MESOZOIC VERTEBRATE PALEONTOLOGICAL SITES FOR POSSIBLE INCLUSION IN THE REGISTRY OF NATURAL LANDMARKS

by

John H. Ostrom

Peabody Museum of Natural History

Yale University

JULY, 1970

R E P O R T

to the

N A T I O N A L P A R K S E R V I C E

on

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Acknowledgements

I am indebted to Dr. William Sill who contributed to the early phase of this study and compiled preliminary lists and made initial evaluations of important Mesozoic fossil vertebrate sites within the United States. I also am grateful to the various members of the staff of the Division of Vertebrate Paleontology of the Peabody Museum who assisted in numerous ways. I gratefully acknowledge the advice and assistance of C. Kenny Dale and Robert Rose of the National Park Service. I am especially appreciative of the patience shown me by Mr. Dale and by the National Park Service.

Abbreviations

AMNH - American Museum of Natural History, New York City

FMNH - Field Museum of Natural History, Chicago

USNM - United States National Museum, Washington, D.C.

YPM - Peabody Museum of Natural History, Yale University

PREFACE

The objectives of this study have been threefold. 1) Compilation of an inventory of important Mesozoic paleontologic sites, particularly of dinosaurs and Mesozoic mammals. 2) Analyses of those sites that are considered of unusual significance and potentially eligible for designation as a Natural Landmark. 3) Recommendation of sites for inclusion in the National Register of Natural Landmarks.

Understandably, a vast majority of the sites listed in the Inventory of this report (Part II) have not been recommended for inclusion in the Natural Landmark Register. In most instances these have not been recommended because in my judgement they are not of outstanding or extraordinary significance; site integrity cannot be established; or no record of the exact location could be found. In some instances worthy sites were not recommended because they duplicated other (recommended) sites that were considered at least slightly superior.

It should be understood that the final decision to recommend or not recommend a particular site was my decision alone based on all information available to me. This should not be interpreted that I would oppose recommendations by other authorities of any sites that I happen not to have included in my List of Qualified Sites (Part IV). I have not visited many of the sites and in many cases the materials derived from these sites are known to me only from secondary sources. The fact that I have not recommended a particular site should not be considered as reason to disqualify that site.

At this point I should say that some disagreement exists among professional paleontologists as to whether reports of this kind should be

compiled. Clearly it is in the Public interest to identify those special items of our National heritage and to preserve them. However, a considerable risk often accompanies such identification. In the present case, identification and location of important paleontologic sites previously known almost exclusively to scientists may seriously jeopardize those sites. Serious threat exists from vandalism alone, but the greatest threat is from amateur fossil collectors and rock hounds. The latter have been known to dig out, break up and haul away tons of fossil skeletons from very remote locations on numerous occasions - solely for the purpose of cutting and polishing "pretty stone". These people have absolutely no regard for the real value of these objects - the scientific significance of a fossil specimen. Because of these hazards, I have been criticized by some of my colleagues for performing this study. However, I happen to believe that it is easier to protect and preserve something when its identity and importance are known. Nevertheless, I agree with my colleagues that publication of this report would be a serious mistake. Until such time as fossil sites can be effectively protected against rock hounds and amateur collectors by Federal Law and harsh penalties, I urgently recommend that this document (and any subsequent reports on this same theme) be restricted. I further recommend, especially in view of the National Park Service program for designation of Natural Landmarks, that the Park Service make a concerted effort to establish a "conservation act" (such as the Antiquities Act) to prohibit the exploitation and destruction of such fossil evidences by unauthorized persons.

John H. Ostrom

Associate Curator of Vertebrate Paleontology, Peabody Museum

and

President, Society of Vertebrate Paleontology

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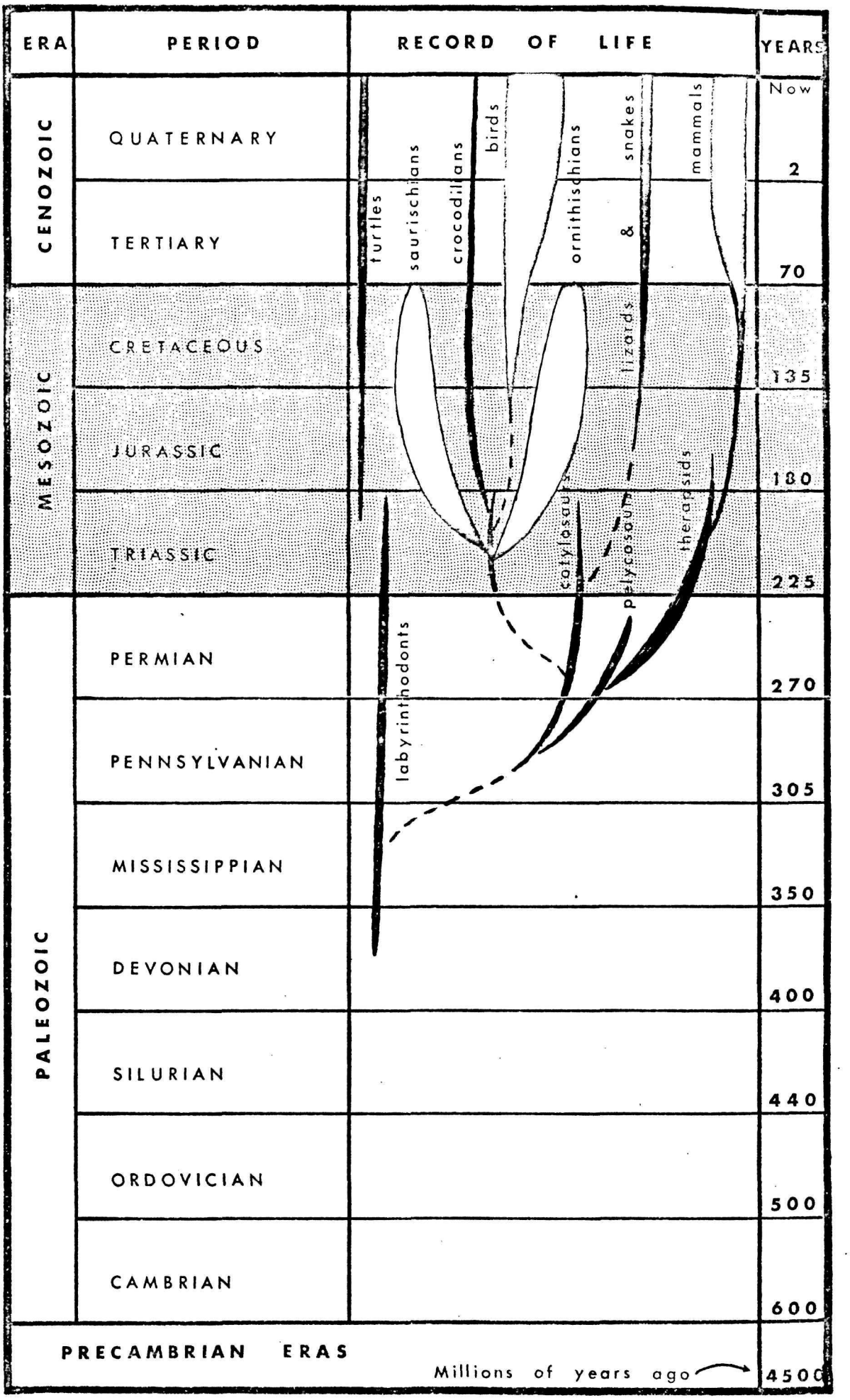

PART I

INTRODUCTORY REMARKS

The Mesozoic or middle era of life covered an interval of about 170 million years and is one of the most important chapters in the history of vertebrate life. It is commonly known as the Age of Reptiles because the fossil evidence clearly indicates that this class of vertebrate animals flourished during Mesozoic times like it never did before - or has since. Symbolic of reptilian success during the Mesozoic are those creatures called dinosaurs, best known of all Mesozoic life. Important though dinosaurs were, they were not the only vertebrates of those times. There were various other familiar reptiles such as turtles, crocodiles, lizards and snakes. The first mammals and birds appeared during the Mesozoic and there were archaic amphibians (called labyrinthodonts) as wellas ancestors of the more modern amphibians (frogs and salamanders). In addition, there were many varieties of mammal-like reptiles (therapsids), ichthyosaurs, plesiosaurs, placodonts, nothosaurs, mosasaurs, phytosaurs, pterosaurs, protorosaurs, procolophonids, pseudosuchians, champsosaurs and many others.

The Mesozoic chapter of life history is particularly important as far as vertebrate animals are concerned for a number of reasons. First of all, it was during Mesozoic times that the two highest vertebrate classes originated - the birds and mammals that dominate the vertebrate world today. Second, the Mesozoic Era witnessed the extinction of one major group (the mammal-like reptiles) that had dominated previous times, and the near extinction of another major kind of reptile (the archosaurs) that dominated the Mesozoic Era. Thus, the Mesozoic encompassed two major changes in terrestrial faunas.

The first migration of vertebrate life from a watery habitat to life on land occurred in mid-Paleozoic times (perhaps Early Devonian). By mid or Late Carboniferous time a variety of small reptiles (and amphibians) were at least moderately well adapted for terrestrial life. These early land tetrapods are classified as stem reptiles (Order Cotylosauria) and primitive mammal-like reptiles (Order Pelycosauria). By Permian time, the continents of the world were dominated by a variety of cotylosaurs (captorhinomorphs, procolophonids, pareiasaurs, millerosaurs), pelycosaurs (sphenacodonts, ophiacodonts, edaphosaurs) and more advanced mammal-like reptiles (gorgonopsians, cynodonts, therocephalians, bauriamorphs, dinocephalians and dicynodonts). In fact, the world was very much dominated by the mammal-like reptiles - including the ancestral stock of mammals.

With the beginning of the Mesozoic Era, a sharp decline occurred in both the cotylosaurs and the mammal-like reptiles. All pelycosaurs and all cotylosaurs (except a few procolophonids) became extinct by Early Triassic times, along with most of the higher mammal-like reptiles (therapsids). During the Triassic Period a major faunal change took place and the landscapes were repopulated with new reptilian kinds - most of which were related and are classified together as archosaurs. The new forms included the thecodonts (phytosaurs, proterosuchians and the dinosaur ancestors - pseudosuchians), crocodilians and the two orders of dinosaurs (Ornithischia, Saurischia), as well as turtles, the first plesiosaurs, ichthyosaurs, placodonts and nothosaurs. Also appearing in Late Triassic times were the first true mammals. The rest of Mesozoic time records the evolutionary diversification of these archosaurs - including the appearance and early radiation of birds. Strangely enough, though, there is very little information about Mesozoic mammals indicating only modest diversi-

fication. The dinosaurs and their archosaurian relatives dominated all lands of the earth.

The final stages of the Mesozoic register a gradual decline of nearly all reptilian kinds and terminate at the end of the Cretaceous with the extinction of all archosaurs except the crocodilians (and the archosaurian derived birds) as well as all of the peculiar aquatic types and many terrestrial forms. Only turtles, lizards and snakes and a few rhynchocephalians survived the great dying at the end of the Mesozoic Era.

The ensuing Cenozoic chapter is well known as a record of the "explosive" diversification of mammals - the terrestrial successors to the dinosaurs.

This very brief and over-simplified summary of the history of Mesozoic terrestrial life is included here solely to place the following statements and the remainder of this report in proper context. The Mesozoic chapter is a most important chapter in the history of land vertebrates for it contained two major, nearly complete, changes in vertebrate faunas. The Mesozoic Era spawned the vertebrate faunas of today and the mark of Mesozoic events is stamped on these faunas.

The object of this study was to compile an inventory of important sites in the United States from which our knowledge about Mesozoic life has been obtained - and to identify those sites that are of special significance and still retain more than historical value today. It should be evident that the preceding summary is derived from thousands of fossil-bearing sites all over the world, as well as from geologic evidence from innumerable other sources. The evidence is extremely fragmentary and the history known to us is thus quite incomplete. Fossil

vertebrate remains of any sort are very rare, and well preserved articulated and complete specimens are extremely rare. It is doubtful that our present knowledge of terrestrial vertebrates of Mesozoic times constitutes more than 20 percent of the total. In other words, as much as 80 percent of the different kinds of Mesozoic life may still be unknown to us. We are constrained in our history lesson by a history book in which four out of every five pages are blank. Perhaps we will discover new bits of history to record on those blank pages with discovery of new sites in those regions of the world that have not yet been fully explored, but in all probability the largest fraction of preserved Mesozoic history has already been discovered. That history rests on sites such as those listed in the Inventory of Part II of this report.

The three chapters of Mesozoic time - Triassic, Jurassic and Cretaceous - are not equally represented in the evidence that exists today, For example: there are no continental deposits in North America of Early or Middle Triassic age - only Late Triassic. Similarly, only Late Jurassic continental deposits are known in the United States, but these are confined to the Rocky Mountain states and are probably limited to a single formation (Morrison) that represents only the latest part - perhaps only a few million years out of 45 million years, the current duration assigned to the Jurassic Period. The fact that the first 90 percent of the Jurassic Period is not represented by any terrestrial deposits within the limits of North America, cannot be dismissed - the largest part of history has not been preserved. The Cretaceous chapter is a little better - in that we have fragments of the continent's history at the beginning of the Cretaceous Period and a moderately good record for much of the last third of that interval. The rest of the Cretaceous terrestrial record is unknown. The sediments preserved for the missing

intervals are marine in origin and register the history of shallow seas and only fragmentary glimpses of life on land.

Brief summaries follow on the nature of the continental sediments of each of the Mesozoic systems preserved within the continental United States.

Continental Triassic Sediments

Continental Triassic rocks occur in two general regions of the United States - the eastern seaboard from Massachusetts to North Carolina and the southwestern and Rocky Mountain states from Texas to Montana. The eastern Triassic sediments occur in long, narrow fault blocks associated with extrusive and intrusive volcanic rocks, bounded by older Paleozoic metasediments. The western Triassic sediments occur as broad sheets (now dissected and locally covered by younger sediments) of shales, sandstones and conglomerates that represent ancient flood plain and channel deposits and dunes sands. The sediments of both regions are of approximately similar ages - Late Triassic.

The restricted areas involved and the more humid environment with the consequent heavy cover of vegetation, greatly minimize the amount of natural exposures of eastern Triassic rocks. It is not surprising, therefore, that most of the Triassic vertebrate sites have been discovered in the process of quarrying or other excavation. With few exceptions, the eastern Triassic discoveries have been associated with human activities related to the settling and urbanization of the eastern states. Future finds will result from similar activities, except that one major difference exists now. Future excavations in eastern Triassic rocks will be for building and highway sites, not for building materials as in the last

century. Thus future sites most probably will be doomed to destruction, and the more destructive procedures used today will further reduce the probabilities of new discoveries.

The stratigraphy of the eastern Triassic is generally similar throughout the region. Formation names differ locally, but all units are referred to the Newark Group and are considered of Carnian, Norian and Rhaetic ages. The facies are predominantly shales, sandy shales and sandstone (arkose) with conglomerates locally. Interbedded with these are various intrusive and extrusive trap rocks. The most common fossils, particularly in New England and New Jersey, are footprints which are known from hundreds of sites and at some locales are present by the thousands. Invariably these occur in the shale facies. Fossil bone is exceedingly rare, being represented by three or four dozen (at the most) fragments. Articulated remains are extremely rare. Bones (as opposed to footprints) seem to occur exclusively in the sandstone facies.

The continental Triassic of the western interior includes a greater variety of facies and probably represents a longer time span than does the eastern sequence. As a result of several fossil finds in the last decade or two, reference of western Triassic formations to a standard stratigraphic column is currently under debate. The classic section of the southwest - Moenkopi, Shinarump, Chinle - occupies a large area (parts of New Mexico, Arizona, Utah and Colorado), but only the Chinle has produced significant remains of terrestrial vertebrates. Overlying the Chinle Formation in much of the southwest is the Kayenta and Navajo Sandstones - both of which have long been considered of Early Jurassic age. Recent finds make this conclusion debateable, suggesting that both may be of Late Triassic age.

Unlike the exposures of eastern Triassic sediments, western exposures are extensive, although often extremely rough - if not impassible. Some fossil vertebrate discoveries here have been accidental, but most fossil sites listed in the Inventory of Part II were found by intensive and deliberate search. The country is so vast and human occupation so sparse that future discoveries in all probability will result from future paleontologic explorations, rather than chance finds.

Jurassic Continental Sediments

Continental Jurassic rocks are limited to the western interior of North America - the Rocky Mountain states from Arizona and New Mexico north to Montana. Although other names have been applied locally in the past, most (if not all) of these sediments may be referred to a single formation - the Morrison. The Morrison Formation consists of claystones, mudstones, sandstones and conglomerates of fluvial origin and spread as a broad blanket, from a few tens of feet to 700 or 800 feet thick, across most of this region. Locally it has been eroded away or is covered by younger sediments. The Morrison Formation represents flood plain and channel sediments deposited by a vast network of major river systems that meandered across broad, low coastal plains. As with the Triassic deposits , these sediments represent only the last part of the Jurassic Period (Kimmeridgian and Portlandian).

Exposures are extensive and the total area involved is great, but the low population density suggests that future discoveries will result largely from intensive and deliberate searches by paleontologists. Hopefully, though, accidental discoveries by ever-broader-ranging amateurs will be brought to the attention of appropriate scientists.

Cretaceous Continental Sediments

Early Cretaceous continental sediments occur locally on the eastern seaboard (Maryland and Washington, D.C.), the south (Texas and Oklahoma) and the Rocky Mountain states from Colorado to Montana. The eastern deposits (Arundel Formation) are considered to be of Neocomian age and have produced small collections of fragmentary dinosaur remains. The western deposits are believed to be slightly younger (Aptian and Albion) and have produced relatively large samples of dinosaurian and other reptilian remains. Exposures of these Lower Cretaceous formations are not as extensive, or as fossiliferous as are those of the Upper Cretaceous. The most productive units to date are the Trinity (Glen Rose) of Texas and Oklahoma, the Kootenai of Montana and the Cloverly of Wyoming and Montana. All three are fluvial in origin, consisting primarily of claystone and sandstones with local conglomerates.

Late Cretaceous continental deposits are limited to the western interior, from New Mexico north to Montana. A few Late Cretaceous terrestrial vertebrates have been recovered along the east coast, but all have come from marine sediments and thus appear to represent rafted carcasses. A few similar occurrences are known from marine sediments in the interior (Niobrara, Pierre and Bear Paw Formations) and along the west coast (Moreno Formation). The Late Cretaceous sequence of the Rocky Mountain region is classic for fossil vertebrate remains and collectively has been one of the most productive sequences in the New World. Such units as the Judith River, Lance, Hell Creek and Two Medicine have produced most of the evidence, but other formations such as the Ojo Alamo, Kirtland, Fruitland, Denver and St Marys have contributed import-

ant finds. Many of these interfinger or are interbedded with marine facies and thus are quite reliably dated from Campanian to Maestrichtian in age. As with most other continental sediments, these are chiefly flood plain and channel deposits of large, lowland drainage systems.

Exposures of Late Cretaceous sediments are quite extensive, although in the last few decades large sections of outcrop belts have been inundated as a result of dam construction by the Corps of Engineers and the Bureau of Reclamation. Most of the Late Cretaceous exposures are in remote and sparsely populated country, hence future discoveries are most likely to be made by paleontologic explorations. Accidental finds by amateurs and 'rock hounds', on the basis of previous experience, are not likely to be reported to appropriate authorities or scientists before the site is damaged. Thus it seems unlikely that significant new finds will result from this source.

The nature of the fossil evidence varies from site to site and from horizon to horizon. The usual find is an isolated bone or a few fragments. Less frequently, several associated, but disarticulated bones will be discovered. Partial skeletons are extremely rare and a complete articulated skeleton is an extremely improbable event. Generally speaking, the coarse clastic facies (channel deposits) are the most fossiliferous, but the remains found here are almost always fragmentary or isolated elements. Partial, articulated skeletons seem to be most common (yet rare) in finer facies (shales and mudstones). The best preservation is usually found in lake deposits (very fine-grained and finely laminated deposits), but such deposits are very uncommon in the continental Mesozoic sediments of North America. In short, our knowledge of the terrestrial life of Mesozoic times is based on highly improbable discoveries of extremely rare and often poorly preserved and fragmentary fossil remains.

PART II

INVENTORY OF MAJOR MESOZOIC FOSSIL VERTEBRATE LOCALITIES

The following inventory of Mesozoic fossil vertebrate localities includes most, but certainly not all, of the major sites within the continental United States that have relevance to the history of dinosaurs and Mesozoic mammals. It should not in any way be considered an exhaustive list. Undoubtedly the Contractors have overlooked some sites that other authorities would consider to have major significance. In addition, numerous localities have been omitted because they have been "lost" - either because of an initial failure to record the location, inaccuracies in original field records, loss of original field records, or alteration of the landscape so that recognition of the site is no longer possible. In addition, many other Mesozoic vertebrate localities have been excluded from this report in keeping with the specifications of the contract, emphasis being given to those sites that are considered of particular significance to our understanding of the rise and ultimate extinction of the dinosaurs and Mesozoic mammals.

Every effort was made to maintain complete objectivity in the assessment of the numerous fossil sites that came to our attention during the course of this investigation, but a certain amount of personal bias must be acknowledged in each judgement as to whether or not a particular site was of <u>major</u> importance. Some sites, with which the authors had little or no first hand experience, may have been downgraded while others that were more familiar to us may have been valued too highly. In the final analysis, each judgement registered here represents

the opinions of the Contractors only and other authorities may well have very different evaluations.

The sole consideration that was applied in the compilation of the Inventory that follows was that of 'paleontologic significance'. Sites, which in our judgement failed to meet that criterion have been excluded. No consideration was given here to the criteria specified by the National Park Service as requisites for designation of a Natural Landmark. Those criteria have been applied in the evaluation of the items in this Inventory and compilation of subsequent sections of this report (Parts III and IV).

The Inventory of Major Mesozoic Fossil Vertebrate Localities is subdivided according to the geologic ages of the various sites, with the oldest sites (Triassic age) listed first and successively younger sites following (Jurassic and Cretaceous). Within each of the three sub-listings, sites are grouped by region or state and not in order of significance. Sites which are further analyzed in Part III and recommended for consideration as a Natural Landmark are identified by ▲▲. Additional potentially eligible sites that are not recommended here are identified by △△.

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INVENTORY OF MAJOR MESOZOIC FOSSIL VERTEBRATE LOCALITIES

TRIASSIC SITES

CONNECTICUT

1 ▲▲ Charles O, Wolcott Quarry (See page 60.)
Manchester, Connecticut

Location: 0.8 mile north of the Buckland Station (New York, New Haven and Hartford Railroad) immediately east of the intersection of Burnham Street and Buckland Road, Manchester Township, Hartford County, Connecticut.

Significance: Discovery site of three Late Triassic dinosaurs (Yaleosaurus, Ammosaurus, Anchisaurus) and the only known site in New England that has produced more than one specimen. An excellent prospect for future finds. Recommended for designation as a Natural Landmark. (See page 60 for analysis.)

Geologic Data: Portland Formation - Late Triassic.

2. Dinosaur State Park (DINOSAUR TRACKWAY NATURAL LANDMARK)
Rocky Hill, Connecticut

Location: 0.75 mile east of Interstate 91 on West Street, 0.25 mile southwest of the State Veterans Home, Rocky Hill, Hartford County, Connecticut.

Significance: One of the largest exposures (in situ) of dinosaur footprints in the world. More than 1,000 prints are exposed in a 9,000 square foot area and unexposed areas of the site may reveal 2,000 or 3,000 more foot prints.

Geologic Data: East Berlin Formation - Late Triassic.

This site has been preserved as a State Park and was designated a Natural Landmark by the National Park Service in 1968.

3. Portland Quarry
Portland, Connecticut

Location: 0.5 mile northeast of the Middletown - Portland bridge over the Connecticut River, along the east

bank directly opposite the entrance of Mattabesset River into the Connecticut River. Originally called the Brazos Quarry, City of Portland, Middlesex County, Connecticut.

Significance: One of the major sites of dinosaur footprint discoveries during the latter part of the last century and the early part of this century. More than a dozen different kinds of prints are recorded from here (Lull, 1953, p. 76). May also have been the site of several dinosaur bones (see Colbert and Baird, 1958).

Geologic Data: Portland Formation - Late Triassic.

4. Wethersfield Cove
Wethersfield, Connecticut

Location: 0.8 mile north of the Wethersfield Town Hall, Hartford County, Connecticut.

Significance: One of the major sites in New England of dinosaur footprints, particularly during the last century. More than a dozen varieties have been found here (Lull, 1953, p. 75).

Geologic Data: Portland Formation - Late Triassic.

5. Glastonbury Ferry
Rocky Hill, Connecticut

Location: West bank of the Connecticut River east of Meadow Road, in the vicinity of the Glastonbury Ferry.

Significance: Another important site of multiple dinosaur (and other) footprints. Lull (1953, p. 75-76) lists more than three dozen different kinds of footprints from this locality.

Geologic Data: Portland Formation - Late Triassic.

6. Orestes Wilcox Quarry
Simsbury Connecticut

Location: 0.5 mile southwest of the Simsbury Station on the New York, New Haven and Hartford Railroad, Township of Simsbury, Hartford County, Connecticut.

Significance: Site of fragments of an extinct crocodile-like reptile, Clepsysaurus (Rutiodon) validus (YPM 2138). This is one of very few New England localities that has produced actual fossil bone (as opposed to footprints).

Geologic Data: New Haven Arkose - Late Triassic.

7. Freeman Clark Quarry
New Haven, Connecticut

Location: 0.3 mile southeast of the Ferry Street bridge over the Quinnipiac River in East Fairhaven, City of New Haven, New Haven County, Connecticut.

Significance: Discovery site of a partial skeleton of an extinct crocodile-like reptile Stegomus arcuatus (YPM 1647). This is one of few New England localities that has produced fossil bone rather than footprints.

Geologic Data: New Haven Arkose - Late Triassic.

8. Sylvan Road Locality
Meriden, Connecticut

Location: The exact, in situ location is not known. The specimen from this site was found as surface float (actually part of a stone wall that may date back to the 1700's), 100 feet east of Sylvan Road, 0.2 mile north of U.S. Alternate # 6, 0.75 milesouth of Merimere Reservoir, City of Meriden, Hartford County, Connecticut.

Significance: Discovery site of a remarkable and very important partial skeleton and skull of one of the last surviving cotylosaurs or stem reptiles (procolophonid). The specimen is the first find of fossil, articulated skeletal material since 1892 in Connecticut. It also is probably the finest of its kind in the world.

Geologic Data: New Haven Arkose ? - Late Triassic.

MASSACHUSETTS

9. Hine's Quarry
Longmeadow, Massachusetts

Location: Approximately 1 mile east of the center of

Longmeadow (probably in the area bounded by Bliss Road, Converse Street and Burbank Road), Hampden County, Massachusetts.

Significance: Site of a partial skeleton of an extinct crocodile-like reptile Stegomosuchus longipes (Amherst College Museum).

Geologic Data: Longmeadow Formation - Late Triassic.

10. Springfield Armory Site
Springfield, Massachusetts

Location: Site of the present United States Armory in downtown Springfield, Hampden County, Massachusetts.

Significance: Site of the earliest recognized fossil vertebrate remains (Anchisaurus polyzelus, Amherst College Museum) from the Triassic of New England. This specimen, though fragmentary, is also one of the earliest dinosaurian finds in the New World.

Geologic Data: Longmeadow Formation - Late Triassic.

11. Mount Holyoke College
South Hadley, Massachusetts.

Location: Exact in situ location of the specimen is not known. The specimen (Podokesaurus holyokeensis) was discovered in a glacial boulder on the Mount Holyoke campus, probably several miles removed from its original site.

Significance: The partial skeleton of Podokesaurus (now destroyed) represented one of only five dinosaur specimens known from the Triassic of eastern North America. Thus this site (were it known precisely) would be as important as the Wolcott Quarry (No. 1) or the Springfield Armory Site (No. 10). A cast of this specimen is in the Yale Peabody Museum.

Geologic Data: Longmeadow Formation - Late Triassic.

12. Moody Corner
South Hadley, Massachusetts

Location: The immediate vicinity of Moody Corner (the intersection of Pearl Street, Barnett Street and Amherst Road (State Highway 116)), 2 miles north

-northeast of the Mount Holyoke campus, South Hadley, Hampshire County, Massachusetts.

Significance: In this immediate vicinity, the first dinosaur footprint to be discovered and recognized as a footprint (bird - not dinosaur) in North America was found by a Pliny Moody in 1800 or 1801. Moody called his footprint 'Noah's raven'. The exact point of Moody's discovery is not known. Although not of outstanding scientific importance, this local might be worthy of special notice from the historical side.

Geologic Data: Longmeadow Formation ? - Late Triassic.

13. Horse Race
Turners Falls, Massachusetts

Location: North and south banks of the Connecticut River at what is locally known as the 'Horse Race', 1 to 2 miles east of the town of Turners Falls, Franklin County, Massachusetts.

Significance: A major locale that produced large numbers of specimens of vertebrate footprints, especially during the latter part of the last century and early part of the present one, Included among the finds were more than two dozen diferent kinds (Lull, 1953, p. 68), primarily dinosaurian.

Geologic Data: Chicopee Formation - Late Triassic.

14. Lily Pond
Turners Falls, Massachusetts

Location: The shores of Barton Cove, north side of the Connecticut River, north and east of Turners Falls and east of the town of Riverside, Franklin County, Massachusetts.

Significance: One of the most prolific localities in all of New England for dinosaurian and other reptilian footprints. Hundreds of specimens have been collected here during the last 100 years and Lull (1953, p. 69) recognized 31 genera and 57 species of animals among these fossil tracks.

Geologic Data: Chicopee Formation - Late Triassic.

15. Ferry at Turners Falls
Riverside, Massachusetts

Location: North bank of the Connecticut River, just upstream from the dam where the old bridge originally crossed the river between Turners Falls and Riverside, Town of Riverside, Franklin County, Massachusetts.

Significance: Site of numerous dinosaur footprint discoveries and collections, particularly 50 to 75 years ago. Lull (1953, p. 69-70) listed more than two dozen species from this locality.

Geologic Data: Chicopee Formation - Late Triassic.

16. Field's Orchard
Riverside, Massachusetts

Location: An abandoned quarry, 0.25 mile west of the Riverside cemetary, 0.25 mile north of State Highway 2 intersection with Main Road in the town of Riverside, Franklin County, Massachusetts.

Significance: Site of numerous dinosaur footprints. Lull (1953, p. 72) lists 30 different species.

Geologic Data: Chicopee Formation - Late Triassic.

NOTE. Should the National Park Service give further consideration to one or more of the previous four sites, it might be appropriate to consider the greater Turners Falls area as as a single locality, uniting sites 13, 14, 15 and 16 listed separately here. Collectively they assume far greater significance and may well be worthy of Natural Landmark designation, although that action is not recommended here.

NEW JERSEY

17. Palisades Locality
Fort Lee, New Jersey

Location: At the base of the Palisades scarp, just south of the west pier of the George Washington Bridge, Fort Lee, Bergen County, New Jersey. (The exact locality could not be determined, but the immediate area has been disturbed by highway construction and urban development and may not be recognizable.)

Significance: Site of discovery and collection of a partial

skeleton of a large crocodile-like reptile called a phytosaur (a near relative of dinosaur ancestors), Clepsysaurus (Rutiodon) manhattanensis (AMNH 4991). This specimen is one of very few fossil vertebrates, other than fish, from the Triassic of New Jersey.

Geologic Data: Lockatong Formation - Late Triassic.

18. Granton Quarry
North Bergen, New Jersey

Location: Immediately west of U.S. Highwy 1 and 9, 0.5 mile west of the North Bergen High School and adjacent to the New York, Susquehanna and Western Railroad in North Bergen, Hudson County, New Jersey.

Significance: This quarry (now destroyed and built over) is perhaps the most important Triassic site in New Jersey and has produced numerous specimens of fish (Diplurus, Turseodus) and a phytosaur (Rutiodon). Most important of all is a flying lizard (Icarosaurus) which received much publicity during the early 1960's and was described by E.H. Colbert of the American Museum in 1966. This specimen is the oldest known record of a flying vertebrate. No dinosaurian remains have been found here, but the above remains are important records of contemporaries of Late Triassic dinosaurs. If this site were still intact, I would give it the highest recommendation for designation as a Natural Landmark.

Geologic Data: Lockatong Formation - Late Triassic.

19. ΔΔ Riker Hill Quarry (See page 62.)
Roseland, New Jersey

Location: 500 yards south of the Morristown and Erie Railroad crossing over Eagle Rock Avenue, Roseland, Morris County, New Jersey.

Significance: Discovered in 1968, this site has already produced numerous very fine specimens of several different kinds of dinosaurian (and other) footprints - largely through the efforts of many enthusiastic and energetic amatuers. Included among the finds are some extremely small footprints of what appears to have been a very small bipedal dinosaur - an animal not much larger than a pidgeon. This may be a unique record of the smallest dinosaur yet known. At least half a dozen varieties are represented among the prints found so far. The site remains more or less intact and thus holds great potential for further discoveries. It should be given serious consideration for in situ preservation

as a State or local park. It is recommended for designation as a Natural Landmark. (See page 62.)

Geologic Data: Brunswick Formation - Late Triassic.

20. Princeton University Library
Princeton, New Jersey

Location: The site of the Firestone Library, Princeton University, Princeton, Mercer County, New Jersey.

Significance: During the excavations for the Firestone Library, large numbers of very well preserved fish (Diplurus) were discovered and collected. These are now preserved in the Museum of the University. No other remains were found. The site is listed here only as a representative of the half dozen or more other localities in New Jersey and Connecticut that have produced exceptional collections of fossil fish that were contemporaries of the Late Triassic dinosaurs. Beyond this, they have no special significance in the present study.

Geologic Data: Lockatong Formation - Late Triassic.

21. Paulison Avenue Site
Passaic - Clifton, New Jersey

Location: In the vicinity of the boundary between Clifton and Passaic, Passaic County, New Jersey. The exact site cannot be determined now because of extensive urban development since the date of discovery, but it lies somewhere between Paulison Avenue and the Delaware, Lackawanna and Western Railroad, approximately 0.5 mile northwest of General Hospital (Lafayette Avenue).

Significance: This site produced several partial skeletons and skulls of a small lizard-like animal called Hypsognathus, and at least one fragmentary dinosaur (which was destroyed before authorities were notified). The Hypsognathus material is now in the American Museum of Natural History in New York and is another important record of the other animals that co-existed with Triassic dinosaurs.

Geologic Data: Brunswick Formation - Late Triassic .

22. Albion Place
Clifton, New Jersey

Location: The street underpass of Broad Street beneath the Delaware, Lackawanna and Western Railroad, 2 blocks (0.1 mile) north of Fenner Avenue on the east side of Garrett Mountain, Clifton, Passaic County, New Jersey.

Significance: Discovery site of the first skeleton of Hypsognathus, a small, lizard-like, extinct reptile included among the stem reptiles (Cotylosauria). This specimen (USNM 11643) is in the Smithsonian Institution, Washington, D.C.

Geologic Data: Brunswick Formation - Late Triassic.

NORTH CAROLINA

23. △△ Egypt Mine, (See page 65.)
Cumnock, North Carolina

Location: Site of coal mine shaft is approximately 0.75 mile north of Cumnock (formerly Egypt) on the south side of Deep River in Lee (formerly part of Moore) County, North Carolina. The location of this shaft is given on the hand drawn map published in Emmons' 1856 "Geological Report of Midland Counties of North Carolina").

Significance: More than a century ago this site produced various fragments of fossil vertebrates, the most important of which are the two tiny and priceless jaws (Dromatherium and Microconodon) that were long thought to be the oldest true mammals. They are now considered to be mammal-like reptiles (cynodonts?). These two specimens are now in the collections at Williams College and the Philadelphia Academy of Science. Other important specimens from the Egypt mine and vicinity are fragments of phytosaurs (Rutiodon) and labyrinthodont amphibians (Eupelor). This site is recommended for consideration as a Natural Landmark because of its long history, the importance of the specimens derived from here, and the potential for further discoveries. (See page 65 for analysis.)

Geologic Data: Cumnock Formation - Late Triassic.

TEXAS

24. Palo Duro State Park (Great Plains [illegible])
Canyon, Texas

Location: 12 miles east of Canyon, Texas, in Randall County.

Significance: Several Triassic fossil vertebrates have been recovered from exposures of the Dockum Formation here. Most important is an uncrushed and nearly complete skull of a coelacanth (fish). Exact localities of these finds are not known since most finds have been made by amatuers.

Geologic Data: Dockum Formation - Late Triassic.

25. Herring Ranch (Great Plains [illegible])
Amarillo, Texas

Location: The precise location of the famed labyrinthodont quarries could not be learned. The Contractors currently are attempting to obtain these data from Dr. Jack Hughes of the Panhandle Plains Museum, Canyon, Texas. Present information indicates the site is several miles northwest of Amarillo in Potter County, probably along the east and south slopes of Sierrita de la Cruize Creek valley.

Significance: Large quarries here produced very large collections of skeletons and skulls of large labyrinthodont amphibians (Eupelor or Buettneria). These are now in the collections of the Panhandle-Plains Museum in Canyon.

Geologic Data: Dockum Formation - Late Triassic.

26. Otis Chalk (Great Plains [illegible] on edge of Edwards Plateau [illegible])
Chalkton, Texas

Location: SE ¼ Sec. 58, Block 29, Waco and Northwestern Railroad Company Survey, 3.5 miles north of Chalkton (formerly Otis Chalk) and State Highway 821, Howard County, Texas. Twoquarries located on the first low hill just west of the road (north from Chalkton), in badlands along the east side of Devils Creek, approximately 0.5 mile west of Arrington Tank.

Significance: No dinosaurs were collected here, but exceptional collections of labyrinthodont amphibians (Eupelor or Buettneria) and protorosaurian reptiles

(Trilophosaurus) were obtained here by the University of Texas.

Geologic Data: Dockum Formation - Late Triassic.

NEW MEXICO

27. Lamy Buettneria Locality
White Lakes, New Mexico

Location: Sec. 31, T. 12 N., R. 11 E., on the west side of U.S. Highway 285, 2 miles northwest of White Lakes and 16 miles south of Lamy, Santa Fe County, New Mexico.

Significance: This site produced large numbers of exceptionally well preserved labyrinthodont skulls and skeletons (Eupelor or Buettneria). These are now in the United States National Museum and the Museum of Comparative Zoology at Harvard University. No dinosaur remains were recovered.

Geologic Data: Chinle Formation - Late Triassic.

28. ▲▲ Ghost Ranch, (See page 67.)
Abiquiu, New Mexico

Location: E ½, SW¼ Sec. 1, T. 24 N., R. 4 E., on the southeast side of the small hill closest to the high mesa "behind the swimming pool". The quarry is almost exactly 0.5 mile northeast of the pool, on the Ghost Ranch northwest of Abiquiu, Rio Arriba County, New Mexico.

Significance: A large number of well preserved skeletons (of all ages) of a small, primitive carnivorous dinosaur (Coelophysis) were collected here in 1948 and 1949 by the American Museum of Natural History. More material exists there now. Coelophysis is one of the earliest known carnivorous dinosaurs and may be ancestral to many (if not all) of the later and better-known flesh-eating dinosaurs (like Allosaurus and Tyrannosaurus). This is a most important site and it is here recommended for designation as a Natural Landmark. (See page 67 for analysis.)

Geologic Data: Chinle Formation - Late Triassic.

ARIZONA

29. Hesperosuchus Locality
Cameron, Arizona

Location: Section 9, T. 28 N., R. 10 E., on the southwest side of the low badlands close to the channel of the Little Colorado River, 5.75 miles southeast of the Cameron bridge, Coconino County, Arizona.

Significance: Site of a partial skeleton of a small thecodont (Hesperosuchus), a member of the reptilian group that probably gave rise to the dinosaurs, crocodiles, pterosaurs and birds. This specimen may be the only representative of that group (Pseudosuchia) known from North America.

Geologic Data: Chinle Formation - Late Triassic.

30. Protosuchus Locality
Cameron, Arizona

Location: Approximately 11 miles east-northeast of the bridge at Cameron (see map - Fig. 1, of Colbert, 1951), on the Ward Terrace, Coconino County, Arizona. The exact locality cannot be recorded because detailed maps of the area were not available at the time these specimens were collected.

Significance: The site of several partial and nearly complete skeletons of Protosuchus, one of the oldest known true crocodilians and the possible ancestor of modern crocodilians.

Geologic Data: Chinle Formation - Late Triassic.

31. ▲▲ Comb Ridge , (See page 69.)
Kayenta, Arizona

Location: Six miles northeast of Kayenta at the top of Comb Ridge on the northeast side of the first major canyon southwest (1.5 miles) of the jeep trail pass through Comb Ridge (the trail to Dinnehotso). A natural arch exists some 200 yards to the northwest of this site. No Township - Range information available.

Significance: The only known locality in North America that contains articulated skeletal material of advanced (tritylodontid) therapsids or mammal-like reptiles. The site has produced dozens of specimens (of all ages) of a species very similar to the Asiatic and South African genus Tritylodon, as well as a skeleton of

Protosuchus (Crocodilia) and some dinosaurian fragments. Although dinosaurian remains are minimal, this is a most important site and is highly recommended for designation as a Natural Landmark. (See page 69 for analysis.)

Geologic Data: Kayenta Formation - Late Triassic ?

32. "*Megalosaurus*" Locality
Tuba City, Arizona

Location: An exact location cannot be given at present because Dr. Welles, who collected this specimen, is in New Zealand at the moment and maps of the area are not adequate for pinpoint location without his knowledge of the site. The site is in the vicinity of Tuba City, 20 miles north-northeast of Cameron in Navajo County, Arizona. Exact location will be obtained upon Dr. Welles return to the United States.

Significance: Discovery site of a moderate-sized, carnivorous dinosaur collected by the University of California at Berkeley. Full significance of this find will not be known until current studies underway by Dr. Welles are completed. Nevertheless, this specimen is one of the largest known carnivorous dinosaurs of probable Triassic age and is also one of very few vertebrate specimens known from the strata lying between the Chinle and the Morrison Formations in the southwestern United States. Site is of importance for both paleontologic and stratigraphic reasons.

Geologic Data: Kayenta Formation - Late Triassic ?

33. Inscription House Lodge
Navajo Indian Reservation, Arizona

Location: 2.5 miles east of Inscription House ruins, on the road between Tuba City and Navajo Mountain, Coconino County, Arizona.

Significance: Site of a fragmentary prosauropod dinosaur that probably is referrable to *Ammosaurus* and close to the Yale specimen from Manchester, Connecticut. One of very few specimens of any vertebrate kind from the Navajo sandstone and an important dinosaur.

Geologic Data: Navajo Formation - Late Triassic ?

34. Betakin Ruin
Navajo Indian Reservation, Arizona

Location: 300 yards east of the road to Betakin Ruin, 3.7 (road) miles north of the Tuba City - Kayenta Road, Navajo County, Arizona.

Significance: Site of a fragmentary prosauropod dinosaur close to the Yale specimen from Manchester, Connecticut. One of very few specimens from the Navajo Sandstone and thus of importance for establishing the age of that formation.

Geologic Data: Navajo Formation - Late Triassic ?

35. Keet Seel Canyon
Navajo Indian Reservation, Arizona

Location: 1 mile south of Keet Seel Ruin on the west side of Keet Seel Canyon northwest of Marsh Pass on the Tuba City - Kayenta Road, Navajo County, Arizona.

Significance: Site of a unique specimen of a small carnivorous dinosaur (Segisaurus) collected by the University of California at Berkeley. This animal is quite distinct from Coelophysis, is usually placed in a separate family by itself, and is not entirely understood in its relationships.

Geologic Data: Navajo Formation - Late Triassic ?

36. Cobra Head Canyon
Navajo Indian Reservation, Arizona

Location: Short tributary canyon on the north side of Tsegi Canyon, 3 miles from the Tuba City - Kayenta Road at Marsh Pass.

Significance: Site of a fragmentary specimen of Protosuchus. The site is important in that it is the only known specimen of Protosuchus from the Navajo Sandstone and is indicative of a Triassic age for that formation rather than the commonly assumed Jurassic age.

Geologic Data: Navajo Formation - Late Triassic ?

WYOMING

37. Little Popo Agie River
Lander, Wyoming

Location: The exact location is not known. Existing records list the site as on the Little Popo Agie River near Lander. Presumably it lies somewhere in the outcrop area of the Popo Agie Formation in the Lyons Valley (Sections 23, 26, 35, 36 of T.33 N., R.99 W. or Sections 2, 3, 11, 12 of T.32 N., R.99 W.), four miles southwest of Lander, Fremont County, Wyoming.

Significance: The site of the only known dinosaur from the Popo Agie Formation and also the only Triassic dinosaur, known to the Contractor, from Wyoming. The partial skeleton has been classified as ornithischian, but Colbert (1961) considered it a carnivorous saurischian (Theropoda).

Geologic Data: Popo Agia Formation - Late Triassic.

NOTE. A number of labyrinthodont amphibians have been collected from the Popo Agie Formation also, but the sites could not be relocated. These remains are similar to those from Texas and New Mexico (Eupelor or Buettneria).

QUESTIONABLE TRIASSIC SITE

COLORADO

38. Hallopus - Nanosaurus Site
Garden Park, Colorado

Location: Eight miles north of Canyon City on the west side of Four Mile Creek in Garden Park, 3 miles above the oil wells, 0.5 mile west of the Felch house. There is considerable doubt as to the precise location of the site of these two specimens and still more uncertainty as to their stratigraphic provenance. The most probable site is a small hill locally called the Nipple, in Sec. 28, T. 17 S., R. 70 W.

Significance: While the ages of these (which may be different) are uncertain, the remains are important - representing a very small theropod (carnivorous) dinosaur (Nanosaurus agilis, YPM 1913) and a small crocodilian (Hallopus victor, YPM 1914). The latter

has been long considered dinosaurian also, but recent analysis of the specimen by A. Walker at Newcastle upon Tyne indicates crocodilian affinities.

Geologic Data: Uncertain. Probably Morrison Formation - Late Jurassic, but could possibly be from Triassic rocks.

JURASSIC SITES

WYOMING

39. ▲▲ Como Bluff Region - Eligible. (See page 71.)
Wyoming

Location: East central Carbon County and west central Albany County, Wyoming. The area north of U.S Highway 30 and the Union Pacific Railroad and south of Rock Creek. This region contains several dozen (perhaps as many as 50) quarries, many of which cannot be precisely located now. So many sites of major importance are involved that the entire area encompassed by T. 22 N., R. 76 W. and T. 22 N., R. 77 W. is specified here rather than giving the precise (or probable) locations of the many quarries. These data (where known) are supplied on the map of this region in Part III of this report.

Significance: This region has been worked intermittantly by hundreds of men from an unknown number of institutions since its discovery in 1877. The area undoubtedly is the most famous dinosaur locality in the world and was in a very large way responsible for the "dinosaur rush" of the late 1800's and early 1900's. It has produced thousands of specimens and literally hundreds of dinosaur remains - including numerous skeletons of Apatosaurus (Brontosaurus), Diplodocus, Camarasaurus, Atlantosaurus, Allosaurus, Coelurus, Laosaurus, Camptosaurus, Stegosaurus, etc. The area also includes the most important site of Jurassic mammals in the western hemisphere (perhaps the most important in the world). The region is still capable of producingsignificant new material, as recent excavations by the Yale Peabody Museum and the American Museum proved during 1968 and 1969. If no other paleontologic site in the United States is approved, this region must receive recognition as a Natural Landmark. (See page 71 for analysis.)

Geologic Data: Morrison Formation - Late Jurassic.

Note: Area was declared eligible in 1966 for Landmark designation.

40. ▲▲ Bone Cabin Quarry , (See page 74.)
Albany County, Wyoming

Location: Approximately 8 miles due north of Aurora Lake (Como Bluff), in the N ½ Sec. 33, T. 24 N., R. 77 W., Albany County, Wyoming. A series of large shallow excavations on the long, gentle slope on the north side of the small, west-flowing tributary to Little Medicine Bow River immediately north of Greasewood Creek.

Significance: This is a major site that was very productive during the turn of the century. American Museum field parties collected numerous partial and nearly complete skeletons of sauropod, theropod, ornithopod amd stegosaurian dinosaurs from these quarries. Much of these collections are now on exhibit or in the collections of that institution. (See page 74 for analysis.)

Geologic Data: Morrison Formation - Late Jurassic.

41. Bone Cabin Stegosaurus Quarry (Wyoming Basin)
Albany County, Wyoming

Location: 0.75 mile southwest of the Bone Cabin Quarry (above), near the base of the prominent bluff south of that quarry, in the SW ¼ Sec. 33, T. 24 N., R. 77 W., Albany County, Wyoming. This site is 2.3 miles northeast of the gap in the Morrison Formation ridge where Greasewood Creek enters the Little Medicine Bow River.

Significance: This is the site of the Stegosaurus skeleton now displayed in the American Museum of Natural History in New York.

Geologic Data: Morrison Formation - Late Jurassic.

42. Nine Mile Quarry (Wyoming Basin)
Carbon County, Wyoming

Location: Close to the center of Section 14, in the SE ¼ Sec. 14, T. 23 N., R. 78 W., Carbon County, Wyoming. The site is north of 'Ninemile Hill' and east-southeast of 'Ninemile Crossing' of the Little Medicine Bow River, approximately 5 miles northwest of Aurora Lake at Como Bluff.

Significance: The second major quarry of the American Museum in the Como Bluff - Bone Cabin region. This site produced the major part of a "Brontosaurus" (= Apatosaurus) skeleton.

Geologic Data: Morrison Formation - Late Jurassic.

43. △△ Sheep Creek Area, (See page 76.) (Southern Rocky Mtns)
Albany County, Wyoming

Location: Sections 10 and 11, T. 25 N., R. 76 W., Albany County, Wyoming. Precise locations of more than half

a dozen quarries (particularly those identified as A, B, C, D, E, F and G) are given on a sketch map in the Carnegie Museum archives.

Significance: These and several other quarries in the immediate area south of Sheep Creek produced 2 excellent skeletons of Diplodocus and partial skeletons of Camarasaurus and Apatosaurus. Most of the specimens are at the Carnegie Museum in Pittsburgh, Pa., but another fine skeleton of Apatosaurus is displayed in the Museum at the University of Wyoming. (See page 76 for analysis.)

Geologic Data: Morrison Formation - Late Jurassic.

44. **Freezeout Hills** (Wyoming Basin)
Carbon County, Wyoming

Location: Township 24 North and Ranges 79 and 80 West in central Carbon County, Wyoming. The critical region lies 12 to 15 miles north-northwest of Medicine Bow and 6 to 15 miles southeast of Bald Mountain. The Carnegie Museum opened numerous quarries in this general area that produced fragments to nearly complete skeletons, chiefly of sauropods. One quarry was recorded as 2 miles north of the TB Ranch. Precise records of these quarry positions may exist in the Carnegie Museum, but they have not been found as yet. Consequently, exact positions are not possible at present.

Significance: Numerous, highly productive quarries that contained sauropod and other dinosaurian remains.

Geologic Data: Morrison Formation - Late Jurassic.

45. **Howe Ranch Quarry** (middle Rocky Mtns)
Shell, Wyoming

Location: NW ¼ Sec. 9, T. 54 N., R. 91 W., 150 feet west of Cedar Creek, Bighorn County, Wyoming, 10 miles northwest of Shell.

Significance: A prolific locality that produced partial, but no complete, skeletons of several dozen individuals of large sauropod dinosaurs - chiefly Barosaurus and Diplodocus. Material currently is in the collections of the American Museum of Natural History.

Geologic Data: Morrison Formation - Late Jurassic. (Originally thought to be in the overlying Cloverly Formation of probable Early Cretaceous age.)

46. Red Fork, Powder River
Johnson County, Wyoming

Location: No precise location survives for the several quarries opened here by the Carnegie Museum. Geology of the area indicates they probably were located in the southeastern part of Township 43 North and Range 83 West - possibly in Sections 34 or 35, as this is the area in which the Red Fork of the Powder River crosses the outcrop belt of the Morrison Formation. Local inquiry or further searches of the Carnegie Museum archives may pinpoint these quarries.

Significance: The Carnegie Museum collected a nearly complete skeleton of Diplodocus (which is now being mounted for display in Houston, Texas), plus parts of other specimens of Diplodocus, Camarasaurus, Haplocanthosaurus and Stegosaurus.

Geologic Data: Morrison Formation - Late Jurassic.

UTAH

47. Dinosaur National Monument
Vernal, Utah

Location: The site of the famed Carnegie dinosaur quarry is well marked on the U.S. Geological Survey Map of the Monument in the SW ¼ Sec. 26, T. 4 S., R. 23 E., Uintah County, Utah.

Significance: One of the most important and most prolific single quarries in the world for dinosaur remains. It has produced uncounted numbers of fragmentary and nearly complete dinosaur skeletons of perhaps a dozen or more species. Included are remains of Apatosaurus, Camarasaurus, Diplodocus, Allosaurus, Ceratosaurus, Camptosaurus, Laosaurus, Dryosaurus and Stegosaurus. Already preserved as a National Monument and maintained by the National Park Service, there is little reason to consider this site for further recognition as a Natural Landmark. It is included here only for the sake of completeness of this inventory.

Geologic Data: Morrison Formation - Late Jurassic.

48. ▲▲ Cleveland-Lloyd Dinosaur Quarry Natural Landmark (See page 78.)
Cleveland, Utah

Location: Approximately 7 miles east of Cleveland, Emery County, Utah; SE ¼ Sec. 22 & NE ¼ Sec. 28, T. 17 S., R. 11 E., Emery County, Utah.

Significance: Large quantities of disarticulated, but exceptionally well preserved remains of various dinosaurs have been collected here during the last 15 years and distributed to several institutions here and abroad. The vast majority of the remains, strangely enough, are those of the carnivore Allosaurus, but some remains have been recovered of Camptosaurus and Stegosaurus. Excavation has been under the direction of W.L. Stokes and James Madsen of the University of Utah. The site has recently (April 28, 1966) been registered as a Natural Landmark. This fact was brought to my attention during the final stages of compilation of this report - after the site had been included in this Inventory. (See page 78 for analysis.)

Geologic Data: Morrison Formation - Late Jurassic.

49. Camarasaurus Quarry
Hanksville, Utah

Location: The quarry is 4.9 road miles west of Hanksville, Wayne County, Utah. It is described by the collector (J.T. Gregory) as located at the "north end of an isolated promontory extending south toward the Fremont River from the most prominent of the 'Pinto Hills', 200 yards south of the highway - in SW ¼ Sec. 35, T.28 S., R. 10 E.". However, that section is 3 miles south of the highway and on the wrong side of Fremont River. A correct location that matches the above description almost exactly is in the NE ¼ Sec. 23, T. 28 S., R. 10 E., Wayne County, Utah.

Significance: The site of a nearly complete sauropod dinosaur skeleton (Camarasaurus ?) collected by Yale University in the late 1950's and now in the collections of the University of Nebraska.

Geologic Data: Morrison Formation - Late Jurassic.

COLORADO

50. Brachiosaurus Locality
Delta, Colorado

Location: Sec. 22 or 23, T. 50 N., R. 12 W., Montrose County, Colorado. The exact location will require further research into the records at the United States National Museum.

Significance: Site of a huge sauropod humerus (cf. Brachiosaurus) that now is displayed at the National Museum.

Geologic Data: Morrison Formation - Late Jurassic.

51. ▲▲ Garden Park, (See page 80.)
Canyon City, Colorado

Location: A series of quarries located in Garden Park, eight miles north of Canyon City along Four Mile Creek in Fremont County, Colorado. Two quarries in the SW ¼ Sec. 28, T. 17 S., R. 70 W. were opened by Yale collectors in 1877, along with various other quarries worked by collectors for E.D. Cope in the same area (Sections 21 qnd 28).

Significance: Very large collections of dinosaurs were collected from several quarries in the Garden Park area, including skeletons of Haplocanthosaurus, Apatosaurus, Brachiosaurus, Allosaurus, Camptosaurus, and Stegosaurus. It also includes the only site outside of the Como Bluff area to produce Jurassic mammals. Because of the several closely associated quarries, the region as a whole (Sections 21, 28, and 33, T. 17 S., R. 70 W.) is recommended for designation as a Natural Landmark. (See page 80 for analysis.)

Geologic Data: Morrison Formation - Late Jurassic.

52. ▲▲ Morrison, (See page 82.)
Colorado

Location: A series of quarries in NW ¼ Sec. 26 and SE ¼ Sec. 35, T. 4 S., R. 70 W., Jefferson County, Colorado - southwest of Denver.

Significance: A number of partial skeletons of several dinosaur species were collected at these quarries. Included are Atlantosaurus, Apatosaurus, Diplodocus, Allosaurus and Stegosaurus. This is the locale that triggered the first interest in 'gigantic saurian bones' with the discovery by Arthur Lakes in April 1877. Because of the historical, as well as the scientific, importance of the region, these two Sections are recommended for collective designation as a Natural Landmark. (See page 82 for analysis.)

Geologic Data: Morrison Formation - Late Jurassic.

SOUTH DAKOTA

53. Barosaurus Locality (Great Plains)
Piedmont, South Dakota

Location: SW ¼ Sec. 11, T. 3 N., R. 6 E., at the east end of Piedmont Butte, Meade County, South Dakota.

Significance: Site of two fragmentary skeletons of the large sauropod Barosaurus. Both specimens are incomplete, but they apparently represent two distinct species (B. lentus, YPM 429; B. affinis, YPM 419). This is one of very few localities in North America to yield this genus.

Geologic Data: Beulah Shale = Morrison Formation - Late Jurassic.

54. Fort Meade (Great Plains)
Sturgis, South Dakota

Location: The precise location of the site is not known. Records give it as 3 miles south of Sturgis on the Fort Meade Military Reservation, Meade County, South Dakota. This would place it in the NW ¼ Sec. 26, T. 5 N., R. 5 E., on the hillside west of the Black Hills National Cemetary, inside the old boundaries (but not the present boundaries) of Fort Meade.

Significance: This site produced an incomplete, but otherwise excellent sauropod skeleton (Apatosaurus), collected about 1900 by the American Museum of Natural History.

Geologic Data: Beulah Shale = Morrison Formation - Late Jurassic.

Unlocated Site

55. Dystrophaeus Locality (Colorado Plateau)
Painted Canyon, Utah (or Colorado?)

Location: Unknown. Cope recorded it as 'Painted Canyon' not far from Sierra Abajo in southeastern Utah close to the Colorado boundary. The contractors were not able to pinpoint this site from materials available and presume the location is lost.

Significance: This was the site of Cope's type of Dystrophaeus, one of the first sauropods to be described from the New World (Cope, 1977).

Geologic Data: McElmo ss. =Morrison Formation - Late Jurassic.

CRETACEOUS SITES

NEW JERSEY

56. ▲▲ Hadrosaurus foulkii Site, (See page 85.)

West Haddonfield, New Jersey

Location: 0.4 mile north of Hopkins Pond, on the north bank of the small stream flowing through Pennypacker Park into Cooper River (within 200 yards of Cooper River), West Haddonfield, Camden County, New Jersey. (The site is very close to the intersection of the 297,500 meter East and the 4417,500 meter North, Zone 18 of the Universal Transverse Mercator Grid.

Significance: This is the site of the first reported find of an articulated dinosaur skeleton in the Western Hemisphere. A partial skeleton of Hadrosaurus foulkii was discovered in a now abandoned marl pit here in the late 1830's. The remainder was salvaged in 1858. and donated to the Philadelphia Academy of Sciences where it was the first dinosaur specimen to be mounted for display. A very important historic site that is recommended for designation as a Natural Landmark. (See page 85 for analysis.)

Geologic Data: Woodbury Formation - Late Cretaceous.

57. Keyport Locality
New Jersey

Location: Shore of Raritan Bay in the Lorillard Company pit 2.5 miles east of Keyport at Union, Monmouth County, New Jersey.

Significance: The site of fragmentary limb bones of a hadrosaurian dinosaur - the type specimen of Cope's (1869) genus Ornithotarsus. This is a significant specimen, but not of major importance.

Geologic Data: Woodbury Formation - Late Cretaceous.

MARYLAND

58. Muirkirk
Maryland

Location: Several unidentifiable clay pits (iron ore pits) in the vicinity of Muirkirk (on the Baltimore and

Ohio Railroad, 2 miles northeast of Beltsville), Prince Georges County, Maryland. Apparently the precise mines or pits that produced the fossil remains noted here were never identified or located in published reports.

Significance: Collections of fragmentary fossil vertebrates, including perhaps a dozen species (half of which represent dinosaurian kinds). The collections are poor, but they do represent one of the few known samples of Early Cretaceous vertebrate life from the New World. A number of type specimens (of sauropod, theropod and ankylosaur) are included.

Geologic Data: Arundel Formation - Early Cretaceous.

59. Bladensburg
Maryland

Location: A clay (iron ore) pit in Bladensburg 1 mile northeast of the District of Columbia boundary, Prince Georges County, Maryland. The exact site cannot be fixed now due to urban expansion in the areas surrounding the Capital.

Significance: Site of fragmentary dinosaur remains of Early Cretaceous age, including the type specimen of Priconodon - one of the earliest records of ankylosaurian dinosaurs.

Geologic Data: Arundel Formation - Early Cretaceous.

NORTH CAROLINA

60. Phoebus Landing
North Carolina

Location: Vicinity of Phoebus Landing on the Cape Fear River, Bladen County, North Carolina. Precise location of the fossil site is not known.

Significance: This site produced a number of isolated, but associated fossil bones - all referrable to the hadrosaurian dinosaurs. Included is the type specimen of Hypsibema.

Geologic Data: Black Creek Formation - Late Cretaceous.

ALABAMA

61. Woods Upper Bluff
Autauga County, Alabama

Location: Sec. 17, T. 16 N., R. 13 E., Autauga County. The site is on the north side of the Alabama River approximately 3 miles north of the town of Edsons.

Significance: Source of a partial hadrosaurian dinosaur skeleton (USNM 6523) collected in 1883.

Geologic Data: Selma Chalk - Late Cretaceous.

62. Battsmith Bluff
Dallas County, Alabama

Location: Sec. 32, T. 17 N., R. 12 E., Dallas County, Alabama.

Significance: Site of a partial skeleton of a hadrosaurian dinosaur (USNM 6524).

Geologic Data: Selma Chalk - Late Cretaceous.

63. Marion Junction
Dallas County, Alabama

Location: Sec. 29, T. 17 N., R. 9 E., southeast of Marion Junction, 10 miles east of Selma, Dallas County, Alabama.

Significance: Site of a partial skeleton of a new hadrosaurian dinosaur (Lophorhothon, FMNH P27383). This specimen is the most diagnostic of the several incomplete dinosaurian specimens from this region of Alabama. Associated with it were fragments of an ankylosaur and a theropod dinosaur.

Geologic Data: Selma Chalk - Late Cretaceous.

TEXAS

64. △△ Greenwood Canyon, (See page 87.)
Forestburg, Texas

Location: 2.5 miles southwest of Forestburg, Montague

County, Texas. The site is in exposures at the head of the short canyon that drains southwestward into Braden Branch, just north and west of the road from Forestburg.

Significance: Only fragments of dinosaurs were recovered in the vicinity of this site, but the site is important primarily because of the mammal remains found. This site (described in 1949) is still the most sigficant Early Cretaceous mammal locality in the New World. (See page 87 for analysis.)

Geologic Data: Trinity Formation - Early Cretaceous.

** Dinosaur Valley Natural Landmark, Somervell Co., Texas. (See page 104.)

OKLAHOMA

65. Acrocanthosaurus Sites
Atoka County, Oklahoma

Location: SW ¼ Sec. 26, T. 4 S., R. 14 E., Atoka County, Oklahoma. This site is slightly more than 1 mile north of the Atoka - Choctaw County Line, 12 miles southwest of Antlers, Oklahoma. A second site was recorded as 0.75 mile east of this site on the section line (between Sec. 26 and 25).

Significance: These two sites produced partial skeletons (2) of a unique carnivorous (theropod) dinosaur - Acrocanthosaurus, an Early Cretaceous successor of Allosaurus.

Geologic Data: Trinity Formation - Early Cretaceous.

MISSOURI

66. Glenallen
Missouri

Location: Center, Sec. 26, T. 31 N., R. 9 E., 0.6 mile northwest of Glenallen on Patton Road, 1 mile north of Glenallen, Bollinger County, Missouri.

Significance: Site of a fragmentary sauropod dinosaur (Parrosaurus), possibly close to Camarasaurus. This apparently represents the only dinosaur so far recorded from the state of Missouri.

Geologic Data: Ripley Formation - Late Cretaceous.

KANSAS

67. Smoky Hill River
Kansas

Location: "Near the Smoky Hill River". No exact location is possible now nearly a century after the collection of the specimen in question. The Smoky Hill River flows eastward almost the entire length of the State.

Significance: The site of one of the first (fragmentary) dinosaur specimens recovered from the American West. Includes the major part of a skeleton and parts of the skull of Claosaurus agilis (YPM 1190), the oldest hadrosaurian dinosaur known from the New World.

Geologic Data: Niobrara Chalk - Late Cretaceous.

68. Silvasaurus Locality
Ottawa County, Kansas

Location: SW ¼ Sec. 8, T. 10 S., R. 1 W., 6 miles northwest of the village of Vine Creek, Ottawa County, Kansas.

Significance: The site of discovery of a partial skeleton with a skull of a primitive armored dinosaur (Ankylosauria) - perhaps the oldest respresentative of that group in the Western Hemisphere. The specimen, named Silvasaurus, is now in the collections of the University of Kansas (No. 10296).

Geologic Data: Dakota Formation - Early Cretaceous.

SOUTH DAKOTA

69. Hierosaurus Locality
Hackbury, ~~South Dakota~~ Kansas

Location: Sec. 16, T. 15 S., R. 26 W., 11 miles south and east of Hackbury, Gove County, South Dakota.

Significance: A partial skeleton of an early armored (Ankylosauria) dinosaur (Hierosaurus) was obtained here.

Geologic Data: Niobrara Chalk - Late Cretaceous.

70. Cheyenne River
South Dakota

Location: Opposite Corral Draw (now Indian Creek) on the west (north) bank of the Cheyenne River (Sec, 35 or 26 ?) in T. 3 S., R. 11 E., Custer County, South Dakota.

Significance: The site of a very fragmentary hadrosaurian dinosaur (Claosaurus affinis, YPM 3219) associated with a giant sea turtle (Archelon).

Geologic Data: Pierre Formation - Late Cretaceous.

71. Moreau River
South Dakota

Location: The precise location of this site is undetermined at present. No published data are available, other than "near Moreau River, South Dakota". More research in the archives of the American Museum of Natural History may produce more specific information.

Significance: This site produced a nearly complete and very well preserved hadrosaurian dinosaur skeleton (the type specimen of Anatosaurus copei, AMNH 5730) - one of the finest specimens in existence.

Geologic Data: Lance Formation - Late Cretaceous.

72. Calico Canyon
Buffalo Gap, South Dakota

Location: SE ¼ Sec. 24, T. 6 S., R. 6 E., Custer County, South Dakota. The "quarry" site is on the north side of the canyon, about 0.25 mile from the canyon entrance, northwest of the town of Buffalo Gap, Custer County, S.D.

Significance: This site produced two very incomplete dinosaur specimens - a primitive armored dinosaur (Hoplitosaurus) and an ornithopod (Camptosaurus), two of the first known, possible Early Cretaceous dinosaurs from western North America.

Geologic Data: "Dakota" Formation (?) - Early Cretaceous.

73. Short Pine Hills
South Dakota

Location: NE ¼ Sec. 35, T. 17 N., R. 1 E., Harding County,

South Dakota.

Significance: Site of a fine Triceratops (horned dinosaur) skull now displayed in the South Dakota School of Mines.

Geologic Data: Lance Formation - Late Cretaceous.

74. "Jump Off" Locality
Harding County, South Dakota

Location: The badlands area known as "the jump off", 10 miles east of Camp Crook, - probably on the South Fork of the Grand River, Harding County, South Dakota.

Significance: This is the site of one of three known skulls of the huge ceratopsian dinosaur Torosaurus. The specimen recovered from here is an important, although incomplete, specimen. It is now housed in the Philadelphia Academy of Sciences (No. 15192).

Geologic Data: Hell Creek Formation - Late Cretaceous.

MONTANA

75. "Cow Island" Locality
Montana

Location: Unknown. This entry is listed here because it a) records the site of an incomplete hadrosaurian dinosaur skeleton of note, and b) indicates the the vague nature of many locality records that typify the surviving records of too many old and valuable sites. The present site is recorded only as "upper Missouri River, near the mouth of the Judith River - - - near Cow Island." The confluence of the Judith and Missouri Rivers is at least 30 miles west of Cow Island, thus indicating the 'precision' of early records.

Significance: Site of discovery of a partial hadrosaurian dinosaur skeleton.

Geologic Data: Judith River Formation - Late Cretaceous.

76. Numerous Unlocated Sites
Montana

This entry is made at this particular point to draw special

attention to a large number of Late Cretaceous localities in the general area of the Missouri River valley of Montana that (apparently) can no longer be located exactly. Important specimens were collected at these various sites; consequently some recognition is warranted here, but until actual sites can be relocated, no further comment is justified. Additional researches into the archives of the institutions involved may reveal some of these sites.

77. "Fort Peck"
Montana

Location: Sec. 22, T. 29 N., R. 43 W., McCone County, 28 miles south of Fort Peck, Montana.

Significance: Site of a nearly complete skeleton (Anatosaurus) of hadrosaurian dinosaur now displayed at the University of Michigan.

Geologic Data: Lance Formation - Late Cretaceous.

78. "Crooked Creek"
Garfield County, Montana

Location: Approximate location is in the northern part of T. 22 N., R. 39 E., Garfield County, Montana. The precise location is feared lost, and in all probability may be inundated by the Fort Peck Reservoir.

Significance: The site of a nearly complete hadrosaurian dinosaur specimen (AMNH 5886) now displayed at the American Museum of Natural History, New York City.

Geologic Data: Hell Creek Formation - Late Cretaceous.

79. ΔΔ Tyrannosaurus Locality, (See page 89.)
Garfield County, Montana

Location: Two localities, apparently close together. The exact location is not available in the published literature, but it is recorded in the archives of the American Museum of Natural History. The sites are listed as situated on the east side (south ?) of Big Dry Creek, 8 miles from the Willis Ranch, 25 miles south of Lismas, Garfield County, Montana.

Significance: These two sites produced one nearly complete skeleton of Tyrannosaurus and one partial skeleton (originally called Dynamosaurus). Because of the fame of Tyrannosaurus, this site should be considered for designation as a Natural Landmark. (See page 89 for analysis.)

Geologic Data: Hell Creek Formation - Late Cretaceous.

80. Brownie Butte
Garfield County, Montana

Location: Section 31, T. 21 N., R. 37 E., south of Hell Creek in Garfield County, Montana.

Significance: One of several sources of extraordinarily rich Late Cretaceous mammal fauna associated with dinosaurian remains (mostly ceratopsin and hadrosaurian). This and the following 7 sites are the most important sites known in the United States for potential new evidence pertaining to the Mesozoic - Cenozoic faunal change.

Geologic Data: Hell Creek Formation - Late Cretaceous.

81. Mammal Hill
Garfield County, Montana

Location: Section 4, T. 21 N., R. 37 E., north of Hell Creek, in Garfield County, Montana.

Significance: A major site for Late Cretaceous mammal remains associated with dinosaurian remains. A diverse fauna from here and the preceding and following localities (82 - 87) are currently under study by R. Sloan and L. Van Valen.

Geologic Data: Hell Creek Formation - Late Cretaceous.

82. Crooked Creek Mammal Site
Garfield County, Montana

Location: Section 36, T. 22 N., R. 39 E., Garfield County, Montana.

Significance: A major site for Late Cretaceous mammal remains associated with dinosaurian remains.

Geologic Data: Hell Creek Formation - Late Cretaceous.

83. McKenna Hollow
McCone County, Montana

Location: Section 4, T. 24 N., R. 43 E., south of Bear Creek, McCone County. Montana.

Significance: A major site for Late Cretaceous mammal fossils associated with dinosaurian remains.

Geologic Data: Hell Creek Formation - Late Cretaceous.

84. Harbicht Hill
McCone County, Montana

Location: Section 32, T. 25 N., R. 43 E., east of Fort Peck Reservoir in McCone County, Montana.

Significance: A major site of fossil Late Cretaceous mammals associated with dinosaurian remains.

Geologic Data: Hell Creek Formation - Late Cretaceous.

85. Ken's Saddle, Bug Creek - Eligible.
McCone County, Montana

Location: Section 8, T. 22 N., R. 43 E., east of Fort Peck Reservoir in McCone County, Montana.

Significance: A major site of Late Cretaceous mammal remains associated with dinosaurian remains. (This site is included in the "Bug Creek Fossil Area Natural Landmark" declared eligible in 1966.)

Geologic Data: Hell Creek Formation - Late Cretaceous.

86. ▲▲ Bug Creek Anthill Locality, (See page 90.) - Eligible.
McCone County, Montana

Location: W ½ Sec. 9, T. 22 N., R. 43 E., on Bug Creek,

east of Fort Peck Reservoir, McCone County, Montana.

Significance: A major site of Late Cretaceous mammal remains associated with dinosaurian remains. Site is recommended for designation as a Natural Landmark. Site is included in eligible area (Bug Creek Fossil Area). (See page 90 for analysis.)

Geologic Data: Hell Creek Formation - Late Cretaceous.

87. Bug Creek West Locality - Eligible.
McCone County, Montana

Location: NE ¼ Sec. 17, T. 22 N., R. 43 E., on Bug Creek, east of Fort Peck Reservoir in McCone County, Montana.

Significance: A major site of Late Cretaceous mammal remains associated with dinosaurian remains. (This site is included in the "Bug Creek Fossil Area Natural Landmark" declared eligible in 1966.)

Geologic Data: Hell Creek Formation - Late Cretaceous.

88. Rock Creek Locality
Lismas, Montana

Location: 20 miles south of Lismas, Garfield County, Montana, on Rock Creek. The exact location was not recorded by the collector and thus cannot be re-established now, some 60 years afterwards.

Significance: A fragmentary skeleton of the largest known ceratopsian dinosaur (Triceratops maximus) was collected at this site in 1909.

Geologic Data: Hell Creek Formation - Late Cretaceous.

89. Milk River Locality I
Blackfeet Indian Reservation, Montana

Location: NE ¼ Sec. 16, T. 37 N., R. 8 W., 0.25 mile east of the Milk River, Glacier (formerly Teton) County, Montana.

Significance: The site of a nearly complete skull and skeleton, plus some other postcranial elements of the small ceratopsian dinosaur Brachyceratops.

Geologic Data: Two Medicine Formation - Late Cretaceous.

90. Two Medicine River Locality
Blackfeet Indian Reservation, Montana

Location: NE ¼ Sec. 15, T. 31 N., R. 7 W., on the south side of Two Medicine River, Glacier (formerly Teton) County, Montana.

Significance: The site of a partial skeleton of a hadrosaurian dinosaur (USNM 7955).

Geologic Data: Two Medicine Formation - Late Cretaceous.

91. Milk River Locality II
Blackfeet Indian Reservation, Montana

Location: Sec 16, T. 37 N., R. 8 W., on the north side of the Milk River about 0.5 mile southwest of Milk River Locality I, Glacier (formerly Teton) County, Montana.

Significance: Site of a complete skull and partial skeleton of an armored dinosaur (Edmontonia) originally described as Paleoscincus (USNM 11868).

Geologic Data: Two Medicine Formation - Late Cretaceous.

92. Buffalo Lake
Blackfeet Indian Reservation, Montana

Location: 3 miles west of Buffalo Lake (Section 20?) in T. 36 N., R. 9 W., Glacier (formerly Teton) County, Montana.

Significance: The site of a nearly complete, unique skeleton of a small horned dinosaur - Montanaceratops (AMNH 5464) - originally described as a new species of Leptoceratops.

Geologic Data: St. Mary River Formation - Late Cretaceous.

93. Milk River Locality III
Blackfeet Indian Reservation, Montana

Location: NW ¼ Sec. 27, T. 37 N., R. 8 W., on the south side of Milk River in Glacier (formerly Teton) County, Montana.

Significance: Site of a skull and fragmentary skeleton of an armored dinosaur (Dyoplosaurus, USNM 11892).

Geologic Data: Two Medicine Formation - Late Cretaceous.

94. Procheneosaurus Locality
Blackfeet Indian Reservation, Montana

Location: "On the Two Medicine River, Blackfeet Indian Reservation", Glacier (formerly Teton) County, Montana. The exact location is not available.

Significance: The site of two fine skeletons of Procheneosaurus (hadrosaurian dinosaur) collected by the American Museum of Natural History in 1916. Most specimens of Procheneosaurus came from Alberta and this is one of very few sites in the United States to produce good remains of this particular form.

Geologic Data: Two Medicine Formation - Late Cretaceous.

95. Powder Hill (Great Plains)
Ekalaka ?, Montana

Location: Section 17, T. 1 S., R. 55 E., Carter County, Montana. Brown and Schlaikjer (1943) give the location of this site as "north of Ekalaka", but the Township cited is some 20 miles southwest of that town. The village of Powderville is in the adjacent Township (T. 1 S., R. 54 E.) only a few miles west of Section 17. It seems reasonable to presume that "Powder Hill" is not far from "Powderville" and thus the direction from Ekalaka is in error rather than the Township and Range designations. Local investigation would be necessary to confirm this.

Significance: This is the site of a fragmentary skull of the large "bone head" dinosaur - Pachycephalosaurus (AMNH 1696).

Geologic Data: Hell Creek Formation - Late Cretaceous.

96. Cow Creek (Great Plains)
Blaine County, Montana

Location: An area about 10 miles upstream from the junction of Cow Creek with the Missouri River, in T. 24 N., R. 22 E. ?, Blaine County, Montana.

Significance: Site of the type specimen (a fragmentary skull) of Triceratops montanus.

Geologic Data: Judith River Formation - Late Cretaceous.

Fossil Area Natural Landmark

97. "Hell Creek" Eligible? (See page 104.)
Garfield County, Montana

Location: Various sites ~~(not precisely located)~~ along the valley of Hell Creek, south of Fort Peck Reservoir in Garfield County, Montana. East ½ R. 36 E. and all of R. 37 E., T. 21 N.

Significance: Numerous partial skulls and skeletons of ceratopsian dinosaurs, chiefly of Triceratops, were collected in this general area by several different collectors. The specimens now are in the collections of the American Museum of Natural History. Designated eligible for Natural Landmark [illegible]

Geologic Data: Hell Creek Formation - Late Cretaceous.

Note: A tract in this area (East ½ R. 36 E. and all of R. 37 E., T. 21 N.) was declared eligible in 1966.

98. Middle Dome
Harlowton, Montana

Location: SW ¼ Sec. 26, T. 7 N., R. 16 E., on the north "rim" of the depression in Middle Dome, southeast of Harlowton, Wheatland County, Montana.

Significance: The site of one of the smallest flesh-eating dinosaurs so far discovered in the New World. The type and only known specimen of Microvenator and also a partial skeleton of an ornithopod dinosaur (Tenontosaurus) were collected here. Several other specimens were collected in the same area (the valley in the center of Middle Dome), but sites have not been relocated.

Geologic Data: Cloverly Formation - Early Cretaceous.

99. ▲▲ Beauvais Creek, (See page 92.)
Crow Indian Reservation, Montana

Location: E ½ Sec. 32 and N ½ Sec. 33, T. 4 S., R. 29 E., the area south of the Cashen Ranch, Big Horn County, Montana.

Significance: A large number of sites worked by the American Museum of Natural History and the Peabody Museum of Yale University produced numerous specimens of armored, ornithopod and theropod dinosaurs. The precise locations of many of these sites are recorded in a report now in press by the senior author of this report (Ostrom, 1970). This is one of the most productive locales in the Western Hemisphere for Early Cretaceous fossil vertebrates. It is recommended for designation as a Natural Landmark. (See page 92 for analysis.)

Geologic Data: Cloverly Formation - Early Cretaceous.

100. Pryor Locality I
Crow Indian Reservation, Montana

Location: SE ¼ Sec. 16, T. 4 S., R. 26 E., 3.5 miles north of Pryor in Yellowstone County, Montana.

Significance: Site of a partial skeleton of an early armored dinosaur (Sauropelta, AMNH 3016).

Geologic Data: Cloverly Formation - Early Cretaceous.

101. Pryor Locality II
Crow Indian Reservation, Montana

Location: SW ¼ Sec. 16, T. 4 S., R. 26 E., 0.2 mile west of Pryor Locality I, 3.5 miles north of Pryor, Yellowstone County, Montana.

Significance: Site of an ornithopod dinosaur (Tenontosaurus, AMNH 3017), skeleton.

Geologic Data: Cloverly Formation - Early Cretaceous.

102. Mott Creek
Crow Indian Reservation, Montana

Location: SW. ¼ Sec. 8, T. 5 S., R. 30 E., south of Beauvais Creek, Big Horn County, Montana.

Significance: Three quarry sites in the immediate vicinity of Mott Creek that produced two partial skeletons of the ornithopod dinosaur Tenontosaurus, a partial skeleton of an armored dinosaur (Sauropelta) and fragments of a carnivorous dinosaur (Deinonychus).

Geologic Data: Cloverly Formation - Early Cretaceous.

103. Push Creek
Crow Indian Reservation, Montana

Location: NE ¼ Sec. 20, T. 5 S., R. 28 E., approximately 1.5 miles west of Push Creek, Big Horn County, Montana.

Significance: Two sites that produced a skeleton each of the ornithopod (Tenontosaurus) and the ankylosaur (Sauropelta), so common in the Cloverly Formation.

Geologic Data: Cloverly Formation - Early Cretaceous.

104. University of Oklahoma Site
Crow Indian Reservation, Montana

Location: SE ¼ Sec. 32, T. 4 S., R. 29 E., 1.25 miles south of the Cashen ranch, Big Horn County, Montana.

Significance: Two sites very close together that produced two partial adult skeletons and parts of several juvenile specimens of Tenontosaurus, an Early Cretaceous ornithopod dinosaur.

Geologic Data: Cloverly Formation - Early Cretaceous.

105. American Museum Locality
Crow Indian Reservation, Montana

Location: SE ¼ Sec. 32, T. 4 S., R. 29 E., 1.25 miles south of the Cashen Ranch on Beauvais Creek, Big Horn County, Montana.

Significance: The site of the major part of an armored dinosaur - possibly a distinct species from the common form (Sauropelta) in the Cloverly Formation.

Geologic Data: Cloverly Formation - Early Cretaceous.

106. Thor Lande Site
Crow Indian Reservation, Montana

Location: NW ¼ Sec. 21, T. 5 S., R. 28 E., 1 mile west of the Thor Lande cabin on Push Creek, Big Horn County, Montana.

Significance: The site of a nearly complete skeleton and skull of a sub-adult specimen of Tenontosaurus, (Ornithopoda), (YPM 5458).

Geologic Data: Cloverly Formation - Early Cretaceous.

107. Rattlesnake Site
Crow Indian Reservation, Montana

Location: NW ¼ Sec. 24, T. 5 S., R. 28 E., Big Horn County, Montana.

Significance: Site of three partial skeletons and one exceptionally fine skull of Tenontosaurus, the Cloverly ornithopod (YPM 5456).

Geologic Data: Cloverly Formation - Early Cretaceous.

108.△△ Bridger, (See page 94.)
Montana

Location: NE ¼ Sec. 17, T. 7 S., R. 24 E., approximately 7 miles southeast of Bridger, Carbon County, Montana.

Significance: One specific quarry (see Ostrom, 1969) produced the remains of several skeletons of an unusual carnivorous dinosaur (Deinonychus) plus fragments of a herbivore (Tenontosaurus). In the immediate area several other quarries produced fragmentary remains of other dinosaurian specimens, chiefly of Tenontosaurus. Recommended. (See page 94 for analysis.)

Geologic Data: Cloverly Formation - Early Cretaceous.

WYOMING

109.▲▲ Lance Creek Area - Eligible in part. (See page 96.) Great Plains
Niobrara County, Wyoming

Location: The large area described below is listed as one single "locality" because it includes a large number of dinosaurian, mammal and other fossil vertebrate sites that it would be difficult to compile a complete list, let alone distinguish major from minor sites. It has been decided that a reasonable approach is to define the region, rather than list each site separately. If desired, for purposes related to possible designation as a Natural Landmark, most of these sites can be pinpointed, but no effort has been made here to locate any of these. The area is bounded by the Cheyenne River on the north, Old Woman and Lance Creeks on the east, the 43° North Latitude on the south and the Niobrara - Converse County line on the west. The area includes most of the following Townships and Ranges: T. 35, 36, 37, 38, 39 and 40 N., R. 62, 63, 64, 65 and 66 W.; See the attached map.

Significance: This is the famed Lance Creek area of the old Converse County that produced literally dozens of horned dinosaurs and hadrosaurian dinosaurs, plus thousands of Late Cretaceous mammals and hundreds of small reptilian and amphibian remains. It is a classic region that has been worked by many paleontologists over the last eight or nine decades and which has been the subject of intensive recent study by Estes (1964) and Clemens (1964, 1966). For other evidence of the significance of this area see Lull and Wright (1942), Lull (1933) and Hatcher (1896). Part of this area was declared eligible in 1966. (See page 96 analysis.)

Geologic Data: Lance Formation - Late Cretaceous.

110. Seven Mile Creek
Weston County, Wyoming

Location: 5 miles north of the Cheyenne River, close to the Niobrara - Weston County line in T. 6 S., R. 63 W., Weston County, Wyoming.

Significance: Site of a fine skeleton of Anatosaurus (hadrosaurian dinosaur - AMNH 5863), now displayed in the American Museum of Natural History.

Geologic Data: Lance Formation - Late Cretaceous.

111. Princeton University Site
Park County, Wyoming

Location: This information is available only from Dr. Glen L. Jepsen, Department of Geology, Princeton University, Princeton, New Jersey.

Significance: The source of a partial skeleton of the primitive ceratopsian Leptoceratops (PU 18133), the only known specimen that is certainly referrable to this otherwise Canadian dinosaur. This specimen is of particular value in that it provides new evidence of correlation of the "Lance" Formation of the Big Horn Basin area of Wyoming and the Upper Edmonton Formation of central Alberta.

Geologic Data: "Lance" Formation - Late Cretaceous.

112. Yale Nodosaurus Site
Albany County, Wyoming

Location: Unknown. The collector (William Reed) placed it 1.5 miles east of "Quarry 13" (at Como Bluff) which would put it in either Section 3 (NE ¼) or Section 2 (NW ¼) of T. 22 N., R. 76 W., Albany County, Wyoming.

Significance: This is the site of one of the early finds of an armored dinosaur - the type specimen of Nodosaurus textilis (YPM 1815). The specimen is a fragmentary skeleton without skull.

Geologic Data: Exact horizon is not known, but the location and the description reported indicate a stratigraphic position that currently is identified as "Dakota Sandstone" - Early Cretaceous.

113. Lander
Fremont County, Wyoming

Location: This site was never recorded accurately because the collector was an amateur. The only available information lists it as "near Lander", Fremont County, Wyoming.

Significance: The site of a partial skeleton of an armored dinosaur (Ankylosauria) - Stegopelta landerensis, which may be one of the oldest known ankylosaurs (together with Nodosaurus, Silvasaurus and Sauropelta.

Geologic Data: Probably from the Thermopolis Formation - Early Cretaceous.

114.▲▲ Crooked Creek - Registered Natural Landmark. (See page 99.) (middle Park area)
Big Horn County, Wyoming

Location: NW ¼ Sec. 28, T. 58 N., R. 95 W., on the east - facing scarp just over the ridge to the east of Crooked Creek, Big Horn County, Wyoming.

Significance: A series of quarries here produced partial skeletons of sauropod, ankylosaurian, theropod and ornithopod dinosaurs, as well as some turtle and crocodilian remains. It is a major site for sauropod remains of Early Cretaceous age (the only site to produce associated sauropod remains of this age from the western interior of North America). (See page 99 for analysis.)

Geologic Data: Cloverly Formation - Early Cretaceous.

Note: This site was registered as a Natural Landmark in July, 1968.

115. Black Buttes Station (Wyoming Basin)
Sweetwater County, Wyoming

Location: 0.5 mile east of Black Buttes Station (on the Union Pacific Railroad) in Sec. 16 (?), T. 18 N., R. 100 W., Sweetwater County, Wyoming.

Significance: This is the site of a fragmentary specimen of a ceratopsian dinosaur (Agathauma) - the type specimen of one of the first discovered ceratopsians.

Geologic Data: Lance Formation - Late Cretaceous.

116. Horse Creek (East Plains)
Goshen County, Wyoming

Location: Sec. 4, T. 22 N., R. 61 W., Goshen County, Wyoming.

Significance: A major portion of a ceratopsian skull (Triceratops) was collected here associated with fragments of hadrosaurian dinosaurs and crocodilian remains.

Geologic Data: Lance Formation - Late Cretaceous.

117. Buck Creek
Niobrara County, Wyoming

Location: 9 miles southwest of the Warren Post Office, Niobrara County, Wyoming. The location is lost.

Significance: The site of a partial skeleton of a large ornithopod dinosaur - Pachycephalosaurus - one of the "bone-head" kinds. This is one of very few specimens known of this creature.

Geologic Data: Lance Formation - Late Cretaceous.

COLORADO

118. Ornithomimus Site
Jefferson County, Colorado

Location: SW ¼ Sec. 27, T. 4 S., R. 69 W., southwest of Denver, close to U.S. Highway 285 in Jefferson County, Colorado.

Significance: The site of the very fragmentary type specimen of Ornithomimus - the peculiar 'ostrich - like' dinosaur (YPM 542).

Geologic Data: Denver Formation - Late Cretaceous.

UTAH

119. Lizard Locality
Emery County, Utah

Location: SE ¼ Sec. 17, T. 19 S., R. 6 E., on the east side of South Dragon (also known as Black Dragon Creek) on the lower slope of the prominent hill that juts out (to the west) from South Horn Mountain, Emery County, Utah.

Significance: The site of several complete and near complete lizard skeletons (Polyglyphanodon, Paraglyphanodon) associated with fragmentary dinosaur remains. This site provides information about some of the lesser elements of the Cretaceous fauna that co-existed with dinosaurs.

Geologic Data: North Horn Formation - Late Cretaceous.

120. Rock Canyon
Emery County, Utah

Location: SW ¼ Sec. 3, T. 19 S., R. 16 E., at the upper end of Rock Canyon, just below the crest of the divide east of North Dragon Creek, Emery County, Utah.

Significance: Site of a partial skeleton of a Late Cretaceous (a rare item) sauropod dinosaur (Alamosaurus). This specimen was one of the first and most important evidences confirming the existence of Cretaceous sauropods.

Geologic Data: North Horn Formation - Late Cretaceous.

121. North Horn Mountain Locality I
Emery County, Utah

Location: NE ¼ Sec. 28, T. 18 S., R. 6 E., on the west slope of North Horn Mountain, Emery County, Utah.

Significance: The site of the major part of a ceratopsian dinosaur skull.

Geologic Data: North Horn Formation - Late Cretaceous.

√122. North Horn Mountain Locality II
Emery County, Utah

Location: SE ¼ Sec. 28, T. 18 S., R. 6 E., approximately 0.25 mile south of North Horn Mountain Locality I (No 121, above), Emery County, Utah.

Significance: The site of the type specimen of Arrhinoceratops utahensis, a large horned dinosaur.

Geologic Data: North Horn Formation - Late Cretaceous.

123. North Horn Mountain Locality III
Emery County, Utah

Location: SW ¼ Sec. 36, T. 18 S., R. 6 E., on the the southeast slope of North Horn Mountain, just east of the large ravine that drains into Rock Canyon, Emery County, Utah.

Significance: This is the site of skull parts of a large ceratopsian (horned dinosaur) that may be closely related to the New Mexico genus Pentaceratops.

Geologic Data: North Horn Formation - Late Cretaceous.

NEW MEXICO

124. "Ojo Alamo"
San Juan County, New Mexico

Location: Slightly less than a mile south of the former site of the Ojo Alamo store on Ojo Alamo Arroya (in Section 6), probably located in the south half of Section 7, T. 24 N., R. 11 W., San Juan County, New Mexico.

Significance: Several sites are situated in this immediate vicinity which produced partial skeletons or skulls of hadrosaurian dinosaurs (especially important is the type specimen of Kritosaurus navajovius, AMNH 5799), and a ceratopsian dinosaur (Monoclonius ?) and fragments of turtle, crocodilian and fish skeletons.

Geologic Data: Ojo Alamo Formation - Late Cretaceous.

125. Hunters Store
San Juan County, New Mexico

Location: 6 miles north of Hunters Store (now Bisti Trading Post - in the SE ¼ Sec. 30, T. 24 N., R. 13 W.). probably in Sec. 29 or 30, T. 25 N., R. 13 W., San Juan County, New Mexico.

Significance: This is the site of a partial skull and skeleton of a large crested hadrosaurian dinosaur (the type specimen of Parasaurolophus tubicen now at the University of Upaala in Sweden also came from this region) now in the National Museum collections (USNM 13492).

Geologic Data: Kirtland Formation - Late Cretaceous.

126. Coal Creek
McKinley County, New Mexico

Location: "Near Coal Creek", 8 miles southeast of Tsaya in McKinley County, New Mexico (not the Coal Creek 10 miles north of Tsaya in San Juan County).

Significance: A nearly complete skeleton and a partial skull of a crested hadrosaurian dinosaur (FMNH P27393) was collected at this site. It represents the only specimen known of this particular species.

Geologic Data: Fruitland Formation - Late Cretaceous.

127. Pentaceratops Locality
San Juan County, New Mexico

Location: 9 miles northeast of Tsaya in T. 23 N., R. 11 W., San Juan County, New Mexico. No more information exists about the precise location of this site.

Significance: A well preserved, nearly complete skull of a large ceratopsian dinosaur (Pentaceratops sternbergii, AMNH 6325) was collected from here. The specimen is still one of very few good specimens of Pentaceratops as well as one of the few known from this region and and formation.

Geologic Data: Fruitland Formation - Late Cretaceous.

128. Kinebeto Wash
San Juan County, New Mexico

Location: 1 mile south of Kinebeto Wash (recorded as Kimbetoh Wash), probably in T. 22 N., R. 10 W., San Juan County, New Mexico. Exact location is not available.

Significance: The site of a fragmentary skull and skeleton of another Pentaceratops. The specimen is part of the collections of the University of Upsala in Sweden.

Geologic Data: Kirtland Formation - Late Cretaceous.

129. Saurolophus Locality
Kinebeto, New Mexico

Location: Sec. 34, T. 23 N., R. 10 W., 4 miles west of Kimbetoh (now Kinebeto) in San Juan County, New Mexico.

Significance: The site of a fragmentary skeleton of the hadrosaurian dinosaur Gaurolophus - one of few sites in the United States to yield remains of this particular genus.

Geologic Data: Kirtland Formation - Late Cretaceous.

NOTE: A number of sites have been discovered during the last five years in the San Juan Basin of New Mexico by Dr. William Clemens and his associates from the University of California at Berkeley. These sites have produced important Late Cretaceous mammal faunas. Clemens' finds have not yet been published and it would be inappropriate to list his localities here. Any additional information about these localities that may be required by the National Park Service should be obtained from Dr. Clemens.

CALIFORNIA

130. Puerto Creek
Stanislaus County, California

Location: SW ¼ Sec. 20, T. 5 S., R. 7 E., approximately 600 feet north and 800 feet east of the SE corner of Section 10, Stanislaus County, California.

Significance: Site of one of the very few known (and identifiable) skeletons (partial) of any dinosaurian kind from the west coast.

Geologic Data: Moreno Formation - Late Cretaceous.

PART III

ANALYSES OF SIGNIFICANT MESOZOIC FOSSIL VERTEBRATE SITES

The following analyses are designed to provide the non-technical or lay reader with a brief description and assessment of those sites identified (▲ △) in the preceding Inventory (Part II) as having unusual scientific and / or historical significance. Each analysis includes (1) a brief description of the site, (2) an exact location (where known), (3) the basis for its significance, (4) a short reference list of technical publications dealing with (or relevant to) the site or the paleontologic data obtained at the site (or in lieu of published data, a summary statement of the paleontologic importance), (5) the present condition of the site (if known to the contractor), and (6) an evaluation for purposes of Natural Landmark designation according to the criteria specified by the National Park Service. All of the sites considered in this section are classified here under Theme II, Subtheme 5. One or more of the following sites may also be suitable for classification under other themes, but reference to other themes is excluded from this report unless specifically warranted by personal knowledge and first hand observations at the site by the author or one of the staff of the Peabody Museum. In most instances the following analyses are derived from secondary sources; only a small fraction of the sites listed in Parts II and III have actually been visited or studied by the author or any of his staff. Consequently, only in the last instance can I make meaningful comments regarding secondary theme classification.

Site numbers used in this section are the same as those given in the Inventory (Part II).

* * * * * * * * * * *

SITE 1.

CHARLES O. WOLCOTT QUARRY, Manchester, Connecticut.

Location: Township of Manchester, Hartford, County, Connecticut. (See Fig. 1.) 0.8 mile north of the Buckland Station (New York, New Haven and Hartford Railroad), immediately east of the intersection of Burnham Street and Buckland Road.

Geologic Data: Portland Arkose (Newark Group), Upper Triassic.

Importance: Actual fossil remains of Triassic vertebrates (as opposed to footprints) are exceedingly rare in New England. This site produced three specimens of partial to nearly complete, articulated dinosaurs (Yaleosaurus colurus, YPM 1883; Anchisaurus solus, YPM 209; Ammosaurus major, YPM 208). This is the only site in New England that has produced more than one specimen (fish-bearing localities excluded) and no other site has produced such complete remains. In other words, this one quarry has produced most of our knowledge about Late Triassic dinosaurs of the northeastern United States.

Description and Present State of the Site: The Wolcott Quarry consists of several moderate-sized excavations in the sides of a small (0.25 x 0.1 mile) heavily wooded hill. The quarries have been abandoned (since about 1890) and are overgrown with shrubs and trees. The existence of these quarries is known primarily to local residents and certain scientists only. Current State maps do not indicate their presence, (See attached map). The property is believed to be in private ownership and there is little likelihood that it will be reactivated or destroyed by residential or industrial construction in the immediate future, although such risk does exist.

Reference List (partial):

Marsh, O.C., 1889. Notice of new American Dinosauria. Amer. Jour. Sci., 37:331-336.

_____, 1891. Notice of new vertebrate fossils. Amer. Jour. Sci., 42:265-269.

_____, 1892. Notes on Triassic Dinosauria. Amer. Jour. Sci., 43:543-546.

_____, 1896. The dinosaurs of North America., U.S. Geol. Surv., 16th Ann. Rept., Pt. 1:133-244.

Huene, F. von, 1906., Ueber die Dinosaurier der aussereuropaeischen Trias. Geol. und Pal. Abh. Neue Folge. VIII, Heft 2:1-60.

_____,1932. Die fossile Reptile-ordnung Saurischia, ihre Entwicklung und Geschichte. Mono. Geol. Pal. Ist Ser, Heft 4:1-368.

Lull, R.S., 1953. Triassic Life of the Connecticut Valley. Connecticut Geol. Nat. Hist Surv., Bull. 81:1-336.

Evaluation: 1.

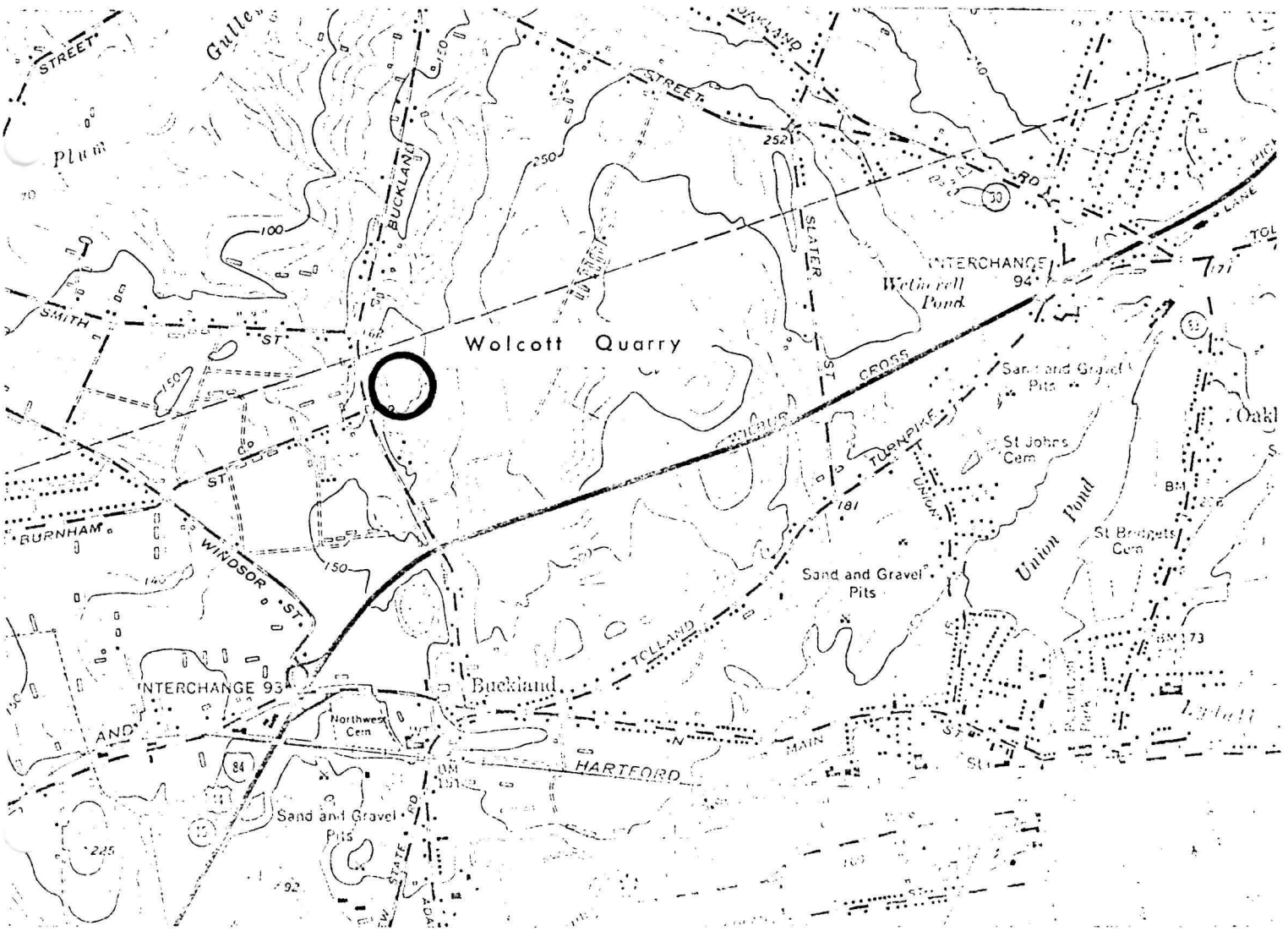
The Wolcott Quarry is unique, paleontologically. It produced the only specimens known of three early dinosaurs and is the only site in New England that has produced more than one dino-

saurian specimen. The quarry is intact and has not been worked since the early 1890's. It is quite possible that other specimens are preserved here. It is our judgement that this site meets the criteria of the National Park Service of National significance and a site of important scientific discoveries. It is classified in Category 1 (see the report by Robert Rose of March 14, 1969, included here as Appendix A, pages 110 - 111) but is judged to have the highest potential of any Triassic site in the eastern United States for future discoveries.

Recommendation: The Wolcott Quarry is recommended for designation as a Natural Landmark.

FIGURE 1. Location of the Charles O. Wolcott Quarry.

(Taken from the 1963 edition of the Manchester Quadrangle, 7.5 minute series, Topographic, N4145-W7230/7.5, Series V816, published by the United States Geological Survey.) Scale = 1:24000.



SITE 19.

RIKER HILL QUARRY, Roseland, New Jersey.

Location: 500 yards south of the Morristown and Erie Railroad crossing over Eagle Rock Avenue, Roseland, ~~Morris~~ County, New Jersey.

Geologic Data: Brunswick Formation (Newark Group), Upper Triassic.

Importance: Since its discovery in the spring of 1968, this site has already produced more than 1,000 specimens of dinosaur and other vertebrate animal footprints, insect trails and other impressions of the fauna of Late Triassic times. An unknown number of specimens have been removed from the site, but many of these have been preserved and are maintained in local collections, principally through the efforts and council of Mr. Robert Salkin of Newark and others. The majority of footprints are of five kinds - the most common types in the Triassic rocks of New Jersey and Connecticut and Massachusetts. These are known by the names Grallator, Eubrontes, Anchisauripus, Anomoepus and Batrachopus. The first four are all bipedal dinosaurs, probably theropod or flesh-eating kinds. The last is the track of a quadrupedal, crocodile-like reptile (thecodont). Numerous other kinds of footprints are preserved, but these have not as yet been positively identified. Most spectacular of these latter are several specimens of very tiny footprints of an extremely small, bipedal dinosaur. These prints measure from 0.5 to 0.75 inches in length and represent the only evidence known to date from any site of such miniature dinosaurs. The animals that made these tracks (probably juveniles) were about the size of a pidgeon or a crow. In addition to the vertebrate tracks numerous invertebrate (insects and other) trails are preserved, together with various sedimentary features (ripple marks) at several levels.

Description and Present State of the Site: The contractors have not visited the site but information provided by others indicate that the site has not been fully exploited, despite heavy collecting activity during the past two years. Considerable potential remains for preservation in situ of a modest to large area of the principal footprint-bearing surface. Current estimates indicate the preservable area might be half the size of the known trackway area at the Rocky Hill site (No. 2.) in Connecticut.

References: Still, Dianna, 1970. On the trail of hometown dinosaurs. Suburban Life, the Magazine of New Jersey, Feb. 1970, pp. 30, 31, 60, 61, 65. (This popular article is all that has been written.)

Evaluation: 2.

The Riker Hill Quarry is not unique, but it is one of only two or three localities of major size along the northeastern coast where large numbers of various kinds of dinosaurian footprints can be preserved in situ. Thus Riker Hill is classified as a Category 2 site, as defined in the March 14, 1969 report by R. Rose

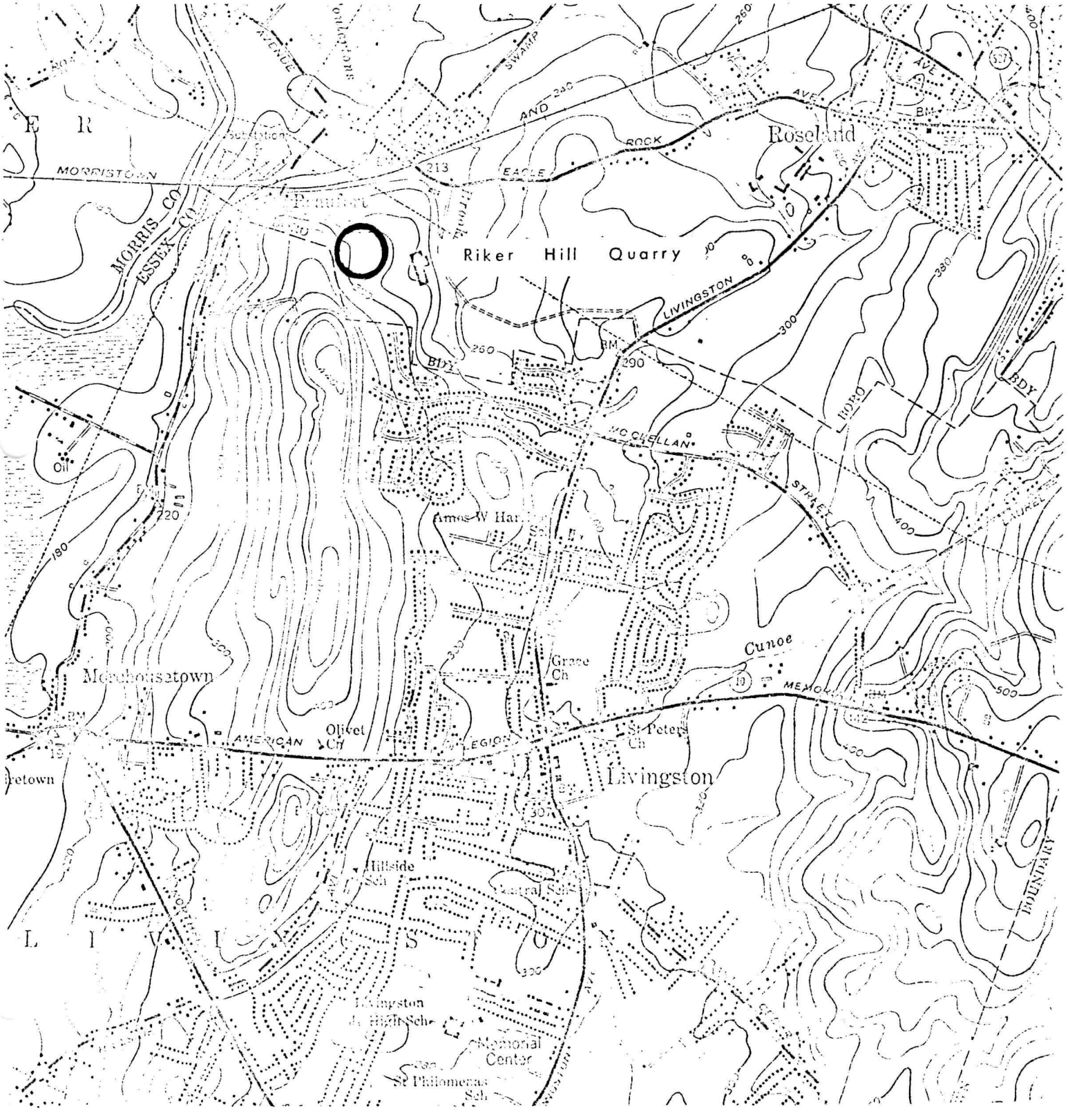
(page 110) to the Division of Special Planning Studies. In situ preservation is infinitely more informative and desirable than removal of specimens to be displayed (or stored away) in museums and schools. The location within the greater New York metropolitan area assures heavy use by a large school population if the site can be developed and properly maintained. Large areas of the site have been quarried, but sufficient areas remain that, upon proper excavation, probably will reveal hundreds, perhaps even thousands of additional prints.

This site has not been given the highest rating (1) for two reasons. Another site (Rocky Hill, Connecticut) of almost identical character has already been included in the Registry of Natural Landmarks. Thus the scientific value, and the National significance of the Riker Hill site is somewhat diminished. The site has not been developed as yet and unless there is good evidence that it will be preserved and developed as a State or local park, designation as a Natural Landmark cannot be justified on scientific or historic grounds.

Recommendation: The Riker Hill Quarry is recommended for consideration as a Natural Landmark <u>only</u> if the site is preserved and developed as a local or State park.

FIGURE 2. Location of the Riker Hill Quarry

(Taken from the 1954 edition of the Caldwell Quadrangle, 7.5 minute series, Topographic, - N4045-W7415/7.5. Published by the United States Geologic Survey.) Scale = 1:24000.



SITE 23.

EGYPT MINE, Cumnock, North Carolina

Location: 0.75 mile north of Cumnock (formerly the town of Egypt) on the south side of Deep River in Lee County, North Carolina.

Geologic Data: Cumnock Formation (Newark Group), Upper Triassic.

Importance: As noted in Part II, this now abandoned coal mine produced a number of fragmentary specimens (labyrinthodont amphibians and phytosaurs), plus two very important tiny jaws of two advanced mammal-like reptiles. These last belong to the order Therapsida that includes the ancestry of placental mammals. No true mammals or dinosaurs have been found at the Egypt Mine, but the site is of major importance as the only site in North America to produce remains of (probable) cynodont therapsids. The two specimens in question (Dromatherium and Microconodon) represent not only the only known cynodonts from North America, but they are among the last survivors of that group (and of therapsids in general). Therapsids were important contemporaries of early dinosaurs.

Description and Present State of the Site: The original source of the fossil finds noted here was the dumps or tailings of the now abandoned Egypt Mine. The present condition of the mine and the old tailings is not known, as the site has not been visited by the contractor.

Reference List (partial):

Leidy, Joseph, 1857. (Remarks on Dromatherium). Proc. Acad. Nat. Sci. Philadelphia, 1857, 149-150.

Marsh, O.C., 1891. Note on Mesozoic Mammalia. Proc. Acad. Nat. Sci. Philadelphia, 1891, 237-241.

Osborn, H.F., 1886. A new mammal from the American Triassic. Science, viii, p. 540.

_____, 1886. Observations upon the Triassic mammals Dromatherium and Microconodon. Proc. Acad. Nat. Sci. Philadelphia, 1886, 359-363.

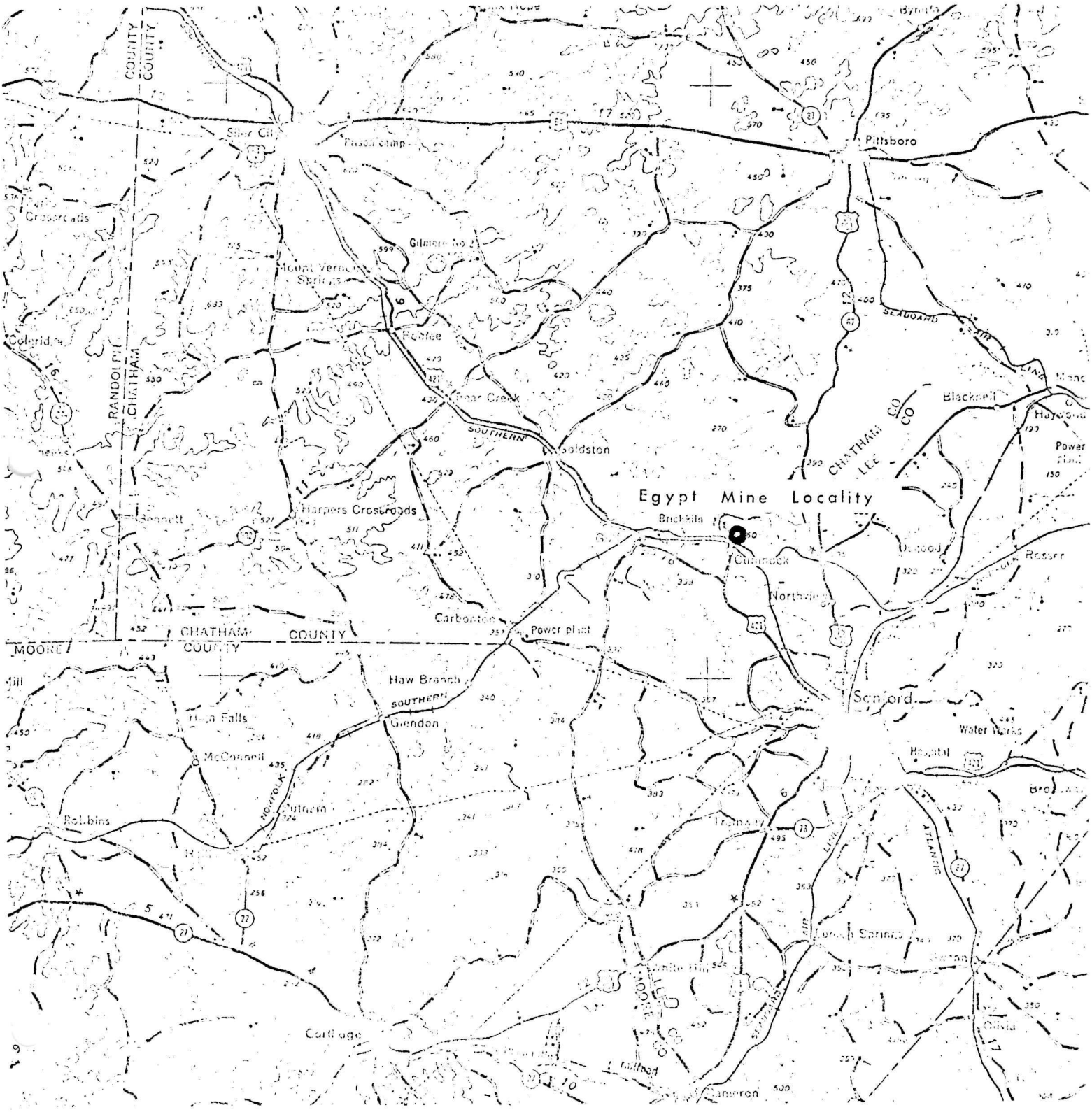
Evaluation: 2.

This site is of major paleontologic importance and in our judgement meets the criteria of National significance as a site of major scientific discoveries relevant to the development (history) of life on earth. It is classified as a Category 1 site (pages 110 - 1) the Rose report of March 14, 1969 to the Division of Special Planning Studies) in that visible evidences of fossil remains are not known to us. On site inspection of the site has not been possible, however, thus we are not in a position to give an up to date assessment of the condition of the site or to guarrantee site integrity. Further evaluation of the Egypt Mine site is suggested before any action is taken with reference to the Registry of Natural Landmarks.

Recommendation: On site evaluation of the Egypt Mine locality for further consideration as a possible designee of Natural Landmark.

FIGURE 3. Location of the Egypt Mine Site.

(Taken from the 1953 edition of the Raleigh, North Carolina topographic map, NI 17-3, AMS Series V501, published by the United States Geological Survey.) Scale = 1:250,000.



SITE 28.

GHOST RANCH, Abiquiu, New Mexico

Location: E ½, SW ¼ Sec. 1, T. 24 N., R. 4 E., on the southeast side of the small hill closest to the high mesa northeast of Ghost Ranch (see Fig. 4.), northwest of Abiquiu, Rio Arriba County, New Mexico.

Geologic Data: Chinle Formation, Upper Triassic.

Importance: This quarry produced dozens of exceptionally well-preserved skeletons of one of the earliest known and most primitive members (Coelophysis) of the carnivorous dinosaurs (Suborder Theropoda). Individuals of all ages are represented in the sample from very young to fully adult specimens. This is one of very few instances where growth stages are well represented in a single sample from what must represent part of a single population. These two important facts (growth stages and a population sample), together with the probable ancestral position of Coelophysis, make this site one of great importance.

Description and Present State of the Site: The American Museum of Natural History operated a large quarry here during 1948 and 1949, but abandoned operations after obtaining all the material required for a detailed analysis of Coelophysis. The deposit was not exhausted. Personal investigations in 1955 and again in 1958 verified the presence of additional fossil bone at the site. No further collecting has been done, but the Peabody Museum (Yale University) and the U.S. National Museum have tentatively planned to collect at this site in the near future. The land is owned by the United Presbyterian Curch in the U.S.A. which has developed a large recreation and conference center near by. The immediate area surrounding the Coelophysis Quarry is intact and has not been disturbed since the American Museum ceased operations in 1949.

Reference List (partial):

Colbert, E.H., 1961, Dinosaurs, their discovery and their world. E.P. Dutton & Co., New York, 300 .

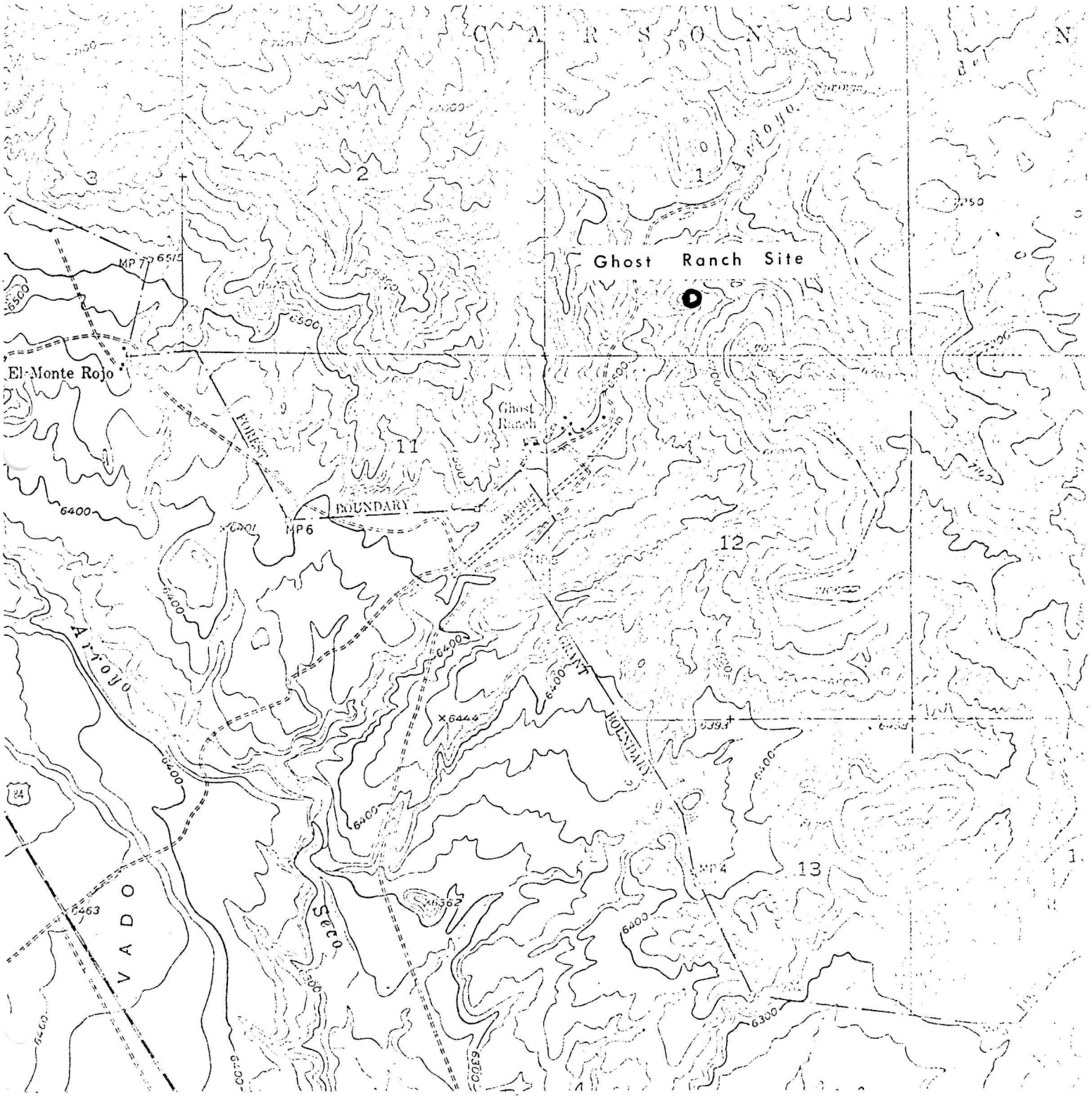
Evaluation: 1.

A site of major scientific importance that meets both criteria 2 and 9 (of page 27, National Park Service Criteria for Parklands) of significant fossil evidence of the development (history) of life, and of a site of important scientific discovery. It also has National significance. It is classified here in Category 2 (see the Rose report - Appendix, p.110 - to the Division of Special Planning Studies), and which should not be publicized until such time as site protection can be guarranteed. It is given the highest rating (1) here and clearly qualifies for designation as a Natural Landmark.

Recommendation: The Ghost Ranch site should be designated a Natural Landmark.

FIGURE 4. Location of the Ghost Ranch Site.

(Taken from the 1953 edition of the Ghost Ranch Quadrangle, 7.5 minute series, Topographic, N3615-W10622.5/7.5, published by the United States Geological Survey.) Scale = 1:24000.



SITE 31.

COMB RIDGE, Kayenta, Arizona.

Location: Six miles northeast of Kayenta near the top of Comb Ridge on the northeast side of the first major ravine 1.5 miles southwest of the jeep trail pass through Comb Ridge (the trail to Dinnehotso). No section, township or range information is available.

Geologic Data: Kayenta Formation, Upper Triassic.

Importance: This is the only known site in North America to produce articulated skeletal remains of advanced therapsids (tritylodonts) or mammal-like reptiles. Closely related tritylodonts are known from many sites on most other continents of the world, but this is the only site discovered to date in North America. Dozens of partial to complete skeletons, articulated and well preserved, have been recovered here, representing all ages from very young to very old individuals. These now reside in the collections of the U.S. Geological Survey and the American Museum of Natural History. These collections constitute one of very few collections of fossil vertebrates that represent a sample of a single population at a single moment in time and also include a sampling of the growth series. This particular site is of additional special significance because of the close evolutionary relationships of the tritylodonts recovered here to those that have been found in South Africa and Asia. Although tritylodonts are the principal kinds found at this site, dinosaurian and crocodilian remains also occur. This is one of the most important Mesozoic sites in North America.

Description and Present State of the Site: This site is situated on an isolated ledge on Comb Ridge far removed from human habitation. Few people know of its exact location because it has been visited only by scientists since its discovery in 1954. There is little liklihood of destruction by human or natural phenomena other than that caused by amateur collectors. As recently as 1966, fossil remains were still evident at the site, previous collections having been limited to samples sufficient for scientific studies. Further collections probably will be made by a few other institutions (especially Yale University Peabody Museum), but the site should be protected against amateur collectors. The site is within the Navajo Indian Reservation and thus subject to Federal jurisdiction.

Reference List (partial):

Lewis, G.E., 1958. American Triassic Mmammal-like vertebrates. Bull. Geol. Soc. Amer. 69:1735.

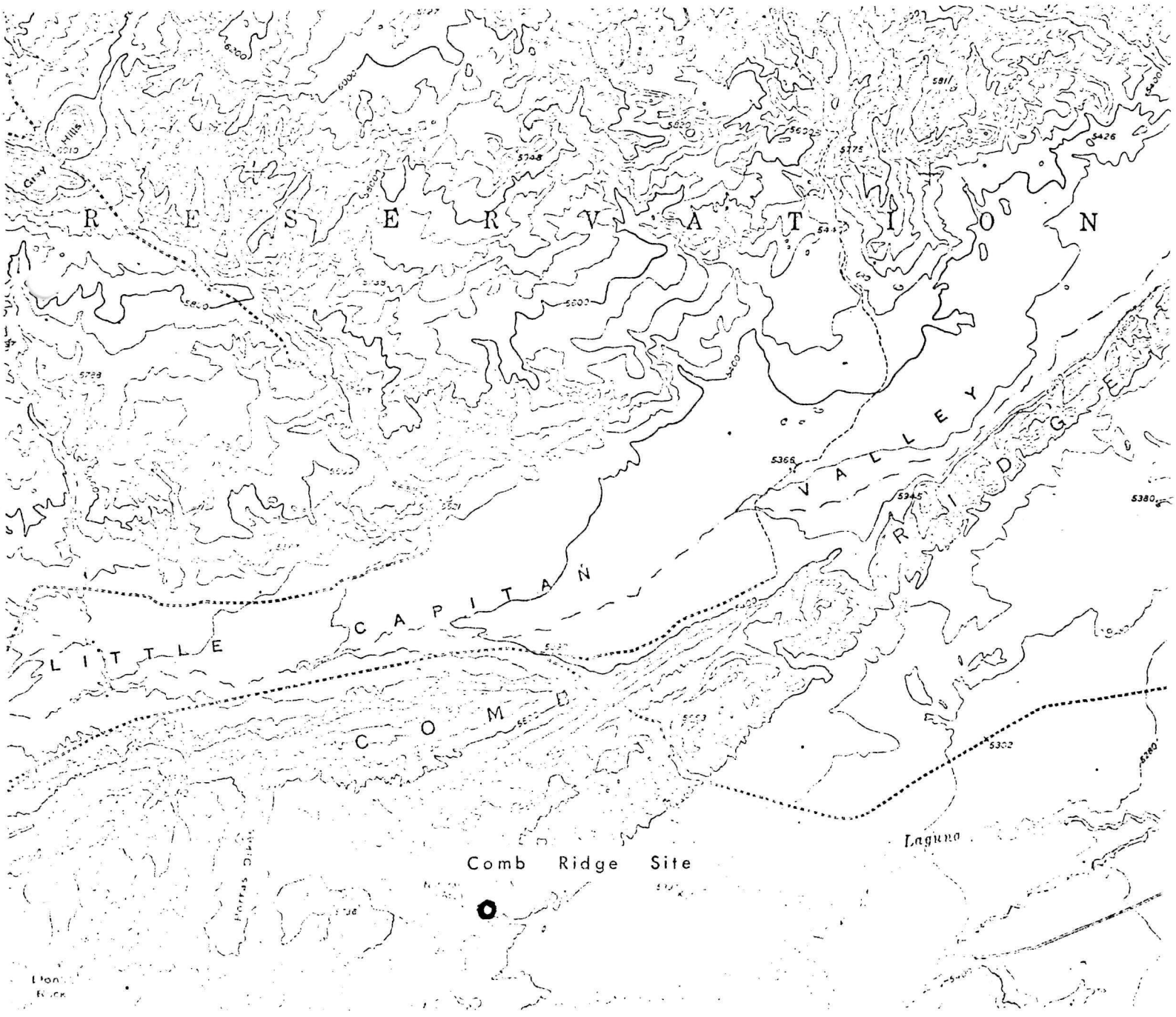
Evaluation: The Comb Ridge site clearly meets the criteria set forth by the National Park Service as to National significance, significant fossil evidence of past life and a site of important scientific discoveries. It is classified in Category 2 (see the Rose report -Appendix, p. - to the Division of Special Planning Studies) as a site that still contains important fossil remains.

It should not be publicized until site security can be guarranteed. The site is given the highest possible evaluation - a rating of 1. and is considered most qualified for designation as a Natural Landmark.

Recommendation: The Comb Ridge Site should be included in the Registry of Natural Landmarks.

FIGURE 5. Location of the Comb Ridge Site.

(Taken from the Agathla Peak Quadrangle, 1952 edition, 15 minute series, Topographic, N3645-W11000/15, published by the United States Geological Survey.) Scale = 1:62500.



SITE 39.

COMO BLUFF, Wyoming. (Part of this area was declared eligible in 1966.)

Location: East central Carbon County and west central Albany County, Wyoming. The recommended area encompasses most of Townships 22 N., Ranges 76 and 77 W., as shown in the accompanying maps of Figures 6 and 7. The region contains a large number of quarries of both scientific and historic importance, many of which are indicated in Figure 7. Because of the large number of sites, the area as a whole is defined here rather than specific sites.

Geologic Data: Morrison Formation, Upper Jurassic.

Importance: Within the scope of the present analysis, this region (rather than site) must be considered the most significant of all. It is the source of an unknown number of fossil vertebrate specimens including ichthyosaurs from the marine Sundance Formation and fish, amphibians, turtles, lizards, rhynchocephalians, pterosaurs, hundreds of dinosaurs and hundreds of priceless Jurassic mammals from the Morrison Formation. The dinosaurian and mammalian remains that were collected here are still among the most important specimens in the world and the Como Bluff region is still (nearly a century after its discovery) only one of three locales in the western hemisphere that has produced the ellusive Jurassic mammals. (The other two locales are Garden Park near Canyon City, Colorado and the Bone Cabin locale to the north of Como Bluff. The last locality first produced mammal remains in 1969 as a result of exploration by a joint Yale - American Museum endeavor.) A list of the important specimens from the Como Bluff region is too long for inclusion here, but such lists have been published (see Ostrom and McIntosh, 1966). These numerous specimens have been the subject of more than 100 technical papers (for a partial list of these see the anotated bibliography in Ostrom and McIntosh, 1966), as well as the basis of much other material included in general text books, and semi-popular and popular writings. The Como Bluff region has had significant impact in more than just scientific happenings.

Description and Present State of the Site: The area prescribed in this report (see Figures 6 and 7) is open prairie crossed by few graded (unpaved) roads. No ranches or residential dwellings are located within the area, but the land is actively used for cattle grazing. Most, if not all, of the presribed area is privately owned. Several of the most important quarries of past collectors, dating back to first exploitation in 1877, are still recognizable. If the area is to be designated as a Natural Landmark, some of these certainly should be marked with some kind of permanent monument - unless site security cannot be guarranteed.

Reference List: There are far too many technical and other publications dealing with this specific area to list them all, or to give fair representation. The following volume contains an anotated bibliography that includes the most important paleontologic papers.

Ostrom, John H. and McIntosh, John S., 1966, Marsh's Dinosaurs, the Collections from Como Bluff. Yale Univ. Press, New Haven, Conn., 388 p.

Evaluation: 1.

The single most important paleontologic site in the western hemisphere (within the scope of this study). It satisfies all criteria specified by the National Park Service for National Landmark qualification - National significance, site of important scientific discoveries, and containing important evidence of the development (history) of vertebrate life of earth. It is here considered a Category 2 site (as defined in the Rose report of March 14, 1969 to the Division of Special Planning Studies of the National Park Service), in that it still contains important specimens (as the recent operations by Yale and the American Museum have shown). The area is given the highest possible evaluation (1.) and part (see Fig. 6.) has been declared eligible for inclusion in the Landmark Register.

Recommendation: Inclusion in the Registry of Natural Landmarks.

Note: Como Bluff and the Cleveland-Lloyd Quarry are the only areas for ostrom accomplishment [illegible] for further study for possible inclusion on the National Park System

FIGURE 6. Location of the Como Bluff Area.

(Taken from the Como Ridge Quadrangle, 1943 edition, 15 minute series, Topographic, N4145-W10600/15, published by the United States Geological Survey.) Scale = 1:62500.

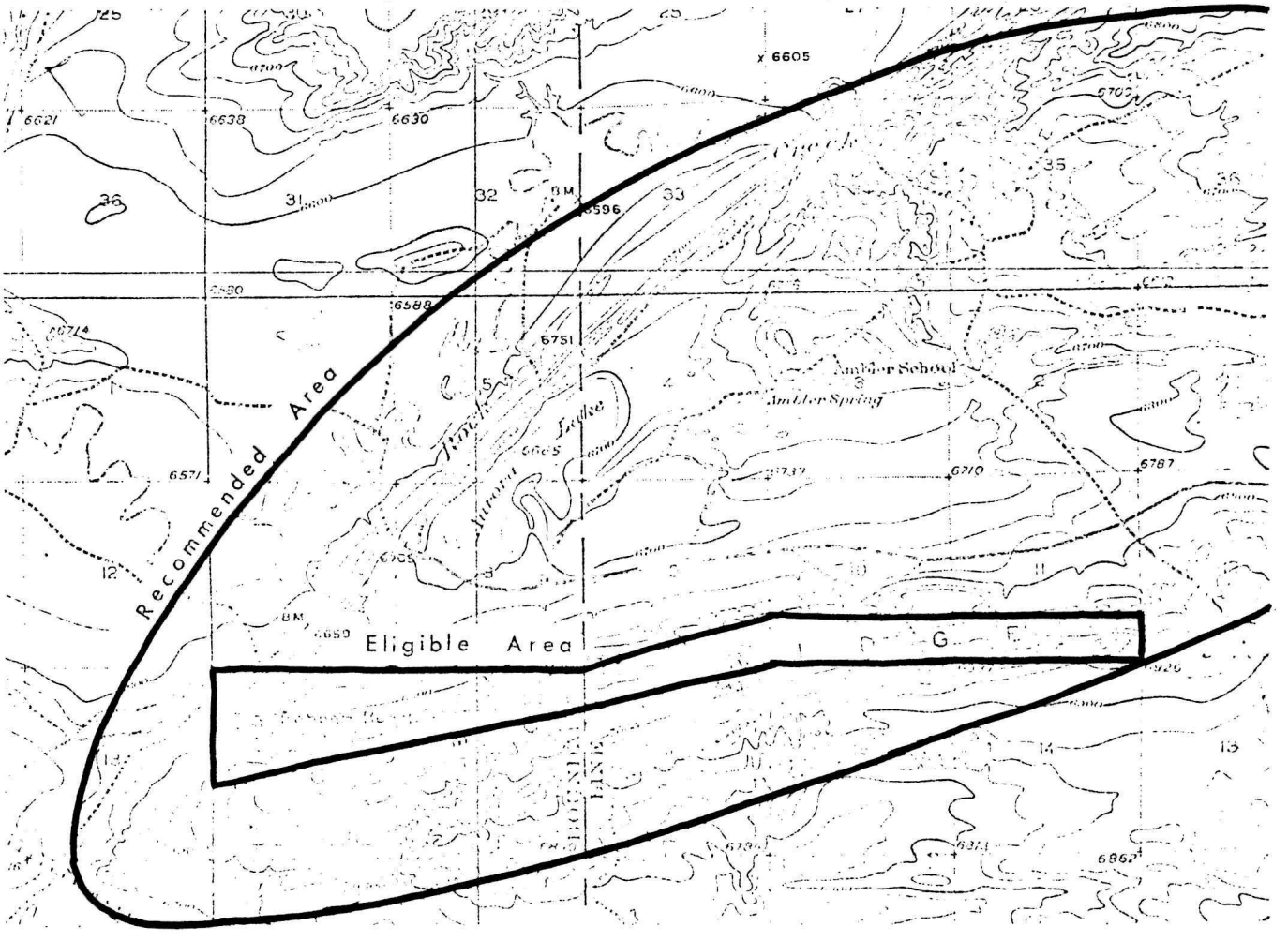
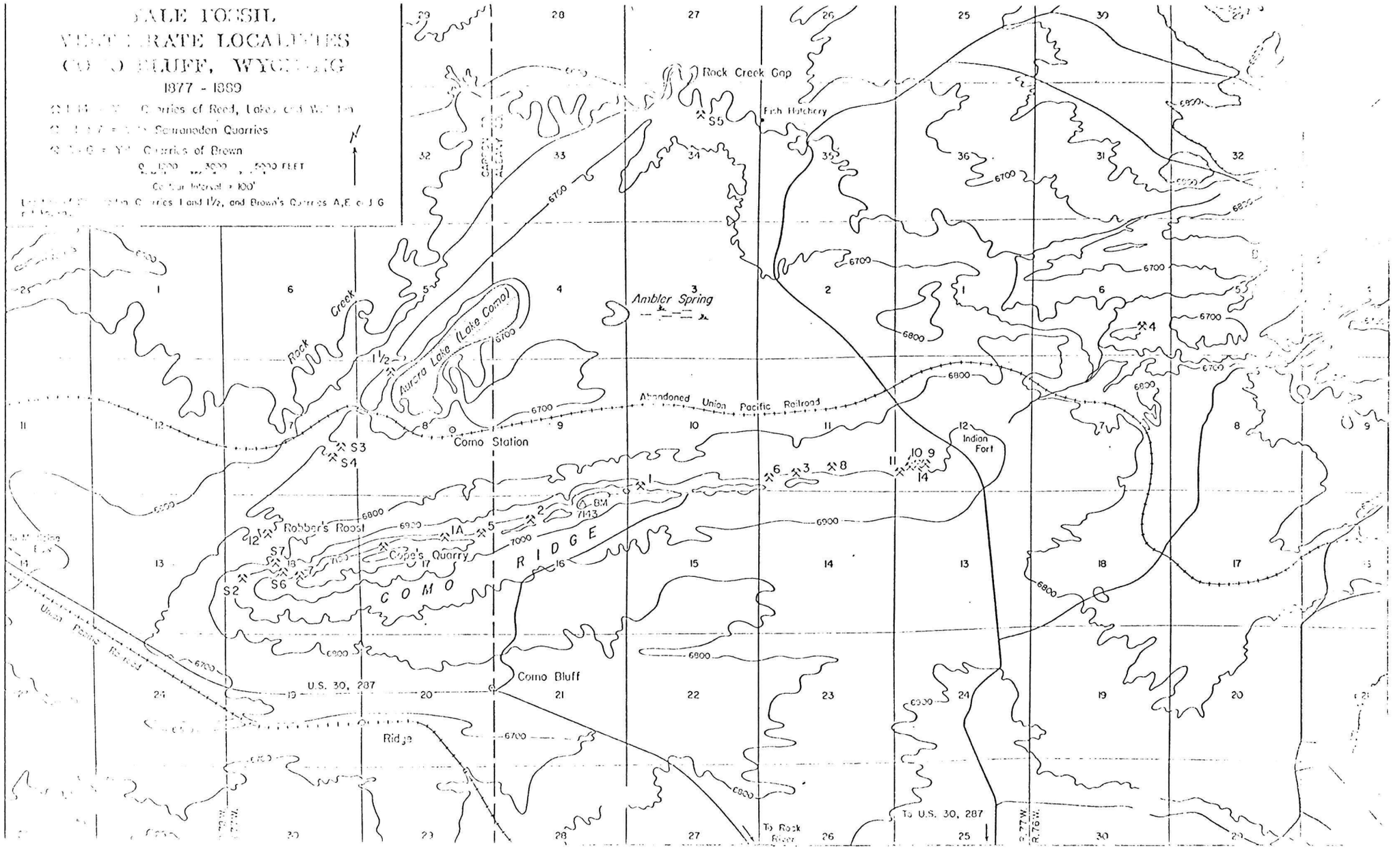


FIGURE 7. Map of the Como Bluff area

(Taken from Ostrom, John H. and McIntosh, John S., 1966. Marsh's Dinosaurs: the collections from Como Bluff. Yale University Press, New Haven, Connecticut.)



SITE 40.

BONE CABIN, Wyoming.

Location: N ½ Sec. 33, T. 24 N., R. 77 W., Albany County, Wyoming, approximately 8 miles north of Aurora Lake at Como Bluff.

Geologic Data: Morrison Formation, Upper Jurassic.

Importance: After Como Bluff, the Bone Cabin area must be recognized as the most significant Jurassic locality for terrestrial vertebrate fossil remains. The numbers of specimens excavated from this site do not match the numbers recovered from the much larger area defined as the Como Bluff area, but nevertheless they represent a major contribution to knowledge and a major fraction of the critical collections from the Morrison Formation from this region. Aside from dinosaurian remains (now in the collections of the American Museum of Natural History) the most significant of recent discoveries are those of fossil mammals made by the Yale - American Museum field party in 1969. Unfortunately a complete list of the kinds of vertebrate animals found here does not exist, but most (if not all) are listed in the collections from Como Bluff, made by myself and J.S. McIntosh.

Description and Present State of the Site: As with the Como Bluff area, this locale is open prairie with no ranch or other residential or agricultural structures (or development) in the immediate vicinity. The critical area is believed to be under private ownership, but may be under Federal jurisdiction under the Taylor Grazing Act. Alteration of the site by future construction or other development is seen as very unlikely for any time in the foreseeable future. The area exists today very much as it did during the 1890's (when collecting activities were at a peak here).

Reference List (partial):

Osborn, H.F., 1899. A skeleton of Diplodocus. Memoir, Amer. Mus. Nat. Hist. 1:191-214.

_____, 1899. Fore and hind limbs of carnivorous dinosaurs from the Jurassic of Wyoming. Bull. Amer. Mus. Nat. Hist. 12:161-172.

_____, Skull and skeleton of the sauropodous dinosaurs Morosaurus and Brontosaurus. Science (ns) 22:374-376.

Colbert, E.H., 1961. Dinosaurs, Their Discovery and their World. E.P. Dutton and Co., New York, 300 pp.

_____, 1968. Men and Dinosaurs. E.P. Dutton and Co., New York, 283 pp.

Evaluation: 1.

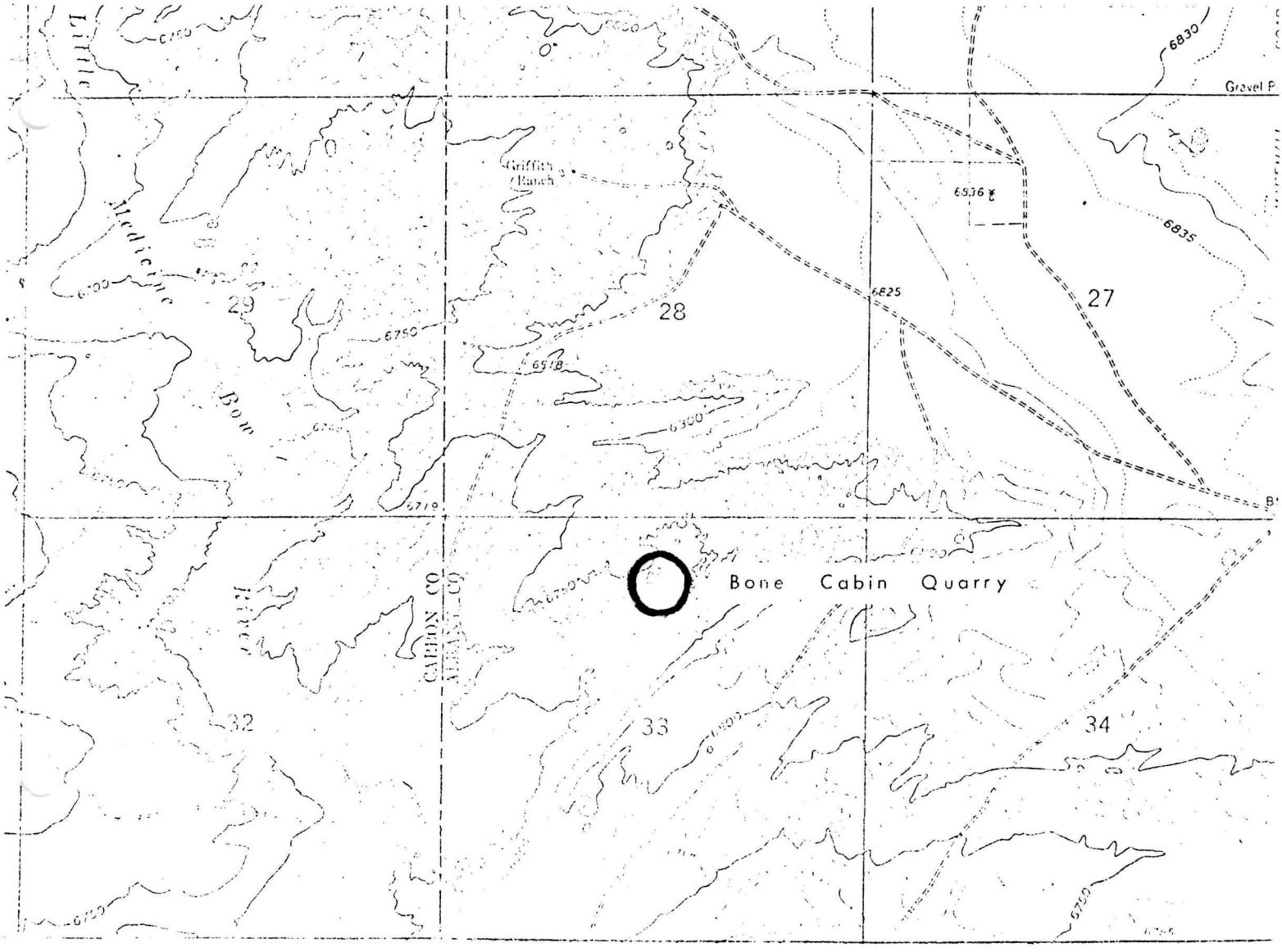
The Bone Cabin region, although less productive in total numbers of recovered specimens and more restricted in area (and accessibility) is second only to the Como Bluff area in overall importance as a Jurassic site of dinosaurian (and recently mammalian) remains. A large collection of partial skeletons of dinosaurs

(chiefly quarried) were obtained here by the American Museum of Natural History during the late 1890's and early 1900's. The area is intact and might well produce additional remains with further excavation. It is our judgement that the Bone Cabin site meets the Criteria of National significance as regards evidence of of the development and history of life and a site of major scientific discoveries. Although apparently assignable to Category 1 (as defined in the Rose report of March 14, 1969), it is considered a probable Category 2 site (bone fragments occur on the surface in the general vicinity) with good potential for future fossil finds with new excavation.

Recommendation: The Bone Cabin Locality is qualified for inclusion in the Registry of Natural Landmarks.

FIGURE 8. Bone Cabin Quarry.

(Taken from the Walker Draw SE Quadrangle, 1961 edition, 7.5 minute series, Topographic, N4200-W10600/7.5, published by the United States Geological Survey.) Scale = 1:24000.



SITE 43.

SHEEP CREEK, Wyoming.

Location: The area encompassed by Sections 10 and 11, T. 25 N., R. 76 W., Albany County, Wyoming. (See new topographic map in press - Toltec 3, N.W., Wyo. - 7½' Quad.)

Geologic Data: Morrison Formation, Upper Jurassic.

Importance: The Sheep Creek area is only slightly less important than the Bone Cabin and Como Bluff areas to the south. Like those locales, Sheep Creek has produced a number of spectacular specimens of dinosaurs, chiefly sauropods. The number of specimens and their scientific importance is less than that of either Como Bluff or Bone Cabin, but they still represent major discoveries and accordingly the Sheep Creek area is a site of major importance. Most of the specimens recovered from the Sheep Creek area are now housed in the collections of the American Museum of Natural History in New York, the United States National Museum in Washington, D.C. and the Carnegie Museum in Pittsburg.

Description and Present State of the Site: As with the two better known sites to the south (Como Bluff and Bone Cabin sites), the Sheep Creek area is open prairie, undeveloped except for occasional fence lines. The region is used intermittantly for grazing. There are no permanent ranch or other structures within the area in question and their seems to be virtually no possibility of such development in the near future. The immediate area is intact and probably has not been fully exploited. Bone fragments on the surface indicate that further excavation might well reveal additional specimens. Accordingly, the area is here designated a probable Category 2 site (see the Rose report of March 14, 1969). This means that the areashould be secured from amateur collectors (because of its remote and thus unpoliced location) prior to any publicity.

Reference List (partial):

Holland, W.J., 1900. The vertebral formula in Diplodocus. Science, (2), 9:816-918.

_____, 1905. The presentation of a reproduction of Diplodocus carnegie to the Trustees of the British Museum. Ann. Carnegie Mus. 3:443-452.

_____, 1905. Discovery of the skeleton of Diplodocus carnegiei Hatcher. Science (ns) 21:935.

_____, 1906. The osteology of Diplodocus Marsh. Memoir Carnegie Mus., 2:225-264.

Evaluation: 2.

This site qualifies for inclusion in the Registry of Natural Landmarks, but because it is so close geographically, and so similar paleontologically, to both the Como Bluff and Bone Cabin areas, it has not been given the highest rating. Moreover, Sheep Creek did not produce the quantity of fossil vertebrate specimens of major

significance that were recovered from these other sites. It did, however contribute a number of fine sauropod skeletons that are among the most complete known. If duplication of, and proximity to, the Como Bluff and Bone Cabin sites is not considered, then the Sheep Creek locale must be given a higher rating - perhaps only slightly lower than the ratings of the two better known sites, (1- ?).

Recommendation: A site of major paleontologic significance, but not recommended at this time for inclusion in the Registry of Natural Landmarks. It should, however, be listed as a site for future consideration.

SITE 48.

CLEVELAND - LLOYD DINOSAUR QUARRY NATURAL LANDMARK, Cleveland, Utah.

Location: Approximately 8 miles east of the town of Cleveland, Emery County, Utah. SE¼ SE¼ Sec. 22 & NE¼ NE¼ Sec. 28, T. 17 S., R. 11 E., Emery County, Utah.

Geologic Data: Morrison Formation, Upper Jurassic.

Importance: This site is unusual in that the fossil remains occur in what might be termed a bone conglomerate. The fossil bones are disarticulated, but occur in great numbers and are very well preserved. Camptosaurus and Stegosaurus remains are present, but those of Allosaurus constitute most of the fossil evidence recovered so far. The fact that carnivore remains predominate is very intriguing. Although few articulated series have been found, this site has provided important new information about growth series in Allosaurus, with many juvenile and sub-adult specimens represented. A most surprising result is evidence that Allosaurus grew as large (perhaps larger than) as Tyrannosaurus. The site has produced enough material to make possible the assembly of a number of composite skeletons that have been distributed to many institutions - including several museum abroad. It is my understanding that the State of Utah may designate this site as a State Park.

Description and Present State of the Site: Not having visited the site, the Contractors are not in a position to give an accurate description of the site and its condition. Second hand sources indicate that the site has not been exhausted and considerable potential remains for further development and production. The area presently is under Bureau of Land Management jurisdiction.

Reference List:

Stokes, W.L., 1961. Dinosaur Quarry near Cleveland, Utah. Proc. Utah Acad. Sci., 38:132-133.

_____, 1963. Cleveland - Lloyd Dinosaur Quarry, Emery County, Utah. Spec. Paper Geol. Soc. Amer., 73:96.

Madsen, J.R. Jr., and Stokes, W.L., 1963. New Information on the Jurassic Dinosaur Ceratosaurus. Spec. Paper Geol. Soc. Amer., 73:90.

Evaluation: 1.

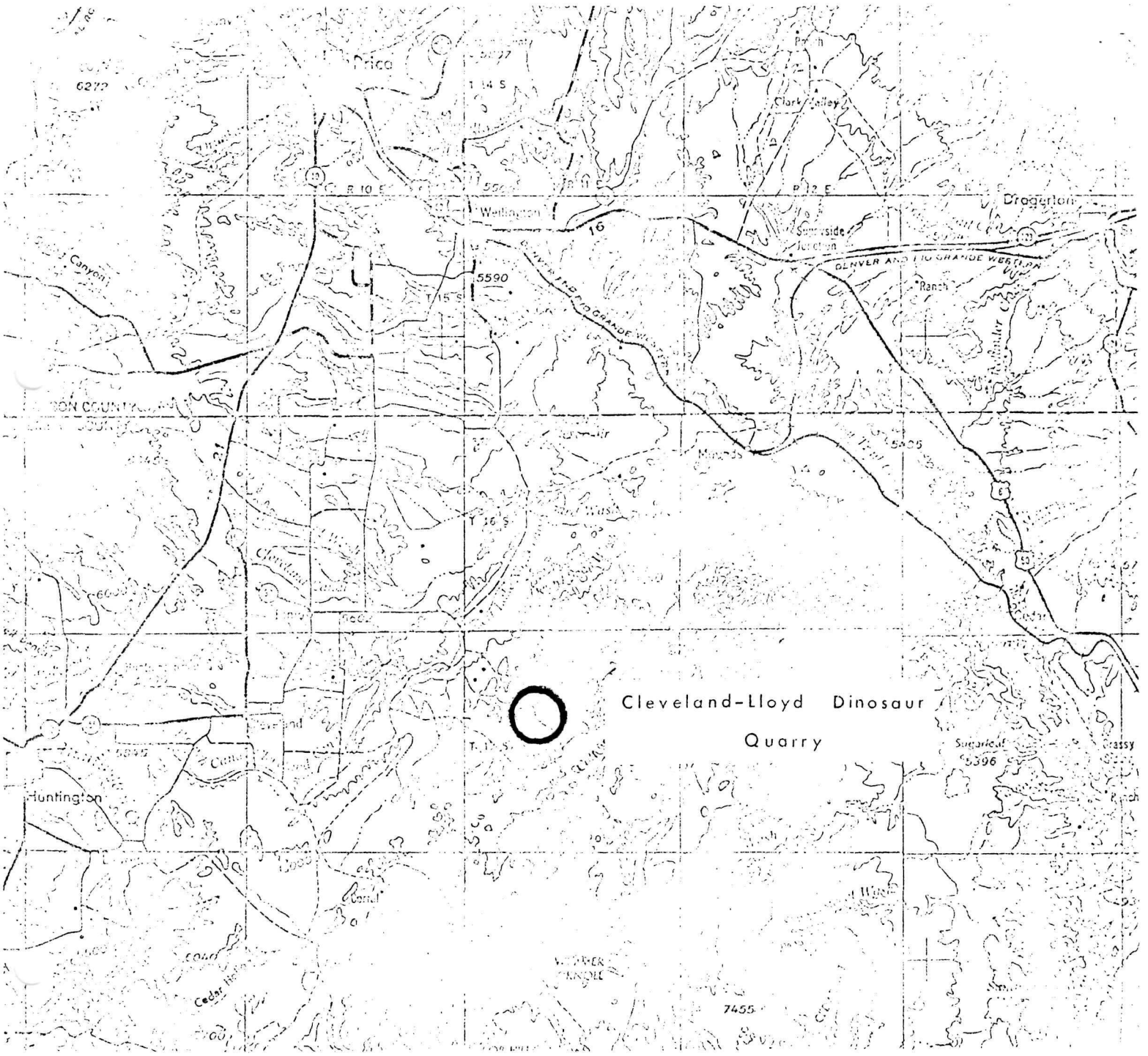
The Cleveland - Lloyd Quarry is given the highest rating here because it has produced a very large sample of Morrison dinosaur remains that may tell us a great deal about growth rates, life habits and paleoecology of the Morrison fauna. Fossil bone is still very much in evidence, thus it represents more than just a site of past discoveries. Accordingly, it is classified here as a Category 2 site that must be protected from amateurs before it is publicized. It is our opinion that the site still retains important evidence of past life and thus is nationally significant. It was registered as a Natural Landmark April 28, 1966.

NOTE Como Bluff and the Cleveland Lloyd Quarry are the only areas Dr. Ostrom recommends as probably qualifying for further study for possible inclusion in the National Park System

Recommendation: The Cleveland - Lloyd Quarry should be entered in the Registry of Natural Landmarks.

FIGURE 9. Location of the Cleveland - Lloyd Quarry.

(Taken from the Price, Utah sheet, 1960 edition, Corps of Engineers series, NJ 12-2, published by the United States Geological Survey.) Scale = 1:250,000.



SITE 51.

GARDEN PARK, Canyon City, Colorado.

Location: ~~SW~~ SE ¼ Sec. 28, T. 17 S., R. 70 W., Fremont County, Colorado, approximately 8 miles north of Canyon City.

Geologic Data: Morrison Formation, Upper Jurassic.

Importance: The Garden Park area is important on two counts. It is one of the three initial sites (the second actually) that were responsible for generating world-wide interest in 'giant saurians' during the latter part of the last century. It also is the site of important collections of a large number of dinosaurian and a few Jurassic mammal specimens. (The latter are the only other Jurassic mammals known from North America from a site outside of the Como Bluff - Bone Cabin areas of Wyoming.) Many of the specimens recovered here are type specimens and some are among the finest specimens recovered from the Morrison Formation. This locale, together with the Morrison, Colorado area and the Como Bluff, Wyoming region were largely responsible for the "great dinosaur rush" of the last century and for the subsequent interest in prehistoric life that made the word "dinosaur" a household word.

Description and Present State of the Site: The site is in a rural and undeveloped area north of Canyon City. It is quite accesible by road and a number of ranches and homes are in the general area, but it is not now threatened by urban development. A monument exists here commemorating the paleontologic significance of the site, but I do not know whether the State or County has assumed any responsibility for protection of the area. Some evidence of fossil bone at several exposures was evident when I last visited the area, so there is reason to believe that future excavations might uncover new remains.

Reference List (partial):

Cope, E.D., 1977. On a gigantic saurian from the Dakota epoch of Colorado. Paleont. Bull., 25:5-10.

Marsh, O.C., 1978. Principal characters of American Jurassic dinosaurs, Part I. Amer. Jour. Sci., (3), 16:411-416.

_____, 1887. Principal characters of American Jurassic dinosaurs, Part IX, The skull and dermal armor of Stegosaurus. Amer. Jour. Sci., (3), 34:413-417.

_____, 1896. Dinosaurs of North America. U. S. Geol. Surv., 16th Ann. Rept., pp. 133-415.

Ostrom, John H. and McIntosh, John S., 1966. Marsh's Dinosaurs: The collections from Como Bluff. Yale Univ. Press, New Haven, Conn., 388 p.

Colbert, E.H., 1968. Men and Dinosaurs. E.P. Dutton & Co., New York City, 283 p.

Evaluation: 1.

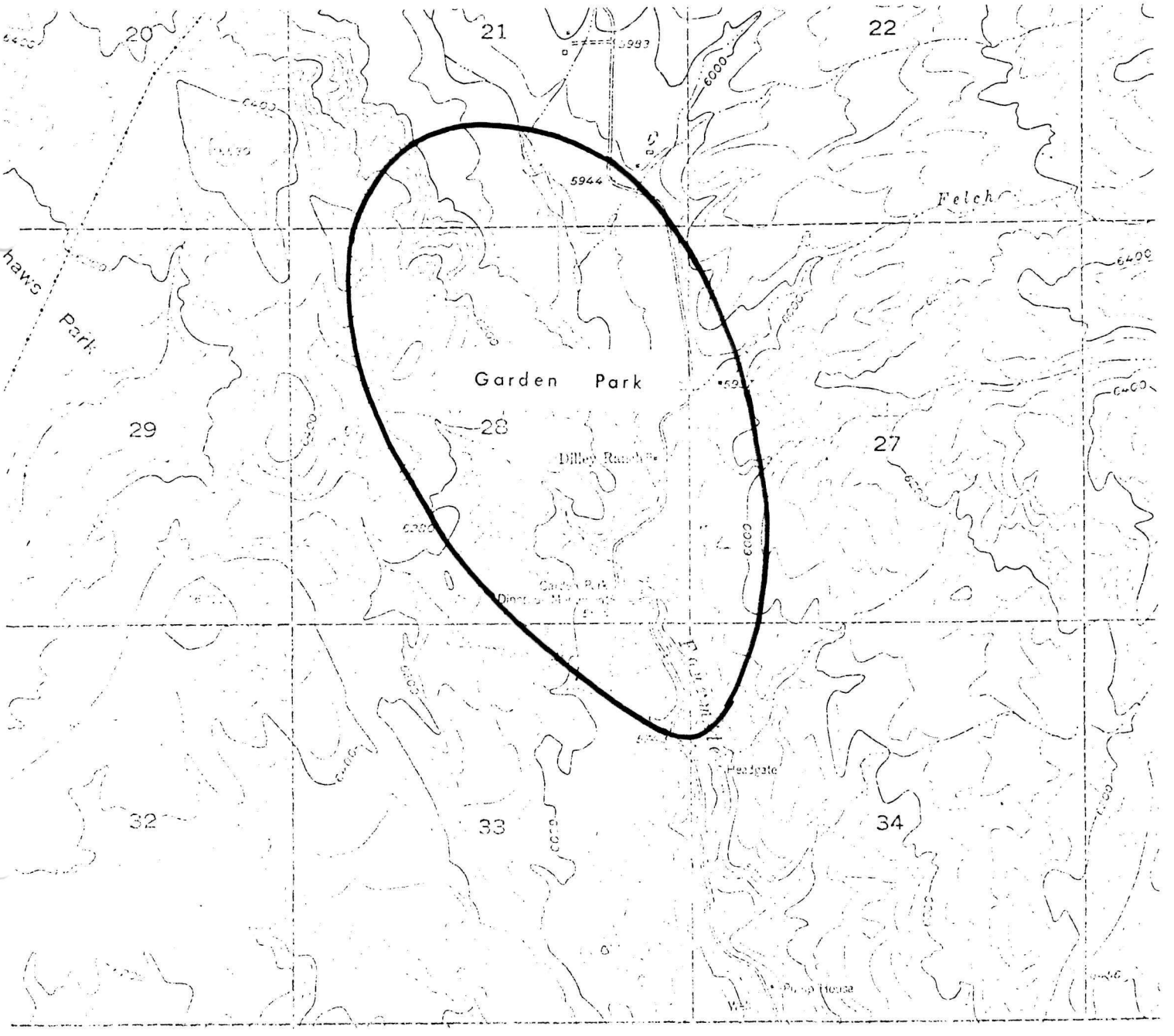
The Garden Park area qualifies for inclusion in the Registry of Natural Landmarks on both scientific and historic grounds.

and is perhaps second only to the Como Bluff area in overall importance. It is our judgement that the site meets the National significance criteria as a site of important scientific discoveries. It is tentatively classified as a Category 2 site (see the Rose report of March 14, 1969), although the region probably has been nearly exhausted. It is rated here the highest possible rank of 1.

Recommendation: The Garden Park area should be included in the Register of Natural Landmarks.

FIGURE 10. Location of the Garden Park area.

(Taken from the Cooper Mountain Quadrangle, 1954 edition, 7.5 minute series, Topographic, N3830-W10507.5/7.5, published by the United States Geological Survey.) Scale = 1:24000.



SITE 52.

MORRISON, Colorado.

Location: NW¼ Sec. 26 and SE ¼ Sec. 35, T. 4 S., R. 70 W., Jefferson County, Colorado.

Geologic Data: Morrison Formation, Upper Jurassic.

Importance: This locale ranks only slightly lower in overall importance than the Garden Park locality and it may be considered comparable by some authorities. Historically, it was this site, together with Garden Park, that first produced gigantic fossil bones and thus triggered the great "dinosaur rush". It subsequently produced fine specimens of a number of dinosaurs, including Apatosaurus (Brontosaurus), Diplodocus, Allosaurus and Stegosaurus. The volume of materials recovered from this site does not compare with that of either Garden Park or Como Bluff, but because of its particular historic importance it may be considered worthy of Natural Landmark designation.

Description and Present State of the Site: The Contractors have not visited the site in nearly a decade and thus cannot give an up to date assessment of the site. It is sufficiently close to metropolitan Denver that considerable changes may have occurred since that time. The original quarries were located along the Morrison hogback southwest of Denver over a distance of two miles north of the village of Morrison. The setting is one that has certain appeal for residential construction, but it is not known to what extent such construction may have altered the vicinity. It is quite probable that the area as a whole will have to be specified, rather than pinpointing precise quarry spots, in order protect the integrity of the quarries. Whatever action follows, on site inspection will be required.

Reference List (partial):

Marsh, O.C., 1877. Notice of a new and gigantic saurian. Amer. Jour. Sci., (3), 14:87-88.

_____, 1877. New order of extinct Reptilia (Stegosauria) from the Jurassic of the Rocky Mountains. Amer. Jour. Sci., (3), 14:513-514.

_____, 1877. Notice of new dinosaurian reptiles from the Jurassic Formation. Amer. Jour. Sci., (3), 14:514-516.

_____, 1878. Notice of new dinosaurian reptiles. Amer. Jour. Sci., (3), 15:241-244.

_____, 1879. Principal characters of American Jurassic dinosaurs. Part II, Amer. Jour. Sci., (3), 17:86-92.

_____, 1896. Dinosaurs of North America. U. S. Geol. Surv., 16th Ann. Rept., pp. 133-415.

Ostrom, John H. and McIntosh, John S., 1966. Marsh's Dinosaurs; the collections from Como Bluff. Yale Univ. Press, New Haven, Conn., 388 p.

Colbert, E. H., 1968. Men and Dinosaurs. E. P. Dutton & Co., New York City, 285 p.

Evaluation: 1-.

The Morrison area qualifies on both scientific and historic grounds and satisfies the criteria of national significance for inclusion in the Registry of Natural Landmarks. It has been rated slightly lower than the highest possible score of 1 because of uncertainties about site integrity and future security of the immediate area from urban expansion.

Recommendation: This site should be included in the Registry of Natural Landmarks if there is reasonable assurance that urban development (past as well as future) will not jeopardize the site.

FIGURE 11. Location of the Morrison area.

(Taken from the Morrison Quadrangle, 1965 edition, 7.5 minute series, Topographic, N3937.5-W10507.5/7.5, published by the United States Geological Survey.) Scale = 1:24000.

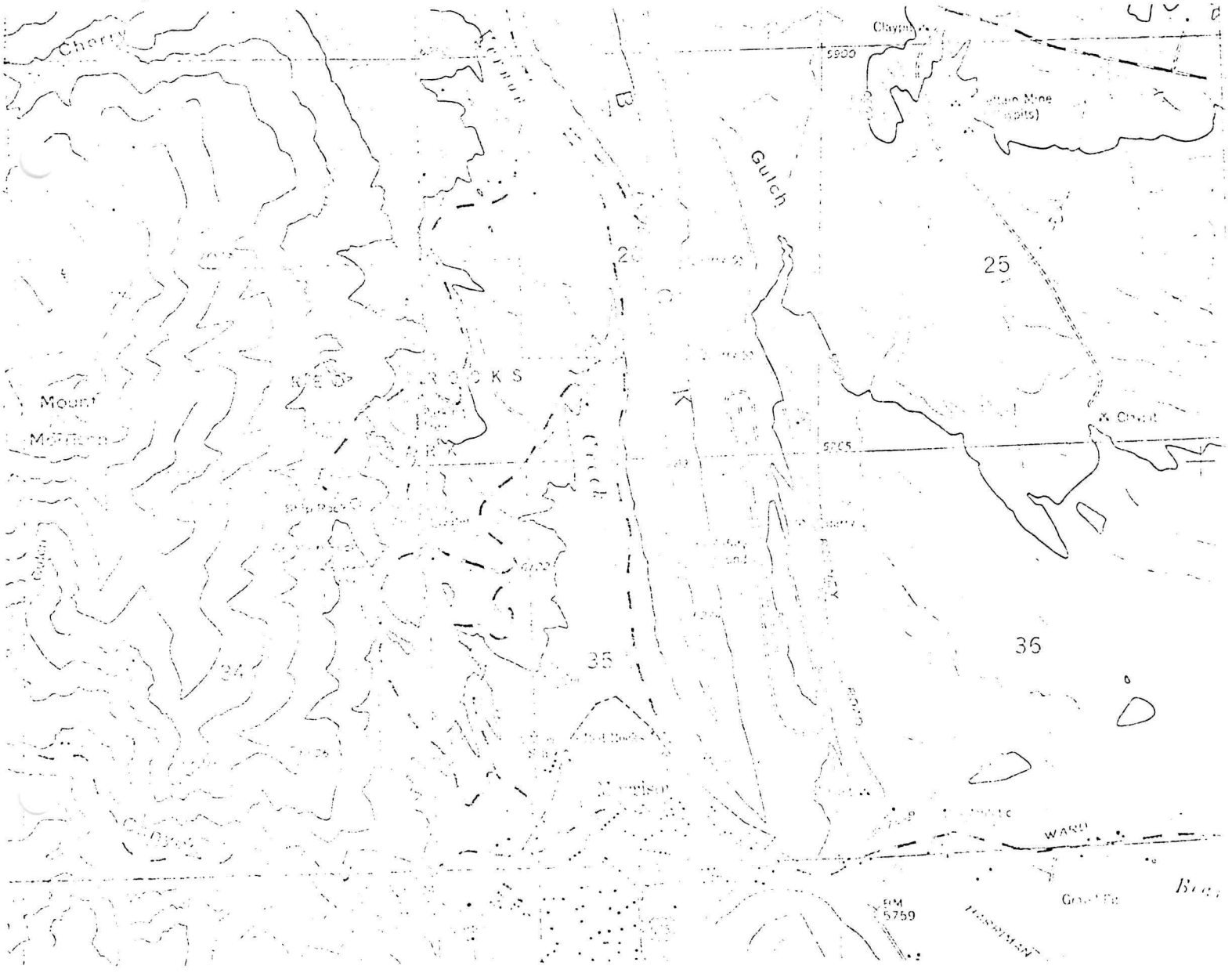


FIGURE 12. Map of the Morrison Quarries.

(Taken from Ostrom, John H. and McIntosh, John S., 1966. Marsh's Dinosaurs: the collections from Como Bluff. Yale University Press, New Haven, Connecticut.)

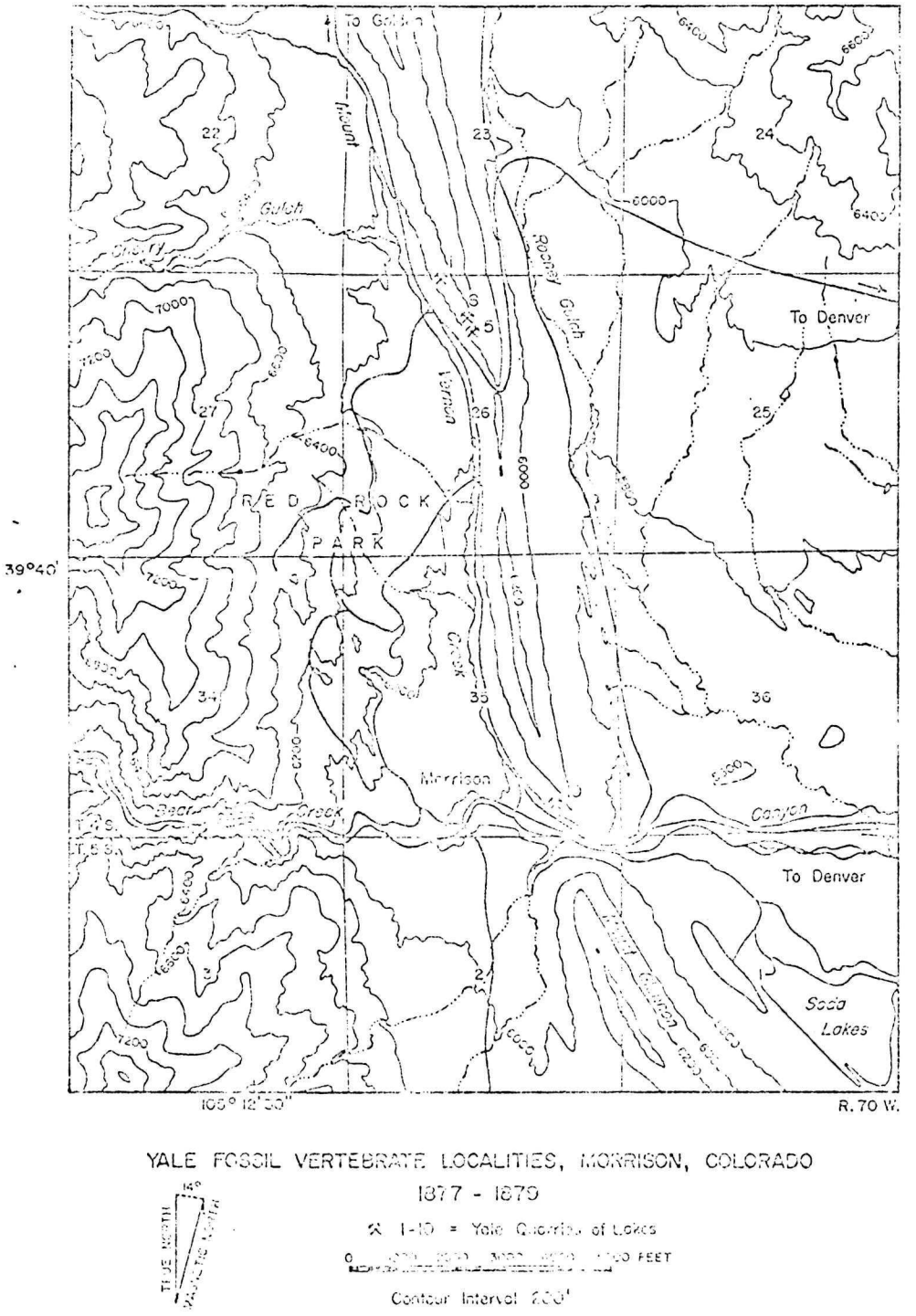


Fig. 2. Map of the Morrison, Colorado, area and the Yale fossil vertebrate localities.

SITE 56.

HADROSAURUS FOULKII SITE, Haddonfield, New Jersey.

Location: In Pennypacker Park adjacent to Cooper River, West Haddonfield, New Jersey.

Geologic Data: Woodbury Formation, Upper Cretaceous.

Importance: The Haddonfield site is one of great scientific and historical importance because it is the source of the first (reported) articulated dinosaurian remains found in the western hemisphere. There are some reports (not verifiable now) of earlier finds that could well have been of isolated dinosaurian bones, but this site is the first site known of an articulated, partial skeleton. Much of the specimen has subsequently been lost, but parts of it are still preserved in the collections of the Philadelphia Academy of Natural Sciences. It is noteworthy that this was also the first dinosaurian specimen to be exhibited in the New World.

Description and Present State of the Site: The Contractor has not visited the site, but the location recorded on a sketch map by Leidy (1858) is now situated within a small community park (Pennypacker Park). Unless industrial or residential expansion threatens the area, the Park and the Hadrosaurus site (now probably covered with fill) would appear to be secure and can be preserved by the City. On site inspection and discussion with local authorities will be required.

Reference List (partial):

Leidy, Joseph, 1858. Hadrosaurus foulkii, a new saurian from the Cretaceous of New Jersey. Proc. Acad. Nat. Sci. Philadelphia, 10:215-218.

Cope, E.D., 1883. On the characters of the skull in the Hadrosauridae. Proc. Acad. Nat. Sci. Philadelphia, 35:97-107.

Colbert, E.H., 1961. Dinosaurs; their discovery and their world. E.P. Dutton & Co., New York City, 300.p.

_____, 1968. Men and Dinosaurs. E.P. Dutton & Co., New York City, 283 p.

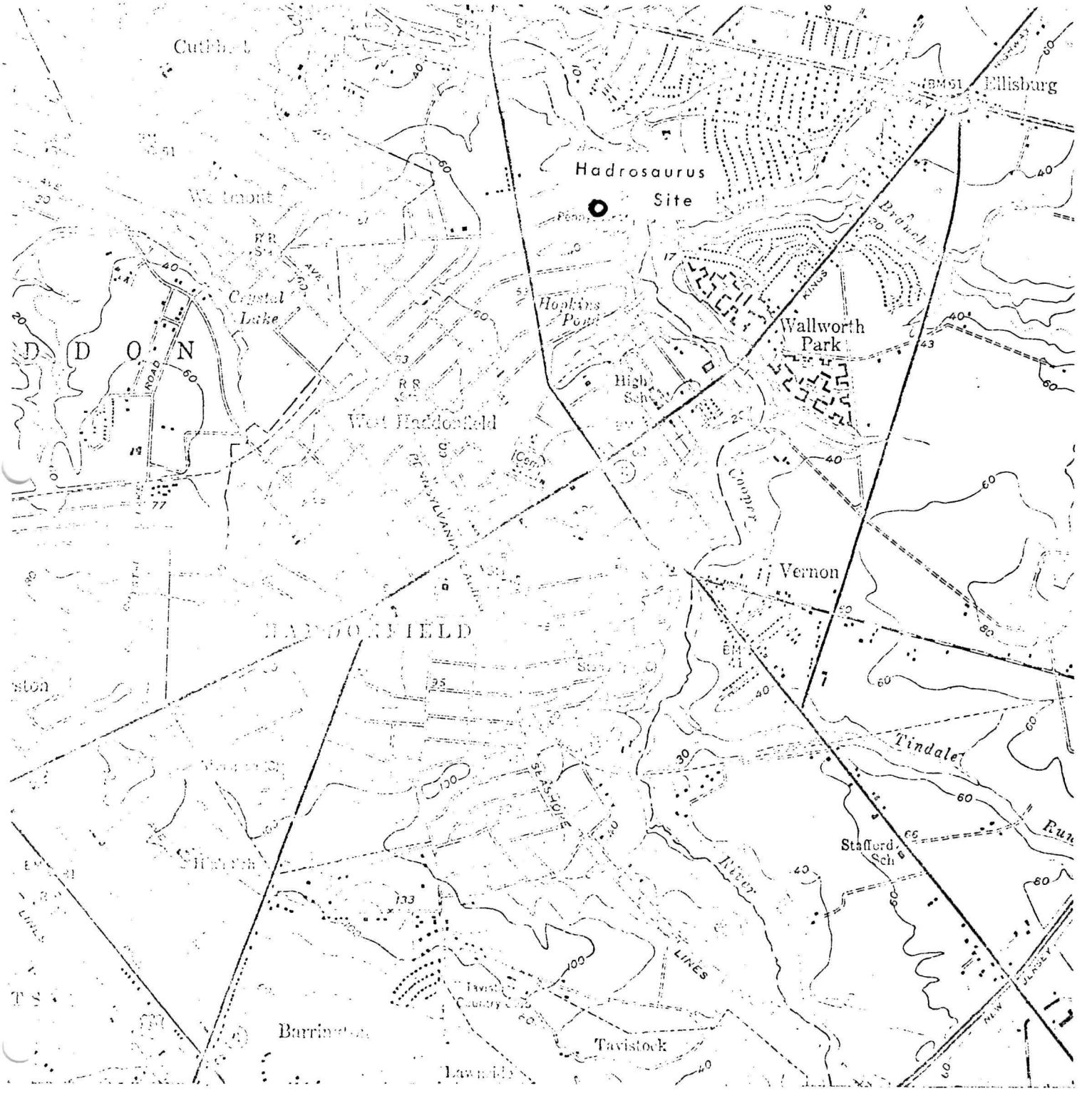
Evaluation: 1.

This site, because of its historical prominence, is given the highest possible rating. Current intact (but modified) condition of the site would make inclusion of the site possible and local situation would seem to provide means for adequate protection. The site meets the National significance criteria and also that of a site of important scientific discovery. It is here classified as a Category 1 site (see the Rose report of March 14, 1969), although future excavation (unlikely) might well reveal additional fossil remains.

Recommendation: Designation as a Natural Landmark.

FIGURE 13. Location of the Hadrosaurus foulkii site.

(Taken from the Camden Quadrangle, 1949 edition, 7.5 minute series, Topographic, N3952.5-W7500/7.5, published by the United States Geological Survey.) Scale = 1:24000.



SITE 64.

GREENWOOD CANYON, Forestburg, Texas.

Location: 2.5 miles southwest of Forestburg, Montague County, Texas.

Geologic Data: Trinity Formation, Lower Cretaceous.

Importance: This is the most important site of Early Cretaceous mammal remains in the western hemisphere, that has been published to date. Major collections were obtained here in the late 1940's by the Field Museum in Chicago. It still is the only published site in North America of Early Cretaceous, but B. Slaughter of Southern Methodist University has recently discovered additional sites in Texas that have not yet been published. (Slaughter's localities should be kept track of for future consideration, but information about them must be obtained from Slaughter.)

Description and Present State of the Site: The Contractors have not visited the Greenwood Canyon locality. It is situated in a rural region of Texas on private land that currently is used for agricultural purposes. The site is semi-protected in that it is privately owned and unrestricted access has been prevented. Some unauthorized collecting may have occurred, but this probably is not a major threat. Construction on the site seems to be a very remote possibility.

Reference List (partial):

Patterson, Brian, 1951. Early Cretaceous mammals from Northern Texas. Amer. Jour. Sci. 249:31-46.

_____, 1955. A symmetrodont from the Early Cretaceous of Northern Texas. Fieldiana, Zool., 37:689-693.

_____, 1956. Early Cretaceous mammals and evolution of mammalian molar teeth. Fieldiana, Geol., 13:1-105.

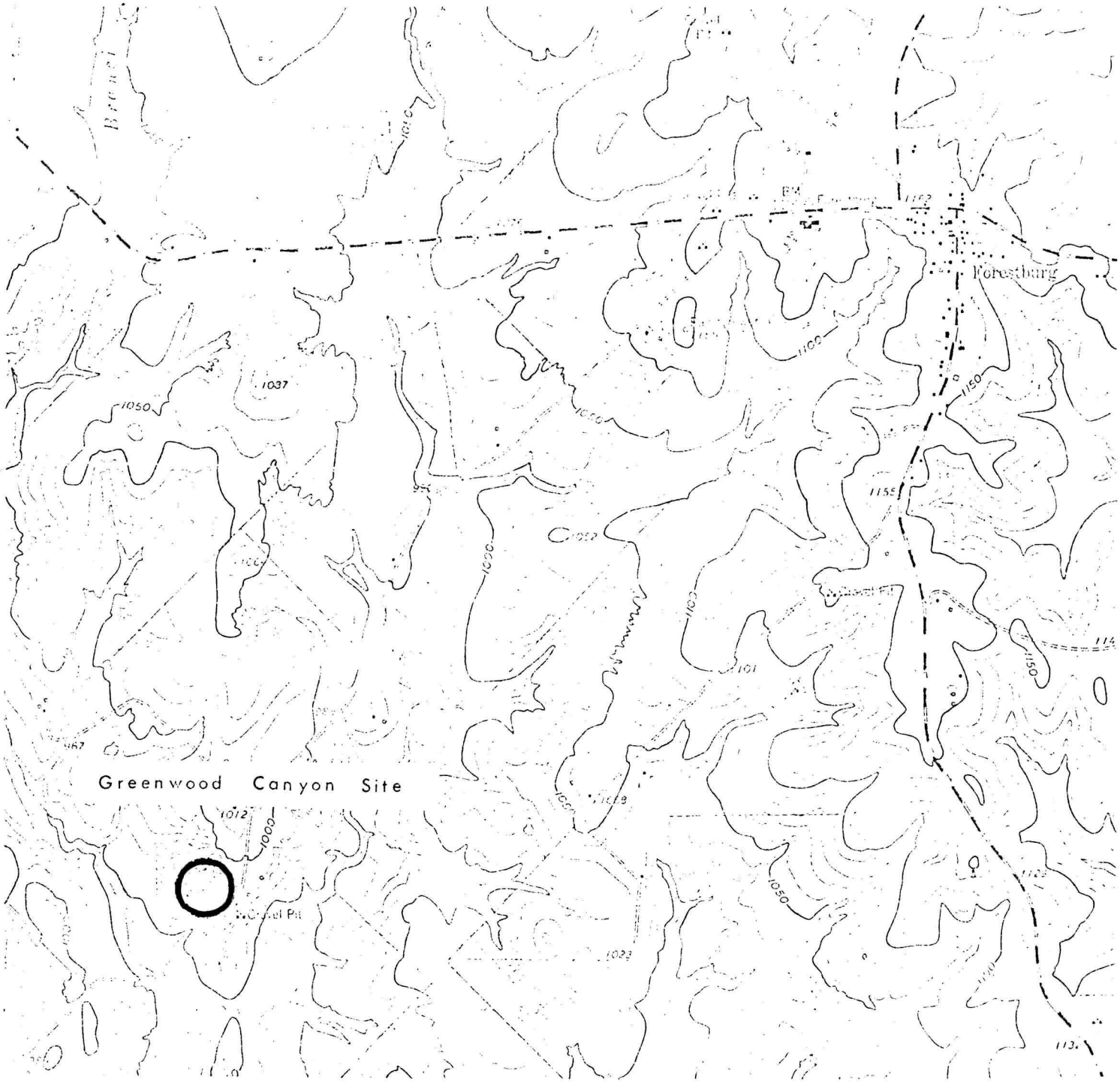
Evaluation: 2.

As one of very few known sites of Early Cretaceous mammals in the New World, which still retains potential for further fossil discoveries, this site might be given the highest possible rating of 1, but in view of the recent discoveries by Slaughter which have not yet been completely evaluated the present site has been downgraded slightly. One or more of the new sites may prove to be of greater significance so that relative importance of this site cannot be given now.

Recommendation: Include the Greenwood Canyon Site on a "standby" list for future consideration and possible inclusion in the Registry of Natural Landmarks after new site evaluations are available.

FIGURE 14. Location of the Greenwood Canyon site.

(Taken from the Forestburg Quadrangle, 1961 edition, 7.5 minute series, Topographic, N3330-W9730/7.5, published by the United States Geological Survey.) Scale = 1:24000.



SITE 79.

TYRANNOSAURUS LOCALITY, Montana.

Location: Exact location not known at present. Records list it as on the east side of Big Dry Creek, 8 miles from the Willis Ranch and 25 miles south of Lismas, in Garfield County, Montana. Quite probably the site is lost and beyond rediscovery now.

Geologic Data: Hell Creek Formation, Upper Cretaceous.

Importance: The site of the most complete specimen of Tyrannosaurus, clearly the best known kind of dinosaur. In fact, Tyrannosaurus (and Brontosaurus) could well be considered symbolic of the "dinosauria" - at least in the public mind. Although Tyrannosaurus is obviously of major importance, it would be difficult to demonstrate that it is scientifically more important than any other dinosaurian kind. Thus, this site is included here chiefly because of the symbolic stature and unusual nature of Tyrannosaurus.

Description and Present State of the Site: Unfortunately, the exact location of this site has not been established and the contractors thus have not inspected the area and cannot describe either the site or its condition. The region given in the field records of the American Museum lies in a remote, badlands area of eastern Montana. It appears there is little likelihood that the site has been - or will be built over. The greatest hazard is that the site may be lost.

Reference List (partial):

Osborn, H.F., 1905. Tyrannosaurus and other Cretaceous carnivorous dinosaurs. Bull. Amer. Mus. Nat. Hist. 21:259-265.

_____, 1906. Tyrannosaurus, Upper Cretaceous carnivorous dinosaur (2nd Comm.), Bull. Amer. Musm Nat. Hist. 22:281-296.

_____, 1912. Crania of Tyrannosaurus and Allosaurus. Memoir Amer. Mus. Nat. Hist., 1:1-30.

_____, 1913. Tyrannosaurus, restoration and model of the skeleton. Bull. Amer. Mus. Nat. Hist., 32:91-92.

_____, 1916. Additional characters of Tyrannosaurus and Ornithomimus. Bull. Geol. Soc. Amer., 37:150-151.

_____, 1916. Skeletal adaptations of Ornitholestes, Struthiomimus, Tyrannosaurus. Bull. Amer. Mus. Nat. Hist., 35: 733-771.

Evaluation: 2.

Although potentially the most famous of all sites listed here, the fact that the exact location is not known (at least to the Contractors) and probably is lost greatly reduces the immediate significance of this site to the National Park Service. Thus it is rated only 2 here and listed under other sites considered.

Recommendation: The Tyrannosaurus site is not recommended (at this time) for inclusion in the Registry of Natural Landmarks. It should be retained on an active list of potential sites, though, in case additional information about the location turns up.

SITE 86.

BUG CREEK ANTHILL LOCALITY, Montana. - Eligible.

Location: W ½ Sec. 9, T. 22 N., R. 43 E., on Bug Creek, McCone County, Montana.

Geologic Data: Hell Creek Formation, Upper Cretaceous.

Importance: This is one of eight recently discovered sites (see Sites 80 - 87 of the Inventory of Part II) that have produced very large collections of diverse mammalian faunas of Latest Cretaceous age - possibly the very last moments of Cretaceous time. Associated with the mammalian remains are numerousfragmentary remains of dinosaurs. Any one of the eight sites qualifies for consideration as a Natural Landmark; the present site is recommended as representative of all eight and as such it is a major source of our knowledge about early mammalian evolution during the waning stages of dinosaurian history. On these grounds it clearly satisfies the criteria of National significance.

Description and Present State of the Site: The site is located in remote rural plains country that is utilized chiefly for grazing purposes and wheat cultivation. There is no liklihood of serious damage to the site by highway or building construction or even further dam construction and flooding of the Missouri River. The site is believed to be on private land and unrestricted access by unauthorized persons is difficult, although not impossible. This site is part of the Bug Creek Fossil Area declared eligible for Natural Landmark designation April 19, 1966. *

Reference List (partial):

Sloan, R.E. and Van Valen, L., 1965. Cretaceous mammals from Montana. Science. 148:220-227.

Evaluation: 1.

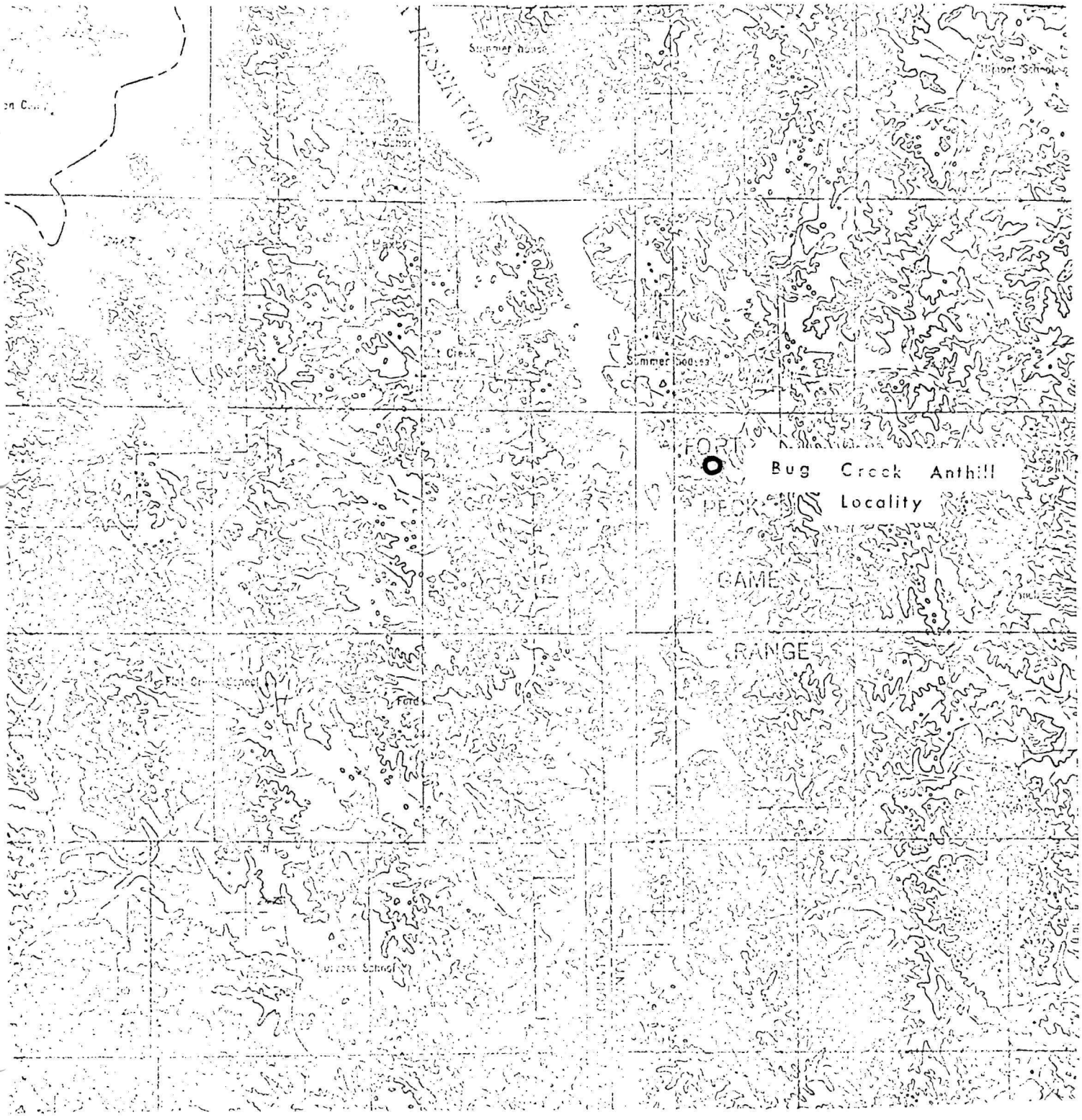
As one of the most productive and important sources of fossil evidence pertaining to the initial stages of mammalian evolutionary radiations during the twilight hours of the dinosaurian reign, the Bug Creek Anthill Site is especially well qualified for inclusion in the Registry of Natural Landmarks. It meets the criteria of National significance and of a site of important scientific discoveries, as well as a site containing evidences of past life. It is classified as a Category 2 site, with ample evidence of further fossil remains at the site. Site security probably will have to be increased. As a private holding, some measure of security exists, but further precautions will be required.

Recommendation: The site should be included in the Registry of Natural Landmarks.

* Note: The Bug Creek Fossil Area that has been declared eligible for Natural Landmark designation also includes Sites 85 and 87 of the Inventory (Part II) of this report.

FIGURE 15. Location of the Bug Creek Anthill Site.

(Taken from the Jordan, Montana sheet, 1958 edition, Corps of Engineers series, NL 13-1, published by the United States Geological Survey.) Scale 1:250,000.



SITE 99.

(for simplicity sake, we are going to call this "Cloverly Formation Site"

BEAUVAIS CREEK, Montana.

Location: E ½ Sec. 32 and N ½ Sec. 33, T. 4 S., R. 29 E., Big Horn County, Montana.

Geologic Data: Cloverly Formation, Lower Cretaceous.

Importance: The region outlined here has produced a large number of partial and nearly complete dinosaurian skeletons (an armored ankylosaur, a large ornithopod and a small carnivore) of Early Cretaceous age. It is the single most productive region in all of North America for Early Cretaceous vertebrates. Terrestrial sediments of this age are not common in North America (or anywhere in the world for that matter) and terrestrial faunas are consequently scarce. Thus, this locality has special significance and should be preserved and recorded in the Registry of Natural Landmarks.

Description and Present State of the Site: This site is situated near the center of the Crow Indian Reservation of southern Montana, approximately 35 "road" miles from the nearest paved highway. Access is difficult with ordinary vehicles and impossible at times even with special vehicles. At present the region is not inhabited, although an abandoned ranch house (Cashen Ranch) is sometimes used as temporary line camp quarters by cattle men. The immediate area is primarily one of grasslands used chiefly for grazing, but there are limited areas cultivated for hay crops and nearby areas are major wheat producers. The fossil sites occur in local badland areas. The general area outlined here (see Fig. 16) would appear to be completely secure from vandalism and destruction by building or highway construction by virtue of its remote location within the Crow Reservation. Nevertheless, some measure will be required to insure site security if the Beauvais Creek area is given prominent publicity.

Reference List (partial):

Ostrom, John H., 1969. A new theropod dinosaur from the Lower Cretaceous of Montana. Postilla, Peabody Museum , Yale Univ. 128:1-17.

_____, 1969. Osteology of Deinonychus antirrhopus, an unusual theropod from the Lower Cretaceous of Montana. Bull. Peabody Mus. Nat. Hist. 30:1-165.

_____, 1970. Stratigraphy and paleontology of the Cloverly Formation (Lower Cretaceous) of the Bighorn Basin area, Wyoming and Montana. Bull. Peabody Mus. Nat. Hist. 35:1-

_____, In Press. Reptiles from the Lower Cretaceous of the western interior.

Evaluation: 1.

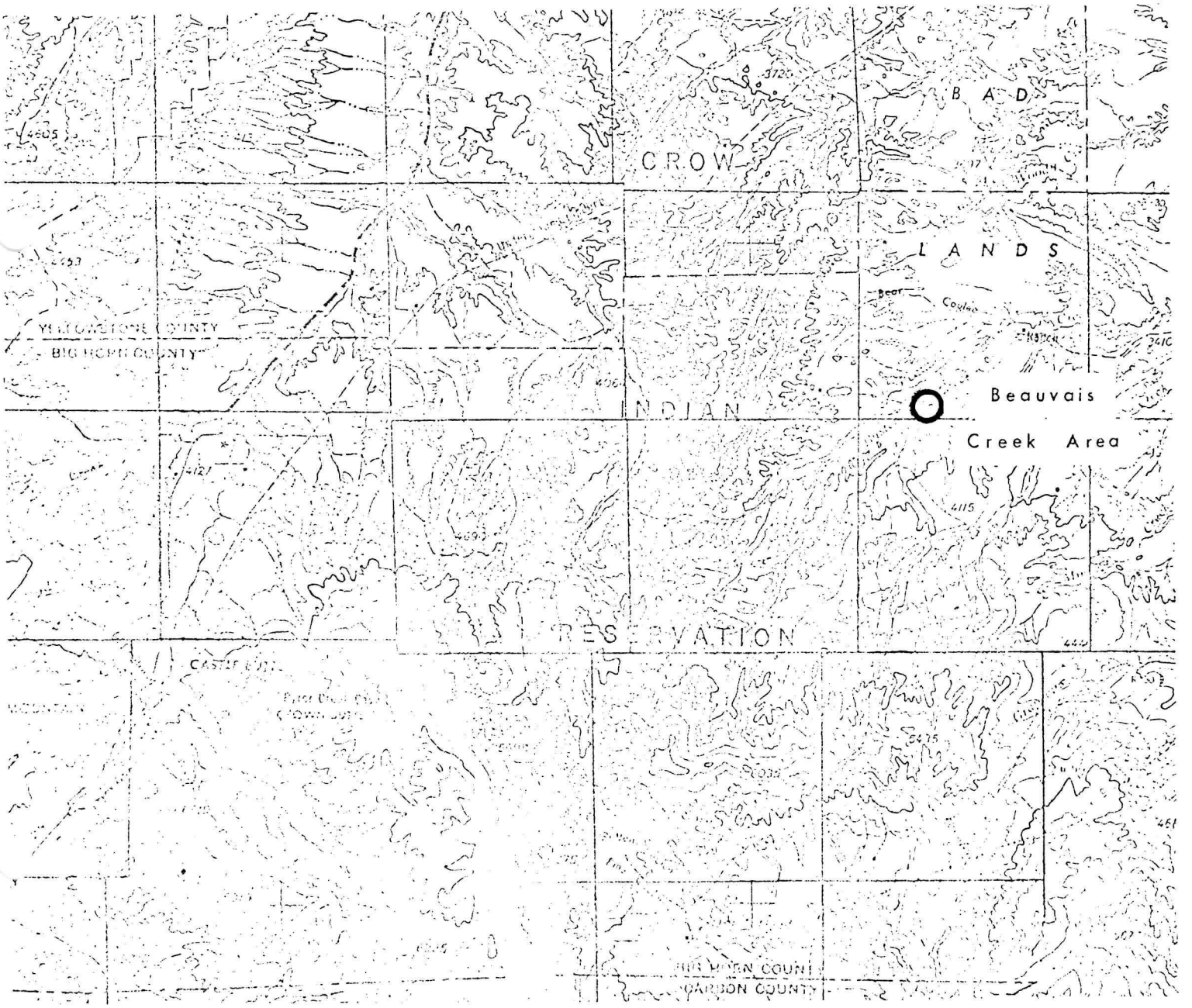
This is a major site of Early Cretaceous vertebrate remains that clearly meets the criteria of National significance as a site of important scientific discoveries and preserving evidence of life of the past. This site is not in the same category as Como Bluff

(Site 39), but it still is one of the major Mesozoic sites in North America. It is given the highest rating here (1). Some evidence remains that fossil bone may still be recovered by new excavation. Accordingly the area has been classified a Category 2 site, but my own exploration and collecting activities here in recent years have led me to the conclusion that new finds of importance are very unlikely.

Recommendation: The Beauvais Creek area definitely should be designated a Natural Landmark.

FIGURE 16. Location of the Beauvais Creek area.

(Taken from the Billings, Montana sheet, 1954 edition, Corps of Engineers series, NL 12-9, published by the United States Geological Survey.) Scale = 1:250,000.



SITE 108.

BRIDGER, Montana.

Location: NE ¼ Sec. 17, T. 7 S., R. 24 E., approximately 7 miles southeast of Bridger, Carbon County, Montana.

Geologic Data: Cloverly Formation, Lower Cretaceous.

Importance: This site includes several quarries that produced numerous partial skeletons from Lower Cretaceous strata (Cloverly Formation), including the remains of armored, ornithopod and carnivorous dinosaurs. Most interesting of these remains are those of several specimens of an unusual, small carnivore, (Deinonychus). The latter are now known to be the earliest representatives of a rather specialized evolutionary line of theropod dinosaurs (Dromaeosauridae).

Description and Present State of the Site: The locality is in gentle to moderately rough, sage brush and badland terrain approximately 5.5 miles east of U.S. Highway 310, and 7 miles southeast of the town of Bridger. The land here is in private ownership and is not likely to be seriously altered by any kind of construction. The critical sites could be threatened by vandals and souvenir hunters, but not without the approval of the owner. Fossil remains are still evident, but extremely difficult (and hazardous) to obtain at the principal quarry sites. The area is clasified here as a Category 2 site according to the Rose report of March 14, 1969.

Reference List (partial):

Ostrom, John H., 1969. A new theropod dinosaur from the Lower Cretaceous of Montana. Postilla, Peabody Museum, Yale Univ., 128:1-17.

_____, 1969. Osteology of Deinonychus antirrhopus, an unusual theropod from the Lower Cretaceous of Montana. Bull. Peabody Mus. Nat. Hist. 30:1-165.

_____, 1969. Terrible Claw. Discovery, 5, No. 1:1-9.

_____, 1970. Stratigraphy and paleontology of the Cloverly Formation (Lower Cretaceous) of the Bighorn Basin area, Wyoming and Montana. Bull. Peabody Mus. Nat. Hist., 35:1- ?

Evaluation: 2.

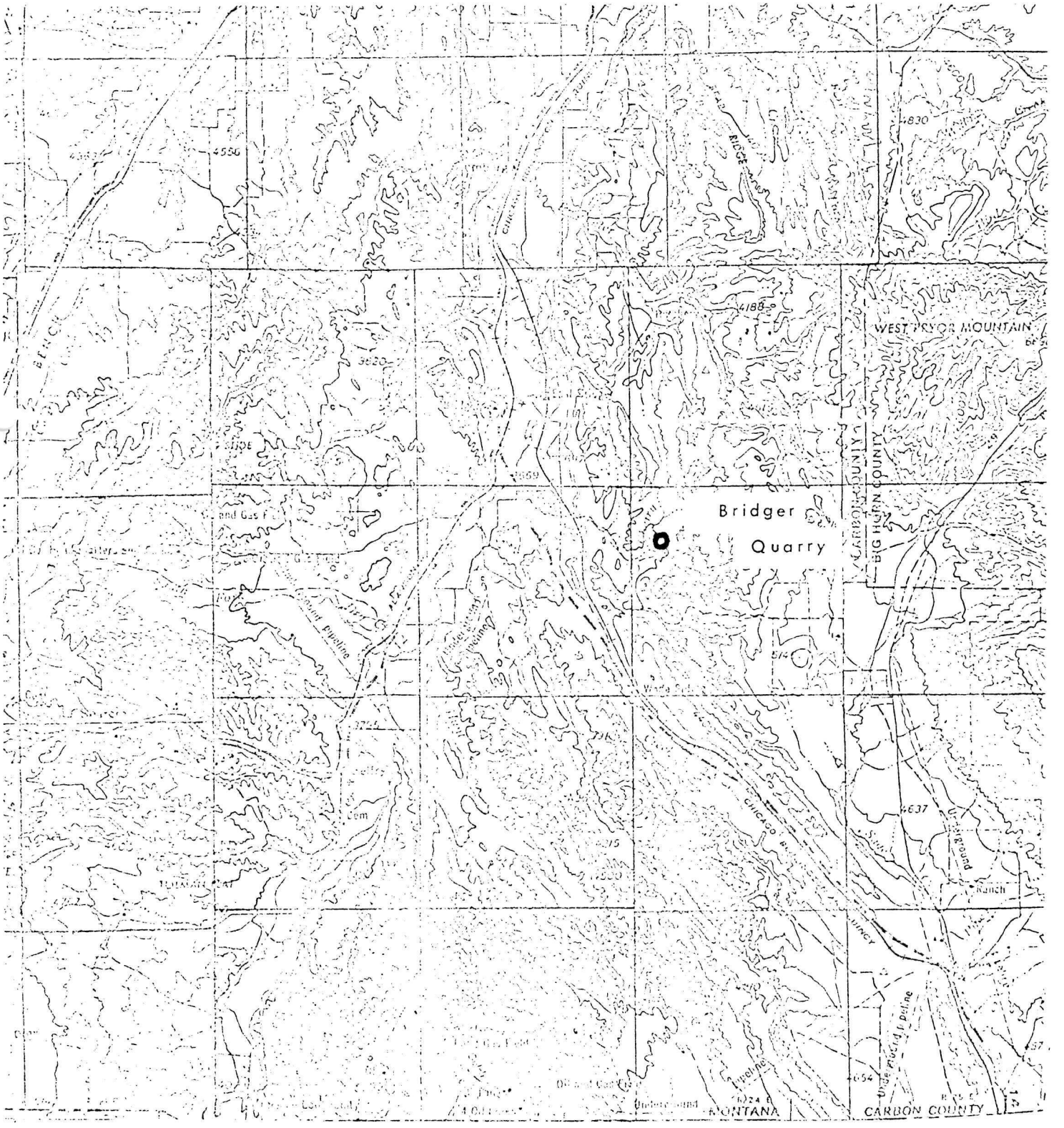
Although not as significant as the Beauvais Creek area (Site 99), or possibly the Crooked Creek, Wyoming Site (No. 114), the Bridger Site is of major importance because of the rarity of Lower Cretaceous fossil vertebrate localities. The site has not been as prolific as the Beauvais Creek or Crooked Creek (Wyoming) sites and thus has been rated only as a 2 level site. Thus it is questionable in my mind whether this particular site truely warrants recognition as a Natural Landmark.

Recommendation: Not recommended at this time for designation as a Natural Landmark. The site should be retained on an active list of potential Natural Landmarks, because it does meet the criteria of National significance and only duplication by other Lower Creta-

ceous sites diminishes its relative value.

FIGURE 17. Location of the Bridger, Montana site.

(Taken from the Billings, Montana sheet, 1954 edition, Corps of Engineers series, NL 12-9, published by the United States Geological Survey.) Scale = 1:250,000.



SITE 109.

LANCE CREEK AREA, Wyoming. - Eligible, in part.

Location: The important area defined here is bounded by the Cheyenne River on the north, Old Woman and Lance Creeks on the east, the 43° North Latitude on the south and the Niobrara - Converse County line on the west. The area includes most of the following Townships and Ranges: T. 36, 37, 38, 39 and 40 N., R. 62, 63, 64, 65 and 66 W. See Figure 18.

Geologic Data: Lance Formation, Upper Cretaceous.

Importance: The area is comparable to the Como Bluff area and is clearly a must for Natural Landmark designation. This is the area that produced the first and largest collections of Cretaceous mammal remains and has also produced an unknown (but large) number of ceratopsian and hadrosaurian (also armored and carnivorous) dinosaur specimens. Probably every major museum in North America - and quite a few museums abroad - have dinosaur specimens from the famed Lance (formerly Ceratops) beds. This region and these strata may be the most fossiliferous continental deposits of Mesozoic age anywhere in the world (although the Red Deer River area of Alberta might be the richest of all). There are so many sites and quarries, (just as with the Como Bluff area) it would be difficult to specify any particular one or two sites as especially worthy of Natural Landmark designation. Therefore, it is suggested that the entire area defined above (and in Figure 18) be designated a Natural Landmark.

Description and Present State of the Site: Most of the terrain encompassed in the designated area is open grassland, with local to large badland areas of moderate relief. It is used chiefly as grazing land, but some hay and wheat are raised locally. The area is sparsely inhabited, but several dozens - perhaps several hundred ranches occur within the region. Industrial, highway or residential construction is a very remote possibility, but even should it take place it will not significantly alter or detract from the sites situated within the defined area. Ample evidence exists that additional fossil remains occur within the area, hence it is defined as a Category 2 site (after the Rose report of March 14, 1969). Consequently, some effort will be necessary to protect the fossil remains from vandals, souvenir hunters and amateur collectors. Part of the area has already been declared eligible for designation as a Natural Landmark (see Fig. 18).

Reference List (partial):

Marsh, O.C., 1889. Discovery of Cretaceous Mammalia. Amer. Jour. Sci. (3), 38:81-92.

_____, 1889. Notic of gigantic horned Dinosauria from the Cretaceous. Amer. Jour. Sci. (3), 38:177-180.

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_____, 1892. Discovery of Cretaceous Mammalia, Part III. Amer. Jour. Sci. (3), 43:249-262.

Hatcher, J.B., 1893. The Ceratops bed of Converse County, Wyoming. Amer. Jour. Sci. (3), 45:135-144.

_____, 1896. Some localities for Laramie mammals and horned dinosaurs. Amer. Nat., 30:112-120.

Lull, R.S., 1933. A revision of the Ceratopsid or horned dinosaurs. Memoir Peabody Mus., 3, pt. 3, 135 pp.

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Estes, Richard, 1964. Fossil vertebrates from the Late Cretaceous Lance Formation, eastern Wyoming. Univ. Calif. Public. Geol. Sci., 49:1-180.

Clemens, W.A., Jr. 1964. Fossil mammals of the type Lance Formation, Wyoming. Part 1. Introduction and Multituberculata. Univ. Calif. Public. Geol. Sci., 48:1-105.

_____, 1966. Fossil mammals of the type Lance Formation, Wyoming. Part 2. Marsupialia. Univ. Calif. Public. Geol. Sci., 62:1-122.

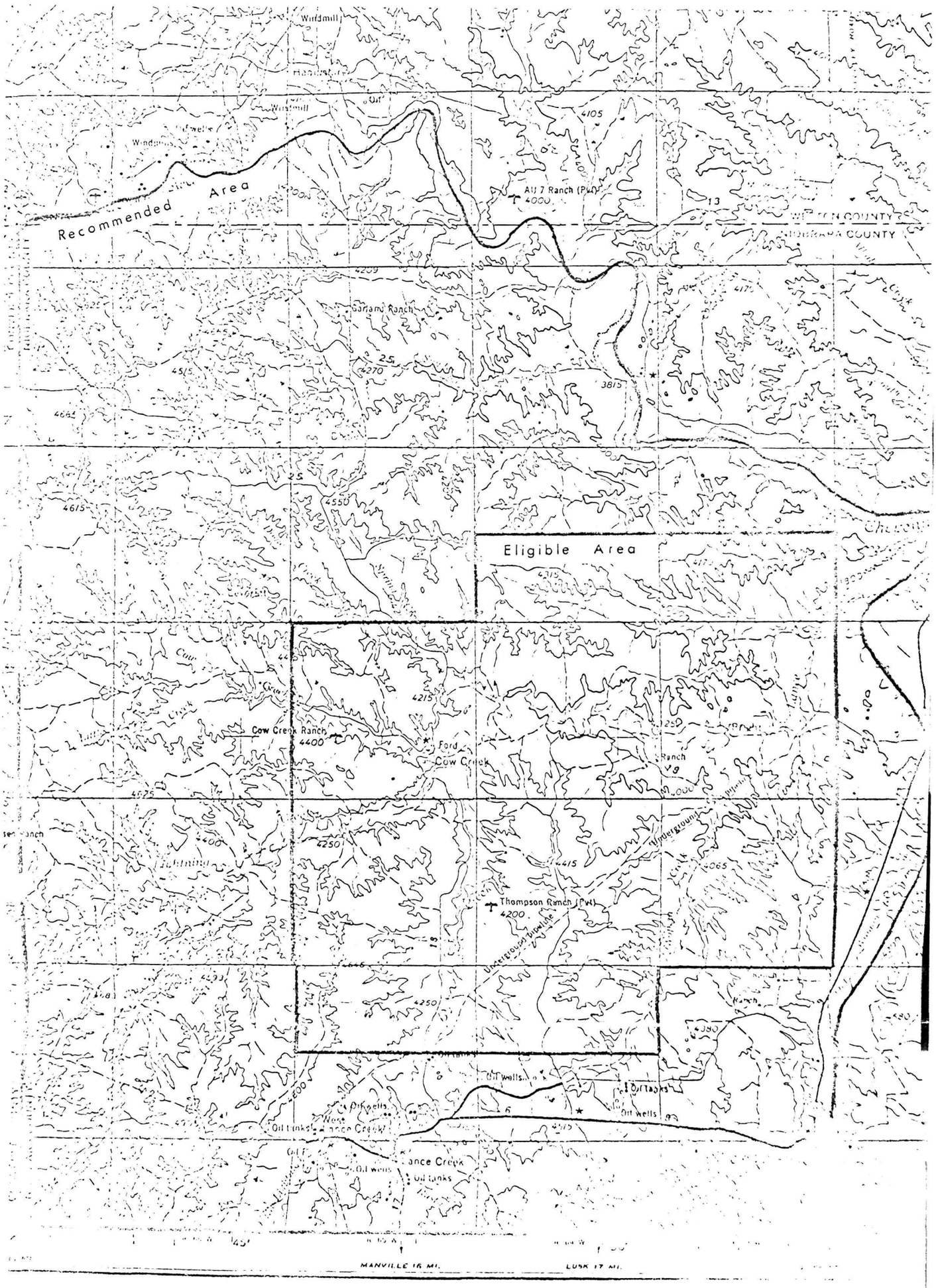
Evaluation: 1.

A region of major importance as the sites of innumerable specimens of Late Cretaceous mammals and dinosaurs. It qualifies for inclusion in the Registry of Natural Landmarks on those grounds and meets the primary criteria of National significance. Most of the region is intact and still capable of revealing fossil remains of Mesozoic life and thus is given the highest rank of 1.

Recommendation: Include in the Registry of Natural Landmarks.

FIGURE 18. Location of the Lance Creek area.

(Taken from the Newcastle, Wyoming; South Dakota; Nebraska sheet, 1962 edition, Corps of Engineers, NK 13-2, published by the United States Geologic Survey.) Scale = 1:250,000.



SITE 114.

CROOKED CREEK NATURAL AREA REGISTERED NATURAL LANDMARK, Lovell, Wyoming.

Location: NW ¼ Sec. 28, T. 58 N., R. 95 W., east of Crooked Creek in Big Horn County, Wyoming.

Geologic Data: Cloverly Formation, Lower Cretaceous.

Importance: This is the site of several quarries that produced fragmentary and disarticulated remains of several kinds of Early Cretaceous dinosaurs. Most important are the remains of a moderate sized sauropod, apparently a titanosaurid, that seems close to the type found in the Arundel Formation of Maryland (Sites 58 and 59 in the Inventory of Part II). These remains are perhaps the most important Early Cretaceous sauropod materials known. Hence this site, in addition to being one of the more productive of rare Lower Cretaceous sites, is the principal site of Sauropod remains. With further excavation this site might provide important evidence about the decline of these large animals which were so abundant and diverse during the preceding Morrison epoch but so rare in Cloverly time.

Description and Present State of the Site: These quarries are in a remote district of northern Wyoming, several "road" miles from the nearest graded road. There are no structures or inhabitants within 3 or 4 miles, although some irrigation and crop cultivation is carried on on the other (west) side of the ridge. The area is semi-desert with little vegetation other than occasional sage and pinjon tree. The probability of construction of any kind is extremely remote. Damage by vandals or amateur collectors is possible since the site is not easily observed. The site was not exhausted by Yale collectors and additional discoveries almost certainly would result from further excavation. It is a Category 2 site (Rose report of March 14, 1969) and thus will require some protection if publicized. At present the site lies on Federal land and the leesee (Lloyd Tillet) is anxious to preserve it from amateurs. This site was designated a Natural Landmark, July 22 1968.

Reference List:

Ostrom, John H., 1965. Cretaceous vertebrate faunas of Wyoming. Guidbook, Wyoming Geol. Assoc., 19th Field Conf. p. 35-41.

_____, 1970. Stratigraphy and Paleontology of the Cloverly Formation (Lower Cretaceous) of the Bighorn Basin area, Wyoming and Montana. Bull. Peabody Mus. 35:1-234.

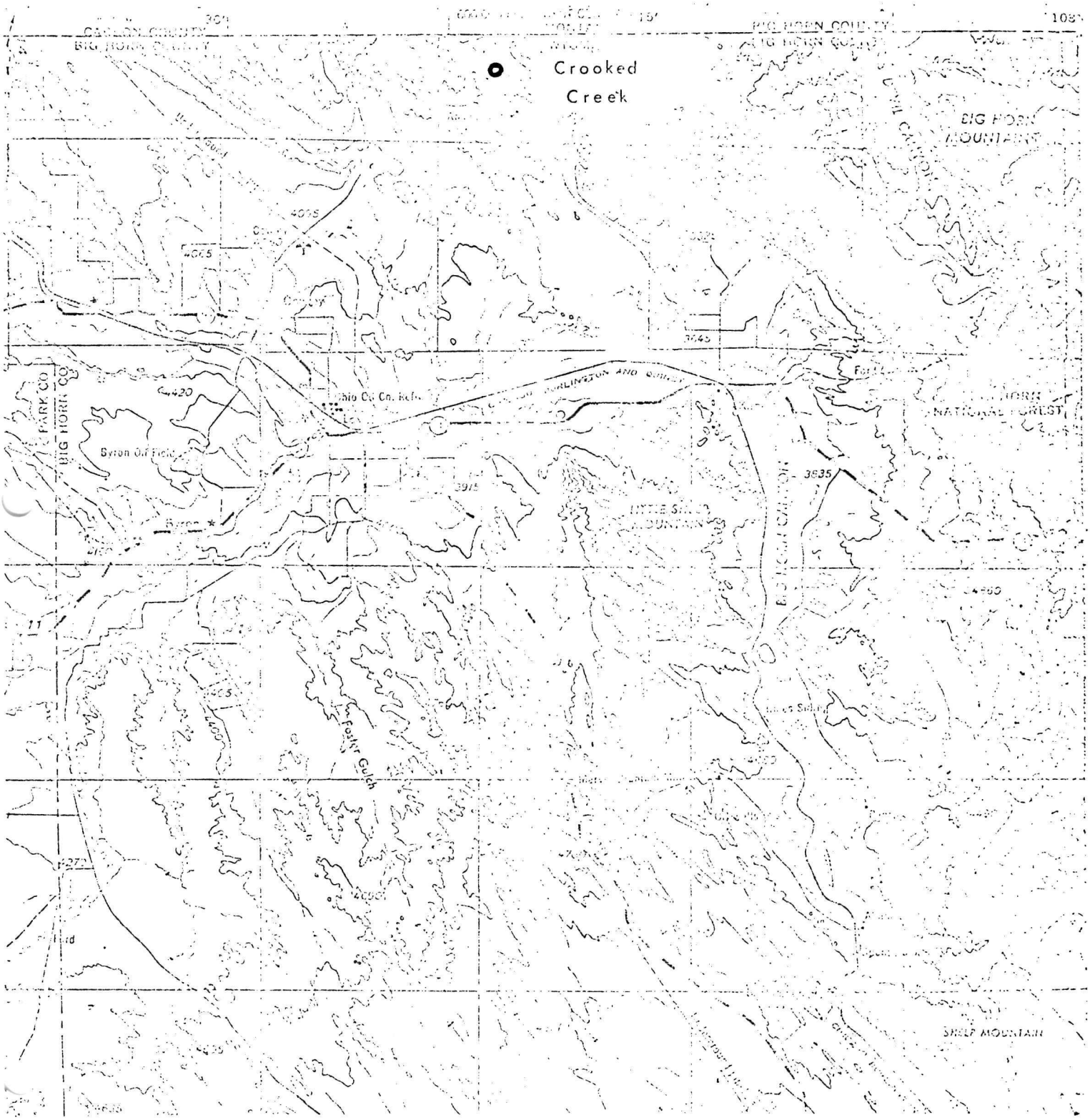
Evaluation: 1-.

The rarity of Early Cretaceous fossil vertebrate sites prompts a high evaluation of this very productive and important site. However, in overall significance it is not comparable to the Beauvais Creek area (Site 99) producing from the same strata. Accordingly, the Crooked Creek site is rated a 1-.

Recommendation: Not required since the site has already been designated. However, in my opinion the site clearly is qualified.

FIGURE 19. Location of the Crooked Creek site.

(Taken from the Cody, Wyoming sheet, 1954 edition, Corps of Engineers, NL 12-9, published by the United States Geological Survey.) Scale = 1:250,000. (See 1964 Sykes Spring 7½' Quadrangle.)



PART IV

LIST OF MESOZOIC PALEONTOLOGIC SITES QUALIFIED FOR INCLUSION IN THE REGISTRY OF NATURAL LANDMARKS

Site 1. Charles O. Wolcott Quarry, Manchester, Connecticut. (JHO)*
(Page 60.) (NEW ENGLAND [illegible] NATIONAL [illegible])

Site 28. Ghost Ranch Locality, Abiquiu, New Mexico. (JHO, EHC)
(Page 67.) (SOUTHERN [illegible])

Site 31. Comb Ridge Locality, Kayenta, Arizona. (JHO, EHC, GEL)
(Page 69.) ([illegible])

O Site 39. Como Bluff, Wyoming. (JHO, JSM)
(Page 71.) (WYOMING BASIN)

Site 40. Bone Cabin Locality, Wyoming. (JHO, JSM)
(Page 74.) ([illegible])

● Site 48. Cleveland-Lloyd Quarry, Cleveland, Utah. (WLS, JRM)
(Page 78.) ([illegible])

Site 51. Garden Park, Canyon City, Colorado. (JSM)
(Page 80.) ([illegible])

Site 52. Morrison, Colorado. (JSM)
(Page 82.) ([illegible])

Site 56. Hadrosaurus foulkii Site, Haddonfield, New Jersey. (JHO)
(Page 85.) ([illegible])

O Site 86. Bug Creek Anthill Locality, Montana. RES, LV)
(Page 90.) (GREAT PLAINS)

Site 99. Beauvais Creek Area, Montana. (JHO) — change name to Cloverly Formation sites
(Page 92.) ([illegible])

O Site 109. Lance Creek Area, Wyoming. (RE, WAC)
(Page 96.) (GREAT PLAINS)

● Site 114. Crooked Creek Natural Area, Wyoming. (JHO)
(Page 99.) ([illegible])

[illegible]

● Sites that already have been registered as Natural Landmarks.

O Sites that have been declared eligible for Landmark designation.

*Initials refer to individuals who can provide additional information about the site. See Authority Index.

PART V

LIST OF OTHER SITES CONSIDERED FOR INCLUSION IN THE REGISTRY OF NATURAL LANDMARKS

Site 19. Riker Hill Quarry, Roseland, New Jersey. (DB, RS)*
(Page 62.)

Site 23. Egypt Mine, Cumnock, North Carolina.
(Page 65.)

Site 43. Sheep Creek Area, Wyoming. (JSM)
(Page 76.)

Site 64. Greenwood Canyon, Forestburg, Texas. (BP, RZ)
(Page 87.)

Site 79. Tyrannosaurus Locality, Montana.
(Page 89.)

Site 108. Bridger, Montana. (JHO)
(Page 94.)

* Initials refer to individuals who can provide additional information about the site. See Authority Index.

AUTHORITY INDEX

BP - Dr. Brian Patterson, Museum of Comparative Zoology, Harvard University, Cambridge, Mass.

DB - Dr. Donald Baird, Department of Geology, Princeton University, Princeton, New Jersey

EHC - Dr. Edwin H. Colbert, Museum of Northern Arizona, Flagstaff, Arizona

GEL - Dr. G. Edward Lewis, United States Geological Survey, Federal Center, Denver, Colorado

JHO - Dr. John H. Ostrom, Peabody Museum of Natural History, Yale University, New Haven, Conn.

JRM - Mr. James R. Madsen, Department of Geology, University of Utah, Salt Lake City, Utah

JSM - Dr. John S. McIntosh, Department of Physics, Wesleyan University, Middletown, Conn.

LV - Dr. Leigh Van Valen, Department of Anatomy, University of Chicago, Chicago, Illinois

RE - Dr. Richard Estes, Department of Biology, Boston University, Boston, Mass.

RES - Dr. Robert E. Sloan, Department of Geology and Geophysics, University of Minnesota, Minneapolis, Minn.

RS - Mr. Robert Salkin, 46 Ivy Street, Newark, New Jersey, 07106

RZ - Dr. Rainer Zangerl, Field Museum of Natural History, Chicago, Illinois

WAC - Dr. William A. Clemmens, Department of Paleontology, University of California at Berkeley

WLS - Dr. W. Lee Stokes, Department of Geology, University of Utah, Salt Lake City, Utah.

LIST OF APPROVED OR PENDING PALEONTOLOGICAL NATURAL LANDMARKS

Bug Creek Fossil Area, McCone County, Montana (Declared eligible).

Cleveland-Lloyd Dinosaur Quarry, Emery County, Utah (Registered).

Como Bluff Area, Carbon and Albany Counties, Wyoming (Declared eligible in part).

Crooked Creek Natural Area, Big Horn County, Wyoming (Registered).

Dinosaur Valley Natural Landmark, Somervell County, Texas (Registered). (Overlooked in this report.)

Hell Creek Fossil Area, Garfield County, Montana (Declared eligible).

Lance Creek Fossil Area, Niobrara County, Wyoming (Declared eligible).

Monument Rocks Natural Area, Gove County, Kansas (Declared eligible). (Not included here; no dinosaurs or mammals.)

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Clemens, William A., Jr., 1964. Fossil mammals of the type Lance Formation, Wyoming. Part I, Multituberculata. Univ. Calif. Public. Geol. Sci. 48:1-105.

_____, 1966. Fossil mammals of the type Lance Formation, Wyoming. Part II, Marsupialia. Univ. Calif. Public. Geol. Sci. 62:1-122.

Colbert, Edwin H., 1961. The Triassic reptile, Poposaurus. Fieldiana, Geol. 14:4, 59-78.

Colbert, Edwin H. and Baird, Donald, 1958. Coelurosaur bone casts from the Connecticut valley Triassic. Amer. Mus. Novitates 1901, 11 p.

Colbert, Edwin H. and Mook, C.C., 1951. The ancestral crocodilian Protosuchus. Bull. Amer. Mus. Nat. Hist. 97:149-182.

Cope, E.D., 1877. On a dinosaurian from the Trias of Utah. Proc. Amer. Phil. Soc. 16:579-584.

Estes, Richard, 1964. Fossil vertebrates from the Late Cretaceous Lance Formation, eastern Wyoming. Univ. Calif. Public. Geol. Sci. 49:1-180.

Hatcher, John Bell, 1896. Some localities for Laramie mammals and horned dinosaurs. Amer. Nat. 30:112-120.

Lull, Richard Swan, 1933. A revision of the Ceratopsia or horned dinosaurs. Memoir Peabody Mus. 3:3, 1-135.

_____, 1953. Triassic life of the Connecticut valley. Bull. Conn. State Geol. Nat. Hist. Surv. 81:1-336.

Lull, Richard Swan and Wright, Nelda, 1942. Hadrosaurian dinosaurs of North America. Spec. Paper Geol. Soc. Amer. 40:1-242

Ostrom, John H. and McIntosh, John S., 1966. Marsh's Dinosaurs: the collections from Como Bluff. Yale Univ. Press, New Haven, Conn., 388 p.

GLOSSARY

ankylosaurian (Ankylosauria) - armored dinosaurs, one of the four major kinds of ornithischian dinosaurs. The ankylosaurs were important during the last part of the Cretaceous.

archosaurs - certain advanced kinds of extinct and living reptiles including crocodilians, thecodonts, pterosaurs and all dinosaurs, but not turtles, lizards or snakes.

bauriamorphs (Bauriamorpha) - advanced mammal-like reptiles (Order Therapsida) close to the ancestry of placental mammals.

captorhinomorphs (Captorhinomorpha) - very primitive reptiles close to the original reptile. Most were small and rather lizard like. Captorhinomorphs include the ancestors of most later and more advanced reptiles.

Carboniferous - A period of geologic time within the Paleozoic Era dating from approximately 350 million years ago to about 270 million years ago. Reptiles first appeared and diversified during the latter half of this interval.

ceratopsian (Ceratopsia) - horned dinosaurs, one of the four major kinds of ornithischian dinosaurs. The ceratopsians were most common in North America during the last part of the Cretaceous Period.

champsosaurs (Champsosauridae) - a family of extinct, crocodile-like reptiles that lived during Cretaceous and early Cenozoic times.

cotylosaurs (Cotylosauria) - the most primitive of all reptiles, the stem reptiles now extinct that are believed to be the ancestors of all reptiles, mammals and birds.

Cretaceous - the final period of Mesozoic time that began about 135 million years ago and ended about 70 million years ago. This is the last period of the "age of dinosaurs".

crocodilians (Crocodilia) - one of the four major kinds of living reptiles. Included are all living and extinct crocodiles, alligators and gavials. They are considered to be the closest living relatives of the dinosaurs.

cynodonts (Cynodontia) - advanced mammal-like reptiles (Order Therapsida) that are believed to include the direct ancestors of true mammals and marsupials.

Devonian - A period of geologic time early in the history of vertebrate life. It began approximately 400 million years ago and ended about 350 million years ago.

dicynodonts (Dicynodontia) - an extinct group of herbivorous mammal-like reptiles (Order Therapsida), some of which appear to have been aquatic.

dinocephalians (Dinocephalia) - another extinct group of herbivorous mammal-like reptiles (Order Therapsida). These were important animals during the Permian Period.

edaphosaurs (Edaphosauria) - one of three major kinds of primitive mammal-like reptiles (Order Pelycosauria) that were abundant during the Late Carboniferous and Permian. Edaphosaurs were probably herbivorous.

gorgonopsians (Gorgonopsia) - an extinct group of advanced mammal-like reptiles (Order Therapsida) important during the Permian. Gorgonopsians appear to have been exclusively carnivorous.

ichthyosaurs (Ichthyosauria) - an extinct group of porpoise-like reptiles that were highly evolved for an aquatic, fish-like mode of life.

Jurassic - the middle period of Mesozoic geologic time that began about 180 million years ago and ended approximately 135 million years ago. This was the middle part of the "age of dinosaurs".

labyrinthodonts (Labyrinthodontia) - primitive amphibians that were abundant during the Late Paleozoic and Triassic. This group included the ancestors of cotylosaurs and all higher reptiles.

mammal-like reptiles - extinct reptile kinds, including pelycosaurs and therapsids, that featured a variety of mammal-like anatomical characters. The ancestors of true mammals are included here.

Mesozoic - the 'age of reptiles' - or the 'age of dinosaurs'. The middle era of life history that spanned 155 million years from about 225 million years ago until about 70 million years ago.

millerosaurs (Millerosauroidea) - a minor extinct group of small, lizard like animals closely related to procolophonids and classified in the stem reptile order - Cotylosauria.

mosasaurs (Mosasauridae) - an extinct group of highly aquatic reptiles belonging to the lizard order - Squamata. They were abundant during the Cretaceous Period and are believed closely related to modern varanid lizards.

nothosaurs (Nothosauria) - a group of primitive, aquatic or semi-aquatic reptiles related to the placodonts and plesiosaurs. They were moderately abundant during the Triassic.

ophiacodonts (Ophiacodontia) - one of three major kinds of primitive mammal-like reptiles (Order Pelycosauria) that were common during the Permian. Ophiacodonts were probably predaceous and some appear to have been fish-eaters.

ornithopods (Ornithopoda) - one of the four major kinds of ornithischian dinosaurs. These were exclusively herbivores and most were bipedal, although some walked on all fours at times. The duck-billed dinosaurs are the best-known members.

ornithischians (Ornithischia) - one of the two major classes of dinosaurs that were abundant during the Mesozoic Era. Included in this Order are the duck-billed (Ornithopoda), armored (Ankylosauria), plated (Stegosauria), and horned (Ceratopsia) dinosaurs.

Paleozoic - the era of geologic time from about 600 million years ago to about 225 million years ago. This was the era during which vertebrate animals first evolved and diversified to many different fish kinds, amphibians and reptiles.

pareiasaurs (Pareiasauroidea) - an extinct group of large, ponderous, herbivorous cotylosaurs that were abundant in some parts of the world during Permian times.

pelycosaurs (Pelycosauria) - an extinct order of primitive mammal-like reptiles that thrived during Late Carboniferous and Permian times. Pelycosaurs gave rise to advanced mammal-like reptiles (Therapsida) and through them to true mammals.

phytosaurs (Phytosauria) - an extinct group of crocodile-like reptiles related to dinosaur ancestors (Pseudosuchia). They are related, but not ancestral to crocodilians and are thought not to be closely related to champsosaurs. They were Triassic.

placodonts (Placodontia) - an extinct group of aquatic reptiles, most of which seem to have been adapted for feeding on shell fish. They are considered closely related to plesiosaurs.

plesiosaurs (Plesiosauria) - another group of extinct aquatic reptiles that were common during Mesozoic times. The plesiosaurs were fish-eaters and some reached lengths of 40 feet or more.

procolophonids (Procolophonidae) - a minor extinct family of lizard-like cotylosaurs or stem reptiles that lived during Permian and Triassic times.

proterosuchians (Proterosuchia) - an extinct group that may be the most primitive archosaurs and include the immediate predecessors of dinosaur ancestors. Important during Early Triassic times.

pseudosuchians (Pseudosuchia) - another extinct group of early archosaurs that includes the probable ancestry of both major kinds of dinosaurs. Pseudosuchians were abundant during the Triassic.

pterosaurs (Pterosauria) - an important group, now extinct, of highly specialized flying reptiles. These animals were rather closely related to dinosaurs, but not to birds. They probably appeared before birds during Jurassic times, but they were not ancestors of birds.

rhynchocephalians (Rhynchocephalia) - a group of small, commonly lizard-like reptiles related to lizards and snakes that thrived during the Mesozoic. A single living species (Sphenodon punctatum) survives today on islands near New Zealand.

saurischians (Saurischia) - one of the two major classes of dinosaurs that included all carnivorous dinosaurs as well as the giant brontosaur-like animals.

sauropods (Sauropoda) - one of the two major kinds of saurischian dinosaurs. The sauropods include all giant brontosaur-like creatures such as Brachiosaurus, Diplodocus and others.

sphenacodonts (Sphenacodontia) - one of the three main kinds of primitive mammal-like reptiles (Order Pelycosauria) that were abundant during Permian times. The sphenacodonts included such well known kinds as Dimetrodon and were the dominant carnivores of Late Paleozoic times.

stegosaurs (Stegosauria) - one of the four major kinds of ornithischian dinosaurs. These are the plated dinosaurs.

thecodonts (Thecodontia) - one of the extinct orders of reptiles that includes dinosaur ancestors (pseudosuchians) as well as other primitive archosaurs such as proterosuchians and phytosaurs.

therapsids (Therapsida) - advanced order of mammal-like reptiles that were abundant during Permian and Triassic times. Included in this order are the ancestors of true mammals.

theropods (Theropoda) - one of the two main kinds of saurischian dinosaur, the flesh-eating dinosaurs. Tyrannosaurus is the best known representative of this group.

therocephalians (Therocephalia) - an extinct group of large, carnivorous, advanced mammalOlike reptiles (Order Therapsida) that were abundant during the Late Permian.

Triassic - the initial period of Mesozoic geologic time which began about 225 million years ago and terminated approximately 180 million years ago. This was the first period of the 'age of dinosaurs'.

APPENDIX

ROSE REPORT TO THE DIVISION OF SPECIAL PLANNING STUDIES

Robert Rose, March 14, 1969

The following excerpts from the Report by Robert Rose to the Division of Special Planning Studies of the National Park Service are included here as an appendix to this report to provide definitions of certain classification terms that are used in the Inventory (Part II) and the Analyses of potential Landmarks (Part III). This report is the result of a request by the Contractor for further criteria and guidelines that might be applied to the evaluation of paleontological sites under consideration for recommendation to the National Park Service. The two categories of sites for which we sought additional useful criteria are:

1. Sites which have produced important fossil remains but are now barren, or at least lacking in visible evidence of such remains.

2. Sites at which fossil bones are still present, but would become barren or seriously depleted of bones before very long if their existence and locations were to become generally known.

Category 1.

A concensus evolved from our discussions that a site now barren of fossils. or which contains no visible evidence of such remains, might be properly classed as potentially eligible for designation as a Natural Landmark if it:

a. Comprises all or a substantial part of a significant land form which would qualify on its own merits as eligible for consideration under one of the subthemes of Teme I - Land Forms of the Present.

b. Possesses composition, structure, stratigraphy or other relationships or characteristics of exceptional value as illustrations of, or clues to, the life forms, land forms or environments of the Mesozoic Era. As a rule of thumb, such sites would be classed as worthy of consideration for designation as natural landmarks if competent paleontologists or other earth scientists were to continue to regard them as significant educational and scientific exhibits of Mesozoic time even though fossil remains are wholly absent or no longer in evidence.

Sites from which the fossils have been documented and removed to scientific repositories might be as significant as if the fossils still were in situ. In some cases the fossil itself may be of little importance beyond yielding its own identity while the matrix may be of great significance.

c. Continues to be regarded as a "must" for visitation by paleontologists or other scientific and educational groups because of its important role in the history of paleontological science. Once such a site is classed as potentially eligible for landmark designation, it would be the responsibility of the National Park Service to determine whether it should be recommended as a Natural or an Historical Landmark.

Category 2.

The following criteria and guidelines embody the concensus of our discussion of vertebrate paleontological sites of the kind which would become endangered once their existence, location or any other information about them were to become common knowledge:

a. The sites should be identified, described and evaluated in the usual way with reference to the reason why information concerning them should not becom common kowledge.

b. The National Park Service would hold any recommendation for Natural Landmark designation in abeyance until such time as adequate protection is assured or it becomes clear that disclosure would be more effective in protecting scientific values than is continued silence.

Instances are known in which owners have willingly committed themselves to the effective protection of sites once they became aware of the fact that such sites are nationally significant and, therefore, worthy of Natural Landmark designation. Also, the National Registry of Natural Landmarks program contains inbuilt provisions giving assurances that sites will not be designated unless and until they can be adequately protected. For example, sympathetic and responsible ownership is one requirement which must be met before a site may become an officially designated Natural Landmark. When the owner applies for registration of a site he agrees to protect its integrity and to permit the National Park Service to make periodic inspections.

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INDEX

(Paleontological sites are listed in capital letters)