STS CONSULTANTS

STS Consultants, Ltd.
1035 Kepler Drive
Green Bay, Wisconsin 54311

voice (920) 468-1978
fax (920) 468-3312
web www.stsconsultants.com

January 26, 2007

Mr. William A. Hartman
GW Partners, LLC
P.O. Box 97
Neenah, Wisconsin 54957-0097

Re: Results of Dewatering Rate Study, Fox River OU1 2006 Remedial Action, North Lake Street, Neenah, Wisconsin -- STS Project No. 4-29316A

Dear Mr. Hartman:

STS Consultants, Ltd. (STS) has prepared this letter-report documenting our observations of the 2006 dewatering rate study completed on several geotextile tubes at the Fox River OU1 project located in the town of Menasha, Wisconsin. The objective of the investigation was to evaluate the geotextile tube dewatering rate for sediments from the Fox River. This letter-report provides background information on the purposes of the dewatering study, discusses the instrumentation put in place to monitor the dissipation of excess pore pressures over time, presents the data collected to date, and provides STS's opinion of the results of the investigation.

Background

As part of the 2006 Remedial Action Work Plan, GW Partners committed to the Wisconsin Department of Natural Resources (WDNR) to evaluate the geotextile tube dewatering rate. To achieve this objective, STS proposed to instrument several geotextile tubes with vibrating wire piezometers to measure and record pore pressures, and volumetric water content probes to measure and record soil moisture levels. Theoretically, the piezometers would measure pore pressure dissipation over time, which is assumed to be directly correlated to the dewatering of the geotextile tubes.

Volumetric water content probes typically used in agricultural irrigation were proposed to measure the soil moisture level. Unlike piezometers that measure pore pressure, the probes measure volumetric water content directly. Theoretically the volumetric water content probes should be able to directly measure the water content at a particular time inside the geotextile tube. The data can then be used to correlate the dissipation of pore pressures measured by the vibrating wire transducers.

Following STS initial proposal and prior to implementation, the installation of the volumetric water content probes was eliminated from the study. STS had several conversations with the equipment supplier, Decagon Devices, regarding the installation and use of the ECH2O Moisture Sensors in dewatering applications. The probes are designed to measure volumetric water content of a soil when the soil volume remains constant, and the water content varies from 0 to 100 percent. In the proposed application the water content would essentially remain constant at 100 percent, while the solids content would increase over time as the geotextile tubes were dewatered. The equipment supplier was skeptical that their probes would provide meaningful data under the proposed application. STS was concerned about the installation, durability, and validity of the data collected using the devices under the field conditions anticipated. Ultimately, a decision was made to eliminate the volumetric water content probes from the dewatering study.

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Instrumentation

The piezometers used to instrument the geotextile tubes were vibrating wire piezometers manufactured and supplied by RST. The vibrating wire piezometer is a robust pressure transducer, designed to allow remote measurements of piezometric levels or borehole pressures over extended periods of time. Each piezometer is equipped with a single channel data logger that records the pressure and temperature on a programmable basis, in our case every hour. The piezometers were placed in a 2 to 3-foot section of 1-inch well screen filled with sand and connected to a 10-foot section of well casing. The well screen and casing serves two purposes; 1) it allows the piezometer to measure the pore water pressures within the geotextile tube while preventing the device from clogging, and 2) it protects the piezometer from damage during insertion and removal. Originally, we proposed to install vented piezometers to eliminate the atmospheric pressure variability from the piezometer readings; however, RST recommended using a sealed piezometer instead. RST was concerned about the durability of the vented piezometers in this application because if the vent tubing is kinked, clogged, or absorbs moisture, the piezometer readings are erroneous. Therefore, RST strongly recommended against using a vented piezometer.

One piezometer was installed in each geotextile tube that was monitored for pore pressures. The installation of each piezometer was completed by cutting a small hole in the geotextile tube and carefully inserting the piezometer into place. Photographs 1-7 show the installation of the piezometer in geotextile tube E-A-9. In 2006, a total of six geotextile tubes were instrumented with piezometers, all following the same general procedure.

Observations

A total of six geotextile tubes were instrumented using the piezometers. The piezometers were left in place as long as possible to obtain the maximum number of readings from each installation. The piezometers recorded hourly temperature and pressure readings from each geotextile tube. The single channel data loggers recorded the data and were periodically downloaded. Table 1 provides a summary of the tubes that were monitored using the vibrating wire piezometers.

Table 1 – Summary of Instrumented Geotextile Tubes

Name & Location	Commenced Filling	Ceased Filling	Piezometer Installed	Piezometer Removed
E-A-9	6/30/06	7/11/06	7/13/06	9/28/06
E-D-4	6/30/06	7/11/06	7/13/06	8/18/06
E-B-8	7/11/06	7/25/06	7/28/06	9/28/06
E-C-6	7/25/06	7/27/06	7/28/06	9/28/06
E-A-4 (2nd Filling)	9/22/06	9/27/06	9/28/06	12/3/06
NW-B-4	9/15/06	9/26/06	9/28/06	12/3/06

The tubes were stacked on top of each other, four levels high. One tube from each of the four levels was instrumented, "A" being the bottom level and "D" being the topmost level. Figure 1 – Fox River OU-1 2006 Remedial Action Geotextile Tube Piezometer Data is a graph of the hourly piezometer readings versus time for all of the geotextile tubes that were instrumented. The pore pressure readings show an overall trend in decreasing pore pressure with time, but there was considerable variability between data points most likely due to variations in barometric pressure. We attempted to normalize the data by taking into account the variability in barometric pressure; however, we were unsuccessful in reducing the variability of the pore pressure readings.

Two of the underlying assumptions in our study were that pore pressure and release of pore pressure play a significant roll in dewatering of the geotextile tubes. Based on the anticipated filling height of the geotextile tubes (6 to 7 feet), we expected piezometer readings up to 60 kilopascals. We also expected that stacking geotextile tubes would increase pore pressures in the underlying geotextile tubes and increase consolidation.

The maximum pore pressure reading recorded during the entire investigation from July 13, 2006 until December 2, 2006 was 4.17 kilopascals. It occurred in Piezometer 01957 installed in geotextile tube A-9 on August 11, 2006. That time corresponds to filling of D-8, which was filled from August 10 to August 15. Drawing No. 001 – J.F. Brennan Company, Inc. Pad Sequence shows the arrangement of geotextile tubes and provides the filling dates to compare against the piezometer data. A similar temporary increase in pore pressure but of lower magnitude was observed between July 10 and July 25 when geotextile tubes B-8 and B-9 were being filled. The magnitude of the change between July 10 and July 25 was less than 1 kilopascal. Similar changes in pore pressures were observed between September 3 and September 24 when filling was taking place in another location on the dewatering pad. So although changes in the pore pressure readings can be correlated between instrumented geotextile tubes and the filling of geotextile tubes above them, all of the pore pressure changes recorded cannot be explained.

Both assumptions appear to be valid, but the data did not reflect the magnitudes expected. The maximum piezometer readings observed in the field were less than 5 kilopascals, more than an order of magnitude less than expected. Additionally, the piezometer readings showed a corresponding increase in pore pressure due to filling the geotextile tubes above the instrumented tube; however, the recorded increase in pore pressures were not consistent, in that the increases are relatively small, and we were not able to distinguish from the data when or if dewatering had been completed.

Conclusions and Opinion

To date, the length of time each geotextile tube is allowed to dewater on the dewatering pad is a function of the space requirements needed to maintain dredging rather than achieving optimum dewatering. STS instrumented several geotextile tubes to monitor pore pressure dissipation to develop a graph of pore pressure dissipation versus time in an attempt to optimize dewatering. In general, the results were as expected, a temporary increase in pore pressure can be correlated to the filling of geotextile tubes above the instrumented tube and pore pressure readings decreasing over time as the geotextile tubes dewatered. However, the magnitude of the pore pressures observed in the geotextile tubes was more than an order of magnitude lower than expected, making it difficult to distinguish changes in pore pressure due to loading or changes in pore pressure due to barometric pressure.

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Based on our field observations and the pore pressure data collected from the geotextile tubes, it is STS' opinion that dewatering continues over time but only to the extent that sediment can gravity drain through the geotextile tube. The observed pore pressures of geotextile tubes in the first, second, third, or top layer were all in the same range, typically 2-3 kilopascals and the optimization of geotextile tube dewatering based on pore pressure data is not practical using the instruments employed with our study.

If you have any questions regarding the study, please contact Mr. John Trast at STS.

Sincerely,

STS CONSULTANTS, LTD.

John M. Trast, P.E.
Senior Project Engineer

Jeanne M. Tarvin, CPG, P.G.
Senior Principal – Hydrogeologist

JXT/jxt

Attachments:
- Piezometer Photographic Log
- Figure 1: Fox River OU-1 2006 Remedial Action Geotextile Tube Piezometer Data
- Drawing No. 001 – J.F. Brennan Company, Inc. Pad Sequence

Photograph 1 – Geotextile Tube E-A-9 on July 13, 2006

Photograph 2 – Cutting a small hole in geotextile tube to insert piezometer.

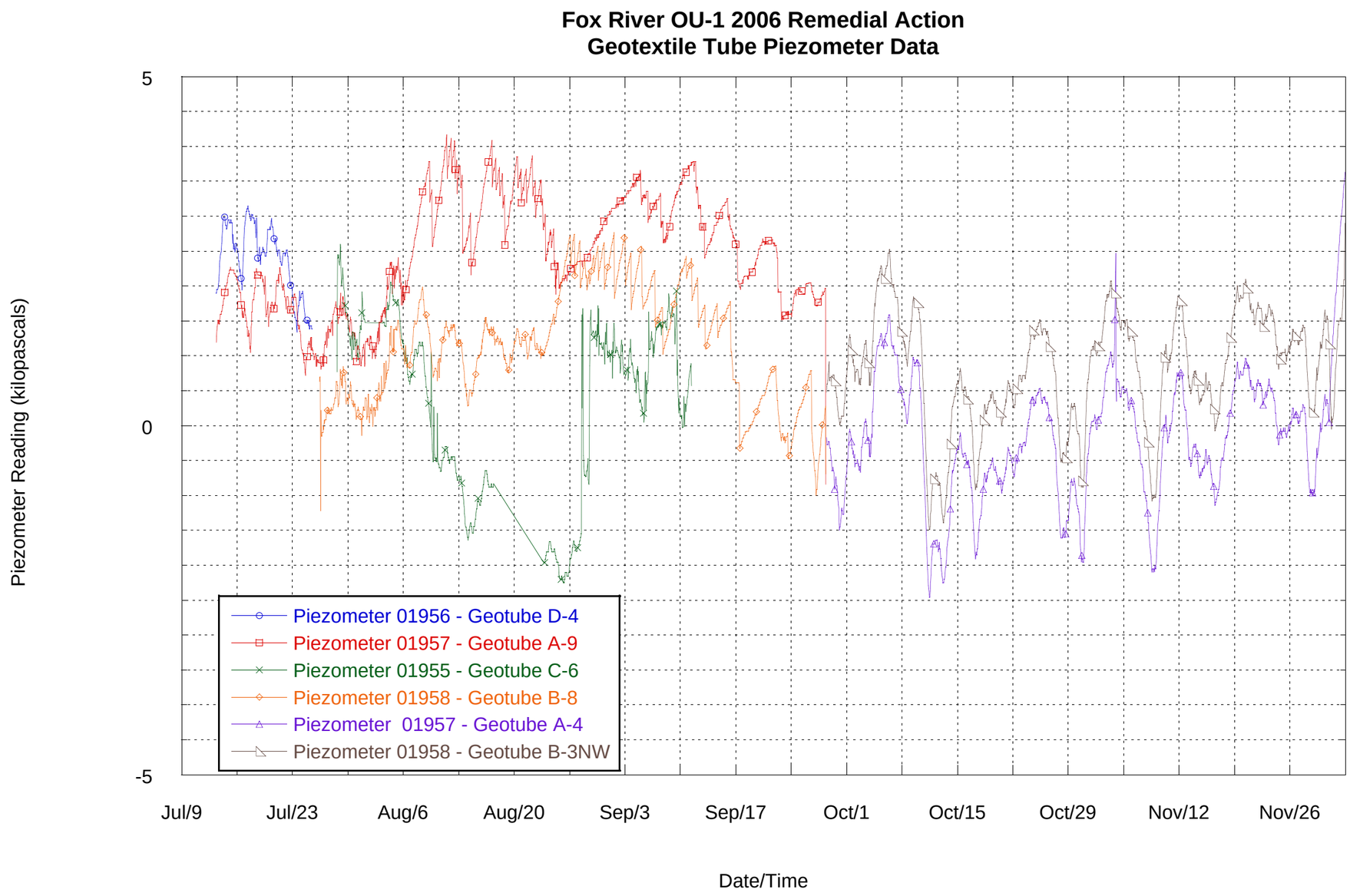
Photograph 3 – Inserting the piezometer.

Photograph 4 – Inserting the piezometer.

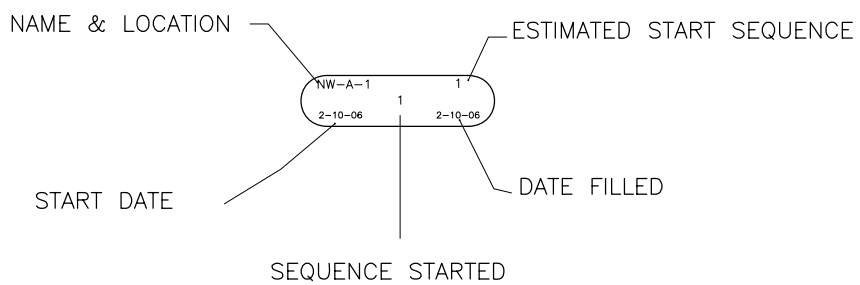
Photograph 5 – Geotextile Tube E-A-9 after installation.

Photograph 6 – The installed piezometer with datalogger.

Photograph 7 – Geotextile Tube E-A-9 on July 26, 2006.


Fox River OU-1 2006 Remedial Action
Geotextile Tube Piezometer Data
Piezometer Reading (kilopascals)
5
0
-5
Jul/9
Jul/23
Aug/6
Aug/20
Sep/3
Sep/17
Oct/1
Oct/15
Oct/29
Nov/12
Nov/26
Date/Time
Piezometer 01956 - Geotube D-4
Piezometer 01957 - Geotube A-9
Piezometer 01955 - Geotube C-6
Piezometer 01958 - Geotube B-8
Piezometer 01957 - Geotube A-4
Piezometer 01958 - Geotube B-3NW

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

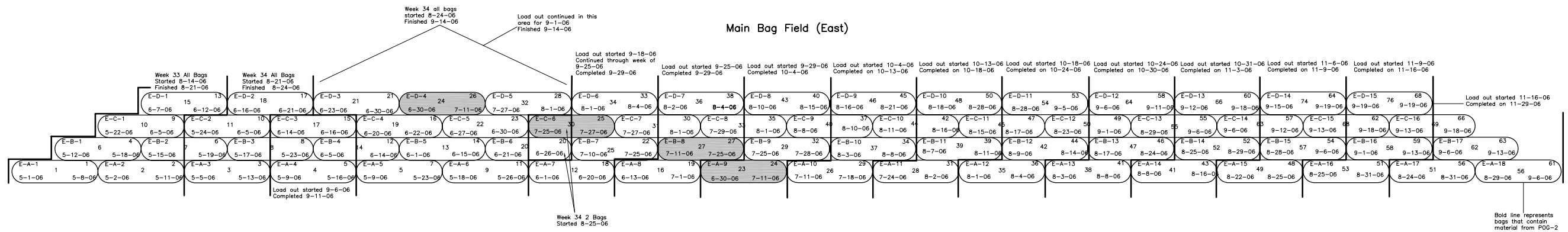


First Day of Geotube Removal

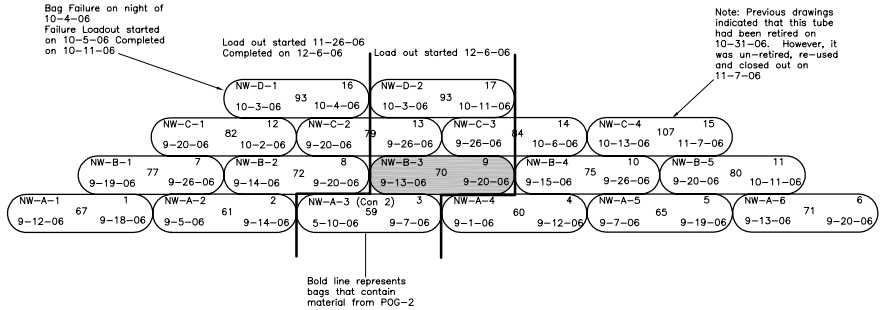
Load out
6-6-06
6-13-06
7-11-06
7-25-06
8-11-06 1/2 Day
8-14-06 to 8-18-06
8-21-06 to 8-25-06
8-28-06 to 8-31-06
9-1-06 to 9-8-06
9-11-06 to 9-15-06
9-18-06 to 9-22-06
9-25-06 to 9-29-06

Load out Cont.
9-29-06 to 10-4-06
10-5-06 to 10-13-06
10-13-06 to 10-18-06
10-18-06 to 10-24-06
10-24-06 to 10-30-06
10-30-06 to 11-3-06
11-6-06 to 11-9-06
11-9-06 to 11-16-06
11-16-06 to 11-29-06
11-29-06 to 12-6-06
12-6-06 to

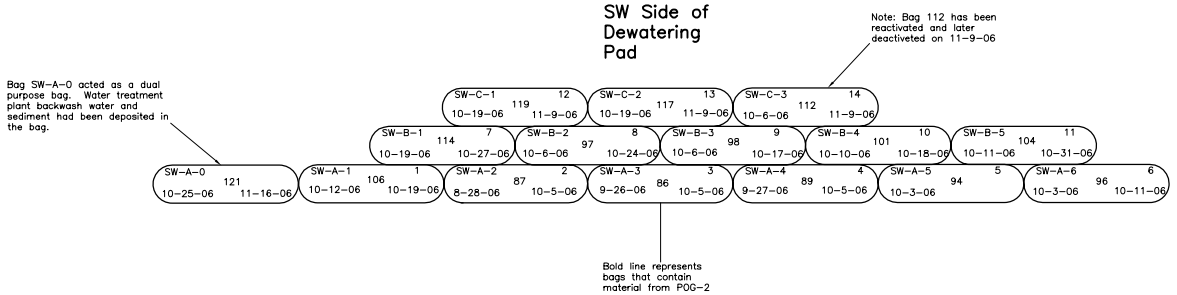
Main Bag Field (East)



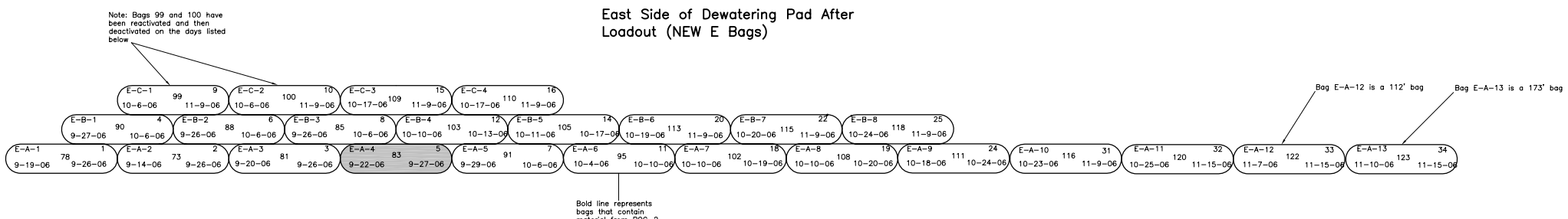
NW Side of Dewatering Pad

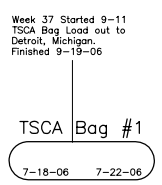


SW Side of Dewatering Pad



East Side of Dewatering Pad After Loadout (NEW E Bags)





BRENNAN
"Marine Professionals"
La Crosse, WI

J. F. BRENNAN CO., INC.

PAD SEQUENCE

DRAWN BY: GMS	ENGR:
Updated By: MRB	DATE: 12-7-06
SCALE: NTS	SIZE: ANSI D
DWG NO. 001	REV: