PHASE I GEOLOGIC FAULT ASSESSMENT
MINNETEX AREA AND ALMEDA GENOA PLACE
DRAINAGE AND PAVING IMPROVEMENTS
WBS NO. M-000289-0002-3
HOUSTON, HARRIS COUNTY, TEXAS

PREPARED FOR:
KIT PROFESSIONALS, INC.
2000 W SAM HOUSTON PARKWAY S, SUITE 1400
HOUSTON, TX 77042

PREPARED BY
HVJ ASSOCIATES, INC.
HOUSTON, TEXAS
AUGUST 21, 2014

REPORT NO. HE1413020
KEY MAP 573R & 574N

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August 21, 2014

Srikanth Punukula, PE
Manager, Public Works Engineering
KIT Professionals, Inc.
2000 W Sam Houston Parkway S, Suite 1400
Houston, TX 77042

Re: Geologic Fault Assessment Project
Minnetex Area and Almeda Genoa Place Drainage and Paving Improvements
WBS No. M-000289-0002-3
Owner: City of Houston
HVJ Project No. HE1413020

Dear Mr. Punukula:

Presented herein is our final Phase I Geologic Fault Assessment for the above captioned project. The study was performed in general accordance with the City of Houston Department of Public Works & Engineering Infrastructure Design Manual Chapter 11 and our proposal number HE1413020 dated May 23, 2014.

This report presents HVJ Associates' understanding of the project's scope, the methodology we employed in executing the work, and the conclusions we reached subject to the limitations discussed in Section 10 of this report.

It has been a pleasure to work with you on this project, and we appreciate the opportunity to be of service. Please notify us if there are questions or comments or if we may be of further assistance.

Sincerely,

HVJ ASSOCIATES, INC.
Texas Firm Registration No. F-000646

Edward F. Hawkinson, PG
Project Manager

EH/MH/MM

Copies Submitted: 4 final, 1 electronic

The following lists the pages which complete this report:

- Main Text - 12 pages
- Plates - 5 pages
- Appendix A - 7 pages
- Appendix B - 10 pages
- Appendix C – 8 pages

TABLE OF CONTENTS

EXECUTIVE SUMMARY I

1. INTRODUCTION 1
   1.1 Project Objective 1
   1.2 Project Scope 1
   1.3 Basis of Report 1
   1.4 Qualifications of Licensed Geologist 2

2. PROJECT DESCRIPTION 2
   2.1 Geologic Setting 2
   2.2 Nature of Faulting 2
   2.3 Indications of Faulting 3

3. AERIAL PHOTOGRAPH, MAP AND LITERATURE REVIEW 4
   3.1 Review of Aerial Photographs 4
   3.2 Review of Topographic Maps 4
   3.3 Literature Review 4

4. RECONNAISSANCE 4
   4.1 Objectives 4
   4.2 Field Reconnaissance 4

5. DESIGN CRITERIA AND RECOMMENDATIONS 5

6. SUMMARY OF FINDINGS/CONCLUSIONS 5
   6.1 Findings 5
   6.2 Conclusions 5

7. LIMITATIONS 6

8. REFERENCES 6

PLATES

SITE VICINITY MAP 1

PROJECT AREA MAP 2

HOUSTON AREA FAULT PATTERN MAP 3

GEOLOGIC FAULT MAP SHOWING SITE AREA 4

APPENDIX

SITE PHOTOGRAPHS ..... A

AERIAL PHOTOGRAPHS ..... B

HISTORIC TOPOGRAPHIC MAPS C

EXECUTIVE SUMMARY

HVJ Associates, Inc. has completed a Phase I Geologic Fault Assessment for the Minnetex Area and Almeda Genoa Place Drainage and Paving Improvements Project. (referred to as the Subject Project Alignments in this report) in Houston, Texas (see Plate 1- Site Vicinity Map and Plate 2 – Project Area Map for the Subject Project Alignments location).

Our services included a review of available published and unpublished literature on faulting in the area and a site reconnaissance. The area is primarily developed with single-family residential structures. Access to the project area was not limited. The available information for this project and the on-site reconnaissance conducted during July 2014 are summarized below:

1. The subject project area appears to be in an area of Houston with well documented fault systems with surface expressions. The project area is not crossed by any documented geologic faulting.

2. Analysis of vertical aerial photographs revealed no linear features, lineaments or shading which may be indicative of the documented geologic fault crossing the Subject Project Alignments. Development in the project area makes resolution of these features difficult on later photographs and in the field.

3. Examination of current and historical topographic maps revealed no topographic features and/or stream and drainage patterns that could be related to faulting.

4. No cracked paving or obvious building damage indicating recent fault movement was observed. Several areas along and near the Subject Project Alignments area showed pavement distress.

5. We conclude the potential for active surface faulting to impact the proposed Subject Project Alignments is low since no documented fault transects the project area.

The location of the faulting west and east of the Subject Project Alignments is fully documented in the geologic literature but not by field reconnaissance. No faulting was observed or is documented in the literature on or near the Subject Project Alignments area. Therefore, we do not recommend additional Assessment(s) to determine the extent of potential faulting in this part of the project area.

Planned construction is unlikely to be impacted by either vertical or horizontal fault movement in the future. We recommend no faulting related design provisions for this project. This executive summary does not fully summarize our findings and opinions. Those findings and opinions are related through the full report only.

1. INTRODUCTION

1.1 Project Objective

HVJ Associates, Inc. was contracted by KIT Professionals, Inc. (KIT) to perform a Phase I Geologic Fault Assessment for the Minnetex Area and Almeda Genoa Place Drainage and Paving Improvements Project in Houston, Texas. Published geologic studies have identified active geologic faulting trending west and east of the Subject Project Alignments area. The objective of this study was to identify active faulting in the study area based on available data and a site reconnaissance and to determine if faulting hazards exist that could affect planned development.

1.2 Project Scope

The scope of services for this study were performed in general accordance City of Houston, Department of Public Works & Engineering Design Manual Chapter 11 "Geotechnical and Environmental Requirements" Section 11.09 Fault Assessment. The following tasks were performed:

1. A search was conducted of available published and unpublished literature on geologic faulting to point out areas of known fault activity and assist in locating direct site-specific evidence. Literature reviewed included publications of the U.S. Geological Survey, Texas Bureau of Economic Geology, Gulf Coast Association of Geological Societies, and the Houston Geological Society.

2. A review of the results of previous fault studies, performed by HVJ Associates, in adjacent areas was conducted and relevant information from those studies was considered for this study.

3. A review of a series of ten vertical aerial photographs from 1935 through 2012 and both recent and historic U.S.G.S. topographic maps was conducted to identify features that may indicate the presence of faulting.

4. A physical site and area reconnaissance was performed to identify and locate features that indicate the presence of faulting. All evidence derived from the literature, photo and map reviews was evaluated in the field.

5. This report was prepared summarizing our findings, conclusions and recommendations.

1.3 Basis of Report

Although this study has been a reasonably thorough attempt to identify faulting in the vicinity of and on the subject property, there is a possibility that existing faults may have escaped detection due to the inherent limitations of this or similar studies or the inaccuracy of published and unpublished data. If faults are present, the surface evidence may not be well developed or may be obscured by erosion, soil and vegetation cover, and/or new construction.

HVJ Associates reserves the right to alter our conclusions and recommendations based on our review of any information obtained after the date of this report. The data obtained during the course of this Assessment and this report is for the sole and exclusive use of KIT. HVJ Associates, Inc. will hold all project data, papers, correspondences and reports pertaining to this study confidential to the extent allowed by law.

Our professional services have been performed using that degree of care and skill ordinarily exercised, under similar conditions, by geotechnical consultants practicing in this or similar localities. No warranty, express or implied, is made as to the professional information included in this report.

1.4 Qualifications of Licensed Geologist

The primary investigator for this study is Mr. Edward Hawkinson. Mr. Hawkinson holds BS and MS degrees in geology from The Ohio State University and the University of Cincinnati respectively, and an MBA from the University of Cincinnati. Mr. Hawkinson is a registered professional geologist in Arkansas, Tennessee and Texas (License Number 45). His career encompasses a period exceeding 30 years involving both Phase I and II Geologic Fault Studies, environmental site assessments, hydrogeology, water resource evaluations, NEPA environmental Assessments and energy exploration.

2. PROJECT DESCRIPTION

The Subject Project Alignments are located in a mostly developed residential area of south Houston. This Assessment was conducted in connection with the design and construction of the Minnetex Area and Almeda Genoa Place Drainage and Paving Improvements Project.

2.1 Geologic Setting

A review of the Bureau of Economic Geology 1992 Geologic Atlas of Texas, Houston Sheet indicates that the uppermost geologic formation underlying the Subject Project Alignments is the Pleistocene Beaumont Formation (map symbol Qb). This formation was deposited on land near sea level in flat river deltas and in inter-delta regions. Soil deposition occurred in fresh water streams and in flood plains (as backwater marsh and natural levees). The courses of major streams and deltaic tributaries changed frequently during the period of deposition, generating within the Beaumont clay a complex stratification of sand, silt and clay deposits. Frequently, stream courses were diverted significant distances from a given point in a backwater marsh, and the water overlying the soil would evaporate since it was cut off from a drainage path. Such water, which would be highly alkaline, would precipitate large nodules of calcium carbonate (calcareous nodules) throughout the surface of evaporation. With the coming of the Second Wisconsin Ice Age, the nearby sea withdrew, leaving the formation several hundred feet above sea level and permitting the soil to desiccate. The process of desiccation compressed the clays in the formation such that they became significantly overconsolidated to a large depth. In addition to pre-consolidating the soil, the process of desiccation, together with the later rewetting, produced a network of fissures and slickensides that are now closed but which represent potential planes of weakness in the soil. The formation weathers to a fairly flat and featureless surface except for numerous rounded shallow depressions and pimple mounds.

Several northwest to southeast trending geologic faults are located to the west of the Subject Project Alignments area. One northeast to southwest trending down to the southeast geologic fault is located east of the Subject Project Alignments area. These faults do not cross the Subject Project Alignments area.

2.2 Nature of Faulting

In the Gulf Coast region of Texas over 200 faults are known or suspected to be active with an aggregate length of approximately 370 miles. Many of these faults are located in the Greater Houston-Galveston area subsidence bowl. Although the existence of most of these faults have been reported in the literature, only 100, with an aggregate length of approximately 140 miles have been mapped at scales suitable for general use. These faults extend offshore several hundred miles and inland north of the Conroe area. Evidence of fault activity includes laterally persistent abrupt changes in the elevation of the ground surface (scarps) where the slope of the land on either side of the fault scarp is similar. Fault scarps can produce linear features (lineaments) on aerial photographs and topographic maps, linear patterns of vegetation that are primarily due to the ponding of water on the downthrown side of the fault, and damage to pavement and other structures. Evidence of active faulting in undeveloped areas may be obscured due to dense vegetation cover such as woods and underbrush.

Many faults are classified as growth (down-to-the-coast) faults wherein the dip angle of the fault near the ground surface is very high, averaging 75 degrees. These faults may have been active for a long period of time. As their name implies, growth faults are active during sedimentation, and consequently, subsurface features include increased thickness of geologic units on the downthrown side and increased displacement of these units with depth adjacent to the fault. Another type of fault found along the Gulf Coast is often associated with growth faults. These faults generally parallel growth faults and have a fault-plane dip that is up-to-the coast. Because of their opposite dip and close association with growth faults, these faults are known as antithetic faults. Growth faults and their antithetic faults have a strike or orientation that generally parallels the coast. Movement rates of growth and antithetic faults are slow and generally range from 0.1 in. to slightly more than 1.0 in. per year. Horizontal movements are extensional and depend upon the dip of the fault, generally being about one-fourth to one-half the vertical movement. These surface movements generally occur in a band of significant width which is likely to be different for each fault and to vary along the length of a particular fault. Band widths of 30 to 50 ft. are common, but wider or narrower bands are also found. In general, fault movement rates may be episodic for a specific fault and an extended period of time may pass between movement periods. Fault movement and fault reactivation has been attributed to fluid withdrawals from pumping of groundwater and oil and gas production, however the predominant affect of this fluid pumping has been local and regional ground subsidence. Fault movement and subsidence rates are documented in Houston where older structures or roadways can display damage.

Other types of faults found along the Gulf Coast are those associated with salt domes. Faults immediate to or overlying salt domes may have surface expressions that tend to be shorter in length and may form either an irregular radial or offset pattern around the salt dome. Away from the dome tangential faults may be present. Unlike growth faults, the orientation of dome-related faults does not follow a general orientation, that is, they can have strikes that are randomly oriented. Many faults mapped in the subsurface are inactive and do not extend to the surface. See Plate 3 showing Houston area fault patterns map.

2.3 Indications of Faulting

Evidence of faulting at the surface is not always readily identifiable and can also be falsely inferred. Topographic features such as escarpments associated with river terraces may resemble a fault scarp. However, in many cases these features cannot be traced laterally for any substantial distance, or the relative direction of movement observed might change significantly which would indicate the feature is not related to active faulting. Normal deterioration on existing buildings and other structures may produce damage that may resemble damage associated with active faulting. Other sources of linears that can erroneously suggest faulting include clearings made for seismic surveys during oil exploration, fence lines, stratigraphic contacts, or drainage patterns. In most cases, the observed linears on aerial photographs are related to changes in vegetation, while on topographic maps they are related to changes in slope and/or drainage patterns.

Though the existence of river terraces and other linear natural topographic features does not necessarily indicate the presence of a fault, there are times wherein fault scarps are coincident with and are the progenitors of these features. Additionally, there are instances where the fault may be offset from such a topographic feature yet nevertheless is the cause of its existence and the control on its orientation.

In undeveloped terrains covered by dense forest and underbrush and possessing varied topographic relief, the visual, onsite identification of fault scarps can be difficult. Lineaments that could be associated with faulting are likely to be masked by the heavy overgrowth. In such environments, several lines of boreholes across the study area may be needed to supplement the aerial photograph/topographic map analysis and field reconnaissance. Electric log data obtained from these boreholes can provide an idea of subsurface conditions and the likelihood of fault existence.

3. AERIAL PHOTOGRAPH, MAP AND LITERATURE REVIEW

3.1 Review of Aerial Photographs

HVJ Associates reviewed a series of ten aerial photographs for the Subject Project Alignments area. None of the aerial photographs showed linear features or shading which may be indicative of faulting. No obvious fault(s) were observed due to modifications of the landscape. The older photographs reviewed (1935 and 1944) showed agricultural development on and near the Subject Project Alignments area. This type of development tends to obscure indicators of fault development.

In viewing aerial photographs, features that may indicate the presence of a fault, include tonal variations in vegetation, areas of standing water and lineations associated with drainage patterns. These features by themselves do not prove that a fault is present, but allow for more effective topographic map review and field reconnaissance.

3.2 Review of Topographic Maps

HVJ Associates reviewed the 1915 and later United States Geological Survey (USGS) Mykawa and Pearland, Texas quadrangle topographic map for the project area. Because of project area terrain with relatively low relief and five-foot contour intervals, no obvious lineaments or possible fault related drainage controls were observed on these maps.

3.3 Literature Review

We reviewed available literature on faults in the area which include USGS publications, university research papers and professional society publications. Although faults exist, seismic activity is not a concern based on the site's location in Seismic Zone O of the Uniform Building Code.

Many of the faults in the Texas Gulf Coast region are considered growth (down-to-the-coast) faults in which the dip angle of the fault near the ground surface averages 75 degrees. Since growth faults are active during sedimentation, subsurface features include increased thickness of geologic units on the downthrown side, and increasing displacement of these units with depth adjacent to the fault. Movement rates of these faults range from less than 0.1 to over 1.0 inches per year.

A fault map contained in a Superfund Sites of Harris County, Texas: Field Trip Guidebook, Houston Geological Society, 1993 which includes an unpublished 11 x 17 map (1" = 2.5 miles) from Dr. Carl Norman, of the University of Houston showing Superfund Sites and major faults shows two northwest to southeast trending geologic faults west of the Subject Project Alignments area. A "Map Showing Surface Faults in the Southeastern Houston Metropolitan Area, Texas: E.R. Verbeek and U.S. Clanton," USGS Open File Report 78-797, 1978 shows one northeast to southwest trending down to the southeast geologic fault east of the Subject Project Alignments area. The location of these geologic faults is shown on Plate 4 – Geologic Fault Map Showing the Site Area.

4. RECONNAISSANCE

4.1 Objectives

A reconnaissance was performed in July 2014 on foot and by automobile to observe the subject areas and to observe areas identified through literature research and on topographic maps for evidence of faulting.

4.2 Field Reconnaissance

During the course of the field reconnaissance, paved roads adjacent to and within the study area were examined for road surface flexures and/or cracks that would be indicative of faulting. Field reconnaissance was performed to physically observe any faulting within or near the Subject Project Alignments and to identify features. We did not observe any fault locations in the field or any

vertical relief that might be indicative of faulting. No pavement damage, cracks and patching which in our opinion are related to faulting was observed on or near the Subject Project Alignments area. No obvious building damage indicating recent fault movement was observed (a series of site photos is provided in Appendix A). No significant scarp development was observed on vacant land adjacent to the pavement areas.

It should be noted that a common complication in many fault studies is that much of the evidence normally used to map surface traces of faults in the Gulf Coast have been destroyed in developed areas. Only the most active and damaging faults or faults whose scarps are of substantial height are likely to be noticed during mapping of developed areas. Mapping of faults is most difficult in areas with recent development; however, in older developed areas the fault can be located quite accurately at many points where it has damaged buildings, road and other manmade structures.

5. DESIGN CRITERIA AND RECOMMENDATIONS

Since no geologic faults were found to cross the Subject Project Alignments or are near enough to the Subject Project Alignments to be a construction issue, we recommend no design criteria to accommodate geologic faulting.

6. SUMMARY OF FINDINGS/CONCLUSIONS

Based on our site reconnaissance and review of available information obtained for this project, our findings and conclusions are summarized below:

6.1 Findings

- No active surface fault appears to cross the Subject Project Alignments.
- We observed no vertical relief associated with faulting on or near the Subject Project Alignments. No pavement damage, cracks and patching were observed during the field reconnaissance. No obvious building damage indicating recent fault movement was observed.
- No linear features possible indicative of faulting were observed on a series of vertical aerial photographs reviewed for this project.
- No linear features or other indicators of faulting were observed on a series of historical topographic maps reviewed for this project.

6.2 Conclusions

Based on the information obtained in this study, the potential for surface faulting in the project area should be considered low. The location of several faults near the Subject Project Alignments is documented in the geologic literature. These faults should not be an issue due to their location. No other faulting was observed or is documented in the literature on or near the project area. Therefore, we conclude that no additional Assessment is needed to determine the extent of potential faulting in the project area.

Faults are not always associated with definitely recognizable fault scarps and their full extent may not be identifiable by visual inspection alone. Additionally, vegetative cover and uneven topography can obscure the presence of a fault, especially if it is slow moving or currently inactive. Predicting future fault activity cannot be done with certainty due to the number of variables involved. Dormant or very slow moving faults can be, respectively, reactivated or accelerated due to a number of reasons, including groundwater withdrawals and petroleum production.

7. LIMITATIONS

The conditions and recommendations contained in this report are based on our review of available documents and field geologic mapping techniques. Shallow soil conditions, cultural activities, new construction, slow movement rates, and repair of existing fault damage may obscure fault-related features.

This report is an instrument of service of HVJ Associates, Inc. The report was prepared for and is intended for the exclusive use of KIT and the City of Houston. The report's contents may not be relied upon by any other party without the express written permission of HVJ Associates and KIT.

The report's findings are based on conditions that existed on the dates of HVJ Associates site visit(s) and should not be relied upon to precisely represent conditions at any other time. All conclusions are qualified by the fact that no excavations or borings were made and no geophysical surveys or logging was conducted. Conclusions about site conditions under no circumstances comprise a warranty that conditions in all areas within the site and study area (and below existing grade) are of the same quality that HVJ Associates has inferred from observable site conditions.

HVJ Associates' findings and conclusions must be considered probabilities based on professional judgment applied to the limited data HVJ Associates was able to gather during the course of this fault study.

8. REFERENCES

The following references were used to compile this report:

- A Study of Active Fault Movement, Houston, Texas and Vicinity. Unpublished M.S. Thesis, University of Houston. J.J. Mastroianni, December 1991.

- Approximate Land-Surface Subsidence in the Houston-Galveston Region, Texas, 1906-78, 1943-78, and 1973-78, Open File Report 80-338, US Geological Survey, March 1980.

- Mukawa and Pearland, Texas Quadrangle Map, Texas, US Geological Survey (various scales), 1995 and earlier.

- Faulting and Land Subsidence from Ground-Water and Hydrocarbon Production, Houston-Galveston, Texas. C.W. Kreitler, Bureau of Economic Geology, Univ. of Texas at Austin, Research Note 8, 1978.

- Khan, Stewart, Otoum, Chang, 2013, Case History A geophysical Assessment of the active Hockley Fault System near Houston, Texas, GEOPHYSICS, Vol. 78, No. 4 (July-August 2013); P. B177–B185, 7 FIGS.

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- Historically Active Faults in the Houston Metropolitan Area, Texas, in Houston Area Environmental Geology: Surface Faulting, Ground Subsidence, Hazard Liability, Verbeek E.R. and Clanton, U.S., Houston Geological Society, 1981.

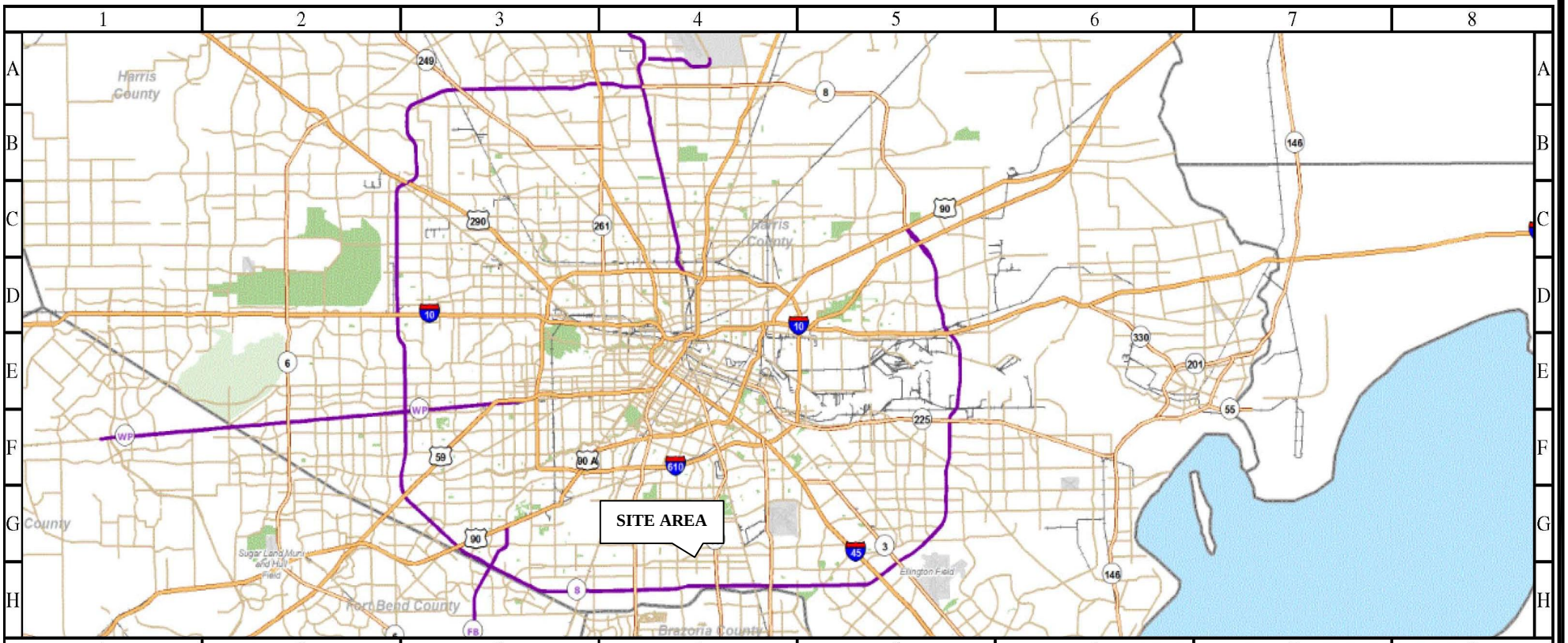
- Soil Survey of Harris County Texas, Soil Conservation Service, US Department of Agriculture, 1972.

- Kreitler, C.W., 1976, Lineations and Faults in the Texas Coastal Zone, Report of Assessments No. 85, Bureau of Economic Geology, the University of Texas.

- Superfund Sites of Harris County, Texas: Field Trip Guidebook, Houston Geological Society, 1993 (includes unpublished 11 x 17 map (1" = 2.5 miles) from Dr. Carl Norman, of the University of Houston showing Superfund sites and major faults).

- Map Showing Surface Faults in the Southeastern Houston Metropolitan Area, Texas: E.R. Verbeek and U.S. Clanton. USGS Open File Report 78-797, 1978.

PLATES



CITY OF HOUSTON

Department of Public Works and Engineering

Geographic Information & Management System (GIMS)

1 inch = 29465 feet

DISCLAIMER: THIS MAP REPRESENTS THE BEST INFORMATION AVAILABLE TO THE CITY.
THE CITY DOES NOT WARRANT ITS ACCURACY OR COMPLETENESS.
FIELD VERIFICATIONS SHOULD BE DONE AS NECESSARY.

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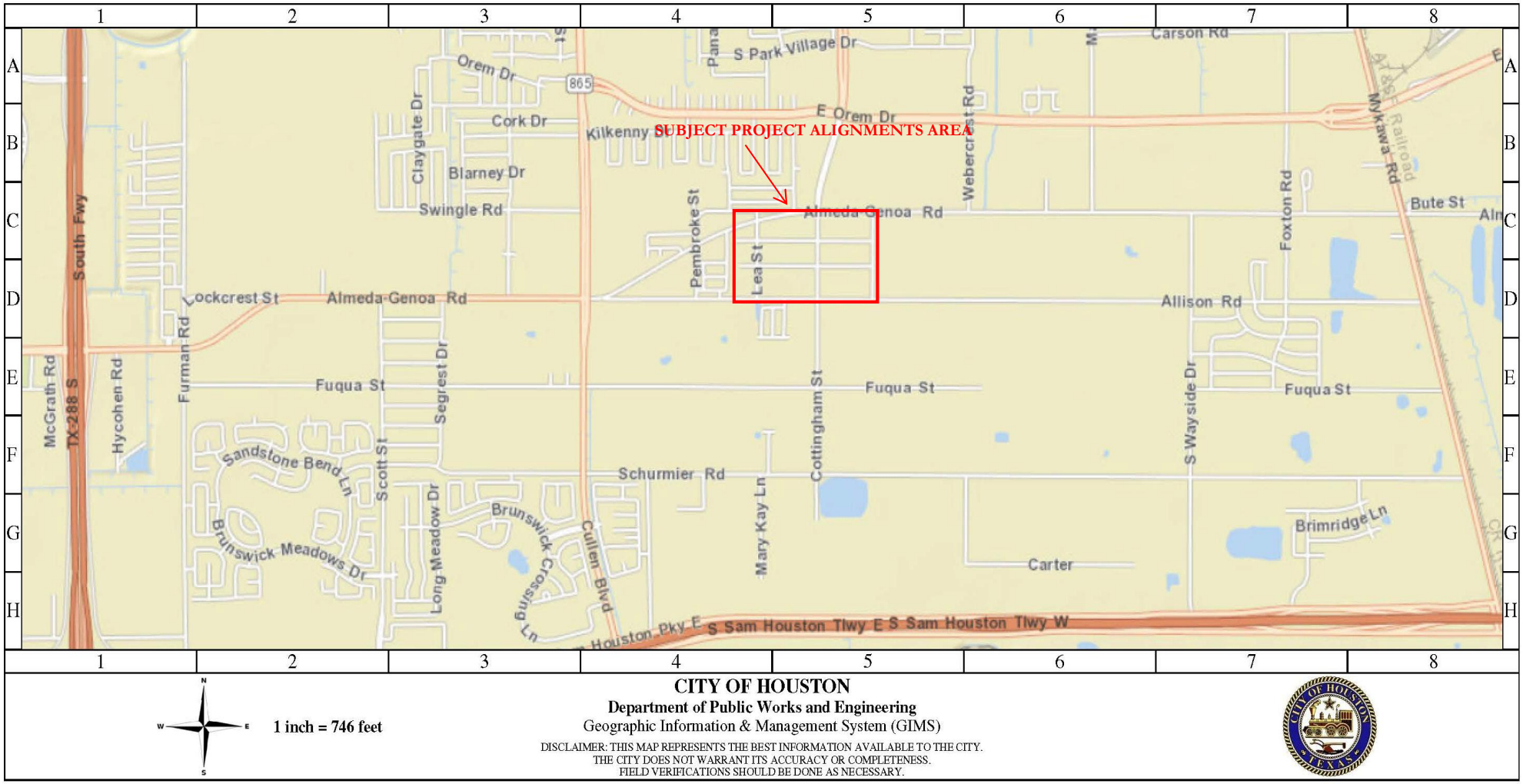
DATE: 6/13/2014	APPROVED BY: EH	PREPARED BY: NL

SITE VICINITY MAP
Geologic Fault Assessment - Minnetex Area and Almeda Genoa Place
Drainage and Paving Improvements

PROJECT NO.: HE1413020	DRAWING NO.: PLATE 1

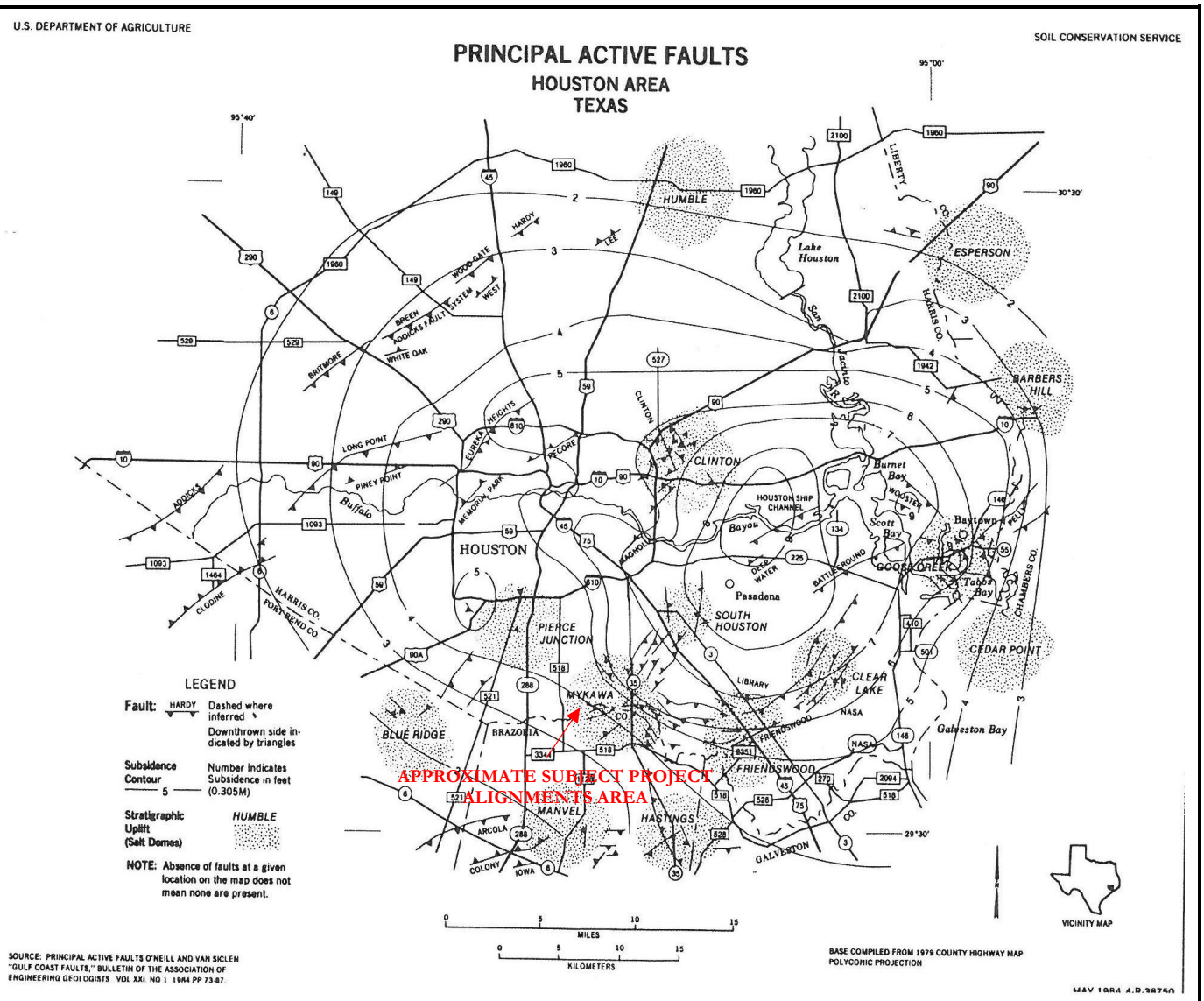


1 inch = 746 feet

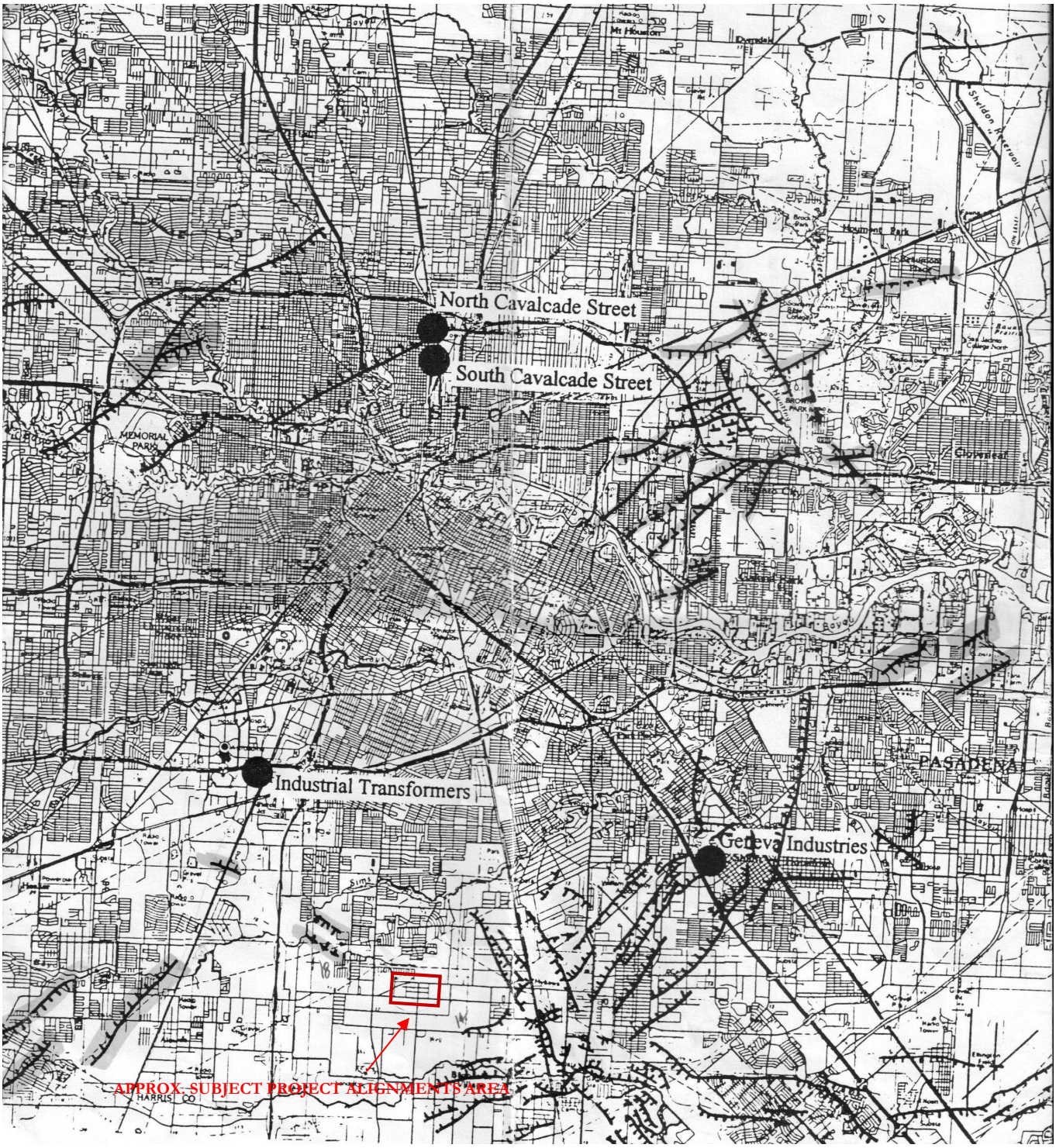
CITY OF HOUSTON
Department of Public Works and Engineering
Geographic Information & Management System (GIMS)

DISCLAIMER: THIS MAP REPRESENTS THE BEST INFORMATION AVAILABLE TO THE CITY.
THE CITY DOES NOT WARRANT ITS ACCURACY OR COMPLETENESS.
FIELD VERIFICATIONS SHOULD BE DONE AS NECESSARY.

HVJ ASSOCIATES	Drawn:	EH	**PLATE 2** **Project Area Map** **Minnetex Area and Almeda Genoa Place** **Drainage and Paving Improvements Geologic Fault Assessment** **Houston, Harris County, Texas**
	Checked:	EH	
	Date:	July 2014	
Project No. HE1413020	Scale	NTS	



HVJ ASSOCIATES		Drawn:	EH	**Plate 3** **Houston Area Fault Pattern Map** **Geologic Fault Assessment** **Minnetex Area and Almeda Genoa Place Drainage and Paving Improvements** **WBS No. M-000289-0002-3** **Houston, Harris County, Texas**	N
		Checked:	EH		
		Date:	August 2014		
Report No.	HE1413020	Scale:	NTS		



NOTE: Fault data from "Field Trip Guidebook," Houston Geological Society, 1993 (compiled by C.E. Norman, University of Houston).

HVJ ASSOCIATES		Drawn:	EH	**PLATE 4** **GEOLOGIC FAULT MAP SHOWING SITE AREA** **Geologic Fault Assessment** **Minnetex Area and Almeda Genoa Place** **Drainage and Paving Improvements** **WBS No. M-000289-0002-3** **Houston, Harris County, Texas**
		Checked:	EH	
		Date:	August 2014	
Report No.	HE1411840	Scale:	NTS	

APPENDIX A

SITE PHOTOGRAPHS

Photo 1. View from Glengarry Road Cul-De-Sac looking east.

Photo 2. View from intersection of Lea Road & Glengarry Road looking north.

Photo 3. View from intersection of Lea Road & Glengarry Rd looking east.

Photo 4. View from intersection of Lincolnshire Road & Cottingham Road looking east.

Photo 5. View from intersection of Lincolnshire Road & Cottingham Road looking south.

Photo 6. View of pavement distress near 4910 Lincolnshire Road.

Photo 7. View from intersection of Lincolnshire Road and Hendricksen Road looking south.

Photo 8. View of pavement distress near the intersection of Glengarry Road and Hendricksen Road.

Photo 9. View from intersection of Cottingham Road & Allison Road looking west.

Photo 10. View from intersection of Lea Road & Almeda Genoa looking west.

Photo 11. View from intersection of MLK Blvd. and Almeda Genoa looking east.

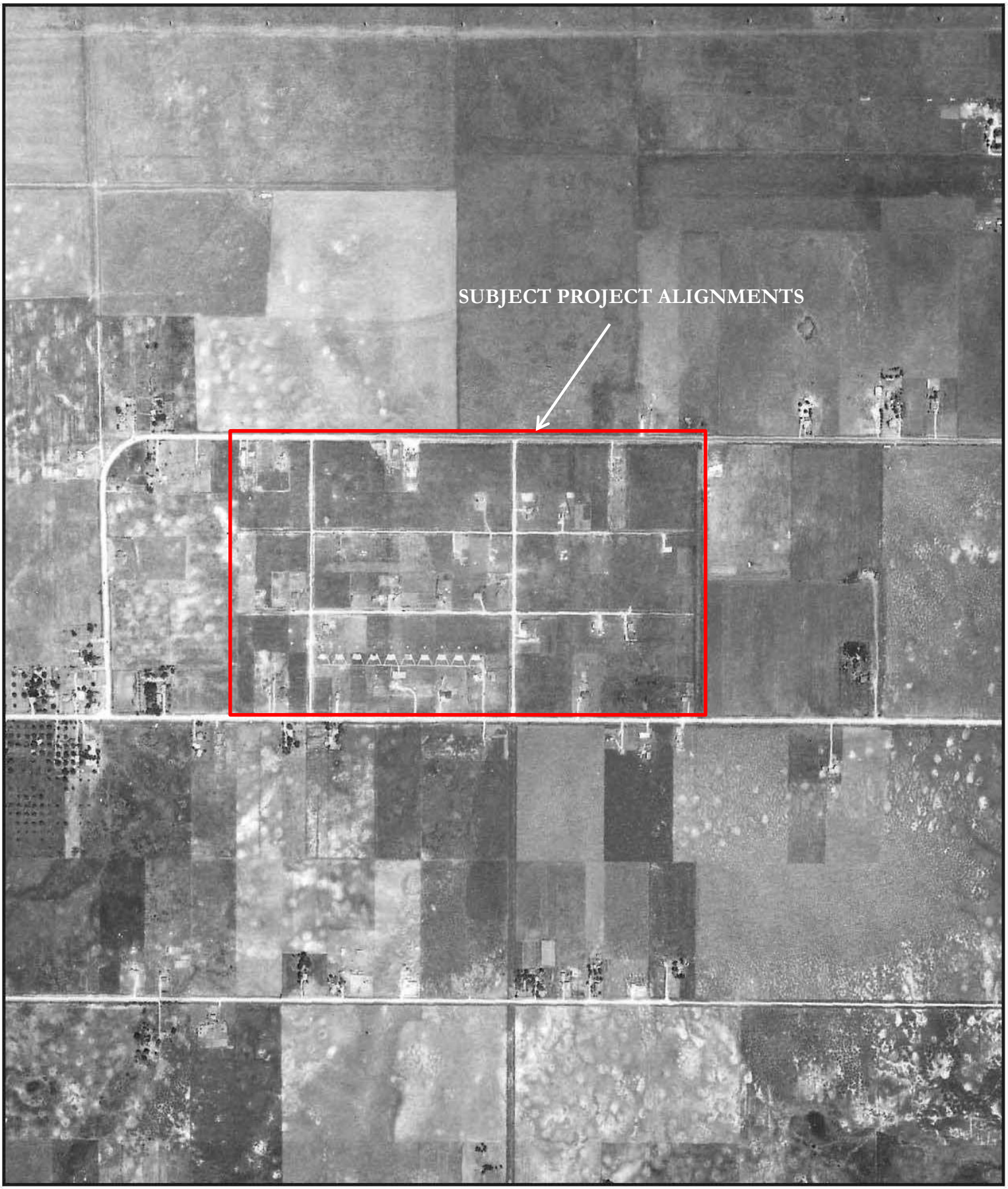
Photo 12. View from intersection of MLK Blvd. and Almeda Genoa looking west.

APPENDIX B

AERIAL PHOTOGRAPHS

Phase I Geologic Fault Assessment - Minnetex Area and Almeda Genoa Place Drainage and Paving Improvements
WBS No. M-000289-0002-3
1935 AERIAL PHOTO
SCALE: 1" = 700'

Phase I Geologic Fault Assessment - Minnetex Area and Almeda Genoa Place Drainage and Paving Improvements
WBS No. M-000289-0002-3
1944 AERIAL PHOTO
SCALE: 1" = 700'



Phase I Geologic Fault Assessment - Minnetex Area and Almeda Genoa Place Drainage and Paving Improvements
WBS No. M-000289-0002-3
1953 AERIAL PHOTO
SCALE: 1" = 700'

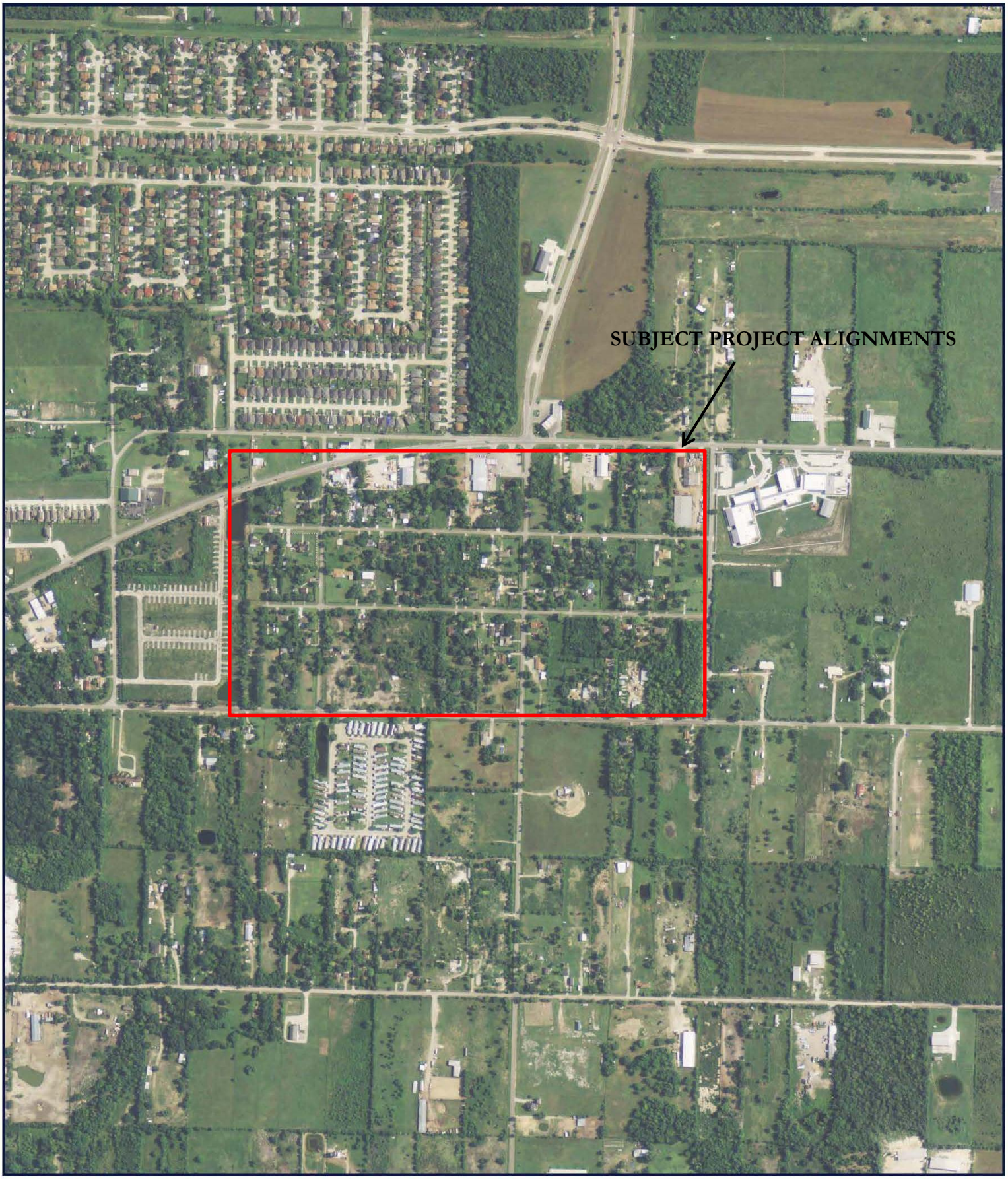
Phase I Geologic Fault Assessment - Minnetex Area and Almeda Genoa Place Drainage and Paving Improvements
WBS No. M-000289-0002-3
1969 AERIAL PHOTO
SCALE: 1" = 700'

Phase I Geologic Fault Assessment - Minnetex Area and Almeda Genoa Place Drainage and Paving Improvements
WBS No. M-000289-0002-3
1979 AERIAL PHOTO
SCALE: 1" = 700'

Phase I Geologic Fault Assessment - Minnetex Area and Almeda Genoa Place Drainage and Paving Improvements
WBS No. M-000289-0002-3
1989 AERIAL PHOTO
SCALE: 1" = 700'

Phase I Geologic Fault Assessment - Minnetex Area and Almeda Genoa Place Drainage and Paving Improvements
WBS No. M-000289-0002-3
2004 AERIAL PHOTO
SCALE: 1" = 700'

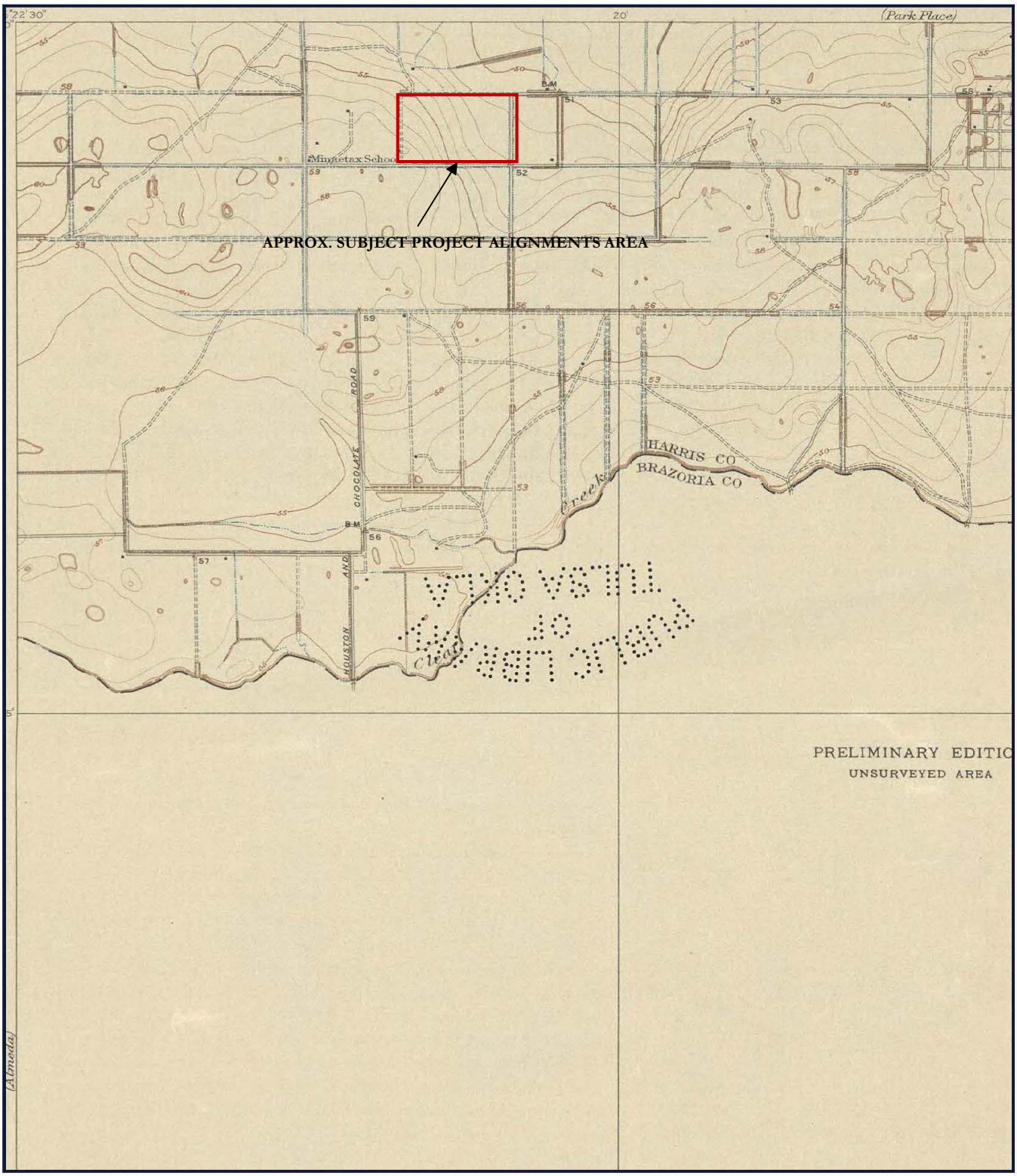
Phase I Geologic Fault Assessment - Minnetex Area and Almeda Genoa Place Drainage and Paving Improvements
WBS No. M-000289-0002-3
1996 AERIAL PHOTO
SCALE: 1" = 700'



Phase I Geologic Fault Assessment - Minnetex Area and Almeda Genoa Place Drainage and Paving Improvements
WBS No. M-000289-0002-3
2012 AERIAL PHOTO
SCALE: 1" = 700'

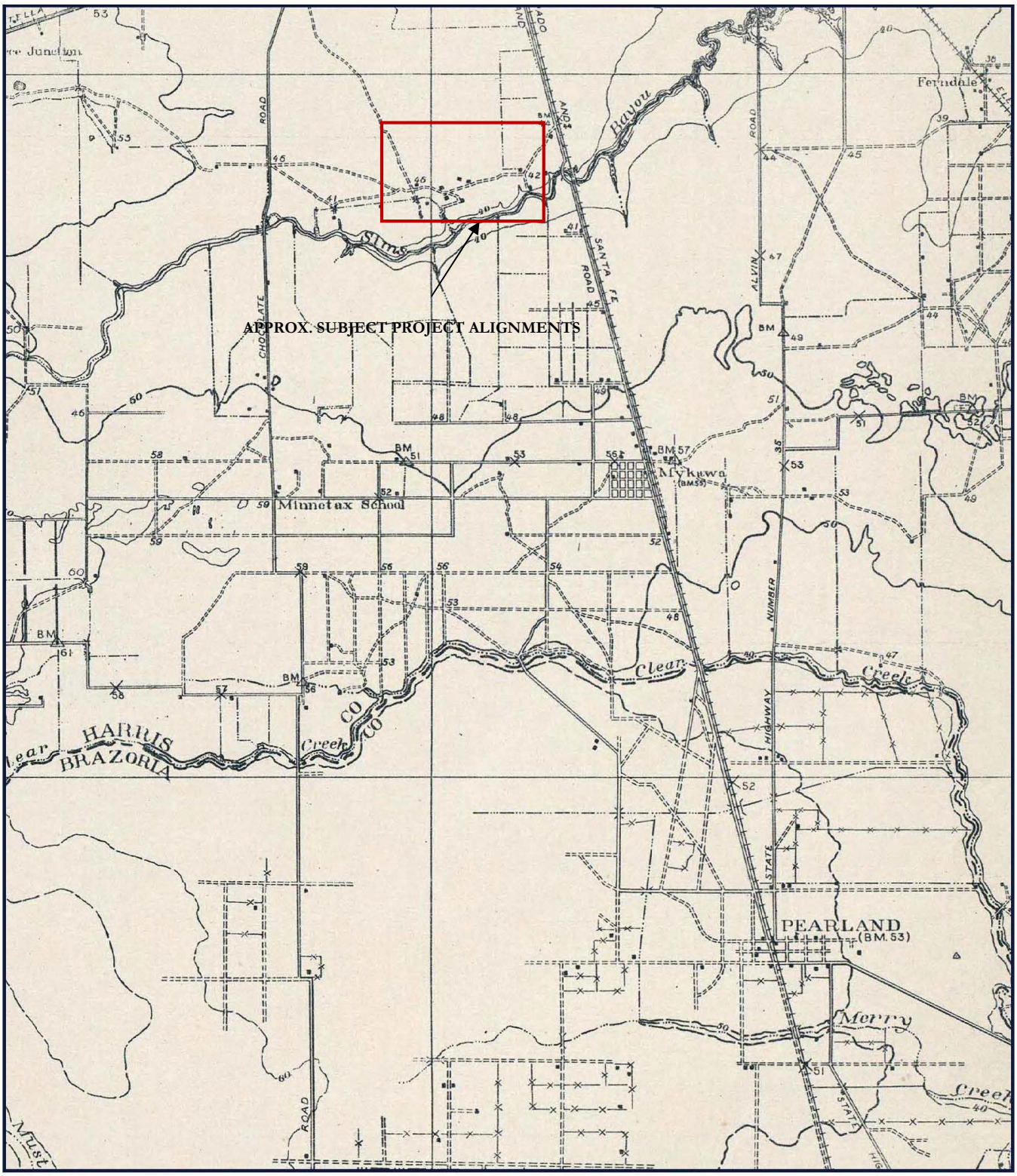
APPENDIX C

TOPOGRAPHIC MAPS



Source: U.S. Geological Survey (1915 Mykawa, TX Quadrangle)

HVJ ASSOCIATES		Drawn:	EH	**TOPOGRAPHIC MAP (1915)** **Geologic Fault Assessment** **Minnetex Area and Almeda Genoa Place** **Drainage and Paving Improvements** **WBS No. M-000289-0002-3** **Houston, Harris County, Texas**
		Checked:	EH	
		Date:	August 2014	
Report No.	HE1413020	Scale:	NTS	



Source: U.S. Geological Survey (1929 Pearland, TX Quadrangle)

HVJ ASSOCIATES		Drawn:	EH	**TOPOGRAPHIC MAP (1929)** **Geologic Fault Assessment** **Minnetex Area and Almeda Genoa Place** **Drainage and Paving Improvements** **WBS No. M-000289-0002-3** **Houston, Harris County, Texas**	N
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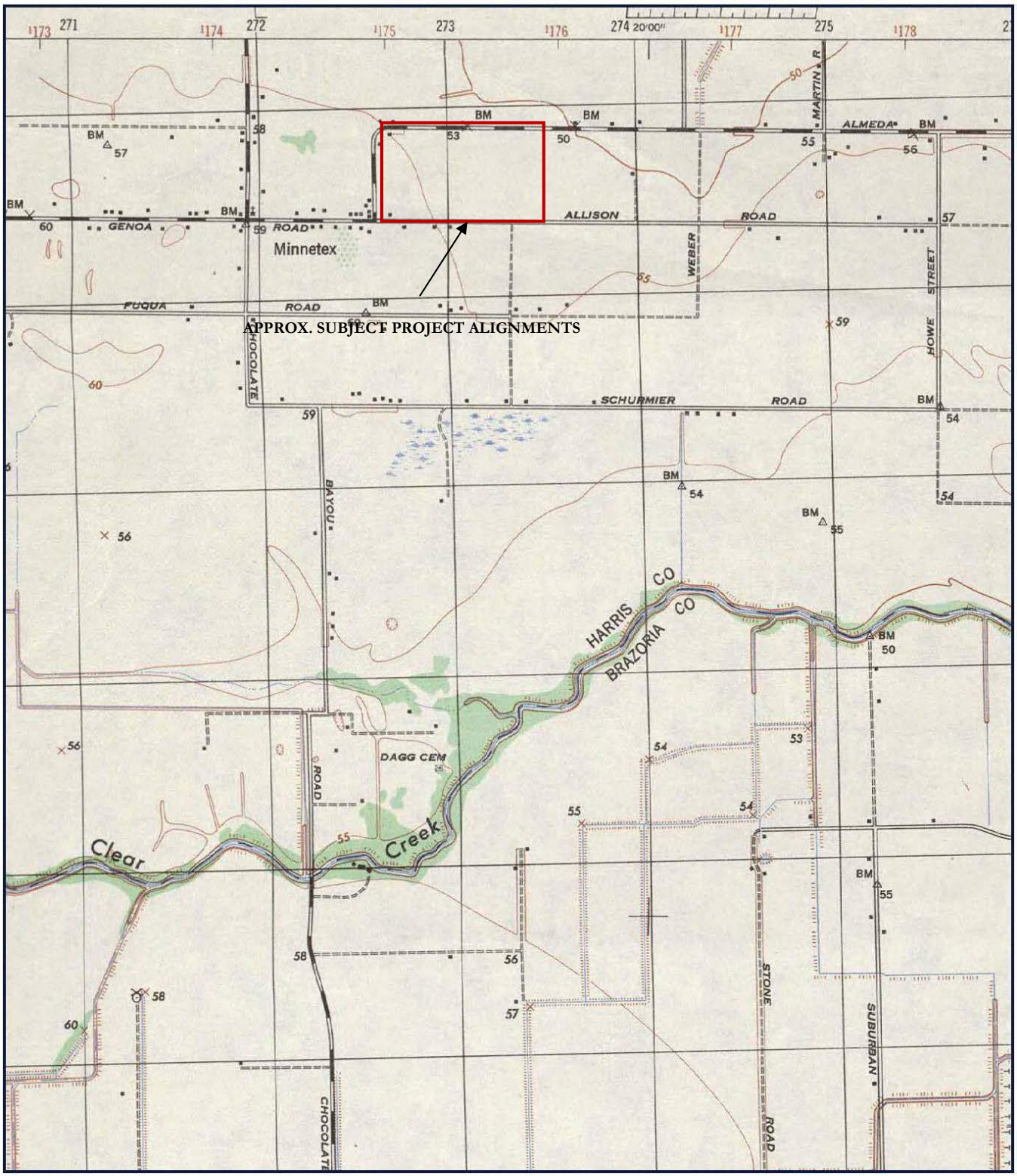
		Date:	August 2014		
Report No.	HE1413020	Scale:	NTS		



Source: U.S. Geological Survey (1947 Pearland, TX Quadrangle)

HVJ ASSOCIATES		Drawn:	EH	**TOPOGRAPHIC MAP (1947)** **Geologic Fault Assessment** **Minnetex Area and Almeda Genoa Place** **Drainage and Paving Improvements** **WBS No. M-000289-0002-3** **Houston, Harris County, Texas**
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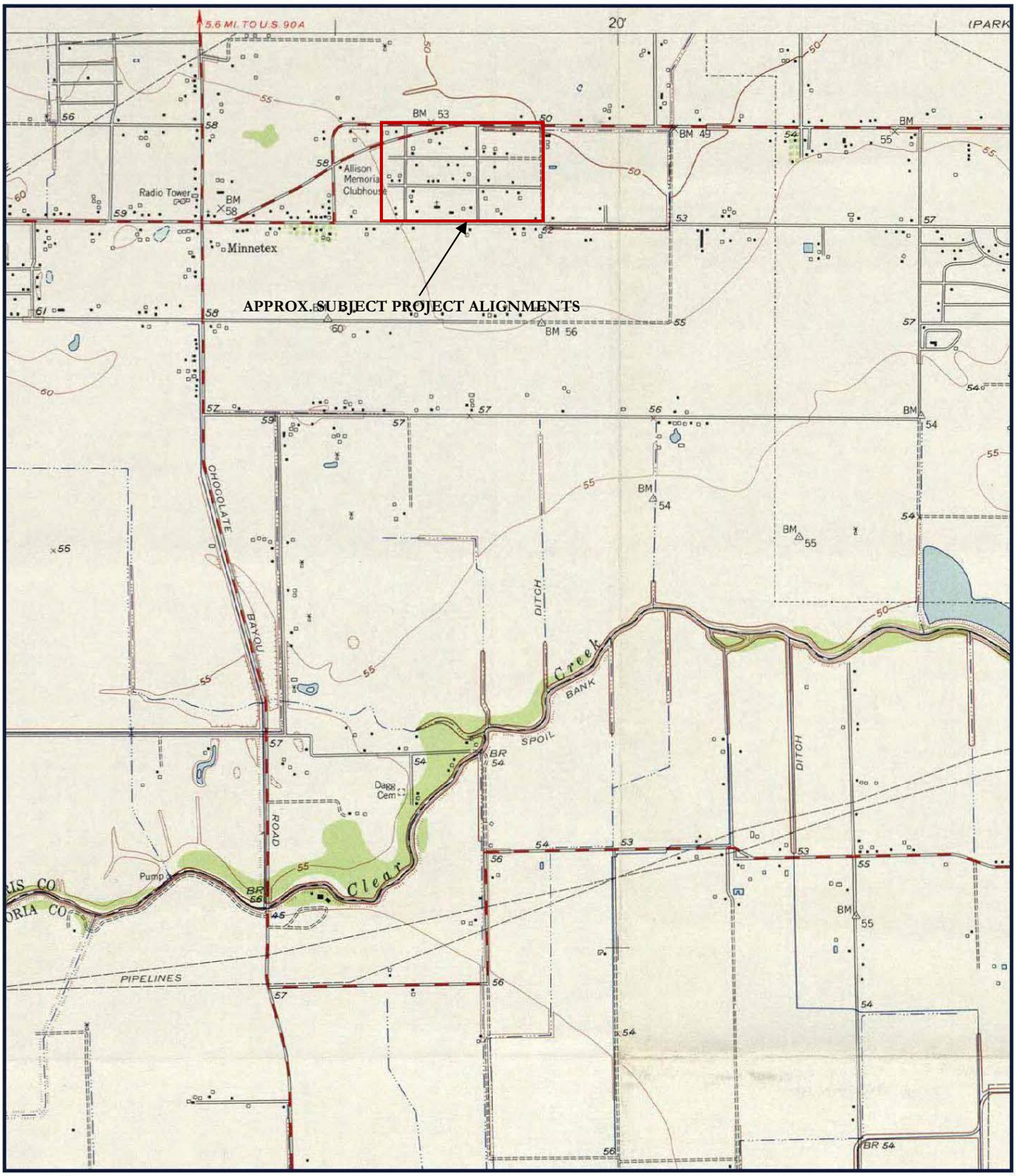
		Date:	August 2014	
Report No.	HE1413020	Scale:	NTS	



Source: U.S. Geological Survey (1955 Pearland, TX Quadrangle)

HVJ ASSOCIATES		Drawn:	EH	**TOPOGRAPHIC MAP (1955)** **Geologic Fault Assessment** **Minnetex Area and Almeda Genoa Place** **Drainage and Paving Improvements** **WBS No. M-000289-0002-3** **Houston, Harris County, Texas**	N
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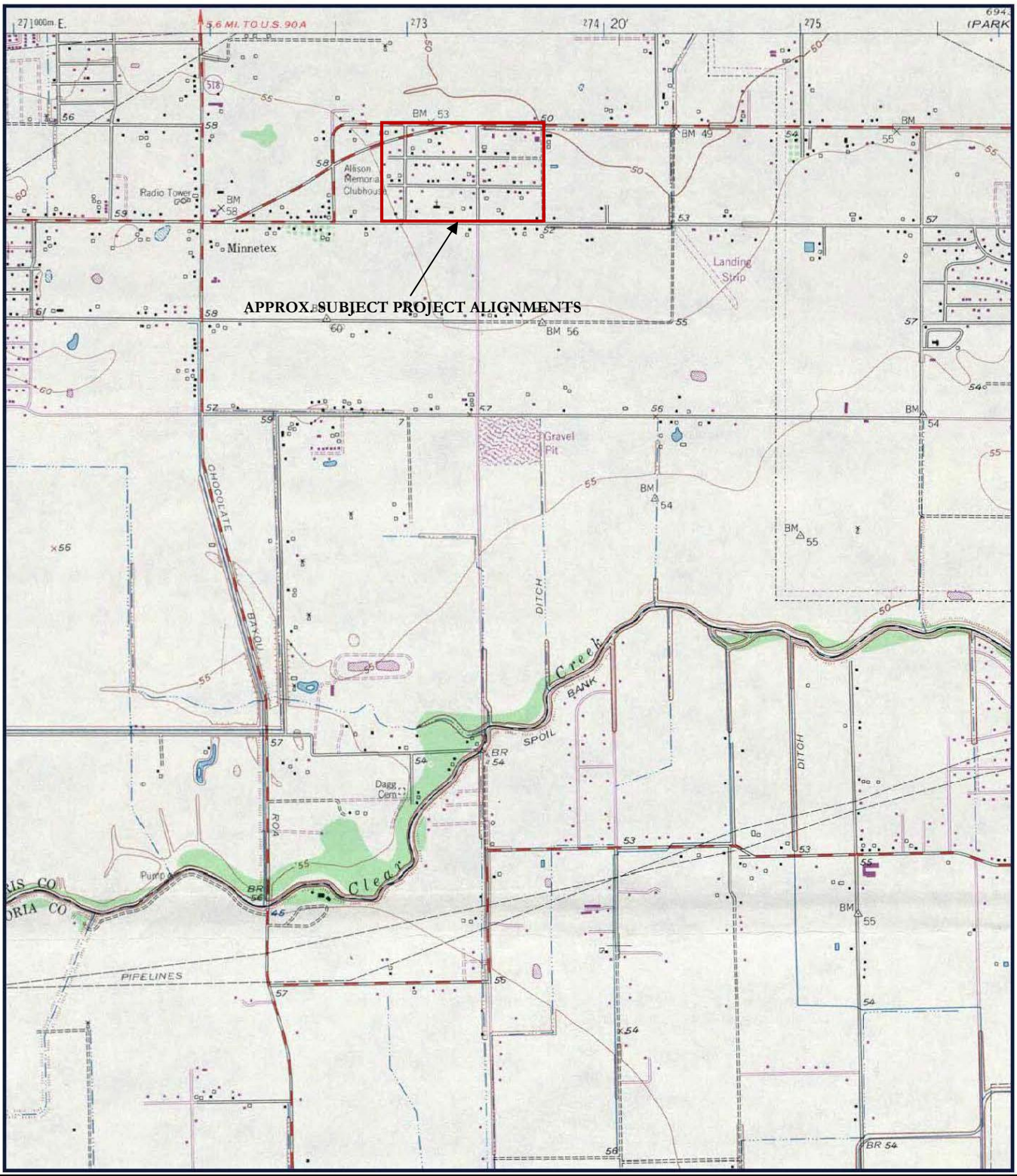
		Date:	August 2014		
Report No.	HE1413020	Scale:	NTS		



Source: U.S. Geological Survey (1969 Pearland, TX Quadrangle)

HVJ ASSOCIATES		Drawn:	EH	**TOPOGRAPHIC MAP (1969)** **Geologic Fault Assessment** **Minnetex Area and Almeda Genoa Place** **Drainage and Paving Improvements** **WBS No. M-000289-0002-3** **Houston, Harris County, Texas**
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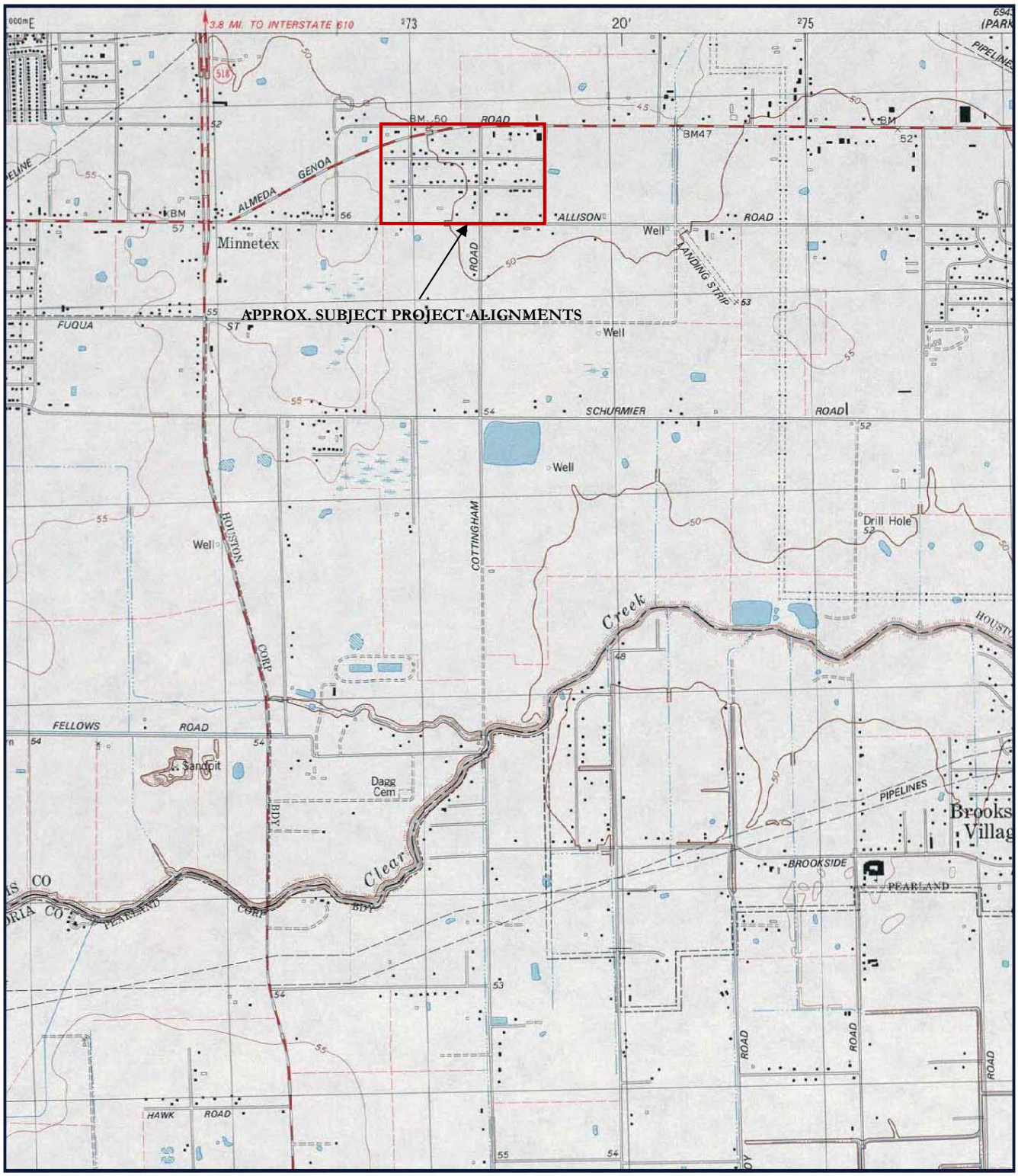
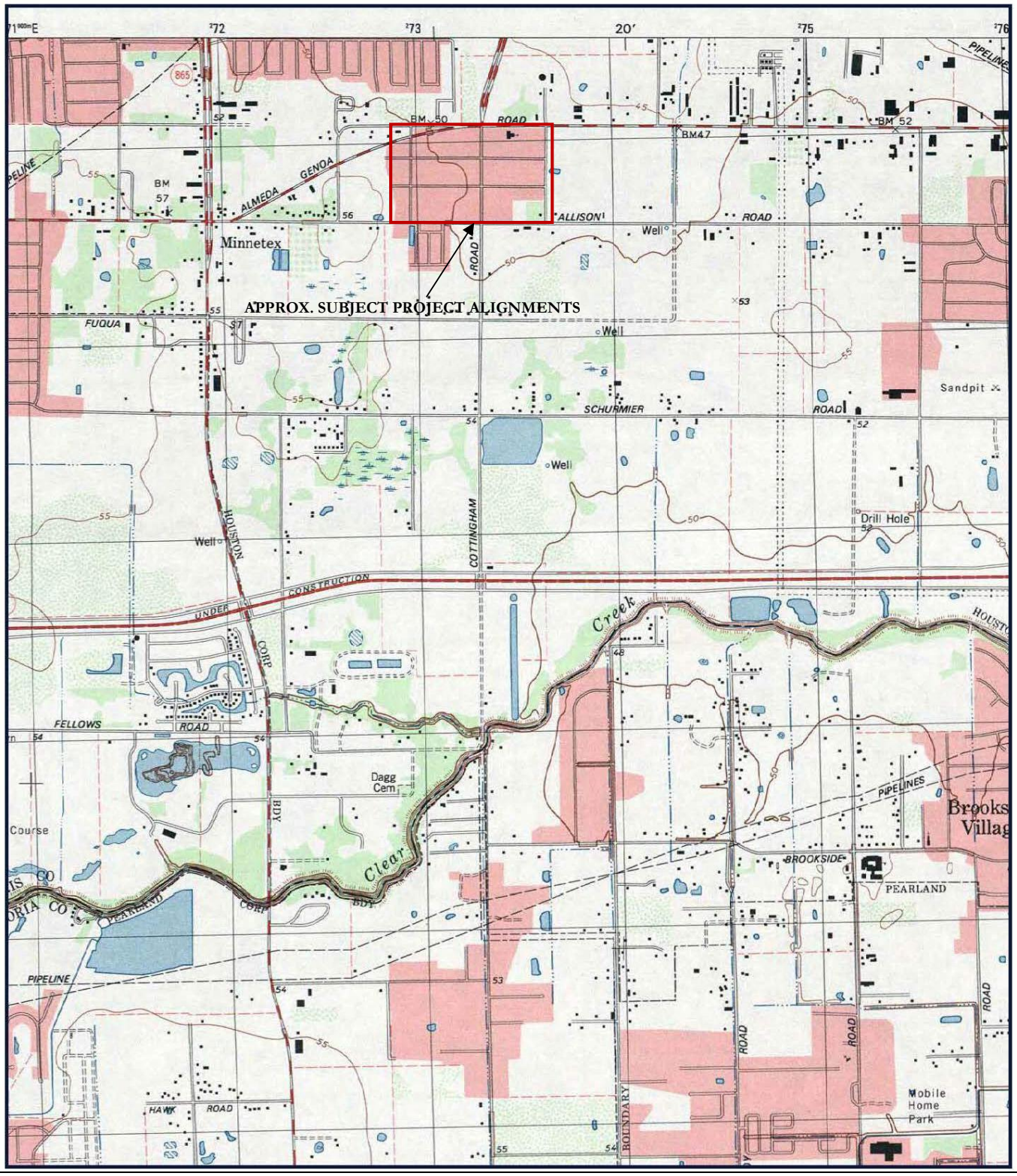
		Date:	August 2014	
Report No.	HE1413020	Scale:	NTS	



Source: U.S. Geological Survey (1982 Pearland, TX Quadrangle)

HVJ ASSOCIATES		Drawn:	EH	**TOPOGRAPHIC MAP (1982)** **Geologic Fault Assessment** **Minnetex Area and Almeda Genoa Place** **Drainage and Paving Improvements** **WBS No. M-000289-0002-3** **Houston, Harris County, Texas**
		Checked:	EH	
		Date:	August 2014	
Report No.	HE1413020	Scale:	NTS	



Source: U.S. Geological Survey (1995 Pearland, TX Quadrangle)

HVJ ASSOCIATES		Drawn:	EH	**TOPOGRAPHIC MAP (1995)** **Geologic Fault Assessment** **Minnetex Area and Almeda Genoa Place** **Drainage and Paving Improvements** **WBS No. M-000289-0002-3** **Houston, Harris County, Texas**
		Checked:	EH	
		Date:	August 2014	
Report No.	HE1413020	Scale:	NTS	