Table 2.5-1 Items of Phase I of the Plant Site Geological Survey of Lungmen NPS

Survey Item		Number	Total Length of Range	Object	Memos
Ground geological survey		1	Within a sphere of radius 5km centered at the plant site	Study on geological stratum order, geological tectonics, rock properties and faults	
Geological drilling		17 34 3	202.1m 861.0m 180.0m	Geological study on basement rock wall groundwater observation	Study on the determination of the plant site. The first phase of the plant site survey. Study on the determination of the plant site.
Groundwater observation		23	623.3m	Groundwater observation	Including water specimen sampling
Seismic wave detection	On land	8	6.6km	Study on the Aoti fault and the Yen Tzu K'en fault	Carried out by American Uauding Uavision associate and Hsinchungkuang Physical Detection Co.
	On sea	15	8055m		
Digging of survey holes		1	59.8m	Study on the Aoti fault	
Digging of test ditches		12	503m	Study on fault ages	

Source: Evaluation Report of Environmental Influence, Revised Version, Electricity Generating Plan of No. 4 Nuclear Power Plant 1 & 2 Units, Volume 1, Taiwan Electric Power Co., Nov. 1991 (Ref. 2.5-57),

Table 2.5-2 Items of Phase II of the Plant Site Geological Survey at Lungmen NPS

Survey Item		Number of Holes	Total Depth (m)	Gradient of Drilling	Object	Memos
Geological drilling		14	1400	Vertical	Geological survey on basement rock wall in the reactor workshop	Used for geological seismic measurement as well
		6	300	60°		
		40	1391.2	Vertical	Geology of the plant building basement and stability of the side slope of the plant area	Some holes are used for groundwater observation and some holes are used for permeability tests concurrently.
		8	240	Vertical		
Seismic wave detection	Horizontal hole explosive measurement	14	1400	Measurement of velocities basement rock wall		Conducted by Hsinchungkuang Physical Detection Co. (H.C..K) in Taiwan.
	Upper hole explosive measurement	5	200			
	Ground refraction	2	1640			
Digging of straight wells and Loading tests on the spot		2	22	Basement rock wall loading and deformation properties		Tests on the spot are conducted by the Earth Mechanical Research Center of Chunghsin Advisory Agency.
Rock mechanical test	General exponential properties	59	Determining the rock core near high structure basement, the implementing, altitude is zero meter	Determination of mechanical parameters of structure basement design		The Earth Mechanical Research Center of Chunghsin Advisory Agency.
	Sound velocity measurements	17				
	Uniaxial compressive strength	34				
	Direct shear tests	4				
	Triaxial strength test	16				
	Tensile test	16				
Measurement and analysis of groundwater		12		Water quality analysis and groundwater observation		Assisted by Institute of Electric Power and Chenliao Observatory
Rock facies determination and X-ray analysis		10	Study on rock mineral components and the variety of expansible clays contained			Conducted by American BETAI Co.

Table 2.5-3 Stratigraphic Correlation of Site Area

Author / Stratigraphy	(1981) PECL/TPC	(1988) Huang and Liu	(1955) Yen and Chen	(1989) Chen
Miocene Formation	Fangchiao Fm / Mushan Fm; Makang Fm / Wuchishan Fm	Aoti Fm; Fangchia m. / Mushan Fm; Makang m.	Aoti Fm; Makang m.	Mushan Formation
Oligocene Formation	Tatung-Shan Fm / Tatung-Shan Fm (Chuchi Fault)	Tatung-Shan Fm / Wentz-keng Fm (Chuchi Fault)	Tatungshan Formation	Tatungshan Formation

Source from : H. H. Tsien (1994)
Geological Re-examination and Re-appraisal of the Site and the Adjacent Area of Atomic Power Plant No. 4.

Table 2.5-4 Summary of Ground Water Observation Well Levels (Average Monthly Levels)

WELL NO.	GR. ELEV.	1980 AUG	SEP	OCT	NOV	DEC	1981 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVG.	HIGH	LOW
8	9.76	7.72	8.11	8.89	9.20	9.06	8.84	9.06	9.34	8.51	8.83	8.96	8.87	8.35	8.67	9.16	9.46	9.47	8.91	9.47	7.72
9	8.85	7.32	7.38	8.64	8.83	8.76	8.65	8.76	8.75	8.34	8.62	8.67	8.00	7.99	8.19	8.49	8.83	8.78	8.46	8.83	7.32
10	10.56	7.72	7.87	9.21	9.48	9.31	9.02	8.87	9.21	8.58	8.86	9.19	8.68	8.18	8.32	9.04	9.52	9.24	8.86	9.52	7.72
11	10.40	7.79	7.90	8.44	8.64	8.82	8.74	8.62	8.54	8.40	8.59	8.55	8.44	8.11	8.55	8.84	9.15	9.04	8.61	9.15	7.79
12	5.80				5.56	5.41	5.37	5.49	5.41	5.09	5.23	5.25	5.02	4.85	5.08	5.37	5.53	5.52	5.31	5.56	5.02
13	7.87	6.24	6.57	6.84	6.99	6.96	6.94	7.11	6.93	6.80	7.02	6.84	6.77	6.67	6.77	6.85	6.88	7.03	6.84	7.11	6.24
14	12.60			11.88	12.17	12.19	12.02	12.14	11.91	12.07	15.05	11.91	11.78	11.61	11.82	11.93	12.04	12.01	11.97	12.19	11.61
15	10.10	5.92	6.30	6.77	6.97	6.70	6.63	7.04	6.64	6.66	6.74	6.82	6.65	6.51	6.65	6.73	6.98	6.81	6.72	7.11	5.92
19	11.00				12.00	11.96	11.78	11.89	11.71	11.55	11.59	11.63	10.67	10.37	11.42	11.59	11.84	11.70	11.59	12.00	10.37
20	6.50				6.40	6.43	6.43	6.32	5.82	6.01	6.05	6.11	5.86	5.83	5.91	6.25	6.32	6.37	6.18	6.43	5.82
22	10.12				9.87	9.86	9.68	9.62	9.39	9.75	9.64	9.58	8.93	8.92	9.12	9.40	9.37	9.49	9.49	9.87	8.92
25	38.63				34.01	33.90	33.98	34.36	33.16	32.93									33.72	34.36	32.93
26	8.87				8.90	8.75	8.70	8.71	8.61	8.75	8.72	8.65	8.63	8.48	8.66	8.76	8.83	8.77	8.72	8.90	8.61
27	16.43	(ARTESIAN)			17.37	17.37	17.37	17.37	17.37	17.37	17.37	17.37	17.37	17.37	17.37	17.37	17.37	17.37	17.31		
28	7.95				5.63	5.86	5.62	5.94	5.76	5.76	6.02	4.46	4.71	5.60	5.67	5.78	5.98	6.04	5.78	6.24	4.46
35	9.70				8.72	8.65	8.83	9.10	8.65	8.67	8.96	7.53	7.60	8.38	8.42	8.68	8.65	8.68	8.57	9.10	7.53
40	7.20				4.24	4.25	4.12	2.36	4.31	3.72	4.10	3.17	3.10	2.91	3.59				3.62	4.31	2.36
42	42.00				31.61	30.79	30.46	30.16	30.60	30.56									30.70	31.61	30.16
44	11.91				11.26	10.47	10.58	11.21	10.75	10.17	10.79	10.45	9.85	9.36	9.85	10.18	10.96	10.24	10.33	11.26	9.36
49	18.70				14.48	14.37	13.88	14.21	13.93	13.82	14.04	13.34	12.79	13.54	13.70	13.80	14.21	14.27	14.00	14.63	12.79
53	11.20															10.05	10.25	10.24	10.01	10.26	9.37
A2	10.77											8.84	7.59	7.34	8.37	8.06	9.12	9.06	8.46	9.12	7.34
A4	2.98	0.96	1.23	2.12	2.51	2.52	2.11	2.41	2.20	2.13	2.30	2.24	2.09	1.85	1.94		2.31	2.44	2.15	2.52	0.96
A7	10.30	8.44	9.06	9.42	9.55	9.44	9.36	9.52	9.41	9.35	9.39	9.30	9.24	8.94	9.37	9.30	9.61	9.48	9.32	9.55	8.44
A9	12.95	12.10	12.19	12.39	12.27	12.17	12.12	12.31	11.94	12.17	12.24	12.07	12.10	12.11	12.16	12.19	12.25	12.21	12.19	12.42	11.94
A18	5.33	3.32	3.62	4.18	4.22	4.22	4.12	4.26	4.04	3.99	4.09	4.05	3.94	3.79	3.84	4.01	4.19	4.20	4.02	4.26	3.32
A19	14.15	12.11	12.22	12.81	13.10	12.90	12.72	13.16	12.68	12.33	13.26	12.80	12.60	12.40	12.52	12.69	13.00	12.87	12.73	13.26	12.11
A21	2.29		-0.06	1.65	2.26	2.23	2.04	2.20	2.24	1.48	2.00	1.98	1.53	0.74	1.22	1.86	2.25	2.23	1.80	2.26	-0.06
A25	10.52	8.13	8.84	9.48	9.89	9.88	9.57	9.89	9.49	9.35	9.73	9.44	9.25	9.03	9.13	9.39	9.74	9.72	9.47	10.00	8.13
A26	5.07	4.00	4.73	4.79	4.82	4.81	4.67	4.36	4.77	4.58	4.75	4.70	4.07	3.95	4.36	4.52	4.48	4.66	4.55	4.82	3.95
A28	14.81	13.12	13.32	14.23	14.59	14.56	14.21	14.43	14.47	14.31	14.39	14.23	13.98	13.97	13.80	14.28	14.31	14.29	14.16	14.59	13.12
A30	9.84	8.34	8.60	9.68	9.71	9.72	9.66	9.65	9.70	9.57	9.61	9.55	9.52	8.99	9.36	9.63	9.70	9.70	9.51	9.74	8.34
A31	3.86	3.26	3.27	3.68	3.63	3.70	3.65	3.66	3.61	3.58	3.68	3.58	3.60	3.55	3.53	3.65	3.67	3.71	3.62	3.71	3.26
B1	8.47											8.09	8.00	7.59	7.70	7.95	8.08	8.10	7.90	8.10	7.59
B2	3.44											2.67	1.92		2.12		1.96	1.81	2.14	2.67	1.81
B3	4.10											3.72	3.61		4.09		4.06	3.77	3.81	4.09	3.49
B4	8.32											6.24	6.07	5.73	6.44	6.04	6.12	5.98	6.19	6.69	5.73
B5	5.67											3.50	2.46	1.74	1.70	2.66	2.66	2.44	2.39	3.50	1.65
B6	3.69											1.00	1.04	0.35	0.99	0.46	0.83	0.97	0.77	1.04	0.35
PB1	14.00																		11.76		
PB3	9.38																		8.71		
PB5	6.84																		6.63		
PB14	13.10																		11.03		
PB19	13.89																		14.16		
PB21	8.35																		7.01		
PB30	8.51																		8.76		
PB33	29.88																		15.11		
PB36	8.98																		8.28		
PB38	12.37																		12.13		

Table 2.5-4 Summary of Ground Water Observation Well Levels (Continued) (Average Monthly Levels)

WELL NO.	GR. ELEV.	1982 JAN	FEB	MAR	APR	MAY	JUN	JUL	AVG.	HIGH	LOW
8	9.76	9.32	9.26	9.22	8.95	8.84	8.81		8.91	9.47	7.72
9	8.85	8.71	8.70	8.70	8.60	8.45	8.39		8.46	8.83	7.32
10	10.56	9.11	9.12	9.20	8.88	8.69	8.40		8.86	9.52	7.72
11	10.40	8.83	8.91	8.85	8.82	8.71	8.66	8.60	8.61	9.15	7.79
12	5.80	5.40	5.38	5.33	5.28	5.31	5.26		5.31	5.56	5.02
13	7.87	6.96	6.99	6.92	6.56	6.81	6.85		6.84	7.11	6.24
14	12.60	11.98	11.98	12.04	11.92	11.90	12.00		11.97	12.19	11.61
15	10.10	6.78	6.88	7.11	6.74	6.73	6.71		6.72	7.11	5.92
19	11.00	11.71	11.72	11.72	11.64	11.59	11.66		11.59	12.00	10.37
20	6.50	6.30	6.23	6.26	6.23	6.23	6.28		6.18	6.43	5.82
22	10.12	9.46	9.52	9.56	9.56	9.53	9.57		9.49	9.87	8.92
25	38.63								33.72	34.36	32.93
26	8.87	8.77	8.73	8.75	8.75	8.74	8.66		8.72	8.90	8.61
27	16.43	17.37	17.37	17.37	17.37	16.94	16.67		17.31		
28	7.95	6.06	6.12	6.24	6.04	6.14	6.23		5.78	6.24	4.46
35	9.70	8.71	8.70	8.67	8.59	8.63	8.63		8.57	9.10	7.53
40	7.20								3.62	4.31	2.36
42	42.00								30.70	31.61	30.16
44	11.91	10.09	10.57	10.10	9.84	9.82	9.97		10.33	11.26	9.36
49	18.70	14.16	14.43	14.31	14.07	13.98	14.63		14.00	14.63	12.79
53	11.20	10.20	10.26	10.20	10.12	10.11	9.37	9.37	10.01	10.26	9.37
A2	10.77		8.94	8.97	8.79	8.79	7.65		8.46	9.12	7.34
A4	2.98	2.41	2.36	2.41	2.30	2.25	2.26		2.15	2.52	0.96
A7	10.30	12.11	12.25	12.17	12.42	12.21	12.19		9.32	9.55	8.44
A9	12.95	12.10	12.19	12.39	12.27	12.17	12.12	12.31	12.19	12.42	11.94
A18	5.33	4.14	4.11	4.11	4.05	4.01	4.05		4.02	4.26	3.32
A19	14.15	12.67	12.69	13.08	12.74	12.73	12.78		12.73	13.26	12.11
A21	2.29	2.08	2.04	2.25	1.94	1.83	1.61		1.80	2.26	-0.06
A25	10.52	10.00	9.64	9.65	9.56	9.43	9.65		9.47	10.00	8.13
A26	5.07	4.75	4.67	4.74	4.57	4.48	4.45		4.55	4.82	3.95
A28	14.81	14.29	14.14	14.19	14.21	14.14	14.11		14.16	14.59	13.12
A30	9.84	9.67	9.64	9.68	9.74	9.70	9.72		9.51	9.74	8.34
A31	3.86	3.68	3.67	3.71	3.70	3.68	3.70		3.62	3.71	3.26
B1	8.47	8.02	7.84	7.86	7.68	7.75	7.99		7.90	8.10	7.59
B2	3.44	1.86	2.28	2.23	2.40				2.14	2.67	1.81
B3	4.10	3.49	3.95	3.93	3.95	3.74	3.64		3.81	4.09	3.49
B4	8.32	6.49	6.69	6.27	6.28	5.93	6.15		6.19	6.69	5.73
B5	5.67	2.48	2.21	2.28	2.24	3.01	1.65		2.39	3.50	1.65
B6	3.69	0.76	0.67	0.82	0.83	0.64	0.65		0.77	1.04	0.35
PB1	14.00							11.76	11.76		
PB3	9.38						8.77	8.65	8.71		
PB5	6.84						6.61	6.64	6.63		
PB14	13.10						11.04	11.01	11.76		
PB19	13.89						14.25	14.07	14.16		
PB21	8.35						6.97	7.04	7.01		
PB30	8.51						8.71	8.81	8.76		
PB33	29.88							15.11	15.11		
PB36	8.98						8.36	8.19	8.28		
PB38	12.37						11.99	12.27	12.13		

Table 2.5-5 Summary of Rainfall Data - Aug 1980 - Jul 1982

Mo.	Total Rain (mm)
Aug 1980	100.4
Sep	396.2
Oct	234.1
Nov	488.0
Dec	309.5
Jan 1981	129.1
Feb	318.9
Mar	115.0
Apr	117.7
May	407.2
June	753.3
Jul	284.3
Aug	53.5
Sep	336.7
Oct	132.1
Nov	573.4
Dec	284.2
Jan 1982	158.2
Feb	314.1
Mar	271.1
Apr	327.2
May	120.8
June	333.1
Jul	240.0
	6708.1/TOTAL
	= 279.5/MO AVG
	= 3354.1/YR AVG

Table 2.5-6 Chemical Analysis of Groundwater, Fluvial Water and Sea Water Samples

		Well 10 (Average 11 Samples)	PB-14 (1 Sample)	PD-19 (1 Sample)	PD-36 (1 Sample)	PD-38 (1 Sample)	Domestic Well (Average 7 Samples)	Shuang-Chi River (Average 5 Samples)	Hsing-Che River (Average 4 Samples)	Shihting River (Average 5 Samples)	Sea Water (Average 5 Samples)
1.	Carbonate (ppm as $CaCO_3$)	NIL	-	-	-	-	NIL	NIL	NIL	NIL	1.7
2.	Bicarbonate (ppm as $CaCO_3$)	57.6	-	-	-	-	195	20.7	19.8	16.7	117
3.	Total Hardness (ppm as $CaCO_3$)	61.3	-	-	-	-	291	28.2	27.4	24.6	6840
4.	Calcium (ppm as $CaCO_3$)	39.4	64	127	185	101	211	12.8	14.3	11.1	1002
5.	Magnesium (ppm as $CaCO_3$)	21.9	-	-		-	80.1	15.4	13.1	13.5	5638
6.	Chloride (ppm as Cl)	24.3	23.6	23.6	23.6	26.2	40.6	12.0	13.7	16.9	18360
7.	$K_2 Cr_2 O_2$ Consumed (ppm as O_2) (COD)	11.1	-	-	-	-	11.8	18.3	14.8	10.2	108
8.	Turbidity (FTU)	6.5	-	-	-	-	0.44	1.3	1.7	2.0	0.78
9.	pH	7.4	7.3	7.2	7.0	7.0	7.9	7.7	7.8	7.6	8.2
10.	Conductivity (umhos/cm)	195	440	450	520	500	571	121	116	99.4	41340
11.	Sulfate (ppm as SO_4)	11.0	5.8	3.0	2.0	3.0	75.2	11.0	9.8	6.4	2294
12.	Silica (ppm as SiO_2)	11.8	4.4	2.5	3.2	5.4	5.6	5.1	5.0	4.5	0.40
13.	Total Iron (ppm as Fe)	0.53	0.66	0.14	0.44	1.02	0.06	0.07	0.08	0.19	0.11
14.	Total Residue (ppm dried at 105°C)	310	-	-	-	-	412	83.3	68.5	82.7	-
15.	Coliform test	-	-	-	-	-	6/7 pos.	-	-	-	-
16.	Sodium (ppm)	16.9	-	-	-	-	26.8	5.8	7.3	6.6	10560
17.	Potassium (ppm)	2.1	-	-	-	-	3.7	0.76	0.78	0.74	420
18.	Fluoride (ppm)	0.16	-	-	-	-	0.25	0.16	0.11	0.10	2.5
19.	Nitrate (ppm)	5.7	-	-	-	-	10.1	2.1	3.0	2.1	125
20.	Bromide (ppm)	TRACE	-	-	-	-	TRACE	TRACE	TRACE	TRACE	-
21.	CO_2 (ppm)	-	3.5	8.7	34.8	18.6	-	-	-	-	-
22.	H_2S (ppm)	-	1.1	0.41	0.35	0.35	-	-	-	-	-
23.	Mn** (ppm as Mn)	NIL	-	-	-	-	NIL	-	-	-	0.06
24.	Total Dissolved Solids (ppm)	-	300	275	348	292	-	-	-	-	-
25.	Temperature (°C)	-	29	29	28	26	-	-	-	-	-

Table 2.5-7 All Earthquakes of Any Magnitude Within 5 Miles of the Site

Catalog	Year	Mn Da Hr Mn Sec Universal Time	Lat N	Lon E	Depth (km)	Dist (mi)	Magnitude Size	Type	Donor
H80	1969	8 1 15:57	25.100	121.900	25	4.0	4.43	ML	H80
H80	1971	2 12 8:25	25.000	121.900	65	3.2	4.99	ML	ISC
IES	1975	4 26 6:23:26.30	25.022	121.935	20	1.9	1.84	ML	IES
IES	1975	8 26 17:34:15.90	24.982	121.941	150	4.5	3.36	ML	IES
IES	1976	8 24 22: 7:26.60	24.975	121.941	86	5.0	2.44	ML	IES
IES	1977	11 28 16:39:46.80	25.092	121.922	15	3.3	2.14	ML	IES
IES	1977	12 31 6:49: 4.20	25.046	121.898	74	1.1	2.39	ML	IES
IES	1978	1 5 8: 6: 8.20	25.046	121.944	95	1.8	2.18	ML	IES
IES	1978	1 16 0:20:28.70	24.980	121.894	70	4.6	2.32	ML	IES
IES	1978	3 19 18: 1: 1.80	25.035	121.899	94	1.2	2.58	ML	IES
IES	1978	4 2 18:28:35.60	25.052	121.844	91	4.5	2.34	ML	IES
IES	1978	8 8 12:36: 2.20	25.058	121.836	73	5.0	2.83	ML	IES
IES	1978	10 20 11:30: 8.50	24.975	121.932	103	4.8	2.21	ML	IES
IES	1978	12 27 6:47:33.40	25.030	121.846	112	4.4	2.42	ML	IES
TAI	1979	3 23 16:44:27.23	25.046	121.893	82	1.4	2.35	ML	TAI
TAI	1979	6 10 13:42:58.09	25.035	121.936	86	1.4	2.45	ML	TAI
TAI	1979	7 17 13: 8:20.33	25.020	121.897	80	2.0	2.45	ML	TAI
TAI	1979	9 23 11:16:32.35	24.982	121.913	90	4.2	2.65	ML	TAI
TAI	1979	11 18 13:47:19.14	24.981	121.913	108	4.3	2.45	ML	TAI
TAI	1980	2 17 20:49:18.96	25.083	121.864	82	4.2	2.05	ML	TAI
TAI	1980	4 2 15:30:15.06	25.079	121.959	111	3.6	2.25	ML	TAI
TAI	1980	5 8 4:29:19.08	24.981	121.896	84	4.5	2.15	ML	TAI
TAI	1980	5 8 8:19:43.36	24.982	121.958	100	5.0	2.25	ML	TAI
TAI	1980	7 10 0:13:47.53	25.038	121.977	128	3.9	3.25	ML	TAI
TAI	1980	8 15 13:53:32.61	25.034	121.842	102	4.6	2.55	ML	TAI
TAI	1980	10 23 14: 4:36.40	25.019	121.911	80	1.7	2.65	ML	TAI
TAI	1980	10 26 7:17:47.24	25.089	121.900	112	3.2	2.75	ML	TAI
TAI	1980	10 31 21:54: 8.94	25.059	121.909	115	1.1	2.45	ML	TAI
TAI	1981	4 5 18:20:50.14	25.004	121.879	37	3.6	2.35	ML	TAI
TAI	1981	4 27 2:10:49.60	25.021	121.891	61	2.2	2.35	ML	TAI
TAI	1981	7 14 7:57:36.46	24.972	121.927	91	5.0	3.05	ML	TAI
TAI	1981	9 14 16:13:45.42	24.996	121.894	91	3.5	2.65	ML	TAI
TAI	1982	1 22 23:49:58.97	25.010	121.965	119	3.9	2.75	ML	TAI
TAI	1982	5 3 10:11:19.87	25.025	121.881	73	2.5	2.45	ML	TAI
TAI	1983	1 26 21:54:52.41	25.000	121.950	50	3.7	2.45	ML	TAI
TAI	1983	7 26 20:51:53.78	25.071	121.849	113	4.5	2.95	ML	TAI
TAI	1983	11 10 4:11:51.82	24.994	121.912	103	3.4	2.85	ML	TAI
TAI	1984	1 26 16:56:53.49	25.087	121.980	54	5.0	2.65	ML	TAI
TAI	1984	3 2 10:43:38.02	25.096	121.953	66	4.3	2.75	ML	TAI
TAI	1984	5 3 1:12: 5.98	25.081	121.926	15	2.6	2.15	ML	TAI
TAI	1984	5 4 13: 2:55.29	25.001	121.867	80	4.2	2.35	ML	TAI
TAI	1984	5 16 12:26:23.10	25.026	121.940	4	2.0	2.65	ML	TAI
TAI	1984	8 10 0:24:31.11	25.048	121.920	15	0.4	2.45	ML	TAI
TAI	1984	8 27 23:32:36.63	25.030	121.855	21	3.9	2.35	ML	TAI
TAI	1984	11 3 19:24:23.91	25.002	121.922	100	2.9	2.55	ML	TAI

From : Bechtel Corporation, "Fourth Nuclear Power Plant,Reevaluation of PSAR,Section 2.5.2",February 1992

Table 2.5-7 (Continued) All Earthquakes of Any Magnitude Within 5 Miles of the Site

Catalog	Year	Mn	Da	Hr	Mn	Sec	Lat N	Lon E	Depth (km)	Dist (mi)	Magnitude Size	Type	Donor
		Universal Time											
TAI	1984	11	19		5:37:50.18		25.010	121.875	10	3.4	2.55	ML	TAI
TAI	1985	5	25		16:58: 4.75		25.069	121.928	111	1.9	2.85	ML	TAI
TAI	1985	10	14		21:17:22.11		25.017	121.931	76	2.1	2.15	ML	TAI
TAI	1986	1	21		6:13:25.79		25.004	121.858	110	4.5	2.95	ML	TAI
TAI	1986	2	21		14:41:37.63		25.006	121.891	49	3.0	2.55	ML	TAI
TAI	1986	3	2		20:28:21.25		25.020	121.908	118	1.7	3.98	ML	ISC
TAI	1986	5	27		12: 9:56.10		25.002	121.869	72	4.1	2.35	ML	TAI
TAI	1986	9	6		10:19:17.64		25.037	121.843	143	4.5	2.65	ML	TAI
TAI	1986	10	13		9:52:13.09		24.993	121.971	56	4.9	2.45	ML	TAI
TAI	1986	10	30		3:39:58.11		24.985	121.869	109	5.0	2.85	ML	TAI
TAI	1989	2	8	20:	4:	8.05	25.010	121.868	16	3.8	2.45	ML	TAI

Refer to *Catalog Notes* at the end of Table 2.5.2-4 for legend and explanation of catalog sources for time, location, and magnitude.

From : Bechtel Corporation, "Fourth Nuclear Power Plant,Reevaluation of PSAR,Section 2.5.2",February 1992

Table 2.5-8 Results of Determination of the Faults Age at Lungmen NPS Site (Carbon-14 Content)

Specimen number	#13515-B
Sampling position	River terrace on the Fangchiao Fault
Results of age determination	About 37,000 C-14 year B.P.
Explanation	Detecting carbonized organic material and carbon
Pre-process	Fragments of carbon were separated from grails, sedimentary soil and other foreign material, then carbonate and organic pollutant were washed out by hot diluted hydrochloric acid and sodium hydroxide in turn, after that, the remainder was washed clean and air-dried before burned into carbon dioxide for analysis.
Conclusions	Because the results show the C-14 activity is not clear, the age of the specimens may surpass the above mentioned age
Determination unit	KRUEGER ENTERPRISES, INC. GEOCHRON LABORATORIES DIVISION U.S.A.
Date of sending of specimens for testing	Aug. 8, 1970
Date of finishing	Sept. 4, 1970

Remarks:
1. Estimation of age was calculated from 1950, based on the Libby half life 5570 of C-14.
2. The activity of 95% N.B.S. oxalic acid was taken as modern standard.

Table 2.5-9 Comprehensive Table of Soil Sampling Category of Lungmen NPS

Sampling Position	Appearance Description of the Specimens	Triangular Coordinate Soil Categorization Methods	PH Value
N4-1	Yellowish, mixture of sand and soil	Sandy loam	4.6
N4-2	Earthy yellow, soft, with small stones	Sandy loam	4.8
N4-3	Blown-black, hard, with small stones	Sandy loam	7.0
N4-4	Yellow mixed with gray, hard, with stones of small and medium size	Sandy loam	5.5
N4-5	Yellow, soft, with high content of sand	Clayey loam	4.5
N4-6	Yellow, without stones	Sandy loam	4.2
N4-7	Yellow, hard, with many rock fragments	Muddy loam	4.9
N4-8	Earthy gray, hard, with rubble of different sizes	Sandy loam	3.9
N4-9	Earthy, soft, with few stones	Sandy loam	5.9
N4-10	Gray-black, dry, with many rock fragments	Sandy soil	8.2
N4-11	Earthy gray, hard, with rubble of different sizes	Sandy loam	7.5

Remarks: Please refer to Figure, 2.5-4 for sampling position.

Table 2.5-10 Table of Mechanical Test Analysis of Rock at Lungmen NPS Site

Mechanical properties of rock			
General exponential properties	Specific gravity (GS)	2.67~2.74	2.67~2.75
	Water content (ω)	1.4~2.3	1.4~2.0
	Density (rt) Ton/cub·m	2.46~2.55	2.43~2.6
	Dry density (rd) Ton/cub·m	2.41~2.51	2.38~2.58
	Pore ratio (e)	0.06~0.13	0.05~0.15
	Porosity (n) %	5.66~11.50	4.76~12.28
	Saturation (Sr) %	40.8~91.00	31.9~86.1
	Water absorptance (Ab) %	2.1~3.8	1.7~2.9
Straight shearing tests of clays between layers	Cohesive force (C) Kg/sq·cm	0.25~1.20	0.25~1.20
	Internal friction angle (ϕ)	1.90~22.5	1.90~22.5
Measurements of sound velocity	Dynamic Young's modulus (Ed) Kg/sq·cm	22E+4~25.3E+4	18E+4~37.8E+4
	Dynamic shear modulus (G) Kg/sq·cm	87E+3~98E+3	63.8E+3~153E+3
	Poisson's ration (ν)	0.231~0.286	0.234~0.409
	Lame's constant (λ) Kg/ sq·cm	77E+3~132E+3	87E+~290E+3
	Volumetric modulus (K) Kg/sq·cm	13E+3~197E+3	150E+3~358E+3
Uniaxial compression tests	Uniaxial compressive strength (qu) Kg/sq·cm	116.7~734.32	140.6~750.5
	Poisson's ratio (ν)	0.14~0.4	0.13~0.43
	Young's modulus (Es) Kg/sq·cm	7.3E+4~42.8E+4	5.4E+4~17E+4
Triaxial tests	Cohesive force (C) Kg/sq·cm	10~20	17~40
	Internal friction angle (ϕ)	54~64	35~66
Tensile tests	Indirect tensile strength (To) Kg/ sq·cm	14.4~89.2	11.0~65.8

Source of the Materials: PACIFIC ENGINEERING & CONSTRUCTION LTD.
"Report of Foundation Conditions for Yenliao Nuclear Units 1 & 2," Volume I, June 1983.

Table 2.5-11 Geologic Log of Drill Hole

臺 灣 電 力 公 司
TAIWAN POWER COMPANY

鑽 孔 地 質 柱 狀 剖 面 圖
GEOLOGIC LOG OF DRILL HOLE

工程項目 FEATURE _____ 計劃 PROJECT _____ 工程地點 STATE _____

鑽孔號碼 HOLE NO. F14 鑽孔地點 LOCATION _____ 座標 COORDINATES _____ 地面高程 GROUND ELEVATION 13.9m 鉛直角 ANGLE FROM VERTICAL 0°

開始日期 BEGUN 8,24,1980 完成日期 FINISHED 9,5,1980 岩盤覆蓋地層深度 DEPTH OF OVERBURDEN 2.35m 總 深 度 TOTAL DEPTH 30m 斜孔方向 BEARING OF ANGLE HOLE _____

地下水面深度或高程 DEPTH OR ELEV. OF WATER TABLE _____ 地質記錄者 HOLE LOGGED BY C. H. Chiao 鑽探工頭 FOREMAN _____

TYPE AND SIZE OF HOLE	CORE RECOVERY (%)	ELEVATION (m)	DEPTH (m)	PERCOLATION TEST OR STANDARD PENETRATION TEST	CASING OR SEALING METHOD	FLUSH WATER LOSSES (%)	GEOLOGIC LOG	PETROGRAPHICAL DESCRIPTION	JOINTING OR FRAGMENTATION	DEGREE OF WEATHERING	PERMEABILITY	DIPS OF JOINT OR BEDDING PLANE
HX			0					0-2.35m: TERRACE DEPOSIT. YELLOWISH BROWN, SANDSTONE COBBLES OR BOULDERS WITH SAND & CLAY MATRIX				
								2.35-3.20m: SANDSTONE, ARKOSIC; WEATHERED GRAYISH ORANGE; FRESH, LIGHT GRAY, FINE, STAINED	f_2	W_3		80°
			5					3.20-12.00m: SANDSTONE, LIGHT GRAY, INTERBEDDED WITH BLACK LAMINATED SILTSTONE. BROKEN AT (5.00-5.25m) (5.47-7.38m) + POLISHED ALONG BEDDING. BROKEN AT (9.21-10.23m) (11.50-12.00m) NO CORE RECOVERY AT (8.40-9.00m) SHEAR AT (4.45-5.00m) (5.25-5.47m) WITH SLIKENSIDE IN IT SHEAR ALONG BEDDING AT (7.38-7.50m) SHEAR AT (7.50-8.40m) (9.00-9.21m) (10.23-11.50m) + BEDDING ALONG CORE NEARLY VERTICAL	f_4 f_3 f_4 f_3	W_2 W_1		65° 50° 90°
NX			10					12.00-13.50m: SANDSTONE, MEDIUM GRAY CORE IS DISTINCTLY BROKEN, PARTLY WITH CLAY				
			15					13.50-16.50m: SHEAR ZONE WITH NEARLY VERTICAL ANGLE, LIGHT GRAY SANDSTONE FRAGMENTS MIXED WITH CLAY				
			20					16.50-21.30m: SANDSTONE, WHITE GRAY, CORE IS DISTINCTLY BROKEN + FRACTURED SHEAR AT (19.67-20.00m) (21.05-21.18m)				

EXPLANATION

- f_1 COMPLETE CORE OR CORE WITH LENGTH MORE THAN 20 cm
- f_2 CORE BROKEN INTO PIECES WITH SIZE RANGING FROM 5 cm TO 20 cm
- f_3 CORE BROKEN INTO PIECES WITH SIZE RANGING FROM 3 cm TO 5 cm
- f_4 CORE BROKEN INTO PIECES WITH LESS THAN 3 cm IN SIZE
- W_1 FRESH CORE
- W_2 SLIGHTLY WEATHERED, STAINED WITH LIMONITE MATERIAL OR SOME CONTAMINATIONS
- W_3 MODERATELY WEATHERED, CORE BECOMING FRIABLE OR EASILY CRUMBLED BY FINGERS
- W_4 HIGHLY WEATHERED, CORE DECOMPOSED OR ALTERED, SOFT, LOOSE AND FRIABLE

Source: Reference 2.5-5, Volume II

Table 2.5-11 Geologic Log of Drill Hole (Continued)

臺 灣 電 力 公 司
TAIWAN POWER COMPANY

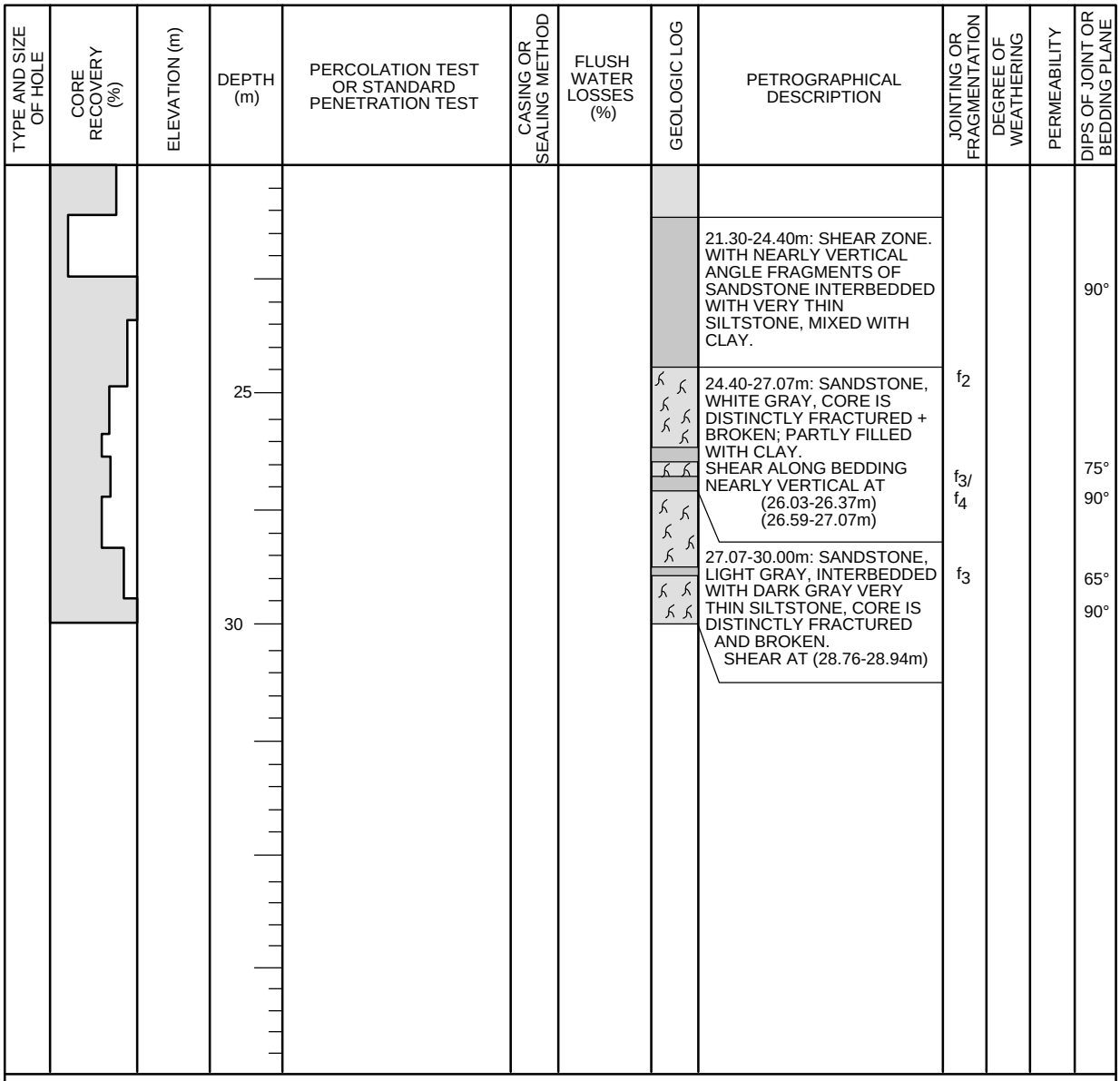
鑽 孔 地 質 柱 狀 剖 面 圖
GEOLOGIC LOG OF DRILL HOLE

FEATURE _____ PROJECT _____ STATE _____

HOLE NO. F14 LOCATION _____ COORDINATES _____ GROUND ELEVATION _____ ANGLE FROM VERTICAL _____

BEGUN _____ FINISHED _____ DEPTH OF OVERBURDEN _____ TOTAL DEPTH _____ BEARING OF ANGLE HOLE _____

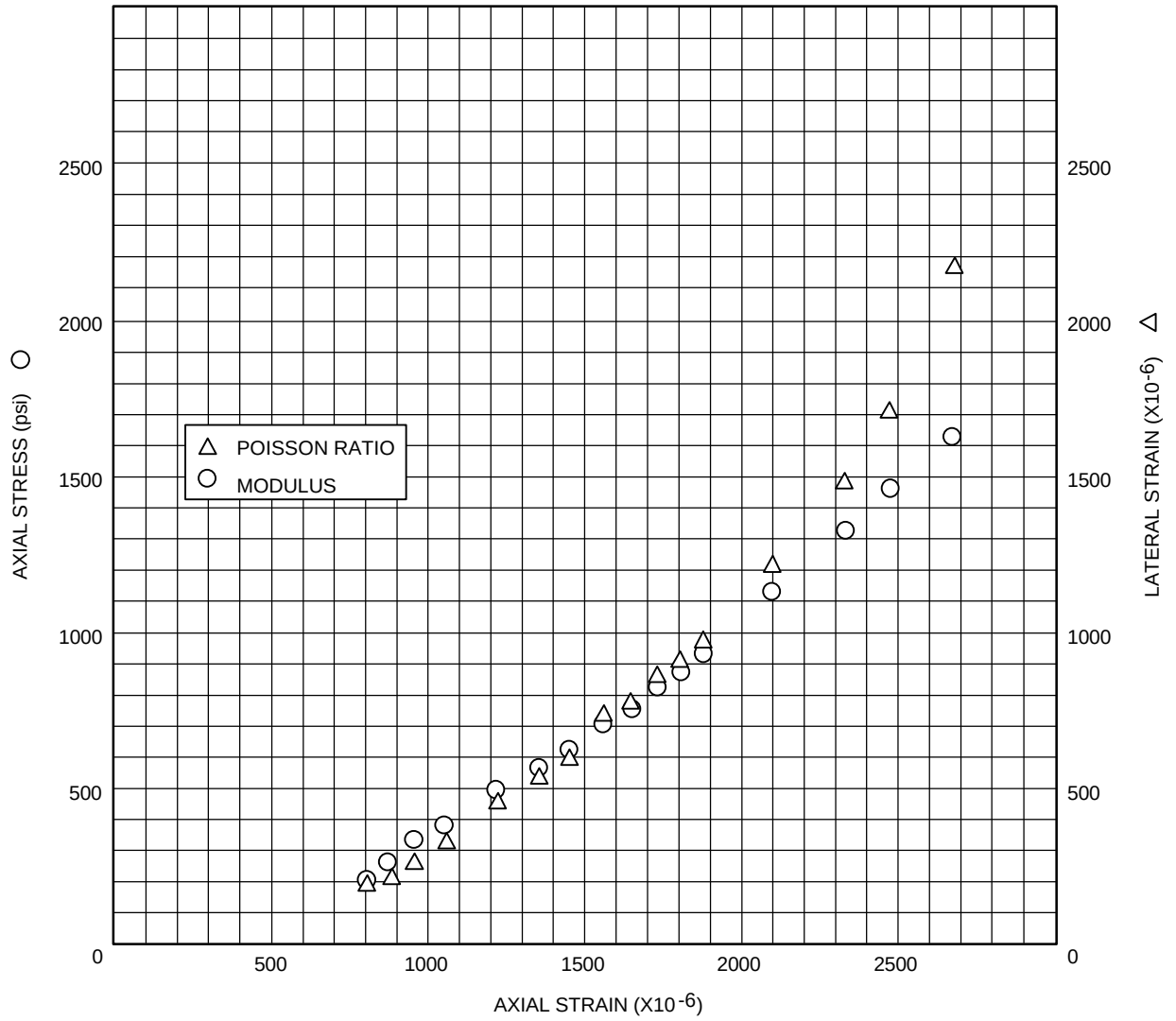
DEPTH OR ELEV. OF WATER TABLE _____ HOLE LOGGED BY _____ FOREMAN _____



EXPLANATION

- f_1 COMPLETE CORE OR CORE WITH LENGTH MORE THAN 20 cm
- f_2 CORE BROKEN INTO PIECES WITH SIZE RANGING FROM 5 cm TO 20 cm
- f_3 CORE BROKEN INTO PIECES WITH SIZE RANGING FROM 3 cm TO 5 cm
- f_4 CORE BROKEN INTO PIECES WITH LESS THAN 3 cm IN SIZE
- W_1 FRESH CORE
- W_2 SLIGHTLY WEATHERED, STAINED WITH LIMONITE MATERIAL OR SOME CONTAMINATIONS
- W_3 MODERATELY WEATHERED, CORE BECOMING FRIABLE OR EASILY CRUMBLED BY FINGERS
- W_4 HIGHLY WEATHERED, CORE DECOMPOSED OR ALTERED, SOFT, LOOSE AND FRIABLE

Table 2.5-12 Modulus of Elasticity and Poisson's Ratio at First Loading Cycle



Source: Reference 2.5-5, Volume II, Appendix B4, Hole #27.

Table 2.5-13 Preliminary Estimation of the Elastic Modulus (E) From the P-Wave Velocity (V_p)

The following approximate empirical formula for consolidated rock may be used:

$$E = V_p^{2.34} \times 10^{-3} \text{ PSI (after Brown and Robertshaw, 1953)}$$

The estimated elastic moduli corresponding to the velocities are tabulated as followers:

V_p (km/s)	E(10^6 PSI)	V_p (km/s)	E(10^6 PSI)
1.8	0.7	3.0	2.3
1.9	0.8	3.1	2.5
2.0	0.9	3.2	2.7
2.1	1.0	3.3	2.9
2.2	1.1	3.4	3.1
2.3	1.2	3.5	3.4
2.4	1.3	3.6	3.6
2.5	1.5	3.7	3.8
2.6	1.6	3.8	4.1
2.7	1.7	3.9	4.3
2.8	1.9	4.0	

Source: Report of Seismic Refraction Survey conducted at the Yenliao Site of Taiwan Power Company, by HCK Geophysical Company, for Taiwan Power Company, October 1980

Table 2.5-14 Petrographic Analysis of Thin Sections

Sample No.	Rock Name	% Quartz	% Matrix or cement	Other constituents (in decreasing abundance)	Texture
F2-1	Fe-rich lithic sandstone	70	0	Chert, hematite, schist fragments, muscovite, feldspar	Fine-grained, well sorted
F2-2	Fe-rich lithic sandstone	65	15 (hematite cement)	Chert, schist fragments, feldspar	Fine-grained, well sorted
F2-3	Siltstone	70	15 (microquartz + clay)	Calcite, muscovite	Silt size grains, weak grain orientation
F3-1	Lithic sandstone	80	0	Chert, schist fragments, feldspar	Fine to medium-grained, well sorted
F3-2	Clayey lithic sandstone	70	14 (microquartz + clay)	Schist fragments, calcite, feldspar	Fine-grained, weak grain orientation
F4-1	Clayey sandstone	40	50 (clay + microquartz + sericite)	Calcite, feldspar	Silt size grains
F5-1	Clayey sandstone	75	15 (clay + microquartz)	Calcite, feldspar	Very fine-grained, moderately sorted
F5-2	Silty shale	50	45 (clay + some microquartz)	Chert, muscovite, feldspar foram remnants	Silt size grains, weak grain orientation
F7-1	Silty shale	35	65 (clay + microquartz)	- - - - -	Silt size grains, slaty cleavage
F8-1	Fe-rich siltstone	35	55 (hematite + microquartz + sericite)	biotite, schist fragments	Silt size grains, moderately sorted
F13-5	Calcareous lithic sandstone	65	20 (calcite cement + clay + microquartz)	Schists fragments, feldspar	Very fine-grained, well sorted
FX-1	Fe-rich lithic sandstone	65	0	Chert, hematite, schist fragments, feldspar	Fine to medium-grained, moderately sorted
FX-2	Lithic sandstone	75	0	Hematite, chert, schist fragments, feldspar	Fine-grained, well sorted

Table 2.5-14 Petrographic Analysis of Thin Sections (Continued)

Sample No.	Rock Name	% Quartz	% Matrix or cement	Other constituents (in decreasing abundance)	Texture
FX-3-1	Clay shale	25	70 (clay)	Sericite, foram remnants?	Silt size grains, slaty cleavage
FX-3-2	Fe-rich graywacke	25	28 (microquartz + some chlorite)	Siderite ($FeCO_3$) (47), relic pyroxene altering to actinolite?	Fine to coarse-grained, poorly sorted
FX-3-3	Clayey lithic sandstone	70	20 (microquartz + clay = calcite)	Chert, schist fragments, feldspar	Fine to medium-grained, poorly sorted
FX-4	Fe-rich sandstone	65	20 (hematite cement)	Chert, feldspar, schist fragments	Fine to medium-grained, well sorted
FX-5	Clay shale	10	65 (clay)	Sericie, magnetite, diaton and foram? remnants	Silt size grains, slaty cleavage
FX-6	Fe-rich lithic sandstone	60	15 (hematite cement)	Chert, schists fragments, feldspar	Fine-grained, moderately sorted
FX-7	Lithic sandstone	75	0	Schist fragments, chert, feldspar	Fine-grained, well sorted, weak grain orientation
FX-8	Lithic sandstone	75	0	Chert, schist fragments, feldspar	Fine-grained, well sorted
F8-2	Siliceous sandstone	65	25 (microquartz + calcite cement with some clay)	Muscovite, biotite, feldspar	Very fine to fine-grained, moderately sorted, weak grain orientation
F8-3	Clayey sandstone	70	20 (microquartz + clay)	Calcite, schists fragments, feldspar	Fine-grained, poorly sorted
F8-4	Clayey sandstone	70	25 (microquartz + clay + calcite)	Schist fragments, feldspar	Fine to medium-grained, well sorted
F9-1	Lithic sandstone	65	0	Chert, schist fragments, hematite, feldspar	Medium-grained, well sorted
F10-1	Sandstone	85	5 (microquartz)	Schists fragments, chert, feldspar	Fine-grained, well sorted

Table 2.5-14 Petrographic Analysis of Thin Sections (Continued)

Sample No.	Rock Name	% Quartz	% Matrix or cement	Other constituents (in decreasing abundance)	Texture
F10-2	Clayey lithic sandstone	73	15 (clay + microquartz)	Schist fragments, chert, feldspar	Fine -grained, moderately sorted
F11-2	Sandstone	78	7 (microquartz)	Schist fragments, clay, feldspar, chert	Fine-grained, well sorted
F13-1	Sandstone	76	15 (microquartz with some hematite)	Schist fragments, feldspar	Fine to medium-grained, moderately sorted
F13-2	Siliceous sandstone	70	15 (microquartz cement)	Schist fragments, clay, chert, feldspar	Fine-grained, moderately sorted
F13-3	Calcareous lithic sandstone	55	25 (calcite cement)	Chert, schist fragments, feldspar	Fine-grained, well sorted
F13-4	Clay shale	20	80 (clay)	- - - - -	Silt size grains, slaty cleavage
FX-9	Clayey sandstone	45	40 (clay + microquartz)	Muscovite, biotite, feldspar	Very fine-grained, moderately sorted, weak grain orientation
FX-10	Clayey Siltstone	40	48 (clay + microquartz)	Calcite, chert, muscovite, feldspar	Silt size grains, moderately sorted
FX-11	Clay shale	35	60 (clay)	Sericite	Silt size grains, slaty cleavage
17-1	Clayey lithic sandstone	65	20 (clay + microquartz)	Chert, calcite, magnetite, schist fragments	Very fine-grained, moderately sorted
17-2	Clayey sandstone	40	50 (clay + microquartz)	Calcite	Very fine-grained, moderately sorted
18-1	Quartzite	73	16 (microquart cement + some clay)	Calcite, schist fragments	Fine-grained, moderately sorted

Source: Reference #2.5.4-2, Volume I

Table 2.5-15 Summary of Groundwater Chemical Analysis
Yenliao Site

DRILL HOLE NO: 16
LABORATORY: POWER RESOURCES SURVEY TEAM LABORATORY REPORT NO: _____
RECEIVED DATE: MAY 1980 COMPLETION DATE: JUNE 1980

DEPTH	10m		20m		30m		40m		50m		60m	
TEST TYPE	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**
1. Carbonate (ppm as $CaCO_3$)	11	32	18	32	18	32	11	38	19	38	14	18
2. Bicarbonate (ppm as $CaCO_3$)	465	472	461	468	461	462	460	476	458	462	465	
3. Total Hardness (ppm as $CaCO_3$)	19	21	18	20	19	20	19	22	20	21	19	19
4. Calcium (ppm as $CaCO_3$)	4	4	3	4	3	4	4	6	4	4	4	4
5. Magnesium (ppm as $CaCO_3$)	15	17	14	17	16	16	13	18	16	17	15	15
6. Chloride (ppm as C1)	29.9	31	29.9	30	29.2	30	29.9	30	29.9	30	30	30.9
7. Free Chlorine (ppm as ($C1_2$)	–	–	–	–	–	–	–	–	–	–	–	–
8. Free Carbon Dioxide (ppm as CO_2)	–	–	–	–	–	–	–	–	–	–	–	–
9. K_2 Cr_2 0_7 Consumed (ppm as 0_2)	–	–	–	–	–	–	–	–	–	–	–	–
10. Mineral Acid (ppm as $CaCO_3$)	–	–	–	–	–	–	–	–	–	–	–	–
11. Turbidity (F.T.U.)	–	–	–	–	–	–	–	–	–	–	–	–
12. pH	8.47	8.57	8.48	8.58	8.49	8.52	8.53	8.67	8.49	8.60	8.47	8.55
13. Conductivity (umhos/cm)	1050	1050	1050	1070	1050	1070	1050	1070	1050	1050	1050	1070
14. Sulfate (ppm as SO_4)	36	45	35	45	36	45	35	43	36	43	35	43
15. Silica (ppm as SiO_2)	11.7	11.8	11.5	13.0	11.6	12.9	11.8	12.0	11.7	11.7	11.13	11.7
16. Total Iron (ppm as Fe)	0.02	0.03	0.14	0.26	0.07	0.14	0.18	0.18	0.25	0.46	0.14	0.16
17. Total solids (ppm)	756	763	668	762	646	015	648	734	688	688	700	731
18. Coliform Test	–	–	–	–	–	–	–	–	–	–	–	–
19. Temperature (Centigrade)	26.6	26.7	26.7	26.8	26.8	26.9	27.0	27.1	27.1	27.2	27.3	27.3

Source: Reference 2.5.4-2, Volume I

Table 2.5-16 Strain-Dependent Shear Modulus Reduction Factors

Effective Shear Strain γ_{eff} (%)	$\log_{10}(\gamma_{eff})$	Shear Modulus Reduction Factor (G/Gmax)	
		In-Situ Rock and Weathered Rock	Crushed Rock Backfill
1.00E-03	-4.0	1.00	1.00
3.16E-03	-3.5	1.00	0.96
1.00E-02	-3.0	0.99	0.86
3.16E-02	-2.5	0.95	0.71
1.00E-01	-2.0	0.90	0.52
3.16E-01	-1.5	0.81	0.35
1.00E-00	-1.0	0.73	0.22
3.16E-00	-0.5	0.64	0.11
1.00E+01	0.0	0.55	0.05

* Strain-compatible damping value shall be limited to 15% for horizontal motion and to 10% for vertical motion.

Table 2.5-17 Strain-Dependent Damping Ratio Values

Effective Shear Strain γ_{eff} (%)	$\log_{10}(\gamma_{eff})$	Damping Ratio (β) Percent (%)*	
		In-Situ Rock and Weathered Rock	Crushed Rock Backfill
1.00E-03	-4.0	0.40	0.50
3.16E-03	-3.5	0.60	0.85
1.00E-02	-3.0	0.80	1.60
3.16E-02	-2.5	1.15	2.80
1.00E-01	-2.0	1.50	4.30
3.16E-01	-1.5	2.25	7.60
1.00E-00	-1.0	3.00	12.70
3.16E-00	-0.5	3.80	18.30
1.00E+01	0.0	4.60	23.00

* Strain-compatible damping value shall be limited to 15% for horizontal motion and to 10% for vertical motion.