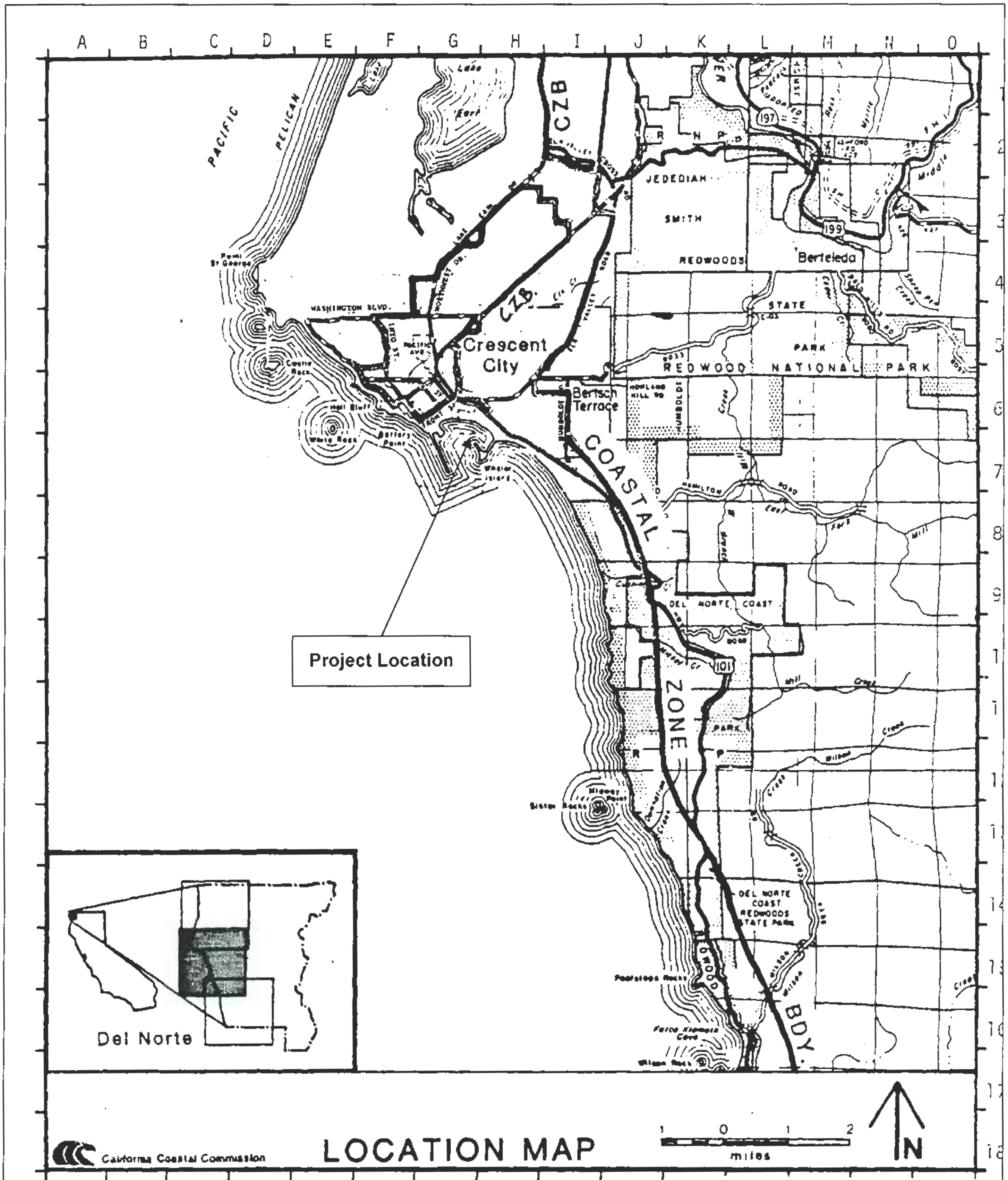


County of Del Norte

EXHIBIT NO. 1

APPLICATION NO.

1-10-035

CRESCENT CITY HARBOR DISTRICT

LOCATION MAP

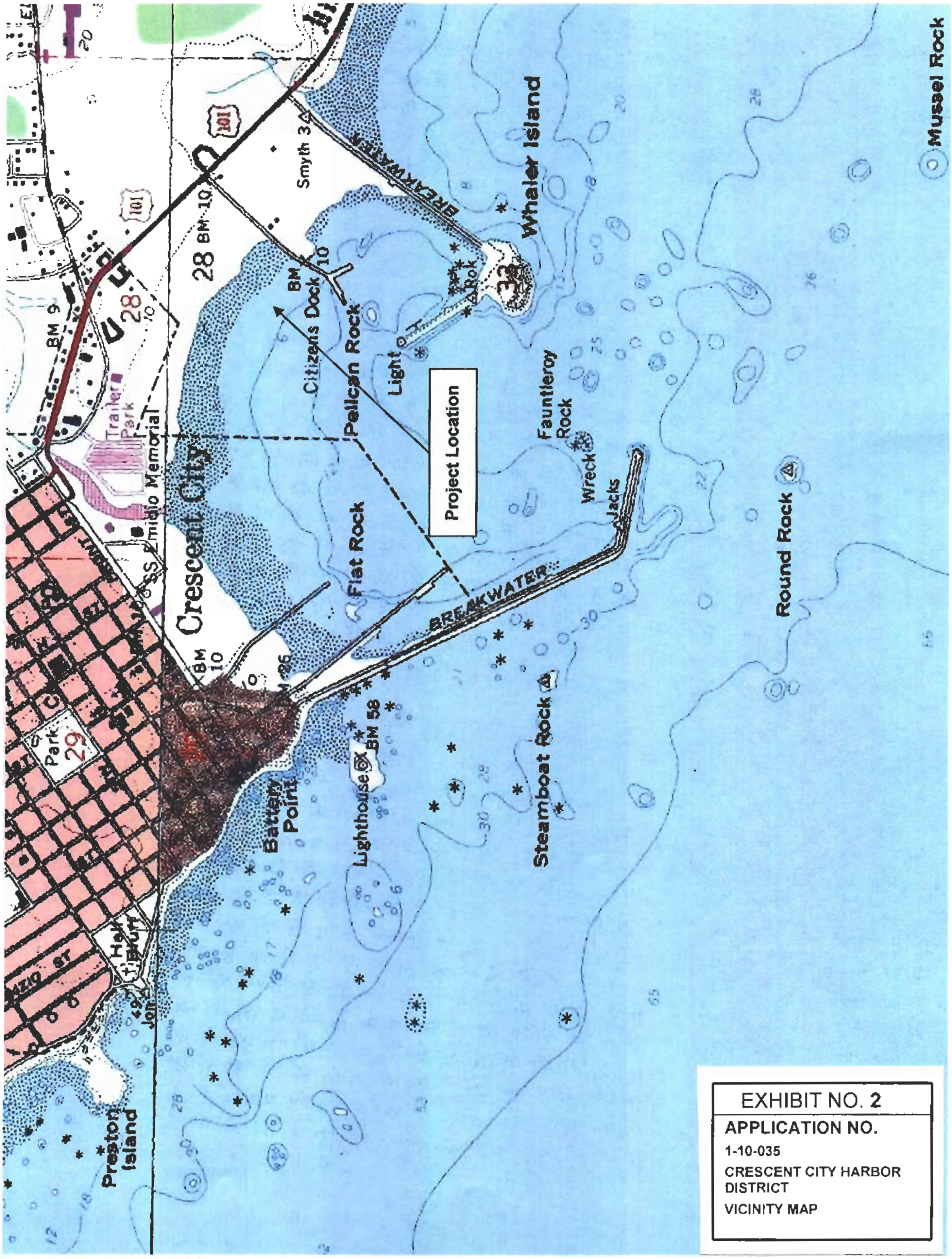


EXHIBIT NO. 2

**APPLICATION NO.**

**1-10-035**

**CRESCENT CITY HARBOR DISTRICT**

**VICINITY MAP**


EXHIBIT NO. 3

APPLICATION NO.

1-10-035

CRESCENT CITY HARBOR DISTRICT

PROJECT SITE AERIAL

EXHIBIT NO. 4
APPLICATION NO.
1-10-035
CRESCENT CITY HARBOR DISTRICT
PROJECT SITE OBLIQUE AERIAL

Source: California Coastal Records Project – 

VICINITY MAP

CRESCENT CITY HARBOR DISTRICT

CRESCENT CITY, CALIFORNIA

# CCHD
# MARINA REPLACEMENT

PROJECT LOCATION

EXHIBIT NO. 5

**APPLICATION NO.**

**1-10-035**

**CRESCENT CITY HARBOR DISTRICT**

**PROJECT PLANS (1 of 27)**

INDEX OF DRAWINGS



**30% DRAFT SUBMITTAL SET 04-16-10**

| No. | Date | Revision | Apvd. |
|---|---|---|---|

DRAWING INFO. DESIGNED BY: JWD DRAWN BY: JJB CHECKED BY: TWT

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CRESCENT CITY HARBOR DISTRICT
BOAT BASIN
CRESCENT CITY, CA

COVER SHEET

JOB NO. 2009-010
SCALE:
DATE: 04-16-10
SHEET
MS1.00

## GENERAL NOTES AND SPECIFICATIONS

### A. GENERAL NOTES

1. THESE GENERAL NOTES PERTAIN TO THE CRESCENT CITY HARBOR DISTRICT INNER BOAT BASIN RECONSTRUCTION, CRESCENT CITY, CALIFORNIA.
2. ALL WORK SHALL CONFORM TO ALL LOCAL BUILDING CODES AND ORDINANCES. WORK SHALL BE COORDINATED WITH THE CRESCENT CITY HARBOR DISTRICT TO MAINTAIN OPERATION AS REQUIRED.
3. PRIOR TO ORDERING FABRICATED MATERIALS OR BEGINNING CONSTRUCTION, CONTRACTOR SHALL VERIFY ALL EXISTING CONDITIONS AND PROPOSED DIMENSIONS AT THE JOB SITE AND SHALL COMPARE STRUCTURAL, CIVIL, MECHANICAL AND ELECTRICAL DRAWINGS BEFORE COMMENCING WORK. CONTRACTOR SHALL NOTIFY THE ENGINEER OF ANY DISCREPANCIES AND SHALL NOT PROCEED WITH WORK AFFECTED BY THE DISCREPANCY UNTIL IT IS RESOLVED WITH THE ENGINEER.
4. NOTES AND DETAILS ON DRAWINGS SHALL TAKE PRECEDENCE OVER GENERAL NOTES AND TYPICAL DETAILS. WHERE NOTES AND DETAILS ON DRAWINGS AND GENERAL NOTES ARE IN CONFLICT, THE MOST STRINGENT SHALL APPLY. CONDITIONS NOT SPECIFICALLY SHOWN SHALL BE CONSTRUED AS SHOWN FOR SIMILAR WORK.
5. DIMENSIONS SHALL TAKE PRECEDENCE OVER SCALED DRAWINGS.
6. AT ALL TIMES CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR THE CONDITIONS OF THE JOB SITE INCLUDING SAFETY OF PERSONNEL AND PROPERTY; AND FOR ALL NECESSARY INDEPENDENT ENGINEERING REVIEWS OF THESE CONDITIONS. THE ENGINEER'S JOB SITE VISITS ARE NOT INTENDED TO INCLUDE REVIEWS OF THE ADEQUACY OF THE CONTRACTOR'S SAFETY MEASURES OR SHORING.
7. STRUCTURES ARE DESIGNED FOR OPERATIONAL LOADS AND SHALL BE PROTECTED FROM ANY EXCESSIVE OR PREMATURE CONSTRUCTION LOADING. CONTRACTOR IS RESPONSIBLE FOR PERFORMING THE ENGINEERING NECESSARY FOR MAKING HEAVY LIFTS, DESIGNING AND FABRICATING LIFTING DEVICES AND INSTALLING WHATEVER ACCESSORIES ARE NEEDED TO BE ATTACHED TO THE STRUCTURES TO PERMIT INSTALLATION.
8. ALL WORK SHALL BE EXECUTED AS INDICATED ON THE DRAWINGS AND IN ACCORDANCE WITH THE BEST TRADE PRACTICES AND WORKMANSHIP. CONDITIONS NOT SPECIFICALLY SHOWN SHALL BE TREATED IN A MANNER CONSISTENT WITH THE INTENT OF THESE DRAWINGS. ALL WORK SHALL ACCOMMODATE THE WORK OF OTHER TRADES.
9. ELEVATIONS ARE REFERENCED TO MEAN LOWER LOW WATER (MLLW)

### B. SOILS AND FOUNDATIONS

1. THE GEOTECHNICAL INVESTIGATION MEMORANDUM PREPARED BY TREADWELL AND ROLLO, INC., DATED XXXX XX, 20XX IS MADE PART OF THESE GENERAL NOTES AND SPECIFICATIONS.

### C. DEMOLITION

1. DEMOLITION TO BE COORDINATED WITH THE CRESCENT CITY HARBOR DISTRICT AND SEQUENCED WITH CONSTRUCTION TO MAINTAIN OPERATION AS REQUIRED.
2. DEMOLISHED MATERIALS SHALL BE REMOVED FROM THE SITE AND DISPOSED OF IN ACCORDANCE WITH LOCAL LAWS AND REGULATIONS.

### D. MATERIALS

1. STRUCTURAL STEEL
   - a) STRUCTURAL STEEL SHALL BE DESIGNED, DETAILED, FABRICATED AND ERECTED IN ACCORDANCE WITH THE AMERICAN INSTITUTE OF STEEL CONSTRUCTION AISC 360 "SPECIFICATIONS FOR STRUCTURAL STEEL BUILDINGS", AND THE AMERICAN WELDING SOCIETY CODE AWS D1.1, "WELDING IN BUILDING CONSTRUCTION".
   - b) STRUCTURAL STEEL PLATES, CHANNELS AND ANGLES: ASTM A36, UNLESS OTHERWISE NOTED.
   - c) WIDE FLANGE SHAPES: ASTM A992.
   - d) STRUCTURAL PIPE: ASTM A53, GRADE B ERW OR SEAMLESS.
   - e) STRUCTURAL TUBING: ASTM A500, GRADE B, 46 KSI YIELD STRESS.
   - f) BOLTS: ASTM A325 AND GALVANIZED, UNLESS OTHERWISE NOTED.
   - g) ALL PLATES ARE A MINIMUM OF ½" THICK UNLESS OTHERWISE NOTED.
   - h) WELDING ELECTRODES SHALL BE E70XX. ALL WELDING SHALL BE PERFORMED BY AWS CERTIFIED WELDERS. ALL WELDED JOINTS SHALL BE AWS PREQUALIFIED GROOVE AND BUTT WELDS ARE "COMPLETE PENETRATION", UNLESS OTHERWISE NOTED.
   - i) ALL JOINTS BETWEEN CONTACT FACES OF FABRICATED STEEL SHALL BE SEAL WELDED IF A STRUCTURAL WELD IS NOT SHOWN ON THE DRAWINGS.
   - j) ALL STRUCTURAL STEEL ACCESSORIES OR INCIDENTAL ITEMS NOT SPECIFICALLY SHOWN OR HEREIN SPECIFIED, BUT NECESSARY TO FULLY CARRY OUT THE OBVIOUS INTENT OF THE PLANS SHALL BE INCLUDED UNDER THIS SECTION WITHOUT ADDITIONAL COST.
   - k) EXCEPT STAINLESS STEEL MEMBERS, ALL STRUCTURAL STEEL, METAL FABRICATIONS AND GRATING SHALL BE GALVANIZED IN ACCORDANCE WITH ASTM A123 OR ASTM A153. GALVANIZING SHALL BE PERFORMED AFTER FABRICATION INTO THE LARGEST PRACTICAL SECTION. GALVANIZED STEEL MARRED OR DAMAGED IN SHIPPING OR IN THE FIELD SHALL BE REPAIRED USING "GALANOX" OR "GALVALLOY" OR EQUIVALENT.
   - l) ALL EXPOSED HARDWARE, MISCELLANEOUS STEEL, STUDS, FERRULE INSERTS AND CAST-IN-PLACE ANCHORS SHALL BE ISOLATED FROM (NOT IN DIRECT CONTACT WITH) REINFORCING STEEL TO AVOID MACRO-CELL FORMATION WHICH CAUSES CORROSION ON REINFORCEMENT.
   - m) INSULATION SHALL BE PROVIDED BETWEEN DISSIMILAR METALS (SUCH AS STRUCTURAL STEEL AND STAINLESS STEEL, STRUCTURAL STEEL AND ALUMINUM, ETC.) TO PREVENT GALVANIC CORROSION.

### D. MATERIALS (CONTINUED)

2. STEEL PILES
   - a) STEEL PILES SHALL BE API 5LX52, ASTM A572 GRADE 50, OR APPROVED ALTERNATIVE OF 50 KSI YIELD STRESS OR GREATER.
   - b) STEEL PILES SHALL BE COATED OVER THE LENGTHS SHOWN ON THE DRAWINGS. THE COATING SHALL BE AS FOLLOWS:
     - 1ST COAT: 3–5 MILS DFT OF WASSER MC-ZINC OR 3–4 MILS DFT OF WASSER MC-MIOZINC
     - 2ND COAT: 5–7 MILS DFT OF WASSER MC-TAR
     - 3RD COAT: 5–7 MILS DFT OF WASSER MC-TAR
   - c) CONTRACTOR SHALL SUBMIT DETAILED INFORMATION TO THE ENGINEER AS TO THE PILE INSTALLATION METHOD PROPOSED.
   - d) PILES MAY BE SPLICED IN THE FIELD AS NECESSARY TO ACCOMMODATE PILE INSTALLATION EQUIPMENT.
3. CONCRETE
   - a) ALL CONCRETE WORK SHALL CONFORM TO THE REQUIREMENTS OF ACI 301, "SPECIFICATIONS FOR STRUCTURAL CONCRETE FOR BUILDINGS" AND THE "STATE OF CALIFORNIA STANDARD SPECIFICATIONS", SECTION 90, EXCEPT AS MODIFIED BY THE SUPPLEMENTAL REQUIREMENTS HEREIN.
   - b) CONCRETE SHALL HAVE MINIMUM 28 DAY F'c OF 5,000 PSI.
   - c) CONCRETE SHALL HAVE A MINIMUM CEMENT CONTENT OF 7 SACKS PER CUBIC YARD OF CONCRETE.
   - d) CONCRETE W/C RATIO SHALL BE A MAXIMUM OF 0.40.
   - e) MAXIMUM AGGREGATE SIZE IS 3/4" INCHES. AGGREGATES SHALL MEET ASTM C33 REQUIREMENTS.
   - f) MAXIMUM SLUMP IS 4 INCHES.
   - g) REQUIRED RANGE OF AIR-ENTRAINMENT IS 3% TO 6%.
   - h) MAXIMUM CHLORIDE ION CONTENT BY MASS OF CEMENT IS 0.06%.
   - i) REINFORCING SHALL CONFORM TO ASTM A615 GRADE 60 UNLESS OTHERWISE NOTED. REINFORCING STEEL TO BE WELDED SHALL CONFORM TO ASTM A706.
   - j) ALL REINFORCING STEEL DETAILING, FABRICATION, ACCESSORIES AND PLACEMENT SHALL CONFORM TO ACI 315 "DETAILS AND DETAILING OF CONCRETE REINFORCEMENT".
   - k) CONTINUOUS REINFORCING STEEL SHALL BE DETAILED IN AS LONG A LENGTH AS PRACTICAL AND SHALL HOOK AROUND CORNERS FROM BOTH DIRECTIONS TO FORM A SPLICE LENGTH.
   - l) HOOKS SHOWN BUT NOT DIMENSIONED SHALL CONFORM TO THE REQUIREMENTS FOR A "STANDARD HOOK" PER ACI 315.
   - m) PROVIDE 2 INCHES MINIMUM COVER FOR REINFORCING BARS UNLESS OTHERWISE NOTED.

### E. FLOAT REQUIREMENTS

1. THE MARINA FLOAT SYSTEM SHALL CONSIST OF CONCRETE FLOAT MODULES CONNECTED WITH EXTERNAL STRUCTURAL MEMBERS AND METAL CONNECTORS. WALKWAY MODULE DIMENSIONS SHALL BE AS SHOWN ON THE DRAWINGS.
2. DEAD LOAD CALM WATER FREEBOARD SHALL BE BETWEEN —— AND ——. DEAD LOAD FREEBOARD SHALL BE MEASURED WHEN THE MARINA IS COMPLETE AND READY FOR ACCEPTANCE. EACH FLOAT MODULE SHALL HAVE SUFFICIENT FLOTATION TO SUPPORT SUPERIMPOSED DEAD LOADS PRIOR TO BEING CONNECTED TO ADJOINING MODULES AND SHALL FLOAT WITH A CROSS SLOPE NOT EXCEEDING 1/4" PER LINEAR FOOT.
3. UNIFORM LIVE LOAD OF 25 PSF SHALL BE USED FOR FIGURING FREEBOARD HEIGHTS. APPLY LIVE LOAD TO FLOAT SURFACE AREA, GRATING, LANDINGS, RAMPS AND GANGWAYS. THE WALKWAYS SHALL ALSO SUPPORT A CONCENTRATED LOAD OF 400 LBS APPLIED 1' FROM ANY EDGE OF THE FLOAT.
4. THE DESIGN WAVE INSIDE THE MARINA IS 15' HIGH WITH 1440 SECOND WAVE PERIOD FOR A TSUNAMI EVENT, --' HIGH X --' LONG FOR A STORM EVENT AND --' HIGH X --' LONG FOR BOAT WAVES.
5. SHOP DRAWINGS SHALL BE SUBMITTED TO THE CONTRACTOR PRIOR TO ANY FABRICATION OR CONSTRUCTION FOR ALL STRUCTURAL ITEMS INCLUDING BUT NOT LIMITED TO THE FOLLOWING: CONCRETE REINFORCEMENT, EMBEDDED STEEL ITEMS AND STRUCTURAL STEEL.
6. CONTRACTOR SHALL SUBMIT TOWING PLAN FOR THE FLOAT DELIVERY TO THE ENGINEER FOR REVIEW AND APPROVAL.

### F. REFERENCE DOCUMENTS


1. AMERICAN CONCRETE INSTITUTE, "BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE", ACI 318-05.
2. MANUAL OF STEEL CONSTRUCTION, AISC (THIRTEENTH EDITION).
3. AMERICAN WELDING SOCIETY CODE AWS D1.1, "STRUCTURAL WELDING CODE – STEEL", 2006.
4. STATE OF CALIFORNIA STANDARD SPECIFICATIONS, MAY 2006.
5. TREADWELL AND ROLLO, INC. GEOTECHNICAL MEMORANDUM DATED XX-XX-XX.
6. BEN C. GERWICK, INC. FINAL DESIGN BASIS DATED XX-XX-XX.
7. BEN C. GERWICK, INC., "CRESCENT CITY HARBOR REHABILITATION, TSUNAMI STUDY" DATED APRIL 2010.
8. STOVER ENGINEERING, "CRESCENT CITY HARBOR SURVEY" DATED 10-14-2009.


**30% DRAFT SUBMITTAL SET 04-16-10**

| No. | Date | Revision | Appd |
|---|---|---|---|

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CRESCENT CITY HARBOR DISTRICT
BOAT BASIN
CRESCENT CITY, CA

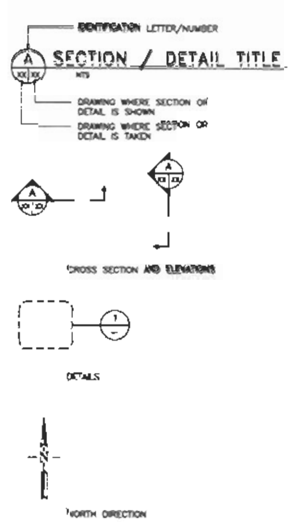
MARINA GENERAL NOTES

JOB NO. 2009-040
SCALE:
DATE: 04-16-10
SHEET
MS1.01

## ABBREVIATIONS

| | |
|---|---|
| & | AND |
| L | ANGLE |
| @ | AT |
| ℄ | CENTERLINE |
| Ø | DIAMETER |
| PL | PLATE |
| ± | PLUS OR MINUS |
| # | POUND OR NUMBER |
| AB | ANCHOR BOLT |
| AC | ASPHALT |
| ADD'L | ADDITIONAL |
| ALT | ALTERNATE |
| ALUM | ALUMINUM |
| BATT | BATTERY |
| BC | BOLT CIRCLE |
| BLDG | BUILDING |
| BOF | BOTTOM OF FOOTING |
| BOT | BOTTOM |
| BRG | BEARING |
| BTW | BETWEEN |
| CALC | CALCULATION |
| C/C | CENTER TO CENTER |
| CG | CENTER OF GRAVITY |
| CHK | CHECK, CHECKERED |
| CIP | CAST IN PLACE |
| CJ | CONSTRUCTION JOINT |
| CLR | CLEAR |
| COL | COLUMN |
| CONC | CONCRETE |
| CONN | CONNECTION |
| CONST | CONSTRUCTION |
| CONT | CONTINUOUS |
| CORR | CORRUGATED |
| CR | CRANE RAIL |
| CSK | COUNTERSUNK |
| CTR | CENTER |
| d | REBAR DIAMETER |
| DBL | DOUBLE |
| DIA | DIAMETER |
| DIM | DIMENSION |
| DL | DEAD LOAD |
| DN | DOWN |
| DWG | DRAWING |
| (E) | EXISTING |
| EA | EACH |
| EC | EPOXY COATING |
| EF | EACH FACE |
| EHW | EXTREME HIGH WATER |
| ELECT | ELECTRICAL |
| ELEV | ELEVATION |
| EMBED | EMBEDMENT |
| ENCL | ENCLOSURE |
| ENGR | ENGINEER |
| ELW | EXTREME LOW WATER |
| EST | ESTIMATE |
| EQ | EQUAL |
| EQUIP | EQUIPMENT |
| EXIST | EXISTING |
| EXP | EXPANSION |
| EW | EACH WAY |
| JT | JOINT |
| FF | FINISHED FLOOR |
| FDTN | FOUNDATION |
| FIN | FINISH |
| FLR | FLOOR |
| FS | FAR SIDE |
| FT (') | FOOT, FEET |
| FTG | FOOTING |
| GA | GAGE, GAUGE |
| GALV | GALVANIZED |
| GND | GROUND |
| GRTG | GRATING |
| HD | HOT-DIPPED |
| HORIZ | HORIZONTAL |
| HS | HIGH STRENGTH |
| HT/HGT | HEIGHT |
| ID | INSIDE DIAMETER |
| INV | INVERT |
| JT | JOINT |
| KN | KILO NEWTON |
| KPa | KILO PASCAL |
| LLH | LONG LEG HORIZONTAL |
| LLV | LONG LEG VERTICAL |
| LOC | LOCATION |
| LONGT | LONGITUDINAL |
| M | METER |
| MAT'L | MATERIAL |
| MAX | MAXIMUM |
| MFR | MANUFACTURER |
| MH | MANHOLE |
| MIN | MINIMUM |
| MISC | MISCELLANEOUS |
| MHW | MEAN HIGH WATER |
| MHHW | MEAN HIGHER HIGH WATER |
| mm | MILLIMETERS |
| MLLW | MEAN LOWER LOW WATER |
| MSL | MEAN SEA LEVEL |
| (N) | NEW |
| NIC | NOT IN CONTRACT |
| NO. (#) | NUMBER |
| NOM | NOMINAL |
| NS | NEAR SIDE |
| NTS | NOT TO SCALE |
| OC | ON CENTER |
| OD | OUTSIDE DIAMETER |
| OH | OVERHEAD |
| O/O | OUT TO OUT |
| OPNG | OPENING |
| OPP | OPPOSITE |
| P/C | PRECAST CONCRETE |
| PFP | POWER FEED POINT |
| PL | PLATE |
| PNL | PANEL |
| P/S | PRESTRESSED |
| PSF | POUNDS PER SQUARE FOOT |
| PSI | POUNDS PER SQUARE INCH |
| PVC | POLYVINYL CHLORIDE |
| PVMT | PAVEMENT |
| PWR | POWER |
| QTY | QUANTITY |
| R, RAD | RADIUS |
| REBAR | REINFORCING |
| RD | ROAD |
| REQ'D | REQUIRED |
| REF | REFERENCE |
| REINF | REINFORCE |
| REV | REVISION |
| R/W | RIGHT OF WAY |
| SCH, SCHED | SCHEDULE |
| SD | STORM DRAIN |
| SEC | SECOND |
| SECT | SECTION |
| SHT | SHEET |
| SIM | SIMILAR |
| SPA | SPACE, SPACES |
| SPECS | SPECIFICATIONS |
| SQ | SQUARE |
| SS | STAINLESS STEEL |
| STA | STATION |
| STD | STANDARD |
| STIFF | STIFFENER |
| STL | STEEL |
| SYMM | SYMMETRICAL |
| T | TELEPHONE |
| T&B | TOP & BOTTOM |
| TEMP | TEMPERATURE |
| THRD | THREAD, THREADED |
| THK | THICK, THICKNESS |
| TOC | TOP OF CONCRETE |
| TOG | TOP OF GRADE |
| TOP | TOP OF PAVEMENT |
| TOPO | TOPOGRAPHY |
| TOR | TOP OF RAIL |
| TP | TELEPHONE POLE |
| TRANSV | TRANSVERSE |
| T/W | TOP OF WALL |
| TYP | TYPICAL |
| UNO | UNLESS OTHERWISE NOTED |
| V | VOLT |
| VIF | VERIFY IN FIELD |
| VERT | VERTICAL |
| VOL | VOLUME |

## LEGEND




**30% DRAFT SUBMITTAL SET 04-16-10**

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|---|---|---|---|---|---|
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MARINA CONSTRUCTION PHASING AND STAGING PLAN

NTS

N

1. REMOVE AND DISPOSE OF EXISTING CONCRETE FLOATS AND DEBRIS TO CREATE CONTRACTOR STAGING AREA.
2. RELOCATE BOATERS AT DOCKS "E", "F", "G" AND "H" TO AVAILABLE SLIPS IN OTHER BERTHS AS AVAILABLE.
3. CONTRACTOR MAY NEED TO CONSTRUCT TEMPORARY BERTHS IN OUTER HARBOR UNTIL MARINA REPLACEMENT IS COMPLETE.
4. REMOVED EXISTING DOCKS "E", "F", "G" AND "H"
5. CONSTRUCT NEW PILING AND DOCKS AT "E", "F", "G" AND "H".
6. RELOCATE BOATERS AT DOCKS "A", "B", "C" AND "D" TO NEW DOCKS AT "E", "F", "G", AND "H" AS AVAILABLE.
7. REMOVE AND DISPOSE OF EXISTING DOCKS AT "A", "H", "C" AND "D"
8. CONSTRUCT NEW PILING AND DOCKS AT DOCKS "A", "H" "C" AND "D".

**30% DRAFT SUBMITTAL SET 04-16-10**

| | | | | |
|---|---|---|---|---|
| STOVER ENGINEERING<br>Civil Engineers and Consultants<br>PO BOX 783 - 711 H STREET<br>CRESCENT CITY, CA 95531 - 707-465-6742 | PRELIMINARY | BEN C. GERWICK, INC.<br>1300 CLAY STREET, SUITE 470<br>OAKLAND, CA 94612<br>TEL: (510) 839-8972<br>FAX: (510) 839-9715 | CRESCENT CITY HARBOR DISTRICT<br>BOAT BASIN<br>CRESCENT CITY, CA<br>MARINA CONSTRUCTION PHASING AND STAGING PLAN | JOB NO. 2009-040<br>SCALE:<br>DATE: 04-16-10<br>SHEET<br>MS1.03 |

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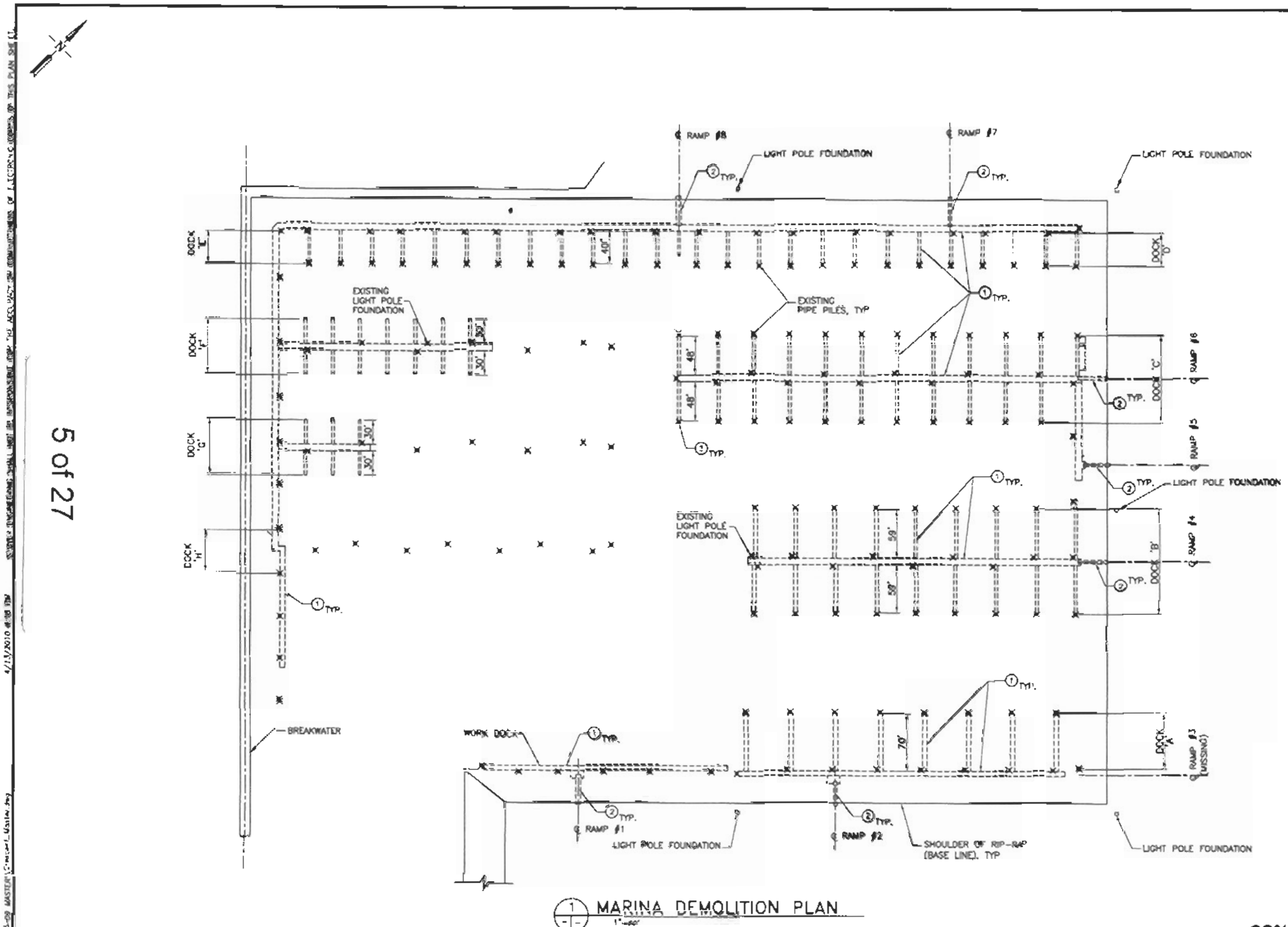


## MARINA DEMOLITION PLAN

LEGEND

- × EXISTING STEEL PILE TO BE REMOVED FOR NAVIGATIONAL HAZARDS
- EXISTING FLOAT TO BE REMOVED

DEMOLITION KEY NOTES:

1. REMOVE EXISTING FLOATS
2. REMOVE EXISTING RAMPS
3. REMOVE EXISTING STEEL PILES FOR NAVIGATIONAL HAZARDS

**30% DRAFT SUBMITTAL SET 04-16-10**

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CRESCENT CITY HARBOR DISTRICT
BOAT BASIN
CRESCENT CITY, CA

MARINA DEMOLITION PLAN

JOB NO. 2009-040
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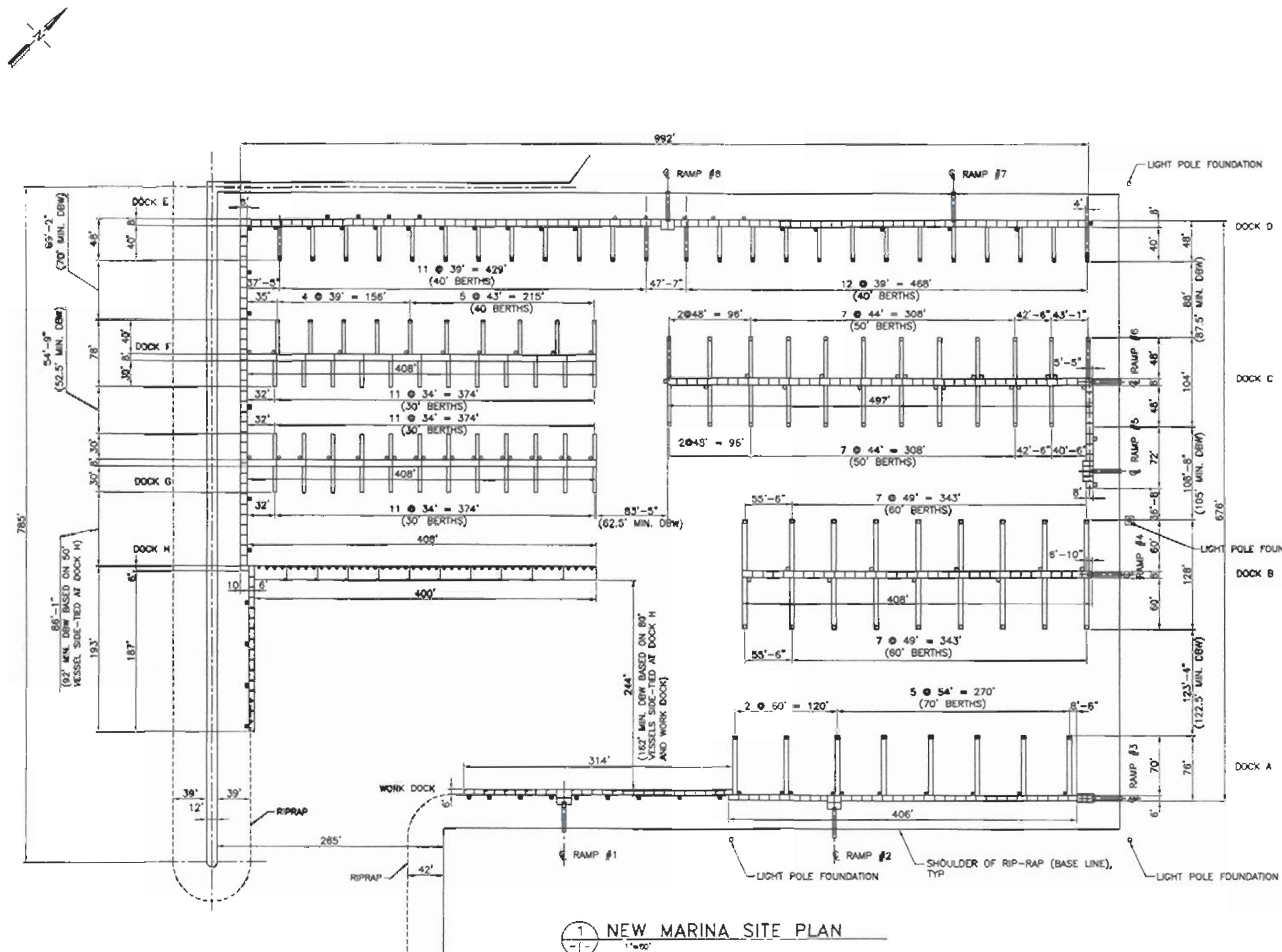


1 NEW MARINA SITE PLAN
1"=60'

LEGEND

○ ● □ ■ ▨ NEW CONCRETE OR STEEL PILES

NOTES:

1. DREDGE BASIN TO -12 FEET MLLW.
2. FURNISH AND INSTALL (SOCKET) NEW CONCRETE AND STEEL PILES.
3. FURNISH AND INSTALL NEW CONCRETE FLOATS.
4. FURNISH AND INSTALL NEW ELECTRICAL POWER AT EACH BERTH.
5. FURNISH AND INSTALL NEW POTABLE WATER AT EACH BERTH.
6. FURNISH AND INSTALL NEW SEWER AND BILGE PUMPOUT AT DOCK 'A'.
7. FURNISH AND INSTALL NEW FIRE SUPPRESSION SYSTEM AT EACH BERTH.

**30% DRAFT SUBMITTAL SET 04-16-10**

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CRESCENT CITY HARBOR DISTRICT
BOAT BASIN
CRESCENT CITY, CA

NEW MARINA SITE PLAN

JOB NO. 2009.040
SCALE:
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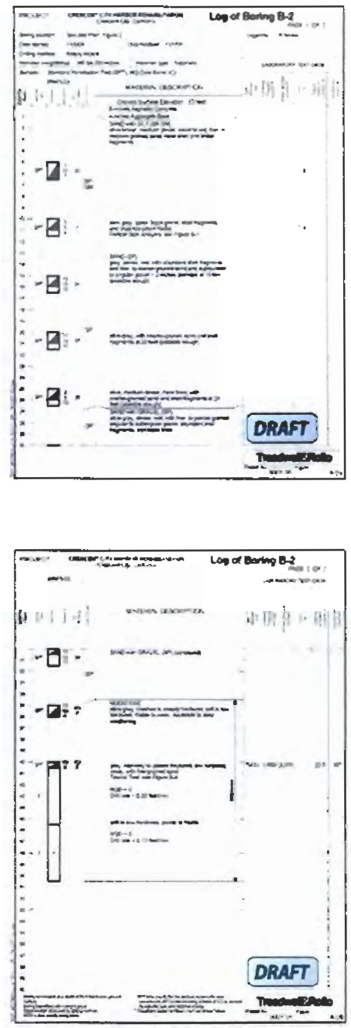
MS1.05


1 BORING LOG EXPLANATION
NTS

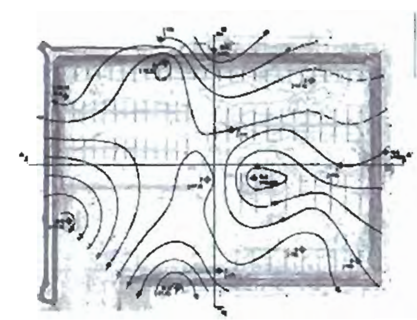

2 LOG OF BORING B-1
NTS




3 LOG OF BORING B-2
NTS

NOTES:

1. BORINGS PERFORMED BY TREADWELL & ROLLO, INC.
2. ELEVATION REFERENCE : MEAN LOWER LOW WATER (MLLW)



KEYPLAN

**30% DRAFT SUBMITTAL SET 04-16-10**

| No. | Date | Revision | Aprvd |
|---|---|---|---|

DRAWING INFO: DESIGNED BY: JWG DRAWN BY: JJB CHECKED BY: TWT

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STOVER ENGINEERING
Civil Engineers and Consultants
PO BOX 783 · 711 H STREET
CRESCENT CITY, CA 95531 · 707-465-6742

PRELIMINARY

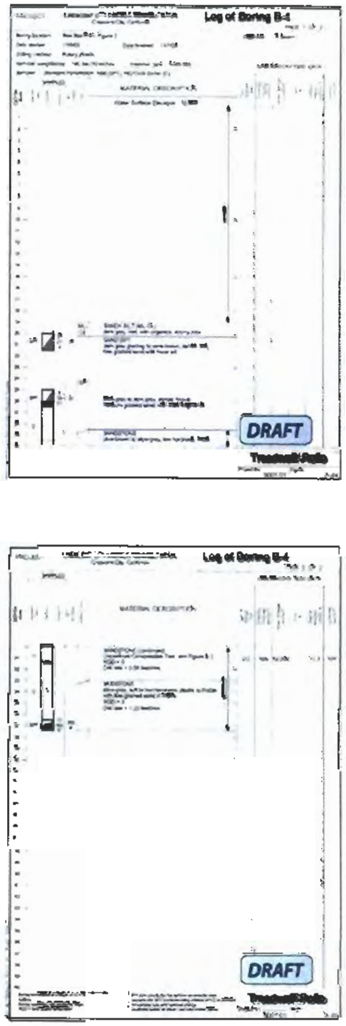
BEN C. GERWICK, INC.
1300 CLAY STREET, SUITE 400
OAKLAND, CA 94612
TEL: (510) 839-8972
FAX: (510) 839-9715

CRESCENT CITY HARBOR DISTRICT
BOAT BASIN
CRESCENT CITY, CA

SOIL BORINGS
SHEET 1 OF 2

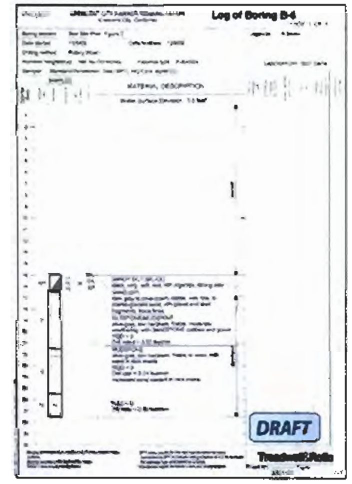
JOB NO. 2009-040
SCALE:
DATE: 04-16-10
SHEET
MS1.06


4 LOG OF BORING B-3
NTS




5 LOG OF BORING B-4
NTS

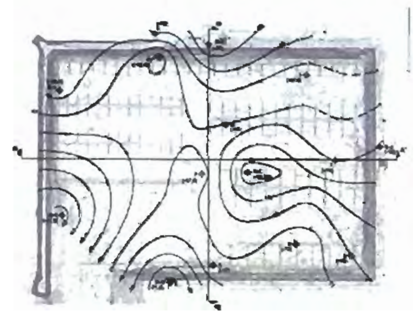

6 LOG OF BORING B-5
NTS




7 LOG OF BORING B-6
NTS

NOTES:

1. BORINGS PERFORMED BY TREADWELL & ROLLO, INC.
2. ELEVATION REFERENCE : MEAN LOWER LOW WATER (MLLW)



KEYPLAN

**30% DRAFT SUBMITTAL SET 04-16-10**

| No. | Date | Revision | Apvd |
|---|---|---|---|

DRAWING INFO: DESIGNED BY: JBG DRAWN BY: JJB/ACHECKED BY: TMT

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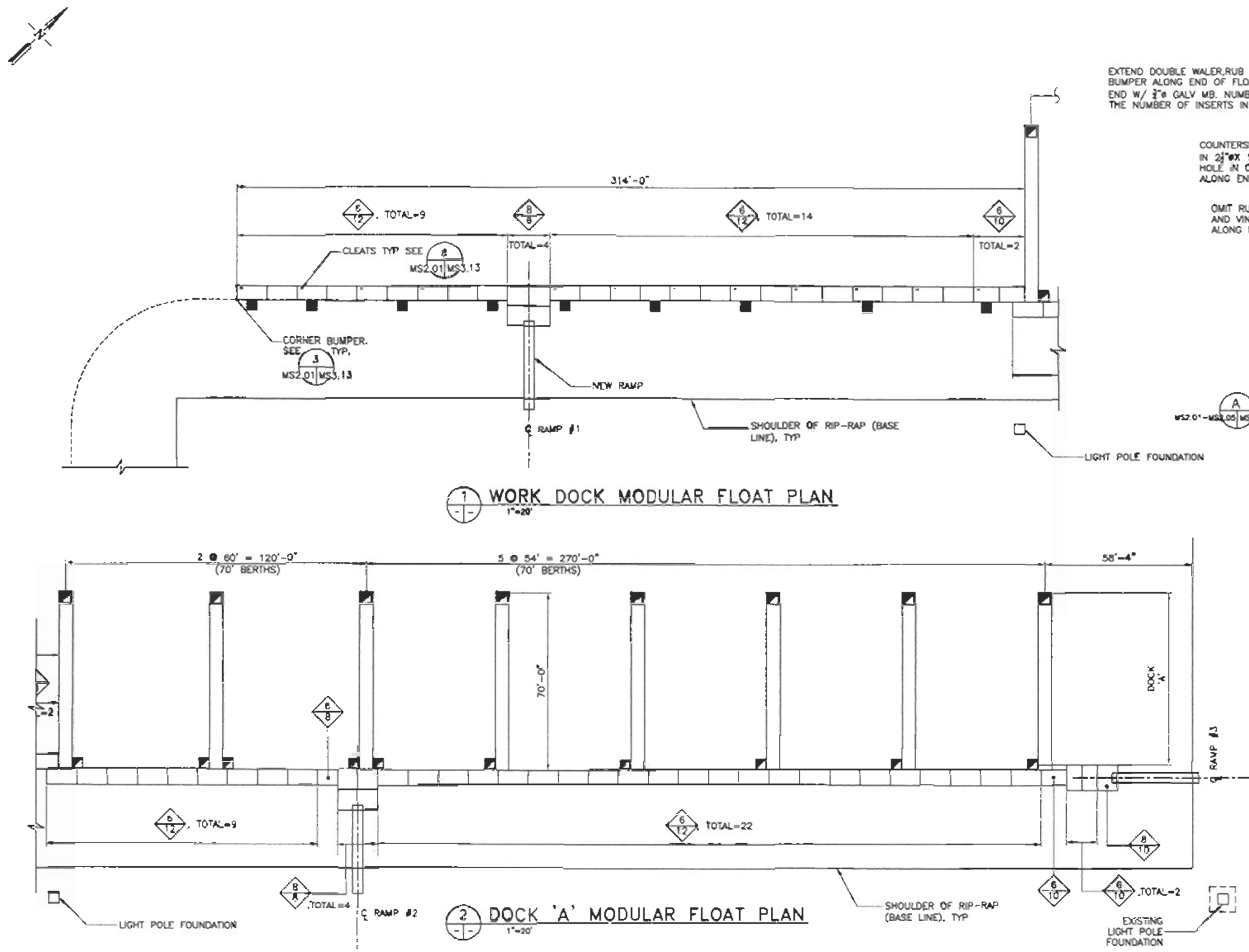
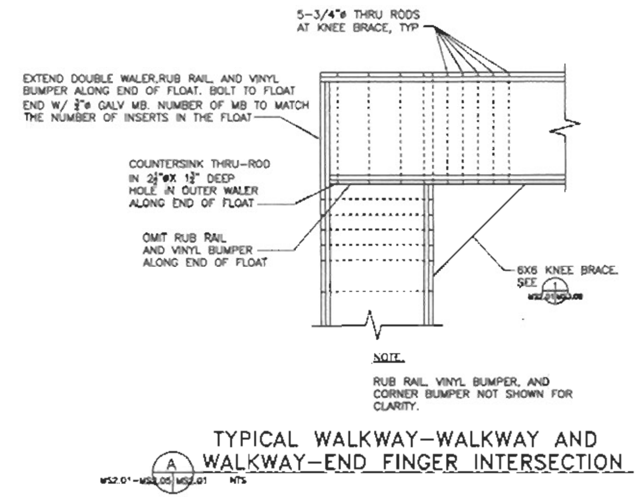
CRESCENT CITY HARBOR DISTRICT
BOAT BASIN
CRESCENT CITY, CA

SOIL BORINGS
SHEET 2 OF 2

JOB NO. 2009-040
SCALE:
DATE: 04-16-10
SHEET
MS1.07




TYPICAL WALKWAY–WALKWAY AND WALKWAY–END FINGER INTERSECTION

MS2.01–MS2.05 | MS2.01 NTS

LEGEND:

- NOMINAL WIDTH / FLOAT IDENTIFICATION / NOMINAL LENGTH AND TYPE
- 24" SQUARE PRESTRESSED PILE
- 16" SQUARE PRESTRESSED PILE
- CORNER BUMPER

NOTES:

1. FOR 6' AND 8' WIDE WALKWAY FLOATS, SEE SHEET MS3.01.
2. FOR PILE GUIDE FRAMING, SEE 1 MS2.01 MS3.10
3. FOR WALER SPLICE LOCATIONS SEE 2 MS2.01 MS3.13. FOR WALER SPLICE DETAIL SEE 1 MS2.01 MS3.13.
4. WHERE END FINGER INTERSECTS WITH THE WALKWAY OR WHERE THE WALKWAYS INTERSECT, OMIT 2X12 RUB RAIL AND VINYL BUMPER FROM THE PORTION OF WALER THAT IS CONTINUOUS THROUGH THE INTERSECTION. SEE A.
5. AT KNEE BRACES, OMIT THE 2X12 RUB RAIL AND VINYL BUMPER ALONG THE LENGTH OF THE KNEE BRACE.
6. 2X12 RUB RAIL, WITH VINYL BUMPER. BOLT TO FLOAT END WITH ¾"ø GALVANIZED MACHINE BOLTS. NUMBER OF MACHINE BOLTS TO MATCH THE NUMBER OF INSERTS IN THE FLOAT.

**30% DRAFT SUBMITTAL SET 04-16-10**

| No. | Date | Revision | Apvd |
|---|---|---|---|

DRAWING INFO: DESIGNED BY: JWC DRAWN BY: JJB CHECKED BY: TBT

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CRESCENT CITY HARBOR DISTRICT
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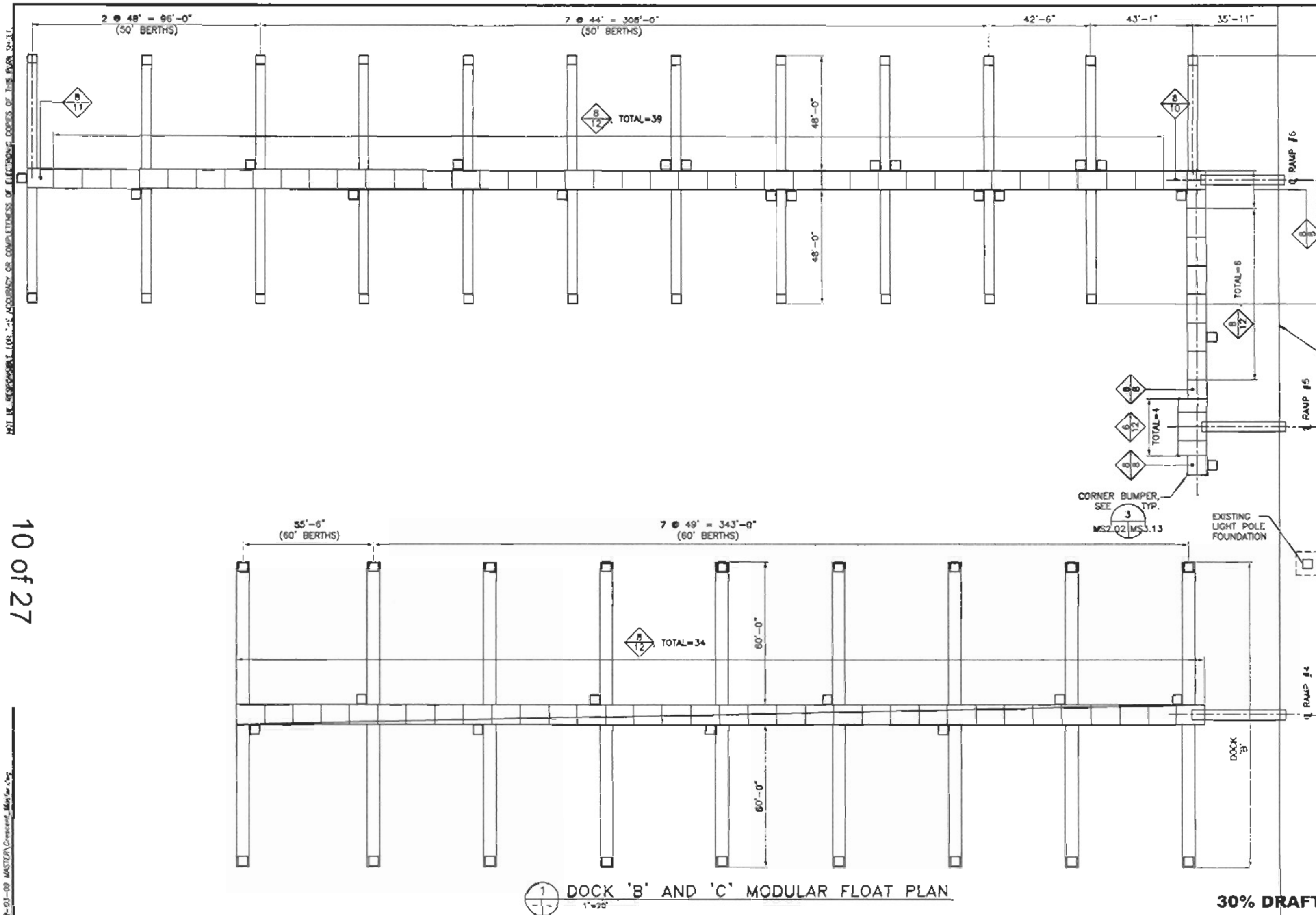
CRESCENT CITY, CA

WORK DOCK AND DOCK 'A' MODULAR FLOAT PLANS

JOB NO. 2009-040
SCALE:
DATE: 04-16-10
SHEET MS2.01




1 DOCK 'B' AND 'C' MODULAR FLOAT PLAN
1"=30'

LEGEND:

- NOMINAL WIDTH
- FLOAT IDENTIFICATION
- NOMINAL LENGTH AND TYPE
- 20" SQUARE PRESTRESSED PILE
- CORNER BUMPER

NOTES:

1. FOR 6' AND 8' WIDE WALKWAY FLOATS, SEE SHEET MS3.01.
2. FOR PILE GUIDE FRAMING, SEE 1 MS2.02 MS3.10
3. FOR WALER SPLICE LOCATIONS SEE 2 MS2.02 MS3.13. FOR WALER SPLICE DETAIL SEE 1 MS2.02 MS3.13.
4. WHERE END FINGER INTERSECTS WITH THE WALKWAY OR WHERE THE WALKWAYS INTERSECT, OMIT 2X12 RUB RAIL AND VINYL BUMPER FROM THE PORTION OF WALER THAT IS CONTINUOUS THROUGH THE INTERSECTION. SEE A MS2.02 MS2.01.
5. AT KNEE BRACES, OMIT THE 2X12 RUB RAIL AND VINYL BUMPER ALONG THE LENGTH OF THE KNEE BRACE.
6. 2X12 RUB RAIL, WITH VINYL BUMPER. BOLT TO FLOAT END WITH ⅝"⌀ GALVANIZED MACHINE BOLTS. NUMBER OF MACHINE BOLTS TO MATCH THE NUMBER OF INSERTS IN THE FLOAT.

**30% DRAFT SUBMITTAL SET 04-16-10**

| No. | Date | Revision | Apvd. |
|---|---|---|---|
| | | | |

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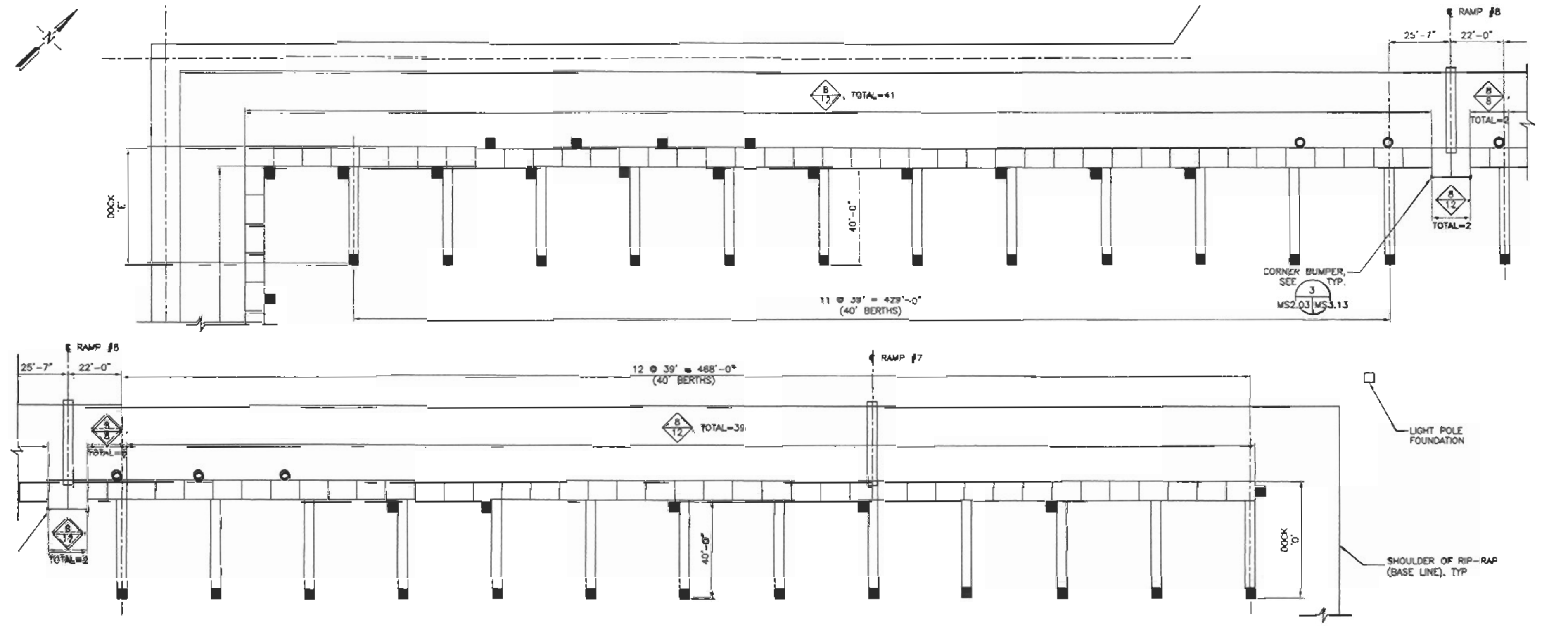
DOCK 'B' AND 'C' MODULAR FLOAT PLAN

JOB NO. 2009-040
SCALE:
DATE: 04-16-10
SHEET
MS2.02




1 DOCK 'D' AND 'E' MODULAR FLOAT PLAN
1"=20'

## NOTES:

1. FOR 8' WIDE WALKWAY FLOATS, SEE SHEET MS3.01.
2. FOR PILE GUIDE FRAMING, SEE 1 MS2.03 MS3.10
3. FOR WALER SPLICE LOCATIONS SEE 2 MS2.03 MS3.13. FOR WALER SPLICE DETAIL, SEE 1 MS2.01 MS3.13.
4. WHERE END FINGER INTERSECTS WITH THE WALKWAY OR WHERE THE WALKWAYS INTERSECT, OMIT 2X12 RUB RAIL AND VINYL BUMPER FROM THE PORTION OF WALER THAT IS CONTINUOUS THROUGH THE INTERSECTION. SEE A MS2.03 MS3.01.
5. AT KNEE BRACES, OMIT THE 2X12 RUB RAIL AND VINYL BUMPER ALONG THE LENGTH OF THE KNEE BRACE.
6. 2X12 RUB RAIL WITH VINYL BUMPER. BOLT TO FLOAT END WITH ¾"ø GALVANIZED MACHINE BOLTS. NUMBER OF MACHINE BOLTS TO MATCH THE NUMBER OF INSERTS IN THE FLOAT.

## LEGEND:

- NOMINAL WIDTH / FLOAT IDENTIFICATION / NOMINAL LENGTH AND TYPE
- ■ 24" SQUARE PRESTRESSED PILE
- O 24"ØX1" PIPE PILE
- ∟ CORNER BUMPER

**30% DRAFT SUBMITTAL SET 04-16-10**

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CRESCENT CITY HARBOR DISTRICT
BOAT BASIN
CRESCENT CITY, CA

DOCK 'D' AND 'E' MODULAR FLOAT PLAN

| | |
|---|---|
| JOB NO. | 2009-040 |
| SCALE: | |
| DATE: | 04-16-10 |
| SHEET | MS2.03 |

| No. | Date | Revision | Apvd. |
|---|---|---|---|

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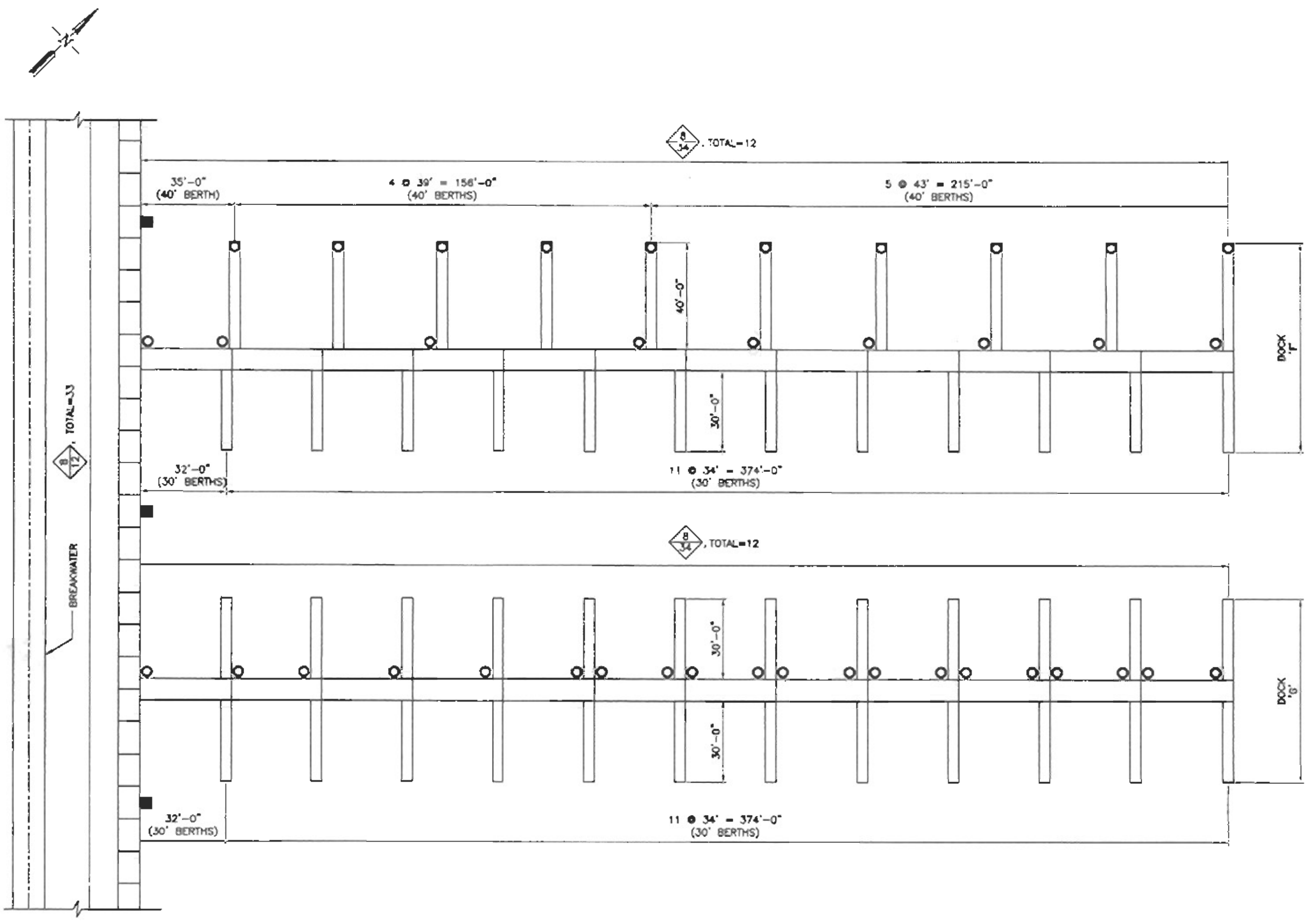


DOCK 'F' AND 'G' MODULAR FLOAT PLAN
1"=20'

## LEGEND:

- ◇ — NOMINAL WIDTH / FLOAT IDENTIFICATION / NOMINAL LENGTH AND TYPE
- L — CORNER BUMPER
- O — 24"ø×1" PIPE PILE
- ■ — 24" SQUARE PRESTRESSED PILE

## NOTES:

1. FOR 8' WIDE WALKWAY FLOATS, SEE SHEETS MS3.01 AND MS3.04.
2. FOR PILE GUIDE FRAMING, SEE 1 MS2.04/MS3.10
3. FOR WALER SPLICE LOCATIONS SEE 2 MS2.04/MS3.13. FOR WALER SPLICE DETAIL SEE 1 MS2.04/MS3.13.
4. WHERE END FINGER INTERSECTS WITH THE WALKWAY OR WHERE THE WALKWAYS INTERSECT, OMIT 2X12 RUB RAIL AND VINYL BUMPER FROM THE PORTION OF WALER THAT IS CONTINUOUS THROUGH THE INTERSECTION. SEE A MS2.04/MS2.01.
5. AT KNEE BRACES, OMIT THE 2X12 RUB RAIL AND VINYL BUMPER ALONG THE LENGTH OF THE KNEE BRACE.
6. 2X12 RUB RAIL WITH VINYL BUMPER. BOLT TO FLOAT END WITH ¾"ø GALVANIZED MACHINE BOLTS. NUMBER OF MACHINE BOLTS TO MATCH THE NUMBER OF INSERTS IN THE FLOAT

**30% DRAFT SUBMITTAL SET 04-16-10**

| No. | Date | Revision | Aprvd |
|---|---|---|---|

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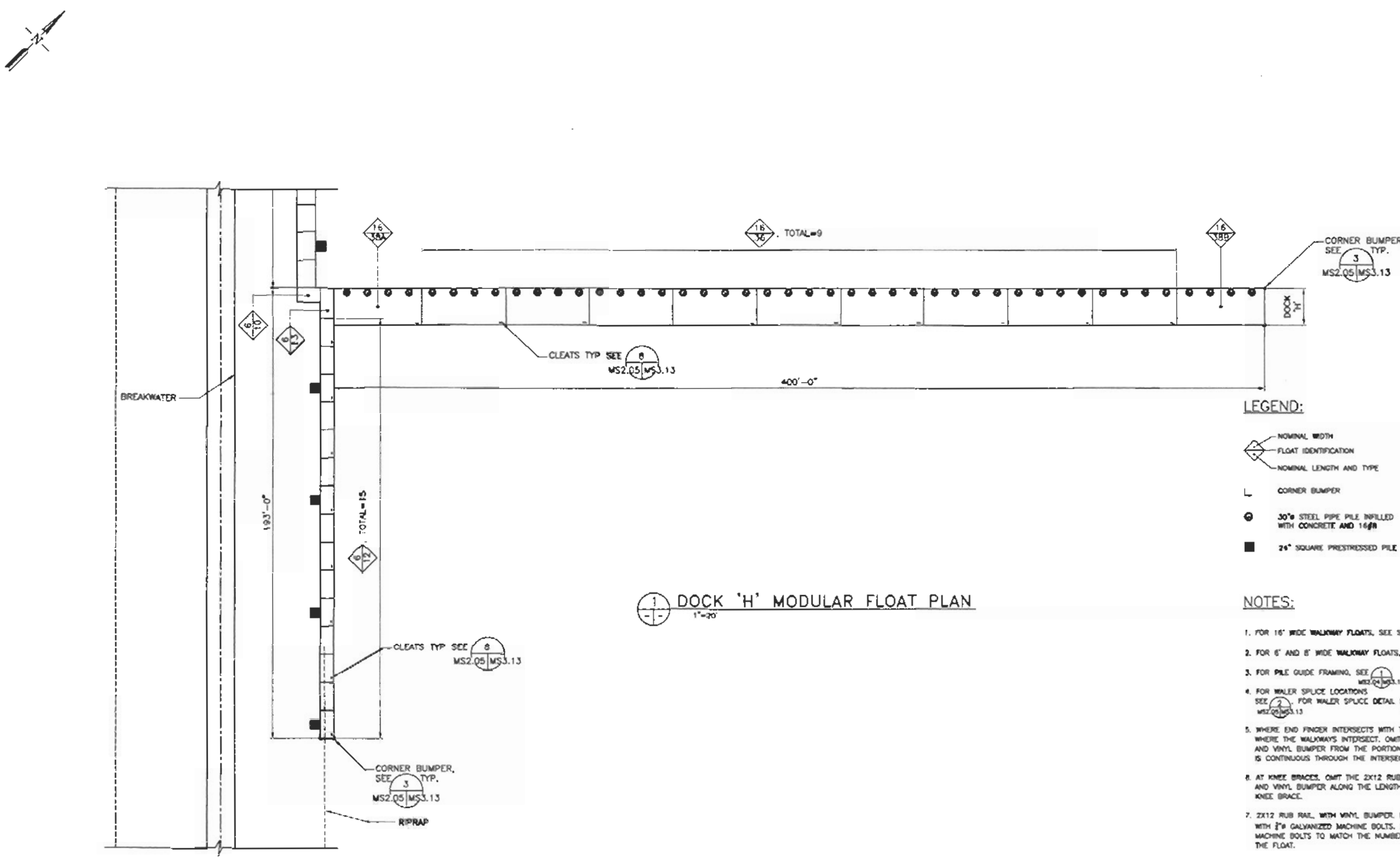
CRESCENT CITY HARBOR DISTRICT
BOAT BASIN
CRESCENT CITY, CA

DOCK 'F' AND 'G' MODULAR FLOAT PLAN

JOB NO. 2009-040
SCALE:
DATE: 04-16-10
SHEET
MS2.04




1 / - | - DOCK 'H' MODULAR FLOAT PLAN
1"=20'

NOTES:

1. FOR 16' WIDE WALKWAY FLOATS, SEE SHEET MS3.05.
2. FOR 6' AND 8' WIDE WALKWAY FLOATS, SEE SHEET MS3.01.
3. FOR PILE GUIDE FRAMING, SEE 1 / MS2.04 | MS3.10
4. FOR WALER SPLICE LOCATIONS SEE 2 / MS2.05 | MS3.13. FOR WALER SPLICE DETAIL SEE 7 / MS2.05 | MS3.13.
5. WHERE END FINGER INTERSECTS WITH THE WALKWAY OR WHERE THE WALKWAYS INTERSECT, OMIT 2X12 RUB RAIL AND VINYL BUMPER FROM THE PORTION OF WALER THAT IS CONTINUOUS THROUGH THE INTERSECTION. SEE A / MS2.05 | MS2.01.
6. AT KNEE BRACES, OMIT THE 2X12 RUB RAIL AND VINYL BUMPER ALONG THE LENGTH OF THE KNEE BRACE.
7. 2X12 RUB RAIL, WITH VINYL BUMPER. BOLT TO FLOAT END WITH ¾"ø GALVANIZED MACHINE BOLTS. NUMBER OF MACHINE BOLTS TO MATCH THE NUMBER OF INSERTS IN THE FLOAT.

**30% DRAFT SUBMITTAL SET 04-16-10**

| No. | Date | Revision | Aprvd. |
|---|---|---|---|

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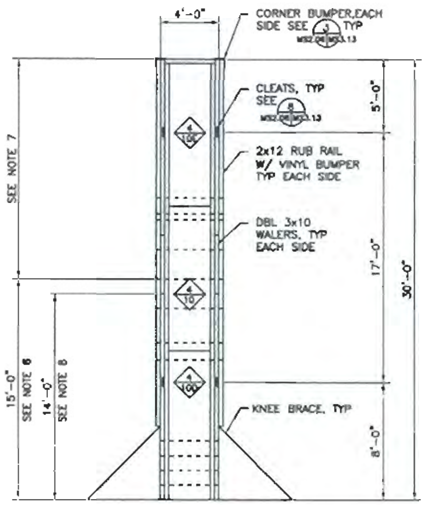
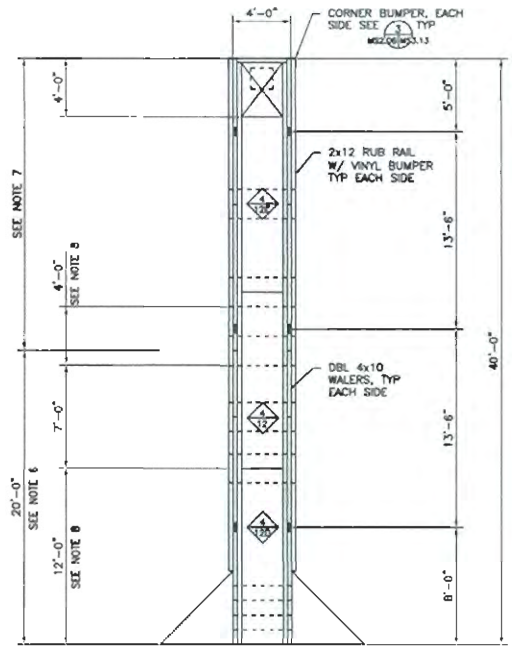
CRESCENT CITY HARBOR DISTRICT
BOAT BASIN
CRESCENT CITY, CA

DOCK 'H' MODULAR FLOAT PLAN

JOB NO. 2009 040
SCALE:
DATE: 04-16-10
SHEET
MS2.05

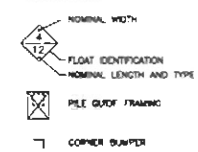



1 30 FOOT FINGER
SCALE 1/4"=1'0"




2 40 FOOT FINGER
SCALE 1/4"=1'0"

LEGEND:




NOTES:

1. FOR FINGER FLOATS, SEE SHEET MS3.07
2. WHERE TWO DIFFERENT SIZE WALERS ARE SPECIFIED, THE LARGER WALER SHALL BE ADJACENT TO THE FLOAT.
3. FOR END PILE FRAMING, SEE 2 MS2.06 MS3.10.
4. FOR KNEE DETAILS, SEE SHEET MS3.09.
5. FOR WALER SPLICE DETAIL SEE 1 MS2.06 MS3.13.
6. 3/4" THRU RODS @ 1'-0" OC AND 6" FROM FLOAT ENDS.
7. 3/4" THRU RODS @ 2'-0" OC AND 6" FROM FLOAT ENDS.
8. NO WALER SPLICES ARE PERMITTED ALONG THE SPECIFIED LENGTH.

**30% DRAFT SUBMITTAL SET 04-16-10**

| No. | Date | Revision | Apvd. |
|---|---|---|---|

DRAWING INFO: DESIGNED BY: JWG DRAWN BY: JURA CHECKED BY: TWT

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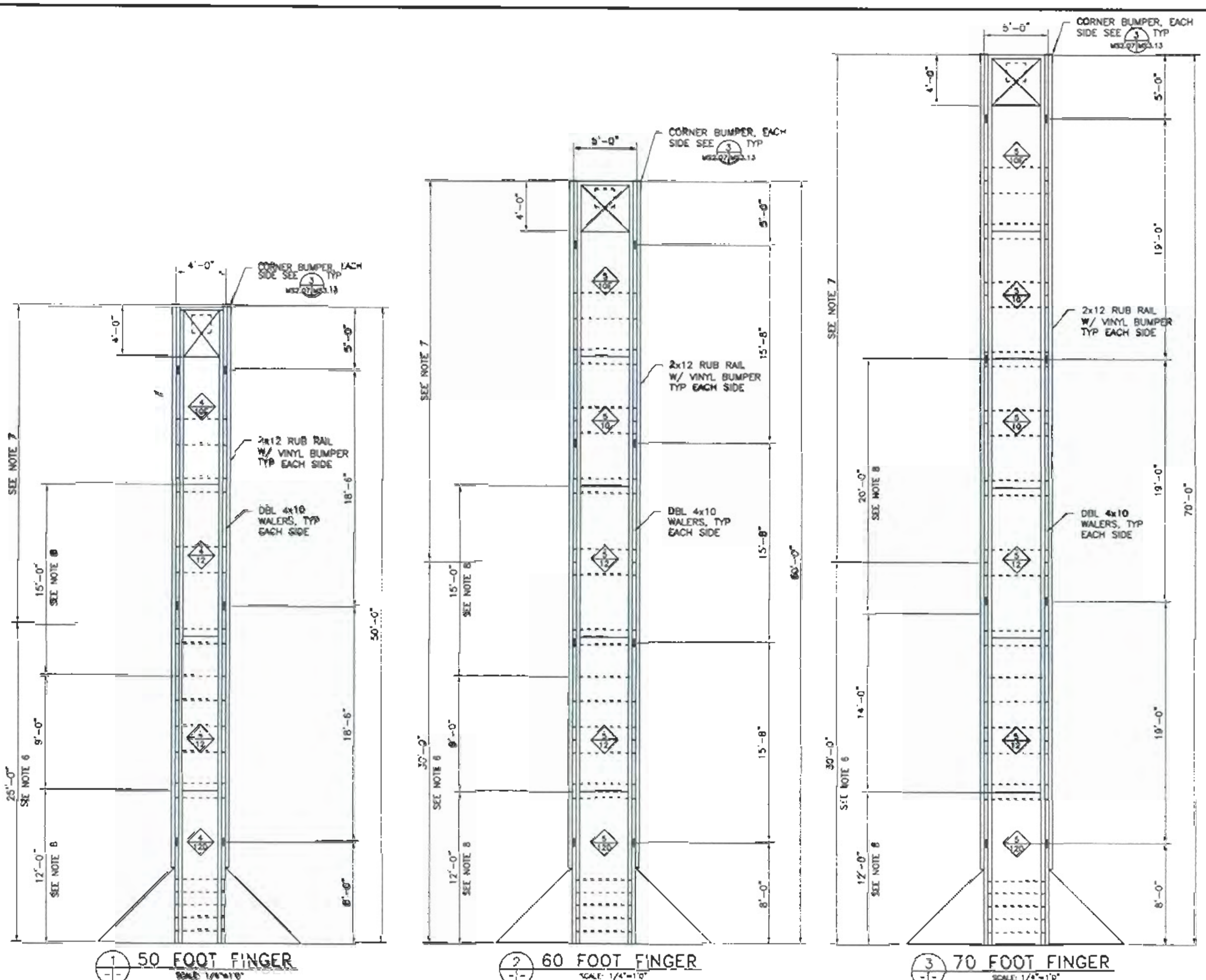
CRESCENT CITY HARBOR DISTRICT
BOAT BASIN
CRESCENT CITY, CA

30' AND 40' FINGER MODULAR FLOAT PLANS

JOB NO. 2009-040
SCALE:
DATE: 04-16-10
SHEET
MS2.06




LEGEND:

- NOMINAL WIDTH
- FLOAT IDENTIFICATION
- NOMINAL LENGTH AND TYPE
- PILE GUIDE FRAMING
- CORNER BUMPER

NOTES:

1. FOR FINGER FLOATS, SEE SHEET MS3.07.
2. WHERE TWO DIFFERENT SIZE WALERS ARE SPECIFIED, THE LARGER WALER SHALL BE ADJACENT TO THE FLOAT.
3. FOR END PILE FRAMING, SEE 2 MS2.07/MS3.10.
4. FOR KNEE BRACE DETAILS SEE SHEET MS3.09.
5. FOR WALER SPLICE DETAIL SEE 1 MS2.06/MS3.13
6. 3/4" THRU RODS @ 1'-0" OC AND 6" FROM FLOAT ENDS.
7. 3/4" THRU RODS @ 2'-0" OC AND 6" FROM FLOAT ENDS.
8. NO WALER SPLICES ARE PERMITTED ALONG THE SPECIFIED LENGTH.

**30% DRAFT SUBMITTAL SET 04-16-10**

| No. | Date | Revision | Apprvl |
| --- | --- | --- | --- |

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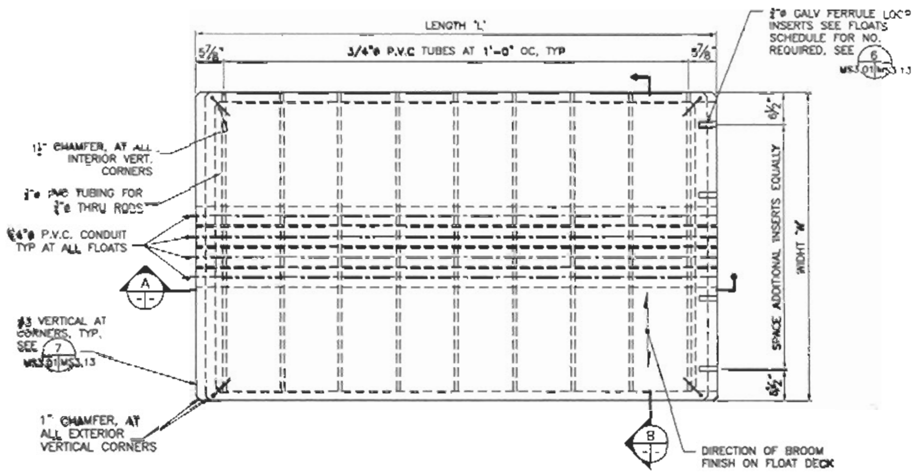
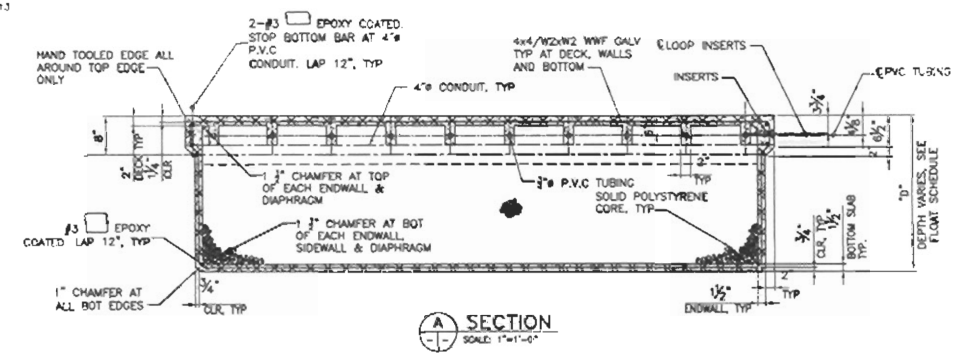
CRESCENT CITY HARBOR DISTRICT
BOAT BASIN
CRESCENT CITY, CA

50', 60', AND 70' FINGER MODULAR FLOAT PLANS

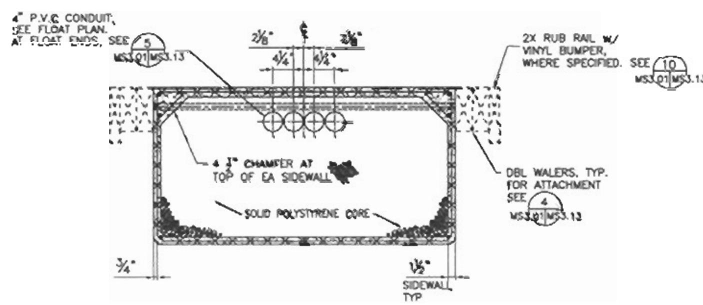
JOB NO. 2009-040
SCALE:
DATE: 04-16-10
SHEET MS2.07




1 MARGINAL AND MAIN WALKWAY FLOAT PLAN
SCALE: 1"=1'-0"




A SECTION
SCALE: 1"=1'-0"




B SECTION
SCALE: 1"=1'-0"

**FLOAT SCHEDULE**

| FLOAT IDENTIFICATION | DIMENSIONS L | W | D | 3/4"⌀ P.V.C. TUBING REQ'D PER FLOAT | FERRULE LOOP INSERTS REQ'D PER FLOAT | REMARKS |
|---|---|---|---|---|---|---|
| 8/8 | 7'-11 3/4" | 7'-6" | 32" | 8 | 0 | |
| 8/10 | 9'-11 3/4" | 7'-6" | 32" | 10 | 0 | |
| 8/11 | 10'-11 3/4" | 7'-6" | 32" | 11 | 0 | |
| 8/12 | 11'-11 3/4" | 7'-6" | 32" | 12 | 0 | |
| 8/8E | 7'-11 3/4" | 7'-6" | 33" | 8 | 4 | |
| 8/10E | 9'-11 3/4" | 7'-6" | 33" | 10 | 4 | |
| 8/12E | 11'-11 3/4" | 7'-6" | 32" | 12 | 4 | |
| 6/10 | 7'-11 3/4" | 5'-6" | 34" | 10 | 0 | |
| 6/12 | 11'-11 3/4" | 5'-6" | 33" | 12 | 0 | |
| 6/13 | 12'-11 3/4" | 5'-6" | 34" | 13 | 0 | |

NOTES:

1. THICKNESS OF DECK, WALLS, DIAPHRAGM, AND BOTTOM SHOWN ARE MINIMUMS. CONTRACTOR MAY PROPOSE INCREASING THICKNESS IN ACCORDANCE WITH THE SPECIFICATIONS.
2. FLOAT DEPTHS ARE BASED ON DIMENSIONS SHOWN. CONTRACTOR MAY ALTER DEPTH IN ACCORDANCE WITH THE SPECIFICATIONS.
3. WHERE REQUIRED, FERRULE LOOP INSERTS SHALL BE LOCATED AT ONE END OF THE FLOAT.
4. FLOAT IDENTIFICATION TYPE J HAS A JUNCTION BOX. SEE DETAIL 3 ON SHEET MS3.08 FOR MORE INFORMATION.
5. FLOAT IDENTIFICATION TYPE F HAS 2-JUNCTION BOXES SEE DETAIL 2 ON SHEET MS3.08 FOR MORE INFORMATION.

**30% DRAFT SUBMITTAL SET 04-16-10**

| No. | Date | Revision | Apprd |
|---|---|---|---|

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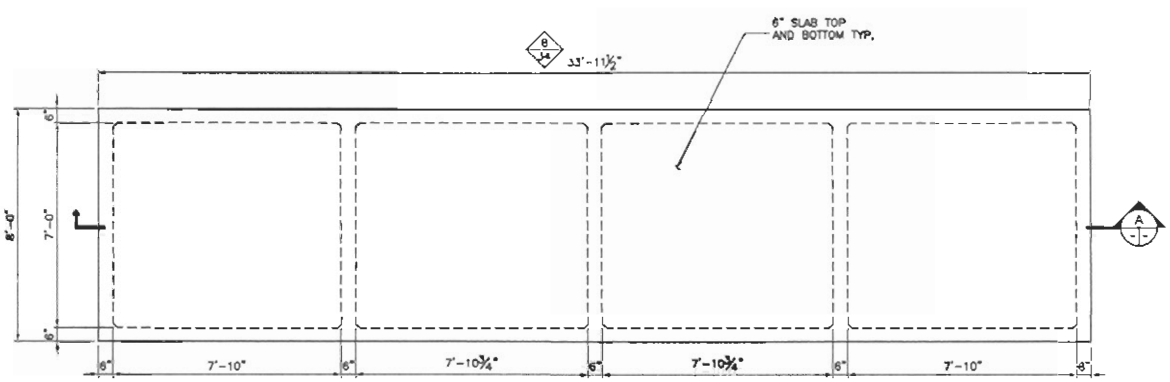
BEN C. GERWICK, INC.

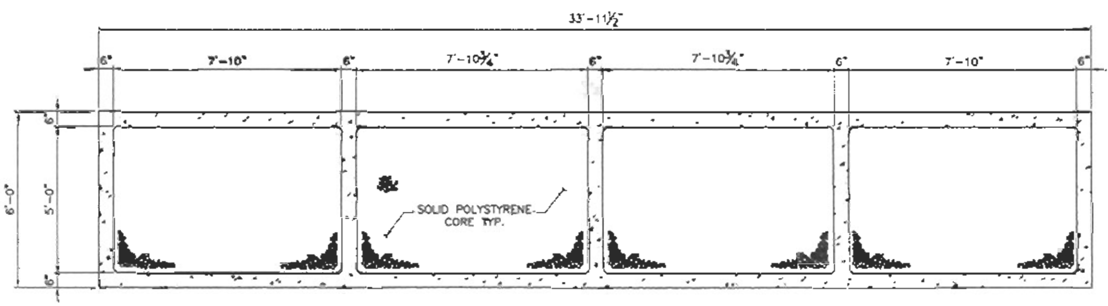
CRESCENT CITY HARBOR DISTRICT
BOAT BASIN
CRESCENT CITY, CA

MARGINAL AND MAIN WALKWAY
FLOAT DETAILS AND SCHEDULE

JOB NO. 2009-040
SCALE:
DATE: 04-16-10
SHEET
MS3.01




1 DOCK 'F' AND 'G' FLOAT PLAN
1/2"=1'-0"




A SECTION
1/2"=1'-0"

**30% DRAFT SUBMITTAL SET 04-16-10**

| No. | Date | Revision | Aprvd. |
|---|---|---|---|

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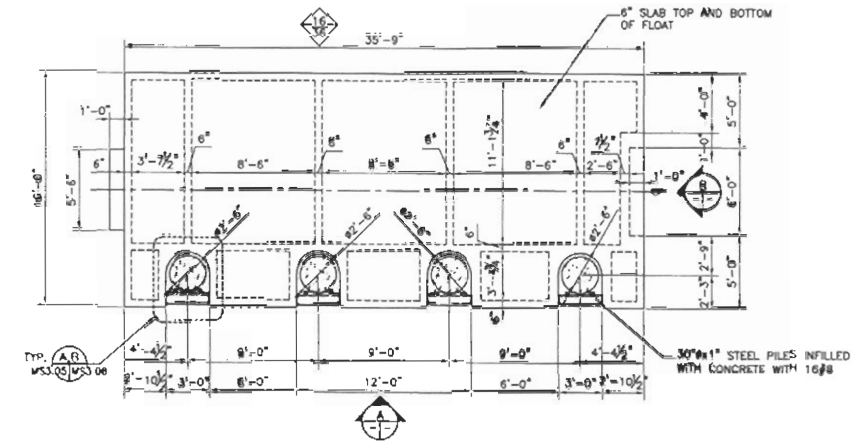
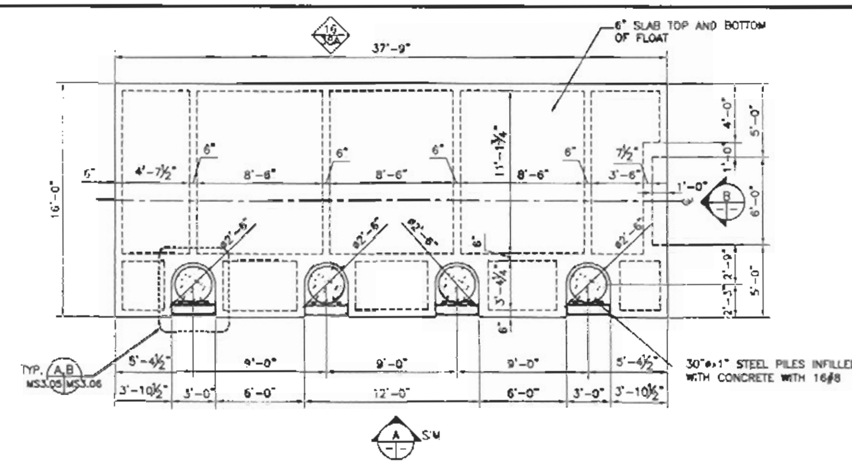
CRESCENT CITY HARBOR DISTRICT
BOAT BASIN
CRESCENT CITY, CA

DOCK 'F' AND 'G' ATTENUATOR FLOAT
DETAILS AND SCHEDULE

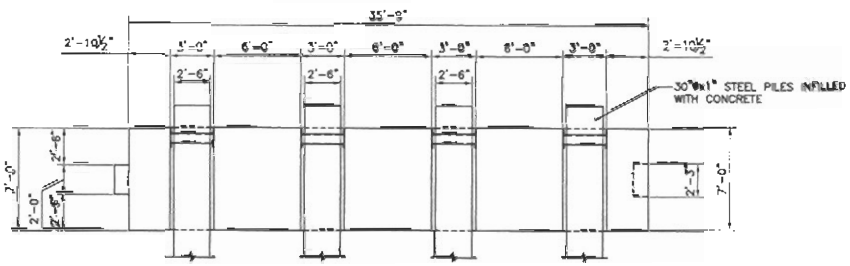
JOB NO. 2009-040
SCALE:
DATE: 04-16-10
SHEET
MS3.04



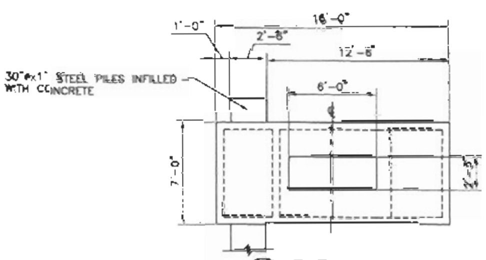

1 16' WIDE ATTENUATOR FLOAT PLAN
SCALE: 1/4"=1'-0"



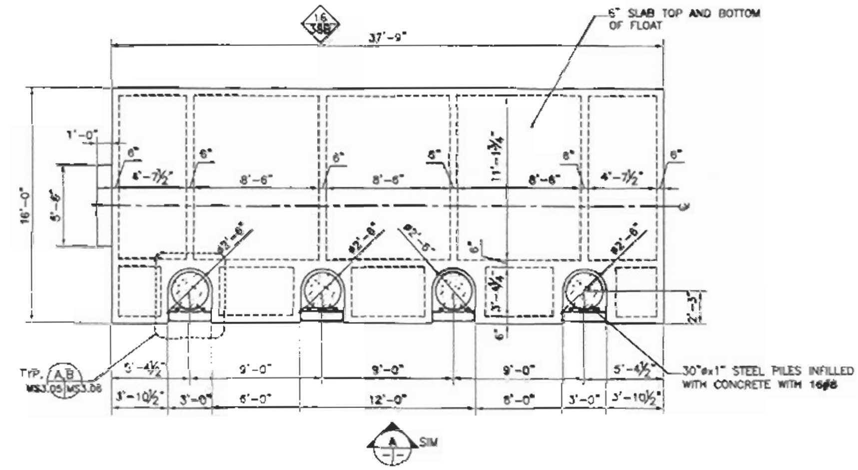

2 16' WIDE ATTENUATOR FLOAT PLAN
SCALE: 1/4"=1'-0"




A ELEVATION
SCALE: 1/4"=1'-0"




B ELEVATION
SCALE: 1/4"=1'-0"




3 16' WIDE ATTENUATOR FLOAT PLAN
SCALE: 1/4"=1'-0"

**30% DRAFT SUBMITTAL SET 04-16-10**

| No. | Date | Revision | Abrvd. |
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CRESCENT CITY HARBOR DISTRICT
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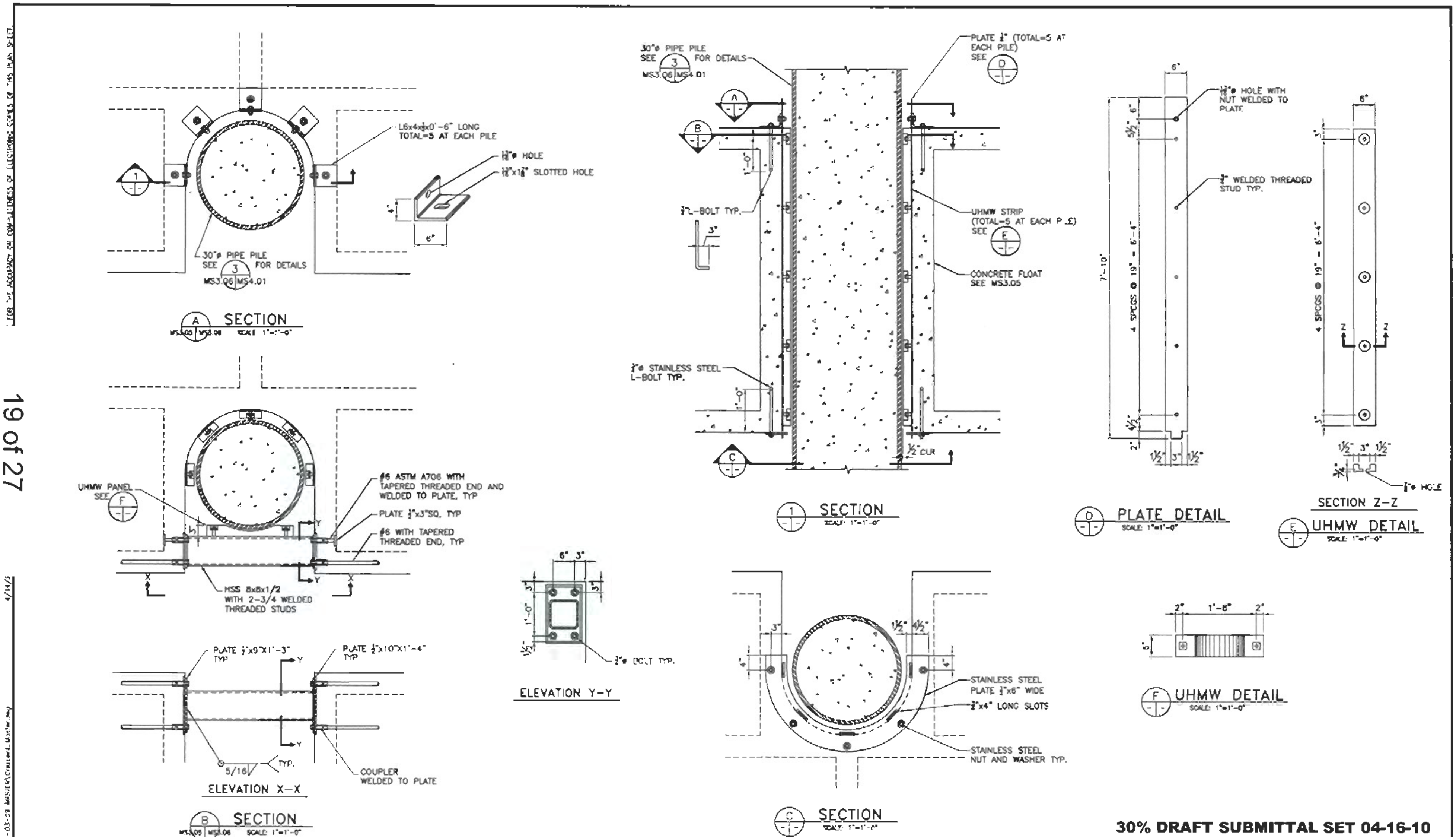
DOCK 'H' ATTENUATOR FLOAT
PLANS AND ELEVATIONS

JOB NO. 2009-040
SCALE:
DATE: 04-16-10
SHEET
MS3.05




**30% DRAFT SUBMITTAL SET 04-16-10**

| No. | Date | Revision | Aprvd. |
|---|---|---|---|
| | | | |

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CRESCENT CITY HARBOR DISTRICT
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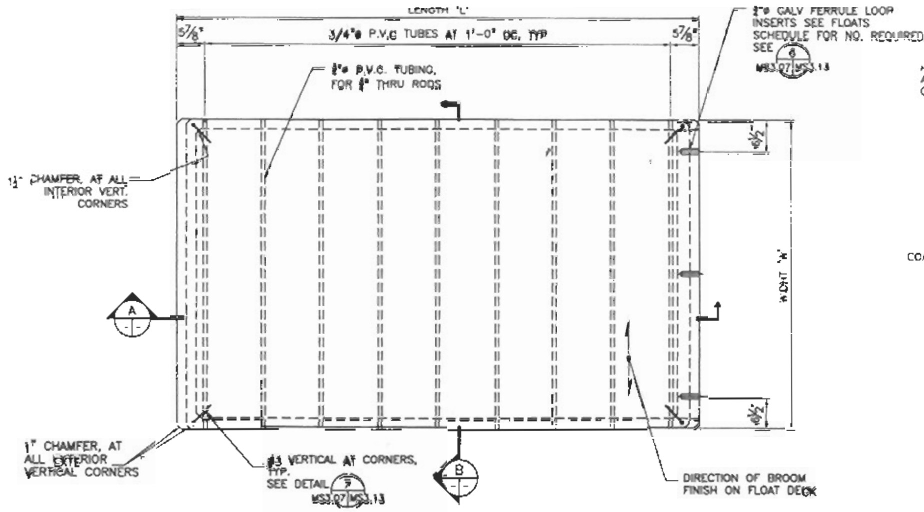
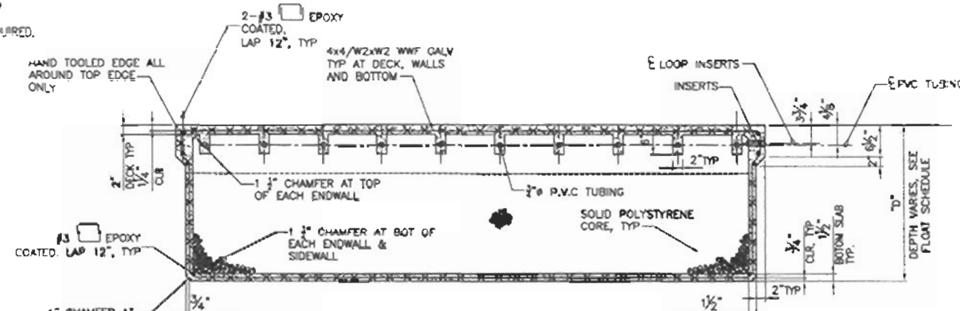
DOCK 'H' ATTENUATOR FLOAT DETAILS

JOB NO. 2009-040
SCALE:
DATE: 04-16-10
SHEET
MS3.06




1 4' AND 5' WIDE FINGER FLOATS PLAN
SCALE: 1"=1'-0"

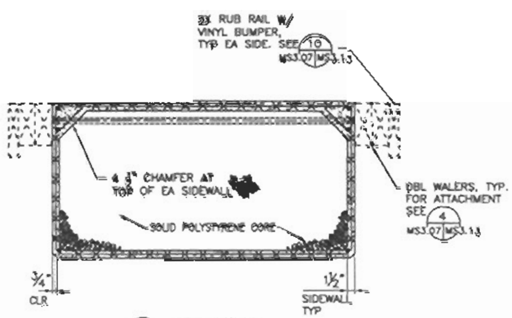



A SECTION
SCALE: 1"=1'-0"

| FLOAT IDENTIFICATION | DIMENSIONS L | DIMENSIONS W | DIMENSIONS D | ⅝"ø P.V.C. TUBING REQ'D PER FLOAT | FERRULE LOOP INSERTS REQ'D PER FLOAT | REMARKS |
|---|---|---|---|---|---|---|
| 4/10 | 9'-11 ½" | 3'-6" | 37" | 10 | - | |
| 4/12 | 11'-11 ½" | 3'-6" | 37" | 12 | - | |
| 5/12 | 11'-11 ½" | 4'-6" | 34" | 12 | - | |
| 4/10 | 9'-11 ½" | 3'-6" | 37" | 10 | - | |
| 4/12 | 11'-11 ½" | 3'-6" | 37" | 12 | | |
| 5/10 | 9'-11 ½" | 4'-6" | 37" | 10 | - | |
| 5/12 | 11'-11 ½" | 4'-6" | 34" | 12 | - | |
| 4/10 | 9'-11 ½" | 3'-6" | 40" | 10 | 3 | |
| 4/12 | 11'-11 ½" | 3'-6" | 39" | 12 | 3 | |
| 5/10 | 9'-11 ½" | 4'-6" | 36" | 10 | 4 | |

NOTES:

1. THICKNESS OF DECK, WALLS, DIAPHRAGM, AND BOTTOM SHOWN ARE MINIMUMS. CONTRACTOR MAY PROPOSE INCREASING THICKNESS IN ACCORDANCE WITH THE SPECIFICATIONS.
2. FLOAT DEPTHS ARE BASED ON DIMENSIONS SHOWN. CONTRACTOR MAY ALTER DEPTH IN ACCORDANCE WITH THE SPECIFICATIONS.
3. WHERE REQUIRED, FERRULE LOOP INSERTS SHALL BE LOCATED AT ONE END OF THE FLOAT.




B SECTION
SCALE: 1"=1'-0"

**30% DRAFT SUBMITTAL SET 04-16-10**

| No. | Date | Revision | Aprvd |
|---|---|---|---|

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CRESCENT CITY HARBOR DISTRICT
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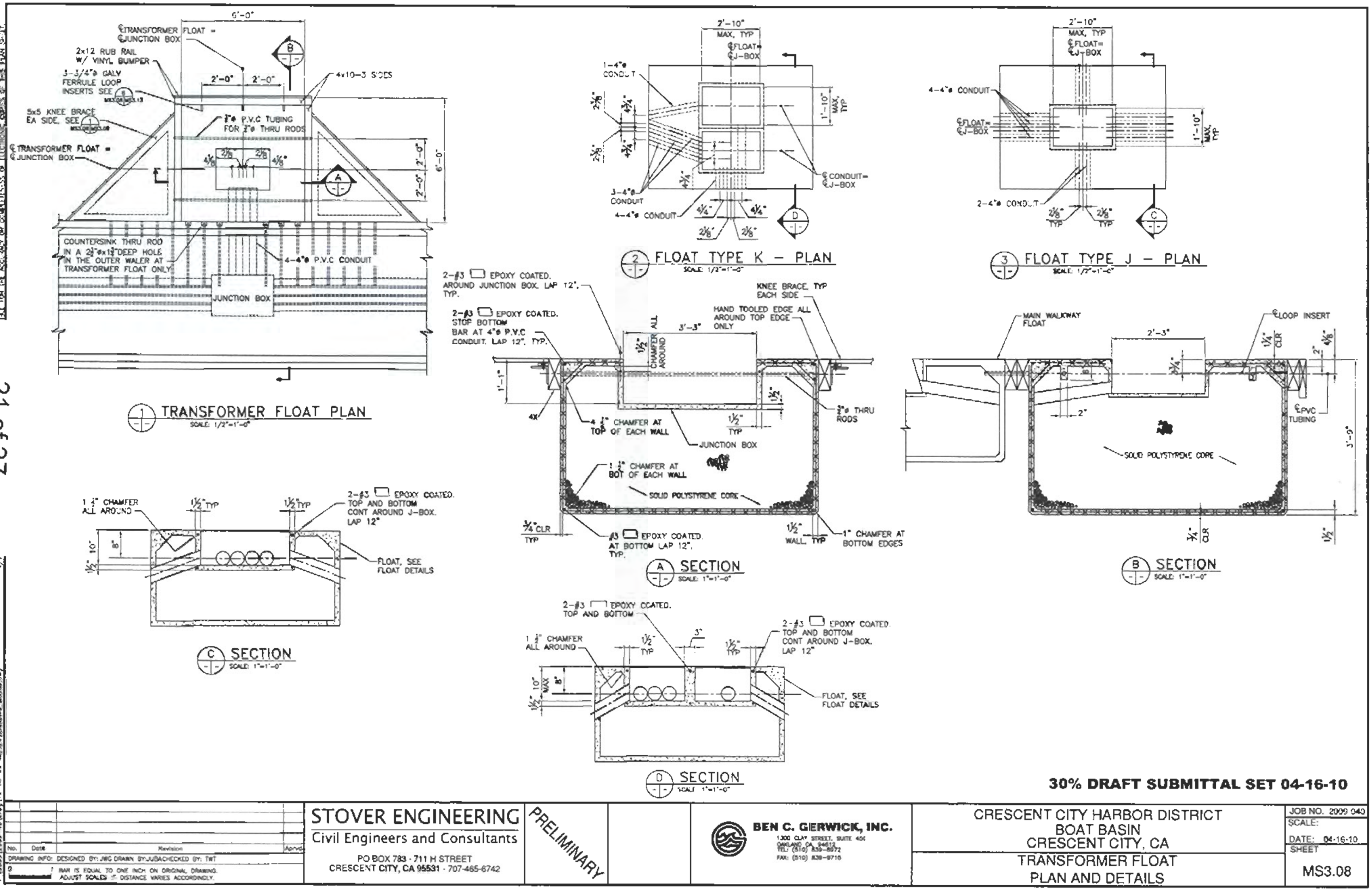
FINGER FLOAT PLAN. DETAILS AND SCHEDULE

JOB NO. 2009-040
SCALE:
DATE: 04-16-10
SHEET
MS3.07


TRANSFORMER FLOAT PLAN
SCALE: 1/2"=1'-0"
FLOAT TYPE K – PLAN
SCALE: 1/2"=1'-0"
FLOAT TYPE J – PLAN
SCALE: 1/2"=1'-0"
SECTION A
SCALE: 1"=1'-0"
SECTION B
SCALE: 1"=1'-0"
SECTION C
SCALE: 1"=1'-0"
SECTION D
SCALE: 1"=1'-0"
℄ TRANSFORMER FLOAT = ℄ JUNCTION BOX
2x12 RUB RAIL W/ VINYL BUMPER
3-3/4"ø GALV FERRULE LOOP INSERTS
5x5 KNEE BRACE EA SIDE
4x10-3 SIDES
P.V.C TUBING FOR THRU RODS
COUNTERSINK THRU ROD IN THE OUTER WALER AT TRANSFORMER FLOAT ONLY
4-4"ø P.V.C CONDUIT
JUNCTION BOX
1-4"ø CONDUIT
3-4"ø CONDUIT
4-4"ø CONDUIT
2-4"ø CONDUIT
℄ CONDUIT= ℄ J-BOX
℄ FLOAT= ℄ J-BOX
2-#3 EPOXY COATED. AROUND JUNCTION BOX. LAP 12". TYP.
2-#3 EPOXY COATED. STOP BOTTOM BAR AT 4"ø P.V.C CONDUIT. LAP 12". TYP.
KNEE BRACE, TYP EACH SIDE
HAND TOOLED EDGE ALL AROUND TOP EDGE ONLY
CHAMFER ALL AROUND
CHAMFER AT TOP OF EACH WALL
CHAMFER AT BOT OF EACH WALL
SOLID POLYSTYRENE CORE
#3 EPOXY COATED. AT BOTTOM LAP 12". TYP.
1" CHAMFER AT BOTTOM EDGES
MAIN WALKWAY FLOAT
℄ LOOP INSERT
℄ PVC TUBING
2-#3 EPOXY COATED. TOP AND BOTTOM CONT AROUND J-BOX. LAP 12"
FLOAT, SEE FLOAT DETAILS
2-#3 EPOXY COATED. TOP AND BOTTOM
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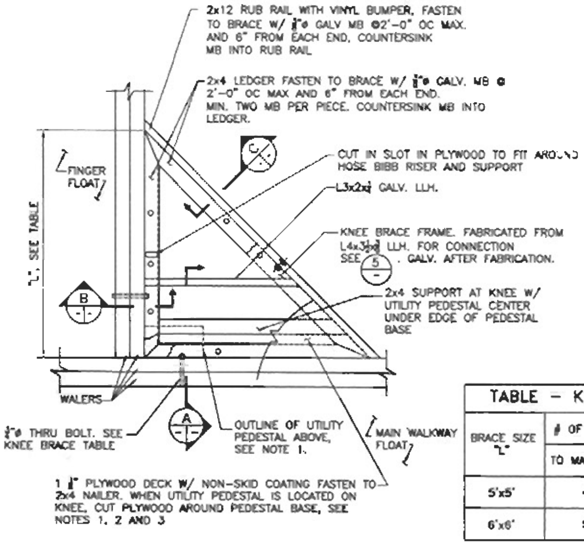
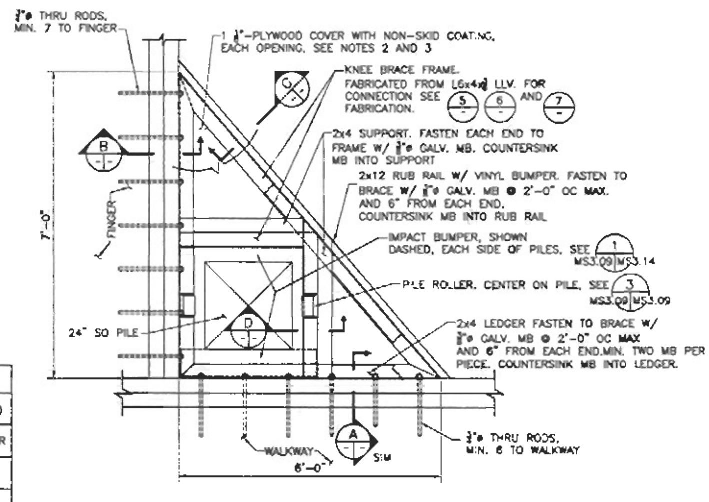
CRESCENT CITY, CA
TRANSFORMER FLOAT
PLAN AND DETAILS
JOB NO. 2009 040
SCALE:
DATE: 04-16-10
SHEET
MS3.08

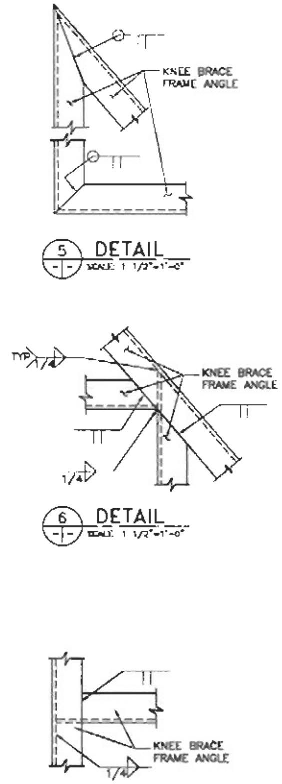



| TABLE - KNEE BRACE | | |
|---|---|---|
| BRACE SIZE "L" | # OF THRU RODS (MIN) TO MAINWALK | TO FINGER |
| 5'x5' | 4 | 5 |
| 6'x6' | 5 | 6 |

1 TYPICAL KNEE BRACE WITHOUT PILE PLAN
MS2.01-MS2.03 | MS3.09 SCALE: 3/4"=1'-0"



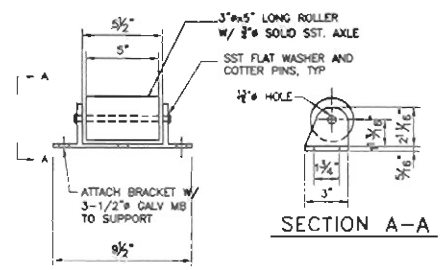

2 KNEE BRACE WITH PILE
MS2.01-MS2.03 | MS3.09 SCALE: 3/4"=1'-0"




5 DETAIL
SCALE: 1 1/2"=1'-0"

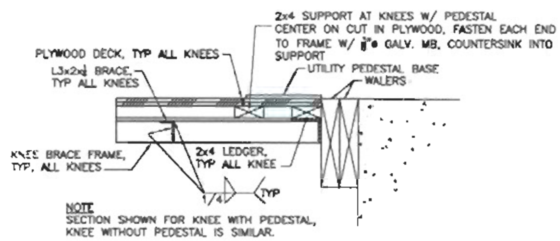
6 DETAIL
SCALE: 1 1/2"=1'-0"

7 DETAIL
SCALE: 1 1/2"=1'-0"



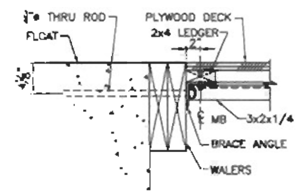

SECTION A-A

4 PILE ROLLER
MS3.09 | MS3.09 SCALE: 3"=1'-0"

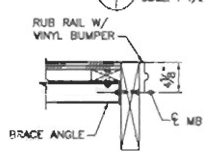



NOTE
SECTION SHOWN FOR KNEE WITH PEDESTAL, KNEE WITHOUT PEDESTAL IS SIMILAR.

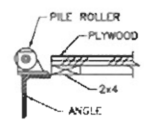
A SECTION
SCALE: 1 1/2"=1'-0"




B SECTION
SCALE: 1 1/2"=1'-0"




C SECTION
SCALE: 1 1/2"=1'-0"




D SECTION
SCALE: 1 1/2"=1'-0"

NOTES:

1. CUT PLYWOOD AROUND PEDESTAL BASE AND FASTEN EACH EDGE TO LEDGER TO ALLOW KNEE COVER TO BE REMOVED WITHOUT HAVING TO REMOVE PEDESTAL.
2. ALL PLYWOOD DECKING SHALL BE FASTENED DOWN WITH #10x2¼ @ 3"OC. STAINLESS STEEL FLAT HEAD WOOD SCREWS. HEADS SHALL BE COUNTERSUNK TYP FOR ALL PLYWOOD DECKING EDGES, UON.
3. PLYWOOD KNEE COVER SHALL BE A CONTINUOUS PIECE, NO SPLICING IS ALLOWED.

**30% DRAFT SUBMITTAL SET 04-16-10**

| No. | Date | Revision | Apvd |
|---|---|---|---|
| | | | |

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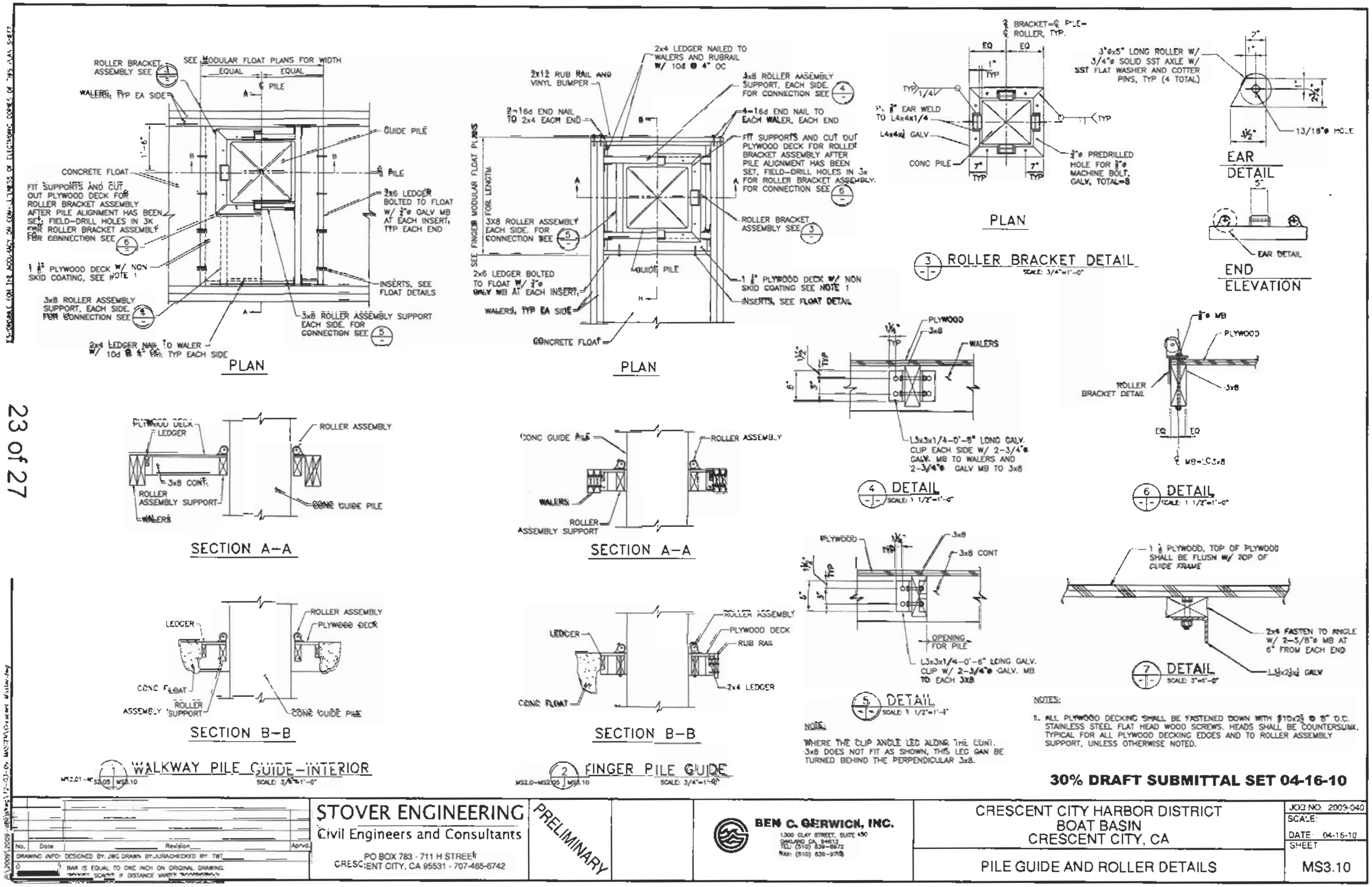
BOAT BASIN
CRESCENT CITY, CA

KNEE BRACING DETAILS

JOB NO. 2009-040
SCALE:
DATE: 04-16-10
SHEET
MS3.09


1 WALKWAY PILE GUIDE-INTERIOR
SCALE: 3/4"=1'-0"
PLAN
SECTION A-A
SECTION B-B
2 FINGER PILE GUIDE
SCALE: 3/4"=1'-0"
3 ROLLER BRACKET DETAIL
SCALE: 3/4"=1'-0"
EAR DETAIL
END ELEVATION
4 DETAIL
SCALE: 1 1/2"=1'-0"
5 DETAIL
SCALE: 1 1/2"=1'-0"
6 DETAIL
SCALE: 1 1/2"=1'-0"
7 DETAIL
SCALE: 3"=1'-0"
ROLLER BRACKET ASSEMBLY SEE
WALERS, TYP EA SIDE
SEE MODULAR FLOAT PLANS FOR WIDTH
EQUAL
GUIDE PILE
CONCRETE FLOAT
FIT SUPPORTS AND CUT OUT PLYWOOD DECK FOR ROLLER BRACKET ASSEMBLY AFTER PILE ALIGNMENT HAS BEEN SET, FIELD-DRILL HOLES IN 3X FOR ROLLER BRACKET ASSEMBLY FOR CONNECTION SEE
1 1/8" PLYWOOD DECK W/ NON SKID COATING, SEE NOTE 1
3x8 ROLLER ASSEMBLY SUPPORT, EACH SIDE. FOR CONNECTION SEE
2x4 LEDGER NAIL TO WALER W/ 10d @ 4" OC, TYP EACH SIDE
3x6 LEDGER BOLTED TO FLOAT W/ 3/4"ø GALV MB AT EACH INSERT, TYP EACH END
INSERTS, SEE FLOAT DETAILS
3x8 ROLLER ASSEMBLY SUPPORT EACH SIDE. FOR CONNECTION SEE
2x12 RUB RAIL AND VINYL BUMPER
2-16d END NAIL TO 2x4 EACH END
2x4 LEDGER NAILED TO WALERS AND RUBRAIL W/ 10d @ 4" OC
3x8 ROLLER ASSEMBLY SUPPORT, EACH SIDE. FOR CONNECTION SEE
4-16d END NAIL TO EACH WALER, EACH END
SEE FINGER MODULAR FLOAT PLANS FOR LENGTH
3X8 ROLLER ASSEMBLY EACH SIDE. FOR CONNECTION SEE
2x6 LEDGER BOLTED TO FLOAT W/ 3/4"ø GALV MB AT EACH INSERT
WALERS, TYP EA SIDE
CONCRETE FLOAT
ROLLER BRACKET ASSEMBLY SEE
1 1/8" PLYWOOD DECK W/ NON SKID COATING SEE NOTE 1
INSERTS, SEE FLOAT DETAIL
ROLLER ASSEMBLY
LEDGER
3x8 CONT.
ROLLER ASSEMBLY SUPPORT
WALERS
CONC GUIDE PILE
PLYWOOD DECK
RUB RAIL
2x4 LEDGER
CONC FLOAT
BRACKET=℄ PILE=℄ ROLLER, TYP.
EQ
TYP
PL 3/8" EAR WELD TO L4x4x1/4
L4x4x1/4 GALV
CONC PILE
7"
3/4"ø PREDRILLED HOLE FOR 3/4"ø MACHINE BOLT, GALV, TOTAL=8
3"øx5" LONG ROLLER W/ 3/4"ø SOLID SST AXLE W/ SST FLAT WASHER AND COTTER PINS, TYP (4 TOTAL)
13/16"ø HOLE
EAR DETAIL
PLYWOOD
3x8
WALERS
L3x3x1/4-0'-8" LONG GALV. CLIP EACH SIDE W/ 2-3/4"ø GALV. MB TO WALERS AND 2-3/4"ø GALV MB TO 3x8
3/4"ø MB
ROLLER BRACKET DETAIL
3/4"ø MB=LC3x8
3x8 CONT
OPENING FOR PILE
L3x3x1/4-0'-6" LONG GALV. CLIP W/ 2-3/4"ø GALV. MB TO EACH 3x8
NOTE:
WHERE THE CLIP ANGLE LEG ALONG THE CONT. 3x8 DOES NOT FIT AS SHOWN, THIS LEG CAN BE TURNED BEHIND THE PERPENDICULAR 3x8.
1 1/8 PLYWOOD, TOP OF PLYWOOD SHALL BE FLUSH W/ TOP OF GUIDE FRAME
2x4 FASTEN TO ANGLE W/ 2-3/8"ø MB AT 6" FROM EACH END
L3x2x1/4 GALV
NOTES:
1. ALL PLYWOOD DECKING SHALL BE FASTENED DOWN WITH #10x2 1/2 @ 8" O.C. STAINLESS STEEL FLAT HEAD WOOD SCREWS. HEADS SHALL BE COUNTERSUNK. TYPICAL FOR ALL PLYWOOD DECKING EDGES AND TO ROLLER ASSEMBLY SUPPORT, UNLESS OTHERWISE NOTED.
30% DRAFT SUBMITTAL SET 04-16-10
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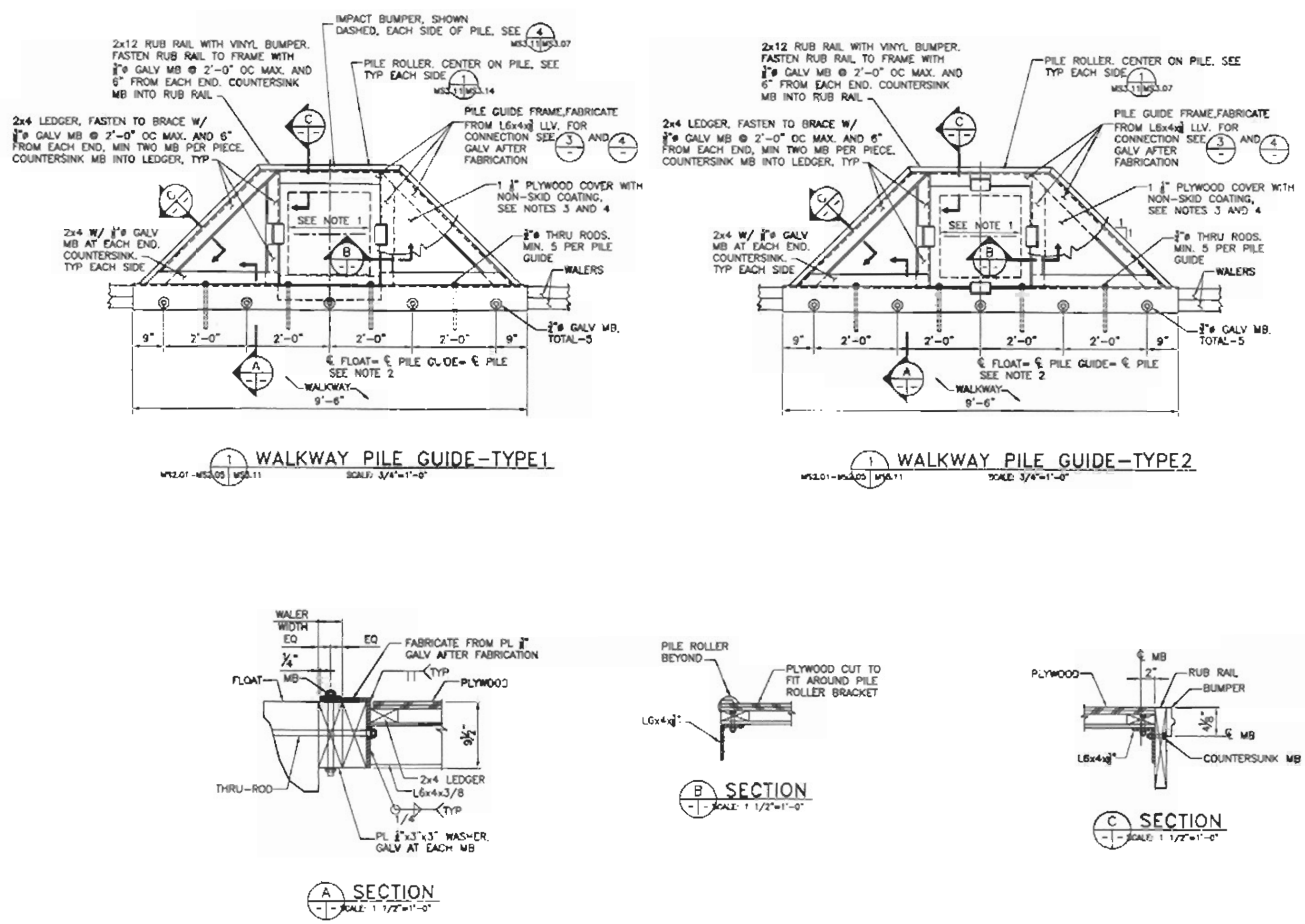
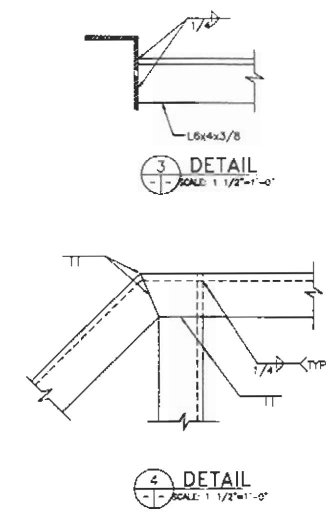
BOAT BASIN
CRESCENT CITY, CA
PILE GUIDE AND ROLLER DETAILS
JOB NO. 2009-040
SCALE:
DATE 04-16-10
SHEET
MS3.10




NOTES:

1. PROVIDE 29" SQUARE OPENING FOR 24"SQUARE PILES AND 25" SQUARE OPENING FOR 20" SQUARE PILES.
2. ADJUST LOCATION OF PILE GUIDE SUCH THAT THE ℄ OF GUIDE MATCHES THE ℄ OF THE FLOAT NEAREST THE PILE LOCATION SHOWN ON THE PLAN.
3. ALL PLYWOOD DECKING SHALL BE FASTENED DOWN WITH #10X2 ½" @8" O.C. STAINLESS STEEL FLAT HEAD WOOD SCREWS. HEADS SHALL BE COUNTERSUNK. TYPICAL FOR ALL PLYWOOD DECKING EDGES, UNLESS OTHERWISE NOTED.
4. PLYWOOD KNEE COVER SHALL BE A CONTINUOUS PIECE. NO SLICING IS ALLOWED.

**30% DRAFT SUBMITTAL SET 04-16-10**

| No. | Date | Revision | Apvd. |
|---|---|---|---|

DRAWING INFO: DESIGNED BY: JWG DRAWN BY: JUBA CHECKED BY: TWT

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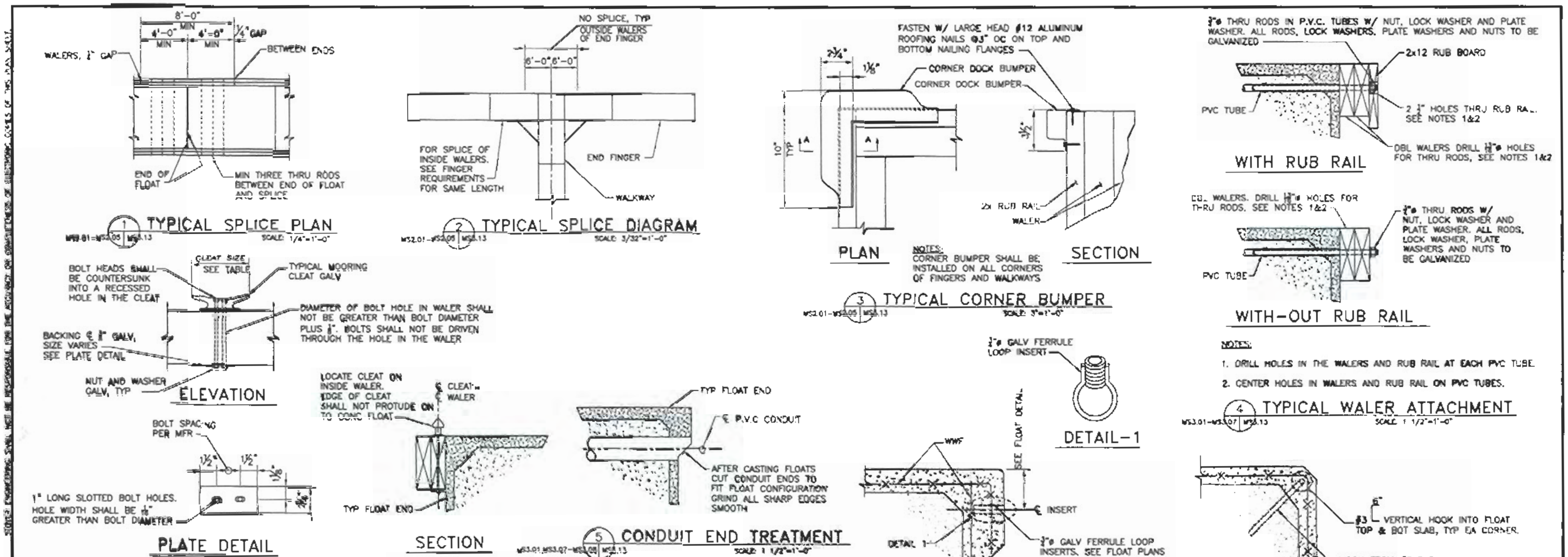
WALKWAY PILE GUIDE DETAILS

JOB NO. 2009-040
SCALE:
DATE: 04-16-10
SHEET
MS3.11



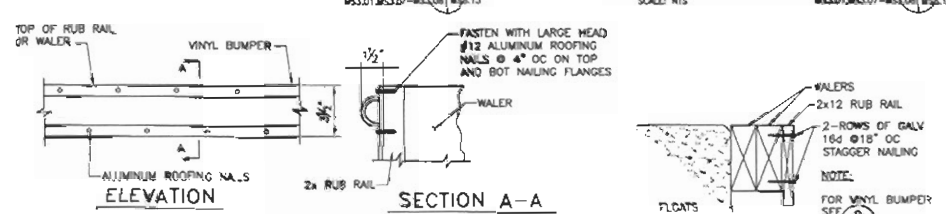

## CLEAT TABLE

| LOCATION | CLEAT SIZE | NUMBER REQUIRED | BOLT DIAMETER |
|---|---|---|---|
| 30' FINGERS | 12" HD | 2 PER BERTH | 5/8" ø |
| 40' & 50' FINGERS | 15" HD | 3 PER BERTH | 3/4" ø |
| 60' FINGERS | 15" HD | 4 PER BERTH | 3/4" ø |
| 70' FINGERS | 15" HD | 4 PER BERTH | 3/4" ø |
| CHANNEL SIDE OF END FINGERS SEE NOTE 3 | 15" HD | SEE PLANS | 3/4" ø |
| WALKWAYS | 15" HD | SEE PLANS | 3/4" ø |

NOTES:

1. HD = HEAVY DUTY CLEAT, ALL OTHERS ARE STANDARD.
2. SEE PLANS FOR CLEAT LOCATIONS AND SPACING AS REQUIRED.
3. ON THE BERTH SIDE OF END FINGERS, USE CLEAT SIZE AND NUMBER REQUIRED FOR THE FINGER LENGTH.

8 TYPICAL MOORING CLEAT DETAILS
SCALE: NTS




NOTES:

1. BUMPER STRIP TO BE INSTALLED CONTINOUSLY ON ALL FINGERS INCLUDING END TIES AND MAIN WALKWAYS & ON WORKING SIDE OF MARGINAL WALKWAYS

9 TYPICAL BUMPER STRIP
SCALE: 3"=1'-0"

10 TYPICAL RUB RAIL
SCALE: 1 1/2"=1'-0"

**30% DRAFT SUBMITTAL SET 04-16-10**

STOVER ENGINEERING
Civil Engineers and Consultants
PO BOX 783 · 711 H STREET
CRESCENT CITY, CA 95531 · 707-465-6742

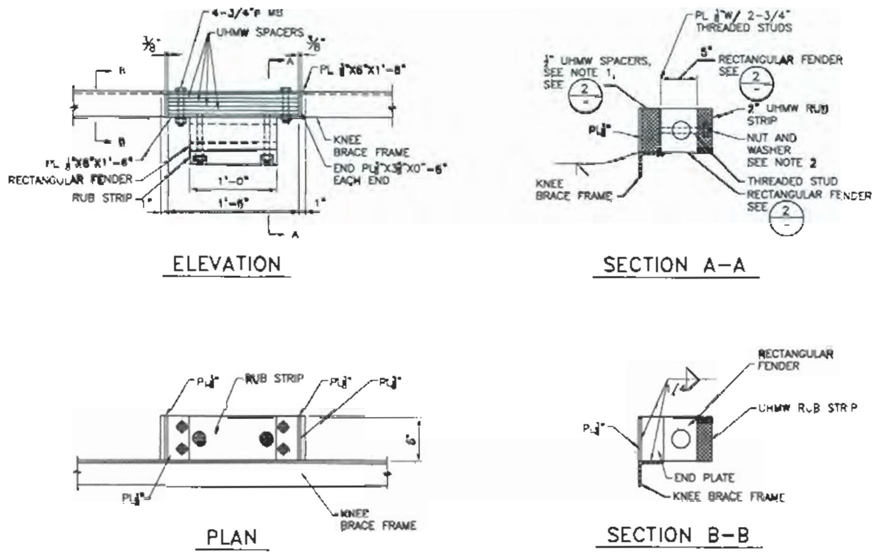
PRELIMINARY

BEN C. GERWICK, INC.

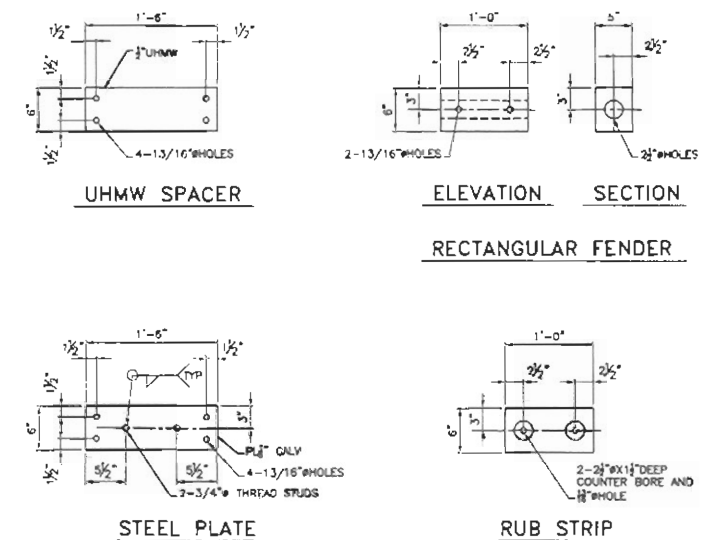
CRESCENT CITY HARBOR DISTRICT
BOAT BASIN
CRESCENT CITY, CA

BERTHING SYSTEM DETAILS

JOB NO. 2009-040
SCALE:
DATE: 04-16-10
SHEET
MS3.13




1 IMPACT BUMPER
SCALE: 1 1/2"=1'-0"




2 IMPACT BUMPER COMPONENT
SCALE: 1 1/2"=1'-0"

NOTES:

1. ADD OR REMOVE SPACERS AS REQUIRED SO THAT THE GAP BETWEEN THE FACE OF RUB STRIP AND FACE OF PILE IS NOT GREATER THAN ½".
2. THREADED STUD LENGTH SHALL NOT EXCEED 5½".

**30% DRAFT SUBMITTAL SET 04-16-10**

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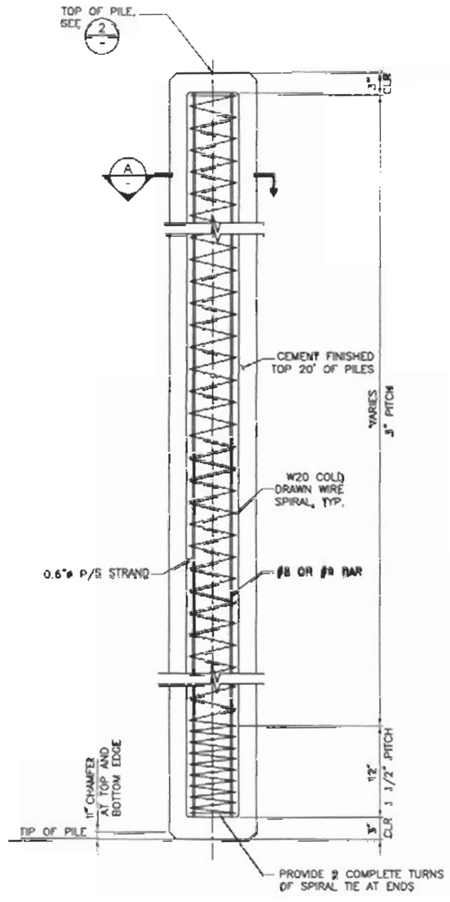
PRELIMINARY

BEN C. GERWICK, INC.

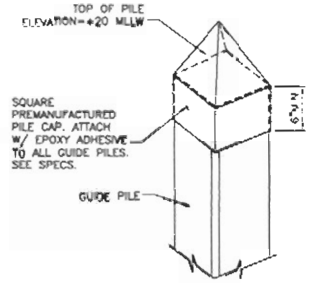
CRESCENT CITY HARBOR DISTRICT
BOAT BASIN
CRESCENT CITY, CA

IMPACT BUMPER DETAILS

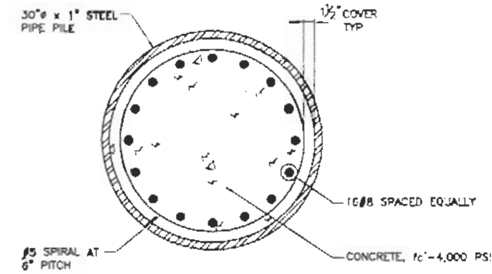
JOB NO. 2009-040
SCALE:
DATE: 04-16-10
SHEET
MS3.14



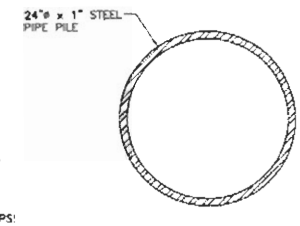

1 WALKWAY PILE GUIDE
SCALE: 1 1/2"=1'-0"



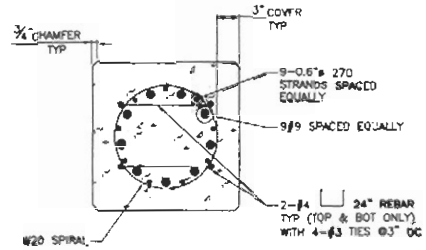

2 TOP OF PILE
SCALE: NTS



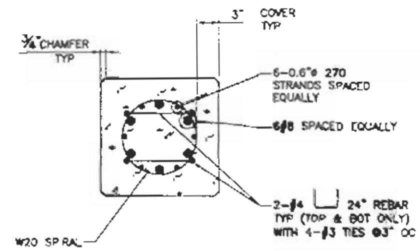

3 TYPICAL 30"ø STEEL PILE SECTION
SCALE: NTS




4 TYPICAL 24"ø STEEL PILE SECTION
SCALE: NTS

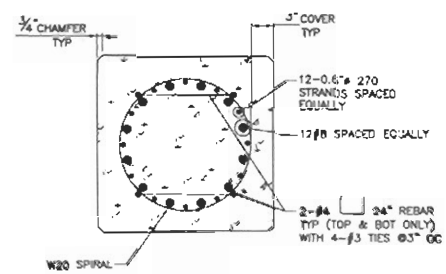



20" PILE




16" PILE

| PILE SCHEDULE | |
|---|---|
| DOCK | TIP ELEVATION (MLLW) |
| A | - FT |
| B | - FT |
| C | - FT |
| D | - FT |
| E | - FT |
| F | - FT |
| G | - FT |
| H | - FT |
| WORK | - FT |




24" PILE

A SECTION–PLAN
SCALE: 1 1/2"=1'-0"

**PRESTRESSED PILE NOTES:**

1. MINIMUM CONCRETE COMPRESSIVE STRENGTH SHALL BE f'c =6000 PSI AT 28 DAYS AND f'c AT TRANSFER OF STRESS = 4000 PSI AT 28 DAYS.
2. MATERIALS:
   - CEMENT SHALL BE TYPE II OR MODIFIED – ASTM C150 TYPE I.
   - AGGREGATES SHALL BE PER ASTM C33 (1" MAX).
   - PRESTRESSING STRANDS SHALL BE ASTM A416 SEVEN WIRE STRANDS WITH A MINIMUM BREAKING STRENGTH OF 270 KSI.
   - REINFORCING STEEL SHALL BE ASTM A615, GRADE 60
   - SPIRAL WIRE SHALL BE ASTM A82 COLD DRAWN WIRE WITH MINIMUM YIELD STRENGTH OF 70 KSI.
3. MINIMUM CONCRETE COVER OVER SPIRAL REINFORCING SHALL BE 3".
4. MAXIMUM STRAND TENSION AT RELEASE (MAX JACKING FORCE BEFORE LOSSES) SHALL BE 40.7 KIPS FOR 0.60 INCH DIAMETER STRANDS.
5. MINIMUM EFFECTIVE PRESTRESS IN CONCRETE AFTER LOSSES = 730 PSI.
6. NOMINAL TIP ELEVATION FOR INDICATOR PILES SHALL BE TWENTY FEET LONGER THAN ESTIMATED TIP ELEVATION SHOWN IN DOCK PILE SCHEDULE. INDICATOR PILE LOCATIONS SHOWN ON PLANS.

**30% DRAFT SUBMITTAL SET 04-16-10**

| No. | Date | Revision | Aprvd |
|---|---|---|---|

DRAWING INFO: DESIGNED BY: JWC DRAWN BY: JJB CHECKED BY: TWT

BAR IS EQUAL TO ONE INCH ON ORIGINAL DRAWING. ADJUST SCALES IF DRAWING VARIES ACCORDINGLY.

STOVER ENGINEERING
Civil Engineers and Consultants
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CRESCENT CITY, CA 95531 · 707-465-6742

PRELIMINARY

BEN C. GERWICK, INC.
1300 CLAY STREET, SUITE 450
OAKLAND, CA 94612
TEL: (510) 839-8972
FAX: (510) 839-9715

CRESCENT CITY HARBOR DISTRICT
BOAT BASIN
CRESCENT CITY, CA

MARINA GUIDE PILE
SCHEDULE AND DETAILS

JOB NO. 2009-040
SCALE:
DATE 04-16-10
SHEET
MS4.01

U.S. Department of Housing and Urban Development

San Francisco Regional Office

450 Golden Gate Avenue

San Francisco, California 94102-3448

# Environmental Assessment

## For HUD-funded Proposals

(HUD recommended format per 24 CFR 58.36, revised 1/99)

Project Identification: Crescent City Harbor District

Inner Boat Basin Rehabilitation Project

Preparers: Ernest W. Perry, Planner Crescent City Harbor District

Wilma Madden, Administrative Assistant Crescent City Harbor District

Ward Stover, Stover Engineering

Responsible Entity: County of Del Norte

Month/Year: July 2010

EXHIBIT NO. 6

APPLICATION NO.

1-10-035

CRESCENT CITY HARBOR DISTRICT

ENVIRONMENTAL ASSESSMENT (1 of 68)

## 1.0 ENVIRONMENTAL ASSESSMENT

**Responsible Entity** [24 CFR 58.2(a)(7)]: County of Del Norte

**Certifying Officer** [24 CFR 58.2(a)(2)]: Jay Sarina, County Administrative Officer,

**Project Name:** Inner Boat Basin Reconstruction

**Project Location:** Crescent City Harbor Inner Boat Basin

**Estimated total project cost:** $20,000,000.

**Grant Recipient** [24 CFR 58.2(a)(5)]: Crescent City Harbor District

**Recipient Address:** 101 Citizens Dock Road, Crescent City, CA 95531

**Project Representative:** Richard Young, CEO-Harbormaster

**Telephone Number:** 707-464-6174

**CONDITIONS OF PROJECT APPROVAL:**

**Air Quality and Water Quality**

1. A Storm Water Pollution Prevention Plan, Erosion Control Plan, a Hazardous Materials Management/Spill Response Plan, and related BMPs will be required of the contractor or contractors to reduce, to the maximum extent possible, the volume, velocity, and pollutant load of storm water and dry weather flows from leaving the project site during construction and from the staging area during construction activity.
2. At all times during construction activities, contractor or contractors shall minimize the area disturbed by excavation, grading, or earth moving (if any) to prevent excessive amounts of dust. During periods of high winds (i.e. wind speed sufficient to cause fugitive dust to impact adjacent properties) contractor shall cover or treat exposed soils areas and active portions of the construction site to prevent fugitive dust.

3. Throughout construction, contractor shall sweep adjacent paved areas sufficient to keep any visible soil material and/or sand from the construction activities from accumulating on the adjacent paved areas.
4. All trucks hauling graded or excavated material offsite, if any, shall be required to cover their loads as required by the California Vehicle Code Sec. 23114, with special attention to preventing spills onto public streets, roads, or highways.
5. The contractor or contractors shall ensure that all construction equipment is maintained and tuned to meet applicable EPA and CARB emission requirements for the duration of the construction activities.
6. All materials placed in the water of the inner boat basin, such as pilings, grouting, pilings, and floats shall be nontoxic.
7. All debris, materials, damaged and destroyed items, sediment, and other materials removed from the inner boat basin shall be disposed of at an approved disposal site.

**Biological Resources**

1. All construction activities in the water of the inner boat basin shall be conducted only between July 1 through October 15 of each work year.
2. Area C on the Gedik maps will be temporarily fenced to between the project area and the sensitive area to prevent trampling, vehicle activity, stockpiling activities, or other construction activities. Installation of the temporary fence will be monitored by a biological monitor.

**Flood Damage Prevention**

1. The project shall comply with the (FEMA approved) Flood Damage Prevention Ordinance, specifically section Chapter 21.45.

**Noise**

1. Contractor or contractors shall minimize the number of vehicles and equipment operating on site at the same time.
2. Construction equipment shall be properly muffled and shrouded to minimize noise levels and maintained to prevent contamination of soil or water from external grease and oil or from leaking hydraulic fluid, fuel, oil, or grease.
3. Hours of construction activity shall be limited to the hours of 7:00 a.m. to 7:00 p.m. on weekdays and on Saturdays and 8:00 am to 5:00 pm on Sundays. Work on state holidays is not allowed without prior approval of the Harbor.
4. All debris, materials, damaged and destroyed items, sediment, and other materials removed from the inner boat basin shall be disposed of at an approved disposal site.

**Cultural Resources**

1. It is the policy of the County of Del Norte that, should any archaeological resources be found during the project construction, construction activities shall be halted at the site until an evaluation of the find is made either by a qualified archaeologist or a representative of a local Rancheria or Rancherias. If human remains are encountered during earth-disturbing activities for the project, all work in the adjacent area shall stop immediately and the Del

Norte County Coroner's office shall be notified. If the remains are determined to be Native American in origin, the Native American Heritage Commission shall be notified and will identify the Most Likely Descendent, who will be consulted for recommendations for treatment of the discovered remains.

**FINDING:** [58.40(g)]

☒ **Finding of No Significant Impact**

(The project will not result in a significant impact on the quality of the human environment)

☐ **Finding of Significant Impact**

(The project may significantly affect the quality of the human environment)

**Preparer Signature:** ______________________________ **Date:** ________

**Title/Agency:** **Ernest Perry, Planner**
**Crescent City Harbor District**

**Certifying Officer Signature:** ______________________________ **Date:** ________

**Title/ Agency:** **Jay Sarina, County Administrative Officer**
**County of Del Norte**

## 2.0 STATEMENT OF PURPOSE AND NEED FOR THE PROPOSAL (40 CFR 1508.9(b))

### 2.1 Background

Crescent City is located in the most northwest part of California, approximately 20 miles south of the border with the State of Oregon. Commercial and limited sport fishing boats operate out of the Crescent City harbor. The Crescent City Harbor District is a political subdivision of the State of California, organized and validated under the California Harbors and Navigation code as an independent special district. The Harbor District is empowered by its authorizing statutes in the California Harbors and Navigation code, section 6000 et seq. The District has a county-wide elected five member Board of Commissioners elected by the residents within the boundaries of the district. The Harbor District has broad powers to own, operate, control or develop harbor works and to provide ownership, operation, maintenance, and management of public use areas (marinas, piers, restrooms, boat launch facilities, parking, moorings, etc) as well as commercial, recreational, and industrial activities within the harbor.

### 2.2 Disaster Event

On November 15, 2006, an 8.3 magnitude earthquake occurred in the Kuril Islands of Japan that generated a tsunami that hit the Japanese coast and generated tsunami warnings for the west coast of the United States. The tsunami generated reached the Hawaiian and California coasts. A tsunami with a series of waves that measured up to six feet in height every 20 minutes for a period of 8 hours engulfed the harbor at Crescent City causing extensive damage to the docks and berthing system of the inner boat basin. The tsunami event created excessive side forces on all of the docks within the inner boat basin causing the concrete docks to flex beyond their structural limits resulting in cracking of the concrete and breaking of the whaler boards that hold the sections of the docks together. The resultant damage totals approximately $20 million to the inner boat basin dock, pilings, floats, and utility infrastructure (electrical, potable water, and fire protection) serving the moored boats in the harbor. Approximately 37,000 square feet of the 57,100 sq. ft. floating docks were damaged beyond repair with the remaining 20,000 square feet severely damaged and still being used. All 161 pilings were damaged, resulting in the loss of structural integrity of the overall berthing system of the inner boat basin. The tsunami event energy waves also deposited approximately 7,800 cubic yards (CY) of additional silt within the inner boat basin and displaced an estimated 8,056 cubic yards of rock slope protection at various locations within the inner boat basin.

The damage from the tsunami was limited to the inner boat basin and its facilities. As the tsunami damage was localized, a federal disaster was not declared, but rather a state disaster only. This resulted in the Office of Emergency Services (OES) being the main funding agency for the repairs, rather than a secondary match to a federal declaration. OES will fund 75% of allowable costs, with a 25% local match required for the remainder of the project. A state Community Development Block Grant (CDBG) is providing funding to meet the local match requirements for OES so that the repair to the inner boat basin can be accomplished.

## 3.0 DESCRIPTION OF THE PROPOSAL (24 CFR 58.32, 40 CFR 1508.25)

### 3.1 Project Area

The project area includes the area of the inner boat basin and the immediate area adjacent to the inner boat basin consisting of the rock slope protected inner walls. The project area also includes a staging area located on an existing paved area adjacent to the inner boat basin. Access and construction activities will utilize existing roadways and/or other paved or previously disturbed areas other than the actual work within the inner boat basin marina as described in Section 2.2.

The project area is located within the urban area of the City of Crescent City, California, within Del Norte County and approximately 400 feet west of Highway 101 in Township 16 North, range 1 West, Section 28. Refer to Figure 1 (page 52) and Figure 2 (page 53) and Photo 1 (page 54).

### 3.2 Proposed Project

The proposed project will restore the inner boat basin to its pre-disaster capacity and function. Since the proposed project is essentially a rebuild of the marina within the confines of the inner boat basin, the Harbor District conducted an examination of dock reconfigurations within the inner boat basin marina in order to maximize the potential to accommodate a range of boat sizes that varies from summer to winter. Summer tends to see more pleasure craft in the harbor as the summer climate is more conducive to recreational use and visits by transient vessels. The winter months tend to have very rough seas and inclement weather factors that discourage visitor and recreational use of boats in the area. The winter months are also the peak months for the commercial fishing catch which tends to draw commercial fishing boats to the harbor from other areas.

Ten layouts were considered and analyzed. Section 4 of this document includes a discussion of the alternatives considered. The Harbor Commission reviewed all ten options during a public meeting of the Commission at their February 16, 2010 regular meeting. The Commission chose Option 8 as the preferred alternative. Option 8 mimics the pre-disaster layout and also provides adequate distribution of all sizes of slips sufficient to meet current needs and provides flexibility to accommodate additional boats in all categories including 30 foot boats if needed in the future. Attached Figure 3 (page 55) is a copy of the proposed project (Option 8).

The preferred alternative will restore the damaged inner boat basin to pre-disaster capacity and service levels as well as reduce the likelihood of damage from future tsunami events. The preferred alternative includes the installation of a wave attenuator as part of the replacement of "H" dock and installation of socketed piles. The capacity of the restored inner boat basin would be approximately the same as pre-disaster capacity. As a result of the State declared disaster, the following are elements of to the rehabilitation and restoration of the inner boat basin:

#### 3.2.1 Dredge and Disposal of Tsunami Generated Silt Material

As a result of the tsunami event, 7,424 CY of dredge materials will be removed from the inner boat basin. The Army Corps of Engineers has determined that the inner boat basin will require a total removal of approximately 27,000 cubic yards of dredging to bring it back to the original recommended depth of minus 12 feet below the mean lower low water (MLLW) level. These same bathymetric surveys showed that 7,800 CY of silt was deposited within the inner boat basin between February of 2006 and July of 2007. The yearly average of fill since 1972 has been 562 CY, with monthly average silt fill being 47 CY. Adjusting for the date of the subject tsunami and the date that the 2006 survey was completed (8 months or 376 CY) would mean that 7,424 CY of total accumulated silt can be attributed to the tsunami. The Harbor District is responsible for removal of the remaining dredging (19,576 CY) through its regular maintenance and will fund this cost through other sources.

Disposal of the 7,424 CY of dredged material will be into the existing on-shore dredge material ponds of the District. The OES funding has authorized removal of the same amount from the dredge ponds as the amount authorized for dredging (7,424 CY) with trucking to an approved disposal site. The disposal of the previously dredged material (primarily sand and other sediments) will be at the previous County landfill site and will contribute to the closure plan for those previous landfill activities.

The accumulated excessive sand fill generated by the tsunami can be observed at low tide in the immediate vicinity of the entrance channel within the inner boat basin. This excessive sand created a sand shoal which restricts maneuvering of commercial fishing vessels coming in and out of the inner boat basin. An island is formed in this area within the inner boat basin during low tides. See Photos 2, 3, and 4 (pages 56-58).

### 3.2.2 Replace Rock Slope Protection Replacement

At the time of inspection by OES of the tsunami damage to the inner boat basin, it was estimated that as much as 8,506 CY of rock slope protection (RSP) within the interior perimeter of the inner boat basin was displaced by the tsunami. Since the Harbor District could not provide specific records prior to the tsunami event to demonstrate that all of the displaced rock slope protection was a result of the tsunami, there was no baseline for OES to determine the lost material that could be attributed to the tsunami. OES concluded "(i)t is reasonable to assume that material was lost, but not necessarily the entire 8,506 CY …it is now estimated that 50% of the 8,506 SF (sic), or approximately 4,253 CY would be contributed to the tsunami and eligible for funding." The district will be financially responsible for replacing any rock slope protection in excess of the 4,253 CY approved for funding by OES. The District will continue to attempt to establish the baseline sought by OES in order to adjust the financial contribution by OES to this project element.

There are two revetment areas within the inner boat basin requiring extensive repair. These two areas are located in the southeast corner of the inner boat basin. These two areas are approximately 45 feet in length and 150 feet in length. In these two instances, the damaged areas are readily visible as most of the RSP is missing and the fabric is crumpled and exposed. There are also approximately eight other spot repairs where the fabric is exposed but most of the RSP still remains. The damaged RSP areas will require the replacement of the geo-fabric and placement of one- and two-ton revetment materials (rock). The various spot repairs may only require placement of revetment depending upon the condition of the fabric. Any removed and/or remaining RSP will be replaced on the revetment area to match the existing slope. The RSP repairs will be conducted within the footprint of the existing revetment materials, with the new materials being placed at approximately the same slope as that of the existing adjacent materials and within the excavated areas extending back away from the inner boat basin such that no further encroachment into the water would occur. The locations of the rock slope protection replacement areas are identified on Figure 4 (page 59).

### 3.2.3 Remove and Replace Pilings

Prior to the tsunami event, there were approximately 161 piles within the inner boat basin. The existing damaged piles are steel piles and are either 12 inches or 14 inches in diameter and vary in depth into the floor of the inner boat basin but are about 8 feet in depth. During an on-site inspection by the Harbor's consulting engineer (Stover Engineering) with the CalEMA Technical Assistance Program Section and the Area Coordinator, OES determined that all of the pilings in the inner boat basin would have to be replaced. This decision was based on the intensity and height of the waves that caused the docks to pound against the piles, breaking them loose from their footings.

The hydraulic forces require the creation of concrete filled sockets in the underlying soft rock to develop sufficient resistance to overturning. The preferred method of installation of the piles will be to place a steel casing through the silt on the bottom of the inner boat basin and drive the steel casing approximately six inches into the rock under the slit. The casing will be oversized for the pile to be installed. For example a 30 inch casing would be used to for a 24 inch concrete pile. After removal of the overburden within the steel casing, a "drill" would be used to create a round hole into the rock and at the required depth (20 to 40 feet dependent upon location) to ensure that the rock could adequately support the estimated pile load. The spoils would be contained in the steel casing and removed to the barge being used to install the new piers. The spoils would be properly disposed. The steel casing will also mitigate sound attenuation into the water during the installation. Then following the boring, the next steps will be to lower the new pile (concrete in most cases with steel in some limited locations) into the hole and grout the annulus between the casing and the pile. Two barges are required; a derrick barge to install the casing, place the pile and grout the socket, and a drill barge to drill the socket. This method has been successfully used on San Clemente Island on a project for the US Navy. Concrete piles have become a more cost effective means of replacement, as steel piles have become expensive.

An alternate method could be used that would consist of driving the piles with an impact vibratory hammer. A vibratory hammer will not be able to install the piles in rock to the required embedment. Vibratory hammers are most useful in sand, or sandy clay, which allow the soil to be displaced during vibration. The steel piles may be driven directly into rock, but the concrete piles would use a H-pile as a stinger at the tip of the pile. The rock bottom of the inner boat basin, therefore, makes underwater boring as described above the preferred method of pile installation.

Based on a review of the 30% plans for the preferred alternative, a breakdown of the increase in piles is as follows:

| | |
|---|---|
| • Work Dock | +3 |
| • A Dock | +2 |
| • B Dock | no change |
| • C Dock | +7 |
| • D Dock | no change |
| • E Dock | +8 |
| • F Dock | +12 |
| • G Dock | +12 |
| • H Dock | +36 (wave attenuator) |
| Total | +80 |

The increased number of pilings to H Dock is due to the fact that H Dock will function as the wave attenuator. H Dock was destroyed during the tsunami with docks G, F, and E, located directly behind Dock H, also being destroyed or substantially damaged, proportionately reflecting the increased number of piles in each of those docks. Velocities both during the November 2006 tsunami, the February 2010 tsunami, and in the tsunami model, are greater around the H Dock area than the B and A dock areas. Therefore, wave forces are greater on the floats and piles on H Dock, G Dock, F Dock, and E Dock. These wave forces diminish as the velocity field reduces in a clockwise swirling pattern throughout the rest of the inner boat basin. This explains why there are more piles and larger floats on E, F, G and H docks.

Pile sizes and floats on A, B, C and D Docks are more influenced by the size of the boat. Bigger boats catch more wind and have more mass. The width of a float is sized to resist sideways bending loads. The greater the side load or spacing of piles requires a wider float. The walkway floats are generally wider (8 feet) than they were previously (6 feet) because the forces of the velocity wave, or boat loads using current design standards for marinas, created stresses too high to put back 6-foot floats.

### 3.2.4 Remove and Replace Docks

The docks will be replaced in total. All new docks will meet current standards but be approximately the same square footage as the previously existing docks. A total of 1,035 individual docks that total 57,100 square feet will be removed and replaced. All removed docks will be disposed at a properly permitted disposal site. Due to the extensive damage to 133 of the previous docks, they were removed immediately after the tsunami event. Other docks have been removed on an individual, as needed basis. These docks and the remaining docks are lifted from the water surface and placed in a storage yard of the harbor. Disposal of the damaged docks will be through the Del Norte Solid Waste Authority or other approved disposal method. The District has been in contact with the Solid Waste Authority and a method and process for disposal has been tentatively set by trucking the damaged docks to the Solid Waste Authority and on to the contracted disposal site of the Authority.

The new prefabricated docks will be trucked from the manufacturer to the staging site located adjacent to the inner boat basin and located within the existing paved parking lot and harbor storage yard. Once the pilings are set, the new docks will be lowered onto the water and connected together to the previously set pilings.

### 3.2.5 Wave Attenuator

The area of the most significant damage from the tsunami is the area lying in the southwest area of the inner boat basin. Dock "H" is gone in total, one-third of dock "G" is gone, and approximately one-half of dock "F" is no longer present. A tsunami study for the Inner boat basin rehabilitation project has been prepared by Ben C. Gerwick, Inc, a consulting engineering firm in Oakland, California. The study determined that "(r)egions of high velocity magnitude develop peak velocities of up to 29 fps (feet per second) in the access channel and at the entrance to the inner boat basin." The report also stated that "(a) pronounced clockwise circulation develops in the marina as a result of the tsunami surges." This water movement was physically observed during the February 27, 2010 tsunami generated by the 8.8 earthquake in Chile when the tsunami reached the inner boat basin with repeated surges of water.

As part of the assignment to Gerwick Inc., they also looked at ways to mitigate the impacts of a tsunami within the inner boat basin. Gerwick looked at two methods of wave attenuation for the "H" dock area. They concluded that "(t)he addition of a solid wall in place of a floating structure at Dock H, with the intent to reduce the peak velocity magnitude in its vicinity, is not effective. The wall does little but displace the high velocities to another region of the marina, exposing other initially sheltered floating structures to strong currents. A more open layout with shallower floats, capable of vertical motion to ride out the tsunami waves allow currents to vent underneath. This open design offers a more tsunami-resistant solution and allows the movement of water and animals through the wave attenuator.

As part of a Coastal review and permitting, measures to reduce future impacts of the same magnitude are usually required to be examined as part of the consideration to issue a permit. This project will require a coastal development permit and, therefore, within the preferred alternative a wave attenuator is being included as a measure to address the need to ensure that future similar events will lessen the exposure of publicly owned facilities, and any privately owned vessels within the harbor at the time, of any similar tsunami.

### 3.2.6 Install Four ADA/ABA Gangways

The Americans with Disabilities Act and the Architectural Barriers Act requires that at least one gangway per pier comply with these acts; none of the existing gangways are in compliance. The level of repair to the inner boat basin triggers compliance with these two acts and, therefore, the District will need to install as a part of this project four ADA/ABA compliant gangways. Due to the slopes involved, the compliant gangways will require installation of a concrete headwall support for each gangway ramp. Each of the four headwalls will measure 65 ft. by 3 ft. (max.) and will require excavation for the footing within the existing parking lot where the rock slope protection and the parking lot adjoin. Best Management Practices (BMP) will apply within each headwall site during construction in order to prevent any sediment generation into the waters of the inner boat basin. The locations of the ADA modified ramps are identified in Figure 5 (page 60) and the preliminary design is illustrated on Figure 6 (page 61). The gangway abutment for each access will be supported by four piles installed in a similar manner as the float piles.

### 3.2.7 Replace Dock Utilities

Removal of the existing docks and their existing utilities requires the replacement docks to also provide dock utilities. The dock utilities that are required include electrical switches, distribution units, pedestals, conduit, wire and a potable water system. The reinstalled new service will have to meet current codes and therefore will be an upgrade over the prior service connections.

### 3.2.8 Installation of a Fire Protection System

Presently, there is no fire protection system on the floats. Fire Hydrants do exist in the vicinity, but no fire suppression system is available on the docks. The Department of Boating and Waterways and local fire codes now require fire protection on new or replacement facilities, including installation of new docks. The fire protection system will basically consist of approximately 5,000 lineal feet of 4 inch pipe providing water to 15 hose reel stations. The fire protection system will be subject to inspection by the local fire chief.

## 3.3 Project Construction Phases

After completion of the environmental review process and securing of the applicable approvals from the permitting agencies (Army Corps of Engineers, North Coast Regional Water Quality Control Board, California Coastal Commission), the Harbor District will take action on the final plans and specifications. Once the plans and specifications have been approved, the construction contract bidding process will be initiated. Once the contractor is selected, the construction will begin. The functionality of the inner boat basin must be maintained during the reconstruction process. Therefore, the west side of the inner boat basin will be reconstructed while the existing docks in the east half are used by the fishing fleet and recreational boaters. In addition, it is expected that work below the water level will be restricted to July $1^{st}$ to October $15^{th}$ (3.5 months). These two factors result in the project taking place over a two year time span with the east side of the inner boat basin being reconstructed the second year.

## 4.0 EXISTING CONDITIONS AND TRENDS (24 CFR 58.40(a)))

### 4.1 Land Use

Current Land Use Designations and Zoning for the project site is Harbor Dependent Commercial. This designation provides areas for commercial and industrial activities that require immediate access to harbor waters or need to be placed adjacent to harbor waters. The principal permitted uses include boat basins, berthing floats, breakwater devices and piers, maintenance dredging and dredge spoils disposal, public facilities, parking lots, and other marine oriented uses. The land use plan for the harbor includes the inner boat basin as a key element. The land use plan has been certified as a Local Coastal Plan by the California Coastal Commission.

The surrounding lands are also designated and zoned for commercial and industrial (fish process and boat repair for example) activities within the harbor. Commercial uses include, but are not limited to, motels, restaurants, vehicle services, surf shop, antique shops, art sales, and marine supplies. There are no known residences within the project area or the surrounding area. A manager's unit for a recreational vehicle park is approximately 1,000 feet south of the inner boat basin. Bay Studio, a privately operated business, manufactures and sells pottery made on site. The Bay Studio shop includes a residence on the second floor and is approximately 1,000 feet northwest of the inner boat basin. An antique shop, located 900 feet northwest of the project site, may include a residence upstairs. All three of these residences are located within commercially zoned land and have other existing commercial activities adjacent to them.

### 4.2 Trends

The City of Crescent City and the County of Del Norte area has been in transition from a natural resources based economy to a service sector economy. There is little diversity in the economic makeup of the community and this deficiency makes the local economy prone to sharp downturns during economic cycles. Currently, the California Employment Development Department estimates the March 2010 unemployment rate for Del Norte County at 14%. Based on the most recent 2000 Census data, the County has a poverty rate of twenty point two percent (20.2%) and Crescent City has a poverty rate of thirty-four point six percent (34.6%)

Restoring the inner boat basin will allow the use of the boat basin for the commercial fishing fleet which will maintain an established economic sector for the area and preserve existing jobs currently occupied by local residents. The inner boat basin also provides opportunities for transient vessels to dock here and general opportunities for present and future visitor usage. The Harbor District has goals to diversify their income stream by the expansion of recreational facilities, destination amenities, and other improvements that will focus on the activities of the inner boat basin and the rest of the harbor area.

## 4.3 Environmental Setting and Biotic Resources

### 4.3.1 Source Documents

There are three documents that have been utilized, in addition to other sources, for this environmental assessment. The documents are: Final Biological Assessment for NMFS, Inner Basin Sea Wall Repair Project-Crescent City Harbor District, FEMA-1628-DR-CA, PW #1387, April 2007 (Appendix A), and the Biological Report for Crescent City Harbor District Master Plan, prepared by Gedik BioLOGICAL Associates, August 2005 (Appendix B). Also utilized was the Final Mitigated Negative Declaration, Crescent City Harbor District Harbor Master Plan, SCH#2005112008, December 2005. The Inner Basin Sea Wall Project included the outer sea wall of the inner boat basin and included in its examination the area one half mile surrounding the sea wall which included the inner boat basin and exceeds the project area of the inner boat basin restoration. The sea wall project is similar to the inner boat basin restoration in that it involves activities both within and above the water line. The sea wall project involves construction activities on the harbor bay side of the sea wall (breakwater); however, the inner boat basin restoration project does not include any activity on the bay side of the breakwater with all activity being within or immediately adjacent to the inner boat basin. The report prepared by Gedik BioLOGICAL (Gedik) includes habitat assessments and floristically appropriate surveys for special-status species conducted by Tamara Gedik for the entire harbor area. The Mitigated Negative Declaration also includes information relative to the Gedik study and other general sources for the entire harbor area.

### 4.3.2 Vegetation

The project area is located in a developed harbor that contains little or no vegetation. Most of the habitat in the harbor area is rather nominal and degraded due to the predominance of paved areas and existing surrounding uses (Gedik 2005). The project area consists of an extensive paved parking lot, previously disturbed and currently used storage yard, and the inner boat basin marina. The little vegetation that is present within the area surrounding the project area is dominated by non-native weedy species. The Gedik report identified the following exotic species in the general area of the harbor; wild oats (Avena fatua), sea rocket (Cakile maritime), hairy cat's-ear (Hypochaeris radicata), perennial ryegrass (Lolium perenne), hottentot fig (Carpobrotus edulis), and white sweetclover (Melilotus alba). Native dune grass (Leymus mollis) was also identified by Gedik as occurring sporadically. The actual project site includes the water area of the inner boat basin, the rock slope walls of the inner boat basin, and the parking area and storage yard adjacent to the inner boat basin (staging area and footings for headwalls for ADA ramps).

The report by Ms. Gedik identified two areas as wetlands that lie within the harbor area. The Gedik report identifies the site of the two wetlands as shown on Exhibit 1 (from Figure 2-b in the Master Plan – refer to page 62). One of the two wetlands is approximately 6,000 square feet (.13 ac.) and consists primarily of a significantly disturbed willow thicket. This willow thicket is approximately 400 feet from the project site and 200 feet from the staging area.

The Gedik report also identified a strip along the beach strand as a wetland. This determination was based primarily on the tidal influence of the area (marine intertidal unconsolidated shore regularly flooded). The identified beach strand is located on the relatively unaltered shoreline east of the project area, adjacent to a portion of the northwesterly wall of the existing breakwater. At this location, identified as Area C on Exhibit 1 (page 62) and shown enlarged in Exhibit 2 (page 63), the sandy beach touches the breakwater and, therefore, the Gedik report mapped wetland. However, no activity is proposed as a part of this project that would require any project encroachment onto the sandy beach or below the existing breakwater. Project activity will be on the inner boat basin side of the breakwater which would place the construction activity approximately 50 feet to 75 feet from the westerly tip of the beach strand, but still physically separated from the beach strand by the existing breakwater wall.

One area of potential Wolf's Evening Primrose habitat, identified in the Gedik report, exists within the harbor area. The subject site is approximately 40 feet in diameter and is located 200 feet northwest of the project area and 200 feet westerly of the staging area. Wolf's Evening Primrose is not listed by the State of California or the Federal Government as a protected species. However, it is a California Native Plant Society (CNPS) list 1B species and plants on this list can be considered pursuant to Section 15370 of the California Environmental Quality Act (CEQA) which requires the project to consider avoiding or mitigating impacts where possible. Additionally, it should be noted that there is the existence of hybrids of Wolf's Evening Primrose in the general area and within the Harbor Area itself. In this instance the site is sufficiently beyond the activity area of the project and the habitat site is located beyond any area where any project activity could be expected. This sensitive area will be temporarily fenced between the project area and the sensitive area to prevent trampling, vehicle activity, stockpiling activities, or other construction activities. Installation of the temporary fence will be monitored by a biological monitor.

A second CNPS listed plant species identified in the Gedik study is the Beach Pea. The Beach Pea is a CNPS list 2 species which means that it is considered rare or endangered by CNPS in California, but is more common elsewhere. Beach pea is low-growing perennial that spreads by rhizomes on open sandy beaches and grass covered foredunes with the mapped habitat area lying more than 1,000 feet northwesterly of the project site and the staging area. There is no activity related to this project that would potentially impact the Beach Pea habitat site.

### 4.3.3 Listed Species

The Final Biological Assessment for the Inner Basin Sea Wall Repair Project (FEMA-1628-DR-CA, PW #1387 Appendix A), included obtaining a list of species that are listed as endangered, threatened, or proposed for listing as endangered or threatened under the Endangered Species Act (ESA) that may occur in the action area of the sea wall project which included the area of the inner boat basin project. The following sources were used:

- The California Department of Fish and Game (CDFG) Natural Diversity Database (CNDDB) records within the following six USGS 7.5-minute quadrangles that include the action area of the sea wall project and vicinity: Crescent City, Sisters Rocks, Childs Hill, Hiouchi, Smith River, and High Divide, California (CDFG 2006)
- A species list for Del Norte County from the Arcata Field Office USFWS website (USFWS 2006)

Two listed fish species, four listed sea turtles, and five listed marine mammal species were identified from these sources as having potential to occur in the vicinity of the seawall project and are listed in Appendix A, Table A-1 of the Final Biological Assessment. Bridget Canty of Nationwide Infrastructure Support Technical Assistance Consultants (NISTAC), FEMA's consultant, conducted a site reconnaissance survey of the seawall action area on September 25, 2006 to ascertain the potential presence of these species. Qualitative assessments of each habitat were used to determine whether each of the species identified in Appendix A, Table 1-A of the seawall BA was likely to occur. NISTAC also reviewed available literature to identify the habitat requirements and distribution of the species included in Table 1-A. FEMA consulted with USFWS for threatened, endangered, and proposed species.

As a result, FEMA determined that the action area of the seawall project provides suitable habitat to support two federally listed species regulated by NMFS under the ESA:

- Southern Oregon/Northern California Coasts (SONCC) coho salmon (Oncorhynchus kisutch)
- Steller sea lion (Eunetopias jubatus)

### 4.3.4 Southern Oregon/Northern California Coasts Coho Salmon ESU

The seawall project and the inner boat basin project occur within the Smith River Hydrologic Unit for this evolutionary significant unit (ESU). The Smith River enters the Pacific Ocean approximately 13 miles north of both project areas. The Smith River historically provided habitat for coho. The Smith River continues to provide important rearing habitat for juvenile salmonids. The Smith River Hydrologic Sub-area (HSA) overlaps with the action area for both the seawall project and the inner boat basin project and includes Elk Creek, a stream which does not flow into the Smith River but flows directly into the Pacific Ocean within the outer limits of the Crescent City harbor. The mouth of Elk Creek is approximately .3 of a mile north of the seawall and inner boat basin projects.

Critical habitat was designated for the ESU on May 5, 1999 (64 Fed. Reg. 2409-24062). Critical habitat for the SONCC coho salmon ESU encompasses accessible reaches between the Mattole River in Humboldt County, California and the Elk River in Oregon approximately 80 miles north of Crescent City. Critical habitat for this ESU includes all "waterways, substrate, and adjacent riparian zones below longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years". The nearest designated critical habitat for the SONCC coho salmon is located at the confluence of Elk Creek and the Pacific Ocean within the outer harbor.

### 4.3.5 Steller Sea Lion

On November 26, 1990, the Steller sea lion was listed as threatened under ESA of 1973 (55 Fed. Reg. 49,204). In 1997, the species was split into two separate Distinct Population Segments (DPS's) at 144° W Longitude (Cape Suckling, just east of Prince William Sound, Alaska) on the basis of demographic and genetic dissimilarities; the status of the western DPS (west of 144° longitude) was changed to endangered, and the status of the eastern DPS (east of 144° longitude) was left unchanged (Bickham et al. 1996; Loughlin 1997) (62 Fed. Reg.

30,772, 30,773). Hence, the Steller sea lions, which use habitat in California, continue to be classified as threatened under the ESA. The Steller sea lion is also protected under the Marine Mammal Protection Act.

The Steller sea lion is the largest of the eared seals, which includes sea lions and fur seals. This species occurs along the rim of the northern Pacific Ocean (Pitcher and Calkins 1981, Gisiner 1985). Steller sea lions occurring near Crescent City are part of the eastern DPS (62 Fed. Reg. 30,772-30,773), which extends from southeastern Alaska to northern California.

Steller sea lions are not known to migrate, but they do disperse widely outside of the breeding season with males typically dispersing away from their breeding rookeries (NMFS 1992).

Steller sea lions occupy breeding territories (or rookeries) from late May through early July, with females arriving about three days before the pup is born (Pitcher and Calkins 1981, Gisiner 1985). Rookeries occur in a wide variety of areas, but most locations have specific characteristics including slightly sloped topography, protection from the wind, and isolation from humans and other mammalian predators. Females generally exhibit site fidelity, and rookery locations change little from year to year (Pitcher and Calkins 1981, Gisiner 1985).

Haulout sites are locations used by breeding, non-breeding, and subadult sea lions during the non-breeding season, and are generally associated with jetties, offshore rocks and islands, logbooms, marina docks, and navigation buoys (Pitcher and Calkins 1982, Gisiner 1985).

Many researchers have described behavioral reactions of marine mammals to human presence, boats, and aircraft (Richardson et al. 1995). Although most of the data are anecdotal, they provide useful information about situations in which some species react strongly, react weakly, or inconsistently, or do not react at all. No specific data on received sound levels are available for most of these incidents (Richardson et al. 1995). Steller sea lions on haulouts exhibit variable reactions to aircraft (Calkins 1979). Approaching aircraft usually frighten some or all animals into the water. Juveniles and pregnant females are more likely to enter the water than are territorial males and females with small pups. Sea lions in the water tolerate close and frequent approaches by vessels, and sometimes congregate around fishing vessels (Richardson et al. 1995). Sea lions hauled out on land are more responsive (Peterson and Bartholomew 1967), but rarely react unless a boat approaches within 100 to 200 meters (m) (Bowles and Stewart 1980). Apparently, visual cues are also involved.

Steller sea lions are found along the coast from Monterey Bay north and are known to breed at Año Nuevo Island, the Farallon Islands, and St. George Reef (NMFS 1997). The nearest documented occurrence of the Steller Sea Lion is approximately 4 mi northwest of the action area on rocks associated with the St. George Reef (CDFG 2006), particularly the St. George Lighthouse (NOAA fisheries 2005b). In 1927, the population at St. George Reef was estimated at 1,500 individuals (NMFS 1992). More recent counts from 1990 to 1995, ranged from 400 to 700 animals, with just over 100 pups born per year (ODFW unpubl. Data cited in NMFS 1997).

Critical habitat has been designated for Steller sea lions (58 Fed. Reg. 45,269-45,285). Rookeries and haulouts are designated as critical habitat in Alaska, whereas in California, major rookeries and associated air and aquatic zones are designated as critical habitat. There are three Steller sea lion rookeries located in California, all three of which are designated as critical habitat. The nearest of these is located at Sugarloaf Island/Cape Mendocino, which is approximately 150 miles south of the action area. This haulout site and the associated 3,000 ft. vertical (above sea level) air zone and the aquatic zone that extends 3,000 ft. seaward from the base of the site, represents the nearest designated critical habitat for this species. There is no critical habitat for the Steller sea lion within the action area or the surrounding vicinity.

### 4.3.6 Potential Adverse Impacts

#### 4.3.6.1 Southern Oregon/Northern California Coasts Coho Salmon ESU

SONCC coho salmon are documented to occur in Elk Creek (CDFG 2004), which flows into the Pacific Ocean near the action area. Potential adverse effects to coho are discussed in this section.

##### 4.3.6.1. 1 Take and Disturbance

Coho could potentially be killed, injured, or temporarily displaced during placement of rock, especially rock placed at or below mean higher high water (MHHW). Typically, to protect anadromous fish species, construction would take place during the in-water work period of June 15 through October 15 when both juveniles and adults are unlikely to be present (Dan Free pers. Comm. December 22, 2006). However, because of the potential effects to Steller sea lions, this in-water work window would be reduced to July 1 through October 15. Therefore, the potential for mortality, injury, or displacement of coho salmon would be significantly decreased or avoided.

##### 4.3.6.1.2 Water Quality – Erosion, sedimentation, turbidity

Potential effects to coho salmon from unintentional introduction of sediment into the water and increased turbidity caused by construction activities could affect feeding rates and growth, increase mortality, cause behavioral avoidance, and reduce macroinvertebrate prey populations. Temporary beneficial effects could include reduced predation by piscivorous fish and birds and enhanced cover for fish. Avoidance and minimization measures (Section 4.2) would be used to contain erosion or sediment associated with construction and in-water work would be restricted to July 1 through October 15. Therefore, effects to coho from erosion, sedimentation, or increased turbidity are anticipated to be insignificant and discountable.

##### 4.3.6.1.3 Water Quality – Petrochemical spills

Potential effects to coho salmon from unintentional introduction of petrochemicals associated with construction equipment could injure or kill coho and/or their macroinvertebrate prey populations. Avoidance and minimization measures (Section 4.2) would be used to minimize the potential for petrochemical spills and in-water work would be restricted to July 1 through October 15 when both juveniles and adults are unlikely to be present. Therefore, potential effects to coho from petrochemical spills would be significantly decreased or avoided.

#### 4.3.6.1.4 Critical Habitat

No effects are anticipated to fundamental habitat elements for SONCC coho salmon as the effects of the proposed action would be localized and, due to the use of avoidance and minimization measures, would not be expected to travel to the estuarine habitat at the mouth of Elk Creek to the north of the action area; therefore, no effects are anticipated to designated critical habitat for this ESU.

#### 4.3.6.1.5 Summary of Potential Adverse Effects to the Coho Salmon

The proposed action may affect the SONCC coho salmon ESU, but will have no effect on critical habitat for this ESU. Implementation of avoidance and minimization measures is recommended in this document to protect their habitat.

### 4.3.6.2 Steller Sea Lion

Sea lions regularly occur in Crescent City Harbor, however, most of these are believed to be northern sea lions and the nearest documented occurrence of the federally listed Steller sea lion is approximately 4 miles northwest of the action area. Potential adverse effects to the Steller sea lions are discussed in this section.

#### 4.3.6.2.1 Noise

Potential effects to Steller sea lions from construction-related noise could disturb and/or temporarily displace Steller sea lions. However, this effect would be temporary and would only occur if Steller sea lions were present during construction, which is unlikely. Construction would be limited to the July 1 through October 15 in-water work period to protect anadromous fish and Steller sea lions. Steller sea lions are known to breed from late May to early July. Therefore, to reduce any effects to Steller sea lions from noise, the in-water work period would be from July 1 through October 15, making the noise impacts insignificant and discountable.

#### 4.3.6.2.2 Water Quality – Erosion, sedimentation, turbidity

Potential effects to Steller sea lions from unintentional introduction of sediment into the water and increased turbidity caused by construction activities could affect feeding opportunities by temporarily reducing aquatic prey populations. Avoidance and minimization measures (Section 4.2) would be used to contain erosion or sediment associated with construction and in-water work would be restricted to July 1 through October 15. Therefore, effects to Steller sea lions from erosion, sedimentation, or increased turbidity are anticipated to be insignificant and discountable.

#### 4.3.6.2.3 Water Quality – Petrochemical spills

Potential effects to Steller sea lions from unintentional introduction of petrochemicals associated with construction equipment could injure or kill Steller sea lions or their aquatic prey populations. However, this effect would only occur if Steller sea lions were present within close proximity to the action area and if a spill were to occur. Avoidance and minimization measures (Section 4.2) would be used to minimize the potential for petrochemical spills and in-water work would be restricted to July 1 through October 15. Therefore, effects to Steller sea lions from petrochemical spills are anticipated to be insignificant and discountable.

#### 4.3.6.2.4 Critical Habitat

There is no designated critical habitat for the Steller sea lion within 150 miles of the action area. Therefore, no effects are anticipated to this species from the proposed action.

#### 4.3.6.2.5 Summary of Potential Adverse Effects to the Steller Sea Lion

The proposed action is not likely to adversely affect the Steller sea lion and will have no effect on designated critical habitat for this species. Implementation of avoidance and minimization measures is recommended in this document to protect their habitat.

## 5.0 Statutory Checklist (24 CFR 58.5)

For each listed statute, executive order or regulation, record the determinations made. Note reviews and consultations completed as well as any applicable permits or approvals obtained. Attach evidence that all required actions have been taken. Record any conditions or mitigation measures required. Then, make a determination of compliance or consistency.

| Factors | Determinations and Compliance Documentation |
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| **Historic Preservation**<br>[36 CFR 800] | A review of the list of California Historical Resources for Del Norte County did not identify any historical resources within the project area. There are no residential structures or other structures on the project site other than the two existing concrete block public restrooms.<br><br>On May 7, 2010, the Harbor District contacted, by letter, Vicky Bates, Coordinator of the North Coastal Information Center (NCIC) of the California Historical Resources Information System at the Yurok Tribe which is the designated SHPO contact for Del Norte County. In her response dated June 28, 2010, Ms. Bates stated that a complete records search was conducted for the project area, including review of previous studies conducted in the vicinity of the project, review of any previously recorded site records (archaeological and historic), review of historic maps, and review of applicable historic and ethnographic documents. Based upon this review, the NCIC predicts there is a **low** probability of finding sites or other evidence of human cultural activity in the project area.<br><br>On May 11, 2010, the Harbor contacted the Elk Valley Rancheria and requested a review of the project by the Rancheria. The Elk Valley Rancheria responded on June 10, 2010. Their response concluded by stating that "(a)s the project does not involve disturbance of known cultural sites, the Tribe proposes a finding of no adverse affect and has no objections to the Inner Boat Basin Rehabilitation Project.<br><br>**See item 5.1.1 of the EA Statutory Checklist Compliance Information. Verification letter from NCIC (SHPO) dated June 28, 2010 from Vicky Bates, Coordinator, and verification letter dated June 10, 2010 from Dale Miller, Chairman of the Elk Valley Rancheria.** |
| **Floodplain Management**<br>[24 CFR 55, Executive Order 11988] | The Community Development Department of the County of Del Norte, the department responsible for implementing the (FEMA approved) Flood Damage Prevention Ordinance, has stated that by complying with the applicable sections of Chapter 21.45, the inner boat basin rehabilitation project of the Harbor will be in comply with the County Flood Damage Prevention Ordinance.<br><br>**See item 5.1.2 of the EA Statutory Checklist Compliance Information. Verification letter dated Mar 19, 2010, from Mr. Randy Hooper, Planner in the Building and Planning Division of Del Norte County Community Development Department** |
| **Wetlands Protection**<br>[Executive Order 11990] | The only potential for wetland to be affected is the area identified by Gedik as being wetland in Area C on her maps. This site is shown in Exhibit 2 (page 63) which is from page 37 of her report. This area is outside of the project area but within 100 feet of the boat basin, although separated from the basin. The sensitive area will be temporarily fenced between the |

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| | project area and the sensitive area to prevent trampling, vehicle activity, stockpiling activities, or other construction activities. Installation of the temporary fence will be monitored by a biological monitor.<br><br>Project activities within the "wetlands" as mapped by Gedik will not take place. Project activities will be more than 200 feet from the nearest on-land wetland (willow thicket). The actual work done within the inner boat basin will be in the waters of the Pacific Ocean that enter and occupy the boat basin. Potential effects from the unintentional introduction of sediment into the water of the inner boat basin will be minimized by avoidance and minimization measures to contain erosion or sediment associated with construction through Best Management Practices (BMPs). Furthermore, in-water work would be restricted to July 1 through October 15, the lowest rainfall months of the year.<br><br>**See item 5.1.3 of the EA Statutory Checklist Compliance Information and see Section 3.0 Description of the Proposal.** |
| **Coastal Zone Management Act** [Sections 307(c),(d)] | The project area is located within the boundaries of the California Coastal Zone in an area where the California Coastal Commission retains permit jurisdiction. A Coastal Development Permit (CDP) will be filed with the California Coastal Commission. Conditions of issuance of the CDP will be included in the project bid process and/or inspection process.<br><br>**See item 5.1.4 of the EA Statutory Checklist Compliance Information. Verified by James R. Baskin, Coastal Planner, California Coastal Commission North Coast District Office via email on May 25, 2010.** |
| **Sole Source Aquifers** [40 CFR 149] | There are no sole source aquifers designated in Del Norte County. Therefore, the project is not located within an area designated by the EPA as being supported by a sole source aquifer.<br><br>**Verified through download of Designated Sole Source Aquifers in EPA Region IX http://www.epa.gov/cgi-bin See item 5.1.5 of the EA Statutory Checklist Compliance information.** |
| **Endangered Species Act** [50 CFR 402] | Coho could potentially be killed, injured, or temporarily displaced during placement of rock, especially rock placed at or below mean higher high water (MHHW). Typically, to protect anadromous fish species, construction would take place during the in-water work period of June 15 through October 15 when both juveniles and adults are unlikely to be present. However, because of the potential effects to Steller sea lions, this in-water work window would be reduced to July 1 through October 15. Therefore, the potential for mortality, injury, or displacement of coho salmon would be significantly decreased or avoided.<br><br>Potential effects to coho salmon from unintentional introduction of sediment into the water and increased turbidity caused by construction activities could affect feeding rates and growth, increase mortality, cause behavioral avoidance, and reduce macroinvertebrate prey populations. Temporary beneficial effects could include reduced predation by piscivorous fish and birds and enhanced cover for fish. Avoidance and minimization measures would be used to contain erosion or sediment associated with construction and in-water work would be restricted to July 1 through October 15. Therefore, effects to coho from erosion, sedimentation, or increased |

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| | turbidity are anticipated to be insignificant and discountable.<br><br>Potential effects to coho salmon from unintentional introduction of petrochemicals associated with construction equipment could injure or kill coho and/or their macroinvertebrate prey populations. Avoidance and minimization measures would be used to minimize the potential for petrochemical spills and in-water work would be restricted to July 1 through October 15 when both juveniles and adults are unlikely to be present. Therefore, potential effects to coho from petrochemical spills would be significantly decreased or avoided.<br><br>No effects are anticipated to fundamental habitat elements for SONCC coho salmon as the effects of the proposed action would be localized and, due to the use of avoidance and minimization measures, would not be expected to travel to the estuarine habitat at the mouth of Elk Creek to the north of the project area; therefore, no effects are anticipated to designated critical habitat for this ESU.<br><br>Potential effects to Steller sea lions from construction-related noise could disturb and/or temporarily displace Steller sea lions. However, this effect would be temporary and would only occur if Steller sea lions were present during construction, which is unlikely. Construction would be limited to the July 1 through October 15 in-water work period to protect anadromous fish and Steller sea lions. Steller sea lions are known to breed from late May to early July. Therefore, to reduce any effects to Steller sea lions from noise, the in-water work period would be from July 1 through October 15, making the noise impacts insignificant and discountable.<br><br>Potential effects to Steller sea lions from unintentional introduction of sediment into the water and increased turbidity caused by construction activities could affect feeding opportunities by temporarily reducing aquatic prey populations. Avoidance and minimization measures would be used to contain erosion or sediment associated with construction and in-water work would be restricted to July 1 through October 15. Therefore, effects to Steller sea lions from erosion, sedimentation, or increased turbidity are anticipated to be insignificant and discountable.<br><br>Potential effects to Steller sea lions from unintentional introduction of petrochemicals associated with construction equipment could injure or kill Steller sea lions or their aquatic prey populations. However, this effect would only occur if Steller sea lions were present within close proximity to the project area and if a spill were to occur. Avoidance and minimization measures (Section 4.2) would be used to minimize the potential for petrochemical spills and in-water work would be restricted to July 1 through October 15. Therefore, effects to Steller sea lions from petrochemical spills are anticipated to be insignificant and discountable.<br><br>A Storm Water Pollution Prevention Plan, Erosion Control Plan, a Hazardous Materials Management/Spill Response Plan, and related BMPs will be required of the contractor or contractors for the project. Implementation of this mitigation would reduce potential impacts to less than significant.<br><br>There is no designated critical habitat for the Steller sea lion within 150 miles of the project area. Therefore, no effects are anticipated to this |

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| | species from the proposed action.<br><br>**See section 4.3 Environmental Setting and Biotic Resources and section 4.6 Mitigation Measures Recommended.** |
| **Wild and Scenic Rivers Act** [Sections 7 (b), (c)] | The project area has no hydrological connection to the Smith River. Therefore no Wild and Scenic Rivers will be adversely affected.<br><br>**Verified through download of National Wild & Scenic Rivers Map http://www.rivers.gov/maps , review of the Crescent City, Calif. and Sister Rocks Quadrangle 7.5 min. quadrangle maps published by USGS and review of Flood Insurance Rate Maps (panel numbers 0050E, 0205E, 0210E, 2015E, 0218E, 0220E, and 0331E) for Del Norte County prepared by the Federal Emergency Management Agency.** |
| **Air Quality** [Clean Air Act, Sections 176 (c) and (d), and 40 CFR 6, 51, 93] | Short-term construction emissions may include fugitive dust and other particulate matter as well as exhaust emissions generated by the equipment being used to remove and install the replacement facilities (floats, pilings, ramps, rock slope protection) and the removal of the excess sand at the boat basin entrance. Given the nature of the project in that it is primarily an activity upon water and the on-land activity is confined to existing paved area, fugitive dust should not be a significant problem. However, in order to address any potential regardless of the level of significance, to reduce potential impacts upon air quality, standard construction BMPs for dust control and emission control practices during the construction period will be implemented, including implementation of an effective Storm Water Pollution Plan (SWPP).<br><br>Vehicle emissions will be mitigated by requiring that the contractor shall ensure that all construction equipment is maintained and tuned to meet applicable EPA and California Air Resources Board (CARB) emission requirements.<br><br>**See item 5.1.6 of the EA Statutory Checklist Compliance Information and section 4.6 Mitigation Measures Recommended.** |
| **Farmland Protection Policy Act** [7 CFR 658] | The project area is not designated for prime farmland, and the project area does not qualify as farmland under the criteria of the County LCP; the nearest mapped prime agricultural land lies some 8,500 feet from the harbor Inner Boat Basin project site. No parcels within or in proximity to the project area are under Williamson Act contract. The soils in the project area are not one of the soils identified as having prime agricultural qualities. There is no known historical use of the project area for traditional agricultural activities. The inner boat basin rehabilitation project will not contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses.<br><br>**See item 5.1.7 of the EA Statutory Checklist Compliance Information. Verification letter dated May 3, 2010, from Ms. Heidi Kunstal, Deputy Director of Building and Planning, County of Del Norte..** |

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| **Environmental Justice**<br>[Executive Order 12898] | The proposed project is a restoration project within an existing commercially and light industrial developed area. There are no residences within the project area. Current Land Use Designations and Zoning for the project site is Harbor Dependent Commercial. The principal permitted uses include boat basins, berthing floats, breakwater devices and piers, maintenance dredging and dredge spoils disposal, public facilities, parking lots, and other marine oriented uses. Social and economic impacts resulting from the proposed project are expected to be generally beneficial to the surrounding community, the City of Crescent City, and the County of Del Norte.<br><br>**See item 5.1.8 of the EA Statutory Checklist Compliance Information. Verification letter dated May 3, 2010, from Ms. Heidi Kunstal, Deputy Director of Building and Planning, County of Del Norte** |

**HUD Environmental Standards Determinations and Compliance Documentation**

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| **Noise Abatement and Control** [24 CFR 51 B] | The project will temporarily increase noise levels during construction due to normal noises attributable to construction activities and construction equipment.<br><br>Construction noise can be controlled by limiting construction activity to the least noise sensitive daytime hours; specifically the hours from 7:00 a.m. to 7:00 p.m. on weekdays and on Saturdays and 8:00 am to 5:00 pm on Sundays. Construction equipment shall be properly muffled and shrouded to minimize noise levels. Implementation of this or similar mitigation would reduce any potential generated noise impacts to less than significant.<br><br>**See item 5.1.9 of the EA Statutory Checklist Compliance Information.** |
| **Toxic or Hazardous Substances and Radioactive Materials**<br>[HUD Notice 79-33] | The project area is substantially removed from sites where hazardous, toxic, or radioactive substances are used or may be present. There presently are no listed EPA superfund sites in Del Norte County although a closed and delisted superfund site does exist approximately three miles northwest of the inner boat basin.<br><br>The fuel underground tanks of Renner Petroleum are located outside of the project area and will not be disturbed by the proposed project. Therefore, the scope of work of the proposed project does not impact nor is affected by the Renner underground storage tanks and fuel dispensing system.<br><br>The Harbor District has three waste oil disposal tanks located within the project area. Each of these tanks are approximately 500 gallons in size and are concrete underground storage vaults with an interior tank. The waste oil is removed from the tanks on a monthly basis or more frequently, if needed. The tanks have a locked cover and the oil can only be removed by the recycler of the waste oil. While these tanks are in the project area, they will not be disturbed. The collection of waste oil from the commercial fishing fleet in these tanks is a critical element in maintaining the water quality of the inner boat basin. |

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| | **See item 5.1.10 of the EA Statutory Checklist Compliance Information. Verification letter dated May 7, 2010, from Ms. Heidi Kunstal, Deputy Director of Building and Planning, County of Del Norte and verification letter dated May 25, 2010, from Steve Wakefield, Fire Chief of Crescent Fire Protection District and Fire Chief for the City of Crescent City.** |
| **Siting of HUD-Assisted Projects near Hazardous Operations** [24 CFR 51 C] | The proposed project does not involve construction of a building, conversion of a building or property to a residential, institutional, recreational (other than boating), commercial (other than commercial fishing), or industrial use. The proposed project is not a rehabilitation project that would result in an increased number of residential densities, the conversion of a type of use of a building to habitation, or making a vacant building habitable. The proposed project does not involve any land acquisition.<br><br>The project site and project area were walked on May 12, 2010, with Paul McAndrews, Facilities Manager for the Harbor District. The area was visually inspected for any above-ground storage of any substances of explosive or fire-prone nature. There were no above ground, stationary storage tanks holding substances of explosive or fire prone nature near or visible from the project site. There are no known facilities handling, processing or manufacturing substances of a fire prone nature or an explosive nature within the project area.<br><br>**Verified in the field on May 12, 2010, with Paul McAndrews, Facilities Manager for the Harbor District.** |
| **Airport Clear Zones and Accident Potential Zones** [24 CFR 51 D] | The project is not within an FAA-designated civilian airport Runway Clear Zone (RCZ), or within a military airfield Clear Zone (CZ) or Accident Potential Zone (APZ).<br><br>**See item 5.1.12 of the EA Statutory Checklist Compliance Information. Verification letter dated May 14, 2010 from James Bernard, Airport Director, Del Norte County Regional Airport.** |

## 5.1 Statutory Checklist Compliance Information

### 5.1.1 Historic Preservation

A review of an aerial photo from 1948 shows the harbor in its initial stages of what is present now. The harbor area in the 1948 photo identifies the presently developed area of the harbor as coastal sandy beach with some coastal dunes. This coastal dune complex is indicative of the original undisturbed area of the harbor.

The project area consists of the marina area of the inner boat basin, a previously excavated area of the shoreline, and the parking lot immediately adjacent to the inner boat basin. The parking lot consists of a paved asphalt concrete surface built on the excavated sand from the inner boat basin. A review of the list of California Historical Resources for Del Norte County did not identify any historical resources within the project area. There are no residential structures or other structures on the project site other than the two existing concrete block public restrooms.

On May 7, 2010, the Harbor District contacted, by letter, Vicky Bates, Coordinator of the North Coast Information Center (NCIC) which is the designated SHPO contact for Del Norte and Humboldt Counties. The NCIC is a function of the Yurok Tribe in Klamath, California. On May 11, 2010, the Harbor also contacted the Elk Valley Rancheria (closest in proximity to the Harbor area) and requested a review of the project by the Rancheria.

The Elk Valley Rancheria responded on June 10, 2010. Their response concluded by stating that "(a)s the project does not involve disturbance of known cultural sites, the Tribe proposes a finding of no adverse affect and has no objections to the Inner Boat Basin Rehabilitation Project.

The response from Ms. Bates, dated June 28, 2010, stated that a complete records search was conducted for the project area, including review of previous studies conducted in the vicinity of the project, review of any previously recorded site records (archaeological and historic), review of historic maps, and review of applicable historic and ethnographic documents. Based upon this review, the NCIC predicts there is a **low** probability of finding sites or other evidence of human cultural activity in the project area.

### 5.1.2 Floodplain Management

The applicable Flood Insurance Rate Map (**FIRM**) for the area that includes the inner boat basin is map number 06015C331E (panel 331 of 675 Del Norte County) effective September 26, 2008. The subject map identifies the inner boat basin as a Zone V, coastal flood zone with velocity hazard (wave action); no base flood elevations determined. Del Norte County uses a Flood Damage Prevention Ordinance, Chapter 21.45 of Del Norte County Code, which is also part of the certified Local Coastal Plan (LCP) for the Coastal Zone. Section 21.45.020 of the Flood Damage Prevention ordinance defines "coastal high hazard area' as the area subject to high velocity waters, including coastal and tidal inundation or tsunamis and defines a V zone as a "special flood hazard area (SFHA)". Marinas are not specifically addressed in Chapter 21.45; however, the ordinance does provide specific sections that do apply.

Section 21.45.050 identifies standards that apply within special flood hazard area. Section 21.45.050 A (1) provides that all new construction and substantial improvements shall be anchored to prevent floatation, collapse or lateral movement of the structure resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy. Item 2 of the same section requires that the improvements shall be constructed with materials and utility equipment resistant to flood damage. And, these improvements shall be constructed using methods and practices that minimize flood damage.

Section 21.45.050 3(b) (ii) (iii) addresses nonresidential construction of unoccupied structures within the flood area if the construction has structural components capable of resisting hydrostatic and hydrodynamic loads and effects of buoyancy, and is certified by a registered professional engineer or architect that the standards of this subsection are satisfied.

Section 21.45.050 F Coastal High Hazard Area provides in subsection 1 that piles or column foundations and structure attached thereto is anchored to resist floatation, collapse, and lateral movement due to the effects of wind and water loads acting simultaneously on all building components. While this section implies a traditional structure, it repeats the desire that piers, such as those to be replaced in the inner boat basin, be capable of withstanding the water loads of an event and be based on water loading values associated with "...the base flood."

The inner boat basin restoration project is utilizing CDBG funds in part to acquire the actual docks and possibly piers to be placed in the boat basin. This requires the project to comply with the flood plain management standards of HUD as required under Executive Order 11988, Floodplain Management, and employs the principals of the Unified National Program for Floodplain Management. Under these requirements the inner boat basin is a non-critical action located in a coastal high hazard area and is also a "functionally dependent use" within the flood zone. The term functionally dependent use "...means a land use that must necessarily be conducted in close proximity to water (e.g.. a dam, marina, port facility, water front park, and many types of bridges)." Section 55.11 allows functionally dependent uses within a coastal high hazard area; however, the project "...shall consider feasible technological alternatives, hazard reduction methods, and related mitigation costs and environmental impacts."

There is not a lot of source information to address marinas and the impacts of tsunamis have on marinas. This District has hands on experience with tsunamis and has observed more than one damaging event. Guidance for implementing flood hazards in marinas is provided in a document on the Army Corps website that was prepared on hurricanes. The document, Hurricane Preparedness Guidelines for Marinas, contains procedures agreed acceptable by the U.S. Federal Emergency Management Agency. Although these guidelines are for hurricanes, the document addresses storm surge with potential surges of 10 to 20 feet above normal high tides. The life expectancy for marina facilities (such as docks and floats) is 50 years. The subject document acceptable to FEMA provides that the recommended design period for hurricanes (wind and tidal surge with tidal surge being similar to a tsunami event) is normally 50 years (2% probability, in any given year) and no less than 25 years (4% probability in any given year).

The Harbor at Crescent City has experienced numerous tsunami events, with the most recent taking place as a result of the Chilean earthquake on February 27, 2010. The presence of the Mendocino Escarpment off shore tends to direct wave energy from a tsunami toward Crescent City and the region around the California/Oregon Stateline. The escarpment reflects some of the wave energy carried by a tsunami to the coastline north of Cape Mendocino. This makes the harbor at Crescent City vulnerable to tsunami events. The impacts of tsunami's on the harbor vary with the magnitude of the tsunami wave, location of the wave source, and other factors such as whether the high tide coincides with the peak wave. There have been at least four documented tsunami events that have caused significant damage to the harbor within the last 60 years. These tsunami's are:

| Year | Wave Height | Damage Reported |
|---|---|---|
| 1952 | 6.8 ft. | boats sunk and 60 ton buoys moved |
| 1960 | 10.7 ft. | boats sunk, docks damaged, streets flooded |
| 1964 | 24 ft.* | 29 city blocks damaged, 21 boats sunk, 11 fatalities |
| 2006 | 5.8 ft | damaged inner boat basin (current rebuild) |

*The tide gauge was damaged during the 1964 tsunami and therefore the wave height maximum is an estimate based on observation.

The 2006 tsunami generated strong hydrodynamic effects that were observed during the tsunami. Local observation described the event as water leaving the harbor and returning in surges, "...like being downstream of a large rapid". The tsunami generated very strong flows at the entrance to the inner boat basin which then travelled in a clockwise circulation within the basin. These currents were the main cause of the damage within the basin. The Harbor Master observed the currents to be severe like a river flow. It was observed that sea lions were unable to swim against the currents, which confirms the currents were in excess of 10 knots (11.5 mph). Flow velocities were estimated to be 13.8 mph. The February 2010 tsunami had similar physical characteristics.

The Harbor District's engineer, Stover Engineering, had a tsunami study prepared for the inner boat basin (Crescent City Harbor Rehabilitation Tsunami Study, May 2010). This study (Gerwick Tsunami Study) is being used by Stover Engineering and Ben C. Gerwick, Inc. to design the replacement improvements of the inner boat basin. Secondly, the tsunami study also provides an analysis of feasible technological alternatives that would significantly minimize future damage caused by future similar tsunamis. The docks, pilings, and wave attenuator along with other improvements included in the preferred alternative all contribute to complying with the requirements discussed above.

### 5.1.3 Wetlands Protection

A Biological Report for Crescent City Harbor District Master Plan, prepared by Gedik BioLOGICAL Associates, August 2005 (Appendix B) identified two areas as wetlands that lie within the harbor area. The Gedik report identifies the site of the two wetlands as shown on Exhibit 1 (page 62 - taken from Figure 2-b of the RRM Master Plan). One of the two wetlands is approximately 6,000 square feet (.13 ac.) and consists primarily of a significantly disturbed willow thicket. This willow thicket is approximately 400 feet from the project site and 200 feet from the staging area.

The Gedik report also identified a strip along the beach strand as a wetland. This determination was based primarily on the tidal influence of the area (marine intertidal unconsolidated shore regularly flooded). The identified beach strand is located on the relatively undisturbed shoreline east of the action and project areas, adjacent to a portion of the northwesterly wall of the existing breakwater. At this location the sandy beach touches the breakwater and, therefore, the Gedik report mapped wetland; however, no activity is proposed as a part of this project that would require any activity on the sandy beach or below the existing breakwater. Project activity (such as removal and/or installation of pilings) could take place on top of the breakwater which would technically place the activity within approximately 50 feet of a 100 feet portion of the mapped beach strand.

The only potential for wetland and sensitive plans to be affected are those identified by Gedik as being in Area C on her maps. This site is shown in Exhibit 2 (page 63) which is from page 37 of her report. This area is outside of the project area but within 100 feet of the boat basin although separated from the basin. The sensitive area will be temporarily fenced off between the project area and the sensitive area to prevent trampling, vehicle activity, stockpiling activities, or other construction activities. Installation of the temporary fence will be monitored by a biological monitor.

Project activities within the "wetlands" as mapped by Gedik will not take place. Project activities will be more than 200 feet from the nearest on-land wetland (willow thicket). The actual work done within the inner boat basin will be in the waters of the Pacific Ocean that enter and occupy the boat basin. Potential effects from the unintentional introduction of sediment into the water of the inner boat basin can be minimized by avoidance and minimization measures to contain erosion or sediment associated with construction through Best Management Practices (BMPs). Furthermore, in-water work would be restricted to July 1 through October 15, the lowest rainfall months of the year.

### 5.1.4 Coastal Zone Management Act

The project area is located within the boundaries of the California Coastal Zone. The California Coastal Commission retains permit jurisdiction for activities within the immediate shoreline including tidelands, submerged lands, and public trust lands). The proposed project involves all three of these elements. The proposed project centers on the ability of the harbor to continue to provide and maintain its function as a safe harbor for the boating public and the commercial fishing industry consistent with the state-wide goals and policies of the Coastal Act of California. Public access will be limited only during construction periods and only to those portions where access would be inconsistent with public safety. Public access will be improved by the placement of ADA compliant access ramps to the floats (docks) within the inner boat basin. Measures will be included in the proposed project to protect Coastal resources including but not limited to the marine environment and water quality.

A Coastal Development Permit (CDP) will be filed with the California Coastal Commission. Conditions of issuance of the CDP will be included in the project bid process and/or inspection process, including conformance with requirements and mitigation measures from the North Coast Water Quality Control Board, US Army Corps of Engineers, and the US Fish and Wildlife Service with respect to the protection of water quality and the marine environment.

### 5.1.5 Sole Source Aquifers

The Safe Drinking Water Act gives the EPA the authority to designate an aquifer as a sole source of drinking water for a specified area. Such a designation means the EPA is obligated to review all federally funded projects in the area in order to determine the project's potential for contamination of the aquifer. A sole source aquifer supplies at least 50% of the drinking water consumed in the area overlying the aquifer.

There are no sole source aquifers designated in Del Norte County. Therefore, the project is not located within an area designated by the EPA as being supported by a sole source aquifer.

Verified through download of Designated Sole Source Aquifers in EPA Region IX
http://www.epa.gov/cgi-bin

### 5.1.6 Air Quality

The project area is located in the North Coast Air Basin, which consists of Del Norte, Humboldt, Mendocino, and Trinity Counties and the northern portion of Sonoma County. The physiographic features that give shape to this Air Basin are the Coast Range mountains to the east and the Pacific Ocean to the west. In the project area, dominant winds exhibit a seasonal pattern. In the summer months, strong north to northwesterly winds are common; during the winter months, storms increase the occurrence of days with winds from a southerly direction. Offshore and onshore flows are common along the coast and are associated with pressure systems in the area. Onshore flows tend to bring foggy cool weather to the coast, while the offshore flows often bring exceptionally warm and sunny days.

The criteria pollutants of greatest concerns for the proposed project are inhalable particulate matter (PM10) and fine particulate matter (PM2.5). Particulate matter in Del Norte County is almost completely the result of the "Miscellaneous Process" category which includes controlled burning for forest management and unpaved road dust. Ozone and carbon monoxide are of less concern in Del Norte County, due to its rural nature. In Del Norte County, only 7% of the total CO (carbon monoxide) comes from on-road motor vehicles. The majority of CO emissions in Del Norte County are from "Miscellaneous Processes" (61% of the total), with an additional 30% coming from wildfires. The primary "Miscellaneous Processes" component is controlled burning for forest management.

In response to being classified as a nonattainment area for California Ambient Air Quality Standards for PM10, the North Coast Unified Air Quality Management District (NCUAQMD) published a Particulate Matter Attainment Plan in 1995. The Plan noted that the Air Basin is not heavily industrialized, with the majority of the industry related to timber. Even though the Air Basin is in nonattainment because PM10 is a regional pollutant, the PM10 monitors in Crescent City have not documented any exceedance of the State PM10 standard.

Short-term construction emissions may include fugitive dust and other particulate matter as well as exhaust emissions generated by the equipment being used to remove and install the replacement facilities (floats, pilings, ramps, rock slope protection) and the removal of the excess sand at the boat basin entrance. Given the nature of the project in that it is primarily an activity upon water and the on land activity is confined to existing paved area, fugitive dust should not be a significant problem. However, in order to address any potential regardless of the level of significance, and to reduce potential impacts upon air quality, standard construction BMPs for dust control and emission control practices during the construction period will be implemented, including implementation of an effective Storm Water Pollution Plan (SWPP).

Vehicle emissions will be mitigated by requiring that the contractor shall ensure that all construction equipment is maintained and tuned to meet applicable EPA and California Air Resources Board (CARB) emission requirements.

### 5.1.7 Farmland Protection Policy Act

The waterfront area of the Harbor in general is influenced by its proximity to the local marine environment. A review of an aerial photo from 1948 shows the harbor in its initial stages of what is present now. The harbor area in the 1948 photo identifies the presently developed area of the harbor as coastal sandy beach with some coastal dunes. This coastal dune complex is indicative of the original undisturbed area of the harbor. Nearly all of the study area has been altered from its natural condition, beginning with maritime operations in the 1800s. Much of the area has been covered with hard surfaces, leaving only a few small areas covered with ruderal vegetation that approximate the original pre-development sand dune condition.

The project area is not designated for prime farmland, and the project area does not qualify as farmland under the criteria of the County LCP; the nearest mapped prime agricultural land lies some 8,500 feet from the harbor Inner Boat Basin project site. No parcels within or in proximity to the project area are under Williamson Act contract. The soils in the project area are not one of the soils identified as having prime agricultural qualities. There is no known historical use of the project area for traditional agricultural activities. The inner boat basin rehabilitation project will not contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses.

Verification letter dated May 3, 2010, from Ms. Heidi Kunstal, Deputy Director of Building and Planning, County of Del Norte.

### 5.1.8 Environmental Justice

Social and economic impacts resulting from the proposed project are expected to be generally beneficial to the surrounding community, the City of Crescent City, and the County of Del Norte. Restoring the inner boat basin will allow the use of the boat basin for the commercial fishing fleet which will maintain an established economic sector for the area and preserve existing jobs currently occupied by local residents. The inner boat basin also provides opportunities for transient vessels to dock here and general opportunities for present and future visitor usage. The Harbor District has goals to diversify their income stream by the expansion of recreational facilities, destination amenities, and other improvements that will focus on the activities of the inner boat basin and the rest of the harbor area.

The proposed project is a restoration project within an existing commercially and light industrial developed area. There are no residences within the project area. Current Land Use Designations and Zoning for the project site is Harbor Dependent Commercial. This designation is to provide areas for commercial and industrial activities which require immediate access to harbor waters or to be placed adjacent to harbor waters. The principal permitted uses include boat basins, berthing floats, breakwater devices and piers, maintenance dredging and dredge spoils disposal, public facilities, parking lots, and other marine oriented uses. The land use plan for the harbor includes the inner boat basin as a key element. The land use plan has been certified as a Local Coastal Plan by the California Coastal Commission.

### 5.1.9 Noise Abatement and Control

In order to facilitate the creation of suitable living environments, the US Department of Housing and Urban Development (HUD) has developed criteria for exterior noise standards for new housing construction assisted or supported by HUD. The proposed project is the restoration of an existing commercial and recreational boat basin in a commercial and industrial designated area. Therefore, the proposed project does not involve the development of noise sensitive uses.

Activities associated with the removal of the damaged facilities and replacement of facilities within the inner boat basin and replacement of those facilities would intermittently and temporarily increase the ambient noise levels due to the use of equipment. There are no residences in the immediate vicinity and only two residences are known to exist in proximity (900 feet or more away) to the project site. These two residences are located on the second floor of a commercial operation, surrounded by other commercial activities within a commercially zoned area of the City of Crescent City.

Construction noise can be controlled by limiting construction activity to the least noise sensitive daytime hours; specifically the hours from 7:00 a.m. to 7:00 p.m. on weekdays and on Saturdays, and 8:00 am to 5:00 pm on Sundays. Construction equipment shall be properly muffled and shrouded to minimize noise levels. Implementation of this or similar mitigation would reduce any potential generated noise impacts to less than significant.

### 5.1.10 Toxic or Hazardous Substances and Radioactive Materials

The proposed project does not involve development for human habitation and the project does not create human occupancy of an enclosed space. The proposed inner boat basin restoration will replace piers and floats (docks) upon the water within the boat basin. The project also involves replacement of rock slope protection at damaged spots along the perimeter of the boat basin. The CDBG funds will be used to purchase the floats and possibly the piers.

The previous use of the project site consisted of undeveloped open coastal sand dunes and the active shoreline of the natural harbor. The inner boat basin was constructed by removing the naturally occurring sand from the shoreline sufficient to create the boat basin. The sand removed from the shoreline was used on-site as fill for the construction of the parking lot; capping the area with asphalt concrete. The immediately surrounding area is relatively undeveloped with ruderal grasses and some dune grasses along the shoreline. There is no evidence of contamination on or near the project site. Approximately 400+ feet from the project site is a non-pressurized fuel storage tank. The tank is part of the fueling system for the boats in the harbor. The system is operated by Renner Petroleum and the system has the proper permits in place for its operation. The actual fueling area is located approximately 500 feet from the project site.

The project area is substantially removed from sites where hazardous, toxic, or radioactive substances are used or may be present. Query results from the EPA Data Warehouse (EnviroFacts) did not reveal any on-site hazardous, toxic, or radioactive sites. There presently are no listed EPA superfund sites in Del Norte County, although a closed and delisted super fund site does exist approximately three miles northwest of the inner boat basin.

An underground storage tank for fuels for the commercial fishing fleet is located off-site and approximately 400 feet from the nearest point of the project area. Exhibit 3 (page 64) identifies the location of the underground storage tank. The fuel system, including the underground tank, is owned and operated by Renner Petroleum of Crescent City. The underground tanks consist of three tanks; one 8,000 gallon double walled tank containing unleaded gasoline, and two 12,000 gallon double walled tanks for diesel fuel. The tanks are properly permitted (State ID Numbers 08-000-012100-000001, 000002, and 000004). The subject tanks are inspected annually with the most recent testing taking place on March 4, 2010. The underground tanks of Renner Petroleum are located outside of the project area and will not be disturbed by the proposed project. Therefore, the scope of work of the proposed project does not impact or is affected by the Renner underground storage tanks and fuel dispensing system.

The Harbor District has three waste oil disposal tanks located within the project area. Exhibit 3 (page 64) identifies the location of the three waste tanks. Each of these tanks are approximately 500 gallons in size and are concrete underground storage vaults with interior tanks. Currently, two of the three tanks are being used. The waste oil is removed from the tanks on a monthly basis or more frequently if needed. The tanks have a locked cover and the oil can only be removed by the recycler of the waste oil. While these tanks are in the project area, they will not be disturbed. The collection of waste oil from the commercial fishing fleet in these tanks is a critical element in maintaining the water quality of the inner boat basin.

Verification letter dated May 7, 2010, from Ms. Heidi Kunstal, Deputy Director of Building and Planning, County of Del Norte. Also, verification letter dated May 25, 2010, from Steve Wakefield, Fire Chief of Crescent Fire Protection District and Fire Chief for the City of Crescent City.

### 5.1.11 Airport Clear Zones and Accident Potential Zones

There are no military airfields located within Del Norte County. The nearest civil airport is McNamara Field (CEC) operated by the Border Coast Regional Airport Authority. The airport is a commercial service and general aviation airport located in Crescent City, California. The airport serves not only the City of Crescent City and the surrounding communities located within Del Norte County (Gasquet, Smith River, Fort Dick and Klamath), but also serves communities in the Curry County area of Southern Oregon, including Brookings-Harbor and Gold Beach.

United Express Airlines provides the commercial passenger service with daily flights to San Francisco and Sacramento, California. The airport is ILS-equipped and is operational 24 hours a day/7 days a week. Airline travel services and gate personnel, as well as Transportation Security Administration personnel, are available in the terminal building during commercial air service operation hours. General Aviation/Fixed Base Operator services are available 24/7.

The distance from the inner boat basin project to the nearest runway at McNamara Field (CEC) is 15,000 feet or 2.85 miles. Therefore, the inner boat basin project is not within an FAA-designated civilian airport Runway Clear Zone (RCZ), or within a military airfield Clear Zone (CZ) or Accident Potential Zone (APZ).

Verification letter dated May 14, 2010, from James Bernard, Director of Border Coast Airport Authority (CEC).

## 6.0 ENVIRONMENTAL ASSESSMENT CHECKLIST Statutory Checklist [Environmental Review Guide HUD CPD 782, 24 CFR 58.40; Ref. 40 CFR 1508.8 &1508.27]

Evaluate the significance of the effects of the proposal on the character, features and resources of the project area. Enter relevant base data and verifiable source documentation to support the finding. Then enter the appropriate impact code from the following list to make a finding of impact. **Impact Codes**: **(1)** - No impact anticipated; **(2)** - Potentially beneficial; **(3)** - Potentially adverse; **(4)** - Requires mitigation; **(5)** - Requires project modification. Note names, dates of contact, telephone numbers and page references. Attach additional materials as needed.

| Land Development | Code | Source or Documentation |
|---|---|---|
| Conformance with Comprehensive Plans and Zoning | 1 | The project is in conformance with the County of Del Norte Land Use Plan and Zoning Ordinances.<br><br>The project site is zoned as Harbor Dependent Commercial and has the same land use designation both permitting boat basins, berthing floats, breakwater devices, and piers; key elements to this project.<br><br>**See item #10 of the EA Statutory Checklist Compliance information. Verification letter dated May 3, 2010, from Ms. Heidi Kunstal Deputy Director of Building and Planning for County of Del Norte.** |
| Compatibility and Urban Impact | 2 | The project is a rehabilitation of an existing inner boat basin (marina) that has been in existence since 1972. The land use plan for the harbor includes the inner boat basin as a key element. The proposed project is within an existing commercially and light industrial developed area. There are no residences within the project area. Current Land Use Designations and Zoning for the project site is Harbor Dependent Commercial.<br><br>**See item #10 of the EA Statutory Checklist Compliance information. Verification letter dated May 3, 2010, from Ms. Heidi Kunstal Deputy Director of Building and Planning for County of Del Norte.** |
| Slope | 1 | The site is relatively flat (less than 3%) and is paved. The average elevation of the project area ranges from sea level for the inner boat basin to approximately 16 feet for the flat parking area. The inner wall of the boat basin has rock slope protection (RSP) placed along its entire length. Slope will have little to no impact on the proposed project site.<br><br>**Verification letter, dated June 29, 2010, from Ward L. Stover, Principal, Stover Engineering.** |
| Erosion | 2 | The inner wall of the boat basin has been damaged and some areas do not have sufficient RSP allowing some erosion to occur. The proposed repairs to the RSP will stabilize the inner wall of the boat basin thereby reducing any erosion presently taking place. Standard BMPs will be required as part of the construction contract.<br><br>**Verification letter, dated June 29, 2010, from Ward L. Stover, Principal, Stover Engineering.** |

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| Soil Suitability | 4 | The harbor area in a 1948 aerial photo identifies the presently developed area of the harbor as a coastal sandy beach with some coastal dunes. The coastal dune complex is indicative of the original undisturbed area of the harbor. A geotechnical investigation was conducted by Treadwell & Rollo. A preliminary seismic evaluation was submitted to the design team indicating that the soil is suitable for the project as proposed in the 30% draft plans. Using piles and spread footings and other appropriate foundation design will be required for the proposed ADA accessible ramps/gangways.<br><br>A final geotechnical report will be prepared at the time final design is completed.<br><br>**Verification letter, dated June 29, 2010, from Ward L. Stover, Principal, Stover Engineering.** |
| Hazards and Nuisances including Site Safety | 4 | The proposed project is a non-residential structure. Section 21.45.050 A.3 of Del Norte County Code, states that a project may be located below the base flood elevation provided any structures placed below that level shall permit the equalization of hydrostatic flood forces. The proposed project does not involve enclosed structures below the base flood elevation. Proposed construction will conform with Section 21.45.05A. A tsunami study was prepared that identified a design load for a 50 year wave. The pile foundation will be anchored to resist floatation, collapse, and lateral movement due to the effects of wind and water loads<br><br>The Community Development Department of the County of Del Norte, the department responsible for implementing the (FEMA approved) Flood Damage Prevention Ordinance has stated that by complying with the applicable sections of Chapter 21.45, the inner boat basin rehabilitation project of the Harbor will be in compliance with the County Flood Damage Prevention Ordinance.<br><br>**See item 5.1.2 of the EA Statutory Checklist Compliance Information. Verification letter dated Mar 19, 2010, from Mr. Randy Hooper, Planner in the Building and Planning Division of County of Del Norte.**<br><br>**Verification letter, dated June 29, 2010, from Ward L. Stover, Principal, Stover Engineering.** |
| Energy Consumption | 4 | The proposed project does not involve development for human habitation and the project does not create human occupancy of an enclosed space. Therefore Title 24 requirements do not apply to this project.<br><br>Construction equipment and hauling of materials to and from the project site may result in a potential short-term increase in fuel consumption. This increase can be mitigated by requiring that the contractor shall ensure that all construction equipment is maintained and tuned to meet applicable EPA and California Air Resources Board (CARB) emission requirements.<br><br>**See item 5.1.6 of the EA Statutory Checklist Compliance Information and section 4.6 Mitigation Measures Recommended** |

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| **Noise** - Contribution to Community Noise Levels | 4 | The project will temporarily increase noise levels during construction due to normal noises attributable to construction activities and construction equipment.<br><br>Construction noise can be controlled by limiting construction activity to the least noise sensitive daytime hours; specifically the hours from 7:00 a.m. to 7:00 p.m. on weekdays and on Saturdays and 8:00 am to 5:00 pm on Sundays. Construction equipment shall be properly muffled and shrouded to minimize noise levels. Implementation of this or similar mitigation would reduce any potential generated noise impacts to less than significant.<br><br>**See item 5.1.9 of the EA Statutory Checklist Compliance information.** |
| **Air Quality**<br><br>Effects of Ambient Air Quality on Project and Contribution to Community Pollution Levels | 4 | The project area is located in the North Coast Air Basin, which consists of Del Norte, Humboldt, Mendocino, and Trinity Counties, and the northern portion of Sonoma County. The air basin is classified as a nonattainment area for California Ambient Air Quality Standards for PM10. Even though the Air Basin is in nonattainment because PM10 is a regional pollutant, the PM10 monitors in Crescent City have not documented any exceedance of the State PM10 standard.<br><br>Short-term construction emissions may included fugitive dust and other particulate matter as well as exhaust emissions generated by the equipment being used to remove and install the replacement facilities and operation of the dredge during the removal of the excess sand at the boat basin entrance. Given the nature of the project in that it is primarily an activity upon water and the on-land activity is confined to existing paved area, fugitive dust should not be a significant problem. However, in order to address any potential, regardless of the level of significance, and to reduce potential impacts upon air quality, standard construction BMPs for dust control and emission control practices during the construction period will be implemented, including implementation of an effective Storm Water Pollution Plan (SWPP)<br><br>Vehicle emissions will be mitigated by requiring that the contractor shall ensure that all construction equipment is maintained and tuned to meet applicable EPA and California Air Resources Board (CARB) emission requirements.<br><br>**See item #8 of the EA Statutory Checklist Compliance information.** |
| **Environmental Design**<br><br>Visual Quality - Coherence, Diversity, Compatible Use and Scale | 1 | The proposed project will restore the damaged inner boat basin to pre-disaster conditions as well as improve the ability of the inner boat basin to withstand similar events in the future. The capacity of the restored inner boat basin would be approximately the same as pre-disaster capacity. The physical appearance of the new float system will be similar to the previous appearance but will include new ADA compliant ramps for access.<br><br>The proposed project will not substantially degrade the existing visual character or quality of the site and its surroundings. The current site has blight issues which will be corrected by the removal of the damaged and derelict docks and the replacement with new docks and piers.<br><br>**See Section 2.2 Description of Proposed Project. Verification letter dated May 3, 2010, from Ms. Heidi Kunstal, Deputy Director of** |

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| | | **Building and Planning for County of Del Norte.**<br><br>**Verified by Richard Young, CEO Crescent City Harbor District 707-464-6174** |

| Socioeconomic | Code | Source or Documentation |
|---|---|---|
| Demographic Character Changes | 1 | The subject project is the rehabilitation of the damaged inner boat basin and the retention of 182 FTE through the proposed project. As a rehabilitation project of an existing facility which is intended to provide facilities in order to retain the existing commercial fishing fleet and its employees both direct and indirect, the project will not significantly alter the demographic characteristics of the community by drawing new individuals to the community. There will be a short term increase of specialized employees during the construction phase but this will be short lived.<br><br>Additionally, the project will not affect any community institutions nor create any physical barriers or difficult access affecting any particular neighborhoods or population groups.<br><br>**See Exhibit 4 (page 65), Job Retention Chart from CDBG staff report.** |
| Displacement | 1 | The project site is developed as an existing albeit severely damaged boat basin (marina). Due to the developed aspects of the existing site and the project intent to replace existing facilities, no persons, businesses, institutions or community facilities will be displaced as a result of this project. No direct or indirect displacement will result.<br><br>**See Sections 1 and 2 of this document (EA) and Employment and Income Patterns section below.** |
| Employment and Income Patterns | 2 | The subject project is the rehabilitation of the damaged inner boat basin which is being funded in part through Cal EMA as a disaster event. Cal EMA will fund approximately 75% of the eligible cost and the remaining 25% is being funded through CDBG. Based upon the amount of CDBG funds being allocated, the project identified to CDBG the retention of 136 FTE position. The majority of the jobs to be retained will be through retaining the commercial fishing fleet. Actual documentation resulted in an estimate of more than 182 FTE being retained through the proposed project. Attachment 5 from the CDBG staff report identifies the list of business types that were documented for closing if the inner boat basin was not reconstructed.<br><br>The project will create temporary construction employment likely to be drawn from the local employment base for non-specialized labor. The project will not result in the displacement of existing jobs but rather focuses on job retention.<br><br>**See Exhibit 4 (page 65), Job Retention Chart from CDBG staff report.** |

| Community Facilities and Services | Code | Source or Documentation |
|---|---|---|
| Educational Facilities | 1 | The inner boat basin is located within the Del Norte County Unified School District. The rehabilitation project is a jobs retention project and replacement of previous harbor facilities. No new families are anticipated to move into the area as a result of this project. In accordance with California Government Code Section 65996, school impact fees do not apply as there is no increased demand on schools facilities caused by the proposed project.<br><br>**Verified by Rodney Jahn, Deputy Superintendent, Business Services, Del Norte Unified School District via telephone at 707-464-6141 on May 17, 2010.** |
| Commercial Facilities | 2 | The subject project is the rehabilitation of the damaged inner boat basin which is being funded in part through Cal EMA and CDBG. As a job retention project, the majority of the jobs to be retained will be through retaining the commercial fishing fleet. Actual documentation resulted in an estimate of more than 182 FTE being retained through the proposed project. Attachment 5 from the CDBG staff report identifies the list of business types that were documented for closing if the inner boat basin was not reconstructed. By rehabilitating the inner boat basin to a functional commercial boat basin, the jobs listed in Attachment 5 will be retained and not lost to the local economy which includes businesses that serve those who work in the commercial fleet and those business that directly serve the fleet.<br><br>The project will create temporary construction employment likely to be drawn from the local employment base for non-specialized labor. The project will not result in the displacement of existing jobs but rather focuses on job retention.<br><br>**See Exhibit 4 (page 65), Job Retention Chart from CDBG staff report.** |
| Health Care | 1 | The proposed project is not expected to significantly impact demand for health care services. The project by its intent is a job retention project for existing residents of the County. Sufficient health care services are already available within the area and no impact is expected.<br><br>Sutter Coast Hospital is located approximately 2.5 miles from the project site and is staffed adequately to handle any services needs generated by the project.<br><br>**Verification letter dated May 17, 2010, from Eugene Suksi, Chief Executive Officer Sutter Coast Hospital.** |
| Social Services | 2 | The proposed project will have a positive social impact of job retention in a community with high rates of unemployment and poverty.<br><br>**Verified by Gary Blatnick, Director of Health and Social Services, County of Del Norte via e-mail on May 18, 2010.** |

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| Solid Waste | 1 | The docks and pilings removed will be processed through the Del Norte Solid Waste Authority for proper disposal. The steel pilings are candidates for recycling. The non-recyclable materials will be transported to the contracted disposal site of the authority. Sufficient capacity is available for the materials to be disposed.<br><br>**Verified by Kevin Hendrick, Director of the Del Norte Solid Waste Management Authority via telephone at 707-465-1100 on May 19, 2010.** |
| Waste Water | 1 | The proposed project is rehabilitation/reconstruction of an existing facility within the urban services boundary of the City of Crescent City. Utilities and services, such as potable water and sanitary sewer collection and treatment are provided by the City of Crescent City through existing lines adjacent to and within the project area. The existing water lines and sewer lines have capacity to continue to serve the proposed project.<br><br>**Verified by James Barnts, Public Works Director, City of Crescent City via telephone at 707-464-9506 on May 18, 2010.** |
| Storm Water | 4 | Nearly all of the harbor has been previously disturbed. The project site has been previously altered from its natural condition. The project site is either the inner boat basin marina area (water) or the adjacent paved parking lots. A Storm Water Prevention Plan, Erosion Plan, a Hazardous Materials Management/Spills Response Plan, and BMPs will be required of the contractor or contractors to reduce, to the maximum extent possible, the volume, velocity, and pollutant load of storm water and dry weather flows from leaving the project site during construction and from the staging area during construction activity.<br><br>**Verification letter, dated June 29, 2010, from Ward L. Stover, Principal, Stover Engineering.** |
| Water Supply | 1 | The proposed project is rehabilitation/reconstruction of an existing facility within the urban services boundary of the City of Crescent City. Utilities and services, such as potable water and sanitary sewer collection and treatment are provided by the City of Crescent City through existing lines adjacent to and within the project area. The existing water and sewer lines have capacity to continue to serve the proposed project.<br><br>**Verified by James Barnts, Public Works Director, City of Crescent City via telephone at 707-464-9506 on May 18, 2010.** |
| Public Safety<br>- Police | 1 | Due to the replacement nature of the project, it is not expected to significantly increase demand for public safety services, including police protection. The area is patrolled by the Del Norte County Sheriff's Department. There is adequate capability to serve the project by the Sheriff's Department.<br><br>**Verification letter from Sheriff Dean Wilson of Del Norte County, dated May 18, 2010.** |
| - Fire | 1 | Due to the replacement nature of the project, it is not expected to significantly increase demand for public safety services, including fire protection. The project site is within the jurisdiction of the Crescent Fire Protection District. Three Fire Stations are located 1 mile, 1.9 miles and |

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| | | 2.2 miles from the inner boat basin. The Fire Chief has determined that the project is not expected to significantly increase demand for fire response<br><br>**Verification letter dated May 25, 2010, from Steve Wakefield, Fire Chief of the Crescent Fire Protection District and Fire Chief for the City of Crescent City.** |
| - Emergency Medical | 1 | Due to the replacement nature of the project, it is not expected to significantly increase demand for public safety services, including emergency medical. The project site is approximately 2.5 miles from Sutter Coast Hospital. The hospital is adequately staffed to handle any medical emergency anticipated to be generated by the project reconstruction.<br><br>**Verification letter, dated May 17, 2010, from Eugene Suksi, Chief Executive Officer Sutter Coast Hospital.**<br><br>The project site is currently served with paved roads, streets, and parking around the inner boat basin. The existing roadways provide adequate access to the site for emergency service response.<br><br>**Verification letter date May 25, 2010, from Steve Wakefield, Fire Chief of the Crescent Fire Protection District and Fire Chief for the City of Crescent City. Verified by John W. Pritchett, General Manager, Del Norte Ambulance, via e-mail, dated May 25, 2010.** |
| Open Space and Recreation<br><br>- Open Space | 2 | The proposed project is a rehabilitation/replacement of existing marina facilities. This marina is primarily used by the commercial fishing fleet; however, it also is occasionally used by recreational boaters, especially those boats too large for the recreational marina off of the Whaler Island breakwater. The inner boat basin is an area frequented by visitors and locals as a place to observe the activities of the commercial fishing fleet and to view sea lions, harbor seals, and birds. The inner boat basin can also be used on an infrequent basis by people in kayaks.<br><br>**Verified by Richard Young, CEO, Crescent City Harbor District, 707-464-6174** |
| - Recreation | 2 | See discussion immediately above. There are no formally designated public parks, wildlife or waterfowl refuges in the project area or surrounding areas. The improved ADA accessways will allow the handicapped and the physically frail to visit the dock areas of the inner boat basin. The existing ramps are not ADA compliant.<br><br>**Verified by Richard Young, CEO, Crescent City Harbor District, 707-464-6174** |
| - Cultural Facilities | 1 | A review of the list of California Historical Resources for Del Norte County did not identify any historical resources within the project area. There are no residential structures or other structures on the project site other than the two existing concrete block public restrooms. Due to the location and type of the project proposed, no impact is anticipated.<br><br>**See item 5.1.1 of the EA Statutory Checklist Compliance Information.** |

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| | | **Verification letter from NCIC (SHPO) dated June 28, 2010, from Vicky Bates, Coordinator, and verification letter dated June 10, 2010 from Dale Miller, Chairman of the Elk Valley Rancheria** |
| Transportation | 1 | The proposed project is a rehabilitation/replacement of existing marina facilities. There is no significant increase in mooring space being proposed as part of this project. The physical constraints of the inner boat basin are not conducive to any radical change in layout or increase in moorings. The proposed rehabilitation will be substantially the same as the previous layout with roughly the same capacity.<br><br>A Traffic Analysis was prepared as part of the analysis for the Master Plan acted upon by the Harbor District in 2006. The traffic study included a twenty year projection. The study concluded that "(u)nder future conditions, all study intersections are projected to continue operating acceptably at LOS C or better except the eastbound Citizens Dock Road approach to U.S. 101, which is projected to operate at LOS D." The rehabilitation project is not a significant change over the previous configuration. There will be no change in traffic patterns or the amount of traffic generated by the inner boat basin other than a temporary potential insignificant increase during the actual rehabilitation by the construction workers.<br><br>Floats and pilings will be constructed off-site and assembled on-site. The old pilings and floats (docks) will be removed by the contractor. The project contractor will be responsible for obtaining transportation permits (if needed) from the Department of Transportation (CalTrans) for oversized or excessive load vehicles travelling on the State roadways and to coordinate with the Del Norte County Roads Division to obtain any necessary permits from them.<br><br>For these reasons, the proposed project will not result in significant transportation impacts.<br><br>**Crescent City Harbor District Master Plan prepared by RRM Design Group (Traffic study prepared by W-Trans)** |

| Natural Features | Code | Source or Documentation |
|---|---|---|
| Water Resources | 1 | The proposed project is rehabilitation/reconstruction of an existing facility within the urban services boundary of the City of Crescent City. Utilities and services, including potable water and fire flow are provided by the City of Crescent City through existing lines adjacent to and within the project area. The existing water lines have capacity to serve the proposed project.<br><br>**Verified by James Barnts, Public Works Director, City of Crescent City via telephone at 707-464-9506 on May 18, 2010.** |
| Surface Water | 4 | Other than the inner boat basin, there are no ponds, lagoons, surface impoundments, wetlands, or natural catch basins on the project site. The construction site and the staging area are paved surfaces other than the replacement of the rock slope and the actual installation of the pilings and the floats (docks). Avoidance and minimization measures are to be used to contain erosion or sediment associated with construction, and to |

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| | | minimize the potential for petrochemical spills,<br><br>**Appendix A Final Biological Assessment for NMFS Inner Basin Sea Wall Repair Project-Crescent City Harbor District, FEMA-1628-DR-CA, PW #1387, April 2007.** |
| Unique Natural Features and Agricultural Lands | 1 | The project area is not designated for prime farmland and the project area does not qualify as farmland under the criteria of the County LCP. The nearest mapped prime agricultural land lies some 8,500 feet from the harbor Inner Boat Basin project site. The soils in the project area are not one of the soils identified as having prime agricultural qualities. There is no known historical use of the project area for traditional agricultural activities.<br><br>The waterfront area of the Harbor in general is influenced by its proximity to the local marine environment. This coastal dune complex is indicative of the original undisturbed area of the harbor. Nearly all of the study area has been altered from its natural condition, beginning with maritime operation in the 1800s. Much of the area has been covered with hard surfaces, leaving only a few small areas covered with ruderal vegetation that approximate the original pre-development sand dune condition.<br><br>**See item #9 of the EA Statutory Checklist Compliance information. Verification letter dated May 3, 2010, from Ms. Heidi Kunstal, Deputy Director of Building and Planning for County of Del Norte.** |
| Vegetation and Wildlife | 4 | Three documents were utilized in addition to other sources for this assessment. The documents are: Final Biological Assessment for NMFS Inner Basin Sea Wall Repair Project-Crescent City Harbor District, FEMA-1628-DR-CA, PW #1387, April 2007 (Appendix A), and the Biological Report for the Crescent City Harbor District Master Plan, prepared by Gedik BioLOGICAL Associates, August 2005 (Appendix B). Also utilized was the Final Mitigated Negative Declaration, Crescent City Harbor District Harbor Master Plan, SCH# 2005112008 December 2005.<br><br>The only potential for wetland and sensitive plants to be affected are those identified by Gedik as being in Area C on her maps. This site is shown in Exhibit 2 (page 63) which is from page 37 of her report. This area is outside of the project area but within 100 feet of the boat basin although separated from the basin. The sensitive area will be temporarily fenced between the project area and the sensitive area to prevent trampling. vehicle activity, stockpiling activities, or other construction activities. Installation of the temporary fence will be monitored by a biological monitor.<br><br>As a result, two federally listed species regulated by NMFS under the ESA were identified as potentially occurring within the project area:<br><br>Southern Oregon/Northern California Coasts (SONCC) coho salmon (Oncorhynchus kisutch)<br>Steller sea lion (Eunetopias jubatus)<br><br>Potential effects from unintentional introduction of sediment or petrochemicals into the water and increased turbidity caused by construction activities could occur. In the case of Coho, they could potentially be killed, injured, or temporarily displaced during placement of |

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| | | rock, especially rock placed at or below mean higher high water (MHHW). Typically, to protect anadromous fish species, construction would take place during the in-water work period of June 15 through October 15 when both juveniles and adults are unlikely to be present). However, because of the potential effects to Steller sea lions, this in-water work window would be reduced to July 1 through October 15. Therefore, the potential for mortality, injury, or displacement of coho salmon would be significantly decreased or avoided. Avoidance and minimization measures are to be used to contain erosion or sediment associated with construction, to minimize the potential for petrochemical spills, and in-water work would be restricted to July 1 through October 15<br><br>The proposed action may affect the SONCC coho salmon ESU, but will have no effect on critical habitat for this ESU. Implementation of avoidance and minimization measures is recommended in this document to protect their habitat.<br><br>The proposed action is not likely to adversely affect the Steller sea lion and will have no effect on designated critical habitat for this species. Implementation of avoidance and minimization measures is recommended in this document to protect their habitat.<br><br>**Appendix A Final Biological Assessment for NMFS Inner Basin Sea Wall Repair Project-Crescent City Harbor District, FEMA-1628-DR-CA, PW #1387, April 2007.**<br><br>**Appendix B Biological Report for Crescent City Harbor District Master Plan, prepared by Gedik BioLOGICAL Associates, August 2005.**<br><br>**Final Mitigated Negative Declaration, Crescent City Harbor District Harbor Master Plan, SCH# 2005112008 December 2005.** |

| Other Factors | Code | Source or Documentation |
|---|---|---|
| Flood Disaster Protection Act (Flood Insurance( (58.6 (a)) | 4 | The Community Development Department of the County of Del Norte, the department responsible for implementing the (FEMA approved) Flood Damage Prevention Ordinance has stated that by complying with the applicable sections of Chapter 21.45, the inner boat basin rehabilitation project of the Harbor will be in compliance with the County Flood Damage Prevention Ordinance.<br><br>**See item 5.1.2 of the EA Statutory Checklist Compliance information. Verification letter dated Mar 19, 2010, from Mr. Randy Hooper, Planner in the Building and Planning Division of County of Del Norte.** |

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| Coastal Barrier Resources Act/Coastal Barrier Improvement Act (58.6 (c)) | 1 | Not applicable in California.<br><br>**USFWS Maps of Coastal Barrier Resources System fws.gov/habitatconservation/coastal_barrier.html** |
| Airport Runway Clear Zone or Clear Zone Disclosures (58.6 (d)) | 1 | The project is not within an FAA-designated civilian airport Runway Clear Zone (RCZ), or within a military airfield Clear Zone (CZ) or Accident Potential Zone (APZ).<br><br>**Verification letter dated May 14, 2010, from James Bernard, Airport Director, Del Norte County Regional Airport.** |

**NOTE:** The Responsible Entity must additionally document and ensure compliance with 24 CFR §58.6 in the ERR, particularly with the Flood Insurance requirements of the Flood Disaster Protection Act and the Buyer Disclosure requirements of the HUD Airport Runway Clear Zone/Clear Zone regulation at 24 CFR 51 Subpart D.

## Summary of Findings and Conclusions

- The proposed project will be compatible with the existing and future land uses in the project site and in the vicinity of the proposed project.
- The rehabilitation/restoration of the inner boat basin for the fishing fleet will result in beneficial economic impacts by providing critical water dependent facilities.
- The proposed project will comply with all statutory regulations pertaining to environmental issues (e.g., wetlands, floodplains, endangered species, historic preservation, toxics, environmental justice, etc.).
- The proposed project will not result in any substantially adverse long-term environmental impacts.
- The proposed project will comply with the applicable sections of Chapter 21.45, the County Flood Damage Prevention Ordinance of the County of Del Norte.
- The proposed project could result in adverse short-term (e.g., construction related, etc.) environmental impacts with regard to. Mitigation measures have, however, been incorporated into the project that will minimize or avoid such short-term impacts.
- The County of Del Norte finds that the proposed project will have no significant effect on the quality of the human environment.
- The County of Del Norte further finds that with the mitigation and implementation measures that the proposed project will have a beneficial impact of retaining jobs in the fishing industry of Del Norte County.

## 7.0 ALTERNATIVE TO THE PROPOSED ACTION [24 CFR 58.40(e), Ref. 40 CFR 1508.9]

### 7.1 Alternatives Process

The Harbor District conducted an examination of dock reconfigurations within the inner boat basin marina in order to maximize the potential to accommodate a range of boat sizes that varies from summer to winter. Summer tends to see more pleasure craft in the harbor as the summer climate is more conducive to recreational use and visits by transient vessels. The winter months tend to have very rough seas and inclement weather factors that discourage visitor and recreational use of boats in the area. The winter months are also the peak months for the commercial fishing catch which tends to draw commercial fishing boats to the harbor from other areas.

Ten layouts were considered and analyzed. Those ten layouts are included in Appendix C as prepared by Stover Engineering, and acted on by the Harbor District on February 16, 2010. The inner boat basin shape and entrance channel are not being considered for overall redesign. The entrance channel, turning movements, lanes to and from the slips, and the interior walls of the marina dictate the options that can be considered. The east side of the basin is confined by the interior sides of the basin and, therefore, Docks A,B,C, D, and the work dock remain basically the same as their previous layout with some minor changes. The potential for alternative layouts exists on the west side of the inner boat basin (the area suffering the most damage) on Docks E, F, G, and H. Table 6 of the Stover report compares the number of slips available for each option to the current vessel need and lists the differences. The difference between the "Correctly Assigned" and "Slips" under each option indicates where boats are presently occupying or have been occupying slips not designed for their boat length.

The Harbor Commission reviewed all ten options during a public meeting of the Commission at their February 16, 2010 regular meeting. Ward Stover of Stover Engineering presented a report to the Commission as an agenda item. Stover's report included a written text discussion, proposed slip sizes and distribution, a schematic layout for each option. The review by the Commission of the ten layouts and their various configurations resulted in narrowing the alternative layout down to three; Option 1, Option 3 and Option 8. The Commission chose Option 8 as the preferred alternative (Proposed Action). Option 8 provides adequate distribution of all sizes of slips sufficient to meet current needs and also provides flexibility to accommodate additional boats in all categories, including 30 foot boats, if needed in the future.

### 7.2 Location Alternative

Location alternatives were not evaluated because the proposed project is a rehabilitation/restoration of an existing water dependent facility. Another location would have to be created which would generate a far greater range of potentially significant environmental impacts. Over 82% of the shoreline of Del Norte County is publicly owned, primarily in State and Federal Parks. The remaining 18% in private ownership is not suitable for a marina and would require substantial physical alteration of the landform. Most of the private ownership is already developed with homes thereby requiring the displacement of families. An alternate location is not feasible or practical for this rehabilitation project.

### 7.3 Original Layout with No Modification Alternative

This Alternative is Option 1 in the Dock Layout Options report by Stover Engineering. Option 1 is the original layout prior to the tsunami event with little to no modification in layout or design. Using basically the previous configuration within the boat basin would not address the need for smaller fishing boats and other similar sized boats. While the 30 foot boats would have adequate slips, the 40 foot boats would have to be tied up in slips for larger boats resulting in inefficient use of the larger slips and creating a potential shortage for these larger boats. This lack of adequate slip variety does not attempt to balance the shift of use between the commercial activities of the winter and the recreational period of the summer months. Option 1 was determined by the Harbor Commission to be inadequate to meet existing and future needs of the harbor.

### 7.4 Original Layout with Increased 50 foot Slips Alternative

This Alternative is Option 3 in the Dock Layout Options report by Stover Engineering. Option 3 maximizes the number of possible 50-foot slips which increases the opportunity to berth smaller boats in mini-marina configurations. These 30 foot and smaller boats would have to be doubled up in their slips. Option 3 has a shortage of 40 foot slips and therefore requires some of the demand created by 40 foot boats to be shifted to the 50 foot boat slips. The shift of slips to the north side of H Dock reduces its ability to provide side tie space for transient vessels. This option does not include the wave attenuator improvements to H Dock, exposing the inner boat basin marina and the boats in the marina to risk of damage from future tsunamis.

### 7.5 Design Tsunami of Less Than a 50-year Recurrence

The preferred alternative is based on the design parameters recommended by Gerwick which is a tsunami recurrence level of 50 years; a 15 foot wave height. This wave height and its accompanying hydraulic forces are the results of the Gerwick Tsunami Study (May 2010). The Gerwick Tsunami Study is a site specific report that builds upon a 2010 NOAA report and the 2007/2008 University of Alaska, Fairbanks reports. The technical focus of the study is to establish the effects of wave action, currents, and loads incurred to moored vessels, floats (docks), and pilings within the inner boat basin thereby reducing tsunami effects. The study numerically simulated tsunami waves entering the harbor and the inner boat basin and tested the effectiveness of various design elements based on a 25 year service life and a 50 year return period for the design tsunami.

By using the recommended Gerwick tsunami return period of 50-years results in designing the inner boat basin marina to withstand a 15.0 ft tsunami wave. Of the four documented damaging tsunami events of the past 60 years, the marina would be able to withstand wave heights of three of the four events, all three having wave heights of less than 15 feet (1952 = 6.8 ft., 1960 = 13 ft., 2006 = 6.8 ft.). The 1964 event had wave heights above 15 feet (20.8 ft and a probable wave height of over 25 feet) and is considered to have a recurrence interval of greater than 50 years.

The Gerwick Study also looked at pile sizes based on current velocities from tsunami events occurring at 10-year, 25-year, and 50-year recurrence intervals. Preliminary pile sizes were developed for hydraulic forces from these event recurrence intervals and relative cost estimates were prepared, see Figure 7 (page 66). Based on the initial 5-29-2009 cost estimate to rebuild the inner boat basin marina of $13.3 million, the approximated costs to construct the inner boat basin marina to withstand a tsunami at 10-year, 25-year, and 50-year recurrence levels would be as follows:

| Tsunami Design Event | Est. Cost | Replacement Cost Per Year |
|---|---|---|
| 10-year | $18 million (est.) | $1.8 million |
| 25-year | $19 million (est.) | $760,000 |
| 50-year | $21 million (est.) | $420,000 |

There is a substantial increase in cost ($13.3 million plus $5 million) to address a 10-year tsunami vs. ignoring the obvious reoccurrence of tsunamis at Crescent City. However, there is a gradual increase between the 10-year, 25-year, and 50-year tsunami design events with a reduced expected cost of replacement per year.

The study also includes a probability and risk analysis. In addition, a probability matrix for the service life and design return period was prepared. The matrix determined that the probability of significant damage to a project with a 25-year service life from a tsunami with a 50-year return period was 40%. The typical design combination for most commercial and residential structures is a 50-year service life and a 100-year event return period, which results in a damage probability of 39% (See Exhibit 6, Risk Analysis formula, on page 67)). Therefore, the damage probability for both a 25-year service life with a 50 year return and 50-year life with a 100-year return are similar. For comparison purposes, should the tsunami return interval be changed to a 25-year tsunami with a 25-year service life, the resultant damage probability is 64% which is greater than 50% and, therefore, generally not an acceptable damage probability for a project of this scope. See Table 1, Design Life and Risk of Occurrence (page 68). The following table summarizes how this probability changes as the design period changes for a marina with a 25 year expected life.

<u>Probability of Destruction</u>

| | Design Period | | |
|---|---|---|---|
| | 10 years | 25 years | 50 years |
| 25 year exp. Life | 93% | 64% | 40% |

If a marina with a 25-year expected life is only designed to resist a wave that occurs on average every 10 years, the odds are 93% (virtually certain) that it will not survive to the end of its expected life. Even if the marina is designed to withstand a 25 year wave, it is still more likely that it will be destroyed before the end of its expected life than it is to survive. Only by designing to the 50 year event does the probability of the marina surviving until the end of its expected life exceed the probability of destruction.

It should be noted that the inner boat basin was completed in 1972 and, therefore, has only been exposed to one significant tsunami event since it's construction; the subject November 2006 tsunami which resulted in substantially damaging the inner boat basin. The November 2006 tsunami was determined by the Gerwick Study to be equivalent to a 15-year event. Of the four significant tsunamis in the last 60 years, two exceed the 2006 tsunami in strength and the third is very close to the magnitude of the 2006 tsunami. (The fourth tsunami is the 2006 tsunami.)

Choosing an alternative with less than a 50-year tsunami design event would not significantly affect the mitigation measures or conditions related to the actual construction activities. Constructing an alternative with less than a 50-year tsunami design is feasible if the permitting agencies specifically in their approval actions allow a less than 50-year tsunami event as the basis for the design. Choosing an alternative with a less than 50-year tsunami design event would expose the public investment in the inner boat basin rebuild to a much higher risk of damage from subsequent tsunamis and, therefore, create an unnecessary additional future cost of public funds. Based on the information above, a design which does not address a 50-year tsunami event is not recommended by the Harbor District's consulting engineers; Stover Engineering and Ben C. Gerwick, Inc.

**7.6 No Action Alternative** [24 CFR 58.40(e)] (Discuss the benefits and adverse impacts to the human environment of not implementing the preferred alternative).

The No Action Alternative (No Project Alternative) consists of leaving the marina in its present condition, partially functional with deteriorated and damaged floats and pilings. Under this alternative, both the potentially beneficial and adverse impacts of the proposed project would be avoided. Adverse impacts which would be avoided include short term impacts related to project construction such as air emissions associated with construction equipment, elevated ambient noise levels, potential for sediment generation, and endangered species impacts. It should be noted, however, that the magnitude of these adverse impacts associated with the proposed project would be less than significant with the mitigation measures recommended. Thus, the No Action Alternative would not avoid any significant environmental impacts, because none are expected if the proposed rehabilitation of the inner boat basin takes place.

The No Action Alternative would not meet the goals and objectives of the proposed project which are to provide the necessary infrastructure (water dependent marina) to retain the 182 FTE jobs at risk under the present conditions of the tsunami damaged inner boat basin.

**7.7 Mitigation Measures Recommended** [24 CFR 58.40(d), 40 CFR 1508.20] (Recommend feasible ways in which the proposal or external factors relating to the proposal should be modified in order to eliminate or minimize adverse environmental impacts.)

1. A Storm Water Pollution Prevention Plan, Erosion Control Plan, a Hazardous Materials Management/Spill Response Plan, and related BMPs will be required of the contractor or contractors to reduce, to the maximum extent possible, the volume, velocity, and pollutant load of storm water and dry weather flows from leaving the project site during construction and from the staging area during construction activity.
2. At all times during construction activities, the contractor or contractors shall minimize the area disturbed by excavation, grading, or earth moving (if any) to prevent excessive amounts of dust. During periods of high winds (i.e. wind speed sufficient to cause fugitive dust to impact adjacent properties) the contractor or contractors shall cover or treat exposed soils areas and active portions of the construction site to prevent fugitive dust.

3. Throughout construction, the contractor or contractors shall sweep adjacent paved areas sufficient to keep any visible soil material and/or sand from the construction activities from accumulating on the adjacent paved areas.
4. All trucks hauling graded or excavated material offsite, if any, shall be required to cover their loads as required by the California Vehicle Code Sec. 23114, with special attention to preventing spills onto public streets, roads, or highways.
5. The contractor or contractors shall ensure that all construction equipment is maintained and tuned to meet applicable EPA and CARB emission requirements for the duration of the construction activities.
6. The contractor or contractors shall minimize the number of vehicles and equipment operating on site at the same time.
7. Construction equipment shall be properly muffled and shrouded to minimize noise levels and maintained to prevent contamination of soil or water from external grease and oil or from leaking hydraulic fluid, fuel, oil, or grease.
8. All construction activities in the water of the inner boat basin shall be conducted only between July 1 through October 15 of each work year.
9. Hours of construction activity shall be limited to the hours of 7:00 a.m. to 7:00 p.m. on weekdays and on Saturdays and 8:00 am to 5:00 pm on Sundays. Work on state holidays is not allowed without prior approval of the Harbor.
10. Area C on the Gedik maps will be temporarily fenced between the project area and the sensitive area to prevent trampling, vehicle activity, stockpiling activities, or other construction activities. Installation of the temporary fence will be monitored by a biological monitor.
11. All materials placed in the water of the inner boat basin, such as pilings, grouting, and floats shall be nontoxic.
12. All debris, materials, damaged and destroyed items, sediment, and other materials removed from the inner boat basin shall be disposed of at an approved disposal site.
13. The project will be designed to comply with Section 21.45.050 A.3 and Section 21.45.050 A.3.b of Chapter 21.45 "Flood Damage Prevention" of the Del Norte County Code. As non-residential construction, the structural components will be capable of resisting hydrostatic and hydrodynamic loads and effects of buoyancy, and will be certified by a registered civil engineer that the standards of these sections are met.

### 7.8 Additional Studies Performed

- Final Biological Assessment for NMFS Inner Basin Sea Wall Repair Project, Crescent City Harbor District, FEMA-1628-DR-CA, PW #1387 April 2007
- A Biological Report for Crescent City Harbor District Master Plan, prepared by Gedik BioLOGICAL Associates, August 2005
- Final Mitigated Negative Declaration, Crescent City Harbor District Harbor Master Plan, SCH# 2005112008 December 2005
- Dock Layout Options – Inner Boat Basin, a report by Stover Engineering Dated February 12, 2010
- Crescent City Harbor Rehabilitation Tsunami Study, prepared by Ben C. Gerwick, Inc. and Stover Engineering dated April 2010 (Executive Summary).

- Harbor District Master Plan (January 2006) prepared by RRM Design Group
- Harbor District Master Plan Traffic study prepared by W-Trans

### 7.9 List of Sources, Agencies and Persons Consulted [40 CFR 1508.9(b)]

- Designated Sole Source Aquifers in EPA Region IX http://www.epa.gov/cgi-bin
- National Wild & Scenic Rivers Map http://www.rivers.gov/maps
- Crescent City, Calif. and Sister Rocks Quadrangle 7.5 min. quadrangle maps published by USGS
- California Department of Fish and Game (CDFG) Natural Diversity Database (CNDDB)
- Flood Insurance Rate Maps (panel numbers 0050E, 0205E, 0210E, 2015E, 0218E, 0220E, and 0331E) for Del Norte County prepared by the Federal Emergency Management Agency
- North Coast Unified Air Quality Management District (NCUAQMD) Particulate Matter Attainment Plan 1995
- USFWS Maps of Coastal Barrier Resources System fws.gov/habitatconservation/coastal_barrier.html
- U.S. Department of Housing and Urban Development HUDnoise.com
- California Employment Development Department Labor Market Information Division (April 16, 2010 Industry Employment & Labor Force March 2009 Benchmark)
- Richard Young, CEO, Crescent City Harbor District
- Ms. Heidi Kunstal, Deputy Director of Building and Planning, Del Norte County
- Mr. Randy Hooper, Planner, Building and Planning Division of Del Norte County
- James R. Baskin, Coastal Planner, California Coastal Commission North Coast District Office
- Steve Wakefield, Fire Chief of Crescent Fire Protection District and Fire Chief for the City of Crescent City
- Paul Mc Andrews, Facilities Manager, Crescent City Harbor District
- James Bernard, Airport Director, Del Norte County Regional Airport
- Rodney Jahn, Deputy Superintendent, Business Services Del Norte Unified School District
- Eugene Suksi, Chief Executive Officer Sutter Coast Hospital
- Gary Blatnick, Director of Health and Social Services , Del Norte County
- Kevin Hendrick, Director, Del Norte Solid Waste Management Authority
- James Barnts, Public Works Director, City of Crescent City
- Dean Wilson, Sheriff, Del Norte County,
- John W. Pritchett, General Manager, Del Norte Ambulance
- Dave Imper, Ecologist, USFWS, Arcata Fish & Wildlife Service Office
- Ted Trenkwalder, Ben C. Gerwick, Inc.
- Dale Miller, Chairman, Elk Valley Rancheria
- Vicky Bates, Coordinator, North Coastal Information Center, California Historical Resources Information System
- *Building Tsunami-Resilient Communities in Humboldt County, California.* Lori Dengler, Troy Nicolini, Dan Larkin, Vicki Ozaki. Proceeding of Solution to Coastal Disasters: Tsunamis 2008

Conference, April 13-16, 2008 in Turtle Bay, Oahu, Hawaii. Sponsored by COPRI of ASCE, National Oceanic and Atmospheric Administration (NOAA), and US Geologic Survey (USGS).

- *Modeling Far-Field Tsunamis for California Ports and Harbors.* Jose Borrero, Burak Uslu, Costas Synolakis, and Vasily V. Titov. Coastal Engineering 2006, Proceedings of the 30th International Conference, San Diego, California, USA, 3-8 September, 2006.
- *Tsunamis Affecting the West Coast of the United States, 1806-1992.* James F. Lander, University of Colorado, Cooperative Institute for Research in Environmental Sciences (CIRES); Patricia A. Lockridge, NOAA, National Geophysical Data Center; Michael J. Kozuch, University of Colorado, CIRES, and Department of Geological Sciences. United States Department of Commerce, National Oceanic and Atmospheric Administration. National Environmental Satellite, Data, and Information Service, December, 1993.
- *Tsunami Hazards: FEMA Coastal Flood Hazard Analysis and Mapping Guidelines Focused Study Report.* Shyamal Chowdhury, Eric Geist, Frank Gonzalez, Robert Macarthur, Costas Synolakis. February, 2005.
- *Protection of Crescent City California from Tsunami Waves.* Robert L. Wiegel March 5, 1965
- Hurricane Preparedness Guidelines for Marinas. Section II. Marinal Hurricane Design Considerations.
- http://chps.sam.usace.army.mil/USHESDATA/FEMA/Marinas/Design.pdf
- 

Figure 1

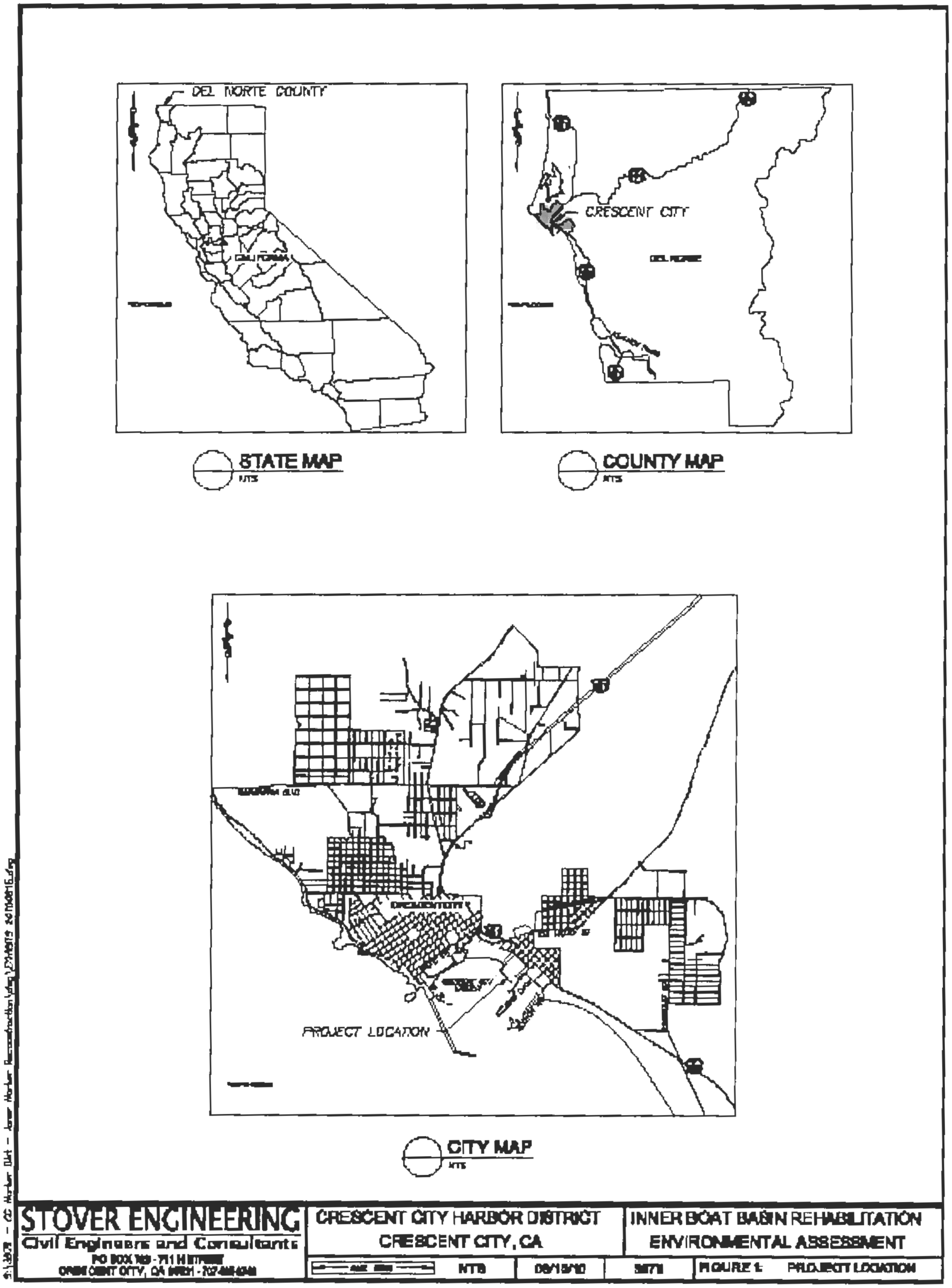
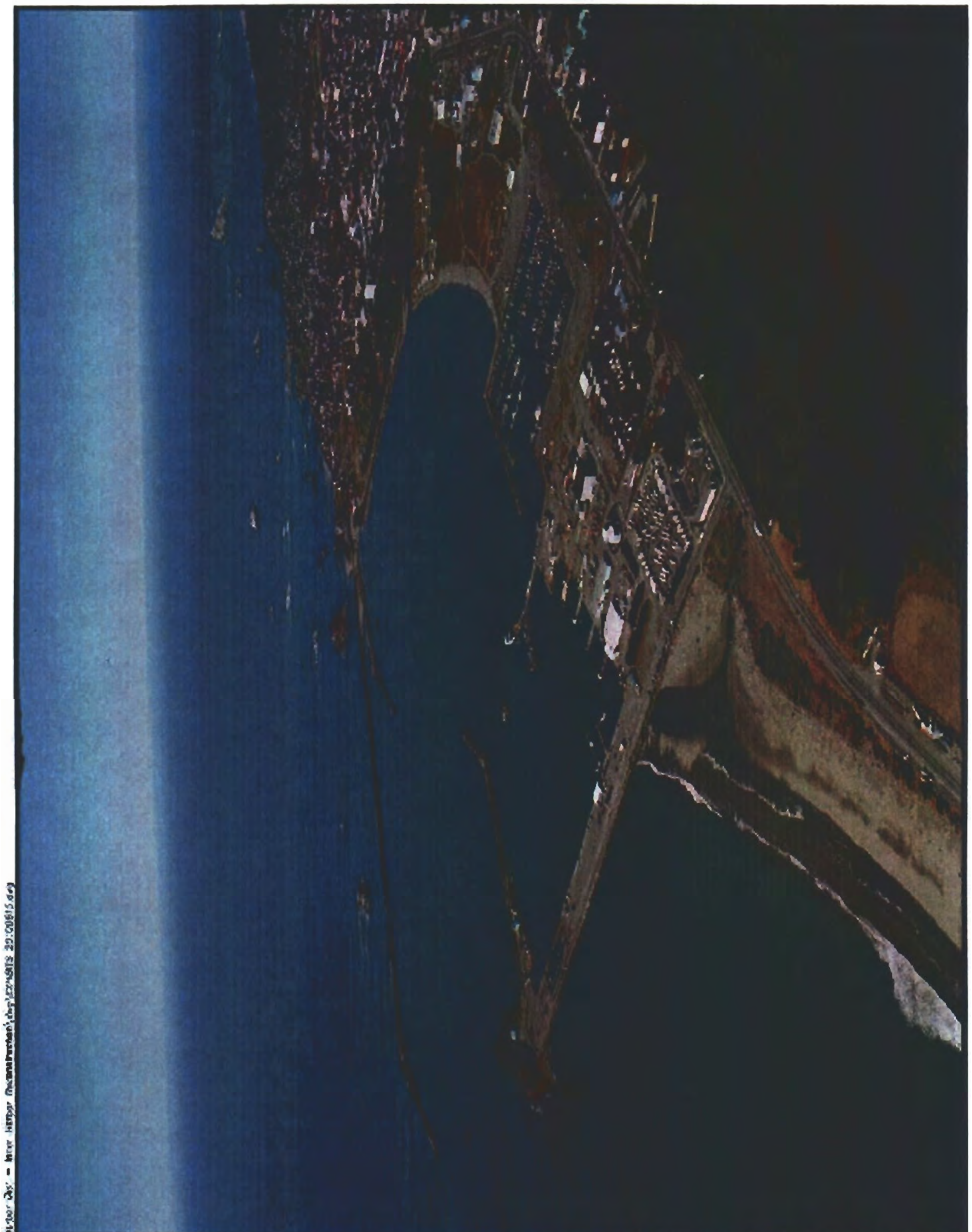

DEL NORTE COUNTY
STATE MAP
NTS
CRESCENT CITY
COUNTY MAP
NTS
PROJECT LOCATION
CITY MAP
NTS
STOVER ENGINEERING
Civil Engineers and Consultants
CRESCENT CITY HARBOR DISTRICT
CRESCENT CITY, CA
INNER BOAT BASIN REHABILITATION
ENVIRONMENTAL ASSESSMENT
NTS
FIGURE 1: PROJECT LOCATION

**Figure 2**


| STOVER ENGINEERING<br>Civil Engineers and Consultants | CRESCENT CITY HARBOR DISTRICT<br>CRESCENT CITY, CA | | | INNER BOAT BASIN REHABILITATION<br>ENVIRONMENTAL ASSESSMENT | |
|---|---|---|---|---|---|
| | | NTS | | FIGURE 2 | STAGING AREA |

**Photo 1**

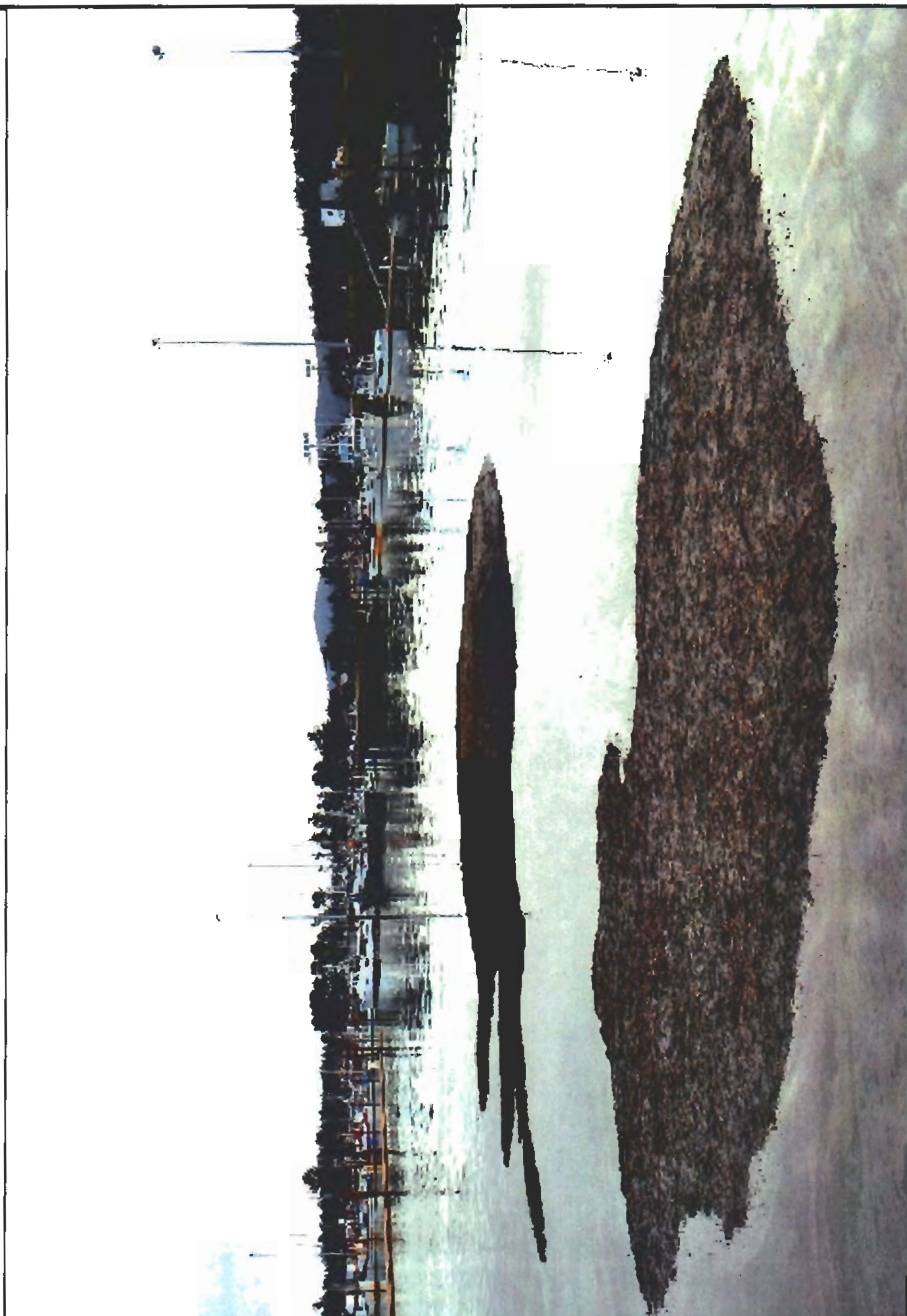


| | | | | |
|---|---|---|---|---|
| STOVER ENGINEERING<br>Civil Engineers and Consultants<br>CRESCENT CITY, CA | CRESCENT CITY HARBOR DISTRICT<br>CRESCENT CITY, CA | | INNER BOAT BASIN REHABILITATION<br>ENVIRONMENTAL ASSESSMENT | |
| | NTS | 06/29/10 | 3679 | PHOTO 1: CRESCENT CITY HARBOR |

**Figure 3**

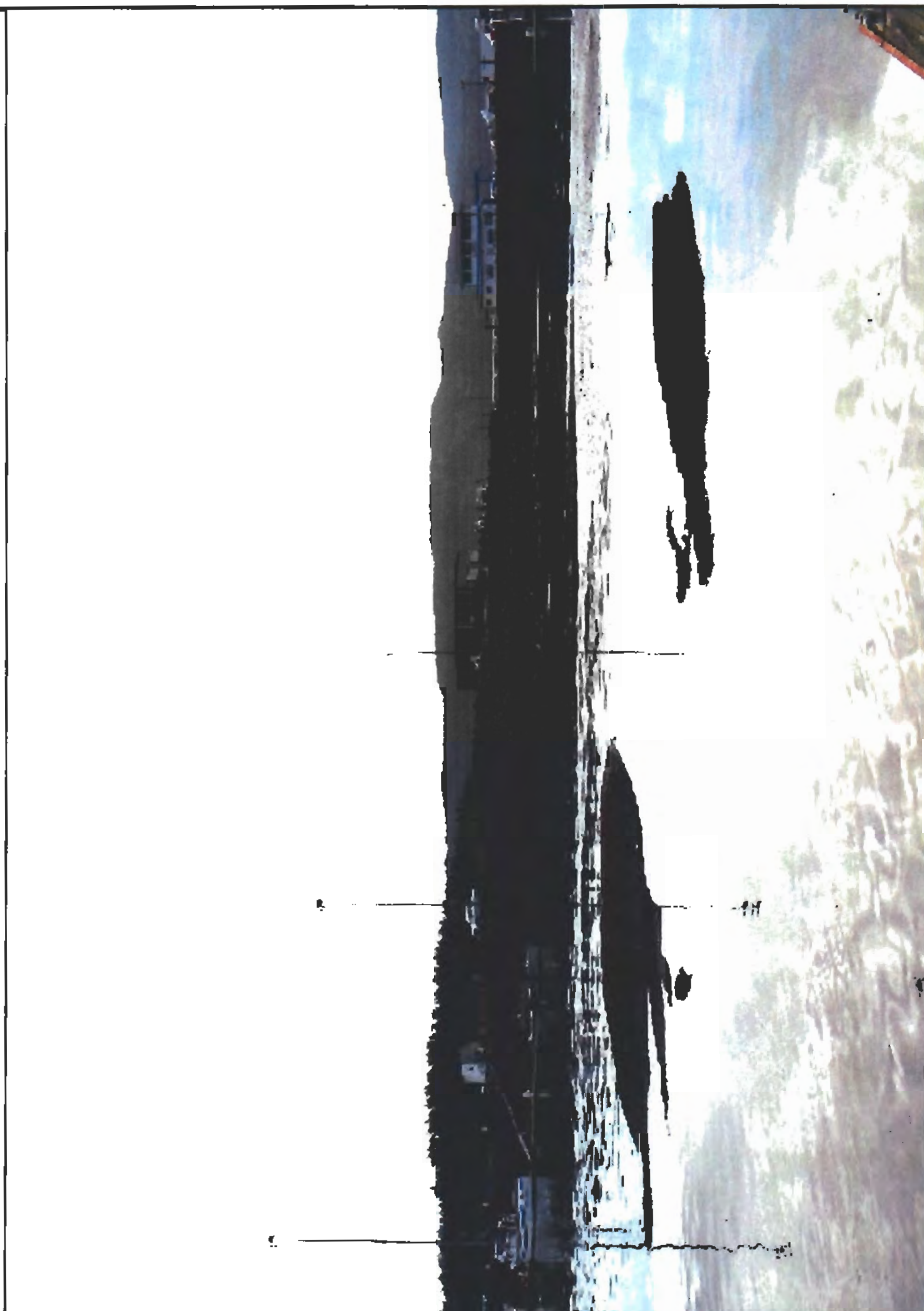

STOVER ENGINEERING
Civil Engineers and Consultants
CRESCENT CITY HARBOR DISTRICT
CRESCENT CITY, CA
INNER BOAT BASIN REHABILITATION
ENVIRONMENTAL ASSESSMENT
NTS
PROPOSED LAYOUT

Photo 2



| STOVER ENGINEERING<br>Civil Engineers and Consultants | CRESCENT CITY HARBOR DISTRICT<br>CRESCENT CITY, CA | INNER BOAT BASIN REHABILITATION<br>ENVIRONMENTAL ASSESSMENT |
|---|---|---|
|  | NTS | PHOTO 2: SAND ISLANDS |

Photo 3



| | | |
|---|---|---|
| **STOVER ENGINEERING** Civil Engineers and Consultants | CRESCENT CITY HARBOR DISTRICT CRESCENT CITY, CA | INNER BOAT BASIN REHABILITATION ENVIRONMENTAL ASSESSMENT |
| | NTS | PHOTO 3: SAND ISLANDS |

**Photo 4**


ACCRUED SAND ISLANDS
(VISIBLE AT MINUS TIDES)
STOVER ENGINEERING
Civil Engineers and Consultants
CRESCENT CITY HARBOR DISTRICT
CRESCENT CITY, CA
INNER BOAT BASIN REHABILITATION
ENVIRONMENTAL ASSESSMENT
PHOTO-4: SAND ISLANDS

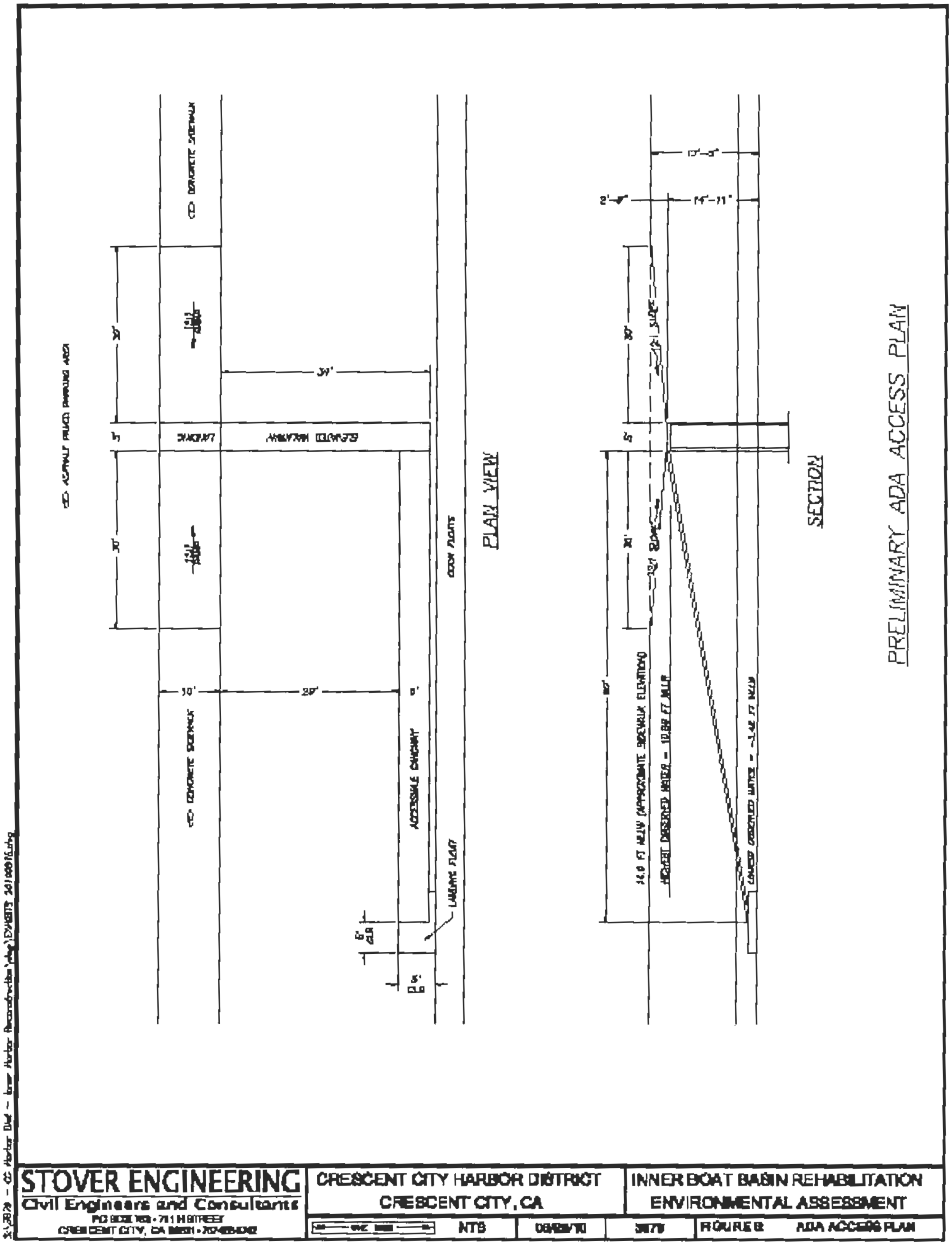
Figure 4


EXTENSIVE REPAIRS
SPOT REPAIRS
STOVER ENGINEERING
Civil Engineers and Consultants
CRESCENT CITY HARBOR DISTRICT
CRESCENT CITY, CA
INNER BOAT BASIN REHABILITATION
ENVIRONMENTAL ASSESSMENT
NTS
FIGURE 4

**Figure 5**

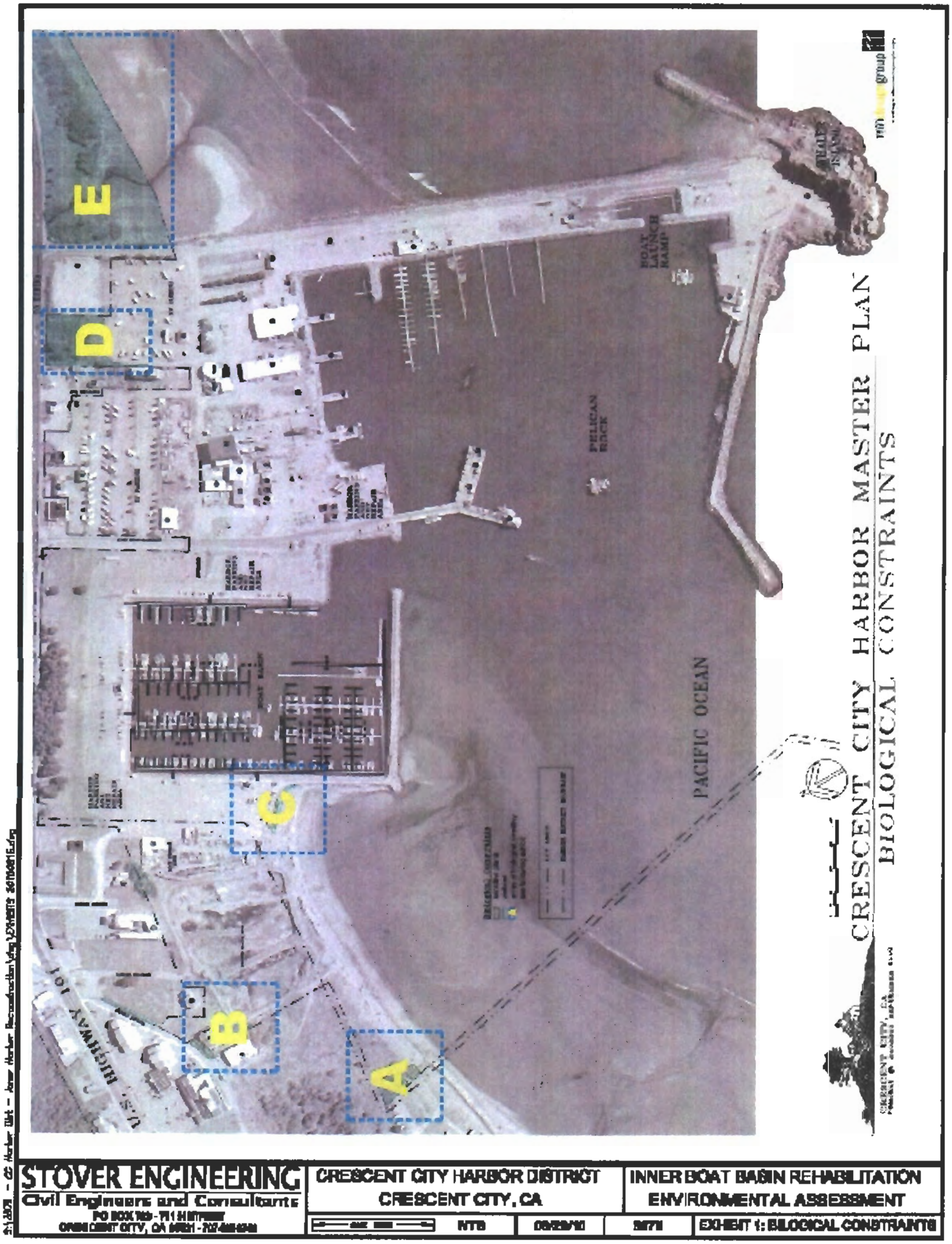

ADA
ADA
ADA
ADA
ADA COMPLIANT GANGWAY LOCATIONS: ADA
STOVER ENGINEERING
Civil Engineers and Consultants
CRESCENT CITY HARBOR DISTRICT
CRESCENT CITY, CA
INNER BOAT BASIN REHABILITATION
ENVIRONMENTAL ASSESSMENT
NTS
ADA RAMPS

## Figure 6



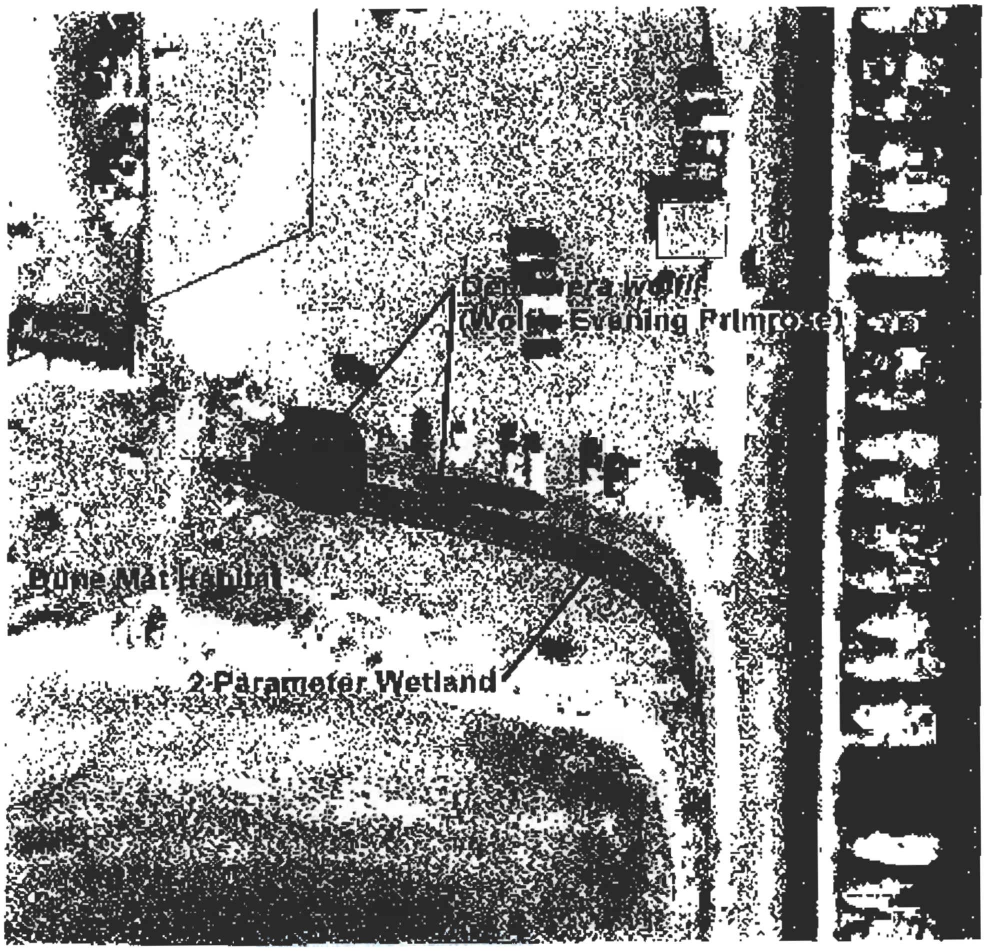
PRELIMINARY ADA ACCESS PLAN
PLAN VIEW
SECTION
STOVER ENGINEERING
Civil Engineers and Consultants
CRESCENT CITY HARBOR DISTRICT
CRESCENT CITY, CA
INNER BOAT BASIN REHABILITATION
ENVIRONMENTAL ASSESSMENT
NTS

**Exhibit 1**



A
B
C
D
E
U.S. HIGHWAY 101
PACIFIC OCEAN
PELICAN ROCK
BOAT LAUNCH RAMP
CRESCENT CITY HARBOR MASTER PLAN
BIOLOGICAL CONSTRAINTS
STOVER ENGINEERING
Civil Engineers and Consultants
CRESCENT CITY HARBOR DISTRICT
CRESCENT CITY, CA
INNER BOAT BASIN REHABILITATION
ENVIRONMENTAL ASSESSMENT
NTS
EXHIBIT 1: BIOLOGICAL CONSTRAINTS

**Exhibit 2**




**Area C**

| STOVER ENGINEERING<br>Civil Engineers and Consultants | CRESCENT CITY HARBOR DISTRICT<br>CRESCENT CITY, CA | | INNER BOAT BASIN REHABILITATION<br>ENVIRONMENTAL ASSESSMENT | |
|---|---|---|---|---|
| | NTS | 10/15/10 | 3578 | FIGURE EXHIBIT 2 |

**Exhibit 3**


RENNER PETROLEUM
WASTE OIL RECYCLING STORAGE TANKS
STOVER ENGINEERING
Civil Engineers and Consultants
CRESCENT CITY HARBOR DISTRICT
CRESCENT CITY, CA
INNER BOAT BASIN REHABILITATION
ENVIRONMENTAL ASSESSMENT

**Exhibit 4**

## Section IV
## Job Retention Chart

County of Del Norte and Crescent City Harbor District
Employment Projections - Jobs Retained by Business, 3/17/09

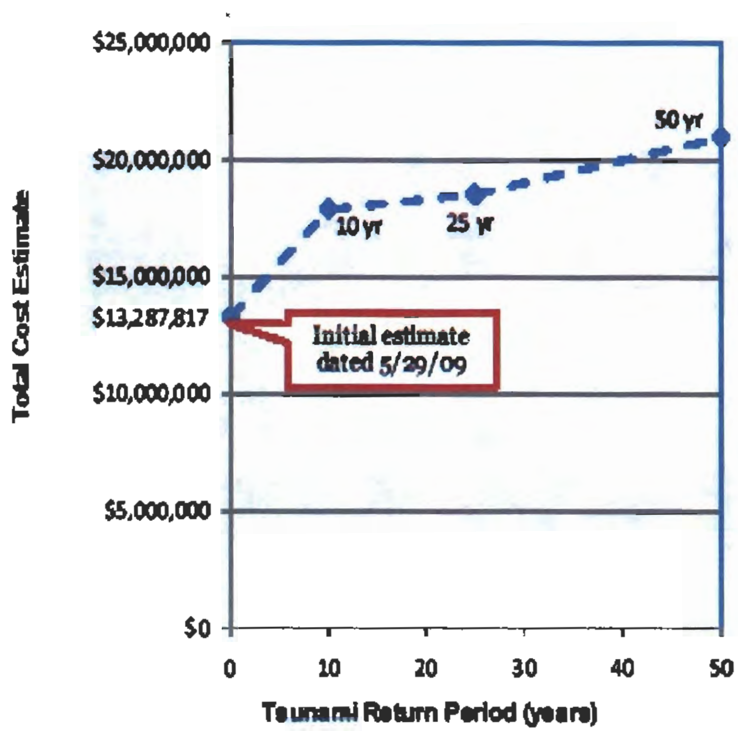
| | Participating Business | # of jobs FT | # of PT jobs (FTE equiv) |
|---|---|---|---|
| 1 | Fishing Vessel 1 | 4 | 0 |
| 2 | Fishing Vessel 2 | 5 | 0 |
| 3 | Fishing Vessel 3 | 3 | 0 |
| 4 | Fishing Vessel 4 | 3 | 0.5 |
| 5 | Fishing Vessel 5 | 3 | 0.25 |
| 6 | Fishing Vessel 6 | 5 | 0 |
| 7 | Fishing Vessel 7 | 3 | 1.5 |
| 8 | Fishing Vessel 8 | 5 | 0.25 |
| 9 | Fishing Vessel 9 | 5 | 0.25 |
| 10 | Fishing Vessel 10 | 4 | 0 |
| 11 | Fishing Vessel 11 | 4 | 0 |
| 12 | Fishing Vessel 12 | 5 | 1 |
| 13 | Fishing Vessel 13 | 3 | 0 |
| 14 | Fishing Vessel 14 | 5 | 1 |
| 15 | Fishing Vessel 15 | 5 | 1 |
| 16 | Fishing Vessel 16 | 2 | 0.5 |
| 17 | Fishing Vessel 17 | 3 | 0.5 |
| 18 | Fishing Vessel 18 | 3 | 0 |
| 19 | Fishing Vessel 19 | 3 | 0 |
| 20 | Fishing Vessel 20 | 4 | 0.5 |
| 21 | Fishing Vessel 21 | 5 | 0 |
| 22 | Fishing Vessel 22 | 5 | 0 |
| 23 | Fishing Vessel 23 | 5 | 0 |
| 24 | Fishing Vessel 24 | 4 | 0 |
| 25 | Fishing Vessel 25 | 3 | 0 |
| 26 | Fishing Vessel 26 | 3 | 0 |
| 27 | Fishing Vessel 27 | 3 | - |
| 28 | Fishing Vessel 28 | 4 | 1 |
| 29 | Fishing Vessel 29 | 3 | |
| 30 | Fishing Vessel 30 | 3 | |
| | **TOTAL FISHING VESSELS** | ***109*** | ***9.25*** |
| | | | |
| | **SUPPORT BUSINESSES** | | |
| 1 | Support Business 1 | 12 | 0 |
| 2 | Support Business 2 | 11 | 5 |
| 3 | Support Business 3 | 4 | 0 |
| 4 | Support Business 4 | 2 | 2 |
| 5 | Support Business 5 | 9 | 1 |
| 6 | Support Business 6 | 6 | 10 |
| 7 | Support Business 7 | 2 | 2 |
| | ***Total Support Business Jobs*** | ***46*** | ***20*** |
| | # of jobs retained | 155 | 29.25 |
| | All Non working Owner | -2 | |
| | TOTAL FTE's | | 182.25 |

(Total needed for $5M @$35,000 = 143 jobs retained)

57

Figure 7

# Return period and cost estimates




- 0 to 10 year return period
  - conventional concrete piles only
- 10 to 25 year return period
  - conventional concrete piles to 24"ϕ steel pipe piles at Dock H
- 25 to 50 year return period
  - conventional concrete piles to 24"ϕ steel pipe piles at Docks F & G
  - increase number and size of piles to 30"ϕ steel pipe piles with concrete infill and reinforcing bars at Dock H

June 14, 2010 Coastal group

Exhibit 5

# Risk analysis

Situation – Tsunami – Design – Model – Loads

- Design parameters
  - 50-year return period for design (F)
  - Design life for the marina is set to 25 years (n)
- Marina Hurricane Design Considerations
  - Recommended return period of 50 years for storm and surge

$$p\{F \text{ event in } n \text{ years}\} = 1 - \left(1 - \frac{1}{F}\right)^n$$

$$p = 1 - \left(1 - \frac{1}{50}\right)^{25} = 39.7\%$$

⇨ Generalize process...

Table 1

# Design life and risk of occurrence

25-yr service life and 25-yr return period is not acceptable

Service life (n)

| Return period (F) | 2 | 3 | 5 | 10 | 20 | 25 | 50 | 100 |
|---|---|---|---|---|---|---|---|---|
| 2 | 75% | 88% | 97% | 100% | 100% | 100% | 100% | 100% |
| 3 | 56% | 70% | 87% | 98% | 100% | 100% | 100% | 100% |
| 5 | 36% | 49% | 67% | 89% | 99% | 100% | 100% | 100% |
| 10 | 19% | 27% | 41% | 65% | 88% | 93% | 99% | 100% |
| 20 | 10% | 14% | 23% | 40% | 64% | 72% | 92% | 99% |
| 25 | 8% | 12% | 18% | 34% | 56% | 64% | 87% | 98% |
| 30 | 7% | 10% | 16% | 29% | 49% | 57% | 82% | 97% |
| 40 | 5% | 7% | 12% | 22% | 40% | 47% | 72% | 92% |
| 50 | 4% | 6% | 10% | 18% | 33% | 40% | 64% | 87% |
| 75 | 3% | 4% | 6% | 13% | 24% | 29% | 49% | 74% |
| 100 | 2% | 3% | 5% | 10% | 18% | 22% | 39% | 63% |

Equivalent risk level

Typical design combination

June 14, 2010 Coastal group

Stover Engineering

# Crescent City Harbor Rehabilitation

Tsunami Study

May 2010

Ben C. Gerwick, Inc.
a COWI company

**1300 Clay Street, 7th Floor**
**Oakland, CA 94612**
**Tel. 510 839 8972**
**Fax. 510 839 9715**
**www.gerwick.com**

Stover Engineering

# Crescent City Harbor Rehabilitation

## Tsunami Study

May 2010

| | |
|---|---|
| Report no. | 2009-39-01 |
| Issue no. | Final |
| Date of issue | 05-17-2010 |
| Prepared | MPJ, JNOT |
| Checked | SHMI |
| Approved | TWT |

REGISTERED PROFESSIONAL ENGINEER
MADS P. JORGENSEN
C 66369
EXP. 06/30/10
CIVIL
STATE OF CALIFORNIA

# Table of Contents

# 1 Executive Summary

Ben C. Gerwick, Inc. has been retained by Stover Engineering to provide engineering design and analyses for remediation of damage incurred to the marina facilities located in the Inner Boat Basin of the Crescent City Harbor.

## 1.1 Background

On November 15, 2006, a tsunami originating in the Kuril Islands across the Pacific struck Crescent City, which resulted in extensive damage to the marina located in the Inner Boat Basin. The total damages amounted to $9.2 million. Stover Engineering has been retained by the Crescent City Harbor District as part of the process of acquiring emergency funding to support rehabilitation of the marina.

## 1.2 Scope of Work

Ben C. Gerwick, Inc. has been retained to provide the detailed design for rehabilitation of the marina facilities, including fingers and floats, access ramps, and appurtenances. Part of the work includes analysis of the 2006 tsunami event and assessment of other such future events for the purpose of providing a basis for the structural engineering design needed for remediation of the marina floats and appurtenances.

## 1.3 Report Outline

The objective of the study is to determine design hydrodynamic loads for the floating and fixed structures of the rehabilitated marina at the Crescent City harbor. In "Tsunami Sources", general information on earthquake-generated waves are provided. Next, a design wave is defined in "Crescent City Tsunami History" and "Tsunami Wave Dynamics". Chapters "Numerical Model Setup" and "Analysis of Velocity Field" focus on the effect of long waves on currents and circulation in the marina. The definition of design load profiles concludes the analysis. These are presented in the last Chapter, "Basis of Design", in the form of peak loads imparted on elements of the marina floating and fixed structures.

## 1.4 Findings

Ben C. Gerwick has performed a wide range of numerical tests to uncover the origin and structure of the current patterns developing in and around the marina during tsunami events. By covering different cases pertaining to dredging conditions, a design velocity magnitude has been established corresponding to a 50-year return period tsunami event, which can be used towards design of piles and floating elements present in the inner boat basin.

## 1.5 Conclusions

Regarding offshore wave transformation within the region of the California/Oregon state line in general, and Crescent City in particular, the key findings are:

- The presence of the Mendocino Escarpment tends to direct wave energy toward Crescent City and the region around the California/Oregon state line;
- The escarpment, in essence a wall of partial height, reflects some of the wave energy carried by the tsunami to the coastline located north of Cape Mendocino.

Based on numerical modeling focusing on the inner boat basin, it has been determined that:

- Regions of high velocity magnitude develop peak velocities of up to 20 fps in the access channel and at the entrance to the inner boat basin;
- A pronounced clockwise circulation develops in the marina as a result of the tsunami surges.

Finally, in light of the hydrodynamic loads expected to develop due to these high velocities, it is concluded that:

- Variations in the velocity field near the floating structures due to dredging in the marina, in the access channel, or a combination hereof do not appreciably affect the design loads;
- The addition of a solid wall in place of a floating structure at Dock H, with the intent to reduce the peak velocity magnitude in its vicinity is not effective. The wall does little but displace the high velocities to another region of the marina, exposing other initially sheltered floating structures to strong currents.
- A more open layout with shallower floats, capable of vertical motion to ride out the tsunami waves and allow currents to vent underneath offers a more tsunami-resistant solution.

# 2 Project Information

## 2.1 Crescent City Harbor and Marina

Crescent City is located in the northern part of California, approximately 16 miles south of the Oregon State boundary. Commercial and sport fishing boats operate out of the harbor. Waterborne traffic in the harbor is in the receipt of gasoline and fuel oils. The long wharf in the western part of the harbor is used by fishing vessels to offload fish. Citizens Dock, a Y-shaped pier is located on the north side of the harbor (Figure 2.1). Several fish houses are on the pier, where fishing boats unload their catch. The Inner Boat Basin features mooring floats for commercial fishing boats and can accommodate about 250 boats, ref. [01].


*Figure 2.1 Aerial view of Crescent City Harbor and Marina (image courtesy of Crescent City Harbor District).*

## 2.2 Project Site

A dredged entrance channel leads north into the harbor to an inner harbor basin which extends around the outer end of the inner breakwater. In March 2008, the controlling depths were 14.2 feet in the entrance channel and 9.5 feet in the basin, ref. [01]. The western breakwater gives good protection from north-westerly winds for vessels anchored in the outer harbor, but the outer harbor is open to the south.

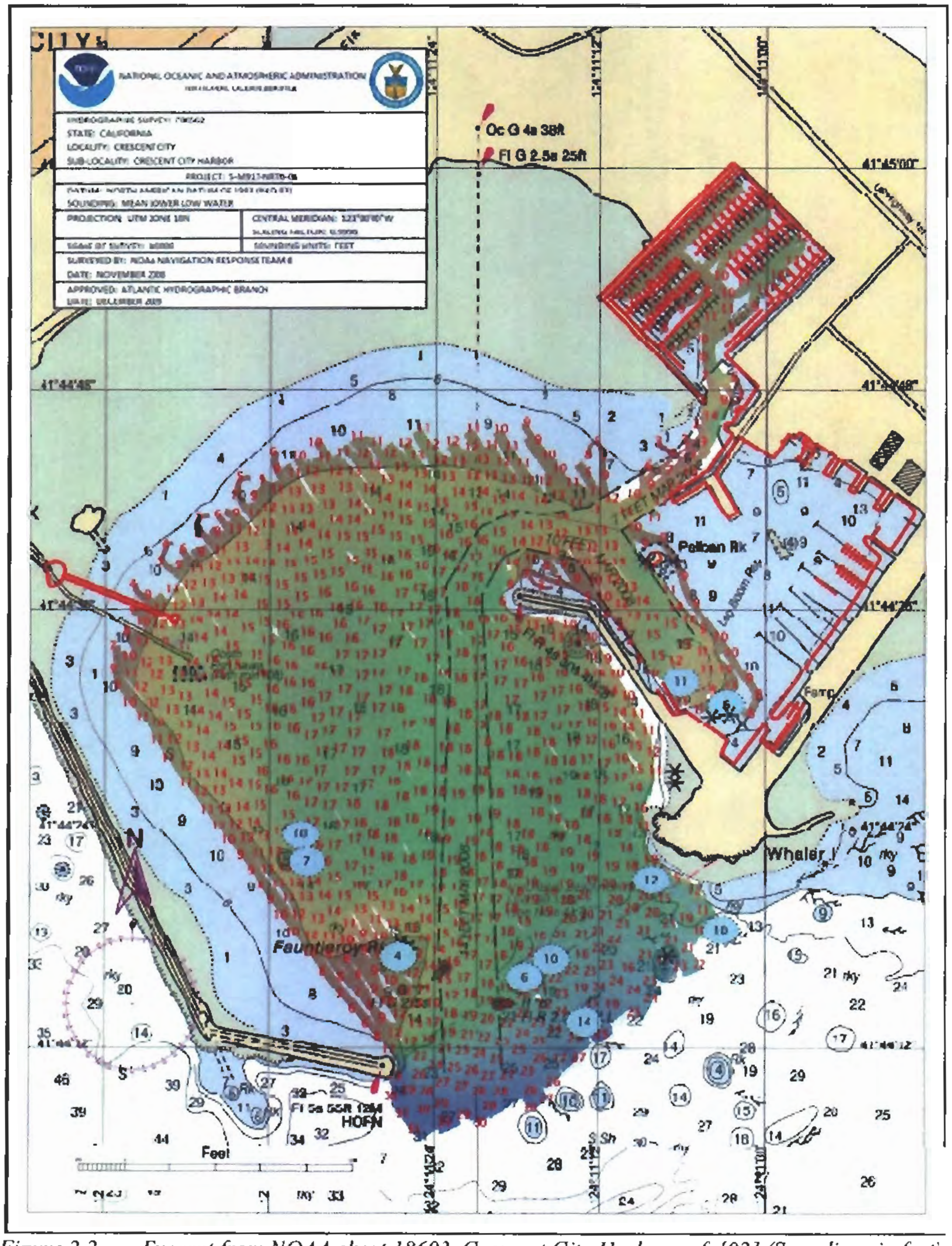



*Figure 2.2 Excerpt from NOAA chart 18603, Crescent City Harbor, ref. [02] (Soundings in feet).*

The approach to Crescent City Harbor is fraught with rocks and shoals. Round Rock is located south of the entrance to the harbor (
Figure 2.2). Mussel Rock, only a few feet high, is located 0.6 miles southeast of Round Rock. A rock, covered 7 feet, 700 yards to the south, pierces the free surface only in a heavy swell. Other covered rocks extend north to Whaler Island. Foul ground with many bare and covered rocks extends nearly a mile offshore along the low but rocky coast northwest of Crescent City Harbor for 3.5 miles to Point St. George, ref. [01].

# 3 Tsunami Sources

Crescent City is located on the Northern Coast of California and is exposed to tsunami events occurring along the Pacific Rim. This includes tsunami waves arising from subsea earthquakes in Alaska and along the Aleutian Islands; continuing along the Russian Kuril Islands down to Japan and back across the Pacific to the South American coast. Due to the frequent seismic and volcanic activity along this rim, the zone is also known as the Pacific Ring of Fire.


*Figure 3.1 Pacific Ring of Fire (red) along active faults around the Pacific.*

Located in Northern California close to the Oregon state line, Crescent City is less exposed to earthquakes originating south of the Equator. The primary exposure is due to earthquakes in the upper part of the Pacific along the Kuril Islands, Aleutian Islands, and Alaska. The Cascadia Subduction Zone extends from Cape Mendocino in Northern California past Oregon and Washington into British Columbia. The Gorda Plate making up its southern portion presents the nearest subsea fault region in proximity to Crescent City, capable of producing large earthquakes and potentially very large tsunamis.

Figure 3.2 shows the common fault types arising from subsea seismic activity. The Pacific is littered with a complex mix of ridges, fracture zones, seamounts, and island chains. It can be inferred from the fault types shown in the figure that crustal plates moving sideways to each other and plates moving away from each other won't produce large tsunami waves as no uplift of the water surface occurs. It is in connection with seismic activity along the subduction zones that significant tsunamis can result. As a subducting plate moves underneath a continental plate, friction can cause large stresses to build up. When these stresses are released and an earthquake occurs, the front of the continental plate may snap up, resulting in an immediate uplift of the ocean surface. This particular mechanism is the one that causes tsunami waves to form during an earthquake[1].

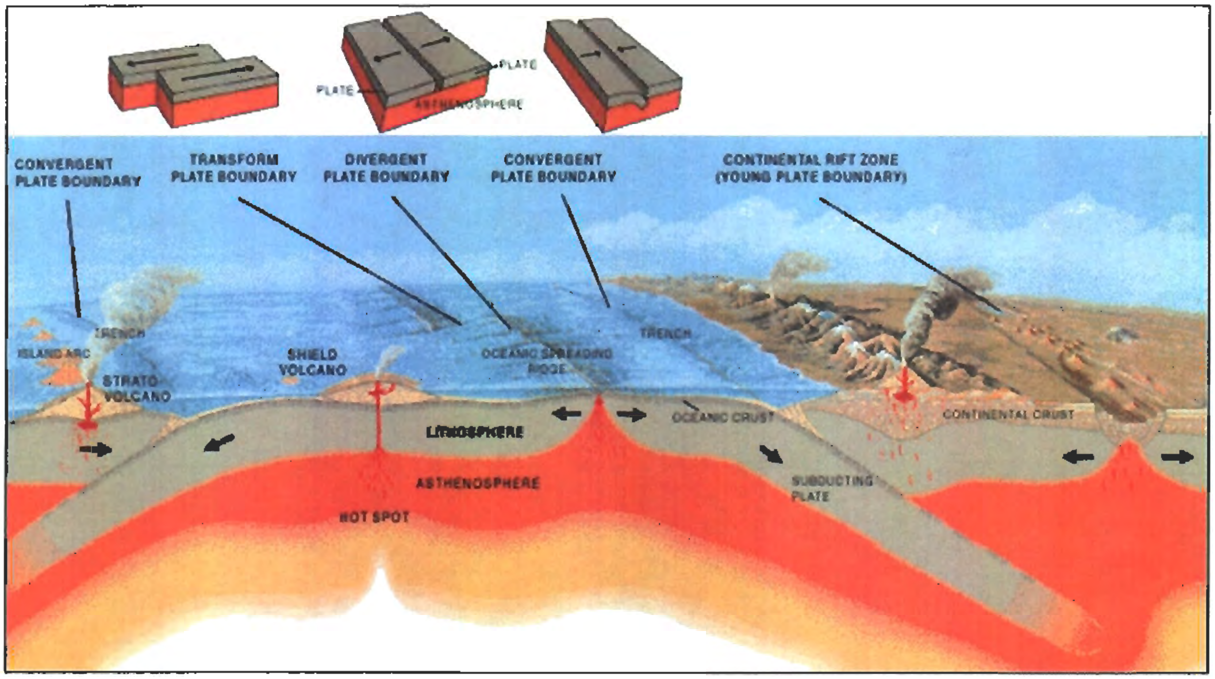



*Figure 3.2 Examples of fault types associated with oceanic ridges and subduction zones (image courtesy of USGS).*

Figure 3.3 shows the progression of events that lead to generation of tsunamis along the subduction zones around the Pacific Basin. The sequence of figures (left to right) show 1) Friction between subducting plate and overriding continental plate causes the plates to stick to each other; 2) Progressive forward motion of the subducting plate results in a slow distortion and uplift of the continental plate; 3) The local friction is overcome by the built-up stresses and the continental plate slides back over the subducting plate. The result is an earthquake and immediate uplift of the ocean off the coast; 4) The water displaced during the earthquake falls back to the ocean level, forming waves which propagate away from the fault zone. The waves coming towards shore may reach land within minutes and may cause devastation. The waves radiating offshore can travel across the Pacific Basin and cause devastation along the shorelines they encounter.

[1] Tsunamis may be triggered by other sources, such as large landslides, for example.

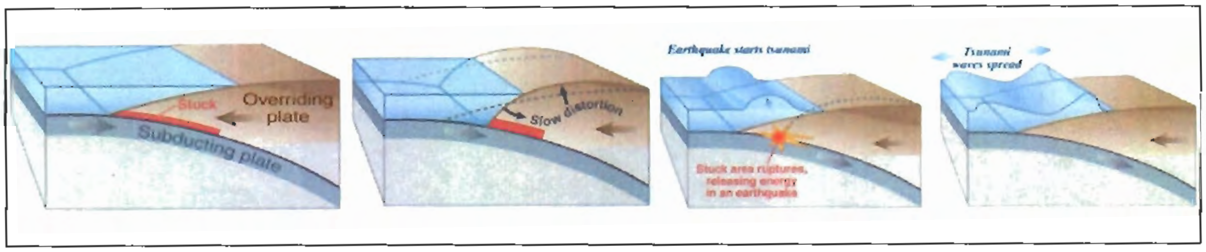



*Figure 3.3 Earthquakes and tsunami generation along subduction zones (reproduced from ref. [03]).*

Figure 3.4 shows the extent of the Cascadia Subduction Zone running along the coast from Vancouver Island to Cape Mendocino. Crescent City, located close to the state line between California and Oregon, is likely susceptible to tsunami waves arising from a partial rupture associated with seismic activity around the Gorda Plate (lower part of figure).

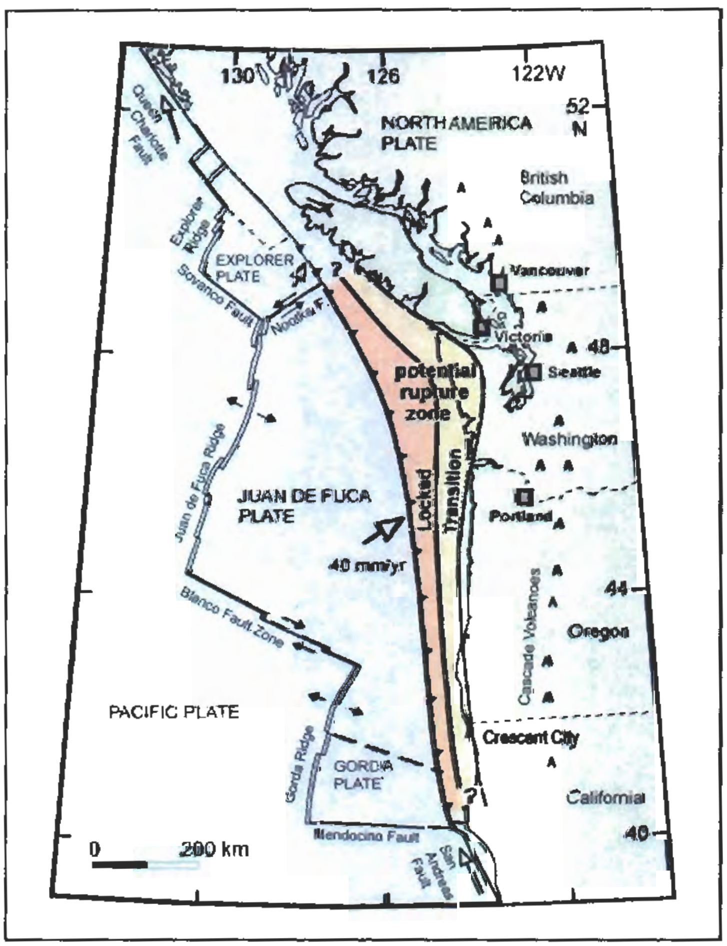



*Figure 3.4 Potential rupture zone along the Cascadia Subduction Zone (Image courtesy of Geological Survey of Canada, NRCan).*

# 4 Crescent City Tsunami History

The following Table 4.1 provides a log of historical tsunami events on record for Crescent City. Highlighted rows indicate stages of construction of the main harbor and marina.

| Date | Origin | Earthquake Magnitude | Wave Height [m] | Comments |
|---|---|---|---|---|
| 1/26/1700 | Cascadia | 8.7-9.2 | - | Widespread damage and submergence. |
| 1855 | | | | First wharf built on Whaler Island. |
| 1920 | | | | Initial construction of outer breakwater. |
| 4/1/1946 | Aleutian Isl. | 8.1 | 0.90 | Recorded. |
| 1950 | | | | Citizen's Dock Built. |
| 11/4/1952 | Kamchatka | 9.0 | 0.72[2] | 4 boats sunk, buoys moved. |
| 3/9/1957 | Aleutian Isl. | 8.6 | 0.70 | Recorded. |
| 5/22/1960 | Chile | 9.5 | 1.70 | $30,000 damage, 2 ships destroyed, others damaged. |
| 10/13/1963 | Kuril Isl. | 8.5 | 0.50 | Recorded. |
| 3/28/1964 | Alaska | 9.2 | 4.85 | $15M damage, 29 city blocks flooded, 11 fatalities, 35 injured. |
| 1964 | | | | Outer breakwater built up and reinforced. |
| 5/16/1968 | Japan | 8.2 | 0.60 | Recorded. |
| 1972 | | | | Inner Boat Basin and Marina Built. |
| 4/25/1992 | N. California | 7.2 | 0.60 | Oscillations in harbor, 4th wave highest. |
| 9/1/1994 | Mendocino | 7.0 | 0.14 | Recorded on tide gauge 45 minutes after earthquake. |
| 10/4/1994 | Kuril Isl. | 8.4 | 0.50 | Recorded. |
| 6/22/2001 | Peru | 8.4 | 0.40 | Recorded. |
| 12/26/2004 | Indonesia | 9.2 | 0.42 | Recorded. |
| 7/15/2005 | N. California | 7.2 | 0.10 | Recorded. |
| 11/15/2006 | Kuril Isl. | 8.3 | 0.88 | $9.2M damages to boat basin. |
| 1/13/2007 | Kuril Isl. | 8.1 | 0.23 | Recorded. |
| 9/30/2009 | Samoa | 8.0 | 0.30 | Recorded. |

*Table 4.1 Tsunami record event log for Crescent City, ref. [04], ref. [05].*

## 4.1 Accounts of Past Significant Tsunami Events at Crescent City

### 4.1.1 November 15, 2006 Kuril Islands Tsunami

According to published sources, ref. [06], the following approximate timeline of events can be outlined for the November 15, 2006, tsunami at Crescent City.

[2] Ref. [1] reports an initial rise of 0.5 m (1.7 feet), a maximum rise of 2.1 m (6.8 feet), and a wave period of 25 mins.

| Time [PST] | Event | Time after Quake [Hours:Minutes] |
|---|---|---|
| 3:14 AM | 8.3 $M_w$ earthquake takes place in the Kuril Island chain. | 0:00 hrs |
| 6:42 AM | Tsunami event bulletins are cancelled. | 3:28 hrs |
| 11:34 AM | Waves arrive along California Coast. | 8:20 hrs |
| 11:48 AM | First waves arrive at Crescent City | 8:34 hrs |
| 1:00 PM | Strong surges commence at Crescent City. | 9:46 hrs |
| 2:00 PM | Docks in marina begin to break up. | 10:46 hrs |
| 2:30 PM | Largest waves arrive. Strong current outflow. | 11:16 hrs |
| 3:40 PM | Currents are still strong. | 12:26 hrs |

*Table 4.2 Record of events of November 15, 2006, tsunami at Crescent City.*

Several hydrodynamic effects were observed during the tsunami event, including clockwise circulation of water in the harbor basin, and very strong current flows at the entrance to the Inner Boat Basin. These currents appeared to be the main cause of the damage incurred to the marina in the Inner Boat Basin. The Harbor Master observed the currents to be severe like a river flow. Flow velocities were estimated to 12 knots (13.8 mph), Ref. [06]. It was also noted that sea lions were unable to swim against the currents, which confirms that the currents were in excess of 10 knots (11.5 mph) (sea lions can advance at burst speeds of up to 25 mph, but generally swim at approximately 11 mph).

*Figure 4.1 Damage to floats in Inner Boat Basin as a result of the 2006 Kuril Islands tsunami event (courtesy of Prof. Lori Dengler, Humboldt State University).*

### 4.1.2 March 28, 1964 Alaskan Tsunami

On March 28, 1964, a magnitude 9.2 earthquake originating in the Prince William Sound in Alaska produced a tsunami that heavily affected the West Coast of the U.S. At Crescent City there were 11 fatalities and damage resulting from the tsunami exceeded $15M.

The first wave that arrived at Crescent City came at 11:39 PM just after high tide. The wave height was 4.8 feet and the wave period was about 29 minutes. The second wave observed was smaller than the initial wave, but the third wave was estimated to have been sixteen feet above MLLW and was at least a foot over Citizens Dock. According to Ref. [07], the drawdown following the third wave was described as exceptional and the water was reported to recede to 3/4 of a mile beyond the outer breakwater. Most of the damage occurred as the fourth and largest wave came in around 1:40 AM. The wave amounted to a height of 20.8 feet above MLLW, ref. [07]. Logs, vehicles, and debris carried by the waves augmented the damage done by the water.

The port facilities and 29 city blocks containing 172 business, twelve house trailers, and 91 homes were damaged or destroyed. Twenty-one boats were sunk and only a few boats escaped by taking to the open sea.

*Figure 4.2 Cars floated and stacked up by tsunami waters, ref. [07].*


*Figure 4.3* *View of Second Street looking west from L Street. Note typical debris in the foreground and buildings floated and moved into the street in the background, ref. [07].*

### 4.1.3 May 22, 1960 Chilean Tsunami

On May 22, 1960, a magnitude 9.5 earthquake off the coast of Chile produced a tsunami, which locally reached a wave height of 25 meters (82 feet). As the waves propagated across the Pacific they caused widespread damage. At Crescent City, three commercial fishing boats were sunk and some damage incurred to the dock facilities. Many tons of debris was left in the lower part of the harbor.

The tsunami waves arriving at Crescent City consisted of a number of 8.5 foot surges, followed by a 13-foot wave around noontime, which caused flooding in parts of the city to the southeast. Around midnight, another series of surges took place. Front Street was flooded from H Street to the east, and Second and Third Streets were flooded from I Street to the east. The southern portions of J, K and L Streets and the portion of Highway 101 coming into the city were also flooded. The flooding deposited logs and debris everywhere, thereby literally covering Front Street.


*Figure 4.4 Inundation at Crescent City's Citizens Dock caused by May 22, 1960 Chilean tsunami, ref. [07].*

The most severe damage was in the vicinity of Citizens Dock (See Figure 4.4). Three commercial fishing boats were sunk: the 50-ft (15.24 m) Ethyl G., the Ida Mae and the Andy N. The Andy N. had been beached for repairs and was picked up from the beach by a wave and floated into the basin where it sank. Other boats suffered considerable damage. The Ethyl G. and Ida Mae were moored fore and aft and were swamped when they drifted crosswise to the retreating current. Most other boat owners were able to loosen their boats from the moorings and ride out the waves within the harbor.

The tsunami surges caused relocation of sediments within the harbor. Soundings showed that twelve feet of sediments were deposited in some parts of the harbor. A steel pile retaining wall at Citizens Dock parking lot partially failed due to the scour of six to seven feet of sand from the seaward toe and increased hydrostatic pressure behind the walls during drawdown. A timber pile mooring dolphin located near the harbor side of the inner breakwater was carried away presumably as a result of scouring of sand at its base and the force of the currents.

### 4.1.4 November 4, 1952 Kamchatkan Tsunami

On November 4, 1952, a magnitude 9.0 earthquake occurred in Kamchatka, which produced a 42.6 ft (13 m) wave locally. Four boats capsized and sunk at Crescent City and 60-ton mooring buoys were moved. The wave was described as a "high tide", and it was reported that four strong surges came in beginning around 8 PM and produced currents estimated to run at 6 mph. Fishing boats tied fore and aft to their moorings would rise as high as the moorings permitted. The swift currents caught their keels and turned four boats completely over and sank them. A fifth boat was overturned but righted itself.

### 4.1.5 April 1, 1946 Aleutian Islands Tsunami

On April 1, 1946, a magnitude 8.6 earthquake took place in the Aleutian Islands and produced a 115-foot (35 m) tsunami wave locally. The tsunami was observed throughout the Pacific Basin. At Crescent City, a wave amplitude of three feet and a twelve minute period was recorded.

The event was notable due to the damage reported elsewhere around the Pacific Rim and Hawaii, and resulted in the creation of the Pacific Tsunami Warning Service, the development of tsunami travel time charts, and a focus on international research and cooperation.

### 4.1.6 January 26, 1700 Cascadia Tsunami

There is evidence in historical records from Japan that a disastrous tsunami, aptly named the Orphan Tsunami, encroached upon its shores on January 26 in the year 1700. Comprehensive research by USGS and the Geological Survey of Japan has uncovered that the tsunami was a result of an earthquake in the Cascadia Subduction Zone of North America. The magnitude of the earthquake ranged from 8.7 to 9.2, ref. [08]. At that time there was no written documentation of the event. However, stories from tribes of the native peoples of Cascadia provide accounts of events of "flooding from the sea", which may have been associated with tsunamis.

Ref. [08] estimates that the rupture along the Cascadia Subduction Zone extended about 680 miles (1,100 km) along the coast from Vancouver Island to Cape Mendocino. The quake caused the sea floor to rise several meters, while land near the coastline fell as much as 2 meters. The tsunami may have reached a height of as much as 33 feet (10 m) along parts of the Pacific Coast. Analysis of geological records reveals that seven such past events have occurred at intervals ranging from 200 to 1,000 years with an average of about 500 years, ref. [08]. It is not given that future seismic events along the Cascadia Subduction zone will produce a full rupture along the majority of the fault. It can also happen that ruptures occur along limited portions of the fault, producing earthquakes of lesser magnitude. Studies of future potential rupture scenarios on the Cascadia Fault can be found in ref. [09].

# 5 Tsunami Wave Dynamics

Due to their long wave periods, tsunami waves can be considered as small-amplitude, shallow-water waves, ref. [10] and [11]. The propagation speed of the initial wave disturbance at the site of the sub-sea earthquake can be obtained using $C = \sqrt{g \cdot d}$, where $C$ is the propagation speed of the wave, $g$ is the acceleration due to gravity, and $d$ is the ocean water depth. For example, for the April 1, 1946 tsunami it was found that the average wave speeds ranged from 375 to 490 miles per hour [12]. The travel time, $T$, between the origin and a given destination can be estimated as $T = L/C$ where $L$ is the distance between the two sites.

As the tsunami propagates across the ocean, its wave height may be less than a foot. However, as the tsunami wave front propagates into shallower water it slows down due to the decrease in water depth (see above equation for $C$). The offshore portion of the wave will be in deeper water and therefore catches up to the slowing wave front. The effect is that a mass of water builds up resulting in an increase of the wave height. This process is called shoaling and is illustrated in Figure 5.1. The process of shoaling may progress to a point where the wave becomes so tall and steep that it is no longer stable and curls over into a breaking wave or bore[3].

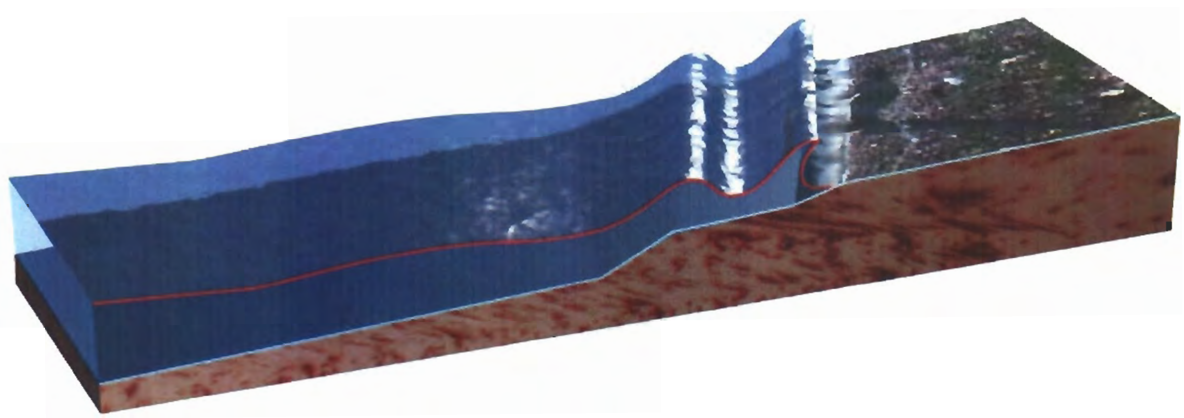


*Figure 5.1 Transformation of tsunami wave from offshore to near-shore due to shoaling (reproduced from www.wikipedia.org).*

Before fully addressing the problem of a tsunami wave propagating toward Crescent City, it is useful to first consider the basic principles that govern wave transformation. The simple shoaling of a shallow-water wave can be estimated by: $H_2 = H_1 \cdot \left(\frac{d_1}{d_2}\right)^{1/4}$, ref. [10], where $H_2$ is the wave height in shallow water, $H_1$ is the wave height in deeper water, $d_1$ is the water depth in deeper water and $d_2$ is the water depth in shallow water. As the wave passes over the coastal shelf, which represents a rela-

[3] In some coastal areas adjacent to deep open waters, large tsunami waves may not break and appear like a fast moving tidal bore.

tively abrupt change in water depth, a portion of the wave energy will be reflected back into deep water and the remainder will transition over the shelf into shallower water. The height of the transmitted wave, $H_t$, can be estimated by: $H_t = H_i \cdot \frac{2\sqrt{d_1}}{\sqrt{d_1}+\sqrt{d_2}}$, where $d_1$ is the initial water depth, $d_2$ the water depth under the transmitted wave, and $H_i$ the incident wave height.

A wave with a height of four inches propagating across the pacific may therefore increase to approximately two feet in height as it comes in across the coastal shelf into shallower water. It should be noted that the aforementioned method is approximate and cannot be used to estimate near-shore tsunami wave heights with a high degree of confidence as several important effects of wave dynamics are not taken into account. In fact, when examining findings of detailed computations of tsunami propagation such as Figure 5.5, it is evident that these simple methods only describe the rudimentary effects, while the overall picture presents a highly complex interaction between the tsunami waves, seabed topography, seamounts, and shorelines. Yet, these simple calculations are useful to estimate the scale of transformation that occurs as a tsunami wave approaches Crescent City.

## 5.1 Tsunami Travel Times

The simple relationship between the tsunami wave propagation speed and local water depth means that the travel time for a tsunami to reach a specific destination can be pre-determined with reasonable accuracy. Figure 5.2 from ref. [13] shows the time it takes for tsunami waves originating along the seismically active zones of the Pacific to arrive at Crescent City. It can be seen that the travel time for tsunamis originating in Alaska is 3-4 hours, from the Aleutian Islands 5-8 hours, Kamchatka Peninsula and Kuril Islands 8-9 hours, Japan 9-12 hours. Likewise, the travel time for tsunami originating along the South American coast ranges from 9 to 17 hours. The travel time for a tsunami generated along the Cascadia Subduction Zone running along the California, Oregon, and Washington coastlines would be less than 2 hours and as little as 30 minutes for a subsea quake near Crescent City.

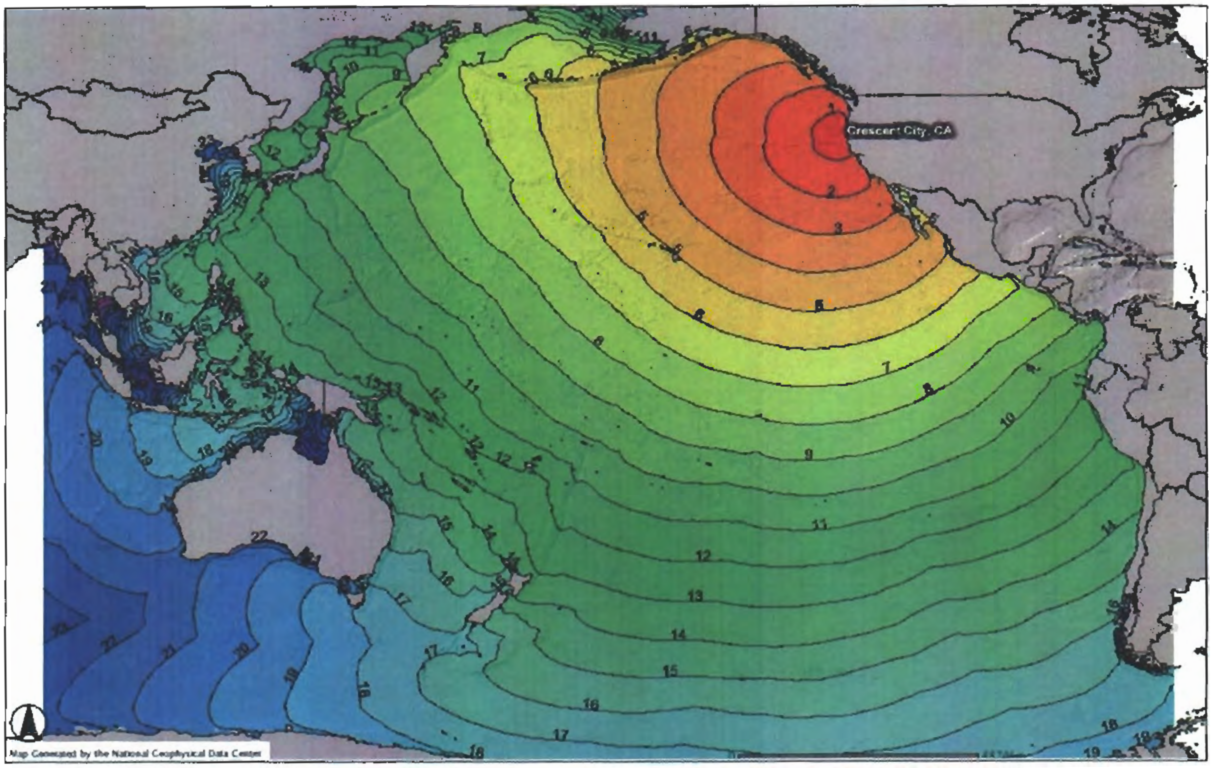



*Figure 5.2 Tsunami wave propagation times (in hours) for arrival at Crescent City, CA, ref. [13].*

## 5.2 Tsunami Phenomena affecting Crescent City

It has been observed in some cases that ports and harbors located in the lee of the *apparent* tsunami wave direct path experience higher waves than sites that are not sheltered. For example, along the California Coast, the bays that had the most protection from the direction of approach of the April 1, 1946, tsunami had the largest rise in water level. For example, at Monterey Bay there was practically no wave at the south side of the bay, but the water level rose 10 feet at Santa Cruz on the north side of the bay [12].

### 5.2.1 Offshore Focusing of Tsunami Wave Energy

In order to examine the propagation of tsunami waves and investigate effects of resonance, trapped waves and edge waves along the coastal shelf, a numerical model has been set up which encompasses the West Coast of the U.S. Figure 5.3 shows the main model domain and seabed topography utilized for propagation of tsunami waves from offshore to the coast. The model has been run with various angles of incidence for waves offshore associated with tsunamigenic events in Alaska, along the Aleutian Islands, and along the Kuril Islands.

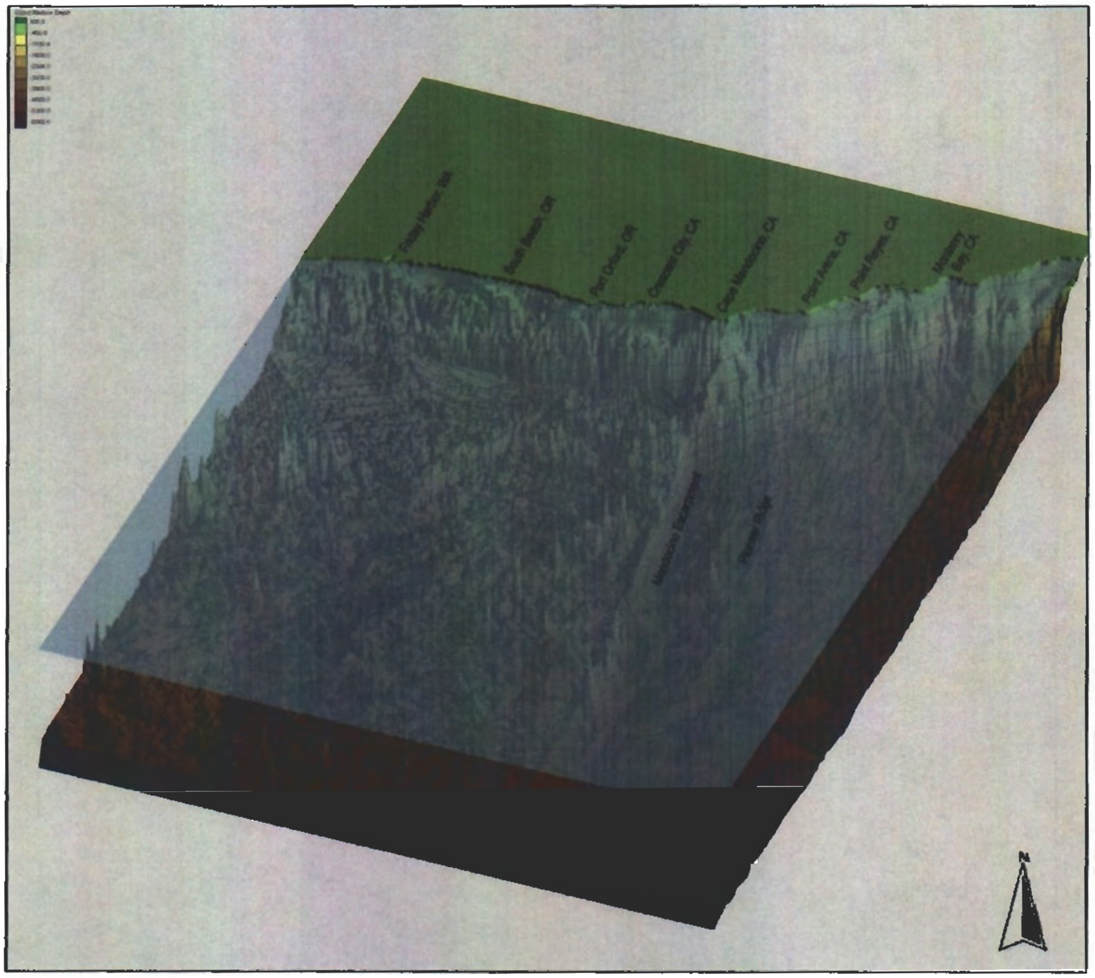



*Figure 5.3* *Seabed topography utilized for numerical model of U.S. West Coast (note vertical scale exaggerated to highlight features on seabed).*

Figure 5.4 provides an indication of the ocean wave dynamics for a tsunami approaching the West Coast of the U.S. from across the Pacific. The green area indicates the U.S. West Coast and land-mass, while the yellow and orange colors represent the offshore seabed topography. Overlain in black lines are contours of wave height for tsunami waves approaching from the west. It can be seen that a focusing of the tsunami wave energy takes place along the coastline between Cape Mendocino, CA and Port Orford, OR.

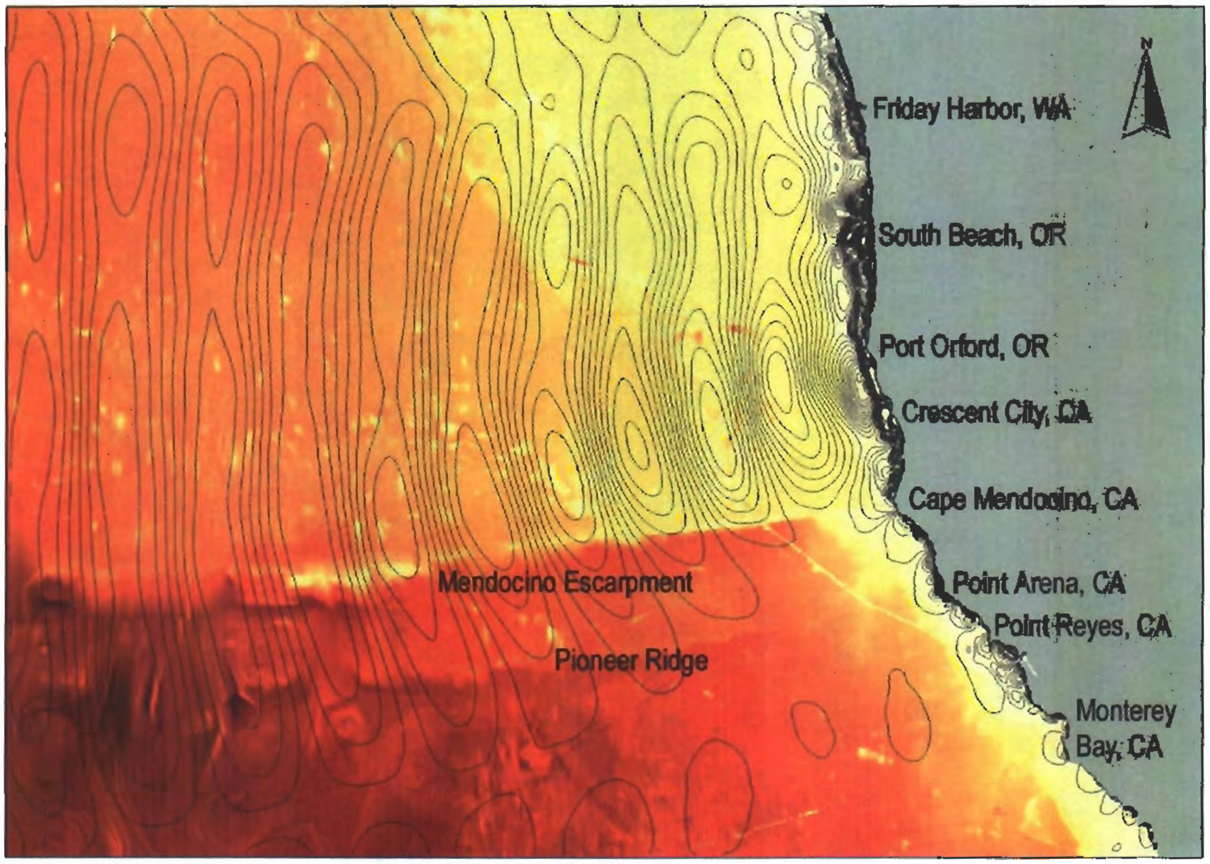



*Figure 5.4 Wave height contours and false color image of ocean seabed topography off U.S. West Coast.*

The focusing effect occurs due to the tsunami wave propagation being swifter south of the Mendocino Escarpment. In this area, indicated by deeper amber colors, the water depth is deeper than in the region north of the escarpment, indicated by the zone of yellow colors. The overall effect is that the portion of the incoming tsunami waves running south of the escarpment tend to turn north to impinge on Crescent City. The same effect cases a dispersion and reduction in tsunami wave energy impinging on the coast south of Cape Mendocino. Another effect is the rise in the seabed topography in the region of the Mendocino Escarpment. The escarpment is essentially a wall of partial height (see Figure 5.3), which causes some of the wave energy propagating from the northern regions to reflect back towards the coastline north of Cape Mendocino. Assuming that the escarpment reflection coefficient, $K_R$, can be taken as $K_R = \frac{1-\sqrt{h_2/h_1}}{1+\sqrt{h_2/h_1}}$, ref. [14], where $h_1$ is the water depth at the toe of the submerged slope and $h_2$ is the water depth at the crest of the slope, the estimated reflection of wave energy amounts to 12-19% of the incoming waves. Due to superposition of the incoming and reflected waves, this would lead to a general increase in wave heights in the region offshore from Crescent City. It is also possible that an increase in wave heights occurs due to a partial mach-stem effect as waves reflected off the escarpment merge with the incoming waves to form a wave front.

Similar findings were uncovered by Wiegel in his 1965 report on protection of Crescent City from tsunami waves, ref. [25]. Recent research conducted by the Tsunami Research Group at the University of Alaska Fairbanks, Institute of Marine Sciences, Physical Oceanography, ref. [15], ref. [16], has detailed these wave phenomena further. They also determined a delayed response for tsunami wave propagation towards Crescent City associated with the Koko Guyot and Hess Rise seamounts (for the November 2006 Kuril Islands tsunami). Other researchers have also found the presence of offshore volcanic ridges and fracture zones to be of importance in directing tsunami wave propagation towards Crescent City. Figure 5.5, which shows the maximum computed tsunami wave heights across the Pacific Basin for the November 15, 2006 Kuril Islands tsunami event, clearly shows a swath of larger waves reaching the area around Cape Mendocino and Crescent City.

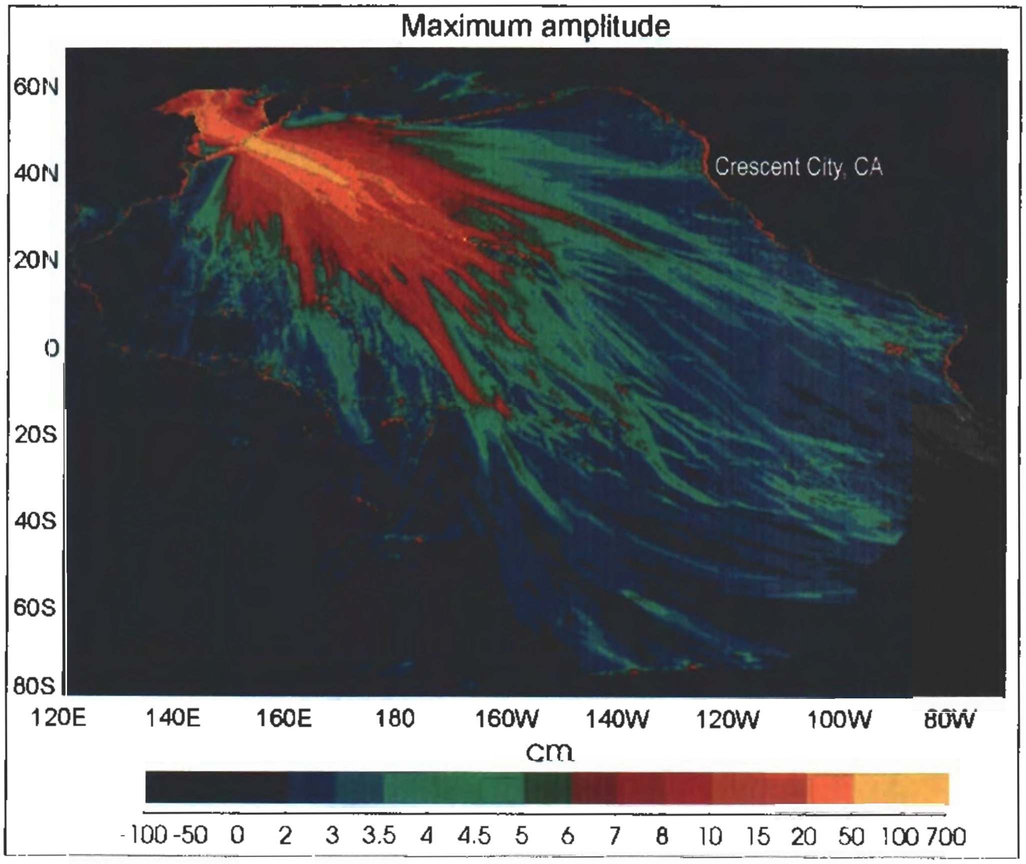



*Figure 5.5 Maximum tsunami wave amplitude across the Pacific Basin resulting from November 15 Kuril Islands tsunami (reproduced from ref. [15]).*

The same effect can be identified in research by others. In Figure 5.6 to Figure 5.9, reproduced from ref. [17], a focusing of tsunami wave energy around Crescent City is noticeable in most tsunami events occurring at sites along the northern Pacific Rim from Alaska, along the Aleutians, past Kamchatka and the Kuril Islands down to Japan. Most of these tsunami simulations clearly show a path of higher waves reaching Cape Mendocino and the area of Crescent City.

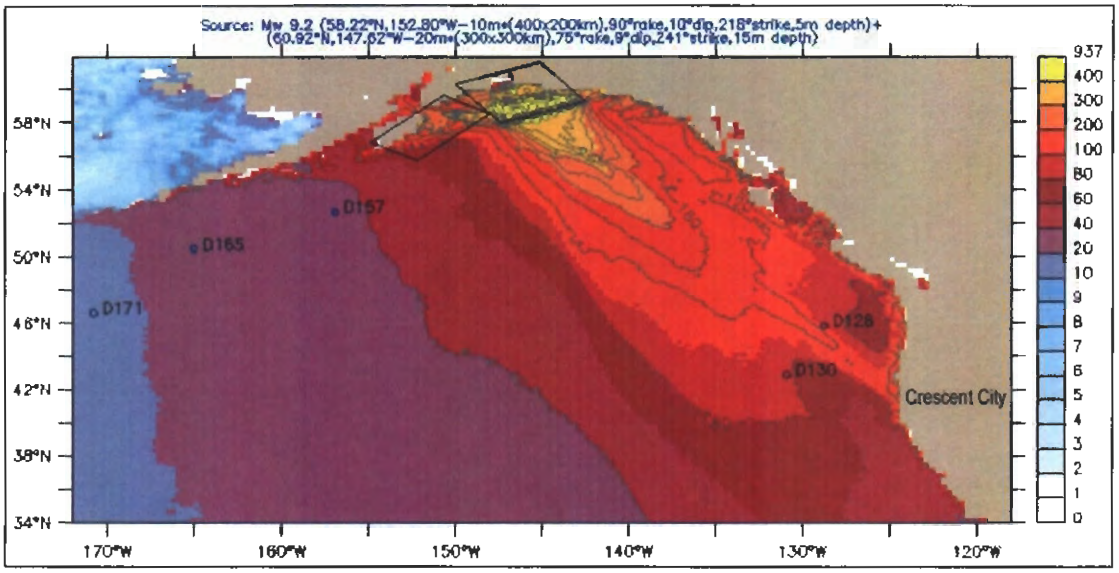



*Figure 5.6 Maximum tsunami wave heights (cm) resulting from magnitude 9.2, 1964 Alaskan Tsunami (reproduced from ref. [17]).*

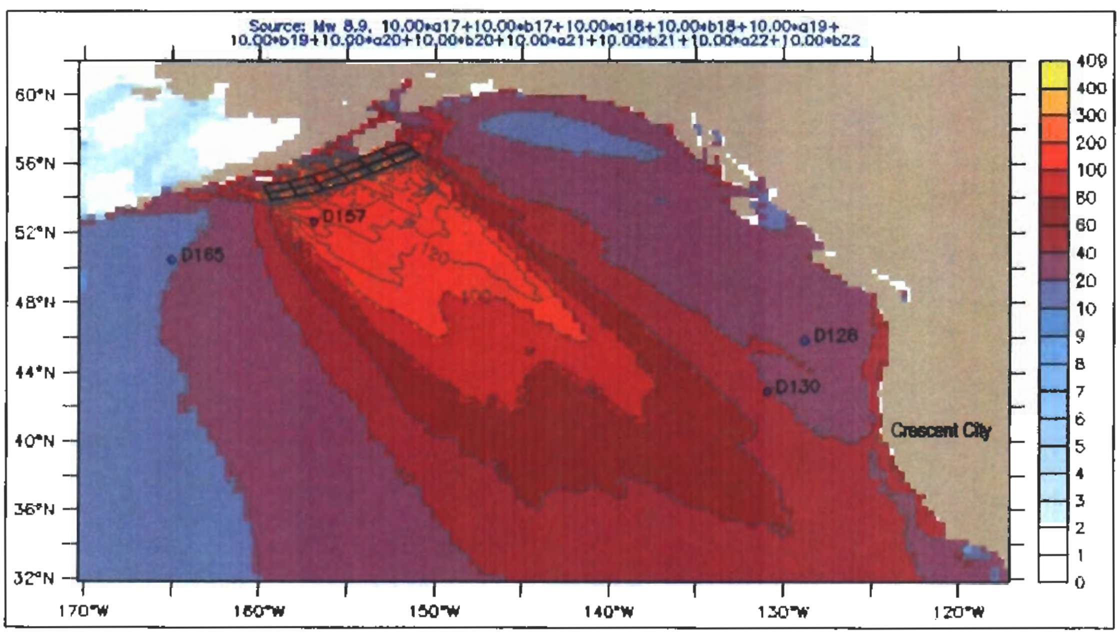



*Figure 5.7 Tsunami wave heights (cm) resulting from magnitude 8.9 earthquake along Aleutian Islands (reproduced from ref. [17]).*

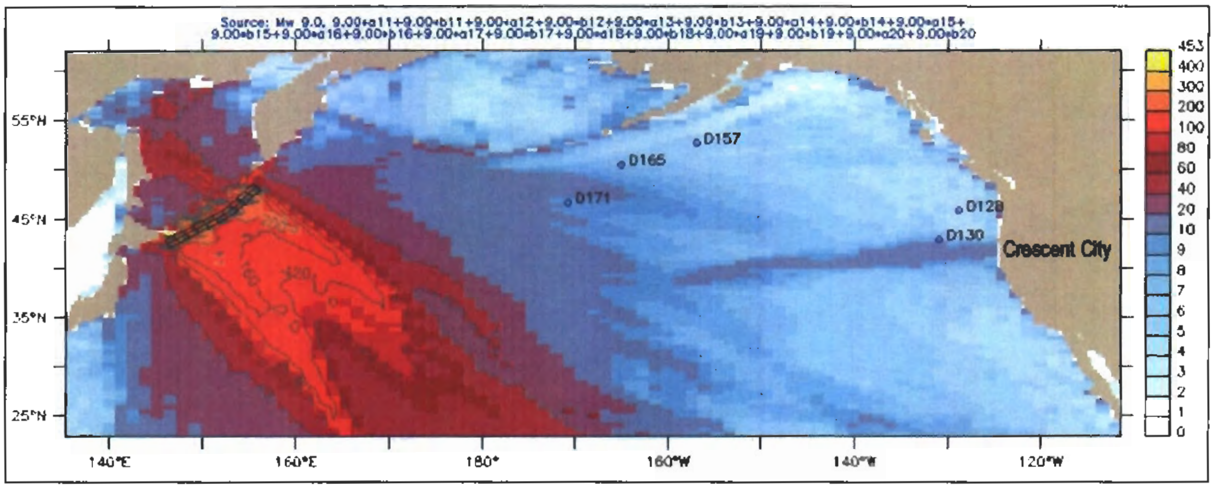



*Figure 5.8 Maximum tsunami wave heights (cm) due to magnitude 9.0 earthquake along Kuril Islands (reproduced from ref. [17]).*

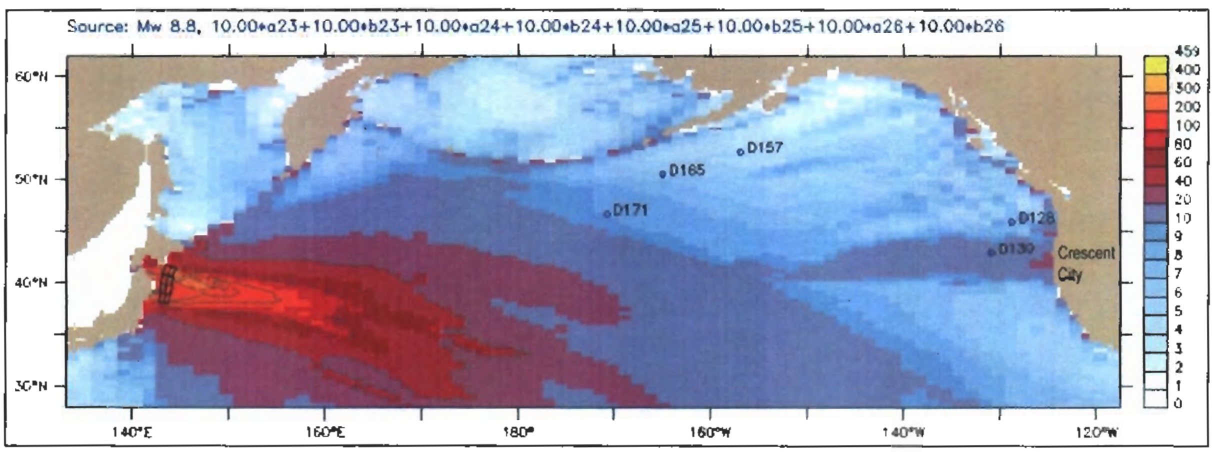



*Figure 5.9 Maximum tsunami wave heights (cm) due to magnitude 8.8 earthquake in Japan (reproduced from ref. [17]).*

### 5.2.2 Local Tsunami Resonance Phenomena

Ref. [16] investigates local tsunami resonance phenomena pertaining to Crescent City in detail and concludes that the resonant periods of wave oscillation within the harbor and marina are around 14 minutes, 8 minutes and 5 minutes, while the resonant periods for the coastal shelf portion between Crescent City and Patrick's Point were estimated at around 30, 25, and 19 minutes.

As the natural periods of oscillation of the harbor and marina basin are somewhat shorter than tsunami wave periods, which are typically around 10-30 minutes, ref. [07], it is likely that any augmented wave agitation associated with tsunami waves is related to resonance on the coastal shelf outside of

Crescent City. From an engineering perspective, this means that tsunami wave heights can likely not be altered significantly through alteration of the port basins or outer breakwater. It is possible that wave resonance might be partially resolved with an alteration of the port structure. However, such modifications are not within the scope of this project. With that, the primary protection against inundation by augmented water levels should focus on the incorporation of barriers and floodwalls rather than alteration of the main layout of the port. However, alteration of structures within the port and Inner Boat Basin might reduce the strong currents observed in connection with tsunami events. This is investigated in detail in other sections of this report.

# 6 Numerical Model Setup

## 6.1 Theoretical Background

The model utilized for the tsunami wave simulation is the BOUSS-2D model of the SMS, Surface Modeling System, maintained by AquaVeo, ref. [18]. A detailed description of the model can be found in ref. [19] from which excerpts are included in the following.

The BOUSS-2D model is a comprehensive numerical model based on a time-domain solution of the Boussinesq equations. These fully nonlinear equations are capable of describing highly asymmetric waves in shallow water, wave-induced currents, wave setup close to the shoreline, and wave-current interaction. The Boussinesq mass and momentum equations are coupled with a one-equation model to emulate the temporal and spatial evolution of the turbulent kinetic energy produced by wave breaking. The equations have also been modified to include the effects of bottom friction and flow through porous structures. The system of equations can simulate most of the hydrodynamic phenomena of interest in coastal regions and harbor basins including shoaling; refraction; diffraction; reflection; transmission; bottom friction; nonlinear wave-wave interaction; wave breaking; runup; wave-induced currents; and wave-current interaction.

### 6.1.1 Constitutive Equations

The model is based on the Boussinesq-type equations derived by Nwogu (1993, 1996), which are integrated over the water depth to describe the propagation and transformation of irregular multi-directional waves over water of variable depth. The equations are fully nonlinear and capable of simulating steep near-breaking waves where the wave height is of the same order as the water depth.

The fully nonlinear form of the equations can be written as:

$$\eta_t + \nabla \cdot u_f = 0$$

where $\eta_t$ represents the water surface elevation, $\nabla$ is the del operator, and $u_f$ is the volume flux density given by:

$$u_f = \int_{-h}^{\eta} u \, dz$$

Where $u$ is the flow velocity at elevation $z$ ranging from the seabed at $z$=-$h$ to the water surface at $z$=$\eta$. The depth-integrated flow velocity $u_{\alpha,t}$ is given by:

$$u_{\alpha,t} + g\nabla\eta + (u_\eta \cdot \nabla)u_\eta + w_\eta \nabla w_\eta + (z_\alpha - \eta)\left[\nabla(u_{\alpha,t} \cdot \nabla h) + (\nabla \cdot u_{\alpha,t})\nabla h\right] + \frac{1}{2}[(z_\alpha + h)^2 - (h+\eta)^2]\nabla(\nabla \cdot u_{\alpha,t}) - \left[(u_{\alpha,t} \cdot \nabla h) + (h+\eta)\nabla \cdot u_{\alpha,t}\right]\nabla\eta + \left[\nabla(u_{\alpha,t} \cdot \nabla h) + (\nabla \cdot u_{\alpha,t})\nabla h + (z_\alpha + h)\nabla(\nabla \cdot u_\alpha)\right]z_{\alpha,t} = 0$$

Where g is the gravitational acceleration, and the volume flux density, $u_f$, becomes:

$$u_f = (h+\eta)\left\{u_\alpha + \left[(z_\alpha + h) - \frac{(h+\eta)}{2}\right][\nabla(u_\alpha \cdot \nabla h) + (\nabla \cdot u_\alpha)\nabla h] + \left[\frac{(z_\alpha + h)^2}{2} - \frac{(h+\eta)^2}{6}\right]\nabla(\nabla \cdot u_\alpha)\right\}$$

Effects of wave breaking are simulated by inclusion of an eddy viscosity term in the momentum equation. The equation takes the following form:

$$F_{br} = -\frac{1}{h+\eta}\nabla\{\nu_t(h+\eta)\nabla \cdot \mathrm{u}_\alpha\}$$

Where $\nu_t$ represents the turbulent eddy viscosity, which is determined from the amount of turbulent kinetic energy, $k$, produced by wave breaking combined with a length scale, $l_t$, representing the dimension of the turbulent patterns.

$$\nu_t = \sqrt{k}\, l_t$$

The turbulent length scale, $l_t$, is approximately equal to the significant wave height.

A one-equation model is employed to describe the production, advection, diffusion, and dissipation of the turbulent kinetic energy, $k_t$, produced by wave breaking, which is given by:

$$k_t = -u_\eta \cdot \nabla k + \sigma\nabla \cdot \nabla(\nu_t k) + B\frac{l_t^2}{\sqrt{C_D}}\left[\left(\frac{\partial u}{\partial z}\right)^2 + \left(\frac{\partial v}{\partial z}\right)^2\right]_{z=\eta}^{3/2} - C_D\frac{k^{3/2}}{l_t}$$

Where B is a parameter taking either the value 0 or 1 depending on when waves are breaking. $C_D$ and $\sigma$ are empirical constants enabling the numerical model to be calibrated with experimental data.

### 6.1.2 Solution Method

The equations are solved using a time domain finite-difference method. The area of interest is discretized as a rectangular grid with the water surface elevation and horizontal velocities defined at the grid nodes in a staggered manner. Time-histories of the velocities and fluxes corresponding to incident storm conditions are specified along external or internal wave generation boundaries. The wave conditions may be periodic or non-periodic, unidirectional or multidirectional. Waves propagating out of the computational domain are absorbed in damping layers placed around the perimeter of the numerical basin. Porosity layers can be placed inside the computational domain to simulate the reflection and transmission characteristics of structures such as breakwaters.

Solution of the equations is achieved using a finite-difference method based on a rectangular grid with grid sizes $\Delta x$ and $\Delta y$, in the x and y directions, respectively. The equation variables $\eta$, $u_\alpha$, and $v_\alpha$ are defined at the grid points in a staggered manner as shown in Figure 6.1. The water depth and surface elevation are defined at grid points (i,j), while the velocities are defined half a grid point on either side of the elevation grid points. The external boundaries of the computational domain correspond to velocity grid points. Partial derivatives are approximated using a forward difference scheme for time and central difference schemes for the spatial variables.

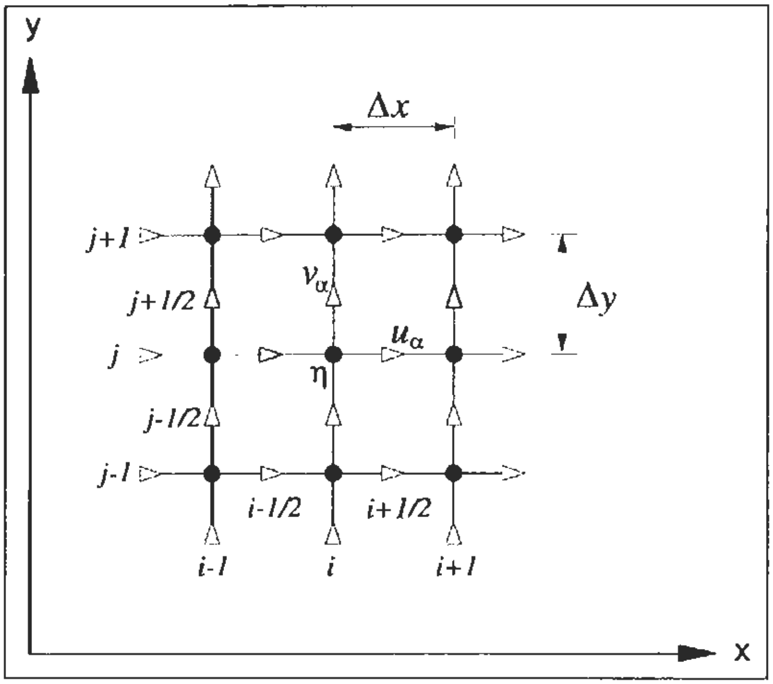



*Figure 6.1 Computational grid for finite difference scheme.*

The numerical solution scheme employed to solve the equations in the time domain is an implicit Crank-Nicolson scheme with a predictor-corrector method used to provide the initial estimate. The first step in the solution scheme is the predictor step in which values of the variables at an intermediate time-step $t = (n + ½)\Delta t$ are determined using known values at $t = n\Delta t$, where $\Delta t$ is the time-step. The second step is the corrector step in which predicted values at $t = (n + ½)\Delta t$ are used to provide an initial estimate of the values at $t = (n+1)\Delta t$. The last step involves iteration using a Crank-Nicolson scheme until convergence is achieved.

## 6.2 Bathymetric Dataset

### 6.2.1 Components

This section provides an overview of the steps taken to compile the harbor bathymetry.

Hydrographic sounding data for the numerical model bathymetry have been obtained from the NGDC, ref. [20] combined with data from the hydrographic survey provided by Stover Engineering per 10-14-2009 for the Inner Boat Basin and associated structures, ref. [21].

The bathymetric data has been compiled from GEO-DAS hydrographic and track-line survey points, data points extrapolated from NOAA charts, and soundings provided by Stover Engineering. The NGDC GEO-DAS data provides data coverage for the coastal and offshore region, while the NOAA charts cover the harbor and coastline in detail. The survey data provided by Stover Engineering is specific to the Inner Boat Basin and provides high-resolution data for the marina and navigation channel. Figure 6.2 provides a rendering of the bathymetry adopted for the numerical model simulations.

The reference horizontal coordinate system utilized in the numerical model is UTM, Zone 10. Vertical datum is MLLW at Crescent City Harbor. Calculations have been performed in the metric (SI) units, which are inherent to the model.

### 6.2.2 Grid Definition

Because the model relies on a finite difference scheme, a Cartesian grid is constructed from the bathymetric dataset. This is done as follows. The three bathymetric datasets described above have been utilized to create a triangulated scatter set of data. The numerical model simulations have been performed on a rectangular grid where the local water depth, as interpolated from the the triangulated scatter set, is appended to each grid cell. The grid is oriented so that its main axes line up with the marina so as to optimize grid resolution in this area (see Figure 6.3). Each cell comprises a 33 ft by 33 ft (10m×10m) square patch. The specifics of the Cartesian grid are as described in Table 6.1.

| Parameter | Description | Value | Unit |
|---|---|---|---|
| $X_0$ | x-coordinate of origin | 398730.17 | m |
| $Y_0$ | y-coordinate of origin | 4621050.12 | m |
| $\alpha_{Az}$ | Azimuth angle of the grid | 315.00 | degrees |
| $D_x$ | Cell grid size, x-direction | 10.00 | m |
| $D_y$ | Cell grid size, y-direction | 10.00 | m |
| $N_x$ | Number of cells in the x-direction | 307 | - |
| $N_y$ | Number of cells in the y-direction | 353 | - |

*Table 6.1 Definition of Cartesian grid adopted for numerical model simulations.*

For computational purposes, cells with an elevation value greater than 0.0 (above MLLW) are classified as land cells. Computations are only performed at ocean cells.

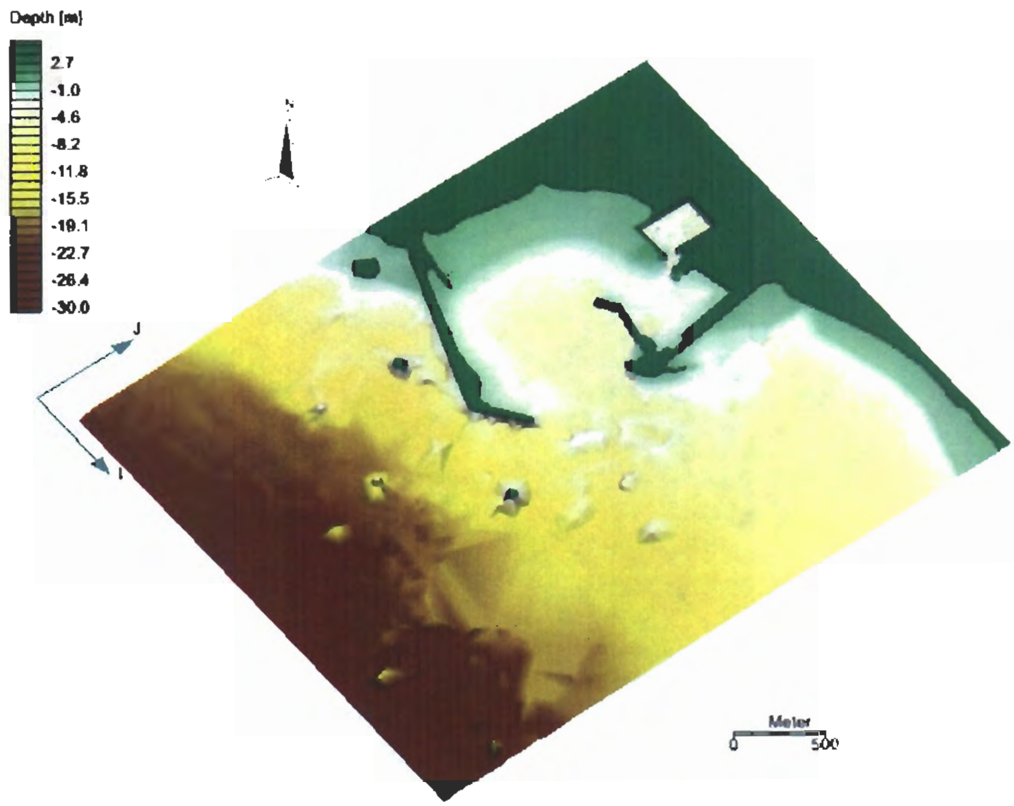



*Figure 6.2 Rendering of bathymetry utilized for numerical model.*

### 6.2.3 Dredged and Non-Dredged Conditions

The bathymetry provided for the marina by Stover Engineering is highly detailed, allowing for a detailed computation of wave-induced currents and recirculation within the Inner Boat Basin prior to maintenance dredging. A close-up view of the data points is provided in Figure 6.3. The marina basin is noted to maintain a fairly constant water depth, and the navigation channel (at similar depths) can be seen leading from the bottom left corner of the figure. A sand shoal accumulating along the marina breakwater is noticeable approximately in the center of the plot.

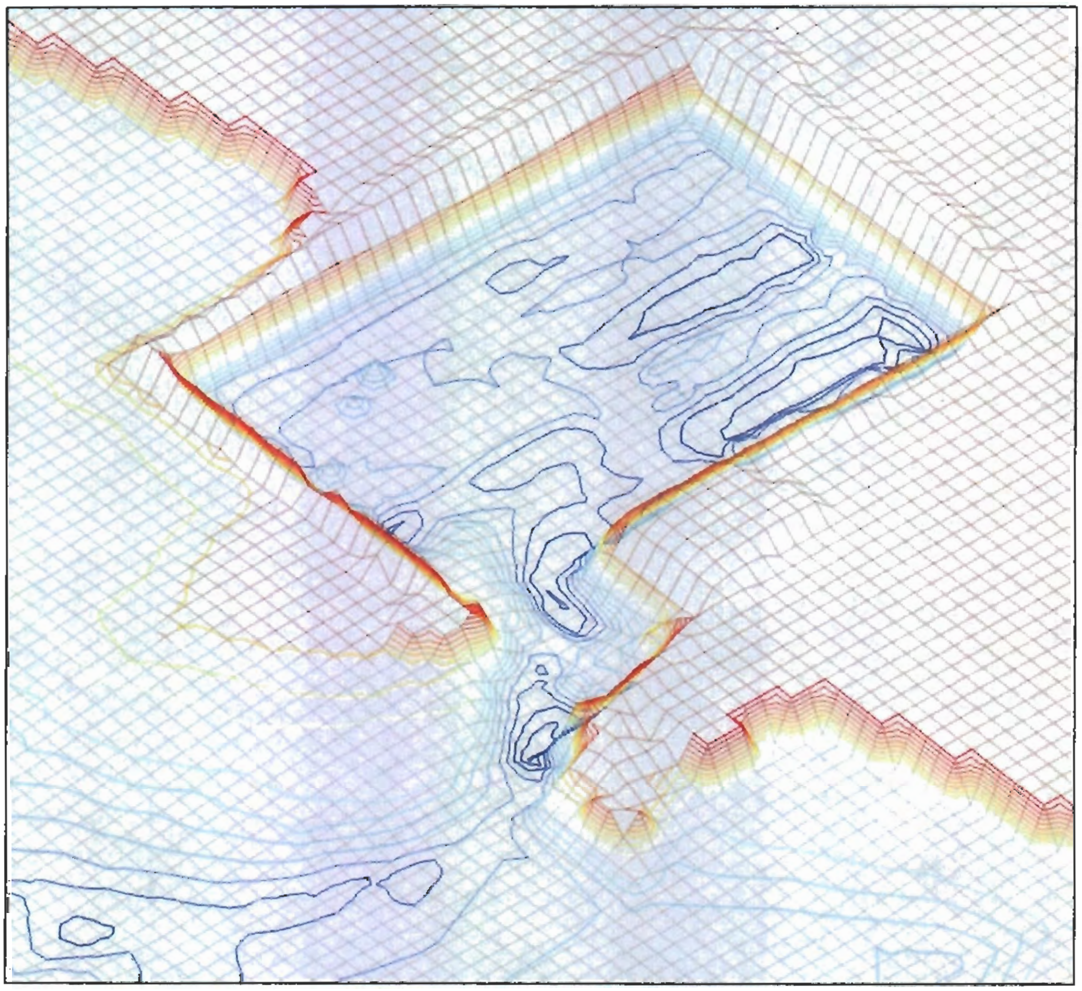


*Figure 6.3 Example of Cartesian grid adopted for numerical model (note grid aligned with Inner Boat Basin to increase resolution).*

## 6.3 Design Wave Data

The wave height, wave period and angle of incidence are the three key parameters defining the overall characteristics of incoming tsunami waves. These have been obtained through numerical simulation and calibration, and from previously published studies.

### 6.3.1 Tsunami Wave Height

The design tsunami wave height is based on the study conducted by Wiegel, ref. [25]. A wave with a return period of 50 years is selected for this project. It is input as the wave-generating boundary condition. Based on Figure 6.4 overleaf the design wave height is:

$$H_D = 15.0 \text{ ft } (4.6 \text{ m})$$

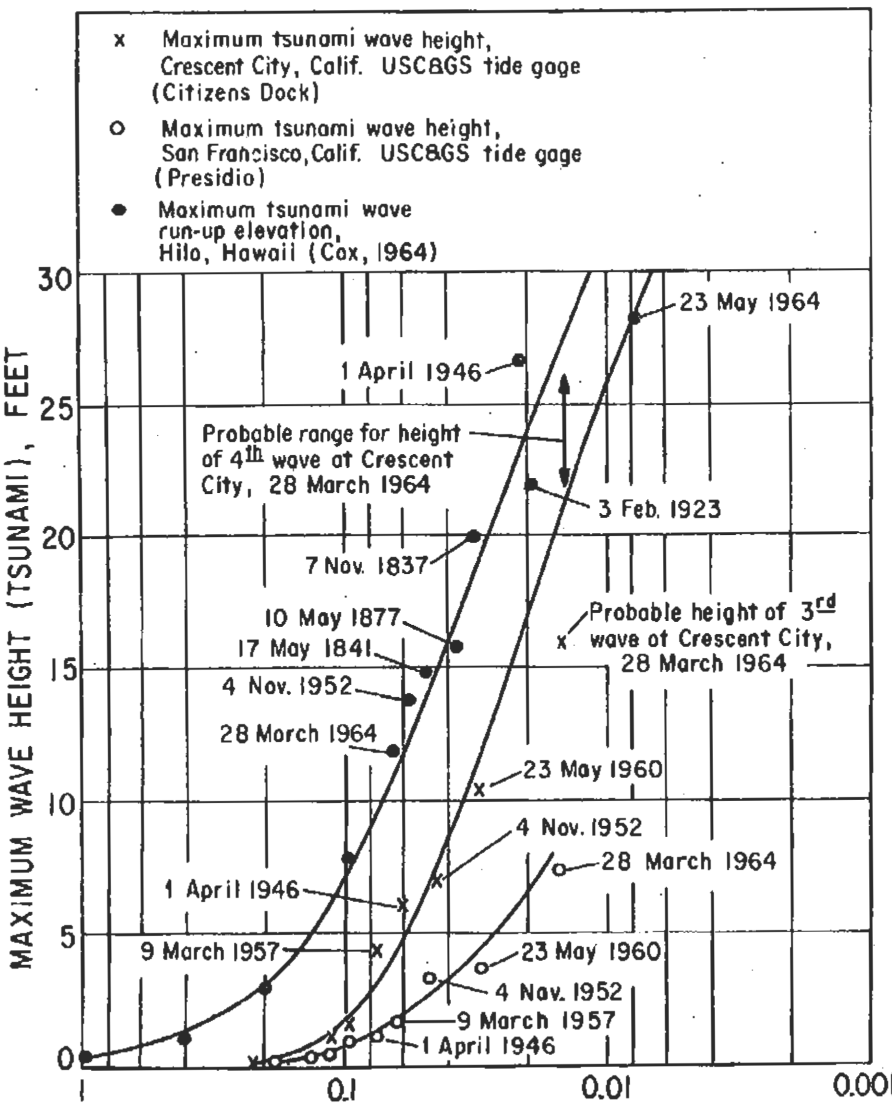



*Figure 6.4 Average frequency per year of tsunamis of equal or greater height, reproduced from ref. [25].*

For reference, it should be noted that the relationship between frequency, $f$, and return period, $T$, is $f = 1/T$, so that e.g. a frequency of 0.1 corresponds to a return period of 10 years.

The data included on Figure 6.4 covers tsunami events up until 1964. A re-analysis of the data including tsunami events from 1965 to up to and including the Samoan Tsunami of Sep. 30, 2009 is provided in Figure 6.5. In the figure, the blue dots represent the original data ending in 1964, while the red boxes represent the data covering the period up until September 2009. The dotted black line represents the average value of all of the recorded events.

Several observations are immediately apparent, which underline the difficulty of associating return periods with tsunami incidents, due to the fact that a tsunami with the potential to affect Crescent City can originate at virtually any point around the Pacific Rim. While recognizing that it takes an earthquake of a certain magnitude and a particular fault slip to produce a tsunami, combined with the effects of transformation and dispersion that might occur to the wave during its transit, it is clear that there is not a very direct path between cause and effect. This is illustrated by the following observations.

Between the original analysis of the tsunami events (blue dots) and the current re-analysis (red boxes), it is clear that the average value (black line) could in fact take several paths, either shifting left or right from its current location. The original data might suggest a steeper curve, while the re-analysis might suggest a slightly flatter curve, which would make the large-scale events less frequent. For example for the tsunami event of 23 May 1960 where a wave height of 10.5 feet was recorded, the statistical analysis yields a return period of such events of around 30 years. However, no such events have occurred in the 50-year period since 1960. This might indicate that the average curve (dotted black line) should be shifted to the right.

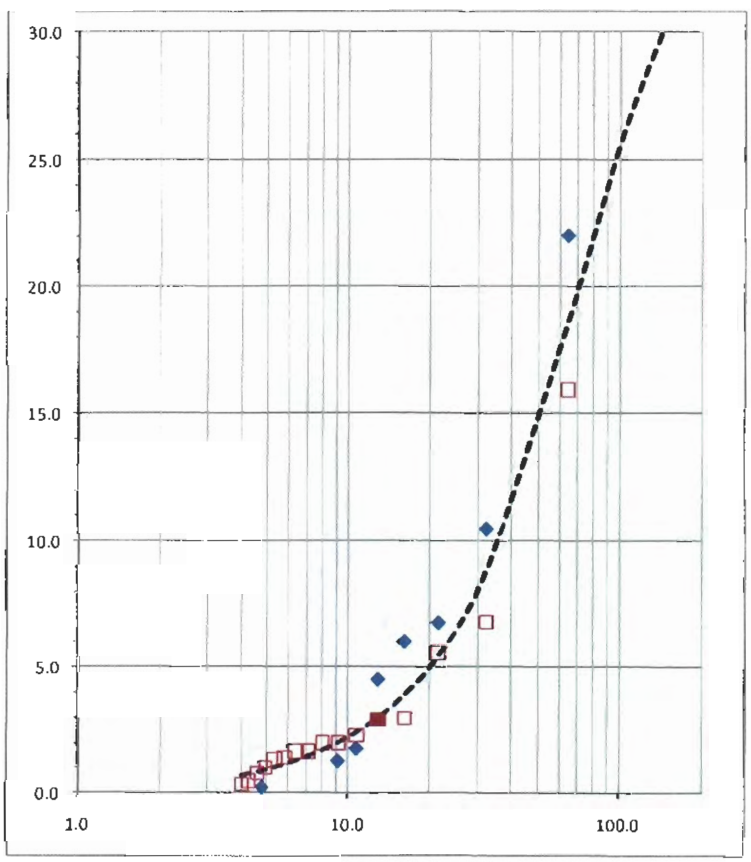



*Figure 6.5 Average return period of tsunamis of equal of greater wave height at Crescent City, CA.*

A similar observation can be made with regards to the November 2006 tsunami event at Crescent City, which is highlighted in Figure 6.5 with a solid red square. Statistically speaking, this event would have a return period of 12-13 years, which both of the analyzed data sets would seem to agree on. However, taking this assumption as valid would mean that Crescent City should have been exposed to damaging tsunami events fairly regularly since the 1960's, experiencing 3 or 4 of such events where only one occurred.

The overall conclusion to these observations is that statistics are not very accurate when only a limited number of events are available for analysis, and it also underlines that the frequency of occurrence of large earthquakes is very irregular. Historical records indicate that the time period between major tsunamis can range from 20 to 200 years, which gives an indication of the uncertainty associated with the statistical averages.

### 6.3.2 Tsunami Wave Periods

Tsunami wave periods are typically around 10-30 minutes, ref. [07]. Smaller periods associated with lesser seismic events are likely also present, but have in the past not been recorded due to the difficulty in registering a small tsunami wave, the amplitude of which might not be noticeable amongst the scattered wind-driven waves along the coast. At the other end of the scale, periods larger than 30 minutes are also known to be associated with seismic events. These oscillations have historically also been difficult to register as they may in many cases not be discernible from the cycle of tidal variations and changes in water level related to storm surges. Sloshing of the water body in the pacific basin has been observed in relation to large seismic events such as the 1964 Alaskan earthquake, where long-period oscillations related to the seismic event were noticeable for days following the earthquake.

A histogram of tsunami wave periods recorded on the West Coast is shown in Figure 6.6. The histogram represents the distribution of all tsunamis that have occurred on the West Coast of the United States from 1806 to 1992, as reported in [07]. Tsunami wave periods recorded at Crescent City are shown in red. The collection of available recorded events at this location is limited and is shown for comparison only.

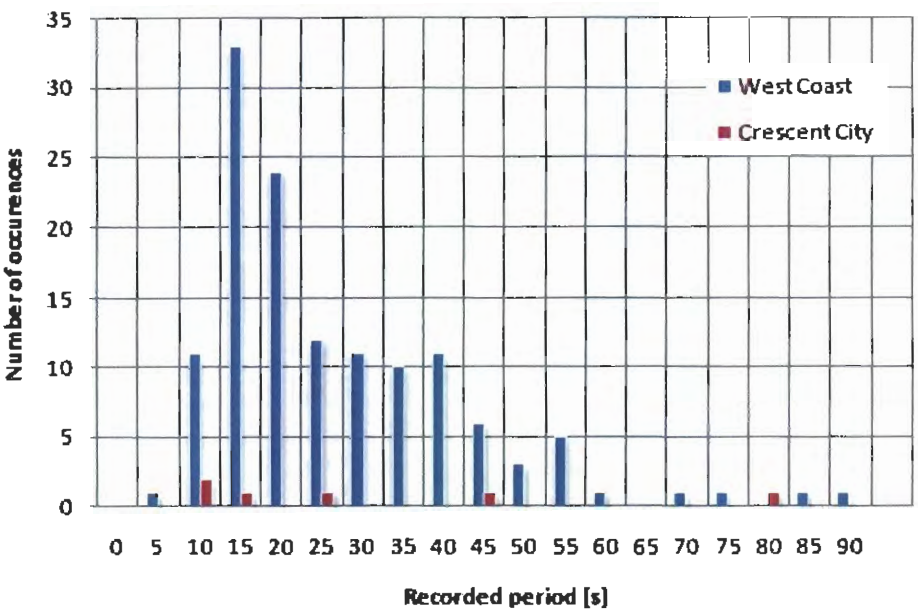



*Figure 6.6* *Wave periods of tsunamis recorded on the West Coast of the U.S.*

As shown in Figure 6.6, tsunami wave periods range from around 5 minutes to 90 minutes. A wave period, $T_D$, of 24 minutes has been selected for the design based on the eyewitness accounts summarized in ref. [06] for the November 2006 tsunami at Crescent City, and other sources, ref. [07]. On the plot above, 24 minutes corresponds to a cumulative exceedance probability of 58.70% when considering the tsunami events recorded on the West Coast within the time range described in the original reference.

$$T_D = 1{,}440s$$

The effects of tsunamis with varying wave periods are examined in the analysis portion of this report.

### 6.3.3 Angle of Incidence

**Effect of Angle of Incidence**

The angle of incidence orients the incoming tsunami waves with respect to the Crescent City harbor, and its selection is important. For example, if waves approach approximately perpendicular to the shore, significant agitation is to be expected within the harbor because the waves propagate directly into the harbor. Conversely, if waves approach the harbor at an oblique angle, the hydrodynamics can be expected to change. This is because a significant amount of reflection at the breakwater would occur. Based on numerical tests performed for the present study, a significant time-lag between the water surface elevations in the marina and in the region outside of the harbor was observed. Those effects are particularly striking when long-waves propagate into the harbor; this phenomenon is described in further detail in the following sections of the report.

**Assessment of the Angle of Incidence**
Based on the travel time associated with various earthquake and ensuing tsunami events, an approximate offshore angle of incidence has been determined by tracing the normal to the time-lapse isoline. A Cartesian grid is superimposed to determine the offshore angle of incidence at the boundary of the numerical model domain as illustrated in Figure 6.7.

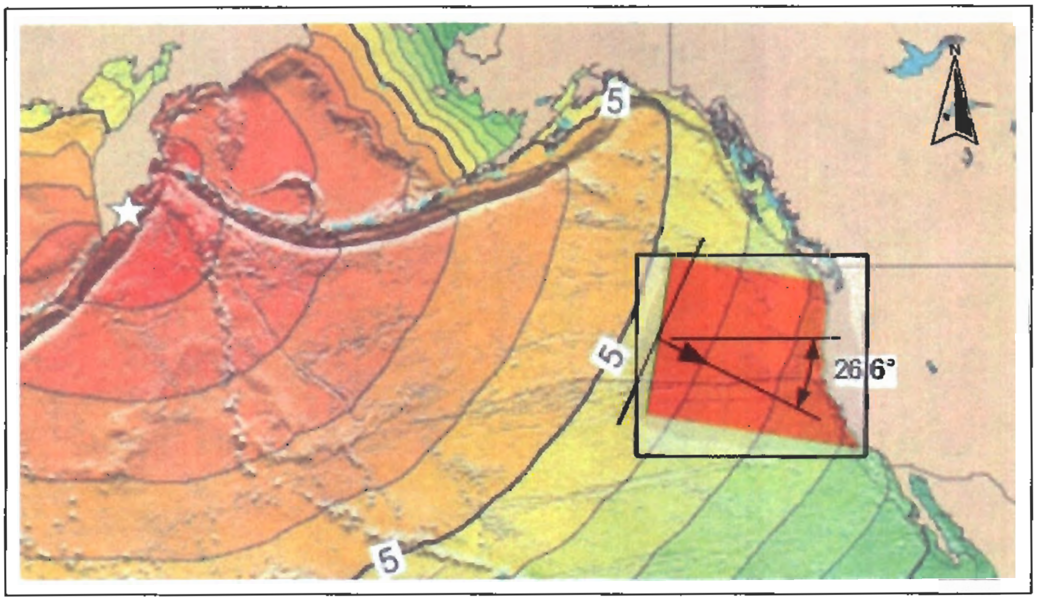



*Figure 6.7 Assessment of offshore tsunami wave angle of incidence.*

In Figure 6.7, the darker shade of orange represents a meso-scale grid utilized to simulate the propagation of a tsunami event originating at the Kamchatka Peninsula. The numerical model is run on the meso-scale grid in order to propagate the tsunami waves to the near-shore region. After the run is complete, the near-shore angle of incidence can be determined. Figure 6.8 shows an example of the water surface elevation isolines for a tsunami wave propagation from offshore water depths to the near-shore region around Crescent City.

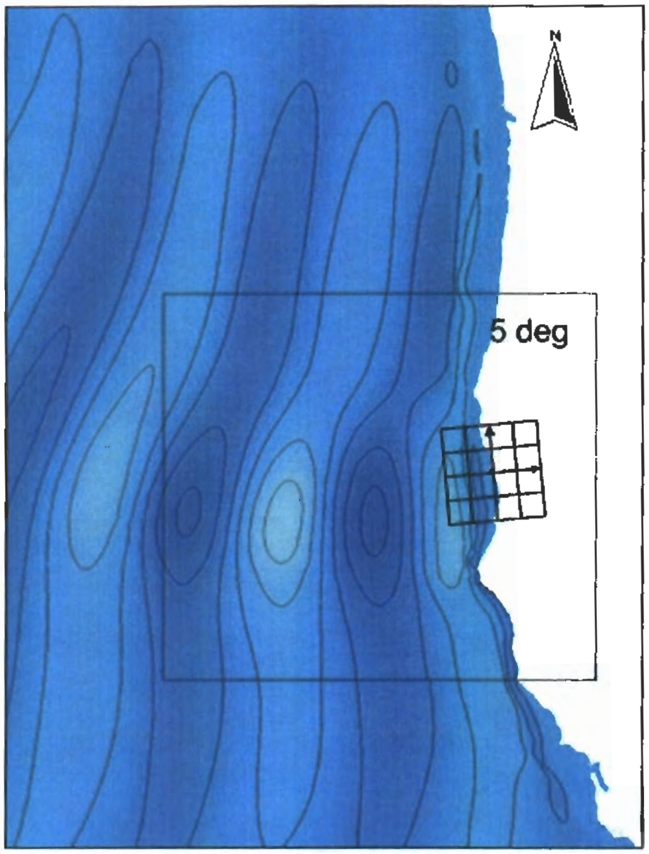



*Figure 6.8* *Snapshot of a monochromatic tsunami wave surface elevation from offshore to near-shore region.*

**Summary of angle of incidence**
The method of analysis outlined in the previous sections has been applied to four basic tsunami design conditions covering the Pacific Rim in the region directly affecting Crescent City. A fairly universal value for the angle of incidence of tsunamis at Crescent City was found, ranging from 5 to 7 degrees, measured as the angle between the horizontal West-East direction and a vector perpendicular to the incoming wave crests. The values for each of the basic tsunami design cases are given in the table below. Eventually, they serve to calculate the angle of incidence to be used as input in the wave generating model boundary condition.

| Event Origin | Near-shore Angle of Incidence |
|---|---|
| Aleutian Islands | 7° |
| Japan | 5° |
| Kamchatka | 5° |
| Alaska | 7° |

*Table 6.2* *Near-shore angle of incidence determined for basic tsunami design scenarios.*

## 6.4 Model Calibration

### 6.4.1 Buoys

Under the charge of the National Oceanographic and Atmospheric Administration's (NOAA) National Data Buoy Center (NDBC) are numerous buoys deployed along the coastlines of the Pacific Basin and at localities such as Crescent City.

**DART Buoys**

As part of the Deep-ocean Assessment and Reporting of Tsunamis (DART) program, a network of 39 stations (see Figure 6.9) has been deployed for the specific purpose of ensuring early detection of tsunamis. The DART buoys collect temperature and pressure at 15-second intervals, and implement a tsunami detection algorithm that allows the system to report more detailed data during tsunami events.

The DART buoy in closest proximity to Crescent City is buoy 46407, located 210 NM West of Coos Bay, OR; it is indicated by the arrow in the figure below.

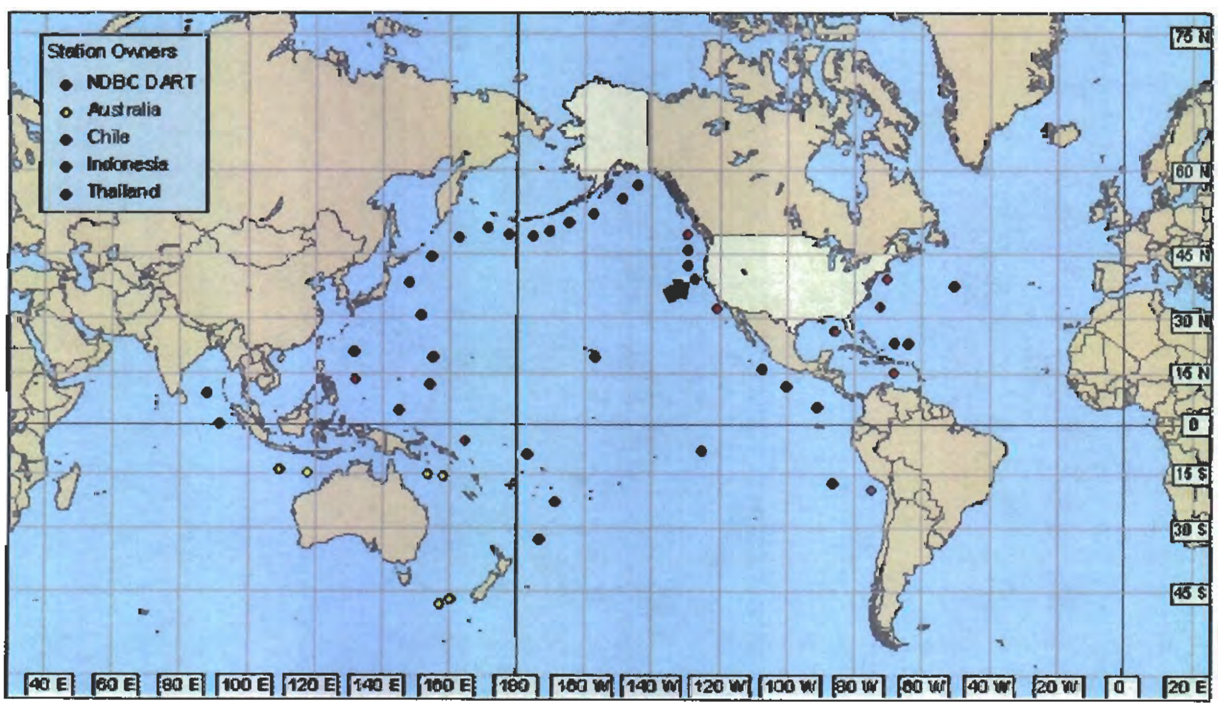



*Figure 6.9 Map of DART buoys located in the Pacific Basin (Source: NOAA NDBC).*

**Coastal Buoys**

A large number of coastal buoys are located along the shores of the U.S. Two such buoys are located near Crescent City as shown in Figure 6.10. One tidal station, Station CECC1 - 9419750 is located within the harbor at Crescent City at 41°44'42" N 124°11'0" W. The station reports wind direction and speed, atmospheric pressure, air and water temperatures, and water levels.

The second buoy is located offshore and northwest of Crescent City at St. George's Reef. The station, 46027 (LLNR 562) is located approximately 8 NM west-northwest of Crescent City at 41°51'1" N 124°22'52" W. The station reports wind direction and speed; wave heights, wave periods and wave direction; atmospheric pressure, air and water temperature, and wind chill.

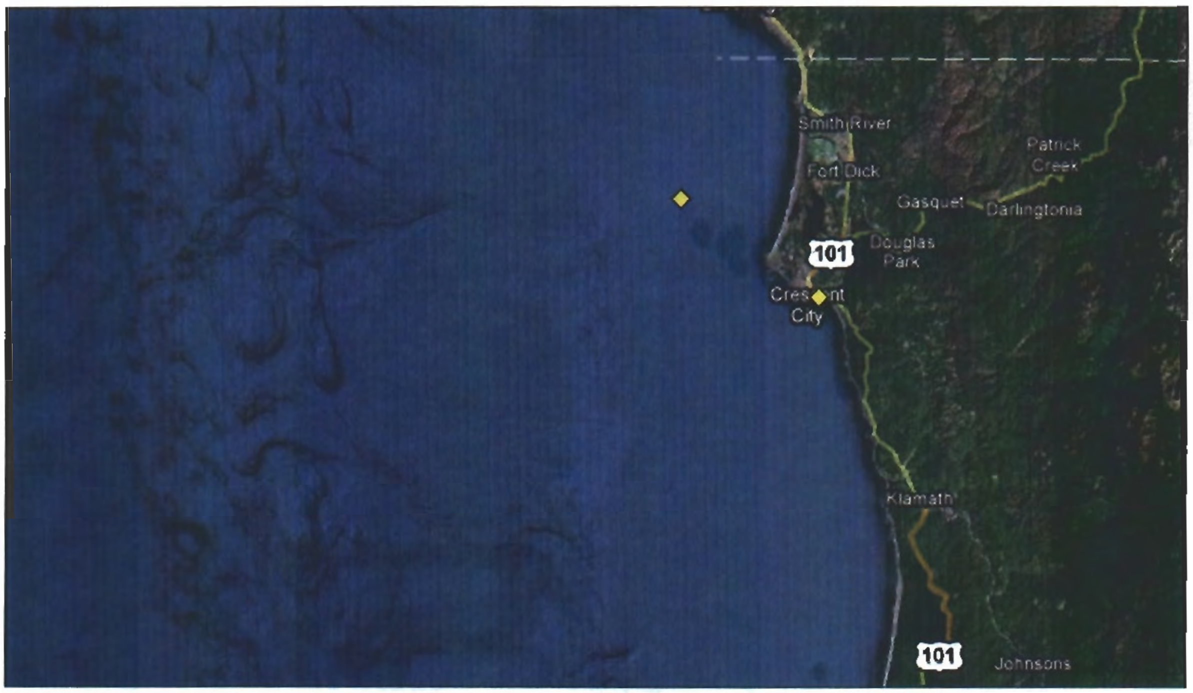



*Figure 6.10 Coastal NOAA buoys in proximity to Crescent City.*

Example water level data recorded during the 2006 Kuril Islands tsunami event for tidal station 9419750, located in Crescent City Harbor, is shown in **Error! Reference source not found.**. The solid blue line represents the astronomical tide water level as predicted by NOAA. The red data points represent the total water surface elevation actually recorded, and the green data points represent the difference between the recorded and the predicted tidal water levels. The record clearly shows the tsunami event on November 15 in the afternoon. However, as the time interval between consecutive readings is not that short, the actual tsunami waves are not captured but show up on the record as scattered data points.

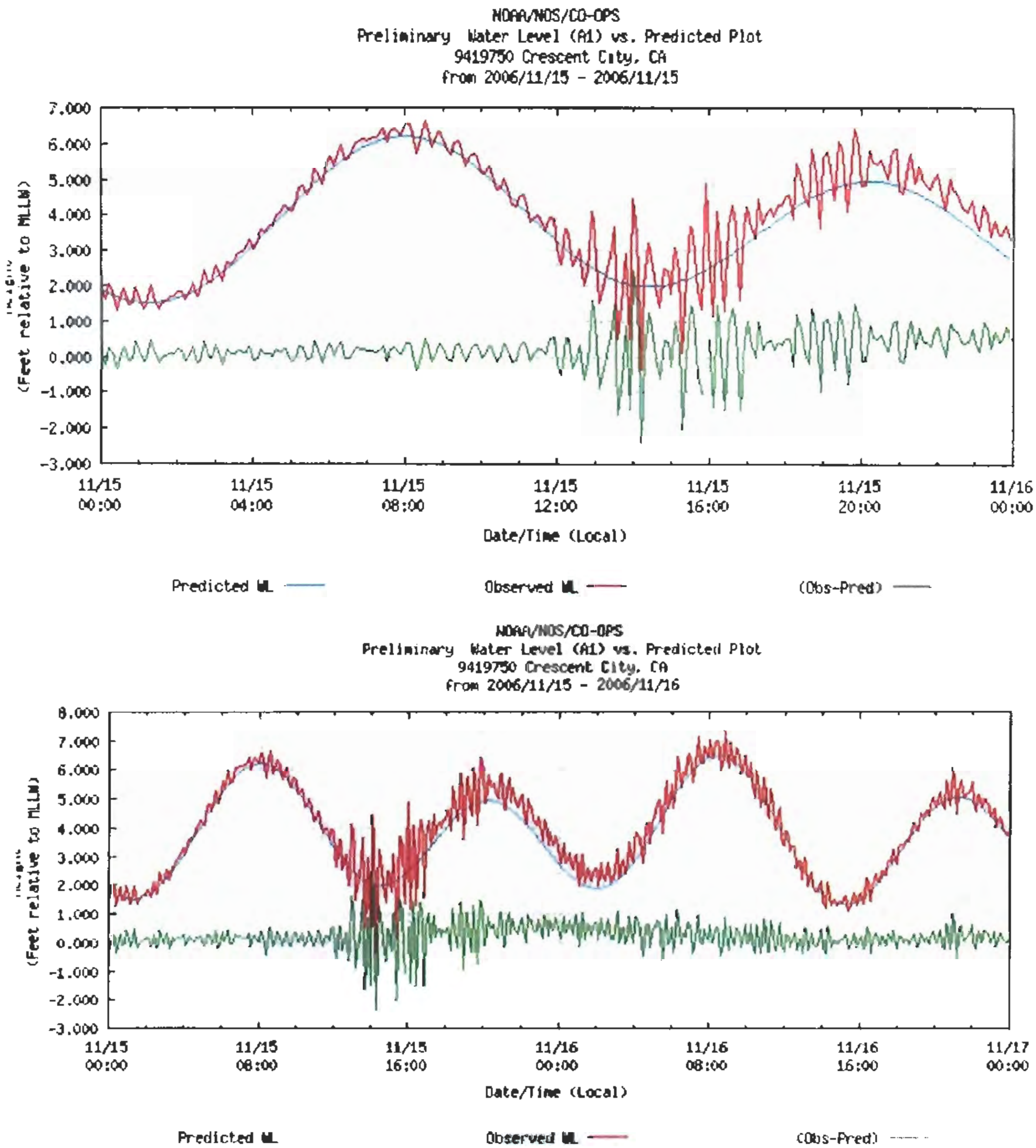



*Figure 6.11 Water level variations recorded at Crescent City during the 2006 Kuril Islands tsunami.*

Offshore from Crescent City, DART buoy 46404 located northwest of Crescent City also captured the 2006 Kuril Islands tsunami event. At this location, where the ocean water depth is around 8,982 ft (2,737.8 m) the approaching tsunami was recorded as a wave with a height of just 2.6 inches (6.5 cm). The event is highlighted in red in Figure 6.12 where the green curve indicates the tidal variation of the ocean surface. It can be noted that in the deep waters offshore, the tsunami wave is barely discernible amongst the small fluctuations associated with recording of the tide.

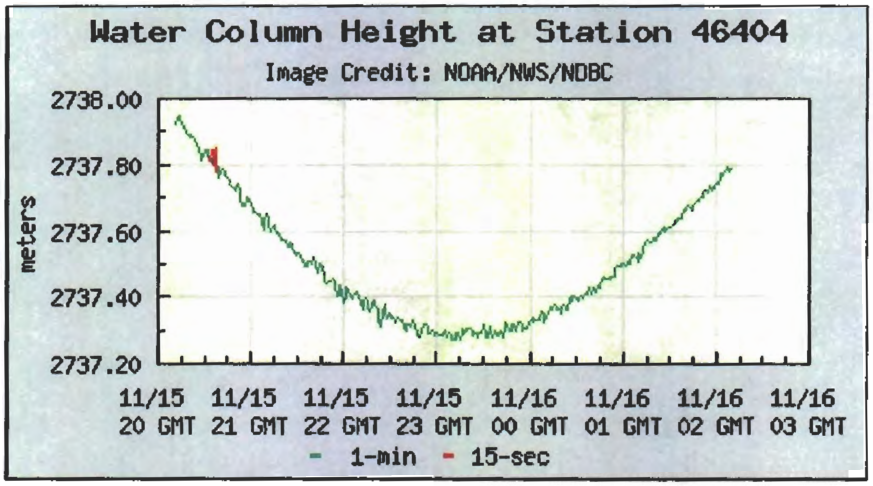



*Figure 6.12 2006 Kuril Islands tsunami recorded offshore from Crescent City.*

The event illustrates the dramatic transformations tsunami waves undergo as they propagate from the deep ocean waters onto the coastal shelf and into shallow water.

# 7 Analysis of Velocity Field

In this section, the design wave is propagated into Crescent City Harbor. The actual dredging conditions are likely to change during the project design lifespan. Therefore, the impact of dredging is also investigated in this section. Here, only the flow structure in and near the inner boat basin is analyzed. The bathymetric changes of interest are:

- Dredged conditions to 15ft below datum in the access channel;
- Dredged inner boat basin to 12ft below datum;
- Addition of a solid wall in place of a marina float to act as a flow deflector.

In addition, model runs are performed as sensitivity analyses so as to evaluate the impact of wave period and tidal offset on the velocity distribution in the marina:

- Maximum velocity vs. design wave period
- Maximum velocity vs. tidal offset

The wave height and tidal adjustments used in each test case are indicated in the text. Together, these investigations serve to better understand the effects of long-wave propagation into Crescent City harbor and its effect on the magnitude of flow velocities in the marina; and the structural and hydraulic changes that can potentially affect its behavior and modulate the intensity of the recirculation patterns in the inner boat basin.

## 7.1 Default Model Settings

### 7.1.1 Wave Parameters

The design wave height is 15 ft (4.57 m); the wave period is 1440s with a tidal offset corresponding to MHHW (+2.1 m above datum) unless otherwise indicated.

### 7.1.2 Numerical Model Parameters

The numerical parameters used for the model runs are indicated below.

- Damping layers ("sponge layers") of 75m, with a damping coefficient of 0.1 are added along the land cells adjacent to ocean cells; these layers are used to minimize wave reflection on the shoreline. As such, they help reduce numerical instabilities;.
- The Chezy coefficient is left to its default value of 30;
- Smagorinsky coefficient of 0.5;
- Turbulent length defined as the design wave height, i.e. 15ft (4.57m) by default;
- The duration of the simulation is set to 4815.2s;
- Timestep of 0.1s; this corresponds to an estimated Courant number of 0.3;
- Model output is set to echo every 24s; to begin at 0.0s and end at 4815s;
- No porosity layers or additional current data are used in this study.

## 7.2 Existing Conditions

The "existing conditions" refer to the original, unmodified bathymetry as defined in Section 6.2. This is unlike the "dredged conditions", where the new access channel and/or inner boat basin depths have been reflected in the bathymetry defined in Section 6.2.2.

The design parameters outlined previously have been applied to establish flow patterns in the inner harbor boat basin when no dredging has occurred. It was determined that magnitude of the flow velocity in the marina was a function of the tsunami wave height, while the overall flow patterns were found to be relatively unaffected by tsunami wave parameters and tidal variations tested.

### 7.2.1 Flow Patterns within the Marina

In this section, an overall description of the flow patterns observed in the harbor serves as an introduction to the detailed visualization of the velocity field developing in the inner boat basin.

**Overall Description**

The flow patterns developing in the marina due to tsunami-induced waves, modeled here as a series of monochromatic long waves, are striking in their regularity and structure. There is a significant delay between the time when the water surface in the outer region reaches its peak elevation and the water surface within the harbor achieves its local maximum. Likewise, peak water surface elevations in the harbor basin and the Inner Boat Basin do not occur simultaneously. Therefore, at times during the tsunami event, there exists a large hydraulic head between the three subzones, namely the harbor basin, the Inner Boat Basin and the region outside of the harbor. This hydraulic head leads to strong currents developing in confined areas, such as the access channel and near the tips of the various breakwaters present in the harbor.

To illustrate this effect, the velocity magnitude[4] is shown as a tsunami wave propagates into the harbor (Figure 7.1). Regions of progressively higher flow velocity magnitude are indicated by yellow, orange, and red colors; a color bar is shown for scaling; the color scheme and matching values apply for all the figures shown in this subsection. This particular simulation was conducted at MHHW, which corresponds to a tidal elevation of 6.89 ft (2.1m) above datum. For these design tsunami-induced waves, with a recurrence interval on average of 50 years, the peak velocities in the marina reach 19.26 fps (5.87 m/s).

A tsunami-induced wave height of 6.4 feet (1.95 m) corresponding to a tsunami event with a 25-year return period yields peak velocities that reach above 9.84 fps (3.0 m/s) in the marina and 13.12 fps (4.0 m/s) at the tip of the main breakwater. This design test case is not shown here because it was observed that the flow field structure is not appreciably affected by the design wave height.

[4] Unless otherwise indicated, throughout the text the term "velocity" refers to the wave-induced velocity magnitude.

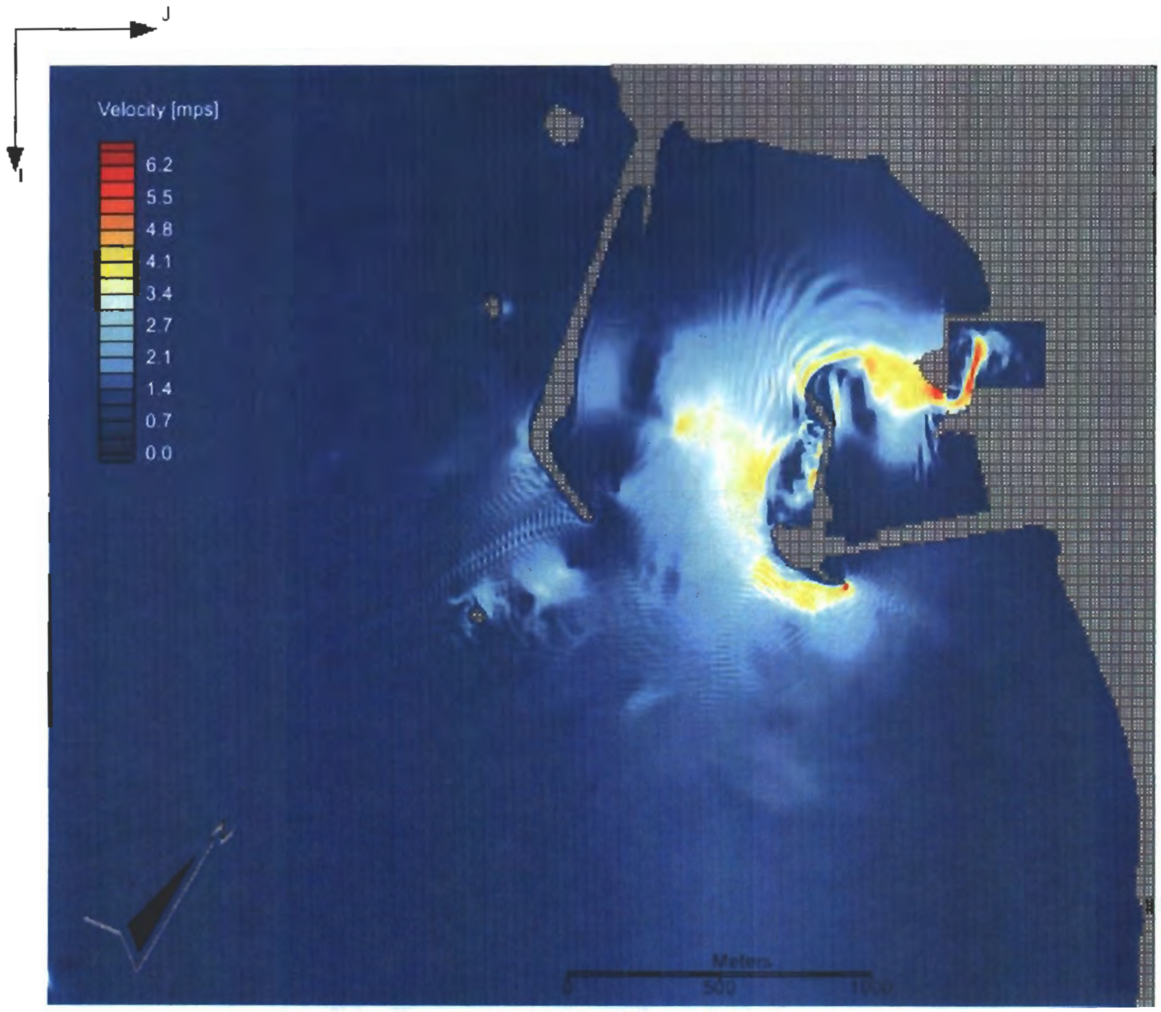



*Figure 7.1 Overview, velocity contour plot, MHHW. Areas in red indicate regions with maximum velocity recorded in the marina. Snapshot shown at 00:50:00 (hh:mm:ss)*

**Inner Boat Basin Velocity Field**

As the tsunami wave propagates into the harbor, a noticeable jet forms at the entrance and into the Inner Boat Basin. Areas of high flow velocities are indicated in yellow and red colors. The areas of high flow velocity within the harbor basin arise due to the substantial gradient present between the regions of water outside of the harbor and within the harbor and marina having disparate elevations. A close-up view of the velocity field in the Inner Boat Basin is shown overleaf.

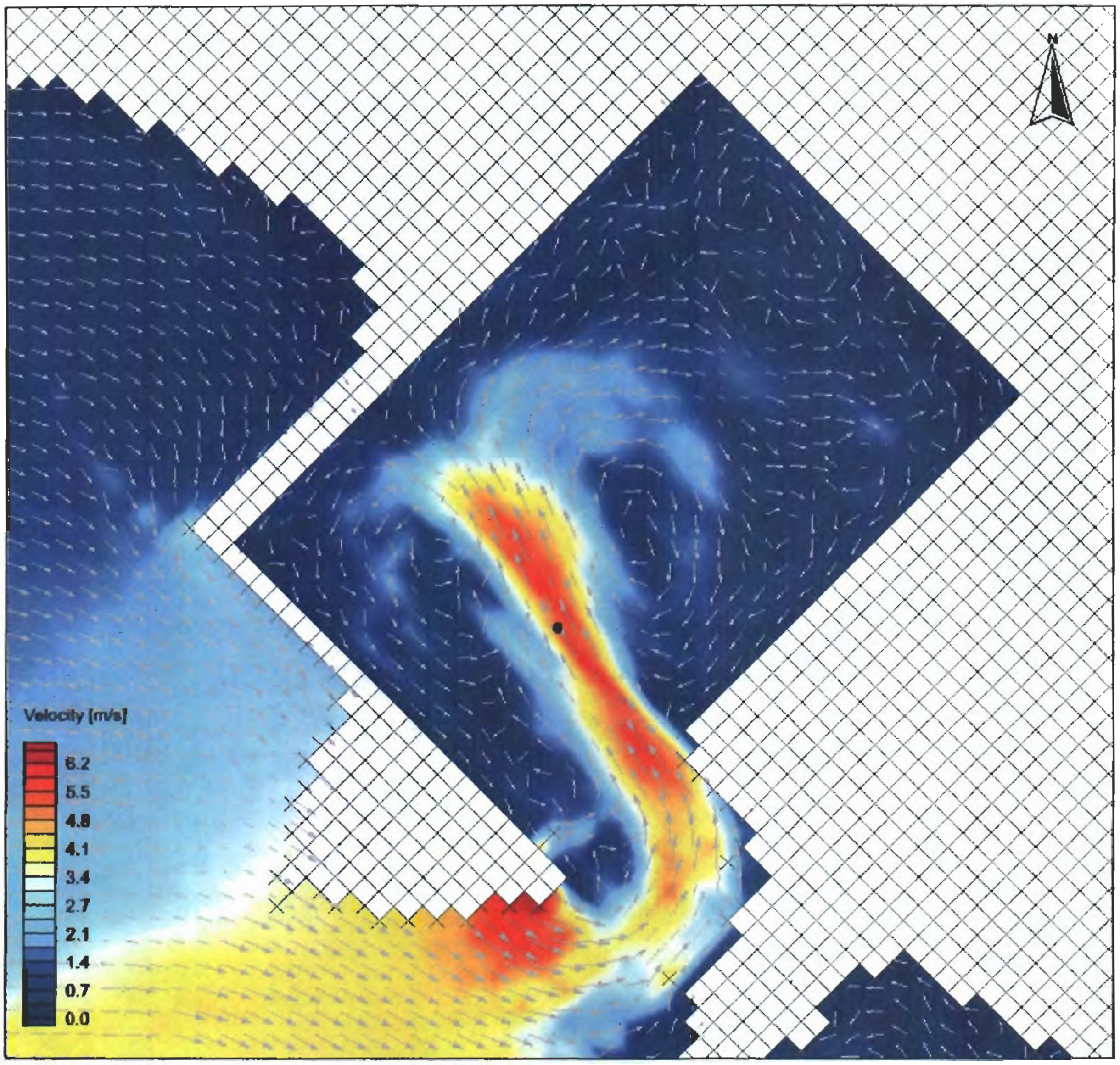



*Figure 7.2 Velocity field, MHHW during inflow phase at timestamp 00 50:00 (hh:mm:ss).*

As seen in Figure 7.2, the clockwise circulation in the inner boat basin is clearly visible. It can be explained by the principle of conservation of mass. As a large amount of water is pushed into the marina, a change in elevation occurs. The fluid is then pushed along the main direction of the incoming momentum. As it meets a solid wall, the fluid momentum is re-directed, forming two vortices on each side of the jet. The primary flow path of the jet is clockwise.

By the time the leftmost, central vortex reaches full strength, the tsunami wave recedes. Water flowing along the southeast wall then flows out of the marina. The core of the vortex is thus displaced northward by inertia, to allow for the nascent current to become the main fluid carrier out of the marina. This is shown in Figure 7.3.

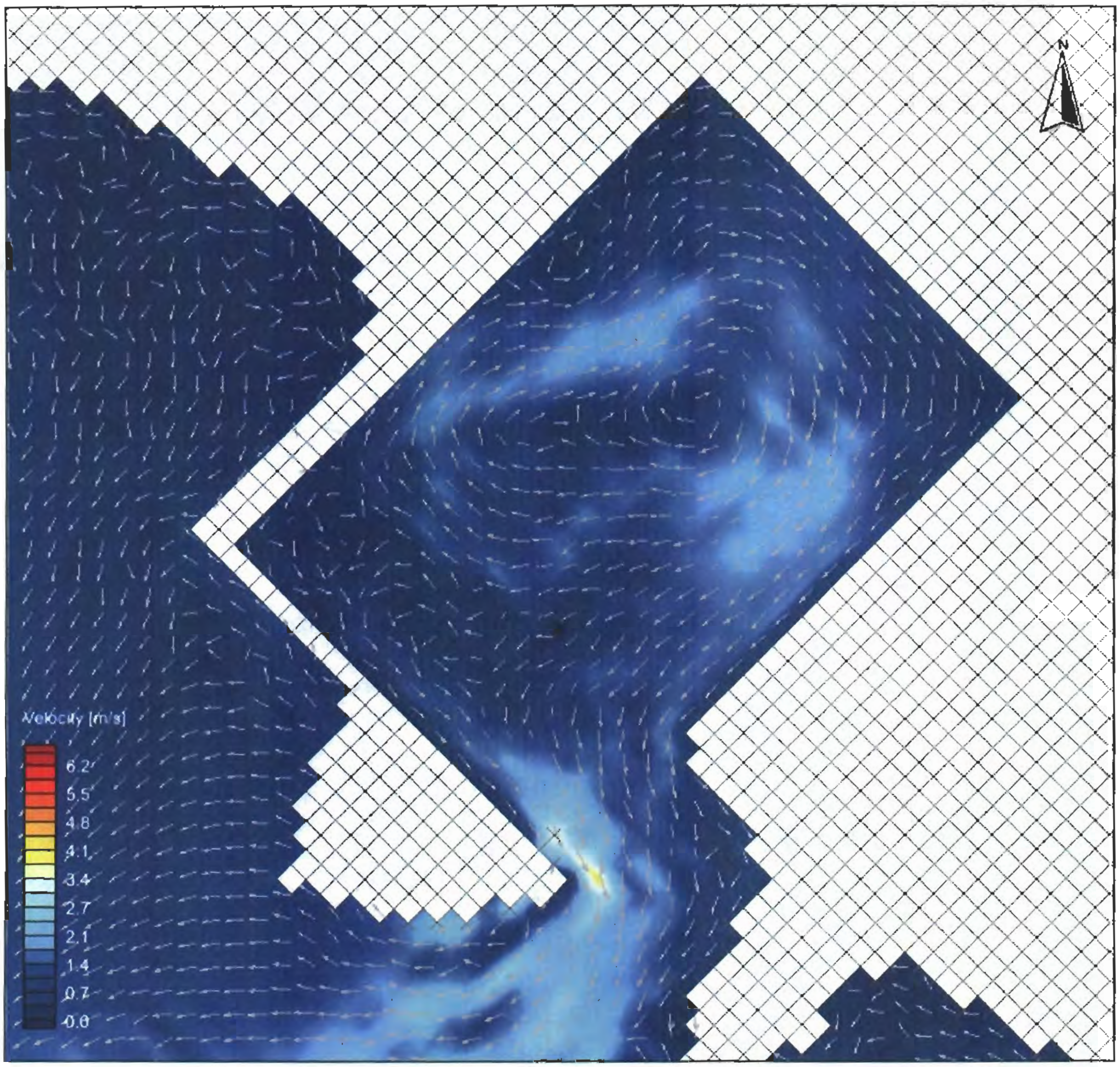



*Figure 7.3 Velocity field, MHHW during outflow phase at timestamp 00:55:36 (hh:mm:ss).*

Note that during the outflow phase, flow velocities are not as large as those occurring during the inflow phase.

### 7.2.2 Maximum Velocities at Dock H

The velocity time series in the vicinity of dock H is extracted from the model. Dock H occupies a critical spot in the marina and is the element subject to the highest hydrodynamic loads. Therefore, it was deemed relevant to place an observation point at this location. The velocity magnitude variation over time is shown in Figure 7.4 below. High velocities are reached in the marina entrance channel. For reference, the coordinates of the extraction point are reported in Table 7.2 The point is shown in Figure 7.2 and Figure 7.3 as a black dot.

| **Probe; access channel; inner harbor basin** | |
|---|---|
| x-coordinate | y-coordinate |
| 401524.2 | 4622400.7 |

*Table 7.1 Dock H probe coordinates.*

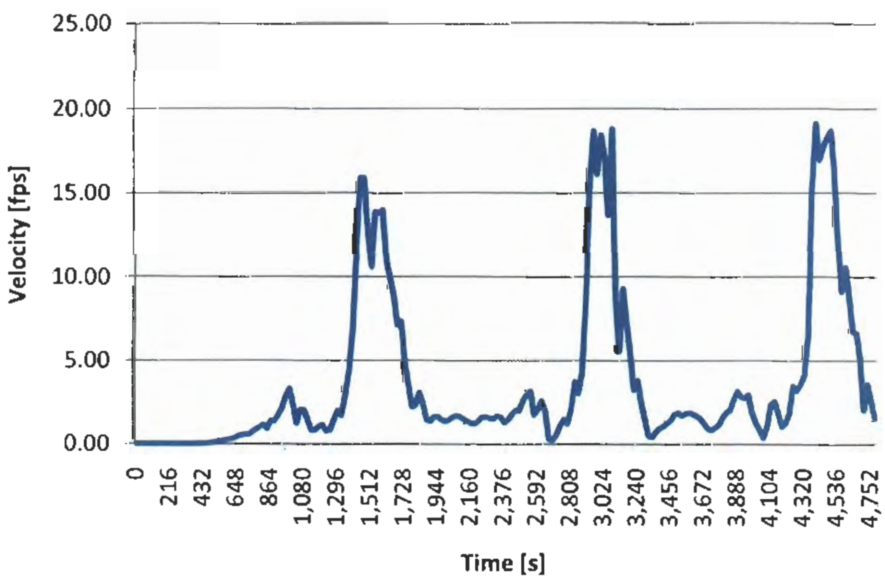



*Figure 7.4 Velocity profile at dock H probe, MHHW.*

The wave-induced velocity magnitude is directly dependent on the tsunami wave parameters, the bathymetry and the tidal elevation. To investigate the impact of tidal offset on maximum current velocity magnitude, in this section, the only variable is the tidal elevation. That is, the adjustment made to the base water surface above the MLLW datum. It was observed that the structure of the flow field is not appreciably impacted by varying tidal offsets. Additionally, it was noted that the largest point velocity values in the inner boat basin were observed at the highest tide (MHHW). A more detailed analysis of these effects is presented in a later subsection.

### 7.2.3 Tsunami Wave Propagation Timeline

To complement the preceding discussion, a sequence of snapshots (Figure 7.5 to Figure 7.8) is included in order to facilitate an understanding of the hydrodynamics in a larger context. The velocity magnitude is plotted in the figures below. The wave period is 24 minutes (1,440 seconds) and the design wave height is set to 15 ft. As the wave approaches the harbor, a gradient is formed between the water body outside of the harbor and the water body within the harbor. Consequently, high flow velocities develop at the mouth of the harbor, as seen at timestamp 00:21:15. As the wave propagates into the harbor, it eventually reaches the inner boat basin, as seen at 00:24:00. A high-velocity jet develops as it pushes through the marina. From the principle of conservation of mass, water circulates in the basin, in a clockwise fashion. Eventually, the wave recedes, while a slowly dissipating vortex maintains a high-velocity clockwise current pattern in the marina. In the figures that follow, all timestamps follow a hh:mm:ss standard.

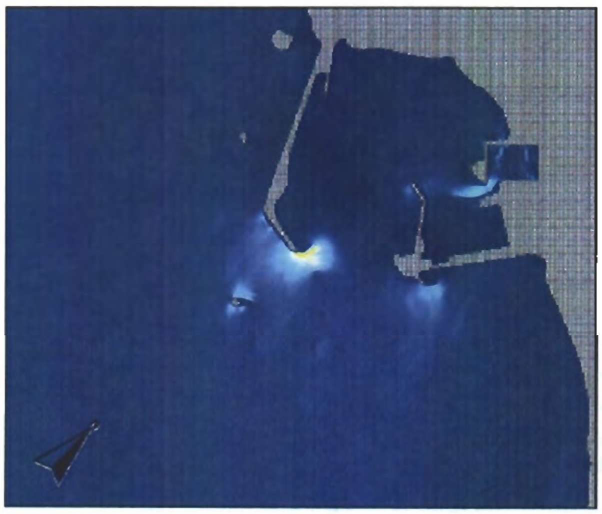


*Figure 7.5 00:16:45.*

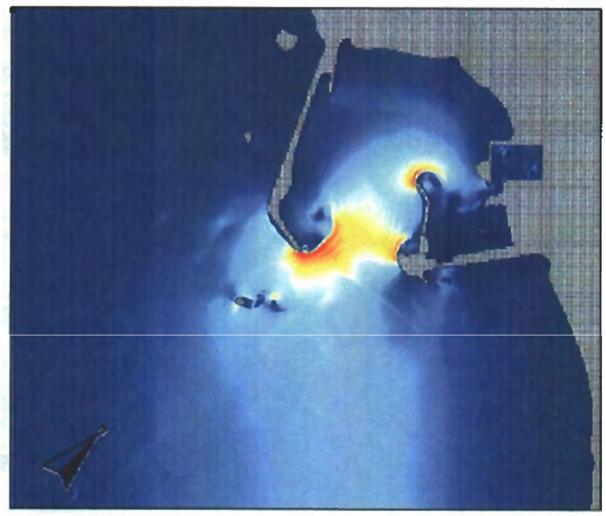


*Figure 7.6 00:21:15.*

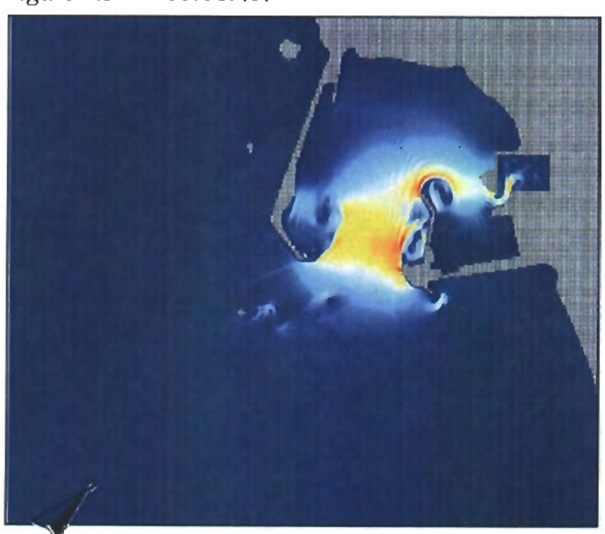


*Figure 7.7 00:24:00.*

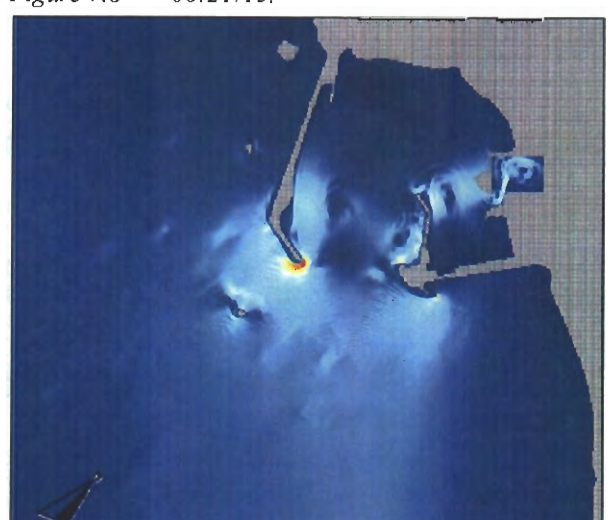


*Figure 7.8 00:27:30.*

### 7.2.4 Sensitivity Analyses

Two sensitivity analyses summarized in the following deal with maximum flow velocities relative to wave period, and maximum flow velocities relative to the tidal offset.

**Wave period and Maximum Velocity Magnitude**

The findings described in the following are limited to the region contained within the inner harbor marina. Simulations have been performed to determine the impact of varying the design wave period on the current velocity magnitude and water level variations. It has been observed that the peak velocity magnitude recorded in the marina is not appreciably modified by a change in the design wave period. The analysis has examined flow data extracted at four locations in areas where high velocities develop. They are all located near the entrance of the marina basin. The probes are positioned so as to optimize the data capture. Two time series have been extracted at each location; one for the velocity magnitude and the other for the water surface elevation. Overall, it is observed that the velocity profile remains relatively unaffected, whereas the maximum surface elevation in the marina is directly related to the wave period. These effects are discussed hereafter. The probe locations coordinates (UTM) are as follows:

| | x-position [m] | y-position [m] |
|---|---|---|
| 1 | 401491.6 | 4622426 |
| 2 | 401508.7 | 4622410 |
| 3 | 401523.7 | 4622396 |
| 4 | 401538.7 | 4622382 |

*Table 7.2 Location of probes.*

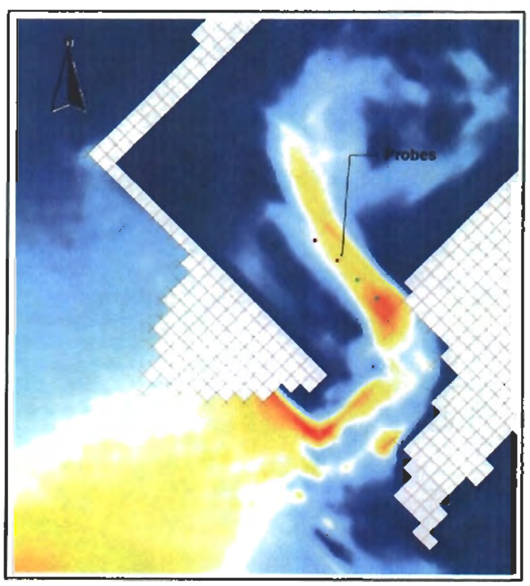



*Figure 7.9 Extraction location.*

A cumulative probability analysis of the range of tsunami wave periods recorded for the West Coast of the United States has been performed. The following percentiles are obtained. It should be noted that the 24-minute period taken as the design period in this report corresponds to a 58.7% cumulative probability.

| Cumulative Probability of Occurrence | Tsunami Wave Period [min] | Maximum velocity magnitude recorded at probes [ft/s] | Maximum water surface elevation above MSL (3.7 ft above MLLW) [ft] |
|---|---|---|---|
| 90.0% | 45 min. | 7.7 fps | 10.0 feet |
| 76.3% | 35 min. | 8.3 fps | 8.8 feet |
| 58.7% | 24 min. | 8.7 fps | 7.2 feet |
| 50.0% | 20 min. | 8.5 fps | 6.9 feet |
| 20.6% | 14 min. | 8.3 fps | 4.2 feet |

*Table 7.3 Magnitude of flow velocity and water surface elevation as a function of wave period.*

The maximum flow velocities and water surface elevations in the marina basin, as recorded by the probes, are shown in Table 7.4. The maximum water surface elevation is noted to increase as the wave period increases. This is because the tsunami wave is somewhat comparable to a tidal wave where more water accumulates in the marina as the time scale increases. This is due to the fact that shorter wave periods are not sufficiently long in duration to allow the full amount of fluid to penetrate inside the marina, before it starts receding. The maximum flow velocities are noted to remain fairly constant irrespective of the tsunami wave period. The values recorded below correspond to calculations involving only three monochromatic tsunami waves generated by the wave-maker in BOUSS-2D. In general, the largest sampled values occurred during the second wave cycle.

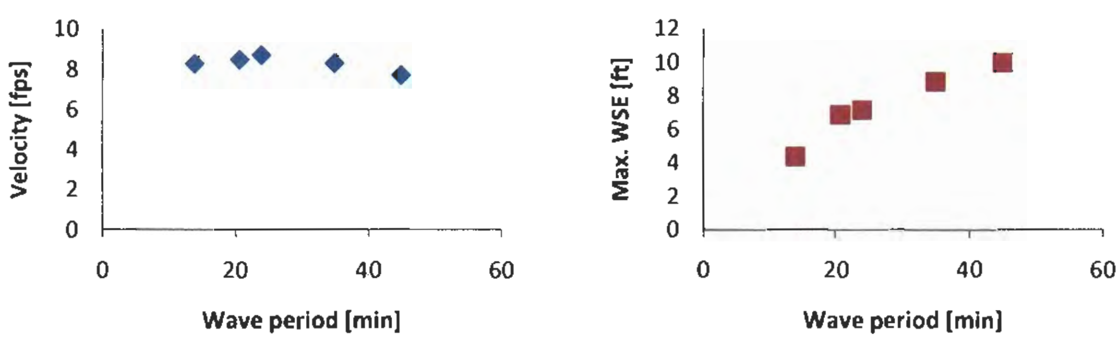



*Table 7.4 Maximum flow velocity magnitude vs. design wave period and tidal offset. Left: Maximum flow velocity in Inner Boat Basin. Right: Maximum water surface elevation in Inner Boat Basin.*

The above results do not provide a complete coverage of the velocity field at all locations in the Crescent City harbor. Rather, they focus on the region of interest, namely the inner boat basin, whose structural elements are to be designed against tsunami-induced drag loads. The maximum velocity amplitudes are not significantly affected by variations in the design tsunami wave period.

**Maximum Velocities at Dock H Relative to Tidal Offset**
The wave-induced velocity intensity is directly dependent on the wave parameters, the bathymetry, and the water level. In this section, the only variable is the tidal elevation. It was observed that large velocities - above 9.8 fps (3.0 m/s) - do occur for the MHW case in certain regions of the marina, albeit these are limited in time and extent.

The table below shows the results obtained at the marina entrance channel for the three tidal elevation studied in this report. The highest velocity of 10.8 fps (3.3 m/s) is recorded for the lowest base water surface elevation. Note that these velocities are depth-averaged: therefore, the velocity profile should be assumed uniform across the whole water column.

| **Tide Level** | **Elevation above MLLW** | **Max. velocity at extraction location** | **Max velocity in marina** |
|---|---|---|---|
| Mean High Water | +1.90 | 8.4 fps (2.55 m/s) | 10.8 fps (3.3 m/s[5]) |
| Mean Sea Level | +1.13 | 7.5 fps (2.30 m/s) | 8.9 fps (2.7 m/s) |
| Mean Low Water | +0.380 | 9.8 fps (3.0 m/s) | 10.0 fps (3.07 m/s[6]) |

*Table 7.5 Flow velocities recorded in the marina and entrance channel for a tsunami event with a recurrence interval of 25 years (design wave height of 6.4 ft and wave period of 1440s).*

## 7.3 Effect of Channel Deepening

In this section, the effect of deepening of the access channel to 15 feet is investigated. The marina is left at its non-dredged depth. To that end, the bathymetry as defined in Section 6.2 is modified in order to reflect the conditions of the deepened channel. The idea is to increase the flow by increasing the water depth, which should theoretically reduce flow velocities. The results are compared to the non-dredged cbannel case. In this particular example the wave parameters are a tidal offset set to MLW, or 1.25 ft above MLLW and a wave height of 6.4 ft (1.95 m).

### 7.3.1 Modification of Bathymetry

First, the existing bathymetry is modified so as to reflect a constant dredged depth along the access channel. Based on communications with Stover engineering, the modified bathymetry reflects a depth of 15 ft (4.572m) below the MLLW datum. The layout of the access channel is based on the Army Corps of Engineers hydrographic survey of 2006. Figure 7.10 shows how the locations of grid-points to be updated were determined by superimposing the USACE hydrographic survey onto the existing bathymetry. The dredged bathymetry was created by removing high points in the access channel, as

[5] The high velocity field is short lived and limited in extent.

[6] The region with high velocities is much larger at MLW than in other test cases, despite the fact that the maximum theoretical velocity is found for the MHW.

well as sand shoals intersection the dredged area. The interface between the original bathymetry and dredged cells was smoothed out to reduce numerical instabilities caused by steep elevation gradient formed between two adjacent cells.

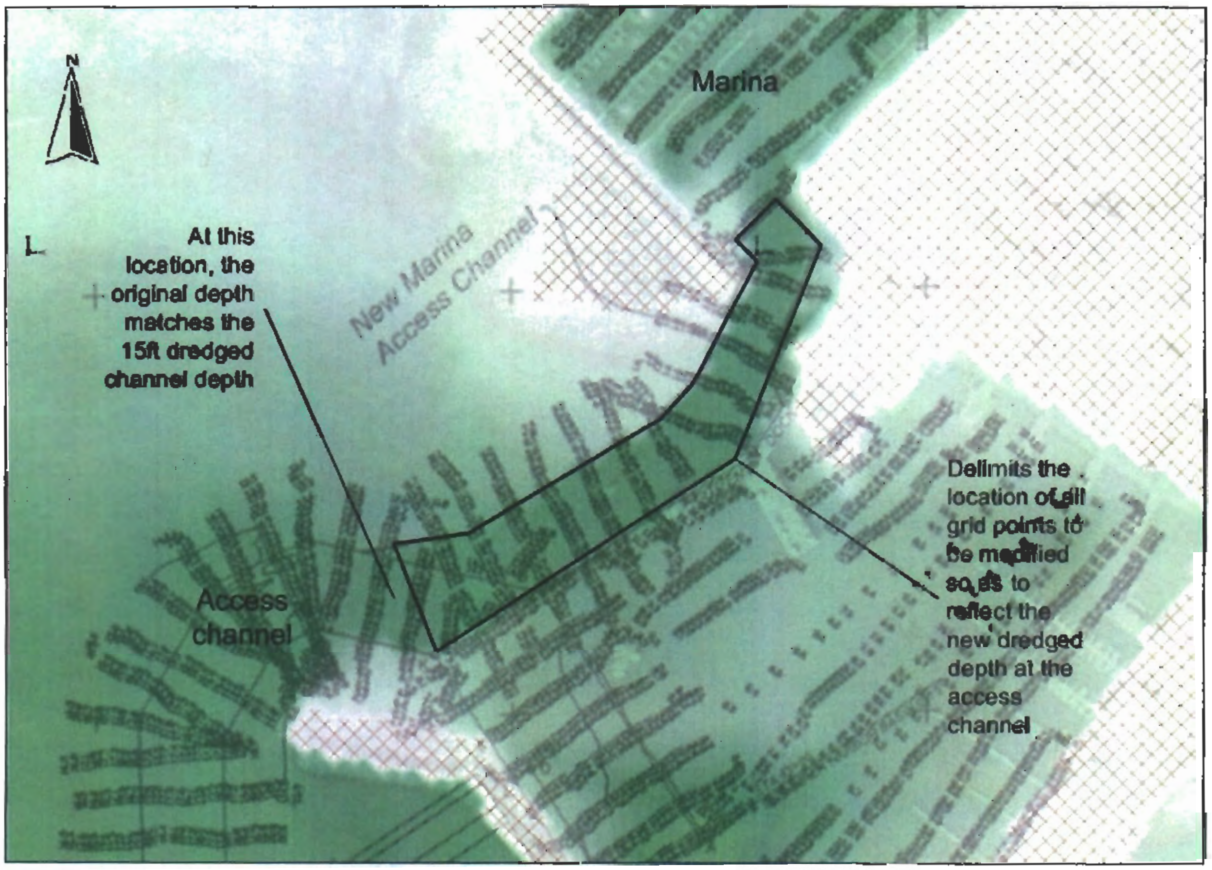



*Figure 7.10 Updated bathymetry based on USACE hydrographic survey and a 15-ft (4.572m) dredge depth.*

### 7.3.2 Results

The velocities determined for the dredged bathymetry have been compared with the flow velocities determined for the existing bathymetry at various locations near the marina for the case of tsunami events with a recurrence interval of 25 years and for the design case of 50 years.

**Single Point Data Collection**

The comparison of the dredged (D) and non-dredged (ND) cases involves a large number of grid-points over a long time period. Data is collected from the probes allocated within the model domain. Each probe collects data at one location. In general, the probes form are positioned on a grid that coincides with the region where large velocities tend to develop. A total of 32 probes were utilized. Their positions in the UTM Zone 10 system of coordinates (in meters) are as follows.

| Probe name | X [m] | Y [m] | Probe name | X [m] | Y [m] |
|---|---|---|---|---|---|
| **M1** | 401487.6 | 4622449.7 | **AC3** | 401536.5 | 4622336.8 |
| **M2** | 401504.2 | 4622434.4 | **AC4** | 401526.1 | 4622325.3 |
| **M3** | 401521.6 | 4622417.0 | **AC5** | 401517.1 | 4622313.5 |
| **M4** | 401539.0 | 4622399.0 | **AC6** | 401504.9 | 4622300.0 |
| **M5** | 401527.5 | 4622385.4 | **AC7** | 401495.2 | 4622290.6 |
| **M6** | 401509.4 | 4622402.8 | **AC8** | 401510.5 | 4622274.3 |
| **M7** | 401491.0 | 4622420.5 | **AC9** | 401526.8 | 4622260.0 |
| **M8** | 401474.7 | 4622433.7 | **AC10** | 401521.3 | 4622285.7 |
| **M9** | 401462.5 | 4622418.8 | **AC11** | 401534.1 | 4622300.0 |
| **M10** | 401479.9 | 4622405.6 | **AC12** | 401544.9 | 4622310.0 |
| **M11** | 401497.6 | 4622388.2 | **AC13** | 401555.0 | 4622321.5 |
| **M12** | 401515.3 | 4622371.5 | **AC14** | 401564.7 | 4622333.3 |
| **M13** | 401541.1 | 4622373.3 | **AC15** | 401569.2 | 4622310.7 |
| **M14** | 401529.2 | 4622359.4 | **AC16** | 401558.8 | 4622298.2 |
| **AC1** | 401555.3 | 4622360.8 | **AC17** | 401548.0 | 4622287.1 |
| **AC2** | 401545.9 | 4622346.9 | **AC18** | 401537.2 | 4622272.9 |

*Table 7.6 Locations of probes utilized for comparison of flow data for dredged and existing bathymetry.*

Together, the probes provide an evenly distributed grid covering the elbow segment of the access channel leading to the marina. The locations of the probes are shown in Figure 7.11.

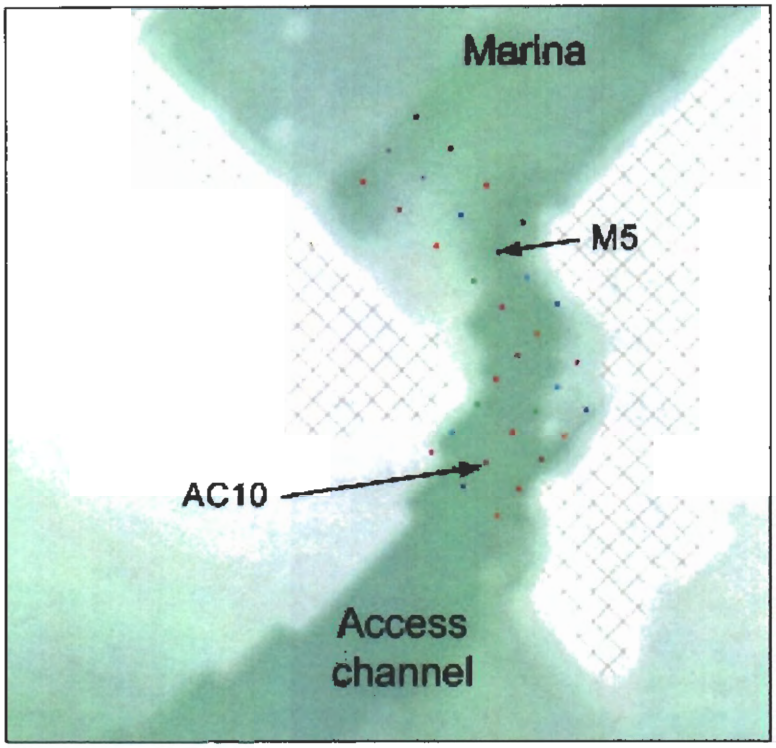
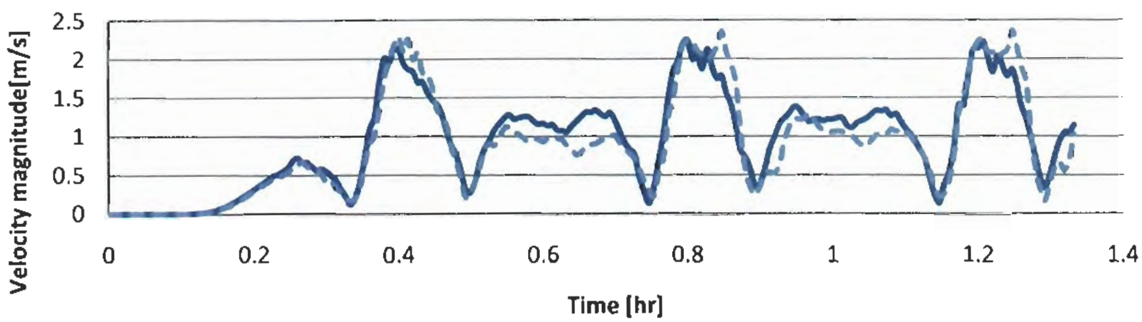



*Figure 7.11 Locations of probes utilized for extraction of flow velocities.*

**Comparison of Results**

Time series of the data collected at the probes, for both the dredged and existing bathymetry have been compared and analyzed. Only the M5 (top figure) and AC10 (bottom figure) are shown in Figure 7.12. In both plots, the dotted line represents the velocity magnitude recorded for the existing bathymetry.



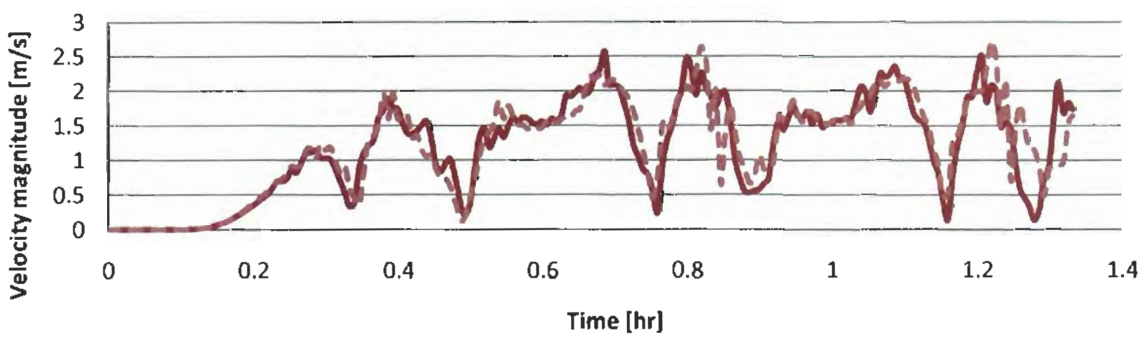




*Figure 7.12 Marina (top figure) and access channel (bottom figure) sample velocity distribution vs. time at locations M5 and AC10, respectively.*

The evolution of the time series at a given probe follows the same pattern. This applies to all the time series recorded, including those not shown here. This enables the application of a simplified process to compare each data set. Namely, because it can be reasonably assumed that the two functions are not shifted in time with respect to each other (i.e., there is no phase lag between the two functions), a point-by-point comparison can be performed. For the probes located in the marina, this is done by calculating the difference

$$\Delta M_i(t) = f^{D}_{M_i}(t) - f^{ND}_{M_i}(t), i = 1 \ldots 14$$

and at the access channel

$$\Delta AC_i(t) = f^{D}_{AC_i}(t) - f^{ND}_{AC_i}(t), i = 1 \ldots 18$$

By analyzing whether the difference is positive or negative allows for an easier reporting of the number of time over the duration of the experiment where the dredged-channel velocity is greater than its non-dredged channel counterpart. It gives a general sense of the evolution of the flow velocity. This is done using a straightforward logical test:

$$\delta_i(t_k) = \begin{cases} 1 \text{ if } \Delta M_i(t_k) > 1 \\ 0 \text{ if } \Delta M_i(t_k) = 0 \\ -1 \text{ otherwise} \end{cases}$$

This information is shown in the two histograms, Figure 7.13 and Figure 7.14. The accompanying data tables featuring the average and maximum values recorded at each probe are provided in the next subsection.

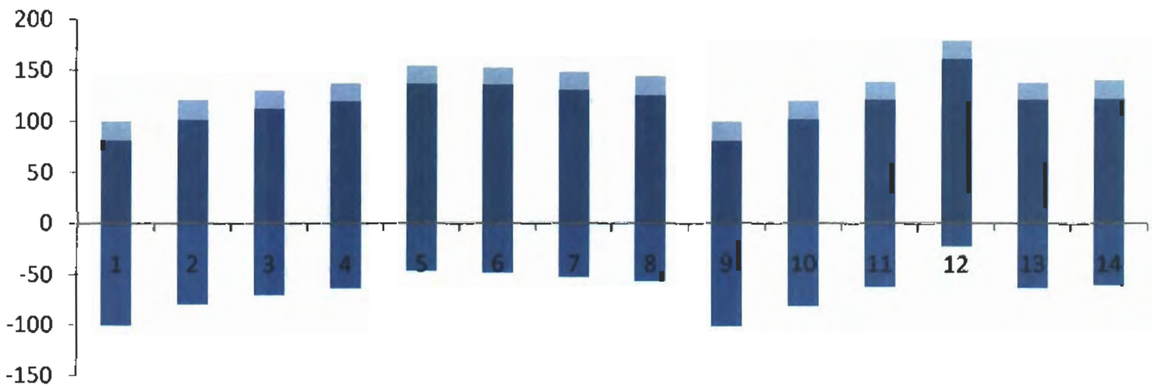



*Figure 7.13 Number of occurrences where difference function values at each marina probes* $M_i$ *are positive (darkest shade) or negative (in lighter shade; lightest shade is when values are equal). This indicates whether the dredged velocity magnitude is greater or smaller, respectively.*

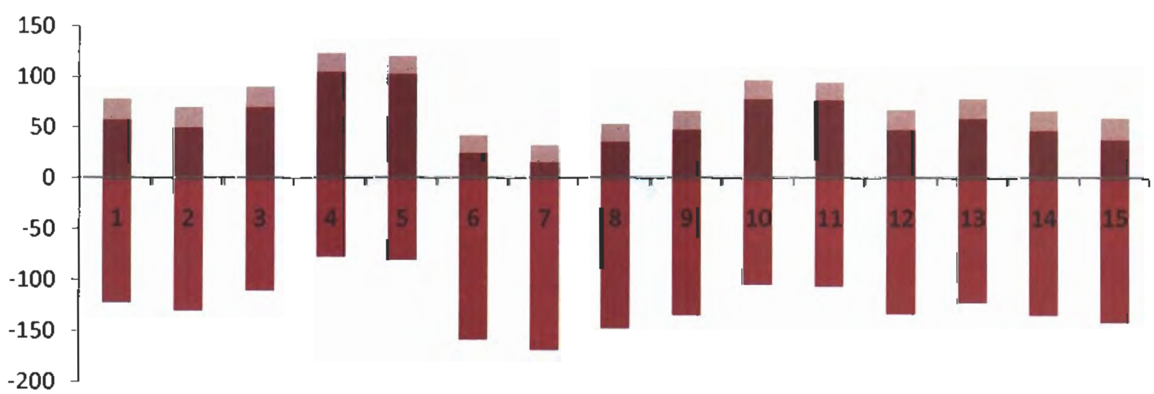



*Figure 7.14 Same as previous figure but for the access channel probes,* $AC_i$.

**Average and Maximum Values**

In addition to the overall trend followed by the velocity field at the aforementioned locations, the maximum and average values are also reported in Table 7.7 and Table 7.8. A common characteristic to all the probes is that the maximum velocities are always recorded pre-dredging. However, the average velocity magnitude remains larger (except for two access channel probes) for the non-dredged case. This can be explained physically by a smoother, more uniform channel cross-section.

At the marina (blue-themed histograms), it is therefore concluded that the flow velocities are slightly greater in general when the channel is dredged. For example, measurements from M12 show that the current velocity is in majority greater or equal to that developing when the channel is not dredged. On the contrary, the relative magnitude of velocity field at the access channel (red-themed histograms) is significantly reduced when dredging has occurred. For example, at the probe AC5 located the farthest from the mouth of the marina, almost all sampled velocities lie below their non-dredged counterparts.

| Probe | Dredged | | Non-dredged | |
|---|---|---|---|---|
| | Average value [fps] | Max [fps] | Average value [fps] | Max [fps] |
| **M1** | 1.59 | 6.19 | 1.82 | 7.31 |
| **M2** | 2.14 | 7.86 | 2.31 | 8.35 |
| **M3** | 2.63 | 8.33 | 2.71 | 8.80 |
| **M4** | 2.94 | 7.36 | 2.88 | 6.96 |
| **M5** | 3.12 | 7.34 | 2.94 | 7.75 |
| **M6** | 2.33 | 6.79 | 2.15 | 6.82 |
| **M7** | 1.72 | 5.54 | 1.55 | 5.41 |
| **M8** | 1.32 | 4.33 | 1.17 | 4.30 |
| **M9** | 0.65 | 1.59 | 0.87 | 2.78 |
| **M10** | 1.14 | 3.27 | 1.21 | 2.92 |
| **M11** | 1.95 | 5.57 | 1.84 | 4.57 |
| **M12** | 3.02 | 7.41 | 2.61 | 6.11 |
| **M13** | 3.33 | 7.97 | 3.25 | 8.52 |
| **M14** | 3.36 | 6.47 | 3.15 | 7.10 |

*Table 7.7 Flow parameters extracted from probes for tsunami event with recurrence interval of 25 years on average.*

| Probe | Dredged | | Non-dredged | |
|---|---|---|---|---|
| | Average value [fps] | Max [fps] | Average value [fps] | Max [fps] |
| AC1 | 2.16 | 5.88 | 2.51 | 7.38 |
| AC2 | 2.75 | 6.64 | 3.05 | 8.33 |
| AC3 | 3.49 | 6.62 | 3.63 | 7.41 |
| AC4 | 3.90 | 7.94 | 3.68 | 7.51 |
| AC5 | 3.91 | 8.54 | 3.78 | 8.08 |
| AC6 | 2.62 | 5.72 | 3.42 | 6.62 |
| AC7 | 2.97 | 6.37 | 4.27 | 8.95 |
| AC8 | 3.66 | 8.17 | 4.23 | 8.23 |
| AC9 | 2.94 | 6.24 | 3.57 | 7.29 |
| AC10 | 3.86 | 8.44 | 3.96 | 8.94 |
| AC11 | 3.55 | 7.58 | 3.63 | 9.44 |
| AC12 | 3.23 | 6.89 | 3.56 | 10.20 |
| AC13 | 2.57 | 6.56 | 2.79 | 8.30 |
| AC14 | 1.98 | 5.12 | 2.42 | 6.44 |
| AC15 | 2.10 | 5.50 | 2.49 | 6.29 |
| AC16 | 2.27 | 6.28 | 2.66 | 7.02 |
| AC17 | 2.82 | 7.22 | 3.18 | 8.20 |
| AC18 | 3.10 | 8.02 | 3.66 | 8.88 |

*Table 7.8 Flow parameters extracted from probes for tsunami event with recurrence interval of 25 years on average.*

The above data is plotted in Figure 7.15. It shows how, on average, the flow velocities decrease in the access channel. It can be concluded that the current velocity is slightly decreased in the access channel after dredging. However, the current velocity tends to increase *on average* in the marina. Higher spikes in the local velocity field are also recorded. Overall, dredging favors a redistribution of the flow over the whole cross-section of the access channel. Therefore, some regions that were initially not exposed to high currents are now subject to higher flow velocities. This evolution is seen in the series of comparative snapshots reported in Figure 7.16.

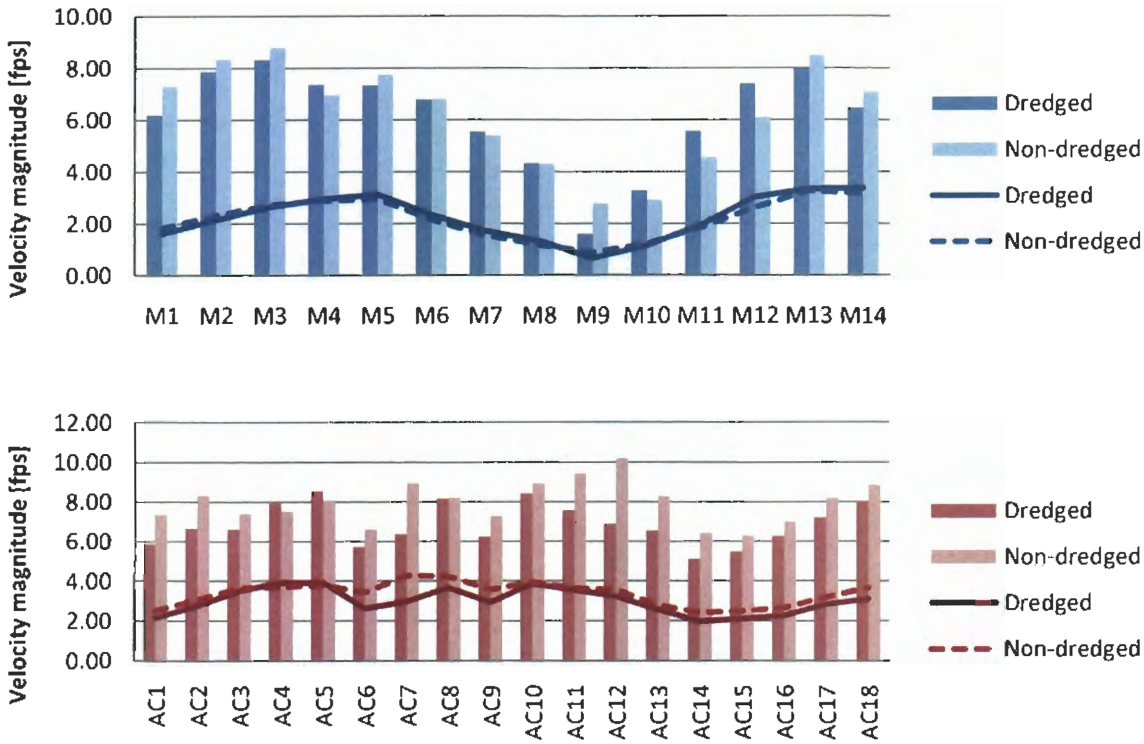



*Figure 7.15 Maximum values (histogram) and average (solid lines) for the dredged (darker share) and non-dredged (lighter shade) cases for probes located in the marina (top figure) and access channel (bottom figure).*

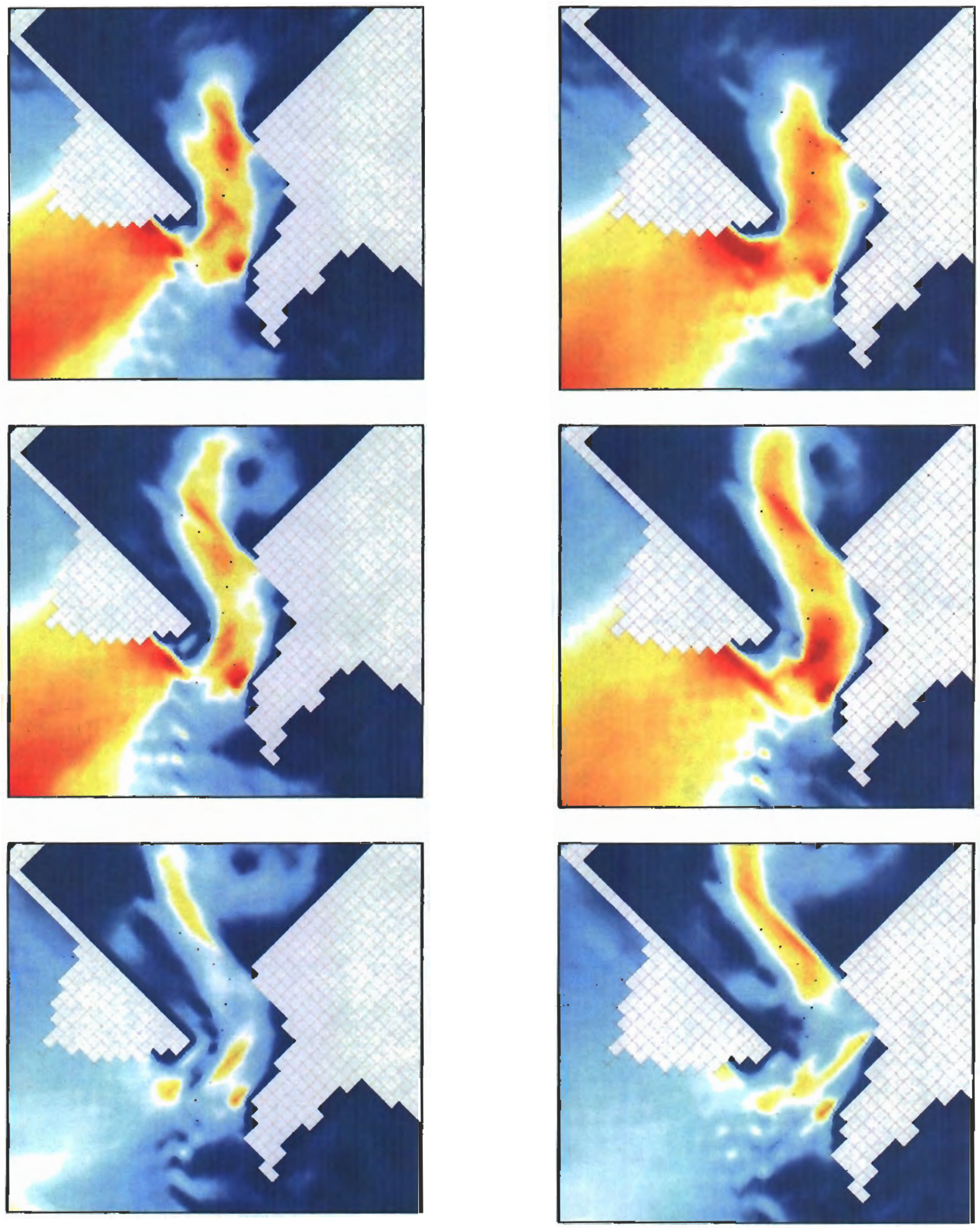


*Figure 7.16 Comparative analysis of the dredged and non-dredged conditions in the access channel. Left column is non-dredged channel conditions; right column is dredged conditions. Sequence is in chronological order, from top to bottom; sequence interval is 2 minutes starting at 48 minutes.*

## 7.4 Effect of Dredged Inner Boat Basin

In this section, the impact of dredging of the inner boat basin on the flow velocities is considered. It is assumed that the bathymetry in the access channel remains unchanged. The design wave height is set to $H_s = 15$ ft; the period is unchanged at $T = 1440$ s; the tidal elevation is MHHW.

The general global structure of the velocity field is not affected by dredging: it features the same circulation patterns as those observed and reported in Section 7.2.1. Locally, however, an increase in magnitude for the velocity profile is observed near Dock H. Its coordinates are indicated in Table 7.1. For illustrative purposes, a comparison is limited to a single time series. The two time series, for simulations with existing and after dredging are plotted in Figure 7.17.

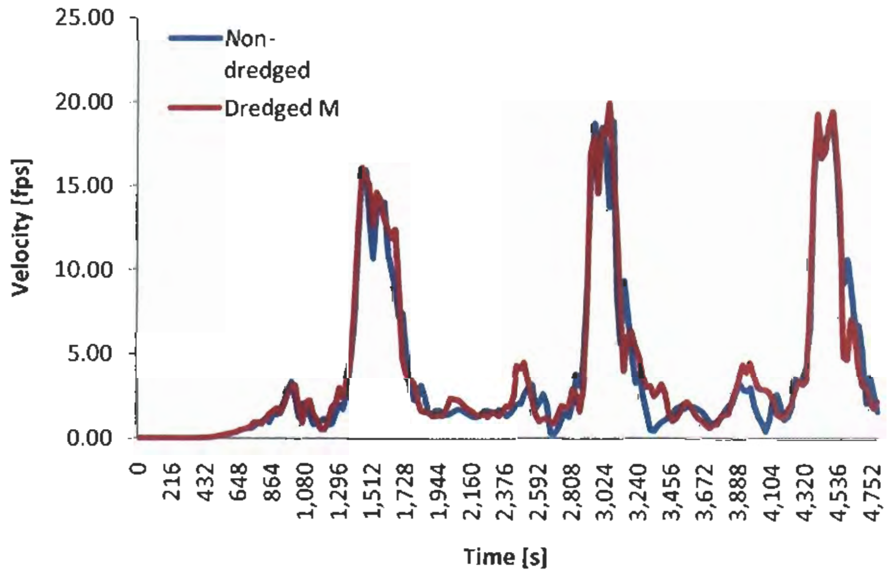



*Figure 7.17 Comparison between the original and dredged inner boat basin conditions*

The maximum velocity for the dredged case $V_{\text{Max, Dredged}} = 19.87$ ft·s$^{-1}$, compared to $V_{\text{Max, non-dredged}} = 19.14$ ft·s$^{-1}$ for the existing case. Overall, the difference in the velocity field before and after dredging remains insignificant.

## 7.5 Dredged Inner Boat Basin and Access Channel

The design wave height is set to $H_s = 15$ ft. Again, no major change in the flow structure is observed. Small variations in the velocity profile near Dock H are observed and are plotted in Figure 7.18 below. Overall, the combination of dredged conditions tends to reduce the velocity magnitude in the marina.

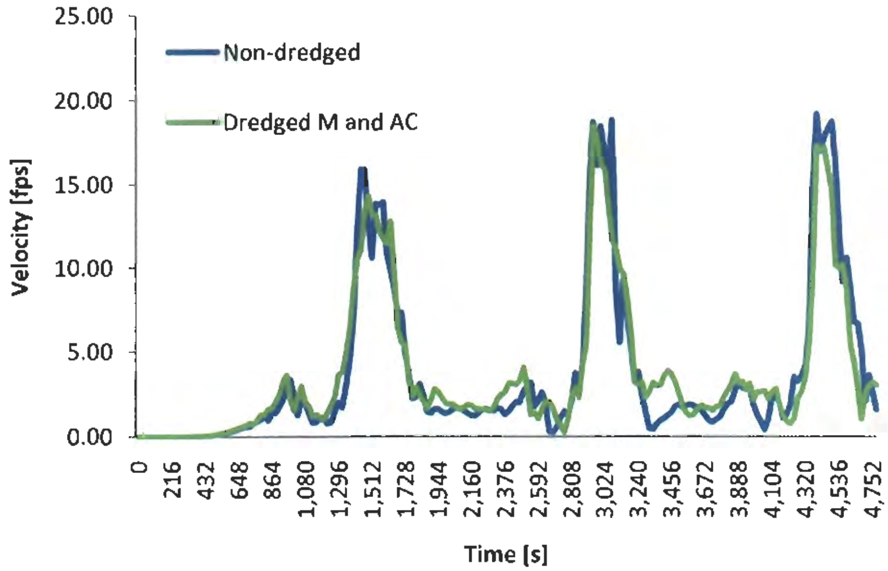



*Figure 7.18 Comparison of velocity time series between the original and fully dredged inner boat basin and access channel conditions*

## 7.6 Addition of Wall in Inner Boat Basin

In addition to dredging, the possibility of adding a wall to redirect the high velocity flow region from the center of the marina to a more confined area is now explored. Contrary to the time series analysis conducted in the previous section, the approach following in this section is more qualitative. It is based on the comparison between maximum values in the marina and their location over time. In this particular case, the design wave height is set to $H_D = 6.4$ ft.

### 7.6.1 Methodology

It is assumed that the wall replaces dock H. The presence of a solid wall significantly affects the velocity distribution in the marina. A solid wall represents dock H, as shown in Figure 7.19. The resolution of the new wall placement in the Cartesian grid is consistent with the size of the grid cells, presently set to 30 ft by 30 ft (10 m by 10 m).

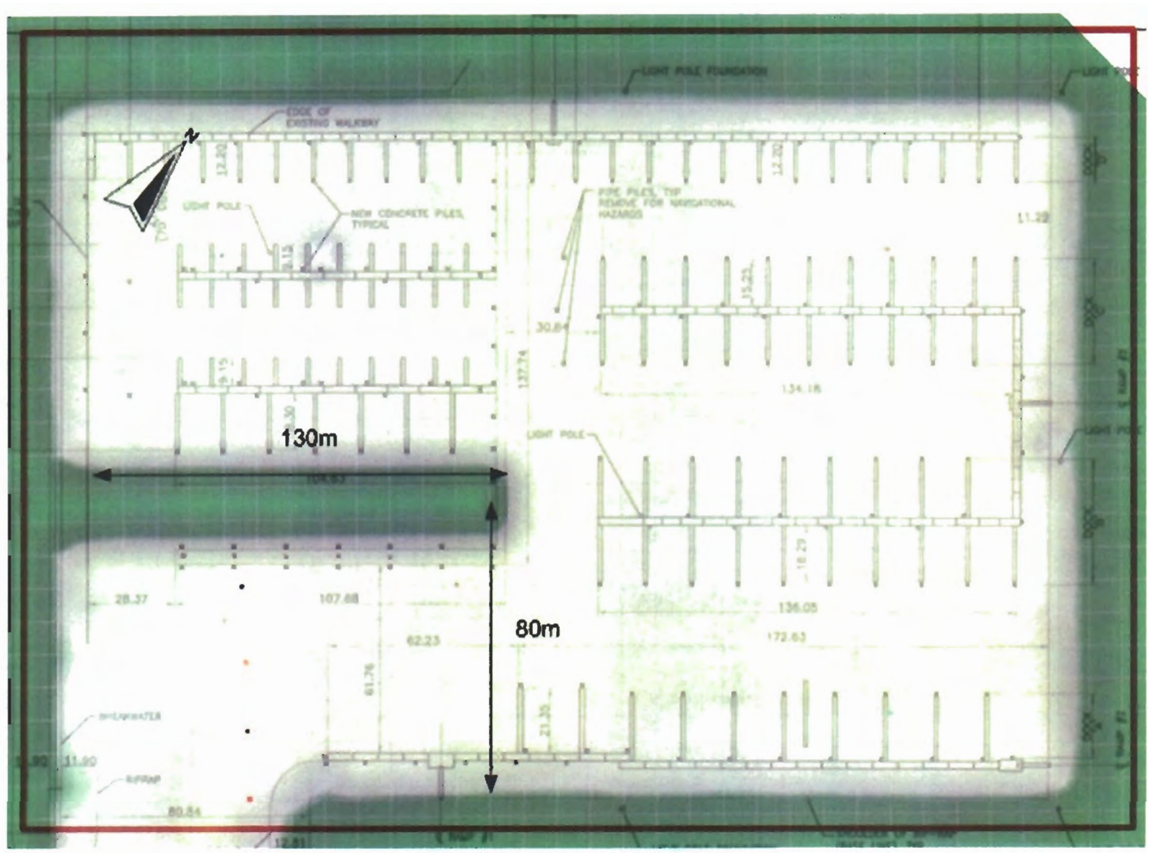



*Figure 7.19* *The Cartesian grid (light gray) is shown here overlaid by the marina dock network. A solid wall represents Dock H.*

### 7.6.2 Comparison with the actual case

The addition of the wall appreciably impacts the structure of the flow in the marina. The most important effect is the displacement of the high velocity region.

**Maximum Velocities**

In terms of maximum velocity magnitude, there is no significant difference between the cases with and without a wall. For a tsunami event with a recurrence interval of 25 years on average, the modified layout produces a maximum velocity of 9.78 fps (2.98 m/s) near the wall when the latter is present; as opposed to a maximum velocity of 8.50 fps (2.59 m/s) when it is not. For illustration, contour plots of the velocity magnitude have been superimposed for each case. This allows for a time history of the locations where high current are present. The limits of the contour plots shown below are as follows. Each line represents a 1 fps (0.3 m/s) increment; only those velocity magnitudes ranging from 4.92 fps (1.5 m/s) to 9.84 fps (3.0m/s) and above are plotted for clarity.

The presence of a solid wall deflects the jet toward the back part of the inner harbor. Also, it creates two secondary recirculation currents that are visible at timestamp 52:00. The selection of snapshots in the figures below was conducted so as to help visualize the development of the jet. Before t = 48:00 and after t = 53:12, other high velocity regions not present for the no-wall case are visible in the marina; however their location and relatively minor intensity and extent do not warrant additional consideration. Finally, it should be noted that the peak velocity magnitude increases when the wall is added.

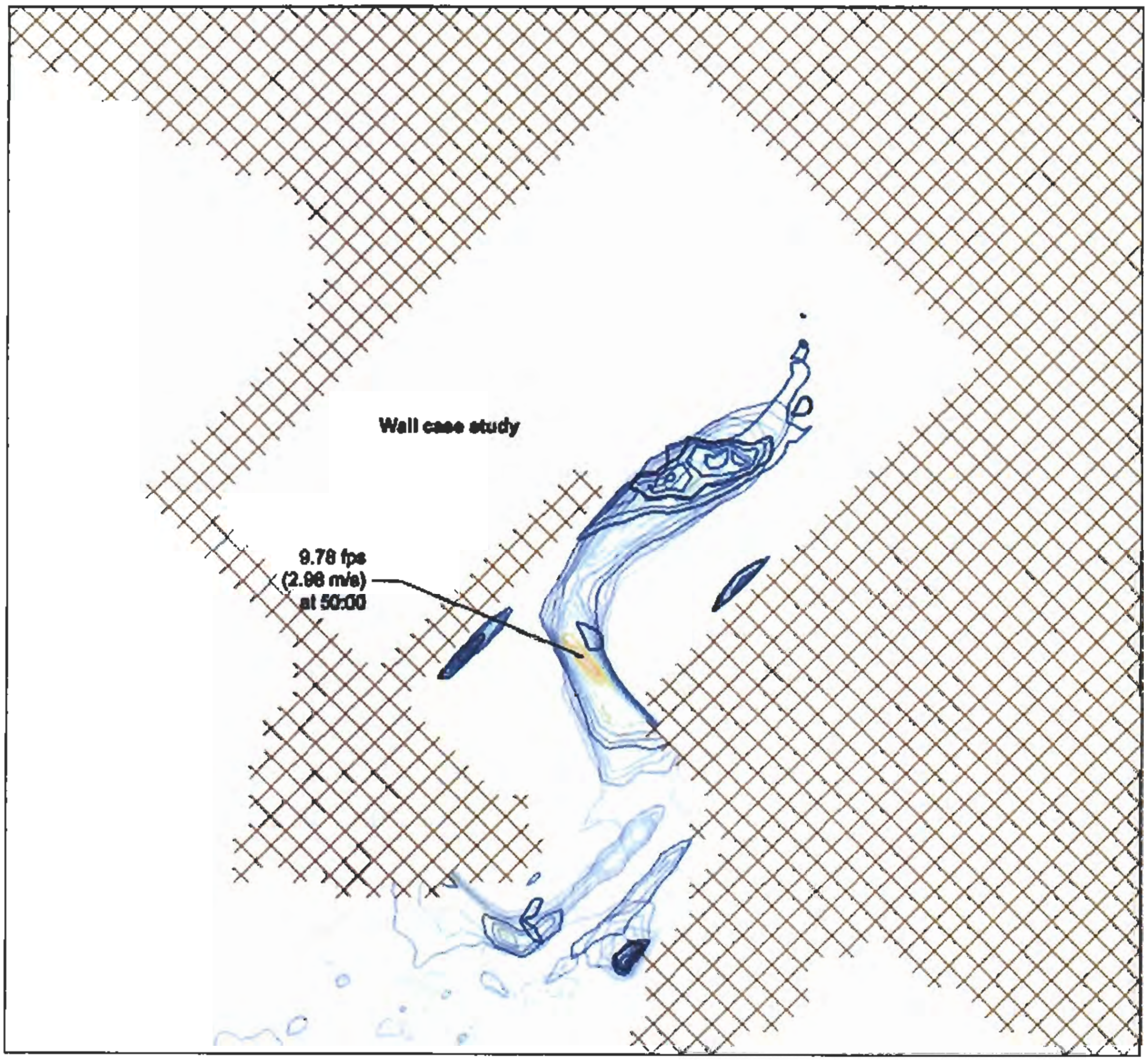



*Figure 7.20 Influence of solid wall in lieu of Dock H. Sequence of snapshots of high-velocity regions; time span: t = 48:00 to t = 53:12.*

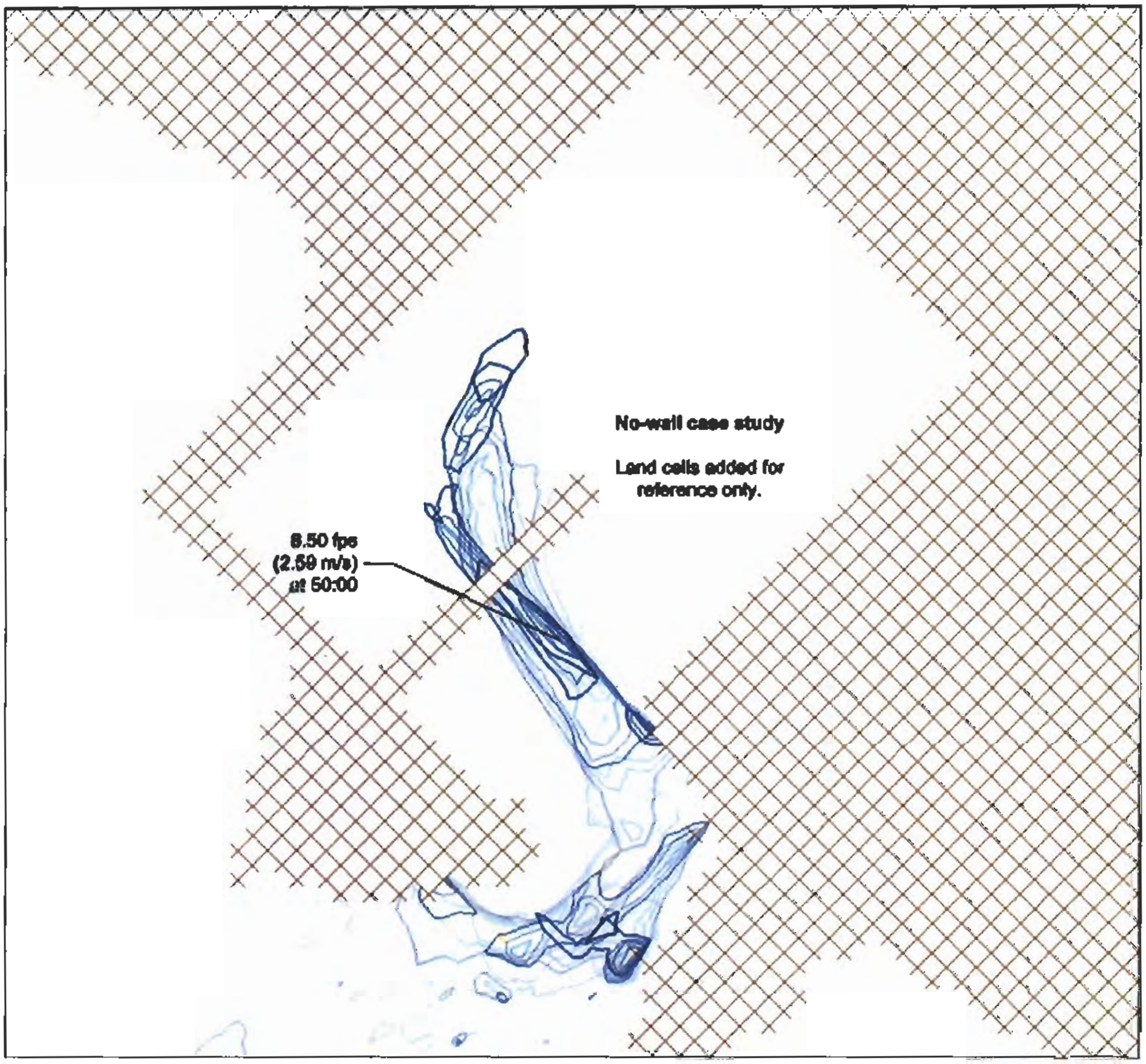



*Figure 7.21* *Same as previous figure but for the no-wall case study. Time span: t = 00:48:00 to t = 00:53:12 (hh:mm:ss).*

# 8 Basis of Design

In the following, a basis of design is provided, which details the information, parameters, and available codes, guidelines, and recommendations applicable to the hydrodynamic design for rehabilitation of the Crescent City Marina.

## 8.1 Project Information

Crescent City is located in the northern part of California, approximately 16 miles south of the Oregon State boundary. Commercial and sport fishing boats operate out of the harbor. Waterborne traffic in the harbor is in the receipt of gasoline and fuel oils. The long wharf in the western part of the harbor is used by fishing vessels to offload fish. Citizens Dock, a Y-shaped pier is located on the north side of the harbor. Several fish houses are on the pier, where fishing boats unload their catch along the pier. The Inner Boat Basin features mooring floats for commercial fishing boats and can accommodate about 250 boats, ref. [01].

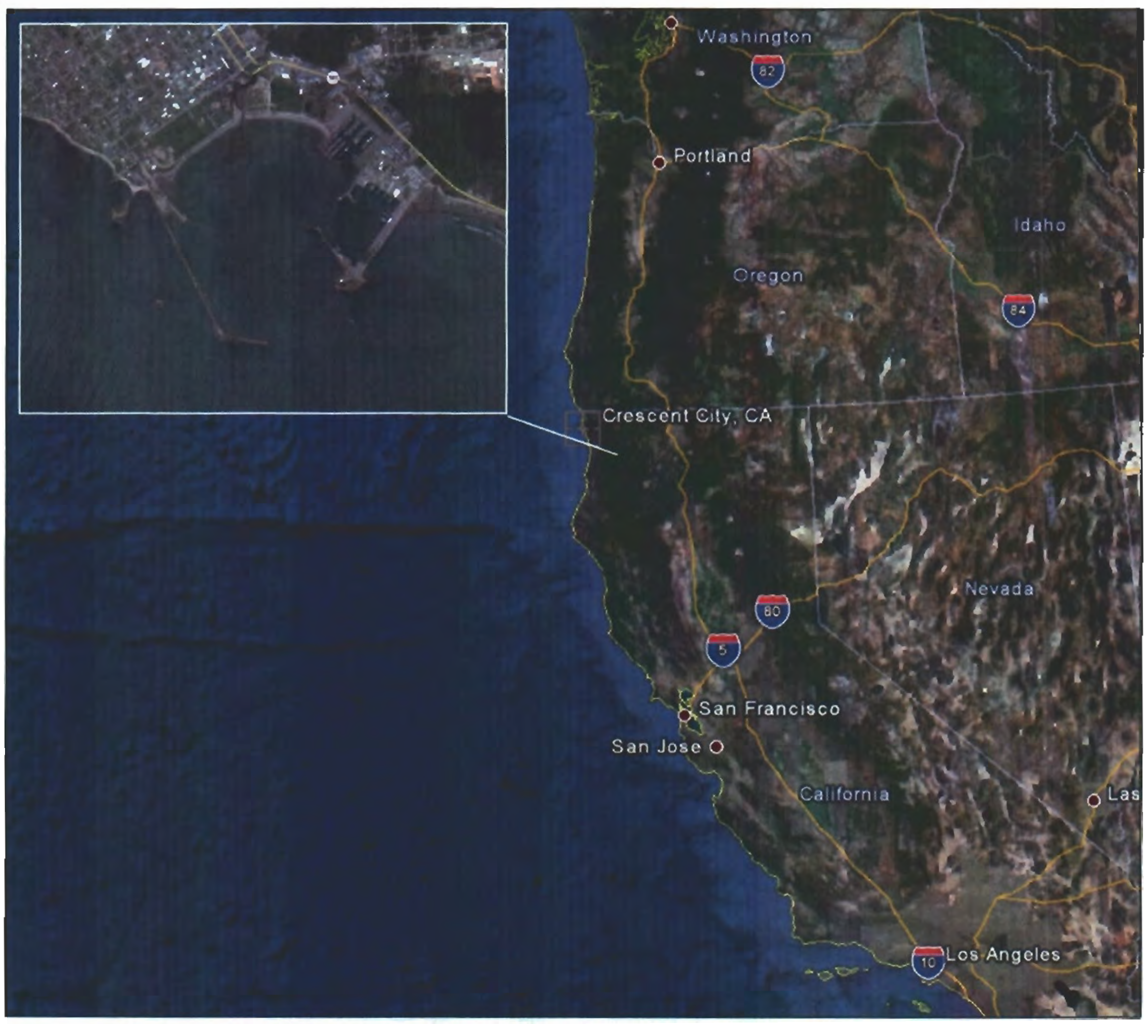



*Figure 8.1 Location of Crescent City.*

## 8.2 Governing Codes and Regulations

### 8.2.1 List of Codes and Standards

The following codes, guidelines, and recommendations are applicable to the hydrodynamic design for the marine structures and related items:

- *Layout & Design Guidelines for Marina Berthing Facilities.* California Department of Boating and Waterways, Boating Facilities Division, 2000 Evergreen Street, Suite 100, Sacramento, California 95815-3888, July 2005.
- *Coastal Engineering Manual (CEM).* U.S. Army Corps of Engineers. 2002. Engineer Manual EM 1110-2-1100, U.S. Army Corps of Engineers, Washington, D.C. (in 6 volumes).
- *Floating Breakwaters. A Practical Guide for Design and Construction.* Report of Working Group 13 of the Permanent Technieal Committee II. Supplement to Bulletin No. 85 (1994) PIANC Permanent International Association of Navigation Congress.
- *Disability Access Guidelines for Recreational Boating Facilities.* Final Report of Working Group 14 of the Recreational Navigation Commission. PIANC International Navigation Association, 2004.
- *Military Handbook - Piers and Wharves.* MIL-HDBK-1025/1, Department of Defense, 30 June 1994, Washington, D.C.
- *Military Handbook - Mooring Design.* MIL-HDBK-1026/4A, Department of Defense, 1 July 1999, Washington, D.C.
- *Harbors Design Manual.* NAVFAC DM-26.1, Department of the Navy, Alexandria, VA, 1984.

## 8.3 Surveys and Datum

### 8.3.1 Bathymetric Surveys

A hydrographic survey has been provided by Stover Engineering per 10-14-2009 for the Inner Boat Basin and associated structures, ref. [21]

The latest survey data available for the navigation channel through the harbor to the marina is provided in the condition survey for Crescent City, conducted by the US Army Corps of Engineers on 16-17 March 2008, ref. [22].

General bathymetric data for the harbor basin and surrounding waters can be found on NOAA chart 18603: St. George Reef and Crescent City Harbor, ref. [02].

Bathymetric data for the offshore waters outside of Crescent City can be found on NOAA chart 18010: Monterey Bay to Coos Bay, ref [23].

### 8.3.2 Horizontal Control

**General**

The horizontal location is the California State Plane Coordinate (SPC) system, Zone 1.

**Inner Boat Basin Alignment**

The Inner Boat Basin is bounded by the following geographical coordinates:

| | |
|---|---|
| North corner: | 41° 45' 00.62" N<br>124° 11' 02.46" W |
| South corner: | 41° 44' 50.31" N<br>124° 11' 02.31" W |
| East corner: | 41° 44' 55.48" N<br>124° 10' 55.47" W |
| West corner: | 41° 44' 53.01" N<br>124° 11' 11.40" W |
| Center of breakwater head: | 41° 44' 47.75" N<br>124° 11' 05.14" W |

The coordinates should be verified and detailed prior to construction.

### 8.3.3 Vertical Control

Vertical Datum: MLLW at 0.0 ft.

## 8.4 Dredging

### 8.4.1 Site Stratification

The seabed within the Inner Boat Basin consists of sand and sandy clay, over a layer of gravel, overlying bedrock, ref. [24].

- Seabed approx at El. -12 ft
- Sand, sandy clay, and clay approx. El. -12 down to El. -13 to -15.
- Gravel, approx. El. -13 to -15 down to El. -16 to -17.
- Rock, approx. El. -16 to -17 and down.

All elevations are with respect to MLLW.

### 8.4.2 Dredged Slopes

No dredging is anticipated as part of this design. However, all slopes shall be designed to ensure that structures are not undermined.

## 8.5 Scour Protection

The pilings for the marina floats will be socketed in bedrock, and scour protection is therefore not anticipated.

## 8.6 Breakwaters and Slope Protection

The original drawings from the construction of the Inner Boat Basin, ref. [24], provide details of the rubble structures, breakwater and slope protection around the marina.

## 8.7 Environmental Data

### 8.7.1 Wind Speeds

Wind recordings obtained by the Western Regional Climate Center for Crescent City from 1984 through 2005 provide a basis for assessment of the long term wind statistics at the site. The wind data is available at www.wrcc.dri.edu/cgi-bin/rawMAIN.pl?idC027. A frequency analysis of the data yields the following wind speed statistics for the eight main compass directions.

| Wind Speed [knots] | Wind direction | | | | | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | |
| 0-5 | 3.8 | 1.7 | 1.5 | 1.5 | 1.8 | 1.7 | 2.1 | 2 | 2.1 | 1.3 | 1.1 | 1 | 1.4 | 1.5 | 2 | 2.2 | 28.8 |
| 5-10 | 2.4 | 1.2 | 0.8 | 0.7 | 1.7 | 2.2 | 3.2 | 3.5 | 2.2 | 0.9 | 0.5 | 0.4 | 0.7 | 1.2 | 2.7 | 3.6 | 27.9 |
| 10-15 | 1.7 | 0.5 | 0.1 | 0.1 | 0.3 | 0.4 | 1.7 | 2.8 | 1.4 | 0.4 | 0.2 | 0.2 | 0.2 | 0.4 | 1.9 | 3.3 | 15.8 |
| 15-20 | 1.8 | 0.2 | 0.1 | - | - | 0.1 | 0.9 | 2.1 | 1.3 | 0.4 | 0.2 | 0.1 | 0.1 | 0.2 | 1.5 | 4.1 | 13.1 |
| 20-25 | 0.8 | - | - | - | - | - | 0.4 | 1.2 | 0.8 | 0.2 | 0.1 | - | - | 0.1 | 0.9 | 3.6 | 8.4 |
| 25-30 | 0.4 | - | - | - | - | - | 0.2 | 0.6 | 0.5 | 0.1 | - | - | - | 0.1 | 0.6 | 2 | 4.6 |
| 30-35 | 0.1 | - | - | - | - | - | - | 0.2 | 0.1 | - | - | - | - | 0.1 | 0.1 | 0.6 | 1.3 |
| 35-40 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.1 |
| >40 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total | 11.1 | 3.6 | 2.6 | 2.3 | 3.7 | 4.4 | 8.5 | 12.6 | 8.6 | 3.3 | 2.1 | 1.8 | 2.4 | 3.7 | 9.8 | 19.5 | 100.0 |

*Table 8.1 Probability of occurrence (in %) that winds occur in the given speed and direction class.*

As seen from Table 8.1, predominant winds are from north-northwest and south-southeast and the highest wind speeds occur from these directions also. Figure 8.2 shows the tabulated data for all wind speeds and directions in the form of a wind rose.

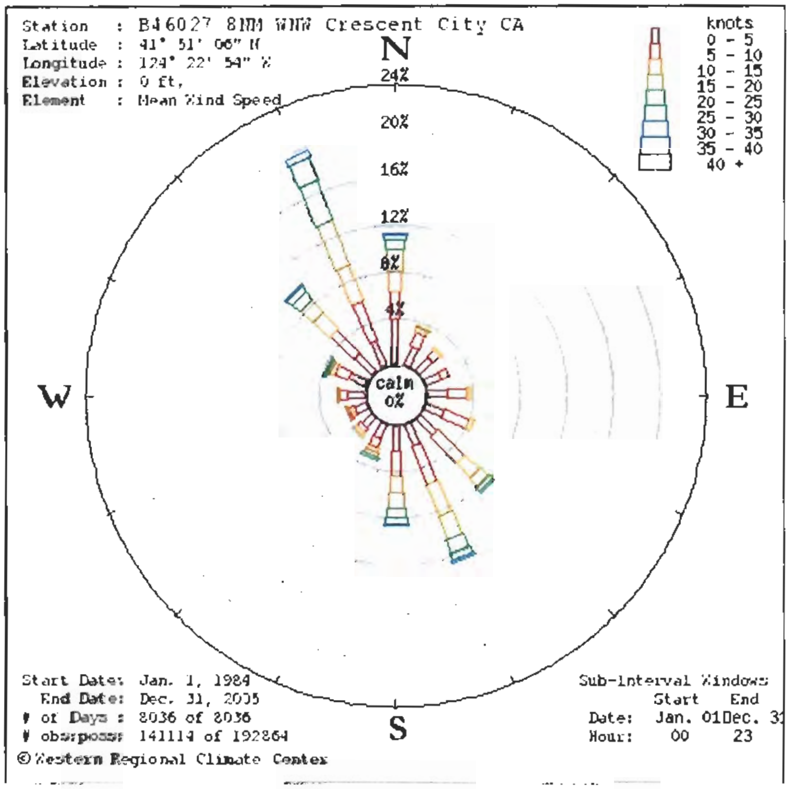



*Figure 8.2 Wind rose for Crescent City, CA.*

Ref. [01] notes that the western breakwater gives good protection from north-westerly winds for vessels anchored in the outer harbor, but the harbor is open to the south. The basin north of Whaler Island provides excellent anchorage for small craft. However, vessels anchored in the harbor should take precaution against a local south-easterly wind known as the kick back or back draft, which frequently blows with considerable violence. This wind follows only periods of strong north-westerly winds outside. It usually starts in the early afternoon and ends about midnight.

Based on the wind statistics, recurrence intervals for the occurrence of given wind speeds and directions have been developed and are shown in Figure 8.3.

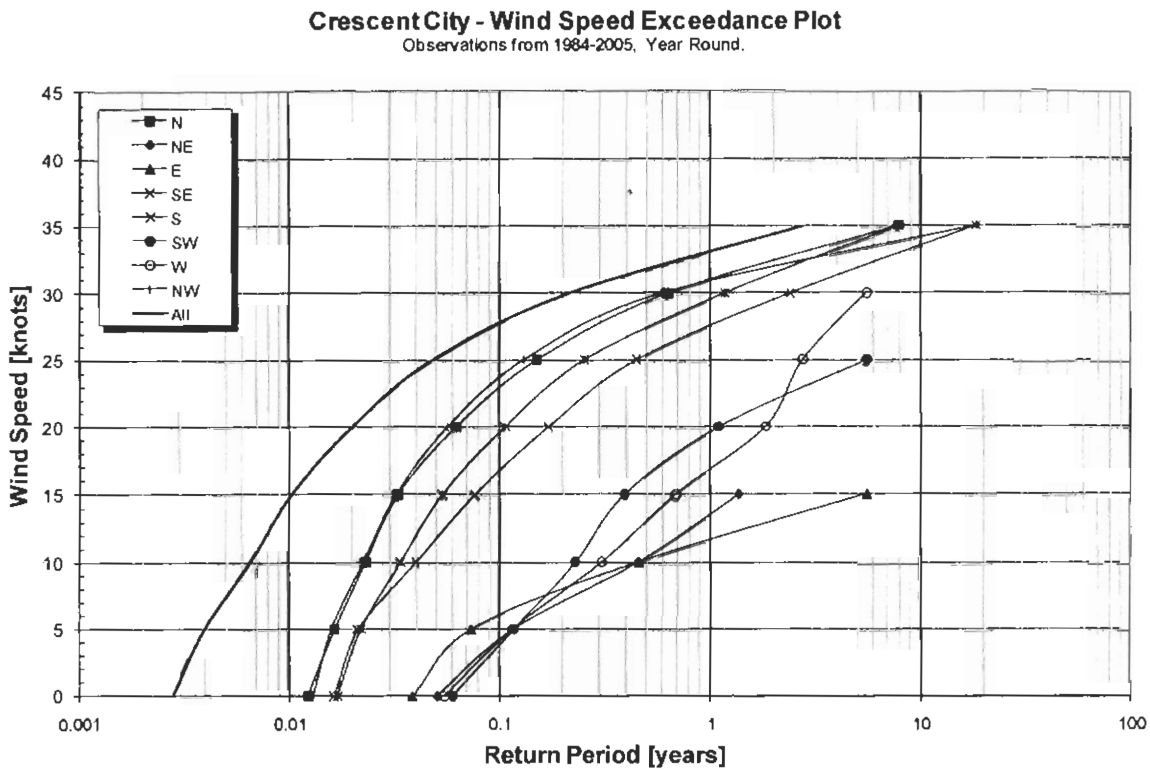



*Figure 8.3 Wind Speed Exceedance Plot for observations from 1984-2005, Year Round.*

Based on the wind speed exceedance plot, the following return periods for wind speeds have been established:

| Exceedance Frequency | Mean Hourly Wind Speed [knots] | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW |
| 1 hr/1 year | 27 | 14 | 9 | 8 | 10 | 12 | 24 | 30 | 28 | 20 | 15 | 10 | 10 | 21 | 28 | 32 |
| 1 hr/10 years | 34 | 23 | 20 | 13 | 15 | 19 | 34 | 35 | 34 | 31 | 26 | 21 | 20 | 37 | 33 | 35 |
| 1 hr/25 years | 37 | 27 | 25 | 15 | 18 | 22 | 38 | 38 | 37 | 35 | 30 | 25 | 25 | 39 | 36 | 37 |
| 1 hr/50 years | 38 | 30 | 27 | 17 | 19 | 24 | 41 | 39 | 38 | 38 | 33 | 28 | 27 | 41 | 37 | 38 |

*Table 8.2 Mean hourly wind speeds estimated for Crescent City, CA.*

It can be seen that the highest 50-year hourly mean wind speeds reach 41 knots from southeast and west-northwest.

### 8.7.2 Currents

Tidal currents are estimated to be negligible compared to currents generated by tsunami waves.

The peak tsunami-induced currents within the Inner Boat Basin estimated for design purposes vary between the docks in the marina. The highest velocities identified were as follows:

| Dock | Peak Flow Velocity | | |
|---|---|---|---|
| | [fps] | [m/s] | [knots] |
| H | 19.26 | 5.87 | 11.4 |
| G | 17.82 | 5.43 | 10.6 |
| F | 14.27 | 4.35 | 8.5 |
| E | 12.71 | 3.88 | 7.5 |
| B | 8.16 | 2.49 | 4.8 |
| C | 9.30 | 2.83 | 5.5 |
| D | 12.00 | 3.66 | 7.1 |
| A | 8.56 | 2.61 | 5.1 |
| W | 12.02 | 3.66 | 7.1 |

### 8.7.3 Water Levels

**Astronomical Tides**

Astronomical tides are evaluated per NOAA Station 9419750 (41° 44.7' N; 124° 11.0' W) as follows:

| El. [ft] | Abbr. | Description |
|---|---|---|
| +10.66 | HOWL | Highest Observed Water Level. |
| +6.87 | MHHW | Mean Higher High Water. |
| +6.23 | MHW | Mean High Water. |
| +3.77 | NGVD29 | National Geodetic Vertical Datum of 1929. |
| +3.74 | MTL | Mean Tide Level. |
| +3.71 | MSL | Mean Sea Level. |
| +1.25 | MLW | Mean Low Water |
| +0.38 | NAVD88 | North American Vertical Datum of 1988. |
| 0.00 | MLLW | Mean Lower Low Water. |
| -3.42 | LOWL | Lowest Observed Water Level. |

*Table 8.3 Water levels and datum relative to Mean Lower Low Water.*

**Design Water Levels**
The design water levels for the project are:

| Design Water Levels | |
|---|---|
| Extreme High Water Level (tsunami and tide) | +14.37 ft |
| Design High Water Level (MHHW) | +6.87 ft |
| Design Low Water Level (MLLW) | +0.00 ft |
| Extreme Low Water Level (tsunami and tide) | -7.50 ft |

*Table 8.4 Design water levels.*

The extreme high and extreme low water levels have been estimated as the Mean High Water and Mean Low Water levels combined with a tsunami wave amplitude of 7.5 feet, corresponding to a tsunami wave height of 15.0 feet (4.6 m).

## 8.8 Hydrodynamic Loads

Hydrodynamic loads on structures in the marine comprise wave-current loads on floats and pilings, and vessels moored in the marina.

### 8.8.1 Hydrodynamic Loads on Vessels

In order to assess the hydrodynamic loads on vessels moored alongside marina floats during a tsunami event, a mooring analysis has been conducted using the OPTIMOOR software maintained by Tension Technology International, Ltd.

The hydrodynamic load on a vessel is governed by the magnitude of the current flow, the cross-sectional area of the vessel hull below the water line and the drag around the hull. As a worst-case-scenario, the largest of the ocean-going crab fishing vessels has been adopted for the analysis. It has been assumed that the vessel is moored alongside the dock, fully laden and exposed to the peak current velocity. The following vessel particulars have been assumed for the analysis.

**Vessel Data**
The characteristics of the design vessels are listed below. These are representative of the large ocean-going crab fishers home to the marina.

| Vessel Class | OCEANGOING FISHING VESSEL |
|---|---|
| Length | 70-80 ft |
| Beam | 20-26 ft |
| Draft | 10-11 ft |

*Table 8.5 Design Vessel Particulars.*

**Mooring Line Data**
The number, type, size and configuration of mooring lines assumed for the design vessels are summarized in the table below.

| Vessel | No. of Lines | Mooring lines No. × size, type | MBL[7] | Configuration H+B+s+s+B+S |
|---|---|---|---|---|
| OCEANGOING FISHING VESSEL | 4* | R: 4 × 32 mm Ø PP. | 10.5 t | s: 1+1+0+0+1+1<br>p: 1+1+0+0+1+1 |

**Legend**

| | | |
|---|---|---|
| W: Steel Wire | H: Head lines | *: suggested type and configuration. |
| R: Synthetic Rope | B: Breast lines | s: starboard side mooring. |
| T: Tails | s: Spring lines | p: port side mooring. |
| | S: Stern lines | PP: Polypropylene. |

*Table 8.6 Mooring line properties and configurations.*

**Mooring Arrangement**
The arrangement of the fishing vessel and moorings as assumed for the analysis is shown in Figure 8.4. A current flow near-perpendicular to the beam of the vessel has been assumed, combined with wind from a south-easterly direction amounting to 24 knots. This corresponds to a wind speed with a return period of one year.

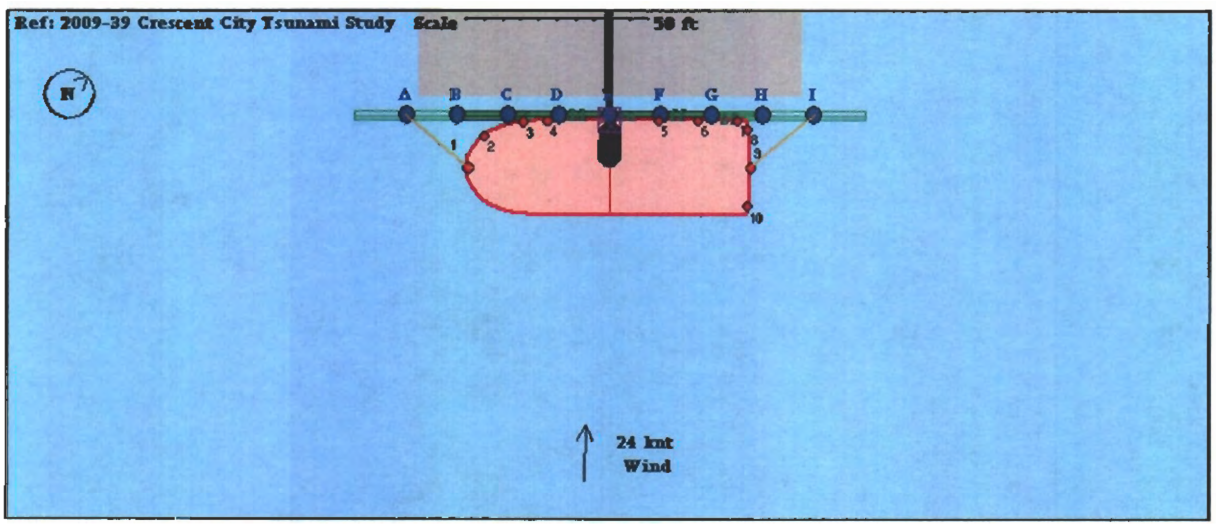



*Figure 8.4 Arrangement for ocean-going fishing vessel at Crescent City Marina.*

The total force acting on the moored vessel amounts to approximately 800 kips, which distributed over the 80-ft length of the vessel yields a horizontal lateral force on the float of 10 kips per linear

[7] MBL: Minimum Breaking Load.

foot. For comparison with this 50-year design case, the load on the moored vessel for the 25-year case amounts to 241 kips corresponding to 3 kips of horizontal force per linear foot of float.

### 8.8.2 Hydrodynamic Loads on structural elements

The drag loads on the piles and floats are calculated using the Morrison equation [26] for the piles and a simple drag force for the floating elements [27]. In the following, it is shown that the inertia component, directly linked to the acceleration of the particles, is negligible compared to the drag component. The results are presented in kips per unit length of structure.

**Theoretical background**

Assuming that the main transverse cross-section of a submerged body is reasonably small compared to the wavelength, Dean and Dalrymple [26] show that the force per unit height that applies on the body is:

$$dF_T = dF_M + dF_D$$

Where the total drag force $dF_T$ is the sum of an inertia component $dF_M$ and a form drag component $dF_D$. The form drag component is a function of the design velocity squared, the water density $\rho_w$, a drag coefficient $C_D$ and the frontal area, D. It reads:

$$dF_D = \frac{1}{2}\rho_w \cdot dz \cdot C_D \cdot D \cdot V^2$$

The term $dz$ refers to a unit vertical length. The inertia component $F_M$ follows. It is basically the inertia experienced by a volume of fluid that would be present in lieu of the submerged body, modulated by an appropriate inertia coefficient. It depends on the acceleration $\vec{a}$ of the fluid. Its magnitude reads:

$$dF_M = \frac{1}{2}\rho_w \cdot dz \cdot C_M \cdot D \cdot \|\vec{a}\|$$

An example time series for calculation of the hydraulic load is shown in Figure 8.5 for a tide level of MLW, a tsunami wave height of 6.4 ft (1.95m), and a tsunami wave period of 24 min (1440 seconds), 6-deg incident angle numerical simulation results. The velocity and acceleration time series are plotted below. The time series is useful for establishing the importance of drag over inertia. In the following, only the drag component is considered in the Morrison equation.

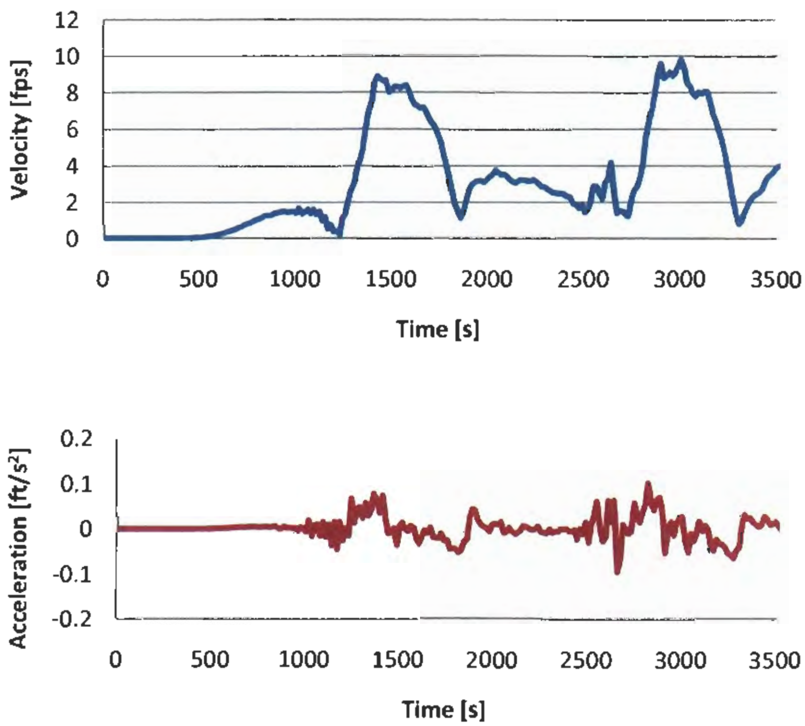



*Figure 8.5 Acceleration and flow velocity.*

As seen in the plot above, the acceleration is less than 0.656 $ft/s^2$ (0.2 $m/s^2$). Consequently, compared to the drag force, the inertia component turns out negligible.

**Hydrodynamic Loads on Piles**

Given a square pile design, with a 2-foot typical dimension, the Reynolds number is:

$$\mathrm{Re} = \frac{U \cdot D}{\nu} = 3.175 \times 10^6$$

where υ is the dynamic viscosity and U is set to 20 fps as a representative current velocity. The regime is fully turbulent, which allows the use of the drag coefficients provided in ref. [27] for the calculation of the drag components. For a square pile, the drag coefficient is 2.2. In the case of a rectangular submerged section, the value of the drag coefficient varies with the ratio of width over depth, and is plotted below:

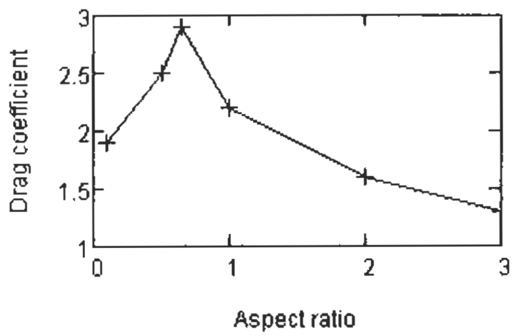



*Figure 8.6 Drag coefficient for rectangular cross-sections as a function of aspect ratio.*

The inertia coefficient is set to 1.5, based on the guidance of ref. [28]. An example of the hydraulic forces imparted on a pile, based on the velocity profile shown above is provided in Figure 8.7.

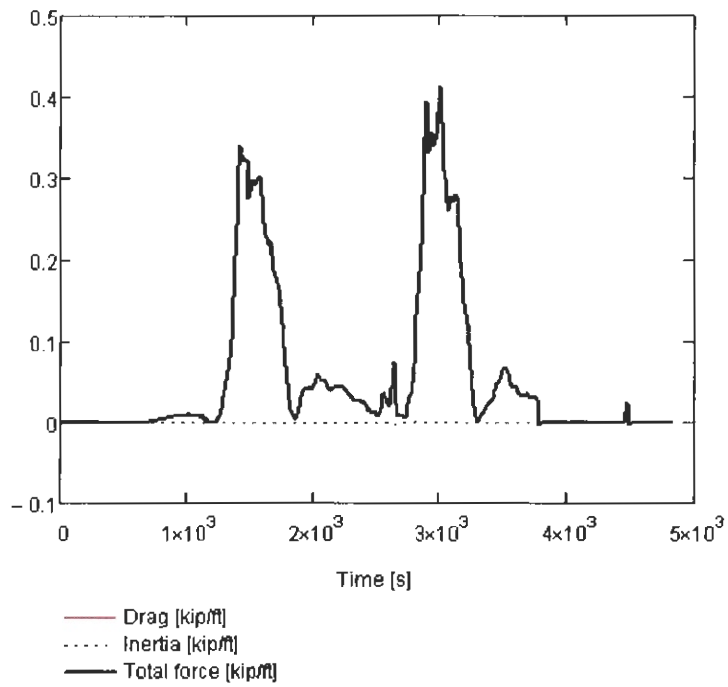



*Figure 8.7 Forces imparted on a representative pile due to current flow.*

In this case the maximum load per unit submerged height, $F_{\text{Max}}$, is:

$$F_{\text{Max}} = \max(dF_T) = 0.413 \text{ kip} \cdot \text{ft}^{-1}$$

**Hydrodynamic Loads on Floats**
In the case of floats, the drag coefficient must be recomputed for each cross section of the elements considered. That is because, in general, a more elongated profile has a tendency to behave more hydrodynamically. A cubic spline function has been applied to calculate the appropriate drag coefficient. The drag force on a floating element reads:

$$F_F(L_F, D_F) = \frac{1}{2} \cdot \rho_w \cdot C_D\left(\frac{L_F}{D_F}\right) D_F \cdot V^2$$

The quantity $D_F$ refers the draft of the float. $L_F$ is the length of the float, and $\rho_w$ is the density of water, while $V$ represents the flow velocity.

The design velocity depends on the location of the docks with respect to the high velocity region. As shown in the figure below, not all docks are subject to the design velocity. For example, Dock A is not exposed to the high currents experienced by Dock H, which is subject to highest design loads. Assuming the process has reached steady-state after two periods, the veloeity profiles are plotted for each dock. The design loads estimated for various float dimensions are summarized in the tables below. Note that the float layout presented in the figure below may or may not reflect the final marina plan.

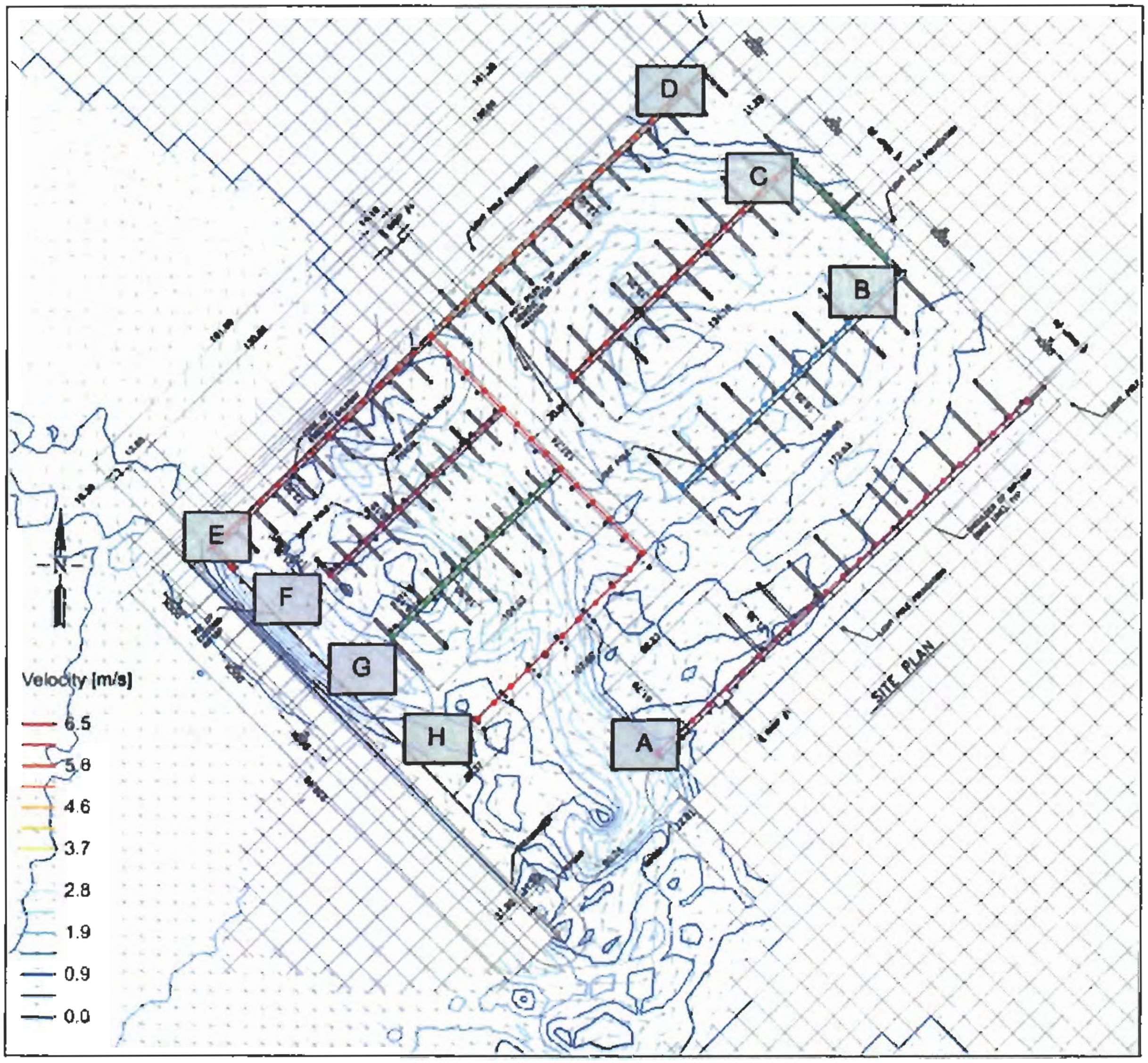



*Figure 8.8 Velocity field and sample marina layout.*

Table 8-7 summarizes the peak loads for each dock as labeled in Figure 8.8.

| Dock | Peak Load | Peak velocity along dock |
|---|---|---|
| | Per linear foot of float | [ft/s] |
| H | 3.90 kips/ft | 19.3 |
| G | 2.96 kips/ft | 17.8 |
| F | 1.07 kips/ft | 14.3 |
| E | 0.85 kips/ft | 12.7 |
| B | 0.34 kips/ft | 8.1 |
| C | 0.46 kips/ft | 9.3 |
| D | 0.76 kips/ft | 12.0 |
| A | 0.18 kips/ft | 5.8 |
| W | 1.60 kips/ft | 12.4 |

*Table 8-7 Note that all quantities are in units of kip per foot of length.*

# 9 Summary and Conclusions

## 9.1 Methodology and Design Wave Parameters

Tsunami events have been analyzed as part of a three-step sequence: 1) generation, 2) propagation, and 3) near-shore effects on structures and shoreline. The wave generation process, initiated by an earthquake either on the coast or offshore, is a complex event. Global models, capable of handling the propagation of the large waves (tsunamis) generated by such earthquakes do not resolve to the level details required for this specific project. The present investigation focuses on the direct effects of a long monochromatic wave encountered during tsunami events.

A near-shore design wave corresponding to the conditions experienced during actual tsunami events near Crescent City was determined. A representative 50-year return period tsunami event at Crescent City has the following parameters:

- A wave height of 15 ft;
- An average period of approximately 24 minutes;
- An angle of incidence of around 6 degrees.

## 9.2 Offshore Wave Transformation

Bathymetric data was compiled from various sources so as to cover the near-shore and the off-shore regions at Crescent City. Large-scale numerical simulations were run to investigate the transformations of tsunami waves as they propagate toward the West Coast of the United States. It was found that tsunami events tend to amplify near Crescent City due to the presence of the Mendocino Escarpment. The key findings are:

- The presence of the Mendocino Escarpment tends to direct wave energy toward Crescent City and the region around the California/Oregon state line;
- The escarpment, acting as a wall of partial height reflects some of the wave energy carried by the tsunami to the coastline located north of Cape Mendocino.

## 9.3 Tsunami-Induced Flow Velocities in the Marina

A detailed bathymetry of the inner boat basin was obtained from a hydrographic survey communicated by Stover Engineering, Inc. Near-shore data were acquired from NOAA and GEO-DAS. Compiled, these data form a comprehensive dataset of the Crescent City Harbor and inner boat basin, which serves as the basis of the numerical modeling.

Based on the design wave information, a study of the velocity field in the inner boat marina was conducted. The key conclusions are as follows:

- Regions of high velocities, with peak velocities of up to 20 fps, develop in the access channel and at the entrance to the inner boat basin;
- A pronounced clockwise circulation develops in the marina as a result of the tsunami surges.

As such, the numerical model is able to replicate the circulation that is mentioned in several eyewitness accounts of past events.

## 9.4 Effect of Dredging and Structures on Tsunami Wave Action

To understand the effects on tsunami waves due to dredging or the addition of protective structures, several cases were investigated. Dredging of the access channel and inner boat basin was evaluated independently, as was the addition of a solid-wall flow deflector at Dock H. The key conclusions are as follows:

- Variations in the velocity field near the floating structures due to dredging in the marina, in the access channel, or a combination hereof do not appreciably affect the design loads;
- The addition of a solid wall in place of a floating structure at Dock H, with the intent to reduce the peak velocity magnitude in its vicinity is not effective. The wall does little but displace the high velocities to another region of the marina, exposing other initially sheltered floating structures to strong currents.
- A more open layout with shallower floats, capable of vertical motion to ride out the tsunami waves and allow currents to vent underneath offers a more tsunami-resistant solution.

# 10 References

[01] *United States Coast Pilot. Volume 7: Pacific Coast: California, Oregon, Washington, Hawaii, and Pacific Islands.* U.S. Department of Commerce, Carlos M. Gutierrez, Secretary; National Oceanic and Atmospheric Administration (NOAA), William J. Brennan, Ph.D., Acting Under Secretary of Commerce for Oceans and Atmosphere, and Administrator; NOAA National Ocean Service, John H. Dunnigan, Assistant Administrator for Ocean Services and Coastal Zone Management, 2009 (41st) Edition.

[02] *NOAA Navigation Chart 18603: St. George Reef and Crescent City Harbor, 16th Ed., Dec. 02.* United States West Coast, California.

[03] *Surviving a Tsunami - Lessons from Chile, Hawaii, and Japan.* U.S. Geological Survey Circular 1187, Version 1.1. Compiled by Brian F. Atwater, Marco Cisternas V., Joanne Bourgeois, Walter C. Dudley, James W. Hendley II, and Peter H. Stauffer. 1999; Reprinted 2001; revised and reprinted 2005.

[04] *Building Tsunami-Resilient Communities in Humboldt County, California.* Lori Dengler, Troy Nicolini, Dan Larkin, Vicki Ozaki. Proceedings of Solutions to Coastal Disasters: Tsunamis 2008 conference, April 13-16, 2008 in Turtle Bay, Oahu, Hawaii; Sponsored by COPRI of ASCE, National Oceanic and Atmospheric Administration (NOAA), and US Geologic Survey (USGS).

[05] *Modeling Far-Field Tsunamis for California Ports and Harbors.* Jose Borrero, Burak Uslu, Costas Synolakis, and Vasily V. Titov. Coastal Engineering 2006, Proceedings of the 30th International Conference, San Diego, California, USA, 3 - 8 September 2006.

[06] *Lessons for California from the November 2006 tsunami in Crescent City, California.* Aggeliki Barberopoulou, Burak Uslu, Lori Dengler. Proceedings of Solutions to Coastal Disasters: Tsunamis 2008 conference, April 13-16, 2008 in Turtle Bay, Oahu, Hawaii; Sponsored by COPRI of ASCE, National Oceanic and Atmospheric Administration (NOAA), and US Geologic Survey (USGS).

[07] *Tsunamis Affecting the West Coast of The United States 1806-1992.* James F. Lander, University of Colorado, Cooperative Institute for Research in Environmental Sciences (CIRES); Patricia A. Lockridge, National Oceanic and Atmospheric Administration, National Geophysical Data Center; Michael J. Kozuch, University of Colorado, CIRES and Department of Geological Sciences. United States Department of Commerce, National Oceanic and Atmospheric Administration. National Environmental Satellite, Data, and Information Service, December 1993.

[08] *The Orphan Tsunami of 1700. Japanese clues to a parent earthquake in North America.* Brian F. Atwater, Musumi-Rokkaku Satoko, Satake Kenji, Tsuji Yoshinobu, Ueda Kazue, David K. Yamaguchi. United States Geological Survey, Reston, Virginia in association with University of Washington Press, Seattle and London. Gale A. Norton, Secretary, U.S.

Department of the Interior, Charles G. Groat, Director, U.S. Geological Survey. Professional Paper 1707, 2005.

[09] *Tsunami Inundation from Great Earthquakes on the Cascadia Subduction Zone along the Northern California Coast.* Burak Uslu, Jose C. Borrero, Lori Dengler, Costas Synolakis, Aggeliki Barberopoulou. Proceedings of Solutions to Coastal Disasters: Tsunamis 2008 conference, April 13-16, 2008 in Turtle Bay, Oahu, Hawaii; Sponsored by COPRI of ASCE, National Oceanic and Atmospheric Administration (NOAA), and US Geologic Survey (USGS).

[10] *Tsunami Engineering.* Special Report No. 6. U.S. Army Corps of Engineers, Coastal Engineering Research Center, Kingman Building, Fort Belvoir, Va. 22060. February 1980.

[11] *Water Levels and Wave Heights for Coastal Engineering Design.* CECW-EH, Engineer Manual 1110-2-1414. Department of the Army, U.S. Army Corps of Engineers, Washington, DC 20314-1000, 5 July 1989.

[12] *Oceanographical Engineering.* Robert L. Wiegel, Professor of Civil Engineering, University of California, Berkeley, 1964.

[13] *Tsunami Travel Times.* National Environmental Satellite, Data and Information Service (NESDIS). NOAA Satellite and Information Service. http://map.ngdc.noaa.gov

[14] *Hydrodynamics of Coastal Regions.* Ib. A. Svendsen and Ivar. G. Jonsson (1980). Technical University of Denmark.

[15] *The Kuril Islands Tsunami of November 2006. Part I: Impact at Crescent City by distant scattering.* Z. Kowalik, J. Horillo, W. Knight, and Tom Logan. Journal of Geophysical Research.

[16] *The Kuril Islands Tsunami of November 2006. Part II: Impact at Crescent City by local enhancement.* J. Horillo, W. Knight, and Z. Kowalik. Journal of Geophysical Research.

[17] *Numerical Modeling of Tsunami Effects at Marine Oil Terminals in San Francisco Bay.* Jose Borrero, Lori Dengler, Burak Uslu, Costas Synolakis. Report Prepared for: Marine Facilities Division of The California State Lands Commission, June 8, 2006.

[18] *Surface Water Modeling System.* Aquaveo Water Modeling Solutions, 75 S. 200 E. Suite 201, Provo, Utah 84606, United States.

[19] *BOUSS-2D: A Boussinesq Wave Model for Coastal Regions and Harbors.* ERDC/CHL TR-01-25. Report 1, Theoretical Background and User's Manual. Okey George Nwogu and Zeki Demirbilek. US Army Corps of Engineers Research and Development Center, Coastal and Hydraulics Laboratory. September 2001.

[20] *National Geophysical Data Center (NGDC).* NOAA Satellite and Information Service. www.ngdc.noaa.gov

[21] *Crescent City Inner Harbor Survey, 10-14-2009.* Stover Engineering, Civil Engineers and Consultants, 711 H Street, Crescent City, CA 95531.

[22] *Condition Survey, Crescent City, Del Norte County, California.* US Army Corps of Engineers, San Francisco District. 16-17 March 2008.

[23] *NOAA Navigation Chart 18010: Monterey Bay to Coos Bay.* United States West Coast, California – Oregon.

[24] *Crescent City Harbor District Boat Basin.* E.D.A. Project No. 07-1-00637. Original drawings by Consulting Engineers SWINC Engineering Inc., Portland OR; Electrical Engineers Downing & Ries, Portland, OR, 1972.

[25] *Protection of Crescent City, California from Tsunami Waves.* Report by Robert L. Wiegel, Consulting Engineer M-4825 for The Redevelopment Agency of the City of Crescent City, 5 March 1965, Berkeley, California.

[26] *Water wave mechanics for engineers and scientists.* R.G. Dean and R.A. Dalrymple, Singapore: World Scientific, 1991.

[27] *Fundamentals of fluid mechanics.* B. Munson, D. Young, and T. Okiishi, New York City, New York: John Wiley & Sons, Inc., 2002.

[28] *Drag and inertia coefficients for horizontally submerged rectangular cylinders in waves and currents.* V. Venugopal, K. Varyani, and P. Westlake, Journal of Engineering for the Maritime Environment, vol. 223, pp. 121-136.

**Jim Baskin**

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**From:** Zane Ruddy [Zane.Ruddy@noaa.gov]

**Sent:** Thursday, January 20, 2011 4:13 PM

**To:** Jim Baskin

**Subject:** Crescent City Harbor District Inner Boat Basin Rehabilitation Project

Jim,

The purpose of this message is to provide an update to the Coastal Commission regarding the status of NMFS' informal Section 7 consultation with Housing and Urban Development and their applicant, County of Del Norte, addressing the Crescent City Harbor District Inner Boat Basin Rehabilitation Project. During the early technical assistance phase of the consultation, the County worked with NMFS to clarify and elaborate on the methodologies and minimization measures employed during pile driving and dredging activities. Following the collaboration, the County concluded that the project may affect, but is not likely to adversely affect federally threatened SONCC ESU coho salmon, Southern DPS green sturgeon, and Stellar sea lions, and is not likely to adversely affect their critical habitat. In addition, HUD, via the County, determined that the proposed action would have an adverse impact on EFH associated with groundfish, coastal pelagic species, and salmon due to short-term adverse effects to water quality resulting from construction activities. To date, NMFS has not identified any additional measures needed to further avoid or minimize adverse effects to EFH.

Currently, the draft NMFS consultation document (letter of concurrence with HUD's determination) is nearing submission to NMFS' internal review and clearance process. I expect informal consultation will conclude shortly. Thank you, and please do not hesitate to contact me if you have any questions or comments.

Zane Ruddy
Fisheries Biologist
NOAA Fisheries
Northern California Office
1655 Heindon Rd, Arcata, CA 95521
(707) 825-5173

EXHIBIT NO. **8**
**APPLICATION NO.**
**1-10-035**
**CRESCENT CITY HARBOR DISTRICT**
**REVIEW AGENCY CORRESPONDENCE**