TECHNICAL REPORT

PALEONTOLOGICAL RESOURCES

LOS ANGELES RAIL RAPID TRANSIT PROJECT
"METRO RAIL"

Draft Environmental Impact Statement and
Environmental Impact Report

Prepared by

WESTEC SERVICES, INC.

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PALEONTOLOGICAL RESOURCES

INTRODUCTION

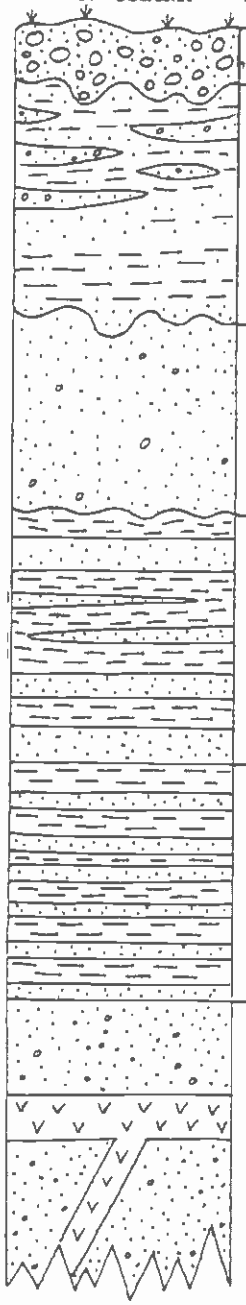
This report presents the results of assessment of impacts on paleontological resources by the Southern California Rapid Transit District Metro Rail Project, City of Los Angeles. This study builds on a preliminary report on paleontological resource evaluation by Bernor (1978) and reflects the following research effort: 1) thorough records and literature search for recorded paleontologic localities along the proposed Metro Rail route, and also for information on the regional paleontologic context of the stratigraphic units that will be affected by the project; 2) communication with scientists at the George C. Page Museum at the La Brea Tar Pits regarding impacts on the La Brea Tar Pits area, the most paleontologically sensitive part of the entire route (special acknowledgement goes to A.E. Tejada-Flores of the Page Museum for data retrieval and documentation); 3) examination of geotechnical report and appendix based on study by Converse Consultants (CWDD, 1981), as well as engineering maps and cross-sections showing planned depth and dimensions of excavations for tunnels and stations.

The first section of the report describes the stratigraphic units (with emphasis on known and potential paleontologic resources) that will be affected by excavations, and discusses the paleontologic sensitivity of these units. The second part of the report treats individual segments of the route with respect to which stratigraphic units (Figure 1) will be encountered (where and at what depth), known and potential paleontologic resources, impacts on known/potential paleontologic resources, and recommendations for mitigation of adverse impact. A paleontologic sensitivity map (Figures 2, 3 and 4) is included as an overlay on the geologic map (Drawing 1, CWDD), the La Brea Tar Pits area, particularly with regard to the proposed station on Wilshire Between Curson and Spaulding. The final section of the report summarizes the impacts and recommendations for mitigation measures to minimize adverse impact.

STRATIGRAPHY AND PALEONTOLOGY

Introductory Statement

In this section, an overview of the stratigraphy, as it relates to the paleontology, is presented to provide a context for the paleontological resources. The paleontologic resources of any area are, in large measure, a function of the kinds of sedimentary deposits. The degree to which fossils are abundant, scarce, or absent in a sedimentary deposit is governed by the original environment of deposition and the vagaries of preservation. Excavations (grading, tunneling, etc.), particularly on the scale required for this project, have great potential for unearthing abundant and significant fossils. Surface occurrences commonly are only a signboard to what may be present in the shallow (excavation depths) subsurface. In this section, the stratigraphy is treated through the succession of formations that appear on the stratigraphic column (Figure 1) and the geologic map (Drawing 1, CWDD, 1981). With regard to sensitivity and scientific importance, fossils of vertebrate animals are generally considered to be more important than invertebrate fossils; however, the question of scientific significance and educational/cultural value is a function of a number of coalescing criteria such as: geologic age, taxonomy (kind of organism) and taxonomic status (new or previously described taxon), quality of preservation, and abundance.

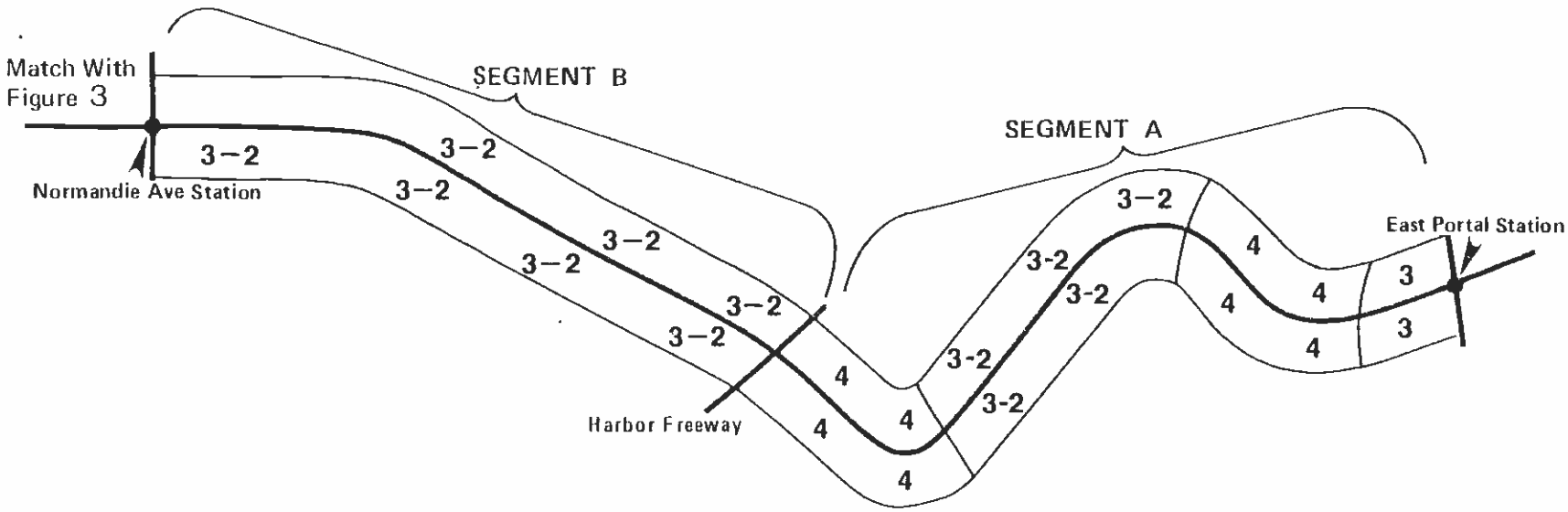


Strat. Column	Formation	Age	Paleoenvironment	Paleontology
	Younger Alluvium	Holocene	Nonmarine	No indigenous fossils *Low
	Older Alluvium "Palos Verdes Sand"	Late Pleistocene	Nonmarine Transitional Shallow Marine	*Extremely high to high Terrestrial mammals abundant at Rancho La Brea; other vertebrates and invertebrates, plants marine invertebrates *Moderate
	San Pedro Formation	Early Pleistocene	Shallow Marine	marine invertebrates occasional marine vertebrates *Moderate
	Fernando Formation	Pliocene	Deep Marine	*Moderate to high marine invertebrates (displaced shallow marine mollusks) foraminifera occasional marine vertebrates
	Puente Formation	Late Miocene	Deep Marine	foraminifera occasional marine invertebrates *high to moderate occasional marine vertebrates (whales, fish, shark teeth, etc.)
	Topanga Formation intrusive igneous	Medial Miocene	Shallow Marine	Locally abundant invertebrates, mainly mollusks rare marine vertebrates *Moderate for Topanga Sandstone *Low for igneous intrusives

* Paleontologic sensitivity rating.

Schematic columnar stratigraphic section of stratigraphic units that will be affected by the Metro Rail Project. Formation thickness not to Scale.

FIGURE 1



LEGEND	
Paleontological Sensitivity	
1	Extremely High
2	High
3	Moderate
4	Low

N

NO SCALE

Paleontologic sensitivity map of Metro Rail route segments A) East Portal to Harbor Freeway and B) Harbor Freeway to Normandie Avenue Station

FIGURE 2

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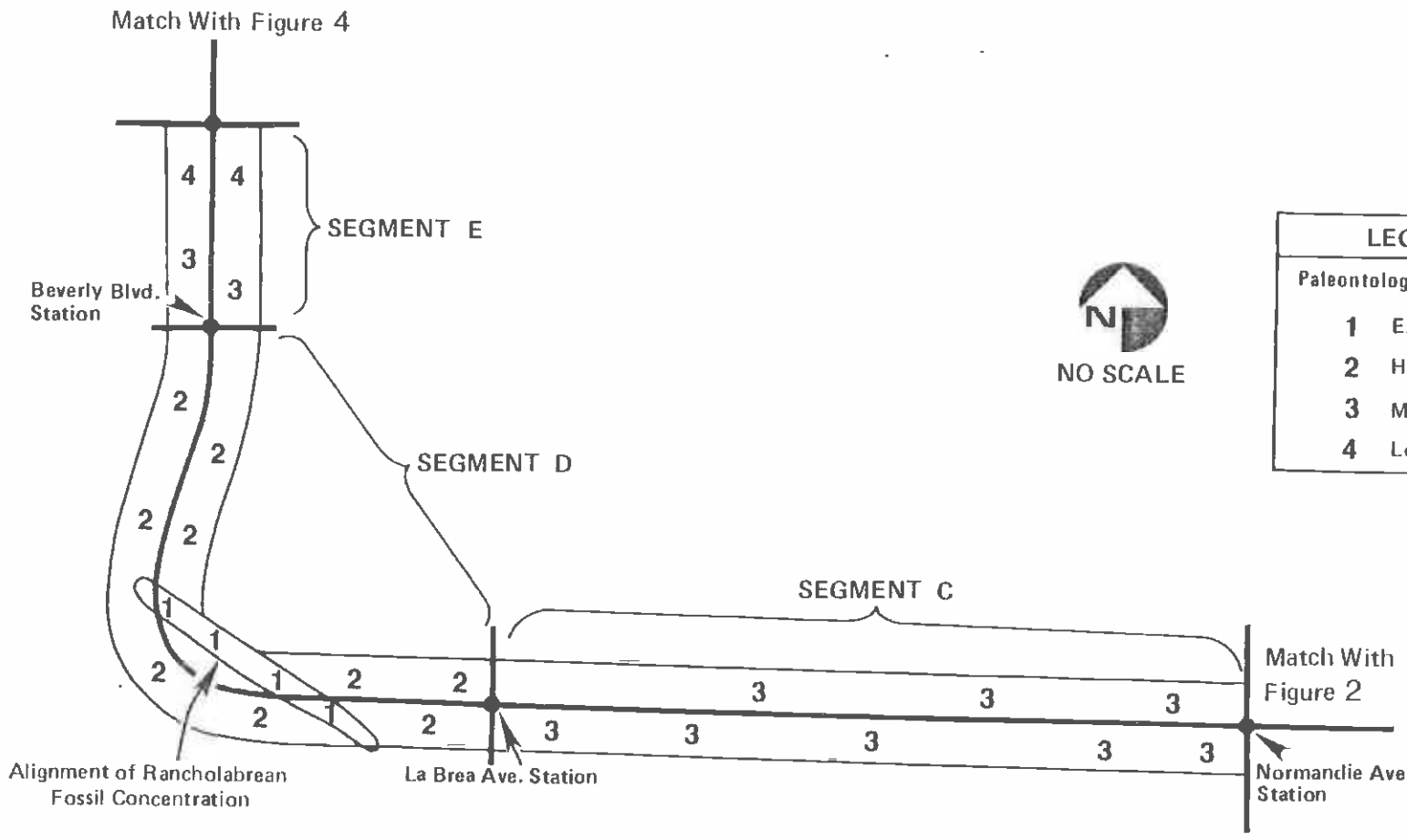

Paleontologic sensitivity map of Metro Rail route segments C) Normandie Station to La Brea Avenue Station, D) La Brea Avenue Station to Beverly Boulevard Station and E) Beverly Boulevard Station to Hollywood Boulevard Station

FIGURE 3

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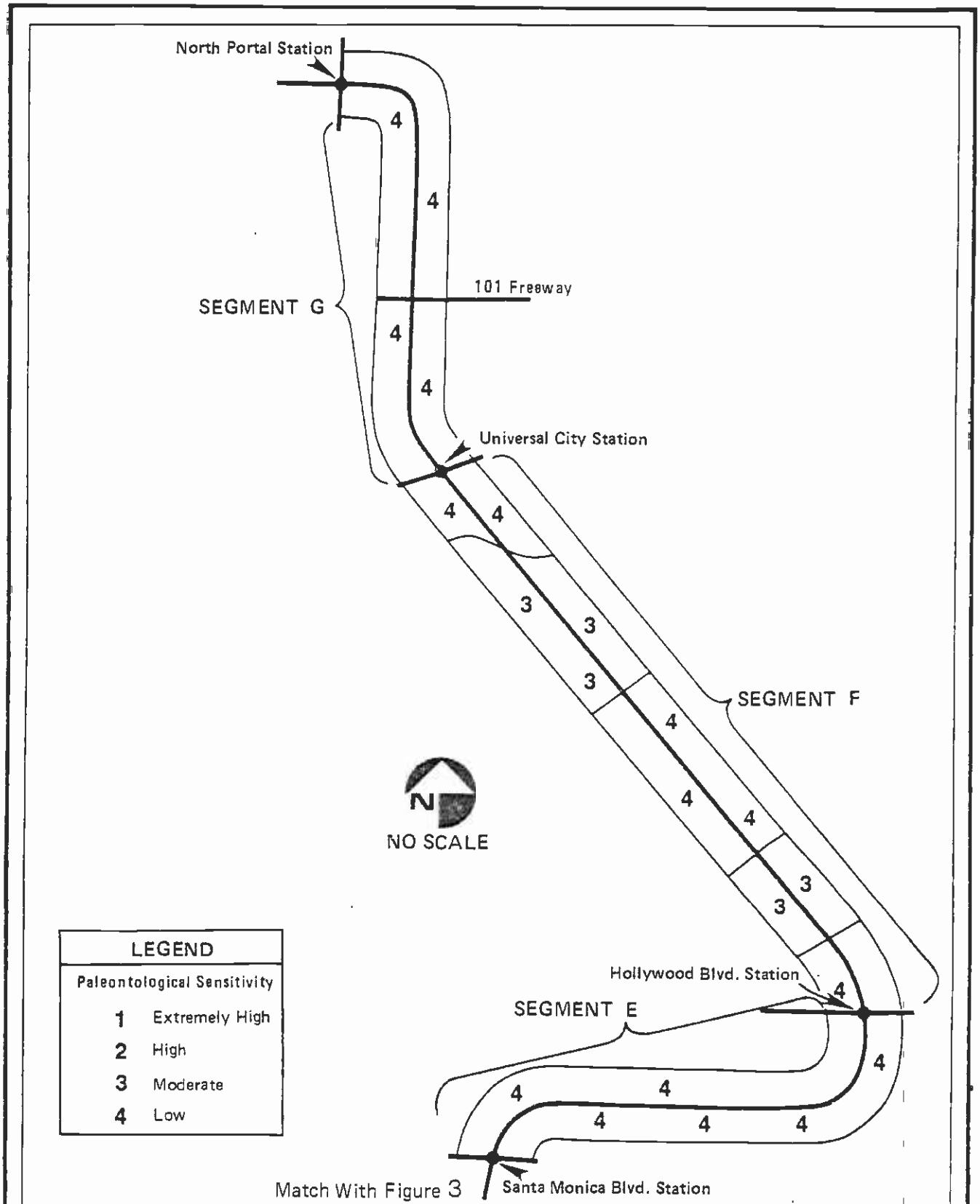


Paleontologic sensitivity map of Metro Rail route segments E) Beverly Boulevard Station to Hollywood Boulevard Station, F) Hollywood Boulevard Station to Universal City Station and G) Universal City Station to North Hollywood Station

FIGURE 4

Topanga Formation

Lithology and Paleoenvironment. The oldest stratigraphic unit along the proposed route is the Topanga Formation of Medial Miocene age (Figure 1; Geologic Map, Drawing 1, CWDD, 1981). The Topanga Formation is exposed in the Santa Monica Mountains (Hollywood Hills part of the proposed route) and consists of sandstone with locally developed interstratified layers of conglomerate, siltstone, and mudstone. These rocks were deposited predominantly in a complex of near-shore, shallow marine environments (Hoots, 1931; Yerkes et al., 1965; Lamar, 1970). Intruded into as well as interstratified with the Topanga sedimentary rocks are igneous rocks of basalt to andesite composition and texture (Figure 1, Drawings 1 and 2, CWDD, 1981).

Paleontology. Numerous invertebrate (predominantly molluscan) and some plant fossil localities are recorded in the Topanga outcrop belt in the eastern Santa Monica Mountains (Hoots, 1931; UCLA locality catalogues), but none are known along the proposed route (Bernor, 1978). Fossils of marine vertebrates in the Topanga Formation have been reported from several localities in Orange County (Cooper, 1977a; 1980) and from the Conejo Arroyo area near Thousand Oaks (Cooper, 1977b), but only scattered occurrences of fish scales have been reported from the Topanga Formation of the eastern Santa Monica Mountains (Lamar, 1970). Owing to their igneous origin, the basalts/andesites in the Topanga Formation do not contain fossils.

Paleontologic Sensitivity. For obvious reasons the basalts and related volcanic/intrusive igneous rocks are of low sensitivity. The sedimentary rocks (sandstones and related lithologies) are considered to be of moderate sensitivity because of prior history of yielding abundant fossil invertebrates (and some plant fossils), some of which have been important in biostratigraphic and paleoecologic studies, and some potential for producing marine vertebrate fossils. There still remain huge gaps in our knowledge of Medial Miocene marine vertebrate taxa and evolution, and any vertebrate fossils discovered would be considered significant. Vertebrate finds could change the sensitivity rating for the Topanga Formation in this area.

Puente Formation

Lithology and Paleoenvironment. The Puente Formation of Late Miocene age (Yerkes et al., 1965) consists of mudstone and shale with interstratified siltstone and sandstone (Figure 1). These well stratified deposits are the products of deep marine basin slope and basin plain turbidite fan depositional system, and depth-sensitive foraminifera in the mudstones generally indicate bathyal paleo-water depths (1000 feet or more) (Yerkes et al., 1965; Durham and Yerkes, 1964; Yerkes, 1970; Lamar, 1970). The Puente is exposed in only a small area along the proposed route (Drawing 1, CWDD, 1981), but is present in the shallow subsurface (below) between the East Portal and the Normandie Avenue station (Drawing 2, CWDD, 1981).

Paleontology. Exposures of Upper Miocene marine strata in the Santa Monica Mountains (Hoots, 1931), Palos Verdes Hills (Woodring et al., 1946; David, 1943), and Whittier and Puente Hills (Durham and Yerkes 1964; Yerkes, 1970) have produced vertebrate fossils including specimens of fish, shark teeth, birds, whales and dolphins, sea cows, and seals from a number of scattered localities (on file at the Natural History Museum of Los Angeles County). Abundant microfossils, mainly foraminifera, have been reported from the Puente Formation and strata of equivalent age. These have proved important for

refined relative age determination (what part of the Upper Miocene) and paleobathymetric studies for oil companies and academia. A few bivalve molluscs were reported from the Puente in bore holes 13 and 15 (CWDD, 1981), but no other paleontologic localities are known from the Puente Formation along the proposed route.

Paleontologic Sensitivity. Because of its marine origin and prior history of yielding vertebrate fossils from a number of scattered localities, the Puente Formation is considered to be of moderate to high sensitivity. Important information on marine vertebrates has come from Upper Miocene marine deposits of the Los Angeles Basin area, but there are still major gaps in our knowledge of Late Miocene faunas and evolutionary patterns (Barnes, 1972).

Fernando Formation

Lithology and Paleoenvironment. Conformably overlying the Puente Formation is a succession of well stratified mudstones and siltstones with interbedded sandstones comprising the Fernando Formation of Pliocene age (Figure 1). The Fernando Formation is a moderately deep marine basin to slope to outer shelf deposit (Yerkes et al., 1965; Conrey, 1967; Lamar, 1970). The nearest exposures are in the Elysian Park-Repetto Hills area (Lamar, 1970), but the Fernando Formation occurs in the shallow subsurface along the proposed route between the East Portal and the Normandie Avenue Station (Drawing 2, CWDD, 1981).

Paleontology. There are a few reports of marine vertebrate fossils (shark tooth near Woodbury College, Bernor, 1978; fish scales and bones from the Elysian Park-Repetto Hills area Lamar, 1970) in the Fernando Formation, but no localities along the proposed route. Invertebrate fossils were reported at various depths in bore holes 8, 9, 10, 15, 20, 21, and 22 (CWDD, 1981) and have been described from the Elysian Park-Repetto Hills area (Lamar, 1970). A large concentration of Pliocene marine invertebrate fossils was recovered in a massive block of limestone during the early 1970s from the excavation for the Atlantic-Richfield Towers building in downtown Los Angeles (M.L. Natland, personal communication; also reported in West Magazine, Los Angeles Times, circa 1971 - "The Miracle of 6th and Flower Street"). This unusual occurrence represents a submarine debris flow of mud, sand, and shallow marine molluscan shells that was transported from shallow to deep water as a mass flow. Reports of shallow marine mollusks in the Fernando Formation in the general downtown Los Angeles area are probably additional examples of similar ecologically displaced faunas.

As in the Puente Formation, microfossils are locally abundant and have been useful for biostratigraphic and paleoecologic zonation.

Paleontologic Sensitivity. The marine origin and occurrence of invertebrate fossils and occasional vertebrate material give the Fernando Formation a moderate to high sensitivity rating.

Lower Pleistocene - San Pedro Sand

Lithology and Paleoenvironments. The San Pedro Formation is confined to the subsurface of the study route and consists of clean quartz sandstone and pebbly sandstone unconformably overlying the Puente and Fernando Formations, mainly in the area

between Normandie Avenue Station and Beverly Boulevard Station (CWDD, 1981). The nearest exposures are in the Palos Verdes Hills approximately 15 miles south of the Metro Rail proposed route (Woodring et al., 1946) and include cross-stratified sand and gravel of shallow marine, probably beach origin.

Paleontology. Locally abundant marine invertebrate fossils (Woodring et al., 1946) and occasional marine vertebrate fossils (whale, dolphin, sea lion, shark, etc.) have been reported.

Paleontologic Sensitivity. Because of its shallow marine origin, its Pleistocene age, and its record of yielding marine invertebrates and occasional vertebrates, the San Pedro Sand is considered to be of moderate sensitivity.

Upper Pleistocene - Older Alluvium (Includes Palos Verdes Sand)

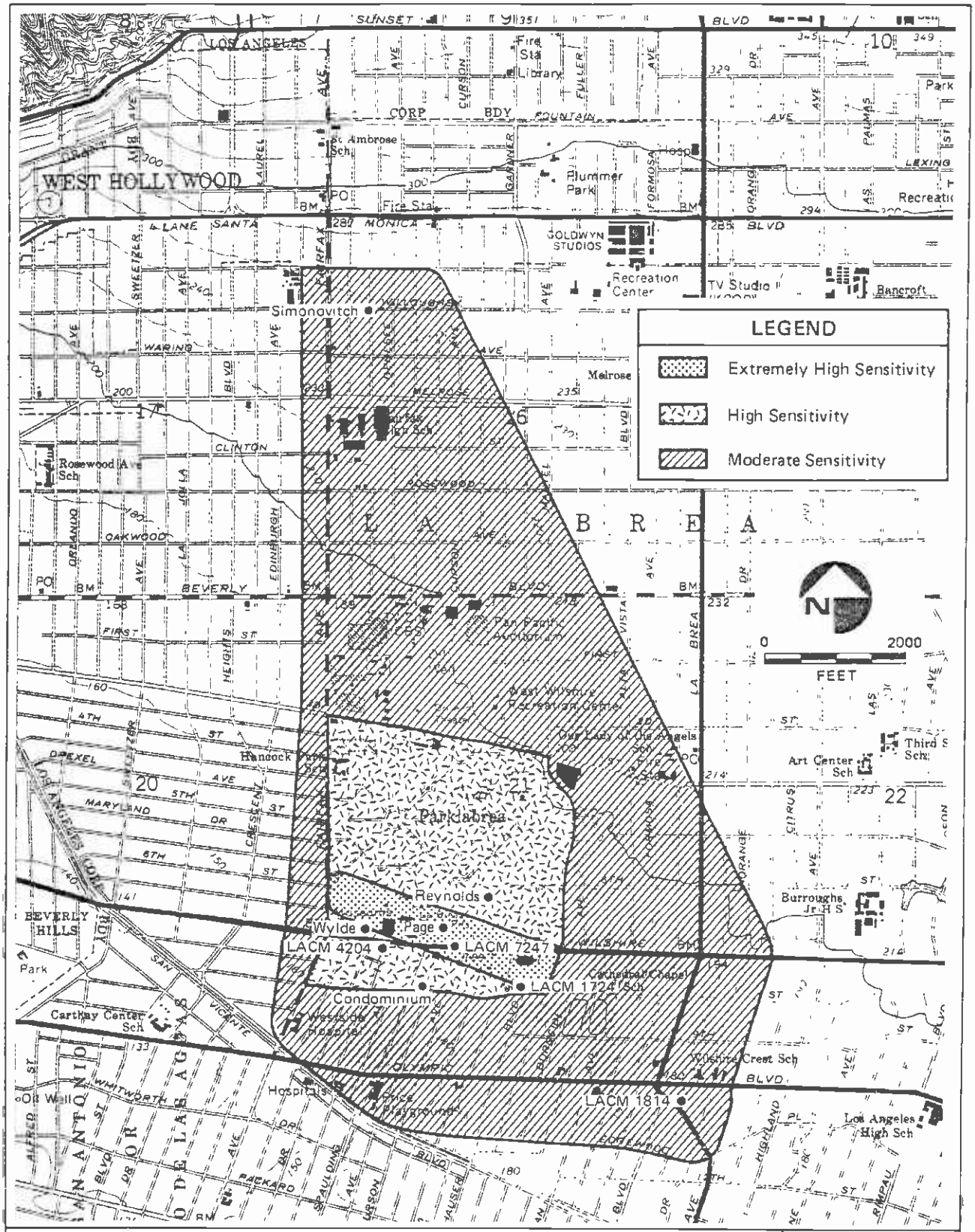
Lithology and Paleoenvironments. Upper Pleistocene deposits are composed of moderately consolidated sand, gravel, and clay in complex interstratified patterns (Figure 1). These surficial deposits unconformably overlie the San Pedro Formation and consist of interstratified shallow marine and nonmarine deposits in the lower part, grading upward into nonmarine alluvial plain deposits in the upper part (Woodard and Marcus, 1973). The upper, nonmarine part lies immediately below the surface throughout much of the area south of the Hollywood Hills (Drawings 1 and 2, CWDD, 1981).

Paleontology. Marine invertebrate fossils have been recovered from this succession from excavation pits in and near the La Brea Tar Pits area and from surface exposures in the Beverly Hills and Cheviot Hills areas (Rodda, 1956; Valentine and Lipps, 1970; Woodard and Marcus, 1973). Fossils of land plants, insects, freshwater invertebrates, and more than a million bones of Late Pleistocene vertebrate land animals (birds and mammals) have been recovered from the nonmarine older alluvium in the La Brea Tar Pits area (see discussion of La Brea Tar Pits area in later section of report; Woodard and Marcus, 1973). Miller (1971) has reported a number occurrences of Late Pleistocene Rancholabrean fauna in areas of the greater Los Angeles Basin outside the La Brea Tar Pits.

Paleontologic Sensitivity. Because the upper part, mainly nonmarine section, of the Older Alluvium is the interval containing the scientifically important, world-renown Rancho La Brea fauna, it is considered to be of high sensitivity in the La Brea Tar Pits area (outlined on Figure 5). The upper part of the succession north and south of the area outlined on Figure 5 as well as the lower, marine part of the succession are considered to be of moderate sensitivity.

Holocene - Younger Alluvium

The youngest surficial deposits (Figure 1; Drawings 1 and 2, CWDD, 1981) consist of loosely consolidated sands, gravels, and minor clays representing geologically recent (less than 10,000 years old) alluvium (Yerkes et al., 1965; CWDD, 1981). Because of the geologically young age these deposits do not have any potential for yielding fossils and therefore are considered to be of low sensitivity.



Known fossiliferous accumulation in the La Brea Tar Pits area

FIGURE 5

METRO RAIL ROUTE SEGMENTS

East Portal to Harbor Freeway

Stratigraphy. Most of this segment will affect the Fernando and Puente Formations at depths of 50 to 60 feet below the surface. Other units affected are older and younger Quaternary alluvium (see Drawing 2, CWDD, 1981).

Paleontology. Invertebrates reported from bore holes 8, 9, 10 and 13 in Puente and Fernando Formations; thus potential for marine invertebrates. No known occurrences, but potential for marine vertebrates in Puente Formation between East Portal and Hollywood Freeway. There is potential also for marine vertebrates in Fernando Formation between Hollywood Freeway and Harbor Freeway; there is also potential for nonmarine vertebrates in Old Alluvium at Civic Center Station.

Sensitivity and Impacts. There is reasonable likelihood of significant fossils being discovered during excavation. This segment is of moderate to high sensitivity (Figure 2).

Recommendations. Civic Center Station excavation from surface should be closely monitored by a qualified paleontologist. Fifth Street and Flower Street Stations excavations need not be monitored, but some spot checking is recommended.

Harbor Freeway to Normandie Avenue Station

Stratigraphy. Fernando Formation will be encountered between Harbor Freeway and Alvarado Street Station below about 25 feet to 30 feet beneath the surface. Puente Formation will be encountered from Alvarado Street Station to Normandie Avenue Station below about 30 to 40 feet beneath the surface. Old Alluvium is present at shallower levels.

Paleontology. Bivalve mollusks reported in Puente Formation from bore hole 13 (CWDD, 1981). There is potential for marine invertebrates and vertebrates in Puente Formation between Alvarado Street Station and Normandie Avenue Station. There is potential for marine invertebrates and vertebrates in Fernando Formation between Harbor Freeway and Alvarado Street Station. There is potential for nonmarine vertebrates in Old Alluvium.

Sensitivity and Impacts. There is reasonable likelihood of significant fossils being discovered during excavations. This segment has a moderate to high sensitivity.

Recommendations. Surface excavations for stations at Alvarado Street, Vermont Avenue, and Normandie Avenue should be closely monitored by a qualified paleontologist.

Normandie Station to La Brea Avenue Station

Stratigraphy. This segment will encounter Older Quaternary Alluvium from the surface down to depths of 50 to 60 feet. Deeper tunneling would also reach the San Pedro Formation and Puente and Fernando Formations.

Paleontology. There are no known occurrences along the route, but there is moderate potential for discovery of non-marine vertebrates as well as other mixed non-marine and marine invertebrates in the Old Alluvium (Palos Verdes Sand).

Sensitivity and Impacts. This segment is of moderate sensitivity with moderate potential for significant fossils being discovered during excavations.

Recommendations. Surface excavations for stations on Wilshire at Western Avenue, Crenshaw Boulevard, and La Brea Avenue should be monitored for fossils, with closest scrutiny at the La Brea Station because of proximity to La Brea Tar Pits area.

La Brea Avenue Station to Beverly Boulevard Station

Stratigraphy. This segment will encounter Older Quaternary Alluvium (Palos Verdes Sand) from the surface down to depths between 30 and about 60 feet. The San Pedro Formation will be reached in some areas below about 30 feet.

Paleontology. This segment embraces the La Brea Tar Pits area, which has produced abundant marine and non-marine invertebrates, plants, and world-famous ice-age land animals.

Sensitivity and Impacts. There is high potential for discovery of scientifically significant fossils during excavation. Unless mitigation measures described later in this report are followed, there will be critical impacts in this area, particularly with regard to the proposed station on Wilshire between Curson and Spaulding (see separate discussion below).

Recommendations. Systematic program of close monitoring, quarrying, and careful salvaging of fossils at any station planned for that segment of Wilshire between Spaulding and Curson is recommended for the reasons stated below.

Impacts of Station on Wilshire Between Spaulding and Curson

Statement. Because it impinges on the very highly sensitive La Brea Tar Pits area, this station will create, by far, the greatest impact on paleontologic resources of any part of the proposed system. As presently projected, the station will front Hancock Park and will intersect the known trend (Figure 5) of fossiliferous accumulations in the La Brea Tar Pits area.

Background. The Rancho La Brea area (Figure 6) has provided the most prolific record of Late Pleistocene vertebrate animal life yet discovered anywhere in the world (Stock, 1956). Because of the abundance and extraordinarily good preservation of specimens, the vertebrate fauna has been designated the type of Upper Pleistocene Rancholabrean mammalian provincial biostratigraphic stage in North America (Savage, 1951). The locality is world-famous and is a national historic landmark. Many publications on various aspects of the fossil assemblage have appeared in the scientific literature (e.g., plants - Frost, 1927; Warter, 1976; invertebrates - Pierce, 1949; Valentine and Lipps, 1970; amphibians and reptiles - Brattstrom, 1953; birds - Howard, 1930; 1962; mammals - Stock, 1956; Marcus, 1960; Akersten, Reynolds, and Tejada-Flores, 1979.)

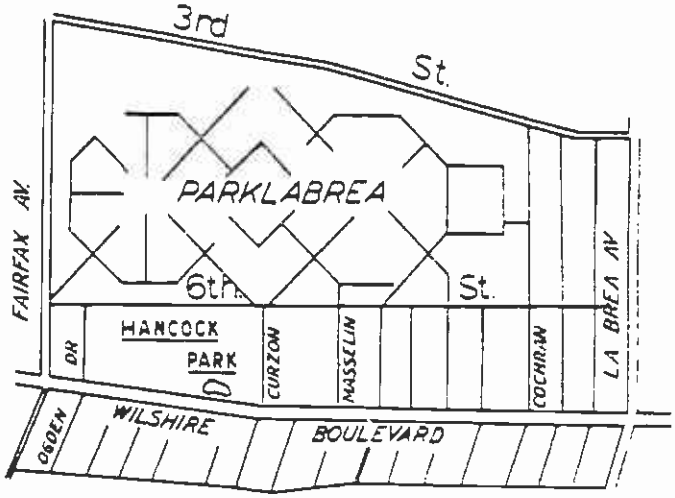
More than 1 million fossil bones as well as specimens of insects, shelled invertebrates, and plant remains have been recovered from about 35 excavations of various size (from approximately 100 that have been dug) since excavations began in 1906 in the La Brea Tar Pits area. Figure 6 is a sketch map of the La Brea Tar Pits area showing the location of pits that have produced fossils. Additional excavations outside the park area also have produced fossils. These occurrences indicate the concentations of fossils are not confined to the La Brea Tar Pits area and that a major excavation at the proposed station site is virtually certain to unearth additional concentrations of fossils. These additional sites are shown in Figure 5 and include (A.E. Tejada-Flores, personal communication):

- California Federal Building Excavation (1962). Fossils were discovered in the southeast corner of the site, approximately 100 yards south of the corner of Wilshire and Hauser Boulevards. The deposit was approximately 1 to 1.5 feet thick and at least 5 feet in diameter (Figure 7). Nine taxa of mammals, numerous birds, and one beetle were recovered. This site is LACM 1924.

- LACM 1814 - Sycamore Site (1963). In the Spring of 1963, a sewer line excavation uncovered a small asphalt and bone deposit on Sycamore Avenue, 100 feet north of La Brea Avenue. The fossiliferous asphaltic sand was 6 feet thick and 3 to 4 feet in diameter, and began at 8 feet below the surface level. The uppermost 6 feet of overburden was recent fill. Many of the normal Rancho La Brea megafauna were present, as well as a euceratherian musk ox new to the fauna.

- LACM 4024 - Mutual Benefit Building Excavation (1969). During the excavation a few scattered fossils were recovered, including a single antiolocaprid bone near the ground surface, a Canis dirus incisor from approximately 46 feet below the surface, and marine mollusks from 50 to 60 feet below the surface. The stratigraphic column for this site is shown in Figure 7.

- LACM 7247 - Gas Company Hole (1972). The Gas Company excavation was located 78 feet west of the eastern property line and 32 feet south of the southern property line of Hancock Park in the westbound traffic lane of Wilshire Boulevard (Figure 5). A fossiliferous deposit was recovered 6 to 8 inches below the old ground surface (1860 to 1880 when the gas pipe was laid) and 48 to 50 inches below the present level. Maximum depth of excavation when this excavation was abondoned was 24 inches below the old ground level. The bone deposit was expanding in all directions except to the east. Many large bones and blocks of fossiliferous matrix were



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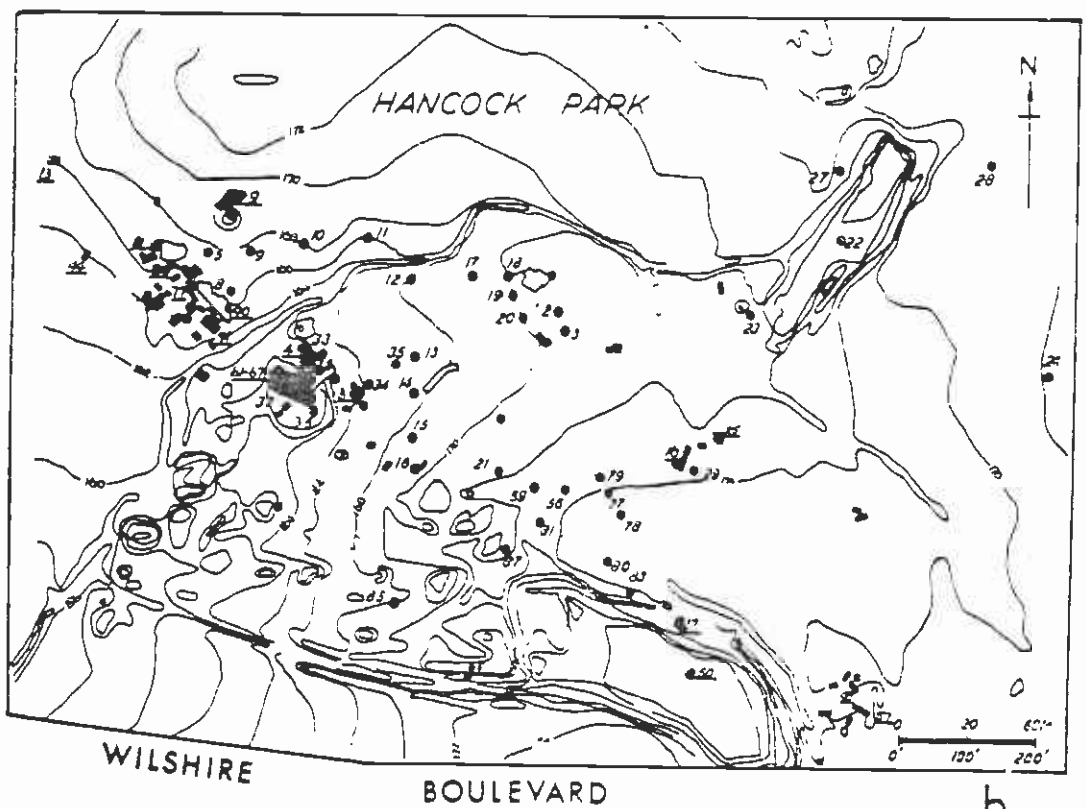
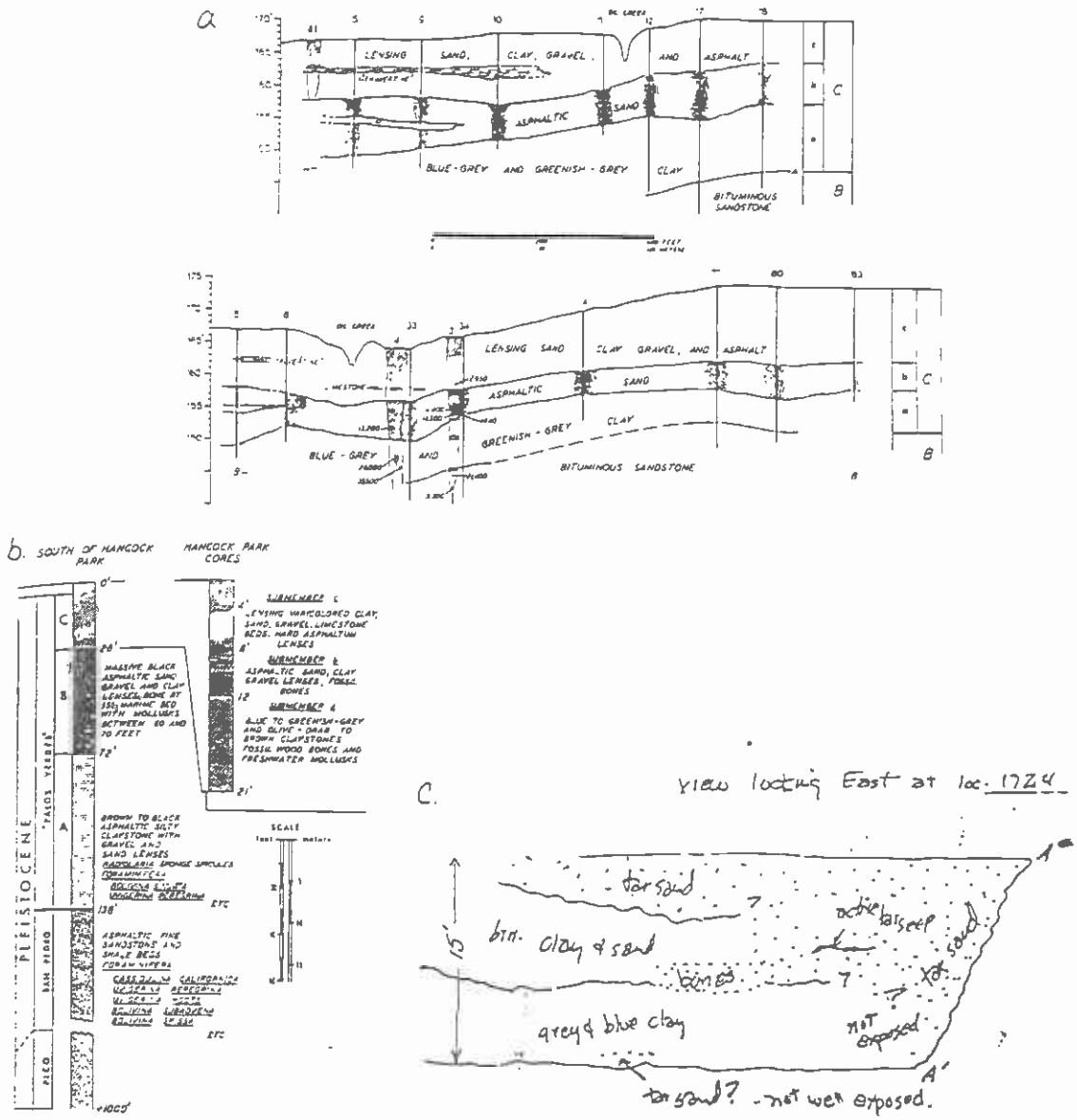


b

Locality of Hancock Park Scientific Monument (Rancho La Brea). b. Locations of major excavations and test cores drilled by the Los Angeles County Museum. Contour intervals and boundaries from a survey completed in 1914. From Woodard and Marcus, 1973.

FIGURE 6



a. Geologic cross-sections of Member C, the most fossiliferous part of the succession, Rancho La Brea. b. Stratigraphic columns at Rancho La Brea and from the Mutual Benefit Insurance Building excavation south of Hancock Park. c. Sketch of bone-bearing interval in excavation at LACM 1724, southeast of Hancock Park. a. and b. from Woodward and Marcus, 1973; c. from A.E. Tejada-Flores, personal communications

FIGURE 7

removed, including a Bison skill and a pair of Felix atrox mandibles. Fossils left in situ when the hole was backfilled include a complete Glossotherium synsacrum (42 cm across the acetabula), a Bison horn core, and a Bison tibia. Clearly from this description, the surface had only been scratched during this small excavation. Excavation for the proposed station on Wilshire no doubt will affect this major deposit.

- Condominium Excavation (1980). In April 1980 excavation for condominiums commenced on the north side of 8th Street between Spaulding Avenue and Stanley Avenue. Fossiliferous matrix was encountered in the southwest corner of the excavation site (the northeast corner of the intersection of Stanley and 8th). Forty-two boxes of fossiliferous matrix were salvaged, but have not yet been processed. No megafauna were present, but there were many small fossils, including Canis latrans, lagomorphs, rodents, snake, and frog, as well as insect, seeds, and wood.

In addition to these well-documented sites, reliable verbal information includes (Figure 5):

- In 1973, Mr. Chris Simovitch, a retired contractor, reported presence of a large mass of asphalt and bones he personally observed many years previously on Willoughby Avenue, approximately 2 blocks east of Fairfax Avenue. This site is now covered with homes.

- Mr. Henry Wylde, retired exhibits director, Los Angeles County Museum of Natural History, mentioned fossils in an aspaltic matrix recovered during the construction of the May Company Annex, on the north side of Wilshire Boulevard, between Orange Grove Avenue and Ogden Drive.

- Mr. Richard Reynolds, Research Associate, Page Museum, recalls the disovery of bones in asphalt in the Prudential Square parking lot (now known as "Museum Square"), on the south side of 6th Street between Curson Avenue and Masselin Street.

All of these occurrences of fossils outside the immediate Hancock Park area indicate the strong likelihood of abundant fossils being discovered during major excavation close to the park.

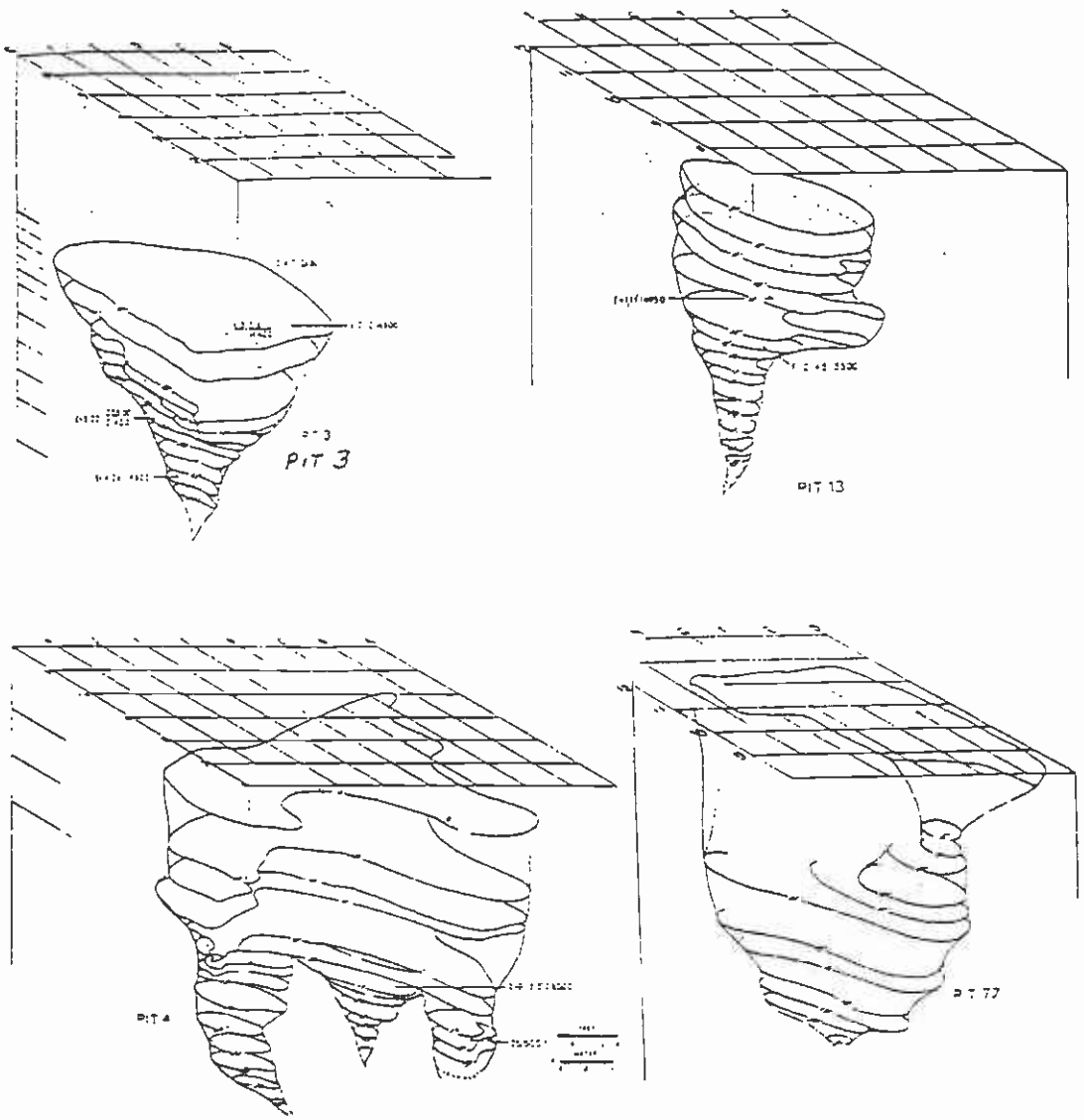
The George C. Page Museum. In 1978 the George C. Page Museum in Hancock Park opened to the public. Anyone interested in learning about the paleontological treasures that have been recovered from this area, the scientific significance of the specimens, and the Late Pleistocene terrestrial paleoecology of the Ranch La Brea area should visit this outstanding museum of La Brea discoveries. The museum features displays of Rancho La Brea animals, and its staff of scientists is engaged in research, preparation, and curation of the tremendous volume of specimens that has been amassed over the years. In June 1975, during the construction of the Museum, a major bone deposit was uncovered in the area which is now the museum's atrium. The fossiliferous asphaltic sand layer was under 4 feet of overburden and 2 feet of asphaltic clay, and was underlain by calcareous blue-green clay. The deposit was 1.5 thick, 32 feet

long east to west, and 8 feet wide, maximum, from north to south. It was removed as 20 individually plaster-jacketed blocks that have not yet been prepared. Unlike all other Rancho La Brea deposits recorded to date, this one consists of articulated skeletons and probably represents a single entrapment episode (A.E. Tejada-Flores, personal communication). This discovery adds further credence to additional important discoveries being made in the area during future excavations. Questions relating to the faunal and floral composition and diversity, the microfossils, paleoecology, and mode of entrapment of the bones and other fossils are continuing subjects of vigorous research effort.

- Stratigraphy. A study of the Los Angeles County Museum catalog entries and of the field notes made at the time of excavation (Woodard and Marcus, 1973), as well as detailed stratigraphy and sedimentologic study of "Pit 91" (LACM 69090) (Maloney and Daigh, 1971; Maloney et al.,1973; Maloney and Akersten, 1974), have revealed that the bones were concentrated in pockets of various sizes formed at the sites of discontinuously active asphalt seeps. This activity occurred during the approximately 20,000 years of alluviation accompanying the Late Pleistocene development of the Santa Monica Plain. Geological evidence indicates that intermittent stream deposition, including fluvial channel, levee, crevasse splay, and overbank deposits, contributed importantly to the concentration and preservation of fossil bone and other material. Both the localization of asphalt seeps as well as the lenticular to pod-like nature of the depositional facies account for the cone-like concentrations and patchy distribution of the fossil assemblages (Figure 8). In June 1969, "Pit 91" (LACM 6909), which had been abandoned in 1915, was reopened. The new excavation concentrated primarily on the recovery of the microvertebrates and invertebrates under-represented in previous collections. The pit encompasses several discrete bone deposits in stream channels separated by nonfossiliferous sediments, illustrating the paleoenvironmental depositional controls on the patchy distribution of fossils. The fossil deposits extend below 15 feet (the present maximum depth). Material from LACM 6906 has been partially processed and two new taxa (Scapanus latimanus and Lasiurus cinereus) have been added to the previously known Rancho La Brea fauna.

  The fossiliferous deposits at Rancho La Brea appear to be confined to the uppermost 55 feet below the present surface and particularly within the uppermost 25 to 30 feet (Woodard and Marcus, 1973). Figure 7 depicts the stratigraphy and Figure 8 illustrates the general style of accumulation of the fossil bones. Table 1 provides data on the depth of accumulation as recorded from excavation pits.

  The proposed depths of excavation and location of the station on Wilshire between Spaulding and Curson will intersect the well-documented northwest-southeast alignment of accumulations of fossils (Figure 5; Woodward and Marcus, 1973). This indicates that this part of the Metro Rail Route will critically impact projected occurrences of fossils. Although there were no reports of bone material or other fossils from the upper 50 to 60 feet in bore holes 19-22 (CWDD, 1981), which encompasses an area from east to north of the proposed station, this should not be taken as an indication that there are no fossils present. It should be emphasized that because of the patchy areal distribution and vertical downward tapering cone shape



Isometric reconstructions of fossil bone accumulations in Pits 3, 4, 13, and 77. From Woodward and Marcus, 1973. This illustrates the downward-tapering, cone-shaped pods that characterize many of the fossil accumulations.

FIGURE 8

Table 1

MAJOR LACM EXCAVATIONS

One of the 96 "pits" dug by the Los Angeles County Museum of Natural History between 1913 and 1915, only 31 were fossiliferous (Figure 1). Their locality numbers, and the maximum depth at which fossils were found in each area listed below.

Pit Number	Maximum Depth Fossils Were Found	Pit Number	Maximum Depth Fossils Were Found
1	no data	44	11 feet
2	no data	49	11 feet
3	27 feet	50	9 feet
4	13.5 feet	51	5 feet
9	34.5 feet	54	9 feet
10	13.5 feet	57	18 feet
13	21 feet	59	11 feet
16	27 feet	60	20 feet
17	27.5 feet (Former Calif. Acad. of Sci. pit)	61/67	20 feet
		65	13.5 feet
25	12 feet	73	8 feet
28	8.5 feet	77	21 feet
35	8 feet	80	12 feet
36	11 feet	81	10 feet
37	8 feet	90	7.5 feet
43	16 feet	91	abandoned at 10 feet

All of these localities produced primarily vertebrate fossils, with the exception of Pit 73, which contained wood only. Note that Pit 59 is actually in Wilshire Boulevard, south of the Hancock Park boundary; furthermore, Pits 28, 35, 36, and 51 are all outside the present northern boundary of the park.

of many of the fossil accumulations, test borings have been and probably will continue to be unsuccessful in locating fossils in the area. Also, almost without exception, there is little, if any, surface indication of individual concentrations of fossils at depth.

In summary, Rancholabrean fossils are abundant in the uppermost unit (Unit C) of the Palos Verdes Sand, which comprises the upper 11 to 26 feet (under recent fill) of the area studied. The outlined area in Figure 5 shows the heaviest concentration of known fossil deposits, and therefore is of extremely high paleontologic sensitivity. Deposits in this area tend to occur in large cone-shaped pockets, vertically oriented and tapering downward (Figure 8). Stratigraphically (Figure 7) the most fossiliferous area coincides approximately with the extent of Unit C, subunit b, of the Palos Verdes Sand, according to Woodard and Marcus (1973). The other area outlined is judged to be not quite so sensitive, but with sensitivity considered high. The northern boundary of this area is placed at 3rd Street because the extensive excavation for the Pan Pacific Park, on the north side of 3rd Street, produced no fossils. The other outline surrounding the above areas in Figure 5 indicates moderate paleontological sensitivity. Such fossiliferous deposits as do occur in this area are more widely separated and appear to occur in small horizontal lenses of asphaltic sand surrounded by blue-green clay rather than in the deep vertical masses in Hancock Park (A.E. Tejada-Flores, personal communication).

Negative Impacts. The obvious negative impact is the potential destruction of many fossil specimens and consequent loss of scientific information. The amount of excavation for the station on Wilshire between Spaulding and Curson will probably exceed the previous total amount of pit excavation; hence there is potential for an additional million or more specimens being unearthed. It is at present impossible to predict an order of magnitude of how many or how few fossils lie within the volume of material that will be removed for the station. The feeling expressed by scientists at the Page Museum is that the number would be staggering.

There is existing federal legislation, i.e., the Antiquities Act of 1906 (16 USC 433), that provides for protection of "objects of scientific interest", which paleontological resources are considered to be. Other laws such as the National Environmental Policy Act (42 USC 4321) and the California Environmental Quality Act (Public Resources Code, Division 13, Section 21000-21176) require mitigation of adverse impacts on important environmental resources, paleontological resources being included as a topic in CEQA's implementing guidelines. These regulations would be especially pertinent to a national landmark such as the La Brea Tar Pits.

Mitigation. Therefore, under the circumstances of excavation for the station, the only way to properly mitigate such a potentially negative impact would be to make provisions for systematic quarrying, salvaging, housing, and curation of specimens - a complex process (Shaw, 1982). Such a large-scale venture as envisioned for this excavation would require an enormous expenditure of manhours over a protracted duration, as well as dollars, and would involve:

- slow, methodical excavation and quarrying that could take several years;
- additional staff and teams of volunteers to conduct the quarry and salvage operation;
- a new facility to house the specimens. There is no room at the Page Museum or the Natural History Museum of Los Angeles County;

- A substantial increase in scientific staff and research facilities for curation and study of specimens. The present staffs of the Page Museum and Natural History Museum of Los Angeles County Museum are already overcommitted;

- A considerable amount of money to support this activity. In short, a Page Museum annex, complete with sizable staff of professionals, would be required to adequately deal with the problem.

Positive Impacts. Given the proper negative impact mitigations, the positive impacts that might accrue include:

- additions of many specimens and expansion of our knowledge of the land life and paleoecology of the Rancholabrean time interval;

- an expanded museum concept at Hancock Park with the opportunity to develop unique public education programs in paleontology and natural history;

- increase in the number of visitors to this fascinating and important site.

However, the benefits that might accrue must be weighed against the cost and complexity of properly mitigating the negative impacts on the many fossils that are certain to be unearthed. Haphazard salvage of fossils will not satisfy the requirements of mitigation. It is important to realize that the context of a fossil (how it relates to others around it and to the sediment within which it is contained) is as important as the fossil itself. Also, microfossils, such as small vertebrate and invertebrate specimens and plant spores and pollen are an important part of the integrated whole. It is doubtful that significant new taxa would be added to the long list already recovered; however, the important information lies in the entire paleontologic context, which is critical to understanding the nature of the paleoenvironmental and the conditions under which the fossils accumulated.

Summary. In the opinion of the professionals at the Page Museum (William Akersten and George Jefferson, personal communication), the present plan and design for a sta tion on Wilshire between Curson and Spaulding is undesirable. It is recommended that plans for this station be abandoned. Avoiding excavations in the La Brea Tar Pits area also was recommended by Bernor in the preliminary report on paleontologic resource evaluation (1978). The original plan of a station at Wilshire and Fairfax would be acceptable. This site does not have the extremely high sensitivity of the presently planned site. In fact, any location south and/or west of that presently proposed would be much more favorable. A station at Fairfax and Wilshire would be in an area of high sensitivity, but mitigation of adverse impact could be accomplished by a well organized program of monitoring and salvaging of specimens discovered during construction. Also, all tunnels should be below 50 feet beneath the surface to avoid potential concentrations of fossils. If the decision is to go ahead with the station between Curson and Spaulding, there must be a carefully planned (beginning now) program of systematic quarrying, which would require at least several years and a significant augmentation of present paleontological staff and volunteers.

Beverly Boulevard Station to Hollywood Boulevard Station

Stratigraphy. Along this segment Younger Quaternary Alluvium will be encountered from about 30 to 85 feet beneath the surface, with increasing thickness from south to north along Fairfax. Below this level for 100 feet or more is Older Quaternary Alluvium.

Paleontology. No fossils in younger alluvium, but some potential for terrestrial vertebrates in Older Alluvium. This segment is of low sensitivity because excavations are not likely to reach below base of Younger Alluvium. Thickness of Younger Alluvium at Santa Monica Boulevard Station, La Brea Avenue Station, and Hollywood Boulevard Station is between 75 and 100 feet.

Recommendations. No monitoring is necessary for excavation of stations.

Hollywood Boulevard Station to Universal City Station

Stratigraphy. Most of this segment will affect the Topanga Formation (Drawings 1 and 2, CWDD, 1981). Topanga sedimentary rocks occur in the southern part of the segment between Hollywood Boulevard Station and the Hollywood Bowl, and in the northern part north of Cahuenga Pass. The central part from the Hollywood Bowl to west of Cahuenga Pass will encounter the intrusive basalt/andesite member of the Topanga Formation.

Paleontology. No localities are known along the proposed route, but numerous invertebrate (and some plant) localities in the eastern Santa Monica Mountains indicate a potential for yielding fossils. There is also some potential for discovery of marine vertebrate fossils (e.g., desmostylans, whale, shark teeth). No fossils are expected in the igneous rocks within the Topanga.

Sensitivity and Impacts. The area where igneous rocks will be encountered is of low sensitivity. Areas where sedimentary rocks of the Topanga Formation will be encountered are considered to be of moderate sensitivity (Figure 4). There is reasonable likelihood of invertebrate fossils being discovered during excavation.

Recommendations. Some monitoring of excavation for the Universal City Station, particularly in the deeper parts, should be conducted by a qualified paleontologist.

Universal City Station to North Hollywood Station

Stratigraphy. Along this segment Younger Quaternary Alluvium will be encountered from the surface down to depths of about 50 to 80 feet. The thinnest section is near Lankershim Boulevard. Older Alluvium, consisting mainly of sand and gravel, lies beneath the younger alluvium.

Paleontology. No fossils are anticipated in this geologically young material.

Sensitivity and Impacts. This segment is of low sensitivity and no impacts are anticipated.

Recommendations. No monitoring of station excavations is required.

SUMMARY AND CONCLUSIONS

With the exception of the La Brea Tar Pits area, there are no recorded paleontologic localities that will be affected and impacted by the proposed Metro Rail project. However, the proposed alignments will pass through and disturb a variety of marine and nonmarine sedimentary deposits ranging in age from Medial Miocene to Holocene surficial alluvium. All stratigraphic units except the Holocene alluvium (Younger Quaternary Alluvium) and the intrusive basalts/andesites within the Topanga Formation are considered to have at least moderate sensitivity with respect to potential paleontologic resources.

Figures 2, 3 and 4 are sensitivity maps of the proposed route. The sensitivity ratings are based on the paleontologic sensitivity of the stratigraphic units in the context of proposed depth of surface excavation for stations and subsurface excavations for tunnels. Excavation for stations in areas designated high sensitivity should be closely monitored by qualified paleontologist(s). Qualification should be subject to approval by the Vertebrate Paleontology Section, Natural History Museum of Los Angeles County. RTD should retain the services of a paleontologist to coordinate and oversee all monitoring and inspection activities. Excavation for stations in areas designated moderate to high or moderate sensitivity should be subject to some monitoring by a qualified paleontologist, the degree of scrutiny being dictated by the relative degree of sensitivity of the stratigraphic unit affected. Excavations for stations in areas designated low sensitivity (Figures 2, 3 and 4) need not be examined for fossils.

The La Brea Tar Pits area and projected extensions in a northwest-southeast alignment are considered to be of extremely high sensitivity (Figures 2, 3, 4 and 5) and disturbance in these areas should be avoided. The station planned for Wilshire between Curson and Spaulding will pose critical impacts on the paleontological resources of the La Brea Tar Pits area. Effort should be made to find an alternate location such as the original site at Wilshire and Fairfax. If this is not feasible in light of other considerations, complex mitigation measures will be required for the proper disposition of the paleontological resources.

All vertebrate specimens recovered during the development phase of the project should be donated to the Natural History Museum of Los Angeles County (LACM). The LACM is a fully accredited, internationally respected biosystematics repository for vertebrate specimens and its staff of scientists is well qualified to conduct research on Cenozoic marine mammals and other vertebrates as well as Quaternary vertebrates. The proper respository for significant specimens is one of the most critical elements in the mitigation of adverse impact on paleontologic resources. Both the LACM and the Page

Museum should oversee all construction in proximity to the La Brea Tar Pits area (Segment D, Figure 3). Personnel at these two museums should be apprised of all plans regarding excavations in this segment and should be in close communication with RTD.

In the event that important or potentially important occurrences of fossils are discovered during the excavation phase, excavation should be temporarily halted or diverted until an appraisal of the find can be made, and, if deemed necessary, the fossils removed. Invertebrate fossils and fossil plant material should be donated to an appropriate educational/research institution as dictated by the level of significance of the materials (e.g., invertebrate fossils from the Topanga Formation should go to the department of Geological Sciences, UCLA because of research interest in the fauna of the Topanga). This decision can be made by the project paleontologist.

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