Basis of Design Memorandum
Alteration of Slip No. 3 Containment Cap
Outboard Marine Corporation Superfund Site

On June 23, 2005, the City of Waukegan (City) and the United States Environmental Protection Agency (USEPA) entered into a Supplemental Consent Decree in the matter of "**United States of America, and People of the State of Illinois, Plaintiffs v. Outboard Marine Corporation, Defendant, and the City of Waukegan, Illinois, Defendant-Intervenor**" (Civil Action No. 88-C-8571)("Supp. Consent Decree"). Under the Supp. Consent Decree the City assumed certain responsibilities for the operation and maintenance of three containment cells at the Outboard Marine Corporation (OMC) Superfund Site ("Site"). The Supp. Consent Decree also contemplated the City's exercise of an Option Agreement and the redevelopment of the Site consistent with remedial measures approved by USEPA. Paragraph 51 of the Supp. Consent Decree further provides that the City may lease portions of the Site to third parties. On September 30, 2005, by exercise of the Option Agreement, the City took title to the Site, including the portion of the Site contiguous to the Waukegan Harbor commonly known as "Slip No. 3".

The City at the time of entering into the Supp. Consent Decree and continuing afterwards has had discussions with Larsen Marine Service (Larsen) on the possibility of leasing Slip No. 3 from the City for the purpose of placing a dry rack storage facility near their existing marina operations at the north end of Waukegan Harbor. This Basis of Design Report addresses a conceptual design (30% design) for the construction of a 130-foot wide by 240-foot long dry rack storage building on top of the existing Slip No. 3 Containment on the west side of the current Larsen operation.

1.0 Background

Prior to the remedial action at Waukegan Harbor (prior to 1989), Larsen operated their Marina business from Slip No. 3 the northernmost existing slip off the main harbor at Waukegan. Slip No. 3 was also the location of the outfall pipe from the Outboard Marine Corporations (OMC's) aluminum engine casting operation and contained more than 90% of the mass of polychlorinated biphenyls in Waukegan Harbor. Since complete removal of the sediments in Slip No. 3 was infeasible, a partial removal was completed for subsequent treatment to substantially reduce the mass. The residual PCB in Slip No. 3 along with the sediment from the upper Waukegan Harbor were enclosed in the Slip as a permanent contained location with protective barriers to prevent contact with ground water, surface water, and soil. This area is known as the Slip No. 3 Containment.

The construction sequence for the Slip No. 3 Containment included the following steps:

1. Slip No. 3 was isolated from the remainder of the Upper Harbor by constructing a double sheet pile wall (two walls twenty-feet apart) across the mouth of Slip No.

3, Picture #1 and backfilling the area between the two walls with a bentonite-sand mixture.
2. The sediment containing the largest part of the PCB mass (approximately 85%) in Slip No. 3 was removed for treatment on other parts of the OMC property, Picture #2.
3. A three foot wide soil-bentonite wall constructed from native sand at the site was installed along the northern, western and southern perimeters of Slip No. 3 and tied into the backfill between the two sheet pile walls across the mouth of the Slip, thus preventing the unrestricted interchange of ground water inside and outside of the containment area (the bottom of Waukegan Harbor is an impermeable glacial till formation known locally as the Chicago hardpan).
4. Approximately thirty thousand cubic yards of sediment (a silt and sand mix) was hydraulically dredged from the Upper Harbor and placed into Slip No. 3 (at completion of the dredging the sediment from the Upper Harbor filled Slip No. 3 to within two to three feet below ground surface, Picture #3).
5. A clean sand cover was spread on the sediment starting at the outside edge and progressing inward as the sediment consolidated and would support the sand cover, Picture #4. Once the sand cover extended across the entire surface of the slip at original grade, additional surcharge sand was moved on top of the cover to accelerate the consolidation of the sediment.
6. Two years after placing the surcharge cover, settlement was complete and the surcharge cover was graded to form the present topographic configuration of the Slip No. 3 containment.
7. A 60-mil HDPE liner, geogrid drain layer, protective geotextile, 18-inches of sand barrier layer and six-inches of topsoil was then placed over the contoured surcharge sand.
8. Two recovery wells were installed in the containment immediately after placement of the sand cover and have operated with a water treatment plant to keep the ground water elevation inside of the containment lower than the outside ground water level since completion of the containment in 1991.

The present topography of the Slip No. 3 Containment Cell is shown on Sheet 1 of 5, 30% Design Package.

During the hydraulic dredging operation, the sediment was deposited near the east end of Slip No. 3 and water was withdrawn for treatment near the west end of the containment. The dredging operation caused the sandier fraction of the sediment to be deposited in the east end of the containment near the double steel sheet pile cutoff wall with the finer organic silt in the west end of the containment.

The surcharge fill consolidated the deposited sediment until significant settlement was completed. An additional surcharge effect from dewatering the containment continues to secure the sediment.

The containment design for the cover that was placed over the graded surcharge sand was based on the following criteria in the approved Remedial Action Plan[1]:

1. The top of the containment cell will be at least 2-feet above the monthly mean 100-year lake level (40 CFR 761.75).
2. Containment cell cover design shall comply with the RCRA regulations, as outlined in 40 CFR 264.310.
3. A topsoil cover, if used, will be a minimum of 6-inches thick.
4. The slope of the cover will be between one and five percent.
5. The cover will have a surface drainage diversion system around the perimeter of the cap.
6. The drainage layer below the top of the cap will have a hydraulic conductivity of greater than 1 x 10^{-2} cm/sec.
7. If a topsoil cover is used, the drainage layer will be overlain by a filter media.
8. The bottom layer will be located two feet below ground surface and will have a slope of at least two percent.
9. The bottom layer will consist of a synthetic liner with a minimum of 40-mil thickness.

2.0 Proposed Alteration to Slip No. 3 Cap

Larsen proposes to install a 130-foot wide by 240-foot long dry rack boat storage building on top of Slip No. 3 containment for use in their Marina operations. The dry rack storage building would have a center aisle 55-feet wide with steel racks on each side of the aisle for storage of 30-35 foot long powerboats. The boat rack is likely to be tall enough to stack four boats (final decision to be made in later stage of the design). The building would be a steel frame building with the columns supported on spread footings and with a grade beam between the footings to carry the backside of the boat racks and the sidewall of the building. The steel racks that support the stacked boats would require another footing along the length of the building aisle. Typical pictures of a dry rack storage facility are shown on Picture 5.

The boats are taken in and out of the rack system using a large forklift truck capable of picking boats up to 20,000 pounds and with a boom that allows for placement in the water at up to –12 feet below grade. The forklift with the boat places a load on the dual wheel rear (non-steering) axle of the forklift that is equivalent to a loaded semi-truck (40,000 pounds). A picture of a typical forklift for dry rack storage is shown on Picture 5.

The property of Slip No. 3 is within the area of the 100-year flood elevation of the City and will have a floor slab elevation of 584 feet (NAD_{88}). A plan view of the building on the Slip No. 3 site is shown on Sheet 2 of 5. The top of the steel sheet pile wall is at 584.5 feet (NAD_{88}) and is approximately the same elevation as the proposed building floor slab. At the sheet pile wall the armor rock that was installed in 1991 to provide wave attenuation will be removed to elevation 571 feet (NAD_{88}) at two locations to allow

[1] Canonie Environmental, "Appendix I-11, Design and Analysis Report", February 1991

for lowering of the boats into the water even at the lowest water levels ever recorded in Lake Michigan. The wave attenuation rock will be removed over a 100-foot wide and a 50-foot wide area to allow for multiple launching tie-off locations to facilitate launching and retrieval operations. The location of the launching and retrieval areas is shown on Sheet 2 of 5. A cross-section of the wall showing the wave attenuation rock that will be removed is shown on Sheet 3 of 5.

An analysis of the stability of the sheet pile walls that contain Slip No. 3 is included in Appendix A. The wall, under the present conditions and without the slide resisting effects of the toe rock, is adequate for the structural system of the front wall face and the tieback system. The stresses in the sheet pile wall are well below the allowable stresses for steel bulkhead design even without the toe rock.

An initial analysis of a likely building support system is based on the sediment and sand cover classifying as loose sand. The analysis is also based on an assumed perimeter column load of 100,000 pounds per column and a boat rack with 20,000-pound boats stacked four high. A seven-foot square spread footing keeps the bearing pressure at less than 2000 pounds per square foot the prescribed load for loose sand as specified in the 2003 International Building Code. The rack footing closest to the aisle would spread its load to a grade beam with a three foot wide footing to maintain a similar bearing capacity. A preliminary estimate of settlement indicates that the immediate settlement when the load is added could be up to ½ inch (the load would consist of the racked boats and snow load on the roof). Based on preliminary analysis, the foundation on the drawings are shown as spread footings bearing on the ground at 42-inches below grade for frost protection and with a grade beam between columns to carry the load of the sidewalls and the boat rack. The preliminary analysis of the bearing capacity and settlement are enclosed in Appendix A.

To investigate the soil conditions under the building, a sampling program is proposed to collect information on the density and characteristics of the consolidated sediment at a location on the east and west ends of the proposed building. Each soil boring will be advanced continuously from just below the existing HDPE liner until contact with the glacial till and will be sampled to determine density, water content, and grain size. The sampling plan is presented in Appendix B. Soil sampling for the areas of the Slip No. 3 containment outside of the original Slip No. 3 sheet pile wall are not proposed, since many soil borings were taken in this area during design of the soil-bentonite wall and are available for use in design of the building footings.

After completing the soil-sampling program, the conceptual footing design shown on the drawings will be modified to support the building loads. If settlement of a spread footing is too great in the areas of sediment fill to meet the tolerance requirements for the building and storage rack system, the footings may have to be supported on displacement piles (H-piles or open end pipe piles) that do not bring sediment to the surface.

The area to the west of the proposed building would be developed as a gravel yard area for surface storage of boats during the off-season and parking during the boating season.

The area would maintain a pitch centered on the entrance to the rack storage building at 584.5 that will allow the liner on top of the Slip No. 3 containment to slope at the minimum slope towards the soil-bentonite walls on either side of the containment.

The recovery wells will remain at their present locations with the well top elevation lowered into a concrete vault at each location. The vault will be designed to sustain the load of the operations in the dry-rack storage building with the cast-iron lid highway load rated to support the loaded forklift. The electric and piping in the vaults will be rerouted under the new liner to a new treatment plant location near the power source at the west end of the containment. Electric power to the well vaults will be above the new liner system and clean water from the treatment plant will discharge through a new pipe to CB-A at the upstream end of the perimeter drainage system. The locations of these features and the plan for the well vault are shown on Sheet 2 of 5 and Sheet 4 of 5.

The new HDPE liner/drainage grid/geotextile cover will be installed to slope from the center of the altered slip sand cover to the soil-bentonite wall top at a consistent slope of approximately 2%. Within the building footprint, there will be no liner. The building system will perform the infiltration limiting effects of the liner. The HDPE liner will be attached to the building at the perimeter grade beam with a stainless steel batten strip, as shown on Sheet 4 of 5.

Larsen may wash the hulls of the boats prior to racking the boats. The plan shows a series of floor drains for the purpose of capturing the wash water. Since these drains will be under the floor without the benefit of underlying liner, the conceptual design is to double enclose the drain lines with the discharge to the storm drainage system. Larsen will also install electric, water and natural gas service to the building. The electric and natural gas will be installed above the liner with the water service installed in a sleeve below the liner to maintain freeze protection for the water supply.

3.0 Investigation of the Sand Cover

The alteration of the cap of the Slip No. 3 Containment to allow for placement of the boat dry rack storage facility should all occur within the surcharge sand that was placed above normal grade at the site. The sand was taken from a large stockpile of sand that was on the former GM coke plant site adjacent to the Upper Harbor. The source of the sand was a United State Army Corps of Engineers dredging program in the entrance channel of Waukegan Harbor (out in the Lake) that was completed in the early 1970's. It is expected that the sand may contain some PCB's at concentrations less than 1ppm, but not the same concentration as the sediment that was placed into the cell from the Upper Harbor (the sediment from the upper harbor included all of the sediment in the harbor with concentrations of PCB greater than 50ppm).

To confirm the PCB concentration of the sand cover and to verify that sediment will not be in the area that will be excavated to lower the cap on the containment cell, a series of soil cores will be collected and analyzed for PCBs. The sample locations are shown on

Sheet 2 of 5. The details of the sampling program and the sampling procedures are presented in Appendix B.

4.0 Basis of Design

The basis of design for the alteration of Slip No. 3 containment for use as a dry rack boat storage facility is centered on four basic design parameters:

1. Provide a new cap that meets the original design criteria or provides equivalent function.
2. Provide a foundation support system for the dry rack storage building that will meet the load and settlement criteria without removal of the sediment from the containment.
3. Identify the surcharge/cover sand as a separate material from the sediment and keep alterations in the surcharge/cover sand or above, including building foundations.
4. Maintain the integrity of the existing recovery well, treatment system and water level monitoring system

4.1 Cap design criteria

The altered Slip No. 3 containment will directly meet most of the previous cap design criteria. The major variation is the use of the building envelope to perform as the upper impermeable liner under the building footprint. The building provides a dual envelope; with the building roof shedding rainwater to down drains that will be directly piped to the perimeter storm water drain system. The floor slab of the building acts as the secondary envelope to prevent surface water from entering the containment. The floor slab will be constructed using PVA additive in the concrete to reduce shrinkage and temperature cracking of the floor slab. If an expansion cold joint has to be incorporated into the final design of the floor slab, the joint will be placed on the high point in the floor drain slope and will be sealed with a waterproof mastic compound.

Compliance with the original design criteria are presented in Table 1

Table 1
Cap Design Criteria

Design Criteria	Means of Compliance
Cap 2-feet above 100-year mean lake level	Low point of cap liner to remain at present elevation on the top of the soil-bentonite wall
Compliance with RCRA regulations	Building provides equivalent permeability less than or equal to the permeability of the bottom liner (glacial till). It also provides long-term minimization of migration of liquids through the closed containment and

	will function with minimum maintenance and will be resistant to erosion and abrasion.
6-inches of topsoil cover where required	Most of the topsoil cover will be removed and replaced with gravel or paved surfaces
Slope of 1-5%	Slope of liner will be 1-2% minimum on west end of containment
Surface drainage ditch around perimeter	Existing surface drainage and surface water storm drain around perimeter will remain in-place.
Drainage layer permeability > 10^{-2} cm/sec	New drainage layer may consist of gravel fill over protective layer that provides drainage of full gravel layer with a permeability of more than 10^{-2} cm/sec
Drainage layer covered with filter layer	Topsoil likely used only around the edges of containment. Filter layer will be present.
Cover two feet below ground surface	To maintain slope cover over liner at center of containment on west end of containment may have 1.5 feet of cover (combined gravel and paving). However, cover will be drainable layer in its entirety, will not be subject to freeze-thaw, and will have a hard non-erosive surface layer.
Synthetic liner at least 40-mil	Synthetic liner where used outside of building footprint will be 60-mil HDPE or LDPE.

4.2 Foundation Support System

The probable design criteria will be a settlement limitation of ½ inch differential settlement between footings for a light steel frame structure supporting the loads of snow and stored boats. The floor slab and outside flatwork concrete for the forklift operation will be designed to support an AASHTO H-20 loading (the loading from a semi-truck). The slab will be 6-8 inches thick with appropriate reinforcing and will bear on a gravel sub base layer that will also act as the drain layer for the cap (see above).

If test results from soil borings taken in the sediment indicate unacceptable settlement with only a spread footing bearing in the surcharge sand, an alternate foundation using displacement piles may have to be used on some of the footings.

4.3 Separation of Surcharge/Cover Sand from Sediment

PCB content will identify the surcharge/cover sand. Sand removed from the surcharge/cover area will be managed in accordance with the requirements of the Illinois Environmental Protection Act. Sand having concentrations less than 1 ppm may be

reused on the Site with the concurrence of the Illinois Environmental Protection Agency (IEPA) and USEPA. Color content will be recorded during investigative sampling to determine if visual factors may be used to delineate the surcharge/cover sand from the underlying sediment.

The design testing will be supplemented during the implementation of the alteration to include additional testing to properly classify sand removed from below the original HDPE liner with the following expected classifications:

1. Less than 1 ppm PCB, may be eligible for reuse on the Site with the concurrence of IEPA and USEPA
2. Equal to or greater than one and less than 50ppm, disposal in a Subtitle D solid waste landfill.
3. Equal to or greater than 50ppm, disposal in a TSCA-approved landfill.

4.4 Existing Recovery Well, Treatment and Monitoring System

Recovery well vaults will be designed to allow for safe, manned access with appropriate ventilation to access the electrical and piping in the vault. The vault will be designed for the AASHTO highway loadings including selection of a manhole that meets the H-20 load requirements.

The treatment plant will be moved to the new location shown on Sheet 2 of 5 with a new floor drain discharge overflow into the containment area and a new power supply and drain line installed. Drainage of treated water will be to the storm sewer pipe on the south side of the containment cell. Pipes from the recovery well to the water treatment facility will be installed under the new HDPE liner and electrical will be installed over the top of the liner in the sub base/drainage layer.

Some of the piezometers and monitoring wells will be changed from exposed to flush-mount covers to allow for surface storage or parking uses of the altered Slip No. 3 cap. No other change is proposed for the water level and water quality monitoring system.

Photograph 1

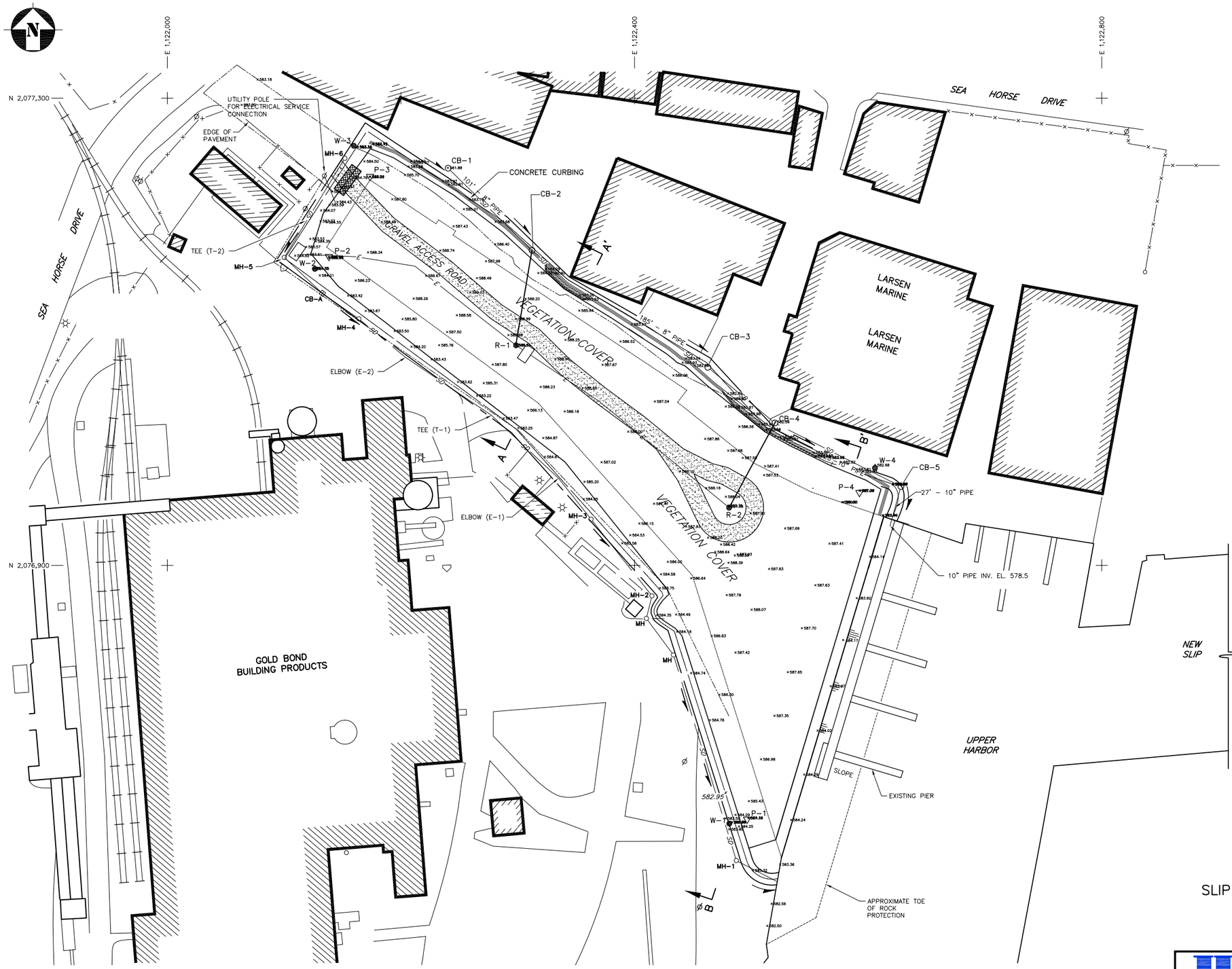
Photograph 2

Photograph 3

Photograph 4

Photograph 5

DRAWING NUMBER 06-001-D1



LEGEND:

- FENCE
- RAILROAD
- UTILITY POLE
- LIGHT POLE
- SOIL BENTONITE WALL
- SOIL BENTONITE WALL WITH PROTECTIVE CONCRETE CAP
- CB — CATCH BASIN
- R-1 — RECOVERY WELL
- P-1 — PIEZOMETER
- W-1 — MONITORING WELL
- E — POWER LINE (UNDERGROUND)
- DIRECTION OF FLOW
- SD — STORM DRAIN
- MH — MANHOLE (4' DIAMETER)
- PROPERTY LINE (APPROXIMATE)

NOTES:

1. ALL ELEVATIONS ARE REFERENCED TO NORTH AMERICAN VERTICAL DATUM 1988 (NAVD88).
2. COORDINATES ARE REFERENCED TO ILLINOIS STATE PLANE EAST ZONE.

SCALE
40 0 40 80 FEET

EXISTING SITE PLAN
SLIP No. 3 CONTAINMENT CELL ALTERATION
PREPARED FOR
CITY OF WAUKEGAN

No.	DATE	ISSUE / REVISION	DWN. BY	CK'D BY	AP'D BY
△			M_A_M		

REFERENCE:
– CANONIE ENVIRONMENTAL SERVICES CORP. RECORD OF CONSTRUCTION DRAWING No. 87-126-E84.

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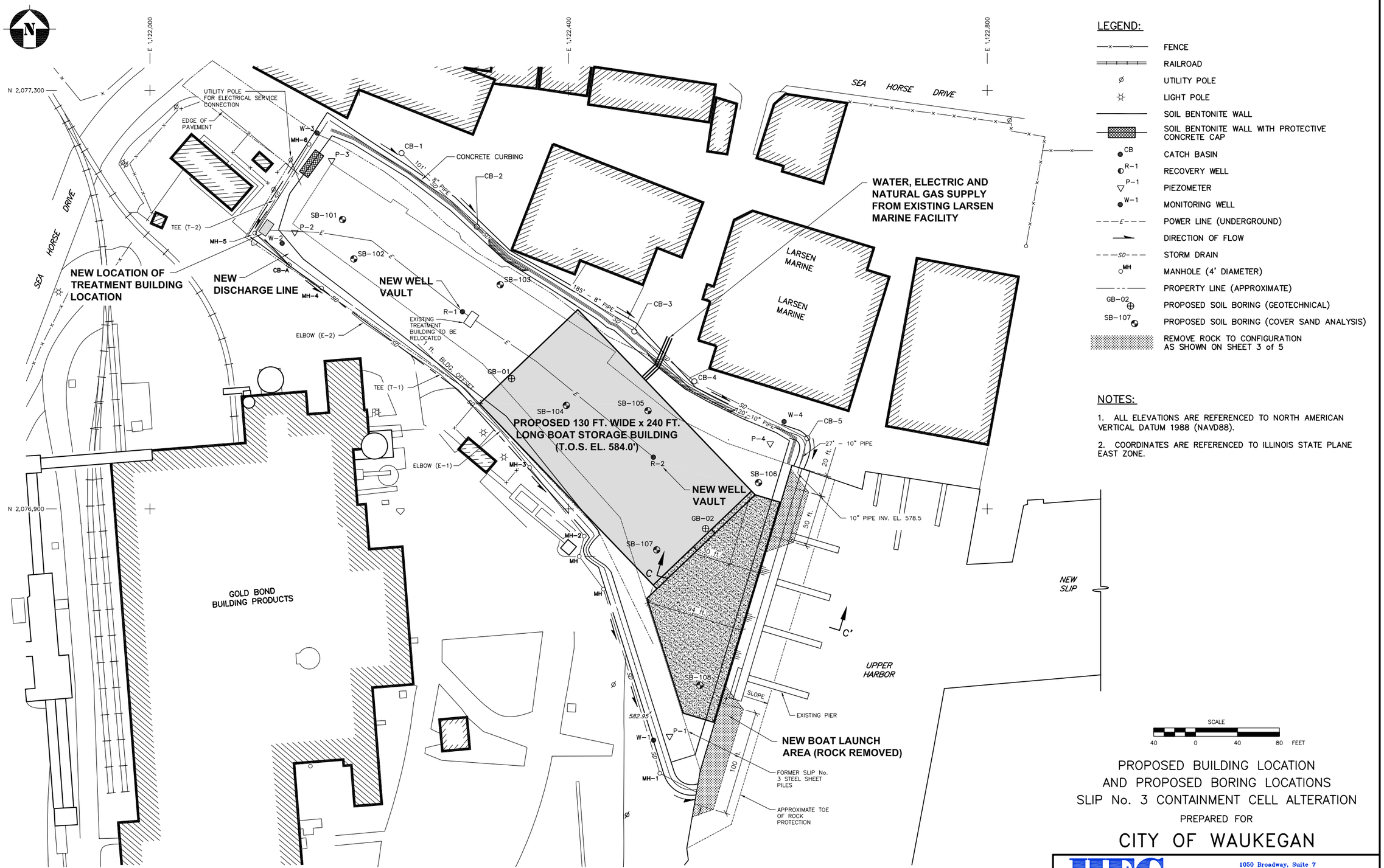
DATE:	04-19-06	SHEET 1 of 5	DRAWING NUMBER	△
SCALE:	AS SHOWN		06-001-D1	

DRAWING NUMBER 06-001-D4



LEGEND:

- FENCE
- RAILROAD
- UTILITY POLE
- LIGHT POLE
- SOIL BENTONITE WALL
- SOIL BENTONITE WALL WITH PROTECTIVE CONCRETE CAP
- CB — CATCH BASIN
- R-1 — RECOVERY WELL
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- W-1 — MONITORING WELL
- E — POWER LINE (UNDERGROUND)
- DIRECTION OF FLOW
- SD — STORM DRAIN
- MH — MANHOLE (4' DIAMETER)
- PROPERTY LINE (APPROXIMATE)
- GB-02 — PROPOSED SOIL BORING (GEOTECHNICAL)
- SB-107 — PROPOSED SOIL BORING (COVER SAND ANALYSIS)
- REMOVE ROCK TO CONFIGURATION AS SHOWN ON SHEET 3 of 5

NOTES:

1. ALL ELEVATIONS ARE REFERENCED TO NORTH AMERICAN VERTICAL DATUM 1988 (NAVD88).
2. COORDINATES ARE REFERENCED TO ILLINOIS STATE PLANE EAST ZONE.

SCALE
40 0 40 80 FEET

PROPOSED BUILDING LOCATION AND PROPOSED BORING LOCATIONS SLIP No. 3 CONTAINMENT CELL ALTERATION

PREPARED FOR

CITY OF WAUKEGAN

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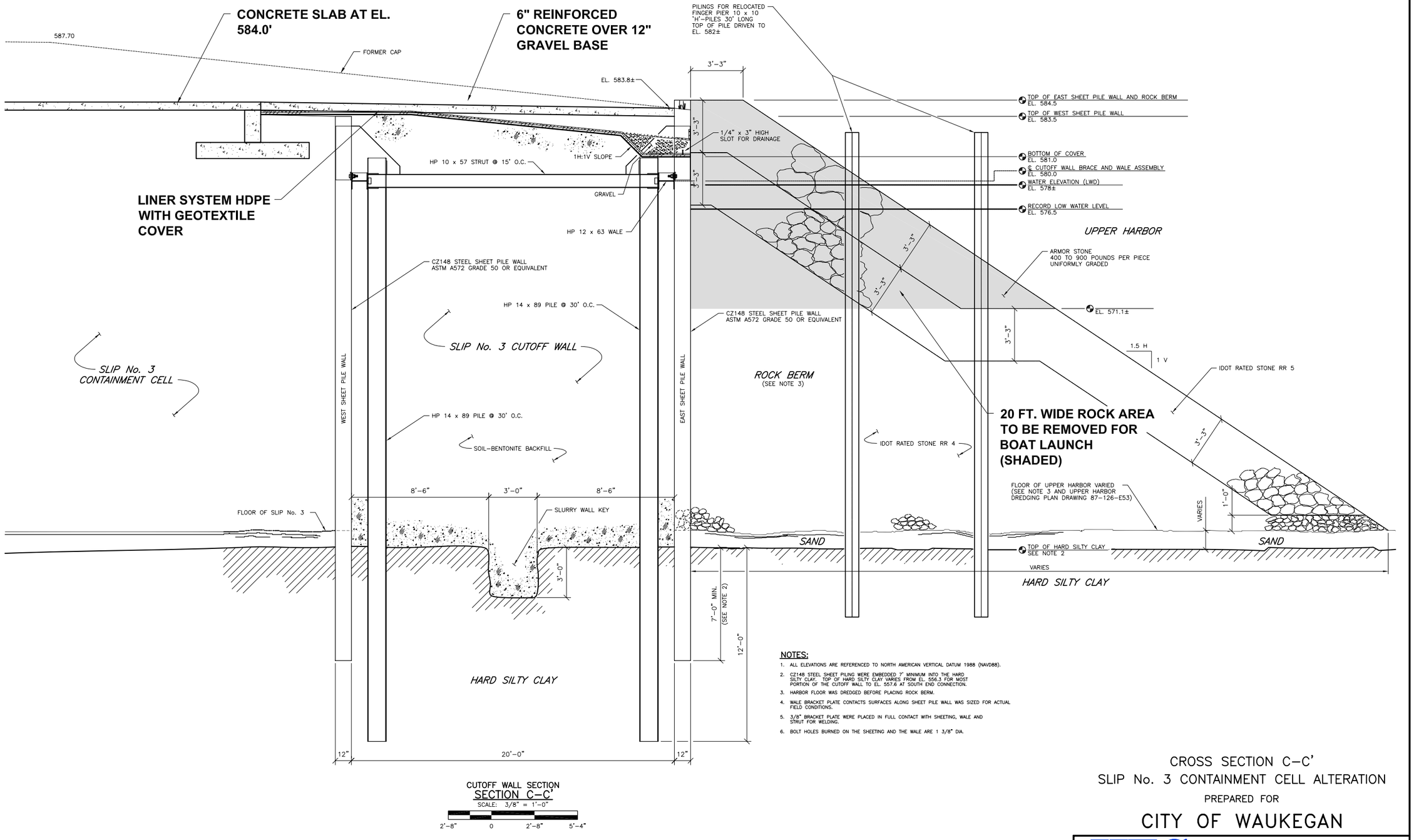
DRAWING NUMBER 06-001-D3



CUTOFF WALL SECTION
SECTION C-C'
SCALE: 3/8" = 1'-0"

2'-8" 0 2'-8" 5'-4"

NOTES:

1. ALL ELEVATIONS ARE REFERENCED TO NORTH AMERICAN VERTICAL DATUM 1988 (NAVD88).
2. CZ148 STEEL SHEET PILING WERE EMBEDDED 7' MINIMUM INTO THE HARD SILTY CLAY. TOP OF HARD SILTY CLAY VARIES FROM EL. 556.3 FOR MOST PORTION OF THE CUTOFF WALL TO EL. 557.6 AT SOUTH END CONNECTION.
3. HARBOR FLOOR WAS DREDGED BEFORE PLACING ROCK BERM.
4. WALE BRACKET PLATE CONTACTS SURFACES ALONG SHEET PILE WALL WAS SIZED FOR ACTUAL FIELD CONDITIONS.
5. 3/8" BRACKET PLATE WERE PLACED IN FULL CONTACT WITH SHEETING, WALE AND STRUT FOR WELDING.
6. BOLT HOLES BURNED ON THE SHEETING AND THE WALE ARE 1 3/8" DIA.

CROSS SECTION C-C'
SLIP No. 3 CONTAINMENT CELL ALTERATION
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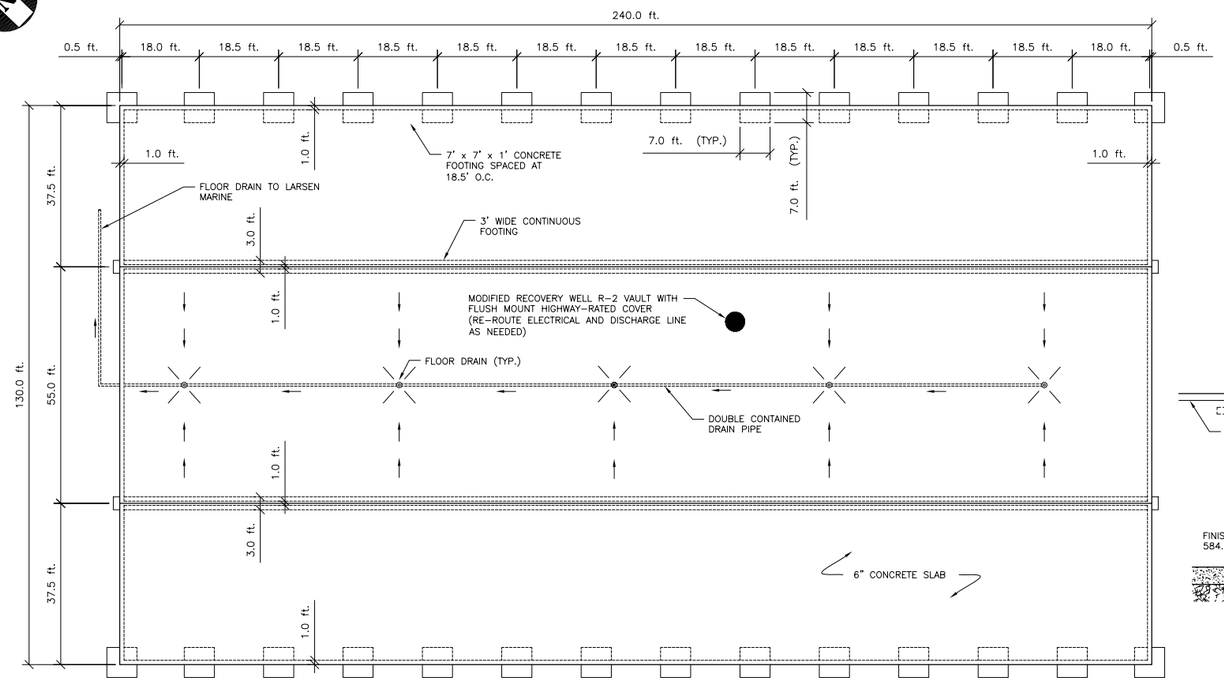
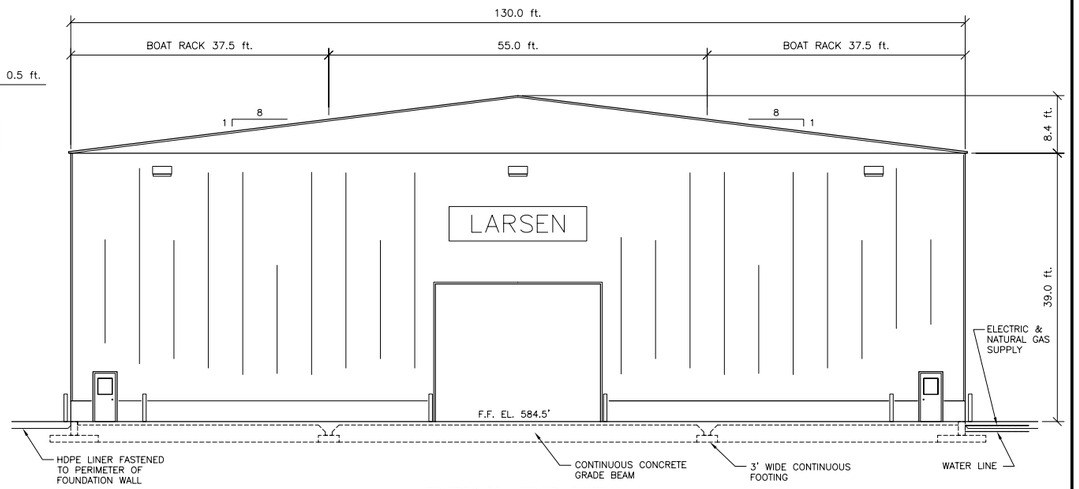
DATE:	04-20-06	SHEET 3 of 5	DRAWING NUMBER 06-001-D3	△
SCALE:	AS SHOWN			

DRAWING NUMBER 06-001-D5

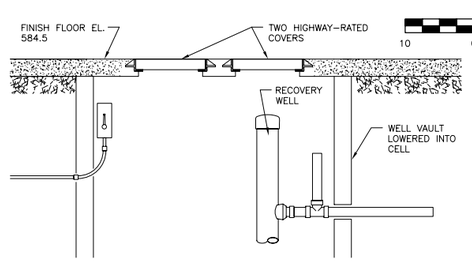


FOUNDATION PLAN
BOAT STORAGE FACILITY

SCALE
16 0 16 32 FEET

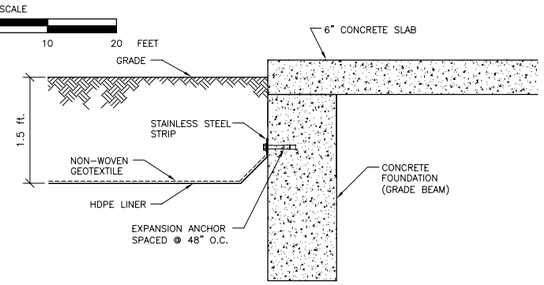


TYPICAL END VIEW
BOAT STORAGE FACILITY



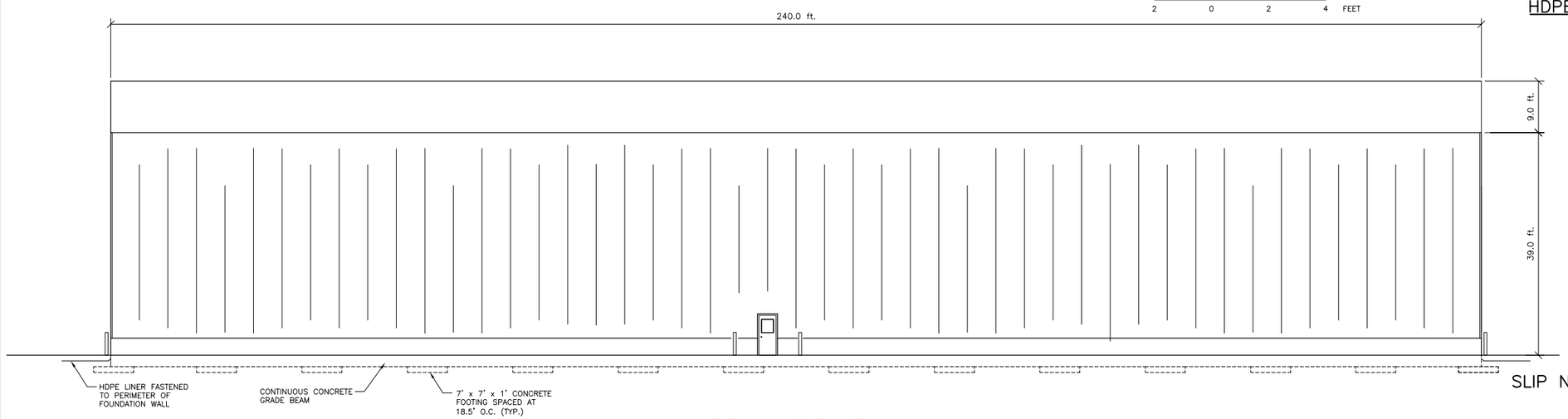
LOWERED WELL VAULT INSIDE BUILDING

SCALE
2 0 2 4 FEET



HDPE LINER/FOUNDATION SEAL DETAIL

SCALE
1 0 1 2 FEET



TYPICAL SIDE VIEW
BOAT STORAGE FACILITY

SCALE
10 0 10 20 FEET

NOTES:

1. WATER SUPPLY DOUBLE-PIPED IN CONTAINMENT AREA TO CONTAIN LEAK AND ALLOW FOR FUTURE MAINTENANCE.
2. ELECTRIC AND NATURAL GAS SUPPLY ABOVE LINER.

BOAT STORAGE FACILITY
PLAN AND ELEVATIONS
SLIP No. 3 CONTAINMENT CELL ALTERATION
PREPARED FOR
CITY OF WAUKEGAN

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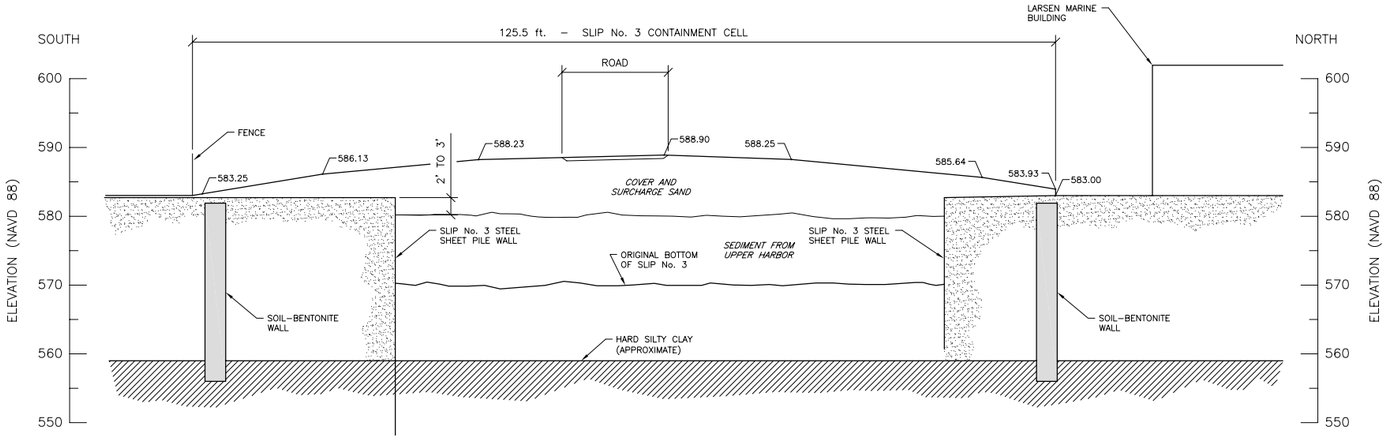
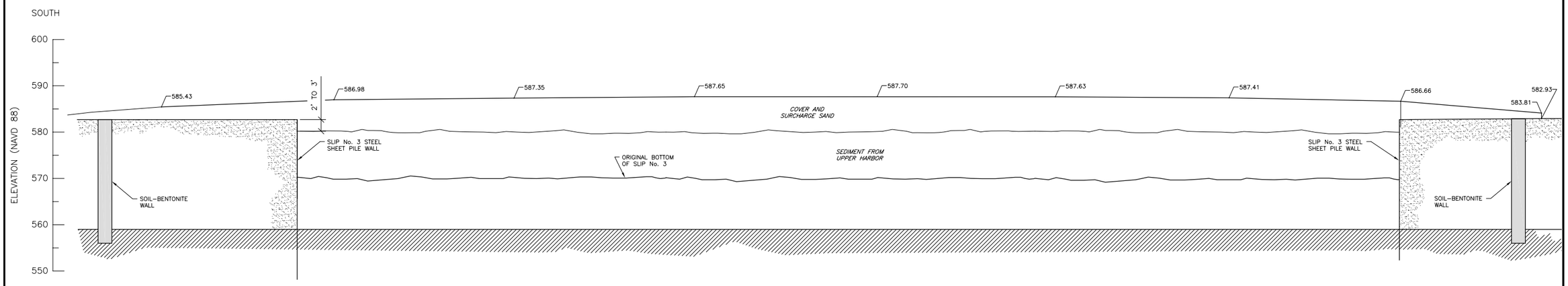
SCALE: AS SHOWN			

DRAWING NUMBER 06-001-D2



CROSS SECTION A–A' (LOOKING WEST)



CROSS SECTION B–B' (LOOKING WEST)

HORIZONTAL SCALE
10 0 10 20 FEET

VERTICAL SCALE
10 0 10 20 FEET

CROSS SECTION A–A AND B–B'
SLIP No. 3 CONTAINMENT CELL ALTERATION

PREPARED FOR

CITY OF WAUKEGAN

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△			M__A__M		

REFERENCE:
– CANONIE ENVIRONMENTAL SERVICES CORP. RECORD OF CONSTRUCTION DRAWING No. 87–126–E84.

HEC
Harrington Engineering & Construction, LLC
A HARD HAT SERVICES™ Company
1050 Broadway, Suite 7
Chesterton, Indiana 46304
Phone: (219) 926-5508 · Fax: (219) 926-8446

DATE:	04–20–06	SHEET 5 of 5	DRAWING NUMBER 06–001–D2	△
SCALE:	AS SHOWN			

Appendix A
Preliminary Design Analysis

HE&C
Harrington Engineering & Construction, Inc.

1

By TJH Date 4-28-06 Subject BOAT TRAVEL-LIFT Sheet No. 1 of 4
Chkd. By Date Proj. No. 06-001
1/4" x 1/4"

MARINE TRAVEL-LIFT MODEL M2000

12-FT NEGATIVE LIFT
MAXIMUM WT. 20,000 lbs @ 8ft C.G.
20,000 lbs = 10 TONS 35 ft. BOAT

MAXIMUM GROUND BEARING PRESSURE 95 PSI
ON DUALS 12.00 x 20 TRUCK TIRES

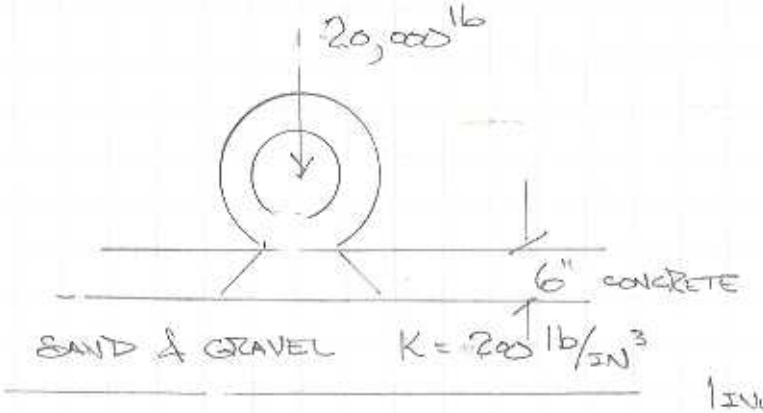
AT MAXIMUM LOAD (FOOTPRINT)

8"
12"
12"

$192 in^2 \times 95 PSI = 18,250 lbs$ / AXLE

OR TOTAL WT. 36,500 lbs

MACHINE WT. Σ 16,500 lbs



INNER SYSTEM

STRESS IN CONCRETE FIG 18-8 360 PSI

interest tables). Designers estimate that truck traffic volume (ADTT) is 13 per cent of the total.

The design ADT is $8500 \times 2.2 = 18{,}700$ vehicles per day, and the ADTT is $18{,}700\ (0.13) = 2430$. Truck traffic each way is $2430/2 = 1215$. The average hourly traffic volume in each direction

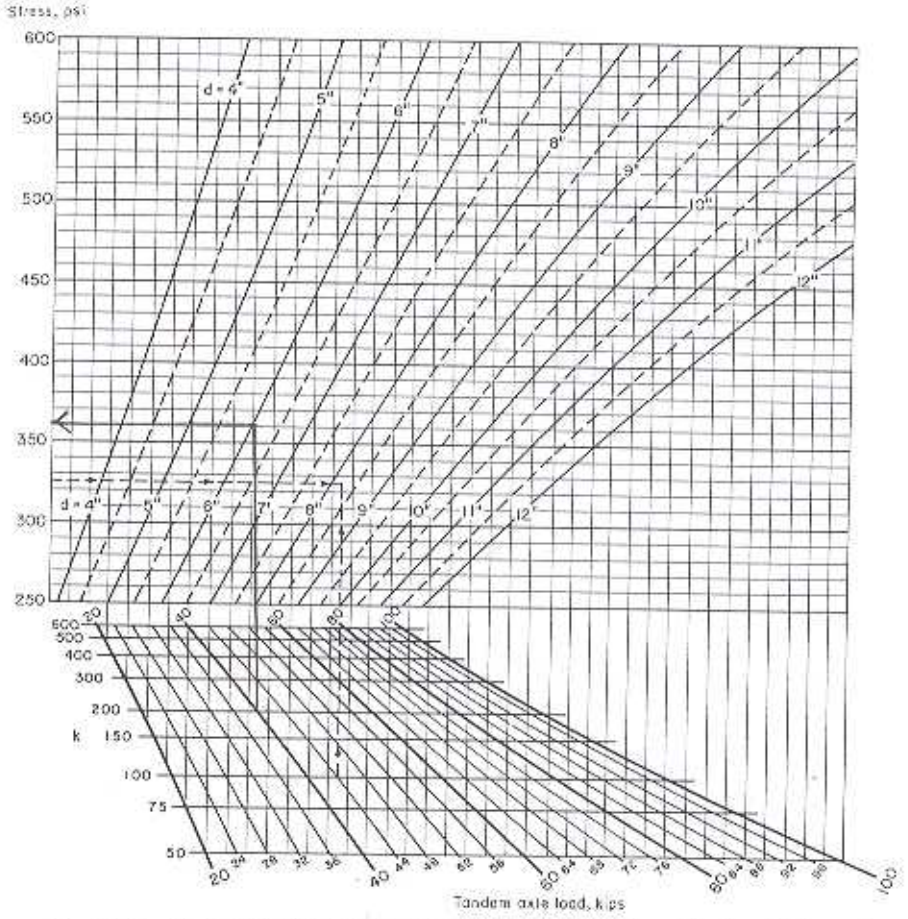


FIG. 18–8. Design chart for tandem-axle loads. (Courtesy Portland Cement Association.)

is 390. Data not shown here reveal that, at this hourly volume, 92 per cent of the trucks will be in the right lane. Thus, for this lane and a design life of 40 years, there will be $1215 \times 0.92 \times 365 \times 40 = 16.32$ million trucks.

PCA engineers evaluated three designs (1A, 1B, and 1C). For design 1A, the k of the subgrade was taken to be 100 pounds per cubic inch,

MARINE TRAVELIFT INC.

The M2000 Marine Forklift Handles Up To 20,000 Pound Boats with 8' Load Center!

Marine Travelift designed the M2000 to meet the challenges of a wide variety of rack and stack applications. The rugged M2000 can handle up to 20,000 lb. (9072 kg) boats with an 8-ft. (2438 mm) load center. It's another state-of-the-art product from Marine Travelift Inc., designer and manufacturer of the world's most advanced boat handling systems.

SPECIFICATIONS

RATED CAPACITY

With 8 ft. (2438 mm) load center and 30 ft. (9144 mm) mast:	
From -12' 0" (-3658 mm) to 10' 0"(3048 mm)	20,000 lbs. (9072 kg)
To 16' 9" (5105 mm)	16,000 lbs. (7257 kg)
At 30' 0" (9144 mm)	12,000 lbs. (5443 kg)
With 8 ft. (2438 mm) load center and 35 ft. (10 668 mm) mast:	
From -12' 0" (-3658 mm) to 10' 0" (3048 mm)	20,000 lbs. (9072 kg)
To 19' 6" (5944 mm)	15,000 lbs. (6804 kg)
At 28' 0" (8534 mm)	12,000 lbs. (5443 kg)
At 35' 0" (10 668 mm)	10,000 lbs. (4536 kg)
With 8 ft. (2438 mm) load center and 43 ft. (13 106 mm) mast:	
From -12' 0" (-3658 mm) to 10' 0" (3048 mm)	20,000 lbs. (9072 kg)
To 23' 6" (7163 mm)	13,400 lbs. (6078 kg)
At 37' 0" (11 278 mm)	10,000 lbs. (4536 kg)
At 43' 0" (13 106 mm)	8,000 lbs. (3628 kg)
Approximate shipping weight (30' mast)	64,000 lbs. (29 030 kg)

MAST AND FORKS (Swing-out style)

Maximum positive lift:	
With 30 ft. (9144 mm) mast	30 ft. (9144 mm)
With 35 ft. (10 668 mm) mast	35 ft. (10 668 mm)
With 43 ft. (13 106 mm) mast	43 ft. (13 106 mm)
Maximum negative lift:	
With 30 ft. (9144 mm) mast	12 ft. (3658 mm)
With 35 ft. (10 668 mm) mast	12 ft. (3658 mm)
With 43 ft. (13 106 mm) mast	12 ft. (3658 mm)

Mariner 2000 Forklift

- Powershift transmission. Makes handling easy and convenient.
- Swing-out forks and remote lift control. Swing-out forks provide exceptional boat handling control. And a convenient remote lift control enables the operator to work quickly and efficiently.
- Optimum visibility. The operator enjoys excellent visibility from the forward mounted cab.
- Heavy-duty mast. Mast features a 12 ft. (3658 mm) negative lift; positive lift is 30 ft. (9144 mm) with optional 35 ft. (10 668 mm) or 43 ft. (13 106 mm).
- Efficient cooling. The M2000 features remote cooling for optimum cooling efficiency.
- Wet-disk brakes. Provide long, maintenance-free performance.
- Stepped ingress/egress. Gives operator easy access to the operator's station from both sides of the machine.

Maximum carriage free lift:	
With 30 ft. (9144 mm) mast	16 ft. 9" (5080 mm)
With 35 ft. (10 668 mm) mast	19 ft. 6" (5791 mm)
With 43 ft. (13 106 mm) mast	23 ft. 6 in. (7163 mm)
Maximum carriage free lift:	
With 30 ft. (9144 mm) mast	16 ft. 9" (5080 mm)
With 35 ft. (10 668 mm) mast	19 ft. 6" (5791 mm)
With 43 ft. (13 106 mm) mast	23 ft. 6 in. (7163 mm)
Maximum lift speed -- Up	50 ft./min (15 240 mm/min.)
Maximum lift speed -- Down (pressure compensated flow control).	45 ft./min (13,716 mm/min.)
Anti-drop feature	velocity fuse
Maximum forward mast tilt	4f
Maximum rearward mast tilt	12f
Standard fork length (from fork face)	20 ft. (6096 mm)
Maximum fork spread	14 ft. 2 in. (4318 mm)
Minimum fork spread	45 in. (1143 mm)
Fork cover style	Rubber-covered semi-cylindrical
Fork cross-section depth	10.5 in. (267 mm)

ENGINE

Make	Cummins 4B3.9-C110 diesel
Horsepower at RPM	110 hp (82 kw) at 2,500 rpm
Peak torque at RPM	293 lb.-ft. (397 Nm) at 1,500 rpm

TRANSMISSION

Style	4-speed Powershift
Cooling	Air to oil
Speed (forward and reverse):	1st -- 1.9 mph (3.6 kph) 2nd -- 3.3 mph (5.3 kph) 3rd -- 6.6 mph (10.6 kph) 4th -- 10.9 mph (17.5 kph)

ELECTRICAL

Alternator	Heavy duty with voltage regulator
Volts	12
Amps	63
Battery	(1) 515 cold-cranking amps
Starting motor	Heavy-duty

HYDRAULIC SYSTEM

Type	Open loop
Maximum operating pressure	2,500 psi (17 235 kPa)
Cooling	Air to oil

DRIVE

Steering	Hydraulic load sensing
Wheelbase	129 in. (3277 mm)
Overall width	111 in. (2819 mm)
Minimum mast height (30' mast)	21 ft. 8 in. (6604 mm)
Tail swing radius	15 ft. 5 in. (4099 mm)
Aisle for 90f turn	Boat length plus 19 ft. 6 in. (5944 mm)
Tires:	
Drive	Dual 12.00 x 20
Steering	Single 12.00 x 20
Air Pressure - Front	130 psi (900 kPa) - Minimum
Air pressure - Rear	116 psi (800 kPa) - Minimum
Maximum ground Bearing pressure (pneumatic tires)	95 psi (655 kPa)
Brakes	Wet disk
Gradeability (with maximum load)	45%
Gradeability shown is for concrete or asphalt surfaces. For other surfaces deduct as follows:	
Mud	4 - 7%
Loose gravel	2 - 4%
Soft sand	2 - 13%

Forklift Width	**30' Mast**	**35' Mast**	**43' Mast**
A. Fork Length	20'/6095 mm	20'/6095 mm	20'/6095 mm
B. Wheel Base	10'9"/3277 mm	10'9"/3277 mm	10'9"/3277 mm
C. Overall Width	9'3"/2819 mm	9'3"/2819 mm	9'3"/2819 mm
D. Turning Radius	15'5"/4699 mm	15'5"/4699 mm	15'5"/4699 mm
E. Height (Mast Extended)	36'7"/11 151 mm	41'7"/12 674 mm	49'7"/15 113 mm
F. Height (Mast Collapsed)	21'8"/6604 mm	24'6"/7468 mm	28'6"/8687 mm
G. Center of Front Axle to Back Edge of Mast	2'/610 mm	2'/610 mm	2'/610 mm
H. Fork Height (Neg. Lift)	12'/3658 mm	12'/3658 mm	12'/3658 mm
J. Fork Height (Mast Collapsed)	16'9"/5105 mm	19'6"/5944 mm	23'6"/7163 mm
K. Fork Height (Mast Extended)	30'/9144 mm	35'/10 668 mm	43'/13 106 mm
L. Forks Clearance--In (Use Inner Holes)	32.5"/826 mm	32.5"/826 mm	32.5"/826 mm
M.Fork Clearance--Out (Use Outer Holes)	14'2"/4318 mm	14'2"/4318 mm	14'2"/4318 mm
N. Fork Height with Cover	9.5"/241 mm	9.5"/241 mm	9.5"/241 mm
O. Overall Length	37'7"/11 455 mm	37'7"/11 455 mm	37'7"/11 455 mm

Standard Equipment

- Diesel engine
- Four-speed powershift transmission
- Heavy-duty steering axle with tapered roller bearing spindles and one double acting hydraulic steering cylinder
- Two-stage telescopic mast with interlocking channels; sealed bearings, and slides
- 30 ft. (9144 mm) mast
- 20 ft. (6096 mm) forks with padding
- Wet-disk brakes
- 20 in. (508 mm) pneumatic dual drive and single steering tires
- 63 amp alternator with voltage regulator
- (1) 90 amp hour battery
- Pilot-operated hydraulic control system
- 54 gallon (204 liter) fuel tank
- 80 gallon (303 liter) hydraulic tank
- Left side mounted cab
- Seat belt
- Stepped ingress/egress from both sides of machine
- Two forward and two rear lights
- One rear and three side mirrors
- Horn
- Back-up alarm
- Polyester paint
- Overhead guard
- Instruments
  - Fuel gauge
  - Oil pressure gauge
  - Engine temperature gauge
  - Ammeter
  - Hourmeter
- Remote control of negative lift (control on either side)
- Remote grease zerks for upper mast rollers
- Options
  - 35 ft. (10 668 mm) mast
  - 43 ft. (13 106 mm) mast
  - Solid tires -- White 12.00 x 20 non-marking

Unit is designed to meet the intent of ANSI B56.1 Part III, 1988 Specifications and standard equipment are current at time of printing. Machines may be pictured with optional equipment. Marine Travelift, Inc. reserves the right to make changes to specifications and equipment without notice.

49 E Yew Street • Sturgeon Bay WI 54235-0066 • USA

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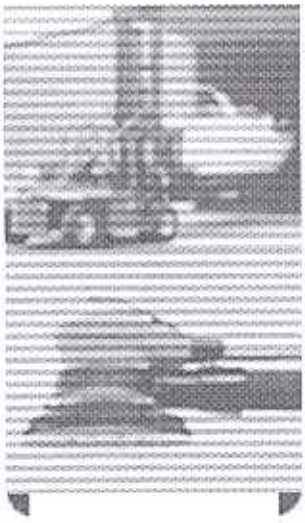
BOATYARD, MARINE AND INDUSTRIAL EQUIPMENT



MARINE TRAVELIFT INC.

There's a Marine Forklift just right for your application...talk to us!

Link to Marine-Travelift Web Site

F1500 Forklift

- Designed and manufactured by the leader in mobile boat handling . . . Marine Travelift, Inc.
- Short wheel base provides excellent maneuverability between the stacks and the waterfront.
- Preferred operator position for maximum visibility.
- Swing-out forks and remote lift control for boat handling convenience.
- Power shift transmission for improved handling.
- Heavy-duty mast with 10' of negative lift.
- The Mariner® F1500 Marine Forklift Handles Up To 15,000 Pound (6800 kg) Boats with 8' Load Center!
- **BOAT HANDLING PERFORMANCE** comes from the leaders in mobile boat handling. Marine Travelift engineers have designed the F1500 to deliver the performance and maneuverability needed for most rack and stack operations.
- **THE SHORT WHEEL BASE** allows the F2500 marine forklift to have a turning radius of just 12'11" (3937 mm) for the tight quarters found between the stacks. The off-set operator's position insures maximum visibility for better boat handling.
- **SWING-OUT FORKS** add control and versatility to boat handling. The convenient remote lift control

maximizes manpower efficiency and helps to speed customer service.
- **HEAVY-DUTY MAST** with 10' (3048mm) of negative lift and 33'8" (10.262 mm) of positive lift means the F1500 marine forklift has a wide application appeal for marina operators.

Return to top

Mariner® M2000 Forklift

- Marine Travelift designed the M2000 to meet the challenges of a wide variety of rack and stack applications. The rugged M2000 can handle up to 20,000 lb. (9072 kg.) boats with an 8-ft. (2438mm) load center. It's another state-of-the-art product from Marine Travelift Inc., designer and manufacturer of the world's most advanced boat handling systems.
- Excellent stability and maneuverability. With its wide track and long wheel base, the M2000 delivers exceptional stability, and its tight-turning steer axle makes it highly maneuverable.
- Power shift transmission. Makes handling easy and convenient.Swing-out forks and remote lift control. Swing-out forks provide exceptional boat handling control. And a convenient remote lift control enables the operator to work quickly and efficiently.Optimum visibility. The operator enjoys excellent visibility from the forward mounted cab.
- Heavy-duty mast. Mast features a 12 ft. (3658 mm) negative lift; positive lift is 30 ft. (9144 mm) with optional 35 ft. (10,688 mm) or 43 ft. (13,106 mm).
- Efficient cooling. The M2000 features remote cooling for optimum cooling efficiency.
- Wet-disk brakes. Provide long, maintenance-free performance.
- Stepped entrance/exit. Gives operator easy access to the operator's station from both sides of the machine.

Return to top

Mariner® F2700 Forklift

- Designed and manufactured by the leader in mobile boat handling . . . Marine Travelift, Inc.
- Engineered for proper handling of boats . . . moves effortlessly between the stacks and the waterfront.
- 40', four-section mast is standard.
- Excellent operator visibility.
- Sure footed operation . . . wide footprint provides stability.
- Adjustable 4-degree forward and 9-degree rearward mast tilt . . . increased boat handling confidence.
- Easy, full-access service to all key areas.
- The Mariner® F2700 Marine Forklift Handles Up To 27,000 Pound Boats With 8' Load Center!
- **SHORT WHEEL BASE** enables turning in close quarters and narrow aisles.
- **EXTRA-WIDE TIRE TRACK** provides the Mariner® F2700 forklift with excellent stability. A full hydraulic load-sensing power steering system provides equal response for all loads and engine speeds.
- **ALL MASTS FEATURE** a nested wide flange mast with multiple-leaf lift chains. All are constructed of high-strength steel for minimal weight, while yielding maximum strength.
- **EASY SERVICE ACCESSIBILITY** is made possible through the use of easily removable access panels and hoods. All machine components can be serviced quickly for less downtime and increased operating time.
- **OPERATOR'S STATION** is positioned forward and to the outside for excellent visibility of the boat outdrive. The adjustable, full suspension seat puts the SAE-compatible control locations at the operator's fingertips for efficient boat handling and travel.
- **DIESEL POWER** is delivered by the efficient Cummins turbo diesel. A closed-loop hydrostatic drive system provides infinite speed variation for both forward and reverse travel with smooth control at any engine speed. Two speed ranges maximize speed and torque performance. The foot-operated controller provides precision movement at any engine speed.

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SITE MAP | INDUSTRIAL EQUIPMENT | MARINE EQUIPMENT
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Harrington Engineering & Construction, Inc.

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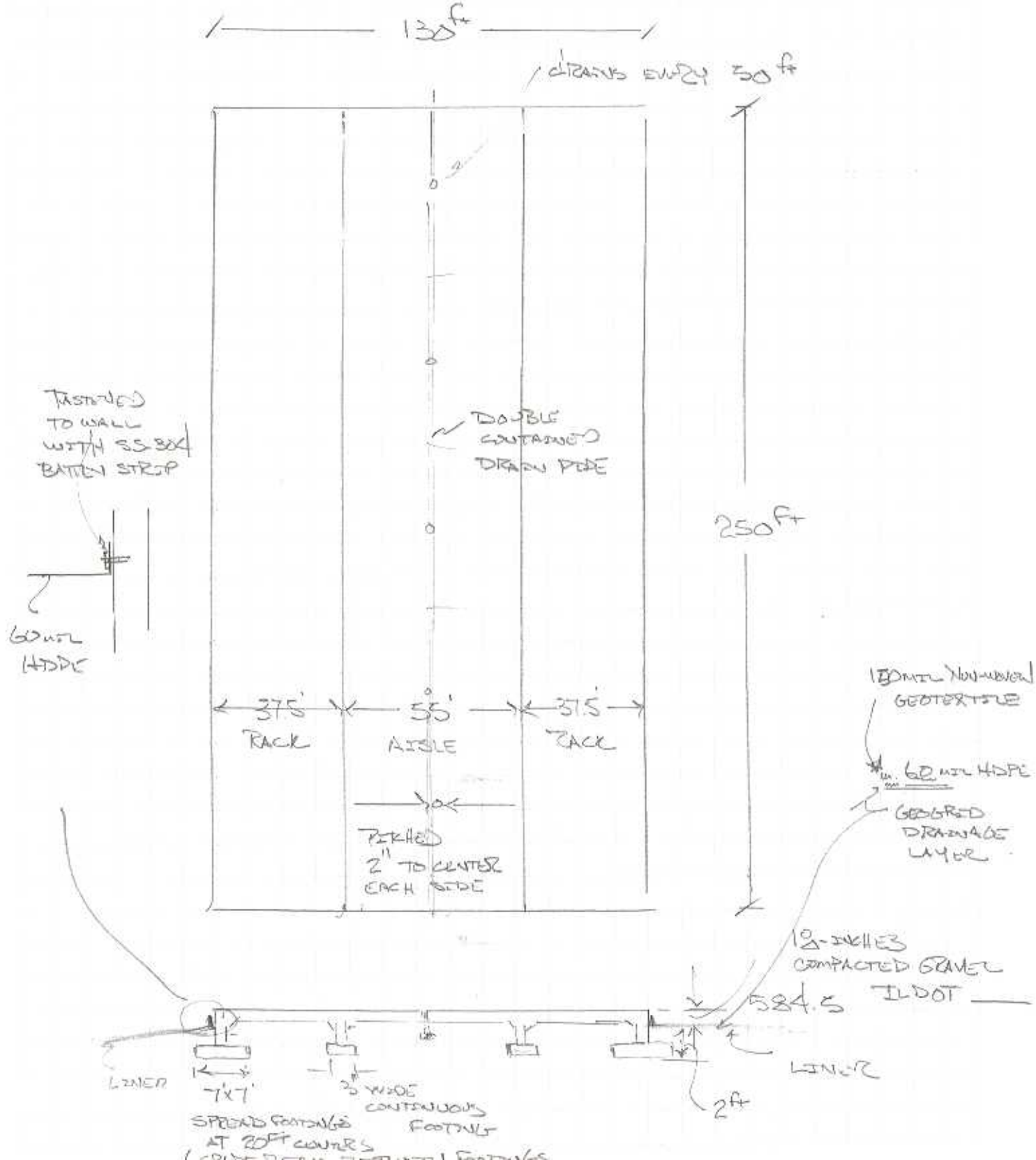
By TJH Date 4.28.06 Subject Bldg Layout Sheet No. 2 of 4

Chkd. By Date Proj. No. 06-001

1/4" x 1/4"



Soil Conditions Between Slurry Wall & Old Slip 3

Borings 5-11 Depth 3.5-5.0 ft (SP sand)

Boring	Blowcount
5	13
6	5
7	28
8	16
9	9
10	9
11	28

Use IBC bearing capacity 2000 psf (Table 1804.2)

Maximum load per column 100k

Footing Req'd $100{,}000\ lb / 2000\ psf = 50\ ft^2$ 7'x7' square

Check settlement on loose sand

$$\rho = P_b \frac{1-\mu^2}{E} I_p$$

Loose sand $E = 1500$ psi
Poisson's ratio $\mu = 0.2$
Square fdn (rigid) $I_p = 0.88$
Strip fdn (rigid) $I_p = 3.0$

7'x7' square

$$\rho = 2000\ psf\ (7\ ft) \frac{1-0.2^2}{1500\ psi.} (0.88)$$

$$= 0.66\ inch \quad (5/8\ inch)$$

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By TJH Date 5-1-06 Subject FOUNDATION Bldg. Sheet No. 4 of 4

Chkd. By Date Proj. No. 06-001

1/4" x 1/4"

STRIP FOOTING UNDER BOAT RACK

4-high 4(20,000lbs)/15ft ≈ 5000 lb/ft

1/2 TO FRONT 2500 lb/ft PLUS RACK WT

3000 lb/ft ON 3 FT WIDE FOOTING

$$e = 1000\,lb/ft^2 (3\,ft)\,\frac{1-0.2^2}{1500\,psi}\,(3.0)$$

$$\doteq 0.5\ \text{INCH}\ (1/2\ \text{INCH})$$

(13)

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BORING LOG

PROJECT No. 87-126-01
BORING No. S-5
LOGGED BY P. Romzick
PAGE No. 1 of 2

PROJECT NAME WAUKEGAN HARBOR
BORING LOCATION N 4398.9214 E 4660.0485 SURFACE ELEVATION 584.07
DRILLER Fox Drilling, Inc. DATE: START 1/17/89 FINISH 1/17/89

DEPTH	SAMPLE No.	TYPE	INTERVAL FROM	TO	BLOW COUNT 0" 6"	6" 12"	12" 18"	REC (in)	USCS SOIL TYPE	WC (%)	qu (TSF)	LAYER DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO
5	1	SS	3.5	5.0	5	6	7	8	SP				Medium Dense Light Brown Fine To Medium Sand	
												8.5		
10	2	SS	8.5	10.0	3	5	7	16	SP				Loose To Medium Dense Brown Fine Sand. (6 In. Gravel Layer At 12.0 Ft.)	
15	3	SS	13.5	15.0	7	6	8	6	SP					
20	4	SS	18.5	20.0	4	3	5	8	SP	25			Trace Of Medium Sand And Fine Gravel From 18.5 To 23.0 Ft. (Gravel Encountered At 23.0 Ft.)	
25	5	SS	23.5	25.0	51	24	22	12	CL		>4.5	24.5		
	6	SS	25.0	27.0	18	28	33	24	CL	15	>4.5		Hard Silty Clay, Some Fine Gravel From 24.5 To 25.0 Ft.	
					69									
	7	SS	28.0	30.0	70	85	90	22	CL		>4.5			
30					100									
	8	SS	30.0	31.9	25	35	73	23	CL		>4.5			
					100/5									
	9	SS	32.0	34.0	44	60	30	21	CL		>4.5		Trace Of Fine Gravel From 32.0 To 34.5 Ft.	
					30									
35	10	SS	34.0	36.0	8	15	20	19	CL		>4.5		Trace Of Coarse Sand From 34.5 To 38.5 Ft.	
					42									
	11	SS	36.0	38.0	18	17	21	0						
					33									
40	12	SS	38.5	40.5	13	24	38	22	CL		>4.5			
					56									

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BORING LOG

PROJECT No. 87-126-01
BORING No. S-5
LOGGED BY P. Romzick
PAGE No. 2 of 2

PROJECT NAME WAUKEGAN HARBOR
BORING LOCATION N 4398.9214 E 4660.0485 SURFACE ELEVATION 584.07
DRILLER Fox Drilling, Inc. DATE: START 1/17/89 FINISH 1/17/89

DEPTH	SAMPLE No.	SAMPLE TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0" 6"	BLOW COUNT 6" 12"	BLOW COUNT 12" 18"	REC (in)	USCS SOIL TYPE	WC (%)	qu (TSF)	LAYER DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO
	13	SS	40.5	42.5	14	22	33	24	CL				Hard Gray Silty Clay.	
					54							42.5		
45													Bottom Of Boring At 42.5 Ft.	
													Notes:	
													1. Boring Was Advanced By Rotary Wash Method Using A 3-In. Dia Roller Bit.	
													2. Ground Water Was Encountered At 3.2 Ft. Below Ground Surface.	
													3. Upon Completion, Boring Was Backfilled With Cement / Bentonite Grout From 42.5 Ft. Ground Surface.	

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BORING LOG

PROJECT No. 87-126-01
BORING No. S-6A
LOGGED BY P. Romzick
PAGE No. 1 of 1

PROJECT NAME WAUKEGAN HARBOR
BORING LOCATION N 4641.1451 E 4578.8412 SURFACE ELEVATION 585.11
DRILLER Fox Drilling, Inc. DATE: START 1/19/89 FINISH 1/19/89

DEPTH	SAMPLE No.	SAMPLE TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0" to 6"	BLOW COUNT 6" to 12"	BLOW COUNT 12" to 18"	REC (in)	USCS SOIL TYPE	WC (%)	qu (TSF)	LAYER DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO
5	1	SS	3.5	5.0	3	2	3	14	SP				Loose To Medium Dense Dark Brown Fine Sand, Some Coarse Sand.	
10	2	SS	8.5	10.0	2	5	6	14	SP				Some Slag And Cinders From 10.0 To 13.0 Ft.	
												13.0		
15													Bottom Of Boring At 13.0 Ft.	

Notes:

1. Boring Was Advanced By Rotary Wash Method Using A 6-in. Dia Roller Bit.

2. Ground Water Was Encountered At 3.2 Ft. Below Ground Surface.

3. Upon Completion, Boring Was Backfilled With Cement / Bentonite Grout From 13.0 Ft. To Ground Surface.

4. Boring Could Not Be Advanced Because Of Obstruction At 13.0 Ft.

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BORING LOG

PROJECT No. 87-126-01
BORING No. S-6B
LOGGED BY P. Romzick
PAGE No. 1 of 2

PROJECT NAME WAUKEGAN HARBOR
BORING LOCATION N 4645.3245 E 4575.0751 SURFACE ELEVATION 585.03
DRILLER Fox Drilling, Inc. DATE: START 1/19/89 FINISH 1/20/89

DEPTH	SAMPLE No.	SAMPLE TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0" 6"	BLOW COUNT 6" 12"	BLOW COUNT 12" 18"	REC (in)	USCS SOIL TYPE	WC (%)	qu (TSF)	LAYER DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO
5													See Boring Log S-6A For Details.	
10												13.0		
15	1	SS	13.5	15.0	12	11	7	0					Medium Dense Gray Fine Sand.	
20	2	SS	18.5	20.0	7	7	22	16	SP					
25	3	SS	23.5	25.5	11	11	20	15	SP/CL			24.0		
					51									
	4	PB	25.5	28.0				26	CL				Hard Gray Silty Clay.	
	5	SS	28.0	28.8	65	86/3		9	CL		> 4.5			
30	6	PB	29.0	31.5				14	CL					
	7	SS	31.5	33.5	43	54	66		CL		> 4.5			
					43							33.5		
35													Bottom Of Boring At 33.5 Ft.	
40														

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BORING LOG

PROJECT No. 87-126-01
BORING No. S-6B
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PAGE No. 2 of 2

PROJECT NAME WAUKEGAN HARBOR
BORING LOCATION N 4645.3245 E 4575.0751 SURFACE ELEVATION 585.03
DRILLER Fox Drilling, Inc. DATE: START 1/19/89 FINISH 1/20/89

DEPTH	SAMPLE No.	SAMPLE TYPE	SAMPLE INTERVAL FROM	SAMPLE INTERVAL TO	BLOW COUNT 0" 6"	BLOW COUNT 6" 12"	BLOW COUNT 12" 18"	REC (in)	USCS SOIL TYPE	WC (%)	qu (TSF)	LAYER	DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO
														Notes: 1. Boring Was Advanced By Rotary Wash Method Using A 6-in. Dia Roller Bit. 2. Ground Water Was Encountered At 3.2 Ft. Below Ground Surface. 3. Upon Completion, Boring Was Backfilled With Cement / Bentonite Grout From 33.5 Ft. To Ground Surface.	

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BORING LOG

(18)

PROJECT No. 87-126-01
BORING No. S-7
LOGGED BY P. Romzick
PAGE No. 1 of 2

PROJECT NAME WAUKEGAN HARBOR
BORING LOCATION N 4780.1219 E 4453.4082 SURFACE ELEVATION 585.49
DRILLER Fox Drilling, Inc. DATE: START 1/18/89 FINISH 1/19/89

DEPTH	SAMPLE No.	SAMPLE TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0"	BLOW COUNT 6"	BLOW COUNT 12"	REC (in)	USCS SOIL TYPE	WC (%)	qu (TSF)	LAYER DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO
5	1	SS	3.5	5.0	12	11	15	15	SP				Medium Dense To Very Dense Brown Fine Sand, Trace Of Fine Gravel From 3.5 To 5.0 Ft.	
10	2	SS	8.5	10.0	5	12	33	16	SP					
15	3	SS	13.5	15.0	19	27	28	15	SP	23				
												18.5		
20	4	SS	18.5	20.0	15	22	26	14	SP				Dense Gray Fine Sand.	
												23.2		
25	5	SS	23.5	25.5	12	15	18	19	CL					
					19									
	6	PB	25.5	28.0				19	CL		>4.5		Hard Gray Silty Clay, Trace Of Fine Sand From 23.5 To 25.5 Ft.	
30	7	PB	28.0	30.5				14	CL					
	8	SS	30.5	32.5	31	34	61	22	CL		>4.5			
					103							32.5		
35													Bottom Of Boring At 32.5 Ft.	
40														

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BORING LOG

PROJECT No. 87-126-01
BORING No. S-7
LOGGED BY P. Romzick
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PROJECT NAME WAUKEGAN HARBOR
BORING LOCATION N 4780.1219 E 4453.4082 SURFACE ELEVATION 585.49
DRILLER Fox Drilling, Inc. DATE: START 1/18/89 FINISH 1/19/89

DEPTH	SAMPLE No.	SAMPLE TYPE	SAMPLE INTERVAL FROM	SAMPLE INTERVAL TO	BLOW COUNT 0" 6"	BLOW COUNT 6" 12"	BLOW COUNT 12" 18"	REC (in)	USCS SOIL TYPE	WC (%)	qu (TSF)	LAYER	DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO
														Notes: 1. Boring Was Advanced By Rotary Wash Method Using A 6-in. Dia. Roller Bit. 2. Ground Water Was Encountered At 3.2 Ft. Below Ground Surface. 3. Upon Completion, Boring Was Backfilled With Cement / Bentonite Grout From 32.5 Ft. To Ground Surface.	

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BORING LOG

PROJECT No. 87-126-01
BORING No. S-8
LOGGED BY P. Romzick
PAGE No. 1 of 2

PROJECT NAME WAUKEGAN HARBOR
BORING LOCATION N 4891.6787 E 4314.9116 SURFACE ELEVATION 584.26
DRILLER Fox Drilling, Inc. DATE: START 1/18/89 FINISH 1/18/89

DEPTH	SAMPLE No.	SAMPLE TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0" 6" 6" 12" 12" 18"	REC (in)	USCS SOIL TYPE	WC (%)	qu (TSF)	LAYER DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO
5	1	SS	3.5	5.0	3 4 12	12	SP				Medium Dense Dark Brown Fine To Coarse Sand, Trace Of Fine Gravel.	
										8.5		
10	2	SS	8.5	10.0	11 16 22	14	SP				Medium Dense To Dense Light Brown Fine Sand.	
15	3	SS	13.5	15.0	8 8 10	11	SP					
										18.5		
20	4	SS	18.5	20.0	17 22 20	15	SP				Dense Gray Fine Sand. (Gravel At 21.3 Ft.)	
										21.7	Hard Gray Silty Clay, Trace Of Fine To Coarse Sand.	
	5	SS	22.0	23.5	15 23 26	14	CL		>4.5		2-In. Layer Gray Clayey Fine Sand, Trace Of Fine Gravel At 25.0 Ft.	
25	6	SS	24.0	26.0	14 63 83	24	CL		>4.5			
					73							
	7	SS	26.0	27.9	18 18 27	18	CL	13	>4.5			
					100/4							
	8	SS	28.0	30.0	20 30 41	24	CL		>4.5			
30					59							
	9	SS	30.0	32.0	20 26 34	16	CL					
					37					32.0		
											Bottom Of Boring At 32.0 Ft.	
35												
40												

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BORING LOG

PROJECT No. 87-126-01
BORING No. S-8
LOGGED BY P. Romzick
PAGE No. 2 of 2

PROJECT NAME WAUKEGAN HARBOR
BORING LOCATION N 4891.6787 E 4314.9116 SURFACE ELEVATION 584.26
DRILLER Fox Drilling, Inc. DATE: START 1/18/89 FINISH 1/18/89

DEPTH	SAMPLE No.	SAMPLE TYPE	SAMPLE INTERVAL FROM	SAMPLE INTERVAL TO	BLOW COUNT 0" to 6"	BLOW COUNT 6" to 12"	BLOW COUNT 12" to 18"	REC (in)	USCS SOIL TYPE	WC (%)	qu (TSF)	LAYER	DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO
														Notes: 1. Boring Was Advanced By Rotary Wash Method Using A 3-in. Dia. Roller Bit. 2. Ground Water Was Encountered At 1.7 Ft. Below Ground Surface. 3. Upon Completion, Boring Was Backfilled With Cement / Bentonite Grout From 32.0 Ft. To Ground Surface.	

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BORING LOG

PROJECT No. 87-126-01
BORING No. S-9
LOGGED BY P. Romzick
PAGE No. 1 of 2

PROJECT NAME WAUKEGAN HARBOR
BORING LOCATION N 4956.0864 E 4427.9251 SURFACE ELEVATION 583.37
DRILLER Fox Drilling, Inc. DATE: START 1/13/89 FINISH 1/17/89

DEPTH	SAMPLE No.	SAMPLE TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0" 6"	BLOW COUNT 6" 12"	BLOW COUNT 12" 18"	REC (in)	USCS SOIL TYPE	WC (%)	qu (TSF)	LAYER DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO
5	1	SS	3.5	5.0	4	5	4	12	SP					
10	2	SS	8.5	10.0	2	3	2	14	SP				Loose To Medium Dense Dark Brown Fine Sand.	
15	3	SS	13.5	15.0	7	8	13	11	SP				Trace Of Coarse Sand From 13.5 To 18.5 Ft.	
20	4	SS	18.5	20.0	10	7	6	13	SM	27			(Gravel At 21.8 Ft.)	
												22.0	Very Dense Gray Clayey Silt, Some Fine To	
	5	SS	22.5	24.0	41	38	46	14	ML	12	>4.5	24.0	Coarse Sand, Trace Fine Gravel.	
25	6	SS	24.0	24.6	15	100/1		6	CL		>4.5		(Hit A Cobble At 24.6 Ft.)	
	7	SS	25.0	27.0	41	55	63	24	CL		>4.5		Hard Gray Silty Clay, Trace Of Fine Gravel From	
					54								24.0 To 24.6 Ft.	
	8	SS	27.0	29.0	16	35	70	24	CL		>4.5			
					99									
30	9	SS	29.0	30.4	32	40	100/5	17	CL		>4.5			
													Some Fine Gravel From 30.5 To 33.0 Ft.	
	10	SS	31.0	33.0	44	31	40	19	CL		>4.5			
					38							33.0		
35													Bottom Of Boring At 33.0 Ft.	
40														

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BORING LOG

PROJECT No. 87-126-01
BORING No. S-9
LOGGED BY P. Romzick
PAGE No. 2 of 2

PROJECT NAME WAUKEGAN HARBOR
BORING LOCATION N 4956.0864 E 4427.9251 SURFACE ELEVATION 583.37
DRILLER Fox Drilling, Inc. DATE: START 1/13/89 FINISH 1/17/89

DEPTH	SAMPLE No.	SAMPLE TYPE	SAMPLE INTERVAL FROM	SAMPLE INTERVAL TO	BLOW COUNT 0" to 6"	BLOW COUNT 6" to 12"	BLOW COUNT 12" to 18"	REC (in)	USCS SOIL TYPE	WC (%)	qu (TSF)	LAYER DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO
													Notes: 1. Boring Was Advanced By Rotary Wash Method Using A 3-in. Dia Roller Bit. 2. Ground Water Was Encountered At 3.2 Ft. Below Ground Surface. 3. Upon Completion, Boring Was Backfilled With Cement / Bentonite Grout From 33.0 Ft. To Ground Surface.	

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BORING LOG

PROJECT No. 87-126-01
BORING No. S-10
LOGGED BY P. Romzick
PAGE No. 1 of 2

PROJECT NAME WAUKEGAN HARBOR
BORING LOCATION N 4870.0244 E 4542.3277 SURFACE ELEVATION 583.66
DRILLER Fox Drilling, Inc. DATE: START 1/12/89 FINISH 1/13/89

DEPTH	SAMPLE No.	TYPE	INTERVAL FROM	TO	BLOW COUNT 0" 6"	6" 12"	12" 18"	REC (in)	USCS SOIL TYPE	WC (%)	qu (TSF)	LAYER DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO
5	1	SS	3.5	5.0	2	4	5	15	SP					
10	2	SS	8.5	10.0	2	12	25	18	SP	14			Loose To Dense Gray Fine Sand, Trace of Coarse Sand Between 3.5 To 5.0 Ft.	
15	3	SS	13.5	15.0	19	20	18	15	SP				Some Coarse Sand And Fine Gravel From 8.5 To 10.0 Ft.	
20	4	SS	18.5	20.0	19	20	26	14	SP					
												22.5		
	5	SS	22.5	24.5	15	23	27	24	CL	12	>4.5		Hard Gray Silty Clay.	
25					40									
	6	SS	24.5	26.5	17	29	41	24	CL		>4.5		Some Fine To Coarse Sand, Trace Of Fine Gravel From 22.5 To 24.5 Ft.	
					54									
	7	SS	26.5	28.5	13	19	30	23	CL		>4.5			
					41									
30	8	SS	28.5	30.3	31	41	92	21	CL		>4.5			
					100/3								Hard Gray Silty Clay, Trace Of Coarse Sand Between 30.5 To 40.5 Ft.	
	9	SS	30.5	31.3	92	100/4		10	CL		>4.5			
	10	SS	32.5	32.9	100/5			5	CL		>4.5			
35	11	SS	34.5	36.5	37	33	40	22	CL		>4.5			
					78									
	12	SS	36.5	38.5	40	28	40		CL		>4.5			
					56			23						
	13	SS	38.5	40.5	13	22	32		CL		>4.5			
40					48			21						

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BORING LOG

PROJECT No. 87-126-01
BORING No. S-10
LOGGED BY P. Romzick
PAGE No. 2 of 2

PROJECT NAME WAUKEGAN HARBOR
BORING LOCATION N 4870.0244 E 4542.3277 SURFACE ELEVATION 583.66
DRILLER Fox Drilling, Inc. DATE: START 1/12/89 FINISH 1/13/89

DEPTH	SAMPLE No.	SAMPLE TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0" to 6"	BLOW COUNT 6" to 12"	BLOW COUNT 12" to 18"	REC (in)	USCS SOIL TYPE	WC (%)	qu (TSF)	LAYER DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO
	14	SS	40.5	42.5	15	24	42	24	CL		>4.5		Hard Gray Silty Clay.	
					52							42.5		
45													Bottom Of Boring At 42.5 Ft.	
													Notes:	
													1. Boring Was Advanced By Rotary Wash Method Using A 3-in. Dia Roller Bit.	
													2. Ground Water Was Encountered At 3.1 Ft. Below Ground Surface.	
													3. Upon Completion, Boring Was Backfilled With Cement / Bentonite Grout From 42.5 Ft. To Ground Surface.	

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BORING LOG

PROJECT No. 87-126-01
BORING No. S-11
LOGGED BY M. Obradovic
PAGE No. 1 of 2

PROJECT NAME WAUKEGAN HARBOR
BORING LOCATION N 4765.9767 E 4674.8341 SURFACE ELEVATION 583.40
DRILLER Fox Drilling, Inc. DATE: START 12/6/88 FINISH 12/7/88

DEPTH	SAMPLE No.	SAMPLE TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0"-6"	BLOW COUNT 6"-12"	BLOW COUNT 12"-18"	REC (in)	USCS SOIL TYPE	WC (%)	qu (TSF)	LAYER DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO
												0.2	(Gravel)	
5	1	SS	4.5	6.5	12	13	15	8	SP				Medium Dense Dark Gray To Black Fine Sand. Odor In Sample No. 1.	
					12									
10	2	SS	9.5	11.5	10	12	17	24	SP			9.5	Medium Dense Gray Fine Sand, Trace Of Fine To Coarse Gravel. Odor In Sample No. 2.	
					22									
15	3	SS	14.5	16.5	13	24	33	8	SM			14.5	Medium Dense To Very Dense Gray Silty Fine Sand.	
					37									
20	4	SS	20.0	22.0	12	14	16	24	SM					
					15									
	5	SS	22.0	22.8	12	9/4		9	SM/CL		4.00	22.5	(Coarse Gravel From 22.5 To 23.0 Ft.)	
	6	SS	23.0	25.0	14	18	20	2	CL		>4.5			
25					38									
	7	SS	25.0	27.0	14	20	24	24	CL		>4.5			
					41									
	8	SS	27.0	28.9	18	34	45	24	CL		>4.5		Very Stiff To Hard Gray Silty Clay, Trace Of Fine To Coarse Sand.	
					100/5									
30	9	SS	29.0	30.3	56	90	100/3	15	CL		>4.5			
	10	SS	31.0	32.5	43	82	92	18	CL		>4.5			
												32.5	Bottom Of Boring At 32.5 Ft.	
35														
40														

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BORING LOG

PROJECT No. 87-126-01
BORING No. S-11
LOGGED BY M. Obradovic
PAGE No. 2 of 2

PROJECT NAME WAUKEGAN HARBOR
BORING LOCATION N 4765.9767 E 4674.8341 SURFACE ELEVATION 583.40
DRILLER Fox Drilling, Inc. DATE: START 12/6/88 FINISH 12/7/88

DEPTH	SAMPLE No.	SAMPLE TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0' 6'	BLOW COUNT 6' 12"	BLOW COUNT 12' 18'	REC (in)	USCS SOIL TYPE	WC (%)	qu (TSF)	LAYER DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO
													Notes: 1. Boring Was Advanced By Rotary Wash Method Using A 3-In. Dia. Roller Bit. 2. Ground Water Was Encountered At 4.5 Ft. Below Ground Surface. 3. Upon Completion, Boring Was Backfilled With Cement / Bentonite Grout From 32.5 Ft. To Ground Surface.	

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- Remove Rock Berm & Load Surface with Fore Lift (250 psf)
- Soil Properties

Fill loose clayey sand $\gamma = 90\ lb/ft^3$, $\phi = 30°$, $c = 0$

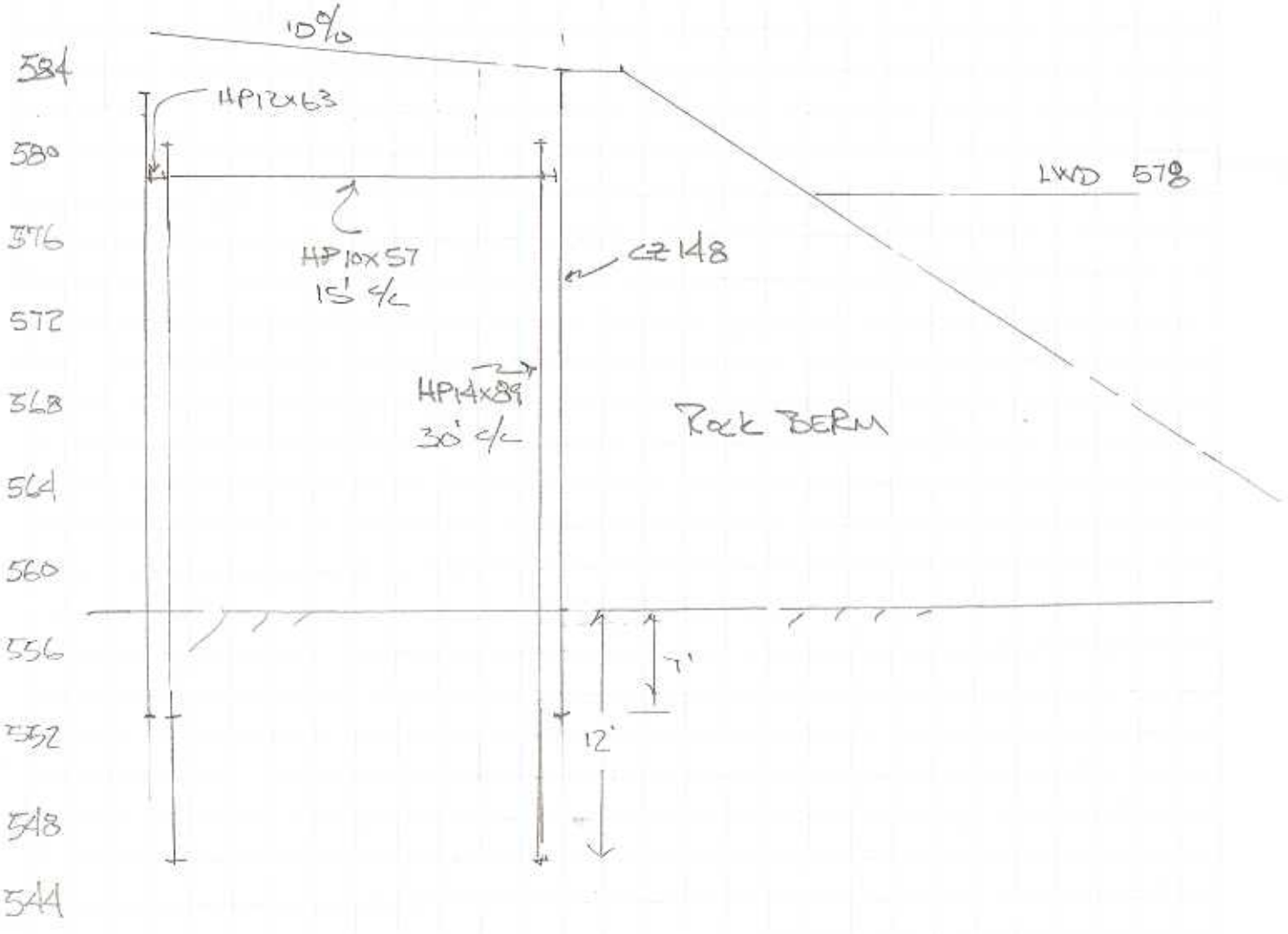
Hard Pan clay till $\gamma = 125\ lb/ft^3$, $\phi = 0°$, $c = 4500\ psf$

1. Water table @ 6 ft below surface
2. Ignore top slope
3. Assume frame & back sheet act as tie rod
4. Tie @ 5 ft from top

Analysis Using SPW-911

PURPOSE: REMOVE STONE & LOWER WALL TOP ELEVATION FOR DRY RACK LAUNCH

- TOP OF SHEETING 584 NAD_{88} (583.5 $IGLD_{85}$)
- @ LWD DISTANCE TO WATER 583.5 − 577.5 = 6.0 FT.



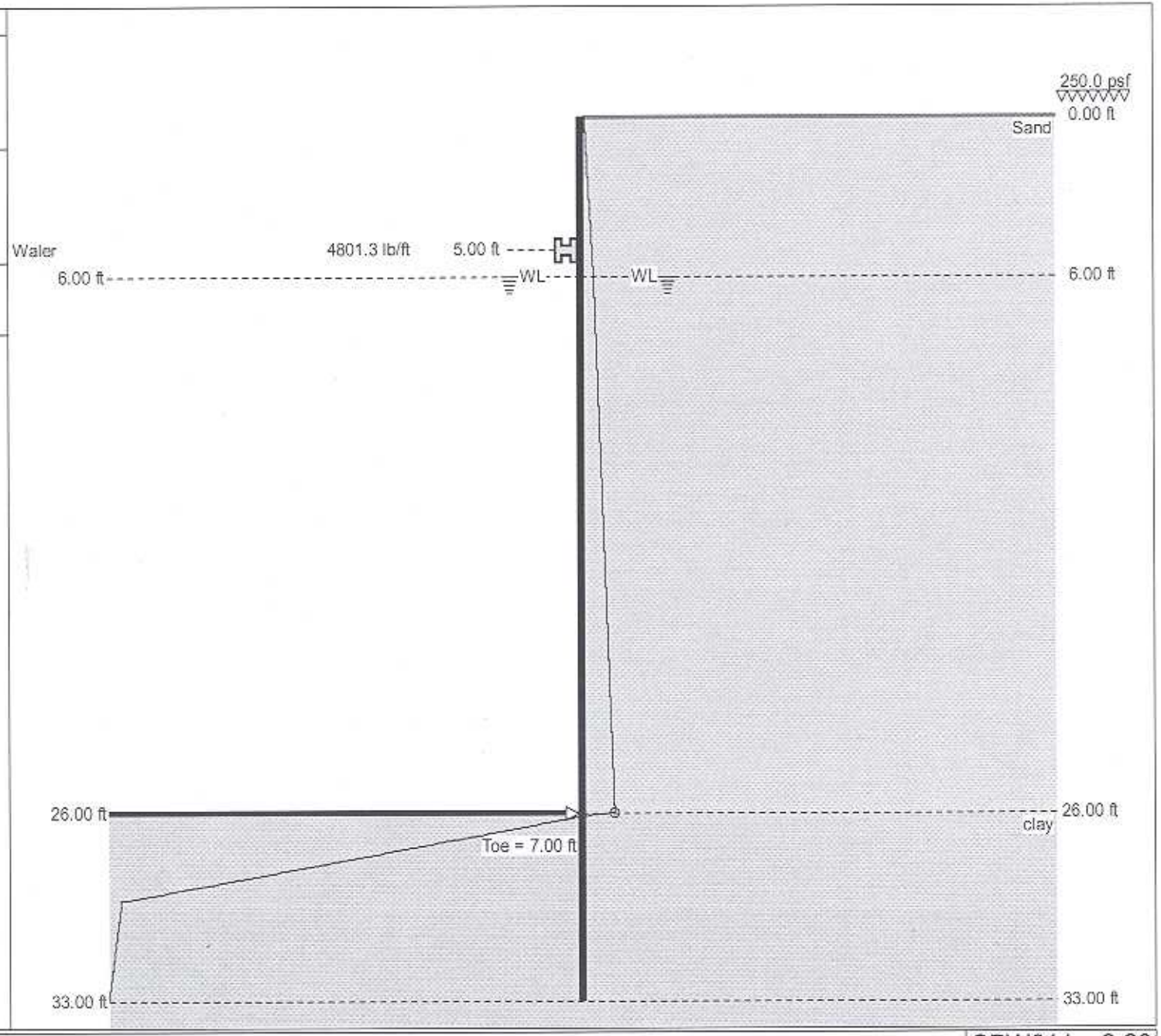
Client: Waukegan Harbor Slip 3 Cutoff

Title: Analysis of Sheeting
Designer: TJH
Ref: 06-001
Page: 1
Date: 4.20.06

Sheet: cz148
Pressure: Rankine; Passive softening ON; Full hydrostatic pressure in cohesive soils.
Toe: Fixed Earth Support

	Maximum	d (ft)
○	630.3 psf	26.00

Analyze impact of stone removal



Harrington Engineering & Construction

SPW911, v2.20

Email: pilebuck@pilebuck.com
Web: www.pilebuck.com

TJH 4-20-06

06-001

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Client: Waukegan Harbor Slip 3 Cutoff

Title: Analysis of Sheeting
Designer: TJH
Ref: 06-001
Page: 2
Date: 4.20.06

Sheet: cz148
Pressure: Rankine; Passive softening ON; Full hydrostatic pressure in cohesive soils.
Toe: Fixed Earth Support

Analyze impact of stone removal

Input Data

Depth Of Excavation = 26.00 ft Depth Of Active Water = 6.00 ft Water Density = 62.43 pcf
Surcharge = 250.0 psf Depth Of Passive Water = 6.00 ft Minimum Fluid Density = 62.43 pcf

Soil Profile Passive Softening Depth = 3.28ft

Depth (ft)	Soil Name	γ (pcf)	γ' (pcf)	C (psf)	C_a (psf)	φ(°)	δ(°)	K_a	K_{ac}	K_p	K_{pc}
0.00	Sand	90.00	56.00	0.0	0.0	30.0	0.0	0.33	0.00	3.00	0.00
26.00	clay	130.00	0.00	4500.0	0.0	0.0	0.0	1.00	2.00	1.00	2.00

Solution

Sheet

Sheet Name	I (in⁴/ft)	E (psi)	Z (in³/ft)	f (psi)	Maximum Bending Moment (ftlb/ft)	Upstand (ft)	Toe (ft)	Pile Length (ft)
cz148	273.90	3.04E+07	40.90	30000.0	102128.2	0.00	7.00	33.00

Load Model: Area Distribution

Supports

Depth (ft)	Type	Linear Load (lb/ft)
5.00	Waler	4801.3

Maxima

	Maximum	Depth
Bending Moment	23871.4 ftlb/ft	16.50 ft
Deflection	0.3 in	16.99 ft
Pressure	630.3 psf	26.00 ft
Shear Force	5169.2 lb/ft	26.12 ft

Harrington Engineering & Construction

SPW911, v2.20

06-001 (31)

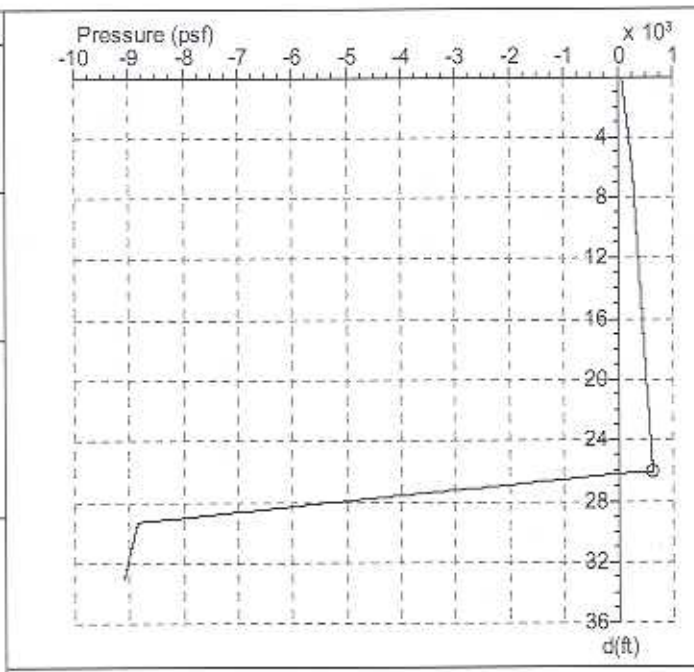
Client: Waukegan Harbor Slip 3 Cutoff

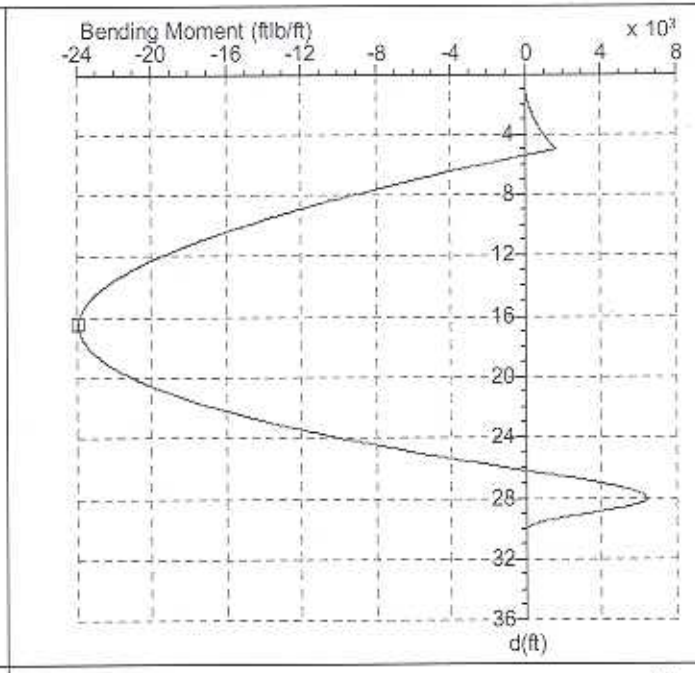
Title: Analysis of Sheeting
Designer: TJH
Ref: 06-001
Page: 3
Date: 4.20.06

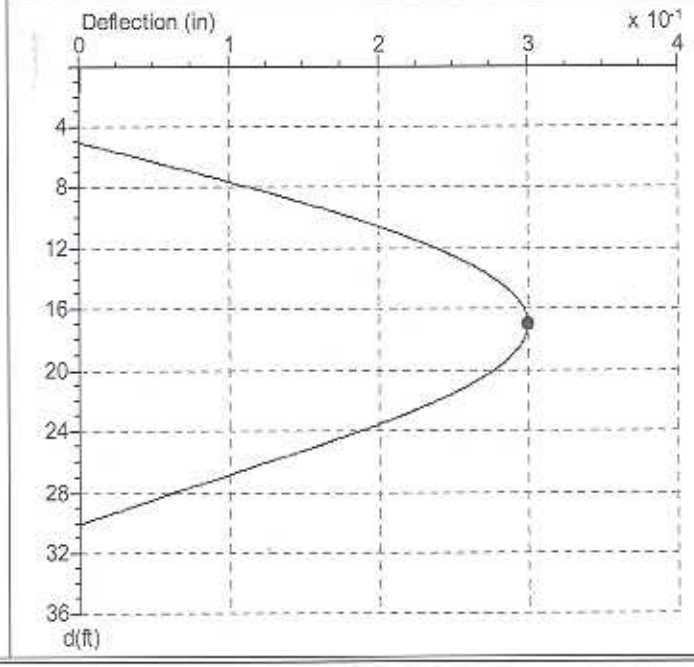
Sheet: cz148
Pressure: Rankine; Passive softening ON; Full hydrostatic pressure in cohesive soils.
Toe: Fixed Earth Support

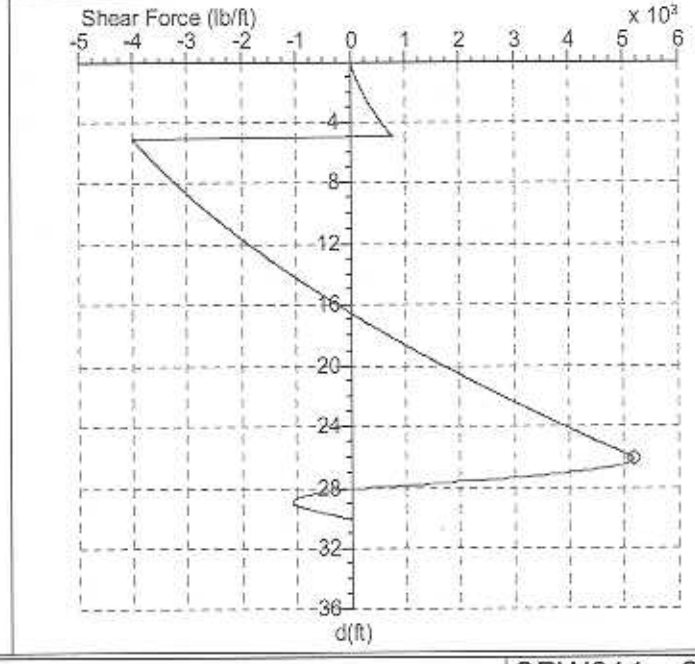
	Maximum	d (ft)
○	630.3 psf	26.00
□	23871.4 ftlb/ft	16.50
◇	5169.2 lb/ft	26.12
●	0.3 in	16.99

Analyze impact of stone removal









Harrington Engineering & Construction

SPW911, v2.20

Client: Waukegan Harbor Slip 3 Cutoff

Title: Analysis of Sheeting
Designer: TJH
Ref: 06-001
Page: 4
Date: 4.20.06

Sheet: cz148
Pressure: Rankine; Passive softening ON; Full hydrostatic pressure in cohesive soils.
Toe: Fixed Earth Support

Analyze impact of stone removal

depth (ft)	P (psf)	M (ftlb/ft)	D (in)	F (lb/ft)
0.00	83.3	0.2	0.0	4.6
0.29	91.5	5.0	0.0	28.7
0.58	100.5	18.5	0.0	57.9
0.88	108.6	38.7	0.0	86.7
1.17	117.6	70.5	0.0	121.1
1.46	126.6	113.2	0.0	158.1
1.75	134.8	162.1	0.0	194.2
2.04	143.8	227.7	0.0	236.4
2.34	151.9	298.9	0.0	277.2
2.63	160.9	390.5	0.0	324.6
2.92	169.9	496.9	0.0	374.8
3.21	178.1	607.2	0.0	422.8
3.50	187.0	744.1	0.0	478.1
3.80	196.0	898.2	0.0	536.2
4.09	204.2	1054.0	0.0	591.3
4.38	213.2	1243.2	0.0	654.6
4.67	221.4	1432.2	0.0	714.4
4.96	230.3	1659.6	0.0	782.9
5.26	239.3	455.6	0.0	-3947.3
5.55	247.5	-619.8	0.0	-3880.3
5.84	256.5	-1781.0	0.0	-3803.9
6.13	263.7	-2918.8	0.0	-3725.0
6.42	268.7	-3932.1	0.1	-3651.8
6.72	274.3	-5023.2	0.1	-3569.5
7.01	279.4	-5993.3	0.1	-3493.3
7.30	285.0	-7036.0	0.1	-3407.9
7.59	290.6	-8052.6	0.1	-3320.7
7.88	295.7	-8953.6	0.1	-3240.1
8.18	301.3	-9918.9	0.1	-3149.7
8.47	306.3	-10772.4	0.1	-3066.1
8.76	311.9	-11684.5	0.1	-2972.5
9.05	317.5	-12568.0	0.2	-2877.2
9.35	322.6	-13345.9	0.2	-2789.1
9.64	328.2	-14173.4	0.2	-2690.6
9.93	333.8	-14970.9	0.2	-2590.4
10.22	338.9	-15669.3	0.2	-2497.9
10.51	344.5	-16407.8	0.2	-2394.4
10.81	349.5	-17051.9	0.2	-2298.9
11.10	355.1	-17729.8	0.2	-2192.3
11.39	360.7	-18375.1	0.2	-2083.9
11.68	365.8	-18933.1	0.2	-1984.0
11.97	371.6	-19514.9	0.2	-1872.4
12.27	377.0	-20062.6	0.2	-1759.1
12.56	382.1	-20530.6	0.3	-1654.7
12.85	387.7	-21011.9	0.3	-1538.2
13.14	392.7	-21418.7	0.3	-1430.8
13.43	398.3	-21831.8	0.3	-1311.1
13.73	403.9	-22208.4	0.3	-1189.6
14.02	409.0	-22518.7	0.3	-1077.8
14.31	414.6	-22824.2	0.3	-953.2
14.60	419.7	-23069.0	0.3	-838.4
14.89	425.3	-23301.6	0.3	-710.5
15.19	430.9	-23495.2	0.3	-580.9
15.48	435.9	-23636.9	0.3	-461.7
15.77	441.5	-23754.7	0.3	-328.9
16.06	447.1	-23832.0	0.3	-194.4
16.35	452.2	-23866.8	0.3	-70.7
16.65	457.8	-23865.5	0.3	67.0
16.94	462.9	-23828.0	0.3	193.7
17.23	468.5	-23746.2	0.3	334.6
17.52	474.1	-23621.4	0.3	477.3
17.81	479.1	-23470.4	0.3	608.4
18.11	484.7	-23262.3	0.3	754.3
18.40	490.3	-23009.9	0.3	901.8
18.69	495.4	-22741.4	0.3	1037.4
18.98	501.0	-22402.7	0.3	1188.2
19.27	506.1	-22055.1	0.3	1326.7
19.57	511.7	-21628.4	0.3	1480.7
19.86	517.3	-21154.8	0.3	1636.4
20.15	522.3	-20683.2	0.3	1779.4
20.44	527.9	-20118.7	0.3	1938.4
20.73	533.0	-19563.6	0.3	2084.3
21.03	538.6	-18906.4	0.3	2246.5
21.32	544.2	-18199.8	0.3	2410.3
21.61	549.3	-17514.3	0.2	2560.7
21.90	554.9	-16712.1	0.2	2727.8
22.19	560.5	-15859.2	0.2	2896.6
22.49	565.5	-15039.2	0.2	3051.5
22.78	571.1	-14087.8	0.2	3223.5
23.07	576.2	-13177.5	0.2	3381.3
23.36	581.8	-12125.8	0.2	3556.5
23.65	587.4	-11020.8	0.2	3733.4
23.95	592.5	-9969.6	0.2	3895.7
24.24	598.1	-8761.5	0.2	4075.9
24.53	603.7	-7498.6	0.2	4257.7
24.82	608.7	-6302.5	0.2	4424.5
25.12	614.3	-4933.6	0.2	4609.5
25.41	619.4	-3640.3	0.1	4779.2
25.70	625.0	-2163.6	0.1	4967.5
25.99	497.9	-629.7	0.1	5153.9
26.28	-440.5	788.6	0.1	5128.4
26.58	-1290.8	2301.2	0.1	4854.8
26.87	-2063.8	3569.7	0.1	4382.9
27.16	-2914.1	4775.8	0.1	3618.4
27.45	-3764.3	5708.2	0.1	2596.6
27.74	-4537.3	6252.8	0.1	1444.5
28.04	-5387.6	6439.6	0.1	-68.3
28.33	-6237.8	5927.1	0.1	-615.5
28.62	-7010.8	4863.3	0.0	-950.1
28.91	-7861.1	3376.3	0.0	-1072.7
29.20	-8634.0	2036.8	0.0	-960.9
29.50	-8862.4	894.7	0.0	-653.0
29.79	-8882.9	211.4	0.0	-329.6
30.08	-8901.4	0.0	0.0	0.0
30.37	-8921.9	0.0	0.0	0.0
30.66	-8942.3	0.0	0.0	0.0
30.96	-8960.9	0.0	0.0	0.0
31.25	-8981.3	0.0	0.0	0.0
31.54	-8999.9	0.0	0.0	0.0
31.83	-9020.4	0.0	0.0	0.0
32.12	-9040.8	0.0	0.0	0.0
32.42	-9059.4	0.0	0.0	0.0
32.71	-9079.8	0.0	0.0	0.0
33.00	-9096.6	0.0	0.0	0.0

Harrington Engineering & Construction

SPW911, v2.20

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APPENDIX B

FIELD SAMPLING PLAN
FOR THE SLIP 3 CONTAINMENT CELL ALTERATION

WAUKEGAN, ILLINOIS

MAY 2006

Prepared For
CITY OF WAUKEGAN

Prepared By

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A HARD HAT SERVICES™ Company

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1.0 Introduction / Objective

This Field Sampling Plan (FSP) is prepared on behalf of the City of Waukegan (City) for the Slip 3 Containment Cell Alteration project. This FSP describes the scope of the investigative sampling to take place at the site. Investigative sampling will be conducted prior to final design of the alteration to Slip 3.

The objectives of the investigative sampling are:

1. To provide data on the extent of PCB's in the overlaying surcharge sand,
2. To determine if surcharge sand can be visually distinguished from underlying sediment, and
3. To provide geotechnical information for design of foundations for a dry-rack storage building to be located on the Slip No. 3 Containment Cell.

1.1 Background

The Slip No. 3 Containment Cell was created and filled with PCB-containing sediments in 1991 and 1992. Two rows of sheet pile were installed across the mouth of Slip No. 3, with the space between filled with a sand-bentonite mix, to isolate the cell from Lake Michigan. An impermeable soil-bentonite cut off wall was installed 20-40 feet behind the existing Slip No. 3 sheet pile walls and tied into the sand-bentonite mix in the double sheet pile wall along the mouth to isolate the cell from local groundwater. The former slip area was then filled with dredged sediments to an elevation of approximately 3 feet below natural grade.

Sand was placed over the dredged sediments to surcharge load the sediment, accelerating the settlement of the sediments. After two years of settling, the surcharge sand was graded for drainage (2% slope on the top of the cap) and a 60-mil high-density polyethylene (HDPE) liner was placed over the surcharge sand. The HDPE liner was overlaid with a geogrid drain layer, geotextile filter fabric, 18 inches of sand, and 6 inches of topsoil. A dewatering system was also installed to maintain groundwater elevation inside the Slip No. 3 Containment Cell lower than the surrounding groundwater. The final elevation of the containment cell cover was approximately 5 feet above the surrounding land, at its highest point.

The City seeks to return the land area above the Slip No. 3 Containment Cell to beneficial use by the neighboring marina (Larsen Marine Services) for indoor/outdoor boat storage. To effect this usage, removal of portions of the surcharge sand, beneath the liner, will be required, as well as the construction of building foundations.

2.0 Investigative Sampling

2.1 Scope

In support of the final design, a total of ten locations will be sampled at the site (refer to Sheet 2 of 5). At each location, a smooth-edge bucket excavator will be used to remove the topsoil and barrier sand and expose the geotextile and HDPE liner. The geotextile fabric, drainage layer and HDPE liner will be cut and removed to the minimum extent necessary for boring operations. Following boring activities, boreholes will be backfilled with soil cuttings or a clean, granular soil up to an elevation of 2 feet below the liner elevation. Between this elevation and the liner, the borehole will be filled with clean granular soil. The liner will be repaired using 60-mil HDPE patch material that will be extrusion welded to the surrounding, undisturbed liner. Repairs will be tested with a soap solution and vacuum box apparatus. Soil cover will be replaced above the liner repairs and compacted with the mini-excavator bucket and tracks and then seeded.

Eight of the ten locations will be sampled using direct-push methods to determine the presence and concentration of PCBs below the liner in both the surcharge sand and the sediment, if encountered. The borings will be advanced to a depth of ten (10) feet below the liner elevation, collecting the soil material in clear acetate tubes. A maximum of 40 samples, five from each boring, will be collected and analyzed for PCBs. The sampled soil will be segregated based on appearance and soil type, in an attempt to differentiate between surcharge sand and sediment.

Two of the ten locations will be sampled using split-spoon methods (ASTM D 1586) to collect geotechnical information. These borings will be advanced from the liner elevation to the Chicago hardpan (25-35 feet below ground surface). Analyses for water content, soil strength, and particle distribution will be performed on samples collected from these borings. This information will be used for final foundation design for the proposed building at the Slip No. 3 Containment Cell.

2.2 Collection Methods and Laboratory Analysis

Prior to collection of samples, sample personnel will don disposable latex or nitrile gloves. New gloves will be used for each non-geotechnical sample collected. Recovered soil from each sample interval will be removed from the clear acetate tubes and composited by thoroughly mixing the soil in a stainless steel mixing bowl, using stainless steel utensils. Clumped material will be broken up prior to mixing. Sampling personnel will then transfer soil to sample jars provided by the contracted analytical laboratory. Reusable sampling equipment will be decontaminated following sample collection as described in Section 2.4 Decontamination Procedures. Soil not sent for laboratory analysis will be containerized and handled as described in the Section 2.5 Investigative-derived Waste.

Sample jars will be labeled to indicate site name, time and date of sample collection, sample location, depth interval of sample, and samplers initials. Samples will be transported to the analytical laboratory under chain-of-custody procedures. Laboratory analysis of samples will be conducted in accordance with USEPA-approved methods. The laboratory performing the analysis will be certified in accordance with the National Environmental Laboratory Accreditations Program.

2.3 Personal Protective Equipment

Site personnel will wear Level D personal protective equipment (PPE) during investigative activities. The following table indicates the level of PPE required during investigative activities.

Activity	Excavation/Backfill	Drilling	Sampling
Hard Hat/Steel Toe Boots	X	X	
Safety Glasses	X	X	X
Tyvek™ Coveralls / Disposable Boot Covers		X*	
Disposable Gloves		X	X

* - Drill crew only

2.4 Decontamination Procedures

A decontamination area will be set up prior to beginning investigative sampling. The area will consist of an open top container underlain by plastic sheeting or similar construction. Tools used for soil sampling will be decontaminated prior to collecting each sample. Stainless steel sampling spoons, knives and bowls will be decontaminated prior to obtaining samples or new equipment will be used for each sample. Direct-push drive tips will be decontaminated prior to advancement of each new acetate sample collection tube.

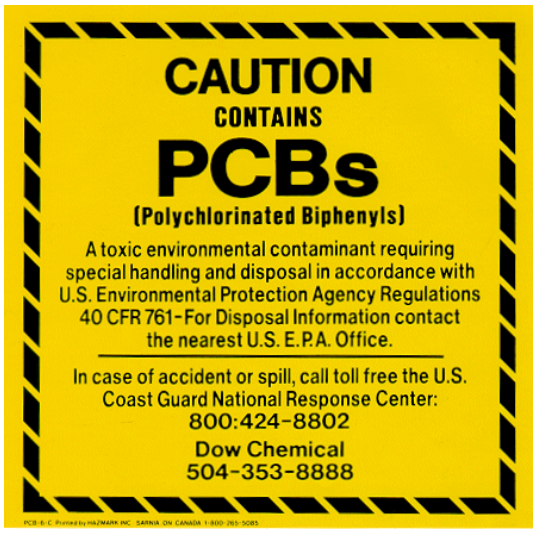
The following decontamination setup for sampling equipment will be provided:

1. A source of potable water will be identified or provided.
2. A washtub will be filled to a depth of about six inches with potable water and Liquinox detergent; the solution will consist of one tablespoon of Liquinox per gallon of water. Equipment will be washed in the solution.
3. Equipment will be rinsed with potable water following the detergent wash.
4. Following the water rinse, the equipment will be rinsed with a 10% methanol solution. Following the methanol rinse, the equipment will be air dried and rinsed again with potable water, placed on a clean sheet of plastic and allowed to dry.
5. All decontamination fluids will be collected and containerized and handled in accordance with the Section entitled “Investigative-derived wastes”.

Drill rig parts exposed to potentially contaminated soils will be cleaned of gross solids using scrapers and stiff bristled brushes. Equipment that cannot be feasibly cleaned using the methods described for sampling equipment will be cleaned with steam. Decontamination fluids and solids will be collected, containerized and handled according to the Section entitled "Investigative-derived Wastes".

2.5 Investigative-derived Wastes

Solid and liquid wastes (including, but not limited to, boring cuttings, decontamination fluids and solids, and PPE) generated from the investigative work will be containerized in 55-gallon drums. The drums will be labeled to indicate the presence of PCBs, the contents, and the date of generation using the following labels or equivalent.



The drums will be sampled for disposal characterization and stored within the former OMC building under the City's custody until the liner replacement work takes place, at which time they will be disposed off-site with PCB-containing soil. Within the OMC building, the drums will be stored in a controlled-access area, under lock and key. Drums will be inspected for integrity on a monthly basis.

3.0 Quality assurance / quality control

Quality Assurance / Quality Control (QA/QC) will be assessed for all aspects of the project, including field, laboratory, and data management activities. A Project Data QA/QC Manager will be designated to perform QA/QC assessments. Analytical results will be provided in a full USEPA Contract Laboratory Program equivalent data package and an electronic data deliverable (EDD). The Project Data QA/QC Manager will review laboratory results to assure that they are complete and that they are validated.

3.1 QA/QC Samples

QA/QC samples will consist of sample duplicates and equipment blanks. Sample duplicates will be collected at a rate of 5% of the total number of environmental samples. Sample duplicates will be prepared by split sampling. Equipment blank samples will be prepared by processing clean sand in the same manner as the environmental samples and will be collected at a rate of 10% the total number of environmental samples.

3.2 Data Validation

The quality of the laboratory test results will be assessed through evaluation of the results of the submitted QA/QC samples and laboratory internal QA/QC results. The laboratory data assessment procedures will consider the following items:

- Analytical Precision - Laboratory precision will be evaluated by calculating the relative percent difference for sample duplicates.

- Analytical Accuracy - Surrogate spikes and laboratory blanks will be reviewed to assess analytical precision. The data validation review will assign data qualifiers to analytical results for samples with surrogate recoveries below established surrogate recovery standards. Depending on the level of recovery, data may be qualified as estimated or unusable, based on low or high surrogate recoveries.

- Positive detections in laboratory blank samples may indicate chemicals introduced into the samples during handling. Site sample chemical detections less than five times the blank sample chemical concentration will be qualified as undetected.

- Positive chemical detections in equipment blank samples will be indicated by qualifying associated chemical data with a QAO internally adopted (E) qualifier to document the equipment blank detection.

- Representativeness - The representativeness review will consider sample preservation and storage procedures followed during the removal action, results of the precision and accuracy evaluation, and sample holding times. Failure of sampling personnel to properly handle Site samples may result in the qualification of data as estimated or unusable. The representativeness review will also consider qualitatively whether

precision or accuracy is sufficient to characterize Site conditions. Analytical data for samples that were not analyzed or extracted within established holding times might be qualified. Samples having PCB sample values above Instrument Detection Limit (IDL) may be flagged as estimated (J) based on the review of all data. Values less than the IDL can be qualified as estimated (UJ) or rejected (R) based on review of all data.

After data has been validated, the Project Data QA/QC Manager will evaluate the results by considering the quality control parameters of precision, accuracy, and representativeness. If data quality indicators do not meet the satisfaction of the Manager, the data may be discarded and re-sampling may occur. The Manager will make this decision after consultation with the other key project personnel.