TECHNICAL MEMO:

FAR FIELD SURVEYS OF SUSPENDED SEDIMENT PLUMES ASSOCIATED WITH HARBOR DEEPENING DREDGING IN NEWARK BAY

S-E-1 Contract Area

(Port Elizabeth Channel)
Survey #1 & #2

Prepared for

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1.0 INTRODUCTION

The resuspension of bottom sediments within aquatic habitats may be induced by a variety of events both natural and anthropogenic. Naturally occurring storms or tidal flows, for example, will influence suspended sediment concentrations within the water column although the scope, timing, duration and intensity of the resuspension may differ from that caused by human activities (Wilber & Clarke 2001). Information on the extent and nature of suspended sediment plumes generated by dredge activities, therefore, is critical to enhance the understanding of sediment transport processes and associated environmental concerns (Puckette 1998).

As part of U.S. Army Corps of Engineers New York District's (USACE-NYD) Harbor-wide Water Quality/Total Suspended Solids (WQ/TSS) Monitoring Program, two (2) far field WQ/TSS surveys were conducted during the weeks of 29 March and 26 April 2009 within the immediate vicinity of Elizabeth Channel near its junction with the Main Channel in Newark Bay, New Jersey. The objective of these far field surveys was to assess the spatial extent and temporal dynamics of suspended sediment plumes associated with mechanical dredging of fine-grained sediment and were consistent with methodology used during previous far field sampling events conducted by USACE-NYD within Newark Bay (USACE 2007a, USACE 2008 and USACE 2009).

Mobile surveys were conducted using a vessel-mounted Acoustic Doppler Current Profiler (ADCP) and consisted of predetermined parallel transects run perpendicular to the axis of the suspended sediment plume. Transects were conducted adjacent to and down-current of the active dredge operation and were run such that the entire spatial extent of the plume's acoustic signature (i.e., the detectable signature above ambient backscatter) was recorded. In addition to the mobile ADCP surveys, turbidity measurements were recorded at multiple fixed locations and at various water depths using optical backscatter sensors (OBS) hung in the water column using an anchor and buoy array. The fixed arrays were deployed at both ambient and down-current of the plume locations with the object to determine the spatial extent of the plume within the channel and beyond the channel boundaries. To establish the calibration for the ADCP backscatter, water samples were collected to directly measure TSS concentration (gravimetric analysis) and turbidity across the broadest possible range of tidal and concentration gradients.

1.1 Study Area & Dredge Plant

Far field WQ/TSS surveys were conducted in the vicinity of an active dredge operating within the S-E-1 Contract Area of the Harbor Deepening Project (HDP) during the weeks of 29 March 2009 (S-E-1 Farfield Survey A) and 26 April 2009 (S-E-1 Farfield Survey B). For all surveys, the dredge plant was situated on the eastern end of Elizabeth Channel between Port Newark Pierhead Channel and the entrance of Elizabeth Channel into the Newark Bay Middle Reach. During the week of 29 March, the dredge was located on the northern side of Elizabeth Channel between the Red “2” and Red “4” navigation buoys while during the week of 26 April it was oriented on the southern side of the channel next to the Port Elizabeth Marine Terminal for four (4) surveys, and on the northern side for the last two surveys conducted on 29 April and 01 May (Figure 1). This is a high volume vessel traffic area frequented by tugs and barges as well as large deep draft commercial vessels including container ships and car carriers.

Port Elizabeth Channel is approximately 300 meters wide and on its eastern end it is flanked to the north by flats just east of the Port Newark Pierhead Channel with prevailing depths of less than two meters. This shallow water area is bounded by channels on all four sides including Elizabeth Channel to the south, Newark Bay Middle Reach to the east, Port Newark Branch Channel to the north and the narrow Port Newark Pierhead Channel to the west which connects Elizabeth Channel to Port Newark Branch Channel..

The dredge contractor for this study was Donjon Marine Company, Inc. (Donjon), operating the Dredge Delaware Bay configured with an eight (8) cubic-yard capacity Cable Arm Environmental Bucket (S/N: 05406). This bucket features an over-square design with greater width than length to reduce sediment loss during bucket closing. In contrast to conventional “grab” buckets, the Cable Arm environmental bucket produces a relatively level cut when removing bottom sediment, thereby enhancing vertical as well as horizontal control. In addition, overlapping steel side plates with rubber seals reduce sediment squeezing out of the side known as windrowing. Rubber flaps on the face of the bucket allow air to escape during descent while sealing the top during ascent, thereby slowing the inflow of water and reducing the loss of material due to washout. In addition to the use of an environmental bucket, best management practices (BMPs) were employed by the dredge contractor to reduce overall sediment resuspension. BMPs included restriction of bucket hoist speed to no more than two feet per second and the use of dredging instrumentation and software to ensure full bucket closure.

2.0 METHODS

2.1 Hydrodynamic Survey

Hydrodynamic conditions within Elizabeth Channel and its immediate vicinity were assessed during both an ebb (02 April) and flood tide (30 April) using a vessel-mounted Teledyne RD Instruments 1200-kHz Workhorse Monitor Series ADCP. The surveys were conducted during periods of non-dredging and incorporated Elizabeth Channel and portions of the Port Newark Pierhead Channel and Newark Bay Middle Reach. The mobile transects were conducted perpendicular to the Elizabeth Channel. Transects began at the western end of the Elizabeth Channel and continued to the Newark Bay Middle Reach. Transect lines were spaced approximately 50 meters apart and were towed at a boat speed of between 2.0 and 2.5 meters/second (m/s).

ADCP data provided a characterization of prevailing hydrodynamic conditions within the area of the Port Elizabeth Channel. Raw data from the hydrodynamic surveys were processed and examined for evidence of stratified flows, tidal eddies, and other patterns that could influence plume dispersion.

2.2 Survey Design of Mobile ADCP Transects

Suspended sediment plumes were also characterized using the ADCP. In the field, RD Instruments WinRiver software was used for real-time display of plume acoustic signatures and data recording. The ADCP operates by emitting acoustic pulses into the water column at set time intervals. Each group of pulses, referred to as an "ensemble," is vertically stratified into discrete, fixed-depth increments, or "bins." The number of bins and size of each bin is a configurable operation parameter of the instrument. In this study, 40 bins of 0.5-meter depth were used, for a maximum profile range of 20 meters. After the instrument emits a pulse, the ADCP then "listens" for the return of any sound (i.e. backscatter) that has been reflected from particles in the water column (in this case, a "particle" is any acoustic reflector, including sediment, plankton, fish, air bubbles etc.). Once the instrument receives the reflected signals, the instrument software can calculate the three-dimensional movement of particles in the water column and thus determine water velocity in each bin. Furthermore, if water samples are collected concurrently, suspended sediment concentration can be determined using additional software and analyses (see Sediview Calibration below). Navigation data and dredge operational data (e.g. barge position, bucket position and bucket open/closed) were collected concurrently by the dredge contractor and integrated during post-processing of data. To cover a range of tidal conditions, ADCP backscatter data were collected during various stages of ebb and flood tides during both surveys.

Prior to initiating the mobile plume surveys, circular transects using the ADCP were conducted around the actively operating dredge to both fix the GPS location of the dredge platform and to assess the location and acoustic strength of the plume, if any. Subsequent ADCP transects were generally oriented in a direction perpendicular to the channel and extended down-current until the plume's acoustic signatures could no longer be detected against background conditions. Background conditions on the days of the surveys were determined by conducting ambient transects up-current of the plume and outside the dredging area. Individual transect length was generally determined by bathymetry at the site, but always with the objective of extending beyond the detectable boundaries of the plume. The number, and consequently spacing, of cross-plume transects were maximized within each designated tidal phase in order to provide complete spatial coverage of the detectable plumes and optimal resolution of internal plume structure.

Results for the mobile ADCP plume transects are presented graphically in three ways:

- Vertical Profile Plots – Vertical cross-section profiles representing individual transects are examined in detail for TSS concentration gradient structure of the plume at known distances from the source.

- Plan View Plots – TSS concentrations are presented as composite horizontal "slices" through the plume signature at two meter depth increments.

- Three-dimensional Plot Depiction – Selected transects are plotted three dimensionally in X, Y, and Z (depth) coordinates and superimposed on the existing bathymetry to show the spatial extent of the plume within the channel (note: the Z axis is exaggerated to show detail better since the X,Y spatial extents are much larger then the Z extents). Channel bathymetry was obtained during dredge contract pre-dredge surveys and, when unavailable, from ADCP data collected during the far field survey.

For all figures, unless otherwise noted, estimates of TSS concentrations above ambient are assumed to be associated with dredging activities.

It is important to note that the ADCP cannot accurately collect data throughout the entire water column. The portion of the water column directly below the surface and directly above the bottom is difficult or impossible to sample accurately due to the blanking distance and sidelobe effects (as described below), respectively. Data are lost near the surface because the ADCP cannot obtain data from immediately in front of its transducers (in addition to the water above the immersion depth of the instrument itself). This blanking distance is user-definable with limitations imposed by the operating frequency of the ADCP. For the 1200kHz ADCP used in this survey, the minimum blanking distance is approximately 0.5 meters.

Data lost near the seabed results from interference of the ADCP signal by acoustic "echoes" reflected from the seabed. The ADCP emits most of its acoustic energy in a very narrowly confined beam; however a small amount of energy is emitted at angles far greater than that of the main lobe. These "side lobes", despite their low power, can contaminate the echo from the main lobe, typically in the area directly above the seabed. The net effect of this side lobe interference is to show erroneously high backscatter from the near-seabed areas. This effect is exacerbated in vessel-mounted surveys when the seabed elevation changes rapidly (e.g. during the transition from the shallows to the channel areas or vice-versa).

2.3 Design of Fixed Station Turbidity Survey

In addition to the mobile ADCP surveys described above, turbidity measurements were recorded at fixed locations and at various water depths using Campbell Scientific, Inc.'s (formerly D&A Instrument Company) OBS-3A turbidity sensors tethered to a taut line and anchored at predetermined depths using a fixed anchor and buoy array. Optical backscatter sensors (OBS) project a beam of near-infrared light into the water, and measure the amount of light reflected back from suspended particles. The OBS units used in this survey were pre-calibrated by the manufacturer against known turbidity standards and were programmed to measure turbidities in the 0-1,000 Nephelometric Turbidity Unit (NTU) range. The OBS units deployed during the fixed station survey were configured to output depth (mean + standard deviation, in meters), turbidity (mean + standard deviation, in NTU), temperature (°C), salinity (ppt), conductivity (mS/cm) and battery level (V). Readings were logged internally every 10 seconds at a rate of 25 samples per second for duration of 5 seconds. That is, every 10 seconds the OBS recorded 125 samples (25 samples/sec x 5 sec). All internally recorded data were retrieved from the units at the end of the survey.

A total of three (3) fixed station turbidity surveys were conducted including one flood tide survey on 02 April and two during an ebb tide on 28 April and 30 April. During each of these fixed station turbidity surveys, a total of three fixed arrays were deployed (one ambient and two down-current of the plume). The ambient array consisted of one OBS unit tethered at mid-depth while each of the down-current arrays consisted of two OBS units each tethered at near surface and near bottom based on water depth. It is assumed for purposes of this study that the ambient suspended sediment concentration is homogenously distributed throughout the water column. Each of the fixed arrays (both ambient and down-current) were located within the vicinity of the active dredge operation (no more than 150 meters away to start). The down-current arrays were positioned within the channel at various locations with the objective to examine turbidity structure within the plume at varying distances from the dredge.

2.4 Water Sample Collection

During the far field survey, water samples were collected to directly measure TSS concentrations (mg/L) and turbidity (NTU) throughout the water column. The water samples were collected from a survey vessel using a Sea-Bird Electronics SBE32C Compact Carousel Water Sampler equipped with six 1.7L Nisken sample bottles. A Campbell Scientific, Inc. OBS-3A optical backscatter sensor was also mounted to the Carousel Sampler and hardwired directly to an onboard laptop. The OBS unit provided real-time depth, temperature, salinity and turbidity values of the entire water profile. The Carousel Sampler was also hardwired to an onboard laptop and featured a magnetically-actuated lanyard release system used to remotely “fire” the sample bottles. A custom application recorded the exact time that each bottle fired to the nearest second.

All of the water samples collected in the field were processed in the laboratory by Test America Laboratories, Inc. for optical turbidity (Method SM 2130-B) and for the gravimetric analysis of TSS concentration (Method SM 2540-D). The laboratory results were then used to provide a robust calibration data set to convert the raw ADCP backscatter measurements to estimates of TSS concentration using the Sediview methodology and software as further described below.

2.5 Sediview Calibration

Following the field data collection effort, the raw acoustic backscatter measurements collected by the ADCP were converted to estimates of suspended sediment concentration using Sediview Software provided by Dredging Research, Ltd. The Sediview Method (Land and Bray 2000) derives estimates of suspended solids concentration in each ADCP data bin by converting relative backscatter intensity to TSS concentration. This process requires collecting a calibration data set consisting of discrete water samples and concurrently recorded ADCP acoustic backscatter data. The degree of confidence that can be placed in the estimates of TSS is proportional to the strength of the calibration data set. The quality of the calibration is in turn dependent on the collection of adequate water samples to represent sediments in suspension at all depths in the water column and across the entire gradient of concentrations occurring in ambient as well as plume conditions.

Samples were collected at known locations within the water column, so that individual gravimetric samples could be directly compared with acoustic estimates of TSS concentration for a “bin” of water as close to the water sample as possible. Following the Sediview calibration, the results were then applied to all of the ADCP files recorded during each of the far-field surveys, resulting in an ADCP-derived estimate of TSS concentration for each recorded ADCP bin for an individual far-field survey. Note, however, that not all of the water samples collected were used in the Sediview calibration; some samples were excluded, for example, if they exhibited excessively high TSS caused by the disturbance of bottom sediment by the Carousel Sampler (i.e. the Carousel apparatus impacts the sea floor) or if the ADCP backscatter exhibited signs of air bubble contamination (e.g. air bubbles will show as extremely high backscatter/TSS estimates but the corresponding water sample for that time/position is relatively low) or interference (e.g. the ADCP beam(s) reflect off the carousel sampler apparatus itself, causing an erroneously high reading).

Because air is injected into the water column as the bucket breaks the air-water interface, and air bubbles are acoustic reflectors, care was exercised in converting acoustic data derived very close to the operating bucket. Air bubbles dissipate by rising to the surface with time. The distance down-current of bubble interference of the signal is therefore influenced by current velocities. During the present study, current flows were relatively slow to moderate, consistent with flows observed in the Providence River where a closed bucket was monitored during maintenance dredging operations (Reine *et al*. 2006). Experiments during the Providence River monitoring, in which the bucket was intentionally plunged through the air-water interface without removing sediment from the bottom, determined that the "bubble signature" pattern dissipated within approximately 50 meters of the source. Beyond 50 meters estimates of TSS concentration for the calibrated ADCP should be accurate.

2.6 Sediment Sample Collection

When possible, *in situ* sediment samples were collected once per day from the dredge scow and the sediment bed using a ponar grab sampler. These samples were analyzed in the laboratory by Test America Laboratories, Inc. for sediment grain size distribution (ASTM D-422 Method), bulk density (ASTM D-2937 Method) and Atterberg Limits (ASTM D-4318 Method).

3.0 RESULTS

3.1 Hydrodynamic Survey

Hydrodynamic conditions within Elizabeth Channel and its immediate vicinity were assessed during both an ebb (02 April) and flood tide (30 April). The surveys were conducted during periods of non-dredging and incorporated Elizabeth Channel and adjacent portions of the Port Newark Pierhead Channel and Newark Bay Middle Reach. The mobile ADCP transects were conducted with a north to south, south to north orientation, perpendicular to Elizabeth Channel. Transects began at the western end of the Elizabeth Channel and continued to the Newark Bay Middle Reach.

3.1.1 Ebb Tide (02 April 2009)

Figure 2a presents the results of the hydrodynamic survey conducted on 02 April 2009 during an ebb tide. Transects were conducted from approximately 14:46 to 18:09 during the middle of an ebb tide predicted to reach a low tide slack water at 20:20.

During the ebb tide survey, depth averaged current velocities within the area ranged between 0.0 m/s and up to approximately 0.35 m/s (Figure 2a). Within the western portion of the Elizabeth Channel, currents were minimal and typically less than 0.05 m/s. Approaching the Port Newark Pierhead Channel from the Elizabeth Channel current velocities increased and generally headed south and east toward the Newark Bay Middle Reach. The Newark Bay Middle Reach had the highest current velocities within the survey area and were directed in a southerly direction during the ebb tide. Immediately south of the flats just east of the Port Newark Pierhead Channel, along the north side of the Elizabeth Channel, currents were found to be slower than those on the south side of the channel, likely due to the flats in the area.

3.1.2 Flood Tide (30 April 2009)

Figure 2b presents the results of the hydrodynamic survey conducted on 30 April 2009 during a flood tide. Transects were conducted from approximately 09:15 to 12:54 during the middle of a flood tide predicted to reach peak high water at 13:44.

During the flood tide survey, depth averaged current velocities within the area ranged between 0.0 m/s and up to approximately 0.25 m/s (Figure 2b). Within the majority of the Elizabeth Channel, currents were minimal and typically less than 0.05 m/s, similar to current velocities observed during the ebb tide. In the northern portion of Elizabeth Channel from the Port Newark Pierhead channel east to the Newark Bay Middle Reach currents were higher than the rest of the channel and were recorded up to 0.25 m/s (Figure 2b).

3.2 S-E-1 Farfield Survey A (Week of 29 March 2009)

3.2.1 Ambient conditions

It is important to consider that no single TSS measurement adequately represents ambient conditions; instead a range of samples variable with regard to depth and tidal conditions is a better representation of the dynamic nature of suspended sediment concentration. On 29 March 2009, a total of 22 ambient water samples were collected at various depths and later analyzed in the laboratory for TSS and turbidity (Table 1). Ambient turbidity values ranged from 2.4 to 12.6 NTU with TSS values ranging between 8 and 32 mg/L. The average gravimetric estimate of TSS concentration based on the 22 ambient water samples was 16.7 mg/L. For graphical purposes, in this study, all acoustically estimated

TSS concentrations greater than 24 mg/L (the highest ambient TSS value used in the Sediview calibration) are herein considered above background and attributable to the dredging-induced plume unless otherwise noted, e.g., clearly attributable to air entrainment from the bucket, vessel prop wash, or from other sources of resuspension such as tug and ship plumes (see Sediview calibration methods, Section 2.5, for further information).

3.2.2 Mobile ADCP Surveys

3.2.2.1 March 31, 2009 – Ebb

The 31 March mobile ADCP plume characterization was completed during the second half of an ebbing tide from approximately 14:55 to 17:05. The survey consisted of one circular transect (Figure 3a), three ambient transects (Figures 3b through 3d) and two sets of down-current transects. The first set consisted of six down-current transects (Figures 3e through 3j) while the second set (Figures 4a through 4e) consisted of five down-current transects. A summary of each of the graphically represented transects is presented in Table 2.

To examine the spatial extent of the plume, a series of plan-view layouts of the ADCP transects depicting estimates of TSS concentrations in two meter depth intervals averaged increments are given in Figures 5a through 5h for the first set and Figures 6a through 6g for the second set. For this survey, as shown in both sets of plan-view figures, the dredge was located on the north side of Elizabeth Channel approximately mid-way between the Red #2 and Red #4 navigation buoys. Ambient transects were conducted west of the dredge platform while down-current transects were south of the dredge and oriented parallel to the channel. Figure 7a and 7b provide a three-dimensional depiction of average TSS values for selected representative transects superimposed on existing channel bathymetry while Figure 8 depicts the average TSS in the same manner, but for the second set of transects.

In the first set of down-current transects, conducted between 14:55 to 16:20, estimated TSS concentration signatures above ambient (24 mg/L) associated with the dredging operation was primarily limited to within the first 100 meters down-current of the dredge. Peak estimated TSS concentrations were between 150 and 200 mg/L near the surface of the water, and between 100 and 150 mg/L near the bottom at approximately 34 meters down-current (Figure 3e). Down-current of transect T04 (102 meters from the dredge) estimated TSS concentrations were only slightly higher than ambient conditions (30-40 mg/L) in localized areas along the surface and bottom substrate.

The plume in transects T01 through T04 appeared to range between 200 and 300 meters wide. However, it is important to note that this is not necessarily the true width of the plume as can be seen more accurately in the TSS profile plots (Figures 5a through 5h). As noted earlier, the down-curent transects were run parallel to the channel and did not bisect the plume perpendicularly. Rather, the plume was bisected at an angle which made the plume appear wider in the vertical profiles, especially along the bottom and surface.

During the second set of down-current transects conducted between 16:30 and 17:05 (Figures 4a through 4e), a strong plume signature was not recorded, although portions of the water column sampled were slightly above ambient conditions (30 to 40 mg/L). These trace signatures may be a result of dissipating remnants of the previously recorded dredge plume or are possibly due to natural flow of TSS along the bottom, as their occurrence was sporadic and did not appear to follow the pattern of the plume recorded earlier. Four of the five down-current transects were conducted in the same directional orientation as the first set, that is, parallel with the Elizabeth Channel. However, the final transect (T11) was conducted perpendicular to Elizabeth Channel, directly east of the dredge, in order to establish the boundary of the plume. In this transect, TSS concentrations of a maximum 60 to 70 mg/L were detected along the very bottom (Figure 4e).

3.2.2.2 April 01, 2009 - Flood

A mobile ADCP plume characterization survey was conducted on 1 April 2009 during the second half of a flood tide from approximately 09:30 through 11:20. The survey consisted of two circular transects (Figures 9a and 9b), three ambient transects (Figures 9c through 9e) and three sets of down-current transects (Table 3). The first set consisted of six down-current transects (Figures 9f through 9k), the second set (Figures 10a through 10h) consisted of eight down-current transects and the final set (Figures 11a through 11g) consisted of seven down-current transects. A summary of each of the graphically represented transects is presented in Table 3.

Initial circular transects during the flood tide survey determined the plume to be located northeast of the dredge. During the first set of down-current transects conducted between 10:02 and 10:20 the plume signature immediately down-current of the dredge (51 meters) was estimated to have peak concentrations near the bottom and surface between 100 and

150 mg/L (Figure 9f). By transect T03 (135 meters down-current from the dredge), peak concentrations were reduced but small areas of the plume were still estimated to have TSS concentrations between 70-80 mg/L (Figure 9h). However, by the following transect, transect T04 (196 meters down-current), the plume had dissipated to near ambient levels (Figure 9i). With the exception of prop wash from a tug boat and other localized disturbances not attributable to the dredge, all transects down-current of T04 generally recorded ambient levels of acoustic signatures.

To examine the spatial extent of the plume during the first set of transects, a series of plan-view layouts of the ADCP transects, in figures 12a through 12g, depict estimates of TSS concentrations in two meter depth intervals averaged increments. Figure 13 provides a three-dimensional depiction of average TSS values for selected representative transects superimposed on existing channel bathymetry.

The second set of down-current transects conducted between approximately 10:20 and 10:50 detected a plume similar in shape to the first set of transects. The first transect of this set (T07) conducted approximately 33 meters down-current of the source recorded estimated TSS concentrations near the surface at 200 to 300 mg/L, based on the the location of the backscatter in the water column and the close location to the bucket some of this acoustic signature was likely attributable to air entrainment (Figure 10a). During the second set, traces of the plume were noticeable up to 280 meters down-current of the dredge (Figure 10g), although down-current of transect T08 (95 meters) the estimated concentration did not exceed 80 mg/L. Plan view profiles of the second set of down-current transects are displayed in Figures 14a through 14g while Figure 15 provides a three-dimensional depiction of the transects within the channel.

The spatial dimensions and concentrations of the plume identified during the third set of transects was slightly different from that identified during the other two sets conducted on the 1 April 2009 flood tide. The plume during the third set was generally confined to the bottom stratum and more wide spread than in the first two down-current sets. The plume extended nearly the entire length of each transect but was only slightly above ambient levels in transects more than 156 meters down-current of the dredge (Figures 10f and 10g). Peak estimated TSS concentrations of 100 to 150 mg/L occurred during the transect closest to the dredge (T15) located 38 meters down-current of the source (Figure 11a). In this transect, peak TSS signature levels were concentrated in a small area near the surface, and possibly influenced by the entrainment of air within the water column. The core of the plume signature as evident in T16, 44 meters down-current of the dredge, did not exceed 90 mg/L, while down-current of T16 the peak concentrations never exceeded 80 mg/L (excluding concentrations detected due to side lobe as described earlier in Section 2.2). Plan view profiles of the third set of down-current transects are displayed in Figures 16a through 16g while Figure 17 provides a three-dimensional depiction of the transects within the channel.

3.2.2.3 April 01, 2009 - Ebb

A mobile ADCP plume characterization survey was also conducted during an ebb tide on 1 April 2009 from approximately 14:00 to 15:25. The survey consisted of the four circular transects (Figures 18a through 18d), two ambient transects (Figures 18e and 18f) and five down-current transects (Figures 18g through 18k). These down-current transects were conducted parallel to Elizabeth Channel and extended out into, and perpendicular with, the Newark Bay Middle Reach. A summary of each of the graphically represented transects is presented in Table 4.

The up-current transects recorded higher than ambient conditions along the bottom of transects A01 and A02 (Figures 18e and 18f). Within these transects, peak estimated TSS concentrations were recorded between 50 and 60 mg/L. This higher than ambient conditions may have been the result of subsurface eddies or non moving waters identified in the hydrodynamic survey (Figure 2) in the area of the dredge which may have caused some of the TSS induced by dredging to move in an up-current direction.

The down-current plume as depicted in the vertical profiles (Figures 18g through 18k) was located primarily in the bottom half of the water column. The highest estimates of TSS were found in the second down-current transect (T02), 41 meters from the dredge (Figure 18h). Down-current of T03 (68 meters from the dredge) only a trace signature of the plume was detected with concentrations slightly above ambient conditions.

The spatial extent of the plume is best displayed in a series of plan-view layouts of the ADCP transects depicting estimates of TSS concentrations in two meter depth-averaged intervals (Figures 19a through 19h). Figure 20 provides a three-dimensional depiction of average TSS values for selected representative transects superimposed on existing channel bathymetry.

3.2.2.4 April 02, 2009 – Flood

The final mobile ADCP survey for the week occurred on 2 April 2009 during a flooding tide. The survey lasted from approximately 09:55 to 12:40 and extended throughout the mid-portion of the flooding tide. The survey included two circular transects (Figures 21a and 21b) used to locate the plume and ambient conditions, and seven down-current transects (Figures 21c through 21i). A summary of each of the graphically represented transects is presented in Table 5.

Figures 22a through 22g display the plan-view profiles of this survey in two meter depth-averaged increments, while Figure 23 provides a three-dimensional depiction of average TSS values for selected representative transects superimposed on existing channel bathymetry. For this survey, the dredge was positioned on the north side of Elizabeth Channel near the Red #4 navigation buoy near the junction with the Newark Bay Pierhead Channel. The down-current transects were conducted west of the dredge and perpendicular to Elizabeth Channel, extending into the Pierhead Channel.

Down-current transects were conducted between approximately 12:15 and 12:40. Peak concentrations within the plume signature were recorded during transect T01 and T02 at approximately 45 and 47 meters from the source and measured between 100 and 150 mg/L near the bottom of the water column and extended no wider than 100 meters (Figures 21c and 21d). Transects T03 and T04 at 71 and 81 meters, respectively, showed the plume focused primarily in the lower third of the water column with peak concentrations generally less than 100 mg/L (Figures 21e and 21f). The plume was still faintly detected at 147 meters down-current of the dredge (T06) with maximum estimates of TSS less than 70 mg/L near the bottom (Figure 21h).

3.2.3 Fixed Station Turbidity Survey

3.2.3.1 April 02, 2009, Flood Tide

Campbell Scientific, Inc.'s OBS-3A units were deployed at various water depths at fixed station locations during a flood tide on 2 April, 2009. Figure 24 presents the locations of the fixed arrays as well as the dredge position during the flood tide survey. Flood tide conditions on 2 April 2009 were predicted for Port Elizabeth, Newark Bay from approximately 08:16 to 13:46 with peak flooding expected at 10:10. Figure 25 plots the recorded turbidity values (NTU) from the surface (dotted black line) and bottom (dotted red line) OBS units at approximately 20 and 40 meters down-current from the dredge

(Figures 25a & 25b, respectively). Ambient turbidity as measured from the up-current OBS at mid-depth is plotted as a blue line and superimposed on both of the down-current plots. To reduce some of the variability inherent in plotting individual OBS readings, a five minute moving average of turbidity is shown as a dashed line to aid in the interpretation. Note that a period of non-dredging occurred from approximately 11:05 to 12:00.

Sampling at the fixed station arrays during the flood tide occurred from approximately 10:45 to 13:40. The majority of both the ambient and down-current turbidity measurements fell into a narrow range of values between 8 and 20 NTU (Figure 25). In general, for the array 20 meters down-current of the dredge, turbidity at the bottom tracked slightly lower than the surface which at times tracked below ambient. Both the surface and bottom meters recorded “pulses” of higher turbidity that peaked at approximately 45 NTU (Figure 25a).

For the array at 40 meters down-current, the bottom meter tracked higher than, or approximately the same as the ambient meter (Figure 25b). The surface meter, however, tracked slightly below both the ambient and the bottom meter. Rapid increases in turbidity concentrations were less frequent and less intense than the array deployed 20 meters from the dredge. In fact, throughout the entire sampling period, turbidity did not exceed more than 20 NTU as a five minute moving average (Figure 25b). The turbidity data can fluctuate rapidly in a brief period, so a five-minute moving average trend line was plotted to smooth out these perturbations to more clearly visualize the general turbidity pattern.

3.2.4 Laboratory Analysis of Water Samples

A total of 72 water samples were collected in the project area during the week of 29 March 2009. The laboratory results of the optical turbidity and the gravimetric analysis of TSS concentration of those 72 samples are presented in Table 1. To accommodate the requirement for calibration of the ADCP backscatter, samples were taken from locations to represent the broadest possible concentration gradient from ambient to the highest TSS concentrations that could be safely collected in the area of the active dredging operation.

In this study, the TSS concentrations of the 72 water samples ranged from 8.8 to 421.0 mg/L and turbidity concentrations ranged from 2.4 to 248.0 NTU. Figure 26a plots the paired gravimetric measurements and ADCP acoustic estimates of TSS arranged in concentration versus time order for the 57 water samples used in the Sediview calibration. Note that some of the 72 water samples collected were excluded if they exhibited clear signs of either air bubble contamination or interference with the water sampler apparatus (see Sediview calibration methods described in section 2.5). Overall, there was a very strong agreement (R^2 = 0.962) between the acoustic estimates of TSS concentration and the gravimetric measurements (Figure 26b).

3.2.5 Sediment Samples

A total of five sediment samples were collected (two from dredge scow and three from dredge area) during the week of 29 March 2009. The laboratory results of these sediment collections for grain size distribution, bulk density and Attenberg Limits are presented in Table 6. Sediment samples collected during the S-E-1 far field survey were comprised mostly of silt and clay with silt comprising between 55 and 63% of each sample collected. Each of the samples collected also consisted of 3 % or 4% fine sand with only two samples containing medium sand (1%) and one sample taken from the dredge scow containing course sand (1%). The dry bulk density of the sediment samples ranged between 31.9 and 44.6 lb/ft^3 with a moisture content of between 105 and 165% (Table 6).

3.3 S-E-1 Farfield Survey B (Week of 26 April 2009)

3.3.1 Ambient conditions

On 27 April 2009, a total of 23 ambient water samples were collected at various depths and later analyzed in the laboratory for TSS and turbidity (Table 7). Ambient turbidity values ranged from 5.1 to 17.4 NTU with TSS values ranging between 13 and 37 mg/L. The average gravimetric estimate of TSS concentration based on the 23 ambient water samples was 24 mg/L. For graphical purposes in this survey, all acoustically estimated TSS concentrations greater than 37 mg/L (the highest ambient TSS concentration used in the Sediview calibration) are herein considered above background and attributable to the dredging-induced plume unless otherwise noted.

3.3.2 Mobile ADCP Surveys

3.3.2.1 April 27 2009 – Ebb

The first of two mobile ADCP plume characterization surveys on 27 April 2009 was completed during the first half of an ebbing tide from approximately 12:15 to 13:20. The survey consisted of one circle transect (Figure 27a), three up-current ambient transects (Figures 27b through 27d) and eight down-current transects (Figures 27e through 27l). A summary of each of the graphically represented transects is presented in Table 8.

For this survey, the dredge was positioned on the south side of Elizabeth Channel near the northeast corner of the Port Elizabeth Marine Terminal. Ambient transects were conducted west of the dredge in Elizabeth Channel while the down-current transects were conducted east of the dredge primarily in the Newark Bay channel proper. A series of plan-view layouts of the ADCP transects depicting estimates of TSS concentrations in two meter depth averaged intervals are given in Figures 28a through 28h. Figure 29 provides a three-dimensional depiction of average TSS values for selected representative transects superimposed on existing channel bathymetry.

Ambient transects A01 and A02, conducted approximately 83 and 113 meters up-current of the dredge, recorded high acoustic backscatter along the surface due to prop wash from passing ships. Transect A03 conducted 210 meters up-current was not as affected by prop wash, although some acoustic disturbance caused by the entrainment of air was still present in the upper five meters of the water column (Figure 27d).

Down-current transects for this survey ranged from approximately 90 to 443 meters from the dredge and were conducted almost entirely within Newark Bay Middle Reach and were oriented parallel to the Newark Bay channel and perpendicular to Elizabeth Channel. The plume recorded down-current of the dredge continued out of Elizabeth Channel in a south east direction before changing orientation to the south-south west with the currents of Newark Bay Middle Reach. Transect T01, 90 meters down-current from the dredge, displays the highest in plume estimates of average TSS recorded during this survey, falling within the range of 300 to 500 mg/l in the upper half of the water column (Figure 27e).

Within the last 200 meters of transect T01 and within transects T02 and T03, conducted at approximately 144 and 280 meters down-current, respectively, the plume appeared within the entire water column with peak estimates of TSS generally between 100 and

150 mg/L, although at least part of this plume may be attributable to the remnant wake (i.e. air bubbles) from the passage of the ships noted earlier during the ambient transects (Figures 27e through 27g). Down-current transects were conducted parallel to the plume such that the vertical profiles display the length of the plume extending down-current, not a perpendicular cross section. Beginning with transect T05 at 364 meters down-current, estimates of TSS associated with the plume generally dissipated to less than 100 mg/L (Figures 27i through 27l).

3.3.2.2 April 27 2009 – Late Ebb/Slack

The second mobile ADCP plume characterization survey on 27 April 2009 was conducted during the end of an ebb tide and into the beginning of a slack tide from approximately 15:20 to 15:45. The survey consisted of one circle transect (Figure 30a) three up-current ambient transects (Figures 30b through 30d), and four down-current transects (Figures 30e through 30h). A summary of each of the graphically represented transects is presented in Table 9.

The circle and ambient transects were conducted while the tide was still ebbing. The circle transect located the dredge plume to be southeast of the dredge, although all three ambient transects conducted up-current recorded higher than ambient acoustic signatures along the upper half of the water column (Figures 30b though 30d).

Down-current transects for this survey ranged from between approximately 55 to 383 meters from the dredge and were conducted within the Elizabeth Channel. Transect T04 was conducted in and parallel to Newark Bay Middle Reach and was much longer than the first three transects, extending approximately 450 meters (Figure 30h). The first three down-current transects recorded a localized plume approximately 55 meters wide within the lower five meters of the water column along the southeast wall of Elizabeth Channel (Figures 30e through 30g). The plume was no longer apparent in transect T04 which extended down-current and parallel to Newark Bay Middle Reach at approximately 383 meters from the dredge (Figure 30h). Estimates of TSS in the upper half of the water column were generally less than 80 mg/L in each of the down-current transects (Figures 30e through 30h).

Figures 31a through 31g display average TSS concentration in two meter depth intervals while Figure 32 displays the orientation and vertical profiles of the transects in relation to the bathymetry of the area.

3.3.2.3 April 28 2009 – Flood

The first of two mobile ADCP plume characterization surveys on the 28 April 2009 was conducted during a flood tide from approximately 10:50 to 11:20. This survey consisted of one circle transect (Figure 33a), three ambient transects (Figures 33b through 33d), and seven down-current transects conducted west (Figures 33e through 33h) and north of the dredge (Figures 33i through 33k). A summary of each of the graphically represented transects is presented in Table 10.

For this survey, the dredge was again positioned on the south side of Elizabeth Channel along the northeast bulkhead of the Port Elizabeth Marine Terminal. Ambient transects were conducted west of the dredge in Elizabeth Channel while the down-current transects were conducted east and then north of the dredge in an attempt to locate if the plume was occurring adjacent to the dredging operation (i.e. not in the typical down-current orientation) due to the slack tide. A series of plan-view layouts of the ADCP transects depicting estimates of TSS concentrations in two meter depth averaged intervals are given in Figures 34a through Figure 34h. Figure 35 provides a three-dimensional depiction of average TSS values with respect to the existing channel bathymetry.

During the circle transect, above ambient TSS concentrations were located south of the dredge between the dredge platform and the Port Elizabeth Marine Terminal bulkhead (Figure 33a). Ambient transects were conducted up-current and perpendicular to Elizabeth channel, although higher than ambient concentrations up to 100 mg/L in the upper third of the water column were detected in ambient transect A01, conducted 53 meters up-current from the dredge (Figure 33b). Only a small remnant of the plume was observed in the first down-current transect located approximately 68 meters from the source with maximum estimates of TSS less than 100 mg/L in the lower half of the water column (Figure 33e). The remaining down-current transects conducted both east and north of the dredge recorded only ambient conditions (Figures 33f through 33k).

3.3.2.4 April 28 2009 – Ebb

A second mobile ADCP plume characterization survey was conducted on 28 April 2009 during an ebb tide from approximately 14:05 to 14:50 and consisted of one circle transect (Figure 36a), three ambient transects conducted at the end of the survey (Figures 39a through 39c), and two sets of down-current transects. The first set of down-current transects (Figures 36b through 36g) consisted of six transects from approximately 14:11 to 14:23 while the second set (Figures 39d through 39g) consisted of four down-current transects from approximately 14:33 to 14:37. Both down-current sets were conducted southeast of the dredge, perpendicular to the Elizabeth Channel. A summary of each of the graphically represented transects is presented in Table 11.

During the circle transect for this survey, the plume was located south east of the dredge with peak estimates of TSS over 500 mg/L in the upper half of the water column (Figure 36a). These peak estimates of TSS were recorded in only the first down-current transect at approximately 57 meters from the source and extended no more than 50 meters across in width (Figure 36b). Peak estimates above 500 mg/L were limited to the upper half of the water column. Due to the proximity of the transect to the bucket and the location of the backscatter within the water column, it is likely that the high mg/l included some air entrainment from the bucket. At transect T02, located approximately 99 meters down-current of dredge, the plume was still present but in much lower concentrations, with only trace areas at the surface and near bottom area recording a signature of 100-150 mg/L (Figure 36c). Beyond 100 meters down-current of the dredge, maximum estimates of TSS were typically less than 100 mg/L and limited to the upper five meters of the water column (Figures 36d through 36g).

Figures 37a through 37g display the plan view profiles of the circle, ambient and first set of transects in two meter depth averaged intervals Figure 38 displays the orientation and vertical profiles of the transects in relation to the bathymetry of the area.

For the second set of down-current transects, the plume detected was approximately 50 meters wide and concentrated on the surface and bottom. Peak concentrations were localized in a small area along the surface and were detected to be 500 mg/L or more at transect T07, 80 meters down-current of the dredge (Figure 39d). Peak concentrations may have been at least partly attributable to air entrainment along the surface, considering the proximity to the dredge operation. Beyond 116 meters down-current of the dredge only trace concentrations (not exceeding 70 mg/L) were found along the upper five meters and bottom three meters of the water column (Figures 39e through 39g).

Figures 40a through 40g display the plan view layouts of the transects at two meter depth increments while Figure 41 depicts the transects three dimensionally and superimposed on the existing channel bathymetry.

3.3.2.5 April 29 2009 – Flood

The 29 April 2009 mobile ADCP plume characterization survey was conducted during a flood tide from approximately 09:00 to 10:00 and consisted of one circle transect (Figure 42a), three ambient transects (Figures 42b through 42d), and fourteen down-current transects (Figures 42e through 42r).

For this survey, the dredge was positioned on the north side of Elizabeth Channel between the Red #2 and Red #4 navigation buoys. Ambient transects were conducted east of the dredge and extended onto the flats just east of the Port Newark Pierhead Channel while the down-current transects were conducted to the west extending on the flats with later transects reaching into the Pierhead Channel. Figures 43a through 43g display the plan view profiles in two meter depth averaged intervals. They show the plume to be localized just west of the dredging operation along the north side of Elizabeth Channel and adjacent to the flats. Figure 44 displays the transects three dimensionally and superimposed on the existing channel bathymetry.

The first down-current transect, T01, was located approximately 77 meters from the dredge and recorded a plume extending 90 meters wide (Figure 42e). Peak estimates of TSS were detected in the upper two meters of the water column and exceeded 500 mg/L, although at least part of the signature is likely attributable to air entrainment along the surface. The core of the plume extended the length of the water column with TSS concentrations between 100 to 150 mg/L.

Peak concentrations of 500 mg/L persisted in a small area approximately five meters wide along the surface during the second down-current transect, T02, 121 meters from the dredge, but again, based on the proximity of the transect to the bucket and the location of the backscatter within the water column, was likely attributable to at least some air entrainment (Figure 42f). Bottom concentrations remained in the 100 to 150 mg/L range. During transect T03 and T04, 145 and 171 meters down-current from the dredge, peak plume concentrations had dissipated to below 100 mg/L, with the exception of small areas along the surface (Figures 42g and 42h). By transect T05, 195 meters down-current of the dredge the maximum TSS concentration within the plume were below 100 mg/L and were concentrated primarily on the bottom (Figure 42i). Generally, no plume signature was apparent after transect T10 at approximately 379 meters down-current of the dredge (Figure 42n).

3.3.2.6 May 01 2009 – Flood

A mobile ADCP plume characterization survey was conducted on 1 May 2009 during a flood tide from approximately 11:25 to 11:55. This flood tide survey consisted of one circle transect (Figure 45a), three ambient transects (Figures 45b through 45d), and five down-current transects (Figures 45e through 45i).

For this survey, the dredge was positioned on the north side of Elizabeth Channel near the Red #4 navigation buoy near the junction with the Newark Bay Pierhead Channel. Ambient transects were conducted east of the dredge and extended onto the flats just east of the Port Newark Pierhead Channel while the down-current transects were conducted to the west and extended into the Pierhead Channel. Figures 46a through 46g display the plan view profiles in two meter depth averaged intervals. They show the plume to be primarily located west of the dredge and centered near the junction of Elizabeth and the Pierhead Channels. Figure 47 displays the transects three dimensionally and superimposed on the existing channel bathymetry.

Peak estimates of TSS above 500 mg/L in concentration were recorded in the upper half of the water column during the first down-current transect, T01, at approximately 87 meters from the dredge (Figure 45e). Core plume signatures of greater than 100 mg/L extended throughout the water column and measured approximately 80 meters wide at the surface. During the second down-current transect, at 110 meters from the dredge, peak TSS concentrations between 200 and 300 mg/L were highly localized along the surface of the water column with the core signature greater than 80 mg/L extending no more than 100 meters in width (Figure 45f). Transect T03, located approximately 122 meters down-current from the dredge, recorded peak conditions between 100 and 150 mg/L again occurring along the surface, but was generally less than 100 mg/L (Figure 45g). By comparison, transect T04, 159 meters down-current from the dredge, recorded peak TSS concentrations between 70 and 80 mg/L over an area approximately 100 meters wide and located primarily in the middle of the water column (Figure 45h). By transect T05, 190 meters down-current from the dredge, the plume was no longer detectable (Figure 45i).

3.3.3 Fixed Station Turbidity Survey

Campbell Scientific, Inc.'s OBS-3A units were deployed at various water depths at fixed station locations during an ebb tide on both 28 April and 30 April 2009.

3.3.3.1 28 April 2009, Ebb Tide

Figure 48 presents the locations and times of deployment of the fixed arrays as well as the dredge position during the ebb tide sampling. Ebb tide conditions on 28 April 2009 were predicted for Port Elizabeth, Newark Bay from approximately 11:41 to 17:38 with peak ebb expected at 14:00. Figures 49a and 49b plot the recorded turbidity values (NTU) from the surface (dotted black line) and bottom (dotted red line) OBS units at approximately 35 and 60 meters down-current from the dredge. Ambient turbidity as measured from the up-current OBS at mid-depth is plotted as a blue line and superimposed on both of the down-current plots. Dashed lines are used to depict the five minute moving averages.

Sampling at the fixed station arrays during the 28 April occurred from approximately 13:40 to 15:55. In the down-current array closest to the dredge, the surface OBS meter was deployed at a depth of approximately six meters, while the bottom OBS meter was deployed at a depth of approximately 11 meters. During the first 40 minutes of the deployment, only a few turbidity measurements above 15 NTU were recorded by the down-current array closest to the dredge (Figure 49a). At 14:10 the array closest to the dredge began recording higher than ambient conditions at the surface OBS meter but not at the bottom meter. Through the duration of the sampling period the surface OBS meter generally recorded above ambient conditions with a few individual turbidity recordings of over 30 NTU. On the contrary, the bottom OBS meter experienced only three spikes in turbidity that were higher than the recorded ambient conditions. However, at no point did the five minute moving average for the bottom OBS exceed the five minute moving average for the ambient meter (Figure 49a).

The array positioned approximately 60 meters down-current of the dredge recorded pulsating levels of turbidity, but the peaks in turbidity were less intense than the array closest to the dredge. The five minute moving averages for both the surface and bottom OBS meters did not exceed 18 NTU. The peak turbidities recorded on this array were recorded on the surface OBS meter, of which, only two peaks exceeded 30 NTU.

3.3.3.2 30 April 2009 Ebb Survey

Figure 50 presents the locations and times of deployment of the fixed arrays as well as the dredge position during the ebb tide sampling conducted on 30 April 2009. Ebb tide conditions were predicted for Port Elizabeth, Newark Bay from approximately 13:44 to 19:55 with peak flooding expected at approximately 17:00. The OBS survey was conducted from approximately 14:45 to 17:00. During this period, dredging stopped at approximately 15:00 as the dredged moved to the south east and the down-current OBS arrays were repositioned from approximately 15:15 to 16:00. Figures 51a and 51b plot the recorded turbidity values (NTU) from the surface (dotted black line) and bottom (dotted red line) OBS units placed approximately 80 then 70 meters and 130 then 125 meters down-current from the dredge. Ambient turbidity as measured from the up-current OBS at mid-depth is plotted as a blue line and superimposed on both of the down-current plots. The ambient array was only deployed after the dredge had been repositioned and began recording at approximately 16:05.

During the initial deployment of the down-current arrays from 14:45 to 15:15, the surface OBS meter closest to the dredge recorded peak turbidity at nearly 50 NTU (Figure 51a). Although the surface OBS unit consistently recorded readings above 20 NTU, the bottom sensor closest to the dredge held steady at approximately 10 NTU. Similarly, at the array 130 meters down-current of the dredge, the surface sensor peaked at over 30 NTU as compared to the bottom sensor which held consistently near 10 NTU (Figure 51b). Note that no additional dredging occurred after the OBS arrays had been redeployed meaning that all three arrays were essentially recording ambient conditions from 16:00 to 17:00.

3.3.4 Laboratory Analysis of Water Samples

A total of 128 water samples were collected within the project area during the week of 26 April 2009. The gravimetric TSS concentrations of these samples ranged from 13.0 to 628.0 mg/L while laboratory turbidity ranged between 3.7 to 327.0 NTU (Table 7). Figure 52a plots the paired gravimetric measurements and ADCP acoustic estimates of TSS arranged in concentration versus time order for water samples used in the Sediview calibration. Note that some of the water samples collected were excluded if they exhibited clear signs of either air bubble contamination or interference with the water sampler apparatus (see Sediview calibration methods described in section 2.5). Overall, however, there was a very strong agreement (R^2 = 0.964) between the acoustic estimates of TSS concentration and the gravimetric measurements (Figure 52b).

3.3.5 Sediment Samples

A total of ten sediment samples (five from dredge scow and five from dredge area) were collected during the week of 26 April 2009. The laboratory results of these sediment collections for grain size distribution, bulk density and Atterberg Limits are presented in

Table 14. Sediment samples collected during the survey were comprised mostly of silt and clay with silt comprising between 50 and 63% of each sample collected while clay content ranged from 31% to 45%. All samples contained fine sand, ranging between 1% and 7% of the distribution. The dry bulk density of the sediment samples ranged between 29.1 and 68.4 lb/ft^3 with a moisture content of between 50 and 174% (Table 14).

4.0 DISCUSSION

During the course of normal dredging operations, some sediment is resuspended into the water column. In many cases, this suspended sediment is evident as a visible turbidity plume within the immediate vicinity of the dredge operation. Because suspended sediment plumes are dynamic rather than static phenomena and because they vary over large areas in short periods of time, particularly when driven by tidal forces, characterizing plumes can present a difficult challenge. Data collected at arbitrarily determined points in time at fixed locations are inadequate to assess dredge plume structure. However, advanced acoustic technologies offer advantages in capturing data at appropriate spatial and temporal scales to allow more accurate interpretation of plume dynamics (Tubman & Corson 2000).

Results of the S-E-1 Survey A and Survey B far field surveys were generally consistent with the results of previous mechanical dredge plume monitoring efforts conducted within Newark Bay (USACE 2007a, USACE 2008, and USACE 2009). The plume was generally confined to the channel with little lateral spread onto the side slope, TSS concentrations were highest at transects closest to the buckets and returned to ambient within 350 meters down current of the dredge. Although exact comparisons between studies are impossible due to varying hydrodynamic conditions and sediment types within the various study areas, some patterns have emerged. During previous surveys, maximum TSS concentrations measured acoustically by the ADCP were recorded to be approaching or higher than 300 mg/L near the surface at the down-current transect closest to the dredge, but rapidly decreased thereafter. Concentrations more than 10 mg/L above background generally did not persist more than 350 meters down-current of the dredge.

The acoustic backscatter patterns and dimensions observed during the far-field surveys conducted in April and early May 2009 within the S-E-1 contract area were variable depending on the tide and the location of the dredge operating within Elizabeth Channel. Due to the nature of the Elizabeth Channel, connecting with Newark Bay Middle Reach and the Port Newark Pierhead Channel, prevailing currents could differ greatly within a short distance. Surveys conducted during the ebb tide, such as those on 31 March and 27 April, proved to be challenging given the existing bathymetry and hydrodynamics of the area as did the flood tide survey on 28 April in which the plume appeared to be concentrated beneath the dredge platform and constricted between the platform and the northeast bulkhead of the Port Elizabeth Marine Terminal (Figures 35a through 35h). In this later survey, the flood tide would be expected to carry any observable plume in a westward direction away from the platform and into Elizabeth Channel. However, down-current transects conducted both to the west and north of the platform failed to locate any appreciable plume beyond surface backscatter in the first four meters of the water column which was likely itself attributable to air entrainment caused by vessel traffic in the area.

During the ebb tide surveys conducted on 31 March (Figures 5a through 5h) and especially on 27 April (Figures 28a through 28h), the prevailing hydrodynamics within the channels and the constricted nature of the sampling area tended to lead to transects that were conducted parallel to the plume instead of perpendicular. This made the plumes appear wider than they actually were such as is shown in Figures 28a through 28h. In this survey, the dredge was situated on the south side of Elizabeth Channel near the northeast corner of the Port Elizabeth Marine Terminal. As shown in the figures, the prevailing ebb tide essentially carried the plume east out of Elizabeth Channel and then south around the corner of Elizabeth Terminal and out into Newark Bay Channel, necessitating that the down-current transects T03 and T08 be conducted parallel to the Newark Bay Channel and parallel to the plume.

Peak estimates of TSS concentration during the S-E-1 surveys were recorded in the upper half of the water column as high as 500 mg/L or greater on occasion but were likely the result, at least in part, of the confined nature of the sampling area which necessitated that initial down-current ADCP transects often be conducted within 50 meters of the dredge platform. As demonstrated in previous far field surveys, ADCP backscatter measurements taken this close to an active dredge are subject to a high degree of "bubble" interference caused by the entrainment of air when the dredge bucket enters and exits the water column (Reine *et al*. 2006, USACE 2007a, USACE 2008, and USACE 2009).

Moreover, Elizabeth Channel is a highly confined and high volume vessel traffic area and several ADCP transects were affected, at least in part, by the acoustic backscatter created by prop wash, such as the ambient transects for the 27 April ebb survey (Figure 27b through 27c), and perhaps more importantly by the sediment resuspension created by the passage of deep-draft container ships and their attending tugs. Previous assessments in Newark Bay have attempted to quantify the spatial and temporal extent of sediment resuspension attributable to deep-draft ships (USACE 2007b), although in the field it is often hard to simultaneously distinguish between the plume created by a passing ship from that created by an active dredge operating within the same channel at the same time. Based on field observations, the 27 April ebb tide survey appears to be one such example of survey that may have been confounded, at least in part, by the passage of deep draft container ships (Figures 27e and 27f).

Sampling at the fixed station OBS arrays was used during the S-E-1 surveys to help define the temporal changes of the turbidity plume at various distances from the operating dredge. In general, for all surveys, down-current turbidity was typically less than 50 NTU even at the arrays located closest to the dredge between 20 and 75 meters down-current (Figures 25, 49 & 52). Figures 25 and 49 especially highlight the "pulsating" nature inherent in the dredge plume with alternating peaks and lulls in turbidity created by the start and stopping of the dredge action. During the 2 April survey, a prolonged period of non-dredging occurred between approximately 11:05 and 12:05 and served to highlight how quickly (within just a few minutes) turbidity returned to ambient conditions once dredging was ceased (Figure 25).

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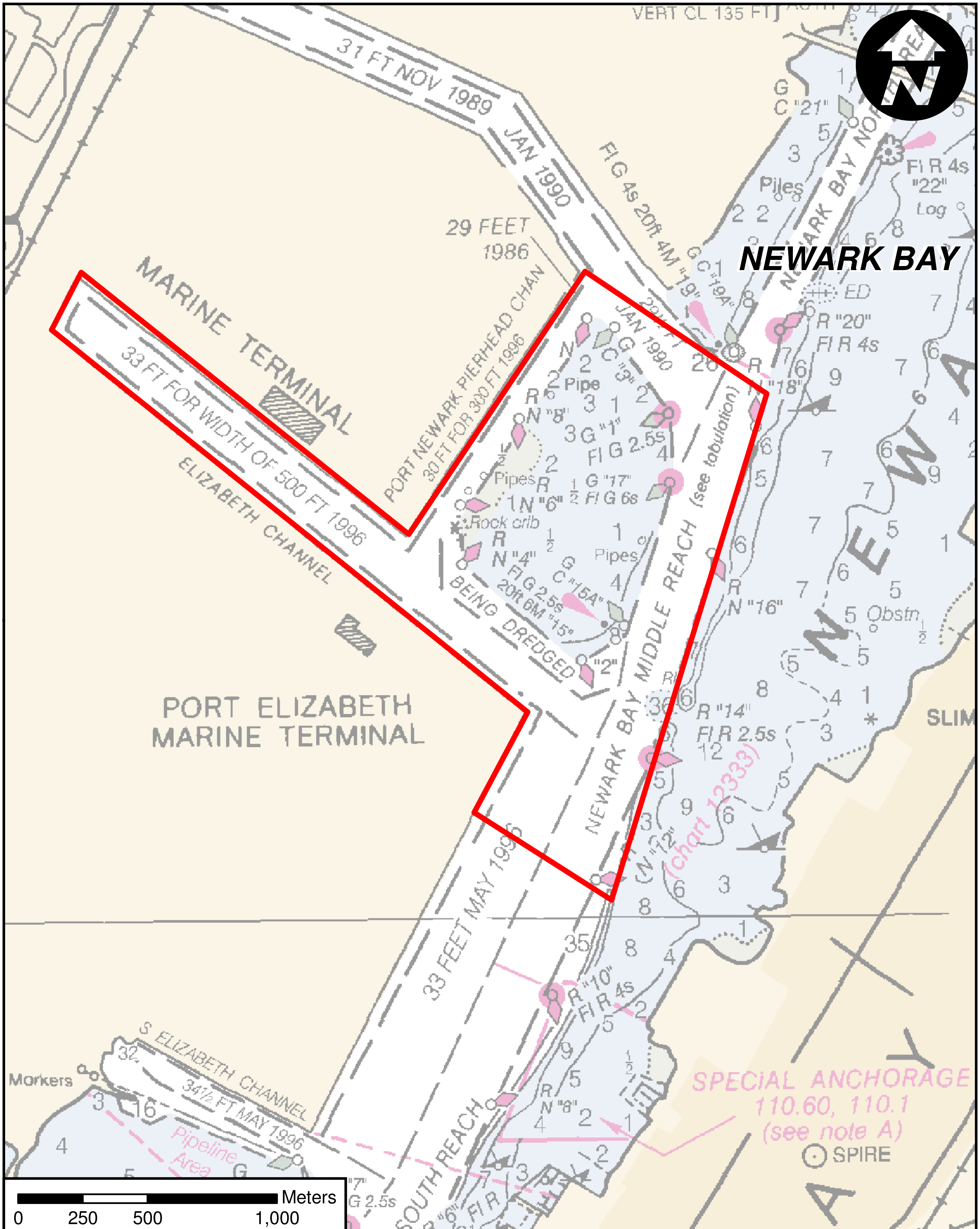


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1	Newark Bay S-E-1 Far-Field Study Area	Tide
1			N/A

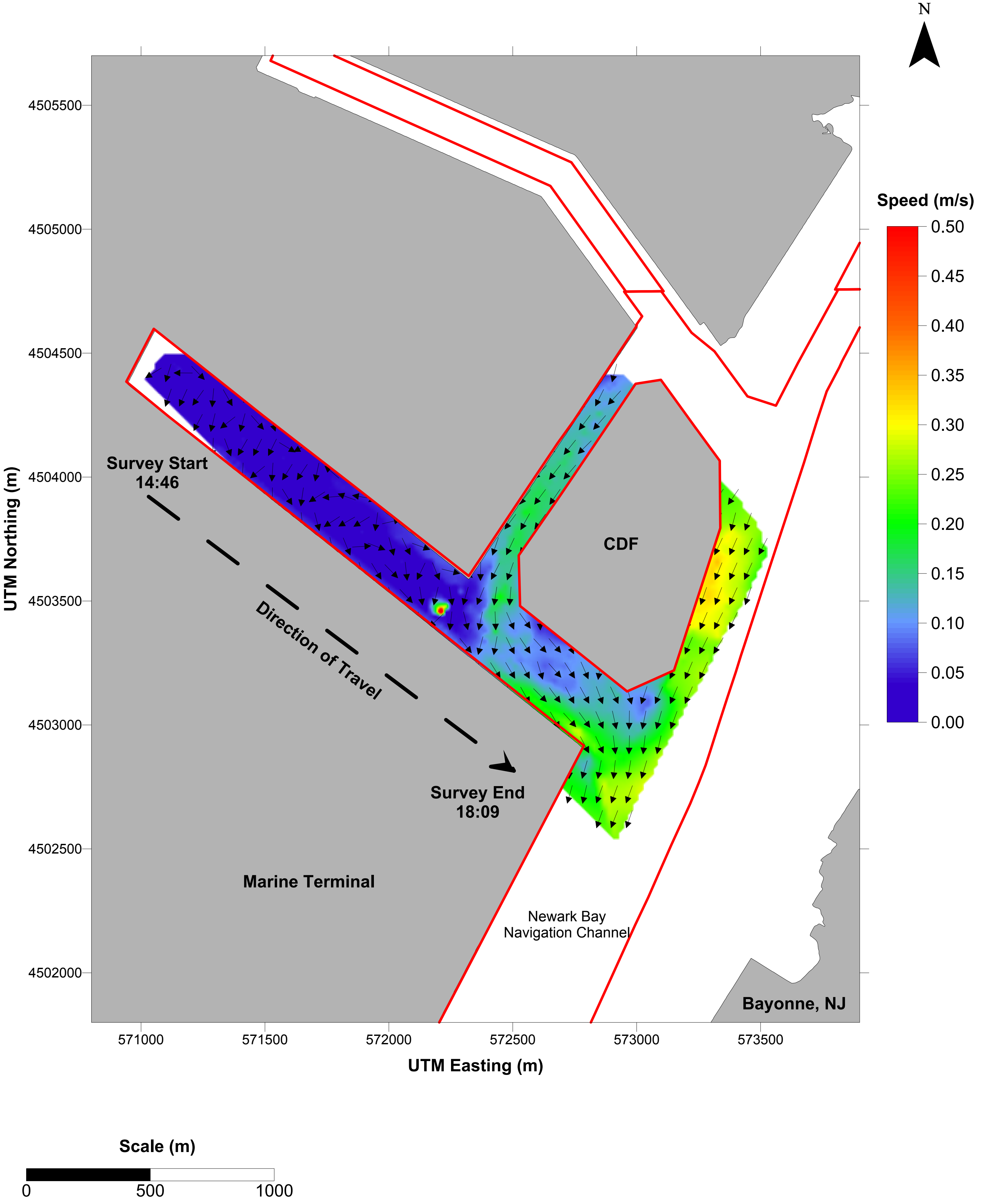


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1	Depth Averaged Velocities 02 April 2009	Tide
2a			Ebb

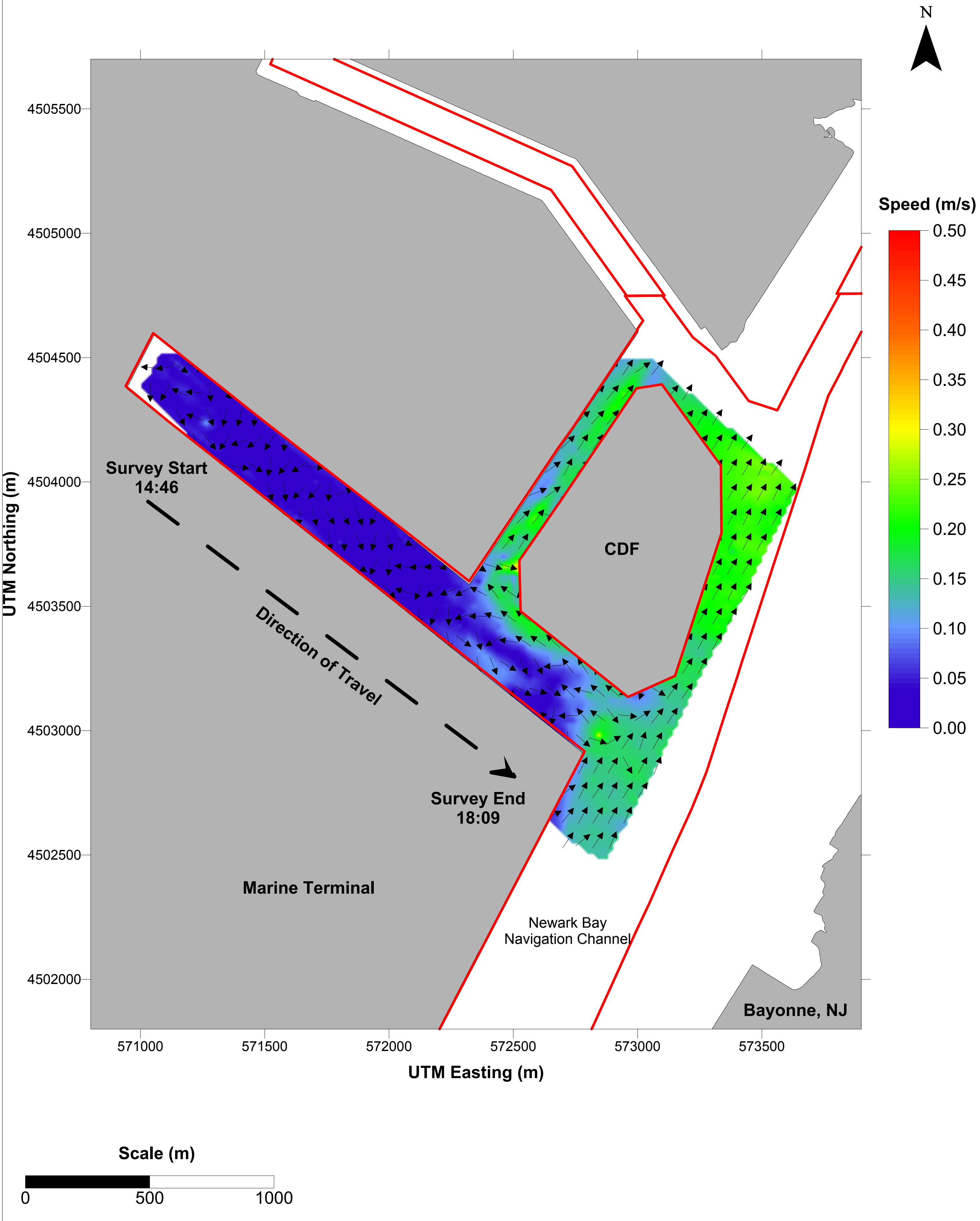


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1	Depth Averaged Velocities 30 April 2009	Tide
2b			Flood

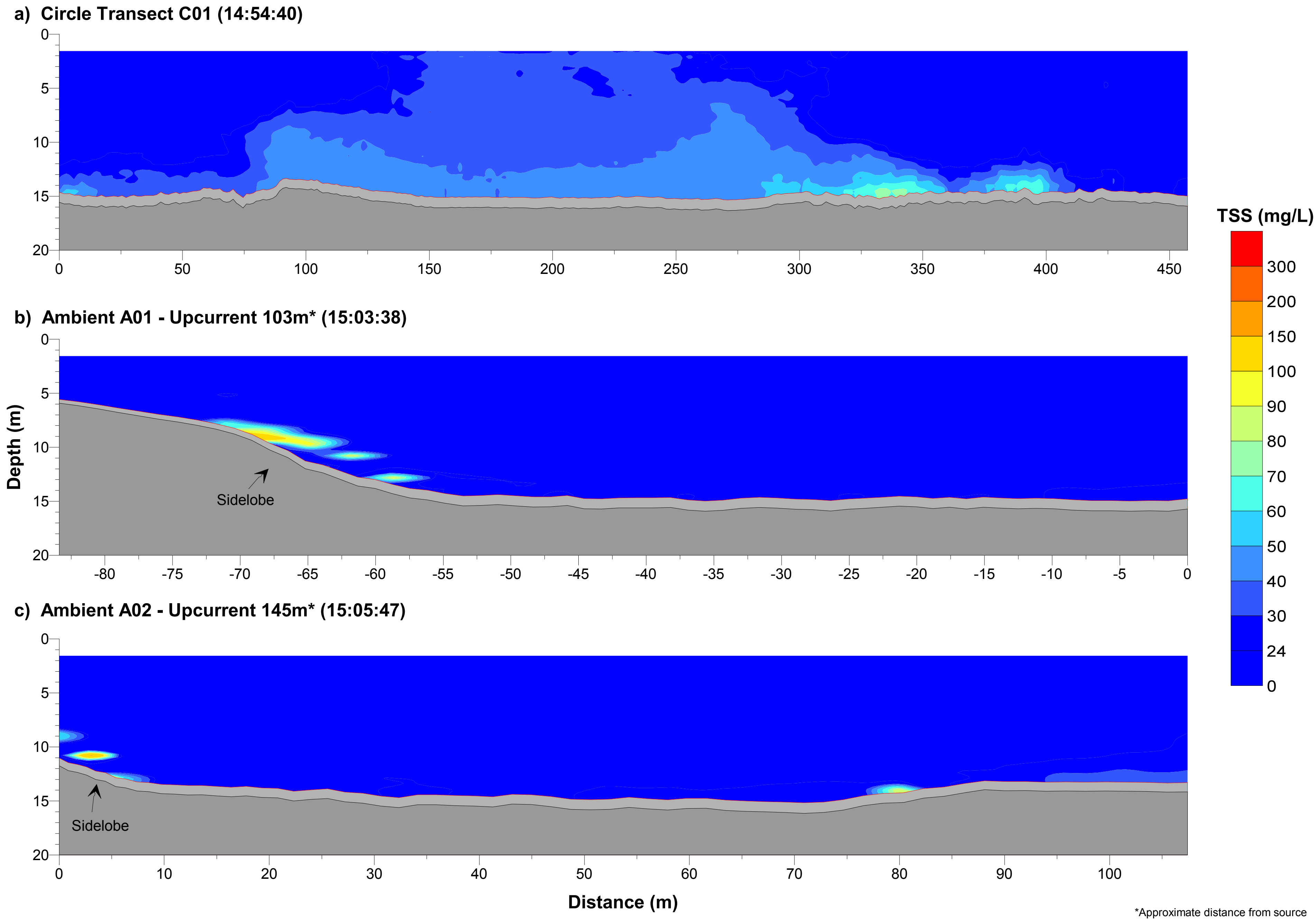
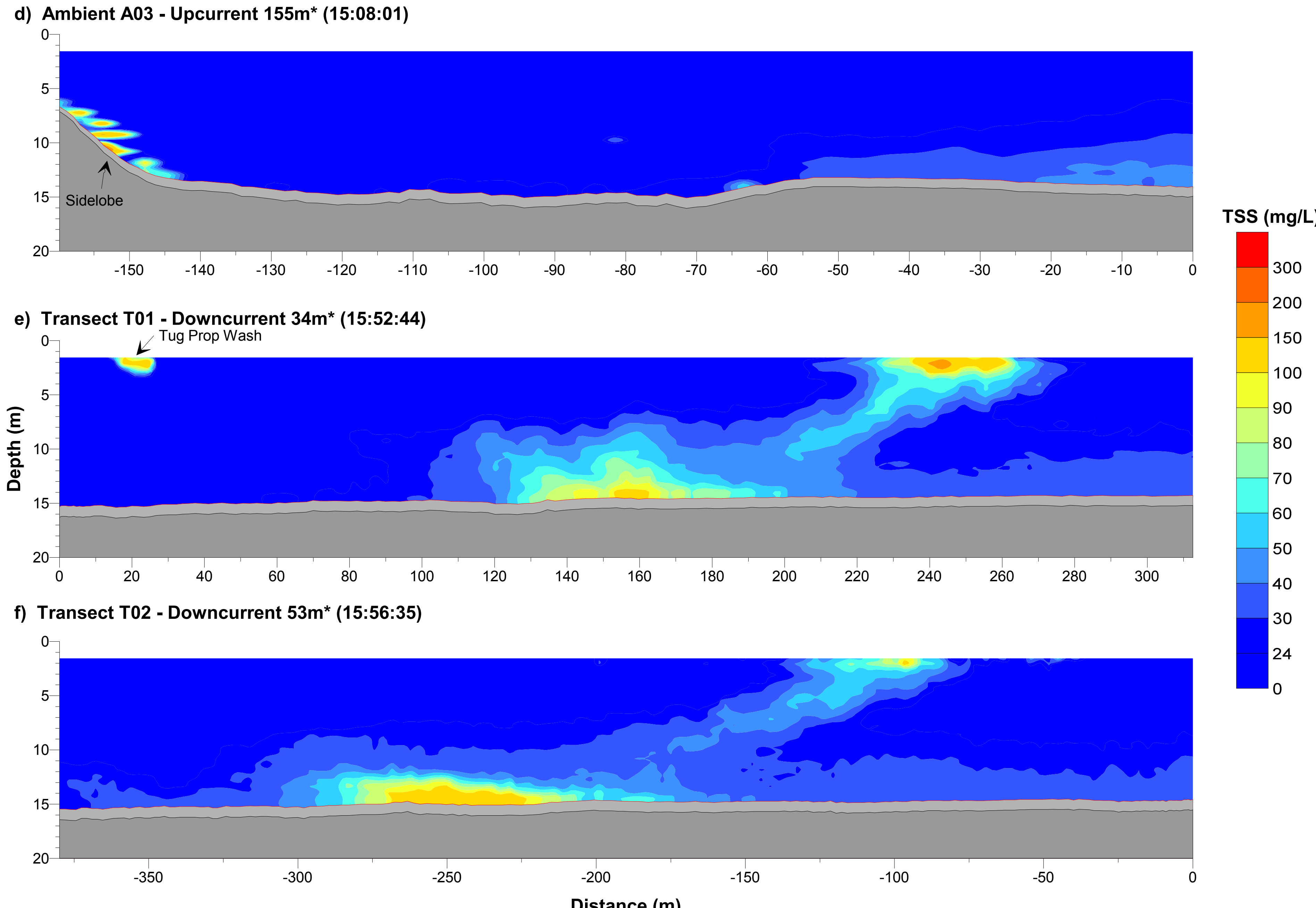
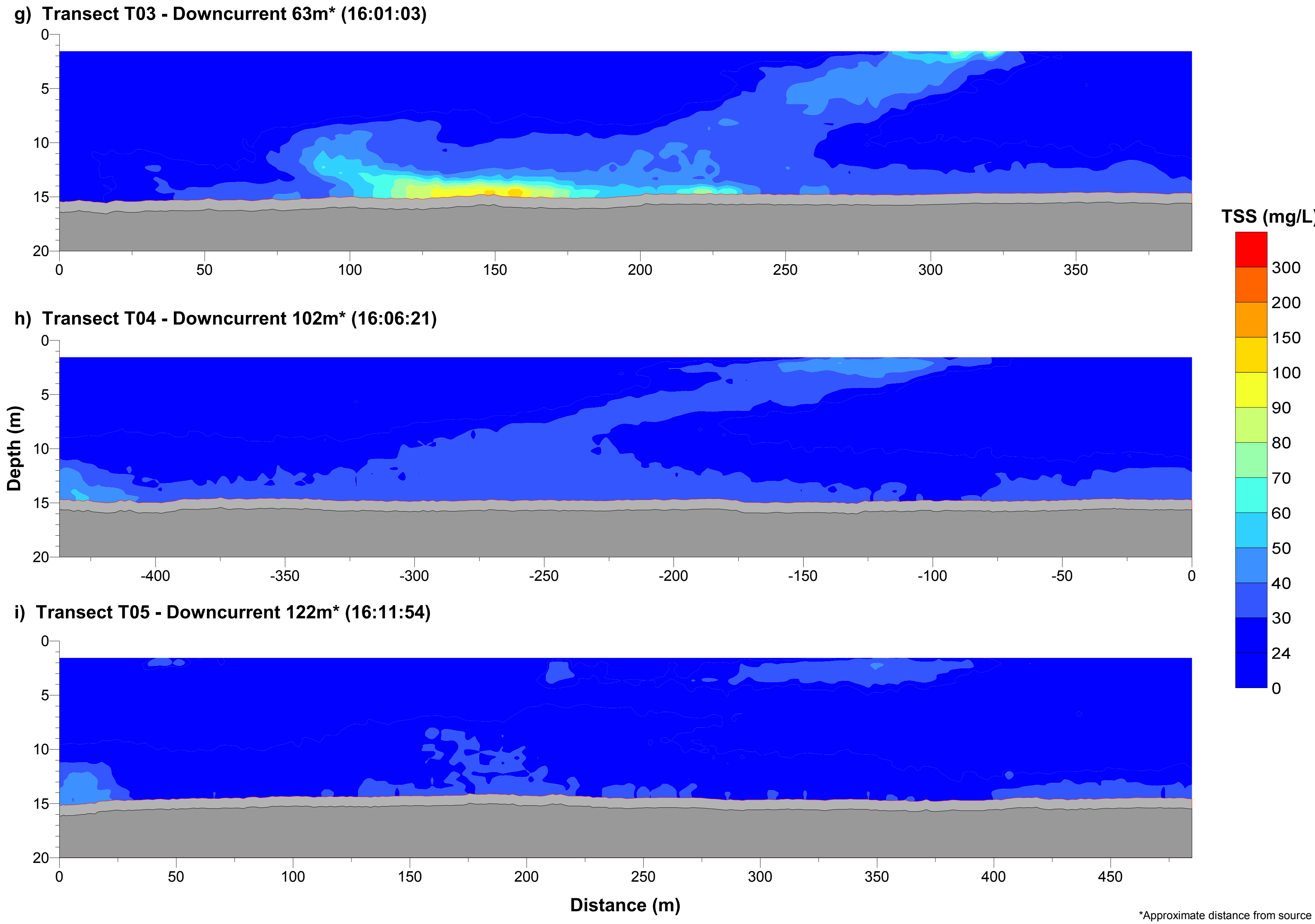


FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	Vertical Profiles of ADCP Average TSS 31 March 2009 (1st Set)	TIDE
3a-c			Ebb



*Approximate distance from source

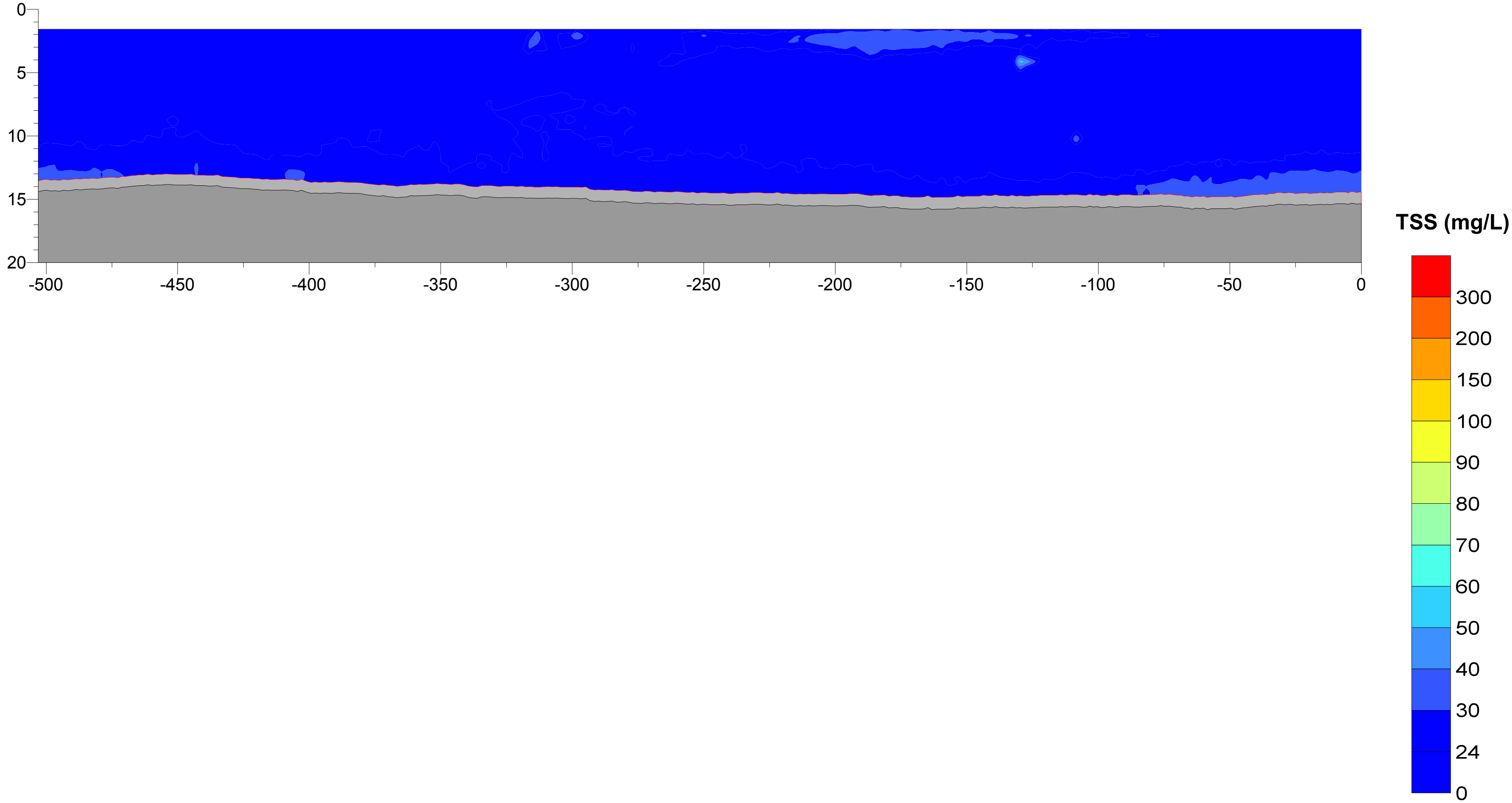
FIGURE	*USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A*	**Vertical Profiles of ADCP Average TSS 31 March 2009 (1st Set)**	TIDE
3d-f			Ebb



*Approximate distance from source

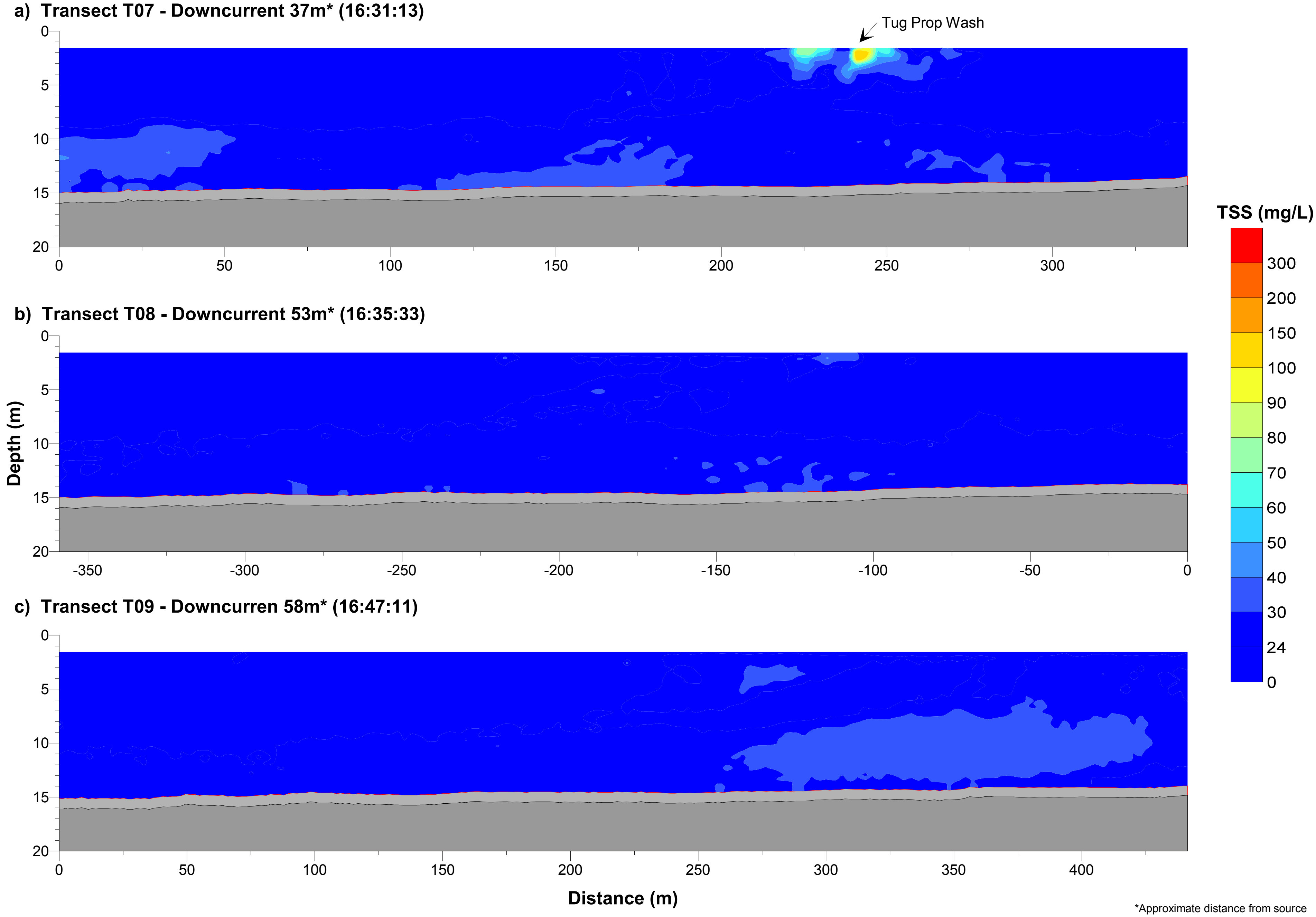
FIGURE	*USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A*	**Vertical Profiles of ADCP Average TSS 31 March 2009 (1st Set)**	TIDE
3g-i			**Ebb**

j) Transect T06 - Downcurrent 141m* (16:17:49)



*Approximate distance from source

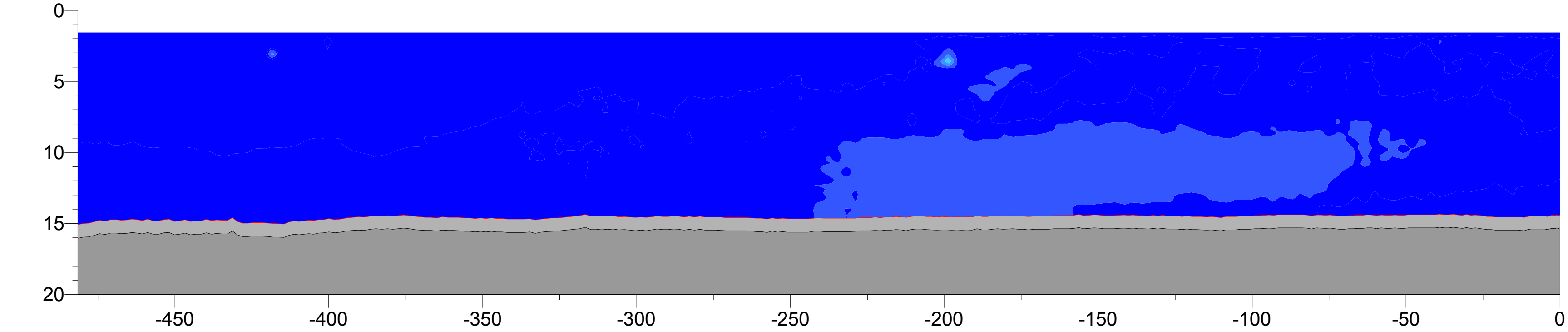
FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	Vertical Profiles of ADCP Average TSS 31 March 2009 (1st Set)	TIDE
3j			Ebb



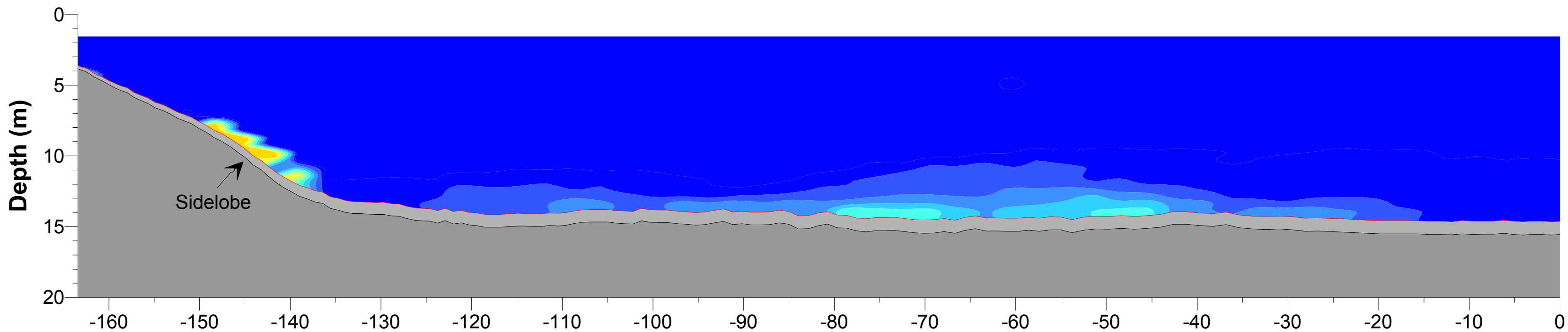
*Approximate distance from source

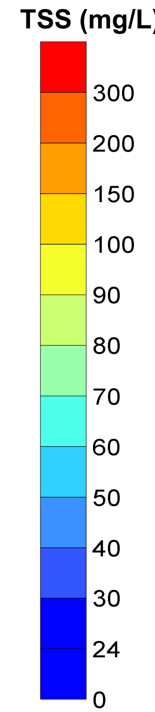
FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	Vertical Profiles of ADCP Average TSS 31 March 2009 (2nd Set)	TIDE
4a-c			Ebb

d) **Transect T10 - Downcurrent 71m* (16:52:31)**



e) **Transect T11 - Downcurrent 104m* (17:03:49)**





*Approximate distance from source

FIGURE	*USACE Harborwide TSS*	**Vertical Profiles of ADCP Average TSS**	TIDE
4d-e	*Far Field Survey* *HDP Contract Area: S-E-1: A*	**31 March 2009 (2nd Set)**	**Ebb**

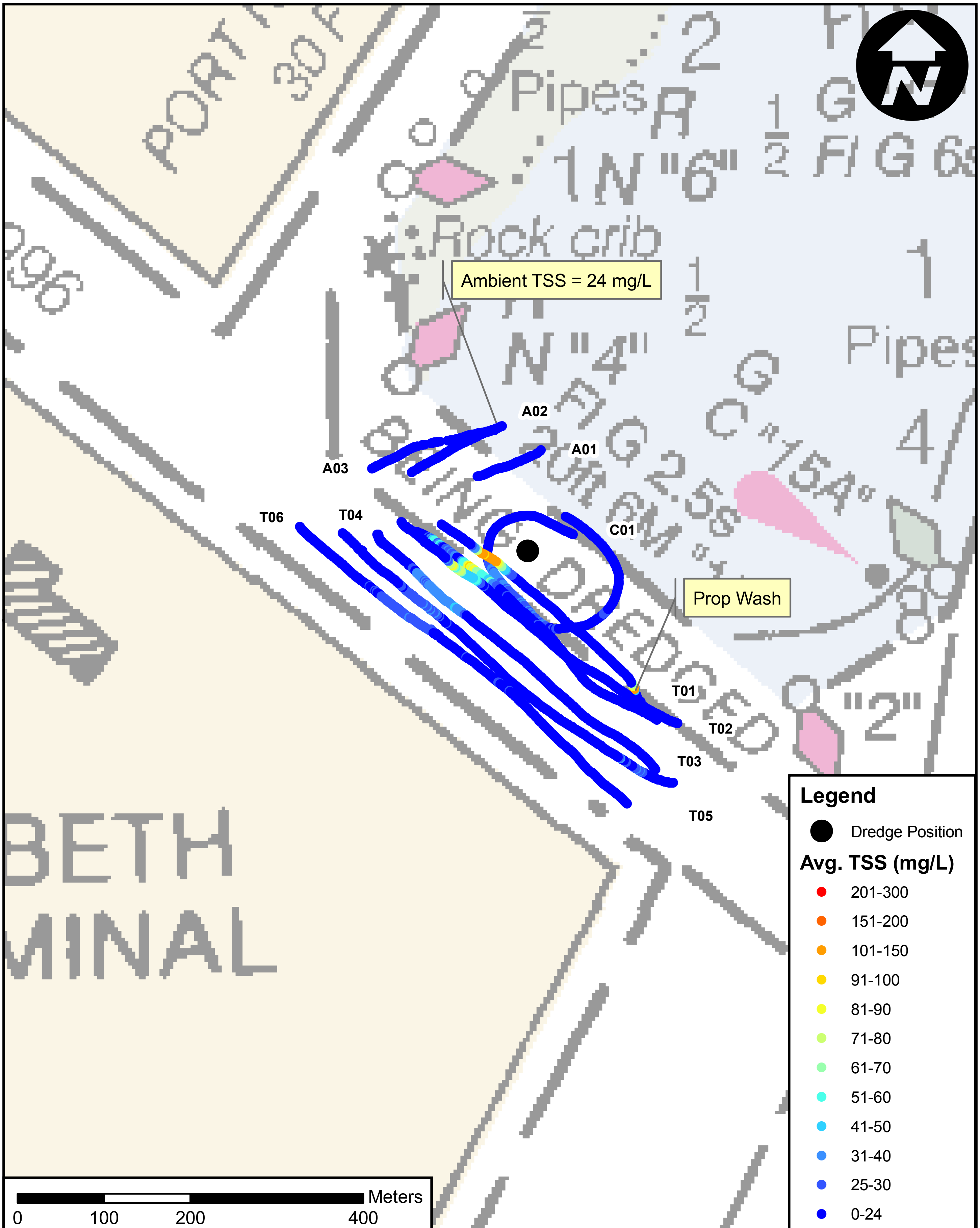


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 31 March 2009 (1st Set) 0-2 Meter Depth Interval	Tide
5a			Ebb

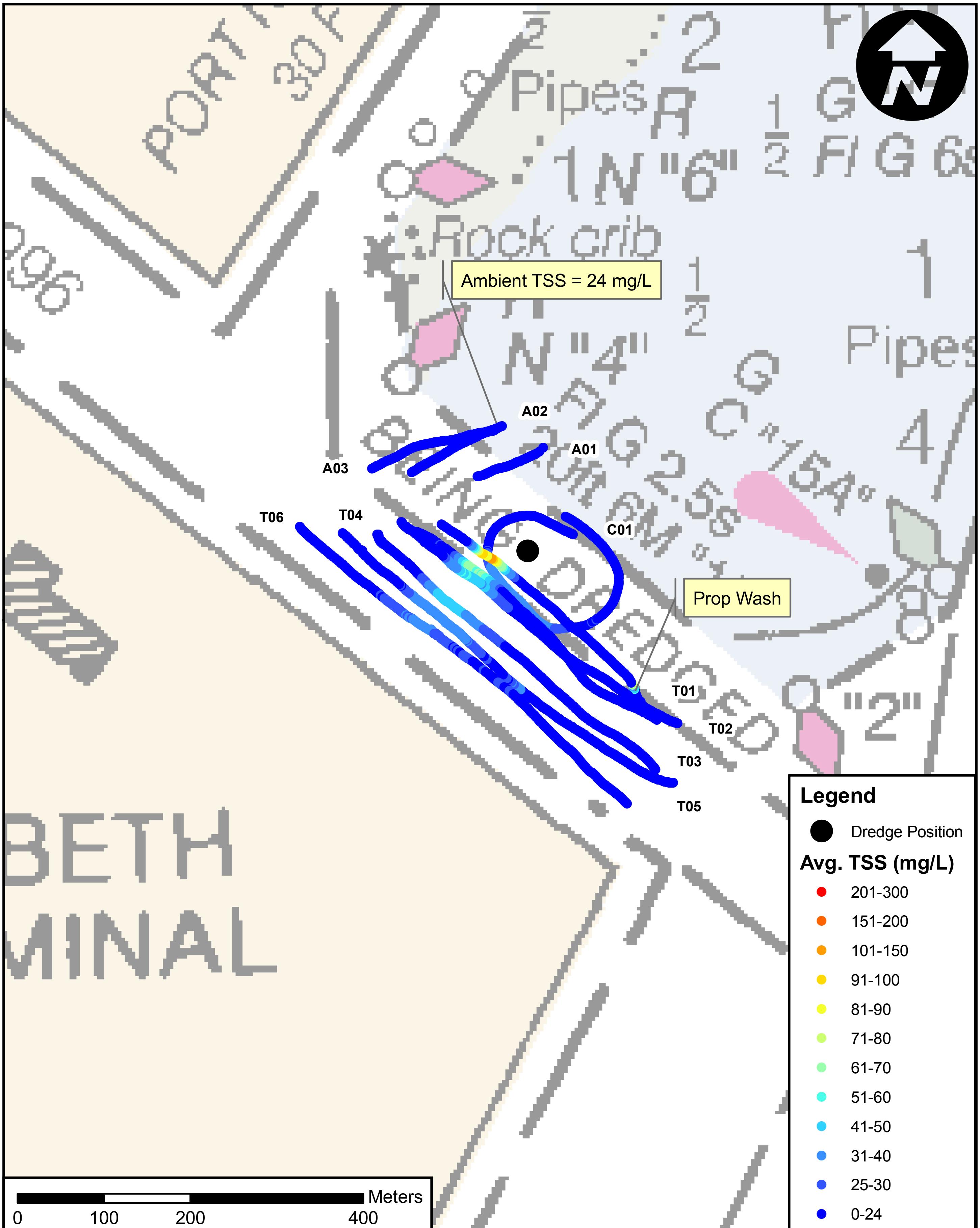


Figure	*USACE Harborwide TSS*	**ADCP Average TSS - 31 March 2009 (1st Set)**	Tide
5b	*Far Field Survey* *HDP Contract Area: S-E-1: A*	**2-4 Meter Depth Interval**	Ebb

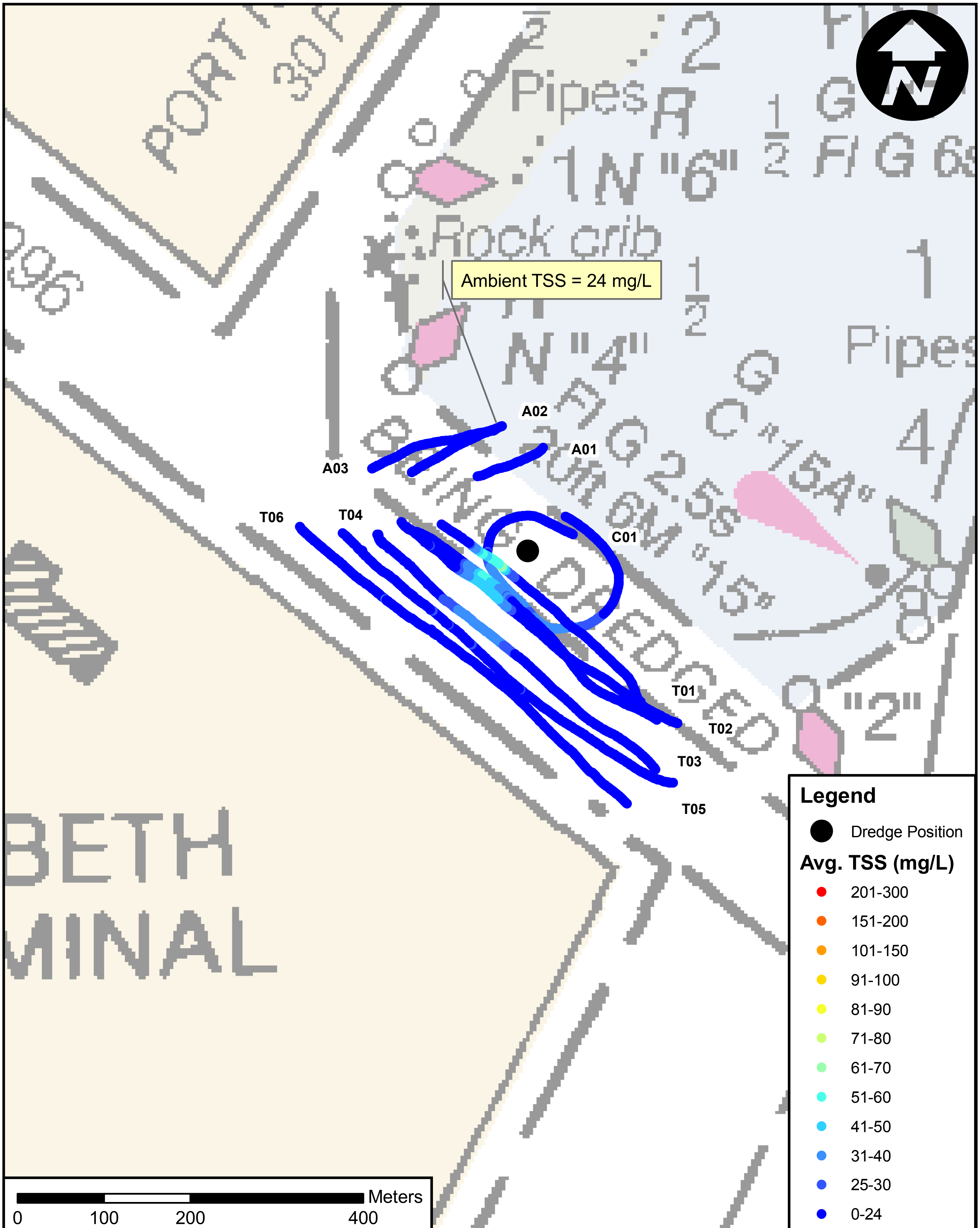


Figure	*USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A*	**ADCP Average TSS - 31 March 2009 (1st Set) 4-6 Meter Depth Interval**	Tide
5c			Ebb

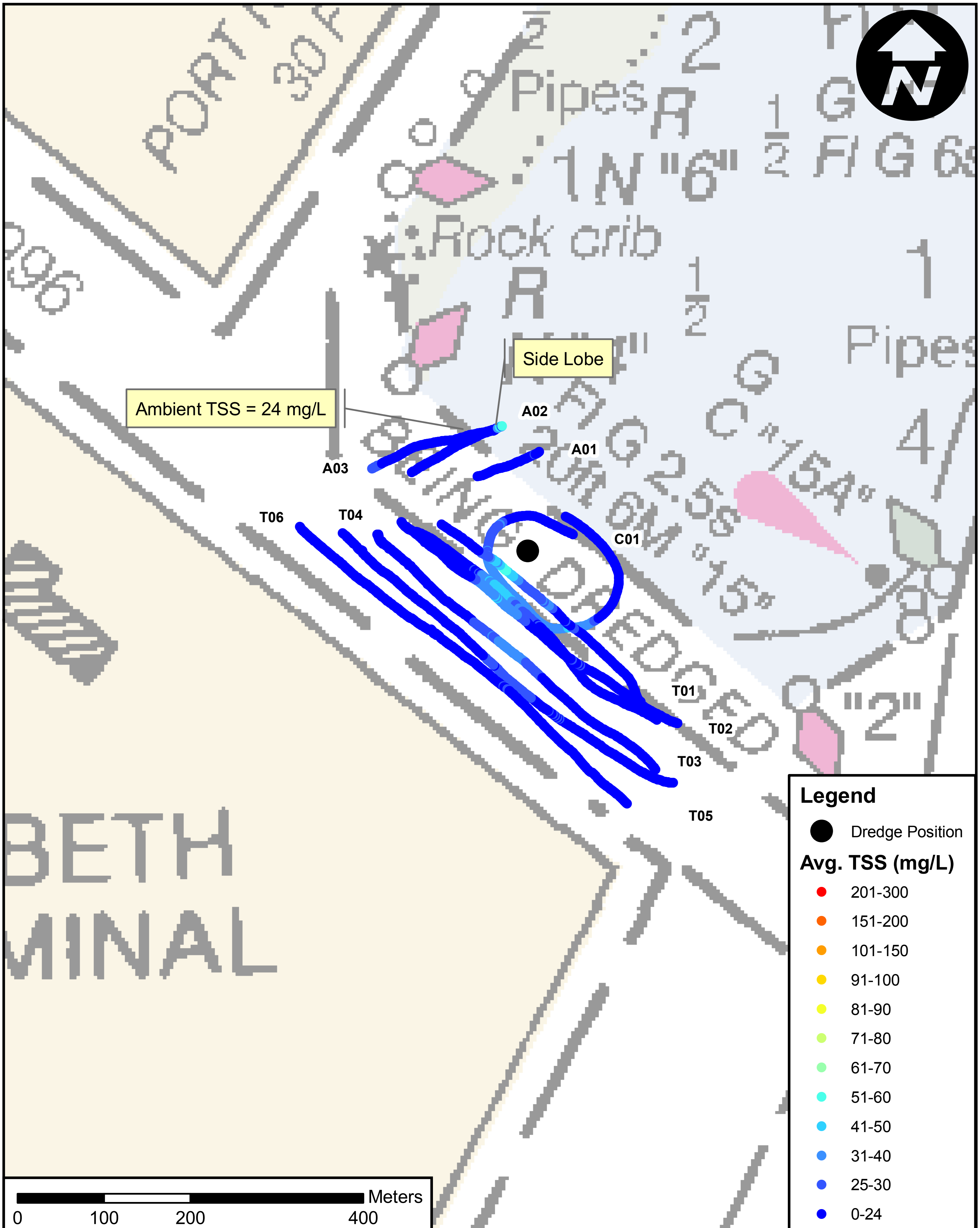


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**ADCP Average TSS - 31 March 2009 (1st Set)** **6-8 Meter Depth Interval**	Tide
5d			Ebb

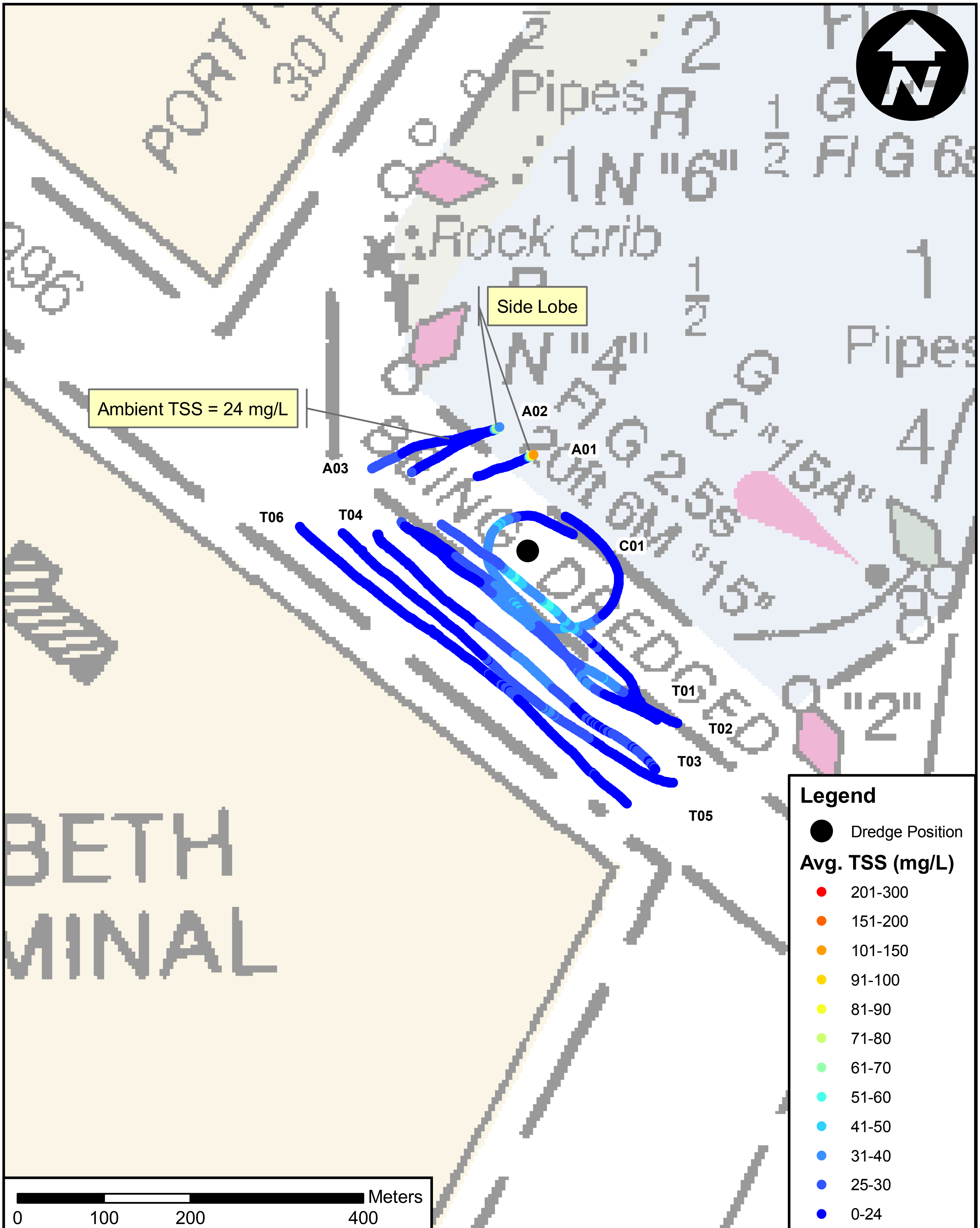


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 31 March 2009 (1st Set) 8-10 Meter Depth Interval	Tide
5e			Ebb

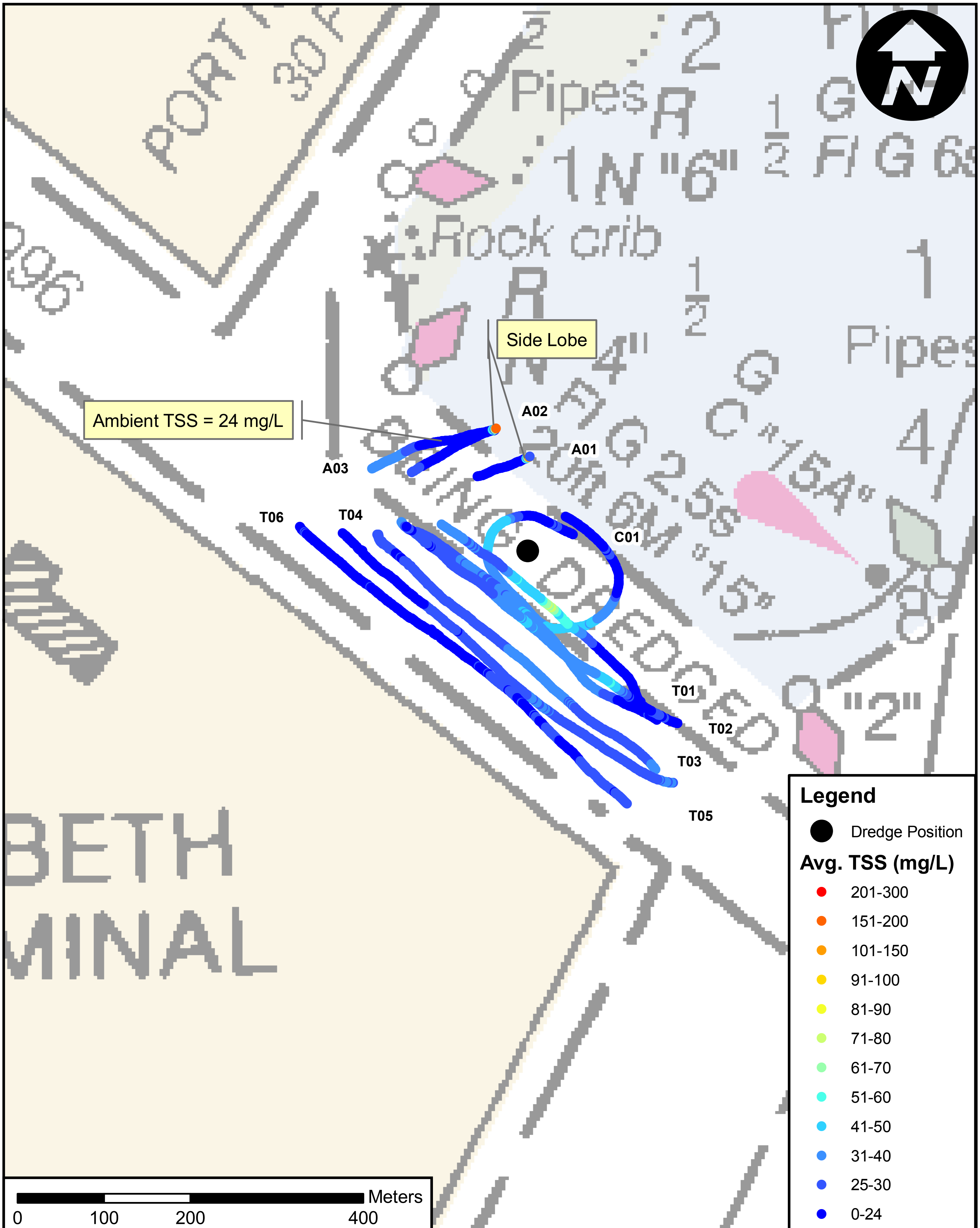


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**ADCP Average TSS - 31 March 2009 (1st Set)** **10-12 Meter Depth Interval**	**Tide**
5f			**Ebb**

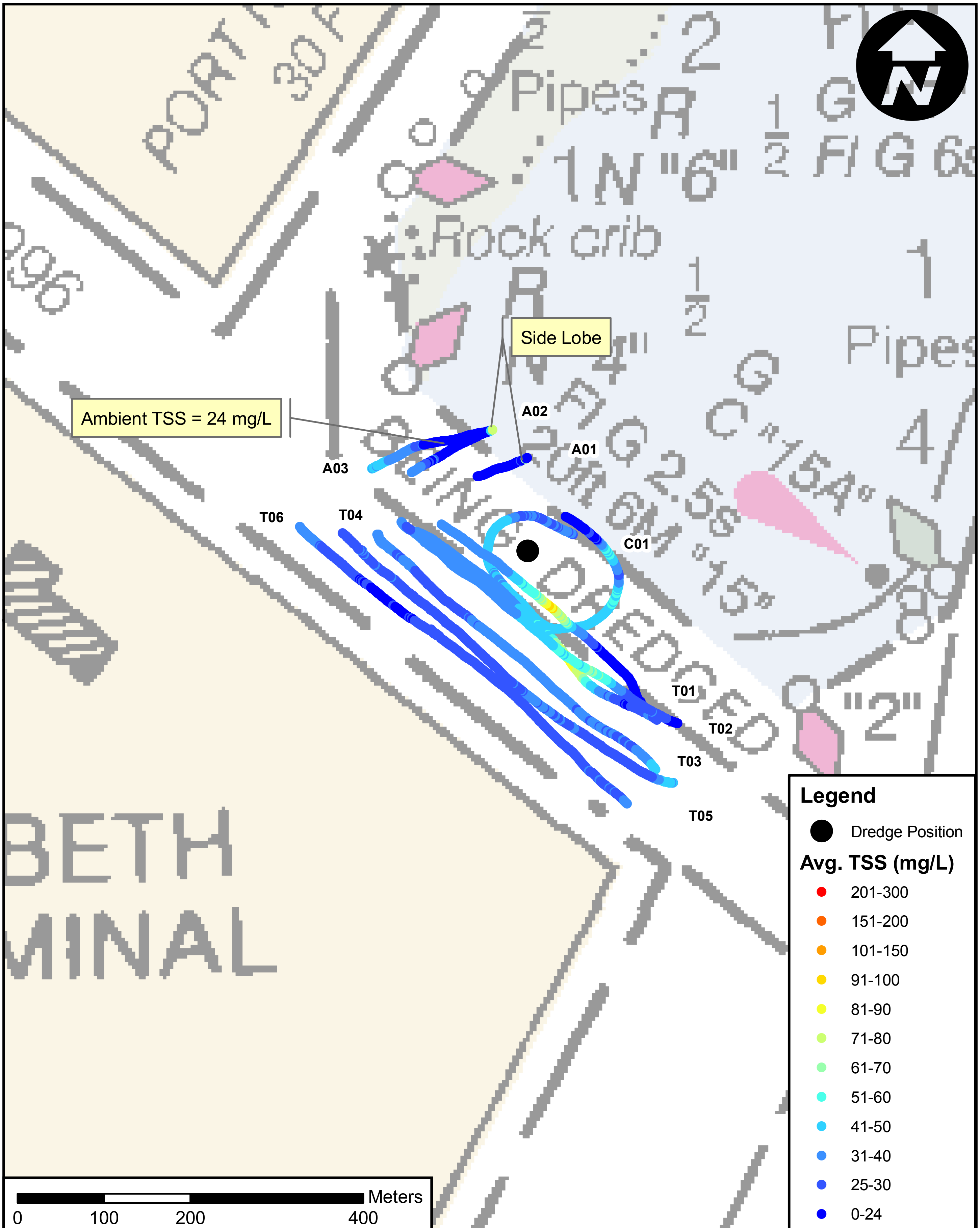


Figure	USACE Harborwide TSS	ADCP Average TSS - 31 March 2009 (1st Set)	Tide
5g	*Far Field Survey* *HDP Contract Area: S-E-1: A*	12-14 Meter Depth Interval	Ebb

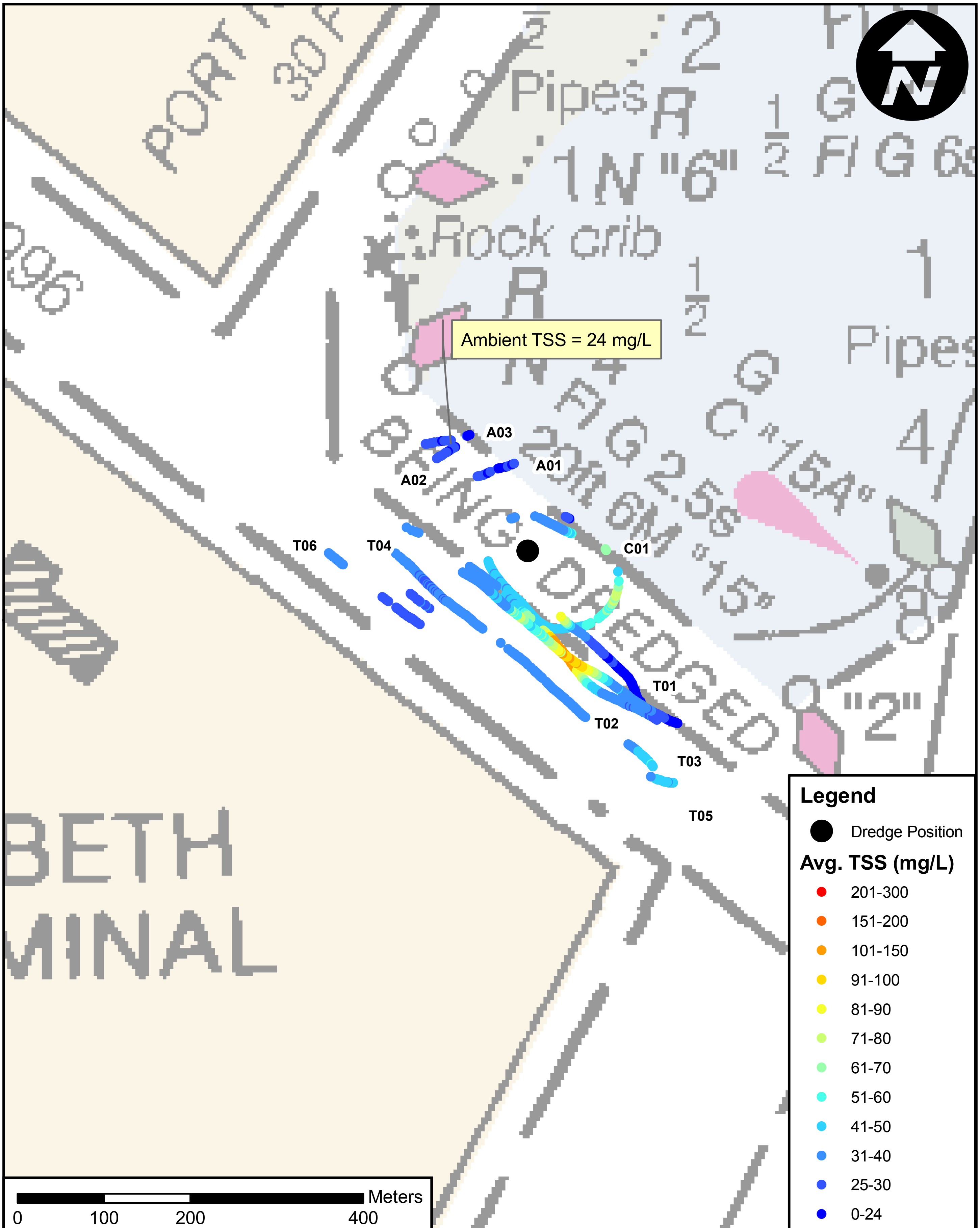


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**ADCP Average TSS - 31 March 2009 (1st Set)** **14-16 Meter Depth Interval**	**Tide**
5h			**Ebb**

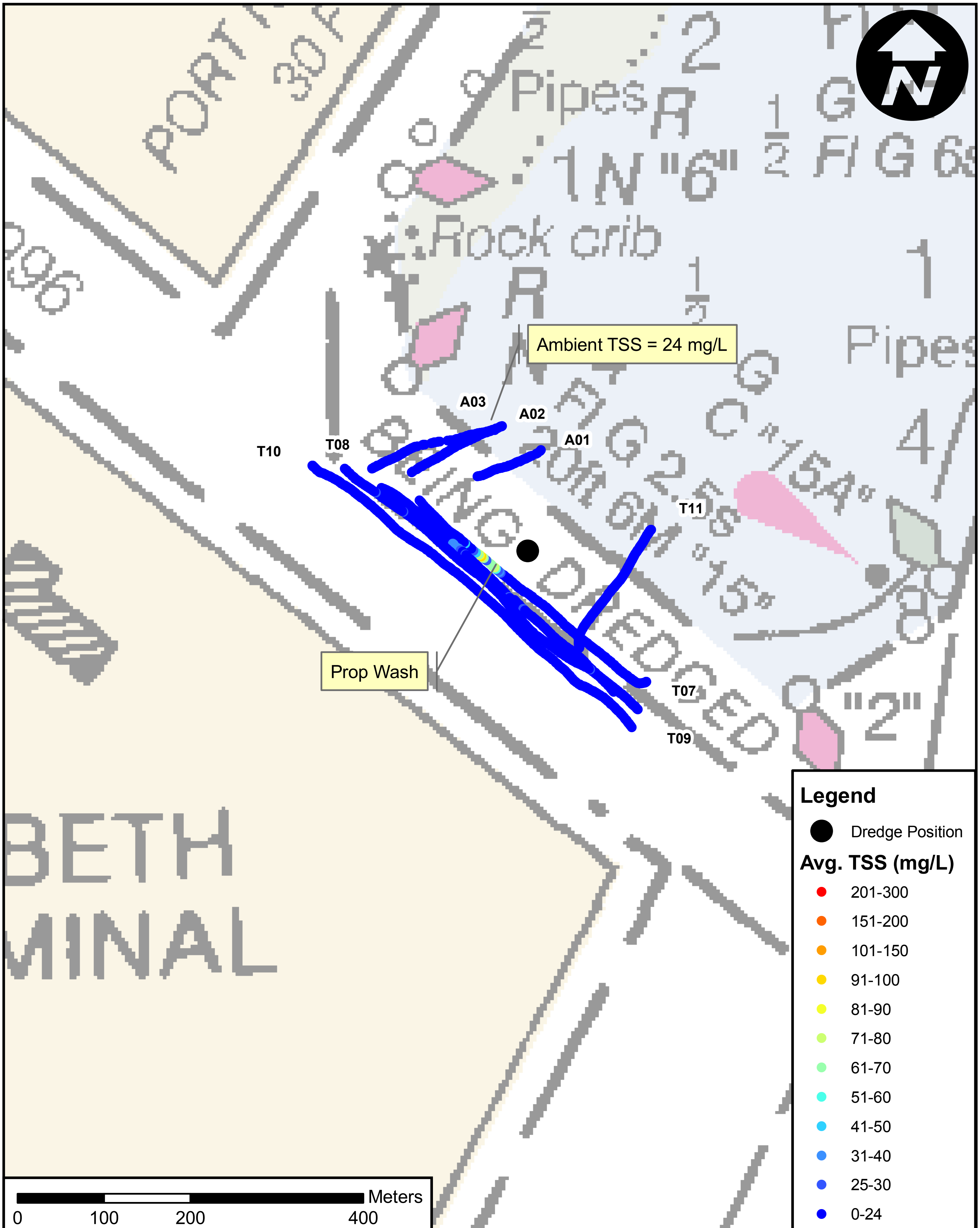


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 31 March 2009 (2nd Set) 0-2 Meter Depth Interval	Tide
6a			Ebb

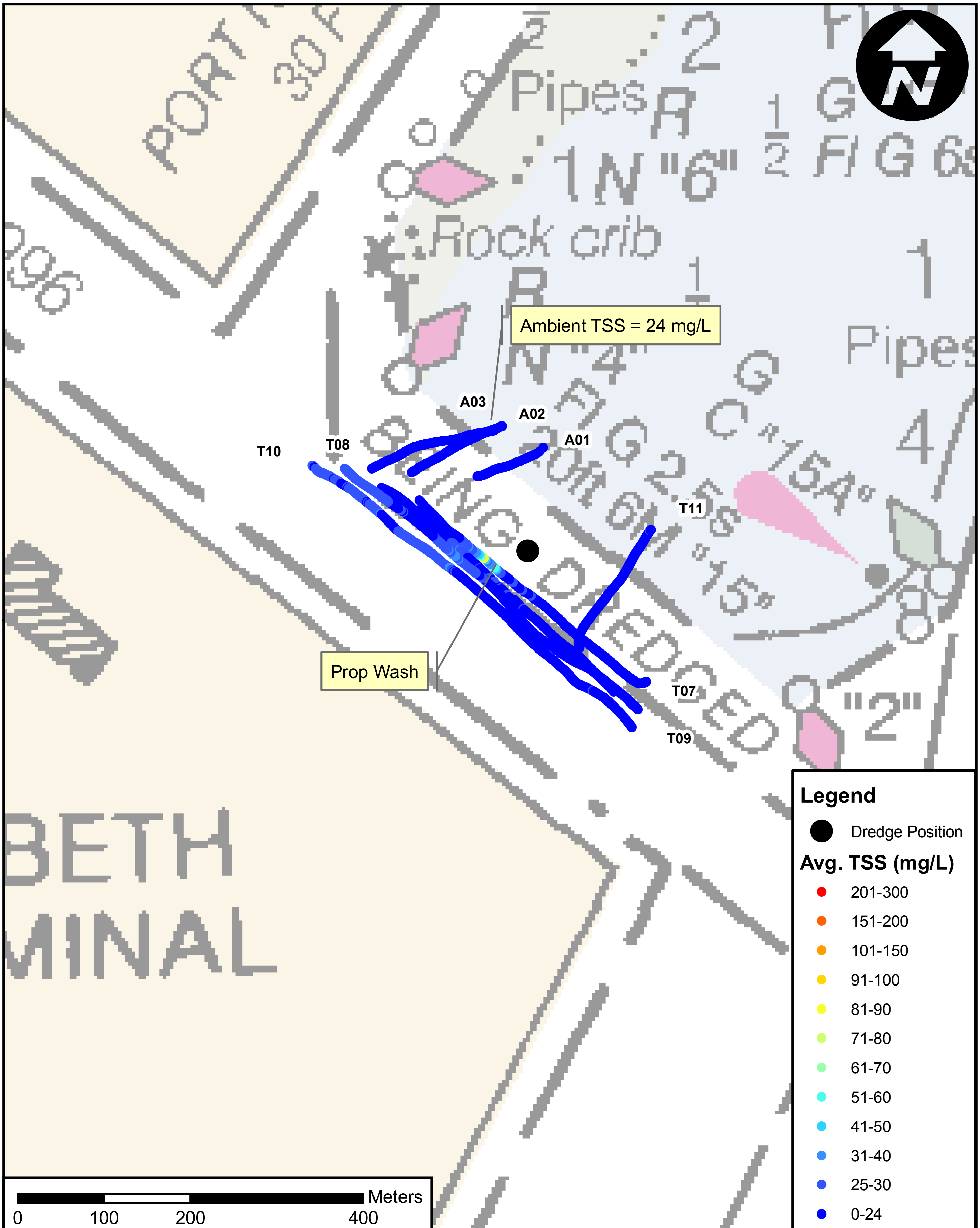


Figure	*USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A*	**ADCP Average TSS - 31 March 2009 (2nd Set) 2-4 Meter Depth Interval**	Tide
6b			Ebb

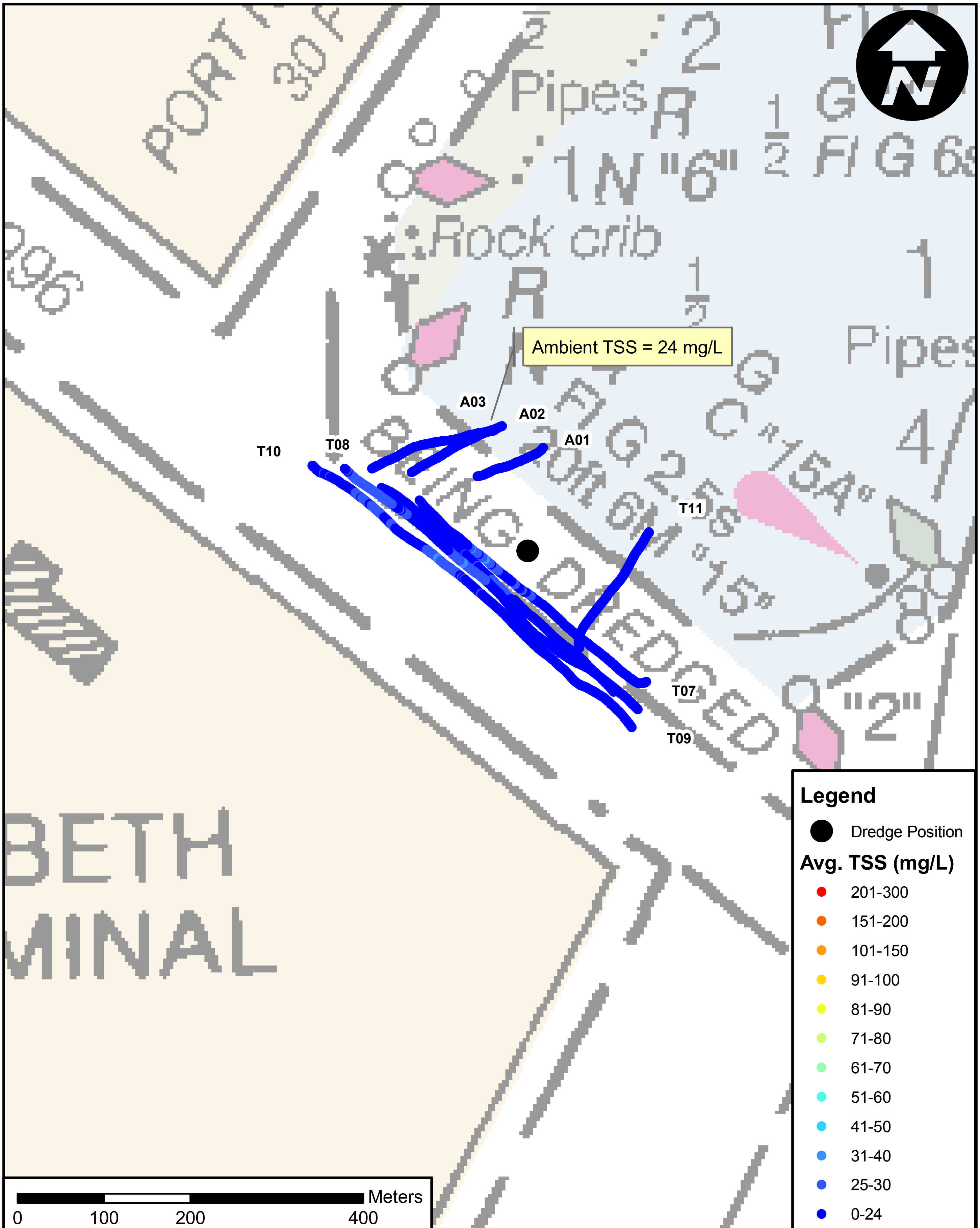


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**ADCP Average TSS - 31 March 2009 (2nd Set)** **4-6 Meter Depth Interval**	**Tide**
6c			**Ebb**

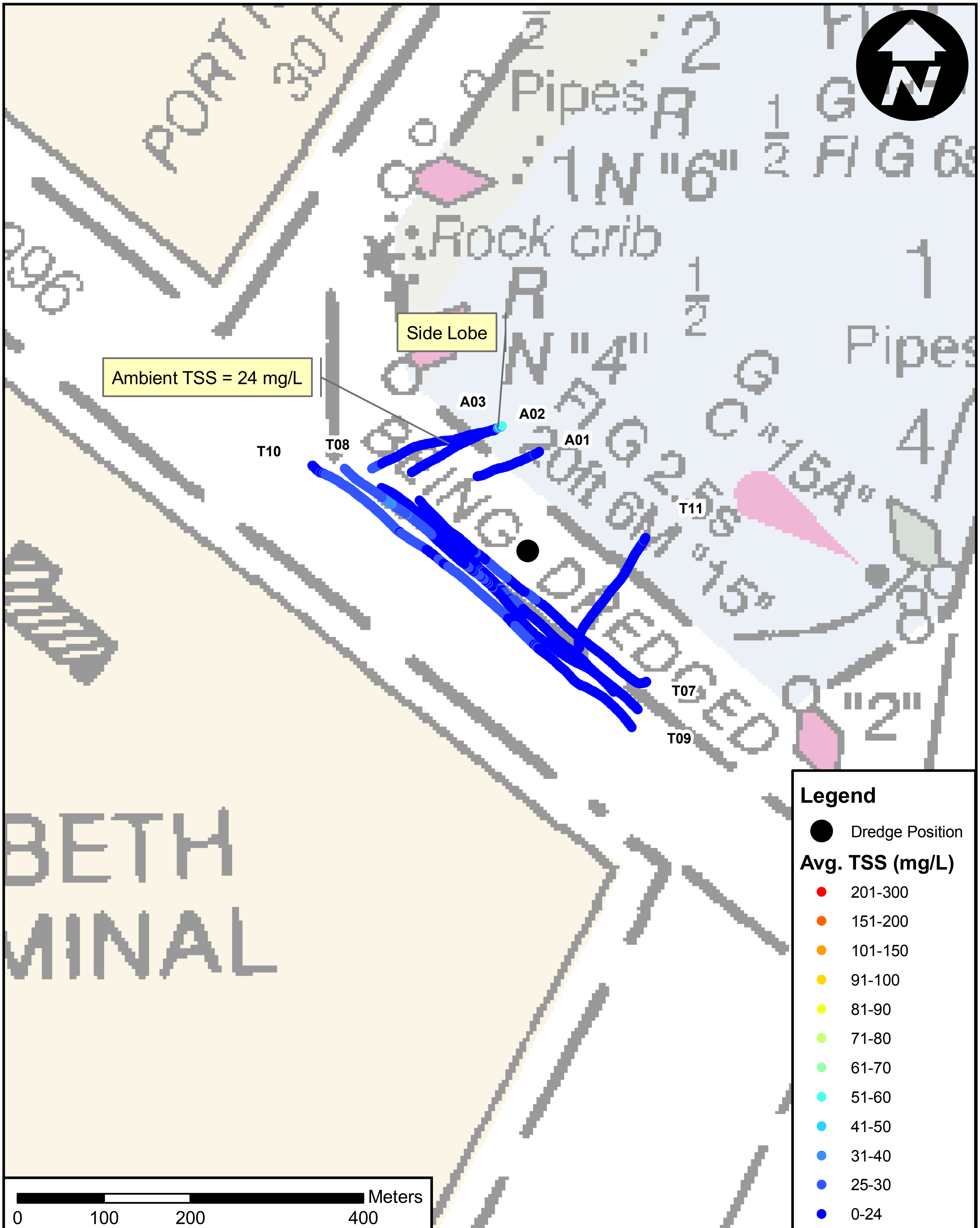


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**ADCP Average TSS - 31 March 2009 (2nd Set)** **6-8 Meter Depth Interval**	Tide
6d			Ebb

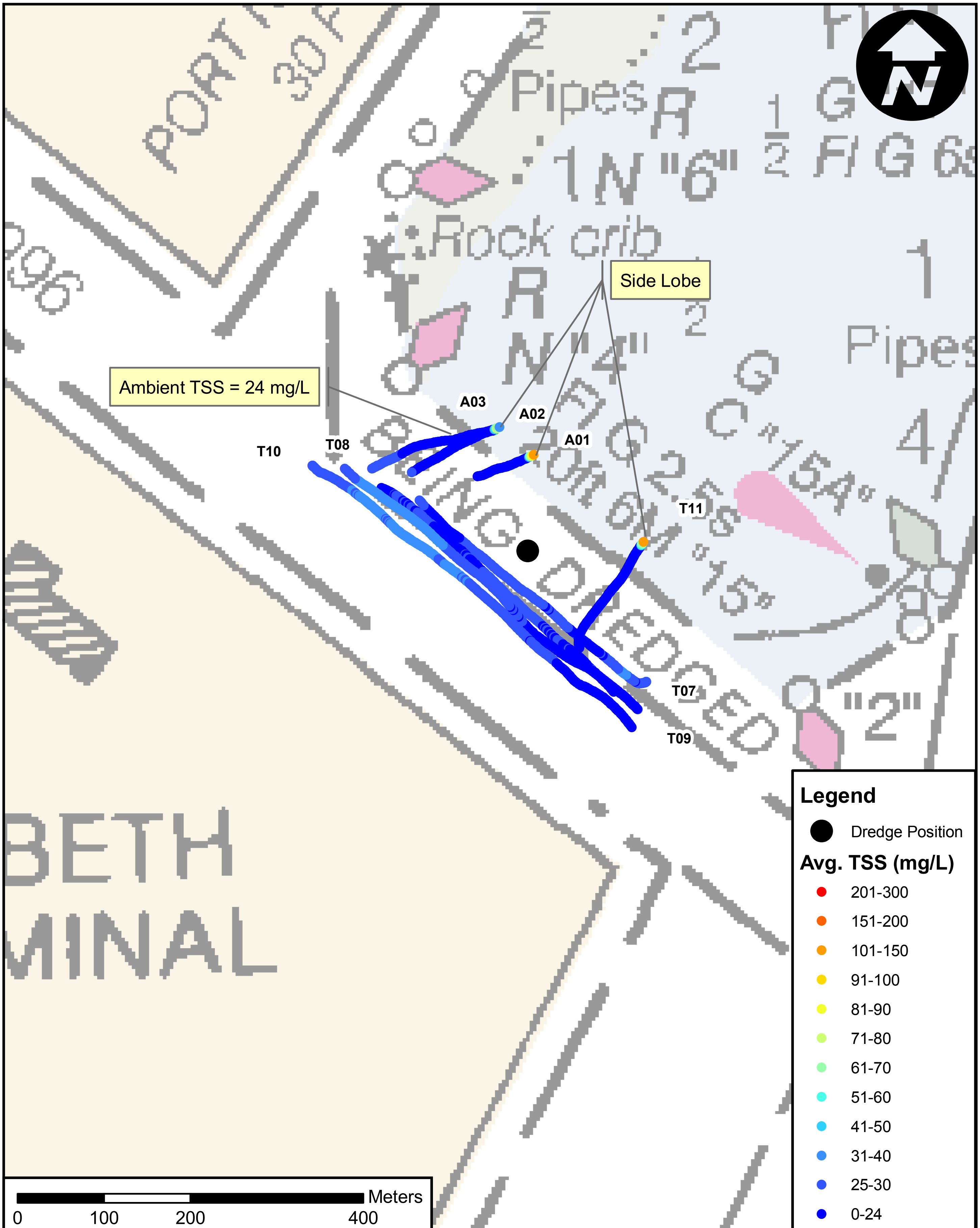


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 31 March 2009 (2nd Set) 8-10 Meter Depth Interval	Tide
6e			Ebb

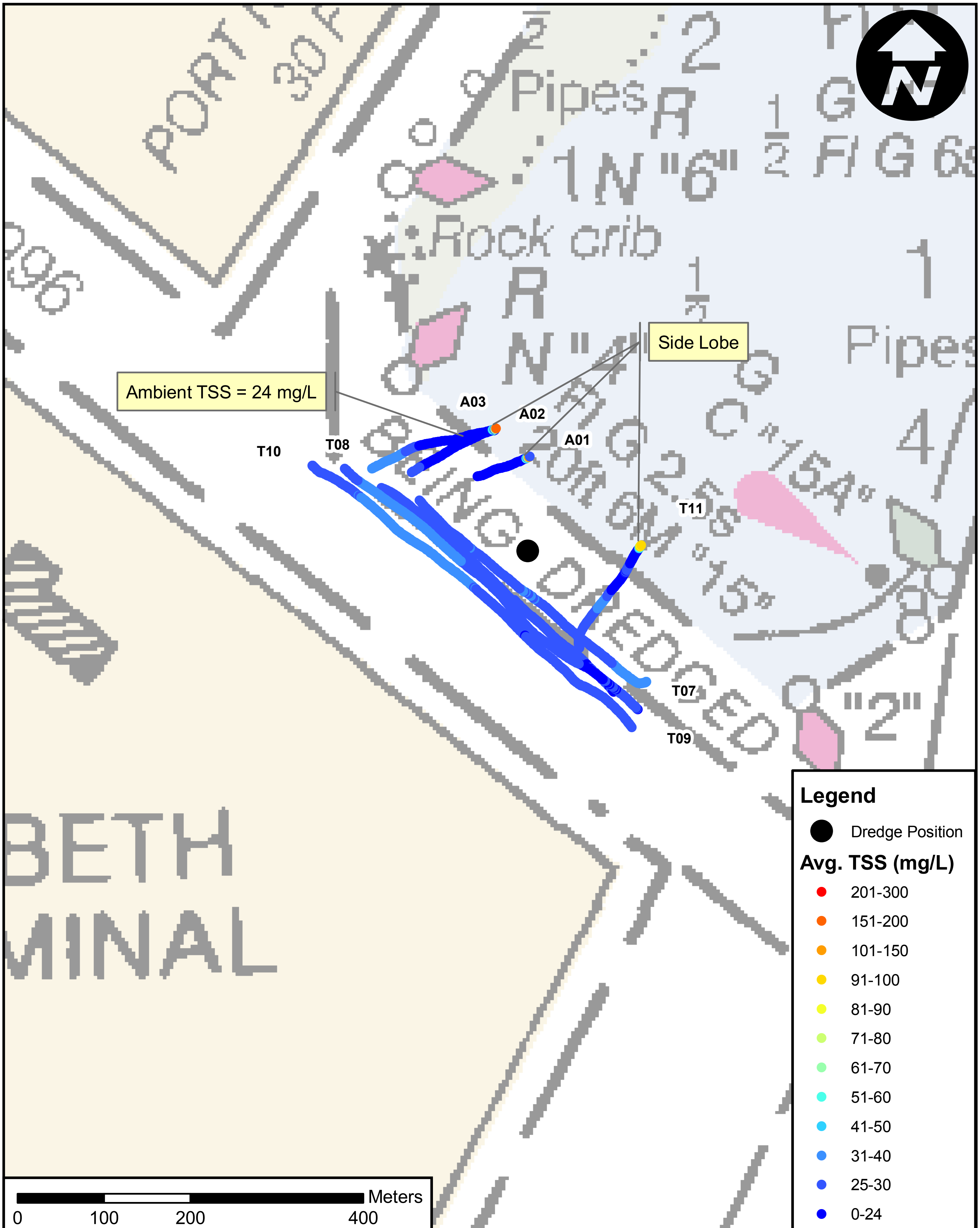


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 31 March 2009 (2nd Set) 10-12 Meter Depth Interval	Tide
6f			Ebb

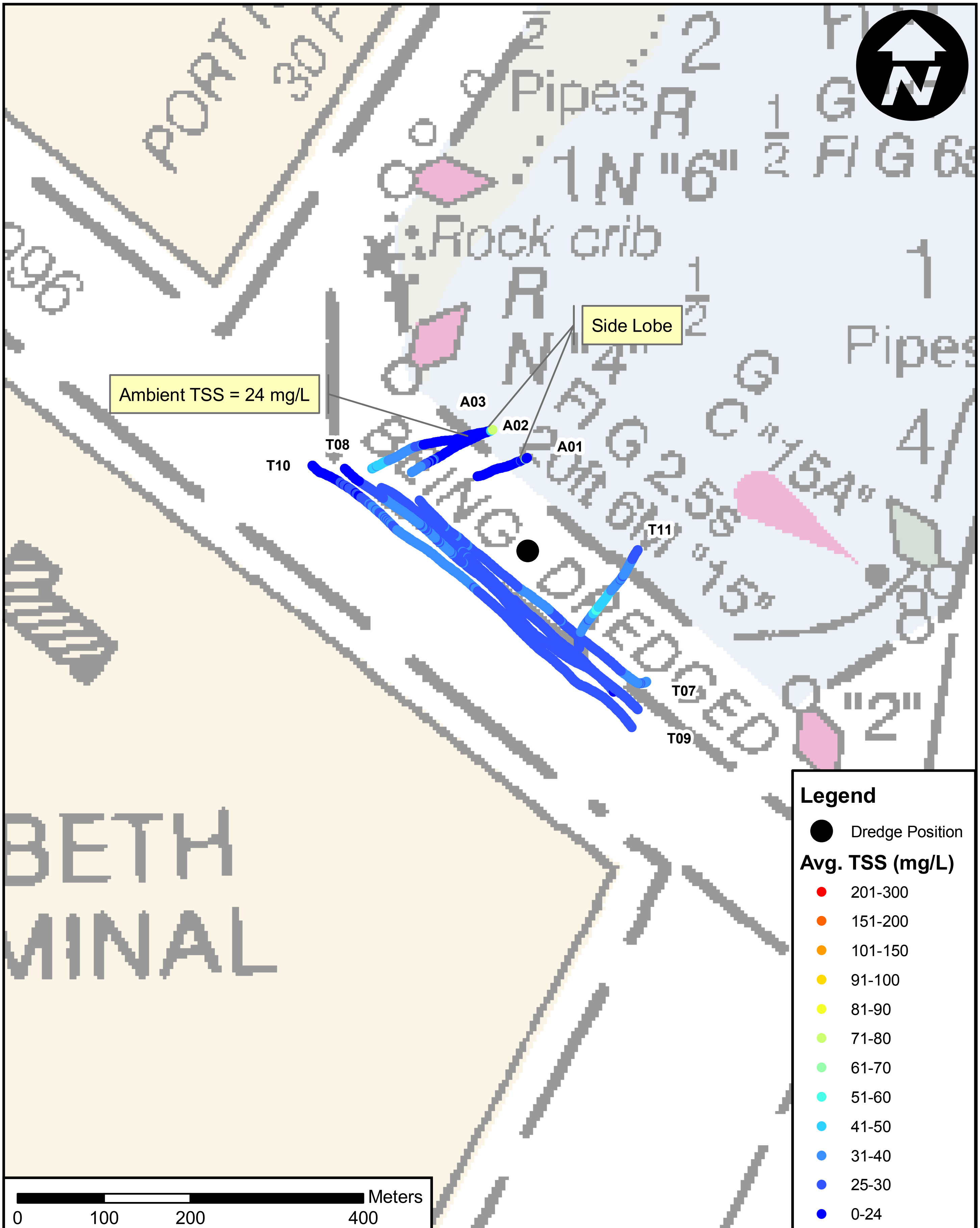
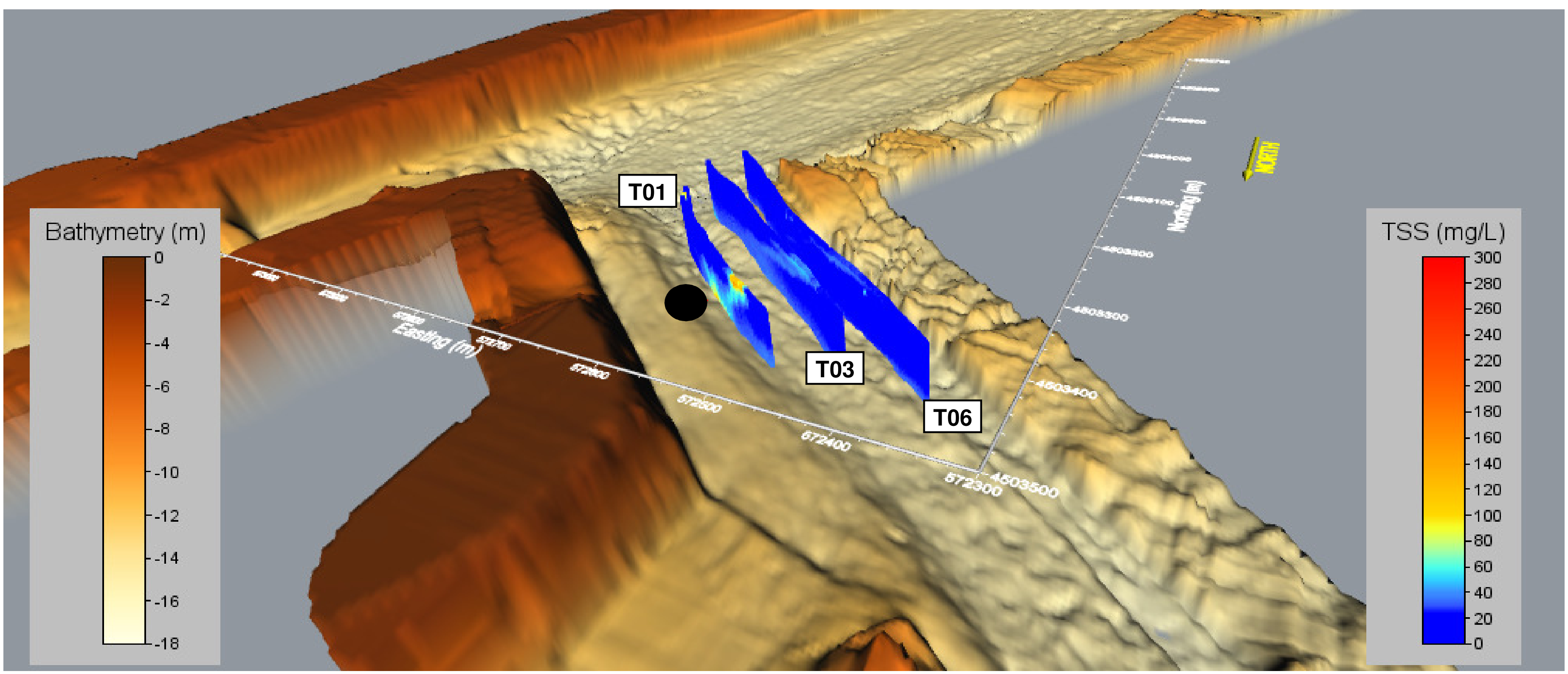


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 31 March 2009 (2nd Set) 12-14 Meter Depth Interval	Tide
6g			Ebb

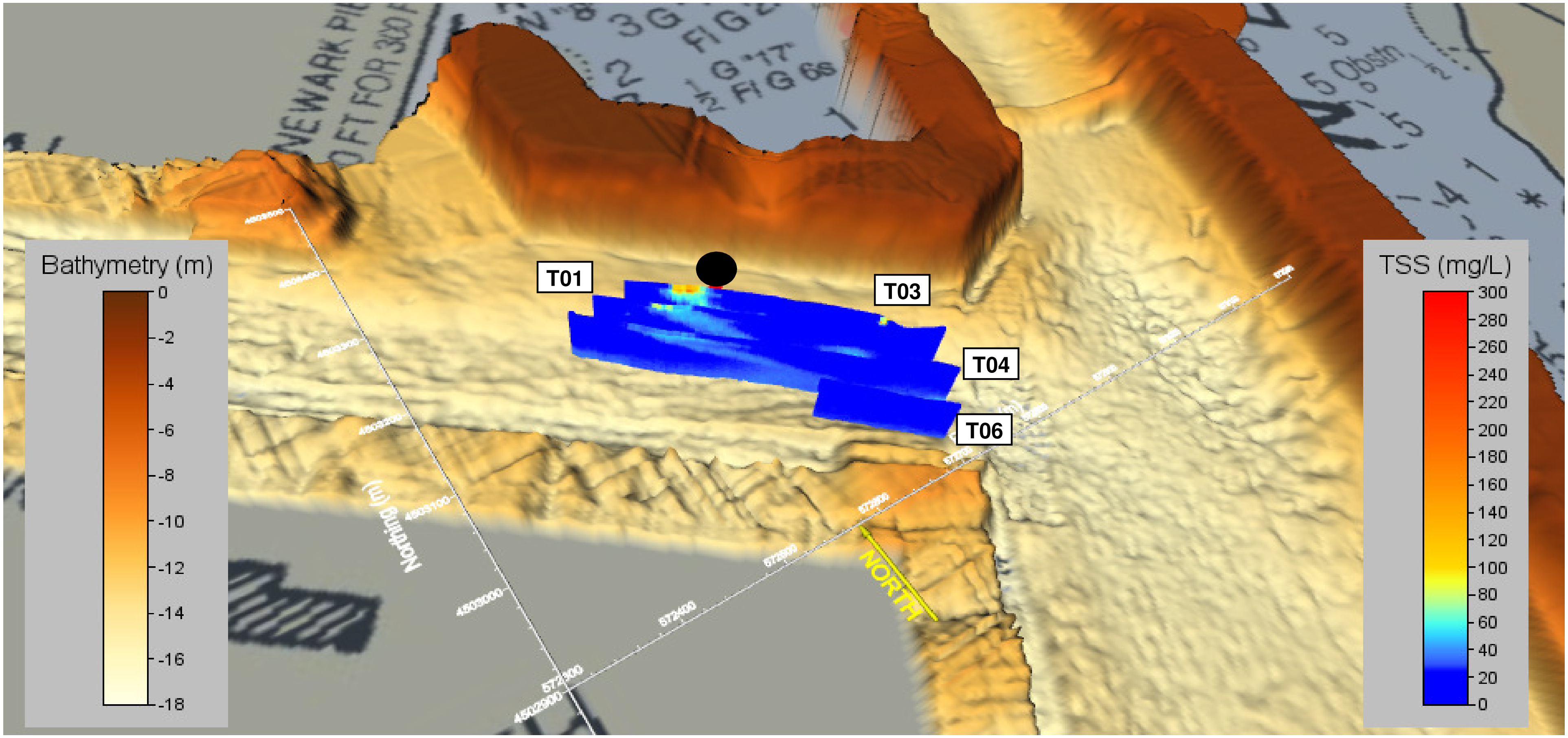


Bathymetry provided by: US Army Corps of Engineers, NY District

Z Scale Exaggerated 6x

● **= Dredge Location**

Figure	*USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A*	**ADCP Average TSS Values with Respect to their x, y, and z Coordinates Superimposed on Channel Bathymetry (1st Set) 31 March 2009**	**Tide**
7a			**Ebb**

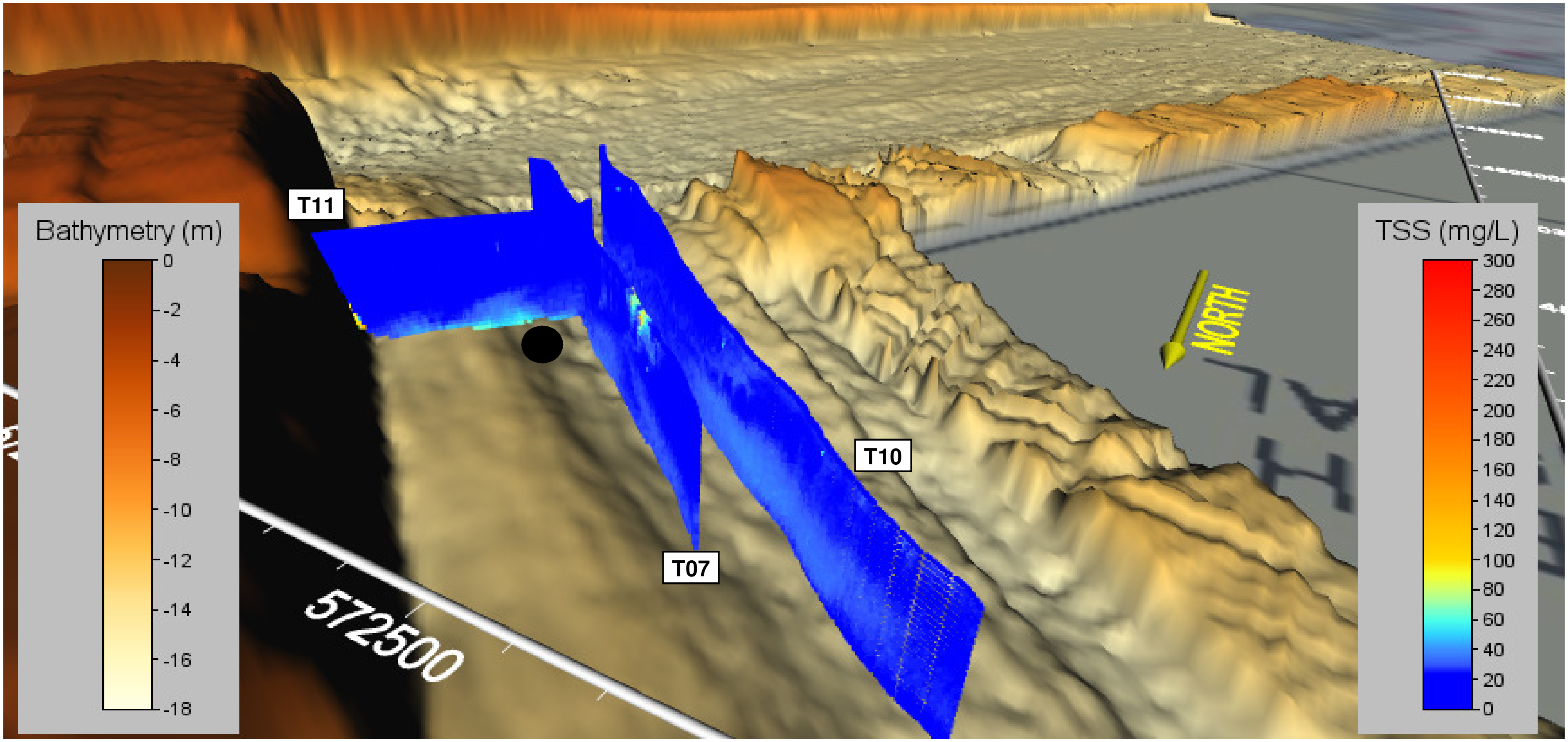


Bathymetry provided by: US Army Corps of Engineers, NY District

Z Scale Exaggerated 6x

● = Dredge Location

Figure	*USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A*	ADCP Average TSS Values with Respect to their x, y, and z Coordinates Superimposed on Channel Bathymetry (1st Set) 31 March 2009	Tide
7b			Ebb



Bathymetry provided by: US Army Corps of Engineers, NY District

Z Scale Exaggerated 6x

● **= Dredge Location**

Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**ADCP Average TSS Values with Respect to their x, y, and z Coordinates** **Superimposed on Channel Bathymetry (2nd Set)** **31 March 2009**	**Tide**
8			**Ebb**

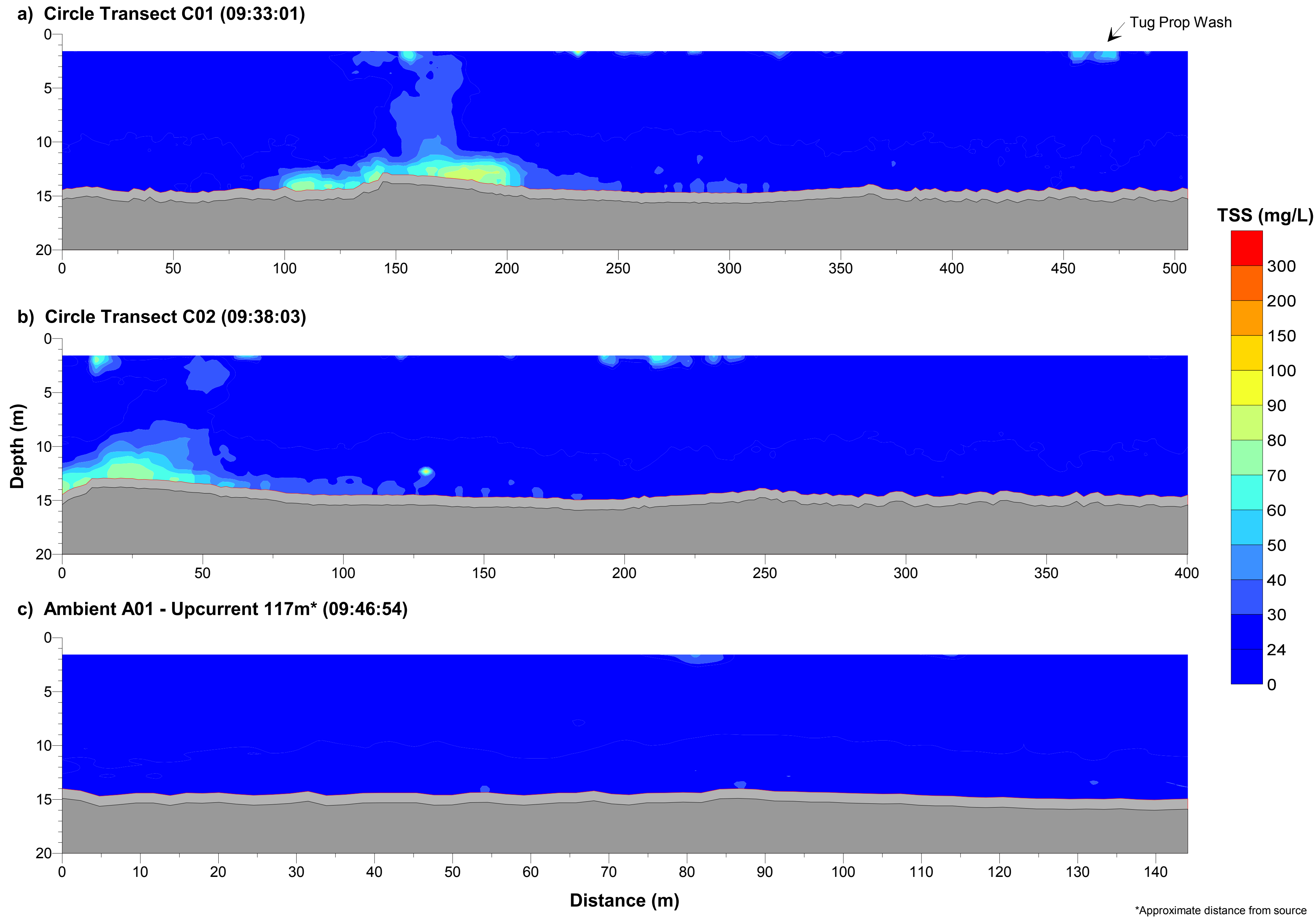
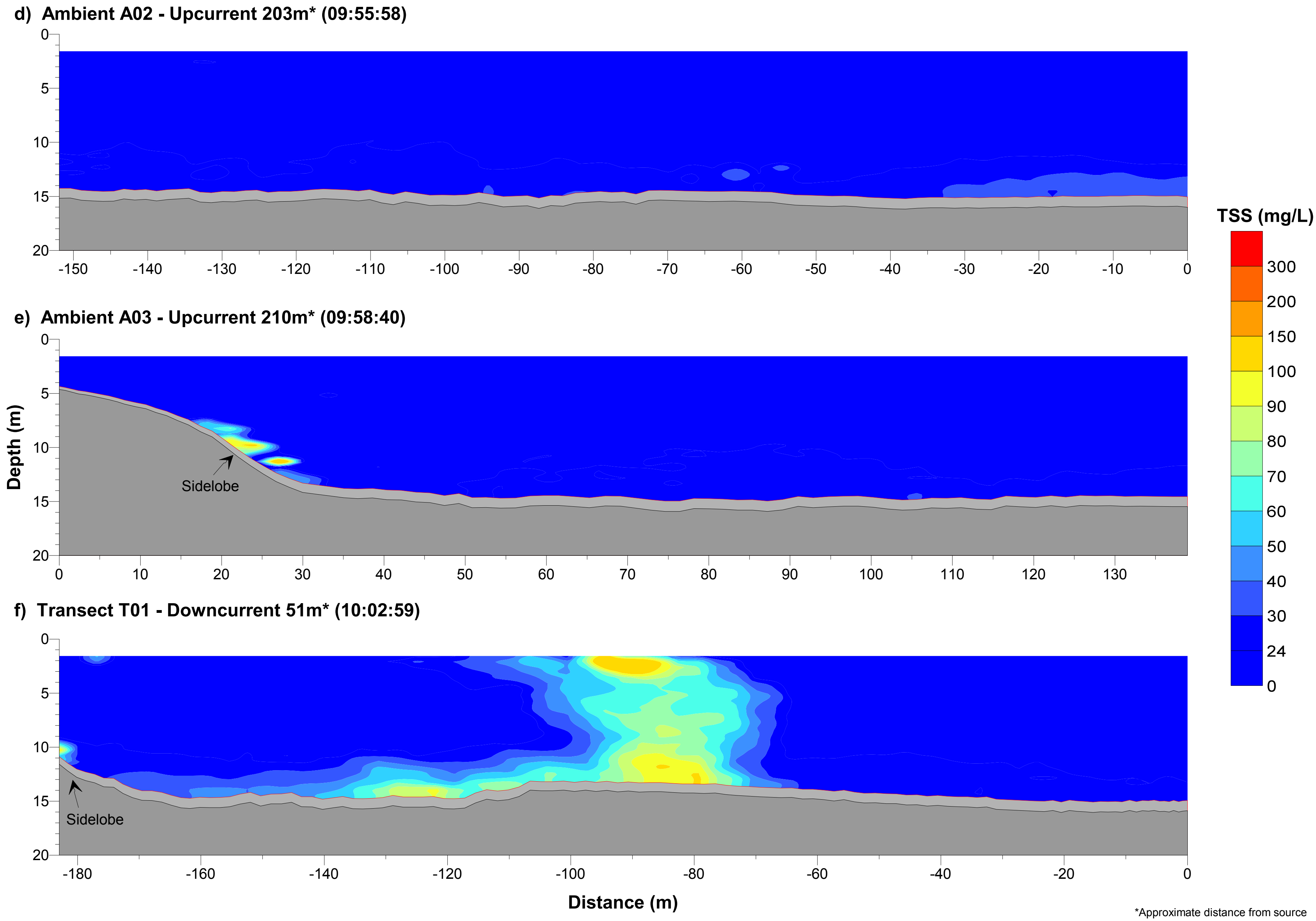
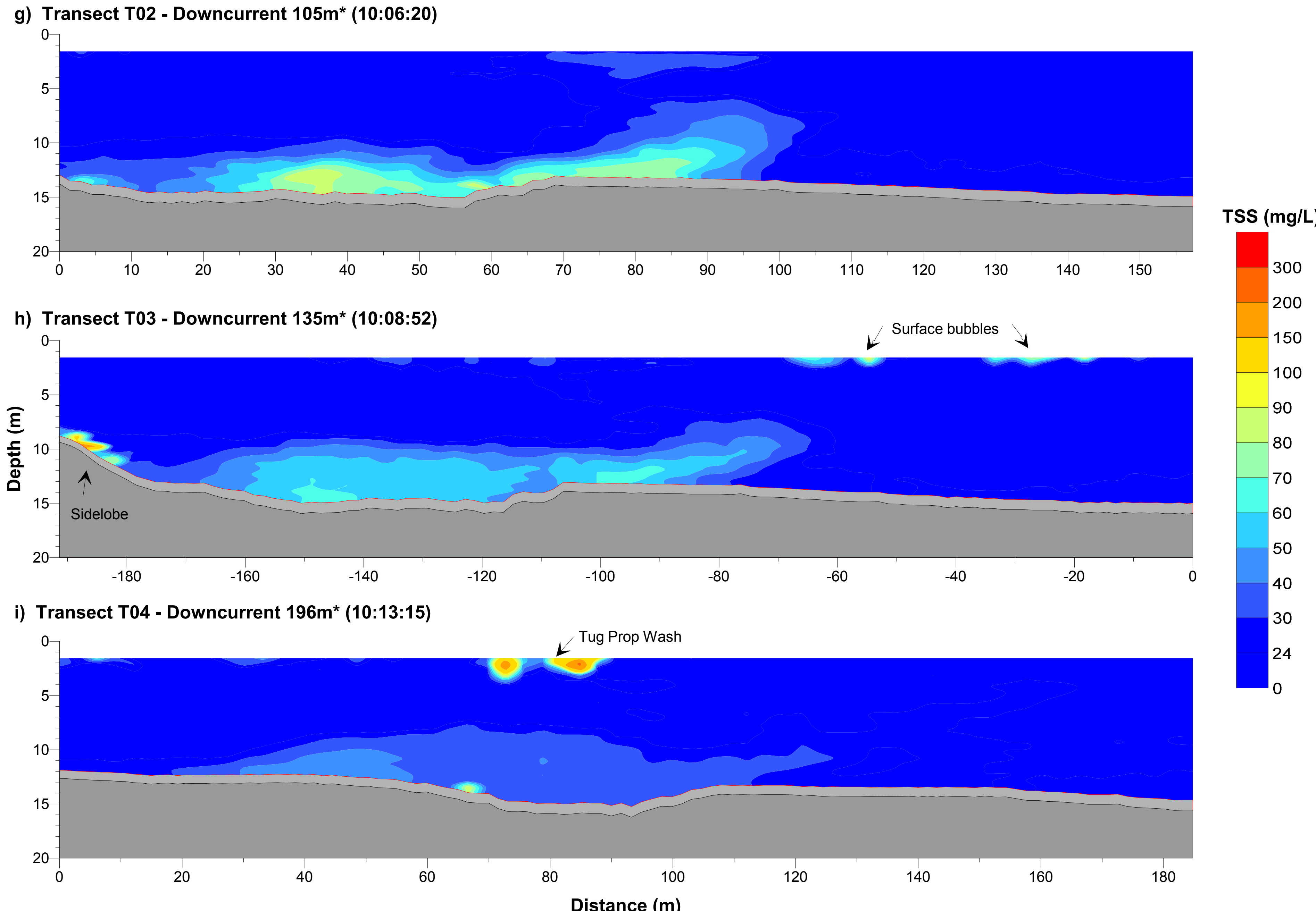


FIGURE	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**Vertical Profiles of ADCP Average TSS** **01 April 2009 (1st Set)**	TIDE
9a-c			Flood



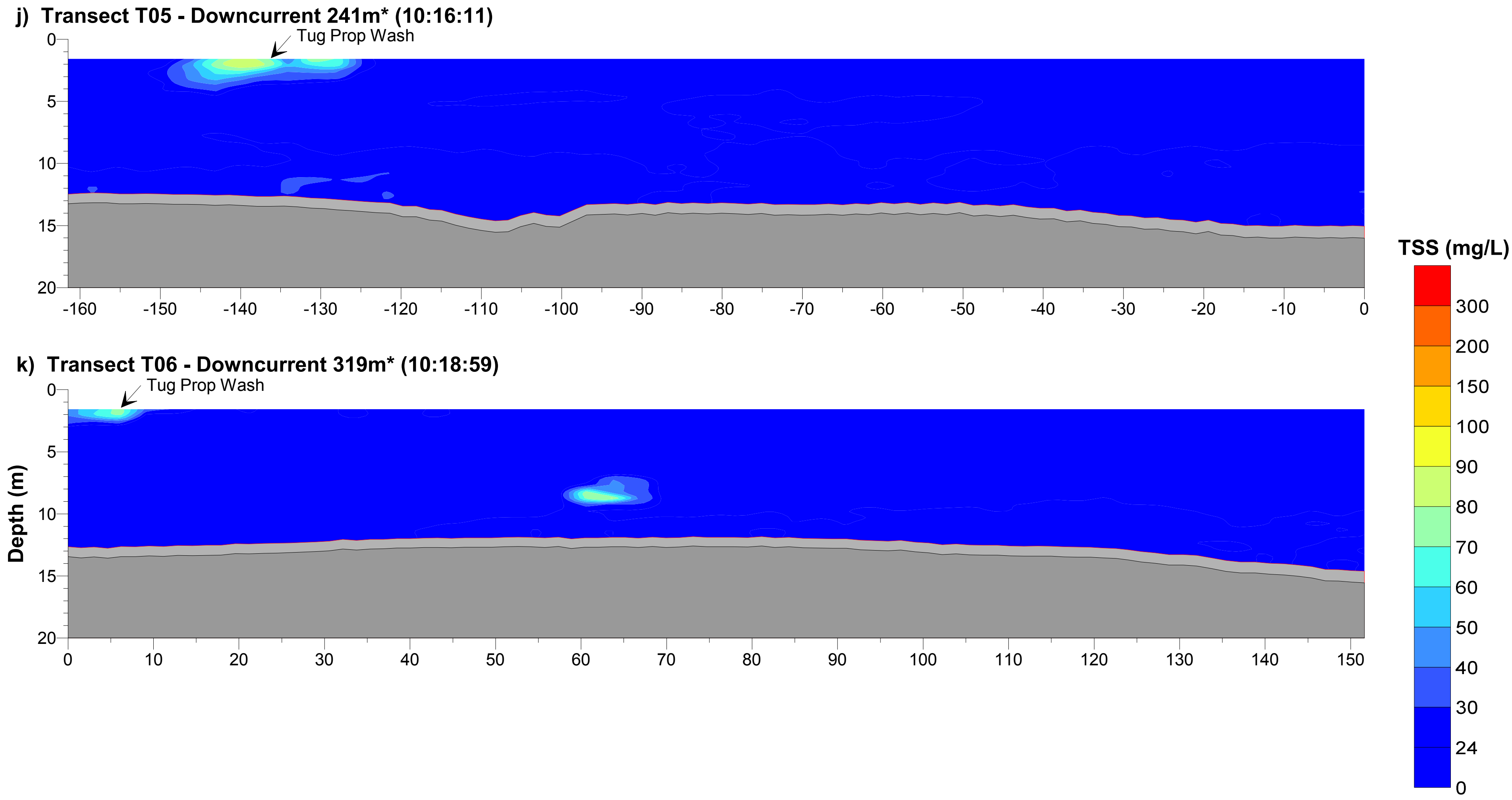
*Approximate distance from source

FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	Vertical Profiles of ADCP Average TSS 01 April 2009 (1st Set)	TIDE
9d-f			Flood



*Approximate distance from source

FIGURE	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**Vertical Profiles of ADCP Average TSS** **01 April 2009 (1st Set)**	TIDE
9g-i			**Flood**



*Approximate distance from source

FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	Vertical Profiles of ADCP Average TSS 01 April 2009 (1st Set)	TIDE
9j-k			Flood

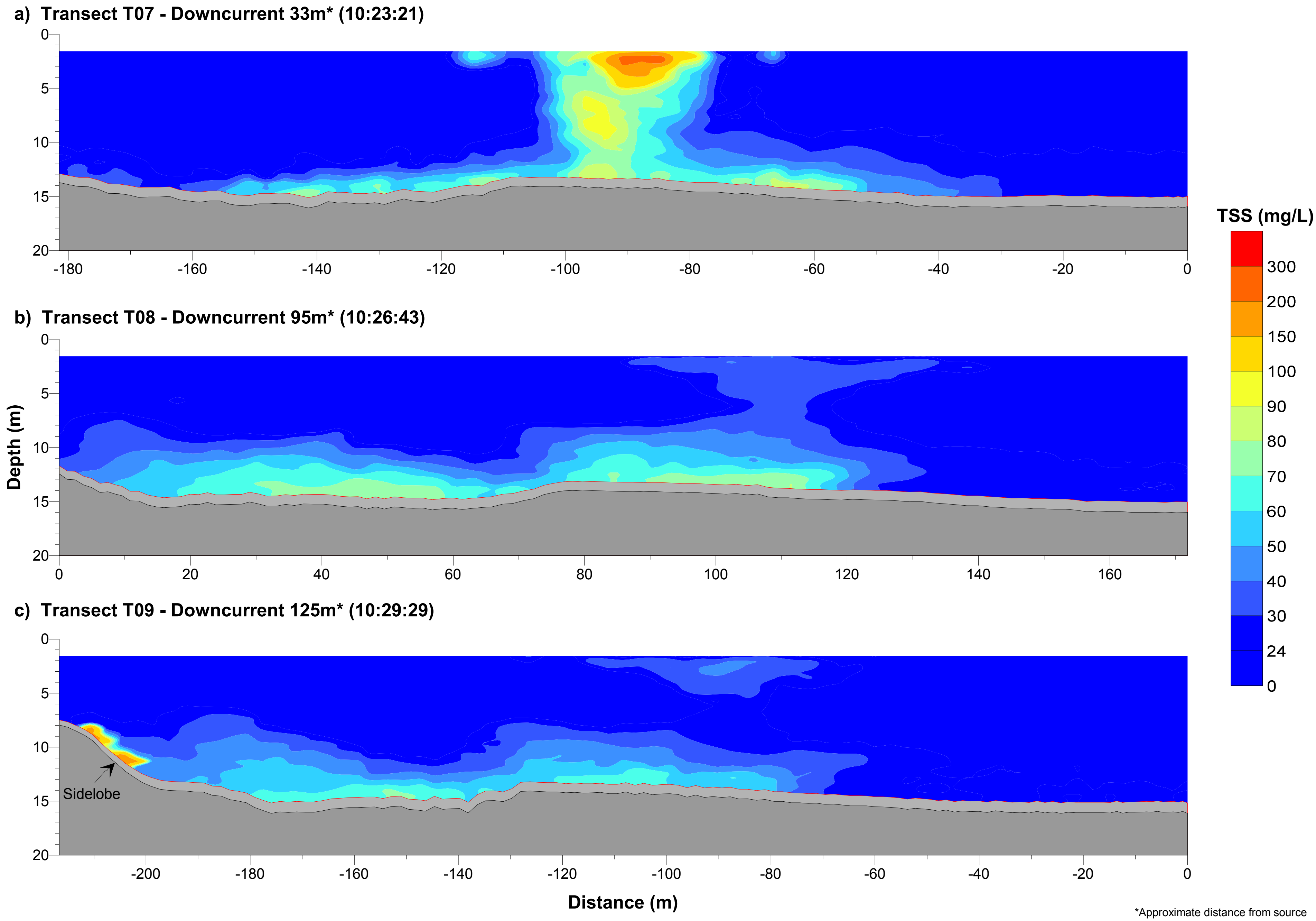


FIGURE	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**Vertical Profiles of ADCP Average TSS** **01 April 2009 (2nd Set)**	TIDE
10a-c			**Flood**

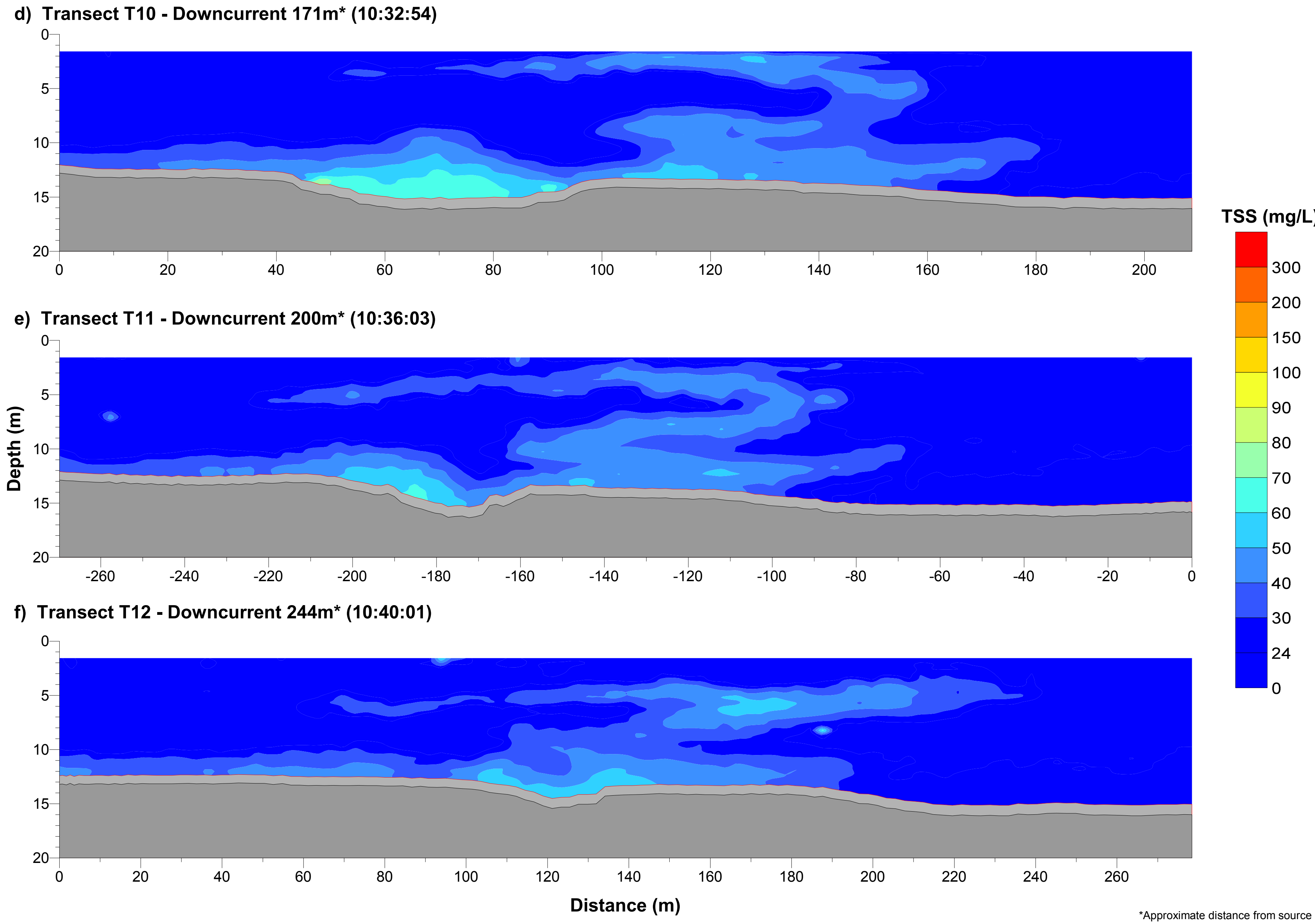
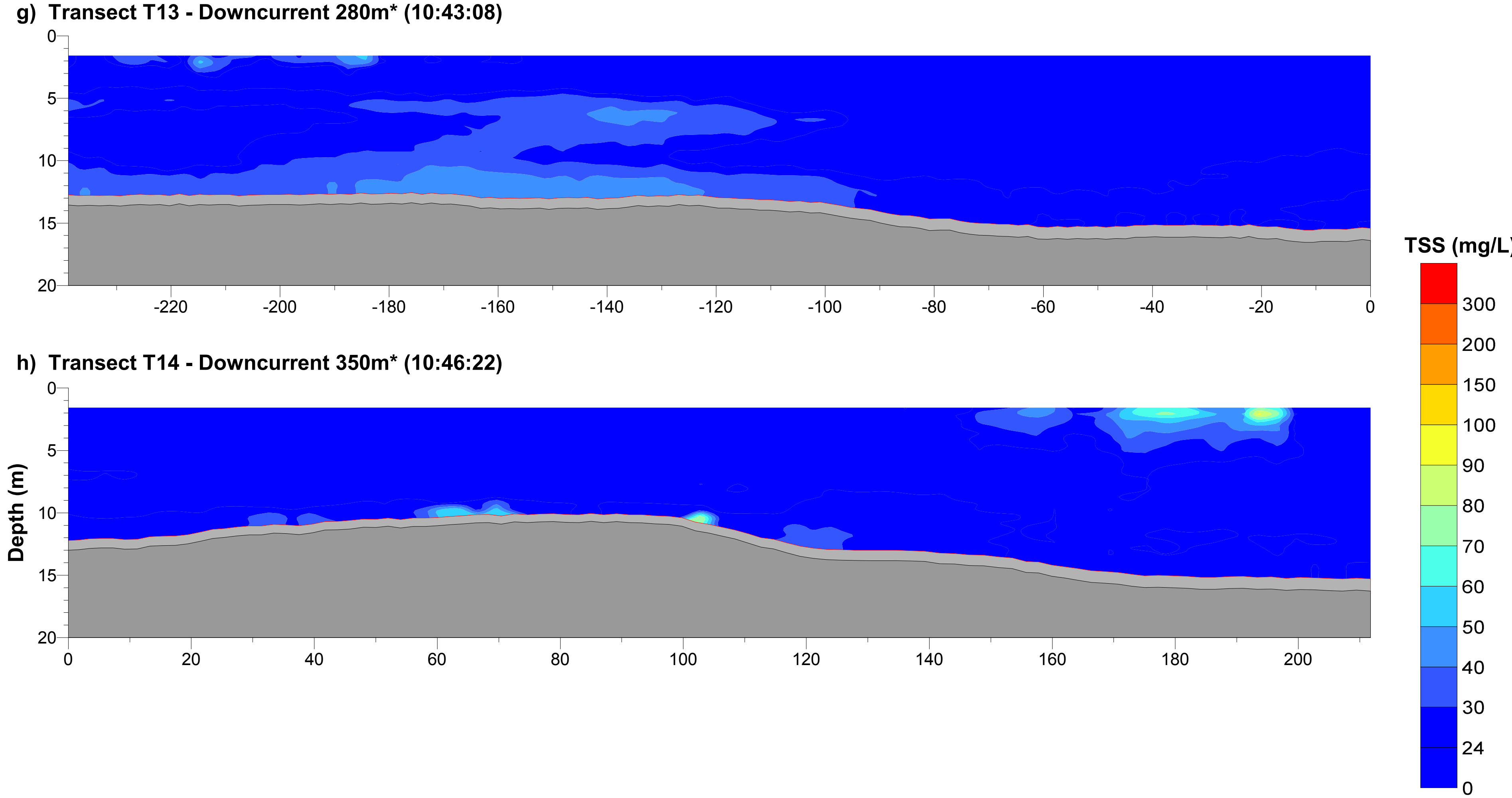


FIGURE	*USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A*	**Vertical Profiles of ADCP Average TSS 01 April 2009 (2nd Set)**	TIDE
10d-f			**Flood**



*Approximate distance from source

FIGURE	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**Vertical Profiles of ADCP Average TSS** **01 April 2009 (2nd Set)**	TIDE
10g-h			**Flood**

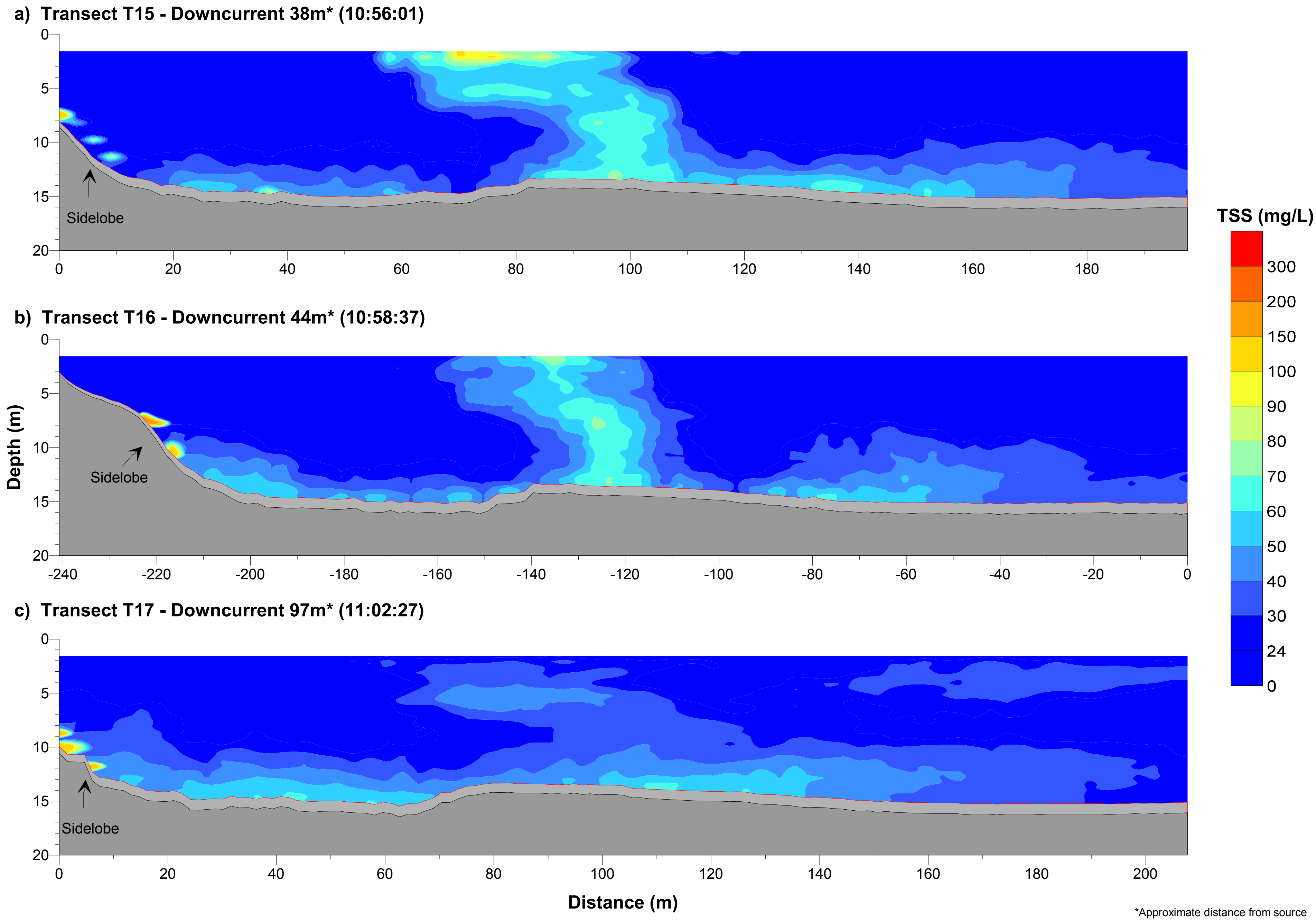
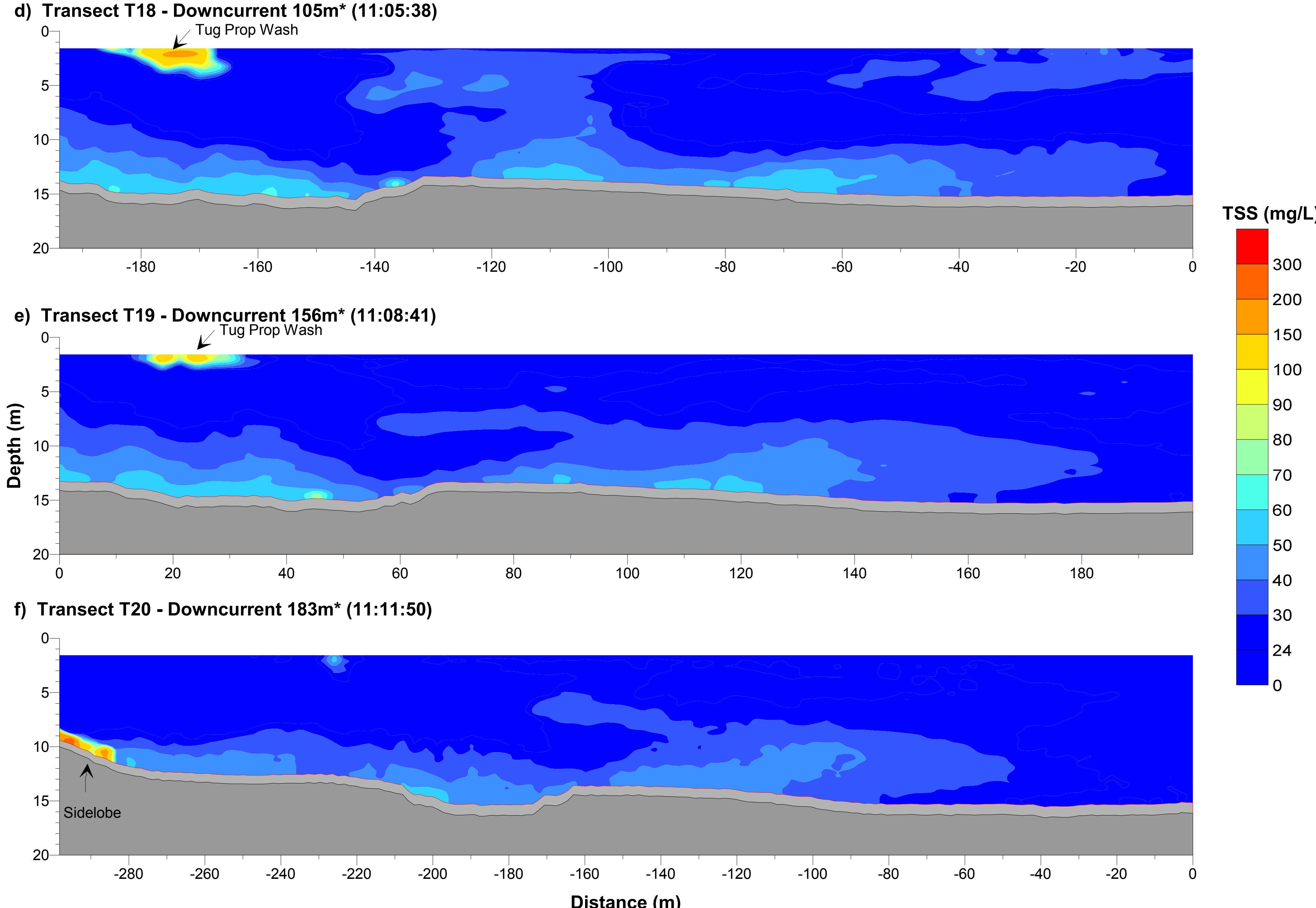


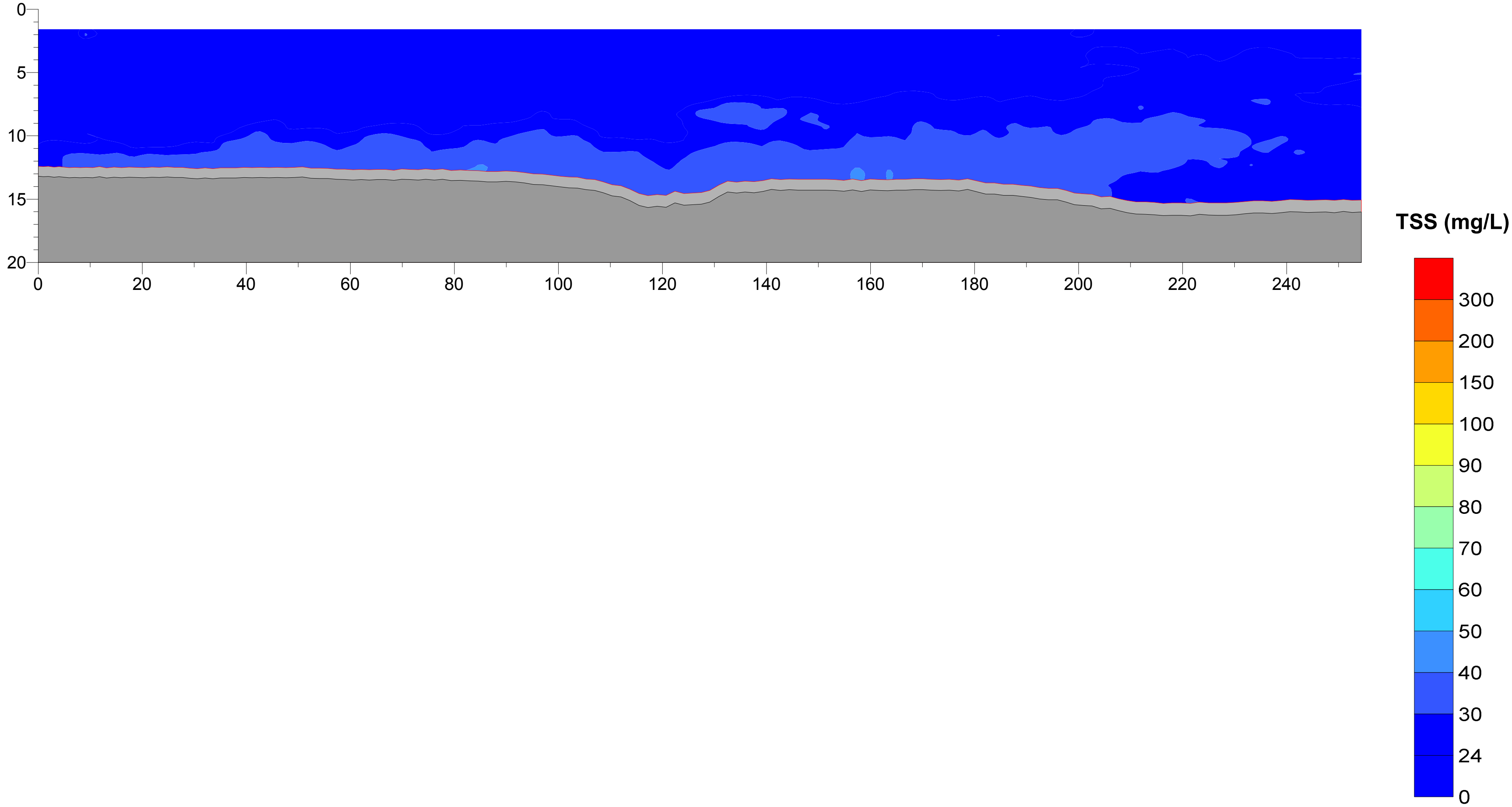
FIGURE	*USACE Harborwide TSS*	**Vertical Profiles of ADCP Average TSS**	TIDE
11a-c	*Far Field Survey* *HDP Contract Area: S-E-1: A*	**01 April 2009 (3rd Set)**	**Flood**



*Approximate distance from source

FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	Vertical Profiles of ADCP Average TSS 01 April 2009 (3rd Set)	TIDE
11d-f			Flood

g) Transect T21 - Downcurrent 240m* (11:16:22)



*Approximate distance from source

FIGURE	*USACE Harborwide TSS*	**Vertical Profiles of ADCP Average TSS**	TIDE
11g	*Far Field Survey* *HDP Contract Area: S-E-1: A*	**01 April 2009 (3rd Set)**	Flood

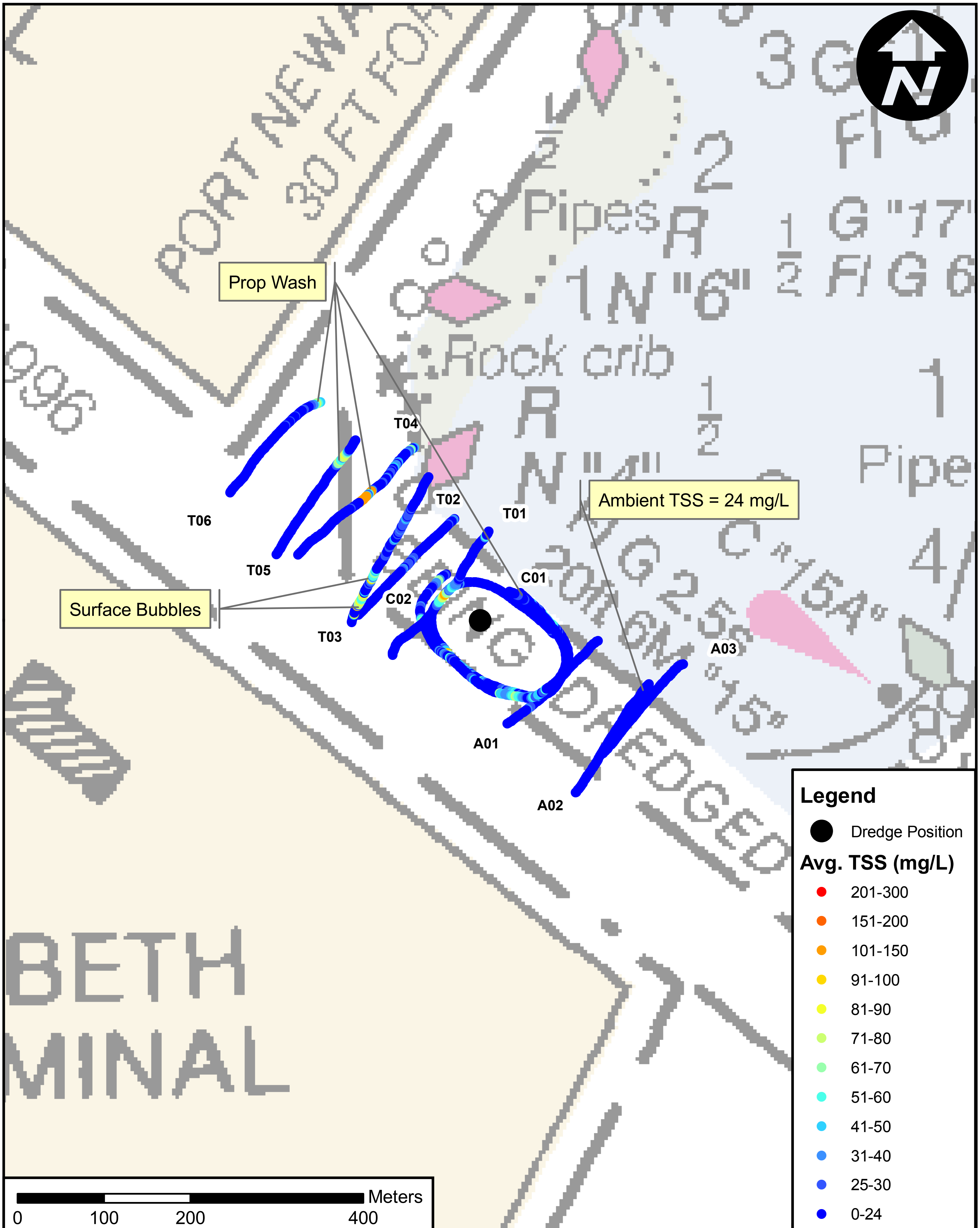


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 1 April 2009 (1st Set) 0-2 Meter Depth Interval	Tide
12a			Flood

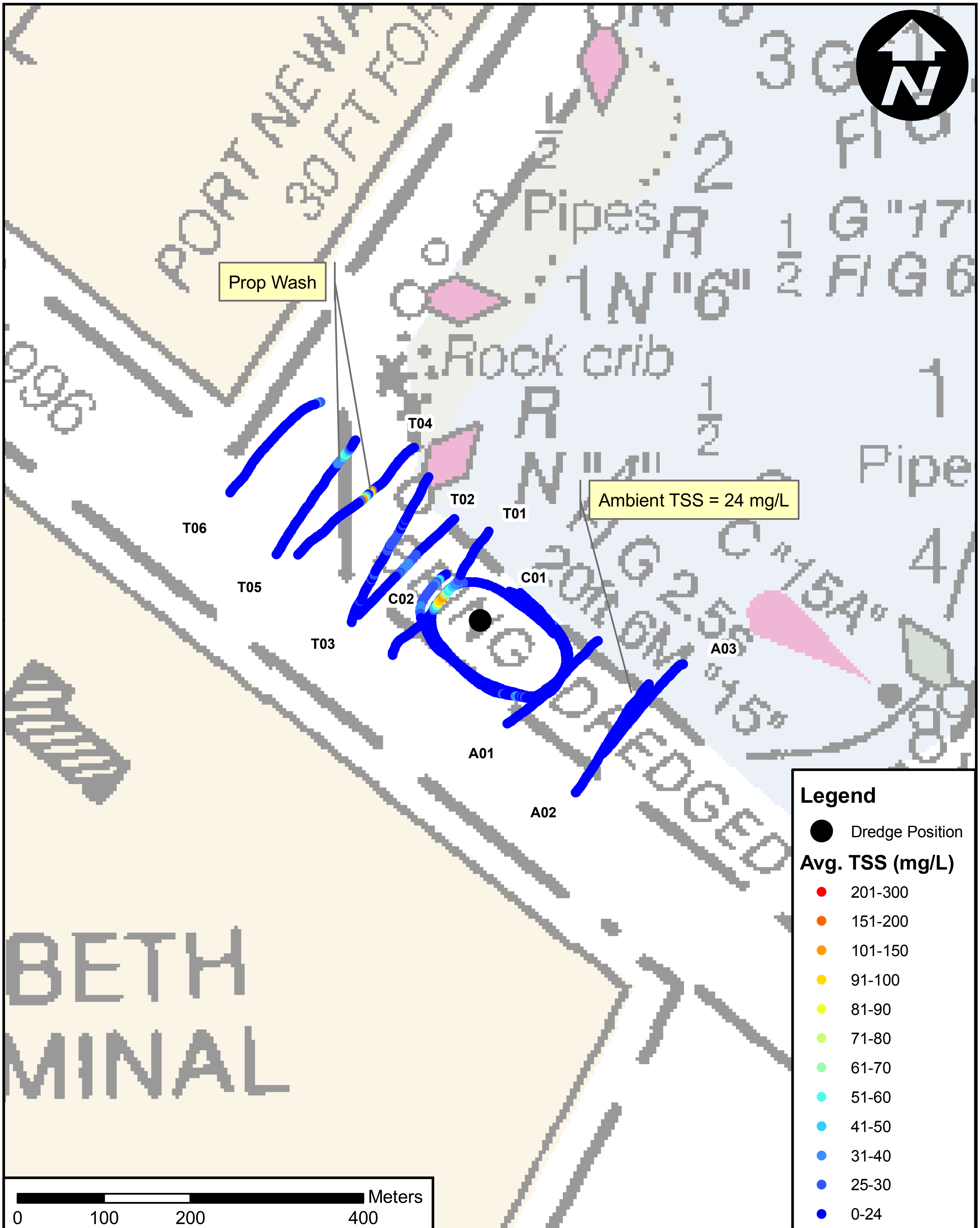


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 1 April 2009 (1st Set) 2-4 Meter Depth Interval	Tide
12b			Flood

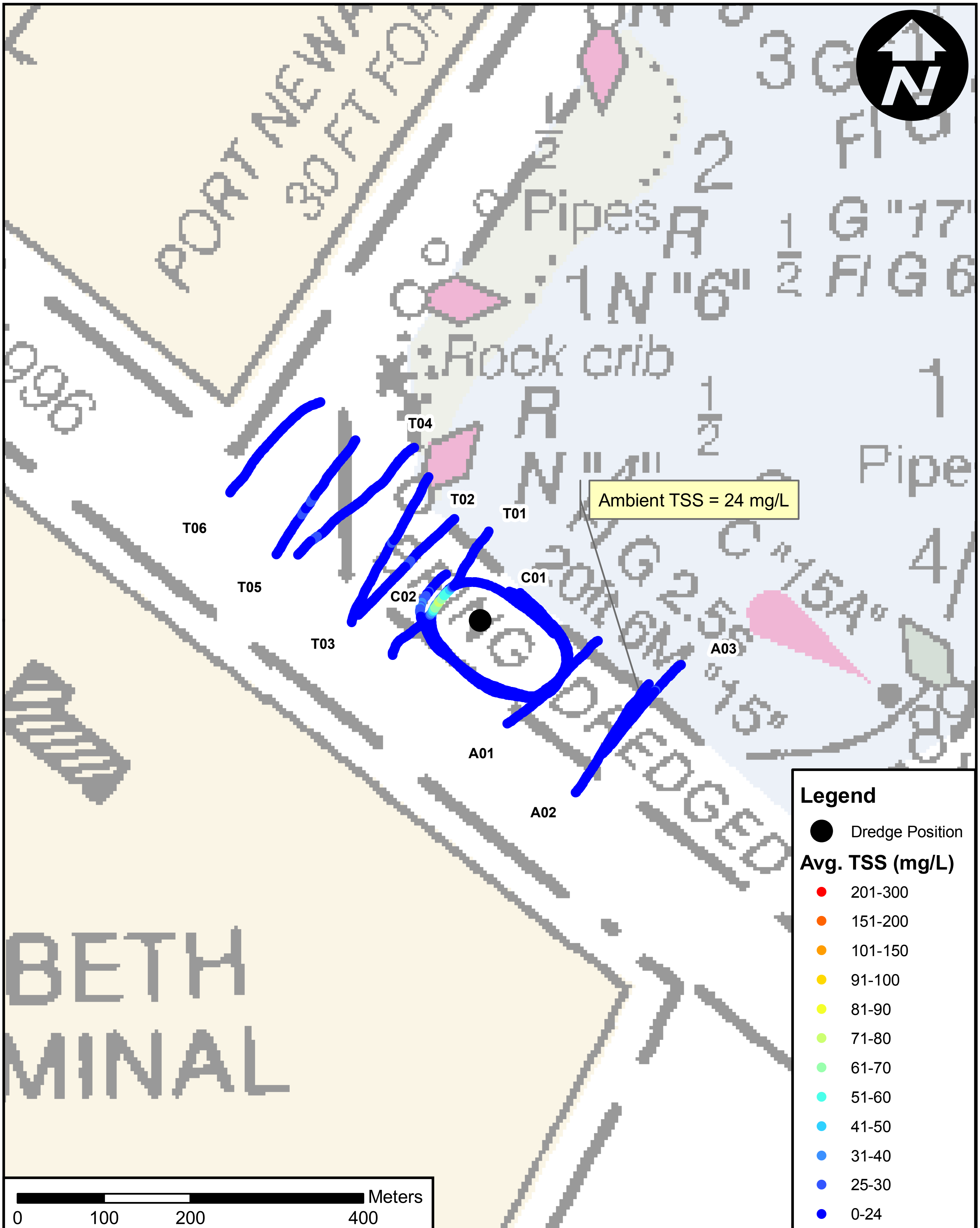


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**ADCP Average TSS - 1 April 2009 (1st Set)** **4-6 Meter Depth Interval**	**Tide**
12c			**Flood**

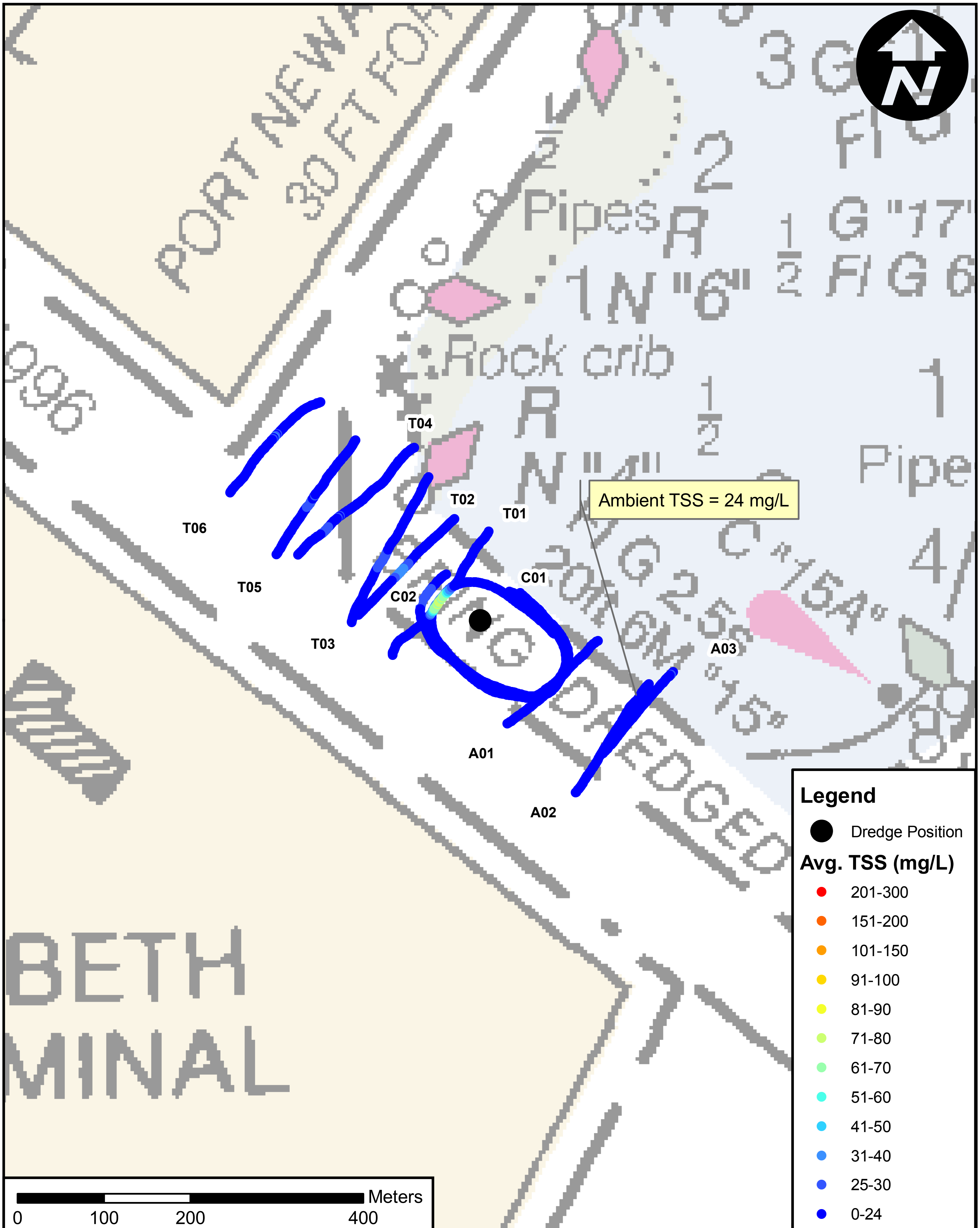


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**ADCP Average TSS - 1 April 2009 (1st Set)** **6-8 Meter Depth Interval**	**Tide**
12d			**Flood**

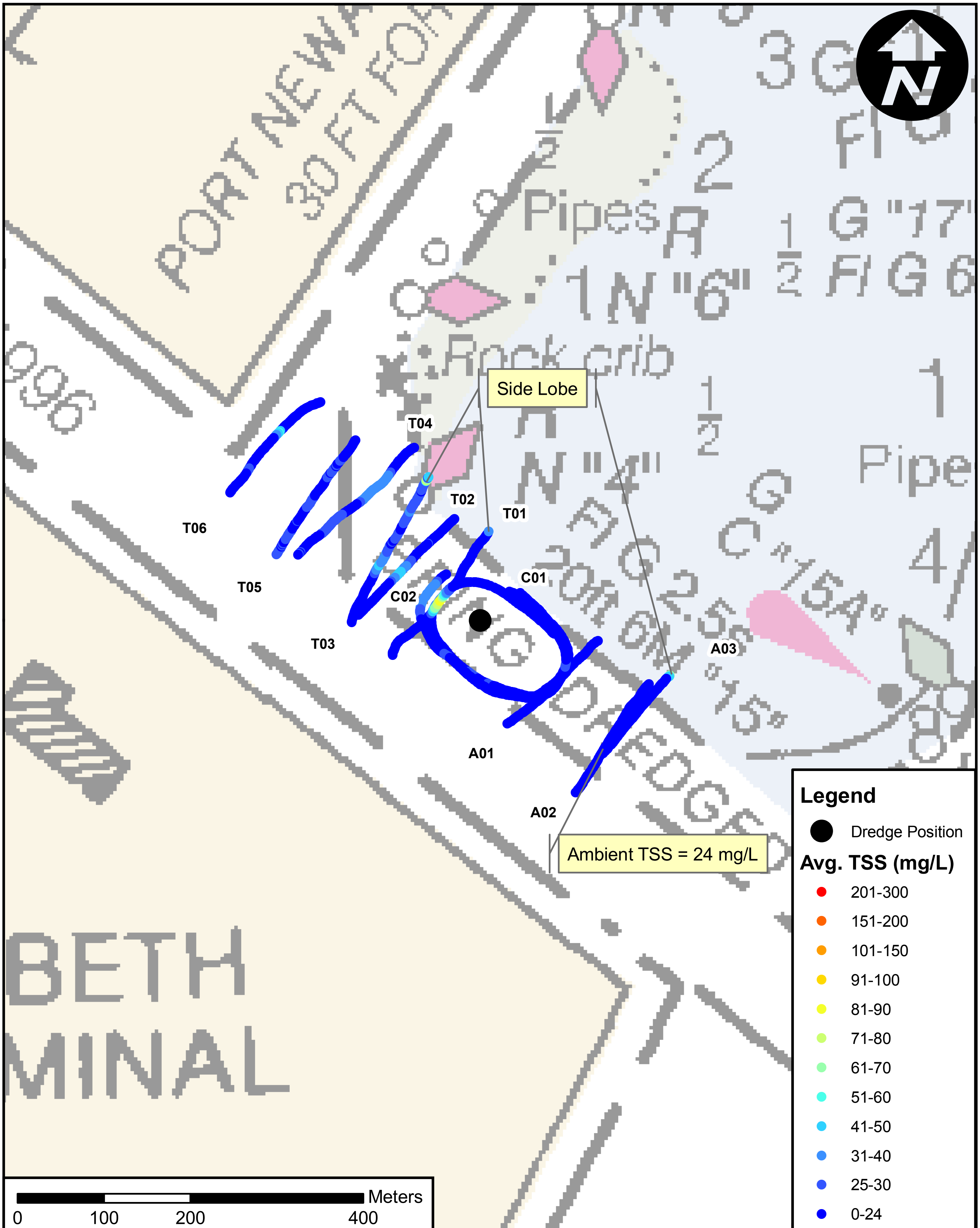


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**ADCP Average TSS - 1 April 2009 (1st Set)** **8-10 Meter Depth Interval**	Tide
12e			Flood

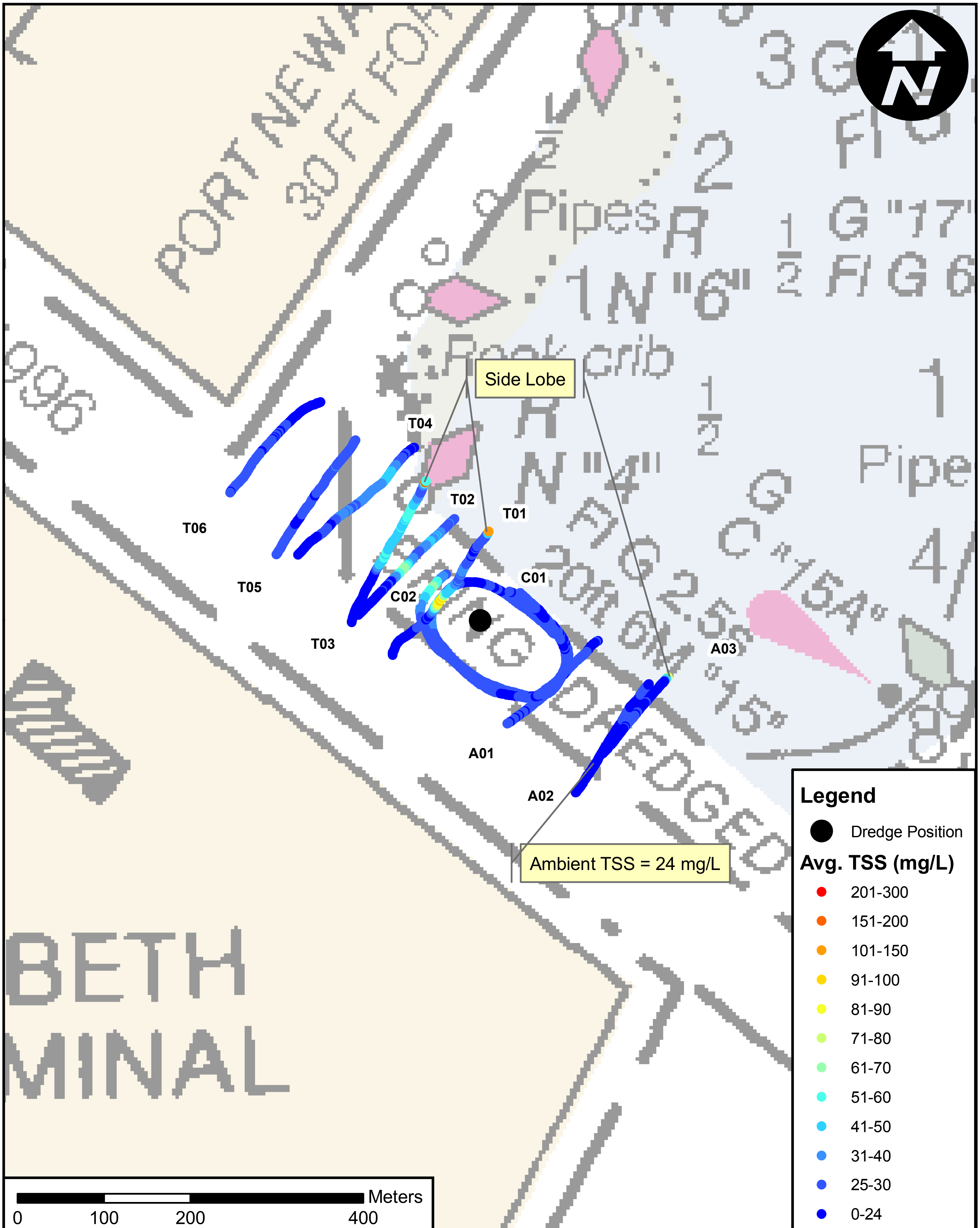


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 1 April 2009 (1st Set) 10-12 Meter Depth Interval	Tide
12f			Flood

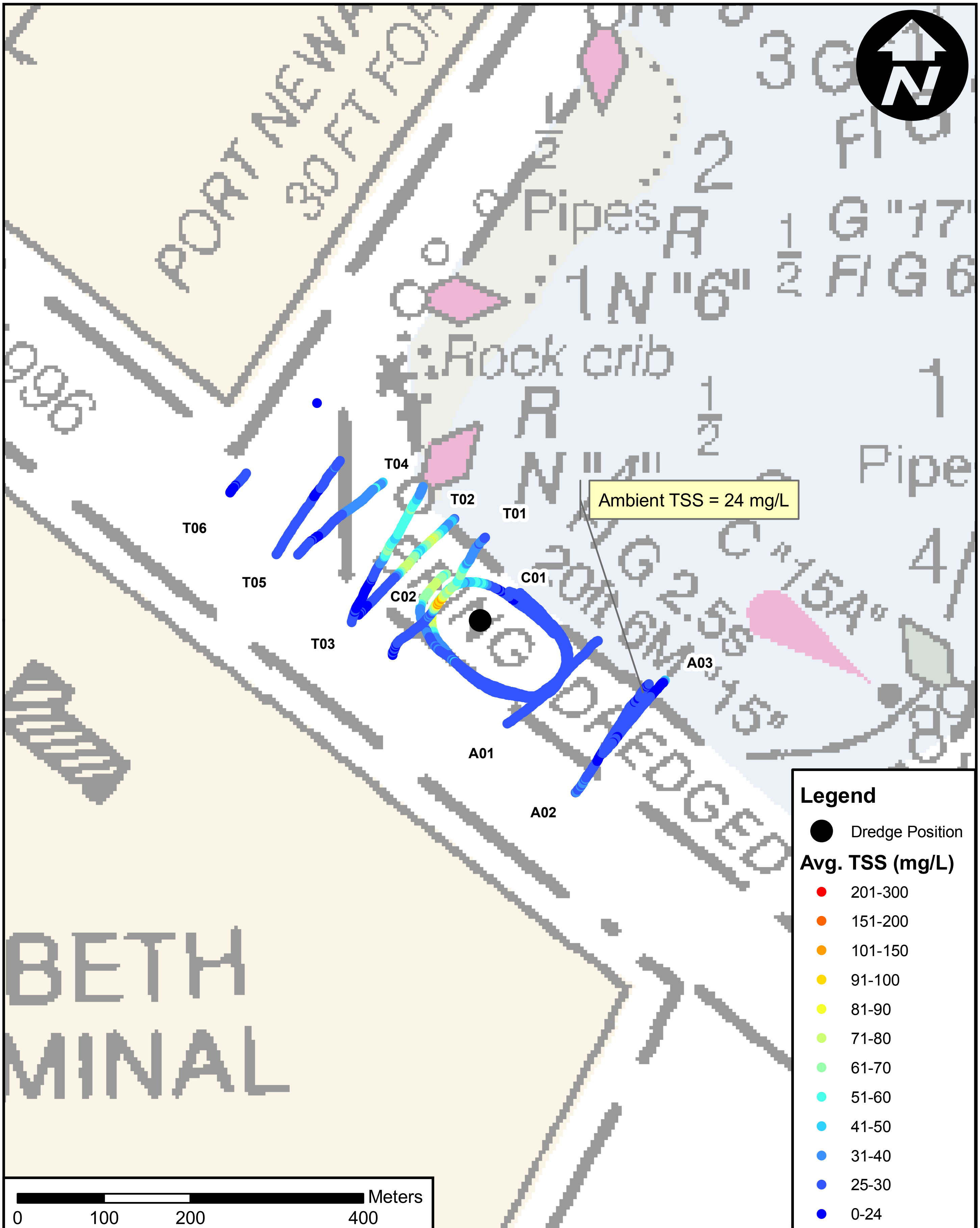
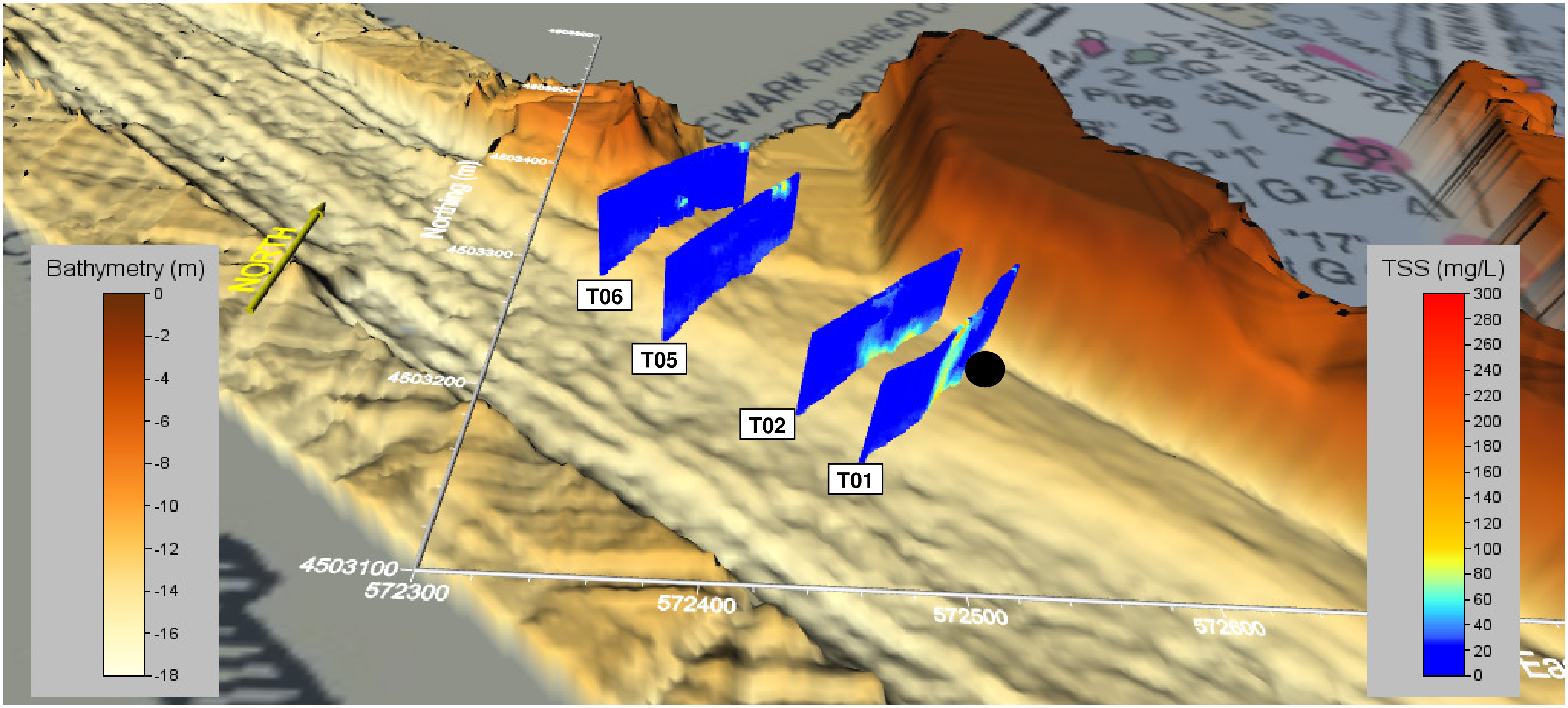


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 1 April 2009 (1st Set) 12-14 Meter Depth Interval	Tide
12g			Flood



Bathymetry provided by: US Army Corps of Engineers, NY District

Z Scale Exaggerated 6x

● = Dredge Location

Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	ADCP Average TSS Values with Respect to their x, y, and z Coordinates Superimposed on Channel Bathymetry (1st Set) 01 April 2009	Tide
13			Flood

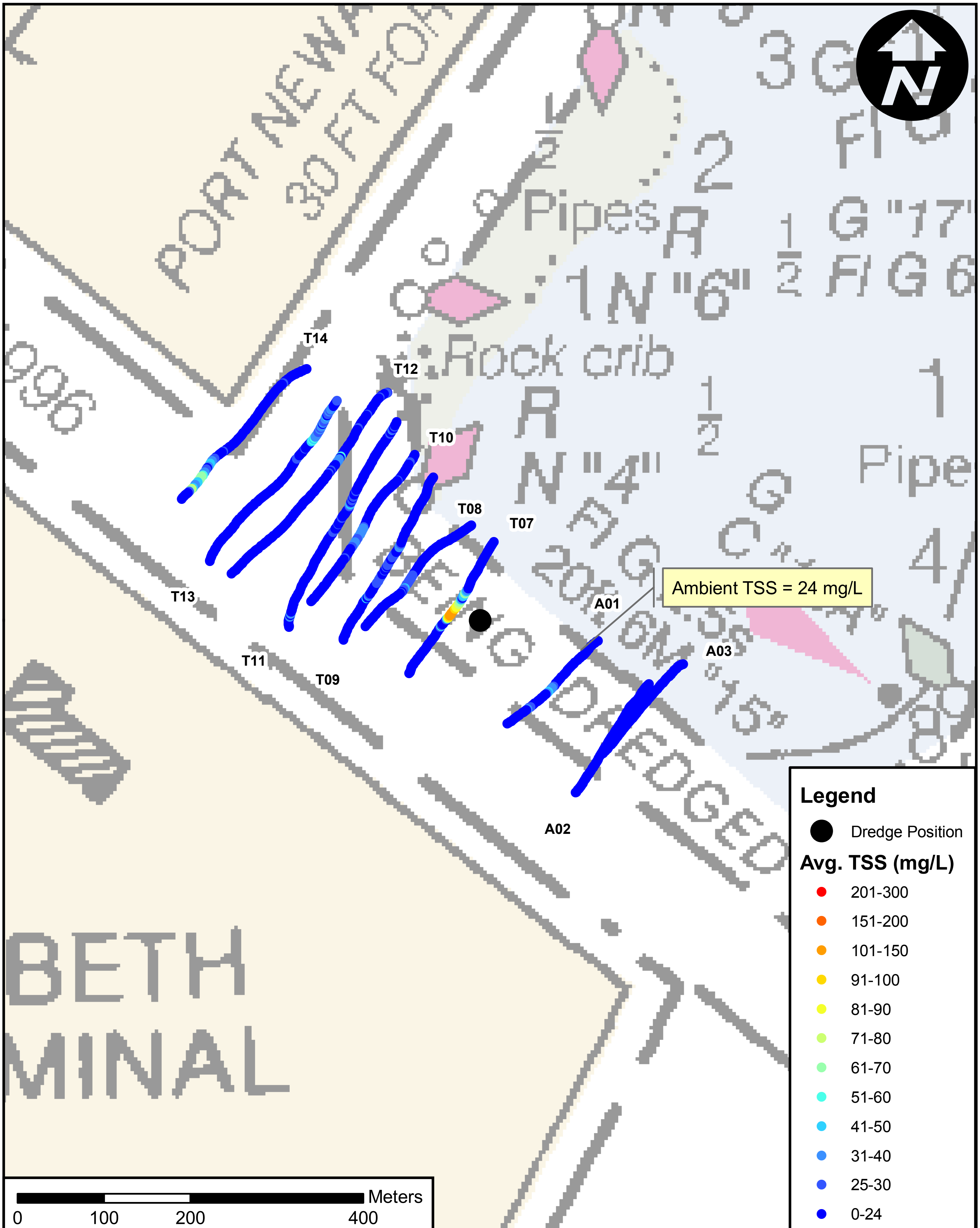


Figure	USACE Harborwide TSS	ADCP Average TSS - 1 April 2009 (2nd Set)	Tide
14a	*Far Field Survey* *HDP Contract Area: S-E-1: A*	0-2 Meter Depth Interval	Flood

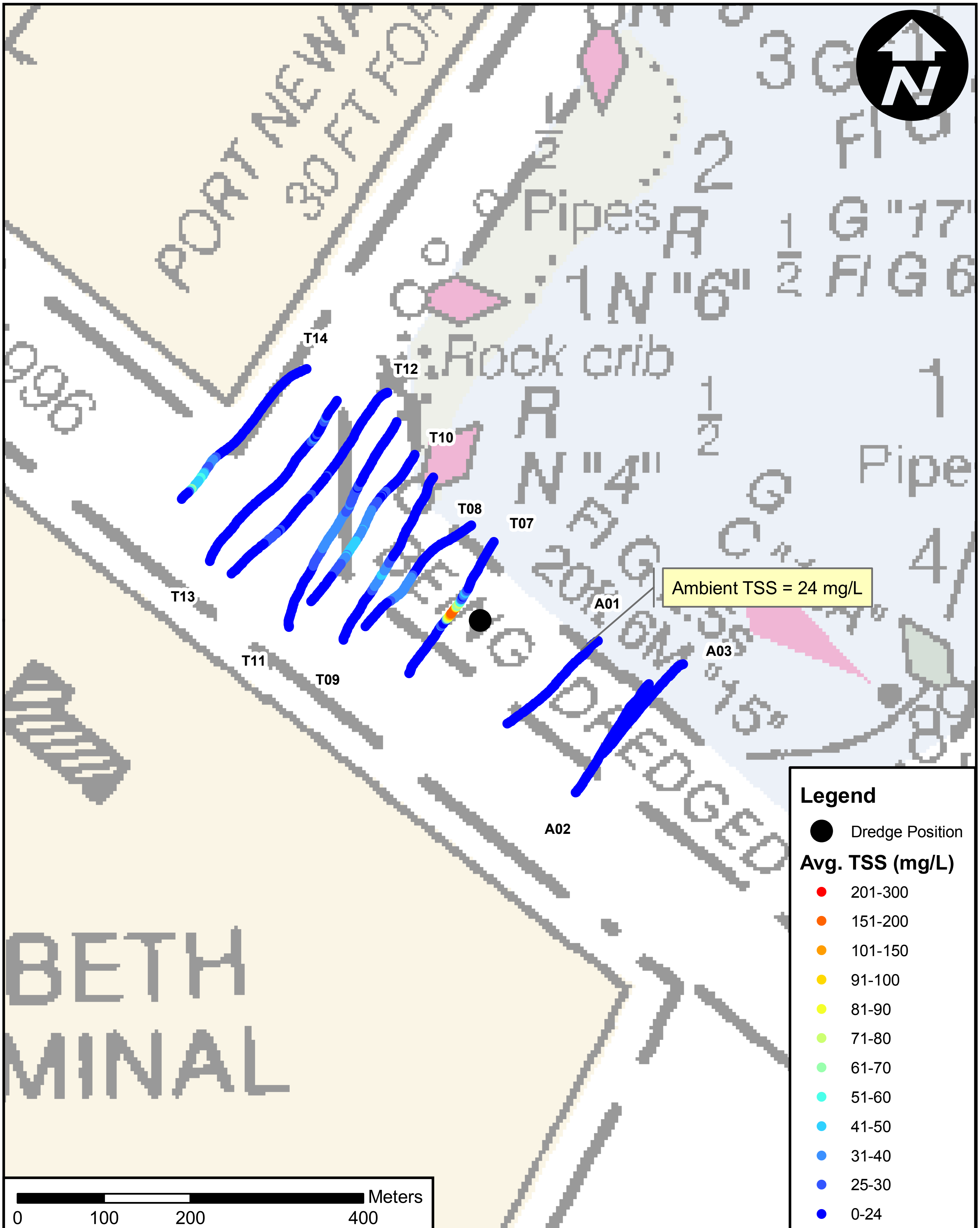


Figure	USACE Harborwide TSS	ADCP Average TSS - 1 April 2009 (2nd Set)	Tide
14b	*Far Field Survey* *HDP Contract Area: S-E-1: A*	**2-4 Meter Depth Interval**	**Flood**

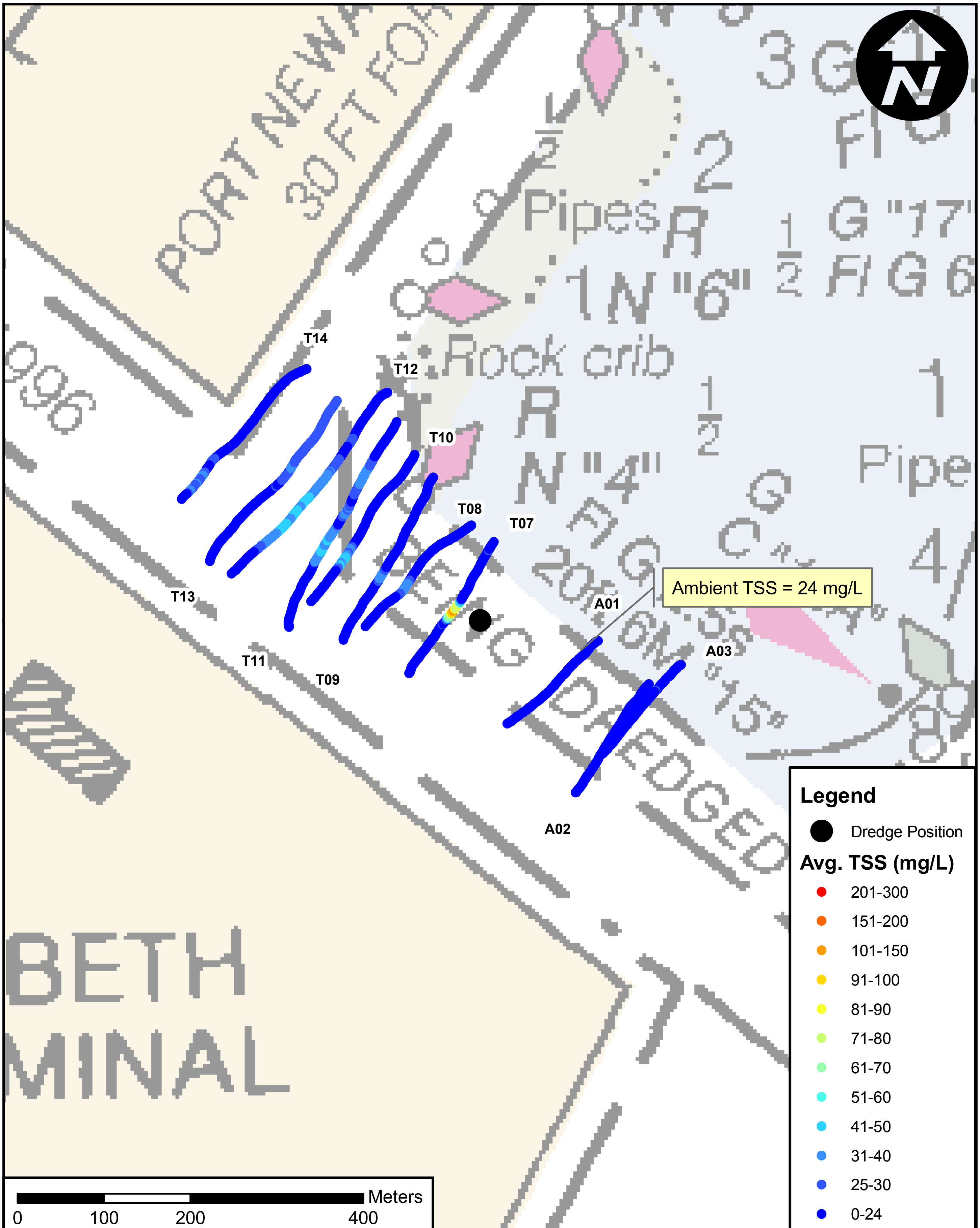


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 1 April 2009 (2nd Set) 4-6 Meter Depth Interval	Tide
14c			Flood

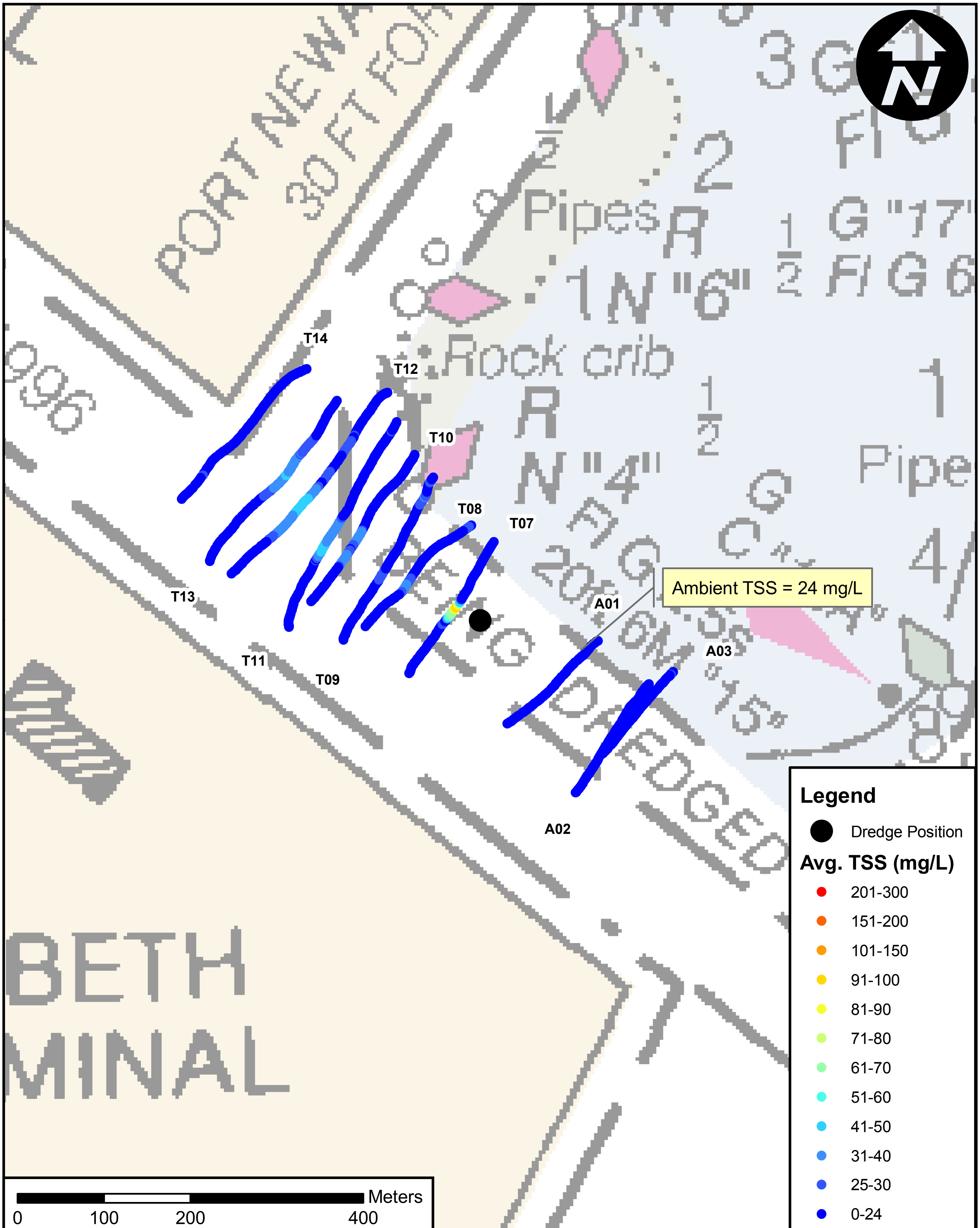


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 1 April 2009 (2nd Set) 6-8 Meter Depth Interval	Tide
14d			Flood

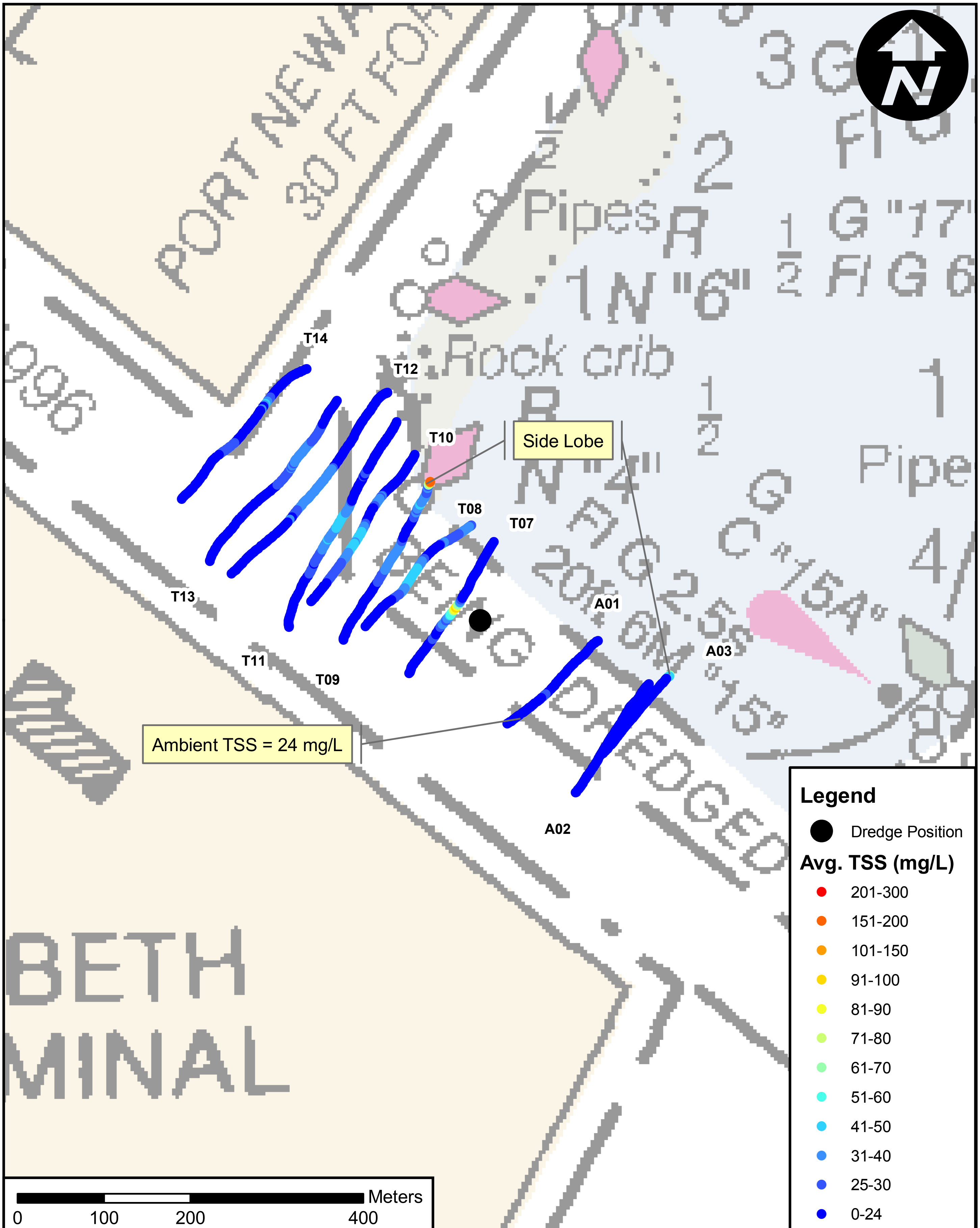


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 1 April 2009 (2nd Set) 8-10 Meter Depth Interval	Tide
14e			Flood

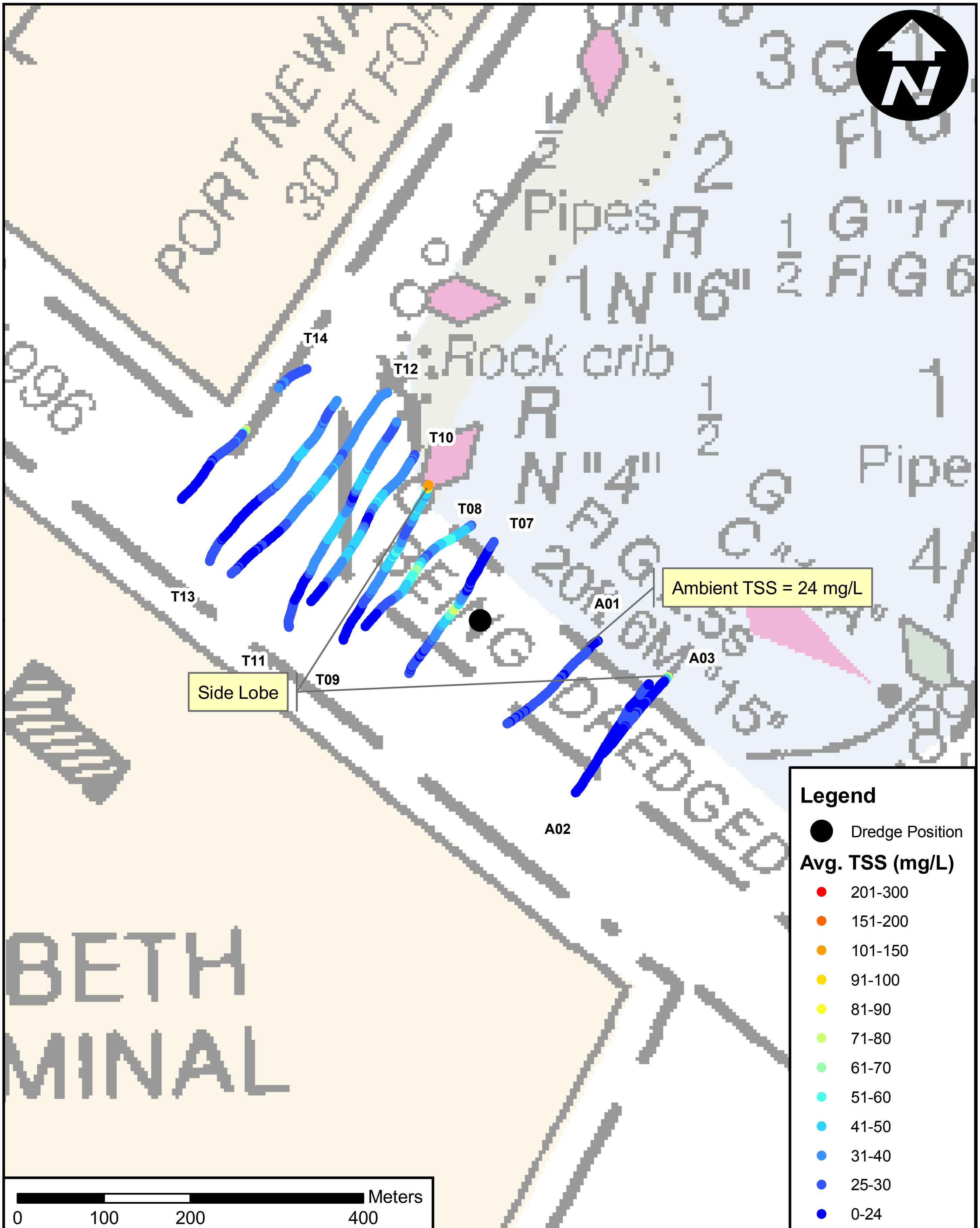


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 1 April 2009 (2nd Set) 10-12 Meter Depth Interval	Tide
14f			Flood

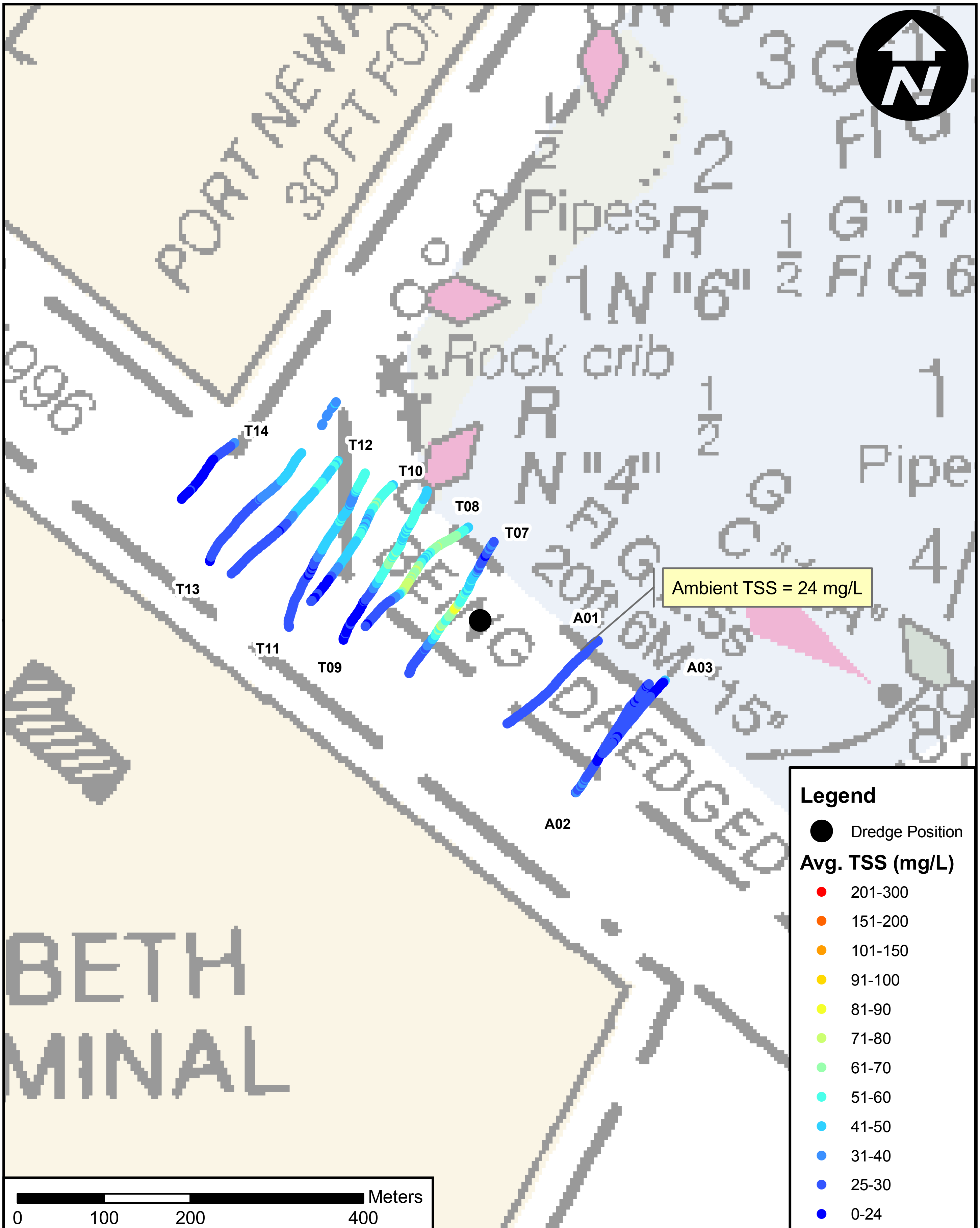
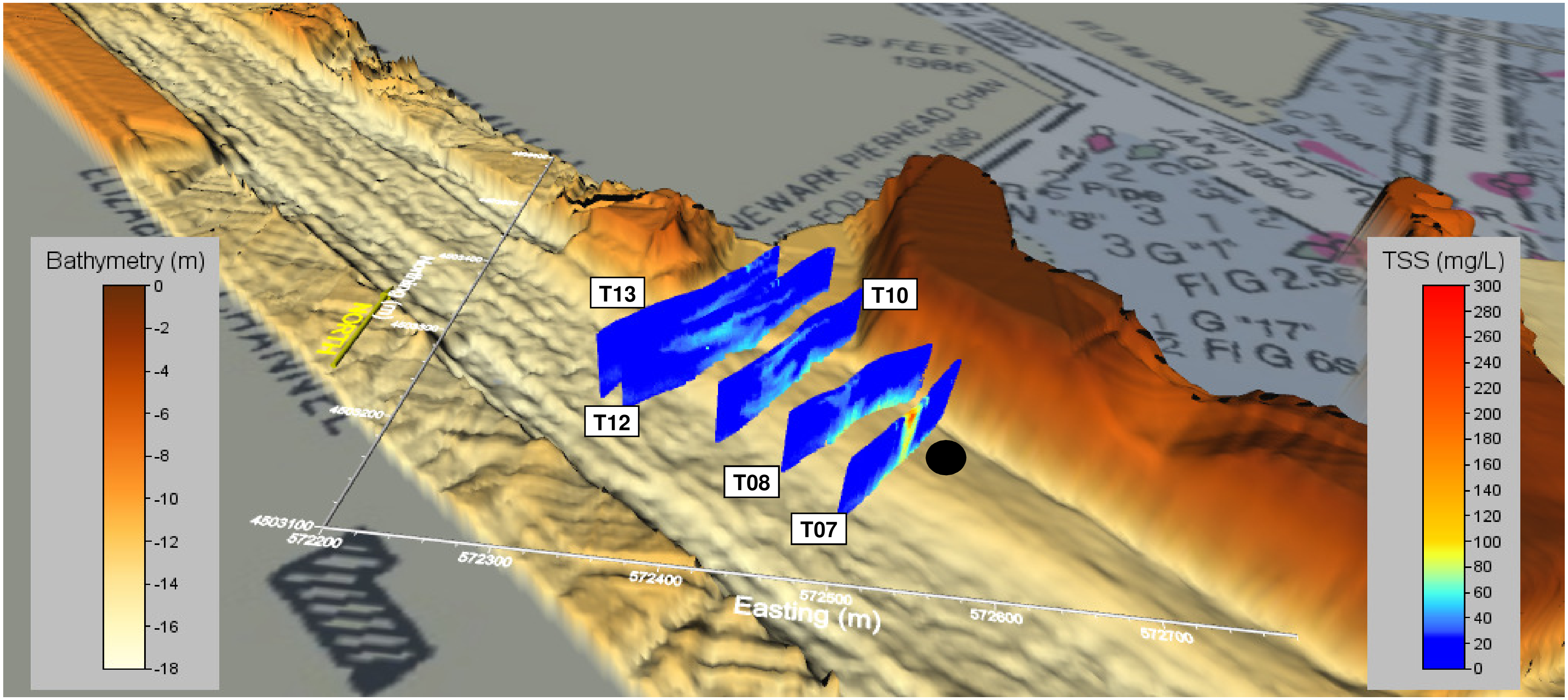


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 1 April 2009 (2nd Set) 12-14 Meter Depth Interval	Tide
14g			Flood



Bathymetry provided by: US Army Corps of Engineers, NY District

Z Scale Exaggerated 6x

● = Dredge Location

Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS Values with Respect to their x, y, and z Coordinates Superimposed on Channel Bathymetry (2nd Set) 01 April 2009	Tide
15			Flood

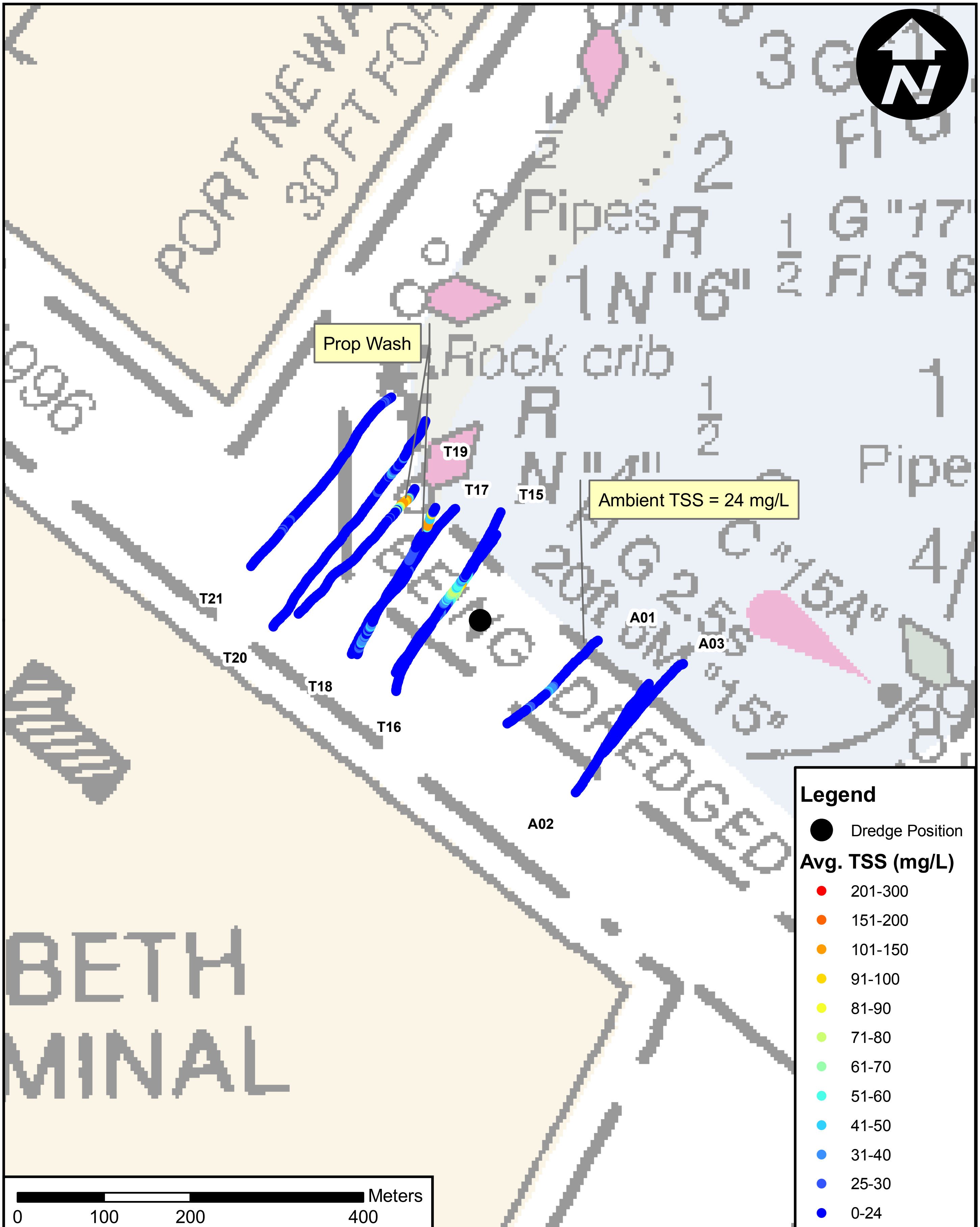


Figure	USACE Harborwide TSS	ADCP Average TSS - 1 April 2009 (3rd Set)	Tide
16a	*Far Field Survey* *HDP Contract Area: S-E-1: A*	0-2 Meter Depth Interval	Flood

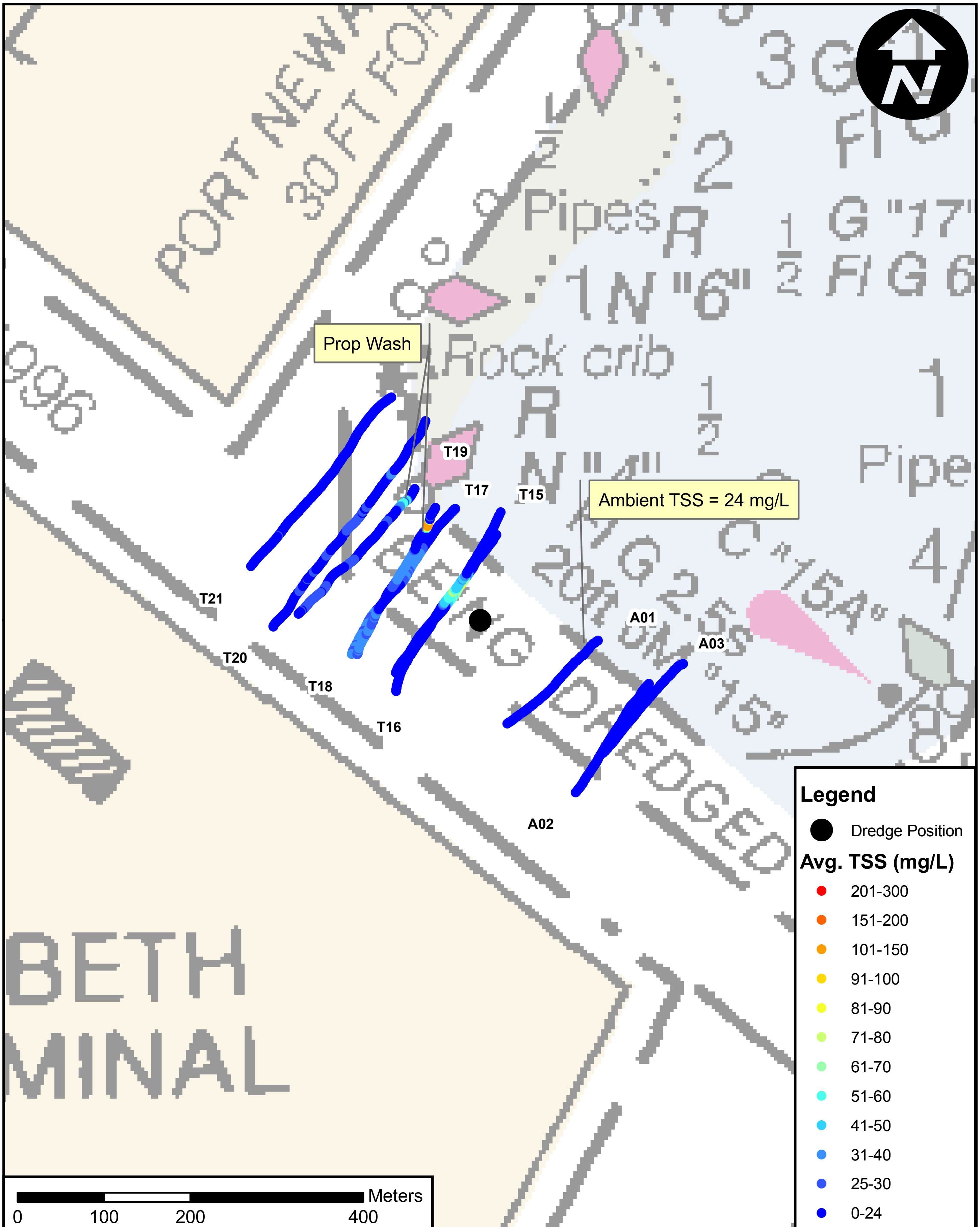


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 1 April 2009 (3rd Set) 2-4 Meter Depth Interval	Tide
16b			Flood

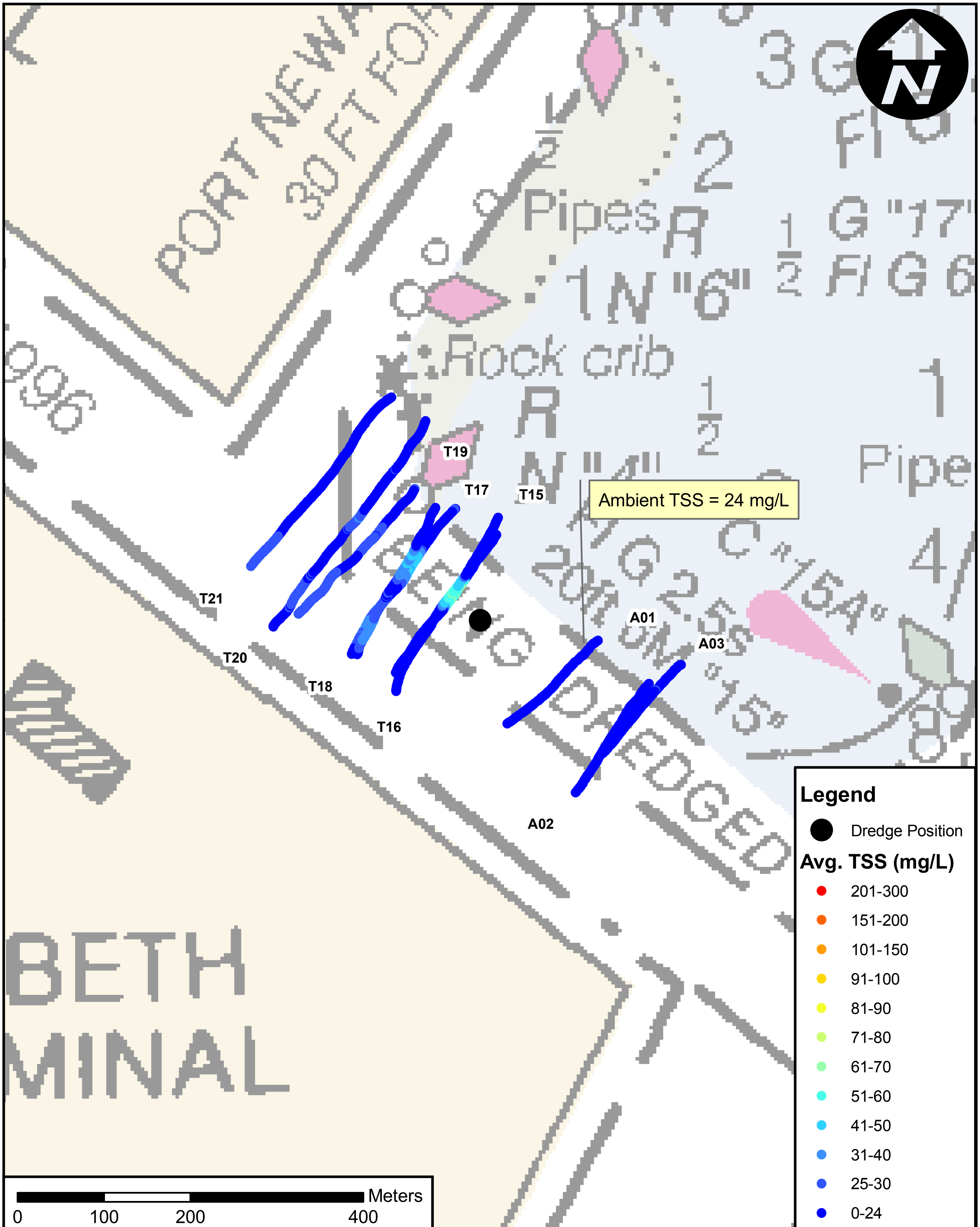


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 1 April 2009 (3rd Set) 4-6 Meter Depth Interval	Tide
16c			Flood

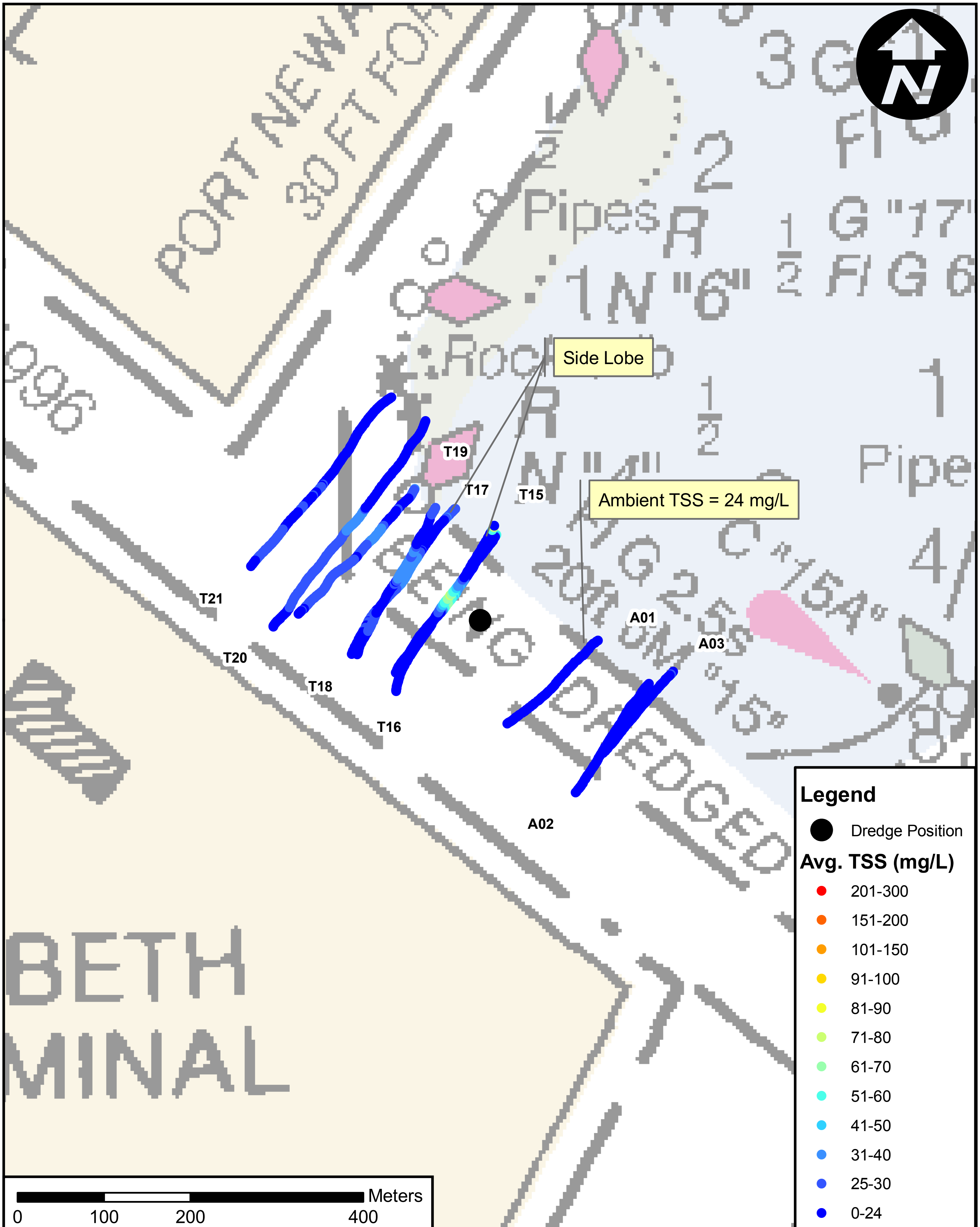


Figure	USACE Harborwide TSS *Far Field Survey* *HDP Contract Area: S-E-1: A*	**ADCP Average TSS - 1 April 2009 (3rd Set)** **6-8 Meter Depth Interval**	**Tide**
16d			**Flood**

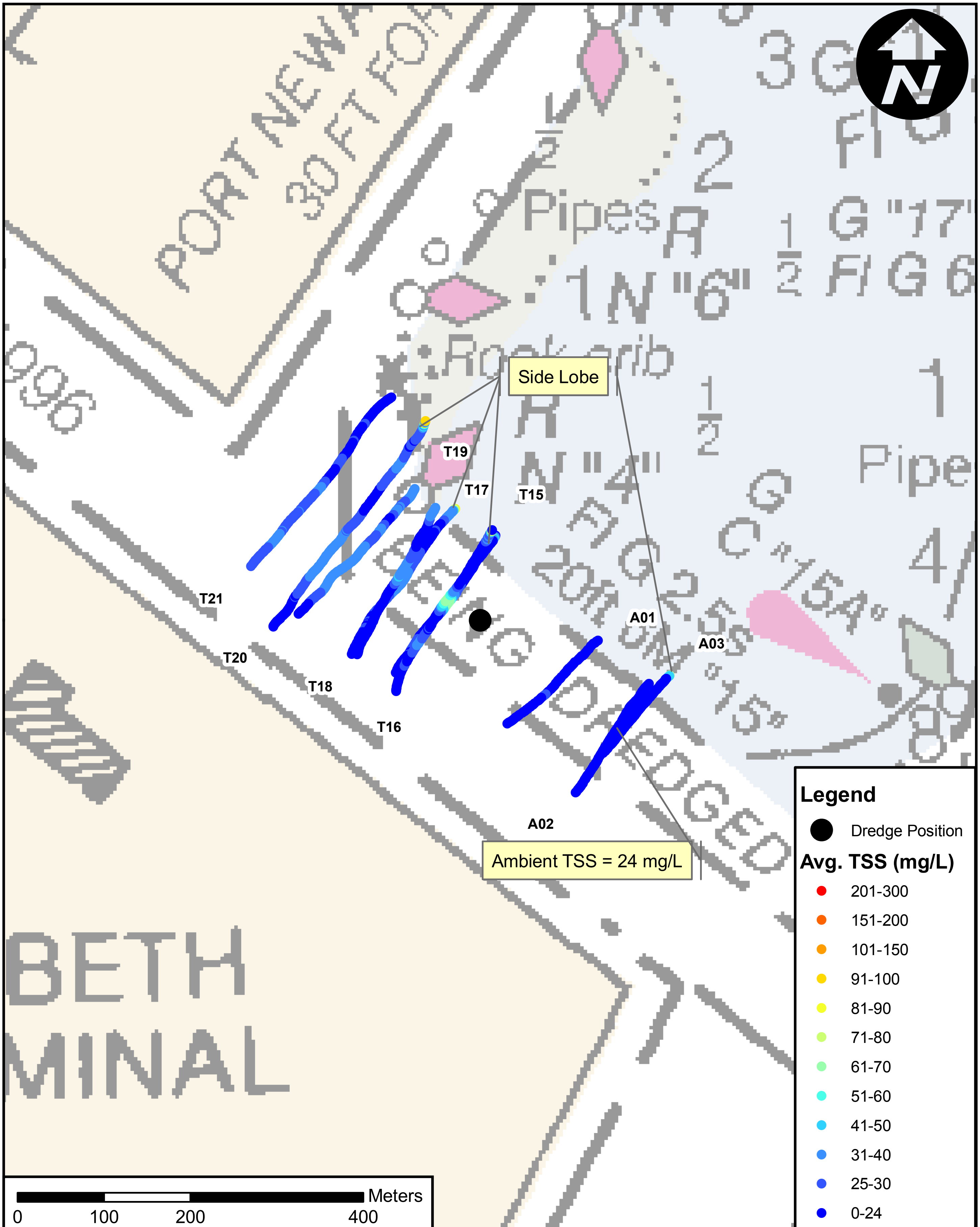


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 1 April 2009 (3rd Set) 8-10 Meter Depth Interval	Tide
16e			Flood

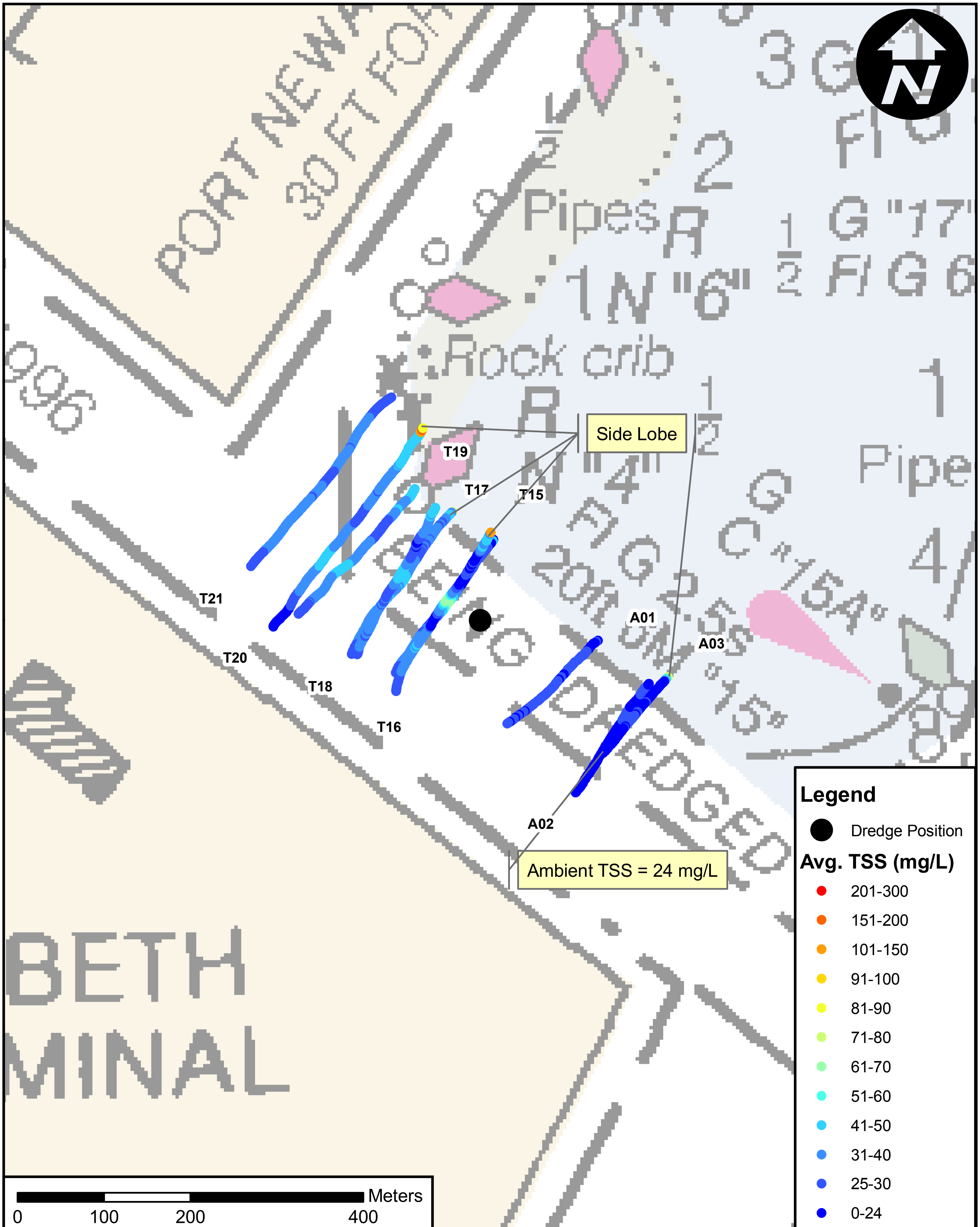


Figure	*USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A*	ADCP Average TSS - 1 April 2009 (3rd Set) 10-12 Meter Depth Interval	Tide
16f			Flood

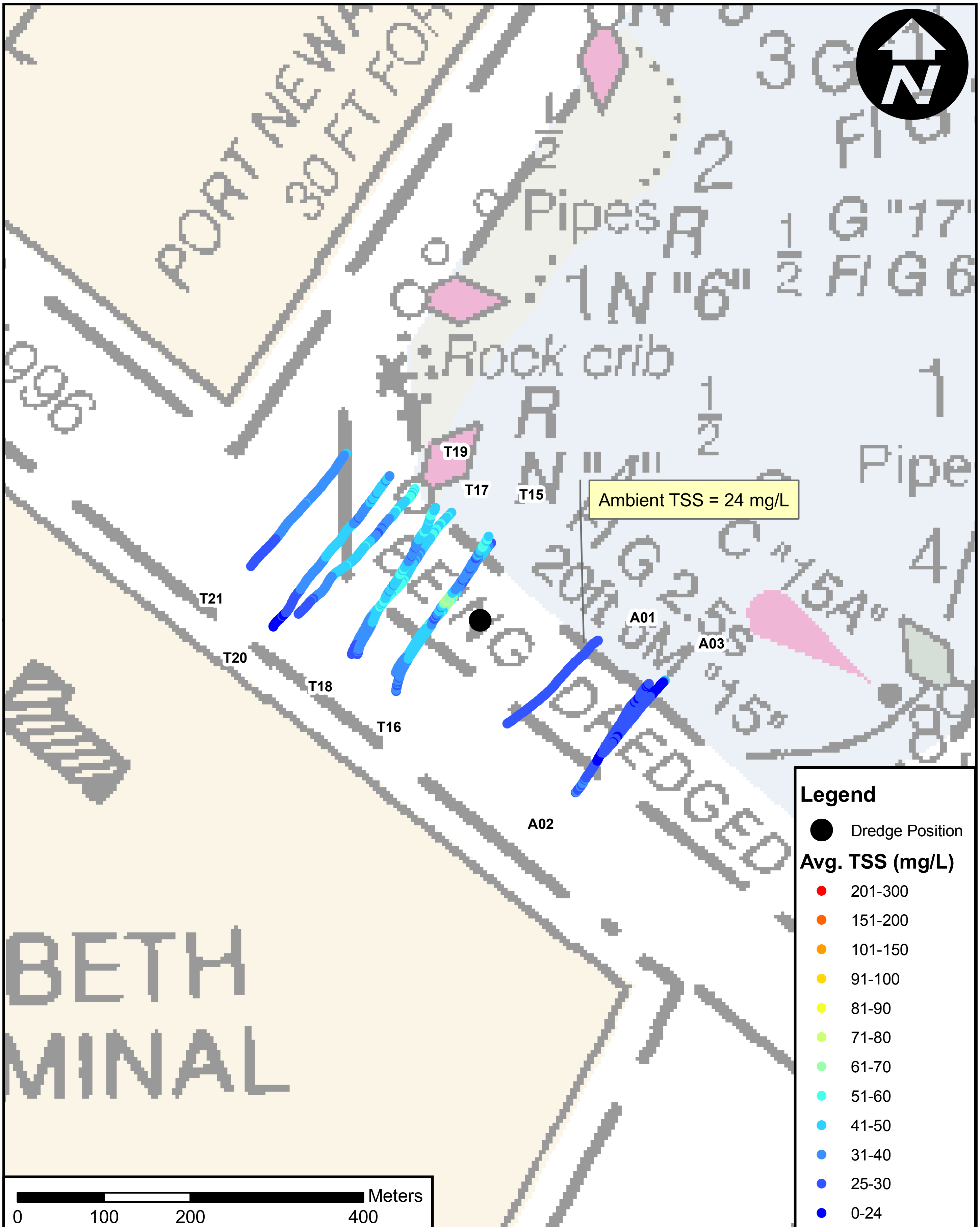
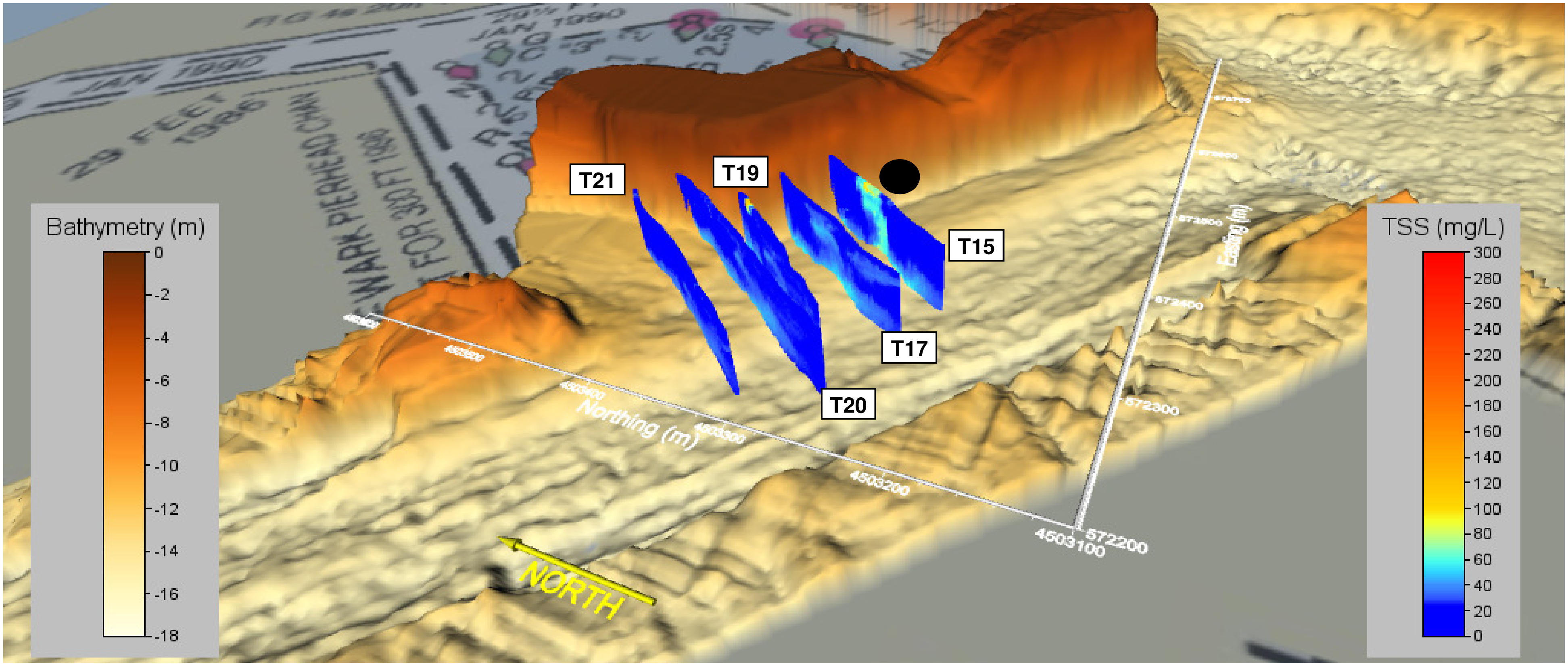


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**ADCP Average TSS - 1 April 2009 (3rd Set)** **12-14 Meter Depth Interval**	**Tide**
16g			**Flood**



Bathymetry provided by: US Army Corps of Engineers, NY District

Z Scale Exaggerated 6x

= Dredge Location

Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**ADCP Average TSS Values with Respect to their x, y, and z Coordinates** **Superimposed on Channel Bathymetry (3rd Set)** **01 April 2009**	**Tide**
17			**Flood**

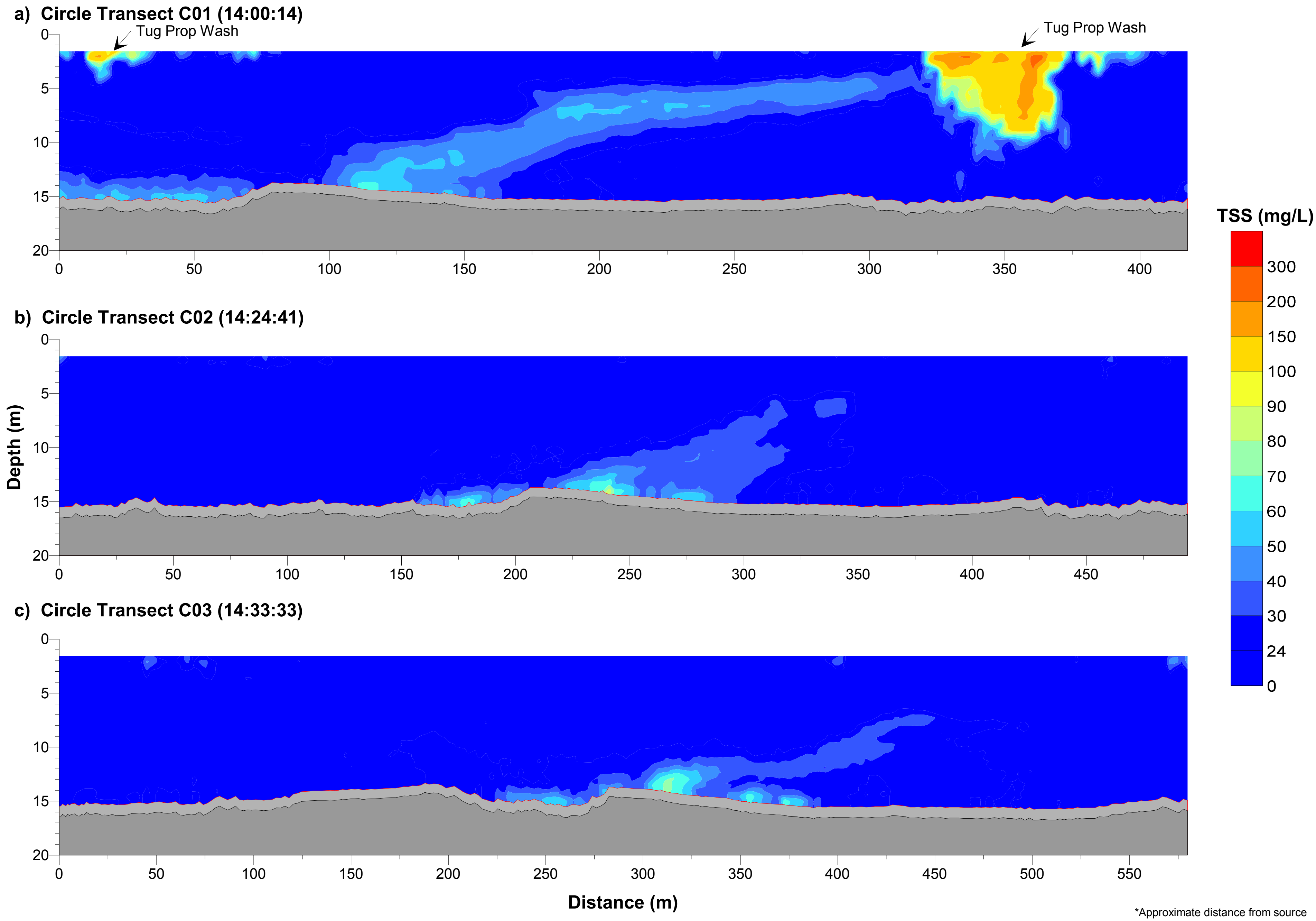
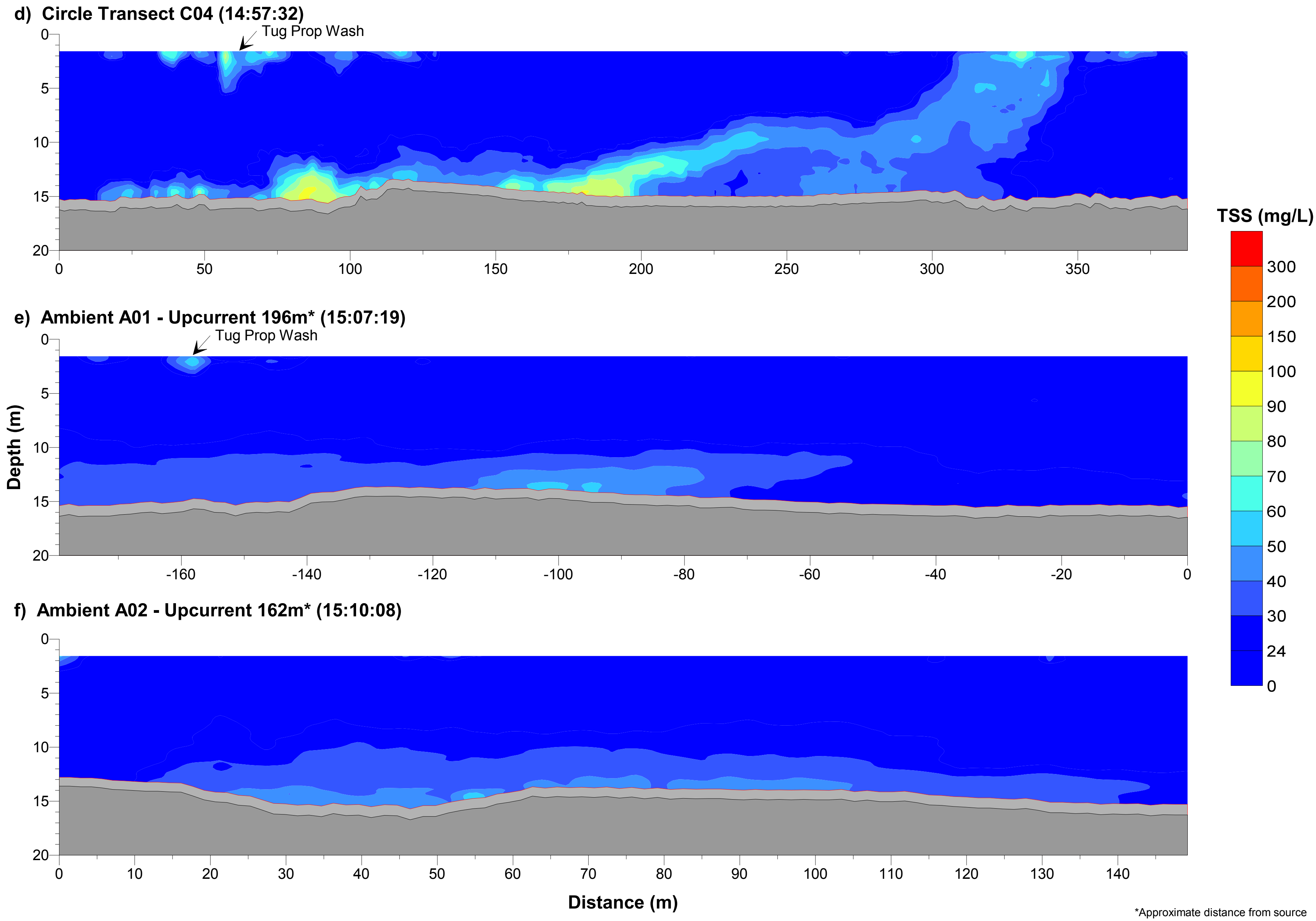
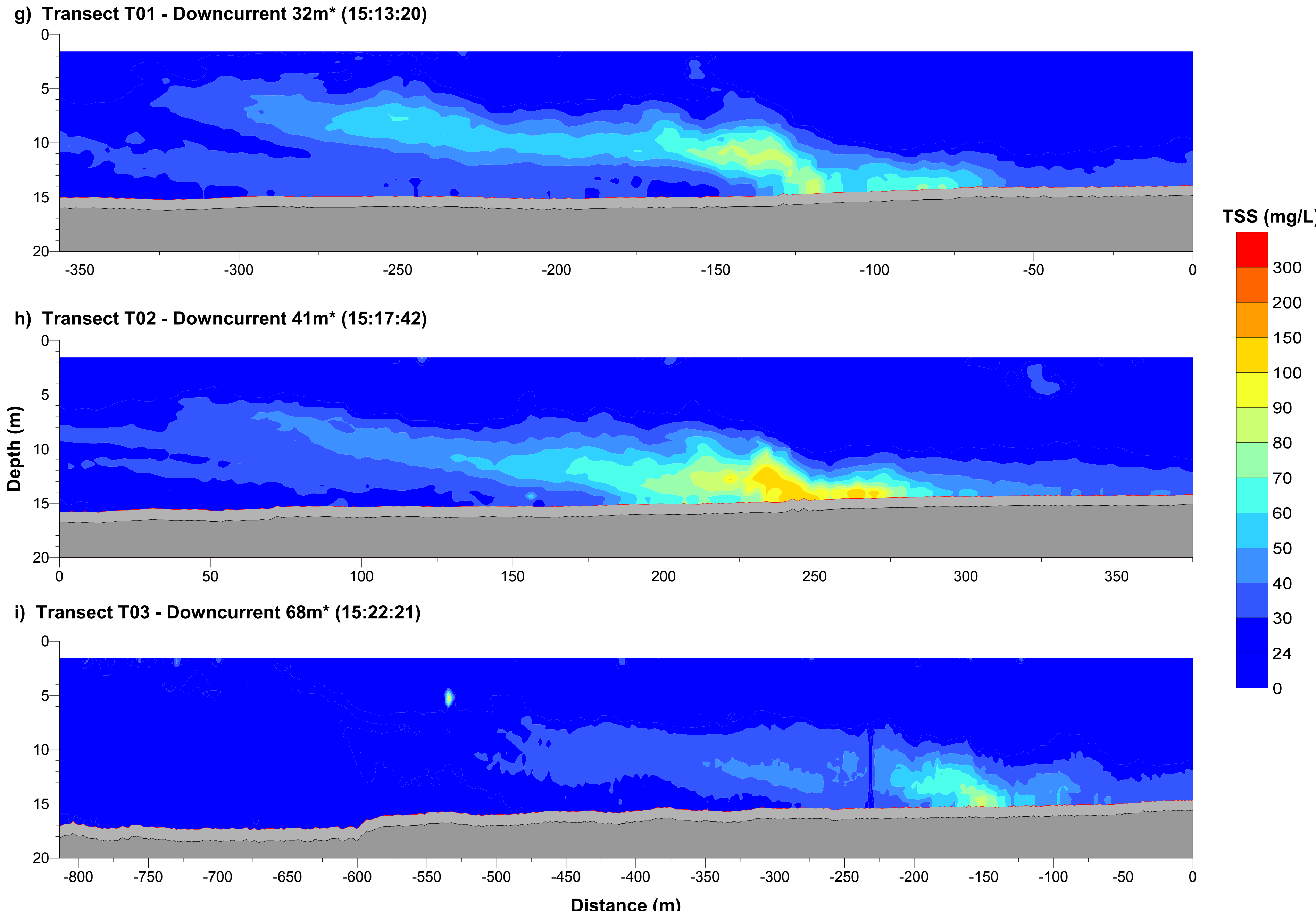


FIGURE	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**Vertical Profiles of ADCP Average TSS** **01 April 2009**	TIDE
18a-c			**Ebb**



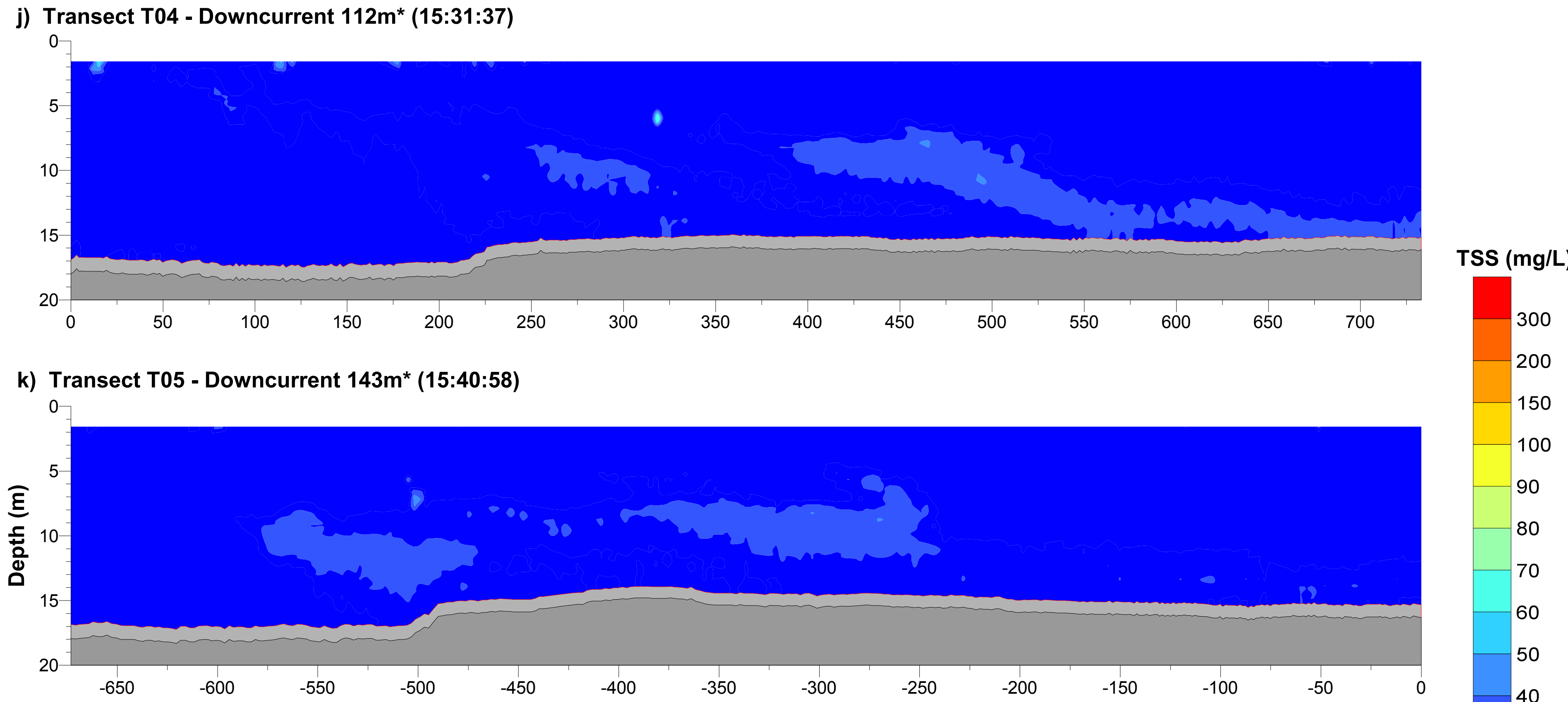
*Approximate distance from source

FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	Vertical Profiles of ADCP Average TSS 01 April 2009	TIDE
18d-f			Ebb



*Approximate distance from source

FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	Vertical Profiles of ADCP Average TSS 01 April 2009	TIDE
18g-i			Ebb



*Approximate distance from source

FIGURE	USACE Harborwide TSS *Far Field Survey* *HDP Contract Area: S-E-1: A*	**Vertical Profiles of ADCP Average TSS** **01 April 2009**	TIDE
18j-k			**Ebb**

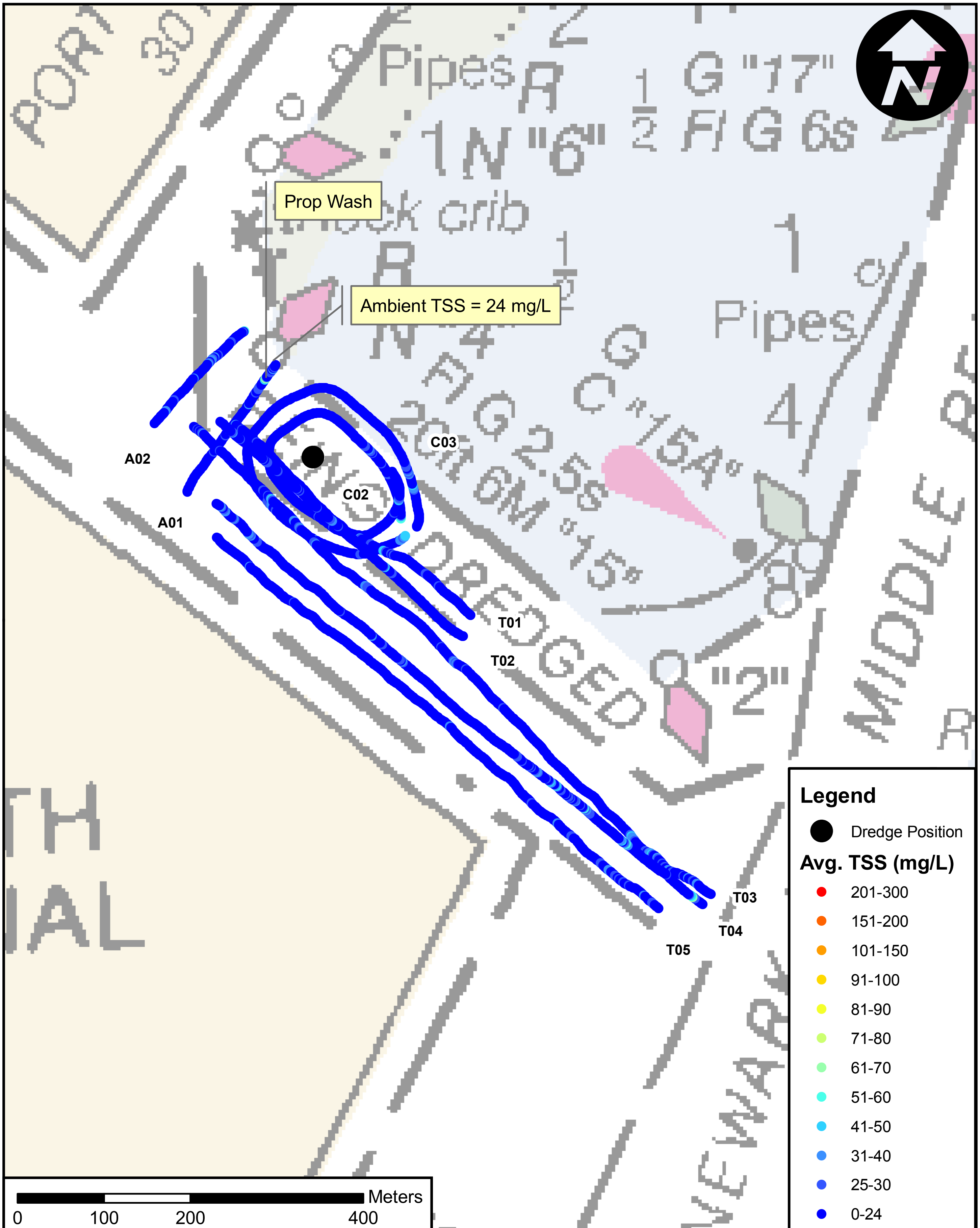


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 1 April 2009 0-2 Meter Depth Interval	Tide
19a			Ebb

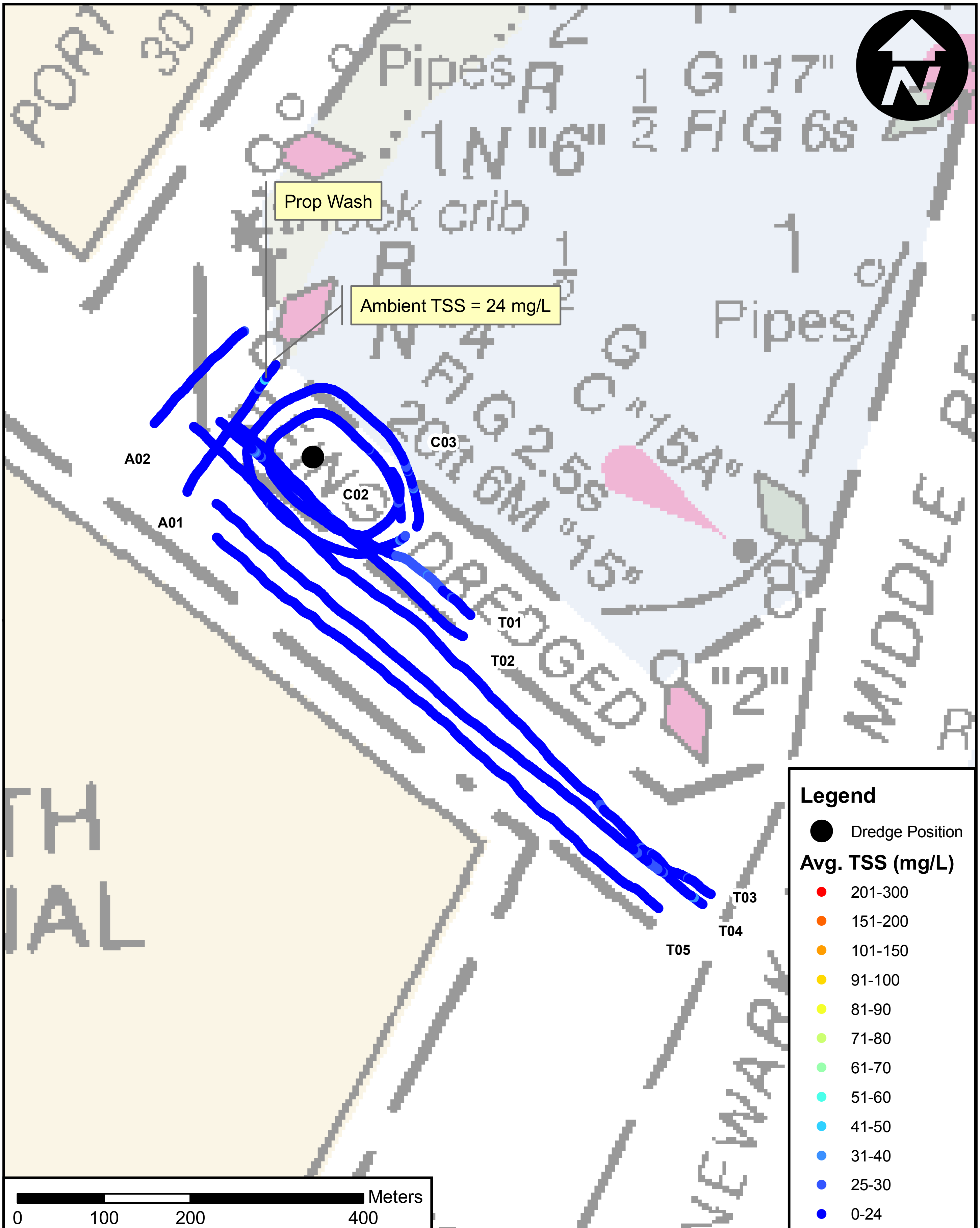


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 1 April 2009 2-4 Meter Depth Interval	Tide
19b			Ebb

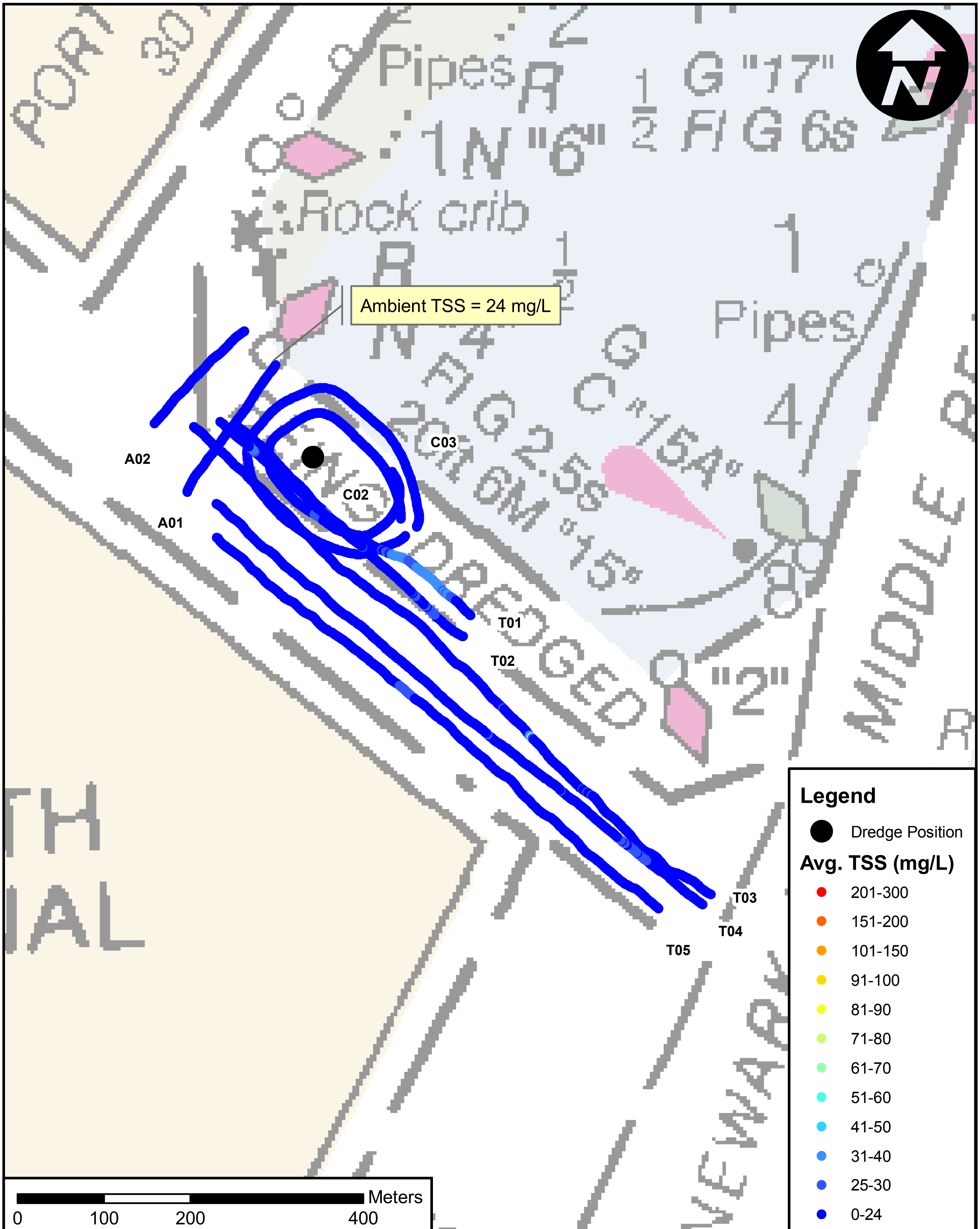


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 1 April 2009 4-6 Meter Depth Interval	Tide
19c			Ebb

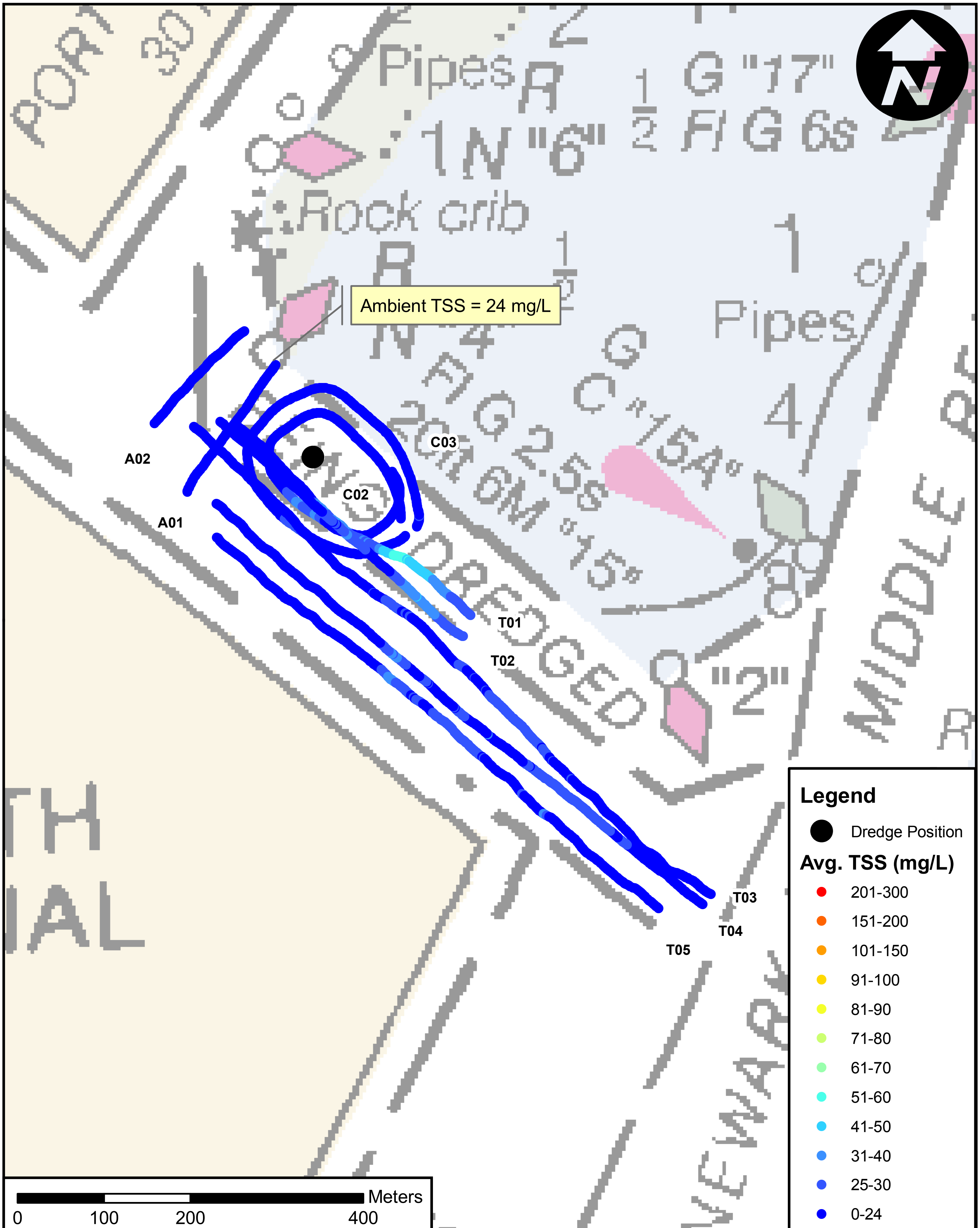


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 1 April 2009 6-8 Meter Depth Interval	Tide
19d			Ebb

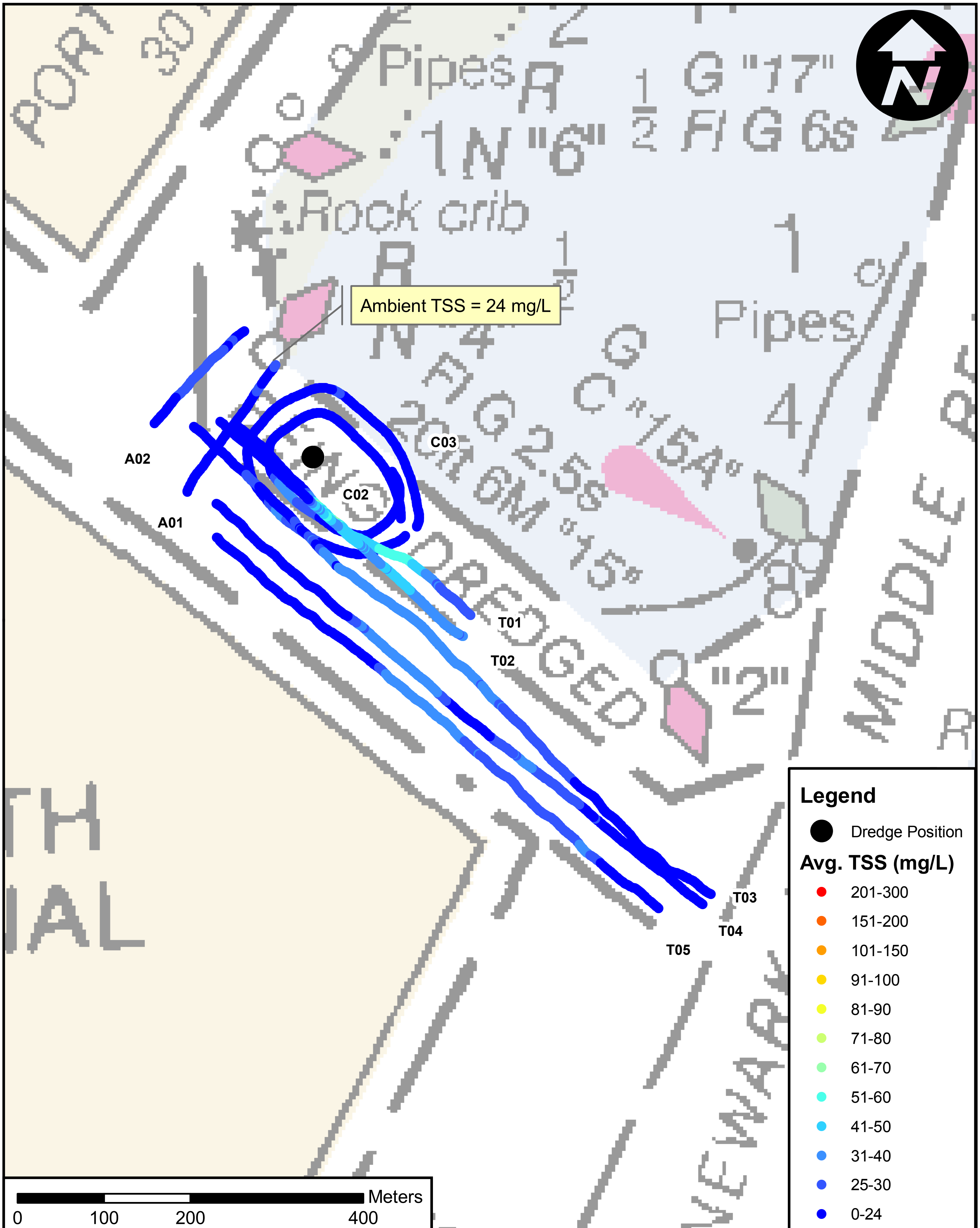


Figure	USACE Harborwide TSS	ADCP Average TSS - 1 April 2009	Tide
19e	*Far Field Survey* *HDP Contract Area: S-E-1: A*	8-10 Meter Depth Interval	Ebb

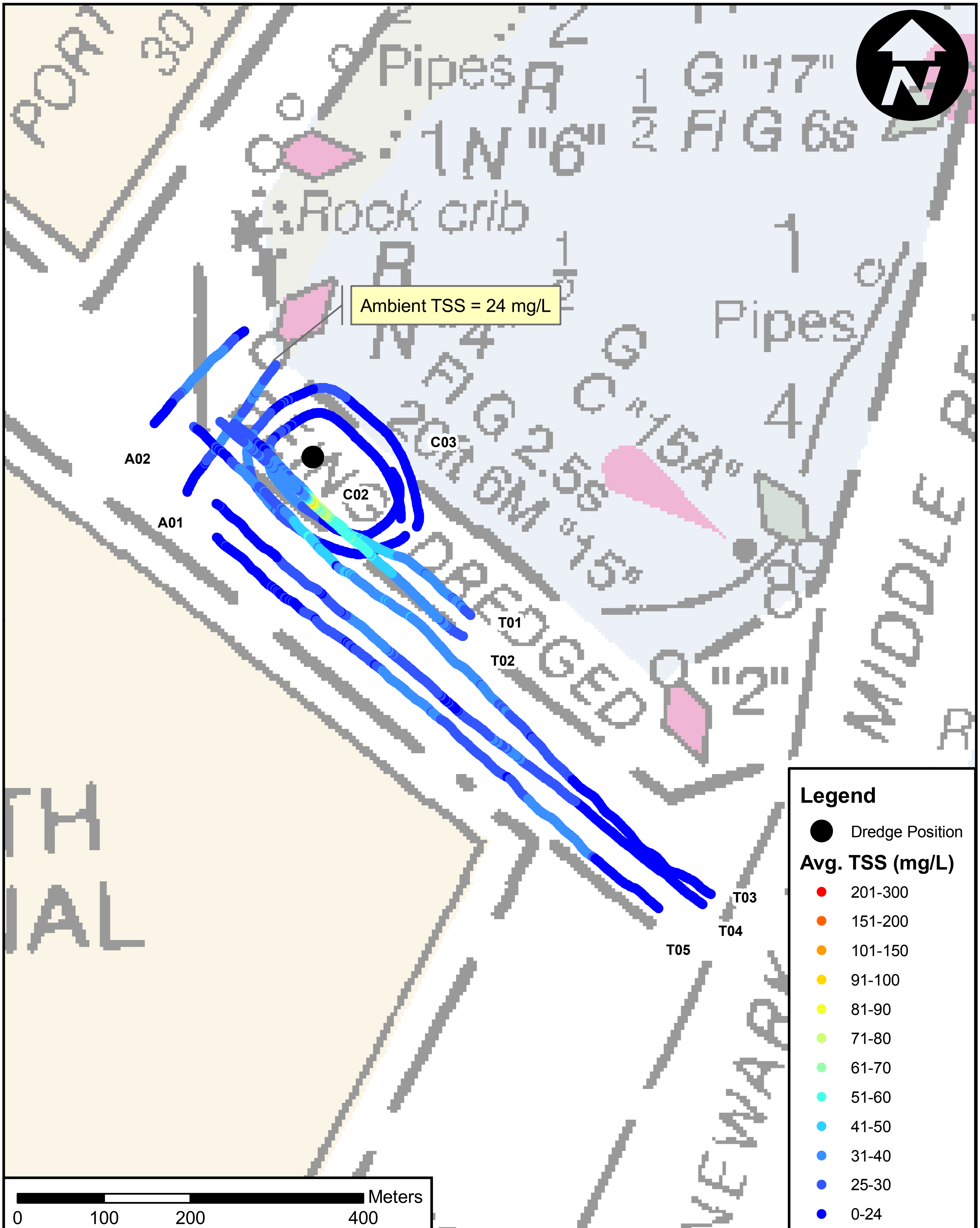


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 1 April 2009 10-12 Meter Depth Interval	Tide
19f			Ebb

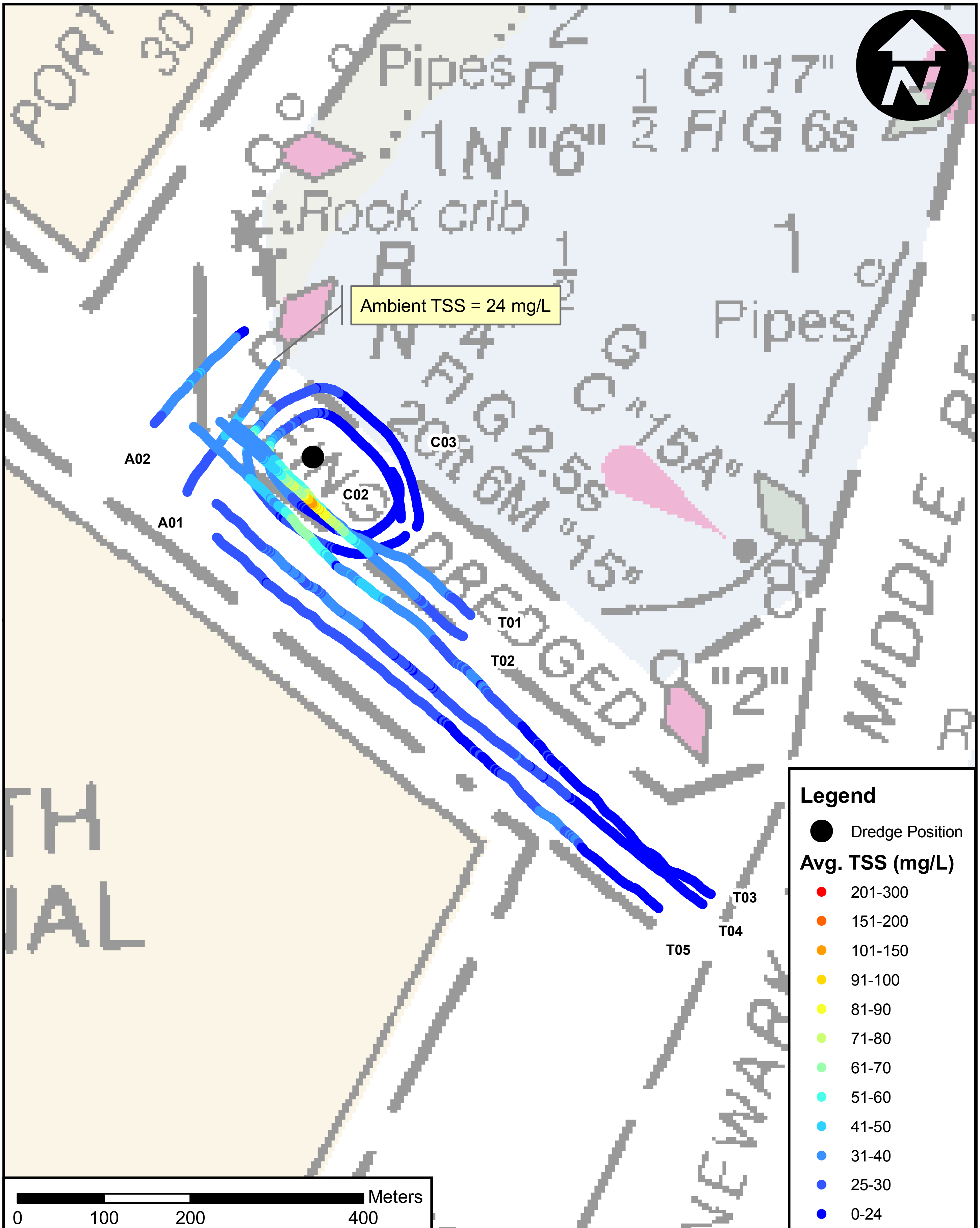


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**ADCP Average TSS - 1 April 2009** **12-14 Meter Depth Interval**	Tide
19g			Ebb

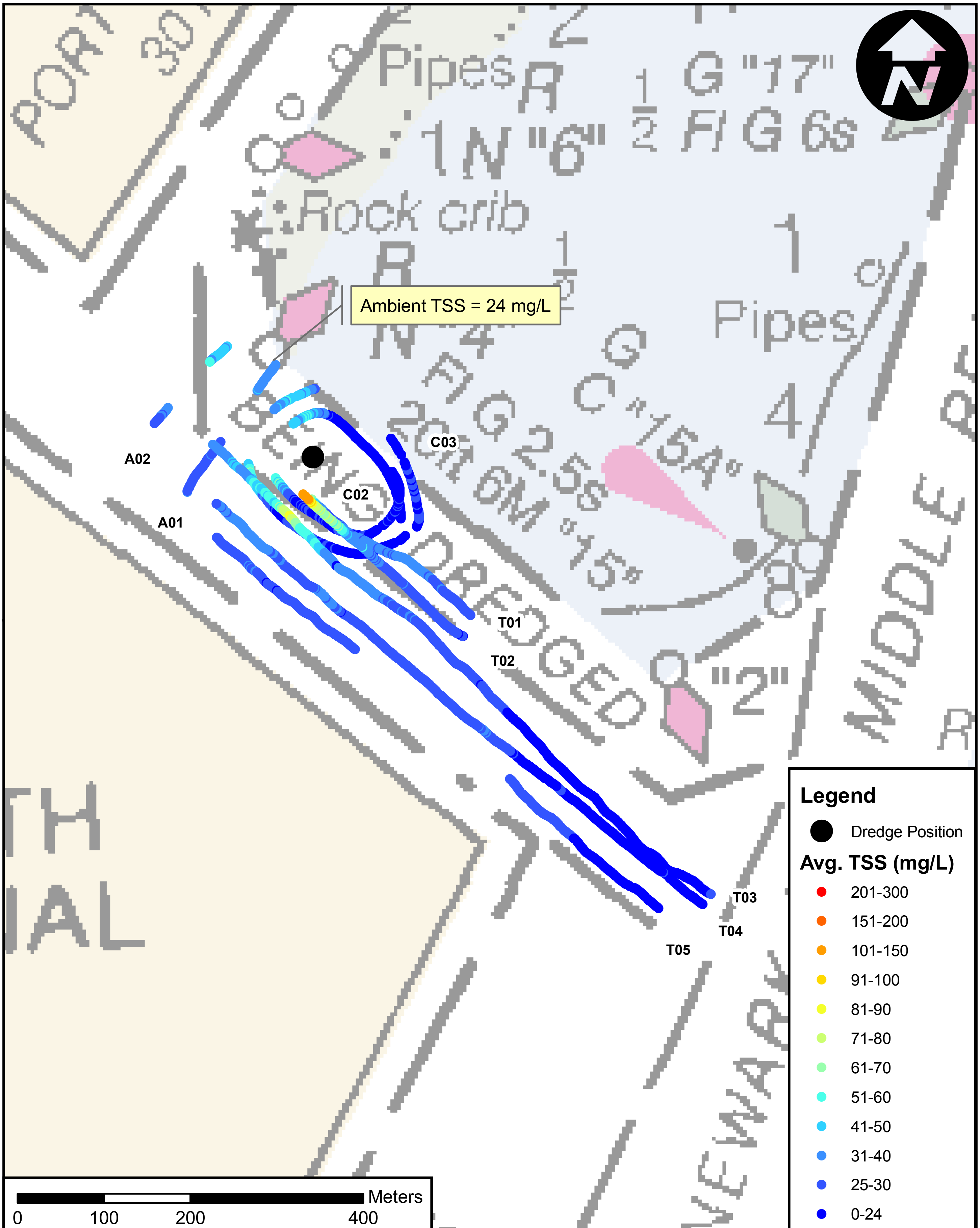
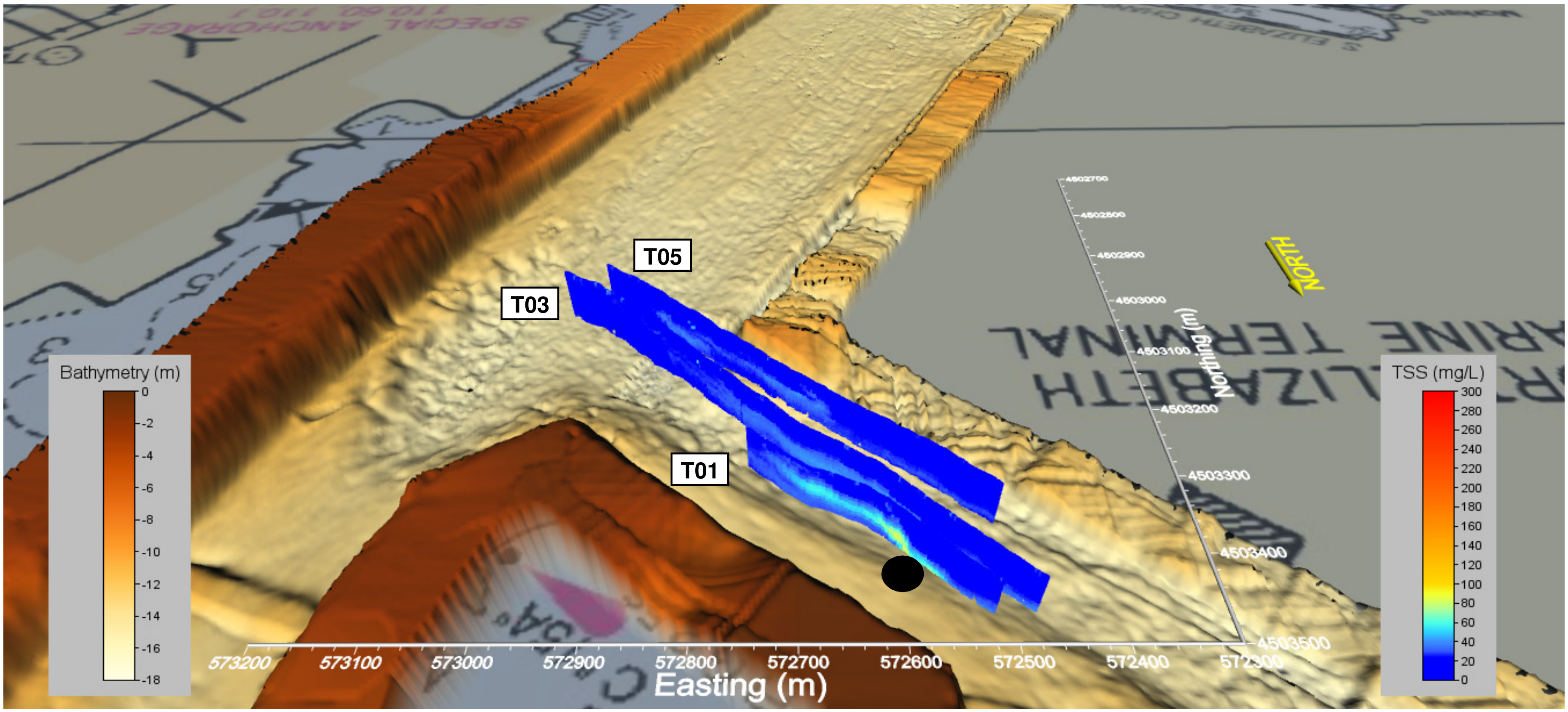


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	ADCP Average TSS - 1 April 2009 14-16 Meter Depth Interval	Tide
19h			Ebb



Bathymetry provided by: US Army Corps of Engineers, NY District

Z Scale Exaggerated 6x

● = Dredge Location

Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**ADCP Average TSS Values with Respect to their x, y, and z Coordinates** **Superimposed on Channel Bathymetry** **01 April 2009**	**Tide**
20			**Ebb**

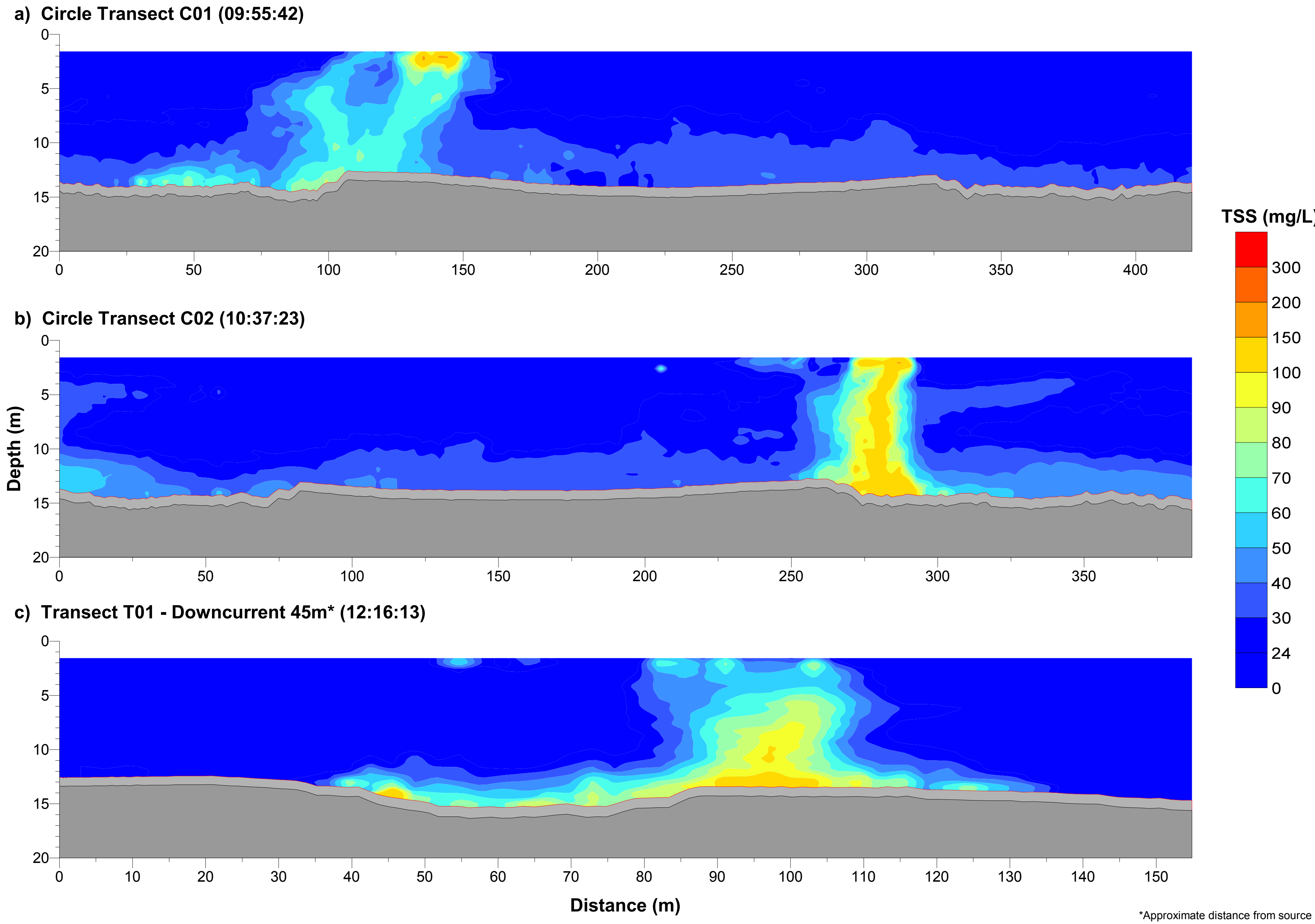
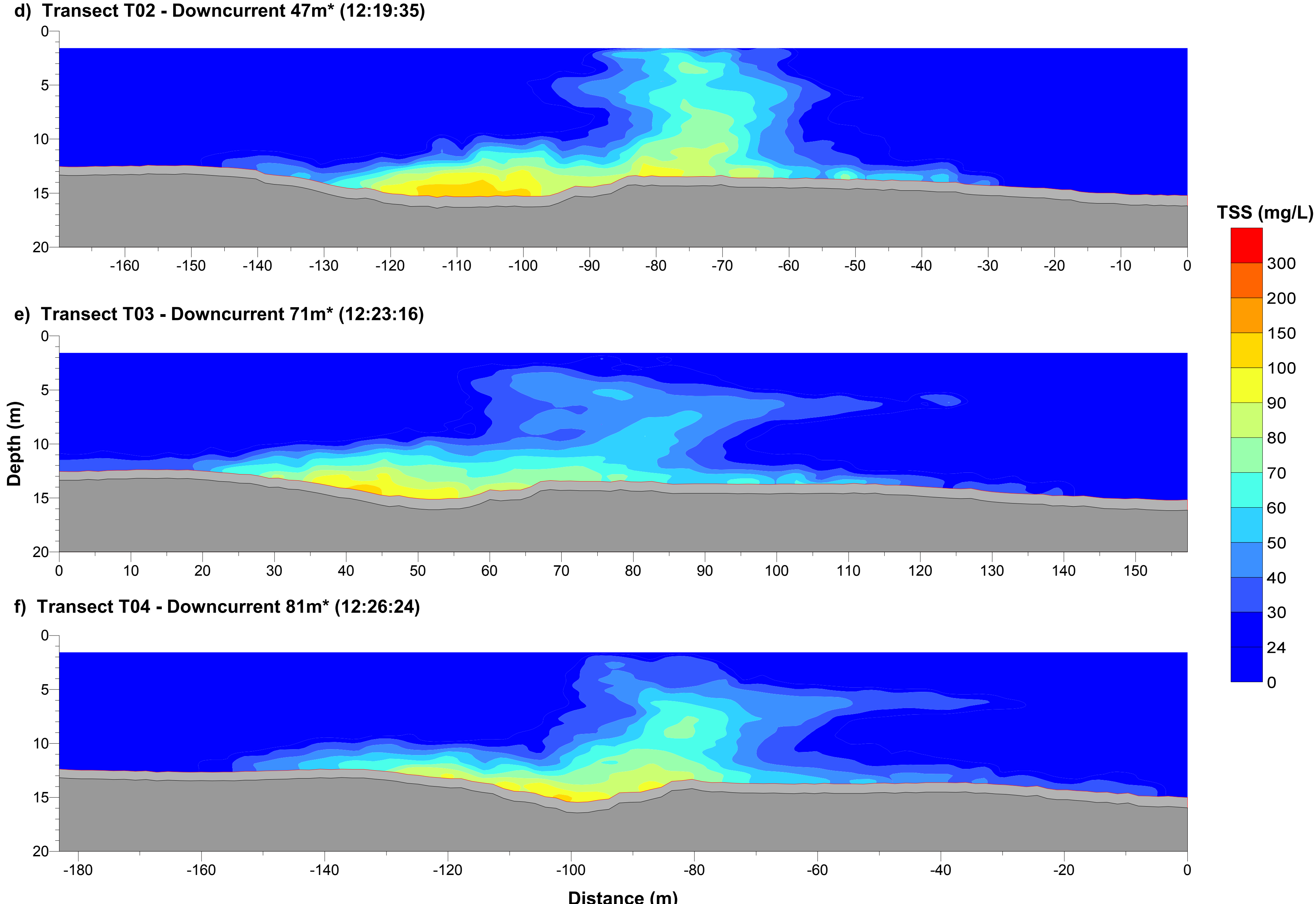
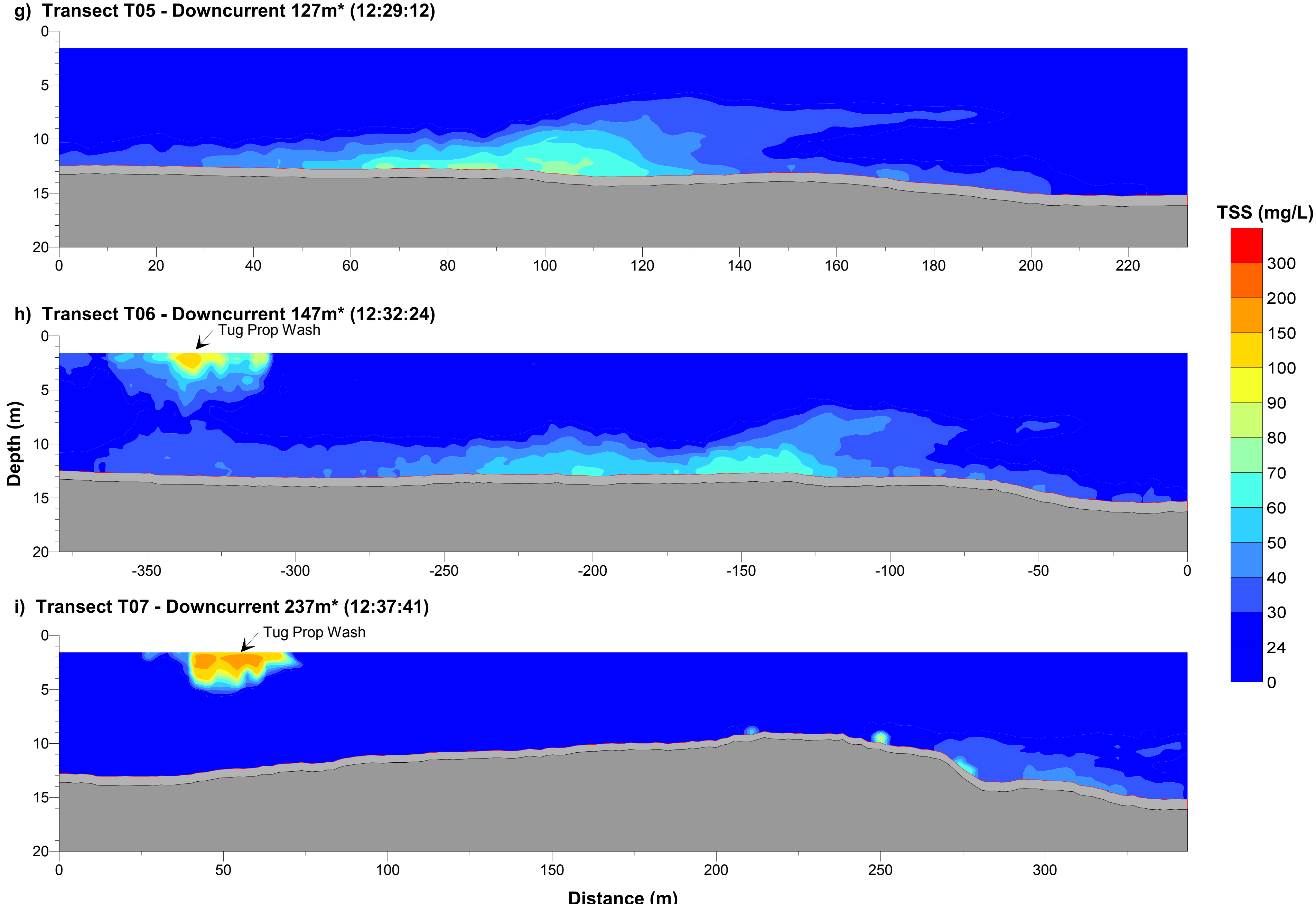


FIGURE	*USACE Harborwide TSS*	**Vertical Profiles of ADCP Average TSS**	TIDE
21a-c	*Far Field Survey* *HDP Contract Area: S-E-1: A*	**02 April 2009**	Flood



*Approximate distance from source

FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	Vertical Profiles of ADCP Average TSS 02 April 2009	TIDE
21d-f			Flood



*Approximate distance from source

FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A	Vertical Profiles of ADCP Average TSS 02 April 2009	TIDE
21g-i			Flood

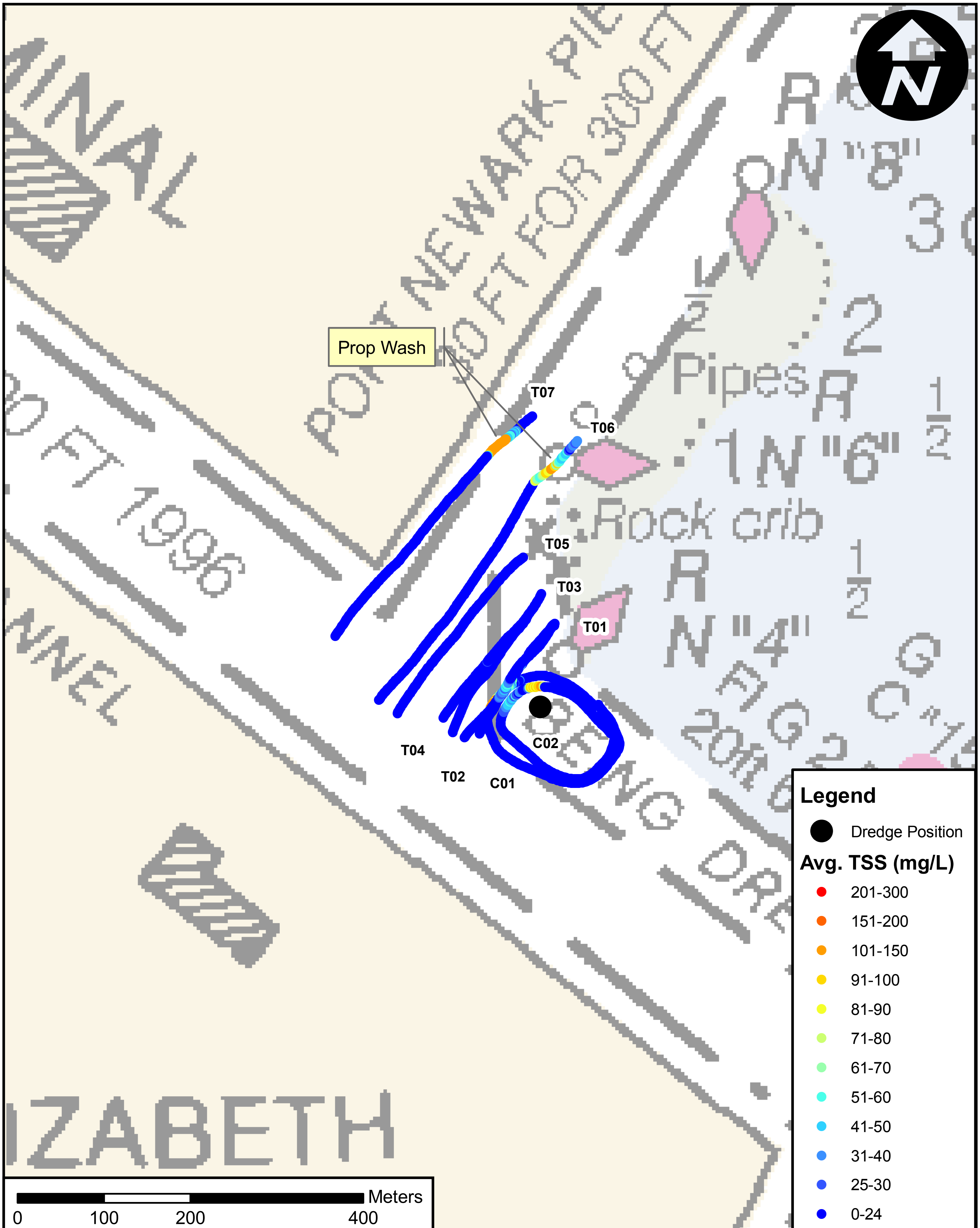


Figure	*USACE Harborwide TSS*	**ADCP Average TSS - 2 April 2009**	**Tide**
22a	*Far Field Survey* *HDP Contract Area: S-E-1: A*	**0-2 Meter Depth Interval**	**Flood**

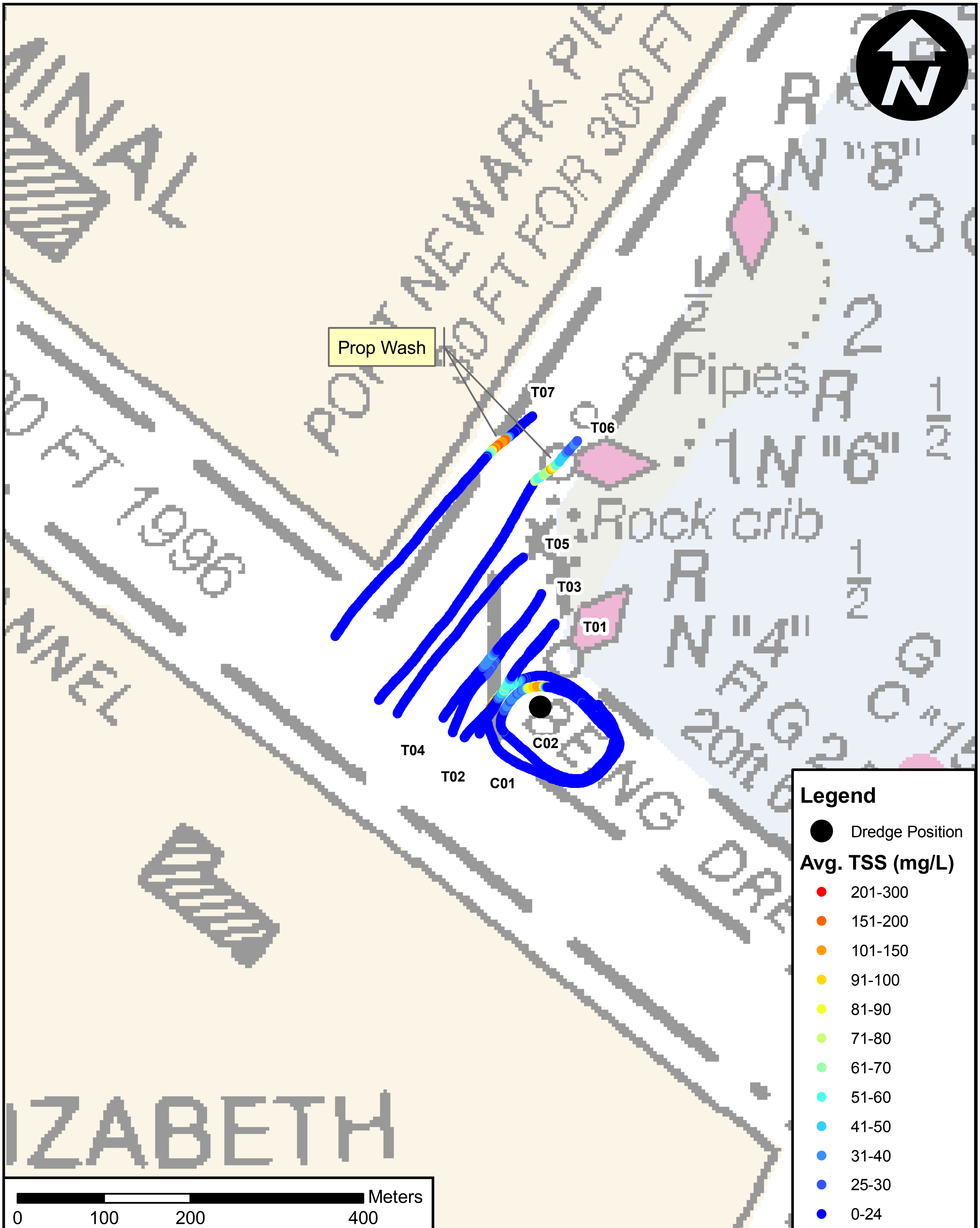


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**ADCP Average TSS - 2 April 2009** **2-4 Meter Depth Interval**	**Tide**
22b			**Flood**

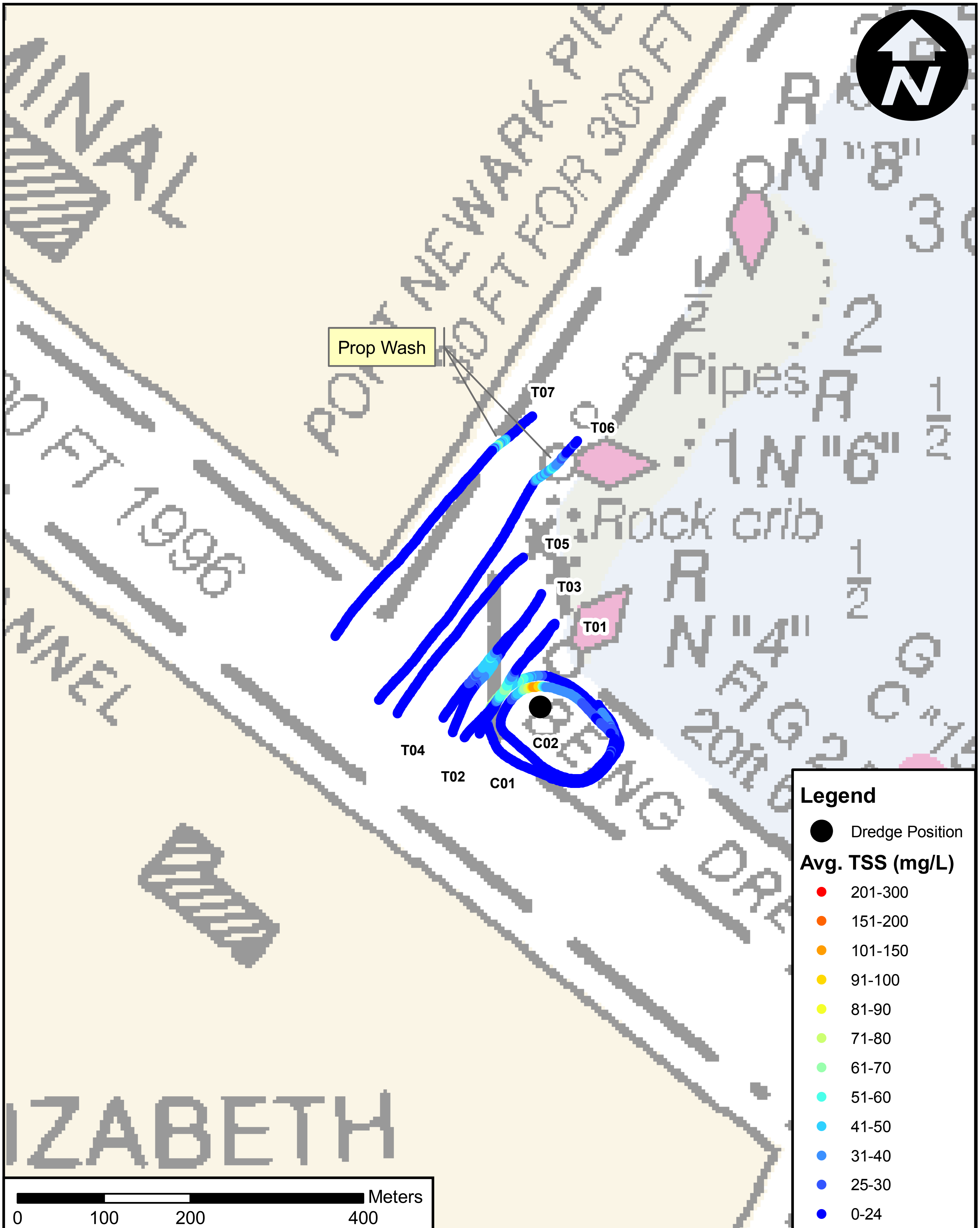


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**ADCP Average TSS - 2 April 2009** **4-6 Meter Depth Interval**	**Tide**
22c			**Flood**

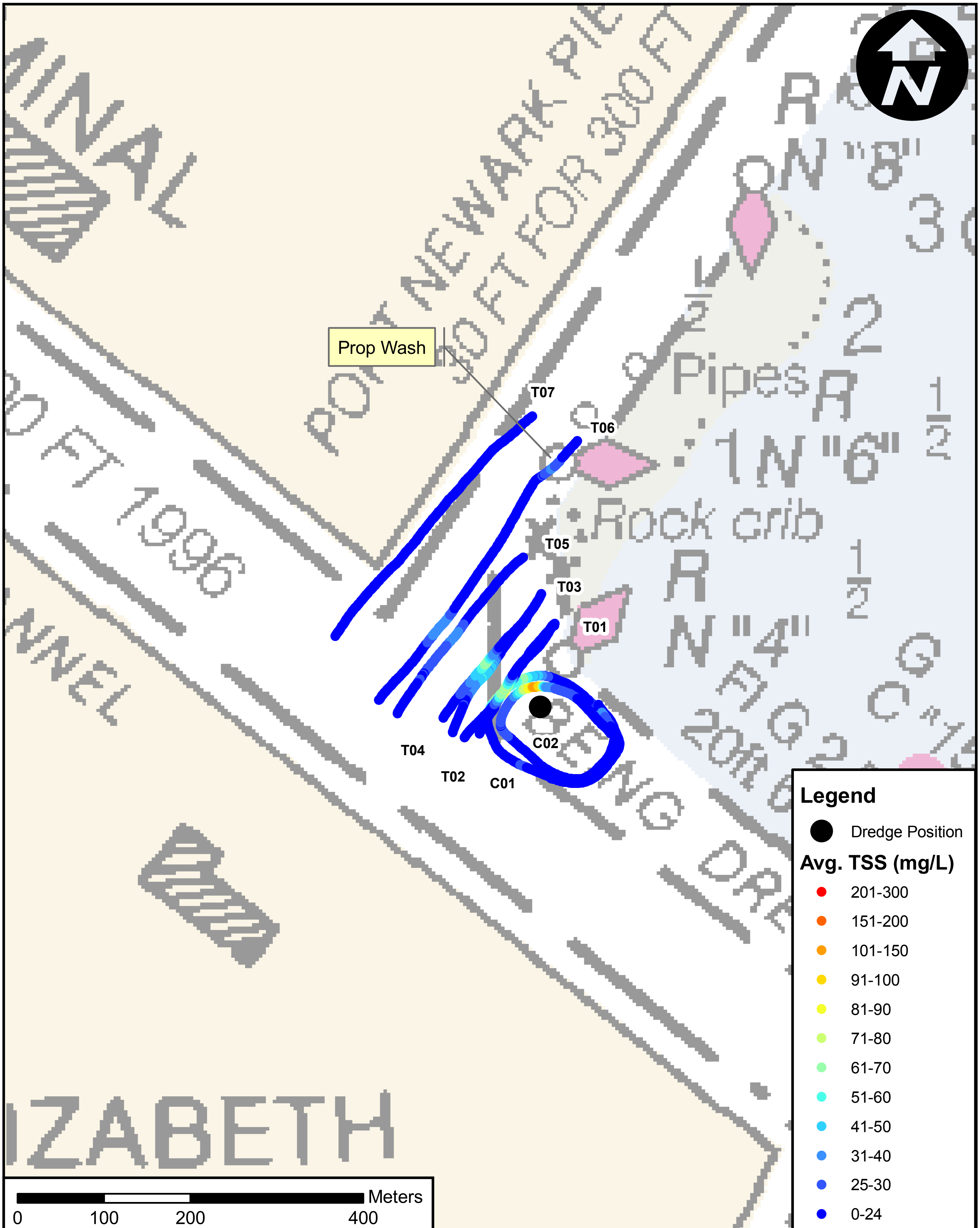


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**ADCP Average TSS - 2 April 2009** **6-8 Meter Depth Interval**	**Tide**
22d			**Flood**

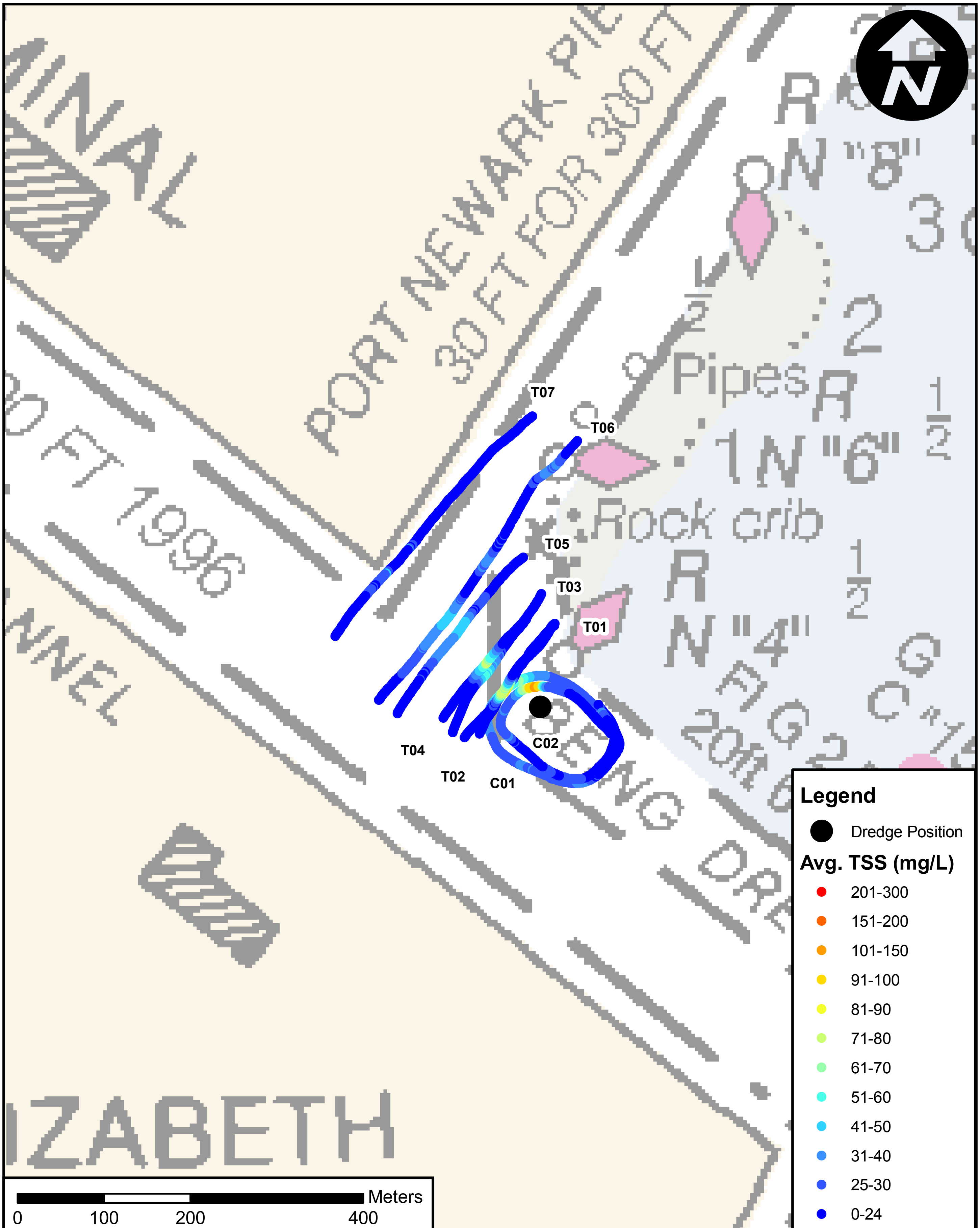


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**ADCP Average TSS - 2 April 2009** **8-10 Meter Depth Interval**	Tide
22e			Flood

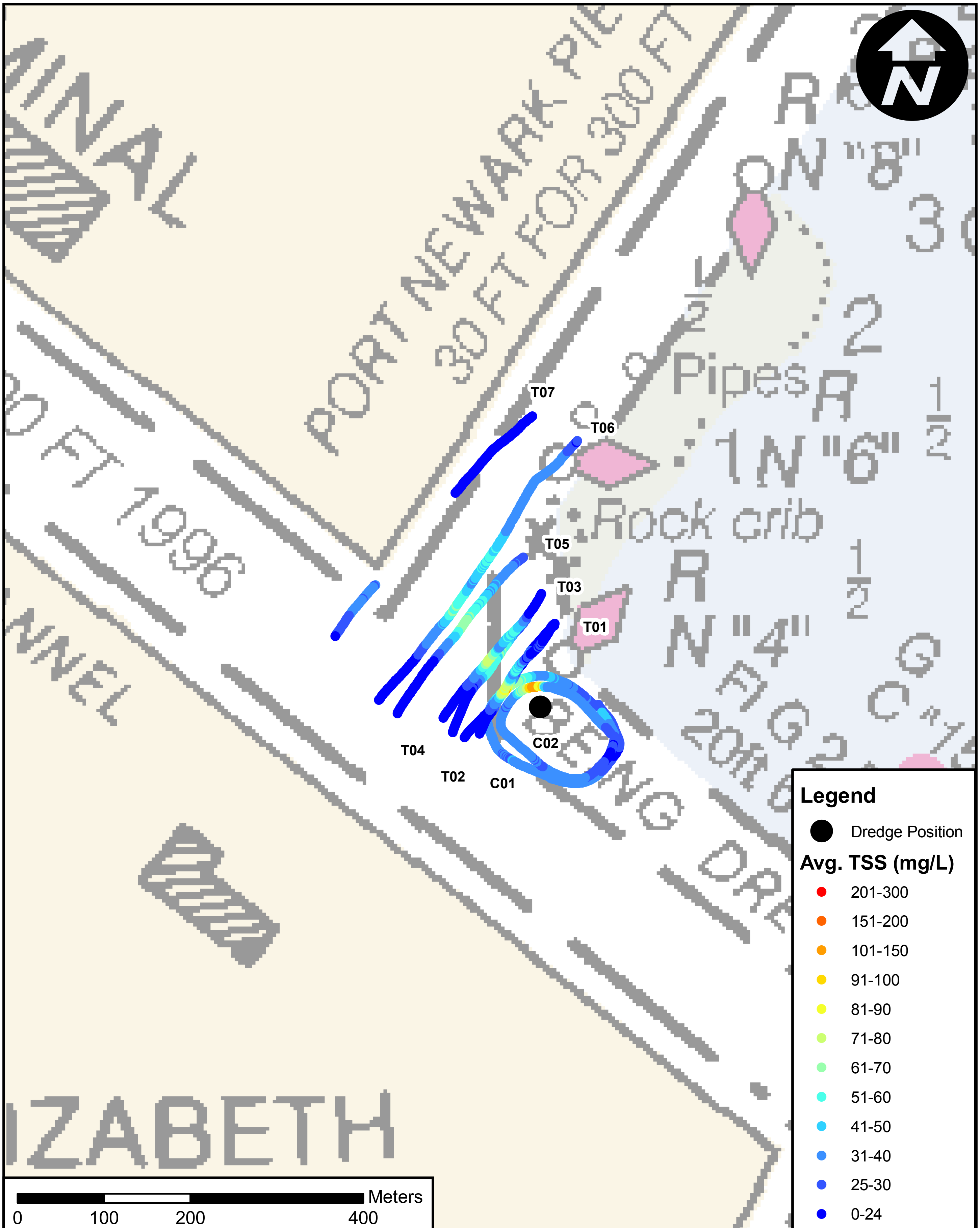


Figure	*USACE Harborwide TSS*	**ADCP Average TSS - 2 April 2009**	**Tide**
22f	*Far Field Survey* *HDP Contract Area: S-E-1: A*	**10-12 Meter Depth Interval**	**Flood**

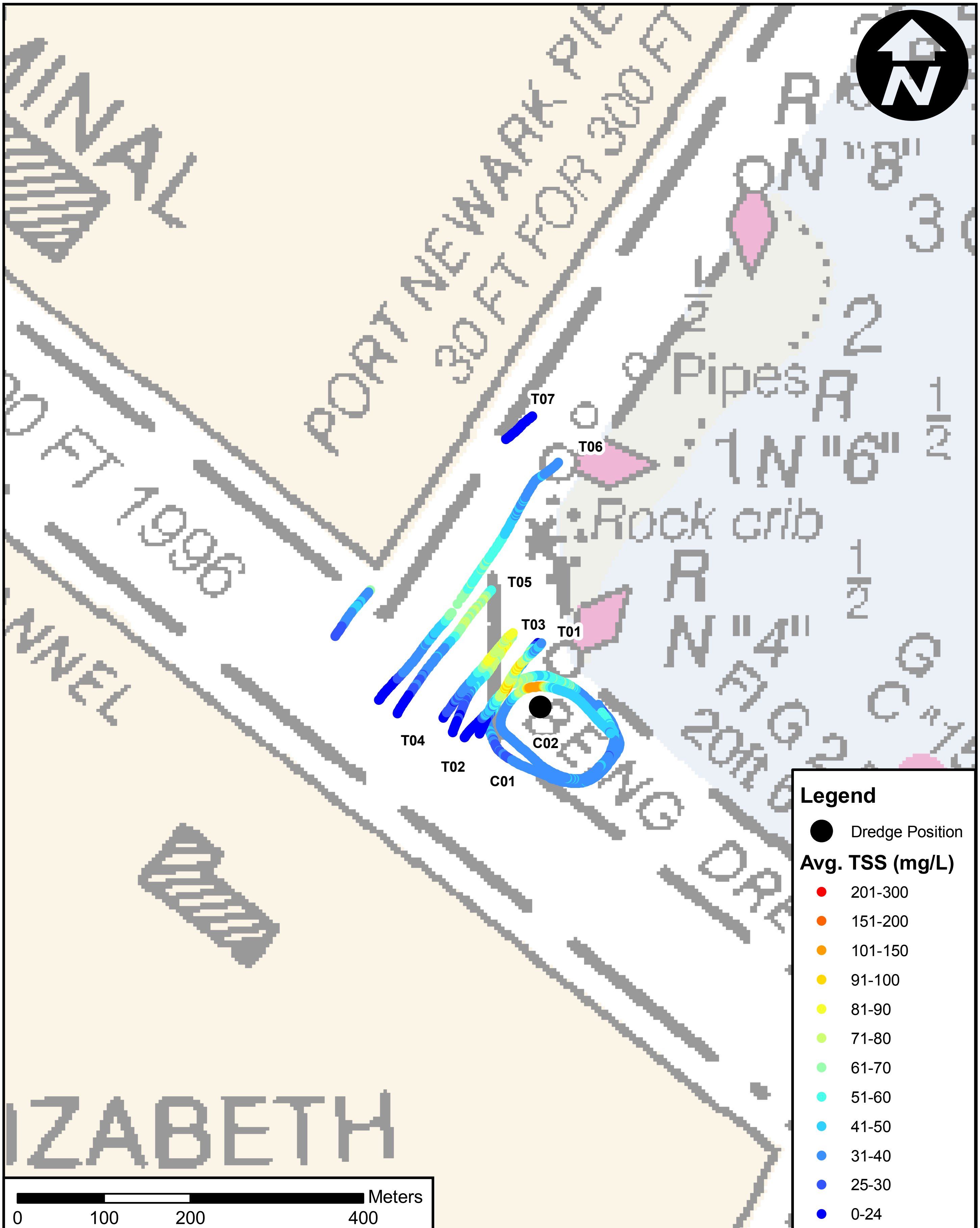
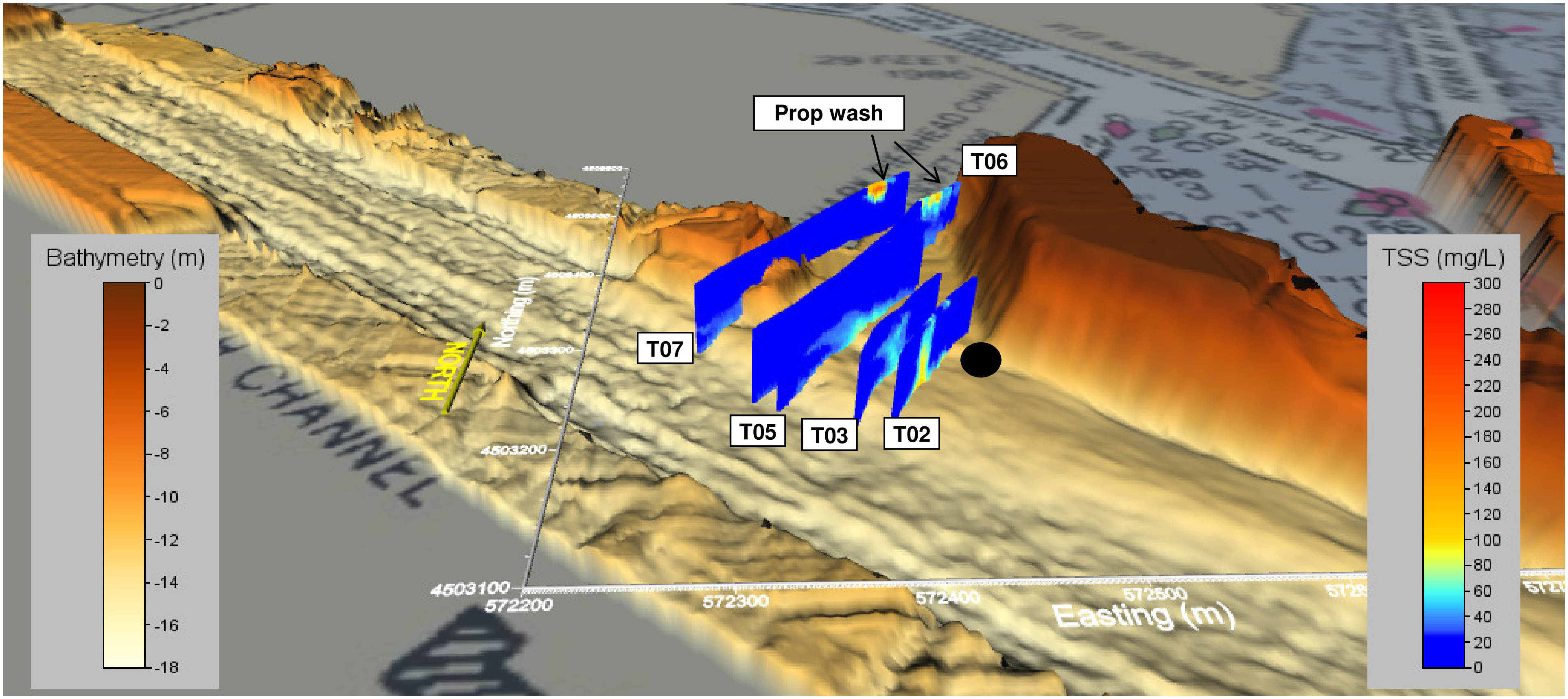


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**ADCP Average TSS - 2 April 2009** **12-14 Meter Depth Interval**	**Tide**
22g			**Flood**



Bathymetry provided by: US Army Corps of Engineers, NY District

Z Scale Exaggerated 6x

● **= Dredge Location**

Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: A*	**ADCP Average TSS Values with Respect to their x, y, and z Coordinates** **Superimposed on Channel Bathymetry** **02 April 2009**	**Tide**
23			**Flood**

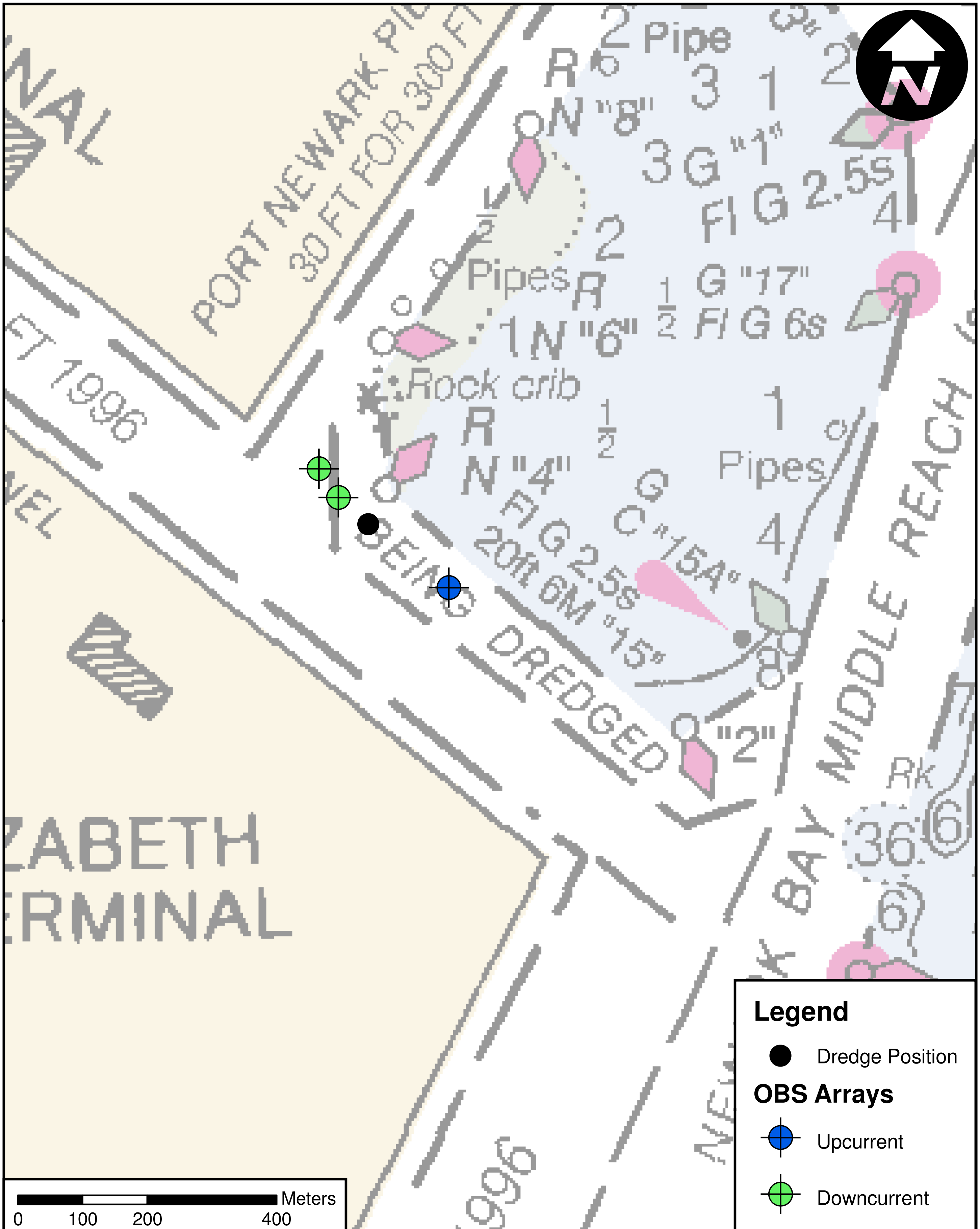
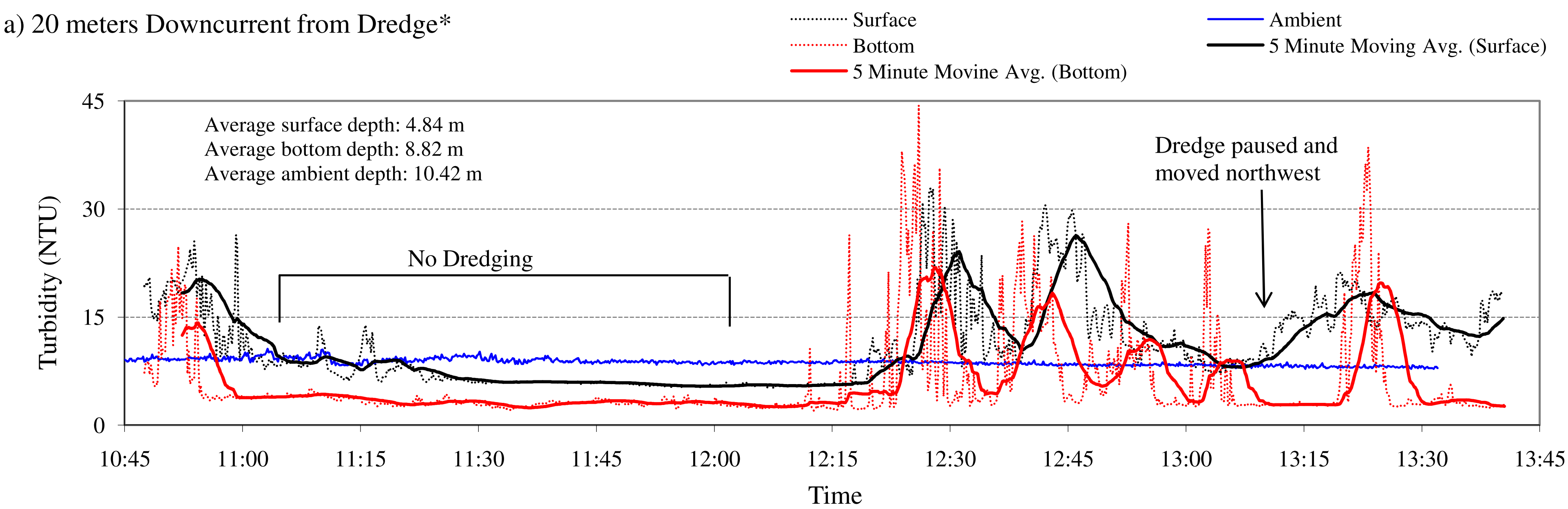
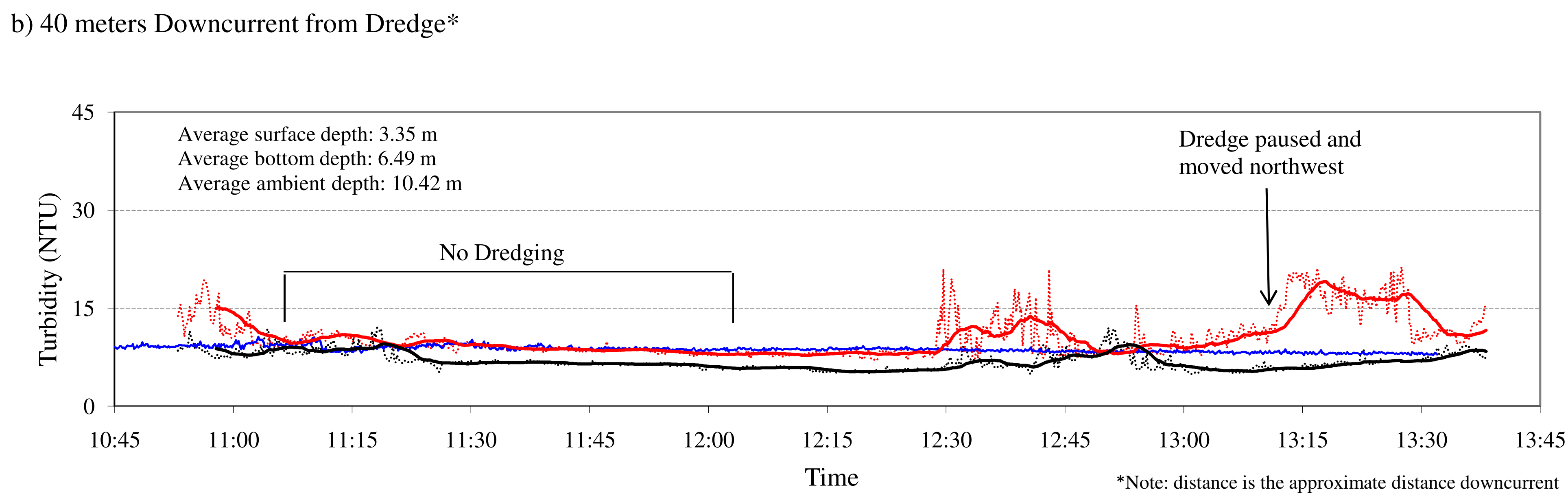


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1	Location of OBS Vertical Arrays and Dredge Position 02 April 2009	Tide
24			Flood





*Note: distance is the approximate distance downcurrent of the dredge during the sampling period

Figure	*USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: A*	**Surface and Bottom OBS Turbidities at a) 20 m and b) 40 m Downcurrent of Dredge. Ambient Station Located Upcurrent of Dredge. 02 April 2009 TSS Survey**	Tide
25			Flood

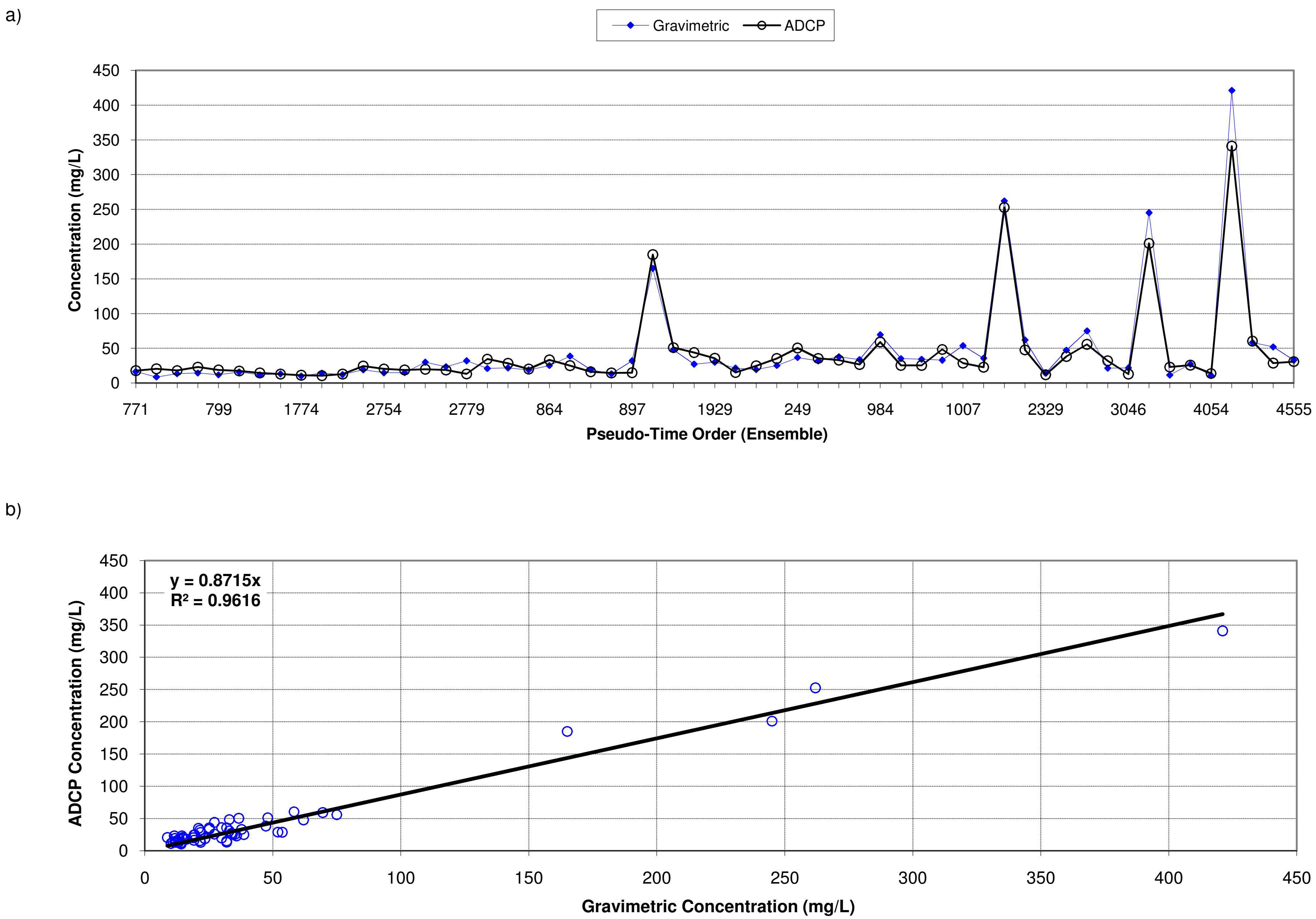
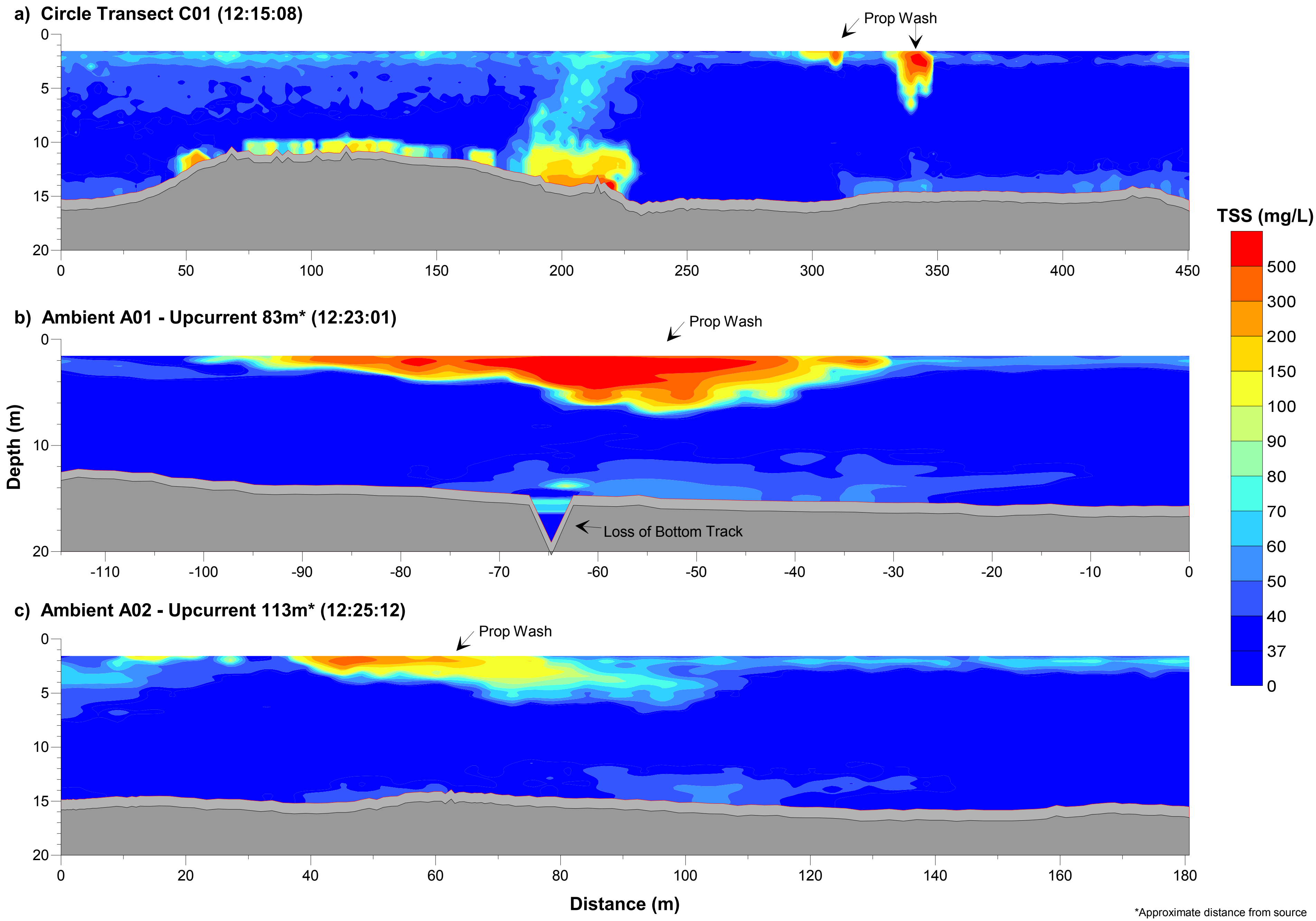


Figure	*USACE Harborwide TSS*	**Comparison of gravimetric and ADCP estimates of TSS concentration**	Tide
26a-b	*Far Field Survey* *HDP Contract Area: S-E-1: A*	**a) Concentration vs. Time b) ADCP Concentration vs. Gravimetric Concentration** **29 March - 2 April 2009 TSS Survey**	**N/A**



*Approximate distance from source

FIGURE	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**Vertical Profiles of ADCP Average TSS** **27 April 2009**	TIDE
27a-c			**Ebb**

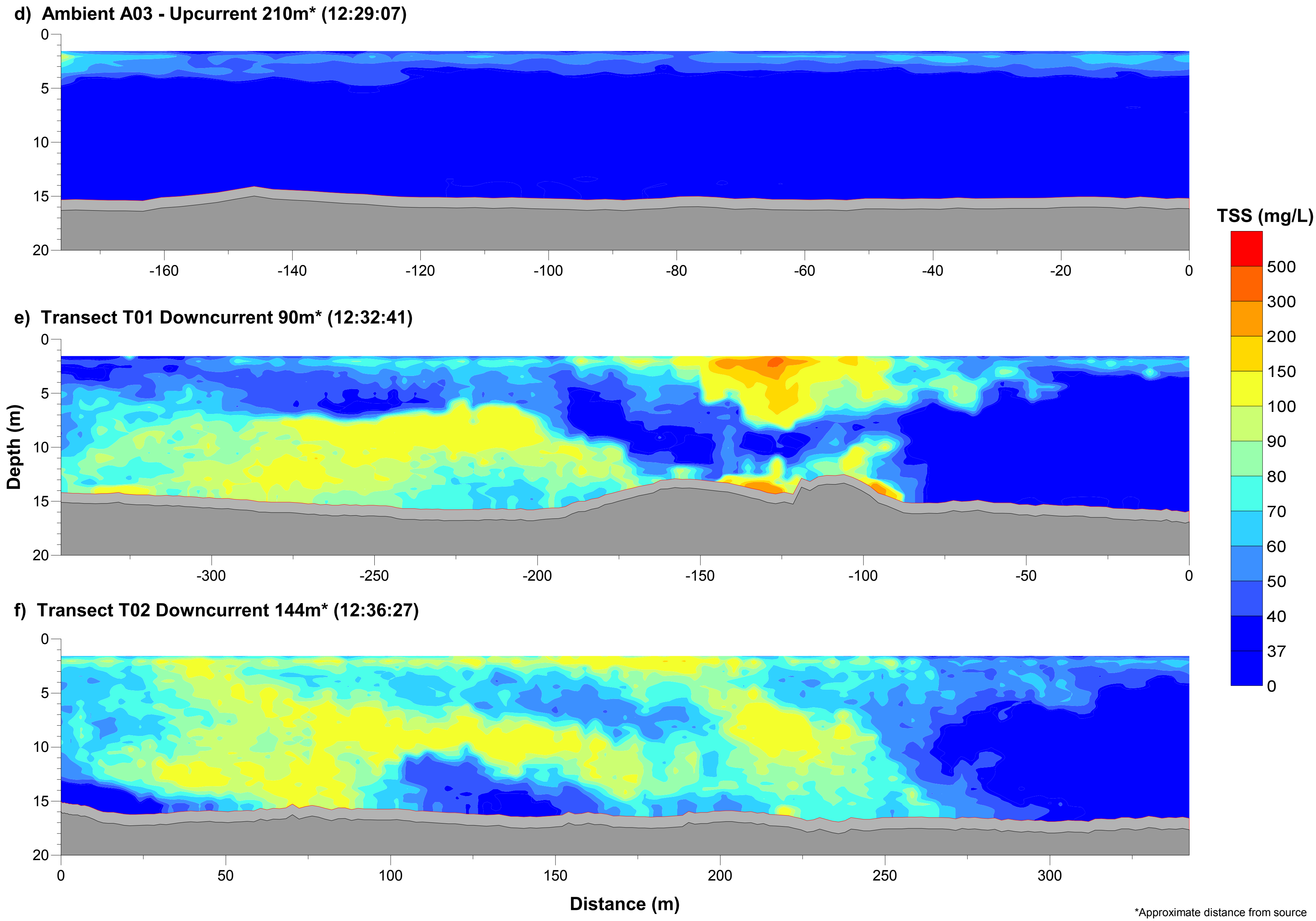
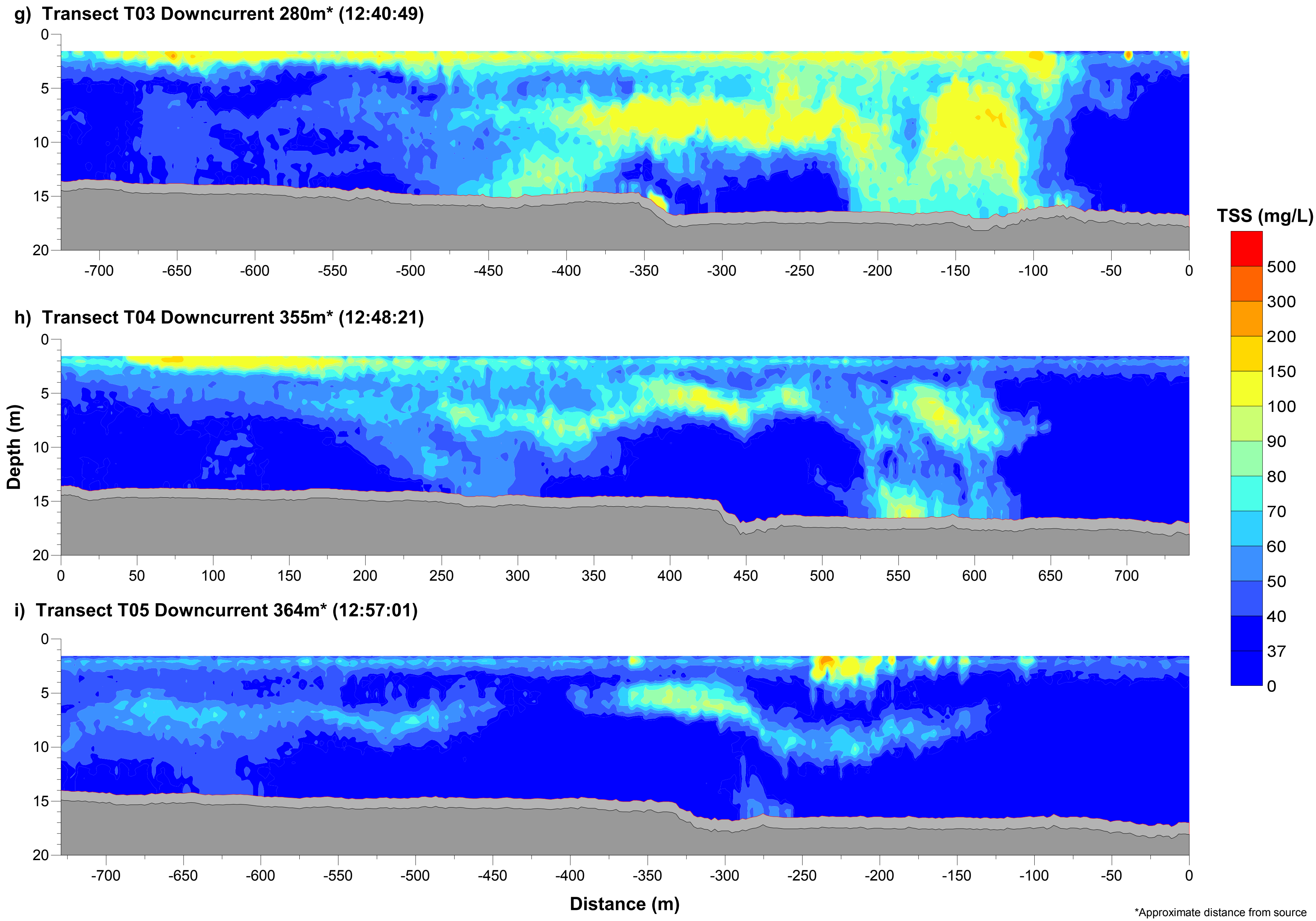
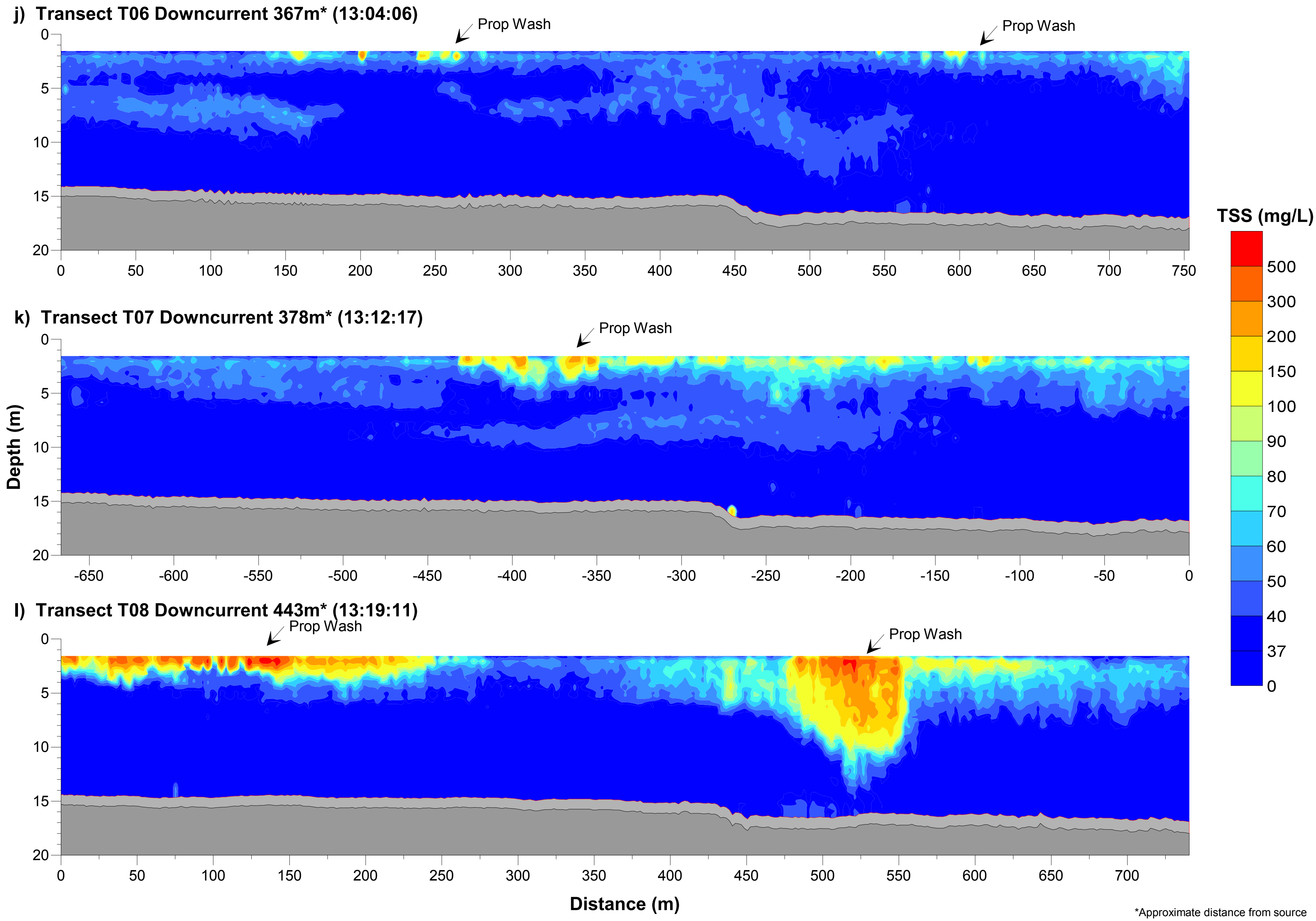


FIGURE	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**Vertical Profiles of ADCP Average TSS** **27 April 2009**	TIDE
27d-f			**Ebb**



*Approximate distance from source

FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	Vertical Profiles of ADCP Average TSS 27 April 2009	TIDE
27g-i			Ebb



*Approximate distance from source

FIGURE			TIDE
27j-l	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**Vertical Profiles of ADCP Average TSS** **27 April 2009**	**Ebb**

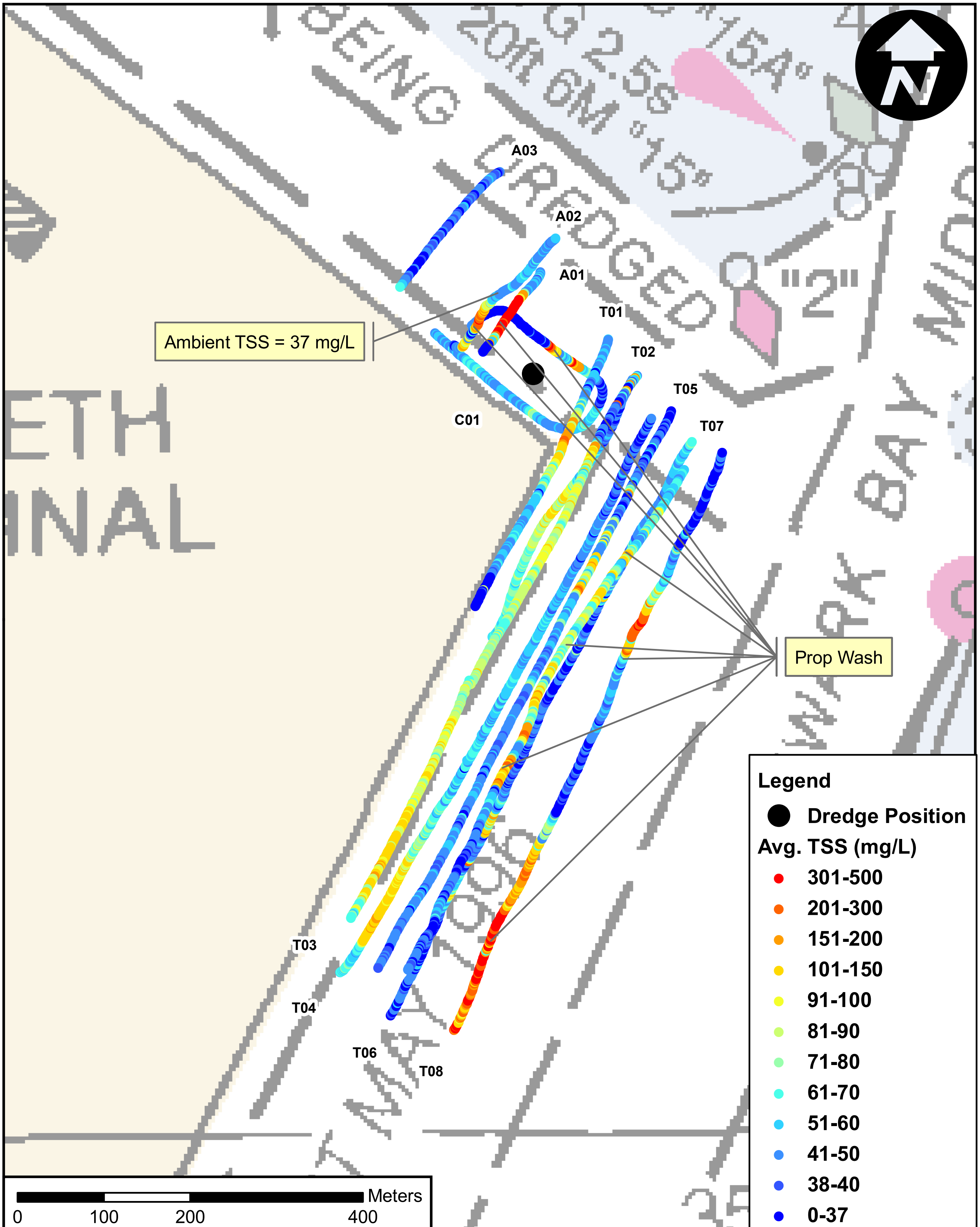


Figure	*USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B*	ADCP Average TSS - 27 April 2009 0-2 Meter Depth Interval	Tide
28a			Ebb

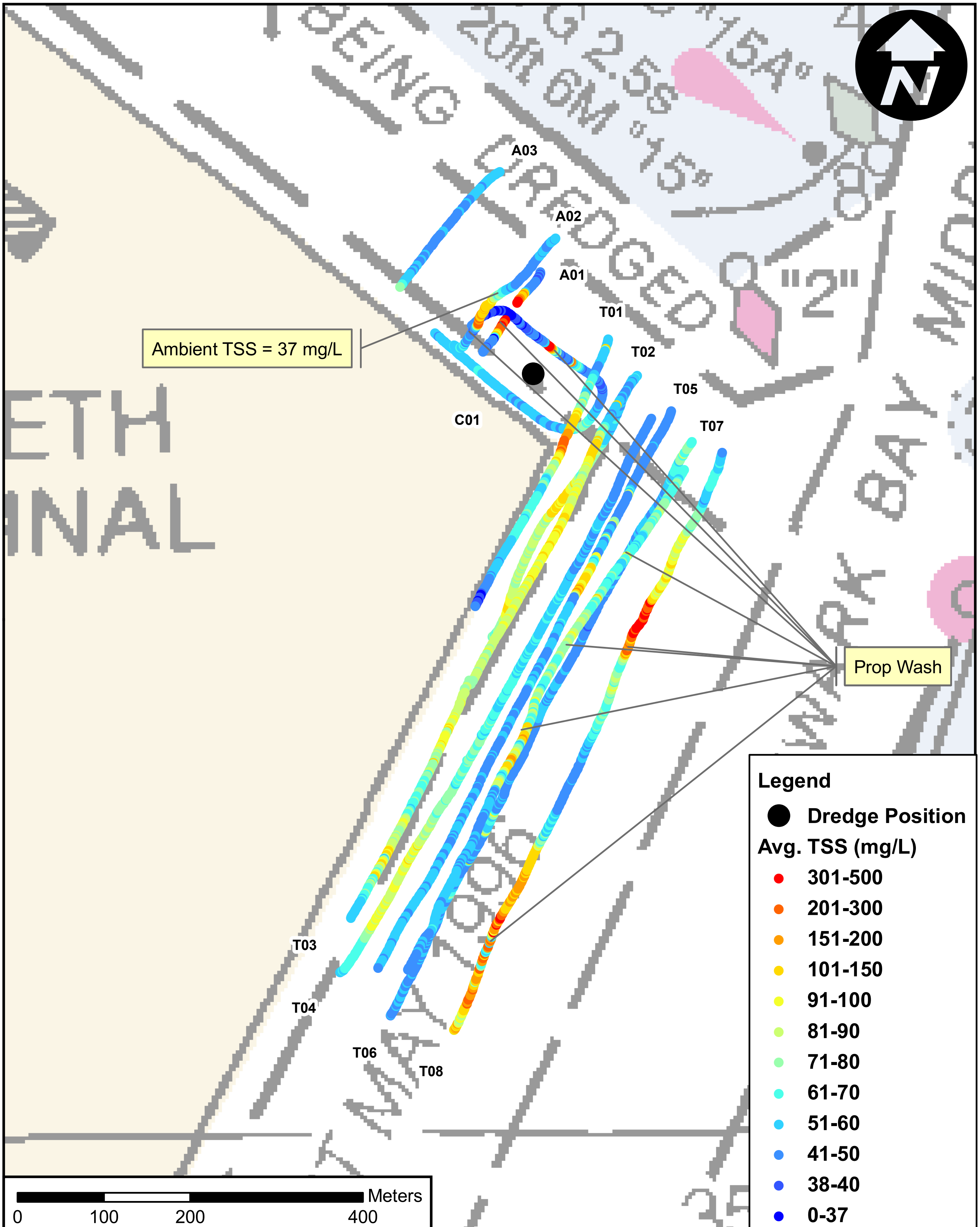


Figure	*USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B*	ADCP Average TSS - 27 April 2009 2-4 Meter Depth Interval	Tide
28b			Ebb

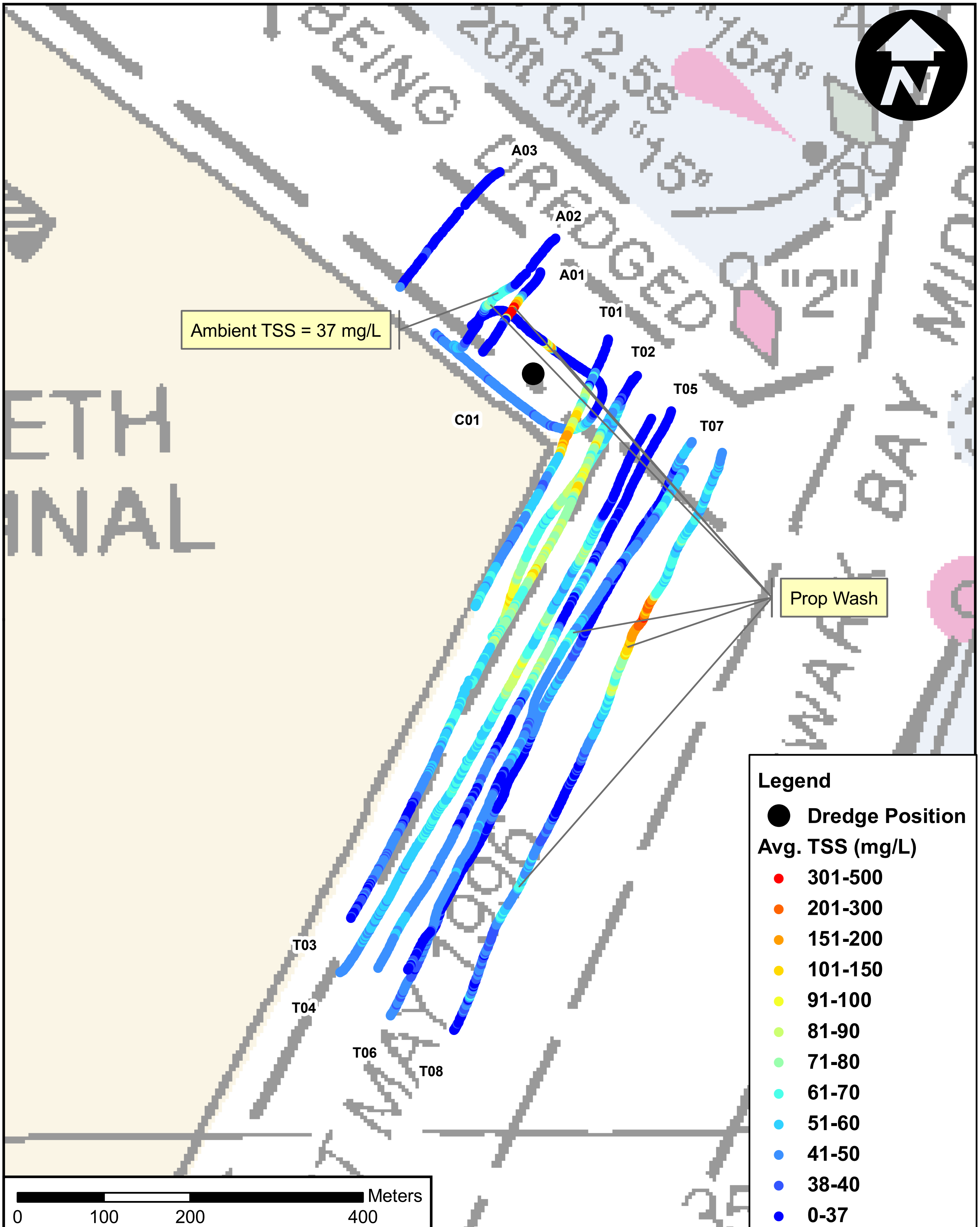


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 27 April 2009** **4-6 Meter Depth Interval**	**Tide**
28c			**Ebb**

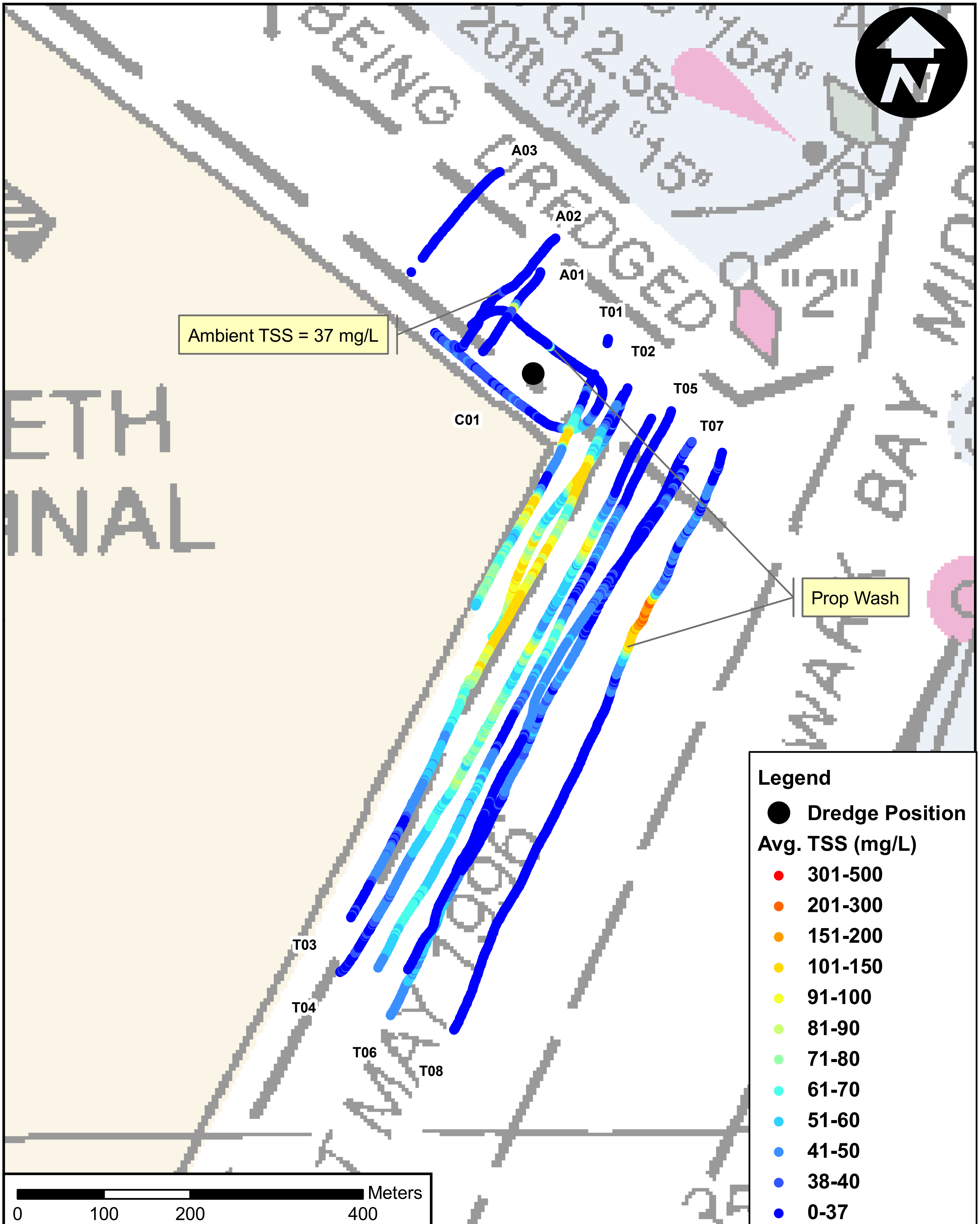


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 27 April 2009** **6-8 Meter Depth Interval**	Tide
28d			Ebb

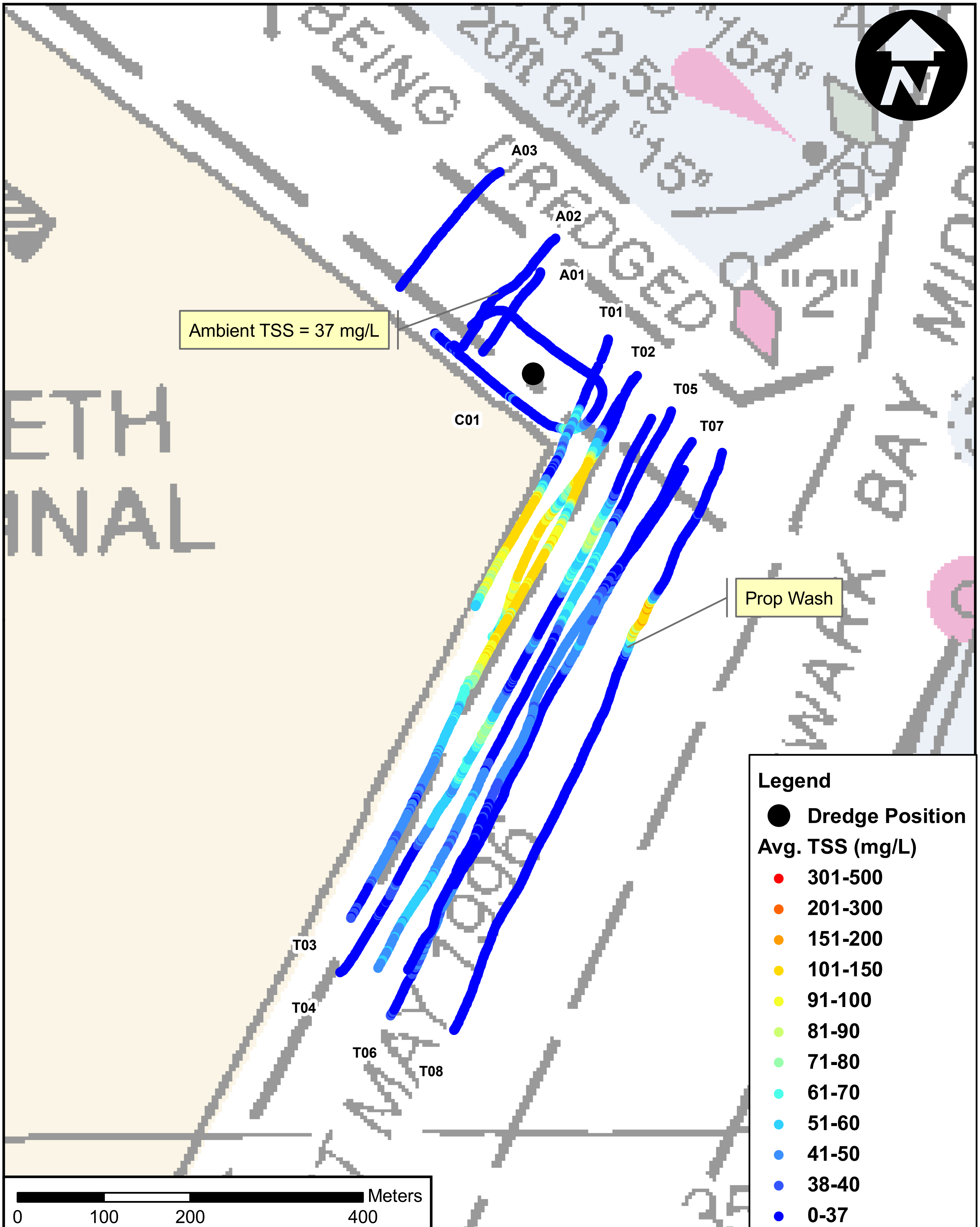


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 27 April 2009** **8-10 Meter Depth Interval**	**Tide**
28e			**Ebb**

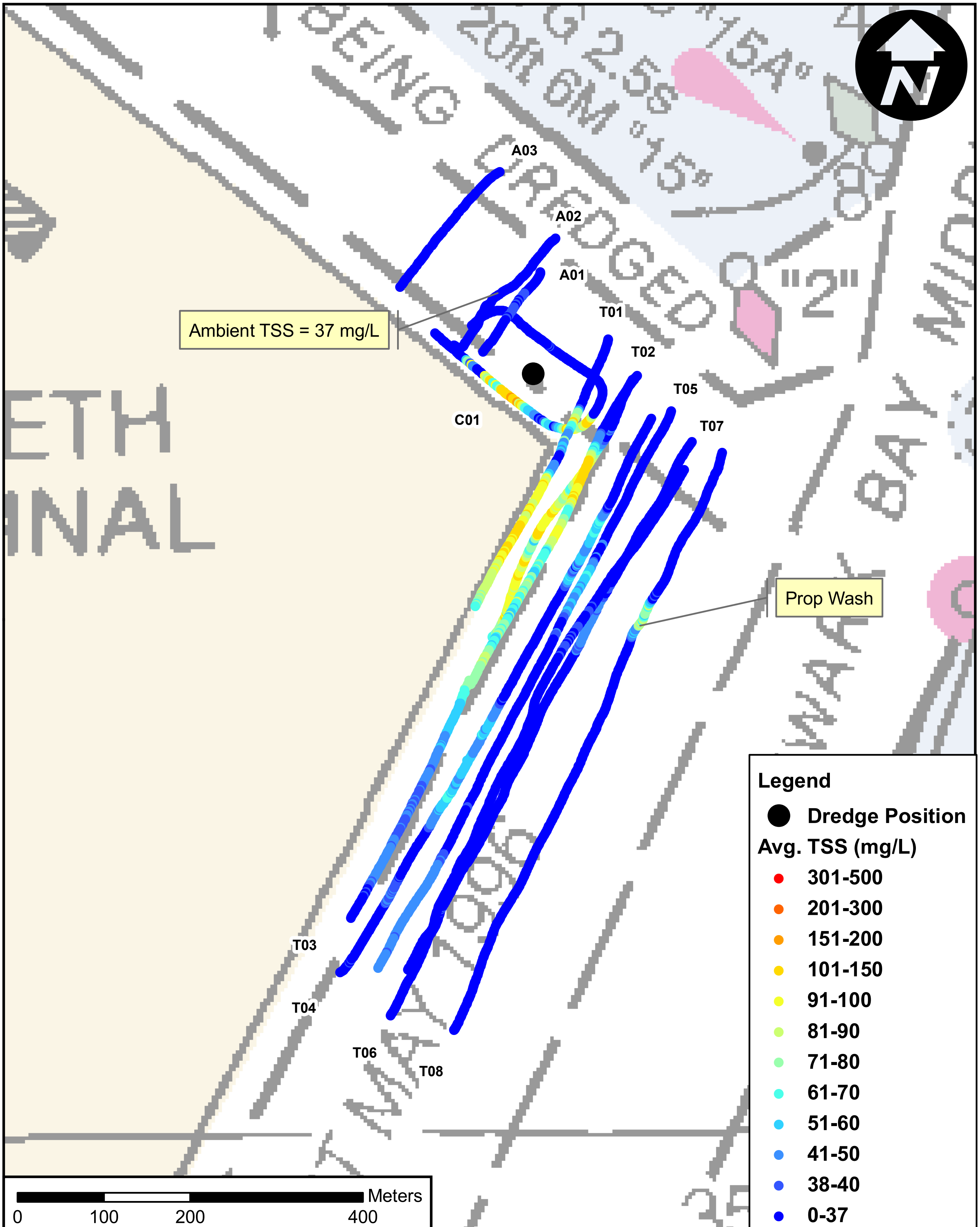


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 27 April 2009** **10-12 Meter Depth Interval**	**Tide**
28f			**Ebb**

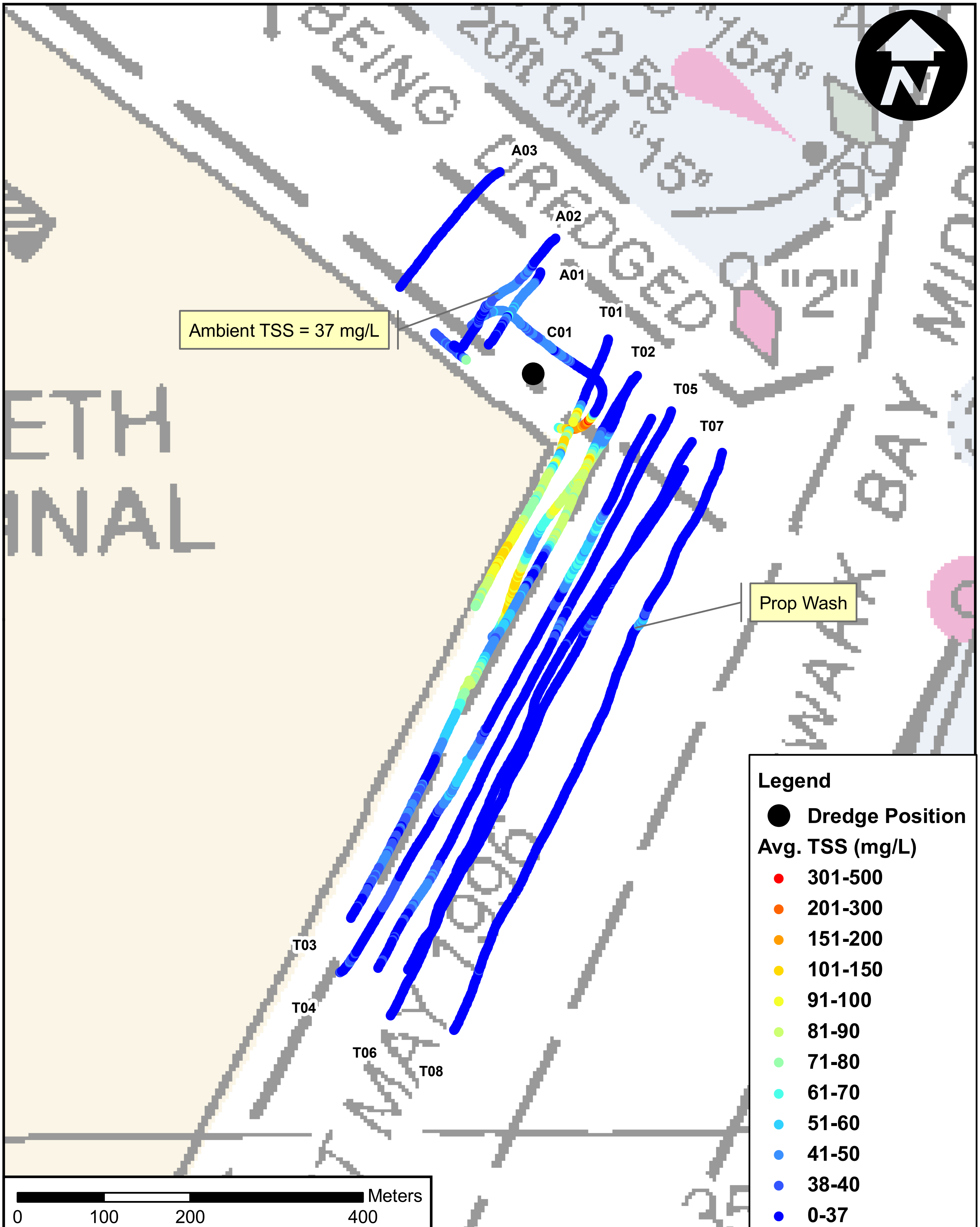


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 27 April 2009** **12-14 Meter Depth Interval**	Tide
28g			Ebb

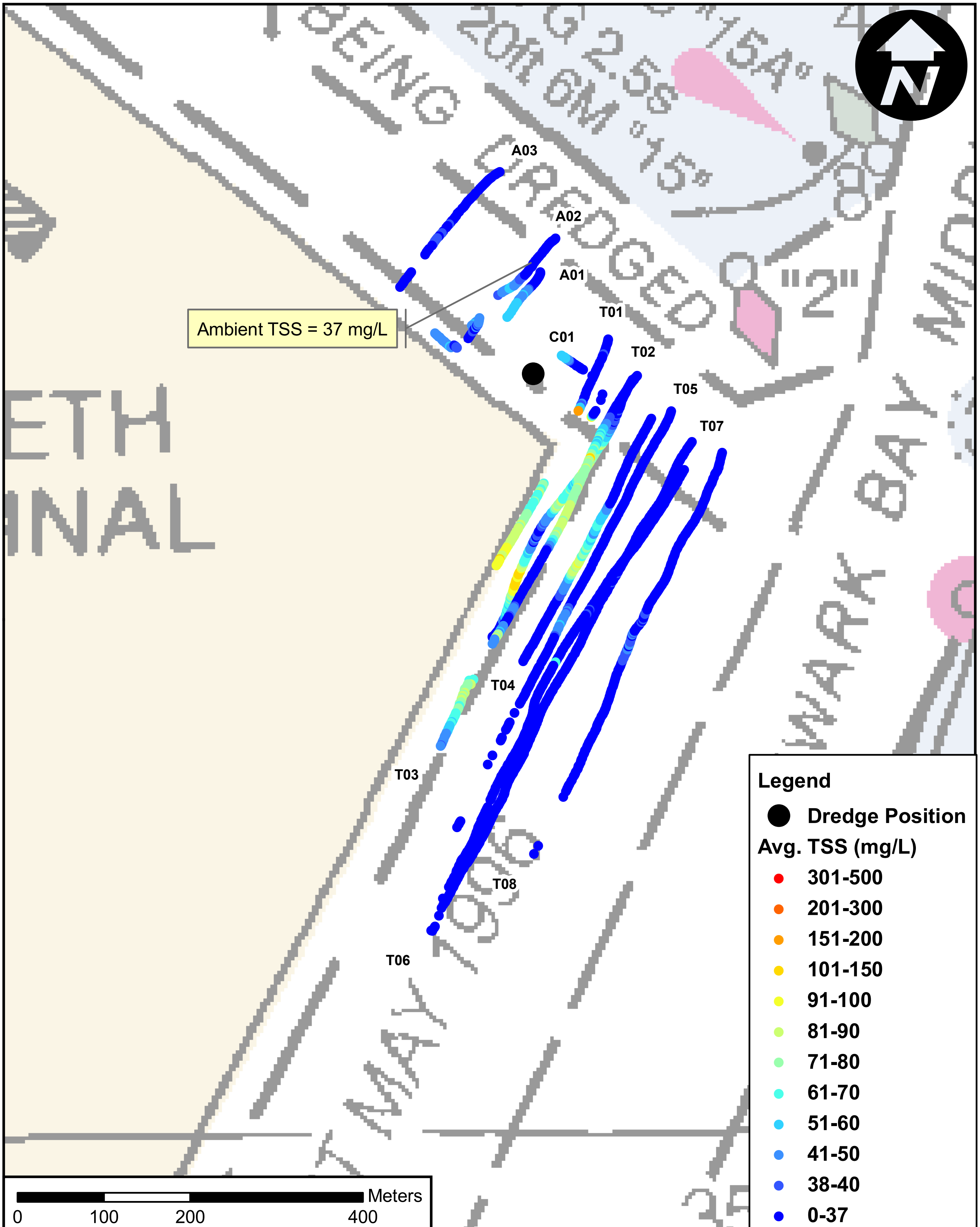
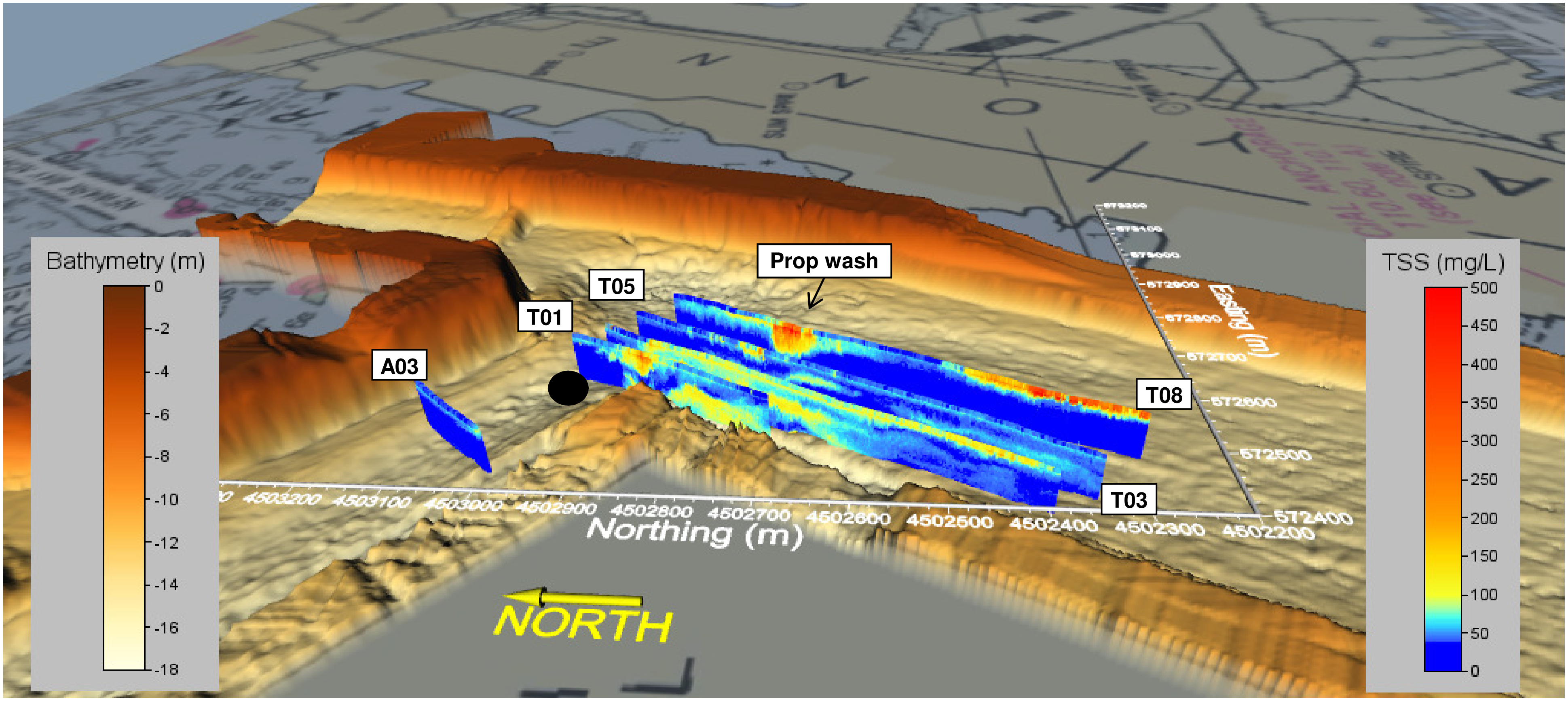


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 27 April 2009** **14-16 Meter Depth Interval**	Tide
28h			Ebb

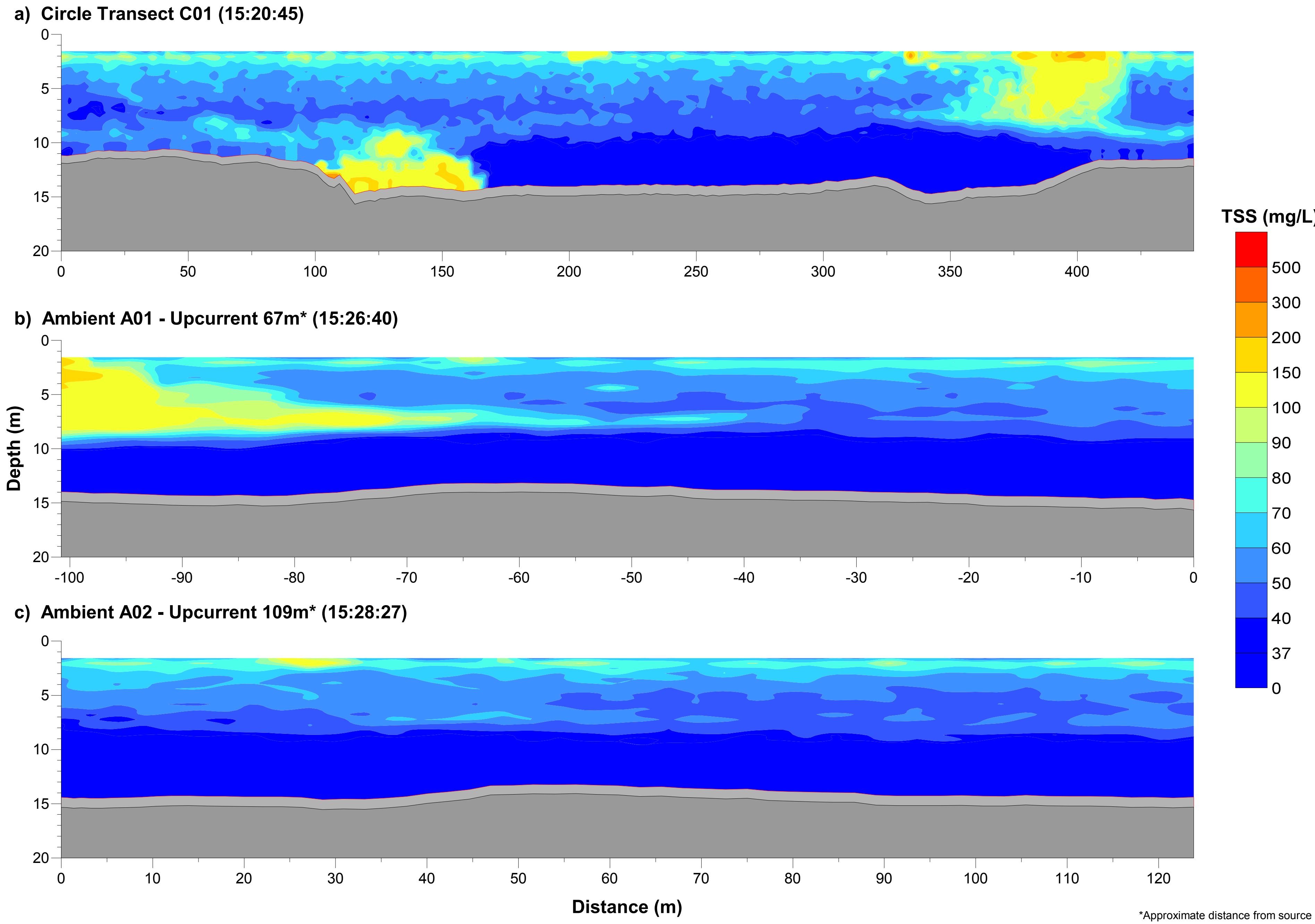


Bathymetry provided by: US Army Corps of Engineers, NY District

Z Scale Exaggerated 6x

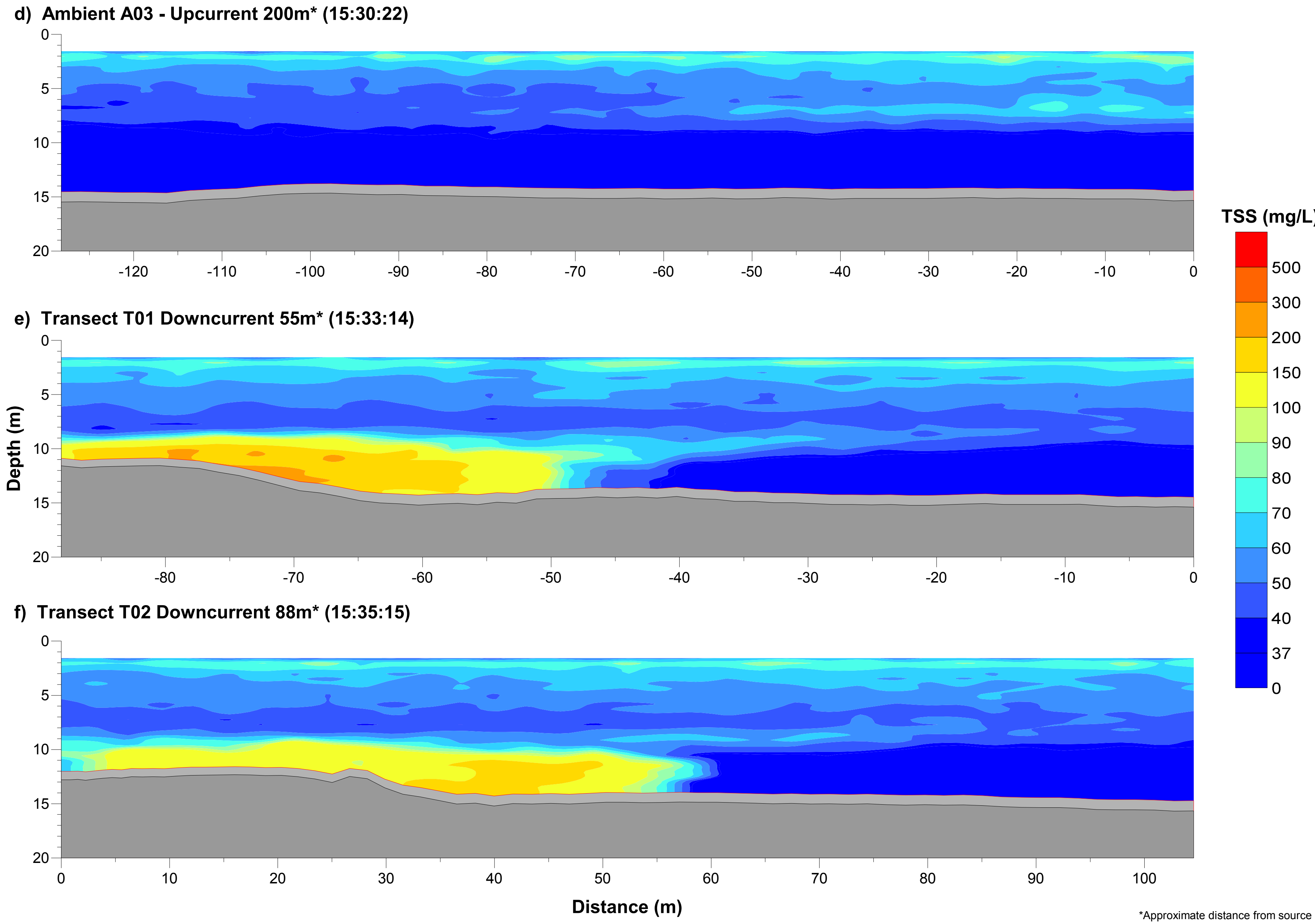
⬤ = Dredge Location

Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	ADCP Average TSS Values with Respect to their x, y, and z Coordinates Superimposed on Channel Bathymetry 27 April 2009	Tide
29			Ebb



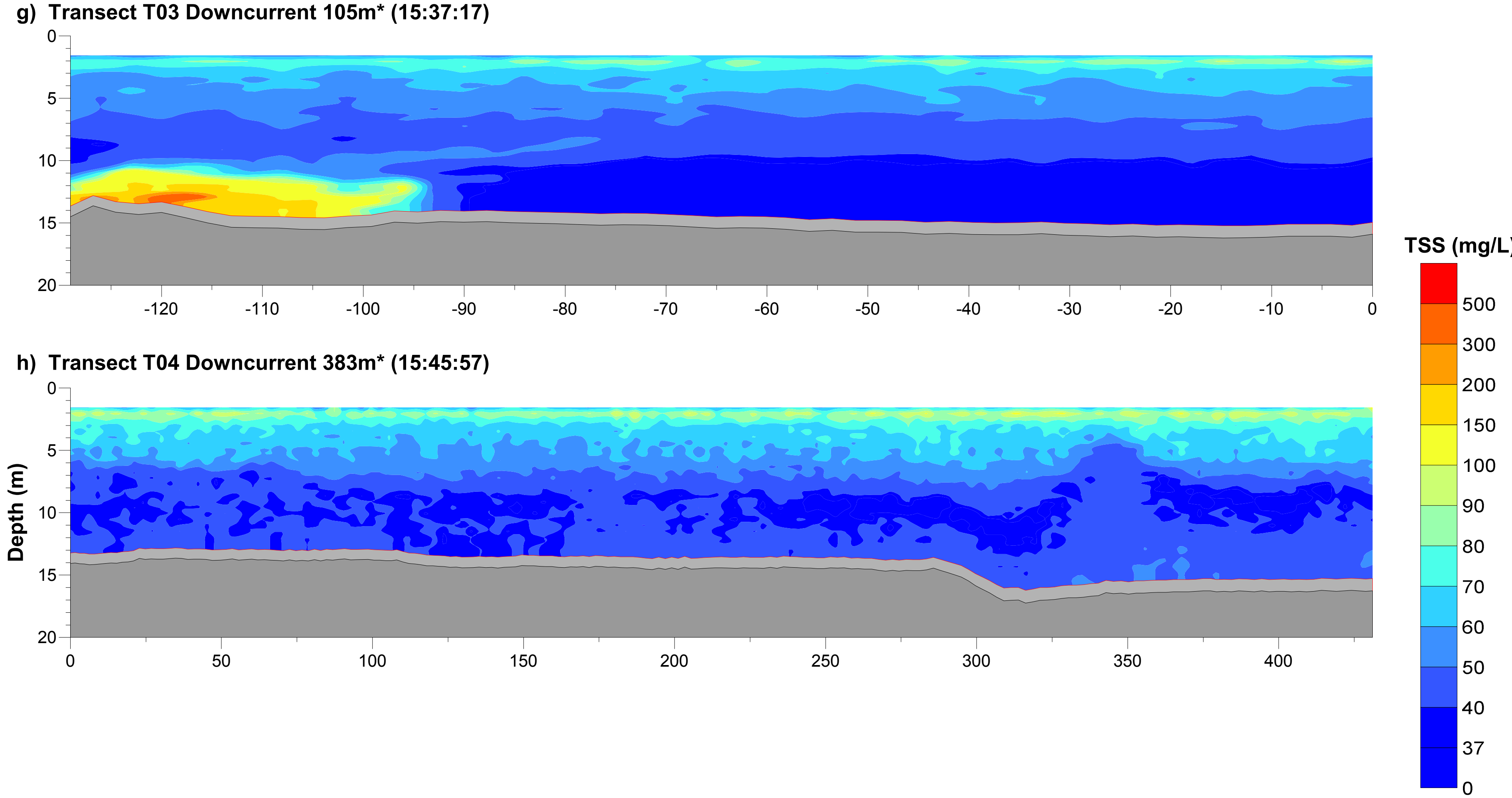
*Approximate distance from source

FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	Vertical Profiles of ADCP Average TSS 27 April 2009	TIDE
30a-c			Late Ebb/Slack



*Approximate distance from source

FIGURE	*USACE Harborwide TSS*	Vertical Profiles of ADCP Average TSS	TIDE
30d-f	*Far Field Survey* *HDP Contract Area: S-E-1: B*	27 April 2009	Late Ebb/Slack



*Approximate distance from source

FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	Vertical Profiles of ADCP Average TSS 27 April 2009	TIDE
30g-h			Late Ebb/Slack

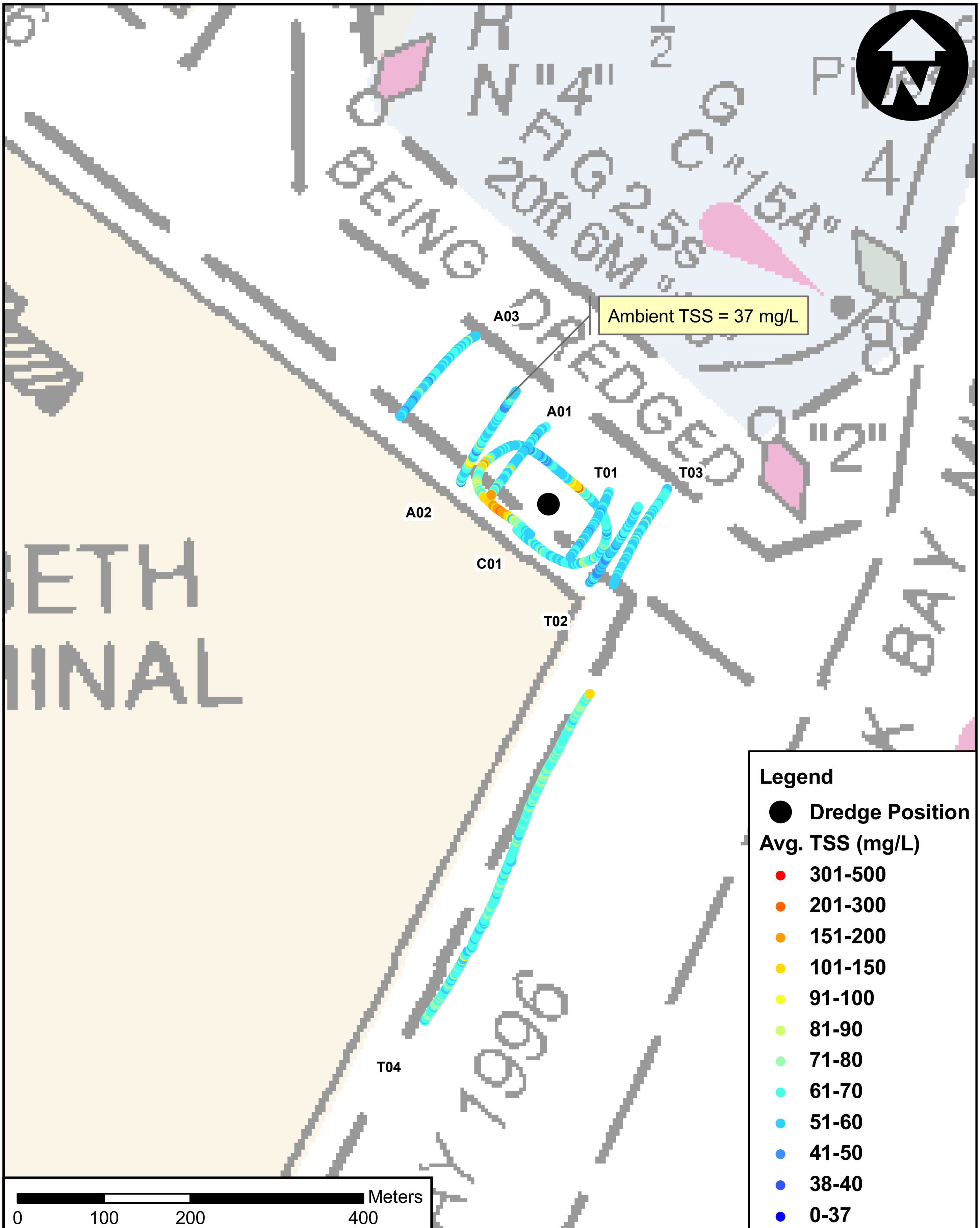


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	ADCP Average TSS - 27 April 2009 0-2 Meter Depth Interval	Tide
31a			Late Ebb/Slack

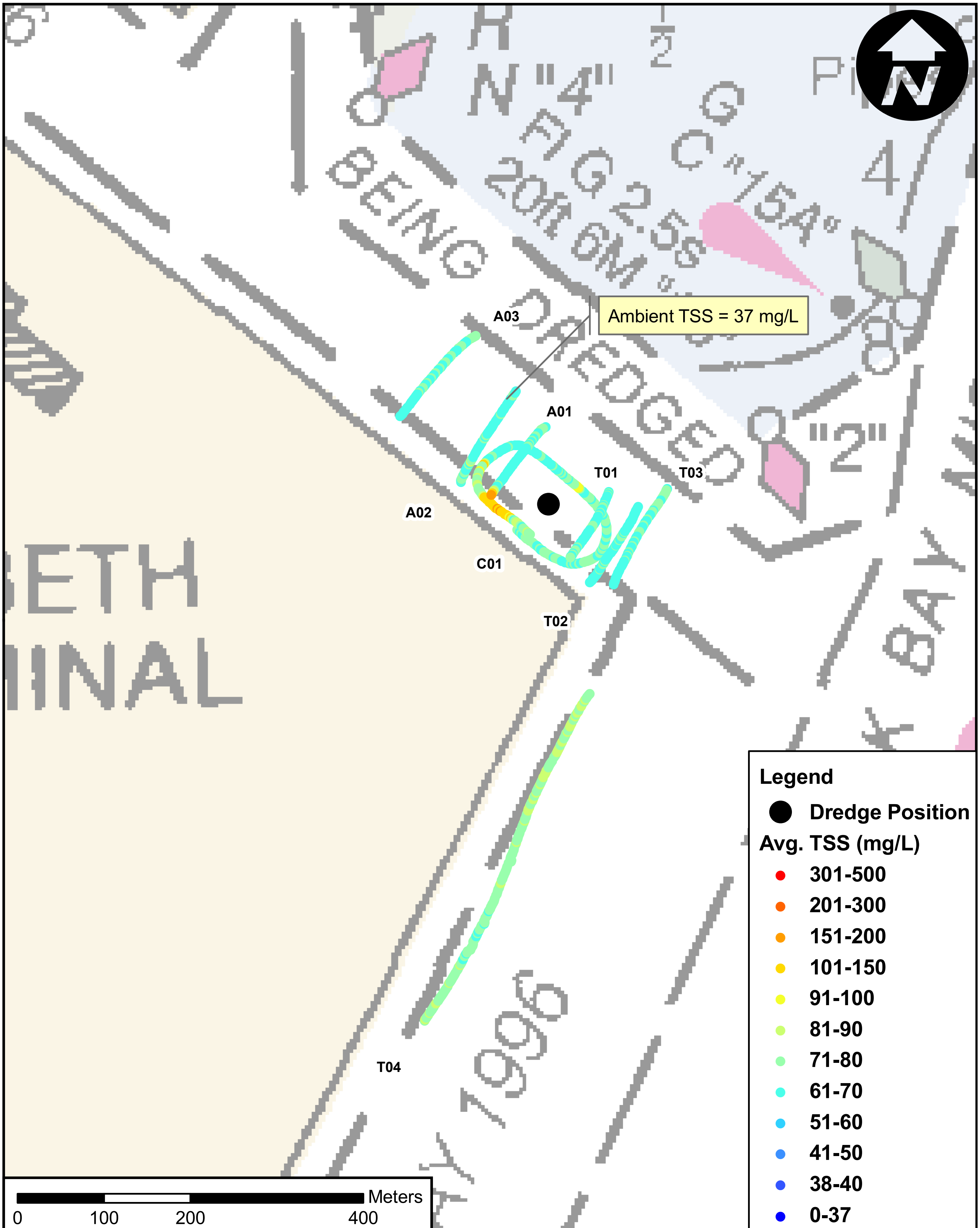


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 27 April 2009** **2-4 Meter Depth Interval**	**Tide**
31b			Late Ebb/Slack

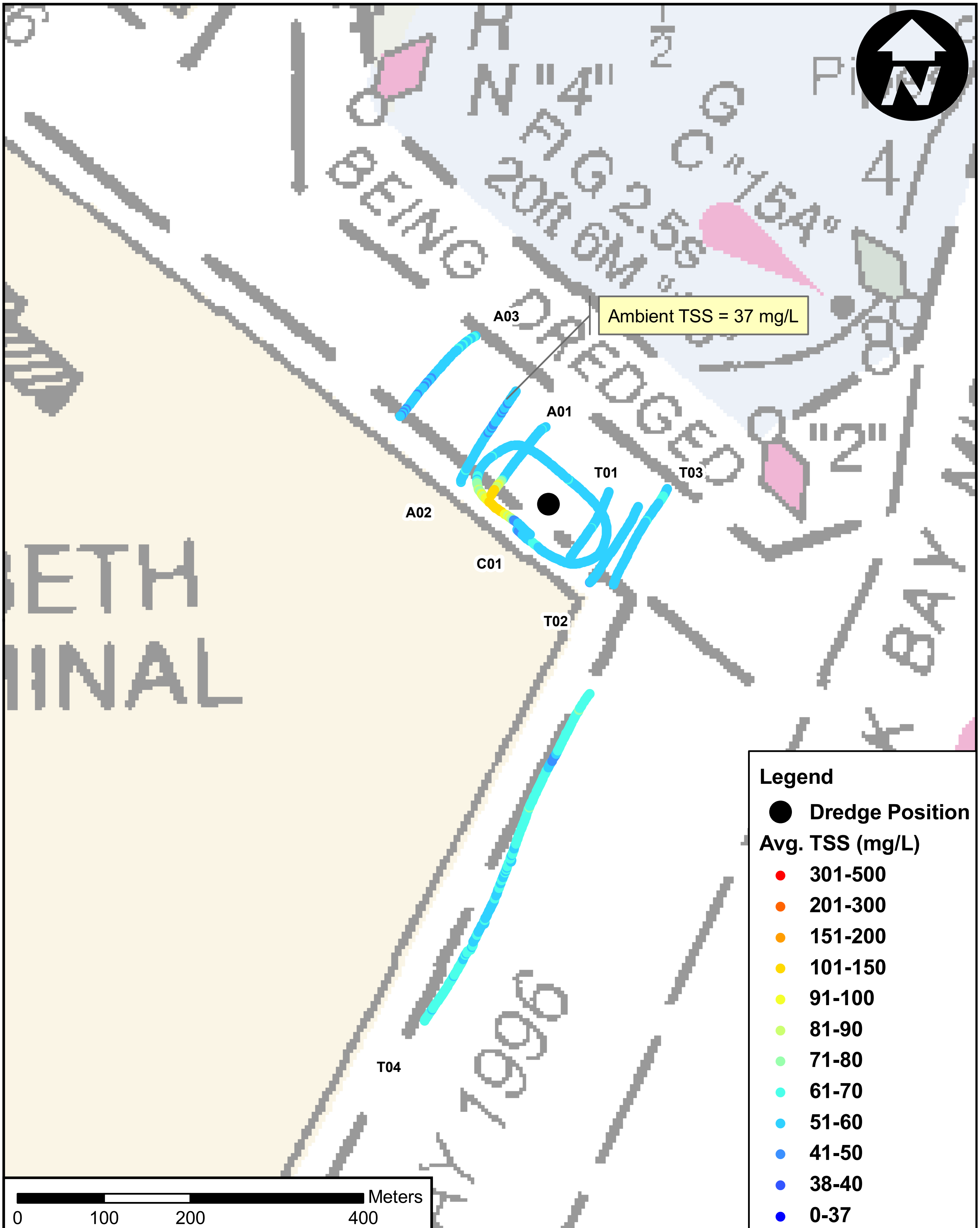


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	ADCP Average TSS - 27 April 2009 4-6 Meter Depth Interval	Tide
31c			Late Ebb/Slack

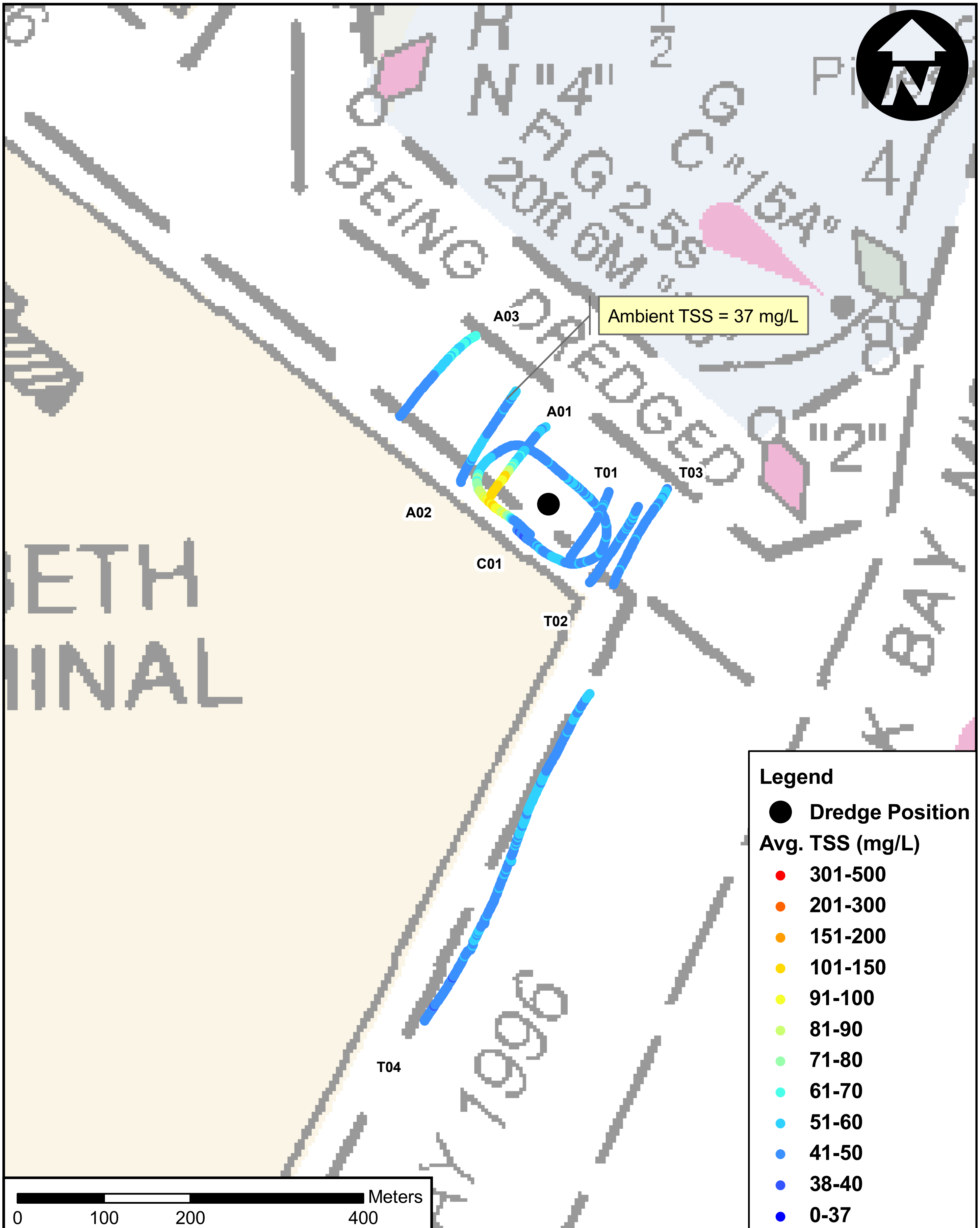


Figure	USACE Harborwide TSS *Far Field Survey* *HDP Contract Area: S-E-1: B*	ADCP Average TSS - 27 April 2009 6-8 Meter Depth Interval	Tide
31d			Late Ebb/Slack

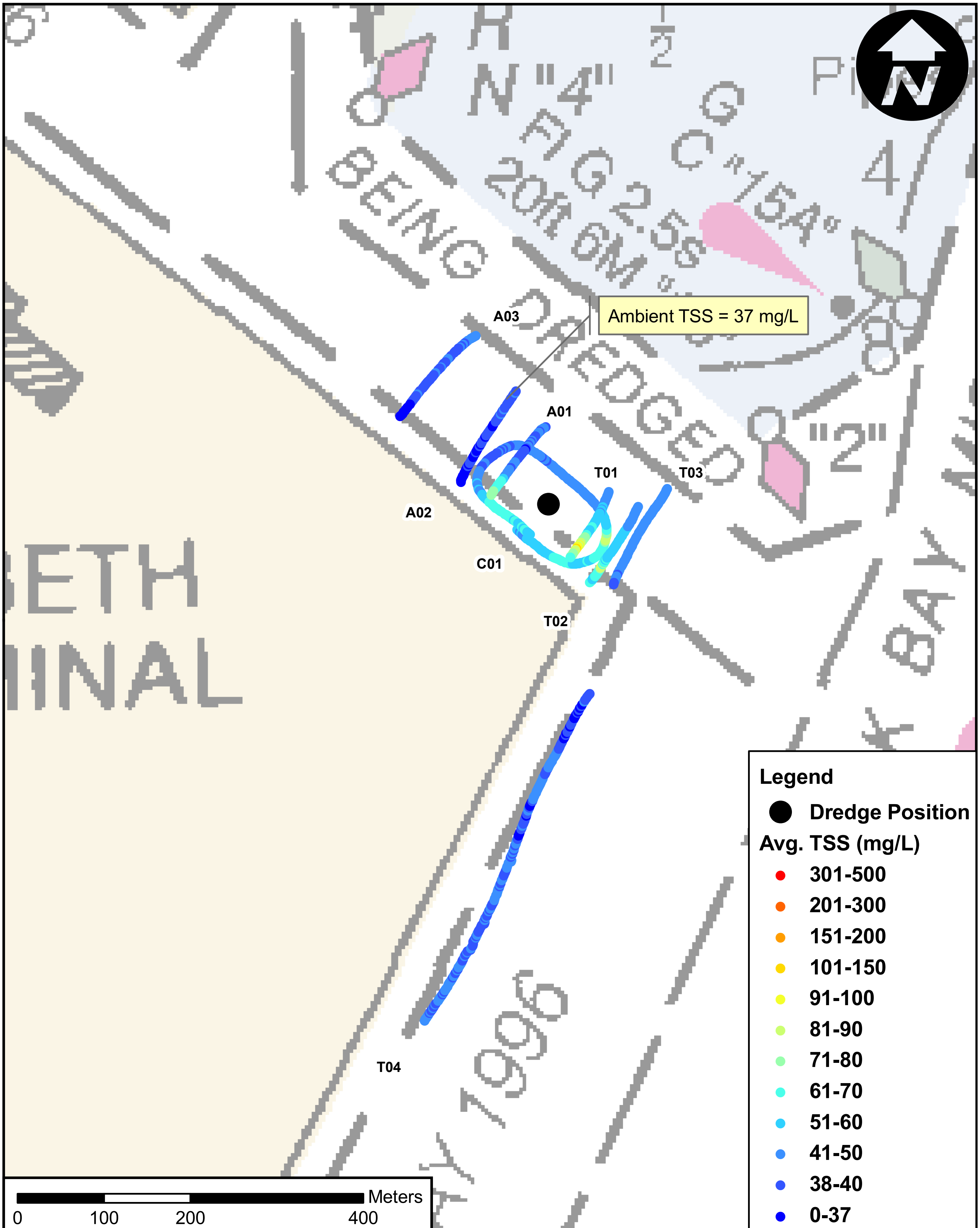


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	ADCP Average TSS - 27 April 2009 8-10 Meter Depth Interval	Tide
31e			Late Ebb/Slack

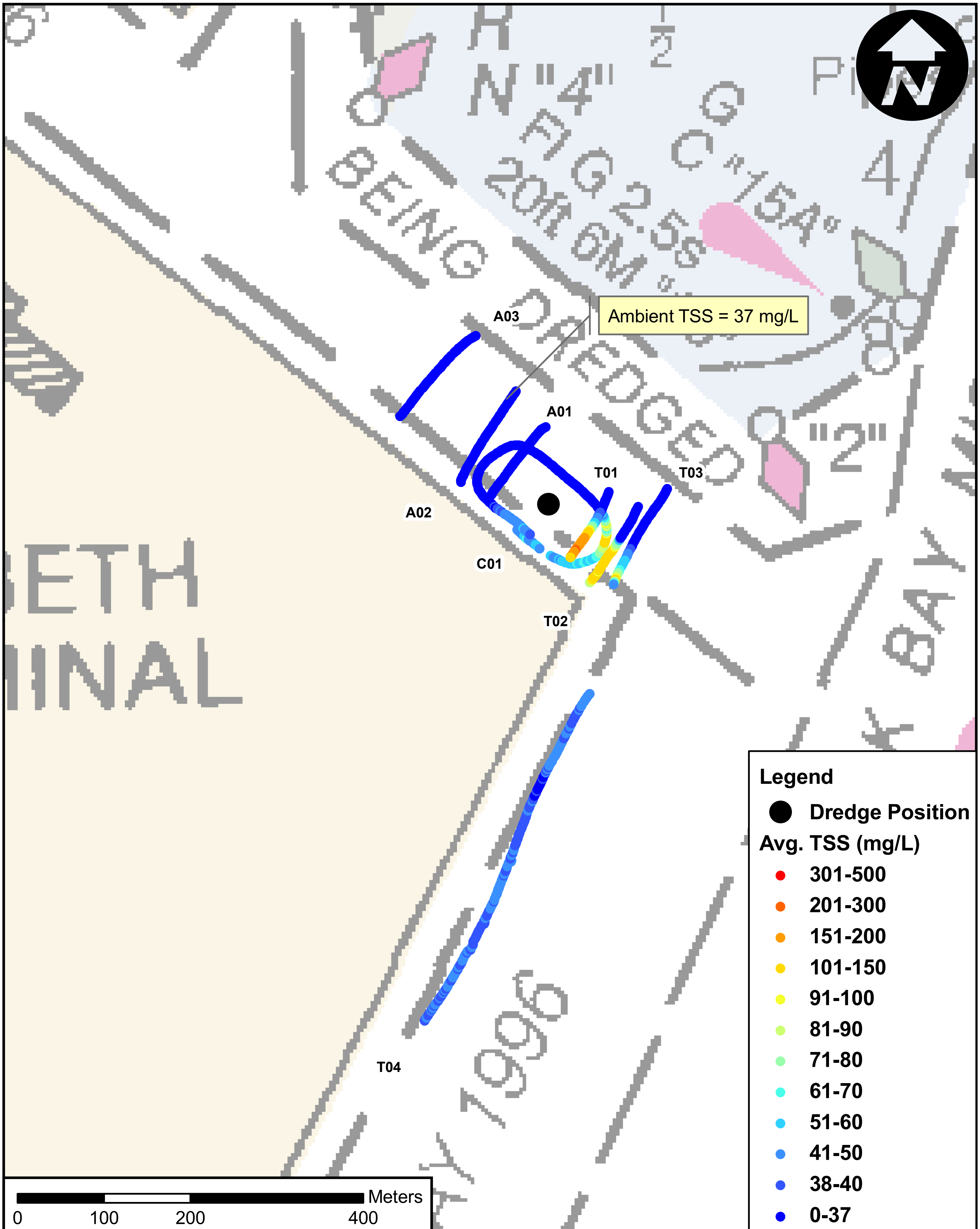


Figure	*USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B*	ADCP Average TSS - 27 April 2009 10-12 Meter Depth Interval	Tide
31f			Late Ebb/Slack

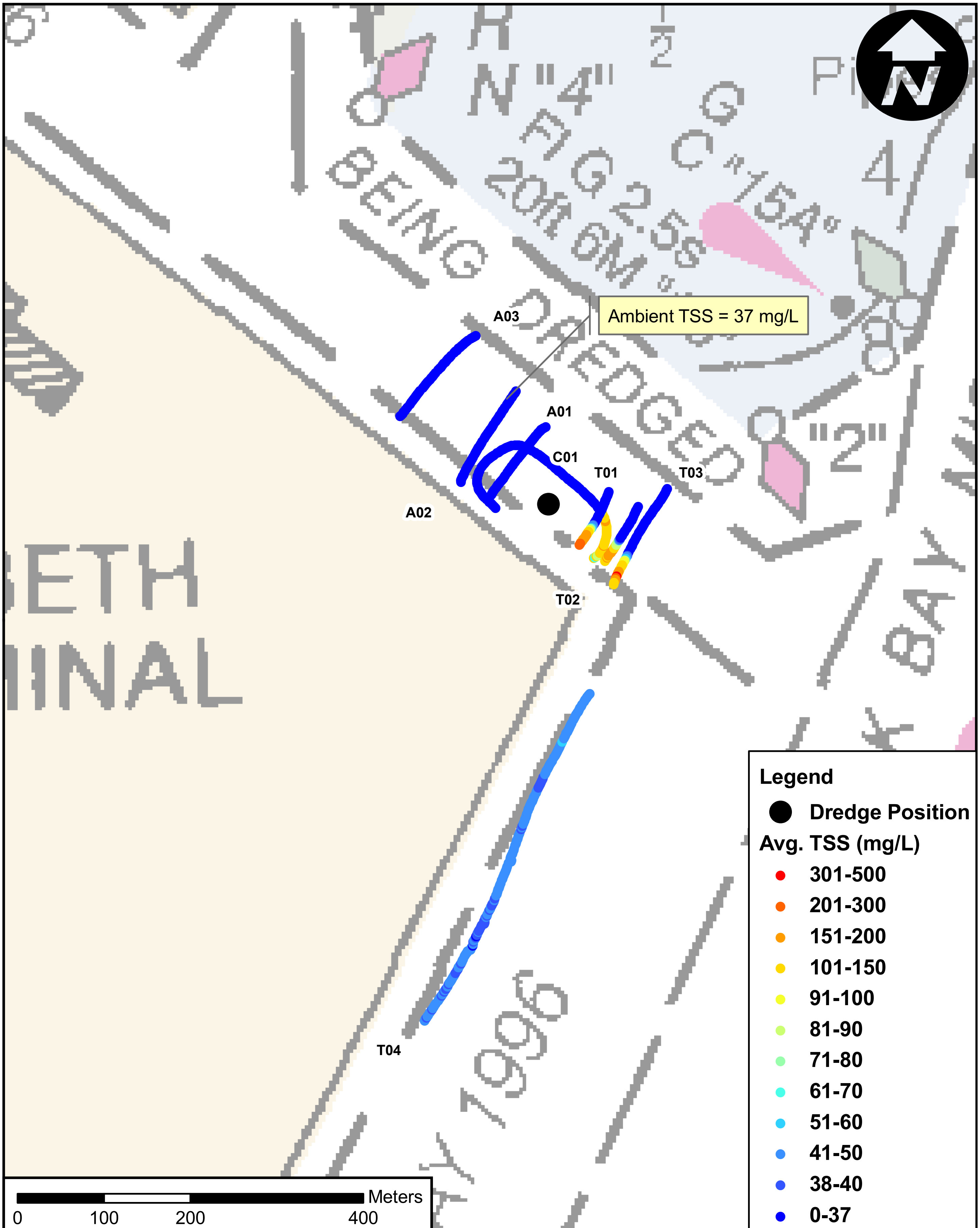
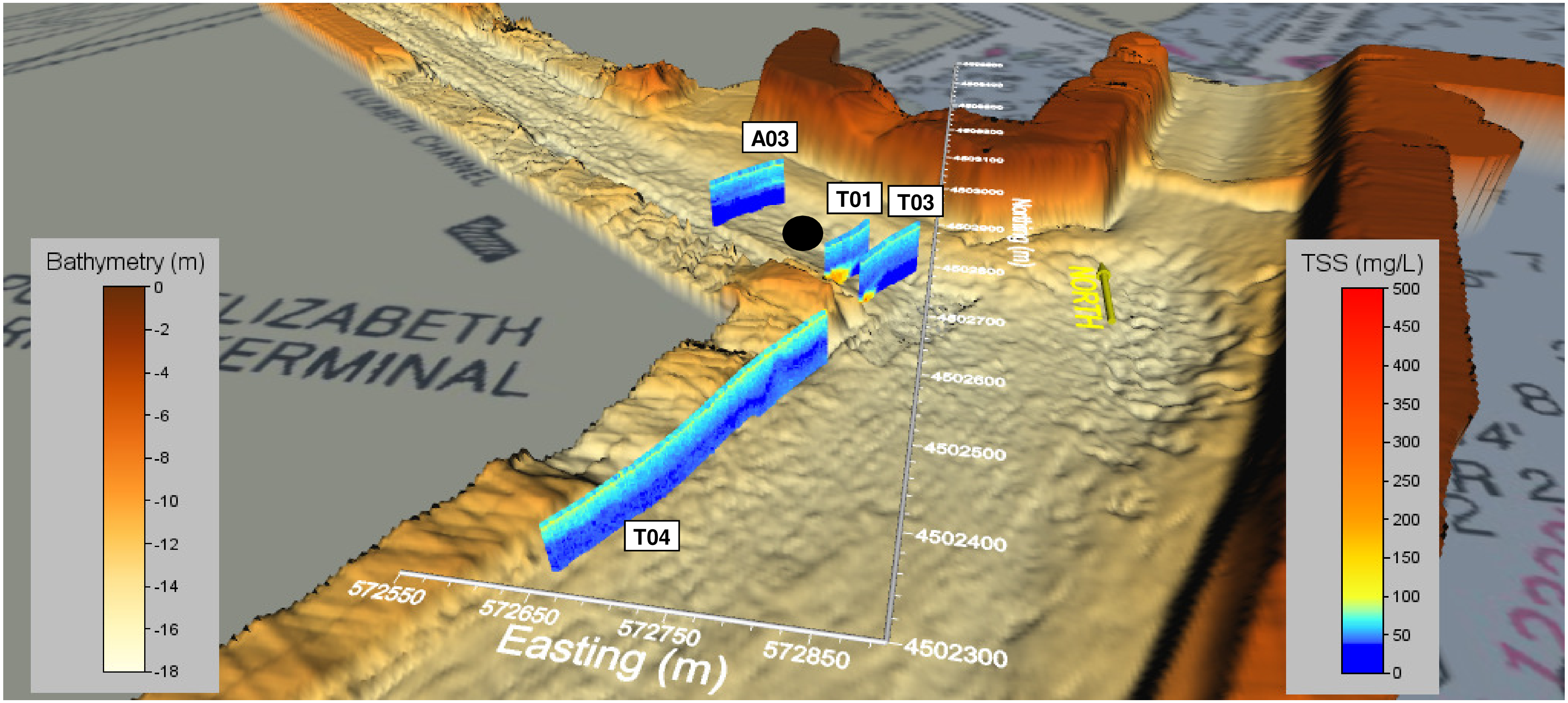


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	ADCP Average TSS - 27 April 2009 12-14 Meter Depth Interval	Tide
31g			Late Ebb/Slack



Bathymetry provided by: US Army Corps of Engineers, NY District

Z Scale Exaggerated 6x

● = Dredge Location

Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	ADCP Average TSS Values with Respect to their x, y, and z Coordinates Superimposed on Channel Bathymetry 27 April 2009	Tide
32			Late Ebb/Slack

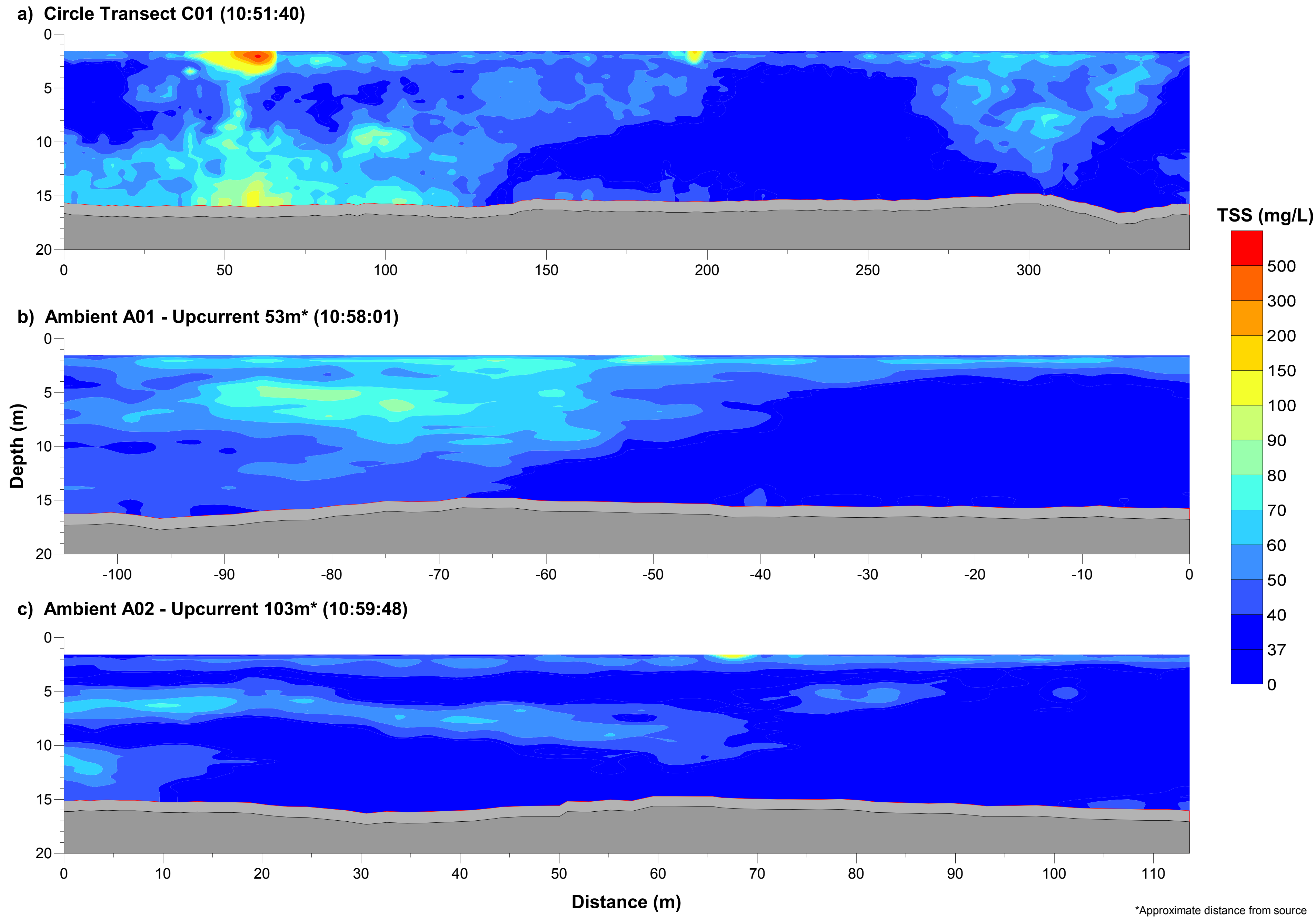


FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	Vertical Profiles of ADCP Average TSS 28 April 2009	TIDE
33a-c			Flood

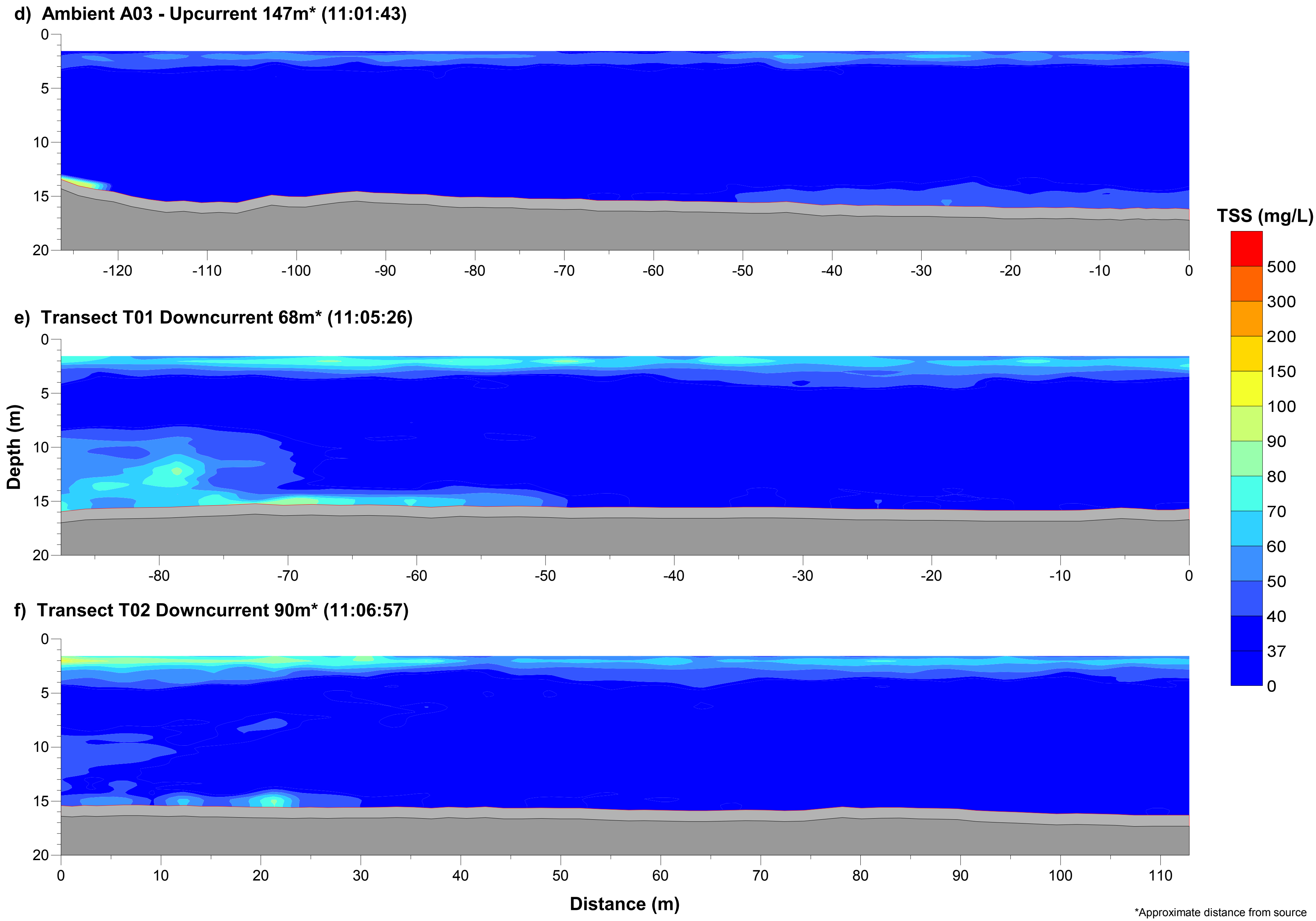


FIGURE	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**Vertical Profiles of ADCP Average TSS** **28 April 2009**	TIDE
33d-f			**Flood**

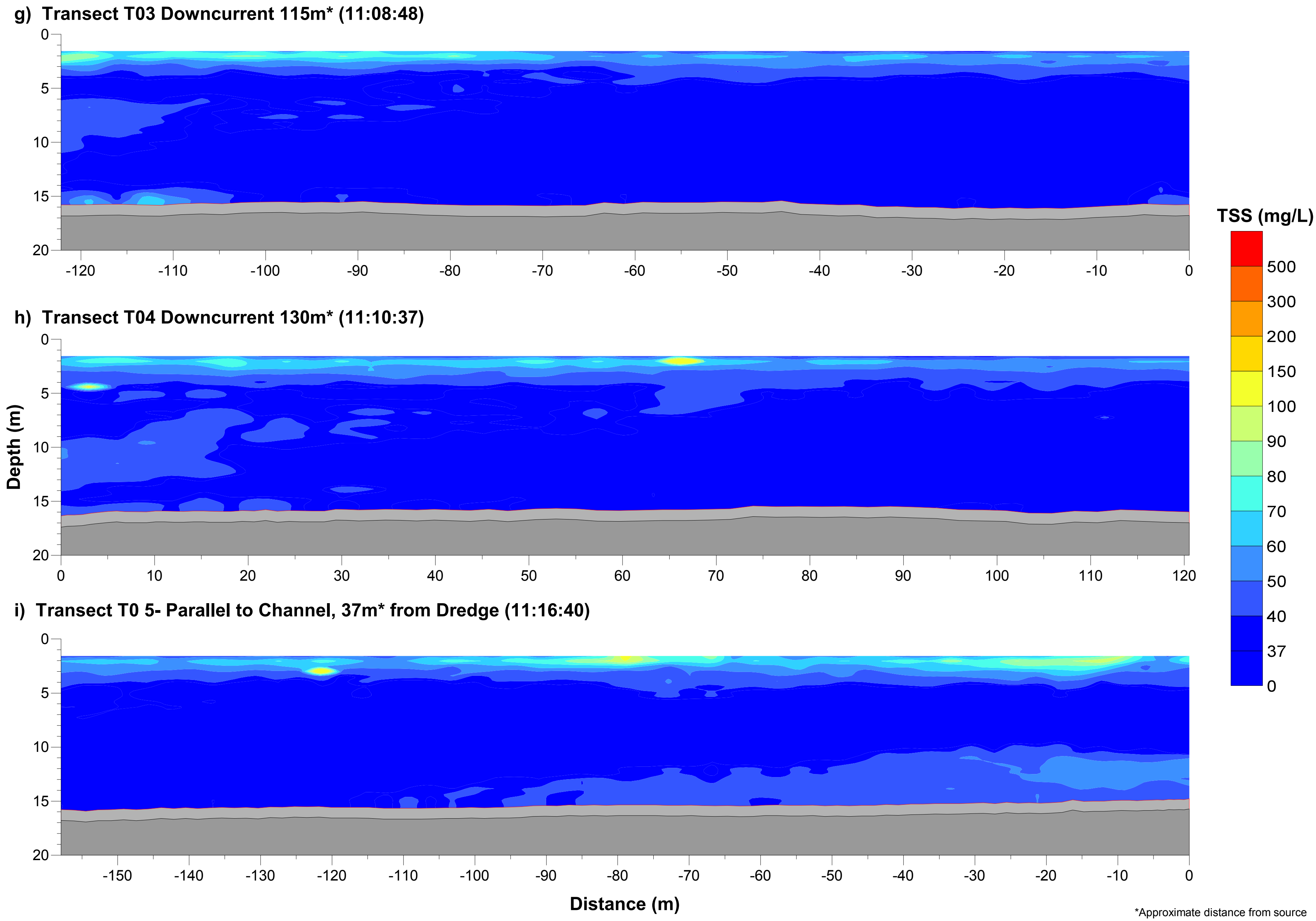
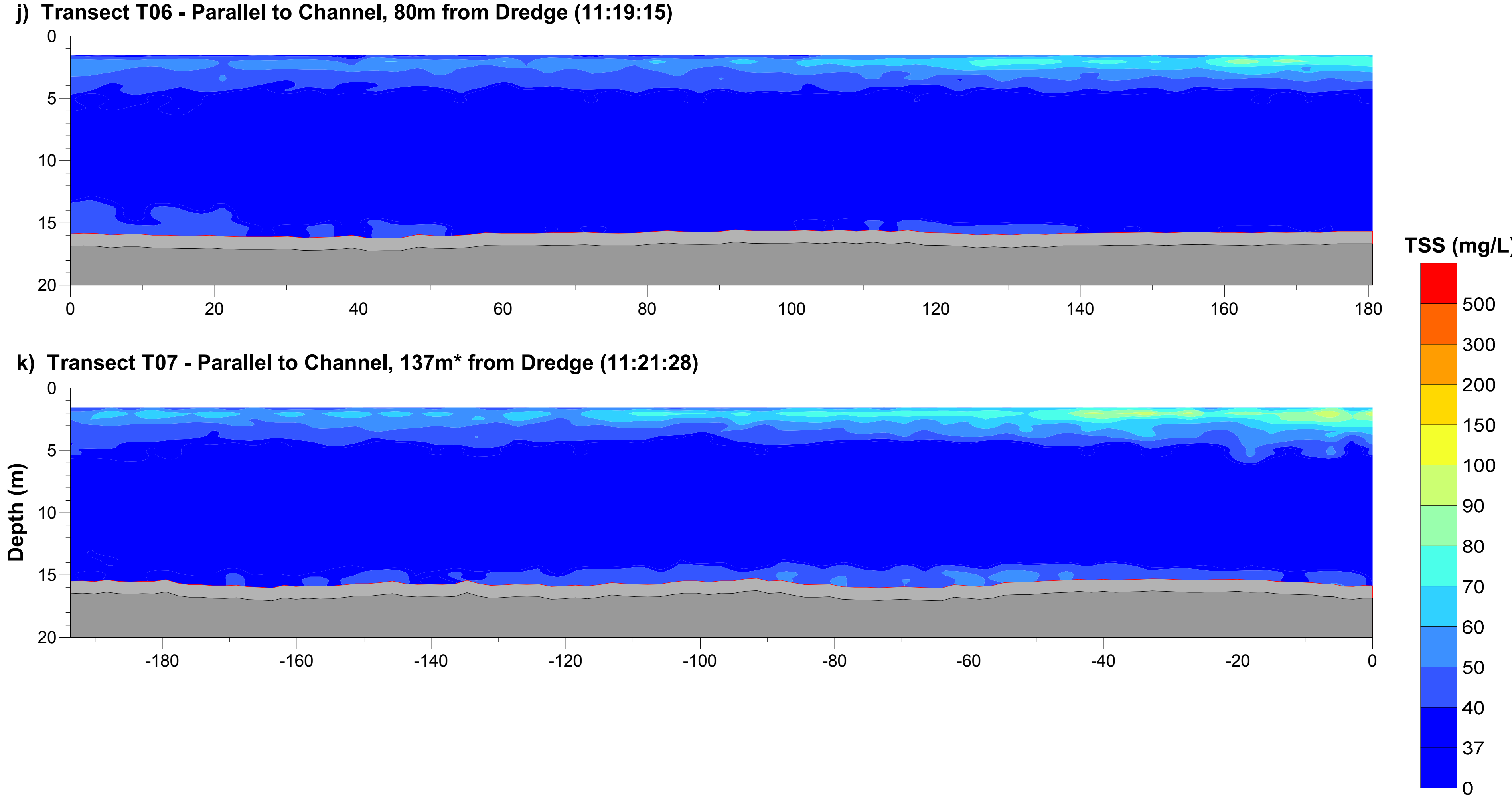


FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	Vertical Profiles of ADCP Average TSS 28 April 2009	TIDE
33g-i			Flood



*Approximate distance from source

FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	Vertical Profiles of ADCP Average TSS 28 April 2009	TIDE
33j-k			Flood

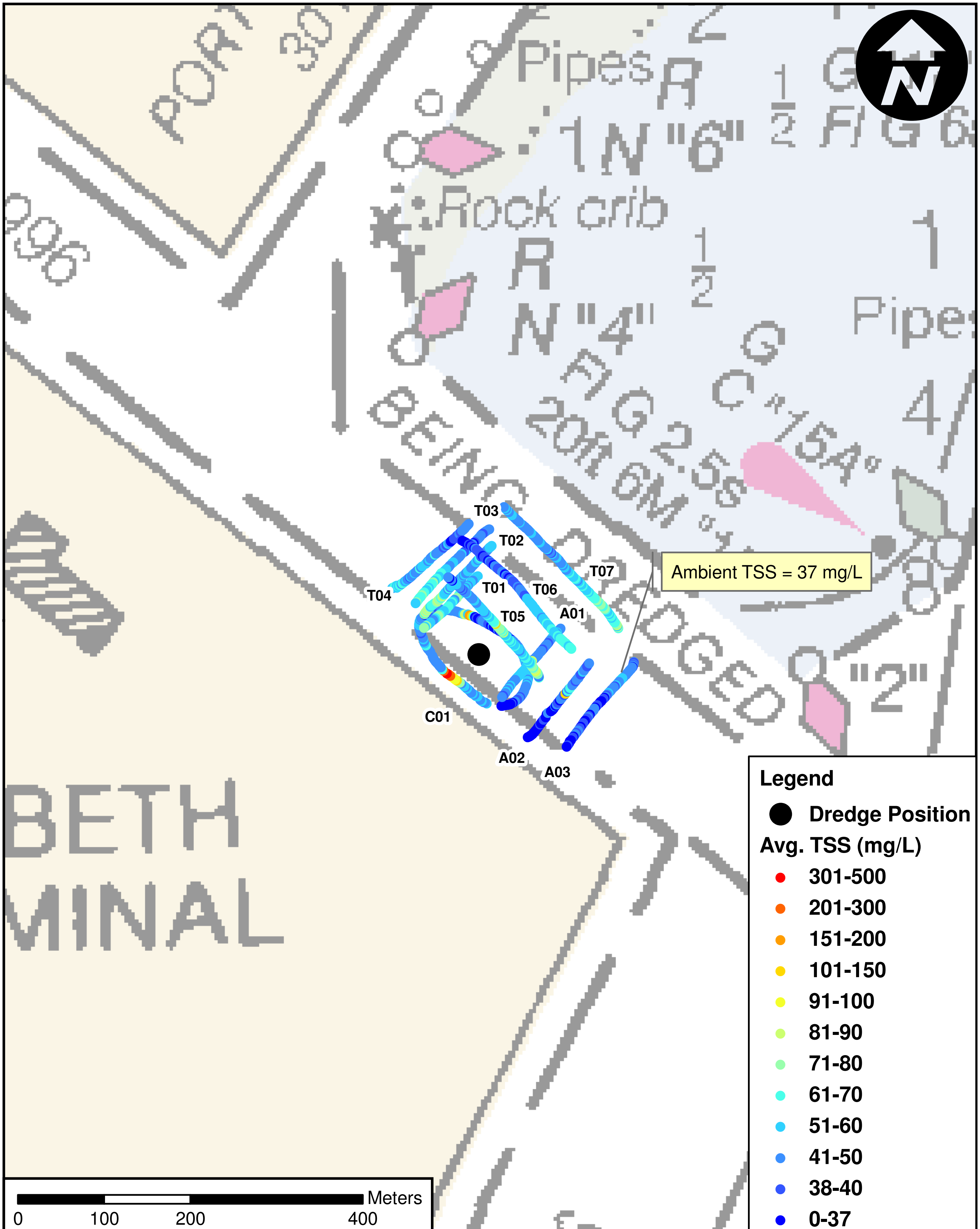


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 28 April 2009** **0-2 Meter Depth Interval**	Tide
34a			Flood

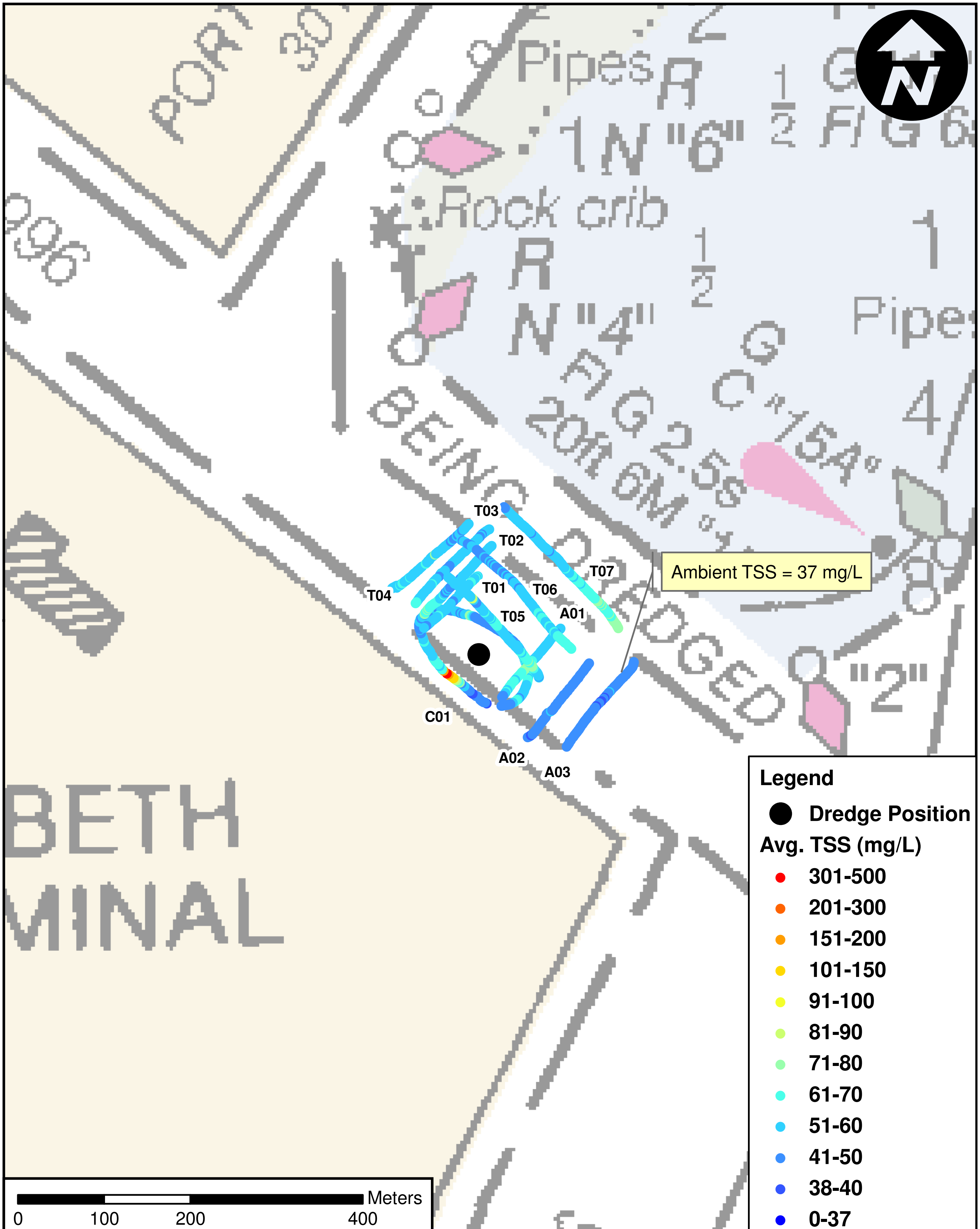


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	ADCP Average TSS - 28 April 2009 2-4 Meter Depth Interval	Tide
34b			Flood

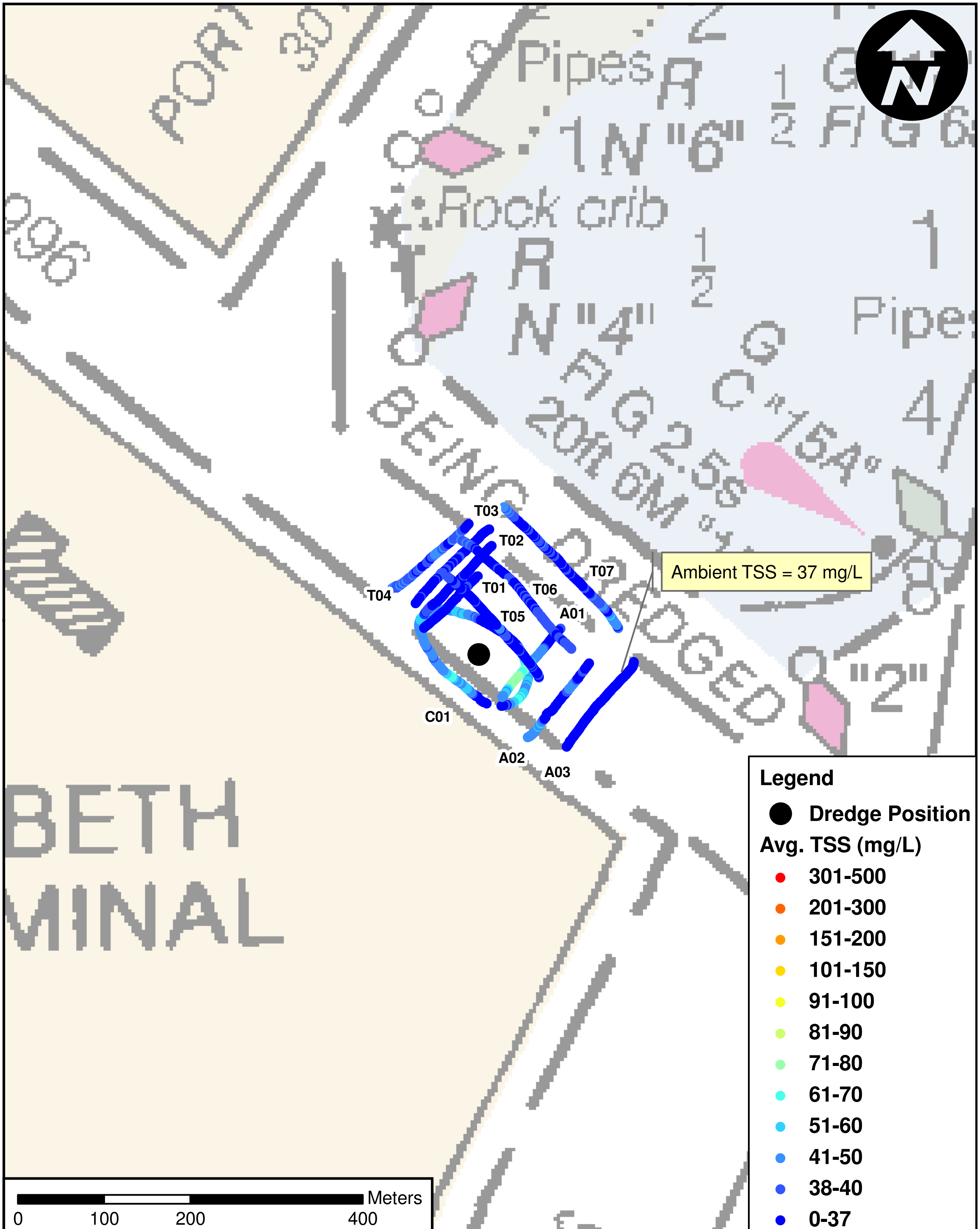


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 28 April 2009** **4-6 Meter Depth Interval**	**Tide**
34c			**Flood**

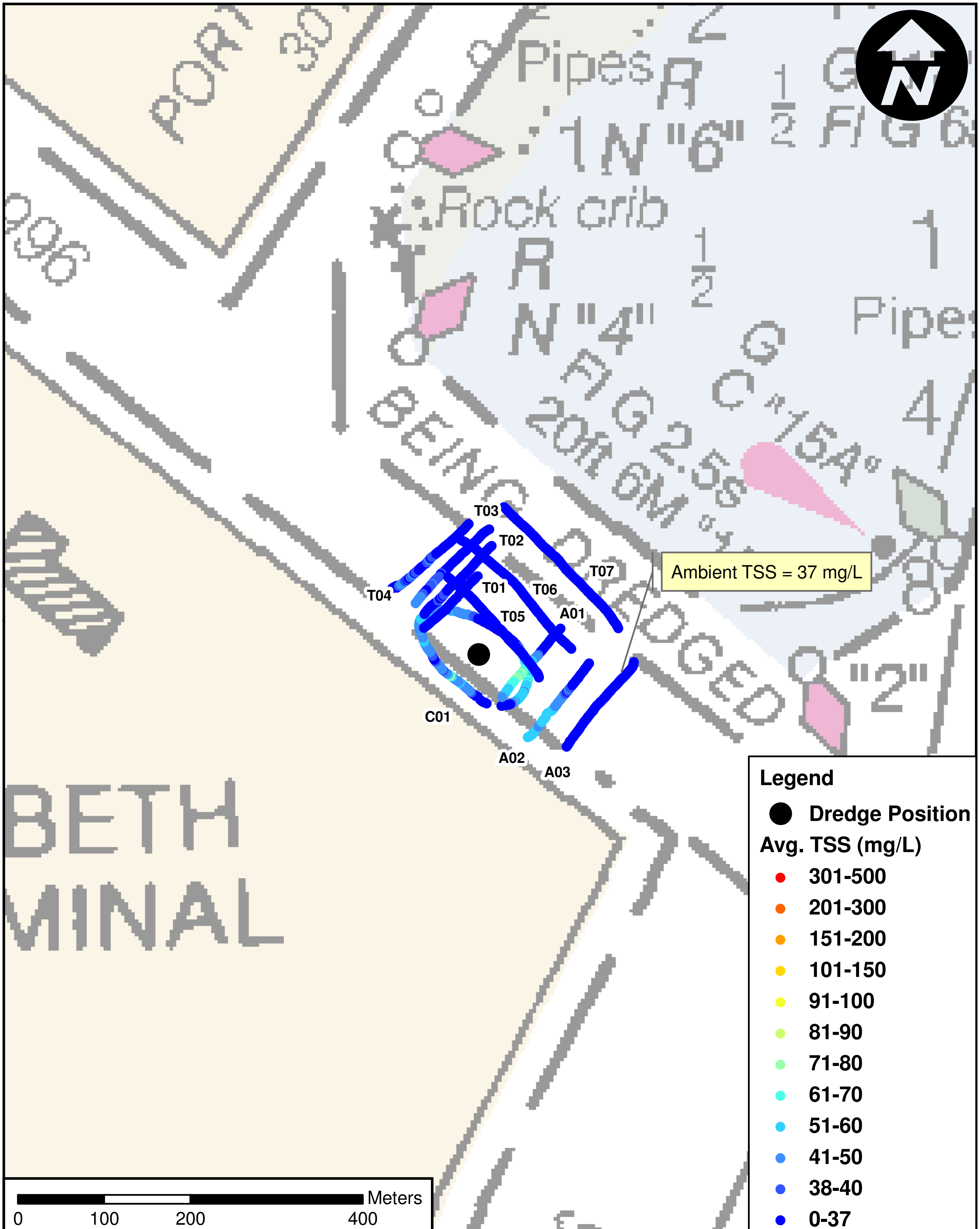


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 28 April 2009** **6-8 Meter Depth Interval**	Tide
34d			Flood

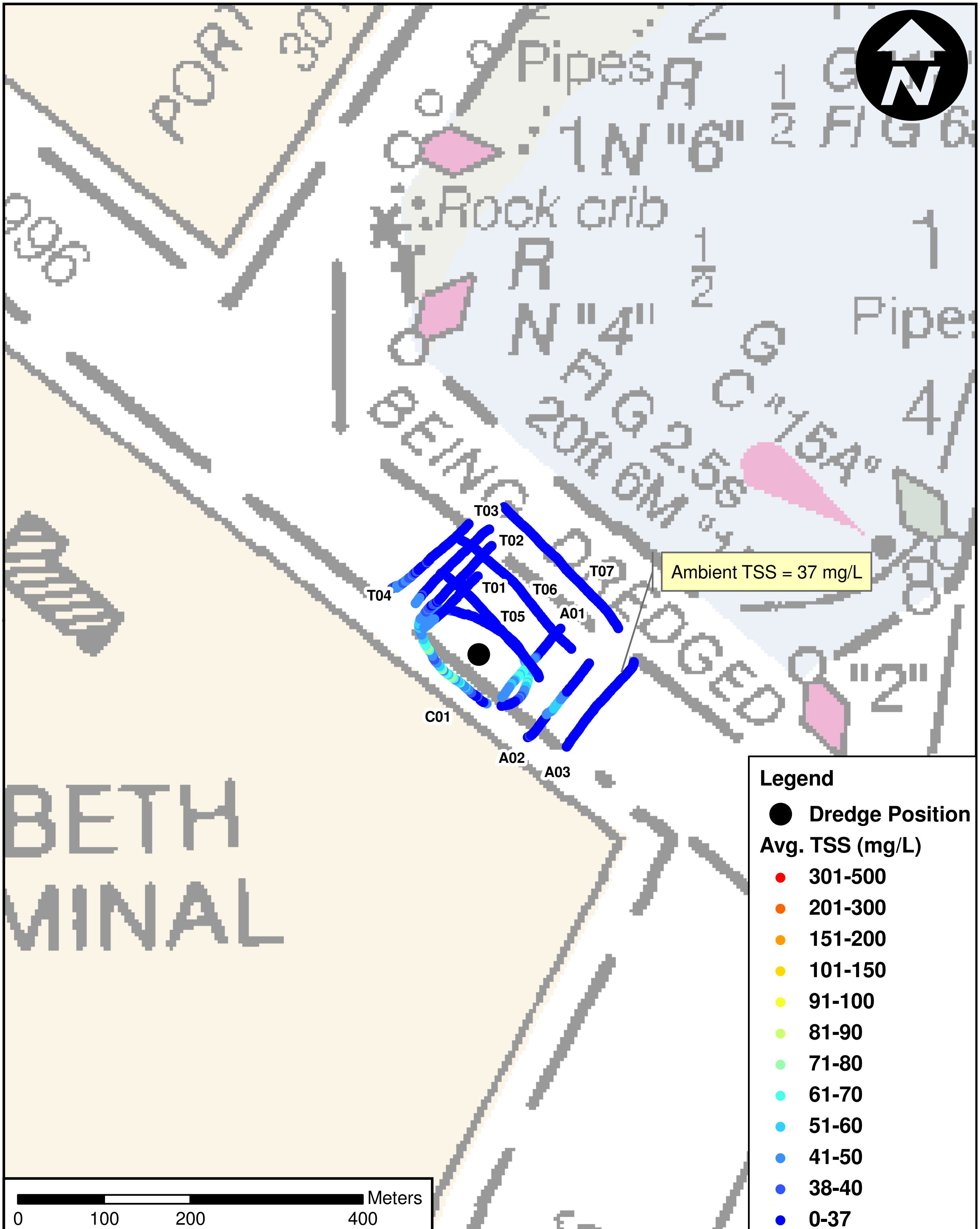


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 28 April 2009** **8-10 Meter Depth Interval**	Tide
34e			Flood

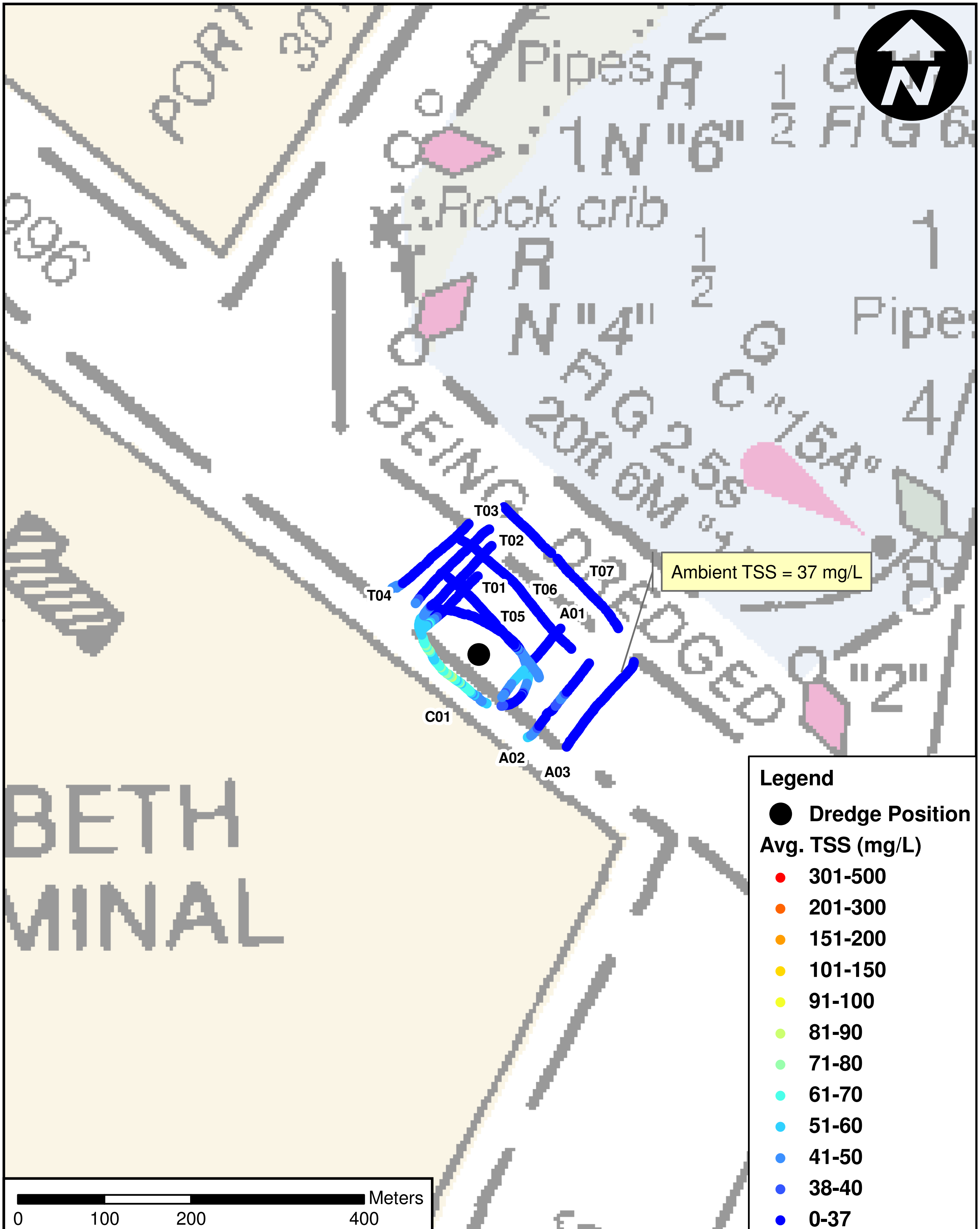


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	ADCP Average TSS - 28 April 2009 10-12 Meter Depth Interval	Tide
34f			Flood

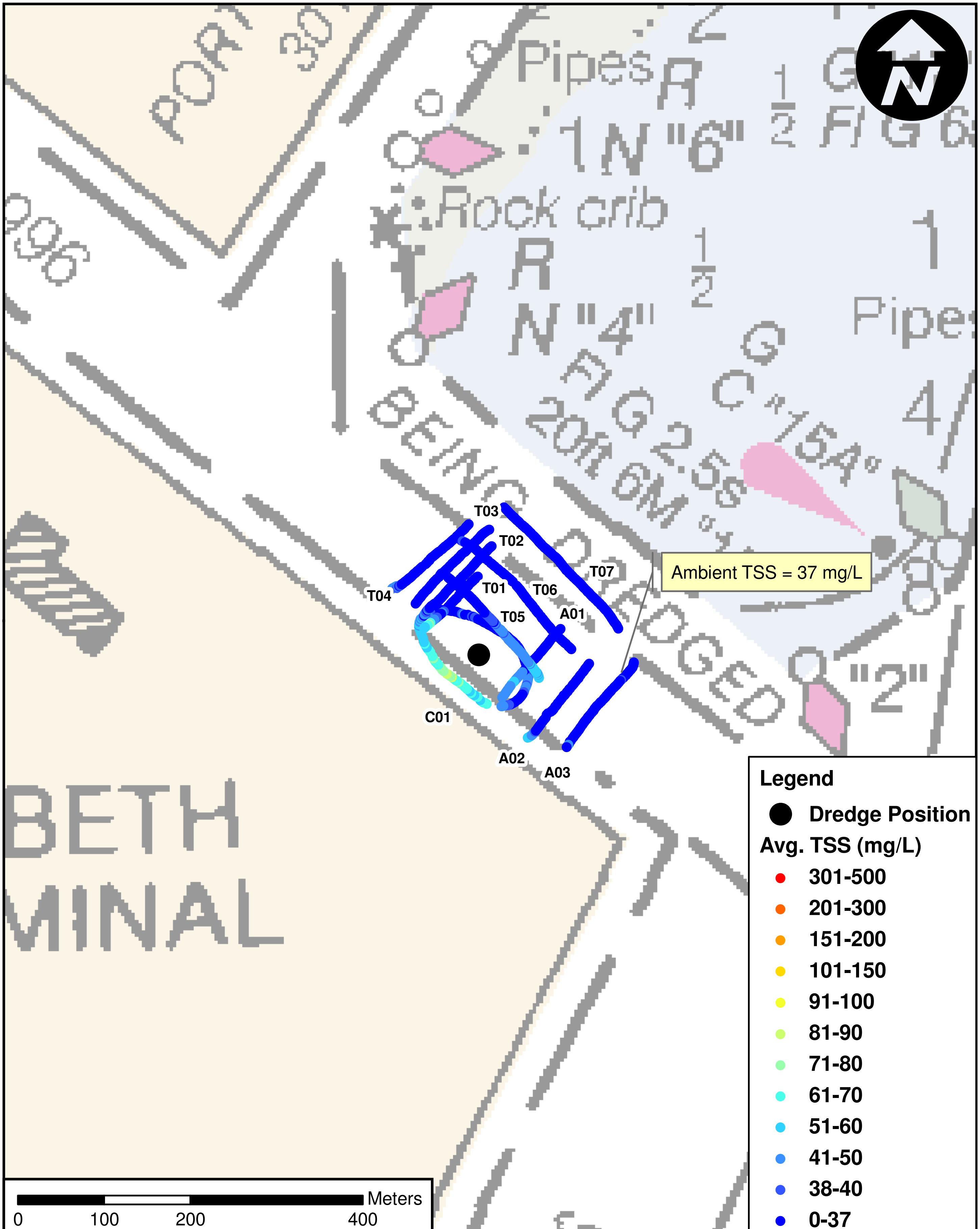


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 28 April 2009** **12-14 Meter Depth Interval**	**Tide**
34g			**Flood**

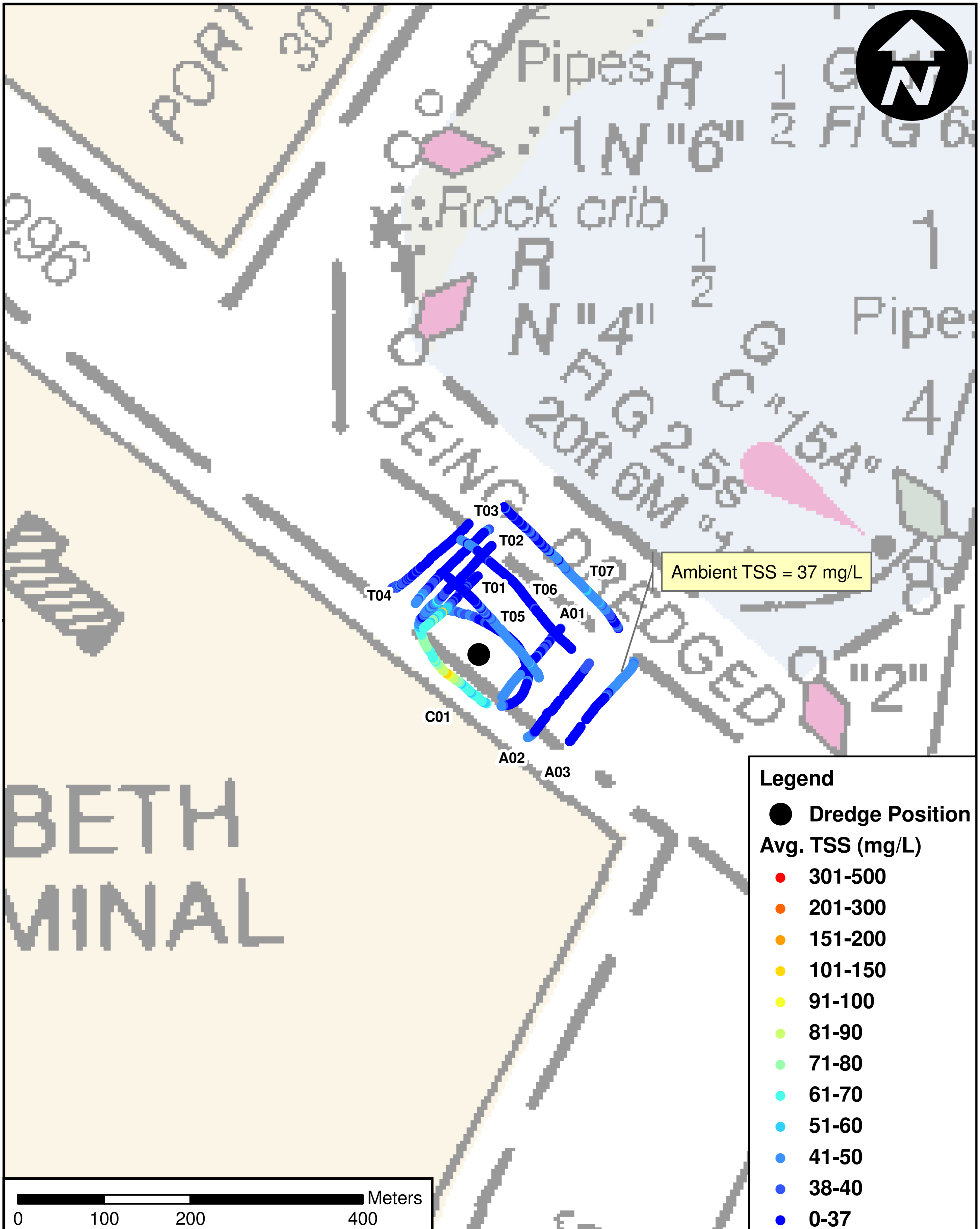
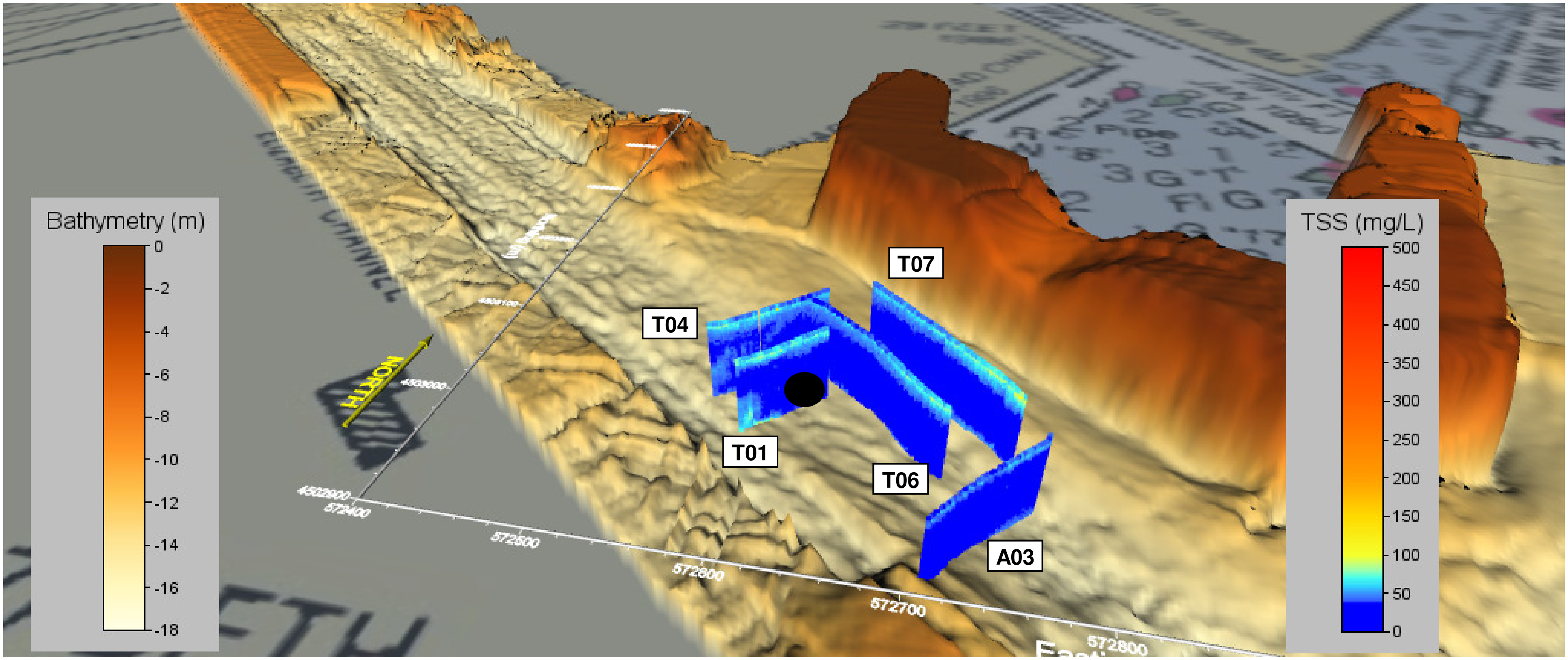


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	ADCP Average TSS - 28 April 2009 14-16 Meter Depth Interval	Tide
34h			Flood

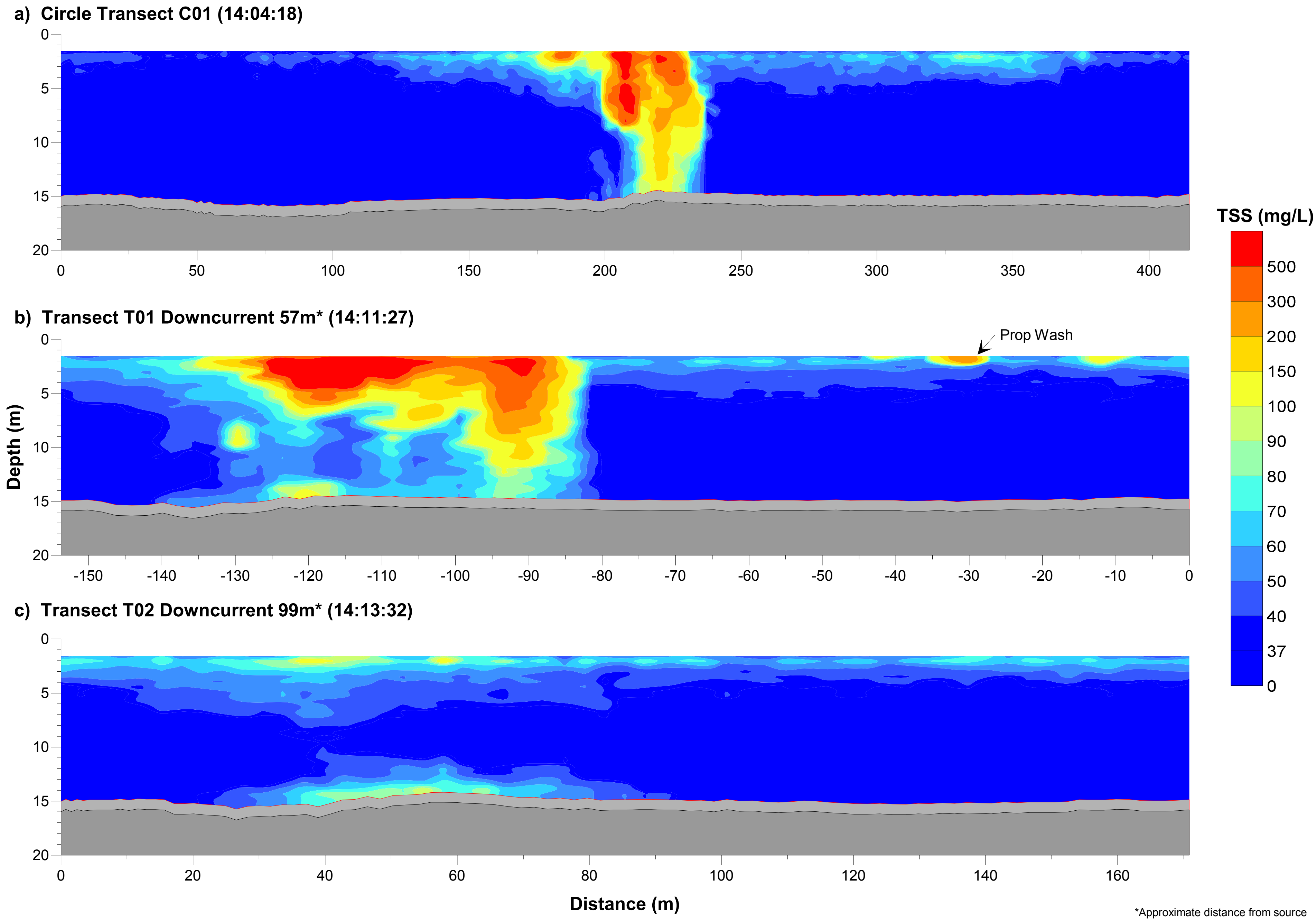


Bathymetry provided by: US Army Corps of Engineers, NY District

Z Scale Exaggerated 6x

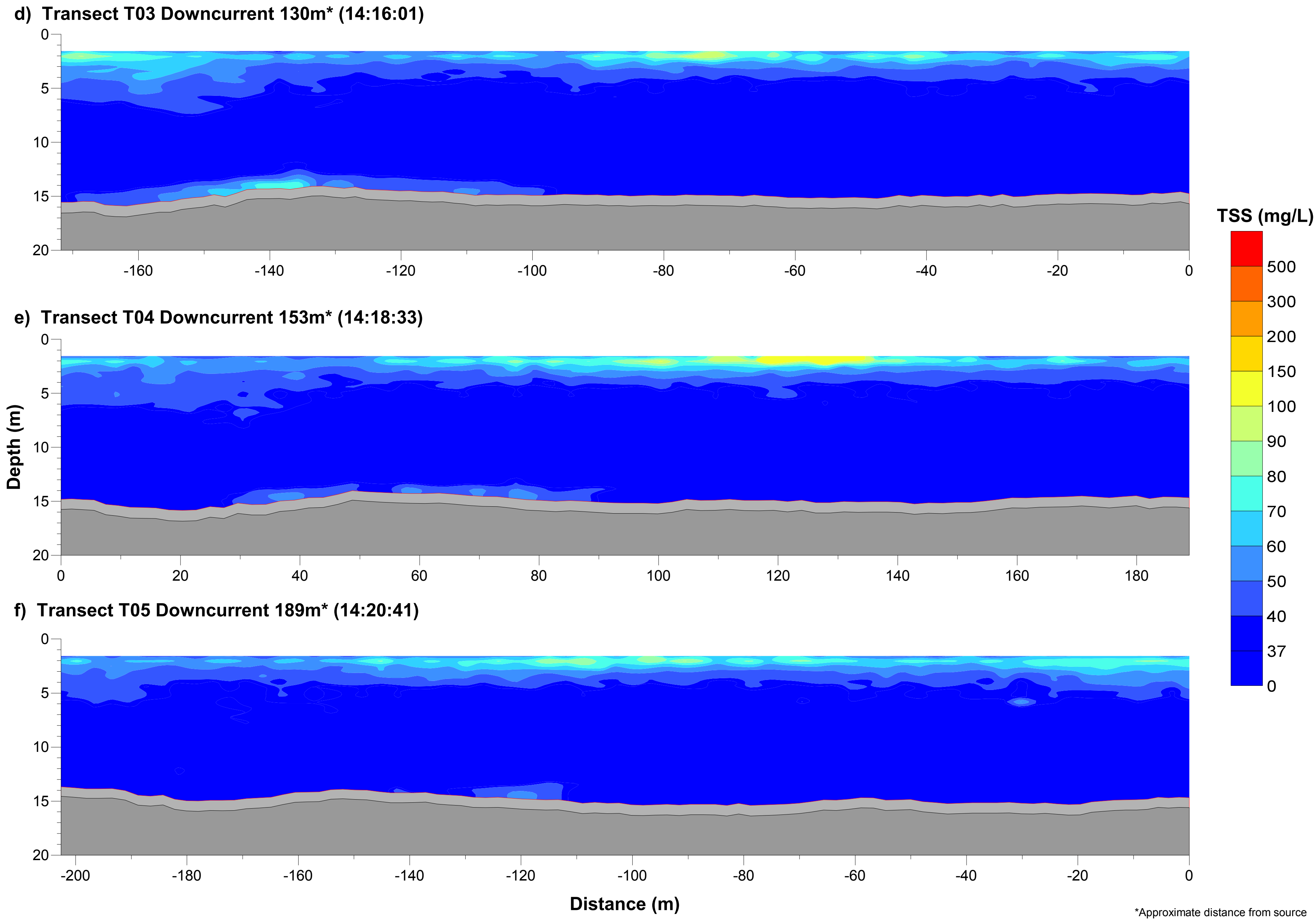
● = Dredge Location

Figure			Tide
35	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS Values with Respect to their x, y, and z Coordinates** **Superimposed on Channel Bathymetry** **28 April 2009**	Flood



*Approximate distance from source

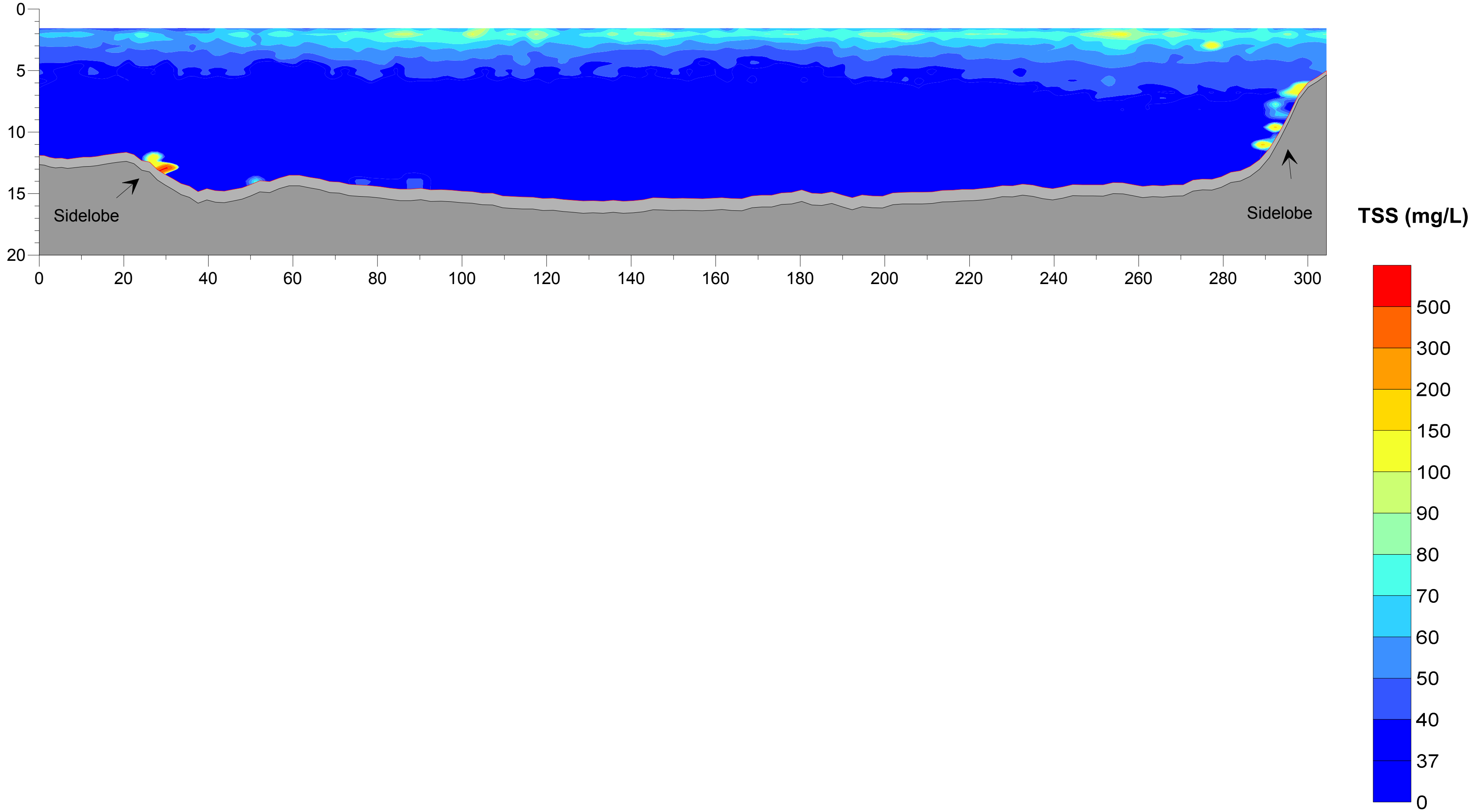
FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	Vertical Profiles of ADCP Average TSS 28 April 2009 (1st Set)	TIDE
36a-c			Ebb



*Approximate distance from source

FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	Vertical Profiles of ADCP Average TSS 28 April 2009 (1st Set)	TIDE
36d-f			Ebb

g) Transect T06 Downcurrent 262m* (14:23:00)



*Approximate distance from source

FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	Vertical Profiles of ADCP Average TSS 28 April 2009 (1st Set)	TIDE
36g			Ebb

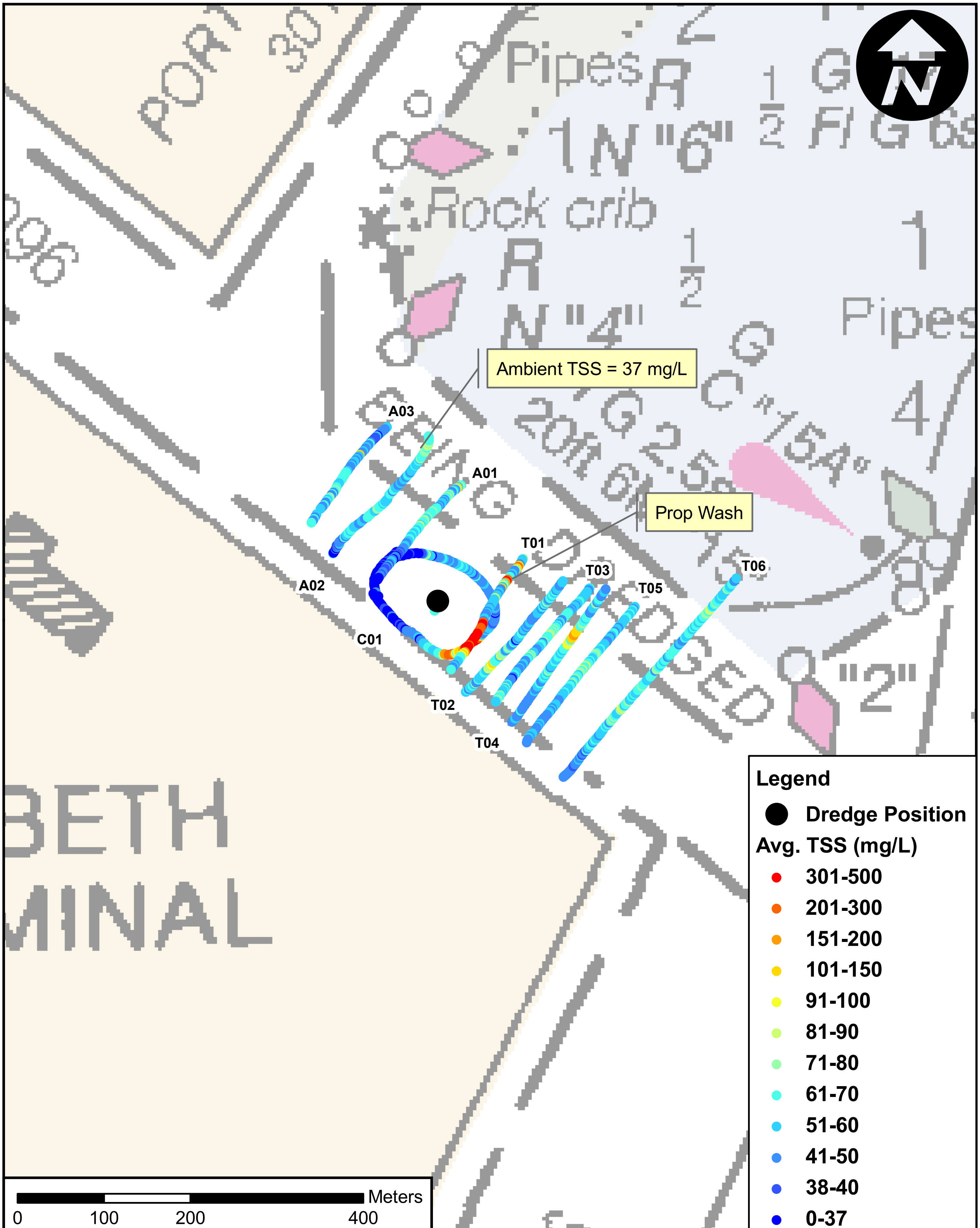


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 28 April 2009 (1st Set)** **0-2 Meter Depth Interval**	**Tide**
37a			**Ebb**

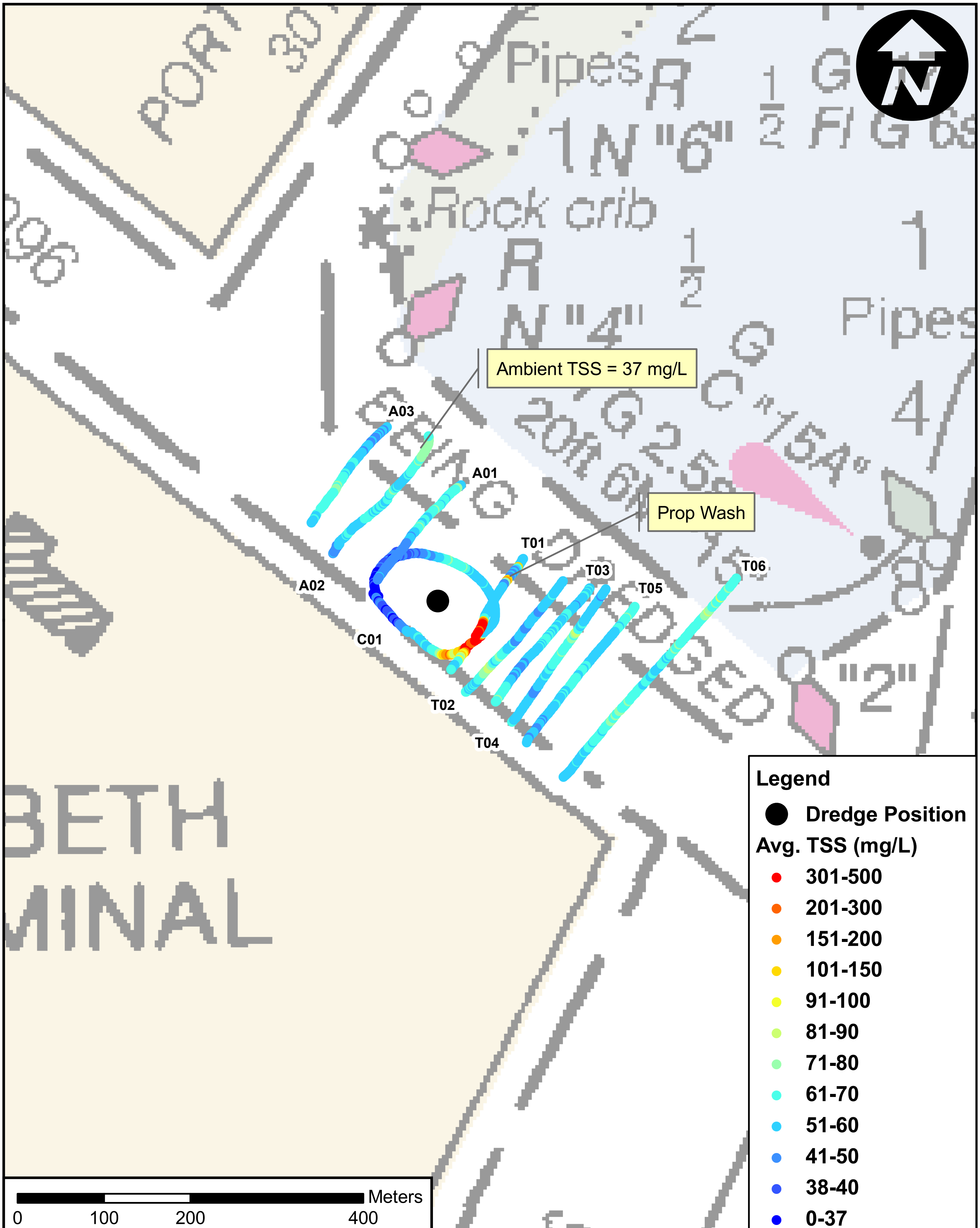


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 28 April 2009 (1st Set)** **2-4 Meter Depth Interval**	Tide
37b			Ebb

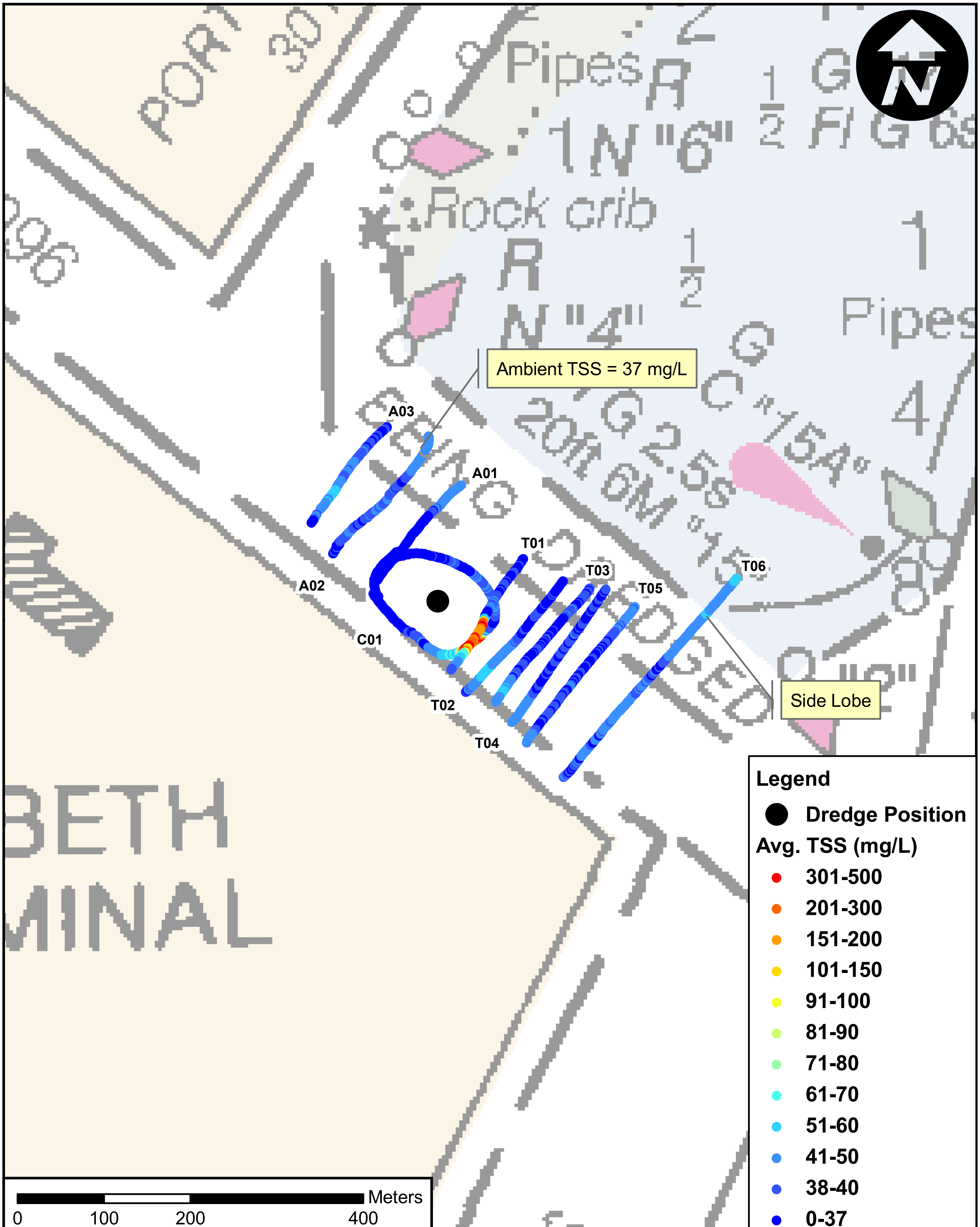


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 28 April 2009 (1st Set)** **4-6 Meter Depth Interval**	Tide
37c			Ebb

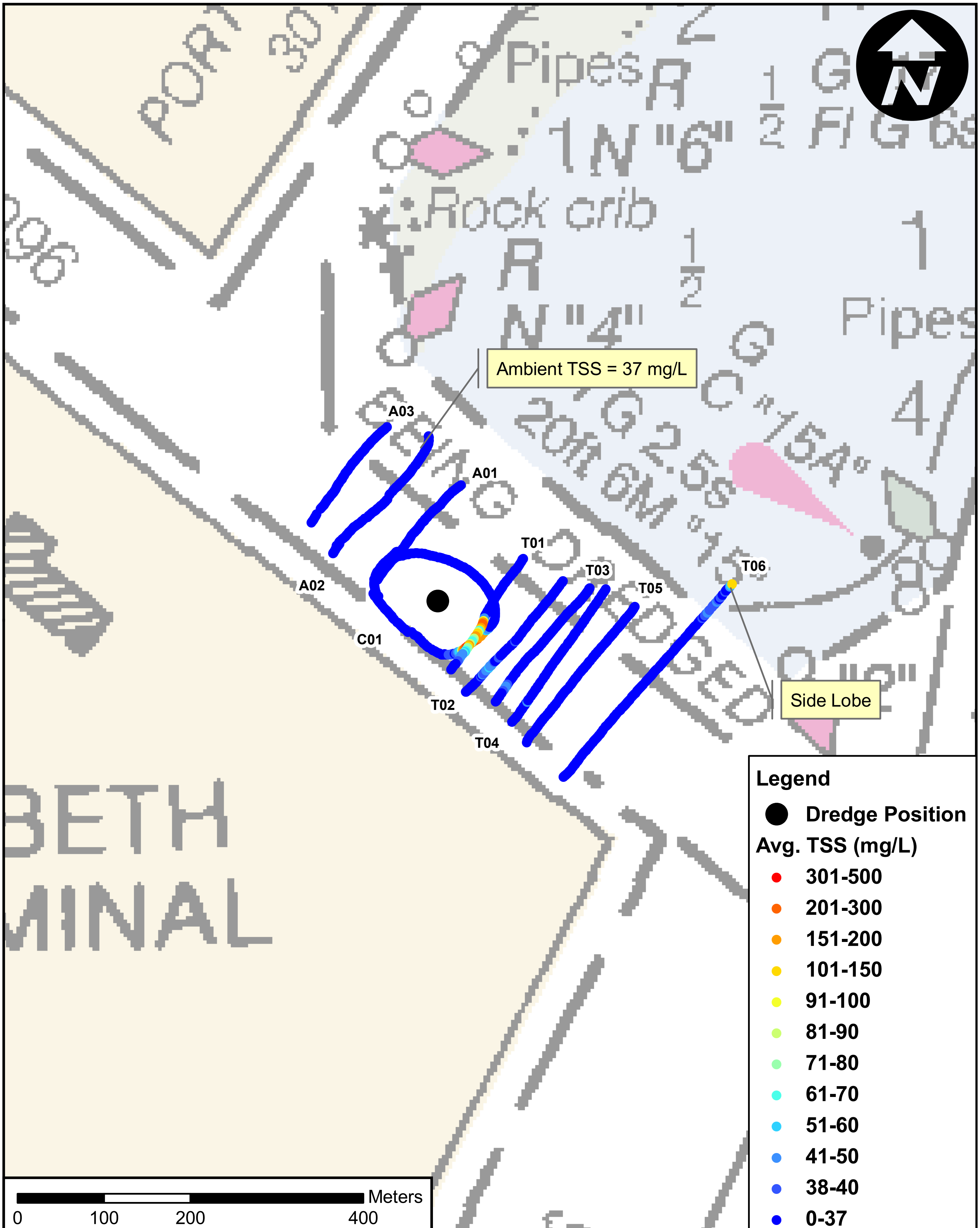


Figure	USACE Harborwide TSS *Far Field Survey* *HDP Contract Area: S-E-1: B*	ADCP Average TSS - 28 April 2009 (1st Set) 6-8 Meter Depth Interval	Tide
37d			Ebb

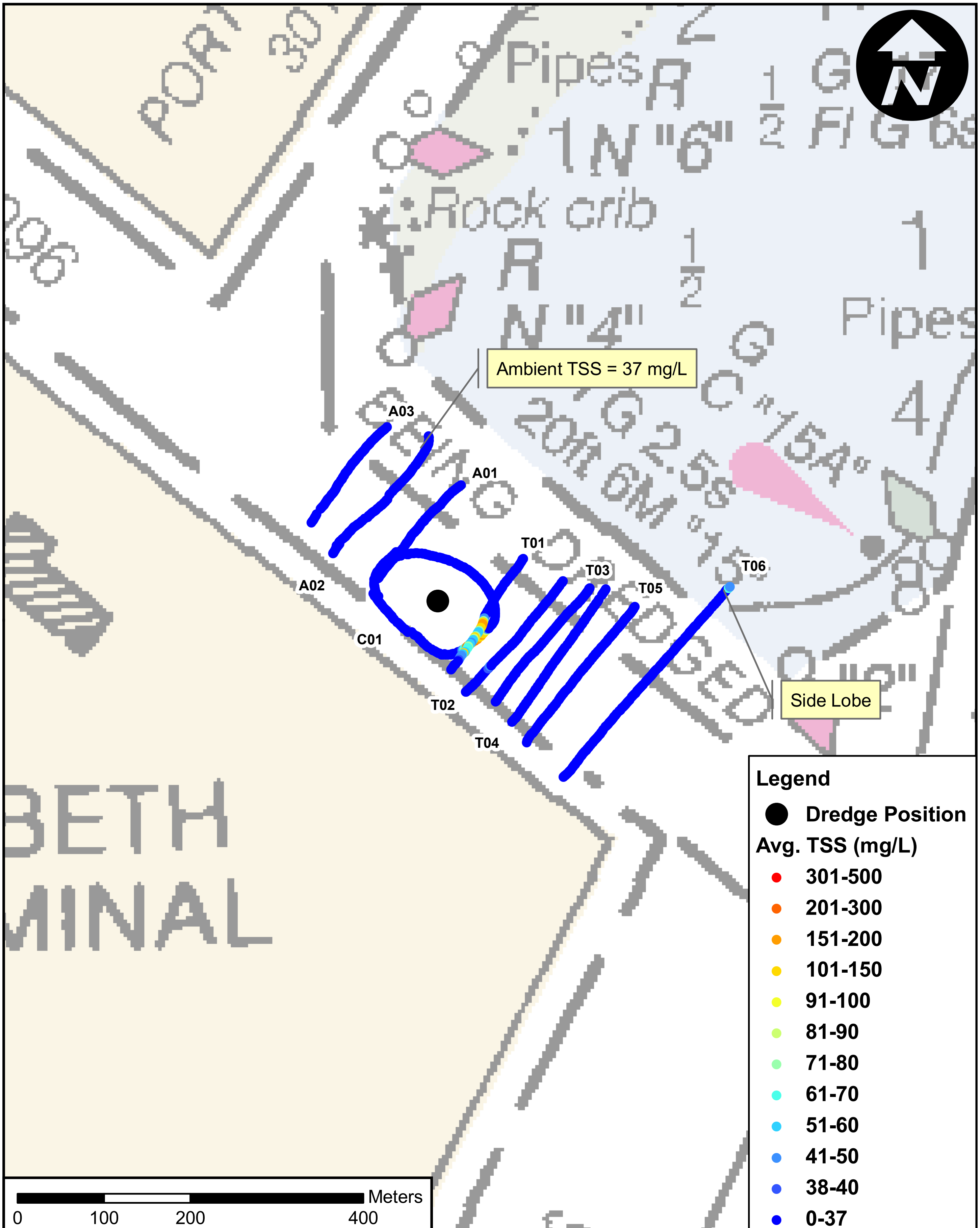


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 28 April 2009 (1st Set)** **8-10 Meter Depth Interval**	**Tide**
37e			**Ebb**

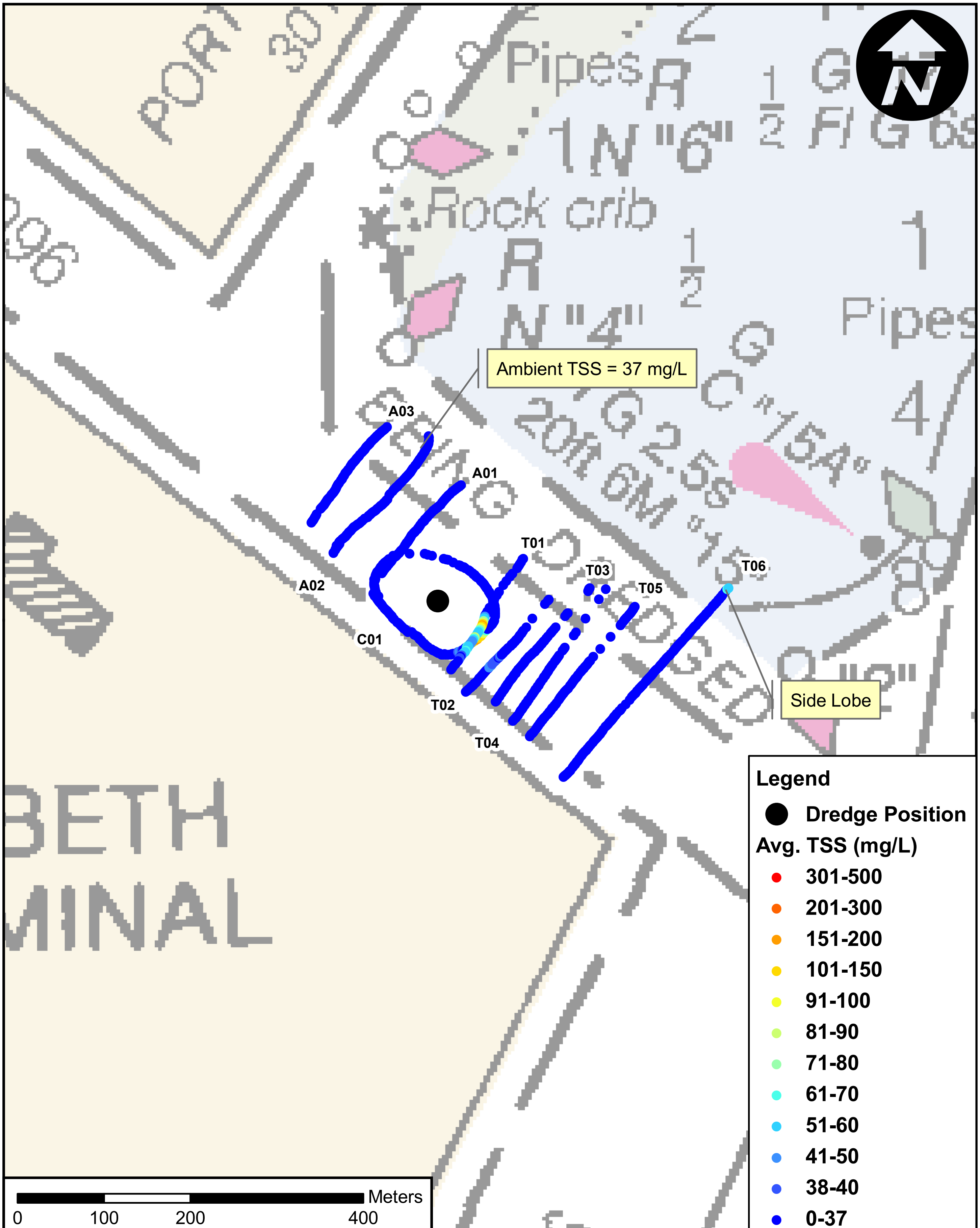


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 28 April 2009 (1st Set)** **10-12 Meter Depth Interval**	Tide
37f			**Ebb**

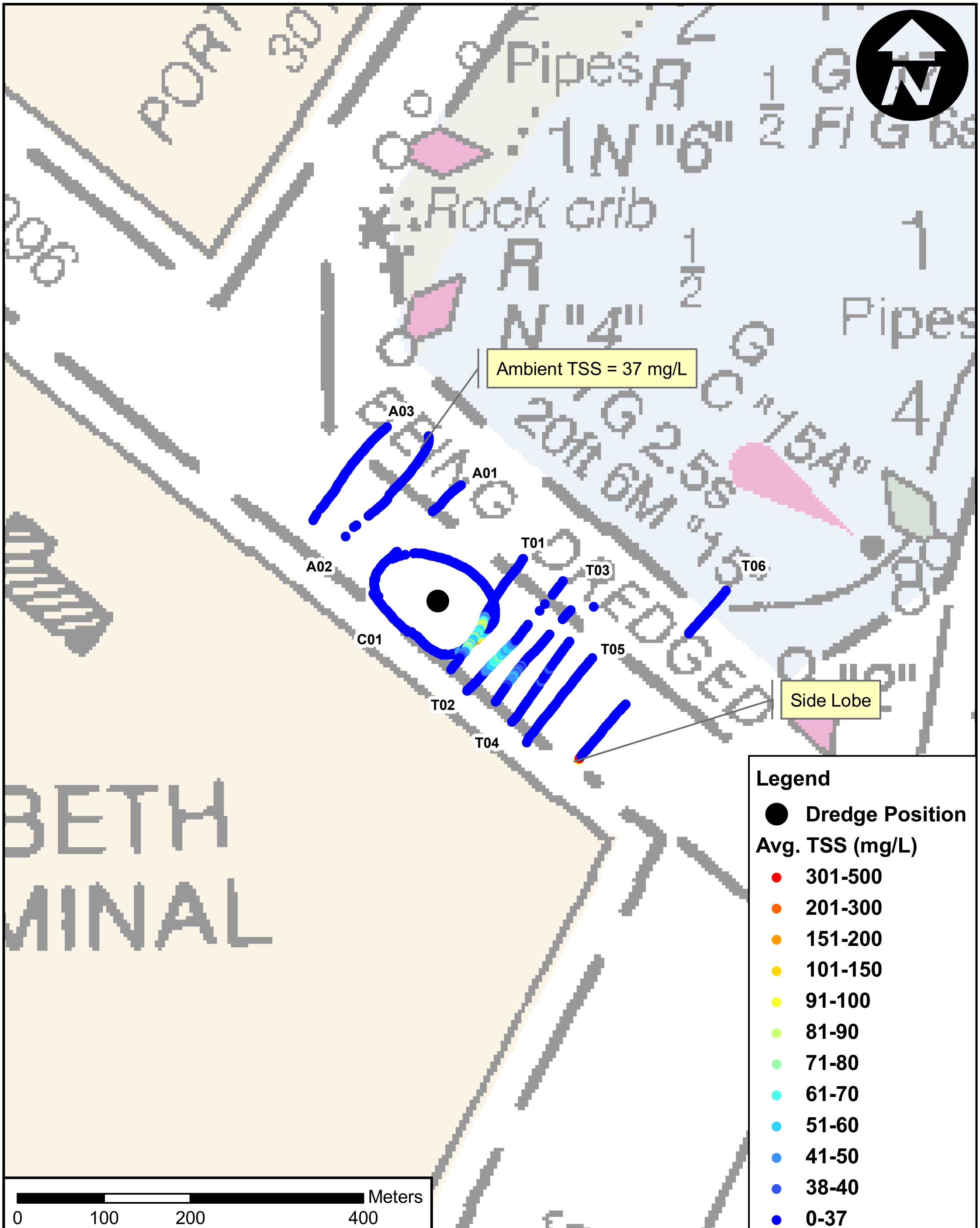


Figure	*USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B*	ADCP Average TSS - 28 April 2009 (1st Set) 12-14 Meter Depth Interval	Tide
37g			Ebb

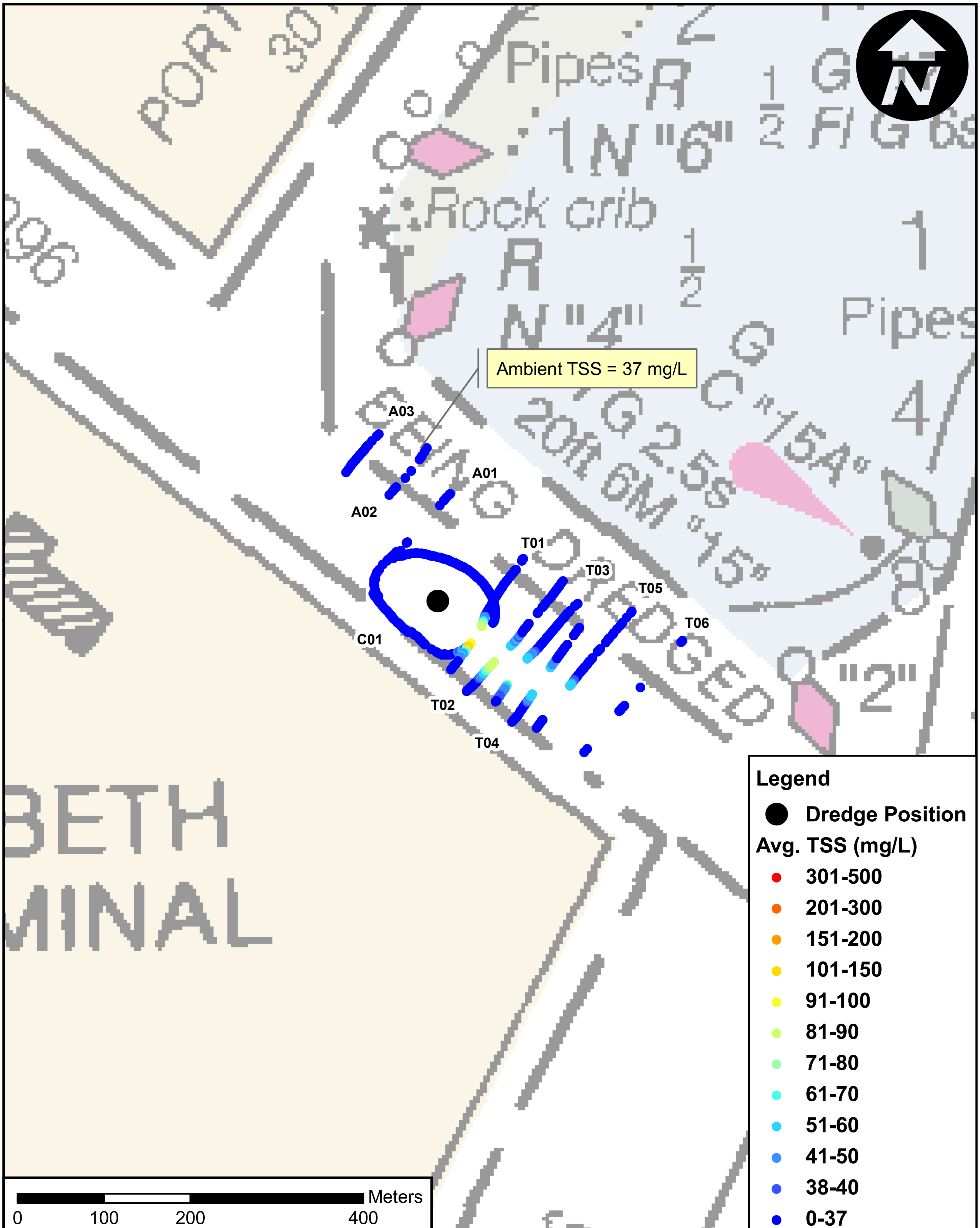
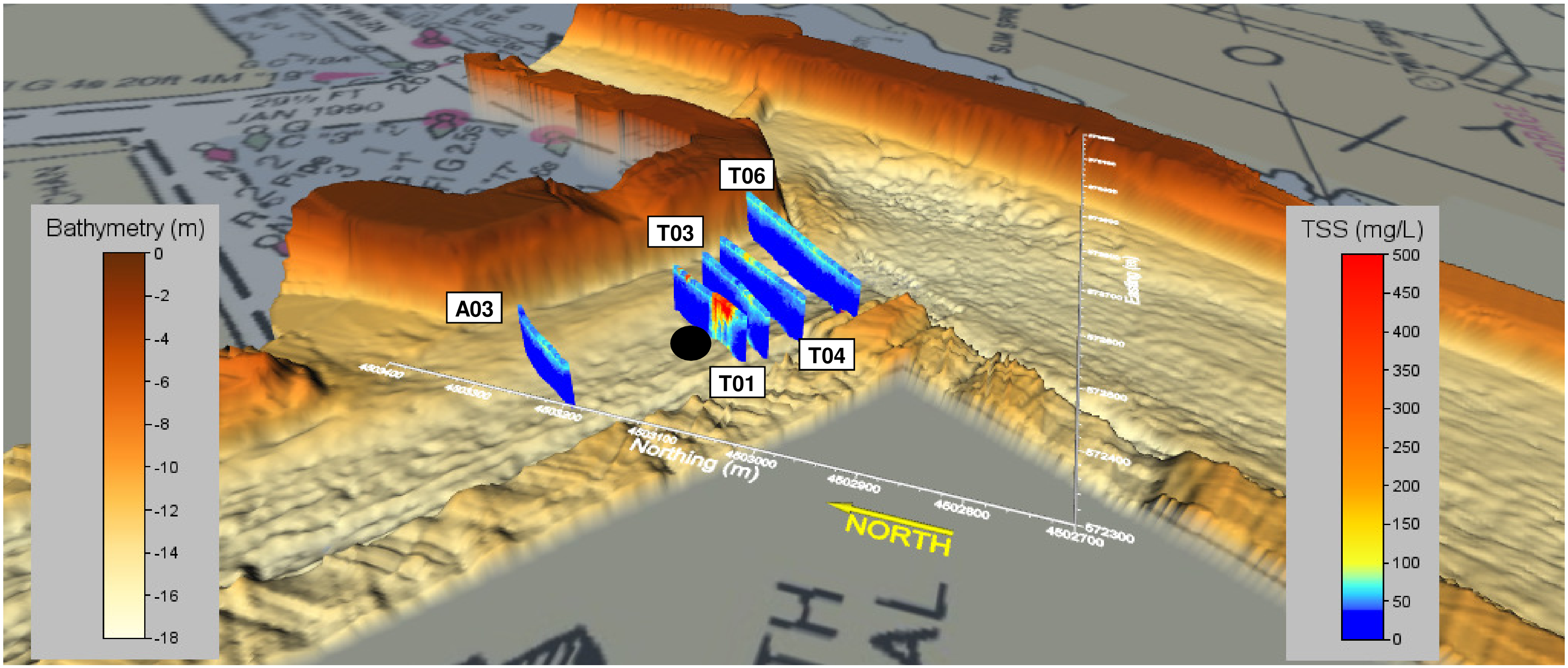


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 28 April 2009 (1st Set)** **14-16 Meter Depth Interval**	Tide
37h			Ebb



Bathymetry provided by: US Army Corps of Engineers, NY District

Z Scale Exaggerated 6x

⬤ = Dredge Location

Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS Values with Respect to their x, y, and z Coordinates** **Superimposed on Channel Bathymetry** **28 April 2009 (1st Set)**	Tide
38			Ebb

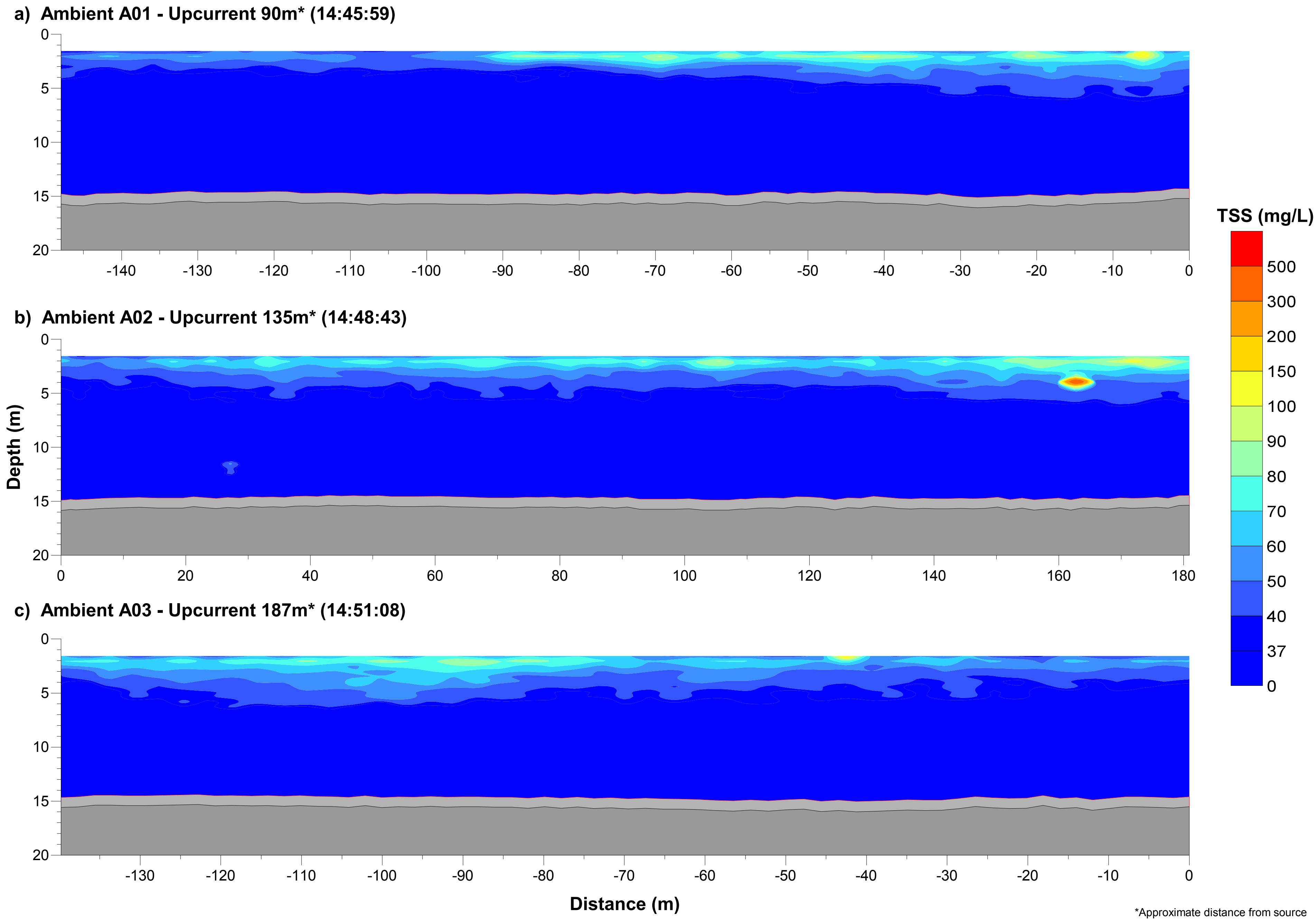
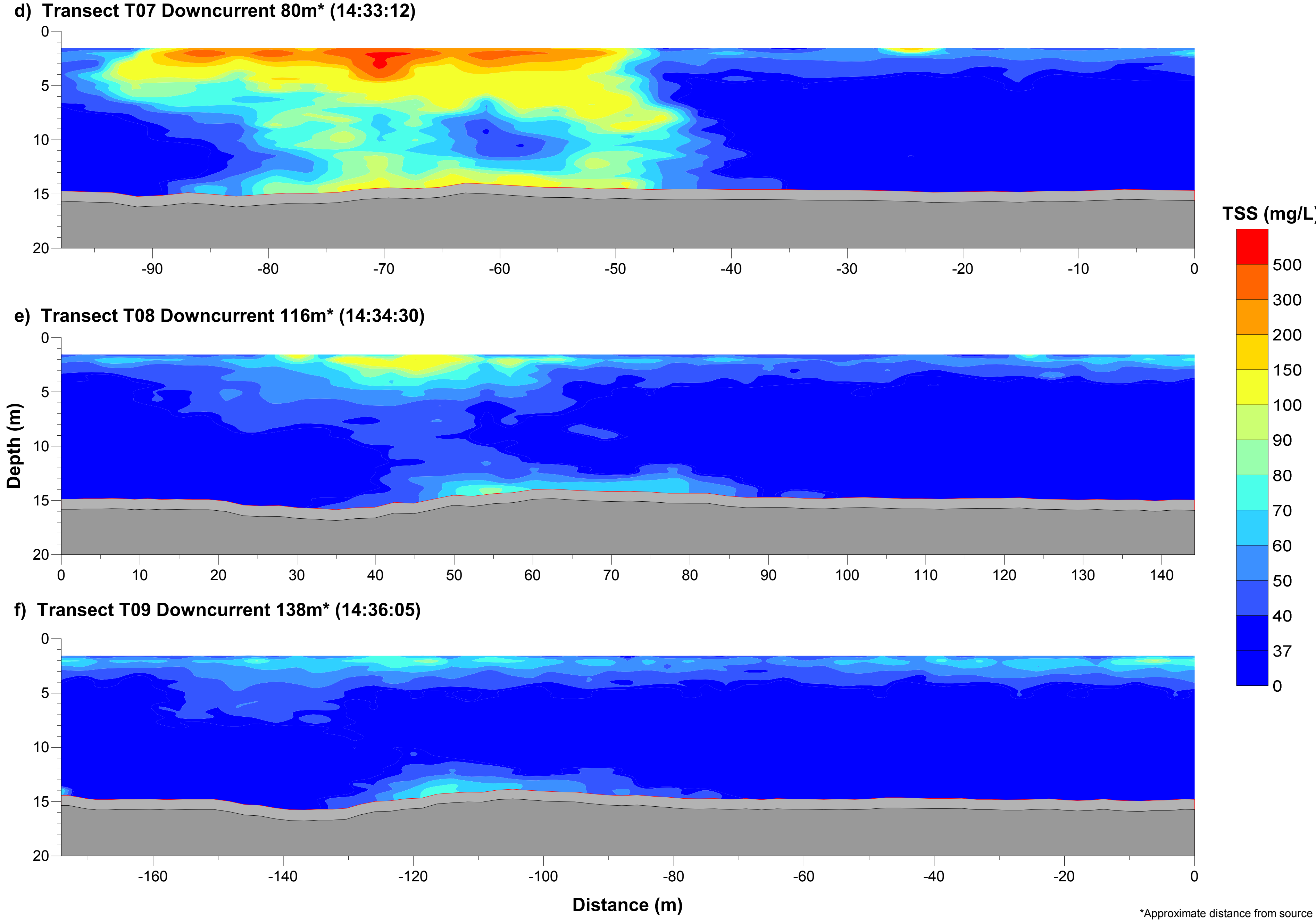


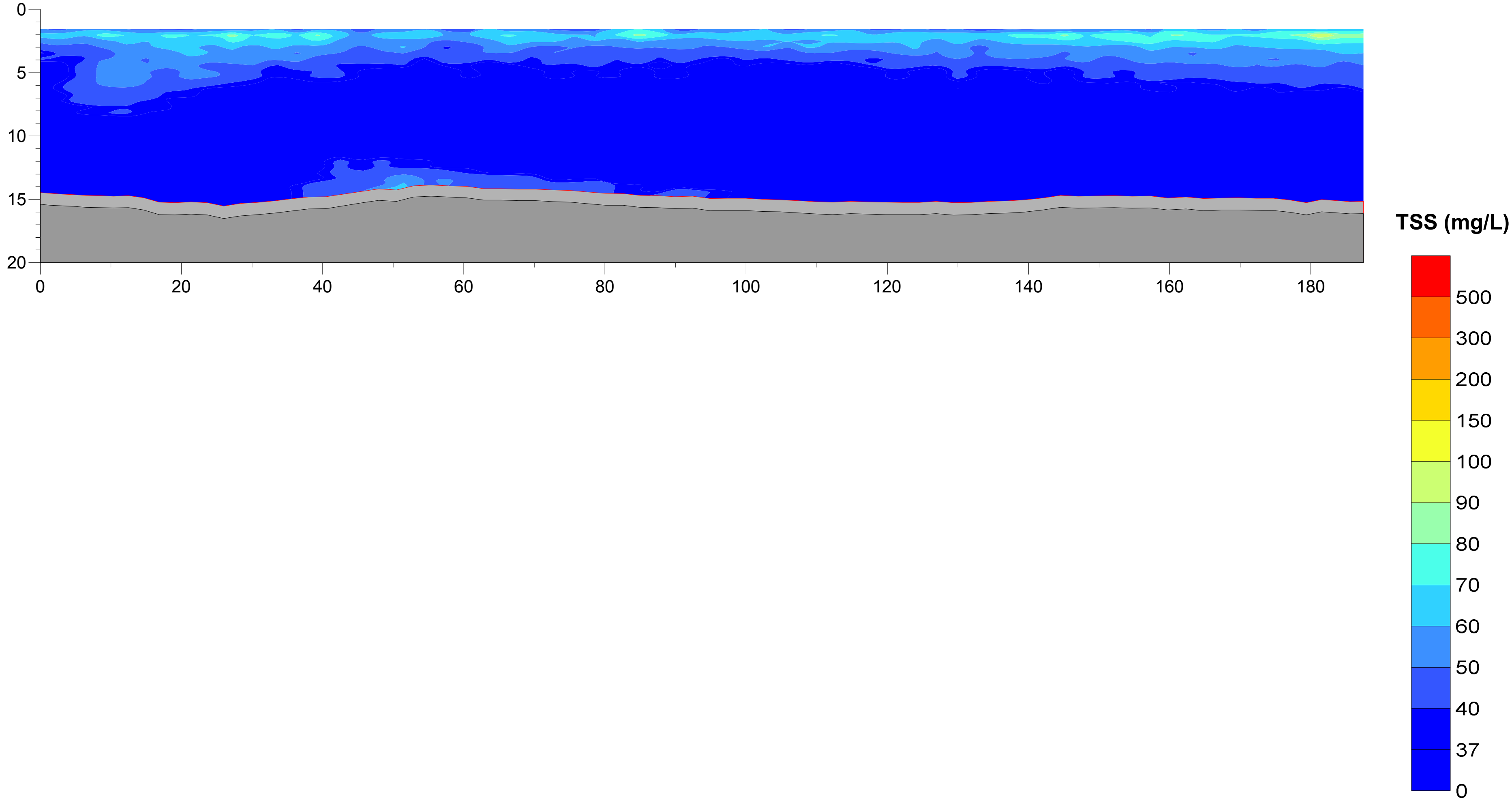
FIGURE	*USACE Harborwide TSS*	**Vertical Profiles of ADCP Average TSS**	TIDE
39a-c	*Far Field Survey* *HDP Contract Area: S-E-1: B*	**28 April 2009 (2nd Set)**	**Ebb**



*Approximate distance from source

FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	Vertical Profiles of ADCP Average TSS 28 April 2009 (2nd Set)	TIDE
39d-f			Ebb

g) Transect T10 Downcurrent 175m* (14:37:58)



*Approximate distance from source

FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	Vertical Profiles of ADCP Average TSS 28 April 2009 (2nd Set)	TIDE
39g			Ebb

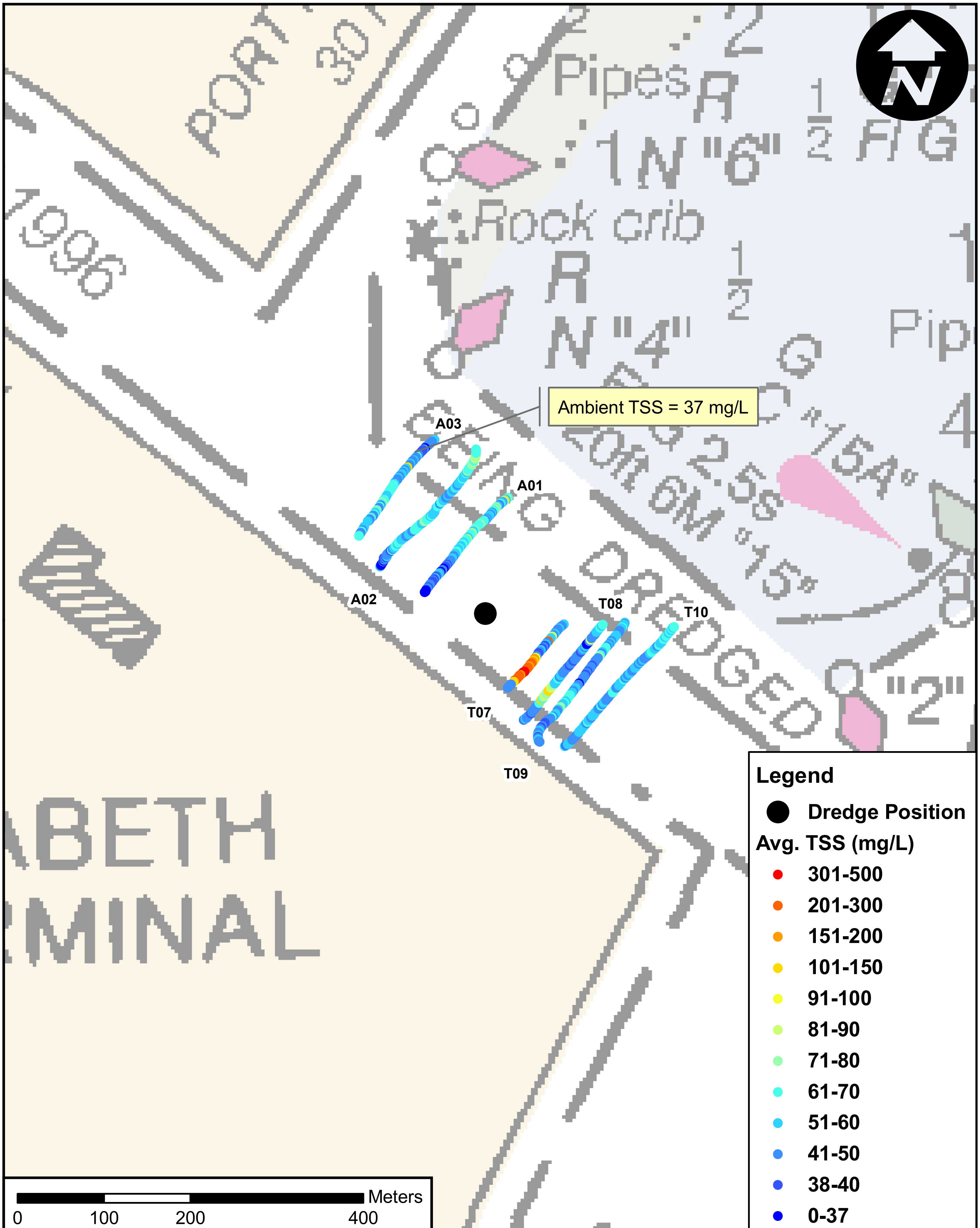


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	ADCP Average TSS - 28 April 2009 (2nd Set) 0-2 Meter Depth Interval	Tide
40a			Ebb

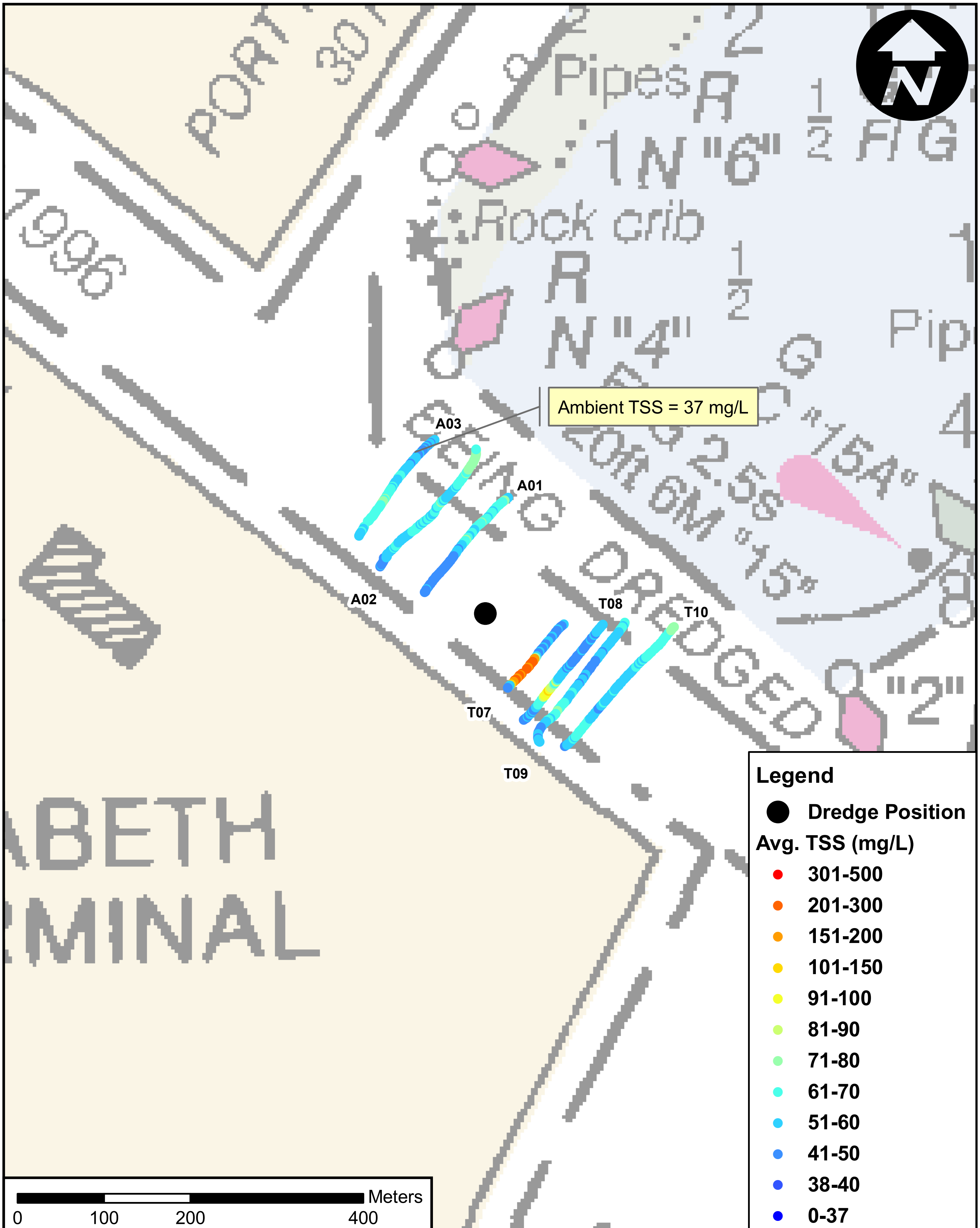


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	ADCP Average TSS - 28 April 2009 (2nd Set) 2-4 Meter Depth Interval	Tide
40b			Ebb

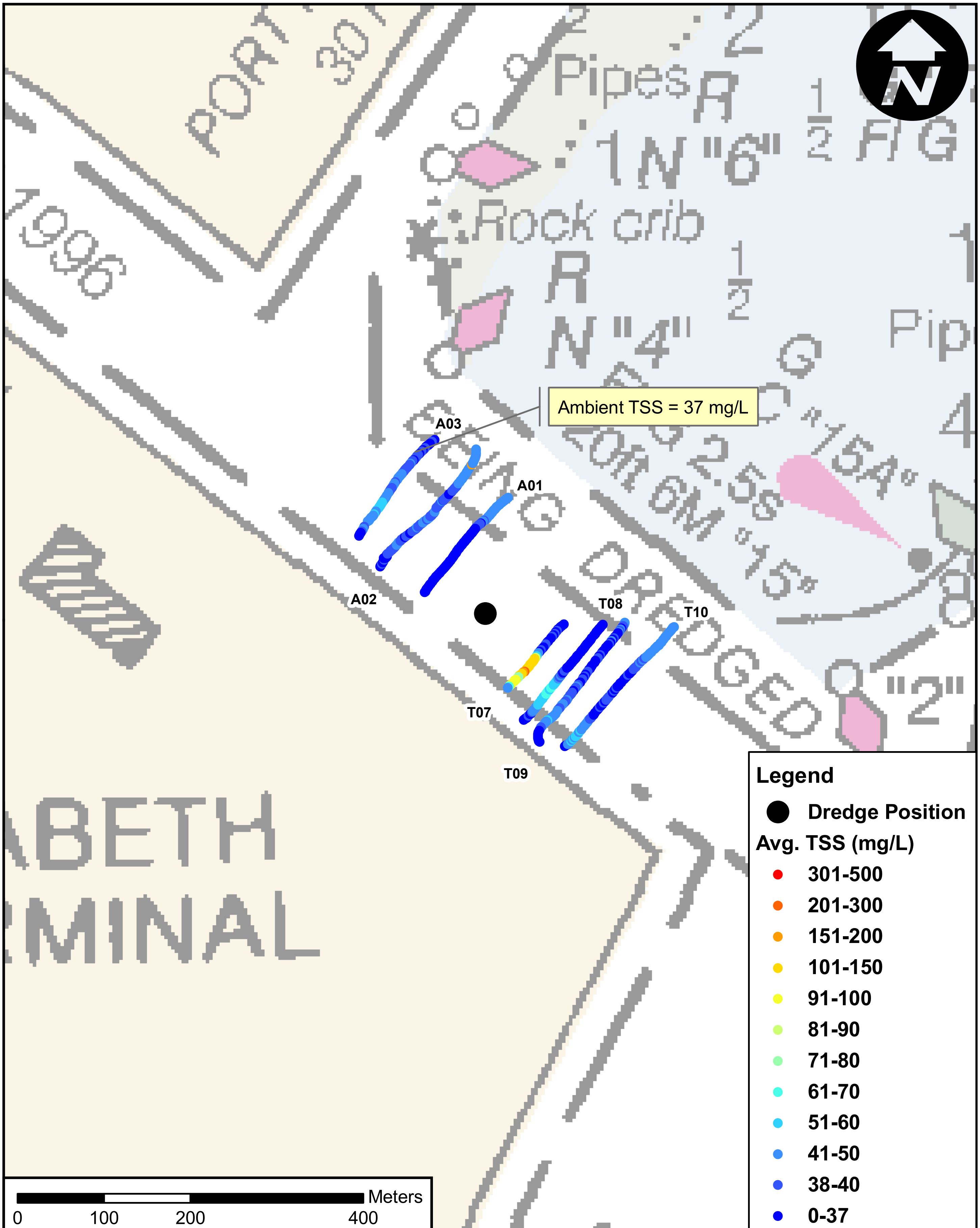


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 28 April 2009 (2nd Set)** **4-6 Meter Depth Interval**	**Tide**
40c			**Ebb**

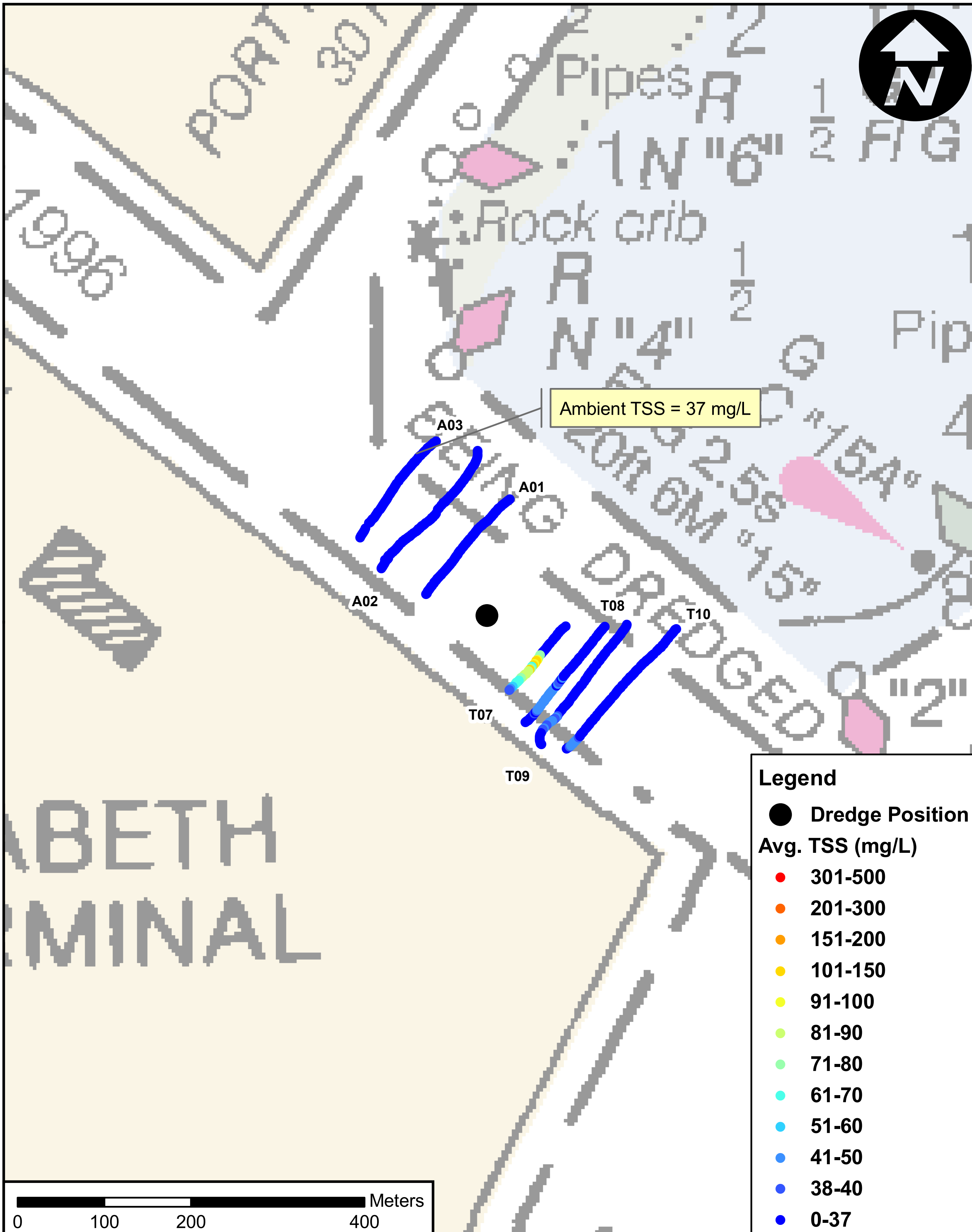


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	ADCP Average TSS - 28 April 2009 (2nd Set) 6-8 Meter Depth Interval	Tide
40d			Ebb

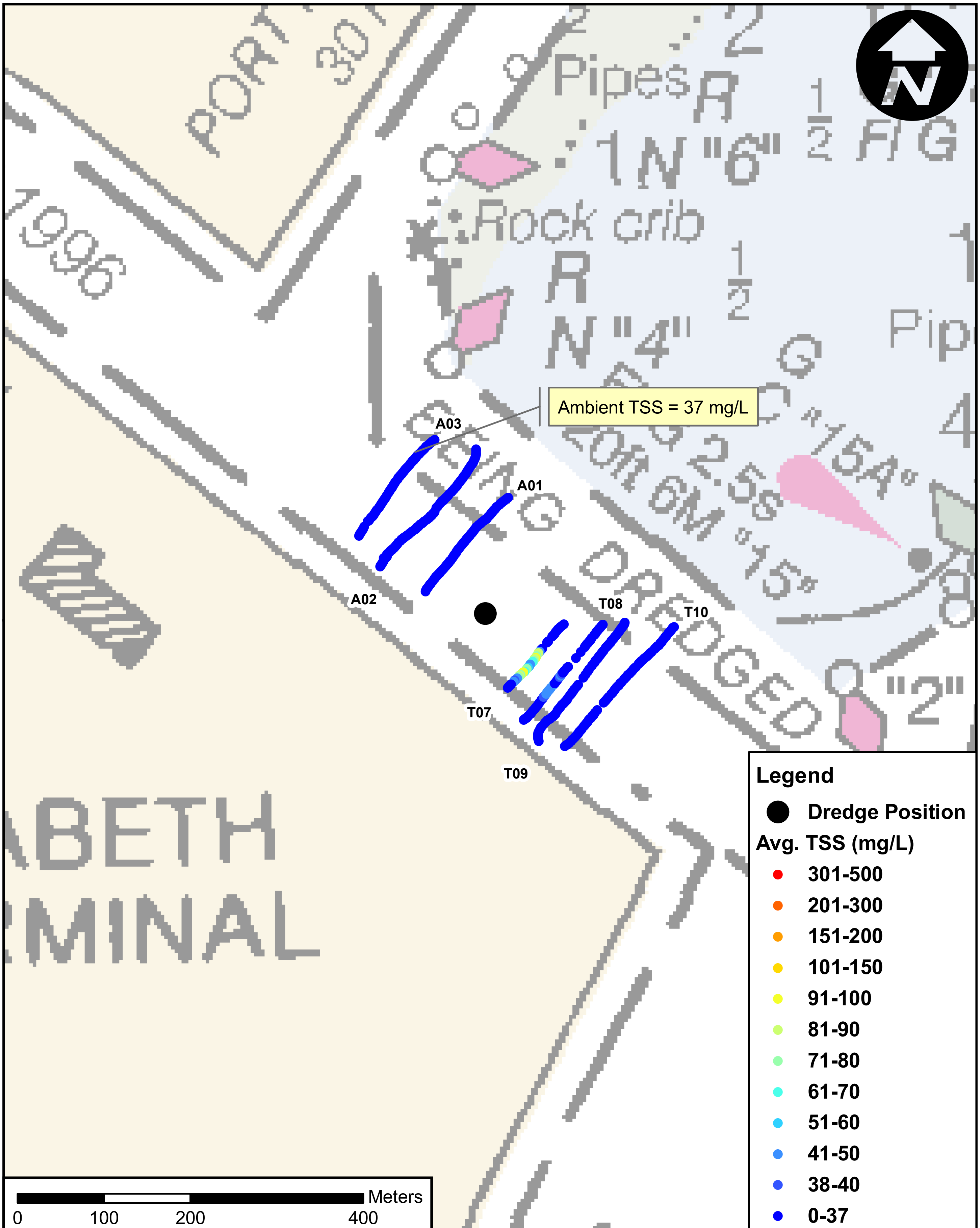


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	ADCP Average TSS - 28 April 2009 (2nd Set) 8-10 Meter Depth Interval	Tide
40e			Ebb

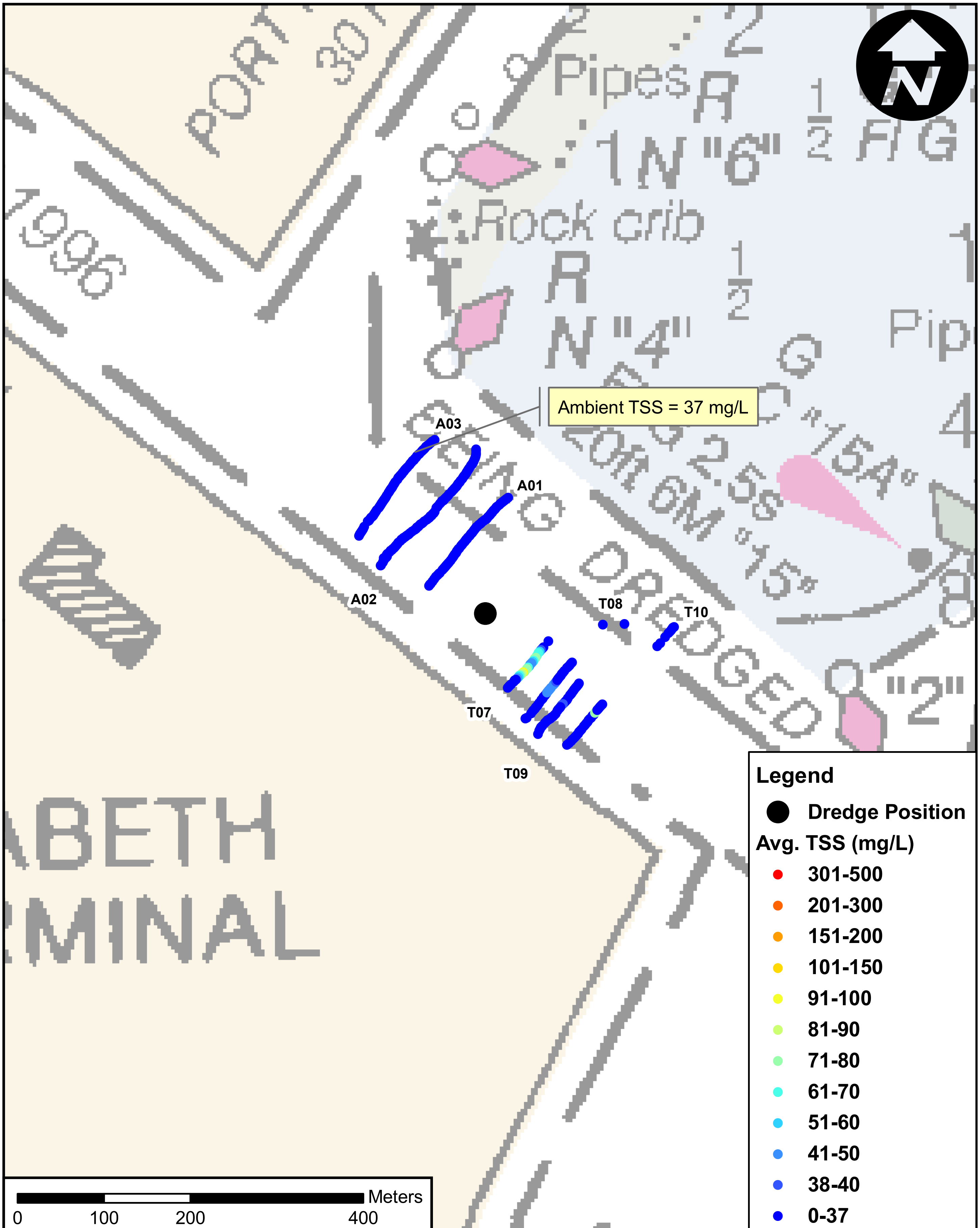


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 28 April 2009 (2nd Set)** **10-12 Meter Depth Interval**	**Tide**
40f			**Ebb**

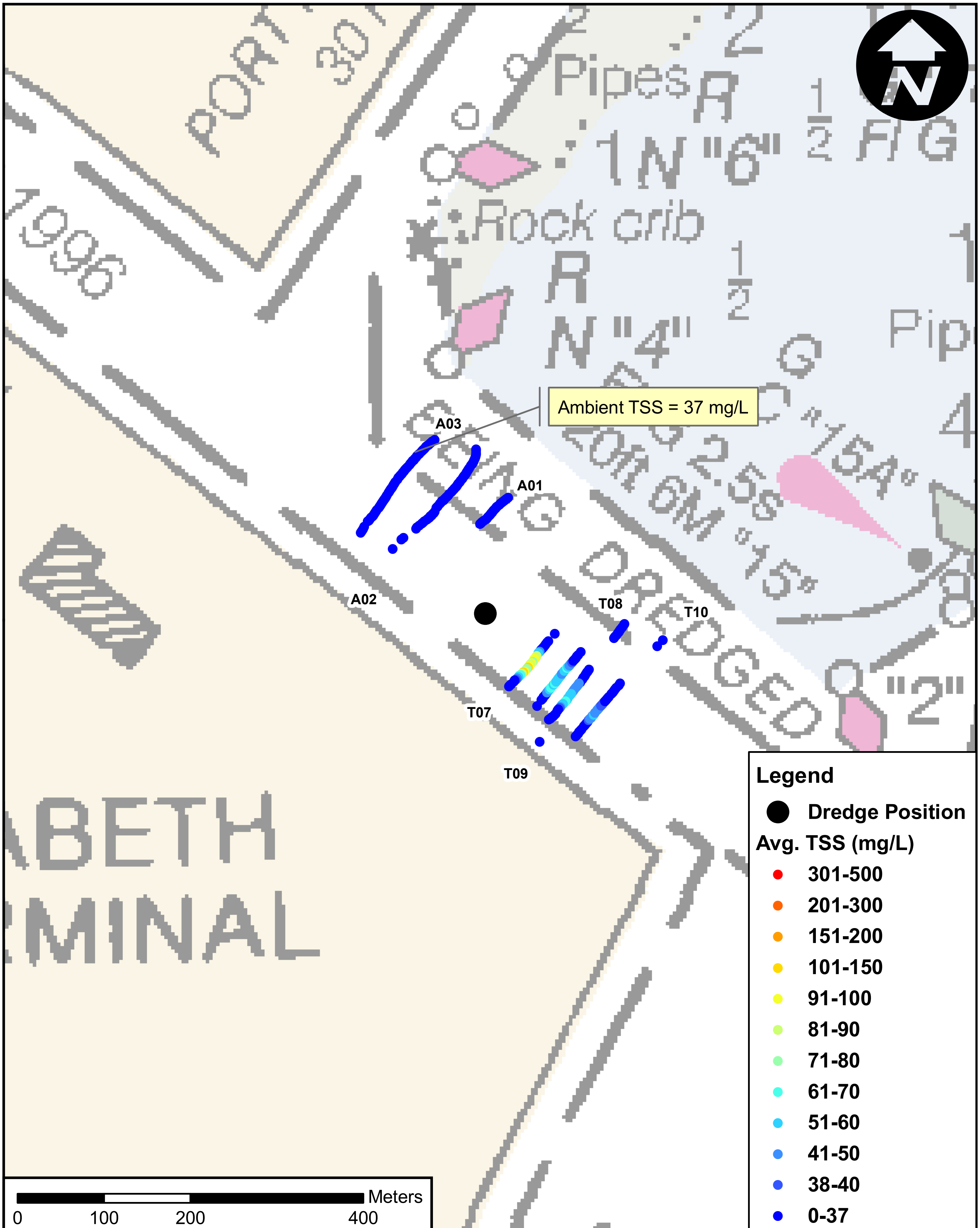
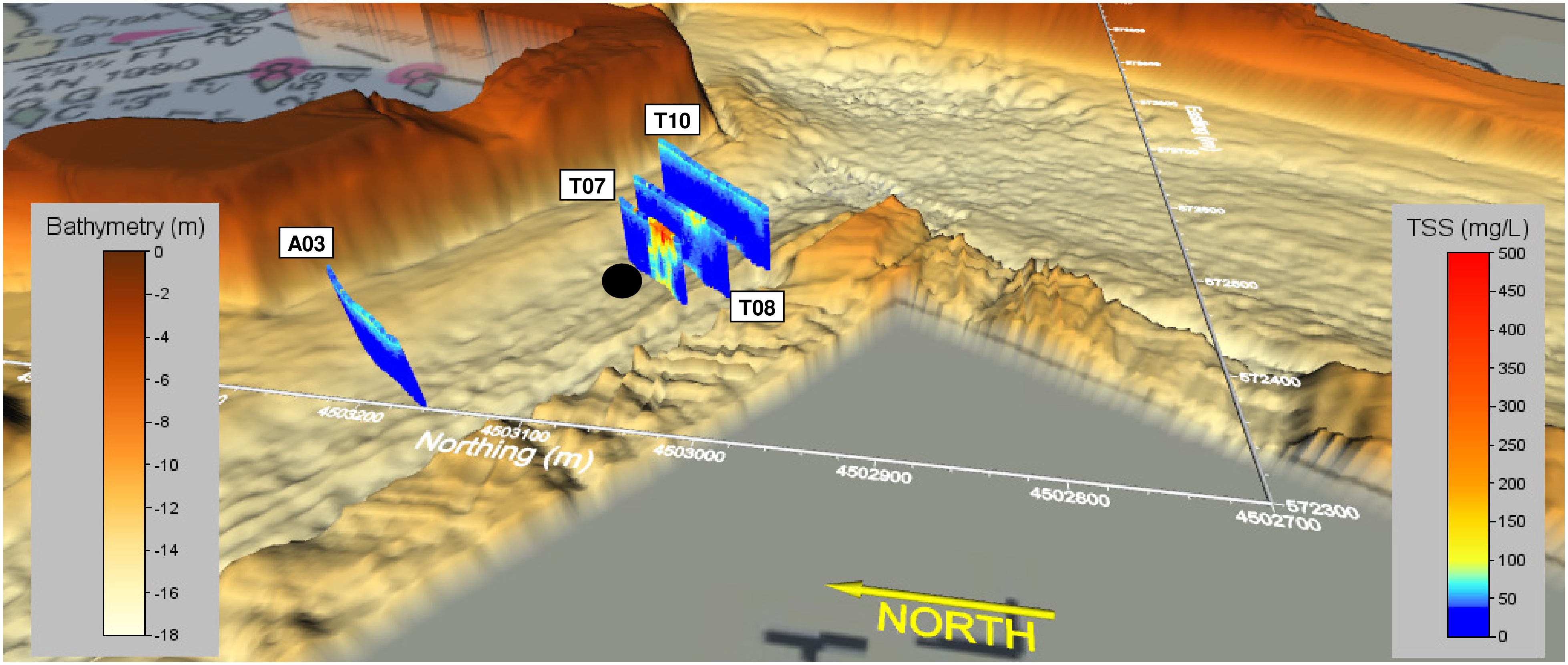


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	ADCP Average TSS - 28 April 2009 (2nd Set) 12-14 Meter Depth Interval	Tide
40g			Ebb



Bathymetry provided by: US Army Corps of Engineers, NY District

Z Scale Exaggerated 6x

● = Dredge Location

Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS Values with Respect to their x, y, and z Coordinates** **Superimposed on Channel Bathymetry** **28 April 2009 (2nd Set)**	Tide
41			Ebb

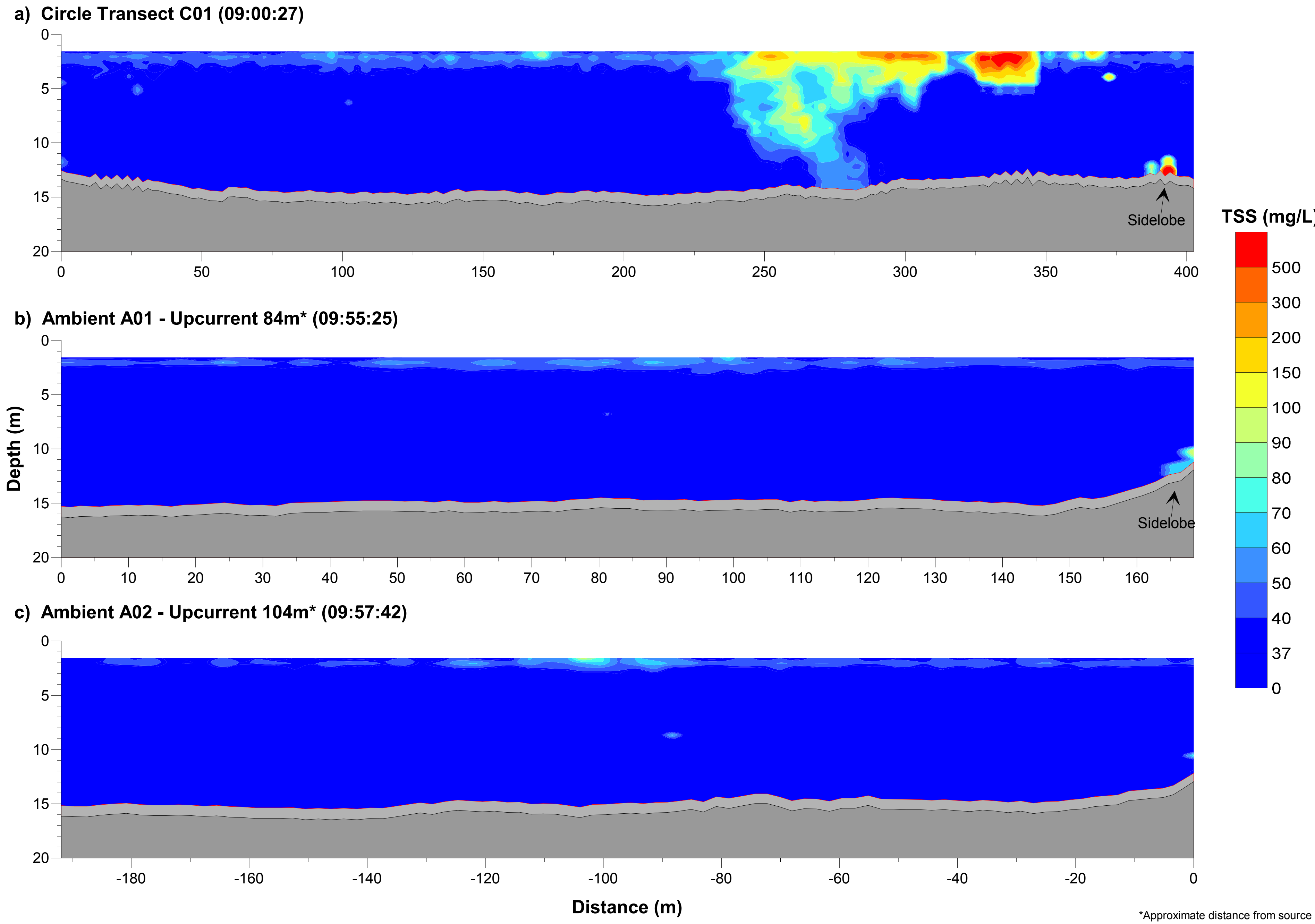
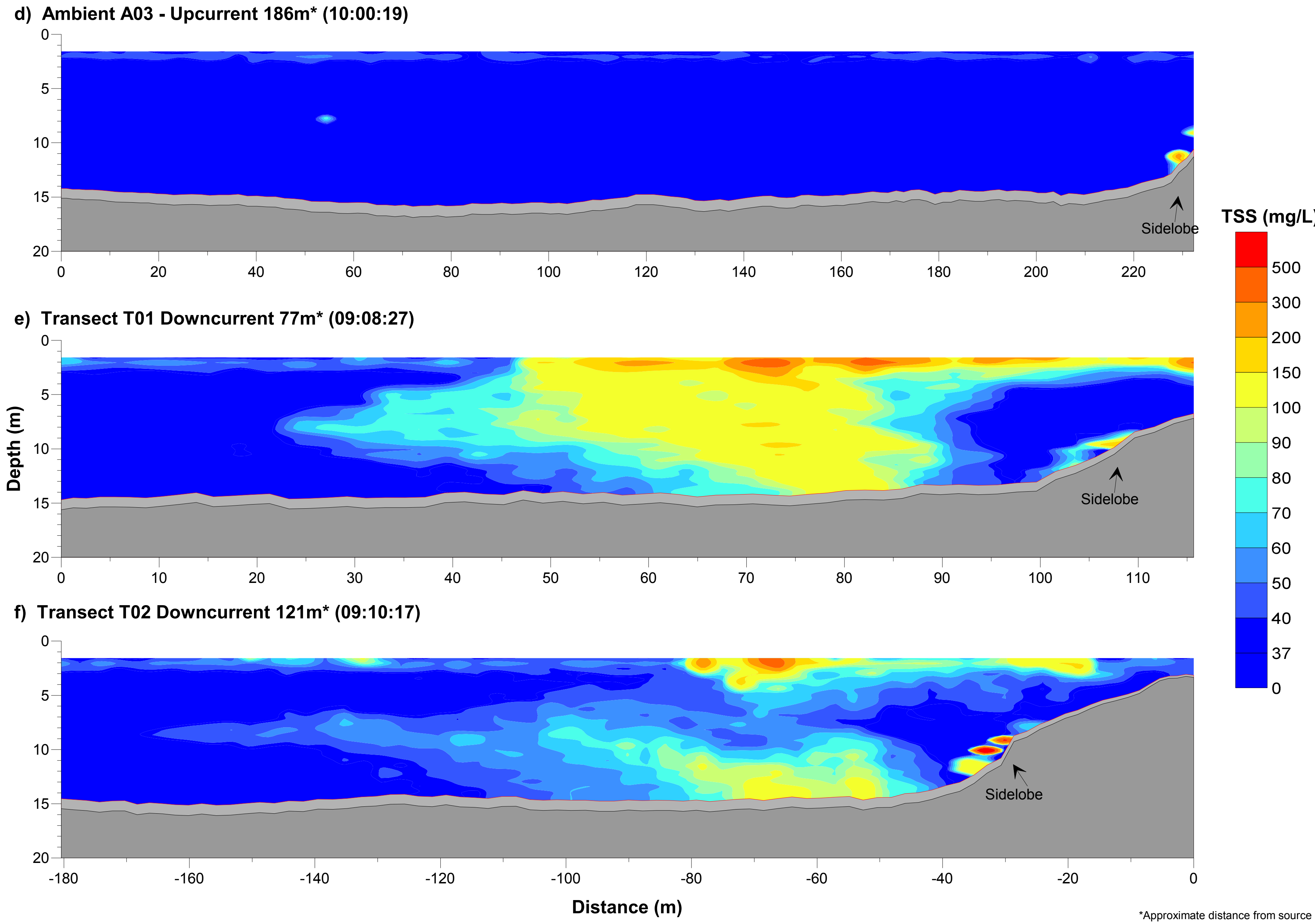


FIGURE	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**Vertical Profiles of ADCP Average TSS** **29 April 2009**	TIDE
42a-c			**Flood**



*Approximate distance from source

FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	Vertical Profiles of ADCP Average TSS 29 April 2009	TIDE
42d-f			Flood

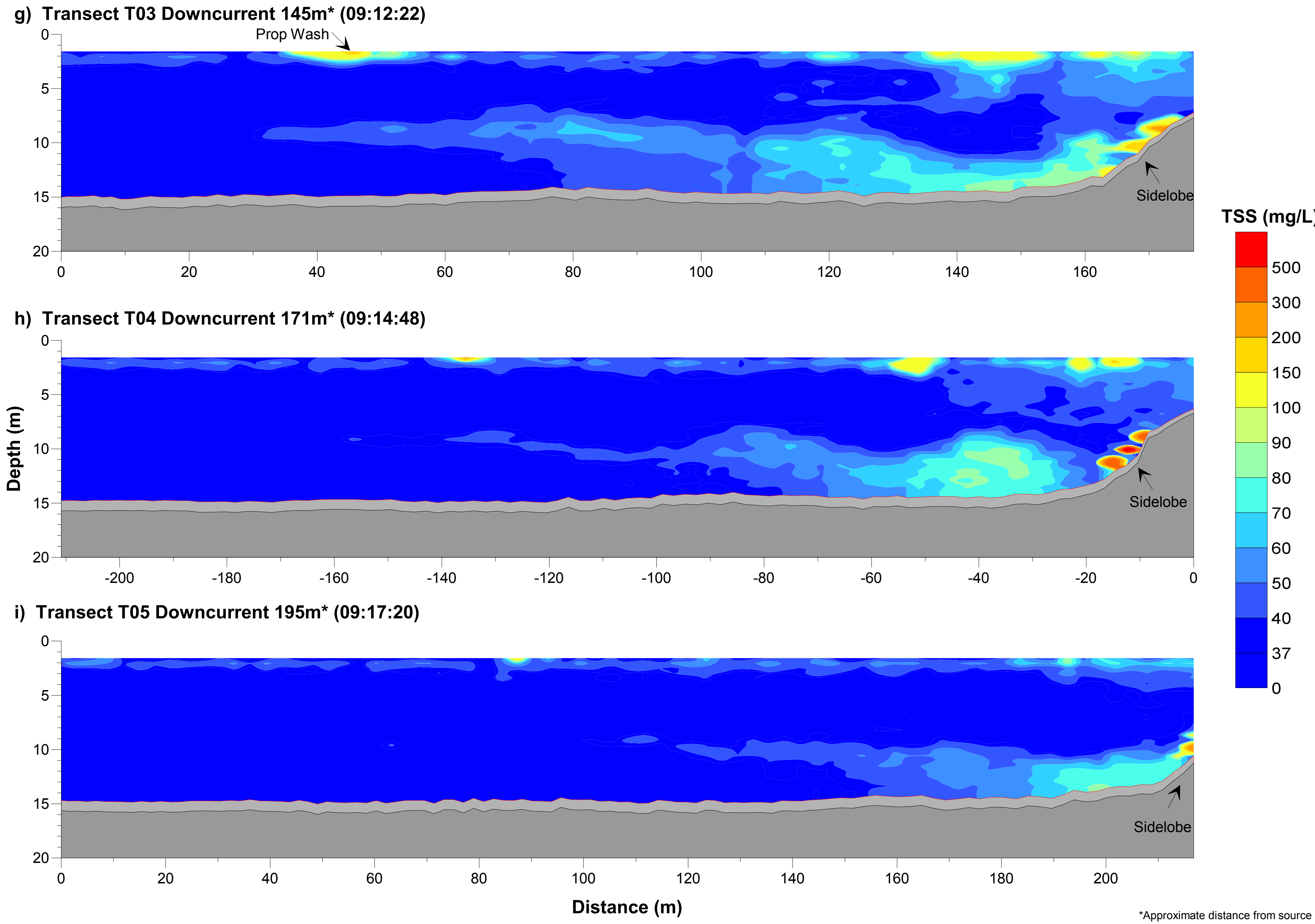


FIGURE	*USACE Harborwide TSS*	Vertical Profiles of ADCP Average TSS	TIDE
42g-i	*Far Field Survey* *HDP Contract Area: S-E-1: B*	29 April 2009	Flood

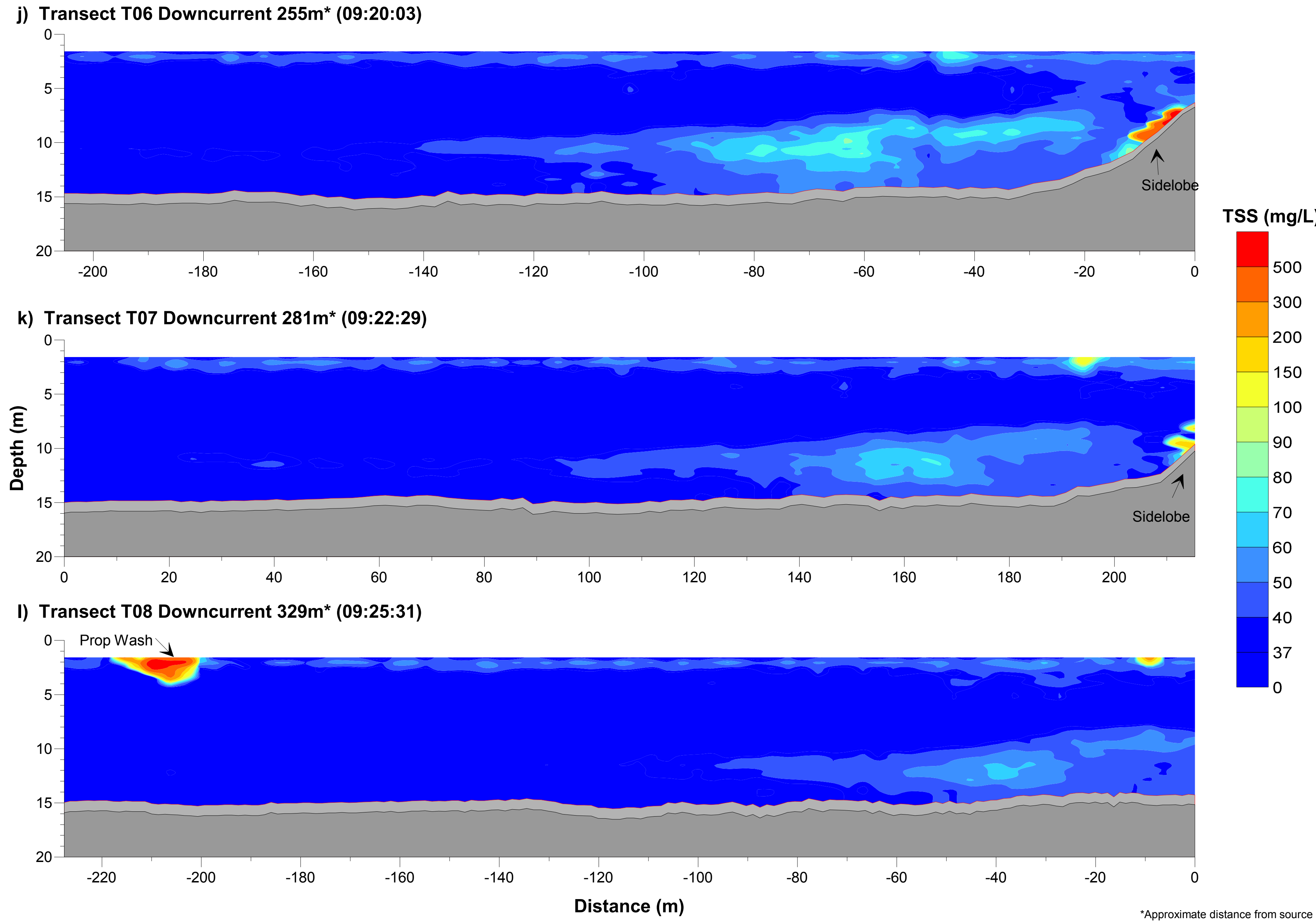


FIGURE	*USACE Harborwide TSS*	Vertical Profiles of ADCP Average TSS	TIDE
42j-l	*Far Field Survey* *HDP Contract Area: S-E-1: B*	29 April 2009	Flood

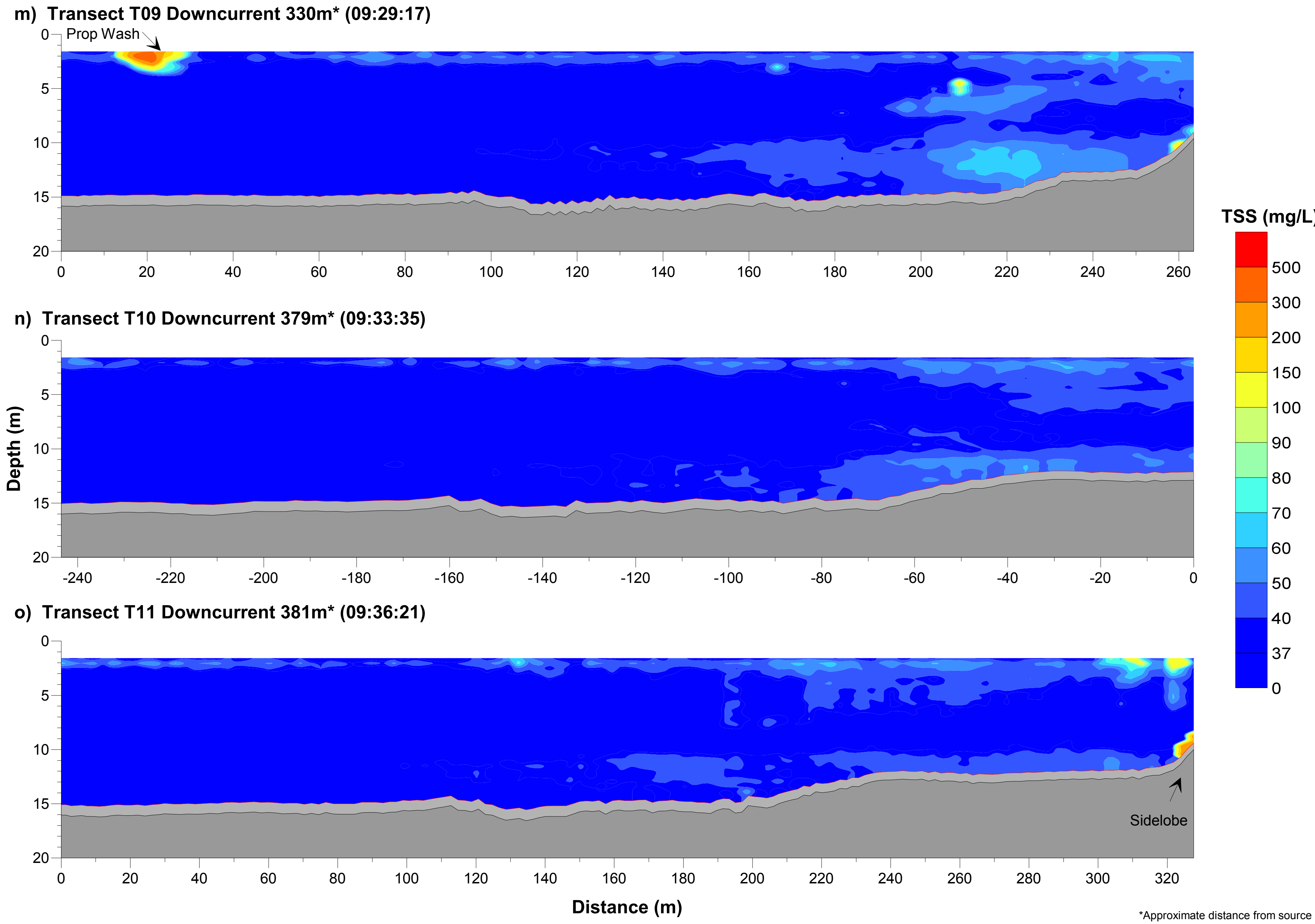
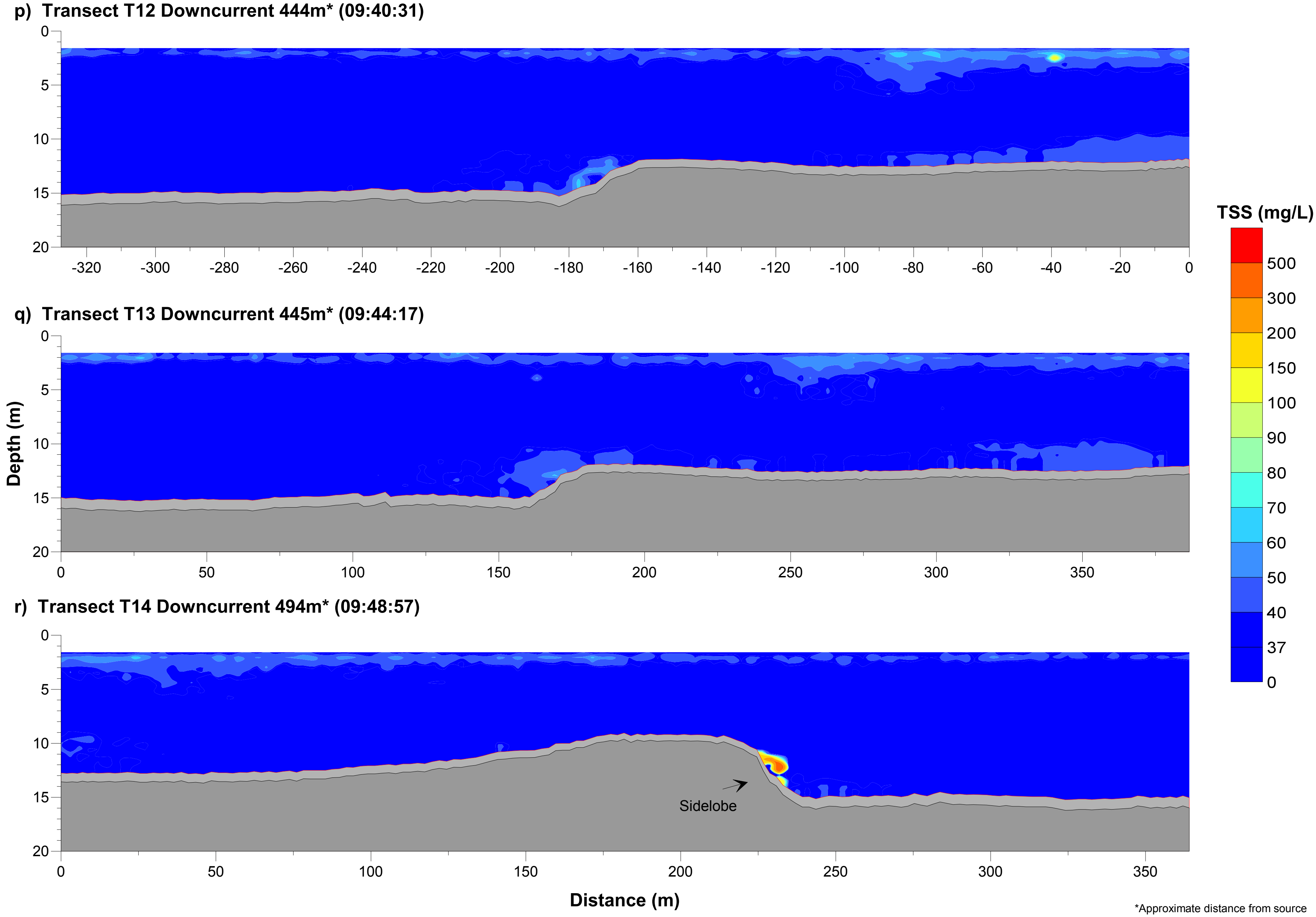


FIGURE	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**Vertical Profiles of ADCP Average TSS** **29 April 2009**	TIDE
42m-o			Flood



*Approximate distance from source

FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	Vertical Profiles of ADCP Average TSS 29 April 2009	TIDE
42p-r			Flood

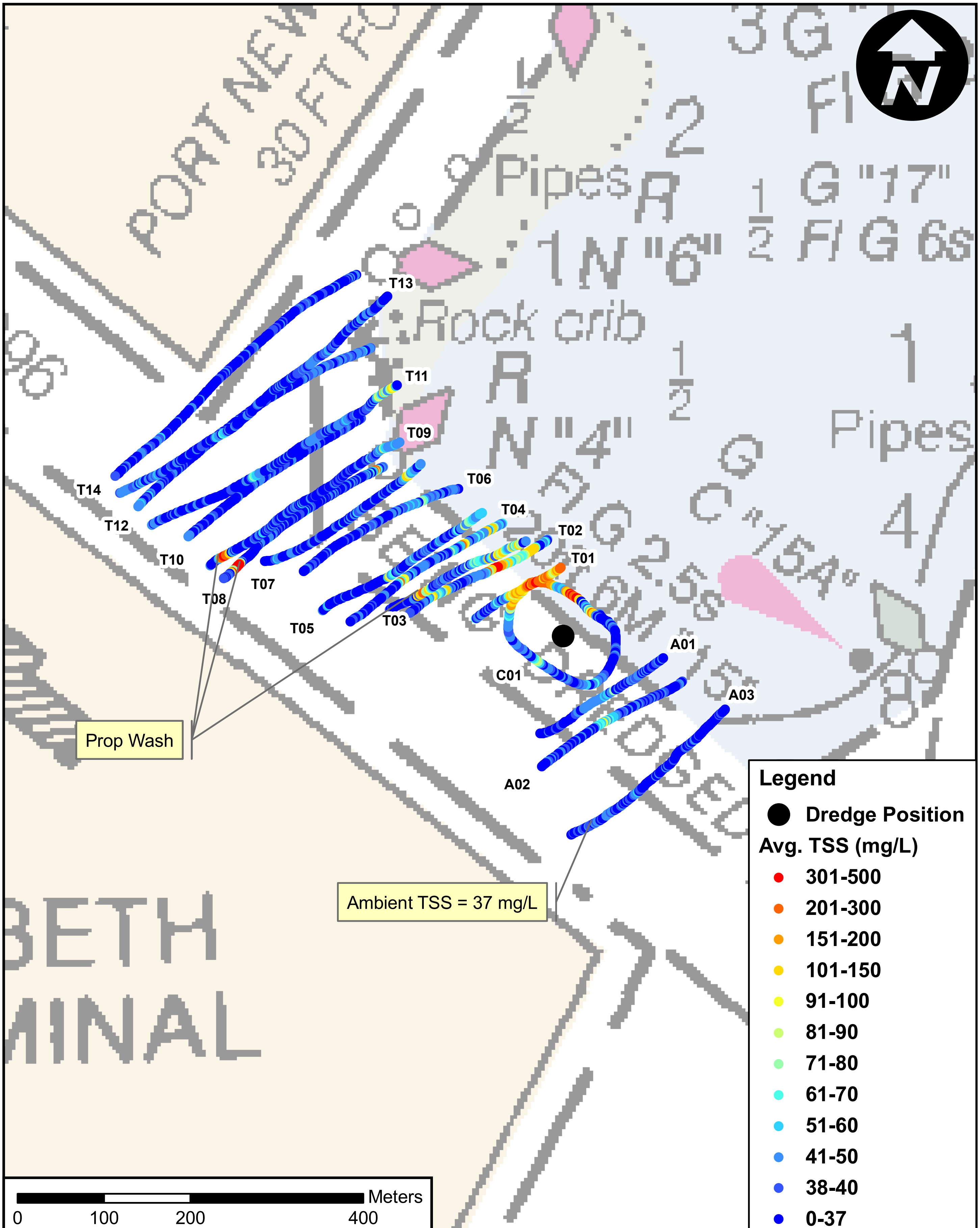


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	ADCP Average TSS - 29 April 2009 0-2 Meter Depth Interval	Tide
43a			Flood

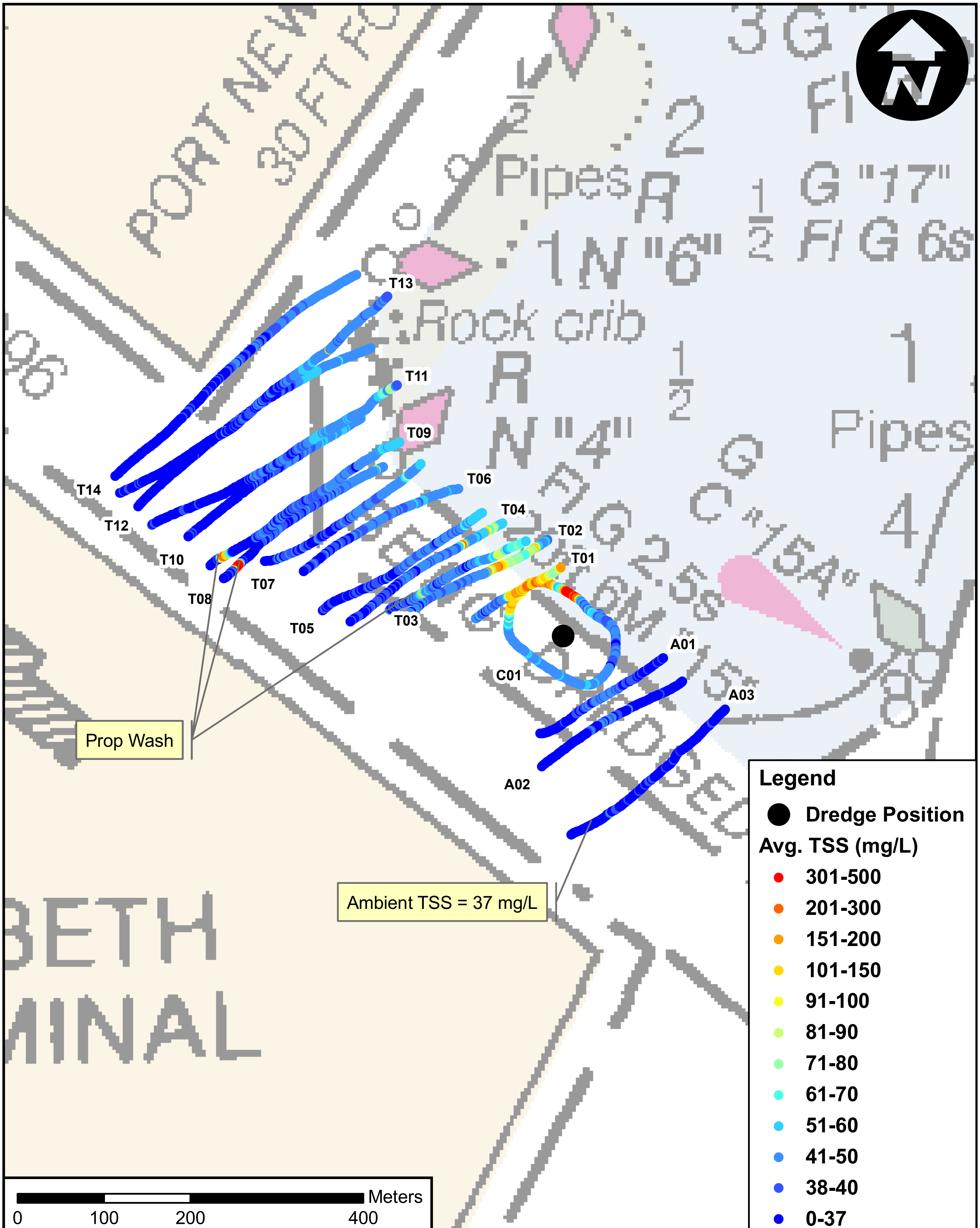


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 29 April 2009** **2-4 Meter Depth Interval**	**Tide**
43b			**Flood**

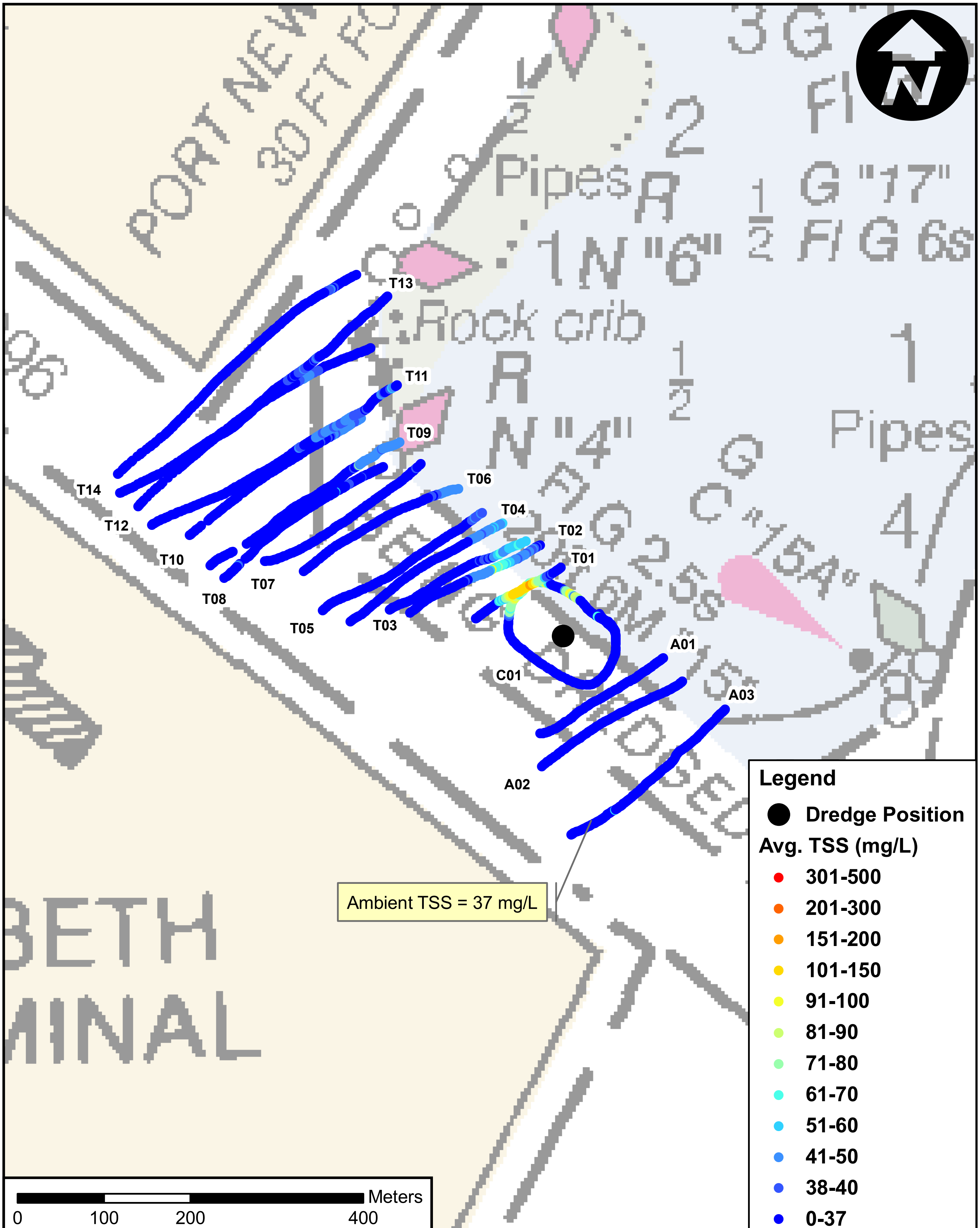


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	ADCP Average TSS - 29 April 2009 4-6 Meter Depth Interval	Tide
43c			Flood

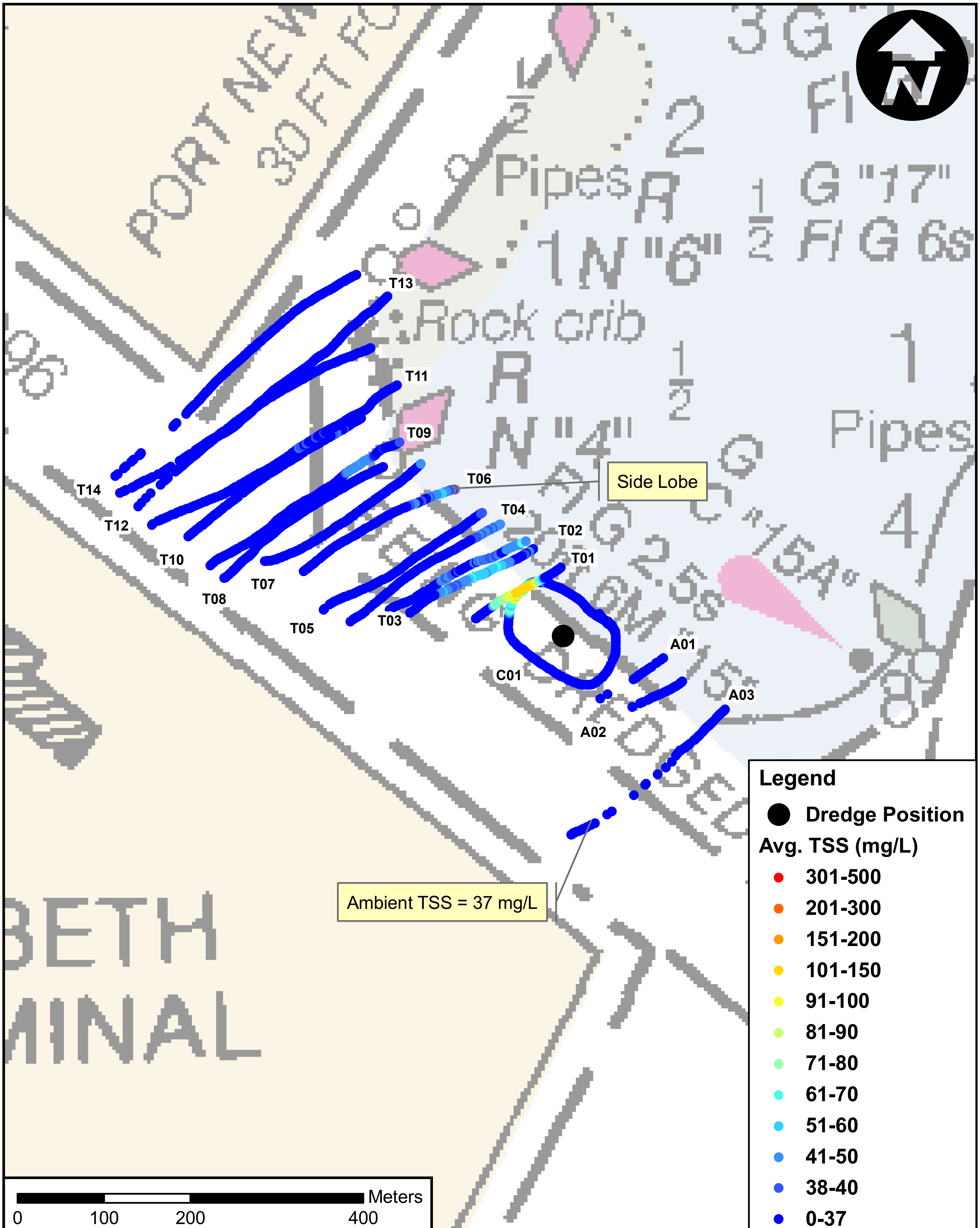


Figure	*USACE Harborwide TSS*	**ADCP Average TSS - 29 April 2009**	Tide
43d	*Far Field Survey* *HDP Contract Area: S-E-1: B*	**6-8 Meter Depth Interval**	Flood

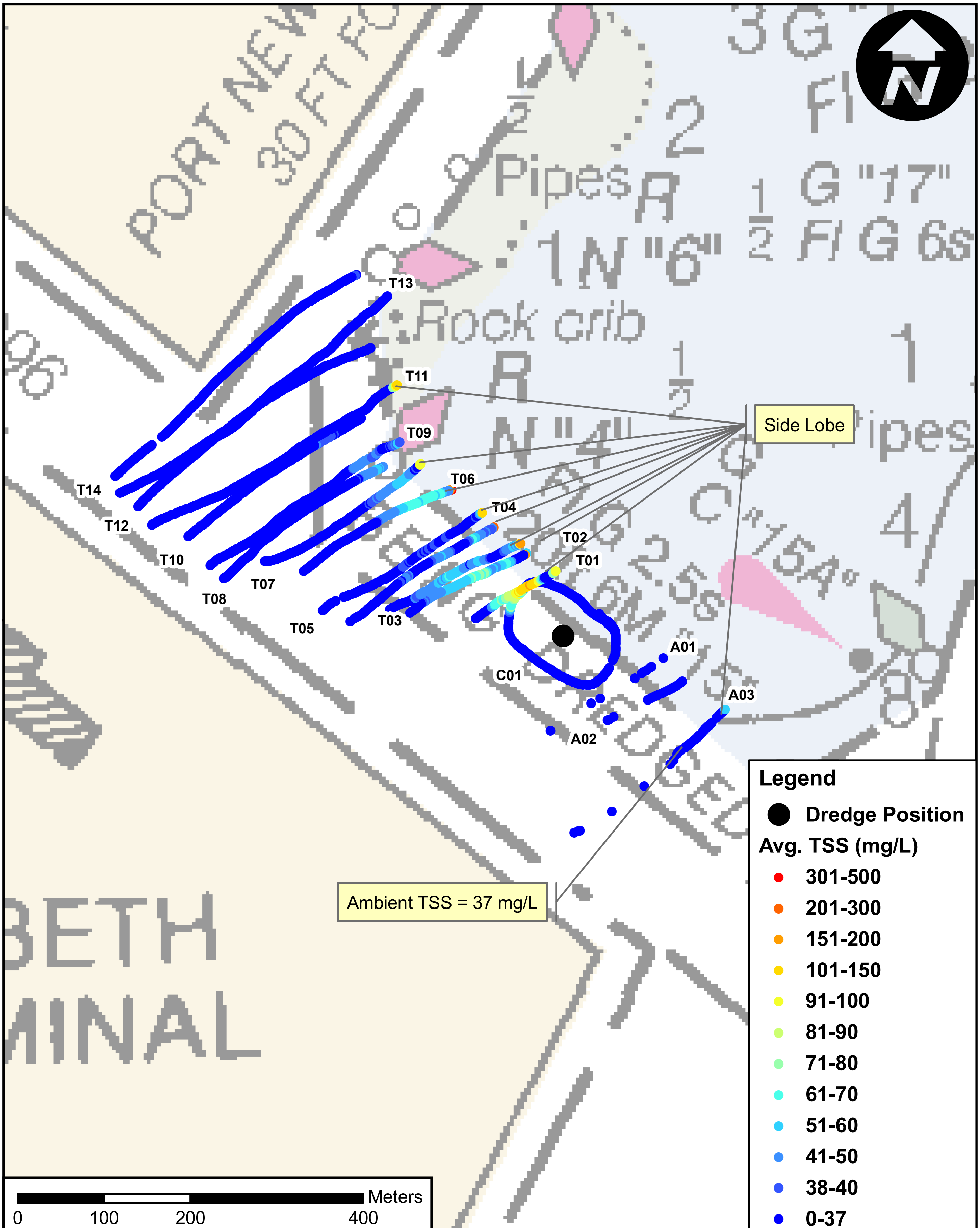


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	ADCP Average TSS - 29 April 2009 8-10 Meter Depth Interval	Tide
43e			Flood

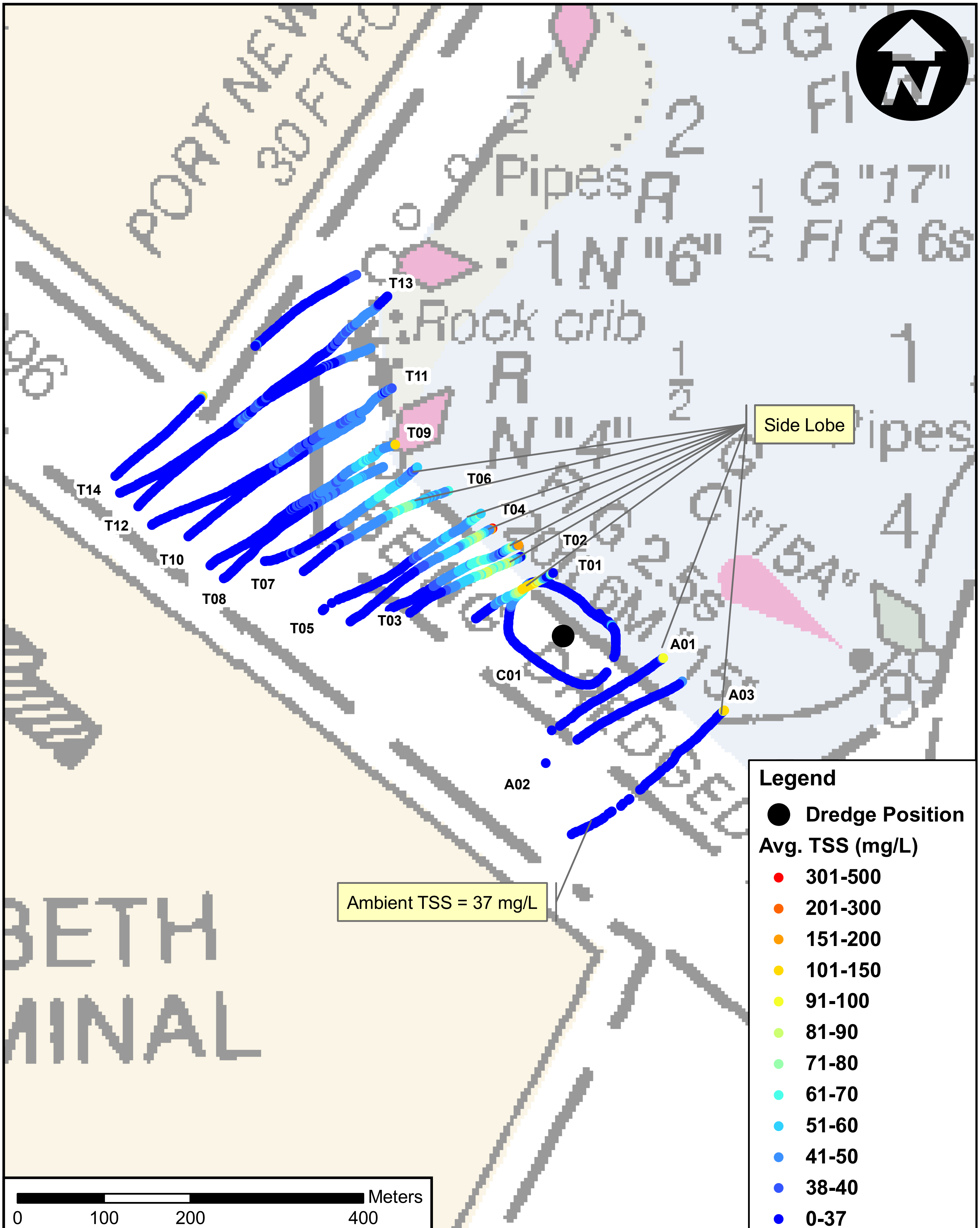


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	ADCP Average TSS - 29 April 2009 10-12 Meter Depth Interval	Tide
43f			Flood

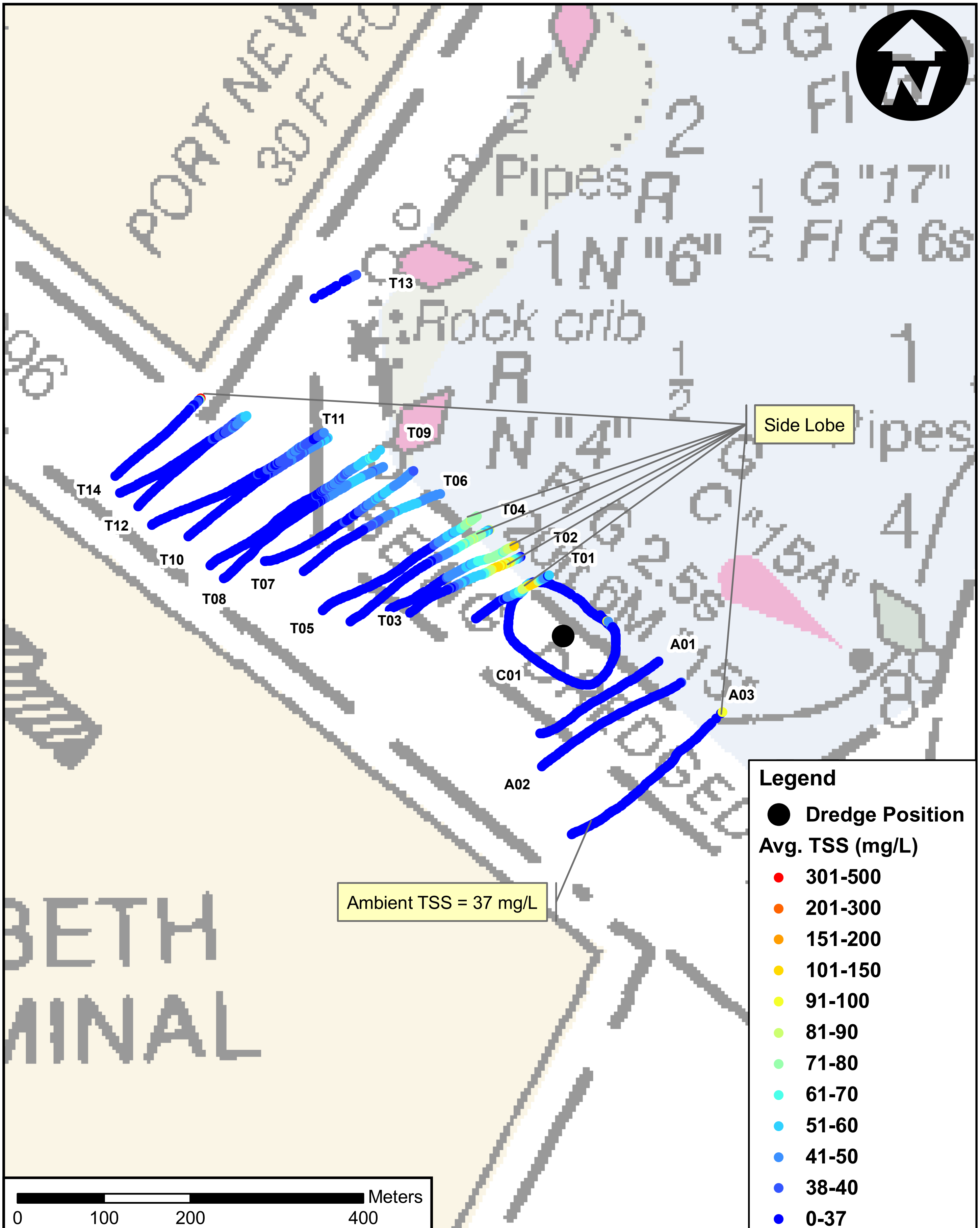


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	ADCP Average TSS - 29 April 2009 12-14 Meter Depth Interval	Tide
43g			Flood

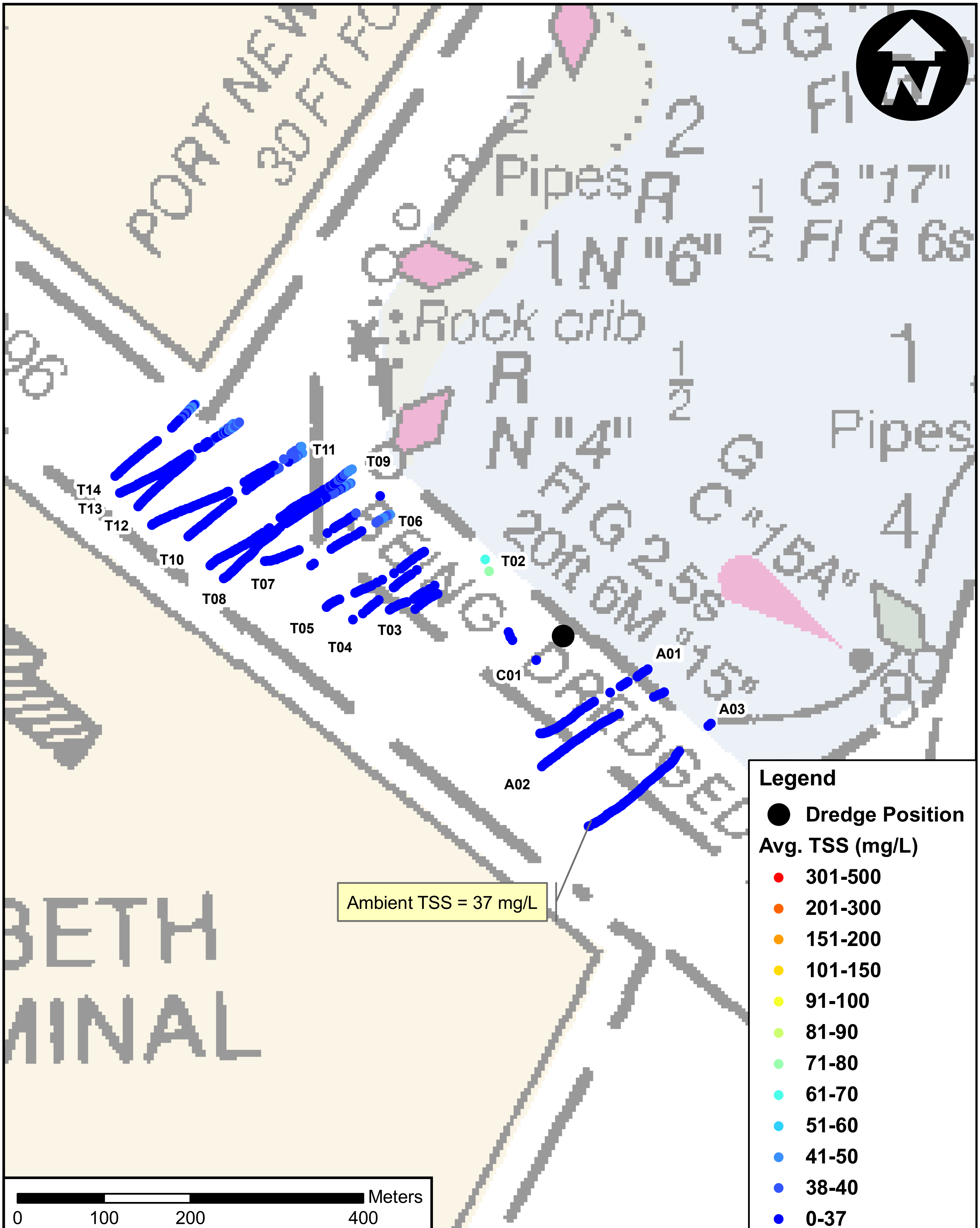
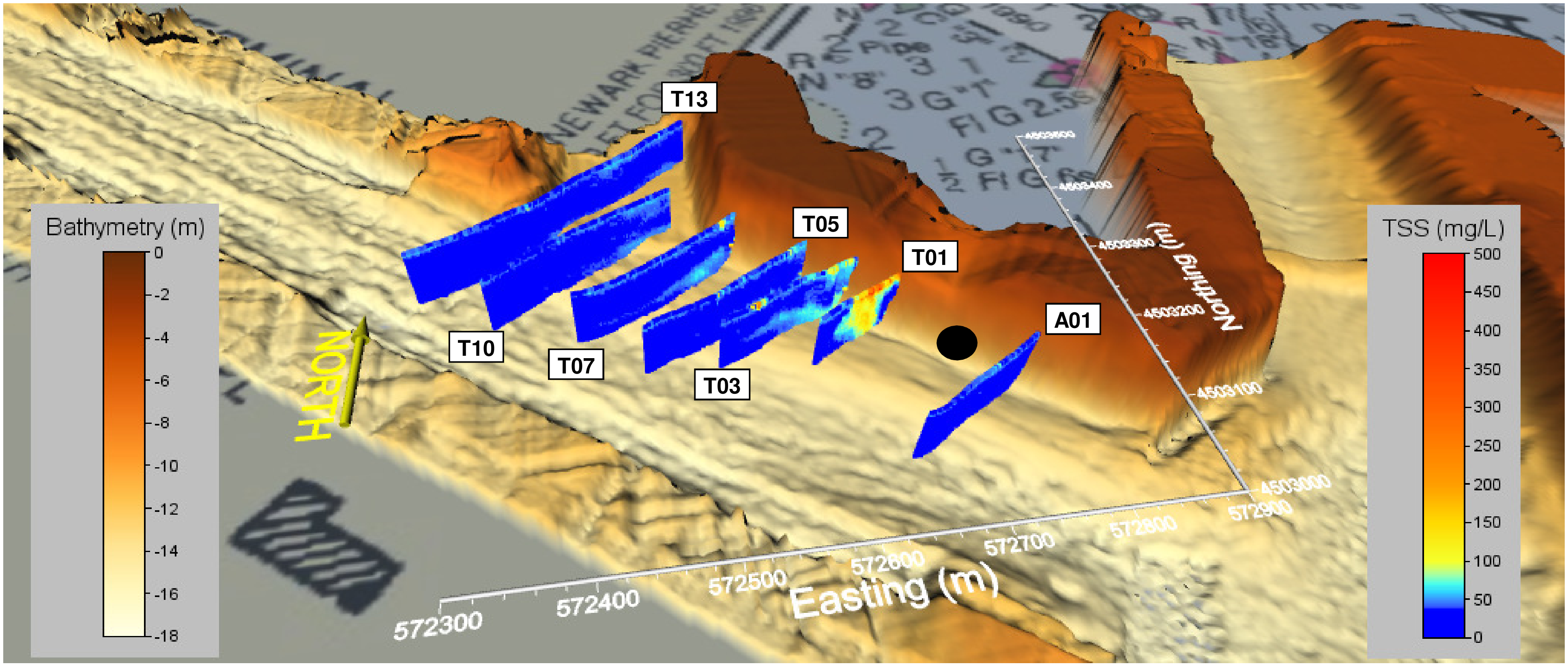


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 29 April 2009** **14-16 Meter Depth Interval**	Tide
43h			Flood



Bathymetry provided by: US Army Corps of Engineers, NY District

Z Scale Exaggerated 6x

● **= Dredge Location**

Figure	*USACE Harborwide TSS*	**ADCP Average TSS Values with Respect to their x, y, and z Coordinates**	**Tide**
44	*Far Field Survey* *HDP Contract Area: S-E-1: B*	**Superimposed on Channel Bathymetry** **29 April 2009**	**Flood**

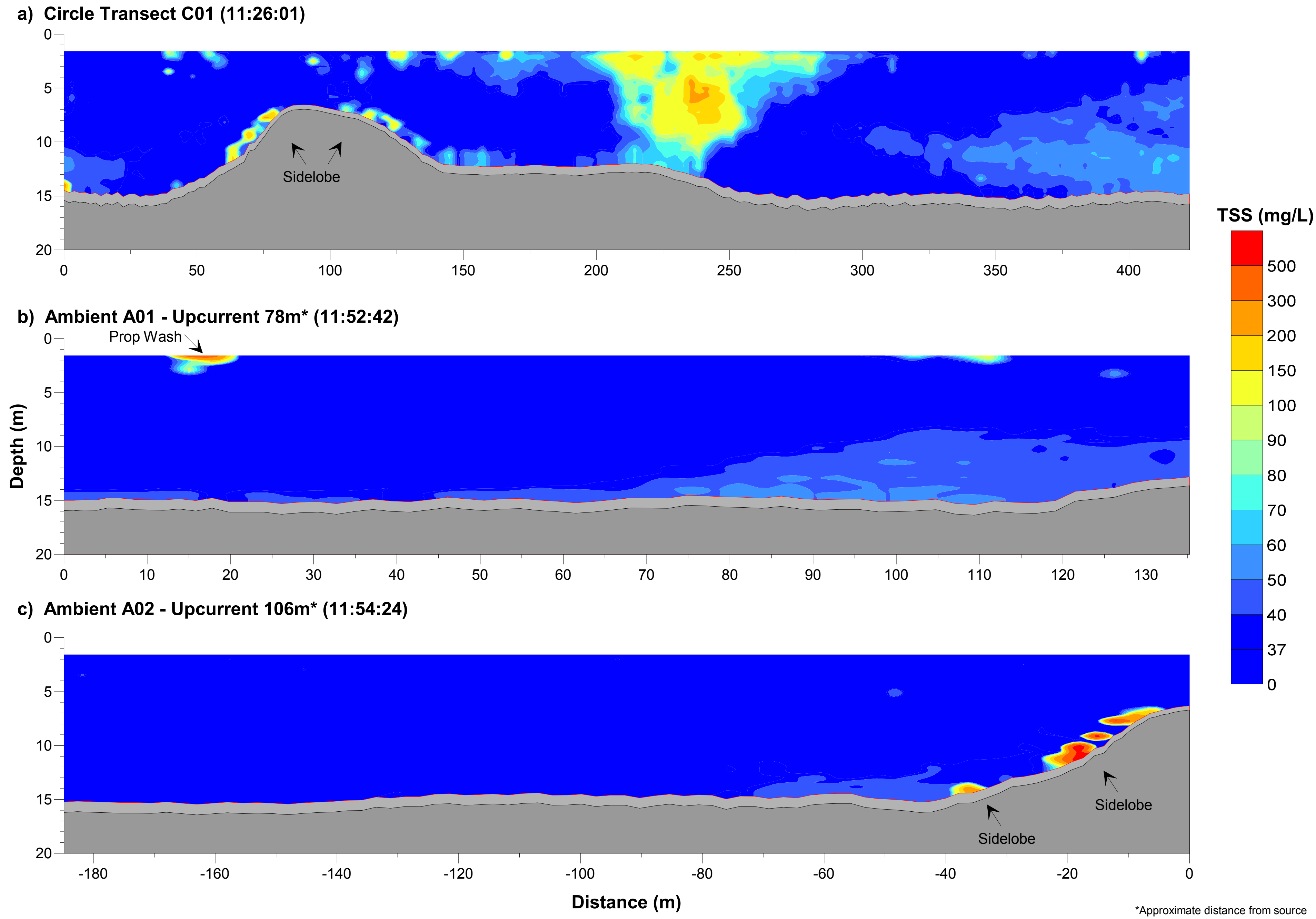


FIGURE	*USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B*	**Vertical Profiles of ADCP Average TSS 01 May 2009**	TIDE
45a-c			Flood

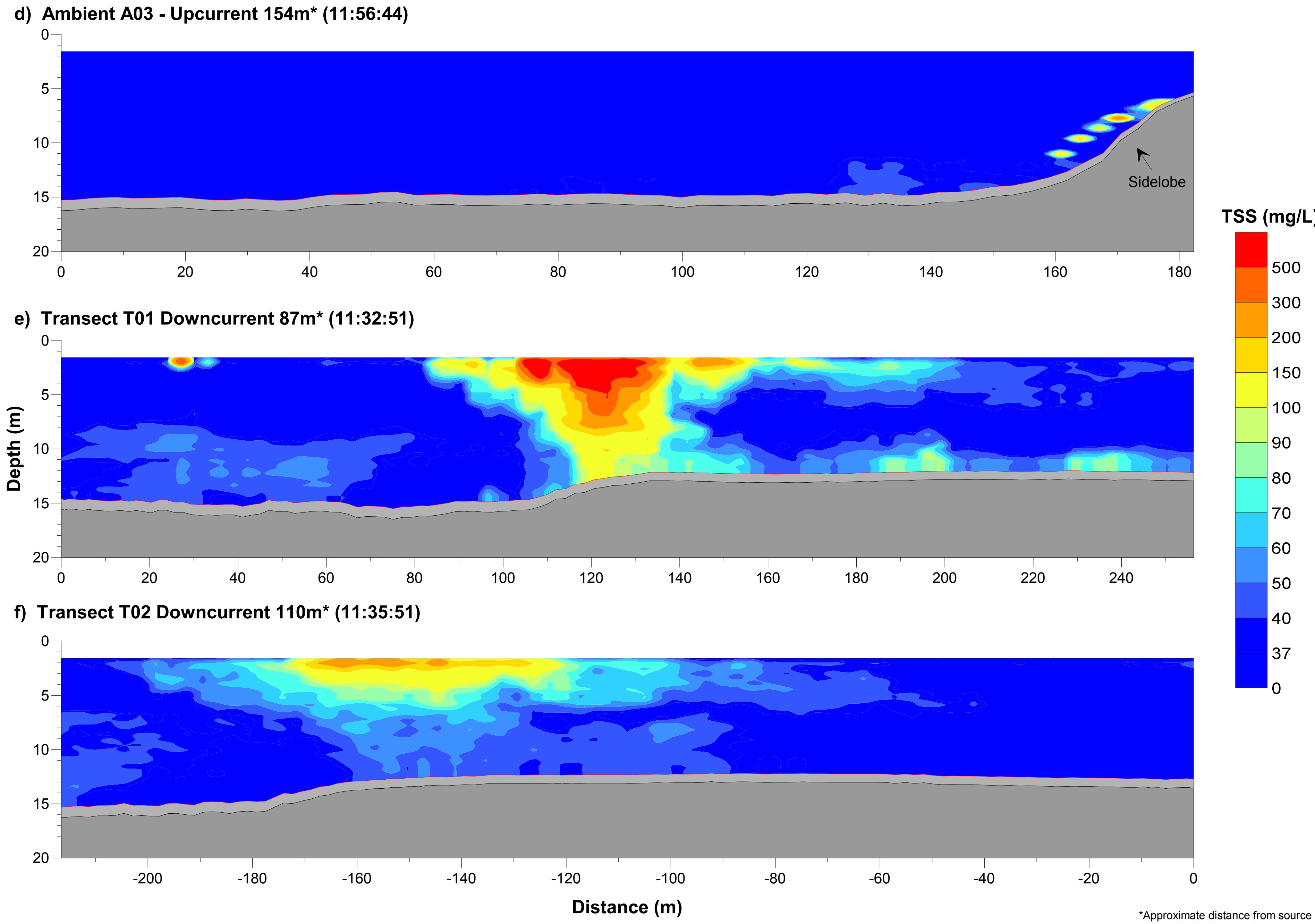


FIGURE	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	Vertical Profiles of ADCP Average TSS 01 May 2009	TIDE
45d-f			Flood

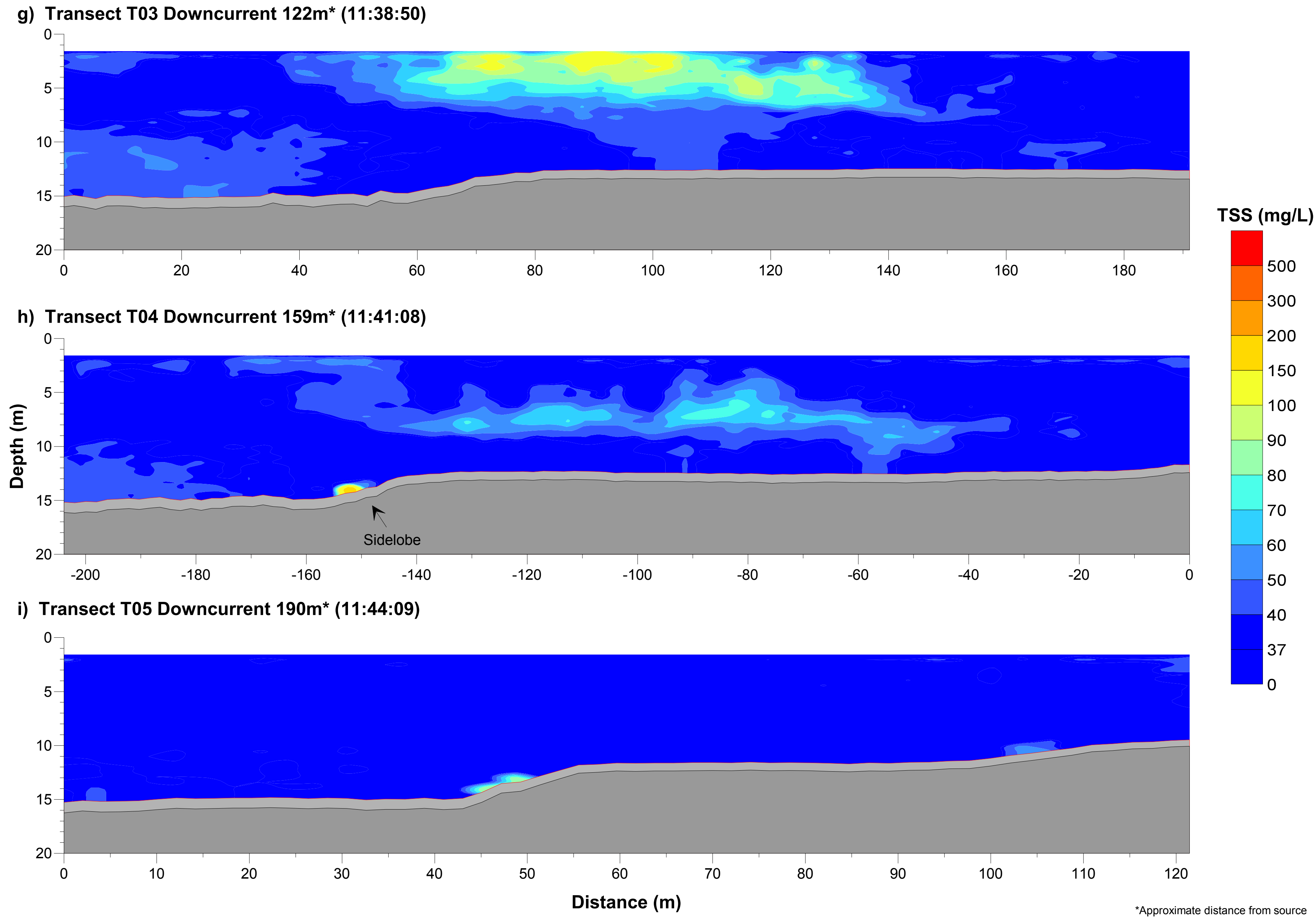


FIGURE	*USACE Harborwide TSS*	**Vertical Profiles of ADCP Average TSS**	TIDE
45g-i	*Far Field Survey* *HDP Contract Area: S-E-1: B*	**01 May 2009**	**Flood**

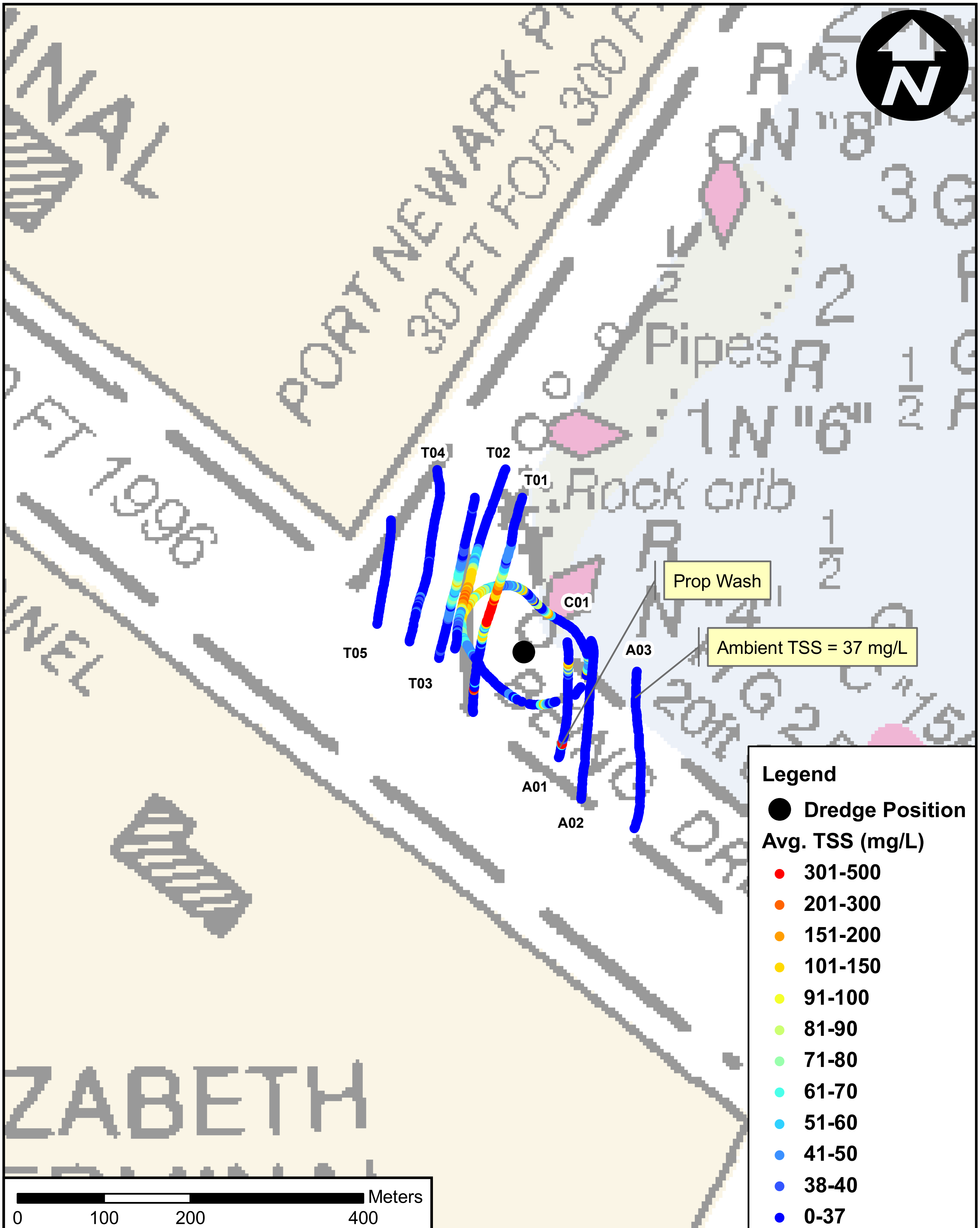


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 01 May 2009** **0-2 Meter Depth Interval**	**Tide**
46a			**Flood**

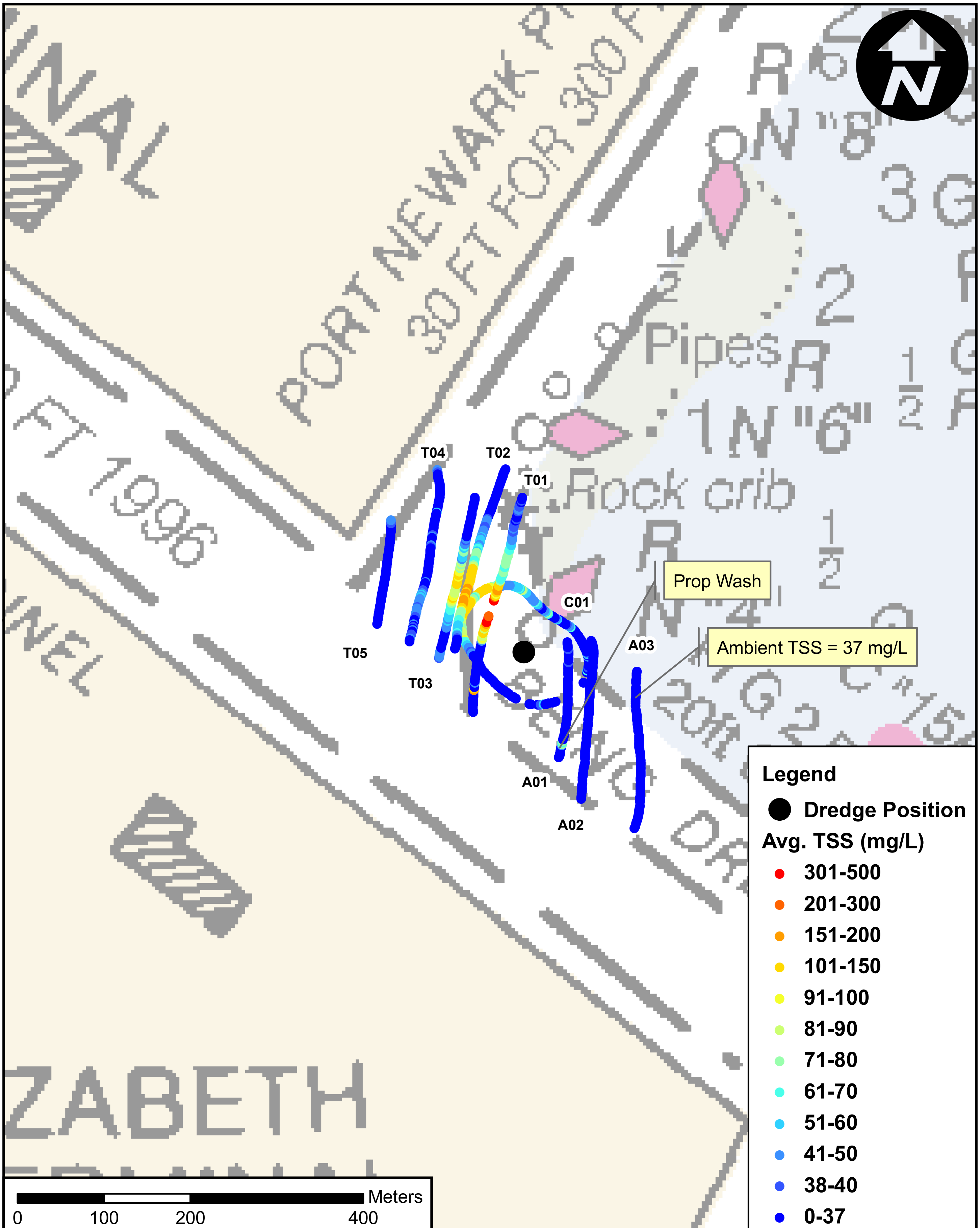


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	ADCP Average TSS - 01 May 2009 2-4 Meter Depth Interval	Tide
46b			Flood

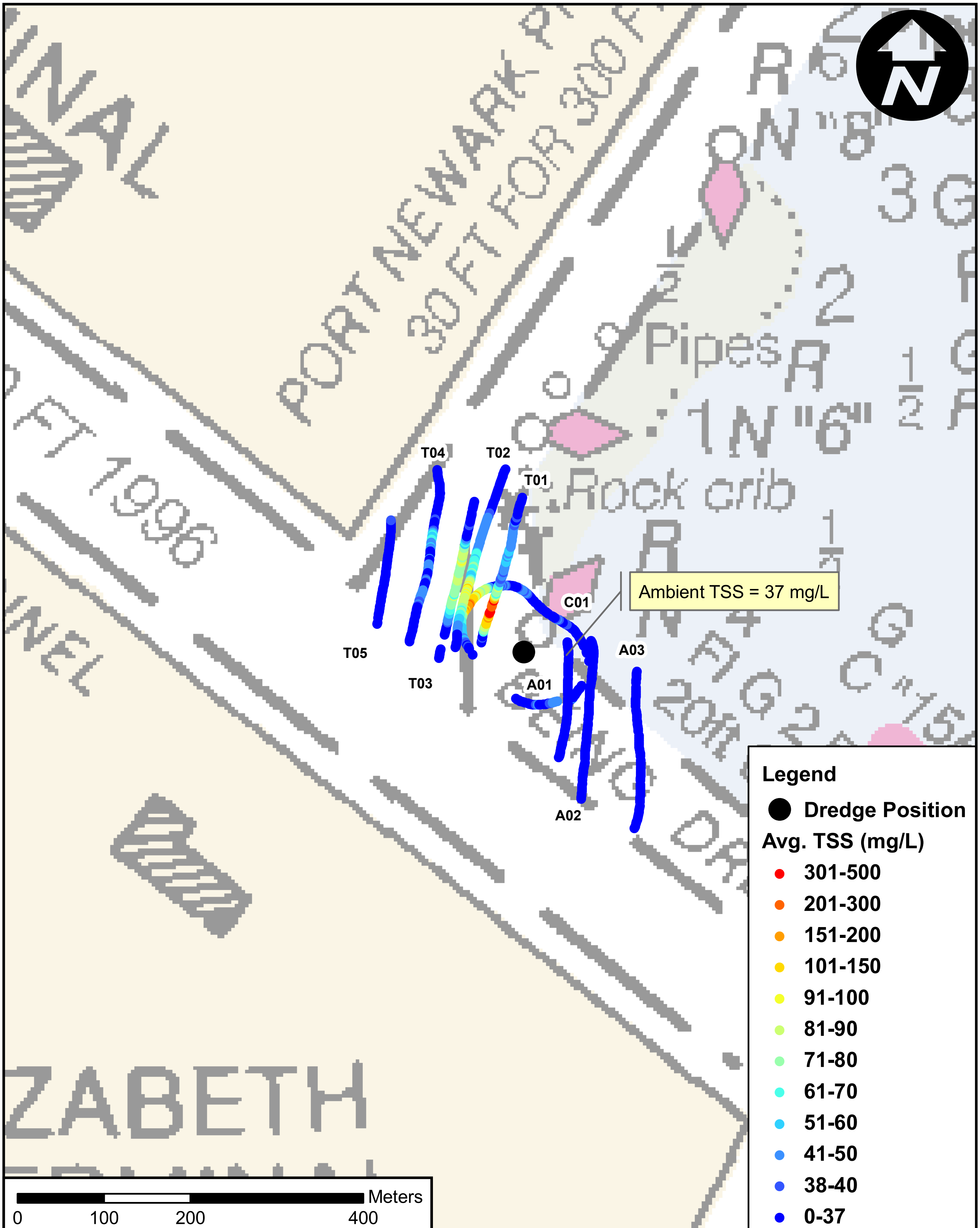


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 01 May 2009** **4-6 Meter Depth Interval**	**Tide**
46c			**Flood**

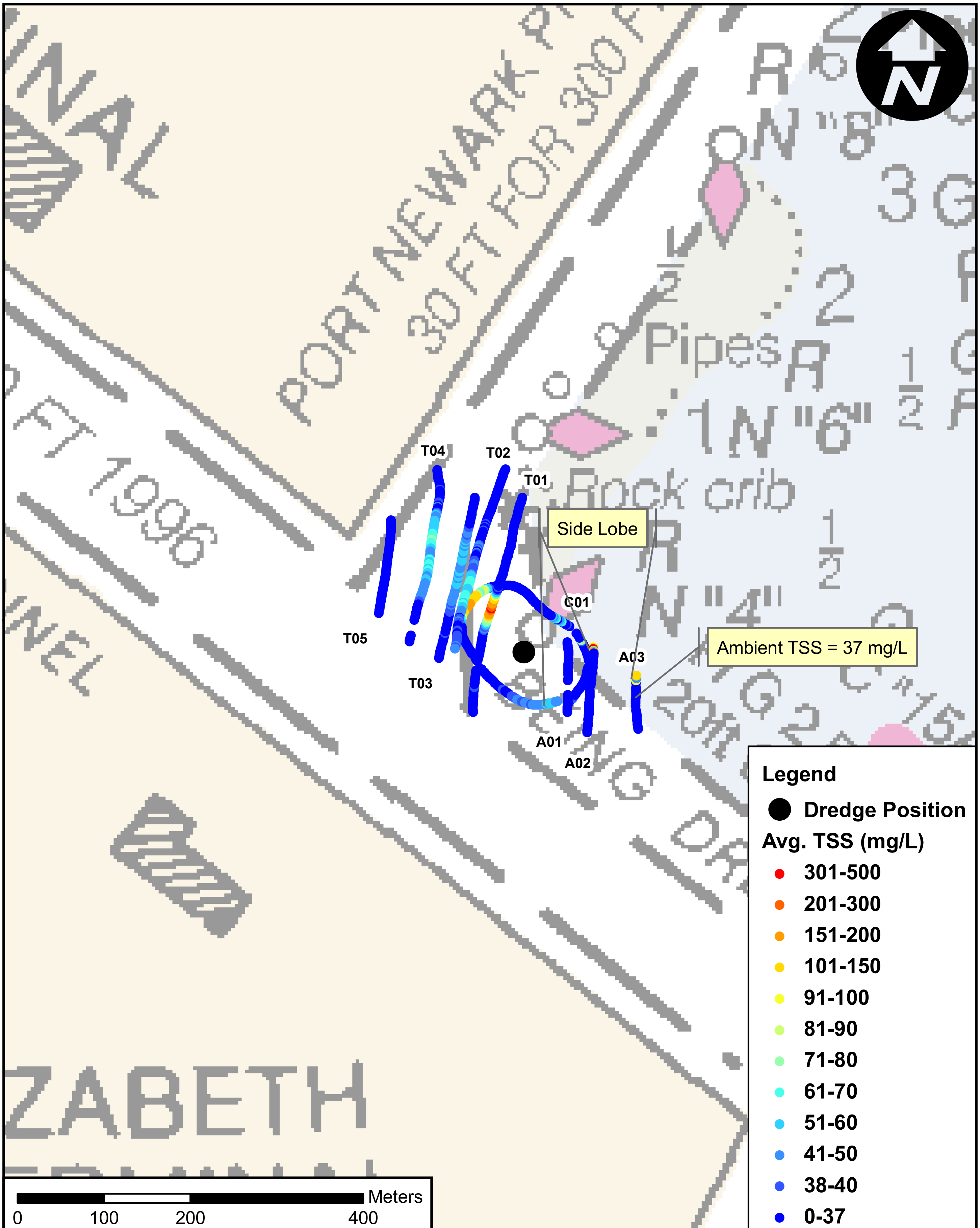


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 01 May 2009** **6-8 Meter Depth Interval**	**Tide**
46d			**Flood**

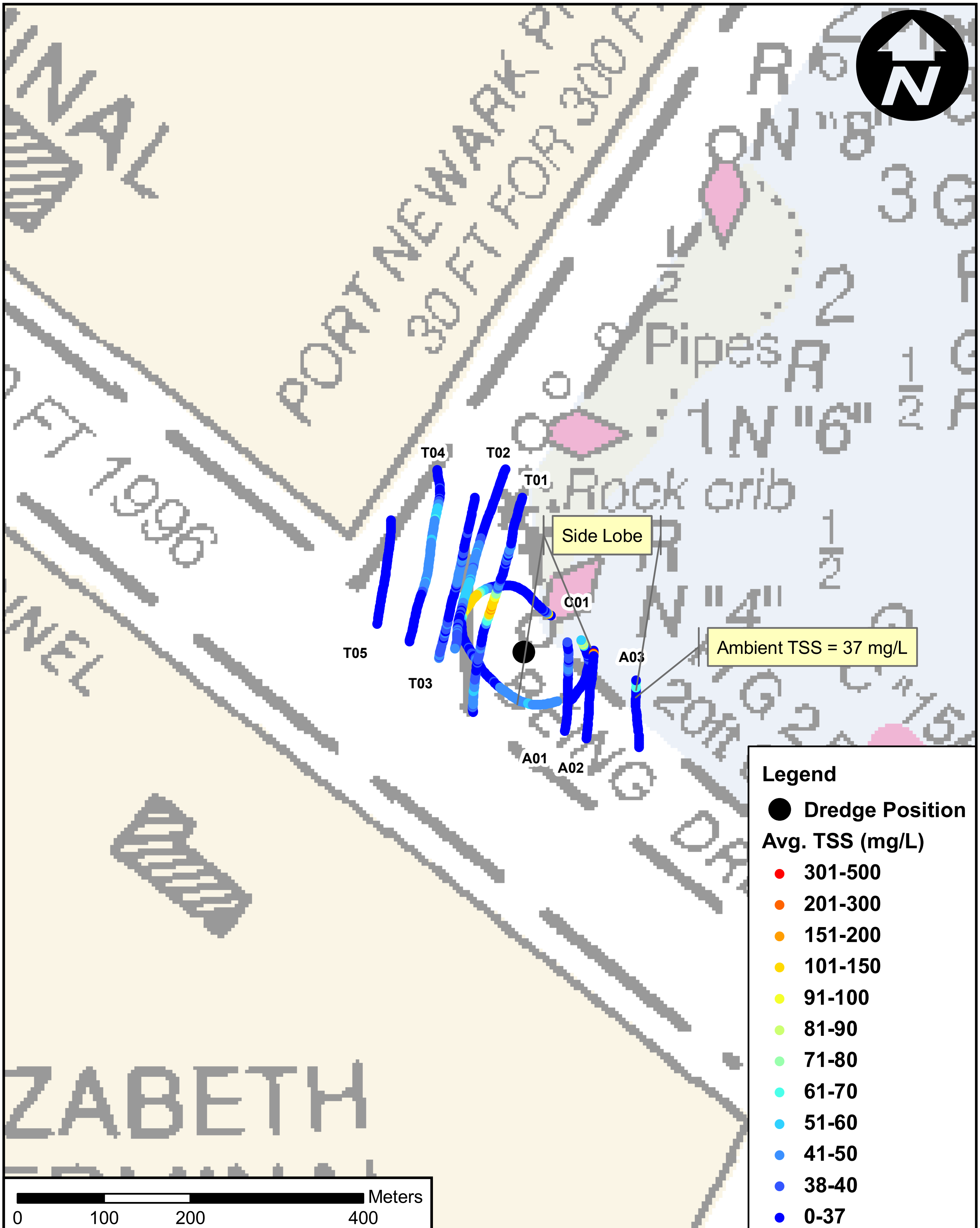


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 01 May 2009** **8-10 Meter Depth Interval**	Tide
46e			Flood

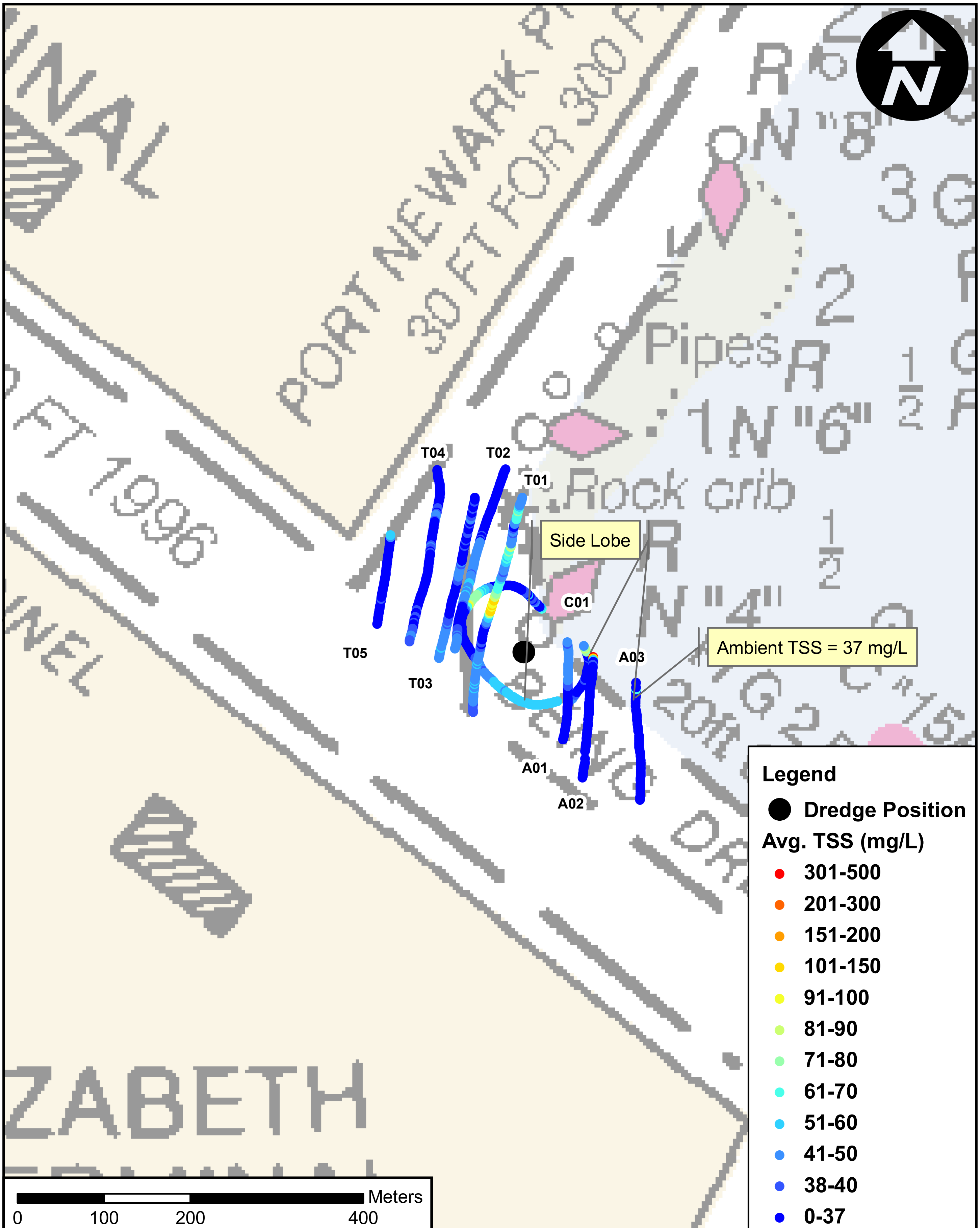


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 01 May 2009** **10-12 Meter Depth Interval**	**Tide**
46f			**Flood**

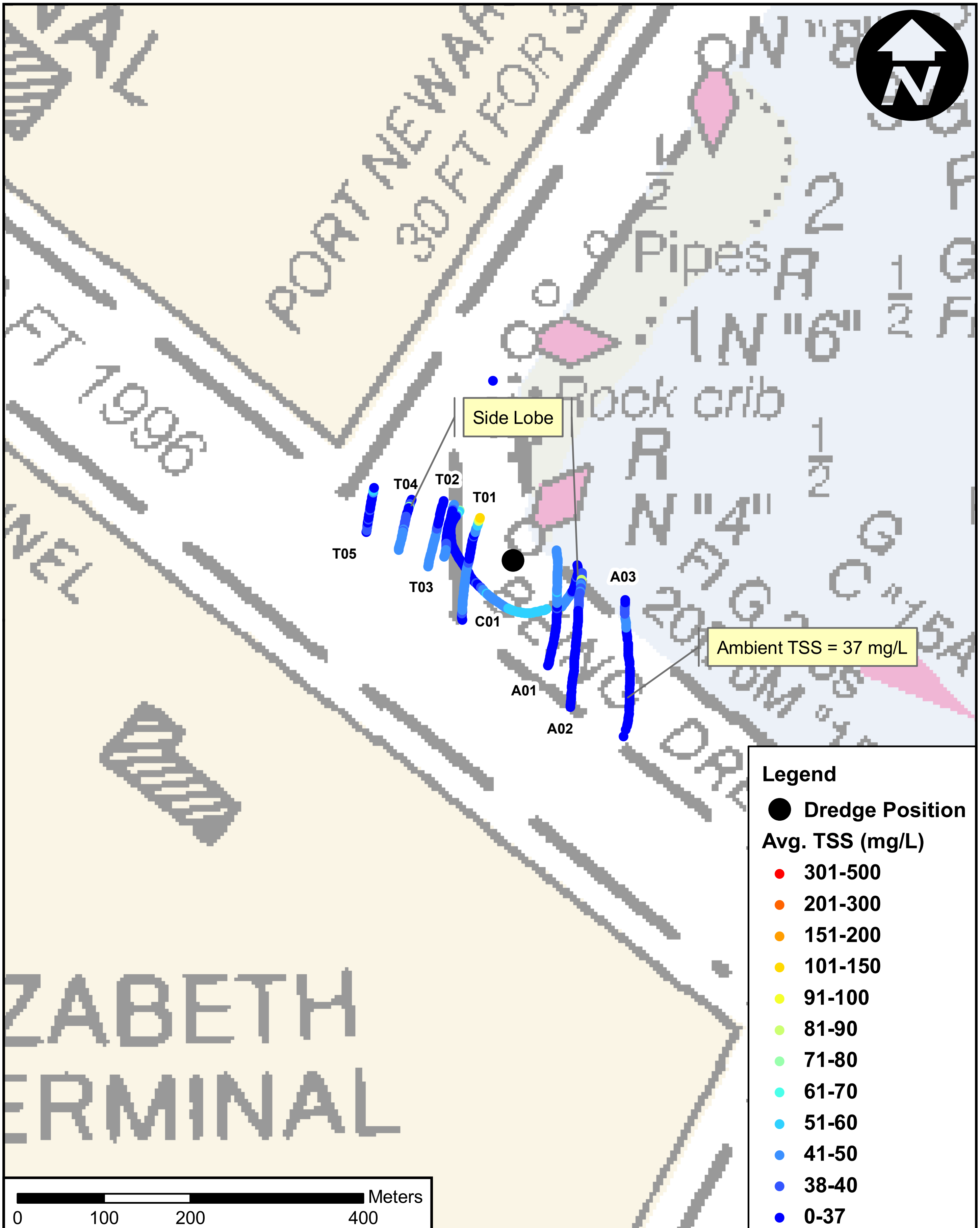


Figure	USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B	ADCP Average TSS - 01 May 2009 12-14 Meter Depth Interval	Tide
46g			Flood

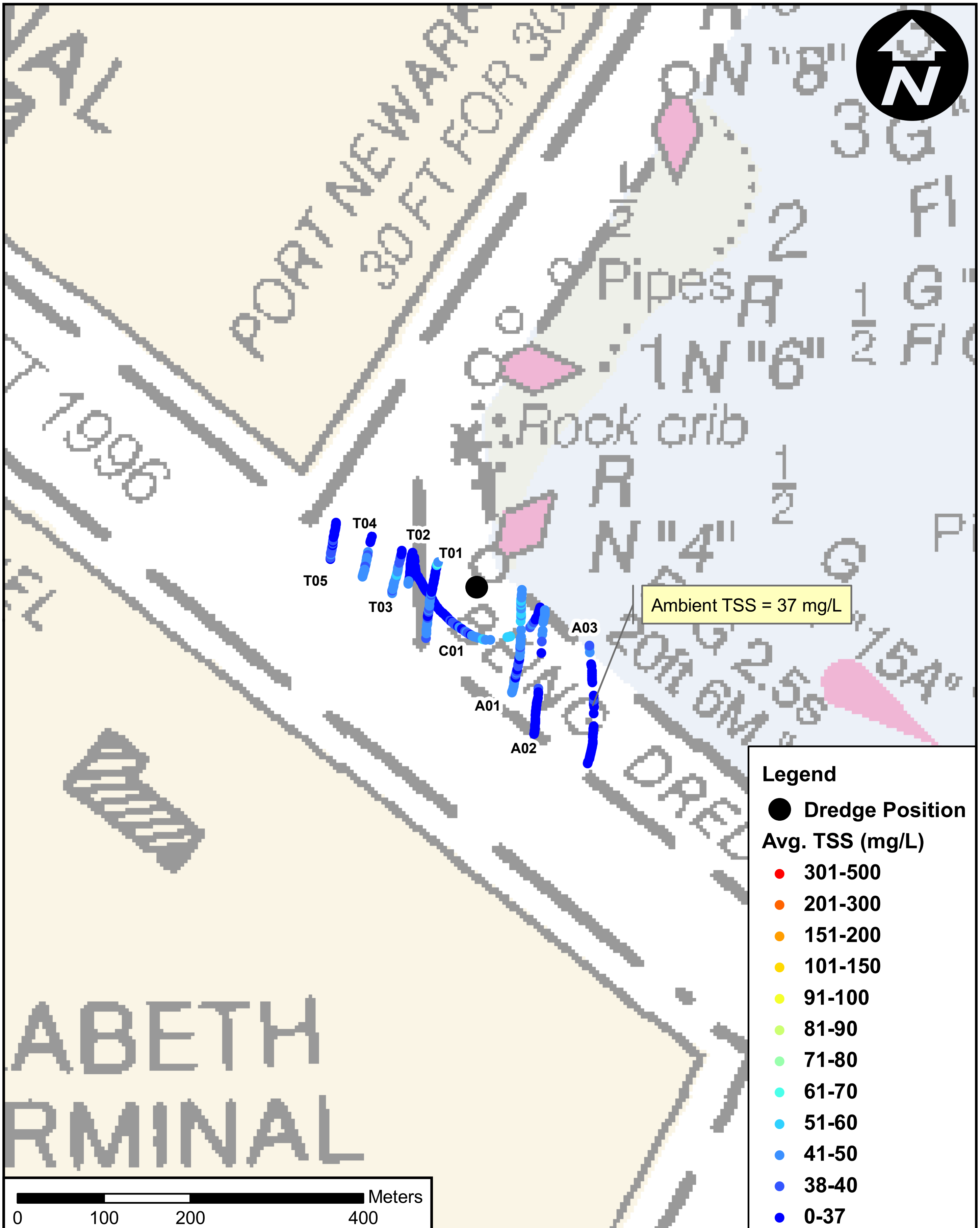
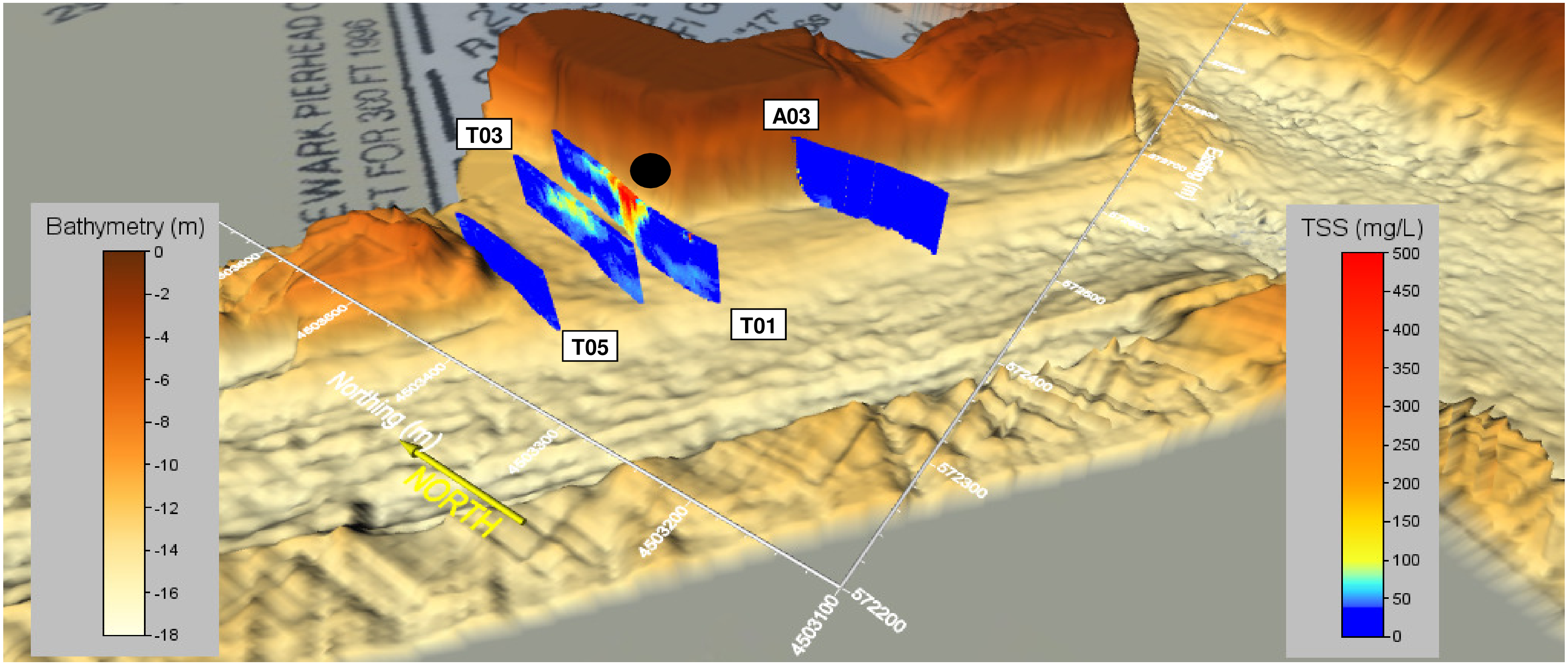


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**ADCP Average TSS - 01 May 2009** **14-16 Meter Depth Interval**	Tide
46h			Flood



Bathymetry provided by: US Army Corps of Engineers, NY District

Z Scale Exaggerated 6x

= Dredge Location

Figure	*USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B*	ADCP Average TSS Values with Respect to their x, y, and z Coordinates Superimposed on Channel Bathymetry 01 May 2009	Tide
47			Flood

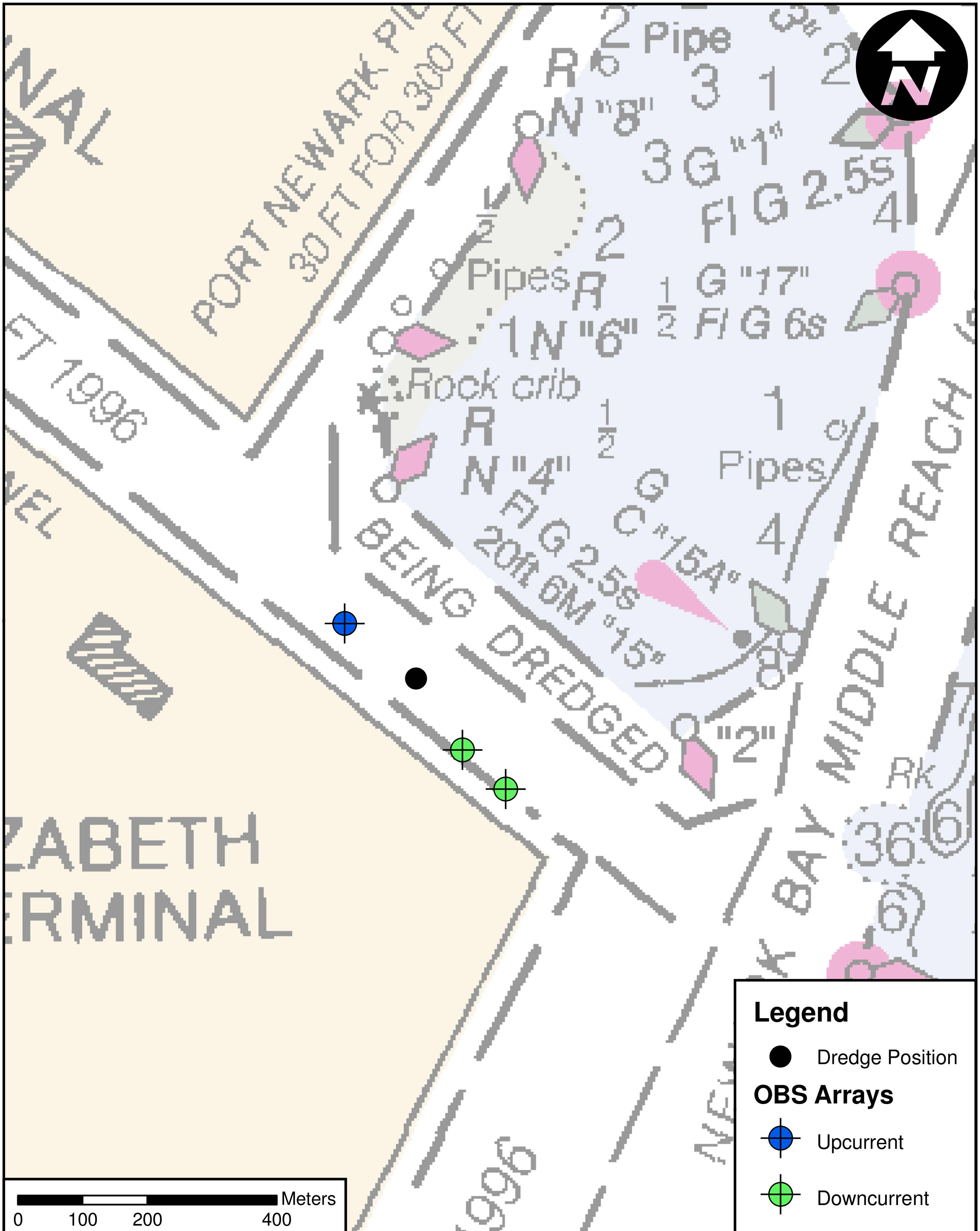
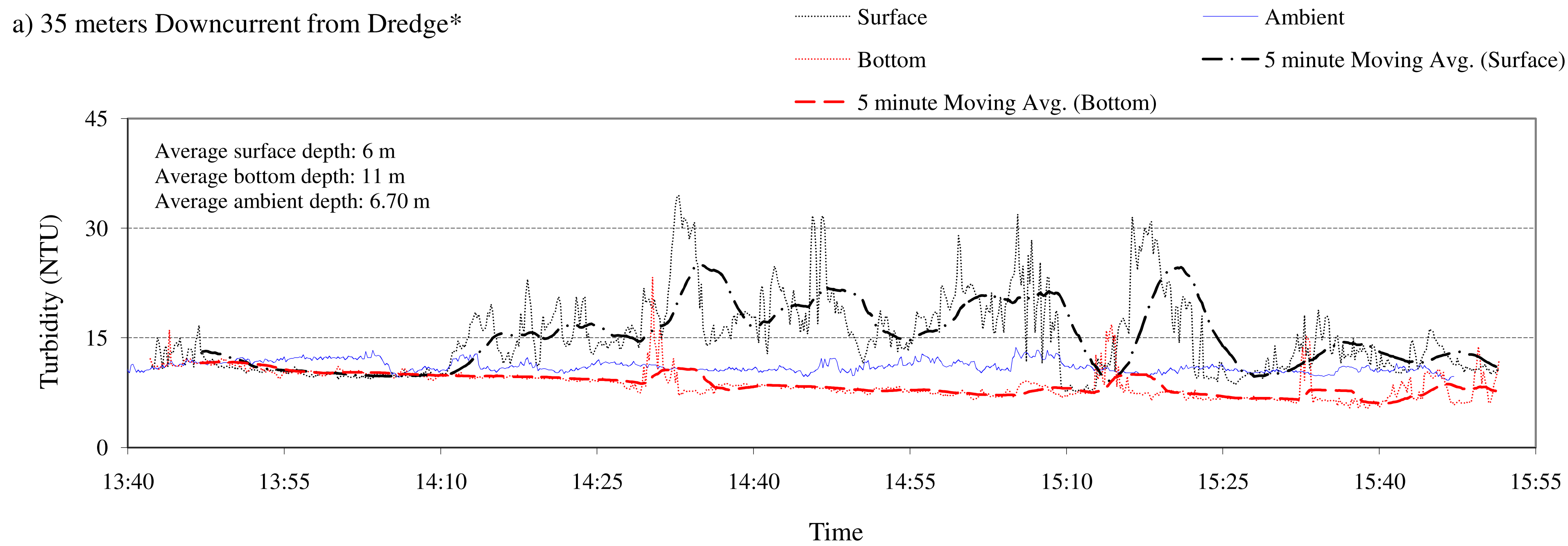
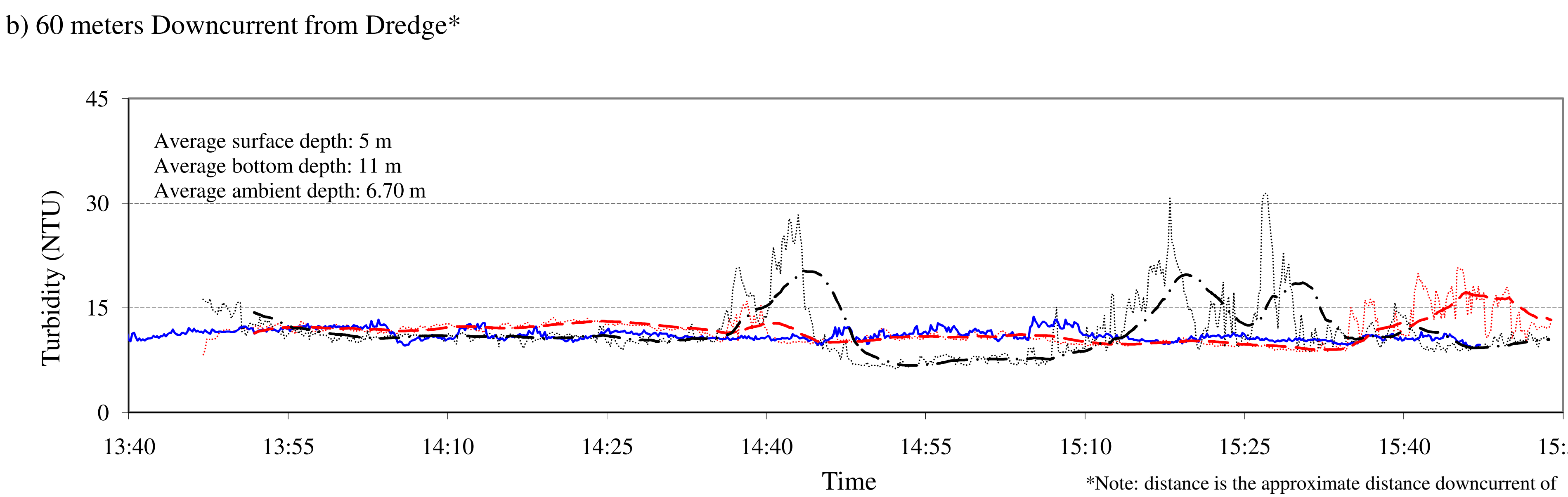


Figure	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1*	**Location of OBS Vertical Arrays and Dredge Position** **28 April 2009**	**Tide**
48			**Ebb**





*Note: distance is the approximate distance downcurrent of the dredge during the sampling period

Figure	*USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B*	**Surface and Bottom OBS Turbidities at a) 35 m and b) 60 m Downcurrent of Dredge. Ambient Station Located Upcurrent of Dredge 28 April 2009 TSS Survey**	Tide
49			Ebb

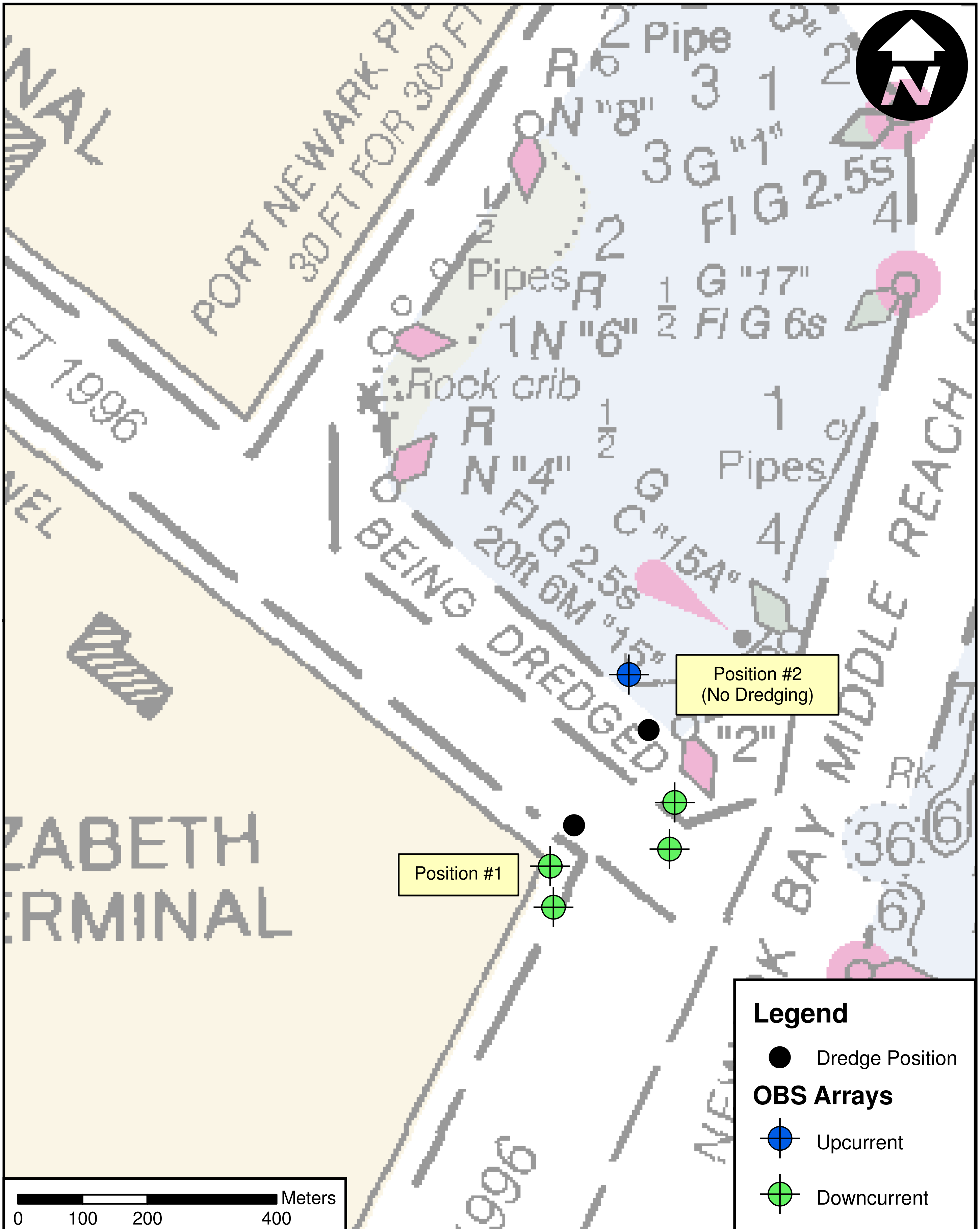
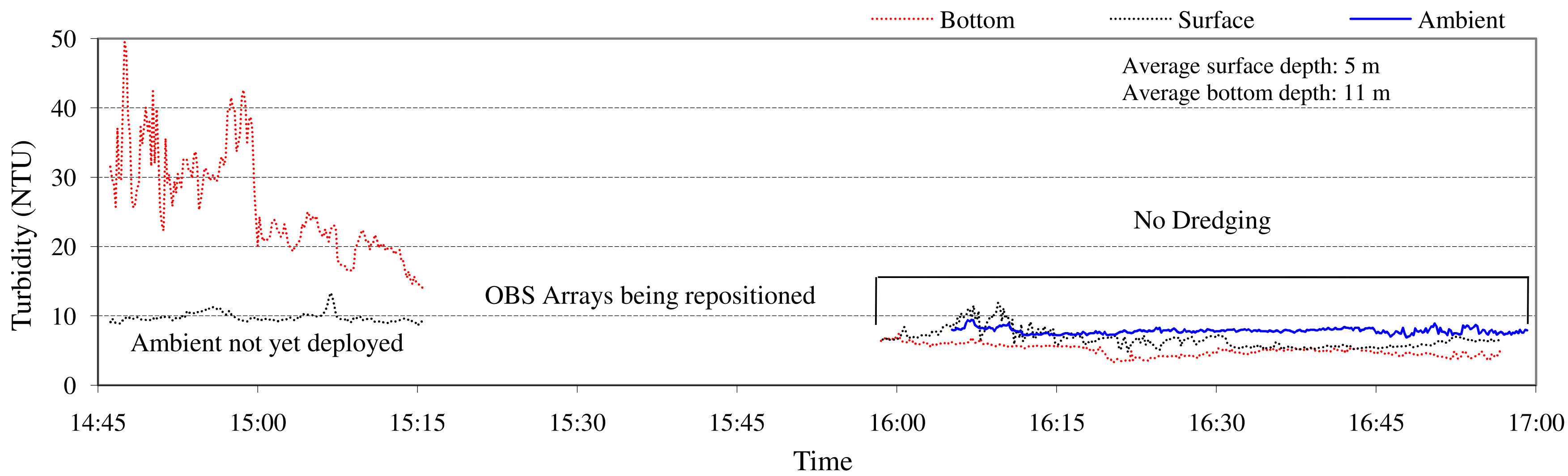
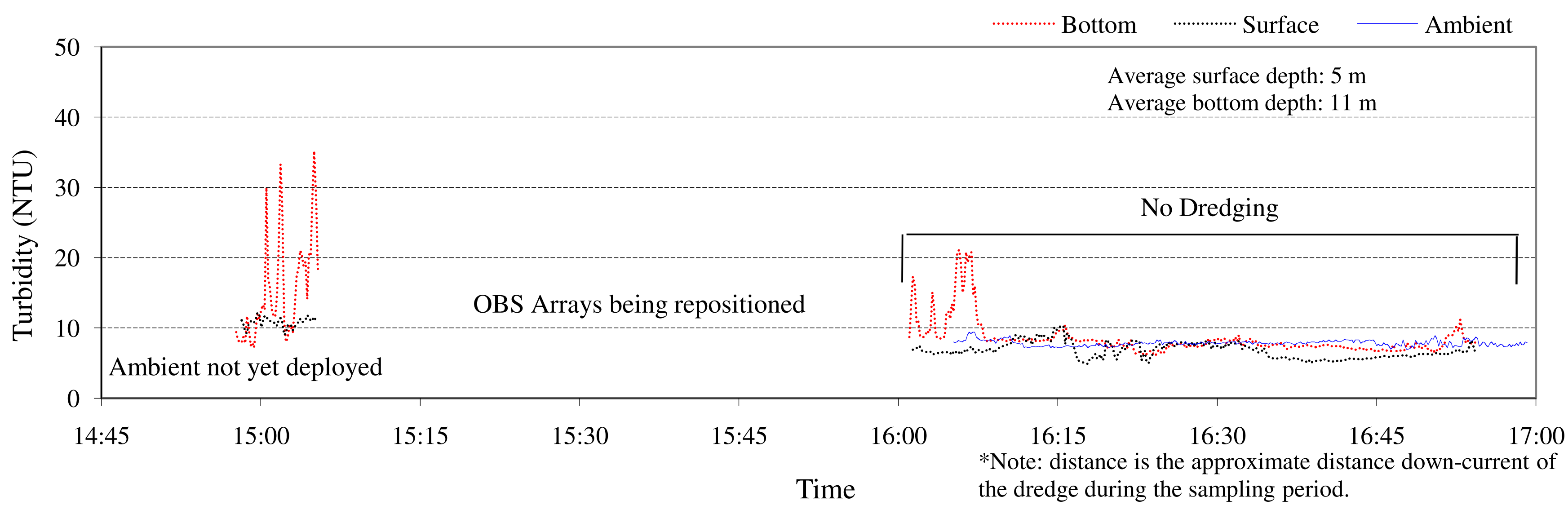


Figure	*USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1*	**Location of OBS Vertical Arrays and Dredge Position 30 April 2009**	Tide
50			Ebb

a) 75 meters Downcurrent from Dredge



b) 130 meters Downcurrent from Dredge



*Note: distance is the approximate distance down-current of the dredge during the sampling period.

Figure	*USACE Harborwide TSS Far Field Survey HDP Contract Area: S-E-1: B*	**Surface and Bottom OBS Turbidities at a) 75 m and b) 130 m Downcurrent of Dredge. Ambient Station Located Upcurrent of Dredge 30 April 2009 TSS Survey**	Tide
51			Ebb

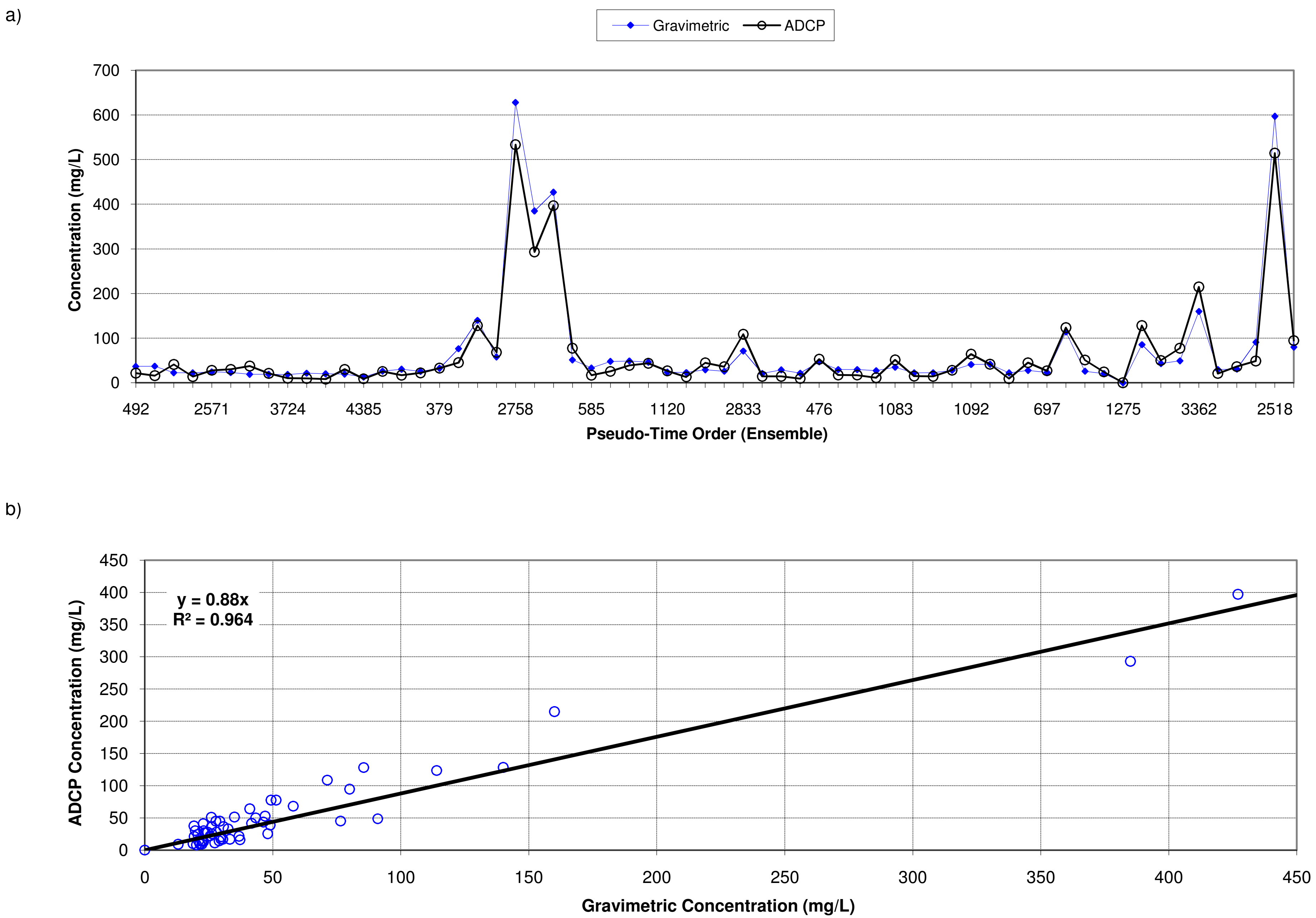


Figure	USACE Harborwide TSS	Comparison of gravimetric and ADCP estimates of TSS concentration	Tide
52a-b	*USACE Harborwide TSS* *Far Field Survey* *HDP Contract Area: S-E-1: B*	**Comparison of gravimetric and ADCP estimates of TSS concentration** **a) Concentration vs. Time b) ADCP Concentration vs. Gravimetric Concentration** **27 April - 1 May 2009 TSS Survey**	**N/A**

Table 1: S-E-1 Survey A: Laboratory Results of Water Samples

Sample Date	Sample Time	Location	TSS (mg/L)	Turbidity (NTU)
3/29/2009	15:37:12	Ambient	16	3.2
3/29/2009	15:37:18	Ambient	9	3.0
3/29/2009	15:37:30	Ambient	14	3.2
3/29/2009	15:37:37	Ambient	15	3.5
3/29/2009	15:37:43	Ambient	12	2.8
3/29/2009	15:55:22	Ambient	16	3.1
3/29/2009	15:55:28	Ambient	12	3.1
3/29/2009	15:55:33	Ambient	13	2.7
3/29/2009	15:55:37	Ambient	10	2.4
3/29/2009	15:55:43	Ambient	14	3.0
3/29/2009	15:55:48	Ambient	12	3.2
3/29/2009	16:13:32	Ambient	19	3.7
3/29/2009	16:13:38	Ambient	15	2.6
3/29/2009	16:13:44	Ambient	15	3.2
3/29/2009	16:13:49	Ambient	30	7.8
3/29/2009	16:13:55	Ambient	24	4.6
3/29/2009	16:14:5	Ambient	32	12.6
3/29/2009	16:26:0	Ambient	15	3.2
3/29/2009	16:26:11	Ambient	21	5.5
3/29/2009	16:26:14	Ambient	22	5.0
3/29/2009	16:26:19	Ambient	19	4.9
3/29/2009	16:26:21	Ambient	14	5.5
3/31/2009	12:8:15	Plume	90	31.3
3/31/2009	12:8:26	Plume	25	6.9
3/31/2009	12:8:29	Plume	39	12.0
3/31/2009	12:8:39	Plume	19	7.3
3/31/2009	12:8:46	Plume	13	4.6
3/31/2009	12:9:3	Plume	32	13.5
3/31/2009	12:27:35	Plume	165	92.0
3/31/2009	12:27:43	Plume	48	15.0
3/31/2009	12:27:51	Plume	27	7.6
3/31/2009	12:28:0	Plume	30	11.1
3/31/2009	12:28:8	Plume	57	12.3
3/31/2009	12:28:17	Plume	22	7.4
4/1/2009	11:46:1	Plume	20	3.5
4/1/2009	11:46:8	Plume	25	4.7
4/1/2009	11:46:15	Plume	37	4.9
4/1/2009	11:46:20	Plume	32	11.5
4/1/2009	11:46:23	Plume	38	11.8
4/1/2009	11:46:25	Plume	34	10.8
4/1/2009	11:59:45	Plume	70	26.0
4/1/2009	11:59:52	Plume	35	10.1
4/1/2009	11:59:59	Plume	34	10.1
4/1/2009	12:0:6	Plume	33	7.6

Sample Date	Sample Time	Location	TSS (mg/L)	Turbidity (NTU)
4/1/2009	12:0:10	Plume	54	21.8
4/1/2009	12:0:11	Plume	36	14.1
4/2/2009	12:46:49	Plume	262	130.0
4/2/2009	12:46:54	Plume	216	104.0
4/2/2009	12:46:57	Plume	180	59.0
4/2/2009	12:47:0	Plume	62	23.8
4/2/2009	12:47:4	Plume	19	5.8
4/2/2009	12:47:25	Plume	14	5.3
4/2/2009	13:0:2	Plume	47	23.7
4/2/2009	13:0:7	Plume	255	126.0
4/2/2009	13:0:9	Plume	163	63.8
4/2/2009	13:0:15	Plume	75	36.0
4/2/2009	13:0:26	Plume	22	6.2
4/2/2009	13:0:36	Plume	22	9.7
4/2/2009	13:1:12	Plume	58	25.0
4/2/2009	13:18:34	Plume	245	108.0
4/2/2009	13:18:38	Plume	383	192.0
4/2/2009	13:18:41	Plume	241	109.0
4/2/2009	13:18:47	Plume	12	3.9
4/2/2009	13:19:2	Plume	27	12.0
4/2/2009	13:19:7	Plume	11	5.1
4/2/2009	13:27:58	Plume	421	248.0
4/2/2009	13:28:2	Plume	58	29.8
4/2/2009	13:28:7	Plume	20	8.6
4/2/2009	13:28:13	Plume	14	7.0
4/2/2009	13:28:17	Plume	52	23.5
4/2/2009	13:28:19	Plume	33	15.6
4/2/2009	13:32:53	Plume	41	9.8

Table 2: 31 March 2009 Far Field Ebb Tide Survey Transect Summary Table

Transect Number	Figure Number	Time	Transect Length	Plume Description	Additional Field Remarks
Set 1					
C01	3a	(14:54:40)	455	Circle	Circle Transects
A01	3b	(15:03:38)	81.5	Ambient	Dredgers washing scow
A02	3c	(15:05:47)	105	Ambient	Pause between ambient and plume due to dredge crew
A03	3d	(15:08:01)	156	Ambient	Prop wash at beginning
T01	3e	(15:52:44)	306	Plume concentrated along the surface and bottom. Core concentrations 150-200 mg/L. (Note plan view plots for width)	
T02	3f	(15:56:35)	371	Plume concentrated along the surface and bottom. Core concentrations 100-150 mg/L. (Note plan view plots for width)	
T03	3g	(16:01:03)	380	Plume concentrated along the bottom with trace signature extending up to and along the surface. Core concentrations 100-150 mg/L. (Note plan view plots for width)	
T04	3h	(16:06:21)	414	Plume barely visable, concentrations not exceeding 50 mg/L.	
T05	3i	(16:11:54)	472	No distinct plume, concentrations not exceeding 50 mg/L.	Prop wash
T06	3j	(16:17:49)	485	No distinct plume, small area of concentrations slighty higher than ambient.	
Set 2					
T07	4a	(16:31:13)	332	No distinct plume, concentrations not exceeding 40 mg/L.	2nd set of plume transects
T08	4b	(16:35:33)	349	No distinct plume, concentrations not exceeding 40 mg/L.	
T09	4c	(16:47:11)	430	No distinct plume, concentrations not exceeding 40 mg/L.	
T10	4d	(16:52:31)	470	No distinct plume, concentrations not exceeding 40 mg/L.	
T11	4e	(17:03:49)	160	No distinct plume, concentrations not exceeding 40 mg/L.	

Table 3: 01 April 2009 Far Field Flood Tide Survey Transect Summary Table

Transect Number	Figure Number	Time	Transect Length	Plume Description	Additional Field Remarks
Set 1					
C01	9a	(09:33:01)	515	Circle	Circle Transect - Prop wash
C02	9b	(09:38:03)	400	Circle	
A01	9c	(09:46:54)	140	Ambient	Prop wash
A02	9d	(09:55:58)	149	Ambient	
A03	9e	(09:58:40)	134	Ambient	
T01	9f	(10:02:59)	178	Plume approx. 30 meters wide with core concentrations between100-150 mg/L	
T02	9g	(10:06:20)	154	Plume approx. 100 meters wide, but only extends through the bottom 5 meters of the water column. Peak concentration 70-80 mg/L	
T03	9h	(10:08:52)	187	Plume approx. 100 meters wide, but only extends through the bottom half of the water column. Peak concentration 60-70 mg/L	Surface bubbles
T04	9i	(10:13:15)	181	Feint plume extending approx 100 meters wide. Peak concentrations between 40-50 mg/L	Heavy prop wash
T05	9j	(10:16:11)	157	No plume	Prop wash at end
T06	9k	(10:18:59)	148	No plume	Prop wash at beginning
Set 2					
T07	10a	(10:23:21)	176	Plume approximately 30 meters wide. Core concentrations between 200-300 mg/L	2nd set plume transects
T08	10b	(10:26:43)	167	Plume approx. 120 meters wide and concentrated in the bottom half of the water column. Peak concentrations do not exceed 90 mg/L.	
T09	10c	(10:29:29)	210	Plume approx 130 meters wide, majority concentrated in bottom half of water column.	
T10	10d	(10:32:54)	204	Plume approx 120 meters wide, peak concentrations between 80-90 mg/L	
T11	10e	(10:36:03)	272	Majority of plume approx 130 meters wide but extends up to 220 meters wide along substrate. Does not exceed 70 mg/L	
T12	10f	(10:40:01)	271	Majority of plume approx 130 meters wide but extends up to 220 meters wide along substrate. Does not exceed 70 mg/L	
T13	10g	(10:43:08)	232	Majority of plume approx 80 meters wide but extends up to 160 meters wide along substrate. Does not exceed 60 mg/L	
T14	10h	(10:46:22)	206	No plume	
Set 3					
T15	11a	(10:56:01)	192	Majority of plume approx 50 meters wide but extends up to 120 meters wide along substrate. Does not exceed 150 mg/L	
T16	11b	(10:58:37)	233	Majority of plume approx 40 meters wide but extends up to 220 meters wide along substrate. Does not exceed 100 mg/L	Stopped dredging
T17	11c	(11:02:27)	209	Plume extends approx 200 meters wide, does not exceed 70-80 mg/L	Dredging started at end of transect
T18	11d	(11:05:38)	189	Plume extends approx 180 meters wide, does not exceed 70-80 mg/L	Prop wash
T19	11e	(11:08:41)	194	Plume extends approx 180 meters wide, does not exceed 70-80 mg/L	Prop wash
T20	11f	(11:11:50)	290	Plume extends approx 120 meters wide, does not exceed 50-60mg/L	Tug passed
T21	11g	(11:16:22)	248	Feint plume extending 220 meters wide, majority of plume between 40-50 mg/L.	

Table 4: 01 April 2009 Far Field Ebb Tide Survey Transect Summary Table

Transect Number	Figure Number	Time	Transect Length	Plume Description	Additional Field Remarks
C01	18a	(14:00:14)	420	Circle	Circle Transect
C02	18b	(14:24:41)	485	Circle	Circle Transect
C03	18c	(14:33:33)	578	Circle	Circle Transect
C04	18d	(14:57:32)	332	Circle	Circle Transect
A01	18e	(15:07:19)	174	Ambient	
A02	18f	(15:10:08)	145	Ambient	
T01	18g	(15:13:20)	347	Core concentrations between 80-90 mg/L (see plan view layout for width)	
T02	18h	(15:17:42)	164	Core concentrations between 100-150 mg/L (see plan view layout for width)	
T03	18i	(15:22:21)	793	Core concentrations between 80-90 mg/L (see plan view layout for width)	
T04	18j	(15:31:37)	716	No distinct plume, concentrations do not exceed 50 mg/L	
T05	18k	(15:40:58)	657	No distinct plume, concentrations do not exceed 50 mg/L	

Table 5: 02 April 2009 Far Field Flood Tide Survey Transect Summary Table

Transect Number	Figure Number	Time	Transect Length	Plume Description	Additional Field Remarks
C01	21a	(09:55:42)	420	Circle	Circle Transect
C02	21b	(10:37:23)	483	Circle	Circle Transect
T01	21c	(12:16:13)	151	Plume approx. 30 meters wide with core concentrations between 100-150 mg/L	
T02	21d	(12:19:35)	167	Plume approx. 70 meters wide with core concentrations between 100-150 mg/L	
T03	21e	(12:23:16)	154	Plume approx. 80 meters wide with core concentrations between 100-150 mg/L	
T04	21f	(12:26:24)	179	Plume approx. 80 meters wide with core concentrations between 100-150 mg/L	
T05	21g	(12:29:12)	228	Plume approx. 80 meters wide with core concentrations between 70-80 mg/L	
T06	21h	(12:32:24)	370	Plume approx. 250 meters wide, mostly along the bottom 5 meters. Core concentrations between 70-80 mg/L	Prop wash at end
T07	21i	(12:37:41)	335	No distict plume. Higher than ambient signature readings along a slope extending approximately 75 meters. Core concentrations between 40-50 mg/L.	Prop wash at beginning

Table 6: S-E-1: Survey A: Sediment Collection and Analysis Summary Table

Area	Date Sampled	Time Sampled	Grain Size Distribution[1]						Bulk Density[2]			Atterberg Limits[3]			
			Gravel	Course Sand	Medium Sand	Fine Sand	Silt	Clay	Wet Bulk Density	Moisture Content	Dry Bulk Density	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
			(%)	(%)	(%)	(%)	(%)	(%)	lb/ft3	(%)	lb/ft3				
Dredge Scow	3/31/2009	10:47	0	0	0	4	63	33	89.8	115	41.8	83	37	46	3
Dredge Field	3/31/2009	11:30	0	0	1	4	63	32	85.1	144	34.8	79	34	45	3
Dredge Field	4/1/2009	9:20	0	0	0	3	59	38	87	163	33.1	92	32	60	2
Dredge Scow	4/1/2009	11:30	0	1	0	3	58	38	91.5	105	44.6	79	50	29	2
Dredge Field	4/2/2009	11:50	0	0	1	3	55	41	84.6	165	31.9	90	59	31	3

[1] ASTM D-422 Method

[2] ASTM D-2937 Method

[3] ASTM D-4318 Method

Table 7: S-E-1 Survey B Laboratory Results of Water Samples

SampleDate	SampleTime	Location	TSS (mg/L)	Turbidity (NTU)
4/27/2009	10:33:46 AM	Ambient	37	15.0
4/27/2009	10:33:52 AM	Ambient	37	17.4
4/27/2009	10:33:56 AM	Ambient	32	10.0
4/27/2009	10:33:59 AM	Ambient	25	11.4
4/27/2009	10:34:01 AM	Ambient	29	12.4
4/27/2009	10:34:04 AM	Ambient	29	8.0
4/27/2009	11:11:48 AM	Ambient	23	7.0
4/27/2009	11:11:55 AM	Ambient	22	8.6
4/27/2009	11:11:58 AM	Ambient	25	11.4
4/27/2009	11:12:03 AM	Ambient	23	6.9
4/27/2009	11:12:14 AM	Ambient	19	8.5
4/27/2009	11:32:55 AM	Ambient	19	7.3
4/27/2009	11:33:01 AM	Ambient	19	6.4
4/27/2009	11:33:05 AM	Ambient	15	5.6
4/27/2009	11:33:09 AM	Ambient	19	6.6
4/27/2009	11:33:14 AM	Ambient	22	6.0
4/27/2009	11:33:20 AM	Ambient	20	7.0
4/27/2009	11:45:12 AM	Ambient	20	8.1
4/27/2009	11:45:18 AM	Ambient	13	5.1
4/27/2009	11:45:22 AM	Ambient	26	9.9
4/27/2009	11:45:27 AM	Ambient	31	8.9
4/27/2009	11:45:29 AM	Ambient	26	8.4
4/27/2009	11:45:33 AM	Ambient	25	6.4
4/27/2009	1:52:33 PM	Plume	33	14.2
4/27/2009	1:52:37 PM	Plume	29	11.7
4/27/2009	1:52:41 PM	Plume	77	27.8
4/27/2009	1:52:43 PM	Plume	20	7.4
4/27/2009	1:52:47 PM	Plume	21	7.3
4/27/2009	1:52:49 PM	Plume	25	8.2
4/27/2009	2:13:25 PM	Plume	140	63.4
4/27/2009	2:13:31 PM	Plume	58	24.3
4/27/2009	2:13:34 PM	Plume	34	13.6
4/27/2009	2:13:38 PM	Plume	25	10.4
4/27/2009	2:13:41 PM	Plume	23	6.3
4/27/2009	2:13:45 PM	Plume	22	6.0
4/27/2009	2:36:16 PM	Plume	628	300.0
4/27/2009	2:36:41 PM	Plume	385	191.0
4/27/2009	2:36:44 PM	Plume	427	168.0
4/27/2009	2:36:47 PM	Plume	297	137.0
4/27/2009	2:36:52 PM	Plume	213	89.0
4/27/2009	2:37:02 PM	Plume	25	10.8
4/27/2009	2:51:39 PM	Plume	195	87.5
4/27/2009	2:52:11 PM	Plume	23	7.6
4/29/2009	10:19:05 AM	Plume	37	16.0

SampleDate	SampleTime	Location	TSS (mg/L)	Turbidity (NTU)
4/29/2009	10:19:09 AM	Plume	51	21.6
4/29/2009	10:19:12 AM	Plume	33	10.4
4/29/2009	10:19:18 AM	Plume	63	19.4
4/29/2009	10:28:51 AM	Plume	128	33.2
4/29/2009	10:28:54 AM	Plume	48	12.0
4/29/2009	10:28:56 AM	Plume	49	19.5
4/29/2009	10:28:58 AM	Plume	46	10.3
4/29/2009	10:29:02 AM	Plume	24	7.2
4/29/2009	10:29:08 AM	Plume	20	8.7
4/29/2009	10:38:14 AM	Plume	66	19.8
4/29/2009	10:38:18 AM	Plume	51	17.8
4/29/2009	10:38:20 AM	Plume	23	6.8
4/29/2009	10:38:23 AM	Plume	29	7.4
4/29/2009	10:38:28 AM	Plume	26	8.1
4/29/2009	10:38:36 AM	Plume	20	7.4
4/29/2009	11:00:05 AM	Plume	46	18.7
4/29/2009	11:00:30 AM	Plume	71	30.7
4/29/2009	11:00:33 AM	Plume	68	21.8
4/29/2009	11:00:37 AM	Plume	21	6.2
4/29/2009	11:00:47 AM	Plume	29	10.2
4/29/2009	11:00:54 AM	Plume	22	7.5
4/29/2009	11:56:15 AM	Plume	47	14.9
4/29/2009	11:56:20 AM	Plume	30	7.1
4/29/2009	11:56:22 AM	Plume	30	7.0
4/29/2009	11:56:28 AM	Plume	32	6.3
4/29/2009	11:56:32 AM	Plume	27	6.2
4/29/2009	11:56:37 AM	Plume	24	6.0
4/29/2009	12:07:20 PM	Plume	127	57.8
4/29/2009	12:07:24 PM	Plume	35	9.0
4/29/2009	12:07:26 PM	Plume	22	7.6
4/29/2009	12:07:27 PM	Plume	23	7.3
4/29/2009	12:07:29 PM	Plume	28	6.7
4/29/2009	12:07:34 PM	Plume	41	9.0
4/29/2009	12:20:59 PM	Plume	26	8.5
4/29/2009	12:21:02 PM	Plume	21	6.3
4/29/2009	12:21:06 PM	Plume	36	10.5
4/29/2009	12:21:08 PM	Plume	42	15.3
4/29/2009	12:21:12 PM	Plume	22	7.4
4/29/2009	12:21:15 PM	Plume	22	5.9
4/29/2009	1:26:59 PM	Plume	28	9.5
4/29/2009	1:27:07 PM	Plume	23	7.6
4/29/2009	1:27:20 PM	Plume	44	10.6
4/29/2009	1:27:24 PM	Plume	114	37.7
4/29/2009	1:27:27 PM	Plume	123	30.1
4/29/2009	1:27:30 PM	Plume	116	35.9

SampleDate	SampleTime	Location	TSS (mg/L)	Turbidity (NTU)
4/29/2009	1:37:29 PM	Plume	26	8.8
4/29/2009	1:37:37 PM	Plume	21	7.4
4/29/2009	1:37:44 PM	Plume	24	5.9
4/29/2009	1:37:59 PM	Plume	86	27.2
4/29/2009	1:38:00 PM	Plume	81	16.6
4/29/2009	1:38:10 PM	Plume	70	23.1
4/29/2009	1:58:14 PM	Plume	60	22.2
4/29/2009	1:58:19 PM	Plume	43	15.9
4/29/2009	1:58:24 PM	Plume	49	14.2
4/29/2009	1:59:01 PM	Plume	27	8.0
4/29/2009	1:59:10 PM	Plume	61	23.1
4/29/2009	1:59:11 PM	Plume	43	13.1
4/29/2009	2:16:05 PM	Plume	160	76.4
4/29/2009	2:17:03 PM	Plume	14	3.7
4/29/2009	2:17:08 PM	Plume	340	179.0
4/30/2009	11:19:14 AM	Plume	77	33.1
5/1/2009	10:36:08 AM	Plume	48	15.3
5/1/2009	10:36:10 AM	Plume	284	134.0
5/1/2009	10:36:17 AM	Plume	279	149.0
5/1/2009	10:36:18 AM	Plume	277	130.0
5/1/2009	10:36:19 AM	Plume	361	177.0
5/1/2009	10:36:31 AM	Plume	272	112.0
5/1/2009	10:58:39 AM	Plume	30	8.8
5/1/2009	10:59:00 AM	Plume	115	55.5
5/1/2009	10:59:02 AM	Plume	84	30.6
5/1/2009	10:59:04 AM	Plume	49	25.1
5/1/2009	10:59:06 AM	Plume	65	33.2
5/1/2009	10:59:08 AM	Plume	31	13.1
5/1/2009	11:08:47 AM	Plume	140	56.8
5/1/2009	11:08:49 AM	Plume	91	49.0
5/1/2009	11:08:51 AM	Plume	597	327.0
5/1/2009	11:09:00 AM	Plume	164	92.0
5/1/2009	11:09:13 AM	Plume	80	32.5
4/27/2009	2:23:19 PM	Plume	228	91.5
4/27/2009	2:23:26 PM	Plume	277	119.0
4/27/2009	2:23:31 PM	Plume	130	56.8
4/27/2009	2:23:36 PM	Plume	52	23.6
4/27/2009	2:23:40 PM	Plume	27	9.4
4/27/2009	2:23:46 PM	Plume	18	6.7

Table 8: 27 April 2009 Far Field Ebb Tide Survey Transect Summary Table

Transect Number	Figure Number	Time	Transect Length	Plume Description	Additional Field Remarks
C01	27a	(12:15:08)	441	-	Circle transect, propwash (ens 110)
A01	27b	(12:23:01)	112	Ambient	Prop wash
A02	27c	(12:25:12)	176	Ambient	Prop wash + wake
A03	27d	(12:29:07)	172	Ambient	
T01	27e	(12:32:41)	340	Recorded up to 200 m long. Core signature at surface 500mg/L	
T02	27f	(12:36:27)	335	250 meters long, no distinct core, peak concentrations between 100-150 mg/L	
T03	27g	(12:40:49)	696	Approx 500 meters long, no distinct core, peak concentrations between 150-200 mg/L	
T04	27h	(12:48:21)	723	Approx 500 meters long, no distinct core, peak concentrations between 100-150 mg/L	
T05	27i	(12:57:01)	713	Signature up to 500 meters long, no distinct core or plume	Surface ensamble 330 source unknown
T06	27j	(13:04:06)	737	Sporradic TSS signature up to 550 meters long. Peak concentration 60-70 mg/L	Prop Wash
T07	27k	(13:12:17)	654	Sporradic TSS signature up to 550 meters long. Peak concentration 60-70 mg/L, mostly near surface	Tug wake/wash ens 4190
T08	27l	(13:19:11)	725	No distinct plume	Surface wash - heavy wash from multiple tugs

Table 9: 27 April 2009 Far Field Late Ebb/Slack Tide Survey Transect Summary Table

Transect Number	Figure Number	Time	Transect Length	Plume Description	Additional Field Remarks
C01	30a	(15:20:45)	439	Circle	Circle transect
A01	30b	(15:26:40)	99	Ambient (Noise recorded in upper half of water column)	
A02	30c	(15:28:27)	121	Ambient (Noise recorded in upper half of water column)	
A03	30d	(15:30:22)	128	Ambient (Noise recorded in upper half of water column)	
T01	30e	(15:33:14)	86	40 meters wide, along the substrate. Peak core concentraitons between 200 -300 mg/L	
T02	30f	(15:35:15)	103	55 meters wide, along the substrate. Peak core concentraitons between 150 -200 mg/L	
T03	30g	(15:37:17)	126	35 meters wide, along the substrate. Peak core concentraitons 500 mg/L or greater	
T04	30h	(15:45:57)	417	No plume detected, general noise throughout water column	

Table 10: 28 April 2009 Far Field Flood Tide Survey Transect Summary Table

Transect Number	Figure Number	Time	Transect Length	Plume Description	Additional Field Remarks
C01	33a	(10:51:40)	345	Circle	
A01	33b	(10:58:01)	103	Ambient (TSS detected)	
A02	33c	(10:59:48)	110	Ambient (TSS detected)	Circle transect
A03	33d	(11:01:43)	121	Ambient	Could not find plume
T01	33e	(11:05:26)	86	Small plume, 40 meters wide along bottom. Core concentration between 80-90 mg/L	
T02	33f	(11:06:57)	108	No plume. Higher than ambient TSS detected at the start	
T03	33g	(11:08:48)	119	Slightly higher than ambient (40 -50mg/L) TSS throughout transect	Transect perpendicular to dredge
T04	33h	(11:10:37)	115	Slightly higher than ambient (40 -50mg/L) TSS throughout transect	Transect perpendicular to dredge
T05	33i	(11:16:40)	154	90 meters wide plume detected along bottom, peak concentrations 60-70 mg/L	Transect perpendicular to dredge
T06	33j	(11:19:15)	174	No plume	Transect perpendicular to dredge
T07	33k	(11:21:28)	189	No plume	Transect parallel to dredge

Table 11: 28 April 2009 Far Field Ebb Tide Survey Transect Summary Table

Transect Number	Figure Number	Time	Transect Length	Plume Description	Additional Field Remarks
Set 1					
C01	36a	(14:04:18)	394	Circle	Transect parallel to dredge
T01	36b	(14:11:27)	150	Large plume, 60 meters wide. Core concentrations over 500 mg/L	Transect parallel to dredge
T02	36c	(14:13:32)	167	Plume along surface and bottom. Excluding ambient surface noise, surface plume 80 meters wide. Core concentrations 100 to 150 mg/L	Circle Transect
T03	36d	(14:16:01)	168	Plume 70 meters wide, 2 meters deep along bottom.	
T04	36e	(14:18:33)	185	Feint thin plume along bottom	
T05	36 f	(14:20:41)	198	Feint thin plume along bottom	
T06	36g	(14:23:00)	297		
Set 2					
T07	39d	(14:33:12)	97	Large deep plume, 60 meters wide extends from surface to bottom. Core concentrations in a small area over 500 mg/L	
T08	39e	(14:34:30)	140	Plume up to 60 meters wide, concentrated on surface and substrate. Core concentrations 100-150 mg/L	
T09	39f	(14:36:05)	171	Faintt plume along bottom and surface. Core concentrations 80-90 mg/L in small area.	
T10	39g	(14:37:58)	183	plume 40 meters wide, up to 3 meters deep. Core concentrations 70-80 mg/L in very small area	
A01	39a	(14:45:59)	145	Ambient	
A02	39b	(14:48:43)	169	Ambient	
A03	39c	(14:51:08)	134	Ambient	

Table 12: 29 April 2009 Far Field Flood Tide Survey Transect Summary Table

Transect Number	Figure Number	Time	Transect Length	Plume Description	Additional Field Remarks
C01	42a	(09:00:27)	393	Circle	
T01	42e	(09:08:27)	112	Plume approx. 70 meters wide, core concentrations of 100-150 mg/L but 500 mg/L or greater occur along surface. Concentrated along channel wall.	
T02	42f	(09:10:17)	176	Plume approx. 80 meters wide, concentrated along surface and substrate. Core concentrations of 100-150 mg/L along substrate 500 mg/L or greater occur along surface. Concentrated along channel wall.	Circle Transect
T03	42g	(09:12:22)	173	Up to 80 meters wide, concentrated along surface and substrate. Peak concentrations along surface 100-150 mg/L. Concentrated along channel wall.	
T04	42h	(09:14:48)	206	Plume approx. 90 meters wide, mostely concentrated along substrate. Core concetrations along substrate 80-90 mg/L, along surface 100-150 mg/L.	
T05	42i	(09:17:20)	215	Plume mostly concentrated along substrate, approx. 80 meters wide. Core concentrations 80-90 mg/L	Prop wash (darker) beginning
T06	42j	(09:20:03)	201	Plume up to 120 meters wide. Core concentrations 80-90 mg/L.	
T07	42k	(09:22:29)	208	Plume approx 100 meters wide. Core concentrations 60 - 70 mg/L.	
T08	42l	(09:25:31)	223	Plume approx. 80 meters wide. Core concentrations 60-70 mg/L.	
T09	42m	(09:29:17)	259	Plume approx. 90 meters wide. Core concentrations between 60-70 mg/L.	
T10	42n	(09:33:35)	240	Plume approx. 80 meters concentrated along surface and substrate. Core concentration 60-70 mg/L	Propwash
T11	42o	(09:36:21)	321	Plume widespread, 160 meters but mostly 40-50 mg/L. Peak concentrations along surface 100-050 mg/L but possibly due to prop wash.	Propwash
T12	42p	(09:40:31)	329	No distinct plume	
T13	42q	(09:44:17)	380	No distinct plume	
T14	42r	(09:48:57)	357	No distinct plume	
A01	42b	(09:55:25)	165	Ambient	
A02	42c	(09:57:42)	187	Ambient	
A03	42d	(10:00:19)	229	Ambient	

Table 13: 01 May 2009 Far Field Flood Tide Survey Transect Summary Table

Transect Number	Figure Number	Time	Transect Length	Plume Description	Additional Field Remarks
C01	45a	(11:26:01)	414	Circle	
T01	45e	(11:32:51)	250	Plume up to 100 meters wide extending throughout the water column. Large area of concentration 500 mg/L or more.	
T02	45f	(11:35:51)	212	Plume approx. 100 meters wide and concentrated along surface. Core concentrations 300-500 mg/L.	Circle transect
T03	45g	(11:38:50)	186	Plume approx. 80 meters wide and concentrated along surface. Core concentrations 100-150 mg/L.	
T04	45h	(11:41:08)	200	Plume approx. 80 meters wide, relatively thing and in the middle of the water column. Core concentrations of 80-90 mg/L.	
T05	45i	(11:44:09)	119	No plume	
A01	45b	(11:52:42)	132	Ambient	
A02	45c	(11:54:24)	181	Ambient	
A03	45d	(11:56:44)	178	Ambient	Propwash from parker

Table 14: S-E-1 Survey B: Sediment Collection and Analysis Summary Table

Area	Date Sampled	Time Sampled	Grain Size Distribution[1]						Bulk Density[2]			Atterberg Limits[3]			
			Gravel	Course Sand	Medium Sand	Fine Sand	Silt	Clay	Wet Bulk Density	Moisture Content	Dry Bulk Density	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
			(%)	(%)	(%)	(%)	(%)	(%)	lb/ft3	(%)	lb/ft3				
Dredge Scow	4/27/2009	9:50	0	0	0	2	62	36	99.2	63	60.7	53	23	30	1
Dredge Field	4/27/2009	13:40	0	0	1	2	53	44	82.6	163	31.4	97	36	61	2
Dredge Scow	4/28/2009	10:40	0	0	0	2	63	35	84.9	128	37.2	88	34	54	2
Dredge Field	4/28/2009	15:30	0	0	1	3	51	45	79.7	174	29.1	96	34	62	2
Dredge Scow	4/29/2009	10:45	0	0	1	5	50	44	95.2	77	53.9	63	26	37	1
Dredge Field	4/29/2009	11:10	0	0	0	7	62	31	84.6	137	35.7	81	29	52	2
Dredge Scow	4/30/2009	15:45	1	1	1	3	56	38	88.1	110	41.9	82	35	47	2
Dredge Field	4/30/2009	16:20	0	0	0	5	58	37	83.8	146	34	81	33	48	2
Dredge Field	5/1/2009	9:30	0	0	1	4	60	35	82	164	31	88	34	54	2
Dredge Scow	5/1/2009	12:00	0	0	0	1	54	45	102.9	50	68.4	56	24	32	1

[1] ASTM D-422 Method

[2] ASTM D-2937 Method

[3] ASTM D-4318 Method