GEOTECHNICAL REPORT

ASPA21.022.WATER - Professional (A&E) Services for the Design and Permitting of Asbestos Cement Pipe Replacement and Water System Upgrade Project from Leloaloa to Aua

Contents

Executive Summary

This geotechnical evaluation has been undertaken by Martam Consulting Corporation through engagement by the American Samoa Power Authority to provide engineering design services for the replacement of asbestos cement pipe from Leloaloa to Aua.

The existing AC pipes are brittle and have been leaking excessively over the years and contributing to ASPA's high non-revenue water problem. High leaks in the system also causes water supply and low-pressure problems in the Aua area and impacts on the central system's water supply going towards the east side of Tutuila Island. Replacing these AC pipes will significantly improve the water pressure in the project area and protect drinking water from contaminant intrusion into the system.

10300 lineal feet of trenching work to an average depth of 4 ~ 4.5 ft will be undertaken for this project from the end of Starkist in Atu'u to the Aua Water Supply Tank above Aua village. For the Geotechnical evaluation 7 Test Pits were dug to ground water and to a maximum of 8ft if ground water was not encountered with the following findings and recommendations:

Atu'u to Aua

- The general depth of the replacement pipe will be in the silty CLAY layers of the trench.
- Rock breaking requirement from St. Theresa to just before where the Aua Fautasi is housed ~ 1800 LF. (600cy).
- Dewatering will be required for Utility Crossings, including trench shields.
- Aua 3 Corner to the Bridge Crossing
- The soil profile indicates predominantly silty clay with cobbles which provides natural side wall stability.
- Trenching should be carried out at low tide and dewatering of groundwater will be required.
- Dewatering will be required for Utility Crossings, including trench shields.

Aua Inland Village Ring Road

- The general depth will be in silty Clay with cobbles along Aua inland village ring road. HFO (Heavy Fuel Oil) was encountered in the test pits.
- All soils contaminated with HFO should be removed and treated offsite. Absolutely no soils containing HFO should be used for backfilling.
- The USACE should be consulted for remediation of this area before waterlines are constructed here.
- An oil separator is to be used during dewatering. Oil skimming should be carried out on the groundwater to remove any free product floating on the surface before dewatering commences.
- Rock breaking is not required for this section of trenchwork.
- Dewatering will be required for Utility Crossings, including trench shields.

Afono Pass

- The soils in this area are generally silty clay loam with boulders, Trenches can be excavated with a standard excavator bucket.
- The first 350LF heading up the hill is likely to have HFO contamination and the USACE should be consulted for remediation before waterlines are installed.
- No rock breaking is required along this section of line.
- Dewatering may be required for Utility Crossings, including trench shields.

Introduction

The project is located, in the Samoan archipelago volcanic chain, in the island of Tutuila, American Samoa. The Aua network defined by the scope of this project, starts from the end of Starkist Cannery in Atu'u to the bridge along Route 1 located in Aua at the project's East boundary. The project also heads into the Aua village along the Aua inland ring road, heading up along the Afono pass to the Aua reservoir tank.

Approximately 7300 lineal feet of trenching will be undertaken for an 8-inch PVCO pipeline installation from Leloaloa to Aua bridge and 3000 lineal feet of 12-inch PVCO pipeline from Aua 3 corner to the Aua Reservoir Tank. A 750 lineal foot trench will also be excavated to accommodate a 6-inch PVCO transmission line from the Well 97 Pump Station in Aua to the Aua Reservoir Tank (refer to figure 3).

The geotechnical investigation is made up of 7 Test Pits excavated to groundwater level or to a maximum of 8ft if groundwater is not encountered. Test pits are analyzed for soil profiles and groundwater characteristics.

Construction considerations have been recommended based on the findings from the Test pit evaluations.

Project Description

The project site is along the Route 1 main arterial road, from the end of the Starkist Tuna cannery processing plant in Atu'u village, through Leloaloa village to Aua village, where it then diverts inland along the Afono Pass Road to a water supply reservoir on a ridge above the main Aua village. The underlying soils specific to the project area are predominantly Beach Sand and Alluvium formed in colluvium and alluvium derived from material weathered from basic igneous rock, with lesser influences of the Pago Volcanic Series (refer to figure 1).

The elevation is near sea level from Atu'u to Aua and then rising to about 175 feet along the Afono pass road to the Aua Tank.

The intended pipe replacement work is located within the road pavement and road reserve with service laterals extending out to households in the surrounding villages.

The geotechnical evaluation, analyzes subsurface areas along the proposed collection system route and presents the findings as follows:

1. Presence of rock (bedrock)

2. Presence of groundwater
3. Geotechnical profile logs
4. Assess impacts of analysis on design, construction and operation and maintenance
5. Incorporation of geotechnical considerations into a construction cost estimate.

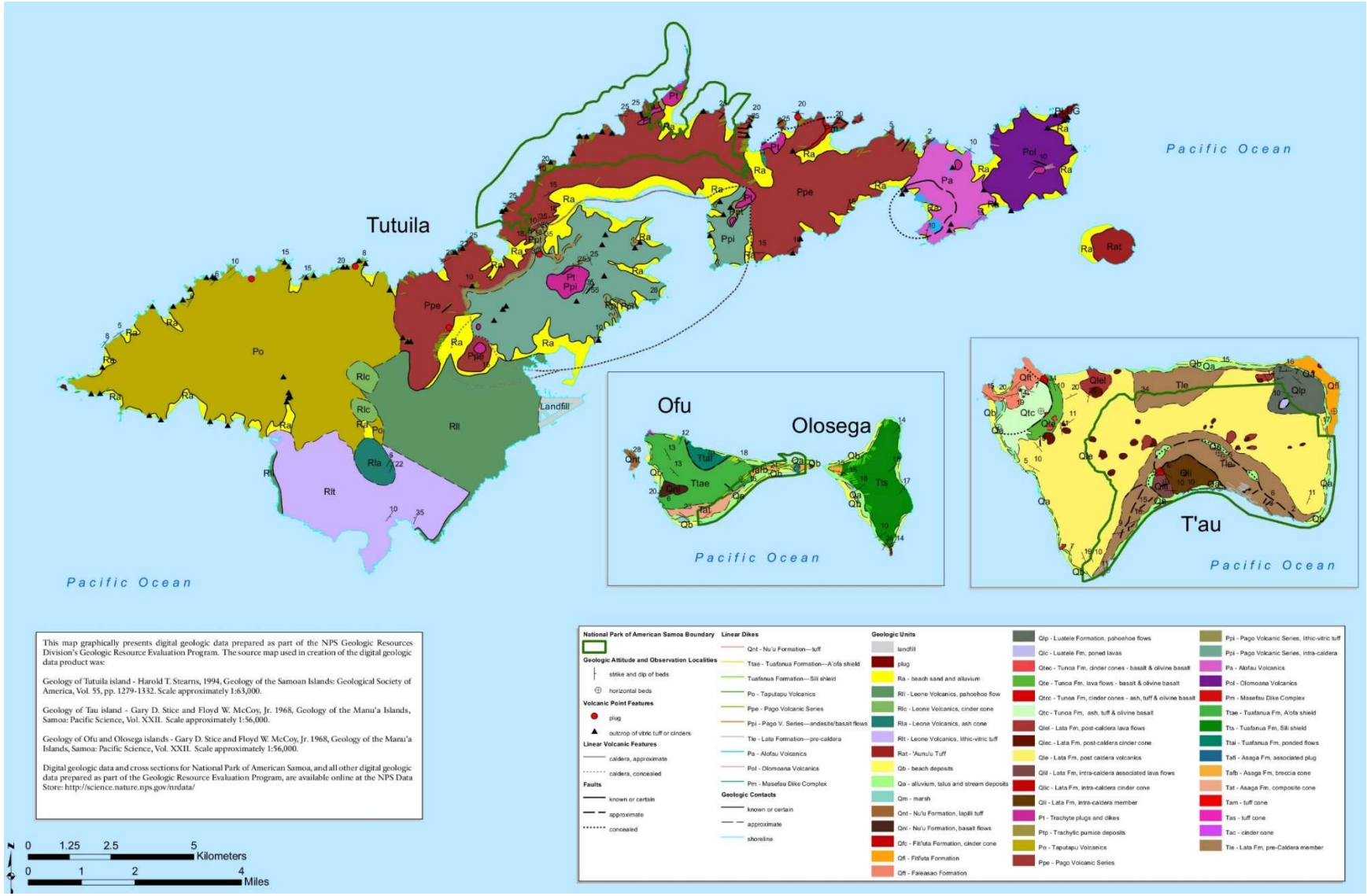


Figure 1: American Samoa Volcanics

Project Site Location

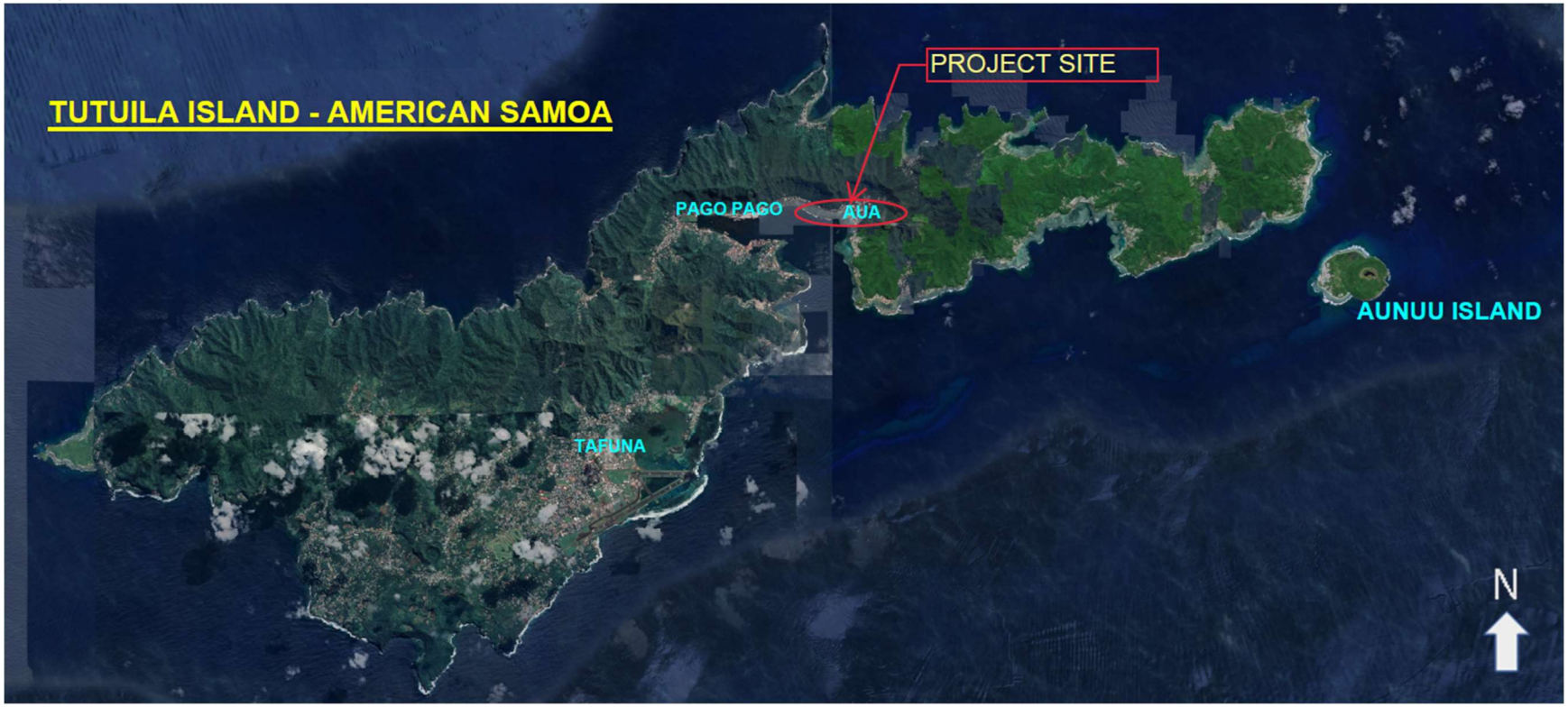


Figure 2: Site Location

Field Exploration and Testing

From the western side of Leloaloa, the ground elevation was between 8.5 to 9.5ft and then from the eastern end of Leloaloa, gently sloped down to just under 5ft into Aua village along the main road. From Aua 3 corner heading inland along the Aua ring road, the grade increases steadily. At the 3-corner intersection along the Afono Pass Road there was a steep increase in grade all the way heading up to the Aua Reservoir Tank.

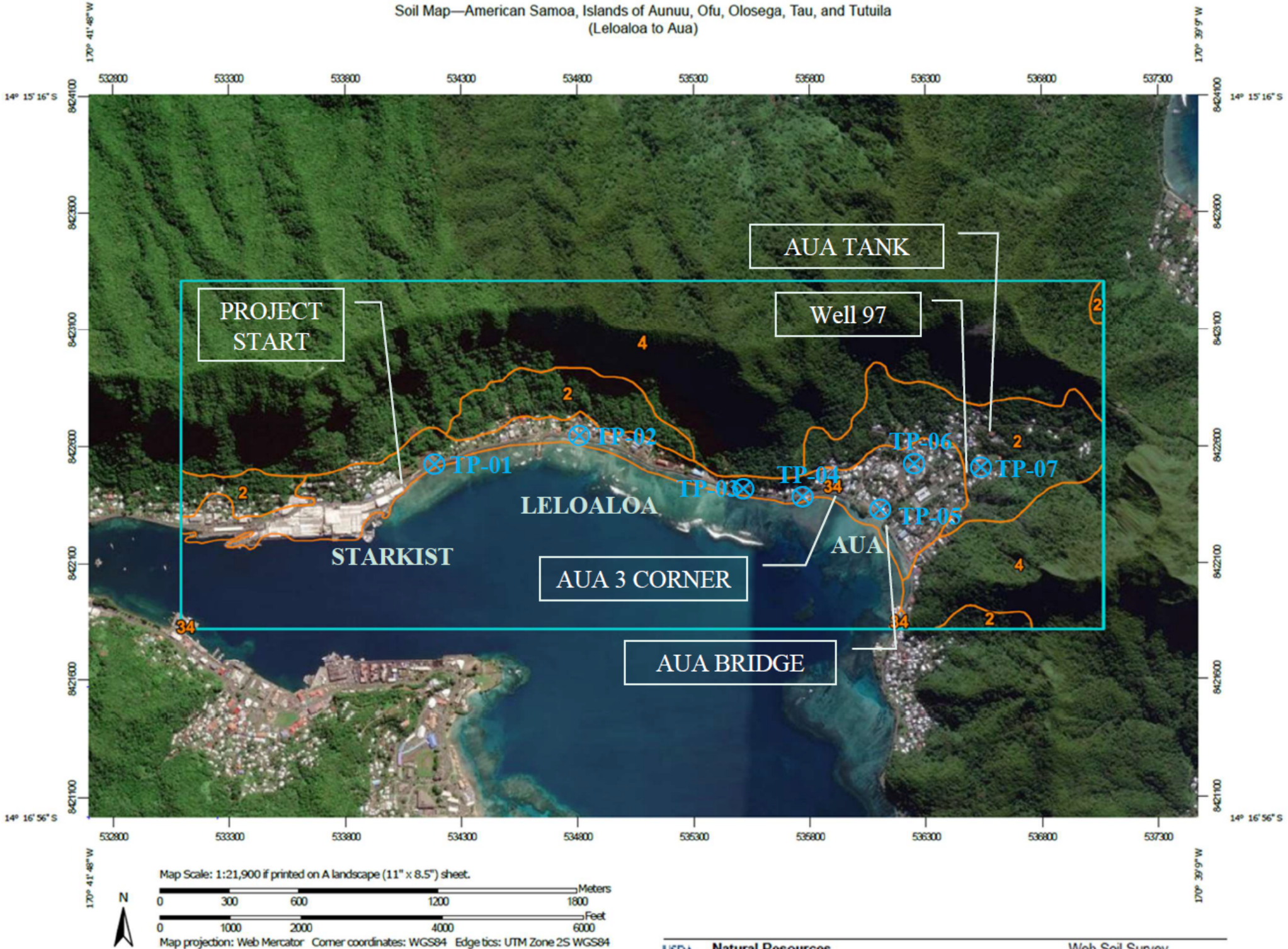
Most of the pipe replacement work will be carried out in the asphalt/concrete roadway or road reserve. The road reserve is typically less than 5ft wide and consist of a combination of grassed areas or concrete sidewalks and have been previously excavated for drainage culverts and utilities.

From geological surveys undertaken by the USDA – Natural Resources Conservation Services, soils for the project site are typically, 'Urban Land-Aua-Leafu Complex' along the entire length of the main road and heading into the main village. Along the Afono Pass Road, including the Aua reservoir tank, soils in this area are underlain by 'Aua very stony silty clay loam' (Refer to figure 3).

Seven test pits were excavated in the vicinity of the proposed replacement pipe alignment from Leloaloa to the bridge crossing in Aua and along the Afono Pass Road heading to the Aua water reservoir tank (Refer to fig 3).

The test pits were advanced from ground surface to the groundwater level or continued to a maximum of 8ft deep if groundwater was not encountered. Soil profiles were taken for each pit noting the depth of layer, soil type and soil consistency. Groundwater levels and inflow rates were also noted. Test pit logs with detailed descriptions of soil characteristics are included in the 'Test Pit Logs' section of this report.

Test Pit ID	Location		Ground level	Total Depth
	Latitude	Longitude	MSL	Ft.
TP 1	258576.001	309288.049	8.57	6.0
TP 2	260706.089	309711.828	8.85	6.0
TP 3	262899.773	308975.868	9.65	8.0
TP 4	263276.472	308906.047	8.87	8.0
TP 5	264804.970	308702.467	5.13	5.0
TP 6	265295.042	309361.438	17.97	6.0
TP 7	266213.964	309327.649	62.25	7.0
Note: Datum - AS1962				


Soil Map—American Samoa, Islands of Aunuu, Ofu, Olosega, Tau, and Tutuila
(Leloaloa to Aua)
AUA TANK
PROJECT START
Well 97
TP-01
TP-02
TP-03
TP-04
TP-05
TP-06
TP-07
LELOALOA
STARKIST
AUA
AUA 3 CORNER
AUA BRIDGE
Map Scale: 1:21,900 if printed on A landscape (11" x 8.5") sheet.
Meters
0 300 600 1200 1800
Feet
0 1000 2000 4000 6000
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 2S WGS84
Natural Resources Conservation Service
Web Soil Survey
National Cooperative Soil Survey

Soil Map—American Samoa, Islands of Aunuu, Ofu, Olosega, Tau, and Tutuila
(Leloaloa to Aua)

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: American Samoa, Islands of Aunuu, Ofu, Olosega, Tau, and Tutuila
Survey Area Data: Version 7, Aug 30, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 30, 2018—Jul 27, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

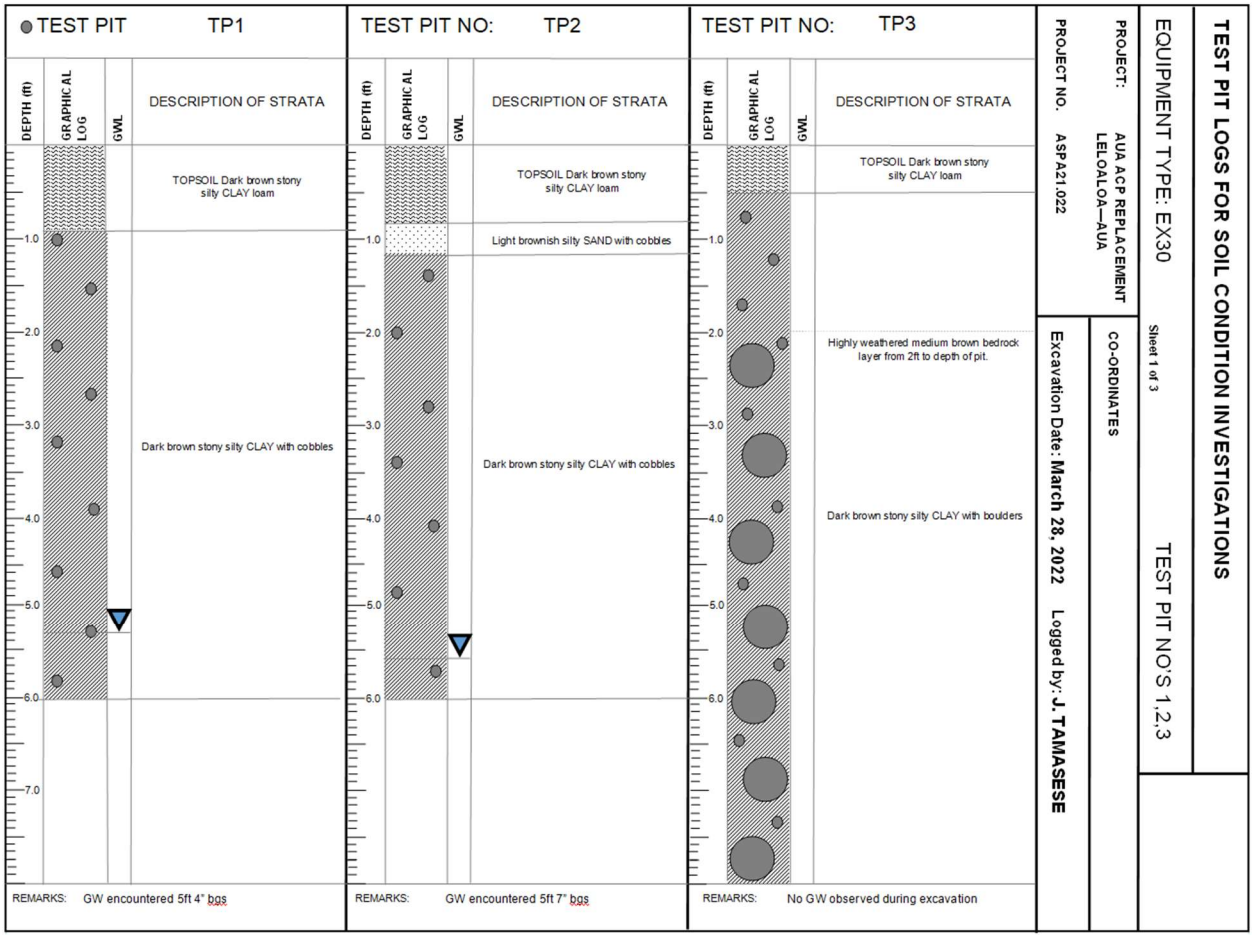
USDA **Natural Resources Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
2	Aua very stony silty clay loam, 30 to 60 percent slopes	180.8	12.3%
4	Fagasa family-Lithic Hapludolls-Rock outcrop association, very steep	703.3	47.9%
34	Urban land-Aua-Leafu complex, 0 to 30 percent slopes	148.6	10.1%
Totals for Area of Interest		**1,469.6**	**100.0%**

Test Pit Logs



TEST PIT LOGS FOR SOIL CONDITION INVESTIGATIONS

EQUIPMENT TYPE: EX30 — TEST PIT NO'S 4,5,6 — Sheet 2 of 3

PROJECT: AUA ACP REPLACEMENT LELOALOA—AUA

PROJECT NO. ASPA21.022 — CO-ORDINATES

Excavation Date: March 28, 2022 — Logged by: J. TAMASESE

TEST PIT NO: TP4

DEPTH (m)	GRAPHICAL LOG	GWL	DESCRIPTION OF STRATA
0.0 – 1.0			TOPSOIL Dark brown stony silty CLAY loam with cobbles
1.0 – 2.0			Light brown silty SAND with cobbles
2.0 – 7.0		▼	Dark brown stony silty CLAY with cobbles

REMARKS: GW encountered @ 7ft 6" bgs

TEST PIT NO: TP5

DEPTH (m)	GRAPHICAL LOG	GWL	DESCRIPTION OF STRATA
0.0 – 1.0			Light brownish yellow silty SAND
1.0 – 2.0			Dark brown stony silty CLAY with cobbles
2.0 – 3.0			Grey silty coral SAND
3.0 – 6.0		▼	Dark brown stony silty CLAY with cobbles

REMARKS: GW encountered @ 4ft 2" bgs

TEST PIT NO: TP6

DEPTH (m)	GRAPHICAL LOG	GWL	DESCRIPTION OF STRATA
0.0 – 1.0			TOPSOIL Dark brown stony silty CLAY loam
1.0 – 6.0		▼	Dark brown stony silty CLAY with cobbles

REMARKS: GW encountered @ 5ft 10" bgs, HFO (Heavy fuel oil) encountered from 4ft to GW

TEST PIT LOGS FOR SOIL CONDITION INVESTIGATIONS

EQUIPMENT TYPE: EX30 — TEST PIT NO'S - 7 — Sheet 3 of 3

PROJECT: AUA ACP REPLACEMENT LELOALOA—AUA

PROJECT NO. ASPA21.022 — CO-ORDINATES

Excavation date: **March 28, 2022** Logged by: **J. TAMASESE**

TEST PIT NO: TP7

DEPTH (m)	GRAPHICAL LOG	GWL	DESCRIPTION OF STRATA
0			TOPSOIL Dark brown stony silty Clay loam
1.0			
2.0			Dark brown silty Clay with cobbles
3.0			
4.0			Cobbles increasing in size with depth
5.0			
6.0			
7.0			

REMARKS: No GW observed during excavation

TEST PIT NO:

DEPTH (m)	GRAPHICAL LOG	GWL	DESCRIPTION OF STRATA
0			
1.0			
2.0			
3.0			
4.0			
5.0			
6.0			

REMARKS: No GW observed during excavation

TEST PIT NO:

DEPTH (m)	GRAPHICAL LOG	GWL	DESCRIPTION OF STRATA
0			
1.0			
2.0			
3.0			
4.0			
5.0			
6.0			

REMARKS: No GW observed during excavation

Analysis of Test Results

Soil Profiles

- From Leloaloa to Aua, topsoil's were mostly a stony silty CLAY loam, friable, moist and slightly plastic.
- Below the topsoil layer soils were typically a ~6 inch sand layer. As the pits progressed deeper the soils were generally dark brown stony silty Clay with cobbles, moist and very plastic.
- Test Pit 3, located on the eastern side of Leloaloa encountered highly weathered igneous bed rock at about 2ft deep. During the excavation the rock generally crumbled into cobbles and boulders and was intermingled with the dark brown silty clays which were moist and very plastic.
- 200 ft east of this area, in Test Pit 4 the soil profiles were the same as those of Western Leloaloa.
- From the end of Leloaloa heading east to the bridge the land sloped gently to much lower elevations and the topsoil was a light brownish yellow beach sand ~6 inches deep, followed by silty Clay with cobbles to depth.
- Heading into Aua and along the gradually increasing grade along the ring road, topsoil was generally ~10-inch stony silty CLAY loam, friable and moist. Below the topsoil the profile changed to silty Clay Loam with cobbles. At Test Pit 6, HFO (Heavy Fuel Oil) was encountered at about 4 ft deep and all the way to the GW at a depth 5ft,10 inches, where free product was floating on the surface.
- Along the Afono Pass Road heading to the tank, the topsoil had been disturbed by previous excavation works for the Phase 2 sewer line project constructed by Fletcher. The soils in this area were consistent with the USDA category 2, Aua very stony silty clay loam from the surface to depth. The soils were very stony silty Clay loam with cobbles. Boulders were encountered from just under 2ft, however were easily removed by the excavator.

Ground Water Profiles

- Groundwater was encountered at depths just over 5ft on the western side of Leloaloa with a low infiltration rate. On the central side of Leloaloa the ground elevation was higher and there was no presence of groundwater encountered up to depths of 8ft. On the very eastern side of Leloaloa, groundwater was encountered at just under 8ft with a low inflow rate.
- Approaching Aua village the ground level is much lower and ground water was encountered at 4ft, 6" bgs in Test pit 5, inflow was moderate, however the pit sidewalls were still stable due to being compact silty Clay with cobbles.
- Heading into Aua village the ground elevation was much higher, steadily rising from 15ft to 20ft before steeply inclining on the Afono pass road to 175ft at the level of the Aua tank. No ground water was observed in these areas.

Environmental Considerations

- HFO (Heavy Fuel Oil) was encountered in Test Pit 6 along with an old 12" Spiral Iron conveyance pipe 2ft from the test pit location. The oil is believed to have leached from oil tanks that were a part of an old Tank Farm that were decommissioned, collapsed in-situ and buried over in 1948. Unfortunately, they were not properly drained of their contents at the time.

- The US Army Core of Engineers (USACE) has been involved in a number of past and ongoing remediation projects to have the HFO removed from the soil. It would be advisable to collaborate with the USACE on the remediation of this area before the pipes are installed. The affected area is from the Sky Lodge Store to the end of the Aua School (~1000LF), and from the 3-corner intersection at the top of the Aua ring road heading up the Afono Pass hill passed the first residence on the right (~350 LF).

Conclusions

Atu'u to Aua

The general depth of the replacement pipe will be in the silty CLAY layers of the trench. From St Theresa Compound to the end of Leloaloa there is an outcrop of igneous bedrock that is highly weathered and breaks into cobbles and boulders when using the excavator. There is still a potential need for rock breaking in this area and a contingency for rock breaking should be included as part of the construction scope of work.

Rock breaking requirement from St. Theresa to just before where the Aua Fautasi is housed ~ 1800 LF. (600cy).

Ground water levels are generally in the lower regions of the pit depth and rates of infiltration are also low. Dewatering will be required for Utility Crossings, including trench shields.

Aua 3 Corner to the Bridge Crossing

This area is at a much lower elevation than the other areas of the project, however, the soil profile indicates predominantly silty clay with cobbles which provides natural side wall stability.

Trenching should be carried out at low tide and dewatering will be required if trenches are to go beyond 4.5 to 5 feet. Trench shields are not required at the depths needed for pipe laying, however, will be required at Utility Crossings.

Aua Inland Village Ring Road

The general depth will be in silty Clay with cobbles along Aua inland village ring road. HFO (Heavy Fuel Oil) was encountered in the test pits. All soils contaminated with HFO should be removed and treated offsite. Absolutely no soils containing HFO should be used for backfilling.

The USACE should be consulted for remediation of this area before waterlines are constructed here.

Trenches should be kept to the minimum depth possible to avoid the requirement for dewatering where HFO is encountered. If, however, dewatering is required, an oil separator is to be used for treatment. Oil skimming should be carried out on the groundwater to remove any free product floating on the surface before dewatering commences.

Rock breaking is not required for this section of trenchwork.

Dewatering will be required for Utility Crossings, including trench shields

Afono Pass

The soils in this area are generally silty clay loam with boulders, Trenches can be excavated with a standard excavator bucket.

The first 350LF heading up the hill is likely to have HFO contamination and the USACE should be consulted for remediation before waterlines are installed.

No rock breaking is required along this section of line. Dewatering may be required for Utility Crossings, including trench shields.

References

Geology of Tutuila Island – Harold T. Stearns, 1994, Geology of the Samoan Islands: Geological Society of America, Vol. 55, pp. 1279-1332. Scale approximately 1:63,000

US Department of Agriculture n.d. Natural Resources Conservation Service, US Department of Agriculture, Web Soil Survey official website, viewed 21 September 2022, <https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx>