MULTIBEAM HYDROGRAPHIC SURVEY AROUND AND UNDER OIL PLATFORMS IN THE SANTA BARBARA CHANNEL AND SANTA MARIA BASIN, CALIFORNIA.

AUGUST 2001

Prepared For: **MINERALS MANAGEMENT SERVICE**
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1. INTRODUCTION

Sea Surveyor, Inc. conducted a series of multibeam hydrographic surveys around eight (8) offshore oil platforms in the Santa Barbara Channel and Santa Maria Basin, California. The objective for these multibeam hydrographic surveys is to identify any shellmounds or debris piles under existing platforms, and determine what factors (depth, slope, platform age, etc.) contribute to the presence of shellmounds. The survey also provided information on the effectiveness of a multibeam sonar system to map shellmounds and debris piles under platforms. These surveys were conducted under subcontract to *MEC Analytical Systems, Inc.* in support of the Minerals Management Service, Pacific Outer Continental Shelf (OCS) Program.

Of the 19 OCS platforms in the Santa Barbara Channel and Santa Maria Basin, 8 platforms were selected to represent a range of water depths, seafloor slopes, and platform ages. The surveyed platforms are located in water depths ranging from –96' to –835' with seafloor slopes ranging from nearly flat to steep (6.5% downward slope). The 8 platforms also represent a nearly 20-year difference in age, ranging from Platform Houchin (33-years) to Platform Gail (14-years).

Figure 1 shows the location of the offshore platforms surveyed. Six offshore platforms located in the Santa Barbara Channel were surveyed from 27 April to 1 May 2001, including Platforms Gina, Gail, Grace, Henry, Houchin, and Hondo. Two offshore oil platforms in the Santa Maria Basin (Platforms Hermosa and Hidalgo) were surveyed on 22-24 June 2001.

The following sections describe the methodology, results, and conclusions from the multibeam hydrographic surveys. Bathymetric contour charts for each offshore platform are presented at the end of this report, along with profile views of the seafloor.

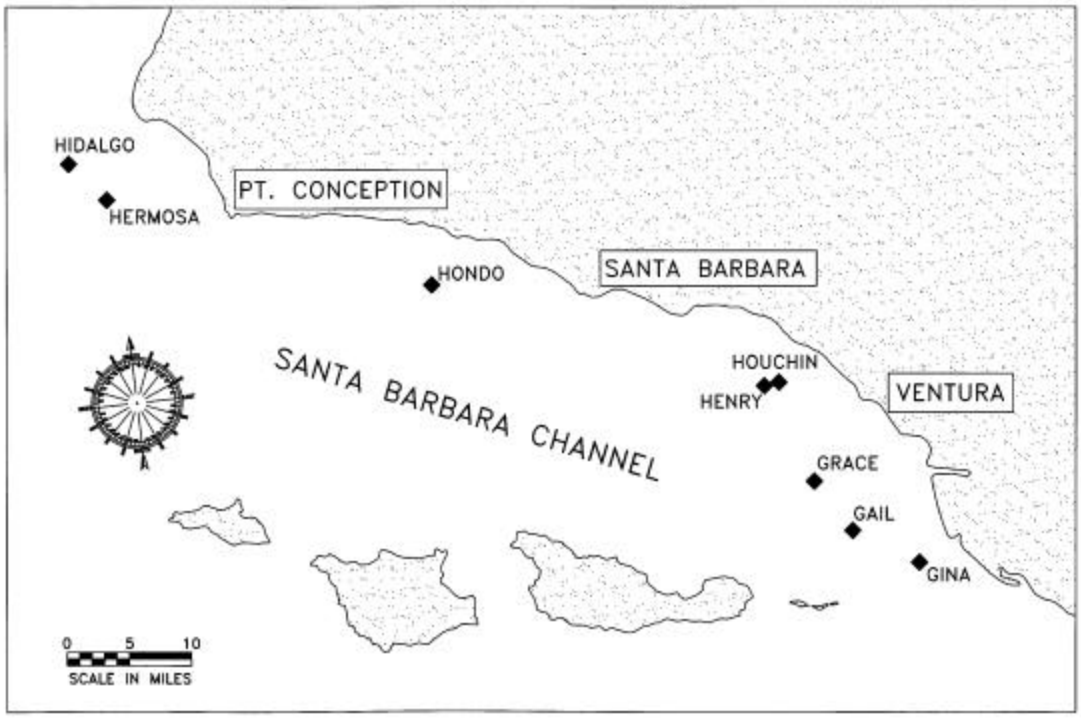


FIGURE 1: Site Map Showing Location Of Platforms Surveyed.

2. SURVEY EQUIPMENT AND METHODS

Sea Surveyor conducted multibeam hydrographic surveys around and under six offshore platforms in the Santa Barbara Channel from 27 April to 1 May 2001. Two additional platforms located in the Santa Maria Basin were surveyed on 22-24 June 2001. The multibeam surveys used Class 1 methods and accuracies outlined in the Army Corps of Engineers' *HYDROGRAPHIC SURVEYING MANUAL* (EM 1110-2-1003, October 1994). A 3-person crew conducted the surveys, including Mr. Steve Sullivan (Project Manager), Mr. Phillip Torres (hydrographic surveyor), and Mr. Andrew Hunt (U.S.C.G.-licensed skipper). Various technicians, ships crew, and observers also participated in the surveys.

Sea Surveyor performed the surveys of the six offshore platforms in the Santa Barbara Channel using our 25' multibeam survey vessel that was transported to Ventura Harbor on its trailer. The hydrographic surveys of the six offshore platforms in the Santa Barbara Channel were conducted under ideal conditions (flat seas and no wind or currents). A long-period 6' swell during the Platform Hondo survey was the only environmental factor that might slightly affect the accuracy of the hydrographic surveys.

The surveys around the 2 offshore platforms in the Santa Maria Basin were conducted from the 100' vessel "COLLEEN", provided by *Antone Sylvester Tug Service* in Long Beach, California. Survey conditions in the Santa Maria Basin were good, but not ideal. Environmental conditions during the survey of Platform Hermosa included 10-knot winds, 5' swell, and 2' seas. Later, during the survey of Platform Hidalgo, conditions increased to 15-knot winds, 5' swell, and 3'-5' seas.

The multibeam hydrographic surveys were conducted along 12 survey lines at various spacings and orientations around each offshore platform. Navigation was provided using the *OMNISTAR* LR-8 differential GPS navigation system. The soundings were corrected for tides monitored by the National Oceanic and Atmospheric Administration (NOAA) at Platform Harmony and reported via the Internet. The soundings are referenced to the Mean Lower Low Water (MLLW) vertical datum and the California State horizontal coordinate system, Zone 6 (NAD-27).

Soundings around and under the offshore platforms were collected using a *SEABEAM* Model 1180 multibeam sonar, which consists of the transducer head, an onboard processor, and a video monitor. The transducer, operating at 180-kHz, is on a fixed mount that was attached to the port side of both survey vessels. Motion sensors, located at different points on the vessels, measure the motion of the sonar. An interactive mouse utilizes the video monitor to adjust system settings such as gain, power, and range. During data collection, the video monitor also shows the acoustic signal being collected along with each digitized beam.

The *SEABEAM* 1180 is dynamically compensated for roll and pitch, and can measure water depths to 2000'. The *SEABEAM* 1180 has a beam width of 1.5-degrees across-track and 2.5-degrees along track over a total swath width of 153-degrees. A TSS 335B motion sensor monitored and measured sonar roll (rotation port and starboard), pitch (rotation fore and aft), and heave (vertical displacement) during data collection. A SCAN 2000 gyrocompass recorded

vessel and sonar yaw (rotation about the Z-axis) during sonar data collection. A Pentium 533 MHz laptop navigation computer uses *HYPACK Max* data acquisition software to record the soundings, navigation data, gyrocompass data, and vessel roll, pitch, and heave. The software was also used for calibrating the multibeam sonar and processing soundings.

Sound velocity profiles were recorded at each platform before and after the hydrographic surveys using a *Valeport* Model 650 sound velocity profiler in order to correct the soundings for varying speed-of-sound through the water column.

After completing the hydrographic surveys around the offshore platforms, the multibeam soundings were processed using *HYSWEEP/HYPACK Max* Multibeam Processing and Editing Software. The soundings were processed using the following steps:

1. Sensor Alignment and Calibration Adjustments: The entire multibeam sonar system was calibrated using industry standards prior to, and immediately following, each survey.
2. Inspection and editing of vessel motion and position data: Satellite coverage and position qualities (HDOP) were dependable throughout the surveys. Seven (7) or eight (8) satellites were standardly visible and HDOP values of less than 2 were typical.
3. Developing tide and sound velocity profile data files: Vertical profiles of sound velocity collected before and after each survey showed consistent vertical gradients at each platform. The soundings were corrected for the vertical profiles of sound velocity.
4. Merging motion, position, and tide data with sounding data along a common time base.
5. Editing sounding data manually and automatically:
    - Fully resolved soundings were edited both manually and automatically to eliminate spikes and bad returns.
    - Soundings at swath angles of greater than 60 degrees were not utilized.
    - Automatic spike filters eliminated 2m or greater jumps in point-to-point soundings.
6. Thinning edited data to desired density
    - The soundings around and under the platforms are displayed in the smallest possible grid to provide the best resolution. Since grid size increases with water depth, deep soundings have lower resolution than shallow soundings.
    - Data was averaged to one sounding per 10’ x 10’ grid for the 4 shallow platforms, and 15’ x 15’ grid for the 4 deep platforms (Gail, Hondo, Hermosa, and Hidalgo). The center sounding in the grid square was retained along with that point's Northing and Easting. If no soundings occurred in a particular grid square, no data was reported.
7. Creating a DXF file for contour creation.
8. Importing the soundings and DXF contour file into AutoCAD for adding text, graphics and final plotting.

3. SURVEY RESULTS

The results from the multibeam hydrographic surveys around and under the offshore platforms are presented in the following sections:

3.1 Platform Gina

Platform Gina was installed in the Santa Barbara Channel 21-years ago approximately 3.7 miles from shore. The water depth around the platform is -96' MLLW. The seafloor around the platform is nearly flat, but gradually slopes downwards towards the southwest. A mound under Platform Gina rises to –83' MLLW (Chart 1).

The 13'-high mound located under Platform Gina is centered under the northern edge of the platform. The base of the mound is oval-shaped, 150' x 210' as measured along the -95' MLLW depth contour. The long-axis of the mound is oriented northwest-southeast. The mound under Platform Gina has a volume of approximately 4,200 cubic yards.

3.2 Platform Gail

Platform Gail was installed in the Santa Barbara Channel 14-years ago approximately 9.9 miles from shore. The water depth at the platform is approximately -740' MLLW (Chart 2). The seafloor around the platform has a 1.5% downward slope towards the south-southwest, but the platform appears to influence the bathymetry because several upslope contours (-738' to –741' MLLW) dip under the platform.

Several small mounds are present under Platform Gail, but these mounds are difficult to identify because they have low relief. Two 3'-high mounds rise to –736' MLLW under the northern edge of the platform. One of the 3'-high mounds measures 40' x 60' at its base, while the other 3'-high mound has a base of 40' x 50'.

In addition to the two 3'-high mounds, there are two 2'-high mounds under the platform. Both 2'-high mounds are located under the western edge of the platform. One of the 2'-high mounds has a base dimension of 20 'x 70', and the other 2'-high mound has a base of 25' x 50'.

The total volume of the 4 mounds under Platform Gail cannot be calculated accurately because the mounds are too small and difficult to identify on a sloping seafloor.

3.3 Platform Grace

Platform Grace was installed in the Santa Barbara Channel 22-years ago approximately 10.5 miles from shore. The water depth at the platform is approximately –318' MLLW. The seafloor around the platform gradually slopes down towards the south. A mound under Platform Grace rises to –305' MLLW (Chart 3).

The 13'-high mound located under Platform Grace is centered in the northwest quadrant under the platform. The base of the mound is oval-shaped, 200' x 390' as measured along the -317' MLLW depth contour. The long-axis of the mound is oriented northwest-southeast. The mound has a volume of approximately 5,500 cubic yards.

3.4 Platform Henry

Platform Henry was installed in the Santa Barbara Channel 22-years ago approximately 4.3 miles from shore. The water depth at the platform is approximately –172' MLLW. The seafloor around the platform is nearly flat. A mound under Platform Henry rises to –153' MLLW (Chart 4).

The 19'-high mound located under Platform Henry is centered in the northwest quadrant under the platform. The base of the mound is circular, with a diameter of about 250' as measured along the –171' MLLW contour. The mound has an estimated volume of 7,200 cubic yards.

3.5 Platform Houchin

Platform Houchin was installed in the Santa Barbara Channel 33-years ago about 4.1 miles from shore. The water depth at the platform is approximately –163' MLLW. The seafloor around the platform gradually slopes down towards the south. A mound under Platform Houchin rises to –142' MLLW (Chart 5).

The 21'-high mound located under Platform Houchin is centered under the platform and has a volume of approximately 10,900 cubic yards. The base of the mound is circular, with a diameter of 280' as measured along the -162' MLLW contour. The mound crests at a north-south oriented ridge that is located under the western half of the platform, possibly corresponding to the location of the drill pipes. The crest of the mound is oval-shaped, measuring 35' x 75' as measured along the -146' MLLW depth contour.

3.6 Platform Hondo

Platform Hondo was installed in the western Santa Barbara Channel 25-years ago approximately 8.2 miles from shore. Water depth at the platform ranges between –826' to –840' MLLW. The seafloor around the platform has a complex bathymetry with a steep (6.5%) downward slope towards the south. The platform appears to influence the bathymetry because the bathymetric contours between –823' to –839' MLLW dip south under the platform. Two mounds are located under Platform Hondo, including a mound under the northern half of the platform and a smaller mound located under the southern half of the platform (Chart 6). The mounds are adjacent to, and upslope of, the platform legs. The west side of the southern and northern mounds may connect.

The mound under the northern half of Platform Hondo is approximately 8’ high, rising to elevation –815’ MLLW. The northern mound has a base of 40’ x 170’ along the –820' MLLW contour, with the long-axis oriented east-west.

The smaller mound located under the southern half of Platform Hondo is 9’ high and has dimensions of 60' x 130' as measured along the –834’ MLLW contour. The mound rises to –825’ MLLW and its long axis is oriented east-west.

Numerous isolated mounds and depressions are scattered around Platform Hondo, the most prominent being an isolated 6’-high mound with base dimensions of 50' x 100' located 200’ east of the platform.

The 3 mounds around and under Platform Hondo have a combined volume of approximately 1,500 cubic yards.

3.7 Platform Hermosa

Platform Hermosa was installed in the Santa Maria Basin 16-years ago, approximately 6.8 miles from shore. Water depth under the platform ranges between –597 to –607' MLLW. The water depth directly under the center of the platform is approximately –602' MLLW. The seafloor around the platform has a steep 5.6% downward slope towards the southwest.

Platform Hermosa (Chart 7) does not appear to significantly influence the seafloor bathymetry; however, the –600' contour under the platform extends further southwest than surrounding contours, and two small 2'-high mounds exist under the northeast and northwest edges of the platform.

The total volume of the mounds around and under Platform Hermosa cannot be calculated accurately because the mounds are too small and difficult to identify on a sloping seafloor.

3.8 Platform Hidalgo

Platform Hidalgo (Chart 8) was installed in the Santa Maria Basin 15-years ago, approximately 5.9 miles from shore. Water depth under the platform ranges between –430' and –440' MLLW. The water depth directly under the center of the platform is approximately –434' MLLW. The seafloor around the platform has a 4.4% downward slope towards the southwest. The seafloor slope steepens southwest (down slope) of the platform.

Platform Hidalgo does not appear to affect the seafloor bathymetry. No mounds or depressions are visible on the bathymetric chart.

4. CONCLUSIONS

Table 1 summarizes the results from the multibeam hydrographic surveys around 6 offshore platforms in the Santa Barbara Channel and 2 offshore platforms in the Santa Maria Basin. Review of the bathymetric contour charts and the information contained in Table 1 allows the following conclusions to be reached:

- The results from the bathymetric surveys show a high degree of comparability against historical soundings. The soundings around 7 platforms match historical soundings within $\pm$1', and the center sounding at Platform Hidalgo matches historical soundings within 1m.

- The results from these surveys demonstrate that multibeam sonar is an effective tool for mapping shellmounds and debris piles around and under offshore platforms in shallow (<350') waters. Since the multibeam sonar found no shellmounds under offshore platforms located in waters deeper than –350', it is unknown whether: 1) no shellmounds exist under platforms deeper than –350', 2) the multibeam sonar cannot resolve shellmounds under platforms located deeper than –350', or 3) both.

- The size of the survey vessel does not influence the quality of the soundings, but sea state (wave height and period) does. Sea state and vessel size are inter-related because a larger vessel is used for the larger wave environment of the Santa Maria Basin.

- The multibeam sonar provides excellent resolution in a 10' x 10' grid for mapping large mounds under shallow (<350') platforms. Mapping small mounds requires better resolution, which cannot be achieved in deep water from a surface-mounted sonar. For better resolution of small mounds under the deep (>350') offshore platforms, it might be necessary to use a submersible as a survey platform, which would shorten the sonar beam and increase resolution.

- Single, well-defined mounds are located under the 4 shallowest platforms surveyed, including:
  - Platform Gina, -96' MLLW
  - Platform Houchin, -163' MLLW
  - Platform Henry, -172' MLLW and
  - Platform Grace, -318' MLLW.

  Besides being in less than 350' water depths, these offshore platforms are all located on flat areas of the seafloor having less than 1% slope.

- Single, well-defined mounds were not found under the 4 deepest platforms surveyed, all of which are on steep slopes greater than 1% (1.5% for Gail, 4.4% for Hidalgo, 5.6% for Hermosa, and 6.5% for Hondo). Multiple small, poorly-defined mounds were found at the 3 deepest platforms surveyed, including Platform Hermosa (-602' MLLW), Platform Gail (-740' MLLW) and Platform Hondo (-835' MLLW). No mounds or depressions were identified under or around Platform Hidalgo.

- For the 4 shallow platforms located in less than 350' water depths, the mounds are always located under the offshore platforms and no mounds are evident on the surrounding seafloor. For the 3 deep platforms located in greater than 600' water depths, low-relief mounds are present under the platforms as well as scattered around the platforms. No mounds or depressions were identified under or around Platform Hidalgo.

- The size, height, or volume of the mounds under the platforms may be related to platform age. The oldest platform (Houchin) has the largest mound and the 3 youngest platforms (Gail, Hermosa, and Hidalgo) either have the smallest mounds or none. Other factors must influence the size, height, and volume of the mounds, because three platforms (Gina, Henry, and Grace) were installed within a year of each other and have mounds with significantly different heights and volumes

- The size, height, or volume of the mounds under the platforms may vary independent of water depth. The 2 largest mounds identified are under Platforms Houchin and Henry, which are located in 163'-172' depths midway between the smaller mounds under Platforms Gina (96' deep) and Grace (318' deep). For the deepwater platforms, Platform Hondo is deeper than Platform Gail, but has larger mounds.

- The size and volume of the mounds under the offshore platforms may be related to the geographic location of the platforms. The largest mounds are under Platforms Henry and Houchin, which are located near one another in Central Santa Barbara Channel. Platforms Gina and Grace, located in the Southern Santa Barbara Channel, have mounds of similar size and volume. Although located far apart, Platforms Gail and Hondo are both located in deep water (740' and 835', respectively) and have similar-sized mounds. The two platforms surveyed in the Santa Maria Basin (Hermosa and Hidalgo) have very small or no mounds.

- For all 7 platforms that had seafloor mounds, a mound is always present under the north edge of the platform.

- A multibeam sonar collects considerable information regarding the location of the platform's legs and drill pipes; however, it is a poor tool for imaging these structures. Multibeam soundings are individual points that do not allow the platform legs or drill pipes to be differentiated from struts, cross-braces, or schools of fish under the platform. Figure 2 shows raw soundings from a single sweep of the multibeam sonar under Platform Hondo. Used alone, the soundings show an infinite number of possible structures under the platforms. The most practical method for outlining the legs and drill pipes under the platforms is to analyze the soundings in conjunction with a side-scan sonar survey around the platform, and then compare the results to detailed engineering drawings of the submerged superstructure.

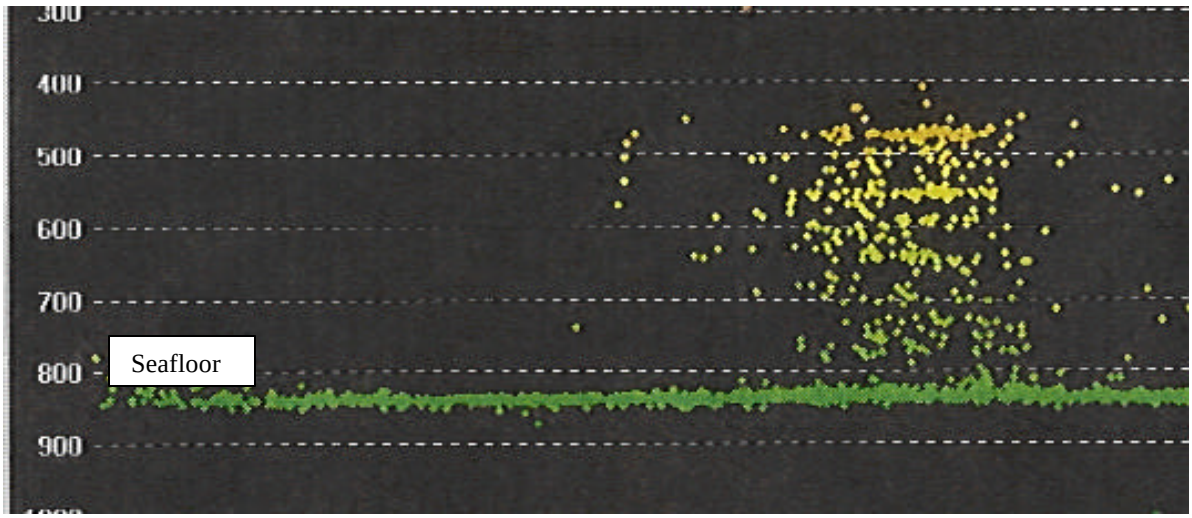
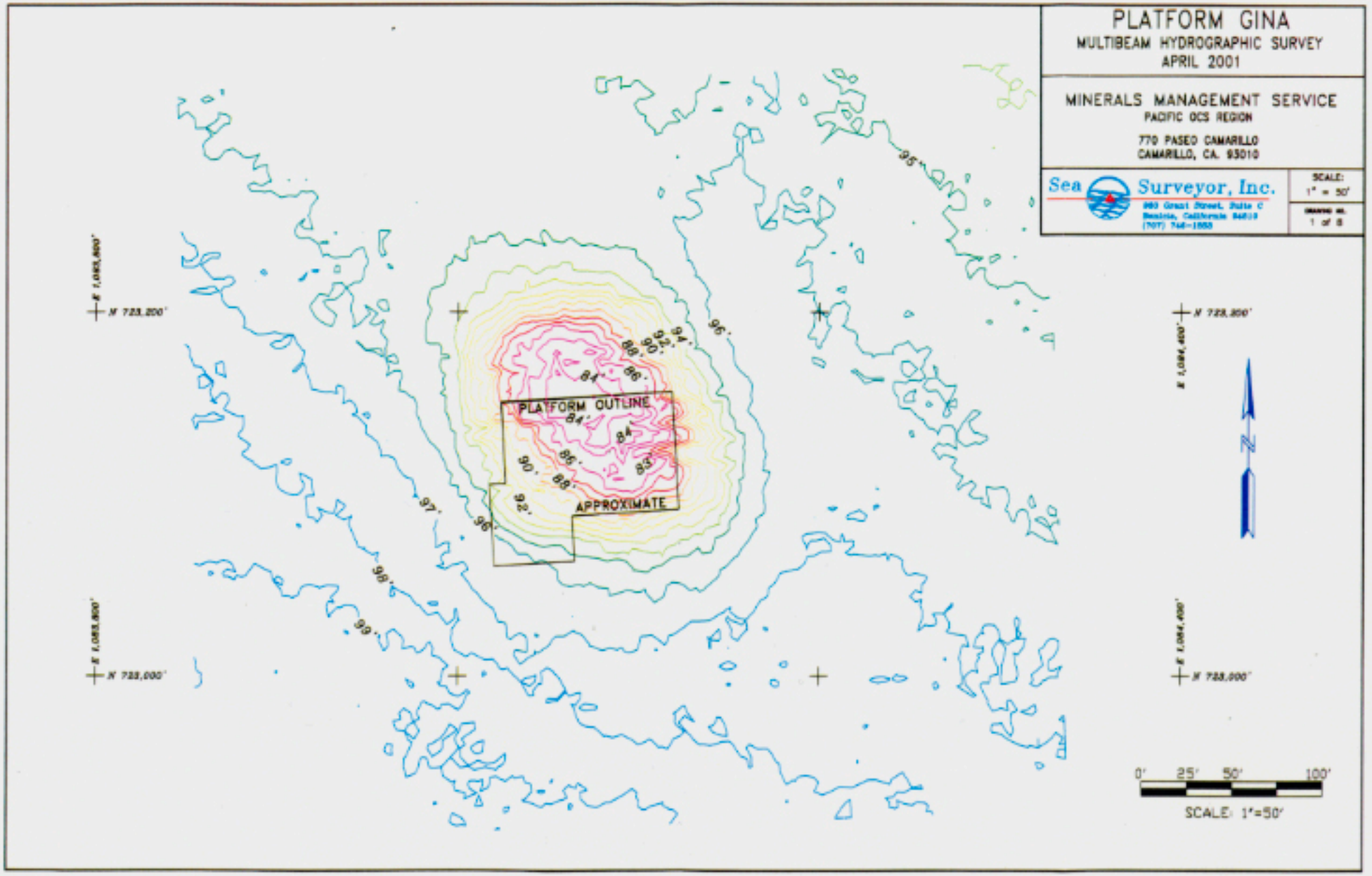


Figure 2: Raw individual soundings around and under Platform Hondo. Soundings in the water column are from the platform's legs, struts, and other structures, as well as schools of fish. Please note that discrete "levels" of the platform can be seen at 475' and 550' water depths.


PLATFORM GINA
MULTIBEAM HYDROGRAPHIC SURVEY
APRIL 2001
MINERALS MANAGEMENT SERVICE
PACIFIC OCS REGION
770 PASEO CAMARILLO
CAMARILLO, CA. 93010
Sea Surveyor, Inc.
SCALE:
1" = 50'
1 of 8
PLATFORM OUTLINE
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N 723,000'
N
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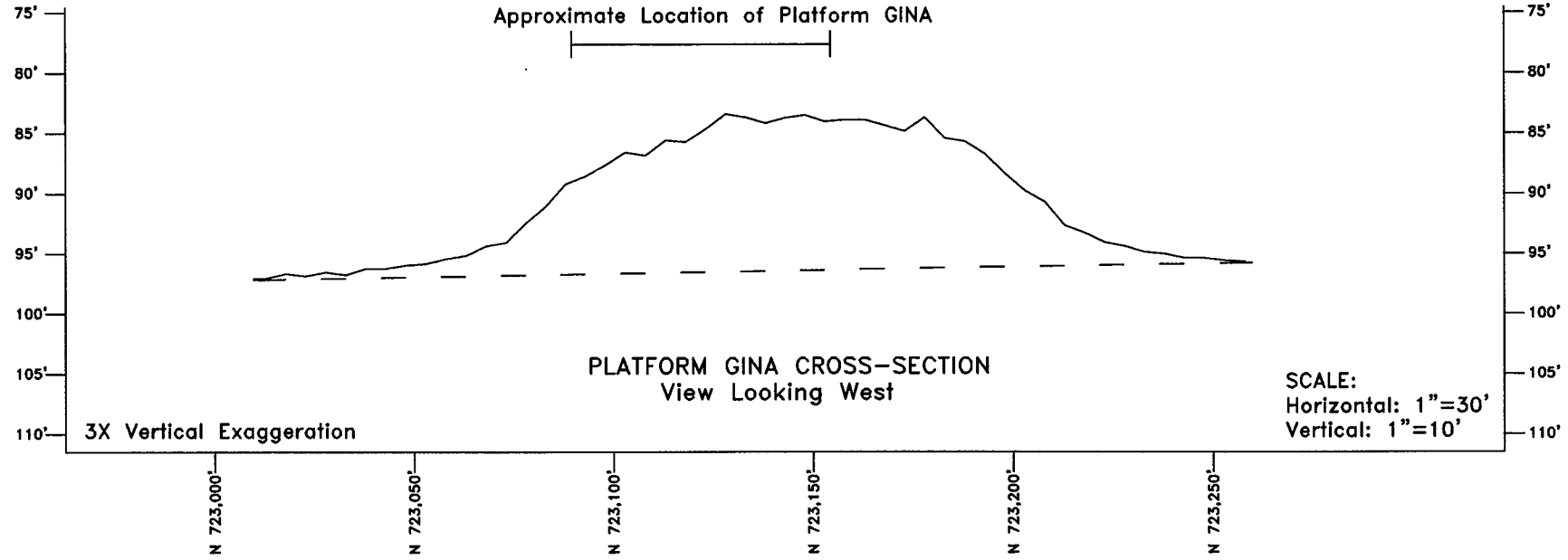
SCALE: 1"=50'



PLATFORM GINA CROSS-SECTION
View Looking West

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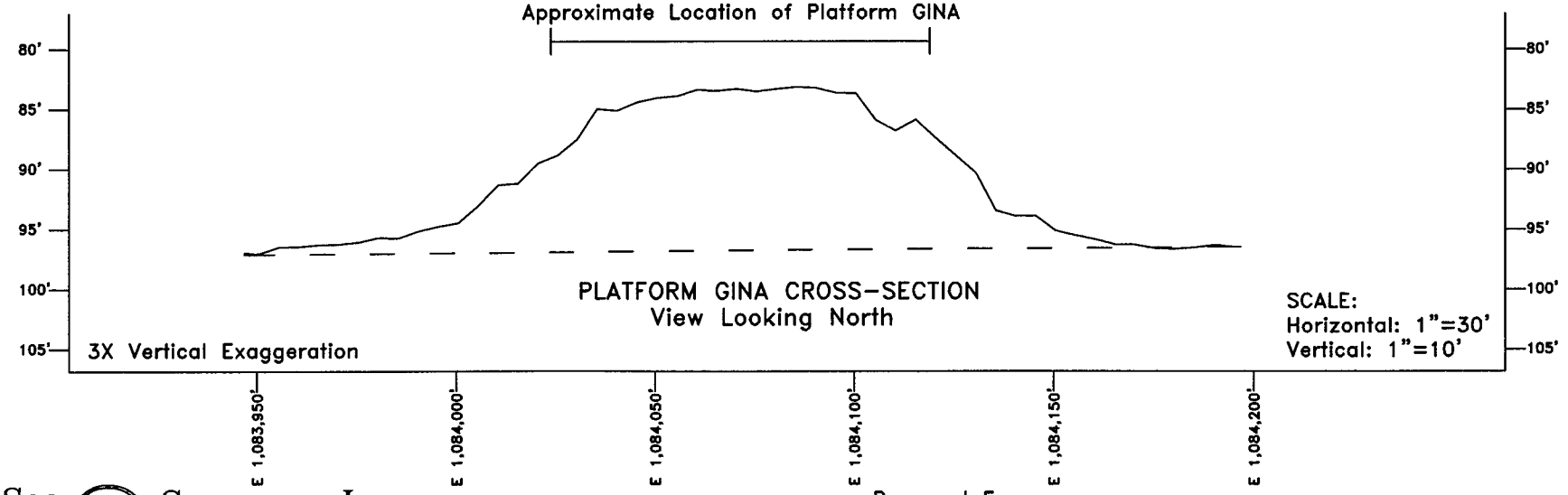
Vertical: 1"=10'



PLATFORM GINA CROSS-SECTION
View Looking North

SCALE:
Horizontal: 1"=30'
Vertical: 1"=10'

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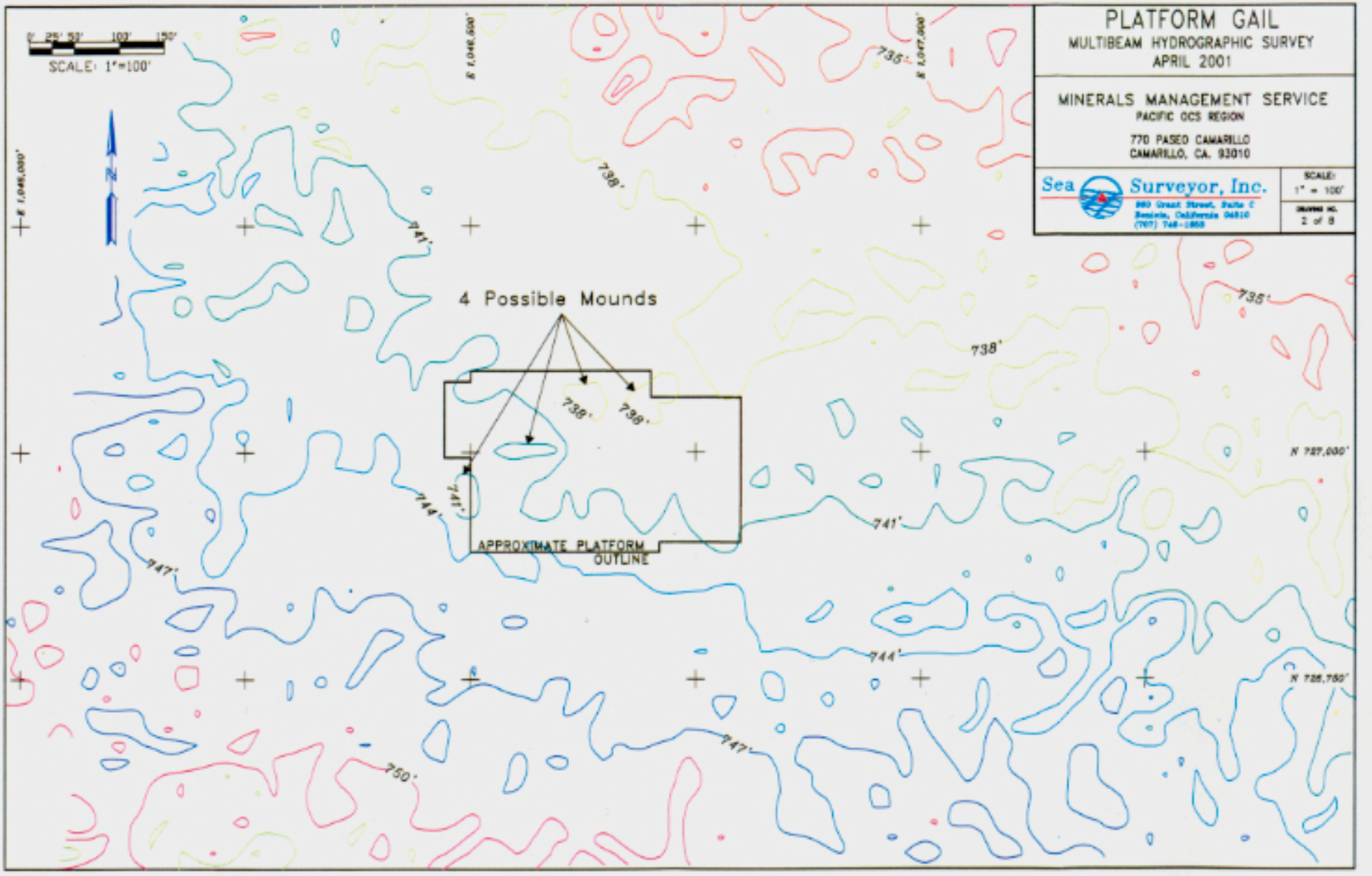
PLATFORM GINA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N 727,000'
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735'
738'
741'
744'
747'
750'
4 Possible Mounds
APPROXIMATE PLATFORM OUTLINE
PLATFORM GAIL
MULTIBEAM HYDROGRAPHIC SURVEY
APRIL 2001
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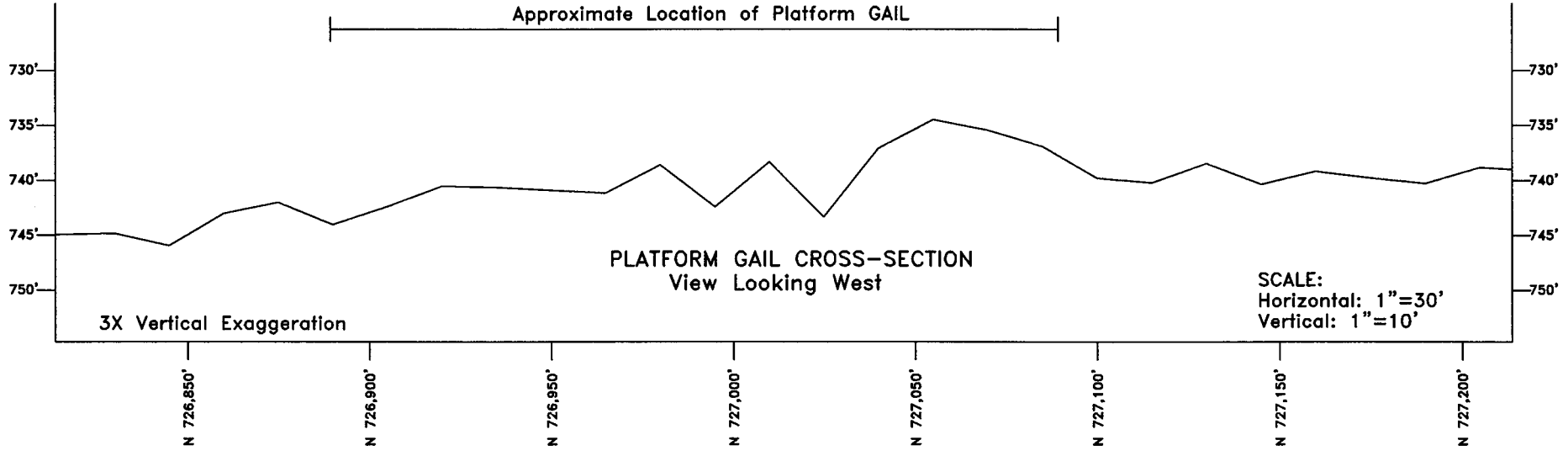
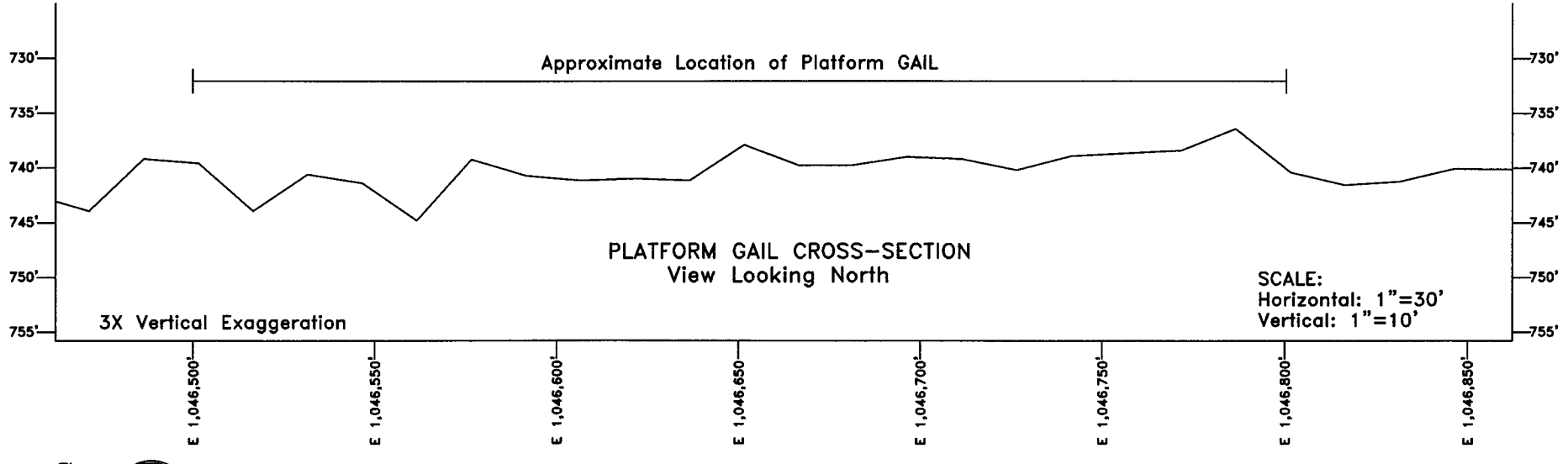
SCALE: 1" = 100'
2 of 8





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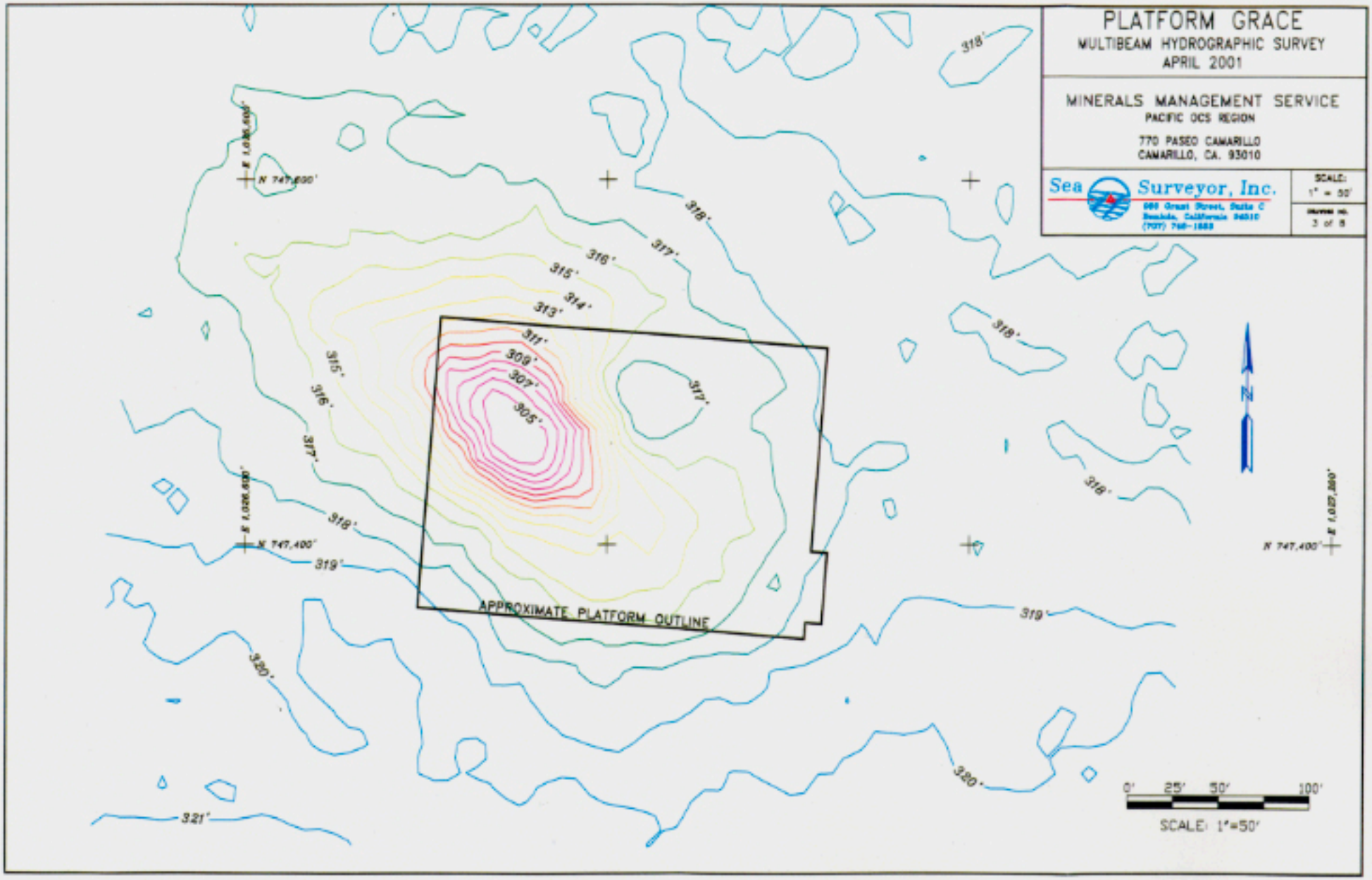
PLATFORM GAIL


PLATFORM GRACE
MULTIBEAM HYDROGRAPHIC SURVEY
APRIL 2001
MINERALS MANAGEMENT SERVICE
PACIFIC OCS REGION
770 PASEO CAMARILLO
CAMARILLO, CA. 93010
Sea Surveyor, Inc.
SCALE: 1" = 50'
3 of 8
N 747,600'
E 1,026,600'
N 747,400'
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N 747,400'
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APPROXIMATE PLATFORM OUTLINE
318'
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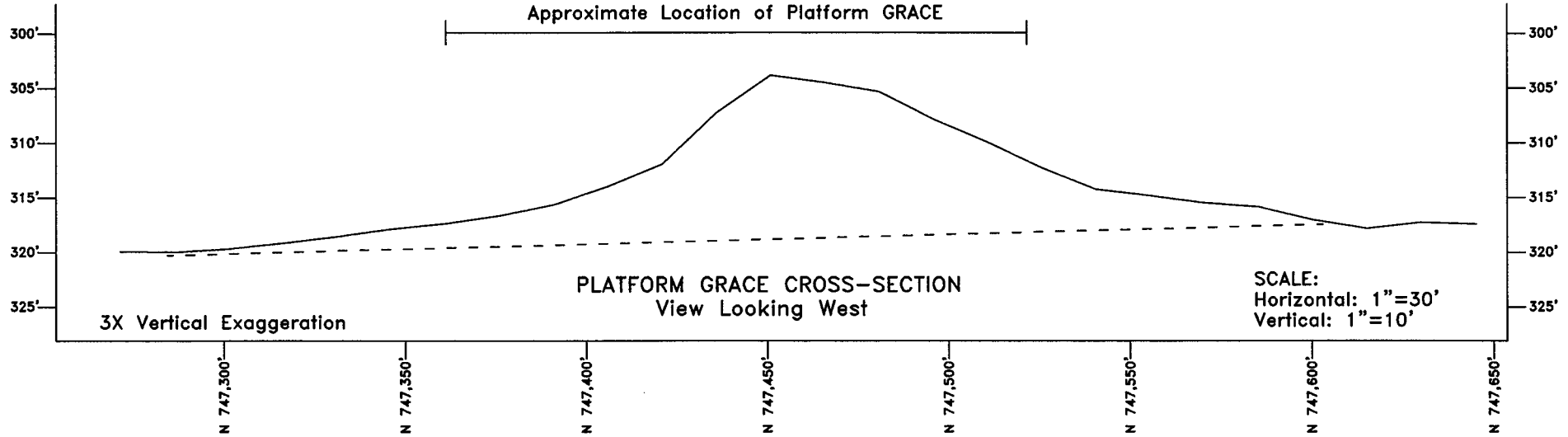

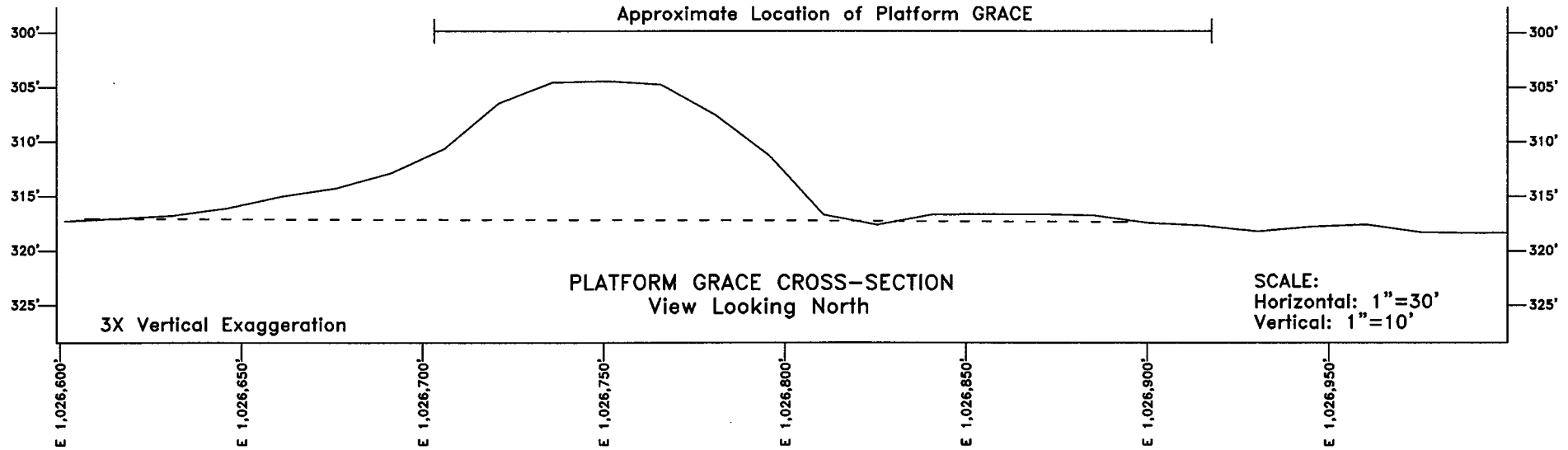

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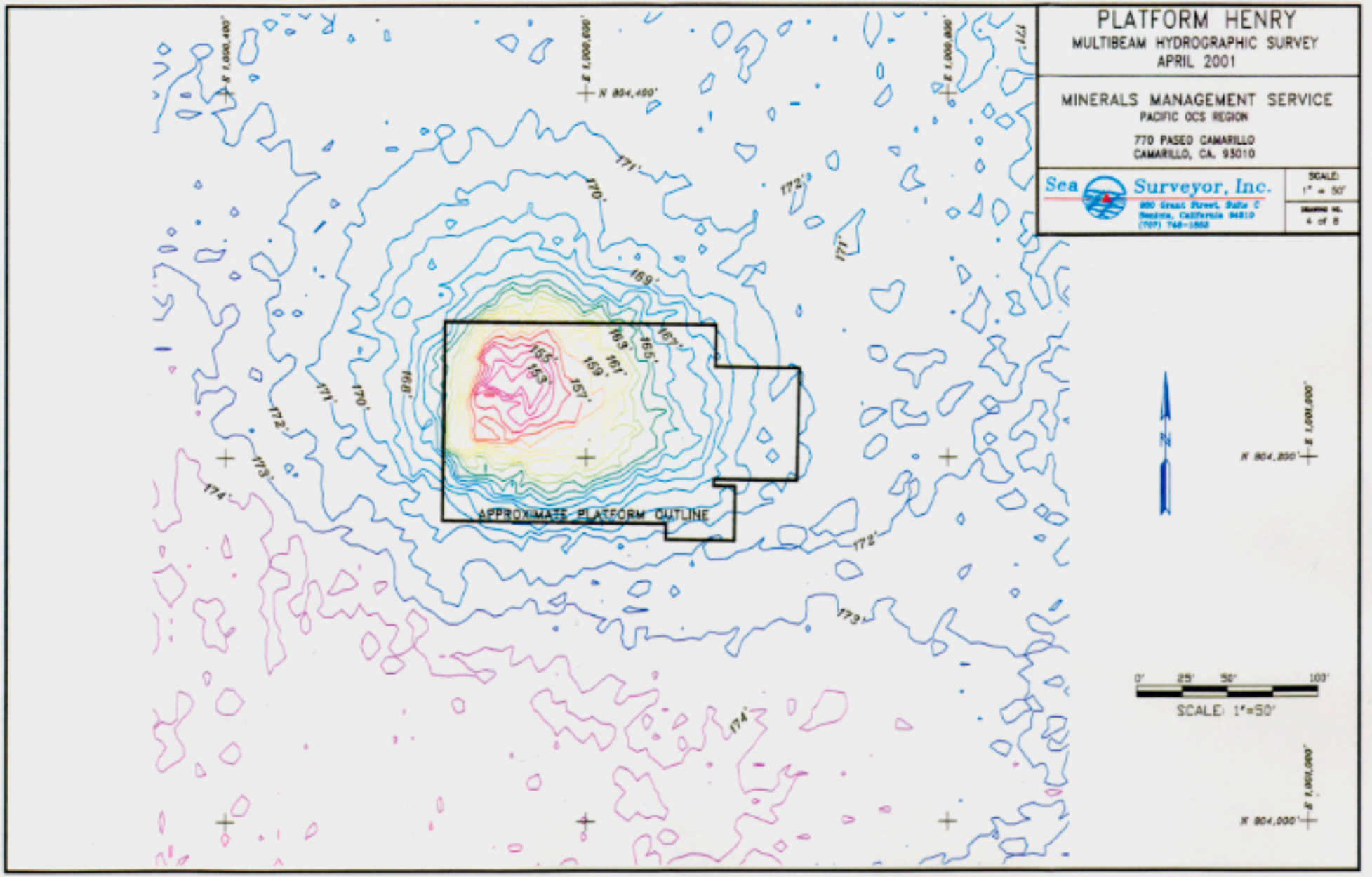
PLATFORM GRACE


PLATFORM HENRY
MULTIBEAM HYDROGRAPHIC SURVEY
APRIL 2001
MINERALS MANAGEMENT SERVICE
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770 PASEO CAMARILLO
CAMARILLO, CA. 93010
Sea Surveyor, Inc.
800 Great Street, Suite C
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(707) 748-1852
SCALE: 1" = 50'
DRAWING NO. 4 of 8
APPROXIMATE PLATFORM OUTLINE
N 804,400'
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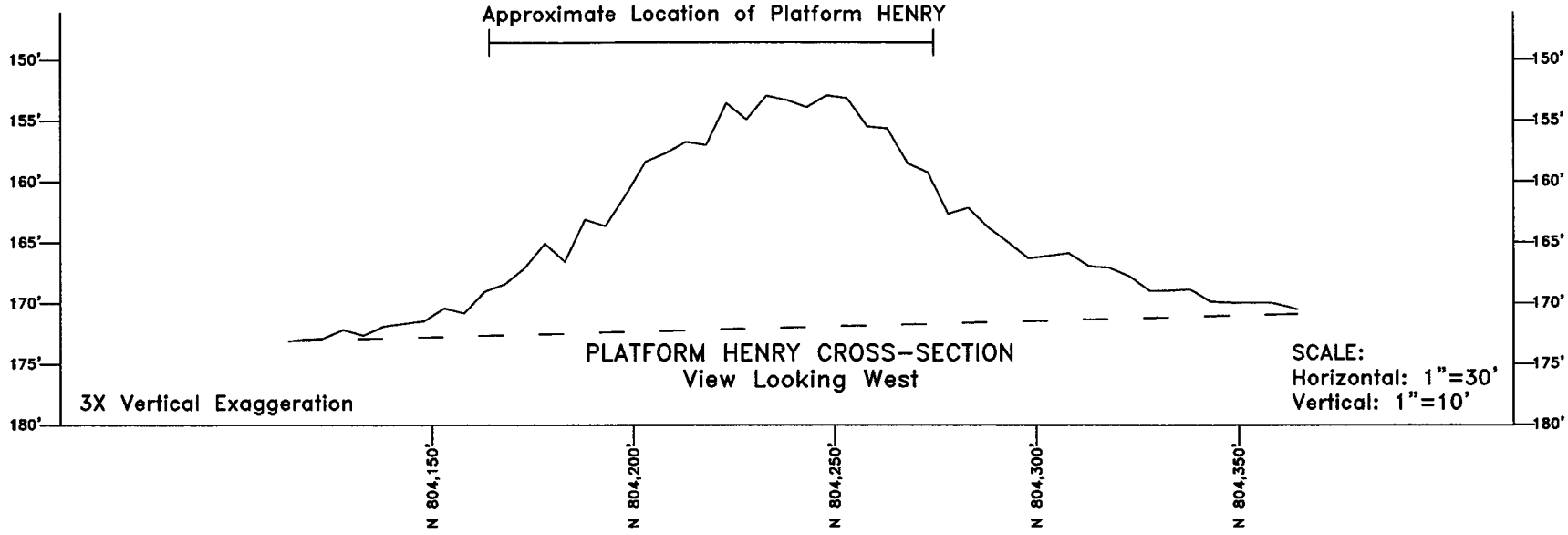

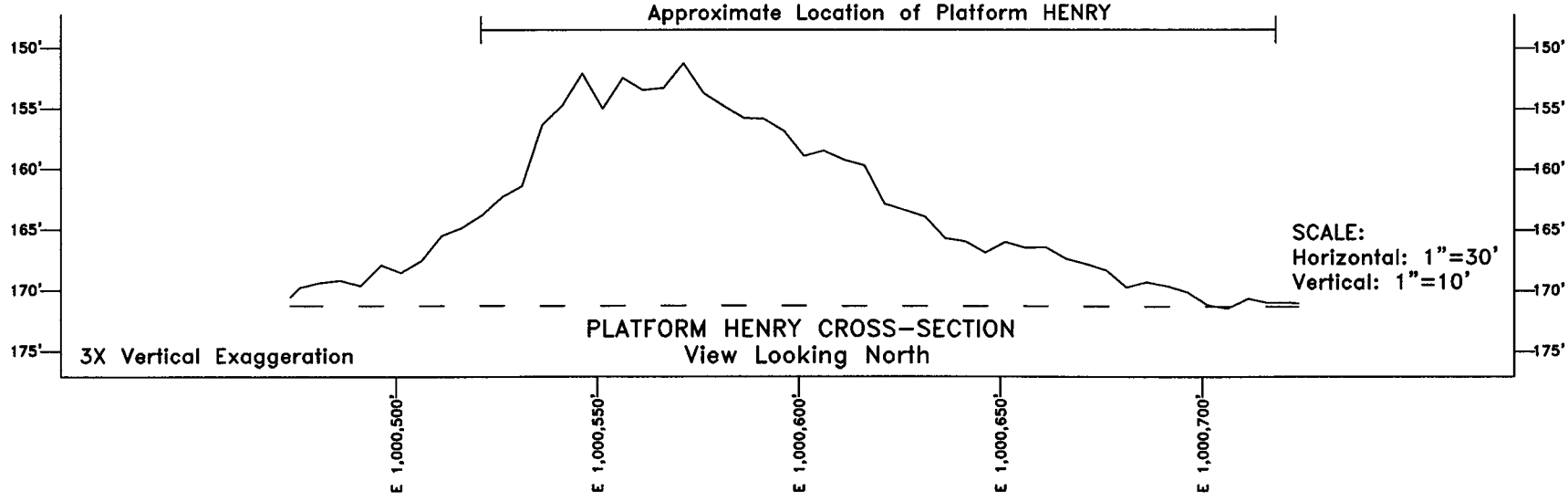

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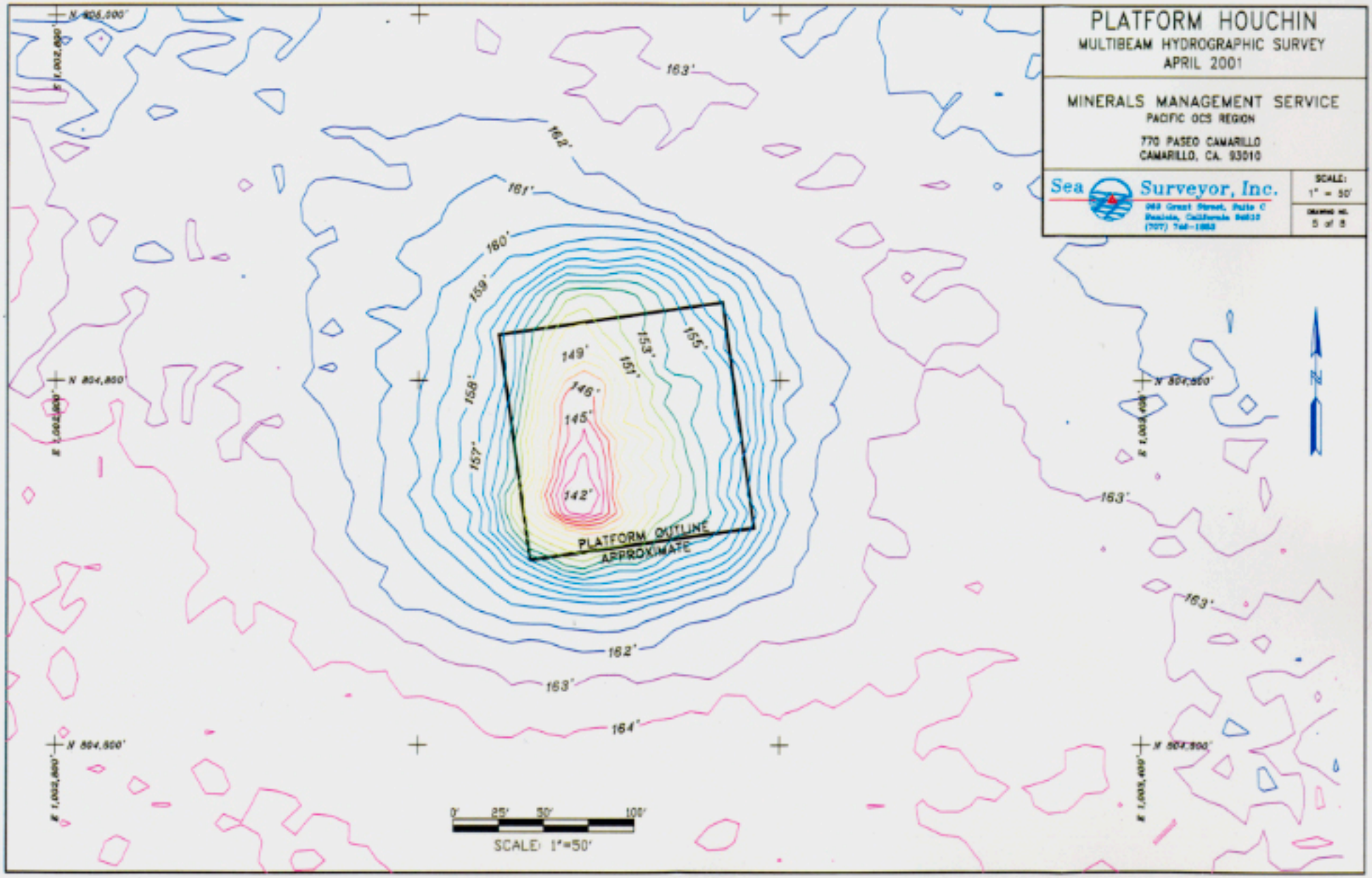
PLATFORM HENRY


PLATFORM HOUCHIN
MULTIBEAM HYDROGRAPHIC SURVEY
APRIL 2001
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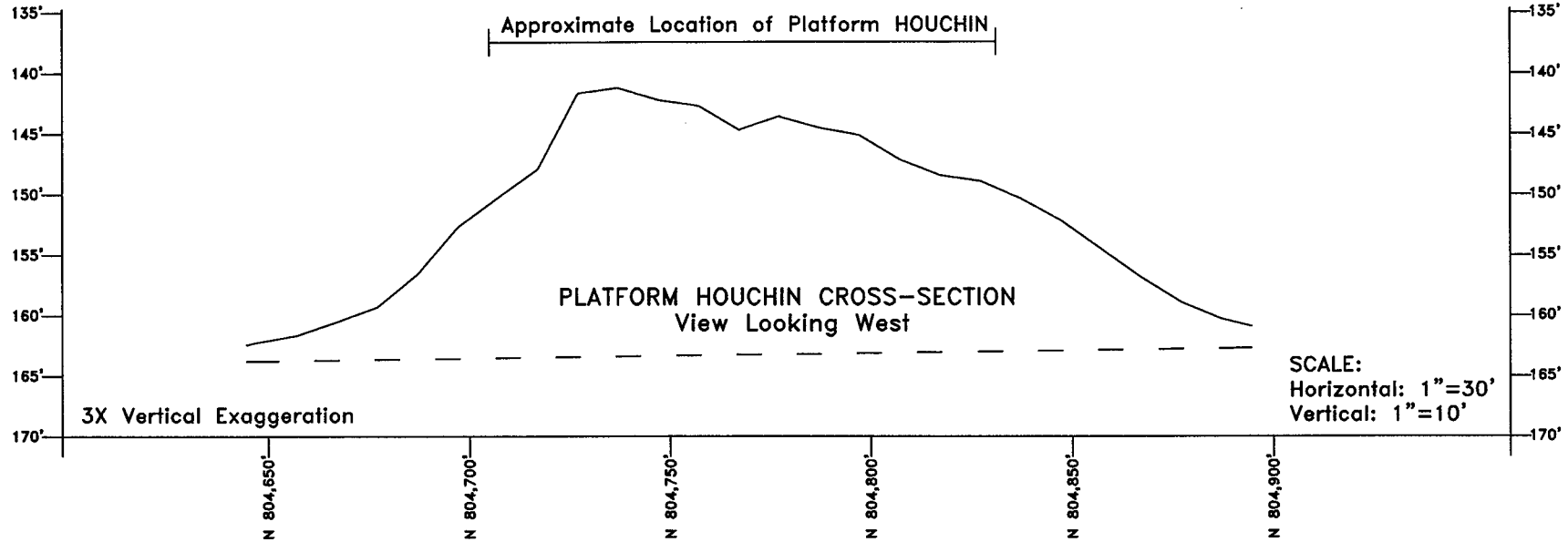
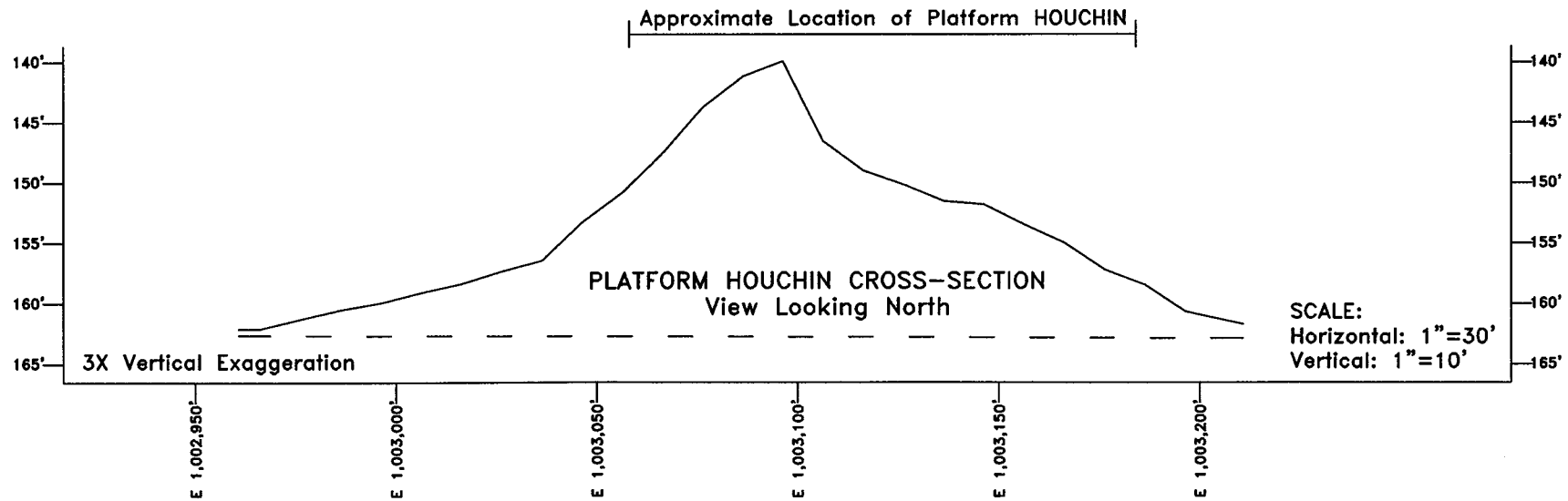
CAMARILLO, CA. 93010
Sea Surveyor, Inc.
SCALE: 1" = 50'
SHEET NO. 5 of 8
N 826,000'
E 1,032,600'
N 804,850'
E 1,032,600'
N 804,500'
E 1,032,600'
N 804,850'
E 1,033,400'
N 804,500'
E 1,033,400'
163'
162'
161'
160'
159'
158'
157'
149'
153'
155'
151'
148'
145'
142'
PLATFORM OUTLINE
APPROXIMATE
162'
163'
164'
163'
163'
0' 25' 50' 100'
SCALE 1"=50'





Sea Surveyor, Inc.
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Benicia, California 94510
(707) 746-1853

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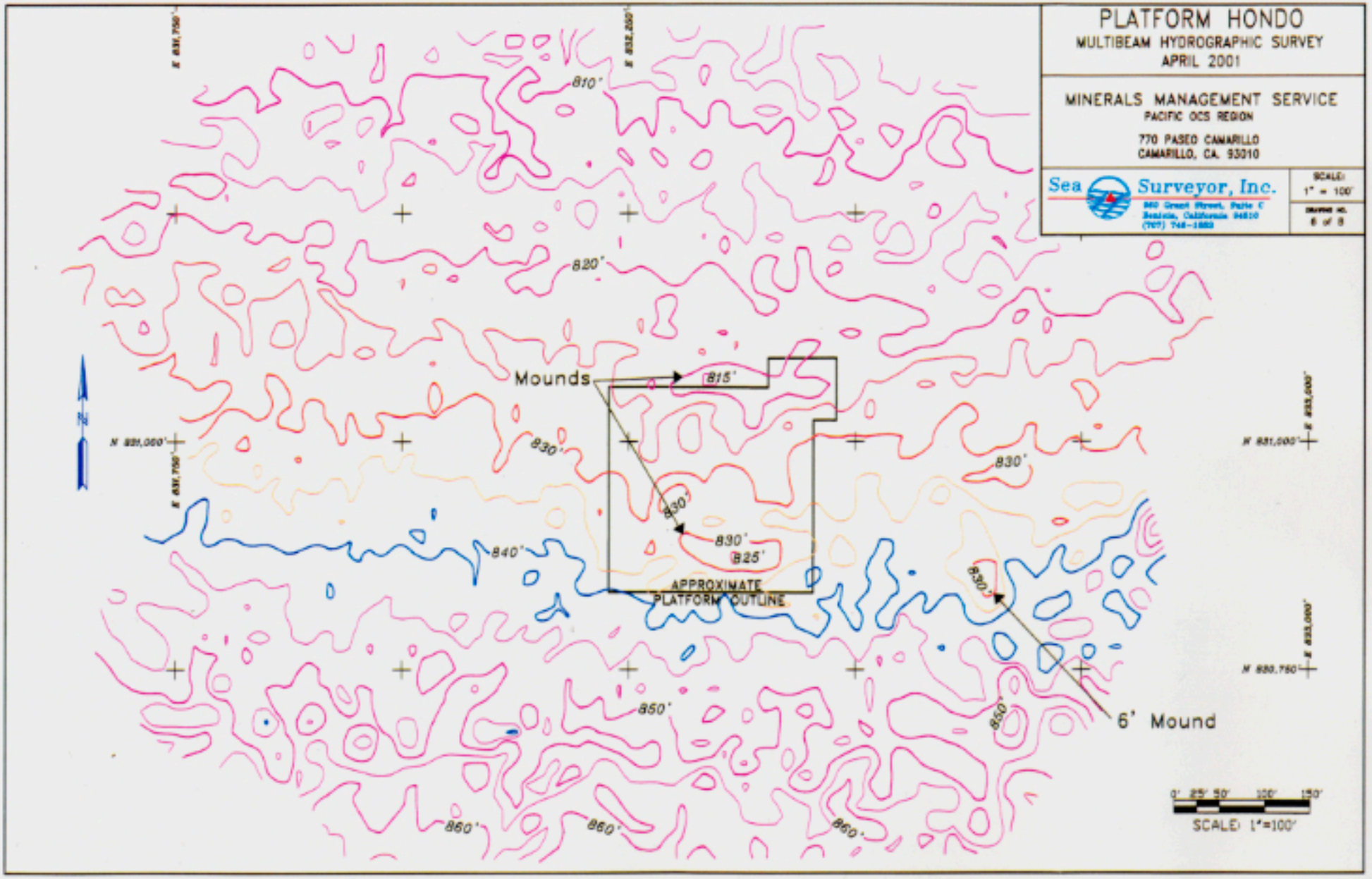
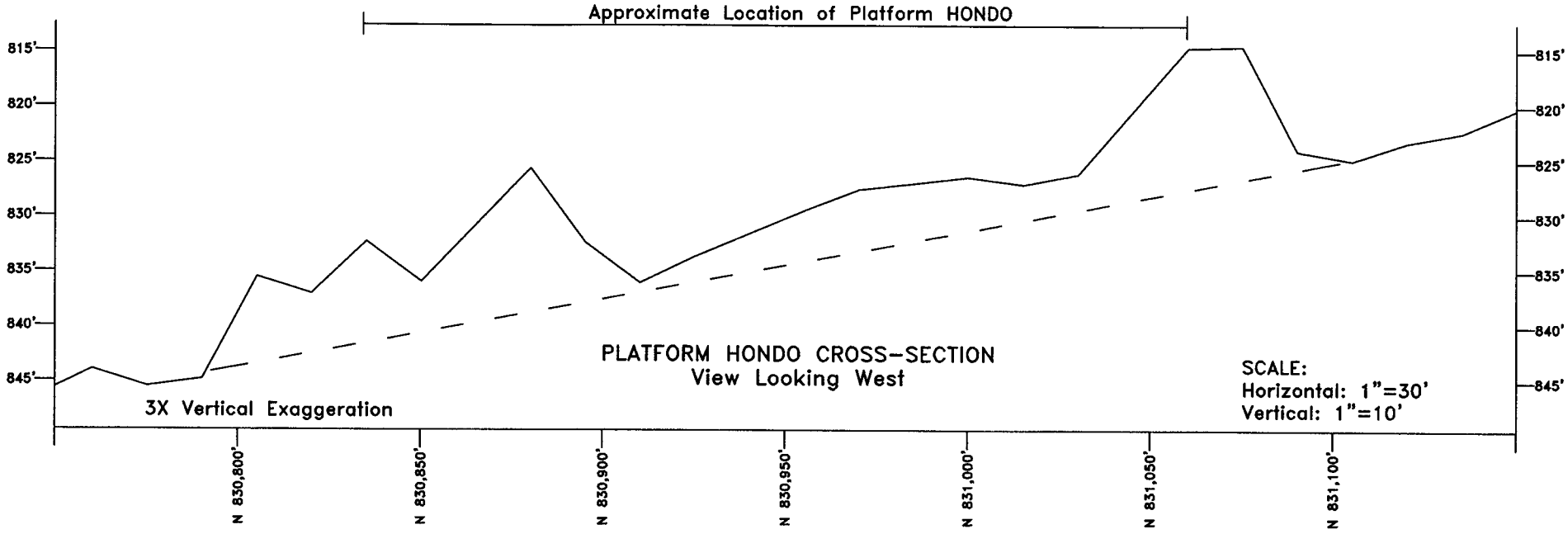
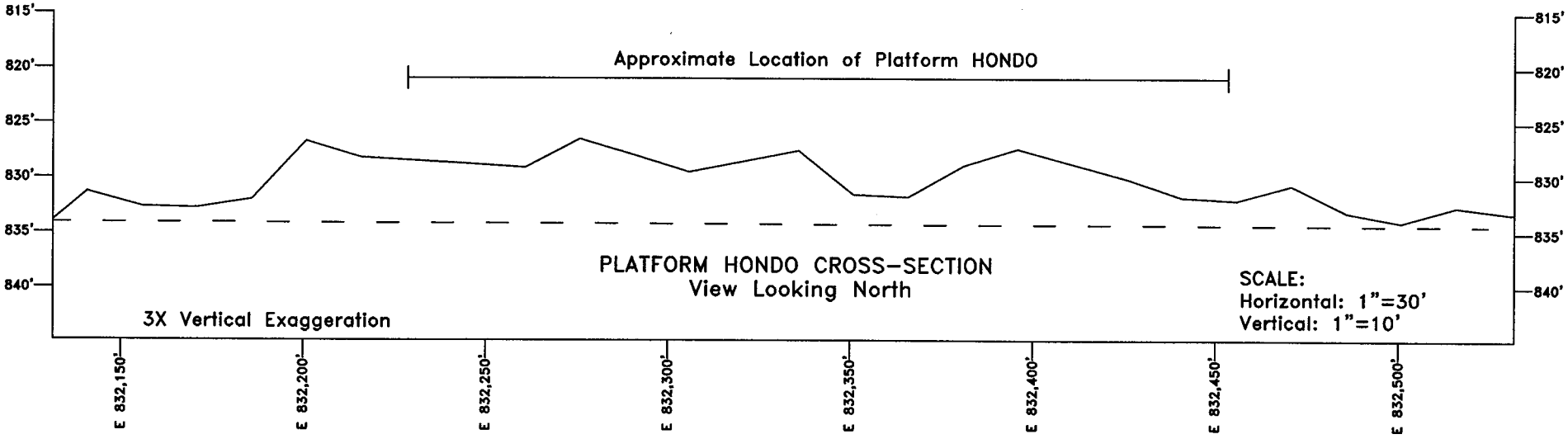
MMS PACIFIC OCS
770 Paseo Camarillo
Camarillo, CA 93010

PLATFORM HOUCHIN


PLATFORM HONDO
MULTIBEAM HYDROGRAPHIC SURVEY
APRIL 2001
MINERALS MANAGEMENT SERVICE
PACIFIC OCS REGION
770 PASEO CAMARILLO
CAMARILLO, CA. 93010
Sea Surveyor, Inc.
SCALE: 1" = 100'
E 831,750'
E 832,250'
E 833,000'
N 831,000'
N 830,750'
810'
820'
830'
840'
850'
860'
815'
825'
Mounds
APPROXIMATE PLATFORM OUTLINE
6' Mound
SCALE 1"=100'





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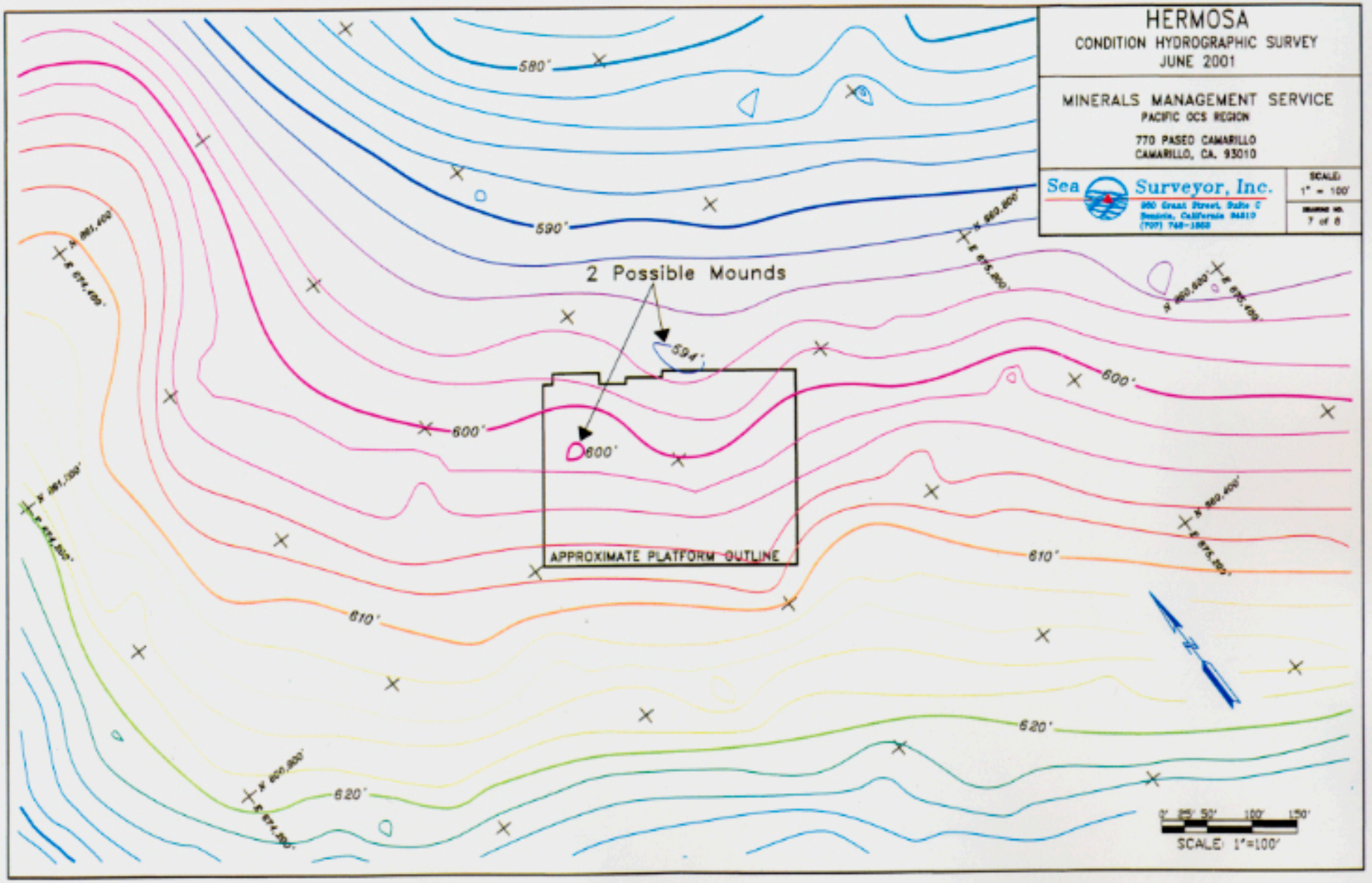
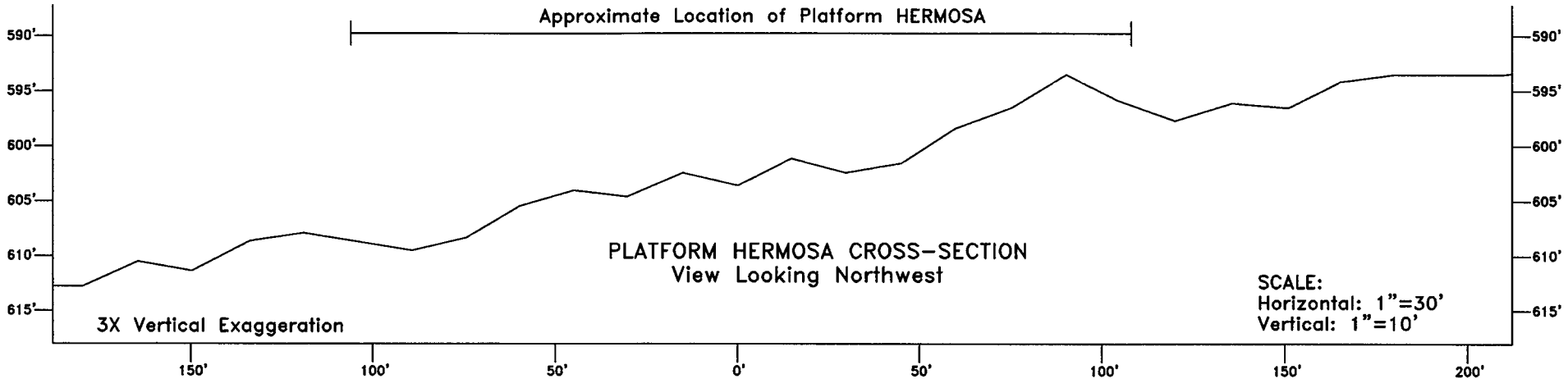
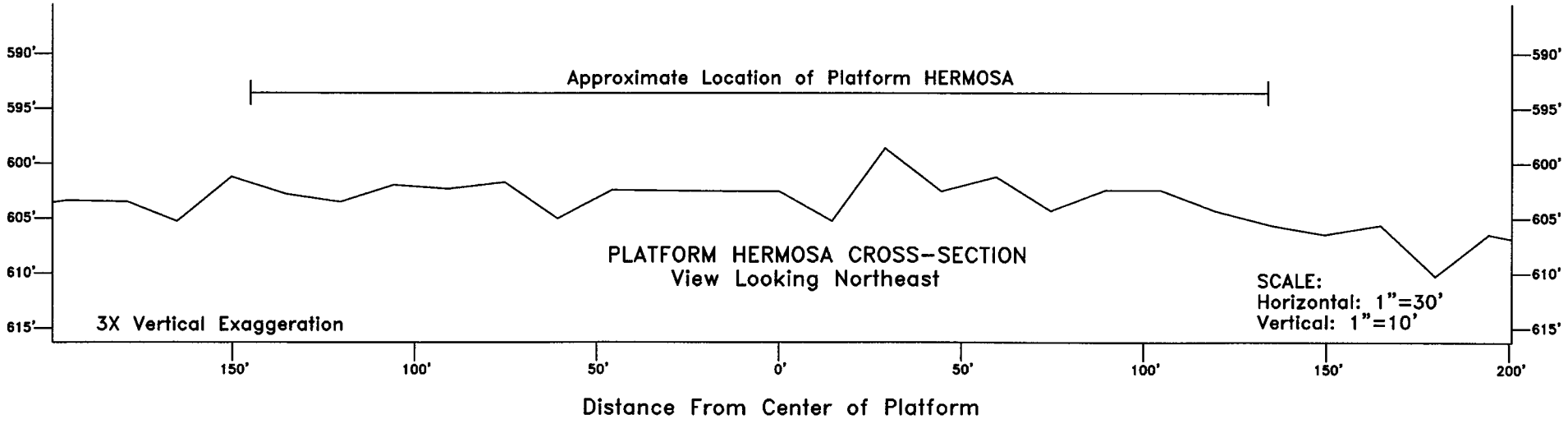
PLATFORM HONDO


HERMOSA
CONDITION HYDROGRAPHIC SURVEY
JUNE 2001
MINERALS MANAGEMENT SERVICE
PACIFIC OCS REGION
770 PASEO CAMARILLO
CAMARILLO, CA. 93010
Sea Surveyor, Inc.
950 Grant Street, Suite C
Seaside, California 93955
(707) 748-1868
SCALE: 1" = 100'
SHEET NO. 7 of 8
2 Possible Mounds
580'
590'
594'
600'
610'
620'
APPROXIMATE PLATFORM OUTLINE
SCALE: 1"=100'





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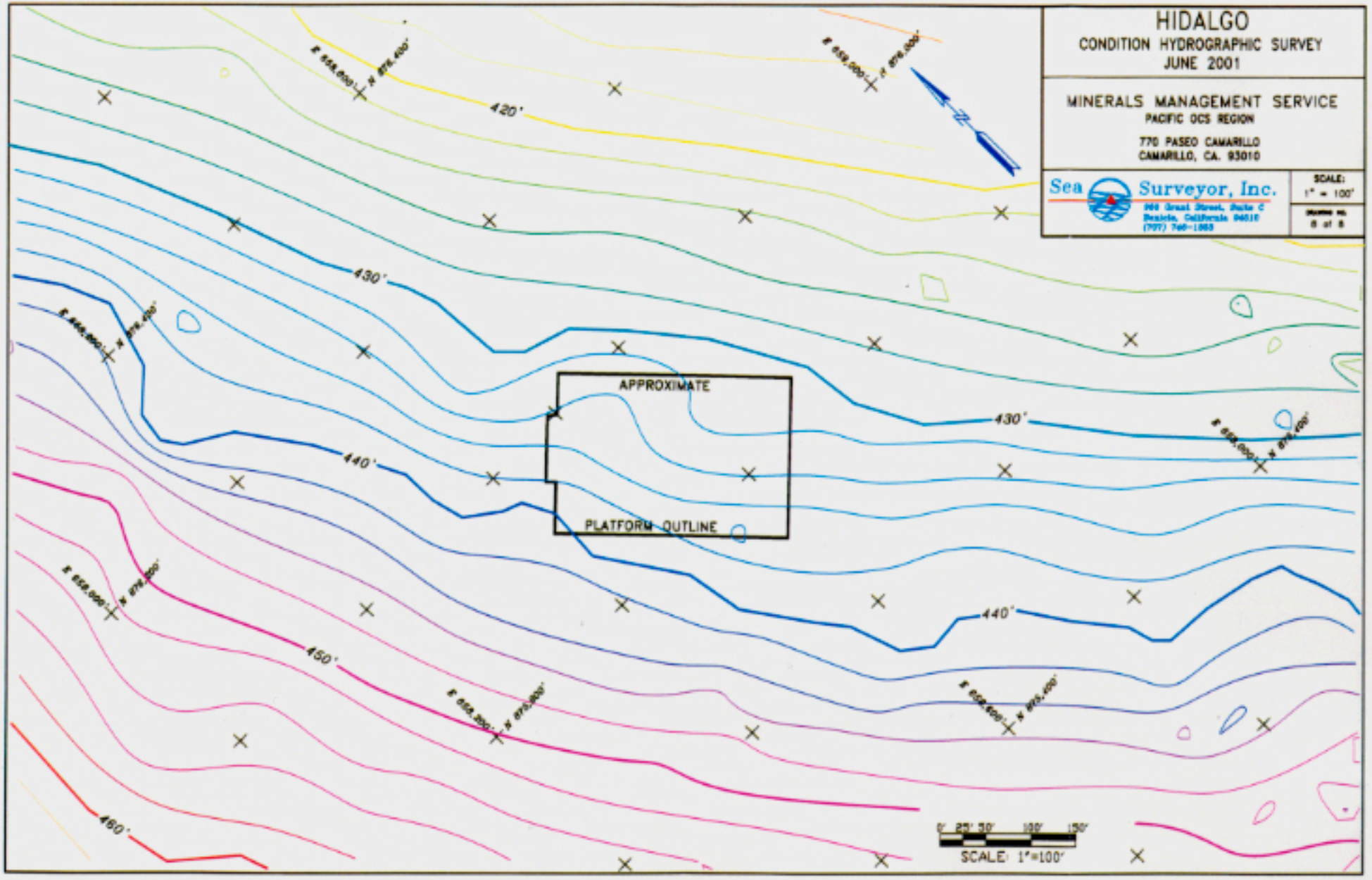
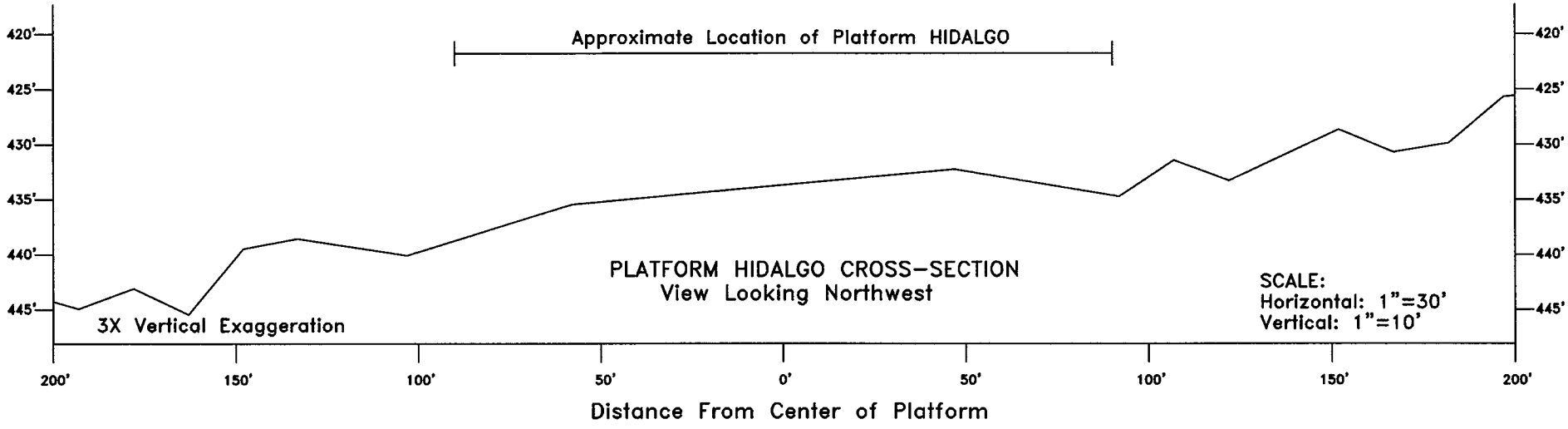
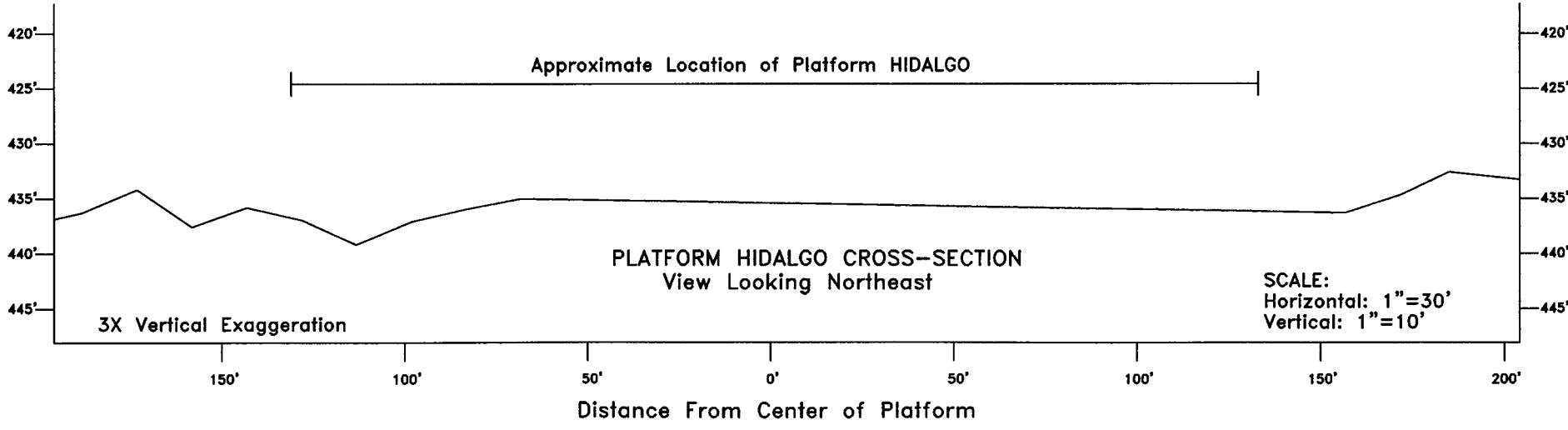
Camarillo, CA 93010

PLATFORM HERMOSA


HIDALGO
CONDITION HYDROGRAPHIC SURVEY
JUNE 2001
MINERALS MANAGEMENT SERVICE
PACIFIC OCS REGION
770 PASEO CAMARILLO
CAMARILLO, CA. 93010
Sea Surveyor, Inc.
SCALE: 1" = 100'
420'
430'
440'
450'
460'
APPROXIMATE
PLATFORM OUTLINE
SCALE: 1"=100'





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Camarillo, CA 93010

PLATFORM HIDALGO