Questions and Answers about EMF
Cave Creek Unified School District #93
March 2006

1. **What is EMF and where is it found?**

   Power lines, electrical wiring, and appliances all produce electric and magnetic fields. EMFs are invisible lines of force that surround any electrical device. Electrical and magnetic fields have different properties and possibly different ways of causing biological effects. Magnetic fields weaken with increasing distance from the source and are measured in miligauss (mG) or tesla (T) as units of measurements. A typical hair dryer can produce 100mG while drying hair.

2. **What types of effects does EMF have?**

   Several kinds of biological effects have been reported in studies of electric and/or magnetic fields. A biological effect is a measurable change in some biological factor. It may or may not have any bearing on health. Overall, effects attributed to EMF's have been small and difficult to reproduce. Very specific laboratory conditions are usually needed for effects of EMF's to be detected. It is not known how EMF's actually cause these effects.

3. **How do Scientists Study Possible Effects of EMF's?**

   They use a type of research called epidemiology—the study of patterns and possible causes of diseases in human populations. Epidemiologists study short-term epidemics such as outbreaks of food poisoning and long-term diseases such as cancer and heart disease. Results of these studies are reported in terms of statistical associations between various factors and disease. The challenge is to discover whether the statistical results indicate a true causal association. This includes assessing possible effects of other factors ("confounders") that could affect study results. A "statistically significant" finding is one in which researchers are 95% confident that an association exists. However, a "statistically significant" finding does not necessarily prove a cause-effect association. Usually, supplemental data are needed from studies of laboratory animals before scientists can conclude that a given factor is a cause of disease.

4. **Are There any Federal or State Standards for EMF's?**

   The state of Arizona has not adopted any standards in relation to Electro-Magnetic Fields. Moreover, in the United States, there are no federal health standards specifically for 60-Hz EMFs. Therefore, we cannot determine levels of exposure which are "safe" or "unsafe".

5. What Process Does Cave Creek School District Use to Maximize Safety?

Before, during and after a new school is built, the District along with the engineers, administrators and architects perform *due diligence* to ensure that the site is safe and has the necessary permits for construction. When a concerned parent/community member brought this issue to the forefront, the District Administration and Governing Board immediately looked into the matter, working with the experts to determine if and when anything needed to be done in regards to any possible issues. The Director of Facilities and Construction is consistently monitoring our facilities and kept apprised of any potential hazards in order to mitigate them successfully.

6. How Will it Affect the New FLEX School?

The FLEX School is slated to open in August of 2006. The Governing Board has directed the Administration to keep the construction on track at this point while continuing to research concerns raised by the community member. A final vote of approval took place at the Governing Board meeting on March 28, 2006.

7. What is the Timeline For the New School?

Dr. Tacy Ashby, Cave Creek Unified School District Superintendent, convened a Short-Range Facilities Committee to address the needs of the community and make a research-based decision as to the best use of the FLEX school. Based on input from stakeholders and data provided, it was decided that the FLEX school should be a middle school and that Sonoran Trails Middle School will be moving to this new site that will be designed with the 6-8th grade student and staff in mind.

8. How and When Will the Parents and Community Be Informed of Decisions?

Information will be sent to the media, to schools for inclusion in the school newsletters, it will be posted on the website and phone calls will be made using our new Community Messaging Service.

9. Where can I go for additional information?

In the United States, public and private funds support EMF research. The federal government has conducted EMF studies for almost 20 years. More than a dozen federal government agencies have been involved. The state governments of New York and California have sponsored EMF-related epidemiologic research and several other states have commissioned EMF research summaries. Major financial support for EMF research has also come from the electric power industry,

primarily through the Electric Power Research Institute. Worldwide, at least 22 countries are conducting EMF research.

Examples of EMF Research by Federal Agencies

Department of Health and Human Services

- *National Institute of Environmental Health Sciences* - health effects and risk assessment.
- *National Institute of Occupational Safety and Health* - video display terminals.
- *Food and Drug Administration* - cellular phones, electric blankets, and medical devices.
- *National Cancer Institute* - epidemiological studies of breast cancer and childhood leukemia.

Department of Defense - radio frequency/breast cancer studies.
Department of Energy - biological mechanisms, exposure assessment.
Department of Transportation - high-speed and magleve trains, electric rail transportation systems.
U.S. Environmental Protection Agency - radio-frequency guidelines, research reviews.

10. How can I get more involved in decisions made in Cave Creek School District?

CCUSD welcomes participation on committees and at Governing Board meetings. Please check out our website for meeting information at www.ccusd93.org or contact the Superintendent's office at 480-575-2016 to participate on committees.

Website used:
World Health Organization - http://www.who.int/peh-emf/en/
Centers for Disease Control - http://www.cdc.gov/niosh/topics/emf/
National Institutes of Environmental Health Sciences - http://www.niehs.nih.gov/emfrapid/booklet/home.htm

EMF SURVEY REPORT

NEW CAVE CREEK MIDDLE SCHOOL
52ND STREET AND PINNACLE VISTA DRIVE
CAVE CREEK, AZ

PREPARED FOR
CAVE CREEK UNIFIED SCHOOL DISTRICT
P.O. BOX 426
CAVE CREEK, AZ 85327

Final Report Date
May 2, 2006

ET&T Project No: 061539

Conducted by:

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1. INTRODUCTION

Environmental Testing & Technology, Inc. (ET&T) was requested by Mr. Dennis Roehler, Director of Facilities and Construction, to conduct a preliminary electromagnetic field (EMF) survey at the currently under construction New Cave Creek Middle School No.93 located at the southeast corner of 52nd Street and Pinnacle Vista Drive in Cave Creek, Arizona.

The survey was requested to assess potential EMF levels at the school site to address the concerns of parents as two power transmission lines are located on the school property. The EMF survey was performed by Peter Sierck, Industrial Hygienist with ET&T on February 13, 2006.

2. METHODOLOGY AND INSTRUMENTATION

EMF measurements were performed extending perpendicularly from the center of the power lines. Measurement data was recorded in 10 foot increments from the center of the power line extending throughout the school complex.

These spot measurements were conducted at approximately 1 meter (3.28 feet) above ground level in accordance with ANSI/IEEE Standard 644-1994. The unit for magnetic flux density (EMF level) measurement is milliGauss (mG)

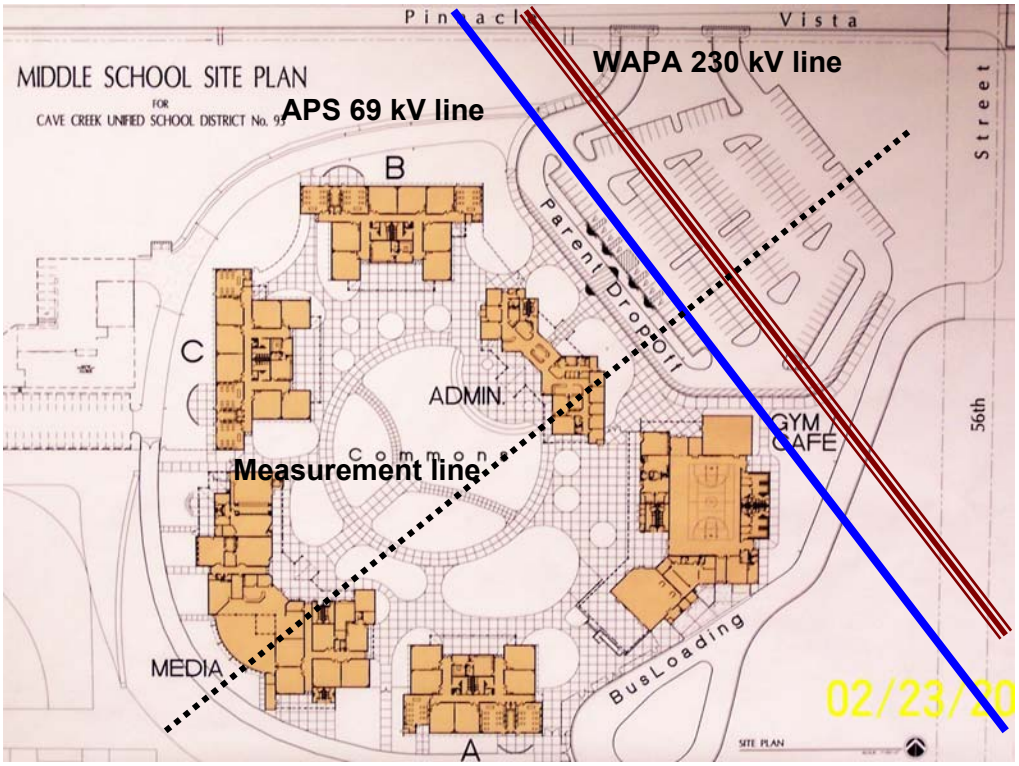
A *Teslatronics Model 710* and a *Holaday HI 3627* tri-axial magnetic field meters were used to measure the magnetic flux density which is referred to in this document as EMF levels. The frequency range for these instruments is 30 Hz to 2000 Hz. The equipment was calibrated prior to the survey according to manufacturer's recommendations.

Current load data and projected future load data was obtained from the utility providers to extrapolate projected average magnetic field levels on the campus. ET&T used a software program titled *MFCALC*, written by the Bonneville Power Authority, to model projected average and projected peak EMF levels at the school site.

3. SITE DESCRIPTION

Two power transmission lines traverse the school property in the parking lot located in front of the school complex. Both transmission lines travel parallel through the length of the parking lot in NW to SE direction.

Graph 1: Site Plan (No to Scale)



The line closest to the school complex is an APS 69 kiloVolt (kV), single circuit, 3 phase transmission line. The conductors are mounted in a triangle configuration on steel poles. The school building closest to this line is the Multi Purpose building. The NE corner of the Multi Purpose building is located 21 feet from the center of the transmission line.

The second transmission line is a Western Area Power Administration (WAPA) 230 kV, single circuit, 3 phase transmission line and located at approximately 87 feet from the NE corner of the Multi Purpose building. The conductors are mounted horizontally on steel lattice towers.

4. EMF MEASUREMENT RESULTS

Spot measurements were performed in 10 foot increments on a perpendicular line extending from the center of the APS 69 kV transmission line in proximity of the Multi Purpose building. The center of the transmission line is the zero (0) point in our measurements. The measurement values were obtained between 11:00 and 11:15 AM on February 13, 2006. Table 1 lists EMF levels in relationship to the distance from the transmission line. The third column identifies the buildings and areas at this distance and the corresponding EMF levels.

Table 1: EMF Levels (mG) Extending From the Northern Property Line

Distance (feet)	EMF levels (mG)	Buildings and Areas
0	7.7	Parking lot
10	6.5	Parking lot
20	5.5	NE section of Multi-Purpose building
30	4.8	NE section of Multi-Purpose building
40	4.1	NE section of Multi-Purpose building
50	3.5	NE section of Multi-Purpose building
60	3.0	NE section of Multi-Purpose building
70	2.6	NE section of Multi-Purpose building
80	2.3	NE section of Multi-Purpose building
90	2.0	NE section of Multi-Purpose building
100	1.7	NE section of Multi-Purpose building East wing of building B-classrooms
110	1.5	Center section of Multi-Purpose building Front of Administration building East wing of building B-classrooms
120	1.3	Center section of Multi-Purpose building Front of Administration building East wing of building B-classrooms
130	1.2	Center section of Multi-Purpose building Front of Administration building East wing of building B-classrooms
140	1.1	Center section of Multi-Purpose building Center of Administration building East wing of building B-classrooms
150	1.0	Center section of Multi-Purpose building Center of Administration building East wing of building B-classrooms
160	0.9	Center section of Multi-Purpose building SW section of Administration building East wing of building B-classrooms
170	0.8	South wing of Multi-Purpose building

		SW section of Administration building Center of building B-classrooms
180	0.7	South wing of Multi-Purpose building SW section of Administration building Center of building B-classrooms
190	0.6	South wing of Multi-Purpose building Center of building B-classrooms
200	0.6	South wing of Multi-Purpose building SW section of building B-classrooms Center of building B-classrooms Central courtyard
210	0.5	South wing of Multi-Purpose building SW section of building B-classrooms Central courtyard
220	0.5	South wing of Multi-Purpose building SW section of building B-classrooms Central courtyard
230	0.4	SW section of building B-classrooms Central courtyard
260	0.3	SW section of building B-classrooms Central courtyard
310	0.2	NE section of Building C-classrooms Central courtyard
360	0.1	Center section of Building C-classrooms NE section of Building A-classrooms Central courtyard
480	0.0	Library - Background levels at property

The electrical current traveling through conductors is creating magnetic fields around the conductor wires. The strength of the magnetic field in the surrounding area is dependent upon:

1) Amount of current flow (referred to as load or power usage)
2) Distance from the power line
3) Distance between the power line conductors
4) Conductor configuration
5) Presence of a net current flow

The decay in the magnetic field levels over distance is related to the actual current flow. This correlation is linear, the higher the current flow, the higher the magnetic field. The further one moves away from the source, the lower the magnetic field becomes.

ET&T has requested the following current flow data (loads or load data): 1) last year's average, 2) maximum load data, and 3) projected average load data from both utility providers. This information is necessary in order to predict average, maximum, and projected average EMF levels at the site. Different sets of data were made available to us. See Section 5 for the load data information provided to us.

A second set of measurements were conducted along a perpendicular line away from the buildings moving through the parking lot in a north easterly direction. Table 2 lists the EMF levels through the parking lot area. Measurements were taken progressing from the 69 kV line, to the 230 kV line, and extending beyond the parking lot area.

Table 2: EMF Levels (mG) in Parking Lot

Distance (feet) from center of 69 kV Line	EMF levels (mG) in parking lot	Corresponding Area
0	7.5	Under 69 kV line
10	9.2	Towards 230 kV line
20	11.9	Towards 230 kV line
30	14.8	Towards 230 kV line
40	17.6	Under 230 kV line
50	19.7	Under 230 kV line
60	21.0	Under 230 kV line
70	21.2	Center of 230 kV line
80	20.8	Under 230 kV line
90	19.6	Under 230 kV line
100	17.7	Under 230 kV line
110	14.9	Away from 230 kV line
120	12.3	Away from 230 kV line
130	10.0	Away from 230 kV line
140	8.2	Away from 230 kV line
150	6.6	Away from 230 kV line
160	5.4	Away from 230 kV line
170	4.6	Away from 230 kV line
180	3.9	Away from 230 kV line
190	3.3	Away from 230 kV line
200	2.9	Away from 230 kV line
210	2.6	Away from 230 kV line
220	2.2	End of parking lot

The EMF levels in the parking lot are significantly higher when compared to the school complex. This is due to the facts that the wire configuration of the 230 kV line creates larger magnetic fields and a higher current load was likely present during our survey time period. The 69 kV line's triangle conductor configuration is a configuration which produces relatively low EMF levels.

5. CURRENT LOAD DATA

ET&T requested, through Mr. Dennis Roehler, current load data during our survey time period from APS and WAPA. Additionally, information on projected future load conditions, historical data and maximum load capacity were requested to enable us to model EMF levels under different load conditions. APS and WAPA have provided the following load data:

APS Data (69 kV line)

Current flow during survey:	100 amps
Historical average load (2005)	114 amps
Projected average flow (2011):	130 amps
Projected summer peak (2011):	370 amps
Maximum capacity	1650 amps

WAPA Data (230 kV line)

Current flow during survey:	186 amps
Projected average flow:	290 amps
Historical peak August 2005:	319 amps
Maximum capacity:	1,449 amps

6. PROJECTED MAGNETIC EMF LEVELS

The strength of the magnetic field is dependent on, and directly proportional to the current flow. That means, if the current flow is doubled, the magnetic field strength will double at the measurement location. ET&T used a software program titled *MFCALC*, written by the Bonneville Power Authority, to model projected average and projected peak EMF levels at the school site. We utilized the load data provided by APS and WAPA in the software modeling process.

6.1 Projected Average and Peak EMF Levels

In our modeling, ET&T used the projected average current flow of 130 amps per phase for the APS 69 kV and 290 amps for the WAPA 230 kV transmission line. The conductor height on the power pole was used as the input height, although in actuality, utility lines sag between the poles which will result in slightly higher EMF levels in these areas. The projected average EMF levels obtained through our software modeling are expressed in Table 3.

To obtain projected peak EMF levels, we used the projected short term summer time peak loads of 370 amps per phase for the 69 kV APS line and 319 amps for the 230 kV WAPA transmission line for modeling purposes. The projected peak EMF levels obtained through our software modeling are expressed in Table 3.

Table 3: Measured and Projected Average EMF Levels (mG)

Distance from Center of APS Line (feet)	EMF Levels (mG) during survey	Projected Average Levels (mG)	Projected Peak Levels (mG)	Buildings and Areas at School Campus (see legend below)
0	7.7	14.5	19.7	Parking lot
10	6.5	12.7	17.8	Parking lot
20	5.5	10.9	15.3	NEMP
30	4.8	9.2	12.9	NEMP
40	4.1	7.7	10.6	NEMP
50	3.5	6.5	8.6	NEMP
60	3.0	5.5	7.3	NEMP
70	2.6	4.8	6.2	NEMP
80	2.3	4.2	5.3	NEMP
90	2.0	3.7	4.6	NEMP
100	1.7	3.2	4.0	NEMP, ECBB
110	1.5	2.9	3.5	CMP, FAB, ECBB
120	1.3	2.6	3.1	CMP, FAB, ECBB
130	1.2	2.3	2.8	CMP, FAB, ECBB
140	1.1	2.1	2.5	CMP, CAB, ECBB
150	1.0	1.9	2.3	CMP, CAB, ECBB
160	0.9	1.8	2.1	CMP, SWAB, ECBB
170	0.8	1.6	1.9	SMP, SWAB, CCBB
180	0.7	1.5	1.7	SMP, SWAB, CCBB
190	0.6	1.4	1.6	SMP, CCBB
200	0.6	1.3	1.5	SMP, SWCBB, CCBB, CCY
210	0.5	1.2	1.4	SMP, SWCBB, CCY
220	0.5	1.1	1.3	SMP, SWCBB, CCY
230	0.4	1.0	1.2	SWCBB, CCY
260	0.3	1.0	1.0	SWCBB, CCY
310	0.2	0.7	0.7	NECBC, CCY
360	0.1	0.5	0.6	CCBC, NECBA, CCY
480	0.0	0.3	0.4	Library

Legend

NEMP	Northeast section Multi Purpose building	SMP	South wing Multi-Purpose building
ECBB	East section classroom building B	CCY	Central courtyard
CCBB	Center of classrooms building B	CCBC	Center section classrooms building C
SWCBB	SW section classrooms building B	NECBA	NE section classrooms Building A
NECBC	NE section classrooms building C		
CMP	Center section Multi-Purpose building		
FAB	Front of Administration building		
CAB	Center of Administration building		
SWAB	SW section of Administration building		

7. SUMMARY

Two power transmission lines are located in the parking lot of the new school campus. The center of the 69kV transmission line, operated by APS, is located very close to the Multi Purpose building (21 feet). A distance of 120 feet is present between the WAPA power line and the front of the administration and the C classroom buildings.

The major contributing factor to the EMF levels at the site is the 230 kV line located further away from the buildings (87 feet from Multi Purpose building). This is mainly due to the conductor configuration and usually higher current flow. The conductor configuration at the 69 kV line is a low EMF wire configuration.

The EMF levels at the school campus and its buildings ranged from 0.0 to 5.5 mG at the time of the survey (see Table 1). ET&T conducted software modeling to obtain projected average and peak data on EMF levels with projected data provided by the utility providers. The computer modeling with projected load data yielded significantly higher levels when compared with the survey measurements. This is due to the lower current flow during our survey in the winter time.

Magnetic field levels are directly related to the current flow, also referred to as the load, on the transmission line. Current loads vary throughout the day and the time of the year. The current load typically peaks during daytime hours in the summer and in the afternoon and evening hours during the winter.

Our modeling showed that under projected average load conditions, the EMF levels at the school campus and its buildings ranged between 0.3 and 10.9 mG. The EMF levels under peak load conditions ranged between 0.4 and 15.3 mG. Higher field levels are to be expected in the front parking lot. For more detailed information on the EMF Levels in the different buildings and areas of the campus, please refer to Table 3 in this report.

The school buildings close to the transmission lines exhibit very high EMF levels when compared to other commercial, residential or public buildings in the US. These projected EMF levels may not reflect the actual EMF levels at a given day as they are dependent on the actual current flow.

The table below provides you with some reference data regarding EMF levels commonly encountered or suggested.

0.0 mG	Background level at school property
0.2 – 0.3 mG	Average at Horseshoe Trail Elementary School
0.1 to 0.5 mG	Common background levels in residential buildings not close to power lines and without wiring problems which are causing high fields

0.9 mG	Average background level in residential buildings in a nationwide residential measurement survey of 1000 US homes (Luciano Zaffanella, 1994). Includes homes next to power lines and with wiring problems.
1.25 mG	California Department of Education's (CDE) design goal for school environment not to exceed 1.2 milliGauss
1.25 mG	Average EMF levels in US schools (L. Zaffanella study, 1998)
2.0 mG	TCO - Swedish labor union standard for acceptable magnetic field emission for computer operator
2.5 mG	MPR 2 Swedish governmental standard for acceptable magnetic field emission for computer operator
1000 mG	American Conference of Governmental Industrial Hygienists (ACGIH)
1000 mG	World Health Organization (WHO) and International Radiation Protection Agency (IRPA)

In the State of California, the Department of Education requires a specific setback from high voltage electrical power transmission lines for new proposed school sites. The set back requirements depend on the nominal voltage of the transmission line. *Title 5, California Code of Regulations*, *Section 14010* requires the following setbacks for high voltage transmission lines:

500-550 kV lines – 350 feet
220-230 kV lines – 150 feet
50-133 kV lines – 100 feet

It is important that during the construction process adherence to the National Electrical Code (NEC) is vigorously enforced and verified to preempt and eliminate potential additional sources of high magnetic fields at the school site. An EMF survey should be conducted after all buildings are in operation.

Reduction of the EMF levels can be achieved by under-grounding or establishing different conductor configurations. ET&T can assist you by EMF modeling with different overhead and underground conductor configurations to assess feasibility and reduction potential. However, the cost of reconfiguring the power lines will likely have to be carried by the school district.

# # #

If you have any further questions, please feel free to contact me at 760-804-9400.

Respectfully Submitted,

Peter Sierck,
Industrial Hygienist/Director