GEOTECHNICAL INVESTIGATION REPORT
& ENGINEERING ANALYSIS - MODIFICATIONS
GOLDEN EAGLE PARK DAM
NEAR GOLDEN EAGLE BOULEVARD
& PALISADES BOULEVARD
FOUNTAIN HILLS, ARIZONA

AGRA Earth & Environmental

ENGINEERING GLOBAL SOLUTIONS

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Submitted To:

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Date Signed 9/15/99
ARIZONA, U.S.A.

September 15, 1999

AEE Job No. 9-117-001011
Report No. 1

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September 15, 1999
AEE Job No. 9-117-001011
Report No. 1

Stantec Consulting, Inc.
7776 Pointe Parkway West
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Attention: Chuck Gopperton, P.E.

Gentlemen:

RE: GEOTECHNICAL INVESTIGATION REPORT
& ENGINEERING ANALYSIS - MODIFICATIONS
GOLDEN EAGLE PARK DAM
NEAR GOLDEN EAGLE BOULEVARD
& PALISADES BOULEVARD
FOUNTAIN HILLS, ARIZONA

Our Geotechnical Investigation Report for the above referenced project is herewith submitted. The report provides the results of the subsurface investigation and laboratory analysis completed for the project, and presents criteria for design and construction of the project.

Should any questions arise concerning this report, please do not hesitate in contacting us.

Respectfully submitted,

AGRA Earth & Environmental, Inc.

Clinton J. Garner, E.I.T.

Reviewed by:

Registered Professional Engineer (Civil) CERTIFICATE NO. 12170 NORMAN HAROLD WETZ Signed 9/15/99 ARIZONA, U.S.A.

Norman H. Wetz, P.E.
Senior Geotechnical Engineer

c: Addressee (12)

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Registered Professional Engineer
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APPENDICES

1.0 INTRODUCTION

This report presents the results of a geotechnical investigation performed by AGRA Earth & Environmental, Inc. (AEE) for the proposed modifications to Golden Eagle Park Dam in Fountain Hills, Arizona. The purpose of this investigation was to evaluate the physical properties of the soils underlying the site. Based on this evaluation, recommendations are presented for design and construction of the project.

2.0 PROJECT DESCRIPTION

Details of the project were provided to us by George Sabol, P.E. of Stantec Consulting, Inc.. It is understood that the crest of the dam will be raised 5 feet and the emergency spillway will be expanded by adding 120 feet to the spillway crest. In addition, a low-level auxiliary outlet consisting of a 4-foot by 8-foot reinforced concrete box culvert will be constructed through the earthen embankment.

The dam is a zoned earth design and has a total length of about 1,000 feet, including 300 feet of emergency spillway and 700 lineal feet of embankment spillway. The crest elevation of the embankment is 1721 feet and the elevation of the spillway invert is 1716 feet. The existing slopes of the dam embankment are about 2H:1V (horizontal to vertical). The maximum height of the zoned earth embankment is about 28 feet. The emergency spillway consists of a concrete sill with riprap on the downstream side of the sill. The embankment spillway consists of two 60-inch diameter reinforced concrete pipes passing through the left end of the dam.

In general, the dam appears to be in good condition. However, there are some isolated areas that have experienced some minor erosion and tree growth which potentially could adversely affect the dam safety. A dam safety evaluation was performed, the results of which are presented in a previous report (AEE, 1998)*.

3.0 INVESTIGATION

3.1 REVIEW OF EXISTING DATA

A geotechnical engineering study previously completed by AEE (AEE, 1998) was reviewed as part of this investigation. This report established engineering properties of the existing embankment materials.

*References are listed at the end of this report.

3.2 SUBSURFACE EXPLORATION

Seven test pits were excavated to depths ranging from 2.5 to 5.0 feet below existing grade in the emergency spillway to determine the presence of riprap. The pits were excavated using a Caterpillar 416C backhoe. Bulk samples were recovered at various locations within the test pits. The soils encountered were continuously examined, visually classified and logged.

Results of the field investigation are presented in Appendix A, including a site plan showing the test pit locations and logs of the excavations. The field investigation was supervised by Brad A. Walldorf, E.I.T., of this firm.

3.3 LABORATORY ANALYSIS

The moisture contents of selected samples recovered were determined. The results of these tests are shown on the test pit logs. Grain-size analysis and Atterberg limits tests were performed on selected samples. The results of these tests are presented in Appendix B.

4.0 SEISMIC HAZARD & EARTHQUAKE DESIGN PARAMETERS

The seismic hazard at the Golden Eagle Park Dam site was evaluated considering historic seismicity within 200 kilometers (km) of the dam site and by deterministic analysis of active faults located within 50 km of the dam site. A map of faults is not included in this report; a map of late Quaternary faulting in Arizona was published by Pearthree and others (1983) and Euge and others (1992). Pearthree (1998) recently updated the database of Quaternary faults in Arizona, and the U.S. Geological Survey, in a cooperative research project with the State of Arizona, has digitized the Quaternary fault traces.

Table 1 contains a summary of faults that are included in the lists by Euge and others (1992) or Pearthree (1998) that are located within 50 km of Golden Eagle Park Dam. The fault names, identification numbers, maximum magnitudes, and locations were taken from Euge and others (1992). Identification numbers by Pearthree (1998) are also presented. Values of mean peak and 84th percentile (one standard deviation larger than the mean) horizontal accelerations were computed using the attenuation published by Spudich and others (1997) specifically for extensional tectonic regimes, such as the Basin and Range and Transition Zone provinces in Arizona.

TABLE 1
SUMMARY OF ACTIVE FAULTS

	Identification Number				Peak Acceleration (g)	
Fault Name	**Euge et al. (1992)**	**Pearthree (1998)**	**Maximum Magnitude**	**Distance (km)**	**Mean**	**84th Percentile**
Carefree	135	947	6.5	16.3	0.13	0.21
Rolls	142	---	6.5	21.3	0.10	0.17
Sugarloaf	141	945	6.75	25.0	0.10	0.16
Alder Creek	136	---	6.5	35.0	0.06	0.11
Horseshoe	133	946	6.75	37.0	0.07	0.11
Tonto Basin Northwest	137	---	6.5	40.0	0.06	0.09
Tonto Basin Central	138	---	6.5	45.0	0.05	0.08

Note: Peak acceleration computed using attenuation relationship of Spudich and others (1997) for rock site conditions.

The Carefree fault is the closest identified fault to the site. It is considered by Euge and others (1992) to be capable of generating earthquakes as large as magnitude 6.5. However, for rupture of its full 10.5 km length, as reported by Pearthree (1998), the expected magnitude would be 6.2, according to the procedure published by Wells and Coppersmith (1994). Pearthree (1998) summarized the Carefree fault as follows:

> "Low, fairly well defined, west- to southwest-facing fault scarps as much as 3 m high formed on Precambrian granite and possibly on Quaternary deposits. Along much of the fault zone, the fault is a contact between bedrock on the upthrown (east) side and middle Pleistocene alluvium on the downthrown (west) side. There are no unequivocal fault scarps on alluvium, but probable alluvial fault scarps observed at a couple of localities are low and gentle. Recent detailed geologic mapping (Skotnicki et al., 1997) strongly suggests that middle Pleistocene deposits are faulted. Holocene and upper Pleistocene deposits cross the fault and are not displaced."

The Sugarloaf fault is considered by Euge and others (1992) to be capable of generating earthquakes as large as magnitude 6.75. However, for rupture of its full 8.0 km length, as reported by Pearthree (1998), the expected magnitude would be 6.1, according to the procedure published by Wells and Coppersmith (1994). Pearthree (1998) summarized the Sugarloaf fault as follows:

> "Fault forms low but fairly sharply-defined, east-facing scarps as much as 5 m high at the boundary between weathered Precambrian granite and Tertiary basin-fill sediment. The bedrock escarpment associated with the fault is not high, but it is quite linear and fairly steep. Fault scarps formed on alluvium are rare and poorly preserved. ... Three trenches were excavated across the fault and a natural fault exposure was cleaned off and interpreted (Pearthree et al., 1995). Detailed study of these exposures indicates that upper and probably uppermost Pleistocene alluvium is faulted against granite; middle to upper Holocene deposits are not faulted."

The omission of several of the faults in Table 1 from Pearthree's (1998) compilation of Quaternary faults in Arizona suggests that insufficient evidence exists to justify including them in the database.

Earthquake catalogs maintained by the National Geophysical Data Center (NGDC) in Boulder, Colorado, and the U.S. Geological Survey Internet site were searched for earthquakes located within a radius of 200 km of the dam site. Figure 1 shows the locations of the epicenters. Also shown are the boundaries of the seismic source zones defined by Euge and others (1992). It can be seen in Figure 1 that historical seismicity is widely scattered in the vicinity of the dam site (which lies near the edge of the Arizona Mountains Zone). A number of earthquakes are shown as having no magnitude. Typically, these are earthquakes in the catalog based on damage or felt reports. Most of these events occurred before seismographs were available to record moderate earthquakes. Improvements to the seismic monitoring networks on a worldwide basis occurred in 1963. Consequently, the threshold magnitude for detection of earthquakes improved at that time.

The historical seismicity data can be converted into a representation of earthquake activity by determining the cumulative number of earthquakes that are equal to or larger than a series of magnitudes and dividing by the number of years in the earthquake record. The annualized earthquake activity of events of magnitude 3 or greater located within 200 km of the Golden Eagle Park Dam is shown in Figure 2. The lower curve in Figure 2 represents the same earthquake activity as described by the upper curve normalized to an area of 1,000 km^2, or a circle with a radius of 17.8 km. The maximum earthquake magnitude shown in Figure 1 and 2 is 5.2.

The data shown in Figure 2 were further developed into earthquake hazard curves shown in Figure 3. Annualized exceedance probabilities (or average recurrence intervals) are shown for a range of peak horizontal acceleration values. Plots of mean and 84th percentile peak acceleration are shown in Figure 3. As noted above, the attenuation relationship of Spudich and others (1997) for rock site conditions was used in converting the data plotted in Figure 2 to that plotted in Figure 3. Also shown in Figure 3 are probabilistic hazard curves from Euge and others (1992) and Frankel and others (1996). The curves determined by these studies are nearly identical, indicating a peak horizontal acceleration of about 0.11 g for an average recurrence interval of 2,500 years, but show higher accelerations than the site-specific deterministic analysis based on the historical earthquake catalog and faults considered active. The rate of earthquake activity within 200 km of the site has been low during historic time. The relative scarcity of geologic evidence of surface fault displacements suggests that the historically low rate probably is also representative of the prehistoric geologic rate of earthquakes in the region.

The mean and 84th percentile accelerations at the dam site for the Carefree fault, the closest active fault, are shown in Figure 3 for reference, as are values that would be generated by a magnitude 6 event at a distance of 5 km. The attenuation relationship by Spudich and others (1997) uses a distance of 0 km for all sites vertically over the projection of the subsurface fault plane. None of the faults listed in Table 1 are located under the Golden Eagle Park Dam, and a minimum distance of 5 km was used to determine maximum accelerations for non-fault specific hypothetical earthquakes (the so-called background earthquake) plotted in Figure 3.

The geologic evidence of prehistoric surface faulting on the Carefree fault was discussed with Dr. Phil Pearthree, geologist with the Arizona Geological Survey (1999 personal communication). Dr. Pearthree noted that the total apparent vertical displacement across the Carefree fault in Quaternary time is probably no more than a few meters, and the slip rate is very low (< 0.01 mm/yr). Therefore, any significant earthquake activity on the Carefree fault must be very rare, even in geologic terms. Therefore, it may not be logical to have a maximum earthquake on the Carefree fault be the controlling event for design of the Golden Eagle Park Dam, particularly if the 84th percentile acceleration is used as the design parameter.

The 84th percentile acceleration at the dam site is also shown in Figure 3 for the Sugarloaf fault, the closest fault assigned a magnitude of 6.75 by Euge and others (1992). The 84th percentile acceleration for the Sugarloaf fault (0.16 g) is the 69th percentile acceleration for the Carefree fault.

Based on the data presented above, it is recommended that a peak horizontal acceleration of 0.13 g be used for the stability analysis of Golden Eagle Park Dam. Based on the 84^{th} percentile curve shown in Figure 3, this acceleration value has an average recurrence interval of approximately 11,500 years. It also is the mean value of peak acceleration calculated for the maximum earthquake on the Carefree fault. The results of probabilistic seismic hazard analyses by Euge and others (1992) and Frankel and others (1996) suggest that the recommended design acceleration corresponds to an average recurrence interval of slightly more than 2,500 years, or a 2 percent exceedance probability in a period of 50 years.

5.0 ANALYSIS OF RESULTS & RECOMMENDATIONS

5.1 EXISTING & PROPOSED CONSTRUCTION

Golden Eagle Park Dam is a zoned earthen embankment that is approximately 28 feet high at its maximum height section. Based on a recent survey of the dam, the average slope of the upstream and downstream faces is 2.3H:1V (horizontal to vertical), as compared to the 2H:1V slope shown on the as-built construction plans.

The dam has a core that varies in width from 32 feet at the base of the dam to 16 feet at the crest. The construction specifications for the project indicate that the core material (Zone I) was to have 100 percent passing the 3-inch sieve, and a maximum of 35 percent passing the no. 200 sieve. In addition, the plasticity index of the material was to range between 5 and 25. Based on lab testing completed for AEE Job No. 8-117-001014, the plasticity for the core material ranged from nonplastic to 6, and the gradation was coarser than the original specifications.

Construction specifications for the shell (Zone II) material indicated that 100 percent of the material should pass a 12-inch sieve, and a maximum of 12 percent should pass the no. 200 sieve. The plasticity of the material was to be less than 5. Laboratory testing indicates that these specifications were generally adhered to although the material is more fine that originally specified.

The proposed new construction includes widening the emergency spillway, installing a low-level auxiliary outlet consisting of a 4-foot by 8-foot reinforced concrete box culvert to the right of the existing embankment spillway, and raising the dam by about 5 feet. All new material will be placed on the crest and upstream face of the existing dam. No new material will be added to the downstream face. The material will be placed at a 2H:1V slope along the upstream face.

In addition, a sand diaphragm will be constructed around the low-level auxiliary outlet to prevent piping and pressure buildup due to any leakage that may occur.

5.2 ANALYSIS OF RESULTS

AEE reviewed test data from the original Geotechnical Report (AEE Job No. 8-117-001014), and have performed additional testing. Based on the results, AEE completed seepage and stability analyses. The results of the analyses are presented in Sections 4.3 and 4.4, respectively. In addition, recommendations for erosion protection and sand diaphragm design, and recommended geometry and materials for raising the dam are provided in Sections 4.2, 4.5 and 4.6, respectively.

5.3 EROSION PROTECTION

According to Stantec Consulting, Inc., the exit velocity of flood waters through the emergency spillway is in the range of 10 to 12 feet per second. Due to the high velocities, a large diameter riprap material would be necessary to prevent erosion. This type of material is not available on-site, and would be expensive to import. The existing riprap extends from the sill downstream to the existing sidewalk. The maximum size of the riprap is 18 inches. The site plan in Appendix A (Figure 10) shows the extent of the existing riprap. It appears that the existing riprap is not adequate for the critical sections of the spillway where high velocity flows are anticipated. It is recommended that wire gabion baskets or mattresses be used to prevent erosion of the emergency spillway where high velocities are present.

5.4 SEEPAGE ANALYSIS

Analyses of potential seepage were completed for the maximum height section using the finite element computer program SEEP/W Version 4, developed by Geo-Slope International (1997). The analyses were limited to estimation of the seepage through the core and embankment fill section and within the upper 23.0 feet of the underlying foundation. An impervious boundary was assumed to exist at a depth of 23.0 feet, for simplicity. Table 2 lists the assumed permeability coefficients for the core, embankment fill and foundation materials. With the free water surface at the freeboard level of 3.0 feet below the dam crest, the phreatic surface is calculated to exit from the dam above the inboard dam toe, as indicated in Figure 4.

The phreatic line indicated in Figure 4 is considered to be conservative, in that prior to that time the flood waters of a short-term storm event (typical for this area) would have receded, significantly reducing the driving pressure head, and lowering the phreatic surface. Negligible seepage is anticipated at the inboard dam face. Therefore, special protection of the dam to prevent piping of soils from the embankment is not considered to be necessary.

TABLE 2
Assumed Coefficients of Permeability for
Flood Control Dam & Foundation Zones

Zone	Assumed Coefficient of Permeability (cm/sec)
Core (Zone I)	1×10^{-4}
Embankment Soils (Zone II)	1×10^{-2}
Foundation Soils	1×10^{-6}

Seepage beneath the embankment (within the upper 23.0 feet) computed by SEEP/W, is estimated to be 1.4×10^{-3} gallons per minute per foot of embankment, measured near the inboard dam toe. This value would be high for most of the dam alignment as the seepage is based on the maximum embankment section, not accounting for reduced head conditions along the remainder of the dam.

5.5 STABILITY ANALYSIS

Analyses of embankment stability through the maximum section were performed using the computer program PC STABL5M (Achilleos, 1988). PC STABL5M is based on a two-dimensional limiting equilibrium method. The factor of safety against failure was calculated using a conventional method of slices approach with the modified Bishop method of analysis. The particular procedure employed generates circular-shaped slope surfaces between specified coordinate limits. The computed factor of safety is conservative relative to solutions obtained by more accurate methods satisfying complete equilibrium.

The geometry and strength parameters used in the analyses are listed in Table 3. The strength parameters for the various zones were chosen to represent average strengths of local materials, which will be used for embankment construction, and the underlying foundation soils. Estimates of soil strength parameters for the dam and foundation are also based on the laboratory sieve and Atterberg limits test data, as well as our experience with similar projects.

TABLE 3
Soil Strength Parameters Used for Stability Analyses

Material Type	Moist Unit Weight (pcf)	Cohesion (psf)	Internal Angle of Friction (degrees)
Core (Zone I)	130	300	32
Embankment Soils (Zone II)	135	0	38
Foundation Soils	107	1,000	28

Post-construction, steady-state seepage, rapid drawdown and pseudo-static analyses were performed for the cross section. The steady-state seepage condition assumes a fully developed phreatic surface extending through the embankment. The potential for this type of phreatic surface developing is considered to be extremely low; however, the full phreatic condition was assumed for the steady-state stability analyses. Pseudo-static analyses (assuming dry conditions) were performed assuming a horizontal acceleration of 0.13g. The likelihood of both severe flooding and a seismic event to occur simultaneously would be extremely remote; thus, this combined case was not considered herein.

Results of the stability analyses are listed in Table 4, and plots of the critical shear surfaces are shown in Figures 5 through 8, inclusive.

TABLE 4
Results of Stability Analysis

Case	Computed Minimum Safety Factor
Post-Construction	1.9
Steady-State	2.0
Rapid Drawdown	1.3
Pseudo-static	1.1

5.6 RECOMMENDED SAND DIAPHRAGM

5.6.1 Gradation & Dimensions

The sand diaphragm was designed in accordance with the method outlined by Wilson and Marsal (1979) for filter design. The sand diaphragm material should conform to the following gradation, determined in accordance with ASTM C136:

Sieve Size (square openings)	Percent Passing by Weight
2 inch	100
1 inch	65-100
1/2 inch	50-85
No. 4	30-65
No. 10	20-50
No. 16	0-40

Dimensioning for the sand diaphragm is shown in Figure 9. The diaphragm should extend from the outer edge of the low-level auxiliary outlet 12 feet above and horizontally from the outlet, and 6 feet below.

5.7 RECOMMENDED GEOMETRY & MATERIALS FOR DAM RAISE

5.7.1 Recommended Geometry

Based on the stability analyses reported in Section 5.5, a slope of 2H:1V is adequate for both upstream and downstream slopes. It is recommended that the core material (see Section 5.7.2) be used to raise the dam from its existing height to the proposed height. The core material should extend horizontally from the top of the existing dam to the point were it matches with the new 2H:1V slope. Below this point, Zone II material should be used for the remainder of the proposed dam addition.

5.7.2 Materials for Dam Raise

Tables 5 and 6 present recommended gradations for materials placed for Zone I (core) and Zone II (shell).

TABLE 5
Zone I (Core)

Sieve Size (Square Openings)	Percent Passing by Weight
3-inch	100
no. 4	60-100
no. 200	15-60

The plasticity index should be between nonplastic and 25.

TABLE 6
Zone II (Shell)

Sieve Size (Square Openings)	Percent Passing by Weight
12-inch	100
no. 4	25-75
no. 200	0-20

The plasticity index should be less than 10.

5.8 EARTHWORK GUIDELINES & TEMPORARY CUT SLOPES

Temporary cut slopes for the construction of the box culvert should be no steeper than 1.0H:1.0V (horizontal to vertical) when excavating in the Zone I materials (core). The cut slopes for the Zone II materials (shell) should be no steeper than 2.0H:1.0V.

Although the original embankment construction was controlled using the modified Proctor (ASTM D1557) density, it is recommended that the standard Proctor (ASTM D698) density be used to control new construction. The standard Proctor will provide for higher moisture contents to be used in construction and will provide a less brittle embankment. It will result in a better transition between the existing and new construction.

All new materials should be compacted to at least 95 percent of maximum dry density in accordance with ASTM D698. Moisture content during compaction should be maintained between 1 percent below to 3 percent above optimum moisture content.

Where construction of embankment materials against existing slopes occurs, the existing slope should be cut a minimum of 2.0 feet horizontally as the fill is brought up in 6- to 8-inch lifts. This will minimize the possibility of slippage between existing materials and new embankment fill. The material cut out should be compacted to the same specification as the fill material.

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FIGURES

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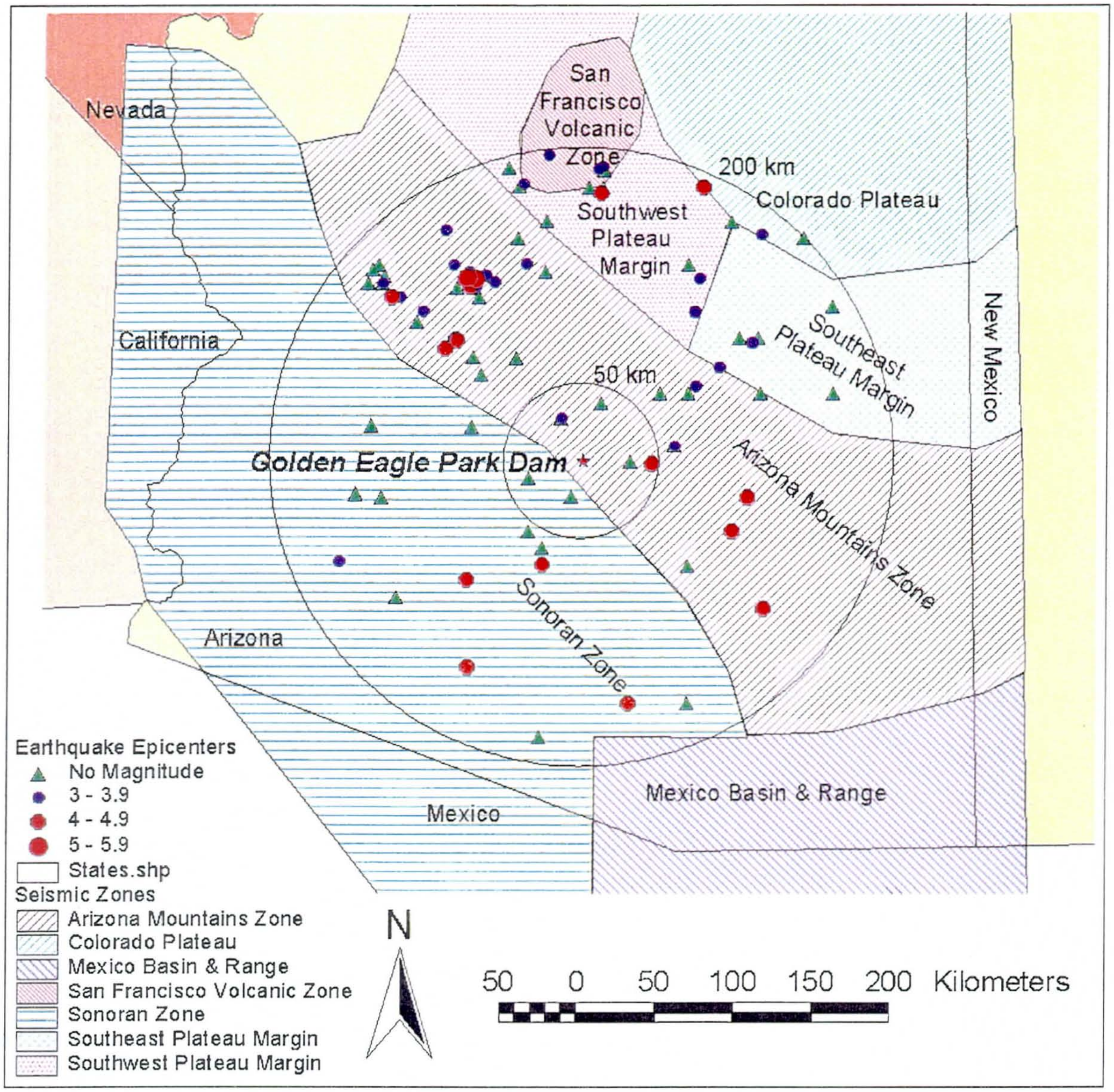

Figure 1
Locations of Earthquake Epicenters within 200 km
of Golden Eagle Park Dam, Fountain Hills, Arizona

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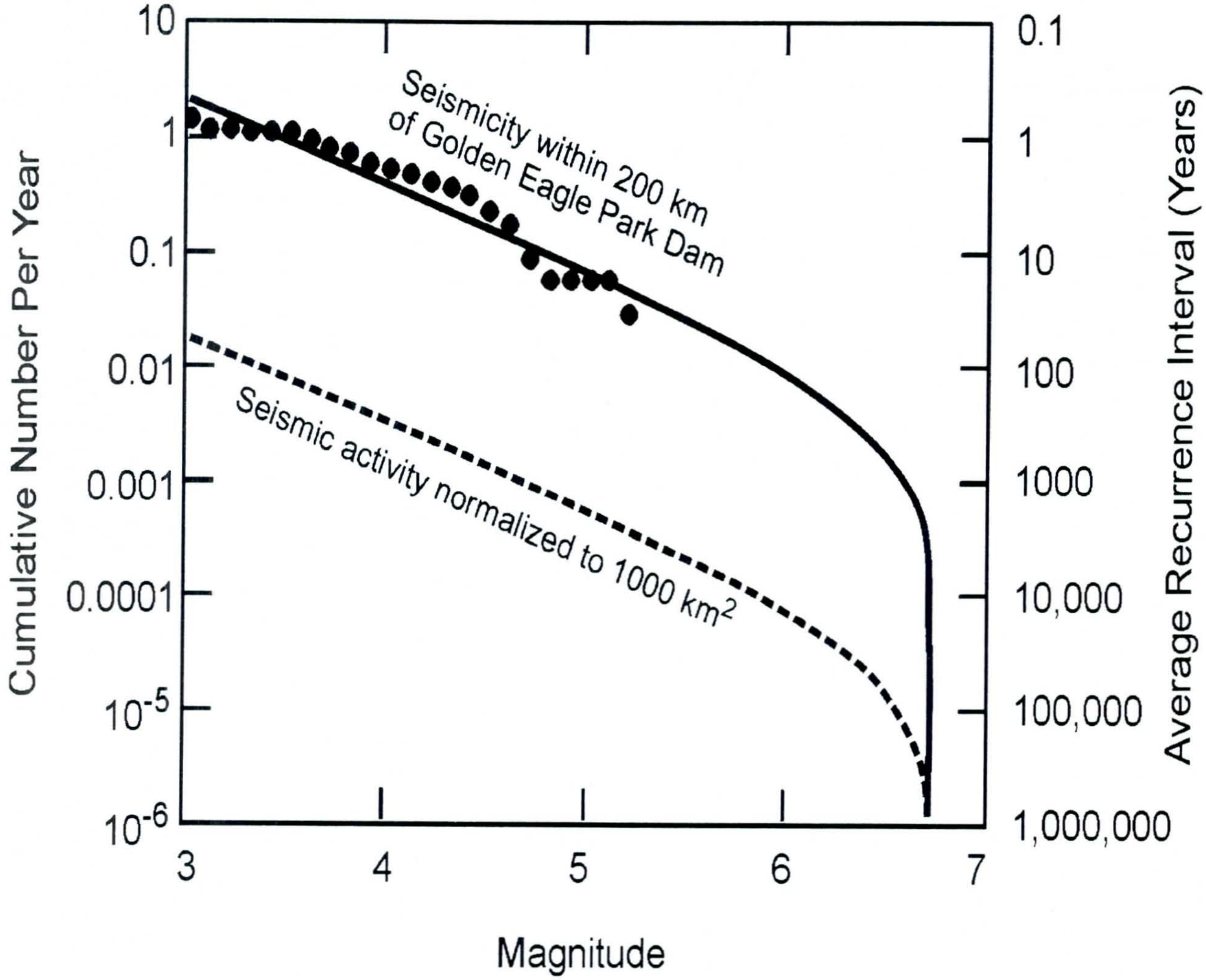

Figure 2
Annualized Earthquake Activity of Magnitude 3 or greater within 200 km of Golden Eagle Park Dam, Fountain Hills, Arizona

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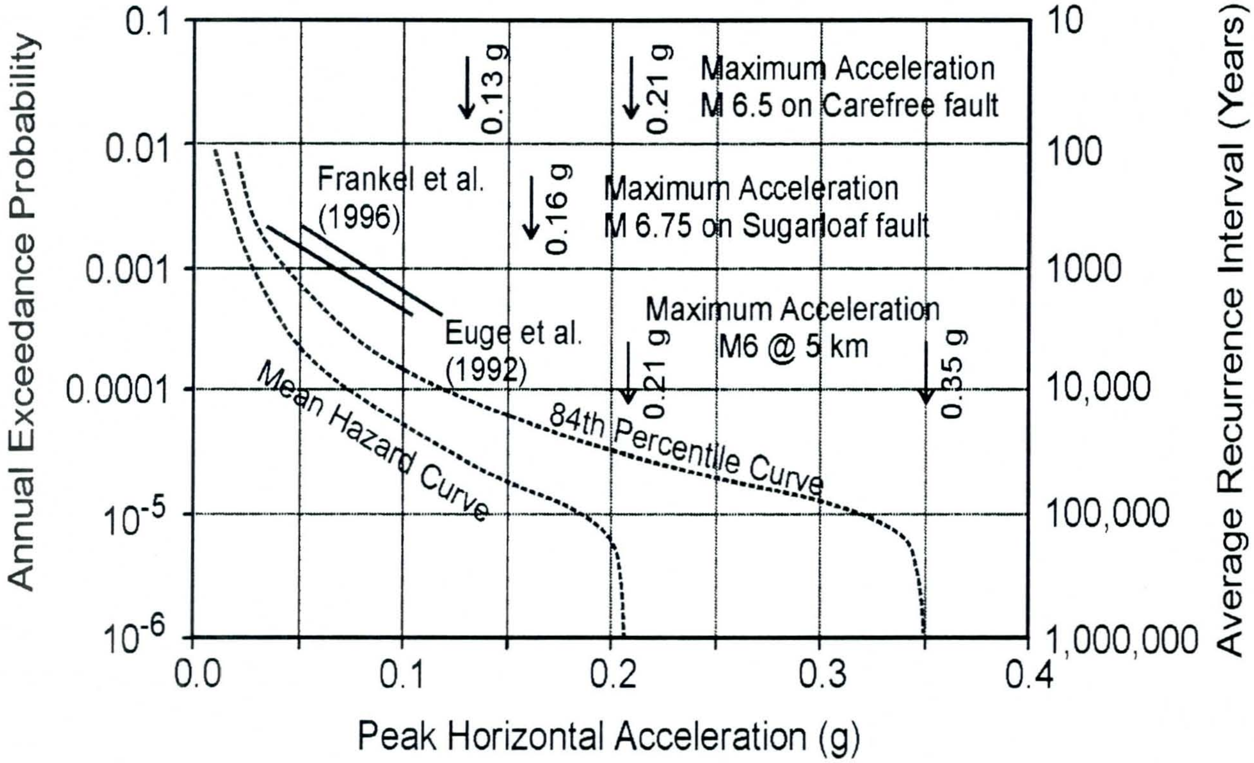
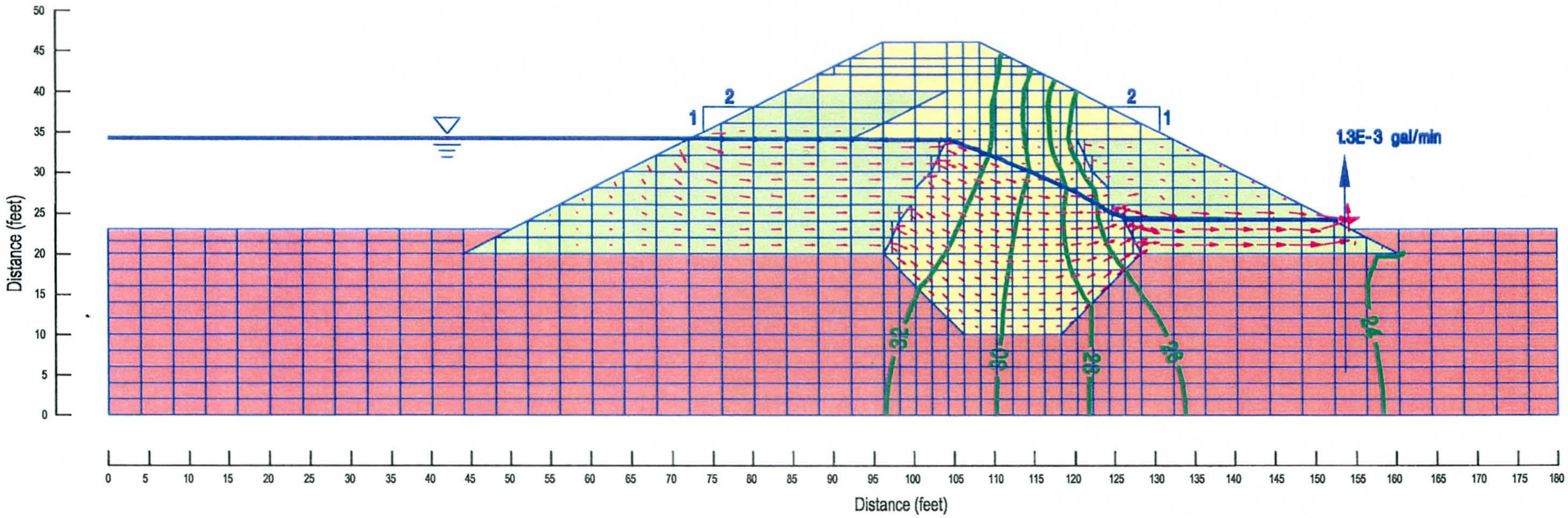


Figure 3

Mean and 84th Percentile Acceleration for the Carefree fault



	Hydraulic Conductivity, ft/sec
Core	1E-4
Embankment Fill	1E-2
Foundation	1E-6

Contours presented represent total head. Seepage rates are presented as the seepage rate for a one-foot width. Seepage analysis was modeled using the finite element computer program SEEP/W (Geo-Slope International, 1998).

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JOB NO. 9-117-001011
DESIGN NHW
DRAWN CJG
DATE 8/99
SCALE 1"=20'

FIGURE 4
RESULTS OF SEEPAGE ANALYSES
GOLDEN EAGLE PARK DAM
FOUNTAIN HILLS, ARIZONA

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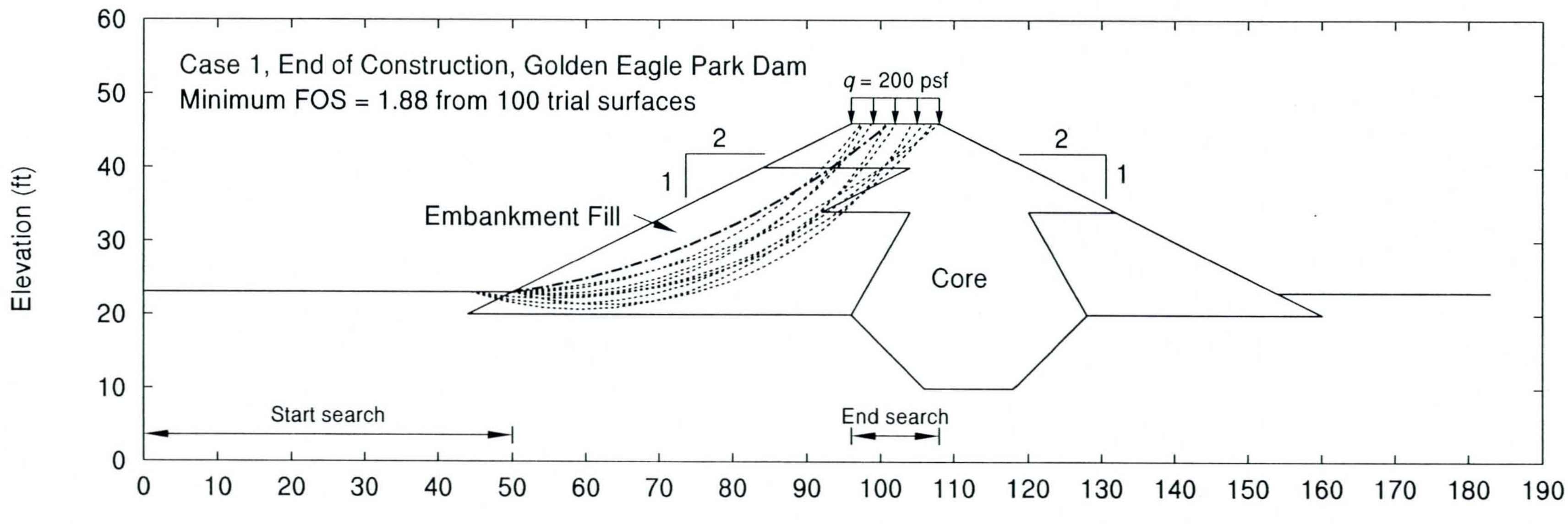

FIGURE 5

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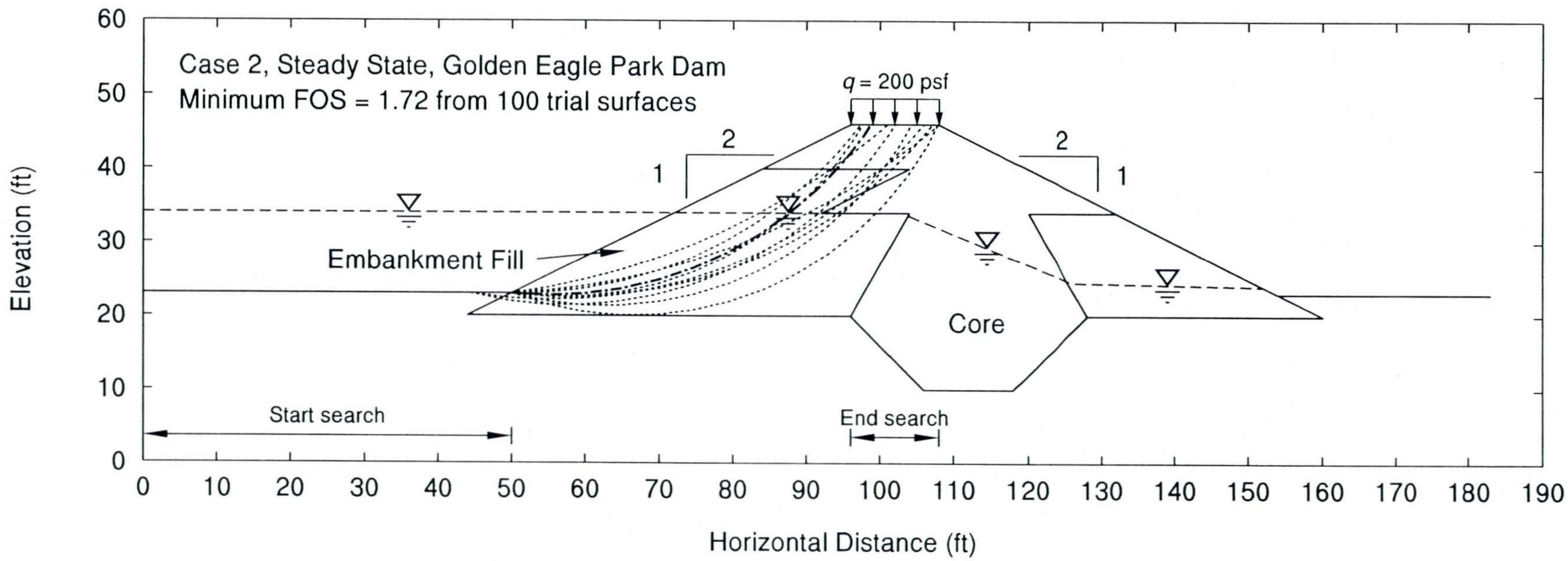

FIGURE 6

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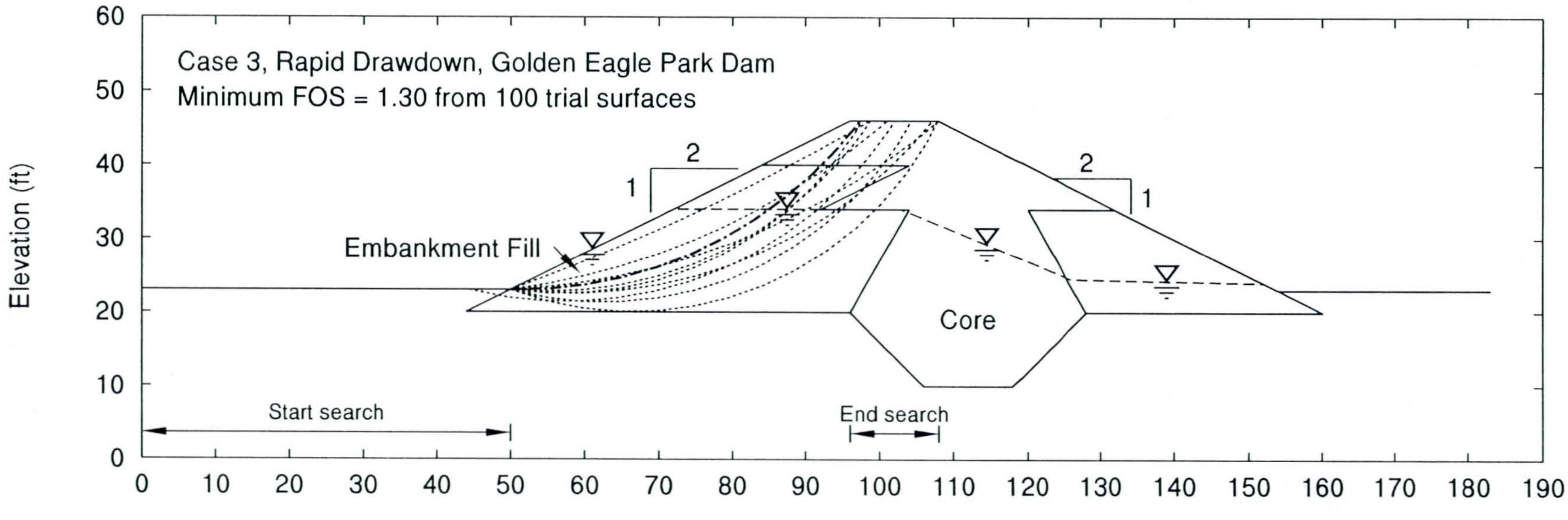

FIGURE 7

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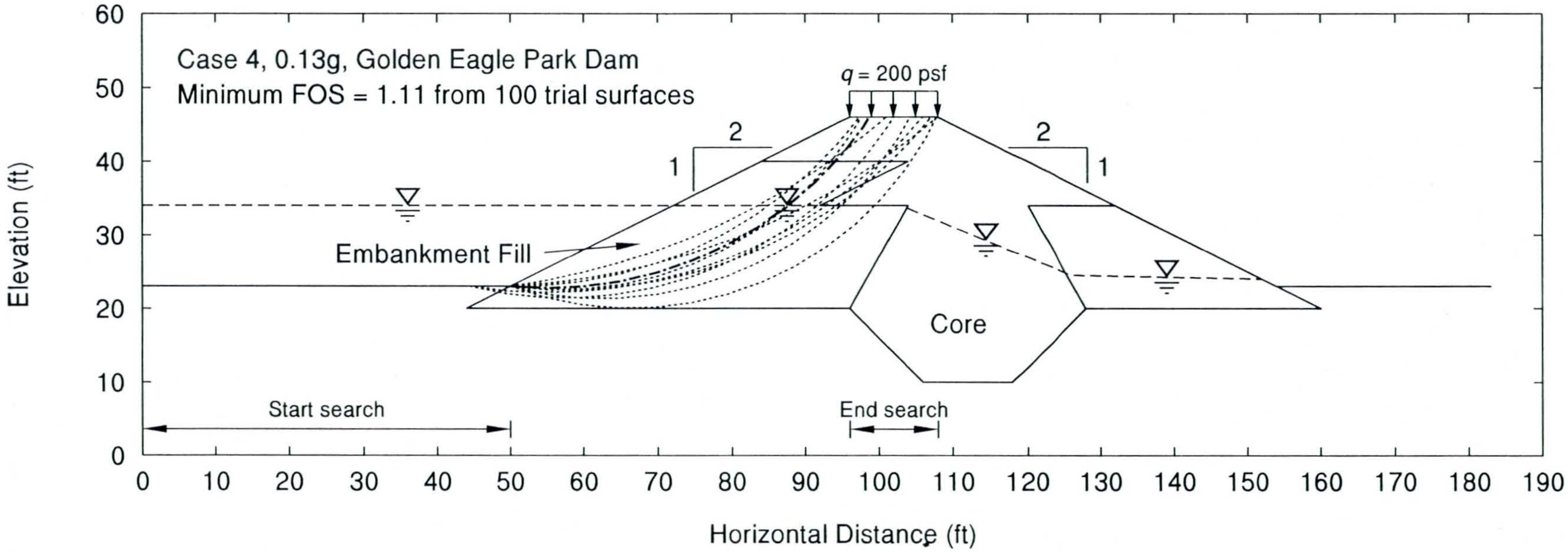

FIGURE 8

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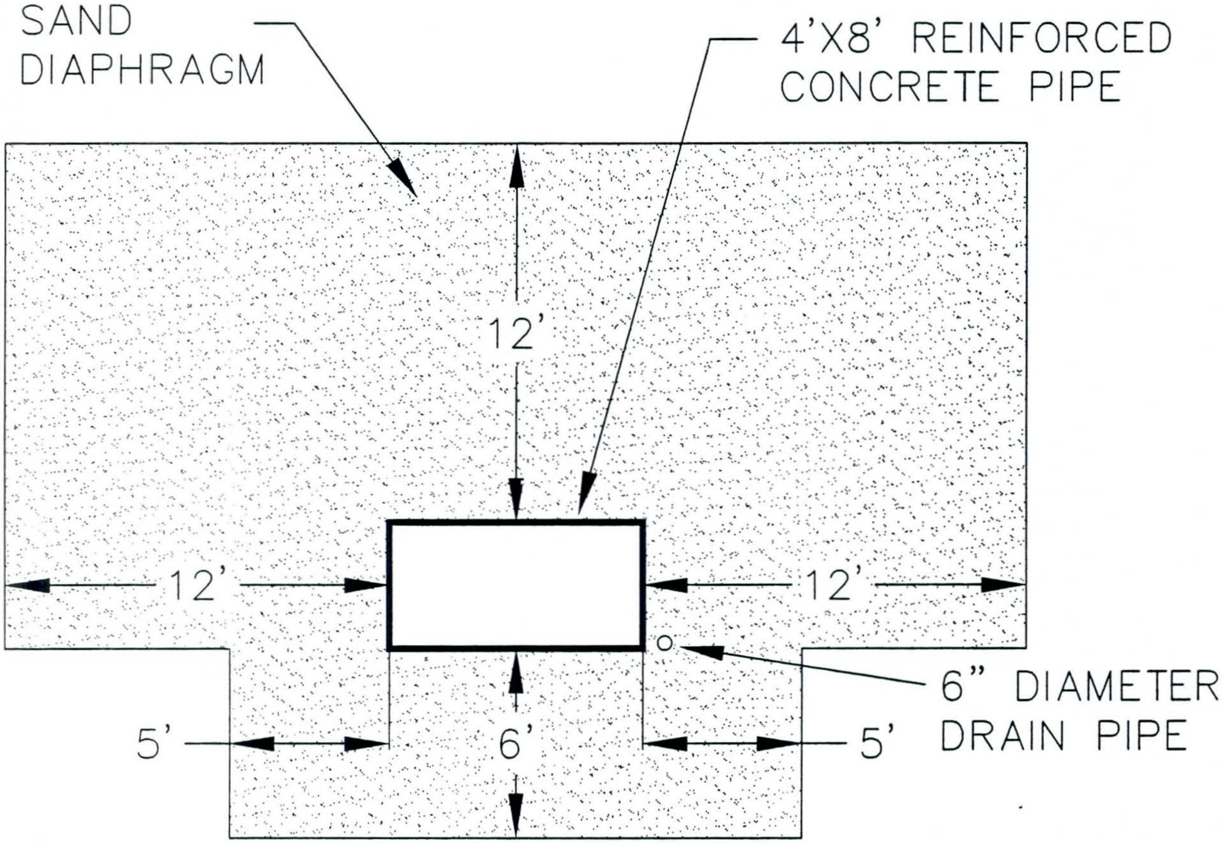

NOTE: SAND DIAPHRAGM SHOULD BE A MINIMUM OF 4' THICK

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Earth & Environmental
ENGINEERING GLOBAL SOLUTIONS
3232 West Virginia Avenue
Phoenix, Arizona 85009-1502
Tel: (602)272-6848
Fax: (602)272-7239

JOB NO.	9-117-001011
DESIGN	CJG
DRAWN	CJG
DATE	9/99
SCALE	1"=6'

FIGURE 9
SAND DIAPHRAGM DESIGN

G:\Engineering-Development\9-117-001011 Golden Eagle Park Dam\CAD Drawings\sand filter.dwg

APPENDIX A

FIELD INVESTIGATION

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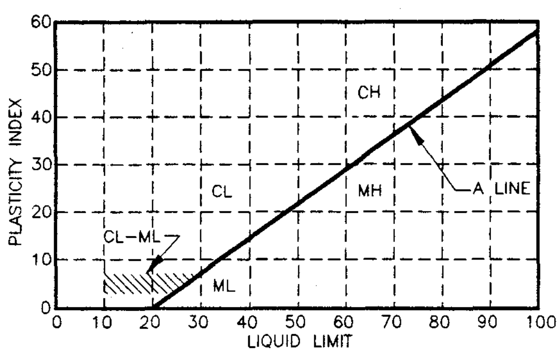
UNIFIED CLASSIFICATION SYSTEM FOR SOILS

Soils are visually classified by the Unified Soil Classification System on the boring logs presented in this report. Grain-size analysis and Atterberg Limits Tests are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For a more detailed description of the system, see "The Unified Soil Classification System" ASTM Designation: D2487.

MAJOR DIVISION				GRAPH SYMBOL	GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	**GRAVELS** (50% or less of coarse fraction passes No. 4 sieve)	**CLEAN GRAVELS** (Less than 5% passes No. 200 sieve)			GW	Well graded gravels, gravel-sand mixtures or sand-gravel-cobble mixtures.
					GP	poorly graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		GM	Silty gravels, gravel-sand-silt mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart		GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (More than 50% of coarse fraction passes No. 4 sieve)	**CLEAN SANDS** (Less than 5% passes No. 200 sieve)			SW	Well graded sands, gravelly sands.
					SP	Poorly graded sands, gravelly sands.
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		SM	Silty sands, sand-silt mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart		SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	**SILTS** LIMITS PLOT BELOW "A" LINE & HATCH ZONE ON PLASTICITY CHART	**SILTS OF LOW PLASTICITY** (Liquid Limit Less Than 50)			ML	Inorganic silts, clayey silts with slight plasticity.
		SILTS OF HIGH PLASTICITY (Liquid Limit More Than 50)			MH	Inorganic silts of high plasticity, silty soils, elastic silts.
	CLAYS LIMITS PLOT ABOVE "A" LINE & HATCH ZONE ON PLASTICITY CHART	**CLAYS OF LOW PLASTICITY** (Liquid Limit Less Than 50)			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		CLAYS OF HIGH PLASTICITY (Liquid Limit More Than 50)			CH	Inorganic clays of high plasticity, fat clays, silty and sandy clays of high plasticity.

NOTE: Coarse-grained soils with between 5% & 12% passing the No. 200 sieve and fine-grained soils with limits plotting in the hatched zone on the plasticity chart to have dual symbol.

PLASTICITY CHART



DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Boulders	Above 300mm (12in.)
Cobbles	300mm to 75mm (12in. to 3in.)
Gravel	75mm (3in.) to No. 4 sieve
Coarse gravel	75mm to 19mm (3in. to 3/4in.)
Fine gravel	19mm (3/4in.) to No. 4 sieve
Sand	No. 4 to No. 200
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Fines (silt or clay)	Below No. 200 sieve

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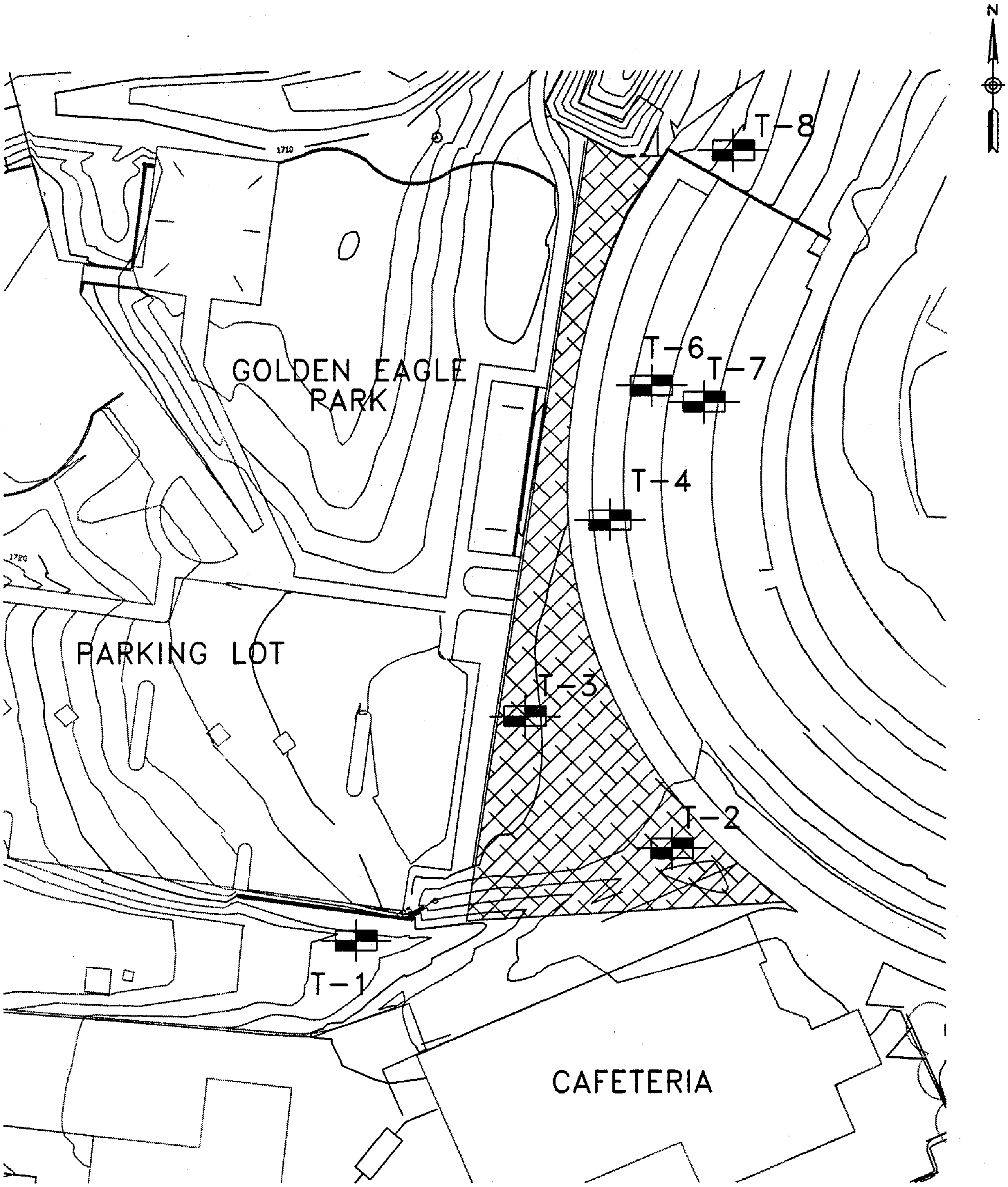

Hatching denotes approximate location of existing riprap.

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JOB NO.	9-117-001011
DESIGN	STANTECH
DRAWN	CJG
DATE	8/99
SCALE	1"=60'

FIGURE 10

TEST PIT LOCATIONS

G:\Engineering-Development\9-117-001011 Golden Eagle Park Dam\CAD Drawings\siteplan.dwg

PROJECT Golden Eagle Park Dam
Near Golden Eagle Boulevard & Palisades Boulevard
Fountain Hills, Arizona

JOB NO. 9-117-001011 **DATE** 7/14/99

LOG OF TEST PIT NO. T1

GROUNDWATER

	DEPTH	HOUR	DATE
∇		none	
▼			

BACKHOE TYPE CAT 416C
LOCATION See Site Plan
SURFACE ELEV.
DATUM

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent Dry Weight (field)	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					SP-SM	slightly moist	**SILTY SAND & GRAVEL**, predominantly medium to coarse grained sand, fine grained gravel, subangular, nonplastic, brown
			D				
					GP	slightly moist	**CLAYEY SAND, GRAVEL & COBBLES**, subangular to angular, lime cementation, low to medium plasticity, light brown
							Stopped Backhoe at 4'
5							
10							
15							
20							
25							

GEOTECH_TP 91171011.GPJ AGRA_ALB.GDT 8/24/99

SAMPLE TYPE

B - Undisturbed Block Sample
D - Disturbed Bulk Sample
U - 3" O.D. 2.42" I.D. tube sample

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LOG OF TEST PIT NO. T2

PROJECT Golden Eagle Park Dam
Near Golden Eagle Boulevard & Palisades Boulevard
Fountain Hills, Arizona

JOB NO. 9-117-001011 **DATE** 7/14/99

GROUNDWATER

	DEPTH	HOUR	DATE
∇		none	
▼			

BACKHOE TYPE CAT 416C
LOCATION See Site Plan
SURFACE ELEV.
DATUM

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent Dry Weight (field)	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					GP	slightly moist to moist	Rip Rap **CLAYEY SAND, BOULDERS, COBBLES & GRAVEL**, fine to coarse grained sand, fine to coarse grained gravel, boulders up to 18" in diameter, angular, low plasticity to nonplastic, brown
			D		SM	moist	Native **SILTY SAND**, trace of fine grained gravel, predominantly medium grained sand, angular to subangular, low plasticity to nonplastic, brown
5							Stopped Backhoe at 5'
10							
15							
20							
25							

GEOTECH_TP 9117011.GPJ AGRA_ALB.GDT 8/24/99

SAMPLE TYPE

B - Undisturbed Block Sample
D - Disturbed Bulk Sample
U - 3" O.D. 2.42" I.D. tube sample

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LOG OF TEST PIT NO. T3

PROJECT Golden Eagle Park Dam
Near Golden Eagle Boulevard & Palisades Boulevard
Fountain Hills, Arizona

JOB NO. 9-117-001011 **DATE** 7/14/99

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

BACKHOE TYPE CAT 416C
LOCATION See Site Plan
SURFACE ELEV.
DATUM

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent Dry Weight (field)	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			D		GM	slightly moist to moist	FILL (Rip Rap) **SILTY SAND, BOULDERS & COBBLES**, boulders up to 18" in diameter, predominantly coarse to medium grained sand, angular, low plasticity, brown
			D		SM	slightly moist	Native **SILTY SAND**, medium to coarse grained sand, angular to subangular, nonplastic to low plasticity, brown
							Stopped Backhoe at 3'
5							
10							
15							
20							
25							

SAMPLE TYPE

B - Undisturbed Block Sample
D - Disturbed Bulk Sample
U - 3" O.D. 2.42" I.D. tube sample

GEOTECH_TP 9171011.GPJ AGRA_ALB.GDT 8/24/99

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PROJECT Golden Eagle Park Dam
Near Golden Eagle Boulevard & Palisades Boulevard
Fountain Hills, Arizona

LOG OF TEST PIT NO. T4

JOB NO. 9-117-001011 **DATE** 7/14/99

GROUNDWATER

	DEPTH	HOUR	DATE
∇		none	
▼			

BACKHOE TYPE CAT 416C
LOCATION See Site Plan
SURFACE ELEV.
DATUM

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent Dry Weight (field)	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			D		SM	moist	FILL **SILTY SAND**, some fine grained gravel, fine to coarse grained sand, subangular to angular, low plasticity to nonplastic, brown
							Stopped Backhoe at 2'6"
5							
10							
15							
20							
25							

GEOTECH_TP 91171011.GPJ AGRA_ALB.GDT 8/24/99

SAMPLE TYPE

B - Undisturbed Block Sample
D - Disturbed Bulk Sample
U - 3" O.D. 2.42" I.D. tube sample

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PROJECT Golden Eagle Park Dam
Near Golden Eagle Boulevard & Palisades Boulevard
Fountain Hills, Arizona

LOG OF TEST PIT NO. T6

JOB NO. 9-117-001011 **DATE** 7/14/99

GROUNDWATER

	DEPTH	HOUR	DATE
∇		none	
▼			

BACKHOE TYPE CAT 416C
LOCATION See Site Plan
SURFACE ELEV.
DATUM

Depth In Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent Dry Weight (field)	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			D		SM	slightly moist to moist	**SILTY SAND**, some fine grained gravel, fine to coarse grained sand, subangular, nonplastic to low plasticity, brown note: occasional cobbles up to 5" in diameter from 1' to 4'
4							Stopped Backhoe at 4'
5							
10							
15							
20							
25							

SAMPLE TYPE

B - Undisturbed Block Sample
D - Disturbed Bulk Sample
U - 3" O.D. 2.42" I.D. tube sample

GEOTECH_TP 91171011.GPJ AGRA_ALB.GDT 8/24/99

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LOG OF TEST PIT NO. T7

PROJECT Golden Eagle Park Dam
Near Golden Eagle Boulevard & Palisades Boulevard
Fountain Hills, Arizona

JOB NO. 9-117-001011 **DATE** 7/14/99

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

BACKHOE TYPE CAT 416C
LOCATION See Site Plan
SURFACE ELEV.
DATUM

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent Dry Weight (field)	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			D		SP-SM	slightly moist	**SILTY SAND & GRAVEL,** fine to coarse grained sand, predominantly fine grained gravel, subangular to angular, nonplastic to low plasticity, light brown
					SP	moist	**SAND**, trace of fine grained gravel, coarse grained, subangular, nonplastic, brown
3							Stopped Backhoe at 3'
5							
10							
15							
20							
25							

SAMPLE TYPE

B - Undisturbed Block Sample
D - Disturbed Bulk Sample
U - 3" O.D. 2.42" I.D. tube sample

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GEOTECH_TP 9171011.GPJ AGRA_ALB.GDT 8/24/99

PROJECT Golden Eagle Park Dam
Near Golden Eagle Boulevard & Palisades Boulevard
Fountain Hills, Arizona

LOG OF TEST PIT NO. T8

JOB NO. 9-117-001011 **DATE** 7/14/99

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

BACKHOE TYPE CAT 416C
LOCATION See Site Plan
SURFACE ELEV.
DATUM

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent Dry Weight (field)	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			D		SM	slightly moist	**SILTY SAND & GRAVEL**, trace of cobbles up to 12" in diameter, fine to coarse grained sand, fine to coarse grained gravel, angular, nonplastic to low plasticity, light brown
					SP	moist to slightly moist	**SAND & GRAVEL**, some silt, predominantly coarse grained sand, fine grained gravel, subangular to subrounded, nonplastic, brown
5							Stopped Backhoe at 5'
10							
15							
20							
25							

GEOTECH_TP 9117011.GPJ AGRA_ALB.GDT 8/24/99

SAMPLE TYPE

B - Undisturbed Block Sample
D - Disturbed Bulk Sample
U - 3" O.D. 2.42" I.D. tube sample

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APPENDIX B

LABORATORY TEST RESULTS

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AGRA Earth & Environmental, Inc.

PROJECT: GOLDEN EAGLE PARK DAM MODIFICATION
LOCATION: FOUNTAIN HILLS

JOB NO: 9-117-001011
WORK ORDER NO: 1
DATE SAMPLED: ####

MECHANICAL SIEVE ANALYSIS
GROUP SYMBOL, USCS (ASTM D-2487)

SIEVE SIZES

				Silt or Clay	SAND								GRAVEL								COBBLES		
					Fine			Medium			Coarse		Fine				Coarse						
Location & Depth	**USCS**	**LL**	**PI**	**#200**	**#100**	**#50**	**#40**	**#30**	**#16**	**#10**	**#8**	**#4**	**1/4"**	**3/8"**	**1/2"**	**3/4"**	**1"**	**1 1/2"**	**2"**	**3"**	**4"**	**6"**	**Lab #**
PERCENT PASSING BY WEIGHT																							
T3 @ 0-1'9"	GM	22	1	16	21	27	30	33	40	46	49	55	59	64	66	71	74	79	82	90	100	100	1
T4 @ .8'-1.4'	SM	NV	NP	22	29	35	38	42	51	61	65	78	82	86	87	95	100	100	100	100	100	100	2
T2 @ 4'-4.5'	SM	NV	NP	34	45	53	57	60	69	76	80	90	92	95	97	100	100	100	100	100	100	100	3
T1 @ 1'-2'	SP-SM	NV	NP	9.4	13	18	25	30	44	59	66	85	91	96	98	99	100	100	100	100	100	100	4
T6 @ 1'-3'	SM	NV	NP	26	34	42	46	50	60	71	75	90	95	98	99	100	100	100	100	100	100	100	5
T7 @ 6"-1'6"	SP-SM	NV	NP	12	16	22	26	30	40	50	55	69	74	78	82	83	88	88	100	100	100	100	6
T8 @ 1.5'-3.5'	SM	22	3	19	24	31	34	38	49	59	64	76	83	89	92	96	97	99	99	100	100	100	7
T3 @ 2.5'-3'	SM	NV	NP	35	42	48	51	54	63	72	75	88	92	95	97	97	100	100	100	100	100	100	8

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