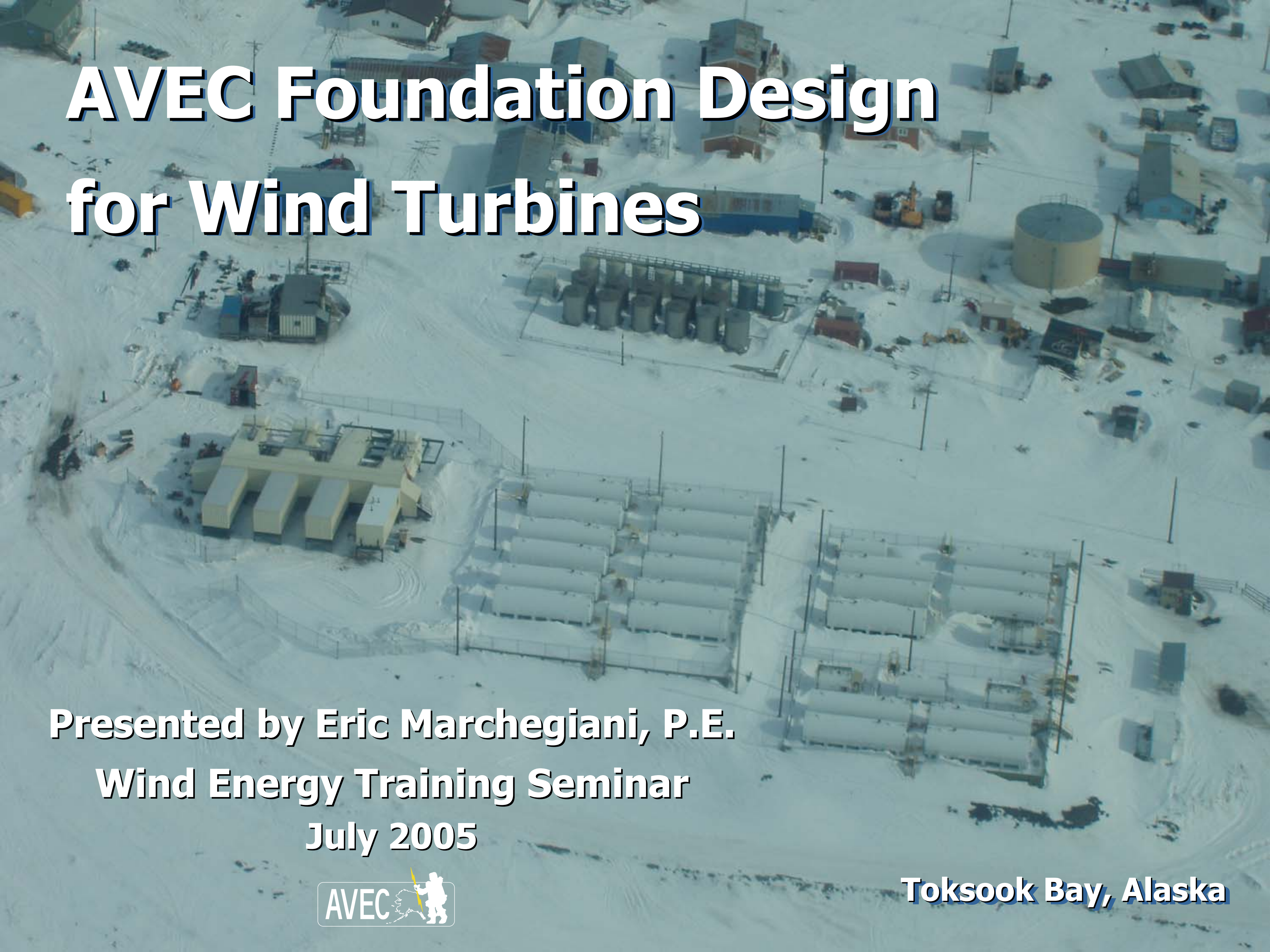
AVEC Foundation Design for Wind Turbines



Presented by Eric Marchegiani, P.E.

Wind Energy Training Seminar

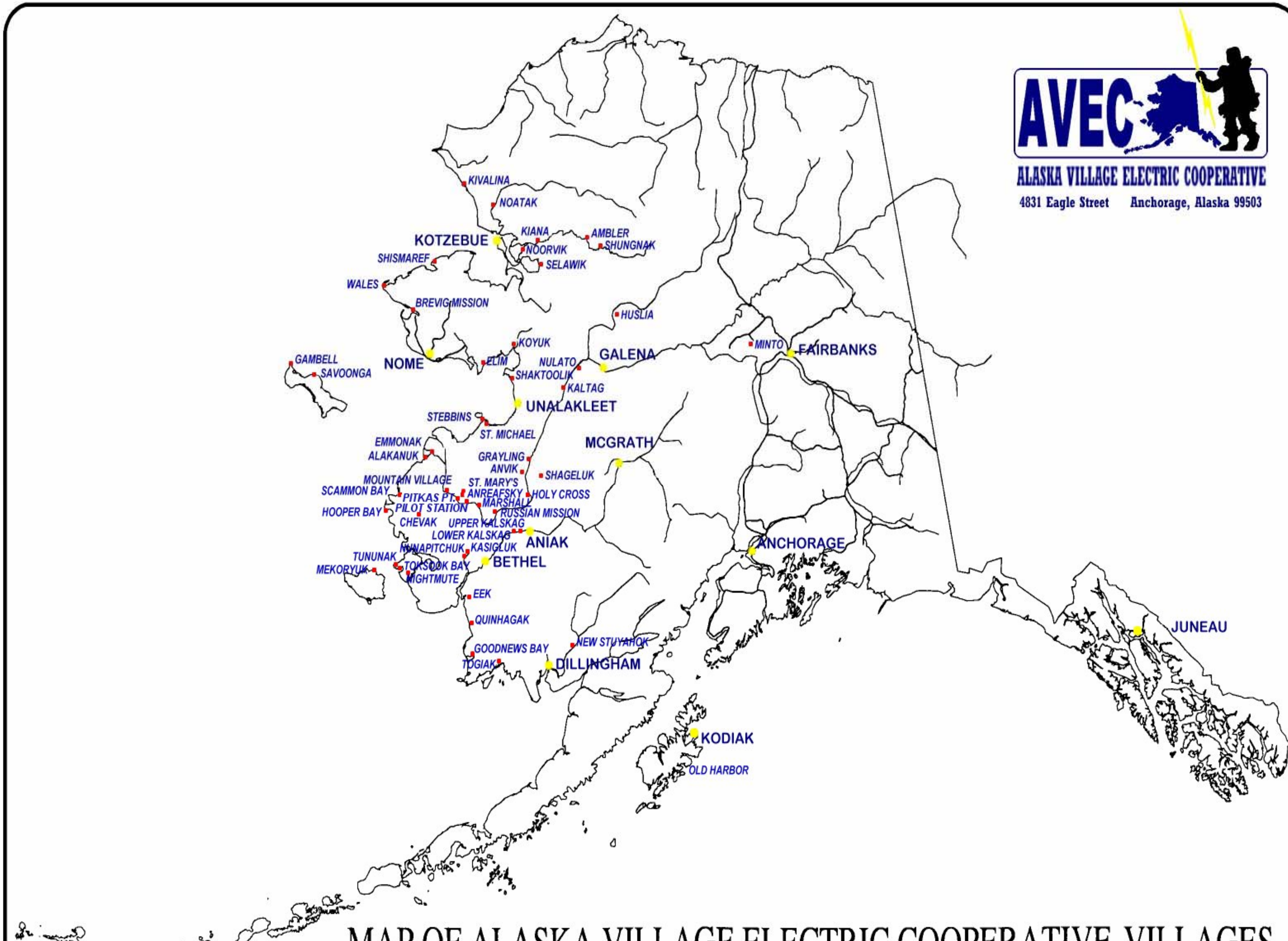
July 2005

AVEC

Toksook Bay, Alaska

Background Information

- **27 of AVEC's 52 villages are in wind regimes of class 4 or better.**
- **Given the characteristics of an NW/100, this means that one machine should be able to produce about 250,000 kWh per year.**
- **Given a diesel efficiency of 14 kWh/gallon generated by our new diesel sets, this means that one 100-kW wind turbine might displace about 17,800 gallons per year of diesel fuel use for power generation. A mini-wind farm of three units would displace about 53,400 gallons per year.**



MAP OF ALASKA VILLAGE ELECTRIC COOPERATIVE VILLAGES

Consider that in 2004 AVEC:

- Purchased 4.9 million gallons of diesel fuel
- Actively used nearly 550 fuel tanks for storage
- Took on fuel in 134 separate deliveries (including 27 by air)
- Has only one village – Minto – that can be supplied by a fuel truck
- Continued to experience electric load growth driven by new water and sewer systems, airports, schools and housing in the villages
  - This load growth increases fuel use and fuel storage needs

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Therefore, successful integration of wind generation could mean the following to AVEC:

- A hedge against increasing fuel costs
- A hedge against the increasing costs of marine deliveries
- Extension of on-hand fuel supplies which may translate to favorable delivery scheduling by marine transporters
- A reduction of the need to build expensive, additional storage on hard-to-acquire or difficult-to-construct sites.

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To do such efforts cost effectively, we need to do good planning and coordinate efforts with other construction projects underway in the village.

- The recent bulk fuel tank farm and power plant priorities of the Denali Commission provide some opportunity to coordinate logistics and use specialty equipment such as pile drivers or cranes that may be on-site.

Access for specialty equipment required to place foundations and erect turbines is a challenge.


Poor roads, water and sewer lines, boardwalks and existing overhead power and phone lines present obstacles and challenges.
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Foundations in permafrost are a challenge

- They must not settle, tilt or be uplifted
- Pile foundations (six to eight piles) may extend 1/3 to 2/3 the height of the tower into the ground

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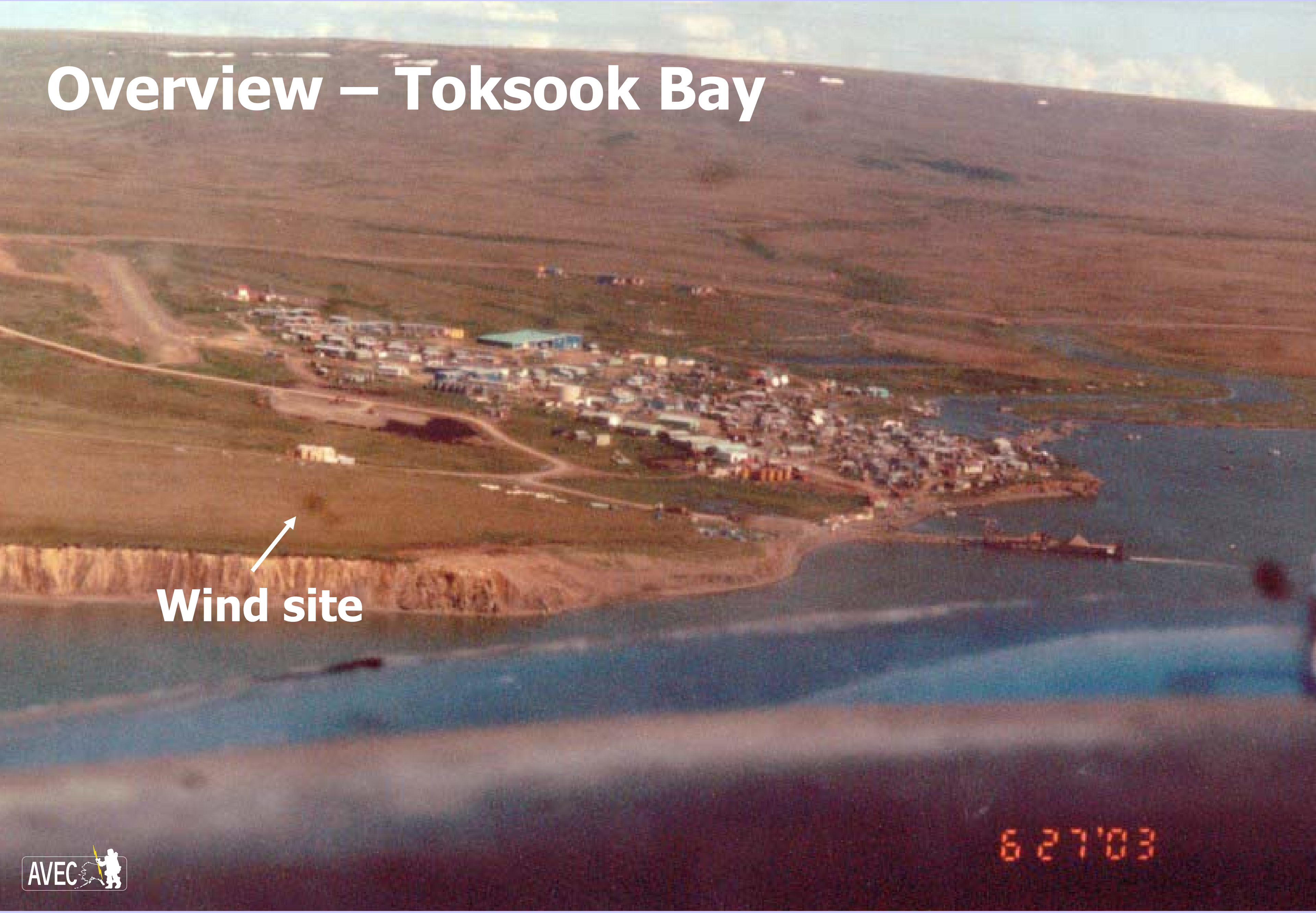
Overview – Toksook Bay



- Holes pre-drilled
- Piles driven to refusal
- Piles later cut

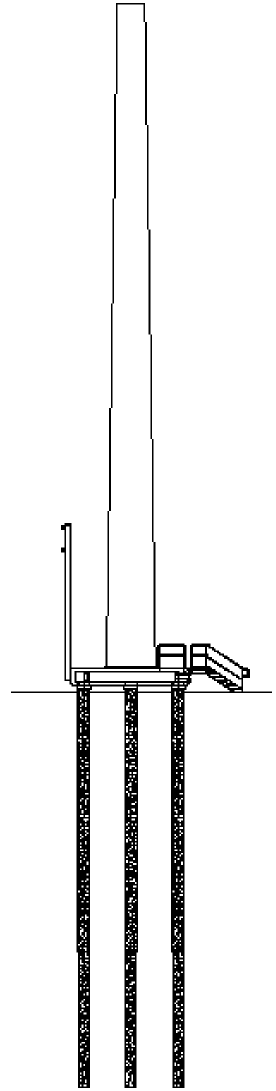
- Drilling out center of piles

  20' below end of pile

- **Six piles for a single tower foundation**

Piles with Met tower.

Steel Foundation Star (Typical of 3)



TOWER & FOUNDATION SECTION

ALASKA VILLAGE ELECTRIC COOPERATIVE

COFFMAN ENGINEERS
800 F Street
Anchorage, Alaska 99501
907-276-6664 Fax 907-276-5042

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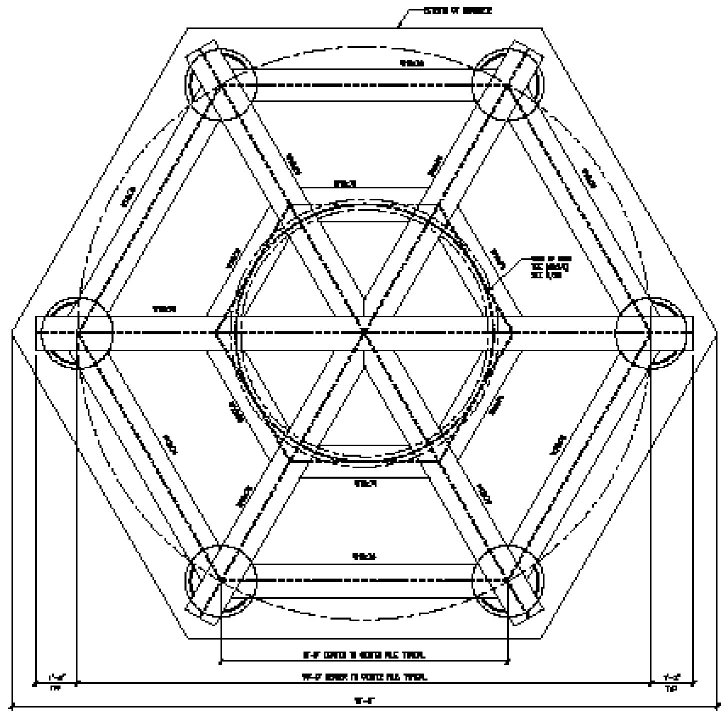
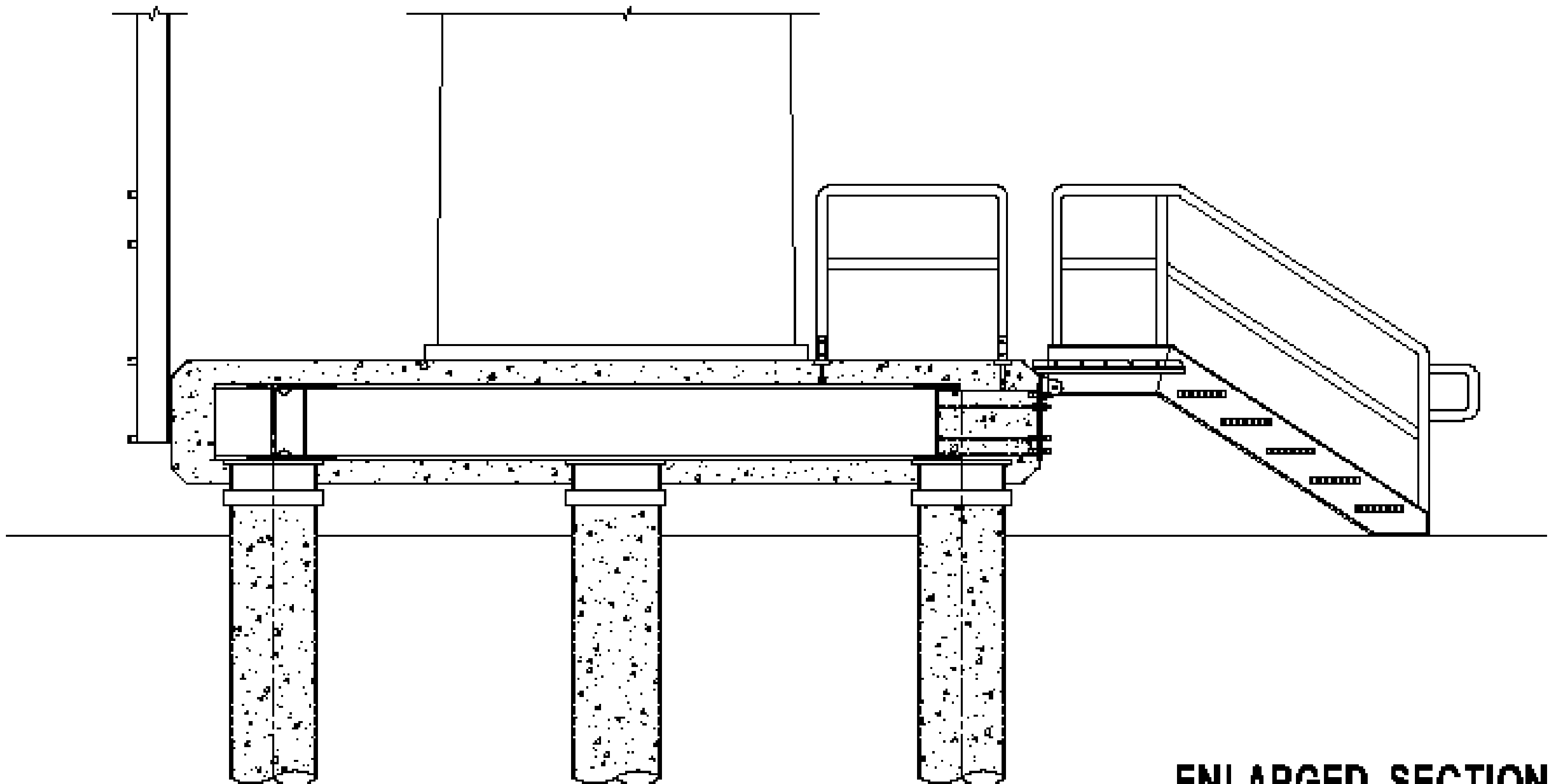


FOUNDATION PLAN

ALASKA VILLAGE ELECTRIC COOPERATIVE
4831 Eagle Street Anchorage, Alaska 99503

COFFMAN ENGINEERS
800 F Street
Anchorage, Alaska 99501
907-276-6664 Fax 907-276-5042



ENLARGED SECTION

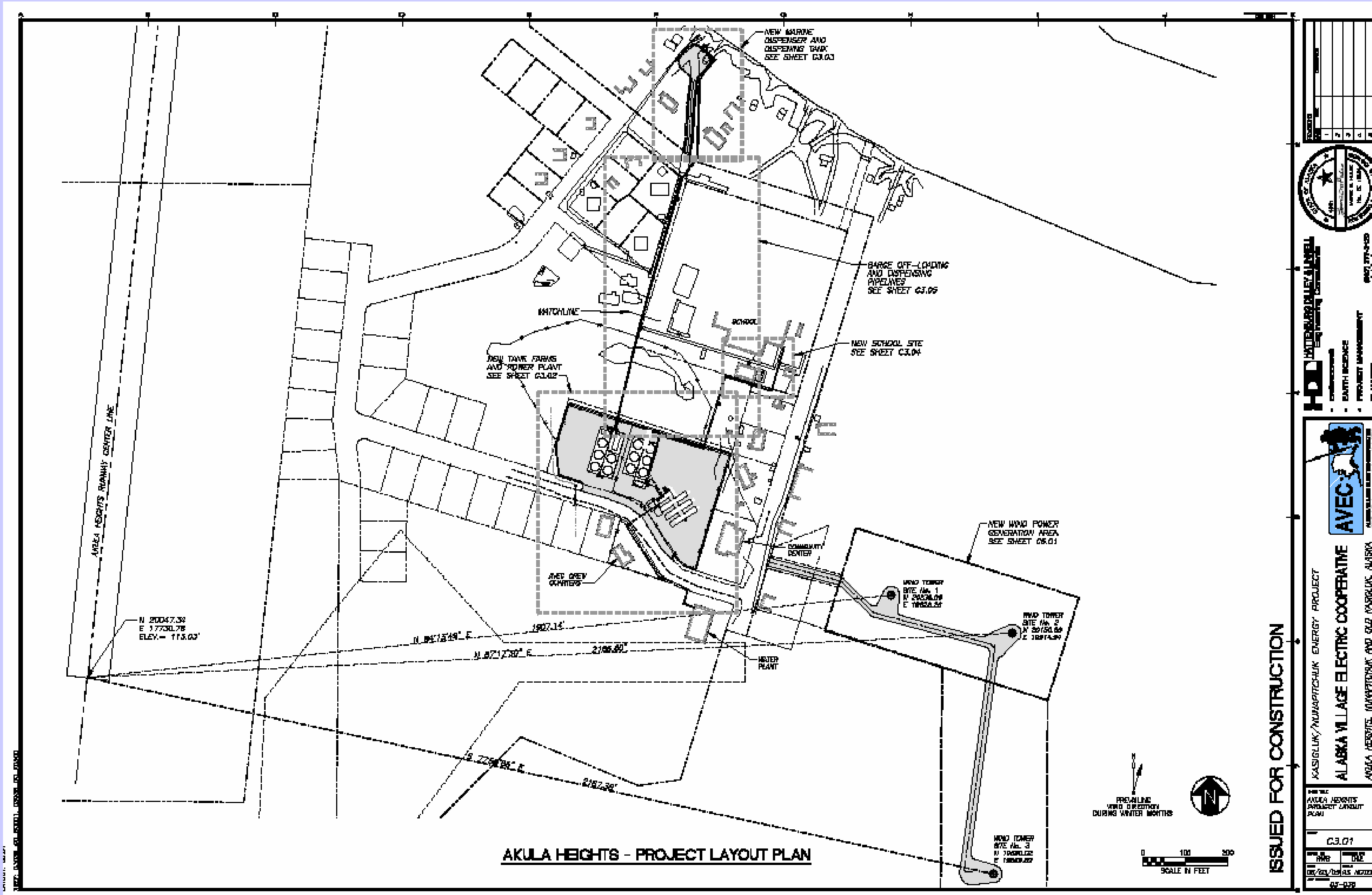
ALASKA VILLAGE ELECTRIC COOPERATIVE
4831 Eagle Street Anchorage, Alaska 99503

COFFMAN ENGINEERS
800 F Street
Anchorage, Alaska 99501
907-276-4864 Fax 907-276-5042

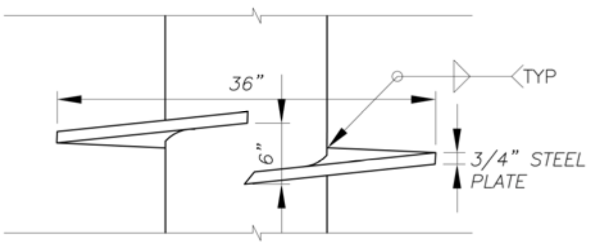
Nacelle at NPS production facility at Barre, Vermont

Danwin Tower Midway Platform

Danwin Tower Inside Flange/Bolt Holes



NEW MARINE DISPENSER AND DISPENSING TANK SEE SHEET C3.03
BARGE OFF-LOADING AND DISPENSING PIPELINES SEE SHEET C3.05
MATCHLINE
SCHOOL
NEW SCHOOL SITE SEE SHEET C3.04
NEW TANK FARMS AND POWER PLANT SEE SHEET C3.02
AKULA HEIGHTS RUNWAY CENTER LINE
AVEC CREW QUARTERS
COMMUNITY CENTER
NEW WIND POWER GENERATION AREA SEE SHEET C6.01
WIND TOWER SITE No. 1
WIND TOWER SITE No. 2
WIND TOWER SITE No. 3
WATER PLANT
N 20047.34
E 17730.78
ELEV.= 113.03'
1907.14'
2186.60'
2167.30'
PREVAILING WIND DIRECTION DURING WINTER MONTHS
N
0
100
200
SCALE IN FEET
AKULA HEIGHTS - PROJECT LAYOUT PLAN
ISSUED FOR CONSTRUCTION
KASIGLUK/NUNAPITCHUK ENERGY PROJECT
ALASKA VILLAGE ELECTRIC COOPERATIVE
AKULA HEIGHTS, NUNAPITCHUK AND OLD KASIGLUK, ALASKA
AVEC
AKULA HEIGHTS PROJECT LAYOUT PLAN
C3.01



3

SECTION - TYPICAL HELIX

SCALE: NONE

NOTES

1. ALL PILES SHALL BE INSTALLED OPEN ENDED WITH ENDS CUT AT 45 DEGREES.

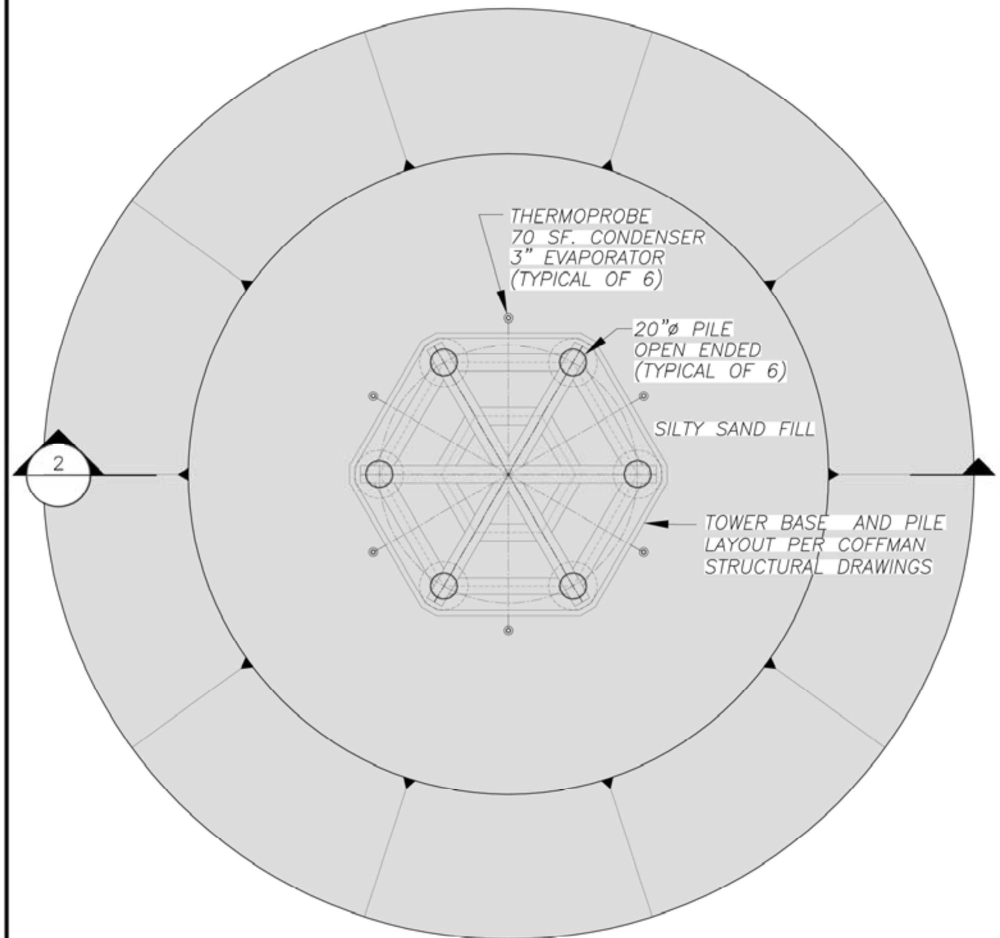
2. THE CONTRACTOR SHALL SUPPLY THE ENGINEER WITH THE INSTALLATION TORQUE OF EACH PILE. THE TORQUE VALUE SHALL BE AVERAGED OVER 24-INCHES DURING INSTALLATION OF EACH PILE WITHIN 5 FEET OF THE FINAL PILE INSTALLATION DEPTH.

3. ALL PIPE SPLICING SHALL BE FULL PENETRATION BUTT WELDS.

4. ALL WELDING, WELD PROCEDURES, PROCEDURES SPECIFICATIONS, AND WELDER QUALIFICATIONS SHALL BE IN ACCORDANCE WITH AWS D1.1. WELD ELECTRODES SHALL BE E70XX MINIMUM.

5. ALL WELD SIZES SHALL BE THE THINNER OF THE TWO METALS JOINED, UNLESS NOTED OTHERWISE.

6. FIELD WELD 1/2"x12" LONG, STEEL PLATE TO TOWER BASE AND CLAMP TO THERMOPROBE ADJUST WIDTH OF STEEL PLATE AS NECESSARY. DO NOT WELD TO THERMOPROBE.



1 WIND GENERATION TOWER BASE PILE LAYOUT PLAN

SCALE: NONE

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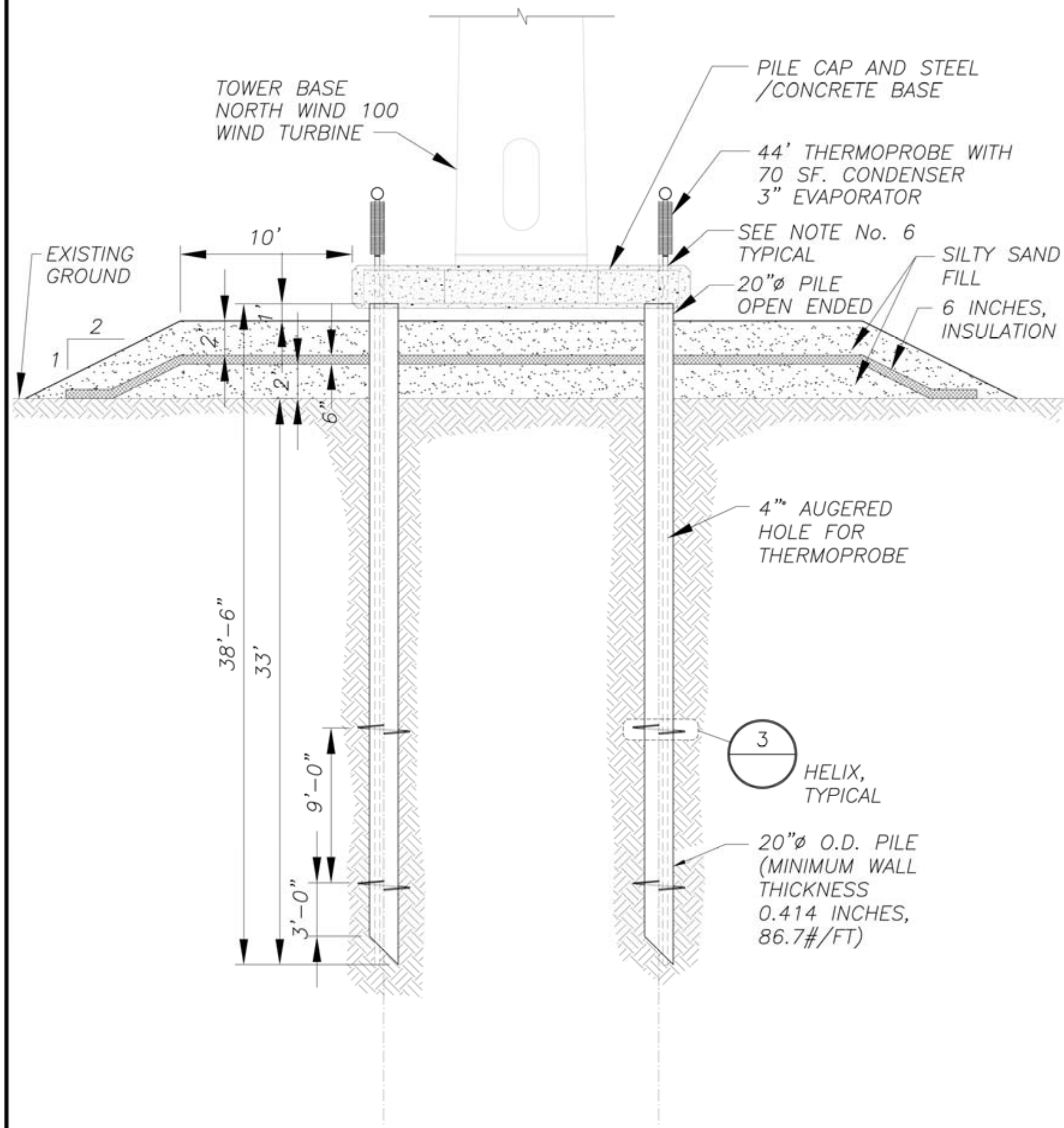

2 **SECTION**

SCALE: NONE

Dover Substation - Fort McMurray
C) Pile Design

Design of Piles Dover substation.doc

Ruth Lake Project- Fort McMurray
G) Design of single Helix in Tension

[Design of Piles at Ruth Lake project SINGLE HELIX.doc]


The end.
Any questions?
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