

Cornet Bay Marina
Oak Harbor
LUST# 2389

Cornet Bay Marina Bulkhead Assessment

November 8, 2006

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Reid Middleton

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File No. 242006.015

November 8, 2006
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Ms. Jil Frain
EA Engineering, Science, and Technology
12011 NE First Street, Suite 100
Bellevue, WA 98005

*Engineers
Planners
Surveyors*

Subject: Cornet Bay Marina Bulkhead Assessment

Reference: Agreement for Professional Services, dated September 1, 2006

Dear Ms. Frain:

The Washington State Department of Ecology (DOE) will conduct environmental restoration involving soil cleanup at Cornet Bay Marina in Oak Harbor, Washington. Prior to performance of the environmental work, Reid Middleton was contracted to perform an assessment of a timber bulkhead at the Marina. Reid Middleton, Inc. is a civil and structural engineering, planning, and surveying firm that provides multidisciplinary development services in the Pacific Northwest and Alaska. We specialize in designing and managing projects in the aviation, military, public works, commercial and industrial, state and institutional, and waterfront areas.

The assessment will determine the condition of the timber bulkhead, comment on proposed construction activities and constraints to protect the bulkhead, and provide an opinion of probable design and construction costs for a replacement bulkhead (if required).

Bulkhead Field Investigation

Reid Middleton conducted the field investigation on September 7, 2006. The weather was partly sunny. The tide was falling to a low tide of 0.0 feet (MLLW=0.0) during the first three hours; high tide was about seven hours later. Field observation at the base of the bulkhead was performed without tidal water present. The tidewater did not reach the bulkhead during the entire field investigation.

The bulkhead was constructed in the 1960s and is approximately 300 feet long. The investigation was performed on foot by a two-person team. The investigation included visual, sounding, and limited destructive evaluations. Sounding involves hitting the timber elements with a hammer and listening for hollow areas. Limited destructive evaluation for a timber structure involves drilling timber elements to determine the size of rot pockets and remaining element thickness.

Washington
Oregon
Alaska

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The investigation began at the north junction of the bulkhead at the “Shell” sign and proceeded south to the walkway to the marina. Subsequent numbering of elements is from north to south, see Figure 1. The main focus of the investigation is a section of bulkhead approximately 170 feet long. The 40-foot long section of bulkhead north of the “Shell” sign was also investigated.

Construction plans are not available for the bulkhead, which consists of creosote-treated timber piling spaced 4 feet on center. Four creosote-treated horizontal walers are behind the piling. Vertical creosote-treated timber planks are attached to the walers. Steel cable tie-backs are wrapped around the top of the piling and angled into the retained fill material. Due to the presence of fill behind the bulkhead, field personnel were unable to determine the type, arrangement, and location of the tie-back anchors. Excavation to the anchors was not included in this scope of work.

Investigation Results

There are three areas of notable deterioration of piling. The following groups of piling are rotten: Piling 4, 5, 13, 14, 15, 45, and 46. Cable tie-backs have some minor surface rust.

There are several locations where the lowest level walers are rotten. The most notable location is the rotten waler that spans from Pile 28 to Pile 33.

Several timber planks were rotten, typically from the mudline up to 3 feet above the mudline. There were a few areas where a small amount of fine fill material has migrated through the timber plank joint or deteriorated location.

The locations of deterioration for piling, walers, and planks did not overlap; so there were no compounding effects on the bulkhead integrity.

Estimated Life Expectancy

A visual and limited destructive evaluation was performed on the timber bulkhead at Cornet Bay Marina. The bulkhead is rated as fair condition. This rating is due primarily to the condition of the piling and lowest level walers. The deteriorated state of the piling and walers is due to checks, splits, construction notching, or mechanical damage that allows water and marine borers to enter the members.

Based on the age and condition of the bulkhead, the life expectancy of the timber planks is estimated to be between seven and ten years. The life expectancy of the piling is anticipated to be between eight and twelve years. Life expectancy of the lowest level walers is estimated at five to eight years. Life expectancy is defined as

individual member failure. Total failure of a portion of the bulkhead would be due to failure of numerous individual elements. There should be evidence of partial failure of the bulkhead in about 10 years. This would likely involve failure of a small section of bulkhead or localized bulging of the bulkhead.

Construction Activities Measures

The following are proposed construction activities that may occur adjacent to the bulkhead.

- Remove soil on the shore side of bulkhead using an excavator to a maximum depth of 9 feet below finished grade.
- Drill holes 4 to 6 feet shore side from the bulkhead using a drill rig to a depth of approximately 15 feet from finished grade.
- Dig and fill trenches 2 to 4 feet deep within 4 to 6 feet shore side of bulkhead.
- Move and replace the store and its concrete foundation.

The following constraints or measures to protect the bulkhead are recommended for each activity.

Remove Soil

Soil material may be removed on the shore side of the bulkhead to a maximum depth of 9 feet below finished grade if the following criteria are followed. No equipment will be allowed within the "no load zone" adjacent to the bulkhead. This no load zone is defined as 16 feet landward from the bulkhead. Any equipment used must be able to reach from 16 feet away. Equipment beyond the no load zone must be placed on a timber raft to distribute the equipment load so that the maximum loading is 100 pounds per square foot. See Figure 6 for an example of equipment on a timber raft. During the excavation procedure, a slope of 30 degrees must be maintained for the excavation area for soil stability under the equipment. In addition, the existing cable tie-backs are not to be removed until 7 feet of depth of soil material is removed from behind the bulkhead. Maximum wall length where tie-backs are removed should be limited to 50 feet. See the attached Figure 2 for details.

Drill Rig

A drill rig may be used on soil that has not been disturbed; thus, no excavation shall occur prior to use of a drill rig. The drill rig should stay a minimum of 6 feet

landward from the bulkhead. The drill rig must be placed on a timber raft to distribute the load so the maximum loading is 100 pounds per square foot. Maximum weight of the drill rig is limited to 20,000 pounds. In addition, the drill rig should only be used for a maximum duration of 4 hours at any location. See attached Figure 3 for details.

If the drill rig is used in an area located 19 feet or farther land side of the bulkhead, then no restrictions are required.

Trenches

Digging and filling trenches 2 to 4 feet wide within 4 to 6 feet from the bulkhead will be allowed with a 16-foot wide no load zone. This requires trenching equipment to stand off 16 feet from the bulkhead and reach 10 to 12 feet. The equipment must use a timber raft to distribute loads, so the maximum loading is 100 pounds per square foot.

Store

The equipment used to move and replace the store and its concrete foundation shall be located east of the store; however, if equipment needs to get close to the west side of the store, a 19-foot wide no load zone must be followed, see Figure 4. No weight restrictions are required beyond the 19-foot no load zone.

General Constraint

There are no restrictions on equipment weight or construction activities if they occur beyond a 19-foot no load zone from the bulkhead, see Figure 4. A minimum of 2 feet of undisturbed soil cover over the existing tie-back anchor must be maintained to avoid loss of integrity of anchor, see Figure 5. Once an anchor is encountered, the maximum depth of excavation is limited to 2 feet above any anchor throughout the project.

Bulkhead Replacement

We recommend a steel sheet pile and steel tie-back system as the most appropriate replacement bulkhead for the site conditions. The preferred location of the new bulkhead would be water side of the existing bulkhead, with the existing bulkhead abandoned in place. Abandonment of the bulkhead in place would be based on permitting approval. The opinion of probable cost is based on replacing the entire bulkhead. This includes the same segments of bulkhead that were inspected, which are approximately 170 and 40 feet long, plus a 105-foot long section not investigated, for a total of 315 linear feet.

Opinion of Probable Costs

A preliminary opinion of probable cost to design and construct a replacement steel sheet pile bulkhead for the 315 linear feet is \$1,070,000. The following elements are included in the design cost: Site surveying, permitting, soil report (include site sample testing), structural calculations, construction cost estimate, specifications, and drawings. An additional \$50,000 should be added to the budget if assistance during the bidding phase of the construction contract is required.

Conclusion

Approximately 210 linear feet of bulkhead was investigated during a visual, sounding, and limited destructive evaluation of the timber bulkhead at the Cornet Bay Marina. The bulkhead is in fair condition due to the piling and lowest level walers. Life expectancy is defined as individual member failure. There should be evidence of partial failure of the bulkhead in about 10 years. This would typically involve failure of a small section of bulkhead or localized bulging of the bulkhead.

Based on the age and condition of the bulkhead, the life expectancy is anticipated to be between seven and ten years for the timber planks, eight and twelve years for the piling, and five to eight years for the lowest level walers.

Soil removal may be performed with a no load zone 16 feet landward from the bulkhead. Additional constraints include equipment placed on a timber raft to distribute load to 100 pounds per square foot maximum, maintaining a 30-degree slope during excavation, and not removing cable tie-backs until 7 feet of soil material behind the bulkhead is removed. Maximum wall length where tie-backs are removed should be limited to 50 feet.

A drill rig with a maximum weight of 20,000 pounds may be used on undisturbed soil. Added constraints include using a timber raft to distribute the load to 100 pounds per square foot maximum and using the drill rig for no more than four hours at any location.

Trenches may be dug and filled adjacent to the bulkhead if a no load zone 16 feet landward from the bulkhead is used. In addition, trenching equipment must use a timber raft to distribute loads to 100 pounds per square foot maximum, in an area 16 to 19 feet landward of the bulkhead.

Equipment used to move and replace the store and its concrete foundation should be located east of the store. If equipment needs to access the west side of the store, a 19-foot no load zone landward from the bulkhead must be followed.

There are no restrictions on construction activity 19 feet landward from the bulkhead. Any construction activity that occurs 16 to 19 feet landward from the bulkhead requires using a timber raft to distribute equipment loading to 100 pounds per square foot maximum.

A sheet pile with steel tie-back system is the recommended replacement bulkhead if necessary. A budgetary cost estimate of \$1,070,000 should be planned for the design and construction of the replacement steel sheet pile bulkhead. This estimate is for the entire length of bulkhead, which is approximately 315 linear feet. The replacement bulkhead is to be installed waterward of the existing bulkhead. Abandonment of the existing bulkhead in place is conditioned on permitting approval.

Sincerely,

Reid Middleton, Inc.



Jason K. Kikuta, P.E.
Project Engineer

Attachments:

- Figure 1 - Marina Site Map
- Figure 2 - Construction Activity Measures
- Figure 3 - Construction Activity Measures
- Figure 4 - Construction Activity Measures
- Figure 5 - Construction Activity Measures
- Figure 6 - Equipment on Timber Raft

11/01/2006 10:25am I:\24\06\015\ASSESSMENT\1415-FIG1.dwg

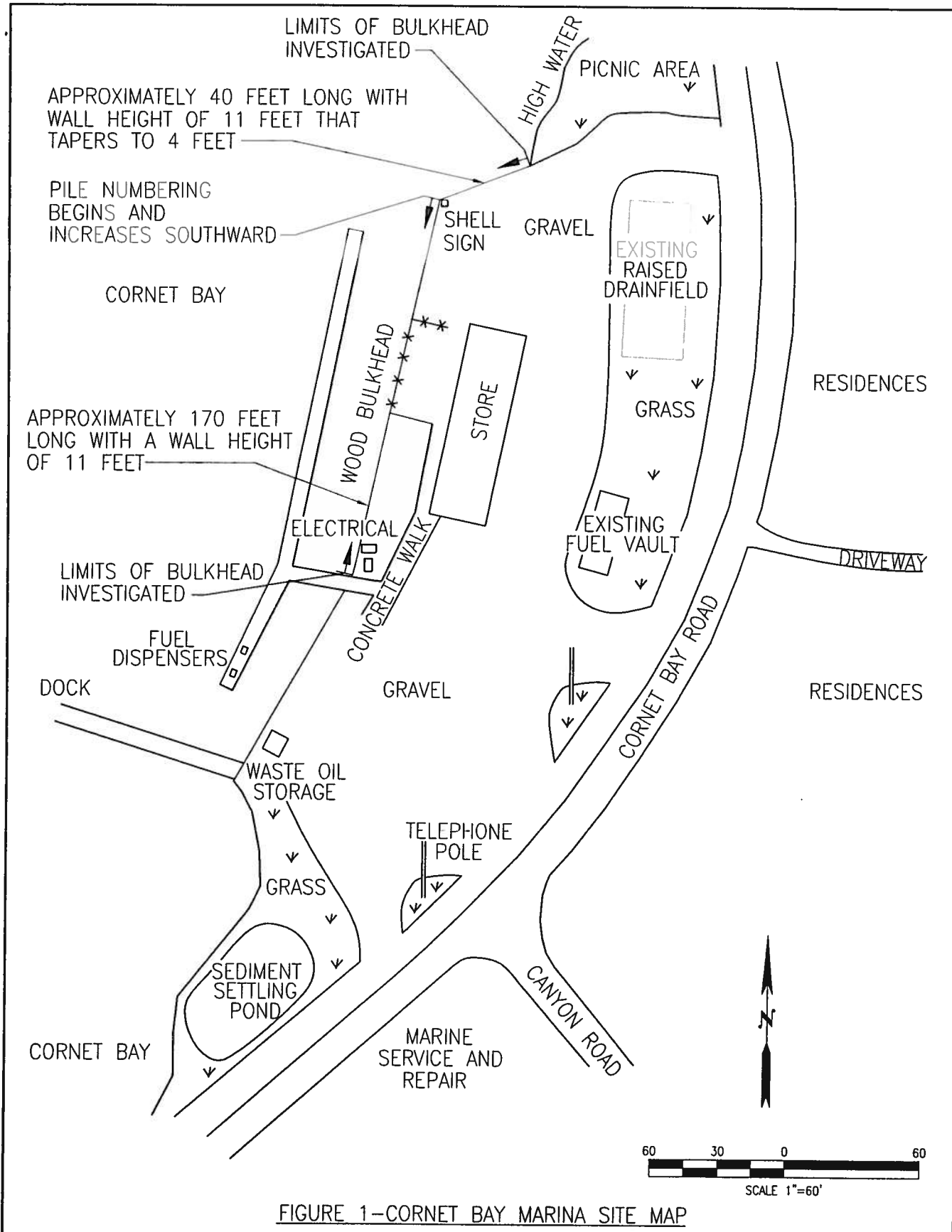


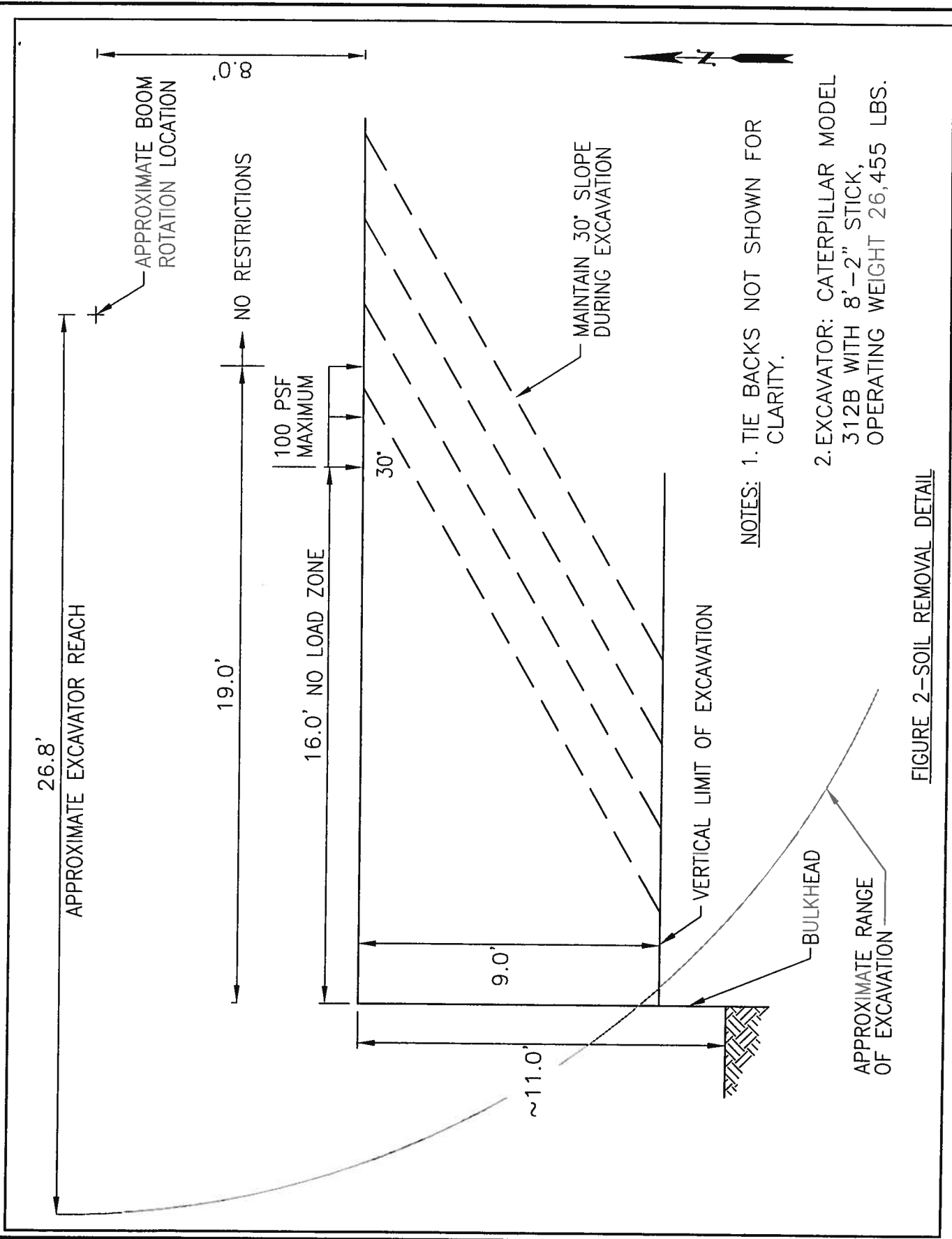
FIGURE 1-CORNET BAY MARINA SITE MAP

CORNET BAY MARINA



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REFERENCE TO SHEET	SCALE	SHEET NO.
DES. JKK	AS SHOWN	
DR. CSM	F.B.	FIG. 1
CH.	DATE 9-29-06	
FILE NO. 24.06.015		OF X SHEETS



- NOTES:
1. TIE BACKS NOT SHOWN FOR CLARITY.
 2. EXCAVATOR: CATERPILLAR MODEL 312B WITH 8'-2" STICK, OPERATING WEIGHT 26,455 LBS.

FIGURE 2-SOIL REMOVAL DETAIL

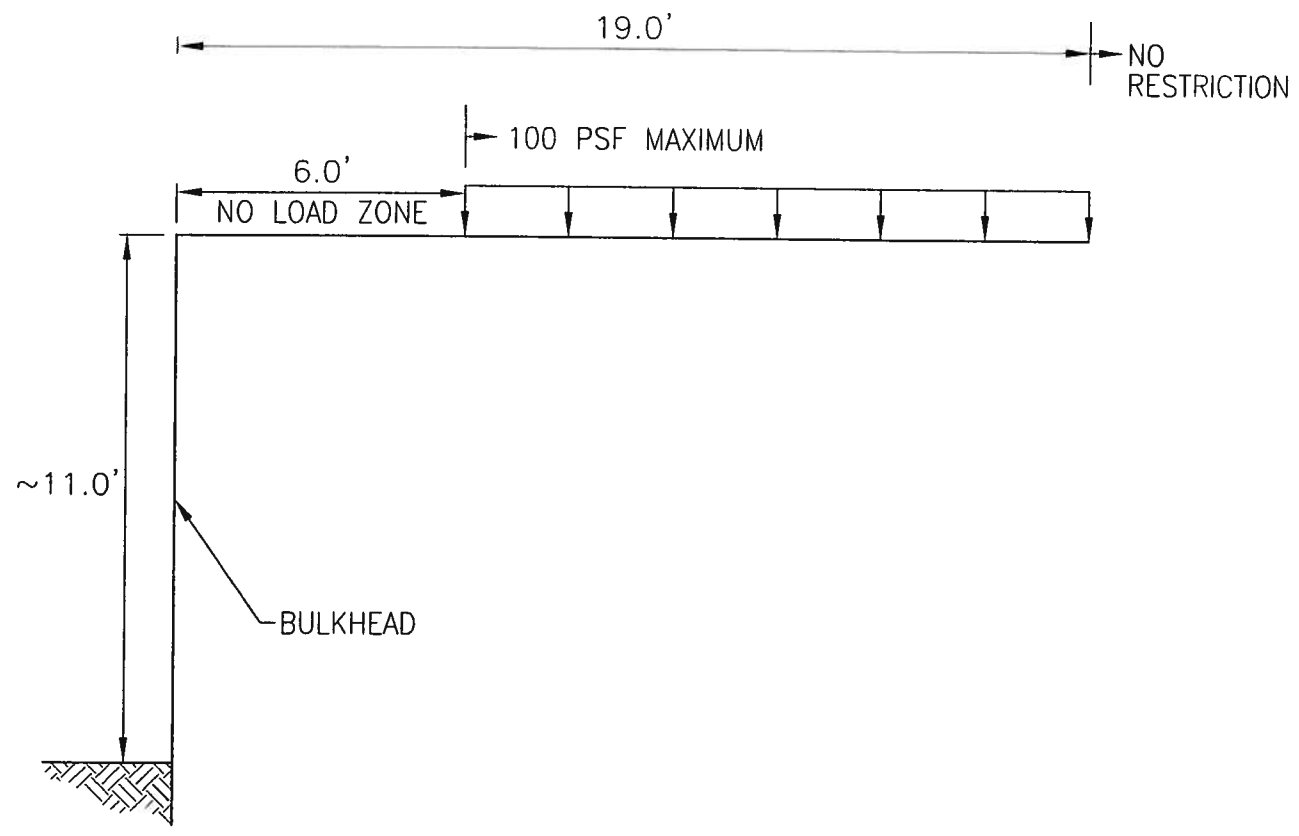
CORNET BAY MARINA
CONSTRUCTION ACTIVITY MEASURES



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REFERENCE TO SHEET		SCALE NONE	SHEET NO.
DES. JKK			
DR. CSM		F.B.	FIG. 2
CH.		DATE 9-29-06	
FILE NO. 24.06.015		OF X SHEETS	

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NOTE: DRILL RIG ALLOWED ONLY ON UNDISTURBED SOIL.
 THIS DETAIL IS FOR DRILL RIG APPLICATION ONLY.



FIGURE 3-DRILL RIG DETAIL

CORNET BAY MARINA
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REFERENCE TO SHEET		SCALE NONE	SHEET NO.
DES. JKK			
DR. CSM	F.B.	DATE 9-29-06	FIG. 3
CH.			
FILE NO. 24.06.015		OF X SHEETS	

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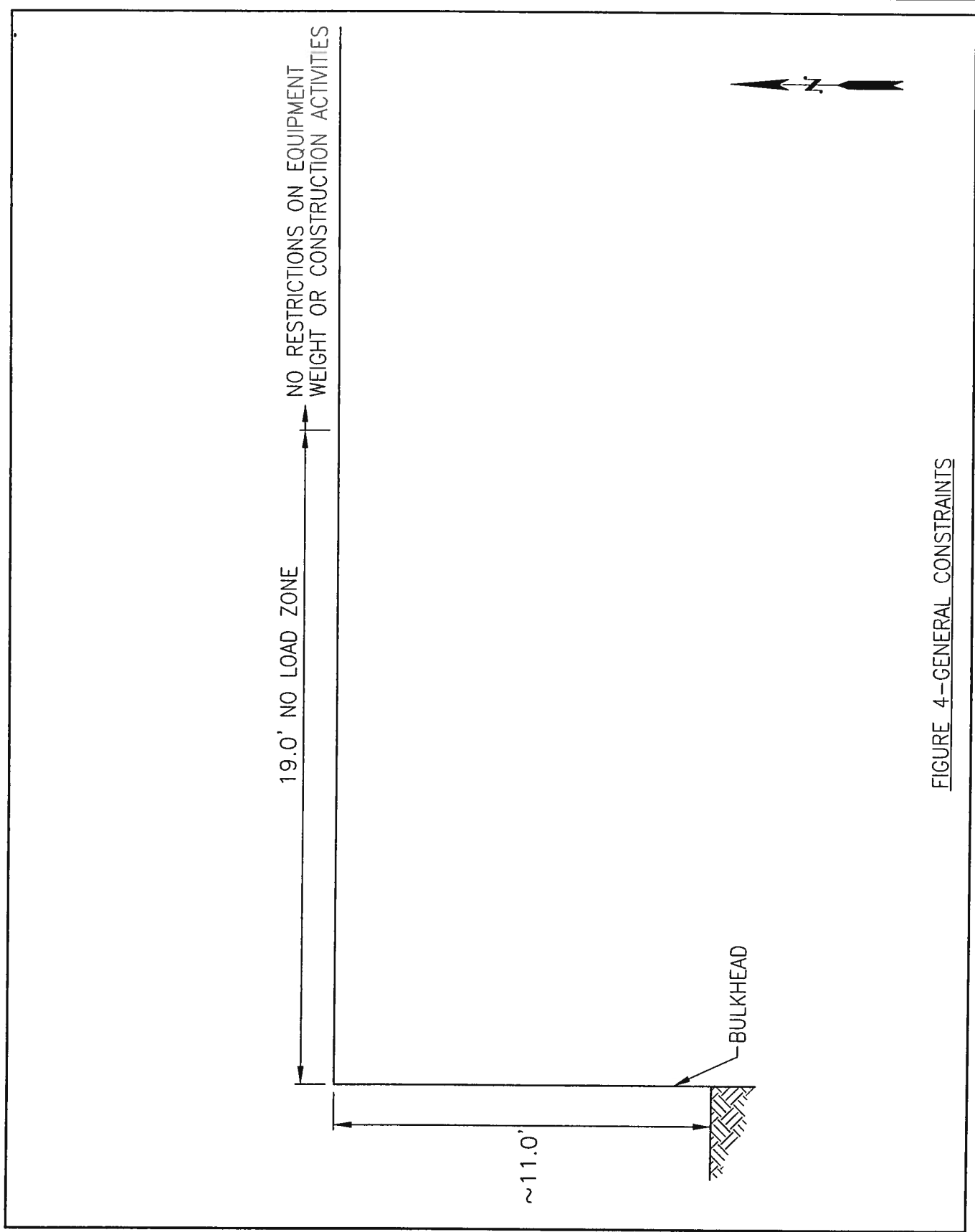


FIGURE 4--GENERAL CONSTRAINTS

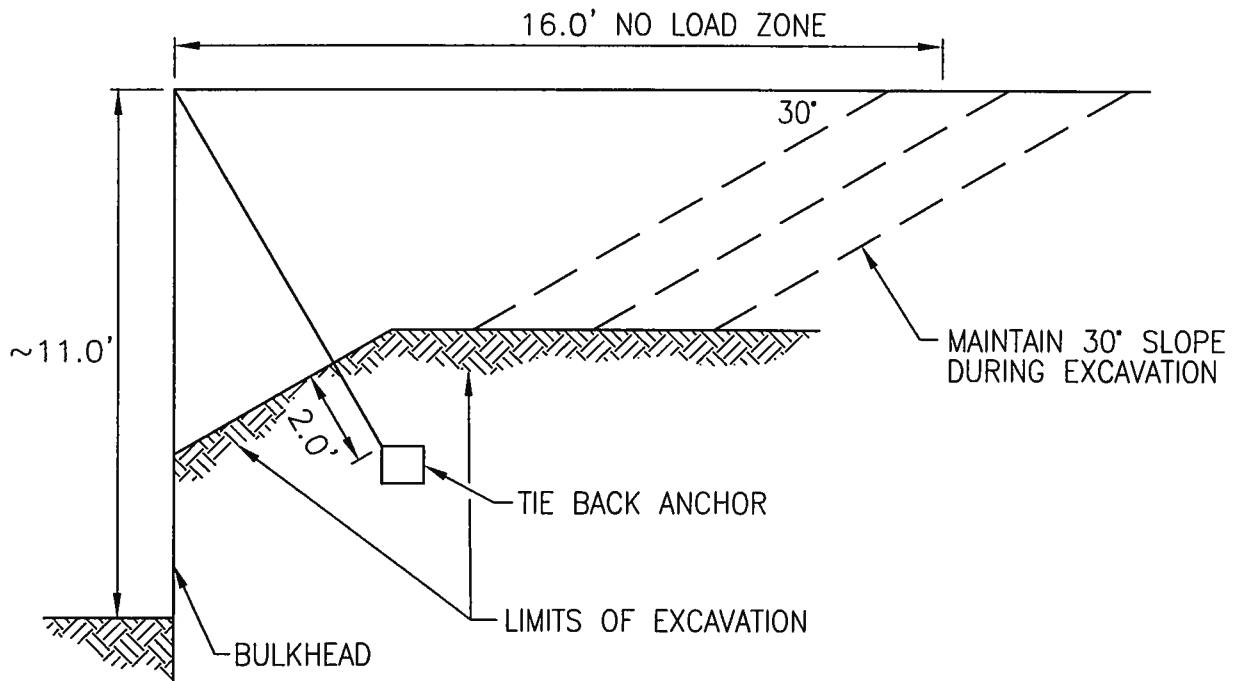
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REFERENCE TO SHEET		SCALE NONE	SHEET NO.
DES. JKK			
DR. CSM		F.B.	FIG. 4
CH.		DATE 9-29-06	
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LIMITS ON EXCAVATION WHEN TIE BACK ANCHOR ENCOUNTERED ABOVE MAXIMUM EXCAVATION DEPTH OF 9 FEET



FIGURE 5—GENERAL CONSTRAINTS

CORNET BAY MARINA
CONSTRUCTION ACTIVITY MEASURES

REFERENCE TO SHEET

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DATE 9-29-06

FIG. 5

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Figure 6. Equipment on Timber Raft.

