BENJAMIN J. CAYETANO
GOVERNOR
STATE OF HAWAII

KALI WATSON
CHAIRMAN
HAWAIIAN HOMES COMMISSION

JOBIE M. K. M. YAMAGUCHI
DEPUTY TO THE CHAIRMAN

STATE OF HAWAII
DEPARTMENT OF HAWAIIAN HOME LANDS
P.O. BOX 1879
HONOLULU, HAWAII 96805

September 5, 1995

Mr. Gary Gill, Director
State of Hawaii
Office of Environmental
Qaulity Control (OEQC)
220 South King Street, 4th Floor
Honolulu, Hawaii 96813

Dear Mr. Gill:

SUBJECT: Final Environmental Assessment for Kula Water Transmission Main, Phase 1, Kula, Maui, Hawaii

Enclosed are four (4) copies of the Final Environmental Assessment (Negative Declaration) for the proposed Kula Water Transmission Main, Phase 1. Based on the analysis of the conditions and impacts presented in the Enviromental Assessment, we have concluded that the proposed project will have no significant effect on the environment. Therefore, we are filing a Negative Declaration for the proposed project.

We request that this Negative Declaration be published in the next OEQC Bulletin. A completed OEQC Bulletin Pubilcation Form is enclosed as required.

Should you have any questions, please have your staff call Mr. Patrick K.M. Young, Land Development Division, at 586-3818.

Sincerely,

Mike Crozier, Administrator
Land Development Division

MC:PY: 0354B

cc: R.T. Tanaka Engineers, Inc.

114

1995-10-23-MA-FEA- Kula Water Transmission Main Phase I

FINAL
ENVIRONMENTAL ASSESSMENT
FOR
KULA WATER TRANSMISSION MAIN, PHASE I
AT KULA, MAUI, HAWAII
TAX MAP KEY: 2-2-02:15 (PORTION)
2-2-13:44 (PORTION

PREPARED FOR:
DEPARTMENT OF HAWAIIAN HOME LANDS
STATE OF HAWAII
P. O. BOX 1879
HONOLULU, HAWAII - 96805

PREPARED BY:
R. T. TANAKA ENGINEERS, INC.
871 KOLU STREET, SUITE 201
WAILUKU, MAUI, HAWAII - 96793

MAY 1994

REVISED: AUGUST 1995

TABLE OF CONTENTS

KULA WATER TRANSMISSION MAIN, PHASE I

TMK: 2-2-02:15 (PORTION)

2-2-13:44 (PORTION)

KULA, MAUI, HAWAII

ENVIRONMENTAL ASSESSMENT

I. APPLICANT:

Department of Hawaiian Home Lands, State of Hawaii, P. O. Box 1879, Honolulu, Hawaii - 96805.

II. APPROVING AGENCIES:

The applicant will have to obtain the following approvals before proceeding with the project:

County of Maui

Maui County Planning Department:

1. Environmental Assessment

Department of Public Works:

1. Construction Plan Approvals
2. Grading and Grubbing Permit

Department of Water Supply:

1. Construction Plan Approvals

III. AGENCIES CONSULTED:

Prior to the development of project plans, the following have been or will be consulted:

County of Maui:

Environmental Coordinator

Department of Planning

Department of Public Works

Department of Water Supply

State of Hawaii:

Department of Transportation

Department of Land & Natural Resources

Department of Agriculture

IV. DESCRIPTION OF THE PROPOSED PROJECT:

A. General:

The proposed project involves the extension of approximately 9,000 linear feet of 18" ductile iron waterline from Naalae Road to the Hawaiian Home Lands parcel in Keokea, Kula, Maui, Hawaii. This pipeline is being built to serve the future needs of the Hawaiian Home Lands as well as the surrounding Kula area.

The sources of water for the Lower Kula Water System are the various stream intakes in the Waiakamoi area on the windward side of Mount Haleakala, approximately 11.5 miles north of the proposed improvements.

B. Proposed Improvements:

The proposed construction will traverse through two private parcels, namely Parcel 44 of Tax Map Key 2-2-13 and Parcel 15 of Tax Map Key 2-2-02. Parcel 44 is presently being used for agricultural farming while Parcel 15 is being used to graze cattle.

The pipeline will connect to the end of the existing 18" Lower Kula Waterline at Naalae Road and

run in a southwesterly direction toward the Hawaiian Home Lands' parcel in Keokea.

V. DESCRIPTION OF THE AFFECTED ENVIRONMENT:

A. Physical Characteristics

1. Project Location

The proposed project site is located in Kula, Maui, Hawaii, approximately 2.5 miles north of the Kula Sanitarium. The general alignment of the pipeline runs parallel with Kula Highway ranging from between 3,000 and 4,000 feet makai of the highway.

Parcel 44 is owned by the Watanabe Family Trust and Parcel 15 is owned by Kaonoulu Ranch.

Parcel 44 is bounded by agricultural lands and Kaonoulu Ranch Lands. Parcel 15 is also bounded by agricultural lands and the Hawaiian Homes parcel.

Figure 2 shows the proposed development site relative to existing roads.

2. Soils

The U.S.D.A. Soil Conservation Services Soil Survey classifies the site (Kula Cobbly Loam, KxaD). This type of soil is characterized as having rapid permeability slow to medium runoff and moderate erosion hazard.

3. Climate

Climate at the project site is typical of Kula region, receiving little annual rainfall, as it lies on the Leeward slopes of Mount Haleakala. Typical of the Hawaiian Islands, trades are the prevailing winds while storm winds are usually from the south or southeasterly direction.

The average annual rainfall in the Kula area ranges from 25 to 40 inches.

4. Topography

Parcel 15 is presently vacant and covered with scrubby vegetation used for cattle grazing. Parcel 44 is under active cultivation by the Watanabe Family. The elevations within the project limits hover at 2,600 feet above mean sea level.

5. Drainage

Drainage runoff from the upper reaches of Haleakala flow through the project site running in one of four gulches. These gulches are Naalae Gulch, Kaonoulu Gulch, Kaipoioi Gulch and Kaakaulua Gulch.

Storm runoff from the proposed construction area sheet flows into one of these four gulches.

6. Flooding

According to the Flood Insurance Rate Maps for Maui County the site is within Zone C designation - "areas of minimal flooding".

B. Biological Characteristics

1. Plant Life

There is no indication of any rare or endangered plants associated with the property. See Flora and Fauna Study in the Appendix of this report.

2. Animal Life

There is no indication of any rare or endangered species of animal associated with this property.

See Flora and Fauna Study in the appendix of this report.

C. Land Use and Zoning

1. State Land Use and Zoning

The property is located within the agriculture district as designated by the Land Use Commission of the State of Hawaii.

2. County Zoning and Lahaina Community Plan

The project site is currently zoned agriculture by the County. The site is within the agriculture district as designated by the Makawao-Pukalani-Kula Community Plan.

3. Existing Land Use

Parcel 44 is presently undeveloped supporting growth of miscellaneous pasture grasses, and wattlewood trees. Parcel 15 is currently used for the cultivation of vegetables.

4. Adjacent Land Use

Lands surrounding the project site are presently used for cattle grazing owned by Kaonoulu Ranch.

Rural residential development is scattered throughout the Kula area.

VI. PROBABLE IMPACT OF PROJECT ON THE ENVIRONMENT AND MITIGATIVE MEASURES TO MINIMIZE ADVERSE IMPACTS AND ALTERNATIVES

A. Primary Impacts

1. Anticipated Short-Term Impacts

Short-term construction related impacts are anticipated. These impacts will last no longer than the construction phase and can be mitigated by proper construction techniques, adherence to generally accepted construction practices and compliance with the Maui County Soil Erosion and Sedimentation Control, OSHA Standards, State Air, Noise and Water Quality Regulations. These short-term effects will include the following:

a. Dust from Construction Operations

Waterwagons and sprinklers will be used to control dust resulting from construction activities. The proposed project site will be kept moist after working hours and on weekends, if necessary. These requirements will be stated in the construction plans and specifications.

b. Noise from Construction Equipment

Noise from construction equipment will be kept within the limits permitted by the State, County and OSHA regulations. Construction activities will be restricted to daylight hours between 7:00 a.m. and 3:30 p.m. No work will be permitted at night except to complete work activities that would endanger the health and safety of the community if left undone.

c. Disruption of Normal Traffic Flow

No serious traffic problems are anticipated during the construction phase since the activity will be confined within the proposed project site. Minor traffic inconvenience will be experienced along Naalae Road. All applicable safety precautions will be adhered to for the safety of motorists and pedestrians.

d. Soil Erosion

The soils at the site are described in Part V of this assessment and are characterized as susceptible to wind erosion if the surface vegetation is removed. This being the case, the contractor will be required to keep the graded areas moist by means of waterwagons or temporary sprinkler systems and to have all exposed areas paved,

grassed or landscaped immediately upon completion of finished grading. Furthermore, soil erosion, will be minimized by adhering to the requirements of Chapter 20.08 of the Maui County Code. No adverse environmental impact is anticipated due to soil erosion.

2. Anticipated Long-Term Impacts

a. Physical Impacts

1) Grading

All areas excavated for pipeline installation will be restored to its original condition.

Long-term grading impacts will be non-existent.

2) Drainage

The completion of the project will not result in increased runoff.

Thus, long-term drainage impacts will be non-existent.

3) Air Quality and Water Quality

Upon completion of the construction of this project, the existing conditions of the area will remain unchanged.

Therefore, long-term air and water quality will also remain unchanged.

4) Noise

Only short-term impacts associated with noise will be encountered as described earlier. Long-term impacts will be non-existent.

5) Aesthetics

Due to the fact that the pipeline will be completely buried the visual character of the site will not be altered upon completion of the project.

6) Historical and Archaeological Features

Two (2) rock platforms were discovered in the vicinity of the project. (See "Archaeological Survey" for the project).

Recommendation of the consulting archaeologist with the approval of the Dept. of Land & Natural Resources will be implemented.

The State Historic Preservation Officer and the County of Maui will be informed immediately should any archaeological features be discovered during grading. Grading operations will not continue until clearance from the State and County is received.

b. Biological Impacts

(Refer to "Flora and Fauna Study" for the project.)

1) Plant

No significant impact on plant life is anticipated as a result of this proposed project. There are no rare or endangered species of plants on the site, nor are there favorable conditions for such species.

2) Animal and Bird

No significant impact on animal and bird life is anticipated as a result of this proposed project. There are no rare or endangered species.

c. Public Facilities and Services

1) School

There are no impacts to school facilities as a result of this project.

2) Public Safety

There are minimal impacts to public safety as a result of this project. During the construction phase the Contractor will be responsible for the safety of the public affected by his operations.

3) Parks and Recreation

There are no impacts to parks and recreational facilities as a result of this project.

d. Infrastructure and Utilities

1) Water

When completed and online, the proposed project will extend the transmission and distribution capabilities of the Maui County Department of Water Supply.

2) Sewer

The County of Maui does not operate any sewage collection or treatment facilities in the Kula area. Completion of this project will not have an impact on sewage disposal in the area.

3) Utilities

The project site is located in an area presently served by Maui Electric Company, and Hawaiian Telephone Company. There should be no impact as a result of this project.

4) Access and Circulation

Access and circulation patterns in the Kula area will not be impacted by the completion of the proposed project.

B. Secondary Impacts

1. Anticipated Short-Term Impacts

The proposed development will provide short-term employment during the period of construction. Most or all of these short-term impacts

will affect the contractors and material suppliers that will be involved in this project.

2. Anticipated Long-Term Impacts

Anticipated long-term impacts of the project include extending the transmission and distribution capabilities of the Maui County Water Department.

C. Alternatives

1. No Project

Any beneficial or adverse impacts associated with the development of this proposed project would not be generated. This alternative is not a preferred alternative due to the fact that the Kula area suffers from the lack of an adequate water system.

VII. OTHER INTEREST AND CONSIDERATION OF GOVERNMENTAL POLICES THAT OFFSET ADVERSE ENVIRONMENTAL EFFECTS

Sufficient governmental control as mandated by the Maui County Code, State Health regulations and Soil Conservation requirements will be enforced to mitigate any adverse environmental impact.

VIII. DETERMINATION AND SUPPORTING REASONS:

In accordance with the Rules and Regulations, the proposed project does not have significant adverse effects upon the environment, as follows:

1. Involves an irrevocable commitment to loss or destruction of any natural or cultural resource.

There are no such natural or cultural resources associated with the project site. If any are discovered, the appropriate agencies will be consulted.

2. Curtails the range of beneficial uses of the environment.

The proposed project will be compatible with the surrounding uses of the area.

3. Conflicts with the County's or State's long-term environmental policies or goals and guidelines.

No long-term environmental conflicts are noted.

4. Substantially affects the economic or social welfare activities of the community, County or State.

The completion of the project is not expected to affect the area's economic or social welfare.

5. Substantially affects public health.

The proposed project is not expected to cause any detrimental effect on the well-being of the public.

6. Involves substantial secondary impacts, such as population changes and effects on public facilities.

The completion of the waterline will not involve substantial secondary impacts such as population changes and effects on public facilities.

7. Involves a substantial degradation of environmental quality.

The proposed project doesn't involve activities that will lower the existing quality of the environment in the area.

8. Is individually limited but cumulatively has considerable effect upon the environment or involves a commitment for larger actions.

The proposed project does not have considerable effect upon the environment. Development is regulated by the County of Maui through its planning and approval process. Approval of the project does not involve a commitment for any larger actions.

9. Substantially affects a rare, threatened, or endangered species of animal or plant, or its habitat.

There are no known rare, threatened or endangered species or habitat associated with the project site.

10. Detrimentally affects air or water quality or ambient noise levels.

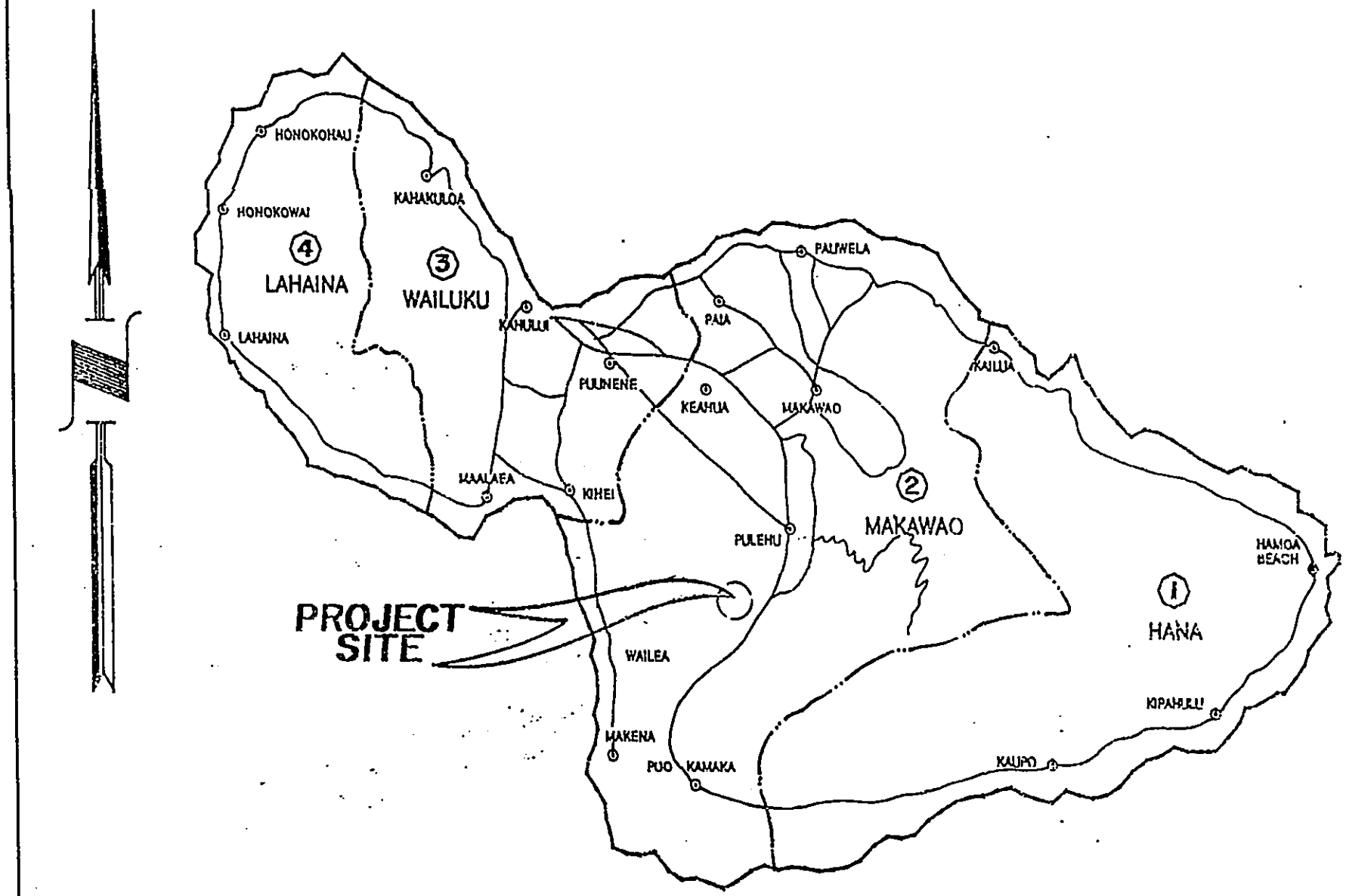
There will be no long-term effects on air quality due to the proposed project.

Short-term impacts on air and water quality, as well as noise, will occur during the construction period, but will be mitigated by normal construction practices and will be regulated and imposed within the plans and specifications.

11. Affects an environmentally sensitive area, such as flood plains, tsunami zones, erosion prone areas, geologically hazardous lands, estuaries, fresh waters or coastal waters.

The proposed project is not anticipated to have any adverse impact on flood plains, tsunami zones, geologically hazardous lands, estuaries, fresh waters or coastal waters. Major flooding or erosion problems are not expected. The project site falls within Zone "C" where minimal flooding is expected as established by the "Flood Insurance Rate Maps" for County of Maui. The project site contains soils which are essentially Kula Series Soil classification and construction of the project will require that all graded areas be grassed, landscaped or paved as soon as finish grading is completed.

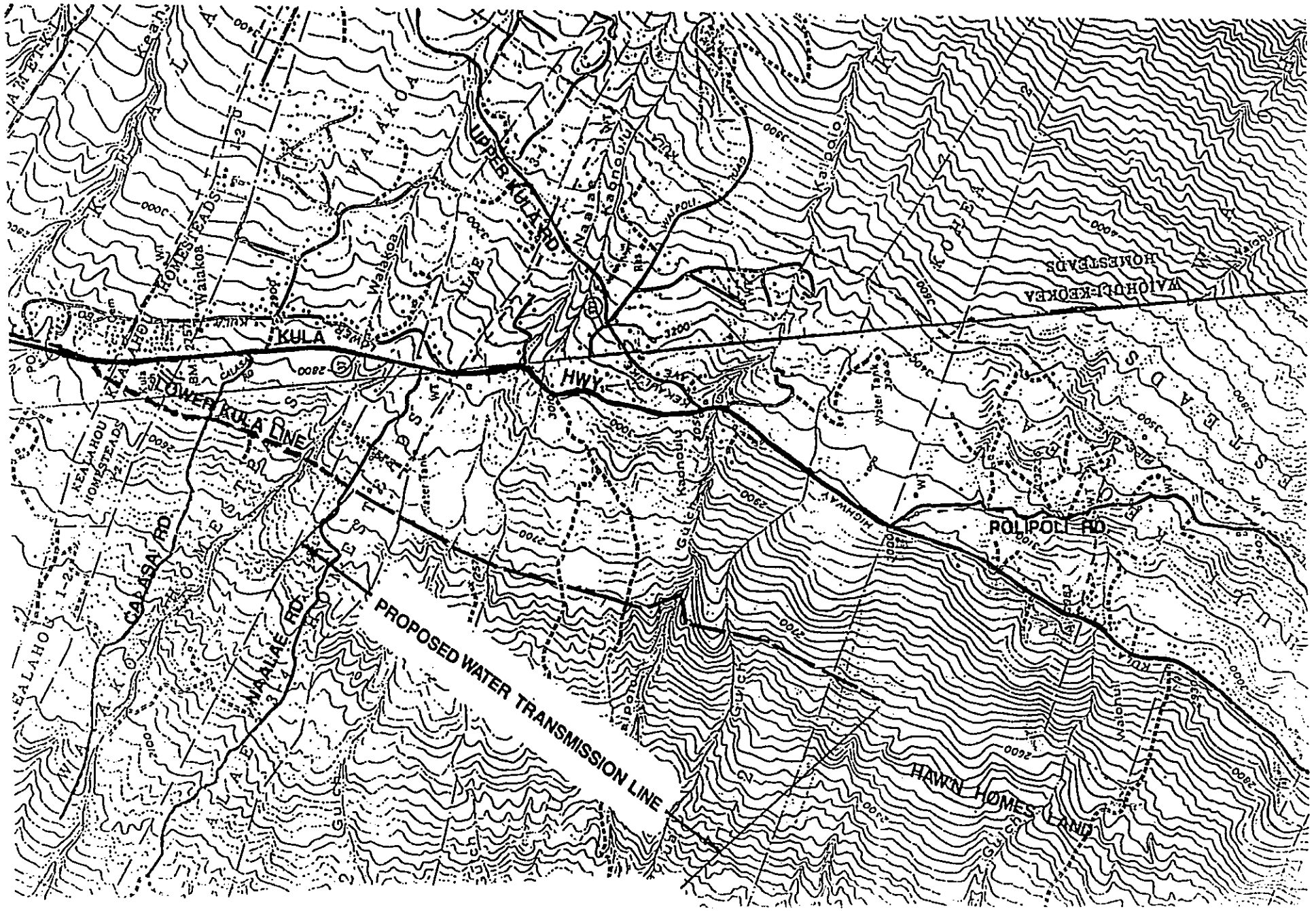
Therefore, it is concluded that this proposed project will not have a significant effect on the environment.



LOCATION MAP

SCALE : 1 inch = 6 miles

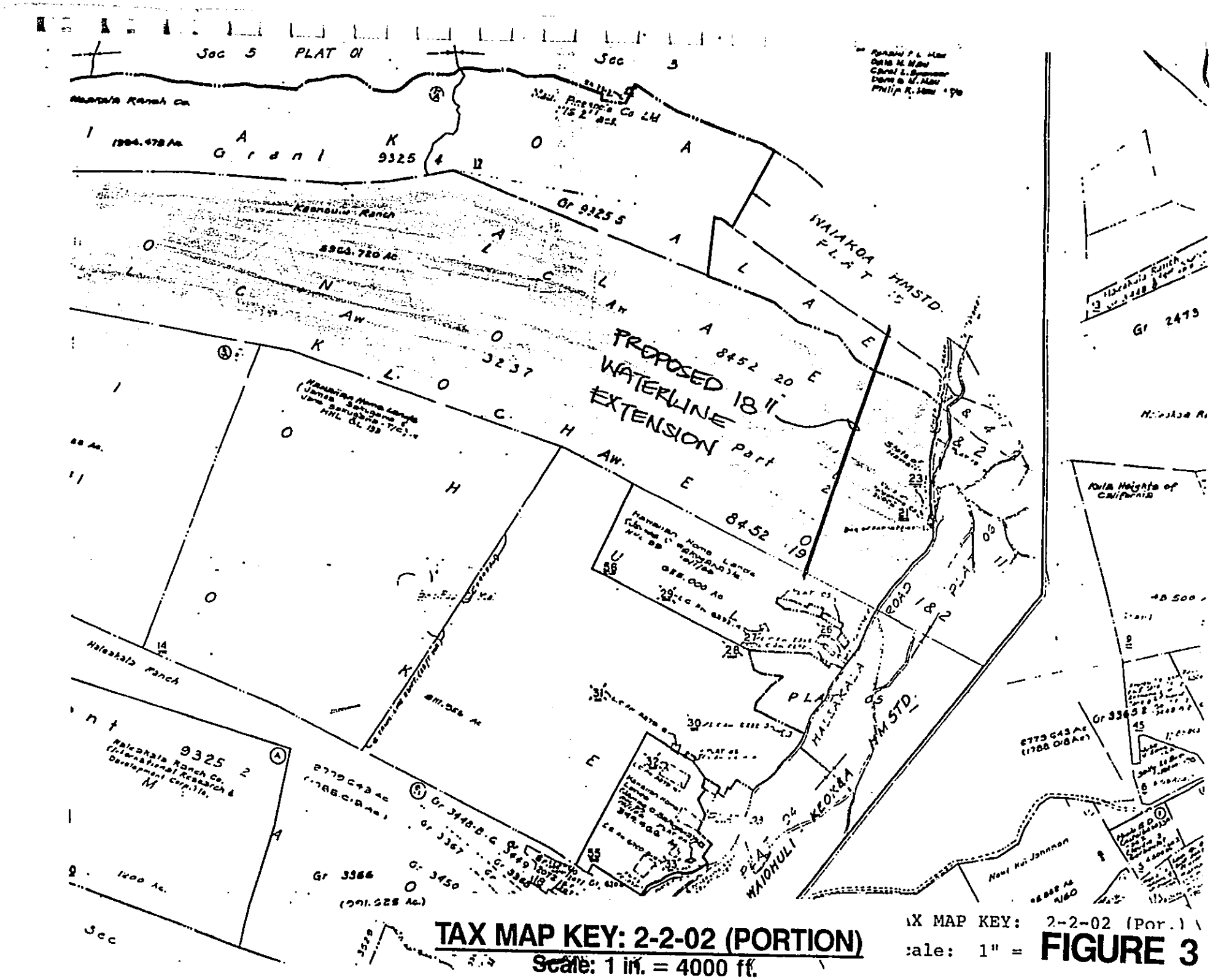
FIGURE 1



USGS MAP

Scale: 1 in. = 2000 ft.

FIGURE 2



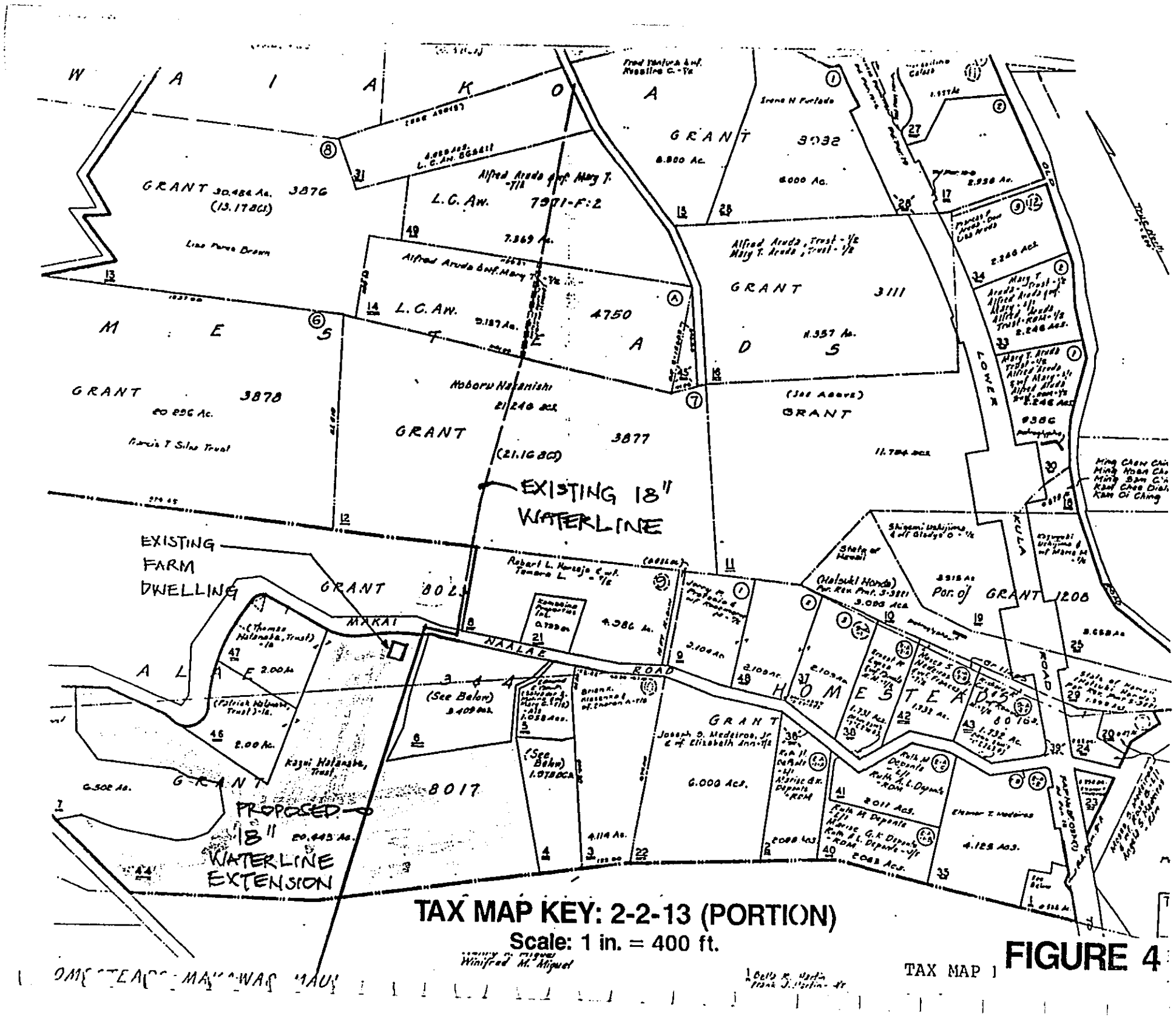
TAX MAP KEY: 2-2-02 (PORTION)

Scale: 1 in. = 4000 ft.

TAX MAP KEY: 2-2-02 (Por.)

Scale: 1" =

FIGURE 3



TAX MAP KEY: 2-2-13 (PORTION)

Scale: 1 in. = 400 ft.

FIGURE 4

SOIL INVESTIGATION

INTRODUCTION

This investigation was made for the purpose of obtaining information on the subsurface conditions from which to provide geotechnical design recommendations and general construction information for the proposed Kula Water Transmission Main, Phase I, to be located in Kula, Maui, Hawaii. The location of the site, relative to the existing streets and landmarks, is shown on the Vicinity Map, Plate 1.

SCOPE OF WORK

The services included logging the excavation of 43 test pits to depths of 1 to 8 feet, obtaining samples of the underlying soils, performing laboratory tests on the samples to determine their engineering characteristics, and performing an engineering analysis from the data gathered. In general, the following information is provided for use by the Engineer:

1. General subsurface conditions, as disclosed by the test pits.
2. Physical characteristics of the soils encountered.
3. Recommendations for lateral bearing pressures.
4. Recommendations for placement of backfill.
5. Special considerations.

PLANNED DEVELOPMENT

From the information provided, the project will consist of extending the Lower Kula Waterline approximately 9,000 lineal feet from Naalae

Road to the Hawaiian Home Lands in Keokea. The water main will be 18-inches in diameter.

SITE CONDITIONS

Surface

The project site is located about 2,100 to 2,800 feet downhill of Kula Highway. The alignment is roughly parallel to the highway and passes through properties designated by Tax Map Key Number 2-2-02 and 2-2-13. The properties consist of vegetable fields, pasture land and wooded area. The alignment crosses 8 gullies or gulches.

Subsurface

The subsurface conditions at the site were explored be excavating 43 test pits to depths of 1 to 8 feet below the existing grade. The locations of the test pits are shown on the Plot Plans, Plates 2A through 2H. Detailed logs of the test pits are presented in the Appendix to this report.

Except at Test Pits 1, 2, 3, 12, 17 and 18, moderately stiff to very stiff, brown, dark-brown, red-brown, gray clayey SILT was encountered from ground surface to depths of 1 to 7.5 feet below grade. At Test Pits 4, 5, 6, 7, 8, 9, 10, 13, 14, 15, 16, 19, 20, 21, 22, 23, 24, 25, 26, 28, 29, 31, 35, 39, 41, 42, and 43, the clayey SILT was underlain by moderately dense to very dense, brown and gray silty GRAVEL to depths of 2.5 to 8 feet below grade.

At Test Pits 1, 2, 12, 17, and 18, no surface layer of clayey SILT was found; moderately to very dense, brown and gray silty GRAVEL was found from ground surface to depths of 1 to 8 feet.

At Test Pit 3, the silty GRAVEL was loose to a dpeth of 7 feet. At Test Pits 32 and 36, soft clayey SILT was encountered to depths of 2.5 feet.

At Test Pits 1, 2, 6, 7, 9, 10, 11, 12, 13, 15, 16, 17, 18, 20, 21, 24, 26, 29, 30, 31, 35, 36, 39, 40, 41, 42, and 43, soft grading to hard BASALTIC ROCK was encountered at or near the bottom of these test pits at 2.5 to 8 feet below grade.

No groundwater was encountered in any of the explorations at the time of the investigation. This does not preclude the possibility of encountering groundwater in other areas of the site especially during and immediately after rains.

From the USDA Soil Conservation Service "Soil Survey of the Islands of Kauai, Oahu, Maui, Molokai and Lanai, State of Hawaii", the site is located in an area designated as Kula cobbly loam, 12 to 20 percent slopes (KxaD).

The Kula series consist of "well-drained soils on uplands on the island of Maui. These soils developed in volcanic ash". In the

KxaD portion of the series, the substratum is basic igneous rock. In some places, rock outcrop occupies 0.1 to 3 percent of the surface. Permeability is moderately rapid, runoff is medium, and the erosion hazard is moderate (USDA, 1972, pg. 76, 77 and Plates 107 and 108).

Geology

The island of Maui is a volcanic doublet that formed when lavas from Haleakala ponded against the older West Maui Mountains. The development of the island above sea level is believed to have occurred between late Pliocene and Pleistocene time (approximately 1 to 12 million years ago).

The site is located on the western slope of the Haleakala Volcano which was built over three rift zones that trend north, southwest and east. These rift zones are studded with large cinder cones. The lava flows making up the main mass of the mountain is known as the Honomanu volcanic series which consists of thin-bedded pahoehoe and aa lava flows. Above the Hononamu volcanics is the Kula volcanic series which consists of thicker andesitic aa flows. Most of the lava flows dip about 12 degrees. Along the southwest and east rift zones only, the volcano is capped with the Hana volcanic series (Stearns, 1966).

CONCLUSIONS AND RECOMMENDATIONS

General

Three (3) general types of materials were encountered in the test pits - clayey SILT, silty GRAVEL and BASALTIC ROCK. Boulders and cobbles were found within the clayey SILT and silty GRAVEL formations.

The water main will cross gulches of varying depths. Special precautions may be required during rainy periods to protect the work area and personnel from flooding and stream flow.

Trench Excavation

The water main will require a minimum trench depth of 7 feet (5-feet of cover plus 6-inches of cushion beneath the 18-inch diameter pipe).

Excavations into the underlying clayey SILT and silty GRAVEL can generally be accomplished with conventional trench excavators. Excavation into the underlying ROCK will likely require heavy equipment, hoeramming, and/or blasting (if permitted).

It should be anticipated that boulders and cobbles will be encountered in the SILT and GRAVEL formation.

Protection of Trench Excavation

All excavation work shall be done in accordance with the OSHA standards - Excavations, 29 CFR Part 1926, dated October 1989.

In general, the materials encountered in the test pits may be classified as follows using the OSHA standard:

Soil Description	Soil Type
moderately stiff to very stiff clayey SILT	A
moderately dense to very dense silty GRAVEL	B
soft clayey SILT	B
loose silty GRAVEL	C
BASALTIC ROCK	"Stable Rock"

For Type A material, excavations less than 20 feet deep can be made with side slopes of 3/4H:1V or flatter. Where the excavation is open for less than 24-hours, the side slope for trenches less than 12-feet deep may be made at 1/2H:1V or flatter.

For Type B material, the side slopes shall be 1H:1V or flatter. For Type C material, the side slope shall be 1-1/2H:1V or flatter.

The areas of loose and soft soils were found at Test Pits 3, 32 and 36. Other loose/soft areas may occur along the water main alignment.

For "Stable Rock", the trench slopes can be excavated vertically. Loose fragments in the side slopes shall be removed prior to any trench construction work.

During construction, visual observations should be made of the material adjacent to the trench. Any cracks or fissures may indicate potential hazards. This may require flattening of the trench slopes and or shoring.

Surcharge loads such as stored material and equipment, and operating equipment and traffic should not be allowed within a 1-1/2H:1V plane projected upwards from the bottom of the trench.

If shoring is preferred, the shoring system shall be made in accordance with the OSHA standard (1989), or designed by a registered professional engineer.

Trench Backfill

Trench backfill work shall be performed in accordance with applicable sections of the "Water System Standards", State of Hawaii, 1985.

Pipe Cushion

Pipe cushion material shall be placed below the pipe (minimum

6-inches deep), around the sides, and to a height of at least 12-inches above the top of pipe.

Backfill Material

Material above the pipe cushion shall consist of material that is free of vegetation, organics, debris, "adobe", rubbish, or other deleterious matter. The material shall contain no particle larger than 6-inches in greatest dimension. It is recommended that the material contain sufficient fines to fill the interstices between larger sized gravelly and cobbly material.

The SILT and GRAVEL material can generally be used as backfill material for the trenches provided the larger sized particles (over 6 inches in diameter) are removed.

Excavation into the underlying BASALTIC ROCK formation will likely generate various sized pieces of rock fragments. The minus 6-inch size pieces may be mixed with the clayey SILT and silty GRAVEL in order to create suitable backfill material. The over-sized pieces should be disposed of off-site, or if suitable, used as GRP material in the gulch area.

Backfill Compaction Requirements

The pipe cushion material may be jetted in accordance with the Water System Standards.

The backfill above the cushion shall be placed in relatively level, loose lifts not exceeding 8 inches in thickness. For yard and non-structural areas, each layer shall be compacted to at least 90 percent of the maximum dry density as determined by the ASTM D1557 test procedure. For structural areas including pavement areas, the top 2-feet of the backfill shall be compacted to at least 95 percent of the maximum dry density (ASTM D1557). Prior to compaction, the backfill material shall be moisture conditioned to plus or minus 3 percent of optimum moisture content (ASTM D1557).

Soil Bearing Capacity

Lateral Bearing

For the clayey SILT and silty GRAVEL, an allowable lateral bearing value of 2,000 pounds per square foot may be assumed for design of horizontal thrust blocks that have at least 5 feet of cover over the pipe.

For the moderately hard to hard ROCK, the lateral bearing value may be assumed as 5,000 psf.

Vertical Bearing

An allowable soil bearing value of 2,000 psf may be used for footings or other structural elements that are embeded a minimum of 12 inches below lowest adjacent grade and bearing on the moderately stiff to very stiff clayey SILT or properly compacted fill.

An allowable bearing value of 4,000 psf may be used for the moderately dense to very dense silty GRAVEL.

For the underlying moderately hard to hard BASALTIC ROCK, an allowable bearing value of 10,000 psf may be used.

For footings located adjacent to new or existing utility trenches, the bottom of the footing shall be deepened below a 1 horizontal to 1 vertical plane projected upwards from the edge of the utility trench.

For footings located on or adjacent to slopes, the footing shall be deepened such that there is a minimum horizontal distance of 5 feet or twice the footing width, whichever is greater, from the edge of the footing to the slope face.

All loose and disturbed soil at the bottom of footing excavations shall be removed to firm soil or the disturbed soil

shall be compacted prior to laying of steel or placing of concrete.

INSPECTION

During the progress of construction, so as to evaluate compliance with the intent of the design concepts, specifications and recommendations contained herein, it is highly recommended that qualified engineering personnel be present to observe the following operations:

1. Trench excavation.
2. Placement of backfill.

REMARKS

The conclusions and recommendations contained herein are based on the findings and observations made at the test pit locations. For the purpose of this report, conditions between and beyond the explorations are assumed to be consistent with those found in the test pits. Actual field conditions may vary.

If conditions are encountered during construction which appear to differ from those disclosed by the explorations, this office shall be notified so as to consider the need for modifications.

This report has been prepared for the exclusive use of the Department of Hawaiian Home Lands, R. T. Tanaka Engineers, Inc. and

their respective design consultants. It shall not be used by or transferred to any other party or to another project without the consent and/or thorough review by this facility. Should the project be delayed beyond the period of one year from the date of this report, the report shall be reviewed relative to possible changed conditions.

Samples obtained in this investigation will deteriorate with time and will be unsuitable for further laboratory tests within one (1) month from the date of this report. Unless otherwise advised, the samples will be discarded at that time.

The following are included and complete this report:

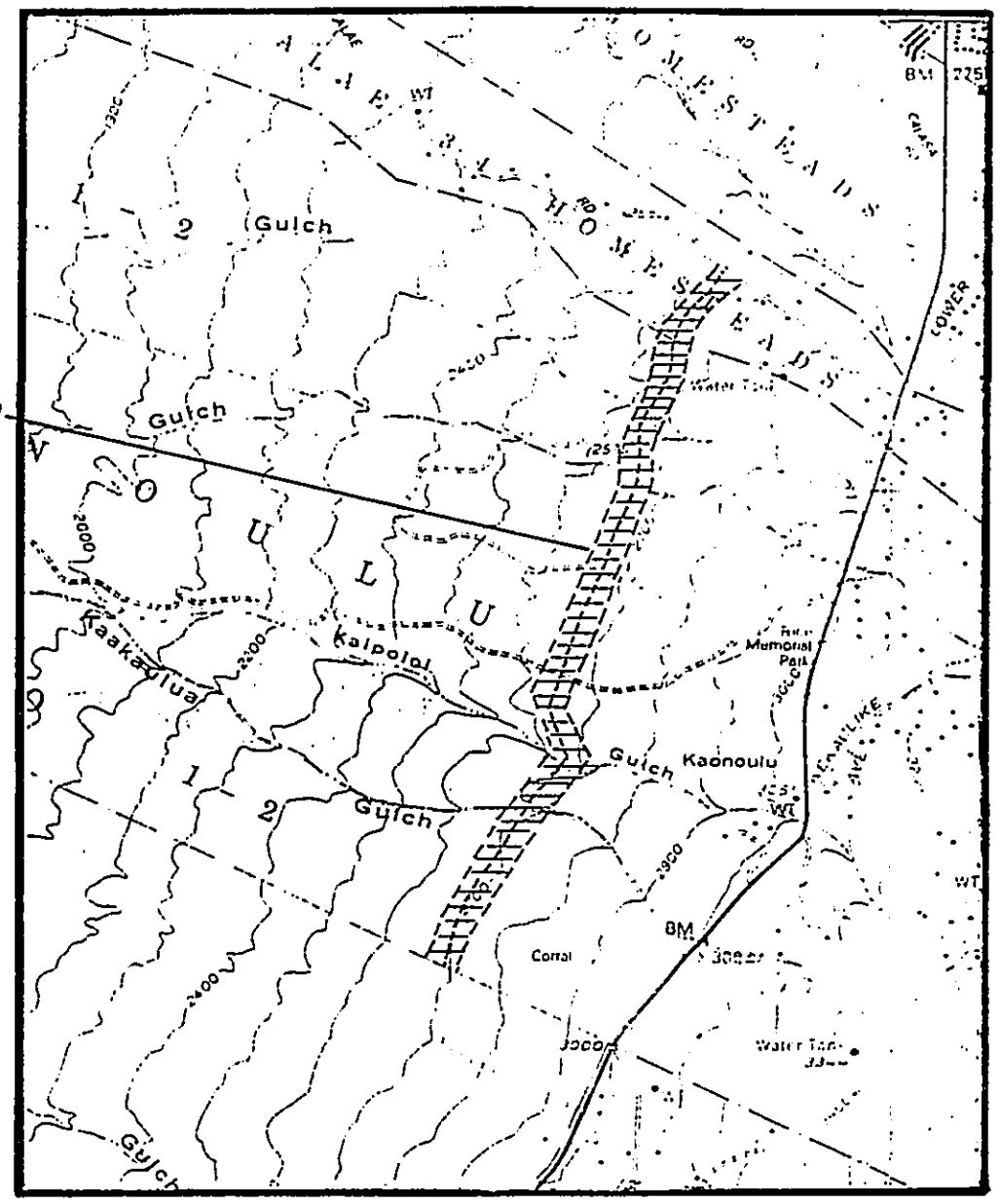
Vicinity Map ---------- Plate 1

Plot Plans ---------- Plates 2A through 2H

Appendix

- Field Investigation
- Laboratory Testing
- Logs of Test Pits
- Results of Laboratory Tests

VICINITY MAP



REFERENCE:

USGS TOPOGRAPHIC MAP
PUU O KALI QUADRANGLE
Dated: 1983

Project No.: M-2335-F

KULAWATER TRANSMISSION MAIN-PHASE I

SOILS INTERNATIONAL
A CORPORATION
Consulting Foundation Engineers and Geologists

PROJECT NO.	
DATE	
SCALE	1" = 2000'
PLATE	1

6) The water main will cross gulches of varying depths. Special precautions may be required during rainy periods to protect the work area and personnel from flooding.

Details of the findings and recommendations are presented in the attached report.

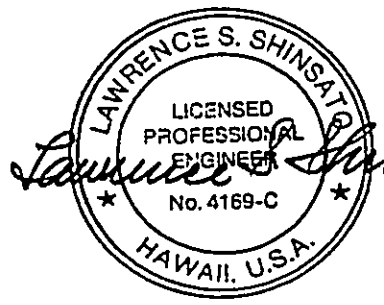
This investigation was made in accordance with generally accepted engineering procedures and included such field and laboratory tests considered necessary for the project. In the opinion of the undersigned, the accompanying report has been substantiated by mathmatical data in conformity with generally accepted engineering principles and presents fairly the design information requested by your organization. No other waranty is either expressed or given.

Respectfully submitted,

SOILS INTERNATIONAL

Lawrence S. Shinsato, P.E.
Vice-President

LSS:ls



This work was prepared by me or under my supervision.

TABLE OF CONTENTS

REPORT
SOILS INVESTIGATION

PROPOSED KULA WATER TRANSMISSION MAIN
PHASE I
KULA, MAUI, HAWAII
TMK: 2-2-02, 2-2-13

for

DEPARTMENT OF HAWAIIAN HOME LANDS

R. T. TANAKA ENGINEERS, INC.
Engineers

Project No. M-2335-F
May 13, 1994

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

99-1255 Waiua Place
Aiea, Hawaii 96701
Phone: (808) 488-0433
Fax: (808) 488-9535

360 Papa Place, #102
Kahului, Maui, Hawaii 96732
Phone: (808) 877-3789
Fax: (808) 871-1592

75-240 Nani-Kailua Drive
Kailua-Kona, Hawaii 96740
Phone: (808) 334-0090
Fax: (808) 329-3411

99-1255 WAIUA PLACE, AIEA, HAWAII 96701 (808) 488-0433 FAX (808) 488-9535

May 13, 1994
Project No. M-2335-F

R. T. Tanaka Engineers, Inc.
871 Kolu Street, Suite 201
Wailuku, Maui, Hawaii 96793

Attention: Mr. Kirk Tanaka

Gentlemen:

The attached report presents the results of a soils investigation for the proposed Kula Water Transmission Main, Phase I which is to be located in Kula, Maui, Hawaii; TMK: 2-2-02 and 2-2-13.

A summary of the findings is as follows:

1) The subsurface condition along the proposed water main alignment was explored by excavating 43 test pits to depths of 1 to 8 feet below existing grade. The test pits encountered loose to very dense silty GRAVEL, moderately stiff to very stiff clayey SILT and soft to hard BASALTIC ROCK.

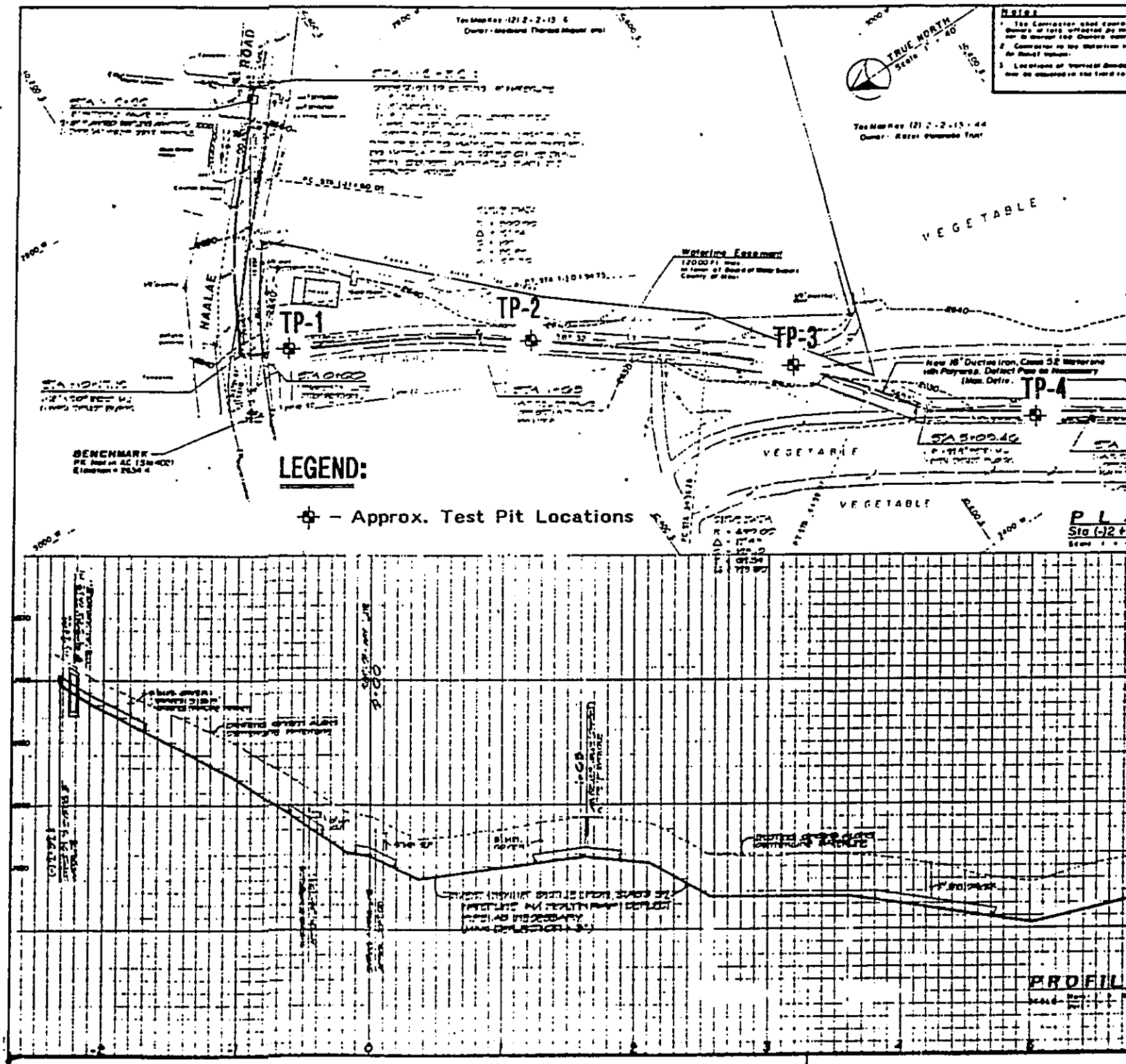
2) No groundwater was encountered in any of the explorations at the time of the investigation. This does not preclude the possibility of encountering groundwater in other areas of the site.

3) Excavations into the underlying clayey SILT and silty GRAVEL can generally be accomplished with conventional trench excavators. Excavation into the underlying ROCK will likely require heavy equipment, hoeramming, and/or blasting (if permitted).

4) The SILT and GRAVEL material can generally be used as backfill material for the trenches. However, boulders were encountered in the formations. The boulders should be removed prior to placing the material into the trenches. Excavated ROCK fragments larger than 6-inches in size should not be used as backfill material.

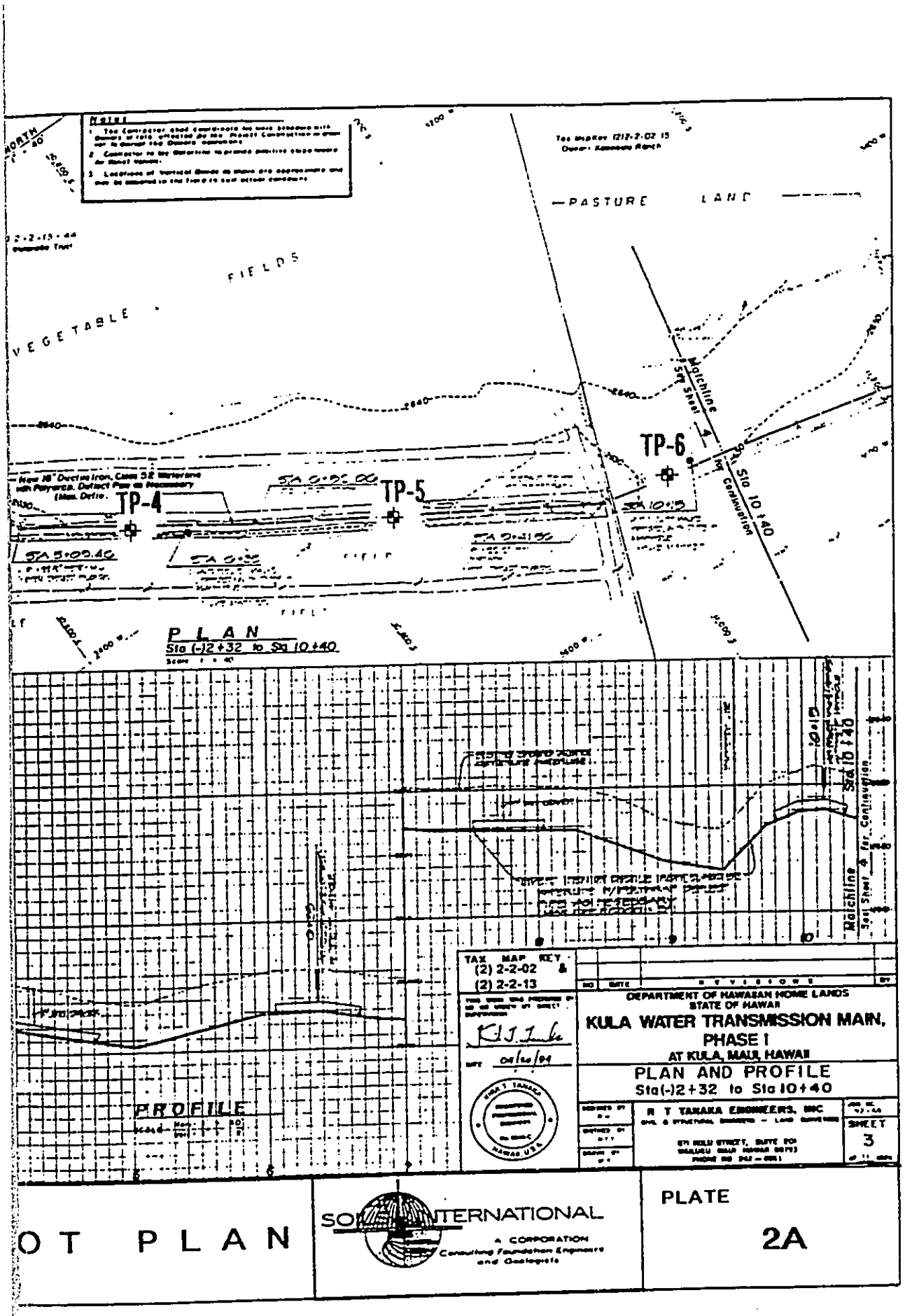
5) All excavation work shall be done in accordance with current OSHA regulations.

DOCUMENT CAPTURED AS RECEIVED

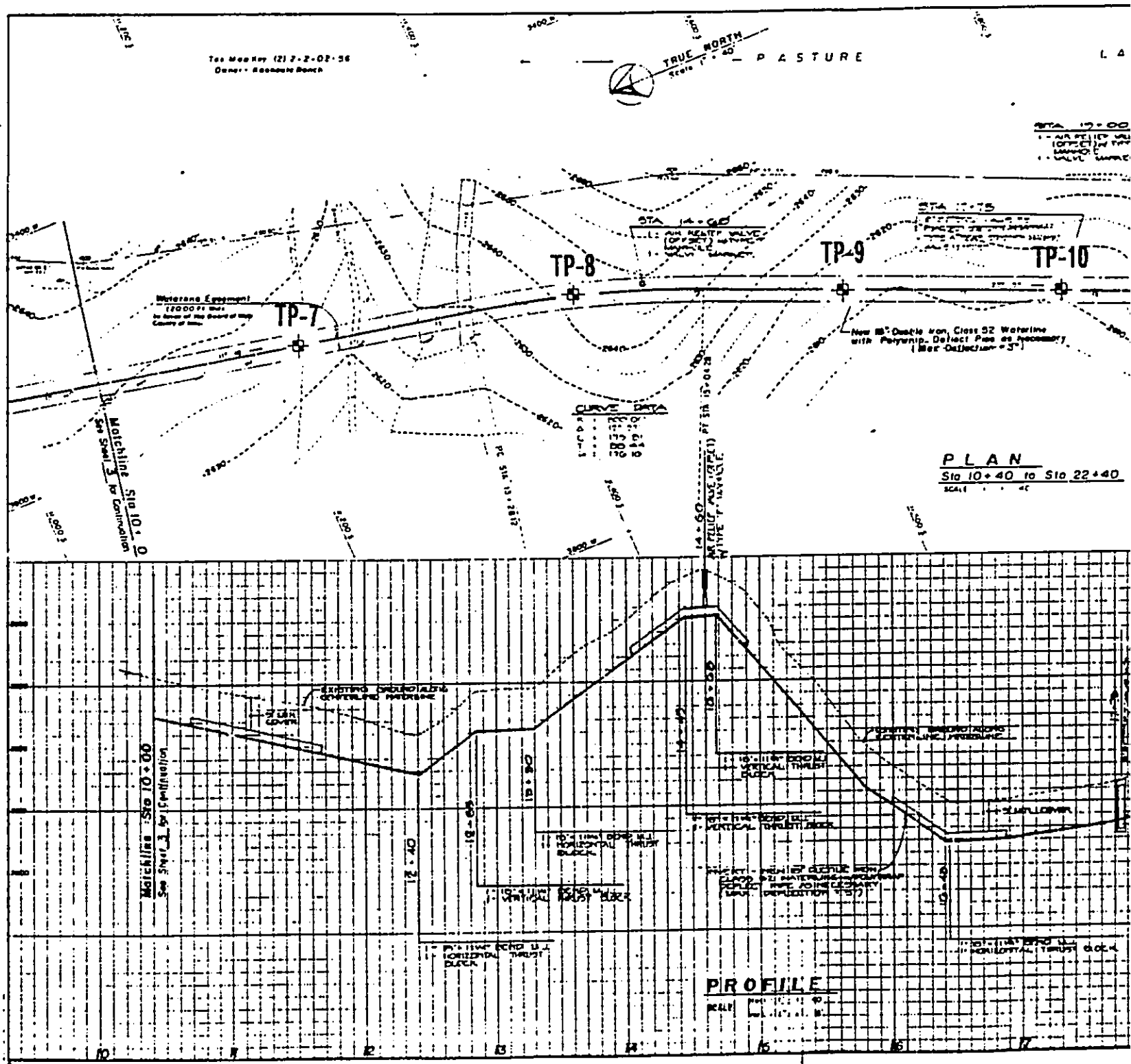


PROJECT NAME	PROJECT NO.	
KULA WATER TRANSMISSION MAIN PHASE I	M-2335-F	PLOT PLA

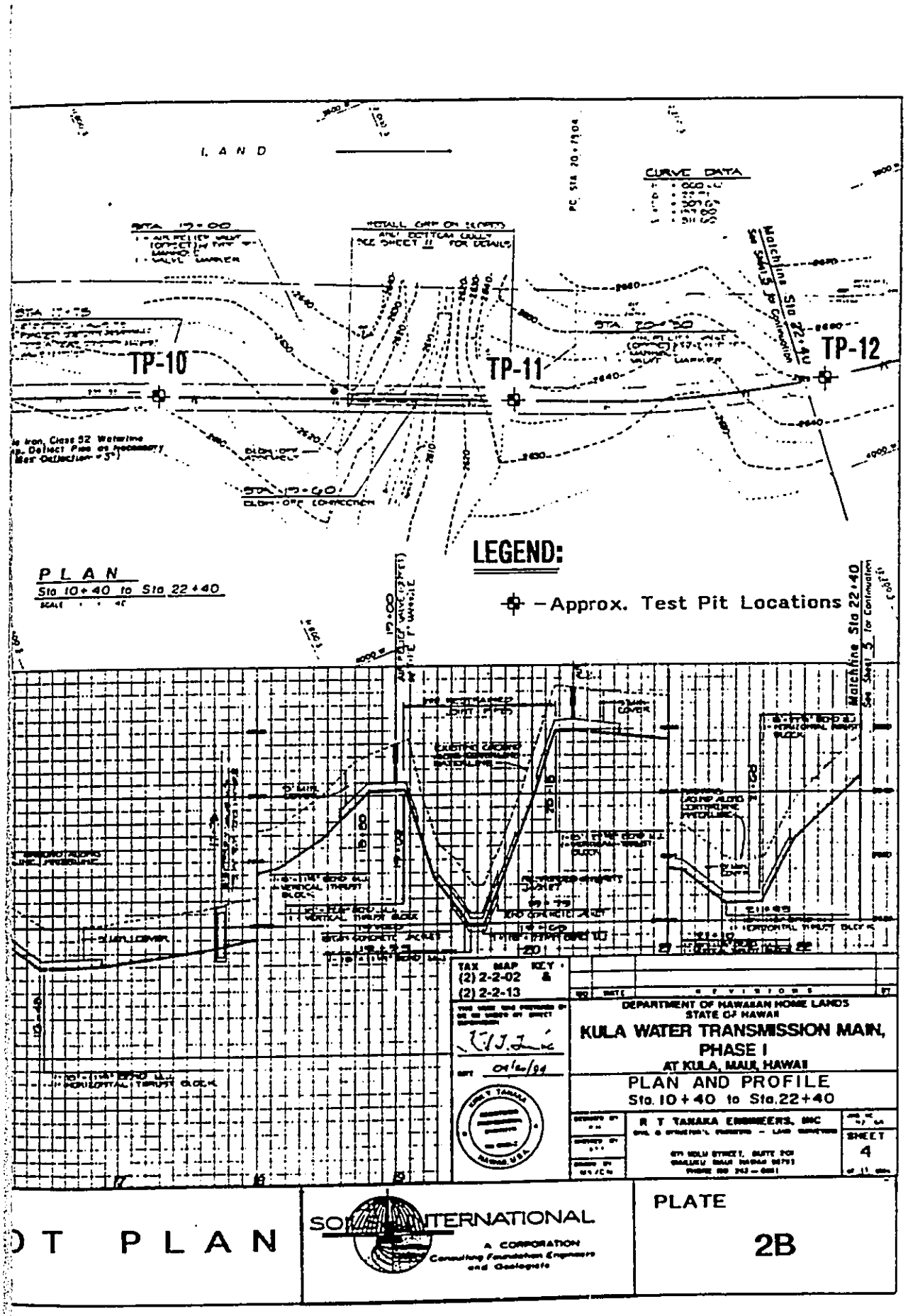
DOCUMENT CAPTURED AS RECEIVED



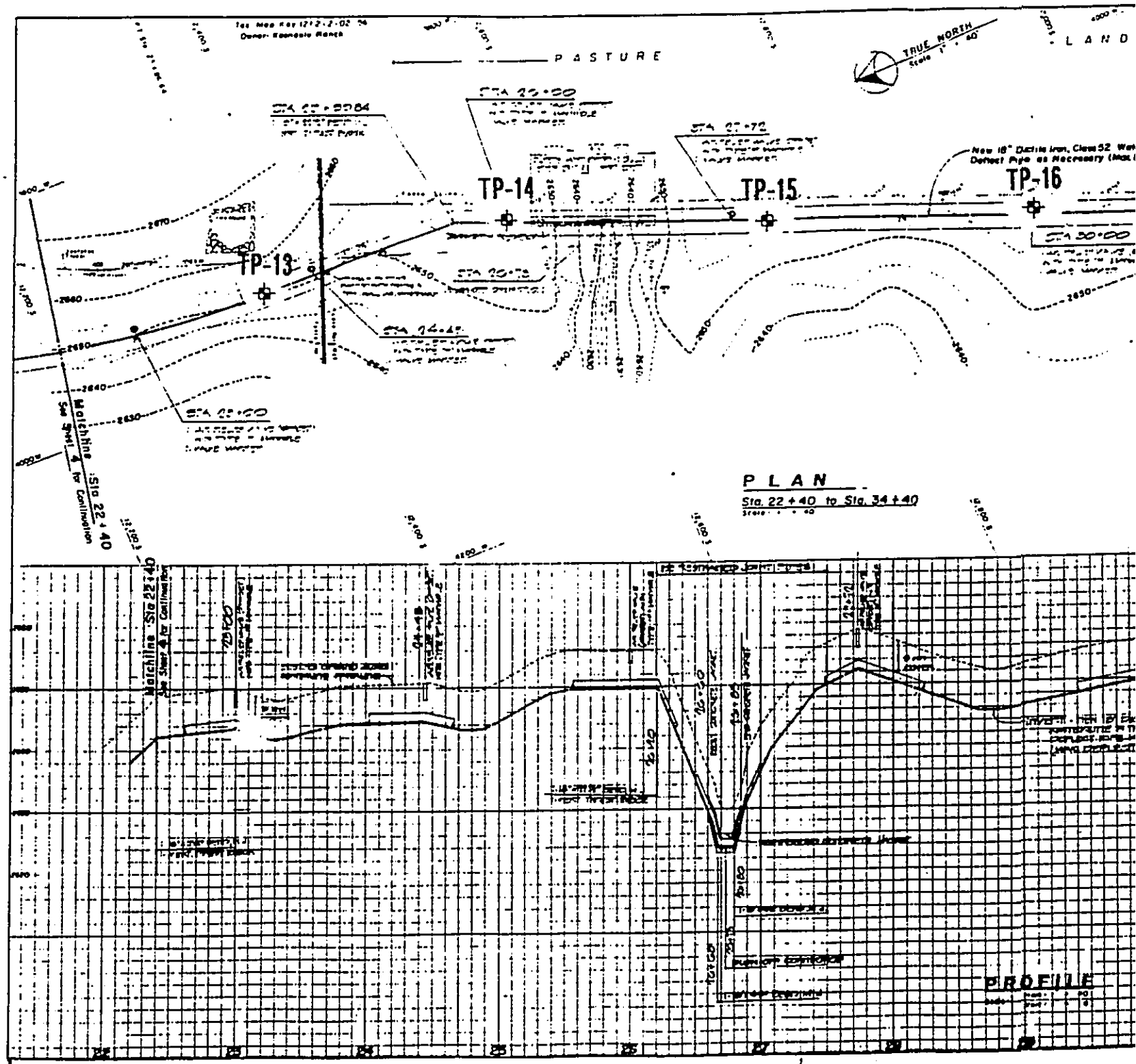
DOCUMENT CAPTURED AS RECEIVED



DOCUMENT CAPTURED AS RECEIVED

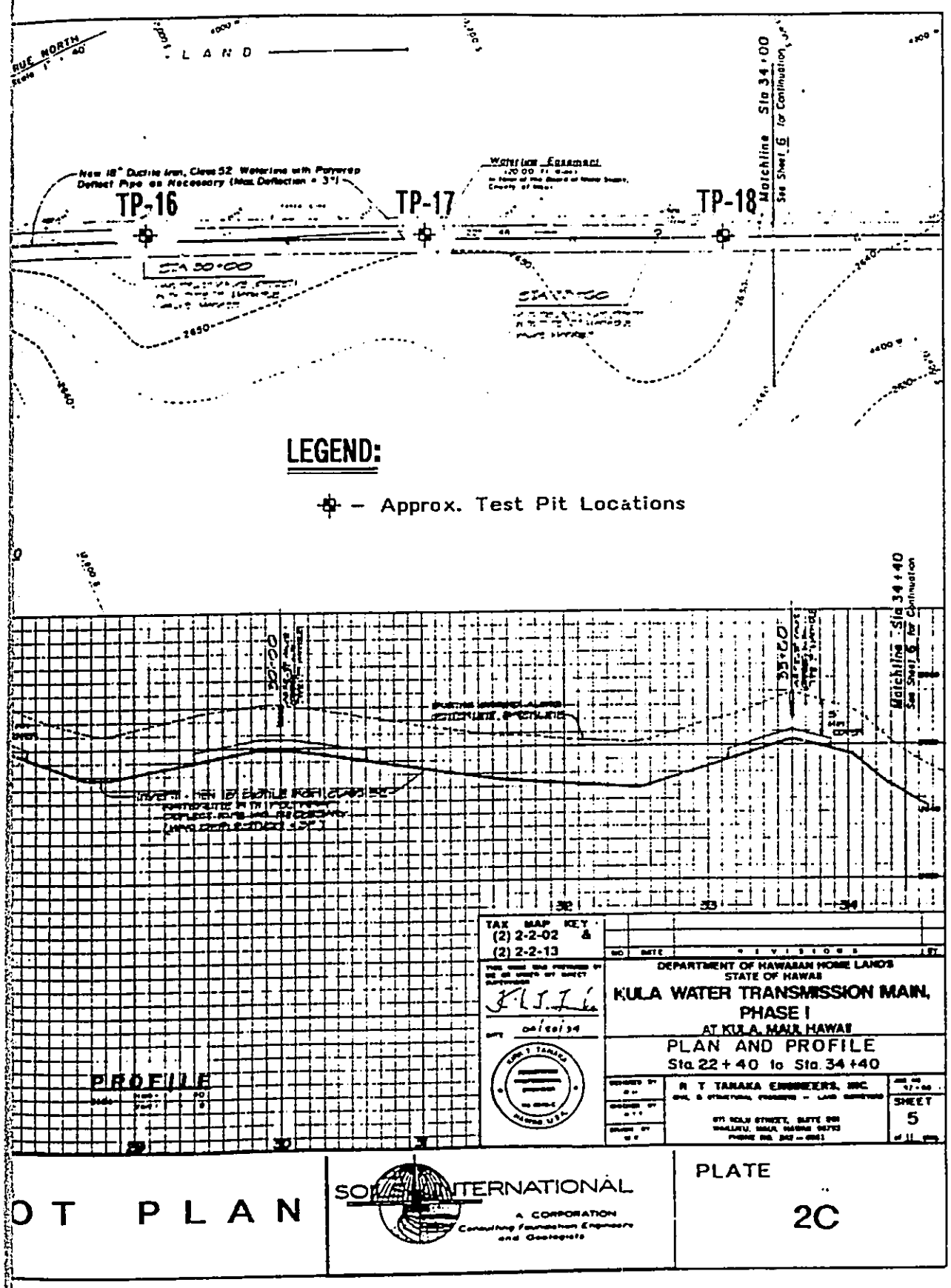


DOCUMENT CAPTURED AS RECEIVED

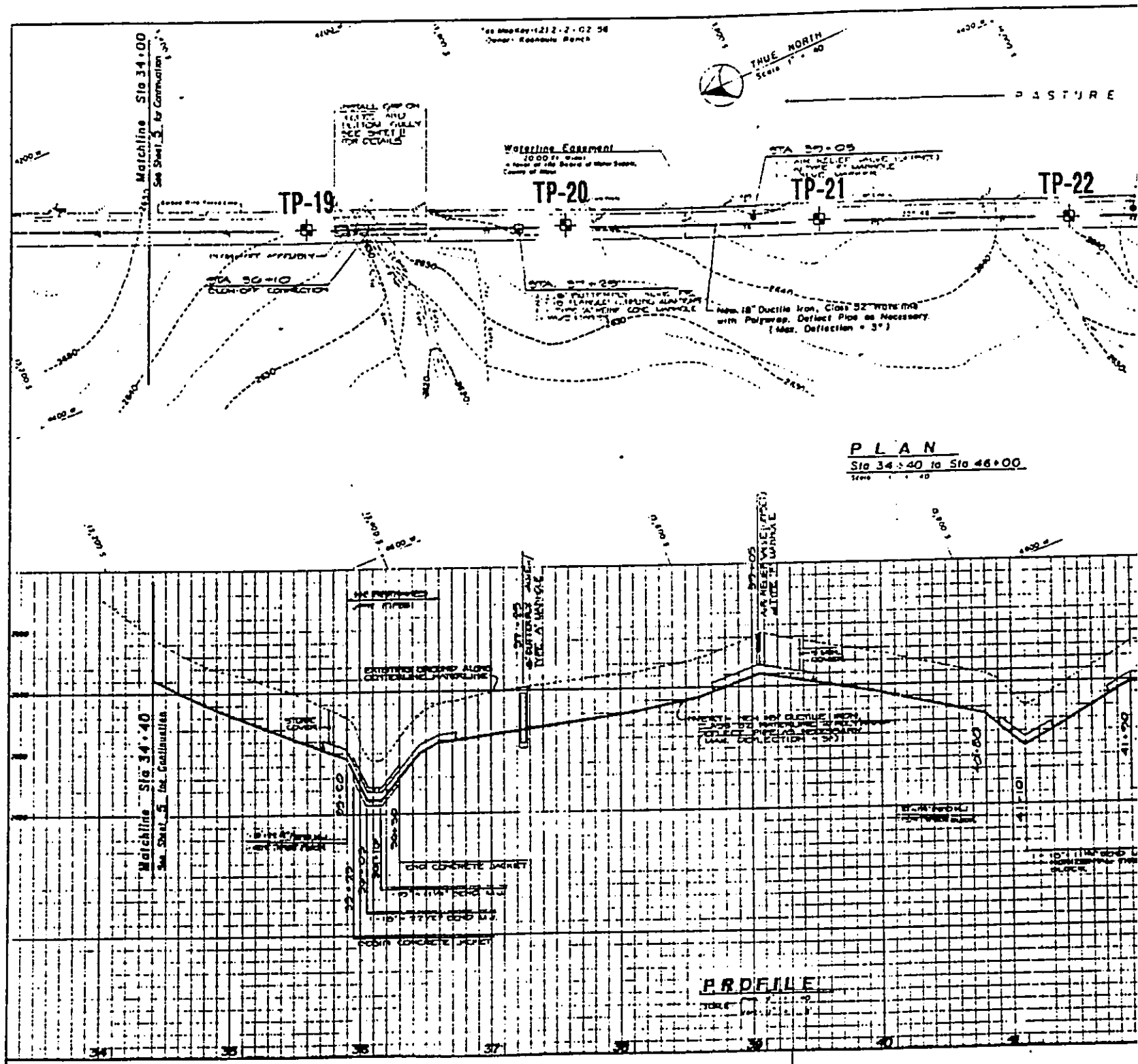


PROJECT NAME	PROJECT NO.	
KULA WATER TRANSMISSION MAIN PHASE I	M-2335-F	PLOT PLA

DOCUMENT CAPTURED AS RECEIVED

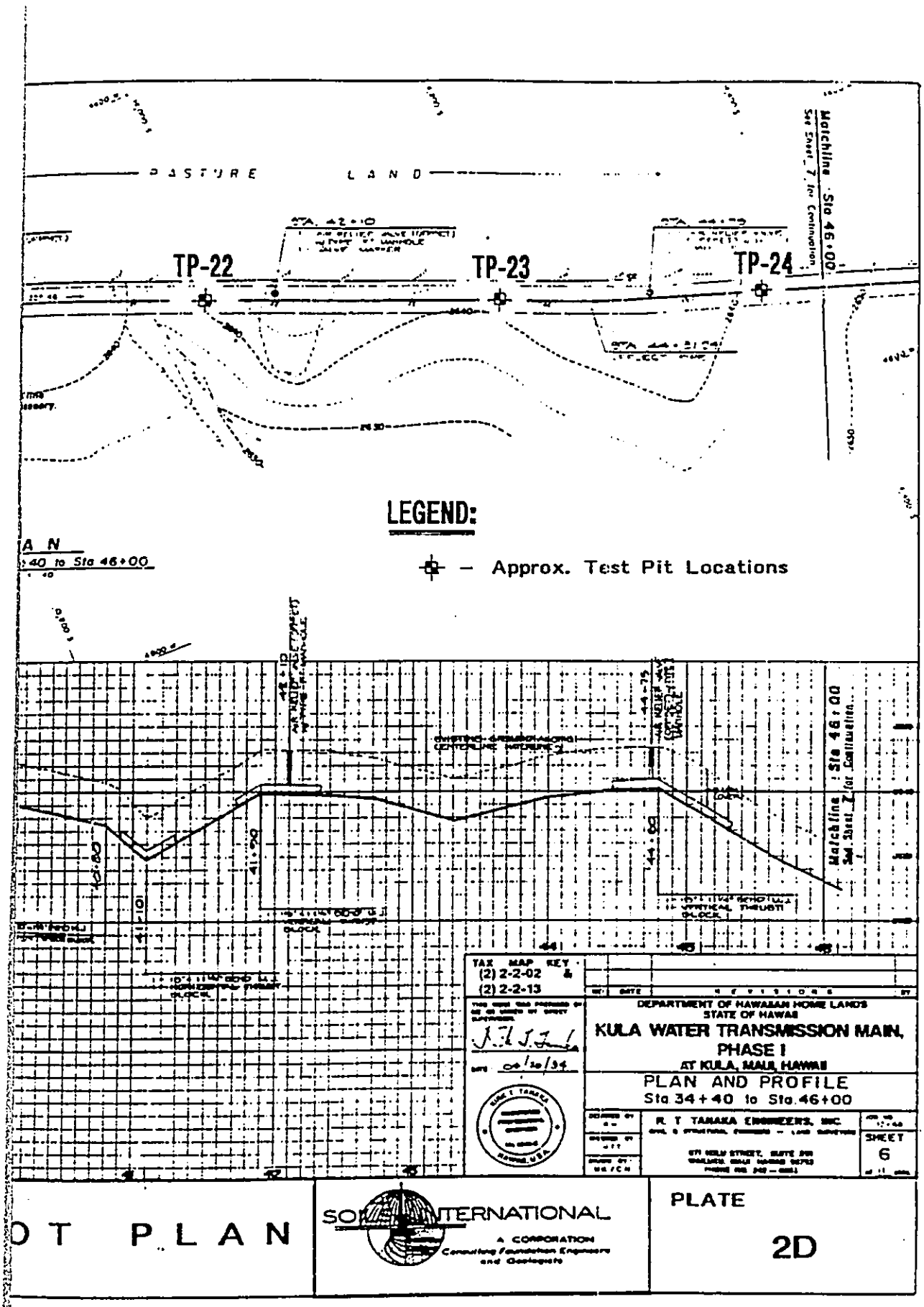


DOCUMENT CAPTURED AS RECEIVED

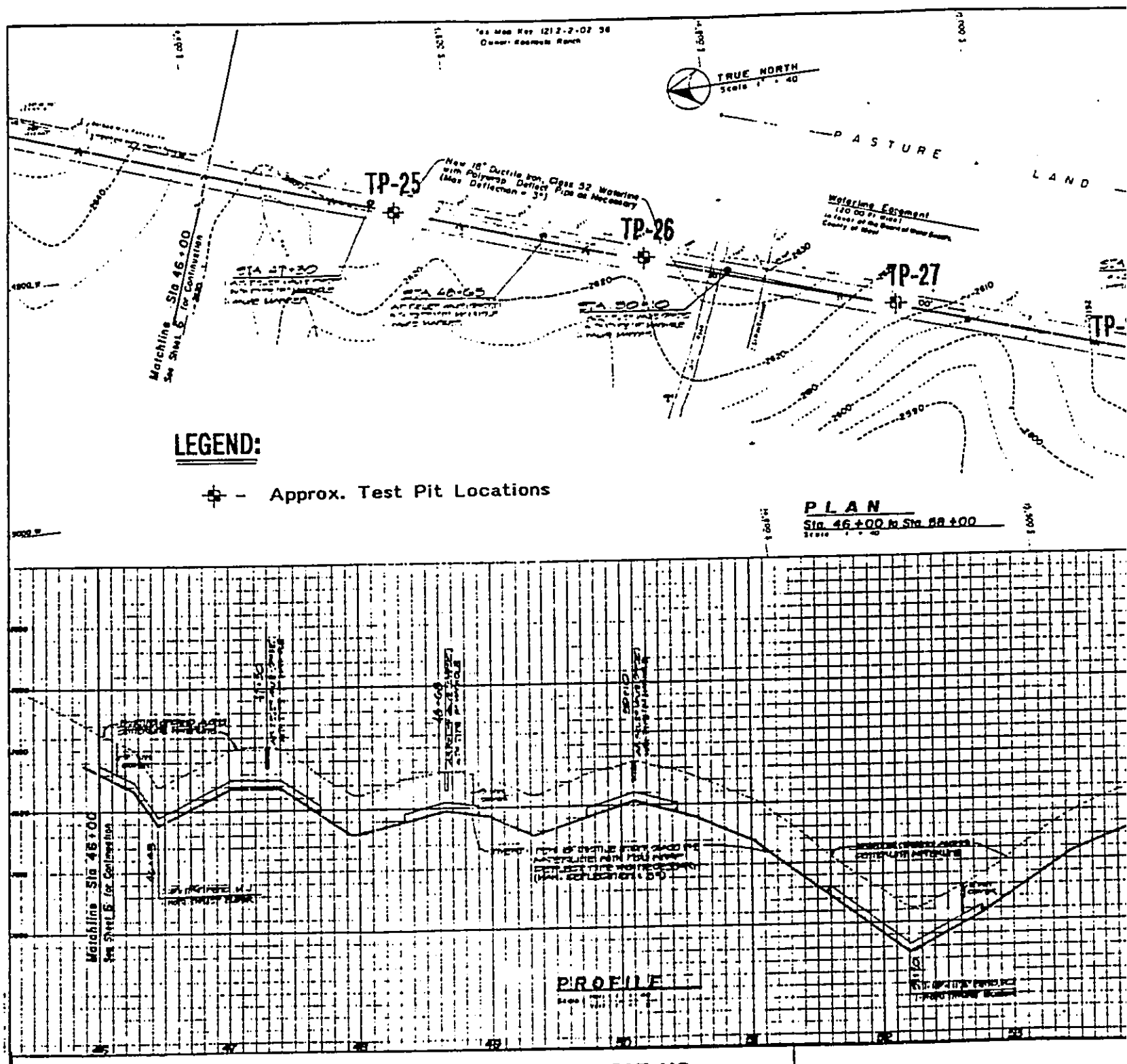


PROJECT NAME	PROJECT NO.	
KULA WATER TRANSMISSION MAIN PHASE I	M-2335-F	PLOT PLA

DOCUMENT CAPTURED AS RECEIVED

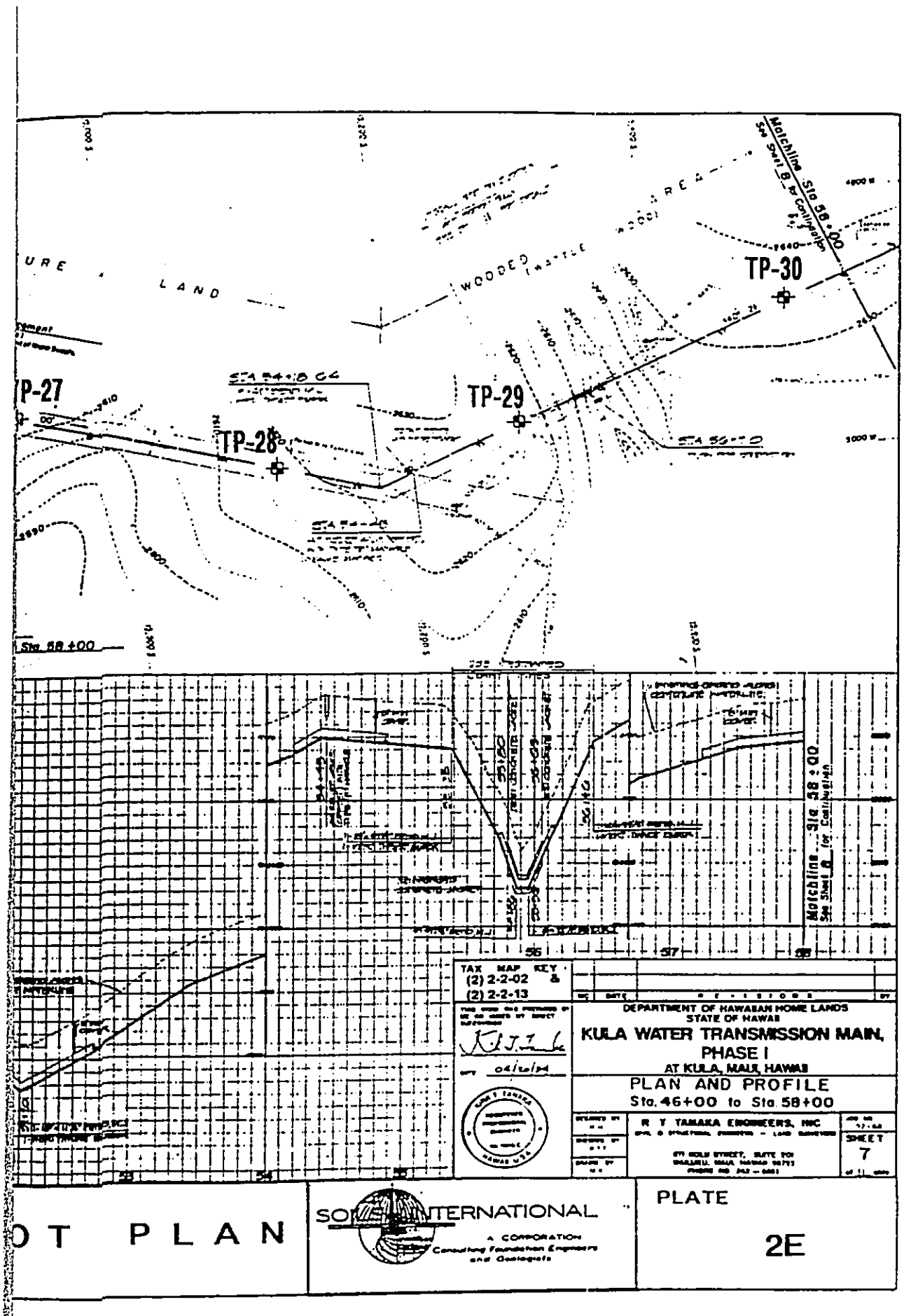


DOCUMENT CAPTURED AS RECEIVED

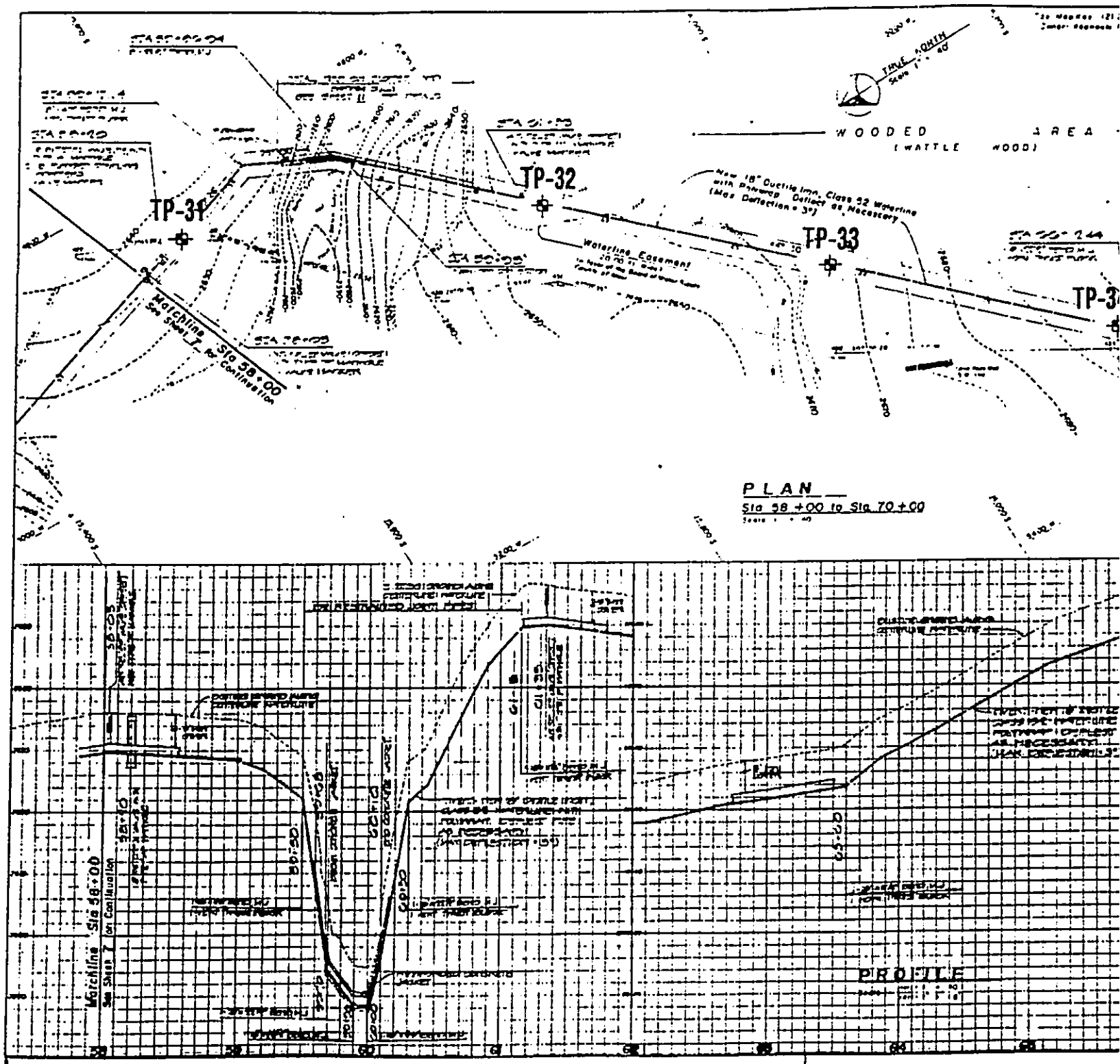


PROJECT NAME	PROJECT NO.	
KULA WATER TRANSMISSION MAIN PHASE I	M-2335-F	PLOT PLA

DOCUMENT CAPTURED AS RECEIVED

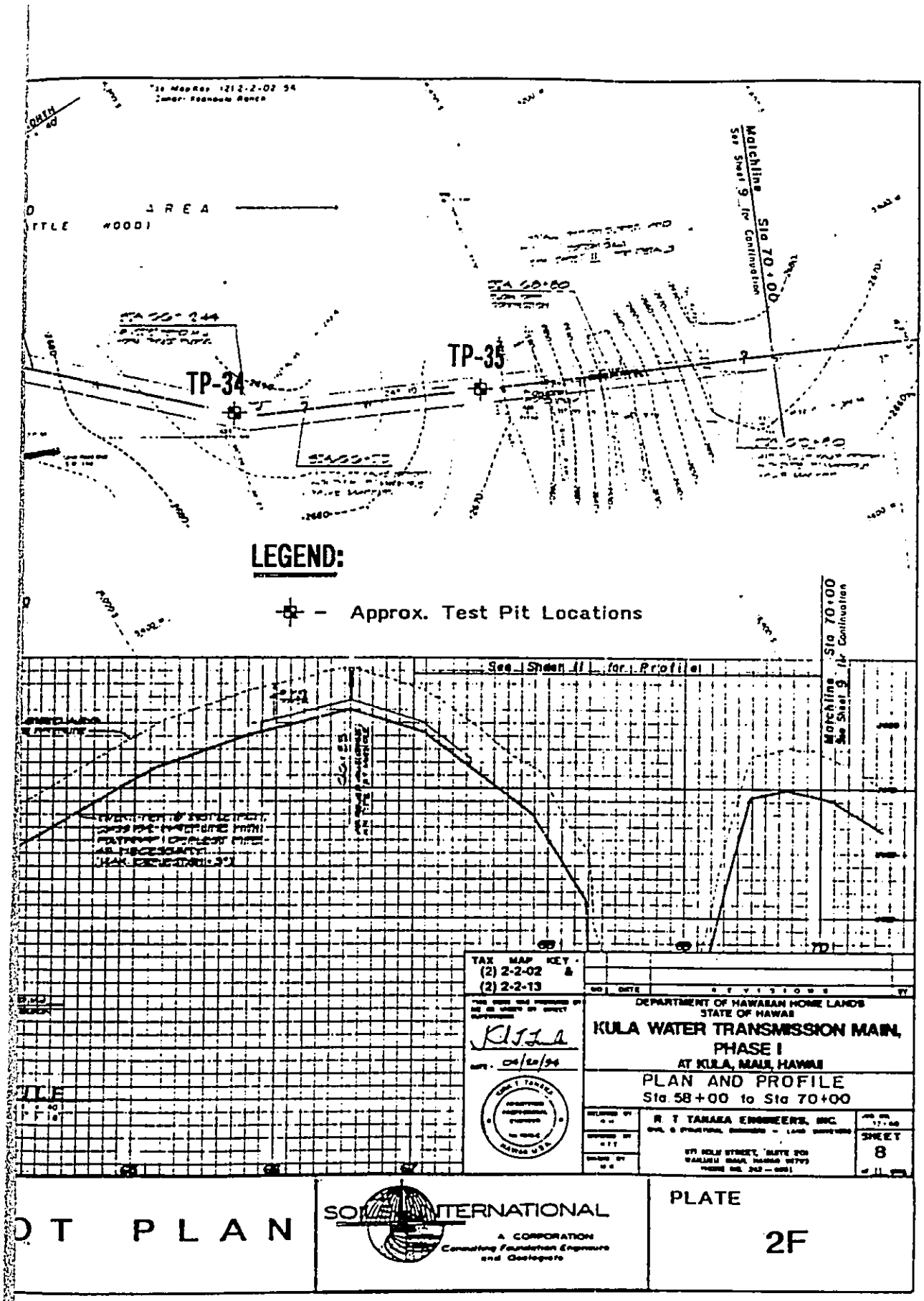


DOCUMENT CAPTURED AS RECEIVED

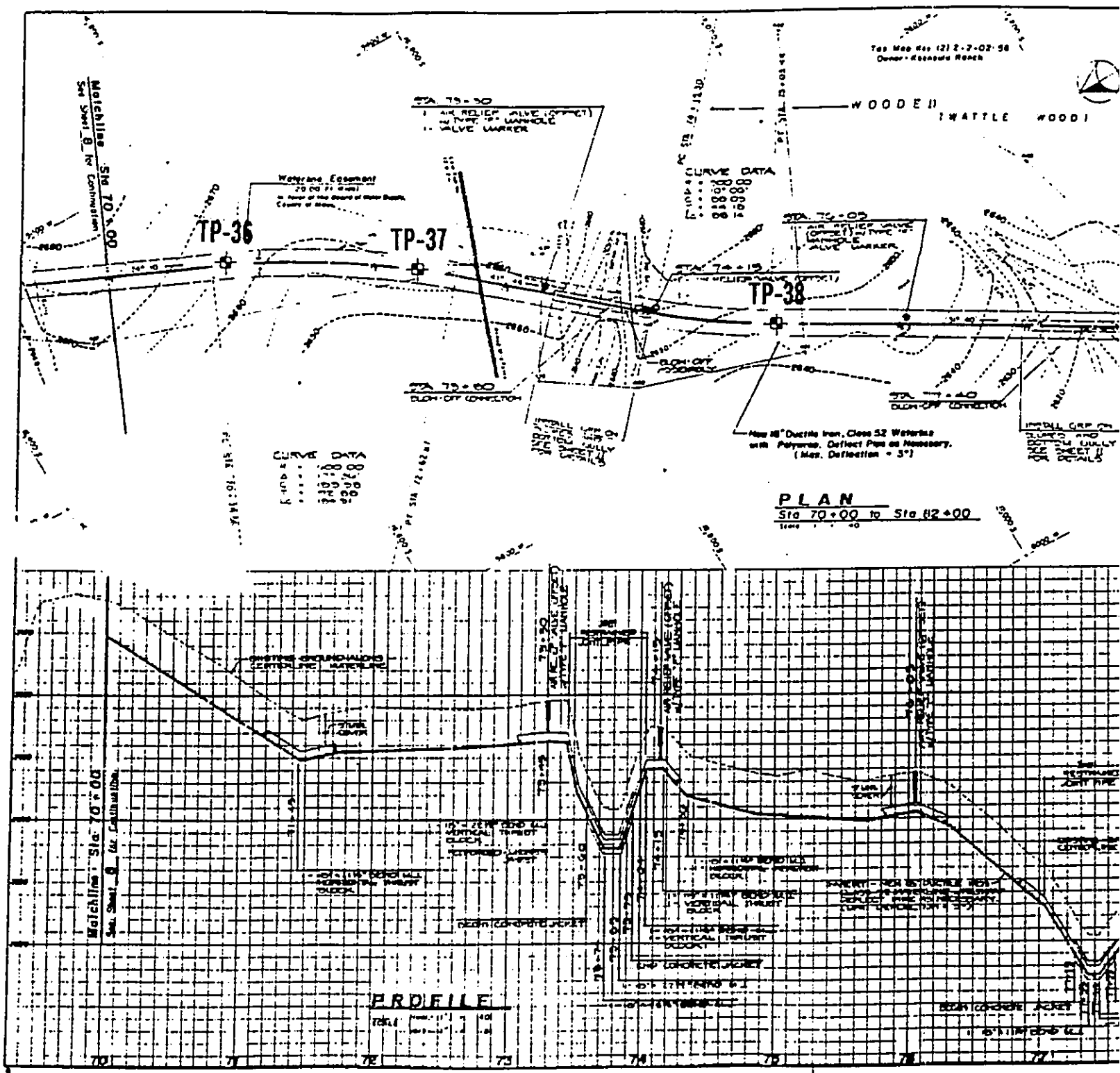


PROJECT NAME	PROJECT NO.	
KULA WATER TRANSMISSION MAIN PHASE I	M-2335-F	PLOT PL

DOCUMENT CAPTURED AS RECEIVED

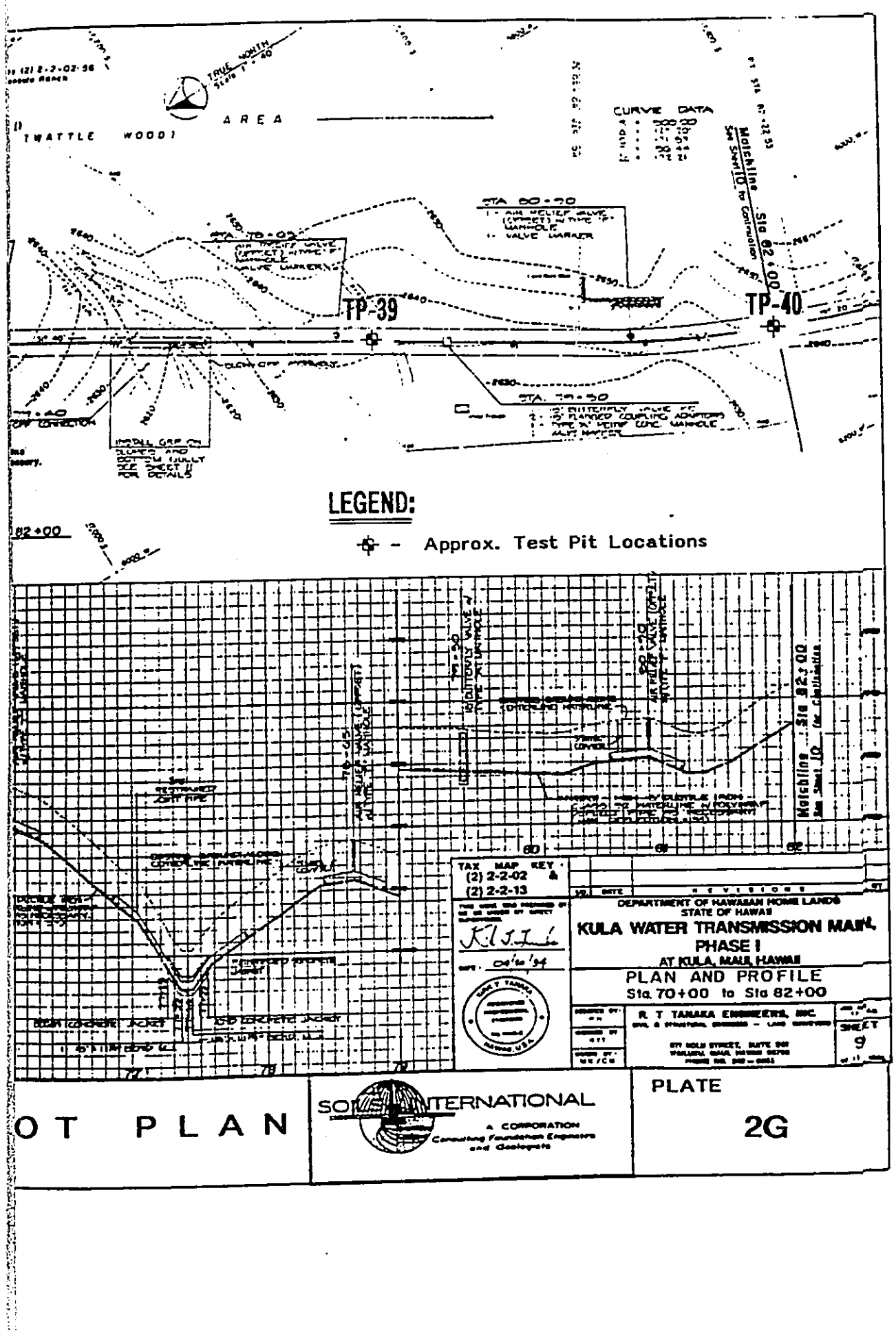


DOCUMENT CAPTURED AS RECEIVED

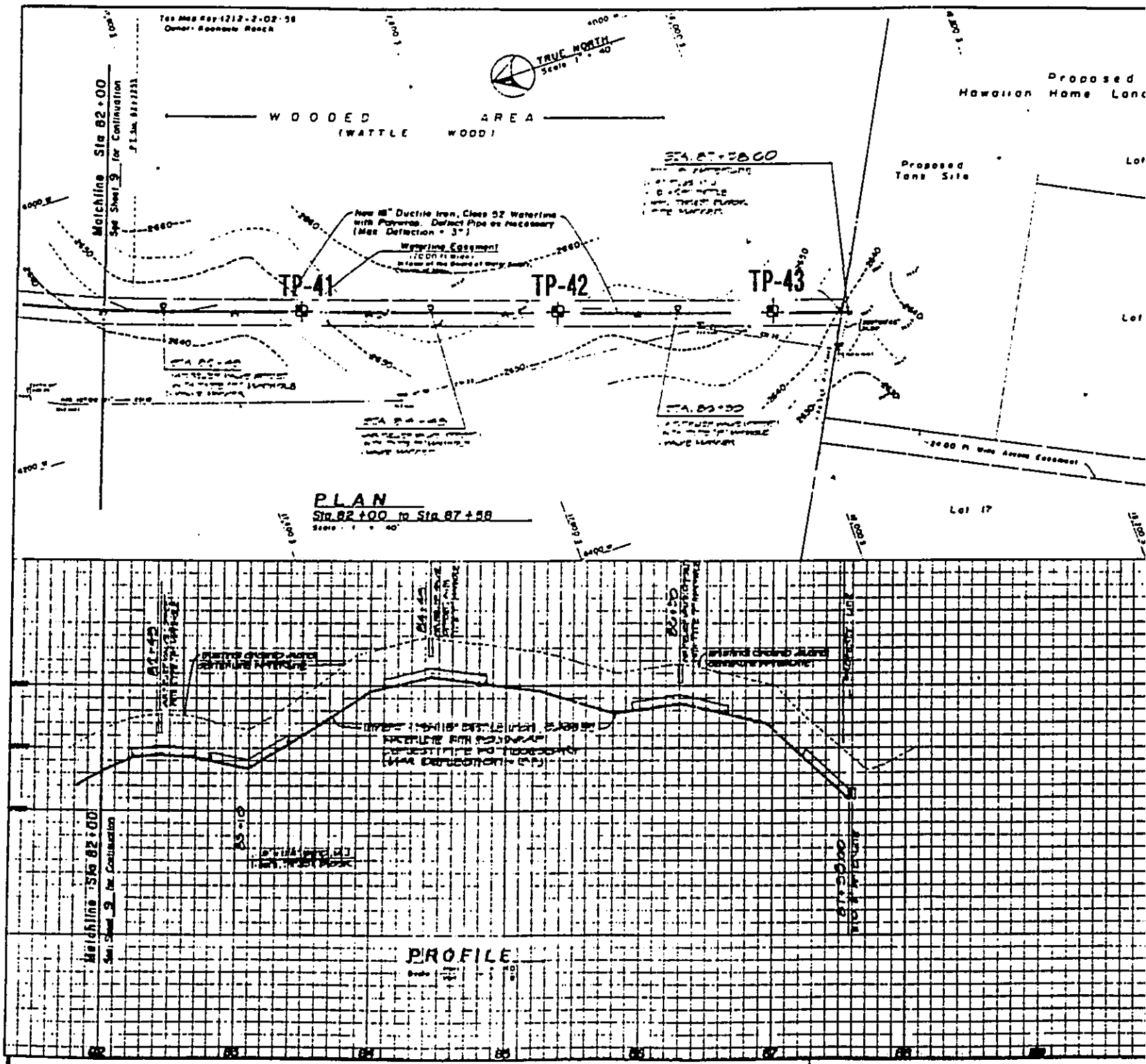


PROJECT NAME	PROJECT NO.	PLOT PL
KULA WATER TRANSMISSION MAIN PHASE I	M-2335-F	

DOCUMENT CAPTURED AS RECEIVED

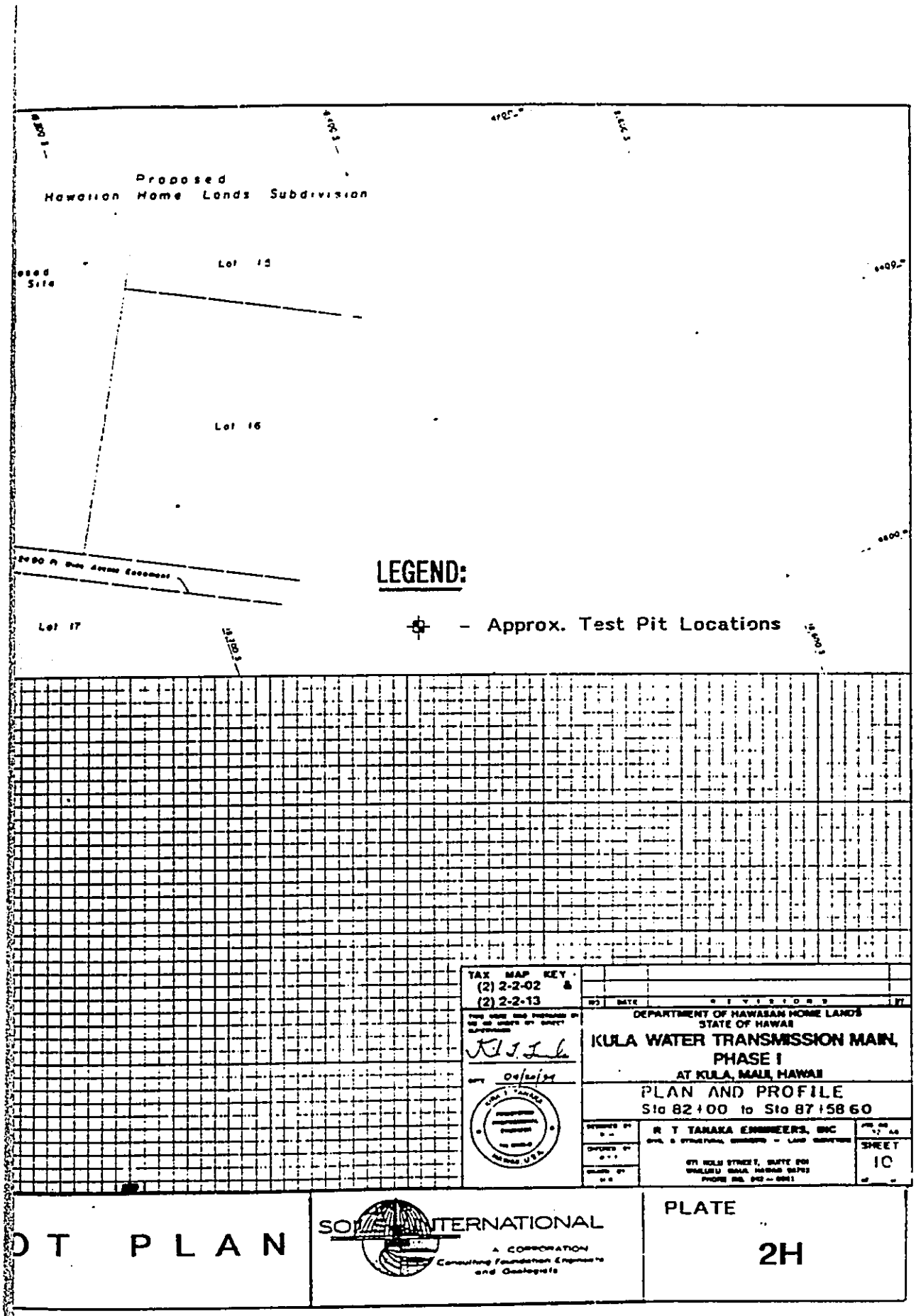


DOCUMENT CAPTURED AS RECEIVED



PROJECT NAME	PROJECT NO.	
KULA WATER TRANSMISSION MAIN PHASE I	M-2335-F	PLOT PLA

DOCUMENT CAPTURED AS RECEIVED



APPENDIX

FIELD INVESTIGATION AND LABORATORY TESTING

FIELD INVESTIGATION

General

The field investigation consisted of performing explorations at the locations shown on the Plot Plan. The method used for the exploratory work is shown on the respective exploration log. A description of the various method or methods used is presented below.

Test Borings Using Truck-Mounted Drilling Equipment

Truck-mounted borings are drilled using a gas-powered drilling rig. The hole is advanced using continuous flight augers, wash boring and/or NX coring.

Auger drilling is used in soils where caving does not occur. The augers are 4-1/2 inch diameter continuous helical flight augers with the lead auger having a head equipped with changeable cutting teeth. Soil cuttings are brought to the surface by the continuous flights. After the bore hole is advanced to the required depth and cleaned of cuttings by additional rotation of the augers, the augers are retracted for soil sampling or in-situ testing.

In soils where caving of the bore hole occurs, the hole is advanced by wash boring or hollow-stem augering. Wash boring consists of advancing steel casing by rotary action and water pressure to flush the soil from the casing. The lead section of the casing is equipped with a carbide or diamond casing bit. After the casing has been advanced to the required depth, soil samples are obtained through the inside of the casing. Hollow-stem drilling consists of advancing the hole with 7-5/8 inch outside diameter and 4-1/4 inch inside

LOG OF TEST PIT NO. 1

ELEVATION: +2636'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 5.5

DATE EXCAVATED: April 23, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		GM	silty GRAVEL, basalt-highly weathered		brown	moist	mod. dense to dense						
2			--with cobbles and boulders (AA clinkers)		brown gray		dense						
4													
6		(RX)	BASALT, moderately to slightly weathered END OF TEST PIT				mod. hard to hard rock						
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 3

LOG OF TEST PIT NO. 2

ELEVATION: +2637'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 4

DATE EXCAVATED: April 23, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		GM	silty GRAVEL, basalt-highly weathered, with cobbles		brown	moist	dense						
			--with boulders (AA clinkers)		light brown								
2				X					23.3				
		(RX)	BASALT, highly to mederately weathered				soft to mod. hard rock						
4			moderately to slightly weathered										
			END OF TEST PIT				mod. hard to hard rock						
6													
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILTEST INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 4

diameter augers. The leading drill bit is connected to drilling rods through the central portion of the auger. At the required sampling depth, the interior drill rods and lead bit are removed, and the soil sample is taken by driving a sampler through the "hollow" section of the augers.

Coring is used for hard formations such as rock, coral or boulders. The core barrel, consisting of a 5-foot long double tube, hardened steel barrel with either a carbide or diamond bit, is attached to drilling rods and set on the hard formation. The core barrel is advanced through the formation by rotation of the core barrel. Water is used to flush out the cuttings. Upon completion of the core run, the sample is removed from the core barrel and inspected. The total core recovery length and the sum of all intact pieces over 4-inch in length are measured. The length of core recovery divided by the length of the core run is the recovery ratio. The combined length of the 4-inch or longer pieces divided by the length of core run is the Rock Quality Designation (RQD). The values provide an indication of the quality of the formation.

Test Borings Using Portable Drilling Equipment

In areas inaccessible to truck-mounted equipment, portable drilling equipment is used to drill the test boring. The boring is advanced by either 1) continuous drive sampling or by 2) using a small gas-powered drill rig with continuous flight augers, wash boring or NX coring.

Soil samples are obtained with a tripod and cathead assembly using soil sampling methods described below.

Test Pits Using Excavators/Hopto

Test pits are excavated using a hopto or backhoe. Material excavated from the pit and the sides and bottom of the pit are visually inspected and a continuous log of the hole is kept.

Explorations Using Hand Tools

In inaccessible areas requiring only shallow explorations, borings and test pits are made using hand equipment. Borings are drilled using hand augers. Test pits are excavated using hand tools. Cuttings from the boring and/or pit are inspected and visually classified.

Soil Sampling

Relatively undisturbed samples of the underlying soils are obtained from borings by driving a sampling tube into the subsurface material using a 140-pound safety hammer falling from a height of 30 inches. Ring samples are obtained using a 3-inch outside diameter, 2.5 inch inside diameter steel sampling tube with an interior lining of one-inch long, thin brass rings. The tube is driven approximately 18 inches into the soil and a section of the central portion is placed in a close fitting waterproof container in order to retain field conditions until completion of the laboratory tests. Standard Penetration Test (SPT) values and disturbed soil samples are obtained with a 2-inch (outside diameter) split-barrel sampler instead of the 3-inch sampler. The number of blows required to drive the sampler into the ground is recorded at 6-inch intervals. The blow count for the last 12-inches is shown on the boring logs.

From test pit excavations, undisturbed samples are retained from cohesive type soil formations and disturbed bulk samples are retained from friable and cohesionless soil formations.

The soil samples are visually classified in the field using the Unified Soil Classification System. Samples are packed in moisture proof containers and transported to the laboratory for testing.

LABORATORY TESTING

General

Laboratory tests are performed on various soil samples to determine their engineering properties. Description of the various tests are listed below.

Unit Weight and Moisture Content

The in-place moisture content and unit weight of the samples are used to correlate similar soils at various depths. The sample is weighed, the volume determined, and a portion of the sample is placed in the oven. After oven-drying, the sample is again weighed to determine the moisture loss. The data is used to determine the wet-density, dry-density and in-place moisture content.

Direct Shear

Direct shear tests are performed to determine the strength characteristics of the representative soil samples. The test consists of placing the sample into a shear box, applying a normal load and then shearing the sample at a constant

rate of strain. The shearing resistance is recorded at various rates of strain. By varying the normal load, the angle of internal friction and cohesion can be determined.

Consolidation Test

Consolidation tests are performed to obtain data from which time rates of consolidation and amounts of settlement may be estimated. The test is performed by placing a specimen in a consolidation apparatus. Loads are applied in increments to the circular face of a one (1) inch high sample. Deformation or changes in thickness of the specimen are recorded at selected time intervals. Water is introduced to or allowed to drain from the sample through porous disks placed against the top and bottom faces of the specimen. The data is then used to plot a stress-volume strain curve which is used in estimating settlement.

Expansion Test - Ring Swell

Expansion tests are performed on clayey soils to determine the expansion potential of the sample. The test is performed using either a remolded or relatively undisturbed field sample. The sample is placed in an expansion apparatus with a one (1) psi surcharge. The sample is saturated and the change in vertical height is recorded. The initial moisture content is varied (field moisture or air-dried) to determine the variation in expansion potential with moisture changes. The data is used to determine the expansion potential of the soil.

Classification Tests

The soil samples are classified using the Unified Soil Classification System. Classification tests include sieve and hydrometer analysis to determine grain size distribution, and Atterberg Limits to determine the liquid limit, plastic limit and plasticity index.

California Bearing Ratio Test

California Bearing Ratio (CBR) tests are performed on materials to determine the bearing strength of the soil for determination of pavement sections. The sample is compacted into a 6-inch diameter mold in 5 equal layers. Each layer is compacted with a 10-pound hammer falling from a height of 18-inches, with each layer receiving 56 blows. The mold is then placed in a water bath for 4-days and the vertical swell is measured under a surcharge weight of 10 pounds. After the soaking period, the sample is placed in a CBR apparatus that has a 3-square inch penetrometer. The penetrometer is pressed vertically into the soil at constant strain and the loads required to press the penetrometer are recorded. A plot of the load-strain relationship is made to determine the CBR value.

Maximum Dry Density/Optimum Moisture Content

The maximum dry density and optimum moisture content of the material is determined in accordance with the ASTM D1557-78 test procedure. The sample is compacted into a mold in 5 equal layers using a 10 pound hammer falling from a height of 18 inches. The diameter of the mold is either 4-inches or 6-inches depending on the proportion of gravel in the sample. The sample is compacted

at various moisture contents to develop a compaction curve for the soil. The curve is usually bell-shaped with a peak indicating the maximum dry density and optimum moisture content.

Penetrometer Test

Penetrometer tests are performed on clayey soils to determine the consistency of the material and an approximate value of the unconfined compressive strength.

Torvane

Torvane tests are used to determine the approximate undrained shear strength of clayey soils. The torvane apparatus consists of a torque device with a small diameter plate that has vanes situated perpendicular to the plate. The vanes are pushed into the soil and torque is applied until failure occurs. The torque required to cause failure is converted to approximate undrained strength of the soil.

LOG OF TEST PIT NO. 3

EQUIPMENT USED: CASE 580K BACKHOE

DATE EXCAVATED: April 23, 1994

ELEVATION: +2631'

DEPTH OF TEST PIT: 8

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		GM	silty GRAVEL, basalt-highly weathered, with cobbles and boulders		brown	moist	loose						
2													
4													
6							mod. dense						
8			END OF TEST PIT										
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 5

LOG OF TEST PIT NO. 4

EQUIPMENT USED: CASE 580K BACKHOE

DATE EXCAVATED: April 23, 1994

ELEVATION: +2632'

DEPTH OF TEST PIT: 7.5

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, some gravel		brown	moist	stiff to very stiff			3.00			
4		GM	silty GRAVEL, basalt-highly weathered		gray brown		dense to very dense						
8			END OF TEST PIT										

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 6

LOG OF TEST PIT NO. 5

ELEVATION: +2630'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 6

DATE EXCAVATED: April 23, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, few gravel		red brown	very moist to moist	stiff			2.25			
						moist	very stiff			4.00			
2									89.2		91	83	8
4		GM	silty GRAVEL, basalt-highly weathered, few cobbles		red brown /gray		dense						
6			END OF TEST PIT										
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 7

LOG OF TEST PIT NO. 6

ELEVATION: +2632'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 2.5

DATE EXCAVATED: April 23, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, some gravel		lt. brown	dry	mod. stiff						
2		GM	silty GRAVEL				dense to very dense						
		(RX)	BASALT, moderately to slightly weathered END OF TEST PIT				mod. hard to hard rock						
4													
6													
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 8

LOG OF TEST PIT NO. 7

ELEVATION: +2625'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 5

DATE EXCAVATED: April 23, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, with gravel		lt. brown	dry	mod. stiff						
2													
		GM	silty GRAVEL				dense						
4													
		(RX)	BASALT, moderately to slightly weathered		lt. gray/ dk. gray		mod. hard to hard rock						
6			END OF TEST PIT										
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 9

LOG OF TEST PIT NO. 8

ELEVATION: +2641'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 7

DATE EXCAVATED: April 23, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, with gravel		dk. brown	moist	mod. stiff		34.7		72	42	30
2		GM	silty GRAVEL				dense						
4			--with cobbles		dk. brown and lt. gray								
6			END OF TEST PIT										
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILTEST INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 10

LOG OF TEST PIT NO. 9

EQUIPMENT USED: CASE 580K BACKHOE

DATE EXCAVATED: April 23, 1994

ELEVATION: +2615'

DEPTH OF TEST PIT: 4

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, some gravel		dk. brown	moist	stiff			4.25			
2			--with gravel		dk. gray								
		GM	silty GRAVEL, with cobbles				dense						
4		(RX)	BASALT, slightly to moderately weathered END OF TEST PIT				mod. hard to hard rock						
6													
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 11

LOG OF TEST PIT NO. 10

ELEVATION: +2613'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 5.5

DATE EXCAVATED: April 25, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, with gravel		yellow brown	dry	stiff						
2			--with cobbles										
4		GM	silty GRAVEL, with cobbles				dense						
6		(RX)	BASALT, slightly to moderately weathered END OF TEST PIT				mod. hard to hard rock						
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 12

LOG OF TEST PIT NO. 11

EQUIPMENT USED: CASE 580K BACKHOE

DATE EXCAVATED: April 25, 1994

ELEVATION: +2636'

DEPTH OF TEST PIT: 8

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, with gravel		dk. brown	moist	stiff						
2													
			--some cobbles		dk. gray								
4													
6													
8		(RX)	BASALT, highly to moderately weathered				soft rock						
			END OF TEST PIT										
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILTECH INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 13

LOG OF TEST PIT NO. 12

EQUIPMENT USED: CASE 580K BACKHOE

DATE EXCAVATED: April 25, 1994

ELEVATION: +2649'

DEPTH OF TEST PIT: 6

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		GM	silty GRAVEL, with cobbles		brown to lt. brown	mod. moist	dense to very dense						
2						mod. moist to moist							
4													
6		(RX)	BASALT, slightly to moderately weathered END OF TEST PIT				mod. hard to hard rock						
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 14

LOG OF TEST PIT NO. 13

ELEVATION: +2650'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 4

DATE EXCAVATED: April 25, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, some gravel		brown	mod. moist to moist	mod. stiff						
2		GM	silty GRAVEL, with cobbles				dense						
4		(RX)	BASALT, slightly to moderately weathered END OF TEST PIT		gray		mod. hard to hard rock						
6													
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 15

LOG OF TEST PIT NO. 14

EQUIPMENT USED: CASE 580K BACKHOE

DATE EXCAVATED: April 25, 1994

ELEVATION: +2656'

DEPTH OF TEST PIT: 7

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, few gravel		brown to lt. brown	mod. moist	mod. stiff						
2													
		GM	silty GRAVEL,				dense to very dense						
4													
6													
			END OF TEST PIT										
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 16

LOG OF TEST PIT NO. 15

ELEVATION: +2657'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 5

DATE EXCAVATED: April 25, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, few gravel		brown to light brown	dry to mod. moist	mod. stiff						
2			--with gravel and cobbles			mod. moist							
		GM	silty GRAVEL, with cobbles				dense to very dense						
4													
		(RX)	BASALT, slightly to moderately weathered				mod. hard to hard rock						
6			END OF TEST PIT										
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 17

LOG OF TEST PIT NO. 16

EQUIPMENT USED: CASE 580K BACKHOE

DATE EXCAVATED: April 25, 1994

ELEVATION: +2656'

DEPTH OF TEST PIT: 5.5

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, few gravel		brown	dry to mod. moist	mod. stiff						
2		GM	silty GRAVEL		brown to lt. brown		dense						
4							dense to very dense						
6		(RX)	BASALT, slightly to moderately weathered END OF TEST PIT				mod. hard to hard rock						
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOI[illegible]NTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 18

LOG OF TEST PIT NO. 17

ELEVATION: +2651'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 6

DATE EXCAVATED: April 25, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		GM	silty GRAVEL, with cobbles and boulders		brown	dry	mod. dense						
2					brown to lt. brown		dense						
4							dense to very dense						
		(RX)	BASALT, highly to moderately weathered				soft rock						
6			moderately to slightly weathered END OF TEST PIT				mod. hard to hard rock						
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOIL INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 19

LOG OF TEST PIT NO. 18

ELEVATION: +2655'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 1

DATE EXCAVATED: April 25, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		GM	silty GRAVEL, with cobbles		brown	dry	dense						
		(RX)	BASALT, slightly to moderately weathered				mod. hard rock						
2			END OF TEST PIT										
4													
6													
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 20

LOG OF TEST PIT NO. 19

EQUIPMENT USED: CASE 580K BACKHOE

DATE EXCAVATED: April 25, 1994

ELEVATION: +2637'

DEPTH OF TEST PIT: 8

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, few gravel		brown	dry to mod. moist	mod. stiff						
2		GM	silty GRAVEL, with cobbles				dense to very dense						
4			--with 12" dia. boulders										
6			–cinder gravel/cobbles, no boulders				mod. dense						
8			END OF TEST PIT										
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 21

LOG OF TEST PIT NO. 20

EQUIPMENT USED: CASE 580K BACKHOE

DATE EXCAVATED: April 25, 1994

ELEVATION: +2642'

DEPTH OF TEST PIT: 3

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, few gravel		brown	mod. moist	mod. stiff						
2		GM	silty GRAVEL, basalt-highly weathered, with cobbles				dense						
4		(RX)	BASALT, slightly to moderately weathered END OF TEST PIT				mod. hard to hard rock						
6													
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 22

LOG OF TEST PIT NO. 21

EQUIPMENT USED: CASE 580K BACKHOE

DATE EXCAVATED: April 25, 1994

ELEVATION: +2647'

DEPTH OF TEST PIT: 3

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, few gravel		brown	mod. moist	mod. stiff						
2		GM	silty GRAVEL, basalt-highly weathered, with cobbles				dense						
4		(RX)	BASALT, slightly to moderately weathered END OF TEST PIT				mod. hard to hard rock						
6													
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 23

LOG OF TEST PIT NO. 22

ELEVATION: +2642'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 8

DATE EXCAVATED: April 25, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, few gravel		brown	mod. moist	mod. stiff						
		GM	silty GRAVEL, basalt-highly weathered, with cobbles				dense to very dense						
2													
4					gray brown								
6													
8			END OF TEST PIT										
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILTEST INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE

24

LOG OF TEST PIT NO. 23

ELEVATION: +2643'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 7

DATE EXCAVATED: April 25, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, few gravel		brown	mod. moist	mod. stiff		47.3		92	63	29
2		GM	silty GRAVEL, basalt-highly weathered, with cobbles				dense to very dense						
4													
6					gray brown								
			END OF TEST PIT										
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILTEST INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 25

LOG OF TEST PIT NO. 24

ELEVATION: +2637'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 4

DATE EXCAVATED: April 25, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, few gravel		brown	dry to mod. moist	mod. stiff						
2		GM	silty GRAVEL, basalt-highly weathered, with cobbles				dense to very dense						
4		(RX)	BASALT, slightly to moderately weathered END OF TEST PIT				mod. hard to hard rock						
6													
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE
26

LOG OF TEST PIT NO. 25

ELEVATION: +2629'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 8

DATE EXCAVATED: April 25, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, few gravel		brown	dry	mod. stiff						
2		GM	silty GRAVEL, basalt-highly weathered, with cobbles				dense						
4							very dense						
6													
8			END OF TEST PIT										
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 27

LOG OF TEST PIT NO. 26

EQUIPMENT USED: CASE 580K BACKHOE

DATE EXCAVATED: April 25, 1994

ELEVATION: +2923'

DEPTH OF TEST PIT: 6.5

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, some gravel		brown	dry	mod. stiff						
4		GM	silty GRAVEL, basalt-highly weathered, with cobbles				very dense						
6		(RX)	BASALT, slightly to moderately weathered END OF TEST PIT				hard to mod. hard rock						
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 28

LOG OF TEST PIT NO. 27

ELEVATION: +2614'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 7

DATE EXCAVATED: April 25, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT		dk. brown	dry	mod. stiff						
2			--gravelly		lt. brown and red brown		stiff						
4													
6													
			END OF TEST PIT										
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 29

LOG OF TEST PIT NO. 28

ELEVATION: +2618'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 7

DATE EXCAVATED: April 25, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, few gravel		lt. brown	dry	mod. stiff						
2			--gravelly, with cobbles		lt. brown and red brown		stiff						
4		GM	silty GRAVEL, with cobbles		lt. gray		dense to very dense						
6			END OF TEST PIT										
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 30

LOG OF TEST PIT NO. 29

EQUIPMENT USED: CASE 580K BACKHOE

DATE EXCAVATED: April 25, 1994

ELEVATION: +2625'

DEPTH OF TEST PIT: 7

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, few gravel		lt. brown	dry	mod. stiff						
2			--gravelly, some cobbles		lt. brown and yellow brown		stiff						
4		GM	silty GRAVEL, with cobbles				dense to very dense						
6		(RX)	BASALT, slightly to moderately weathered END OF TEST PIT				hard to mod. hard rock						
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILTEST INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 31

LOG OF TEST PIT NO. 30

ELEVATION: +2634'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 2.5

DATE EXCAVATED: April 25, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, few gravel		dk. brown	dry	stiff						
										2.00			
2			--with gravel, few cobbles										
		(RX)	BASALT, slightly to moderately weathered		lt. gray		hard to mod. hard rock						
			END OF TEST PIT										
4													
6													
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 32

LOG OF TEST PIT NO. 31

ELEVATION: +2636'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 4.5

DATE EXCAVATED: April 25, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, few gravel		dk. brown	dry	stiff						
2			--with gravel, some cobbles		lt. brown and yellow brown								
		GM	silty GRAVEL, with cobbles				dense to very dense						
4					lt.gray								
		(RX)	BASALT, slightly to moderately weathered END OF TEST PIT				hard to mod. hard rock						
6													
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 33

LOG OF TEST PIT NO. 32

EQUIPMENT USED: CASE 580K BACKHOE

DATE EXCAVATED: April 26, 1994

ELEVATION: +2656'

DEPTH OF TEST PIT: 7.5

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, some gravel		red brown	dry	soft to mod. stiff						
2			--gravelly		gray brown/ lt. brown		mod. stiff						
4			--with cobbles										
6													
8			END OF TEST PIT										
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOI[illegible]TERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 34

LOG OF TEST PIT NO. 33

ELEVATION: +2663'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 7

DATE EXCAVATED: April 26, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, few gravel		red brown	dry	mod. stiff						
2			--some gravel		brown		stiff						
4			--with gravel, few cobbles										
6				X					37.1				
8			END OF TEST PIT				very stiff						
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 35

LOG OF TEST PIT NO. 34

ELEVATION: +2686'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 7.5

DATE EXCAVATED: April 26, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT		dk. brown	moist	mod. stiff						
2			--some gravel and cobbles		dk. gray		very stiff						
						dry	stiff						
4			--gravelly		lt. brown		very stiff						
6			--with cobbles										
8			END OF TEST PIT										
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILTEST INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 36

LOG OF TEST PIT NO. 35

EQUIPMENT USED: CASE 580K BACKHOE

DATE EXCAVATED: April 26, 1994

ELEVATION: +2674'

DEPTH OF TEST PIT: 7.5

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, with gravel		red brown	dry	stiff						
6		GM	silty GRAVEL, with cobbles		lt. gray		dense / very dense						
8		(RX)	BASALT, slightly to moderately weathered END OF TEST PIT				mod. hard to hard rock						
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 37

LOG OF TEST PIT NO. 36

ELEVATION: +2664'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 7

DATE EXCAVATED: April 26, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, some gravel		lt. brown	dry	soft						
2			--some cobbles				mod. stiff						
4			--gravelly		lt. brown		stiff						
6			--few cobbles		lt. gray								
8		(RX)	BASALT, slightly to moderately weathered END OF TEST PIT				mod. hard to hard rock						
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 38

LOG OF TEST PIT NO. 37

EQUIPMENT USED: CASE 580K BACKHOE

DATE EXCAVATED: April 26, 1994

ELEVATION: +2658'

DEPTH OF TEST PIT: 7.5

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, few gravel and cobbles		red brown	dry	mod. stiff						
2			--with gravel		dk. brown		stiff						
4					yellow brown								
6			--few cobbles										
8			END OF TEST PIT				very stiff						
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 39

LOG OF TEST PIT NO. 38

EQUIPMENT USED: CASE 580K BACKHOE

DATE EXCAVATED: April 26, 1994

ELEVATION: +2647'

DEPTH OF TEST PIT: 7

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, few gravel and cobbles		brown	mod. moist	mod. stiff						
			--with gravel		brown to lt. brown		stiff						
2													
4													
6													
			END OF TEST PIT										
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILTEST INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 40

LOG OF TEST PIT NO. 39

ELEVATION: +2635'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 3

DATE EXCAVATED: April 26, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, few gravel		brown	mod. moist	mod. stiff						
2		GM	silty GRAVEL, with cobbles		lt. brown		dense						
4		(RX)	BASALT, slightly to moderately weathered END OF TEST PIT				mod. hard to hard rock						
6													
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE
41

LOG OF TEST PIT NO. 40

EQUIPMENT USED: CASE 580K BACKHOE

DATE EXCAVATED: April 26, 1994

ELEVATION: +2643'

DEPTH OF TEST PIT: 2.5

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, with boulders and cobbles		brown to lt. brown	dry to mod. moist	mod. stiff						
2		(RX)	BASALT, slightly to moderately weathered END OF TEST PIT				mod. hard to hard rock						
4													
6													
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 42

LOG OF TEST PIT NO. 41

ELEVATION: +2647'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 5

DATE EXCAVATED: April 26, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, few gravel		brown	mod. moist to moist	mod. stiff						
2			--with gravel										
4		GM	silty GRAVEL, with cobbles		lt. brown		dense to very dense						
6		(RX)	BASALT, slightly to moderately weathered END OF TEST PIT				mod. hard to hard rock						
8													
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 43

LOG OF TEST PIT NO. 42

ELEVATION: +2655'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 6.5

DATE EXCAVATED: April 26, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, few gravel		brown to lt. brown	mod. moist	mod. stiff						
2		GM	silty GRAVEL, with cobbles and boulders				dense to very dense						
4					lt. brown		very dense						
6		(RX)	BASALT, slightly to moderately weathered				mod. hard to hard rock						
8			END OF TEST PIT										
10													
12													
14													

PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILTECH INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 44

LOG OF TEST PIT NO. 43

ELEVATION: +2649'

EQUIPMENT USED: CASE 580K BACKHOE

DEPTH OF TEST PIT: 3.5

DATE EXCAVATED: April 26, 1994

DEPTH TO GROUNDWATER: N.A.

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
0		MH	clayey SILT, with gravel		lt. brown	dry	mod. stiff						
		GM	silty GRAVEL, with cobbles				dense to very dense		25.2				
4		(RX)	BASALT, slightly to moderately weathered END OF TEST PIT				mod. hard to hard rock						
6													
8													
10													
12													
14													

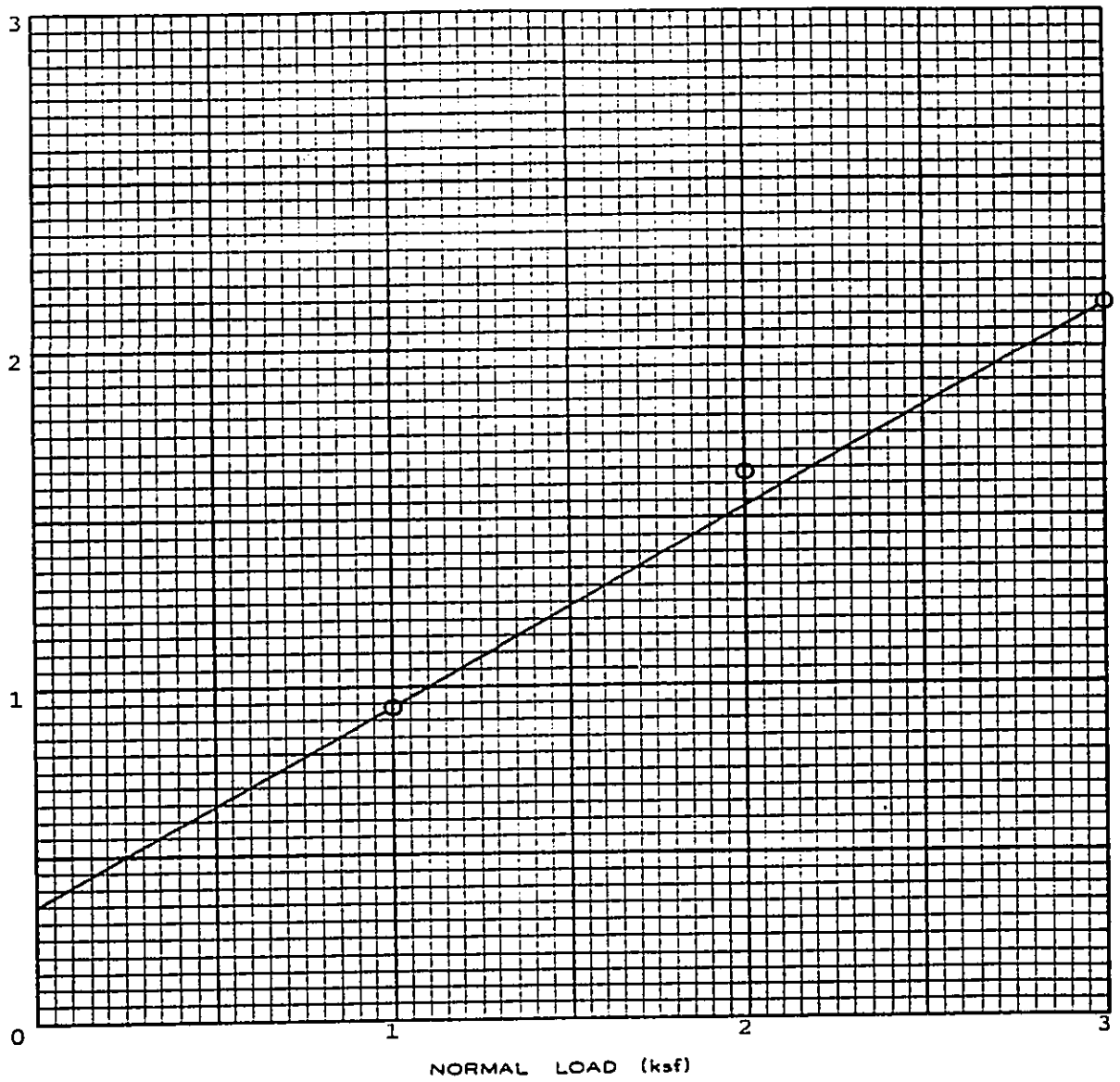
PROJECT NAME: KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO.: M-2335-F

SOILS INTERNATIONAL
A CORPORATION
Geotechnical Consultants

PLATE 45

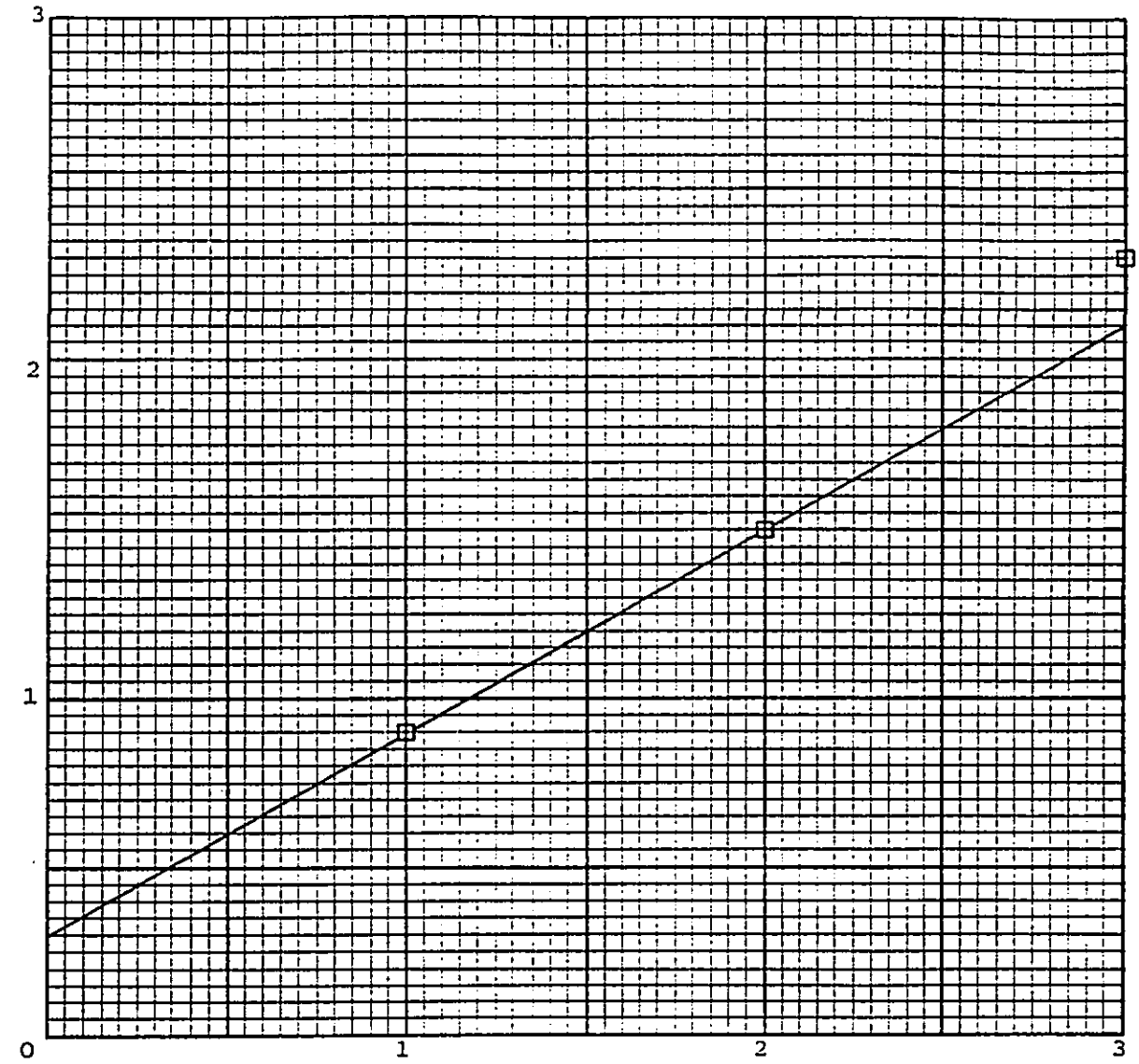
DIRECT SHEAR TEST



	LOCATION	DEPTH (ft.)	COHESION (psf)	ANGLE OF INTERNAL FRICTION	TEST CONDITIONS
O	TP-5, S-1	2.5'	350	30°	Remolded - Residual Strength

PROJECT:	PROJECT NO.		PLATE
KULA WATER TRANSMISSION MAIN PHASE I	M-2335-F	SOILS INTERNATIONAL 99-1255 WAIUA PLACE AIEA, HAWAII 96701	46

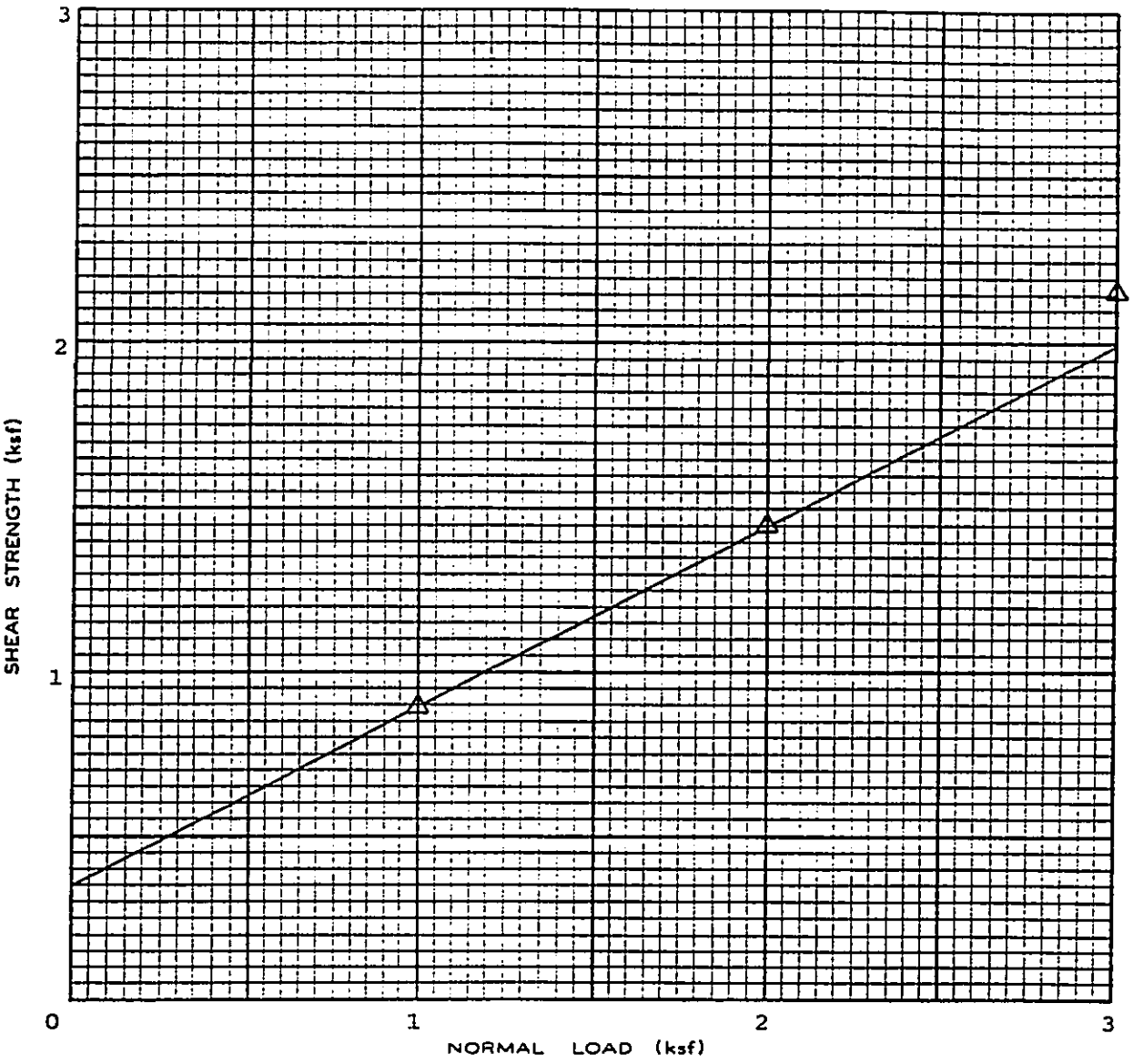
DIRECT SHEAR TEST



	LOCATION	DEPTH (ft.)	COHESION (psf)	ANGLE OF INTERNAL FRICTION	TEST CONDITIONS
☐	TP-8, S-1	2.0'	300	31°	Remolded - Residual Strength

PROJECT:	PROJECT NO.		PLATE
KULA WATER TRANSMISSION MAIN PHASE I	M-2335-F	SOILS INTERNATIONAL 99-1255 WAIUA PLACE AIEA, HAWAII 96701	47

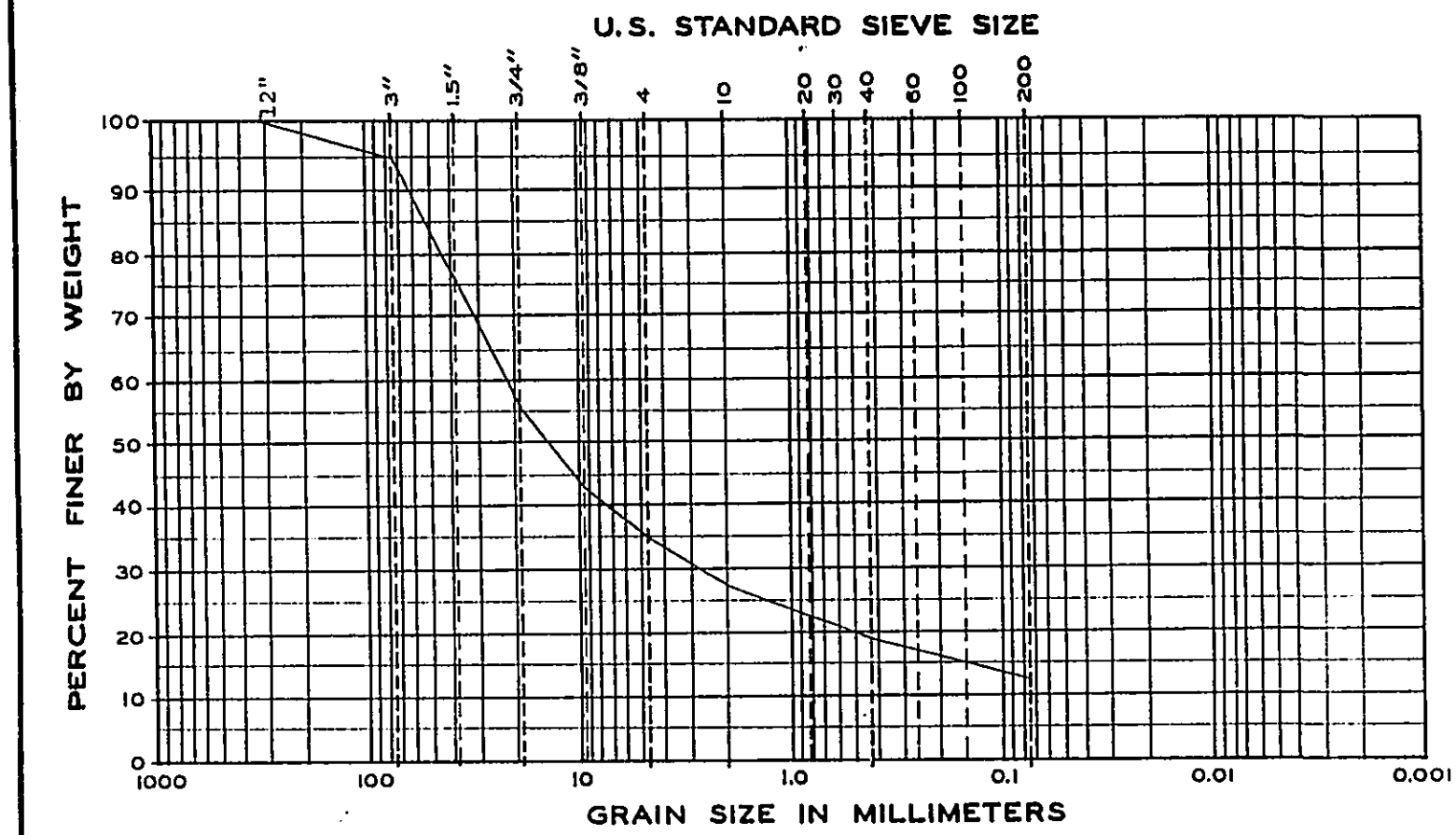
DIRECT SHEAR TEST



	LOCATION	DEPTH (ft.)	COHESION (psf)	ANGLE OF INTERNAL FRICTION	TEST CONDITIONS
△	TP-33, S-1	6.5'	350	28°	Remolded - Residual Strength

PROJECT:	PROJECT NO.		PLATE
KULA WATER TRANSMISSION MAIN PHASE I	M-2335-F	SOILS INTERNATIONAL 99-1255 WAIUA PLACE AIEA, HAWAII 96701	48

GRAIN SIZE DISTRIBUTION



% PASSING	
3"	95.3
1.5"	76.2
3/4"	56.3
1/2"	
3/8"	43.0
4	35.0
10	27.7
20	
30	
40	19.0
60	17.2
100	15.4
200	12.5

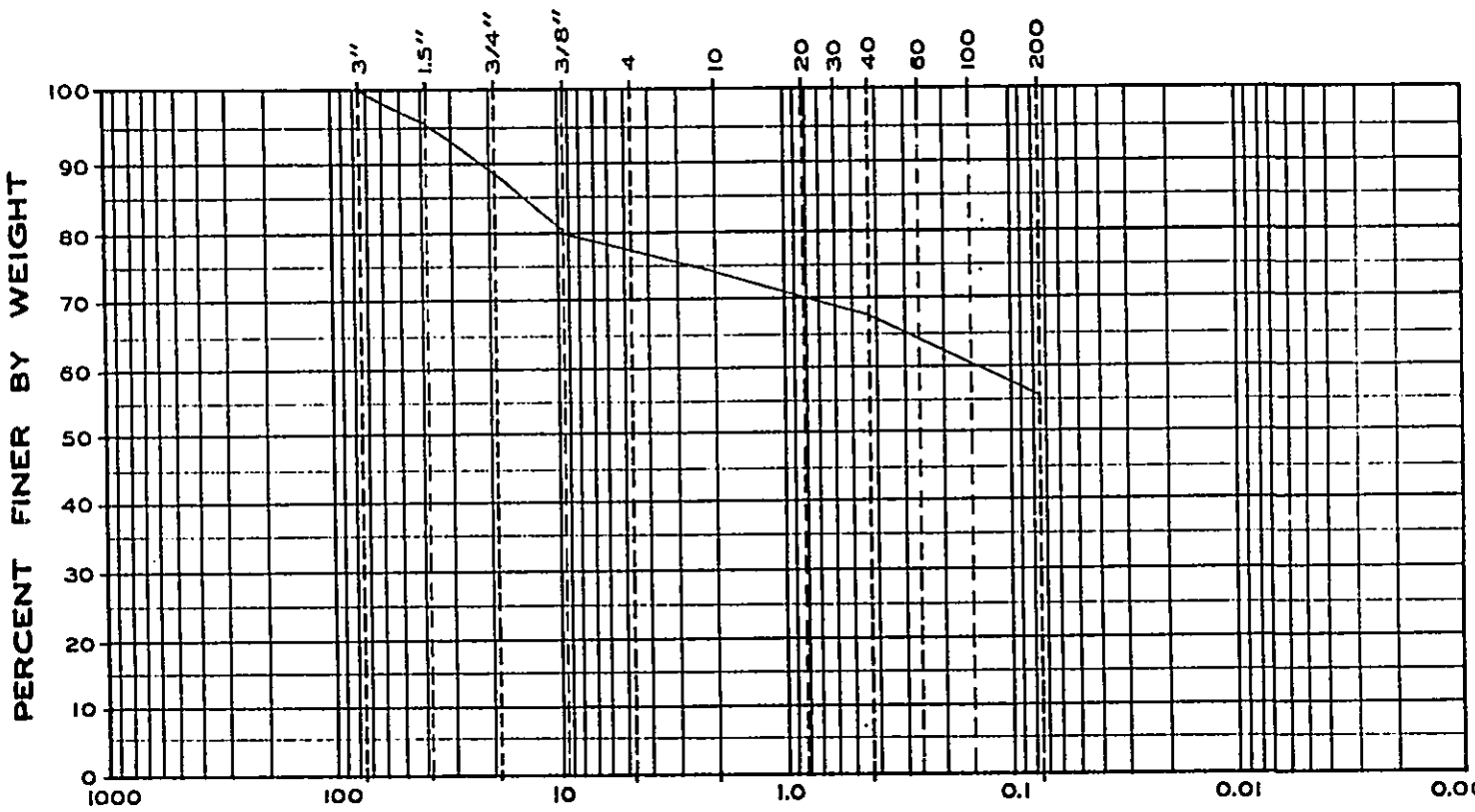
	COBBLE	GRAVEL		SAND			SILT OR CLAY	ATTERBERG LIMITS		
		COARSE	FINE	CO	MEDIUM	FINE				

LOCATION	DEPTH	GROUP SYMBOL	CLASSIFICATION	MOISTURE CONTENT	LL	PL	PI
TP-2, S-1	3.0'	GM	silty GRAVEL, with sand	23.3%			

KULA WATER TRANSMISSION MAIN-PHASE I — PROJECT NO. M-2335-F

SOILS INTERNATIONAL — PLATE 49

GRAIN SIZE DISTRIBUTION



% PASSING	
3"	100.0
1.5"	95.6
3/4"	88.6
1/2"	
3/8"	80.7
4	77.0
10	74.5
20	
30	
40	67.9
60	64.9
100	60.2
200	55.3

	COBBLE	GRAVEL		SAND			SILT OR CLAY	ATTERBERG LIMITS		
		COARSE	FINE	CO	MEDIUM	FINE				

LOCATION	DEPTH	GROUP SYMBOL	CLASSIFICATION	MOISTURE CONTENT	LL	PL	PI
TP-33, S-1	6.5'	(MH)	SILT; with gravel and sand	37.1%			

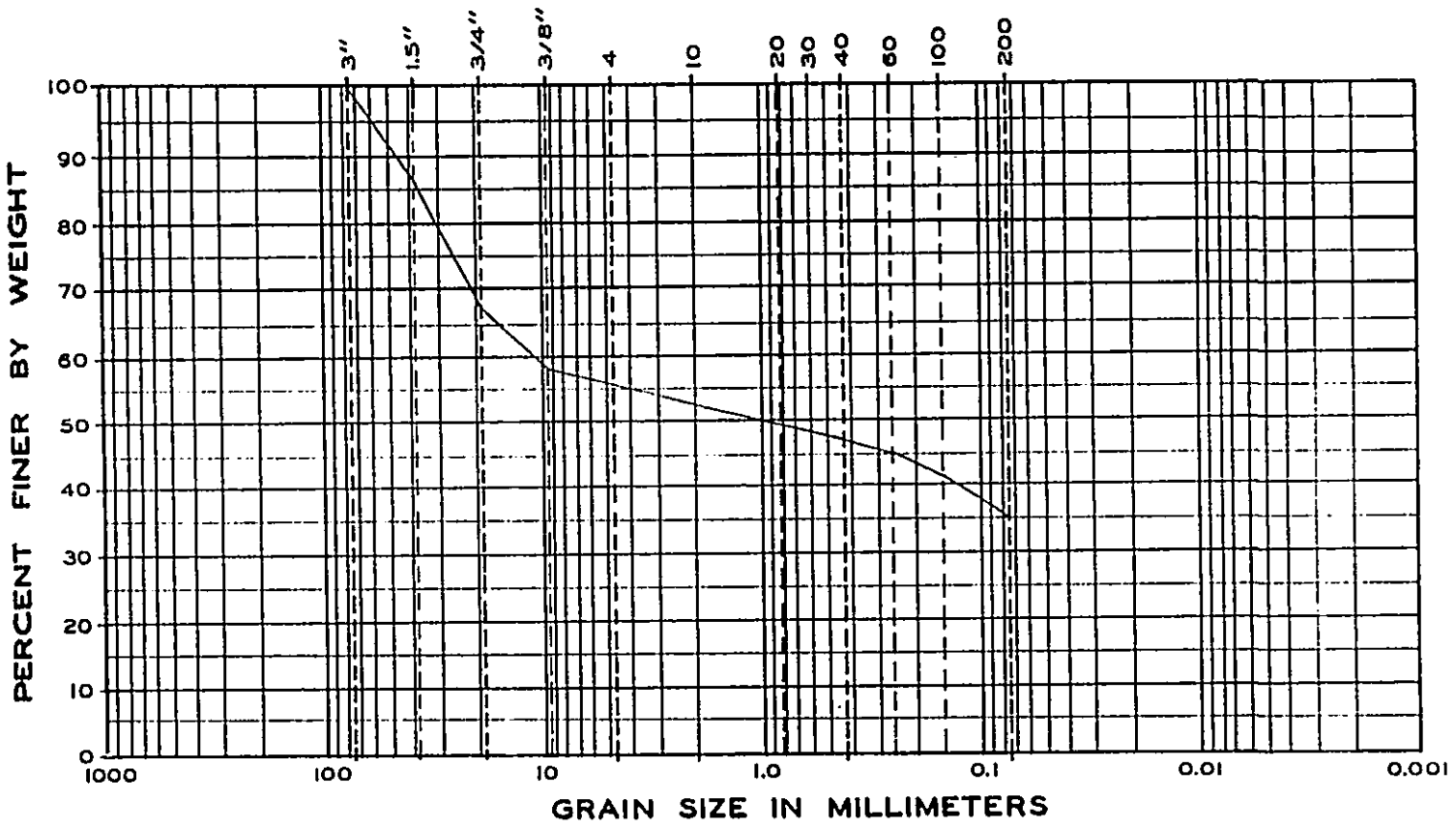
KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO. M-2335-F

SOILS INTERNATIONAL

PLATE 50

GRAIN SIZE DISTRIBUTION



% PASSING	
3"	100.0
1.5"	86.8
3/4"	67.1
1/2"	
3/8"	58.2
4	55.1
10	53.3
20	
30	
40	47.8
60	45.3
100	41.8
200	35.3

	COBBLE	GRAVEL		SAND			SILT OR CLAY	ATTERBERG LIMITS		
		COARSE	FINE	CO	MEDIUM	FINE				

LOCATION	DEPTH	GROUP SYMBOL	CLASSIFICATION	MOISTURE CONTENT	LL	PL	PI
TP-43, S-1	3.0'	GM	silty GRAVEL; with sand	25.2%			

KULA WATER TRANSMISSION MAIN-PHASE I

PROJECT NO. M-2335-F

SOILS INTERNATIONAL

PLATE 51

FLORA AND FAUNA STUDIES

BIOLOGICAL ASSESSMENT STUDIES -- FLORA & FAUNA
KULA WATER TRANSMISSION MAIN, PHASE I
KEOKEA, KULA, ISLAND OF MAUI

by

Winona P. Char

CHAR & ASSOCIATES
Honolulu, Hawai'i

Prepared for: TANAKA ENGINEERS, INC.

May 1994

BIOLOGICAL ASSESSMENT STUDIES -- FLORA & FAUNA
KULA WATER TRANSMISSION MAIN, PHASE I
KEOKEA, KULA, ISLAND OF MAUI

INTRODUCTION

The proposed Kula Water Transmission Main, Phase I, project involves the extension of the Lower Kula waterline approximately 10,000 linear feet from Na'alae Road to the Hawaiian Home Lands in Keokea. The water transmission line will follow just above the 2,600-foot contour interval. Where it leaves Na'alae Road, the waterline will follow along a dirt road through vegetable fields and then cross under a barbed-wire fence onto pasture land (Ka'ono'ulu Ranch). The pasture land consists of gently rolling slopes dissected by shallow gullies and four rather steep and narrow gulches; these are respectively, Na'alae, Ka'ono'ulu, Kaipoioi, and Ka'akaulua gulches.

Field studies to assess the floral (botanical) and faunal resouces found within and adjacent to the water transmission main corridor were conducted on 05 May 1994. The primary objectives of the field studies were to: 1) describe the major vegetation types; 2) provide information on the bird and mammal communities; and 3) search for threatened and endangered plants and wildlife.

SURVEY METHODS

Prior to the field studies, a search was made of the literature to familiarize the principal investigator with other biological studies conducted in the general area. Existing topographic and soil (Foote et al. 1972) maps were examined to determine access, boundaries, reference points, and terrain characteristics. The

alignment for the water transmission line had been surveyed and flagged prior to our field studies.

For the botanical studies, a corridor 100 ft. wide was surveyed following along the waterline. Notes were made on plant associations and distribution, substrate types, slope, exposure, drainage, etc. Plant identifications were made in the field; plants which could not be positively identified were collected for later determination in the herbarium and for comparison with the most recent taxonomic treatment.

For the vertebrate fauna, field observations were made along the corridor and on adjacent pasture lands with binoculars, and by listening for vocalizations. These observations were concentrated during the peak bird activity periods of early morning. Attention was also paid to the presence of tracks and scats (droppings) as indicators of bird and mammal activity. No attempts were made to trap mammals in order to obtain data on their ralative abundance and distribution.

FLORAL (BOTANICAL) RESOURCES

The plant names used in the discussion below follow Wagner et al. (1990) for the flowering plants and Lamoureux (1988) for the ferns.

The proposed waterline crosses over actively cultivated lands for about 1,000 ft. where it leaves Na'alae Road. Head cabbage is the most commonly grown vegetable crop along with smaller plantings of broccoli, Romaine lettuce, and red and green lettuce. Patches of weeds and grasses occur on steeper, uncultivated slopes and boulder piles. The most abundant of these plants are Spanish needle (Bidens pilosa), Bermuda grass or manienie (Cynodon dactylon), castor bean (Ricinus communis), and pangola grass (Digitaria pentzii). One native species, the koali (Ipomoea

indica), a member of the morning-glory family with pink to pale lavender colored flowers, is occasional on uncultivated areas.

After crossing the vegetable farm, the waterline passes through pasture land for the remainder of its length. Two variants of the pasture land can be recognized in the field. From where the waterline leaves the vegetable farm to just before Kaipoioi Gulch, the pasture land is dominated by Kikuyu grass (Pennisetum clandestinum) with scattered clumps of lantana shrubs (Lantana camara) and panini cactus (Opuntia ficus-indica). The lantana and cactus form dense, prickly thickets which may cover 30 to 40% of the pasture land. The common pasture legumes are Glycine wightii, bur clover (Medicago plymorpha), Spanish clover or ka'imi (Desmodium incanum), and common vetch (Vicia sativa). Other grasses associated with the pasture area include Bermuda grass, at least three Bromus species, Indian dropseed (Sporobolus indicus), molasses grass (Melinis minutiflora), buffel grass (Cenchrus ciliaris), brome fescue (Vulpia dertonensis), and oats (Avena sativa). Rocky outcroppings and areas with thin, stony soil support air plant (Kalanchöe pinnata), Natal redtop grass (Rhynchelytrum repens), Guinea grass (Panicum maximum), and the native kilau fern (Pteridium aquilinum var. decompositum).

The second variant of the pasture land vegetation is Kikuyu grass with an open forest of black wattle trees (Acacia mearnsii), 12 to 20 ft. tall. The black wattle, a member of the legume or bean family, is a native of Australia and was first brought to the island of Lana'i in 1911 (Wagner et al. 1990). Today it is naturalized throughout most of the main Hawaiian Islands in pastures and dry to mesic forests. It is considered a weedy tree since it can cover large areas quite rapidly by producing suckers or runners. Live tree cover on this part of the pasture land is about 30 to 40%. Tree cover was denser at one time, but many of the larger trees have been cut down for better pasture management.

Herbaceous species found in this type of pasture land include hedge mustard (Sisymbrium officinale), weed verbena (Verbena litoralis), allseed (Polycarpon tetraphyllum), and goosefoot (Chenopodium murale).

Gulch areas support dense stands of black wattle trees and a few shrubs such as guava (Psidium guajava), Christmas berry (Schinus terebinthifolius), and lantana. A few patches of ferns and other moisture-loving species can be found on some of the shadier, damper gulch walls; these include Australian maidenhair fern (Adiantum hispidulum), Deparia petersonii, blechnum fern (Blechnum occidentale), Colombian cuphea (Cuphea carthagenensis), and daisy fleabane (Erigeron karvinskianus).

Eight native species can be found associated with the pasture land vegetation. A few plants of kupala vine (Sicyos pachycarpus) and kakonakona grass (Panicum torridum) are found near a small gully just before the Department of Hawaiian Home Lands property. Pua kala (Argemone glauca), the native poppy, occurs on rocky areas. Other natives are 'uhaloa (Waltheria indica), koali, 'ilima (Sida fallax), kilau fern, and popolo (Solanum americanum).

FAUNAL RESOURCES

The names used in the discussion below follow those given in Hawaii's Birds (Hawaii Audubon Society 1989) and van Riper and van Riper (1982) for the mammals.

No endemic land birds were recorded during the field survey. The Short-eared Owl or Pueo (Asio flammeus sandwichensis) is the only endemic land bird that may on occasion occur here (Hawaii Audubon Society 1989; Pratt et al. 1987). The State of Hawaii, Division of Forestry and Wildlife, lists the Pueo as an endangered species for the island of O'ahu only. It has recently been upgraded to a category 2 status by the U.S. Fish and Wildlife

Service (1994a); a category 2 species is a potential candidate for listing as threatened or endangered.

One Pacific Golden-plover (Pluvialis fulva) was recorded in pasture land just below the Kula Highway. Plover are expected to use the pasture land along the waterline corridor. These migratory birds arrive in the islands in early August and depart to arctic breeding grounds during the last week of April; some of the juveniles will stay through the summer.

The remainder of the birds recorded on or along the waterline corridor are introduced or exotic species (Table 1). The most abundant of these were the Japanese White-eye (Zosterops japonicus), Northern Cardinal (Cardinalis cardinalis), House Finch (Carpodacus mexicanus), and Warbling Silverbill (Lonchura malabarica). Commonly recorded species were the Gray Francolin (Francolinus pondicerianus), Eurasian Skylark (Alauda arvensis), and Nutmeg Mannikin (Lonchura punctulata). The francolin and skylark occupied the open, grassy areas, while the other species preferred the more wooded areas, especially the gulches. A water trough located near survey point "444" is a main hub of bird activity. Small flocks of House Finch, Warbling Silverbill, and Nutmeg Mannikin were observed here.

The pasture land is used for grazing beef cattle (Bos taurus) and horses (Equus caballus). Besides cattle and horses, the following species were recorded. Scats of the Small Indian Mongoose (Herpestes auropunctatus) were observed in the pasture area near some of the dirt roads which cross through the corridor. Fresh Axis Deer (Axis axis) scats were found in the area of the water trough. The contractors for the soil survey and archaeological studies reported a number of deer sightings on the pasture land area prior to our field studies. Feral pig (Sus scrofra) tracks and diggings were noted in the pasture area.

TABLE 1. Summary of the birds recorded during the field studies, Kula Water Transmission Main, Phase I, Keokea, Kula, island of Maui.

Common name	Scientific name	Status[1]	Relative abundance[2]
Pacific Golden-plover	Pluvialis fulva	V	u
Gray Francolin	Francolinus pondicerianus	A	c
Ring-necked Pheasant	Phasianus colchicus	A	o
Eurasian Skylark	Alauda arvensis	A	c
Japanese White-eye	Zosterops japonicus	A	a
Spotted Dove	Streptopelia chinensis	A	o
Zebra Dove	Geopelia striata	A	o
Common Myna	Acridotheres tristis	A	u
Northern Mockingbird	Mimus polyglottis	A	o
Northern Cardinal	Cardinalis cardinalis	A	a
House Sparrow	Passer domesticus	A	u
House Finch	Carpodacus mexicanus	A	a
Warbling Silverbill	Lonchura malabarica	A	a
Nutmeg Mannikin	Lonchura punctulata	A	c

[1]Status (symbols after Hawai'i Audubon Society 1989).

A = alien, introduced to and established in the Hawaiian Islands by humans

V = visitor, regular migrants that winter over in the Hawaiian Islands

[2]Relative abundance

a = abundant
c = common
o = occasional
u = uncommon

The Hawaiian Hoary Bat or 'Ope'ape'a (Lasiurus cinereus semotus) may fly over the corridor area, but not much is known about its habit. It is active from late afternoon to after sunset. It's population is recorded as sparse on the island of Maui (van Riper and van Riper 1982; Tomich 1986). No bats were found on this survey.

DISCUSSION AND RECOMMENDATIONS

Flora

The proposed Kula Water Transmission Main, Phase I, project will primarily impact Kikuyu grass-dominated pasture lands. Besides the Kikuyu grass, other common components are lantana, panini cactus, and black wattle trees. All of the above plants are introduced species. The waterline will also cross vegetable fields for a short span where it leaves Na'alae Road.

Eight native species can be found on or along the waterline corridor. Four of these, the kupala vine (Sicyos pachycarpus), kakonakona grass (Panicum torridum), native poppy or pua kala (Argemone glauca), and the kilau fern (Pteridium aquilinum var. decompositum) are endemic, that is, they are native only to the Hawaiian Islands. The other species -- 'uhaloa (Waltheria indica), 'ilima (Sida fallax), koali (Ipomoea indica), and popolo (Solanum americanum) -- are indigenous species, that is, they are native to the Hawaiian Islands and also elsewhere.

All of these native plants can be found in similar environmental habitats throughout the Hawaiian Islands. None of the plants are listed, proposed, or candidate threatened and endangered species (U.S. Fish and Wildlife Service 1989, 1990, 1992, 1994b); nor are any considered rare and/or vulnerable (Wagner et al. 1990). Because the vegetation has been disturbed for such a long time, there are no native plant-dominated vegetation types on the waterline

corridor or on the immediately adjacent lands.

Given the findings above, the proposed Kula Water Transmission Main project is not expected to have a significant negative impact on the botanical or floral resources. There are no botanical reasons to impose any restrictions, impediments, or conditions to the construction of the proposed waterline.

Fauna

Fourteen bird species were recorded on or along the proposed waterline corridor. With the exception of the Pacific Golden-plover or Kolea, which is a migratory visitor, all of the other birds recorded are introduced or exotic species. The Pueo might on occasion forage in the area, but was not recorded during our survey.

All the mammals which occur on or along the waterline corridor are introduced. Only two mammals are native to the Hawaiian Islands; these are the Hawaiian Monk Seal (Monachus schauinslandii) and the Hawaiian Hoary Bat. Although not recorded during our survey, the bat may fly over the area as it is known from Maui.

The proposed waterline is not expected to have a negative impact on the vertebrate fauna as it is of a limited nature. It will not negatively impact any native vegetation types which provide habitat for threatened and endangered wildlife (U.S. Fish and Wildlife 1989, 1994a).

REFERENCES CITED

Foote, D.E., E.L. Hill, S. Nakamura, and F. Stephens. 1972. Soil survey of the islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. Soil Conservation Service, U.S. Dept. of Agriculture, Washington, D.C.

Hawaii Audubon Society. 1989. Hawaii's birds. 4th edition. Hawaii Audubon Society, Honolulu.

Lamoureux, C.H. 1988. Draft checklist of Hawaiian pteridophytes, Kupukupu O Hawai'i Ne'i. October 1988.

Pratt, H.D., P.L. Bruner, and D.G. Berrett. 1987. A field guide to the birds of Hawaii and the Tropical Pacific. Princeton University Press.

Tomich, P.Q. 1986. Mammals in Hawaii. B.P. Bishop Museum Press, Honolulu.

van Riper, S.G. and C. van Riper, III. 1982. A field guide to the mammals in Hawaii. Oriental Publ. Co., Honolulu.

U.S. Fish and Wildlife Service. 1989. Endangered and threatened wildlife and plants. 50 CFR 17.11 & 17.12.

_____. 1990. Endangered and threatened wildlife and plants; Review of plant taxa for listing as Endangered and Threatened Species; Notice of review. Federal Register 55 (35): 6184-6229.

_____. 1992. Endangered and threatened wildlife and plants; Determination of endangered or threatened status for 15 plants from the island of Maui, HI. Federal Register 57 (95): 20772-20788.

_____. 1994a. Animals, Hawaiian Islands, Listed, proposed or candidate species under the U.S. Endangered Species Act, Updated: March 17, 1994. Unpublished.

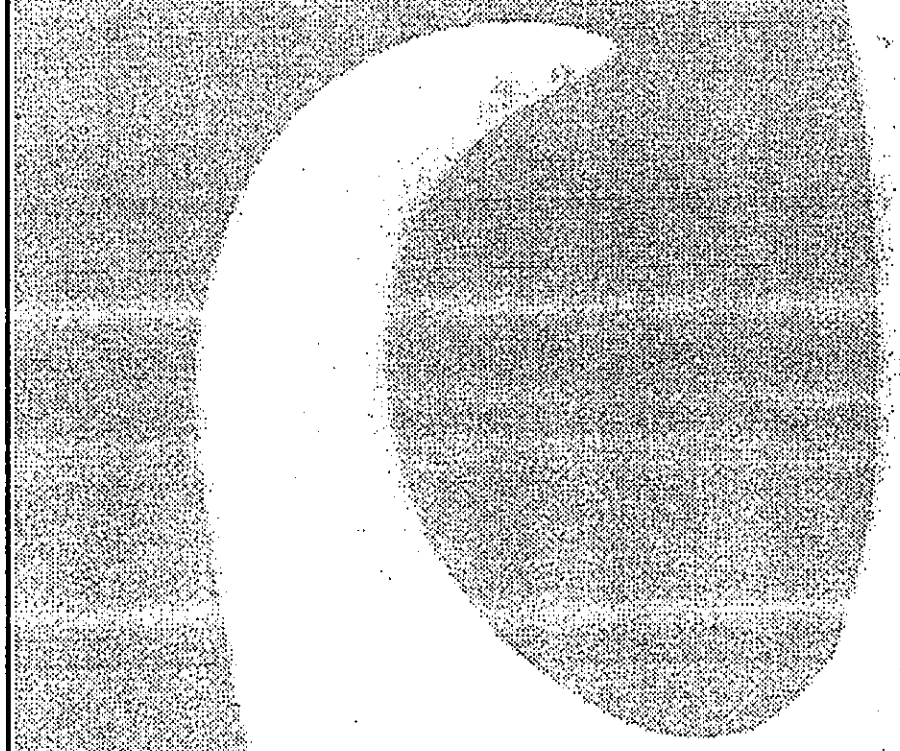
_____. 1994b. Plants, Hawaiian Islands, Listed, proposed or candidate species under the U.S. Endangered Species Act, Updated: March 28, 1994. Unpublished.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1990. Manual of the flowering plants of Hawai'i. 2 vols. University of Hawai'i Press and B.P. Bishop Museum Press, Honolulu. B.P. Bishop Museum Special Publication No. 83.

ARCHAEOLOGICAL INVENTORY SURVEY

AN ARCHAEOLOGICAL INVENTORY SURVEY REPORT FOR THE PROPOSED LOWER KULA WATER TRANSMISSION MAIN, PHASE I PASSING THROUGH TMK: 2-2-02: 15 AND TMK: 2-2-13: 44 AND THE AHUPUA'A OF KOHEO 1st AND 2nd, KAONOULU, AND ALAE 1st TO 4th, MAKAWAO DISTRICT, ISLAND OF MAUI

JUNE 1994



Prepared for:

Mr. Kirk T. Tanaka
Tanaka Engineers, Inc.
871 Kolu Street, Suite 201
Wailuku, Hawaii 96793

Prepared by:

Archaeological Consultants of Hawaii, Inc.
James R. Moore, B.S.
Joseph Kennedy, M.A.
59-624 Pupukea Rd.
Haleiwa, Hawaii 96712

Table of Contents

AN ARCHAEOLOGICAL INVENTORY SURVEY REPORT FOR THE PROPOSED LOWER KULA WATER TRANSMISSION MAIN, PHASE I PASSING THROUGH TMK: 2-2-02:15 AND TMK: 2-2-13:44 AND THE AHUPUA'A OF KOHEO 1st AND 2nd, KAONOULU, AND ALAE 1st TO 4th, MAKAWAO DISTRICT, ISLAND OF MAUI

Abstract

An archaeological inventory survey was conducted on a 100 foot wide corridor proposed to be utilized for an 18 inch water main. A 100% surface survey was undertaken. This survey identified eight significant historic sites whose functions were interpreted as agricultural and residential/burial(?). Feature types encountered include walls, platforms, an enclosure, an alignment of boulders, a modified outcrop, and a water trough.

Following consultations with Tanaka Engineers, Inc., it was decided that mitigation of the effects of pipeline construction on features encountered within the proposed corridor would take the form of altering the path of the pipeline in order to avoid features. Therefore, no subsurface testing was conducted during the current study. Based upon the findings of this survey and dependent upon the mitigation procedures summarized above, Archaeological Consultants of Hawaii, Inc. recommends a finding of "no adverse effect" on significant archaeological sites located within the subject property

Section 1: Introduction

At the request of Mr. Kirk T. Tanaka of Tanaka Engineers, Inc., an archaeological inventory survey was conducted by Archaeological Consultants of Hawaii, Inc. (ACH) on a corridor which passes through properties owned by Kaonoulu Ranch and the Kazui Watanabe Trust, et al.. The corridor crosses two TMK's (TMK: 2-2-02:15 and TMK: 2-2-13:44) and seven ahupua'a (Kohea 1st and Kohea 2nd, Kaonoulu, and Alae 1st through 4th) located in Makawao District on the Island of Maui (see Map 1). The purpose of an inventory survey is to evaluate the significance of historic resources located on a property and to make recommendations concerning the mitigation of future construction activities upon possibly significant historic resources.

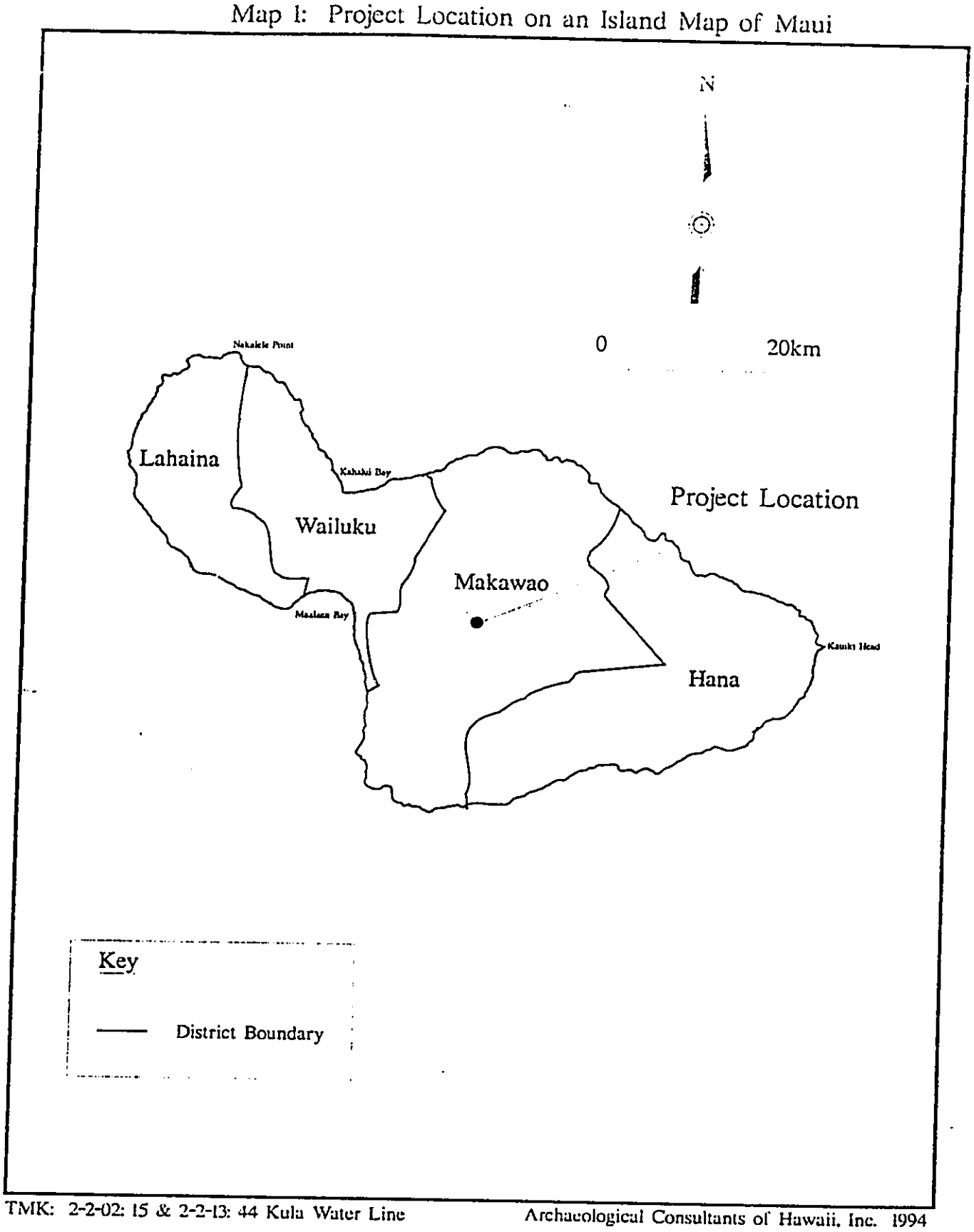
This report provides a description of the subject property and its environment, a summary of the historic background and land use patterns pertinent to the property, and a summary of previous archaeological research undertaken within nearby ahupua'a. It also includes a description of the inventory survey field methods and findings as well as an assessment of the archaeological significance of the property.

Section 2: Physical Setting

The subject property consists of a corridor 100ft wide located on the leeward slopes of Mount Haleakala on the Island of Maui. The corridor lies between geographic grid coordinates 20 44' through 45'N by 156 20' through 21'W and between Universal Transverse Mercator (UTM) coordinates 2295000 through 2297500mN by 776500 through 777000mE (see Map 2). Rainfall in the vicinity of the subject property amounts to approximately 30 inches per year (Armstrong 1973). Foote et al. (1972) depict the expected soils through the corridor as Kamaole very stony silt loam and/or Kula cobbly loam. The corridor is located between 2600 and 2700ft above mean sea level (AMSL).

The northern end of the corridor, a length of approximately 300m, extends to Naalae Rd. passing through farm land owned by the Watanabe Trust and cultivated with cabbage and broccoli (both members of the genus Brassica). The remainder of the corridor passes through open range land with rolling hills and intermittent shallow gulches. Vegetation in the open range land consists lantana (Lantana camera), 'ilima (Sida fallax), panini (Opuntia sp.), wattle wood (Acacia decurrens) and a variety of grasses.

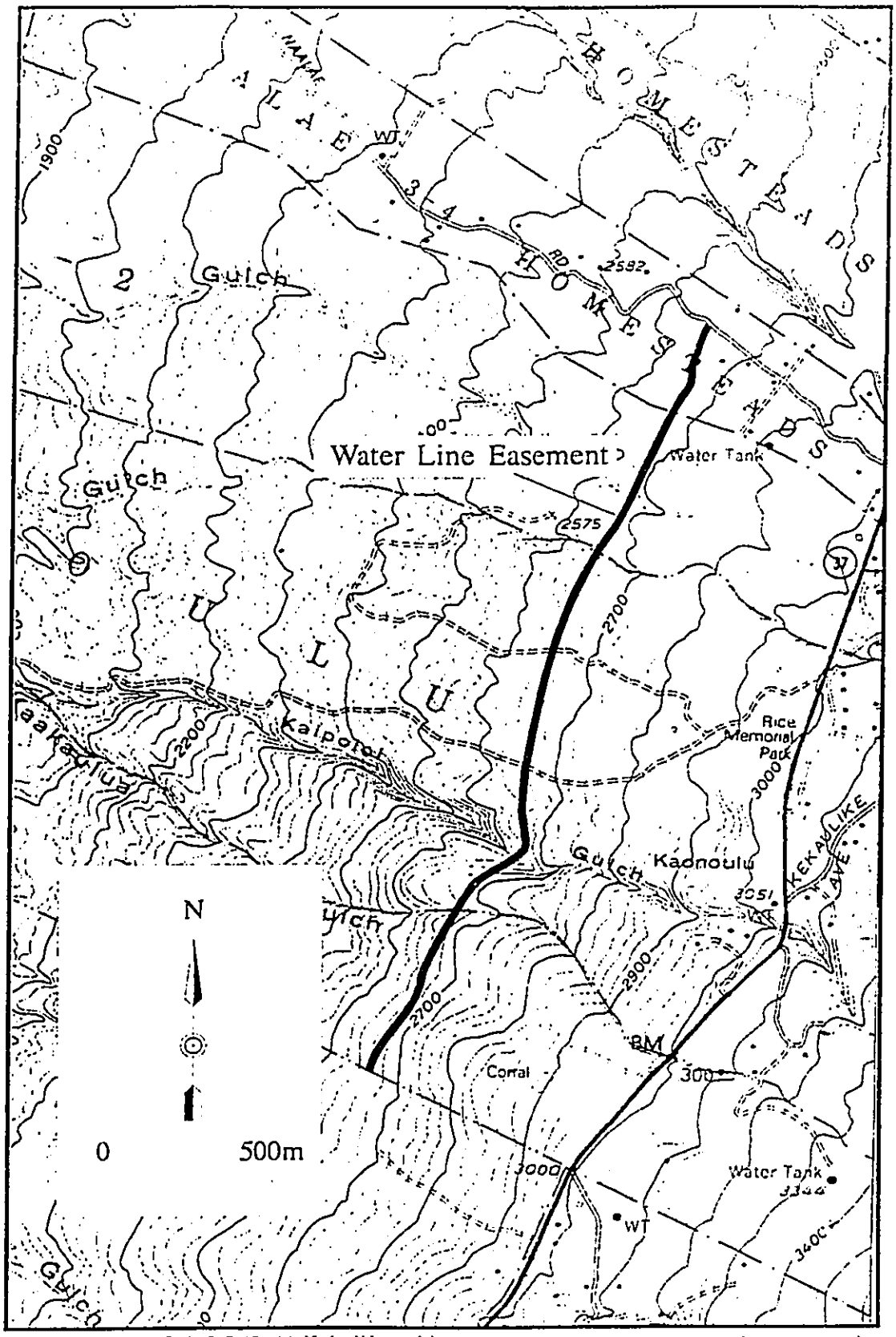
Map 1: Project Location on an Island Map of Maui



TMK: 2-2-02: 15 & 2-2-13: 44 Kula Water Line

Archaeological Consultants of Hawaii, Inc. 1994

Map 2: Subject Property on a USGS Map



TMK: 2-2-02: 15 & 2-2-13: 44 Kula Water Line

USGS 7.5 Minute Series (Topographic)
Pau O Kali Quadrangle 1983

Section 3: Historic Review

Section 3.1: Land Use History

The corridor through which the subject property passes lies within the district of Makawao, formerly known as Kula. Kolb has described Kula as "a minor political district under the jurisdiction of the West Maui chiefs", possessing five communities occupying land units which extended from the sea to the mountain (1994:3).

Major ecological zones are recognized on the kula slopes of Haleakala with individual zones dependent upon elevation. Above an arid intermediate zone, separating coastal habitations from the high forest zone, lies a zone in which enough rainfall occurs to support dryland agriculture. It is within this zone that an upland field system with accompanying settlements is found and through which the subject corridor passes.

The upland field system at Kula is thought to have replaced small, isolated garden plots during the expansion period of island settlement (Kirch 1985) when population growth required the development of agriculturally marginal areas. According to Kolb, the expansion of the Kula upland field system occurred circa A.D. 1400 - 1650 utilizing "extensive stone and earth embankments for the retention of soil" (1994:4). This system is thought to have followed the natural contour of the land utilizing rainfall as opposed to irrigation.

By the time of contact, this system was utilized intensively for the cultivation of sweet potato and possibly dryland taro. This intensive use continued after contact until the decline of the indigenous population allowed for the influx of immigrant Chinese who, during the gold rush, converted much of the land to the production of export crops.

At the time of the Great Mahele the corridor through which the subject property passes was divided into portions of one Grant and two Land Commission Awards. The northern portion of the subject corridor, currently owned by the Watanabe Trust, was dispensed as Grant 8017, for which there are only dimensional records. The remainder of the subject corridor, currently owned by Kaonoulu Ranch, was awarded as portions of two LCA's.

The northern portion of the Kaonoulu Ranch tract was awarded in Land Commission Award 8452 to Keohokalole. Testimony recorded in the Native Register describes the lands:

> At Kula, Island of Maui, Keokea Ahupua'a, there are three small mala of sweet potatoes and one mala of taro,

made by our own hands, not by those-of-the-people-of-the-land. (Native Register for LCA 8452: pg. 568)

The southern portion of the Kaonoulu Ranch tract was awarded in Land Commission Award 3237 (Part 2) to Hewahewa. Original, untranslated, testimony accompanying Royal Patent 7447 for this LCA describe a kuleana in Kula that was used to "mahi uala nou" (roughly translated as "farm plump sweet potatoes").

Throughout the twentieth century, land use within the subject corridor has remained generally stable. Kaonoulu Ranch has used the majority of the corridor as pasture land while the northern end of the corridor, owned by the Watanabe Trust, has been used for the cultivation of common vegetables.

Section 3.2: Previous Archaeology

Little archaeological work has been conducted in the vicinity of the subject property. Early twentieth century work by Thrum and Walker concentrated on documenting the location of monumental structures. The most recent studies in the area have been conducted by Paul H. Rosendahl, Inc. (PHRI)(Brown & Haun 1989) and Kolb (1994).

PHRI conducted an inventory survey level investigation on two tracts of land totalling 1025.4 acres. The two tracts consisted of lands to be developed into two subdivisions, Keokea Subdivision and Waiohuli Subdivision. Waiohuli Subdivision shares its northern border with Kaonoulu Ranch and the subject corridor abuts this boundary. PHRI's survey identified 159 sites consisting of 274 features including functional types ranging from heiau to agricultural mounds. Interestingly, site and feature density decreased dramatically in Waiohuli as opposed to Keokea. Brown and Haun attribute this to "extensive historic disturbance in the area" (1989:27).

Kolb conducted intensive investigations at Molohai Heiau (State Site #50-50-10-1037) in which he identified a series of occupational phases. Information collected indicated the ritual use of the heiau from as early as A.D. 1057 until its abandonment as a ritualistic site circa A.D. 1819 (1994:2). Following its abandonment, the site was apparently utilized for agricultural purposes. The most interesting conclusions of Kolb's work were the indications of transitions in the ritualistic utilization of faunal species during different occupational episodes indicating possible time frames for environmental changes in the upper woodlands of Maui. During Kolb's investigations information was obtained that indicated large portions of the upland field system were chained and dozed including the areas through which the subject corridor passes (per. comm. Kolb 1994).

Section 3.3: Settlement Pattern and Expected Finds

Based on the summary of the historic land use and previous archaeological work presented above, a predictive model for the vicinity of the subject property can be proposed. This area of Kula was first utilized by small family groups cultivating isolated garden patches. As the population of the Hawaiian Islands increased the area became highly developed as an upland field system. This system incorporated permanent and seasonal habitation sites interspersed amongst agricultural features that generally conformed with the topography of the land. Included amongst the agricultural and residential sites were ritual features such as heiau and burials.

Because of the known disturbances to the area, a surface survey of lands in this region could expect to find only remnants of formerly more extensive agricultural features. Possible residential features that had escaped disturbance could be found in the form of isolated platforms or enclosures. Since most disturbances to the area occurred on the surface, the likelihood of extant subsurface deposits should be relatively high. Historic modifications to the landscape are also likely.

Section 4: Archaeological Methodology

Joseph Kennedy, M.A. was the Principal Investigator for the project. The field work was conducted on April 21 and 22, 1994 by Michael O'Shaughnessy B.A.. A pedestrian survey was conducted across one hundred percent of the property in a series of controlled (compass) sweeps. The sweeps were conducted parallel to the proposed corridor, generally oriented in northwest-southeast transects. Visibility was excellent and it is unlikely that cultural properties, if extant, were overlooked.

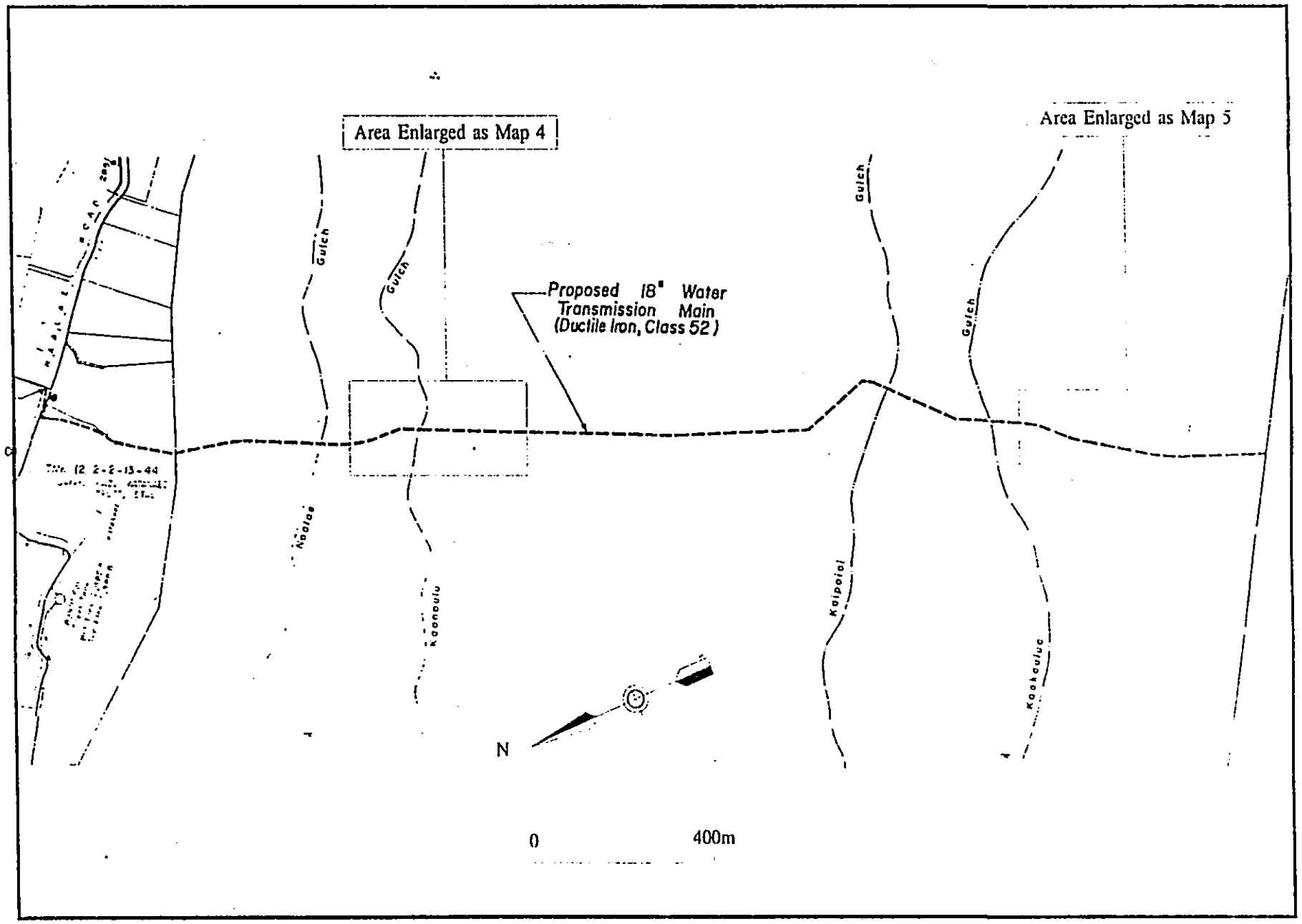
Section 5: Archaeological Findings

The surface survey identified eight sites (Sites 3542 through 3549) consisting of nine features lying within the 100ft wide corridor (see Maps 3, 4 and 5). Several of these sites are of historic ranching origins while others may be remnants of formerly more extant agricultural complexes.

Site 3542 - This site consists of a pair of adjacent platforms located in pasture lands south of Naalae Gulch (see Map 4).

Feature 3542:A is a square platform measuring approximately 10m on a side. It is located on the edge of a slope with its western side facing downslope. The structure

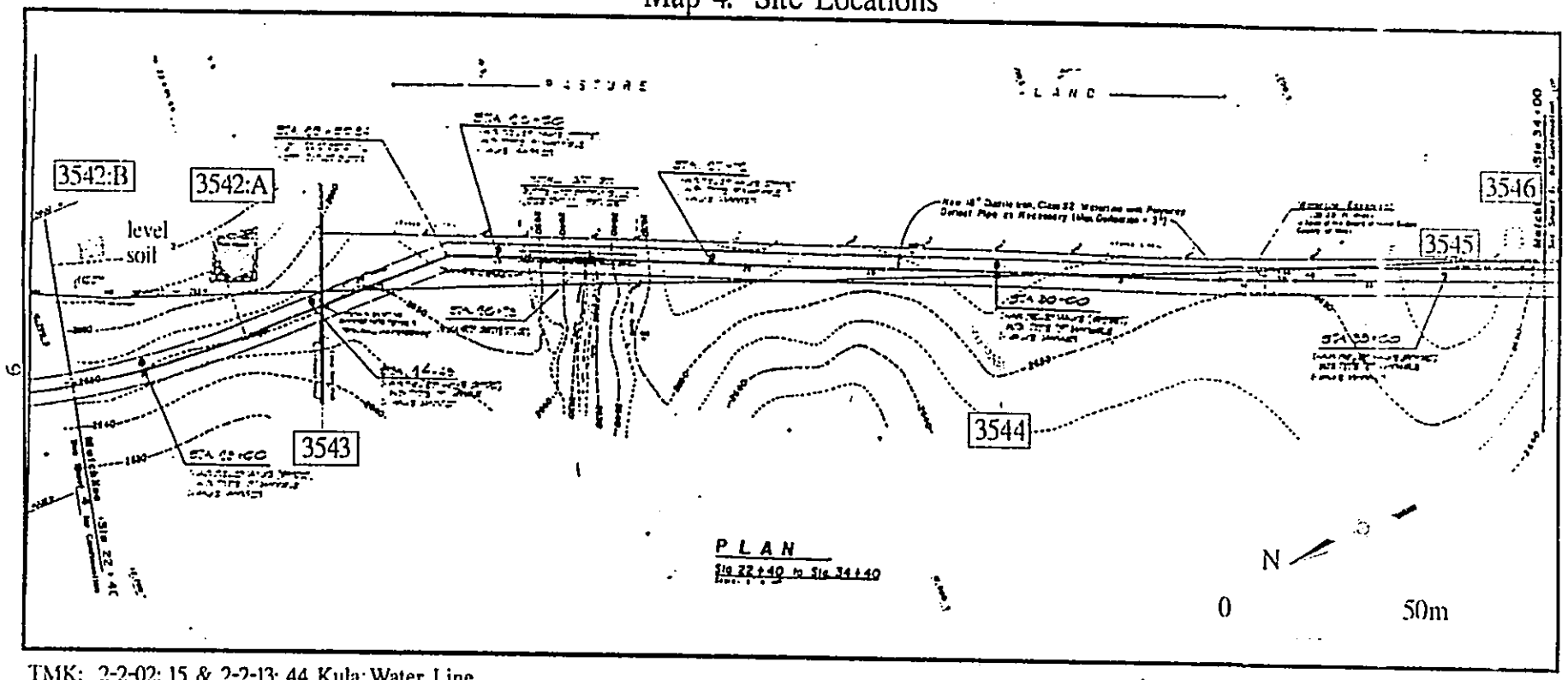
Map 3: Location of Enlarged Sections - Maps 4 and 5



TMK: 2-2-02: 15 & 2-2-13: 44 Kula Water Line

source: R.T. Tanaka, Inc., (Sheet 2) 1994

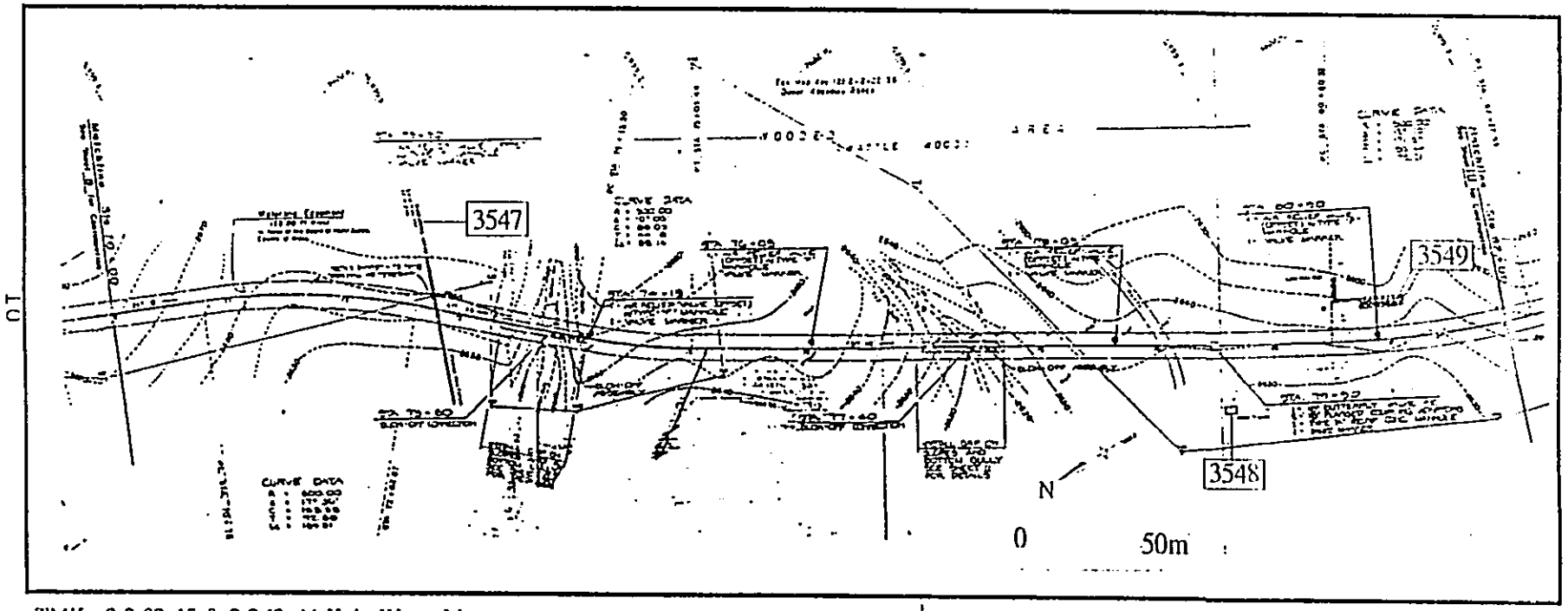
Map 4: Site Locations



TMK: 2-2-02: 15 & 2-2-13: 44 Kula Water Line

R.T. Tanaka Inc., (Sheet 5) 1994

Map 5: Site Locations



TMK: 2-2-02: 15 & 2-2-13: 44 Kula Water Line

source: R.T. Tanaka Inc., (Sheet 9) 1994

is constructed of walls of angular basalt stones from 15 to 55cm in diameter and has a level soil interior. The western, or downslope side stands 125cm above ground level (AGL) while the eastern side approaches ground level standing 10cm AGL. Both the northeastern corner and southern side are badly deteriorated. The platform is partially overgrown with lantana and panini and there is evidence of recent disturbance in the form of fresh cow manure.

Feature 3542:B is a smaller square platform measuring approximately 5m on a side. The structure is constructed of walls of angular basalt stones from 15 to 55cm in diameter and reaching up to one meter in width due to extensive deterioration caused by the movements of cattle. This feature has a gently sloping, soil filled interior with predominantly lantana cover.

These features are interpreted as remnants of a formerly more extensive complex, probably constructed prior to contact and subsequently partially destroyed by historic ranching activities. Prior to historic disturbances this complex would have consisted of scattered agricultural features with interspersed temporary or seasonal habitation features in which the presence of burials cannot be discounted. Because ACH was informed that the mitigation of possibly significant sites would entail the movement of the proposed line, no subsurface excavations were conducted.

Site 3543 - This site consists of a low rock wall with a barbed wire fence running its length. It is located in pasture lands south of Naalae Gulch (see Map 4). The wall runs east-west and measures approximately 105m in length with the subject corridor crossing about mid-way along the wall. It is constructed from angular basalt stones approximately 30cm in diameter and measures 50cm high by 25cm wide. This wall was likely constructed in the historic period for the control of grazing livestock.

Site 3544 - This site consists of a modified outcrop located in pasture lands approximately 100m south of Kaonoulu Gulch (see Map 4). The structure is located on a hillock of exposed bedrock immediately west of the fence line which parallels the corridor. The structure is formed by a single course alignment of boulders standing 50cm AGL. The alignment runs roughly east-west for a length of approximately 15m. This site is interpreted as an agricultural feature.

Site 3545 - This rough alignment of boulders is located in pasture lands approximately 200m south of Kaonoulu Gulch (see Map 4). The structure is formed by a single course alignment of boulders which stand 80cm AGL and extend for a length of approximately 3m reaching the existing fence line. This site is interpreted as an agricultural feature.

Site 3546 - This site consists of a roughly defined enclosure located in pasture lands located about 230m south of Kaonoulu Gulch (see Map 4). The structure measures approximately 5m square and the walls, while there are portions of each still intact, are mostly tumbled and scattered from the movements of cattle. The walls are constructed of angular basalt boulders standing up to 75cm AGL. This site may also represent the remnants of a formerly more extensive agricultural complex which has been destroyed by historic ranching activities.

Site 3547 - This site consists of a low rock wall with a barbed wire fence running its length. It is located in an area of wattle wood south of Kaakaulua Gulch (see Map 5). The wall runs southeast-northwest and measures approximately 130m in length with the subject corridor crossing its western end. It is constructed from angular basalt stones approximately 30cm in diameter and measures 25cm high by 25cm wide. This wall was likely constructed in the historic period for the control of grazing livestock.

Site 3548 - This site consists of a small, concrete water trough located in an area of wattle wood south of Kaakaulua Gulch (see Map 5). The trough measures approximately 3m long, 1m wide and stands 55cm AGL. This site was likely constructed in the historic period for the benefit of grazing livestock.

Site 3549 - This site consists of a deteriorated wall segment located immediately south of Site 3548 (see Map 5). The structure is constructed from angular basalt stones approximately 30cm in diameter. The wall stands two courses tall measuring approximately 45cm AGL and varies between 50 and 150cm wide. This site may also represent the remnants of a formerly more extensive agricultural complex which has been destroyed by historic ranching activities.

Section 6: Discussion

The one hundred percent, archaeological surface inventory survey conducted across the subject property identified two classes of sites. Several sites within the corridor can be attributed to historic ranching activities including Sites 3543, 3547 and 3548. The remainder of the sites (Sites 3542, 3544, 3545, 3546 and 3549) may represent remnants of the upland field system known to exist in the area at the time of contact (see Table 1).

Sites attributed to historic ranching consist of walls and a water trough. Sites 3543 and 3547 are constructed of low rock walls to which barbed wire fencing has been added. It is possible that these walls are also remnants of the former agricultural system which have been subsequentely

Table 1: Summary of Site Significance Evaluations

Site	Feature	Description	Function	Significance Evaluations Prior to IS	After IS
3542		Adjacent Platforms	Hab/Bur?	D and E(?)	D and E(?)
	A	Platform			
	B	Platform			
3543		Wall	Ag	D	NLS
3544		Modified Outcrop	Ag	D	NLS
3545		Rock Alignment	Ag	D	NLS
3546		Enclosure	Ag	D	NLS
3547		Wall	Ag	D	NLS
3548		Concrete Trough	Ag	D	NLS
3549		Wall	Ag	D	NLS

Code For Significance Evaluation Criteria

NS - Not Significant
NLS - No Longer Significant
A - Site Reflects Major Trends in History
B - Site is Associated with the Life of a Significant Person
C - Site is an Excellent Example of a Site Type
D - Site Likely to Yield Important Scientific Data
E - Site has Cultural Significance (heiau, shrine, burial, etc.)

note: IS = Inventory Survey
Hab = Habitation
Bur = Burial
Ag = Agricultural

modified for ranching. Site 3548 is a concrete water trough used to water livestock in the historic period. Each of these sites can be considered significant for their information content (Criterion D) but following the documentation of the current study are considered "no longer significant".

Of the sites thought to be remnants of the former field system, four (Sites 3544, 3545, 3546 and 3549) are simply rock walls or alignments which are ascribed an agricultural function. These sites can also be considered significant for their information content (Criterion D) and following the documentation of the current study are considered "no longer significant".

The remaining site (Sites 3542) may represent residential or burial features expected to be found interspersed amoung the agricultural features. Therefore, this site is considered significant under both criteria D and E (for its information content and due to its possible cultural significance, respectively). Because, prior to the surface survey, the mitigation of possibly significant sites was agreed to be avoidance through the re-alignment of the waterline corridor, no subsurface testing was conducted and the function of these sites has yet to be ascertained.

It is recommended that in order to mitigate the impact of waterline construction activities the corridor be re-aligned and a buffer zone be established to avoid Site 3542. A permanent buffer zone of 50ft should be established surrounding the site prior to construction.

Conclusion

An archaeological inventory surface survey was conducted on a 100 foot wide corridor for proposed water line passing through lower Kula. This survey identified eight significant historic sites whose functions were interpreted as agricultural and residential/burial(?). Feature types encountered include walls, platforms, an enclosure, an alignment of boulders, a modified outcrop, and a water trough.

Following consultations with Tanaka Engineers, Inc., it was decided that mitigation of the effects of pipeline construction on features encountered within the proposed corridor would take the form of altering the path of the pipeline in order to avoid features. Because sites were encountered of possible historic significance, it is recommended that the pipe line corridor be re-aligned to avoid Sites 3542 and 3546. Based upon the findings of this survey and dependent upon the mitigation procedures summarized above, Archaeological Consultants of Hawaii, Inc. recommends a finding of "no adverse effect" on significant archaeological sites located within the subject property

BIBLIOGRAPHY

Armstrong, R.W.

1983 Atlas of Hawaii (2nd edition). Honolulu: University of Hawaii Press.

Brown, Roderick S, and Alan E. Haun, with Helen W. Smith

1989 "Archaeological Inventory Survey Keokea and Waiohuli Subdivisions". Prepared for the Department of Hawaiian Homelands by PHRI. Manuscript on file at the *DLNR-SHPD*.

Foote, D. E., E. L. Hill, S. Nakamura, and F. Stephens

1972 Soil Survey of the Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. U.S. Dept. of Agriculture - Soil Conservation Service and University of Hawaii Agricultural Experiment Station. Washington, D.C., Government Printing Office.

Kirch, Patrick

1985 Feathered Gods and Fishhooks. Honolulu: University of Hawaii Press.

Kolb, Michael J.

1994 "Ritual Activity and Chiefly Economy at an Upland Religious Site on Maui, Hawaii". Journal of Field Archaeology. Vol. 21, Number 3.

Land Board (Board of Commissioners to Quiet Land Titles)

1846-1855 Native and Foreign Registers; Native and Foreign Testimonies; Award Books. Archives of Hawaii.

Pukui, M.K., S. H. Elbert, and E.T. Mookini

1974 Place Names of Hawaii. Honolulu: University of Hawaii Press.

Spriggs, M.T., and P.L. Tanaka

1988 Na Nea "Imi Ka Wa Kahiko: An Annotated Bibliography of Hawaiian Archaeology. Asian and Pacific Archaeology Series II. Social Science Research Institute, University of Hawaii at Manoa.

Thrum, T.G.

1907 "Heiau and Heiau Sites Throughout the Hawaiian Islands". Hawaiian Annual and Almanac for 1907. T.G. Thrum. Honolulu.

1908 "Heiaus and Heiau Sites Throughout the Hawaiian Islands". Hawaiian Annual and Almanac for 1908. T.G. Thrum. Honolulu.