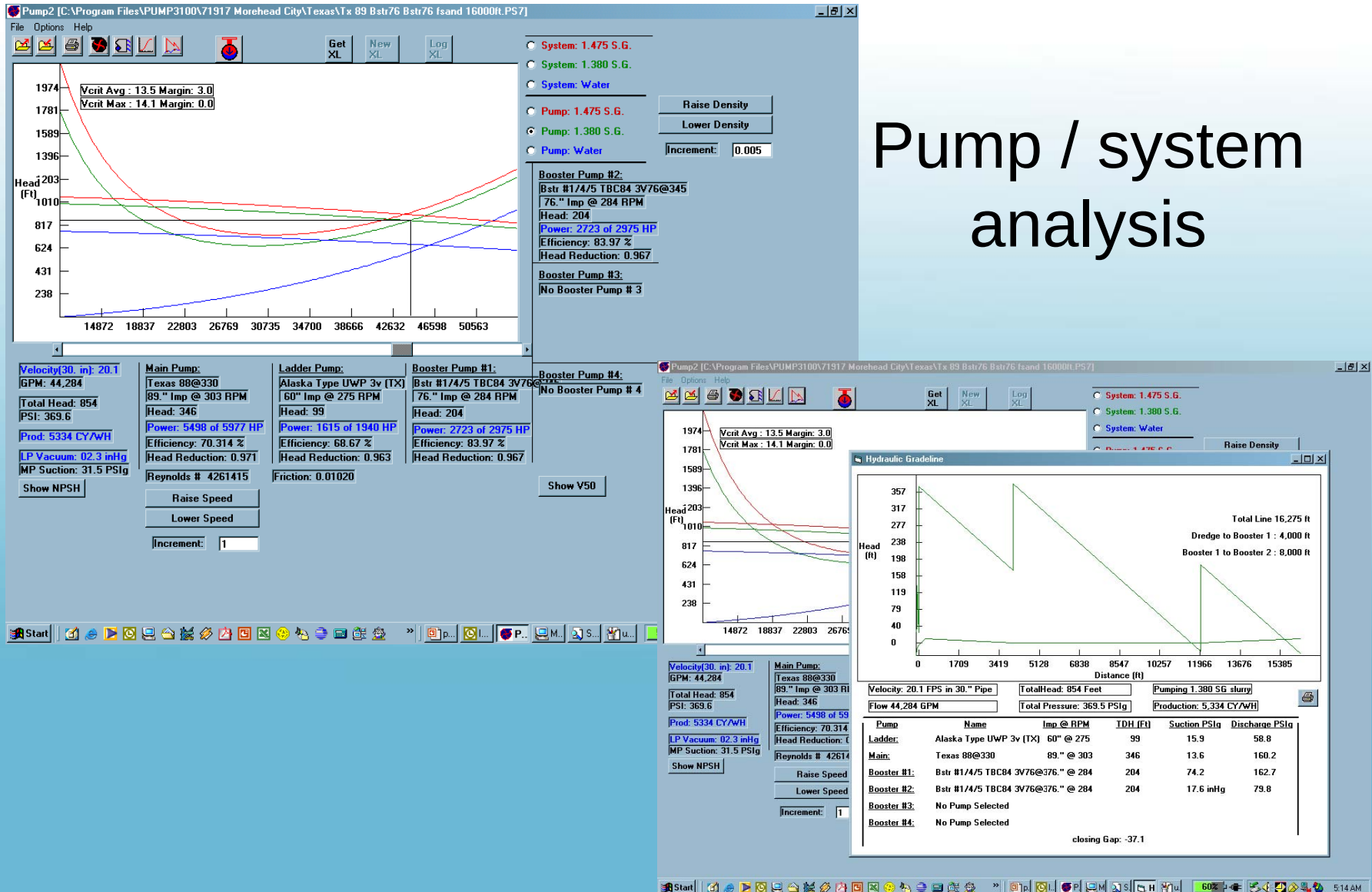
CSD Production Limits

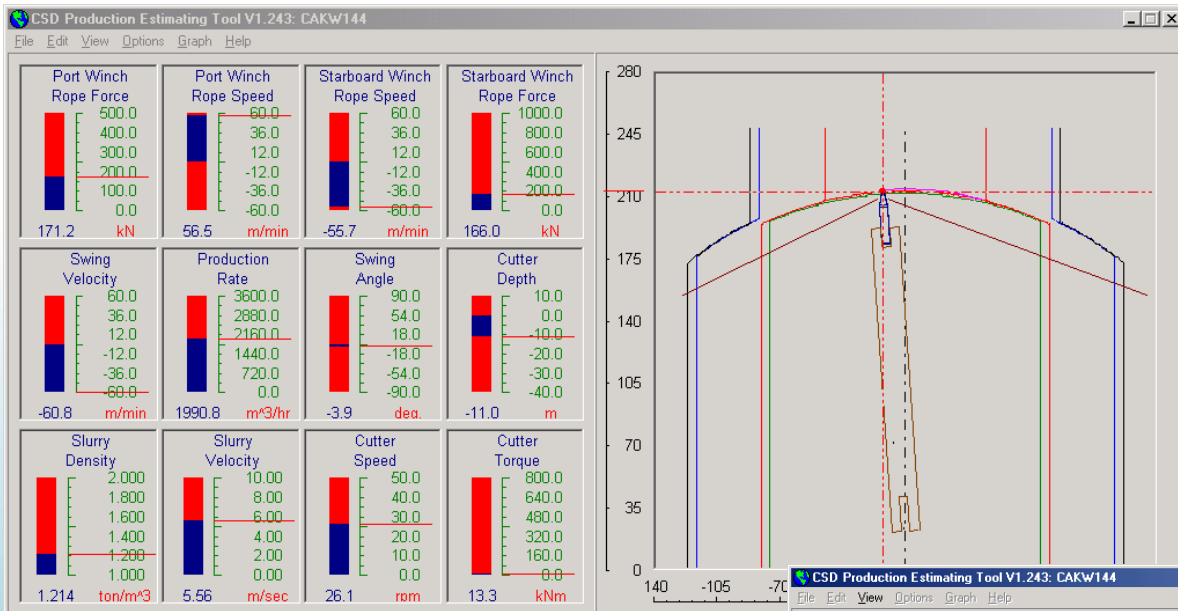
- Pumping capacity
- Dig limit – ability to excavate the material
- Swing limit – How fast can the dredge swing?



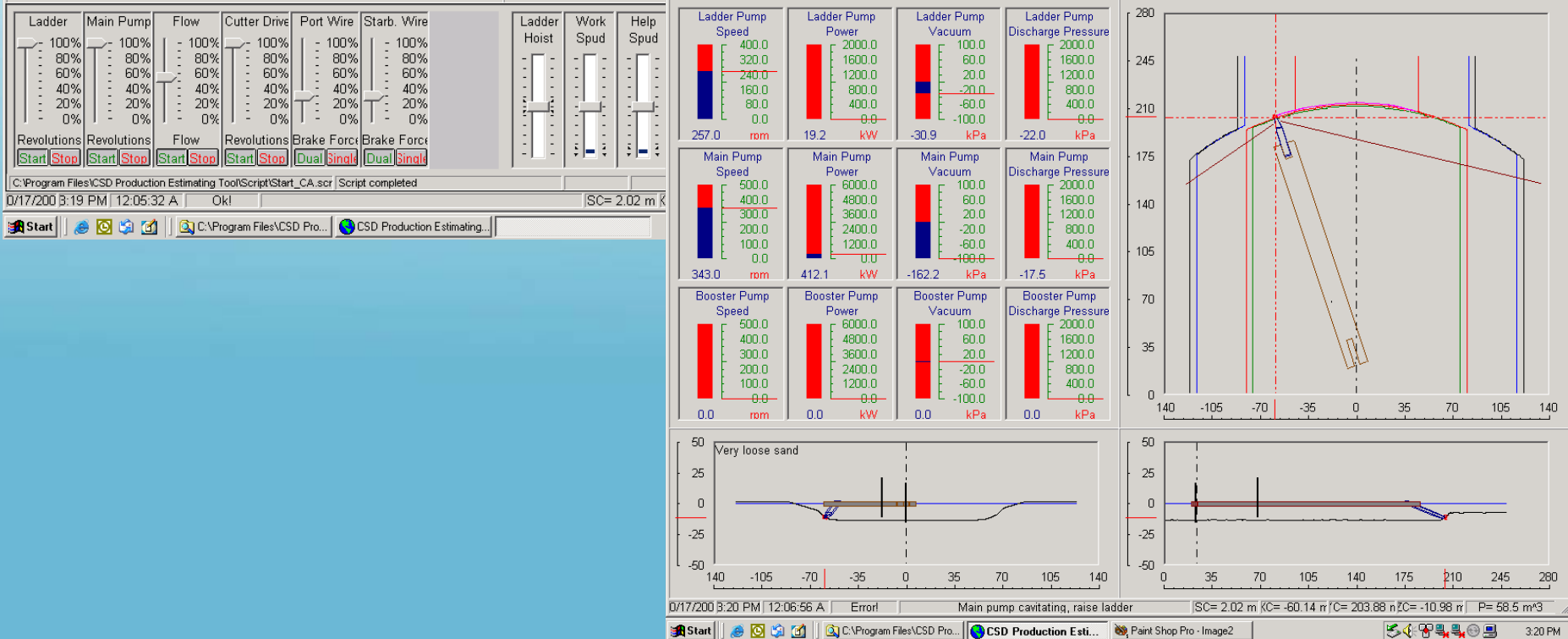
Production Engineering Tools

Pump / system analysis





CSD Simulators



Mat'l Load	=	3486.88	CY
Total Load	=	5846.82	shT
Loading Time	=	67.2	min
Loading Production	=	51.89	CY/min
Overflow losses (situ)	=	386.96	CY
D50	=	0.46	mm
D85	=	1.3	mm
Mixture S.G.	=	1.21	s.g.
Mixture Flow-single arm	=	30000	GPM



Time(min)	D50	D85
Init	0.48	1.318
5	0.48	1.318
10	0.48	1.318
15	0.48	1.318
20	0.48	1.445
25	0.53	1.585
30	0.53	1.585
35	0.53	1.585
40	0.53	1.585
45	0.53	1.585
50	0.53	1.585
55	0.53	1.585
60	0.58	1.738
65	1.32	6.31
Final	5.75	10.
Avg	0.53	1.905

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

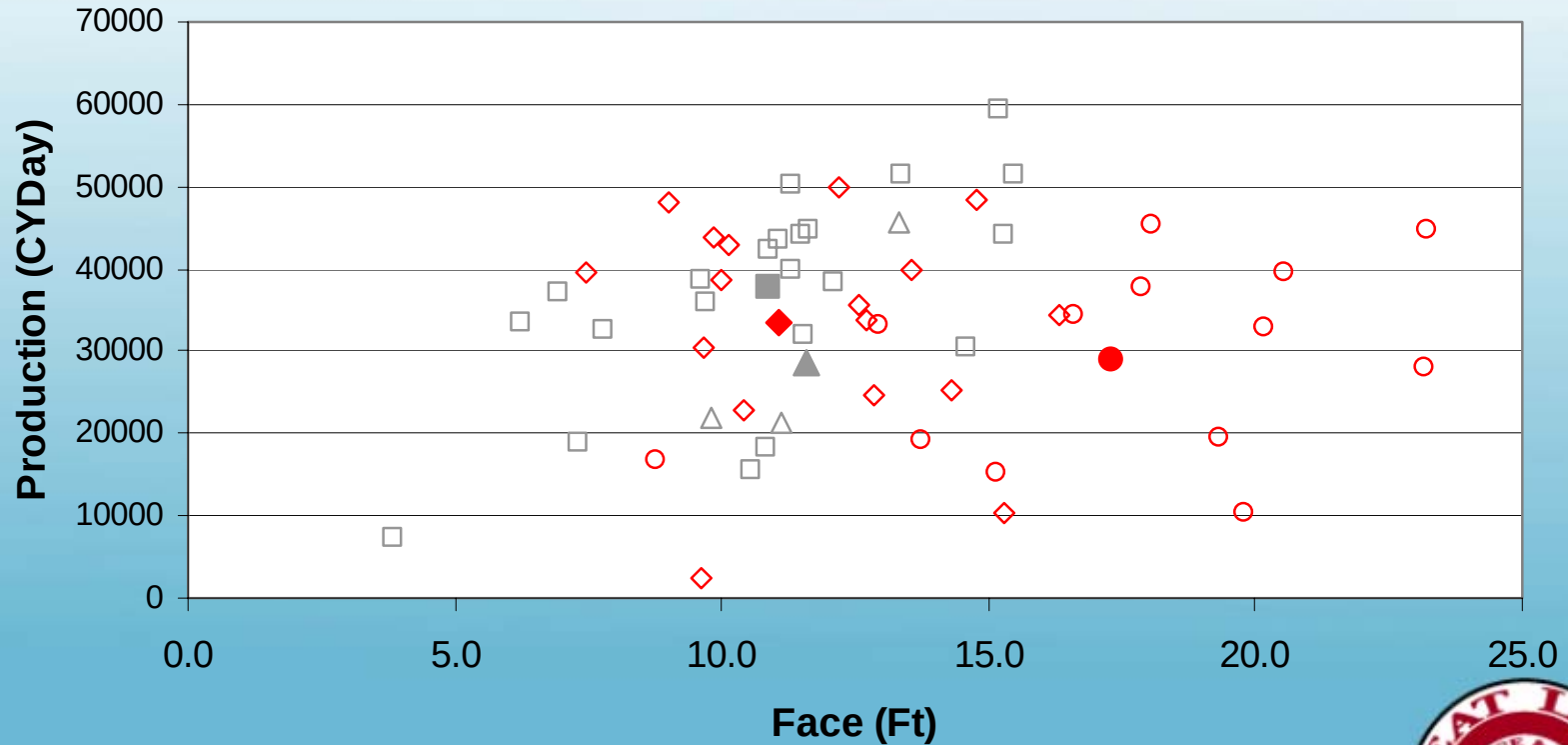
- 12.4' Face
- 17900' Pipe
- Dredge Alaska

2005

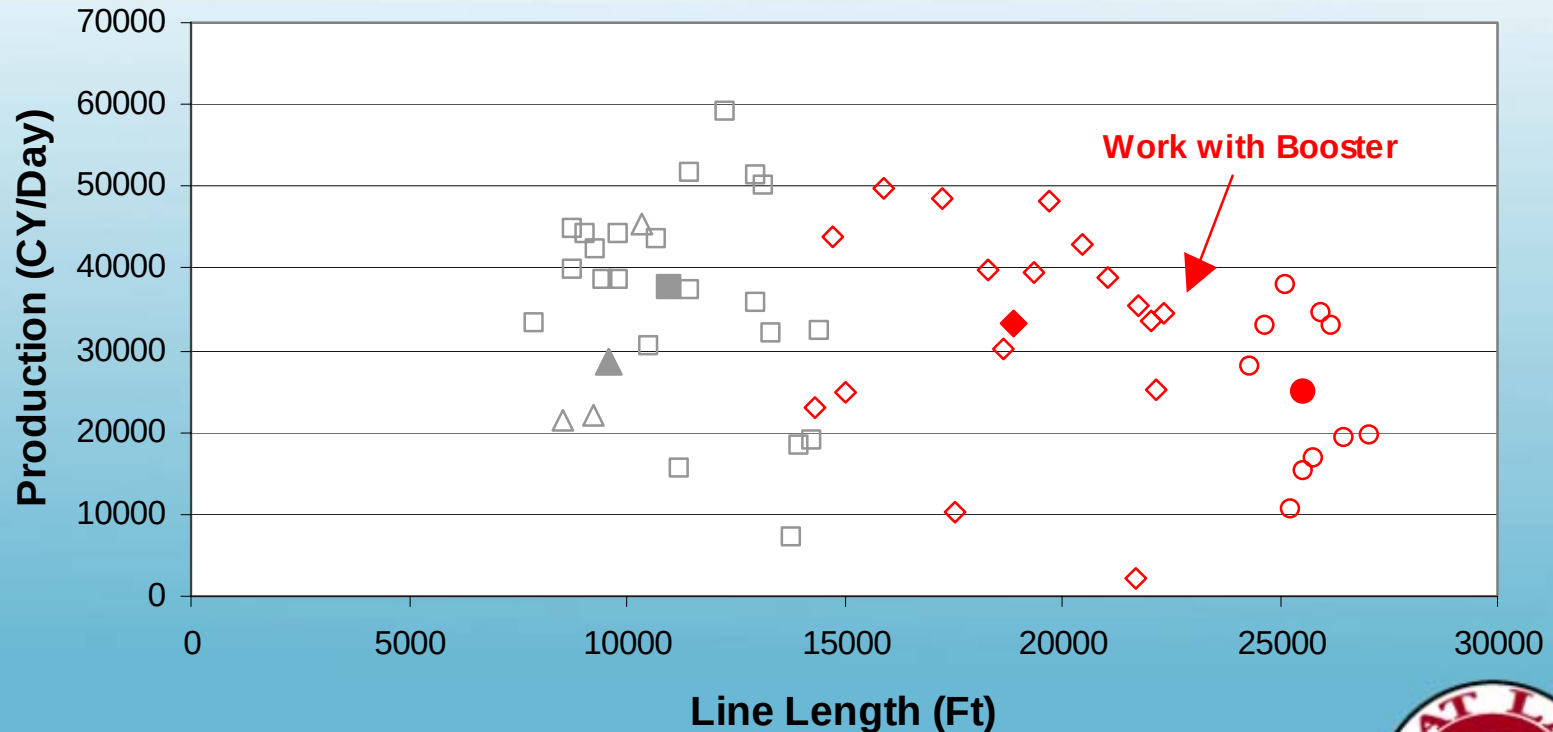
- 8.4' Face
- 22800' Pipe
- Dredge Texas



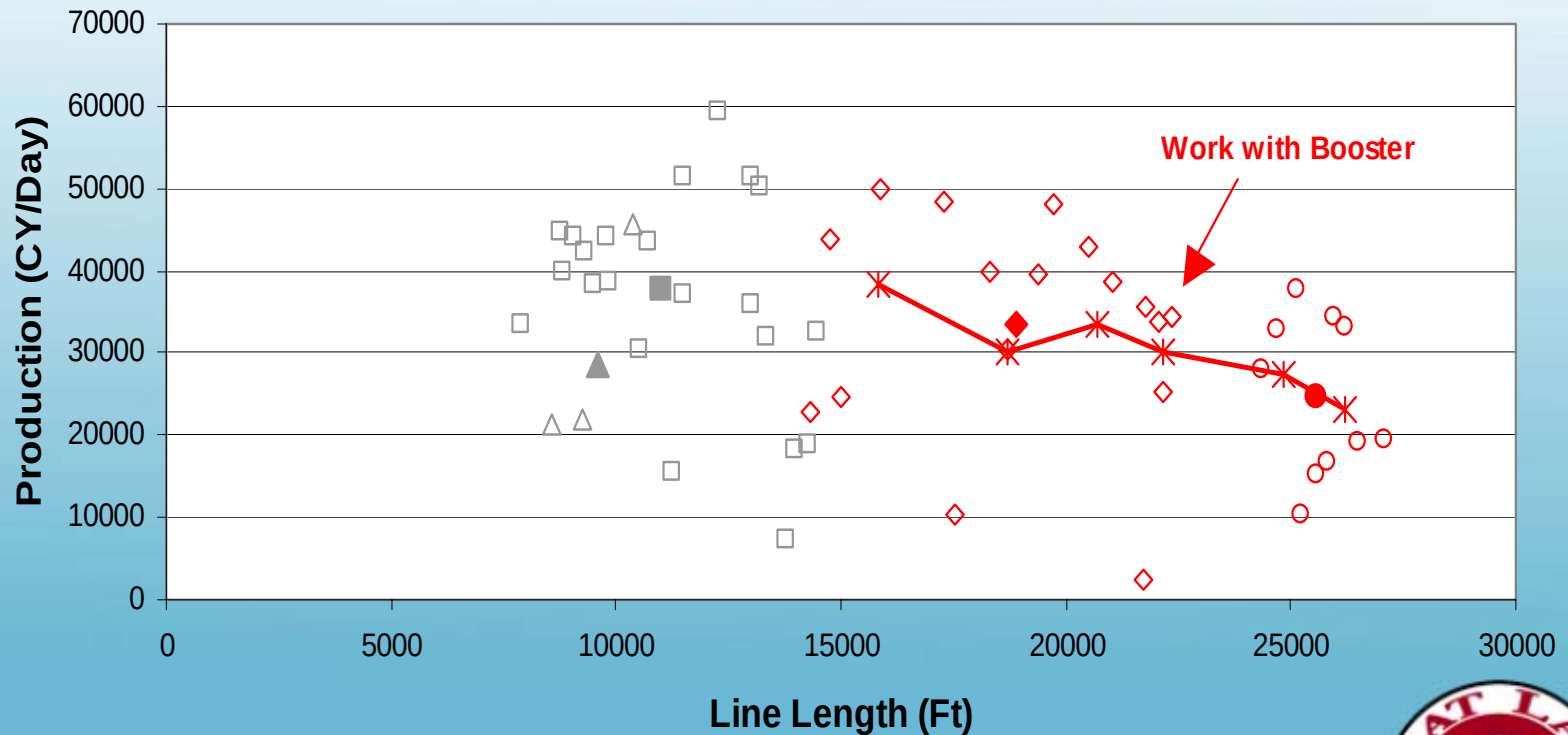
1995 Project – by Face



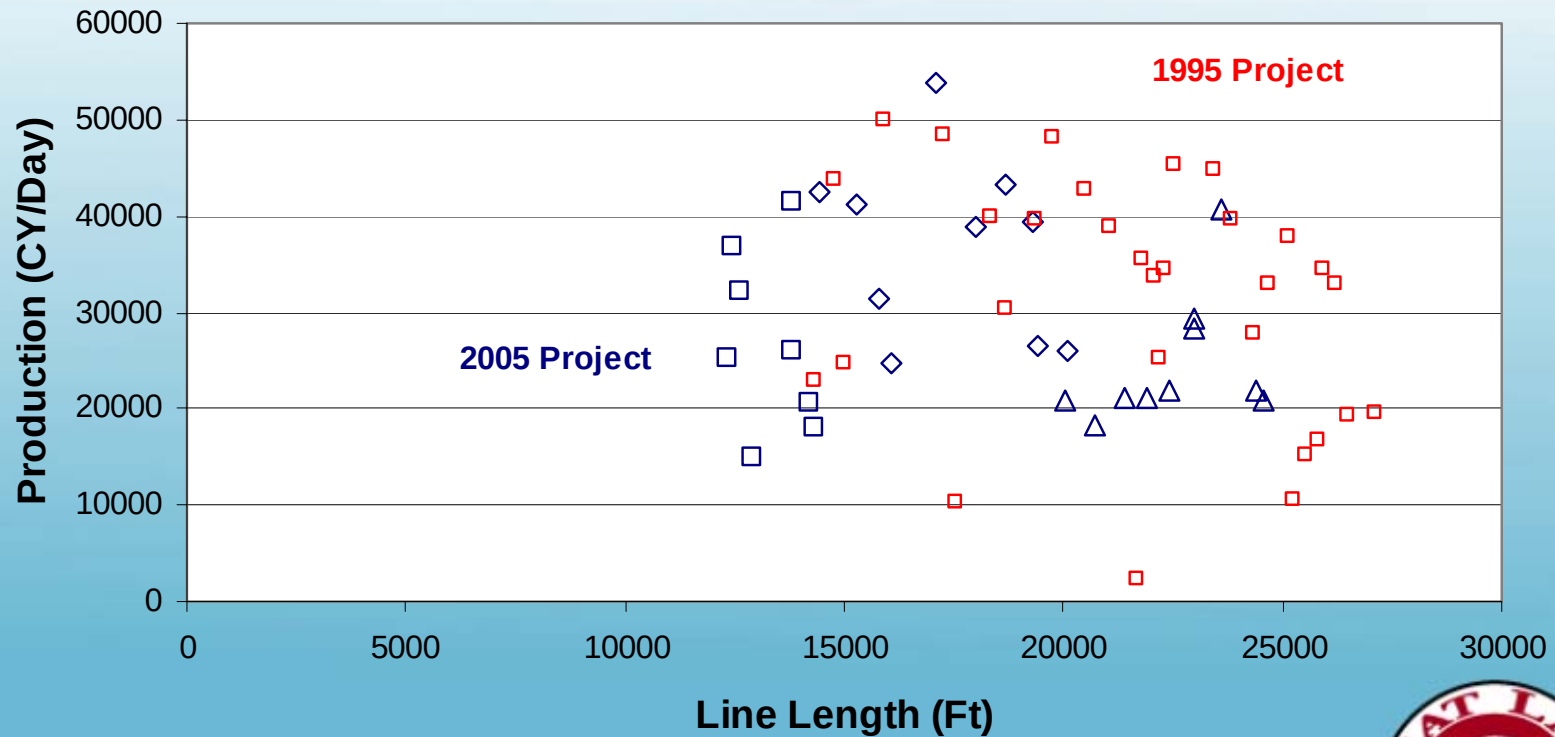
1995 Project – by Line Length



1995 Project – by Line Length



2005 Project - Results





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