

# WATANA AIRSTRIP FEASIBILITY STUDY PHASE I

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FOR THE SUSITNA HYDROELECTRIC PROJECT

> SUBMITTED TO ALASKA POWER AUTHORITY

> > APRIL 1983

HARZA-EBASCO SUSITNA JOINT VENTURE

## WATANA AIRSTRIP FEASIBILITY STUDY

## PHASE I

PAGE

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# WATANA AIRSTRIP FEASIBILITY STUDY

## PHASE I

#### A. INTRODUCTION

During the performance of exploration activities associated with the FY 83 Winter Geotechnical Program, it became apparent that a fixed-wing airstrip at the Watana Camp Site could significantly cut the logistical costs of site programs.

In accordance with Alaska Power Authority guidance and direction, culminating with a meeting on March 19, 1983, a two-phase Watana Airport Study Plan was proposed and approved for implementation.

The basic scope of the Phase I Feasibility Study presented in this report was to determine the cost benefits of constructing an airstrip at the Watana Site this summer. The cost benefit analyses were performed by evaluating permitting, site specific soils conditions of the upper materials along the proposed airstrip centerline, airstrip usage and economics.

Based upon APA review and concurrence with the Phase I Feasibility conclusions and recommendations, as stated herein, the scope of Phase II of the study will include planning and preparation activities.

Planning activities will encompass an in depth field study of topography and drainage, equipment mobilization plans and schedules, detailed preparation of cost estimates and the filing of required permit applications.

Preparation activities will encompass the development of a contract package, provide preparation management, cost and schedule control, quality control and the development of a set of as-built drawings and details. Keeping these goals in mind, the conclusions and recommenda+ions of the Task 39 Study Team now follow.

## B. CONCLUSIONS AND RECOMMENDATIONS

As a result of the performance of the Feasibility Study discussed herein, the following conclusions and recommendations have been reached:

## CONCLUSIONS

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CALCULATION FOR

- The construction of a temporary airstrip at the Watana Camp this s umer is both feasible and cost effective.
- 2. The topography at the Watana site in the vicinity of the proposed sirstrip naturally favors a 2,500 foot long runway with expansion potential to 4,000 feet and 6,000 feet lengths requiring additional earthwork activity.
- 3. The natural existing foundation materials are silty sande with small amounts of gravel overlain by a thin section of peat and organics.
- 4. Due to the high silt content of the structural foundation materials, these materials are classified as poorly draining. This property of the foundation has been heavily considered in the planning, preparation and maintanence of the airstrip.

5. Two types of airstrips have been proposed; a winter strip and a year round strip. Both strips will require the mobilization of additional equipment to the site.

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The winter strip is a 2,500 foot long runway without surfacing. The use of the airstrip will be limited to periods when the foundation materials remain frozen (possibly November to May) and will require the strategic location of snow fences and large quantities of grader maintenance during periods of breakup and freeze. The total order of magnitude cost estimate for this strip is \$200,000 and it will take approximately one month to prepare.

The year round strip places a stabilized soil surfacing on top of the proposed winter strip for a total order of magnitude cost of \$400,000 and an additional 20 days of preparation.

6. Results of the economic analyses indicate that the cost of airstrip preparation can be offset in total through savings in fixed-wing support to site activities. Considering an active two season site exploration program and strategically planned fuel hauls;

- a) The winter strip will fully pay for itself after
   11 months of use, with a potential savings o:
   \$275,000 each year, thereafter. The winter strip
   will require a significantly greater amount of
   maintenance than the surfaced, year round strip.
- b) The year round strip will pay for itself after 17 months of use, wi\*h a potential savings of \$360,000 per year, thereafter.

It has therefore been concluded that the year round surfaced strip affords the greatest savings per year of operation after break even, and provides the highest degree of reliability of the cases evaluated.

## RECOMMENDATIONS

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1. As a result of the above stated conclusions, and taking into consideration budgetary restrictions for the upcoming FY 84, it is the Joint Venture's recommendation to proceed with the preparation of a wincer strip this summer in July, 1983. Next year with the advent and start up of an active summer exploration program, the stabilized soil surfacing could be installed on the winter strip prior to peak demand on the airstrip.

By advocating this two stop preparation scheme, partial benefits will be realized during the first half of FY 84, with full benefits during the second half of the FY 84.

 Following this approach, after formal Alaska Power Authority review and approval of the Feasibility Results, the Phase II - Planning and Preparation Activities will begin.

The Phase II Activitiy will be divided into two subtasks. The first subtask will include planning activities such as a detailed field topographic study, the development of a mobilization plan and schedule, a detailed preparation cost estimate and permit application. The second subtask will include preparation activities such as the development of a contract package of preparation details, preparation management, schedule and cost control, quality control and the development of a package of as built details.

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The estimated cost of providing the planning subtask activity described above is \$42,000, with a work duration of approximately 3 weeks. During this time, the estimated cost and schedule for the actual airstrip preparation will be developed.

As stated before, preparation activities can not begin until all required permits and authorizations are granted.

#### C. PERMITTING

A feasibility permitting review was performed on the proposed airstrip in Section 27 (28), T 32N, R5E, SM. Included in this review were requirements for permits, approvals, and land use authorizations. The results of this review are presented in Table A.

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In reviewing each of the eleven authorizations presented in the table, attention mus: be given to Authorization No. 7, Corp of Engineers Section 404 Permit, to discharge dredge or fill materials to wetlands.

The requirements of this permit application are directly dependent upon the results of Authorization No. 6, Wetland Determination by the Corp. To minimize possible delays in preparation, due to the estimated minimum 90 day approval cycle, the Joint Venture will implement a request for Authorization No. 6 as soon as Phase II Activities are approved by the Alaska Power Authority.

#### D. SITE INVESTIGATIONS

As part of the Phase I Feasibility Study, a site investigation was renformed to determine soil properties and foundation requirements, borrow material sources along the proposed airstrip alignment, bearing capacity, drainage, preparation equipment requirements, and schedules of preparation costs.

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This section of the report presents the results of the site investigation and laboratory testing program completed in early April 1983 at the Watana Camp Site as they relate to the conceptual planning activities for the proposed airstrip. It is .ot the detailed plan that is required for preparation of the airstrip. The detailed plan for the airstrip will be developed in Phase II of the program upon review and approval of this report. A temporary airstrip of 2500 feet will be the emphasis of this report with mention of extending the airstrip length to 4,000 and 6,000 feet is deemed necessary.

The airstrip location is as described by R & M Consultants in their October 1980 report, attached a. Appendix A. This location has been chosen based on prevailing wind data that has been collected at the Watana Site. The prevailing winds are out of the northeast such that an orientation of north  $60^{\circ}$  east will provide good wind coverage under most weather conditions.

The airstrip is located on Cook Inlet native corporations land [Section 27 (28), T32N, R5E, S.M.] rather than BLM land for the purpose of reducing the permit requirements. The natural topography in the general vicinity of the airstrip is relatively flat thus providing a site with a potential for the preparation of a cost efficient airstrip.

Presented below is a discussion on the site investigation and laboratory testing programs:

## 1. SCLLS INVESTIGATION

The soils investigation of the airstrip was accomplished in conjunction with the Winter Geotechnical Program. The winter investigation avoided excessive cost and ground disturbance that would have occured if a spring (break-up) program was implemented. The drill rig used was a Mobile 24 mounted on a self-propelled flex track rig. A four inch drill bit was attached to a 3 3/4" continuous flight auger, thus providing a means of sample recovery and field determination of soil identification.

A total of fifty-five auger holes were drilled along the airstrip alignment to an average depth of five feet, as shown in Figure No. 1. The Boring Logs of these holes are presented in Appendix B. The flight auger procedure of drilling provided a very disturbed sample, affecting identification and classification, and is limited to recovering material no greater than 1' - 1 1/2" in size.

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Samples were recovered and placed in plastic bags for laboratory identification, sealed in jars for moisture content, and saved in cloth bags for proctor compaction testing later on.

The soil boring results of the drill program, as shown in Figures 2 and 3, have determined that an organic scil layer of 0-2 feet in depth covers most of the airstrip. An area of deep organics is located just north of centerline at station 36+00; and a very wet and deep organic area is located between station 41+50 and station 47+00. A minor pocket of frozen ground was located just north of station 36+00 at a depth of 3-5 feet.

Underlying the organic material is a silty sand material with small amounts of gravel. This material will be the airstrip structural foundation material.

Figure 2 shows the main strip boring profile along the centerline of the airstrip along with the true scale ground elevation exhibiting the natural slope. For the sake of presenting detailed boring log data, this profile and others, have been exaggerated in scale.

The airstrip has been divided into three main segments. The main strip is 2,500 feet long with the possibility of expansions to the east and west of 1,500 feet and 2,000 feet, respectively. The main strip is differentiated from the east and west extensions by major topographic features. Each of the three airstrip segments requires relatively small amounts of earthwork if treated by itself, but when combined into a single strip, major earthwork will be required at each end of the 2,500 foot strip. Thus, for the present time, considering camploading and budget, emphasis will be placed on the initial strip only.

The centerline grade of the proposed strip shown on Figure 2 has been held as close to 2 % as possible to utilize natural topography, remove unstable materials as ' to minimize out and fill quantities. Profile "D-D" shows the depth and limits of peat 75 feet north of the runway between station 34+00 and 37+00. A minimum of two feet of the peat will be removed. A stabilizing fabric will be placed over the completed excavation and natural silty sands backfill will be placed to grade.

Figure 3 shows the soil profile for the east and west extension of the initial main airstrip. The west extension may be used to increase the runway to a total length of 4,000 feet and the east extension in combination with the west extension can increase the runway length to the total length of to 6,000 feet. The west extension will require regrading of the initial temporary airstrip when prepared The east extension will require substantial earthwork and engineering activities due to topography and foundation conditions. This area has a 500 foot long section of runway that is very wet and consists of peat to depths of five feet. Below the peat is a wet and soft silty sand. Large earthmoving equipment and a borrow source for sand and gravel will be required for extending the airstrip to 6,000 feet through this area.

## LABORATORY TESTING

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Laboratory testing was performed by Harding-Lawson and Associates personnel located at the Watana Site soil laboratory and in the Anchorage laboratory. The types of tests performed were sieve analysis, moisture content, specific gravity, Atterberg limits, minus 200 wash sieves, organic content, hydrometer analysis, proctor compaction and soil stabilization tests. The results of all tests (excluding the soil stabilization program, are summarized in Table 2 and presented in Appendix C.

The results of the sieve analysis tests indicate that the typical natural existing soil, to be used in the preparation of the airstrip, is a silty sand with a small amounts of gravel. Generally there is 50% sand with 30-40% silt and 5-20% gravel. The gravel is subangular and subrounded. Figure 4 shows a group of gradation curves compiled from typical samples. The material is classified as SM under the Unified Soil Classification System.

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Moisture contents were performed on samples at various depths and locations. Generally, the soils within four feet of the surface have moisture contents of 15-20% and the lower soils have moisture contents of 8 to 12%. Specific gravity tests were performed with the results ranging between 2.72 and 2.75, the general range for soils with this classification.

Due to the high sand content in most of the samples only three Atterberg limit tests were performed. The samples were located in the area of the west extension. The results of the tests indicate soils with low plasticity. All other samples from the foundation examined were found to be nonplastic. As an extension of the sieve analysis and Atterberg limit data, hydrometer tests were performed. These tests indicate that the clay content of the fines portion of the samples tested is generally less than 5%. As an additional means of determining the amount of fines in the samples, minus 200 sieve tests were performed. This test gave quick results for several soil samples.

Organic content tests were performed to evaluate the heavy organic content of the top layer. Proctor compaction tests were performed at various locations along the airstrip. The results indicated a maximum dry density ranging between 128-133 pcf at an optium moisture content of 8%.

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Through evaluation of the data discussed above, the following considerations are presented:

The ideal material for the airstrip foundation would be a gravelly sand which would allow for a well compacted base along with a free draining material thus providing for low maintenance. The silty sand foundation at the Watana Site is a material with an assumed permeability of  $10^{-5}$  cm/sec and which is classified as a poor drainage material. Therefore, discussions will follow later in the report concerning the preparation of a surface treatment.

Following the completion of the site investigation and laboratory test program, and taking these factors into consideration, Feasibility Study activities were initiated. The details of the study are presented in report Section E, to follow.

#### E. FEASIBILITY CONSIDERATIONS

Utilizing the data obtained from the site investigation programs, Feasibility Study activities were initiated. These activities included, conceptual planning, construction considerations, soil cement surfacing, runway expansion cost and schedule considerations. The details of each of these activities follows:

#### 1. CONCEPTUAL PLANNING

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The natural topography where the proposed airstrip is located is generally flat with minor sloping depressions and hills. To aid in the preparation of the airstrip the proposed runway grade has been selected to follow the natural topography allowing for strippin as required. A major consideration in preparation of the airstrip is the availability of equipment. Presently at the site there is a D-7 bulldozer and a one cubic yard front end loader. Due to the limitations of available site equipment to prepare the airstrip, and the desire to disturb the least amount of land possible, the airstrip has been proposed to be fifty feet wide with ten foot shoulders.

Figure 5 shows a proposed typical airstrip section. The soil stabilized surfacing is an option discussed later in the report.

Drainage ditches will run along both sides of the runway and discharge flow at convenient low points in the natural topography. The ditches are planned to allow for quick drainage of the airstrip surface so that the surface can be used as soon as possible after a rain storm. The airstrip surface is to be crowned at 2% in the transverse direction to create rapid drainage of free surface water.

In the area where the soft material can not be removed without creating a large excavation, filter fabric will be used to stabilize the foundation.

## 2. PREPARATION CONSIDERATIONS

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To prepare the 2,500 foot initial airstrip this summer, extra consideration must be given to the existing topography and equipment availability. A small grader and a small roller must be mobilized to the site to complete the preparation of the strip. Earthwork and grading on the runway will be limited to the capability of the D-7 dozer and a grader to push material and move small quantities of spoil material with the front-end loader. Compaction of material will be accomplished by track walking with the bulldozer, a small wobble wheel roller, and the front end loader. Expected compaction will be about 85%. This will generate an insitu compacted density of approximately 110 pcf.

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The method of preparation will be to load and blade the organic material to the sides of the airstrip and push and blade usable materials along the axis of the runway. The total cut volume is approximately 11,500 cubic yards of which 5,350 cubic yards is spoil and 4,620 is to be used for fill. The remaining 1,465 cubic yards of usable fill is cut between stations 12+00 to 34+00 and can be used as fill between stations 35+00 to 37+00 where the deep peat layer exist.

## 3. SOIL STABILIZATION

As stated earlier in the report, the runway foundation materials are a silty sand with small amounts of gravel. These materials are a poor drainage material which will prevent airstrip use during break-up and wet periods (May through October). Laboratory and field experience gained during the past twenty years in the construction industry has shown conclusively that soils can be hardened adequately by the addition of relatively small quantities of portland cement. The stabilized soil mixture results in a strong, durable surfacing material providing additional longevity to the runway and reducing maintenance costs.

Preparing a soil cement surfacing in the first foot of depth at the proposed Watana airstrip would provide a hard surface and with a 2% crown will provide very good drainage characteristics. Due to frost heaving, settling and loading, the stabilized soil will eventually break-up into a gravel type material that could be regraded as required during normal maintenance of the airstrip and recemented if desired.

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One of the key factors that account for successful application of soil-cement as a surfacing layer is careful predetermination of engineering control factors in the laboratory and their application throughout preparation.

To determine the amount of cement required, a laboratory program is currently in progress at Harding and Lawson's Anchorage laboratory. Site soils, representative of the airstrip foundation materials were brought to the laboratory for visual examination and evaluation. The soil was then classified by the AASHO system so that the Industry Standard empirical graphs and charts made by Portland Cement Association can be used for the short cut method. The short cut method is based on standard soils and provides trial mix recommendations to help reduce the time needed to perform various tests.

After determining the theoretical soil cement ratio from grain size characteristics, soil cement cylinders are then prepared in four inch models for wet-dry tests, freeze-thaw tests and comprensive strength breaks at 7 days, 28 days, and 60 days.

Due to the time required for the completion of this phase of the testing the results of soil stabilization test program will be presented, as a supplementary report as soon as the results are available.

## 4. RUNWAY EXPANSION

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The 2500 foot airstrip described above is considered to be a temporary facility. A major expansion may be required before construction of the dam begins. To expand the airstrip to four thousand feet would require regrading the temporary airstrip from station 0+00 to station 40+00. The soil between station 0+00 and 14+00 will require remedial treatment of a soft foundation area and would require the minor use of major earth moving equipment to excavate and regrade a constant slope airstrip.

If a still longer airstrip is required to support the camp operations and site construction activities, the east extension can be used, thus producing a runway of six thousand feet. This area of expansion would require major earthwork to take care of the very wet and soft area between station 41+50 and station 47+00. Also needed

would be a borrow source of sand and gravel so that the airstrip can be adequately built to provide a good landing surface with free drainage.

#### 5. COST AND SCHEDULE

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Based upon the conceptual planning details previously discussed, preliminary cost and schedule estimates were developed. Estimates were based upon the preparation of two types of preliminary airstrip, both of which are 2,500 foot by 70 foot. The definition of each of these types of strips are defined below:

## A. WINTER STRIP

The winter strip is proposed to be prepared to the standard dimensions without a runway surfacing. Preparation is based upon the availability of a D-7 Dozer, a one-yard frontend loader, a small motor grader and a small roller. The dozer and loader are already at the site. A small motor grader and roller will have to be mobilized by helicopter to the site prior to the start of preparation.

Preparation activities will emphasize closing up the surface of the runway and drainage features. It is envisioned that with adequately

placed snow fences and continued maintenance of the runway, service may be considered reliable from November through May of each year. Air service to the Watana Camp during the remaining months of June through October, is to be supplied through helicopter services when the airstrip can not be used.

The order of magnitude cost for the preparation of this type of strip is estimated to be \$200,000. This estimate is based upon a 7-man construction team on each shift, two shifts per day. Utilizing standard production rates for the required equipment, a duration of thirty days is calculated for preparation. Equipment mobilization, the cost of materials, and logistical support are also included in this estimate cost.

It must be noted at this time that airstrip preparation activicies cannot be started until permitting requirements are fulfilled.

#### B. YEAR ROUND STRIP

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The year round strip is proposed to be prepared to the standard dimensions discussed above with the addition of a one foot thick stabilized soil runway surfacing. Preparation is based upon the completion of the winter strip described above with the addition of the stabilized soil surfacing.

The preparation of the surfacing will require the additional mobilization of a large disc, pump and piping system and cement. The preparation of the surfacing will require an additional twenty days to complete at an additional estimated cost of \$200,000. The total cost of the soil stabilization, year round strip is therefore, estimated to be \$400,000.

The cost-benefit ratios for e in of the two types of strips are presented in Section F, Economic Analysis, which follows.

#### F. ECONOMIC ANALYSES

The economic analyses performed as part of this feasibility study was basically divided into two subtasks. The first, was to formulate the total costs of equipment mobilization and airstrip preparation. The results of this subtask have been presented in Section E of this report. The second subtask involved establishing a rate structure for fixed-wing service of all types, and for rotary wing service as well. The cost savings of fixed-wing service to the proposed airstrip vs. helicopter service for the camp was then calculated considering activities such as fuel hauls, personnel transport, equipment and grocery deliveries, and maintenance. Based on the assumed duration of future exploration programs, fixed-wing costs to the winter strip and to the year round strip were compared to helicopter service costs and the break even durations were established.

## 1. FIXED-WING VERSUS ROTARY WING SERVICE

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In order to accomplish the economic analyses and cost comparisons described above two basic study cases were defined.

CASE 1 Considers the construction of 2,500 foot by 70 foot airstrip at the Watana camp, suitable for light aircraft up to a CASA 212 or a Twin Otter. This case is further divided as follows:

<u>CASE 1A</u> Considers the use of the winter strip from November 1st to April 30th; with heavy maintenance and chancy usage from May 1st to October 31st. Fuel hauls are planned in April and November. The total cost of construction is \$200,000.

<u>CASE 1B</u> Considers the use of the year round strip with normal maintenance and fuel hauls are planned in February and July. The total cost of construction is \$400,000.

<u>CASE 2</u> Considers the use of rotary wing helicopter service to the Watana Site. Winter traffic of personnel and light freight are planned into Miller Lake on skis. Summer traffic is planned to Tarkeetna by fixed-wing and then by helicopter to Watana. Fuel lifts are made by helicopter from the Chulitna siding to the site in February and July.

## 2. USAGE PLAN

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Following the definition of the study cases above, the following usage plan was established as a base for the comparative cost analyses.

#### CASE 1A ASSUMPTIONS (WINTER STRIP)

#### o <u>Winter Season</u>

- Four fixed-wing trips per week from Anchorage to
   Watana with personnel and luggage.
- One trip per week from Anchorage to Watana with supplies and freight.
- Two fuel lifts of 100,000 gallons (April & November).

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- Chancy usage with high maintenance factor.
- 40% of flights are able to use the strip. The remainder use helicopter service.
- Two fixed-wing trips per week from Anchorage to
   Watana with personnel, luggage and supplies (as possible).
- Remainder of flights are fixed-wing to Talkeetna,
   rotary to Watana as described in detail in Case 2
   below.

- Local Watana helicopter support of field activities
   will be equal in all cases and is therefore not
   considered in the cost comparison.
- Use of 1983 costs-unescalated.

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## CASE 1B ASSUMPTIONS (YEAR ROUND STRIP)

- Four fixed-wing trips per week from Anchorage to Watana
   with personnel and luggage.
- One trip per week from Anchorage to Watana with supplies and freight.
- o Two fuel lifts of 100,00 gallons each.
- Local Watana helicopter support of field activities
   will be equal in all cases and is therefore not
   considered in the cost comparison.

o Use 1983 costs-unescalated

## CASE 2 ASSUMPTION (ROTARY WING ONLY)

- Four fixed-wing trips per week from Anchorage to Talkeetna with personnel and luggage, followed by helicopter transport to Watana; from May through December.
- One trip per week as described above for supplies and freight - all year round.
- Four fixed-wing trips per week from Anchorage to Watana with personnel and luggage to Miller Lake on skis; from December to May.
- Two fuel hauls of 100,000 gallons each in February and
   July by helicopter from the Chulitna siding to Watana.
- Local Watana helicopter support of field activites will be equal in all cases and is therefore not considered in the cost comparison.
- o Use 1983 costs-unescalated.

# 3. COST ANALYSIS

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Utilizing the above defined study cases and usage plans, the following costs were developed.

# CASE 1A (WINTER STRIP)

0	\$	42,000	cost	of	preparation	of	plans
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- o \$200,000 construction cost
- o \$ 40,600 per quarter transport costs (strip
   partially closed)

\$ 75,000 fuel lift cost

\$ 18,000 per quarter - winter maintenance cost
(strip open)

- o \$ 30,000 pur quarter summer maintenance cost
  (strip partially closed)
- o \$48,600 per quarter work hour cost for travel
   (strip partially closed)

o \$32,400 per quarter - work hour cost for travel
 (strip open)

# CASE 1B (YEAR ROUND STRIP)

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- o \$ 63,000 cost of preparation of plans
- o \$400,000 construction cost
- o \$ 26,600 per guarter transport costs
- o \$ 75,000 fuel lift costs
- o \$ 32,400 per quarter work hour cost for travel

# CASE 2 (ROTARY WING ONLY)

- o Zero construction cost
- o \$ 50,600 per quarter transport costs
- o \$171,000 fuel haul costs.
- o \$ 68,400 per quarter work hour cost for travel

The accumulated cost; of each of the three study cases are presented in Figure 6.

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An analysis of these relationships indicates that the potential earned savings from fixed-wing service to the camp will fully equal the \$200,000 construction cost of the winter strip after 11 months of assumed usage. In the same way, the break even point for the \$400,000, year round strip is found to be 17 months.

Once the break even point is reached, the winter strip accrues savings over the helicopter case at an average rate of \$23,000 per month. The year round strip accrues savings over the helicopter case at an average rate of \$30,000 per month taking all these factors into consideration. If the strip is built this July 1983, the total savings accrued to April 1986 by the construction of the winter strip is approximately \$477,400 while the total savings accrued by the year round strip is also approximately \$467,000.

At this time, emphasis must be given to the chancy nature of the winter strip during break up and freeze cycles. Slight changes in weather from the assumed usage pattern could weigh heavily to the helicopter usage case thus increasing the costs significantly. The year round strip provides a much higher level of reliability with an larger overall cost savings as well.

The accumulated cost of ech of these three cases described above are presented in the table which follows.

# AIRSTRIP STUDY COSTS

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	CASE 1A (Winter Strip)		CASE 1B (Year Round)	CASE 2 (Helicopter)	
7/83	\$ 42,000	Design Cost	\$ 63,000	-0~	
	200,000	Cost of Strip	400,000	\$ 50,600	
	40,600	Strip Operation	26,600	-0-	
	30,000	Maintenance (summer)	18,000	-0-	
	48,600	Workhour Cost-Travel	32,400	64,800	
10/83	\$ 361,200	Cumulative Costs	\$ 540,000	\$ 115,400	
	\$ 26,600	Strip Operation	\$ 26,600	\$ 50,600	
a se que	75,000	Fuel Haul	75,000	171,000	
	18,000	Maintenance (winter)	18,000	-0-	
	32,400	Workhour Cost-Travel	32,400	<u> </u>	
L/84	\$ 513,200	Cumulative Costs	\$ 692,000	\$ 401,800	
20 M M	\$ 26,600	Strip Operation	\$ 26,600	\$ 50,600	
51	18,000	Maintenance (winter)	18,000	-0-	
t	32,400	Workhour Cost-Travel	32,400	64,800	
4/84	\$ 590,200	Cumulative Costs	\$ 769,000	\$ 517,200	
ŀ	\$ 40,600	Strip Operation	\$ 26,600	\$ 50,600	
	75.000	Fuel Haul	75,000	171.000	
2.	30,000	Maintenance (summer)	18,000	-0-	
1	48,600	Workhour Cost-Travel	32,400	64.800	
7/84	\$ 784,400	Cumulative Costs	\$ 921,000	\$ 803,600	
	\$ 40,600	Strip Operation	\$ 26,600	\$ 50,600	
	30,000	Maintenance (summer)	18,000	-0-	
	48,600	Workhour Cost-Travel	32,400	68,800	
_0/84	\$ 903,600	Cumulative Costs	\$ 998,000	\$ 923,000	
	\$ 26,600	Strip Operation	\$ 26,600	\$ 50,600	
1	75,000	Fuel Haul	75,000	171,000	
	18,000	Maintenance (winter)	18,000	-0-	
- ( -	32,400	Workhour Cost-Travel	32,400	68,800	
1/85	\$1,055,600	Cumulative Costs	\$1,150,000	\$1,213,400	
	\$ 26,600	Strip Operation	\$ 26,600	\$ 50,600	
	18,000	Miantenance (winter)	18,000	- 0	
	32,400	Workhour Cost-Travel	32,400	68,800	
. :4/85	\$1,132,600	Cumulative Costs	\$1,227,000	\$1,332,800	
	\$ 40,600	Strip Operation	\$ 26,600	\$50,600	
1	75,000	Fuel Haul	75,000	171,000	
1	30,000	Maintenance (summer)	18,000	- 0-	
	48,600	Workhour Cost-Travel	32,400	68,800	
7/85	\$1,326,800	Cumulative Costs	\$1,379,000	\$1,623,200	

#### AIRSTRIP STUDY COSTS

	CASE 1A (Winte	<u>er Strip)</u>	CASE 1B (Year Round)	CASE 2 (Helicopter)
	\$ 40,600	Strip Operation	\$ 26,600	\$ 50,600
	48,600	Workhour Cost-Travel	32,400	68,800
.9/85	\$1,446,000	Cumulative Costs	\$ 1,456,000	\$1,742,600
	\$ 26,600	Strip Operation	\$ 26,600	\$ 50,600
	75,000	Fuel Haul	75,000	171,000
	18,000	Maintenance (winter)	18,000	0
	32,400	Workhour Cost-Travel	\$ 32,400	68,800
1/86	\$1,598,000	Cumulative Costs	\$ 1,608,000	\$2,033,000
	\$ 26,600	Strip Operation	\$ 26,600	\$ 50,600
	18,000	Maintenance (winter)	18,000	-0-
	32,400	Workhour Cost-Travel	32,400	68,800
4/86	\$1,675,000	Cumulative Costs	\$ 1,685,000	\$2,152,400

#### TOTAL COST SUMMARY

Winter Strip- from 7/83 to 4/86	\$ 1,675,000	· •
Year Round Strip- from 7/83 to 4/86	\$ 1,685,000	BREAK EVEN
Present Helicopter Usage- from 7/83 to 4/86	\$ 2,152,400	

#### DIFFERENTIAL COST SUMMARY

Using the existing helicopter usage plan as a base:

° The winter strip breaks even in cost in 11 months (6/84), and accumulates savings at the rate of \$ 275,000 each year thereafter. By 4/86, the total accumulated savings will amount to \$ 477,400.

 $^\circ$  The year round strip breaks even in cost in 17 months (12/84), and accumulates savings at the rate of \$ 360,000 each year thereafter. By 4/86, the total accumulated savings will amount to \$ 467,000.

<sup>°</sup>The construction of either fixed wing airstrip at the Watana Site this summer will provide significant cost savings (\$ 470,000) compares to helicopter use during the planned site investigation programs through April 1986.



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#### TABLE A Watana Base Camp-Proposed Airstrip Permits and Land Use Authorizations

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Aut	horization	Agency	Description	Lead Time	Comments
1.	Land Use Section 27	Knikatnu, Inc.	APA Agreement	In effect	Will require extension (Expires 1/1/84)
	Section 28	CIRI (Knik select)	APA Agreement	In effect	Will require extension (expires 1/1/84)
2.	Talkeetna Special Use Permit	Matanuska-Susitna Borough	a Special Use Permit	est. 30 days	
сл <b>,</b>	Material Acquisition	CIRI	Purchase		Dependent upon Native definition of subsurface borrow, or surface use.
41 o	Notice of Intent to Establish an Airport Land Area	FAA ing	Form 7480-1	21–30 days	
5.	Operating Certificate	FAA	Form 5280-1	up to 30 days	Airstrip inspection required
6.	Wetland Determination	n COE	Request to determine if COE permit required	10 days	

#### TABLE A Watana Base Camp-Proposed Airstrip Permits and Land Use Authorizations

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<u>Authorization</u>	Agency	Description 1	Lead Time	
7. Permit to discharge dredged or fill materia to wetlands	ls COE	Section 404 Permit	est. minin 90 days	num
8. Certificate Reasonable	of			
Assurance	ADEC	Review of COE with respect to maintaining State water quality standar	est. 30 da rds	łys
9. Determinatio of Consisten with Coastal	n cy			
Mgt. Program	AD9D9	Review of COE Permit with respect to maintaining Sta water quality standards	est. 30 days ate	
10. Aviation Radio Beaco	n FCC	-	none	Watana Base Camp has a signal issued to CIR-H&N 7/29/80
ll. Archaeologi	cal		Norma	C
Ciearance	ALINK-LP		NONE	and archae- ological clearance recommended. However, should any cultural resources be uncovered luring construction or use of the airstrip, the project archaeolotist must be contacted so necessary action can be taken.

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NO			EN S		PARTICLE SIZE ANALYSIS						RG	MOIST.	REMARKS
ORING	AMPLE YPE	EPTH (13:	INIFIED LASSIFI	TOBBLE GRAVEL SAND SILT/CLAY	P1	W <sub>c</sub> (%)							
AS1	S F	0-1		Selle de la conten que par fei de la conten de la c		tang tanggal tan data da sa kang bahar							Organic Content 17.2
ASI	4994589452995986	1-3	eli di ci companya da di secondo da di se					galano ari uziyo, Jakabri					Organic 3 9
ASI	annersing Sam. A	13	untilitati (Cinii "ni ninesengi pute			naanym, ** 30704030444.450223	43.4	mikacimu nisilus uhisiksisinki					a - isseite diestroineite in internet
ASI	97 - V. Retrief of Children	3-4	SM		9.4	53.9	36.7	engeleristen aller alleringen und					
AS2		0-1					48.9						Sontent 76.4
AS2		13					50.7	10-10-10-10-10-10-10-10-10-10-10-10-10-1					naciones des conventions des la propositiones des la propositiones des la propositiones de la conventiones de s
AS2		3-4.5	nangalitik y sowe ceregoldentikasan									1.41	arturanska svota na konstantik a konstantik som
AS3		2.5-3	SM		6.4	64.3	29.3	sumulationstandard. Artificial		anter tanangkang			nan daya too waxaa w
AS3	NOME - TOTAL MORE AND A	3-4	a Naviguarianska konstantinska statu					- MI TITE - ANTONIO MANDA		asa yiliye Shootaa		25.7	Scontent 4.5
AS3	an an Inner State State	5-7	18-16-17-17-18-18-18-18-18-18-18-18-18-18-18-18-18-			ST. LEWIS LAUNANUS TY AND AND		57 - ¥ "dragovin, mater - mili		Ca ana di manja ka Sila di Janjan			Egganie 1.7
AS3	Lagoculos kontententen	8-9.5	SM		3.1	58 <b>.</b> 6	39.3	HORMANDY DOMINING DIRE			 		an an an a state of the formation of the state
AS4	- macery espiritu	56	ana da kana ang kana kana kana kana kana kana	SAL SAMEWARKE JESSE VESSENINGS (STOC		n ar a land to a land an	18.9	er-Talanes contract, contracted and service		Dan en angele			Organic 11
ASS	nandra. Walk	3.5-4	NOR BY CHARGE AN INCOME OF THE	ar előninsámuskulóniruszt a arch		The state of the s		K - 192 - 74		31 <b>3-3</b>		84.7	Content 89.
AS5	176.474.491.762.782	5.5-6	.5	and a second second		FF A	44.5	HILLOW MALE ALL ALL ALL ALL ALL ALL ALL ALL ALL					alan sana ang ang ang ang ang ang ang ang ang
ASS	alan kata Talanda d		SM		6.9	22.4		an a		a. <del>ma</del> lataramanan			ana manana kata ang k
AS7	naga centra tanàna dia mandritra dia mandritra dia mandritra dia mandritra dia mandritra dia mandritra dia mand	1.5-3	.5 SM		9.4	48.2	42.4	1000-101-210000-001-1 <sup>-10</sup> -0-20					and a substantial statement of the substantial statement of the substantial statement of the substantial statem
AS7	Rectorectory	3.0.0	SM		14.6	45,7	39./ 27 0	r wurden eine Stadiologie aussie als seine der		11117-147 August		12./	n faran arayan mun a an
ASY ASY	 `	1.5-4	.5 SM	or a damanananan an an ar sa cana	0	57.6	42.4	ves					9890 - MARCH ML AND MARCH THE GALL AND A MARCH MARC
1 GN		J.,	6.2 Q.1	Dagitanina ana "tagangana ata	5		76.07	700 					986 8 986 ******************************

							TABLE B						
ON			N S S		PARTIC	LE SIZE A	NALYSIS	1999)	AI	TERB	ERG	MOIST.	REMARKS
RING	APLE	11H ET)	IFIED SSIFI N SYS	S COBBLE	IEVE AN	ALYSIS (9	/6)	ORO- TER		E P.L	D Pl.	W. (%)	
log	SAA 17P	DEP	₹32		ORNer-			HY ME TES			Ļ		
AS12		.5-1.0	SM	nowers and a state of the second s	7.4	62.1	30.5						Organic Content 8.8%
AS13		7-10	SM		8.0	54.7	37.3	yes		-	ļ	22.2	
AS13		13-15	SM		25.8	45.0	29.2	1990 1 1991 10 10 10 10 10 10 10 10 10 10 10 10 10					
AS13		15-17.	5 SM		17.1	49.0	33.9						
AS14	4.2.00.000.000	5-7.5	Same of the second s	111770-0114-101774620480480464				and descent and a start of the start of the start				an the second	Organic Content 11.2
AS14.	1012-704 0018-140-	8-10	SM	general contraction of Jose and a	14.6	51_2_	_34_2	1997-1997-1997-1997-1997-1997-1997-1997		tunisti tan tang sayan.		alexentro and the other states	analista tonis in Sonato da Santa anga anga anga anga anga anga anga
<u>AS14</u>		<u>12.5-1</u>	5 SM	tanut han sevilihiki kana diseleri ket	12.0	53.5	34.5	er vir die die General Versie voor versten School	-			an a tagain	annotheristic virit 2 Merilia Radio Carllon Carllon and Salah and Carlo and Arabian Constants
<u>AS16</u>		5-7.5	SN.	146 <b>- 19</b> 66 (1201) (1201) (1201) (1201)	34.1	38.5	27.3	er innensenen berunden 1754		unio mangalajo a			######################################
AS17		5-7.5	SM	tadeguzzoiazianieizanieizaniei	0	52.2	47.8	yes	18	.4	16.5	2.3	
AS17	ļ	7.5-10	SM	MAN AND SECONDARY MANAGEMENT	3.9	52.6	43.5	12.5447.1577. <b>1</b> 1.2643.1215.1545.1715.1715	20	.8	17.1	3.7	
AS19		5-7	SM	10-10-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0	13	52.2	34.8	anaagapar - Narran ka ka ka ka ka ka		1.5000000000000000000000000000000000000		11.5	
AS21		3-4	SM		9.2	51.3	34.5	Perchaphist (product datacetymour vice)		MANDAR MICHAEL			
AS23		35	SM		7.2	58.8	34.0						
AS24		1.5-2.	5 SM		10.2	53.5	36.3					13.3	
AS25		1-2.5	SM		4.6	53.3	42.1						
AS26		1-2.5	SM		4.2	48.7	47.1					26.4	
AS26		2.5-4	SM			46.6	53.4	yes					G <sub>S</sub> =2.75
AS26	of Counters of the State of State	7.5-9	SM		40.7	30.2	29.1	and an end of the second s				an a	l₁/2" piece of gravel
\S27		3-5	SM		19.4	52.4	28.2	*******				949 Marcine Materia and	
		State			ar - a annearan	national products of the second	and a subsection of the subsec	aunter de Juis northeatracteur acteur		untri marsana		anime - Managara Japaga Mara	

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LAB TEST SUMMARY WATANA AIRSTRIP STUDY Susitna Hydroelectric Project



		-					TABLE E						
ON			SOUL TEM-		PARTIC	LE SIZE A	NALYSIS	1994 - Maria Barranda (1995) - Maria Maria (1994) 2014 - Maria Maria (1994) - Maria (1		TERBE	RG	MOIST.	REMARKS
ING	al al	EE	SSIFIC SSIFIC	S	IEVE AN	ALYSIS (	/o)		Large managements	LIMITS			
BOR	SAM TYPI	DEP.	TC N	CORRE	GRAVEL	SAND	SILI/CLAY	HYD MET TEST	L.L.	κ.L.		W <sub>c</sub> (%a)	
AS28		1.5-2.	5 SM		10.8	58.8	30.4	Particular Carlor Carlor Carlor Carlor					
AS28		9.5-10	.0 SM		16.5	52.1	31.5	1990 C 1910 C					
AS29		1-2.5	SM		9.8	54.6	35.6						excession of the Data State of the
AS29		6-7.5	SM		20.0	52.1	27.9	NIR Y MIL GOMMINT OF DESIGN		a spore for called			
AS30		1-2.5	SM		5.4	54.4	39.7	yes				23.5	
AS30		2.5-5	SM		8.5	52.0	39.5	ginn hannan tir fandrink annan ei menne.			-CUTORALISED NA		
AS31	50010100000000000000000000000000000000	2.5-3		1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -	an de la companya de	1999-1299-1999-1999-1999-1999-1999-1999		a an ann an Annaiceann ann an Annaiceann				16.8	
AS32	2008-007-007-007-00-00-007-00-00-00-00-00-00	.5-2.0			na for an anna an ann an ann an ann an ann an	nerindepitetine den Pilitin		94.227 / 13 Maar 24 / 24 Mar 2000					Organic Content 6.4
AS33		.5-2.5				page they taxable many same of the sector		NOTO - INTERNO SI MATONI				17.3	Matterio (Thin 1964) No 1870 Caugh Carlos
AS33		2.5-5	SM		8.7	56.2	35.1	• Statuti stass normane en une	1.60000001000.0000		1/24750-000-00-000-000-000-000-000-000-000-0	12.3	
AS34	)#030(2010112.6474)	.5-2.0				Statute Crabber Rabarranda		-10-1111-1121-1121-11-121-11-11-11-11-11-11			409.000 marks 1900 miles	86.3	Organic Content 10.1
AS35	Lazzy Poston and Posto	0-2.5	SM		19.8	51.0	29.2	THE CONTRACTION OF THE CONTRACT		In the second	and the state of the local day	10.6	
AS36	antonio autonia de	0-2.5	SM		21.4	58.7	19.4	Stand State of the					
AS37		1-2.5	SM	nter new Thomas Annual Agent Annual Ta	10.5	64.7	24.8						
AS37		2.5-4.	5				37.1	17-1234291046827148274020202010771711					
AS38		1-2.5	SM		13.2	63.2	23.6						
AS38		2.5-4					41.3						
AS40		1-2.5	SM		8.3	55.2	36.5	1997 - 179 - 1997 - 1997 - 1998 - 1998 - 1998 - 1998 - 1998 - 1998 - 1998 - 1998 - 1998 - 1998 - 1998 - 1998 -			Multiplet et de l'Alfred		
AS41		2-4	SM		9.3	48.3	42.4			Ì			WARRENA (CONSERVICE) ALL PROBLEM MOLECULAR CONSERVES - RESERVED AND A

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NG N	Щ		SYSTEC S	S	IEVE AN	ALYSIS (°	76)	°∝		LIMITS	5	CONTENT	
BORI	SAMP	DEPTH (FEET	CLASS TION	COBBLE	GRAVEL	SAND	SILT/CLAY	HYDR METE TEST	L.L.	P.L.	P1.	W <sub>c</sub> (%)	
AS42		1-2.5	SM		11.5	51.1	37.4	understeine Beitrichnen auf der Ster				26.6	anangaanaadaa waxayaada maasho magaaciina dhiftanaa i
AS42		2.5-5	SM		22.3	57.7	20.0	nen og skale state af skale				9.9	G <sub>s</sub> =2.67
AS43		1-2						an a	quantination			19.8	ananastasi na sa salasi na sa
AS44		<b>₀</b> 5-2.0						ustaanii waxaa ayaa faayiinii sa		autounter survivals	analistinesi Tabihisti	26.4	1865-1869 1879 1879 1879 1879 1879 1879 1879 187
AS44		2-4	SM		15.6	62.8	31.6	2011-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1			NUMBER OVAL	14.3	and desirates bencheratives and the construction construction of the construction of t
AS45	and the second second	1-2.5	SM		3.0	51.7	3	47 15 6 2 10 10 10 10 10 10 10 10 10 10 10 10 10		an owned and a state of the	a,orantouaa/mat	21.3	an a
AS45		3-5	SM		5.8	57.6	JU.6	an ann an		an that was do not they	AND THE REAL PROPERTY OF THE	11.0	NANSTANDAL JARAN TANTAN TANDA TANA MANJARA MANJARA MANJARA MANJARA MANJARA MANJARA MANJARA MANJARA MANJARA MANJ
AS4F		•2•c	SM		10.3	60.6	29.1	anazzoaria instructuria discor		LANDON CARAGORDING	an landa way ngagiit y		an and and a substance of the
AS47		2 j	SANG-MOLICIPULATIONS		international Laterantica of Internation			200800947420-0950 <sup>-10</sup> 10-100-025-2000749		and the second		37.6	
AS49		2-3.5	SM		3, 7	47.5	45.2	an staate deel noor worksteen a same er			MORNELIUS MAN	Same Bill Annow Station and	anna ann an tha ann an tha ann an tha ann an tha ann an thann ann ann ann ann ann ann ann an thagadh agus an th
AS49		5-7.5	SM		0	51.1	48.9	yes			1910-1410-719-824-144	anan da dan bahar kalang karang k	nan minaka virindi dala di kata di kata di kata di kata di kata da kata da kata da kata da kata da kata da kata
AS49	-	5-7.5		1001 - 704 - 104 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100	eniqueri doctione a monormi docer a ducer			antikkaus, hojo samo kalunan akon mara kalu	20	.11	5.4	4.8	G <sub>S</sub> =2.72
a.949	of Batroan Academics	5-7.5	non andre active active		NAMA AND THE OWNER OF THE OWNER OF THE			14738-011-011-011-0112-0112-0112-0112-0112-0			leenimaretuntakiriga	13.4	MICHNOLOGIAL LANGE BRUNDLEGUNG DAN MARTING UND DE THE BRUNDLEGUNG DE THE BRUNDLEGUNG DE THE BRUNDLEGUNG DE THE
Éan Iala 1889an Ialan		1-2.5	SM		10.2	69.3	20.5						onen un dostatos de la constitución
AS51		3-5	SM		6.9	50.1	43.0						
AS52		1-2.5					46.1		President Contract				
AS54		1-2	SM		5.4	50.4	44.2					13.0	
AS54		8.5-9	SM		6.2	61.4	32.4	1.127.1540 T18+0007.0023012340105805.000				5.6	
					9496-9718710152916-876-64551-970-5280C	Destrongust, course analysis,	Pharman and a second				1779-17-189-1 gau + Lev		naaraadaan ahaa ahaa ahaa ahaan ahaan ahaan ahaa ah
			and a second second second							orea da lo va sa sense da se			

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LAB TEST SUMMARY

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Susitna Hydroelectric Project

NO			Son RA- Stew		PARTIC	LE SIZE A	NALYSIS	provention and entropy and with the	A	TTERBE	RG	MOIST.	REMARKS
SORING	SAMPLE	JEPTH FEET)	JNIFIED CLASSIFI	COBBLE	IEVE AN	ALYSIS (?	/6) SILT/CLAY	HYDRO- METER TEST	LL.	P.L.	9   <u>P</u> 1.	W <sub>c</sub> (%)	
MCl		2-2.5			Tan California Antonio Constanti antonio California			an tao amin'ny faritr'o amin'ny faritr'o amin'ny faritr'o amin'ny faritr'o amin'ny faritr'o amin'ny faritr'o am				22.7	999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 -
MCl		3-3.5						1939-502 <b>632 97 67 60 69 60 70 70 70</b>	İ			20.8	na ann an Anna ann ann ann ann ann ann a
MCL		01.5											Organic 13.7
MC2		2-2.5	SM		8.7	65.9	30.4					20.2	
мсз		2.5-3.	0 SM		0.0	62.8	37.2	127104414148184145881111-0712148101					an an suit a that an
MC4		2-2.5	SM		2.1	66.4	31.5				1000-000-00-00		na jakens kannasiosisisto moosiosisto moonistoodoonaasaa
MC5		2-2.5	SM		7.2	55.5	37.3				NATURA AN CONTRACTOR		
MC6		1-1.5	al (provider Hersteinen Herstrader Therm		an anal and the second care - of	and a constant of the second o		79419941996296194691946919469194691946		-			Organic Content 4.7
<u>MC6</u>	PERMIT PERMIT PERMIT	3-5	SM		6.6	54_)	39-3	NILLING THE STOCKED TO STOCKED					andadon sunda anda ang kasa na kasa ang
<u>VC7</u>		1-2.5	en application of scill 2013 and we can provide the decision of scill 2013 and we can provide the decision of s		ana manang manang manang	ana mangana kata Kanananga	_36.0_	1076-007-007-007-007-007-007-007-007-007-		and the states of	art neži z Sino opubra " J		n de la mais
MC8		1-2	SM		52.6	47.4				and the Computer	172804274.64444.682.e		NARVINA A STATESARVA JALI (METZERIJA, BESKENA A A STELEVICA
VC9	1000-1-10210-140	1-2	a northa than a thanka tha a share a s		1942-1955-1956-1966-1966-1966-196	nakimberjingerjinana signifika	27.9	an a	per Guantum conservation	ka da ka	De Millione og ov		NAMMERVIE 1772. JAHOMATSIN KOWASSINA METAMIKAN MENJAMI MENJAMI MENJAMI MENJAMI
an the second	CARDING COMPANY OF THE MEDICAL OF	rhulespenishes/calibertines	99000000000000000000000000000000000000		Mildo Miler Transiscon Solderi Carad	energiaenen antesa	1924echazolikovenszere and	Skalinsk av Julius 2006 (2007)			suustunes maarga	nani-antonin-arrow Maria an	anactionary and a substance and
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SUSITNA HYDROELECTRIC PROJECT

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TASK Z

SURVEYS AND SITE FACILITIES SUBTASK 2.03

RESUPPLY AND EMERGENCY SERVICES AIRSTRIP LOCATION STUDY

Prepared For:

ALASKA POWER AUTHORITY

ACRES AMERICAN, MCORPORATED

Prepared By: R&M CONSULTANTS, INC.

OCTOBER 198)

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### SECTION

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#### A. INTRODUCTION

This Study was done as an integral part of the larger Susitna Hydroelectric Project studies. The Susitna Hydroelectric Project includes proposals for one or more large hydroelectric dams on the upper Susitna River between the Parks Highway near Talkeetna and the Denali Highway. Site locations for two major dams are being studied. The site identified as "Watana Dam" is the furtherest upstream site. Winter access is possible on the North side of the river near the Watana site.

During the winter of 1979/80 a forty man base camp was moved in using a "Roligon" train from the Denali Highway. This camp is located on relatively level terrain North of the Susitna River a short distance upstream from the Watana site. Crews have been working out of this camp since the early spring of 1980 and continuous field operations are expected well into 1982 and beyond. The camp has been labeled "Watana Camp".

Access to Watana Camp at this time is possible by helicopter on a year round basis and by Roligon during winter months. It is difficult to anticipate supply requirements with sufficient accuracy to allow resupply by Roligon on an annual basis. Resupply by helicopter is difficult and mu more costly than if fixed wing aircraft could be used. In addition personnel access could be provided much more economically by fixed wing aircraft.

A determination has been made that adequate landing facilities for fixed wing aircraft should be provided near Watana Camp. The purpose of this location study is to determine the best location for a runway capable of handling fixed wing aircraft up to and inculding the Twin Otter.

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- 4. In order to reduce the permit requirements Watana Camp was located on Cook Inlet Regional Corporation land rather than BLM land. It was felt that, if possible, the runway for the Twin Otter should also be confined to Cook Inlet Regional Corporation land.
- The orientation of a runway should always be determined, as much as possible, by the prevailing winds. Wind data was available from the camp weather station.
- Wet land encrotherment is always a consideration from an engineering viewpoint. Construction on wet areas is generally more complex and expensive than on well drained soils. It is obviously desirable to choose an alignment with a minimum of water problems.
- 7. Available soils data has been included as a parameter. Soil logs from barrow pit exploration were available and were considered. The location of available material sources and the suitability of native materials for construction have definate impacts on project costs.
- 8. While not specified FAA criteria for a General Transport runway is assumed to control. Basic démensions are shown in Table 1. Maximum runway grades are not to exceed 2%. Exhibit 4 shows the primary cross-sectional requirements.

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#### TABLE I

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-Parallel Taxiway	J	1501	150'	2001	300'
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-Taxiway Center- line	L	50°	75'	100 •	2001
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<u>/1</u> Letters are keyed to those shown as dimensions on Figure 3.

<u>12</u> Basic Transport Column A is to be used only at those low activity sites where an existing utility runway, having no anticipated need for an instrument approach procedure of any kind, is extended for business jets. For all other basic transport airports use Column B.

<u>/3</u> Make straight taxiway soctions 50 feet when airplanes with a wheel tread over 25 feet will use the airport. A width of 60 feet will be required for airplanes with tread over 35 feet. Make curved sections conform to Figure 8.

\* Taken from FAA AC 150/5300-6

#### C. APPROACH

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Work began in late August 1980, with a detailed analysis of wind data accumulated by the weather stations at Watana Camp. The prevailing winds are out of the North East such that an orientation of North  $60^{\circ}$  East will provide good wind coverage under most weather conditions. The wind data is shown on Exhibit 8.

With the prevailing winds documented and the controling grades and dimensions chose from FAA Advisory Circulars the selection of alternative locations could be made. Contour mapping generated by the Corps of Engineers on a scale of 1"=200" with 5 tour intervals was used. Two potential runway sites were idense ed on the contour mapping quite close to Watana Camp. Alternate A is South of camp as close as dimensions in Table 1 will allow. Alternate B is on a low ridge North of camp at about the same distance. There were no other locations apparent that were close to Watana Camp.

Each alternative was reviewed to determine how well each controlling parameter was satisfied. Alternative A appears to be the preferred location from this review. A field trip was made to review each alternative. Alternative A was flagged in the field for review by the Archeological team. The Archeological review team cleared the Alternative A location.

#### D. ANALYSIS

In many respect both alternatives were essentially equal.

Both alternatives were selected to fit FAA criteria in an effort to provide the safest possible facility.

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Soils are essentially identical. Both locations lay within an area which has been identified as a potential material source for the dam. Alternate A is located along the edge of the borrow area and would have less impact on use of the barrow area than would alternate B.

There is only minor differences in the amounts of wet land that will be effected by either alternative if extended to dimensions required for the C-130. A portion of alternate A can be developed to handle the Twin Otter without significant encroachment on obvious wet lands or a need for drainage provisions other than careful surface grading.

Alternate A can be developed entirely on Gook Inlet Regional Corporation land. This is true not only for the first stage Twin Otter capability but for the C-130 capability also if length can be held to 5600 feet. Alternate B on the other hand is located largely on BLM land.

Alternate A is positioned so close to Watana Camp that an aircraft parking and fueling areas can be provided adjacent to the existing fuel storage area and the camp warehouse. This will provide for easy servicing and unloading of aircraft.

Grades are such that if alternate B were selected an access road of approximately one-half mile would be necessary to move fuel to planes or personnel and freight from planes. From a logistic stand point alternate A has a major advantage over alternate B.

The principal advantage of alternate B over alternate A deals with the clear zone surface on the Westerly approach. This approach is over the North end of the Watana Dam. The approach to alternate B provides a very comfortable clearance of several hundred feet over what may be a very active construction area if the dam is built. Alternate A provides minimum verticle clearance over the

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potential construction area. If a runway capable of serving C-130 aircraft is eventually built or alternate A careful consideration must be given to potential conflicts between construction equipment and the clear zone surface for the Westerly approach. An acceptable clear zone can be maintained for alternate A in any case.

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When all parameters are considered alternate A is the more attractive alternate for the following reasons:

- 1. Best access to Watana Camp;
- 2. Least expensive construction to serve the Otter aircraft;
- Minimal drainage problems with the first stage of constuction;
- Minimal interference with potential material source for the dam.

#### E. RECOMMENDATIONS

The preferred location of a runway to provide for Twin Otter service to Watana Camp is fairly clearcut. It is recommended that a 2500 foot runway be constructed using a portion of alternate A as shown on Exhibit 2, 3, and 4. This initial runway should be constructed at the highest elevation consistant with balanced earth work in order to keep construction costs for this temporary facility to a minimum. The finished runway and safety area should be graded to drain to existing natural drainages. In addition, care should be taken so as not to create any areas that will trap snow. Organic soils should be removed from the runway prism as depths to sound material are minimal. Consideration should be given to providing a crushed aggregate surface on the runway itself. There will be occassions when aircraft may choose to use the facility during marginal weather conditions. For this reason the use of retro-reflective runway markers is recommended. These devises are on alternative to low intensity runway lights that do not require power.

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#### F. QUANTITY ESTIMATES - WATANA AIRSTRIP

Item I. Waste Excavation  $\frac{(2500 \text{ ft. x } 100 \text{ ft. x } 2')}{27} = 18,519 \text{ c.y.}$ Use 1.2 for contingency - use  $\underline{22,500}$  c.y.

- Item 2. Unclassified Excavation  $\frac{(320') (5') (2500')(1.2)}{(2) (27)} = 88,888 \text{ c.y. use } 90,000 \text{ c.y.}$
- Item 3. Fabric for Safty Area and Parking Area Safety Area  $\frac{100^{\circ} \times 2500^{\circ}}{9} = 27,778 \text{ s.y.}$ Extended Safty Area  $\frac{300\times200\times2}{9} = 13,333 \text{ s.y.}$ Parking Area  $= \frac{13000 \text{ s.y.}}{55,000 \text{ s.y.}}$
- Item 4. Crushed Surfacing [ (13000 s.y. + (2500)(100)(0.5)] (1.05) = 7136 cy say 7200 c.y.

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Item 5. Retro-Reflective Markers ± 75

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G. CONSTRUCTION COST ESTIMATE

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# APPENDIX B

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## SOIL BORING LOG

Sheet 2 of 2 Date 4/7/53

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| Boring No <u>AS 37</u><br>Feature <u>AIRSTRIP</u> <u>\$ \$77+00</u><br>Coordinates: N<br>E<br>Logged by <u>EEA</u> DNR |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                      |                                                                                                            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<u>4/8/83</u> Groun | d Elevation<br>Elevation<br>Depth<br>d-Water E                                                                 | evation                                             |  |  |
| Depth<br>(Elevation)                                                                                                   | Aig Błow<br>Count                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Sample<br>Interval                                   | Sample No.<br>and Type                                                                                     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               |                                                                                                                | 1 <sup>ST</sup> <sup>1</sup> ITEMPT<br>REFUSAL @ 10 |  |  |
| 4 4 24                                                                                                                 | ng L. J. Jun Y. Land Boundary Manufacture And Development American Street of Land Control Vision                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                      | Constraints and the second of the second sec | and the second sec       |                                                                                                                 |                | <i>Redoism Влоши Fine Graven</i><br>5 <sub>льгу</sub> Бано (F-c)                                                               | Y                                                                                                              |                                                     |  |  |
| A Iw                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                      | R                                                                                                          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| 5                                                                                                                      | na data baran yang manan na                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                      | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | And and a second se                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | na na 1 mar ang manangkangkan na n                                             |                | GERY GRAUELLY SILTY SAHOL                                                                                                      | FQ                                                                                                             |                                                     |  |  |
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1	Depth (Elevatic-) Rig Blow	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	nstrumentation	Remerks				
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1 1 REDDISM BEOWN SILTY SAND (F.C.) TR OF FINE SRAVEL DRY B B B B B B B B B B B B B		Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks		
	an and a second a				1				REODISH BROWN SILTY SAND (F-C) TR OF FINE GRAVEL DRY REFUSAL ON AUGER @ \$35				

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1 GRAY SILTY SAND (E.C) 3 GRAY SILTY SAND (E.C) 7 ATTEMPT BAS SAMFAG FOR FENTLE 0 5 - 3 5 7 ATTEMPT BAS SAMFAG FOR FENTLE 0 5 - 3 5 7 ATTEMPT FOR FENTLE 1 ATTEMPT FO	Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Lengtn Recovered	Graphic Log	Soil Description	Instrumentation	Remarks			
				1				GRAY SILTY SAND (F.C) TROF FINE GRAVEL		BAB SAMAAE FOR FROCTOR U.S 35 MC 15.8			

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The second s	Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
and the second sec								BRAWH ORGANIC JANO GRAY SILTY SAND TROF GRAVEL REFUSAL ON AUGER @ 3.5'		1 Co SAMELE F. R. Preuciur ().5 - 3.5
								Boring No		Sheet of

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		2			BRAY SILTY SAND TR OF FILE GRAVEL BRAY SILTY FILE SAND TROF COARSE SAND		E. X A MC 376 MC 376 MC 13 42 M 410-00 And 9% CLAA 9% CLAA PI = 4.75 LA = 201 PL = 1535

Rock Elevation Total Depth 25 Ground-Wate: Elevation	Angle (from Horizontal) $90$ Bearing Date Started $1/0/03$ Date Complete.' $7/0/03$	r ID.	50. R	50 Я ДЛ	153 e, p 47	К5 й N Е Е Е/	No e AL nates	ng ure dir	3orin Featu Doord Loggr
op art e e Remarks su	Soil Description	Graphic Log	Length Recovered	Blow Count per 0.5 ft.	Sample No. and Type	Sample Interval	Rig Blow Count		Cepth (Elevation)
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	MARZA - EBASCO	SOIL	BORING LOG		Sheet of Date7/2/53
	Boring No AS 52	Angle (from	Horizontal) 90	Ground Elevatio	on
107 <b>m</b>	Feature AIRSTRIP & 5414	Date Starte	A/8/83	- Rock Elevation Total Depth	55
	E ARM DAR	Date Comp	leted	Ground-Water E	levation
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		OLIVE	GRAY SILTY FIME	SANO	_
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## LABORATORY TEST REPORTS

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Project WATANA DAM         Hole MS 13         Depth 15-17 <sup>5</sup> AH- Dry NT Total Sample & Tare         1774         TOTAL SAMPLE           Tare Weight 1 (2) 5 4/2         Classification         1247 Gravella Silting Sand (Sim)           Total Sample WT 1231         Sieve Dia. Size         Num. WT Dry WT Z Ret.         Cum. X of To Ret.           Moisture Content         4" 101.6         -         -           -10 Material         3" 76.2         -         -           Can No.         11% 38.1         -         -           MT-Soil& Can(Met)         1" 25.4         0         -         -           MT-Soil& Can(Dry)         3/4" 19.1         55:0         -         -         -           MT-Soil& Can(Dry)         5" 44         -         -         -         -         -           WT of Soil (Dry)         #10         2.0         -         -         -         -           WT of Soil (Dry)         Pan         -         -         -         -         -           Sample         Grams         Jar #         Mashed Sample & Tare         -         -         -           Steve         Dia. MM         Cum. WT Weight         % of Total         Retained         Retained	° 4/7/83	WORK SHEET - PART	CLE SIZE ANAL	'SIS METER	Job No. <u>15032</u>	,003.08
Aff-Dry NT Total Sample & Tare         1774         TOTAL SAMPLE           Tare Weight 1 (2)         5.1/2         Classification         Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sample & Sampl	ject WATANA DAN	enterstellen enverse internet forset Mensen verste state state andere som mense at state state state state stat	Hole HS	13	Depth 15	-17 <sup>5</sup> 7
Tare Weight ) (2)       Classification       Sieve Dia. Cum. WT Dry WT % Cum. % of To         Total Sample WT 1231       Sieve Dia. Cum. WT Dry WT % Cum. % of To         Noisture Content       4" 101.6       Ret. Ret. Ret. Pas         Noisture Content       4" 101.6       Ret. Ret. Pas         -10 Material       2" 76.2         -10 Material       2" 76.2         -10 Material       2" 76.2	-Đry XT Total ple & Tare	1774	TOTAL SAMPLE			
Total Sample WT       1231       Sieve Size       Dia. MM       Cum. WT Ret.       Dry WT Ret.       Z Ret.       Cum. % of To Ret.         Moisture Content -10 Material       4"       101.6	e Weight   C	542 Classification	just bury gravel	in sith	sand (sm	)
Moisture Content       4"       101.6       -10         -10       Material       3"       76.2       -10         Can No.       1%"       30.8       -10       -10         Can No.       1%"       30.1       -10       -10         WT-Soil& Can(Dry)       3/4"       19.1       55.0       24.5       6         Loss       #4       6.6       211.0       -17.4       6         Material       #4.0       2.0       -10       -17.4       6         Material       #4.0       2.0       -17.4       6       6       6         Material       10       2.0       -17.4       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6	al Sample WT	IZ31 Sieve Dia. Size MM	Cum. WT Dry WT Ret. Ret.	% Ret.	Cum. % o Ret.	f Total  Passin
Can No.         2"         50.8	sture Content Material	4" 101.6 3" 76.2	ана (раз раз са зарание на зарание) на собрание с так со тока на так се на бала на собрание на собрание на соб Собрание на собрание на собрание на собрание на собрание с так со тока на собрание на собрание на собрание на с Собрание на собрание на соб			
MT-Soil& Can(Wet)       1"       25.4       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0	No.	overneendeensecrecorrenteendeensecrecorrenteendeensecrecorrenteendeensecrecorrenteendeensecrecorrenteendeensecre anominister anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation anticipation antic	178 Carriel 1997 Carrier & Bourgesterne Person (1999 - 604 1972) 1977 - 201 1976 & Alicony 19			
MI-Solra Can(Dry)       12.7       21.0       6.6       2         Weight of Can       #10       2.0       -17.4       1         WT of Soil (Dry)       Pan       -17.4       1       1         WT of Soil (Dry)       Pan       -17.4       1       1         WT of Soil (Dry)       Pan       -17.4       1       1         WT Representative       Grams       Jar #       WT Vashed Sample & Tare       -17.4         Sample       grams       Jar #       WT Vashed Sample & Tare       -17.4         Size       Dia. MM       Cum. WT       Weight       %       % of Total       Cum. 3 of Tot         Size       Dia. MM       Cum. WT       Weight       %       % of Total       Cum. 3 of Tot         Size       Dia. MM       Cum. WT       Weight       %       % of Total       Cum. 3 of Tot         10.       2.000       245.0       -       -       -       -       -       -       -       -       -       -       -       -       -       -       -       -       -       -       -       -       -       -       -       -       -       -       -       -       -	Soil& Can(Wet)	2/41 10 1	550		145	100
LOB3         #4         4.6         2110         -17.4         4           Wit of Can         #10         2.0		oncanna anna an that an that an the second and the second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second se	81.0		6.6	93,4
WT of Soil (Dry)       Pan         % Moisture       Total         REPRESENTATIVE MINUS NO. IO SAMPL."         WT Representative       Jar #       WI Vashed Sample & Tare       //20.00         Sieve       Dia. MM       Cum. WT       Weight       % of Total       Cum. % of Total         Sieve       Dia. MM       Cum. WT       Weight       % of Total       Cum. % of Total         Sieve       Dia. MM       Cum. WT       Weight       % of Total       Cum. % of Total         Sieve       Dia. MM       Cum. WT       Weight       % of Total       Cum. % of Total         Size	ght of Can		2110		-17.1	82.9
REPRESENTATIVE MINUS NO. IO SAMPL:           WT         Representative Sample         Jar         WT Uashed Sample & Tare         / 2000           Sieve         Dia. MM         Cum. WT         Weight         %         % of Total         Cum. % of Total           Sieve         Dia. MM         Cum. WT         Weight         %         % of Total         Cum. % of Total           Sieve         Dia. MM         Cum. WT         Weight         %         % of Total         Cum. % of Total           Size         Ret.         Retained         Retained         Retained         Ret.         Pass           10         2.000         2400         0.425         5120         700         700           200         0.425         5120         7100         700         700         700           200         0.053         7100         5000         7000         5000         7000         5000         7000         5000         7000         5000         7000         5000         7000         5000         7000         5000         7000         5000         7000         50000         7000         50000         7000         50000         7000         50000         7000         50000         <	of Soil (Drv)		ดสุของของสุของการเหลือจากรายสมบัติสามสมบัติสามสุของสมบัติสามสุของสุของสมบัติสามสุข สมบัติสามสุของการเหลือจากรายสมบัติสามสุของสมบัติสามสุของสมบัติสามสุของสุของสมบัติสามสุของ			a)
REPRESENTATIVE MINOS NO. 10 SAMPLE         WT       Representative Sample       grams       Jar #       With Uashed Sample & Tare   /2000 Tare Weight   2000       Care / 2000         Size       Ret.       Retained       Retained       Retained       Retained       Retained       Ret.       Passing         10       2.000       2900       2900       2900       2000       2900       71.0       70.0         200       0.425       51/2       0.000       71.0       70.0       70.0       70.0         200       0.425       51/2       0.000       71.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70.0       70	Labite Contraction of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Contract of the Cont	DOCCATTATIVE MANN		) 		ACCESSION ACCESSIONNESSCOLUM
WT         Representative Sample         grams         Jar #         Washed Sample & Tare   1/2000         Corrected Weight         Seve           Sieve         Dia. MM         Cum. WT         Weight         %         % of Total         Cum. % of Total           Size         Ret.         Retained         Retained         Retained         Retained         Retained         Ret.         Pass           10         2.000         245.0	<sup></sup>	PREDENIATIVE WINUS	NU. IU SAMPLI	ane factorianteriore		
State         Dia.         MM         Cum. WT         Weight         %         % of Total         Cum. % of Total           Size         2.000         245.0         8etained         Retained         Retained         Retained         Retained         Ret.         Pass           10         2.000         245.0         70         70         70         70           20         0.850         477         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70         70	Representati	e grams Jar #	<u>Wi Washed Sa</u> <u>Lare Weight</u>	THE G IS	ure /	6.60
Steve         Dia.         MM         Cum. with Ret.         Weight Retained         % of local         Cum. s of local           Size         Ret.         Retained         R			IWashed Sampl	<u>e Weight</u>	Cum " o	* Total
ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID         ID<	e juta. mm	Ret Retained	Retained R	or local stained	Ret	Daccin
20         0.850         47/2         72.7         6           30         0.600         4/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200         5/200	2.000	245.0	I NECATINE IN	SCATHER	24.5	76.7
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HARDING LAWSON ASSOCIATES ENGINEERS. GEOLOGISTS & GEOPHYSIC:STS

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HARDING LAWSON ASSOCIATES

PROJECT: Watana Dam	2014-2014 CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CONTRACTOR CON				DATE:	
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TARE NO.	58.00	47 54	4976			
L SITARE PLUS DRY SOIL	50.09	41.68	43.77		1997 Contractor of the Original Contract	
T & WATER W	791	5.86	599			
Y O TARE	10.84	11.35	11.30			
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HARDING LAWSON ASSOCIATES Engineers, geologists & geophysicists

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HARDING LAWSON ASSOCIATES Engineers. geologists / grophysicists



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HARDING LAWSON ASSOCIATES COMPARISON DECIDENTS & CEDENTLO STS

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HARDING LAWSON ASSOCIATES ENDINEERS, GEOLODISTS & CECT-FOIDISTS

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HARDING LAWSON ASSOCIATES Engineers. Geologists & Geophysicists

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HARDING LAWSON ASSOCIATES ENGINEERS, GEOLOGISTS & GEOPHYSICISTS
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HARDING LAWSON ASSOCIATES Engineers, geologists & geophysicists



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HARDING LAWSON ASSOCIATES Engineers, gedlugists & geophysicists



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## MISCELLANEOUS TEST RECORDS

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Job <u>Watana Dam</u>		No. 15	032,003.0	18	s/m A Dan	e: 4-11-8
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Depth	1-31	3-45	5-6	1-31	5.545	
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Cup No.	MN -10	MA-37	M&-11	MA-46	41148	
Dry Wt. Sefore Wash & Tare	316.28	3-9.19	205.41	181.10	318.9	digene.
Dry Wt After Wash & Tare	247,2	238.2	187.6	282.0	495.0	ł
Dry Wt Passing No. 200	69.08	14 7 1	22.51	199,1	323,7	
Cup Mt	88.0	90.06	87.99	88.7	91,1	1
Dry Wt Before Wash	159.2	250,93	117.92	392.4	727.5	
% Passing No. 200	43.4	48.9	18.9	50.7	44.5	
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HARDING LAWSON ASSOCIATES ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

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Job <u>Watana Dam</u>		No. ]	5032,003.0	18 By:		Date:	
Boring	AS 37	AS 38	A552	mc-7	mc -9	ASHH	
Depth	= a5-4.S	#2 2,5-4	#1 1-2.5	#1 1-2.5	=1 1-2	7105-2	}
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Dry Wt. Before Wash & Tare	488.5	1311.0	10470	1044.0	762.0	837.1	
Dry Wt After Wash & Tare	341.1	989.0	812.0	864.0	845.0	5 26,5	
Dry Wt Passing No. 200	147.4	324	235	180	117	310.6	
Cup Wt	90.81	531	537	544.0	542.0	86.4	
Dry Wt Before Wash	377.69	780	510	500	430	750.7	
% Passing No. 200	37.1	1 41.3	46.1	36.0	21.9	41.4	
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HARDING LAWSON ASSOCIATES ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

	Organic Cont	ent Loss By I	gnition		
Project: <u>Watana Dam</u>		Jc5 No.:	15032,003.08	By: B Date:	(241-6-B) 4/8/2
Boring	AS1 = 1	AS1 # 7	1 AS2 = 1	AS3 #2	1 AS3 = 3
Depth	0-1	1-7	0-1	3-4	5-7
Soil	very Dark	very Dark	Very Dink	Very Dairy	Darte bre
	Brown Pete	Sitty Send	Brown Pete	breyick Brownes	freed.
	all of Spaalysed				
Pan No.	(-7	(-22	(-6)	(.5	(-8
Drv Wt Before Burn & Tare	38.36	62.06	77.12	61.85	1 6 9
Dry Wt After Burn & Tare	34.76	60.78	20.44	57.88	62.
Wt Loss	3.60	1,28	6.69	1.97	.6
Pan Wt	17.49	18.53	14.37	18.24	161
Dry Wt Before Burn	20.97	43.53	8.76 .	43.61	46.
% Organic Matter	17.2%	2,9%	76.4%	4,5%	1.
			A		
Boring	AS4-1	ASS = 1	AS12 - 1	-	
Uepth	5-6	3.5-41	.5-1.0		
2011	Elack	very Dory	Lact		
		( some	العربين المالك		
			· · · · · ·		
			Urganre		
Pan No.	(-1)	(-19	(-20		
Dry Wt Before Burn & Tare	-24	22.0	52.02		
Ury WI Atter Burn & Tare	44.12	17.09	49.04		
Pan Wt	26.6	3,01	2.48		
Dry Wt Before Burn	30.51	5.60	22.86		
% Organic Matter	11,5%	89.5%	8.8%		
Notes & Additional Tests					
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Project: <u>Watana Dam</u>		Job No.:	15032,003.08	Date:.	4-11-8
Boring	0 C 14 #1	BC 32	0534	m	mcG
Depth	5.7.5	#1 .5-2.0	#1 .5-2.0	#1 0-1.5	파) 1-).
Soil		Very Lark greyish Bran		Burban	Jan Da
Pan No.	(-22	C-5	(-7	(-19	C-20
Dry Mt Sefore Rurn & Tare	40 75	4975	UE 19	42 57	61.19
Dry Wt After Burn & Tare	45.37	47.27	42.38	· 39,86	59.18
Wt Loss	3.28	1.98	2.81	3.71	2.0
Pan Wt	18.54	18.23	17.48	16.49	18.14
Dry Wt Cefore Burn	30.21	31.02	27.71	27.08	43.05
% Organic Matter	11.2	6.4	10.1	13.7	4.7
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CHICKEERS. GEOLDGISTS GEDPHYSICISTS

15032,003.08 MOISTURE CONTENT - DRY DENSITY No. 15032, BY (14 /MR DATE 7/10 6) Watana Dam JOB ASS=1 AS7=2 AS13=21 AS2#3 AS3#2 BORING 10' 3.5-4' 3-4.5 3-4 7-10' DEPTH SOIL Very Daris Dan't Gregic Very Dart Very Der Dark Brown brey Brown Small Silt Erown Georgis Scores Simpleis inturit ed Champs apperts to Contarring Hold + Sand Be all project 1 2 inde ~ 96 LENGTH TUBE + W, SOIL TUBE W, SOIL 100 FACTOR W. DENSITY MA-1 | M7-48 | MA-20 | CUP # MA-35 MA-4 CUP + W, SOIL CUP + D, SOIL MOIST, LOSS 1405.5 307.26 31-42 100.37 267,02 272.26 370,06 224.95 280.21 98.40 280.26 417.00 (46.50) 185.66 25.7 87.461 40,76 CUP 88.84 復 10.94 D. SOIL 191.37 144.14 22.2 1 12.7 MOIST, CONT. 14,1 200 DRY DENSITY 100 BORING DEPTH SOIL LENGTH TUBE + W.SOIL TUBE W. SOIL EACTOR W. DENSITY -CUP # CUP - W. SOIL CUP - D. SOIL MOIST, LOSS CUP D. SOIL MOIST, CONT, ż DRY DENSITY

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HARDING LAWSON ASSOCIATES ENSINEERS, SEOLOSISTS & GEOPHYSICISTS

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CUP + D.SOIL	353.41	1318.85	763.2	700.1		822 8	10073	15
MOIST, LOSS	30.34	30.24	177.8	103.4		1122.6	162.0	+
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HARDING LAWSON ASSOCIATES ENGINEERS, GEOLOGISTS & GEOPSITICUSTS

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CUP + W.SOIL	35442	294.87	36.71	1725.2	1-201	1.1.2	22 57	23
CUP + D.SOIL	327.82	265.50	286.6	696.0	1368.0	1797.0	301.85	20
MOIST, LOSS	37.11	39.37	73.88	35	108	216	20.1 a	-
CUP 5 COU	80.47	20.02	41.56		236	342	128	<u> </u>
		<u></u>	76.17	9.6	020	<u></u>	112:321	1.0
MOIST. CONT.	11.0	15.8	37.6	13.4	13.0	5.6	22.7	20
MOIST, CONT, DRY DENSITY		15.8	37.6	13.4	13.0	5.6	22.7	30
MOIST, CONT, DRY DENSITY BORING	 mca	15.8	37.6	13.4	13.0	5.6	22.7	<u> </u>
MOIST, CONT, DRY DENSITY BORING DEPTH	mc 2 #2 2-2.5		37.6	13.4	13.0	5.6	22.7	37
MOIST, CONT, DRY DENSITY BORING DEPTH SOIL	11.0 mc 2 #2 2-3.5		37.6	13.4	13.0	5.6	22.7	37
MOIST, CONT, DRY DENSITY BORING DEPTH SOIL	11.0 mc 7 #2 7.7.5	<u>15.8</u>	37.6	13.4	13.0	5.6	22.7	33
MOIST, CONT, DRY DENSITY BORING DEPTH SOIL	11.0 mca 22.5 1.1.1. Liny	<u>15.8</u>	37.6	13.4	13.0	5.6	22.7	31
MOIST, CONT, DRY DENSITY BORING DEPTH SOIL	11.0 mca #22.3.5		37.6	13.4	13.0	5.6	22.7	
MOIST, CONT, DRY DENSITY BORING DEPTH SOIL	11.0 mc 2 # 22.5 12.25	<u></u>	37.6	13.4	13.0	5.6	22.7	33
MOIST, CONT, DRY DENSITY 2 ORING DEPTH SOIL	11.0 mc 2 #2 2-3.5		37.6	13.4	13.0	5.6	22.7	34
MOIST, CONT, DRY DENSITY 3 ORING DEPTH SOIL	11.0 mc 2 22.5 12.5 12.5 12.5 12.5		37.6	13.4	13.0	5.6	22.7	34
MOIST, CONT, DRY DENSITY 3 ORING DEPTH SOIL	11.0 mc 2 2.2.5 12.5 12.5 12.5 12.5		37.6	13.4	13.0	5.6	22.7	24
MOIST, CONT, DRY DENSITY & ORING DEPTH SOIL SOIL LENGTH TUBE + W.SOIL TUBE	11.0 mc 2 2.2.5 12.5 12.5 12.5 12.5		37.6	13.4	13.0	5.6	22.7	
MOIST, CONT, DRY DENSITY 3 ORING DEPTH SOIL SOIL LENGTH TUBE * W.SOIL TUBE W. SOIL	11.0 mc 2 2.2.5 1.2.5 1.2.5 1.2.5 1.2.5		37.6	13.4	13.0	5.6	22.7	57
MOIST, CONT, DRY DENSITY 3 ORING DEPTH SOIL SOIL LENGTH TUBE * W.SOIL TUBE W. SOIL FACTOR	11.0 mc 2 2.2.5 12.5 12.5 12.5		37.6	13.4	13.0	5.6	22.7	33
MOIST, CONT, DRY DENSITY 3 ORING DEPTH SOIL SOIL LENGTH TUBE * W.SOIL TUBE W. SOIL FACTOR W. DENSITY	11.0 mc 2 2.2.5 1.2.5 1.2.5 1.2.5 1.2.5		37.6	13.4	13.0	5.6	22.7	
MOIST, CONT, DRY DENSITY &ORING DEPTH SOIL SOIL LENGTH TUBE * W.SOIL TUBE W.SOIL FACTOR W. DENSITY CUP #	11.0 mc 2 2.2.5 1		37.6	13.4	13.0	5.6	22.7	5
MOIST, CONT, DRY DENSITY 3 ORING DEPTH SOIL SOIL LENGTH TUBE + W.SOIL TUBE W. SOIL EACTOR W. DENSITY CUP # CUP + W. SOIL	11.0 mc 2 2-2.5 12.5 12.5 12.5 12.5 12.5 12.5 12.5 1		37.6	13.4	13.0	5.6	22.7	57
MOIST, CONT, DRY DENSITY 3 ORING DEPTH SOIL SOIL LENGTH TUBE * W.SOIL TUBE W. SOIL FACTOR W. DENSITY CUP # CUP # CUP + W. SOIL CUP + D. SOIL	11.0 mc 2 2.2.5 12.5 12.5 12.5 12.5 12.5 12.5 12		37.6	13.4	13.0	5.6	22.7	
MOIST, CONT, DRY DENSITY 3 ORING DEPTH SOIL SOIL LENGTH TUBE * W.SOIL TUBE W. SOIL FACTOR W. DENSITY CUP # CUP + W. SOIL CUP + D. SOIL MOIST, LOSS	11.0 mc 2 2 2-2.5 12: 52 12: 5		37.6	13.4	13.0	5.6	22.7	5.0
MOIST, CONT, DRY DENSITY PORING DEPTH SOIL SOIL LENGTH TUBE * W.SOIL TUBE W.SOIL FACTOR W. DENSITY CUP # CUP + W. SOIL CUP + D. SOIL MOIST, LOSS CUP	11.0 mc 2 2.2.5 1		37.6	13.4	13.0	5.6	22.7	51
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