Geomorphological Studies

Coring Fine Sediment Deposits

K. Skalak

J. Pizzuto

U Delaware Geology

Rich Landis

DuPont

Lidar Bank Erosion Surveys, Historical Aerial Photo Analysis

Erica Rhoades

Dr. Michael O'Neal

U Delaware Geography

Pramenath Narinesingh

J. Pizzuto

U Delaware Geology

Coring Mud Deposits

Katie Skalak – U. Del. Geology

Jim Pizzuto – U. Del. Geology

Rich Landis - DuPont

Summary of project

- Katie, Jim, Rich, and Craig Arnold (URS) cored mud deposits in November
- Cored 5 deposits successfully
- Analyzed for Hg, LOI, grain size, and samples archived for C-14 dating
- Results for Hg, LOI, grain size
- Expect results from C-14 analysis soon

Location of Deposits

- Three deposits cored from Hopeman to Dooms
- Two deposits cored from Dooms to Crimora

Physiographic Settings

- Long pooled sections caused by bedrock or old mill dams (D5A)
- Regions downstream of riffles in channel margins with LWD accumulations (H1A, H2C)
- Bank obstructions usually caused by trees (H2A)
- Side channel backwaters where flow separates around islands (D7A)

H1A

H2C

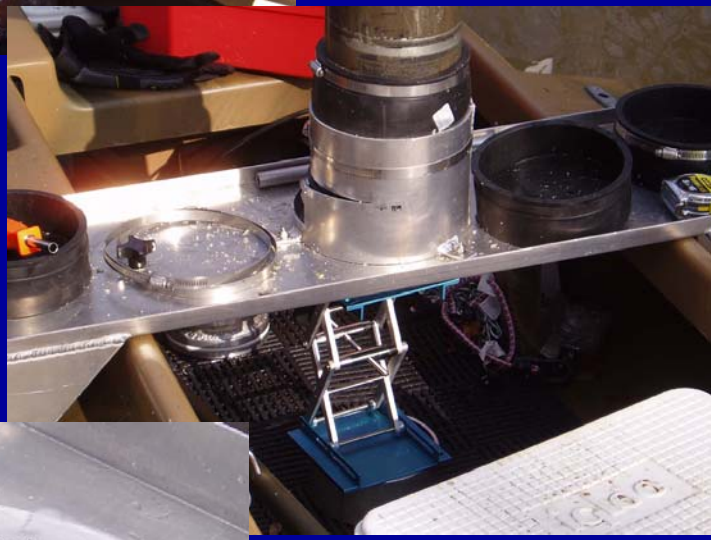
H2A

D5A

D7A

Summary of Coring Methods

- Tripod placed over mud deposit
- Core pipe (6-inch Teflon tube) attached
- Piston with valve at the top to regulate suction
- Extruded on apparatus attached to boat
- Sampled for analytes in the field and at Forestry Center

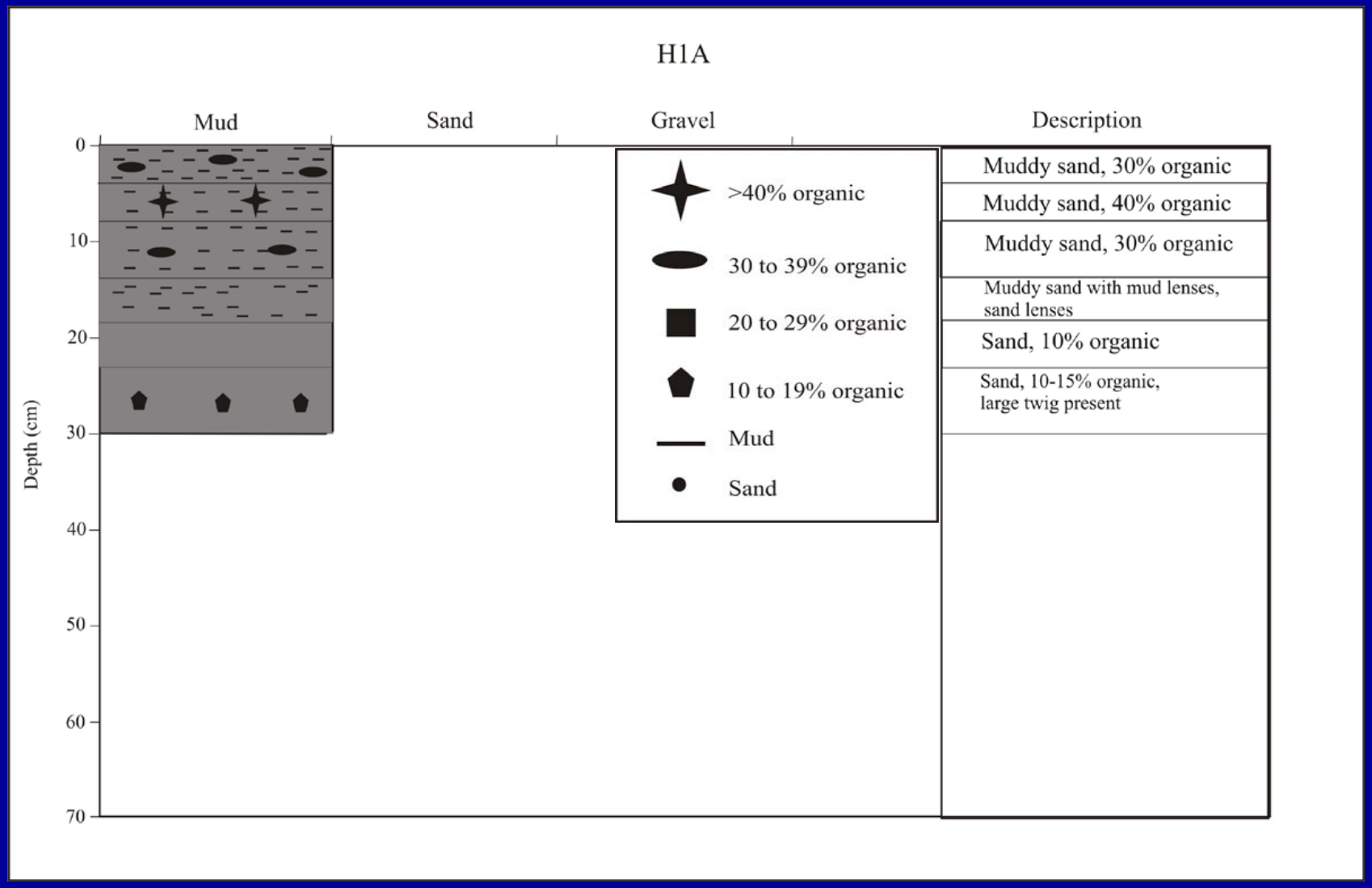


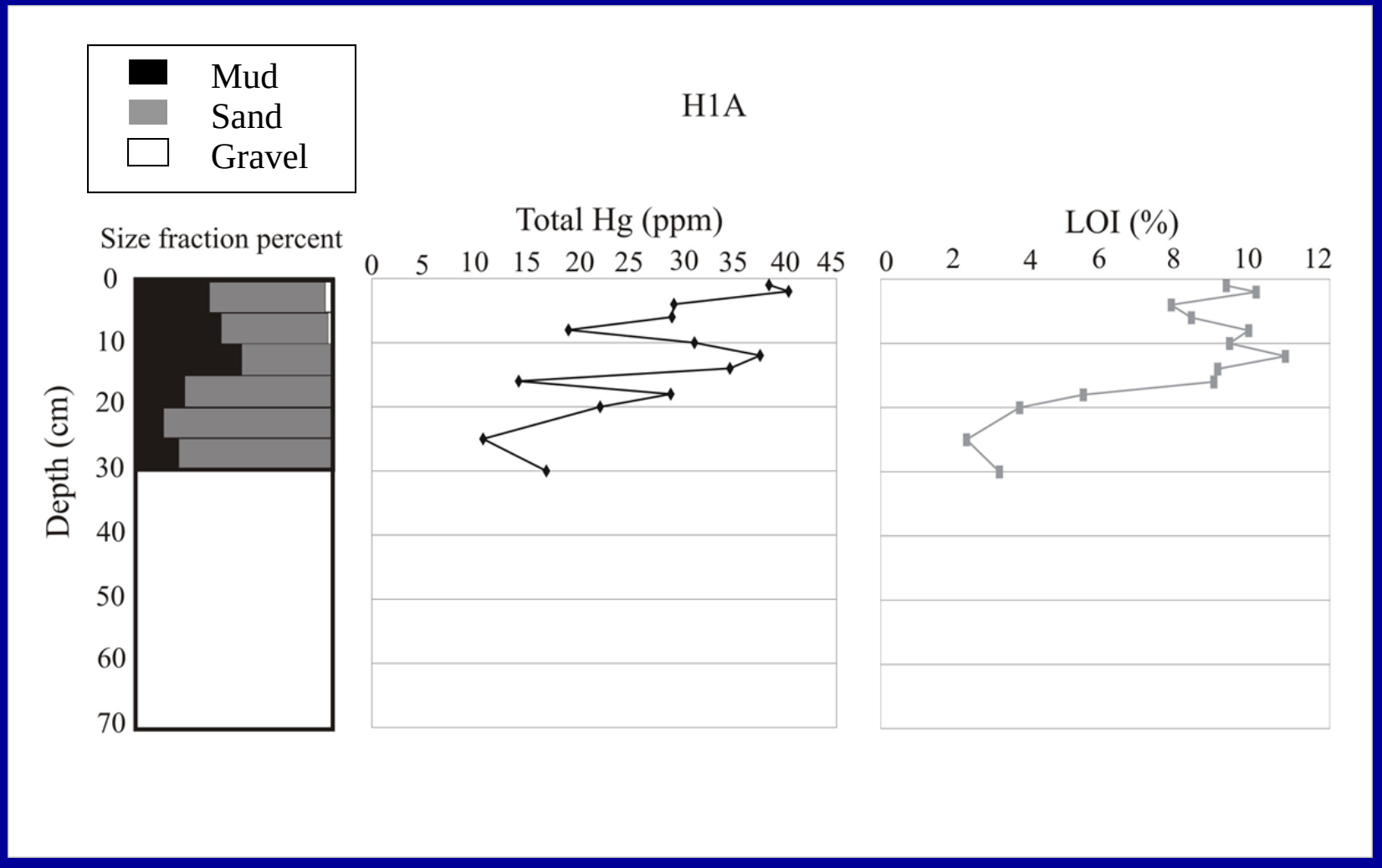
Results

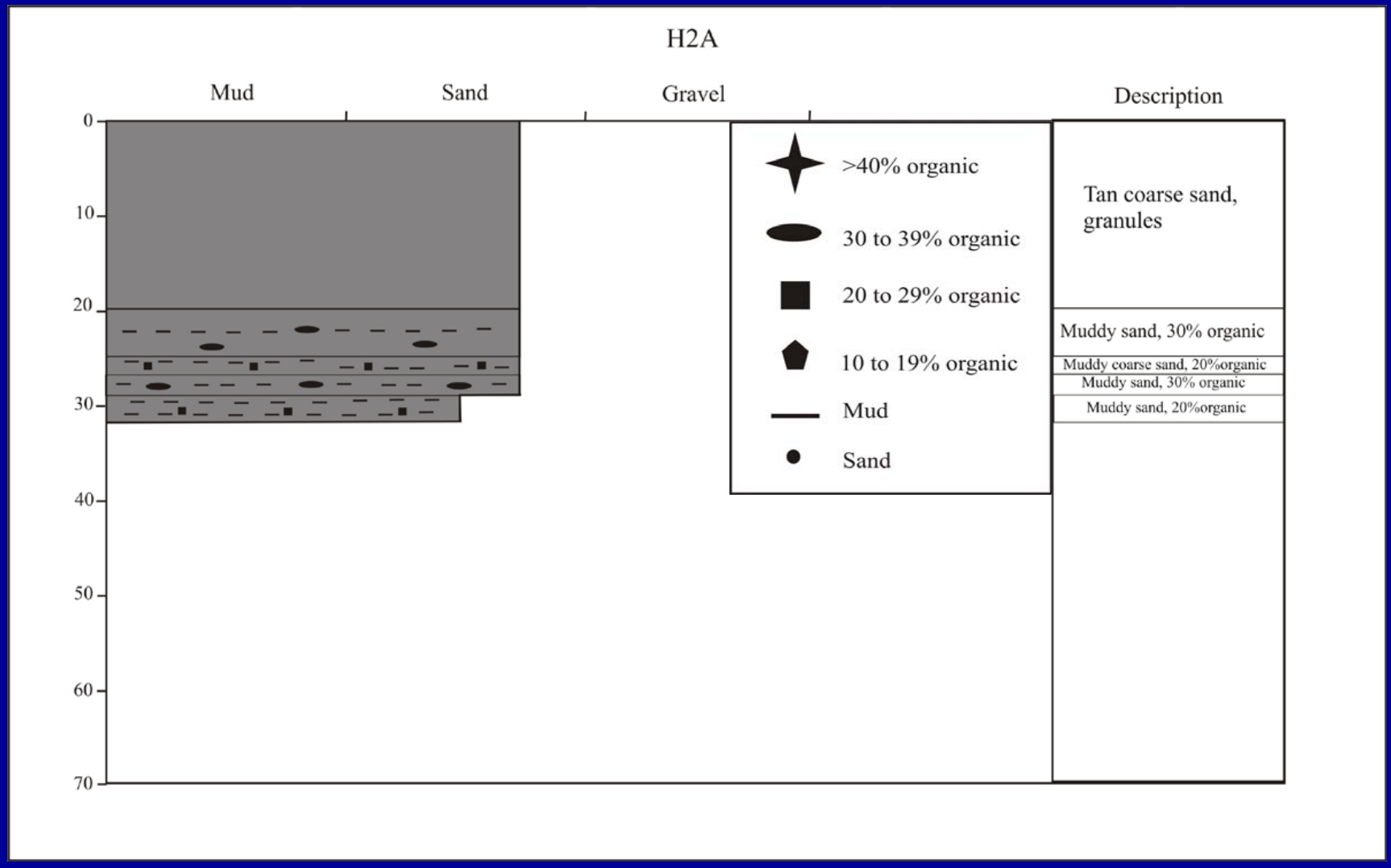
Two figures for each coring location

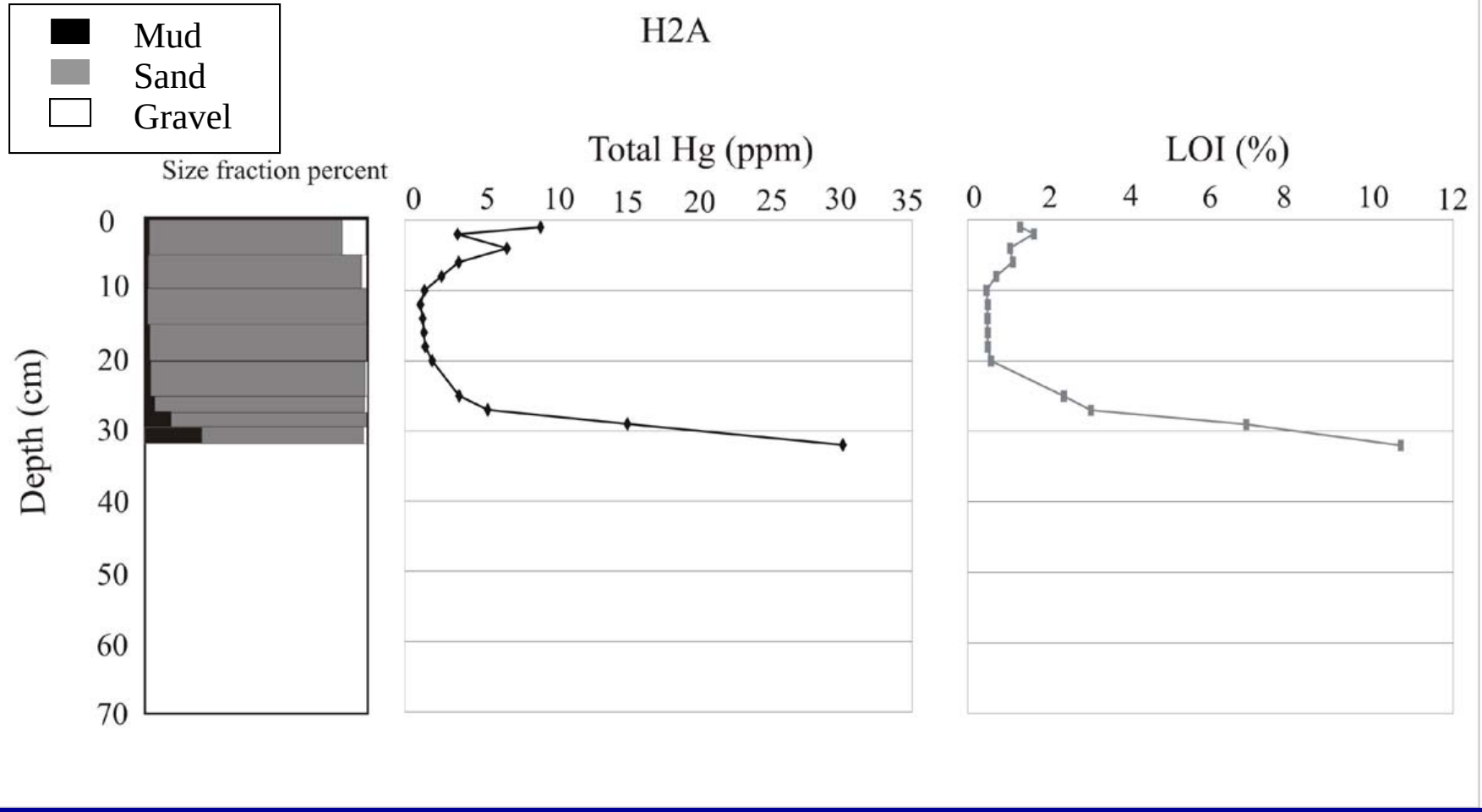
1. Core log generated in the field qualitatively

2. Results for grain size, total Hg, and LOI

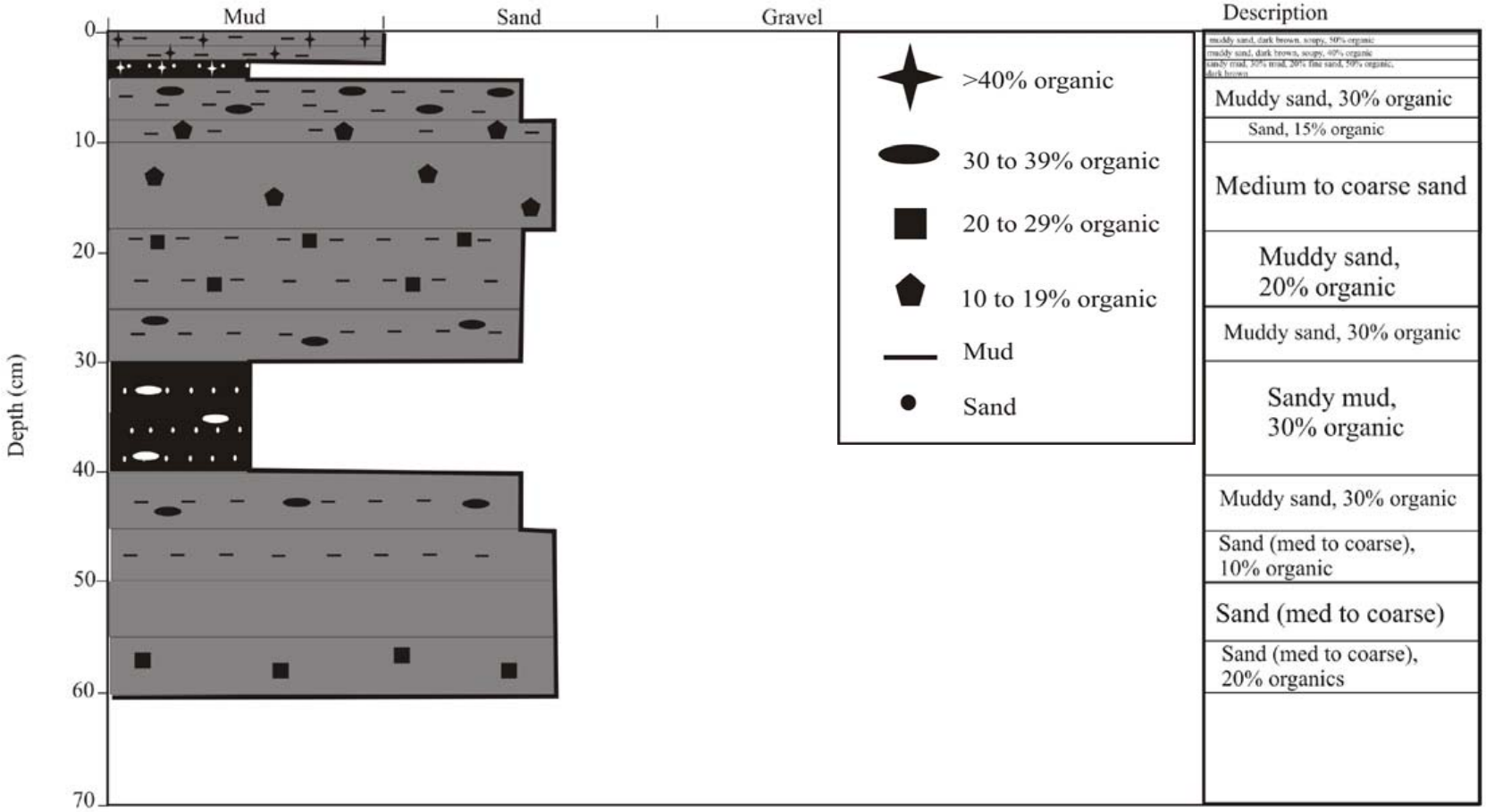

H1A
Mud
Sand
Gravel
Description
Depth (cm)
0
10
20
30
40
50
60
70
>40% organic
30 to 39% organic
20 to 29% organic
10 to 19% organic
Mud
Sand
Muddy sand, 30% organic
Muddy sand, 40% organic
Muddy sand, 30% organic
Muddy sand with mud lenses, sand lenses
Sand, 10% organic
Sand, 10-15% organic, large twig present

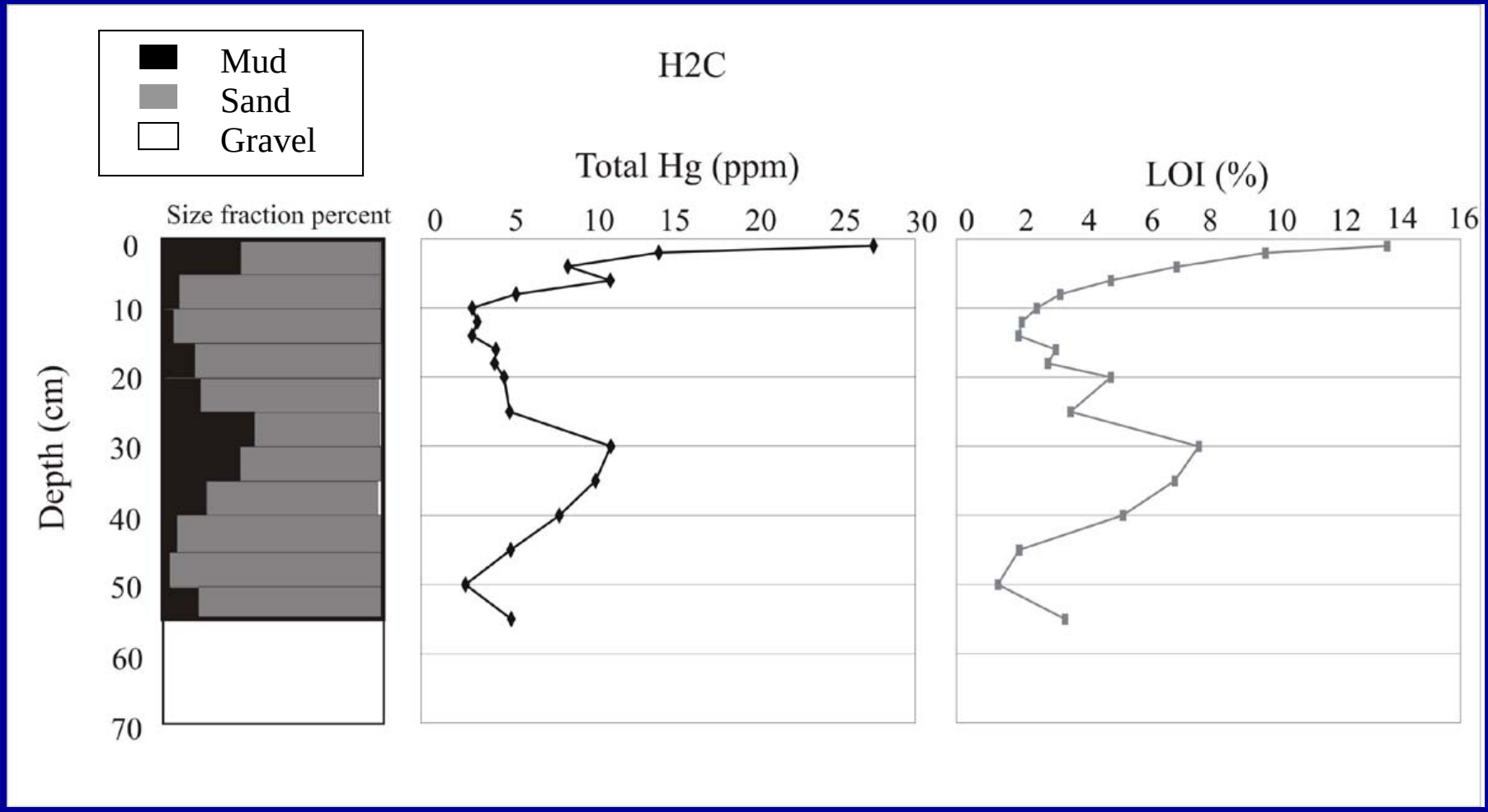

Mud
Sand
Gravel
H1A
Size fraction percent
Depth (cm)
0
10
20
30
40
50
60
70
Total Hg (ppm)
0 5 10 15 20 25 30 35 40 45
LOI (%)
0 2 4 6 8 10 12

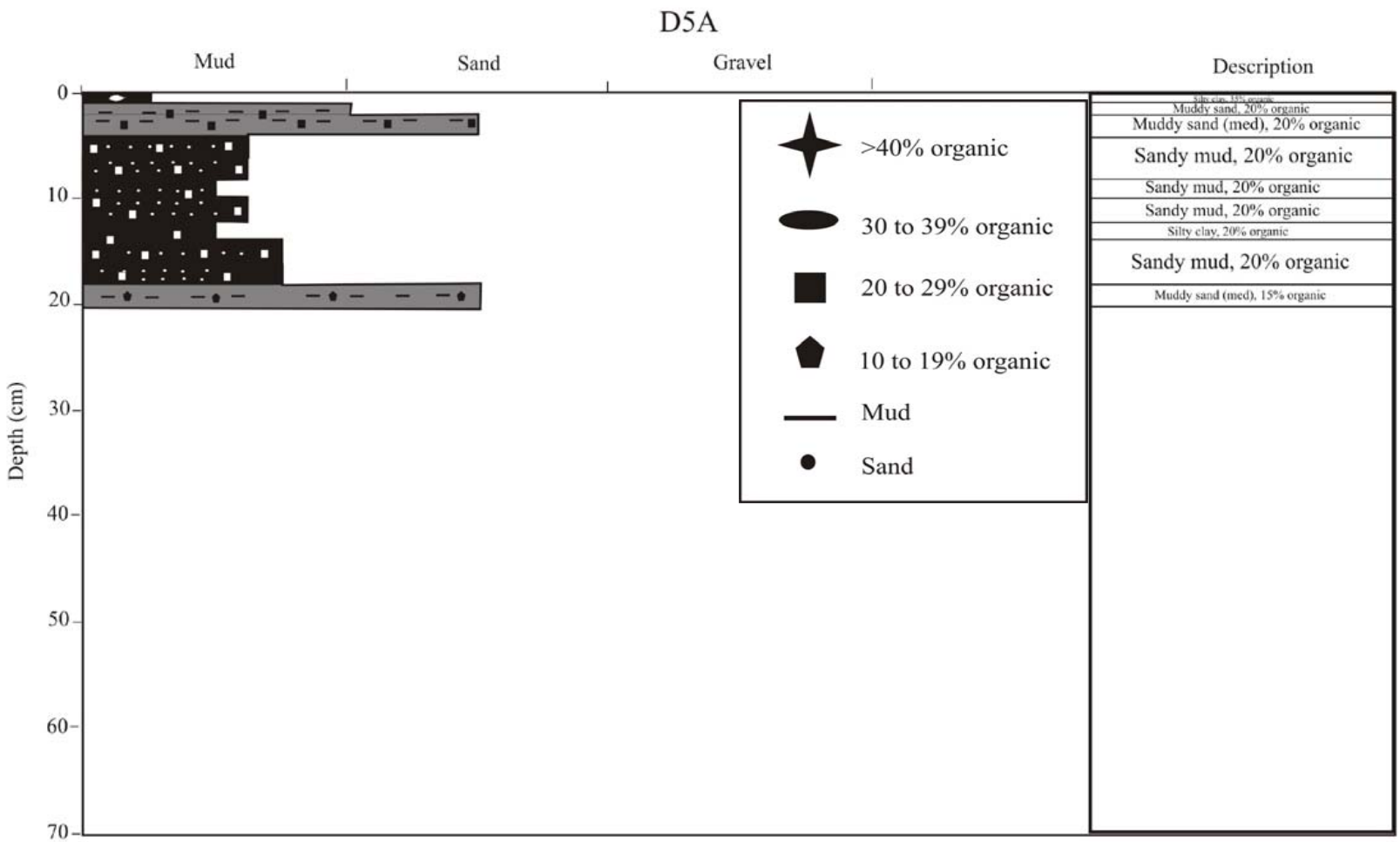

H2A
Mud
Sand
Gravel
Description
0
10
20
30
40
50
60
70
>40% organic
30 to 39% organic
20 to 29% organic
10 to 19% organic
Mud
Sand
Tan coarse sand, granules
Muddy sand, 30% organic
Muddy coarse sand, 20%organic
Muddy sand, 30% organic
Muddy sand, 20%organic

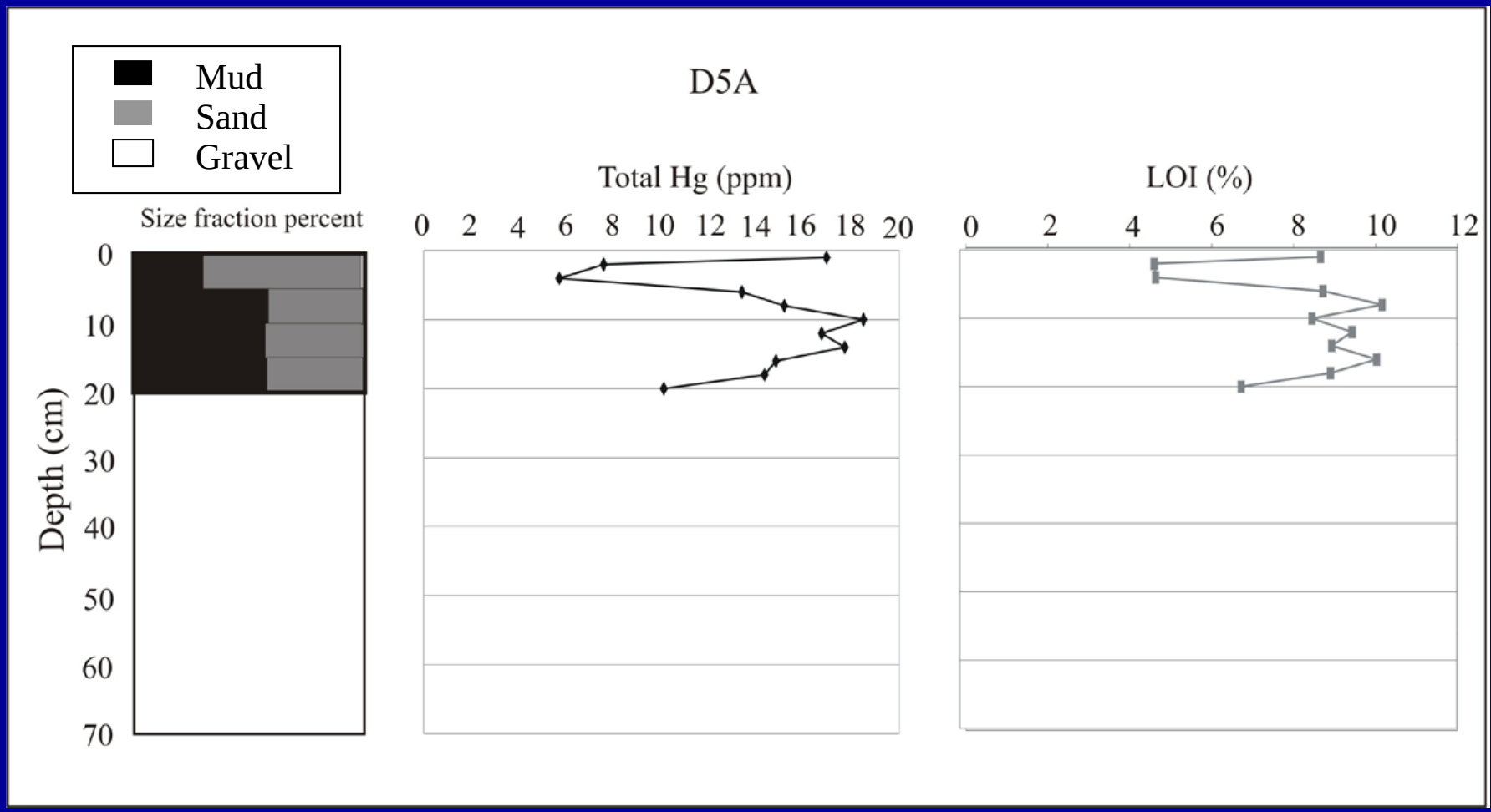

Mud
Sand
Gravel
H2A
Size fraction percent
Depth (cm)
0
10
20
30
40
50
60
70
Total Hg (ppm)
0
5
10
15
20
25
30
35
LOI (%)
0
2
4
6
8
10
12

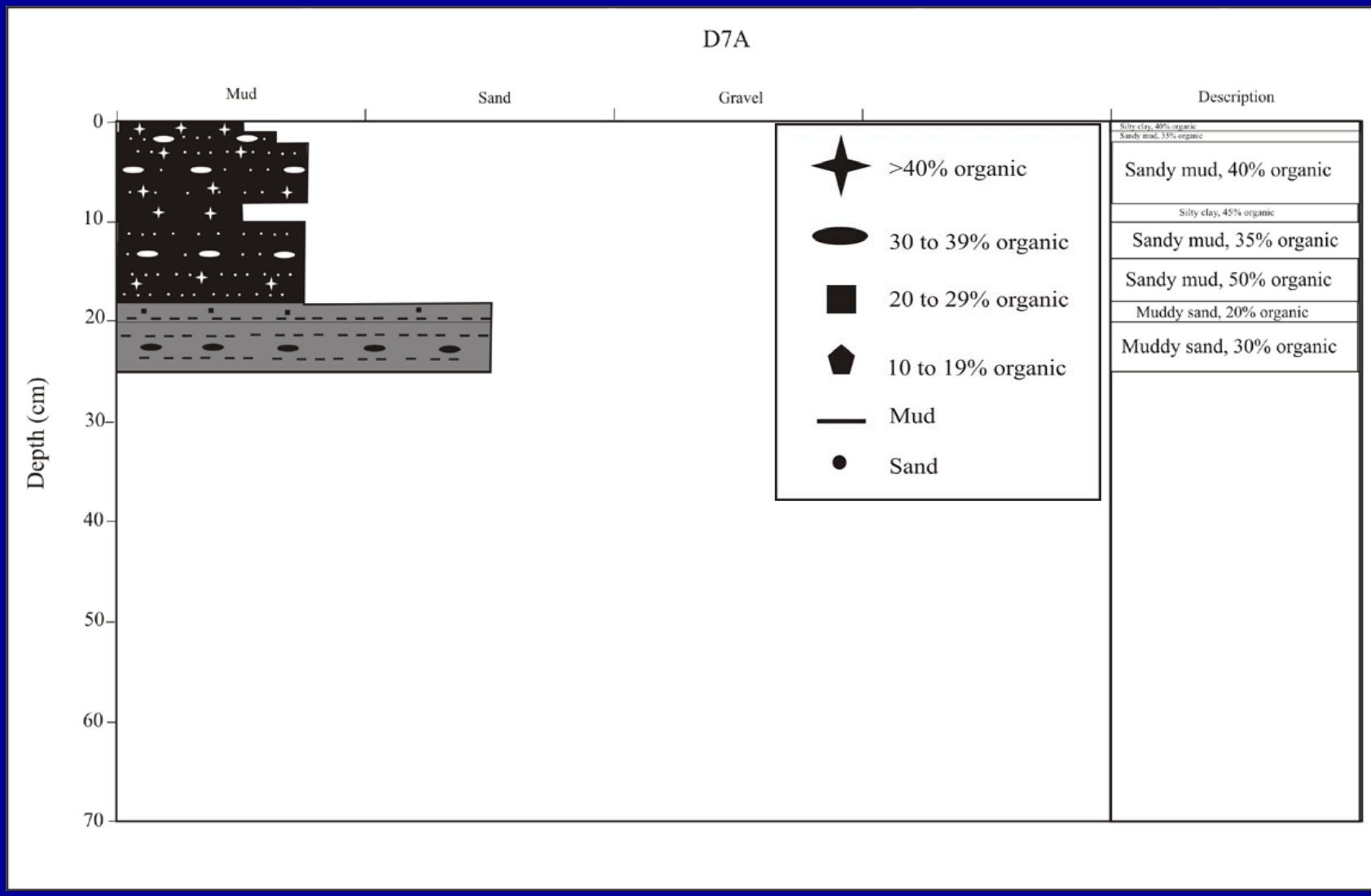
H2C

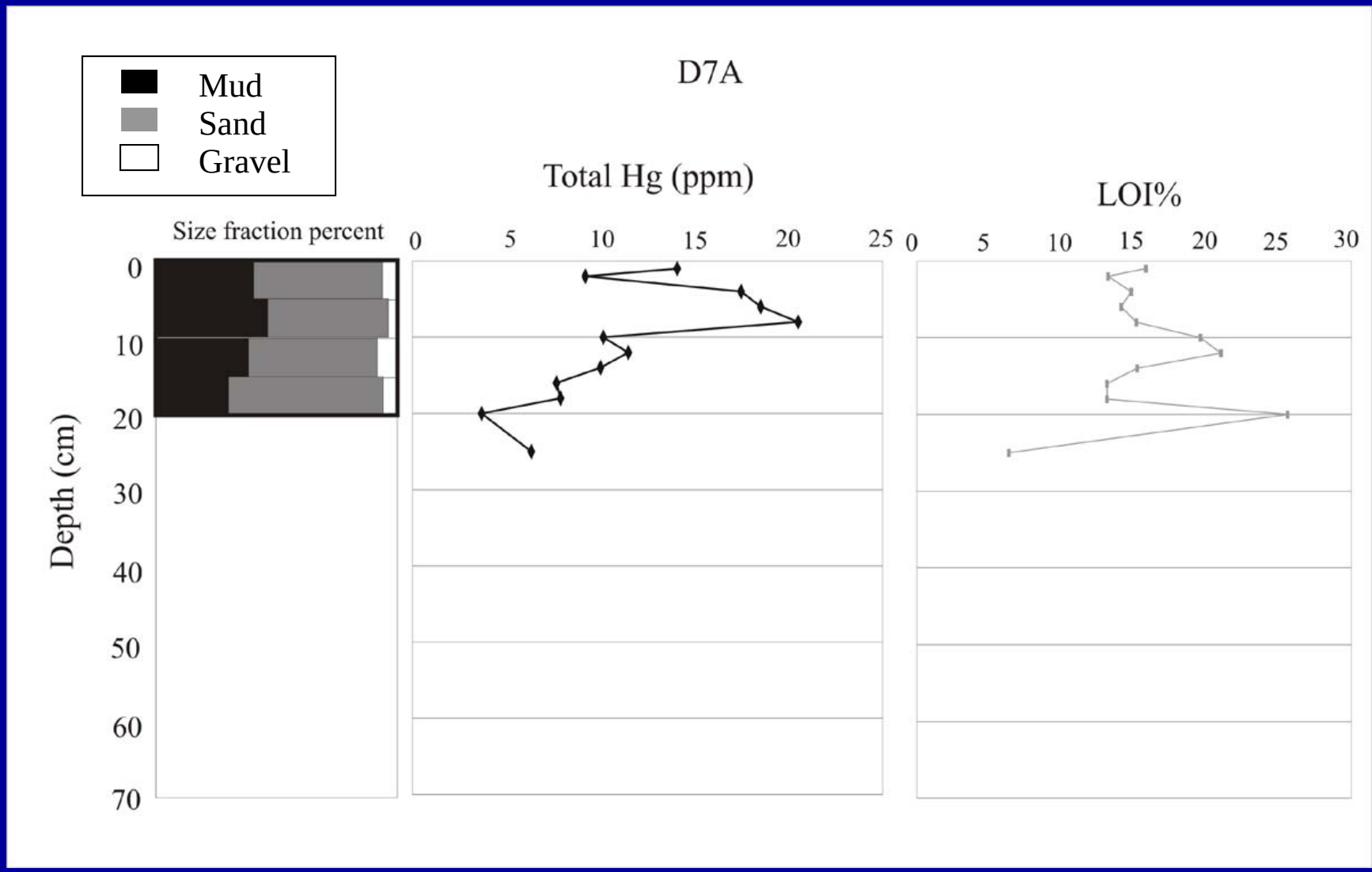

Mud
Sand
Gravel
Depth (cm)
0
10
20
30
40
50
60
70
>40% organic
30 to 39% organic
20 to 29% organic
10 to 19% organic
Mud
Sand
Description
muddy sand, dark brown, soupy, 50% organic
muddy sand, dark brown, soupy, 40% organic
sandy mud, 35% mud, 20% fine sand, 50% organic, dark brown
Muddy sand, 30% organic
Sand, 15% organic
Medium to coarse sand
Muddy sand, 20% organic
Muddy sand, 30% organic
Sandy mud, 30% organic
Muddy sand, 30% organic
Sand (med to coarse), 10% organic
Sand (med to coarse)
Sand (med to coarse), 20% organics


Mud
Sand
Gravel
H2C
Total Hg (ppm)
LOI (%)
Size fraction percent
Depth (cm)
0
10
20
30
40
50
60
70
0
5
10
15
20
25
30
0
2
4
6
8
10
12
14
16

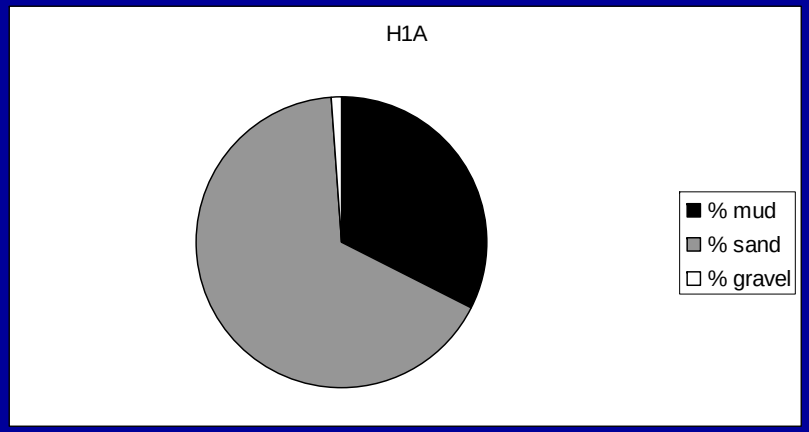

D5A
Mud
Sand
Gravel
Description
Depth (cm)
0
10
20
30
40
50
60
70
>40% organic
30 to 39% organic
20 to 29% organic
10 to 19% organic
Mud
Sand
Muddy sand, 20% organic
Muddy sand (med), 20% organic
Sandy mud, 20% organic
Sandy mud, 20% organic
Sandy mud, 20% organic
Silty clay, 20% organic
Sandy mud, 20% organic
Muddy sand (med), 15% organic

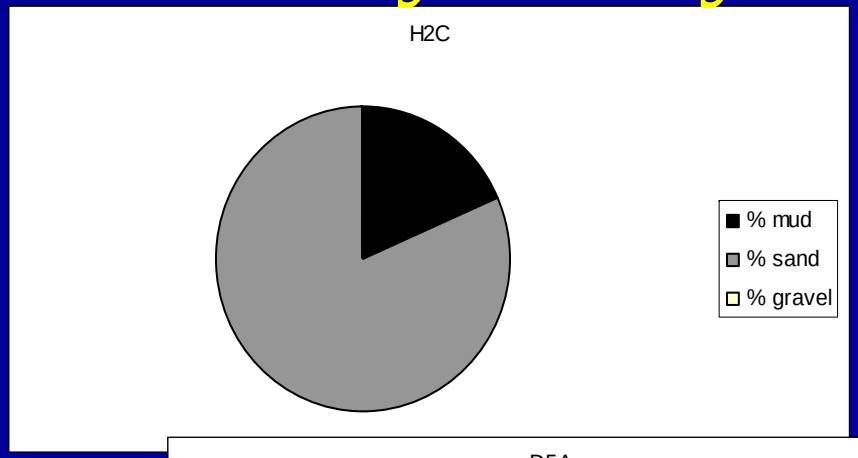

Mud
Sand
Gravel
D5A
Size fraction percent
Total Hg (ppm)
LOI (%)
Depth (cm)
0
10
20
30
40
50
60
70
0 2 4 6 8 10 12 14 16 18 20
0 2 4 6 8 10 12

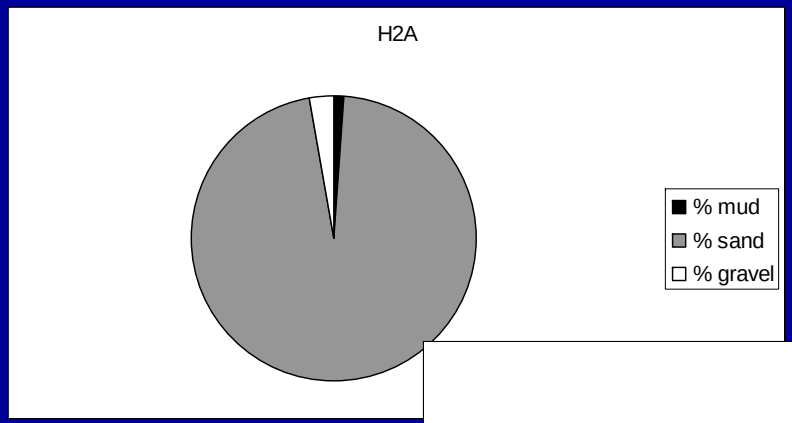

D7A
Mud
Sand
Gravel
Description
Depth (cm)
0
10
20
30
40
50
60
70
>40% organic
30 to 39% organic
20 to 29% organic
10 to 19% organic
Mud
Sand
Silty clay, 40% organic
Sandy mud, 35% organic
Sandy mud, 40% organic
Silty clay, 45% organic
Sandy mud, 35% organic
Sandy mud, 50% organic
Muddy sand, 20% organic
Muddy sand, 30% organic

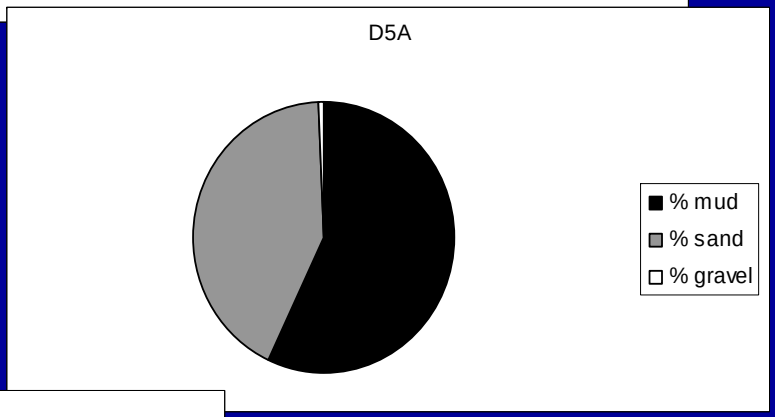

Mud
Sand
Gravel
D7A
Total Hg (ppm)
LOI%
Size fraction percent
Depth (cm)
0
10
20
30
40
50
60
70
0
5
10
15
20
25
0
5
10
15
20
25
30

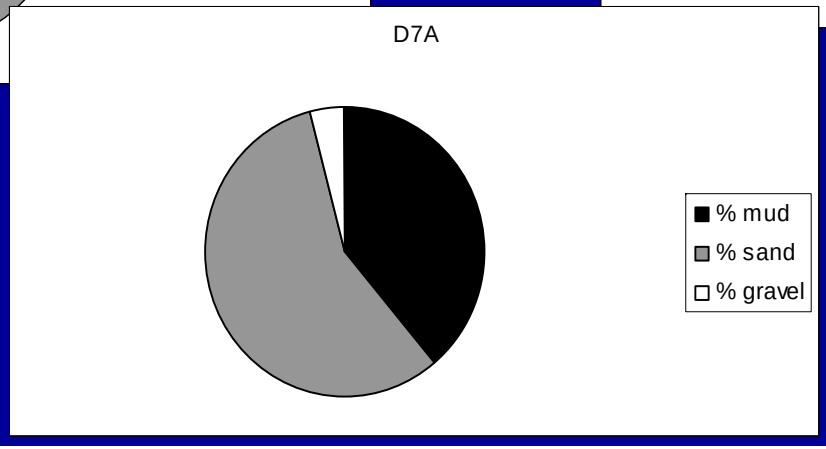
“Mud” Deposits are very sandy..







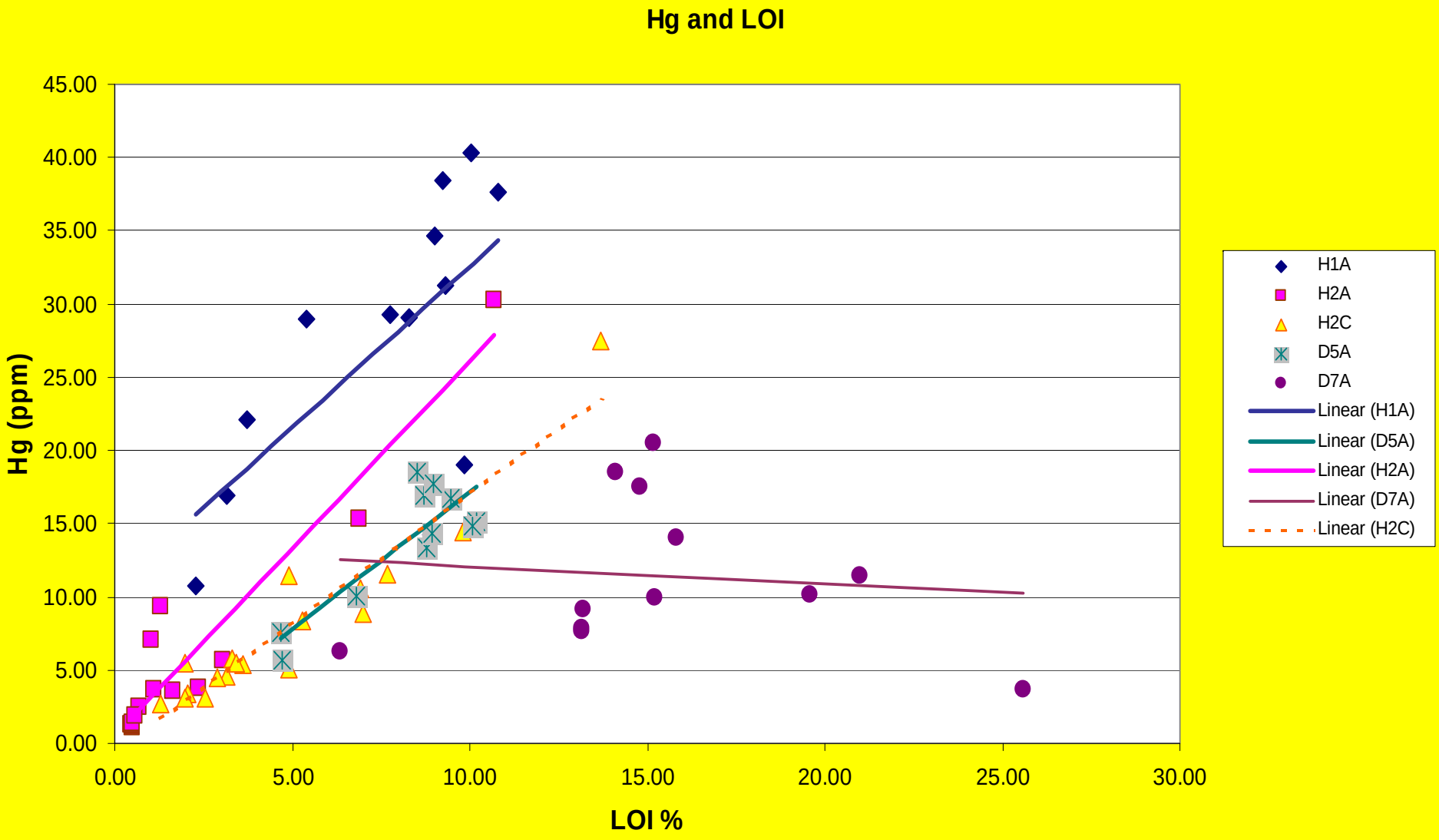




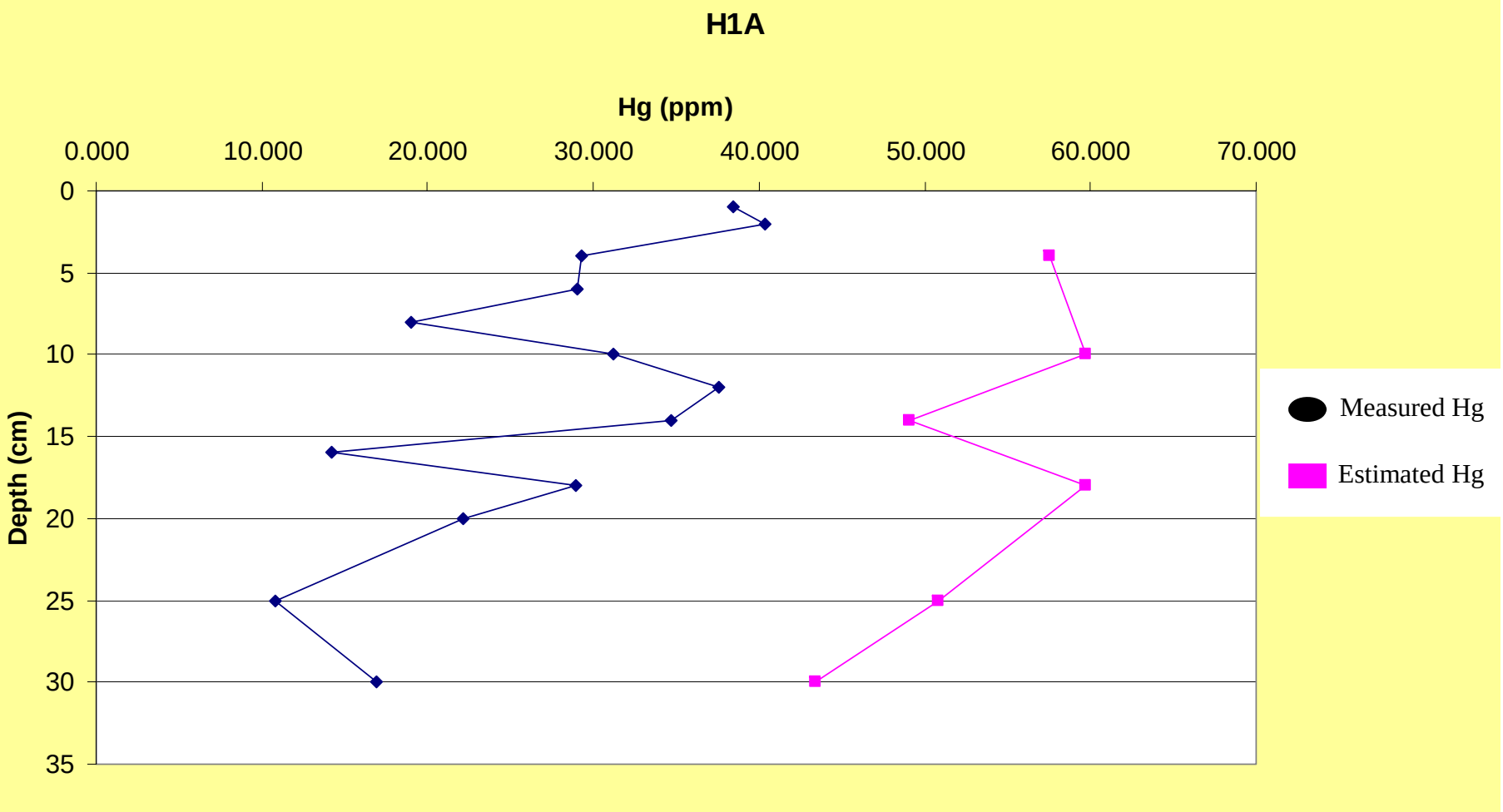
Statistical Correlations

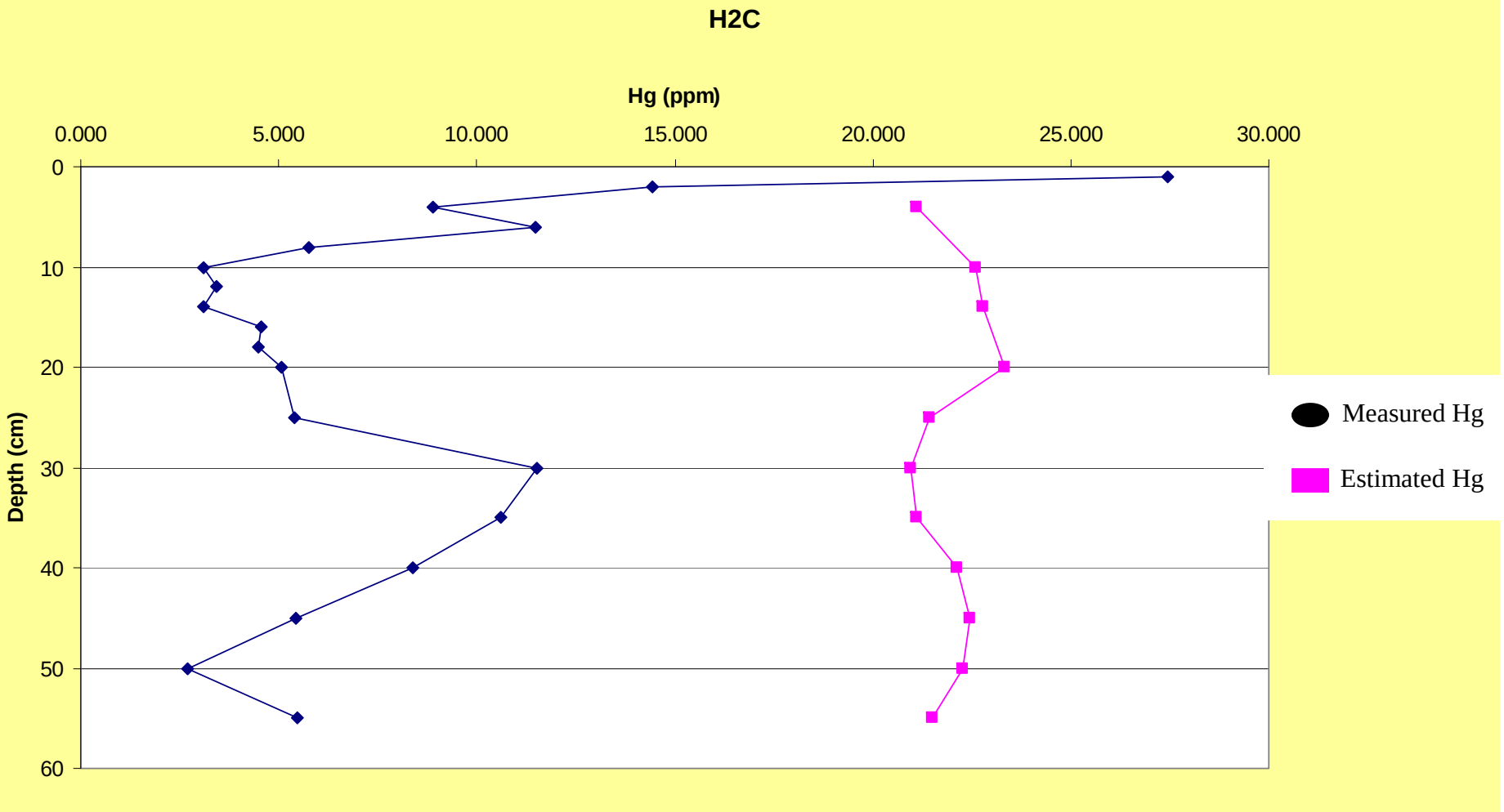
- Appears to be a good correlation with Hg and LOI and mud
- For each core, used multiple regression to obtained equations relating Hg concentrations to concentrations of mud and LOIS
- Used regression equations to estimate what Hg concentrations would likely be if sand was not present
  - Assumption: Hg associated with sand is negligible!

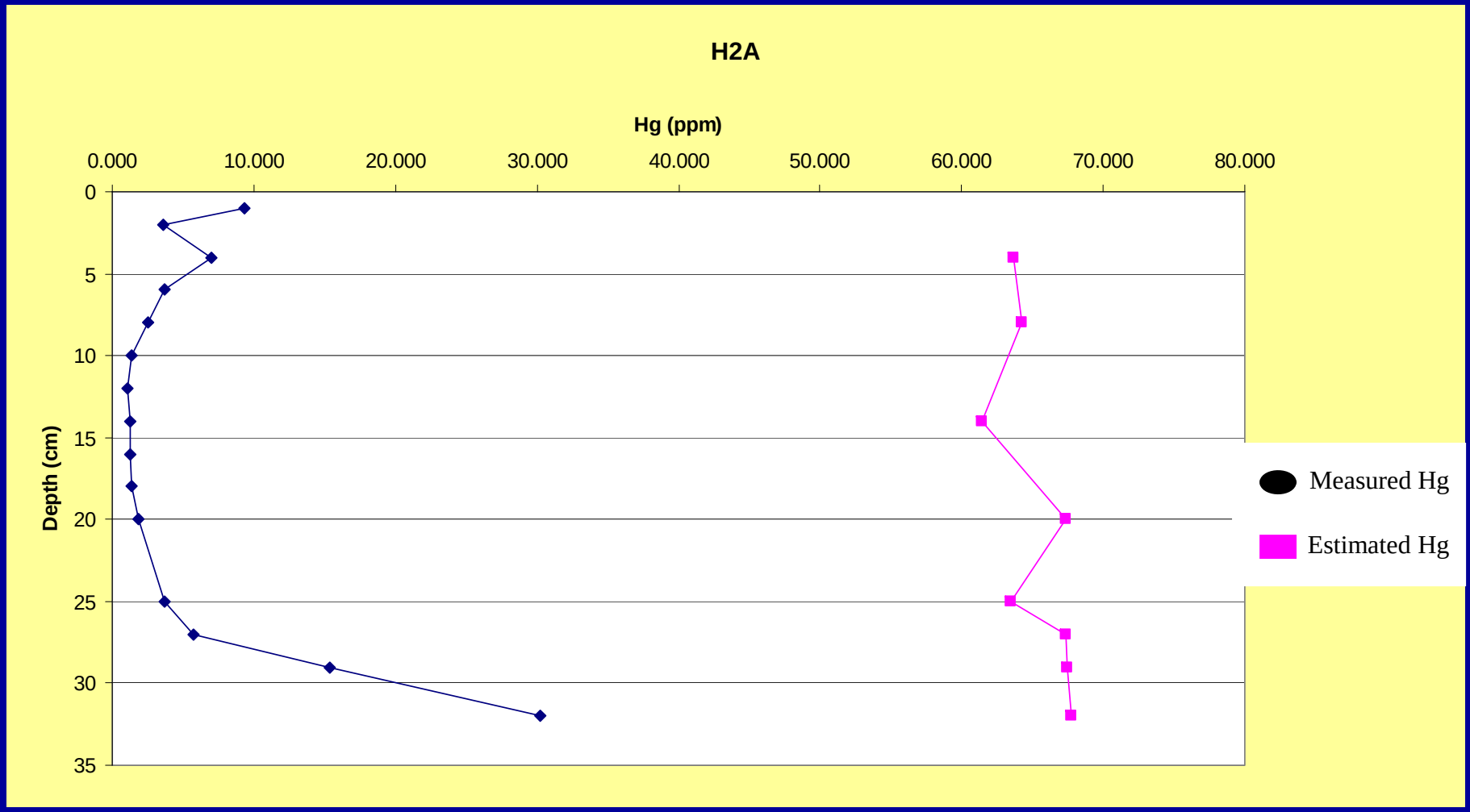
Hg vs LOI for Each Core…



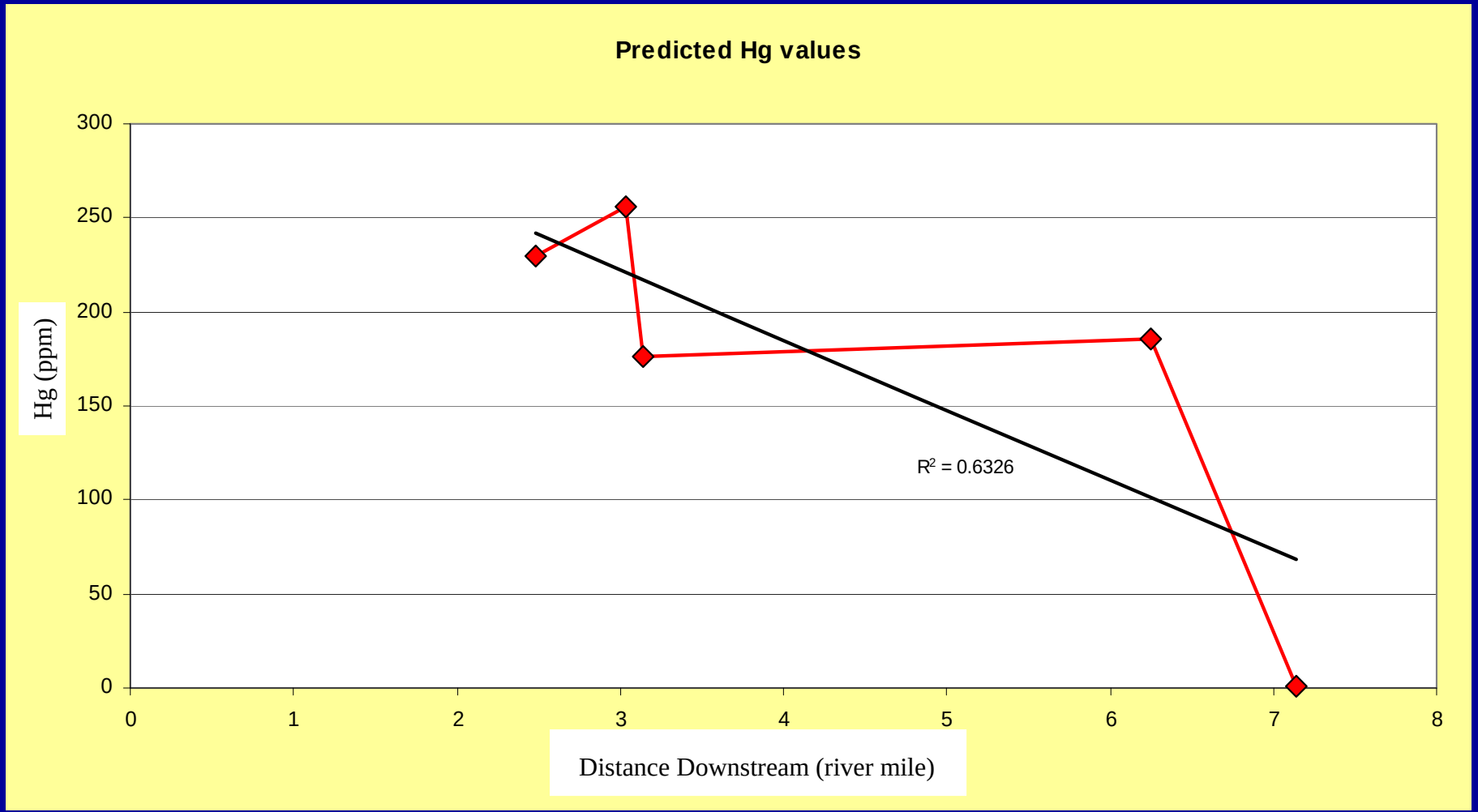
Measured Hg and Hg With Sand "Removed"




H2C
Hg (ppm)
0.000
5.000
10.000
15.000
20.000
25.000
30.000
Depth (cm)
0
10
20
30
40
50
60
Measured Hg
Estimated Hg


H2A
Hg (ppm)
0.000
10.000
20.000
30.000
40.000
50.000
60.000
70.000
80.000
Depth (cm)
0
5
10
15
20
25
30
35
Measured Hg
Estimated Hg

Average Hg on "LOI" (Organic Matter) vs River Mile



Implications

- There is a good correlation with total Hg and LOI
- It appears that Hg concentration on LOI decreases with distance downstream from the plant
- Need to collect more cores with a wider spatial distribution to assess relationship

Future Research

- Map, describe, and possibly sample mud deposits from Crimora to Port Republic
- Assess the hydrodynamic processes controlling mud storage with physical laboratory experiments
  - (these experiments are NOT supported through the Science Team)
- Integrate results from experiments and field through a numerical modeling approach

Analysis of Historical Aerial Photographs

Erica Rhoades

Dr. Michael O'Neal

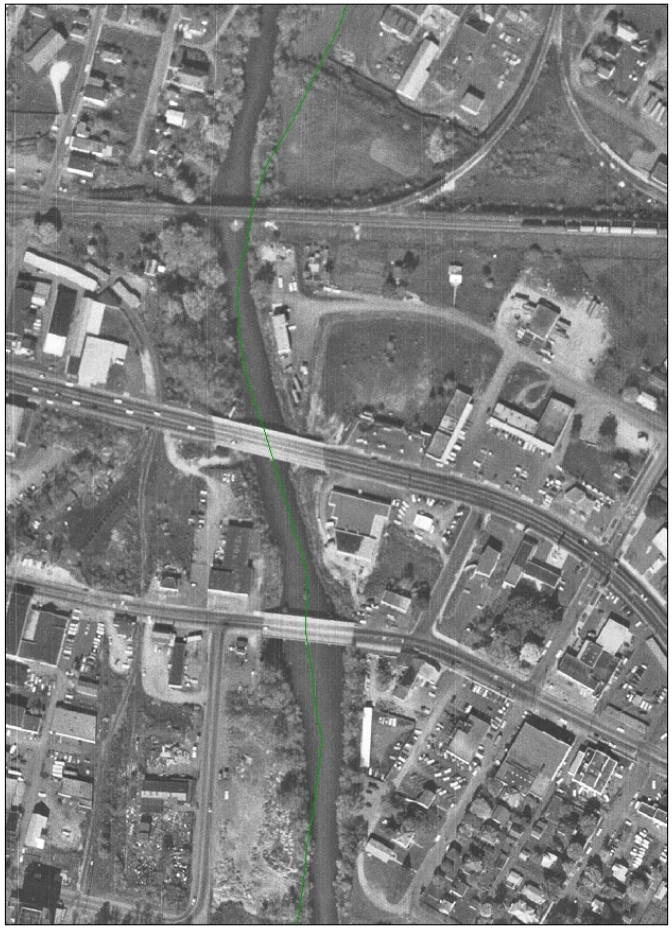
U Delaware Dept. of Geography

Georeference All Scanned Photos Individually for Highest Resolution

- Use raw lidar data from Spring, 2005 as benchmark for comparison
- Map changes in bank position
- Quantify bank erosion rates and patterns of channel shifting at decadal timescales
- Use to supplement short-term tripod lidar surveys of eroding river banks

Two example images…

1966 Air Photo



2005 Orthophoto

Lidar Bank Erosion Surveys Jan 31 2006-Feb 1, 2006

Erica Rhoades

Dr. Michael O'Neal

Prame Narinesingh

Jim Pizzuto

Statistics

- Two ½ day surveys
- 3 Sokkia high resolution GPS units provide real world coordinates with a resolution of ~0.01 m after being in place for 2-3 hours.
- Permanent benchmarks left at each site to enable precise re-surveys
- 1,793,698 points surveyed at site 1
- 2,134,363 points surveyed at site 2
- Root-mean-square survey errors all less than 0.007 m.

First Survey

Permanent Benchmark, Wastewater Treatment Plant

Targets on Permanent Mounts on Cutbank

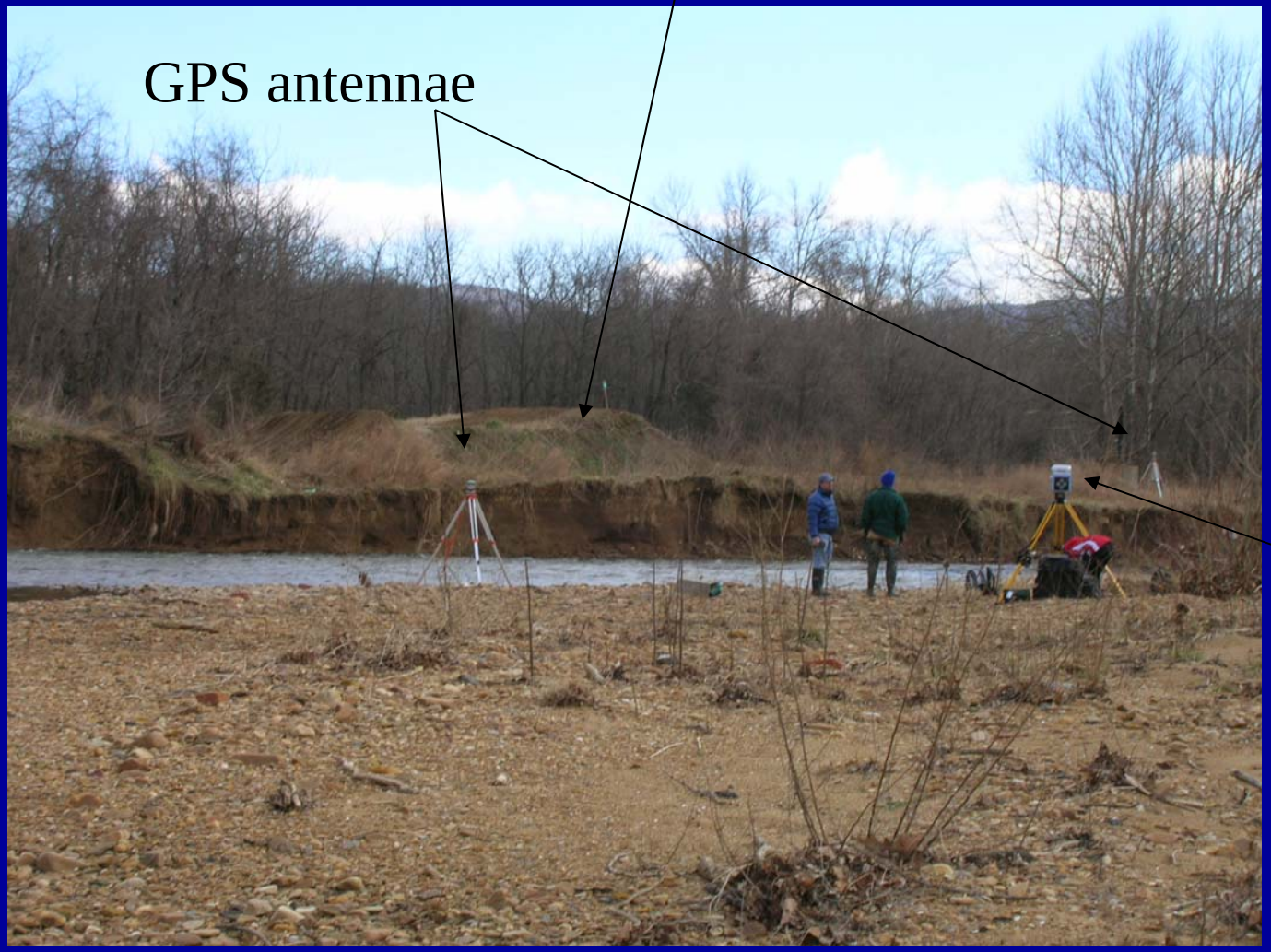
Target Closeup

Metal plate left in tree; clamp and target removed

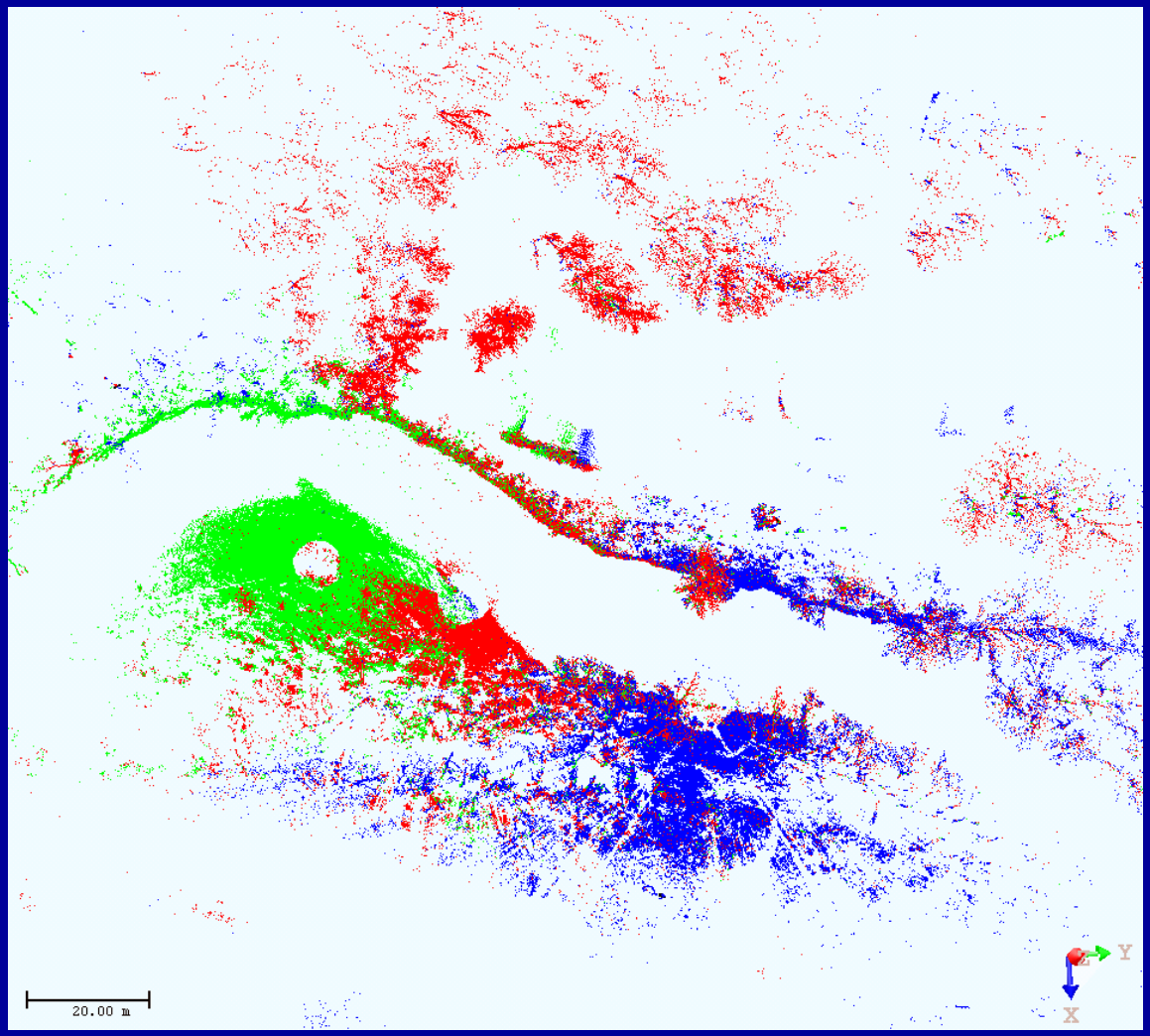
Target on tree at downstream end of bend

Surveying…

Remember the bump



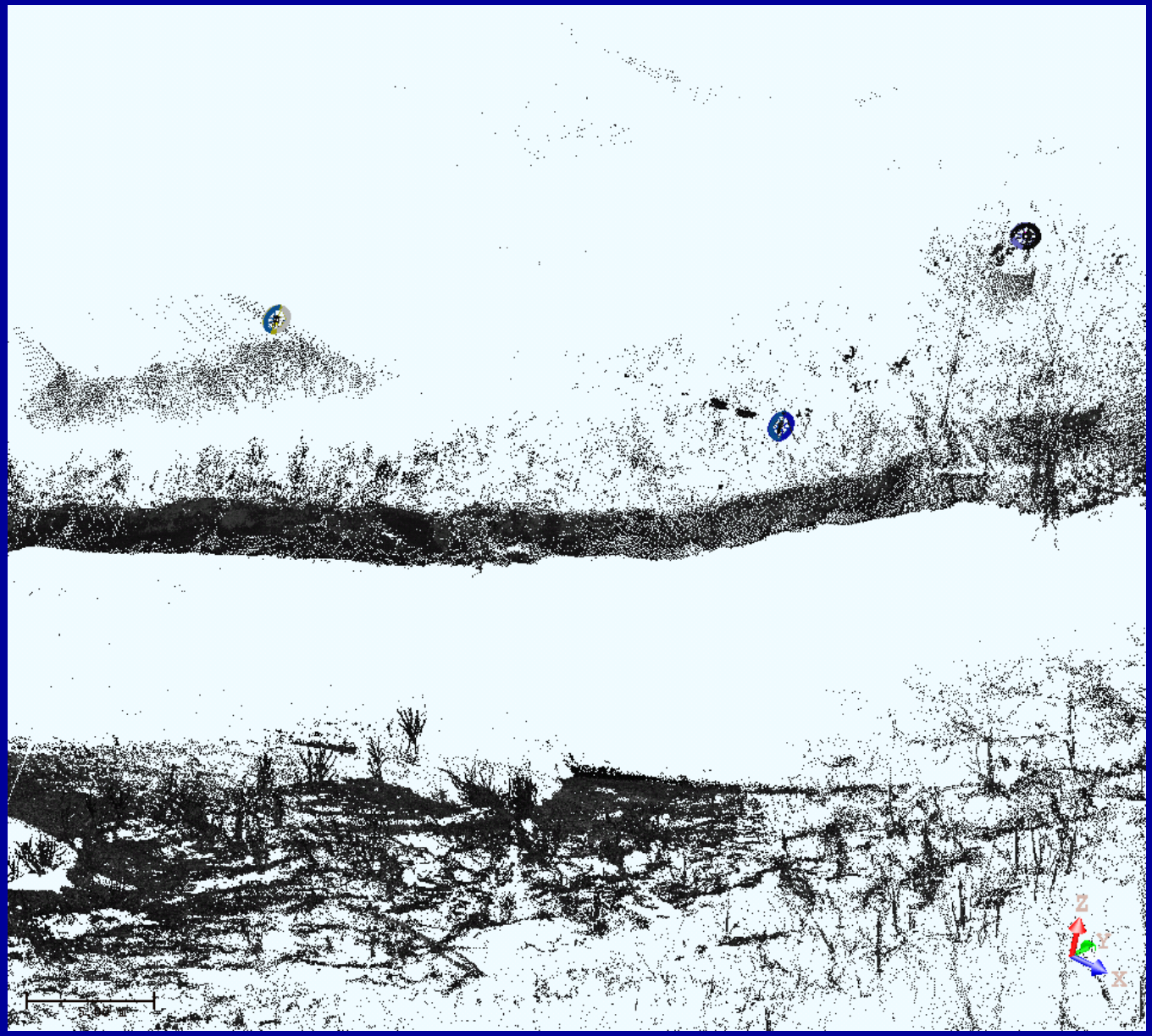
Wastewater Treatment Bend 1/31/06 River Mile 1.7-1.8



Color here is related to intensity of the returned signal..

A “true color image”…

Surveyed points shown in black….



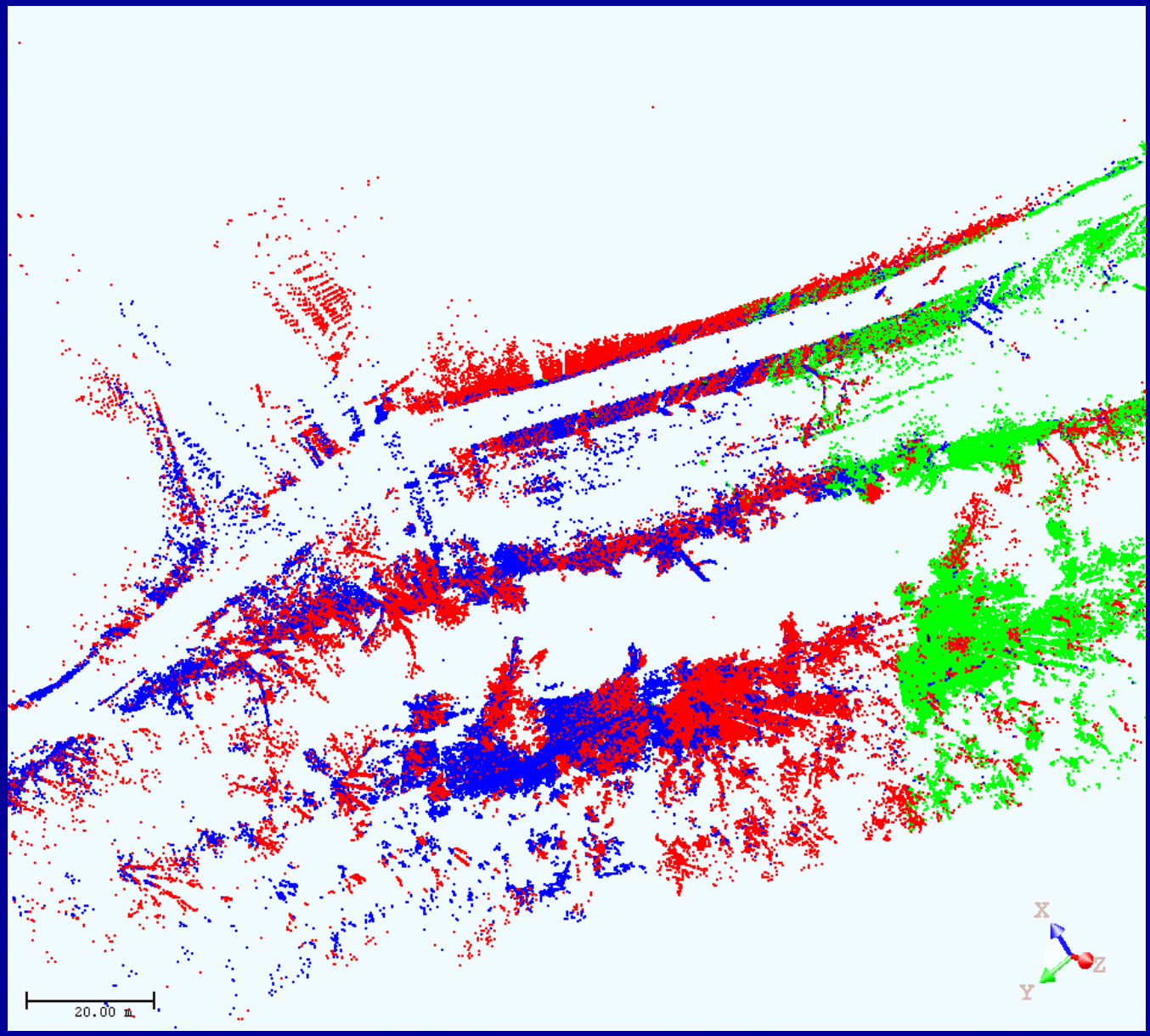

Z
Y
X
5.00 m

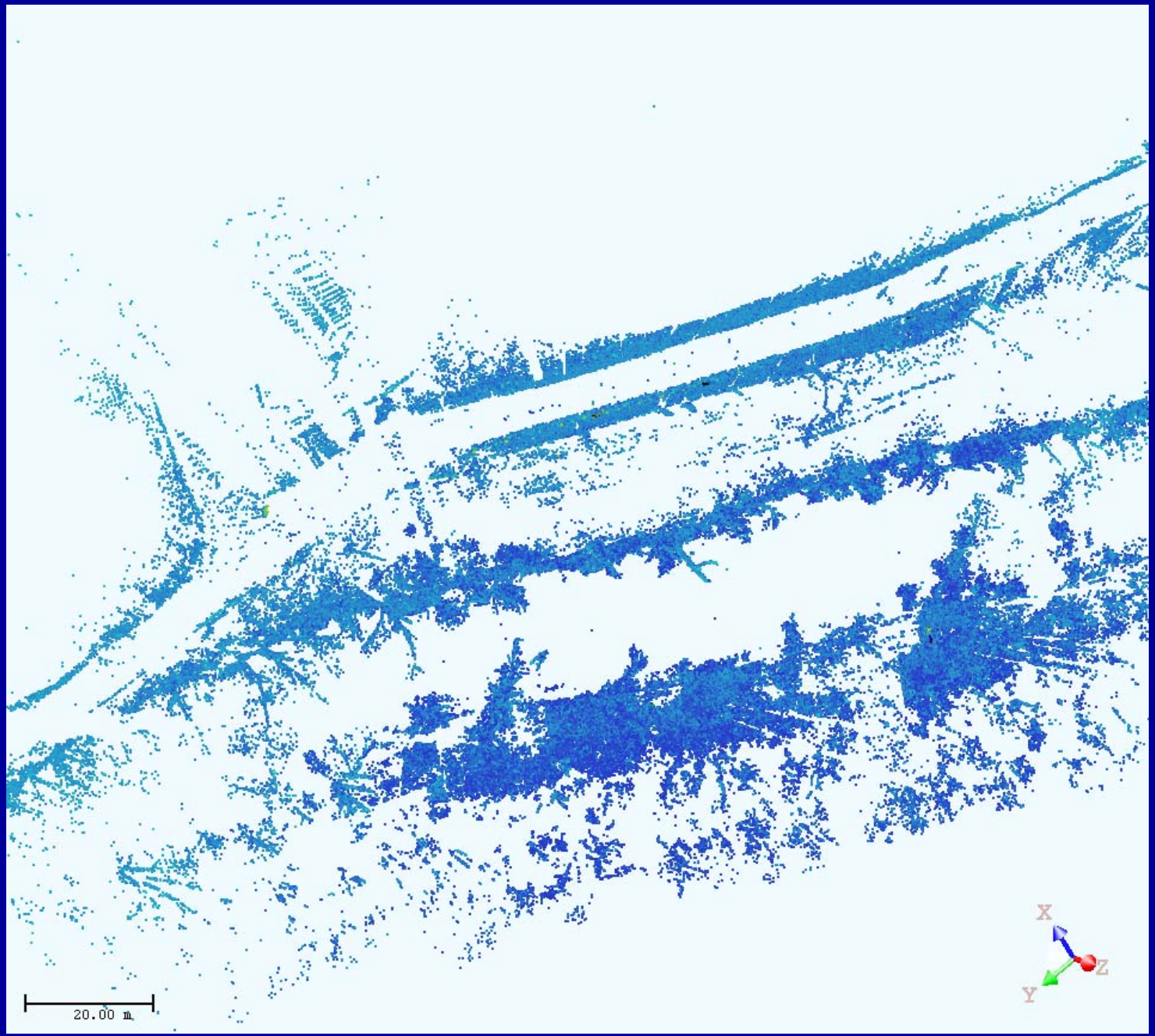

Z
X
Y
2.00 m

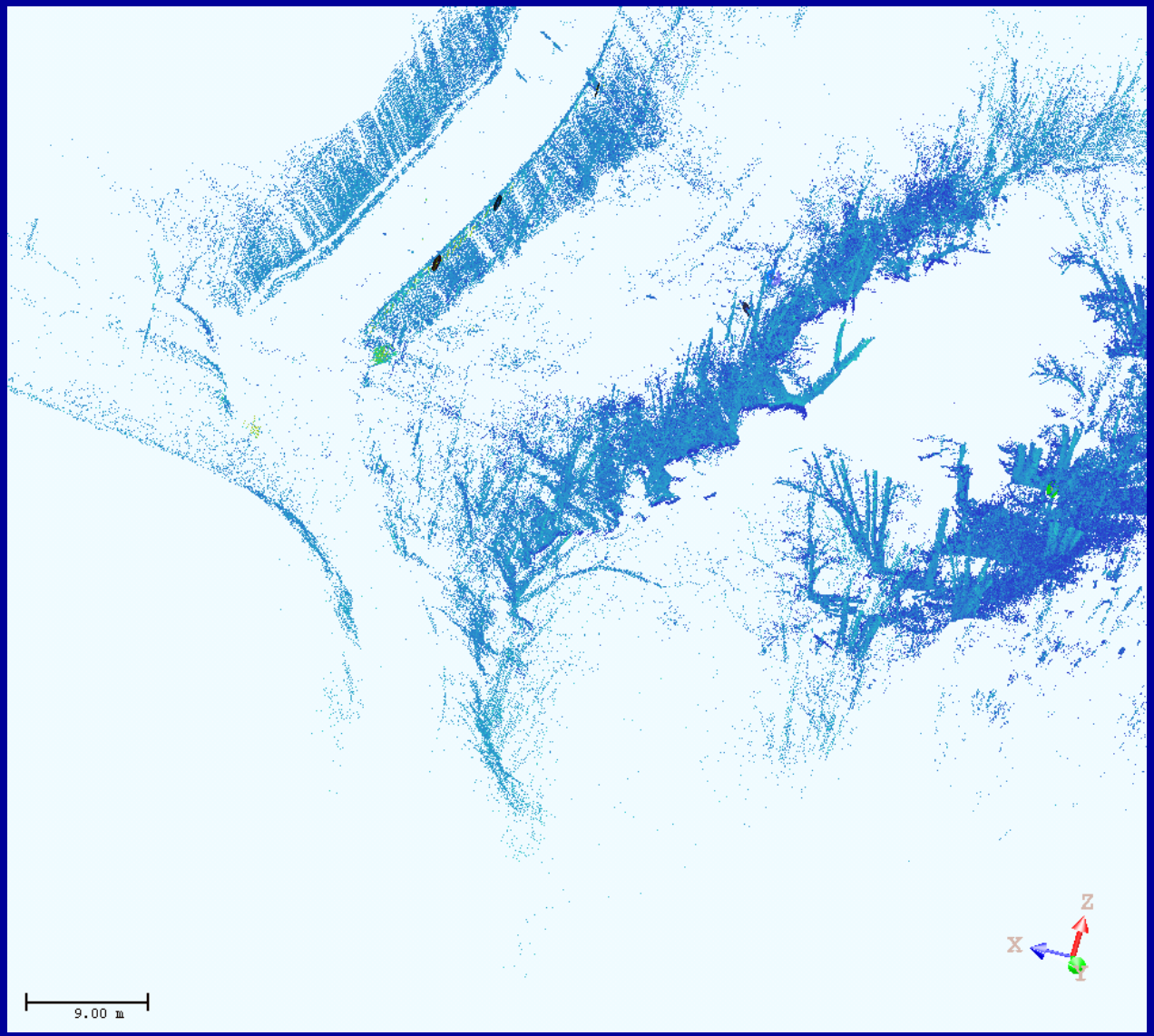

3.00 m
Z
Y
X

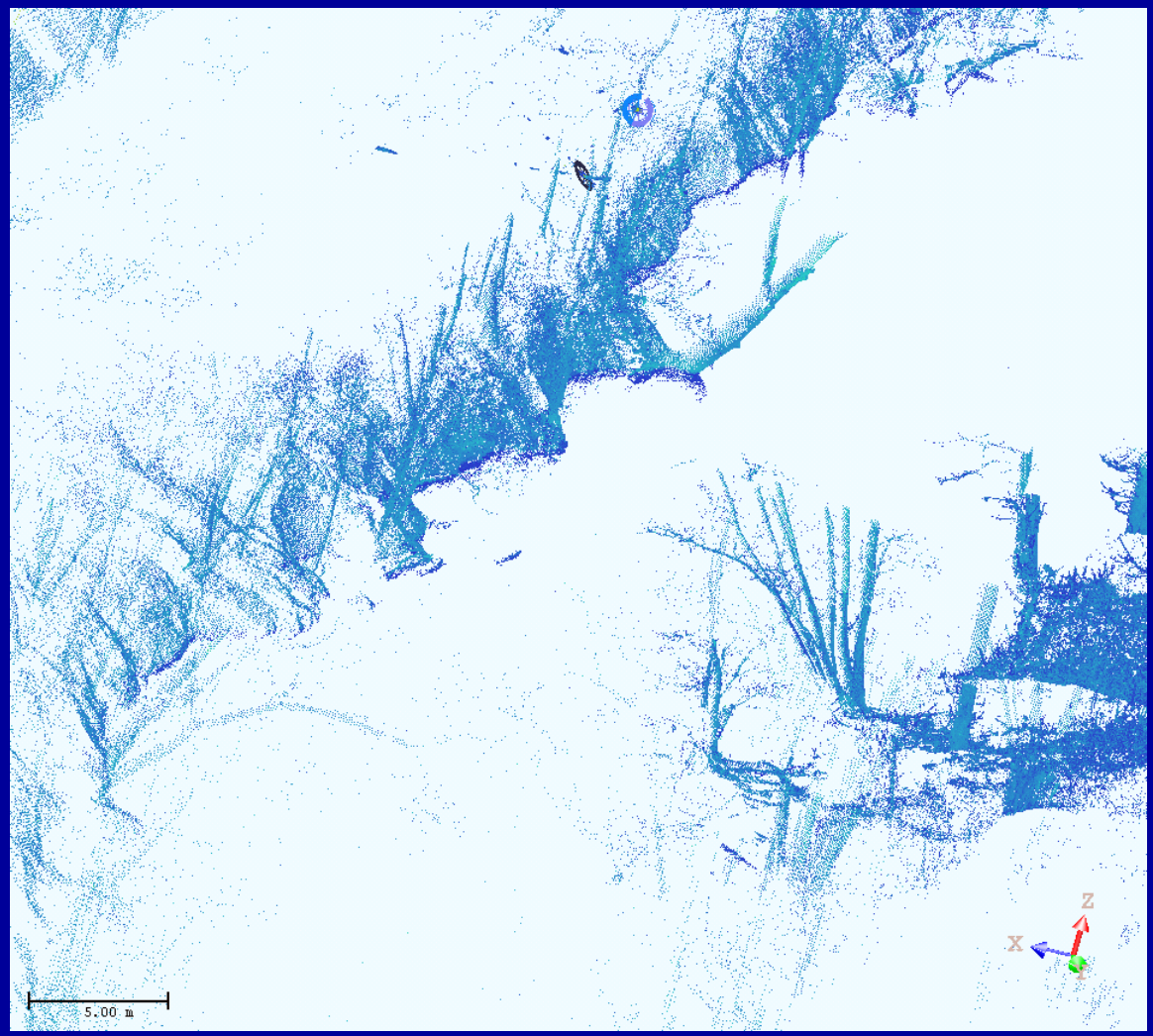
Second Survey

“Hopeman Bend” 2/1/06 River Mile 2.9-3.0




20.00 m
X
Z
Y


9.00 m
Z
X


5.00 m
Z
X

Future Plans – Bank Surveys

- 36 sites selected for repeat surveys to determine bank erosion rates
  - 21 are “priority” sites with presumed high rates, high potential for Hg inputs to the stream
- Surveys will begin asap.
- Varying vegetation type, channel morphology, etc.
- Use data to develop predictive “model” that can be applied to the entire study area

Other Ongoing Studies

- Continue geomorphic mapping and geomorphic surveys
  - Continue initial surveys of 2005 to cover the entire study area to Port Republic
- Finalize measurements of all components of the fine-grained sediment budget for Waynesboro-Port Republic

2 Presentations @
American Geophysical Union Joint Assembly,
Baltimore, May 2006 (Hydrology Section)

- Coring results
- Bank lidar survey results