

3104

Frank

Geotechnical Investigation

Fault-Rupture Hazard Evaluation
Mad River Fault Zone
Alquist-Priolo Special Study Zone
Portions of Section 6, T6N, R1E, H.M.
Arcata North 7.5 Quadrangle

McKinleyville School District Property

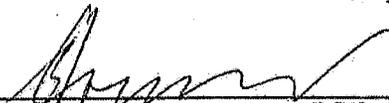
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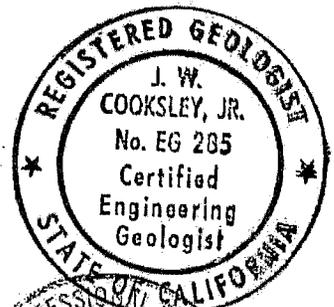
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July 1989

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Fault-Rupture Hazard Evaluation
Mad River Fault Zone
McKinleyville School District
Job No. 3104

INTRODUCTION

The McKinleyville School District property is located in an Alquist-Priolo Special Studies Zone (CDMG, 1983) of the Mad River Fault and requires a special geologic investigation and report. As mapped by the California Division of Mines & Geology, the Special Fault Zone bisects the property (Figure 1). LACO ASSOCIATES identified one trace of an active fault near the south end of the property along School Road (Figure 2). The school district is proposing to develop the site for a school.

The subject property is in the McKinleyville, California, area, Sec 6, T6N, R1E, H.M. It is located between the intersection of School Road and Washington Avenue. County road access is via School Road off Highway 101 (Figure 2). The 10 acre site is undeveloped.

SCOPE OF WORK

LACO ASSOCIATES was hired to conduct a limited scope investigation to satisfy the intent of the Alquist-Priolo Special Studies Zones Act of 1972 (CDMG, Special Publication 42). The intent of investigation by LACO ASSOCIATES was to determine if the site is threatened by surface displacement from future faulting. The risk to the site is qualitatively assessed. The scope of this work consisted of a review of pertinent geologic literature of

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the area, examination of aerial photographs of the property, backhoe trenching, trench logging and interpretation, and report preparation.

SITE CONDITIONS

The project area encompasses a portion of a gently sloping broad knoll that steps down approximately 3 feet to the south across the fault scarp to a lower gently sloping surface. The knoll has been graded flat in the past during construction of a baseball field. The removed soil was used as fill on the north side of the property. Vegetation on-site consists predominantly of grasses and Lupine.

The subject site is underlain by Franciscan sandstone. Late Pleistocene marine terrace sands and gravels unconformably overlie the Franciscan deposits on a marine terrace abrasion platform. The marine terrace age (maximum) is estimated at 83 Ka (Carver and others, 1987). Dune sand and colluvium of probable Holocene age mantles the marine deposits (Carver and others, 1987).

The Franciscan rocks at the site are coarse grained graywacke sandstones. The sandstone is moderately weathered and fractured. Fracturing and shearing is more pronounced immediately above the fault.

The marine terrace sediments are predominantly well sorted fine to coarse sand and pebbly sand overlying lag gravels and cobbles

on the abrasion surface.

The colluvium is poorly sorted silty sand loam and pebbly sand. Animal borrows (krotavina) are common, indicating that bioturbation is important in the local soil forming processes.

GEOLOGIC SETTING

The subject site lies to the northeast of Cape Mendocino and the Mendocino Triple Junction (Figure 3). South of Cape Mendocino transform tectonics of the San Andreas strike-slip fault system is dominant (Figure 4). North of Cape Mendocino the strike-slip motion changes to low-angle reverse and thrust faulting and folding.

The deformation is associated with the Cascadia Subduction Zone north of the triple junction. The Gorda Plate (oceanic crust) within the Cascadia Subduction Zone slides along the Mendocino fracture zone and is subducted under North America. Subduction of the internally contracting Gorda Plate is probably the major factor influencing the upper plate crustal deformation on land in Humboldt County (Figure 4). A Quaternary convergence rate for the Gorda Plate is estimated at 20 mm/yr (Carver and Burke, 1988) which includes the Little Salmon Fault Zone and the Mad River Fault Zone. Deformation and contraction on land within the North American forearc consists of a 30 Km wide zone (Kelsey and Carver, 1989). Net Quaternary north east-southeast contraction across the forearc occurs as a fold and thrust belt.

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The School Road study site (Figure 2), and Northwestern Humboldt County are within the fold and thrust belt (Figure 4) of the upper plate crustal deformation associated with the deformation front of the Gorda Plate. The Mad River Fault Zone is an expression of the active crustal deformation and faulting.

METHODS OF INVESTIGATION

LACO ASSOCIATES used current accepted state of the art procedures to acquire and interpret the data necessary to satisfy the intent of the Alquist-Priolo Specials Study Act for this investigation. Pertinent geologic maps and literature for the area were reviewed. Stereo paired areal photographs were interpreted in context of fault geomorphology. The project site geomorphology was mapped. The bedrock geology and geomorphology around the site was field reviewed. Previous field work (trenching) by Carver (1989) on the same trace of the Mad River Fault was discussed and field reviewed with Dr. Carver. The open trenches were visited by Carver on 06/07/89 and reviewed by Cooksley (CEG) on 06/07/89.

Prior to trenching, hand augured borings established the depth to groundwater and the shallow marine abrasion platform. The borings and geomorphology were used to approximately locate the projected fault surface prior to trenching.

Two overlapping trenches were excavated and logged across the

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fault trace and through the Alquist-Priolo Special Studies Zone boundary within the subject site. As the trench was excavated through the fault segment it was shored and the west wall was scraped clean and a five by five foot grid was set. For best exposure the east wall was scraped, clean and gridded in the overlapping trench segment. All significant features in the trench including the cross trench strike and dip of the fault were measured and plotted on grid paper at a scale of 1 inch to 2.5 feet. The stratigraphic units were described and pedogenic soils were described and sampled (Sheets T1, 1-8; T2, 1-4).

PREVIOUS WORK ON THE MAD RIVER FAULT ZONE

Manning and Ogle (1950) mapped and named faults in the zone that is now called the Mad River Fault Zone. Earth Sciences Associates (1976) and Woodward-Clyde Consultants (1980) examined the Mad River Fault Zone in their study of the seismic safety of the Humboldt Bay nuclear power plant. Woodward-Clyde Consultants trenched the Trinidad Fault and McKinleyville Fault during their investigations. They concluded that the nature of the deformation associated with the McKinleyville Fault is characteristic of thrust faults examined in the Humboldt Bay vicinity. The Mad River Fault Zone was first described in detail by Carver, Stephens and Young in 1982. They mapped a zone of deformation and faulting that had an approximate width between 26 km and 50 km.

The fault zone contains five primary thrust faults; 1) Trinidad Fault, 2) Blue Lake Fault, 3) Mckinleyville Fault, 4) Mad River

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Fault and 5) Fickle Hill Fault. The faults offset late Pleistocene marine and non-marine sediments and Holocene deposits (Carver, 1988).

Carver et al. (1985) have further defined the Mad River Fault Zone and have produced detailed maps of the fault zone. Work on the fault zone has been continued by Carver, Burke, and Kelsey, (1985); Lehre and Carver, (1985); Kelsey and Carver, (1986); and Carver and Burke, (1987). Local consultants that have trenched faults within the Mad River Fault Zone include: Harrison, (LACO ASSOCIATES, 1986); Bush, (1986, 1987, 1988); and Bush and O'Dea, (1988).

Carver and Burke (1989) examined the Mad River Fault just northwest of the School Road-Washington Avenue project site in their Trenching Investigation of Northwestern California Faults, Humboldt Bay Region. Some conclusions contained in their final report are relevant to the project site and are;

1. The structural expression of the Mad River Fault at the trench site is a sharp-hinged asymmetrical overturned anticline.
2. The fold geometry and structure is similar to the fault propagation folds described by Suppe (1986).
3. The fault structure, as expressed at the trench site, is a blind thrust.
4. Faulting and fold growth has occurred in sudden intermittent episodes. All events are less than 83 ka.

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5. The Mad River Fault has experienced at least one large Holocene slip event.
6. Results of trenching showed evidence that the fault is capable of producing displacements ranging from 3.2m to 3.3m during a seismic event.
7. The corresponding slip rate was determined to be 0.7mm/yr. with a recurrence interval of 6500 years.

MAD RIVER FAULT AT THE SCHOOL ROAD-WASHINGTON AVENUE SITE

Findings from LACO ASSOCIATES investigation are summarized and are;

1. The fault is the northern strand of the Mad River Fault as mapped and zoned as potentially active by the California Division of Mines and Geology (1983).
2. The relative sinuous fault scarp crosses the project site at a strike between N60W and N75W (Figure 2).
3. The Mad River Fault scarp of 15 feet at the School Road site (Carver, 1988) decreases in a southwest direction to 3 feet (along strike) at the School Road-Washington Avenue site (this report). This scarp continues to decrease in height rapidly to the southwest along strike and finally disappears into rolling topography.
4. The low rounded knoll northeast of the fault scarp may be an open anticlinal fold similar to that observed by Bush (Price property, 1987) with an eastern limb that flattens out to the northeast.

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5. The fault is a northwest-trending (N66W) low angle (26 degree NE dipping) thrust as exposed in trench 2. Where trenched on the School Road-Washington Avenue site, only one fault trace is apparent.
6. On the School Road-Washington Avenue site the projected fault would project to the surface about 40 feet out from the base of the scarp, under relatively flat lying ground. This area is overlain by active bioturbated A and AB horizon soils. The scarp at the study site is the surface expression of a fold that is geometrically and structurally similar to fault-propagation folding described by Suppe (1986). The folding is caused by compression in front of a fault tip during fault propagation (Suppe, 1986).
7. The fault, as exposed in trenches on the School Road-Washington Avenue site, has thrust Franciscan sandstone (Tertiary-Cretaceous) over late Pleistocene marine terrace deposits and possible Holocene colluvium. The Holocene age is assumed by partial similarity and proximity (about 600 feet) to faulted Holocene deposits dated at the School Road site (Carver, 1988) of the Mad River Fault. Only one colluvial wedge deposit is apparent below the fault on the lower plate. This differs from the multiple colluvial wedges observed at the School Road site (Carver, 1988), Price property (Bush, 1987) and at the Strodder property (Bush, 1988)

on the same apparent strand of the Mad River Fault.

8. Total dip-slip displacement could not be measured at the School Road-Washington Avenue site.

CONCLUSIONS FROM THIS INVESTIGATION

1. The fault is the north strand of the Mad River Fault as mapped by CDMG (1983) and zoned as potentially active (Figure 1).
2. On-site, the fault is a N66W striking, 26 degree NE dipping low angle thrust fault (see sheets T2, 1-4). Only one fault is apparent in the trenches (sheets T1, 1-8; T2, 1-4).
3. Where trenched on the School Road-Washington Avenue site, the fault has thrust Franciscan sandstones over late Pleistocene marine lag cobbles and gravel (see trench logs, this report). At least one colluvial wedge (undifferentiated) is assumed to overlie the marine deposits below the fault on the lower plate.
4. The fault has experienced at least two late Pleistocene slip events and probably at least one Holocene event. Holocene age of the colluvium (on-site) exposed in the trenches is assumed from comparisons to the School Road site (Carver, 1988), Price site (Bush, 1987) and to the Stodder site (Bush, 1988).
5. Dip-slip displacement could not be measured at the site because of the lack of any stratigraphic or piercing

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point match across the fault where trenched. Slickensides on the fault plane indicate pure dip slip.

6. The trace of the fault is about 40 feet beyond the base of the scarp. There is no direct expression of a surface trace of the fault where trenched or elsewhere on the School Road-Washington Avenue site.
7. The scarp is the surface expression of the fault-propagation folding associated with the thrust faulting on the Mad River Fault. There are at least 5 kink bends to the overall fold across a width of 25 feet. The geometry and structure is consistent with that described by Suppe (1988) for fault-propagation folding.
8. The scarp is the only off-site to on-site photolineniment or ground observed match up.
9. The site was trenched from the south property boundary (School Road) across the fault to the Alquist-Priolo Special Studies Boundary to the north (Washington Avenue). Only one fault was exposed in the trenches (Figure 2 and trench logs, this report).
10. Fault propagation fold bending should be considered a hazard to structures. Some surface deformation associated with the bending can be expected during fault movement.
11. Risk assessment to the untrenched portion of the property (outside the Alquist-Priolo Special Studies boundary) from seismic shaking or fault movement should

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be considered in a geotechnical foundation investigation.

12. Using this investigation on the Mad River Fault in combination with work from Bush (1987,1988), Carver (1988) and by methods described by Slemmons and Depolo (1986) the conclusions are;
 - a) The recurrence interval is between 6,5000 years.
 - b) Maximum Credible Earthquake is 7.3 M.
 - c) Maximum Probable Earthquake is 7.3 M.
 - d) Bedrock acceleration is estimated at 0.7 g.
 - e) Surface soil acceleration is estimated (preliminary) at 0.5 g.
13. The deep seismic (Gorda Plate subduction) earthquake risks to the School Road-Washington Avenue site are;
 - a) Maximum Credible Earthquake is 8.3 M to 9.2 M.
 - b) Maximum Probable Earthquake is 7.6 M to 7.8 M.
 - c) Soil and rock accelerations are estimated at 0.3g.
14. The frequency of occurrence of earthquakes within the quadrant bounded by coordinated 41 degrees N, 132.6 degrees W, 40.3 degrees N and 124.8 degrees W (Figure 5) was estimated based on a statistical analysis of the historical earthquake history. The available results of that analysis are presented on Table 1.

RECOMMENDATIONS

1. Do not build any structure for human occupancy in zone

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of setback (exclusion) in Figure 2. This zone begins at south boundary line (fence line along School Road) and extends north past the fault to 50 feet north of the top of the scarp.

2. Design all structures to the 1988 Uniform Building Code, Chapter 23 for Seismic Zone 4.
3. The Site Soil Coefficient should be established after a geotechnical investigation.
4. Risk assessment to the untrenched portion of the property (outside the Alquist-Priolo Special Studies boundary) from seismic shaking or fault movement should be considered in a soils/foundation investigation.

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References

- Carver, G.A., Stephens, T., and Young, J.C., 1985, Quaternary Geologic Map of the Mad River Fault Zone. 5 1:24,000 map sheets and legend (unpublished).
- Carver, G.A., Stephens, T., and Young, J.C. 1982, Mad River Fault Liniment Zone: Unpublished report for California Division of Mines and Geology, 20p, 15 plates, scale 1:24,000 and 1:62,5000.
- Carver, G.A. and Burke, R.M., 1989, Final Report, Trenching Investigation of Northwestern California Faults, Humboldt Bay Region; USGS Grant 14-08-0001-G1082.
- Carver, G.A., Burke, R.M., Kelsey, H.M., 1987, Quaternary Deformation in Region of the Mendocino Triple Junction; unpublished final report, National Earthquake Hazard Reduction Program; U.S. Geological Survey.
- Carver, G.A., 1987, Geologic Criteria for Recognizing Individual Plaeo-Seismic Events in Compressional Tectonic Environments, in Anthony J. Crone, ed., Directions in Paleo Seismology, U.S. Geol. Survey Open File Report, 87-673, p. 115-128.
- California Divisions of Mines and Geology, 1983, Alquist-Priolo Specials Studies Zone Act Map, Arcata North 7.5' quadrangle.
- Bush, B., 1987, Evaluation of Fault-Rupture, Tilting, and Overthrust Plate-collapse Hazard and Associated Levels of Risk, Price Property (AP# 508-225-30), Mad River Fault Zone, McKinleyville, CA. (unpublished client report).
- Bush, B., 1988, Alquist-Priolo Fault Investigation of the Stodder Property (AP# 508-241-45), Mad River Fault Zone, McKinleyville, CA. (unpublished client report).
- Field Conference Guide, October 1&2, 1988, Neotectonics of Coastal Northwestern California, Trip Leaders; Carver, G., Burke, B., O'Dea, K., Vick, G.
- Geotechnical Consultants, 1981, Geotechnical Reconnaissance-Proposed Greater Eureka Wastewater Treatment Plant, Elk River Site, City of Eureka; Santa Ana office, California.
- Harrison, J.M., 1985, Geologic Investigation, Surface Fault Rupture Hazard Evaluation, Alquist-Priolo Special Study Zone Report, Portions of Section 6, T6N, R1E, H.M. APN 508-071-26, Prepared of C. Leppek (unpublished client report).

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- Hart, E., 1982, Mad River Fault Zone in California. Special Publication 42. CDMG, Sacramento, 24pp.
- Kelsey, H.M. and Carver, G.A., 1988, Late Neogene and Quaternary Tectonics Associated with the Northward Growth of the San Andreas Transform Fault, Northern California, J. Geophys Res., v.93, n.B5, p.4797-4819.
- McPherson, R.C., 1989, Seismicity and Focal Mechanisms Near the Mendocino Triple Junction, Northern California, unpublished M.S. thesis, Humboldt State Univ., 81p.
- Ogle, B.A., 1988, Geology of the Eel River Valley Area, Humboldt County, California: California Divisions of Mines and Geology.
- Redwood Country, American Geomorphological Field Group Field Trip Guidebook, 1985 Conference Northwestern California, Co-conveners: Kelsey, H.M.
- Seed, H.B., and Idriss, 1982, Ground Motions and Soil Liquefaction During Earthquakes, Earthquake Engineering Research Institute.
- Slemmons, D.B., and Depolo, C.M., (1986), Evaluation of Active Faulting and Associated Hazards, Active Tectonics, Studies in Geophysics, National Academy Press, Washington D.C., pp45-62.
- Smith, T.C., 1982, Mad River Fault Zone (Trinidad, McKinleyville, Mad River, Fickle Hill, and related faults), CDMG Fault Evaluation Report FER-138 (unpublished open-file report).
- Suppe, J., 1983, Geometry and Kinematics of Fault-bend Folding: American Journal of Science, 283(7), p.684-721.
- Woodward-Clyde Consultants, October 1980, Evaluation of the Potential for Resolving the Geologic and Seismic Issues at the Humboldt Bay Power Plant Unit Number 3: Unpublished consulting report for Pacific Gas and Electric Company, Summary Report, 74p.

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APPENDIX

Figure 1 Special Studies Zones Map (Partial)

Figure 2 Site Plan

Figure 3 Faults and Active Structures at the Southern End
of the Cascadia Subduction Zone

Figure 4 Major On-Shore Late Quaternary Thrusts and Folds

Figure 5 Gorda Plate Seismicity from 1974-1984

Table 1 Summary of Northern California Fault Zones

Sheets T1-8 Trench Logs

Sheets T2-4 Trench Logs

Legend

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project *ALQUIST-FRIOLO STUDY*

location *MCKINLEYVILLE, CA*

client *MATSON ARCHITECTS*

by *DPS*

date *6-89*

checked *FRB*

date

sheet no

FIGURE

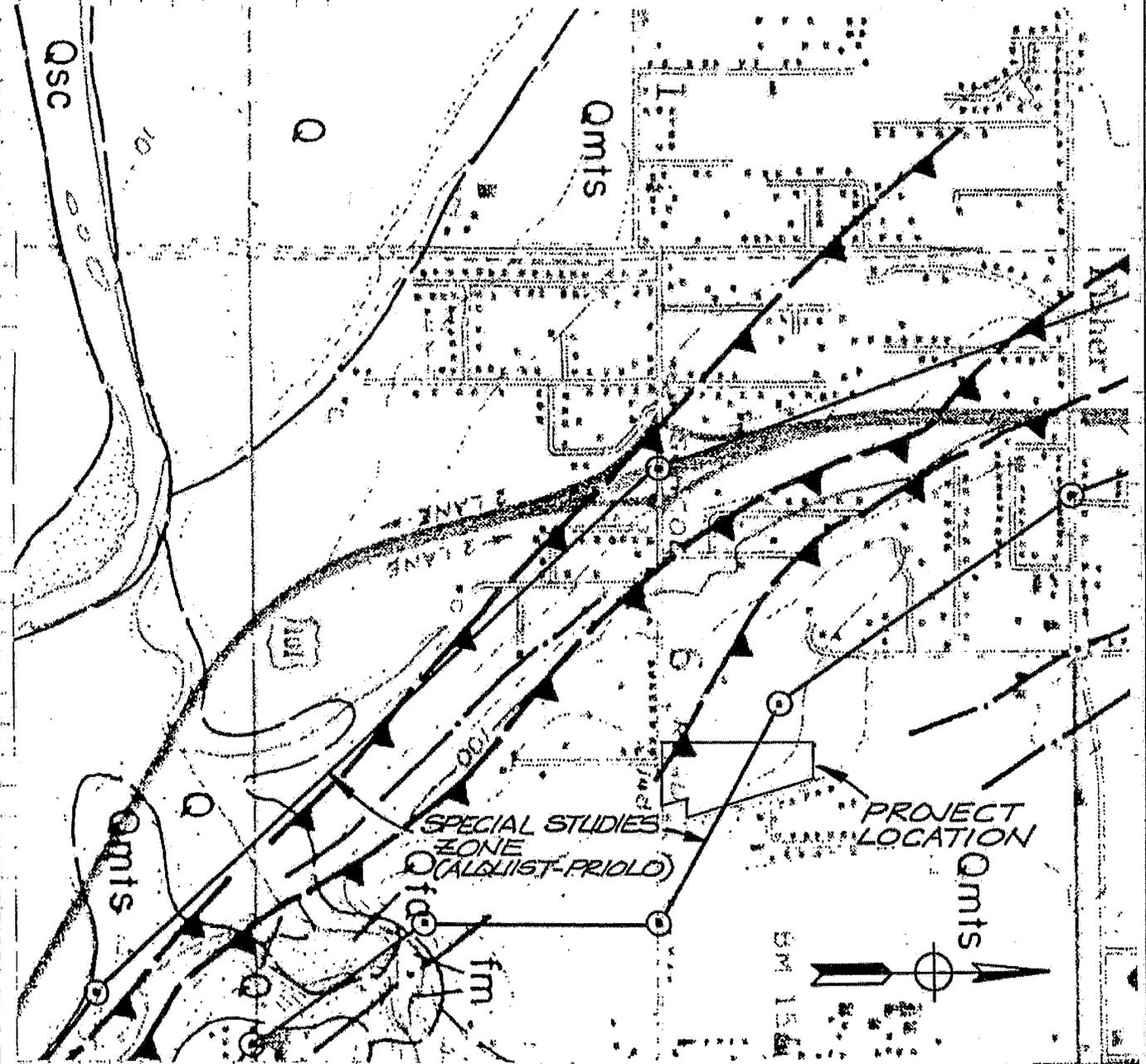
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SPECIAL STUDIES ZONES MAP (PARTIAL)

1" = 1000'

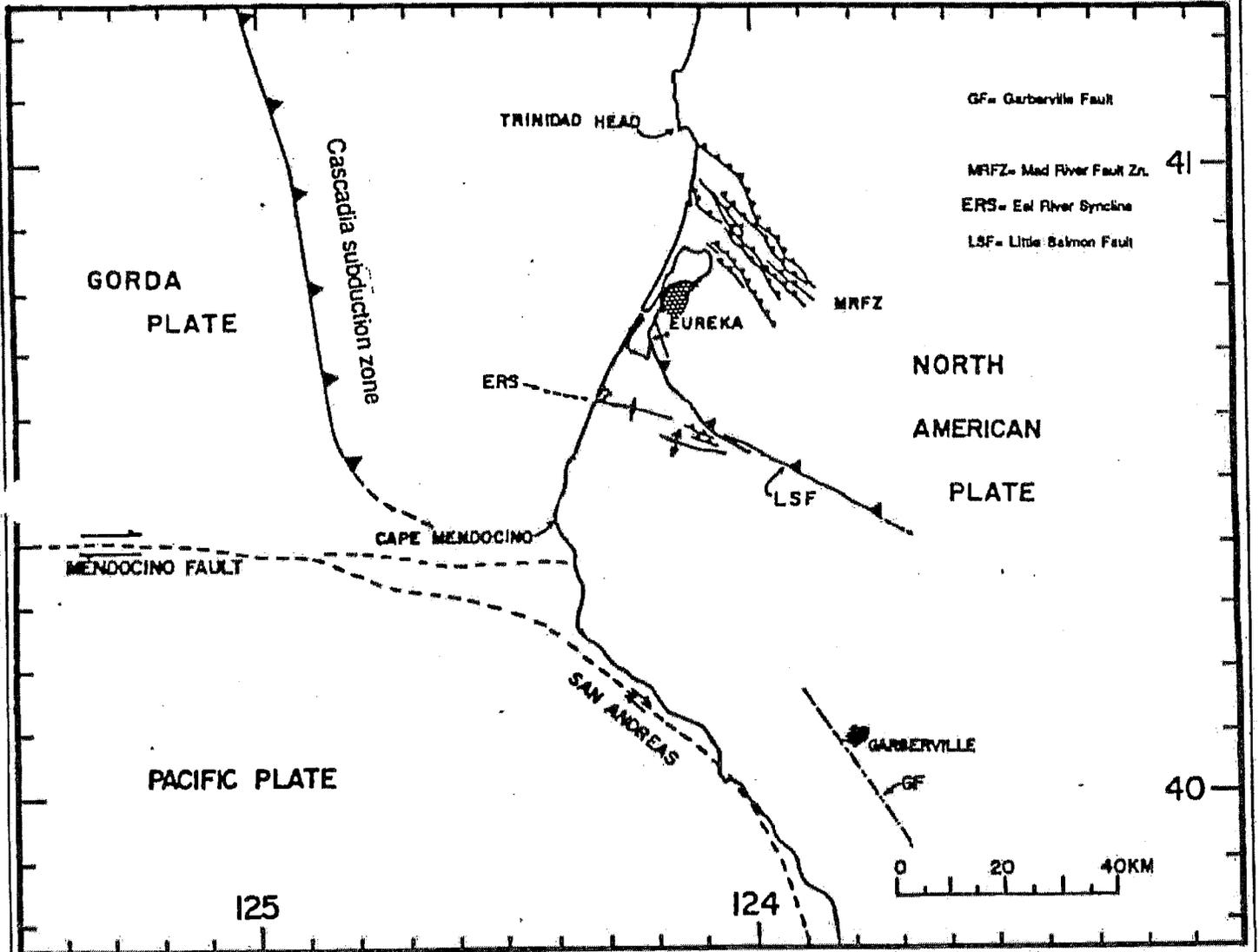


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project	Alquist-Priolo Study	by	DPS	sheet no	FIGURE
location	McKinleyville, CA	date			3
client	Matson Architects	checked		job no	
	McKinleyville School District	date			3104

FAULTS & ACTIVE STRUCTURES AT THE SOUTHERN END OF THE CASCADIA SUBDUCTION ZONE (AFTER MACPHERSON, 1989)



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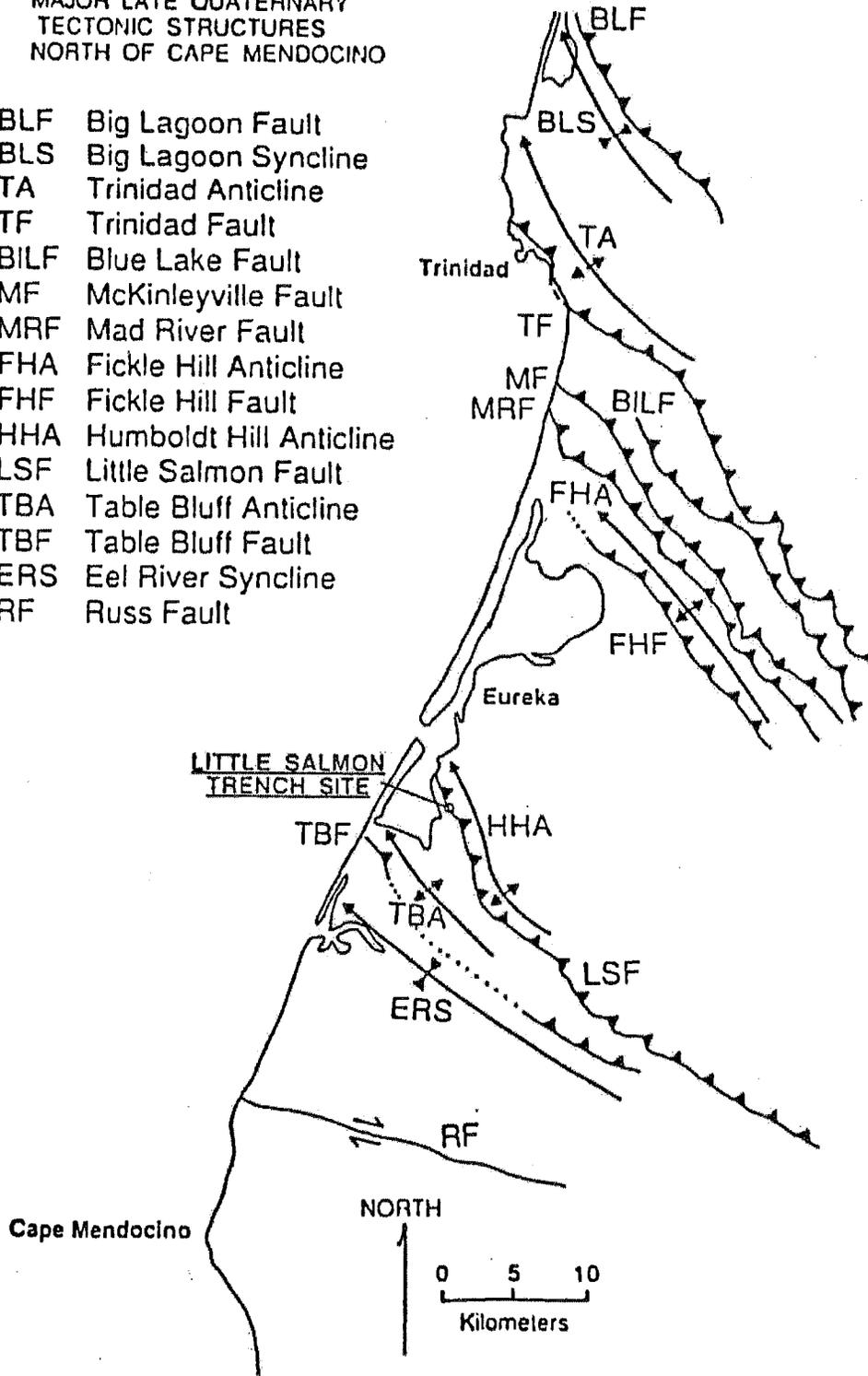
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Project	Alquist-Priolo Study	by	DPS	sheet no.	FIGURE 4
location	McKinleyville, CA	date		job no.	
client	Matson Architects	checked			
	McKinleyville School District	date			3104

MAJOR ONEHORE LATE QUATERNARY THRUSTS & FOLDS IN NORTHERN COASTAL CALIFORNIA. SITE ON THE LITTLE SALMON FAULT WAS TRENCHED IN THIS STUDY. (AFTER CARNER & BURKE, 1989).

MAJOR LATE QUATERNARY
TECTONIC STRUCTURES
NORTH OF CAPE MENDOCINO

- BLF Big Lagoon Fault
- BLS Big Lagoon Syncline
- TA Trinidad Anticline
- TF Trinidad Fault
- BILF Blue Lake Fault
- MF McKinleyville Fault
- MRF Mad River Fault
- FHA Fickle Hill Anticline
- FHF Fickle Hill Fault
- HHA Humboldt Hill Anticline
- LSF Little Salmon Fault
- TBA Table Bluff Anticline
- TBF Table Bluff Fault
- ERS Eel River Syncline
- RF Russ Fault



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project, Alquist-Priolo Study

by *DPS*

sheet no
FIGURE

location McKinleyville, CA

date

5

client, Matson Architects

checked

job no

McKinleyville School District

date

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*GORDA FLATE SEISMICITY FROM 1974 - 1984,
WITH MAGNITUDES RANGING FROM +7.0 TO 0.0
(AFTER MACPHERSON, 1989).*

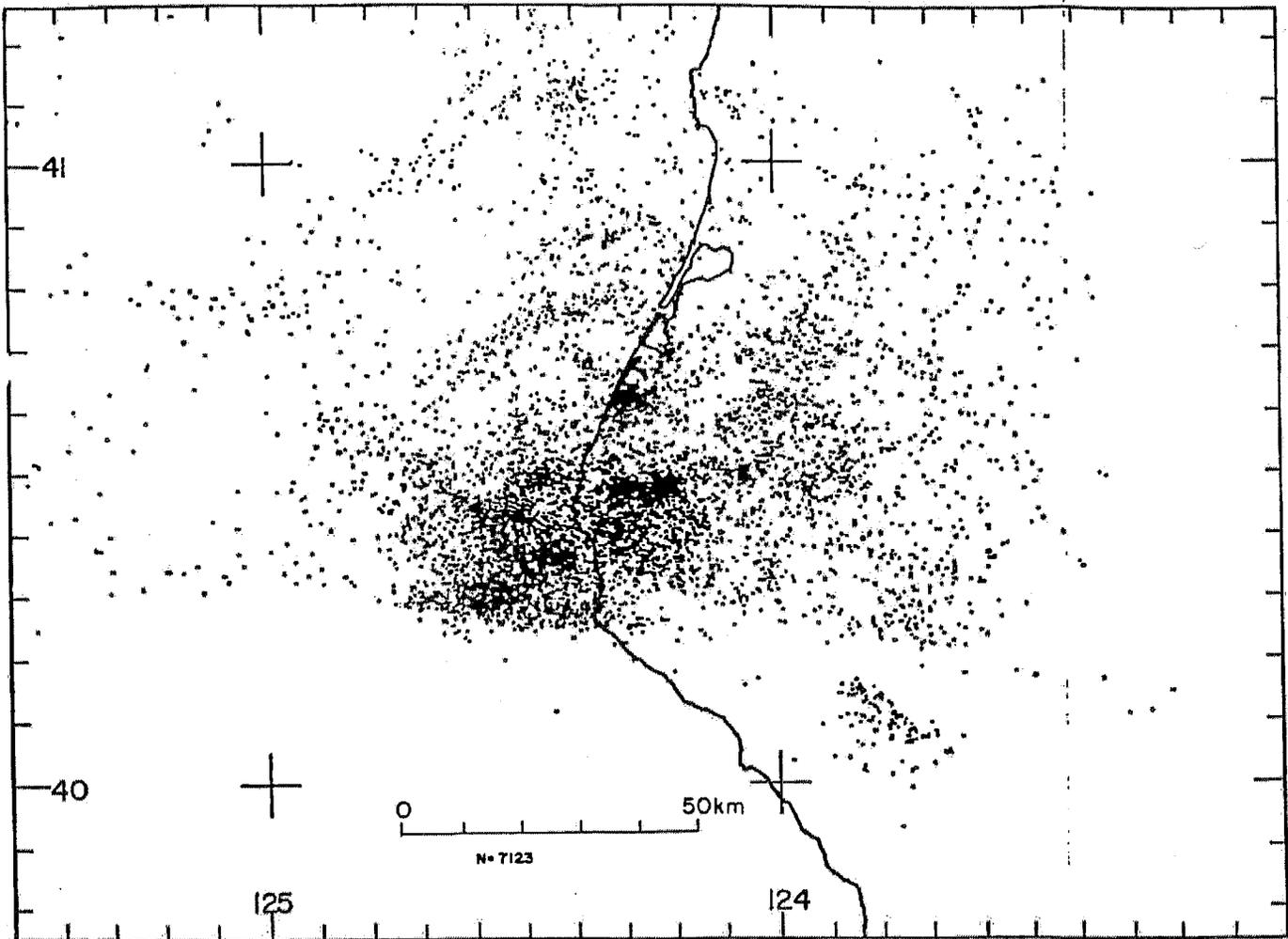


Table 1 - Summary of Northern California Fault Zones

Fault Zone	Individual Faults	Fault Type	Maximum Historic Magnitude	Magnitude	Maximum Credible Earthquake ¹ Recurrence Interval	Probability ² of Occurrence Next 100 Years
Mad River	Big Lagoon	Thrust	No Historic EQ	7.3	6,500yrs	1.5%
	Blue Lake	Thrust	No Historic EQ	7.3	6,500yrs	1.5%
	Trinidad	Thrust	No Historic EQ	7.3	6,500yrs	1.5%
	McKinleyville	Thrust	No Historic EQ	7.3	6,500yrs	1.5%
	Mad River	Thrust	No Historic EQ	7.3	6,500yrs	1.5%
Northern San Andreas	Fickle Hill	Thrust	No Historic EQ	7.3	6,500yrs	1.5%
		Slip/Dip	8.3, 1906	8.3	300yrs	24%
Eastern Mendocino Fracture		Transform	Not Evaluated	6.5	17yrs	100%
		Gorda	7.0, 11/8/80, 20 km	7.3	50yrs	27%
Little Salmon		Thrust	No Historic EQ	7.6-7.8	440yrs	18.3%
		Subduction	No Historic EQ	8.3 ³ -9.2 ⁴	440yrs	18.3%

Notes: (1) Maximum credible earthquake is defined as the maximum event which may ever be expected at the building within the known geological framework (Title 24).
(2) Probabilities calculated assuming a Poisson process.
(3) Rupture of Gorda Segment, $M_0=8.3$.
(4) Rupture of 60% of subduction zone length, $M_0=9.2$.

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by DPS

sheet no

location MCKINLEYVILLE CA

date 7-89

client MATSON ARCHITECTS

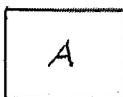
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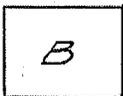
LEGEND (T1,1-8; T2,1-4)

date

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UNDIFFERENTIATED A AND AB HORIZON SOILS DEVELOPED INTO COLLOIDAL SILTY SAND WITH SCATTERED PEBBLES. THE A HORIZON IS DARK GRAY-BROWN (10 YR 3/2, MOIST) WITH MODERATE DEVELOPED CRUMB STRUCTURE. THE B HORIZON IS BROWNISH-YELLOW (10 YR 6/6, MOIST). THIS SURFACE SOIL IS BIOTURBATED AND KROTAVENA'S ARE COMMON.



UNDIFFERENTIATED B HORIZON SOILS DEVELOPED INTO SILTY SAND. CLAY CONCENTRATED NEAR BASE (Bt HORIZON). THE B HORIZON SOILS ARE PREDOMINANTLY REDISH-BROWN (5 YR 7/4, MOIST).



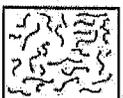
MnO-CEMENTED SAND LAYER ABOVE CLAYEY SAND LAYER.



PERVASIVELY SHEARED SHALEY MUDSTONE, (Kf) FRANCISCAN COMPLEX METASEDIMENTS



GRAYWACKE SANDSTONES, (Kf) FRANCISCAN COMPLEX METASEDIMENTS, SOME VERY WEATHERED, RE-WORKED.



GRAYWACKE SANDSTONE, (Kf) FRANCISCAN COMPLEX METASEDIMENTS BEDROCK, VERY FRACTURED AND WEATHERED.



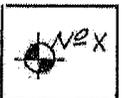
PREFERENTIAL WEATHERING FRONTS ALONG SHEARED FABRIC WITHIN THE CLAYEY MEDIUM SAND. GENERAL ALTERNATING THIN ZONES OF REDUCTION AND OXIDATION HAS RESULTED IN RAINBOW COLORATION. BANDING ROUGHLY FOLLOWS FOLD GEOMETRY.



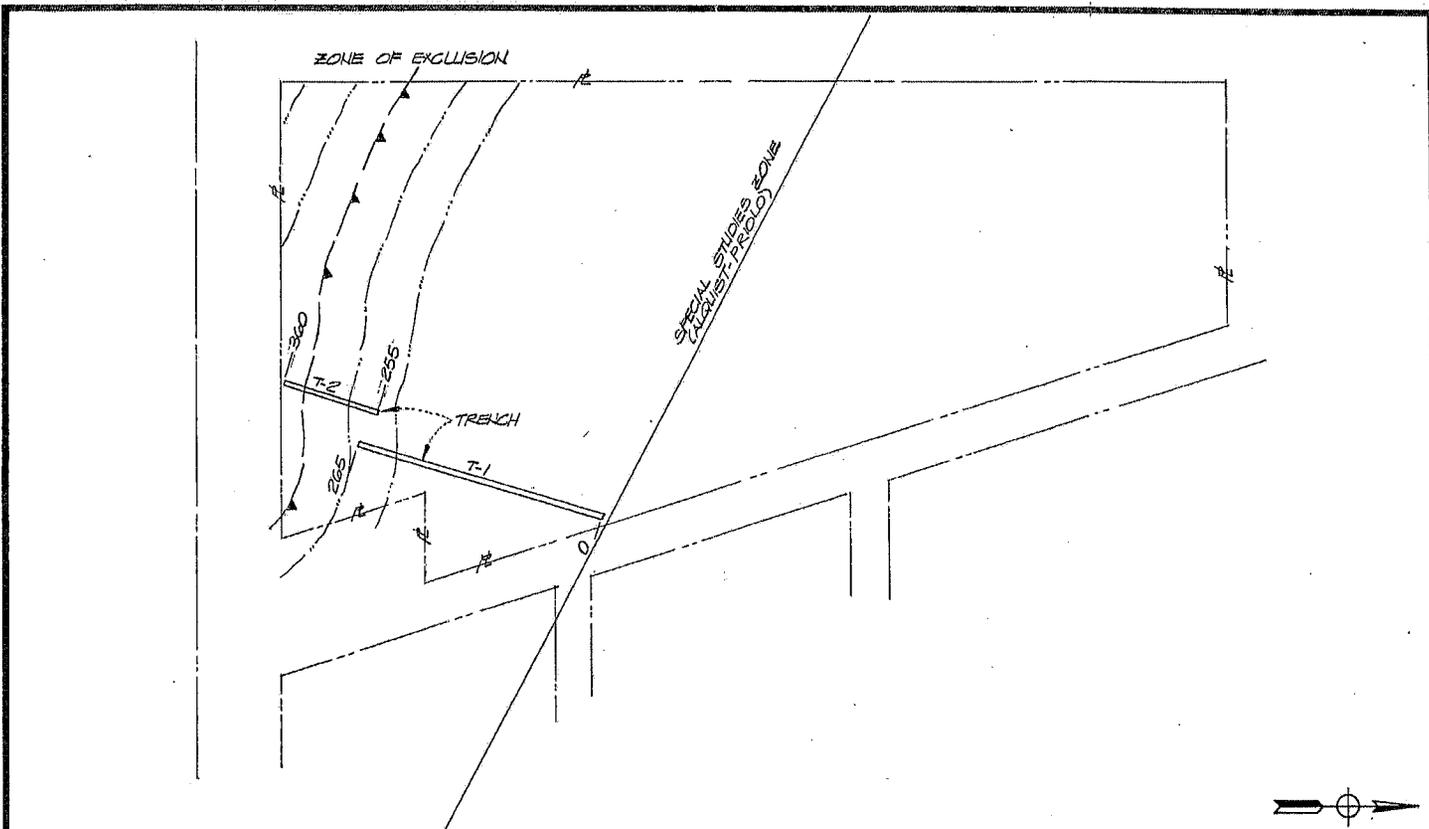
MARINE TERRACE ABRASION PLATFORM



FAULT PLANE, RELATIVE MOTION INDICATED



SAMPLE LOCATION AND DESIGNATION

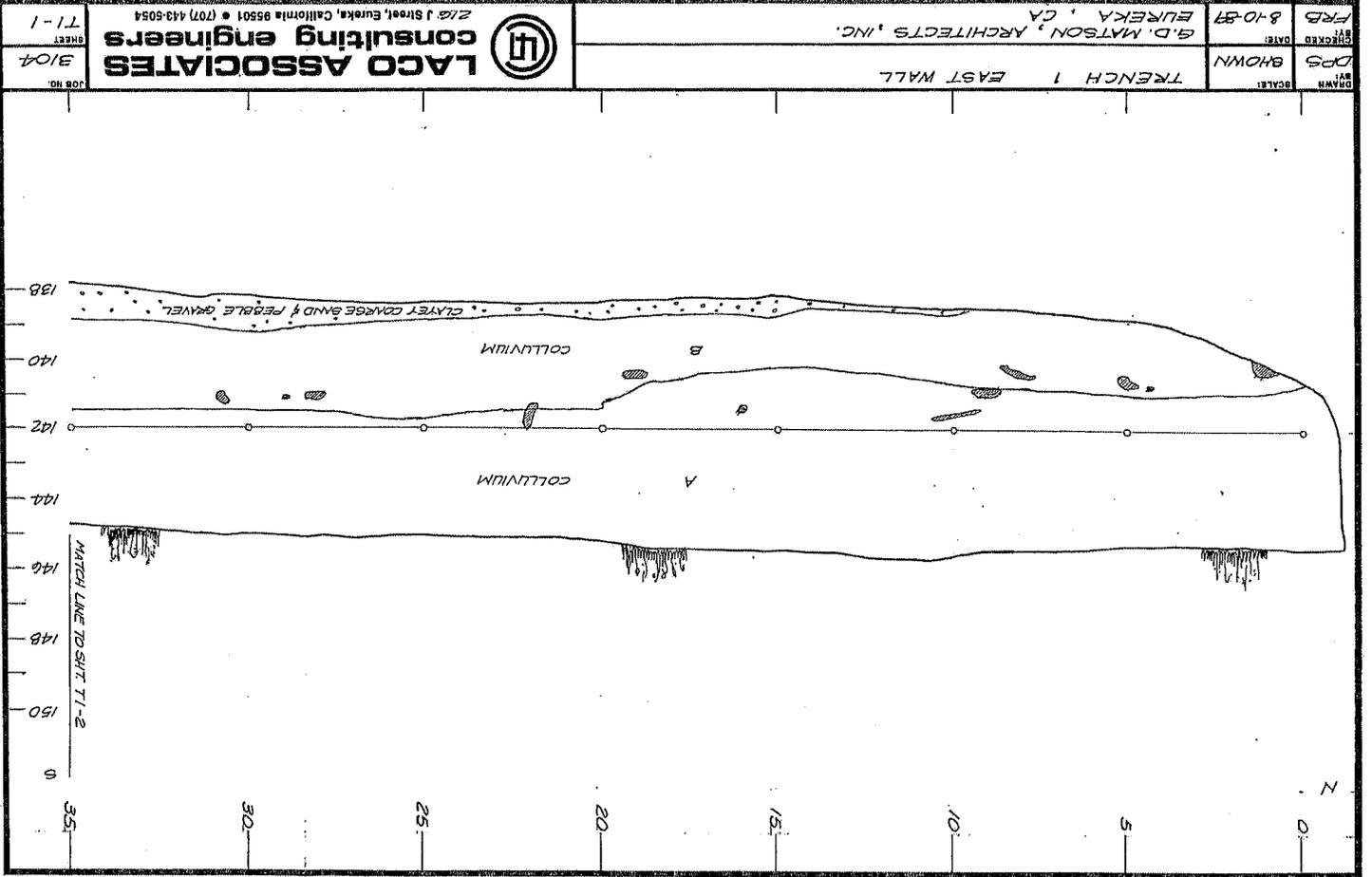


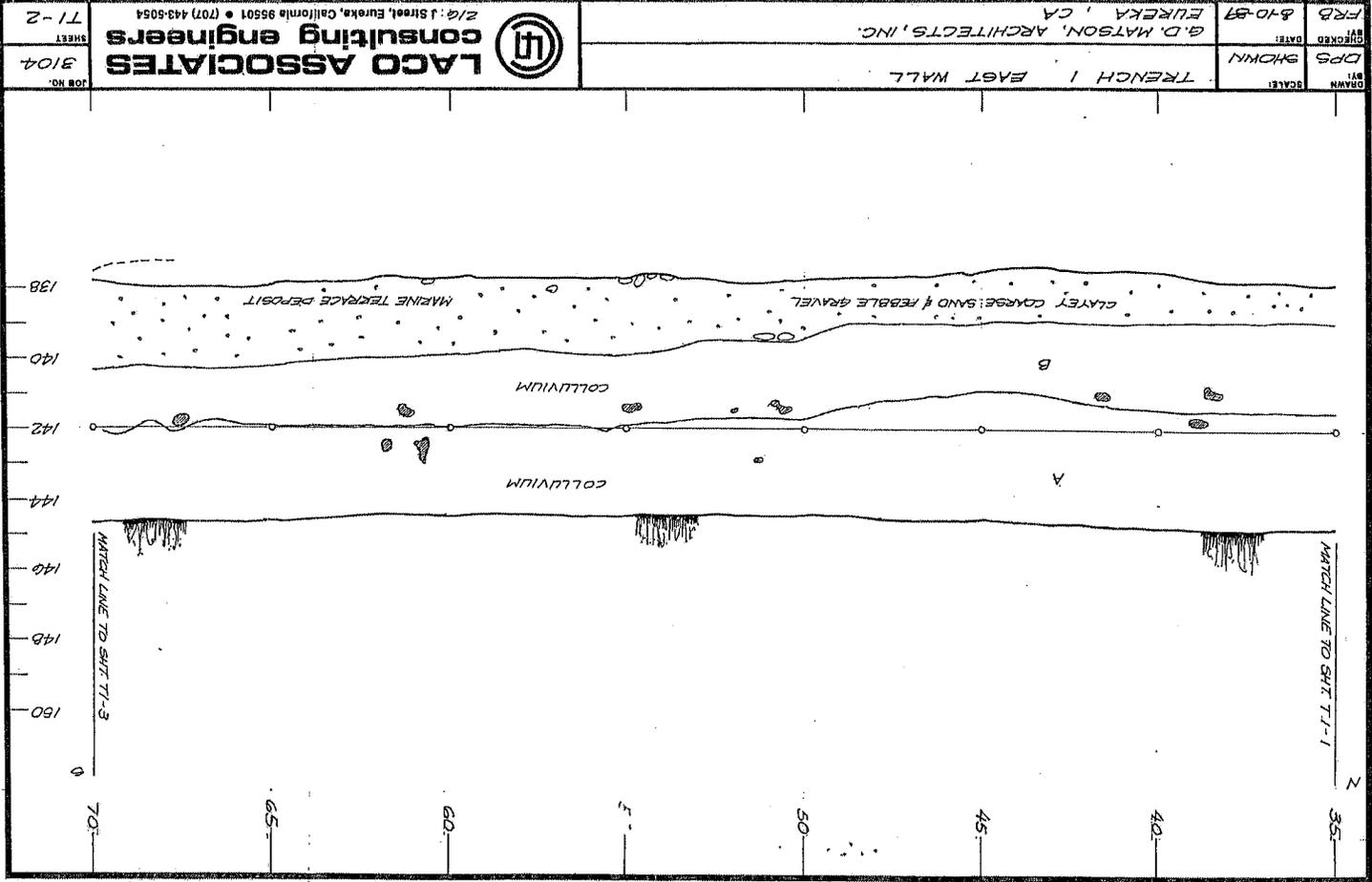
DRAWN BY: DRS	SCALE: 1" = 100'	SITE PLAN MCKINLEYVILLE, CA	JOB NO. 3104
CHECKED BY: FRB	DATE: 8-10-89	G. D. MATEON ARCHITECTS EUREKA, CA	SHEET FIGURE 2



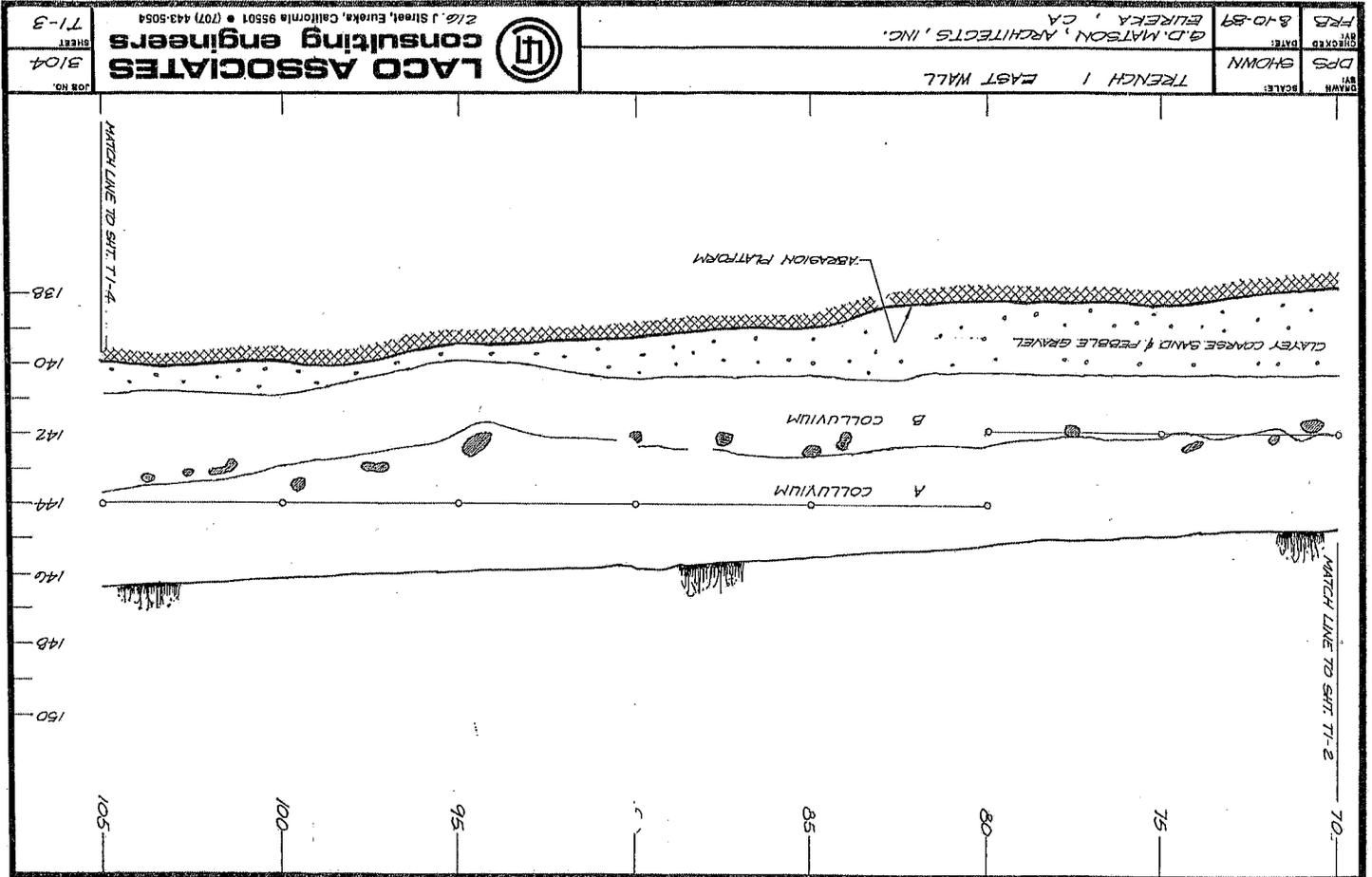
LACO ASSOCIATES
 consulting engineers

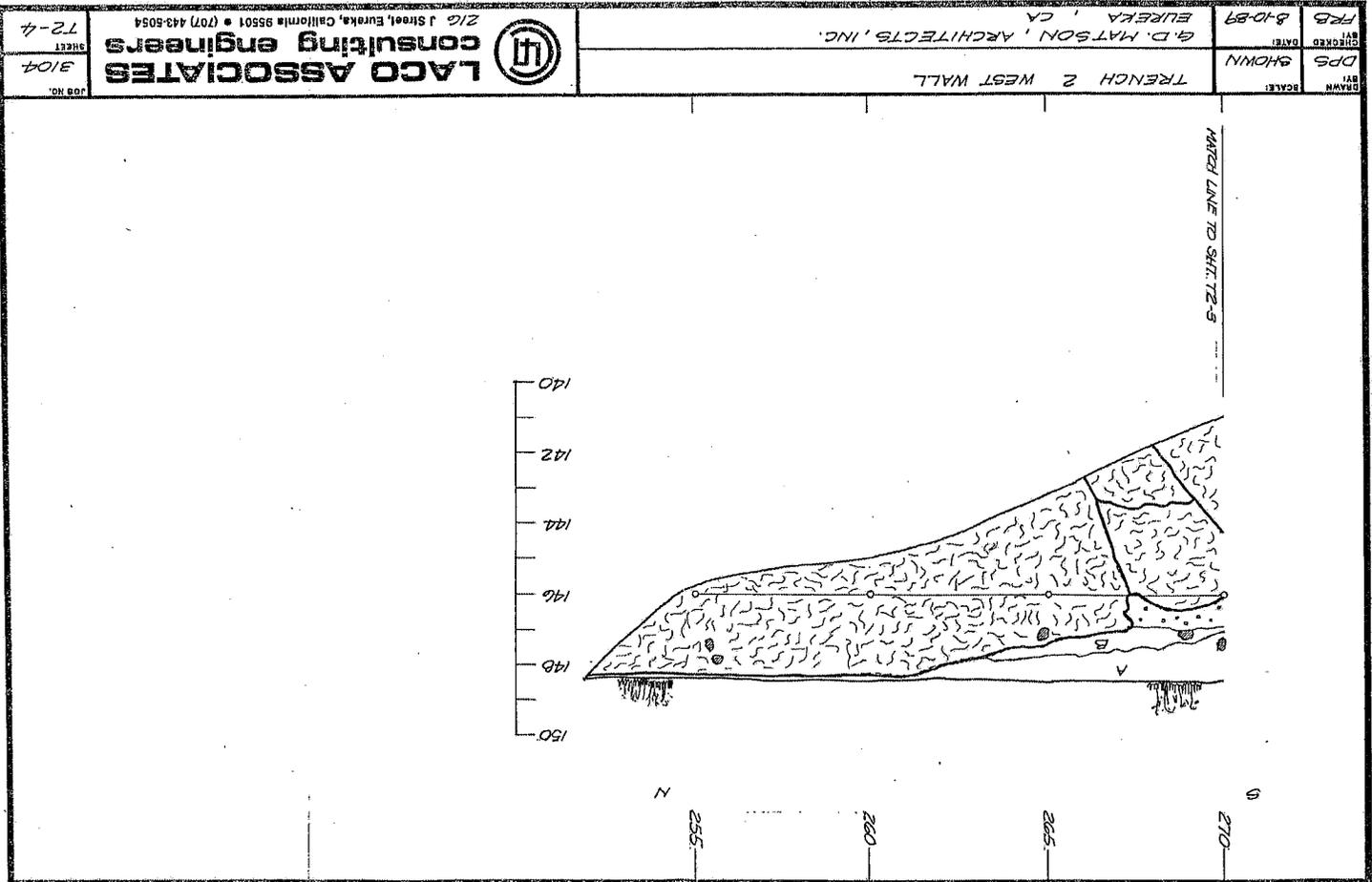
212 J Street, Eureka, California 95501 • (707) 443-5054





JOB NO. 3104	DATE: 8-10-87	SCALE: AS SHOWN	DESIGNED BY: G.D. MATSON, ARCHITECTS, INC.	PROJECT: TRENCH 1 EAST WALL
SHEET T1-2	DATE: 8-10-87	SCALE: AS SHOWN	DESIGNED BY: G.D. MATSON, ARCHITECTS, INC.	PROJECT: TRENCH 1 EAST WALL
LACO ASSOCIATES consulting engineers 214 J Street, Eureka, California 95501 • (707) 443-6054		G.D. MATSON, ARCHITECTS, INC. EUREKA, CA		





DATE:	8-10-89
BY:	FRB
SCALE:	
DRWN:	
CHKD:	DPS
APP:	SHOWN

TRENCH 2 WEST WALL

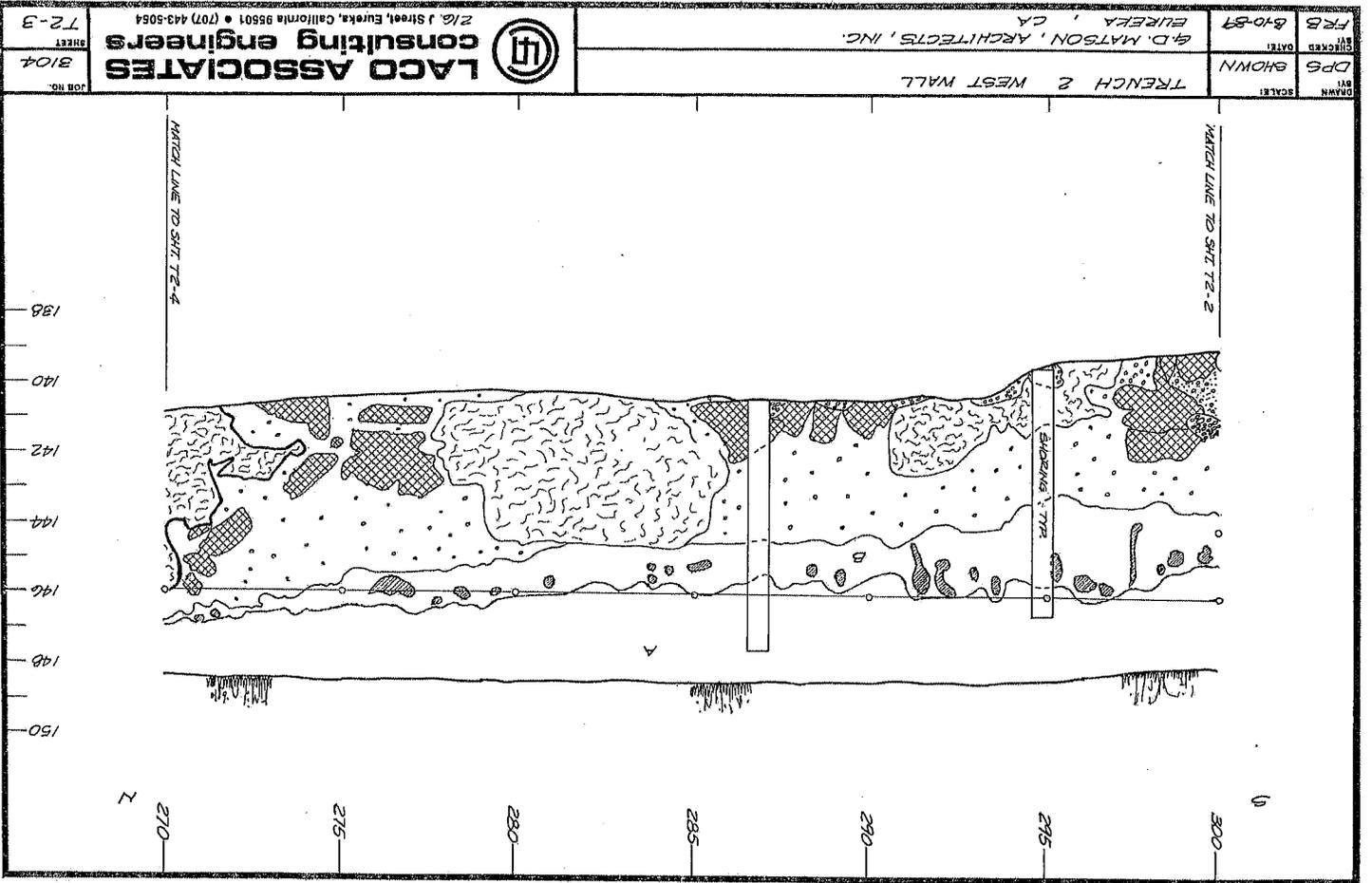
G. D. MATSON ARCHITECTS, INC.
EUREKA, CA



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JOB NO.:	3104
SHEET:	72-4

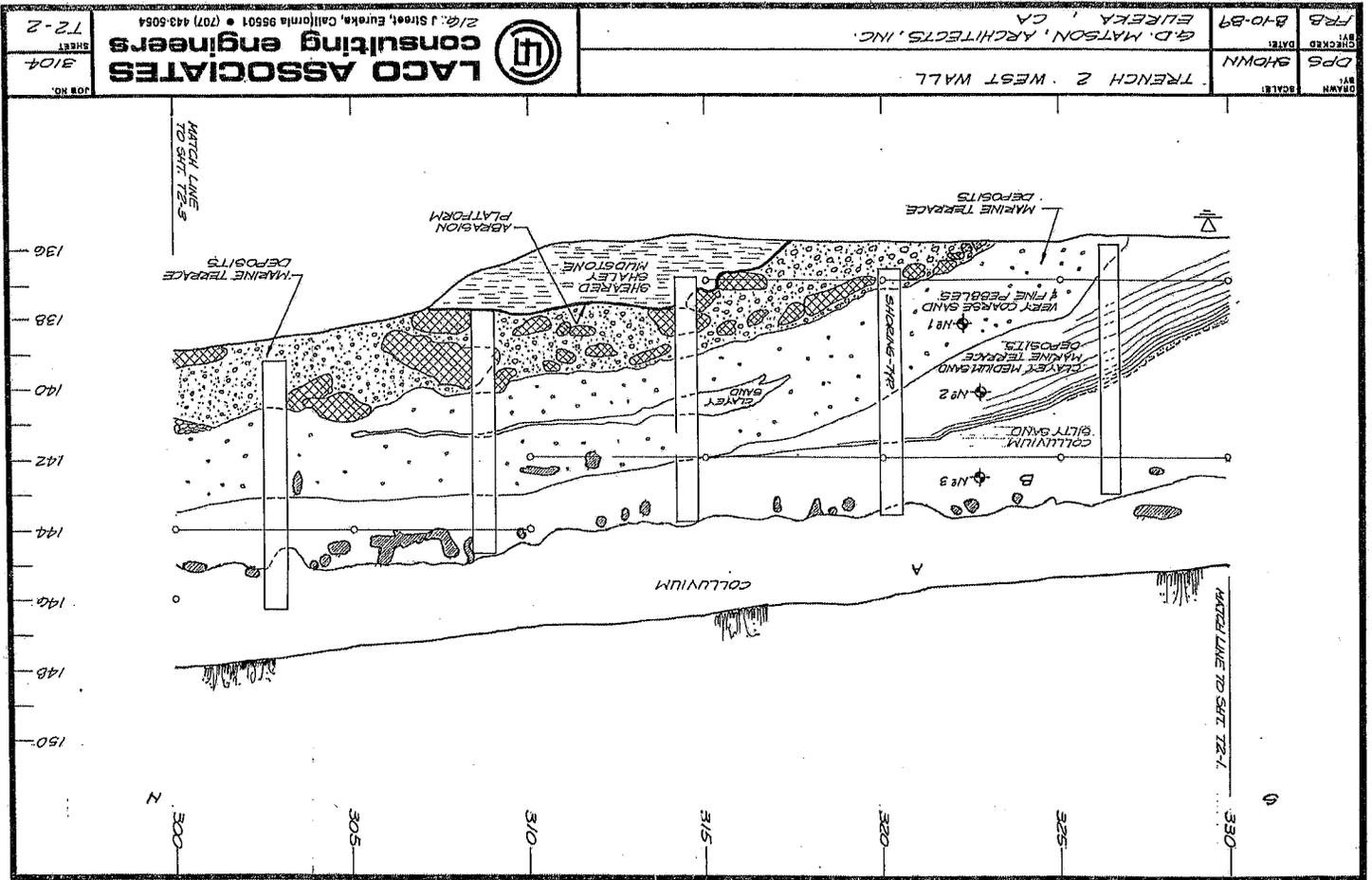


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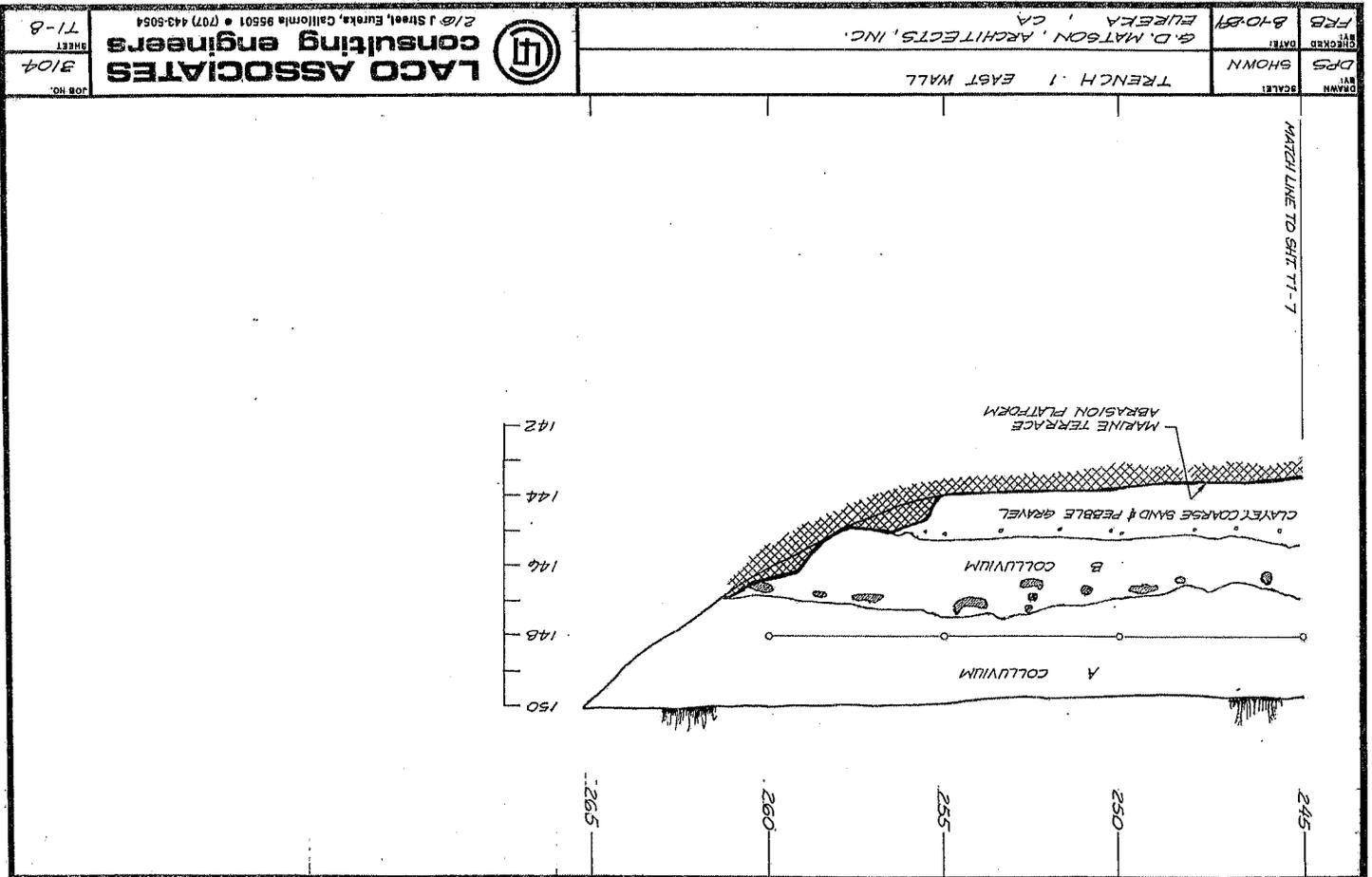


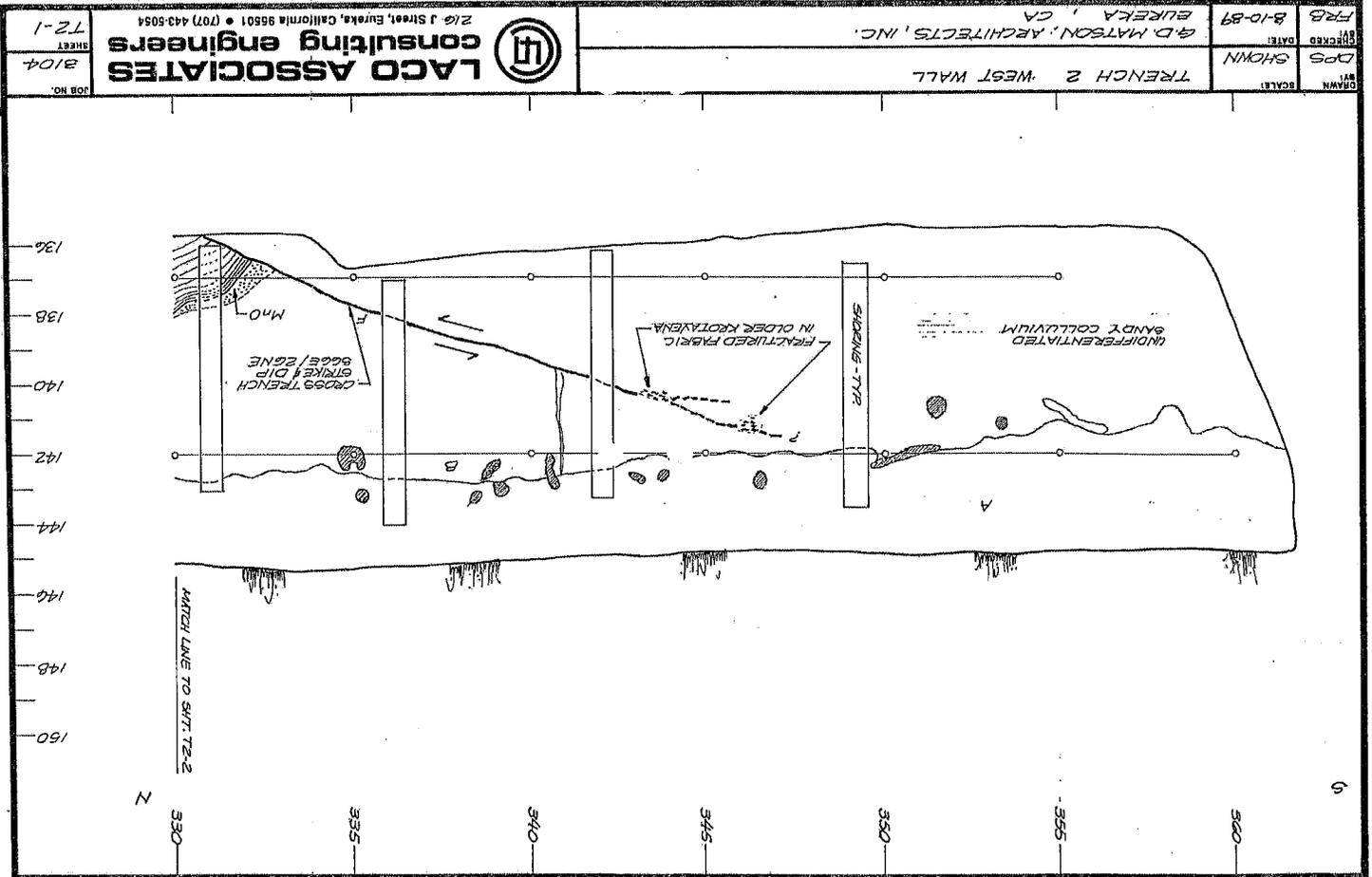
G.D. MATSON, ARCHITECTS, INC.
 EUREKA, CA

JOB NO. 3104
SHEET 72-3



JOB NO. 3104	SHEET 72-2	LACO ASSOCIATES consulting engineers 210 J Street, Eureka, California 95501 • (707) 443-6054		G.D. MATSON, ARCHITECTS, INC. EUREKA, CA		DATE:	RFB: B-10-B9
				TRENCH 2 WEST WALL		DPS SHOWN	DRAWN:





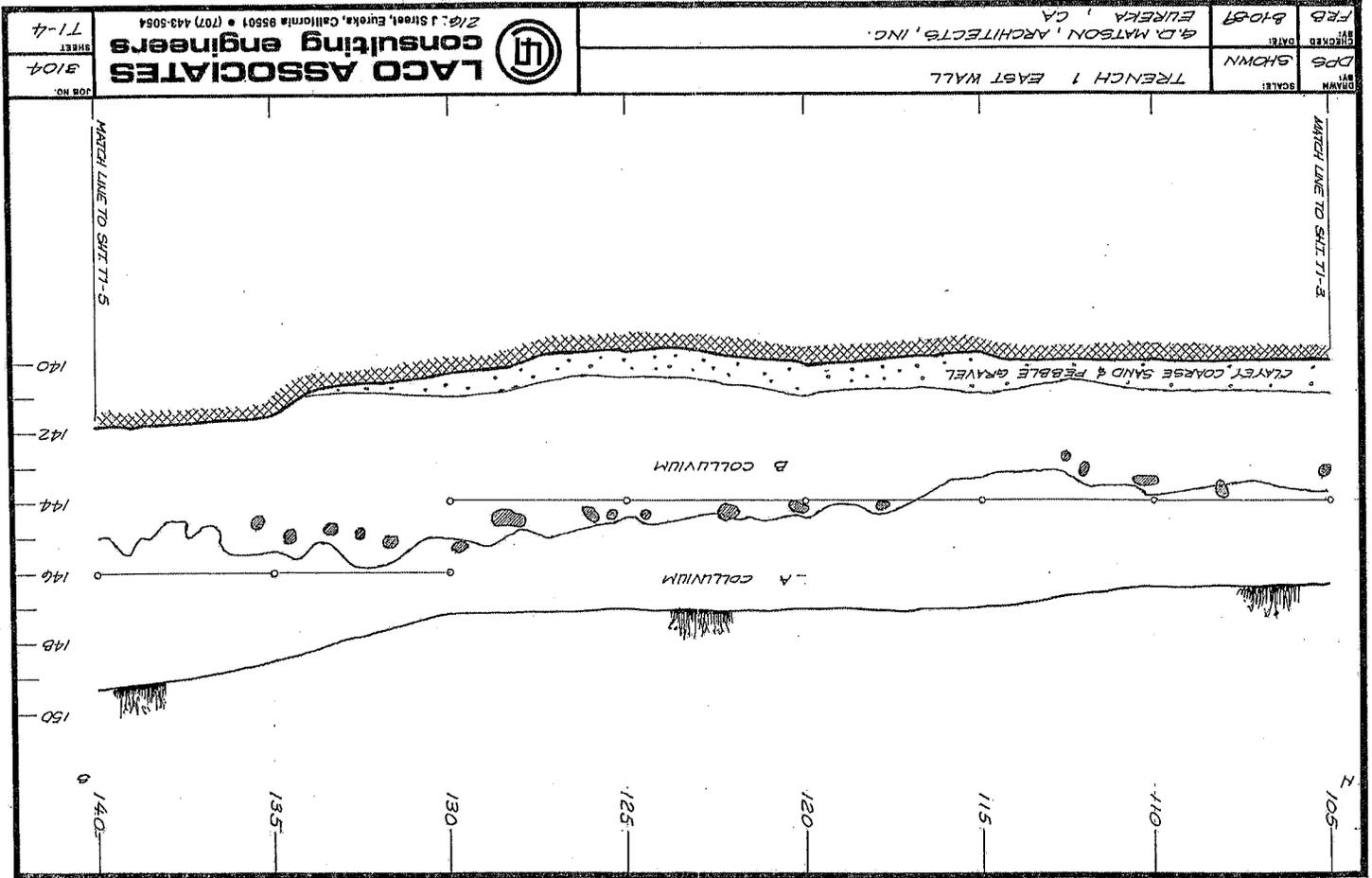
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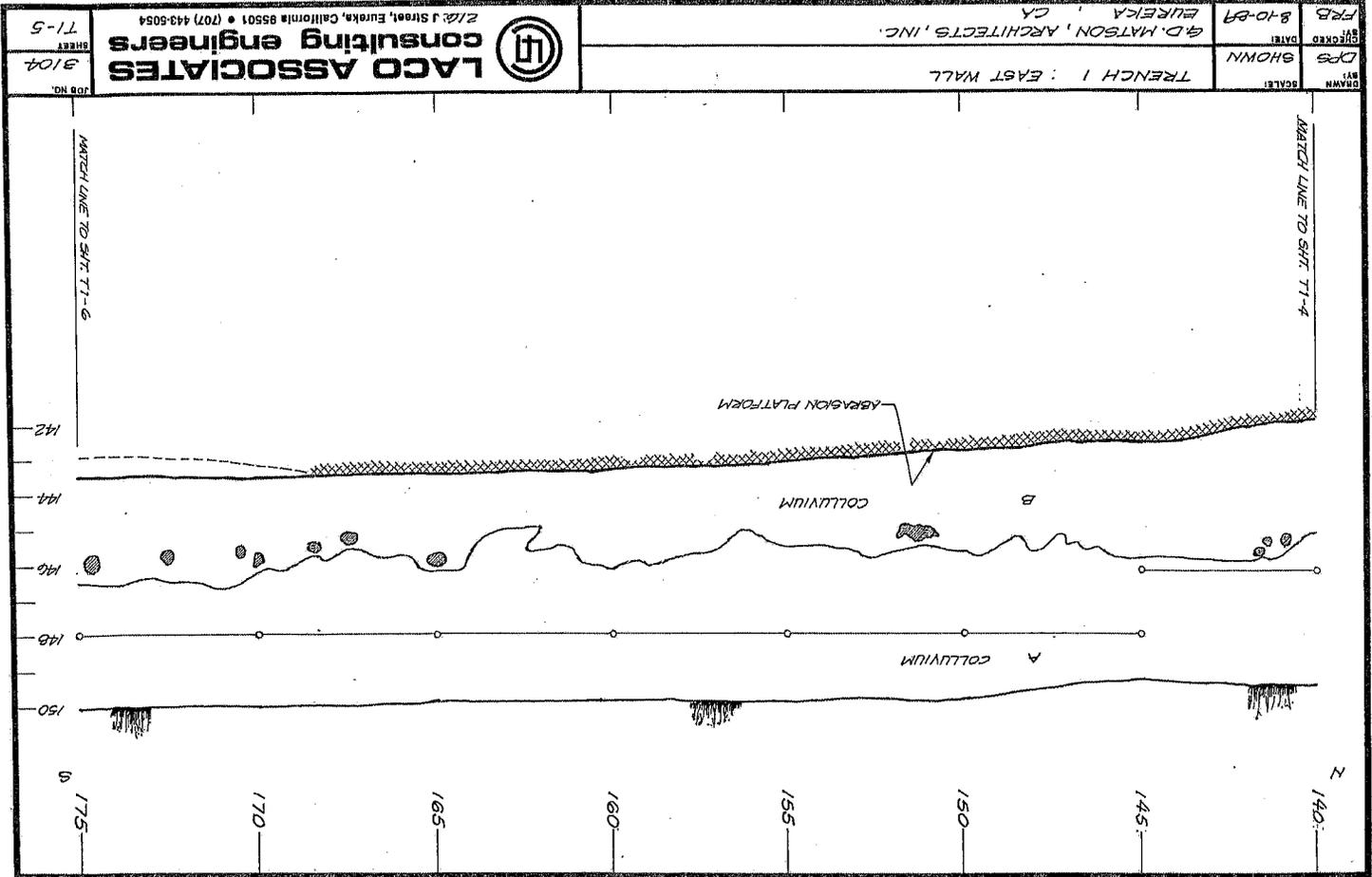
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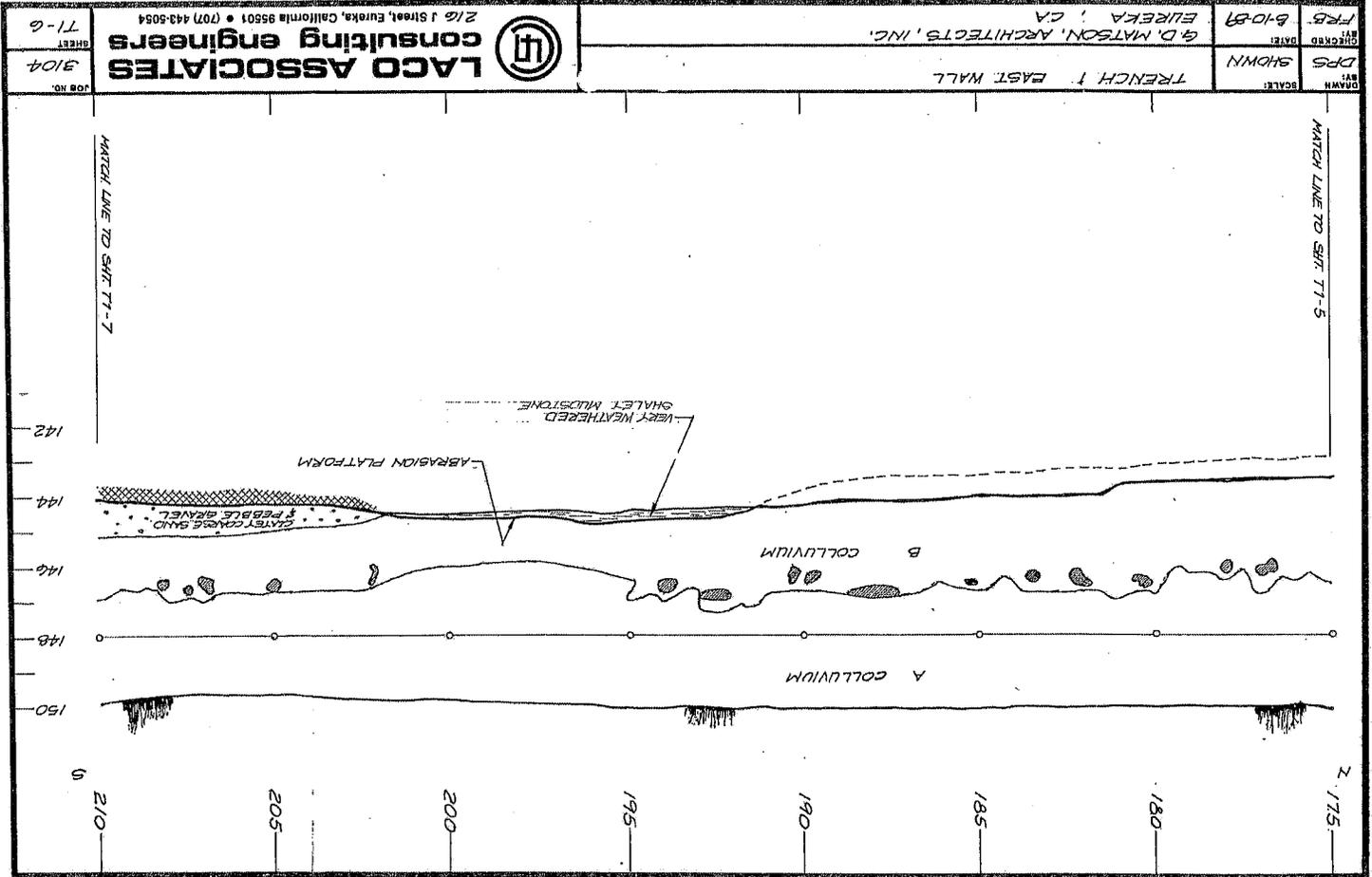
G.D. MATSON, ARCHITECTS, INC.
 EUREKA, CA
 TRENCH 2 WEST WALL

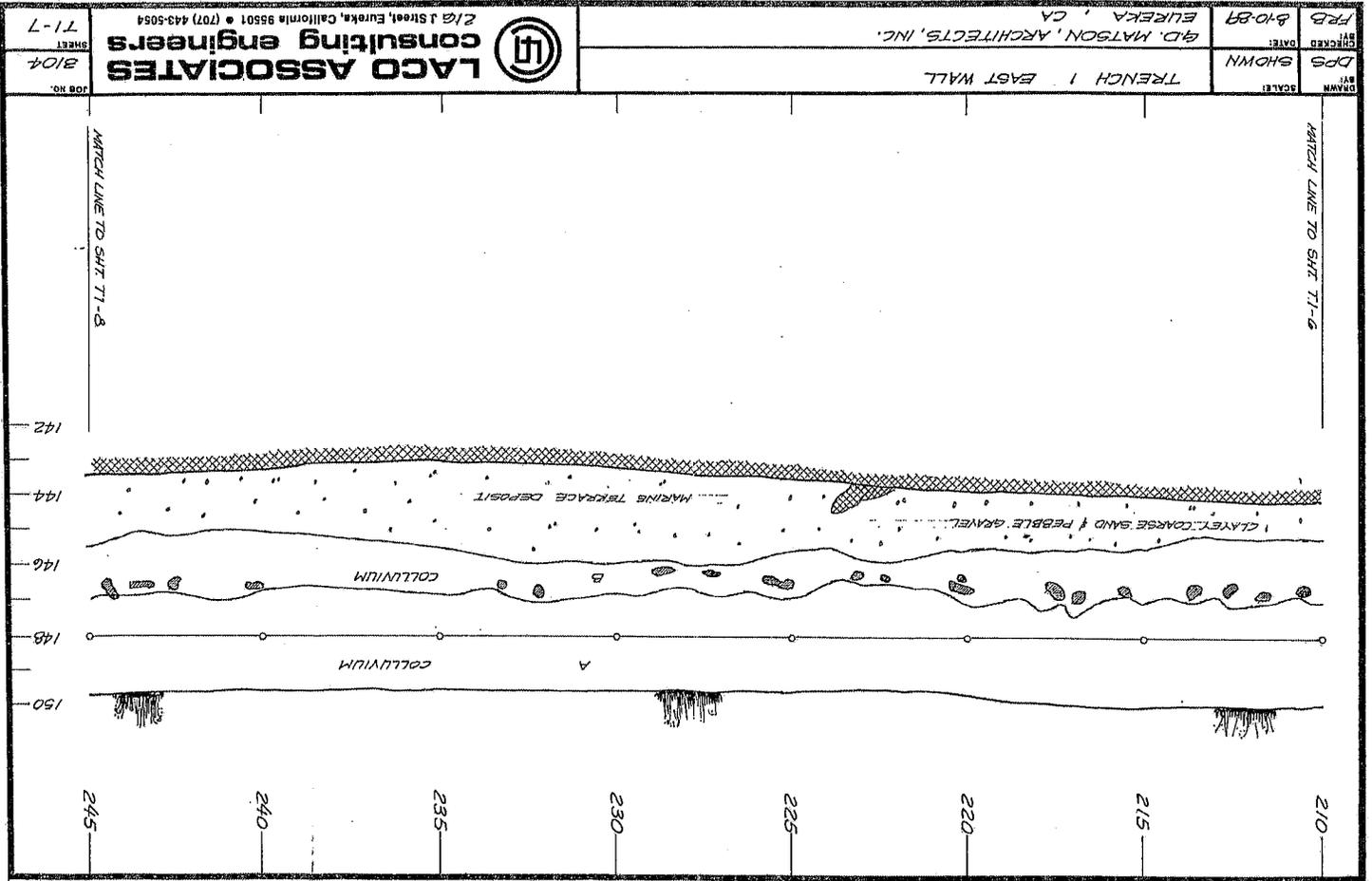
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 DATE: 8-10-89
 CHECKED BY: FRB





JOB NO. 3104	LACO ASSOCIATES consulting engineers 212 J Street, Eureka, California 95501 • (707) 443-5054		DATE: 8-10-89	PROJECT: PRB
			SCALE: 1" = 10'	DRAWN: DRS
71-5	G.D. MATSON, ARCHITECTS, INC. EUREKA, CA		TRENCH 1 : EAST WALL	





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 CHECKED BY: BJO-BJ
 EUREKA, CA

G.D. MATSON, ARCHITECTS, INC.



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JOB NO.: [blank]
 SHEET: 8104
 T1-7

MATCH LINE TO SHIT T1-8

MATCH LINE TO SHIT T1-6

142
144
146
148
150
245
240
235
230
225
220
215
210

COLLUVIUM
COLLUVIUM

CLAYEY, COARSE SAND & PEBBLE GRAVEL
MARKING TERRACE DEPOSIT

TRENCH 1 EAST WALL