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Staff:	Robert S. Merrill
Staff Report:	November 26, 2003
Hearing Date:	December 11, 2003
Commission Action:	

REVISED STAFF REPORT: REGULAR CALENDAR

APPLICATION NO.:	**1-03-028**
APPLICANT:	Frank Rohner
PROJECT LOCATION:	342 Roundhouse Creek Road, in the Big Lagoon area, Humboldt County (APNs 517-251-014 & 517-251-015)
PROJECT DESCRIPTION:	Merge two parcels resulting in one parcel of approximately 34,400 square feet and relocate the existing residence approximately 85 feet to the east.
GENERAL PLAN DESIGNATION:	Residential Estates (RE)
ZONING DESIGNATION:	Residential Single Family with no further subdivision and design review requirements (RS-XD)

LOCAL APPROVALS RECEIVED:	Humboldt County Lot Merger; Humboldt County Special Permit for Design Review.
OTHER APPROVALS REQUIRED:	None
SUBSTANTIVE FILE DOCUMENTS:	(1) Humboldt County Local Coastal Program; (2) CDP File No. NCR-74-CC-344

SUMMARY OF STAFF RECOMMENDATION:

Staff recommends approval with conditions of the coastal development permit application for the proposed project on the basis that, as conditioned by the Commission, the project is consistent with the Coastal Act.

The proposed project involves the merger of two parcels stacked adjacent to a coastal bluff edge and relocation of an existing residence from a location near the bluff edge that is vulnerable to bluff retreat hazards to a safer location approximately 85 feet to the east on what is currently the adjacent vacant parcel. The project site is located at 294 and 306 Roundhouse Creek Road, in the Big Lagoon Park Subdivision, approximately 6.5 miles north of Trinidad in Humboldt County.

The project site is located along a shoreline that has experienced extraordinary bluff retreat. Anecdotal information indicates that other lots within the subdivision experienced more than 60 feet of bluff retreat during the winter of 1997 and 1998. The long-term bluff retreat rate is estimated at 1 foot per year. The applicants commissioned a geotechnical evaluation of the site that included an analysis of long term bluff retreat rate and a quantitative slope stability analysis. The geotechnical investigation recommended a setback for the proposed relocated residence of 160 feet to ensure its safety over the next 75 years. The Commission Staff Geologist has reviewed the geotechnical investigation and opines that geotechnical evaluation was adequate and that the recommended setback would assure geologic stability over the next 84 years. As proposed by the applicant, prior to completion of the geotechnical investigation, the house would be relocated only 85 feet from the bluff edge. Therefore, to assure the geologic stability of the relocated house, staff recommends that the Commission impose conditions that would require the house to be sited consistent with the 160-foot setback recommendation of the applicant's geologist.

Staff recommends that the Commission attach additional special conditions, including conditions to 1) require that all terms and conditions of the permit are recorded as deed restrictions; 2) prohibit future bluff or shoreline protective devices; 3) require the applicants to assume the risk of geologic hazard and waive liability for the Commission; and 4) require an erosion and runoff control plan and the removal of demolition debris to control sedimentation and protect water quality.

Staff recommends that the Commission find the project, as conditioned, is consistent with the Chapter 3 policies of the Coastal Act.

STAFF NOTES:

1. Standard of Review

The proposed project is located on the west side of Roundhouse Creek Road, in the Big Lagoon Park Subdivision south of Big Lagoon in Humboldt County. Humboldt County has a certified LCP. However, the project is located in an area of deferred certification (ADC). Therefore, the standard of review that the Commission must apply to the project is the Chapter 3 policies of the Coastal Act.

2. Commission Action Necessary

The Commission must act on the application at the December 11, 2003 to meet the requirements of the Permit Streamlining Act

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I. MOTION, STAFF RECOMMENDATION AND RESOLUTION:

The staff recommends that the Commission adopt the following resolution:

Motion:

I move that the Commission approve Coastal Development Permit No. 1-03-028 pursuant to the staff recommendation.

Staff Recommendation of Approval:

Staff recommends a **YES** vote. Passage of this motion will result in approval of the permit as conditioned and adoption of the following resolution and findings. The motion passes only by affirmative vote of a majority of the Commissioners present.

Resolution to Approve the Permit:

The Commission hereby approves a coastal development permit for the proposed development and adopts the findings set forth below on grounds that the development as conditioned will be in conformity with the policies of Chapter 3 of the Coastal Act. Approval of the permit complies with the California Environmental Quality Act because either 1) feasible mitigation measures and/or alternatives have been incorporated to substantially lessen any significant adverse effects of the development on the environment, or 2) there are no further feasible mitigation measures or alternatives that would substantially lessen any significant adverse impacts of the development on the environment.

II. STANDARD CONDITIONS: See Attachment A.

III. SPECIAL CONDITIONS:

1. Construction Responsibilities and Debris Removal

The permittee shall comply with the following construction-related requirements:

A. No construction materials, debris, or waste shall be placed or stored where it may be subject to entering coastal waters; and

B. All construction debris, including general wastes from the demolition of the commercial buildings and excavated asphaltic-concrete paving at the site, shall be removed and disposed of in an upland location outside of the coastal zone or at an approved disposal facility.

2. Erosion and Runoff Control Plan

A. **PRIOR TO ISSUANCE OF COASTAL DEVELOPMENT PERMIT NO. 1-03-028**, the applicant shall submit an Erosion and Runoff Control Plan for review and approval of the Executive Director. The Erosion and Runoff Control Plan shall incorporate design elements and/or Best Management Practices (BMPs) which will serve to minimize the volume and velocity of stormwater runoff leaving the developed site, and to capture sediment and other pollutants contained in stormwater runoff from the development, by facilitating on-site infiltration and trapping of sediment generated from construction. The final drainage and runoff control plans shall at a minimum include the following provisions:

1. A physical barrier consisting of bales of straw placed end to end shall be installed between any construction and bluff edges that are downslope of

the construction. The bales shall be composed of weed-free rice straw, and shall be maintained in place throughout the construction period.

2. Vegetation at the site shall be maintained to the maximum extent possible and any disturbed areas shall be replanted or seeded with native vegetation immediately following project completion.

3. All on-site debris stockpiles shall be covered and contained at all times.

4. Provide that runoff from the roof, driveway and other impervious surfaces from the completed development shall be collected and directed into pervious areas on the site (landscaped areas) for infiltration to the maximum extent practicable in a non-erosive manner, prior to being conveyed off-site. Where gutters and downspouts are used, velocity reducers shall be incorporated, to prevent scour and erosion at the outlet.

B. The permittee shall undertake development in accordance with the approved Erosion and Runoff Control plans. Any proposed changes to the approved plans shall be reported to the Executive Director. No changes to the approved plans shall occur without a Coastal Commission approved amendment to this coastal development permit unless the Executive Director determines that no amendment is legally required.

3. **Conformance of the Design and Construction Plans to the Geotechnical Investigation Report**

A. All final design and construction plans, including site and foundation plans, shall be consistent with the recommendations contained in the Geotechnical report entitled, "Recommended Setback for the Rohner Bluff-top Home Based on an Erosion –Rate Analysis and Factor-of Safety Considerations, 294 Roundhouse Creek Road, Big Lagoon Park Subdivision, Humboldt County, California (APNs 517-251-14 and 517-251-15)," dated October 6, 2003, prepared by Busch Geotechnical Consultants. **PRIOR TO ISSUANCE OF THE COASTAL DEVELOPMENT PERMIT**, the applicant shall submit, for the Executive Director's review and approval, evidence that a licensed professional (Certified Engineering Geologist or Geotechnical Engineer) has reviewed and approved all final design, construction, site, and foundation plans and has certified that each of those plans is consistent with all of the recommendations specified in the above-referenced geotechnical reports approved by the California Coastal Commission for the project site.

B. The permittee shall undertake development in accordance with the approved final plans. Any proposed changes to the approved final plans shall be reported to the

Executive Director. No changes to the approved final plans shall occur without a Commission amendment to this coastal development permit unless the Executive Director determines that no amendment is legally required.

4. **Deed Restriction**

PRIOR TO ISSUANCE OF THE COASTAL DEVELOPMENT PERMIT, the applicant shall submit to the Executive Director for review and approval documentation demonstrating that the applicant has executed and recorded against the parcel(s) governed by this permit a deed restriction, in a form and content acceptable to the Executive Director: (1) indicating that, pursuant to this permit, the California Coastal Commission has authorized development on the subject property, subject to terms and conditions that restrict the use and enjoyment of that property; and (2) imposing the Special Conditions of this permit as covenants, conditions and restrictions on the use and enjoyment of the Property. The deed restriction shall include a legal description of the entire parcel or parcels governed by this permit. The deed restriction shall also indicate that, in the event of an extinguishment or termination of the deed restriction for any reason, the terms and conditions of this permit shall continue to restrict the use and enjoyment of the subject property so long as either this permit or the development it authorizes, or any part, modification, or amendment thereof, remains in existence on or with respect to the subject property.

5. **No Future Bluff or Shoreline Protective Device**

A. By acceptance of this permit, the applicants agree, on behalf of themselves and all successsors and assigns, that no bluff or shoreline protective device(s) shall ever be constructed to protect the development approved pursuant to Coastal Development Permit No. 1-03-028, including, but not limited to, the residence with the attached garage, foundations, septic system, utilities, driveway, or appurtenant residential development in the event that the development is threatened with damage or destruction from waves, erosion, storm conditions, bluff retreat, landslides, ground subsidence or other natural hazards in the future. By acceptance of this permit, the applicants hereby waive, on behalf of themselves and all successors and assigns, any rights to construct such devices that may exist under Public Resources Code Section 30235.

B. By acceptance of this Permit, the applicants further agree, on behalf of themselves and all successors and assigns, that the landowner(s) shall remove the development authorized by this permit, including the relocated residence, new foundations, new driveway, and other appurtenant residential development, if any government agency has ordered that the structures are not to be occupied due to any of the hazards identified above. In the event that portions of the development fall to the beach before they are removed, the landowner shall remove all recoverable debris associated with the development from the beach and ocean and lawfully dispose of the material in an approved disposal site. Such removal shall require a coastal development permit.

C. In the event the edge of the bluff recedes to within 10 feet of the principal residence but no government agency has ordered that the structures not be occupied, a geotechnical investigation shall be prepared by a licensed geologist or civil engineer with coastal experience retained by the applicant, that addresses whether any portions of the residence are threatened by wave, erosion, storm conditions, or other natural hazards. The report shall identify all those immediate or potential future measures that could stabilize the principal residence without shore or bluff protection, including but not limited to removal or relocation of portions of the residence. The report shall be submitted to the Executive Director and the appropriate local government official. If the geotechnical report concludes that the residence or any portion of the residence is unsafe for occupancy, the permittee shall, within 90 days of submitting the report, apply for a coastal development permit amendment to remedy the hazard which shall include removal of the threatened portion of the structure.

6. <u>Assumption of Risk, Waiver of Liability and Indemnity</u>

By acceptance of this permit, the applicants acknowledge and agree: (i) that the site may be subject to hazards from landslide, bluff retreat, erosion, subsidence, and earth movement; (ii) to assume the risks to the applicants and the property that is the subject of this permit of injury and damage from such hazards in connection with this permitted development; (iii) to unconditionally waive any claim of damage or liability against the Commission, its officers, agents, and employees for injury or damage from such hazards; and (iv) to indemnify and hold harmless the Commission, its officers, agents, and employees with respect to the Commission's approval of the project against any and all liability, claims, demands, damages, costs (including costs and fees incurred in defense of such claims), expenses, and amounts paid in settlement arising from any injury or damage due to such hazards.

7. <u>Future Development Restriction</u>

This permit is only for the development described in coastal development permit No. 1-03-028. Pursuant to Title 14 California Code of Regulations section 13250(b)(6), the exemptions otherwise provided in Public Resources Code section 30610(a) shall not apply to the development governed by the coastal development permit No. 1-03-028. Accordingly, any future improvements to this structure authorized by this permit shall require an amendment to permit no. 1-03-028 from the Commission or shall require an additional coastal permit from the Commission or from the applicable certified local government. In addition thereto, an amendment to permit no. 1-03-028 from the

Commission or an additional coastal permit from the Commission or from the applicable certified local government shall be required for any repair or maintenance identified as requiring a permit in Public Resources Code Section 30610(d) and Title 14, California Code of Regulations Sections 13252(a)-(b).

IV. FINDINGS AND DECLARATIONS

The Commission hereby finds and declares:

1. Site & Project Description

The proposed project involves the merger of two parcels stacked adjacent to a coastal bluff edge and relocation of an existing residence from a location near the bluff edge that is vulnerable to bluff retreat hazards to a safer location approximately 85 feet to the east on what is currently the adjacent vacant parcel. The project site is located at 294 and 306 Roundhouse Creek Road, in the Big Lagoon Park Subdivision, approximately 6.5 miles north of Trinidad in Humboldt County.

The purpose of the proposed merger is to allow for the relocation of the existing residence. The relocation of the house is intended to move the house out of immediate danger from bluff retreat. The residence is currently located approximately 45 feet form the edge of the bluff. According to a preliminary geologic evaluation prepared for the site by SHN Consulting Engineers, "Recent coastal bluff retreat has removed several tens of feet from the western edge of the property, leaving the residence in a high risk location near the top edge of the coastal bluff face."

The specific development proposed includes (1) the merger of the two lots to create one approximately 34,400-square-foot lot, (2) the physical relocation of the house to be placed approximately 85 feet inland on a new foundation, (3) driveway and parking area modifications, and (4) landscaping.

The existing approximately 1,620-square-foot home was authorized by Coastal Development Permit No. NCR-74-CC-344, granted in 1974 by the North Coast Regional Commission. In addition to the home, the current bluff edge parcel includes a gravel parking area, septic system, and landscaping. The inland parcel is currently vacant but is partially landscaped. The proposed new location of the residence is an existing grassy lawn. Only minimal grading is proposed to establish the new foundations.

The subject property is located within a residential subdivision of approximately 1/3-acre lots partially developed with modest homes with built mostly since the early 1970s. The neighborhood is served by a community water system and individual septic systems.

The property is not within any County designated scenic or view area, although some limited blue water views are afforded through the property. The subject property contains no known environmentally sensitive habitat area. Except for the bluff itself, the property slopes gently to the west with an average slope of less than 20%. The bluff is approximately 126 feet high in this location, and is very steep.

Although Humboldt County has a certified local coastal program, the project site is located within the Big Lagoon Area of Deferred Certification. The area was not certified in part because of issues concerning protecting future development from the extraordinary bluff retreat that occurs along this section of the Humboldt County coastline.

2. <u>Locating and Planning New Development</u>

Section 30250(a) of the Coastal Act states that new development shall be located within or near existing developed areas able to accommodate it or in other areas with adequate public services and where it will not have significant adverse effects, either individually or cumulatively, on coastal resources. The intent of this policy is to channel development toward more urbanized areas where services are provided and potential impacts to resources are minimized.

The proposed development is located in a rural area where one single-family home per parcel is a principally permitted use. The applicant has an existing septic system and is served by a community water system. The Humboldt County Health Department has determined that suitable areas exist on the property to accommodate a septic system. As discussed in the findings below, the proposed development has been conditioned to ensure the protection of the relocated residence from geologic hazards and to avoid water quality impacts from runoff from the site. In addition, the proposed merger of two parcels into one would reduce the overall density of development that could occur in the area, further reducing impacts to coastal resources.

Therefore, the Commission finds that the proposed development is consistent with Coastal Act Section 30250(a) to the extent that it is located in a developed area, it has adequate water and septic capability to accommodate it, and it will not cause significant adverse effects, either individually or cumulatively, to coastal resources.

3. <u>Geologic Hazards</u>

Section 30253 states in applicable part:

> *New development shall:*
>
> *(1) Minimize risks to life and property in areas of high geologic, flood, and fire hazard.*

> *(2) Assure stability and structural integrity, and neither create nor contribute significantly to erosion, geologic instability, or destruction of the site or surrounding area or in any way require the construction of protective devices that would substantially alter natural landforms along bluffs and cliffs...*

The subject property is located on a bluff top situated approximately 126 feet above the ocean. The Big Lagoon Subdivision was built on an uplifted marine terrace that has been subject to extraordinary rates of bluff retreat in the past. According to the geotechnical analysis prepared for the project by Busch Geotechnical Consultants (BUSCH), the bluff at the project site is approximately 126 feet in height with a near vertical to slightly overhanging top. According to BUSCH, the Franciscan Complex bedrock which is exposed in the headlands of Patrick's Point State park and elsewhere along the coast, does not outcrop at the base of the bluff in the subdivision. In addition, the beach is unprotected by offshore rocks or a nearby headland. As a result, whenever winter storm waves strip the sand from the beach, the base of the bluffs with its erodible marine terraces begin to erode.

In previous actions on Coastal Development permits, the Commission has interpreted Section 30253 of the Coastal Act to require that coastal development be sited a sufficient distance landward of coastal bluffs that it will neither be endangered by erosion nor lead to the construction of protective coastal armoring during the assumed economic life of the development. The Commission has generally assumed the economic life of a new house to be 75 to 100 years. A setback adequate to protect development over the economic life of a development must account both for the expected bluff retreat during that time period and the existing slope stability. Long-term bluff retreat is measured by examining historic data including vertical aerial photographs and any surveys conducted that identified the bluff edge. Slope stability is a measure of the resistance of a slope to land sliding, and is assessed by a quantitative slope stability analysis. In such an analysis, the forces resisting a potential landslide are first determined. These are essentially the strength of the rocks or soils making up the bluff. Next, the forces driving a potential landslide are determined. These forces are the weight of the rocks as projected along a potential slide surface. The resisting forces are divided by the driving forces to determine the "factor of safety." The process involves determining a setback from the bluff edge where a factor of safety of 1.5 is achieved. The quantitative slope stability analysis needs to be prepared by licensed geotechnical professional familiar with the process.

The applicant commissioned two separate geotechnical investigations of the site. SHN Consulting Engineers and Geologists performed a geotechnical investigation of the site documented in a report dated March 11, 2003 (SHN). Busch Geotechnical Consultants performed a geotechnical investigation of the site documented in a report dated October 6, 2003 (BUSCH). The BUSCH investigation was performed after the SHN investigation, and is self-contained and not dependent on the earlier investigation.

In assessing the long-term bluff retreat rate at the site, the BUSCH investigation utilized 14 aerial photographs spanning 61 years. The report documents anecdotally short-term erosion events in the nearby area resulting in up to 60 feet of bluff retreat in a single winter season (1997-1998). The report indicates a long-term average erosion rate for the 61 year period is .74 feet per year, but recommends that the calculated rate be rounded up to 1 foot per year to account for higher erosion rates determined by other studies.

The BUSCH investigation includes a quantitative slope stability analysis. The slope stability analysis shows that the current bluff is marginally stable, with a static factor of safety of 1.024. The factor of safety increases with distance from the bluff edge. BUSCH determined that a factor of safety of 1.5, the industry standard for new development, is achieved 76 feet from the bluff edge.

Based on the results of the analysis of long term bluff retreat and slope stability, BUSCH recommends a minimum setback line from the present bluff edge of 160 feet to protect the relocated house over its assumed 75-year lifespan. This setback consists of the 76-foot slope stability setback plus 75 additional feet to account for the 1-foot per year bluff retreat rate, and 9 additional feet to provide an "extra measure of prudence." BUSCH also recommends that the relocated home use a home foundation that would facilitate moving the house in the future.

Coastal Commission staff geologist Dr. Mark Johnsson has reviewed the SHN and BUSCH reports and conferred with the applicants' geologists. Dr. Johnsson has opined in a memo to staff dated November 18, 2003 attached as Exhibit 8 that he believes the long-term erosion rate used by BUSCH of 1.0 foot is "an appropriate site-specific long-term erosion rate for this site." With regard to the quantitative slope stability analysis, Dr. Johnsson states that "the shear strength and unit weight values adopted in this analysis are appropriate." In conclusion, Dr. Johnsson opines that the applicant's geologist's recommended setback of 160 feet would "assure geologic stability for approximately the next 84 years."

As proposed by the applicant, the relocated house would be set back approximately 85 feet from the bluff edge. This setback was proposed prior to the completion of the BUSCH geotechnical investigation and is not consistent with the bluff edge setback recommend by BUSCH. To ensure that (1) the house to be moved because of geologic safety concerns is actually setback a sufficient distance to ensure its safety from bluff erosion and cliff retreat during the typical economic lifespan of a house and (2) the setback would be of sufficient distance to eliminate the need for shoreline protection devices to protect the structure in the future consistent with Section 30253 of the Coastal Act, the Commission attaches Special Condition No. 3. This special condition requires that all final design and construction plans, including site and foundation plans, shall be consistent with the recommendations contained in the BUSCH Geotechnical report, and reviewed and approved by the Executive Director. As conditioned, the house must be relocated to provide for the 160-foot bluff setback recommended by BUSCH. In addition, the condition will require the applicants to adhere to the second recommendation of the BUSCH report that the relocated home use a home foundation that would facilitate moving the house in the future. The Commission finds that the proposed development as conditioned will be set back a sufficient distance from the bluff edge to provide for a 75-year design life for the development and eliminate the need for shoreline protection devices to protect the development consistent with Section 30253 of the Coastal Act.

The Commission also attaches Special Condition No. 5, which prohibits the construction of shoreline protective devices on the parcel, requires that the landowner provide a geotechnical investigation and remove the house and its foundation if bluff retreat reaches the point where the structure is threatened, and requires that the landowners accept sole responsibility for the removal of any structural debris resulting from landslides, slope failures, or erosion of the site. These requirements are consistent with Section 30253 of the Coastal Act, which states that new development shall minimize risk to life and property in areas of high geologic, flood, and fire hazard, assure structural integrity and stability, and neither create nor contribute significantly to erosion, geologic instability, or destruction of the site or surrounding areas, nor in any way require the construction of protective devices that would substantially alter natural landforms along bluffs and cliffs. The Commission finds that the proposed development could not be approved as being consistent with Section 30253 of the Coastal Act if projected bluff retreat would affect the proposed development and necessitate construction of a seawall to protect it.

As conditioned, the development would relocate a residence with portions of the development as close as approximately 160 feet to a bluff that is gradually eroding. Thus, the proposed development would be located in an area of high geologic hazard. The proposed development can only be found consistent with the above-referenced LCP provisions if the risks to life and property from the geologic hazards are minimized and if a protective device will not be needed in the future. The applicant has submitted information from a registered engineering geologist which states that if the new development is set back 160 feet from the bluff edge, it will be safe from erosion and will not require any devices to protect the proposed development during its useful economic life.

Although a comprehensive geotechnical evaluation is a necessary and useful tool that the Commission relies on to determine if proposed development is permissible at all on any given bluff top site, the Commission finds that a geotechnical evaluation alone is not a guarantee that a development will be safe from bluff retreat. It has been the experience of the Commission that in some instances, even when a thorough professional geotechnical analysis of a site has concluded that a proposed development will be safe from bluff retreat hazards, unexpected bluff retreat episodes that threaten development during the life of the structure sometimes still do occur. Examples of this situation include:

- <u>The Kavich Home at 176 Roundhouse Creek Road in the Big Lagoon Area north of Trinidad (Humboldt County)</u>. In 1989, the Commission approved the construction of a new house on a vacant bluff top parcel (Permit 1-87-230). Based on the geotechnical report prepared for the project it was estimated that bluff retreat would jeopardize the approved structure in about 40 to 50 years. In 1999 the owners applied for a coastal development permit to move the approved house from the bluff top parcel to a landward parcel because the house was threatened by 40 to 60 feet of unexpected bluff retreat that occurred during a 1998 El Nino storm event. The Executive Director issued a waiver of coastal development permit (1-99-066-W) to authorize moving the house in September of 1999.

- The Denver/Canter home at 164/172 Neptune Avenue in Encinitas (San Diego County). In 1984, the Commission approved construction of a new house on a vacant bluff top lot (Permit 6-84-461) based on a positive geotechnical report. In 1993, the owners applied for a seawall to protect the home (Permit Application 6-93-135). The Commission denied the request. In 1996 (Permit Application 6-96-138), and again in 1997 (Permit Application 6-97-90) the owners again applied for a seawall to protect the home. The Commission denied the requests. In 1998, the owners again requested a seawall (Permit Application 6-98-39) and submitted a geotechnical report that documented the extent of the threat to the home. The Commission approved the request on November 5, 1998.

- The Bennett home at 265 Pacific Avenue, Solana Beach (San Diego County). In 1995, the Commission approved a request to construct a substantial addition to an existing bluff top home (Permit 6-95-23). The minimum setback for the area is normally 40 feet. However, the applicants agreed to waive future rights to shore/bluff protection if they were allowed to construct 25 feet from bluff edge based on a favorable geotechnical report. The Commission approved the request on May 11, 1995. In 1998, a substantial bluff failure occurred, and an emergency permit was issued for a seawall. The follow-up regular permit (#6-99-56) was approved by Commission on May 12, 1999. On August 18, 1999, the Commission approved additional seawall and upper bluff work on this and several other properties (Permit #6-99-100).

- The Arnold project at 3820 Vista Blanca in San Clemente (Orange County). Coastal development permit (Permit # 5-88-177) for a bluff top project required protection from bluff top erosion, despite geotechnical information submitted with the permit application that suggested no such protection would be required if the project conformed to 25-foot bluff top setback. An emergency coastal development permit (Permit #5-93-254-G) was later issued to authorize bluff top protective works.

The Commission notes that the examples above are not intended to be absolute indicators of bluff erosion on the subject parcel, as coastal geology can vary significantly from location to location. However, these examples do illustrate that site-specific geotechnical evaluations cannot always accurately account for the spatial and temporal variability associated with coastal processes and therefore cannot always absolutely predict bluff erosion rates. Collectively, these examples have helped the Commission form it's opinion on the vagaries of geotechnical evaluations with regard to predicting bluff erosion rates.

The BUSCH geotechnical investigation report states the following:

> "Although we have used standard engineering geologic practices and professional standards of care to provide erosion-rate estimates, predictions, and a risk assessment,

> nothing in this report should be construed to state or imply a guarantee of safety of the home for any specific duration of time. Bluff retreat occurs in a largely unpredictable fashion, and it will continue to occur in the Big Lagoon area into the foreseeable future. Even if we have overstated the risk at the proposed site, and the future realized rate of bluff failure is less than the minimum rate we predict, it is important to understand that LOW risk is not the same as NO risk; rapid rate bluff failure could occur before the calculated minimum economic lifespan is realized (herein stated as 75 years).
>
> In conclusion, although the evaluation presented here in is based on a consideration of the geologic, geodetic, tectonic, and near shore marine processes active at Big Lagoon, greater or lesser retreat rates than those documented in the past and predicted in the future may be realized in the next 75 years."

This language in the report itself is indicative of the underlying uncertainties of this and any geotechnical evaluation and supports the notion that no guarantees can be made regarding the safety of the proposed development with respect to bluff retreat.

Geologic hazards are episodic, and bluffs that may seem stable now may not be so in the future. Therefore, the Commission finds that the subject lot is an inherently hazardous piece of property, that the bluffs are clearly eroding, and that the proposed new development will be subject to geologic hazard and could potentially someday require a bluff or shoreline protective device, inconsistent with Section 30253 of the Coastal Act. The Commission finds that the proposed development could not be approved as being consistent with Section 30253 of the Coastal Act if projected bluff retreat would affect the proposed development and necessitate construction of a seawall to protect it.

Based upon the geologic report prepared by the applicants geologist and the evaluation of the project by the Commission's staff geologist, the Commission finds that the risks of geologic hazard are minimized if the residence is set back approximately 160 feet or more from the bluff edge as proposed. However, given that the risk cannot be eliminated and the geologic report cannot assure that shoreline protection will never be needed to protect the residence, the Commission finds that the proposed development is consistent with the Coastal Act only if it is conditioned to provide that shoreline protection will not be constructed. Thus, the Commission further finds that due to the inherently hazardous nature of this lot, the fact that no geology report can conclude with any degree of certainty that a geologic hazard does not exist, the fact that the approved development and its maintenance may cause future problems that were not anticipated, and because new development shall not engender the need for shoreline protective devices, it is necessary to attach Special Condition No. 5 prohibiting the construction of seawalls and Special Condition No. 6 requiring the waiver of liability.

In addition, as noted above, some risks of an unforeseen natural disaster, such as an unexpected landslide, massive slope failure, erosion, etc. could result in destruction or partial destruction of the house or other development approved by the Commission. In addition, the development itself and its maintenance may cause future problems that were not anticipated. When such an event takes place, public funds are often sought for the clean-up of structural debris that winds up on the beach or on an adjacent property. As a precaution, in case such an unexpected event occurs on the subject property, the Commission attaches Special Condition No. 5, which requires the landowner to accept sole responsibility for the removal of any structural debris resulting from landslides, slope failures, or erosion on the site, and agree to remove the house should the bluff retreat reach the point where a government agency has ordered that the structure not be occupied.

The Commission finds that Special Condition No. 4 is required to ensure that the proposed development is consistent with the Coastal Act. Special Condition No. 4 is required to provide notice of potential hazards of the property and help eliminate false expectations on the part of potential buyers of the property, lending institutions, and insurance agencies that the property is safe for an indefinite period of time and for further development indefinitely into the future, or that a protective device could be constructed to protect the approved development. The condition requires that the applicant record and execute a deed restriction approved by the Executive Director against the property that imposes the special conditions of this permit as covenants, conditions and restrictions on the use and enjoyment of the property.

Additionally, the Commission attaches Special Condition No. 6, which requires the landowner to assume the risks of extraordinary erosion and geologic hazards of the property and waive any claim of liability on the part of the Commission. Given that the applicants have chosen to implement the project despite these risks, the applicants must assume the risks. In this way, the applicants are notified that the Commission is not liable for damage as a result of approving the permit for development. The condition also requires the applicants to indemnify the Commission in the event that third parties bring an action against the Commission as a result of the failure of the development to withstand hazards. In addition, the requirement of Special Condition No. 4 that a deed restriction be recorded will ensure that future owners of the property will be informed of the risks, the Commission's immunity from liability, and the indemnity afforded the Commission.

The Commission notes that Section 30610(a) of the Coastal Act exempts certain additions to existing single-family residential structures from coastal development permit requirements. Pursuant to this exemption, once a house has been constructed, certain additions and accessory buildings that the applicant might propose in the future are normally exempt from the need for a permit or permit amendment.

Section 30610(a) of the Coastal Act exempts certain additions to existing single family residential structures from coastal development permit requirements. Pursuant to this exemption, once the house has been constructed, certain additions and accessory buildings that the applicant might propose in the future could be exempt from the need for a permit or permit amendment. Depending on its nature, extent, and location, such an addition or accessory structure could contribute to geologic hazards at the site. For example, installing a landscape irrigation system on the property in a manner that leads to saturation of the bluff could increase the potential for landslides or catastrophic bluff failure. Another example would be installing a sizable accessory structure for additional parking, storage, or other uses normally associated with a single family home in a manner that does not provide for the recommended setback from the bluff edge.

To avoid such impacts to coastal resources from the development of otherwise exempt additions to existing homes, Section 30610(a) requires the Commission to specify by regulation those classes of development which involve a risk of adverse environmental effects and require that a permit be obtained for such improvements. Pursuant to Section 30610(a) of the Coastal Act, the Commission adopted Section 13250 of Title 14 of the California Code of regulations. Section 13250(b)(6) specifically authorizes the Commission to require a permit for additions to existing single-family residences that could involve a risk of adverse environmental effect by indicating in the development permit issued for the original structure that any future improvements would require a development permit. As noted above, certain additions or improvements to the approved structure could involve a risk of creating geologic hazards at the site. Therefore, in accordance with provisions of Section 13250 (b)(6) of Title 14 of the California Code of Regulations, the Commission attaches Special Condition No. 7 which requires that all future development on the subject parcel that might otherwise be exempt from coastal permit requirements requires an amendment or coastal development permit. This condition will allow future development to be reviewed by the Commission to ensure that future improvements will not be sited or designed in a manner that would result in a geologic hazard. Special Condition No. 4 also requires recordation of a deed restriction to ensure that all future owners of the property are aware of the requirement to obtain a permit for development that would otherwise be exempt. This will reduce the potential for future landowners to make improvements to the residence without first obtaining a permit as required by this condition.

The Commission thus finds that the proposed development, as conditioned, is consistent Section 30253 of the Coastal Act, since the development as conditioned will not contribute significantly to the creation of any geologic hazards, will not have adverse impacts on the stability of the coastal bluff or on erosion, will not require the construction of shoreline protective works, and the Commission will be able to review any future additions to ensure that development will not be located where it might result in the creation of a geologic hazard. Only as conditioned is the proposed development consistent with Section 30253 of the Coastal Act.

4. <u>Water Quality</u>

Coastal Act Section 30230 states as follows:

> *Marine resources shall be maintained, enhanced, and where feasible, restored. Special protection shall be given to areas and species of special biological or economic significance. Uses of the marine environment*

> *shall be carried out in a manner that will sustain the biological productivity of coastal waters and that will maintain healthy populations of all species of marine organisms adequate for long-term commercial, recreational, scientific, and educational purposes.*

Coastal Act Section 30231 states as follows:

> *The biological productivity and the quality of coastal waters, streams, wetlands, estuaries, and lakes appropriate to maintain optimum populations of marine organisms and for the protection of human health shall be maintained and, where feasible, restored through, among other means, minimizing adverse effects of waste water discharges and entrainment, controlling runoff, preventing depletion of ground water supplies and substantial interference with surface water flow, encouraging waste water reclamation, maintaining natural vegetation buffer areas that protect riparian habitats, and minimizing alteration of natural streams.*

Storm water runoff from new residential development can adversely affect the biological productivity of coastal waters by degrading water quality. Section 30230 and 30231 of the Coastal Act require the protection of the biological productivity and quality of coastal waters.

As discussed above, the subject parcel is located on a coastal terrace atop a steep coastal bluff. Excavation of the site to remove the old foundations of the house would expose demolition debris and loosened soil to storm water runoff. Runoff originating from the development site that is allowed to drain over the bluff edge would contain entrained sediment and other pollutants in the runoff that would contribute to degradation of the quality of marine waters.

Consistent with Coastal Act Sections 30230 and 30231, the Commission attaches Special Condition Nos. 1 and 2 to minimize erosion and sedimentation impacts from the proposed construction of the residence. Special Condition No. 1 requires that efforts be taken to ensure that in the handling and storage of construction materials, demolition debris, and other wastes, no such materials be allowed to fall to the ocean. Special Condition No. 1 further requires that all debris and waste be removed for the project site and disposed of in an upland location outside of the coastal zone or at an approved disposal facility.

Special Condition No. 2 requires that the applicants submit for the review and approval of the Executive Director an Erosion and Runoff Control Plan that would provide that (1) straw bales be installed to contain runoff from construction areas, (2) on-site vegetation be maintained to the maximum extent possible during construction, (3) any disturbed areas be replanted or seeded with native vegetation following project completion, (4) all on-site stockpiles of construction debris be covered and contained to prevent polluted water runoff, and (5) runoff from the roof, driveway, and other impervious surfaces of the development be collected and directed into pervious areas on the site for infiltration and that velocity reducers be used on roof downspouts.

The Commission finds that as conditioned, the proposed development is consistent with Section 20.492.020 because erosion and sedimentation will be controlled and minimized by (1) maintaining on-site vegetation to the maximum extent possible; (2) replanting or seeding any disturbed areas with native vegetation following project completion; (3) covering and containing debris stockpiles at all times; (4) using straw bales to control runoff during construction; and (5) directing runoff from the completed development in a manner that would provide for infiltration into the ground. Furthermore, the Commission finds that the proposed development as conditioned is consistent with the provisions of Coastal Act Sections 30230 and 30231 requiring that the biological productivity of coastal waters be sustained because storm water runoff from the proposed development would be directed away from the coastal bluff and would be controlled on site by infiltration into vegetated areas.

5. Visual Resources

Section 30251 of the Coastal Act states that the scenic and visual qualities of coastal areas shall be considered and protected as a resource of public importance, and requires in applicable part that permitted development be sited and designed to protect views to and along the ocean and scenic coastal areas, to minimize the alteration of natural land forms, to restore and enhance where feasible the quality of visually degraded areas, and to be visually compatible with the character of surrounding areas.

The subject parcel is located on a bluff top site in a subdivision overlooking the Pacific Ocean. The site is not located within a designated "Highly Scenic Area." Some limited blue water views are afforded through the property. However, the proposed development will not adversely affect views to or along the coast, as the project involves relocating an existing house in a manner that should impact views similarly to the way the house currently impacts views.

Therefore, the proposed development is compatible with the character of the surrounding area. In addition, the site where the house would be relocated is relatively flat and the development would require only minimal grading. Therefore, the amount of landform alteration will be minimized consistent with Section 30251.

The Commission thus finds that the proposed development, as conditioned, is consistent with Section 30251 of the Coastal Act, as the project has been sited and designed to minimize visual impacts, will be visually compatible with the character of surrounding areas, and will not result in significant landform alteration.

6. Public Access

Projects located within the coastal development permit jurisdiction of a local government are subject to the coastal access policies of both the Coastal Act and the LCP. Coastal Act Sections 30210, 30211, and 30212 require the provision of maximum public access opportunities, with limited exceptions. Section 30210 states that maximum access and recreational opportunities shall be provided consistent with public safety needs and the need to protect public rights, rights of private property owners, and natural resource areas from overuse. Section 30211 states that development shall not interfere with the public's right of access to the sea where acquired through use or legislative authorization, including, but not limited to, the use of dry sand and rocky coastal beaches to the first line of terrestrial vegetation. Section 30212 states that public access from the nearest public roadway to the shoreline and along the coast shall be provided in new development projects except where it is inconsistent with public safety, military security needs, or the protection of fragile coastal resources, adequate access exists nearby, or agriculture would be adversely affected.

In its application of these policies, the Commission is limited by the need to show that any denial of a permit application based on these sections, or any decision to grant a permit subject to special conditions requiring public access, is necessary to offset a project's adverse impact on existing or potential public access.

There is no evidence of trails on the site and no indication from the public that the site has been used for public access purposes in the past. Furthermore, the proposed development will not increase the demand for public access to the shoreline and will otherwise have no significant impact on existing or potential public access. Therefore, the Commission finds that the proposed project, which does not include provision of public access, is consistent with the public access policies of the Coastal Act.

7. California Environmental Quality Act.

Section 13096 of the Commission's administrative regulations requires Commission approval of coastal development permit applications to be supported by a finding showing the application, as modified by any conditions of approval, to be consistent with any applicable requirement of the California Environmental Quality Act (CEQA). Section 21080.5(d)(2)(A) of CEQA prohibits a proposed development from being approved if there are feasible alternatives or feasible mitigation measures available, which would substantially lessen any significant adverse effect the proposed development may have on the environment.

The Commission incorporates its findings on conformity with the Chapter 3 policies of the Coastal Act at this point as if set forth in full. These findings address and respond to all public comments regarding potential significant adverse environmental effects of the project that were received prior to preparation of the staff report. As discussed herein, in the findings addressing the consistency of the proposed project with the Chapter 3 policies of the Coastal Act, the proposed project has been conditioned to be found consistent with the Coastal Act. Mitigation measures, which will minimize all adverse environmental impacts have been required. As conditioned, there are no feasible alternatives or feasible mitigation measures available, beyond those required, which would substantially lessen any significant adverse impact that the activity may have on the environment. Therefore, the Commission finds that the proposed project can be found to be consistent with the requirements of the Coastal Act to conform to CEQA.

<u>Exhibits</u>

1. Regional Location Map
2. Vicinity Map
3. Parcel Map
4. Existing Site Plan
5. Proposed Plot Plan
6. Recommended Geologic Setback
7. Geotechnical Report
8. Staff Geologist's Memorandum

ATTACHMENT

Standard Conditions:

1. Notice of Receipt and Acknowledgment. The permit is not valid and development shall not commence until a copy of the permit, signed by the permittee or authorized agent, acknowledging receipt of the permit and acceptance of the terms and conditions, is returned to the Commission office.

2. Expiration. If development has not commenced, the permit will expire two years from the date on which the Commission voted on the application. Development shall be pursued in a diligent manner and completed in a reasonable period of time. Application for extension of the permit must be made prior to the expiration date.

3. Interpretation. Any questions of intent or interpretation of any condition will be resolved by the Executive Director of the Commission.

4. Assignment. The permit may be assigned to any qualified person, provided assignee files with the Commission an affidavit accepting all terms and conditions of the permit.

5. Terms and Conditions Run with the Land. These terms and conditions shall be perpetual, and it is the intention of the Commission and the permittee to bind all future owners and possessors of the subject property to the terms and conditions.

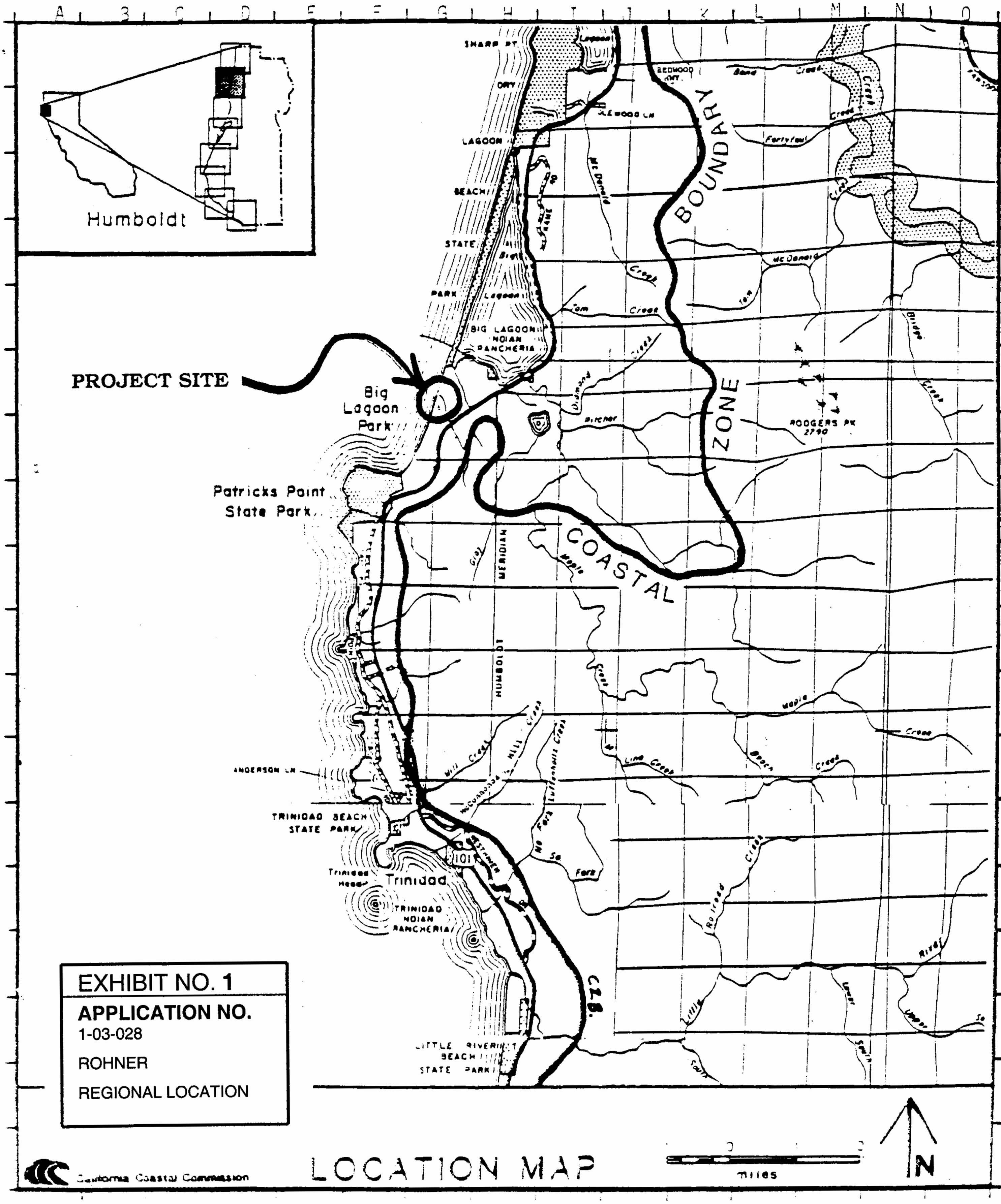


EXHIBIT NO. 1

APPLICATION NO.
1-03-028
ROHNER
REGIONAL LOCATION

County of Humboldt

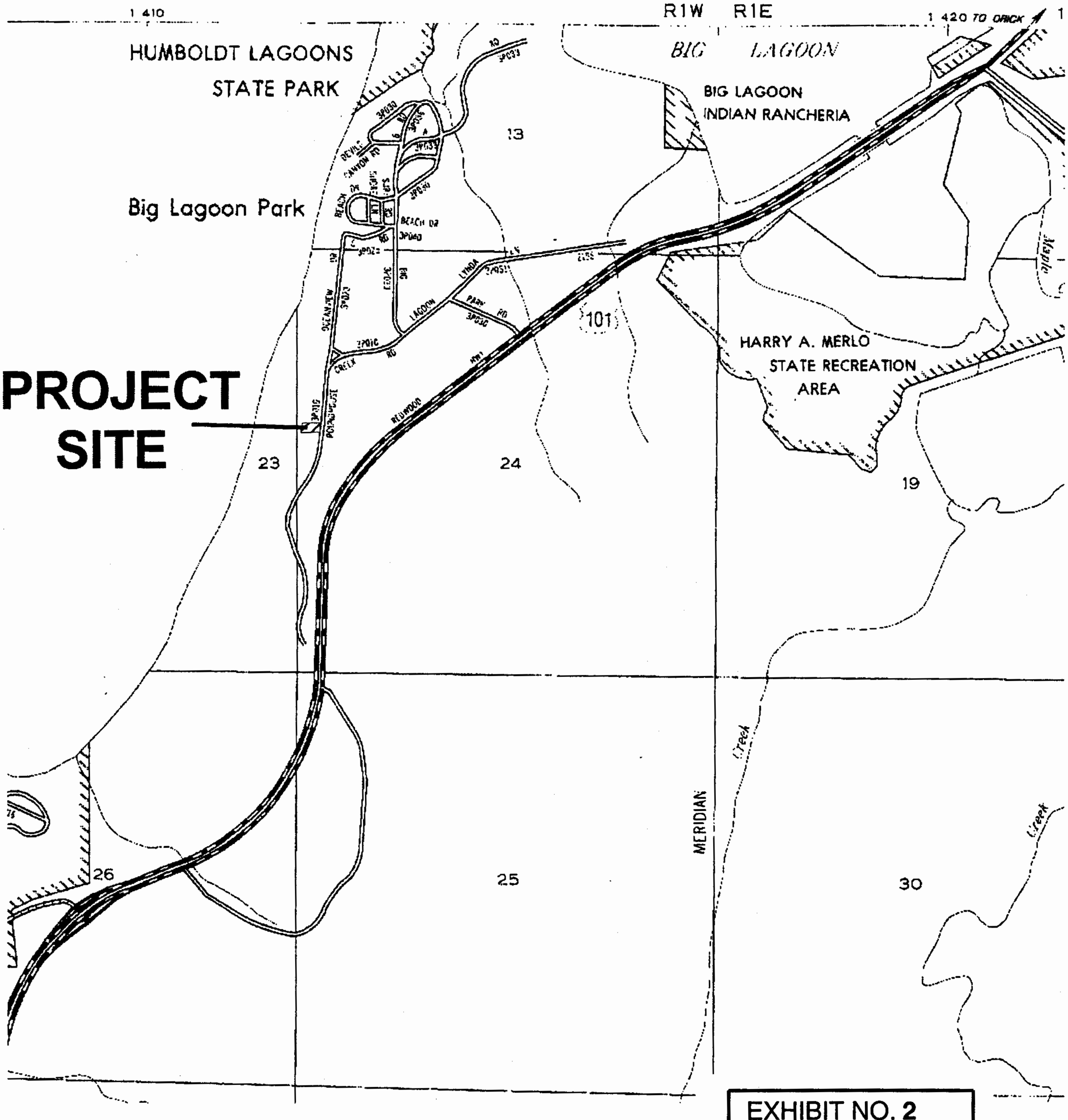
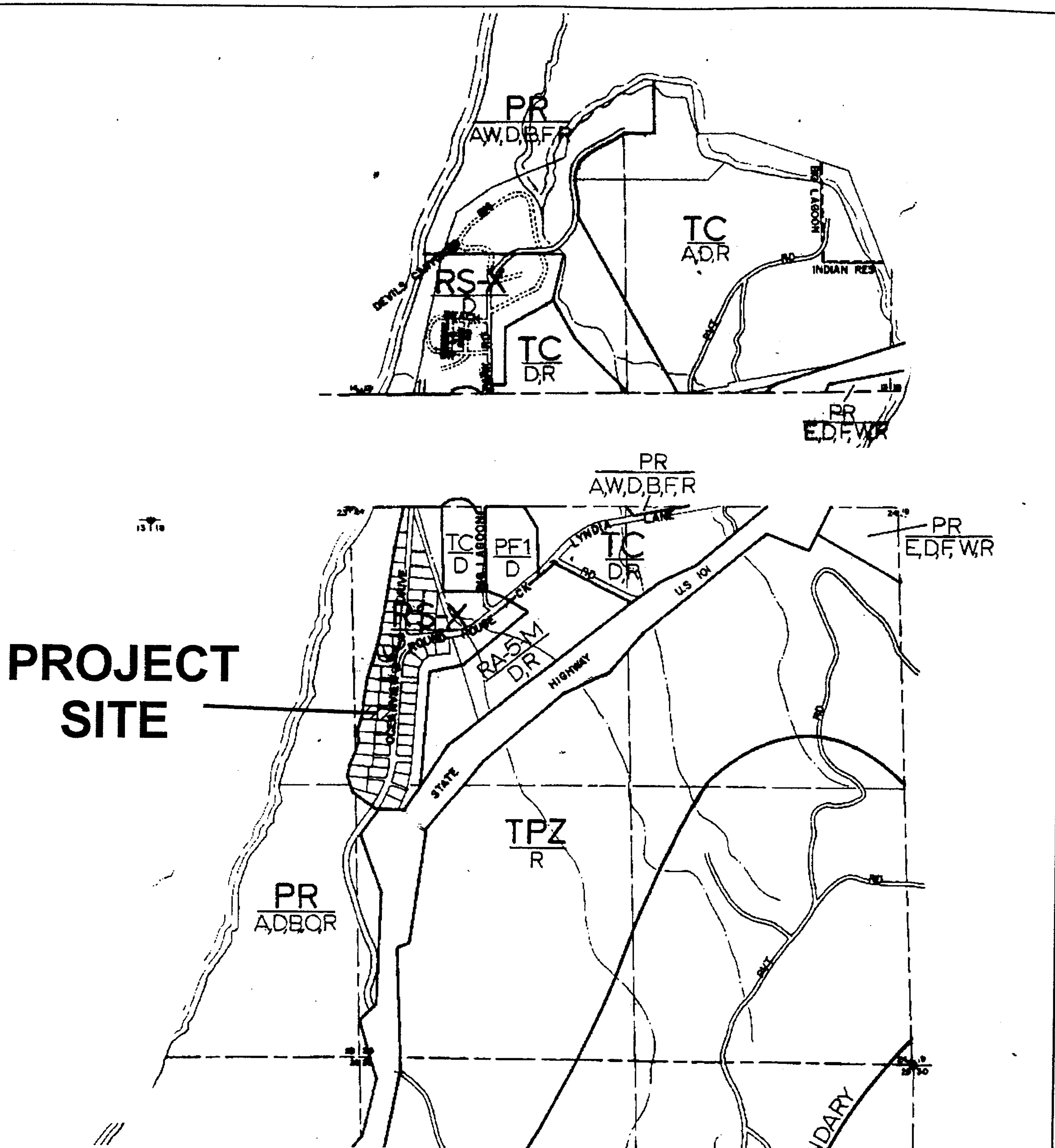


EXHIBIT NO. 2
APPLICATION NO. 1-03-028 ROHNER VICINITY MAP (1 of 2)

PROPOSED ROHNER NOTICE OF MERGER
BIG LAGOON AREA NOM-02-19
APN: 517-251-14 & -15
SECTION 24 T9N R1W H. B. & M.
LOCATION MAP

Map is not drawn to scale.



PROPOSED ROHNER NOTICE OF MERGER
BIG LAGOON AREA NOM-02-19
APN: 517-251-14 & -15
SECTION 24 T9N R1W H. B. & M.
ZONING MAP

N
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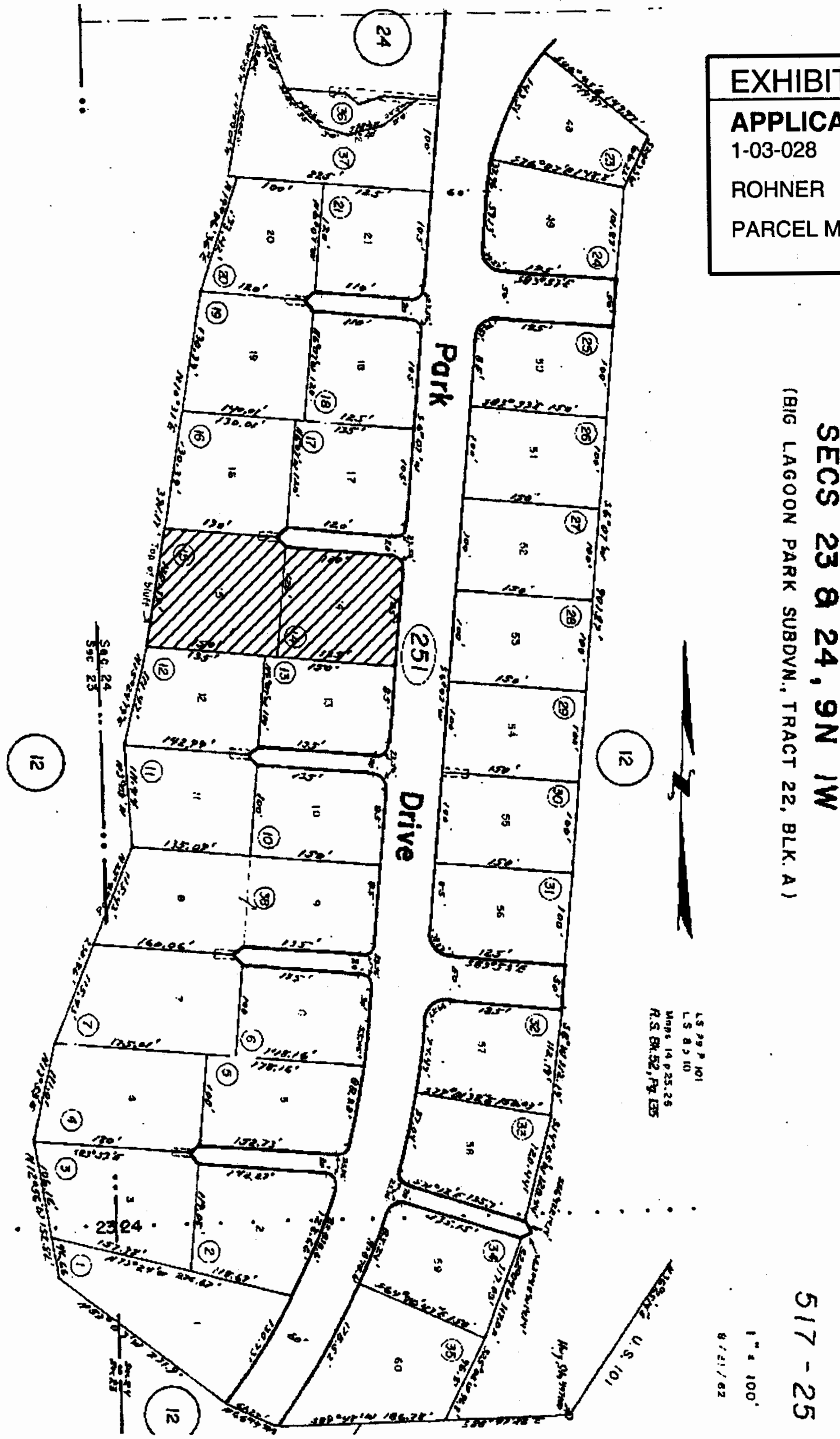
2 of 2

Map is not drawn to scale.

EXHIBIT NO. 3

APPLICATION NO.
1-03-028
ROHNER
PARCEL MAP



PROPOSED ROHNER NOTICE OF MERGER
BIG LAGOON AREA NOM-02-19
APN: 517-251-14 & -15
SECTION 24 T9N R1W H. B. & M.
ASSESSOR PARCEL MAP

Map is not drawn to scale.

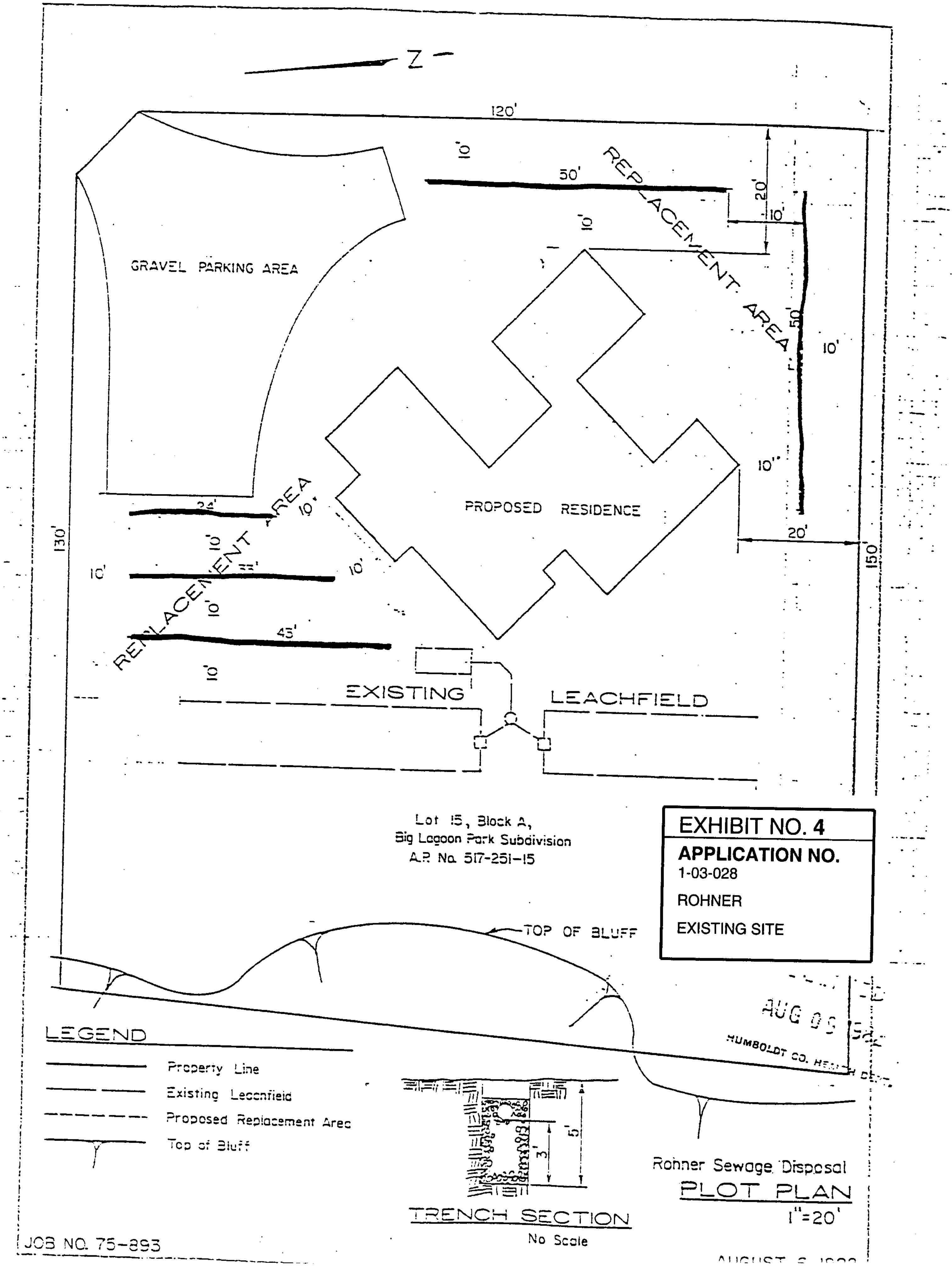


EXHIBIT NO. 4

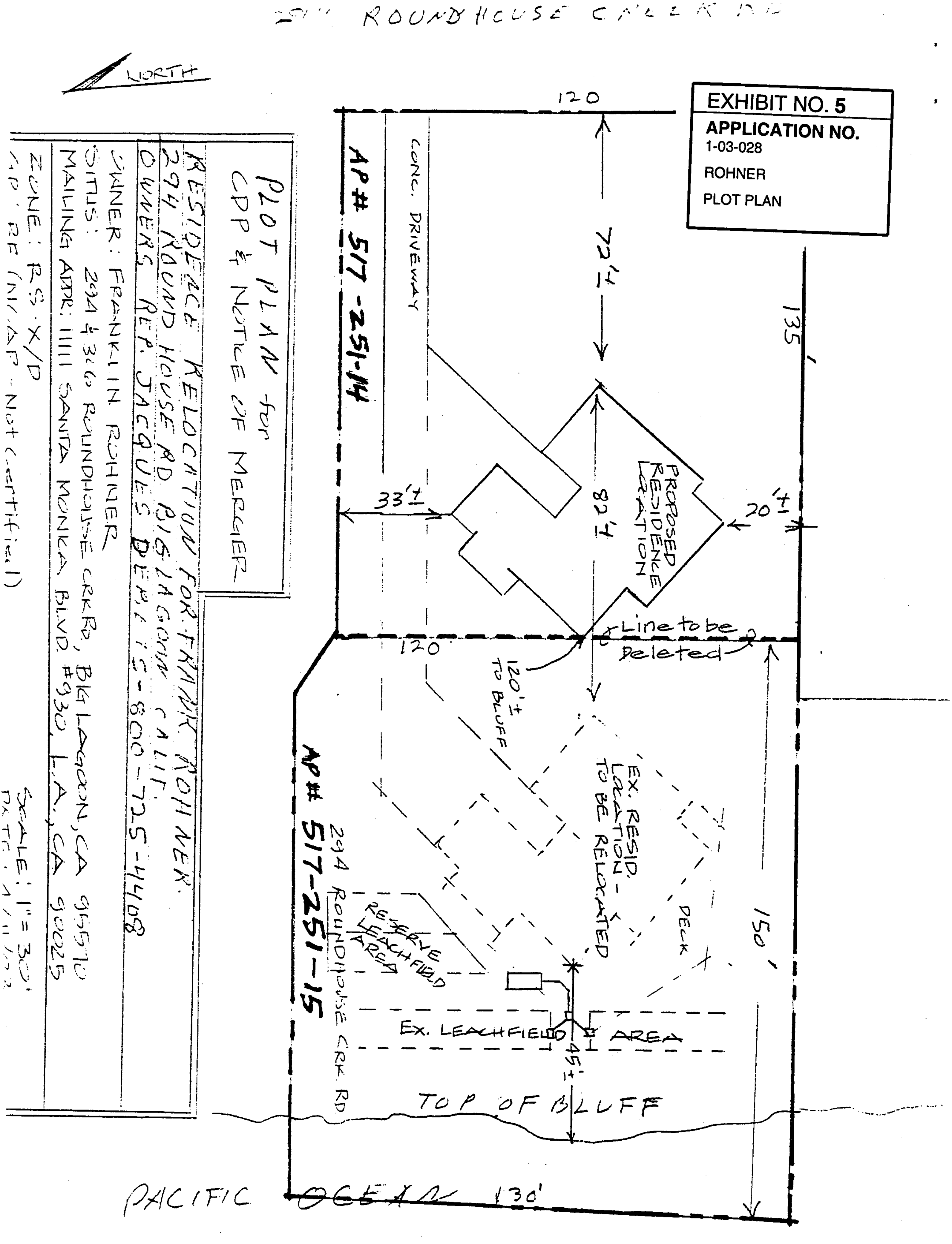
APPLICATION NO.
1-03-028
ROHNER
EXISTING SITE

EXHIBIT NO. 5

APPLICATION NO.
1-03-028

ROHNER

PLOT PLAN



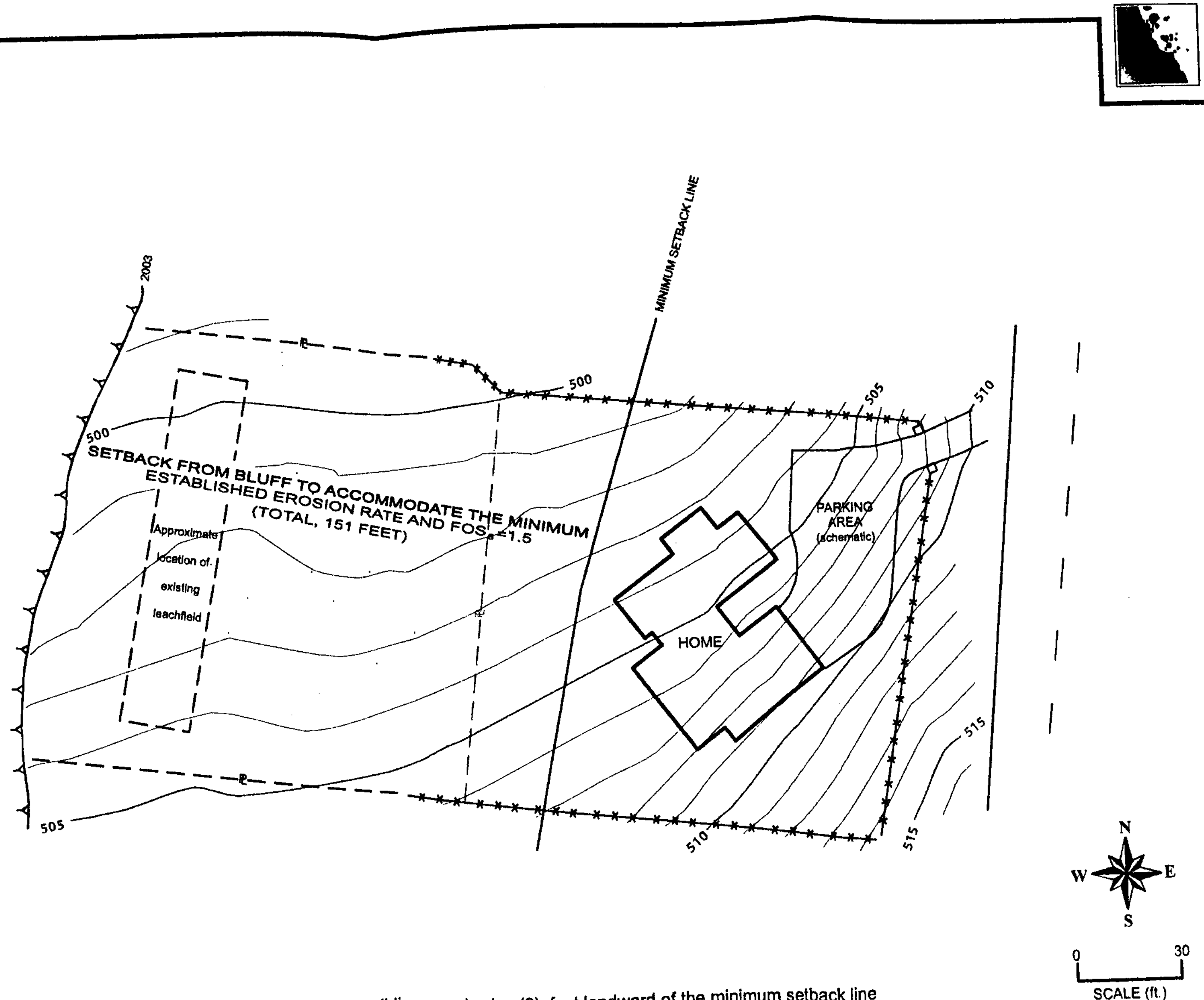


Figure 7. Desired Rohner building area. This building area is nine (9) feet landward of the minimum setback line determined using the methodology discussed in the text.

EXHIBIT NO. 6
APPLICATION NO.
1-03-028
ROHNER
RECOMMENDED GEO
SETBACK

EXHIBIT NO. 7
APPLICATION NO.
1-03-028
ROHNER
GEOTECHNICAL REPORT
(1 of 39)

October 6, 2003

BUSCH GEOTECHNICAL CONSULTANTS

Frank Rohner
11421 Waterford Street
Los Angeles, CA

Recommended Setback for the Rohner Bluff-top Home Based on an Erosion-Rate Analysis and Factor-of-Safety Considerations, 294 Roundhouse Creek Road, Big Lagoon Park Subdivision, Humboldt County, California [APNs 517-251-14 and 517-251-15]

EXECUTIVE SUMMARY

This report provides a setback for the Rohner home based on a methodology approved by the California Coastal Commission (CCC). The report characterizes the geologic site conditions, provides a preliminary factor of safety analysis of the bluff, and provides information about long term and short term erosion rates at the site. The report also discusses the probable economic lifespan of the home after relocation. **The report recommends a setback of 160 feet based on an average long-term erosion rate of 1.0 ft/yr applied for 75 years, a 76-ft setback attributable to Factor-of-Safety calculations, and an additional 9 ft for prudence.**

Ultimately, this report was necessary because the Rohner home currently is ~44 ft east of the top of a 126-ft-high bluff composed of erodible late Pleistocene sediments. A recent (winter 1997-98) episode of bluff retreat removed up to ~40 ft of bluff from the southwestern edge of the property (and the adjacent lot to the south), putting the home at an increased level of risk of damage by the next episode of rapid-rate retreat. Of his own volition, the owner decided to relocate the home to the east. This report facilitates that move by providing required geotechnical information.

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Geotechnical and Geologic Studies for Land Development and Resource Management
Please visit our website at buschgeotech.com

INTRODUCTION

Contract Information, Site Location, and Purpose of the Report

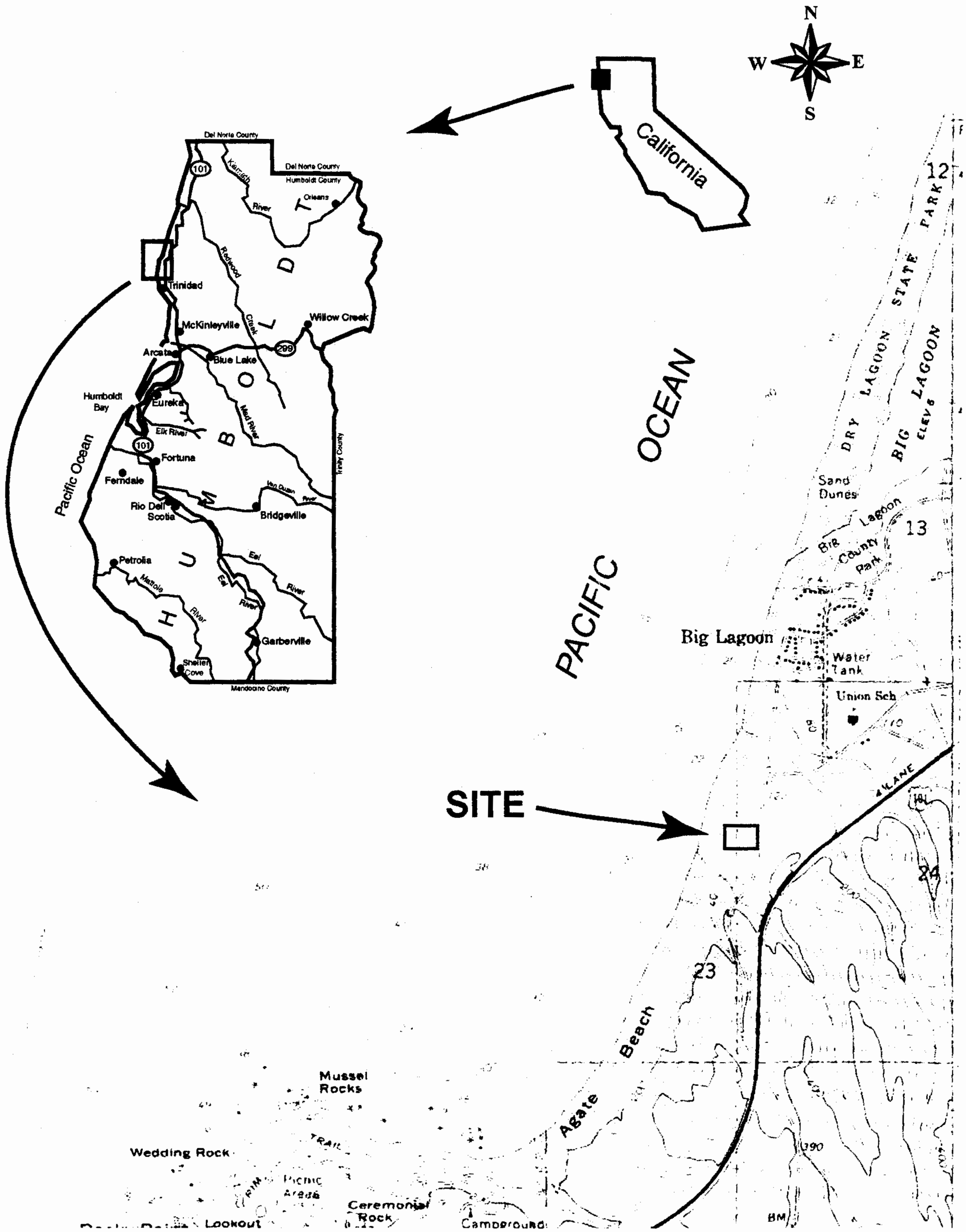
We are delivering this document under the terms of BGC contract #03-053 dated 8/21/03. The report provides geologic information about erosion rates, bluff-failure modes, and levels of risk associated with the relocation of the home.

Mr. Rohner owns three lots located in the Big Lagoon Park Subdivision in northern Humboldt County. This area is about 6.5 miles north of Trinidad. All three lots are in the southern part of the subdivision, west of Roundhouse Creek Road (see Figure 1). Two are bluff-top lots. The home sits on one.

The properties are Lots 12, 14, and 15 of the subdivision, respectively Humboldt County APNs 517-215-12, 517-251-14, and 517-251-15 (see Figure 2). Lots 12 and 15 are the bluff-top lots and Lot 14 is the lot onto which the home would be moved. The focus of this report is Lots 14 and 15; we do not address Lot 12 at all, other than to mention a stratigraphic feature on it. The Rohner home, a single-story wood-frame single-family residence on a concrete-block perimeter foundation, sits on Lot 15. Mr. Rohner proposes to merge Lots 14 and 15 and move the home east onto former Lot 14 . **At its closest, the relocated home will be 160 ft from the location of the top-of-bluff at the time we completed this report.**

The ultimate purpose of this report is to provide a setback for the home based on a methodology approved by the California Coastal Commission (CCC). To do this we characterize the geologic site conditions, provide a preliminary factor-of-safety analysis of the bluff, and provide information about long term and short term erosion rates at the site. We also discuss the probable economic lifespan of the home after relocation. **Although two previous geologic reports have been prepared for the site (SHN, 2003a, b), this report is self-contained. It presents all of the geologic information necessary for the CCC to make a determination.**

Figure 1. Nested Site Location Map. The topographic map is a portion of the USGS Trinidad 7.5' quadrangle map. Various scales.



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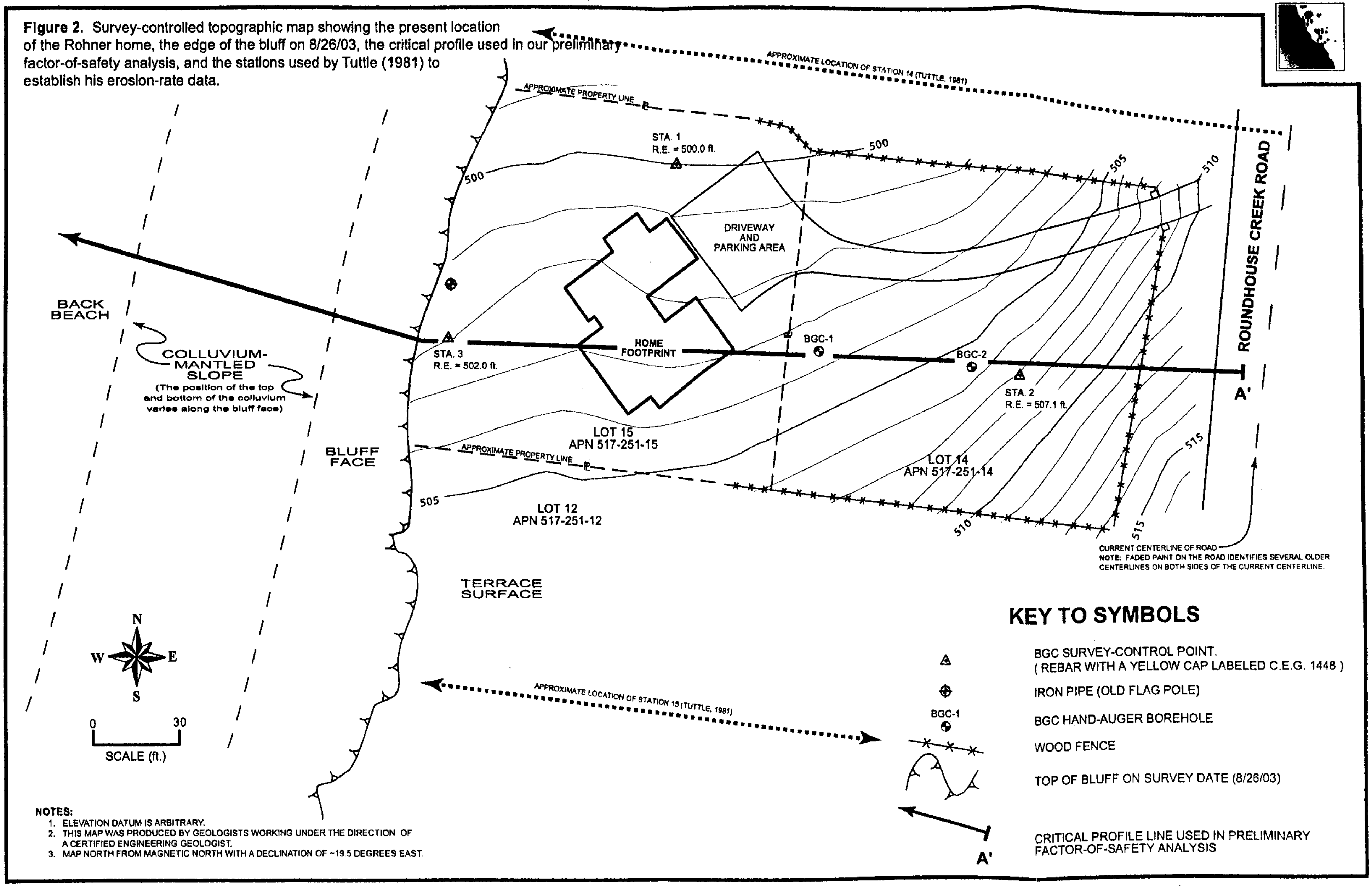


Figure 2. Survey-controlled topographic map showing the present location of the Rohner home, the edge of the bluff on 8/26/03, the critical profile used in our preliminary factor-of-safety analysis, and the stations used by Tuttle (1981) to establish his erosion-rate data.

Scope of Work and Methods

Generally speaking, and to simplify somewhat, our scope-of-work called for us to calculate historic short-term erosion rates and a long-term erosion rate of the Rohner homesite property; to predict a future erosion rate; to complete a quantitative slope stability analysis based on measured and assumed site-specific conditions; to provide an overall risk assessment; and to recommend a minimum setback for the Rohner home based on our work. Specific tasks in our scope-of-work included:

- Reviewing pertinent professional literature, consultant's reports, maps, and stereographic pairs of air photos;
- Making a survey-controlled topographic base map of the lot on which the Rohner home currently sits and of the contiguous lot onto which it will be moved;
- Making a survey-controlled critical profile of the bluff face on the lot;
- Characterizing the stratigraphy of the site by describing the bluff face and selecting appropriate soil parameters for the various identified lithostratigraphic units;
- Characterizing the geology of the site;
- Completing a preliminary mathematical ("Factor-of-Safety") analysis of the bluff and identifying the location of the $FOS_s = 1.5$ line on the critical profile and the project base map;
- Using a hand-auger to explore, describe, and sample shallow soils in the proposed relocation area in case a foundation-soils report was needed by either the California Coastal Commission or Humboldt County;
- Testing selected representative shallow soil samples for that soils report;
- Providing erosion rate information and a recommended setback based on the long-term erosion rate and the preliminary FOS calculations;
- Providing a risk assessment for the proposed home relocation area;
- Interacting with the client, his representatives, and key staff of involved regulatory agencies (notably, Mark Johnsson of the California Coastal Commission); and
- Providing this report.

On August 20th, 2003, our principal, Bob Busch, C.E.G., made a reconnaissance-level inspection of the site with Staff Engineering Geologist Bryan Dussell. Bob and Bryan returned to the site on August 26th with BGC Staff Geologist Beau Whitney to make a detailed inspection of the lot and bluff-face (as possible); profile the bluff face using a total station; hand-auger exploration holes in the proposed home relocation area; take field notes and documentary digital photographs; and collect representative soil samples of the shallow soils for use in a possible foundation-soils report.

We use standard practices and professional standards of care for all of our geotechnical studies, and we follow American Society of Testing and Materials (ASTM) procedures for all sampling and lab testing. We also follow the recommendations provided by Southern California Earthquake Center (SCEC) for implementation of DMG Special Publication 117 (SCEC, 2002). For this job, to determine site-specific erosion rates and to recommend a setback, we followed the methods described in Johnsson (in press). This report contains field and lab data, the results of a preliminary factor-of-safety (FOS) analysis, a summary of observations and conclusions, and a hazard and risk assessment.

We surveyed the site and profile using a Sokkia Set 3A Total Station and SDR 33 Data Recorder. In the office we finished CADD work on the map and profile.

To measure the position of the bluff top on the aerial photographs we used a Xerox machine capable of incremental (percent-by-percent) enlargements to enlarge each photograph about 400%. On the ground we measured the length of a specific feature that is present on all photographs (a field in a park), then we used that measurement to determine the exact scale of the enlargement. The field is less than 100 ft lower in elevation that the Rohner site, so the scales of the two areas are within 1% of each other (Avery, 1968). We worked in stereo with the original photographs to locate the exact position of the top edge of the bluff, then we measured the distance from the centerline of Roundhouse Creek Road to the edge-of-bluff on the enlargement. Using this methodology, we can measure the centerline-to-bluff distance to an accuracy of + / - about 11 feet. Although we can measure a distance to within 1/60th of an inch (equivalent to +/- ~5 to 6 ft at the enlarged scale of most of the photos), an additional error of up to ~5 ft is introduced by the historic variability of the position of the road centerline stripe. At present there are at least five centerline stripes on the road at the entrance to the Rohner driveway. The difference between the two outside lines is about five feet. Additional discussion follows.

ENGINEERING GEOLOGY OF THE SITE

Site Geology

The Big Lagoon Subdivision was built on an uplifted marine terrace, the 83,000-year-old Savage Creek terrace (Carver and Burke, 1992). The western, seaward edge of the terrace ends at the Pacific Ocean. Over time, the ocean has eroded into the terrace and created a bluff-backed shoreline. Along its entire length the bluff maintains a nominal >60° face with a near-vertical to slightly overhanging top. In map view the edge of the bluff is surprisingly linear, trending about N15°E. It does not contain deep cusps or "bites" caused by recent large bluff failures, and our review of aerial photographs dating back to 1942 indicates that it never has. We estimate that the deepest failure since 1942 bit back no more than ~40 ft into the top-of-bluff. The next two deepest failures removed no more than ~20 ft.

The site is located at the northern edge of the Mad River fault zone (MRfz) of Carver et al. (1982). The MRfz is the onland portion of the Cascadia fault and fold belt (ibid.). Compressional tectonics in the belt formed the Big Lagoon fault (at the north side of Big Lagoon about 4.2 mi north of the Rohner lots) and the Trinidad fault (which passes out to sea about 6 miles south of the site), and they tilted the terrace to the north (Carver, 1987). As a result of this dip, the bluff height varies from ~175 ft at Patrick's Point State Park about 5100 ft south of the site, to zero at the south edge of Big Lagoon where the terrace surface dives beneath the water. At the Rohner site, the top of the bluff is ~126 ft above the back-beach.

Along the western edge of the subdivision, erodible marine terrace sediments back up the beach. Franciscan Complex bedrock, which is exposed in the headlands of Patrick's Park State Park and on the north side of the Big Lagoon fault, does <u>not</u> outcrop at the base of the bluff in the subdivision. Here the beach is unprotected by offshore rocks or a nearby headland, so whenever winter storm waves strip the sand from the beach, the base of the bluffs—whether talus or in-situ soil units—begins to erode. At times the result is rapid-rate erosion of the bluff (e.g., Tuttle, 1981).

Based on their characteristics, the sediments at the site—technically, poorly consolidated rocks, can be placed into four main units (our soil units 2 through 5 of Figures 3 and 4). These units are capped by a dark brown eolian topsoil ~2 ft thick (not shown on Figure 4). For our FOS analysis we grouped the beach sand and colluvium mantling the base of the bluff into soil unit 1.

The uppermost soil unit (soil unit 2) is a loose, yellow-brown to olive-brown silty fine sand (USCS, SM) of probable eolian origin. This unit is ~20 ft thick at the face of the bluff and ~12 ft thick at borehole BGC-1 some 140 ft back of the bluff edge. Along most of the bluff face, this unit maintains a near vertical face.

Soil unit 3 is a coarse grained deposit (USCS, SW-GW). This unit is composed of alternating beds of pebble conglomerate, pebbly sandstone, and sandstone. Beds vary in thickness from a few inches to a few feet. The pebbles are well-graded subangular to well-rounded (mostly well-rounded) clasts derived from Franciscan Complex sites and reworked older marine terraces. The beds vary in thickness laterally and are a crudely fining upward sequence. Sub-horizontal bands of iron and manganese cementation of variable thickness are common throughout this unit.

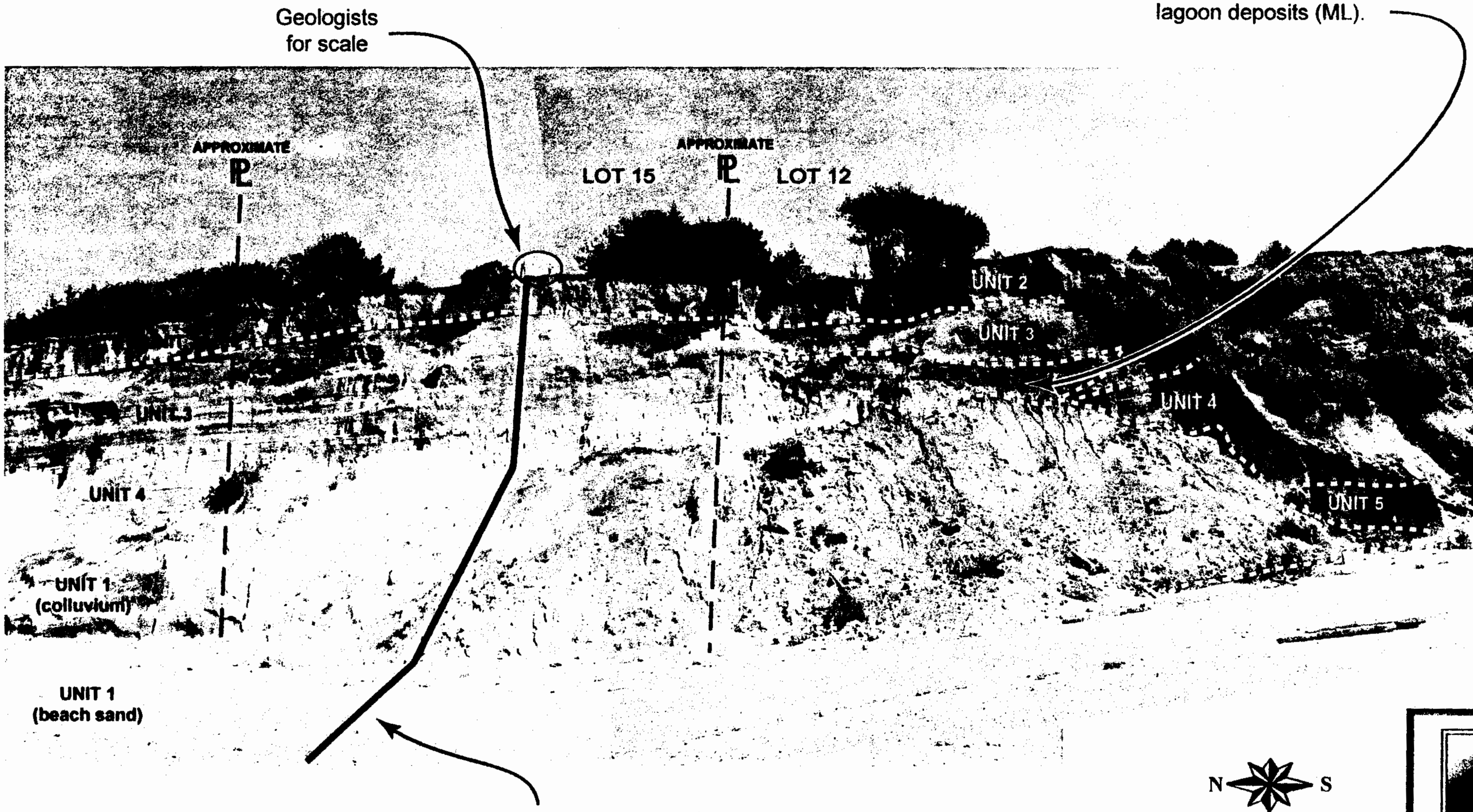
Soil unit 4 is a medium dense, poorly graded, fine- to medium-sand ~45 ft thick (USCS, SP). The sand is slightly coarser than the sand in soil unit 3. The grains are subangular to subrounded. Low-angle cross-bedding is visible throughout the unit.

Soil unit 5 is covered with talus across most of the site. We described the unit from a small exposure immediately south of the site (see Figure 3). There, the unit is composed of alternating poorly graded sands with interlayer pebble conglomerate beds. This unit is composed of numerous fining-upward sequences.

Immediately south of the property line within the upper part of soil unit 3 is a localized organic-rich deposit. Here, the conglomerate and sandstone beds of soil unit 3 change laterally into a dark brown to black clayey silt. The silt deposit is strongly lenticular and contains woody debris including seemingly in-place root masses. This deposit represents an isolated shallow-water, low-energy estuarine or lagoonal facies. This silt was wet at the time of our investigation. This fine-grained layer impedes the downward percolation of groundwater, so springs, seeps, groundwater staining, and small soil pipes (open voids) are common in the bluff face just above these layers. Perhaps coincidentally—and perhaps not—this area is the approximate axis of the largest recent failure on the entire bluff face.

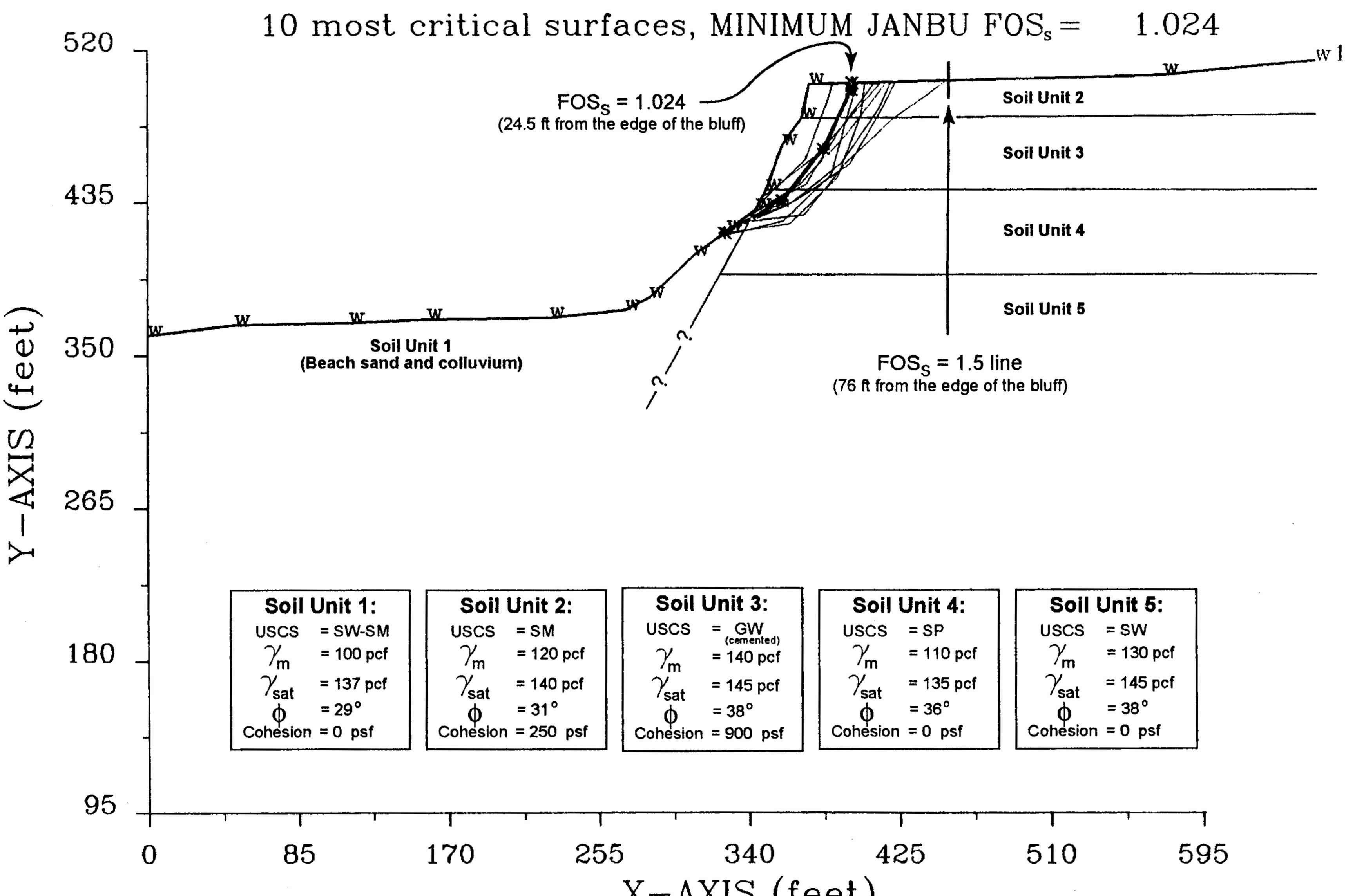
Figure 3. Photograph of the bluff face on the Rohner property on 8/26/03 showing the five soil units used in the preliminary factor of safety analysis, and the profile line. Note the two geologist at the top of the bluff for scale.

Soil Unit 1: Bluff colluvium and beach.
Soil Unit 2: Eolian sand (SM) with a topsoil cap (ML).
Soil Unit 3: Interbedded sand (SW) and gravel (GW) with iron and magnesium cementation.
Soil Unit 4: Cross-bedded sand (SP).
Soil Unit 5: Interbedded sand (SW) and gravel (GW) with repeating finning upward sequences.



NOTE: This figure contains color for clarity.
If the figure does not contain color, then it has been reproduced.

Figure 4. Critical profile of the bluff. See Figures 2 and 3 for the profile location on the Rohner property. All soil parameters assumed. See text for discussion.



NOTE: For clarity, we show the FOS$_s$= 1.5 line and the failure arc with the minimum FOS in red. If the figure does not contain color, then it has been reproduced.

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Aalto (1989) describes these soil units as part of the "upper Agate Beach deposit". Excluding the capping unit (soil unit 2), he interprets all of these deposits as records of storm events in a high-energy shallow-water environment. Near the Park stairway to Agate Beach, the upper Agate Beach unit is ~30 m thick. To the north the unit thickens to ~300 m (ibid.).

Seismic Hazard

Coastal northern California is located within an active tectonic regime. The most likely source of an earthquake that could affect this site is the southern part of the offshore Gorda plate. The predicted peak ground acceleration of the design basis earthquake (DBE) for the area is 0.64 g (USGS, 2003).

The Big Lagoon area is located within the Mad River fault zone, sandwiched between two active regionally significant thrust faults, the Big Lagoon fault about 4.2 miles north of the site and the Trinidad fault about 5.5 miles away to the south. Both faults dip to the northeast. The slip plane of the Trinidad fault passes beneath the Rohner site at depth. The recurrence interval of individual faults within the Mad River fault zone is two thousand years or less (Petersen et al., 1996). The date of the last rupture of either of these faults is unknown.

Work by geoscientists has demonstrated that great (M_w 8.0 to 9.0) earthquakes have occurred in the coastal Pacific Northwest in the recent past, and that the potential for similar earthquakes to occur is HIGH within the next 200 years. These earthquakes occur along the dipping interface between the oceanic Juan de Fuca plate and the continental North America plate. Plate tectonic processes are causing the Juan de Fuca plate to subduct (dive down) beneath the North America plate, so it underlies North America, beginning at the base of the continental slope, which is offshore. This tectonic interface, which is called the Cascadia subduction zone or Csz, last ruptured early in the evening on January 26, 1700 (Satake et al., 1996). The most recent work suggests that recurrence interval of great Csz earthquakes is 480-535 yrs (Kelsey and others, 2002). Previously it was thought to be ~300 to 500+ years (Clarke and Carver, 1992). A Csz event would cause a regional catastrophe in the Pacific Northwest. Prior to the publication of Kelsey and others, 2002, the probability of a Csz event was thought to be 10% to 20% within the next 50 years (Geomatrix, 1995). Seismogenic failures of the bluff strand would occur during a Cascadia event.

Bluff Failure Processes, Global Warming, and Geodesy

In the Big Lagoon area, bluff failures are caused primarily by marine undercutting of the base of the erodible marine terrace sediments. As the base of the bluff erodes to an over-steepened slope angle (~70° to near-vertical), the sediments fail as planar slides, debris slides, and "flake" failures of coherent blocks of sediment. Over time these failures cause the top-of-bluff to "backwaste" or "erode back."

In the Pacific Northwest in general, and in the Big Lagoon area in particular, undercutting by winter waves historically has caused dramatic, rapid, episodic shoreline retreat, especially during and following strong El Nino years. An El Nino is a climatic perturbation that effects the entire Pacific Ocean basin and the surrounding land masses. A strongly negative value of the June-November Southern Oscillation Index [SOI] is used to classify a year as a strong El Nino year (per the logic of Redmond and Koch, 1991). Typically, strong storms occur during an "El Nino winter." Based on the SOI, an El Nino winter occurred in 1940-41, 1941-42, 1946-47, 1951-52, 1965-66, 1972-73, 1977-78, 1982-83, 1987-88, 1993-94, 1994-1995, and 1997-98 (WRCC, 2003). Ranked by their SOI, the El Ninos of 1982-83 (-2.42), 1940 (-1.80), 1941 (-1.73), 1997 (-1.67), 1965 (-1.58), and 1977 (-1.52) were the strongest (ibid.). Of these, the Pacific Northwest was most affected by the 1982-83 event, which Quinn et al. (1987) classify as a very strong El Nino. Very strong El Ninos have an average recurrence interval of ~50 years, but a range of 13 to 150 years (ibid.). The previous very strong El Nino occurred in 1925-26 (ibid.).

In the Pacific Northwest, coastal erosion typically is greater (more rapid, more significant) during strong El Ninos because the winter water height is higher than average, large storms tend to be more frequent, and storm swells tend to be larger. In addition, wave trains may arrive from a different direction than usual. During an El Nino winter, after a few weeks of exceptionally adverse wave and current conditions, most of the sands and fine gravels on an affected beach have been moved offshore into deeper-than-usual water. When the protective beach is gone, marine undercutting of the base of the bluff begins, followed by rapid-rate bluff back-wasting. Furthermore, erosion remains more rapid afterwards, at least at sites where erodible bluffs have lost their beach, until the beach profile approaches its "normal" configuration. Unfortunately, the transport of the sand farther offshore prevents the sand from returning to the beach the following summer. As a result of the interaction of these complex factors, at least three of the five past strong El Ninos (1940-41, 1941-42, and 1997-98) have triggered an episode of rapid-rate bluff erosion in the Big Lagoon area (conclusion based on aerial photo research and review of reports including Tuttle, 1981; Falls, 1998; BGC, 1998; SHN, 1998; SHN, 2003a, b). Surprisingly, the 1982-83 "Very Strong El Nino" winter did <u>not</u> trigger a significant episode of erosion at the Rohner site.

When El Nino winter waves and the associated longshore currents redistribute beach sands, a multi-year episode of sea cliff erosion begins and does not abate until a beach is present again. This phenomenon was wide-spread in the Pacific Northwest following the 1982-83 El Nino (Komar, 1986; Tuttle, 1987; Peterson et al., 1990).

In addition, groundwater emerging from the bluff face can cause subsurface erosion and bluff instability. This process causes certain areas of the bluff top to experience larger-than-typical failures. Localized saturation, higher porewater pressures, and associated groundwater affects collectively may have been the cause of the recent failure at the south edge of the property (above the silt bed within soil unit 3).

Until recently, eustatic sea level rise has been cited as 1.8 +/- 0.2 mm/yr (Douglas, 1991). However, this rate may be accelerating. The "best midrange estimate" of the Intergovernmental Panel on Climate Change (IPCC, 2001) is that eustatic sea level will rise 50 cm over the next century, or 5.0 mm/yr. In Oregon, where the beaches have been studied in greater detail than in northern Humboldt County, many beaches have a 50:1 (H:V) slope (Peterson et al., 1991). Theoretically, and with other things held equal, a 2 mm rise of sea level each year could lead to a long-term retreat rate of an erodible bluff of ~10 cm/yr (3.9" or 0.33 ft/yr); a 5 mm rise could trigger a retreat of ~25 cm (9.9" or 0.8 ft/yr).

Despite the high potential for retreat, many Oregon bluffs show little or no retreat over a 50-year time span, probably because roughly equivalent tectonic uplift is occurring (Peterson et al., 1992). A similar situation exists for some Humboldt County and Del Norte County beaches. That is, tectonic uplift roughly offsets global sea level rise by raising the land at about the same rate as sea level is rising. The current estimate is that the Big Lagoon area is rising about 4 mm/yr (Mitchell et al., 1994).

Although it is an ominous situation that sea level is rising, and that the <u>rate</u> of rise is increasing, episodic bluff erosion presents a greater hazard to the Rohner property than does inundation.

Summary of Air Photo Observations

(All measurement distances are +/- ~11 ft; see following discussion)

A large reentrant (for this coastal strand) was present just south of the Rohner property from prior to 1942 through 1948. When it formed, the failure "bit" at least 50 ft out of the bluff top. (The failure might have occurred as one large failure, but more probably it happened as a series of small failures.) In the 1942, photos waves are lapping up against the base of the bluff. (Recall that successive strong El Ninos struck the Pacific Northwest and affected the Big Lagoon area during the winters of 1940-41 and 1941-42. The winter storms would have removed most—if not all—of the beach and triggered rapid-rate erosion.) By 1948, a narrow beach is present at the base of the bluff. (In the Big Lagoon area, even large storm waves cannot reach the base-of-bluff when a beach is present. The beach must be almost completed eroded away before marine undercutting of the base of the bluff can begin.)

In the 1954 and 1958 photos a wide beach is present at the base of the bluff, so the bluff is protected from wave erosion. Thick vegetation blankets the bluff face.

By 1962, the trees and brush on the terrace surface had been cleared and the infrastructure for this part of the subdivision had been started. The top of the bluff just north of the Rohner site is bare and has a jagged appearance from recent small bluff failures. None of the failures appears to have removed more than 10 or 20 ft from the edge of the bluff.

By 1966, the access driveways for the lots in this part of the subdivision had been established. Bare soil is exposed across the entire bluff face, perhaps due to the 1965-66 El Nino winter. Despite the bluff failures, the edge-of-bluff is linear. Only one failure has removed a significant "bite" from the top of the bluff. This failure is located west of the intersection of Roundhouse Creek Road and Park Drive, but it does not appear to be a "typical" bluff failure. It is tear-drop shaped (the bulb end is in the bluff face), extends at least 100 ft into the bluff, and has a northwest-southeast trend (it is not perpendicular to the bluff face). A large alluvial fan is present on the beach at the outlet of the "tear drop." We suspect that this feature is the result of surface erosion of the bluff top and face caused by the heavy winter rains of December, 1964. We surmise that run-off captured by newly constructed Roundhouse Creek Road and part of the recently cleared terrace surface spilled over the edge of the bluff here and gullied it severely.

By 1970, homes had been constructed on the east side of Roundhouse Creek Road. Most of the bluff face was bare and a road had been built through the center of the tear-drop-shaped feature present in 1966. Near the center of the Rohner property, a failure ~80 ft long had bit back into the bluff edge ~20 ft.

The 1974 and 1981 photos record a period of relative stability of the bluff top and face. On both photos, vegetation covers most of the bluff face. Home construction has continued in the subdivision on both sides of Roundhouse Creek Road.

In 1982, the upper part of the bluff face once again is mostly devoid of vegetation and has a jagged appearance. As in the 1962 and 1966 photos, the bluff face is linear and does not contain any significant reentrants.

Home construction continued in the subdivision through 1988. Several homes, including the Rohner home, are visible on the west side of Roundhouse Creek Road. A small cuspate notch is barely visible west of the home. The cusp appears to have removed less than ~20' of the bluff edge.

The favorable scale of the 1996 photos permits a more accurate interpretation of detail. The cusp west of the Rohner home is still visible as a ~20 ft deep "bite." The south edge of the cusp merges into a narrow "peninsula" in the bluff top. The peninsula failed during the most recent (1997-98) bluff failure.

To recap and summarize, the edge of the bluff south of Big Lagoon has remained essentially linear, trending ~N15°E, through the ~60 years of photos we reviewed. The largest bluff failure we observed "bit" into the bluff edge no more than ~40 ft (+/- ~11 ft), and failures <20 ft in depth (+/- ~11 ft) appear to be the <u>characteristic</u> failure size. (The larger-than-typical feature visible in the 1966 photos is a gully system related to surface runoff following road construction).

Erosion Rates

In 1981, Don Tuttle of the Humboldt County Department of Public Works (now retired) compiled coastal bluff erosion data for much of the Humboldt County coastline (Tuttle, 1981). His data was based on historic photographs, aerial photographs, maps, survey notes, highway plans, historical letters and journals, archaeological reports, and interviews with long-time residents.

In the Big Lagoon area, Tuttle established numerous stations to measure bluff retreat on air photos taken between 1941 and 1974. He cross-checked his measurements using various other sources of data. Tuttle's stations 14 and 15 flank the north and south sides of the Rohner property, respectively (see Figures 2 and 6). At both stations he measured the distance from the top-of-bluff to the centerline of Roundhouse Creek Road.

In a nutshell, Tuttle found that the bluffs near Big Lagoon had retreated from 40 to 100 ft in the 50 years preceding his report (1981). Since then, retreat has continued in the same type of punctuated equilibrium that he recorded: decade-long periods of essentially no erosion have been broken by episodes of rapid erosion, the most recent occurring in response to the El Nino winter of 1997-98 (Tuttle, 2003, personal commun.).

Tuttle's data for 1941 to 1974 indicate that the bluff retreat rate near the Rohner site (stations 14 and 15) averages ~1.5 ft/yr. However, the next stations to the south (stations 16a and 16b) recorded a bluff retreat rate of 2.1 ft/yr and 2.7 ft/yr, respectively. The highest bluff retreat rate recorded was 4.6 ft/yr at station 18 (~900 ft south of the Rohner property). Tuttle's work indicates that by 1974, erosion had removed about one third of the depth of Lot 12, and half of the depth of the adjacent lot to the north (Lot 16). Since 1974, seemingly only a few feet of erosion have occurred there (Tuttle, 2003, personal commun.).

For this project, we expanded on Tuttle's work by reviewing additional sets of aerial photographs. Our goal was to use the photos to attempt to quantify bluff retreat rates during specific time intervals per the methodology of Johnsson (in press), and to provide additional data for the time between 1974 and today. We gathered all stereo pairs of aerial photographs that were readily available from Humboldt County (the Department of Natural Resources) and the State (the California Geological Survey, Eureka office). The photos were taken in 1942, 1948, 1954, 1958, 1962, 1966, 1970, 1974, 1981, 1982, 1984, 1988, 1996, and 2000. We then measured the distance from the centerline of Roundhouse Creek Road, through the center of Lots 14 and 15, to the top of the bluff. We also measured the length of an object visible on all photographs (a field bordered by roads). We used the length of the field, which is at the same approximate elevation as the Rohner site, to determine the actual scale of each photo. We did this for the photo at the original scale and as enlarged ~400% (see Table 1).

Standard textbooks (e.g., Avery, 1968) indicate that the mensuration of objects using aerial photographs is accurate only within limits. However, the degree of uncertainty can be quantified. To estimate the error on this job, we compared our measurement of the distance from the centerline of Roundhouse Creek Road to the top-of-bluff on the 1974 and 1981 photographs with the distance shown on the survey-controlled project base map (Van Fleet, 1976). In each case, our measurement was greater than the distance as recorded on the map. We used the discrepancy (11 ft) to establish an error bar (+/- 11 ft.) around our measurements from the aerial photographs (Figure 5). On the Rohner site, our accuracy was limited by several factors:

1) **Scale limitations and variations:** Before enlargement, the scale of the air photos ranges from 1"=2,500' (1:30,000) to 1"=614' (1:7,368). After enlargement, the scale ranges from 1"=700' (1:8,400 to 1"=150' (1:1,800). On the 1:30,000-scale photographs, trying to measure 5 ft of bluff retreat requires measuring to an accuracy of two thousandths of an inch. Our best ruler is accurate only to $1/60^{th}$ of an inch. In addition, the field we used to scale the photos is about 100 ft lower in elevation than the Rohner site. This change in elevation alters a 1:12,000 scale to 1:11,800 or 1:12,200, depending on which of these elevations the scaling targets were located (Avery, 1968).
2) **Variable position of the road centerline:** The location of the centerline of Roundhouse Creek Road has varied over time. Today, multiple painted centerlines are present on the road, and the location of the line varies by up to ~5 ft at the Rohner driveway.
3) **Reproduction distortion:** Even on an excellent Xerox machine, enlarging a photo might introduce distortion of 1 or 2% in at least one dimension. Because the field we used to scale the photos is not next to the Rohner properties, the two objects may have been distorted unequally.

The measurements made by Tuttle (1981) were subject to the same types of intrinsic inaccuracies. For example, Tuttle's measurement of the position of the bluff edge was accurate for the south side the Rohner property, but there is a ~19 ft discrepancy on the north side of the property. We determined this by comparing his data to the survey-controlled Rohner site map (Van Fleet, 1976) (see Figure 6).

Applying a uniform error bar (+/- 11 ft.) to our data points (Figure 5), we drew "best fit lines" through the data field to estimate various possible "short term" erosion rates. We calculated the "long term" erosion rate for the site using the two end member data points (1942, 2003). Our estimates of the "short-term" erosion rates are 2.44 ft/yr between ~1942 and ~1958; 0.03 ft/yr from ~1958 through ~1997; and ~1.00 ft/yr from ~1997 through the present (2003).

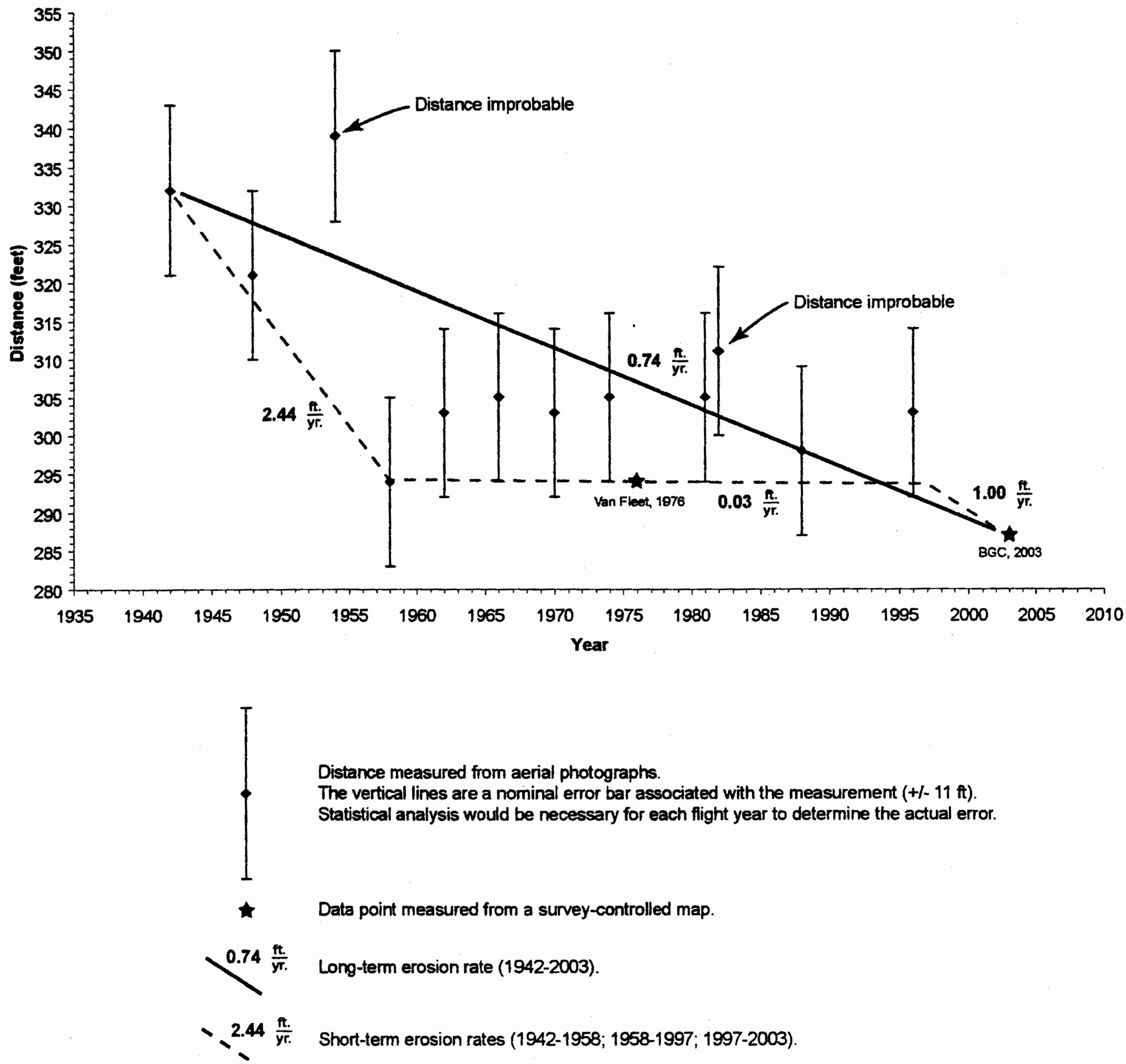
Table 1. Bluff retreat data for the Rohner property.

Year	Distance from the centerline of Roundhouse Creek Road to the top edge of the bluff (in ft) through the center of the Rohner properties.	Source of measurement	Scale 1"=original/enlarged
2003	287	Map	30'
1996	303	Air photo	1,001'/275'
1988	298	Air photo	2,502'/345'
1982	311	Air photo	614'/321'
1981	305	Air photo	1,844'/323'
1976	294	Map	10'
1974	305	Air photo	973'/300'
1970	303	Air photo	973'/292'
1966	305	Air photo	1,030'/300'
1962	303	Air photo	947'/300'
1958	294	Air photo	1,001'/309'
1954	339	Air photo	1,523'/292'
1948	321	Air photo	1,592'/305'
1942	332	Air photo	1,668'/306'

Maps = Van Fleet, 1976; BGC, this report (Figure 6).

Figure 5. Graph showing the distance from the center of Roundhouse Creek Road to the top edge of the bluff seaward of the Rohner home. All distances were measured through the center of the Lots 14 and 15 (Profile A-A' of Figure 2). See text for discussion.

Distance from the center of Roundhouse Creek Road to the top of bluff at the Rohner residence



Although the calculated "long term" erosion rate (1942-2003) is 0.74 ft/yr, our recommended minimum setback distance is based on an erosion rate of 1.00 ft/yr (see **RECOMMENDATIONS**). Although 1.0 ft/yr is less than the rate Tuttle recorded for the general site vicinity based on the period 1941-1975, we believe it is appropriate to use because: it is conservative rather than liberal; it is based on 61 years (Tuttle's was based on ~34 years); and the bluff face currently is "unstable."

In summary, our work confirms that bluff erosion has been episodic and unpredictable in the strand of bluffs south of Big Lagoon. At the Rohner property, a significant episode of retreat began during the winter of 1940-41, and rapid-rate erosion apparently continued until about 1958. Then, the bluff remained relatively stable until late in the winter of 1997-1998, even though the coastline was subjected to numerous El Ninos, including the very strong El Nino of 1982-1983.

Although the intrinsic error associated with measuring the bluff position using air photos makes it nearly impossible to document small-scale (10-ft-deep) bluff failures with a high degree of confidence, the photos do allow a qualitative evaluation of the condition of the bluff. That is, we can see changes in vegetation on bluff face so can recognize periods of relative stability and instability of the bluff face and top.

Quantitative Slope Stability Assessment

Introduction

Previously, SHN Consulting Engineers and Geologist Inc. provided a geologic evaluation of the site (SHN, 2003a). That report did not include elements considered necessary by the California Coastal Commission. Specifically, the report did not include a "factor-of-safety" (FOS) analysis or detailed erosion rate information for the site*. Ultimately, that is why this report was necessary.

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*The SHN report also included factual errors, including the statement that the Rohner home had been condemned, when, in fact, it was neither "red-tagged" nor "yellow-tagged" [Binder, 2003, personal communication]. A subsequent report [SHN, 2003b] provided limited erosion rate data and a rationale for not performing a FOS analysis. Interestingly, the report authors argued that the profile used in any FOS analysis would be only a "snapshot" of the "dynamic, ever-changing environment," yet their Figure 2 shows identical conceptualized profiles for 1941, 1962, 1974, and 2003. That figure supports our thesis, not theirs: although the bluff face is a dynamic environment, an equilibrium profile develops on a bluff as a function of the rock or sediment types, their strength characteristics, and the unit geometries. As long as these factors remain relatively constant, the established profile maintains itself as the bluff backwastes over time. Consequently, a FOS analysis of a bluff is useful for an analysis of the bluff over time.

Description of Our FOS Model

The bluff on the Rohner property is ~126 ft high. The upper 19 ft is near-vertical. Below that, the slope of the face averages ~70°. A pile of talus estimated to be up to ~40 ft thick rests against the lower 55 ft of the face (see Figure 4).

To evaluate the level of risk the bluff might pose to the relocated Rohner home, we completed a preliminary quantitative slope stability analysis of a slope profile (Figure 4). Our analysis is "preliminary" because a "final" analysis, if required, must be done by an engineer registered in California. The purpose of a preliminary analysis is to determine whether or not the stability conditions are so marginal that a final analysis is required. A preliminary analysis often uses assumed soil parameters whereas a final analysis often uses site-specific parameters derived from appropriately tested soil samples. Conditions are not marginal on the Rohner site, so a final analysis is unnecessary.

The mathematical analysis, which is called a "factor-of-safety" (FOS) analysis, assesses the stability of a slope by comparing the forces resisting failure to the forces driving failure. In a stable slope, the forces resisting failure exceed the driving forces, so the FOS is > 1.0. When the two forces are equal, the FOS = 1.0 and slope failure is imminent. The greater the FOS, the greater the stability of the slope. We used the modified Janbu method, the computer program XSTABL, version 4.0, and a 5-layer model. Based on our understanding of the site, we divided the bluff into five separate soil units and modeled the characteristics of each. To model extreme winter conditions, we saturated the soil profile to the surface, providing a "worst-case" scenario for the site. However, because the granular soils and free face facilitate drainage, it is improbable that the soils within many tens of feet of the face of the bluff could ever become saturated. Consequently, the FOS generated by our model is conservative (is lower that the true FOS, which would be determined by setting the groundwater table at the winter high level determined by over-winter groundwater monitoring).

The minimum allowable value for the static factor-of-safety (FOSs) of a slope depends on the following (Duncan and Buchignani, 1975; SCEC, 2002):

(1) The degree of uncertainty in the shear strength measurements, slope geometry, and other conditions;

(2) The cost of flattening or lowering the slope to make it more stable;

(3) The cost and consequence of a slope failure; and

(4) Whether the slope is temporary (e.g., a construction cutbank) or permanent.

Typical practice is to recommend that the minimum static stability of an area of concern be FOS_s = 1.2 (Fang and Mikroudis, 1991) to 1.25 (Duncan and Buchignani, 1975), or greater (ibid.; Huang, 1983; SCEC, 2002; Johnsson, in press). The better the soil stratigraphy and strength data are known, the lower the FOS_s can be because there is greater certainty in the "truthfulness" of the FOS analysis.

To model the Rohner bluff we broke out and described various soil units exposed in the bluff face, then picked appropriate assumed soil parameters based in part on a nearby study (LACO, 2002), in part on our understanding of similar late Pleistocene marine terrace deposits we have studied elsewhere in Humboldt County (e.g., BGC, 1996a,b,c,d), and in part on published literature (Hunt, 1984). We ran reiterative analyses using different soil parameters until we were able to model a failure of approximately the same size ("bite back" depth) as the largest failure we observed on any aerial photograph.

In summary, our FOS work attempts to model the largest failures that occurred in the bluff during the past ~60 years. Our model is conservative because we set the groundwater table at the surface, a situation that cannot happen because of the steep bluff face and free-draining natural of the sediments.

Conclusions from Preliminary FOS Analysis

Figure 4 graphically present the results of our preliminary FOS analysis of the critical profile using the slope geometry, stratigraphy, and water table shown on the figure. The soil parameters we used are listed on the figure. We do not show or discuss constraints (such as failure segment length) that we used. The figure illustrates the 10 most probable failure surfaces for the conditions evaluated; the failure surface with the asterisks is the surface with the lowest FOS. We did multiple other "runs" to model slightly different soil parameters and conditions. We selected this analysis as most representative of the site conditions as we understand them.

Our analysis suggests that the minimum static FOS for the critical profile is FOS_s = 1.02, and that the dynamic FOS for the same profile during the design basis earthquake (DBE) is FOS_d = 0.84. **The results of our preliminary FOS analysis indicate that the outermost ~24 ft of the edge of the bluff are Provisionally Stable. In plain English, the bluff edge is marginally stable. This is consistent with our air photo review of ~3200 linear ft of the Big Lagoon coastal strand bluff. None of the photos showed a failure that removed more than ~40 ft of bluff.**

Setback Philosophies and The Concept of Economic Lifespan

(Excerpted and edited from prior BGC reports)

To provide an oceanside setback distance for new construction or the relocation of an existing home, a consultant—at minimum—must specify a project lifespan (usually 75 years on the California coast), a known long-term average rate or a more conservative "predicted" rate (in feet or inches per year), and "an acceptable level of risk" (usually stated subjectively as LOW, MODERATE, or HIGH). The "acceptable level of risk" usually is specified is LOW, meaning that the probability of loss is low enough that "a prudent person of average economic means" would accept the risk (i.e., would buy or build the home) (see Appendix IV). Sometimes a MODERATE level of risk is acceptable, for example, when the owner is of above average economic means and can afford to repair or move a structure or other improvement. Even a HIGH level of risk might be acceptable to an owner, as long as the hazard is the destruction of personal property, <u>not</u> injury or loss of life. Thus building on or near a slow-moving landslide that could destroy the home might be acceptable, but building on or near a site that could suffer a nearly instantaneous, catastrophic failure <u>never</u> is.

In Oregon, a setback determined using the preceding approach usually is acceptable. However, on the California coast, a "minimum setback" generally is the sum of three components: (1) the erosion-rate component, (2) a component determined by calculating the location of the FOS_s = 1.5 line based on a critical

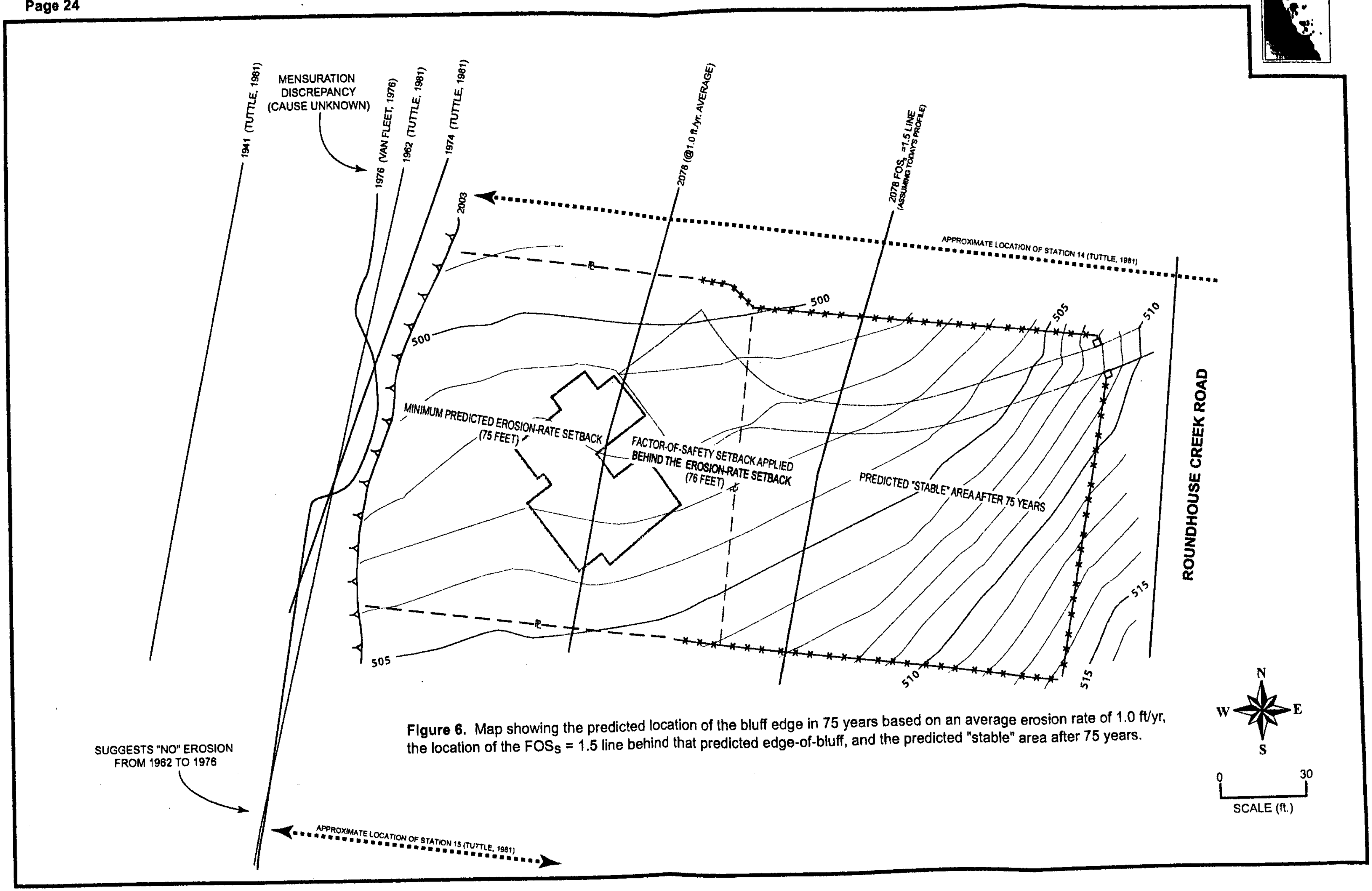

Figure 6. Map showing the predicted location of the bluff edge in 75 years based on an average erosion rate of 1.0 ft/yr, the location of the FOS$_S$ = 1.5 line behind that predicted edge-of-bluff, and the predicted "stable" area after 75 years.

profile, which is assumed to be a dynamic equilibrium profile (as discussed earlier), and (3) a component whose purpose is to further compensate for the uncertainties inherent in the analysis procedure.

A consultant calculates the probable economic lifespan of an existing home by dividing its distance from the encroaching bluff top by the known (or assumed) annual erosion rate. The result is a predicted economic lifespan. The greater the erosion rate used, the shorter the predicted lifespan; the smaller the erosion rate, the longer the lifespan. For example, if a home sits back 100 feet and the annualized erosion rate is 4/ft yr, the predicted economic lifespan is 25 years (less the time lost by the necessity of moving the house before the bluff top is at the back door).

Because consultants' opinions vary, one consultant might believe that a home built 100 ft back from a cliff edge eroding at 4 ft/yr is exposed to a LOW level of risk, whereas another might believe the risk exposure is HIGH.

After a prediction is made and a period of time actually passes, e.g., 10 yrs, it is possible to reassess the risk to the home using revised numbers. For example, in the same example, if the predicted lifespan of 25 years was based on a 4.0 ft/yr average erosion rate, but 10 years after the prediction it is obvious that the realized erosion rate actually averages 5.0 ft/yr, an unbiased observer would have to conclude that the home is exposed to a greater risk of damage than was originally thought. Using the example numbers, the predicted lifespan—as recalculated based on the more accurate, 5 ft/yr erosion rate—would be reduced to 16 years (80 ft original setback distance divided by 5 ft/yr average erosion = 16 yrs). The larger the realized average erosion rate, the shorter the actual economic lifespan of the structure. The smaller the rate, the longer the economic lifespan.

Proposed Location of the Relocated Rohner Home, And Its Predicted Economic Lifespan

Figure 6 shows the "minimum setback line" for the Rohner home. It is 151 feet eastward of the present top-of-bluff. The figure also shows the predicted location of the bluff in 75 years (in 2078), assuming an average erosion rate of 1.0 ft/yr. We used this slightly conservative rate (rather than the calculated 0.74 ft/yr rate) because there is uncertainty in the calculated rate, the bluff edge currently is Unstable on the lot, and the beach does not appear to have rebuilt to its "normal," pre-1996-97 winter width. The "minimum setback line" is the sum of the setback component due to the predicted erosion and the component due to our FOS calculations. The figure also shows the location of the FOS_s=1.5 line (plotted as 76 ft behind the calculated position of the top-of-bluff 75 years in the future). The ground east of the FOS line (the "minimum setback line") represents the ground predicted to be "stable" after 75 years. This "stable area" is about three-fourths of Lot 14.

If the CCC approves, the Rohner home will be setback 160 ft from the present top-of-bluff (see RECOMMENDATIONS and Figure 7). This distance provides for 75 years of erosion, a catastrophic bluff failure back to the FOS_s = 1.5 line, and an extra measure of prudence (9 ft).

To calculate the possible economic lifespan for the relocated Rohner home if the realized annualized erosion rate is greater than the anticipated 1.0 ft/yr, we divided the component of the bluff-top setback derived from the annualized erosion rate (75 ft) plus the "safety factor" distance (9 ft) by two different hypothesized future average erosion rates (2 ft/yr and 4 ft/yr). Each of the two results is a "predicted alternative scenario economic lifespan." The greater the hypothesized future erosion rate selected, the higher the probability of loss during the desired economic lifespan (75 yrs). In our examples, using a hypothesized future average erosion rate of 2.0 ft/yr for the relocated Rohner home decreases the predicted economic lifespan from 75 + 9 = 84 yrs to 75/2 + 9/2 = 42 yrs. Using 4.0 ft/yr as the erosion rate decreases the lifespan to 75/4 + 9/4 = 18.75 + 2.25 = 21 yrs. Note that none of these calculations consider the 76 ft component of the setback due to the FOS calculations. Also note that if the long-term erosion rate calculated for the site based on the 1941-2003 data (0.74 ft/yr) is realized in the future, the economic lifespan of the relocated Rohner home will exceed 75 years by over 25 years.

RECOMMENDATIONS

REC 1. Set the home back a minimum of 155 feet from the flag pole stanchion, which was 5 feet back from the bluff edge when we worked, and 243 feet west of the east property line fence. This converts to a recommended setback distance of 160 feet from the bluff edge in September, 2003.

REC 2. Use a home foundation that facilitates moving the home in the future.

27439

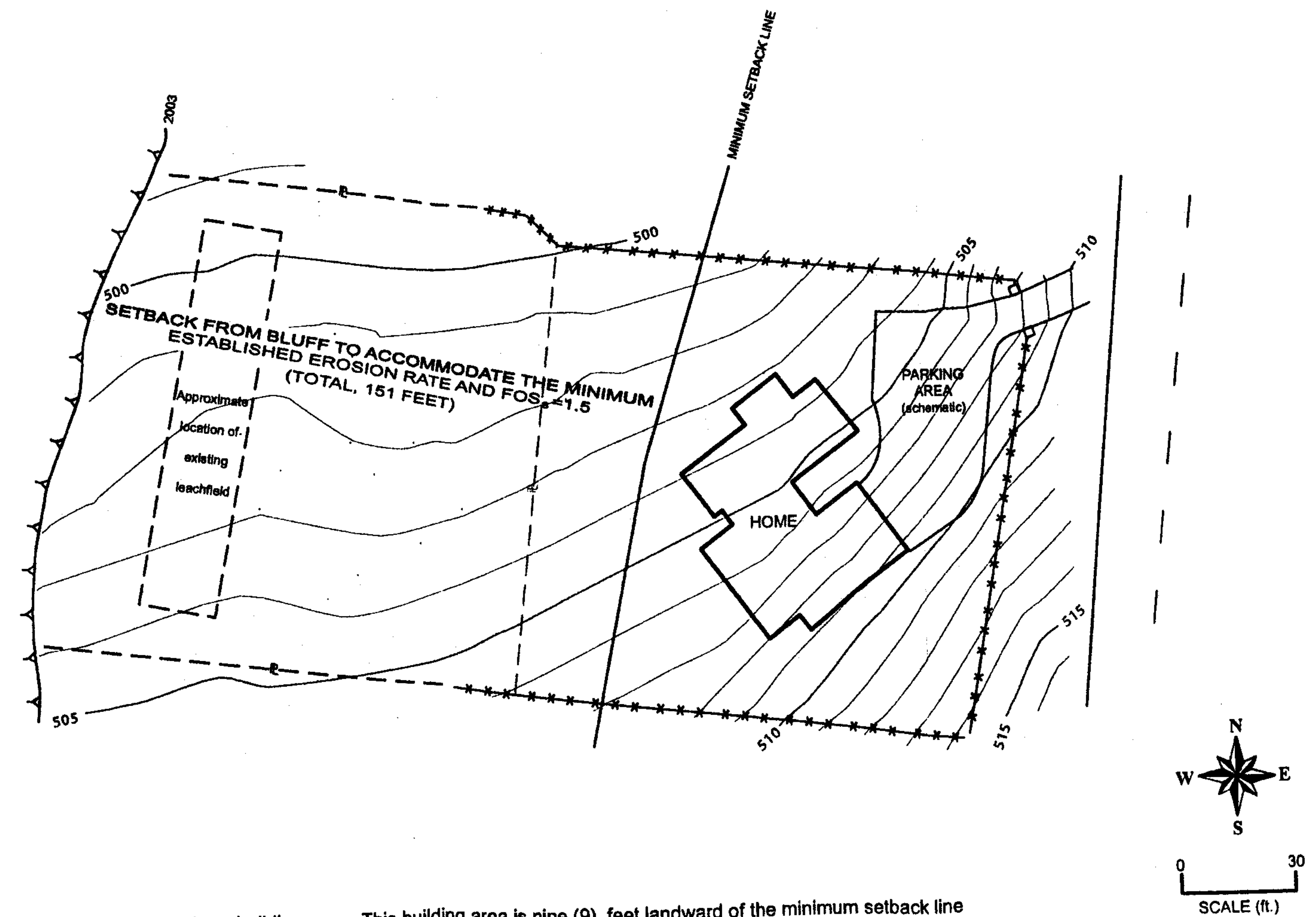

Figure 7. Desired Rohner building area. This building area is nine (9) feet landward of the minimum setback line determined using the methodology discussed in the text.

LIMITATIONS, CLOSURE, and AUTHENTICATION

Although we have used standard engineering geologic practices and professional standards of care to provide erosion-rate estimates, predictions, and a risk assessment, nothing in this report should be construed to state or imply a guarantee of safety of the home for any specific duration of time. Bluff retreat occurs in a largely unpredictable fashion, and it will continue to occur in the Big Lagoon area into the foreseeable future. Even if we have <u>over</u>stated the risk at the proposed site, and the future <u>realized</u> rate of bluff failure is <u>less</u> than the <u>minimum</u> rate we predict, it is important to understand that LOW risk is not the same as NO risk: rapid-rate bluff failure could occur before the calculated minimum economic lifespan is realized (herein stated as ~75 years).

In conclusion, although the evaluation presented herein is based on a consideration of the geologic, geodetic, tectonic, and nearshore marine processes active at Big Lagoon, greater or lesser retreat rates than those documented in the past and predicted for the future may be realized in the next 75 years.

Thank you for hiring us. Please call if you have questions or we can help you in some other way.

Respectfully submitted this sixth day of October, 2003,

Busch Geotechnical Consultants

Bryan Dussell
Project Geologist

R. E. Busch, Jr., Ph.D.
C. E. G. #1448

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Attached: **REFERENCES CITED**
Appendix IA. Soil Logs (4 pp.)
Appendix IB. Unified Soils Classification System (1 p.)
Appendix III. BGC's Slope Stability Classification System (1 p.)
Appendix IV. Risk Terminology (1 p.)

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APPENDIX IA

SOIL LOG **BUSCH GEOTECHNICAL CONSULTANTS**

Job: Rohher **Job #:** 03-053 **By:** REB / BBW **Log #:** BGC-1

Equipment: Hand Auger **Date:** 08/26/2003

Page: 1 of 2

Datum: Ground Surface

Laboratory Data						
Uc (tsf)	shear strength (psf)	% water	dry density (pcf)	sample	depth in feet	**Unified Soil Classification** texture, consistency, moisture, color, symbol
					-	
					-	Silt, slightly sandy (fine), soft, dry, dark brown, ML.
					-	
					1	
					-	
					-	
					-	
					2	
					-	Silt, slightly sandy (fine), sort, dry, yellowish brown, ML.
				tube	-	
					-	becomes sandy...
					3	
				tube	-	Sand, silty, loose, dry, yellowish brown, SM; contains
					-	concretions (<1" diameter), local Fe cementation.
					-	
					4	
					-	
					-	
				tube	-	
					5	
					-	
					-	
					-	
					6	
					-	Sand, loose, dry, light yellowish brown to olive brown, SP.
					-	
					-	
					7	
					-	
					-	
					-	
					8	very rare coarse rounded sand grains
					-	
					-	
					-	Sand, silty, loose, moist, light yellowish brown to olive brown,
					9	SM.
					-	
					-	
					-	
					10	
					-	

Notes: Uc (unconfined compressive strength) measured by penetrometer
"Quick" shear strength measured by torvane

SOIL LOG **BUSCH GEOTECHNICAL CONSULTANTS**

Job: Rohher **Job #:** 03-053 **By:** REB / BBW **Log #:** BGC-1

Equipment: Hand Auger **Date:** 08/26/2003

Page: 2 of 2

Datum: Ground Surface

Laboratory Data						
Uc (tsf)	shear strength (psf)	% water	dry density (pcf)	sample	depth in feet	**Unified Soil Classification** texture, consistency, moisture, color, symbol
					-	Sand, loose, moist, dark yellowish brown, olive, and strong brown, SP.
					-	
					-	
					11	fine pebbles
					-	
					-	grading to
					-	
					12	
				bulk	-	
					-	Sand, gravelly, loose, moist, multi-colored, SW-GW
				bulk	-	
					13	
					-	Bottom of hole at 13'
					-	
					-	
					14	
					-	
					-	
					-	
					15	
					-	
					-	
					-	
					16	
					-	
					-	
					-	
					17	
					-	
					-	
					-	
					18	
					-	
					-	
					-	
					19	
					-	
					-	
					-	
					20	
					-	

Notes: Uc (unconfined compressive strength) measured by penetrometer
"Quick" shear strength measured by torvane

SOIL LOG **BUSCH GEOTECHNICAL CONSULTANTS**

Job: Rohher **Job #:** 03-053 **By:** REB / BBW **Log #:** BGC-2
Equipment: Hand Auger **Date:** 08/26/2003
Page: 1 of 2

Datum: Ground Surface

Laboratory Data						
Uc (tsf)	shear strength (psf)	% water	dry density (pcf)	sample	depth in feet	**Unified Soil Classification** texture, consistency, moisture, color, symbol
					-	
					-	Silt, slightly sandy (fine), soft, dry, dark brown, ML.
					-	
					1	
					-	
					-	
					-	
					2	
					-	Silt, slightly sandy (fine), sort, dry, yellowish brown, ML.
					-	
					-	
					3	
					-	
					-	
					-	
					4	
					-	
					-	becomes sandy
					-	
					5	
					-	Sand, silty, loose, dry, yellowish brown, SM; contains
					-	
					-	
					6	
					-	
					-	Sand, loose, dry, light yellowish brown to olive brown, SP.
					-	
					7	
					-	
					-	
					-	
					8	
					-	
					-	
					-	
					9	
					-	
					-	
					-	
					10	
					-	

Notes: Uc (unconfined compressive strength) measured by penetrometer
"Quick" shear strength measured by torvane

SOIL LOG **BUSCH GEOTECHNICAL CONSULTANTS**

Job: Rohher **Job #:** 03-053 **By:** REB / BBW **Log #:** BGC-2

Equipment: Hand Auger **Date:** 08/26/2003

Page: 2 of 2

Datum: Ground Surface

Laboratory Data						
Uc (tsf)	shear strength (psf)	% water	dry density (pcf)	sample	depth in feet	**Unified Soil Classification** texture, consistency, moisture, color, symbol
					-	
					-	
					-	
					11	
					-	
					-	
					-	Sand, slightly clayey, medium, moist, yellowish brown, SW; partially cemented.
					12	
					-	
					-	
					-	
					13	
					-	
					-	
					-	
					14	
					-	
					-	
					-	
					15	
					-	
					-	
					-	
					16	
					-	
					-	
					-	Bottom of hole in same.
					17	
					-	
					-	
					-	
					18	
					-	
					-	
					-	
					19	
					-	
					-	
					-	
					20	
					-	

Notes: Uc (unconfined compressive strength) measured by penetrometer
"Quick" shear strength measured by torvane

APPENDIX 1B 1

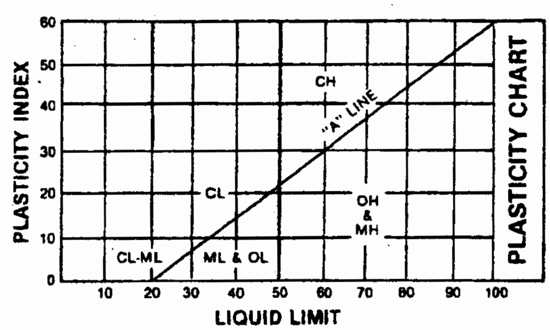
UNIFIED SOILS CLASSIFICATION SYSTEM

MAJOR DIVISIONS		SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS (More than ½ of soil > no. 200 sieve size)	GRAVELS (More than ½ of coarse fraction > no. 4 sieve size)	GW	Well graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (More than ½ of coarse fraction < no. 4 sieve size)	SW	Well graded sands or gravelly sands, little or no fines.
		SP	Poorly graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS (More than ½ of soil < no. 200 sieve size)	SILTS & CLAYS Liquid limit less than 50	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		OL	Organic silts and organic silty clays of low plasticity.
	SILTS & CLAYS Liquid limit greater than 50	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silty clays, organic silts.
HIGHLY ORGANIC SOILS		PT	Peat and other highly organic soils.

CLASSIFICATION CHART

CLASSIFICATION	U.S. STANDARD SIEVE SIZE
BOULDERS	Above 12"
COBBLES	12" to 3"
GRAVEL	3" to No. 4 sieve
Coarse	3" to ¼"
Fine	¼" to No. 4
SAND	No. 4 to No. 200
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
SILT & CLAY	Below No. 200 sieve

GRAIN SIZE CHART



PLASTICITY CHART

MOISTURE CONTENT (VISUAL CLASSIFICATION)
Dry – Damp – Moist – Wet

CONSISTENCY OF FINE GRAINED SOILS		DENSITY OF COARSE GRAINED SOILS	
CLASSIFICATION	COHESION (PSF)	CLASSIFICATION	STANDARD PENETRATION (BLOW COUNT)
Very Soft	0-250	Very Loose	0-4
Soft	250-500	Loose	4-10
Medium Stiff	500-1000	Medium	10-30
Stiff	1000-2000	Dense	30-50
Very Stiff	2000-4000	Very Dense	50 +
Hard	4000 +		

DENSITY - CONSISTENCY

574 39

APPENDIX III

BGC's QUALITATIVE SLOPE-STABILITY CLASSIFICATION
(Young, 1978, modified by Busch, 1980b)

VS - Very Stable (NEGLIGIBLE risk):
negligible and gently sloping interfluves, seepage slopes, and some convex creep slopes (e.g., ridge crests and knolls) underlain by intrinsically strong rocks; flat and gently rolling terraces away from the edges.

S - Stable (NEGLIGIBLE to VERY LOW risk):
slightly less stable areas of the same land-forms as in VS; gentle to low-moderate slopes of strong rocks.

MS - Moderately Stable (LOW to MODERATE risk):
gentle to low-moderate slopes of soft topographies (e.g., ridge edges, noses, and upper flanks); high-moderate slopes on most intermediate and hard topographies (e.g., some convex creep slopes and transportational midslopes).

PS - Provisionally Stable (MODERATE to HIGH risk):
moderate and high-moderate slopes in soft topographies (e.g., transportational midslopes, usually with relic mass-movement landforms) and steep slopes on hard topographies.

U - Unstable (HIGH risk):
temporarily inactive or slightly active sites of chronic mass wasting (e.g., earthflows, complex slump-earthflows, slumps, slopes with many soil slip scars, failing terrace edges).

VU - Very Unstable (HIGH to VERY HIGH risk):
extremely steep areas of soft topography and actively failing mass-wasting sites.

These categories qualitatively evaluate the intrinsic slope stability of a landscape. They take into account various structural, topographic, stratigraphic, geologic, hydrologic, and vegetative influences on stability. The categories necessarily are subjective, and naturally are gradational. Developmental activities subsequent to classification can detrimentally affect stability and can correspondingly increase levels of risk.

APPENDIX IV

EXPLANATION OF RISK ZONES

(Paraphrased from Moore & Taber, 1978; standardized with BGC's slope-stability classification)

The level of risk associated with a geologic hazard that potentially could cause a loss is described in terms of risk classes ranked in the following ascending scale:

NONE, NEGLIGIBLE, LOW, MODERATE, HIGH, VERY HIGH

The risk or probability of loss due to an action of a recognized geologic hazard is directly related to the level of risk associated with the hazard and to the nature of the potentially affected facility. A "reasonable risk" is defined as a probability of significant loss that is low enough to be acceptable to a prudent person (owner) of average economic means.

The nature, cost, and projected economic lifespan of an improvement, the economic means of the owner, the type and level of site maintenance, the feasibility of making potentially necessary repairs, public policy, etc., are factors that collectively established an acceptable (a "reasonable") level of risk. The definition of "reasonable risk" for a present owner/user must be compatible with "reasonable risk" for projectable successor owners and/or users.

For fixed improvements susceptible to permanent damaging effects of ground movement—such as a typical single family residence, a "reasonable level of risk" for a prudent person of average economic means generally is considered to be NEGLIGIBLE or LOW. For similar improvements, a MODERATE risk level generally is a level of risk that exceeds "a reasonable level of risk" with respect to loss of property, not of life. However, this level of risk sometimes may be acceptable to a prudent person of above-average economic means. HIGH and VERY HIGH levels of risk almost always pose a level of risk that exceeds a "reasonable risk" and would be unacceptable to any prudent person for such improvements.

For improvements of low cost that are readily amenable to repair or are not susceptible to the damaging affects of ground movement, or for land uses that might not be affected seriously by ground movement (i.e., some roads, picnic areas, or campgrounds, etc.), a MODERATE or HIGH level of risk may be considered to be a "reasonable risk."

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18 November 2003

EXHIBIT NO. **8**
APPLICATION NO.
1-03-028
ROHNER
STAFF GEOLOGIST'S MEMORANDUM (1 of 3)

GEOTECHNICAL REVIEW MEMORANDUM

To: Bob Merrill, Coastal Program Manager
From: Mark Johnsson, Staff Geologist
Re: 1-03-028 (Rohner)

In regard to the above referenced permit application, I have reviewed the following documents:

1) SHN Consulting Engineers and Geologists 1998, "Geologic hazard criteria for episodic. large scale accelerated bluff retreat conditions at the Big Lagoon Park subdivision, Tract 22, Blk. A, Humboldt County, California", 3 p. letter report dated 3 April 1998 and signed by T. A. Stephens (RG 5030).

2) SHN Consulting Engineers and Geologists 2003, "Geologic evaluation of bluff stability conditions relative to an existing residence at 294 Roundhouse Creek Road (A.P.#517-251-15), Big Lagoon Park subdivision, California", 3 p. letter report dated 11 March 2003 and signed by T. A. Stephens (RG 5030) and G. D. Simpson (CEG 2107).

3) SHN Consulting Engineers and Geologists 2003, "Revised geologic evaluation of bluff stability conditions relative to an existing residence at 294 Roundhouse Creek Road (A.P.#517-251-15), Big Lagoon Park subdivision, California", 5 p. letter report dated 27 June 2003 and signed by T. A. Stephens (RG 5030) and G. D. Simpson (CEG 2107).

4) Busch Geotechnical Consultants 2003, "Recommended setback for the Rohner bluff-top home based on an erosion-rate analysis and factor-of-safety considerations, 294 Roundhouse Creek Road, Big Lagoon Park Subdivision, Humboldt County, California [APNs 517-251-14 and 517-251-15]", 32 p. geologic report dated 6 October 2003 and signed by J. C. Busch, R.E. and B. Dussell.

In addition, I have discussed the site with Dr. Bob Busch, geotechnical consultant for the project, on several occasions. I also have spoken with Mr. Tom Stevens of SHN, who also worked for the applicant on the project.

As you know, the existing bluff-top residence at this site currently is set back from the bluff edge an insufficient distance to guarantee its safety given ongoing coastal bluff erosion at the site. The applicant proposes to move the house to a new foundation to be constructed on an adjacent parcel, located further from the current bluff edge. The purpose of this review is to assess the adequacy of the new proposed setback.

Reference (1) was undertaken to provide the Humboldt County planning department with a qualitative risk assessment for the Big Lagoon Park subdivision. Reference (2) provided a more site-specific, but still qualitative, risk assessment for the existing residence. When the applicant was asked for a more quantitative setback analysis, using the criteria usually considered by the Commission staff, reference (3) was provided. As I explained to both Mr. Stevens and Dr.

Busch, in order to evaluate proposed setbacks for new development, the Commission staff needs to be provided both with long-term bluff retreat rate data, and with adequate slope stability data. The former were supplied in reference (3), but Mr. Stevens and his colleague Gary Simpson, who also signed the report, declined to perform a quantitative slope stability analysis at the site. They do offer a reasoning for why they feel that a quantitative slope stability analysis is not appropriate at the site, which includes the changing nature of the topographic profile of the eroding coastal bluff, and the difficulty and expense of collecting all of the necessary information. Nonetheless, as outlined in Johnsson (in press), staff feels that, despite its limitations, a quantitative slope stability analysis is the only way that we can adequately assure that the proposed location will be sufficiently stable to assure the integrity of the structure for its useful economic life. Accordingly, the applicant commissioned Busch Geotechnical to complete the necessary studies, which are reported on in reference (4).

Reference (4), like reference (3) contains an adequate assessment of the long-term bluff retreat rate at the site. Reference (4) contains an especially detailed analysis, making use of 14 aerial photographs spanning 61 years. Both reports also document anecdotally short-term erosion events resulting in up to 60 feet of bluff retreat in a single winter season (1997-98). Intermediate-term erosion rates vary between 0.03 feet per year and 2.44 feet per year. The calculated long-term average erosion rate for the 61 year period is 0.74 feet per year (reference 4). This is somewhat lower than the 1.13 feet per year calculated in reference (3) from fewer aerial photographs, and the rate of ~1.5 feet per year reported in an independent reference (Tuttle, 1981). Accordingly, reference (4) recommends that the calculated rate be rounded up to 1 foot per year. Although this is less than the rate calculated in the other references, it is reasoned that it is appropriate because, in part, it is based on a longer time interval and on more data. I feel that the rate reported in reference (4) is based on the largest data set of any of the three references, is relatively careful work (the only superior methodology would have involved photogrammetric analysis), and conservatively rounds the calculated rate upwards from 0.74 feet per year to 1.0 feet per year. Therefore, I feel that the value of 1.0 feet per year is an appropriate site-specific long-term erosion rate for this site.

Reference (4) includes a quantitative slope stability analysis, based on a four-layer model for the stratigraphy of the coastal bluff. The shear strength parameters and unit weight data for these four layers are taken from the literature and from the professional experience of the consultants. Although I would have preferred that the report contain better justification of these values, upon further discussion with Dr. Busch and review of relevant literature I feel that the shear strength and unit weight values adopted in this analysis are appropriate. The slope stability analysis shows that the current bluff is marginally stable, with a static factor of safety of 1.024. The factor of safety increases with distance from the bluff edge, and the point corresponding to a factor of safety of 1.5, the industry standard for new development, is located 76 feet from the bluff edge.

As explained in detail in Johnsson (in press), in order to assure stability for the expected economic life of the development, a setback must account both for existing slope stability and for the expected bluff retreat for the assumed economic life of the development. In this case, it is somewhat difficult to evaluate the expected economic life of the development, as the proposal is for the relocation of an existing house. The Commission typically assumes an economic life of 75 to 100 years for *new* development. The long-term erosion rate of 1.0 feet per year therefore results in a 75-100 year bluff-erosion setback. In order to assure that at the end of this time the development still has an adequate factor of safety against landsliding, the 76 foot slope stability setback must be added. Thus, the minimal setback to assure stability for 100 years would be 176 feet, or 151 feet for 75 years. See Johnsson (in press) for a discussion of other assumptions that go into this analysis.

Reference (4), in contrast, recommends a setback of 160 feet. This is based on an assumed economic life of 75 years with an added "extra measure of prudence" of 9 feet. It is my opinion that this setback assures geologic stability for approximately the next 84 years.

Note that there is no need for a "buffer," commonly added to a setback based solely on long-term erosion rates in order to allow for uncertainty in all aspects of the analysis, to allow for any future increase in bluff retreat rate due, for example, to an increase in the rate of sea level rise, to assure that at the end of the design life of the structure the foundations are not actually being undermined, and to allow access so that remedial measures can be taken as erosion approaches the foundations, because the slope-stability setback added to the long-term bluff retreat setback can do "double duty" as that buffer.

I hope that this review is helpful. Please do not hesitate to contact me if you have additional questions.

Sincerely,

Mark Johnsson, Ph.D., CEG

Additional References Cited:

Johnsson, Mark J., *in press*, Establishing Development Setbacks from Coastal Bluffs, *in* Magoon, Orville et al. (eds.) *Proceedings, California and the World Ocean '02*. Reston, Virginia: American Society of Civil Engineers.

Tuttle, D.C., 1981, Investigation and methods for determining coastal bluff erosion, historical section. Unpublished report prepared under Sea Grant, p. 161.